AKD™

User Guide

Edition: Revision B, December 2010

Valid for Hardware Revision A

Part Number: 903-200006-00

Patents Pending

Original Instructions

Keep all manuals as a product component
during the life span of the product.
Pass all manuals to future users/owners
of the product.

Record of Document Revisions:

Revision	Remarks
6/2010	Combined User Guide and Parameter and Command Reference Guide (released in WorkBench only).
9/2010, Rev-	Combined User Guide, CANopen, and EtherCAT manuals. Updated for Release 1.3.
11/2010, Rev. A	Usability improvements, minor topic edits.
12/2010, Rev. B	User Guide part number updated.

Hardware Revision (HR)

Hardware Revision	Usable Firmware	Usable Workbench	Remarks
A	M_01-03-00-zzz	1.0.3.zzz	

EnDat is a registered trademark of Dr. Johannes Heidenhain GmbH
EtherCAT is a registered trademark of EtherCAT Technology Group
HIPERFACE is a registered trademark of Max Stegmann GmbH
WINDOWS is a registered trademark of Microsoft Corporation
AKD is a registered trademark of Kollmorgen Corporation

Current patents:

US Patent 5,646,496 (used in control card R/D and 1 Vp-p feedback interface)

US Patent 5,162,798 (used in control card R/D)

US Patent 6,118,241 (used in control card simple dynamic braking)

Technical changes which improve the performance of the device may be made without prior notice.

Printed in the United States of America

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1 About this User Guide

This guide describes the operation and use of the AKD drive. Each section details a specific topic related to the use of the product in basic terms which will help you get the most from the product. Each section include examples to help guide you in setting up and use the various features available in the drive.

This guide is for users who have installed and tested the drive according to the *AKD Installation Manual*. The *AKD Installation Manual* is included on the product CD and contains critical safety information.

1.1 About this User Guide

This guide describes the operation and use of the AKD drive. Each section details a specific topic related to the use of the product in basic terms which will help you get the most from the product. Each section include examples to help guide you in setting up and use the various features available in the drive.

This guide is for users who have installed and tested the drive according to the *AKD Installation Manual*. The *AKD Installation Manual* is included on the product CD and contains critical safety information.

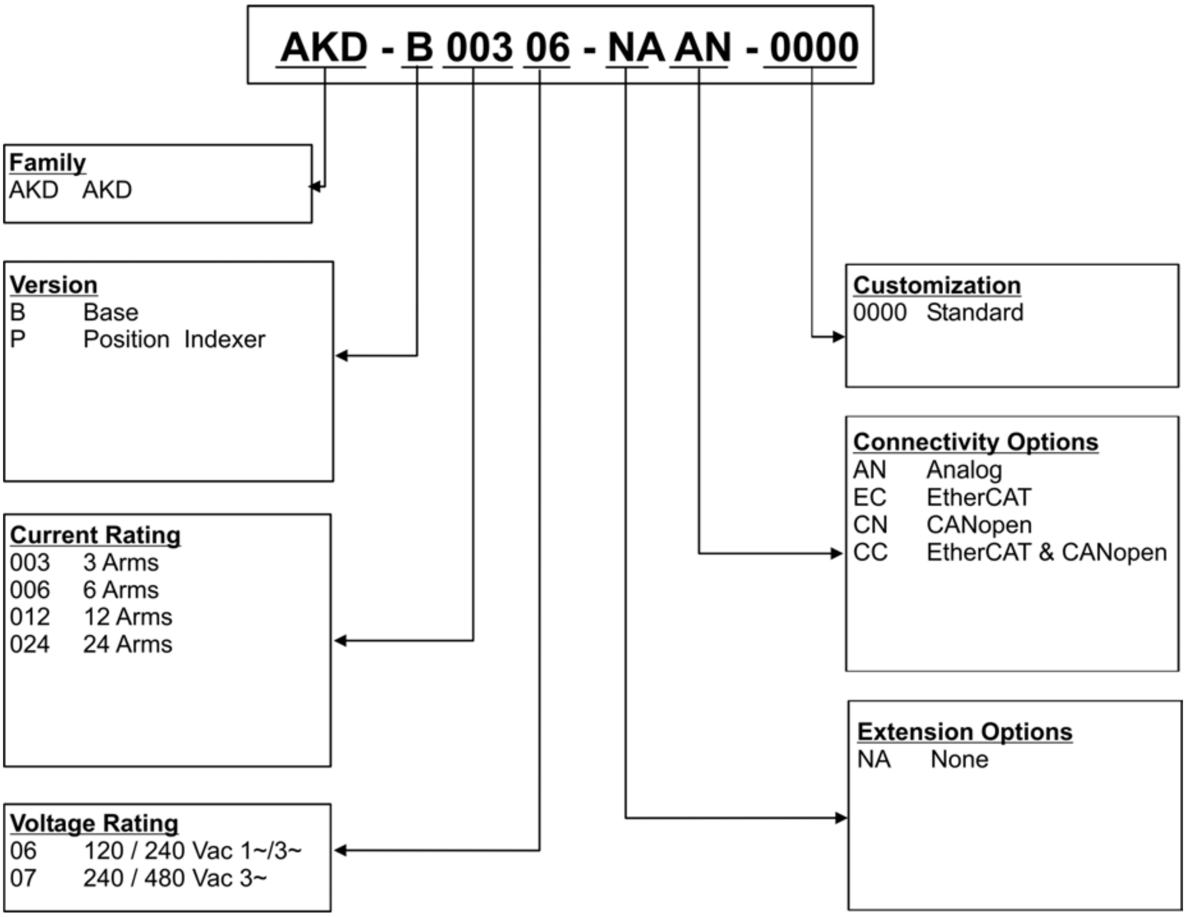
1.2 Abbreviations

Abbreviation	Meaning
AGND	Analog ground
CE	Communité Européenne
COM	Serial interface for a personal computer
DCOMx	Communication line for digital inputs (with x=7 or 8)
Disk	Magnetic storage (diskette, hard disk)
EEPROM	Electrically erasable programmable memory
EMC	Electromagnetic compatibility
F-SMA	Fiber optic cable connector according to IEC 60874-2
LED	Light-emitting diode
LSB	Low significant byte (or bit)
MSB	Main significant byte (or bit)
NI	Zero pulse
PC	Personal computer
PE	Protective earth
PLC	Programmable logic control
PLL	Phase locked loop
PLS	Programmable limit switch
PWM	Pulse-width modulation
RAM	Random access memory (volatile memory)
R_{Brake}/R_B	Brake resistor (also called a regen resistor)
RBext	External brake resistor
RBint	Internal brake resistor
RCD	Residual current device
RES	Resolver
ROD	Incremental encoder (A quad B)
S1	Continuous operation
STO	Safe torque off
Vac	Volts, alternating current
Vdc	Volts, direct current

2 AKD Models

AKD drive models are available in a variety of combinations of features. The part number identifies the features included in your model.

The figure below shows part number identification for drive features:



The customization code includes language version of printed material for European countries:

- D000 for German
- E000 for English
- F000 for French
- I000 for Italian

2.1 CC Drive Models

CC drive models allow you to select between EtherCAT, CANopen, or analog operation. This drive model is identified with a new model number of the form AKD-Pxxxxx-NACC-0000 (the CC is the unique identifier).

The CC drive model is fitted with both the EtherCAT (X5 and X6) and CANopen (X12 and X13) fieldbus connectors and a new software parameter (DRV.TYPE) allows you to select which features the drive supports; you cannot use EtherCAT and CANopen at the same time.

3 Basic Drive Setup

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3.1 Basic Drive Setup

The AKD Quick Start Guide provides details for basic drive setup. Basic drive setup consists of the following general steps:

Hardware Installation:

1. Install the drive in on your conductive panel and connect the Protective Earth ground.
2. Connect the logic power you will need to operate all of the control logic to X1.
3. Connect the motor power to X2.
4. Connect the feedback to X10.
5. Connect the inputs and outputs you will be using on X7 and X8.
6. Bring AC power to the unit and connect AC power to X3 or X4.
7. Connect drive communications to X11.
8. Confirm that you can communicate with the drive and that your PC is linked to the AKD.

Software Installation and Drive Communication Setup:

1. Install and start the interface software (WorkBench).
2. Set the drive IP address using the S1 and S2 switches.
3. Configure the drive using the **Setup Wizard**.

WorkBench System Requirements

Required Components: Microsoft .NET Framework 2.0

Supported Operating Systems:

- Windows XP
- Windows Vista
- Windows 7

3.2 Display Codes

During drive operation, the drive display shows the following codes, depending on the drive status.

Display Code	Status
o0	Normal operation, current mode, no faults
o1	Normal operation, velocity mode, no faults
o2	Normal operation, position mode, no faults
F [3 digit code, flashing]	Fault (see Fault and Warning Messages)
n [3 digit code, flashing]	Warning (see Fault and Warning Messages)
I,P [IP address]	Displaying drive IP address
[.]	Drive enabled
[.] (flashing)	Drive in an internal dynamic brake mode (DRV.ACTIVE = 3).
d2	Firmware download: corrupted operational FPGA; resident FPGA is functional.
d3	Firmware download: HW download (HW switch was pressed - Rev 3 and higher).
d4	Firmware download: Corrupted operational FW.
d5	Firmware download: SW download (download command was issued from the operational FW).
dL	Loading image process is running.
dF (flashing)	Failure during firmware download.
Sb	Special mode: Burn-in

3.3 AKD Setup Wizard

The Setup Wizard contains step by step instructions for configuring a drive for the first time and generating a simple test motion. You can access the Setup Wizard from the AKD Overview screen or by right clicking on the drive name.

The Setup Wizard is useful when you first set up your system. The wizard confirms your connection with the drive and then leads you through a series of steps to quickly get your drive up and running. With plug and play feedback devices, several steps are skipped (feedback, brake) because the drive automatically configures these settings. For all systems, you can select the units you want to use, configure your operation mode, tune the system, and perform some simple jog moves within the wizard. After you are comfortable with the basic system setup, you can save your settings to the drive and exit the wizard.

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4 Connecting the Drive

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4.1 Connected and Disconnected States

WorkBench always starts disconnected from any drives. The **Disconnected** view opens when you start WorkBench and offers two choices:

- **Connect**: Opens the **Connect to a Drive** view.
- **Delete**: Opens a list of available drives and allows you to delete a drive from WorkBench.

While WorkBench is trying to establish communications with the drive, WorkBench is in the connecting state. Normally, WorkBench will be in the connecting state for a few moments before the connection is established. If WorkBench cannot establish communications correctly, then a five second timeout occurs and WorkBench returns to the disconnected state.

4.2 Disconnected

When WorkBench is disconnected from a drive, no communication exists between your PC and the drive.

The drive becomes disconnected because of one of the following conditions:

- When WorkBench starts it remembers which drives you were using previously but it does not initially connect to these drives.
- If WorkBench detects that it can no longer communicate with the drive, it will automatically go to this disconnected state. Common causes include a network cable being disconnected or the drive being turned off.
- You pressed the disconnect command.

To restore communication:

1. Clicking Connect will start communication with the drive. If WorkBench cannot find the drive, it will immediately return to the disconnected state.
2. Pressing select will show a window where you can select a different drive you would like to use.
3. Pressing delete will remove this drive from the navigation tree on the left hand side of the main window.

4.3 Device Not Shown

If your specific drive is not shown in the list, then WorkBench has not been able to find the drive.

Common reasons why your drive is not shown in the list include the following:

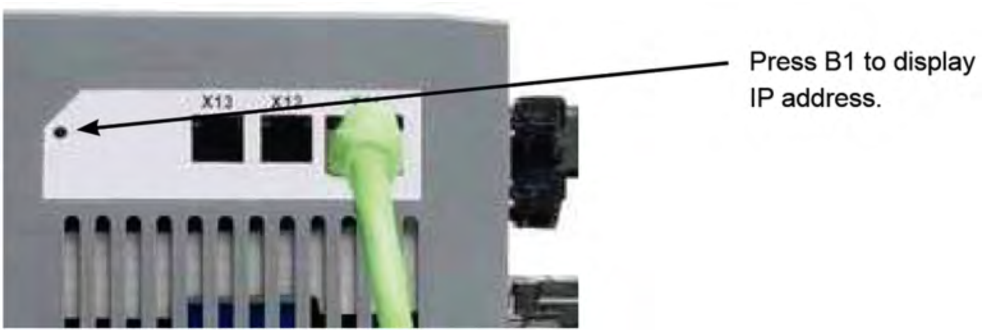
- The drive is not powered on.
- One of the network cables between your PC and the drive are not connected correctly. You can check if the cable is connected to the drive by checking that the link LED on the Ethernet connector is on continuously. If your PC has a link LED, then you should check that this LED is also continuously lit (usually, this LED is next the RJ45 socket on your PC).
- A router on the network between your PC and the drive is blocking the drive discovery messages. Make sure that port 5002 is not blocked by any routers or firewalls. You can enter the IP address of your drive directly into WorkBench if a router or firewall is blocking port 5002. Often, firewalls are the cause of a blocked connection.
- Your PC and the drive are on different subnets. Networks, especially those with many devices on them, are split up into multiple subnets. The discovery protocol used to find drives will only work if your PC and the drive are both on the same subnet .You can enter the IP address of the drive directly into WorkBench if this is the case.
- The network mask defines more than 512 possible addresses. In this case, WorkBench will not ping all of these addresses, so you must unblock discover ports or specify directly the IP address of your drive.

When an adapter has such a network mask, its background will be shown as yellow to warn that this network will not be discovered with all discover protocols.

4.4 Find and Enter IP Address

You can view the drive IP address on the drive display by pressing the button shown below. The display shows the digits of the IP address in sequence, with dots separating the numbers. You should see four numbers separated by three dots, for example, 192.168.1.5.

You can enter the IP address if you press **More** and check the **Specify Address** box.



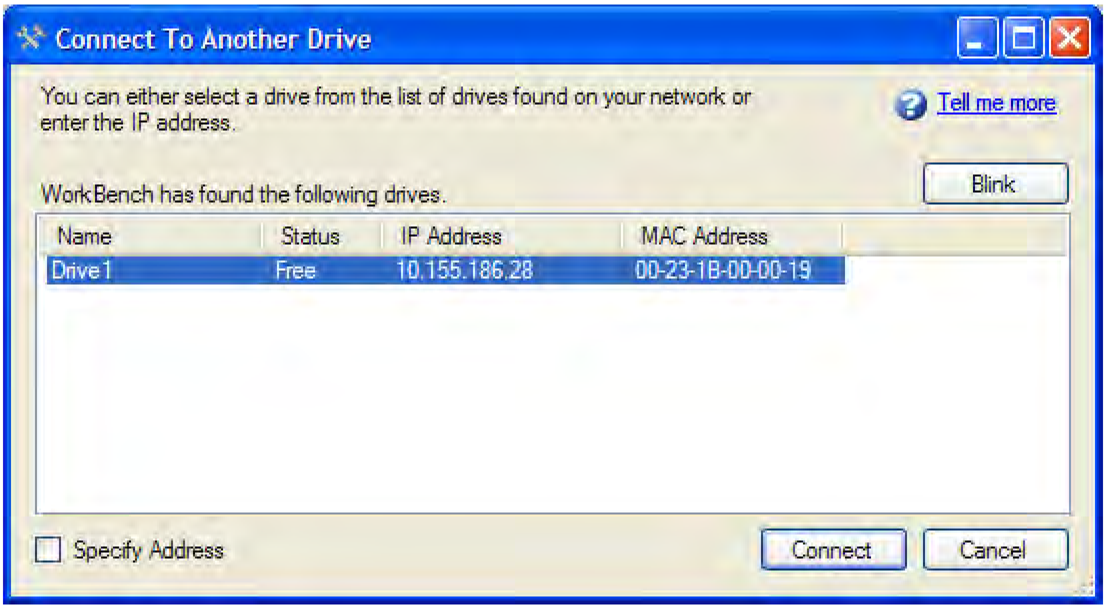
4.5 Check Communications

If you have more than one drive connected to your network, then you can confirm that the new drive is connected to the correct network as follows:

1. A two-digit, seven-segment LED display is located on the front of the drive near the top. If you can see the display, then press the **Blink Display** button on the drive and drive will flash the seven-segment display on and off.
2. If it is difficult to see the display, then you can check the MAC address in the WorkBench list against the MAC address on the label of the drive. The drive is connected if the numbers displayed in WorkBench match the numbers printed on the label on the side of the drive.

4.6 Connect To Another Drive

This window allows you to change the drive that you are using.



Button or Dialog Box	Description
Name	Displays the drive name. By default the name is "No_Name". You can change the name by connecting to the drive and navigating to the top item in the navigation tree.
Status	Only one user at a time can connect to a drive. If someone else is connected to the drive, it is **Busy**. If **Free** is displayed, then you can connect.
Blink	Clicking **Blink** forces the display on the selected drive to alternate between the whole display being on and the whole display being off for 20 seconds.
MAC Address	Displays the MAC address of the drive. The MAC address is unique and is also printed on the label on the side of the drive.
IP Address	Displays the IP address of the drive. You can enter a raw IP address (1.2.3.4) or a DNS name. You can optionally specify an alternate port number to the default (port 23) by appending it (e.g. 1.2.3.4:1000).
Specify Address	If your drive does not appear in the list, you can enter its IP address (e.g. 1.2.3.4) or a DNS name. You can optionally specify an alternate port number to the default port 23) by appending it (e.g. 1.2.3.4:1000).

5 Communicating with the Drive

5.1 Check Communications 39

5.0.1 Overview

In order to use the drive, you must be able to communicate with the drive using WorkBench and an Ethernet connection. With some basic network knowledge, you can quickly establish communication with your drive. The drive uses TCP/IP (a worldwide standard for high-speed communication); both the AKD and your PC need to understand each other through this standard in order to communicate. This section explains how to establish a TCP/IP link between your PC and a drive.

5.0.2 Identifying the Drive IP Address

The first step in establishing communication with the drive is to identify the drive IP address. WorkBench and the drive find each other using this IP address, which tells your PC where to look for the drive in order to make the communication connection. You can establish communication through the IP address with two types of connections:

- **Automatic:** Allow the drive and PC to link automatically.
- **Direct:** Connect to a drive directly based on a known IP address.

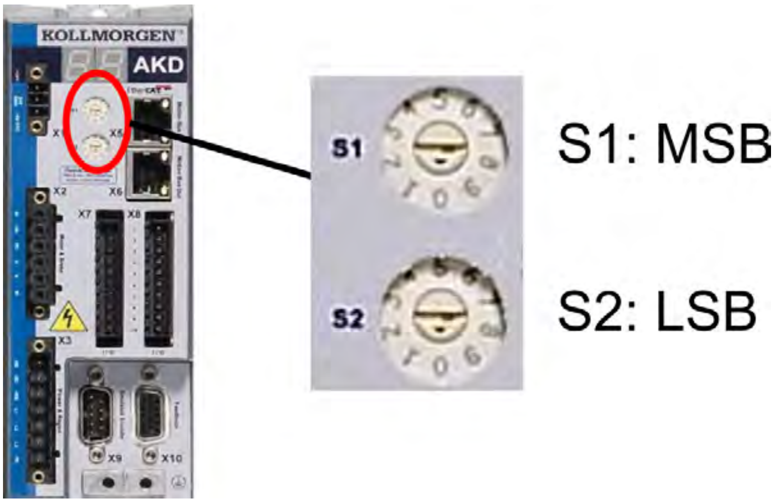
5.0.2.1 Automatic (Dynamic) IP Addressing

Automatic (also called “dynamic”) addressing is performed using the Dynamic Host Configuration Protocol (DHCP). This protocol makes it easy for a device to attach to a network. The drive is set in automatic IP mode by setting the two rotary switches to zero (S1 and S2, located on the front of the drive). Your PC is set in automatic mode by configuring the TCP/IP screen to "Obtain an IP address automatically"

When first communicating with the drive, conflicts might exist with other programs or devices connected to your computer that are competing for IP addresses. If you have a problem recognizing a drive, then try turning off other devices (especially a wireless device or remote network connection). If you still have problems connecting with the drive, check in the troubleshooting area of this manual.

5.0.2.2 Static IP Addressing

Another option in connecting to the drive is via a static IP connection. In this case you are assigning a specific IP address to the drive and you are modifying your pc network configuration to be able to recognize the static address. The drive IP address can be set using the two rotary switches on the front of the drive.



The address will then be set as 192.168.0.S1S2, with S1 representing the 10’s digit and S2 the 1’s digit. As you turn the switches, the drive displays the S1 and S2 values.

Example:

S1 is set to 3, S2 is set to 5, the address now is set to: 192.168.0.35.

In order for the drive to connect to the PC, the PC network configuration must find this address. First, identify which network port you are using to communicate with the drive. Once you have identified the port, you can access the properties area of the network connection (on your PC) and set up the proper masking to allow the two devices to communicate. The configuration is set up in the “Use the following IP address:”.Set the IP address to 192.168.0.100 and the Subnet mask to 255.255.255.0. This allows the two devices to recognize each other and connect point to point (note that S1 = 0 and S2 = 0 is automatic (dynamic) IP adressing).

5.1 Check Communications

If you have more than one drive connected to your network, then you can confirm that the new drive is connected to the correct network as follows:

1. A two-digit, seven-segment LED display is located on the front of the drive near the top. If you can see the display, then press the **Blink Display** button on the drive and drive will flash the seven-segment display on and off.
2. If it is difficult to see the display, then you can check the MAC address in the WorkBench list against the MAC address on the label of the drive. The drive is connected if the numbers displayed in WorkBench match the numbers printed on the label on the side of the drive.

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5.2 Troubleshooting Connection and Communication Problems

5.2.1 No Drives are Shown

If no drives are shown in the list, then WorkBench has not found any drives.

Common reasons why drives may not appear in the list include the following:

- The drive is not powered on.
- One of the network cables between your PC and the drive is not connected correctly. If the cable is connected correctly, then the LINK LED on the Ethernet connector is lit continuously. If your PC has a LINK LED you should check that this is also continuously lit (normally this LED is next the RJ45 socket on your PC).
- A router on the network between your PC and the drive is blocking the drive discovery messages. You can enter the IP address directly into WorkBench if this is the case (to find the drive IP address, see 5.2.2 Device Not Shown.

5.2.2 Device Not Shown

If your specific drive is not shown in the list, then WorkBench has not been able to find the drive.

Common reasons why your drive is not shown in the list include the following:

- The drive is not powered on.
- One of the network cables between your PC and the drive are not connected correctly. You can check if the cable is connected to the drive by checking that the link LED on the Ethernet connector is on continuously. If your PC has a link LED, then you should check that this LED is also continuously lit (usually, this LED is next the RJ45 socket on your PC).
- A router on the network between your PC and the drive is blocking the drive discovery messages. Make sure that port 5002 is not blocked by any routers or firewalls. You can enter the IP address of your drive directly into WorkBench if a router or firewall is blocking port 5002. Often, firewalls are the cause of a blocked connection.
- Your PC and the drive are on different subnets. Networks, especially those with many devices on them, are split up into multiple subnets. The discovery protocol used to find drives will only work if your PC and the drive are both on the same subnet .You can enter the IP address of the drive directly into WorkBench if this is the case.
- The network mask defines more than 512 possible addresses. In this case, WorkBench will not ping all of these addresses, so you must unblock discover ports or specify directly the IP address of your drive. When an adapter has such a network mask, its background will be shown as yellow to warn that this network will not be discovered with all discover protocols.

5.2.3 Find and Enter IP Address

You can view the drive IP address on the drive display by pressing the button shown below. The display shows the digits of the IP address in sequence, with dots separating the numbers. You should see four numbers separated by three dots, for example, 192.168.1.5.

You can enter the IP address if you press **More** and check the **Specify Address** box.


Press B1 to display
IP address.

5.3 TCP/IP Communication Protocols

5.4 IP Address

The IP address of a drive uniquely defines the drive on the network. Ethernet requires that every device on a network segment must have a unique IP address.

5.4.1 Port Number

The AKD drive supports the following protocols using the following port numbers:

TCP: Port 23. Telnet for normal communications with the drive.

Port 502. Modbus TCP.

UDP: Ports 5002 and 5003. These ports are used to discover AKD drives on the local subnet.

5.4.2 MAC Address

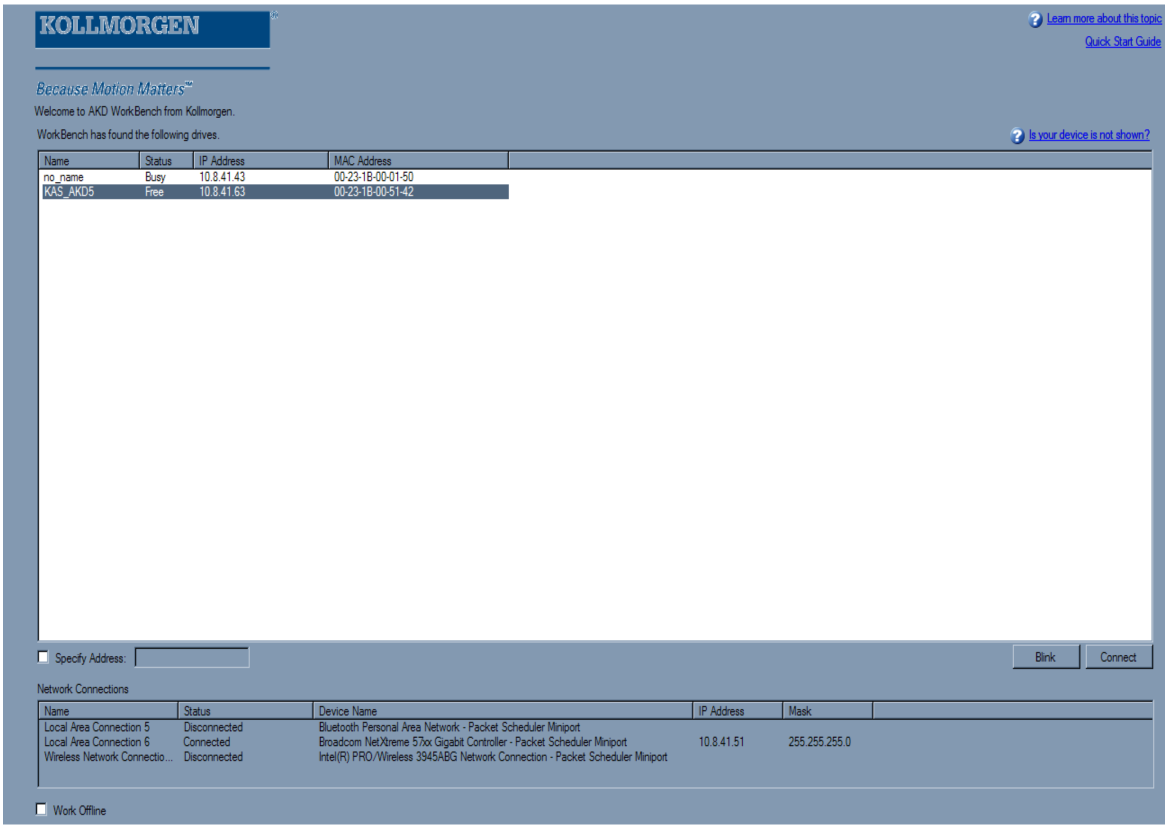
Ethernet also requires that every device must have a globally unique identifier called the MAC address. The MAC address is a 48 bit number normally shown as a series of six hexadecimal numbers (for example, 00:AA:11:BB:22:CC).

Every AKD drive is given a unique MAC address when it is manufactured and this MAC address cannot be changed. The MAC address of every drive is printed on the sticker on the side of the drive.

6 Using WorkBench

6.1 Welcome Screen

This view lets you select which AKD drive you wish to work with. You can work with a physical drive via the Ethernet port of your PC (online) or with a drive simulation (offline).



6.1.1 Online

Select **Online** to display a list of the AKD drives that WorkBench has found on your local network. You can select one of these drives from the list and click **Next** to continue. This will connect you to the drive and you will be given the option to use a wizard to setup the drive.

Button or Dialog Box	Description
Name	The name that someone has given the drive. By default, the name is "No_Name". You can change the name by connecting to the drive and navigating to the top item in the navigation tree.
Status	Only one user can connect to an AKD at a time. If someone else is connected to the drive, then the status is **Busy**. If no one is connected to the drive, then the status is **Free** and you will be able to connect.
Blink	Clicking **Blink** will force the display on the selected drive to to repeatedly flash the display LEDs.
MAC Address	This is the MAC address of the drive. The MAC address is unique and is also printed on the label on the side of the drive.
IP Address	This is the IP address of the drive.

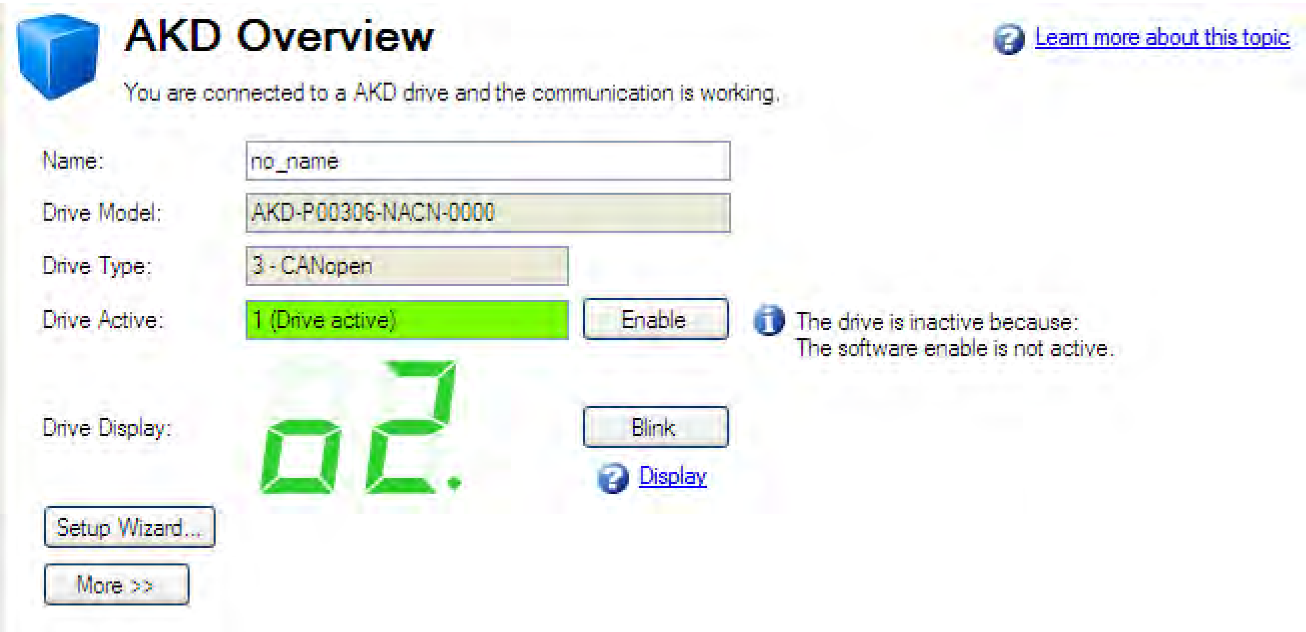
Button or Dialog Box	Description
Specify Address	If your drive does not appear in the list, you can enter its IP address (e.g. 1.2.3.4) or a DNS name. You can optionally specify a different port number than the default port 23) by appending it (for example, 1.2.3.4:1000 would be port 1,000).

6.1.2 Offline

Select **Offline**to display a list of the different models that WorkBench can simulate. Once you have made your selection, click **Next** and the **Overview** screen for the Offline drive opens.

6.2 AKD Overview

Once your drive is connected, the **AKD Overview** shows a summary of the drive that you are using.



You can view or edit the following information from the Overview window.

Button or Dialog Box	Description	Parameter
Name	Names each drive in use with a unique identifier.	DRV.NAME
Drive Model	Displays the model number of this drive. The model number is also on the label on the side of the drive. If you are offline, then you can change the type of drive that you are simulating.	DRV.INFO
Drive Type	Selects the operational fieldbus for your drive.	DRV.TYPE
Drive Active	The drive is active when it is enabled and also supplies voltage to the motor.	DRV.ACTIVE
Enable	Click **Enable** to turn on the power stage in the drive and apply voltage to the motor. This command may fail for many reasons; see "DRV.EN" (=> p. 363) for further details.	DRV.EN
Disable	Click Disable to turn off the power stage and remove the voltage applied to the motor.	DRV.DIS

Button or Dialog Box	Description	Parameter
Drive Display	This graphic replicates the two-digit seven-segment display located on the front face of the drive. The seven-segment display shows a code that indicates the state of the drive and any faults that may be present. WorkBench shows a copy of what the drive display currently shows. A key to the display is here.	
Blink	Click Blink to force the display to alternate between the whole display being on and the whole display being off for 20 seconds. You can use this button to confirm that you are communicating with the correct drive hardware.	DRV.BLINKDISPLAY
Setup Wizard	The Setup wizard takes you through the essential configuration steps so that you can control the motor movement.	
More	Click **More** to display **Serial Number**, **Firmware Version**, **Cumulative On Time**, and **Update Firmware**.	
Serial Number	This text box displays the unique serial number of the drive you are communicating with. The serial number is also shown on the label on the side of the drive.	DRV.INFO
Firmware Version	This text box displays the version of the firmware code running inside the drive.	DRV.VER
Download	Click **Download** to retrieve the latest AKD firmware from Kollmorgen. See 19.1 Downloading Firmware	
Cumulative On Time	This text box displays the cumulative time this drive has been powered on. When the drive is powered on, this value continues counting from the value it had when the drive was last turned off.	DRV.RUNTIME
Update Firmware	Use this box to select the firmware version you want your drive to run.	
Drive IP Address	This text box displays the IP address of the drive that you are communicating with.	
MAC Address	This text box displays the MAC address of the drive that you are communicating with. The MAC address is unique and is also printed on the label on the side of the drive.	

6.3 Online and Offline

WorkBench allows you to work online (working with a real drive) or offline (working without any drive hardware).

6.3.1 Online Drive

An online drive is working with a specific physical drive on your network.

Each online drive can either be connected to the drive (WorkBench has an active connection with the drive and data is being passed between WorkBench and the drive) or it can be disconnected (there is no communication between WorkBench and the drive). If communications are lost (for example a network cable is disconnected) with a drive then WorkBench will switch the drive to the disconnected state.

Only one PC can be connected to a drive at a time.

6.3.2 Offline Drive

An offline drive allows you to use WorkBench without having any drive hardware. The parameters of a drive are simulated within WorkBench. An offline drive allows you to create a drive configuration as well as exploring the different screens within WorkBench. Because this is a simulation there are a number of operations that are not possible (for example commanding motion).

6.3.3 Switching Between Online and Offline

WorkBench does not allow you to change an instance drive between offline or online. If you wish to move a configuration between two devices that you can save the parameters to a file and then import this parameter file into a new drive you have created.

6.4 Watch

This window allows you to view the current value of selected information from the drive. You can toggle the window on/off by clicking the glasses on the tool bar.

By default, the watch window shows position, velocity, and current for the selected drive. The list can be customized as shown below.

Button or Dialog Box	Description
Add	Adds a new parameter to the watch list.
Edit	Allows you to modify the selected item.
Delete	Removes the selected items from the list.
Move Up	Moves the selected items up one place in the list.
Move Down	Moves the selected items down one place in the list.

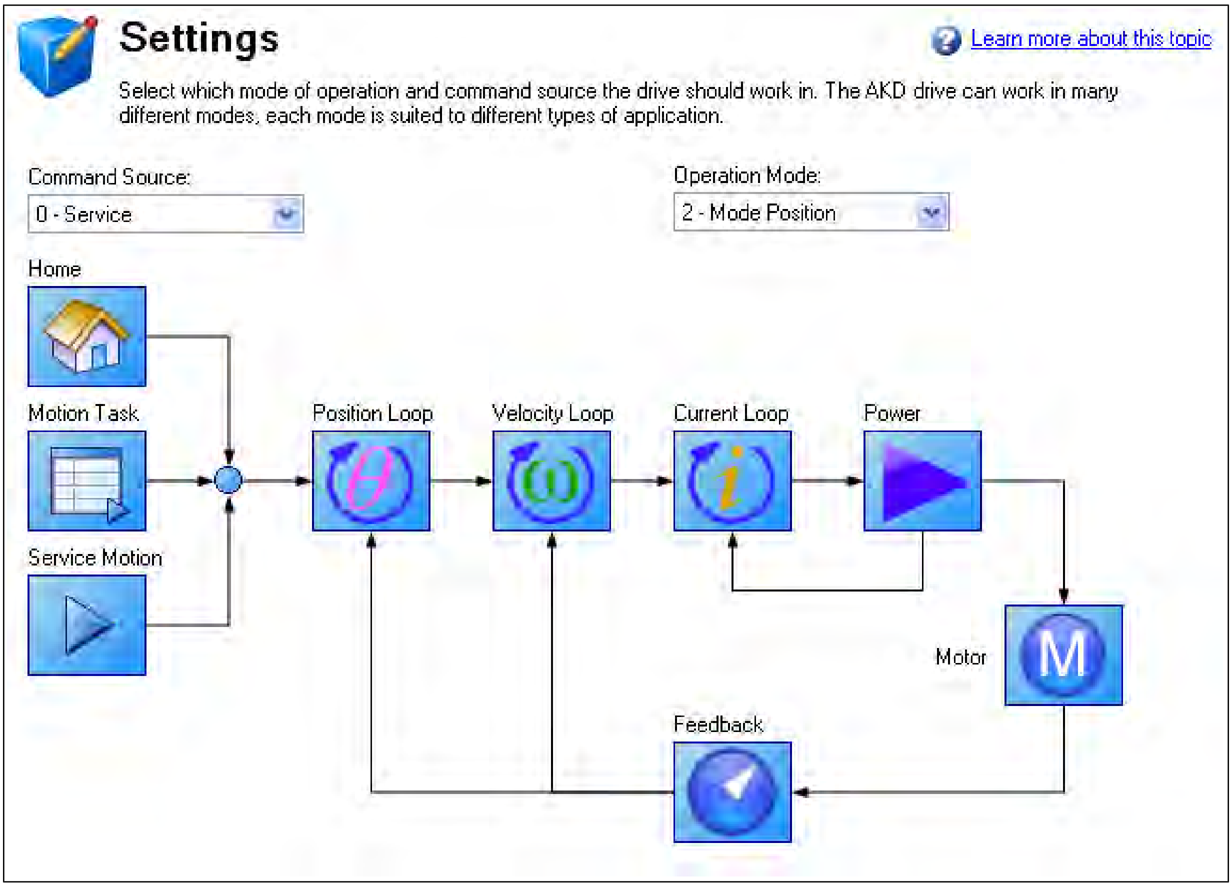
6.5 Settings

6.5.1 Navigation Tree

The Settings view allows you to configure the drive to fit your specific application. When you click Settings in the navigation pane located to the left of the WorkBench screen, additional views for configuring your drive appear. By default, only settings applicable to your current drive operation mode and command source will appear in this tree. To show all settings available for the AKD (even if the these settings are not used with the current operation mode and command source), right click on **Settings** and select **Show all Settings**.

6.5.2 Settings View

From the main Settings view, you can configure the following drive settings:



Button or Dialog Box	Description
Command Source	Selects where the command is being provided: 0-Service: You communicate with the drive using the TCP/IP service channel. 1-Fieldbus: The drive is being controlled by commands coming over the field-bus. 2-Gearing: The position is proportional to the secondary feedback. 3-Analog: The analog input provides a current, velocity, or position command.
Operation Mode	Selects the control loop being commanded from the source: 0-Torque Mode: Drive controls are based on the current passing through the motor. For a rotary motor, this value is proportional to the torque of the motor; for linear motors, this value is proportional to the force the motor generates. 1-Velocity Mode: Drive controls are based on the velocity of the motor. 2-Position Mode: Drive controls are based on the position of the motor.
Motion and Control Loop Graphics	Allows you to selects the details related to each specific loop from a graphical interface.

See 11 Using Command Source and Operating Modes for details on configuring the drive for your application.

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7 Configuring Drive Power

7.1 Power ... **52**

7.2 Regeneration ... **54**

7.1 Power

7.1.1 Drive Setup for Power and Bus

The **Power** screen allows you to confirm Power Bus settings and accommodate external regeneration needs if required. Nothing is required for this screen if you have no regeneration requirements. Review the data on the screen to be certain the bus voltage is at the appropriate levels you expect (approximate input line AC voltage * 1.4). The other values are the appropriate limits for over voltage and under voltage for the particular drive. You can select the undervoltage fault mode to trigger either only when the drive is enabled or always.

From the **Power** screen, you can view and configure the drive power settings as follows:

Button or Dialog Box	Description	Parameter
Measured Bus Voltage	Reads the current DC bus voltage.	VBUS.VALUE
Over Voltage Fault Level	Reads the over voltage fault level.	VBUS.OVFTHRESH
Under Voltage Fault Level	Reads the under voltage fault level.	VBUS.UVFTHRESH
Under Voltage Fault Mode	Sets under voltage mode.	VBUS.UVMODE
Regen Resistor Type	Sets the regen resistor type to either -**1-External Regen** or **0-Internal Regen (if available)**.	REGEN.TYPE
Regen Power	Reads the regen power (only visible for external regen).	REGEN.POWERREGEN.POWER
External Regen Resistance	Sets the external, user-defined regen resistor resistance (only visible for external regen).	REGEN.REXT
External Regen Heat Up Time	Sets the external regen resistor thermal protection time constant (only visible for external regen).	REGEN.TEXT
External Regen Power	Sets the regen resistor's power fault level for an external regen resistor (only visible for external regen).	REGEN.WATTEXT

See 7.2 Regeneration for more information about regen resistors and sizing regen resistors.

7.1.2 Direct DC Mains Operation

Direct DC input is available on all standard AKD models. The DC input should be run into the AC input connection. Positive and negative DC lines should use L1 and L2 connections (polarity is not critical). L1 and L2 connections are found on either the X3 connector or the X4 connector depending on the model.

(see "Mains Supply Connection (X3, X4)" (=> p. 237) for more information on this connection).

The nominal level of DC voltage applied must be compatible with the voltage fault levels in the drive. You must also consider voltage variations in the DC power supply above and below the nominal value so that nuisance faults are avoided.

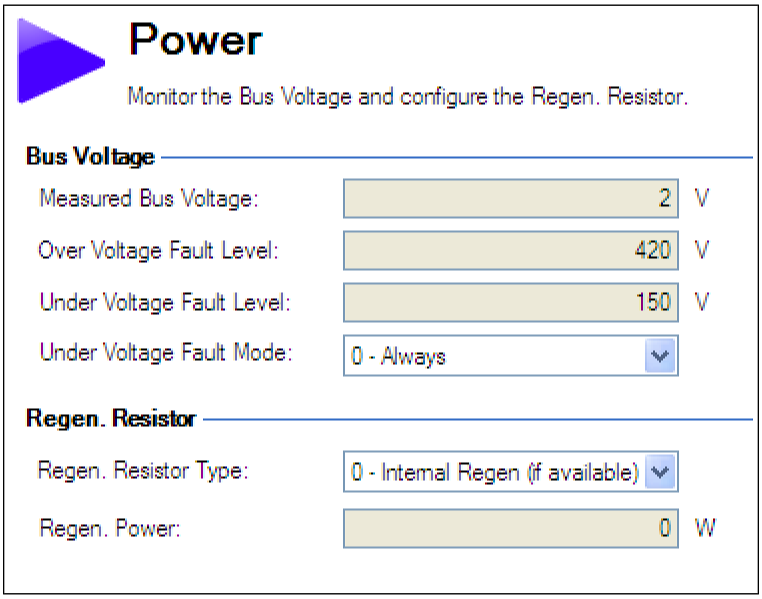
When you determine the maximum nominal DC voltage applied to the drive you should also consider the regeneration circuit, in addition to the over voltage level. Running the drive slightly below the over voltage level is not possible because the drive does not have the capability to dissipate regenerated energy. This practice can also be harmful to the regen circuit. A good practice is not to exceed the nominal DC voltage produced by a standard AC installation. For the AKD-zzzzz06, 340 Vdc is the equivalent DC voltage for an 240 Vac supply and for the AKD-xxxxx07, 680 Vdc is the equivalent DC voltage for a 480 Vac supply.

The voltage fault levels are also shown in the **Power** screen and depend on the voltage level of drive used.

Voltage ranges are as follows:

Model	Under Voltage Level	Over Voltage Level
AKD-zzzz06	90 Vdc	420 Vdc
AKD-zzzz07	380 Vdc	840 Vdc

You can view bus voltage values in the **Power** screen as shown below:



7.2 Regeneration

7.2.1 Overview

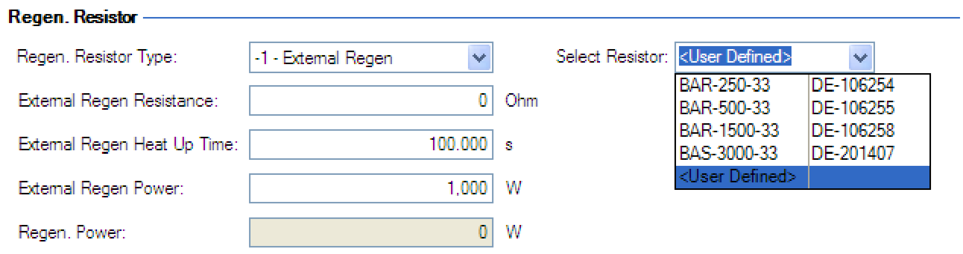
Regeneration, or "shunting", dissipates energy from the DC bus during deceleration of the motor load. During deceleration, the motor acts as a generator that pumps energy back into the system. If this energy is not dissipated, then the bus energy level can exceed acceptable levels (VBUS.OVFTHRESH). If the system exceeds the maximum bus voltage, then the drive generates an over voltage fault (F501 and shuts down. A regeneration resistor, or regen resistor, is an external device that dissipates excess energy and allows the drive to function normally during deceleration.

Follow these steps to determine the regen needs for your system and to configure the drive for regen:

1. Calculate motor peak and continuous regenerative energy and use this value to size the regen resistor.
2. Select a compatible regen resistor.
3. Configure regen parameter values in WorkBench.

7.2.2 Regen Resistor Options

In the **Power** screen, you can select from a variety of pre-sized regen resistors using the **Regen Resistor Type** box.



When you select -1-External Regen, the **Select resistor** box appears and contains the pre-sized resistors for your drive. Select the model regen resistor that you are using and the drive will populate the remainder of the fields. If you are using a nonstandard resistor, then choose **<User defined>** and fill in the appropriate values for your resistor.

NOTE If you use a nonstandard resistor, contact Kollmorgen technical support to confirm that the nonstandard resistor will work correctly with your system.

7.2.3 Calculating Motor Peak Energy and Regen Resistor Size

In order to determine whether or not your system requires a regen resistor, you must calculate the peak kinetic energy that the motor generates during deceleration and the continuous regeneration energy created by the motor. If this energy exceeds the drive capacity, then you need a regen resistor. In many cases, peak or continuous regenerated energy does not exceed the drive capacity and no regen resistor is needed.

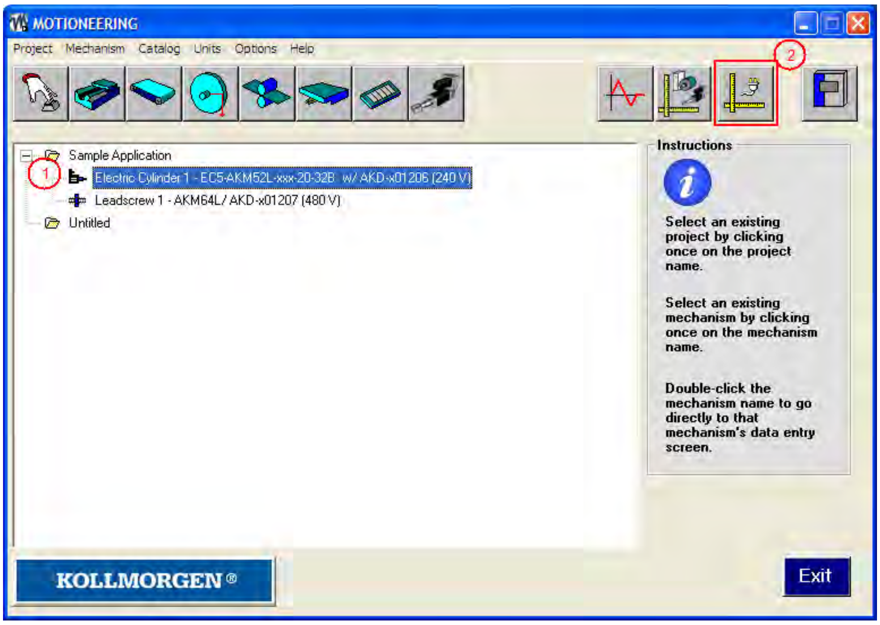
The calculation for peak kinetic energy requires values for several factors that affect the generation of energy in a motion system:

- Load inertia
- Motor inertia
- Motor speed from which deceleration occurs
- Time required to decelerate

Regen resistor sizing information for your particular application can be calculated using the Motioneering® Application Engine. You can download this program here:

http://www.kollmorgen.com/website/com/eng/support/design_tools/motioneering.php

After you install and set up this program, highlight your application (1) and then click on the Power Supply Sizing icon (2).



The application then displays the regen sizing tool; see the application help for further sizing assistance.

7.2.4 Selecting a Compatible Regen Resistor

After you calculate the appropriate resistor size, compare the results with the capabilities of the drive and, if necessary, select an external regeneration resistor which matches these capabilities from the chart below. The resistors shown below are included in the WorkBench setup. If you do not find a match for your application, please contact the Kollmorgen customer support team for further assistance.

NA Part Number	EU Part Number	Resistor Type	AKD-x-00306	AKD-x-00606	AKD-x-01206	AKD-x-02406	AKD-x-00307	AKD-x-00607	AKD-x-01207	AKD-x-02407
BAFP-100-33	DE-201437	External Resistor, 100 W, 33 ohms	x	x	x					
BAFP-200-33	DE-201438	External Resistor, 200 W, 33 ohms	x	x	x					
BAR-250-33	DE-106254	External Resistor, 250 W, 33 ohms	x	x	x		x	x	x	
BAR-500-33	DE-106255	External Resistor, 500 W, 33 ohms	x	x	x		x	x	x	
BAR-1500-33	DE-106258	External Resistor, 1500 W, 33 ohms	x	x	x		x	x	x	
BAS-3000-33	DE-201407	External Resistor, 3000 W, 33 ohms	x	x	x		x	x	x	
BAR-600-23	DE-200613	External Resistor, 600 W, 23 ohms								x
BAR-1000-23	DE-200614	External Resistor, 1000 W, 23 ohms								x
BAS-2000-23	DE-200615	External Resistor, 2000 W, 23 ohms								x
BAS-3000-23	DE-200616	External Resistor, 3000 W, 23 ohms								x
BAS-4000-23	DE-200617	External Resistor, 4000 W, 23 ohms								x
BAR-500-15	DE-201439	External Resistor, 500 W, 15 ohms				x				
BAR-1000-15	DE-201440	External Resistor, 1000 W, 15 ohms				x				
BAS-2000-15	DE-103871	External Resistor, 2000 W, 15 ohms				x				
BAS-3000-15	DE-103872	External Resistor, 3000 W, 15 ohms				x				
BAS-6000-15	DE-103873	External Resistor, 6000 W, 15 ohms				x				

7.2.5 Configuring Regen Parameter Values

If you use an external regen resistor, then you must also include additional information about the regen resistor in the**Power**view. These values are automatically inserted in WorkBench. The chart below summarizes these three additional values:

- **External Regen Resistance** (REGEN.REXT, ohms)
- **External Regen Heat Up Time** (REGEN.TEXT, seconds)
- **External Regen Power** (REGEN.WATTEXT, watts)

These parameters allow the regen resistor to function properly and dissipate power appropriately for your system.

NA Part Number	EU Part Number	Resistor Type (all resistors UL recognized)	Resistance ohms (REGEN.REXT)	Heat Up Time s (REGEN.TEXT)	Power Rating W (REGEN.WATTEXT)
BAFP-100-33	DE-201437	External Resistor, 100 W, 33 ohms	33	16.5	100
BAFP-200-33	DE-201438	External Resistor, 200 W, 33 ohms	33	27.5	200
BAR-250-33	DE-106254	External Resistor, 250 W, 33 ohms	33	22.0	250
BAR-500-33	DE-106255	External Resistor, 500 W, 33 ohms	33	33.0	500
BAR-1500-33	DE-106258	External Resistor, 1500 W, 33 ohms	33	25.7	1,500
BAS-3000-33	DE-201407	External Resistor, 3000 W, 33 ohms	33	77.0	3,000
BAR-600-23	DE-200613	External Resistor, 600 W, 23 ohms	23	27.5	600
BAR-1000-23	DE-200614	External Resistor, 1000 W, 23 ohms	23	27.5	1,000
BAS-2000-23	DE-200615	External Resistor, 2000 W, 23 ohms	23	77.0	2,000
BAS-3000-23	DE-200616	External Resistor, 3000 W, 23 ohms	23	84.3	3,000
BAS-4000-23	DE-200617	External Resistor, 4000 W, 23 ohms	23	77.0	4,000
BAR-500-15	DE-201439	External Resistor, 500 W, 15 ohms	15	33.0	500
BAR-1000-15	DE-201440	External Resistor, 1000 W, 15 ohms	15	27.5	1,000
BAS-2000-15	DE-103871	External Resistor, 2000 W, 15 ohms	15	77.0	2,000
BAS-3000-15	DE-103872	External Resistor, 3000 W, 15 ohms	15	84.3	3,000
BAS-6000-15	DE-103873	External Resistor, 6000 W, 15 ohms	15	91.7	6,000

7.2.6 Related Parameters

REGEN Parameters

VBUS.OVWTHRESH

VBUS.VALUE

8 Configuring Motor Settings

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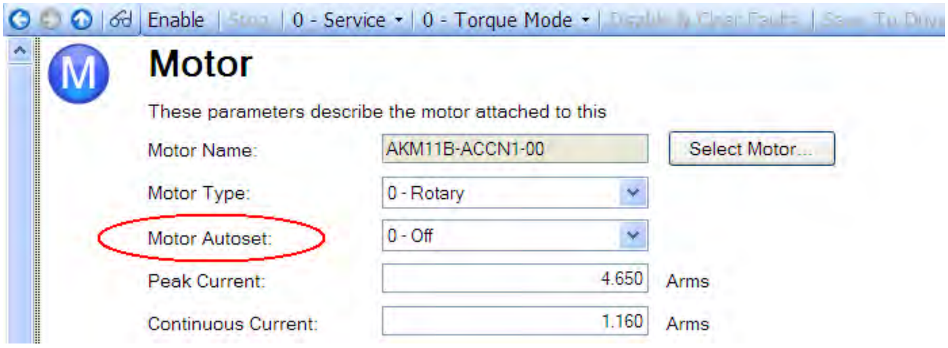
8.1 Motor

8.1.1 Overview

The **Motor** screen is used to set up or confirm the parameters of the motor that is connected to the drive. In certain cases, based on the feedback type, the motor parameters will automatically be set. The drive will auto-detect feedback devices that are preset with the appropriate feedback and motor parameters when MOTOR.AUTOSET is set to 1 (default). The values the drive uses for commutation and current and velocity loop gains will be populated automatically.

If your motor does not have a plug and play feedback device, then you must turn off the motor autoset feature as shown in the screenshot below (MOTOR.AUTOSET = 0) and select the appropriate motor from the motor parameter database.



All of the appropriate Kollmorgen motors compatible with the AKD drive are contained in the motor database. For motors that are not listed, click **Select Motor** to open a custom motor view in which you can input the appropriate motor parameters.

8.1.2 Motor Setup

For SFD, Endat, and BiSS feedback devices, the drive will automatically be detected and the correct motor parameters will be automatically set in the AKD drive. If your motor is detected automatically, the parameters in the **Motor** view are shaded and not accessible. If you have a non-plug and play standard device (such as an incremental encoder or resolver), you can use this screen to enter the standard AKM, Cartridge motor, DDR, or DDL motor. Other motors can be entered using the **Custom Motor** selection and setting up the parameters (see section on non memory motors). Select the standard motor from the drop down list and select ok. The AKD drive will now show all of the appropriate parameters needed for the motor to operate properly.

8.1.3 Using the Motor View

The **Motor** view displays parameters related to the specific motor attached to the drive as follows:

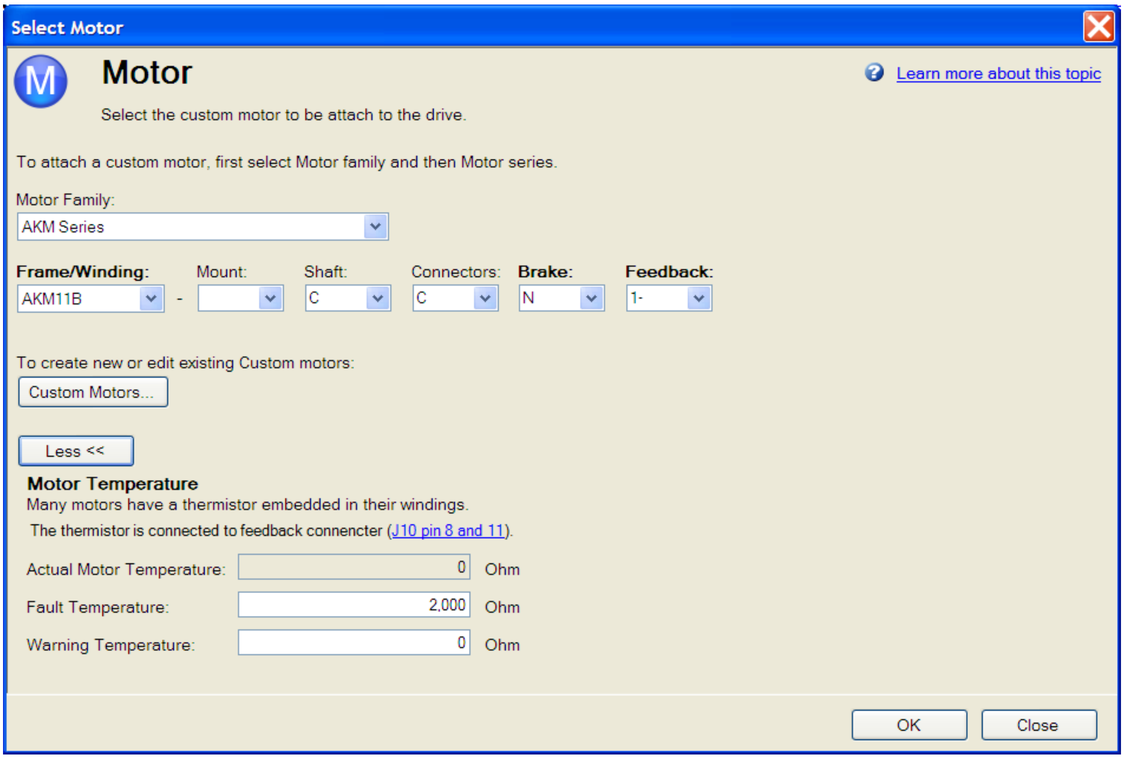
- Motor Name: The motor part number read from the autoset device, or the name from the motor database. When entering a custom motor name, the motor name should not contain any spaces.
- Motor Type: This field allows you to select the proper parameters for a rotary motor or a linear motor (linear motors are a future feature).
- Motor Autoset: This setting to allows the drive to automatically set up a plug and play motor (MOTOR.AUTOSET = 1). With **Motor Autoset** turned off (MOTOR.AUTOSET = 0), you can access the motor database to select a catalog or custom motor.

The next set of parameters displayed are specific to the electrical and mechanical characteristics of the motor connected to the AKD drive.

- Peak Current: Motor peak current rating in Amps rms.
- Continuous Current: Motor continuous current rating in Amps rms.
- Inertia: Motor rotor inertia in Kg-cm^2.
- Torque Constant: Motor torque contant in Nm/Arms.
- Inductance: Motor rated inductance in milliHenries
- Motor Poles: Number of motor poles.
- Maximum Speed: Motor maximum rated speed
- Motor Resistance: Motor winding resistance in Ohms.
- Maximum Voltage:Motor maximum rated voltage in Volts rms.
- Motor Phase: Motor phase offset (used to set motor commutation as required - for most devices this is set to 0).
- Coil Thermal Constant: Motor coil thermal time constant in mHz.

8.1.4 Selecting a Motor

The **Select Motor** button opens a screen in which you can configure a non-plug and play motor or custom motor.



When this screen is opened, WorkBench displays by default the motor matched to the current motor name attached to the drive. WorkBench searches matching motor as follows:

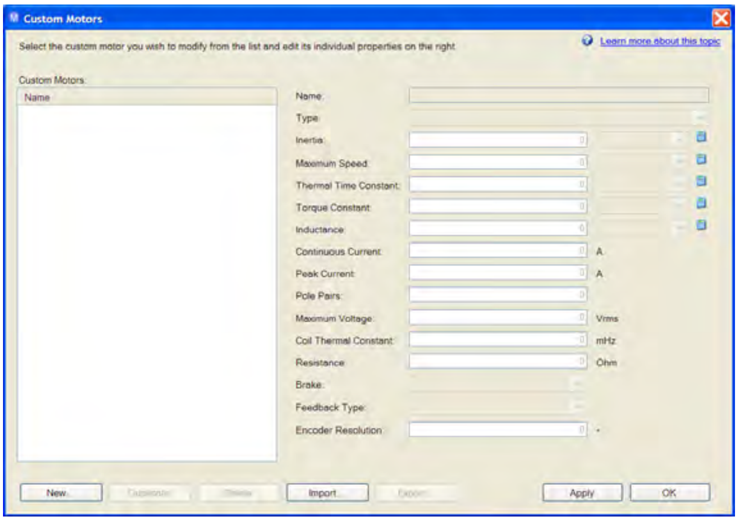
1. WorkBench first checks the motor name with custom motors for a match.
2. If a match is not found, then WorkBench checks the name with the standard motors database for a match.
3. If a match is not found, then an AKM motor is selected.

For non-plug and play motors, a database of catalog motors is available based on the different Kollmorgen motor families. When you select a motor family, a part number is displayed according to the selected motor family. You can change the part number as needed, and the complete motor name will be displayed according to your selection. This complete motor name is sent to drive. The portions of the part number labeled in bold are required values.

The **More/Less** button displays and hides motor temperature settings.

8.1.4.1 Configuring Custom Motors

Click on **Custom Motor** to creat and edit custom motors in the following screen:



In this view, you can import or export a motor parameter file, or create a custom motor of your choice. The appropriate parameters must be chosen as listed. Several of the parameters allow you to select an alternate unit of measure. When building a custom motor file, do not use blank spaces in the name you choose. Once you have configured one or more custom motors, if you select a custom motor from the list and click **OK**, then the selected custom motor will be displayed in the **Select Motor** screen.

The actions available in the custom motor screen include:

- **New**. Allows you to start a new custom motor (with default values) or load a catalog motor you may want to modify.
- **Duplicate**. Makes a copy of the highlighted motor in the custom motor list.
- **Delete**. Deletes the highlighted motor in the customer motor list.
- **Import**. Allows you to import a motor file (*.motor) from another location
- **Export**. Allows you to save teh highlighted motor file (*.motor) to another location
- **Apply**. Accepts the values you have entered for the specific motor files you are entering.
- **OK**. Returns you to the **Motor Selection** screen.

When entering any of the motor data, be certain the units are correct. The AKD drive uses the motor parameters to set up the various feedback loops and limits associated with the motor selected.

Note that if you select a custom motor from the list and click Ok button then that selected custom motor will be displayed in the Select Motor screen.

8.1.4.2 Validating Motor Parameters

When you click **OK** in the **Select Motor** screen, WorkBench validates the range with the drive. If any error is found, an error screen is displayed. Click **Continue** to set the motor parameters in the drive. Click **Cancel** to close this screen.

If errors occur while setting the motor parameters, an error screen indicates which parameters require additional attention.

Related Parameters

MOTOR Parameters

8.2 Feedback 1

The Feedback view allows you to configure the primary position feedback device fitted to your motor.

When you select your feedback device from the Feedback Selection list, the appropriate feedback configuration choices appear below the dial.

8.2.1 Overview

The AKD offers a variety of feedback solutions, which allows you to optimize your system based on your specific machine needs. The available feedback options include resolver, SFD, sine-cosine encoder (Endat 2.1, BiSS, Hiperface), incremental encoder, as well as line-count, single, and absolute variations. Your motor model number will indicate the type of feedback that you have. With some incremental encoders, parameters are set up in the encoder itself, and the AKD drive recognizes the feedback automatically and sets up the drive accordingly. This automatic recognition is called "plug and play". Currently, SFD and Endat are plug and play encoders. Other feedback types require that you enter parameters manually.

8.3 Using Feedback Options

Use the **Feedback** screen to set up your system to match the proper feedback device. By default, the drive uses the **Auto** setting to detect feedback devices. This setting allows the drive to interrogate the feedback device to see if it is a recognized plug and play device. If the drive recognizes the device, then all the parameters for that device and motor are loaded into the drive. Both the feedback and the motor information are now present in the drive and the system is operable.

If the feedback is a non- plug and play device, then you can choose from the list of supported devices in **Feedback Selection** list and then enter the line count manually. The following sections describe each supported device available in the **Feedback Selection** list and the input information required to configure each device.

8.3.1 Auto

This is the default setting and is used to determine if a plug and play device is available. If a plug and play device is available, the **Auto** mode is replaced by the feedback device detected, along with the appropriate resolution settings.

8.3.2 Incremental Encoder

The incremental encoder is a non-plug and play device. Incremental encoders are available in a variety of line counts. If you select an incremental encoder option, the encoder resolution must be entered into the **Rotary Encoder Resolution** box. The units for this field are in counts per revolution, which is post-quadrature (multiplies the lines per revolution by 4).

8.3.3 Sine Encoder

Sine encoders are offered with different data communication protocols. These include Endat, BiSS, Hiperface, and others. A standard sine-cosine encoder with simple analog communication is not a plug and play device. As with the incremental encoder, the line count is entered in the **Rotary Encoder Resolution** box.

8.3.4 Endat 2.1, Endat 2.2

Endat-based sine encoders are plug and play compatible, and the system will properly recognize these encoders. With the AKD set in **Auto**, this encoder type is detected and the feedback and motor parameters are loaded automatically.

8.3.5 BiSS

BiSS will be plug and play in a future release. Currently, the device is programmed with the motor and feedback information and once selected will sets up the feedback and motor parameters in the AKD.

8.3.6 Hiperface

Hiperface is a plug and play device that will be supported in a future release.

8.3.7 Resolver

The resolver feedback option is not plug and play. When selecting the resolver option, three specific parameters are set by default for the standard AKM resolver: phase lag, transformation ratio, and feedback poles. Currently,the AKD does not support non-Kollmorgen standard resolver options.

8.3.8 SFD

Smart Feedback Device (SFD) is Kollmorgen's most popular plug and play device. SFD allows for quick and easy setup from the **Auto** mode, which automatically configures the drive with the motor and feedback parameters.

8.3.9 Using Wake and Shake (WS)

8.3.9.1 Overview

Wake and shake (WS) is used to establish commutation in drives with the following types of feedback:

- Incremental encoders
- Sine encoders without an absolute data channel
- BiSS type C encoders

When controlling a brushless DC (BLDC) motor, you must know the electrical position of the motor shaft. Without absolute position data, it is impossible for the drive to know which sequence of coils to energize to produce motion. Absolute feedback devices, such as resolvers and absolute encoders, can detect position directly. Incremental devices, such as incremental encoders and sine encoders without a parameter channel, must determine electrical position indirectly at start up. The AKD uses the WS feature to determine electrical position by sending the motor short bursts of current and measuring the resulting incremental motion. The drive uses this measurement to estimate electrical position accurately enough to control the motor.

8.3.9.2 Configuring WS

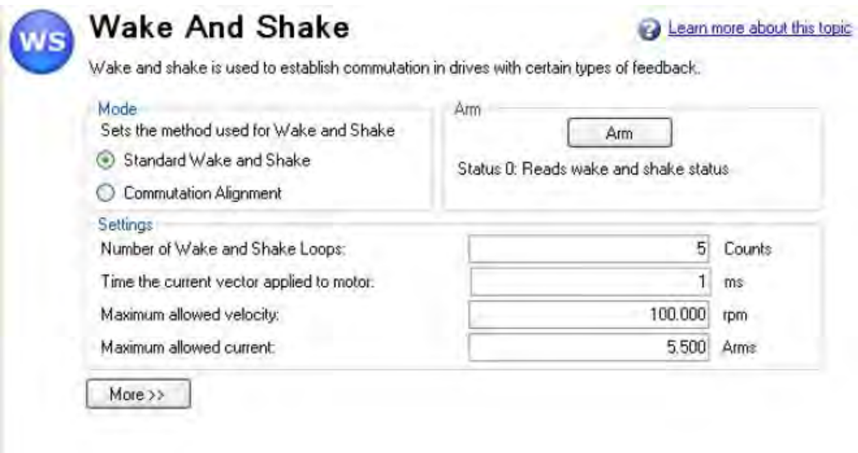
You can configure WS after your motor has been connected to the AKD according to the *AKD Installation Manual*. The WS procedure is initiated automatically when both the hardware and software enable signals become logic high.

Before attempting to enable the drive, the drive must be compensated for the motor and the AKD servo loops must be stable.

Compensation values for many rotary motors are included in a database already loaded into the AKD.

NOTE: An unstable system will not function properly during or after the WS process.

Use the default **Wake and Shake** view to configure your system:



Mode:

Select the mode (WS.MODE) according to your application needs [insert guidance on how to select]

Arm:

Click **Arm** to set WS to start at the next drive enable (WS.ARM). This area also shows the current status of the wake and shake process. See WS.STATE for a detailed explanation of the possible states.

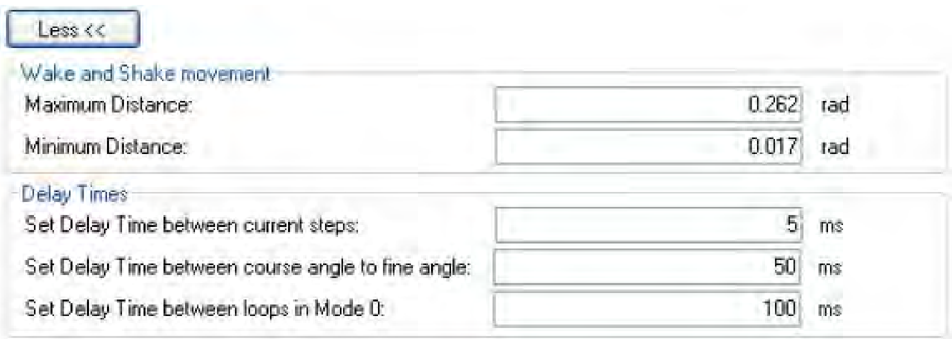
WS.ARM is not relevant to any feedback type.

Settings:

- **Number of Wake and Shake Loops**. By default, the WS feature uses the mean of all wake and shake repetitions, called "loops", to establish commutation (WS.NUMLOOPS; see Using WS: Advanced for a discussion of loops). If fewer than five loops are used, commutation may be incorrect, possibly causing poor performance or stability.
- **Time the current vector applied to motor.**This box specifies specifies the duration of the current pulse used for commutation. Increasing this value (WS.T) increases the movement of the system in direct proportion to the move distance (WS.DISTMAX or WS.DISTMIN.
- **Maximum allowed velocity**. If a velocity higher than this value (WS.VTHRESH) is detected while WS is running, then a fault will be generated.
- **Maximum allowed current**. This value (WS.IMAX) is directly proportional to the movement. A value that is too low may fail to cause movement; a value that is too high value may cause an over speed fault.

Wake and Shake, More View

To configure additional WS settings, click **More** at the bottom of the default view to display the following options:



Wake and Shake Movement

Use these boxes to set values for the maximum (WS.DISTMAXand minimumWS.DISTMINmovement required for finding commutation.

Delay Times

Delay time is the time that elapses when switching different current vectors. Use these boxes to set specific time delays for current steps WS.TDELAY1, coarse to fine angle (WS.TDELAY2) and time between loops in mode 0 (WS.TDELAY3).

Special Cases for WS

Operation with Motor Brake

An amplifier with a motor brake operates the WS procedure similar to an amplifier without a brake. All precautions and behavioral descriptions above also apply in this case. It is important to note that the brake is automatically engaged (motor brake, not holding brake) after the WS process is complete. The brake may cause unexpected movement if the DRV.OPMODE used prior to WS does not retain position. If a force component is present parallel to the track on a linear motor (gravity, load, etc.), or tangential on a rotary motor, the motor may move from the startup position after WS completes and the brake is engaged.

If the application requires that the startup position be retained, have the controller system ready to take control immediately after WS is complete. One way to set this control is to have the drive in DRV.OPMODE 1 (digital velocity) or DRV.OPMODE 2 (position mode) on power-up. This precaution keeps the motor stationary after enable.

End of Travel Limits

If anything restricts the motion of the motor, a commutation fault can occur. Examples of situations that may result in faults include the following:

1. If the motor is resting against a rigid endstop, the movement of the motor may be impeded below the minimum threshold set by WS.DISTMIN. This lack of movement causes a fault.
2. If the motor is actuating a limit sensor/switch, the system (PLC, SWLS.LIMIT0 and SWLS.LIMIT1) may be preventing the AKD from producing motion. If descriptive motion is not achieved, the system faults.

Large Load Inertia or High Friction System

Systems with a large load mismatch may need more current than the default setting for correct commutation. Begin with the default value for WS.IMAX and gradually increase or decrease as needed. If adjusting WS.IMAX does not result in a successful commutation, the width of the search pulse can be increased by increasing WS.T.

8.3.9.3 Using WS: Advanced

WS is performed upon enable in order to establish a valid value for MOTOR.PHASE at startup. For the AKD, MOTOR.PHASE is used to calculate electrical phase. With absolute feedback devices, MOTOR.PHASE is a fixed offset between absolute mechanical position and the electrical position. With incremental devices, position is accumulated relative to an initial MOTOR.PHASE. However, at startup, MOTOR.PHASE is invalid since the initial position is random, thus the requirement for the WS process.

WS is a two-step process:

1. The drive sequentially pulses a user-specified current, WS.IMAX, at each electrical quadrant (0°, 90°, 180°, 270°). Based on the resulting observed movement, an approximate location is calculated.
2. The drive pulses current and adjusts the commutation angle at small increments to find a precise position.

The amplitude of the current pulses in this process does not exceed WS.IMAX. The AKD repeats these two steps for a user-specified number of times (WS.NUMLOOPS) to produce a more accurate estimate of the electrical phase.

The drive normally indicates warning 478 before WS is initiated and successful. If WS fails, the commutation is not valid and the drive indicates one of faults 473 to 479.

Maximizing WS Reliability

The following suggestions will help you achieve successful commutation:

- Incorrect determination of MOTOR.PHASE may cause a system runaway. Since the typical movement during correct operation of WS is very small, you can use the velocity overspeed parameters (WS.VTHRESH and DRV.VTHRESH) to prevent a runaway. Prior to enabling the drive, set DRV.VTHRESH 100 mm/s for linear motors or 200 rpm for rotary motors. After a successful enable, DRV.VTHRESH can be returned to the normal operating value.
- Set WS.IMAX to its default value, WS.IMAX=0.5*min(MOTOR.IPEAK, DRV.IPEAK).
- Set WS.NUMLOOPS 20 for best results in many applications.
- WS.T specifies the duration for which the search current is applied. With a stable velocity loop, most applications work well with the default value of WS.T 0. The default value causes the software to calculate the width of the search pulse based on the velocity loop proportional gain, VL.KP. Increasing WS.T effectively increases the movement of the motor during WS, which may be necessary for systems with a low-resolution feedback or high load inertia.

- WS.IMAX specifies the amplitude of the current pulse used during the initial/rough commutation. A WS.IMAX value that is too low may result in a fault by failing to cause enough movement for commutation. If the value is too high, the preset movement threshold could be exceeded, also resulting in a fault. If the default value is producing faults for too little movement, gradually adjust this parameter to overcome excessive friction and/or load on the system. WS.IMAX also specifies the maximum current used in the second stage of commutation. The initial current is 25% of WS.IMAX, then steps up to 100% of WS.IMAX.
- FB1.SELECT selects the type of feedback used by the amplifier. The WS feature is used only for FB1.-SELECT = 11, 21, 31. The feedback must be configured prior to initiating the WS procedure.
- MOTOR.BRAKE If your amplifier has a motor brake, set MOTOR.BRAKE = 1. For motors without a brake, set MOTOR.BRAKE = 0.

CAUTION

Adjust WS.T with extreme caution. Increasing WS.T increases the movement of the system. Applying an incorrect value of WS.T may cause erratic drive behavior.

NOTE

When initiating WS, the motor may experience a runaway. Stay clear of all moving parts. Ensure there are properly operating safety devices such as hardware limit switches and suitable end-of-travel limits.

NOTE

If WS.NUMLOOPS is less than 5, commutation may be incorrect. This condition may cause faults and/or adversely affect performance or stability. Set WS.NUMLOOPS = 20.

8.3.9.4 Related Parameters

WS Parameters

DRV.IPEAK

FB1.SELECT

MOTOR.BRAKE

MOTOR.PHASE

MOTOR.IPEAK

8.3.9.5 Troubleshooting WS

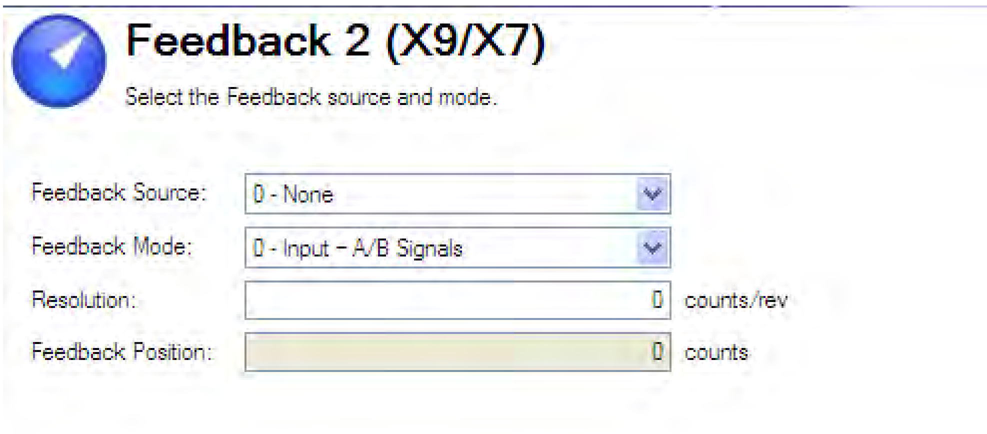
Problem	Possible Cause	Remedy
Excessive Movement	• Brake slips on vertical system. • External forces on motor too great.	• Check brake. • Remove forces acting on motor. • Lower WS.IMAX.

Problem	Possible Cause	Remedy
Insufficient Movement	• Motor brake too rigid. • Motor resting on rigid end-stop. • Too much friction on motor track. • Foreign objects impeding movement of motor. • Motor load very large, and impedes sufficient movement. • WS.DISTMIN manually set too high • WS.IMAX too low	• Check brake • Check physical location of motor • Check friction and cleanliness of motor track • Increase WS.IMAX value
Other	• Drive not configured correctly.	• Check drive compensation • Verify amplifier feedback

8.3.10 Commutation Alignment

8.4 Feedback 2

The Feedback 2 screen helps configure how you will be using either connector X9 or X7. The screen uses the term feedback in the labels, but you can also think of this as the “signal” source depending on how you use these connection points.



The **Feedback source** box allows you to choose from three feedback sources:

Source 0 – This simple indicates you are not using either connector as a feedback source.

Source 1 – This is tied to use of connector X9 (consider for emulated encoder connection).

Source 2 – This is tied to use of connector X7 (consider for the high speed opto inputs on the I/O Connector).

Feedback Mode offers three selections as well, depending how you are using the connection source above.

Mode 0 – The input is configured as A/B signals.

Mode 1 – The input is configured as Step and Direction signals.

Mode 2 – The input is configured as Up-down signals.

The **Resolution** box sets the resolution of the device you have indicated as your input of signal source.

Encoder Emulation Output

The drive offers the flexibility to use connector X9 for an encoder emulation output. This output can be set up using the Encoder Emulation view (see 8.4.1 Encoder Emulation .

The **Emulation Mode**box offers three settings for Encoder Emulation mode:

Mode 0 – The connector is free to use as an input

Mode 1 – The X9 connector is now set up as an encoder emulation with a once per rev index pulse (resolution is set in the next parameter (Emulation Resolution).

Mode 2 – The X9 connector is now set up as an absolute index pulse

Emulation Resolution sets the resolution desired for the output of the emulated encoder.

The **Index or Absolute offset** is dependent on which emulation mode is selected, allowing you to set an offset for either the index pulse or absolute pulse.

A check box allows you to consider the motor direction based on the encoder output.

8.4.1 Encoder Emulation

8.4.1.1 Overview

The encoder emulation (EEO) connector (X9) can be used as an either an output or an input. As an output, you can use this connector for position feedback to an analog controller and for configuring the drive as the master in a master/slave system. You can also use X9 connector as an input for controlling the drive through an A/B, pulse and direction, or up/down command. Common applications for this input include using the drive with a stepper controller and configuring the drive as the slave in a master/slave system.

8.4.1.2 Using Encoder Emulation

You can configure the X9 connector from the **Encoder Emulation** screen by setting the connector function, resolution, and (where applicable) input position. The **Electronic Gearing** screen also has provisions for setting the function of the X9 connector.

8.4.1.3 Function Settings

Function settings for the X9 connector are assigned through the "DRV.EMUEMODE" (=> p. 359) parameter.

Mode 0: Disable X9

Input (No EEO Output). The EEO connector (X9) is configured as an input. See Feedback 2 (FB2) for definitions for the EEO Connector (X9). Note that this mode is also deprecated and will behave as it did with firmware versions prior to M_01-03-00-000.

In earlier firmware versions, this mode indicates that the EEO connector is not operative.

Output Modes 1 and 2

In the output modes, the drive calculates the motor shaft position from the cyclic- absolute signals of the primary feedback, generating incremental-encoder compatible pulses from this information. Pulse outputs on the SubD connector X9 are three signals: A, B and index, with 90° phase difference (i.e. in quadrature, hence the alternative term “A quad B” output), with a zero pulse.

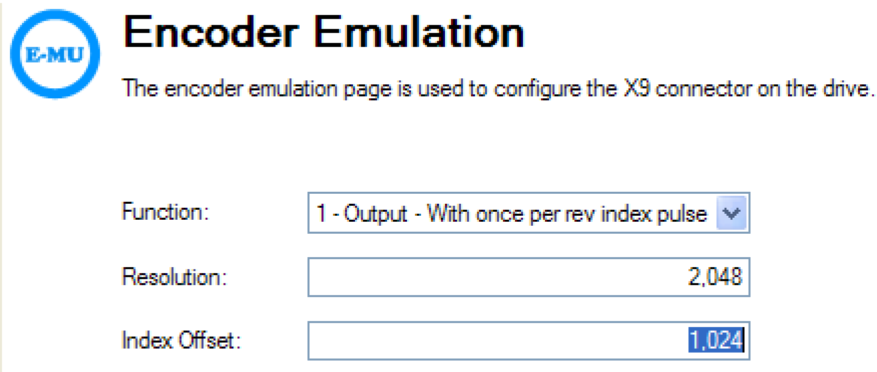
If you are using the AKD as a master, the slave drives use the master's encoder output signals as command input and follows these commands (velocity and direction). The drives operate from an internal supply voltage.

Mode 1– Aquad B with once per rev index pulse

Output Mode 1 - A quad B with Once per Rev Index Pulse Connection Diagram

This output mode simulates an encoder signal from the X9 port to another AKD or external controller. EEO resolution ("DRV.EMUERES" (=> p. 361)) defines how many counts are outputted for one revolution of the primary feedback.

Index offset ("DRV.EMUEZOFFSET" (=> p. 362)) determines the point during the revolution of the primary feedback when the index pulse (X9 pins 7&8) is output through the X9 port. The pulse will occur once every revolution of the primary feedback at the positive value of the offset.

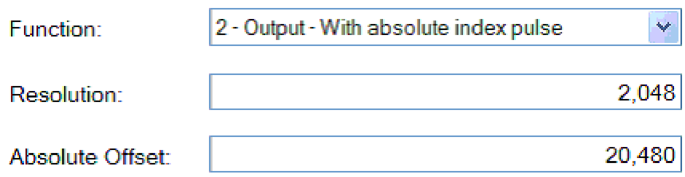


In this case, the Index is offset 180 degrees, or halfway through the revolution of the primary feedback.

Mode 2– A quad B with absolute index pulse

Output Mode 2 - A quad B with Absolute Index Pulse Connection Diagram

When mode 2 is chosen, a box will appear for an absolute index point to be entered ("DRV.EMUEMTURN" (=> p. 360)). The absolute index pulse will be output when the X9 output position reaches the assigned value. The index will be output when the feedback position in counts matches this parameter. In the example below, the absolute index pulse output will occur after 10 positive revolutions of the motor. The absolute index is referenced from the zero point of the primary feedback and is reset when the drive is homed.



Input Modes 3, 4, and 5

The X9 connector is also capable of input modes. These input modes correspond to the signal types described below. The **Electronic Gearing** screen also includes provisions for setting the function of the X9 connector for input modes.

Mode 3-A quad B signals

Input Mode 3 - A quad B Signals Connection Diagram

Input mode 3 allows an A quad B encoder or the encoder emulation output of another drive to be connected and used as a commander encoder, dual loop feedback, gearing, or camming input.

Mode 4-Pulse/direction signals

Input Mode 4 - Pulse/direction Signals Connection Diagram

Input mode 4 allows the drive to be connected to a third-party stepper-motor controller. The number of steps can be adjusted so that the drive can be adapted to match the step-direction signals of any stepper controller.

Mode 5-Up/down signals

Input Mode 5 - Up/down Signals Connection Diagram

The drive can be connected to a third-party controller which delivers up-down signals.

Mode 6-Output – with once per rev index and Input – Step and Direction

This mode allows you to output emulated encoder signals from the X9 (Emulated Encoder) connector, and input a step handwheel signal into the X7 (High Speed Opto IO) connector simultaneously. Mode 6 and 7 are identical, with the exception that the emulated encoder has an incremental Z pulse (Z pulse occurs every revolution) in mode 6, and an absolute Z pulse (Z pulse occurs at one absolute position) in mode 7.

Mode 7 – Output – with absolute Index and Input – Step and Direction

This mode allows you to output emulated encoder signals from the X9 (Emulated Encoder) connector, and input a step handwheel signal into the X7 (High Speed Opto IO) connector simultaneously. Mode 6 and 7 are identical, with the exception that the emulated encoder has an incremental Z pulse (Z pulse occurs every revolution) in mode 6, and an absolute Z pulse (Z pulse occurs at one absolute position) in mode 7.

8.4.1.4 Resolution

The resolution setting defines how many counts are output for one revolution of the primary feedback (when X9 is configured as an output), or how many counts will be considered a full revolution of the input signal from an external controller (when X9 is configured as an input). The resolution value is post-quadrature; for example, a 1,000 count encoder has a resolution of 4,000 counts.

Note: If the resolution value is set to 0, then the X9 connector will not produce a command.

8.4.1.5 Related Parameters and Commands

The DRV.EMUEMODE parameter sets the EEO output and input modes. The resolution (before multiplication) is set by the DRV.EMUERES function. The DRV.EMUEZOFFSET parameter adjusts and saves the zero pulse position within one mechanical turn. DRV.EMUEMTURN sets the absolute index point in mode 2 and DRV.HANDWHEEL sets the position at which the index pulse is output in output mode 2.

DRV.EMUEDIR

DRV.EMUEMODE

DRV.EMUEMTURN

DRV.EMUERES

DRV.EMUEZOFFSET

DRV.HANDWHEEL

8.5 Non-Plug and Play Feedback Devices

To set up an AKD drive with a non-plug and play feedback device (for example a resolver or an encoder), you must select a motor from the list of standard or custom motors or enter the motor parameters manually. Once the motor data is entered into WorkBench, an initial set of parameters can be calculated and downloaded to the drive.

8.6 Parameters

The following parameters can be initialized to their default values or calculated from user-supplied motor data:

IL.KP	IL.LIMITN	VL.KP	PL.KI = 0 (Default Value)
IL.KFFACC	IL.LIMITP	VL.KI	PL.INTINMAX = 0.419 (Default Value)
IL.KBUSFF	IL.PWMFREQ	VL.LIMITN	PL.INTOUTMAX = 0.419 (Default Value)
IL.FRICTION	IL.KVFF	VL.LIMITP	MOTOR.IPEAK
IL.OFFSET	IL.FOLDFTHRESHU	VL.THRESH	MOTOR.ICONT
IL.INTEN	IL.FOLDWTHRESH	VL.KVFF	MOTOR.PITCH
IL.IVFB	IL.MFOLDD	PL.KP	MOTOR.POLES
IL.KPDRATIO	IL.MFOLDT	PL.KD = 0 (Default Value)	MOTOR.TYPE

8.7 Calculations

WorkBench uses the following equations to calculate parameter values.

8.7.1 Current Loop

The current loop proportional gain (IL.KP) must be such that the current loop closed loop crossover frequency/bandwidth (BW) nominal is the lesser of 2000 Hz or (PWM Frequency/4).

Then, with this frequency:

IL.KP = 2*π*(desired bandwidth in Hz)*(motor L line-line in H)

Setting the D and Q components

8.7.2 Velocity Loop

VL.KP = (2*π*75)*(2*Jm/Kt) = 300*PI*Jm/Kt

VL.KI = 5

8.7.3 Position Loop

PL.KP = ??

8.7.4 Slider Tuning

The slider tuning algorithm in WorkBench currently uses the following algorithm.

8.7.4.1 Input - Motor Data

The values for inertia, Jm (Kg / cm2), and torque constant, Kt (Nm/A), are obtained from either the SFD or the motor model number that you select.

8.7.4.2 Constants

Velocity Loop Bandwidth – BW = The default value is 75Hz.

Input - Inertia Ratio – Q = The default is 1.

8.7.4.3 Output - Control Loop Gains

VL.KP = 2 * π * BW * Jm * (1+Q) * 0.0001/Kt

VL.KPI = BW*0.08 -1 (minimum of 1)

PL.KP = BW/5

8.8 Foldback

The foldback feature in the AKD protects both the motor and the drive from overheating. Two current foldback algorithms run in parallel in the drive: the drive foldback algorithm and the motor foldback algorithm. Each algorithm uses different sets of parameters. Each algorithm has its own foldback current limit, IL.DIFOLD (drive foldback) and IL.MIFOLD (motor foldback). The overall foldback current limit is the minimum of the two at any given moment.

IL.IFOLD = min (IL.DIFOLD, IL.MIFOLD).

Foldback is not the same as current limits. Instantaneous current limits for the drive are set by the positive peak current (IL.LIMITP) and negative peak current (IL.LIMITN) in the Limits view in WorkBench. The foldback algorithms may reduce the current output to the motor in spite of the current limit settings.

8.8.1 Drive Foldback

The drive foldback algorithm monitors current feedback; since this is a monitoring function, the drive foldback parameters are not user configurable. If the current feedback exceeds the continuous current rating of the drive (DRV.ICONT), then the algorithm decreases the current to the DRV.ICONT level. For example, under a step command input condition, the foldback algorithm allows maximum peak current (DRV.IPEAK) output from the drive for a short period of time (up to IL.DFOLDD time), after which the drive begins an exponential foldback (with time constant of IL.DFOLDT) of the current to the drive’s continuous current.

It takes a few seconds for the exponential decay to drop from the drive’s peak current to its continuous level. A recovery time, where the feedback current is below DRV.ICONT level, is required to allow current above DRV.ICONT level again. A recovery time of IL.DFOLDR with 0 current allows the drive to apply DRV.IPEAK current for IL.DFOLDD time.

8.8.2 Setting up motor foldback

Motor foldback is set up automatically when using a plug and play motor or when a particular motor is selected from the WorkBench database.

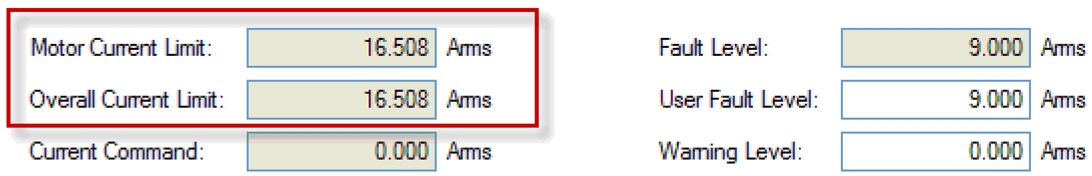
If you are using a custom motor, use the Motor view in WorkBench to set custom values needed for foldback configuration.The parameter entries required for the drive to apply motor foldback protection properly are coil thermal constant (MOTOR.CTFO), peak current of the motor (MOTOR.IPEAK), and continuous current of the motor (MOTOR.ICONT). These values are used to setup the algorithm for motor foldback.

8.8.3 Setting Fault and Warning Levels

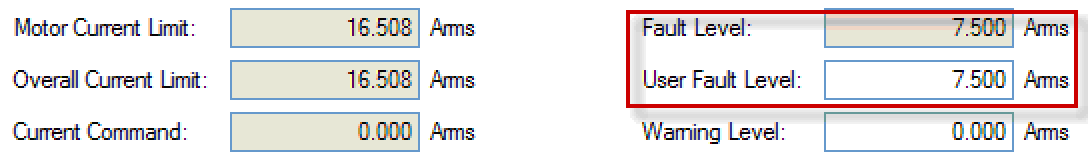
The **Motor Current Limit** and **Overall Current Limit** boxes show status variables that are constantly updated by the foldback algorithm. As current is applied above the drive or motor continuous rating, the capacity for the application of peak current starts to decrease. The motor current limit and overall current limit are actively decreased. If the move profile requires less than continuous current rating for a period of time, the Motor Current Limit and Overall Current Limit begin to increase until they reach maximum foldback capacity once again.

When Motor Current Limit or Overall Current Limit < Warning Level, an n524 status warning is triggered. When Motor Current Limit or Overall Current Limit < Fault Level, an F524 fault is triggered and the drive power stage is disabled. The load then coasts to a stop.

In the **Foldback** screen, setting the Warning Level to 0 turns off the warning feature. Otherwise, the Warning Level must be set above the Fault Level, but below the Motor Current Limit and Overall Current Limit to trigger a warning.

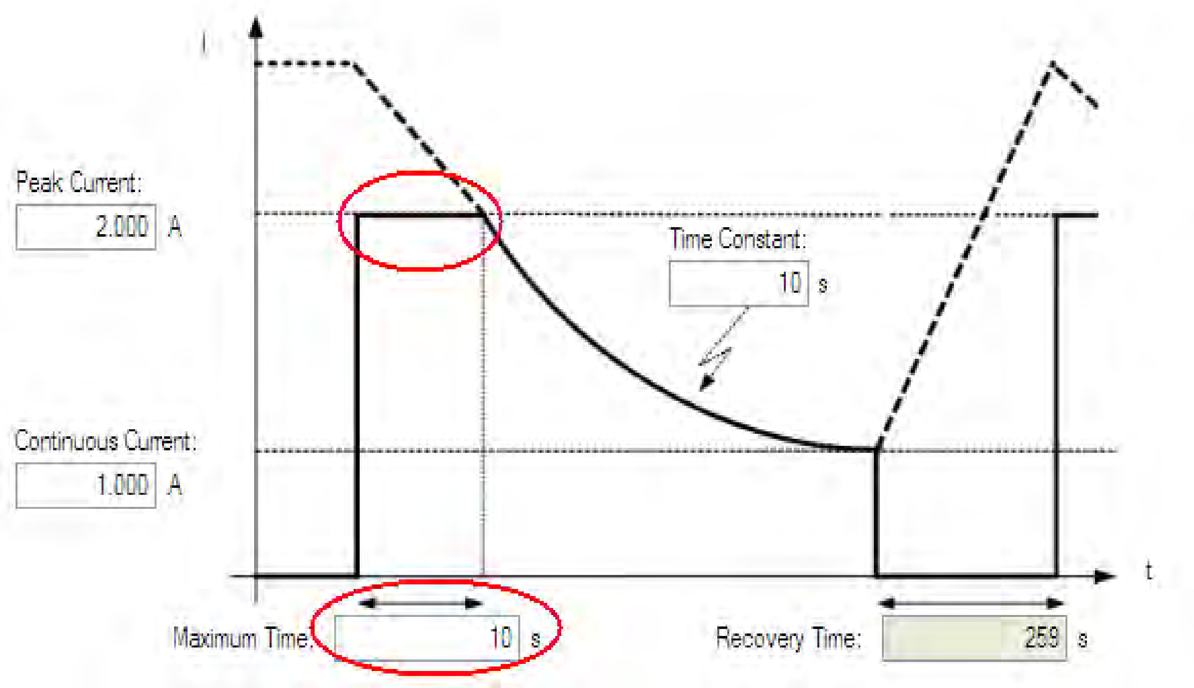


If User Fault Level is set above Fault Level, the User Fault Level will be ignored. The User Fault Level is used to increase the time the drive is operated in foldback mode without faulting. For instance if the default Fault Level is 9.000 Arms and a User Fault Level is set to 7.5 Arms, the Fault Level is changed to 7.5 Arms. This configuration effectively increases the time that foldback will be applied to the drive before faulting.



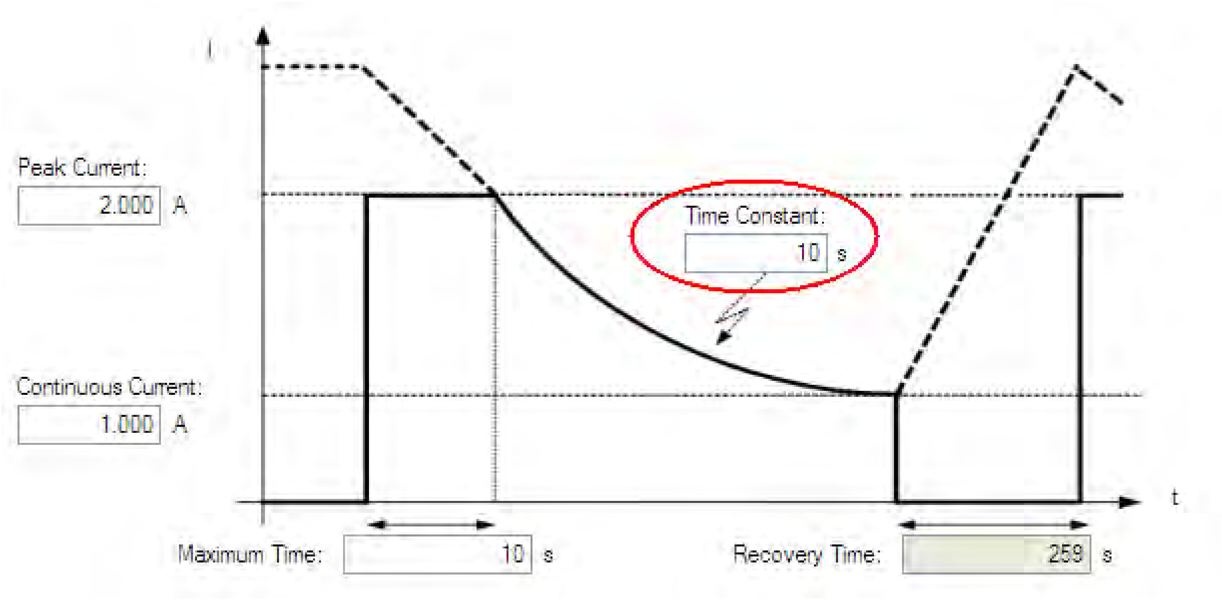
8.8.4 Motor Peak Current Time

Peak current (MOTOR.IPEAK) along with coil thermal constant (MOTOR.CTFO) are used to determine the maximum time the motor can sustain peak current. The maximum time (IL.MFOLDD) is displayed in the **Foldback** screen as shown below:



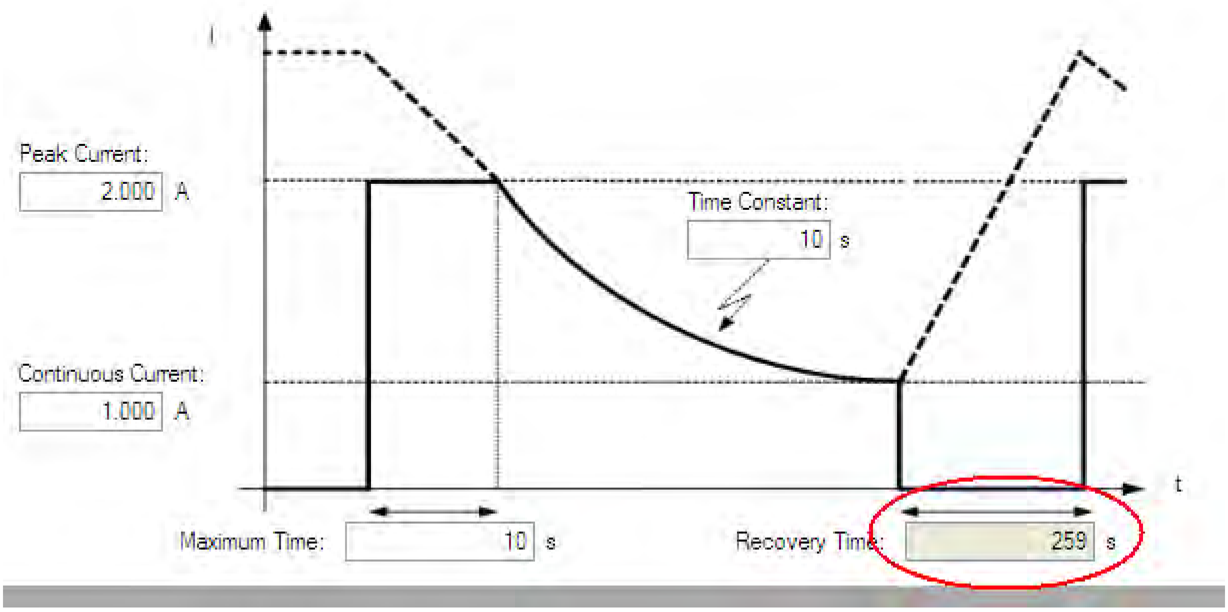
8.8.5 Motor Foldback Ramp

Once the maximum time for motor peak current has elapsed, if the move profile still demands peak current from AKD, the drive will exponentially lower the current applied to the motor. The Time Constant (IL.MFOLDT) dictates the profile. A smaller time constant represents a steeper decline in current applied to the motor.



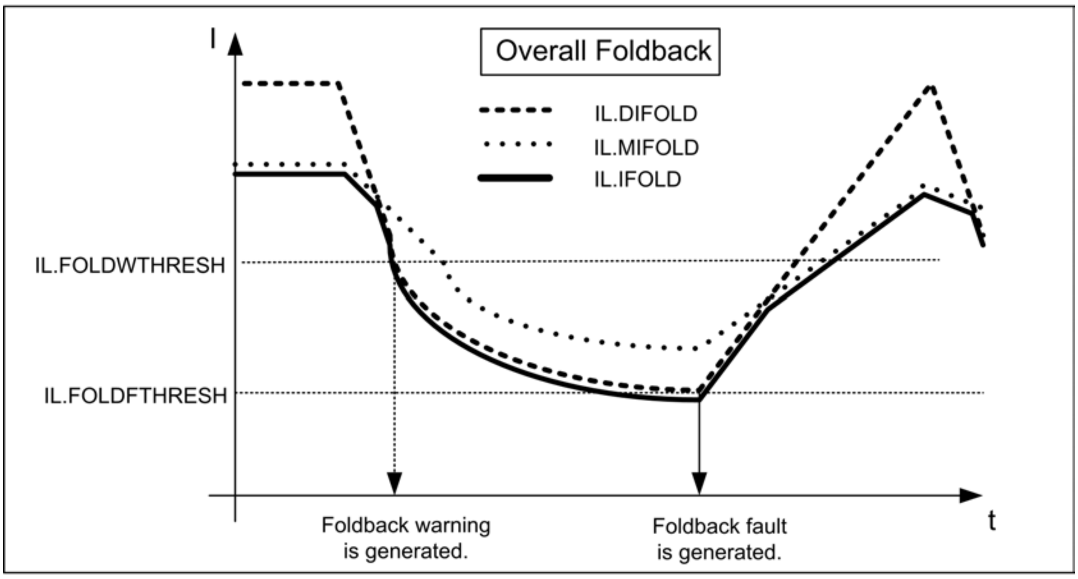
8.8.6 Motor Recovery

Once the peak motor current available has reached the continuous current of the motor, the motor needs Recovery Time (IL.MFOLDR) to cool down. Full Recovery Time (IL.MFOLDR) at 0 current is required for the motor to reach full maximum capacity in the shortest amount of time. The drive can command a current less than continuous current to continue driving the load, but the recovery time for full maximum capacity is increased.



8.9 Overall Foldback

The overall limit is the momentary minimum value between the drive foldback and the motor foldback. The overall foldback is shown in the diagram below. You can set the warning and the fault levels as shown in the diagram.



8.10 Brake

The brake output on connector X2 controls a mechanical brake that optionally may be fitted to a motor. The brake is applied and released relative to the **Drive Active** state of the drive. You can modify the release and apply delays using the parameters shown below.

Button or Dialog Box	Description	Parameter
Brake Control	Does this motor have a brake?	MOTOR.BRAKE
Brake Release Delay	The time between the drive being active and the brake being released.	MOTOR.TBRAKERLS
Brake Apply Delay	The time between the brake being applied and the drive not being active.	MOTOR.TBRAKEAPP

8.11 Using Position Capture

8.11.1 Overview

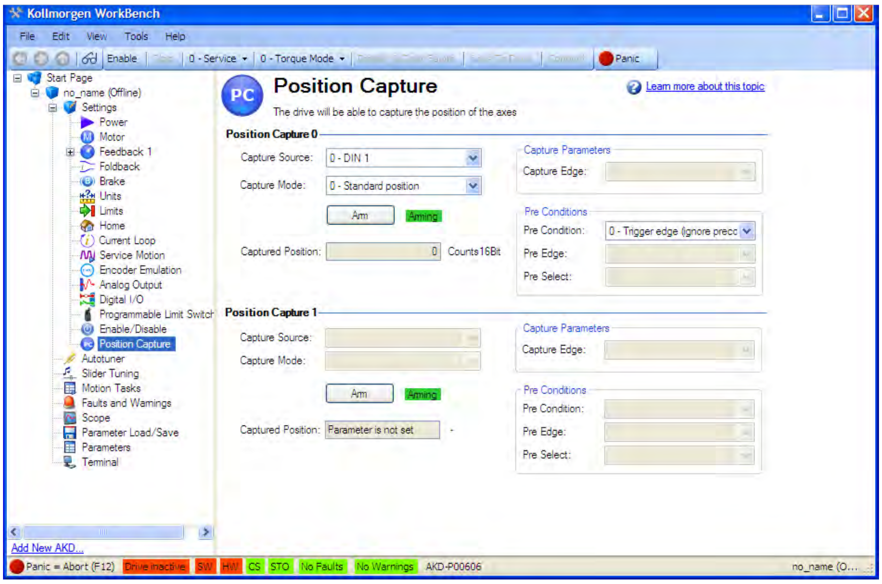
Position capture allows you to precisely determine what the motor position (or drive clock time) was when a specific event triggers. The AKD drive uses two independent captures, which operate similarly. The descriptions provided in this user guide refer to Capture 0, but also apply to Capture 1.

Position capture is used in precision environments, where the motor may be moving at very high velocities, an IO is triggered, and you must know exactly where the motor was when the event occurred. Homing algorithms often use position capture.

Position capture will capture the motor position (or drive clock time) when the capture trigger is activated. The capture engine operates on a faster clock than the 16 kHz clock used in the scope and recorder. This faster clock allows the position capture to obtain more accurate results than those obtained using the scope or recorder clock.

8.11.2 Configuring Position Capture

To configure the position capture, select **Position Capture** from the **Settings** group:



8.11.2.1   Setting the Capture Source (CAP0.TRIGGER)

The capture source determines which input on the drive causes the position capture to trigger.

Capture Source Options:

0 – DIN 1through **6 – DIN 7**. These options trigger on the Digital Input 1 pin through Digital Input 7 pin, respectively.

7 – RS485 Input 1 through **9 – RS485 Input 3**. These options trigger on the RS485 Input 1 pin through RS485 Input 3 pin, respectively.

10 – Primary Index. This option triggers on the primary encoder index.

8.11.2.2   Setting the Capture Mode (CAP0.MODE)

The capture mode determines what information is saved on the drive when the capture triggers.

Capture mode options:

0 – Standard Position. Captures the motor position in drive units

1 – Drive Internal Time. Captures the time of the trigger in ns

2 – Distributed Clock Time. Captures the network (Ethercat) distributed clock time

3 – Primary Encoder Signal. Captures the motor postion triggering on primary encoder index. This mode automatically rearms after each trigger.

If either **0 - Standard Position** or **3 - Primary Encoder Signal** is selected, delays may occur and are associated with feedback devices that are digital or interpolated .

8.11.2.3   Arming and Retrieving the Capture Value (CAP0.EN and CAP0.T)

CAP0.EN arms the capture and CAP0.T retrieves the capture value. Once you have configured the capture, you must arm it before it will trigger. Click **Arm** (1) to arm the capture.

Once the capture is armed, when it triggers, the captured value will be displayed below the Arm button (2).

8.11.2.4   Setting the Capture Edge (CAP0.EDGE)

The capture edge determines which input state change triggers the capture.

Capture Edge Options:

1 – Rising Edge. Captures when the input signal goes high, from a low state.

2 – Falling Edge. Captures when the input signal goes low, from a high state.

3 – Both Edges. Captures any time the input signal changes state.

8.11.2.5 Setting the Pre-Condition Event: (CAP0.EVENT)

The Capture Pre-Condition Event gives the user more flexibility in setting what conditions must be present for the Capture to trigger.

Event Options:

0 – No precondition. Capture triggers as soon as the capture edge occurs.

1 – Trigger Edge after precondition. Captures triggers only when the precondition occurs before the capture edge occurs.

2 – Trigger Edge while precondition = 1. Captures triggers only while the precondition is evaluated and is true while the capture edge occurs.

3 – Trigger Edge while precondition = 0. Captures triggers only while the precondition is evaluated and is false while the capture edge occurs

8.11.2.6 Setting up a Pre-Condition for complex capture

Setting the Precondition Edge: (Terminal Command: CAP0.PREEDGE)

The pre-edge determines what input state change triggers the precondition. This feature operates the same as the capture edge described above.

Setting the Pre-Condition Select: (Terminal Command: CAP0.PRESELECT)

The preselect chooses what input source will trigger the precondition (based on the preedge setting, and the prefilter setting). This feature operates the same as the capture source described above.

8.11.3 Related Parameters

CAP Parameters

9 Selecting Units for Your Application

9.1 Selecting Units 80
9.2 Units Example 80

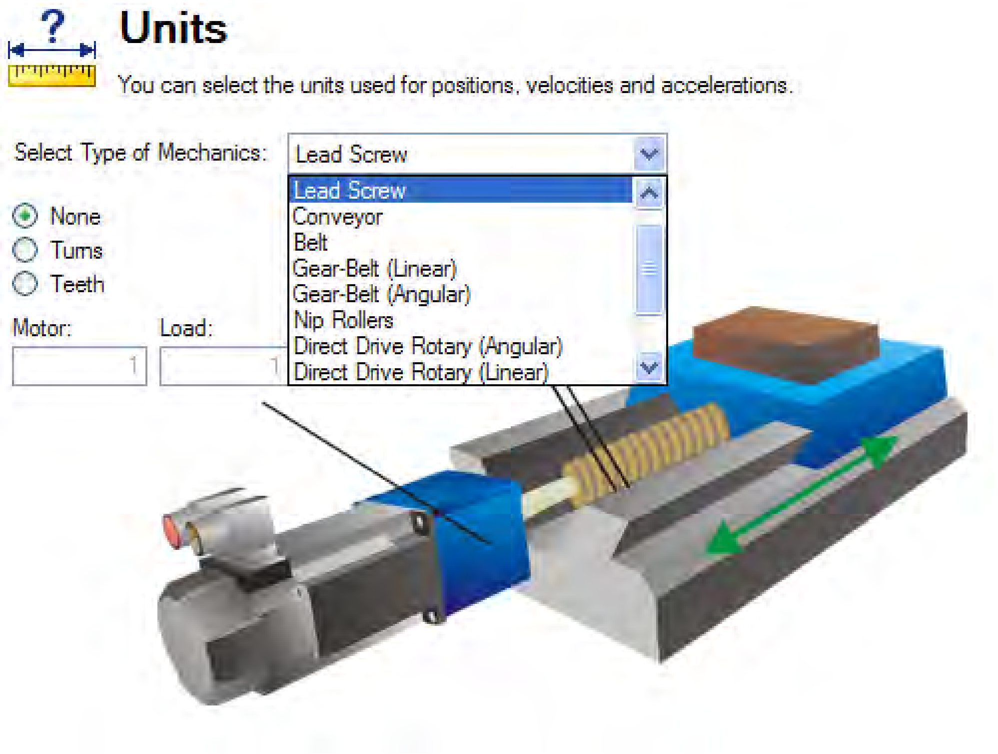
9.1 Selecting Units

The AKD uses three primary measures of motion: position, velocity, and acceleration. You must first choose units of measurement for each of these, and then enter the details of the mechanics in order to scale the chosen units appropriately.

9.2 Units Example

1. Select type of mechanics

To set the units in the drive for a particular application, first select the type of mechanics present.



2. Select Position Units

By default, position is measured in counts. Counts are the smallest unit of position that can be represented in the drive. This unit of measure equates to 4,294,967,296 counts/revolution of the motor. You can use the units screen to change this measurement into a meaningful scale relating to the units of the application.

For position units, five selections are available:

0-Counts (4,294,967,296/rev)

1 –Radians (2*π /rev)

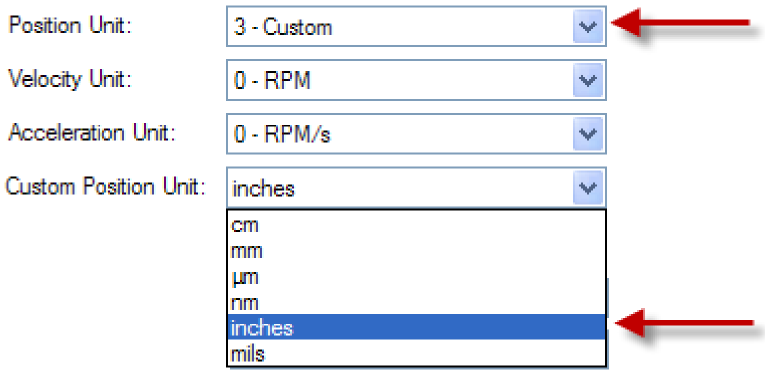
2- Degree (360/rev)

3 – Custom (set by user according to mechanics of machine)

4 – Counts (16-bit) (65,536 /rev)

The AKD uses full 32-bit quantization for internal calculations regardless of unit settings. User units settings will not affect performance, resolution, or accuracy of the servo system.

Choose “3-Custom”, and then select your desired position units, for example, millimeters.



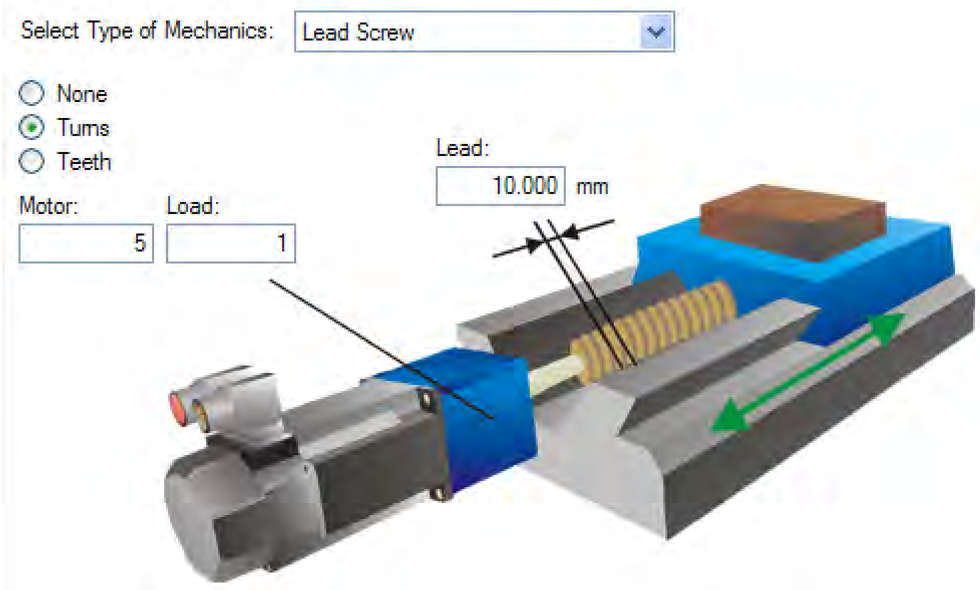
3. Select Velocity Units

For velocity, select **Custom/s** to set the measurement to mm/sec.

4. Select Acceleration Units

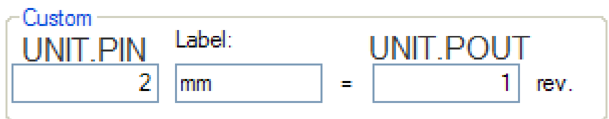
For acceleration, select **Custom/s^2** to set the measurement to mm/sec^2.

Once the chosen units of measurement are established, the details of the mechanics need to be entered to establish the scaling of the chosen units.



In this example, a lead screw with a 10 mm lead and a 5:1 gearbox has been selected. A 10 mm lead means the load will traverse 10 mm for every turn of the screw. A scale factor is applied based on the values entered for the chosen mechanics. This scaling is done through UNIT.PIN and UNIT.POUT parameters in the AKD, which are automatically adjusted when the mechanics values are entered.

In this example, scaling is adjusted as follows:



UNIT.PIN is calculated as follows:

10 mm/screw turn * 1 screw turn/5 motor turns = 2mm/motor turn

UNIT.PIN and UNIT.POUT can be directly entered using the **Motor Only** selection from the **Select Type of Mechanics** box.

9.2.1 Settings

The settings for units are automatically applied. The unit settings in the drive will reflect last settings made in the units screen before exiting. To save settings into the nonvolatile memory of the drive, click the **Save to Drive** button in the toolbar.

9.2.2 Related Parameters

UNIT Parameters

DRV.NVSAVEDRV.NVSAVE

MOTOR.TYPE

10 Configuring General Drive Settings

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10.1 Digital Inputs and Outputs

10.1.1 Overview

The drive has programmable digital inputs and outputs that you can use to initiate motion, control auxiliary devices, or trigger other actions. The inputs and outputs should be wired according to the instructions in the drive Installation Manual. Note that the input on pin 4 of the X8 connector is dedicated as an enable input.

10.1.2 Using Digital I/O

Once wired correctly, digital inputs and outputs can be used for a variety of functions such as to trigger auxiliary devices, initiate homing moves or other motion tasks, or set travel limits. This section describes the specific functionality of the programmable I/O.

I/O Tip: When using I/O devices, you must carefully consider the type of device you use for switches. An unsuitable switch can cause switch bounce, which in turn can cause erroneous triggers to occur. For example a low cost xx switch, as it is toggled, will bounce a few times before it turns on or off. A device that is monitoring these inputs frequently may interpret the bounce as multiple triggers of that I/O. The drive has the ability to reduce this type of error using some debounce techniques to ignore sudden state changes caused by bounces.

10.1.3 Digital Inputs

Digital inputs can be set in different modes based on the desired function. These functions are outlined below:

Mode 0: Off

This mode is the non-use state. The drive defaults to this setting.

Mode 1: Fault Reset

This mode is used to clear the drive faults. A change in state causes the drive to reset faults. This mode will only correct non-fatal faults (see fault chart). Upon a rising edge a command, which is similar to DRV.CLRFAULTS, is issued and faults are cleared.

Mode 2: Start Motion Task

This mode is used to start motion task number X. This input will trigger a motion task number as defined in the extra parameter field for this input.

X = the value of the associated input parameter.

It is assumed that motion task number X exists.

Example:

-->`DIN1.MODE 2` - sets the input mode to be Start Motion Task

-->`DIN1.PARAM 1` - sets the Motion Task to start to be 1.

-->`MT.LIST` - confirms that Motion Task 1 exists.

-->`10.000 [counts] 1000.000 [rpm] 0 1001.358 [rpm/s] 1001.358 [rpm/s] 0 0 0 [ms]`

<Create a rising edge of the input>

<Motion Task 1 executed>

Mode 3: Motion Task Select Bit

This mode is used to select the motion tasks that are stored in the drive (numbers 1 to 127) or the reference traverse/homing (0). The motion task number is presented externally at the digital inputs. The motion task set by this mode will be executed when digital input assigned to mode 4 (motion task start selected) gets a rising edge.

Example

Assume:

DIN1.MODE = DIN2.MODE

DIN3.MODE =3

The state of input 1 and 3 is 1.

The state of input 2 is 0.

Motion task 5 (2^0+2^2) will be executed.

Mode 4: Motion Task Start Selected

This mode is used to start the motion task that is stored in the servo amplifier, by giving the motion task number. This input utilizes a secondary variable for the motion task number to be started with the Input trigger. The secondary variable is set by mode 3 (Motion task select bit).

Motion task number “0” initiates homing/reference traverse. A rising edge starts the motion task and a falling edge cancels the motion task.

Mode 5: Start Home

This mode is used to start the homing motion task on the rising edge. The falling edge has no effect on this input mode of operation.

Mode 6: Start Jog

This mode is used to start a jog move. This input mode utilizes a secondary variable for the jog’s velocity. The jog will start upon a rising edge. A falling edge stops the jog.

Mode 7: Reserved

Mode 8: Zero Latch

This mode is used to define the current drive position as the zero pulse for the drive EEO and sets the incremental encoder zero pulse offset. The current position, depending on the incremental encoder resolution that is set, is calculated at the rising edge and stored as an offset. An automatic save is then generated. This function is used to perform an automatic setting of the zero pulse in one turn of the motor.

Mode 9: Command Buffer

This mode is used to execute four different sets of command buffers. Each set contains two buffers: low and high, for a total of eight buffers. DINx.PARAM for this mode can be 1 to 4, and determines which set of buffers to use.

To set the high and low values of the eight buffers from the terminal screen, use the commands DIN.HCMDx and DIN.LCMDx (1<=x<=4). Use ";" to separate the two buffer commands. Each buffer contains up to 128 characters.

Example:

-->`DIN1.MODE 9` (sets command buffer mode to digital input 1)

-->`DIN1.PARAM 1` (sets the first set of buffers to digital input 1)

-->`DIN.HCMD1 DRV.OPMOE 1;` (sets high command buffer)

-->`DIN.LCMD1 DRV.OPMOE 0;` (sets low command buffer)

Under this configuration, a rising edge in digital input 1 will set DRV.OPMODE to 1 and a falling edge will set DRV.OPMODE to 0.

You can also set the command buffers from the **Digital I/O** view in WorkBench; see 10.2 Command Buffer

Mode 10: Control Fault Relay

This mode is used to create an external fault.

Input state is 0 – drive regular behavior

Input state is 1 – “Fault 245 – external fault” is issued.

Mode 11: Home reference

This mode is used to receive a physical home reference switch located on the machine to use for the different Home Types.

Mode 12: Reserved

Mode 13: Controlled Stop

This mode is used to stop the motor using the deceleration variable ramp. If zero velocity is reached, the power stage is then disabled. Also see controlled stop (CS) parameters and commands and Controlled Stop.

Mode 14: Reserved

Mode 15: Quick Stop

This mode is used to stop the motor. It is equivalent to issuing a DRV.STOP command.

Mode 16: Activate Electronic Gearing

This mode starts/activates an electronic gearing procedure upon a rising edge.

Mode 17: Activate Electronic Gear Position Shift

This mode is used to add a position shift to the gearing upon a rising edge. The distance of the position shift is set by the secondary variable. The secondary variable is set by DINx.PARAM. The parameter is in position units and is used to incorporate a phase shift while operating in electronic gearing mode.

Example: An input is set to add a 180 degree "phase shift" when triggered. As the drive is following the electronic gearing input, the input is triggered and the motor will follow the drive acceleration and deceleration rates to shift 180 degrees while maintaining the gearing synchronization.

Mode 18: Positive Limit Switch

This mode will cause the input to operate as the positive limit switch. If the positive limit switch input is triggered (goes low), the positive direction motion will then be stopped.

⚠ CAUTION	**When setting up the hardware limit switches, you must be certain that the switch remains in the triggered state until you move off of the switch. A very low deceleration rate combined with a high approach velocity may overshoot the switch. This action will caue the position limit warning to be canceled. The warning is not latched, therefore if the switch is overshot, additional movement in the same direction (if commanded) will be possible. This movement can cause machine damage.**

Mode 19: Negative Limit Switch

This mode will cause the input to operate as the negative limit switch. If the negative limit switch input is triggered (goes low), the negative direction motion will then be stopped.

⚠ CAUTION	**When setting up the hardware limit switches, you must be certain that the switch remains in the triggered state until you move off of the switch. A very low deceleration rate combined with a high approach velocity may overshoot the switch. This action will caue the position limit warning to be canceled. The warning is not latched, therefore if the switch is overshot, additional movement in the same direction (if commanded) will be possible. This movement can cause machine damage.**

Mode 20: Brake Release

This mode is used to lift the brake when the drive is not active.

Input = 0: the drive controls the brake (regular drives behavior)

Input = 1: the user controls the brake (lift or close using commands)

Mode 21: Current Limit

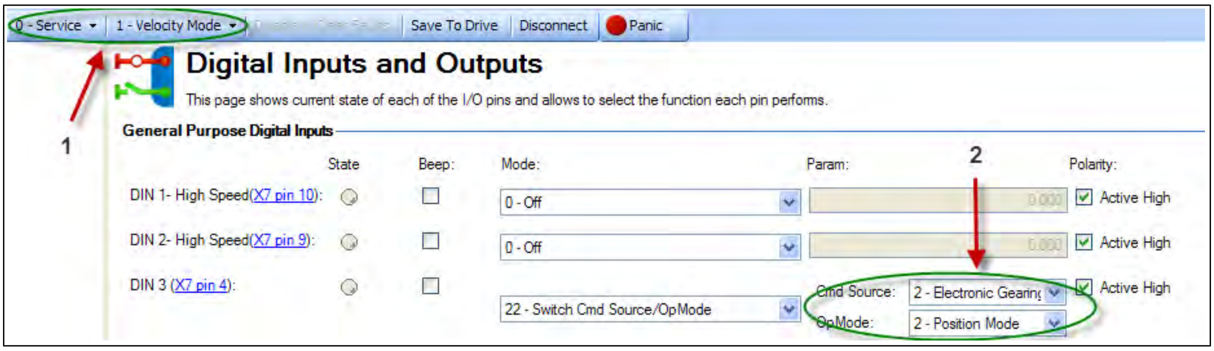
This mode is used to limit the drive current. The current limit is set by a secondary variable; use DINx.PARAM to set the secondary variable.

Mode 22: Switch Command Source and Opmode

This mode is used to switch between the present command source/opmode and another command source/opmode setting predetermined by the user upon the level change of a digital input. Arrow 1 in the screen shot below indicates the present command source/opmode that the drive is set for. This is the mode the drive is in when the digital input is not high. This low state is determined by the original settings for DRV.CMDSOURCE and DRV.OPMODE.

The drive will switch into the command source/opmode setting shown in arrow 2 when the digital input level changes to high. This setting is stored by DINx.PARAM and is edited with the drop down boxes at arrow 2.

Note: When the digital input is switched high, the DRV.CMDSOURCE and DRV.OPMODE will take the values defined by DINx.PARAM. Do not perform a "drive save" in this state, or the low state and high state settings will become the same.



DINX.PARAM	Command Source	Opmode
0	0-service	0-torque
1	0-service	1-velocity
2	0-service	2-position
10	1-fieldbus	0-torque
11	1-fieldbus	1-velocity
12	1-fieldbus	2-position
N/A	2-electronic gearing	0-torque
N/A	2-electronic gearing	1-velocity
22	2-electronic gearing	2-position
30	3-analog	0-torque
31	3-analog	1-velocity
32	3-analog	2-position

10.1.4 Digital Outputs

Mode 0-User (Default = 0):The output state is decided by the user or fieldbus.

Mode 1-Mains Ready: The output mode produces a high signal if the drive DC bus voltage is higher than the under voltage error level and lower than the over voltage error level.

Mode 2-Software Limit: This output turns on when the software limit positions are reached. This output procudes a high signal if a software limit is reached by traveling in the direction of that software limit. Software limits are set in the **Limits** view. In the **Limits** view, Position 0 is the position limit for negative travel, while Position 1 is the limit for positive travel.

Mode 3-Move Complete: When a motion task has completed its move and the trajectory reaches zero, the move is considered complete and the output will activate.

Mode 4-In Position: This output mode produces a high signal when the absolute value of the position error is less than than the parameter entered in the extra parameter field.

Mode 5-Position Greater than X: When the position is greater than the parameter entered in the extra parameter field, the output will activate.

Mode 6-Position Less than X: When the position is less than the parameter entered in the extra parameter field, the output will activate.

Mode 7-Warning: This output will activate when the drive experiences a warning, such as positive or negative limit switch input triggered.

Mode 8-Enable: If you need an output to indicate that the drive is enabled, use this output mode.

Mode 9: Reserved.

Mode 10-Motor Brake: The output mode produces a high signal if a brake is disengaged (this is when the power is applied to the brake and the motor is free to spin). The output mode produces a low if a brake is engaged (this is when power is removed from the brake and the brake is set).

Mode 11-Drive Faults: The output mode produces a high signal if the drive has a fault.

Mode 12-Absolute velocity greater than x: The output mode produces a high signal when the absolute value of the velocity is greater than a variable x. Use DOUTx.PARAM to set x.

Mode 13-Absolute velocity less than x: The output mode produces a high signal when the absolute value of the velocity is less than a variable x.

Use DOUTx.PARAM to set x.

Mode 14-Homing complete: The output mode produces a high signal when the homing process is

completed.

Mode 15- PLS.STATE bits OR connected: The output mode produces a high signal if at least one of the PLS.STATE bits is high (the PLS is active) and if the corresponding bit in the DOUTx.PARAM parameter also has been set to high. The DOUTx.PARAM command connects the PLS.STATE bits to the digital output itself and thus acts as an enable mask.

Example:

```
|<- Bit 7 to 0 ->|

DOUT1.PARAM = 23 = 0b 0 0 0 1 0 1 1 1 (Binary code)
```

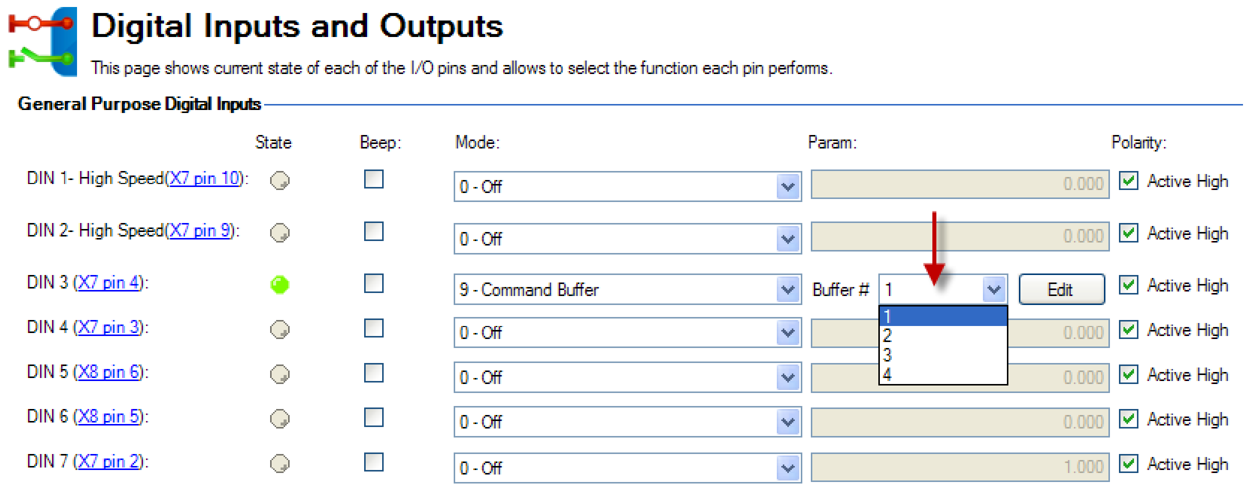
The digital output 1 is active when bit 0 or bit 1 or bit 2 or bit 4 of PLS.STATE is high. All other bits within PLS.STATE are not considered by the digital output mode due to the DOUT1.PARAM setting. Do not use decimal places for the DOUTx.PARAM parameter for this particular digital output mode.

10.2 Command Buffer

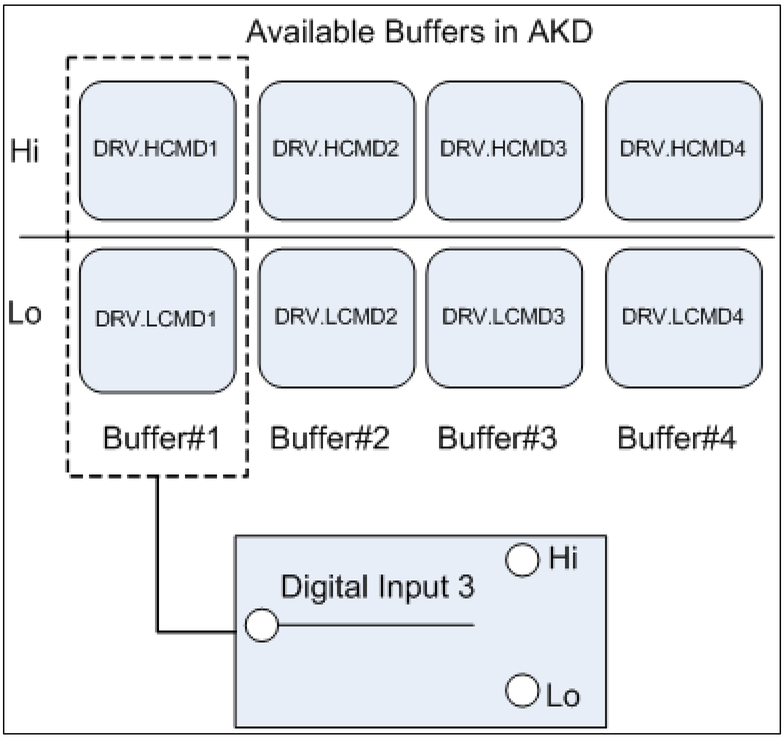
10.2.1 Overview

The Command Buffer input mode (10.1 Digital Inputs and Outputs) allows you to change values for parameters using a digital input.

The drive has four available buffers. A digital input configured for command buffer mode is linked to one command buffer set. This is determined by the user (see arrow 1). In this case, command buffer 1 is used.



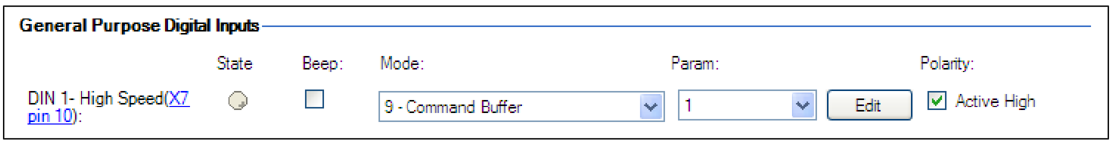
The graphic below explains the architecture of the buffers.



10.2.2 Editing the Command Buffers

By default, the buffers are empty. Each side of the buffer can contain 128 characters maximum (parameter and value included). You can use the **Command Buffer Editor** to enter the sequence of commands to the digital input buffer. You can enter the sequence of commands into Low command buffer (DIN.LCMDx) or High command buffer (DIN.HCMDx) and save these settings to the drive.

To edit the command buffers, open the **Digital I/O** view and select **Digital input mode** as **9 – Command Buffer**.



The **Param** box lists the available command buffers. Select desired command buffer number for the DIN. This number sets to the DINx.PARAM keyword. When you mouse over the **Param** box, the Tooltip displays the current content of the High command buffer and Low command buffer in the drive.

To edit the selected command buffer, click **Edit** to display the command buffer editor screen.

The command buffer editor screen has following properties:

Button or Dialog Box	Description
Command Buffer Number	The identification number of the command buffer (1, 2, 3, 4).
High Command Buffer	Adds sequence of commands to the High command buffer parameter. Contents are saved to the keyword DIN.HCMDx. A maximum of 128 characters can be set to drive along with the separator ";". Commands must be entered line by line and when saving to the drive each commands will be formed into single line separated by ";".
Low Command Buffer	Adds sequence of commands to the Low command buffer parameter. Contents are saved to the keyword DIN.LCMDx. A maximum of 128 characters can be set to drive along with the separator ";". Commands must be entered line by line and when saving to the drive each commands will be formed into single line separated by ";".
Ok	Saves the sequence of commands to the drive.
Close	Closes the screen and returns to Digital I/O view. If contents are not saved to drive before closing the screen, confirmation message "The commands have been modified and not save to drive. Do you want close without saving?" is displayed.

Commands and parameters are entered on separate lines with a space between the parameter and the value.

A semicolon separator is not necessary in the editor, but it is required if the buffers are edited inside the terminal window.

10.2.3 Behavior of the Command Buffer

Digital inputs have either a high or a low state. The contents of the buffer are executed at the rising edge of the state change. The contents of the buffer are also loaded at drive power up according to the starting state of the digital input. When the command buffer is initially configured, the buffer is not executed until the first digital input state change is detected.

Tip: Once you have the buffer configured and tested, put the digital input in the most common state that it will be in at start up. Save the parameters to the drive. This will synchronize the NVRAM with the buffer, so at start up, values will not have to be changed.

10.2.4 Delays for the Buffer

There is a delay command that can be used to delay the execution of a command or parameter change (DRV.CMDDELAY). The value can be from 0 ms to 5000 ms.

The following commands may require a delay before the next command in the buffer can be executed:

DRV.EN (100 ms min)

DRV.DIS (50 ms min)

Example:

```
DRV.EN
DRV.CMDDELAY 100
MT.MOVE
```

The command buffer does not send back warnings when a parameter is invalid or out of range, so make sure the syntax is correct and that the digital input changes during legal drive states for the commands given.

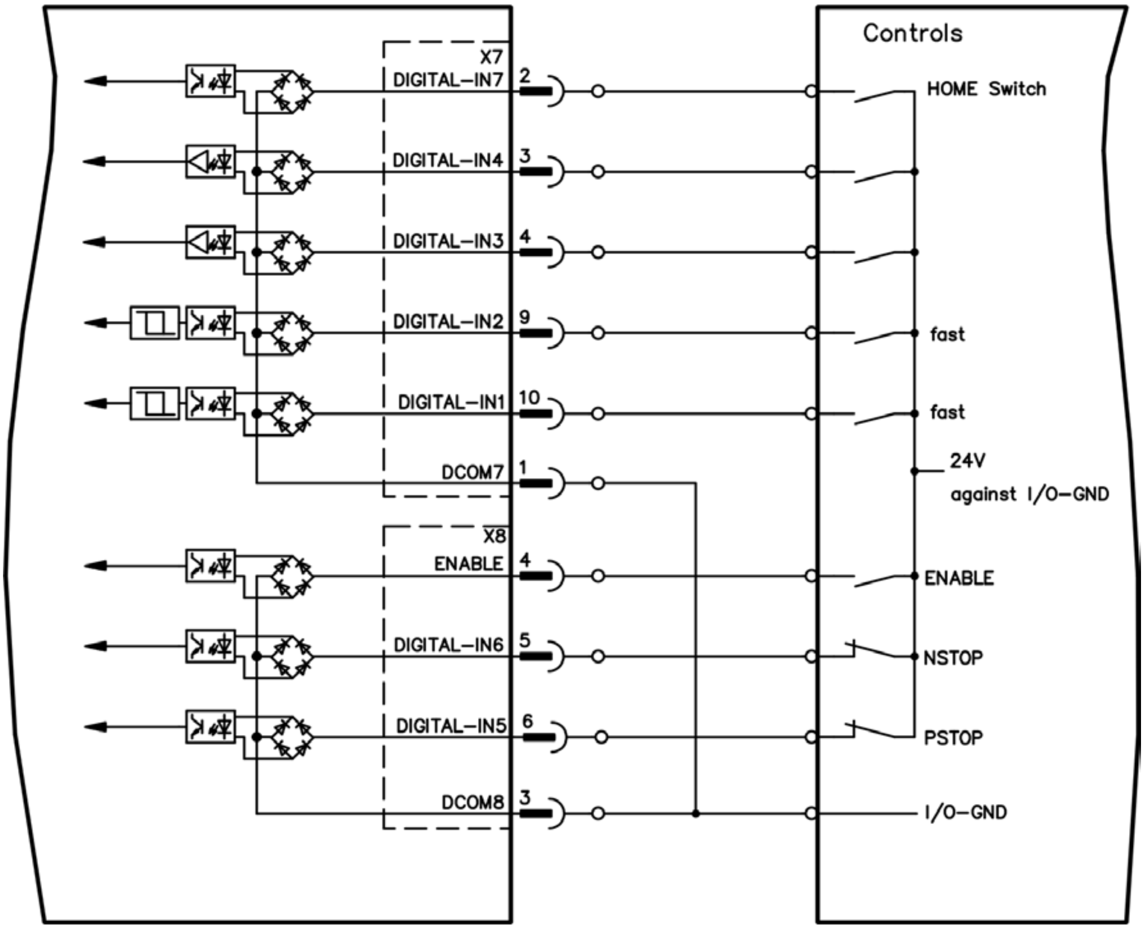
10.3 Digital Inputs (X7/X8)

The drive provides 8 digital inputs (=> p. 239). These can be used to initiate pre-programmed functions that are stored in the drive. A list of these pre-programmed functions is included in the WorkBench. Digital Input 8 is not programmable but is fixed to the ENABLE function.
If an input is programmed, it must be saved to the drive.

NOTE	**Depending on the selected function the inputs are high or low active.**

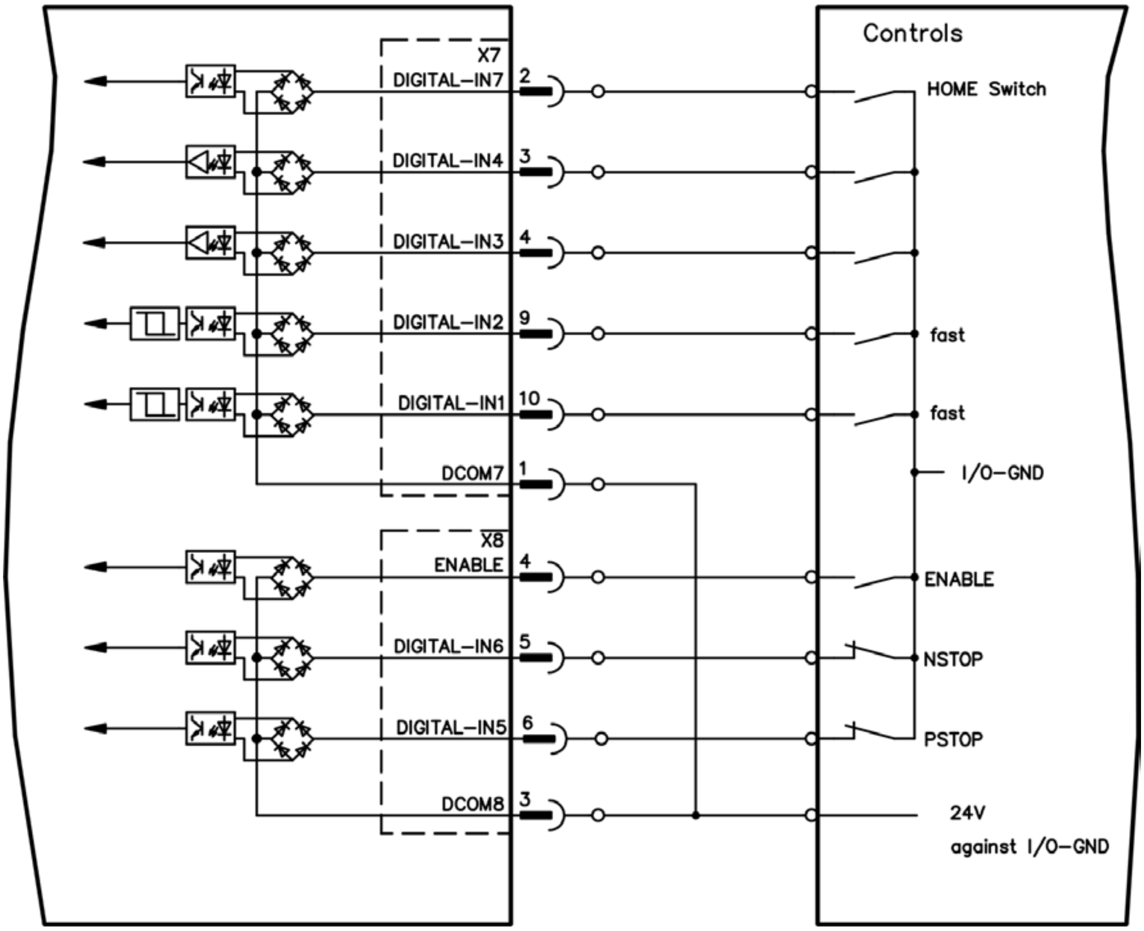
The inputs can be used with switched +24 V (source type) or switched GND (sink type). See diagrams below.

Digital Input Wiring Diagram (Source type connection)



Controls
X7
DIGITAL–IN7
2
HOME Switch
DIGITAL–IN4
3
DIGITAL–IN3
4
DIGITAL–IN2
9
fast
DIGITAL–IN1
10
fast
DCOM7
1
24V
against I/O–GND
X8
ENABLE
4
ENABLE
DIGITAL–IN6
5
NSTOP
DIGITAL–IN5
6
PSTOP
DCOM8
3
I/O–GND

Digital Input Wiring Diagram (Sink type connection)



10.3.1 Digital Inputs 1 and 2

These inputs (X7/9 and X7/10) are particularly fast and are therefore suitable for latch functions, for example. They can also be used as 24 V inputs for electronic gearing (=> p. 1)

Technical characteristics

- Floating, reference common line is DCOM7
- Sink or Source type sensors possible
- High: 15 to 30 V/2 to 15 mA , Low: -3 to 5 V/<15 mA
- Update rate: Hardware 2 µs

10.3.2 Digital Inputs 3 to 7

These inputs are programmable with the setup software. By default,all inputs are not programmed (off).

For more information refer to the setup software.

Technical characteristics

Choose the function you require in WorkBench.

- Floating, reference common line is DCOM7 or DCOM8
- Sink or Source type sensors possible
- High: 15 to 30 V/2 to 15 mA, Low: -3 to 5 V/<15 mA
- Update rate: Software 250 µs

10.3.3 Digital Input 8 (ENABLE)

Digital Input 8 (terminal X8/4) is set to Enable function.

- Floating, reference common line is DCOM8
- Sink or Source type wiring is possible
- High: 15 to 30 V/2 to 15 mA , Low: -3 to 5 V/<15 mA
- Update rate: direct connection to hardware (FPGA)

The output stage of the drive is enabled by applying the ENABLE signal (Terminal X8/4, active high). Enable is possible only if input STO has a 24 V signal (see page 1). In the disabled state (low signal) the connected motor has no torque.

A software enable by means of the setup software is also required (AND link), although this can also be permanently enabled with WorkBench.

10.4 Analog Input

10.4.1 Analog Input

If the drive command source is set to analog, then the analog input to the drive supplies the current or velocity command to the control loops of the drive.The default analog input screen displays a summary block diagram of the analog input. You can adjust the analog input settings from this view as follows:

Button or Dialog Box	Description	Parameter
Offset	The offset adds a bias to the analog input command. This offset is commonly used to remove any biases that may be present on the analog input signal.	AIN.OFFSET
Input Voltage	The value of the analog input after the offset, deadband, and low pass filters.	AIN.VALUE
Scale	If the opmode is current mode, then this value is the amount of current that will be commanded for each volt on the analog input. If the opmode is velocity mode, then this value is the velocity that will be commanded for each volt on the analog input.	AIN.ISCALE AIN.VSCALE AIN.PSCALE
Torque Command	The current or velocity command that is sent to the control loops.	IL.CMD PL.CMDor VL.CMD

Click the **More** button to access a detailed view of the analog input. You can adjust additional analog input settings from this view as follows:

Button or Dialog Box	Description	Parameter
Low Pass Filter	The break point frequency for the low pass filter.	AIN.CUTOFF
Deadband	The threshold for the deadband. This parameter is commonly used to reduce noise while the drive is stationary.	AIN.DEADBAND

Both analog input views provide a link to the encoder emulation output setup; see 8.4.1 Encoder Emulation for more details on this feature.

10.4.2 Related Parameters and Commands

AIN Parameters

10.5 Analog Output

The drive has one analog output. You can either directly control the voltage output or select a different mode to output different signals. Analog output is configured through the X8 connector; for detailed information this connector, see Connection Diagrams, Analog Output.

Button or Dialog Box	Description	Parameter
Analog Output Mode	Select which internal signal is output by the analog output.	AOUT.MODE
Analog Output Value (user)	Enter the analog output value (when AOUT.MODE = 0, analog output signal is determined by the user)	AOUT.VALUEU

Button or Dialog Box	Description	Parameter
Analog Output Value	Displays the voltage that this analog output generates.	AOUT.VALUE
Analog Velocity Scale Factor	Scales the analog output (AOUT.VALUE) for AOUT.MODE = 1, 2, or 3.	AOUT.VSCALE

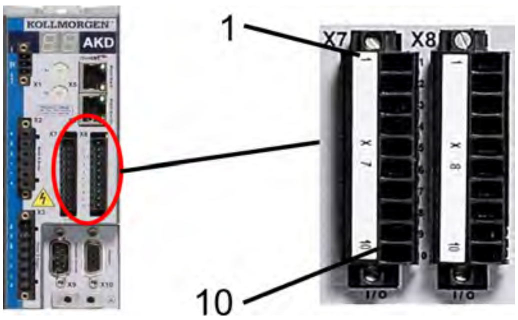
The analog output modes consist of the following:

AOUTx.MODE	Description
0	User variable. The analog output signal is determined by the user (using AOUT.VALUEU).
1	Actual velocity. The analog signal describes the current velocity value.
2	Velocity error. The analog signal describes the velocity error value.
3	Velocity command. The analog signal describes the velocity command value.
4	Actual current. The analog signal describes the actual current value.
5	Current command. The analog signal describes the current command value.
6	Actual position. The analog signal describes the current position value.
7	Position error. The analog signal describes the position error value.
8	Triangle wave. The analog signal is a triangle wave (sawtooth pattern).
9	Debug mode. In this mode the user can define a drive variable to monitor via the analog output (AOUT.VALUEU).

Analog output return

10.6 I/O Connection

All standard digital and analog I/O signals are connected to X7 and X8.



10.6.1 I/O Connectors (X7 and X8)

Conn.	Pin	Signal	Abbreviation	Recommended Function	Specials
X7	1	Digital Common X7	DCOM7	Common line for X7 pins 2, 3, 4, 9, 10	N/A
X7	2	Digital Input 7	DIGITAL-IN 7	Programmable	N/A
X7	3	Digital Input 4	DIGITAL-IN 4	Programmable	N/A
X7	4	Digital Input 3	DIGITAL-IN 3	Programmable	N/A
X7	5	Digital Output 2-	DIGITAL-OUT2-	Programmable	N/A
X7	6	Digital Output 2+	DIGITAL-OUT2+	Programmable	N/A
X7	7	Digital Output 1-	DIGITAL-OUT1-	Programmable	N/A
X7	8	Digital Output 1+	DIGITAL-OUT1+	Programmable	N/A
X7	9	Digital Input 2	DIGITAL-IN 2	Reference point	high speed
X7	10	Digital Input 1	DIGITAL-IN 1	Home switch	high speed
X8	1	Fault Relay Output	Fault Relay Output	N/A	N/A
X8	2	Fault Relay Output	Fault Relay Output	N/A	N/A
X8	3	Digital Common X8	DCOM8	Common line for X8 pins 4, 5, 6	N/A
X8	4	Digital Input 8	DIGITAL-IN 8	Output stage enable	not programmable
X8	5	Digital Input 6	DIGITAL-IN 6	Negative limit switch	N/A
X8	6	Digital Input 5	DIGITAL-IN 5	Positive limit switch	N/A
X8	7	Analog Ground	AGND	Analog GND	N/A
X8	8	Analog Output +	Analog-Out	Actual velocity voltage	N/A
X8	9	Analog Input -	Analog-In-	Velocity set point	N/A
X8	10	Analog Input +	Analog-In+		N/A

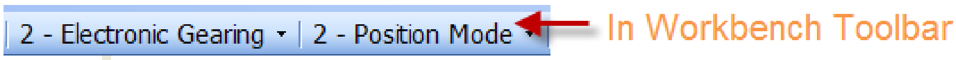
Digital common lines for X7 and X8 are not common to each other.
The DCOMx line should be connected to the 0V of the I/O supply when using sensors of type "Source" with digital inputs.
The DCOMx line should be connected to the 24V of the I/O supply when using sensors of type "Sink" with digital inputs.

10.7 Electronic Gearing

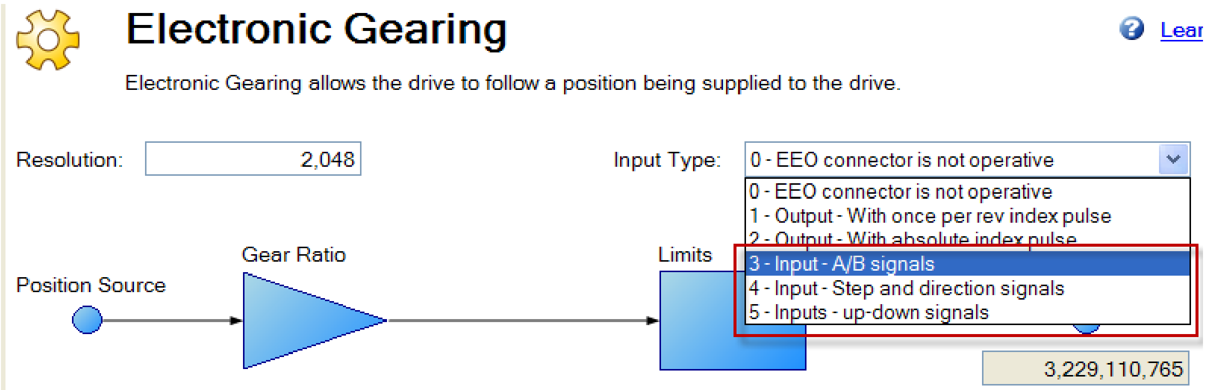
10.7.1 Overview

Electronic gearing is the act of sending a digital pulse position command to the AKD drive. The X9 connector is used for controlling the drive through an A/B type signal, pulse and direction (also called step and direction), or up/down command. A common application for electronic gearing is using servos with a stepper controller or daisy chaining multiple AKD drives from one master drive as slave drives.

In order to command an AKD using electronic gearing, the command source (DRV.CMDSOURCE) must be set to **2-Electronic Gearing** and the opmode (DRV.OPMODE) must be set to **2-Position Mode**.

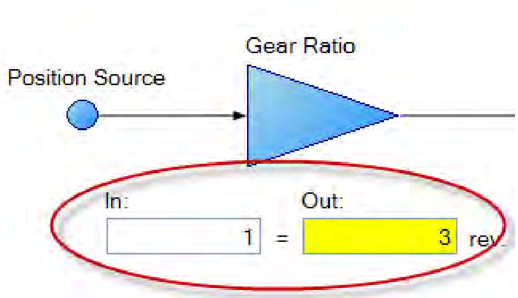


The input modes of the X9 connector are used to set up the AKD for electronic gearing.



Only input modes 3,4, and 5 pertain to electronic gearing input.

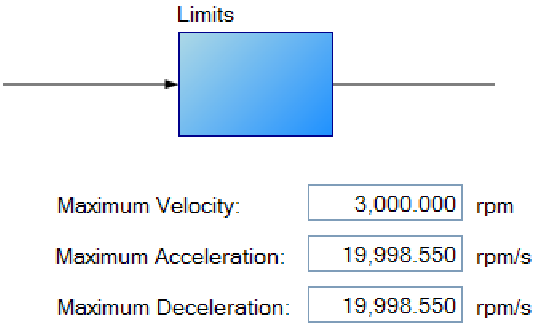
Resolution is the post-quadrature value of the counts/revolution of the input. Additionally, a gear ratio can be applied to affect the output ratio of the motor.



The position command (DRV.HANDWHEEL) reads the EEO value, where 4,294,967,296 is a full revolution of the input, then the value rolls over. Gear ratio does not affect the EEO value. If the output is set to 3 output revs per input rev, there will be 4,294,967,296 counts per 3 revolutions of the motor.

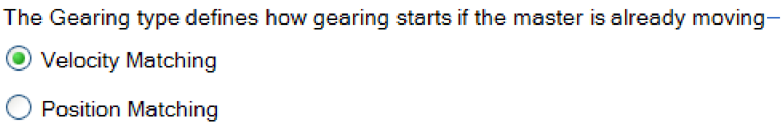
10.7.2 Limits

Electronic Gearing has independent limits, as shown below:



These limits (GEAR.ACCMAX, GEAR.DECMAX, GEAR.VELMAX) are applied only during gearing mode and the units are consistent with speed and acceleration of the output motor. All other limits in the drive are active along with gearing limits.

If the master is already moving when entering electronic gearing mode, velocity or position can be matched (GEAR.MODE):



In **Velocity Matching**, the motor will ramp up to the same velocity with no concern over lost steps during the acceleration period.

In **Position Matching**, the motor will match the position command from the switchover point by speeding up to recover the lost steps during the acceleration period.

More information on each type of input mode is found here:

3 – AquadB (see Command encoder signal connection

4 – Pulse/Direction input (see Pulse / Direction signal connection)

5- Up/Down input (see Up / Down signal connection)

10.7.3 Determining Maximum Cable Length

When you use an external incremental encoder as an input to X9, you must determine the maximum allowable cable length.

NOTE	**This information is only applicable when using an external encoder as either a secondary feedback input or a gearing command (DRV.EMUEMODE3). Not applicable for any other X9 mode or when using two AKDs in a master/slave system.**

The X9 port has a 5V output used to supply power to an external incremental encoder.

The maximum cable length depends on the current draw of the external encoder and the cable type connecting the X9 port. The following example can be used as a guide to calculate the maximum cable length for your application.

X9 port characteristics:

Nominal Supply Voltage:5 V

Tolerance: 5%

Minimum Supply Voltage: 4.75 V

Maximum current: 0.25 A

Permitted wire gauge: 20-28 AWB (Typical for D9 connector)

Sample Application Hardware:

Example external encoder: Hengstler RI-36H (RS-422 encoder) used with X9 port.

Encoder Nominal Supply Voltage: 5V (+/- 10%)

Minimum Supply Voltage: 4.5 V calculated based on tolerance above

Maximum required encoder supply current: 50 mA

Example cable:

Lapp Li2YCY - 24AWG (0.22 mm^2)

Loop resistance: 0.186 Ohms/m

Sample Calculations:

Maximum Permissible voltage cable drop = 0.25 V

= (Minimum Supply Voltage from AKD) 4.75 V – (Minimum supply voltage of RI-36H encoder) 4.5V

Maximum permissible resistance of cable run to X9 = 5 Ohms

= (Max voltage cable drop) 0.25V ÷ (Maximum encoder current) 0.05A

Maximum permissible cable length for example application = 26.9 m

= (Max cable resistance) 5 Ohms ÷ 0.186 Ohms/m

10.7.4 Related Parameters:

GEAR Parameters

DRV.CMDSOURCE

DRV.EMUEMODEDRV.EMUEMODE

DRV.EMUERES

DRV.HANDWHEELDRV.HANDWHEEL

DRV.OPMODE

This screen allows you view and modify the various drive limits.

Button or Dialog Box	Description	Parameter
Current Limits		
Positive Peak Current	The maximum positive current allowed.	IL.DLIMITP
Negative Peak Current	The maximum negative current allowed.	IL.DLIMITN
Velocity Limits		
Positive Speed Limit	The maximum speed allowed in the positive direction.	VL.LIMITP
Negative Speed Limit	The maximum speed allowed in the negative direction.	VL.LIMITN
Over Speed Limit	The threshold velocity for an over speed fault.	VL.THRESH
Position Limits		
Maximum Following Error	The maximum position error. If the position error PL.ERR is larger than PL.ERRFTHRESH, then the drive generates a fault	PL.ERRFTHRESH
Position Limit 0	The minimum position the drive can reach before generating a negative software position fault.	SWLS.LIMIT0
Position Limit 1	The maximum position the drive can reach before generating a positive software position fault.	SWLS.LIMIT1
Acceleration Limits		
Acceleration	The acceleration ramp used to profile some motion.	DRV.ACC
Deceleration	The deceleration ramp used to profile some motion.	DRV.DEC
Motor Limits	Motor limits are set through the Motor Foldback Screen (see 8.8 Foldback	

10.7.5 Limits

The limits screen covers most of the basic system limits, including current, velocity, and position.

- **Current Limits:** The current limits are set based on the drive ratings. You can change these limits to be lower then the default values for the drive, however, this may effect the expected performance of your application.
- **Velocity Limits:** The velocity limits are set based on the motor ratings. You can modify these settings above the ratings of the motor if the application requires some overhead, but be aware the motor has mechanical limitations and may be damaged if run above those limits. It is best to leave these at the default ratings for the motor selected.
- **Position Limits:** The position limits can be set based on your specific machine application requirements. The Maximum Position Error can be set to cause a fault when the position error exceeds the value you insert here. Position Limit 0 is tied to the clockwise (positive) motor direction. As the motor reaches the position entered, the motor will stop and display a warning n107. Position Limit 1 is tied to the counter-clockwise (negative) motor direction. As the motor reaches the position entered, the motor will stop and display a warning n108.
- **Acceleration Limits:** This field allows you to raise accelerations to give the system crisp moves. These limits default to a low value, so you may wish to change these after the mechanics and other sections of your system are defined.

10.8 Programmable Limit Switch

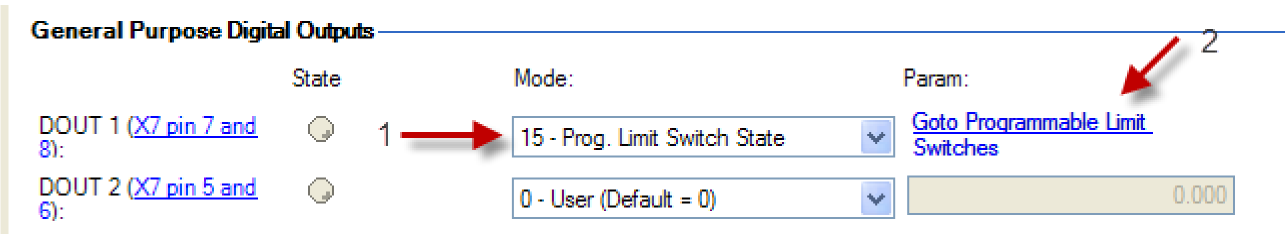
10.8.1 Overview

Programmable Limit Switches (PLSs) are used to turn on and off drive digital outputs based on the drive's position. Multiple positions can be combined to affect the state of an output when PLSs are combined.

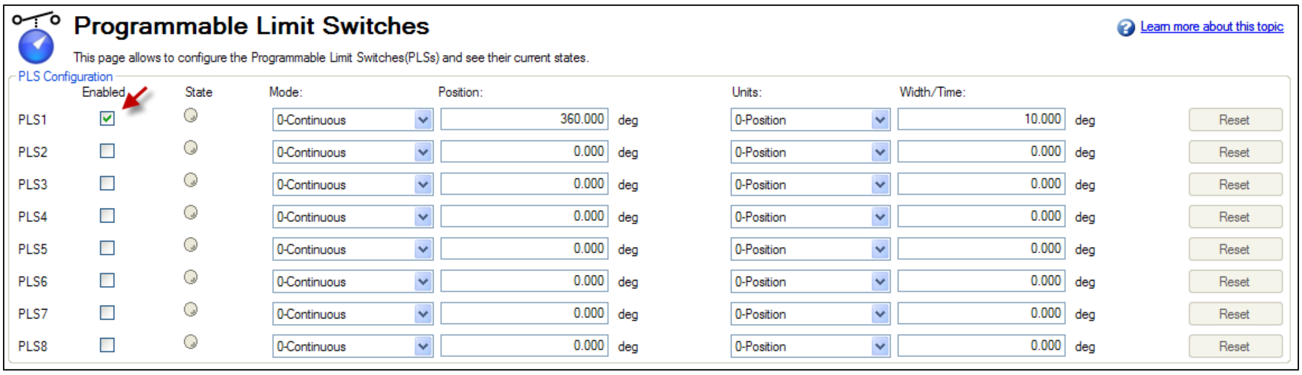
10.8.2 Using Programmable Limit Switches

To use PLSs, you must first configure a digital output as follows:

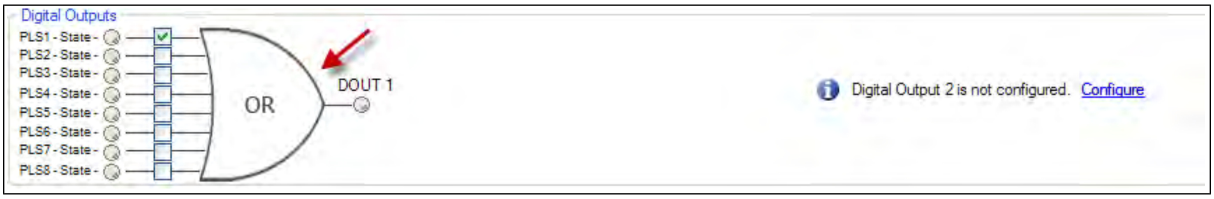
1. Click on the Digital I/O icon in the the tree view.
2. Set the output of your choice to mode fifteen (see 1 below). In this example, digital output 1 is used.
3. Now that the digital output mode is set for PLS, you can click on the **Goto Programmable Limit Switch** link (see 2 below) to open the PLS screen (this screen is also shown in the WorkBench tree view).



The PLS screen is used to establish the positions for the output(s) to turn on.

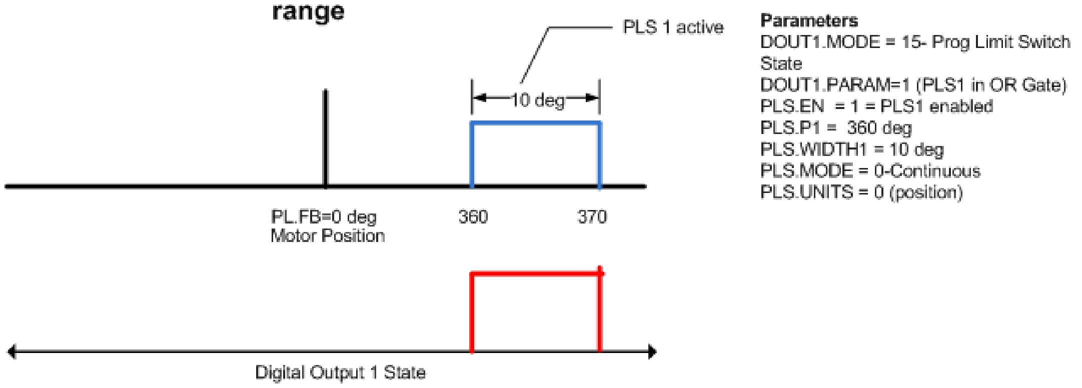


The PLS configuration section of the screen sets the mode and limits of each of the eight PLSs. The PLS is ignored unless it is enabled (see arrow). In the screen example, PLS1 is set for continuous operation in position mode. Every time the 360 degree position (PL.FB) is crossed in either direction, the output will turn on for 10 degrees of motor movement.

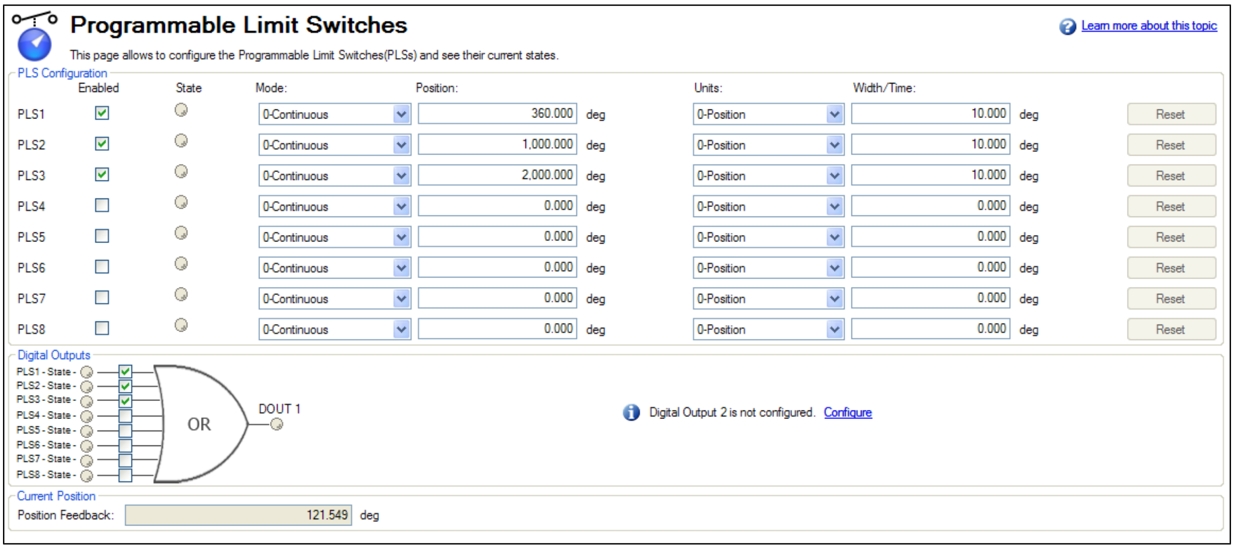


The final step is to configure the OR gate for the PLSs on which output is triggered. The gate appears for setup in the screen when a digital output is configured in Mode 15 – Prog Limit Switch State. Since only PLS1 is configured, select PLS 1 (see arrow above)

PLS Example 1 – Turning on a digital output for a position range

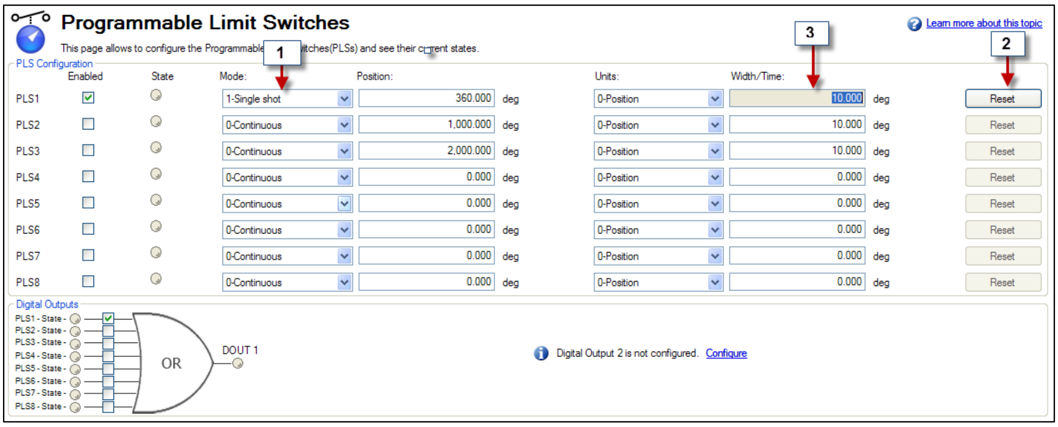


To setup an output with multiple turn-on points, configure and enable more PLS's and include them in the OR Gate.

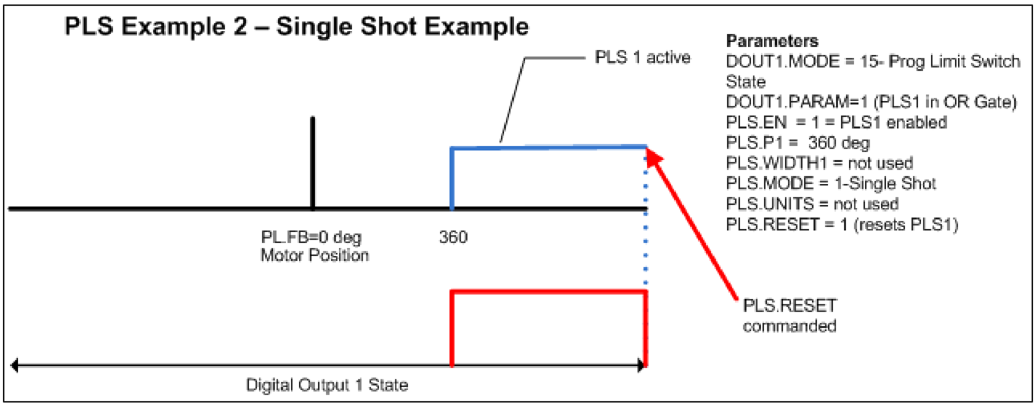


10.8.3 Single Shot Mode

Single shot mode is a special mode of PLS. Single shot mode (see 1 below) turns on the output until it is reset (see 2 below). Normal operation of this mode usually depends on a machine controller to reset the PLS using the fieldbus object for PLS.RESET.



Single Shot Example:



10.8.4 Related Parameters and Commands

PLS Parameters and Commands

10.1 Digital Inputs and Outputs

10.9 Enable/Disable

10.9.1 Overview

The AKD offers a wide variety of options on how you can use the hardware and software enables, as well as STO to cover the variety of conditions you may require.

10.9.2 Enable Modes

10.9.2.1 Hardware Enable Mode

The AKD has two methods which the drive can be enabled, using the Hardware enable. This is controlled by DRV.HWENMODE. Mode 0 allows for the drive to enable and clear faults on the rising edge of the hardware enable input. Mode 1 will NOT clear any faults on the rising edge of the hardware enable input, allowing you to review any current faults and manually clearing.

10.9.2.2 Software Enable Default

In addition, the Software Enable has two methods for enabling the AKD. This is controlled by DRV.E-NDEFAULT. Default 0 leaves the software in the disabled state upon start-up. Default 1 enables the software upon start-up.

10.9.3 Disable Modes

Use DRV.DISMODE to select the method for stopping the drive.

Mode 0: Immediately disable drive.

With this condition, the drive will immediately disable the power stages and the driven motor will either coast to a stop or in the case of a vertical or overhung load axis, will fall abruptly. If a brake is present, the brake will be applied according to MOTOR.TBRAKEAPP. Using Digital Input mode 13, you can achieve a controlled stop as described in Mode 2.

Mode 1: Dynamic Brake to a stop.

In this situation, the drive will utilize the dynamic brake feature and stop motion quickly, then disable the power stage. In most cases, the driven motor will stop quickly (pending the joules available and load circumstances). In the case of an overhung or vertical load, the driven motor will attempt to stop, but then will continue to allow the load to fall if no measures have been taken to secure the load.

Note for Modes 2 and 3, you can access the Controlled stop section to set the values of the controlled stop deceleration rate, the velocity threshold, and time in velocity threshold to deactivate the drive.

Mode 2: Controlled stop, then disable.

In this mode, a controlled stop will take place based on a variety of parameters that you set. First, the driven motor will decelerate at a controlled rate (CS.DEC) until one of two things happens. 1) The motor reaches the velocity limit set (CS.VTHRESH) for a period of time (CS.TO), or 2) The drive emergency time out is reached (DRV.DSTO). Once either of these cases is reached, the power stage will be disabled (and brake applied if present)

Mode 3: Controlled stop, then dynamic brake.

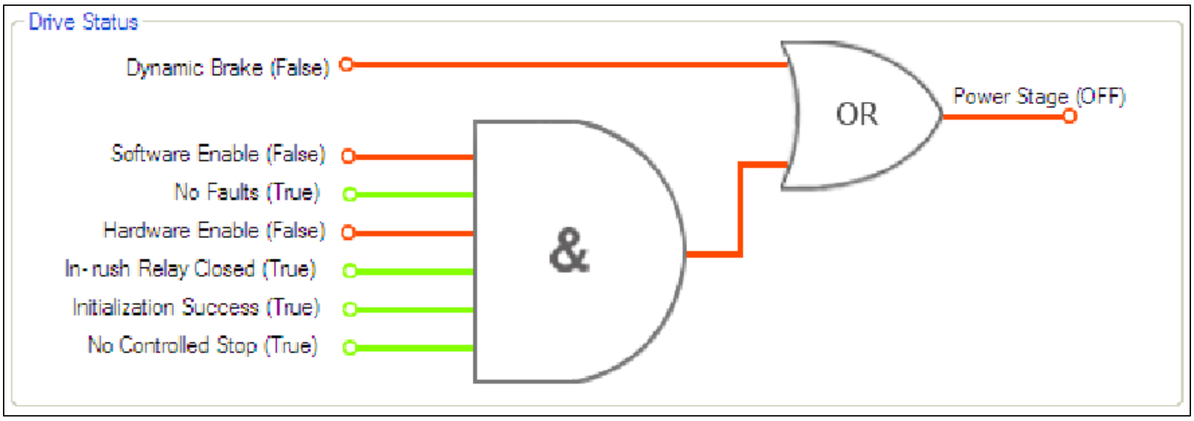
Similar to Mode 2, the motor will decelerate at a controlled rate (CS.DEC) until CS.VTHRESH is reached for a period of time (CS.TO). The drive will then dynamically brake and disable under the same conditions as described in Mode 2.

The Disable Timeout Setting determines the amount of time the drive will follow the disable mode before it deactivates the drive regardless of method chosen and alerts with an Emergency Timeout Fault.

All of these disable modes will operated based on what type of disable command is received. Any critical faults, hardware disable, or STO disable will immediately turnoff the power stage, thus letting the driven motor coast of free fall based on how the motor is secured.

10.9.4 Drive Status

The **Drive Status** area is displayed below the settings area and includes a graphical representation of drive active status with different sets of inputs. If the input or output is enabled, then it is shown in green; if the input or output is disabled, then it is shown in red. The inputs to the OR and & (AND) gates identify which conditions are true (green) or false (red) and follow the normal logic for & (AND) and OR gates. This diagram is useful in finding which input may be preventing the drive from being enabled. Click **More** to see the details of how the control stop is executed displayed both logically and graphically.



10.9.5 Controlled Stop

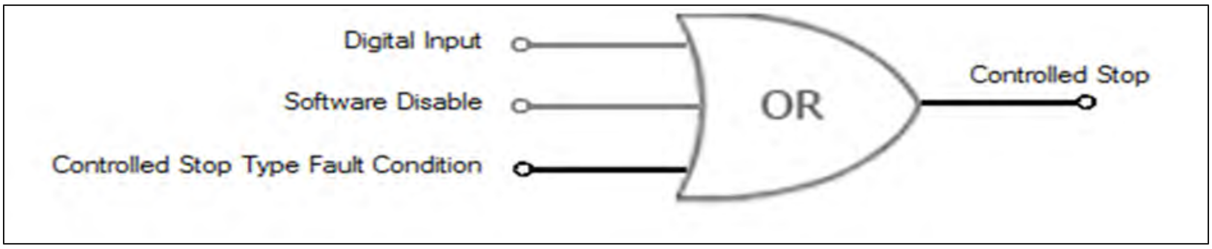
The Controlled Stop area displays values for parameters associated with controlled stop.

Button or Dialog Box	Description	Parameter
Velocity Threshold	Sets the velocity threshold for controlled stop process.	CS.VTHRESH
Velocity Threshold Timeout	Sets the velocity threshold, which is the time value for the drive velocity to be within CS.VTHRESH before the drive disables	CS.TO
Deceleration	Sets the deceleration value for the controlled stop process.	CS.DEC
Control stop Input	Displays the list of digital inputs configured to controlled stop mode separated by ','. When no controlled stop mode is configured, this box displays the message: **No CS Input Configured**. **Configure Input** link will opens the Digital I/O screen where you can configure the controlled stop mode.	

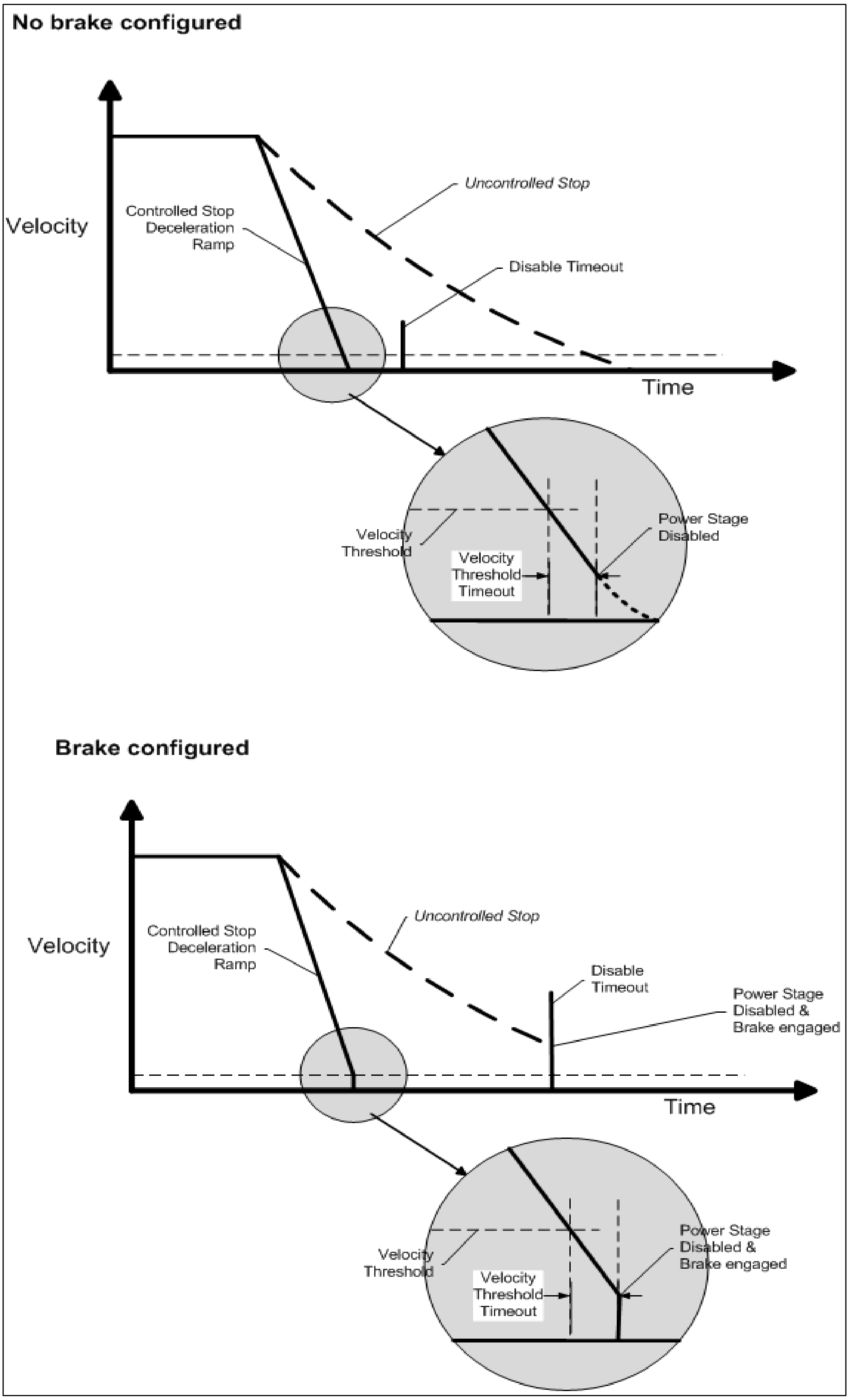
10.9.6 More/Less Button

The **More** button reveals the status diagram for the controlled stop configuration. It also displays the block diagram for the control stop. Two block diagrams available: one for a brake fitted and another for no brake.

Control stop status diagram



Controlled Stop Block Diagram


No brake configured
Velocity
Controlled Stop Deceleration Ramp
Uncontrolled Stop
Disable Timeout
Time
Velocity Threshold
Velocity Threshold Timeout
Power Stage Disabled
Brake configured
Velocity
Controlled Stop Deceleration Ramp
Uncontrolled Stop
Disable Timeout
Power Stage Disabled & Brake engaged
Time
Velocity Threshold
Velocity Threshold Timeout
Power Stage Disabled & Brake engaged

10.10 Controlled Stop

In a controlled stop, drive motion is brought to a standstill in a controlled manner. The drive commands a zero velocity from the motor. The motor decelerates at the prescribed deceleration value (CS.DEC).

A controlled stop can occur in four ways:

- The user configures a programmable digital input to mode 13 using DINx.MODE. For example, if DIN1.MODE 13 is applied, digital input 1 is set to controlled stop.
- Either a controller or the user (through the WorkBench terminal window) initiates a software disable (DRV.DIS) command .
- CANopen PDO is set to 3442.

CANopen Property	Value
Index/Subindex	3442/0
Data Type	Unsigned 8
Access	W/O
PDO mappable	N/A
Description	Controlled stop
ASCII Object	

- A fault initiates a controlled stop from the drive. See 17.1 Fault and Warning Messages for the faults which initiate a controlled stop.

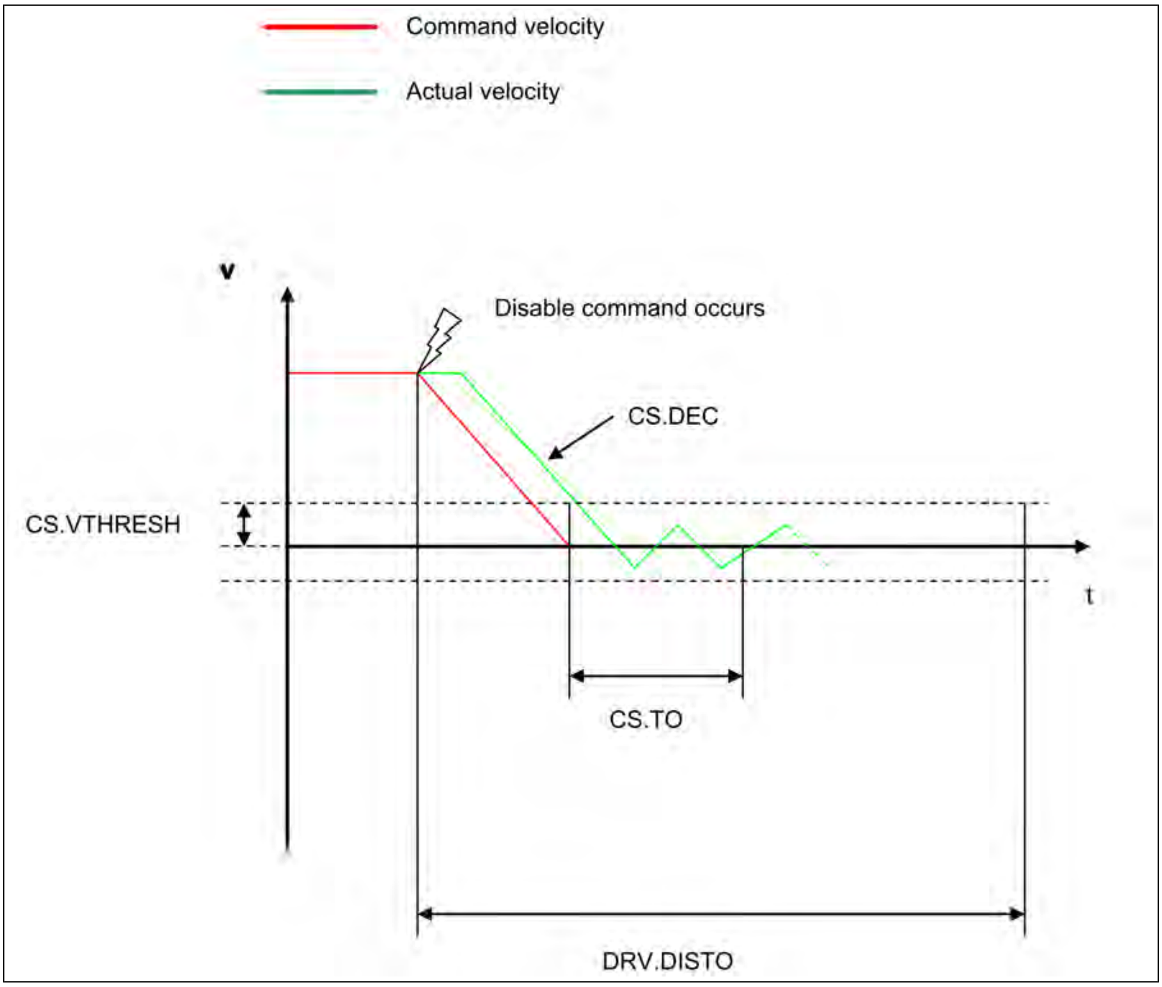
The controlled stop mechanism is activated in the following cases:

1. DRV.DISMODE = 2 and user executes DRV.DIS from the terminal or WorkBench disable buttons.
2. DRV.DISMODE = 2 and user executes DRV.DIS from a fieldbus connected to the drive.
3. A fault happens for which the reaction evolves controlled stop (CS). After the CS is executed, the drive disables.
4. A digital input mode (DINx.MODE) is set to 13. If the digital input state changes (active high or low according to DINx.INV) the CS is executed, then the drive disables.
5. HW limit switch: A digital input is defined as a positive (negative) limit switch (DINx.MODE 18 or 19). When the limit switch is met, the CS mechanism starts running. In this case, the parameter DRV.DISTO is not active.
6. SW limit switch: SWLS defines an active SW limit. When the limit is met, the CS mechanism starts running. In this case, the parameter DRV.DISTO is not active.

Use the drive CS parameters to configure a controlled stop as follows:

1. CS.DEC: Deceleration ramp that is used for disable.
2. CS.VTHRESH: Velocity 0 threshold. The motor shaft is considered as stopped as soon as the actual velocity (filtered through a 10 Hz filter, such as VL.FBFILTER) is within ± CS.VTHRESH.
3. CS.TO: Velocity 0 time. The actual velocity must be consecutively within 0 ± CS.VTHRESH for the time CS.TO, before the drive completes the CS process. This value is used since the motor can overshoot out of the VEL0 window depending on the gains, deceleration ramp, motor inertia and so on.
4. DRV.DISTO: Disable time out. This parameter sets an overall and independent running check as to whether or not the drive can achieve the disable state. If the VEL0 window set in step 3 is too small, it is possible that the drive may never reach the end of the CS process. The DRV.DISTO parameter and functionality addresses this issue by disabling the drive after the DRV.DISTO time elapses, even if the CS process did not end.

Controlled Stop Diagram



When configuring the controlled stop feature, please note the following:

- If the HW limit switch is active and any of the other CS activated, the only difference will be that in this case the DRV.DISTO will limit the time before disabling the drive.
- If the value of DRV.OPMODE of the drive is current mode, the drive will not execute the CS but instead stop immediately.
- Set DRV.DISTO to an appropriate value that will allow the motor to decelerate from any velocity to 0 with DRV.DEC. This value must also allow the motor to afterwards remain within VL.FB for CS.TO consecutively within 0 ± CS.VTHRESH.

The drive issues a fault F703 in case that the DRV.DISTO counter expires during a controlled stop procedure.

10.10.0.1 Related Parameters and Commands

CS Parameters

CS.STATE: Reads the current state of controlled stop process (0 = controlled stop is not occurring. 1 = controlled stop is occurring).

DIN1.MODE TO DIN7.MODE

DRV.DIS

DRV.DISTO
DRV.DISMODE

10.10.1 Related topics:

10.12 Emergency Stop

10.1 Digital Inputs and Outputs

17.1 Fault and Warning Messages

10.11 Dynamic Braking

Dynamic braking is method to slow a servo system by dissipating the mechanical energy in a resistor driven by the motor back EMF. The drive has a built in advanced (patent pending) dynamic braking mode which operates fully in hardware. When activated, the drive shorts the motor terminals in phase with the back EMF (q axis) but continues to operate the non-force producing current loop (d-axis) with 0 current. This forces all of the dynamic braking current to be stopping current and insures the fastest stopping/amp of motor terminal current.

The drive hardware also limits the maximum dynamic braking motor terminal current via the DRV.DBILIMIT parameter to prevent the drive, motor, and customer load from encountering excessive currents/forces. When the current is not being limited, the mechanical energy is dissipated in the motor terminal resistance. When the current is being limited, energy is returned to the drive bus capacitors. When the amount of returned energy raises the bus capacitor voltage enough, the drive activates the regeneration control to start transferring the returned energy to the regen resistor. This resistor could be internal or external to the drive depending on drive model and drive wiring.

Whether and how the drive uses dynamic braking mode depends on the drive disable mode (DRV.DISMODE) setting.

10.11.1 Drive Regeneration

When the servo motor is slowing down at a rate faster than friction and motor losses would slow the motor, then mechanical energy can be returned to the drive. This returned energy initially drives the internal bus voltage upwards. When the returned energy is high enough, the regeneration control transfers the excess returned energy into the regeneration power resistor. If the regeneration control cannot fully handle the power returned (for example, because there is not a regen resistor present or its resistance value is too high), then the bus voltage will continue to rise and a bus over voltage fault will happen and disable the drive completely, which allows the motor to freewheel.

10.11.1.1 AKD-x00306 to AKD-x00606

These units do not have an internal regeneration resistor. In many applications machine friction, motor losses, and the limited bus capacitor energy absorption handles the application. But, depending on the exact application requirements, an external resistor can be connected.

10.11.1.2 AKD-x01206 to AKD-x02406 and AKD-xzzz07

These units have an internal regeneration resistor plus the capability to connect an external resistor if higher power levels are needed.

Related Topics

See section *6.14 Dynamic Braking* in the *AKDInstallation Manual* for detailed information on dynamic braking.

DRV.DISMODE

DRV.DBILIMIT

10.12 Emergency Stop

10.13 Safe Torque Off (STO)

Safe torque off (STO) is a restart lock safety feature that prevents a system restart. The STO input provides direct electrical control of the power stage of the AKD drive; it bypasses the processor and will disable the power stage irrespective of software or other hardware signals.

STO is controlled by a digital input on the X1 connector (pin 3) that must have 24V applied to it; otherwise, the drive will not enable.If the STO digital input does not have 24V applied to it and you attempt to enable the drive (using the hardware and software enables) the drive will generate a 602 "Safe Torque Off" fault. If you see this fault you need to apply 24V to the STO input and then clear the fault (DRV.CLRFAULTS) before you can enable the drive. The STO will not generate a fault until you try to enable the drive. You can read the current faults using DRV.FAULTS.

```
-->DRV.FAULTS

602: Safe torque off.

-->
```

The current state of the STO can be read using the STO.STATE parameter (this returns 1 if 24V is being applied to this input). WorkBench also shows you the state of the STO input in the status bar at the bottom of the window.

10.14 Under Voltage Fault Behavior

You can adjust the conditions for an under voltage fault using VBUS.UVMODE in the WorkBench terminal screen:

VBUS.UVMODE = 1 (default)

The drive will not report an under voltage fault unless the drive is enabled and VBUS.VALUE falls below VBUS.UVFTHRESH

VBUS.UVMODE = 0

The drive will report an under voltage condition any time VBUS.VALUE falls below VBUS.UVFTHRESH.

When an under voltage fault occurs, the drive is disabled and issues the following alerts:

- WorkBench alert: 502 Bus Under Voltage
- Drive LED alert: Left LED displays [F], right LED displays [u-V].
- Fault relay output turns on.

11 Using Command Source and Operating Modes

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11.3 Current Loop ... 113
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11.1 Overview

Operation modes (opmodes) allow you to set up your drive to communicate directly over the Ethernet input, a specific fieldbus, or an analog or digital control.

There are two basic components to how you will command the drive and how it will behave. The “Service mode” indicates how the drive will be communicated to. The drive has communication options via Ethernet, a variety of fieldbuses, through an analog input, and through electronic gearing, or digital inputs. The second component ties to which loop you will be controlling (torque, velocity, or position).

11.2 Using Command Source and Operation Modes

There are two methods to access these two parameters within WorkBench. The first is by selecting the **Settings** screen from the left hand tree. By clicking on the top level of the **Settings** folder, you access the graphical representation of both the Command source and Operation Mode. The drop down box then allows you to select the desired command type and control loop you wish to activate. Please note that some Command Sources can only be used with certain control loops (as an example, Electronic Gearing can only be used in position loop Operation Mode).

11.2.1 Command Source

The command source sets how you communicate with the drive. Initially, you might be communicating via your PC using the Ethernet connection. Each Command Source is listed below:

11.2.1.1 Service

This is the most common source used when establishing initial communications with the drive to set the system up, and when you may need to “service” the drive. The Service source communicates with your PC via the Ethernet port located on the top of the drive at connector X11.

11.2.1.2 Fieldbus

When using a fieldbus, such as CANOpen or EtherCAT, the drive is set with this command source. For CANOpen, use the connectors X12 and X13 located on the top of the drive. For EtherCAT, Connectors X5 and X6 located on the front of the drive are used.

11.2.1.3 Electronic Gearing

If the drive will be used to follow the output of an external encoder, following motion using an electronic gear ratio, then you should use this command source. When using Electronic Gearing, the Operation mode must be set in the Position Loop mode. This is also the mode used for step and direction inputs as well.

11.2.1.4 Analog

This command source allows the drive to be controlled from an analog source. Typically a +/- 10 Vdc signal is attached to connector X8 pins 9 and 10. Varying the analog input will then vary torque, velocity, or position based on the Operation mode selected.

11.2.1.5 Operation Mode

The operation mode identifies which servo loop you will be controlling. The drive offers torque, velocity, or position control. From the setting screen page, a graphical representation of the loop is displayed. By clicking these graphical representations, you can access additional loop information such as gains, filters, and other settings.

11.2.2 Related Parameters

DRV.CMDSOURCE

DRV.OPMODEDRV.OPMODE

11.3 Current Loop

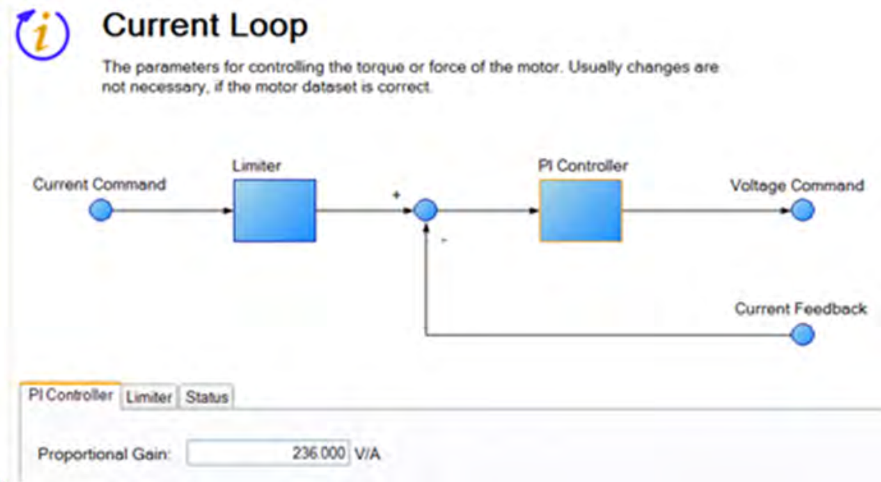
11.3.1 Overview

The current loop is active when the drive operates in current torque (current) mode (DRV.OPMODE = 0). The parameters that govern the current loop are shown in the Current Loop view. The various types of tuning for the drive adjust these parameters automatically, so you normally do not need to adjust the current loop parameters in the current loop screen. The Current Loop view includes an active block diagram. If you click on a block in the diagram, the appropriate tab opens below.

A more detailed block diagram for the current loop is included in Block Diagrams

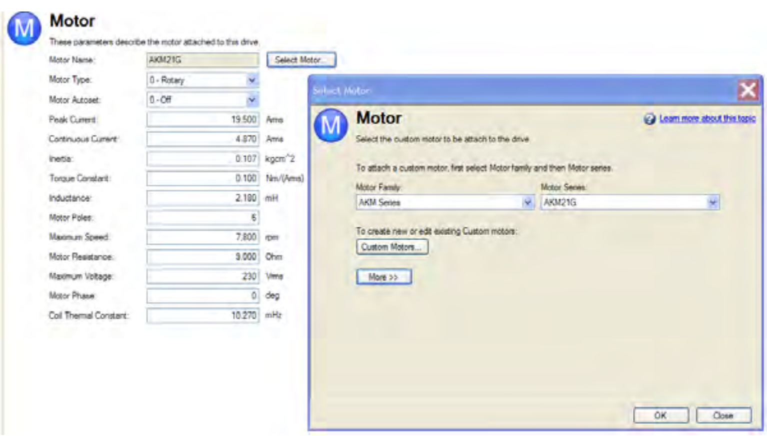
11.3.2 Current Loop Gain

The current loop is tuned based on the inductance of the motor used with the drive. The current loop gain is automatically set so that the idealized current loop crossover frequency is IL.KP/L in rad/sec where L is the motor line-line inductance.



Current loop gain is set automatically by the drive using the following methods:

- **Option A**. When a feedback device is automatically identified by the drive and the motor data is automatically populated (Motor Autoset = 1-On) the proportional gain of the current loop (il.kp) is set based on the motor data and is shown as a read-only parameter in the current loop screen.
- **Option B**.When the motor is selected using the motor database or using the custom motor tool, the imported inductance value is used to set the current loop proportional gain.



NOTE	**Manual adjustments to the current loop proportional gain parameter are not normally required during the motor tuning procedure. If manual adjustments are made to the current loop proportional gain parameter, repeating the motor setup procedure will overwrite the changes and restore the value to the Kollmorgen calculated value.**

Related Parameters

IL Parameters

DRV.OPMODE

11.4 Velocity Loop

11.4.1 Overview

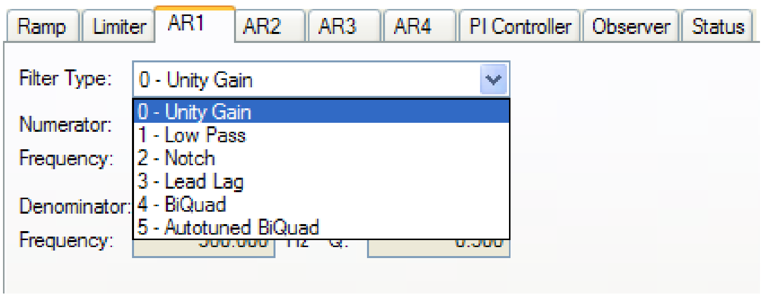
The velocity loop is active when the drive operates in velocity mode (DRV.OPMODE = 1) or position mode (DRV.OPMODE = 2). The parameters that govern the velocity loop are shown in the Velocity Loop view. The various types of tuning for the AKD adjust these parameters automatically, so you normally do not need to adjust the velocity loop parameters in the velocity loop screen.

A detailed block diagram for the velocity loop is included in Block Diagrams.

11.4.2 Tabs in the Velocity Loop View

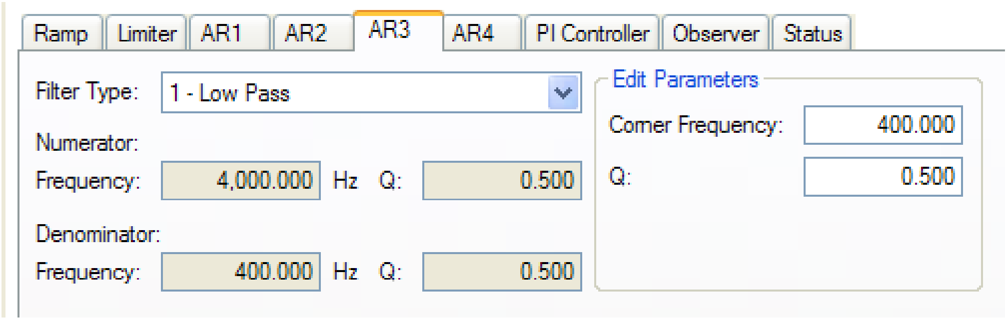
The velocity view includes an active block diagram. If you click on a block in the diagram, the appropriate tab opens below.

- **Ramp limiter** . The ramp limiter consists of the acceleration limits of the AKD. These acceleration limits override both motion task and electronic gearing acceleration limits, so they must be set higher than the highest required motion task acceleration or gearing acceleration value. These acceleration and deceleration limits are also shown in the Service Motion view and the Limits view (DRV.ACC and DRV.DEC).
- **Velocity clamp**. The velocity clamp affects the maximum speed of the drive when the command source is service (DRV.CMDSOURCE = 0). This speed limit affects motion commanded in service motion and in motion tasks. These limits are also found in the limit screen on WorkBench. (VL.LIMITP and VL.LIMITN)
- **AR1, AR2, AR3, AR4**: These values are the independent bilinear quadratic (bi-quad) filters inside the drive. AR1 and AR2 are in the forward path and AR3 and AR4 are in the feedback path. These bi-quad filters can each be configured in five different modes.



0–Unity Gain. The filter is off, and it will not affect the loop.

1–Low Pass. In modes 1, 2, and 3, the bi-quad filter is configured for each respective type of filtering. The Edit Parameters field is used to set up the filter. The actual bi-quad filter values are shown to the left:



2–Notch

3–Lead Lag

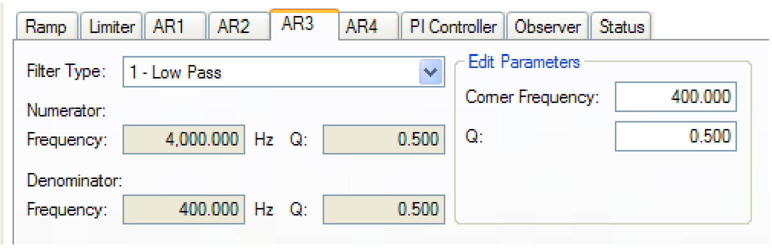
4–Bi-quad . A manually configured Bi-quad filter. This is an advanced tuning function.

5–Autotuned Biquad . When the autotuner sets a filter after the autotune process is complete, the values are input into the Bi-Quad filter and are shown as a read only values.

- **Status**. The status tab shows parameters that are relevant to the velocity loop performance.

11.4.3 Velocity Loop Default Settings and Changes

By default, a PI loop with a low-pass filter (AR3) is set in the drive.



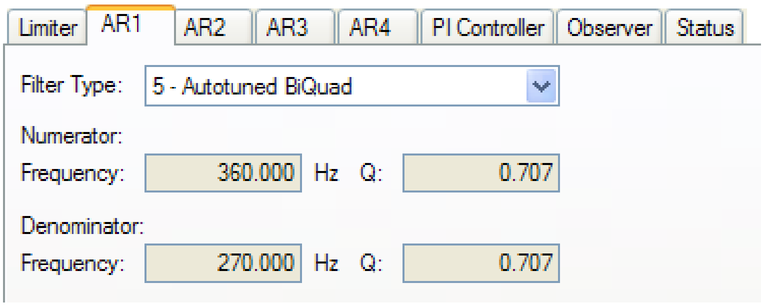
The default value for the low-pass filter is 400 Hz. The low-pass filter is important for disturbance rejection, and it also reduces the audible noise of the system.

11.4.3.1 Velocity Loop Changes Based on Slider Tuning

Slider tuning (see 14.1 Slider Tuning) uses the slider control to adjust the proportional gain and integral gain values of the velocity loop based on the desired bandwidth. If you adjust the bandwidth using the slider tuner and then return to the velocity loop screen, you will see different values inside the proportional gain and integral gain fields. No adjustment is made to the filters automatically by using the slider tuner. Only the proportional and integral terms are adjusted.

11.4.3.2 Velocity Loop Changes Based on Autotuner

When the Autotuner (see 14.3 Using the Autotuner) is used in Autotune mode, changes are made to the proportional gain, integral gain, filters and other parameters not related to the velocity loop screen directly. The values adjusted are dependent on the drive, motor, load, and the autotuner settings. The filters that are adjusted by the autotuner are automatically put into mode **5-Autotuned Bi-quad**.



No adjustments can be made to mode **5- Autotuned BiQuad** filters that are set by the autotuner. If adjustment to the tuning of the system is desired after the autotune process is completed, then these adjustments should be made in the settings of the autotuner. The autotune process can then be repeated.

Related Parameters

VL Parameters

DRV.ACC

DRV.CMDSOURCE

DRV.DEC

DRV.OPMODE

Related Topics

10.7.5 Limits

12.2 Motion Tasks

12.3 Service Motion

10.7 Electronic Gearing

14 Tuning Your System

11.5 Position Loop

11.5.1 Overview

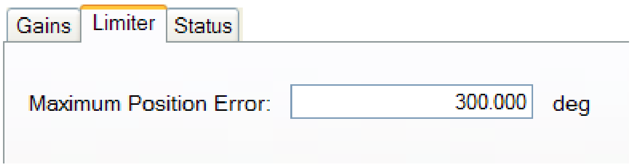
The position loop is active when the drive operates in position mode (DRV.OPMODE = 2). The parameters that govern the position loop are shown in the Position Loop view. The various types of tuning inside AKD adjust these parameters, so you normally do not need to adjust the position loop parameters in the position loop screen.

A detailed block diagram for the position loop is included in Block Diagrams.

11.5.2 Tabs in the Position Loop View

The position loop view includes an active block diagram. If you click on a block in the diagram, the appropriate tab opens below.

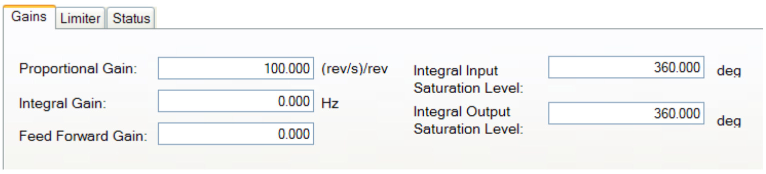
- **Gains**. This tab shows the gains for the position loop.
- **Limiter**. The value in the **Maximum Position Error** box (PL.ERRFTHRESH) limits the position error (PL.ERR) that can be present. When the maximum position error is exceeded, the drive generates fault 439, Following Error. If the maximum position error is set to 0 (default) then the maximum position error is ignored.



- **Status**. This tab shows the present value of commanded position (PL.CMD), position feedback (PL.FB), position error (PL.ERR), and velocity command (VL.CMD).

11.5.3 Position Loop Default Behavior and Changes

By default, only a proportional gain (PL.KP) is applied in the position loop.



11.5.3.1 Position Loop Changes Based on Slider Tuning

Slider Tuning (see 14.1 Slider Tuning) adjusts the proportional gain of the position loop (along with velocity loop view parameters; see 11.4 Velocity Loop). If you adjust the bandwidth using the slider tuner, then when you return to the position loop screen, you will see a change to the proportional gain only. No adjustment is made to the integral gain or feedforward gain through the slider tuner. The integral saturation levels are not applicable when the integral gain is set to 0. In the **Gains** tab, the boxes for these values may be populated with default values whether or not the integral gain is set to 0.

11.5.3.2 Position Loop Changes Based on Autotuner

When the Autotuner (see 14.3 Using the Autotuner) is used in Autotune mode, changes are made to the position loop proportional gain, integral gain, feedforward gain and other parameters not related to the Position Loop view directly. The values adjusted are dependent on the drive, motor, load, and the autotuner settings.

Related Parameters

PL Parameters

DRV.OPMODE

VL.CMD

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12 Creating Motion

12.1 **Homing** 120

12.2 **Motion Tasks** 129

12.3 **Service Motion** 134

12.4 **Jog Move** 135

12.1 Homing

12.1.1 Overview

Homing is used to mechanically move a motor (connected to a mechanism) to a specific location on the machine, referred to as “home”. Motion tasks then use this home as a reference point for movements that must base a known position on this reference point. Motor movement is usually controlled by a variety of limit switches (end of travel) and a home reference switch. Using these reference points with the logic of the drive allows the machine to find and set the home reference point.

12.1.2 Using Homing

The AKD includes a variety of homing methods (set with HOME.MODE) to accommodate your machine needs:

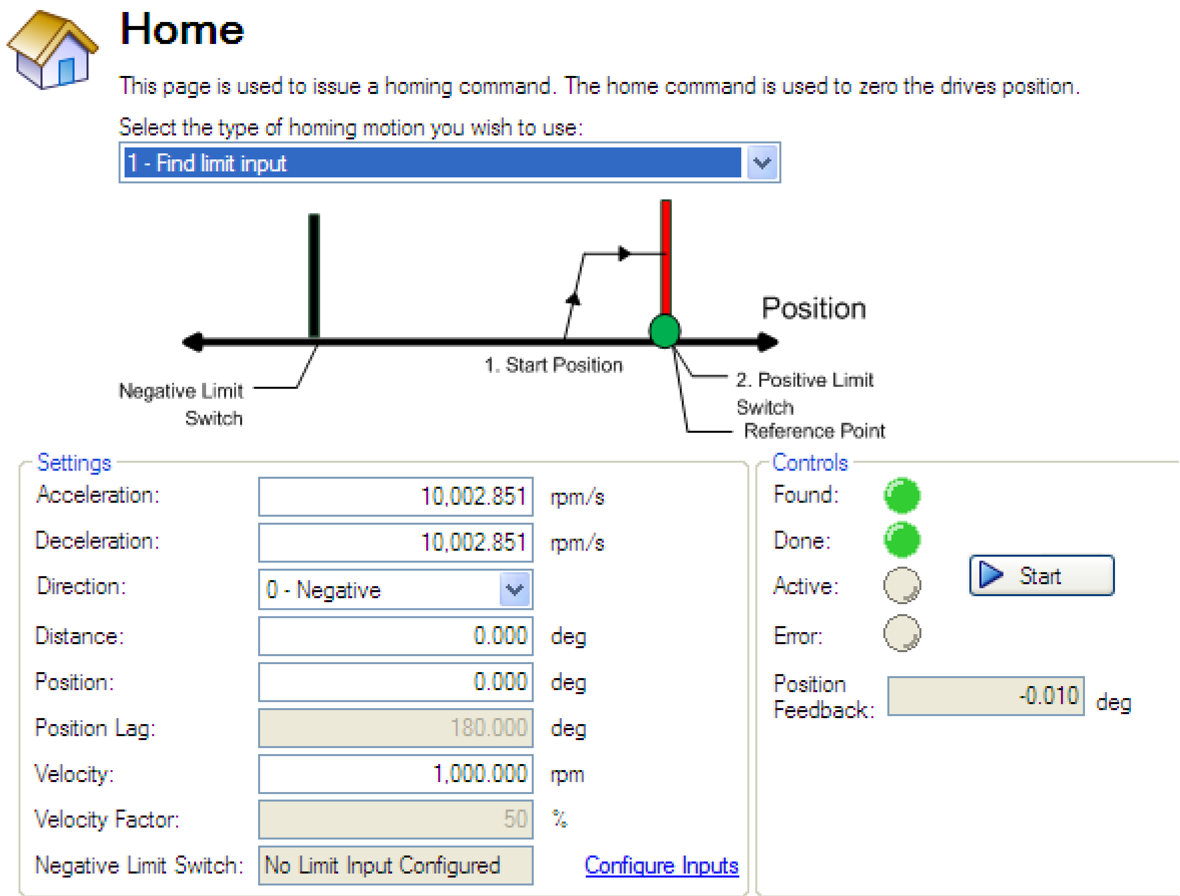
- Home using current position (HOME.MODE 0)
- Find limit input (HOME.MODE 1)
- Find input limit then find zero angle (HOME.MODE 2)
- Find input limit then find index (HOME.MODE 3)
- Find home input (HOME.MODE 4)
- Find home input then find zero angle (HOME.MODE 5)
- Find home input then find index (HOME.MODE 6)
- Find zero angle (HOME.MODE 7)
- Move until position error exceeded (HOME.MODE 8)
- Move until position error exceeded, then find zero angle (HOME.MODE 9)

Each of these homing methods offers a different way to achieve a home reference point based on your particular system mechanics. All homing methods provide the options of adjusting the acceleration, deceleration, and speed for homing moves. In addition, once the homing move is completed, you can either set an offset position or make an offset move as required. Homing modes, guidance for mode selection, and homing examples are included in 12.1.2.2 Selecting and Using Homing Modes

Note: When using any of the methods that use homing switches and limits, please refer to the Input/Output section for proper wiring techniques.

12.1.2.1 Home Default Window

The Home window provides a means to select your homing method and configure the homing settings. This window also provides a simple controls to start homing and confirm homing success.



Mode Selection:

Use this box to select the appropriate homing mode. Homing modes are described below in Selecting and Using Homing Modes. The active options in the **Settings** area change depending on the homing mode selected.

Settings:

- **Acceleration**: Sets the acceleration ramp used during the homing procedure.
- **Deceleration**: Sets the deceleration ramp used during the homing procedure.
- **Direction**: Sets the start direction for homing movement.
- **Distance**: Sets a prescribed distance you want the motor to move once the home reference point is found. A zero value (default) corresponds to the axis actively returning to the defined position found during the homing process.
- **Position**: Sets the current position to a precribed value once the home reference point is found.
- **Position Lag**: Sets the position error threshold, which is used for indicating home reference when using using the hardstop modes 8 and 9.
- **Velocity**: Sets the initial velocity used for homing moves.
- **Velocity Factor**: In modes where a limit is reached, and direction is reversed, the valocity factor allows you to reduce the velocity as a precentage of the homing velocity.
- **Positive/Negative Limit Switch/Home Reference/Peak Current**: These fields appear based on the mode selected. For homing to limits and home reference, this field will indicate how the digital inputs are configured as well as providing a link to the digital input page. For Homing to a hard stop, the Peak Current field allows you to set the peak current limit desired during homing.

Controls:

- **Found**: When the home reference is found, then this indicator is green.
- **Done**: When the home move ic complete, this indicator is green.
- **Active:** This indicator will be green while the Home move is taking place.
- **Error**:This indicator will be red if something in the homing sequence failed.
- **Position Feedback**: This window reports the current value for PL.PFB.
- **Start/Stop**: Click this button to start or stop the selected homing method.

12.1.2.2 Selecting and Using Homing Modes

Homing Mode 0: Home Using Current Position

Using the current position is the most basic homing method. This method simply uses the current position of the motor as the home point reference. Two values allow you to further define homing with this method:

- Distance: A value other then zero will cause a movement of the motor the distance entered in counts (or other units based on your units settings). You can use this to establish a home point at some prescribed distance from the initial starting position of the motor. This home will be at the offset distance entered from zero.

- Position: You can use this parameter to set the value of the home position other then zero. This allows you to offset your home reference away from zero. PL.FB will be set to the value you enter when the motor reaches the home reference point (based on the method selected).

The distance and position offsets are available and behave similarly on all of the homing types. Either the motor will move an additional distance (distance value) after it finishes the homing method, or will set the position to the amount entered in the position value.

Homing Mode 0 Example

Use the current position as home and have the motor end motion 180 degrees from home:

1. Select Mode 0 from the drop down box.
2. Enter 180 into the **Distance** box.
3. Click **Start**,
4. The motor will move 180 degrees from the start position. The **Position Feedback** box (PL.FB) will show 180 (the motor is now sitting 180 degrees from home).

Homing Mode 1: Find Limit Input

The find limit input mode moves to a limit input. This method can be used if you have a positive or negative limit switch available that you want to establish as a home reference point. **NOTE: Limit Switches should be set to Active Low (when switch power is lost, no current is flowing, thus drive homes at the point of the loss in power of the limit switch).**

The sequence of this homing mode is as follows:

1. The motor starts to move in the positive or negative direction, depending on the value you set in the-Settings, Direction (HOME.DIR) on the **Home Setup** screen.
2. The motor stops as soon as the hardware limit switch has been detected and then reverses direction.
3. The home position is set when the limit switch is no longer active. The actual and command position of the drive is immediately set to the home position value (HOME.P) and the motor ramps down to zero velocity. The axis is then moved to the position (HOME.P) + distance offset (HOME.DIST).

The values for distance and position can be used as described in homing mode 0.

⚠ CAUTION	**When homing to a limit switch, the limit switch must remain in the triggered state while the motor decelerates to zero and begins to reverse. A very low acceleration rate combined with a high approach velocity may overshoot the switch and cause it to become active. This action will cause a homing error fault.**

Homing Mode 1 Example

Use the positive end of travel limit as home reference, and then set this position to be -20 degrees.

1. Select Mode 1 from the drop down box and enter 20 into the Position box.

2. Set the direction to positive. When Start is selected, the motor will move until it encounters the positive end of travel switch.

3. As soon as the switch is triggered, the motor will reverse direction until the switch is no longer active.

4. As soon as the switch is no longer active, the position will be set to -20 degrees and the motor will ramp to 0. Depending on the velocity you are homing with, and the settings of the acceleration/deceleration ramps, the position feedback will be close to the position you entered.

Homing Mode 2: Find Input Limit then Find Zero Angle

Similar to the Find Input Limit method, the find input limit then find zero angle[1] mode follows the same steps, but upon completion of the move, it continues to move to find the zero angle reference of the motor.

NOTE: Limit switches should be set to Active Low (when switch power is lost, no current is flowing, thus drive homes at the point of the loss in power of the limit switch).

The specific steps are as follows:

1. The motor starts to move according to the direction (HOME.DIR) setting.
2. The motor stops as soon as the hardware limit switch has been detected and changes direction of movement.
3. The home position has been found as soon as the hardware limit switch is no longer active. The actual and the command position of the drive will immediately be set to the HOME.P value plus distance to the mechanical zero angle of the feedback device according to the current direction.
4. The motor moves to the home position (HOME.P) plus the distance move offset is applied (if present), which is located at the mechanical zero-angle of the feedback.

The values for distance and position can be used as described in home mode 0.

⚠ CAUTION	**When homing to a limit switch, the limit switch must remain in the triggered state while the motor decelerates to zero and begins to reverse. A very low acceleration rate combined with a high approach velocity may overshoot the switch and cause it to become active. This action will cause a homing error fault.**

Homing Mode 2 Example

Use the positive end of travel limit as home reference and then move to the zero angle of the motor

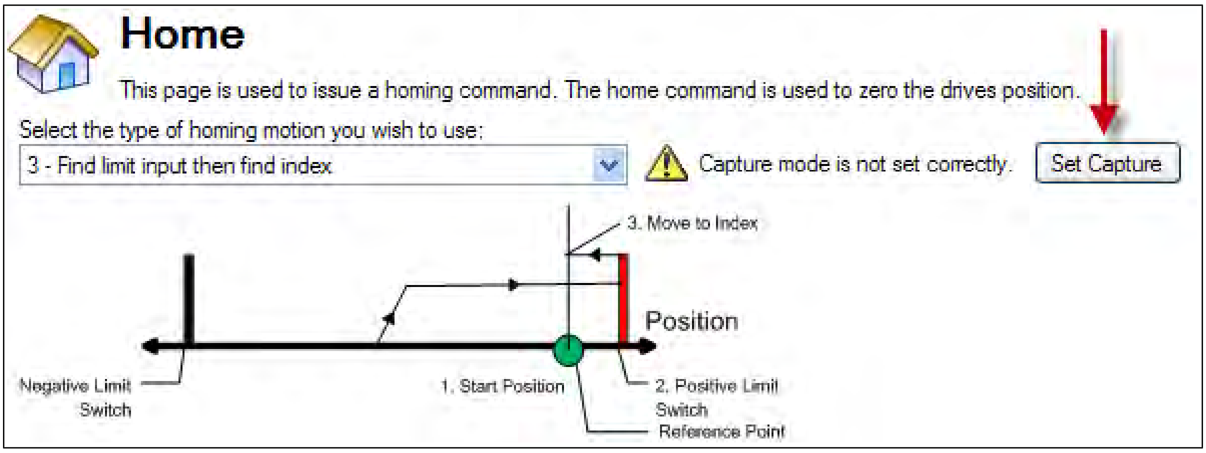
1. Use the positive end of travel limit as home reference and then move to the zero angle of the motor.
2. Select Mode 2 from the drop down box.
3. Set the Direction to Positive.
4. When Start is selected, the motor will move until it encounters the positive end of travel switch.

[1] Mechanical zero angle of the feedback = 0 degree.

5. As soon as the switch is triggered, the motor will reverse direction and move to the zero angle of the motor.

Homing Mode 3: Find Input Limit then Find Index

Similar to the Find Input Limit method, this follows the same steps, but upon completion of the move, it continues to move to find the index pulse of the motor. This method can only be used with feedback devices that have an index pulse such as incremental encoders and analog sine encoders with an index channel (Feedback selection 10, 11, 20, 21). This method requires that Capture Mode is turned on in the home screen. With Mode 3 selected, a **Set Capture** button appears (see arrow below). Click **Set Capture** to set the Position Capture mechanism correctly for proper homing with an index pulse.



Once homing is triggered, the homing routine is performed as follows:

1. The motor starts to move according to the HOME.DIR setting.
2. The motor stops as soon as the hardware limit switch has been detected and changes direction of movement.
3. The motor ramps down to a reduced velocity as soon as the hardware limit switch is no longer active (please refer also to HOME.FEEDRATE). The drive is searching for the index-signal during this time. The home-position has been found as soon as the index-signal has been detected by the drive.
4. The actual and the command position of the drive will be set to the HOME.P value as soon as the index pulse is found. The drive then ramps down to velocity 0. The axis is then moved to the position (home.p) + distance offset (home.dist).

⚠ CAUTION	**When homing to a limit switch, the limit switch must remain in the triggered state while the motor decelerates to zero and begins to reverse. A very low acceleration rate combined with a high approach velocity may overshoot the switch and cause it to become active. This action will cause a homing error fault.**

Homing Mode 3 Example

Use the positive end of travel limit as home reference, and then move to the index reference of the motor feedback device at 50% of the original home velocity.

1. Select Mode 3 from the drop down box.
2. Set the Direction to Positive.
3. In the **Home** screen click **Set Capture**.
4. Set the velocity factor to 50%.

5. When Start is selected, the motor will move until it encounters the positive end of travel switch. As soon as the switch is triggered, the motor will reverse direction, decelerate to a reduced velocity based on the Velocity Factor value, and move until the motor encounters the index pules of the feedback device.

Homing Mode 4: Find Home Input

Homing Mode 4 establishes the home reference based on an external home switch connected to a drive digital input (DINx.MODE - 11 Home Reference).

The sequence of this homing mode is as follows:

1. The motor starts to move according to the direction (HOME.DIR) setting.
2. The home position has been found as soon as the home-switch becomes active while traveling in the selected direction of motion (HOME.DIR). The actual and command position of the drive will immediately be set to the position (HOME.P) value and the motor ramps down to velocity 0. The axis is then moved to the position (home.p) + distance offset (home.dist).

The hardware limit switches are monitored during the homing procedure. The drive behaves as follows in case that a hardware limit switch is active before the home-switch has been activated:

a. The motor changes the direction until the home switch is crossed.
b. The motor ramps down to zero velocity and reverses direction again after crossing the home-switch.
c. The home-switch will now be activated according to the direction (HOME.DIR) setting and when the home-position has been found. The actual and the command position of the drive will immediately be set to the position (HOME.P) value and the motor ramps down to zero velocity. The axis is then moved to the position (home.p) + distance offset (home.dist).

Homing Mode 4 Example

Move in the negative direction towards the home reference point and then move 180 degrees from the reference point

1. Select Mode 4 from the drop down box.
2. Set the **Direction** to **Negative** and enter 180 for distance.
3. Click Start.
4. The motor moves until it encounters the home reference switch. As soon as the switch is triggered, the motor moves an increment of 180 degrees as desired.

Homing Mode 5: Find Home Input then Find Zero Angle

The sequence of this homing mode is as follows:

1. The motor starts to move according to the Direction (HOME.DIR) setting.
2. The home position has been found as soon as the home-switch becomes active while traveling in the selected direction of motion (HOME.DIR). The actual and the command position of the drive will immediately be set to the Position (HOME.P) value plus the distance to the mechanical zero angle of the feedback device according to the current direction.
3. The motor moves to the home Position (HOME.P) value plus the distance move offset is applied (if present), which is located at the mechanical zero-angle of the feedback.

The hardware limit switches are monitored during the homing procedure. The drive behaves as follows in case that a hardware limit switch is active before the home-switch has been activated:

a. The motor changes the direction until the home switch is crossed.
b. The motor ramps down to zero velocity and changes afterwards the direction again after crossing the home-switch.
c. The home-switch will now be activated according to the HOME.DIR setting and when the home-position has been found. The actual and the command position of the drive will immediately be set to the position (HOME.P) value plus distance to the mechanical zero angle of the feedback device according to the current direction.

d. The motor moves to the home Position (HOME.P) value plus the distance move offset is applied (if present), which is located at the mechanical zero-angle of the motor feedback.

Homing Mode 5 Example

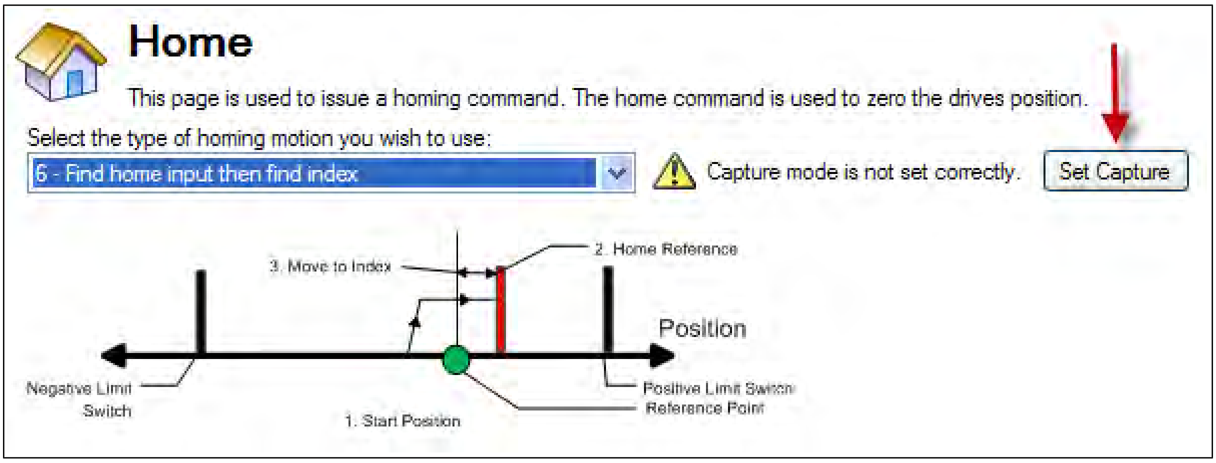
Move in the positive direction towards the home reference point and then move 60 degrees from the zero angle location.

1. Select Mode 5 from the drop down box.
2. Set the Direction to Positive and enter 60 for distance.
3. When Start is selected, the motor will move until it encounters the Home reference switch. As soon as the switch is triggered, the motor will move to the zero angle location plus an additional 60 degrees as desired.

Homing Mode 6: Find Home Input then Find Index

Similar to the Home input method, this follows the same logic as the other homing methods, first completing the home to input method, and finding the index pulse of the motor feedback.

This homing mode starts motion until a digital input, which is assigned to act as a home-switch, has been activated. The motor moves afterwards with a reduced velocity (HOME.FEEDRATE) until the index signal has been detected by the drive. **NOTE: This method requires that Capture Mode is turned on. This is done in the home screen. With Mode 6 selected, a "Set Capture" button will appear (see arrow below). Pressing the button sets the Position Capture mechanism correctly for proper homing with an index pulse..**



The home-switch must be activated according to the setting of the HOME.DIR setting.

The sequence of this homing mode is as follows:

1. The motor starts to move according to the HOME.DIR command.
2. The motor decelerates to a reduced velocity according to the HOME.FEEDRATE setting as soon as the home-switch becomes active during a motion in direction of the HOME.DIR setting.
3. The actual- and the command position of the drive will immediately be set to the HOME.P value as soon as the index-signal has been detected. The motor decelerates until velocity 0 has been reached.

The hardware limit switches are monitored during the whole homing procedure. The drive behaves as follows in case that a hardware limit switch is active before the home-switch has been activated:

a. The motor changes the direction until the home-switch is crossed.
b. The motor ramps down to zero velocity and changes direction again after crossing the home-switch.
c. The home-switch will now be activated according to the HOME.DIR command. The motor decelerates to a reduced velocity according to the HOME.FEEDRATE setting as soon as the home-switch becomes active.
d. The actual and the command position of the Drive will immediately be set to the HOME.P value as soon as the index-signal has been detected. The motor decelerates until zero velocity has been reached. The axis is then moved to the position (HOME.P) + distance offset (HOME.DIST).

Homing Mode 7: Find Zero Angle

The sequence of this homing mode is as follows:

1. The home value is immediately found by the drive and the actual and the command position of the drive will immediately be set to the Position (HOME.P) value plus the distance to the mechanical zero angle of the feedback device according to the current direction.
2. The motor moves to the home Position (HOME.P) value, which is located at the mechanical zero-angle of the feedback.

Homing Mode 7 Example

Move in the positive direction towards the zero angle location.

1. Select Mode 7 from the drop down box.
2. Set the direction to Positive.
3. When Start is selected, the motor will move to the zero angle location.

Homing mode 8: Move Until Position Error Exceeded

This method is also referred to as move to hard or mechanical stop. The AKD has several options related to this method as well. For this basic method, the motor will move until it encounters a hard stop, causing the position error to exceed a specific threshold you set. Once the threshold is exceeded, the motion stops and home reference is established. You can use the Distance or Position as described initially in this section. One caution; make sure you choose the direction appropriately to move off of the stop if you use the distance offset.

The sequence in this homing mode is as follows:

1. As this home move is initiated, the moptor will move according to the Direction (HOME.DIR) value until the positon error exceeds the Position Lag (HOME.PERRTHRESH) value.
2. The motor is now at home position (HOME.P) value.

Homing Mode 8 Example

Move in the positive direction towards a hard stop and limit the current to 1 amp. Allow 30 degrees of error before considered at the hard stop.

1. Select Mode 8 from the drop down box.
2. Set the Direction to Positive, Position Lag to 30 degrees and Peak Current to 1.
3. When Start is selected, the motor will move to the hard stop with a peak current of 1 amp.
4. As the position error exceeds the 30 degrees, the home Position (HOME.P) is set.

Homing Mode 9: Move Until Position Error Exceeded then Find Zero Angle

The sequence in this homing mode is as follows:

1. As this home move is initiated, the motor will move according to the Direction (HOME.DIR) value until the positon error exceeds the Position Lag (HOME.PERRTHRESH) value.
2. The home value is immeadiately found by the drive and the actual and the command position of the drive will be set to the Position (HOME.P) value plus the distance to the mechanical zero angle of the feedback device according to the current direction.
3. The motor moves to the home Position (HOME.P) plus the distance move offset is applied (if present) value, which is located at the mechanical zero-angle of the feedback.

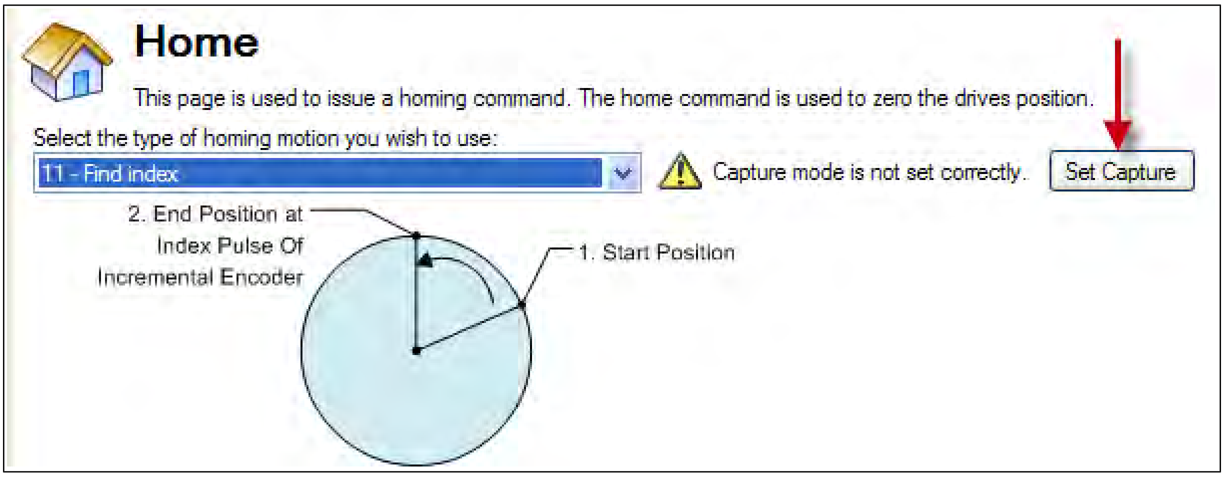
Homing Mode 9 Example

Move in the positive direction towards a hard stop and limit the current to 1 amp. Allow 30 degrees of error before considered at the hard stop. Then move to the zero angle of the motor and designate this as the 180 point.

1. Select Mode 9 from the drop down box.
2. Set the Direction to Positive, Position to 180, Position Lag to 30 degrees and Peak Current to 1.
3. When Start is selected, the motor will move to the hard stop with a peak current of 1 amp. As the position error exceeds the 30 degrees, the home Position (HOME.P) is set and the Position will be set to 180.

Homing Mode 11: Find Index

This method can only be used with feedback devices that have an index pulse such as incremental encoders and analog sine encoders with an Index channel (Feedback selection 10, 11, 20, 21). This method requires that Capture Mode is turned on in the home screen. With Mode 11 selected, a **Set Capture** button appears (see arrow below). Click **Set Capture** to set the position capture mechanism correctly for proper homing with an index pulse.



Once homing is triggered, the homing routine is performed as follows:

1. The motor starts to move according to the HOME.DIR setting.
2. The Motor is searching for the index pulse during this time.
3. If the Motor finds the Index pulse, then the Home-position is found.
4. The actual and the command position of the Drive will be set to the HOME.P value as soon as the index-signal is found. The Drive then ramps down to velocity 0.
5. If the Limit switch is active before Index signal, then the Motor changes the direction and then repeats steps 3 and 4.

Homing Mode 11 Example: Find Index Signal.

1. Select Mode 11 from the drop down box.
2. Set the Direction to Positive.
3. In the home screen press the “set capture” button.
4. When Start is selected, the motor will move until it encounters the index reference and then it stops.
5. If Limit switch is encountered before Index reference, the Motor changes direction and searches for Index signal in the opposite direction.

Unlike Homing Mode 3, the Home position is set as soon as the index pulse is found, irrespective of the direction of motion.

12.1.3 Using Homing: Advanced

The various homing methods in the AKD offer several options for setting up your home reference. When using any of the methods that use homing switches and limits, please refer to the Input/Output section for proper wiring techniques.

12.1.3.1 Related Parameters and Commands

HOME Parameters

PL.FB

"CAP0.MODE, CAP1.MODE" (=> p. 312): Sets index capture method

12.1.3.2 Related Topics

10.1 Digital Inputs and Outputs

DIN Parameters

DOUT Parameters

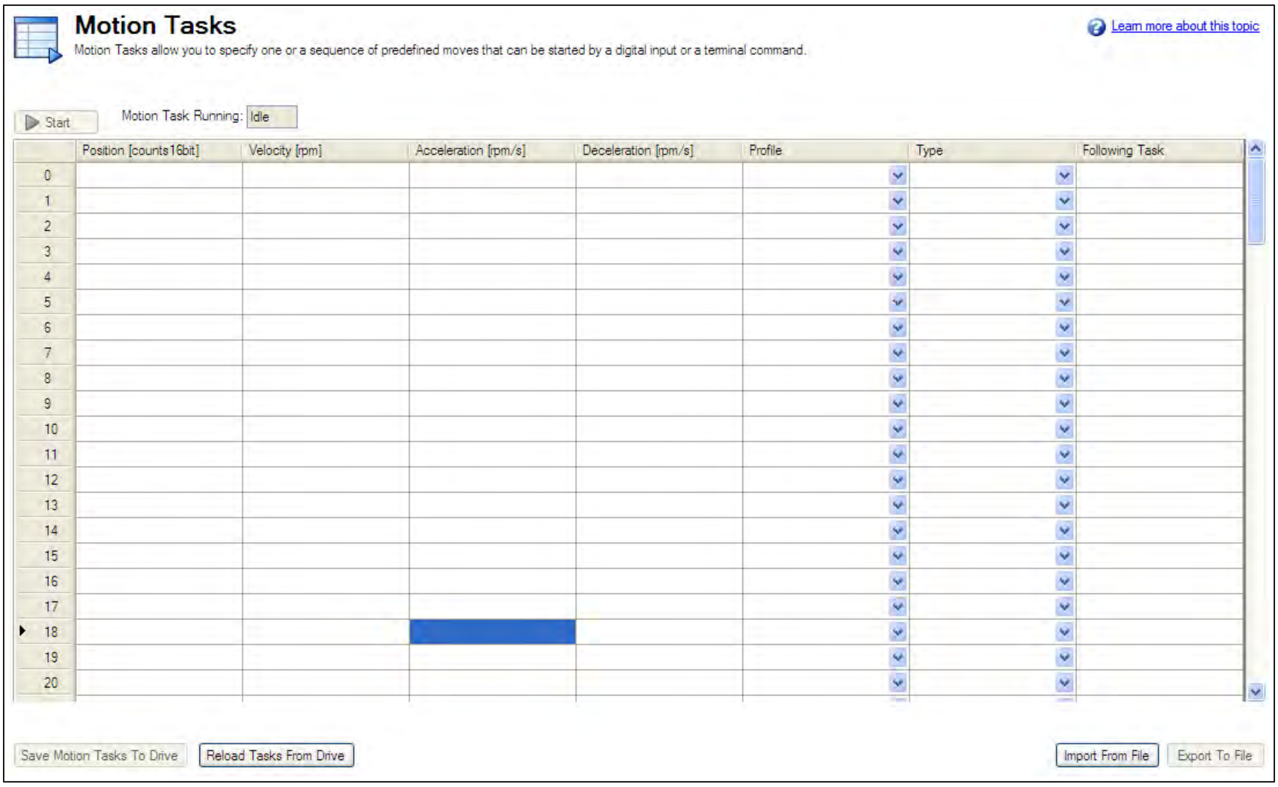
12.2 Motion Tasks

12.2.1 Overview

The AKD offers several options for executing moves, which are called "motion tasks" in WorkBench. You can directly link an input to a single motion task, assign inputs as a BCD pointer and execute, command over the Ethernet connection, or automatically execute a motion task as the result of the completion of another move event. Using WorkBench, you can also set up a single motion task or a sequence of motion tasks through the Motion Task screen, which is accessed from the Settings view. The Motion Task view allows you to modify a variety of parameters for a given move, including move profile, move type, velocity, distance, and acceleration limits.

12.2.2 Motion Task Input Table

Motion tasks can be easily entered and manipulated using the Motion Task Table. With this table, you can enter specific motion tasks and edit tasks, as well as insert and delete tasks, much like an Excel spreadsheet. The data table you build remains in WorkBench until you load the tasks into the drive. Once the tasks are loaded, you have access to the graphical representation of the moves (as in previous versions of WorkBench).

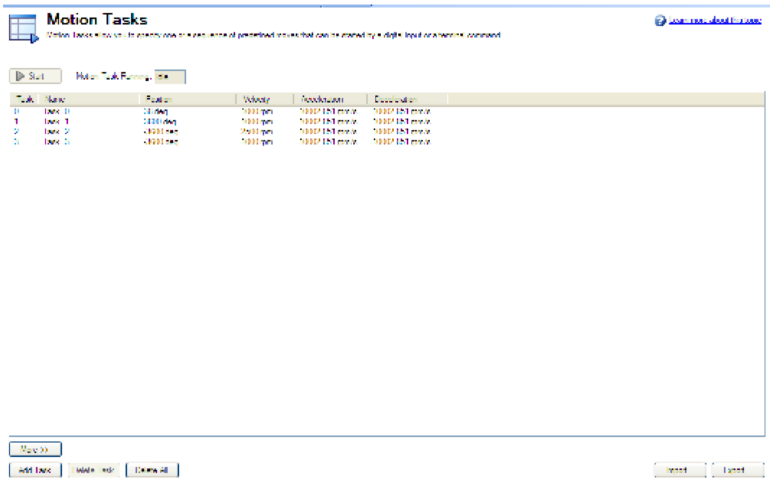


Enter values in each column for each task that you require. Once you enter an item, that field will change color indicating it has been edited but not yet loaded to the drive. Continue entering your tasks row by row. If you find that you skipped a task, you can easily insert it before or after a row that you highlight, and right-click to open the menu options. You can also select a task and using the right click access the copy and paste commands.

For delays and motion blends, double click on the line you want to edit and the delay and blend options will be available to adjust. You must load any changes or modifications to the drive before they will be available for use.

12.2.3 Using Motion Tasks

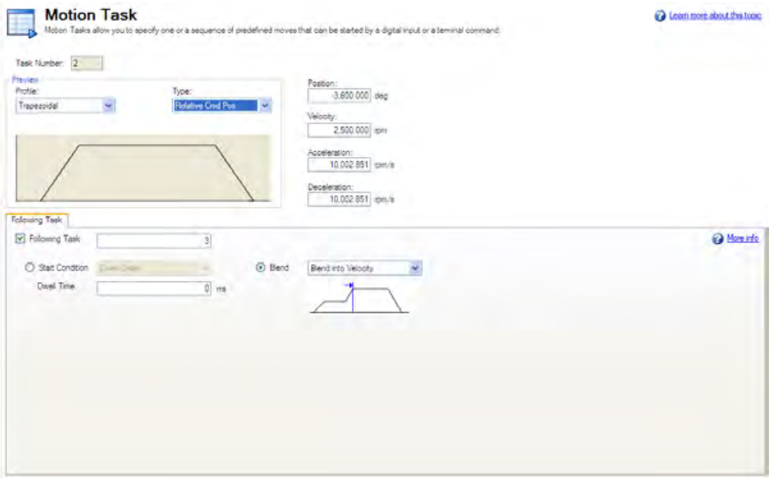
Use the Motion Task view to create and execute new motion tasks within WorkBench. As you add motion tasks, the new tasks appear as branches. You can use the root Motion Task view to view all tasks at once and execute individual tasks. When you select the Motion Task view, the Motion Task table is opened, as shown below.



From this view, you can perform the following actions:

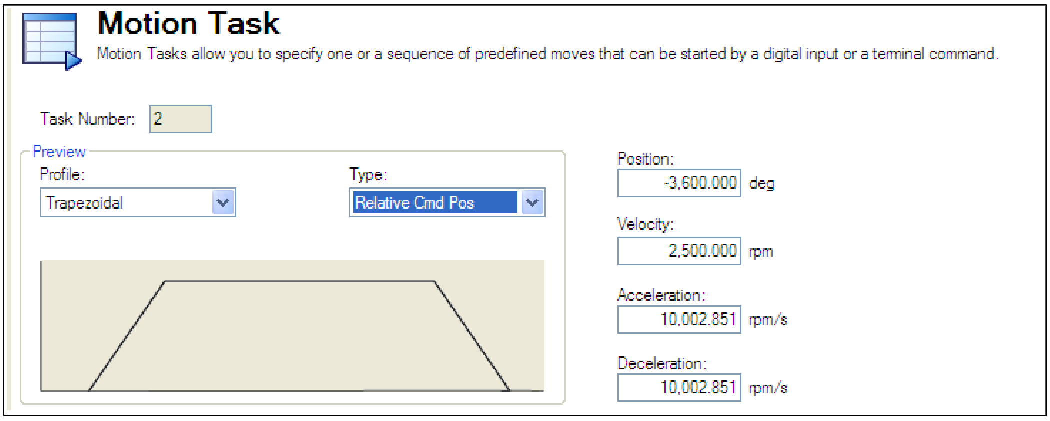
Button or Dialog Box	Description
Start	By highlighting an existing motion task, you can use this button to initiate that task (and subsequesnt tasks it may be linked to). In order to start any Motion Task, the motor must have been homed.
More/Less	This expands the Task table to include additional information regarding each task.
Add Task	Adds a task into the task table. Note the the task table fills in a task with default values. Double click on the task to open the task edit area.
Delete Task	Deletes the highlighted tasks
Delete All	Deletes all tasks in the table
Import	Allows importation of a .xml file to the task table.
Export	Exports to a .xml file the current list of tasks in the table.

When you add a task to the task table, double click on the task to edit the task settings. The following edit view opens:



Once in the edit screen, you can adjust move type, position command, velocity and accelerations as well as sequencing options. The editable fields include:

- **Profile** : This area sets the basic shape of the move. At present, the drive allows only a trapazoid profile (future versions will include S curves and other profile options).



- **Type**: Sets the type of move, absolute or incremental type moves
- **Position**: This is the command position (PL.CMD), based on the type of move selected.
- **Velocity**: Sets the peak or traverse velocity depending on the move parameters
- **Acceleration**: Sets the profile acceleration ramp (this can not be set higher then the drive acceleration limit setting - DRV.ACC)
- **Deceleration**: Sets the profile deceleration ramp (this can not be set higher then the drive deceleration limit setting - DRV.DEC)

In addition to these profile settings, you can set additional parameters on how your next move will be executed. These parameters include:

- **Following Task**: By checking this box, you can indicate which task you want to follow the task that you are editing.

- **Start Condition**: This box allows for different start conditions to initiate the following task. Currently, the only option is a dwell delay. The dwell delay time can be entered in the dwell time box.
- **Blend**: It is possible to blend moves together by using the blend option. This option allows either a blend to velocity, or blend to acceleration.

Once you have entered the data, you can click on the Motion Task root directory to bring the table up to execute your moves.

12.2.3.1 Motion Profiles

Trapezoidal moves include a fixed ramped acceleration (set by MT.ACC), a traverse period at velocity (set by MT.VEL), and a fixed ramped deceleration (set by MT.DEC). The distance traveled during the move is determined by the type of move (absolute or incremental). Position is set using MT.P. Note that for short moves, the traverse velocity may not ever be reached.

12.2.3.2 Motion Types

Motion tasks can use the following motion types:

- Absolute
- Relative to current position command (PL.CMD)
- Relative to the target position of the previous motion task

Motion types define how the target position will be calculated. These can be either incremental (relative) or absolute. An incremental move is a move that increments a specific distance. The AKD allows the user to increment based on two different beginning positions as described below. Absolute moves move to a specific position based the actual position form an established zero or home point.

Absolute motion task

An absolute move type will move to the actual position indicated by MT.P. A home move would have been established to provide the reference for actual positions on the machine. In this case, the target position = PL.CMD=MT.P

Example:

You want to move to a position that is 68 degrees from home reference.

On the Motion Task edit page, Select the Absolute move type, and then enter 68 into the position block (units should be set in degrees). Enter the traverse speed and adjust the acceleration and deceleration parameters as needed. Once you move off the edit screen you can select this task and initiate a start. Regardless of your current position, the motor will now rotate to the absolute position of 68 degrees as referenced from the home position.

Motion task relative to current position command (PL.CMD)

This type is simply an incremental move. The target position is based on the current position represented by PL.CMD plus the increment you want to move. Specifically, Target Position = PL.CMD + MT.P.

Example:

Your current motor position at the time you activate the motion task is 38 degrees. You want to move an increment of 30 degrees.

On the Motion Task edit page, Select the Relative Command Position move type, and then enter 30 into the position block(units should be set in degrees). Enter the traverse speed and adjust the acceleration and deceleration parameters as needed. Once you move off the edit screen you can select this task and initiate a start. The motor will move 30 degrees form the current position. After the motion task, the motor will now be at 68 degrees (38 + 30 = 68).

Motion task relative to the target position of the previous motion task

Using the last target position as the start point, this profile will move the increment chosen from that old position. This motion type is recommended in situations where a previous task may have been interrupted, or you want to eliminate any accumulated error. The target position will look at the previous target position and then add the increment you enter for this task. Specifically, Target Position = Previous Target Position + MT.P.

Example:

You initiated a motion task to increment 360 degrees, but that task was interrupted and the motor was stopped at 175 degrees. You use this method and increment another 360 degrees, the motor will complete the motion at 720 degrees (basically, it finished the first move to 360, and then made the additional distance requested of 360 degrees).

The task would be set up similar to the Relative command position example above. To view this in action, set up 2 tasks, once Relative Command Position and the second, Relative Old Target Position. Use low velocities so you can stop motion before the move is completed. Start the first move and then stop before it finishes. Then select the second move. The motor will stop at the desired end position if the stop had not occured. Try this again, but do not use the Relative Old Target Position and you will see the difference.

12.2.4 Using Motion Tasks: Advanced

12.2.4.1 Joining multiple tasks

Tasks can be joined in sequence using the task setup screen. Dwells can be added to allow the following tasks to wait a specific amount of time before starting. Tasks can also be blended to provide for smoother transitions between multiple moves. AKD allows blending with either acceleration or velocity.

12.2.4.2 Start Conditions

AKD currently provides only one alternatives to start a following task at this time (more are planned):

- **Dwell Delay**. Starts the following task after the dwell time entered (MT.FTIME)

12.2.4.3 Blending

As an alternative to dwells, the AKD can blend motion tasks to provide smooth transitions between multiple tasks. This feature extends the life of your machine life by minimizing mechanical wear due to hard move transitions (jerks).

- **No blend**. No blend, move starts upon completion of the previous task
- **Blend into Acceleration**. Blends the acceleration of the current task into the following task. As the target position of the first task is reached, the acceleration blends into the second task. This prevents the motor from decelerating to zero before starting the second move. This only works where both accelerations are driving the motor in the same direction.
- **Blend into Velocity**. Blends the velocity of the current task into the following task. In this method, the target position is reached as the velocity of the second move is reached. The belnding begins prior to

reaching the target position, and is completed at the target position of the first move, and the traverse velocity of the second move. This only works when both velocitys are in the same direction.

Related Parameters and Commands

MT Parameters and Commands

DRV.MOTIONSTAT: Bit 0 monitors if motion tasking is active.

AIN Parameters

AOUT Parameters

DIN Parameters

DOUT Parameters

HOME Parameters

12.3 Service Motion

Service motion allows you to set up simple motion. It is typically used during initial set up to exercise the system. It can be used to help troubleshoot the system, execute tuning, make repetative moves for verification of mechanical set up, or for other general simple motion needs. There are multiple ways to set up motion depending on the desired result in torque, velocity or position modes. In all modes, you can run a momentary pulse, set up reversing motion, or initiate continuous motion. The chart below identifies the commands available on the Sevice Motion screen.

Button or Dialog Box	Description
Pulse	Alternates between the commanded current or velocity and zero velocity. You can specify the time period between the commanded value and the return to zero. Setting a time to zero will generate a continuous command.
Reversing	Alternates between the two commanded values. You can specify the time the command will be held in each state.
Continuous	Runs the commanded current or velocity continuously.
Velocity 1/Velocity 2	Sets the two different velocities that are commanded
Time 1/Time 2	Sets the time for which the different commands are generated. Setting a time to zero generates a continuous command.
Acceleration/Deceleration	Used to set acceleration and deceleration values when in velocity and position modes.
Start/Stop	Starts and stops the motion.
Position Feedback	Displays the present position of the motor.
Velocity Feedback	Displays the present velocity of the motor.

Related Parameters:

SM.I1
SM.I2
SM.I2
SM.MOVE
SM.T1
SM.T2
SM.V1
SM.V2

12.4 Jog Move

This screen verifies that the servo system is able to command motion. Verify the settings for velocity, acceleration, and deceleration. Adjust these settings if necessary. Click **Jog** and continuous motion will occur until you click **Stop**. If motion does not occur, check for warnings, faults, or prompts from WorkBench.

If erratic motion and or vibration occur when motion is commanded, open the wizard **Tuning** screen and reduce the desired bandwidth significantly. If erratic motion continues, exit the **Setup Wizard** and use the **Autotuner** and **Service Motion** screens in the settings tree for more advanced setup of the servo system.

NOTE In order to tune the system the drive must be in service-type command source and either velocity or position opmode. If the drive is in torque opmode, then a popup screen will allow you to switch into velocity mode.

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13 Saving Your Drive Configuration

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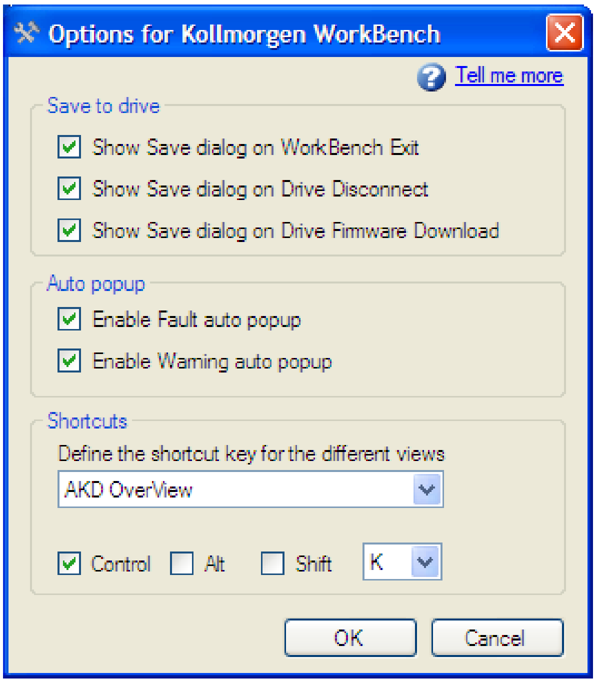
13.4 Save On Firmware Download ... 140

13.1 Save Options

WorkBench offers several options for saving your drive configuration. From the WorkBench menu, if you select **Tools** and then **Options**, the following window appears:

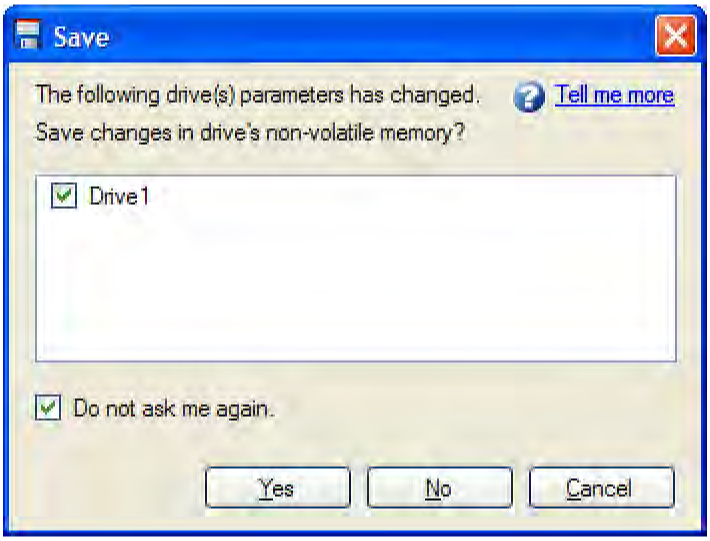


The **Save** options are applied as follows:

Button or Dialog Box	Description
Show Save dialog on WorkBench exit	If this box is checked, then every time you exit WorkBench a dialog will ask you if you wish to save the drive parameters to nonvolatile memory. If this box is not checked, the dialog will not be shown.
Show Save dialog on Drive Disconnect	If this box is checked, then every time you disconnect from a drive a dialog will ask you if you wish to save the drive's parameters to nonvolatile memory. If this box is not checked the dialog will not be shown.
Show Save dialog on Drive Firmware Download	If this box is checked and any parameter is changed, then every time you download a firmware to a drive, a dialog will ask you if you wish to save the drive’s parameters to nonvolatile memory. If this box is not checked the dialog will not be shown

13.2 Save On Exit

When you exit WorkBench while you are connected to a drive, you may see this dialog box:



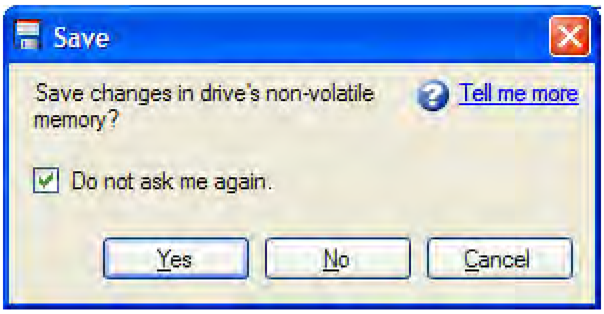
As you are working with a drive all the changes you make are stored in the volatile memory within the drive. If you power cycle the drive or loose power to the drive then any changes you have made to the drive would be lost. You can save the drive parameters to nonvolatile memory at any time and these saved parameters will be restored when the drive next powers up.

While you are connected to the drive WorkBench monitors all the changes you make to the drives parameters. An asterisk in the navigation tree shows if a parameter has been changed. If you do not change any drive parameters this dialog will not be shown.

Button or Dialog Box	Description
Yes	Saves the parameters to the nonvolatile memory within the selected drives and then exits WorkBench.
No	WorkBench will exit. No drive parameters will not be saved to nonvolatile memory.
Cancel	This will stop the exit command and WorkBench will remain open.
Do not ask me again	If you check this WorkBench will not show this dialog again. There is an option in the Options dialogue to restore this setting.

13.3 Save On Disconnect

When you disconnect from the drive, you may see this dialog box:



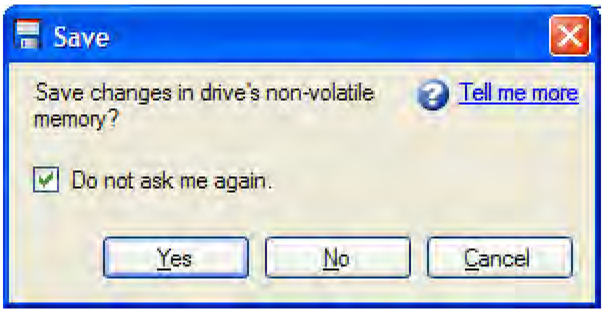
As you work with a drive, all the changes you make are stored in the volatile memory within the drive. If you restart the drive or lose power to the drive, then any changes you made to the drive would be lost. You can save the drive parameters to nonvolatile memory at any time, and these saved parameters will be restored when the drive next powers up.

While you are connected to the drive, WorkBench monitors all the changes you make to the drive parameters. An asterisk in the navigation tree shows if a parameter has been changed. If you do not change any drive parameters, this dialog box will not be shown.

Button or Dialog Box	Description
Yes	Saves the parameters to the nonvolatile memory within the drive and then finish disconnecting.
No	Disconnects the drive. The drive parameters are not saved to nonvolatile memory.
Cancel	Stops the disconnect command. You remain connected to the drive.
Do not ask me again	Does not diplay this dialog box again. If you check this box, WorkBench does not show this dialog again. The **Options** dialog includes a command to restore this setting.

13.4 Save On Firmware Download

When you download firmware to the drive, you may see this dialog box:



As you work with a drive, all the changes you make are stored in the volatile memory within the drive. If you restart the drive or lose power to the drive, then any changes you made to the drive are lost. To save these changes, you can save the drive parameters to nonvolatile memory at any time. If you save the changes to the nonvolatile memory, these saved changes will be restored when the drive next powers up.

While you are connected to the drive, WorkBench monitors all of the changes that you make to the drive parameters. An asterisk in the navigation tree indicates that a parameter has been changed. If you do not change any drive parameters, this dialog box will not be shown.

Button or Dialog Box	Description
Yes	Saves the parameters to the nonvolatile memory within the drive and then opens dialog box for the user to select the firmware file for downloading.
No	The drive parameters are not saved to nonvolatile memory. It opens dialog box for the user to select the firmware file for downloading.
Cancel	Stops the download command.
Do not ask me again	Does not display this dialog box again. If you check this box, WorkBench does not show this dialog again. The Options dialog includes a command to restore this setting.

14 Tuning Your System

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Most servo systems require some level of tuning (setting up the desired response of the system usually with the load attached). This can be done through several methods available within AKD WorkBench.

Slider Tuning - Slider tuning offers a very simplistic approach to tuning and can get you underway quickly. With this method, just the proportional and integral gains are adjusted based on the desired bandwidth you wish to achieve. You can take into account your load inertia if it is known. None of the Bi-quad filters are impacted by the slider tuning.

Auto Tuner - This is an easy way to get a more sophisticated tuning accomplished. The details of how auto-tuning works are included in the advanced section of this subject. However, the autotune approach is a simple one-button solution that lets the system configure all of the tuning parameters for you. The autotuner is a robust solution to get your sytem tuned and ready to operate in a wide variety of mechanical configurations and loads.

Manual Tuning - Certain applications may require manual tuning where you set the gains and filters based on the specific performance you are looking for. You may also need to "tweak" the tuning that was set up in either the slider or autotune section to optimize your application performance.

14.1 Slider Tuning

This view allows you to vary the tuning of your drive using the slider.

14.1.0.1 Gentle, Medium, and Stiff

These buttons select three of the most common bandwidths:

- Gentle works in all but the most challenging situations.
- Medium is the default and works in most situations.
- Stiff works for unloaded motors.

14.1.0.2 The Slider

As you drag the slider to the right, the stiffness increases. In many situations, you cannot drag the slider fully to the right side because the system will become unstable.

14.1.0.3 Inertia Ratio

If you know the inertia ratio of your load, then entering it can improve the performance of your system. If you do not know the inertia of your load then WorkBench will assume a ratio of 1:1, which will give good performance in many configurations. The inertia ratio is the ratio of your load with respect to the inertia of your motor.

14.2 Load Inertia

The inertia ratio is the ratio of the load with respect to the inertia of the motor. If you know the inertia ratio of the load, then entering it can improve the performance of your system. If you do not know the load inertia, then Work-Bench assumes a ratio of 1:1, which will give good performance in many configurations.

14.3 Using the Autotuner

14.3.1 Overview

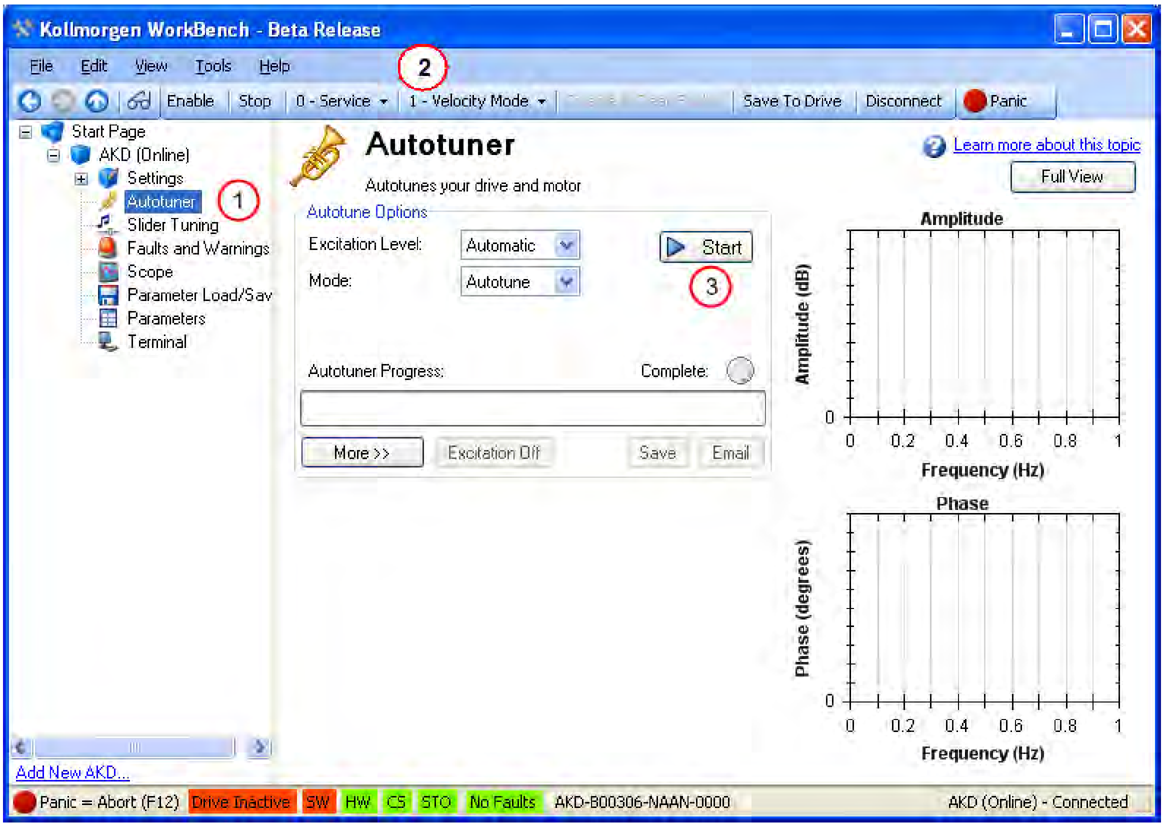
The AKD Autotuner makes it easy and fast to tune your servo system. The advanced technology in the AKD Autotuner achieves high performance and stability for both simple and complicated loads. The Autotuner can work in a “one button” mode that requires no decisions from the user. It can also be set up in specific modes to control how the Autotuner operates for specific requirements. Finally, the Autotuner collects frequency response data (a Bode plot) that can be used for advanced analysis.

NOTE	**The Autotuner will not work reliably on a vertical axis since the motor may rest against an end stop; in this case, the inertia will not always be correctly identified.**

14.3.2 Using the Autotuner

The Autotuner defaults to a “one button” mode, in which autotuning is completely automatic after pushing the start button. In the **Settings** select your desired operation mode, then tune your system with the Autotuner as follows:

1. To open the autotuner, select **Autotuner** from the navigation tree.
2. Select whether you would like the drive to be tuned in **1-Velocity** or **2-Position** Mode. If the drive is in torque mode, the Autotuner will tune in position mode by default. This is set by using the tool bar and changing the mode to either velocity or position. The drive must be disabled in order to change the operation mode.
3. Click **Start**.



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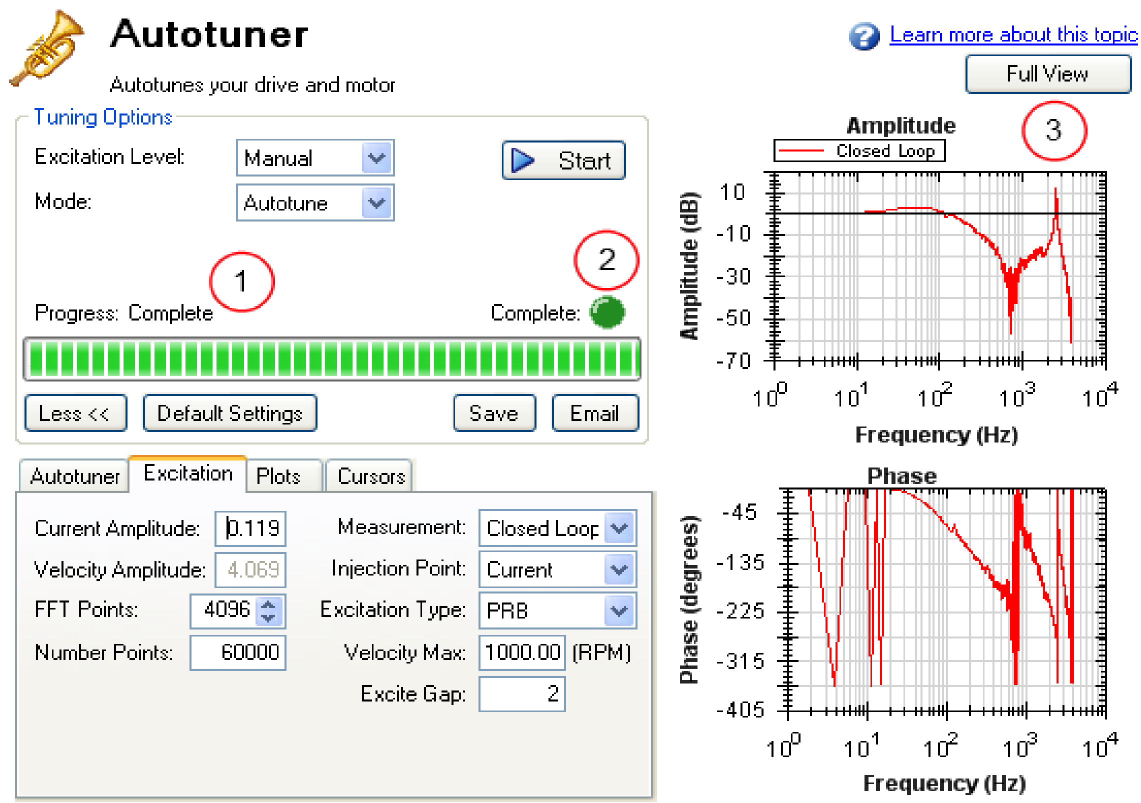
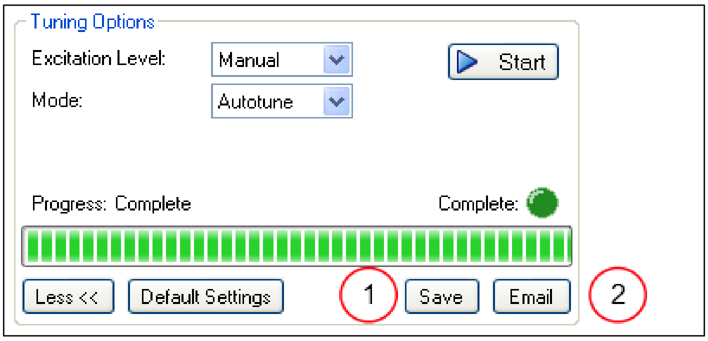
The Autotuner will then perform several tests and display results as shown below. The progress bar (1) shows the relative progress of the Autotuner, so you can estimate when the tuning will be finished. When the tuning is complete, the green **Complete** LED (2) illuminates, and a Bode plot (3) is displayed showing the frequency response of the tuned system.

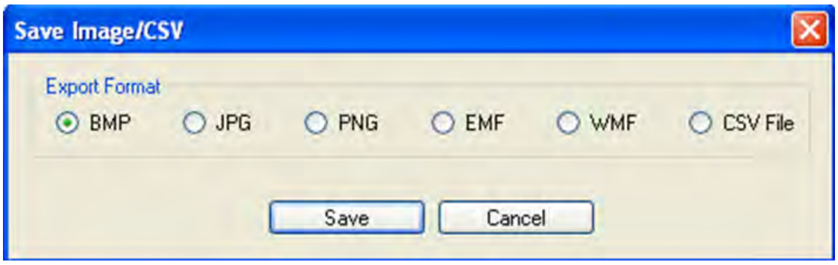


14.3.2.1 Saving and Emailing Bode Plots

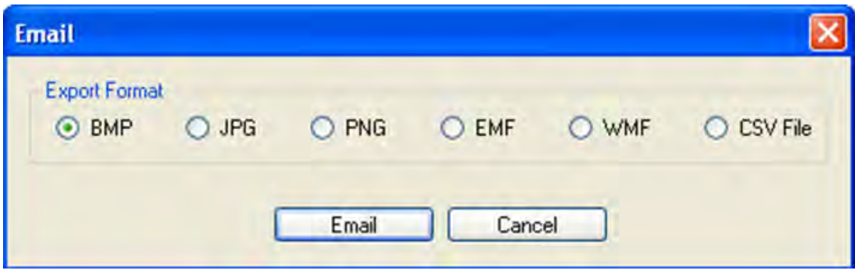
To save screenshots and raw data of a Bode plot, click on either **Save** (1), or **Email** (2).



Clicking **Save** opens a prompt to select how to save the screenshot or data. Selecting BMP, JPG, PNG, EMF, or WMF saves the Bode plot as an image. Choosing CSV saves the raw data that is currently plotted as a comma delimited file. Click **Save** to save the file to your hard drive in the desired format.



Clicking **Email** opens a similar prompt. Select the file format in which you wish to save the image or raw data, and an email will be created for you with the file automatically attached for your convenience. Click **Email** to create the email with the selected file attachment.



14.3.3 Measurement Options

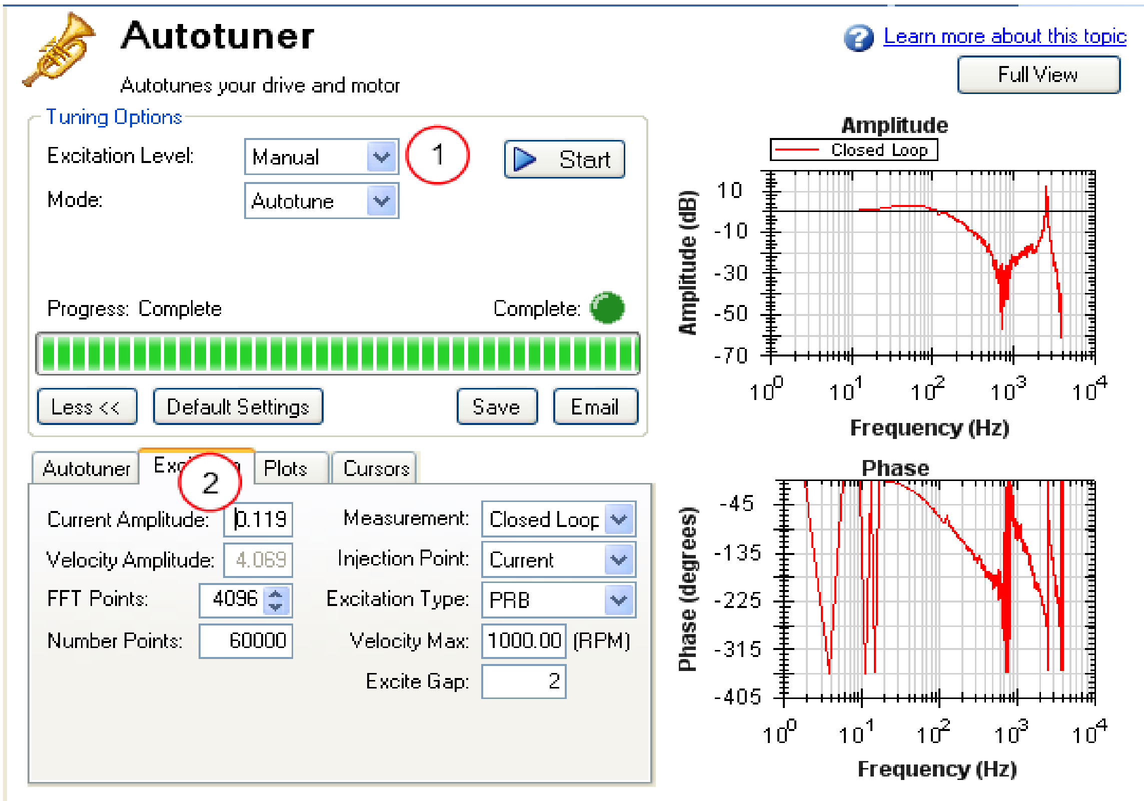
By default, the Autotuner determines the excitation level automatically and autotunes the drive and motor. The Autotuner also allows you to enter a manual excitation level or to take only Bode measurements (without autotuning the system).

14.3.3.1 Using Manual Excitation Levels

By default, the Autotuner is set to use the automatic excitation level. To obtain the automatic excitation level, the Autotuner runs a friction test at the beginning to determine how much excitation is needed to break friction and get an accurate measurement.

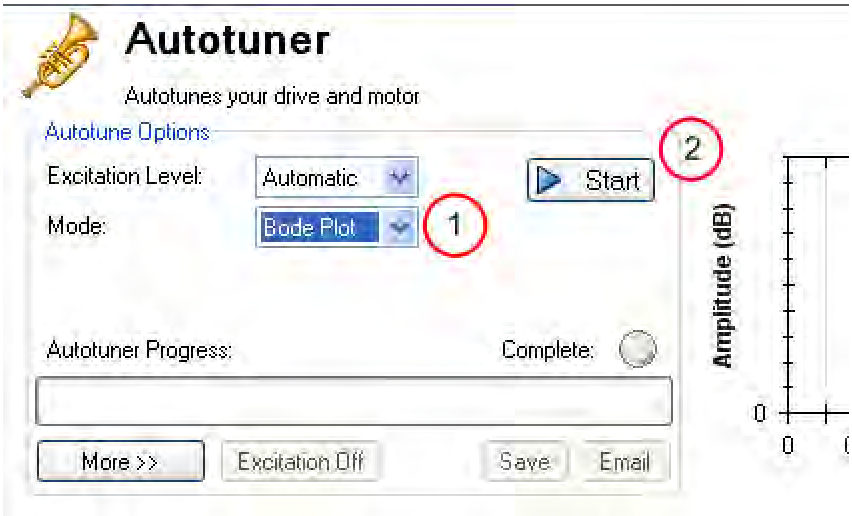
To change this excitation level, click on the **Excitation Level** drop down box (1), and select **Manual**. Then enter a new **Current Amplitude** (2) in amps.

Note: If the **Injection Point** is set to **Current**, then the **Current Amplitude** box will be enabled to enter an excitation level; if the **Injection Point** is set to **Velocity**, the **Velocity Amplitude** box will be enabled to enter an excitation level.



14.3.3.2 Taking a Bode Measurement without Autotuning

You may wish to take only the frequency response of a system, rather than autotuning. To take a frequency response measurement without autotuning, click on the **Mode** drop down box (1) and select **Bode Plot**, then click **Start** (2).



14.3.4 Using the Autotuner: Advanced

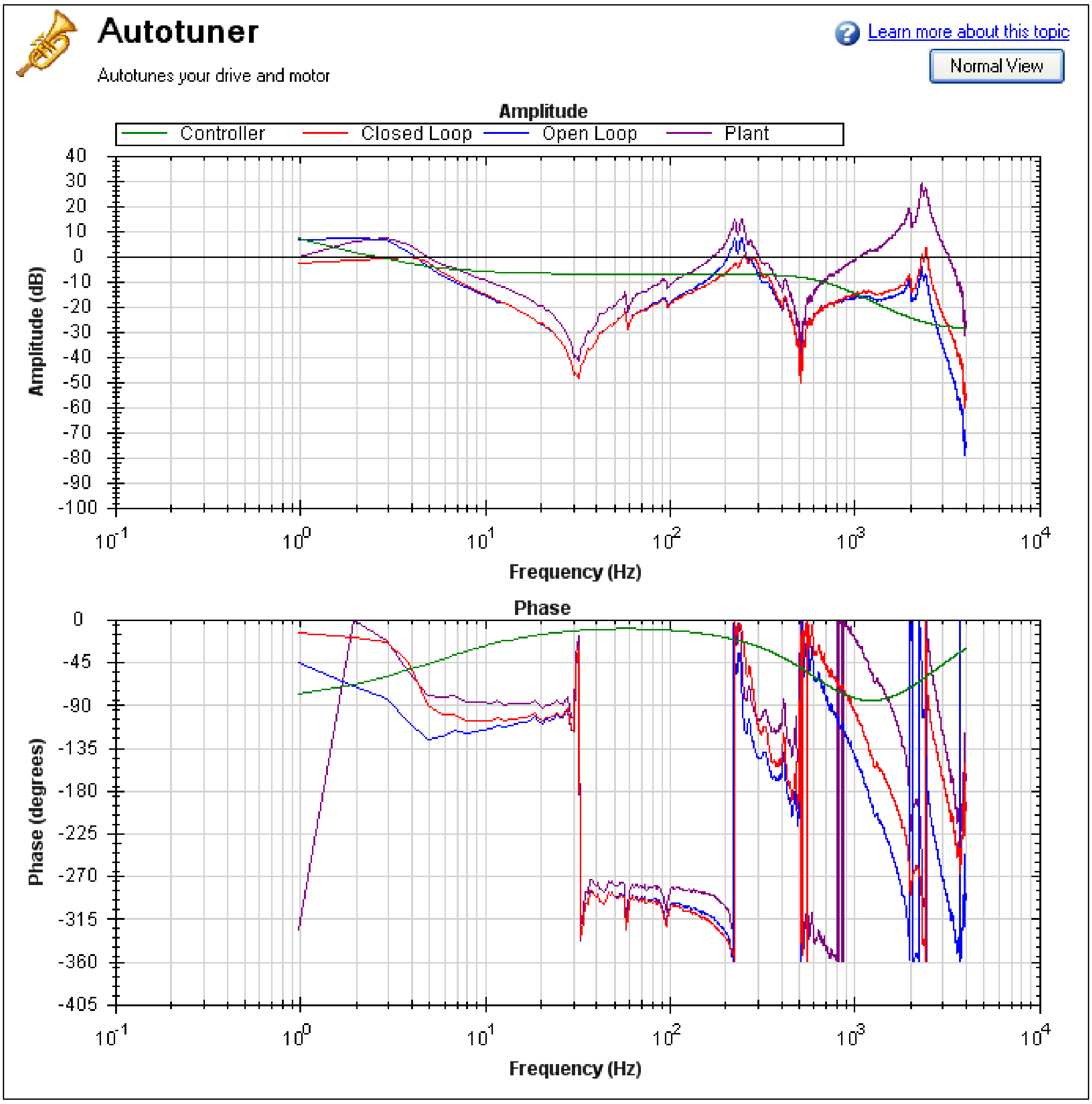
The Autotuner can be set up to use specific modes or limits in tuning to provide tuning in ways you can control, while still taking advantage of the Autotuner's ability to make decisions quickly and effectively for you.

To use the advanced modes of the Autotuner, click the **More** button to display the additional features for advanced autotuning:

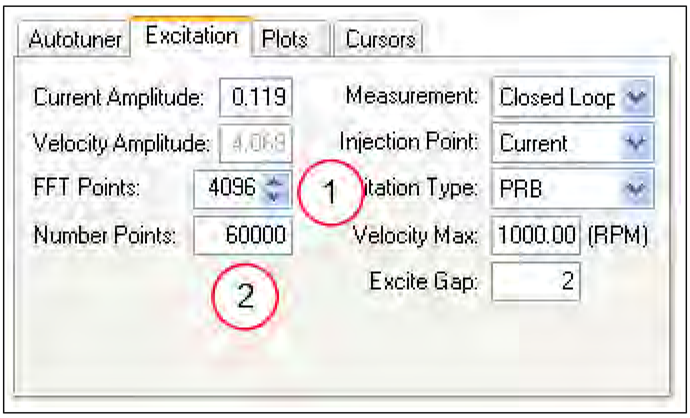
14.3.4.1 Typical Cases for Advanced Autotuning

Tuning Systems with Low-Frequency Resonances

Systems with low-frequency resonances are challenging because low frequency data is difficult to measure. While the Autotuner can tune these systems, you can expect lower system performance. If your system has a first anti-resonance of 12 Hz (pictured below), you can expect approximately 6 Hz (half the frequency of the first anti-resonance) of closed loop bandwidth.

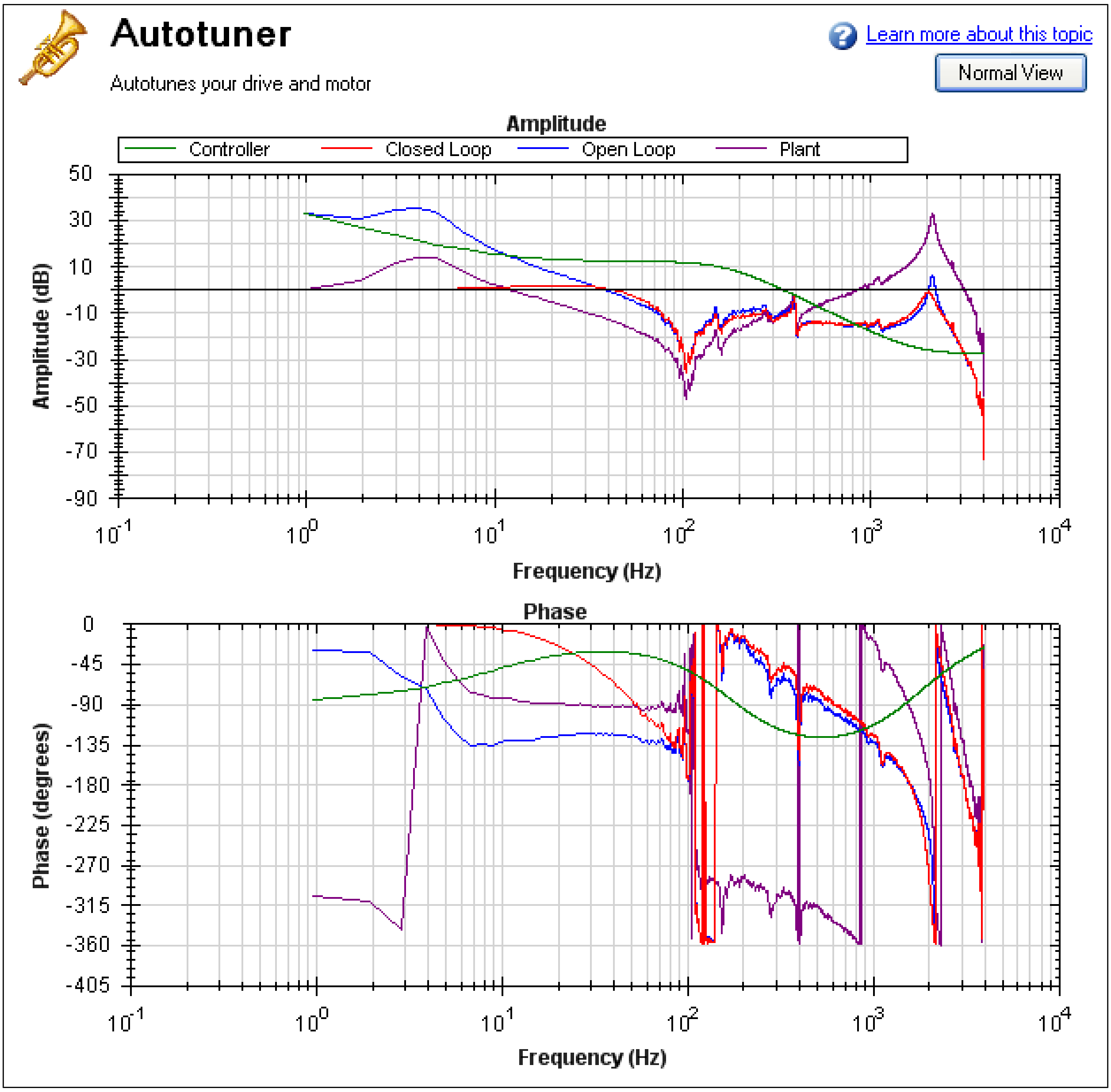


In addition, in order to accurately measure the low frequency resonances, the fast Fourier transform (FFT) resolution must be sufficiently fine to accurately measure the low-frequency resonance. A good place to start is to have an FFT resolution of 1/10 of the frequency of the lowest anti-node. In the case shown below, an anti-resonance of 12 Hz is present, so the resolution should be approximately 1.2 Hz FFT resolution. The Autotuner can function with the resonance if it is accurately measured, as shown below. To adjust the FFT resolution, adjust **FFT Points** in the **Recording Options** tab as needed.

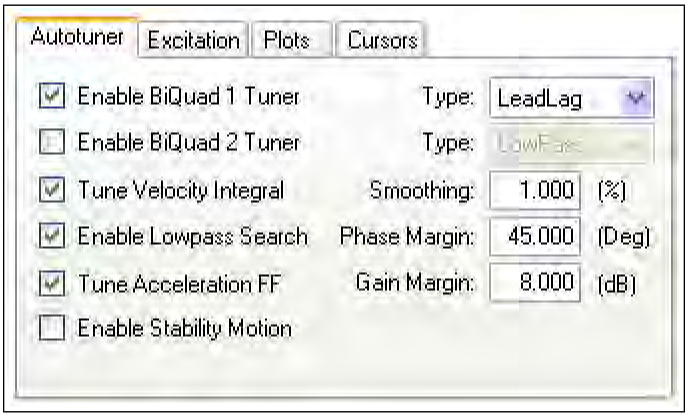


Tuning Systems with High-Frequency Resonances

Some systems have resonances at very high frequencies (greater than 1 kHz). When the resonance is this large, it can prove a challenge in tuning, because these systems generate high noise levels that are often audible. An example of a large resonance is shown below. This example is from a steel flywheel mounted to an AKM 22E motor. The source of the resonance is the spring mass relationship between the motor rotor, shaft, and flywheel.

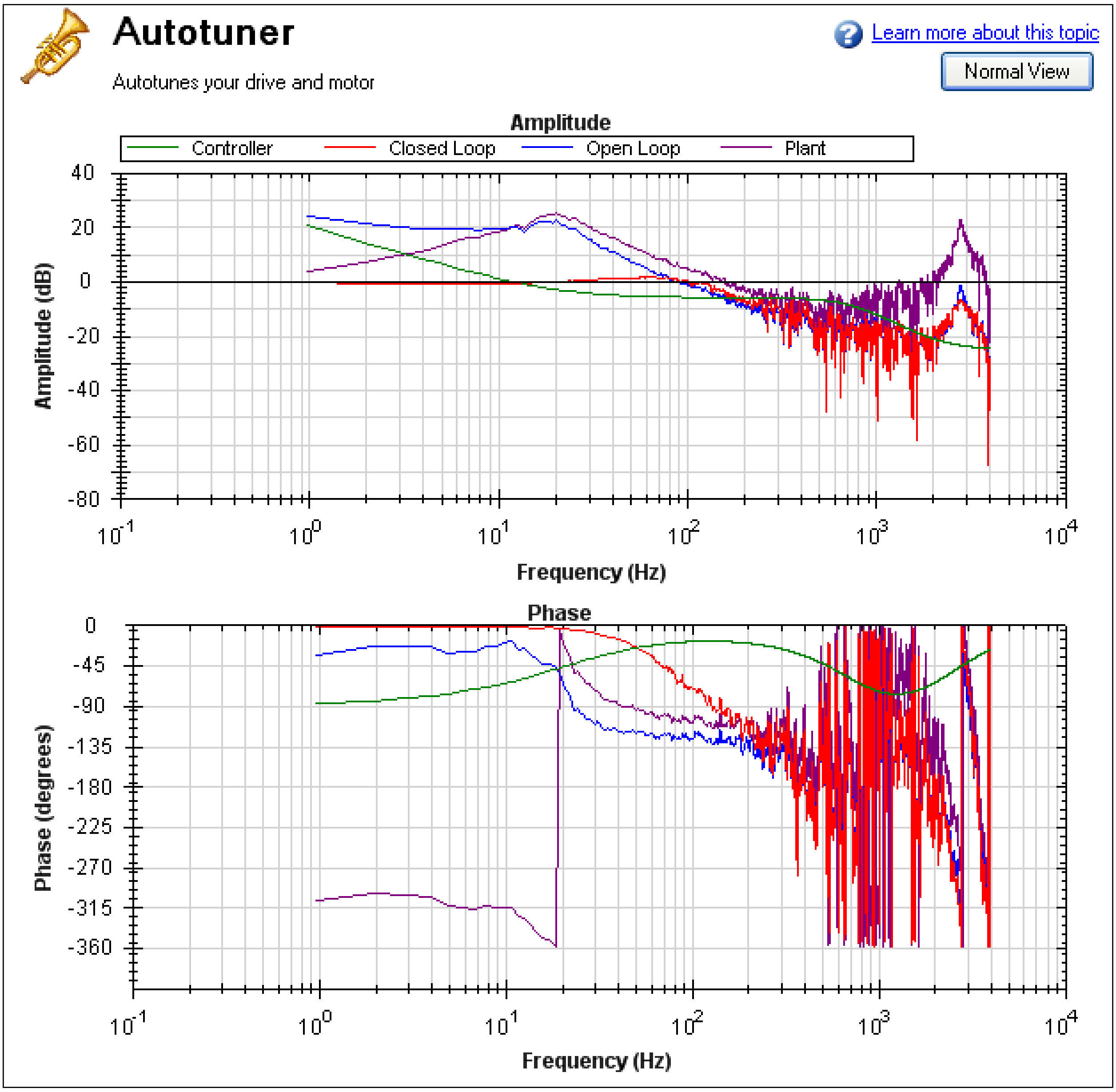


One way to resolve this problem is to use a low-pass filter in the feedback path. To use this filter, simply check the **Enable Lowpass Search** in the Autotuner, which is the default behavior.

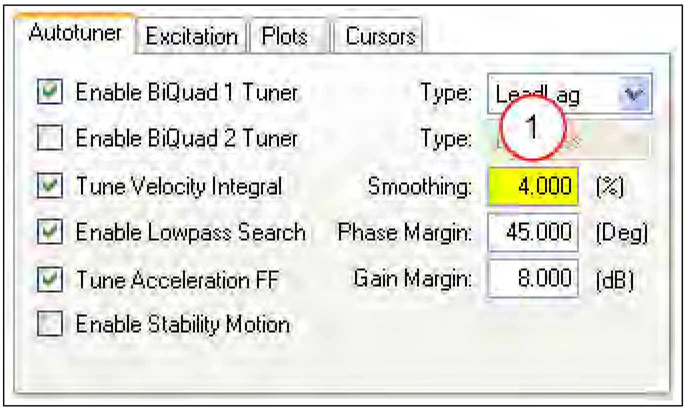


Tuning systems with noisy frequency responses

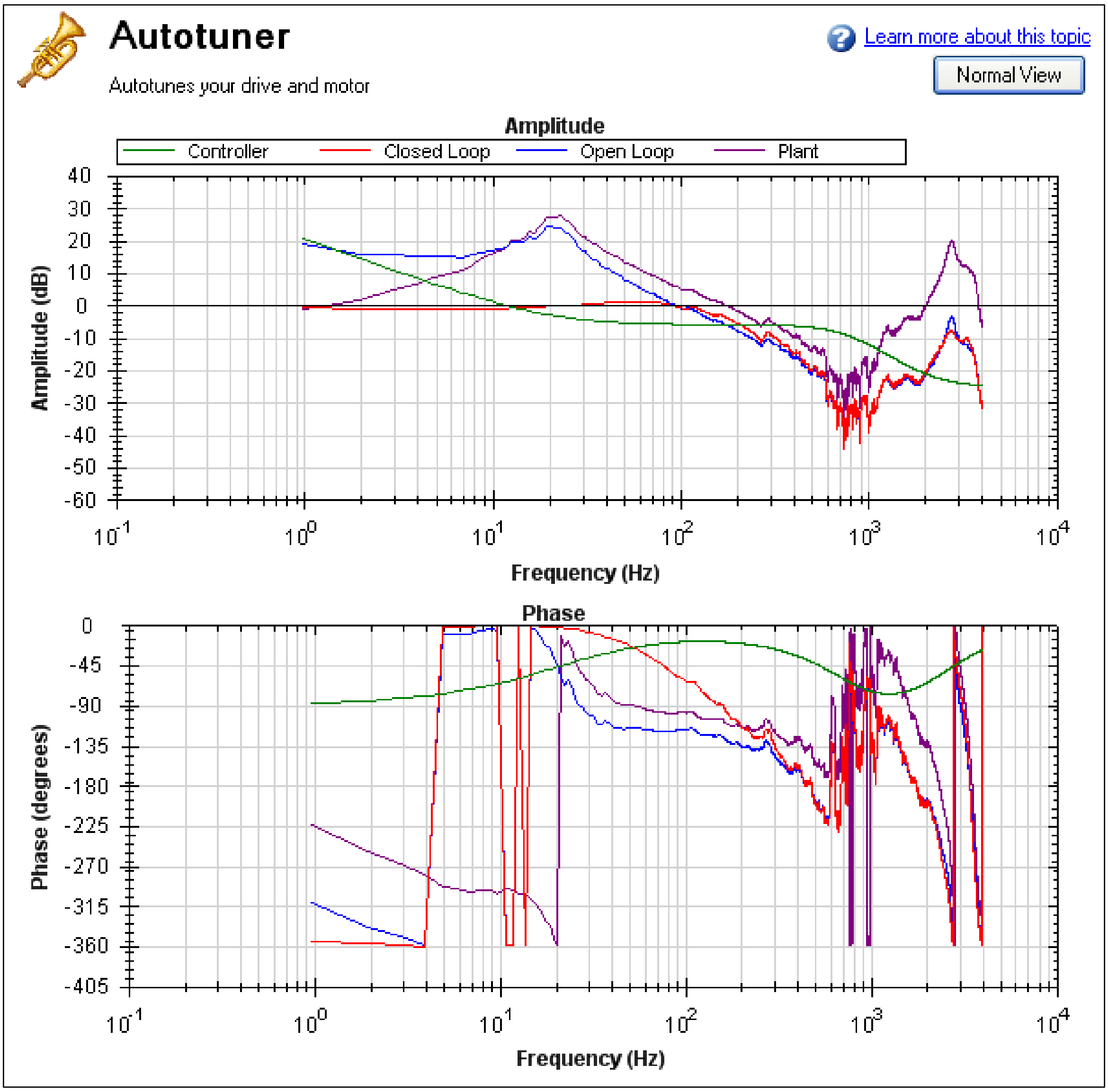
When using a motor with a low-resolution incremental encoder or resolver, the high frequency response may be noisy. Below is a Bode plot created after autotuning of an incremental encoder with 8,192 counts per revolution.



To make the Bode plot easier to read, increase the smoothing factor (1) in the advanced **Autotuner Options**.

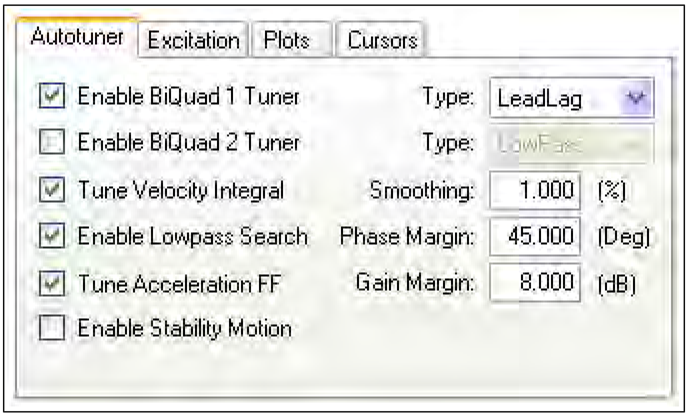


After increasing the smoothing percentage, the Bode plot traces become cleaner and easier to read:



14.3.4.2 Autotuner Options

When you click **More** in the Autotuner view, the following options are displayed:



Enable BiQuad 1 Tuner

Check this box to use the first anti-resonance filter in the forward path (AR1). You can specify the type of filter to use in the **Type** box to the right of **Enable BiQuad 1 Tuner**.

Enable BiQuad 2 Tuner

Check this box to use the second anti-resonance filter in the forward path (AR2). You can specify the type of filter to use in the **Type** box to the right of **Enable BiQuad 2 Tuner**. Enabling this option may significantly slow your computer during this operation.

Biquad Type

For Biquad 1 and 2, you can choose what type of filter to implement. The four options are:

1. **LeadLag**: The LeadLag filter is the default, and will work for most servo systems.
2. **Lowpass**: A Lowpass filter requires the least amount of processing time. The autotuner will place the low-pass to get the maximum bandwidth possible.
3. **Resonator**: The Resonator filter is like a Notch filter with tunable bandwidth and notch depth. The Resonator takes longer to calculate than the LeadLag filter.
4. **Custom**: The Custom filter takes the longest to calculate and does not restrict the Autotuner to a filter shape. This filter type provides excellent results, but may significantly slow your computer while the filter is calculated.

Tune Acceleration FF

This box turns on and off the acceleration feedforward tuner. If this box is checked, the Autotuner will measure the inertia attached to the motor shaft, and using this measurement, will calculate an appropriate acceleration feedforward and write it to the drive (IL.KACCFF)

Enable Stability Motion

When this checkbox is checked, after the Autotuner has completed, the Autotuner will command a short move in the clockwise direction, then back to its origin and monitor the motor's parameters to determine if the tuning is stable. If an instability is detected, the drive will generate Fault 133: Instability during Autotune.

Phase and Gain Margins

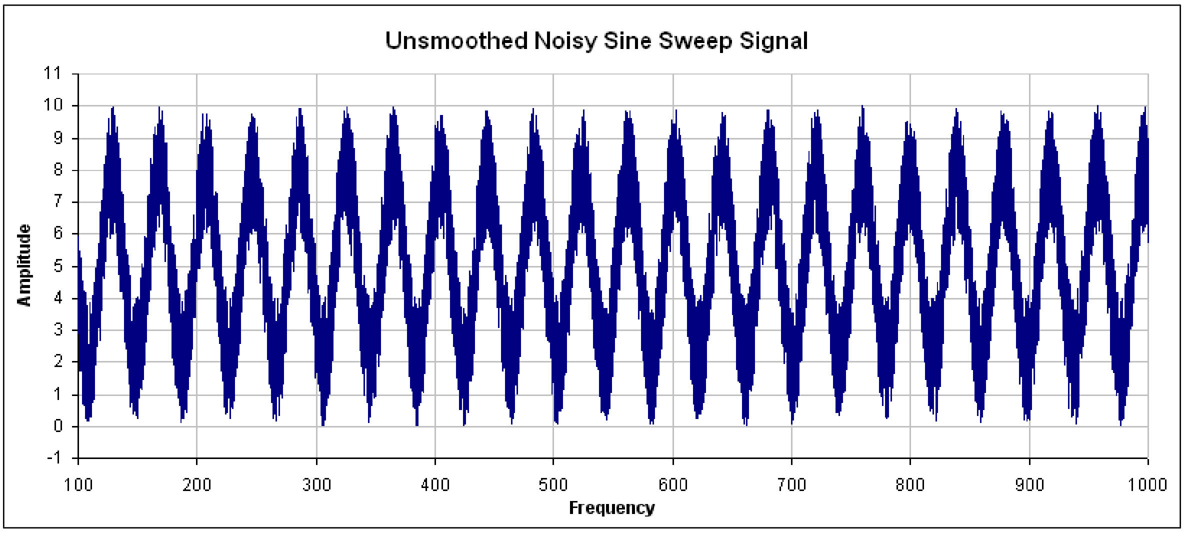
The autotuner always ensures that the tuning satisfies stability criteria that can be adjusted in units of phase margin (in degrees) and gain margin (in dB). The Autotuner uses default values for phase and gain margin, but you can adjust these values to ensure higher stability or to allow the autotuner to be more aggressive by using lower gain and phase margins.

Smooth %

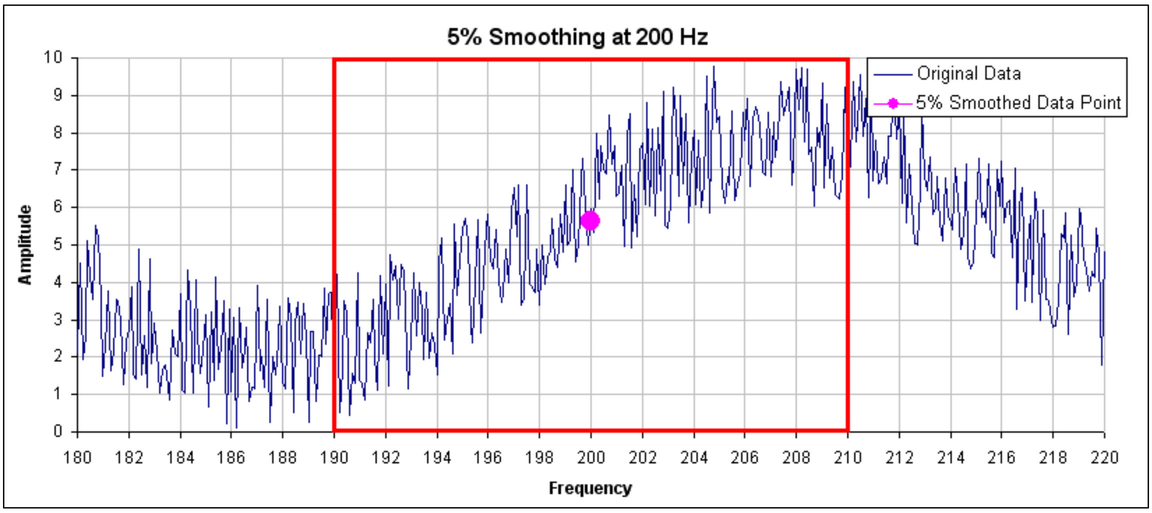
This value applies a moving average smoothing filter to the frequency response gathered during autotuning. This process reduces noise in the frequency response that can occur when making short frequency response measurements, using low resolution encoders, conducting low amplitude frequency response tests, or for other reasons. The smoothing filter iterates through each frequency on the FFT plot. For each frequency, all frequencies within the **Smooth %** range will have their magnitudes averaged.

For example, if you smooth a Bode plot with 5% smoothing, at 100 Hz, it will average all the values between 95Hz and 105Hz; when the filter gets to 1000 Hz, the filter will average all the values between 950 Hz and 1050 Hz.

As an example, assume a noisy sine sweep signal and use a 5% smoothing factor. Below is a noisy signal with a range of 100 Hz to 1000 Hz.

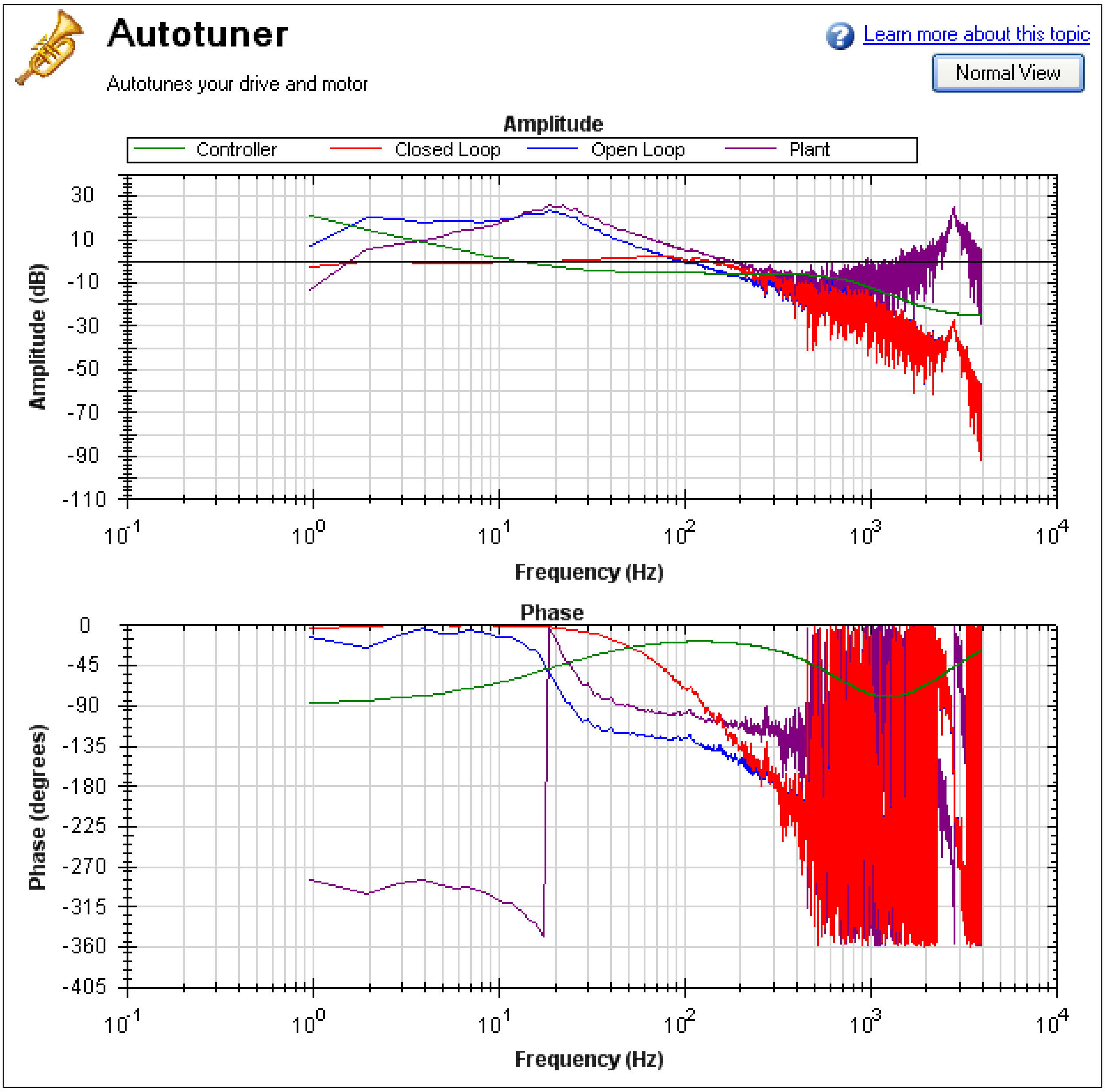


In this example, examing how the smoothing filter affects a single point shows how the smoothing filter works on a full plot. If you zoom in on 200 Hz +/- 5%, this gives a range of 190 Hz – 210Hz. The smoothing filter averages this range of values and puts the average right on 200 Hz. The figure below shows the zoomed data around 200 Hz and the averaged value of all frequencies +/- 5% (the red box illustrates the range of frequencies being smoothed).

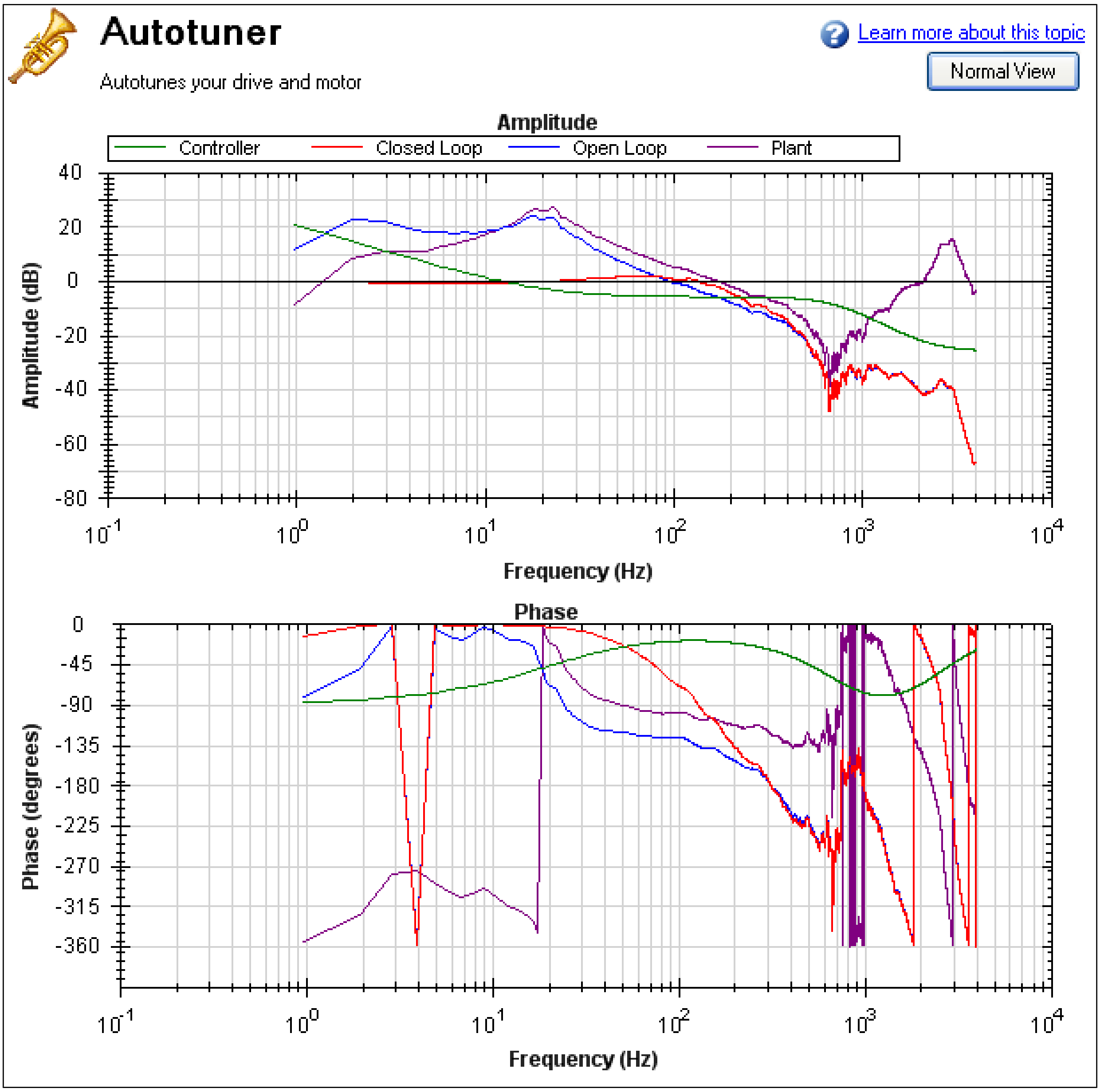


In the Autotuner, the smoothing filter will do this analysis for every frequency point on the Bode plot. If the data is too noisy, then you can increase the smoothing percentage to smooth the noise out and see the underlying data patterns. A comparison of a system with 0.1% smoothing and 8% smoothing is shown below.

0.1% smoothing


Autotuner
Autotunes your drive and motor
Learn more about this topic
Normal View
Amplitude
Controller
Closed Loop
Open Loop
Plant
Amplitude (dB)
30
10
-10
-30
-50
-70
-90
-110
10^{-1}
10^{0}
10^{1}
10^{2}
10^{3}
10^{4}
Frequency (Hz)
Phase
Phase (degrees)
0
-45
-90
-135
-180
-225
-270
-315
-360
-405
Frequency (Hz)

8% Smoothing



Note: Smoothing decreases the peaks of resonances; if smoothing is too high, a resonance may be completely hidden. If the Autotuner cannot identify a resonance due to high smoothing, the system may become unstable.

Tune Velocity Integral

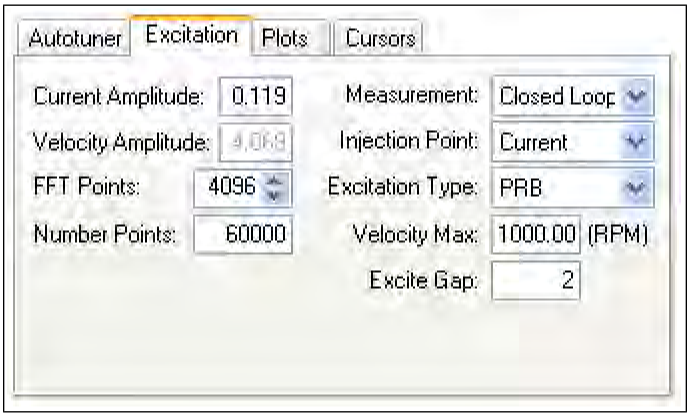
Check this box to tune VL.KI (velocity loop integral gain). If this box is unchecked, the Autotuner will set VL.KI to zero.

Enable Low Pass Search

Check this to tune a fourth-order low pass filter in the feedback path (AR 3 and 4). If this box is unchecked, the Autotuner will not modify the anti-resonance filters in the feedback path.

14.3.4.3 Recording Options

The Autotuner screen also provides options for recording tuner output:



Current Amplitude

This box sets the amplitude of the current used to excite the system during a current injection mode excitation. This amplitude applies to all excitation types when the **Injection Point** is set to **Current**. The **Current Amplitude** box is disabled if the **Injection Point** is set to anything else.

Velocity Amplitude

This box sets the amplitude of the velocity used to excite the system during a velocity injection mode excitation. This amplitude applies to all excitation types when the **Injection Point** is set to **Velocity**. The **Velocity Amplitude** box is disabled if the **Injection Point** is set to anything else.

Measurement

This box sets the measurement type used during a measurement. The Autotuner functions only if **Plant** measurement is selected; autotune does not function in other measurement modes.

- **Closed Loop** directly measures the closed loop frequency response of the servo.
- **Plant** directly measures the plant, including drive, motor, and mechanics coupled to the motor.
- **Controller**directly measures the controller response, which includes the tuning in the velocity and position loops, and anti-resonance filters 1 & 2.

Injection Point

The **Injection Point** box sets the source location of the excitation used during autotuning. **Current** mode uses a torque disturbance at the torque output. During current injection point measurements, the excitation will use the **Current Amplitude** value to set the size of the excitation.

Velocitymode uses a velocity command to excite the system. During velocity injection point measurements, the excitation will use the **Velocity Amplitude**value to set the size of the excitation.

Excitation Type

Excitation Type box allows you to chooses the type of excitation. Noise, pseudo random binary (PRB), and sine are the options available.

- **Noise** uses a pseudo random noise signal to excite the system. The signal varies between +/- current or velocity amplitude (depending on injection point). The signal contains a frequency spectrum that goes from a lower limit equal to:

  16,000/(Excite Gap * Number Points) Hz

  to a higher limit equal to:

  (16,000/Excite Gap) Hz

  The richness of the frequency spectrum comes from variance in the amplitude of the noise signal.

- **PRB** uses a pseudo random binary signal to excite the system. The signal is either + or – current or velocity amplitude (depending the injection point). The signal contains a frequency spectrum that goes from a lower limit equal to the larger of:

  (16,000/(2^BODE.PRBDEPTH * Excite Gap)) or 16,000/(Excite Gap * Number Points) Hz

  to a higher limit equal to:

  (16,000/Excite Gap) Hz

  BODE.PRBDEPTH is set to 19 by the autotuner. The richness of the frequency spectrum comes from variance in the phase of the signal, not the amplitude.
- **Sine** requires that you specify the start frequency, end frequency, and frequency step size. The sine sweep takes significantly longer than a noise or PRB measurement, but is often cleaner. Be careful when selecting a step size: too large of a step size may miss important resonances, and too small of a step size increases measurement time.

FFT Points

The **FFT Points**box is only visible and applicable in noise and PRB measurements. **FFT Points** sets the resolution of the FFT's measurement. The frequency resolution is equal to

16,000/(Excite Gap * FFT Points)

By increasing **FFT Points**, the resolution becomes finer, but noise in the frequency response increases.

Excite Gap

The **Excite Gap** box is only visible and applicable in noise and PRB measurements. This box sets how frequently the test excitation is updated. The excite gap minimum value is 1; this value is normally set to 2 for autotuning. The excite rate is 16,000/gap. You can limit high frequency excitation by increasing the **Excite Gap** value.

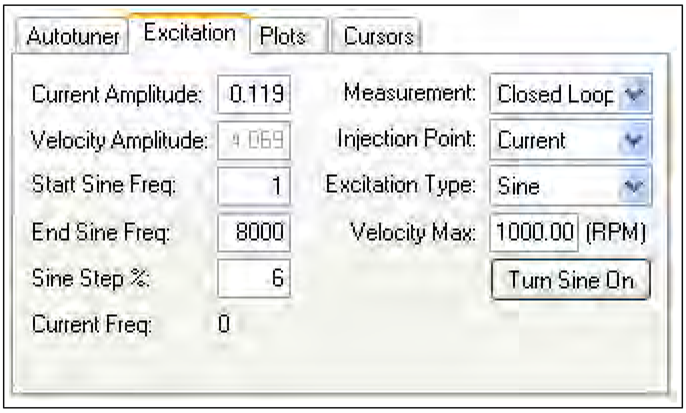
Number Points

The **Number Points** box is only visible and applicable in noise and PRB measurements. This box sets the length of recording while measuring the frequency response of the system. The measurement length is:

Number Points * Excite Gap/16,000 seconds

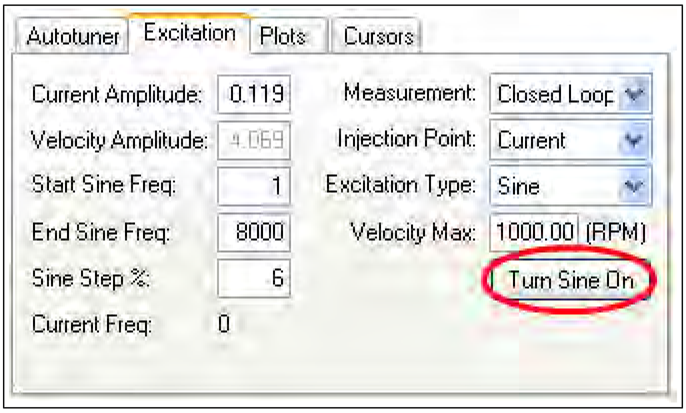
Velocity Max

The **Velocity Max** box allows the user to specify the maximum velocity the motor should be able to move while performing excitation. This box is not in effect for normal drive operation; it is only visible during the autotuner excitation phases. This value is implemented as soon as the autotuner begins, and as soon as the autotuner is finished, the previous overspeed threshold (VL.THRESH) is restored.

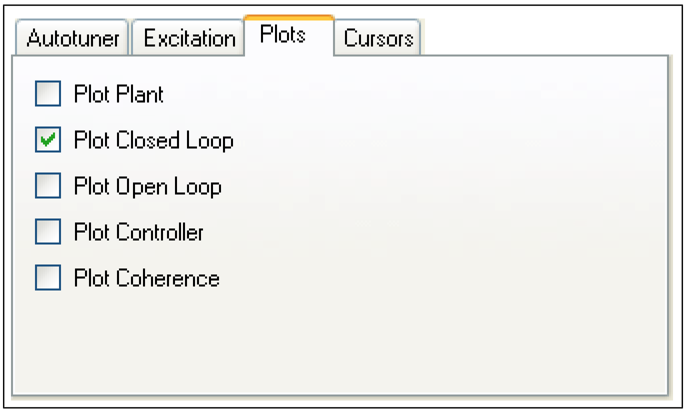


If **Excitation Type**box is set to **Sine**, different configuration options become available.

- **Start Sine Freq**: The Sine sweep test will begin at this frequency. The start frequency must be greater than zero and less than the end sine frequency. **Start Sine Freq** is only visible and applicable to Sine measurements.
- **End Sine Freq**: The Sine sweep test will end at this frequency. The end frequency must be less than or equal to 8,000, and more than the sine start frequency. **End Sine Freq** is only visible and applicable in Sine measurements
- **Sine Step %**: This box sets the sine step size. The sine sweep is discrete, not continuous. Each frequency is a multiple of the previous. For example, if the first frequency was 1 and the step size was 6%, the second frequency would be 1 * 1.06 = 1.06 Hz, the third frequency would be 1.06 * 1.06 = 1.12 Hz. This continues until the current frequency exceeds the **End Sine Frequency** value. **Sine Step %** is only visible and applicable in Sine measurements
- **Current Freq**: This field displays the current frequency of the sine sweep . **Current Freq** is only visible and applicable in Sine measurements
- **Turn Sine On**: This button allows the user to excite the system at a single sine frequency. When this button is pressed, it grays out boxes that do not apply. You may change the sine frequency and amplitude. To stop the sine excitation, click **Turn Sine Off**. **Turn Sine On** is only visible and applicable in Sine measurements.



14.3.4.4 Plot Options



By default, only the Closed Loop plot is selected. You can control which of these responses are displayed on the Bode plot by checking or unchecking the **Plot Plant**, **Plot ClosedLoop**, **Plot Open Loop**, **Plot Controller**, and **Plot Coherence** checkboxes shown.

Coherence

The coherence option is only available for noise and PRB measurements; it is not available for Sine excitation measurements.

Coherence is an indicator of how accurate your data is. For example, 0 dB (1 in linear numbers) means you have perfect coherence. Another way to think of this concept is that for one unit of input, you get one unit of output. Coherence is calculated as follows:

$$\boxed{Coherence = \frac{(Pxy \times Pxy^*)^2}{(Pxx \times Pxx^*) + (Pyy \times Pyy^*)}}$$

where:

Pxx = Power Spectral Density of Input signal

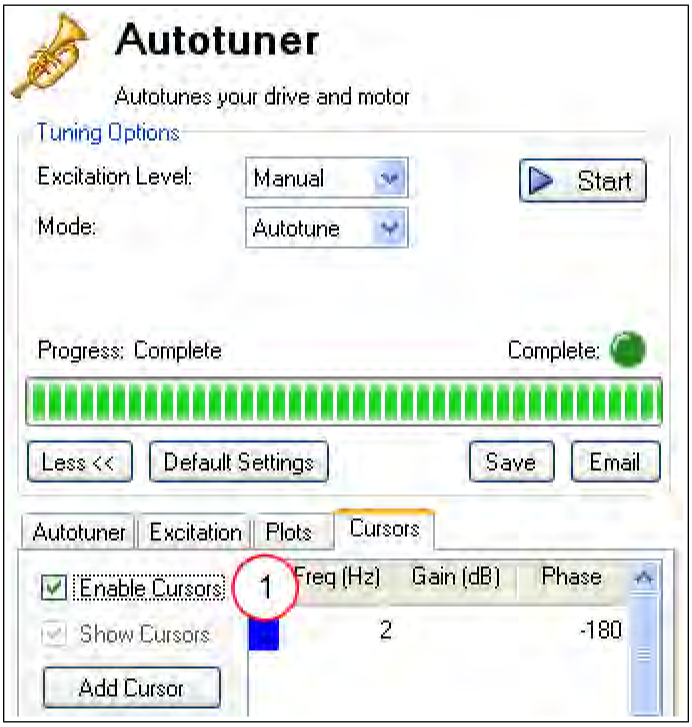
Pyy = Power Spectral Density of Output signal

Pxy = Cross Spectral Density of Input and Output

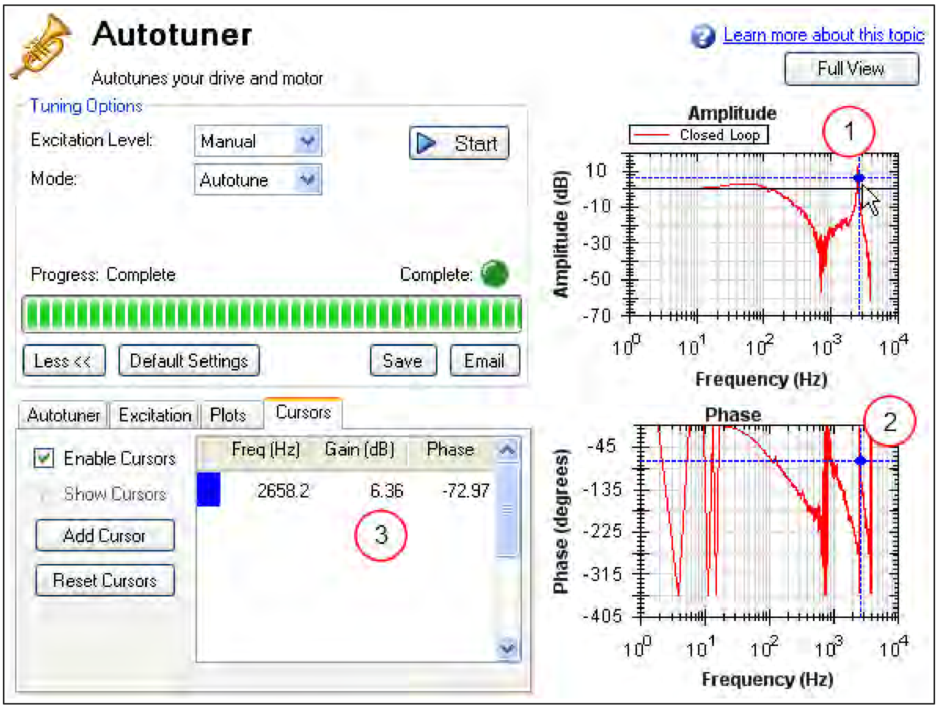
* designates complex conjugate

14.3.4.5 Cursors

Enabling cursors allows you to note specific points of interest on the Bode plot and create a table of reference points in the summary table. To enable cursors, click the **Enable Cursors** checkbox (1).



To move the cursor, move your mouse over the cursor in either the Amplitude (1), or Phase (2) plots, click and hold the left mouse button, and drag the cursor to a new location. Notice as you drag the mouse, the Frequency, Gain and Phase change in the summary window (3).



To add more cursors, click **Add Cursor**; you can add 10 cursors to the Bode Plot. When selecting a cursor, the cursor closest to the mouse will be selected. While dragging the cursor, the cursor will snap to the closest trace on the plot.

When cursors are enabled, zoom functions on the graph are disabled. To re-enable zooming, un-check **Enable Cursors**.

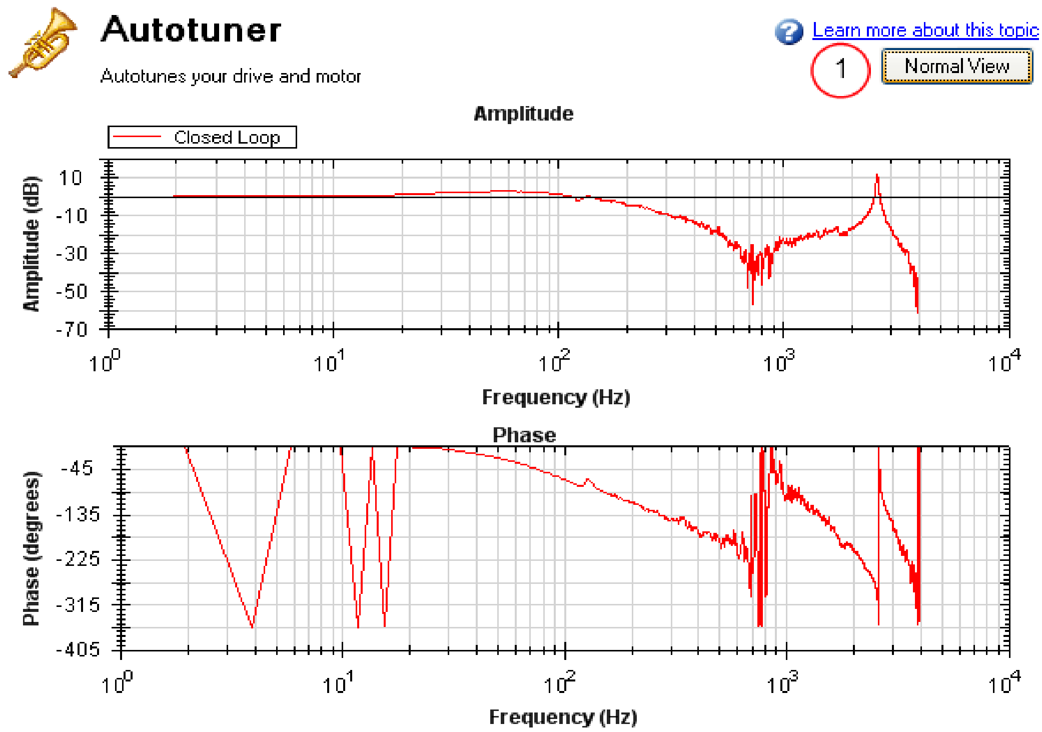
The dotted crosshair lines are only drawn for the active cursor selected; to remove all cursors from the screen, but retain their position, uncheck **Show Cursors** . To reset all cursors, click **Reset Cursors**.

Note: If a CSV file is saved or emailed after placing a cursor on the Bode plot, a cursor summary is included in the CSV raw data.

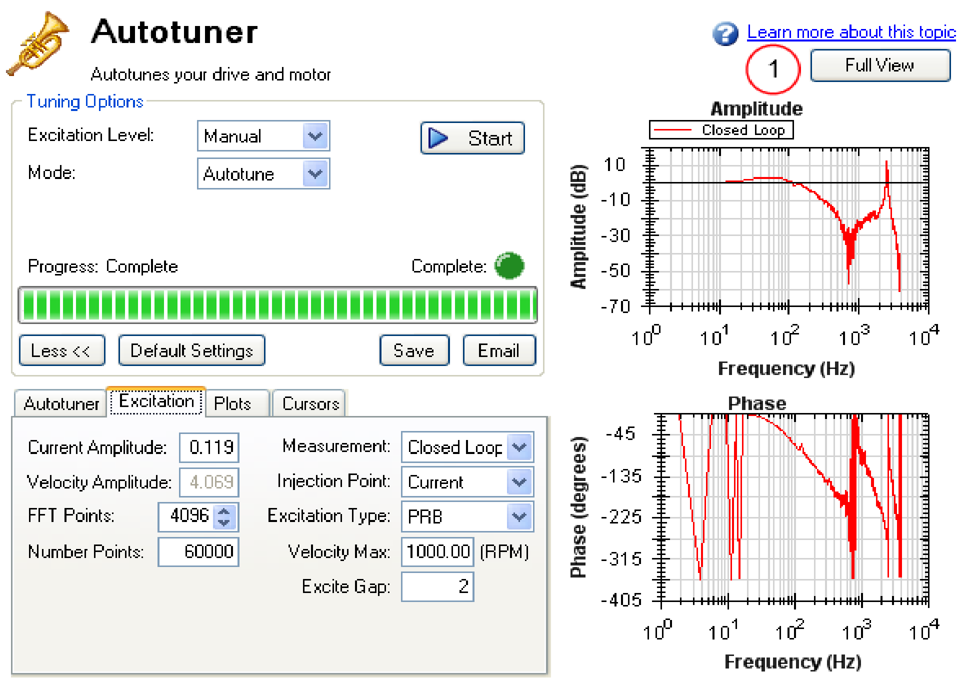
14.3.4.6 Resizing Bode Plots

In the autotuner view, the **Full View**and **Normal View**button (1) in the upper right of the window allows you to see the Bode Plot in greater or less detail. When viewig the Bode Plot in full view, the autotuner settings are hidden behind the Bode Plot. To access the autotuner settings, click the **Normal View** button in the upper right of the window.

Simple measurement normal view



Simple measurement full view



Reading and Understanding the Bode Plot

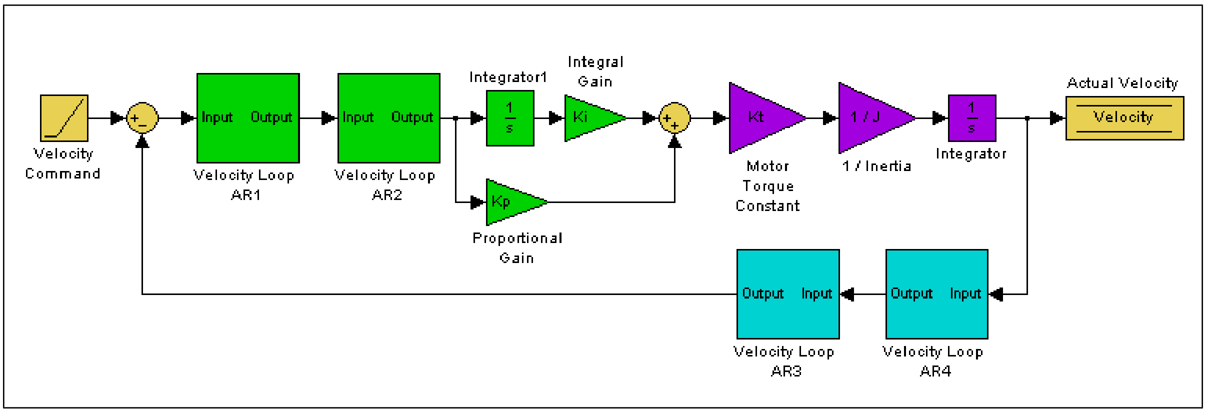
You can operate the autotuner without understanding how to read a Bode plot; however, understanding Bode plots will help you to use more advanced tuning techniques, which are covered more in depth in the Advanced Tuning For Velocity and Position Loops documentation.

Four Bode plot traces are displayed by default:

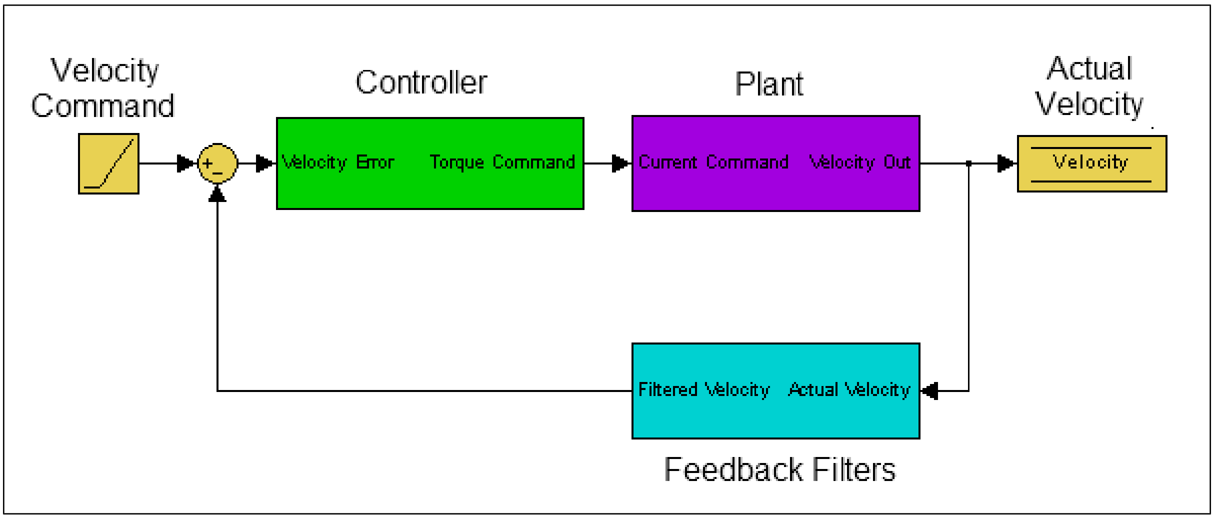
1. Controller (green): This trace represents the frequency response of the tuning in the velocity loop and position Loop, this trace also includes anti-resonance filter 1 and 2 (also referred to as [C]).

2. Closed loop (red): This trace shows the frequency response of G/(1 + G * H) where G = C * P, and H is the frequency response of anti-resonance filters 3 and 4.
3. Open loop (purple): This trace shows the frequency response of G * H, where G = C * P, and H is the frequency response of anti-resonance filters 3 and 4.
4. Plant: This trace shows the frequency response of the mechanics of the drive and motor (also referred to as [P])

The diagram of the velocity loop on the drive below explains the frequency response that each of these traces represents:"Tuning Guide" (=> p. 164)



These blocks can be grouped into Controler, Plant, and Feedback sections:



All of the green blocks have been grouped together to create the Controller [C]. The Controller is the portion of the control loop containing all velocity and position loop tuning, including the forward path filters.

All of the purple blocks have been combined to make the Plant [P]. The plant represents the mechanical and electrical properties of the motor, drive and any mechanical bodies attached to the motor.

The two feedback filters have been combined into one block. This value is never measured directly; however it contributes to both the Open Loop [G] and Closed Loop [T] frequency responses.

The definition of the Open Loop [G] frequency response is:

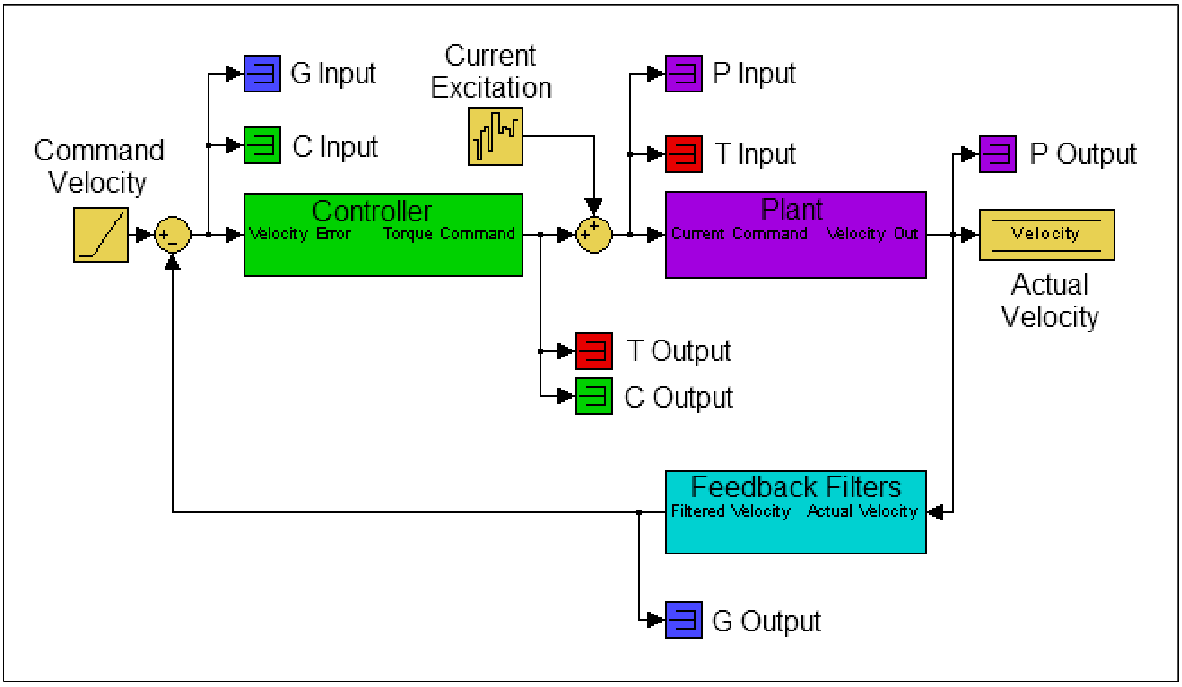
Open Loop = Controller x Plant x Feedback Filters

The definition of the Closed Loop [T] frequency response is:

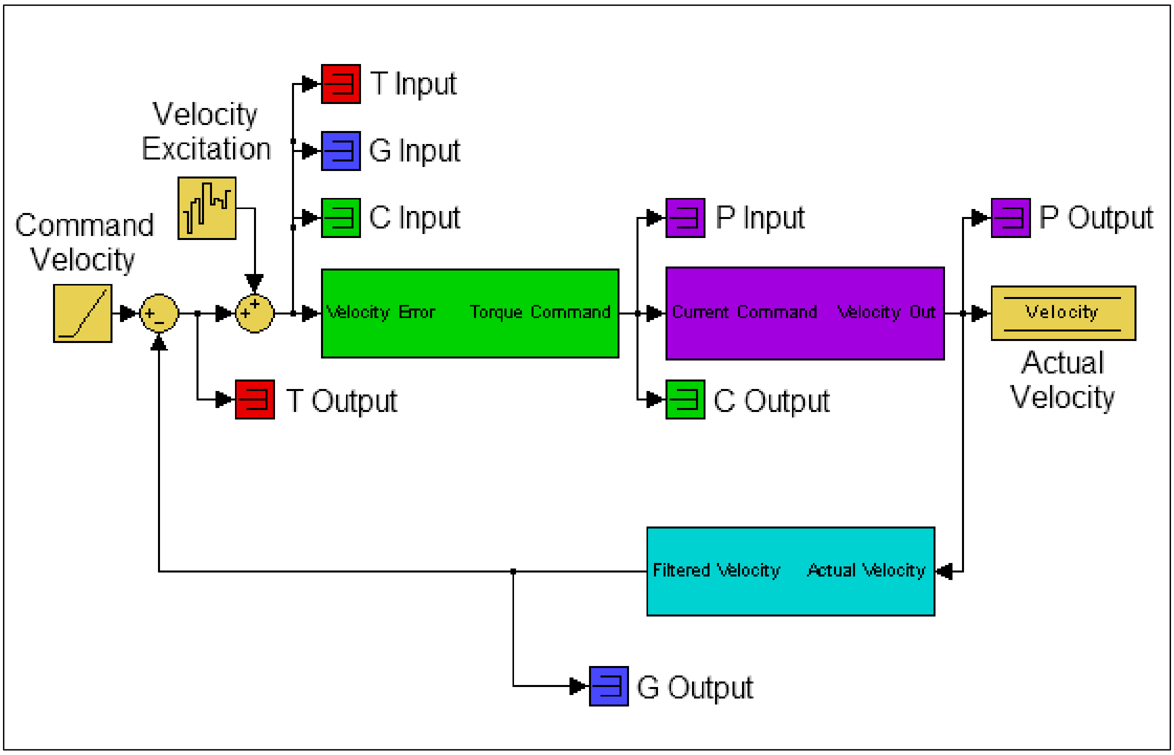
$$ClosedLoop = \frac{Controller \times Plant}{1 + Controller \times Plant \times FeedbackFilters}$$

Below is a diagram of measurement points (input and output) for each of these frequency responses. The input and output markers have been color coded with the color they appear in the Autotuner:

Current Excitation:



Velocity Excitation:

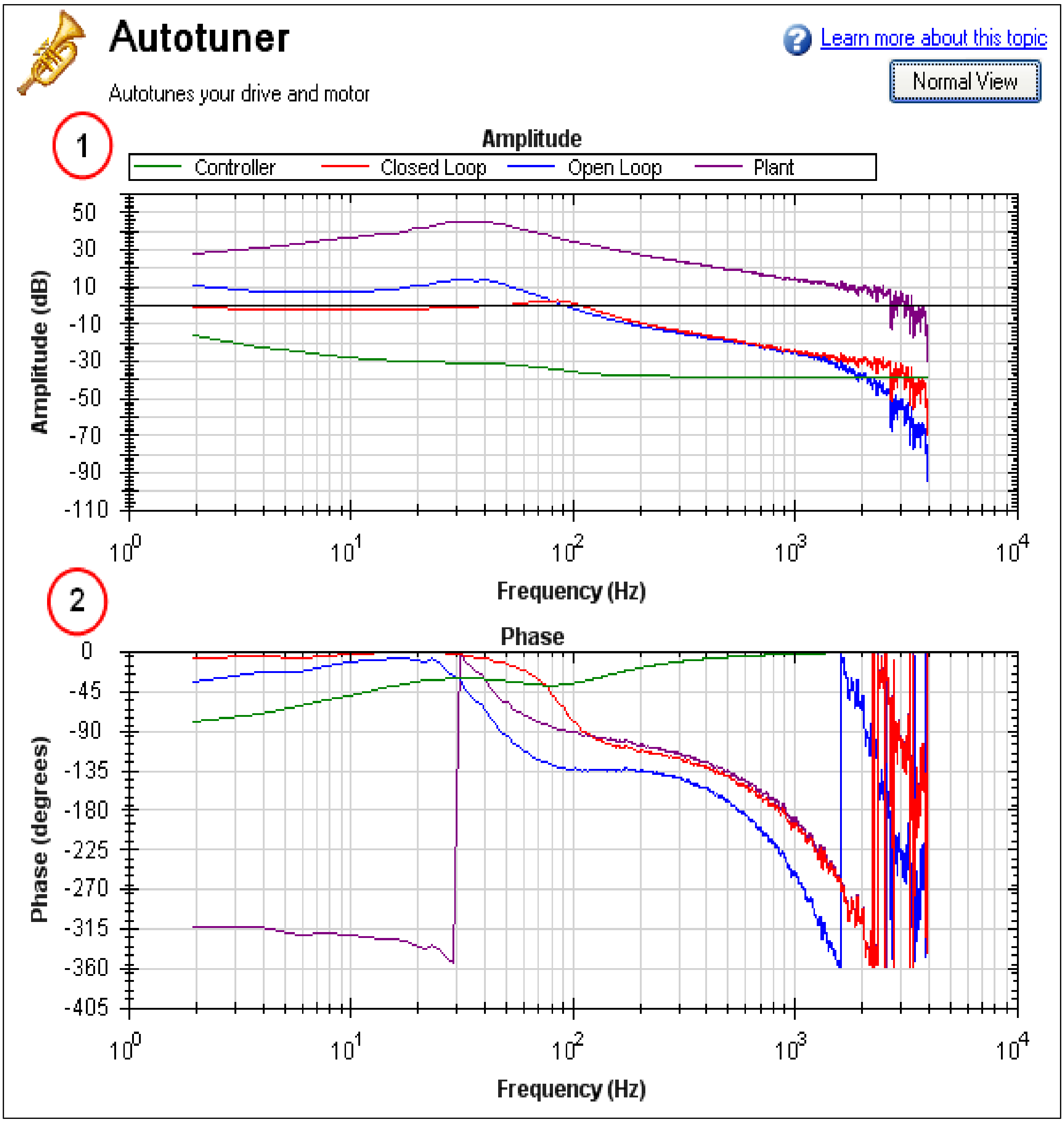


The resulting plots are the frequency response of output/input for each measurement.

For more information regarding these traces, please refer to the Advanced Tuning For Velocity and Position Loops documentation.

Below is a Bode plot of a motor with no load. The top plot is the magnitude plot (1); this plot shows the gain of the system with respect to frequency. This plot is often used to determine the bandwidth of the servo system.

The lower plot is the phase plot (2). This plot is used in conjunction with the magnitude plot to determine stability, and helps you to understand what kind of latencies exist in the servo system, or if latencies are induced by filters in the velocity loop.



14.4 Tuning Guide

14.4.1 Overview

This section covers tuning the velocity and position loops in the AKD. Servo tuning is the process of setting the various drive coefficients that are needed for the drive to optimally control the servo motor for your application. There are different ways to tune, and several are covered here. We will give you guidance on what the different methods of tuning are and when to use them.

The AKD works in three major operation modes: torque, velocity, and position operation mode. No servo loop tuning is required for torque mode. Velocity loop and position loop tuning are covered below.

The AKD has an auto tuner that will provide the tuning that many applications will need. This section describes the tuning process and how to tune the AKD, specifically for cases where the user does not want to use the auto tuner.

Tuning in this section will focus on tuning in the time domain. This means that we will look at the velocity or position response vs. time as the criteria we use to decide how well tuned a control loop is tuned.

14.4.2 Determining Tuning Criteria

Choosing the proper specifications for a machine is a prerequisite for tuning. Unless you have a clear understanding of the type of performance needed to push the machine into production, the tuning process will cause more problems and headaches than it solves. Take time to layout ALL the requirements of the machine—nothing is too trivial to consider.

- Determine what the most important criteria are. The machine was likely designed and developed with a certain performance in mind. Include ALL performance criteria in the specification. Do not concern yourself with whether or not the criteria sound scientific. (i.e. If the motion needs to visibly look smooth, put it in the specification. If it can't have any noise, put it in the specification.) At the end of the development phase, the machine's performance should match the performance previously set in the specification. This will ensure that the machine meets its performance goals and that it is ready for production.
- Test the machine with realistic motion. Do not simply tune the machine to make short linear motion, when it will make long, s-curve motions in the real world. Unless you test the machine with realistic motion, there is no way to determine if it is ready for production.
- Determine some specific, quantitative criteria for identifying unacceptable motion. It's better to be able to tell when a motion is unacceptable than to try and figure out the exact point where acceptable motion becomes unacceptable. Here are some examples of motion criteria:

  a. +/– x position error counts during the entire motion.
  b. Settling to within +/- x position error counts, within y milliseconds.
  c. Velocity tolerance of x% measured over y samples.

- DO NOT pick criteria based on what is the most popular technique of the day. It is important to focus on the things that will get the machine into production with reliable performance, based on fundamental understanding of the system.

After you have constructed a detailed servo performance specification, you are now ready to start tuning your system.

14.4.3 Before You Tune

In the worst case, if something goes wrong during tuning, the servo can run away violently. You need to make sure that the system is capable of safely dealing with a servo run away. The drive has several features that can make a servo run away safer:

- Make sure that the limit switches turn the drive off when tripped. If a complete run away occurs, the motor can move to a limit switch very quickly.
- Make sure the max motor speed is set accurately. If a complete run away occurs, the motor can reach max speed quickly and the drive will then disable.

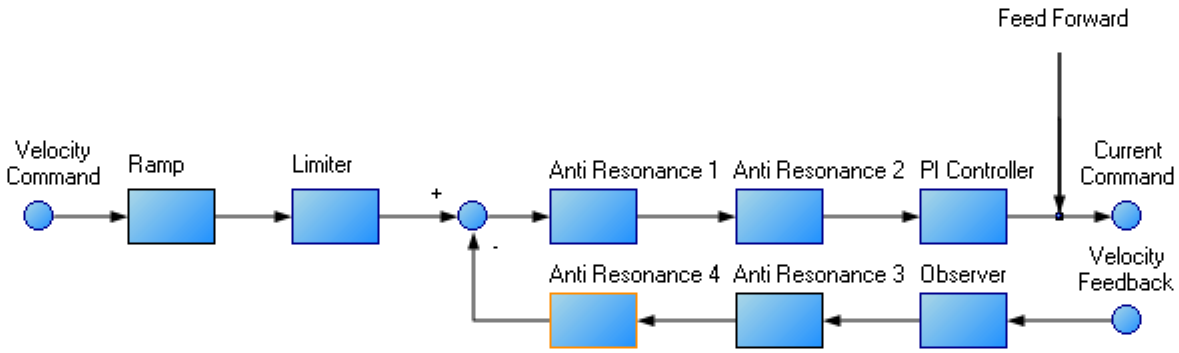
14.4.4 Closed Loop Tuning Methods

The closed loop control loop is responsible for the desired position and / or velocity (trajectory) of the motor and commanding the appropriate current to the motor to achieve that trajectory. The challenge in closed loop control loops is to make a system that not only follows the desired trajectory, but also is stable in all conditions and resist external forces, and do all of this at the same time.

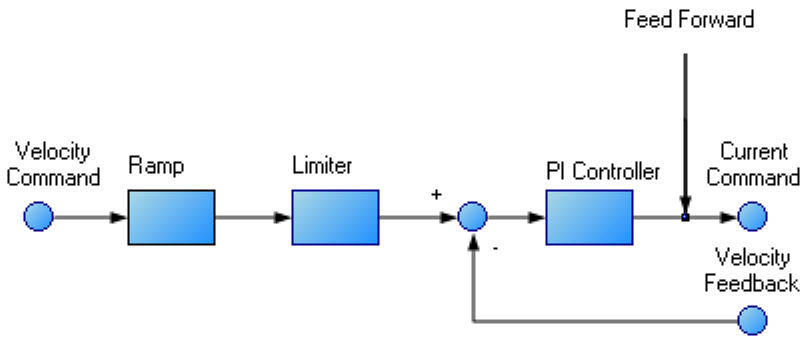
When in velocity operation mode, only the velocity loop is tuned. When in position operation mode, both the velocity and position loops must be tuned.

14.4.4.1 Tuning the Velocity Loop

The velocity loop on the AKD consists of a PI (proportional, integral) in series with two anti resonance filters (ARF) in the forward path and two anti resonance filters in series in the feedback path.



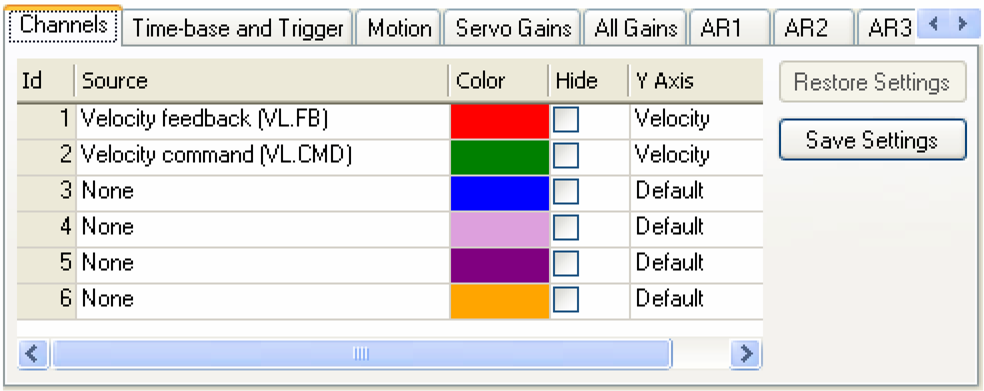
To perform basic tuning of the velocity loop, you can use just the PI block and set ARF1 and ARF2 to unity (no effect) and set the observer to 0 (no effect). Using just the PI block simplifies the process of tuning the velocity loop. To start tuning you can adjust the PI Controller block first. A simplified velocity loop without anti resonant filters and observer is shown below. This is how you can think of the loop before the anti resonant filters and observer is used.



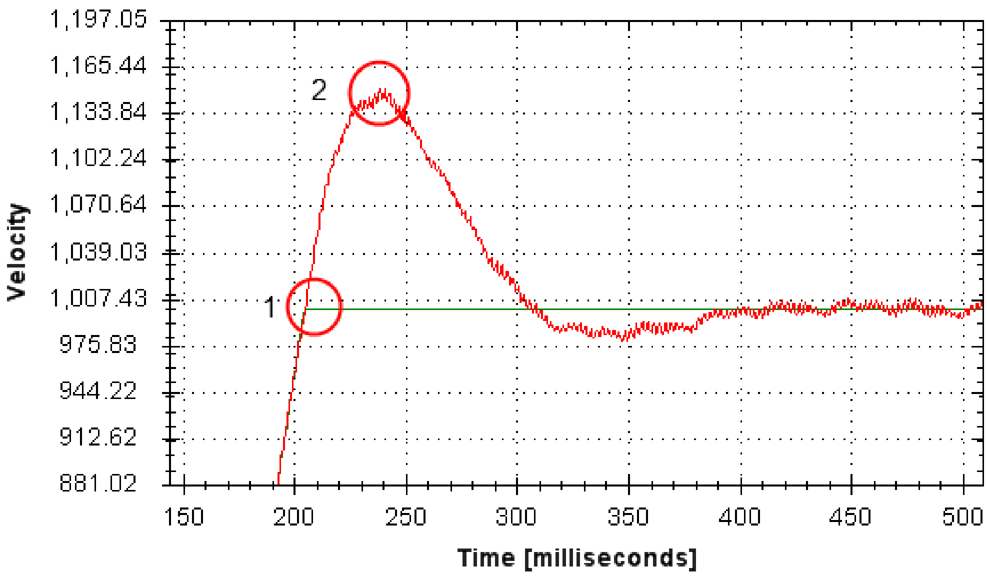
Procedure for simple velocity loop tuning:

1. Set DRV.OPMODE to velocity or position, as appropriate for your application. If DRV.OPMODE is set to position, set VL.KVFF to 1.0.
2. Set VL.KP to 0.
3. Set VL.KI to 0.
4. Set service motion to make a motion that is similar to the move speeds that will be used in the real application. Do not set the service motion to a speed higher than ½ of the maximum motor speed, to allow for safe overshoot during tuning. Set acceleration to an appropriate value for your application. Set service motion to reversing. Set time1 and time2 equal to 3 times the expected settling time for the system. 1.0 second is a reasonable value for time1 and time2, if you don’t know the expected settling time.

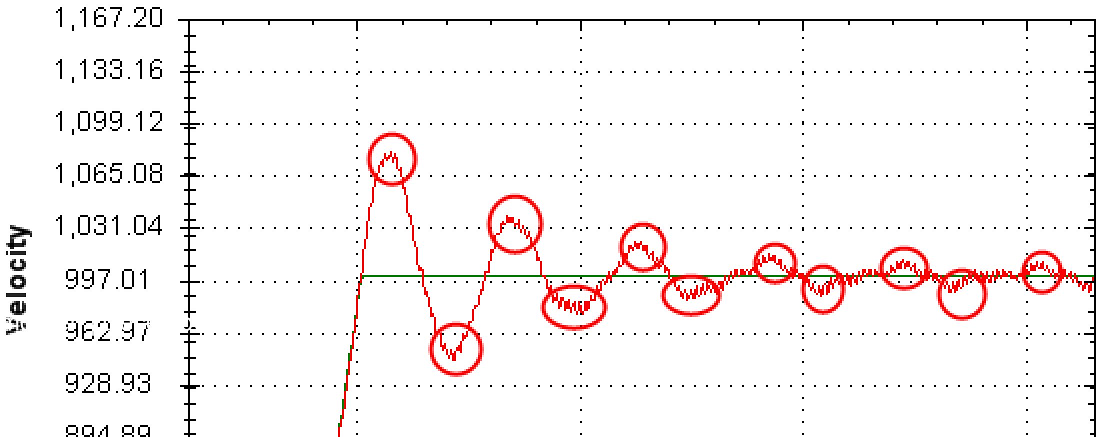
5. Enable the drive and start the service motion. You should see no motion, as there are no velocity loop tuning gains at this point.
6. When adjusting VL.KP and VL.KI, below record VL.FB and VL.CMD. These are the traces that are used to determine the performance of the velocity loop.



7. Adjust VL.KP. Keep increasing VL.KP by a factor of 2 until you either:
   - Hear an objectionable noise from the system (buzzing, humming, etc.)
   - See velocity overshoot. No velocity overshoot should be present when using only VL.KP.
   - When you reach one of the limits above, decrease VL.KP to the value where there were no objectionable noises or overshoot.
8. Adjust VL.KI. Increase VL.KI by a factor of 1.5 until you either:
   - Hear or see objectionable noise or shuddering from the system
   - See > 15% overshoot
   - Here is an example of 15% overshoot. This is zoomed in view of a service motion commanded to 1000 RPM (location 1), where the overshoot peaks at 1150 RPM (location 2).



   - Here is an example of 11 overshoots. Each overshoot is shown by a red circle.



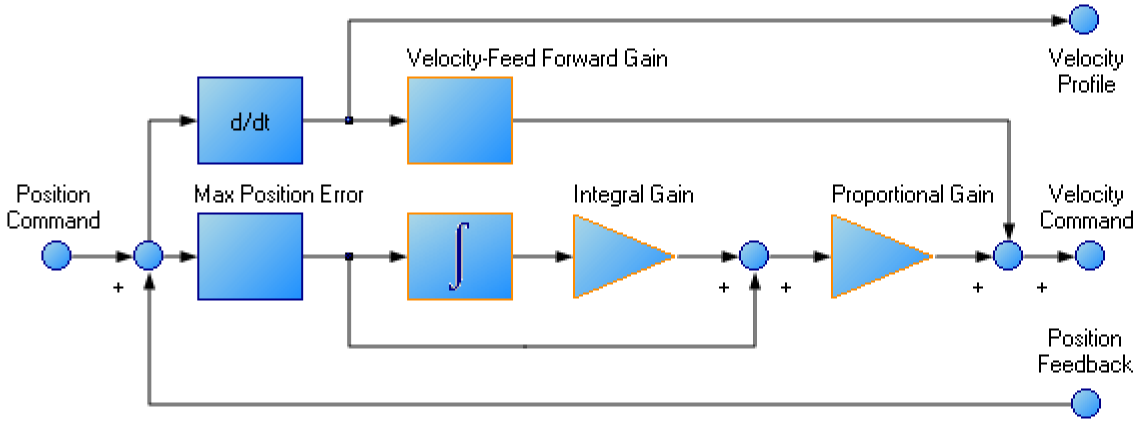
- When you reach one of the limits above, decrease VL.KI to the value where there were no objectionable noises or overshoot.

9. Stop the service motion

14.4.4.2 Tuning the Position Loop

The position loop is a second loop that builds upon a correctly tuned velocity loop to provide accurate control over position. The position loop is a simple element that consists of a PI loop. It is simplest to tune the P and I terms in the velocity loop and use only the P term in the position loop.

At most, use only three non-zero P and I terms from both the velocity loop and the position loop. One combination would be VL.KP, VL.KI, and PL.KP. Another valid combination would be VL.KP, PL.KP, and PL.KI. The VL.KP, VL.KI, and PL.KP combination is shown here.



Procedure for tuning position loop:

1. Set VL.KVFF to 1
2. Increase PL.KP until either:

- You see 25% overshoot
- You see > 3 overshoots
- You hear objectionable noises from the system.
- When you reach one of the limits above, decrease PL.KP to the value where there were no objectionable noises or overshoot.

14.4.5 Torque Feedforward Tuning Methods

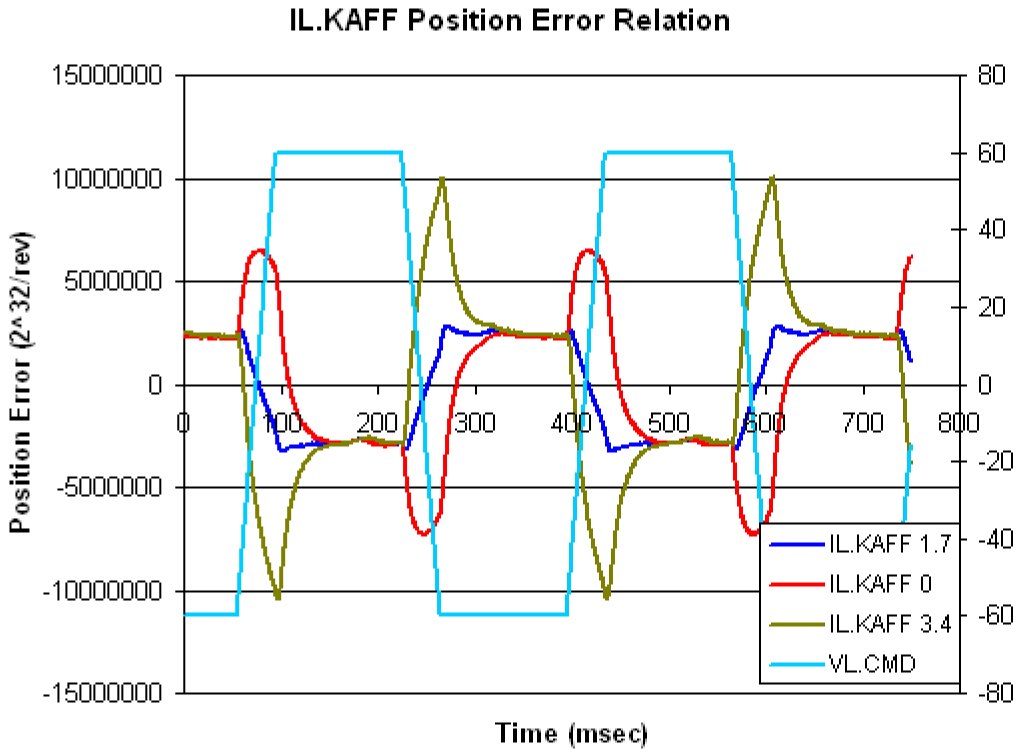
The torque based feedforward terms on the AKD effectively model the physics of your motor and allow the drive to command the appropriate current, even before the encoder has time to send data back to the drive. Torque based feedforward terms allow you to lower following error with virtually no stability penalty.

14.4.5.1 Shape Based Feedforward Tuning

To adjust IL.KAFF:

- Tune the VL.KP and VL.KI as shown above in the velocity loop tuning section. Set DRV.OPMODE to velocity (or set PL.KP and PL.KI to 0 and vl.kvff to 1).
- Set up a short, repeating service motion with accelerations that are representative of the moves you will use in your application (exact values for acceleration are not critical).
- Turn up IL.KAFF until the position error (PL.ERR) is proportional to the inverted velocity command. The adjustment of IL.KAFF will focus on removing bumps on acceleration and deceleration. The pic-

ture below has an ideal value of IL.KAFF of 1.7.



14.4.6 Using Anti-Resonance Filters

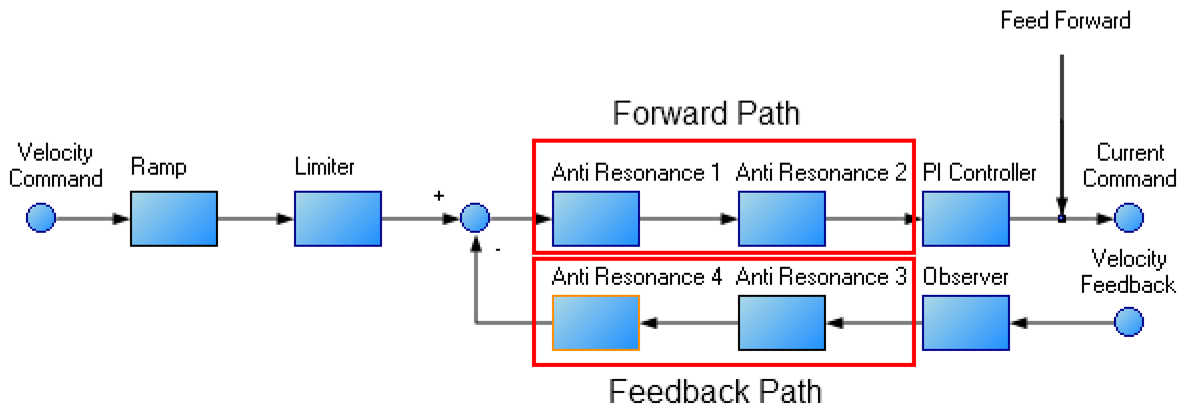
The AKD has four anti resonance filters. Two filters are in the forward path and two are in the feedback path.

Similarities

- Both types are typically used to enhance stability and performance of the system.

Differences

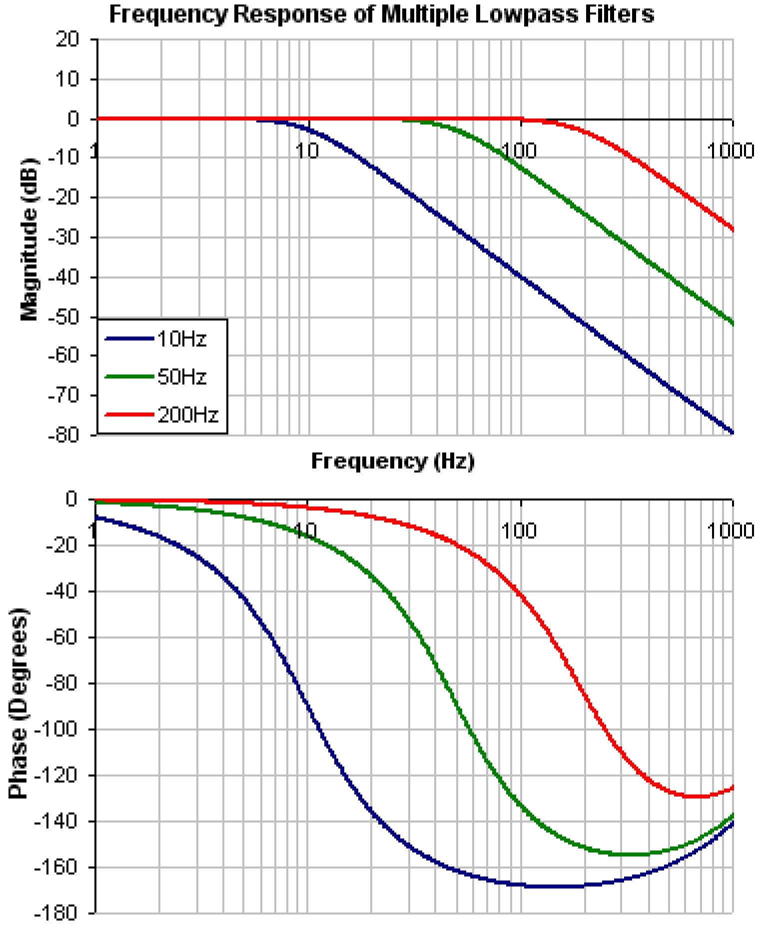
- Forward path filters result in higher phase lag in closed loop system response.
- Forward path filters limit spectrum from reaching the motor / feedback path filters only filter the feedback after it has been to the motor.



1.6.1 Types of Anti Resonance Filters

Low Pass

A low pass filter allows signals through below a corner frequency and attenuates the signals above the same corner frequency. The behavior at the corner frequency can be specified with the low pass Q.



To specify a lowpass filter, you must specify the frequency and Q for both the zero and pole on anti resonance filter 1. To do this, see the following example using the terminal commands that sets:

- Filter Type = Biquad
- Zero frequency = 700 Hz (This is the Lowpass cutoff frequency)
- Zero Q = 0.707
- Pole frequency = 5000 Hz
- Pole Q = 0.707

VL.ARTYPE1 0

VL.ARZF1 700

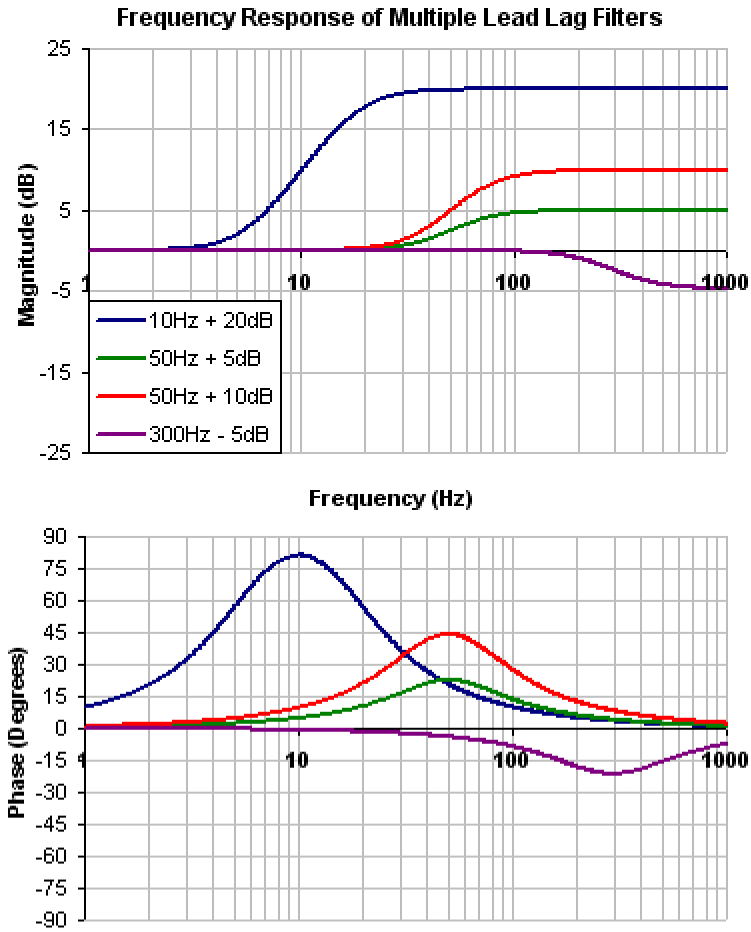
VL.ARZQ1 0.707

VL.ARPF1 5000

VL.ARPQ1 0.707

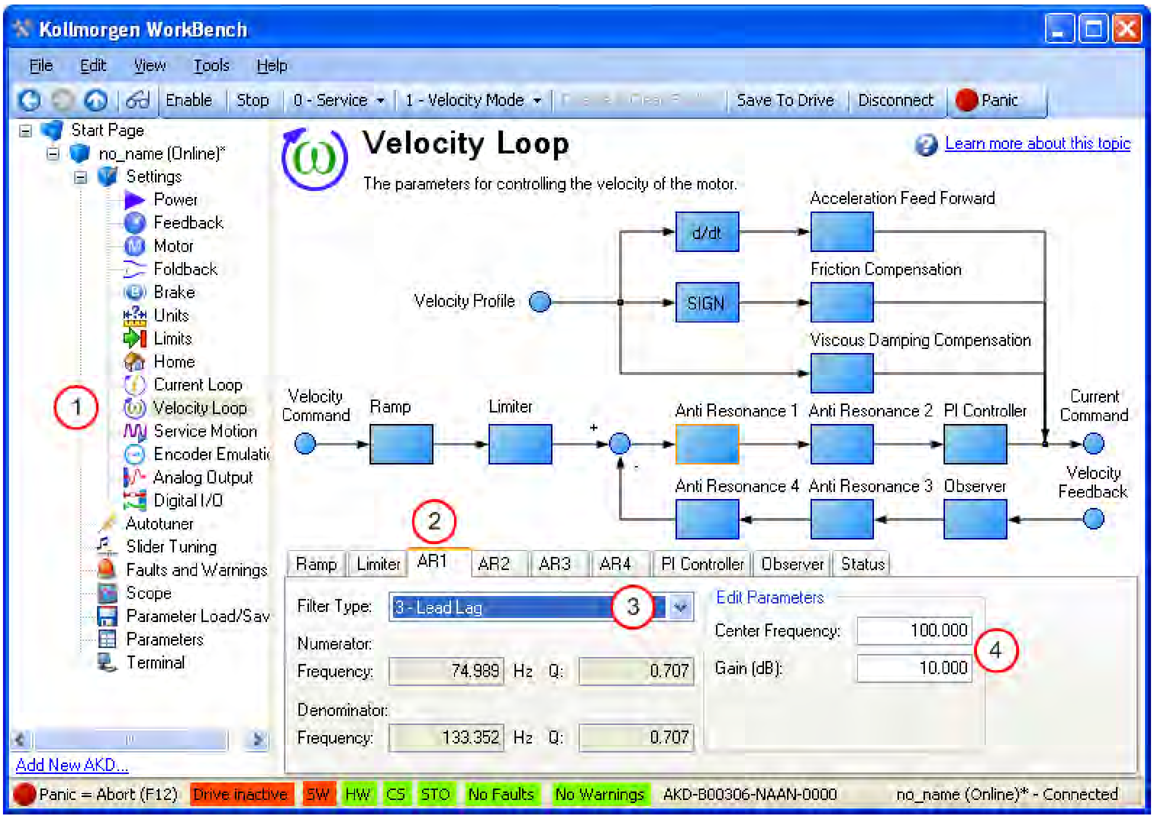
Lead Lag

A lead lag filter is a filter that has 0 dB gain at low frequencies and a gain that you specify at high frequencies. You also specify the frequency that the gain at which the transition occurs.



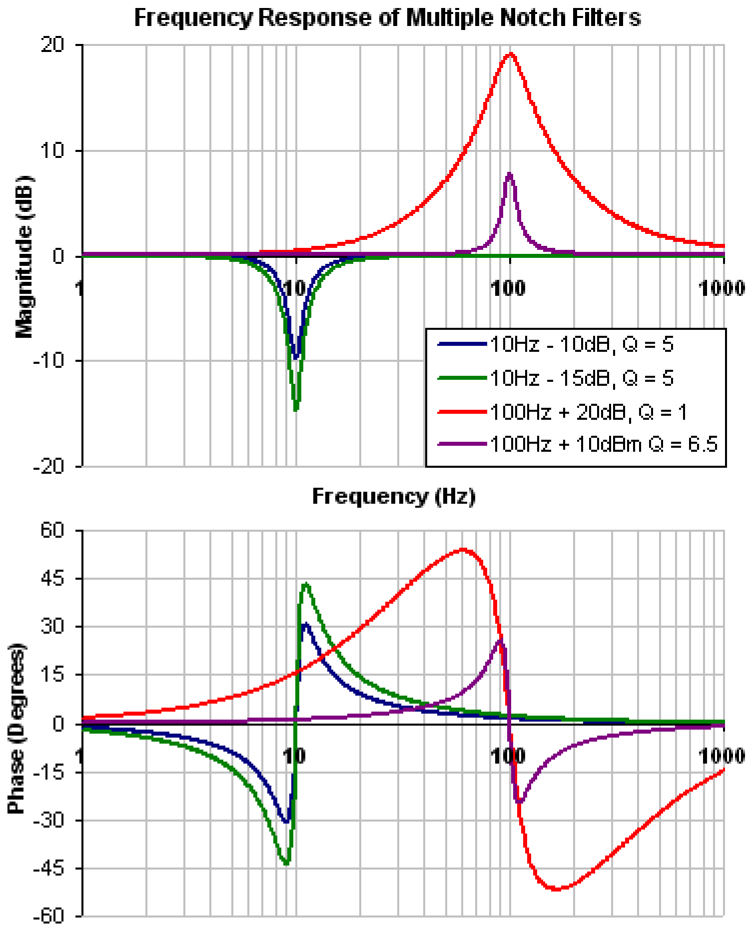
To specify a Lead Lag filter, you must specify the Center Frequency and high frequency Gain (dB). To do this, see the following example by clicking on the Velocity Loop:

Click on Velocity Loop (1), then select the AR1 Tab (2), using the Filter Type drop down, select Lead Lag (3), lastly, enter the desired Center Frequency and Gain of the Lead Lag filter (4).



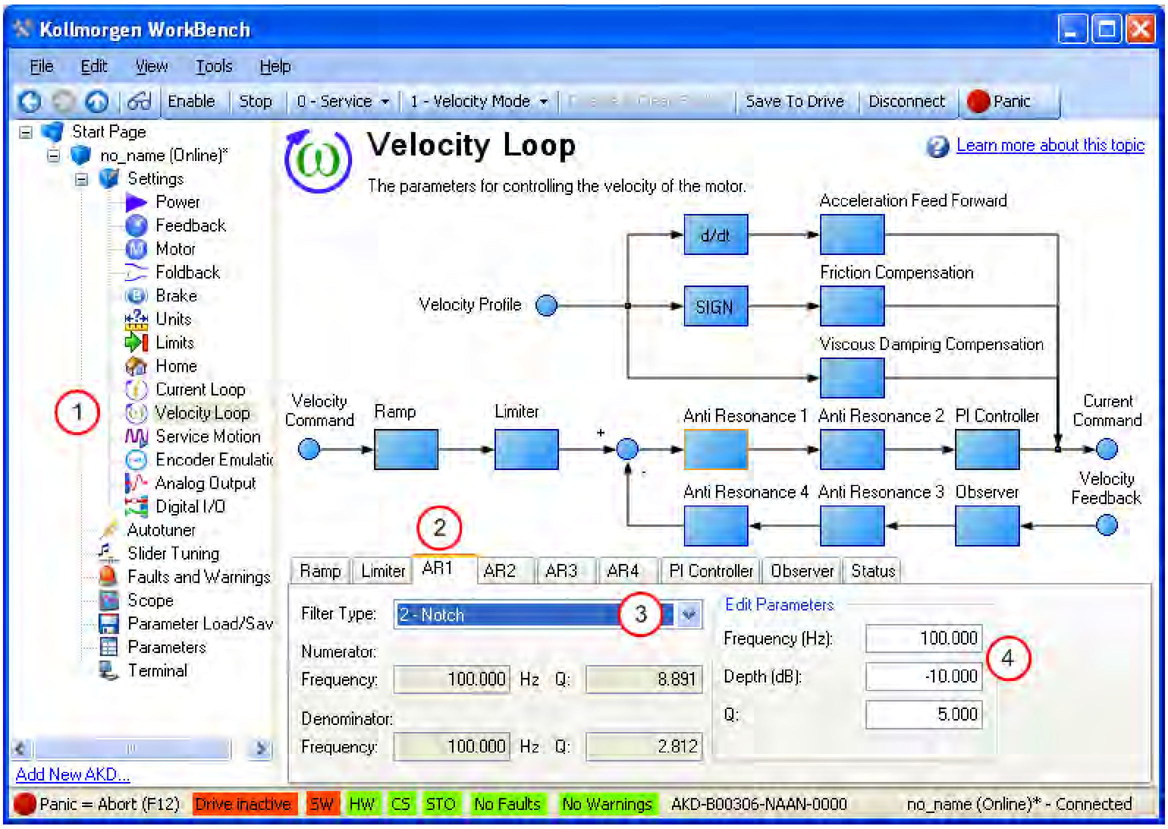
Notch

A notch filter changes gain at a specific frequency. You specify the frequency at which the gain change occurs (Frequency (Hz)), how wide of a frequency range the cut occurs (Q), and how much the gain changes (Notch Depth (dB)).



To specify a notch filter, you must specify the Frequency (Hz), Depth (dB) and Width (Q) of the notch. To do this, see the following example by clicking on the Velocity Loop:

Click on Velocity Loop (1), then select the AR1 Tab (2), using the Filter Type drop down, select Notch (3), lastly, enter the desired Frequency, Depth and Q of the Notch filter (4).



Biquad

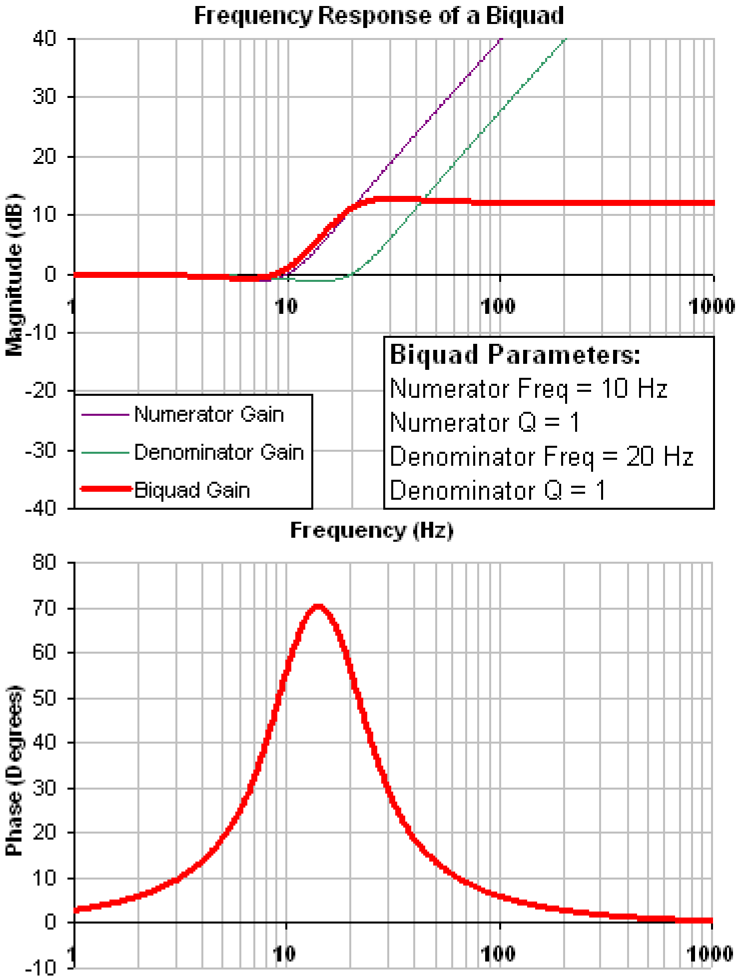
A biquad is a flexible filter that can be thought up as being made up of two simpler filters; a zero (numerator) and a pole (denominator). In fact, the pre-defined filters mentioned above are really just special cases of the biquad.

Both the zero (numerator) and the pole (denominator) have a flat frequency response at low frequencies and a rising frequency response at high frequencies. The transition frequency and damping must be specified for both the numerator and denominator.

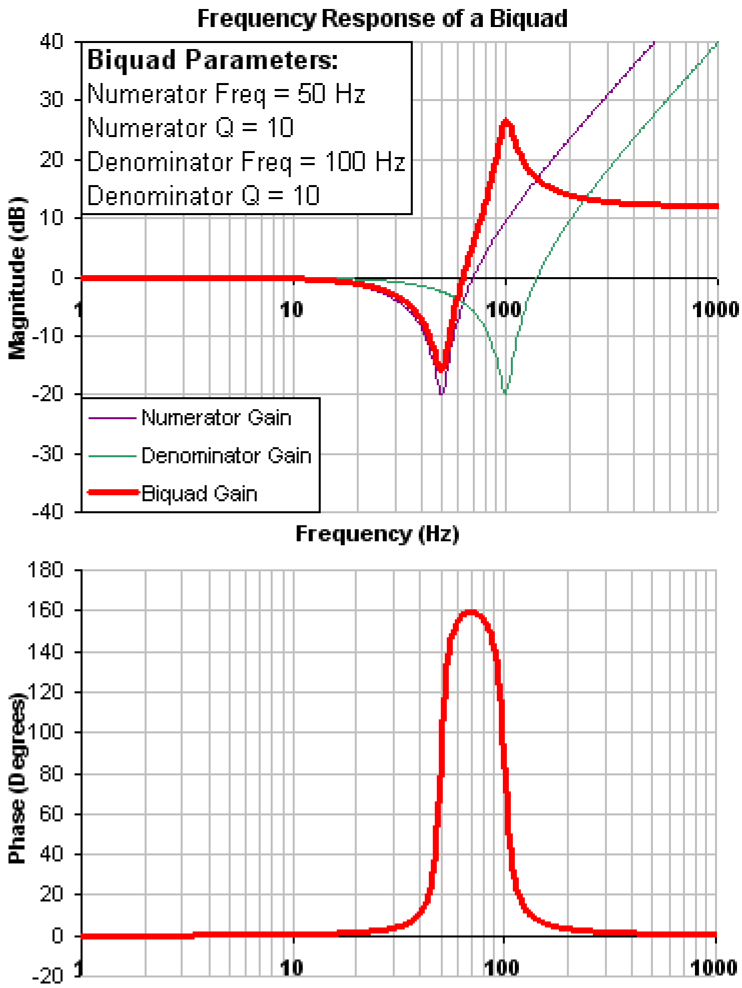
Analyzing the numerator and denominator, the frequency response calculation is simple:

If the numerator and denominator are plotted in dB, the biquad response is numerator – denominator. Understanding how the numerator and denominator work is crucial in understanding how a biquad frequency response is created.

Below is an example of a biquad filter similar to a Lead Lag filter type. To help understand how to determine the frequency response of the biquad, the numerator and denominator response have been plotted. If the denominator is subtracted from the numerator, the biquad response is the result.

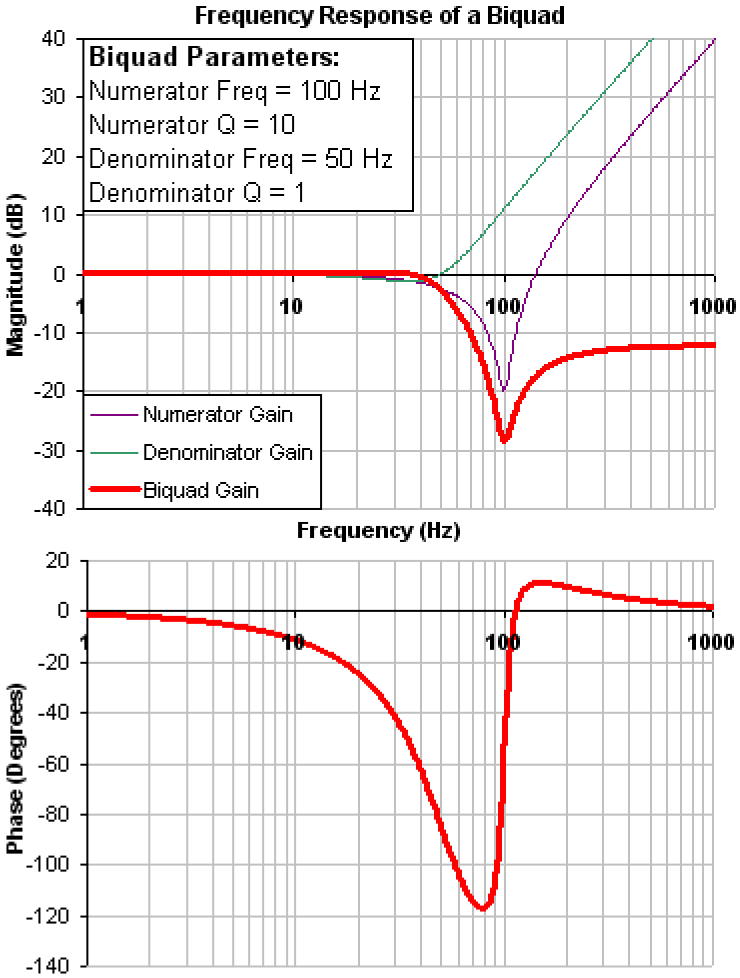


The biquad filter is very flexible, this allows custom filters to be designed. Below is an example of a resonance filter using a biquad, notice how the high Q values affect the numerator and denominator. This gives a biquad frequency response similar to a mechanical resonance.



The previous two examples used a numerator frequency lower than the denominator frequency, yielding a positive gain in high frequencies. If the denominator frequency is lower than the numerator frequency, then high frequencies will have a negative gain.

Below is an example where the numerator frequency is higher than the denominator, notice the high frequencies have a negative gain.



To specify a biquad filter, you must specify the frequency and Q for both the zero and pole on anti resonance filter 3. To do this, see the following example using the terminal commands that sets:

- Filter Type = Biquad
- Zero frequency = 100 Hz
- Zero Q = 0.7
- Pole frequency = 1000 Hz
- Pole Q = 0.8

VL.ARTYPE3 0

VL.ARZF3 100

VL.ARZQ3 0.7

VL.ARPF3 1000

VL.ARPQ3 0.8

14.4.6.1 Biquad Calculations

In the s-domain, the linear biquad response is calculated:

$$\text{Biquad Frequency Response} = \frac{s^2 + \frac{\omega_N}{Q_N}s + \omega_N^2}{s^2 + \frac{\omega_D}{Q_D}s + \omega_D^2}$$

To convert from idealized s-domain behavior to a more realistic z-domain behavior, we convert using a pole / zero transform. To calculate the frequency response for an individual frequency:

$$t = 62.5\mu\,\text{sec}$$

$$N_{Rad} = 1-(2Q_N)^{-2}$$

$$N_{2Unscaled} = 1$$

$$if(N_{Rad} > 0): N_{1Unscaled} = -2e^{-2\omega_N\zeta_N t}\cos(\omega_N t\sqrt{1-\zeta^2})$$

$$if(N_{Rad} <= 0): N_{1Unscaled} = -2e^{-2\omega_N\zeta_N t}\cosh(\omega_N t\sqrt{1-\zeta^2})$$

$$N_{0Unscaled} = e^{-2\omega_N\zeta_N t}$$

$$D_{Rad} = 1-(2Q_D)^{-2}$$

$$D_2 = 1$$

$$if(D_{Rad} > 0): D_1 = -2e^{-2\omega_D\zeta_D t}\cos(\omega_D t\sqrt{1-\zeta^2})$$

$$if(D_{Rad} <= 0): D_1 = -2e^{-2\omega_D\zeta_D t}\cosh(\omega_D t\sqrt{1-\zeta^2})$$

$$D_0 = e^{-2\omega_D\zeta_D t}$$

$$N_{Scale} = \frac{N_{0Unscaled} + N_{1Unscaled} + N_{2Unscaled}}{D_0 + D_1 + D_2}$$

$$N_2 = N_{2Unscaled} / N_{Scale}$$

$$N_1 = N_{1Unscaled} / N_{Scale}$$

$$N_0 = N_{0Unscaled} / N_{Scale}$$

$$\angle_Z = \omega\, t = 2\pi * freq * t$$

$$Num_{Re} = N_2 Cos(2\angle_Z) + N_1 Cos(\angle_Z) + N_0$$

$$Num_{Im} = N_2 Sin(2\angle_Z) + N_1 Sin(\angle_Z)$$

$$Den_{Re} = D_2 Cos(2\angle_Z) + D_1 Cos(\angle_Z) + D_0$$

$$Den_{Im} = D_2 Sin(2\angle_Z) + D_1 Sin(\angle_Z)$$

$$Gain_{dB} = 20\log_{10}\left(\frac{\sqrt{Num_{Re}^{\ 2} + Num_{Im}^{\ 2}}}{\sqrt{Den_{Re}^{\ 2} + Den_{Im}^{\ 2}}}\right)$$

$$Phase_{deg} = \frac{180}{\pi}\left(\tan^{-1}\left(\frac{Num_{Re}}{Num_{Im}}\right) - \tan^{-1}\left(\frac{Den_{Re}}{Den_{Im}}\right)\right)$$

14.4.6.2 Common Uses Of Anti Resonance Filters

Low pass filters in the feedback path. This is a common way to deal with noisy feedback sensors. When used in combination with noisy feedback sensors, significant reduction in audible noise can result.

Lead / lag filters in the forward path. This is a common way to achieve phase lead for control loops without exciting high frequency resonances.

Low pass filters in the forward path. This is a common way to limit high frequency energy from reaching a system that can not productively use energy at these high frequencies. This is also used to lower the effect of system resonances over a wide range of frequencies.

Notch filters are used to cancel system resonances. Notch filters are designed to be the opposite in amplitude of system resonances. Notch filters are applied to very specific frequencies, and therefore you must know your system resonance frequencies accurately to use them effectively.

15 Scope

15.1 Overview

The scope allows you to plot up to six different parameters from the drive. Use **Full View** and **Normal View** to toggle between the scope setup (normal) and a larger view of only the scope output (full). You can configure, save, and restore scope settings from the normal view. The lower right corner of the normal view also includes a box that indicates status and drive and scope control buttons (**Enable Drive**, **Start Recording**, and **Refresh**).

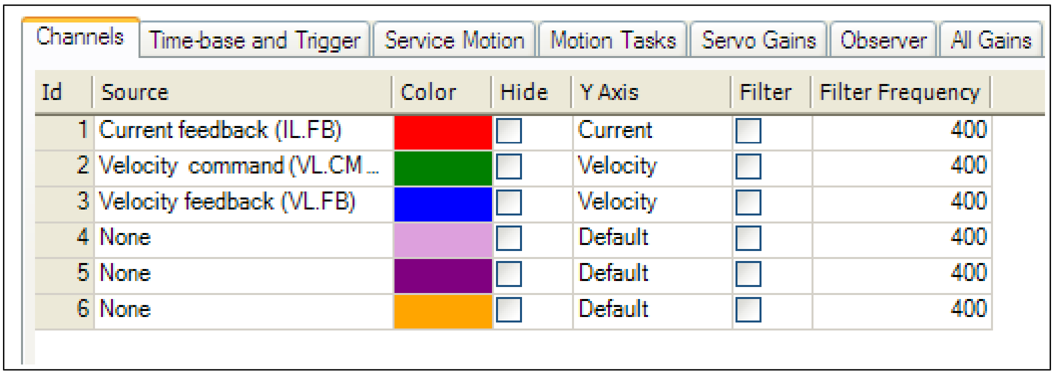
15.2 Using the Scope

You can set up scope plots using the tabs summarized below:

Tab	Function
Channels	Select data source, plot axes, and plot appearance.
Time Base and Trigger	Select how much data to record and when to start recording the data.
Service Motion	Generate basic motion.
Servo Gains	Adjust the servo loop gains.
All Gains	View all current tuning gains in the drive and manually edit gains.
AR1, AR2, AR3, AR4	Adjust filter settings.
Save and Print	Save the plot as a raw data file or as an image file; email the plot; print the plot;open the data file in Excel.
Measure	Display basic data read from the plots.
Cursors	Turn on the cursors and view the data at the cursor positions.
Display	Pan, zoom, and control the grid and background color.

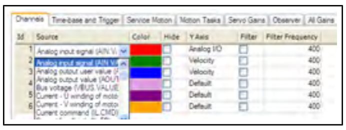
15.2.1 Scope Channels Tab

The **Channels** tab allows you to select and record up to six channels simultaneously. Select the data to record for each channel from the lists in the **Source**, **Color**, **Y-axis**, and **Filter** and **Filter Frequency** columns. Once a recording is shown on the scope screen, you can click **Hide** to remove a channel from the scope display.



15.2.1.1 Source Column

To set a channel to record, click the source you want to set and choose the appropriate channel. You can choose from None (no data is collected on that channel), preset trace types, or enter a user defined trace. Choosing “<User Defined>” allows you to record data from pre-defined locations. These locations are provided by the factory to collect less common values.



15.2.1.2 Color Column

For valid sources, you can click on the color in the Color tab and choose a different color than the default, or create a custom color.

15.2.1.3 Hide Column

You can check the **Hide** box to hide a given plot trace. This feature can make it easier to focus on specific data as needed.

15.2.1.4 Y-Axis Column

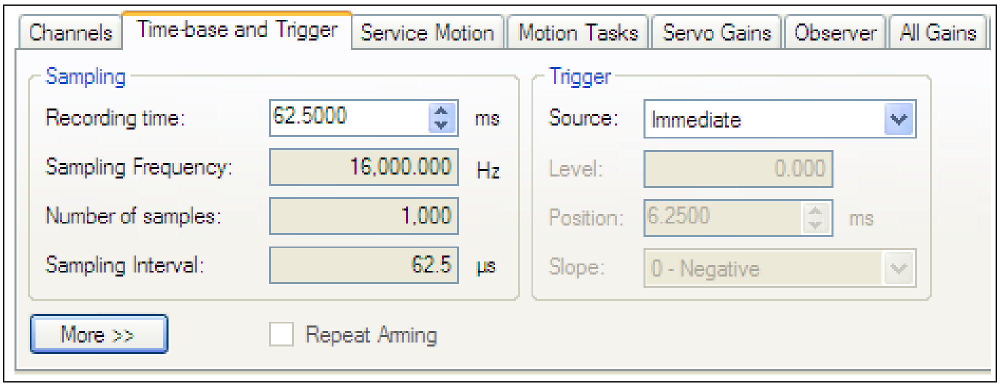
The Y-axis column allows you to choose on which Y-axis the channel will be displayed. Several predefined Y-axis groups exists. Click on the item in the column to change the label for the trace.

15.2.1.5 Filter and Filter Frequency Column

Check this box and use the frequency column to apply a low pass filter to the data collected. The filter is applied when the data is collected. It is not applied to data already collected if this is checked after the data is collected.

15.2.2 Scope Time-base and Trigger Tab

Use the **Time-base and Trigger** tab to select how much data to record and when to start (trigger) recording the data. You can set length of recording in ms and the sampling frequency in Hz. The number of samples is a calculated value displayed for reference.The trigger can be set to trigger immediately when you click **Start Recording**or to trigger when a specified value for a given signal is reached. The default **Time-base and Trigger** view specifies recording time, sampling frequency, and either an immediate trigger or a trigger based on a specified signal. Click the **More** button in this view to specify a given number of samples, sampling frequency, sampling interval, and access additional trigger options.

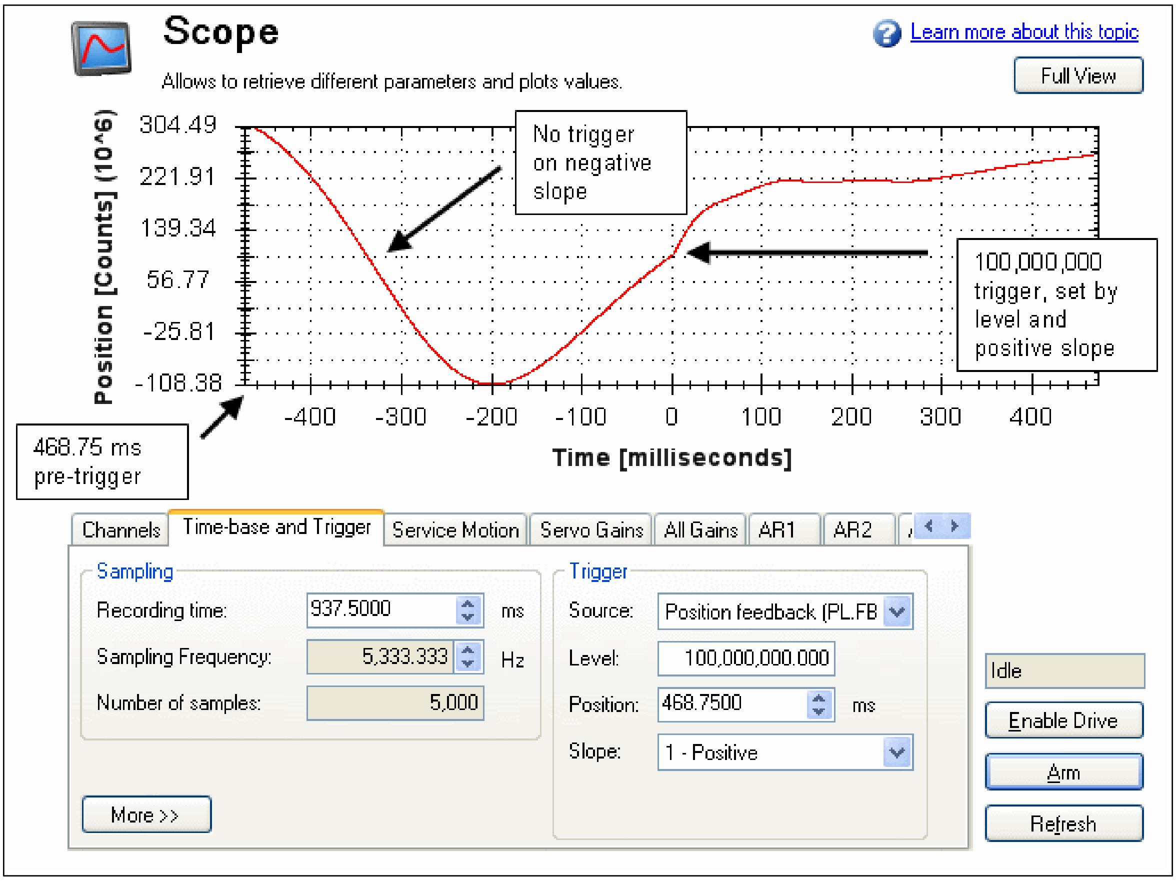


In this tab, you can set length of recording in ms and the sampling frequency in Hz. The number of samples is a calculated value displayed for reference. You can also choose the trigger source to be **Immediate** (triggers as soon as you click the **Start Recording** button) or to be one of many predefined sources.

If you choose a source other than **Immediate**, you can set the level, position, and slope for the trigger value.

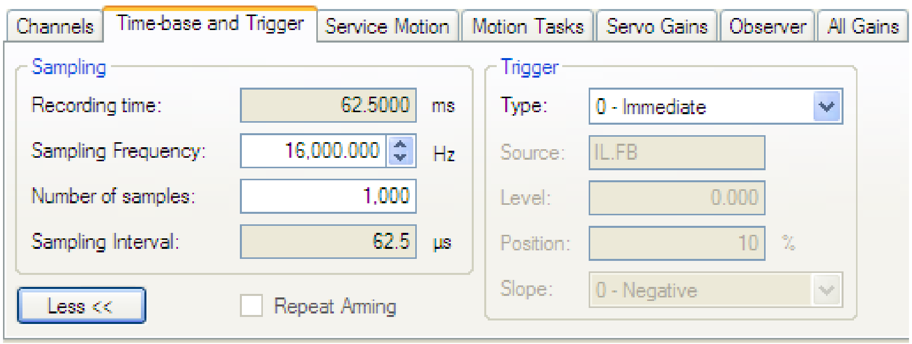
- Level sets the value of the source that triggers the recording to start.
- Position sets the amount of time that the scope displays before the trigger occurred.
- Slope sets whether the source data must pass the level value in a positive or negative direction.

An example of triggering is shown below:



15.2.2.1 Scope Time-base and Trigger, More View

Click **More** to display additional options for configuring the time-base and trigger.



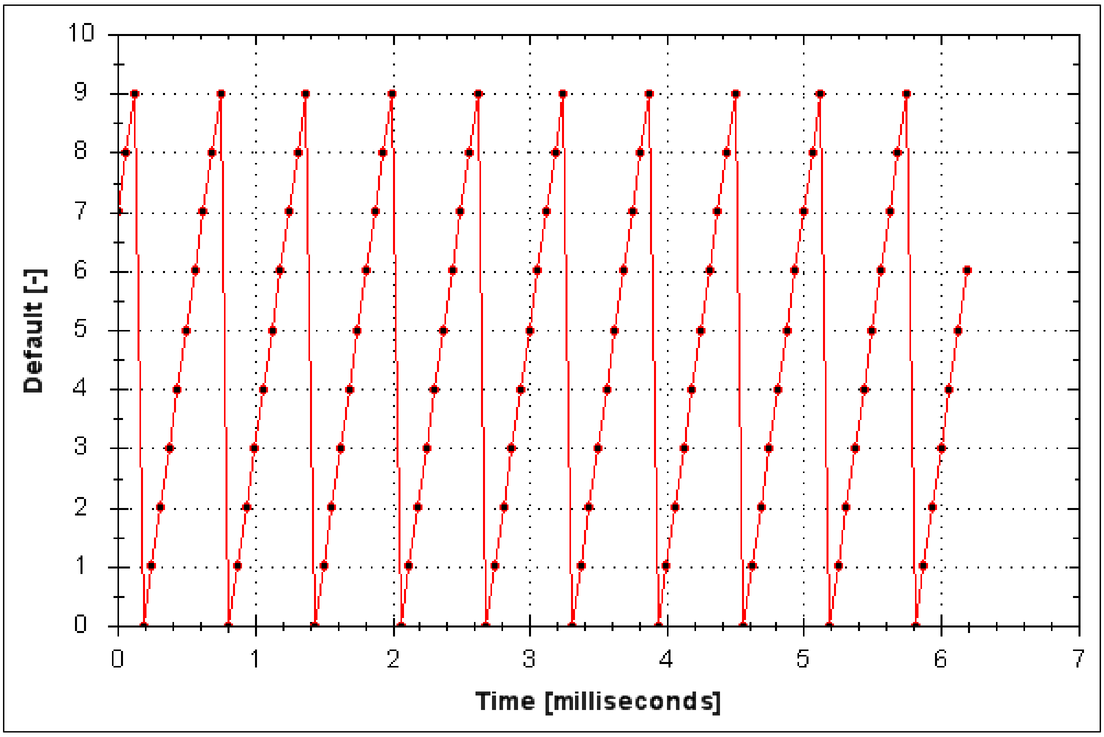
In the **Sampling** area of this view, you can specify the recording length by entering a sampling frequency and a number of samples. Here, the recording time is a calculated value displayed for reference.

What is triggering?

Triggering allows you to precisely control the start point of data collected in the scope. For example, if you are looking for a large spike, you can set the trigger to start the scope to begin recording when it sees the large spike. This section describes the triggering functionality of the scope.

Test Signal

To show specific examples, it is useful to examine variations on a record a test signal that generates a sawtooth signal that starts at 0 and increases by one every drive sample (1/16,000 second) to a maximum of 9, then returns to 0. This signal continues indefinitely. A picture of this signal is shown below.



15.2.2.2 Trigger Type

The **Trigger** area in the **More** view offers more flexibility than the default view. You can specify four types of trigger types (REC.TRIGTYPE):

- **Immediate - 0**. This mode will start recording as soon as the recording command (REC.TRIG) is received by the drive.
- **Command / On Next Command – 1**. This trigger type lets you specify a trigger on the next telnet command received by the drive. This is useful in a telnet session via Hyperterminal (or a similar program).WorkBench is constantly sending telnet commands, so this is not typically used in a WorkBench session.
- **Parameter / On Source Signal – 2**. This trigger type lets you specify a trigger source and set of conditions to trigger recording of data. This is very similar to the triggering used on oscilloscopes.
- **Boolean – 3**. This trigger type lets you trigger on a boolean (0 or 1), such as drive active status.

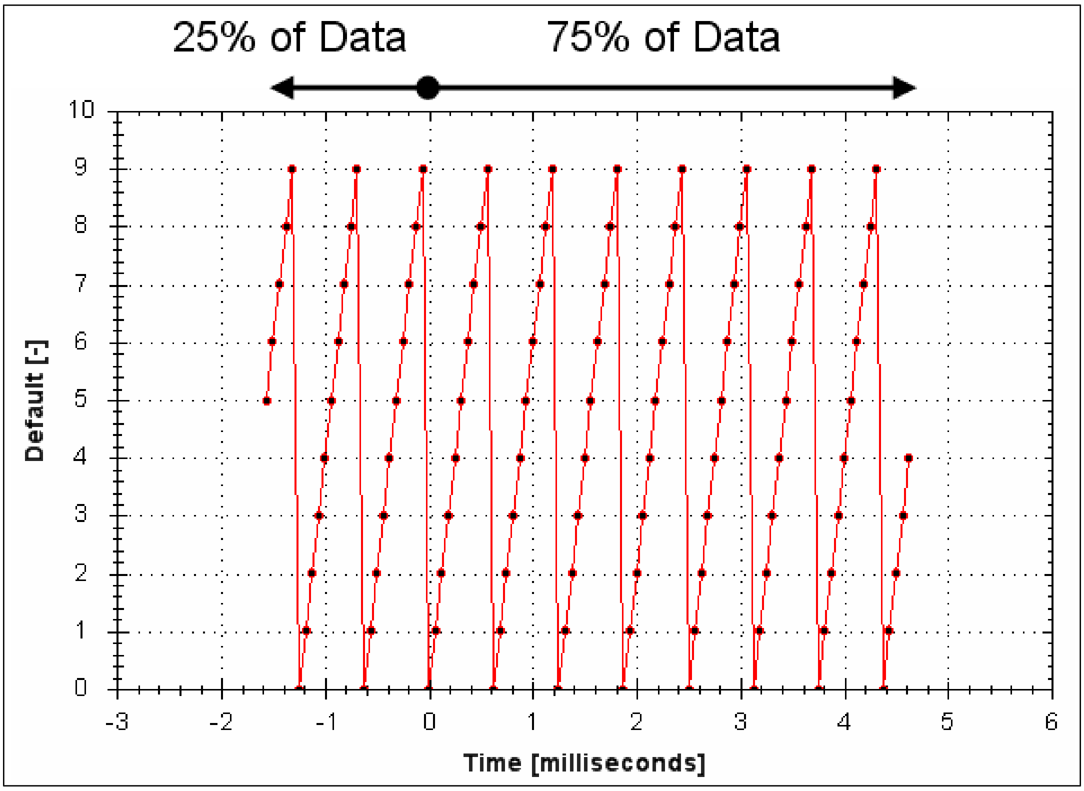
15.2.2.3 Trigger Position

Trigger Position (REC.TRIGPOS) allows you to collect data that occurs before the trigger occurs. If you have a rare condition, you may want to see the conditions that led up to it. Trigger position lets you control how much signal is collected before the trigger condition occurred.

Trigger position is specified in units of percent (%). If you specify a trigger position of X% , X% of the data is before 0 ms in the data time and 100-X% (the rest of the data) is at or greater than 0 ms. In the picture below, trigger position is set to 25% (REC.TRIGPOS 25).

In the WorkBench scope, the 0 time point is clear. When collecting the data via REC.RETRIEVE or similar commands, the time is not returned, so some caution should be used when the trigger point is important to understand.

Trigger position is not used in trigger type “Immediate” (TRIGTYPE 0).



15.2.2.4 Trigger Value

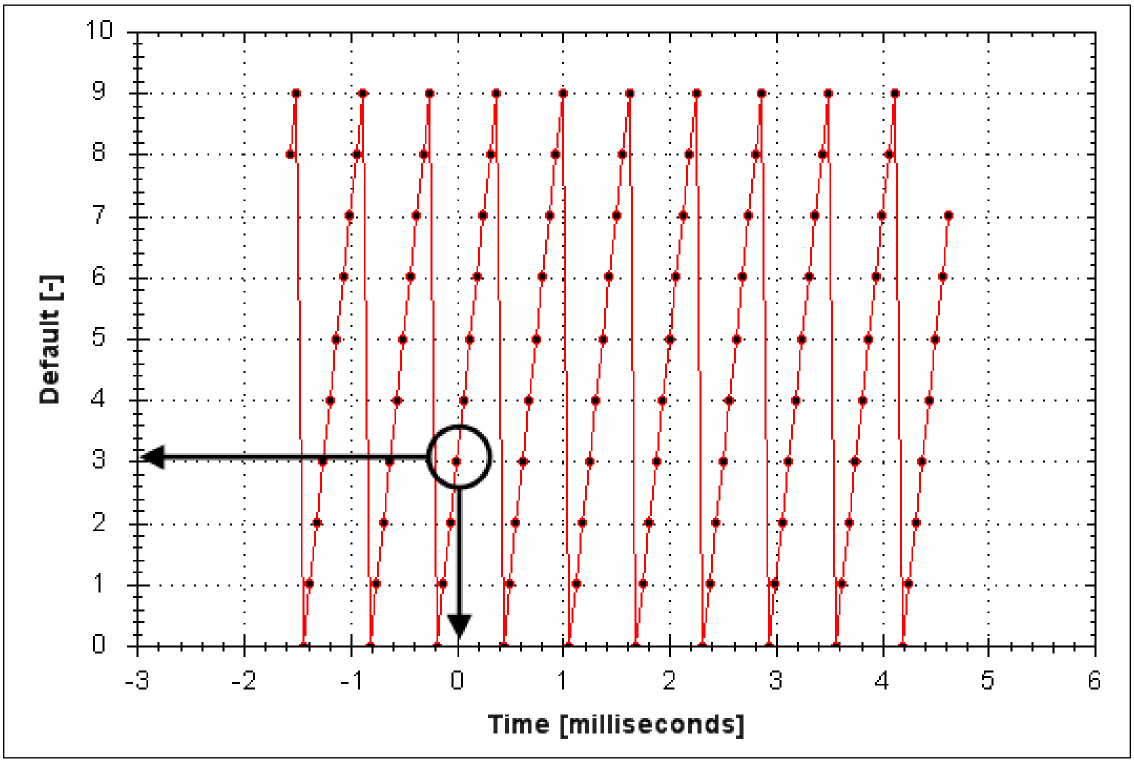
The trigger value (REC.TRIGVAL) specifies a target value that should trigger the recording to start. The trigger value is used in trigger type Parameter / On Next Signal only.

The trigger value is not used in the boolean trigger type. Use the trigger slope to set the polarity of the boolean trigger.

When the trigger slope is positive, the trigger value will trigger when:

- The trigger source is less than the trigger value in the previous recording sample
- The trigger source is greater than or equal to the trigger value in the current recording sample

Below is an example showing triggering of trigger value of 3 (REC.TRIGVAL 3) and positive trigger slope (REC.TRIGSLOPE 1). You can see that the recording triggers at time zero when the source reaches the value of 3.



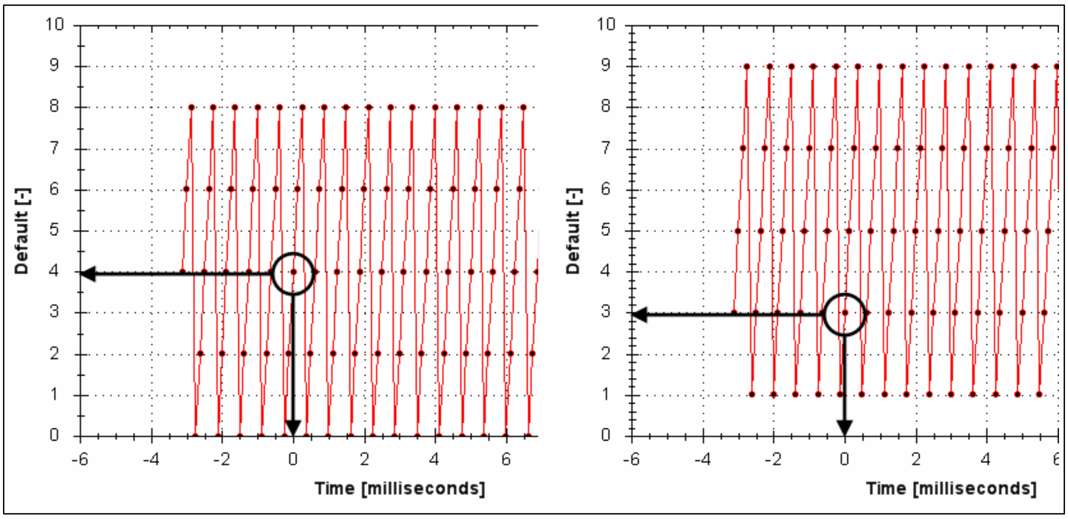
When the trigger slope is negative, the trigger value will trigger when:

- The trigger sources is greater than the trigger value in the previous recording sample.
- The trigger source is less than or equal to the trigger value in the current recording sample.

15.2.2.5 Effects of Recorder Gap

When the recording rate is less than16,000 Hz (REC.GAP > 1), there can be some impact on the triggering of the recorder. When using pretriggering and a recording rate of less than 16,000 Hz, the trigger only evaluates every N samples, where N is the value of REC.GAP. Two effects result from this condition:

1. You cannot be sure of the moment that the recorder is triggered any closer than N samples. An example of this is shown below where the trigger value is set to 3, the trigger slope is positive and the recorder gap is 2. Both examples are the same data, but one instance collected and triggered on the odd data. The other example collected and triggered on the even data.



2. You can miss triggers, whose duration is less than N samples, where N is the value of REC.GAP. This is because the trigger is only evaluated every N samples.

A workaround for the above effects is available by setting the recorder trigger position to zero (REC.TRIGPOS 0). This eliminates conflicts between pretrigger and post-trigger timing and will guarantee trigger evaluation every sample, eliminating the cases above.

15.2.2.6 Trigger Slope

Trigger Slope specifies whether you trigger on a positive or negative change in the trigger source. The effect of the trigger slope is different for trigger type Boolean and On Next Signal modes.

Boolean Trigger Type

When using Boolean type:

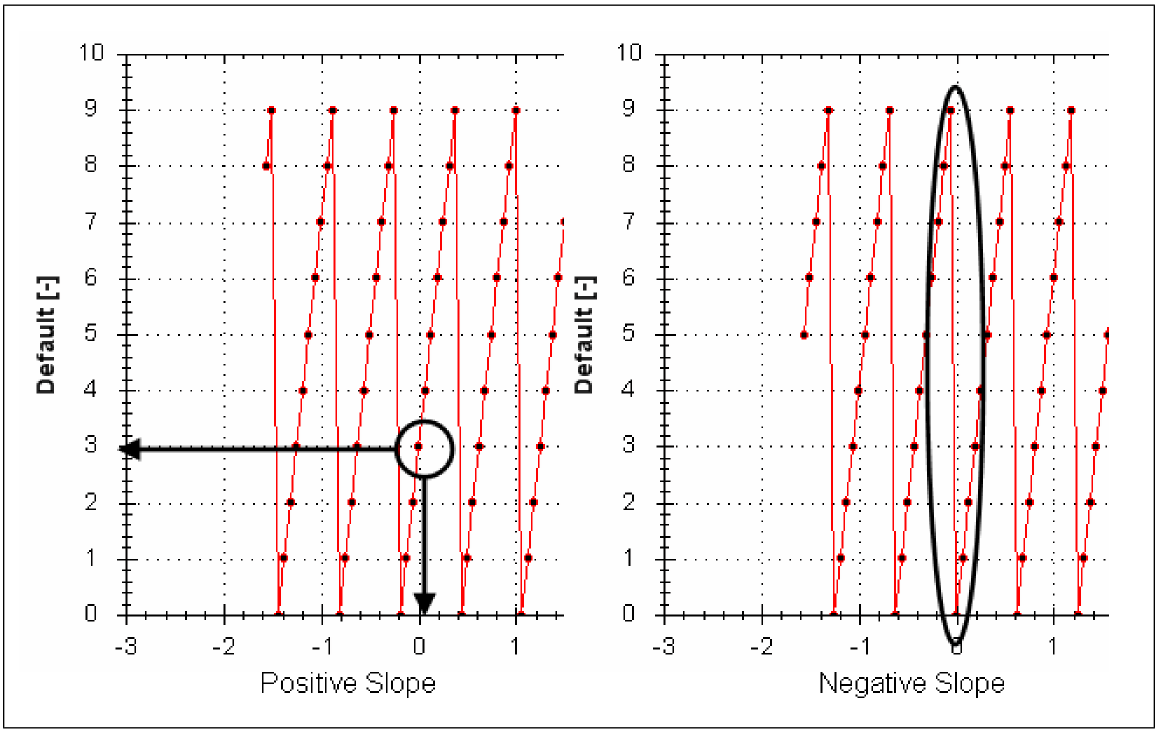
- A positive slope will trigger when the trigger source is 1
- A negative slope will trigger when the trigger source is 0

The boolean trigger type is a state trigger. There is no need to transition from 0 to 1 to trigger with the positive slope. If the trigger source is 1 from the start, the positive slope will immediately trigger.

On Next Signal Trigger Type

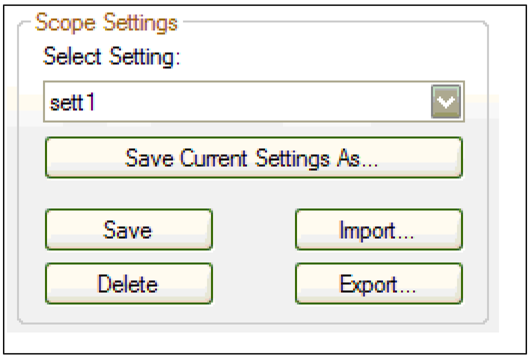
With "On Next Signal" trigger type allows you to specify if the recorder should trigger when the signal crosses the trigger level in the positive or negative direction. The signal only needs to reach the trigger level; it does not need to pass the trigger level.

In the examples below, the trigger value is set to 3 (REC.TRIGVAL 3.000). You can see that with positive slope, the trigger occurs exactly when the signal transitions from 2 to 3, because it reached 3. The negative slope case triggers when the signal transitions from 9 to 0, because it crossed 3 on the way.



15.3 Scope Settings

Scope settings are used to store and retrieve the scope parameters.You can save multiple settings, called "presets", under different names. You can save, delete, import, or export the presets. The settings are stored in WorkBench project file (default.wbproj) and settings are common to all the drives in WorkBench.

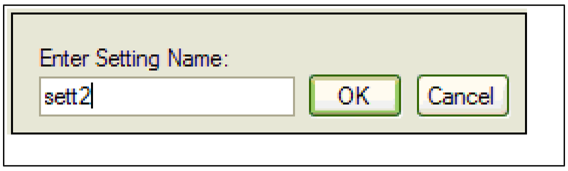


15.3.1 Load a setting (preset) to Scope screen

In Scope Settings section, the existing presets are listed in the **Select Setting** box. To load a setting to the scope screen, select the desired preset from the **Select Setting** list.

15.3.2 Create a new preset

1. Modify any scope parameters.
2. Select **Save and Print** tab.
3. Click **Save current settings As**. The following dialog is displayed:



4. Enter the setting name and click **OK**. The current settings are saved as a preset with the given name and displayed in the list.

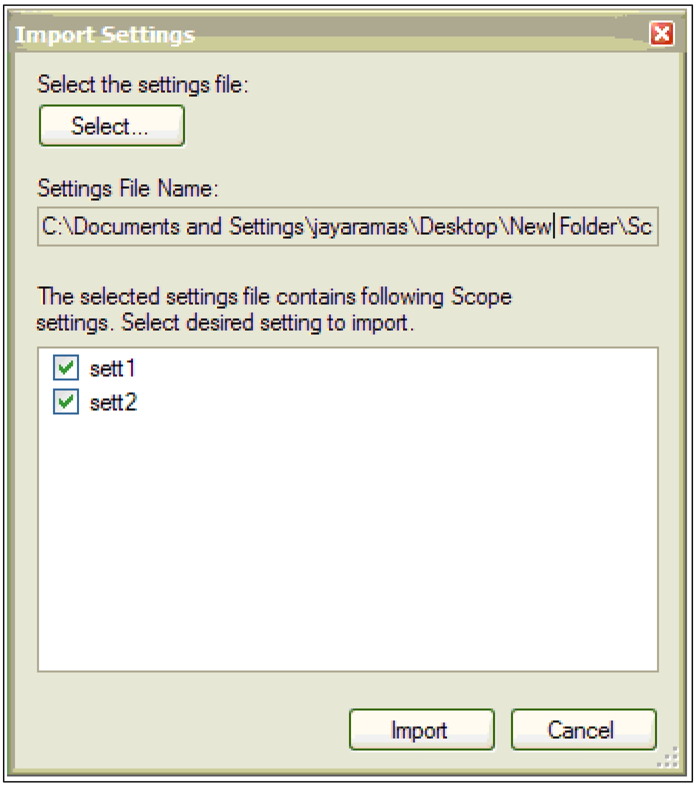
15.3.3 Save or delete preset

Save saves any modification to the open preset. **Delete** deletes the open preset.

15.3.4 Import preset

Import the presets contained in the selected settings file as follows:

1. Click on Import button following dialog will be displayed.

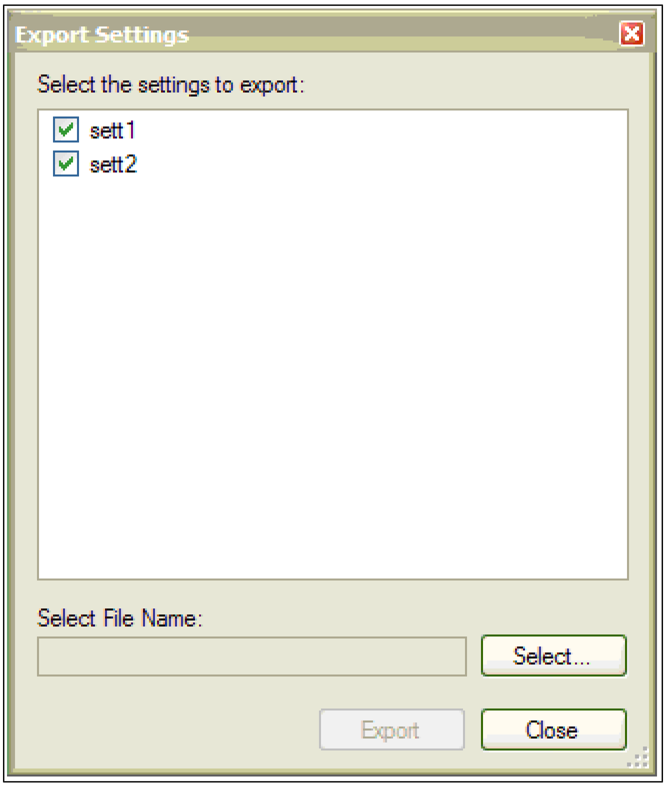


2. Select the settings file by clicking “Select…” button.
3. All the scope presets will be displayed contained in the selected settings file.
4. Select/Deselect the presets and then click on Import.
5. If preset name already exists in application the confirmation message will be shown to user to replace it or to ignore.

15.3.5 Export preset

Export a preset to a file as follows:

1. Click **Export** and the following dialog is displayed:



2. The existing presets are displayed and user can select/deselect the preset to export.
3. Select the file name to export.
4. Click **Export** to export the selected presets to a file.

15.3.6 Scope axis scaling and zooming

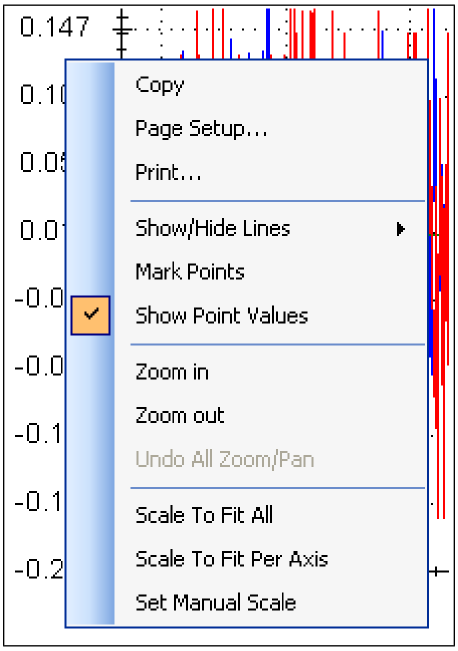
The scope provides two mechanisms to allow the you to visualize the data:

- Scaling: you can choose the scale for the different axes.
- Zooming: you can choose a particular portion of the scope that you want to observe more in details, and then come back to previous scaling.

Two different scaling modes are provided on each axis:

- Manual: you can determine the minimum and maximum value of the axis (X or Y axis).
- Scale to fit: the program will compute a scale for this axis that will display all the curves bound to it (X or Y axis).

These functionalities are accessible through the contextual menu when right-clicking in the axis zone. A simple left-click in the axis zone will provide the manual range functionality. A supplementary functionality allows you to perform a scale to fit on all axes is also available, which allows a good overview.

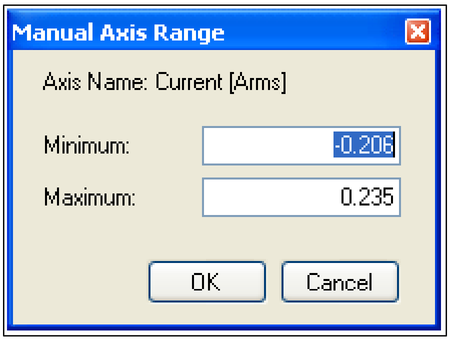


The zoom functionality allows you to navigate in a portion of the graphic. When you reset the zoom, the initial scales are shown.

In the display tab, when "Remember Axis Scale" is set, the scales of the axes are kept between two sequential recordings. You can fine tune the scale to visualize a particular behavior and record a second time and see the same behaviour without having to redo all the tuning. When not checked, a scale to fit all will be performed after each record. This setting is reseted when exiting WorkBench and should be explicitly set at next startup.

15.3.7 Manual range per axis

Click **Manual Y Axis** to open a dialog box to set the range for the axis. Enter the Y-axis minimum value and Y-axis maximum value. Click **OK** to reset the Y-axis to new range.



15.3.8 Unit display on Y axis

The unit on the Y-axis is displayed if all scope signals units are identical for that Y-axis. If different units apply to different signals, the units are displayed as [-]. For example, if the velocity Y-axis has signals VL.FB and IL.CMD, then the unit displayed is [-], since the units for these parameters are different. If IL.CMD is hidden, then the correct unit for VL.FB, rpm, is displayed.

Related Parameters:

BODE Parameters

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16 Using Parameters and the Terminal Screen

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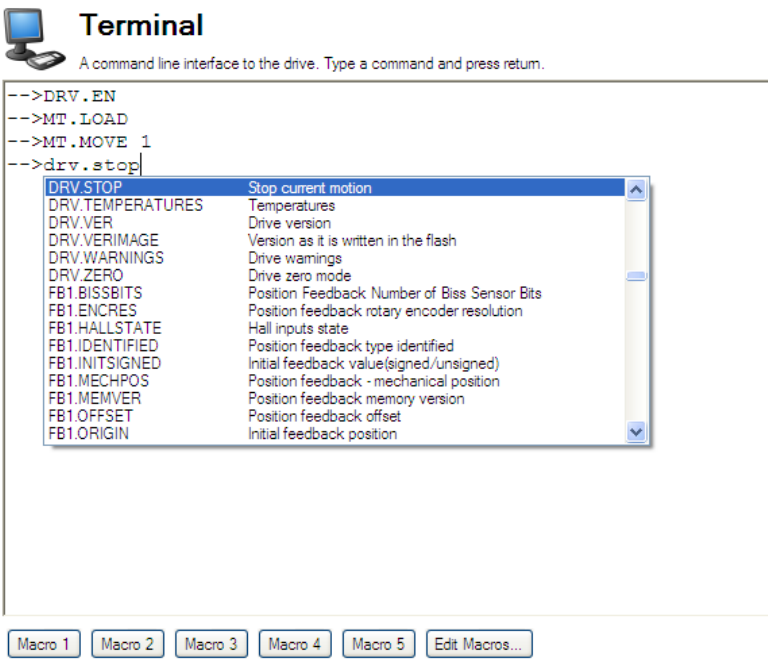
16.1 Terminal

16.1.1 Overview

The terminal mode provides a quick and easy way to issue commands to the drive directly. Typically used by "power users" who are familiar with the command set, the terminal mode can help in setup, troubleshooting, and other diagnostic actions. When using the terminal mode, WorkBench shows the parameter and command set in a popup view and uses an autocomplete tool to help you select the proper parameter or command. Right-click in the command entry area to open a popup menu for editing commands and for clearing the screen. The terminal also provides a macro editor that allows a series of commands to be executed via a single command (called a macro). Macros are useful when you must frequently execute a sequence of commands.

16.1.2 Using the Terminal

Click Terminal in the navigation tree to issue parameters and commands in the terminal mode. You can enter parameters and commands at the prompt as shown in this example:



The terminal supports the following keyboard shortcuts:

Keyboard Shortcut	Description
F2	Executes the last command.
Up Arrow	Gets the previous command from the command history.
Down Arrow	Gets the next command from the command history.
CTRL+J	Shows the list of commands that the drive supports.
CTRL+L	Opens the Parameter Load/Save view.
ESC	Hides the command list if command list is open. Clears the line if command list is not open.
Enter (Return)	Executes the current command. This command sends the text you have typed to the drive and then prints text the drive returns on the next line.

16.1.3 Macros

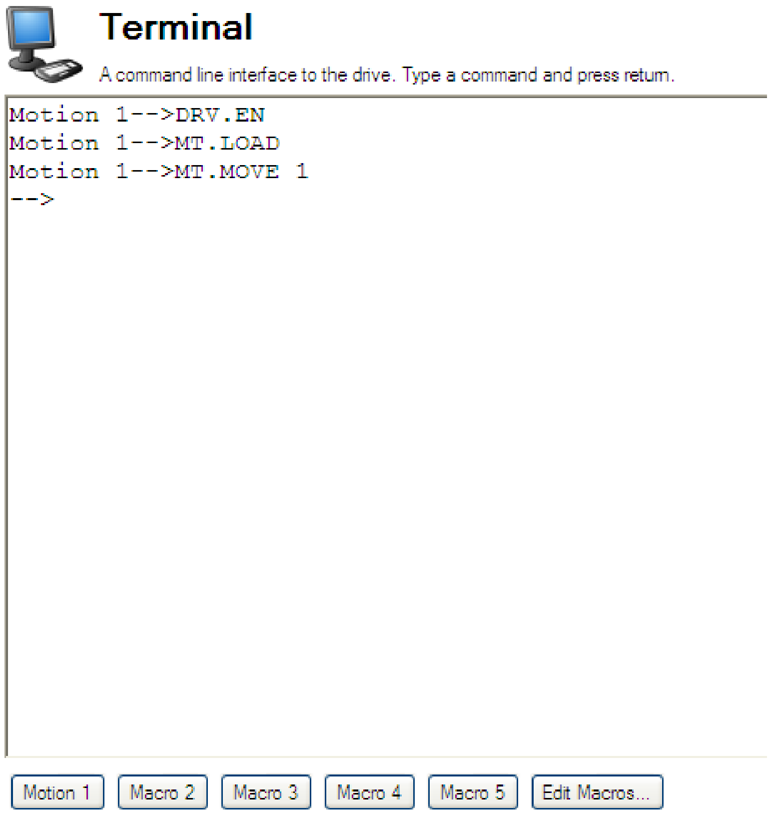
Macros are a short sequence of instructions that can be sent to the drive using a single button. You can create up to five macros within the terminal mode using the macro editor. Each of the macros can be given a name and will appear as a button below the Terminal screen area. When you select the button, the command set tied to that macro will appear in the Terminal area and the commands will be executed. If there are commands which are not entered correctly, the terminal screen area will indicate the errors.

You can access macros and the macro editor from the buttons are located at the bottom of the terminal screen. Click a macro button to execute the associated macro. The **Edit Macros** button opens the macro editor used to create and edit macros. You can also assign custom names to the macro buttons with this editor.

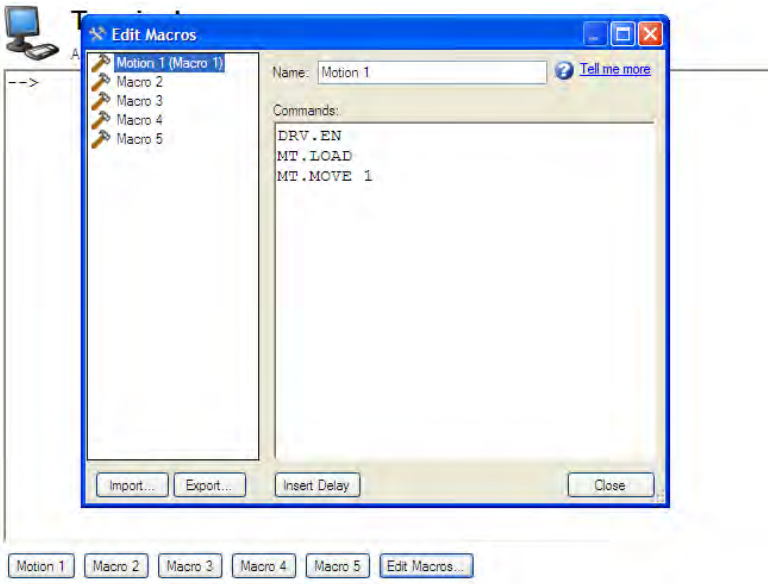
16.1.3.1 Creating a Macro from Terminal commands

You can create a macro from a sequence of terminal commands as follows:

1. Enter the sequence of commands.



2. Copy the sequence of commands, then click **Edit Macro**. Select a macro from the tree on the left, then paste the sequence of commands into the Commands area of the Edit Macros window.



3. Select **Save** to save your macro.

16.1.3.2 Macro Editor

The macro editor allows you to create and modify up to five macros.WorkBench automatically saves the macros that you create. If you exit WorkBench and then start WorkBench again, the macros you defined will still be available.

To create or edit a macro from the editor, open the **Terminal** screen and click on **Edit Macros** (located at the bottom of the screen). Select the macro you wish to edit from the tree on the left, then use the features described below to build the macro. You can add comments in the macro after the ";" symbol.

Button or Dialog Box	Description
Name	Allows you to give each macro a unique name. This name will be shown on the button in the terminal view.
Commands	Displays the commands that are sent to the drive when you use this macro. The response from the drive is displayed in the terminal.
Import	Overwrites the selected macro with the contents of a macro file exported from another computer.
Export	Sends the selected macro to a text file to that you can import into WorkBench running on another computer.
Add Delay	Inserts a step into the macro that causes a delay for a specified number of milliseconds before continuing. A line that starts with #delay 5000 will pause the execution of the macro for 5000 milliseconds.
Close	Closes this window and returns to the terminal view.

16.2 Viewing Parameters

You can view and edit parameters in the **Parameters** screen. You can view and write parameters in the **Terminal** screen.

16.3 Parameter List

This screen displays a list of the current values of all the parameters that the drive supports. You can sort some of the rows by clicking the column headers.

Button or Dialog Box	Description
Refresh	Reads all the parameters from the drive and update the contents of the table.
Print	Sends the data that you see on the screen to the printer.
eMail	Opens an email message and attaches a comma separated file to the email message.
More/Less	Adds two more columns to the table with the range and default values for each parameter.

16.4 Parameter Load/Save

To copy a configuration (all the drive parameters that are stored in the drives nonvolatile memory) from one drive to another, click the **Save to File** button on the first drive and then use the **Load from File** on the second drive. If you wish the second drive to keep these new parameters after the drive is turned off, then you can save the parameters to the nonvolatile memory with **Save To Drive**.

Button or Dialog Box	Description
Save To File	Copies all the drive parameters and creates a file.
Load From Drive	Sets all the drive parameters within the drive to the values contained within the file you select.
Save to Drive	Saves all drive parameters into the nonvolatile memory of the drive. Each time the drive powers on, it will start with these saved parameters.
Default	Returns all the drive parameters back to their default values. Any changes you have made are lost.

Summary of Parameters and Commands

This table contains an alphabetical list of parameters and commands, with a brief description for each. The parameter name and description are linked to the parameter tables. The description field also notes if a parameter is not active in all opmodes. Generally speaking, all parameters and commands are active in all opmodes, with the following exceptions:

Parameter or Command	Active in Opmodes
GEAR (all parameters and commands)	2 (position) only
HOME (all parameters and commands)	2 (position) only
MT (all parameters and commands)	2 (position) only
SM.I1, SM.I	0 (torque) only
SM.V1, SM.V2	1 (velocity) only

Parameter or Command	Active in Opmodes
SM.VPM1, SM.VPM2	2 (position) only
VL (all parameters and commands)	1 (velocity) and 2 (position) only

Parameter or Command	Type	Description
Analog Input (AIN)		
AIN.CUTOFF	NV	Sets the analog input low-pass filter cutoff frequency.
AIN.DEADBAND	NV	Sets the analog input signal deadband.
AIN.ISCALE	NV	Sets the analog current scale factor.
AIN.OFFSET	NV	Sets the analog input offset.
AIN.PSCALE	NV	Sets the analog position scale factor.
AIN.VALUE	R/O	Reads the value of the analog input signal.
AIN.VSCALE	NV	Sets analog velocity scale factor.
AIN.ZERO	Command	Zeroes the analog input signal.
Analog Input/Output (AIO)		
AIO.ISCALE	NV	Sets the analog current scale factor.
AIO.VSCALE	NV	Sets velocity scale factor.
AIO.PSCALE	NV	Sets position scale factor.
Analog Output (AOUT)		
AOUT.DEBUGADDR	NV	Sets the memory address to debug.
AOUT.DEBUGDATATYPE	NV	Sets the data type of the value to be debugged.
AOUT.DEBUGSCALE	NV	Sets the scale to be used for debug.
AOUT.ISCALE	NV	Sets the analog current scale factor.
AOUT.MODE	NV	Sets the analog output mode.
AOUT.OFFSET	NV	Sets the analog input offset.
AOUT.PSCALE	NV	Sets the analog position scale factor.
AOUT.VALUE	NV	Reads the analog output value.
AOUT.VALUEU	R/W	Sets the analog output value.
AOUT.VSCALE	NV	Sets velocity scale factor for analog output.
Bode plot (BODE)		
BODE.EXCITEGAP	R/W	Controls how often the excitation is updated.
BODE.FREQ	R/W	Sets the frequency of the sine excitation source.
BODE.IAMP	R/W	Sets current command value used during the Bode procedure.
BODE.IFLIMIT		Sets the current fault duration limit in seconds for the BODE.MODE 5 stability test.
BODE.IFTHRESH		Sets the current fault threshold for the BODE.MODE 5 stability test.
BODE.INJECTPOINT	R/W	Sets whether the excitation uses current or velocity excitation type.
BODE.MODE	R/W	Sets the mode of the excitation.
BODE.MODETIMER	R/W	Sets the watchdog timer of the excitation.
BODE.PRBDEPTH	R/W	Sets the length of the PRB signal before it repeats.
BODE.VAMP	R/W	Sets the amplitude of the excitation when in velocity mode.
BODE.VFLIMIT		Sets the velocity fault duration limit (seconds) for the BODE.MODE 5 stability test

Parameter or Command	Type	Description
BODE.VFTHRESH		Sets the current fault threshold for the BODE.MODE 5 stability test.
Capture (CAP)		
CAP0.EDGE, CAP1.EDGE	R/W	Selects the capture edge.
CAP0.EN, CAP1.EN	R/W	Enables or disables the related capture engine.
CAP0.EVENT, CAP1.EVENT		Controls the precondition logic.
CAP0.FILTER, CAP1.FILTER	R/W	Controls the precondition logic.
CAP0.MODE, CAP1.MODE	NV	Selects the captured value.
CAP0.PLFB, CAP1.PLFB	R/O	Reads captured position value.
CAP0.PREEDGE, CAP1.PREEDGE		Selects the capture precondition edge.
CAP0.PREFILTER, CAP1.P-REFILTER	R/W	Sets the filter for the precondition input source.
CAP0.PRESELECT, CAP1.PRE-SELECT	R/W	Sets the precondition trigger.
CAP0.STATE, CAP1.STATE	R/O	Indicates whether or not trigger source was cap-tured.
CAP0.T, CAP1.T	R/O	Reads time capture (if time capture was con-figured).
CAP0.TRIGGER, CAP1.TRIGGER	R/W	Specifies the trigger source for the position cap-ture.
Controlled Stop (CS)		
CS.DEC	NV	Sets the deceleration value for the controlled stop process.
CS.STATE	NV	Returns the internal status of the controlled stop process.
CS.TO	NV	Sets the time value for the drive velocity to be within CS.VTHRESH.
CS.VTHRESH	NV	Sets the velocity threshold for the controlled stop.
Digital Input (DIN)		
DIN.ROTARY	R/O	Reads the rotary knob value.
DIN.STATES	R/O	Reads the digital input states.
DIN1.INV TO DIN7.INV	R/W	Sets the indicated the polarity of a digital input mode.
DIN1.MODE TO DIN7.MODE	NV	Sets the digital input modes.
DIN1.PARAM TO DIN7.PARAM	R/W	Sets a value used as an extra parameter for dig-ital inputs nodes.
DIN1.STATE TO DIN7.STATE	R/O	Reads a specific digital input state.
Digital Output (DOUT)		
DOUT.CTRL	NV	Sets the source of digital outputs (firmware or fieldbus).
DOUT.RELAYMODE	R/W	Indicates faults relay mode.
DOUT.STATES	R/O	Reads the state of the two digital outputs.
DOUTx.MODE	NV	Sets the digital output mode.
DOUT1.PARAM AND DOUT2.PARAM	NV	Sets extra parameters for the digital outputs.
DOUT1.STATE AND DOUT2.STATE	R/O	Reads the digital output state.

Parameter or Command	Type	Description
DOUT1.STATEU AND DOUT2.STATEU	R/W	Sets the state of the digital output node.
Drive (DRV)		
DRV.ACC	NV	Describes the acceleration ramp for the velocity central loop.
DRV.ACTIVE	R/O	Reads the enable status of an axis.
DRV.BLINKDISPLAY	Command	Causes the display to blink for 10 seconds.
DRV.BURNINOFFT (Password Protected)	R/W	Sets the burn-in test mode off time.
DRV.CLRFAULTHIST	Command	Clears the fault history log in the NV.
DRV.CLRFAULTS	Command	Tries to clear all active faults in the drive.
DRV.CMDDELAY	R/W	Issues a delay before next command is executed.
DRV.CMDSOURCE	NV	Sets the command source (service, fieldbus, analog input, gearing, digital, or Bode).
DRV.CRASHDUMP	Command	Retrieves diagnostic information after the drive crashes.
DRV.DBILIMIT	NV	Sets the maximum amplitude of the current for dynamic braking.
DRV.DEC	NV	Sets the deceleration value for the velocity loop.
DRV.DIR	R/W	Changes drive direction.
DRV.DIS	Command	Disables the axis (software).
DRV.DISMODE	NV	Selects among disable immediately or stop and then disable options.
DRV.DISSOURCES	R/O	Returns the possible reason for a drive disable.
DRV.DISTO	R/W	Sets the emergency timeout
DRV.EMUEDIR	R/W	Sets the direction of the emulated encoder output (EEO) signal.
DRV.EMUEMODE	R/W	Sets the mode of the emulated encoder output (EEO) connector.
DRV.EMUEMTURN	R/W	Defines the location of the index pulse on the EEO (emulated encoder output) when DRV.EMU-EMODE=2.
DRV.EMUERES	R/W	Sets the resolution of the EEO (emulated encoder output).
DRV.EMUEZOFFSET	R/W	Sets the resolution of the EEO (emulated encoder output).
DRV.EN	Command	Enables the axis (software).
DRV.ENDEFAULT	R/W	Sets the default state of the software enable.
DRV.FAULTHIST	R/O	Reads the last 10 faults from NV memory.
DRV.FAULTS	R/O	Reads the active faults.
DRV.FLASHREAD (Password Pro-tected)	R/O	Reads a value from the serial flash memory.
DRV.HANDWHEEL	R/O	Reads the EEO input value.
DRV.HELP	R/O	Reads the minimum, maximum, and default values for a specific parameter or command.
DRV.HELPALL	R/O	Retrieves the minimum, maximum, default, and actual values for all available parameters and commands.

Parameter or Command	Type	Description
DRV.ICONT	R/O	Reads the continuous rated current value.
DRV.INFO	R/O	Reads general information about the drive.
DRV.IPEAK	R/O	Reads the peak rated current value.
DRV.IZERO	R/W	Sets the current that will be used during the DRV.ZERO procedure.
DRV.LIST	R/O	Reads the list of available parameters and commands.
DRV.LOGICVOLTS		Reads the logic voltages.
DRV.NAME	NV	Sets and reads the name of the drive.
DRV.NVLIST	R/O	Lists the NV parameters and values from the RAM.
DRV.NVLOAD	W/O	Loads all data from the NV memory of the drive into the RAM parameters.
DRV.NVSAVE	Command	Saves the drive parameters from the RAM to the NV memory.
DRV.ONTIME	R/O	Returns how long the drive has been running since last power up.
DRV.OPMODE	NV	Sets the drive operation mode (current, velocity, or position).
DRV.READFORMAT	R/W	Sets the value returned to either decimal or hexadecimal.
DRV.RSTVAR	Command	Sets default values in the drive without re-booting the drive and without resetting the NV memory.
DRV.RUNTIME	R/O	Returns how long the drive has been running since first activated.
DRV.SETUPREQBITS	R/O	Reads the bitwise set status of parameters that must be set before the drive can be enabled
DRV.SETUPREQLIST	R/O	Reads the list of parameters that must be set before the drive can be enabled.
DRV.STOP	Command	This command stops all drive motion.
DRV.TEMPERATURES	R/O	Reads the temperature of drive components.
DRV.VER	R/O	Reads the drive version.
DRV.VERIMAGE	R/O	Returns the version data from each image.
DRV.TEMPERATURES	R/O	Reads the temperature of drive components.
DRV.WARNINGS	R/O	Reads the active warnings.
DRV.ZERO	R/W	Sets the zero mode. The procedure is activated when the drive is enabled.
Feedback (FB1)		
FB1.ENCRES	NV	Sets the resolution of the motor encoder.
FB1.HALLSTATE	R/O	Reads the Hall switch values (encoder feedback
FB1.IDENTIFIED	R/O	Reads the type of feedback device used by the drive/motor.
FB1.INITSIGNED	NV	Sets initial feedback value as signed or unsigned.
FB1.LDLL	R/O	Reads the motor line-to-line inductance from the FPGA.
FB1.LQLL	R/O	Reads the motor line-to-line inductance in the back emf axis (q axis) from the SFD memory from the FPGA.
FB1.MECHPOS	R/O	Reads the mechanical position.

Parameter or Command	Type	Description
FB1.MEMDUMP	W/O	Dumps the memory ID data values of a feedback with memory
FB1.MEMVER	R/O	Returns the memory feedback version.
FB1.OFFSET	NV	Sets position feedback offset.
FB1.POLES	R/O	Reads the number of feedback poles.
FB1.OFFSET	NV	Sets position feedback offset.
FB1.POLES	R/O	Reads the number of feedback poles.
FB1.SELECT	NV	Sets user entered type or identified type (–1).
Fieldbus (FBUS)		
FBUS.PARAM1 TO FBUS.PARAM20	NV	Set fieldbus specific meanings.
FBUS.PLLSTATE	R/O	Returns the status of the PLL
FBUS.PLLTHRESH	NV	Sets number of successful synchronized cycles needed to lock the PLL.
FBUS.SAMPLEPERIOD	NV	Sets fieldbus sample period.
FBUS.SYNCACT	R/O	Reads actual distance from the desired sync distance.
FBUS.SYNCDIST	NV	Sets time target for synchronization.
FBUS.SYNCWND	NV	Sets symmetrically arranged window around the desired sync distance.
FBUS.TYPE	R/O	Shows the active fieldbus type.
Gearing (GEAR)		
GEAR.ACCMAX	R/W	Sets the maximum allowed acceleration value; active in opmode 2 (position) only.
GEAR.DECMAX	R/W	Sets the maximum allowed deceleration value; active in opmode 2 (position) only.
GEAR.IN	R/W	Sets the denominator of the electronic gearing ratio; active in opmode 2 (position) only.
GEAR.MODE	R/W	Selects electronic gearing mode; active in opmode 2 (position) only.
GEAR.MOVE	Command	Starts the electronic gearing; active in opmode 2 (position) only.
GEAR.OUT	R/W	Sets the numerator of the electronic gearing ratio; active in opmode 2 (position) only.
GEAR.VMAX	R/W	Reads the maximum allowed velocity value; active in opmode 2 (position) only.
Homing (HOME)		
HOME.ACC	R/W	Sets homing acceleration; active in opmode 2 (position) only.
HOME.AUTOMOVE	R/W	Sets homing auto move flag.
HOME.DEC	R/W	Sets homing deceleration; active in opmode 2 (position) only.
HOME.DIR	NV	Sets homing direction; active in opmode 2 (position) only.
HOME.DIST	R/W	Sets homing distance; active in opmode 2 (position) only.
HOME.FEEDRATE	R/W	Sets homing velocity factor; active in opmode 2 (position) only.

Parameter or Command	Type	Description
HOME.IPEAKHOME.IPEAK	R/W	Sets the current limit during homing procedure to a mechanical stop; active in opmode 2 (position) only.
HOME.MODEHOME.MODE	R/W	Selects the homing mode; active in opmode 2 (position) only.
HOME.MOVEHOME.MOVE	Command	Starts a homing procedure; active in opmode 2 (position) only.
HOME.PHOME.P	R/W	Sets home position; active in opmode 2 (position) only.
HOME.PERRTHRESH HOME.PERRTHRESH	R/W	Sets the position lag threshold; active in opmode 2 (position) only.
HOME.SETHOME.SET	Command	Immediately sets the home position; active in opmode 2 (position) only.
HOME.VHOME.V	R/W	Sets homing velocity; active in opmode 2 (position) only.
Hardware Limit Switch (HWLS)		
HWLS.NEGSTATE	R/O	Reads the status of the negative hardware limit switch.
HWLS.POSSTATE	R/O	Reads the status of the positive hardware limit switch.
Current Loop (IL)		
IL.BUSFF	R/O	Displays the current feedforward value injected by the fieldbus.
IL.CMD	R/O	Reads the value of the q-component current controller inside the FPGA.
IL.CMDU	R/W	Sets the user current command.
IL.DCMD (Password Protected)	R/O	Reads the value of the d-component current controller inside the FPGA.
IL.DCMD (Password Protected)	R/O	Reads the value of the d-component current controller inside the FPGA.
IL.DCMDU (Password Protected)	R/W	Sets user d-component current command.
IL.DEADBAND (Password Protected)	R/O	Reads the deadband of two IGBTs in series connection.
IL.DFB	R/O	Reads the actual value of the d-component current.
IL.DFOLDD (Password Protected)	R/O	Reads the motor foldback maximum time at motor peak current.
IL.DFOLDR (Password Protected)	R/O	Reads the motor foldback recovery time.
IL.DFOLDT	R/O	Reads the motor foldback time constant of the exponential current drop (foldback).
IL.DIFOLD	R/O	Reads the drive foldback current limit.
IL.DLIMITN	R/W	Sets the negative user (application-specific) d-component current limit.
IL.DLIMITP	R/W	Sets the positive user (application-specific) d-component current limit.
IL.FB	R/O	Reads the actual value of the d-component current.
IL.FOLDFTHRESH	NV	Reads the foldback fault level.
IL.FOLDWTHRESH	NV	Sets the foldback warning level.
IL.IFOLD	R/O	Reads the overall foldback current limit.

Parameter or Command	Type	Description
IL.INTEN (Password Protected)	NV	Enables/disables the integrator part of the PI loop.
IL.IUOFFSET (Password Protected)	R/W	Sets the offset added to the sigma-delta measured current value in the u-winding.
IL.IUFB	R/O	Reads the sigma-delta measured current in the u-winding of the motor.
IL.IVFB	R/W	Sets the sigma-delta measured current in the u-winding of the motor.
IL.IVOFFSET (Password Protected)	R/W	Sets the offset added to the sigma-delta measured current value in the v-winding.
IL.KP	NV	Sets the proportional gain of the q-component of the PI regulator.
IL.KPDRATIO	NV	IL.KPDRATIO
IL.LIMITN	NV	Sets the negative user (application-specific) current limit.
IL.LIMITP	NV	Sets the positive user (application-specific) current limit.
IL.MFOLDD	NV	Sets the motor foldback maximum time at motor peak current.
IL.MFOLDR	R/O	Sets the motor foldback recovery time.
IL.MFOLDT	NV	Sets the motor foldback time constant of the exponential current drop (foldback).
IL.MIFOLD	R/O	Sets the motor foldback current limit.
IL.PWMFREQ (Password Protected)	NV	Reads and sets the PWM frequency of the IGBTs.
IL.VDCMD	R/O	Sets the output of the d-component PI-regulator.
IL.VCMD	R/O	Sets the output of the q-component PI regulator.
IL.VUFB	R/O	Reads the measured voltage on the u-winding of the motor.
IL.VVFB	R/O	Reads the measured voltage on the v-winding of the motor.
IL.DLIMITN	R/W	Sets the negative user (application-specific) d-component current limit.
IL.DLIMITP	R/W	Sets the positive user (application-specific) d-component current limit.
IL.FB	R/O	Reads the actual value of the d-component current.

Motor (MOTOR) Parameters		
MOTOR.BRAKE	NV	Sets the presence or absence of a motor brake.
MOTOR.TBRAKEAPP	NV	The delay time used for applying the motor brake.
MOTOR.TBRAKERLS	NV	The delay time used for releasing the motor brake.
MOTOR.ICONT	NV	Sets the motor continuous current.
MOTOR.INERTIA	NV	Sets the motor inertia.
MOTOR.IPEAK	NV	Sets the motor peak current.
MOTOR.KT	NV	Sets the torque constant of the motor.
MOTOR.LQLL	NV	Sets the line-to-line motor Lq.
MOTOR.VMAX	NV	Sets the maximum motor speed.

MOTOR.NAME	NV	Sets the motor name.
MOTOR.PHASE	NV	Sets the motor phase.
MOTOR.PITCH	NV	Sets the motor pitch.
MOTOR.POLES	NV	Sets the number of motor poles.
MOTOR.R	NV	Sets the stator winding resistance phase-phase in ohms.
MOTOR.TEMP	R/O	Reads the motor temperature represented as the resistance of the motor PTC.
MOTOR.TEMPFAULT	NV	Sets the motor temperature fault level.
MOTOR.TEMPWARN	NV	Sets the motor temperature warning level.
MOTOR.TYPE	NV	Sets the motor type.
MOTOR.VOLTMAX	NV	Sets the motor maximum voltage.
Motion Task (MT)		
MT.ACC	R/W	Specifies motion task acceleration; active in opmode 2 (position) only.
MT.CLEAR	Command	Clears motion tasks from the drive; active in opmode 2 (position) only.
MT.CNTL	R/W	Sets motion task control word; active in opmode 2 (position) only.
MT.CONTINUE	Command	Continues a stopped motion task; active in opmode 2 (position) only.
MT.DEC	R/W	Sets motion task deceleration; active in opmode 2 (position) only.
MT.EMERGMT	R/W	Selects a motion task to be triggered after an emergency stop procedure; active in opmode 2 (position) only.
MT.MTNEXT	R/W	Specifies following motion task number; active in opmode 2 (position) only.
MT.TNEXT	R/W	Specifies following motion task time; active in opmode 2 (position) only.
MT.LIST	Command	Lists all initialized motion tasks in the drive; active in opmode 2 (position) only.
MT.LOAD	Command	Reads/loads a motion task number from the drive; active in opmode 2 (position) only.
MT.MOVE	Command	Starts a motion task; active in opmode 2 (position) only.
MT.NUM	R/W	Sets the motion task number; active in opmode 2 (position) only.
MT.PARAMS	Command	Shows a motion task; active in opmode 2 (position) only.
MT.P	R/W	Sets the motion task position; active in opmode 2 (position) only.
MT.SET	Command	Sets the motion task in the drive; active in opmode 2 (position) only.
MT.TNUM	R/W	Motion task customer table number.
MT.V	R/W	Sets the motion task velocity; active in opmode 2 (position) only.
Position Loop (PL)		
PL.CMD	NV	Reads the position command directly from the entry to the position loop.

PL.ERR	NV	Returns the position error present when the drive is controlling the position loop.
PL.ERRFTHRESH	NV	Sets the maximum position error.
PL.ERRWTHRESH	NV	Sets the position error warning level.
PL.FB	R/O	Reads the position feedback value.
PL.FBSOURCE	NV	Sets the feedback source for the position loop.
PL.INTINMAX	NV	Limits the input of the position loop integrator by setting the input saturation.
PL.INTOUTMAX	NV	Limits the output of the position loop integrator by setting the output saturation.
PL.KI	NV	Sets the integral gain of the position loop.
PL.KP	NV	Sets the proportional gain of the position regulator PID loop.
Programmable Limit Switch (PLS)		
PLS.EN	R/W	Enables programmable limit switch (PLS).
PLS.MODE	NV	Selects programmable limit switch mode.
PLS.P1 TO PLS.P8	NV	Sets the trigger point for programmable limit switches.
PLS.STATE	R/O	Reads the programmable limit switch state.
Recorder (REC)		
REC.ACTIVE	R/O	Indicates if data recording is in progress (active).
REC.CH1 to REC.CH6	R/W	Sets recording channels 1 to 6.
REC.DONE	R/O	Checks whether or not the recorder has finished recording.
REC.GAP	R/W	Specifies the gap between consecutive samples.
REC.NUMPOINTS	R/W	Sets the number of points to record.
REC.OFF	R/W	Turns the recorder OFF.
REC.RETRIEVE	R/O	Transfers all the recorded data to the communication channel.
REC.STOPTYPE	R/W	Sets the recorder stop type.
REC.TRIG	Command	Triggers the recorder.
REC.TRIGSLOPE	R/W	Sets the trigger slope.
REC.TRIGTYPE	R/W	Sets the trigger type.
REC.TRIGVAL	R/W	Sets the trigger value.
Regen Resistor (REGEN)		
REGEN.POWER	R/O	READS REGEN RESISTOR'S CALCULATED POWER.
REGEN.REXT	N/V	SETS THE EXTERNAL, USER-DEFINED REGEN RESISTOR RESISTANCE.
REGEN.TEXT	R/W	Sets the external regen resistor thermal protection time constant.
REGEN.TYPE	N/V	SETS THE REGEN RESISTOR TYPE.
REGEN.WATTEXT	R/W	SETS THE REGEN RESISTOR'S POWER FAULT LEVEL FOR AN EXTERNAL REGEN RESISTOR.
Service Motion (SM)		
SM.I1	R/W	Sets service motion current 1; active in opmode 0 (torque) only.

SM.I2	R/W	Sets service motion current 2; active in opmode 0 (torque) only.
SM.MODE	R/W	Sets the service motion mode.
SM.MOVE	Command	Starts the service motion.
SM.T1	R/W	Sets the service motion time 1.
SM.T2	R/W	Sets the service motion time 2.
SM.V1	R/W	Sets service motion velocity 1; active in opmode 1 (velocity) and 2 (position).
SM.V2	R/W	Sets service motion velocity 2; active in opmode 1 (velocity) and 2 (position).
Units (UNIT)		
UNIT.ACCLINEAR	NV	Sets the linear acceleration/deceleration units.
UNIT.ACCROTARY	NV	Sets the rotary acceleration/deceleration units.
UNIT.LABEL	NV	Sets user-defined name for user-defined position units.
UNIT.PIN	NV	Sets gear IN for the unit conversion.
UNIT.PLINEAR	NV	Sets the linear position units.
UNIT.POUT	NV	Sets gear out for the unit conversion.
UNIT.PROTARY	NV	Sets the position units when the motor type (MOTOR.TYPE) is rotary.
UNIT.VLINEAR	NV	Sets the linear velocity units.
UNIT.VROTARY	NV	Sets the velocity units when the motor type (MOTOR.TYPE) is rotary.
Bus voltage (VBUS)		
VBUS.OVFTHRESH	R/O	Reads the over voltage fault level.
VBUS.OVWTHRESH	N/V	Sets voltage level for over voltage warning.
VBUS.RMSLIMIT	R/O	Reads the limit for the bus capacitors load.
VBUS.UVFTHRESH	R/O	Sets the under voltage fault level.
VBUS.UVMODE		Indicates undervoltage (UV) mode.
VBUS.UVWTHRESH	NV	Sets voltage level for undervoltage warning.
VBUS.VALUE	R/O	Reads DC bus voltage.
Velocity Loop (VL)		
VL.ARPF1 TO VL.ARPF4	R/W	Sets the natural frequency of the pole (denominator) of anti-resonance (AR) filters 1, 2, 3, and 4; active in opmodes 1 (velocity) and 2 (position) only.
VL.ARPQ1 TO VL.ARPQ4	R/W	Sets the Q of the pole (denominator) of anti-resonance (AR) filter 1; active in opmodes 1 (velocity) and 2 (position) only.
VL.ARTYPE1 TO VL.ARTYPE4	NV	Indicates the method used to calculate BiQuad coefficients; active in opmodes 1 (velocity) and 2 (position) only.
VL.ARZF1 TO VL.ARZF4	R/W	Sets the natural frequency of the zero (numerator) of anti-resonance (AR)filter 1; active in opmodes 1 (velocity) and 2 (position) only.
VL.ARZQ1 TO VL.ARZQ4	R/W	Sets the Q of the zero (numerator) of anti-resonance filter #1; active in opmodes 1 (velocity) and 2 (position) only.

VL.BUSFF	R/O	Displays the velocity loop feedforward value injected by the field-bus; active in opmodes 1 (velocity) and 2 (position) only.
VL.CMD	R/O	Reads the actual velocity command; active in opmodes 1 (velocity) and 2 (position) only.
VL.CMDU	R/W	Sets the user velocity command; active in opmodes 1 (velocity) and 2 (position) only.
VL.ERR	R/O	Sets the velocity error; active in opmodes 1 (velocity) and 2 (position) only.
VL.FB	R/O	Reads the velocity feedback; active in opmodes 1 (velocity) and 2 (position) only.
VL.FBFILTER	R/O	Filters VL.FB value; active in opmodes 1 (velocity) and 2 (position) only.
VL.FBSOURCE	NV	Sets feedback source for the velocity loop; active in opmodes 1 (velocity) and 2 (position) only.
VL.FF	R/O	Displays the velocity loop overall feedforward value; active in opmodes 1 (velocity) and 2 (position) only.
VL.GENMODE	NV	Selects mode of velocity generation (Observer, d/dt); active in opmodes 1 (velocity) and 2 (position) only.
VL.KBUSFF	R/W	Sets the velocity loop acceleration feedforward gain value; active in opmodes 1 (velocity) and 2 (position) only.
VL.KI	NV	Sets the velocity loop integral gain for the PI controller; active in opmodes 1 (velocity) and 2 (position) only.
VL.KP	NV	Sets velocity loop proportional gain for the PI controller; active in opmodes 1 (velocity) and 2 (position) only.
VL.KVFF	R/W	Sets the velocity loop velocity feedforward gain value; active in opmodes 1 (velocity) and 2 (position) only.
VL.LIMITN	NV	Sets the velocity lower limit; active in opmodes 1 (velocity) and 2 (position) only.
VL.LIMITP	NV	Sets the velocity high limit; active in opmodes 1 (velocity) and 2 (position) only.
VL.LMJR	R/W	Sets the ratio of the estimated load moment of inertia relative to the motor moment of inertia; active in opmodes 1 (velocity) and 2 (position) only.
VL.THRESH	NV	Sets the over speed fault value; active in opmodes 1 (velocity) and 2 (position) only.
Wake and Shake (WS)		
WS.ARM	Command	Sets wake and shake to start at the next drive enable.
WS.DISTMIN	R/W	Sets the minimum movement required for wake and shake.
WS.IMAX	R/W	Sets maximum current used for wake and shake.
WS.MODE	R/W	Sets the method used for wake and shake.
WS.DISTMAX	R/W	Sets maximum movement allowed for wake and shake.

WS.NUMLOOPS	R/W	Sets the number of repetitions for wake and shake.
WS.STATE	R/O	Reads wake and shake status
WS.T	R/W	Sets wake and shake current-vector appliance time
WS.TDELAY1	NV	Delay for wake and shake timing
WS.TDELAY2	NV	Sets the delay for wake and shake timing.
WS.TDELAY3	NV	Sets the delay for wake and shake between loops in mode 0.
WS.VTHRESH	NV	Defines the maximum allowed velocity for Wake & Shake

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17 Faults and Warnings

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17.1 Fault and Warning Messages

When a fault occurs, the drive fault relay is opened, the output stage is switched off (motor loses all torque), or the load is dynamically braked. The specific drive behavior depends on the type of fault. The LED display on the front panel of the drive shows the number of the fault that occurred. If a warning is issued prior to the fault, the warning is shown on the LED and has the same number as the associated fault. Warnings do not trip the power stage of the drive or fault relay output.

The left side of the LED displays F for a fault or n for a warning. The right side displays the fault or warning number as follows: 1-0-1-[break]. The highest priority fault is displayed on the LED. Multiple faults may be present when a fault condition is occurring. Check the AKDWorkBench Fault Screen or read the status of DRV.FAULTS through the controller or HMI for the entire list of faults.

NOTE	More information about fault messages and clearing faults can be found in the WorkBench online help. Procedures for clearing faults are described in the online help topic entitled "Faults and Warnings".

Fault	Message/Warning	Cause	Remedy
0		Reserved.	N/A
101	Firmware incompatible. Warning issued prior to fault.	Installed firmware is not compatible with the drive hardware.	Load compatible firmware into the drive.
102	Resident firmware failed. Warning issued prior to fault.	Software failure detected.	Restart drive. If issue persists, contact technical support.
103	Resident FPGA failed.	Software failure detected. Load resident FPGA failure occurred (several cases according to flowchart, including incompatible image to FPGA type and fieldbus type).	Restart drive. If issue persists, contact technical support.
104	Operational FPGA failed.	Software failure detected. Load operational FPGA failure occurred (several cases according to flowchart).	Restart drive. If issue persists, contact technical support.
105	NV memory stamp invalid.	NV memory stamp is corrupted or invalid.	Reset the drive to default memory values using **Parameter Load** in WorkBench.
106	NV memory data (might occur when downloading firmware).	NV memory data is corrupted or invalid. This fault often occurs when downloading firmware.	Reset the drive to default memory values using **Parameter Load** in WorkBench.
107	Positive switch limit exceeded. Warning issued prior to fault.	Positive software position limit is exceeded.	Move the load away from the limits.
108	Negative switch limit exceeded. Warning issued prior to fault.	Negative software position limit is exceeded.	Move the load away from the limits.
121	Homing error.	Drive did not finish homing sequence.	Check homing sensor.
123	Invalid motion task. Warning issued prior to fault.	Invalid motion task.	Check motion task settings and parameters to make sure that the values entered will produce a valid motion task. Refer to the motion task documentation for additional guidance on specific causes of invalid motion tasks.

Fault	Message/Warning	Cause	Remedy
125	Synchronization lost. Warning issued prior to fault.	The fieldbus lost synchronization.	Check fieldbus connection (X5 and X6 if you are using EtherCAT; X12 and X13 if you are using CANopen) or the settings of your EtherCAT or CANopen master.
126	Too much movement. Warning issued prior to fault.	Too much movement was created during a Bode plot. Motor is unstable and is not following drive instructions.	Check that the system is closed loop stable. Refer to the system tuning guide.
127	Incomplete emergency stop procedure.	Incomplete emergency stop procedure (problem with the emergency stop motion task).	Disconnect power from drive and check emergency stop procedure.
128	MPOLES/FPOLES not an integer.	Ratio of motor poles to feedback poles must be a whole number.	Change to a compatible feedback device.
129	Heartbeat lost.	Heartbeat lost.	Check CANopen cabling. Reduce bus load or increase the heartbeat update time.
130	Secondary feedback supply over current.	Problem in secondary feedback detected.	Check X9 connection.
131	Emulated encoder line break.	Problem in secondary feedback detected.	Check secondary feedback (X9 connection).
132	Emulated encoder Z break.	Problem in secondary feedback detected.	Check secondary feedback (X9 connection).
133	Instability during Autotune	Drive current (IL.CMD) or velocity feedback (VL.FB) exceeds allowable limit (BODE.IFLIMIT or BODE.VFLIMIT). This fault only occurs in BODE.MODE 5, which uses a stability checking algorithm. This fault often occurs when complex mechanics, belts, and compliant loads are present, which make accurate measurement hard to obtain with the Autotuner settings.	Change BODE.MODE if appropriate. If BODE.MODE 5 is appropriate and the fault occurs at the end of an Autotuning, then the motor is not robustly stable. You can manually adjust Autotuner settings to increase FFT point resolution, record points, and current excitation. Manual tuning may be required to make the motor stable.
134	Secondary feedback illegal state.	Problem in secondary feedback detected.	Check X9 connection.
135	Homing is needed. Warning issued prior to fault.	Attempt to issue motion task before the axis is homed. Axis must be homed before motion task can start.	Change opmode or home axis.
201	Internal RAM failed.	Hardware failure detected.	Restart drive. If issue persists, contact technical support.
202	External RAM failed.	Hardware failure detected.	Restart drive. If issue persists, contact technical support.
203	Code integrity failed.	Software failure detected. FPGA register access failure occurred.	Restart drive. If issue persists, contact technical support.
204 to 232	EEPROM failure detected	EEPROM failure detected	Restart drive. If issue persists, exchange drive.
234 to 237	Temperature sensor high. Warning issued prior to fault.	High temperature limit reached.	Check cabinet ventilation system.

Fault	Message/Warning	Cause	Remedy
240 to 243	Temperature sensor low. Warning issued prior to fault.	Low temperature limit reached.	Check cabinet ventilation system.
245	External fault.	This fault is user generated and is caused by user settings.	Users can configure a digital input to trigger this fault (DINx.MODE = 10). The fault occurs according to this input setting. Clear the input to clear the fault.
247	Bus voltage exceed allowed thresholds.	Hardware problem in bus measurement.	Troubleshoot and repair hardware problem.
301	Motor overheated. Warning issued prior to fault.	Motor overheated.	Check ambient temperature. Check motor mounting heat sink capability
302	Over speed.	Motor exceeded VL.THRESH value.	Look for overshoot or lower requested speed.
303	Runaway.	Motor did not follow command values.	Gains are too low; motor is being over driven.
304	Motor foldback. Warning issued prior to fault.	Maximum motor power has been exceeded; the power has been limited to protect the motor	Motion is requiring too much power. Change move profile to reduce load on motor. Check for load jamming or sticking. Check that current limits are set correctly.
305	Brake open circuit.	Motor brake open circuit.	Check cabling and general functionality.
306	Brake short circuit.	Motor brake short circuit.	Check cabling and general functionality.
307	Brake closed during enable state.	Motor brake closed unexpectedly.	Check cabling and general functionality.
308	Voltage exceeds motor rating.	Drive bus voltage exceeds the motor's defined voltage rating.	Make sure that the motor fits the driving rating.
401	Failed to set feedback type.	Feedback is not connected or wrong feedback type selected	Check primary feedback (X10 connection).
402	Analog signal amplitude fault.	Analog signal amplitude is too low. Analog fault (resolver signal amplitude or sin/cos amplitude)	Check primary feedback (X10 connection), resolver and sine/cos encoder only.
403	EnDat communication fault.	General communication problem with feedback.	Check primary feedback (X10 connection), EnDat only
404	Hall error.	Hall sensor returns invalid Hall state (111, 000); either all Hall sensors are on or off. Legal Hall states are 001, 011, 010, 110, 100, and 101. This fault can be caused by a broken connection in any one of the Hall signals.	Check the feedback wiring; check all feedback connectors to ensure all pins are positioned correctly.
405	BiSS watchdog fault.	Bad communication with the feedback device.	Check primary feedback (X10 connection), Biss only.

Fault	Message/Warning	Cause	Remedy
406	BiSS multicycle fault.	Check primary feedback (X10 connection), Biss only.	
407	BiSS sensor fault.	Check primary feedback (X10 connection), Biss only.	
408 to 416	SFD Feedback Fault	Bad communication with the SFD device.	Check primary feedback (X10 connection).If fault persists, internal feedback failure. Return to manufacturer for repair.
417	Broken wire in primary feedback.	In primary feedback, a broken wire was detected (incremental encoder signal amplitude).	Check feedback cable continuity.
418	Primary feedback power supply.	Power supply fault for primary feedback.	Check primary feedback (X10 connection).
419	Encoder init procedure failed	Phase find procedure did not complete successfully.	Check encoder wiring, reduce/balance motor load prior to phase finding.
424	Resolver amplitude low.	Resolver signal amplitude is below minimum level.	Check primary feedback (X10 connection).
425	Resolver amplitude high.	Resolver signal amplitude is above maximum level.	Check primary feedback (X10 connection).
426	Resolver error.	Resolver excitation fault.	Check primary feedback (X10 connection).
427	Analog low.	Analog signal amplitude low.	Check primary feedback (X10 connection).
428	Analog high.	Analog signal amplitude high.	Check primary feedback (X10 connection).
429	Incremental low.	Incremental encoder signal amplitude is below minimum level.	Check primary feedback (X10 connection).
430	Incremental high.	Incremental encoder signal amplitude is above maximum level.	Check primary feedback (X10 connection).
431	Secondary feedback Hall error.	Secondary feedback illegal Hall state (000,111).	Check X9 connection.
432	Communication fault.	General communication problem with secondary feedback.	Check secondary feedback (X10 connection).
437	Close to limit.	Drive or motor over current or over speed warning.	Check for increased load, jamming or sticking. Is position error set too low?
438	Following error (numeric) Warning issued prior to fault.	Motor did not follow command values. Motor exceeded maximum allowed position following error (numeric).	Check for increased load, jamming or sticking. Is position error set too low?
439	Following error (user). Warning issued prior to fault.	Motor did not follow command values. Motor exceeded maximum allowed position following error (user).	Check feedback commutation setup and tuning parameters.
450	Following error (presentation).	Motor did not follow command values. Motor exceeded maximum allowed position following error (presentation).	Check feedback commutation setup and tuning parameters.
473	Wake and Shake. Insufficient movement	There was less movement than defined by WS.DISTMIN.	Increase WS.IMAX and/or WS.T
475	Wake and Shake. Excess movement.	WS.DISTMAX has been exceeded.	Increase WS.DISTMAX value or reduce WS.IMAX or WS.T.

Fault	Message/Warning	Cause	Remedy
476	Wake and Shake. Fine-coarse delta too large.	The angle difference between the coarse and fine calculation was larger than 72 deg.	Modify WS.IMAX or WS.T and try again.
478	Wake and Shake. Over-speed. Warning issued prior to fault.	WS.VTHRESH was exceeded.	Increase WS.VTHRESH value or reduce WS.IMAX or WS.T.
479	Wake and Shake. Loop angle delta too large. Warning issued prior to fault.	The angle between complete loops was larger than 72 deg.	Modify WS.IMAX or WS.T and try again.
501	Bus over voltage. Warning issued prior to fault.	Bus voltage too high. Usually, this problem is load related.	Reduce load or change motion profile. Check system regen capacity; add capacity if needed. Check mains voltage.
502	Bus under voltage. Warning issued prior to fault.	Bus voltage below threshold value.	Check mains voltage.
503	Bus capacitor overload. Warning issued prior to fault.	Single phase AC input on a drive only rated for three-phase input or excessive single-phase power load.	Check mains voltage.
504 to 518	Internal supply voltage fault	Internal supply voltage fault detected	Check wiring for electromagnetic compatibility (EMC). If issue persists exchange drive.
519	Regen short circuit.	Regen resistor short circuit.	Regen IGBT short circuit. Contact technical support.
520	Regen overload.	Regen resistor overload.	Motor is being overhauled or motor is being stopped too quickly.
521	Regen over power. Warning issued prior to fault.	Too much power stored in regen resistor.	Increase regen resistor capacity.Either get larger brake resistor or use DC bus sharing to dissipate power..
523	Bus over voltage FPGA	Bus over voltage hard fault.	Check mains voltage and check system brake capacity.
524	Drive foldback. Warning issued prior to fault.	Maximum drive power has been exceeded. The power has been limited to protect the drive.	Motion requires too much power. Change profile to reduce load .
525	Output over current.	Current exceeds drive peak.	Check for short or feedback faults.
526	Current sensor short circuit.	Current sensor short circuit.	Restart drive. If issue persists, contact technical support.
527	Iu current AD converter stuck.	Hardware failure detected.	Restart drive. If issue persists, contact technical support.
528	Iv current AD converter stuck.	Hardware failure detected.	Restart drive. If issue persists, contact technical support.
529	Iu current offset limit exceeded.	Hardware failure detected.	Restart drive. If issue persists, contact technical support.
530	Iv current offset limit exceeded.	Hardware failure detected.	Restart drive. If issue persists, contact technical support.

Fault	Message/Warning	Cause	Remedy
531	Power stage fault.	Hardware failure detected.	Restart drive. If issue persists, replace drive.
532	Drive motor parameters setup incomplete.	Before a motor can be enabled, you must configure a minimum set of parameters. These parameters have not been configured.	Issue the command DRV.SETUPREQLIST to display the list of the parameters that you must configure. Configure these parameters either manually or automatically. You can manually configure these parameters in three ways: (1) set each parameter individually; (2) use the setup wizard to select the motor; or (3) select the motor type from the motor data base in the Motor window (MOTOR.AUTOSET must be set to 0 (FALSE)). If you use the Motor window, you must first select the feedback type. If the motor has Biss Analog, Endat, or SFD feedback (feedback with memory), then these parameters are set automatically when MOTOR.AUTOSET is set to 1 (TRUE).
534	Failed to read motor parameters from feedback device.	Motor either does not have motor feedback memory, or the motor feedback memory is not programmed properly so the parameters cannot be read.	Try to read parameters again by clicking the **Disable** and **Clear Faults** button, or by issuing the DRV.CLRFAULTS command. If this attempt is not successful, then set MOTOR.AUTOSET to 0 (false) and program the parameters using the setup wizard or manually set up the parameters. If the motor has motor memory (Biss Analog, Endat, and SFD motors have motor memory), return the motor to have the memory programmed.
602	Safe torque off.	Safe torque off function has been triggered.	Reapply supply voltage to STO if safe to do so.
701	Fieldbus runtime.	Runtime communication fault.	Check fieldbus connections (X11), settings, and control unit.
702	Fieldbus communication lost. Warning issued prior to fault.	All fieldbus communication was lost.	Check fieldbus connections (X11), settings, and control unit.
703	Emergency timeout occurred while axis should disable	Motor did not stop in the timeout defined.	Change timeout value, change stop parameters, improve tuning.

17.2 Clearing Faults

You can clear drive faults in four ways: 1. using the WorkBench toolbar; 2. using the WorkBench terminal screen, 3.using the CANopen interface; or 4.using an external digital signal. In the first three methods, clearing the fault automatically disables the drive (by issuing the DRV.DIS command). After the fault is cleared, you must then enable the drive again (by issuing the DRV.EN command). In the fourth method, clearing the fault does not automatically disable the drive. Once the fault is cleared, the drive will immediately become enabled again when no fault conditions exist.

1. Using the WorkBench toolbar. Click the **Clear Fault** button to clear the fault, then click the **Enable** button to enable the drive again.

2. Using an ASCII command. In WorkBench terminal screen, enter DRV.CLRFAULTS, then enter DRV.EN to enable the drive.
3. Using the CANopen interface (Object 6040h: Controlword DS402). The ASCII control commands are built up from the logical combination of the bits in the control word and external signals (enable output stage). You can configure the **Reset Fault** bits in the control word to clear the fault. See Table x in the CANopen manual for details on clearing faults using this method. After the fault is cleared, you must enable the drive.
4. Using an external digital signal. First, provide a disable command to the drive, since this command is not automatically issued when the fault is cleared using an external digital signal. You must provide this disable command after the drive has disabled itself and before the clear fault command is issued in order for the clear fault command to be accepted.

Digital input mode 1 clears a fault condition. In the WorkBench terminal screen, enter DINx.MODE 1, with x set to the corresponding digital input number. Table x in the Installation Manual includes digital input numbers and corresponding pin connections.

Example:

DIN2.MODE 13 sets digital input 2 (pin 9 on connector X7) to perform the clear fault function. Any free digital input shown in Table x can be set to mode 1 (Reset faults).

17.3 Parameter and Command Error Messages

Error Message	Meaning	Remedy	Occurrence
Error: Parameter or command was not found.	Parameter or command string was not recognized as a known command.	Check the entered string for accuracy. Consult the reference guide or enter DRV.LIST in the WorkBench terminal screen to find valid parameters and commands.	General.
Error: Not a trigger parameter.	Parameter cannot be used for triggering the scope.	Use a different parameter as a trigger value.	Recorder parameters.
Error: Parameter not recordable.	Parameter cannot be scoped.	Do not scope this parameter.	Recorder parameters.
Error: Wrong argument for parameter or command.	Argument was not accepted.	Check the entered argument for accuracy. Consult the reference guide or enter DRV.LIST in the WorkBench terminal screen to find valid parameter and command arguments.	General.
Error: No arguments allowed for parameter or command.	Parameter or command supports no arguments.	Enter parameter or command again with no arguments.	Commands and read-only parameters
Error: Too many arguments for parameter or command.	Too many arguments provided for this parameter or command.	Enter again with fewer arguments.	All parameters and commands with no or one argument.
Error: No float allowed.	Float number was entered, but only integer numbers are allowed.	Enter integer value instead.	All parameters and commands with integer arguments.
Error: Parameter or command is read-only.	Argument was not accepted because the parameter or command is read-only.	Enter again with no arguments.	Commands and all read-only parameters.
Error: Parameter is temporarily write protected.	Argument was not accepted because the parameter is currently read-only.	Check reference guide or WorkBench help to determine if the parameter is read-only, read-write, or nonvolatile.	Some parameters that come from the Smart Feedback Device (SFD).
Error: Argument greater than maximum value.	Entered argument was beyond maximum value.	Enter a value that is within the allowable range. See reference guide or WorkBench help for ranges.	Commands and read-write parameters.
Error: Too many characters in parameter or command.	Parameter or command string was too long.	Shorten string and enter again.	General.
Error: Argument less than minimum value.	Entered argument was too small.	Enter value that is within the limits.	Commands and read-write parameters.
Error: Argument is out of data range.	Entered argument was not withing the data range limits.	Enter value that is within the limits.	Commands and read-write parameters.
Error: Parameter or command is password protected.	Use of this parameter or command requires a password.	Contact technical support to obtain password. Enter valid password.	Password protected parameters and commands.

Error Message	Meaning	Remedy	Occurrence
Error: Wrong operation mode for parameter or command.	Requested parameter or command cannot be performed in this operation mode.	Change to valid operation mode.	
Error: Drive enabled. Disable drive and continue.	Action can only be performed if drive is disabled.	Disable drive and repeat action.	
Error: Drive disabled. Enable drive and continue.	Action can only be performed if drive is enabled.	Enable drive and repeat action.	
Error: Data value is invalid.	Entered data was not valid.	Provide valid data.	
Error: Argument must be an even number.	Argument is not an even number.	Enter a value divisible by two without remainder.	
Error: Argument must be an odd number.	Argument must be an odd number.	Enter a value not divisible by two with remainder.	
Error: Axis is not homed.	Axis is not homed.	Home axis and repeat action.	
Error: All recorder channels empty.	No data is specified to record.	Specify the data to be recorded and start again.	Recorder commands.
Error: Process already active.	Required action is already running.	Wait until action is finished and start again if needed.	
Error: Motor is currently in motion.	Action can only be performed if motor is not moving.	Stop motion and repeat action.	Motion tasks, service motion, and others.
Error: EEPROM is bad or does not exist.	EEPROM is damaged.	Restart drive. If fault persists, replace the drive and consult technical support.	
Error: Unknown board.			
Error: Fault exists.Correct fault condition and then clear faults.	A fault is present in the system.	Clear the fault, disable the drive, and then enable the drive again.	
Error: Cannot clear faults. Issue software or hardware disable first.		Clear hardware or software enable and repeat action.	
Error: EEPROM is busy.			
Error: Invalid motor/feedback poles ratio.			
Error: Unknown Fault.	Situation should not happen.	Clear fault. If fault recurs, consult technical support.	Unknown.
Error: Invalid motor/feedback poles ratio.			
Error: Invalid motion task parameter.			
Error: Invalid motion task number.			

Error Message	Meaning	Remedy	Occurrence
Error: Invalid motion task velocity.			
Error: Invalid motion task acceleration or deceleration.			
Error: Invalid motion task customer profile table number.			
Error: Invalid motion task following number.			
Error: Function not available for the active command source.			
Error: Invalid Bode plot mode for this function.			
Error: Invalid sine-sweep Bode plot mode.			
Error: Bode plot start frequency greater than or equal to end frequency.			
Error: Function not available while a controlled stop is in process.			
Error: Not enough memory available.			
Error: Function not available while a Bode-plot measurement is active.			
Error: Iu/Iv offset calculation not finished.			
Error: Buffer overflow.			
Error: Cannot save to EEPROM while inrush relay is closed.			
Error: Test mode is off.			
Error: Cannot change digital input mode. Issue software or hardware disable first.			
Error: Internal drive procedure active: controlled stop, burn-in, phase find, or zero.			
Error: General motion fault.			

17.4 CANopen Emergency Messages and Error Codes

Emergency messages are triggered by internal equipment errors. They have a high ID-priority to ensure quick access to the bus. An emergency message contains an error field with pre-defined error/fault numbers (2 bytes), an error register (1byte), the error category (1 byte), and additional information.
Error numbers from 0000h to 7FFFh are defined in the communication or drive profile. Error numbers from FF00h to FFFFh have manufacturer-specific definitions. The following table describes the various error codes:

Error Code	Fault/Warning Code	Description
0x0000	0	Emergency error free
0x3110	523	Bus over voltage
0x3120	-	Bus under voltage
0x3130	503	Phase failure
0x3180	503	Warning: Supply missing phase
0x3210	501	DC link over-voltage
0x3220	502	DC link under-voltage
0x4210	234	Excess temperature, device (control board)
0x4310	235	Excess temperature, drive (heat sink)
0x5113	512	Supply low voltage, U3 = supply +5 V
0x5114	505	Supply low voltage, manufacturer specific: supply 1V2
0x5115	507	Supply low voltage, manufacturer specific: supply 2V5
0x5116	509	Supply low voltage, manufacturer specific: supply 3V3
0x5117	514	Supply low voltage, manufacturer specific: supply 12 V
0x5118	516	Supply low voltage, manufacturer specific: supply -12V
0x5119	518	Supply low voltage, manufacturer specific:supply 3V3 analogue
0x5180	504	Supply overvoltage, manufacturer specific:supply 1V2
0x5181	506	Supply overvoltage, manufacturer specific:supply 2V5
0x5182	508	Supply overvoltage, manufacturer specific:supply 3V3
0x5183	510	Supply overvoltage, manufacturer specific:supply 5V0
0x5184	513	Supply overvoltage, manufacturer specific:supply 12 V
0x5185	104	Supply overvoltage, manufacturer specific:supply -12V
0x5186	517	Supply overvoltage, manufacturer specific:supply 3V3 analogue
0x5510	201	Hardware memory, RAM
0x5530	105	Hardware memory, EEPROM
0x5580	106	Hardware memory, non-volatile memory data
0x5581	202	Hardware memory, external Ram for resident firmware failed
0x5582	203	Hardware memory, code integrity failed for resident firmware
0x5583	102	Hardware memory, resident firmware failed
0x5584	103	Hardware memory, resident FPGA failed
0x5585	104	Hardware memory, operational FPGA failed
0x7180	301	Motor overheat
0x7182	305	Motor open circuit
0x7183	306	Motor short circuit
0x7184	307	Motor brake closed
0x7303	426	Resolver 1 fault
0x7305	417	Incremental sensor 1 fault
0x7380	402	Feedback 1, analogue fault
0x7381	403	Feedback 1, EnDat communication fault
0x7382	404	Feedback 1, illegal hall
0x7383	405	Feedback 1, BiSS watchdog

Error Code	Fault/Warning Code	Description
0x7384	406	Feedback 1, BiSS multi cycle
0x7385	407	Feedback 1, BiSS sensor
0x7386	408	Feedback 1. SFD configuration
0x7387	409	Feedback 1, SFD UART overrun
0x7388	410	Feedback 1, SFD UART frame
0x7389	412	Feedback 1, SFD UART parity
0x738A	413	Feedback 1. SFD transfer timeout
0x738C	415	Feedback 1, SFD mult. corrupt position
0x738D	416	Feedback 1, SFD Transfer incomplete
0x738E	418	Feedback 1, power supply fault
0x738F	401	Feedback 1, failed to set feedback
0x73A0	424	Feedback 2, resolver amplitude low
0x73A1	425	Feedback 2, resolver amplitude high
0x73A2	425	Feedback 2, resolver fault
0x73A3	427	Feedback 2, analogue low
0x73A4	428	Feedback 2, analogue high
0x73A5	429	Feedback 2, incremental low
0x73A6	430	Feedback 2, incremental high
0x73A7	431	Feedback 2, halls
0x73A8	432	Feedback 2, communication
0x73A9	-	Reserved
0x73AA	-	Reserved
0x8130	129	Life Guard Error or Heartbeat Error
0x8311	304	Excess torque
0x8331	524	Torque fault
0x8480	302	Velocity overspeed
0x8580	107	Software limit switch, positive
0x8581	108	Software limit switch, negative
0x8611	439	Following error
0x8780	125	Fieldbus synchronization lost
0xFF00	701	Fieldbus runtime fault
0xFF01	702	Fieldbus communication lost
0xFF02	529	Iu offset limit exceeded
0xFF03	530	Iv offset limit exceeded
0xFF04	521	Stored energy reached critical point
0xFF05	527	Iu detection stuck
0xFF06	528	Iv detection stuck
0xFF07	525	Control output over current
0xFF08	526	Current sensor short circuit
0xFF09	128	Axis dpoles
0xFF0A	531	Power stage fault
0xFF0B	602	Safe torque off
0xFF10	414	Warning: SFD single corrupted position.
0x8380	524	Warning: Drive foldback
0x8387	304	Warning: Motor foldback
0xFF13	438	Warning: Control position deviation
0x8582	107	Warning: Positive software position limit is exceeded.
0x8583	108	Warning: Negative software position limit is exceeded.

Error Code	Fault/Warning Code	Description
0x8684	123	Warning: Motion global warning
0x7786	301	Warning: Motor overheated.
0x4380	234	Warning: Control temperature sensor 1 high
0x4387	235	Warning: Power temperature sensor 1 high.
0x4382	236	Warning: Power temperature sensor 2 high.
0x4393	237	Warning: Power temperature sensor 3 high.
0x4394	240	Warning: Control temperature sensor 1 low.
0x4385	241	Warning: Control temperature sensor 1 low.
0x4396	242	Warning: Power temperature sensor 2 low.
0x4392	243	Warning: Power temperature sensor 3 low.
0x3280	502	Warning: Bus under voltage.
0x3780	503	Warning: Input phase loss.
0x3287	521	Warning: Dynamic Braking I^2T.
0x8787	125	Warning: Fieldbus PLL unlocked.

17.5 Unknown Fault

This fault message occurs when an undefined fault condition is encountered.

17.5.0.1 Remedies

1. Click **Clear Fault**.

18 Troubleshooting the AKD

Faults occur for a variety of reasons, depending on the conditions in your installation. The causes of faults in multi-axis systems can be especially complex. If you cannot resolve a fault using the troubleshooting guidance presented below, customer support can give you further assistance.

Fault	Possible Causes	Remedy
HMI message: Communication fault	— wrong cable used — cable plugged into wrong position on servo amplifier or PC — wrong PC interface selected	— plug cable into the correct sockets on the servo amplifier and PC — select correct interface
Motor does not rotate	— servo amplifier not enabled — software enable not set — break in setpoint cable — motor phases swapped — brake not released — drive is mechanically blocked — motor pole no. set incorrectly — feedback set up incorrectly	— apply ENABLE signal — set software enable — check setpoint cable — correct motor phase sequence — check brake control — check mechanism — set motor pole no. — set up feedback correctly
Motor oscillates	— gain is too high (speed controller) — feedback cable shielding broken — AGND not wired up	— reduce VL.KP (speed controller) — replace feedback cable — join AGND to CNC-GND
Drive reports following error	— Irms or Ipeak set too low —current or velocity limits apply — accel/decel ramp is too long	—verify motor/drive sizing —verify that IL.LIMITN, IL.LIMITP, VL.LIMITN, or VL.LIMITP is not limiting the drive —reduce DRV.ACC/DRV.DEC
Motor overheating	— motor operating above its rating	—verify motor/drive sizing —verify motor continuous and peak current values are set correctly
Drive too soft	—Kp (speed controller) too low —Ki (speed controller) too low —filters set too high	—increase VL.KP (speed controller) —increase VL.KI (speed controller) —refer to documentation regarding reducing filtering (VL.AR*)
Drive runs roughly	—Kp (speed controller) too high —Ki (speed controller) too high — filters set too low	—reduce VL.KP (speed controller) —reduce VL.KI (speed controller) —refer to documentation regarding increasing filtering (VL.AR*)

19 Firmware and Firmware Updates

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19.1 Downloading Firmware

To download firmware, click **More** on the **Overview** screen (see 6.2 AKD Overview). The information displayed includes the current firmware version. Click **Download Firmware** to display the **Download Firmware** view and update the firmware.

When you download the firmware, you may see a **Save** dialog box; see 13.4 Save On Firmware Download for more information about saving your drive configuration prior to a firmware download.

During the download , you cannot perform any actions with the drive.

CAUTION	While WorkBench is downloading firmware to your drive, do not remove the 24 V logic power. If you remove the 24 V logic power during a firmware download, a severe drive crash can occur. If a crash occurs, the drive will restart in a special mode and WorkBench will prompt you to reload the firmware.

During the firmware download, the Download Firmware view displays a progress bar and the following messages as the download proceeds:

1. **Reading the firmware file**. This step duration depends on where the file is physically stored.
2. **Resetting the drive**. This step takes about 10 seconds.
3. **Erasing the old firmware**. This step takes about 20 seconds.
4. **Downloading the new firmware to the drive**. The drive downloads the new firmware and then programs the new firmware into the nonvolatile memory of the drive. This step takes about 20 seconds.
5. **Resetting the drive**. This step takes about 10 seconds.

During the download process, the drive LED displays [dL]. Additional codes may appear during the download; see 3.2 Display Codes for a description of display codes related to a firmware download.

19.2 Firmware Compatibility

WorkBench is compatible with all previous drive firmware versions. Any new WorkBench versions issued are compatible with older firmware versions. WorkBench forward compatibility, however, cannot be ensured. When a behavior in the firmware changes, an older WorkBench version may not function correctly with the new firmware. Kollmorgen recommends that you update WorkBench when you install new firmware.

The table below describes compatibility between WorkBench and firmware versions:

	Firmware version M_01-01-00-zzz	Firmware version M_01-02-00-zzz
WorkBench Version 1.1.x.x	√	x
WorkBench Version 1.2.x.x	√	√

Any new firmware not listed here may have compatibility issues with WorkBench. Please check for latest version of WorkBench on the Kollmorgen website:

http://www.kollmorgen.com/akd_software

19.3 Invalid Firmware

When WorkBench connects to a drive, it checks to make sure that the drive is executing a compatible version of the drive firmware. If the drive is executing invalid firmware, then WorkBench cannot operate correctly and shows this window.

Button	Description
Download	This command allows you to select a different version of the firmware and download it to the drive.

Button	Description
Disconnect	This command stops all communications with the drive and return to the disconnected state.

19.4 Forcing the drive into firmware download mode

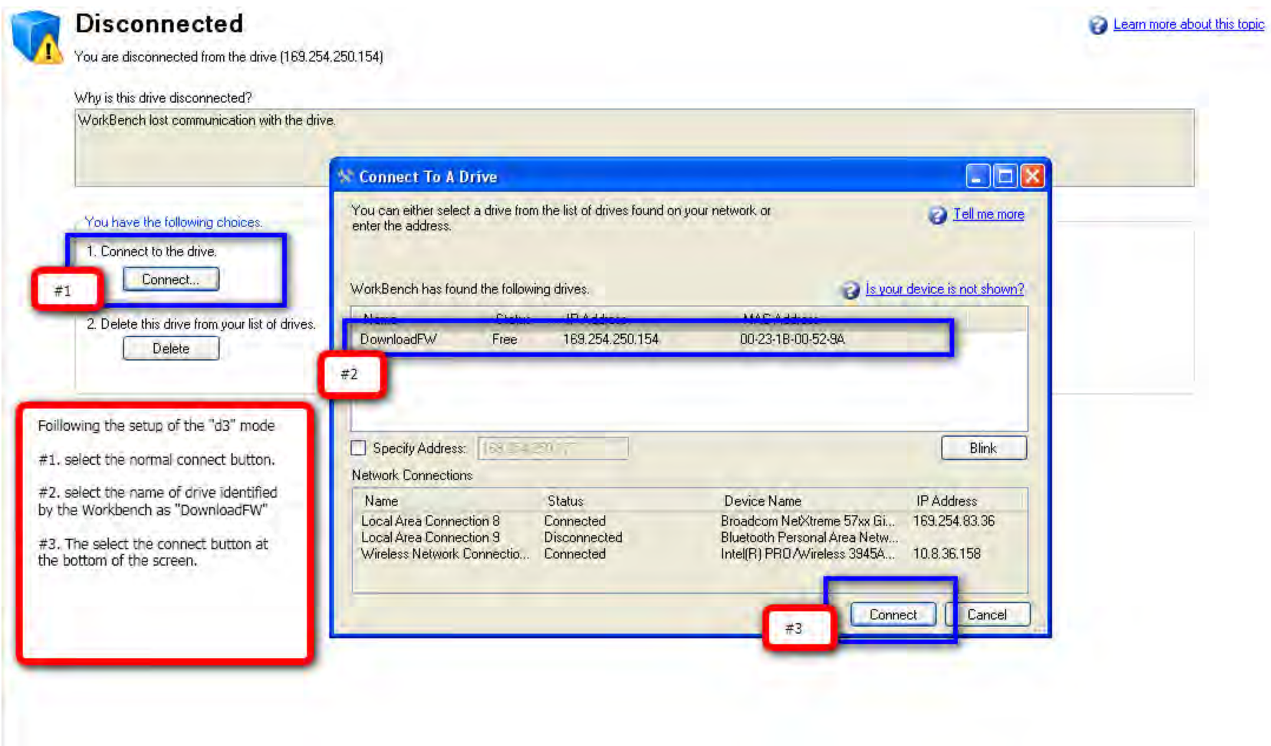
19.5 Forced download of AKD firmware.

In most cases, you can download firmware using the WorkBench without setting the hardware into a specific download state. If you are unable to connect to WorkBench for some reason, the following “forced firmware download” procedure is needed.

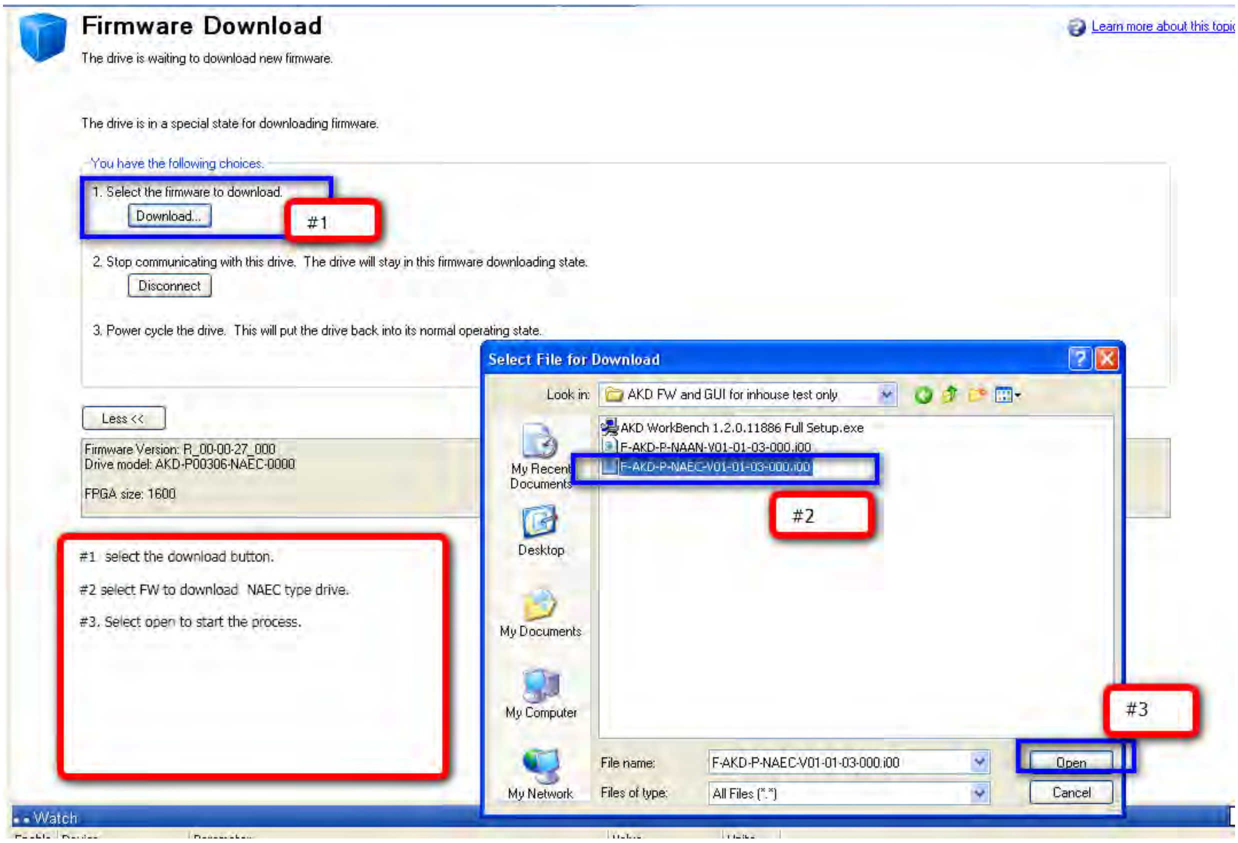
Power the AKD unit down then:

1. Depress the B1 button (display of IP Address Button) while powering up the drive. Continue to depress the button until the drive display shows "d3 " (5-10 sec).
2. Once the display on the drive shows "d3" , have the EtherNet cable connected to the drive Point to Point.
3. The drive can now be connected to WorkBench in download mode.
4. Select the firmware to be downloaded; click **Open** to start the process.

WorkBench will display the **Disconnected** view. See the screenshots below for the download connection sequence.



The **Firmware Download** view appears next. See the screenshot below for the firmware selection and download sequence.



3.Next, the **Downloading Firmware** view appears and the progress bar displays the firmware download progress.

4. Once the download is complete, open the **AKD Overview** screen. The **Firmware Version** box displays the new firmware version, which confirms your successful download.

Connection Diagrams

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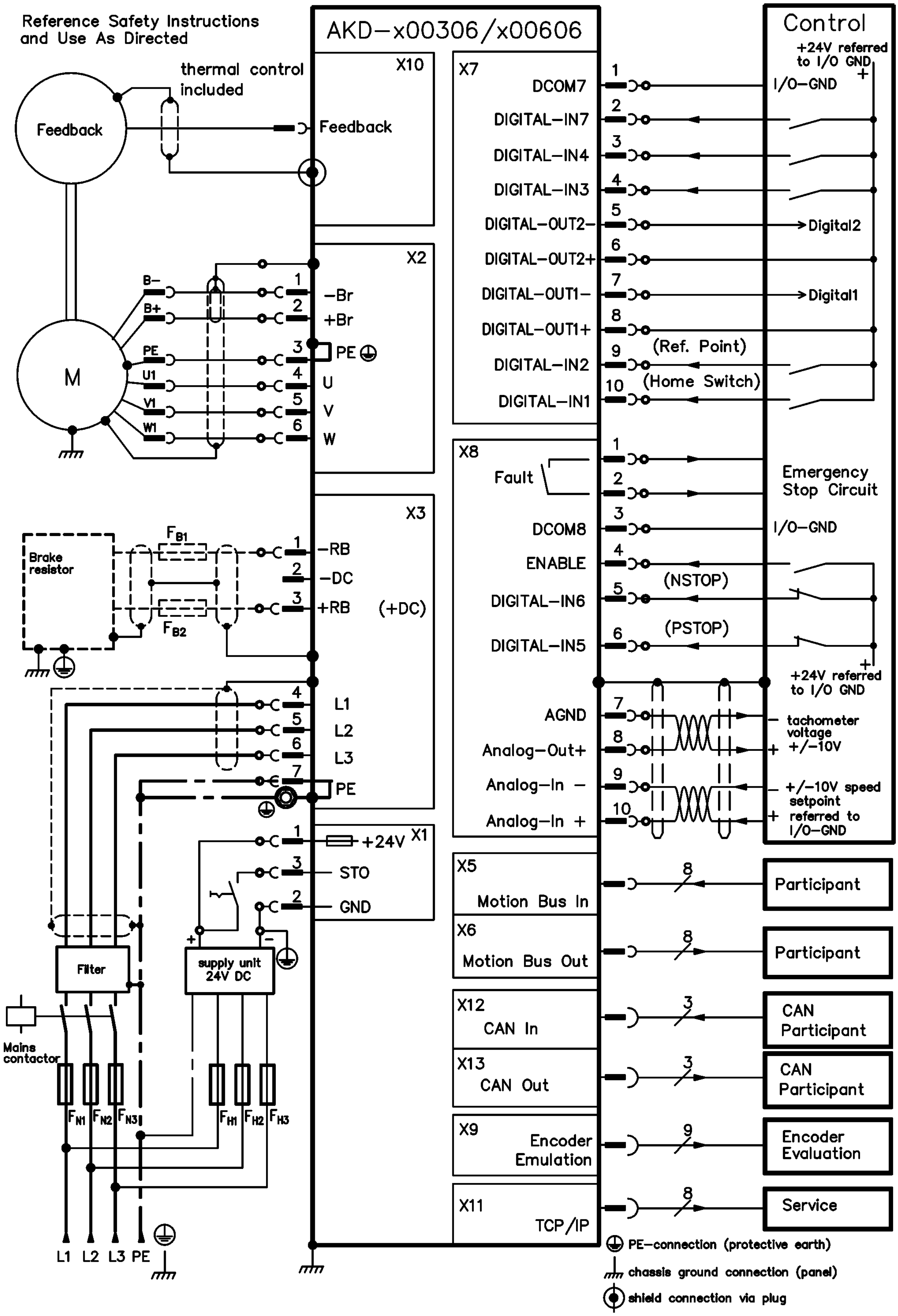
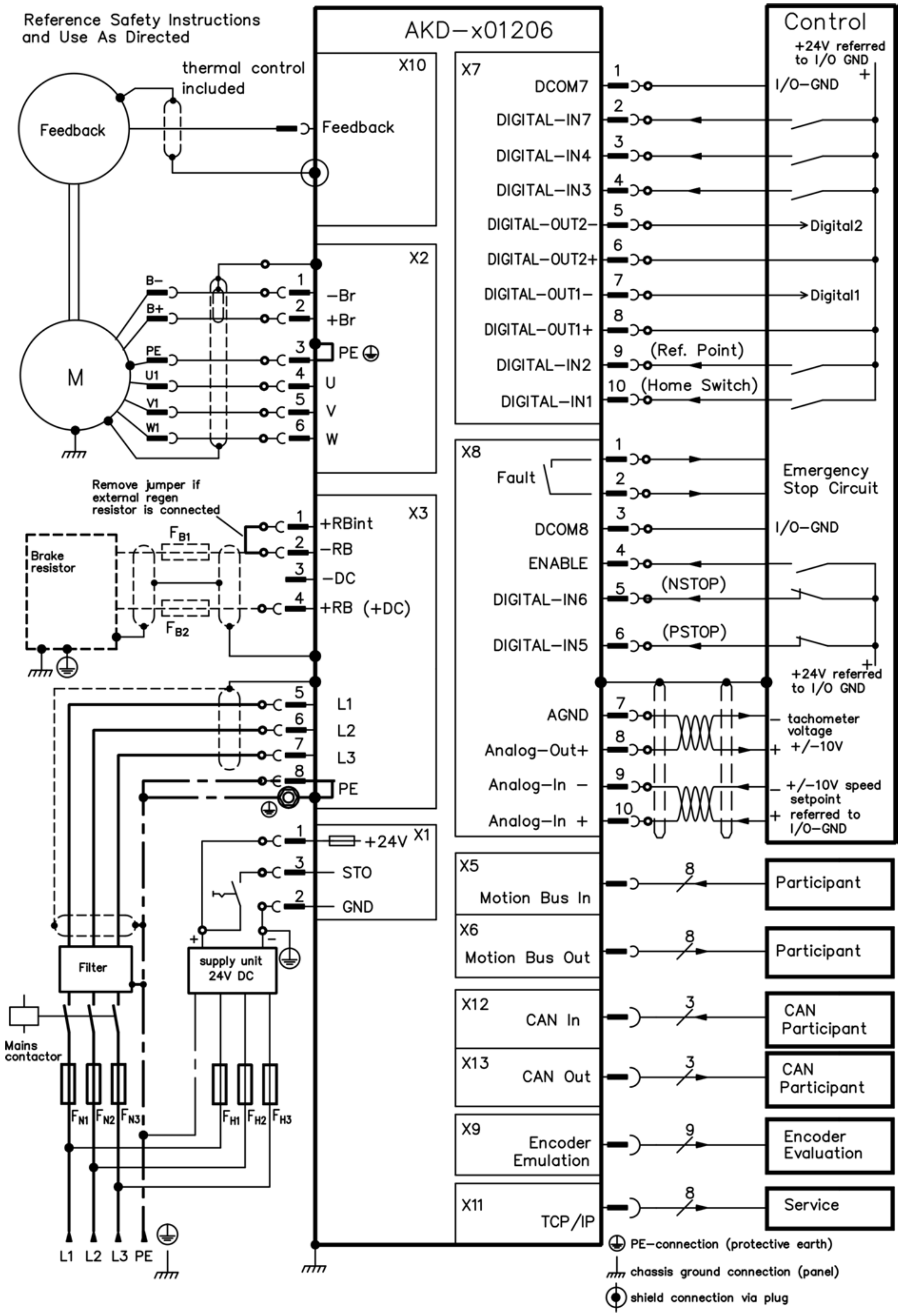
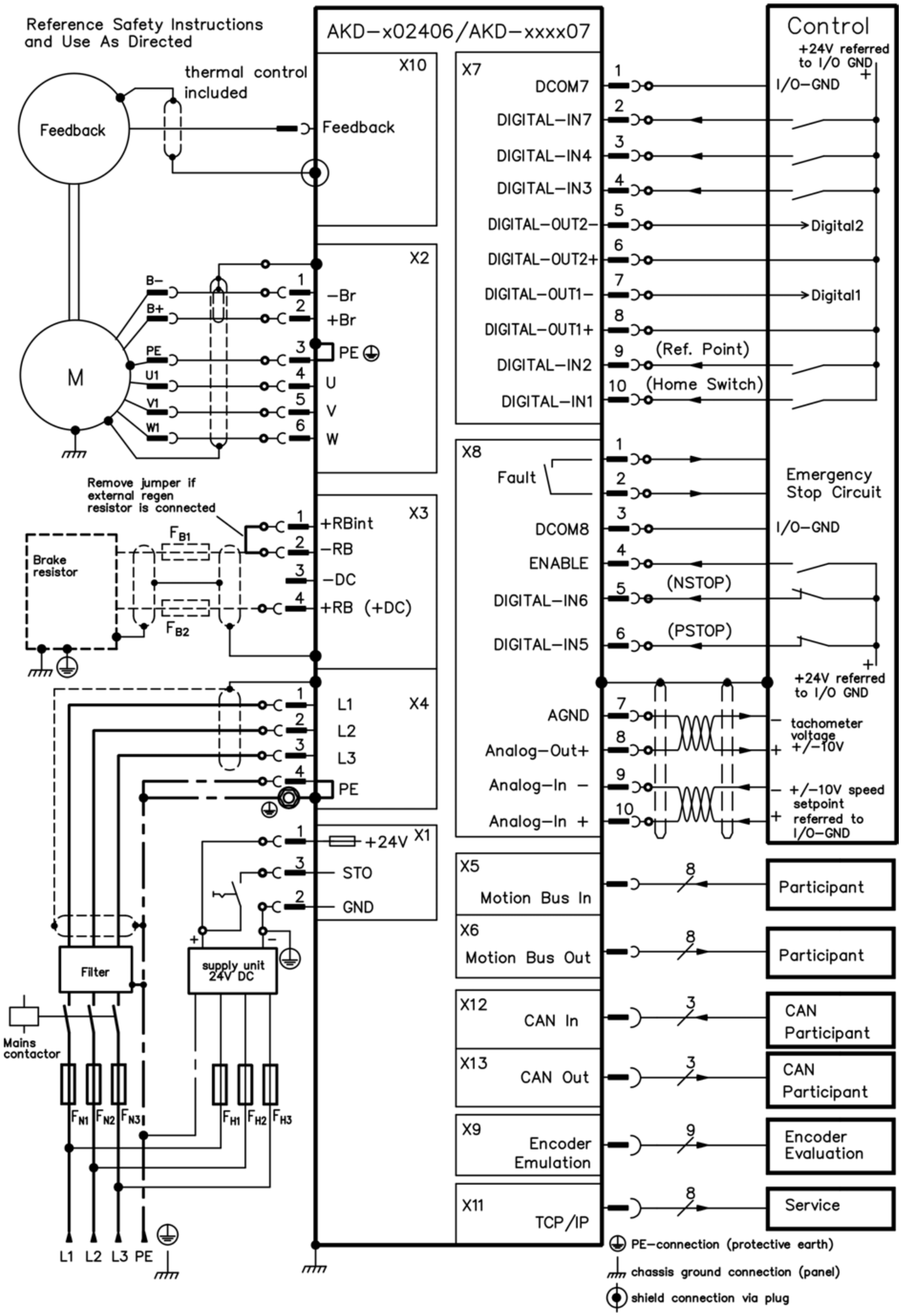
19.6 Connection Diagram, AKD-x00306 to x00606



19.7 Connection Diagram, AKD-x01206



19.8 Connection Diagram, AKD-x02406 and AKD-xzzz07



19.9 24 V Auxiliary Supply (X1)

The following diagram describes external 24 Vdc power supply, electrically isolated, for example, via an isolating transformer. The required current rating depends on the use of motor brake and option card (see page 1 or following).

Pin	Signal	Description
1	+24	+24 Vdc Auxiliary voltage
2	GND	24V Supply GND
3	STO	STO enable (Safe Torque Off)

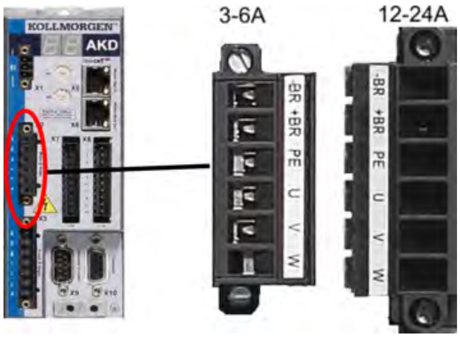
19.10 Motor Connection

Together with the motor supply cable and motor winding, the power output of the drive forms an oscillating circuit. Characteristics such as cable capacity, cable length, motor inductance, and frequency ("Electrical Data - xzzz06" (=> p. 1) or "Electrical Data -xzzz07" (=> p. 1)) determine the maximum voltage in the system.

NOTICE **The dynamic voltage rise can lead to a reduction in the motor operating life and, on unsuitable motors, to flashovers in the motor winding.**

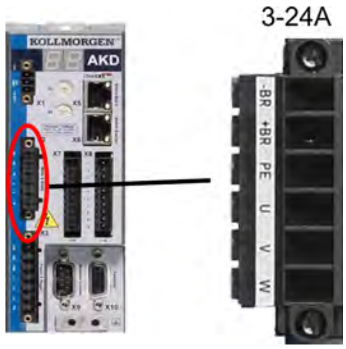
- **Only install motors with insulation class F (acc. to IEC60085) or above.**
- **Only install cables that meet the requirements (see "Wiring" on page 1).**

Connector X2 AKD-xzzz06



Pin	Signal	Description
1	-BR	Motor holding brake, negative
2	+BR	Motor holding brake, positive
3	PE	Protective earth (motor housing)
4	U	Motor phase U
5	V	Motor phase V
6	W	Motor phase W

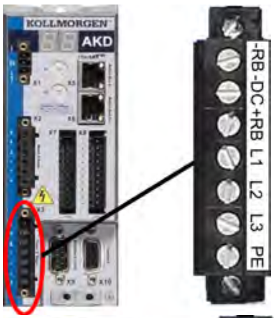
Connector X2 AKD-xzzz07



Pin	Signal	Description
1	-BR	Motor holding brake, negative
2	+BR	Motor holding brake, positive
3	PE	Protective earth (motor housing)
4	U	Motor phase U
5	V	Motor phase V
6	W	Motor phase W

19.11 External Brake Resistor (X3)

For technical data on the brake circuit "Dynamic Braking" (=> p. 1). Fusing (such as fusible cut-outs) to be provided by the user see page 1.



AKD-x00306 to AKD-x00606 (X3)		
Pin	Signal	Description
1	-RB	External Brake Resistor negative
3	+RB	External Brake Resistor positive

AKD-x01206 (X3)		
Pin	Signal	Description
1	+Rbint	Internal Brake Resistor positive
2	-RB	External Brake Resistor negative
4	+RB	External Brake Resistor positive

AKD-x02406 & AKD-xzzz07 (X3)		
Pin	Signal	Description
2	-RB	External Brake Resistor negative
4	+RB	External Brake Resistor positive

19.12 DC Bus Link (X3)

The DC bus link can be connected in parallel so that the brake power is divided between all the drives that are connected to the same DC bus link circuit.

Every drive must have it's own power connection to mains voltage, even if the DC bus link is used.

NOTICE	**The drive can be destroyed if DC bus link voltages are different. Only drives with mains supply from the same mains (identical mains supply voltage) may be connected by the DC bus link. Use unshielded single cores (cross section see page 1) with a maximum length of 200 mm. Use shielded cables for longer lengths.**

AKD-x00306 to AKD-x00606 (X3)		
Pin	Signal	Description
2	-DC	DC-Link Bus negative
3	+DC (+RB)	DC-Link Bus positive

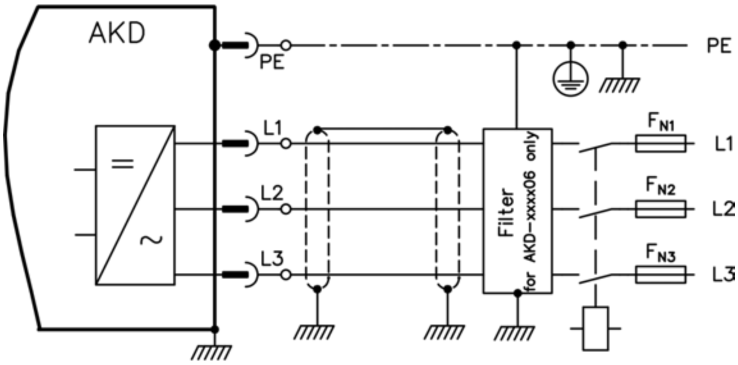
AKD-x01206 (X3)		
Pin	Signal	Description
3	-DC	DC-Link Bus negative
4	+DC (+RB)	DC-Link Bus positive

AKD-x02406 & AKD-xzzz07 (X3)		
Pin	Signal	Description
3	-DC	DC-Link Bus negative
4	+DC (+RB)	DC-Link Bus positive

19.13 Mains Supply Connection (X3, X4)

19.13.1 Three Phase connection (all AKD types)

- Directly to 3-phase supply network, supply networks see page 1
- Filtering for AKD-xzzz06 to be provided by the user.
- Fusing (such as fusible cut-outs) to be provided by the user see page 1.



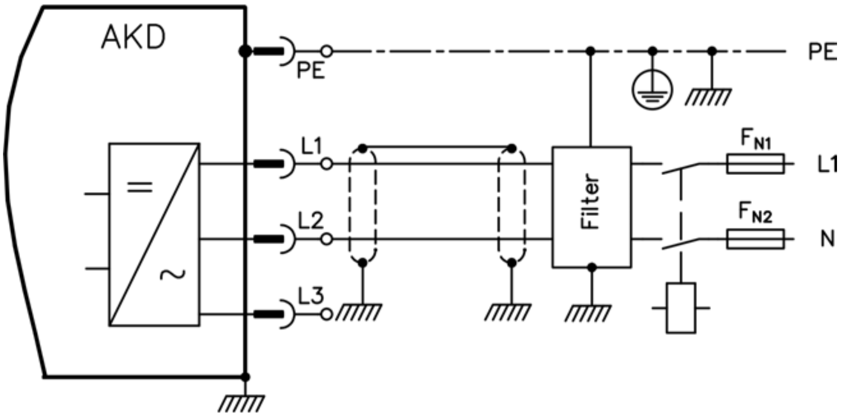
AKD-x00306 to AKD-x00606 (X3)		
Pin	Signal	Description
4	L1	Line 1
5	L2	Line 2
6	L3	Line 3
7	PE	Protective Earth

AKD-x01206 (X3)		
Pin	Signal	Description
5	L1	Line 1
6	L2	Line 2
7	L3	Line 3
8	PE	Protective Earth

AKD-x02406 & AKD-xzzz07 (X4)		
Pin	Signal	Description
1	L1	Line 1
2	L2	Line 2
3	L3	Line 3
4	PE	Protective Earth

19.13.2 Single phase connection (AKD-xzzz06 only)

- Directly to single-phase supply network (1 x 120 V$_{-10\%}$ to 1 x 240 V$^{+10\%}$)
- Supply networks see page 1
- Leave L3 open circuit
- Filtering to be provided by the user.
- Fusing (such as fusible cut-outs) to be provided by the user see page 1.

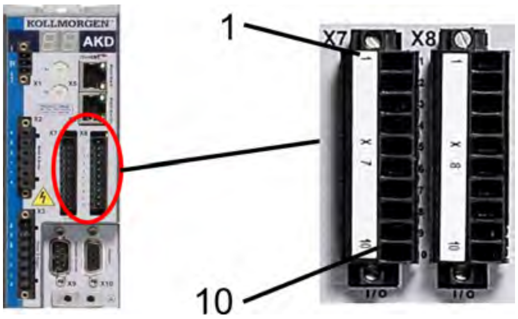


AKD-x00306 to AKD-x00606 (X3)		
Pin	Signal	Description
4	L1	Line 1
5	L2 (N)	Neutral
7	PE	Protective Earth

AKD-x01206 (X3)		
Pin	Signal	Description
5	L1	Line 1
6	L2 (N)	Neutral
8	PE	Protective Earth

19.14 I/O Connection

All standard digital and analog I/O signals are connected to X7 and X8.



19.14.1 I/O Connectors (X7 and X8)

Conn.	Pin	Signal	**Abbreviation**	Recommended Function	Specials
X7	1	Digital Common X7	DCOM7	Common line for X7 pins 2, 3, 4, 9, 10	N/A
X7	2	Digital Input 7	DIGITAL-IN 7	Programmable	N/A
X7	3	Digital Input 4	DIGITAL-IN 4	Programmable	N/A
X7	4	Digital Input 3	DIGITAL-IN 3	Programmable	N/A
X7	5	Digital Output 2-	DIGITAL-OUT2-	Programmable	N/A
X7	6	Digital Output 2+	DIGITAL-OUT2+	Programmable	N/A
X7	7	Digital Output 1-	DIGITAL-OUT1-	Programmable	N/A
X7	8	Digital Output 1+	DIGITAL-OUT1+	Programmable	N/A
X7	9	Digital Input 2	DIGITAL-IN 2	Reference point	high speed
X7	10	Digital Input 1	DIGITAL-IN 1	Home switch	high speed
X8	1	Fault Relay Output	Fault Relay Output	N/A	N/A
X8	2	Fault Relay Output	Fault Relay Output	N/A	N/A
X8	3	Digital Common X8	DCOM8	Common line for X8 pins 4, 5, 6	N/A
X8	4	Digital Input 8	DIGITAL-IN 8	Output stage enable	not programmable
X8	5	Digital Input 6	DIGITAL-IN 6	Negative limit switch	N/A
X8	6	Digital Input 5	DIGITAL-IN 5	Positive limit switch	N/A
X8	7	Analog Ground	AGND	Analog GND	N/A
X8	8	Analog Output +	Analog-Out	Actual velocity voltage	N/A
X8	9	Analog Input -	Analog-In-	Velocity set point	N/A
X8	10	Analog Input +	Analog-In+		N/A

Digital common lines for X7 and X8 are not common to each other.
The DCOMx line should be connected to the 0V of the I/O supply when using sensors of type "Source" with digital inputs.
The DCOMx line should be connected to the 24V of the I/O supply when using sensors of type "Sink" with digital inputs.

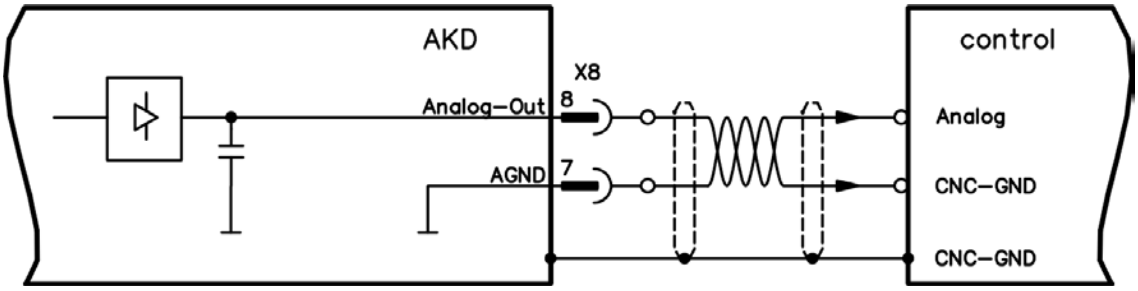
19.15 Analog Output (X8)

Terminals X8/7-8 can be used to output converted analog values of digital measurements recorded in the drive. A list of the pre-programmed functions is included in the WorkBench setup software.

Technical characteristics

- Differential-output voltage max:. ± 10 V
- Resolution: 16 Bit
- Accuracy: < 0.05 V
- Output impedance: < 10 ohms
- Specification complies with IEC 61131-2 Table 11
- Frequency response: 4 kHz
- Maximum output current: > 10 mA
- Maximum capacitive load: 10 nF
- Current protected

Analog Output Wiring Diagram



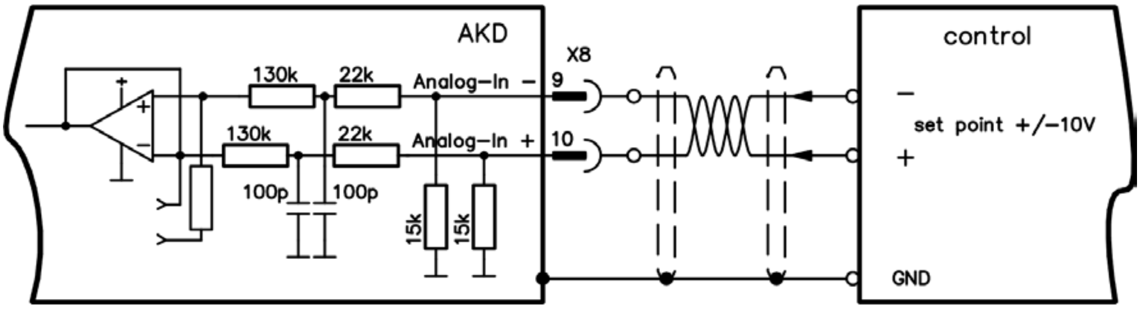
19.16 Analog Input (X8)

The drive is fitted with one differential input for analog torque, velocity, or position control.

Technical characteristics

- Differential-input voltage max.: ± 10 V
- Resolution: 16 Bit
- Accuracy: 13 Bit
- Input resistance:30 kohms
- Common-mode voltage range for both inputs: ± 10 V
- Update rate: 25 µs

Analog Input Wiring Diagram



Application examples for set point input Analog-In:

- adjustable external current limit
- reduced-sensitivity input for setting-up/jog operation
- pre-control/override

Defining the direction of rotation

Standard setting: clockwise rotation of the motor shaft (looking at the shaft end) affected by positive voltage between terminal X8/10 (+) and terminal X8/9 (-)

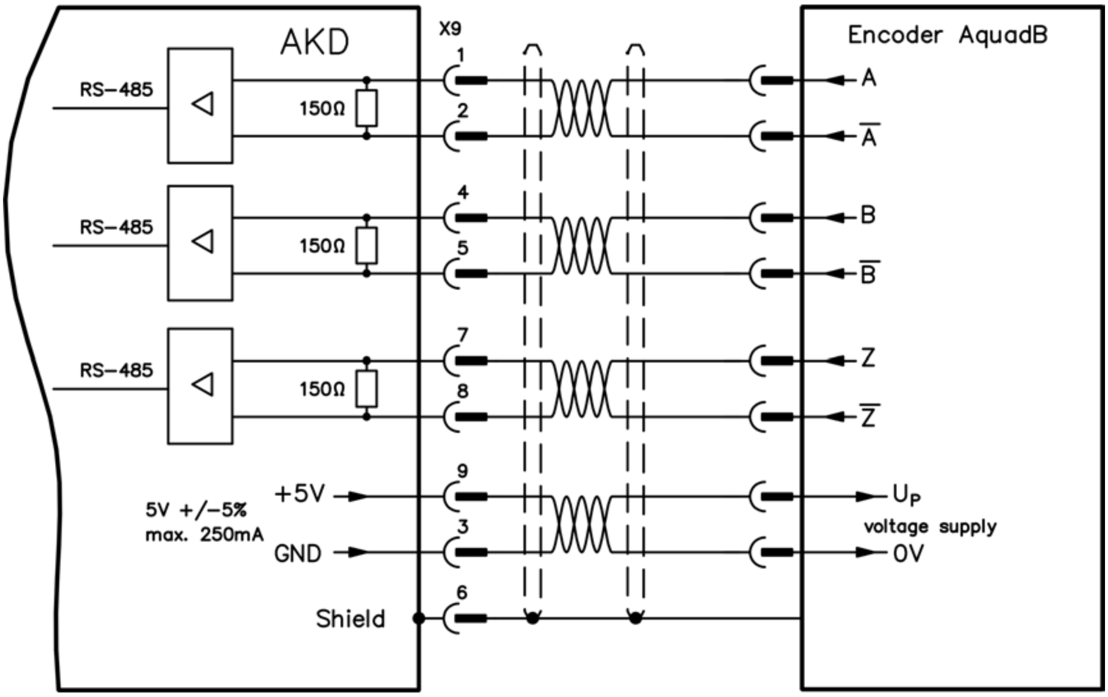
To reverse the direction of rotation, swap the connections to terminals X8/9-10, or change the DRV.DIR parameter in the “Feedback” screen page.

19.17 Command encoder signal connection

19.17.1 Incremental encoder input 5 V (X9)

A 5 V A quad B encoder, or the encoder emulation output of another drive can be connected to this input and used as a commander encoder, dual loop feedback, gearing or camming input. Don't use for primary motor feedback connection!

Connection Diagram



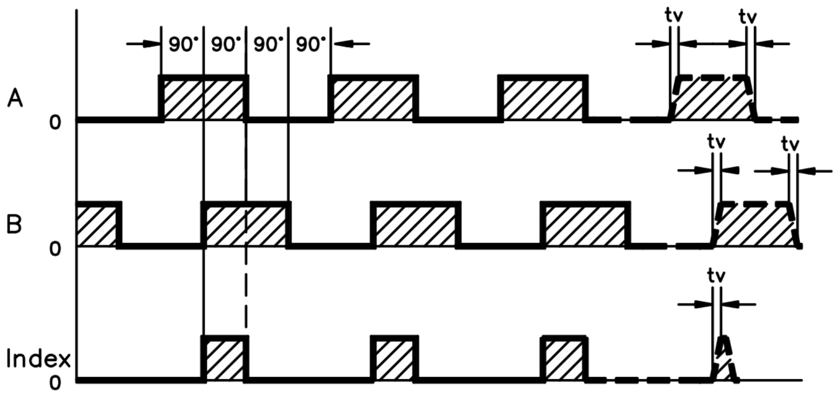
19.17.2 Incremental encoder input 24 V (X7)

A 24 V A quad B encoder can be connected to the digital inputs 1 and 2 and used as a commander encoder, dual loop feedback, gearing or camming input. Don't use for primary motor feedback connection!

Connection Diagram

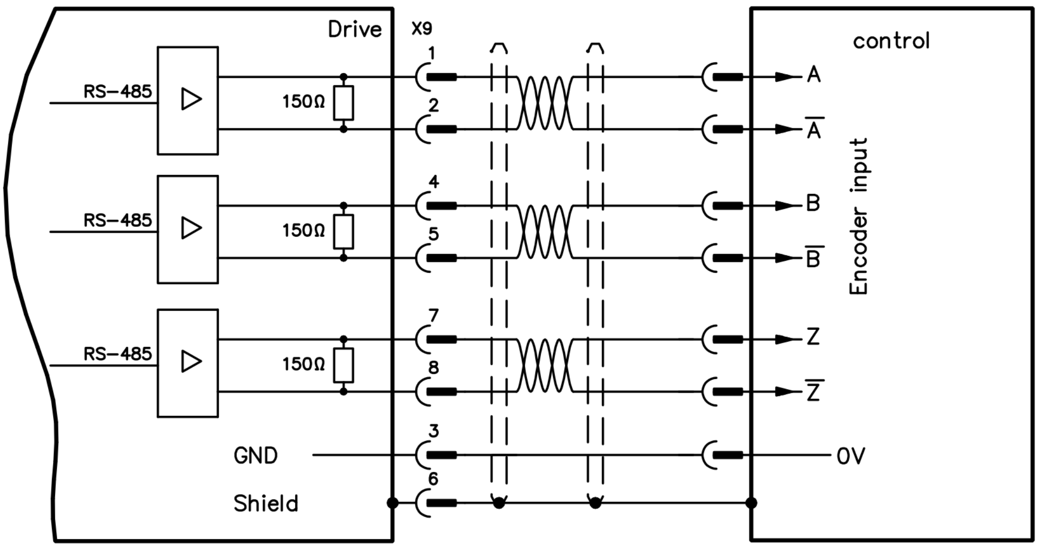
19.17.3 Emulated Encoder Output (EEO) - A quad B (X9)

The drive calculates the motor shaft position from the cyclic- absolute signals of the primary feedback, generating incremental-encoder compatible pulses from this information. Pulse outputs on the SubD connector X9 are 3 signals, A, B and Index, with 90° phase difference (i.e. in quadrature, hence the alternative term “A quad B” output), with a zero pulse.
The resolution (before multiplication) can be set by the DRV.EMUERES parameter. Use the DRV.EMUEZOFFSET parameter to adjust + save the zero pulse position within one mechanical turn. The drivers operate from an internal supply voltage.



tv max. 30ns

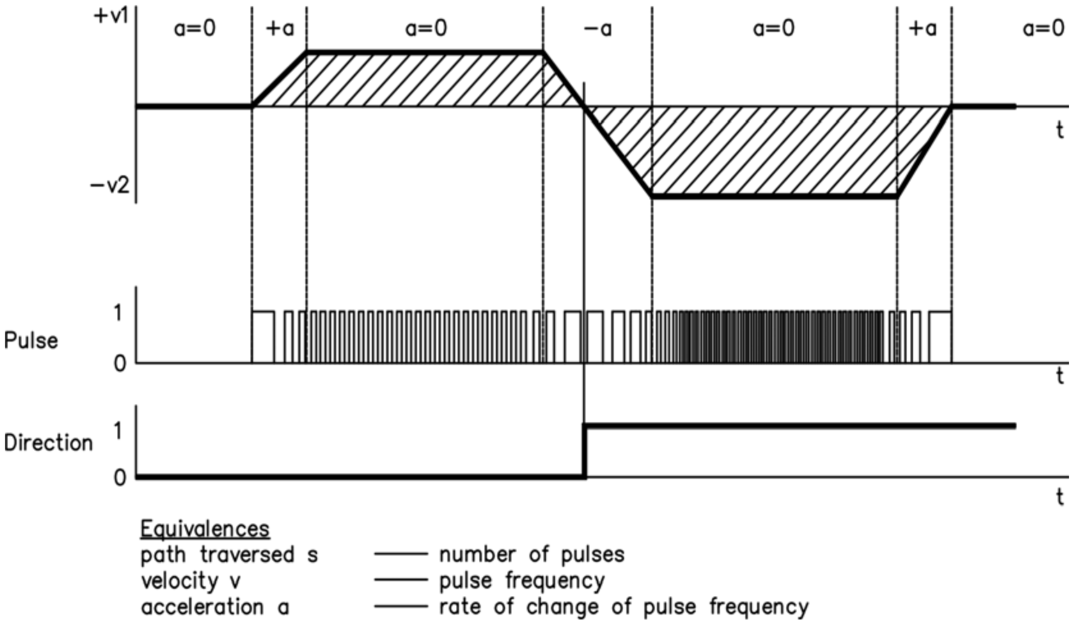
Connection Diagram



19.18 Pulse / Direction signal connection

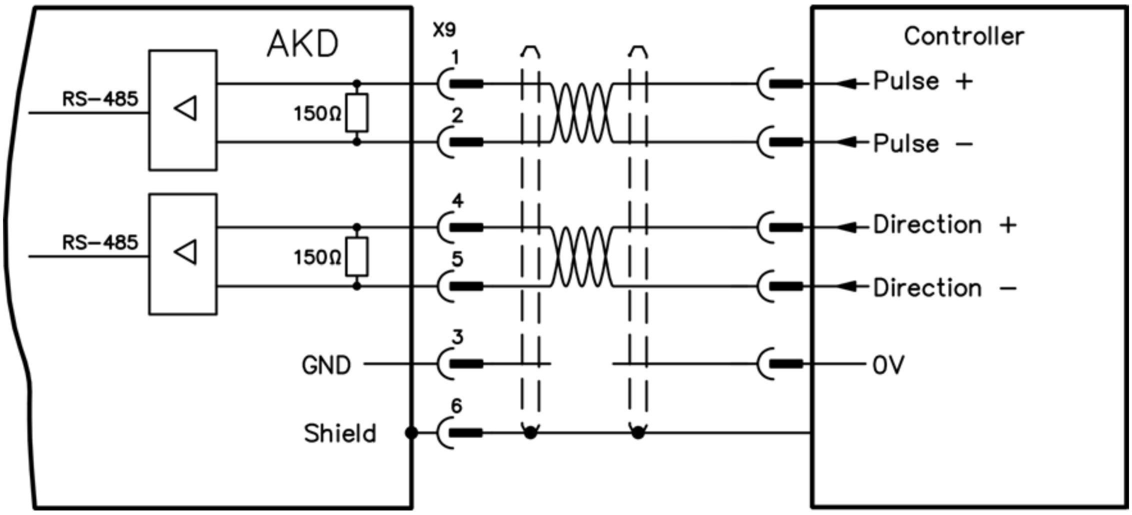
The drive can be connected to a stepper-motor controller. Set parameters for the drive with WorkBench. The number of pulses can be adjusted, so that the drive can be adapted to match any stepper controller.

Speed profile and signal diagram



19.18.1 Pulse / Direction input 5 V (X9)

Connection to 5 V signal level stepper-motor controllers.



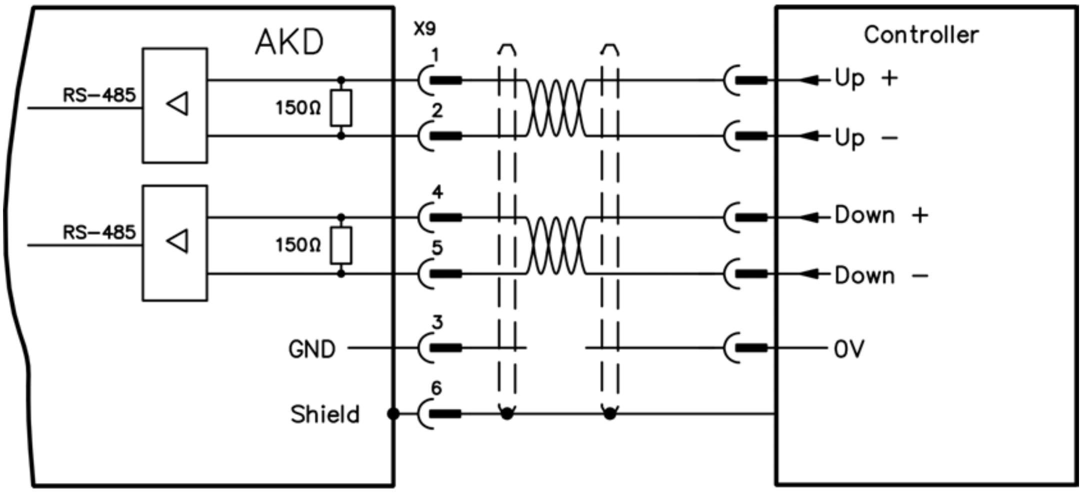
19.18.2 Pulse / Direction input 24 V (X7)

Connection to 24 V signal level stepper-motor controllers.

19.19 Up / Down signal connection

19.19.1 Up / Down input 5 V (X9)

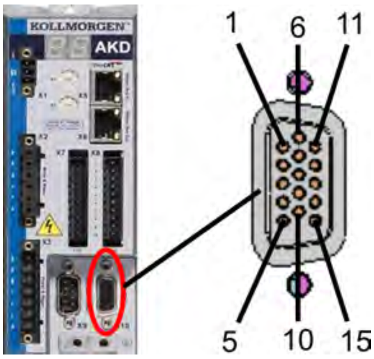
The drive can be connected to a third-party controller which delivers5 V up-down signals



19.19.2 Up / Down input 24 V (X7)

The drive can be connected to a third-party controller which delivers 24 V up-down signals.

19.20 Feedback Connector (X10)

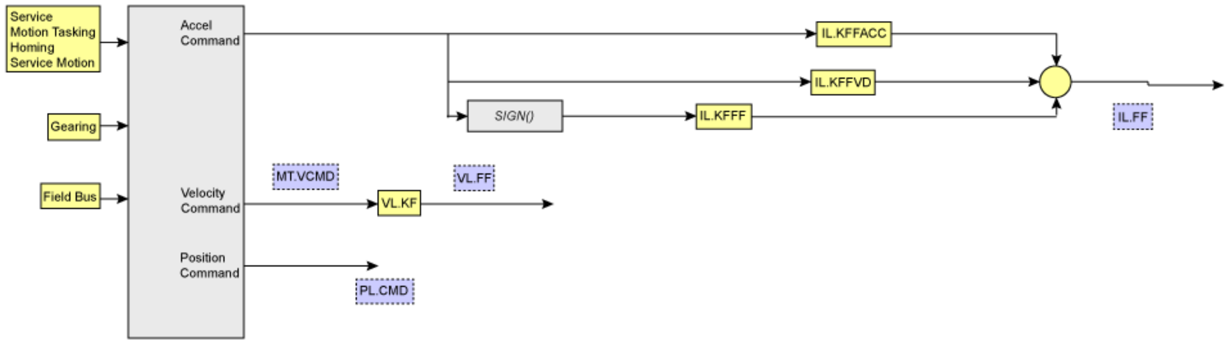


Pin	SFD	Resolver	BiSS (analog)	EnDAT 2.1	EnDAT 2.2	Hiper-face	Sine Encoder +Hall	Incremental Encoder +Hall
1	-	-	-	-	-	-	Hall U	Hall U
2	-	-	CLOCK+	CLOCK+	CLOCK+	-	Hall V	Hall V
3	-	-	CLOCK-	CLOCK-	CLOCK-	-	Hall W	Hall W
4	SENSE+	-	SENSE+	SENSE+	SENSE+	SENSE+	SENSE+	SENSE+
5	SENSE-	-	SENSE-	SENSE-	SENSE-	SENSE-	SENSE-	SENSE-
6	COM+	R1 Ref+	DATA+	DATA+	DATA+	DATA+	Zero+	Zero+
7	COM-	R2 Ref-	DATA-	DATA-	DATA-	DATA-	Zero-	Zero-
8	-	Thermal control (PTC)						
9	-	Thermal control (PTC, GND)						
10	+5 V	-	+5 V	+5 V	+5 V	+8 to +9 V	+5 V	+5 V
11	0 V	-	0 V	0 V	0 V	0 V	0 V	0 V
12	-	S1 SIN+	A+	A+	-	SIN+	A+	A+
13	-	S3 SIN-	A-	A-	-	SIN-	A-	A-
14	-	S2 COS+	B+	B+	-	COS+	B+	B+
15	-	S4 COS-	B-	B-	-	COS-	B-	B-

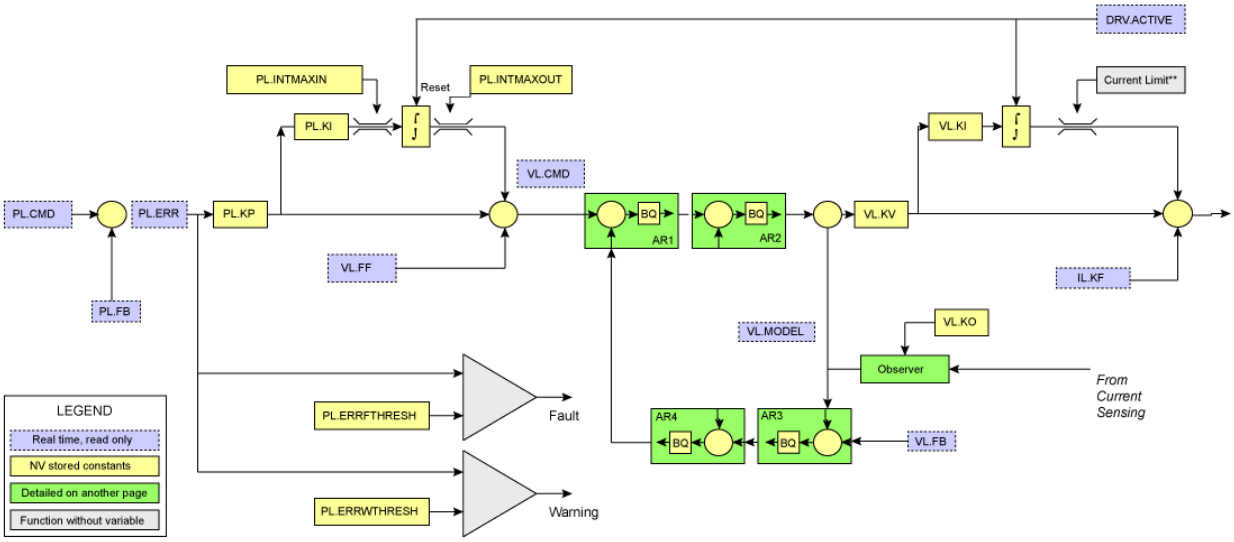
Block Diagrams

19.21 **Block Diagram for Current Loop** 247
19.22 **Block Diagram for Position/Velocity Loop** 247

19.21 Block Diagram for Current Loop



19.22 Block Diagram for Position/Velocity Loop



Appendix A

Parameter and Command Reference Guide

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About the Parameter and Command Reference Guide

This reference guide provides descriptive information about each parameter and command used in the drive firmware. Parameters and commands are used to configure the drive or to return status information from the drive using the WorkBench terminal screen. The use of these parameters and commands to perform various drive functions is detailed in related sections of the AKD User Guide.

Drive parameters and commands include the following:

AIN Parameters
AIO Parameters
AOUT Parameters
BODE Parameters
CAP Parameters
CS Parameters
DIN Parameters
DOUT Parameters
DRV Parameters and Commands
FB1 Parameters
FB2 Parameters
FBUS Parameters
GEAR Parameters
GUI Parameters
HOME Parameters
HWLS Parameters
IL Parameters
MOTOR Parameters
MT Parameters and Commands
PL Parameters
PLS Parameters and Commands
REC Parameters and Commands
REGEN Parameters
SM Parameters
STO Parameters
SWLS Parameters
UNIT Parameters
VBUS Parameters
VL Parameters
WS Parameters

A summary table of basic information for all parameters and commands is also available:

Summary of Parameters and Commands

For each parameter or command, this reference guide presents the following tables of information, followed by a description of the command, examples, and links to related information in the User Guide, as appropriate.

General Information	
Type	One of four types: • Command: Action or W/O command. • NV Parameter: R/W and stored in nonvolatile (NV) memory • R/W Parameter: Can be either read from or written to the drive. • R/O Parameter. Can only be read from the drive
Description	Brief description of the parameter or command and notes if the parameter or command is not active in all opmodes.
Units	Appropriate units (see Table of Units for unit descriptions)
Range	Permissible range; multiple ranges are sometimes present.
Default Value	Determined at setup process time or motor ID; otherwise set to 0.010.
Data Type	Integer, Boolean, Float, or String
See Also	Links to related information such as other parameters, block diagrams, schematics, or other sections of the product manual.
Start Version	The minimum firmware version required to use the parameter or command

Fieldbus	Index/Subindex	Object Start Version
Fieldbus type, such as EtherCAT COE and CAN-open or Modbus.	Index/subindex values for the parameter or command. The index value may be linked to the Object Dictionary for each fieldbus, if the object dictionary contains more detailed information about the object.	The minimum firmware version number required to use the fieldbus.

Additional data types may include the following:

Type	Description
Error	Illegal type=0
b	Boolean
U8	8 x unsigned numbers
S8	8 x signed numbers
U16	16 x unsigned numbers
S16	16 x signed numbers
U32	32 x unsigned numbers
S32	32 x signed numbers
U64	64 x unsigned numbers
S64	64 x signed numbers

Parameter and Command Naming Conventions

Abbreviation	Term
ACC	Acceleration
APP	Apply
CLR	Clear
CS	Controlled Stop
I	Current
D	Current d-component
DEC	Deceleration
DIR	Direction
DIS	Disable
DIST	Distance
EMUE	Emulated encoder
EN	Enable
ERR	Error
F	Fault
FB	Feedback
FF	Feedforward
K	Gain
INT	Integrator
LIM	Limit
L	Loop
MAX	Maximum
MIN	Minimum
N	Negative
NV	Nonvolatile
P	Position, Proportional, Positive
RLS	Release
R	Resistance
STATE	Status, State, Stat
THRESH	Threshold
T	Time
TMAX	Timeout
U	User
V	Velocity, Volt
W	Warning

Summary of Parameters and Commands

This table contains an alphabetical list of parameters and commands, with a brief description for each. The parameter name and description are linked to the parameter tables. The description field also notes if a parameter is not active in all opmodes. Generally speaking, all parameters and commands are active in all opmodes, with the following exceptions:

Parameter or Command	Active in Opmodes
GEAR (all parameters and commands)	2 (position) only
HOME (all parameters and commands)	2 (position) only
MT (all parameters and commands)	2 (position) only

Parameter or Command	Active in Opmodes
SM.I1, SM.I	0 (torque) only
SM.V1, SM.V2	1 (velocity) only
SM.VPM1, SM.VPM2	2 (position) only
VL (all parameters and commands)	1 (velocity) and 2 (position) only

Parameter or Command	Type	Description
Analog Input (AIN)		
AIN.CUTOFF	NV	Sets the analog input low-pass filter cutoff frequency.
AIN.DEADBAND	NV	Sets the analog input signal deadband.
AIN.ISCALE	NV	Sets the analog current scale factor.
AIN.OFFSET	NV	Sets the analog input offset.
AIN.PSCALE	NV	Sets the analog position scale factor.
AIN.VALUE	R/O	Reads the value of the analog input signal.
AIN.VSCALE	NV	Sets analog velocity scale factor.
AIN.ZERO	Command	Zeroes the analog input signal.
Analog Input/Output (AIO)		
AIO.ISCALE	NV	Sets the analog current scale factor.
AIO.VSCALE	NV	Sets velocity scale factor.
AIO.PSCALE	NV	Sets position scale factor.
Analog Output (AOUT)		
AOUT.DEBUGADDR	NV	Sets the memory address to debug.
AOUT.DEBUGDATATYPE	NV	Sets the data type of the value to be debugged.
AOUT.DEBUGSCALE	NV	Sets the scale to be used for debug.
AOUT.ISCALE	NV	Sets the analog current scale factor.
AOUT.MODE	NV	Sets the analog output mode.
AOUT.OFFSET	NV	Sets the analog input offset.
AOUT.PSCALE	NV	Sets the analog position scale factor.
AOUT.VALUE	NV	Reads the analog output value.
AOUT.VALUEU	R/W	Sets the analog output value.
AOUT.VSCALE	NV	Sets velocity scale factor for analog output.
Bode plot (BODE)		
BODE.EXCITEGAP	R/W	Controls how often the excitation is updated.
BODE.FREQ	R/W	Sets the frequency of the sine excitation source.
BODE.IAMP	R/W	Sets current command value used during the Bode procedure.
BODE.IFLIMIT		Sets the current fault duration limit in seconds for the BODE.MODE 5 stability test.
BODE.IFTHRESH		Sets the current fault threshold for the BODE.MODE 5 stability test.
BODE.INJECTPOINT	R/W	Sets whether the excitation uses current or velocity excitation type.
BODE.MODE	R/W	Sets the mode of the excitation.
BODE.MODETIMER	R/W	Sets the watchdog timer of the excitation.
BODE.PRBDEPTH	R/W	Sets the length of the PRB signal before it repeats.
BODE.VAMP	R/W	Sets the amplitude of the excitation when in velocity mode.

Parameter or Command	Type	Description
BODE.VFLIMIT		Sets the velocity fault duration limit (seconds) for the BODE.MODE 5 stability test
BODE.VFTHRESH		Sets the current fault threshold for the BODE.MODE 5 stability test.
Capture (CAP)		
CAP0.EDGE, CAP1.EDGE	R/W	Selects the capture edge.
CAP0.EN, CAP1.EN	R/W	Enables or disables the related capture engine.
CAP0.EVENT, CAP1.EVENT		Controls the precondition logic.
CAP0.FILTER, CAP1.FILTER	R/W	Controls the precondition logic.
CAP0.MODE, CAP1.MODE	NV	Selects the captured value.
CAP0.PLFB, CAP1.PLFB	R/O	Reads captured position value.
CAP0.PREEDGE, CAP1.PREEDGE		Selects the capture precondition edge.
CAP0.PREFILTER, CAP1.P-REFILTER	R/W	Sets the filter for the precondition input source.
CAP0.PRESELECT, CAP1.PRE-SELECT	R/W	Sets the precondition trigger.
CAP0.STATE, CAP1.STATE	R/O	Indicates whether or not trigger source was cap-tured.
CAP0.T, CAP1.T	R/O	Reads time capture (if time capture was con-figured).
CAP0.TRIGGER, CAP1.TRIGGER	R/W	Specifies the trigger source for the position cap-ture.
Controlled Stop (CS)		
CS.DEC	NV	Sets the deceleration value for the controlled stop process.
CS.STATE	NV	Returns the internal status of the controlled stop process.
CS.TO	NV	Sets the time value for the drive velocity to be within CS.VTHRESH.
CS.VTHRESH	NV	Sets the velocity threshold for the controlled stop.
Digital Input (DIN)		
DIN.ROTARY	R/O	Reads the rotary knob value.
DIN.STATES	R/O	Reads the digital input states.
DIN1.INV TO DIN7.INV	R/W	Sets the indicated the polarity of a digital input mode.
DIN1.MODE TO DIN7.MODE	NV	Sets the digital input modes.
DIN1.PARAM TO DIN7.PARAM	R/W	Sets a value used as an extra parameter for dig-ital inputs nodes.
DIN1.STATE TO DIN7.STATE	R/O	Reads a specific digital input state.
Digital Output (DOUT)		
DOUT.CTRL	NV	Sets the source of digital outputs (firmware or fieldbus).
DOUT.RELAYMODE	R/W	Indicates faults relay mode.
DOUT.STATES	R/O	Reads the state of the two digital outputs.
DOUTx.MODE	NV	Sets the digital output mode.
DOUT1.PARAM AND DOUT2.PARAM	NV	Sets extra parameters for the digital outputs.

Parameter or Command	Type	Description
DOUT1.STATE AND DOUT2.STATE	R/O	Reads the digital output state.
DOUT1.STATEU AND DOUT2.STATEU	R/W	Sets the state of the digital output node.
Drive (DRV)		
DRV.ACC	NV	Describes the acceleration ramp for the velocity central loop.
DRV.ACTIVE	R/O	Reads the enable status of an axis.
DRV.BLINKDISPLAY	Command	Causes the display to blink for 10 seconds.
DRV.BURNINOFFT (Password Protected)	R/W	Sets the burn-in test mode off time.
DRV.CLRFAULTHIST	Command	Clears the fault history log in the NV.
DRV.CLRFAULTS	Command	Tries to clear all active faults in the drive.
DRV.CMDDELAY	R/W	Issues a delay before next command is executed.
DRV.CMDSOURCE	NV	Sets the command source (service, fieldbus, analog input, gearing, digital, or Bode).
DRV.CRASHDUMP	Command	Retrieves diagnostic information after the drive crashes.
DRV.DBILIMIT	NV	Sets the maximum amplitude of the current for dynamic braking.
DRV.DEC	NV	Sets the deceleration value for the velocity loop.
DRV.DIR	R/W	Changes drive direction.
DRV.DIS	Command	Disables the axis (software).
DRV.DISMODE	NV	Selects among disable immediately or stop and then disable options.
DRV.DISSOURCES	R/O	Returns the possible reason for a drive disable.
DRV.DISTO	R/W	Sets the emergency timeout
DRV.EMUEDIR	R/W	Sets the direction of the emulated encoder output (EEO) signal.
DRV.EMUEMODE	R/W	Sets the mode of the emulated encoder output (EEO) connector.
DRV.EMUEMTURN	R/W	Defines the location of the index pulse on the EEO (emulated encoder output) when DRV.EMUEMODE=2.
DRV.EMUERES	R/W	Sets the resolution of the EEO (emulated encoder output).
DRV.EMUEZOFFSET	R/W	Sets the resolution of the EEO (emulated encoder output).
DRV.EN	Command	Enables the axis (software).
DRV.ENDEFAULT	R/W	Sets the default state of the software enable.
DRV.FAULTHIST	R/O	Reads the last 10 faults from NV memory.
DRV.FAULTS	R/O	Reads the active faults.
DRV.FLASHREAD (Password Protected)	R/O	Reads a value from the serial flash memory.
DRV.HANDWHEEL	R/O	Reads the EEO input value.
DRV.HELP	R/O	Reads the minimum, maximum, and default values for a specific parameter or command.

Parameter or Command	Type	Description
DRV.HELPALL	R/O	Retrieves the minimum, maximum, default, and actual values for all available parameters and commands.
DRV.ICONT	R/O	Reads the continuous rated current value.
DRV.INFO	R/O	Reads general information about the drive.
DRV.IPEAK	R/O	Reads the peak rated current value.
DRV.IZERO	R/W	Sets the current that will be used during the DRV.ZERO procedure.
DRV.LIST	R/O	Reads the list of available parameters and commands.
DRV.LOGICVOLTS		Reads the logic voltages.
DRV.NAME	NV	Sets and reads the name of the drive.
DRV.NVLIST	R/O	Lists the NV parameters and values from the RAM.
DRV.NVLOAD	W/O	Loads all data from the NV memory of the drive into the RAM parameters.
DRV.NVSAVE	Command	Saves the drive parameters from the RAM to the NV memory.
DRV.ONTIME	R/O	Returns how long the drive has been running since last power up.
DRV.OPMODE	NV	Sets the drive operation mode (current, velocity, or position).
DRV.READFORMAT	R/W	Sets the value returned to either decimal or hexadecimal.
DRV.RSTVAR	Command	Sets default values in the drive without re-booting the drive and without resetting the NV memory.
DRV.RUNTIME	R/O	Returns how long the drive has been running since first activated.
DRV.SETUPREQBITS	R/O	Reads the bitwise set status of parameters that must be set before the drive can be enabled
DRV.SETUPREQLIST	R/O	Reads the list of parameters that must be set before the drive can be enabled.
DRV.STOP	Command	This command stops all drive motion.
DRV.TEMPERATURES	R/O	Reads the temperature of drive components.
DRV.VER	R/O	Reads the drive version.
DRV.VERIMAGE	R/O	Returns the version data from each image.
DRV.TEMPERATURES	R/O	Reads the temperature of drive components.
DRV.WARNINGS	R/O	Reads the active warnings.
DRV.ZERO	R/W	Sets the zero mode. The procedure is activated when the drive is enabled.
Feedback (FB1)		
FB1.ENCRES	NV	Sets the resolution of the motor encoder.
FB1.HALLSTATE	R/O	Reads the Hall switch values (encoder feedback
FB1.IDENTIFIED	R/O	Reads the type of feedback device used by the drive/motor.
FB1.INITSIGNED	NV	Sets initial feedback value as signed or unsigned.
FB1.LDLL	R/O	Reads the motor line-to-line inductance from the FPGA.

Parameter or Command	Type	Description
FB1.LQLL	R/O	Reads the motor line-to-line inductance in the back emf axis (q axis) from the SFD memory from the FPGA.
FB1.MECHPOS	R/O	Reads the mechanical position.
FB1.MEMDUMP	W/O	Dumps the memory ID data values of a feedback with memory
FB1.MEMVER	R/O	Returns the memory feedback version.
FB1.OFFSET	NV	Sets position feedback offset.
FB1.POLES	R/O	Reads the number of feedback poles.
FB1.OFFSET	NV	Sets position feedback offset.
FB1.POLES	R/O	Reads the number of feedback poles.
FB1.SELECT	NV	Sets user entered type or identified type (–1).
Fieldbus (FBUS)		
FBUS.PARAM1 TO FBUS.PARAM20	NV	Set fieldbus specific meanings.
FBUS.PLLSTATE	R/O	Returns the status of the PLL
FBUS.PLLTHRESH	NV	Sets number of successful synchronized cycles needed to lock the PLL.
FBUS.SAMPLEPERIOD	NV	Sets fieldbus sample period.
FBUS.SYNCACT	R/O	Reads actual distance from the desired sync distance.
FBUS.SYNCDIST	NV	Sets time target for synchronization.
FBUS.SYNCWND	NV	Sets symmetrically arranged window around the desired sync distance.
FBUS.TYPE	R/O	Shows the active fieldbus type.
Gearing (GEAR)		
GEAR.ACCMAX	R/W	Sets the maximum allowed acceleration value; active in opmode 2 (position) only.
GEAR.DECMAX	R/W	Sets the maximum allowed deceleration value; active in opmode 2 (position) only.
GEAR.IN	R/W	Sets the denominator of the electronic gearing ratio; active in opmode 2 (position) only.
GEAR.MODE	R/W	Selects electronic gearing mode; active in opmode 2 (position) only.
GEAR.MOVE	Command	Starts the electronic gearing; active in opmode 2 (position) only.
GEAR.OUT	R/W	Sets the numerator of the electronic gearing ratio; active in opmode 2 (position) only.
GEAR.VMAX	R/W	Reads the maximum allowed velocity value; active in opmode 2 (position) only.
Homing (HOME)		
HOME.ACC	R/W	Sets homing acceleration; active in opmode 2 (position) only.
HOME.AUTOMOVE	R/W	Sets homing auto move flag.
HOME.DEC	R/W	Sets homing deceleration; active in opmode 2 (position) only.
HOME.DIR	NV	Sets homing direction; active in opmode 2 (position) only.

Parameter or Command	Type	Description
HOME.DIST	R/W	Sets homing distance; active in opmode 2 (position) only.
HOME.FEEDRATE	R/W	Sets homing velocity factor; active in opmode 2 (position) only.
HOME.IPEAKHOME.IPEAK	R/W	Sets the current limit during homing procedure to a mechanical stop; active in opmode 2 (position) only.
HOME.MODEHOME.MODE	R/W	Selects the homing mode; active in opmode 2 (position) only.
HOME.MOVEHOME.MOVE	Command	Starts a homing procedure; active in opmode 2 (position) only.
HOME.PHOME.P	R/W	Sets home position; active in opmode 2 (position) only.
HOME.PERRTHRESH HOME.PERRTHRESH	R/W	Sets the position lag threshold; active in opmode 2 (position) only.
HOME.SETHOME.SET	Command	Immediately sets the home position; active in opmode 2 (position) only.
HOME.VHOME.V	R/W	Sets homing velocity; active in opmode 2 (position) only.
Hardware Limit Switch (HWLS)		
HWLS.NEGSTATE	R/O	Reads the status of the negative hardware limit switch.
HWLS.POSSTATE	R/O	Reads the status of the positive hardware limit switch.
Current Loop (IL)		
IL.BUSFF	R/O	Displays the current feedforward value injected by the fieldbus.
IL.CMD	R/O	Reads the value of the q-component current controller inside the FPGA.
IL.CMDU	R/W	Sets the user current command.
IL.DCMD (Password Protected)	R/O	Reads the value of the d-component current controller inside the FPGA.
IL.DCMD (Password Protected)	R/O	Reads the value of the d-component current controller inside the FPGA.
IL.DCMDU (Password Protected)	R/W	Sets user d-component current command.
IL.DEADBAND (Password Protected)	R/O	Reads the deadband of two IGBTs in series connection.
IL.DFB	R/O	Reads the actual value of the d-component current.
IL.DFOLDD (Password Protected)	R/O	Reads the motor foldback maximum time at motor peak current.
IL.DFOLDR (Password Protected)	R/O	Reads the motor foldback recovery time.
IL.DFOLDT	R/O	Reads the motor foldback time constant of the exponential current drop (foldback).
IL.DIFOLD	R/O	Reads the drive foldback current limit.
IL.DLIMITN	R/W	Sets the negative user (application-specific) d-component current limit.
IL.DLIMITP	R/W	Sets the positive user (application-specific) d-component current limit.
IL.FB	R/O	Reads the actual value of the d-component current.

Parameter or Command	Type	Description
IL.FOLDFTHRESH	NV	Reads the foldback fault level.
IL.FOLDWTHRESH	NV	Sets the foldback warning level.
IL.IFOLD	R/O	Reads the overall foldback current limit.
IL.INTEN (Password Protected)	NV	Enables/disables the integrator part of the PI loop.
IL.IUOFFSET (Password Protected)	R/W	Sets the offset added to the sigma-delta measured current value in the u-winding.
IL.IUFB	R/O	Reads the sigma-delta measured current in the u-winding of the motor.
IL.IVFB	R/W	Sets the sigma-delta measured current in the u-winding of the motor.
IL.IVOFFSET (Password Protected)	R/W	Sets the offset added to the sigma-delta measured current value in the v-winding.
IL.KP	NV	Sets the proportional gain of the q-component of the PI regulator.
IL.KPDRATIO	NV	IL.KPDRATIO
IL.LIMITN	NV	Sets the negative user (application-specific) current limit.
IL.LIMITP	NV	Sets the positive user (application-specific) current limit.
IL.MFOLDD	NV	Sets the motor foldback maximum time at motor peak current.
IL.MFOLDR	R/O	Sets the motor foldback recovery time.
IL.MFOLDT	NV	Sets the motor foldback time constant of the exponential current drop (foldback).
IL.MIFOLD	R/O	Sets the motor foldback current limit.
IL.PWMFREQ (Password Protected)	NV	Reads and sets the PWM frequency of the IGBTs.
IL.VDCMD	R/O	Sets the output of the d-component PI-regulator.
IL.VCMD	R/O	Sets the output of the q-component PI regulator.
IL.VUFB	R/O	Reads the measured voltage on the u-winding of the motor.
IL.VVFB	R/O	Reads the measured voltage on the v-winding of the motor.
IL.DLIMITN	R/W	Sets the negative user (application-specific) d-component current limit.
IL.DLIMITP	R/W	Sets the positive user (application-specific) d-component current limit.
IL.FB	R/O	Reads the actual value of the d-component current.

Motor (MOTOR) Parameters		
MOTOR.BRAKE	NV	Sets the presence or absence of a motor brake.
MOTOR.TBRAKEAPP	NV	The delay time used for applying the motor brake.
MOTOR.TBRAKERLS	NV	The delay time used for releasing the motor brake.
MOTOR.ICONT	NV	Sets the motor continuous current.
MOTOR.INERTIA	NV	Sets the motor inertia.
MOTOR.IPEAK	NV	Sets the motor peak current.

MOTOR.KT	NV	Sets the torque constant of the motor.
MOTOR.LQLL	NV	Sets the line-to-line motor Lq.
MOTOR.VMAX	NV	Sets the maximum motor speed.
MOTOR.NAME	NV	Sets the motor name.
MOTOR.PHASE	NV	Sets the motor phase.
MOTOR.PITCH	NV	Sets the motor pitch.
MOTOR.POLES	NV	Sets the number of motor poles.
MOTOR.R	NV	Sets the stator winding resistance phase-phase in ohms.
MOTOR.TEMP	R/O	Reads the motor temperature represented as the resistance of the motor PTC.
MOTOR.TEMPFAULT	NV	Sets the motor temperature fault level.
MOTOR.TEMPWARN	NV	Sets the motor temperature warning level.
MOTOR.TYPE	NV	Sets the motor type.
MOTOR.VOLTMAX	NV	Sets the motor maximum voltage.
Motion Task (MT)		
MT.ACC	R/W	Specifies motion task acceleration; active in opmode 2 (position) only.
MT.CLEAR	Command	Clears motion tasks from the drive; active in opmode 2 (position) only.
MT.CNTL	R/W	Sets motion task control word; active in opmode 2 (position) only.
MT.CONTINUE	Command	Continues a stopped motion task; active in opmode 2 (position) only.
MT.DEC	R/W	Sets motion task deceleration; active in opmode 2 (position) only.
MT.EMERGMT	R/W	Selects a motion task to be triggered after an emergency stop procedure; active in opmode 2 (position) only.
MT.MTNEXT	R/W	Specifies following motion task number; active in opmode 2 (position) only.
MT.TNEXT	R/W	Specifies following motion task time; active in opmode 2 (position) only.
MT.LIST	Command	Lists all initialized motion tasks in the drive; active in opmode 2 (position) only.
MT.LOAD	Command	Reads/loads a motion task number from the drive; active in opmode 2 (position) only.
MT.MOVE	Command	Starts a motion task; active in opmode 2 (position) only.
MT.NUM	R/W	Sets the motion task number; active in opmode 2 (position) only.
MT.PARAMS	Command	Shows a motion task; active in opmode 2 (position) only.
MT.P	R/W	Sets the motion task position; active in opmode 2 (position) only.
MT.SET	Command	Sets the motion task in the drive; active in opmode 2 (position) only.
MT.TNUM	R/W	Motion task customer table number.
MT.V	R/W	Sets the motion task velocity; active in opmode 2 (position) only.

Position Loop (PL)		
PL.CMD	NV	Reads the position command directly from the entry to the position loop.
PL.ERR	NV	Returns the position error present when the drive is controlling the position loop.
PL.ERRFTHRESH	NV	Sets the maximum position error.
PL.ERRWTHRESH	NV	Sets the position error warning level.
PL.FB	R/O	Reads the position feedback value.
PL.FBSOURCE	NV	Sets the feedback source for the position loop.
PL.INTINMAX	NV	Limits the input of the position loop integrator by setting the input saturation.
PL.INTOUTMAX	NV	Limits the output of the position loop integrator by setting the output saturation.
PL.KI	NV	Sets the integral gain of the position loop.
PL.KP	NV	Sets the proportional gain of the position regulator PID loop.
Programmable Limit Switch (PLS)		
PLS.EN	R/W	Enables programmable limit switch (PLS).
PLS.MODE	NV	Selects programmable limit switch mode.
PLS.P1 TO PLS.P8	NV	Sets the trigger point for programmable limit switches.
PLS.STATE	R/O	Reads the programmable limit switch state.
Recorder (REC)		
REC.ACTIVE	R/O	Indicates if data recording is in progress (active).
REC.CH1 to REC.CH6	R/W	Sets recording channels 1 to 6.
REC.DONE	R/O	Checks whether or not the recorder has finished recording.
REC.GAP	R/W	Specifies the gap between consecutive samples.
REC.NUMPOINTS	R/W	Sets the number of points to record.
REC.OFF	R/W	Turns the recorder OFF.
REC.RETRIEVE	R/O	Transfers all the recorded data to the communication channel.
REC.STOPTYPE	R/W	Sets the recorder stop type.
REC.TRIG	Command	Triggers the recorder.
REC.TRIGSLOPE	R/W	Sets the trigger slope.
REC.TRIGTYPE	R/W	Sets the trigger type.
REC.TRIGVAL	R/W	Sets the trigger value.
Regen Resistor (REGEN)		
REGEN.POWER	R/O	READS REGEN RESISTOR'S CALCULATED POWER.
REGEN.REXT	N/V	SETS THE EXTERNAL, USER-DEFINED REGEN RESISTOR RESISTANCE.
REGEN.TEXT	R/W	Sets the external regen resistor thermal protection time constant.
REGEN.TYPE	N/V	SETS THE REGEN RESISTOR TYPE.
REGEN.WATTEXT	R/W	SETS THE REGEN RESISTOR'S POWER FAULT LEVEL FOR AN EXTERNAL REGEN RESISTOR.
Service Motion (SM)		

SM.I1	R/W	Sets service motion current 1; active in opmode 0 (torque) only.
SM.I2	R/W	Sets service motion current 2; active in opmode 0 (torque) only.
SM.MODE	R/W	Sets the service motion mode.
SM.MOVE	Command	Starts the service motion.
SM.T1	R/W	Sets the service motion time 1.
SM.T2	R/W	Sets the service motion time 2.
SM.V1	R/W	Sets service motion velocity 1; active in opmode 1 (velocity) and 2 (position).
SM.V2	R/W	Sets service motion velocity 2; active in opmode 1 (velocity) and 2 (position).
Units (UNIT)		
UNIT.ACCLINEAR	NV	Sets the linear acceleration/deceleration units.
UNIT.ACCROTARY	NV	Sets the rotary acceleration/deceleration units.
UNIT.LABEL	NV	Sets user-defined name for user-defined position units.
UNIT.PIN	NV	Sets gear IN for the unit conversion.
UNIT.PLINEAR	NV	Sets the linear position units.
UNIT.POUT	NV	Sets gear out for the unit conversion.
UNIT.PROTARY	NV	Sets the position units when the motor type (MOTOR.TYPE) is rotary.
UNIT.VLINEAR	NV	Sets the linear velocity units.
UNIT.VROTARY	NV	Sets the velocity units when the motor type (MOTOR.TYPE) is rotary.
Bus voltage (VBUS)		
VBUS.OVFTHRESH	R/O	Reads the over voltage fault level.
VBUS.OVWTHRESH	N/V	Sets voltage level for over voltage warning.
VBUS.RMSLIMIT	R/O	Reads the limit for the bus capacitors load.
VBUS.UVFTHRESH	R/O	Sets the under voltage fault level.
VBUS.UVMODE		Indicates undervoltage (UV) mode.
VBUS.UVWTHRESH	NV	Sets voltage level for undervoltage warning.
VBUS.VALUE	R/O	Reads DC bus voltage.
Velocity Loop (VL)		
VL.ARPF1 TO VL.ARPF4	R/W	Sets the natural frequency of the pole (denominator) of anti-resonance (AR) filters 1, 2, 3, and 4; active in opmodes 1 (velocity) and 2 (position) only.
VL.ARPQ1 TO VL.ARPQ4	R/W	Sets the Q of the pole (denominator) of anti-resonance (AR) filter 1; active in opmodes 1 (velocity) and 2 (position) only.
VL.ARTYPE1 TO VL.ARTYPE4	NV	Indicates the method used to calculate BiQuad coefficients; active in opmodes 1 (velocity) and 2 (position) only.
VL.ARZF1 TO VL.ARZF4	R/W	Sets the natural frequency of the zero (numerator) of anti-resonance (AR)filter 1; active in opmodes 1 (velocity) and 2 (position) only.
VL.ARZQ1 TO VL.ARZQ4	R/W	Sets the Q of the zero (numerator) of anti-resonance filter #1; active in opmodes 1 (velocity) and 2 (position) only.

VL.BUSFF	R/O	Displays the velocity loop feedforward value injected by the field-bus; active in opmodes 1 (velocity) and 2 (position) only.
VL.CMD	R/O	Reads the actual velocity command; active in opmodes 1 (velocity) and 2 (position) only.
VL.CMDU	R/W	Sets the user velocity command; active in opmodes 1 (velocity) and 2 (position) only.
VL.ERR	R/O	Sets the velocity error; active in opmodes 1 (velocity) and 2 (position) only.
VL.FB	R/O	Reads the velocity feedback; active in opmodes 1 (velocity) and 2 (position) only.
VL.FBFILTER	R/O	Filters VL.FB value; active in opmodes 1 (velocity) and 2 (position) only.
VL.FBSOURCE	NV	Sets feedback source for the velocity loop; active in opmodes 1 (velocity) and 2 (position) only.
VL.FF	R/O	Displays the velocity loop overall feedforward value; active in opmodes 1 (velocity) and 2 (position) only.
VL.GENMODE	NV	Selects mode of velocity generation (Observer, d/dt); active in opmodes 1 (velocity) and 2 (position) only.
VL.KBUSFF	R/W	Sets the velocity loop acceleration feedforward gain value; active in opmodes 1 (velocity) and 2 (position) only.
VL.KI	NV	Sets the velocity loop integral gain for the PI controller; active in opmodes 1 (velocity) and 2 (position) only.
VL.KP	NV	Sets velocity loop proportional gain for the PI controller; active in opmodes 1 (velocity) and 2 (position) only.
VL.KVFF	R/W	Sets the velocity loop velocity feedforward gain value; active in opmodes 1 (velocity) and 2 (position) only.
VL.LIMITN	NV	Sets the velocity lower limit; active in opmodes 1 (velocity) and 2 (position) only.
VL.LIMITP	NV	Sets the velocity high limit; active in opmodes 1 (velocity) and 2 (position) only.
VL.LMJR	R/W	Sets the ratio of the estimated load moment of inertia relative to the motor moment of inertia; active in opmodes 1 (velocity) and 2 (position) only.
VL.THRESH	NV	Sets the over speed fault value; active in opmodes 1 (velocity) and 2 (position) only.
Wake and Shake (WS)		
WS.ARM	Command	Sets wake and shake to start at the next drive enable.
WS.DISTMIN	R/W	Sets the minimum movement required for wake and shake.
WS.IMAX	R/W	Sets maximum current used for wake and shake.
WS.MODE	R/W	Sets the method used for wake and shake.
WS.DISTMAX	R/W	Sets maximum movement allowed for wake and shake.

WS.NUMLOOPS	R/W	Sets the number of repetitions for wake and shake.
WS.STATE	R/O	Reads wake and shake status
WS.T	R/W	Sets wake and shake current-vector appliance time
WS.TDELAY1	NV	Delay for wake and shake timing
WS.TDELAY2	NV	Sets the delay for wake and shake timing.
WS.TDELAY3	NV	Sets the delay for wake and shake between loops in mode 0.
WS.VTHRESH	NV	Defines the maximum allowed velocity for Wake & Shake

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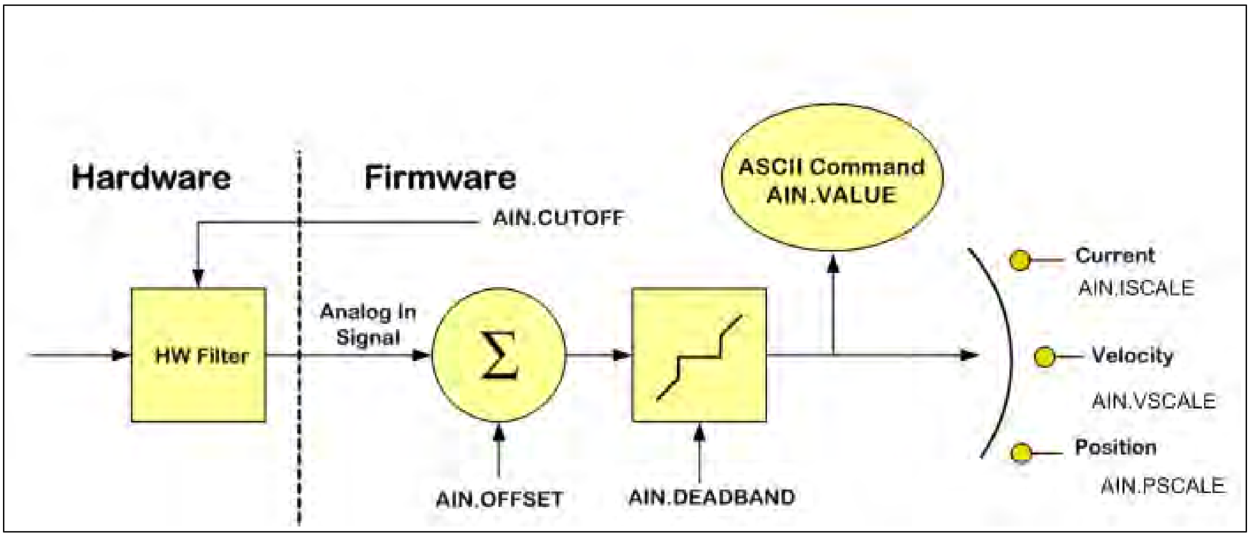
AIN Parameters

This section describes the analog input (AIN) parameters. AIN parameters function as shown in the block diagram below:

Analog Input Block Diagram



AIN.CUTOFF

General Information	
Type	NV Parameter
Description	Sets the analog input low-pass filter cutoff frequency.
Units	Hz
Range	0 to 10,000 Hz
Default Value	5,000 Hz
Data Type	Float
See Also	Analog Input Block Diagram
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	0	M_01-03-00-000

Description

AIN.CUTOFF sets the break frequency in Hz for two cascaded single-pole low-pass filters on the hardware command input. Since the two poles are cascaded at the same frequency, the -3 dB frequency is 0.64*AIN.CUTOFF in hertz and the 10% to 90% step response rise time is 0.53/AIN.CUTOFF in seconds.

Suggested operating values are as follows:

- Analog torque opmode: 5 kHz
- Analog velocity opmode: 2.5 kHz
- General purpose analog input high resolution: 500 Hz

Related Topics

10.4 Analog Input

Velocity Controller Environment Block Diagram (for the drive controller environment).

AIN.DEADBAND

General Information	
Type	NV Parameter
Description	Sets the analog input signal deadband.
Units	V
Range	0 to 12.5 V
Default Value	0 V
Data Type	Float
See Also	Analog Input Block Diagram
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	2	M_01-03-00-000

Description

AIN.DEADBAND sets the deadband of the analog input signal. If the absolute value of the analog input signal is less than the AIN.DEADBAND value, then no analog command signal is generated.

Related Topics

10.4 Analog Input

Velocity Controller Environment Block Diagram (for the drive controller environment).

AIN.ISCALE

General Information	
Type	NV Parameter
Description	Sets the analog current scale factor.
Units	A/V
Range	0.001 to 22.4 A/V
Default Value	0.001 A/V
Data Type	Float
See Also	Analog Input Block Diagram
Start Version	M_01-01-01-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	4	M_01-03-00-000

Description

AIN.ISCALE sets the analog current scale factor that scales the analog input (AIN.VALUE) for DRV.OPMODE = 1 (analog torque mode).

The value entered is the motor current per 10 V of analog input. This value may be either higher or lower than 100%, but the actual analog input will be limited by the application current limit (IL.LIMITN and IL.LIMITP).

Related Topics

10.4 Analog Input

Velocity Controller Environment Block Diagram (for the drive controller environment).

AIN.OFFSET

General Information	
Type	NV Parameter
Description	Sets the analog input offset.
Units	V
Range	–10 to +10 V
Default Value	0 V
Data Type	Float
See Also	Analog Input Block Diagram, AIN.ZERO
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	6	M_01-03-00-000

Description

AIN.OFFSET sets the analog offset, which is added to the analog input command to the drive. This value compensates for the analog input signal (AIN.VALUE) offset or drift.

Related Topics

10.4 Analog Input

Velocity Controller Environment Block Diagram (for the drive controller environment).

AIN.PSCALE

General Information	
Type	NV Parameter
Description	Sets the analog position scale factor.
Units	Depends on UNIT.PROTARY or UNIT.PLINEAR Rotary: counts/V,rad/V, deg/V, (PIN/POUT)/V, 16-bit counts/V Linear: counts/V, mm/V, µm/V, (PIN/POUT)/V, 16-bit counts/V
Range	Rotary: 1 to 9,223,372,036,854,775 counts/V 0 to 13,493,026.816 rad/V 0.06 to 179.0 deg/V 0 to 10,737,418.240 (PIN/POUT)/V 0 to 140,737,488,355.327 16-bit counts/V Linear: 1 to 9,223,372,036,854,775 counts/V 0 to 2,147,483.648 mm/V 0 to 2,147,483,648.000 µm/V 0 to 10,737,418.240 (PIN/POUT)/V 0 to 140,737,488,355.327 16-bit counts/V
Default Value	Rotary: 1 counts/V 0 rad/V 0 deg/V 0 (PIN/POUT)/V 0 16-bit counts/V Linear: 1 count/V 0 rad/V 0 deg/V 0 (PIN/POUT)/V 0 16-bit counts/V
Data Type	Float
See Also	N/A
Start Version	M_01-01-01-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3472h/0	M_01-00-00-000
Modbus	8 (64-bit)	M_01-03-00-000

Description

AIN.PSCALE is an analog position scale factor that scales the analog input (AIN.VALUE) for DRV.OPMODE = 2 , DRV.CMDSOURCE = 3 (analog position mode).

Related Topics

10.4 Analog Input

Velocity Controller Environment Block Diagram (for the drive controller environment).

AIN.VALUE

General Information	
Type	R/O Parameter
Description	Reads the value of the analog input signal.
Units	V
Range	-12.5 to +12.5 V
Default Value	N/A
Data Type	Float
See Also	AIN.OFFSET, AIN.ZERO, Analog Input Block Diagram
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3470h/4 3509h	M_01-00-00-000
Modbus	16	M_01-03-00-000

Description

AIN.VALUE reads the analog input value after the value is filtered (as shown in the Analog Input Block Diagram).

Related Topics

10.4 Analog Input

Velocity Controller Environment Block Diagram (for the drive controller environment).

AIN.VSCALE

General Information	
Type	NV Parameter
Description	Sets analog velocity scale factor.
Units	Depends on UNIT.VROTARY or UNIT.ACCLINEAR Rotary: rpm/V, rps/V, (deg/s)/V, [(PIN/POUT)/s]/V, (rad/s)/V Linear: counts/s/V, (mm/s)/V, (µm/s)/V, [(PIN/POUT)/s]/V
Range	Rotary: 0.060 to 60,000 rpm/V 0.001 to 1,000 rps/V 0.359 to 360,000 (deg/s)/V 0.005 to 5,000 [(PIN/POUT)/s]/V 0.006 to 6,283.186 (rad/s)/V Linear: 0.001 to 1.000 counts/s/V 0.001*MOTOR.PITCH to 1,000.000*MOTOR.PITCH (mm/s)/V 0.998*MOTOR.PITCH to 1,000,000.000*MOTOR.PITCH (µm/s)/V 0.005 to 5,000 [(PIN/POUT)/s]/V
Default Value	Rotary: 0.060 rpm/V 0.001 rps/V 0.359 (deg/s)/V 0.005 [(PIN/POUT)/s]/V 0.006 (rad/s)/V Linear: 0.001 counts/s/V 0.001*MOTOR.PITCH (mm/s)/V 0.998*MOTOR.PITCH (µm/s)/V 0.005 to 5,000 [(PIN/POUT)/s]/V
Data Type	Float
See Also	N/A
Start Version	M_01-02-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3629h/0	M_01-00-00-000
Modbus	14	M_01-03-00-000

Description

AIN.VSCALE is an analog velocity scale factor that scales the analog input AIN.VALUE) for DRV.OPMODE = 1 (analog velocity mode).

The value entered is the motor velocity per 10 V of analog input. This value may be either higher or lower than the application velocity limit (VL.LIMITP orVL.LIMITN), but the actual analog I/O will be limited by VL.LIMITP or VL.LIMITN.

Related Topics

10.4 Analog Input

Velocity Controller Environment Block Diagram (for the drive controller environment).

AIN.ZERO

General Information	
Type	Command
Description	Zeroes the analog input signal.
Units	N/A
Range	N/A
Default Value	N/A
Data Type	N/A
See Also	AIN.VALUE, AIN.OFFSET
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	N/A	M_01-00-00-000
Modbus	16	M_01-03-00-000

Description

AIN.ZERO causes the drive to zero the analog input signal (AIN.VALUE). You may need to execute this command more than once to achieve zero offset, and AIN.OFFSET is modified in this process.

Related Topics

10.4 Analog Input

Velocity Controller Environment Block Diagram (for the drive controller environment).

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AIO Parameters

AIO.ISCALE

General Information	
Type	NV Parameter
Description	Sets the analog current scale factor.
Units	A/V
Range	0.001 to 22.4 A/V
Default Value	0.001 A/V
Data Type	Float
See Also	Analog Input Block Diagram
Start Version **End Version**	M_01-00-00-000 M_01-01-01-000

Description

AIO.ISCALE sets the analog current scale factor that scales the following:

- The analog input (AIN.VALUE) for DRV.OPMODE = 0 (analog torque mode), DRV.CMDSOURCE = 3 (analog).
- The analog output (AOUT.VALUE) for AOUT.MODE = 5 or 6. The value entered is the motor current per 1 V of analog input or output. This value may be either higher or lower than 100%, but the actual analog I/O will be limited by the application current limit (IL.LIMITN and IL.LIMITP).

AIO.PSCALE

General Information	
Type	NV Parameter
Description	Sets position scale factor.
Units	Depends on UNIT.PROTARY or UNIT.PLINEAR Rotary: counts/V,rad/V, deg/V, (PIN/POUT)/V, 16-bit counts/V Linear: counts/V, mm/V, um/V, (PIN/POUT)/V, 16-bit counts/V
Range	Rotary: 1 to 9,223,372,036,854,775 counts/V 0 to 13,493,026.816 rad/V 0 to 773,094,113.280 deg/V 0 to 10,737,418.240 (PIN/POUT)/V 0 to 140,737,488,355.327 16-bit counts/V Linear: 1 to 9,223,372,036,854,775 counts/V 0 to 2147483.648 mm/V 0 to 2147483648.000 um/V 0 to 10737418.240 (PIN/POUT)/V 0 to 140737488355.327 16-bit counts/V
Default Value	Rotary: 1 counts/V 0 rad/V 0 deg/V 0 (PIN/POUT)/V 0 16-bit counts/V Linear: 1 count/V 0 rad/V 0 deg/V 0 (PIN/POUT)/V 0 counts16 bit/V
Data Type	Float
See Also	Analog Input Block Diagram
Start Version **End Version**	M_01-00-00-000 M_01-01-01-000

Description

AIO.PSCALE is an analog position scale factor that scales:

1. The analog input (AIN.VALUE) for DRV.OPMODE = 2 , DRV.CMDSOURCE = 3 (analog position mode)

2. The analog output (AOUT.VALUE) for AOUT.MODE = 6, or 7. (actual position or position error) per 10 V of analog input or output.

AIO.VSCALE

General Information	
Type	NV Parameter
Description	Sets velocity scale factor.
Units	Depends on UNIT.VROTARY or UNIT.ACCLINEAR Rotary: rpm/V, rps/V, (deg/s)/V, [(PIN/POUT)/s]/V, (rad/s)/V Linear: counts/s/V, (mm/s)/V, (um/s)/V, [(PIN/POUT)/s]/V
Range	Rotary: 0.060 to 60,000 rpm/V 0.001 to 1,000 rps/V 0.359 to 360,000 (deg/s)/V 0.005 to 5,000 [(PIN/POUT)/s]/V 0.006 to 6,283.186 (rad/s)/V Linear: 0.001 to 1.000 counts/s/V 0.001*MOTOR.PITCH to 1,000.000*MOTOR.PITCH (mm/s)/V 0.998*MOTOR.PITCH to 1,000,000.000*MOTOR.PITCH (um/s)/V 0.005 to 5,000 [(PIN/POUT)/s]/V
Default Value	Rotary: 0.060 rpm/V 0.001 rps/V 0.359 (deg/s)/V 0.005 [(PIN/POUT)/s]/V 0.006 (rad/s)/V Linear: 0.001 counts/s/V 0.001*MOTOR.PITCH (mm/s)/V 0.998*MOTOR.PITCH (um/s)/V 0.005 to 5,000 [(PIN/POUT)/s]/V
Data Type	Float
See Also	Analog Input Block Diagram
Start Version **End Version**	M_01-00-00-000 M_01-01-01-000

Description

AIO.VSCALE is an analog velocity scale factor that scales:

1. The analog input (AIN.VALUE) for DRV.OPMODE = 2 (analog velocity mode)
2. The analog output (AOUT.VALUE) for AOUT.MODE = 1, 3, or 7. The value entered is the motor velocity per 10 V of analog input or output. This value may be either higher or lower than the application velocity limit (VL.LIMITP or VL.LIMITN), but the actual analog I/O will be limited by VL.LIMITP or VL.LIMITN.

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AOUT Parameters

AOUT.DEBUGADDR

General Information	
Type	NV Parameter
Description	Sets the memory address to debug.
Units	N/A
Range	4 to 4,292,870,142
Default Value	4
Data Type	Integer
See Also	AOUT.MODE
Start Version	M_01-01-01-000

Description

AOUT.DEBUGADDR sets the memory address to debug when AOUT.MODE = 9 (debug mode).

Related Topics

10.5 Analog Output

AOUT.DEBUGSCALE

General Information	
Type	NV Parameter
Description	Sets the scale to be used for debug.
Units	N/A
Range	0.001 to 9,223,372,036,854,775.000
Default Value	1
Data Type	Float
See Also	AOUT.MODE
Start Version	M_01-01-01-000

Description

AOUT.DEBUGSCALE sets the scale to be used for debug when AOUT.MODE = 9 (debug mode).

Related Topics

10.5 Analog Output

AOUT.ISCALE

General Information	
Type	NV Parameter
Description	Sets the analog current scale factor.
Units	A/V
Range	0.001 to 22.4 A/V
Default Value	0.001 to 22.4 A/V
Data Type	Float
See Also	AOUT.VALUE
Start Version	M_01-01-01-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	18	M_01-03-00-000

Description

AOUT.ISCALE sets the analog current scale factor that scales the analog output (AOUT.VALUE) for AOUT.MODE = 4 or 5. The value entered is the motor current per 10 V of analog input or output. This value may be either higher or lower than 100%, but the actual analog I/O will be limited by the application current limit (IL.LI-MITN and IL.LIMITP).

Related Topics

10.5 Analog Output

AOUT.MODE

General Information	
Type	NV Parameter
Description	Sets the analog output mode.
Units	N/A
Range	0 to 9
Default Value	0
Data Type	Integer
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3470h/1	M_01-00-00-000
Modbus	20	M_01-03-00-000

Description

AOUT.MODE sets the analog output functionality.

AOUTx.MODE	Description
0	User variable. The analog output signal is determined by the user (using AOUT.VALUEU).
1	Actual velocity. The analog signal describes the current velocity value.
2	Velocity error. The analog signal describes the velocity error value.
3	Velocity command. The analog signal describes the velocity command value.
4	Actual current. The analog signal describes the actual current value.
5	Current command. The analog signal describes the current command value.
6	Actual position. The analog signal describes the current position value.
7	Position error. The analog signal describes the position error value.
8	Triangle wave. The analog signal is a triangle wave (sawtooth pattern).
9	Debug mode. In this mode the user can define a drive variable to monitor via the analog output (AOUT.VALUEU).

Example

You can use AOUT.VALUEU to implement a voltage output as follows:

```
-->AOUT.MODE 0

-->AOUT.VALUEU 5

-->AOUT.VALUEU 4.33
```

Related Topics

10.5 Analog Output

AOUT.OFFSET

General Information	
Type	NV Parameter
Description	Sets the analog input offset.
Units	V
Range	-10 to +10 V
Default Value	0 V
Data Type	Float
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	22	M_01-03-00-000

Description

This parameter sets the analog input offset.

Related Topics

10.5 Analog Output

AOUT.PSCALE

General Information	
Type	NV Parameter
Description	Sets the analog position scale factor.
Units	Depends on UNIT.PROTARY or UNIT.PLINEAR Rotary: counts/V,rad/V, deg/V, (PIN/POUT)/V, 16-bit counts/V Linear: counts/V, mm/V, µm/V, (PIN/POUT)/V, 16-bit counts/V
Range	Rotary: 1 to 9,223,372,036,854,775 counts/V 0 to 13,493,026.816 rad/V 0 to 773,094,113.280 deg/V 0 to 10,737,418.240 (PIN/POUT)/V 0 to 140,737,488,355.327 16-bit counts/V Linear: 1 to 9,223,372,036,854,775 counts/V 0 to 2,147,483.648 mm/V 0 to 2,147,483,648.000 µm/V 0 to 10,737,418.240 (PIN/POUT)/V 0 to 140,737,488,355.327 16-bit counts/V
Default Value	Rotary: 1 counts/V 0 rad/V 0 deg/V 0 (PIN/POUT)/V 0 16-bit counts/V Linear: 1 counts/V 0 rad/V 0 deg/V 0 (PIN/POUT)/V 0 counts16 bit/V
Data Type	Float
See Also	AOUT.VALUE
Start Version	M_01-01-01-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3471h/0	M_01-00-00-000
Modbus	24 (64-bit)	M_01-03-00-000

Description

AOUT.PSCALE is an analog position scale factor that scales the analog output (AOUT.VALUE) for AOUT.MODE = 6, or 7 (actual position or position error) per 10 V of analog input or output.

Related Topics

10.5 Analog Output

AOUT.VALUE

General Information	
Type	N/V Parameter
Description	Reads the analog output value.
Units	V
Range	–10 to +10 V
Default Value	0
Data Type	Float
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3470h/2	M_01-00-00-000
Modbus	28 (64-bit)	M_01-03-00-000

Description

AOUT.VALUE reads the analog output value. This parameter can also be used to set the value of the analog output when AOUT.MODE = 0 (analog output signal is determined by the user).

Related Topics

10.5 Analog Output

AOUT.VALUEU

General Information	
Type	R/W Parameter
Description	Sets the analog output value.
Units	V
Range	–10 to +10 V
Default Value	0
Data Type	Float
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3470h/3	M_01-00-00-000
Modbus	32 (64-bit)	M_01-03-00-000

Description

AOUT.VALUEU reads/writes the analog output value when AOUT.MODE = 0 (analog output signal is determined by the user).

Related Topics

10.5 Analog Output

AOUT.VSCALE

General Information	
Type	NV Parameter
Description	Sets velocity scale factor for analog output.
Units	Depends on UNIT.VROTARY or UNIT.ACCLINEAR Rotary: rpm/V, rps/V, (deg/s)/V, [(PIN/POUT)/s]/V, (rad/s)/V Linear: counts/s/V, (mm/s)/V, (µm/s)/V, [(PIN/POUT)/s]/V
Range	Rotary: 0.060 to 60,000 rpm/V 0.001 to 1,000 rps/V 0.359 to 360,000 (deg/s)/V 0.005 to 5,000 [(PIN/POUT)/s]/V 0.006 to 6,283.186 (rad/s)/V Linear: 0.001 to 1.000 counts/s/V 0.001*MOTOR.PITCH to 1,000.000*MOTOR.PITCH (mm/s)/V 0.998*MOTOR.PITCH to 1,000,000.000*MOTOR.PITCH (µm/s)/V 0.005 to 5,000 [(PIN/POUT)/s]/V
Default Value	Rotary: 0.060 rpm/V 0.001 rps/V 0.359 (deg/s)/V 0.005 [(PIN/POUT)/s]/V 0.006 (rad/s)/V Linear: 0.001 counts/s/V 0.001*MOTOR.PITCH (mm/s)/V 0.998*MOTOR.PITCH (µm/s)/V 0.005 [(PIN/POUT)/s]/V
Data Type	Float
See Also	AOUT.VALUE
Start Version	M_01-01-01-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3470h/5	M_01-00-00-000
Modbus	36	M_01-03-00-000

Description

AOUT.VSCALE is an analog velocity scale factor that scales the analog output (AOUT.VALUE) for AOUT.MODE = 1, 2, or 3. The value entered is the motor velocity per 10 V of analog output. This value may be either higher or lower than the application velocity limit (VL.LIMITP or VL.LIMITN), but the actual analog I/O will be limited by VL.LIMITP or VL.LIMITN.

BODE Parameters

BODE.EXCITEGAP

General Information	
Type	R/W Parameter
Description	Controls how often the excitation is updated.
Units	Drive samples
Range	1 to 255 drive samples
Default Value	2 drive samples
Data Type	N/A
See Also	BODE.MODE
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	38	M_01-03-00-000

Description

BODE.EXCITEGAP controls how often the excitation is updated. The excitation is updated every n drive samples, where n is BODE.EXCITEGAP. For example, if BODE.EXCITEGAP = 2, then the excitation is updated every 2/(16,000 Hz) = 1/8,000 Hz = 0.000125 sec. When measuring a system, update the excitation only as often as the data is recorded.

Example

Set excitation update rate to 8,000 Hz:

```
-->BODE.EXCITEGAP 2
```

Set excitation update rate to 4,000 Hz:

```
-->BODE.EXCITEGAP 4
```

Get excitation update rate (already set to 8000 Hz):

```
-->BODE.EXCITEGAP 2
```

Related Topics

14.3 Using the Autotuner

14.3.4 Using the Autotuner: Advanced

15 Scope

1.2.1.5 Bode (set command source)

6.5 Settings

126

Error: Invalid Bode plot mode for this function. and other errors)

BODE.FREQ

General Information	
Type	R/W Parameter
Description	Sets the frequency of the sine excitation source.
Units	Hz
Range	0 to 8,000 Hz
Default Value	0 Hz
Data Type	Float
See Also	BODE.MODE BODE.INJECTPOINT, BODE.IAMP, BODE.VAMP
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	40	M_01-03-00-000

Description

BODE.FREQ sets the frequency of the sine excitation source in Hz. The sine excitation source is used to take frequency response measurements of a system.

Example

Setting up a sine excitation source of 0.2 A at 50 Hz:

```
-->BODE.INJECTPOINT 1
-->BODE.IAMP 0.2
-->BODE.FREQ 50.0
-->BODE.MODE 2
```

Related Topics

14.3 Using the Autotuner

14.3.4 Using the Autotuner: Advanced

15 Scope

1.2.1.5 Bode (set command source)

6.5 Settings

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Error: Invalid Bode plot mode for this function. and others)

BODE.IAMP

General Information	
Type	R/W Parameter
Description	Sets current command value used during the Bode procedure.
Units	A
Range	+/- Combined drive and motor current limit
Default Value	0.2 A
Data Type	Float
See Also	BODE.INJECTPOINT, BODE.FREQ
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	42	M_01-03-00-000

Description

BODE.IAMP sets the amplitude of the excitation when in current mode as set in BODE.INJECTPOINT. When using BODE.MODE = 1 and BODE.INJECTPOINT = 1, this parameter will determine the level of noise injected to commanded current value.

Example

Set the excitation current to 0.2 A:

```
-->BODE.IAMP 0.2
```

Get the excitation current (already set to 0.2 A):

```
-->BODE.IAMP 0.200 [A]
```

Related Topics

14.3 Using the Autotuner

14.3.4 Using the Autotuner: Advanced

15 Scope

1.2.1.5 Bode (set command source)

6.5 Settings

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Error: Invalid Bode plot mode for this function. and others)

BODE.IFLIMIT

General Information	
Type	R/W Parameter
Description	Sets the current fault duration limit in seconds for the BODE.MODE 5 stability test.
Units	s
Range	0.001 to 60.000
Default Value	0
Data Type	Decimal
See Also	BODE.MODE,BODE.MODETIMER, BODE.IFTHRESH, BODE.VFLIMIT, BODE.VFTHRESH
Start Version	M_01-02-10-000

Description

When BODE.MODE is set to 5, the firmware monitors the drive current (IL.CMD). When IL.CMD goes above BODE.IFTHRESH, an internal counter records the length of time IL.CMD was above BODE.IFTHRESH. If the internal counter reaches BODE.IFLIMIT, Fault 133 – Instability during Autotune will be generated.

The smaller BODE.IFLIMIT, the quicker Fault 133 will be generated when IL.CMD exceeds BODE.IFLIMIT.

Example

Set BODE.IFTHRESH to 6 Amps:

```
-->BODE.IFTHRESH 6
```

Set BODE.IFLIMIT to 0.500 seconds:

```
-->BODE.IFLIMIT 0.5
```

Set BODE.MODE to 5 to enable stability detection:

```
BODE.MODE 5
```

Related Topics

14.3 Using the Autotuner

14.3.4 Using the Autotuner: Advanced

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BODE.IFTHRESH

General Information	
Type	R/W Parameter
Description	Sets the current fault threshold for the BODE.MODE 5 stability test.
Units	A
Range	0.001 to DRV.IPEAK or MOTOR.IPEAK (whichever is lowest) A
Default Value	0 A
Data Type	Decimal
See Also	BODE.MODE,BODE.MODETIMER, BODE.VFLIMIT, BODE.VFTHRESH , BODE.IFLIMIT
Start Version	M_01-02-10-000

Description

When BODE.MODE is set to 5, the firmware monitors the drive current (IL.CMD). When IL.CMD goes above BODE.IFTHRESH, an internal counter records the length of time IL.CMD was above BODE.IFTHRESH. If the internal counter reaches BODE.IFLIMIT, Fault 133 (Instability during Autotune) is generated.

Example

Set BODE.IFTHRESH to 6 Amps:

```
-->BODE.IFTHRESH 6
```

Set BODE.IFLIMIT to 0.500 seconds:

```
-->BODE.IFLIMIT 0.5
```

Set BODE.MODE to 5 to enable stability detection:

```
BODE.MODE 5
```

Related Topics

14.3 Using the Autotuner

14.3.4 Using the Autotuner: Advanced

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BODE.INJECTPOINT

General Information	
Type	R/W Parameter
Description	Sets whether the excitation uses current or velocity excitation type.
Units	N/A
Range	0 to 2
Default Value	0
Data Type	Integer
See Also	BODE.IAMP, BODE.MODE, BODE.VAMP
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	44	M_01-03-00-000

Description

BODE.INJECTPOINT sets whether the excitation uses current or velocity excitation type.

BODE.INJECTPOINT	Description
0	None
1	Current
2	Velocity

Example

Set BODE.INJECTPOINT to current:

```
-->BODE.INJECTPOINT 1
```

Get BODE.INJECTPOINT (already set to current):

```
-->BODE.INJECTPOINT 1
```

Related Topics

14.3 Using the Autotuner

14.3.4 Using the Autotuner: Advanced

15 Scope

1.2.1.5 Bode (set command source)

6.5 Settings

126

Error: Invalid Bode plot mode for this function. and others)

BODE.MODE

General Information	
Type	R/W Parameter
Description	Sets the mode of the excitation.
Units	N/A
Range	0 to 4
Default Value	0
Data Type	Integer
See Also	BODE.INJECTPOINTBODE.VAMP
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	46	M_01-03-00-000

Description

BODE.MODE sets the mode of the excitation.. The excitation can be set to the modes shown in the table below. BODE.MODE is always set to **None** when Ethernet communication is disconnected. The peak amplitude of the excitation is set by either BODE.IAMP or BODE.VAMP (depending on BODE.INJECTPOINT).

BODE.MODE is subject to a watchdog timer (BODE.MODETIMER). If BODE.MODETIMER is 0, then BODE.MODE is not affected. If BODE.MODETIMER is set to a value greater than 0, then BODE.MODE will be set to 0 (None) after the BODE.MODETIMER time milliseconds. If you reset BODE.MODE to a non-zero value while it is already a non-zero value, this will reset the watchdog timer. This mechanism is intended to turn off the excitation signal if you lose communication with the drive.

BODE.MODE	Description	Comments
0	None	Turns all excitation off
1	PRB	Uses Pseudo Random Binary (PRB) excitation. PRB is a signal that is always +/- peak amplitude, varying only in phase. PRB excitation results in a flat excitation frequency spectrum. PRB results in a high peak excitation amplitude, which can help minimize friction in a frequency response test. PRB excitation repeats every (2^BODE.PRBDEPTH) / BODE.EXCITEGAP drive samples. This repetition can be used to reveal the effects of friction.
2	Sine	Uses Sine excitation
3	Noise	Uses random noise excitation. Noise is a random number generator that varies between +/- peak amplitude.
4	Offset	Sets a torque offset equal to BODE.IAMP

Example

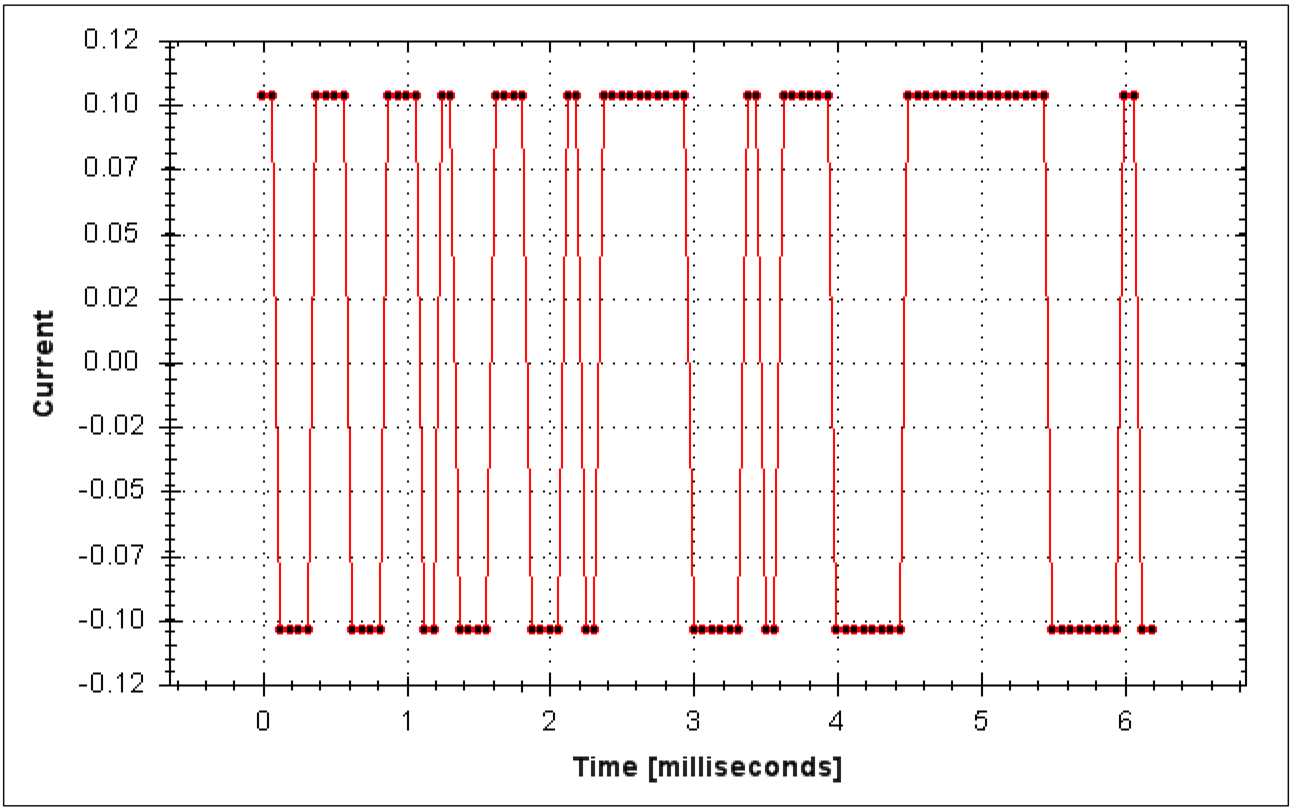
Set BODE.MODE to PRB:

```
-->BODE.MODE 1
```

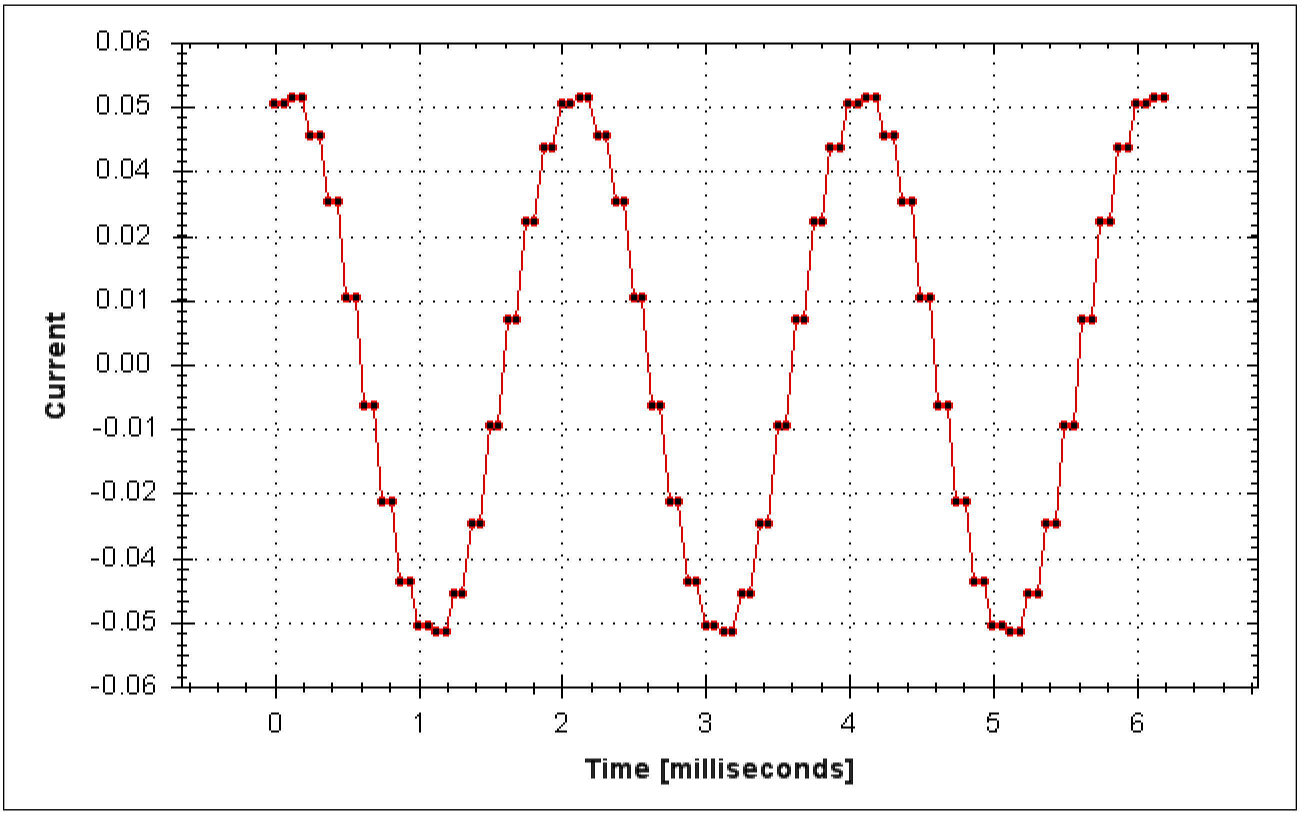
Get BODE.MODE (already set to PRB):

```
-->BODE.MODE 1
```

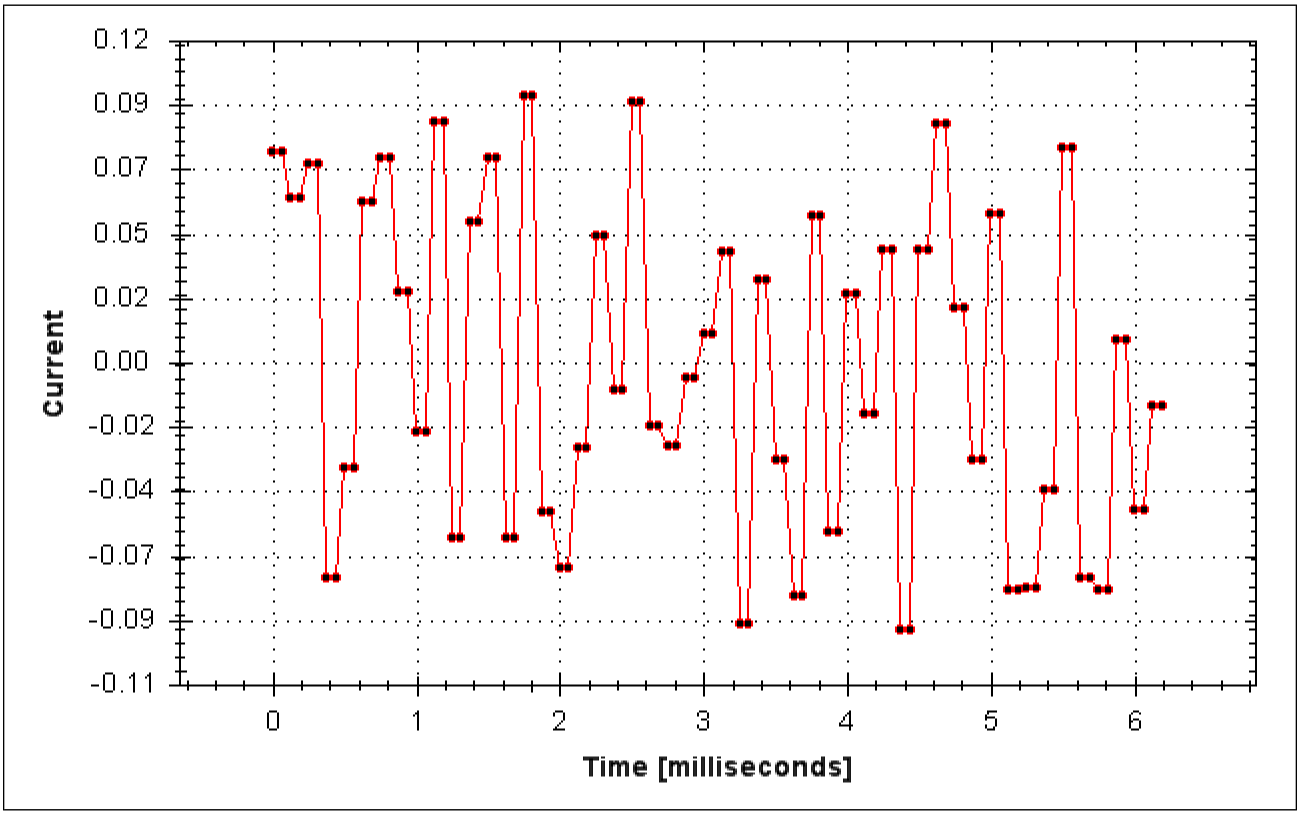
PRB excitation:



Sine excitation:



Noise excitation:



Related Topics

14.3 Using the Autotuner

14.3.4 Using the Autotuner: Advanced

15 Scope

1.2.1.5 Bode (set command source)

6.5 Settings

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Error: Invalid Bode plot mode for this function. and others)

BODE.MODETIMER

General Information	
Type	R/W Parameter
Description	Sets the watchdog timer of the excitation.
Units	ms
Range	0 to 268,435,456
Default Value	0
Data Type	Integer
See Also	BODE.MODE
Start Version	M_1-03-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	48	M_01-03-00-000

Description

BODE.MODETIMER sets the watchdog timer for the excitation. This watchdog is used to automatically turn off the excitation of the system if communication is lost. It is highly recommended that you use the watchdog for any excitation measurements. The WorkBench autotuner and Bode tool automatically use these values, requiring no action from you.

If the BODE.MODETIMER is a nonzero value, the Bode watchdog is enabled. BODE.MODE will be set to 0 (None) after the BODE.MODETIMER value elapses. To reset the watchdog timer, reset BODE.MODE to a non-zero value.

BODE.MODETIMER	Comments
0	BODE.MODE is left at the value you set it to.
> 0	Uses pseudo random binary (PRB) excitation. PRB is a signal that is always +/- peak amplitude, varying only in phase. PRB excitation results in a flat excitation frequency spectrum. PRB also results in a high peak excitation amplitude, which can help minimize friction in a frequency response test. PRB excitation repeats every (2^BODE.PRBDEPTH)/BODE.EXCITEGAP drive samples. This repetition can be used to reveal the effects of friction.

Example

Disable BODE.MODETIMER:

-->BODE.MODETIMER //

Set to 0 to disable the watchdog

0

-->BODE.MODE // Observe starting state of the Bode mode

0

-->BODE.MODE 1 // Set Bode mode to PRB

-->BODE.MODE // Observe Bode mode state is the same after 0.5 seconds

1

-->BODE.MODE // Observe Bode mode state is the same after 10 seconds

1

Enable BODE.MODETIMER:

-->BODE.MODETIMER 1000 // Set watchdog to 1 second

-->BODE.MODE 1 // Set Bode mode to PRB

-->BODE.MODE // Observe Bode mode state is the same after 0.5 seconds

1

-->BODE.MODE // Observe Bode mode state has been set to zero after 1.0 seconds

0

Enable and reenable BODE.MODETIMER:

-->BODE.MODETIMER 2500 // Set watchdog to 2.5 seconds

-->BODE.MODE 1 // Set Bode mode to PRB

-->BODE.MODE // Observe Bode mode state is the same after 1.5 seconds

1

-->BODE.MODE 1 // Set Bode mode to PRB, resetting the watchdog timer to the original 2.5 second value set above.

-->BODE.MODE // Observe Bode mode state is the same after 3.0 seconds after the original enabling of BODE.MODE 1

-->BODE.MODE // Observe Bode mode state has been set to zero after 4.0 seconds after the original enabling of BODE.MODE

0

Related Topics

14.3 Using the Autotuner

14.3.4 Using the Autotuner: Advanced

15 Scope

1.2.1.5 Bode (set command source)

6.5 Settings

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Error: Invalid Bode plot mode for this function. and others)

BODE.PRBDEPTH

General Information	
Type	R/W Parameter
Description	Sets the length of the PRB signal before it repeats.
Units	NA
Range	4 to 19
Default Value	19
Data Type	Integer
See Also	BODE.MODE, BODE.INJECTPOINT, BODE.IAMP, BODE.VAMP
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	50	M_01-03-00-000

Description

BODE.PRBDEPTH sets the length of the PRB signal before it repeats. This applies only when BODE.MODE = PRB. The PRB excitation will repeat after (2^BODE.PRBDEPTH) / BODE.EXCITEGAP drive samples.

Example

Set BODE.PRBDEPTH to 19:

```
-->BODE.PRBDEPTH 19
```

Get BODE.PRBDEPTH (already set to 19):

```
-->BODE.PRBDEPTH 19
```

Related Topics

14.3 Using the Autotuner

14.3.4 Using the Autotuner: Advanced

15 Scope

1.2.1.5 Bode (set command source)

6.5 Settings

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Error: Invalid Bode plot mode for this function. and others)

BODE.VAMP

General Information	
Type	R/W Parameter
Description	Sets the amplitude of the excitation when in velocity mode.
Units	rpm
Range	0 to maximum motor speed
Default Value	0
Data Type	Float
See Also	BODE.MODE, BODE.INJECTPOINT
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	52	M_01-03-00-000

Description

BODE.VAMP sets the amplitude of the excitation when in velocity mode as set in BODE.INJECTPOINT.

Example

Set the excitation velocity to 100 RPM

```
-->BODE.VAMP 100
```

Get the excitation velocity(already set to 100 RPM)

```
-->BODE.VAMP
100.000 [rpm]
```

Related Topics

14.3 Using the Autotuner

14.3.4 Using the Autotuner: Advanced

15 Scope

1.2.1.5 Bode (set command source)

6.5 Settings

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Error: Invalid Bode plot mode for this function. and others)

BODE.VFLIMIT

General Information	
Type	R/W Parameter
Description	Sets the velocity fault duration limit (seconds) for the BODE.MODE 5 stability test
Units	s
Range	0.001 to 60.000
Default Value	0
Data Type	Decimal
See Also	BODE.MODE, BODE.MODETIMER, BODE.IFLIMIT, BODE.IFTHRESH, BODE.VFTHRESH
Start Version	M_01-02-10-000

Description

When BODE.MODE is set to 5, the firmware monitors the drive feedback velocity VL.FB. When VL.FB goes above BODE.VFTHRESH, an internal counter records the length of time VL.FB was above BODE.VFTHRESH. If the internal counter reaches BODE.VFLIMIT, Fault 133 – Instability during Autotune will be generated.

The smaller BODE.VFLIMIT, the quicker Fault 133 will be generated when VL.FB exceeds BODE.VFLIMIT.

Example

Set BODE.VFTHRESH to 10 RPM:

```
-->BODE.VFTHRESH 10
```

Set BODE.VFLIMIT to 0.500 seconds

```
-->BODE.VFLIMIT 0.5
```

Set BODE.MODE to 5 to enable stability detection

```
-->BODE.MODE 5
```

Related Topics

14.3 Using the Autotuner

14.3.4 Using the Autotuner: Advanced

133

BODE.VFTHRESH

General Information	
Type	R/W Parameter
Description	Sets the current fault threshold for the BODE.MODE 5 stability test.
Units	rpm (or user selected units)
Range	0.001 to MOTOR.VMAX
Default Value	0
Data Type	Decimal
See Also	BODE.MODE, BODE.MODETIMER, BODE.IFLIMIT, BODE.I-FTHRESH, BODE.VFLIMIT
Start Version	M_01-02-10-000

Description

When BODE.MODE is set to 5, the firmware monitors the drive feedback velocity VL.FB. When VL.FB goes above BODE.VFTHRESH, an internal counter records the length of time VL.FB was above BODE.VFTHRESH. If the internal counter reaches BODE.VFLIMIT, Fault 133 – Instability during Autotune will be generated.

The smaller BODE.VFLIMIT, the quicker Fault 133 will be generated when VL.FB exceeds BODE.VFLIMIT.

Example

Set BODE.VFTHRESH to 10 RPM:

```
-->BODE.VFTHRESH 10
```

Set BODE.VFLIMIT to 0.500 seconds:

```
-->BODE.VFLIMIT 0.5
```

Set BODE.MODE to 5 to enable stability detection:

```
-->BODE.MODE 5
```

Related Topics

14.3 Using the Autotuner

14.3.4 Using the Autotuner: Advanced

133

CAP Parameters

CAP0.EDGE, CAP1.EDGE

General Information	
Type	R/W Parameter
Description	Selects the capture edge.
Units	N/A
Range	1 to 3
Default Value	1
Data Type	U8
See Also	CAP0.PREEDGE, CAP1.PREEDGE
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex		Object Start Version
Modbus	54 80	CAP0.EDGE CAP1.EDGE	M_01-03-00-000

Description

The filtered trigger source is monitored for rising edge, falling edge, or both edges. The event mode logic may ignore the precondition edge detection; however, the trigger always uses edge detection.

The precondition logic has an identical feature controlled by CAP0.PREEDGE, CAP1.PREEDGE.

Value	Description
0	Reserved
1	Rising edge
2	Falling edge
3	Both edges

Related Topics

8.11 Using Position Capture

CAP0.EN, CAP1.EN

General Information	
Type	R/W Parameter
Description	Enables or disables the related capture engine.
Units	N/A
Range	0 to 1
Default Value	0
Data Type	Boolean
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex		Object Start Version
Modbus	56 82	CAP0.EN CAP1.EN	M_01-03-00-000

Description

This parameter enables or disables the related capture engine. After each successful capture event, this parameter is reset to 0 and must be activated again for the next capture. Also note that CAP0.PLFB, CAP1.PLFB is set to 0 when this parameter is set to 1.

0 = Disable

1 = Enable

Related Topics

8.11 Using Position Capture

CAP0.EVENT, CAP1.EVENT

General Information	
Type	R/W Parameter
Description	Controls the precondition logic.
Units	N/A
Range	0 to 3
Default Value	0
Data Type	U8
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex		Object Start Version
EtherCAT COE and CANopen	3460h/5 3460h/6	CAP0.EVENT CAP1.EVENT	M_01-00-00-000
Modbus	58 84	CAP0.EVENT CAP1.EVENT	M_01-03-00-000

Description

The event mode controls use of the precondition logic. The four event modes are listed below.

Event	Description
0	Trigger Event = Trigger edge (ignore precondition)
1	Trigger Event = Trigger edge after precondition edge
2	Trigger Event = Trigger edge while precondition = 1
3	Trigger Event = Trigger edge while precondition = 0

Example

Event 0

The following diagram shows an example of Event = 0 (trigger on edge, trigger edge = rising). In this mode, the precondition logic is ignored.

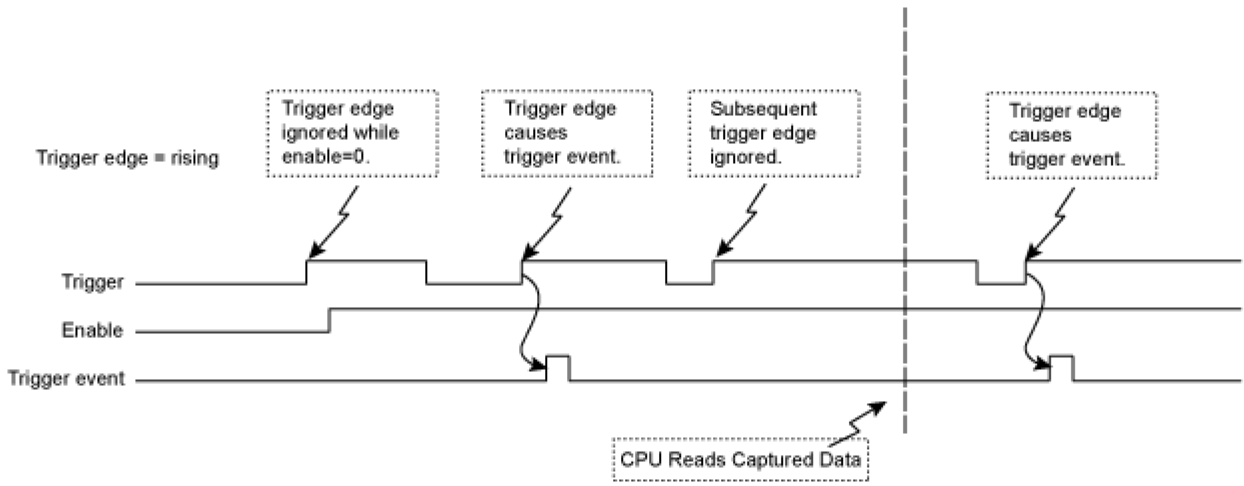


Figure 1: Trigger Edge Mode

Events 2 and 3 (Trigger edge while precondition = 0 or 1)

In these events, the precondition logic samples the current (post-filter) state of the selected precondition source input. The capture engine looks for a trigger edge while the precondition input is at a "1" or "0" state.

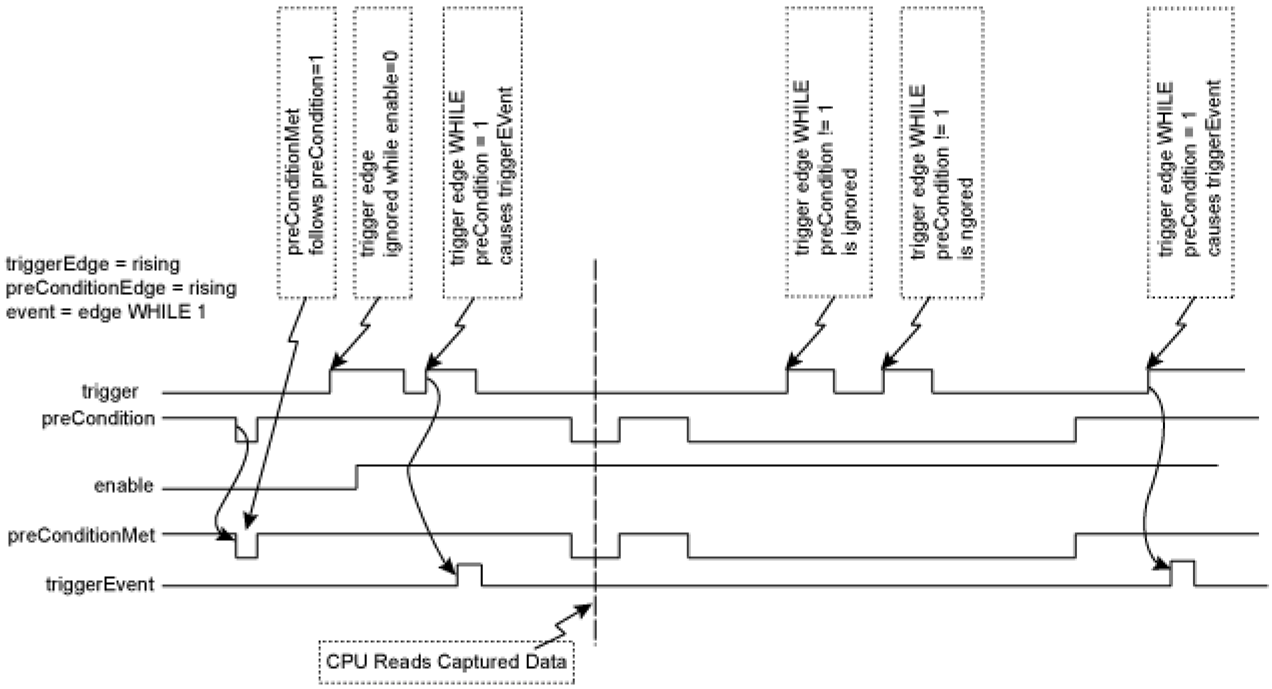


Figure 2: Trigger edge WHILE precondition edge

Event 1 (Trigger edge after precondition)

In this event, each trigger event requires Enable=1, a new precondition edge, followed by a new trigger edge. The sequence requirements are shown in the figure below.

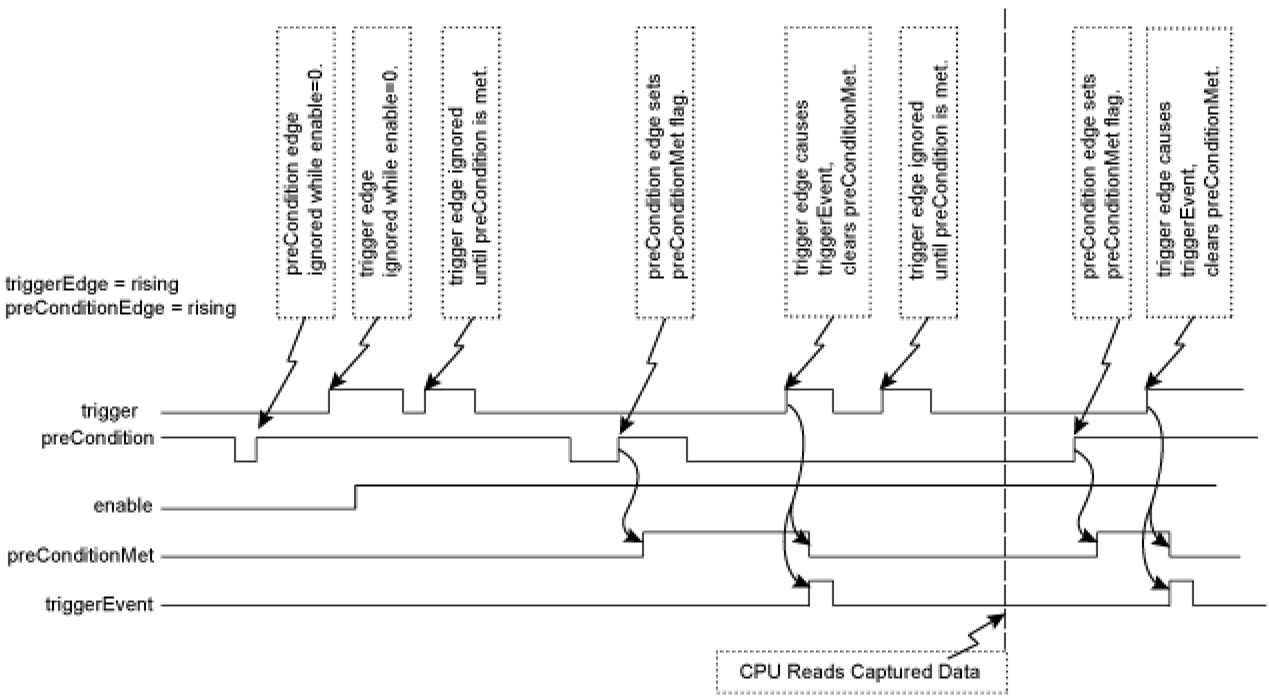


Figure 3: Trigger edge after precondition edge

Note: If the precondition and trigger edges occur at the same time, it is not a valid trigger event. A subsequent trigger edge must occur after the precondition edge. The same time resolves to a single 40 ns clock tick in the trigger event logic (after the optional filter function as well as any sensor, cable, or noise delays).

Related Topics

8.11 Using Position Capture

CAP0.FILTER, CAP1.FILTER

General Information	
Type	R/W Parameter
Description	Sets the filter for the capture source input.
Units	N/A
Range	0 to 2
Default Value	0
Data Type	U8
See Also	CAP0.PREFILTER, CAP1.PREFILTER
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex		Object Start Version
Modbus	60 86	CAP0.FILTER CAP1.FILTER	M_01-03-00-000

Description

An optional glitch filter may be used to debounce the input trigger signals. By default the filter is disabled. A 0.6 µs filter may be selected for fast signals such as RS422, or fast opto. A 40 µs filter may be selected for slow opto inputs. Exact values for each filter mode are listed below (the precondition logic has an identical filter).

Filter Mode (if no glitch)	Trigger Filter (filter clock enable period)	Filter Delay			
		Min (µs)	Typical (µs)	Max (µs)	(µs)
off	0	N/A	N/A	N/A	N/A
(default)	0	0	0	N/A	N/A
fast	1	0.56	0.6	0.64	0.80
slow	2	35.84	38.4	40.96	5.12

The filter uses seven stages of delay when enabled. An input glitch restarts the filter delay. The clock enable period for the seven stage filter is set to 0.080 us for the fast filter, 5.12 us for the slow filter. The filter delay for a clean input edge is therefore an average of 7.5 periods (+/-0.5 period for worst case).

Related Topics

8.11 Using Position Capture

CAP0.MODE, CAP1.MODE

General Information	
Type	NV Parameter
Description	Selects the captured value.
Units	N/A
Range	0 to 3
Default Value	0
Data Type	U8
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex		Object Start Version
EtherCAT COE and CANopen	3460h/3 3460h/4	CAP0.MODE CAP1.MODE	M_01-00-00-000
Modbus	62 88	CAP0.MODE CAP1.MODE	M_01-03-00-000

Description

Mode 0 is the standard position capture which stores PL.FB. Data can be retrieved with CAP0.PLFB, CAP1.PLFB.

Mode 1 is the drive internal time capture. Data can be retrieved with CAP0.T, CAP1.T.

Mode 2 is the KAS EtherCAT distributed clock time (DCT) capture. Instead of using a position value, the DCT is calculated. There is no user parameter to retrieve the captured DCT. Attempting to set Mode = 2 with anything other than an EtherCAT system will result in an invalid parameter error.

Mode 3 is capture of primary encoder signal. It is used to home onto a feedback index.This mode sets other parameters needed for this mode. These parameters can be changed later, but this is not recommended unless your input source of the index signal varies. Parameters set in this mode are:

- CAPx.TRIGGER 10: index mark of primary encoder
- CAPx.EDGE 1: rising edge
- CAPx.EVENT 0: ignore precondition

Also the capture engine is immediately enabled and is continuously triggered again.

Related Topics

8.11 Using Position Capture

CAP0.PLFB, CAP1.PLFB

General Information	
Type	R/O Parameter
Description	Reads captured position value.
Units	Depends on UNIT.PROTARY or UNIT.PLINEAR Rotary: counts, rad, deg, PIN/POUT, 16-bit counts Linear: counts, mm, µm, PIN/POUT, 16-bit counts
Range	Full range of a signed 64 bit variable
Default Value	0
Data Type	S64
See Also	UNIT.PROTARY, UNIT.PLINEAR
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex		Object Start Version
EtherCAT COE and CANopen	20A0h/0 20A1h/0 20A2h/0 20A3h/0	CAP0.PLFB CAP0.PLFB CAP1.PLFB CAP1.PLFB	M_01-00-00-000
Modbus	64 (64-bit) 90 (64-bit)	CAP0.PLFB CAP1.PLFB	M_01-03-00-000

Description

This parameter reads the captured position value scaled to actual set units. See UNIT.PROTARY or UNIT.PIN for these units.

Related Topics

8.11 Using Position Capture

CAP0.PREEDGE, CAP1.PREEDGE

General Information	
Type	R/W Parameter
Description	Selects the capture precondition edge.
Units	N/A
Range	1 to 3
Default Value	1
Data Type	U8
See Also	CAP0.EDGE, CAP1.EDGE
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex		Object Start Version
EtherCAT COE and CANopen	3460h/7 3460h/8	CAP0.PREEDGE CAP1.PREEDGE	M_01-00-00-000
Modbus	68 94	CAP0.PREEDGE CAP1.PREEDGE	M_01-03-00-000

Description

The precondition edge is monitored for rising edge, falling edge, or both. The event mode logic may ignore the precondition edge detection (trigger always uses edge detection).

The filtered trigger source has an identical feature controlled by CAP0.EDGE, CAP1.EDGE.

Value	Description
0	Reserved
1	Rising edge
2	Falling edge
3	Both edges

Related Topics

8.11 Using Position Capture

CAP0.PREFILTER, CAP1.PREFILTER

General Information	
Type	R/W Parameter
Description	Sets the filter for the precondition input source.
Units	N/A
Range	0 to 2
Default Value	0
Data Type	U8
See Also	CAP0.FILTER, CAP1.FILTER
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	70 CAP0.PREFILTER 96 CAP1.PREFILTER	M_01-03-00-000

Description

You can use an optional glitch filter to debounce the input trigger signals. By default the filter is disabled. A 0.6 us filter may be selected for fast signals such as RS422, or fast opto. A 40 us filter may be selected for slow opto inputs. Exact values for each filter mode are listed below.

Filter (if no glitch)	Trigger Filter (filter clock enable period)	Filter Delay (us)			
		Min	**Typ**	**Max**	
off	0	N/A	N/A	N/A	N/A
(default)	0	0	0	N/A	N/A
fast	1	0.56	0.6	0.64	0.80
slow	2	35.84	38.4	40.96	5.12

The filter uses seven stages of delay when enabled. An input glitch restarts the filter delay. The clock enable period for the seven-stage filter is set to 0.080 us for the fast filter, 5.12 us for the slow filter. The filter delay for a clean input edge is therefore an average of 7.5 periods (+/- 0.5 period for worst case).

Related Topics

8.11 Using Position Capture

CAP0.PRESELECT, CAP1.PRESELECT

General Information	
Type	R/W Parameter
Description	Sets the precondition trigger.
Units	N/A
Range	0 to 11
Default Value	0
Data Type	U8
See Also	CAP0.TRIGGER, CAP1.TRIGGER
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex		Object Start Version
EtherCAT COE and CANopen	3460h/9 3460h/10	CAP0.PRESELECT CAP1.PRESELECT	M_01-00-00-000
Modbus	72 98	CAP0.PRESELECT CAP1.PRESELECT	M_01-03-00-000

Description

This parameter specifies the input signal for the precondition trigger.

Trigger Source	Input Name
0	General Input 1
1	General Input 2
2	General Input 3
3	General Input 4
4	General Input 5
5	General Input 6
6	General Input 7
7	RS485 Input 1
8	RS485 Input 2
9	RS485 Input 3
10	Primary Index
11	Tertiary Index

Related Topics

8.11 Using Position Capture

CAP0.STATE, CAP1.STATE

General Information	
Type	R/O Parameter
Description	Indicates whether or not trigger source was captured.
Units	N/A
Range	0 to 1
Default Value	0
Data Type	Boolean
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex		Object Start Version
Modbus	74	CAP.STATE	M_01-03-00-000
	100	CAP1.STATE	

Description

When enabling the capture (CAP0.EN, CAP1.EN), this parameter is set to 0 until the next event is captured.

0 = Not captured

1 = Captured

Related Topics

8.11 Using Position Capture

CAP0.T, CAP1.T

General Information	
Type	R/O Parameter
Description	Reads time capture (if time capture was configured).
Units	ns
Range	N/A
Default Value	N/A
Data Type	U32
See Also	CAP0.MODE, CAP1.MODE
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	20A0h/0 CAP0.T 20A1h CAP0.T 20A2h/0 CAP1.T 20A3h/0 CAP1.T	M_01-00-00-000
Modbus	76 CAP0.T 102 CAP1.T	M_01-03-00-000

Description

If time capture was configured, the captured time is stored in this parameter. The reference time is the occurrence of the last MTS signal (recurring every 62.5 µs), so this is a purely drive internal time.

Related Topics

8.11 Using Position Capture

CAP0.TRIGGER, CAP1.TRIGGER

General Information	
Type	R/W Parameter
Description	Specifies the trigger source for the position capture.
Units	N/A
Range	0 to 11
Default Value	0
Data Type	U8
See Also	CAP0.PRESELECT, CAP1.PRESELECT
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex		Object Start Version
EtherCAT COE and CANopen	3460h/1 3460h/2	CAP0.TRIGGER CAP1.TRIGGER	M_01-00-00-000
Modbus	78 104	CAP0.TRIGGER CAP1.TRIGGER	M_01-03-00-000

Description

This parameter specifies the trigger source (capture input signal).

Trigger Source	Input Name
0	General Input 1
1	General Input 2
2	General Input 3
3	General Input 4
4	General Input 5
5	General Input 6
6	General Input 7
7	RS485 Input 1
8	RS485 Input 2
9	RS485 Input 3
10	Primary Index
11	Tertiary Index

Related Topics

8.11 Using Position Capture

CS Parameters

Controlled stop (CS) parameters set the values for the controlled stop process.

CS.DEC

General Information	
Type	NV Parameter
Description	Sets the deceleration value for the controlled stop process.
Units	Depends on UNIT.ACCROTARY or UNIT.ACCLINEAR Rotary: rps/s, rpm/s, deg/s^2, (PIN/POUT)/s^2, rad/s^2 Linear: counts/s^2, mm/s^2, µm/s^2, (PIN/POUT)/s^2
Range	Rotary: 0.031 to 833,333.333 rps/s 1.860 to 50,000,000.000 rpm/s 11.158 to 300,000,000.000 deg/s^2 0.155 to 4,166,666.752 (PIN/POUT)/s^2 0.195 to 5,235,987.968 rad/s^2 Linear: 0.000 to 833.333 counts/s^2 0.031*MOTOR.PITCH to 833333.333*MOTOR.PITCH mm/s^2 30.994*MOTOR.PITCH to 833333333.333*MOTOR.PITCH µm/s^2 0.155 to 4,166,666.667 (PIN/POUT)/s^2
Default Value	Rotary: 166.714 rps/s 10,002.851 rpm/s 60.017.108 deg/s^2 833.571 (PIN/POUT)/s^2 1,047.496 rad/s^2 Linear: 0.166 counts/s^2 166.714*MOTOR.PITCHMOTOR.PITCH mm/s^2 166,714.191*MOTOR.PITCHMOTOR.PITCH µm/s^2 833.571 (PIN/POUT)/s^2
Data Type	Float
See Also	CS.VTHRESH, CS.TO, DRV.DIS, DIN1.MODE TO DIN7.MODE, DRV.DISMODE, DRV.DISSOURCES
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3440h/1	M_01-00-00-000
Modbus	106 (64-bit)	M_01-03-00-000

Description

This parameter sets the deceleration value for the controlled stop process.

Related Topics

10.10 Controlled Stop
10.1 Digital Inputs and Outputs
17.1 Fault and Warning Messages (this table indicates faults for which a controlled stop occurs)

CS.STATE

General Information	
Type	R/O Parameter
Description	Returns the internal status of the controlled stop process.
Units	N/A
Range	N/A
Default Value	N/A
Data Type	N/A
See Also	CS.DEC, CS.VTHRESH, CS.TODRV.DISMODE, DRV.DISSOURCES
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3441h/0	M_01-00-00-000
Modbus	110	M_01-03-00-000

Description

CS.STATE returns the internal state machine value of the controlled stop.

0 = controlled stop is not occurring.

1 = controlled stop is occurring

Related Topics

10.10 Controlled Stop

10.1 Digital Inputs and Outputs

17.1 Fault and Warning Messages (this table indicates faults for which a controlled stop occurs)

CS.TO

General Information	
Type	NV Parameter
Description	Sets the time value for the drive velocity to be within CS.VTHRESH.
Units	ms
Range	1 to 30,000 ms
Default Value	6 ms
Data Type	Integer
See Also	CS.DEC, CS.VTHRESH, CS.STATE, DRV.DIS, DIN1.MODE TO DIN7.MODE, DRV.DISMODE, DRV.DISSOURCES
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3440h/3	M_01-00-00-000
Modbus	112	M_01-03-00-000

Description

CS.TO is the time value for the drive velocity to be within CS.VTHRESH before the drive disables.

Example

Set time value to 100 ms:

```
-->CS.TO 100
```

Related Topics

10.10 Controlled Stop

10.1 Digital Inputs and Outputs

17.1 Fault and Warning Messages (this table indicates faults for which a controlled stop occurs)

CS.VTHRESH

General Information	
Type	NV Parameter
Description	Sets the velocity threshold for the controlled stop.
Units	rpm, rps, deg/s, (PIN/POUT)/s
Range	0 to 200 rpm
Default Value	5 rpm
Data Type	Float
See Also	CS.DEC, CS.TO, CS.STATE DRV.DIS, DIN1.MODE TO DIN7.MODE, DRV.DISMODE, DRV.DISSOURCES
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT and CANopen	3440h/2	M_01-00-00-000
Modbus	114	M_01-03-00-000

Description

CS.VTHRESH is the velocity threshold for the controlled stop algorithm.

Example

Set velocity threshold for controlled stop at 100 rpm:

```
-->CS.VTHRESH 100
```

Related Topics

10.10 Controlled Stop

10.1 Digital Inputs and Outputs

17.1 Fault and Warning Messages (this table indicates faults for which a controlled stop occurs)

DIN Parameters

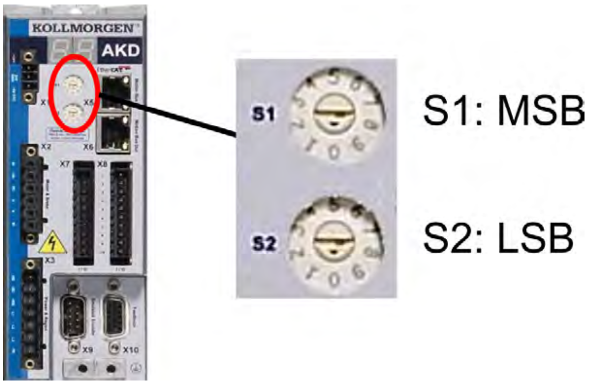
DIN.ROTARY

General Information	
Type	R/O Parameter
Description	Reads the rotary knob value.
Units	N/A
Range	0 to 99
Default Value	N/A
Data Type	Integer
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	116	M_01-03-00-000

Description

DIN.ROTARY reads the rotary knob value.



Related Topics

10.1 Digital Inputs and Outputs

DIN.STATES

General Information	
Type	R/O Parameter
Description	Reads the digital input states.
Units	N/A
Range	0000000 to 1111111
Default Value	N/A
Data Type	String
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	118	M_01-03-00-000

Description

DIN.STATES reads the states of the seven digital inputs. The leftmost bit represents digital input 1 (DIN1) and the rightmost bit represents digital input 7 (DIN7).

Related Topics

10.1 Digital Inputs and Outputs

DIN1.INV TO DIN7.INV

General Information	
Type	R/W Parameter
Description	Sets the indicated the polarity of a digital input mode.
Units	N/A
Range	0 to 1
Default Value	0
Data Type	Boolean
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex		Object Start Version
Modbus	120	DIN1.INV	M_01-03-00-000
	130	DIN2.INV	
	140	DIN3.INV	
	150	DIN4.INV	
	160	DIN5.INV	
	170	DIN6.INV	
	180	DIN7.INV	

Description

Sets the indicated the polarity of a digital input mode.

Example

DIN1.INV = 0 : Input is active high.

DIN1.INV = 1 : Input is active low.

Related Topics

10.1 Digital Inputs and Outputs

DIN1.MODE TO DIN7.MODE

General Information	
Type	R/W Parameter
Description	Sets the digital input modes.
Units	N/A
Range	0 to 22
Default Value	0
Data Type	Integer
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3562h/0 DIN1.MODE 3565h/0 DIN2.MODE 3568h/0 DIN3.MODE 356Bh/0 DIN4.MODE 36F6h/0 DIN5.MODE 36F9h/0 DIN6.MODE 36FCh/0 DIN7.MODE 60FDh/0 DIN1.MODE TO DIN7.MODE	M_01-00-00-000
Modbus	122 DIN1.MODE 132 DIN2.MODE 142 DIN3.MODE 152 DIN4.MODE 162 DIN5.MODE 172 DIN6.MODE 182 DIN7.MODE	M_01-03-00-000

Description

DIN1.MODE to DIN7.MODE parameters set the functionality of the digital inputs 1 through 7. Digital inputs and corresponding X7 and X8 pin connectors are described in the *AKD Installation Manual*, section 8.16.4, Digital Inputs. The table below summarizes the digital input modes; for detailed descriptions of each mode, see 10.1 Digital Inputs and Outputs.

DINx.MODE	Description	Task
0	No function; off	0 - None
1	Fault reset	1 - Background
2	Start motion task (use DINx.PARAM for this task)	2 - 1 KHz
3	Motion task select bit (see Motion Tasks)	3 - Background
4	Motion task start selected (see Motion Tasks)	4 - 1 kHz
5	Start home (see Homing)	5 - Background
6	Start jog	6 - Background
7	Reserved	7 - Background
8	Zero latch	8 - Background
9	Command buffer	9 - Background
10	Control fault relay	10 - Background
11	Home reference	11 - 1 kHz
12	Reserved	12 - None

DINx.MODE	Description	Task
13	Controlled stop (see Controlled Stop)	13 - 1 kHz
14	Reserved	14 - None
15	Quick stop	15 - Background
16	Activate electronic gearing (see Electronic Gearing)	16 - Background
17	Activate electronic gear position shift	17 - Background
18	Positive limit switch	18 - 4kHz
19	Negative limit switch	19 - 4kHz
20	Brake release	20 - Background
21	Current limit	21 - 4kHz
22	Opmode and Command Source switch	22 - Background

Related Topics

10.2 Command Buffer

10.1 Digital Inputs and Outputs

10.1.3 Digital Inputs

10.10 Controlled Stop

12.1 Homing

12.2 Motion Tasks

10.7 Electronic Gearing

17.2 Clearing Faults

245

CS Parameters

DIN1.PARAM TO DIN7.PARAM

General Information	
Type	R/W Parameter
Description	Sets a value used as an extra parameter for digital inputs nodes.
Units	N/A
Range	-9,223,372,036,854,775,000 to +9,223,372,036,854,775,000
Default Value	0
Data Type	Float
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex		Object Start Version
Modbus	124 (64-bit)	DIN1.PARAM	M_01-03-00-000
	134 (64-bit)	DIN2.PARAM	
	144 (64-bit)	DIN3.PARAM	
	154 (64-bit)	DIN4.PARAM	
	164 (64-bit)	DIN5.PARAM	
	174 (64-bit)	DIN6.PARAM	
	184 (64-bit)	DIN7.PARAM	

Description

This parameter sets a value that is used as an extra parameter for digital inputs nodes.

Example

The digital input mode "Start motion task" is used to start a motion task. This mode uses an extra parameter as the ID of the motion task to be started.

Related Topics

10.1 Digital Inputs and Outputs

DIN1.STATE TO DIN7.STATE

General Information	
Type	R/O Parameter
Description	Reads a specific digital input state.
Units	N/A
Range	0 to 1
Default Value	N/A
Data Type	Boolean
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex		Object Start Version
Modbus	128	DIN1.STATE	M_01-03-00-000
	138	DIN2.STATE	
	148	DIN3.STATE	
	158	DIN4.STATE	
	168	DIN5.STATE	
	178	DIN6.STATE	
	188	DIN7.STATE	

Description

DIN1.STATE to DIN7.STATE reads the state of one digital input according to the number identified in the command.

Related Topics

10.1 Digital Inputs and Outputs

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DOUT Parameters

DOUT.CTRL

General Information	
Type	NV Parameter
Description	Sets the source of digital outputs (firmware or fieldbus).
Units	N/A
Range	0 to 1
Default Value	0
Data Type	Boolean
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	190	M_01-03-00-000

Description

DOUT.CTRL sets the source of the digital outputs:

0 = Firmware controlled

1 = Fieldbus controlled

Related Topics

10.1.4 Digital Outputs

DOUT.RELAYMODE

General Information	
Type	R/W Parameter
Description	Indicates faults relay mode.
Units	N/A
Range	0 to 1
Default Value	0
Data Type	Boolean
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	192	M_01-03-00-000

Description

DOUT.RELAYMODE indicates the faults relay mode as follows:

If DOUT.RELAYMODE= 0 and faults exist, then the relay is open.
If DOUT.RELAYMODE= 0 and faults do not exist, then the relay is closed.

If DOUT.RELAYMODE = 1 and the drive is disabled, then the relay is open.
If DOUT.RELAYMODE = 1 and the drive is enabled, then the relay is closed.

Related Topics

10.1.4 Digital Outputs

DOUT.STATES

General Information	
Type	R/O Parameter
Description	Reads the state of the two digital outputs.
Units	N/A
Range	0 to 11
Default Value	N/A
Data Type	String
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	194	M_01-03-00-000

Description

DOUT.STATES reads the states of the two digital outputs. The rightmost bit represents DOUT2 and the left-most bit represents DOUT1.

Related Topics

10.1.4 Digital Outputs

DOUTx.MODE

General Information	
Type	NV Parameter
Description	Sets the digital output mode.
Units	N/A
Range	0 to 14
Default Value	0
Data Type	Integer
See Also	DOUT1.PARAM AND DOUT2.PARAM
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	196 DOUT1.MODE 206 DOUT2.MODE	M_01-03-00-000

Description

DOUTx.MODE sets the functionality of the digital outputs. The table below summarizes the digital output modes; for detailed descriptions of each mode, see 10.1 Digital Inputs and Outputs.

DOUTx.MODE	Description
0	User (default = 0)
1	Mains ready
2	Software limit switch reached
3	Move complete
4	In position
5	Position greater than x
6	Position less than x
7	Drive produced warning
8	Drive enabled
10	Motor brake
11	Drive produced fault
12	Absolute velocity greater than x
13	Absolute velocity less than x
14	Homing complete
15	PLS.STATE bits or connected

Related Topics

10.1.4 Digital Outputs

DOUT1.PARAM AND DOUT2.PARAM

General Information	
Type	NV Parameter
Description	Sets extra parameters for the digital outputs.
Units	N/A
Range	DOUT1.PARAM: –357,913.941 to 357,913.941 DOUT2.PARAM: –79,164,837,199.872 to 79,164,837,199.856
Default Value	0
Data Type	Integer
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex		Object Start Version
Modbus	198 (64-bit) 208 (64-bit)	DOUT1.PARAM DOUT2.PARAM	M_01-03-00-000

Description

DOUT1.PARAM and DOUT2.PARAM set the extra parameter needed for the digital outputs calculations, respectively.

Related Topics

10.1.4 Digital Outputs

DOUT1.STATE AND DOUT2.STATE

General Information	
Type	R/O Parameter
Description	Reads the digital output state.
Units	N/A
Range	0 to 1
Default Value	N/A
Data Type	Boolean
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	202 DOUT1.STATE 212 DOUT2.STATE	M_01-03-00-000

Description

DOUT1.STATE and DOUT2.STATE read the state of one digital output according to the value stated in the command. These parameters can also be used to set a value of one digital output (only if the output mode is idle).

Related Topics

10.1.4 Digital Outputs

DOUT1.STATEU AND DOUT2.STATEU

General Information	
Type	R/W Parameter
Description	Sets the state of the digital output node.
Units	N/A
Range	0 to 1
Default Value	0
Data Type	N/A
See Also	N/A
Start Version	M_01-01-01-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	204 DOUT1.STATEU 214 DOUT2.STATEU	M_01-03-00-000

Description

DOUT1.STATEU and DOUT2.STATEU set the state of the digital output node as follows:

0 = deactivated

1 = activated

DOUT1.STATEU and DOUT2.STATEU are used when DOUTx.MODE = 0 (user mode).

Related Topics

10.1.4 Digital Outputs

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DRV Parameters and Commands

DRV.ACC

General Information	
Type	NV Parameter
Description	Describes the acceleration ramp for the velocity loop.
Units	Depends on UNIT.ACCROTARY or UNIT.ACCLINEAR Rotary: rps/s, rpm/s, deg/s², (PIN/POUT)/s² , rad/s² Linear: counts/s² , mm/s² , µm/s² , (PIN/POUT)/s²
Range	Note: The range and default values of (PIN/POUT)/s² units depend on the values of PIN and POUT. The range and default values listed in this table are derived from the default values of PIN and POUT. Rotary: 0.031 to 833,333.333 rps/s 1.860 to 50,000,000.000 rpm/s 11.158 to 300,000,000.000 deg/s² 0.155 to 4,166,666.666 (PIN/POUT)/s² 0.375 to 5,235,987.750 rad/s² Linear: 0.000 to 833.333 counts/s² 0.031*MOTOR.PITCH to 833,333.333*MOTOR.PITCH mm/s² 30.995*MOTOR.PITCH to 2,147,483.647*MOTOR.PITCH µm/s² 0.155 to 2,147,483.647 (PIN/POUT)/s²
Default Value	Note: The range and default values of (PIN/POUT)/s² units depend on the values of PIN and POUT. The range default values listed in this table are derived from the default values of PIN and POUT. Rotary: 166.714 rps/s 10,002.851 rpm/s 60,017.108 deg/s² 833.571 (PIN/POUT)/s² 1,047.496 rad/s² Linear: 0.166 counts/s² 166.714*MOTOR.PITCH mm/s² 166,714.191*MOTOR.PITCH µm/s² 833.571 (PIN/POUT)/s²
Data Type	Float
See Also	DRV.DEC, UNIT.ACCLINEAR, UNIT.ACCROTARY
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3501h/0	M_01-00-00-000
Modbus	216 (64-bit)	M_01-03-00-000

Description

Describes the acceleration ramp for the velocity central loop.

Related Topics

10.7.5 Limits

DRV.ACTIVE

General Information	
Type	R/O Parameter
Description	Reads the enable status of an axis.
Units	N/A
Range	0, 1, 3
Default Value	N/A
Data Type	Integer
See Also	DRV.EN,DRV.DISSOURCES
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	220	M_01-03-00-000

Description

DRV.ACTIVE reads the enable status of an axis as follows:

- DRV.ACTIVE = 0 drive disabled
- DRV.ACTIVE = 1 drive enabled
- DRV.ACTIVE = 3 drive enabled and in dynamic brake mode

There is no state 2.

When the drive is in state 3, the drive display shows a blinking decimal point. Additionally, if the drive is in state 3 the Parameter Load/Save view does not allow you to download a parameter file.

If an axis is not enabled (DRV.ACTIVE is 0), but DRV.EN is 1 and the hardware enable is high, read the value of DRV.DISSOURCES to query the reason that the drive is not enabled.

Related Topics

3.2 Display Codes

10.9 Enable/Disable

DRV.BLINKDISPLAY

General Information	
Type	Command
Description	Causes the display to blink for 10 seconds.
Units	N/A
Range	N/A
Default Value	N/A
Data Type	N/A
See Also	N/A
Start Version	M_01-00-00-000

Description

DRV.BLINKDISPLAY causes the drive display located on the front of the drive to blink for 10 seconds. This command allows the user to identify the drive that is currently communicating with WorkBench.

DRV.CLRFAULTHIST

General Information	
Type	Command
Description	Clears the fault history log in the NV.
Units	N/A
Range	N/A
Default Value	N/A
Data Type	N/A
See Also	DRV.FAULTHIST
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	222	M_01-03-00-000

Description

DRV.CLRFAULTHIST clears the fault history from the nonvolatile memory of the drive.

This command erases all faults returned by DRV.FAULTHIST.

DRV.CLRFAULTS

General Information	
Type	Command
Description	Tries to clear all active faults in the drive.
Units	N/A
Range	N/A
Default Value	N/A
Data Type	N/A
See Also	DRV.FAULTS, DRV.EN, DRV.DIS
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	224	M_01-03-00-000

Description

DRV.CLRFAULTS tries to clear all active faults in the drive. If the command succeeds, then the reply to DRV.FAULTS states that no faults exist. If the command fails, then the fault condition is still present.

When a fault occurs, the fault is registered in the drive fault handler. DRV.CLRFAULTS clears the fault from the drive fault handler. However, if the fault still exists in the system, DRV.CLRFAULTS fails and the fault is re-registered in the fault handler.

Note that executing a drive disable (DRV.DIS) followed by a drive enable (DRV.EN) has the same effect as executing DRV.CLRFAULTS.

Related Topics

17.2 Clearing Faults

DRV.CMDDELAY

General Information	
Type	Command
Description	Issues a delay before next command is executed.
Units	ms
Range	0 to 5,000 ms
Default Value	0 ms
Data Type	Float
See Also	N/A
Start Version	M_01-03-00-000

Description

This parameter is used when drive commands are used in a script and a delay is needed between the execution of two consecutive commands. DRV.CMDDELAY creates a delay in the execution of drive commands. In the period of time specified, no commands are executed. This feature is especially useful for command buffers.t

Example

If the script is:

```
DRV.EN

IL.CMDU 0.1
```

then DRV.CMDDELAY is used between the two entries to delay execution 5 ms until the drive is enabled:

```
DRV.EN

DRV.CMDDELAY 5

IL.CMDU 0.1
```

Related Topics

10.2 Command Buffer

DRV.CMDSOURCE

General Information	
Type	NV Parameter
Description	Sets the command source (service, fieldbus, analog input, gearing, digital, or Bode).
Units	N/A
Range	0 to 3
Default Value	0
Data Type	Integer
See Also	DRV.OPMODE
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	226	M_01-03-00-000

Description

DRV.CMDSOURCE specifies the source of the command to the drive. DRV.OPMODE sets the operation mode to the relevant control loop.

DRV.CMDSOURCE values can be set as follows:

Value	Description
0	Service, TCP/IP command
1	Fieldbus command
2	Gearing command
3	Analog command

DRV.CMDSOURCE can be changed while the drive is enabled or disabled. If you use the terminal to change the operation mode, then it is recommended that you disable the drive before changing the command source.

⚠ WARNING If you change DRV.CMDSOURCE from the terminal while the drive is enabled, the system may experience a step change in demand.

Example

To set the command source to the TCP/IP channel and the operation mode to velocity:

```
-->DRV.CMDSOURCE 0

-->DRV.OPMODE 1
```

Related Topics

11 Using Command Source and Operating Modes

DRV.CRASHDUMP

General Information	
Type	Command
Description	Retrieves diagnostic information after the drive crashes.
Units	N/A
Range	N/A
Default Value	N/A
Data Type	N/A
See Also	N/A
Start Version	M_01-00-00-000

Description

Drives rarely crash, but if a crash occurs, information that can help diagnose the cause of a crash is saved to the nonvolatile (NV) memory within the drive. After the drive is restarted, you can use the DRV.CRASHDUMP command to retrieve this diagnostic information, which can be emailed to Kollmorgen for further support.

If the drive crashes (display flashes an F and three bars), it saves the diagnostic information to a specific block of the drive NV memory. The DRV.CRASHDUMP command then prints the diagnostic information from this NV memory block. Subsequent crash conditions will overwrite the NV memory block. Since the NV memory block is overwritten, but never erased, the DRV.CRASHDUMP command always shows the diagnostic information for the most recent crash.

DRV.DBILIMIT

General Information	
Type	NV Parameter
Description	Sets the maximum amplitude of the current for dynamic braking.
Units	Arms
Range	0 to minimum of drive peak current (DRV.IPEAK) and motor peak current (MOTOR.IPEAK).
Default Value	Minimum of drive continuous current (DRV.ICONT) and motor continuous current (MOTOR.ICONT).
Data Type	Float
See Also	DRV.DISMODE
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3444h/0	M_01-00-00-000
Modbus	228	M_01-03-00-000

Description

This parameter sets the maximum amplitude of the current for dynamic braking.

Example

Setting DRV.DBILIMIT to 2 limits the dynamic brake current to 2 Arms.

Related Topics

10.10 Controlled Stop

CS Parameters

10.11 Dynamic Braking

DRV.DEC

General Information	
Type	NV Parameter
Description	Sets the deceleration value for the velocity loop.
Units	Depends on UNIT.ACCROTARY or UNIT.ACCLINEAR Rotary: rps/s, rpm/s, deg/s², (PIN/POUT)/s², rad/s² Linear: counts/s², mm/s², µm/s², (PIN/POUT)/s²
Range	Rotary: 0.031 to 833,333.333 rps/s 1.860 to 50,000,000.000 rpm/s 11.158 to 300,000,000.000 deg/s² 0.155 to 4,166,666.752 (PIN/POUT)/s² 0.195 to 5,235,987.968 rad/s² Linear: 0.000 to 833.333 counts/s² 0.031*MOTOR.PITCH to 833,333.333*MOTOR.PITCH mm/s² 30.994*MOTOR.PITCH to 833,333,333.333*MOTOR.PITCH µm/s² 0.155 to 4,166,666.667 (PIN/POUT)/s²
Default Value	Rotary: 166.714 rps/s 10,002.851 rpm/s 60.017.108 deg/s² 833.571 (PIN/POUT)/s² 1,047.496 rad/s² Linear: 0.166 counts/s² 166.71*MOTOR.PITCH4MOTOR.PITCH mm/s² 166,714.191*MOTOR.PITCHMOTOR.PITCH µm/s² 833.571 (PIN/POUT)/s²
Data Type	Float
See Also	DRV.ACC, UNIT.ACCROTARY, UNIT.ACCLINEAR, DRV.OPMODE
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3522h/0	M_01-00-00-000
Modbus	230 (64-bit)	M_01-03-00-000

Description

DRV.DEC sets the deceleration value for the velocity loop command (VL.CMDU) and for the analog velocity command (AIN.VALUE). The operation mode (DRV.OPMODE) must be set to velocity mode for this command to function.

Related Topics

10.10 Controlled Stop

10.7.5 Limits

DRV.DIR

General Information	
Type	R/W Parameter
Description	Changes drive direction.
Units	N/A
Range	0 to 1
Default Value	0
Data Type	Integer
See Also	N/A
Start Version	M_01-00-00-000

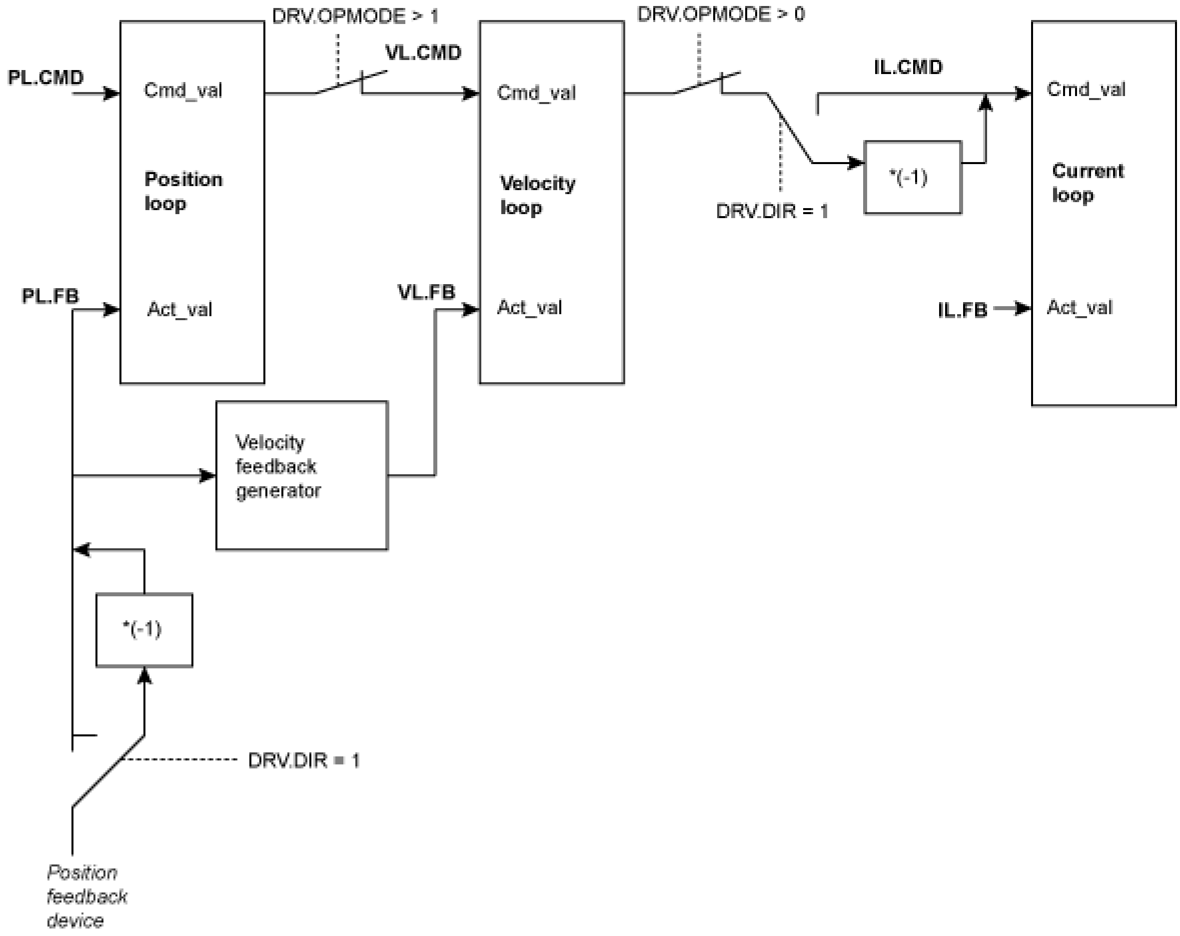
Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	352Ah/0	M_01-00-00-000
Modbus	234	M_01-03-00-000

Description

DRV.DIR changes the direction of the motor by changing the algebraic sign of the current command and position feedback value according to the figure below.

Note the following when using DRV.DIR:

- You can only change the DRV.DIR command when the drive is disabled.
- The drive status changes to "Axis not homed" as soon as the DRV.DIR parameter changes value (see DRV.MOTIONSTAT).
- You must verify the settings of the hardware limit switches. If necessary, switch the positive and negative hardware limit switches by swapping the wires at the digital inputs.


DRV.OPMODE > 1
VL.CMD
DRV.OPMODE > 0
IL.CMD
PL.CMD
Cmd_val
Position loop
PL.FB
Act_val
Cmd_val
Velocity loop
VL.FB
Act_val
*(-1)
DRV.DIR = 1
Cmd_val
Current loop
IL.FB
Act_val
Velocity feedback generator
*(-1)
DRV.DIR = 1
Position feedback device

DRV.DIS

General Information	
Type	Command
Description	Disables the axis (software).
Units	N/A
Range	N/A
Default Value	Analog drive software enabled. All other types of drive software disabled.
Data Type	N/A
See Also	DRV.EN, DRV.DISSOURCES, DRV.ACTIVE, DRV.DISMODE, DRV.DISTO
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3443h/0	M_01-00-00-000
Modbus	236	M_01-03-00-000

Description

DRV.DIS issues a software disable to the drive. The method by which the drive will be disabled (either immediately or with a ramp down first) is controlled by DRV.DISMODE.

By querying the value of DRV.ACTIVE, you can check whether the drive is currently enabled or disabled.

By querying the value of DRV.DISSOURCES, you can check whether the software enable bit is high (software enabled was issued by executing DRV.EN) or the software enable bit is low (software disable was issued by executing DRV.DIS).

If DRV.DIS is commanded the emergency timeout is started. If the drive does not disable or activate dynamic brake within DRV.DISTO, fault "703" (=> p. 215) is reported.

Related Topics

17.2 Clearing Faults

10.10 Controlled Stop

10.2 Command Buffer

DRV.DISMODE

General Information	
Type	NV Parameter
Description	Selects among disable immediately or stop and then disable options.
Units	N/A
Range	0 to 3
Default Value	0
Data Type	Integer
See Also	DRV.DBILIMIT ,DRV.DISTO, CS.VTHRESH
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	35FFh/0	M_01-00-00-000
Modbus	238	M_01-03-00-000

Description

DRV.DISMODE sets the drive reaction to a DRV.DIS command.

Value	Behavior
0	Disable axis immediately.
1	Use dynamic brake to ramp down. The drive remains in the dynamic brake state after the motor has stopped. The drive is disabled in the sense that it does not close the control loop and cannot perform a motion, but PWM stays active.
2	Use a controlled stop to ramp down and then disable the drive.
3	Use active disable to ramp down, and then use dynamic brake. The drive remains in the dynamic brake state after the motor has stopped. The drive is disabled in the sense that it does not close the control loop and cannot perform a motion, but PWM stays active.

In all cases described above, if a brake is configured (MOTOR.BRAKE), the brake closes if VL.FB drops below CS.VTHRESH.

⚠ WARNING	Be careful with vertical loads when modifying this parameter. Coordinate this parameter's correct setting properly with the drive brake settings. If these settings are not coordinated, then vertical loads may have no stopping or holding force when the drive is disabled and the load could fall.

Related Topics

10.10 Controlled Stop

CS Parameters

10.11 Dynamic Braking

DRV.DISSOURCES

General Information	
Type	R/O Parameter
Description	Returns the possible reason for a drive disable.
Units	N/A
Range	N/A
Default Value	N/A
Data Type	N/A
See Also	DRV.ACTIVE, DRV.FAULTS, DRV.EN, DRV.DIS
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	240	M_01-03-00-000

Description

DRV.DISSOURCES is a bitwise parameter that returns the status of possible causes of a drive disable. If this parameter is 0, then the drive is enabled.

The return value specific bits are as follows:

Bit	Status and Response
0	Software disable (execute DRV.EN to issue software enable)
1	Fault exists (read DRV.FAULTS to get the active faults)
2	Hardware disable (remote enable input is low)
3	In-rush disable (the in-rush relay is opened)
4	Initialization disable (the drive did not finish the initialization process)
5	Controlled stop disable from a digital input.

Related Topics

10.10 Controlled Stop

DRV.DISTO

General Information	
Type	R/W Parameter
Description	Sets the emergency timeout
Units	ms
Range	0 to 120,000 ms
Default Value	1,000 ms
Data Type	U32
See Also	DRV.DIS, DRV.DISMODE
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3445h/0	M_01-00-00-000
Modbus	242	M_01-03-00-000

Description

This timer starts when DRV.DIS is issued (regardless of the DRV.DIS origin). After this timeout elapses, the actual state of the drive is compared to the DRV.DISMODE setting. If the actual state does not match the DRV.DISMODE setting, a fault is reported and the hardware immediately executes the DRV.DISMODE setting (for instance, disable or activate dynamic brake). Setting DRV.DISTO to 0 will disable the timeout.

Related Topics

10.10 Controlled Stop

DRV.EMUEDIR

General Information	
Type	R/W Parameter
Description	Sets the direction of the emulated encoder output (EEO) signal.
Units	N/A
Range	0 to 1
Default Value	0
Data Type	N/A
See Also	DRV.EMUEMODE
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3493h/0	M_01-00-00-000
Modbus	244	M_01-03-00-000

Description

This parameter allows the user to change the direction of the emulated encoder output. DRV.DIR also affects the output direction (through an XOR, "exclusive or", operation). The drive uses DRV.DIR and DRV.EMUEDIR to decide the direction of the emulated encoder output. If DRV.DIR and DRV.EMUEDIR have the same value, then DRV.EMUEDIR is set to 0 (meaning an increase in the motor feedback will result an increase of the encoder emulation output and vice-versa). If these parameters have different values, then DRV.EMUEDIR is set to 1 (meaning an increase in the motor feedback will result in a decrease of the encoder emulation output and vice-versa).

DRV.EMUEMODE

General Information	
Type	R/W Parameter
Description	Sets the mode of the emulated encoder output (EEO) connector.
Units	N/A
Range	0 to 5
Default Value	0
Data Type	Integer
See Also	DRV.EMUERES, DRV.EMUEZOFFSET, DRV.EMUEMTURN
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3534h/0	M_01-00-00-000
Modbus	246	M_01-03-00-000

Description

This parameter sets the EEO connector to act as either an input or output as follows:

Setting	Function
0	Input (No EEO Output). The EEO connector (X9) is configured as an input. See Feedback 2 (FB2) for definitions for the EEO Connector (X9). Note that this mode is also deprecated and will behave as it did with firmware versions prior to M_01-03-00-000. In earlier firmware versions, this mode indicates that the EEO connector is not operative.
1	Output, with once per rev index pulse.
2	Output, with absolute index pulse.
3	Input, A/B signals.
4	Input, step and direction signals.
5	Input, up-down signals.
6	Output, with once per rev index and Input, step and direction.
7	Output, with absolute index and Input, step and direction

Related Topics

8.4.1 Encoder Emulation

DRV.EMUEMTURN

General Information	
Type	R/W Parameter
Description	Defines the location of the index pulse on the EEO (emulated encoder output) when DRV.EMUEMODE=2.
Units	counts
Range	0 to 4,294,967,295
Default Value	0
Data Type	Integer
See Also	DRV.EMUEMODE, DRV.EMUERES
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3491h/0	M_01-00-00-000
Modbus	248	M_01-03-00-000

Description

If the EEO mode with absolute index is selected (DRV.EMUEMODE=2), the index will be output when the feedback position (in counts) matches this parameter.

Related Topics

8.4.1 Encoder Emulation

DRV.EMUERES

General Information	
Type	R/W Parameter
Description	Sets the resolution of the EEO (emulated encoder output).
Units	lines/rev (when DRV.EMUEMODE = 1, 2, or 3) counts/rev (when DRV.EMUEMODE = 4 or 5)
Range	0 to 65,535 lines per revolution
Default Value	0 lines per revolution
Data Type	Integer
See Also	DRV.EMUEMODE
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3535h/0	M_01-00-00-000
Modbus	250	M_01-03-00-000

Description

This parameter sets the emulated encoder (EEO) resolution. DRV.EMUERES also defines how many lines are output for one revolution of the primary feedback (when this port is configured as an output), or how many lines will be considered a full revolution of the handwheel (when this port is configured as an input).

Related Topics

8.4.1 Encoder Emulation

DRV.EMUEZOFFSET

General Information	
Type	R/W Parameter
Description	Sets the location of the EEO (emulated encoder output) index pulse (when DRV.EMUEMODE=1).
Units	1/65536 rev
Range	0 to 65535 rev
Default Value	0 rev
Data Type	Integer
See Also	DRV.EMUEMODE, DRV.EMUEMTURN
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3537h/0	M_01-00-00-000
Modbus	252	M_01-03-00-000

Description

When EEO multiturn is selected (DRV.EMUEMODE=1), this parameter sets a position of the EEO index. When the primary feedback position (within a revolution) equals this value, an index pulse will output.

Related Topics

8.4.1 Encoder Emulation

DRV.EN

General Information	
Type	Command
Description	Enables the axis (software).
Units	N/A
Range	N/A
Default Value	Analog drive software is enabled. All other types of drive software are disabled.
Data Type	N/A
See Also	DRV.DIS, DRV.DISSOURCES DRV.ACTIVE
Start Version	M_01-00-00-000

Description

DRV.EN issues a software enable to the drive. You can query the value of DRV.ACTIVE to check whether the drive is currently enabled or disabled.

You can also query the value of DRV.DISSOURCES to check whether the software enable bit is high (software enabled was issued by executing DRV.EN) or the software enable bit is low (software disable was issued by executing DRV.DIS). If the drive software enable bit is low and DRV.EN is executed, then drive faults are automatically cleared during the software enable process.

Related Topics

17.2 Clearing Faults

10.2 Command Buffer

10.9 Enable/Disable

DRV.ENDEFAULT

General Information	
Type	R/W Parameter
Description	Sets the default state of the software enable.
Units	N/A
Range	0 to 1
Default Value	0
Data Type	Boolean
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	256	M_01-03-00-000

Description

DRV. ENDEFAULT sets the default state of the software enable on power up for drives without fieldbuses (DRV.CMDSOURCE other than 1).

Related Topics

10.9 Enable/Disable

DRV.FAULTHIST

General Information	
Type	R/O Parameter
Description	Reads the last 10 faults from NV memory.
Units	N/A
Range	N/A
Default Value	N/A
Data Type	N/A
See Also	DRV.FAULTS, DRV.CLRFAULTHIST
Start Version	M_01-00-00-000

Description

DRV.FAULTHISTORY returns the last 50 faults that occurred in the drive. The faults are shown with their fault number (which matches the one displayed on the drive display) and a timestamp that indicates when they last occurred.

Issue a DRV.CLRFAULTHIST to clear this fault log.

DRV.FAULTS

General Information	
Type	R/O Parameter
Description	Reads the active faults.
Units	N/A
Range	N/A
Default Value	N/A
Data Type	N/A
See Also	DRV.CLRFAULTS, DRV.FAULTHIST, DRV.CLRFAULTHIST
Start Version	M_01-00-00-000

Description

DRV.FAULTS returns a list of all currently active faults in the system, preceded by their fault number which matches the number displayed on the drive display.

To clear the faults, either issue a DRV.CLRFAULTS or issue a DRV.DIS followed by DRV.EN.

If no active faults are in the system, then after executing DRV.CLRFAULTS the value read by DRV.FAULTS is "No faults active".

Example

```
-->DRV.FAULTS

502: Bus under voltage.

-->
```

DRV.HANDWHEEL

General Information	
Type	R/O Parameter
Description	Reads the EEO input value.
Units	1/4,294,967,296 rev
Range	0 to 4,294,967,295 rev
Default Value	0 rev
Data Type	Integer
See Also	DRV.EMUERES, DRV.EMUEMODE
Start Version **End Version**	M_01-00-00-000 M_01-03-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	2050h/0	M_01-00-00-000
Modbus	258	M_01-03-00-000

Description

When the EEO is selected as an input (DRV.EMUEMODE=3,4,5), this parameter reads the EEO value (where 4,294,967,296 is a full revolution, then the value rolls over). DRV.EMUERES defines the how many counts constitute a revolution on the EEO. This parameter represents the feedback 2 positions when feedback 2 is configured to be active.

When secondary feedback is selected (DRV.EMUEMODE is 0 and FB2.SOURCE = 1 (X9), or FB2.SOURCE = 2 (X7)), this parameter represents the secondary feedback position (where 4,294,967,296 is a full revolution, then the value rolls over). FB2.ENCRES defines how many counts define a revolution for the secondary feedback.

Related Topics

8.4.1 Encoder Emulation

DRV.HELP

General Information	
Type	R/O Parameter
Description	Reads the minimum, maximum, and default values for a specific parameter or command.
Units	N/A
Range	N/A
Default Value	N/A
Data Type	N/A
See Also	N/A
Start Version	M_01-00-00-000

Description

This parameter returns more information about a specific parameter or command.

In most cases, except special parameters, this command tells you the minimum, maximum, default, and actual value of a parameter. Exceptions are commands that do not have these values (such as DRV.EN) or information commands (such as DRV.VER).

Related Topics

16.1 Terminal

DRV.HELPALL

General Information	
Type	R/O Parameter
Description	Retrieves the minimum, maximum, default, and actual values for all available parameters and commands.
Units	N/A
Range	N/A
Default Value	N/A
Data Type	N/A
See Also	N/A
Start Version	M_01-00-00-000

Description

This parameter retrieves all information about all parameters and commands in the firmware. In most cases, DRV.HELPALL returns the minimum, maximum, default, and actual value for each parameter and command. Exceptions include parameters and commands that do not have these values (such as DRV.EN) or pure INFO commands (such as DRV.VER).

Related Topics

16.1 Terminal

DRV.HWENMODE

General Information	
Type	R/W Parameter
Description	Selects the action that the hardware enable digital input will perform.
Units	N/A
Range	0 to 1
Default Value	0
Data Type	Integer
See Also	N/A
Start Version	M_01-03-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3506h/0	M_01-03-00-000
Modbus	260	M_01-03-00-000

Description

This parameter selects the action that the hardware enable digital input will perform.

0 = The rising edge of the hardware enable will clear the drive faults.

1 = The rising edge of the hardware enable will not clear the drive faults.

The high/low state of the hardware enable is always used to control the active enable state of the drive.

Related Topics

10.9 Enable/Disable

DRV.ICONT

General Information	
Type	R/O Parameter
Description	Reads the continuous rated current value.
Units	Arms
Range	N/A
Default Value	N/A
Data Type	Float
See Also	DRV.IPEAK
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	262	M_01-03-00-000

Description

DRV.ICONT returns the drive continuous rated current in Arms.

The value of the continuous current is read automatically on drive boot from the power EEPROM of the drive. This value cannot be modified.

DRV.INFO

General Information	
Type	R/O Parameter
Description	Reads general information about the drive.
Units	N/A
Range	N/A
Default Value	N/A
Data Type	String
See Also	N/A
Start Version	M_01-00-00-000

Description

DRV.INFO returns general information about the drive.

Example

```
Danaher Motion - Digital Servo Drive

----------------------------------------------------------------------

Drive mode                          : AKD-B00606-NAAN-0000

Continuous current                     : 12.000 A

Peak current: 30.000 A

Mac address: 00.23.1B.00.00.16

FPGA size: 1600

Fieldbus type: Analog

Power type                              : MV - Medium Voltage

Product serial number: 16777215

Product manufacturing date code   : 65535

Power board serial number                : 0

Power board manufacturing date code: 0

Control board serial number: 0

Control board manufacturing date code: 0

Option board serial number: 0

Option board manufacturing date code: 0
```

DRV.IPEAK

General Information	
Type	R/O Parameter
Description	Reads the peak rated current value.
Units	Arms
Range	N/A
Default Value	N/A
Data Type	Float
See Also	DRV.ICONT
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	264	M_01-03-00-000

Description

DRV.IPEAK returns the drive peak rated current in Arms.

The value of the peak current is read automatically on drive boot from the power EEPROM of the drive. This value cannot be modified.

Related Topics

8.8 Foldback

8.3.9 Using Wake and Shake (WS)

DRV.IZERO

General Information	
Type	R/W Parameter
Description	Sets the current that will be used during the DRV.ZERO procedure.
Units	Arms
Range	Drive peak current to 0 Arms
Default Value	0 Arms
Data Type	Float
See Also	DRV.ZERO
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	266	M_01-03-00-000

Description

This parameter sets the current that is used during the DRV.ZERO procedure.

DRV.LIST

General Information	
Type	R/O Parameter
Description	Reads the list of available parameters and commands.
Units	N/A
Range	N/A
Default Value	N/A
Data Type	String
See Also	N/A
Start Version	M_01-00-00-000

Description

DRV.LIST reads the list of available commands and parameters from the drive.

To filter this list, enter DRV.LIST followed by the prefix of the commands and parameters that you wish to display.

Example

Return a list of all available commands in the system:

```
-->DRV.LIST
```

Return all commands with the prefix DRV:

```
-->DRV.LIST DRV
```

DRV.LOGICVOLTS

General Information	
Type	R/O Parameter
Description	Reads the logic voltages.
Units	mv , Ω
Range	N/A
Default Value	N/A
Data Type	String
See Also	N/A
Start Version	M_01-00-00-000

Description

DRV.LOGICVOLTS reads the logic voltages data of 1.2 V, 2.5 V, 3.3 V, 5 V, 12 V, –12 V, and 3.3 AV.

Example

Below is an example of the output for this command:

```
ch0 = 1.2V    : 1211 mv

ch1 = 2.5V      :2488 mv

ch2 = 3.3V      :3274 mv

ch3 = 5V        :4950 mv

ch4 = 12V    :11892 mv

ch5 = -12V    :-11912 mv

ch6 = 3.3AV   :3300 mv

ch7 = R ohm   :100000 ohm
```

DRV.MEMADDR

General Information	
Type	R/W Parameter
Description	Sets the read and write address.
Units	N/A
Range	N/A
Default Value	1.U8
Data Type	N/A
See Also	DRV.MEMDATA
Start Version	M_01-00-00-000

Description

DRV.MEMADDR sets the address that is used by DRV.MEMDATA. The input can be either an internal parameter of the drive or any direct address from the DSP address space (SDRAM, internal RAM, or asynchronous memory). The input value can be either decimal or hexadecimal with 0x prefix.

Type extension can be one of the following:

U8,S8,U16,S16,U32,S32,U64,S64.

Examples

Setting to an internal parameter:

```
-->DRV.MEMADDR CCommandHandler.Debug1
```

Setting to an internal address:

```
-->DRV.MEMADDR 0xffabcde.u16
```

DRV.MEMDATA

General Information	
Type	R/W Parameter
Description	Sets or reads a value from an internal address.
Units	N/A
Range	N/A
Default Value	N/A
Data Type	N/A
See Also	DRV.MEMADDR
Start Version	M_01-00-00-000

Description

DRV.MEMDATA reads a value from the address that was set by DRV.MEMADDR or writes a value to this address. The input value can be either decimal or hexadecimal with 0x prefix.

Examples

Read a value from internal address:

```
-->DRV.MEMDATA 01
```

Write a hexadecimal value to an internal address:

```
-->DRV.MEMADDR 0x01
```

DRV.MOTIONSTAT

General Information	
Type	R/O Parameter
Description	Reads the motion status of the drive.
Units	N/A
Range	0 to 4,294,967,295
Default Value	N/A
Data Type	Integer
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3492h/0	M_01-00-00-000
Modbus	268	M_01-03-00-000

Description

This command indicates the current status of the drive internal motion (see table below).

Bit	Significance	Description
0	0x00000001	Motion task is active (high active)
1	0x00000002	Home position found /reference point set (high active)
2	0x00000004	Home routine finished (high active). Bits 1 and 2 both must be set to confirm that the homing process is complete.
3	0x00000008	Homing active (high active)
4	0x00000010	Homing error condition has occurred (high active)*
5	0x00000020	Slave in electronic gearing mode synchronized (high active)
6	0x00000040	Electronic gearing is active (high active)
7	0x00000080	Emergency stop procedure in progress (high active)
8	0x00000100	Emergency stop procedure has an error (high active)
9	0x00000200	Service motion active (high active)
10	0x00000400	A motion task could not be activated /invalid MT (high active)**
11	0x00000800	Motion task target position has been reached. See also MT.TPOSWND (high active).
12	0x00001000	Motion task target velocity has been reached. See also MT.TVELWND (high active).
13	0x00002000	The Bode plot procedure within the drive is active (high active).
14	0x00004000	The target position of a motion task has been crossed. This situation occurs for motion tasks with a change on the fly when triggering the DRV.STOP command just before the reaching the target velocity of the current active motion task. The ramp-down procedure with the motion task deceleration ramp causes the target position to be crossed (high active).

* A possible error condition for homing to a reference switch could be that no reference switch was found between two hardware limit switches.

** A possible error condition for an invalid motion task could be that a motion task tried to trigger automatically following motion task that has never been initialized (called an "empty motion" task).

DRV.NAME

General Information	
Type	NV Parameter
Description	Sets and reads the name of the drive.
Units	N/A
Range	N/A
Default Value	No-Name
Data Type	String
See Also	N/A
Start Version	M_01-00-00-000

Description

You can assign a unique name to any drive. This name is one way to identify the drive in a multiple drive network (for instance, in a TCP/IP network on which multiple drives reside).

From the terminal screen, DRV.NAME returns the name of the drive as ASCII characters.

DRV.NVLIST

General Information	
Type	R/O Parameter
Description	Lists the NV parameters and values from the RAM.
Units	N/A
Range	N/A
Default Value	N/A
Data Type	N/A
See Also	N/A
Start Version	M_01-00-00-000

Description

DRV.NVLIST lists all the drive parameters that reside in NV memory.

The list includes each parameter name, followed by its current value from the RAM.

DRV.NVLOAD

General Information	
Type	W/O Parameter
Description	Loads all data from the NV memory of the drive into the RAM parameters.
Units	N/A
Range	N/A
Default Value	N/A
Data Type	N/A
See Also	DRV.NVLOAD DRV.NVLIST
Start Version	M_01-00-00-000

Description

DRV.NVLOAD loads all data from the NV memory of the drive into the RAM parameters.

DRV.NVSAVE

General Information	
Type	Command
Description	Saves the drive parameters from the RAM to the NV memory.
Units	N/A
Range	N/A
Default Value	N/A
Data Type	N/A
See Also	DRV.RSTVAR
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	1010h 35EBh/0	M_01-00-00-000
Modbus	N/A	N/A

Description

DRV.NVSAVE saves the current drive parameter values from the RAM to the NV memory.

The drive parameters that were saved to the NV are read from the NV on the next drive boot, causing the values to be automatically set to the saved values on every drive boot.

Executing DRV.RSTVAR does not modify the values of the NV, but instead sets the drive values in RAM to their defaults.

DRV.ONTIME

General Information	
Type	R/O Parameter
Description	Returns how long the drive has been running since last power up.
Units	Days:Hours:Minutes:Seconds
Range	N/A
Default Value	N/A
Data Type	String
See Also	Returns how long the drive has been running since first activated.
Start Version	M_0-0-59

Description

This parameter returns the length of time that the drive has been running for the current session (since the last power up).

DRV.OPMODE

General Information	
Type	NV Parameter
Description	Sets the drive operation mode (current, velocity, or position).
Units	N/A
Range	0 to 2
Default Value	0
Data Type	Integer
See Also	DRV.CMDSOURCE
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	35B4h/0	M_01-00-00-000
Modbus	270	M_01-03-00-000

Description

DRV.OPMODE specifies the operation mode of the drive. You must also use DRV.CMDSOURCE to set the source of the command to the drive.

The operation mode values can be set as follows:

Mode	Description
0	Current (torque) operation mode
1	Velocity operation mode
2	Position operation mode

DRV.OPMODE can be changed while the drive is enabled or disabled. If you are using the terminal to change the operation mode, then it is recommended that you disable the drive before changing the operation mode. If you change the operation mode from the terminal while the drive is enabled, the system may experience a step change in demand.

Example

Set the source of the command to a TCP/IP channel and the desired operation mode to velocity:

```
-->DRV.CMDSOURCE 0

-->DRV.OPMODE 1
```

Related Topics

11 Using Command Source and Operating Modes

10.10 Controlled Stop

11.3 Current Loop

10.1 Digital Inputs and Outputs

11.4 Velocity Loop

11.5 Position Loop

8.3.9 Using Wake and Shake (WS)

DRV.READFORMAT

General Information	
Type	R/W Parameter
Description	Sets the value returned to either decimal or hexadecimal.
Units	N/A
Range	10 or 16
Default Value	10
Data Type	Integer
See Also	N/A
Start Version	M_01-00-00-000

Description

DRV.READFORMAT sets the return values type to either decimal or hexadecimal.

Format	Description
10	Sets the read values to decimal format
16	Sets the read values to hexadecimal format

DRV.RSTVAR

General Information	
Type	Command
Description	Sets default values in the drive without re-booting the drive and without resetting the NV memory.
Units	N/A
Range	N/A
Default Value	N/A
Data Type	N/A
See Also	
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	272	M_01-03-00-000

Description

DRV.RSTVAR causes the drive to return to the default values without the need to re-boot the drive first and without resetting the NV memory. Use DRV.RSTVAR to return to the default settings and recover a working drive.

DRV.RUNTIME

General Information	
Type	R/O Parameter
Description	Returns how long the drive has been running since first activated.
Units	Days:Hours:Minutes:Seconds
Range	N/A
Default Value	N/A
Data Type	String
See Also	N/A
Start Version	M_01-00-00-000

Description

DRV.RUNTIME returns the length of time that the drive has been running since it was first activated. This time includes the current session and the total amount of time from all previous sessions.

DRV.SETUPREQBITS

General Information	
Type	R/O Parameter
Description	Reads the bitwise set status of parameters that must be set before the drive can be enabled
Units	N/A
Range	N/A
Default Value	N/A
Data Type	N/A
See Also	DRV.SETUPREQLIST, MOTOR.AUTOSET
Start Version	M-00-00-64-000

Description

This parameter returns the bitwise set status of parameters that needs to be set up before the drive can be enabled. Only when this parameter returns 0 can the drive be enabled.

Parameter	Bits
IL.KP	0x00000001
MOTOR.IPEAK	0x00000002
MOTOR.ICONT	0x00000004
MOTOR.VMAX	0x00000008
MOTOR.POLES	0x00000010
MOTOR.PHASE	0x00000020

Please note that if MOTOR.AUTOSET is set to 1 (parameters automatically calculated from motor ID data), then all values in the list will be initialized from the feedback device. Otherwise, the parameters must be set manually.

Example

```
-->DRV.SETUPREQBITS

0

-->
```

DRV.SETUPREQLIST

General Information	
Type	R/O Parameters
Description	Reads the list of parameters that must be set before the drive can be enabled.
Units	N/A
Range	N/A
Default Value	N/A
Data Type	N/A
See Also	DRV.SETUPREQBITS, MOTOR.AUTOSET
Start Version	M-00-00-64-000

Description

This parameter returns the list of parameters that must be set before the drive can be enabled and also whether or not each one of those parameters is set. Only when all commands have value of 0 can the drive be enabled.

Please note that if MOTOR.AUTOSET is set to 1 (parameters automatically calculated from motor ID data), then all values in the list will be initialized from the feedback device. Otherwise, the parameters must be set manually.

Example

```
-->DRV.SETUPREQLIST

IL.KP 0

MOTOR.ICONT 0

MOTOR.IPEAK 0

MOTOR.POLES 0

-->
```

DRV.STOP

General Information	
Type	Command
Description	This command stops all drive motion.
Units	N/A
Range	N/A
Default Value	N/A
Data Type	N/A
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	35FEh/0	M_01-00-00-000
Modbus	274	M_01-03-00-000

Description

This command stops all drive motion.

DRV.TEMPERATURES

General Information	
Type	R/O Parameter
Description	Reads the temperature of drive components.
Units	°C
Range	55 to 125 °C
Default Value	N/A
Data Type	String
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3610h/0 3611h/0	M_01-00-00-000
Modbus	N/A	M_01-03-00-000

Description

DRV.TEMPERATURES reads the temperature in different parts of the drive (power and control boards). The temperature is read from temperature sensors located in the drive.

Example

Below is an example of the output for this command :

```
Control Temperature: 39 °C
Power1  Temperature: 31 °C
Power2  Temperature: Sensor does not exist.
Power3  Temperature: Sensor does not exist.
```

DRV.TYPE

General Information	
Type	R/O on analog, EtherCAT and CANopen models R/W on the CC drive model.
Description	Selects the operational fieldbus on CC drive models.
Units	N/A
Range	0 to 3
Default Value	2
Data Type	Integer
See Also	FBUS.TYPE, DRV.INFO
Start Version	M_01-03-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	276	M_01-03-00-000

Description

DRV.TYPE allows you to select the operational fieldbus for your drive. This parameter is read-write on the CC drive models and read-only on the analog, EtherCAT, and CANopen drive models. To change the operational fieldbus of your drive:

1. Set DRV.TYPE to one of the following values:

    0 = Analog (no EtherCAT or CANopen) with no position indexer functionality.

    1 = Analog (no EtherCAT or CANopen) with position indexer functionality.

    2 = EtherCAT

    3 = CANopen

2. Save the parameters to the NV memory on the drive by issuing the DRV.NVSAVE command
3. Power cycle the 24 V supply to the drive. When the drive has finished powering up, it will be working with the new selection.

Changing DRV.TYPE does not immediately change the type of the drive fieldbus selection. You must power cycle the drive to start the drive with the selected functionality.

You cannot use EtherCAT and CANopen at the same time. Use FBUS.TYPE or DRV.INFO to identify the field-bus currently in use.

Related Topics

2 AKD Models

DRV.VER

General Information	
Type	R/O Parameter
Description	Reads the drive version.
Units	N/A
Range	N/A
Default Value	N/A
Data Type	String
See Also	N/A
Start Version	M_01-00-00-000

Description

DRV.VER reads both FPGA and firmware versions.

The version data presented is hard coded in the firmware code.

Example

Below is an example of the output for this command:

```
Danaher Motion - Digital Servo Drive

-------------------------------------

FPGA version : FP0004_0001_00_07

Firmware Version : M_0-0-15_T_2009-01-19_10-36-28_IR
```

DRV.VERIMAGE

General Information	
Type	R/O Parameter
Description	Returns the version data from each image.
Units	N/A
Range	N/A
Default Value	N/A
Data Type	String
See Also	N/A
Start Version	M_01-00-00-000

Description

DRV.VERIMAGE reads the versions of the different images in the drive. This parameter returns the version data from each image .i00 file.

Example

Below is an example of the output for this parameter:

```
Danaher Motion - Digital Servo Drive

------------------------------------

Resident Firmware: R_0-0-11

Operational Firmware: M_0-0-15

Resident FPGA: FPB004_0001_00_07

Operational FPGA : FP0004_0001_00_07
```

DRV.WARNINGS

General Information	
Type	R/O Parameter
Description	Reads the active warnings.
Units	N/A
Range	N/A
Default Value	N/A
Data Type	N/A
See Also	N/A
Start Version	M_01-00-00-000

Description

DRV.WARNINGS returns a list of all currently active warnings in the system.

DRV.ZERO

General Information	
Type	R/W Parameter
Description	Sets the zero mode. The procedure is activated when the drive is enabled.
Units	N/A
Range	0 to 1
Default Value	0
Data Type	Integer
See Also	DRV.IZERO
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	278	M_01-03-00-000

Description

The zero procedure is a sequence in which phase commutation is initialized. During this procedure, the motor is held at a certain known electrical position (by applying a current defined by DRV.IZERO). After the motor rests at this position, the commutation angle is calculated and set automatically.

FB1 Parameters

FB1.BISSBITS

General Information	
Type	NV Parameter
Description	Specifies the number of Biss Sensor (Position) Bits for the BiSS Mode C encoder in use.
Units	bits
Range	0 to 64 bits
Default Value	32 bits
Data Type	Integer
See Also	FB1.SELECT, FB1.IDENTIFIED
Start Version	M_01-01-00-100 and M_01-01-03-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	280	M_01-03-00-000

Description

FB1.BISSBITS specifies the number of BiSS sensor (position) bits for the BiSS Mode C encoder in use. Typically the value is either 26 or 32 for a BiSS Mode C Renishaw encoder. The required value for this parameter is provided by the feedback device manufacturer for the particular device being used.

Related Topics

8.2 Feedback 1

FB1.ENCRES

General Information	
Type	NV Parameter
Description	Sets the resolution of the motor encoder.
Units	Encoder counts
Range	0 to 2^{32}-1
Default Value	1,024
Data Type	Integer
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3533h/0	M_01-00-00-000
Modbus	282	M_01-03-00-000

Description

This parameter sets or gets the resolution of the motor encoder (encoder feedback systems only) in number of counts per revolution for a rotary motor and the number of encoder pitches per motor pole pitch for a linear motor. The number of encoder counts per revolution is obtained by multiplying the motor catalog resolution in units of PPR by four. For example, for a 1024 PPR resolution motor, the number of encoder counts per revolution is 1024*4 = 4096. For this motor FB1.ENCRES must be set to 4096.

For linear motors, the value of FB1.ENCRES is set to the number of encoder pitches per motor pole pitch. For a motor with 32 mm pole pitch, and a 40 µm encoder pitch, the value for FB1.ENCRES should be set to 32 mm/40 µm = 800.

Related Topics

8.2 Feedback 1

FB1.HALLSTATE

General Information	
Type	R/O Parameter
Description	Reads the Hall switch values (encoder feedback only).
Units	Binary
Range	0 0 0 to 1 1 1
Default Value	N/A
Data Type	String
See Also	N/A
Start Version	M_01-00-00-000

Description

FB1.HALLSTATE reads the Hall switch values (encoder feedback only).

Related Topics

8.2 Feedback 1

FB1.IDENTIFIED

General Information	
Type	R/O Parameter
Description	Reads the type of feedback device used by the drive/motor.
Units	N/A
Range	N/A
Default Value	N/A
Data Type	Integer
See Also	FB1.SELECT
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	284	M_01-03-00-000

Description

This parameter is set according to FB1.SELECT on drive power up if FB1.SELECT is not –1; otherwise the parameter value is read from the drive memory.

Type	Description
0	Unknown
10	Incremental encoder with A/B Quad, marker pulse and Hall
11	Incremental encoder with A/B Quad, marker pulse and no Hall
20	Sine Encoder , with marker pulse and Hall
21	Sine encoder , with marker pulse & No Halls
30	EnDat 2.1 with Sine Cosine
31	EnDat 2.2
32	BiSS with Sine Cosine
33	HIPERFACE
34	BiSS Mode C Renishaw
40	Resolver
41	SFD

Related Topics

8.2 Feedback 1

FB1.INITSIGNED

General Information	
Type	NV Parameter
Description	Sets initial feedback value as signed or unsigned.
Units	N/A
Range	0 to 1
Default Value	0
Data Type	Integer
See Also	FB1.ORIGIN
Start Version	M-0-0-51

Fieldbus	Index/Subindex	Object Start Version
Modbus	286	M_01-03-00-000

Description

This parameter sets whether the initial value of the feedback read from the feedback device will be set as a signed or as an unsigned value.

0 = Unsigned

1 = Signed

The drive internal process for the feedback initialization is as follows:

1. Reads the position feedback.
2. Adds the origin to the feedback.
3. Determines modulo from Step 2 by the actual feedback bits.
4. Sets the position feedback sign according to FB1.INITSIGNED.

Related Topics

8.2 Feedback 1

FB1.MECHPOS

General Information	
Type	R/O Parameter
Description	Reads the mechanical position.
Units	counts
Range	0 to 4,294,967,295 counts
Default Value	N/A
Data Type	Integer
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	288	M_01-03-00-000

Description

FB1.MECHPOS reads the mechanical angle which is equal to the lower 32 bits in the 64-bit position feedback word.

Related Topics

8.2 Feedback 1

FB1.MEMVER

General Information	
Type	R/O Parameter
Description	Returns the memory feedback version.
Units	N/A
Range	N/A
Default Value	N/A
Data Type	Integer
See Also	N/A
Start Version	M_01-00-00-000

Description

FB1.MEMVER returns the memory feedback version (only applicable for feedbacks with memory).

Related Topics

8.2 Feedback 1

FB1.OFFSET

General Information	
Type	NV Parameter
Description	Sets position feedback offset.
Units	Depends on UNIT.ACCROTARY or UNIT.PLINEAR Rotary: counts, rad, deg, PIN/POUT, 16-bit counts Linear: counts, mm, µm, PIN/POUT, 16-bit counts
Range	Rotary: -5,123,372,000,000,005.000 to 5,123,372,000,000,005.000 counts -7495.067 to 7495.067 rad -429,436.096 to 429,436.096 deg -5,964.390 to 5,964.390 [PIN/POUT] -78,176,452.637 to 78,176,452.636 16-bit counts Linear: -5,123,372,000,000,005.000 to 5,123,372,000,000,005.000 counts -1192.878*MOTOR.PITCH to 1192.878*MOTOR.PITCH mm -1192877.952*MOTOR.PITCH to 1192877.952*MOTOR.PITCH µm -5964.390 to 5964.390 PIN/POUT -78176452.637 to 78176452.636 16-bit counts
Default Value	0
Data Type	Float
See Also	PL.FB
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3490h/0	M_01-00-00-000
Modbus	290 (64-bit)	M_01-03-00-000

Description

FB1.OFFSET is a value added to the position feedback (PL.FB).

Example

If PL.FB is 10 deg and FB1.OFFSET is set to –10 deg, then the next read of PL.FB will return ~0 deg.

Related Topics

8.2 Feedback 1

FB1.ORIGIN

General Information	
Type	NV Parameter
Description	Adds to the initial feedback position.
Units	Depends on UNIT.ACCROTARY or UNIT.ACCLINEAR Rotary: counts, rad, deg, PIN/POUT, 16-bit counts Linear: counts, mm, µm, PIN/POUT, 16-bit counts
Range	Rotary: 0.000 to 5,123,372,000,000.000 counts 0.000 to 7,495.067 rad 0.000 to 429,436.096 deg 0.000 to 5,964.390 PIN/POUT 0.000 to 78,176,452.636 16-bit counts Linear: 0.000 to 5,123,372,000,000.000 counts 0.000 to 1,192.878 mm 0.000 to 1,192,877.952 µm 0.000 to 5,964.390 PIN/POUT 0.000 to 78,176,452.636 counts16 Bit
Default Value	0 counts
Data Type	Float
See Also	FB1.INITSIGNED
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3656h/0	M_01-00-00-000
Modbus	294 (64-bit)	M_01-03-00-000

Description

FB1.ORIGIN is a value that is added to the feedback device position. Initial value and modulo are determined from the number of bits of the feedback:

Initial position value = (<feedback from device> + FB1.ORIGIN) modulo <number of feedback bits>

The number of feedback bits is set according to the feedback type. For memory feedbacks it is the number of feedback bits; for none memory it is always single turn.

The drive internal process for the feedback initialization is as follows:

1. Reads the position feedback.
2. Adds the origin to the feedback.
3. Determines modulo from Step 2 by the actual feedback bits.
4. Sets the position feedback sign according to FB1.INITSIGNED.

Example

This example uses UNIT.PROTARY set to 2 (degrees)

It also assumes that the drive is connected to a single turn feedback device with memory.

FB1.ORIGIN is set to 22 and saved into NV memory.

Drive boots and reads from feedback device position 340 degrees. According to the description section above, calculation will be:

(340 + 22) modulo 360 = 2 degrees.

Therefore the initial feedback value will be set to 2 degrees.

Related Topics

8.2 Feedback 1

FB1.PFIND

General Information	
Type	R/W Parameter
Description	A procedure that allows the user to find the commutation angle for encoder feedback, which has no halls.
Units	NA
Range	0, 1
Default Value	0
Data Type	Integer
See Also	FB1.PFINDCMDU
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	298	M_01-03-00-000

Description

A procedure that allows the user to find the commutation angle for encoder feedback (which has no Halls).

Related Topics

8.2 Feedback 1

FB1.PFINDCMDU

General Information	
Type	R/W Parameter
Description	Current value used during the phase finding procedure (PFB.PFIND=1)
Units	A
Range	0 to DRV.IPEAK
Default Value	0
Data Type	Float
See Also	PFB.PFIND
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	300	M_01-03-00-000

Description

FB1.PFINDCMDU sets the current value used during the phase finding procedure.

Related Topics

8.2 Feedback 1

FB1.POLES

General Information	
Type	R/O Parameter
Description	Reads the number of feedback poles.
Units	N/A
Range	2 to 128
Default Value	2
Data Type	Integer
See Also	MOTOR.POLES
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	302	M_01-03-00-000

Description

FB1.POLES sets the number of individual poles in the feedback device. This variable is used for the commutation function, as well as for velocity feedback scaling, and represents the number of individual poles (not pole pairs). The division value of motor poles (MOTOR.POLES) and feedback poles (FB1.POLES) must be an integer when moving drive to enable, otherwise a fault is issued.

Related Topics

8.2 Feedback 1

FB1.PSCALE

General Information	
Type	R/W Parameter
Description	Sets position scaling value for fieldbus transferred position objects.
Units	N/A
Range	0 to 32
Default Value	20
Data Type	Integer
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	304	M_01-03-00-000

Description

Position values transfered over fieldbus are converted from native 64-bit values to a maximum 32-bit position value. This parameter sets the resolution/revolution of position values back to the controller.

FB1.PSCALE determines the counts per revolution of position values delivered by fieldbus. The default value is 20, which yields 2^20 counts/revolution. This scaling is used for CAN PDOs 6064 (Position Actual Value) and 60F4 (Following Error Actual Value).

Example

The drive always works internally with 64-bit position values. The drive internal 64-bit actual position should contain the following value:

0x0000.0023.1234.ABCD

The lower 32 bits represent the mechanical angle of the feedback. The upper 32 bits represent the number of turns.

FB1.PSCALE = 20

The 32-bit position is: 0x0231234A

FB1.PSCALE = 16

The 32-bit position is: 0x00231234

Related Topics

8.2 Feedback 1

FB1.RESKTR

General Information	
Type	NV Parameter
Description	Sets the resolver nominal transformation ratio.
Units	N/A
Range	0.001 to 50.000
Default Value	0.5
Data Type	Float
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	306	M_01-03-00-000

Description

This parameter sets the resolver nominal transformation ratio. It affects the resolver excitation output amplitude. The value can be obtained from the resolver data sheet.

Related Topics

8.2 Feedback 1

FB1.RESREFPHASE

General Information	
Type	NV Parameter
Description	Sets the electrical degrees of phase lag in the resolver.
Units	electrical degrees
Range	-180 to 180°
Default Value	-2°
Data Type	Float
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	308	M_01-03-00-000

Description

This parameter sets the electrical degrees of phase lag in the resolver.

See the motor resolver datasheet for the value for this parameter .

Related Topics

8.2 Feedback 1

FB1.SELECT

General Information	
Type	NV Parameter
Description	Sets user entered type or identified type (–1).
Units	N/A
Range	–1, 10, 20, 30, 31, 32, 40, 41
Default Value	–1
Data Type	Integer
See Also	FB1.IDENTIFIED
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	353Bh/0	M_01-00-00-000
Modbus	310	M_01-03-00-000

Description

FB1.SELECT sets the feedback type manually (see FB1.IDENTIFIED) or allows the drive to automatically identify the feedback type on power up.

FB1.SELECT Input Values

Input Value	Description
–1	The drive automatically identifies the type of feedback as part of the power up process. Setting this value does not modify FB1.IDENTIFIED, unless it is saved in the NV memory for the next power up. If a feedback with memory is connected to the drive, the value of FB1.IDENTIFIED is set automatically to the feedback identified and all parameters read from the feedback are set according to the values read from the feedback. If no feedback is connected or a feedback with no memory is connected, the value of FB1.IDENTIFIED is set to 0 (no feedback identified) and all values normally read from the feedback are read from NV memory (if stored in NV) otherwise they are set to the default values.
10	Manually sets the type to incremental encoder. This input sets the value of FB1.IDENTIFIED to 10. If the feedback setting fails, FB1.IDENTIFIED is automatically set to 0 (no feedback identified).
20	Manually sets the type to sine encoder. This input sets the value of FB1.IDENTIFIED to 20. If the feedback setting fails, FB1.IDENTIFIED is automatically set to 0 (no feedback identified).
30	Manually sets the type to Endat 2.1. This input sets the value of FB1.IDENTIFIED to 30. If the feedback setting fails, FB1.IDENTIFIED is automatically set to 0 (no feedback identified).
31	Manually sets the type to Endat 2.2. This input sets the value of FB1.IDENTIFIED to 31. If the feedback setting fails, FB1.IDENTIFIED is automatically set to 0 (no feedback identified).
32	Manually sets the type to BiSS. This input sets the value of FB1.IDENTIFIED to 32. If the feedback setting fails, FB1.IDENTIFIED is automatically set to 0 (no feedback identified).
33	Manually sets the type to Hyperface. This input sets the value of FB1.IDENTIFIED to 33. If the feedback setting fails, FB1.IDENTIFIED is automatically set to 0 (no feedback identified).

Input Value	Description
40	Manually sets the type to resolver. This input sets the value of FB1.IDENTIFIED to 40. If the feedback setting fails, FB1.IDENTIFIED is automatically set to 0 (no feedback identified).
41	Manually sets the type to SFD. This input sets the value of FB1.IDENTIFIED to 41. If the feedback setting fails, FB1.IDENTIFIED is automatically set to 0 (no feedback identified).

FB1.SELECT Feedback Types

Type	Description
0	Unknown
10	Incremental encoder with A/B Quad, marker pulse and Hall
11	Incremental encoder with A/B Quad, marker pulse and no Hall
20	Sine Encoder , with marker pulse and Hall
21	Sine encoder , with marker pulse & No Halls
30	EnDat 2.1 with Sine Cosine
31	EnDat 2.2
32	BiSS with Sine Cosine
33	HIPERFACE
34	BiSS Mode C Renishaw
40	Resolver
41	SFD

Related Topics

8.2 Feedback 1

FB1.TRACKINGCAL

General Information	
Type	NV Parameter
Description	Controls tracking calibration algorithm.
Units	N/A
Range	0 to 1
Default Value	0
Data Type	Integer
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	312	M_01-03-00-000

Description

This parameter turns the tracking calibration algorithm on or off for sine-cosine or resolver.

0 = Tracking calibration is off.

1 = Tracking calibration is on.

Related Topics

8.2 Feedback 1

FB2 Parameters

FB2.ENCRES

General Information	
Type	NV Parameter
Description	Sets the secondary feedback (FB2) resolution.
Units	counts/rev
Range	0 to 262,140 counts/rev
Default Value	0
Data Type	Integer
See Also	FB2.MODE, FB2.SOURCE
Start Version	M_01-03-00-000

Description

This parameter sets the feedback 2 (FB2) resolution and defines how many counts input into the secondary feedback will be considered a full revolution.

Related Topics

8.4 Feedback 2

FB2.MODE

General Information	
Type	R/W Parameter
Description	Sets the mode for the second feedback inputs, EEO connector (X9) and high speed opto inputs (pins 9 and 10 on X7).
Units	N/A
Range	0 to 2
Default Value	0
Data Type	Integer
See Also	FB2.ENCRES, FB2.SOURCE
Start Version	M_01-03-00-000

Description

This parameter sets the feedback 2 input type as follows:

0 = Input A/B Signals

1 = Input Step and Direction Signals

2 = Input, up-down signals

Related Topics

8.4 Feedback 2

FB2.SOURCE

General Information	
Type	R/W Parameter
Description	Sets the source for the second feedback input. Choices are the EEO connectors (X9) which are RS485 inputs, or the X7 connector's high speed opto inputs (pins 9 and 10).
Units	N/A
Range	0 to 2
Default Value	0
Data Type	Integer
See Also	FB2.ENCRES, FB2.MODE
Start Version	M_01-03-00-000

Description

This parameter sets the secondary feedback source to be either the EEO connector (X9) or the high speed opto inputs on the I/O Connector (X7) as follows:

0 = None

1 = Feedback Source X9 (EEO connector)

2 = Feedback Source X7 (High Speed Opto Inputs on the I/O Connector)

Related Topics

8.4 Feedback 2

FBUS Parameters

FBUS.PARAM1 TO FBUS.PARAM20

General Information	
Type	NV Parameter
Description	Set fieldbus specific meanings.
Units	N/A
Range	See table below.
Default Value	See table below.
Data Type	Unsigned 32
See Also	CANopen Communication Manual, EtherCAT Communication Manual
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	36E5h/0 FBUS.PARAM01 36EAh/0 FBUS.PARAM06 36E6h/0 FBUS.PARAM02 36EBh/0 FBUS.PARAM07 36E7h/0 FBUS.PARAM03 36ECh/0 FBUS.PARAM08 36E8h/0 FBUS.PARAM04 36EDh/0 FBUS.PARAM09 36E9h/0 FBUS.PARAM05 36EEh/0 FBUS.PARAM10	M_01-00-00-000
EtherCAT COE and CANopen Range FBUS.PARAM01 FBUS.PARAM02 FBUS.PARAM03 FBUS.PARAM04 FBUS.PARAM05	**EtherCAT COE** / **CANopen** N/A / 125; 250; 500; 1000 0 to 1 / 0 to 1 1,001 to 65,535 / N/A 0 to 1 / 0 to 1 0 to 1 / 0 to 1	
EtherCAT COE and CANopen Default Value FBUS.PARAM01 FBUS.PARAM02 FBUS.PARAM03 FBUS.PARAM04 FBUS.PARAM05	**EtherCAT COE** / **CANopen** N/A / 125 1 / 0 0 / N/A 1 / 0 0 / 0	
Modbus	314 FBUS.PARAM01 334 FBUS.PARAM11 316 FBUS.PARAM02 336 FBUS.PARAM12 318 FBUS.PARMA 338 FBUS.PARAM13 320 FBUS.PARAM04 340 FBUS.PARAM14 322 FBUS.PARAM05 342 FBUS.PARAM15 324 FBUS.PARAM06 344 FBUS.PARAM16 326 FBUS.PARAM07 346 FBUS.PARAM17 328 FBUS.PARAM08 348 FBUS.PARAM18 330 FBUS.PARAM09 350 FBUS.PARAM19 332 FBUS.PARAM10 352 FBUS.PARAM20	M_01-03-00-000

Description

FBUS.PARAM01 sets the baud rate for the CANopen bus. Supported baud rates are 125, 250, 500 and 1000 kBaud.

FBUS.PARAM02 switches the phase locked loop (PLL) for synchronized use: 0 = OFF, 1 = ON

FBUS.PARAM03 sets the configured station alias for EtherCAT.

FBUS.PARAM04 switches the surveillance of SYNC-signals: 0 = OFF, 1 = ON

FBUS.PARAM05 is used to configure some special behaviors of the DS402.

FBUS.PARAM06 - FBUS.PARAM10 are reserved.

FBUS.PARAM04 Additional Notes

FBUS.PARAM04 enables (1) or disables (0) the synchronization supervision of the CANOpen or EtherCAT fieldbus.

Default values:

- CANOpen: disabled (0)
- EtherCAT: enabled (1)

The synchronization supervision is active when:

- FBUS.PARAM04 = 1
- The first CANOpen Sync message or first EtherCAT frame was received.

When more than three CANOpen sync messages or seven EtherCAT frames have not been received, and the drive is enabled, fault 125, "Synchronization lost", occurs.

FBUS.PARAM05 Additional Notes

Bit 0 configures the behavior of DS402 state machine in case of fault resets.

- Bit 0 = 1: Faults can only be reset using DS402 control word bit 7.
- Bit 0 = 0: The reset can also be done via telnet or digital input and the DS402 state machine reflects this condition.
- Bit 1 = 1: The state of the hardware enable does not change the state machine state Operation Enable.
- Bit 0 = 0: If the state Operation Enable or Switched on is active it falls back to the state switched On Disabled, if the Hardware enable goes to 0.
- Bit 2 = 1: Workbench/Telnet can not software enable the drive, when CAN/EtherCAT are Operational.
- Bit 0 = 0: Workbench/Telnet can software enable the drive.
- Bit 3 = 1: DS402-state machine is not influenced, if the software-enable is taken away via Telnet.
- Bit 0 = 0: DS402-state machine is influenced, if the software-enable is taken away via Telnet.

FBUS.PLLSTATE

General Information	
Type	R/O Parameter
Description	Returns the status of the PLL
Units	N/A
Range	N/A
Default Value	N/A
Data Type	N/A
See Also	FBUS.PARAM1 TO FBUS.PARAM20, Fieldbus documentation
Start Version	M_01-02-00-000

Description

FBUS.PLLSTATE returns the status of the phase locked loop (PLL). The PLL states are as follows:

PLL State	Description
PLL not activated	This state is set using FBUS.PARAM02. Not each fieldbus or operation mode needs synchronization.
PLL activated, but unlocked	The PLL is activated but has not yet been locked successfully. This state is related to the fieldbus master, as well as to the fieldbus mode of operation.
PLL activated and locked	PLL is fully operational and locked

For more information, see the *AKD CANopen Manual*, Phase Locked Loop.

FBUS.PLLTHRESH

General Information	
Type	NV Parameter
Description	Sets number of successful synchronized cycles needed to lock the PLL.
Units	N/A
Range	0 to 10,000
Default Value	0
Data Type	Integer, U32
See Also	Appendix B: Fieldbus Manuals
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	354	M_01-03-00-000

Description

This parameter sets number of successful synchronized cycles needed to lock the PLL.

FBUS.SAMPLEPERIOD

General Information	
Type	NV Parameter
Description	Sets fieldbus sample period.
Units	Whole multiples of MTS 250 µs
Range	4 to 128 and value must be a power of 4
Default Value	32 = 2 ms
Data Type	U8
See Also	Appendix B: Fieldbus Manuals
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	60C2h/0	M_01-00-00-000
Modbus	356	M_01-03-00-000

Description

This parameter sets the fieldbus cycle time. It is normally written in the startup phase of the field busses via the object 60C2 subindex 1 (interpolation time units) and 2 (interpolation time index), where the index stands for a power of 10 seconds (for instance, -3 stands for milliseconds) and the units are the counts of these units. Kollmorgen recommends the following standard cycle rates, 250 us (4), 500 us (8), 1 ms (16), 2 ms (32), 4 ms (64).

FBUS.SYNCACT

General Information	
Type	R/O Parameter
Description	Reads actual distance from the desired sync distance.
Units	ns
Range	0 to 250,000 ns
Default Value	0 ns
Data Type	Integer, U 32
See Also	Appendix B: Fieldbus Manuals
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	358	M_01-03-00-000

Description

This parameter reads actual distance from the desired sync distance.

FBUS.SYNCDIST

General Information	
Type	NV Parameter
Description	Sets time target for synchronization.
Units	ns
Range	0 to 250,000 ns
Default Value	100,000 ns
Data Type	Integer, U32
See Also	Appendix B: Fieldbus Manuals
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	360	M_01-03-00-000

Description

This parameter sets time target for synchronization.

FBUS.SYNCWND

General Information	
Type	NV Parameter
Description	Sets symmetrically arranged window around the desired sync distance.
Units	ns
Range	0 to 1,000,000 ns
Default Value	50,000 ns
Data Type	Integer, U2
See Also	Appendix B: Fieldbus Manuals
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	362	M_01-03-00-000

Description

This parameter sets symmetrically arranged window around the desired sync distance.

FBUS.TYPE

General Information	
Type	R/O Parameter
Description	Shows the active fieldbus type.
Units	N/A
Range	0 to 3
Default Value	0
Data Type	U8
See Also	Fieldbus Manuals
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	364	M_01-03-00-000

Description

FBUS.TYPE shows the active fieldbus type.

0 = No fieldbus available

1 = SynqNet

2 = EtherCAT

3 = CANopen

GEAR Parameters

GEAR.ACCMAX

General Information	
Type	R/W Parameter
Description	Sets the maximum allowed acceleration value; active in opmode 2 (position) only.
Units	Depends on UNIT.ACCROTARY or UNIT.ACCLINEAR Rotary: rps/s, rpm/s, deg/s^2, (PIN/POUT)/s^2, rad/s^2 Linear: counts/s^2, mm/s^2, µm/s^2, (PIN/POUT)/s^2
Range	Rotary: 0.031 to 833,333.333 rps/s 1.860 to 50,000,000.000 rpm/s 11.158 to 300,000,000.000 deg/s^2 0.155 to 4,166,666.752 (PIN/POUT)/s^2 0.195 to 5,235,987.968 rad/s^2 Linear: 0.000 to 833.333 counts/s^2 0.031*MOTOR.PITCH to 833,333.333*MOTOR.PITCH mm/s^2 30.994*MOTOR.PITCH to 83,3333,333.333*MOTOR.PITCH µm/s^2 0.155 to 4,166,666.667 (PIN/POUT)/s^2
Default Value	Rotary: 166.714 rps/s 10,002.851 rpm/s 60.017.108 deg/s^2 833.571 (PIN/POUT)/s^2 1,047.496 rad/s^2 Linear: 0.166 counts/s^2 166.714*MOTOR.PITCHMOTOR.PITCH mm/s^2 166,714.191*MOTOR.PITCHMOTOR.PITCH µm/s^2 833.571 (PIN/POUT)/s^2
Data Type	Float
See Also	UNIT.ACCROTARY, UNIT.ACCLINEAR, GEAR.DECMAX
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	366 (64-bit)	M_01-03-00-000

Description

This parameter limits the acceleration of the slave to a numerical higher value.

Related Topics

10.7 Electronic Gearing

GEAR.DECMAX

General Information	
Type	R/W Parameter
Description	Sets the maximum allowed deceleration value; active in opmode 2 (position) only.
Units	Depends on UNIT.ACCROTARY or UNIT.ACCLINEAR Rotary: rps/s, rpm/s, deg/s^2, (PIN/POUT)/s^2, rad/s^2 Linear: counts/s^2, mm/s^2, µm/s^2, (PIN/POUT)/s^2
Range	Rotary: 0.031 to 833,333.333 rps/s 1.860 to 50,000,000.000 rpm/s 11.158 to 300,000,000.000 deg/s^2 0.155 to 4,166,666.752 (PIN/POUT)/s^2 0.195 to 5,235,987.968 rad/s^2 Linear: 0.000 to 833.333 c/s^2 0.031*MOTOR.PITCH to 833,333.333*MOTOR.PITCH mm/s^2 30.994*MOTOR.PITCH to 833,333,333.333*MOTOR.PITCH µm/s^2 0.155 to 4,166,666.667 (PIN/POUT)/s^2
Default Value	Rotary: 166.714 rps/s 10,002.851 rpm/s 60,017.108 deg/s^2 833.571 (PIN/POUT)/s^2 1,047.496 rad/s^2 Linear: 0.166 counts/s^2 166.714*MOTOR.PITCHMOTOR.PITCH mm/s^2 166,714.191*MOTOR.PITCHMOTOR.PITCH µm/s^2 833.571 (PIN/POUT)/s^2
Data Type	Float
See Also	UNIT.ACCROTARY, UNIT.ACCLINEAR, GEAR.ACCMAX
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	370 (64-bit)	M_01-03-00-000

Description

This parameter limits the deceleration of the slave to a numerical higher value.

Related Topics

10.7 Electronic Gearing

GEAR.IN

General Information	
Type	R/W Parameter
Description	Sets the denominator of the electronic gearing ratio; active in opmode 2 (position) only.
Units	N/A
Range	1 to 65,535
Default Value	1
Data Type	Integer
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	374	M_01-03-00-000

Description

This parameter sets the denominator of the gear ratio for the electronic gearing mode. The gear ratio is used in order to increase and decrease the slave velocity. The slave velocity can be calculated by the following formula:

Slave velocity = Master velocity * GEAR.OUT/GEAR.IN

Be sure that you set the external master source number of signals per revolution correctly. Also, select the gear ratio so that the maximum electronic gearing velocity (GEAR.VELMAX) is not exceeded.

Master velocitymax * GEAR.OUT/GEAR.IN < GEAR.VELMAX

Related Topics

10.7 Electronic Gearing

GEAR.MODE

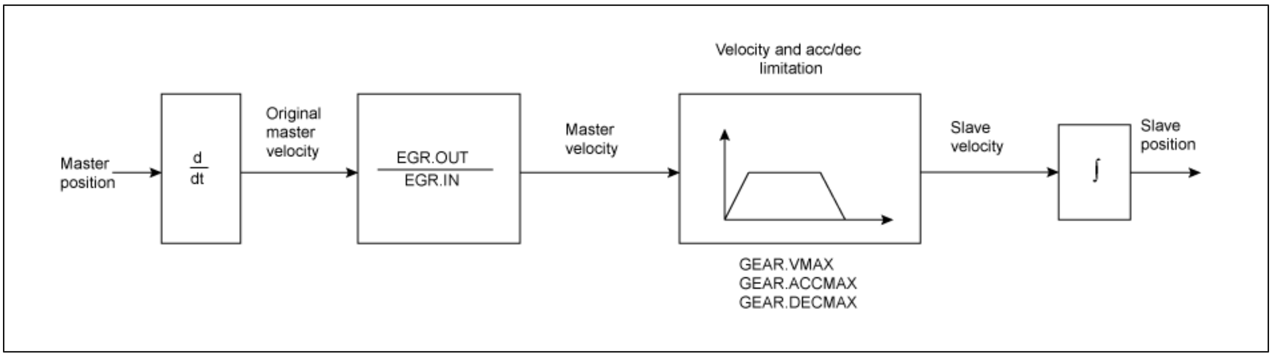
General Information	
Type	R/W Parameter
Description	Selects electronic gearing mode; active in opmode 2 (position) only.
Units	N/A
Range	0 to 1
Default Value	0
Data Type	Integer
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	376	M_01-03-00-000

Description

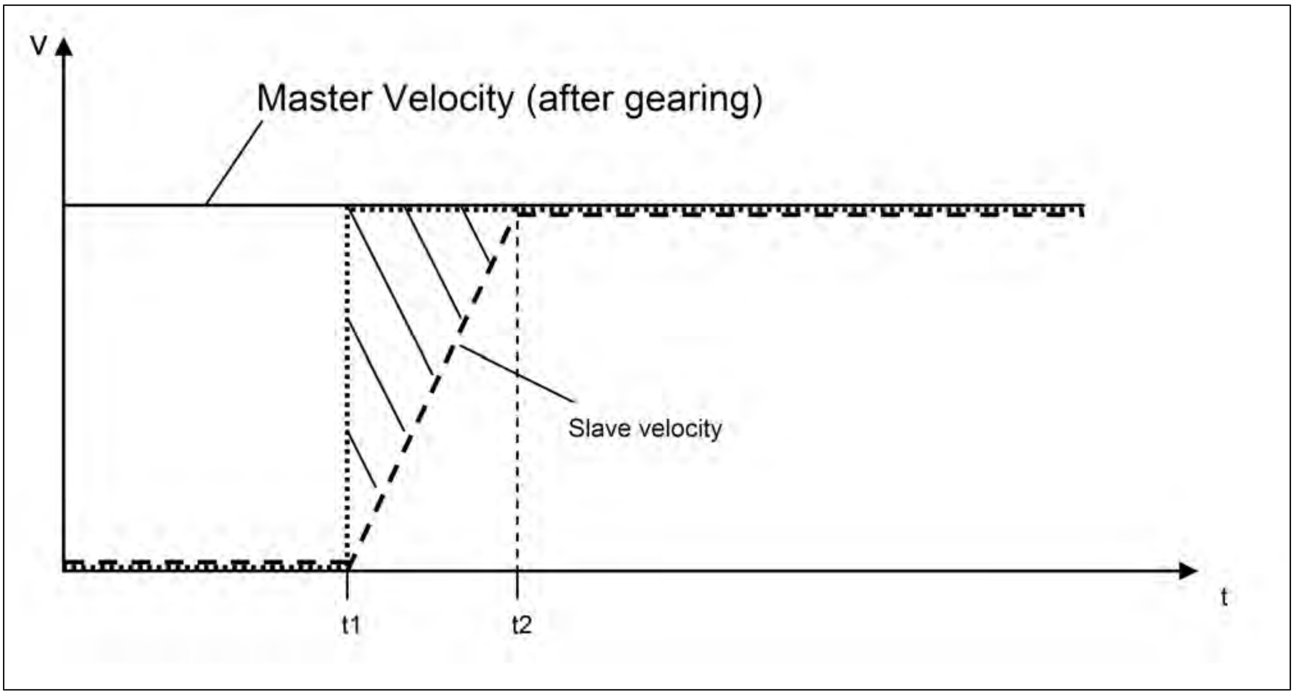
This parameter selects the electronic gearing mode at the beginning of the electronic gearing procedure. The gearing mode determines drive synchronization. In the context of electronic gearing, synchronization means that the slave follows the master pulses without losing counts due to acceleration or velocity limitations.

- Mode 0: The slave is not immediately synchronized after a GEAR.MOVE command. The slave accelerates until the master velocity (velocity after the gearing) has been reached. The drive is synchronized as soon as the velocity of the master has been reached.
- Mode 1: The slave is immediately synchronized after a GEAR.MOVE command.



Block diagram of the electronic gearing feature

The slave position is forwarded to the position loop. Ensure that DRV.OPMODE has been set to 2 and DRV.CMDSOURCE has been set to 2. The slave is able to reach the master velocity according to the GEAR.VMAX setting. GEAR.VMAX does not limit the slave velocity.



Acceleration process for GEAR.MODE 0

Time	Description
t<t1	The master sends already signals to the slave drive, but the GEAR.MOVE command has not been triggered yet.
t = t1	A GEAR.MOVE command has been triggered.
t1<t<t2	The slave accelerates according to the GEAR.ACCMAX setting. The position, which is marked with solid lines, will be ignored.
t=t2	The slave has reached the master velocity and is from now on considered as synchronized. Synchronization means that the slave will not lose any more position counts coming from the master.
t>t2	The slave follows the master input signals.

Related Topics

10.7 Electronic Gearing

GEAR.MOVE

General Information	
Type	Command
Description	Starts the electronic gearing; active in opmode 2 (position) only.
Units	N/A
Range	N/A
Default Value	N/A
Data Type	N/A
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	378	M_01-03-00-000

Description

The command GEAR.MOVE starts the electronic gearing procedure according to the selected electronic gearing mode. The electronic gearing process can be stopped using the DRV.STOP command.

Related Topics

10.7 Electronic Gearing

GEAR.OUT

General Information	
Type	R/W Parameter
Description	Sets the numerator of the electronic gearing ratio; active in opmode 2 (position) only.
Units	N/A
Range	-32,768 to +32,767
Default Value	1
Data Type	Integer
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	380	M_01-03-00-000

Description

This parameter is the numerator of the gear ratio for the electronic gearing mode. The gear ratio is used in order to increase/decrease the slave velocity. The slave velocity can be calculated by the following formula:

Slave velocity = Master velocity * GEAR.OUT/GEAR.IN

Make sure that the external master source has been set properly. Also, be certain to select a gear ratio such that the maximum electronic gearing velocity (GEAR.VELMAX) will not be exceeded.

Master velocitymax * GEAR.OUT/GEAR.IN < GEAR.VELMAX

Related Topics

10.7 Electronic Gearing

GEAR.VMAX

General Information	
Type	R/W Parameter
Description	Reads the maximum allowed velocity value; active in opmode 2 (position) only.
Units	Depends on UNIT.ACCROTARY or UNIT.ACCLINEAR Rotary: rpm, rps, deg/s, (PIN/POUT)/s, rad/s Linear: counts/s, mm/s, µm/s, (PIN/POUT)/s
Range	Rotary: 0.001 to 12,000.000 rpm 0.001 to 200.000 rps 0.001 to 72,000.000 deg/s 0.001 to 1,000.000 (PIN/POUT)/s 0.001 to 1256.637 rad/s Linear: 0.001 to 0.200 counts/s 0.001*MOTOR.PITCH to 200.000*MOTOR.PITCH mm/s 0.004*MOTOR.PITCH to 200,000.000*MOTOR.PITCH µm/sec 0.001 to 1,000.000 (PIN/POUT)/s
Default Value	Rotary: 3,000 rpm 50 rps 18,000.002 deg/s 250.000 (PIN/POUT)/s 314.159 rad/s Linear: 0.050 counts/s 50 mm/s 50,000.004MOTOR.PITCH µm/s 250.000 (PIN/POUT)/s
Data Type	Float
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	382	M_01-03-00-000

Description

This parameter limits the maximum velocity of the slave drive.

Related Topics

10.7 Electronic Gearing

GUI Parameters

GUI parameters are used within WorkBenchfor data reporting and data storage.

GUI.DISPLAY

General Information	
Type	R/O Parameter
Description	Reads drive display data.
Units	N/A
Range	N/A
Default Value	N/A
Data Type	Display
See Also	N/A
Start Version	M_01-00-00-000

Description

This parameter reports to the GUI what the drive currently is displaying. For all GUI commands, the data is compressed and formatted for the GUI, not for the user.

GUI.PARAM01

General Information	
Type	NV Parameter
Description	Used by the GUI to store data.
Units	N/A
Range	2,147,483,648 to 2,147,483,647
Default Value	0
Data Type	Integer
See Also	N/A
Start Version	M_01-00-00-000

Description

The GUI uses this parameter to store data. Only the GUI can modify this data (not the user).

GUI.PARAM02

General Information	
Type	NV Parameter
Description	Used by the GUI to store data.
Units	N/A
Range	2,147,483,648 to 2,147,483,647
Default Value	0
Data Type	Integer
See Also	N/A
Start Version	M_01-00-00-000

Description

The GUI uses this parameter to store data. Only the GUI can modify this data (not the user).

GUI.PARAM03

General Information	
Type	NV Parameter
Description	Used by the GUI to store data.
Units	N/A
Range	2,147,483,648 to 2,147,483,647
Default Value	0
Data Type	Integer
See Also	N/A
Start Version	M_01-00-00-000

Description

The GUI uses this parameter to store data. Only the GUI can modify this data (not the user).

GUI.PARAM04

General Information	
Type	NV Parameter
Description	Used by the GUI to store data.
Units	N/A
Range	2,147,483,648 to 2,147,483,647
Default Value	0
Data Type	Integer
See Also	N/A
Start Version	M_0-0-15

Description

The GUI uses this parameter to store data. Only the GUI can modify this data (not the user).

GUI.PARAM05

General Information	
Type	NV Parameter
Description	Used by the GUI to store data.
Units	N/A
Range	2,147,483,648 to 2,147,483,647
Default Value	0
Data Type	Integer
See Also	N/A
Start Version	M_01-00-00-000

Description

The GUI uses this parameter to store data. Only the GUI can modify this data (not the user).

GUI.PARAM06

General Information	
Type	NV Parameter
Description	Used by the GUI to store data.
Units	N/A
Range	2,147,483,648 to 2,147,483,647
Default Value	0
Data Type	Integer
See Also	N/A
Start Version	M_01-00-00-000

Description

The GUI uses this parameter to store data. Only the GUI can modify this data (not the user).

GUI.PARAM07

General Information	
Type	NV Parameter
Description	Used by the GUI to store data.
Units	N/A
Range	2,147,483,648 to 2,147,483,647
Default Value	0
Data Type	Integer
See Also	N/A
Start Version	M_01-00-00-000

Description

The GUI uses this parameter to store data. Only the GUI can modify this data (not the user).

GUI.PARAM08

General Information	
Type	NV Parameter
Description	Used by the GUI to store data.
Units	N/A
Range	2,147,483,648 to 2,147,483,647
Default Value	0
Data Type	Integer
See Also	N/A
Start Version	M_01-00-00-000

Description

The GUI uses this parameter to store data. Only the GUI can modify this data (not the user).

GUI.PARAM09

General Information	
Type	NV Parameter
Description	Used by the GUI to store data.
Units	N/A
Range	2,147,483,648 to 2,147,483,647
Default Value	0
Data Type	Integer
See Also	N/A
Start Version	M_01-00-00-000

Description

The GUI uses this parameter to store data. Only the GUI can modify this data (not the user).

GUI.PARAM10

General Information	
Type	NV Parameter
Description	Used by the GUI to store data.
Units	N/A
Range	2,147,483,648 to 2,147,483,647
Default Value	0
Data Type	Integer
See Also	N/A
Start Version	M_01-00-00-000

Description

The GUI uses this parameter to store data. Only the GUI can modify this data (not the user).

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HOME Parameters

HOME.ACC

General Information	
Type	R/W Parameter
Description	Sets homing acceleration; active in opmode 2 (position) only.
Units	Depends on UNIT.ACCROTARY or UNIT.ACCLINEAR Rotary: rps/s, rpm/s, deg/s^2, (PIN/POUT)/s^2, rad/s^2 Linear: counts/s^2, mm/s^2, µm/s^2, (PIN/POUT)/s^2
Range	Rotary: 0.031 to 833,333.333 rps/s 1.860 to 50,000,000.000 rpm/s 11.158 to 300,000,000.000 deg/s^2 0.155 to 4,166,666.752 (PIN/POUT)/s^2 0.195 to 5,235,987.968 rad/s^2 Linear: 0.000 to 833.333 counts/s^2 0.031*MOTOR.PITCH to 833,333.333*MOTOR.PITCH mm/s^2 30.994*MOTOR.PITCH to 833,333,333.333*MOTOR.PITCH µm/s^2 0.155 to 4,166,666.667 (PIN/POUT)/s^2
Default Value	Rotary: 166.714 rps/s 10,002.851 rpm/s 60,017.108 deg/s^2 833.571 (PIN/POUT)/s^2 1,047.496 rad/s^2 Linear: 0.166 counts/s^2 166.714*MOTOR.PITCHMOTOR.PITCH mm/s^2 166,714.191*MOTOR.PITCHMOTOR.PITCH µm/s^2 833.571 (PIN/POUT)/s^2
Data Type	Float
See Also	UNIT.ACCROTARY, UNIT.ACCLINEAR
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3502h/0 609Ah/0	M_01-00-00-000
Modbus	384 (64-bit)	M_01-03-00-000

Description

This parameter determines the acceleration of the motor during the homing procedure.

Related Topics

12.1 Homing

HOME.AUTOMOVE

General Information	
Type	R/W Parameter
Description	Sets homing auto move flag.
Units	N/A
Range	0 to 1
Default Value	0
Data Type	Integer
See Also	HOME.MODE
Start Version	M_01-02-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	388	M_01-03-00-000

Description

HOME.AUTOMOVE allows the drive to start a homing procedure after enabling the drive.

HOME.AUTOMOVE = 0: The drive is not allowed to start automatically a homing procedure after the enable command.

HOME.AUTOMOVE = 1: The drive automatically starts a homing procedure after the enable command.

When HOME.AUTOMOVE is set to 1, the drive continuously checks the following conditions:

1. Is the drive enabled (DRV.ACTIVE = 1)?
2. Is the drive in DRV.OPMODE = 2?
3. Has the command source been adjusted to 0 (DRV.CMDSOURCE = 0)?
4. Is no other motion currently active (see DRV.MOTIONSTAT)?

As soon as all of the conditions above are true, the drive activates the homing procedure, which has been selected via the HOME.MODE setting. The automatic homing procedure is finished as soon as the homing procedure has been successfully triggered by the drive. From now on the drive will not attempt to trigger any additional homing procedure.

HOME.AUTOMOVE is not functional in release M_01-03-00-000 for homing procedures which require an external index signal (HOME.MODE 3, 6, 10, and 11).

Related Topics:

12.1 Homing

HOME.DEC

General Information	
Type	R/W Parameter
Description	Sets homing deceleration; active in opmode 2 (position) only.
Units	Depends on UNIT.ACCROTARY or UNIT.ACCLINEARUNIT.A-CCLINEAR Rotary: rps/s, rpm/s, deg/s^2, (PIN/POUT)/s^2, rad/s^2 Linear: counts/s^2, mm/s^2, µm/s^2, (PIN/POUT)/s^2
Range	Rotary: 0.031 to 833,333.333 rps/s 1.860 to 50,000,000.000 rpm/s 11.158 to 300,000,000.000 deg/s^2 0.155 to 4,166,666.752 (PIN/POUT)/s^2 0.195 to 5,235,987.968 rad/s^2 Linear: 0.000 to 833.333 counts/s^2 0.031*MOTOR.PITCH to 833,333.333*MOTOR.PITCH mm/s^2 30.994*MOTOR.PITCH to 833,333,333.333*MOTOR.PITCH µm/s^2 0.155 to 4,166,666.667 (PIN/POUT)/s^2
Default Value	Rotary: 166.714 rps/s 10,002.851 rpm/s 60.017.108 deg/s^2 833.571 (PIN/POUT)/s^2 1,047.496 rad/s^2 Linear: 0.166 counts/s^2 166.714*MOTOR.PITCHMOTOR.PITCHmm/s^2 166,714.191MOTOR.PITCH µm/s^2 833.571 (PIN/POUT)/s^2
Data Type	Float
See Also	UNIT.ACCROTARY, UNIT.ACCLINEAR
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3524h/0 609Ah/0	M_01-00-00-000
Modbus	390 (64-bit)	M_01-03-00-000

Description

This parameter sets the deceleration of the motor during the homing procedure.

Related Topics:

12.1 Homing

HOME.DIR

General Information	
Type	NV Parameter
Description	Sets homing direction; active in opmode 2 (position) only.
Units	N/A
Range	0 to 1
Default Value	1
Data Type	Integer
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	6098h6098h	M_01-00-00-000
Modbus	394	M_01-03-00-000

Description

This parameter determines the direction in which the motor should start to move during a homing procedure.

0 = Movement in negative direction.

1 = Movement in positive direction.

Related Topics

12.1 Homing

HOME.DIST

General Information	
Type	R/W Parameter
Description	Sets homing distance; active in opmode 2 (position) only.
Units	Depends on UNIT.PROTARY or UNIT.PLINEARUNIT.ACCLINEAR Rotary: counts, rad, deg, PIN/POUT, 16-bit counts Linear: counts, mm, µm, PIN/POUT, 16-bit counts
Range	N/A
Default Value	0
Data Type	Float
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	396	M_01-03-00-000

Description

This parameter takes effect only after the homing procedure is complete (see the HOME.MODE description). HOME.DIST specifies an additional movement after the homing procedure is complete. The drive uses the homing acceleration, deceleration, and velocity parameters for this movement. This parameter can be used to let the motor move away from the home position by the value of HOME.DIST.

A value not equal to 0 triggers an additional movement of the selected homing distance after the general homing procedure. A value of 0 for HOME.DIST causes no additional movement.

Related Topics

12.1 Homing

HOME.FEEDRATE

General Information	
Type	R/W Parameter
Description	Sets homing velocity factor; active in opmode 2 (position) only.
Units	%
Range	0 to 100%
Default Value	50%
Data Type	Integer
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	6099h/2	M_01-00-00-000
Modbus	400	M_01-03-00-000

Description

This parameter is used in order to reduce the velocity during the index search (index = zero-pulse of a feedback device). This parameter determines the percentage of the homing velocity (HOME.V) that should be used during the index-search.

Related Topics

12.1 Homing

HOME.IPEAK

General Information	
Type	R/W Parameter
Description	Sets the current limit during homing procedure to a mechanical stop; active in opmode 2 (position) only.
Units	A
Range	± Drive peak current A
Default Value	[(1/120) * DRV.IPEAK] A
Data Type	Float
See Also	HOME.MODE
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	35E2h/0	M_01-00-00-000
Modbus	402 (64-bit)	M_01-03-00-000

Description

This parameter sets the intermediate current limit during a homing procedure to a mechanical stop (HOME.MODE 8 and 9). The current-controller limit (IL.LIMITP and IL.LIMITN) is set to ±HOME.IPEAK while the homing procedures are active.

HOME.IPEAK is active as soon as the homing procedure starts and remains active until the home position is found. Previous current limit settings are re-activated before the motor covers the homing distance (HOME.DIST ≠ 0).

Related Topics

12.1 HomingHoming mode 8: Move Until Position Error Exceeded

HOME.MODE

General Information	
Type	R/W Parameter
Description	Selects the homing mode; active in opmode 2 (position) only.
Units	N/A
Range	0 to 10
Default Value	0
Data Type	Integer
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	6098h6098h	M_01-00-00-000
Modbus	406	M_01-03-00-000

Description

HOME.MODE specifies the homing procedure of the drive. The homing modes available in the drive are summarized in the following table; see 12.1 Homing for a detailed discussion and examples for each mode:

Mode	Description
0	Home using current position
1	Find limit input
2	Find input limit then find zero angle
3	Find input limit then find index
4	Find home input
5	Find home input then find zero angle
6	Find home input then find index
7	Find zero angle
8	Move until position error exceeded
9	Move until position error exceeded, then find zero angle

Related Topics

12.1 Homing

HOME.MOVE

General Information	
Type	Command
Description	Starts a homing procedure; active in opmode 2 (position) only.
Units	N/A
Range	N/A
Default Value	N/A
Data Type	N/A
See Also	N/A
Start Version	M_01-00-00-000

Description

The HOME.MOVE command starts a homing procedure. The DRV.OPMODE must be set to 2 (closed position loop) and DRV.CMDSOURCE must be set to 0 (TCP/IP command).

Related Topics

12.1 Homing

HOME.P

General Information	
Type	R/W Parameter
Description	Sets home position; active in opmode 2 (position) only.
Units	Depends on UNIT.PROTARY or UNIT.PLINEAR Rotary: counts, rad, deg, PIN/POUT, 16-bit counts Linear: counts, mm, µm, PIN/POUT, 16-bit counts
Range	N/A
Default Value	0
Data Type	Float
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	607Ch/0	M_01-00-00-000
Modbus	410 (64-bit)	M_01-03-00-000

Description

This parameter sets the home position. The command and actual position of the drive will be set to this value as soon as a homing event occurs. The homing events differ in each homing mode.

Related Topics

12.1 Homing

HOME.PERRTHRESH

General Information	
Type	R/W Parameter
Description	Sets the position lag threshold; active in opmode 2 (position) only.
Units	Depends on UNIT.PROTARY or UNIT.PLINEAR Rotary: counts, rad, deg, PIN/POUT, 16-bit counts Linear: counts, mm, µm, PIN/POUT, 16-bit counts
Range	N/A
Default Value	N/A
Data Type	Float
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3482h/0	M_01-00-00-000
Modbus	414 (64-bit)	M_01-03-00-000

Description

This parameter is used for the homing modes against a mechanical stop (HOME.MODE = 8 and 9). The absolute value of the following error (PL.ERR) is compared with HOME.PERRTHRESH in order to detect a mechanical stop.

Related Topics

Homing mode 8: Move Until Position Error Exceeded

HOME.SET

General Information	
Type	Command
Description	Immediately sets the home position; active in opmode 2 (position) only.
Units	N/A
Range	N/A
Default Value	N/A
Data Type	N/A
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	35F0h/0	M_01-00-00-000
Modbus	418	M_01-03-00-000

Description

The HOME.SET command immediately homes the drive. The drive can be homed in an enabled or disabled state. Motion in the current mode of operation (DRV.OPMODE=0) or velocity mode of operation (DRV.OPMODE=1) is not affected by the HOME.SET command. Motion in the position mode of operation (DRV.OPMODE=2) is immediately aborted when the HOME.SET command is issued.

Related Topics

12.1 Homing

HOME.V

General Information	
Type	R/W Parameter
Description	Sets homing velocity; active in opmode 2 (position) only.
Units	Depends on UNIT.VROTARY or UNIT.VLINEAR Rotary: rpm, rps, deg/s, (PIN/POUT)/s, rad/s Linear: counts/s, mm/s, µm/s, (PIN/POUT)/s
Range	Rotary: 0.001 to 12,000.000 rpm 0.001 to 200.000 rps 0.001 to 72,000.000 deg/s 0.001 to 1,000.000 (PIN/POUT)/s 0.001 to 1,256.637 rad/s Linear: 0.001 to 0.200 counts/s 0.001*MOTOR.PITCH to 200.000*MOTOR.PITCH mm/s 0.004*MOTOR.PITCH to 200,000.000*MOTOR.PITCH µm/sec 0.001 to 1,000.000 (PIN/POUT)/s
Default Value	Rotary: 60 rpm 1 rps 359.999 deg/s 5 (PIN/POUT)/s 6.283 rad/s Linear: 0.001 counts/s 1MOTOR.PITCH mm/s 999.998*MOTOR.PITCHMOTOR.PITCH µm/sec 5.000 (PIN/POUT)/s
Data Type	Float
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	6099h/1	M_01-00-00-000
Modbus	420	M_01-03-00-000

Description

This parameter sets the velocity of the motor during the homing procedure.

Related Topics

12.1 Homing

HWLS Parameters

HWLS.NEGSTATE

General Information	
Type	R/O Parameter
Description	Reads the status of the negative hardware limit switch.
Units	0 to 1
Range	N/A
Default Value	Boolean
Data Type	HWLS.POSSTATE
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	422	M_01-03-00-000

Description

HWLS.NEGSTATE reads the status of the negative HW limit switch as follows:

0 = Low

1 = High

HWLS.POSSTATE

General Information	
Type	R/O Parameter
Description	Reads the status of the positive hardware limit switch.
Units	N/A
Range	0 to 1
Default Value	N/A
Data Type	Boolean
See Also	HWLS.NEGSTATE
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	424	M_01-03-00-000

Description

HWLS.POSSTATE reads the status of the positive hardware limit switch as follows:

0 = Low

1 = High

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IL Parameters

IL.BUSFF

General Information	
Type	R/O Parameter
Description	Displays the current feedforward value injected by the fieldbus.
Units	Arms
Range	N/A
Default Value	N/A
Data Type	Float
See Also	IL.KBUSFF
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	426	M_01-03-00-000

Description

This parameter displays the current feedforward value injected by the fieldbus.

Related Topics

11.3 Current Loop

IL.CMD

General Information	
Type	R/O Parameter
Description	Reads the value of the q-component current controller inside the FPGA.
Units	Arms
Range	± Drive peak current (DRV.IPEAK)
Default Value	N/A
Data Type	Float
See Also	DRV.IPEAK
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	428	M_01-03-00-000

Description

IL.CMD displays the q-component current command value of the current loop after any limitation (such as a parameter setting or I^2t calculation).

IL.CMD is limited also by motor peak current, IL.LIMITN and IL.LIMITP.

Related Topics

10.4 Analog Input

11.3 Current Loop

IL.CMDU

General Information	
Type	R/W Parameter
Description	Sets the user current command.
Units	Arms
Range	[Maximum of user negative current limit (IL.LIMITN) and negative motor peak current (MOTOR.IPEAK)] to [minimum of user positive current limit (IL.LIMITP) and motor peak current (MOTOR.IPEAK)]
Default Value	0 Arms
Data Type	Float
See Also	DRV.IPEAK, DRV.OPMODE,DRV.CMDSOURCE
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	430	M_01-03-00-000

Description

This parameter sets the user current command value.

The current command value, which is provided to the current loop (IL.CMD), can be limited further using a parameter setting or I^2t calculation. IL.CMDU is limited also by motor peak current, IL.LIMITN and IL.LIMITP.

Related Topics

11.3 Current Loop

IL.DIFOLD

General Information	
Type	R/O Parameter
Description	Reads the drive foldback current limit.
Units	Arms
Range	0 to 2,147,483.647 Arms
Default Value	N/A
Data Type	Float
See Also	Foldback
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3559h/0	M_01-00-00-000

Description

IL.DIFOLD is the output of the drive foldback algorithm. It is an artificial current, which can be higher or lower than the drive peak current (DRV.IPEAK). When IL.DIFOLD is lower than the existing current limit (such as IL.LIMITP), it becomes the active current limit.

IL.DIFOLD decreases when the actual current is higher than drive continuous current and increases (up to a certain level) when the actual current is lower than drive continuous current.

Related Topics

11.3 Current Loop

IL.FB

General Information	
Type	R/O Parameter
Description	Reads the actual value of the d-component current.
Units	Arms
Range	± Drive peak current (DRV.IPEAK)
Default Value	N/A
Data Type	Float
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3558h/0	M_01-00-00-000
Modbus	432	M_01-03-00-000

Description

This parameter reads the measured, de-rotated actual current value of the motor.

Related Topics

11.3 Current Loop

IL.FF

General Information	
Type	R/O Parameter
Description	Displays the current loop overall feedforward value
Units	Arms
Range	N/A
Default Value	N/A
Data Type	Float
See Also	IL.KBUSFF, IL.KVFF, IL.OFFSET, IL.FRICTION, IL.KACCFF
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	434	M_01-03-00-000

Description

This parameter displays the current loop overall feedforward value.

Related Topics

11.3 Current Loop

IL.FOLDFTHRESH

General Information	
Type	R/O Parameter
Description	Reads the foldback fault level.
Units	Arms
Range	0 to 500 Arms
Default Value	Drive peak current (DRV.IPEAK)
Data Type	Float
See Also	Foldback
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3420h/0	M_01-00-00-000
Modbus	436	M_01-03-00-000

Description

IL.FOLDFTHRESH is the fault level of the current foldback algorithm. If IL.IFOLD drops below the value for IL.FOLDFTHRESH, then a fault is generated and the drive is disabled.

To avoid reaching the current foldback fault level, set IL.FOLDFTHRESHU well below the continuous current value for both the drive and the motor or set the IL.FOLDFTHRESHU value to zero.

Related Topics

11.3 Current Loop

IL.FOLDFTHRESHU

General Information	
Type	NV Parameter
Description	Sets the user value for the foldback fault level.
Units	Arms
Range	0 to 500 Arms
Default Value	Drive peak current (DRV.IPEAK)
Data Type	Float
See Also	IL.FOLDFTHRESH, Foldback
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3421h/0	M_01-00-00-000
Modbus	438	M_01-03-00-000

Description

IL.FOLDFTHRESHU is the fault level of the current foldback algorithm. The value of IL.FOLDFTHRESH is the minimum of DRV.IPEAK, MOTOR.IPEAK, and IL.FOLDFTHRESHU.

Related Topics

11.3 Current Loop

IL.FOLDWTHRESH

General Information	
Type	NV Parameter
Description	Sets the foldback warning level.
Units	Arms
Range	0 to 500 Arms
Default Value	0 A
Data Type	Float
See Also	Foldback
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	355Ah/0	M_01-00-00-000
Modbus	440	M_01-03-00-000

Description

IL.FOLDWTHRESH is the warning level of the current foldback algorithm. When IL.IFOLD drops **below** IL.FOLDWTHRESH a warning is generated.

To ensure that the current foldback warning level is never reached, IL.FOLDWTHRESH should be set well below the continuous current value for both the drive and the motor. You can also set the IL.FOLDFTHRESH value to zero.

Related Topics

11.3 Current Loop

IL.FRICTION

General Information	
Type	R/W Parameter
Description	Sets friction compensation value.
Units	A
Range	0 to the minimum of user positive current limit (IL.LIMITP) and motor peak current (MOTOR.IPEAK).IL.LIMITP
Default Value	0
Data Type	Float
See Also	IL.FF
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3422h/0	M_01-00-00-000
Modbus	442	M_01-03-00-000

Description

Position command derivative sign is multiplied by this value to be injected to the current command.

Related Topics

11.3 Current Loop

IL.IFOLD

General Information	
Type	R/O Parameter
Description	Reads the overall foldback current limit.
Units	A
Range	0 to 2,147,483.647 A
Default Value	N/A
Data Type	Float
See Also	Foldback
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3425h/0	M_01-00-00-000
Modbus	444	M_01-03-00-000

Description

Two current foldback algorithms run in parallel in the drive: the drive foldback algorithm and the motor foldback algorithm. Each algorithm uses different sets of parameters.

Each algorithm has its own foldback current limit, IL.DIFOLD and IL.MIFOLD. The overall foldback current limit is the minimum of the two at any given moment.

IL.IFOLD = min (IL.DIFOLD, IL.MIFOLD).

IL.DIFOLD is an artificial current, which can be higher or lower than the drive or motor peak current. When IL.IFOLD becomes lower than the existing current limit (such as IL.LIMITP), it becomes the active current limit.

Related Topics

11.3 Current Loop

IL.IUFB

General Information	
Type	R/O Parameter
Description	Reads the sigma-delta measured current in the u-winding of the motor.
Units	A
Range	± Drive peak current (DRV.IPEAK)
Default Value	N/A
Data Type	Float
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	446	M_01-03-00-000

Description

This parameter displays the measured current in the u-winding of the motor.

Related Topics

11.3 Current Loop

IL.IVFB

General Information	
Type	R/W Parameter
Description	Sets the sigma-delta measured current in the u-winding of the motor.
Units	A
Range	± Drive peak current (DRV.IPEAK)
Default Value	0 A
Data Type	Float
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	448	M_01-03-00-000

Description

IL.IVFB is an offset value that is added to the measured current in the u-winding of the motor. This value is used for compensating for an error in the current measurement. The drive measures 256 times the current in the u-winding when powering-up the drive. Afterwards, the drive calculates the average value of the measured current and uses this value for the offset value.

Related Topics

11.3 Current Loop

IL.KACCFF

General Information	
Type	R/W Parameter
Description	Sets current loop acceleration feedforward gain value
Units	mArms/(rad/s²)
Range	0.0 to 2.0 mArms/(rad/s²)
Default Value	0 mArms/(rad/s²)
Data Type	Float
See Also	IL.FF
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3426h/0	M_01-00-00-000
Modbus	450	M_01-03-00-000

Description

This value sets the gain for the acceleration feedforward (a scaled second derivative of the position command is added to the current command value) .

This parameter is valid only in the position mode (DRV.OPMODE = 2).

Related Topics

11.3 Current Loop

IL.KBUSFF

General Information	
Type	RW
Description	Current loops fieldbus injected feed-forward gain
Units	NA
Range	0 to 2
Default Value	0
Data Type	Float
See Also	IL.FF, IL.BUSFF
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	452	M_01-03-00-000

Description

This parameter scales the feedforward term added by the fieldbus to the current command. The nominal feed-forward value can be multiplied by this gain value.

This parameter is only used in the position mode (DRV.OPMODE = 2).

Related Topics

11.3 Current Loop

IL.KP

General Information	
Type	NV Parameter
Description	Sets the proportional gain of the q-component of the PI regulator.
Units	V/A
Range	0 to 2,000 V/A
Default Value	Read from the motor or, if no memory, 50.009 V/A
Data Type	Float
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3598h/0	M_01-00-00-000
Modbus	454	M_01-03-00-000

Description

IL.KP is used to modify the proportional gain of the PI-loop that controls the q-component of the current.

Related Topics

11.3 Current Loop

IL.KPDRATIO

General Information	
Type	NV Parameter
Description	Sets the proportional gain of the d-component current PI-regulator as a percentage of IL.KP
Units	N/A
Range	0 to 100
Default Value	1
Data Type	Float
See Also	IL.KP
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3596h/0	M_01-00-00-000
Modbus	456	M_01-03-00-000

Description

This parameter allows the user to modify the proportional gain of the PI-loop, which controls the d-component of the current.

Related Topics

11.3 Current Loop

IL.KVFF

General Information	
Type	R/W
Description	Current loops velocity feed-forward gain
Units	N/A
Range	0 to 2
Default Value	0
Data Type	Float
See Also	IL.FF
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	458	M_01-03-00-000

Description

This parameter sets the gain for the velocity loop feedforward. The nominal feedforward value can be multiplied by this gain value.

This parameter is only used in position mode (DRV.OPMODE = 2).

Related Topics

11.3 Current Loop

IL.LIMITN

General Information	
Type	NV Parameter
Description	Sets the negative user (application-specific) current limit.
Units	A
Range	Negative drive peak current (DRV.IPEAK) to 0 A
Default Value	Negative drive peak current (DRV.IPEAK)
Data Type	Float
See Also	IL.LIMITP
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	356Fh/0	M_01-00-00-000
Modbus	460	M_01-03-00-000

Description

This parameter sets the negative user limit clamp value of the torqueproducing q-component current command (IL.CMD). The current command is additionally limited by the motor peak current setting (MOTOR.IPEAK) and by the present value of the foldback I²t peak motor current protection.

Related Topics

11.3 Current Loop

IL.LIMITP

General Information	
Type	NV Parameter
Description	Sets the positive user (application-specific) current limit.
Units	A
Range	0 A to drive peak current (DRV.IPEAK)
Default Value	Drive peak current (DRV.IPEAK)
Data Type	Float
See Also	IL.LIMITN
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	356Eh/0	M_01-00-00-000
Modbus	462	M_01-03-00-000

Description

This parameter sets the positive user limit clamp value of the torque-producing q-component current command (IL.CMD). The current command is additionally limited by the motor peak current setting (MOTOR.IPEAK) and by the present value of the foldback I^2t peak motor current protection.

Related Topics

11.3 Current Loop

IL.MFOLDD

General Information	
Type	R/O Parameter
Description	Sets the motor foldback maximum time at motor peak current.
Units	s
Range	0.1 to 2400 s
Default Value	10 s
Data Type	Float
See Also	Foldback
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	464	M_01-03-00-000

Description

IL.MFOLDD sets the maximum time allowed for the motor to remain at peak current before starting to fold towards the motor continuous current. When at motor peak current, IL.MFOLDD is the amount of time before the foldback algorithm starts to reduce the current.

Related Topics

11.3 Current Loop

IL.MFOLDR

General Information	
Type	R/O Parameter
Description	Sets the motor foldback recovery time.
Units	s
Range	0.1 to 65,535 s
Default Value	Calculated from other foldback parameters.
Data Type	Float
See Also	Foldback
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	466	M_01-03-00-000

Description

IL.MFOLDR sets the recovery time for the motor foldback algorithm. If 0 current is applied for at least the recovery time duration, it is possible to apply motor peak current for the duration of IL.MFOLDD time.

The IL.MFOLDR value is automatically calculated from other foldback parameters.

Related Topics

11.3 Current Loop

IL.MFOLDT

General Information	
Type	R/O Parameter
Description	Sets the motor foldback time constant of the exponential current drop (foldback).
Units	s
Range	0.1 to 2,400 s
Default Value	10 s
Data Type	Float
See Also	Foldback
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	468	M_01-03-00-000

Description

IL.MFOLDT sets the time constant of the exponential drop (foldback) of the current towards motor continuous current.

Related Topics

11.3 Current Loop

IL.MIFOLD

General Information	
Type	R/O Parameter
Description	Sets the motor foldback current limit.
Units	A
Range	0 to 2147483.647 A
Default Value	N/A
Data Type	Float
See Also	Foldback
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	35A4h/0	M_01-00-00-000
Modbus	470	M_01-03-00-000

Description

IL.MIFOLD sets the output of the motor foldback algorithm. It is an artificial current, which can be higher or lower than the motor peak current. When IL.MIFOLD becomes lower than the existing current limit (IL.LIMITP) it becomes the active current limit.

IL.MIFOLD decreases when the actual current is higher than motor continuous current and increases (up to a certain level) when the actual current is lower than the motor continuous current.

Related Topics

11.3 Current Loop

IL.OFFSET

General Information	
Type	RW Parameter
Description	A constant current command added to compensate for gravity.
Units	A
Range	[IL.LIMITN to IL.LIMITP
Default Value	0 A
Data Type	Float
See Also	IL.FF
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3423h/0	M_01-00-00-000
Modbus	472	M_01-03-00-000

Description

This value is added to the overall current loop feedforward value.

Related Topics

11.3 Current Loop

IL.VCMD

General Information	
Type	R/O Parameter
Description	Sets the output of the q-component PI regulator.
Units	Vrms
Range	0 Vrms to bus voltage
Default Value	N/A
Data Type	Integer
See Also	IL.VDCMD
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	474	M_01-03-00-000

Description

Sets the output of the current loop that controls the q-component of the current.

Related Topics

11.3 Current Loop

IL.VUFB

General Information	
Type	R/O Parameter
Description	Reads the measured voltage on the u-winding of the motor.
Units	V
Range	–1200*VBusScale to +1200*VBusScale
Default Value	N/A
Data Type	Integer
See Also	IL.VVFB
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	476	M_01-03-00-000

Description

Reads the measured voltage on the u-winding of the motor.

Related Topics

11.3 Current Loop

IL.VVFB

General Information	
Type	R/O Parameter
Description	Reads the measured voltage on the v-winding of the motor.
Units	V
Range	–1200*VBusScale to +1200*VBusScale
Default Value	N/A
Data Type	Integer
See Also	IL.VUFB
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	478	M_01-03-00-000

Description

The range for this parameter depends on whether the drive model is an MV/240 Vac or an HV/480 Vac.

The VBusScale parameter sets the drive model:

MV/240 Vac: VBusScale = 1

HV/480 Vac: VBusScale = 2

VBusScale is used for multiple parameter ranges that are model dependent, such as IL.KP.

Related Topics

11.3   Current Loop

MOTOR Parameters

MOTOR.AUTOSET

General Information	
Type	NV Parameter
Description	Determines which drive parameters are calculated automatically.
Units	N/A
Range	0 to 1
Default Value	0
Data Type	Boolean
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3451h/0	M_01-00-00-000
Modbus	480	M_01-03-00-000

Description

This parameter determines whether or not certain drive parameters (for example, IL.KP or MOTOR.POLES) are calculated automatically. A value of 1 causes the parameters to be automatically calculated from the motor ID data (read from memory-supporting feedback devices, such as SFD, Endat, and BISS). Automatically calculated parameters are read-only. A value of 0 disables the automatic calculation and you must set the parameters manually. Manually set parameters are read-write.

Related Topics

8.1   Motor

MOTOR.BRAKE

General Information	
Type	NV Parameter
Description	Sets the presence or absence of a motor brake.
Units	N/A
Range	0 to 1
Default Value	0
Data Type	Boolean
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3587h/0	M_01-00-00-000
Modbus	482	M_01-03-00-000

Description

The MOTOR.BRAKE parameter notifies the firmware whether a brake exists or not. It does not apply or release the brake. If a brake is found to be present, the firmware considers hardware indications regarding the brake circuits (such as open circuit or short circuit). If a brake does not exist, then the firmware ignores the hardware indications since they are irrelevant.

Value	Status
0	Motor brake does not exist.
1	Motor brake exists and brake hardware circuitry checks are enabled.

Enabling the MOTOR.BRAKE (value set to 1) when no motor brake exists creates a fault.

The motor brake is polled every 16 ms.

Related Topics

8.1 Motor

MOTOR.BRAKERLS

General Information	
Type	Command
Description	Allows a user to release the motor brake.
Units	N/A
Range	0 to 1
Default Value	0
Data Type	Integer
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3450h/0	M_01-00-00-000
Modbus	484	M_01-03-00-000

Description

This command allows a user to release the motor brake.

0 = Drive controls the brake.

1 = Brake is released.

Note: A digital input mode is also used for the same purpose. The two mechanisms are independent.

Related Topics

8.1 Motor

MOTOR.BRAKESTATE

General Information	
Type	R/O Parameter
Description	Reads the actual status of the motor brake.
Units	N/A
Range	Brake closed or not present. Brake opened.
Default Value	Brake closed or not present.
Data Type	String
See Also	N/A
Start Version	M_01-00-00-000

Description

This parameter reads the actual status of the motor brake and can only show two states:

1 = Brake closed or not present

2 = Brake open

Related Topics

8.1 Motor

MOTOR.CTF0

General Information	
Type	NV Parameter
Description	Sets the thermal constant of the motor coil.
Units	mHz
Range	0.265 to 16,000 mHz
Default Value	10 mHz
Data Type	Float
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3454h/0	M_01-00-00-000
Modbus	486	M_01-03-00-000

Description

This parameter is used to configure the thermal constant of the motor coil, which is the break frequency of a single-pole low-pass filter model of the thermal dynamics of the motor coil.

This parameter, together with MOTOR.IPEAK and MOTOR.ICONT, determine the motor foldback parameters IL.MFOLDD,IL.MFOLDT, and IL.MFOLDR.

Calculating MOTOR.CTF0

Given a motor coil/winding thermal time constant T in seconds, then:

MOTOR.CTF0 = $1/(2\pi T)$

Related Topics

8.1 Motor

MOTOR.ICONT

General Information	
Type	NV Parameter
Description	Sets the motor continuous current.
Units	A
Range	0.1 to 500 A
Default Value	1.0 A
Data Type	Float
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	358Eh/0	M_01-00-00-000
Modbus	488	M_01-03-00-000

Description

This parameter is used to configure the motor continuous current.

Related Topics

8.1 Motor

MOTOR.IDDATAVALID

General Information	
Type	R/O Parameter
Description	Reports the status of the motor memory.
Units	N/A
Range	N/A
Default Value	0
Data Type	Integer
See Also	N/A
Start Version	M_01-02-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	490	M_01-03-00-000

Description

MOTOR.IDDATAVALID reports the status of the motor memory status.

The valid values for this keyword are the following:

Value	Description
0	Error in identification
1	Success in identification
2	Identification in process
3	Identification not started yet
4	Success recognizing feedback, but failed to varify OEM data integrity

Related Topics

8.1 Motor

MOTOR.INERTIA

General Information	
Type	NV Parameter
Description	Sets the motor inertia.
Units	kgcm² for rotary motors kg for linear motors
Range	1 to 200,000 kgcm² or kg
Default Value	100 kgcm² or kg
Data Type	Float
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	35ABh/0	M_01-00-00-000
Modbus	492	M_01-03-00-000

Description

This parameter sets the motor inertia.

Related Topics

8.1 Motor

MOTOR.IPEAK

General Information	
Type	NV Parameter
Description	Sets the motor peak current.
Units	mA
Range	0.200 to 1,000 A
Default Value	2.000 A
Data Type	Float
See Also	IL.LIMITP, IL.LIMITN
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	358Fh/0	M_01-00-00-000
Modbus	494	M_01-03-00-000

Description

This parameter configures the drive for the motor's peak, instantaneous-rated current. MOTOR.IPEAK is used to limit clamp the magnitude of the torque producing q-component current command (IL.CMD).

Related Topics

8.1 Motor

MOTOR.KT

General Information	
Type	NV Parameter
Description	Sets the torque constant of the motor.
Units	Nm/A
Range	0.001 to 65 Nm/A
Default Value	0.1 Nm/A
Data Type	Float
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3593h/0	M_01-00-00-000
Modbus	496	M_01-03-00-000

Description

This parameter is the torque constant of the motor in Nm/A. The value can be online checked according to the following equation:

$$Kt = 60 * \sqrt{3} * Ui / (2 * \pi * n)$$

Where:

Ui = induced voltage of the motor
n = actual rotor velocity

Related Topics

8.1 Motor

MOTOR.LQLL

General Information	
Type	NV Parameter
Description	Sets the line-to-line motor Lq.
Units	mH
Range	1 to 2^{32} H
Default Value	17.000 H
Data Type	Float
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3455h/0	M_01-00-00-000
Modbus	498	M_01-03-00-000

Description

This parameter is used to configure the motor line-to-line inductance.

Related Topics

8.1 Motor

MOTOR.NAME

General Information	
Type	NV Parameter
Description	Sets the motor name.
Units	N/A
Range	11 chars
Default Value	N/A
Data Type	String
See Also	N/A
Start Version	M_01-00-00-000

Description

This parameter is used to set the motor name.

Related Topics

8.1 Motor

MOTOR.PHASE

General Information	
Type	NV Parameter
Description	Sets the motor phase.
Units	Electrical degrees
Range	0 to 360°
Default Value	0°
Data Type	Integer
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	359Ch/0	M_01-00-00-000
Modbus	500	M_01-03-00-000

Description

This parameter sets the motor phase.

Related Topics

8.1 Motor

MOTOR.PITCH

General Information	
Type	NV Parameter
Description	Sets the motor pitch.
Units	µm
Range	1,000 to 1,000,000 µm
Default Value	1.000 µm
Data Type	Integer
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	502	M_01-03-00-000

Description

This parameter defines the pole-to-pair pitch for the linear motor in micrometers.

Related Topics

8.1 Motor

MOTOR.POLES

General Information	
Type	NV Parameter
Description	Sets the number of motor poles.
Units	N/A
Range	0 to 128
Default Value	6
Data Type	Integer
See Also	FB1.POLES
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	359Dh/0	M_01-00-00-000
Modbus	504	M_01-03-00-000

Description

MOTOR.POLES sets the number of motor poles. This command is used for commutation control and represents the number of individual magnetic poles of the motor (not pole pairs). The division value of motor poles (MOTOR.POLES) and feedback poles (FB1.POLES) must be an integer when setting drive to enable, otherwise a fault is issued.

Related Topics

8.1 Motor

MOTOR.R

General Information	
Type	NV Parameter
Description	Sets the stator winding resistance phase-phase in ohms.
Units	Ω
Range	0.001 to 650 Ω
Default Value	10 Ω
Data Type	Float
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3456h/0	M_01-00-00-000
Modbus	506	M_01-03-00-000

Description

MOTOR.R sets the stator winding resistance phase-to-phase in ohms.

Related Topics

8.1 Motor

MOTOR.RTYPE

General Information	
Type	NV Parameter
Description	Defines the type of thermal resistor inside the motor.
Units	N/A
Range	0 to 1
Default Value	0
Data Type	Boolean
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	508	M_01-03-00-000

Description

This parameter defines the type of thermal resistor used inside of the motor to measures motor temperature.

0 = PTC

1 = NTC

Related Topics

8.1 Motor

MOTOR.TBRAKEAPP

General Information	
Type	NV Parameter
Description	The delay time used for applying the motor brake.
Units	ms
Range	0 to 1,000 ms
Default Value	75 ms
Data Type	Integer
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	366Eh/0	M_01-00-00-000
Modbus	510	M_01-03-00-000

Description

This parameter is used to configure the mechanical delay when applying the motor brake. MOTOR.TBRAKEAPP is a time delay that is applied when a brake exists and the drive is disabled at the end of a controlled stop. This delay lasts from the time that the brake is commanded to engage until the time that the drive is disabled.

This feature allows you to disable the drive and engage the brake on a vertical application without the load falling. Without this time delay, if you immediately disable the drive then the load falls during the time needed for the brake to mechanically engage.

Related Topics

8.1 Motor

MOTOR.TBRAKERLS

General Information	
Type	NV Parameter
Description	The delay time used for releasing the motor brake.
Units	ms
Range	0 to 1,000 ms
Default Value	75 ms
Data Type	Integer
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	366Fh/0	M_01-00-00-000
Modbus	512	M_01-03-00-000

Description

This parameter is used to configure the mechanical delay when releasing the motor brake. MOTOR.TBRAKERLS is a time delay that is applied when a brake exists and the drive is enabled. When the drive is enabled, the brake is commanded to disengage, and during the MOTOR.TBRAKERLS period of time the drive does not accept a motion command. This delay allows the brake to fully disengage before the drive begins a new motion.

Related Topics

8.1 Motor

MOTOR.TEMP

General Information	
Type	R/O Parameter
Description	Reads the motor temperature represented as the resistance of the motor PTC.
Units	Ω
Range	0 to 2^{32} Ω
Default Value	N/A
Data Type	Integer
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3612h/0	M_01-00-00-000
Modbus	514	M_01-03-00-000

Description

This parameter is used to get the motor temperature which is represented as the resistance of the motor PTC.

Related Topics

8.1 Motor

MOTOR.TEMPFAULT

General Information	
Type	NV Parameter
Description	Sets the motor temperature fault level.
Units	Ω
Range	0 to 2,000,000,000 Ω
Default Value	0 Ω = switched off
Data Type	Integer
See Also	MOTOR.TEMP
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3586h/0	M_01-00-00-000
Modbus	516	M_01-03-00-000

Description

This parameter is used to configure the motor temperature fault level as a resistance threshold of the motor PTC. A zero value prevents any warning from being issued.

Related Topics

8.1 Motor

MOTOR.TEMPWARN

General Information	
Type	NV Parameter
Description	Sets the motor temperature warning level.
Units	Ω
Range	0 to 2,000,000,000 Ω
Default Value	0 Ω = switched off
Data Type	Integer
See Also	MOTOR.TEMP
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3453h/0	M_01-00-00-000
Modbus	518	M_01-03-00-000

Description

This parameter is used to configure the motor temperature warning level as a resistance threshold of the motor PTC.

A zero value prevents any warning from being created.

Related Topics

8.1 Motor

MOTOR.TYPE

General Information	
Type	NV Parameter
Description	Sets the motor type.
Units	N/A
Range	0 to 1
Default Value	0
Data Type	Integer
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	520	M_01-03-00-000

Description

MOTOR.TYPE sets the drive control algorithms to different motor types as follows:

0 = Rotary motor

1 = Linear motor

Related Topics

8.1 Motor

MOTOR.VMAX

General Information	
Type	NV Parameter
Description	Sets the maximum motor speed.
Units	rpm
Range	100 to 40,000 rpm
Default Value	3,000 rpm
Data Type	Integer
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	35A3h/0	M_01-00-00-000
Modbus	522	M_01-03-00-000

Description

This parameter is used to configure the maximum speed of the motor.

Related Topics

8.1 Motor

MOTOR.VOLTMAX

General Information	
Type	NV Parameter
Description	Sets the motor maximum voltage.
Units	Vrms
Range	110 to 900 Vrms
Default Value	230 Vrms
Data Type	Integer
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3452h/0	M_01-00-00-000
Modbus	524	M_01-03-00-000

Description

This parameter sets the maximum permissible motor voltage. For instance, if a motor that is rated for a 400 V supply is connected to the drive, then the MOTOR.VOLTMAX setting is 400. This value also sets regen resistor and over voltage thresholds in the drive to acceptable values for the motor so that the motor windings are not damaged.

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MT Parameters and Commands

MT.ACC

General Information	
Type	R/W Parameter
Description	Specifies motion task acceleration; active in opmode 2 (position) only.
Units	Depends on UNIT.ACCROTARY or UNIT.ACCLINEAR Rotary: rps/s, rpm/s, deg/s², (PIN/POUT)/s², rad/s² Linear: counts/s², mm/s², µm/s², (PIN/POUT)/s²
Range	Rotary: 0.031 to 833,333.333 rps/s 1.860 to 50,000,000.000 rpm/s 11.158 to 300,000,000.000 deg/s² 0.155 to 4,166,666.752 (PIN/POUT)/s² 0.195 to 5,235,987.968 rad/s² Linear: 0.000 to 833.333 counts/s² 0.031*MOTOR.PITCH to 833,333.333*MOTOR.PITCH mm/s² 30.994*MOTOR.PITCH to 833,333,333.333*MOTOR.PITCHµm/s² 0.155 to 4,166,666.667 (PIN/POUT)/s²
Default Value	Rotary: 166.714 rps/s 10,002.851 rpm/s 60.017.108 deg/s² 833.571 (PIN/POUT)/s² 1,047.496 rad/s² Linear: 0.166 counts/s² 166.714*MOTOR.PITCHMOTOR.PITCH mm/s² 166,714.191*MOTOR.PITCHMOTOR.PITCH µm/s² 833.571 (PIN/POUT)/s²
Data Type	Float
See Also	MT.NUM , MT.P, MT.V, MT.CNTL, MT.DEC, MT.TNUM, MT.MTNEXT , MT.TNEXT, MT.SET , MT.LOAD
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	6083h/0	M_01-00-00-000
Modbus	526 (64-bit)	M_01-03-00-000

Description

MT.ACC specifies the motion task acceleration and is used by the MT.SET and MT.LOAD command. This parameter is a temporary value, since a motion task is only set after a MT.SET command. The motion task acceleration is further limited by the maximum allowed acceleration DRV.ACC

A value of 0 for MT.ACC should not be used when setting a motion task via MT.SET because this value causes a validity check of the MT.SET command to fail.

A value of 0 for MT.ACC after an MT.LOAD command displays an empty (not initialized) motion task.

Related Topics

12.2 Motion Tasks

MT.CLEAR

General Information	
Type	Command
Description	Clears motion tasks from the drive; active in opmode 2 (position) only.
Units	N/A
Range	N/A
Default Value	N/A
Data Type	N/A
See Also	MT.NUM , MT.P, MT.V, MT.CNTL, MT.ACC,MT.DEC, MT.TNUM, MT.MTNEXT , MT.TNEXT, MT.SET , MT.LOAD
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	530	M_01-03-00-000

Description

MT.CLEAR clears a motion task from the drive. This command needs one argument in order to clear a motion task. A motion task consists of the following parameters: MT.NUM , MT.P, MT.V, MT.CNTL, MT.ACC,MT.DEC, MT.TNUM, MT.MTNEXT , MT.TNEXT

A value of –1 clears all motion tasks in the drive (MT.CLEAR –1).

Example

MT.CLEAR 5: Clear motion task number 5.

After performing a command such as MT.PARAMS 5, the drive displays the following:

```
5   0.000 Counts   0.000 rpm   0   0.000 rpm/s   0.000 rpm/s   0   0   0
ms
```

A value of 0 for velocity, acceleration, or deceleration displays motion task as uninitialized.

Related Topics

12.2 Motion Tasks

MT.CNTL

General Information	
Type	R/W Parameter
Description	Sets motion task control word; active in opmode 2 (position) only.
Units	N/A
Range	0 to 4,294,967,295
Default Value	0
Data Type	Integer
See Also	MT.NUM , MT.P, MT.V, MT.ACCMT.V, MT.DEC, MT.TNUM, MT.MTNEXT MT.MTNEXT , MT.SET , MT.LOAD
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	35AFh/0 6086h/0	M_01-00-00-000
Modbus	532	M_01-03-00-000

Description

MT.CNTL specifies the motion task control word, which is used by the MT.SET and MT.LOAD commands. The control word describes the behavior of the motion task. This parameter is a temporary value, since a motion task is only set after an MT.SET command is issued.

Since this parameter is read bitwise, it can combine multiple functions into a single word. The meaning of each bit is described in the tables below.

Table 1: Motion Task (MT) Bit Descriptions

Bit	Meaning	Description
0	0x00001	See Table 2: MT Type.
1	0x00002	
2	0x00004	
3	0x00008	
4	0x00010	If this bit is 0, then the next MT is not executed. If this bit is 1, then the next MT is executed.
5	0x00020	See Table 3: Next MT Start Type.
6	0x00040	
7	0x00080	
8	0x00100	
9	0x00200	
10	0x00400	See Table 4: MT Acceleration Type.
11	0x00800	
12	0x01000	Activates the override functionality for a trapezoidal MT. If this bit is 1, a motion task with override functionality must be activated (see bit 5).

Table 2: MT Type

Bits 3, 2, 1, 0	Description
0000	Absolute MT. The target position is defined by the MT.P value.

Bits 3, 2, 1, 0	Description
1000	Absolute MT. The target position is defined by an external source, such as an analog input.
0001	Relative MT. The target position is defined as: Target position = PL.CMD + MT.P
0011	Relative MT. The target position is defined as: Target position = Target position of the last motion task + MT.P
0101	Relative MT. The target position is defined as: Target position = External start position + MT.P The ‘external start position’ can be generated by a latched position, analog input, and other sources.
0111	Relative MT. The target position is defined as: Target position = PL.FB + MT.P

Table 3: Next MT Start Type

Bits 9, 8, 7, 6, 5	Description
00000	Switches over to next MT after stopping. After an MT ends, the next MT starts immediately.
00001	Switches over to next MT after stopping and delay. After an MT ends, the MT following time (MT.TNEXTelapse in order to start the next MT.
00010	Switches over to next MT after stopping and external event. After an MT ends, an external event (such as a high digital input) must occur in order to start the next MT.
00011	Switches over to next MT after stopping, delay, and external event. After an MT ends, the MT.TNEXTmust elapse and an external event (such as a high digital input) must occur in order to start the next MT.
00111	Switches over to next MT after stopping, then delay or external event. After an MT ends, the MT.TNEXT must elapse or an external event (such as a high digital input) must occur in order to start the next MT.
10000	Switches over to the next MT at present MT speed (change on the fly). After reaching the target position of an MT, the next MT starts. The drive then accelerates with the adjusted acceleration ramp of this next MT to the target velocity of this next MT. The MT.TNEXT setting is ignored.
11000	Switches over to the next MT at next MT speed (change on the fly).When the target position of an MT is reached, the drive has already accelerated with the acceleration ramp of the next MT to the target velocity of the next MT. Thus, the drive begins the next MT at the next MT target velocity. The MT.TNEXT setting is ignored if adjusted.

Table 4: MT Acceleration Type

Bits 11, 10	Description
00	Trapezoidal acceleration and deceleration.

Bits 11, 10	Description
01	1:1 customer table motion task. The drive follows the customer table without inserting a constant velocity phase between the acceleration and deceleration process. This setting allows the usage of nonsymmetric velocity profiles. The MT.TNUM parameter defines which table to use for the 1:1 profile handling. See "AKD Customer Profile Application Note" on the Kollmorgen web site (www.kollmorgen.com) for additional details.
11	Standard customer table motion task. The drive accelerates according to the shape of the customer table by stepping through the first half of the customer table. Then the drive inserts a constant velocity phase until the brake-point is reached. Finally, the drive decelerates by stepping through the second half of the customer profile table. The MT.TNUM parameter defines which table to use for the 1:1 profile handling. This mode allows also a change on the fly between motion tasks (see Table 3 above). See "AKD Customer Profile Application Note" on the Kollmorgen web site (www.kollmorgen.com) for additional details.

Related Topics

12.2 Motion Tasks

MT.CONTINUE

General Information	
Type	Command
Description	Continues a stopped motion task; active in opmode 2 (position) only.
Units	N/A
Range	N/A
Default Value	0
Data Type	N/A
See Also	MT.NUM , MT.P, MT.V, MT.CNTL, MT.ACCMT.V, MT.DEC, MT.TNUM, MT.MTNEXT MT.MTNEXT , MT.SET , MT.LOAD
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	534	M_01-03-00-000

Description

MT.CONTINUE continues a motion task that has been stopped by the DRV.STOP command.

Related Topics

12.2 Motion Tasks

MT.DEC

General Information	
Type	R/W Parameter
Description	Sets motion task deceleration; active in opmode 2 (position) only.
Units	Depends on UNIT.ACCROTARY or UNIT.ACCLINEAR Rotary: rps/s, rpm/s, deg/s², (PIN/POUT)/s², rad/s² Linear: counts/s², mm/s², µm/s², (PIN/POUT)/s²
Range	Rotary: 0.031 to 833333.333 rps/s 1.860 to 50000000.000 rpm/s 11.158 to 300000000.000 deg/s² 0.155 to 4166666.752 (PIN/POUT)/s² 0.195 to 5235987.968 rad/s² Linear: 0.000 to 833.333 counts/s² 0.031*MOTOR.PITCH to 833333.333*MOTOR.PITCH mm/s² 30.994*MOTOR.PITCH to 833333333.333*MOTOR.PITCH µm/s² 0.155 to 4166666.667 (PIN/POUT)/s²
Default Value	Rotary: 166.714 rps/s 10,002.851 rpm/s 60.017.108 deg/s² 833.571 (PIN/POUT)/s² 1,047.496 rad/s² Linear: 0.166 counts/s² 166.714*MOTOR.PITCHMOTOR.PITCH mm/s² 166,714.191*MOTOR.PITCHMOTOR.PITCH µm/s² 833.571 (PIN/POUT)/s²
Data Type	Float
See Also	MT.ACC, MT.NUM , MT.P, MT.V, MT.CNTL, MT.TNUM, MT.MTNEXT , MT.TNEXT, MT.SET , MT.LOAD
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	6084h/0	M_01-00-00-000
Modbus	536 (64-bit)	M_01-03-00-000

Description

MT.DEC specifies the motion task deceleration and is used by the MT.SET and MT.LOAD commands. This parameter is a temporary value, since a motion task is only set after an MT.SET command is issued. The motion task deceleration is further limited by the maximum allowed acceleration, DRV.DEC.

A value of 0 for MT.DEC should not be used when setting a motion task via MT.SET because this value causes a validity check of the MT.SET command to fail.

A value of 0 for MT.DEC after an MT.LOAD command displays an empty (not initialized) motion task.

Related Topics

12.2 Motion Tasks

MT.EMERGMT

General Information	
Type	R/W Parameter
Description	Selects a motion task to be triggered after an emergency stop procedure; active in opmode 2 (position) only.
Units	N/A
Range	1 to 128
Default Value	0
Data Type	N/A
See Also	MT.NUM , MT.P, MT.V, MT.CNTL, MT.ACC, MT.DEC, MT.TNUM, MT.MTNEXT , MT.TNEXT, MT.SET , MT.LOAD
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	540	M_01-03-00-000

Description

MT.EMERGMT selects the motion task to be triggered after an emergency stop procedure.

A value of –1 shows that no motion task must be started after a ramp-down procedure in a closed position loop mode of operation.

Related Topics

12.2 Motion Tasks

MT.LIST

General Information	
Type	Command
Description	Lists all initialized motion tasks in the drive; active in opmode 2 (position) only.
Units	N/A
Range	0
Default Value	N/A
Data Type	MT.NUM , MT.P, MT.V, MT.CNTL, MT.ACC, MT.DEC, MT.TNUM, MT.MTNEXT , MT.TNEXT, MT.SET , MT.LOAD
See Also	M_01-00-00-000
Start Version	N/A

Description

MT.LIST reads every initialized motion task from the drive. A motion task consists of the following parameters: MT.NUM , MT.P, MT.V, MT.CNTL, MT.ACC, MT.DEC, MT.TNUM, MT.MTNEXT , and MT.TNEXT.

A motion task is considered as initialized as soon as MT.V, MT.ACC, and MT.DEC of that specific motion task have values not equal to 0.

Related Topics

12.2 Motion Tasks

MT.LOAD

General Information	
Type	Command
Description	Reads/loads a motion task number from the drive; active in opmode 2 (position) only.
Units	N/A
Range	N/A
Default Value	0
Data Type	N/A
See Also	MT.NUM , MT.P, MT.V, MT.CNTL, MT.ACC, MT.DEC, MT.TNUM, MT.MTNEXT , MT.TNEXT, MT.SET
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	542	M_01-03-00-000

Description

MT.LOAD reads out a motion task number MT.NUM from the drive. A motion task consists of the following parameters: MT.NUM, MT.P, MT.V, MT.CNTL, MT.ACC, MT.DEC, MT.TNUM, MT.MTNEXT , MT.TNEXT. These parameters belong to the motion task number MT.NUM and are refreshed by MT.LOAD.

Related Topics

12.2   Motion Tasks

MT.MOVE

General Information	
Type	Command
Description	Starts a motion task; active in opmode 2 (position) only.
Units	N/A
Range	N/A
Default Value	0
Data Type	N/A
See Also	MT.NUM , MT.P, MT.V, MT.CNTL, MT.ACC, MT.DEC, MT.TNUM, MT.MTNEXT , MT.TNEXT, MT.SET , MT.LOAD
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	544	M_01-03-00-000

Description

MT.MOVE starts a motion task. This command needs one argument in order to start a motion task. The drive must be homed, otherwise the motion task will not start (see also HOME commands).

Example

MT.MOVE 3 -> Start motion task number 3.

Related Topics

12.2 Motion Tasks

Mode 2: Start Motion Task in 10.1 Digital Inputs and Outputs (see also Modes 3: Motion Task Select Bit and Mode 4: Motion Task Start Selected in this topic)

MT.MTNEXT

General Information	
Type	R/W Parameter
Description	Specifies following motion task number; active in opmode 2 (position) only.
Units	N/A
Range	0 to 128
Default Value	0
Data Type	Integer
See Also	MT.NUM , MT.P, MT.V, MT.CNTL, MT.ACC, MT.DEC, MT.TNUM, MT.TNEXT, MT.SET , MT.LOAD
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	35BCh/0	M_01-00-00-000
Modbus	546	M_01-03-00-000

Description

MT.MTNEXT specifies the number of the following motion task and is used by the MT.SET and MT.LOAD command. This parameter is a temporary value. A motion task is only set after an MT.SET command.

The motion task control word can be selected so that a following motion task is executed after a first motion task. This parameter displays which motion task should be started after the first motion task.

Related Topics

12.2 Motion Tasks

MT.NUM

General Information	
Type	R/W Parameter
Description	Sets the motion task number; active in opmode 2 (position) only.
Units	N/A
Range	0 to 128
Default Value	0
Data Type	Integer
See Also	MT.P, MT.V, MT.CNTL, MT.ACC, MT.DEC, MT.TNUM, MT.MTNEXT , MT.TNEXT, MT.SET , MT.LOAD
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	365Bh/0	M_01-00-00-000
Modbus	548	M_01-03-00-000

Description

MT.NUM specifies the motion task number, which is used by the MT.SET and MT.LOAD commands. This parameter is a temporary value. A motion task is only set after an MT.SET command is issued.

Related Topics

12.2 Motion Tasks

MT.P

General Information	
Type	R/W Parameter
Description	Sets the motion task position; active in opmode 2 (position) only.
Units	Depends on UNIT.PROTARY or UNIT.PLINEAR
Range	N/A
Default Value	0
Data Type	Float
See Also	MT.NUM , MT.V, MT.CNTL, MT.ACC, MT.DEC, MT.TNUM, MT.MTNEXT , MT.TNEXT, MT.SET , MT.LOAD
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	607Ah /0	M_01-00-00-000
Modbus	550 (64-bit)	M_01-03-00-000

Description

MT.P specifies the motion task position, which is used by the MT.SET and MT.LOAD command. Depending on the motion task control word (MT.CNTL), the MT.P command can either be the target position of the motion task or a relative distance. This parameter is a temporary value. A motion task is only set after an MT.SET command.

Related Topics

12.2 Motion Tasks

MT.PARAMS

General Information	
Type	Command
Description	Shows a motion task; active in opmode 2 (position) only.
Units	N/A
Range	N/A
Default Value	0
Data Type	N/A
See Also	MT.NUM , MT.P, MT.V, MT.CNTL, MT.ACC, MT.DEC, MT.TNUM, MT.MTNEXT , MT.TNEXT, MT.SET , MT.LOAD
Start Version	M_01-00-00-000

Description

MT.PARAMS displays a motion task. This command needs one argument in order to show a motion task. If you enter MT.PARAMS without an argument, the drive returns the current or last active motion task.

Example

MT.PARAMS 5

The drive responds as follows:

```
7   5222.000 Counts   135.000 rpm   1   550.746 rpm/s   654.458 rpm/s
0   0   0 ms
```

Related Topics

12.2 Motion Tasks

MT.SET

General Information	
Type	Command
Description	Sets the motion task in the drive; active in opmode 2 (position) only.
Units	N/A
Range	N/A
Default Value	0
Data Type	N/A
See Also	MT.NUM , MT.P, MT.V, MT.CNTL, MT.ACC, MT.DEC, MT.TNUM, MT.MTNEXT , MT.TNEXT, MT.LOAD
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3431h/0	M_01-00-00-000
Modbus	554	M_01-03-00-000

Description

MT.SET sends a motion task to the drive. A motion task consists of the following parameters: MT.NUM , MT.P, MT.V, MT.CNTL, MT.ACC, MT.DEC, MT.TNUM, MT.MTNEXT , and MT.TNEXT.

The motion task number (MT.NUM) with the parameters above is sent to the drive only after the MT.SET command.

Related Topics

12.2 Motion Tasks

MT.TNEXT

General Information	
Type	R/W Parameter
Description	Specifies following motion task time; active in opmode 2 (position) only.
Units	ms
Range	0 to 65,535 ms
Default Value	0 ms
Data Type	Integer
See Also	MT.NUM , MT.P, MT.V, MT.CNTL, MT.ACC, MT.DEC, MT.TNUM, MT.MTNEXT , MT.SET , MT.LOAD
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	35BDh/0	M_01-00-00-000
Modbus	556	M_01-03-00-000

Description

MT.TNEXTspecifies the time that must elapse before starting a following motion task. This value is used by the MT.SET and MT.LOAD command. This parameter is a temporary value. A motion task is only set after an MT.SET command.

The motion task control word can be selected so that a following motion task is executed after a first motion task and this additional delay time.

Related Topics

12.2 Motion Tasks

MT.TNUM

General Information	
Type	R/W Parameter
Description	Sets the motion task customer table number; active in opmode 2 (position) only.
Units	N/A
Range	0 to 7
Default Value	0
Data Type	Integer
See Also	MT.NUM , MT.P, MT.V, MT.CNTL, MT.ACC, MT.DEC, MT.MTNEXT , MT.TNEXT, MT.SET , MT.LOAD
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	558	M_01-03-00-000

Description

MT.TNUM specifies the customer profile table and is used by the MT.SET and MT.LOAD command. This parameter is a temporary value. A motion task is only set after an MT.SET command.

The drive can have up to eight customer specific profile tables. The drive performs an S-curve acceleration with these profile tables. The shapes of these tables have an impact on the shape of the motion task acceleration and deceleration. The motion task control word specifies if a customer profile table is used or not.

This parameter has no impact when a trapezoidal motion task acceleration and deceleration profile is selected (see Table 4: MT Acceleration Typein the MT.CNTL description).

Related Topics

12.2 Motion Tasks

MT.TPOSWND

General Information	
Type	R/W Parameter
Description	Sets the motion task target position window; active in opmode 2 (position) only.
Units	Depends on UNIT.PROTARY or UNIT.PLINEAR Rotary: counts, rad, deg, PIN/POUT, 16-bit counts Linear: counts, mm, µm, PIN/POUT, 16-bit counts
Range	N/A
Default Value	0.5 rev
Data Type	Float
See Also	DRV.MOTIONSTAT
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	35C6h/0	M_01-00-00-000
Modbus	560 (64-bit)	M_01-03-00-000

Description

Within DRV.MOTIONSTAT, MT.TPOSWND is used to indicate that the target position of a motion task has been reached. DRV.MOTIONSTAT displays a "Target Position Reached" bit as soon as the following statement becomes true:

abs(actual_position – target_position) < MT.TPOSWND

Related Topics

12.2 Motion Tasks

MT.TVELWND

General Information	
Type	R/W Parameter
Description	Sets the motion task target velocity window; active in opmode 2 (position) only.
Units	Depends on UNIT.VROTARY or UNIT.VLINEAR Rotary: rpm, rps, deg/s, (PIN/POUT)/s, rad/s Linear: Counts/s, mm/s, µm/s, (PIN/POUT)/s
Range	Rotary: 0.000 to 12000.000 rpm 0.000 to 200.000 rps 0.000 to 72000.000 deg/s 0.000 to 1000.000 (PIN/POUT)/s 0.000 to 1256.637 rad/s Linear: 0.000 to 0.200 counts/s 0.000 to 200.000*MOTOR.PITCH mm/s 0.000 to 200,000.000*MOTOR.PITCH µm/sec 0.000 to 1000.000 (PIN/POUT)/s
Default Value	Rotary: 60.000 rpm 1.000 rps 359.999 deg/s 5.000 (PIN/POUT)/s 6.283 rad/s Linear: 0.001 counts/s 1.000*MOTOR.PITCH mm/s 999.998*MOTOR.PITCH µm/sec 5.000 (PIN/POUT)/s
Data Type	Float
See Also	DRV.MOTIONSTAT
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3856h/0	M_01-00-00-000
Modbus	564	M_01-03-00-000

Description

Within DRV.MOTIONSTAT, MT.TVELWND is used to indicate that the target velocity of a motion task has been reached. DRV.MOTIONSTAT displays a "Target Velocity Reached" bit as soon as the following statement becomes true:

(target velocity – MT.TVELWND) < actual velocity < (target velocity + MT)

Related Topics

12.2 Motion Tasks

MT.V

General Information	
Type	R/W Parameter
Description	Sets the motion task velocity; active in opmode 2 (position) only.
Units	Depends on UNIT.VROTARY or UNIT.VLINEAR Rotary: rpm, rps, deg/s, (PIN/POUT)/s, rad/s Linear: counts/s, mm/s, µm/s, (PIN/POUT)/s
Range	Rotary: 0.000 to 12,000.000 rpm 0.000 to 200.000 rps 0.000 to 72,000.000 deg/s 0.000 to 1,000.000 (PIN/POUT)/s 0.000 to 1,256.637 rad/s Linear: 0.000 to 0.200 counts/s 0.000 to 200.000*MOTOR.PITCH mm/s 0.000 to 200,000.000*MOTOR.PITCH µm/sec 0.000 to 1000.000 (PIN/POUT)/s
Default Value	0
Data Type	Float
See Also	MT.NUM , MT.P, MT.CNTL, MT.ACC, MT.DEC, MT.TNUM, MT.MTNEXT , MT.TNEXT, MT.SET , MT.LOAD
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	6081h6081h	M_01-00-00-000
Modbus	566	M_01-03-00-000

Description

MT.V specifies the motion task velocity, which is used by the MT.SET and MT.LOAD command. This parameter is a temporary value. A motion task is only set after an MT.SET command. The motion task velocity is furthermore limited by VL.LIMITP or VL.LIMITN depending on the direction of the motion task.

A value of 0 should not be used when setting a motion task via MT.SET because this value causes a validity check of the MT.SET command to fail.

A value of 0 after an MT.LOAD command displays an empty (not initialized) motion task.

Related Topics

12.2 Motion Tasks

MT.VCMD

General Information	
Type	R/O Parameter
Description	Reads the derivative of PL.CMD; active in opmode 2 (position) only.
Units	Depends on UNIT.VROTARY or UNIT.VLINEAR
Range	N/A
Default Value	N/A
Data Type	Float
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	568	M_01-03-00-000

Description

MT.VCMD returns the derivative of the position loop trajectory (PL.CMD), which is therefore a velocity. MT.VCMD is updated while the drive is in DRV.OPMODE 2 and is processing the following motion types:

- Motion tasking
- Homing
- Electronic gearing
- Service motion
- External trajectory coming from a fieldbus
- External trajectory calculated from an analog input signal

Related Topics

12.2 Motion Tasks

PL Parameters

PL.CMD

General Information	
Type	NV Parameter
Description	Reads the position command directly from the entry to the position loop.
Units	Depends on UNIT.PROTARY or UNIT.PLINEARUNIT.ACCLINEAR Rotary: counts, rad, deg, (PIN/POUT), 16-bit counts Linear: counts, mm, µm, (PIN/POUT), 16-bit counts
Range	N/A
Default Value	N/A
Data Type	Float
See Also	PL.FB
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	570 (64-bit)	M_01-03-00-000

Description

PL.CMD returns the position command as it is received in the position loop entry.

Related Topics

11.5 Position Loop

10.4 Analog Input

PL.ERR

General Information	
Type	NV Parameter
Description	Returns the position error present when the drive is controlling the position loop.
Units	counts, rad, deg, (PIN/POUT)
Range	N/A
Default Value	N/A
Data Type	Float
See Also	PL.FB
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	35C5h/0 60F4h/0	M_01-00-00-000
Modbus	574 (64-bit)	M_01-03-00-000

Description

PL.ERR returns the position error present when the drive is controlling the position loop. PL.ERR is the difference between the actual position of the motor shaft (PL.FB) and the commanded position of the drive (PL.CMD). If the drive is not in the position operating mode (DRV.OPMODE = 2), then the PL.ERR value is not generated by the drive and this parameter is read as 0.

Related Topics

11.5   Position Loop

PL.ERRFTHRESH

General Information	
Type	NV Parameter
Description	Sets the maximum position error.
Units	Depends on UNIT.ACCROTARY or UNIT.ACCLINEAR Rotary: counts, rad, deg, (PIN/POUT), 16-bit counts Linear: counts, mm, µm, (PIN/POUT), 16-bit counts
Range	Rotary: 0.000 to 5,123,372,000,000,005.000 counts 0.000 to 7,495,067.136 rad 0.000 to 429,436,076.032 deg 0.000 to 5,964,389.888 (PIN/POUT) 0.000 to 78,176,452,636.718 16-bit counts Linear: 0.000 to 5,123,372,000,000,005.000 counts 0.000 to 1,192,877.952*MOTOR.PITCH mm 0.000 to 1,192,878,014.464*MOTOR.PITCH µm 0.000 to 5,964,389.888 (PIN/POUT) 0.000 to 78,176,452,636.718 16-bit counts
Default Value	Rotary: 42,949,672,960.000 counts 62.832 rad 3,600.000 deg 50.000 (PIN/POUT) 655,360.000 16-bit counts Linear: 42,949,672,960.000 counts 10.000*MOTOR.PITCHMOTOR.PITCHmm 10,000.000*MOTOR.PITCH µm 50.000 (PIN/POUT) 655,360.000 16-bit counts
Data Type	Float
See Also	PL.ERR
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	35C7h/0 6065h/0	M_01-00-00-000
Modbus	580 (64-bit)	M_01-03-00-000

Description

This parameter sets the maximum position error. If the position error PL.ERR is larger than PL.ERRFTHRESH the drive generates a fault. If PL.ERRFTHRESH is set to 0, the maximum position error is ignored.

Example

Set position rotary units to 2 (degrees). Setting PL.ERRFTHRESH to 1000 states that is the position error is larger than 1000 degrees, the drive will generate a fault.

UNIT.PROTARY 2

PL.ERRFTHRESH 1000

Related Topics

11.5 Position Loop

PL.ERRMODE

General Information	
Type	R/W Parameter
Description	Sets the type of following error warning and fault usage.
Units	0- Standard following error 1-Enhanced following error
Range	0 to 1
Default Value	0
Data Type	Boolean
See Also	PL.ERR, PL.ERRFTHRESH, PL.ERRWTHRESH
Start Version	M_01-02-09-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	578	M_01-03-00-000

Description

PL.ERRMODE sets the type of following error warning and fault usage.

Mode 0 - following error magnitude fault

In Mode 0, the values of PL.ERRFTHRESH and PL.ERRWTHRESH are compared against the value of PL.ERR. If the absolute value of PL.ERR is larger than PL.ERRWTHRESH, then a warning is generated. If the absolute value of PL.ERR is larger than PL.ERRFTHRESH, then a fault is generated.

Mode 1 - deviation from predicted trajectory fault

In Mode 1, the values of PL.ERRFTHRESH and PL.ERRWTHRESH are compared against the following value:

<error> = abs(PL.ERR - [(VL.CMD – VL.FF) / PL.KP])

If the absolute value of <error> is larger than PL.ERRWTHRESH for a consecutive period of 100 ms, then a warning is generated. If the absolute value of <error> is larger than PL.ERRFTHRESH for a consecutive period of 100 ms, then a fault is generated.

In mode 1, if PL.KI is not 0 then the following error prediction mechanism is turned off. When the drive is disabled, the following error limit tests are turned off and the warnings are cleared. A value of 0 in PL.ERRFTHRESH or PL.ERRWTHRESH disables the respective functionality.

Example

Assuming

PL.ERRMODE = 0, PL.ERRFTHRESH=1.2, PL.ERRWTHRESH=1, then PL.ERR reads 1.1.

In this case the warning is generated, but the fault is not.

Assuming PL.ERRMODE = 0, PL.ERRFTHRESH=1.2, PL.ERRWTHRESH=1, then PL.ERR reads 1.3.

In this case the warning is generated, as well as the fault.

Related Topics

11.5 Position Loop

PL.ERRWTHRESH

General Information	
Type	NV Parameter
Description	Sets the position error warning level.
Units	Depends on UNIT.PROTARY or UNIT.PLINEARUNIT.ACCLINEAR Rotary: counts, rad, deg, (PIN/POUT), 16-bit counts Linear: counts, mm, µm, (PIN/POUT), 16-bit counts
Range	Rotary: 0.000 to 5,123,372,000,000,005.000 counts 0.000 to 7,495,067.136 rad 0.000 to 429,436,076.032 deg 0.000 to 5,964,389.888 (PIN/POUT) 0.000 to 78,176,452,636.718 16-bit counts Linear: 0.000 to 5,123,372,000,000,005.000 counts 0.000 to 1,192,877.952*MOTOR.PITCH mm 0.000 to 1,192,878,014.464*MOTOR.PITCH µm 0.000 to 5,964,389.888 (PIN/POUT) 0.000 to 78,176,452,636.718 16-bit counts
Default Value	0.000 deg
Data Type	Float
See Also	PL.ERR
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3483h/0	M_01-00-00-000
Modbus	580 (64-bit)	M_01-03-00-000

Description

If this value is not equal 0 and the position error PL.ERR is larger than this value, the drive will generate a warning.

If PL.ERRWTHRESH is set to 0 the warning is not issued.

Example

Set position rotary units to 2 degrees. If you set PL.ERRWTHRESH to 100 and the position error is larger than 100 degrees, then the drive will generate a warning.

UNIT.PROTARY 2

PL.ERRWTHRESH 100

Related Topics

11.5   Position Loop

PL.FB

General Information	
Type	R/O Parameter
Description	Reads the position feedback value.
Units	Depends on UNIT.PROTARY or UNIT.PLINEARUNIT.ACCLINEAR Rotary: counts, rad, deg, (PIN/POUT), 16-bit counts Linear: counts, mm, µm, (PIN/POUT), 16-bit counts
Range	N/A
Default Value	N/A
Data Type	Float
See Also	FB1.OFFSET
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	6064h6064h/0	M_01-00-00-000
Modbus	588 (64-bit)	M_01-03-00-000

Description

PL.FB returns the position feedback value.

Note that this value is not the pure feedback value read from the feedback device, but also includes the value of the FB1.OFFSET and an internal offset set automatically by the FW when a homing switch is actuated.

Related Topics

11.5 Position Loop

Selecting and Using Homing Modes

PL.FBSOURCE

General Information	
Type	NV Parameter
Description	Sets the feedback source for the position loop.
Units	N/A
Range	0 to 1
Default Value	0
Data Type	Boolean
See Also	VL.FBSOURCE
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	592	M_01-03-00-000

Description

This parameter determines the feedback source to be used by the position loop. A value of 0 selects the primary feedback, 1 selects the secondary feedback.

Related Topics

11.5 Position Loop

PL.INTINMAX

General Information	
Type	NV Parameter
Description	Limits the input of the position loop integrator by setting the input saturation.
Units	Depends on UNIT.PROTARY or UNIT.PLINEAR Rotary: counts, rad, deg, (PIN/POUT), 16-bit counts Linear: counts, mm, µm, (PIN/POUT), 16-bit counts
Range	Rotary: 0.000 to 18,446,744,073,709.000 counts 0.000 to 26,986.052 rad 0.000 to 1,546,188.288 deg 0.000 to 21,474.836 (PIN/POUT) 0.000 to 281,474,976.710 16-bit counts Linear: 0.000 to 18,446,744,073,709.000 counts 0.000 to 4,294.968*MOTOR.PITCH mm 0.000 to 4,294,967.296*MOTOR.PITCH µm 0.000 to 21,474.836 (PIN/POUT) 0.000 to 281,474,976.710 16-bit counts
Default Value	Rotary: 3,999,989,760.000 counts 5.852 rad 335.275 deg 4.657 (PIN/POUT) 61,035.000 16-bit counts Linear: 3,999,989,760.000 counts 0MOTOR.PITCH mm 9MOTOR.PITCH µm 4.657 (PIN/POUT) 61,035.000 16-bit counts
Data Type	Float
See Also	PL.FB
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3481h/1	M_01-00-00-000
Modbus	594 (64-bit)	M_01-03-00-000

Description

PL.INTINMAX limits the input of the position loop integrator by setting the input saturation. When used in concert with PL.INSATOUT, this variable allows you to make the position loop integrator effective near the target position. Far from the target position, however,the integrator is not dominant in the loop dynamics.

Related Topics

11.5 Position Loop

PL.INTOUTMAX

General Information	
Type	NV Parameter
Description	Limits the output of the position loop integrator by setting the output saturation.
Units	Depends on UNIT.PROTARY or UNIT.PLINEAR Rotary: counts, rad, deg, (PIN/POUT), 16-bit counts Linear: counts, mm, µm, (PIN/POUT), 16-bit counts
Range	Rotary: 0.000 to 18,446,744,073,709.000 counts 0.000 to 26,986.052 rad 0.000 to 1,546,188.288 deg 0.000 to 21,474.836 (PIN/POUT) 0.000 to 281,474,976.710 counts16 bit Linear: 0.000 to 18,446,744,073,709.000 counts 0.000 to 4,294.968*MOTOR.PITCH mm 0.000 to 4,294,967.296*MOTOR.PITCH µm 0.000 to 21,474.836 (PIN/POUT) 0.000 to 281,474,976.710 16-bit counts
Default Value	Rotary: 3,999,989,760.000 counts 5.852 rad 335.275 deg 4.657 (PIN/POUT) 61,035.000 16-bit counts Linear: 3,999,989,760.000 counts 0MOTOR.PITCH mm 9MOTOR.PITCH µm 4.657 (PIN/POUT) 61,035.000 16-bit counts
Data Type	Float
See Also	PL.INTINMAX
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3481h/2	M_01-00-00-000
Modbus	598 (64-bit)	M_01-03-00-000

Description

PL.INTOUTMAX limits the output of the position loop integrator by setting the output saturation.

When used in concert with PL.INTINMAX, this variable allows you to make the position loop integrator effective near the target position. Far from the target position, however, the integrator is not dominant in the loop dynamics.

Related Topics

11.5 Position Loop

PL.KI

General Information	
Type	NV Parameter
Description	Sets the integral gain of the position loop.
Units	Hz
Range	0 to 250 Hz
Default Value	0 Hz
Data Type	Float
See Also	PL.KP, PL.KD
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3480h/0	M_01-00-00-000
Modbus	602	M_01-03-00-000

Description

PL.KI sets the integral gain of the position regulator PID loop.

Related Topics

11.5 Position Loop

PL.KP

General Information	
Type	NV Parameter
Description	Sets the proportional gain of the position regulator PID loop.
Units	(rev/s)/rev
Range	0 to 2,147,483.008 (rev/s)/rev
Default Value	100 rps/rev
Data Type	Float
See Also	PL.KI, PL.KD
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3542h/0	M_01-00-00-000
Modbus	604	M_01-03-00-000

Description

PL.KP sets the proportional gain of the position regulator PID loop.

Related Topics

11.5 Position Loop

PL.MODP1

General Information	
Type	R/W parameter
Description	Sets modulo range parameter.
Units	Depends on UNIT.PROTARY and UNIT.PLINEAR
Range	N/A
Default Value	N/A
Data Type	Float
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3637h/0	M_01-00-00-000
Modbus	606 (64-bit)	M_01-03-00-000

Description

This parameter is either the beginning or the end of the modulo range, depending on whether this value is smaller or larger than PL.MODP2. If you set PL.MODP1 equal to PL.MODP2, an error message occurs.

Condition	Beginning of the modulo-range	End of the modulo-range
PL.MODP1 < PL.MODP2	PL.MODP1	PL.MODP2
PL.MODP2 < PL.MODP1	PL.MODP2	PL.MODP1

Related Topics

11.5 Position Loop

PL.MODP2

General Information	
Type	R/W Parameter
Description	Sets the beginning or end modulo range parameter.
Units	Depends on UNIT.PROTARY and UNIT.PLINEAR.
Range	N/A
Default Value	N/A
Data Type	Float
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3638h/0	M_01-00-00-000
Modbus	610 (64-bit)	M_01-03-00-000

Description

This parameter is either the beginning or the end of the modulo range, depending on whether this value is smaller or larger than PL.MODP1.

Condition	Beginning of the modulo range	End of the modulo range
PL.MODP1 < PL.MODP2	PL.MODP1	PL.MODP2
PL.MODP2 < PL.MODP1	PL.MODP2	PL.MODP1

Related Topics

11.5 Position Loop

PL.MODPDIR

General Information	
Type	R/W Parameter
Description	Sets the direction for absolute motion tasks.
Units	N/A
Range	0 to 2
Default Value	0
Data Type	Integer
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3430h/0	M_01-00-00-000
Modbus	614	M_01-03-00-000

Description

This parameter defines the direction of an absolute motion task when the modulo position has been activated. For more details about absolute motion tasks, see .12.2 Motion Tasks. For absolute motion tasks, you can only select a target position within the modulo range.

PL.MODPDIR Settings

Value	Description
0	The motor moves in a negative direction if the target position of the absolute motion task is less than the current position. The motor moves in positive direction if the target position of the absolute motion task is greater than the current position.
1	The motor always moves in a positive direction relative to the target position of the absolute motion task.
2	The motor always moves in a negative direction relative to the target position of the absolute motion task.

PL.MODPEN

General Information	
Type	R/W Parameter
Description	Enables the modulo position.
Units	N/A
Range	0 to 1
Default Value	0
Data Type	Integer
See Also	N/A
Start Version	M_01-00-00-000

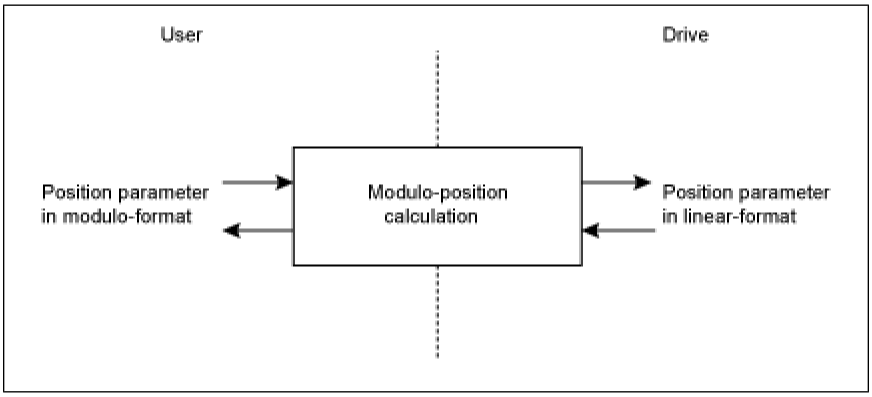
Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	35CFh/0	M_01-00-00-000
Modbus	616	M_01-03-00-000

Description

A value of 0 disables the modulo-position and a value of 1 enables the modulo-position feature. The modulo-position feature can be used for circular applications such as round tables.

The position loop of the drive uses always a linear position variable but the data-exchange between the user and the drive uses the modulo-position calculation in order to convert values from linear format into modulo format and vice versa.

The following figure shows the interface between the user and the drive for PL.MODPEN=1:



Related Topics

11.5 Position Loop

PLS Parameters and Commands

PLS.EN

General Information	
Type	R/W Parameter
Description	Enables programmable limit switch (PLS).
Units	N/A
Range	0 to 255
Default Value	0
Data Type	Integer
See Also	PLS.MODE, PLS.RESET, PLS.STATE, PLS.UNITS, PLS.P1 to PLS.P8, PLS.WIDTH1 to PLS.WIDTH8, PLS.T1 to PLS.T8
Start Version	M_01-02-03-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	34A3h/1	M_01-02-03-000
Modbus	618	M_01-03-00-000

Description

PLS.EN is a bit variable which determines the mode of an individual PLS. Eight PLSs are available in the drive.

Example

Bit Value	Behavior
Bit 0 = 0	Disables PLS 1
Bit 0 = 1	Enables PLS 1
Bit 7 = 0	Disables PLS 8
Bit 7 = 1	Enables PLS 8

Related Topics

10.8 Programmable Limit Switch

PLS.MODE

General Information	
Type	R/W Parameter
Description	Selects programmable limit switch mode.
Units	N/A
Range	0 to 255
Default Value	0
Data Type	Integer
See Also	PLS.EN, PLS.RESET, PLS.STATE, PLS.UNITS, PLS.P1 to PLS.P8, PLS.WIDTH1 to PLS.WIDTH8, PLS.T1 to PLS.T8
Start Version	M_01-02-03-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	34A3h/3	M_01-02-03-000
Modbus	620	M_01-03-00-000

Description

PLS.MODE is a bit variable which determines the mode of an individual PLS. Eight PLSs are available in the drive.

Example

Bit Value	Behavior
Bit 0 = 0	PLS 1 is monitored continuously.
Bit 0 = 1	PLS 1 is monitored until it is triggered once (single-shot method). The PLS observation can be re-armed using the PLS.RESET command.
Bit 7 = 0	PLS 8 is monitored continuously.
Bit 7 = 1	PLS 8 is monitored until it is triggered once (single-shot method). The PLS observation can be re-armed using the PLS.RESET command.

Related Topics

10.8 Programmable Limit Switch

PLS.P1 TO PLS.P8

General Information	
Type	R/W Parameter
Description	Sets the trigger point for programmable limit switches.
Units	Depends on UNIT.PROTARY or UNIT.PLINEAR
Range	N/A
Default Value	0
Data Type	Float
See Also	UNIT.PROTARY
Start Version	M_01-02-03-000

Fieldbus	Index/Subindex		Object Start Version
EtherCAT COE and CANopen	34A0h/1	PLS.P1	M_01-02-03-000
	34A0h/2	PLS.P2	
	34A0h/3	PLS.P3	
	34A0h/4	PLS.P4	
	34A0h/5	PLS.P5	
	34A0h/6	PLS.P6	
	34A0h/7	PLS.P7	
	34A0h/8	PLS.P8	
Modbus	622 (64-Bit)	PLS.P1	M_01-03-00-000
	626 (64-Bit)	PLS.P2	
	630 (64-Bit)	PLS.P3	
	634 (64-Bit)	PLS.P4	
	638 (64-Bit)	PLS.P5	
	642 (64-Bit)	PLS.P6	
	646 (64-Bit)	PLS.P7	
	650 (64-Bit)	PLS.P8	

Description

PLS.P1 to PLS.P8 define the trigger point of the PLS. For further information about how these parameters affect PLS behavior, see the PLS.UNITS parameter description.

Related Topics

10.8 Programmable Limit Switch

PLS.RESET

General Information	
Type	W/O Parameter
Description	Resets programmable limit switch.
Units	N/A
Range	0 to 255
Default Value	N/A
Data Type	Integer
See Also	PLS.EN, PLS.MODE, PLS.STATE, PLS.UNITS, PLS.Px (x=1…8), PLS.WIDTHx (x=1…8), PLS.Tx (x=1…8)
Start Version	M_01-02-03-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	34A3h	M_01-02-03-000
Modbus	654	M_01-03-00-000

Description

This parameter is a bit variable and is used in order to re-arm the corresponding PLS.STATE observation for another single-shot PLS use (see also PLS.MODE).

Example

Bit Value	Behavior
Bit 0 = 0	The PLS 1 observation (PLS.STATE bit 0) is not re-armed.
Bit 0 = 1	The PLS 1 observation (PLS.STATE bit 0) is re-armed.
Bit 7 = 0	The PLS 8 observation (PLS.STATE bit 7) is not re-armed.
Bit 7 = 1	The PLS 8 observation (PLS.STATE bit 7) is re-armed.

Related Topics

10.8 Programmable Limit Switch

PLS.STATE

General Information	
Type	R/O Parameter
Description	Reads the programmable limit switch state.
Units	N/A
Range	N/A
Default Value	N/A
Data Type	Integer
See Also	PLS.EN, PLS.RESET, PLS.UNITS, PLS.MODE, PLS.P1 TO PLS.P8, PLS.WIDTH1 TO PLS.WIDTH8, PLS.T1 TO PLS.T8
Start Version	M_01-02-03-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	34A3h/4	M_01-02-03-000
Modbus	656	M_01-03-00-000

Description

This parameter is a bit variable and displays the current status of the individual programmable limit switches.

Example

Bit 0 = 0: Programmable Limit Switch 1 (PLS 1) is not active.

Bit 0 = 1: Programmable Limit Switch 1 (PLS 1) is active.

Bit 7 = 0: Programmable Limit Switch 8 (PLS 8) is not active.

Bit 7 = 1: Programmable Limit Switch 8 (PLS 8) is not active.

Related Topics

10.8 Programmable Limit Switch

PLS.T1 TO PLS.T8

General Information	
Type	R/W parameter
Description	Sets programmable limit switch time
Units	ms
Range	0 to 65,536 ms
Default Value	500 ms
Data Type	Integer
See Also	PLS.EN, PLS.RESET, PLS.STATE, PLS.UNITS, PLS.MODE, PLS.WIDTH1 TO PLS.WIDTH8, PLS.P1 TO PLS.P8
Start Version	M_01-02-03-000

Fieldbus	Index/Subindex		Object Start Version
EtherCAT COE and CANopen	34A2h/1	PLS.T1	M_01-02-03-000
	34A2h/2	PLS.T2	
	34A2h/3	PLS.T3	
	34A2h/4	PLS.T4	
	34A2h/5	PLS.T5	
	34A2h/6	PLS.T6	
	34A2h/7	PLS.T7	
	34A2h/8	PLS.T8	
Modbus	658	PLS.T1	M_01-03-00-000
	660	PLS.T2	
	662	PLS.T3	
	664	PLS.T4	
	666	PLS.T5	
	668	PLS.T6	
	670	PLS.T7	
	672	PLS.T8	

Description

These parameters define the time of the PLS pulse for time-based PLS handling.

For further information about the PLS functionality, especially the meaning of the PLS.T1 to PLS.T8 parameter, refer to the PLS.UNITS parameter.

Related Topics

10.8 Programmable Limit Switch

PLS.UNITS

General Information	
Type	R/W parameter
Description	Sets programmable limit switch (PLS) units.
Units	N/A
Range	0 to 255
Default Value	0
Data Type	Integer
See Also	PLS.EN, PLS.RESET, PLS.STATE, PLS.MODE, PLS.P1 TO PLS.P8PLS.WIDTH1 TO PLS.WIDTH8, PLS.T1 TO PLS.T8
Start Version	M_01-02-03-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	34A4h/0	M_01-02-03-000
Modbus	674	M_01-03-00-000

Description

PLS.UNITS is a bit variable which determines the behavior of the eight PLSs available in the drive. This parameter is used to select the units for the PLS pulse.

Examples

Bit Value	Behavior
Bit 0 = 0 **Position-based PLS handling.**	The PLS.STATE parameter displays an active PLS 1 when the position is within the range of PLS.P1 + PLS.WIDTH1 (PLS.P1 <= PL.FB <= PLS.P1+PLS.WIDTH1). When the parameter PLS.WIDTH1 has been set to the value of 0, this bit will be activated as soon as PLS.FB >= PL.P1.
Bit 0 = 1 **Time-based PLS handling.**	After PLS.P1 is crossed, the PLS.STATE parameter displays an active PLS 1 for a PLS.T1 ms period of time.
Bit 7 = 0 **Position-based PLS handling.**	The PLS.STATE parameter displays an active PLS 8 when the position is within the range of PLS.P8 + PLS.WIDTH8 (PLS.P8 <= PL.FB <= PLS.P8+PLS.WIDTH8). When the parameter PLS.WIDTH8 has been set to the value of 0, this bit will be activated as soon as PLS.FB >= PL.P8.
Bit 7 = 1 **Time-based PLS handling.**	After PLS.P8 has been crossed. the PLS.STATE parameter displays an active PLS 8 for a PLS.T8 ms period of time.

Continuous position-based PLS handling

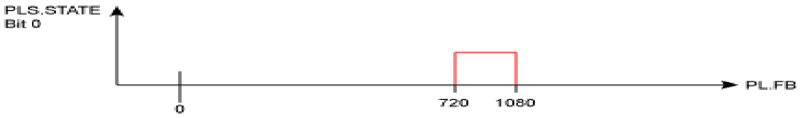
PLS.P1 = 720

PLS.WIDTH1 = 360

PLS.UNITS bit 0 (for PLS 1) = low; PLS.T1 is not considered.

PLS.EN bit 0 (for PLS 1) = high

PLS.MODE bit 0 (for PLS 1) = low



Time-based PLS handling

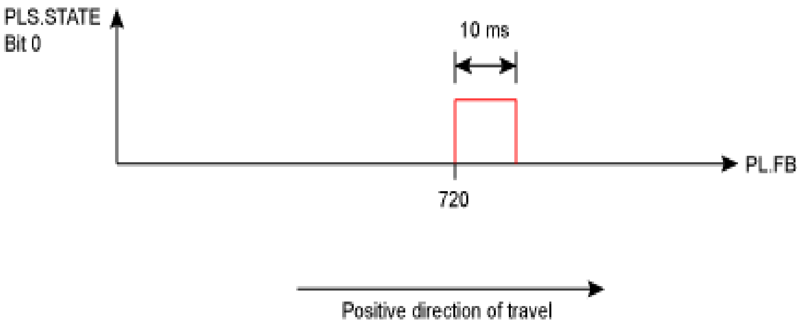
PLS.P1 = 720

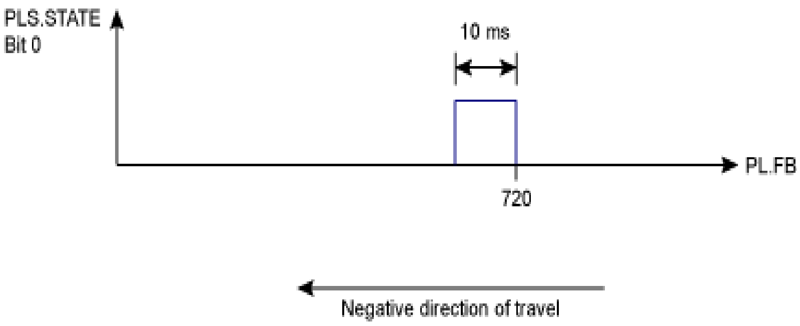
PLS.T1 = 10

PLS.UNITS bit 0 (for PLS 1) = low; PLS.WIDTH1 is not considered.

PLS.EN bit 0 (for PLS 1) = high

PLS.MODE bit 0 (for PLS 1) = low





Related Topics

10.8 Programmable Limit Switch

PLS.WIDTH1 TO PLS.WIDTH8

General Information	
Type	R/W parameter
Description	Programmable Limit Switch Width
Units	Depends on UNIT.PROTARY or UNIT.PLINEAR
Range	N/A
Default Value	0
Data Type	Float
See Also	PLS.EN, PLS.RESET, PLS.STATE, PLS.UNITS, PLS.MODE, PLS.P1 TO PLS.P8, PLS.T1 TO PLS T8
Start Version	M_01-02-03-000

Fieldbus	Index/Subindex		Object Start Version
EtherCAT COE and CANopen	34A1h/1	PLS.WIDTH1	M_01-02-03-000
	34A1h/2	PLS.WIDTH2	
	34A1h/3	PLS.WIDTH3	
	34A1h/4	PLS.WIDTH4	
	34A1h/5	PLS.WIDTH5	
	34A1h/6	PLS.WIDTH6	
	34A1h/7	PLS.WIDTH7	
	34A1h/8	PLS.WIDTH8	
Modbus	676 (64-Bit)	PLS.WIDTH1	M_01-03-00-000
	680 (64-Bit)	PLS.WIDTH2	
	684 (64-Bit)	PLS.WIDTH3	
	688 (64-Bit)	PLS.WIDTH4	
	692 (64-Bit)	PLS.WIDTH5	
	696 (64-Bit)	PLS.WIDTH6	
	700 (64-Bit)	PLS.WIDTH7	
	704 (64-Bit)	PLS.WIDTH8	

Description

These parameter define the width of the PLS pulse for position-based PLS handling. For further information about the PLS functionality, especially the meaning of the PLS.WIDTH1 to PLS.WIDTH8 parameter, refer to the PLS.UNITS parameter.

Related Topics

10.8 Programmable Limit Switch

REC Parameters and Commands

REC.ACTIVE

General Information	
Type	R/O Parameter
Description	Indicates if data recording is in progress (active).
Units	N/A
Range	0 to 1
Default Value	N/A
Data Type	Boolean
See Also	REC.DONE, REC.OFF
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	708	M_01-03-00-000

Description

REC.ACTIVE indicates whether or not data recording is in progress. Recording is in progress if the trigger was met and the recorder is recording all data.

Related Topics

15 Scope

REC.CH1 to REC.CH6

General Information	
Type	R/W Parameter
Description	Sets recording channels 1 to 6.
Units	N/A
Range	N/A
Default Value	CH1 = IL.FB CH2 = IL.CMD CH3 = VL.FB CH4 = Empty CH5 = Empty CH6 = Empty
Data Type	String
See Also	REC.TRIG
Start Version	M_01-00-00-000

Description

REC.CHx specifies the recording channels.

There are 3 options to set the recording channels values:

- Set 0, CLR, or CLEAR. This setting clears the recording channel.
- Set one of the recordable commands. The list of recordable commands can be obtain by executing REC.RECPRMLIST.
- Set an internal value or variable of the drive (same as for DRV.MEMADDR input).

Related Topics

15 Scope

REC.DONE

General Information	
Type	R/O Parameter
Description	Checks whether or not the recorder has finished recording.
Units	N/A
Range	0 to 1
Default Value	N/A
Data Type	Boolean
See Also	REC.ACTIVE, REC.OFF
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	710	M_01-03-00-000

Description

REC.DONE indicates that the recorder has finished recording. This value is reset to 0 when the recorder trigger is set. The drive also resets this value when the recording has finished or when REC.OFF is executed.

Related Topics

15 Scope

REC.GAP

General Information	
Type	R/W Parameter
Description	Specifies the gap between consecutive samples.
Units	N/A
Range	1 to 65,535
Default Value	1
Data Type	Integer
See Also	REC.TRIG
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	712	M_01-03-00-000

Description

REC.GAP specifies the gap between consecutive samples. The recording base rate is 16 kHz, thus a gap of 1 means that a sample is recorded every 62.5 µs.

Related Topics

15 Scope

REC.NUMPOINTS

General Information	
Type	R/W Parameter
Description	Sets the number of points to record.
Units	N/A
Range	1 to 65,535
Default Value	1,000
Data Type	Integer
See Also	REC.TRIG
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	714	M_01-03-00-000

Description

REC.NUMPOINTS specifies the number of points (samples) to record.

Related Topics

15 Scope

REC.OFF

General Information	
Type	R/W Parameter
Description	Turns the recorder OFF.
Units	N/A
Range	N/A
Default Value	N/A
Data Type	N/A
See Also	REC.ACTIVE, REC.DONE, REC.READY
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	716	M_01-03-00-000

Description

REC.OFF turns the recorder off. In order to set the recorder again, the recorder must first be armed and then a trigger set.

Related Topics

15 Scope

REC.RECPRMLIST

General Information	
Type	R/O Parameter
Description	Reads the list of recordable parameters.
Units	N/A
Range	N/A
Default Value	N/A
Data Type	N/A
See Also	REC.CH1 to REC.CH6
Start Version	M_01-00-00-000

Description

This command returns the list of recordable parameters. You can use recordable parameter as an input to any of the recording channels.

Note that an internal address or a registered variable can be used as input to any of the channels in addition to the list.

Related Topics

15 Scope

REC.RETRIEVE

General Information	
Type	R/O Parameter
Description	Transfers all the recorded data to the communication channel.
Units	N/A
Range	N/A
Default Value	N/A
Data Type	String
See Also	N/A
Start Version	M_01-00-00-000

Description

REC.RETRIEVE causes the drive to transfer all the recorded data to the communication channel.

Example

The following format is the retrieve reply format (for N samples, G sample gap, and M parameters, where M<=6):

```
Recording
<N>,<G>
<parameter name 1> … <parameter name M>
Value11 … Value1M
Value N1 …  ValueNM
```

Related Topics

15 Scope

REC.RETRIEVEDATA

General Information	
Type	R/W Parameter
Description	Retrieves the recorded data without the header.
Units	N/A
Range	N/A
Default Value	N/A
Data Type	N/A
See Also	REC.RETRIEVE, REC.RETRIEVEHDR, REC.RETRIEVESIZE
Start Version	M_01-00-00-000

Description

REC.RETRIEVEDATA retrieves a section of recorded data according to REC.RETRIEVESIZE from the received index; if no index is received, the drive retrieves the data from next section. An index is supplied to enable multiple retrieves and to give better control on the buffer in case of overflow. If no index or a negative value is present, then the index is ignored.

WorkBench uses this parameter to retrieve the data continuously for RT recoding.

The size of the data returned by this command depends on the number set by REC.RETRIEVESIZE.

Use REC.RETRIEVE for complete recording information view.

Notes:

- If REC.RETRIEVESIZE is larger than the buffer size, then it simply returns the whole buffer (no error).
- If the index is received, the data will be continuously returned starting from the given index (default starting index is 0).
- If the index is out of the bounds of the buffer, then it will be ignored.
- If recorder is active and REC.STOPTYPE==0, then this parameter returns an error.
- If REC.STOPTYPE==1, then this parameter returns the next section of data in the buffer (even if it reached the end of the buffer, it will return to the beginning of the buffer and add the data from index 0.)
- If REC.STOPTYPE==1 and the retrieve is too slow (gets overrun by the recorder), an overflow error message is returned instead of the retrieved data.
- If REC.STOPTYPE==0 and no index is received, continuously send the sections of data until the end of the buffer is reached. Then, return to the beginning of buffer and continue.
- A new REC.TRIG command automatically sets the index to 0.

Example

The following example retrieves data from index 100 in the size of 10 (hence places 100 to 109 in the buffer)

```
REC.NUMPOINTS 1000

REC.RETRIVESIZE 10

REC.TRIG

REC.RETRIEVEDATA 100
```

Related Topics

15 Scope

REC.RETRIEVEFRMT

General Information	
Type	R/W Parameter
Description	Sets the format for recorded data output.
Units	N/A
Range	0 to 1; 0 = Standard format, 1 = Internal format (high speed)
Default Value	1
Data Type	Integer
See Also	REC.RETRIEVE, REC.RETRIEVEDATA
Start Version	M_00-00-64-000

Description

Recorded data is transferred to the communication channel in one of two formats: standard or internal high speed. The standard (slower) format cannot be used for continuous recording, but is more easily read. The high speed format allows continuous data recording (needed for autotuning). WorkBench supports both formats.

Example

The following recorder data is in standard format:

```
10,1
IL.FB,VL.CMD,VL.FB
-0.086,0.000,2.661
0.000,0.000,3.605
0.029,0.000,-0.486
```

The following recorder data is in internal format:

```
10,1
IL.FB,VL.CMD,VL.FB
F3-0x56,F30x0,F30xA65
F30x0,F30x0,F30xE15
F30x1D,F30x0,F3-0x1E6
```

Related Topics

15 Scope

REC.RETRIEVEHDR

General Information	
Type	R/O Parameter
Description	Retrieves the recorded header without the data.
Units	N/A
Range	N/A
Default Value	N/A
Data Type	N/A
See Also	REC.RETRIEVE, REC.RETRIEVEDATA
Start Version	M_01-00-00-000

Description

This command retrieves the recorded header without the data of the recording.

WorkBench uses this parameter to retrieve the header once before continuously reading the data for RT recoding.

Use REC.RETRIEVE for complete recording information view.

Related Topics

15 Scope

REC.RETRIEVESIZE

General Information	
Type	R/W Parameter
Description	Sets the number of samples that REC.RETRIEVEDATA returns.
Units	recorder samples
Range	0 to 65,535 recorder samples
Default Value	1,000 recorder samples
Data Type	Integer
See Also	REC.RETRIEVEDATA, REC.RETRIEVEHDR
Start Version	M_01-00-00-000

Description

This parameter sets the number of samples that REC.RETRIEVEDATA returns.

WorkBench also uses this parameter to set the number of samples returned when retrieving the data continuously for RT recoding.

Use REC.RETRIEVE for the complete recording information view.

Related Topics

15 Scope

REC.STOPTYPE

General Information	
Type	R/W Parameter
Description	Sets the recorder stop type.
Units	N/A
Range	0 or 1
Default Value	0
Data Type	Integer
See Also	REC.RETRIEVEDATA, REC.RETRIEVESIZE
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	718	M_01-03-00-000

Description

This parameter sets the stop type for the recording.

0 = Recorder runs, continuously filling the recording circular buffer.

1 = Recorder fills in the buffer once.

To stop RT recording, execute REC.OFF.

Related Topics

15 Scope

REC.TRIG

General Information	
Type	Command
Description	Triggers the recorder.
Units	N/A
Range	N/A
Default Value	N/A
Data Type	N/A
See Also	REC.RETRIEVE, REC.OFF
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	720	M_01-03-00-000

Description

REC.TRIG starts the trigger according to the trigger type defined by REC.TRIGTYPE.

REC.TRIG sets the value of REC.DONE to 0.

After calling REC.TRIG, the data that was recorded by previous recording is deleted and cannot be retrieved.

No REC parameters can be set after a call to REC.TRIG until the recorder has finished or until REC.OFF is executed.

Related Topics

15 Scope

REC.TRIGPARAM

General Information	
Type	R/W Parameter
Description	Sets the parameter that triggers the recorder.
Units	N/A
Range	N/A
Default Value	IL.FB
Data Type	String
See Also	REC.TRIG
Start Version	M_01-00-00-000

Description

REC.TRIGPARAM sets the parameter on which the recorder triggers.

This parameter is only used when REC.TRIGTYPE = 2.

Input values are:

1. One of the set drive parameters list that can be set as a trigger. The available parameters for trigger are: PL.ERR, PL.CMD, PL.FB, VL.CMD, VL.FB, IL.CMD, and IL.FB.
2. Internal value or variable of the drive (same as for DRV.MEMADDR input).

Related Topics

15 Scope

REC.TRIGPOS

General Information	
Type	R/W Parameter
Description	Sets the trigger position in the recording buffer.
Units	%
Range	1 to 100%
Default Value	10%
Data Type	Integer
See Also	REC.TRIG, REC.NUMPOINTS
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	722	M_01-03-00-000

Description

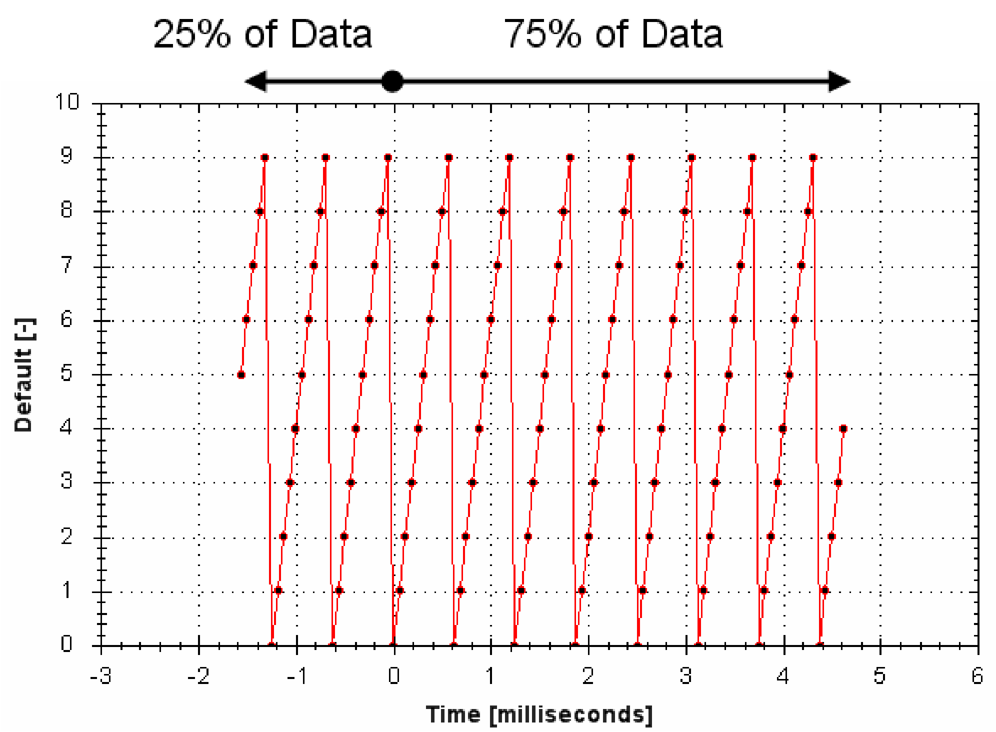
REC.TRIGPOS sets the trigger position in the recording buffer. The recording buffer size is defined by REC.NUMPOINTS. The input value is a percentage of the buffer (that is, a value of 25 means saving 25% of the buffer data before the trigger occurs and 75% after it occurs). This parameter is only used when REC.TRIGTYPE = 2 or 3.

Trigger Position

Trigger position (REC.TRIGPOS) allows you to collect data that occurs before the trigger occurs. In some instances, you may want to see the conditions prior to the trigger. Trigger position lets you control how much signal is collected before the trigger condition occurred .

Trigger position is specified in units of percent (%). If you specify a trigger position of x% , then x% of the data is before 0 ms in the data time and 100-x% (the rest of the data) is at or greater than 0 ms. In the figure below, the trigger position is set to 25% (REC.TRIGPOS 25).

In the WorkBench scope, the 0 time point is clear. When collecting the data using REC.RETRIEVE or similar commands, the time is not returned, so some caution should be used when the trigger point is important to understand.



Related Topics

15 Scope

REC.TRIGPRMLIST

General Information	
Type	R/O Parameter
Description	Reads the list of possible trigger parameters.
Units	N/A
Range	N/A
Default Value	N/A
Data Type	N/A
See Also	REC.TRIGPARAM
Start Version	M_01-00-00-000

Description

This command returns the list of trigger parameters. Each one of those parameters can serve as the trigger parameter (input to REC.TRIGPARAM).

Note that an internal address or a registered variable can be used as input to REC.TRIGPARAM in addition to the list that this parameter returns.

Related Topics

15 Scope

REC.TRIGSLOPE

General Information	
Type	R/W Parameter
Description	Sets the trigger slope.
Units	0 = Negative 1 = Positive
Range	0 to 1
Default Value	0
Data Type	Boolean
See Also	REC.TRIG, REC.NUMPOINTS
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	726	M_01-03-00-000

Description

REC.TRIGSLOPE sets the recorder trigger slope. This parameter is only used when REC.TRIGTYPE = 2 or 3.

Related Topics

15 Scope

REC.TRIGTYPE

General Information	
Type	R/W Parameter
Description	Sets the trigger type.
Units	0 = immediate 1 = command 2 = parameter 3 = boolean
Range	0 to 2
Default Value	0
Data Type	Integer
See Also	REC.TRIG, REC.TRIGPARAM, REC.TRIGVAL, REC.TRIGSLOPE REC.TRIGPOS
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	728	M_01-03-00-000

Description

REC.TRIGTYPE sets the type of trigger.

Input values are as follows:

Value	Description
0	Recording starts immediately
1	Recording starts on the next command executed through the TCP/IP. The trigger location in the buffer is set according to REC.TRIGPOS.
2	Recording starts per the values of REC.TRIGPARAM, REC.TRIGVAL, REC.TRIGSLOPE, and REC.TRIGPOS.
3	Recording starts when the value of REC.TRIGPARAM is 0 for REC.TRIG-SLOPE = 0 or 1 for REC.TRIGSLOPE = 1

Related Topics

15 Scope

REC.TRIGVAL

General Information	
Type	R/W Parameter
Description	Sets the trigger value.
Units	The units of the parameter are chosen according to the unit type.
Range	0 to 2
Default Value	0
Data Type	Integer
See Also	REC.TRIG, REC.TRIGPARAM, REC.TRIGVAL, REC.TRIGSLOPE, REC.TRIGPOS
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	730 (64-bit)	M_01-03-00-000

Description

REC.TRIGVAL is the value that must be met by REC.TRIGPARAM for the trigger to occur. The units of this parameter are set according to the units of REC.TRIGPARAM.

Related Topics

15 Scope

REGEN Parameters

REGEN.POWER

General Information	
Type	R/O parameter
Description	Reads regen resistor's calculated power.
Units	Watt
Range	N/A
Default Value	N/A
Data Type	Integer
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3416h/0	M_01-00-00-000
Modbus	734 (64-bit)	M_01-03-00-000

Description

This parameter reads regen resistor's calculated power, which is determined as follows:

$(V^2 / R) * DutyCycle$

Related Topics

7.2 Regeneration

REGEN.REXT

General Information	
Type	NV Parameter
Description	Sets the external, user-defined regen resistor resistance.
Units	Ω
Range	0 to 255 Ω
Default Value	0 Ω
Data Type	Integer
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	35C2h/0	M_01-00-00-000
Modbus	738	M_01-03-00-000

Description

REGEN.REXT sets the external user-defined regen resistor resistance. This variable is needed for the regen resistor temperature estimation algorithm.

Related Topics

7.2 Regeneration

REGEN.TEXT

General Information	
Type	R/W Parameter
Description	Sets the external regen resistor thermal protection time constant.
Units	s
Range	0.1 to 1,200 s
Default Value	100 s
Data Type	Float
See Also	REGEN.WATTEXT, REGEN.REXT
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3415h/0	M_01-00-00-000
Modbus	740	M_01-03-00-000

Description

REGEN.TEXT is a thermal time constant used to protect an external regeneration (regen) resistor from overheating and failing. Its value is the time-to-fault when input power steps from 0 to 150% of REGEN.WATTEXT. The drive's regen resistor protection algorithm continuously calculates the power dissipated in the resistor and processes that power value through a single pole low pass filter to model the regen resistor's thermal inertia. When the filtered regen power on the output of the filter exceeds REGEN.WATTEXT, a fault occurs. REGEN.TEXT sets the time constant of this thermal inertia filter.

REGEN.TEXT can often be found directly on power resistor data sheets. On the data sheets, find the peak overload curve and then find the safe allowed time to be at 150% of the regen resistor's continuous power rating. Another way regen resistor peak overload capability is often specified is by giving the energy rating in joules of the resistor. If you have the energy rating E then:

REGEN.TEXT = (1.1)*((joule limit)/REGEN.WATTEXT)

Example

The external regen resistor is rated for 250 W continuous, is 33 ohm, and has a joule rating of 500 joules. To use this resistor, the drive settings become:

REGEN.TYPE = -1 (External Regen)

REGEN.REXT = 33

REGEN.WATTEXT = 250

REGEN.TEXT = (1.1)*(500 j)/(250 W) = 2.2 sec

Related Topics

7.2 Regeneration

REGEN.TYPE

General Information	
Type	NV Parameter
Function	Sets the regen resistor type.
WorkBench Location (Screen/Dialog Box)	Power/Regen Resistor Type
Units	N/A
Range	–1 to 0
Default Value	0
Data Type	Integer
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3412h/0	M_01-00-00-000
Modbus	742	M_01-03-00-000

Description

You can specify a user-defined external regen resistor, select an internal regen resistor, or choose from a list of predefined regen resistors. The values for REGEN.TYPE are shown below:

Type	Description
–1	External user-defined regen resistor
0	Internal regen resistor

If you specify a user-defined regen resistor, then you must also define this resistor's resistance (REGEN.REXT), heatup time (REGEN.REXT), and power (REGEN.WATTEXT).

Related Topics

7.2 Regeneration

REGEN.WATTEXT

General Information	
Type	R/W parameter
Description	Sets the regen resistor's power fault level for an external regen resistor.
Units	W
Range	0 to 62,000 W
Default Value	1000 W
Data Type	Integer
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3414h/0	M_01-00-00-000
Modbus	744	M_01-03-00-000

Description

Sets the regen resistor's power fault level for an external regen resistor (when REGEN.TYPE = -1). Above this fault level, the regen resistor's PWM wil be 0 and a fault will be issued.

Related Topics

7.2 Regeneration

SM Parameters

SM.I1

General Information	
Type	R/W Parameter
Description	Sets service motion current 1; active in opmode 0 (torque) only.
Units	A
Range	–Drive peak current to +Drive peak current
Default Value	0.025 · Drive peak current
Data Type	Float
See Also	SM.ACCTYPE, SM.I2, SM.MODE, SM.MOVE, SM.T1, SM.T2, SM.V1, SM.V2, SM.VPM1, SM.VPM2
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	746	M_01-03-00-000

Description

SM.I1 defines the current that is used in service motion modes 0 and 1 (see SM.MODE).

Related Topics

12.3 Service Motion

SM.I2

General Information	
Type	R/W Parameter
Description	Sets service motion current 2; active in opmode 0 (torque) only.
Units	A
Range	–Drive peak current to +Drive peak current
Default Value	0.025 · Drive peak current
Data Type	Float
See Also	SM.ACCTYPE, SM.I1, SM.MODE, SM.MOVE, SM.T1, SM.T2, SM.V1, SM.V2, SM.VPM1, SM.VPM2
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	748	M_01-03-00-000

Description

SM.I2 defines the current that is used in service motion mode 1 (see SM.MODE).

Related Topics

12.3 Service Motion

SM.MODE

General Information	
Type	R/W Parameter
Description	Sets the service motion mode.
Units	N/A
Range	0 to 1
Default Value	0
Data Type	Integer
See Also	SM.I1, SM.I2, SM.MOVE, SM.T1 SM.T2, SM.V1, SM.V2, DRV.ACCDRV.DEC
Start Version	M_01-01-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	750	M_01-03-00-000

Description

SM.MODE defines the mode of service motion for each loop. Two types of service motion are available :

1. A constant motion in one direction (endless or for a certain amount of time).
2. An alternating motion.

The possible modes for this parameter are described in the following table:

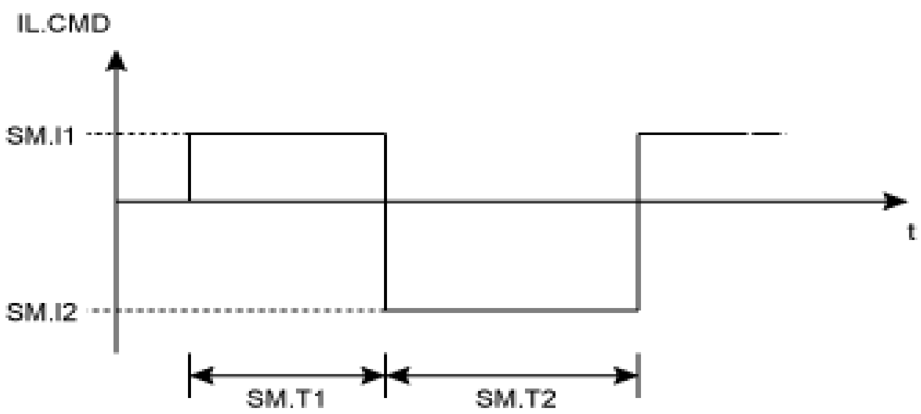
<table>
<tr><th>SM.MODE</th><th>Description</th><th>Requirements</th></tr>
<tr><td>0</td><td>Constant motion in closed current loop mode of operation.
DRV.OPMODE 0:
The drive generates a constant current command value (SM.I1) for a certain amount of time (if SM.T1>0) or endless (if SM.T1=0). The drive will not generate any ramps in this mode of operation.
DRV.OPMODE 1 or 2:
The drive generates a constant velocity command value (SM.V1) for a certain amount of time (if SM.T1>0) or endless (if SM.T1=0). The drive generates acceleration and deceleration ramps according to the DRV.ACC and DRV.DEC setting in this mode of operation.
The service motion can be stopped by using the DRV.STOP command.</td><td>DRV.OPMODE = 0,1, or 2
DRV.CMDSOURCE = 0</td></tr>
</table>

SM.MODE	Description	Requirements
1	• DRV.OPMODE 0: The drive generates a current command value (SM.I1) for a certain amount of time (SM.T1). Afterwards the drive generates a current command value (SM.I2) for another certain amount of time (SM.T2). This sequence is repeated as long as a DRV.STOP command occurs. The drive will not generate any ramps in this mode of operation. • DRV.OPMODE 1 or 2: The drive generates a velocity command value (SM.V1) for a certain amount of time (SM.T1). Afterwards the drive generates a velocity command value (SM.V2) for another certain amount of time (SM.T2). This sequence is repeated as long as a DRV.STOP command occurs. The drive will generate an acceleration and deceleration ramps according to the DRV.ACC and DRV.DEC setting in this mode of operation.	DRV.OPMODE = 0, 1, or 2 DRV.CMDSOURCE = 0

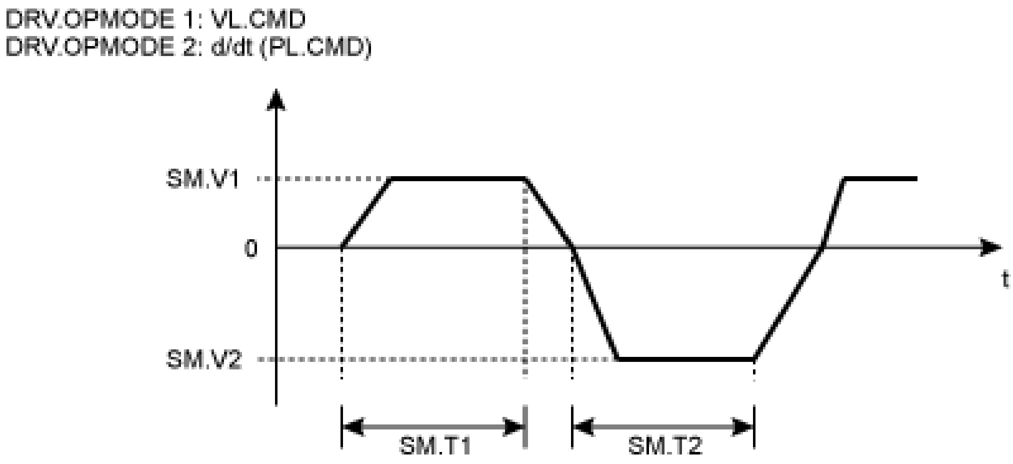
Ramps

The drive uses DRV.ACC and DRV.DEC for the ramps in DRV.OPMODE 1 (closed velocity) and 2 (closed position). The drive does not generate any ramps in service motion mode 0 and 1.

Service Motion for DRV.OPMODE 0 and SM.MODE 1



Service motion for DRV.OPMODE 1 or 2 and SM.MODE 1



The deceleration process from SM.V1 or SM.V2 to 0 is not included in SM.T1 and SM.T2, respectively. SM.T1 and SM.T2 start as soon as the command value has reached the velocity 0.

Related Topics

12.3 Service Motion

SM.MOVE

General Information	
Type	Command
Description	Starts the service motion.
Units	N/A
Range	N/A
Default Value	N/A
Data Type	N/A
See Also	SM.MODE
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	752	M_01-03-00-000

Description

This command starts the service motion that has been selected by the SM.MODE parameter.

Related Topics

12.3 Service Motion

SM.T1

General Information	
Type	R/W Parameter
Description	Sets the service motion time 1.
Units	ms
Range	0 to 65,535 ms
Default Value	500 ms
Data Type	Integer
See Also	SM.I1, SM.I2, SM.MODE, SM.MOVE, SM.T2, SM.V1, SM.V2, SM.VPM1, SM.VPM2
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	754	M_01-03-00-000

Description

SM.T1 defines the time of the service motion that is used in all service motion modes (see SM.MODE). For an alternating service motion mode, SM.T1 may not be set to 0.

Related Topics

12.3 Service Motion

SM.T2

General Information	
Type	R/W Parameter
Description	Sets the service motion time 2.
Units	ms
Range	1 to 65,535 ms
Default Value	500 ms
Data Type	Integer
See Also	SM.I1, SM.I2, SM.MODE, SM.MOVE, SM.T1, SM.V1, SM.V2, SM.VPM1, SM.VPM2
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	756	M_01-03-00-000

Description

SM.T2 defines the time of the service motion that is used in service motion modes 1, 3, and 5 (see SM.MODE).

Related Topics

12.3 Service Motion

SM.V1

General Information	
Type	R/W Parameter
Description	Sets service motion velocity 1; active in opmode 1 (velocity) and 2 (position).
Units	Depends on UNIT.ACCROTARY or UNIT.ACCLINEAR Rotary: rpm, rps, deg/s, (PIN/POUT)/s, rad/s Linear: Counts/s, mm/s, µm/s, (PIN/POUT)/s
Range	Rotary: -12,000.000 to 12,000.000 rpm -200.000 to 200.000 rps -72,000.000 to 72,000.000 deg/s -1,000.000 to 1,000.000 (PIN/POUT)/s -1,256.637 to 1,256.637 rad/s Linear: -0.200 to 0.200 Counts/s -200.000*MOTOR.PITCH to 200.000*MOTOR.PITCH mm/s -200,000.000*MOTOR.PITCH to 200,000.000*MOTOR.PITCH µm/s -1,000.000 to 1,000.000 (PIN/POUT)/s
Default Value	Rotary: 60.000 rpm 1.000 rps 359.999 deg/s 5.000 (PIN/POUT)/s 6.283 rad/s Linear: 0.001 Counts/s 1.000*MOTOR.PITCH mm/s 999.998*MOTOR.PITCH µm/sec 5.000 (PIN/POUT)/s
Data Type	Float
See Also	SM.I1, SM.I2, SM.MODE, SM.MOVE, SM.T1, SM.T2, SM.V2
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	758	M_01-03-00-000

Description

SM.V1 defines the velocity that is used in service motion modes 0 and 1 (see SM.MODE) in the closed velocity and position mode of operation.

Related Topics

12.3 Service Motion

SM.V2

General Information	
Type	R/W Parameter
Description	Sets service motion velocity 2; active in opmode 1 (velocity) and 2 (position).
Units	Depends on UNIT.ACCROTARY or UNIT.ACCLINEAR Rotary: rpm, rps, deg/s, (PIN/POUT)/s, rad/s Linear: counts/s, mm/s, µm/s, (PIN/POUT)/s
Range	Rotary: -12,000.000 to 12,000.000 rpm -200.000 to 200.000 rps -72,000.000 to 72,000.000 deg/s -1,000.000 to 1,000.000 (PIN/POUT)/s -1,256.637 to 1,256.637 rad/s Linear: -0.200 to 0.200 counts/s -200.000*MOTOR.PITCH to 200.000*MOTOR.PITCH mm/s -200,000.000*MOTOR.PITCH to 200,000.000*MOTOR.PITCH µm/s -1,000.000 to 1,000.000 (PIN/POUT)/s
Default Value	Rotary: -60.000 rpm -1.000 rps -359.999 deg/s -5.000 (PIN/POUT)/s -6.283 rad/s Linear: -0.001 counts/s -1.000*MOTOR.PITCH mm/s -999.998*MOTOR.PITCH µm/sec -5.000 (PIN/POUT)/s
Data Type	Float
See Also	SM.I1, SM.I2, SM.MODE, SM.MOVE, SM.T1, SM.T2, SM.V1
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	760	M_01-03-00-000

Description

SM.V2 defines the velocity that is used in service motion mode 1 (see SM.MODE) in the closed velocity and position mode of operation.

Related Topics

12.3 Service Motion

STO Parameters

STO.STATE

General Information	
Type	R/O Parameter
Description	Returns the status of the safe torque off.
Units	N/A
Range	0 to 1
Default Value	N/A
Data Type	Integer
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	762	M_01-03-00-000

Description

STO.STATE returns the status of the safe torque off.

1 - Safe torque on (no safe torque off fault).

0 - Safe torque off (safe torque off fault).

Related Topics

10.7.5 Limits

10.13 Safe Torque Off (STO)

SWLS Parameters

SWLS.EN

General Information	
Type	NV Parameter
Description	Enables and disables software travel limit switches.
Units	N/A
Range	0 to 3
Default Value	0
Data Type	U8
See Also	DRV.MOTIONSTAT
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	764	M_01-03-00-000

Description

This parameter enables the software travel limit switches. The software limit switches are only active if the axis is homed.

Example

Bit 0 = 0: Disable SWLS.LIMIT0

Bit 0 = 1: Enable SWLS.LIMIT0

Bit 1 = 0: Disable SWLS.LIMIT1

Bit 1 = 1: Enable SWLS.LIMIT1

Related Topics

10.7.5 Limits

12.1 Homing

HOME Parameters

SWLS.LIMIT0

General Information	
Type	NV Parameter
Description	Sets the position of the software travel limit switch 0.
Units	Position units
Range	-9,007,199,254,740,992 to 9,007,199,254,740,991
Default Value	0
Data Type	S64
See Also	UNIT.PROTARY, UNIT.PLINEAR
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	607Dh/1	M_01-00-00-000
Modbus	766 (64-bit)	M_01-03-00-000

Description

This parameter sets the compare register for the software limit switch 0. This value can be either the lower or the upper software limit switch register, depending on the configuration of the software limit switches. Whichever switch is set largest is the positive limit switch; the other switch becomes the negative limit switch. These switches can be used in addition to hardware limit switches. The software limit switches are only active if the axis is homed. For more information about homing, please refer to the HOME Parameters and DRV.M-OTIONSTAT.

Related Topics

10.7.5 Limits

12.1 Homing

HOME Parameters

SWLS.LIMIT1

General Information	
Type	NV Parameter
Description	Sets the position of the software travel limit switch 0.
Units	Position units
Range	-9,007,199,254,740,992 to 9,007,199,254,740,991
Default Value	1,048,576.000 counts, 16-bit (firmware versions M_01-02-00-000 and above) 68,719,476,736 counts (for firmware version M_01-01-00-000)
Data Type	S64
See Also	UNIT.PROTARY, UNIT.PLINEAR
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	607Dh/2	M_01-00-00-000
Modbus	770 (64-bit)	M_01-03-00-000

Description

This parameter sets the compare register for the software limit switch 1. This value can be either the lower or the upper software limit switch register, depending on the configuration of the software limit switches. Whichever switch is set largest is the positive limit switch; the other switch becomes the negative limit switch. These switches can be used in addition to hardware limit switches. The software limit switches are only active if the axis is homed. For more information about homing, please refer to the HOME Parameters and DRV.MOTIONSTAT.

Related Topics

10.7.5 Limits

12.1 Homing

HOME Parameters

SWLS.STATE

General Information	
Type	R/O Parameter
Description	Reads the actual status of software limit switches.
Units	N/A
Range	0 to 3
Default Value	0
Data Type	U8
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	774	M_01-03-00-000

Description

This parameter reads the status word of the software limit switches. The status word indicates the result of the compare between the software limit switch compare register and the actual position of the position loop.

Example

Bit 0 = 0: SWLS.LIMIT0 is not active.

Bit 0 = 1: SWLS.LIMIT0 is active.

Bit 1 = 0: SWLS.LIMIT1 is not active.

Bit 1 = 1: SWLS.LIMIT1 is active.

Bits 2 to 7 are currently not in use.

Related Topics

10.7.5 Limits

12.1 Homing

HOME Parameters

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UNIT Parameters

UNIT.ACCLINEAR

General Information	
Type	NV Parameter
Description	Sets the linear acceleration/deceleration units.
Units	N/A
Range	0 to 3
Default Value	0
Data Type	Integer
See Also	DRV.ACC, DRV.DEC, MOTOR.TYPE
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	776	M_01-03-00-000

Description

UNIT.ACCLINEAR sets the units type for the acceleration and deceleration parameters, when the motor type (MOTOR.TYPE) is linear.

Type	Description
0	[PIN/POUT]/s^2
1	millimeters per second squared (mm/s^2)
2	micrometers per second squared (µm/s^2)
3	Feedback counts/s^2

Related Topics

9 Selecting Units for Your Application

UNIT.ACCROTARY

General Information	
Type	NV Parameter
Description	Sets the rotary acceleration/deceleration units.
Units	rpm/s, rps/s, deg/s^2 , [PIN/POUT]/s^2
Range	0 to 3
Default Value	0 rpm/s
Data Type	Integer
See Also	DRV.ACC, "DRV.DEC" (=> p. 351), MOTOR.TYPE
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3659h/0	M_01-00-00-000
Modbus	778	M_01-03-00-000

Description

UNIT.ACCROTARY sets the acceleration/deceleration units when the motor type (MOTOR.TYPE) is rotary.

Type	Description
0	rpm/s
1	rps/s
2	deg/s^2
3	(PIN/POUT)/s^2

Related Topics

9 Selecting Units for Your Application

UNIT.LABEL

General Information	
Type	NV Parameter
Description	Sets user-defined name for user-defined position units.
Units	N/A
Range	Maximum 16 characters, no spaces
Default Value	PIN/POUT
Data Type	String
See Also	UNIT.PLINEAR, UNIT.POUT
Start Version	M_01-00-00-000

Description

If you define a special position unit with UNIT.PLINEAR and UNIT.POUT, then you can give this unit a descriptive name. You can name the unit anything you wish, as long as the name is limited to 16 characters and includes no spaces. This name is shown in derived units as velocity and acceleration.

This parameter is descriptive only and does not influence drive internal functions in any way.

Related Topics

9 Selecting Units for Your Application

UNIT.PIN

General Information	
Type	NV Parameter
Description	Sets gear IN for the unit conversion.
Units	User units
Range	0 to 4,294,967,295
Default Value	100
Data Type	Integer
See Also	UNIT.POUT
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	35CAh/0 6092h/0	M_01-00-00-000
Modbus	780	M_01-03-00-000

Description

UNIT.PIN is used in conjunction with UNIT.POUT to set application specific units. This parameter is used as follows in the drive unit conversion:

- For position, this parameter sets the units as [PIN/POUT]/rev.
- For velocity, this parameter sets the units as [PIN/POUT]/s.
- For acceleration/deceleration, this parameter sets the units as [PIN/POUT]/s^2.

Related Topics

9 Selecting Units for Your Application

UNIT.PLINEAR

General Information	
Type	NV Parameter
Description	Sets the linear position units.
Units	N/A
Range	0 to 4
Default Value	0
Data Type	Integer
See Also	PL.FB, PL.CMD, MOTOR.TYPE
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	782	M_01-03-00-000

Description

UNIT.PLINEAR sets the units type for the position parameters when the motor type (MOTOR.TYPE) is linear.

Type	Description
0	32-bit counts
1	Millimeters (mm)
2	Micrometers (μm)
3	(PLINEAR/POUT) per revolution
4	16-bit counts

Related Topics

9 Selecting Units for Your Application

UNIT.POUT

General Information	
Type	NV Parameter
Description	Sets gear out for the unit conversion.
Units	User units.
Range	0 to 4,294,967,295
Default Value	20
Data Type	Integer
See Also	UNIT.PLINEAR
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	35CBh/0 6092h/2	M_01-00-00-000
Modbus	784	M_01-03-00-000

Description

UNIT.POUT is used in conjunction with UNIT.PLINEAR to set application specific units in UNIT.POUT. This parameter is used as follows in the drive unit conversion:

- For position, this parameter sets the units as [PIN/POUT]/rev.
- For velocity, this parameter sets the units as [PIN/POUT]/s.
- For acceleration/deceleration, this parameter sets the units as [PIN/POUT]/s^2.

Related Topics

9 Selecting Units for Your Application

UNIT.PROTARY

General Information	
Type	NV Parameter
Description	Sets the position units when the motor type (MOTOR.TYPE) is rotary.
Units	counts, rad, deg, [PIN/POUT], 16-bit counts
Range	0 to 4
Default Value	4 16-bit counts (for firmware versions M_01-02-00-000 and above) 0 counts (for firmware version M_01-01-00-000)
Data Type	Integer
See Also	PL.FB, PL.CMD, MOTOR.TYPE
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3660h/0	M_01-00-00-000
Modbus	786	M_01-03-00-000

Description

UNIT.PROTARY sets the position units when the motor type (MOTOR.TYPE) is rotary.

Value	Units
0	counts
1	radians
2	degrees
3	[PIN/POUT]
4	16-bit counts

Related Topics

9 Selecting Units for Your Application

UNIT.VLINEAR

General Information	
Type	NV Parameter
Description	Sets the linear velocity units.
Units	N/A
Range	0 to 3
Default Value	0
Data Type	Integer
See Also	VL.FB, VL.CMDU, VL.CMD, MOTOR.TYPE
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	788	M_01-03-00-000

Description

UNIT.VLINEAR sets the units type for the velocity parameters when the motor type (MOTOR.TYPE) is linear.

Type	Description
0	(PIN/POUT) per second
1	Micrometers per second
2	Millimeters per second
3	Counts per second

Related Topics

9 Selecting Units for Your Application

UNIT.VROTARY

General Information	
Type	NV Parameter
Description	Sets the velocity units when the motor type (MOTOR.TYPE) is rotary.
Units	rpm, rps, deg/s, (PIN/POUT)/s
Range	0 to 3
Default Value	0 rpm
Data Type	Integer
See Also	VL.FB, VL.CMDU, VL.CMD, MOTOR.TYPE
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	365Fh/0	M_01-00-00-000
Modbus	790	M_01-03-00-000

Description

UNIT.VROTARY sets the velocity units when the motor type (MOTOR.TYPE) is rotary.

Value	Units
0	rpm
1	rps
2	deg/s
3	(PIN/POUT)/s

Related Topics

9 Selecting Units for Your Application

VBUS Parameters

VBUS.OVFTHRESH

General Information	
Type	R/O Parameter
Description	Reads the over voltage fault level.
Units	Vdc
Range	0 to 900 Vdc
Default Value	N/A
Data Type	Integer
See Also	VBUS.UVFTHRESH
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	794	M_01-03-00-000

Description

VBUS.OVFTHRESH reads the over voltage fault level for the DC bus.

This value is read from the drive EEPROM and varies according to the drive type.

Related Topics

7.2 Regeneration

VBUS.OVWTHRESH

General Information	
Type	NV Parameter
Description	Sets voltage level for over voltage warning.
Units	Vdc
Range	0 to 900 Vdc
Default Value	0 Vdc (warning disabled)
Data Type	U16
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	796	M_01-03-00-000

Description

If VBUS.VALUE value exeeds VBUS.OVWTHRESH, then a warning is generated.

Related Topics

7.2 Regeneration

VBUS.RMSLIMIT

General Information	
Type	R/O Parameter
Description	Reads the limit for the bus capacitors load.
Units	Vrms
Range	N/A
Default Value	N/A
Data Type	Integer
See Also	N/A
Start Version	M_00-00-55-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	798	M_01-03-00-000

Description

This parameter reads the limit of the bus capacitor load. When the bus capacitor loads exceeds this limit, the drive generates fault F503.

Excessive bus capacitor load may indicate a disconnected main supply phase.

Related Topics

7.2 Regeneration

VBUS.UVFTHRESH

General Information	
Type	R/W Parameter
Description	Sets the under voltage fault level.
Units	Vdc
Range	90 to 420 Vdc
Default Value	90 Vdc
Data Type	Integer
See Also	VBUS.OVFTHRESH
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	800	M_01-03-00-000

Description

VBUS.UVFTHRESH sets the undervoltage fault level of the DC bus.

The default value is read from the EEPROM, but can by modified by the user and stored on the NV RAM. This value varies according to drive type.

Related Topics

7.2 Regeneration

VBUS.UVMODE

General Information	
Type	N/V Parameter
Description	Indicates undervoltage (UV) mode.
Units	N/A
Range	0 to 1
Default Value	1
Data Type	Boolean
See Also	N/A
Start Version	M_0-0-37

Fieldbus	Index/Subindex	Object Start Version
Modbus	802	M_01-03-00-000

Description

This parameter indicates undervoltage (UV) mode.

When VBUS.UVMODE - 0, an undervoltage fault is issued whenever the DC bus goes below the undervoltage threshold.

When VBUS.UVMODE = 1, an undervoltage fault is issued whenever the DC bus goes below the under voltage threshold and the controller attempts to enable the drive (software or hardware enable).

Related Topics

7.2 Regeneration

VBUS.UVWTHRESH

General Information	
Type	NV Parameter
Description	Sets voltage level for undervoltage warning.
Units	Vdc
Range	0 to 900 Vdc
Default Value	10 volts above the default value of the under voltage fault threshold (VBUS.UVFTHRESH). The default value of VBUS.UVFTHRESH is hardware dependent.
Data Type	U16
See Also	VBUS.UVFTHRESH
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	804	M_01-03-00-000

Description

If VBUS.VALUE value drops below VBUS.UVWTHRESH, then a warning is generated.

Related Topics

7.2 Regeneration

VBUS.VALUE

General Information	
Type	R/O Parameter
Description	Reads DC bus voltage.
Units	Vdc
Range	0 to 900 Vdc
Default Value	N/A
Data Type	Float
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	361Ah/0	M_01-00-00-000
Modbus	806	M_01-03-00-000

Description

VBUS.VALUE reads the DC bus voltage.

Related Topics

7.2 Regeneration

7.2 Regeneration

VL Parameters

VL.ARPF1 TO VL.ARPF4

General Information	
Type	R/W Parameter
Description	Sets the natural frequency of the pole (denominator) of anti-resonance (AR) filters 1, 2, 3, and 4; active in opmodes 1 (velocity) and 2 (position) only.
Units	Hz
Range	5 to 5,000 Hz
Default Value	500 Hz
Data Type	Float
See Also	VL.ARPQ1 TO VL.ARPQ4, VL.ARZF1 TO VL.ARZF4, Sets the Q of the zero (numerator) of anti-resonance filter #1; active in opmodes 1 (velocity) and 2 (position) only.
Start Version	M_01-02-00-000

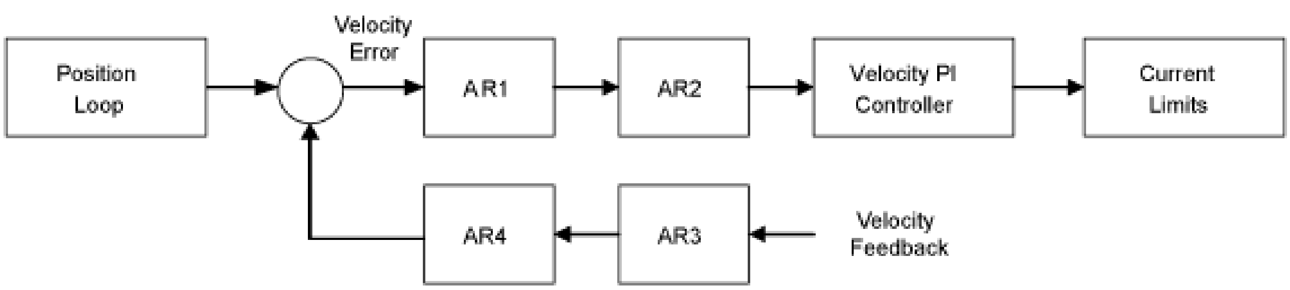
Fieldbus	Index/Subindex		Object Start Version
EtherCAT COE and CANopen	3406h/1 3406h/2 3406h/3 3406h/4	VL.ARPF1 VL.ARPF2 VL.ARPF3 VL.ARPF4	M_01-02-00-000
Modbus	808 810 812 814	VL.ARPF1 VL.ARPF2 VL.ARPF3 VL.ARPF4	M_01-03-00-000

Description

VL.ARPF1 sets the natural frequency of the pole (denominator) of AR filter 1. This value is F_P in the approximate transfer function of the filter:

$$ARx(\mathbf{s}) = [\mathbf{s}^2/(2\pi F_Z)^2 + \mathbf{s}/(Q_Z 2\pi F_Z) + 1] / [\mathbf{s}^2/(2\pi F_P)^2 + \mathbf{s}/(Q_P 2\pi F_P) + 1]$$

The following block diagram describes the AR filter function; note that AR1 and AR2 are in the forward path, while AR3 and AR4 are applied to feedback:



AR1, AR2, AR3, and AR4 are used in velocity and position mode, but are disabled in torque mode.

Discrete time transfer function (applies to all AR filters)

The velocity loop compensation is actually implemented as a digital discrete time system function on the DSP. The continuous time transfer function is converted to the discrete time domain by a backward Euler mapping:

$\mathbf{s} \approx (1-z^{-1})/t$, where t = 62.5 µs

The poles are prewarped to F_P and the zeros are prewarped to F_Z.

Related Topics

11.4 Velocity Loop

VL.ARPQ1 TO VL.ARPQ4

General Information	
Type	R/W Parameter
Description	Sets the Q of the pole (denominator) of anti-resonance (AR) filter 1; active in opmodes 1 (velocity) and 2 (position) only.
Units	None
Range	0.2 to 20
Default Value	0.5
Data Type	Float
See Also	VL.ARPF1 TO VL.ARPF4, VL.ARZF1 TO VL.ARZF4, VL.ARZQ1 TO VL.ARZQ4
Start Version	M_01-02-00-000

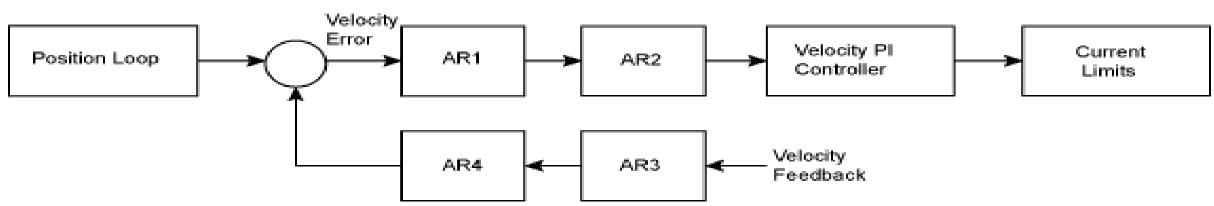
Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3406h/5 VL.ARPQ1 3406h/6 VL.ARPQ2 3406h/7 VL.ARPQ3 3406h/8 VL.ARPQ4	M_01-02-00-000
Modbus	816 VL.ARPQ1 818 VL.ARPQ2 820 VL.ARPQ3 822 VL.ARPQ4	M_01-03-00-000

Description

VL.ARPQ1 sets the Q (quality factor) of the pole (denominator) of AR filter 1. This value is Q_P in the approximate transfer function of the filter:

$$ARx(\mathbf{s}) = [\mathbf{s}^2/(2\pi F_Z)^2 + \mathbf{s}/(Q_Z 2\pi F_Z) + 1] / [\mathbf{s}^2/(2\pi F_P)^2 + \mathbf{s}/(Q_P 2\pi F_P) + 1]$$

The following block diagram describes the AR filter function; note that AR1 and AR2 are in the forward path, while AR3 and AR4 are applied to feedback:



AR1, AR2, AR3, and AR4 are used in velocity and position mode, but are disabled in torque mode.

Discrete time transfer function (applies to all AR filters)

The velocity loop compensation is actually implemented as a digital discrete time system function on the DSP. The continuous time transfer function is converted to the discrete time domain by a backward Euler mapping:

$\mathbf{s} \approx (1-z^{-1})/t$, where t = 62.5 µs

The poles are prewarped to F_P and the zeros are prewarped to F_Z.

Related Topics

11.4 Velocity Loop

VL.ARTYPE1 TO VL.ARTYPE4

General Information	
Type	NV Parameter
Description	Indicates the method used to calculate BiQuad coefficients; active in opmodes 1 (velocity) and 2 (position) only.
Units	N/A
Range	0
Default Value	0
Data Type	U8
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3405h/1 VL.ARTYPE1 3405h/2 VL.ARTYPE2 3405h/3 VL.ARTYPE3 3405h/4 VL.ARTYPE4	M_01-00-00-000
Modbus	824 VL.ARTYPE1 826 VL.ARTYPE2 828 VL.ARTYPE3 830 VL.ARTYPE4	M_01-03-00-000

Description

These parameters indicate the method used to calculate the biquad coefficients VL.ARPFx, VL.ARPQx, VL.ARZFx, and VL.ARZQx. A value of 0 indicates that the coefficients are set directly. This parameter has no effect on the filter itself, but is only used to determine the original design parameters. Currently, only the value of 0 is supported.

Related Topics

11.4 Velocity Loop

VL.ARZF1 TO VL.ARZF4

General Information	
Type	R/W Parameter
Description	Sets the natural frequency of the zero (numerator) of anti-resonance (AR)filter 1; active in opmodes 1 (velocity) and 2 (position) only.
Units	Hz
Range	5 to 5,000 Hz
Default Value	500 Hz
Data Type	Float
See Also	VL.ARPF1 TO VL.ARPF4,VL.ARPQ1 TO VL.ARPQ4, VL.ARZQ1 TO VL.ARZQ4
Start Version	M_01-02-00-000

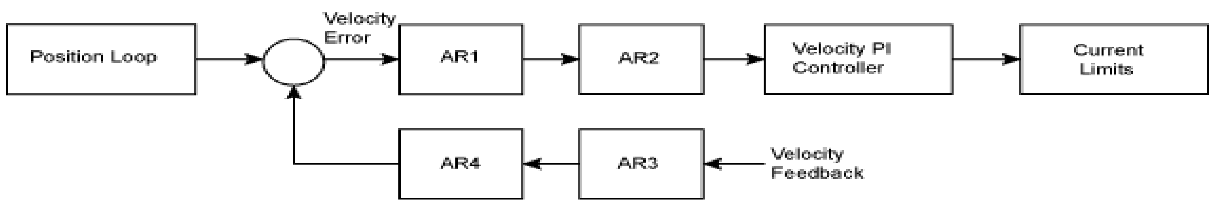
Fieldbus	Index/Subindex		Object Start Version
EtherCAT COE and CANopen	3406h/9 3406h/A 3406h/B 3406h/C	VL.ARZF1 VL.ARZF2 VL.ARZF3 VL.ARZF4	M_01-02-00-000
Modbus	832 834 836 838	VL.ARZF1 VL.ARZF2 VL.ARZF3 VL.ARZF4	M_01-03-00-000

Description

VL.ARZF1 sets the natural frequency of the zero (numerator) of AR filter 1. This value is F_Z in the approximate transfer function of the filter:

ARx(**s**) = [**s**²/(2πF_Z)² +**s**/(Q_Z2πF_Z) + 1]/ [**s**²/(2πF_P)² +**s**/(Q_P2πF_P) + 1]

The following block diagram describes the AR filter function; note that AR1 and AR2 are in the forward path, while AR3 and AR4 are applied to feedback:



AR1, AR2, AR3, and AR4 are used in velocity and position mode, but are disabled in torque mode.

Discrete time transfer function (applies to all AR filters)

The velocity loop compensation is actually implemented as a digital discrete time system function on the DSP. The continuous time transfer function is converted to the discrete time domain by a backward Euler mapping:

s ≈ (1-z^{-1})/t, where t = 62.5 µs

The poles are prewarped to F_P and the zeros are prewarped to F_Z.

Related Topics

11.4 Velocity Loop

VL.ARZQ1 TO VL.ARZQ4

General Information	
Type	R/W Parameter
Description	Sets the Q of the zero (numerator) of anti-resonance filter #1; active in opmodes 1 (velocity) and 2 (position) only.
Units	N/A
Range	0.1 to 5
Default Value	0.5
Data Type	Float
See Also	VL.ARPF1 TO VL.ARPF4, VL.ARPQ1 TO VL.ARPQ4, VL.ARZF1 TO VL.ARZF4
Start Version	M_01-02-00-000

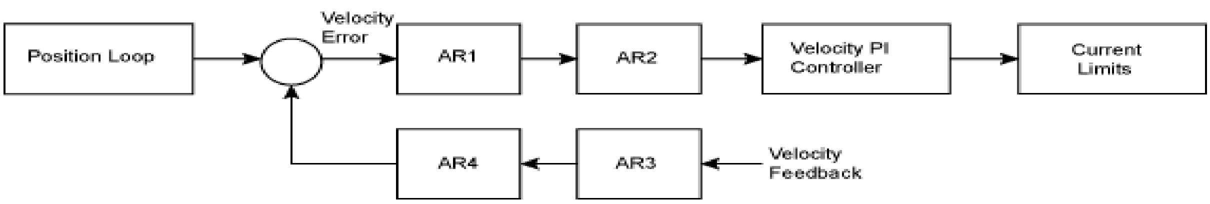
Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3406h VL.ARZQ1 3406h/E VL.ARZQ2 3406h VL.ARZQ3 3406h/10 VL.ARZQ4	M_01-02-00-000
Modbus	832 VL.ARZQ1 834 VL.ARZQ2 836 VL.ARZQ3 838 VL.ARZQ4	M_01-03-00-000

Description

VL.ARZQ1 sets the Q (quality factor) of the zero (numerator) of AR filter 1. This value is Q_Z in the approximate transfer function of the filter:

$AR1(\mathbf{s}) = [\mathbf{s}^2/(2\pi F_Z)^2+\mathbf{s}/(Q_Z 2\pi F_Z) + 1]/ [\mathbf{s}^2/(2\pi F_P)^2 +\mathbf{s}/(Q_P 2\pi F_P) + 1]$

The following block diagram describes the AR filter function; note that AR1 and AR2 are in the forward path, while AR3 and AR4 are applied to feedback:



AR1, AR2, AR3 and AR4 are used in velocity and position mode, but are disabled in torque mode.

Discrete time transfer function (applies to all AR filters)

The velocity loop compensation is actually implemented as a digital discrete time system function on the DSP. The continuous time transfer function is converted to the discrete time domain by a backward Euler mapping:

$\mathbf{s} \approx (1-z^{-1})/t$, where t = 62.5 µs.

The poles are prewarped to F_P and the zeros are prewarped to F_Z.

Related Topics

11.4 Velocity Loop

VL.BUSFF

General Information	
Type	R/O Parameter
Description	Displays the velocity loop feedforward value injected by the field-bus; active in opmodes 1 (velocity) and 2 (position) only.
Units	Depends on UNIT.VROTARY or UNIT.VLINEARUNIT.ACCLINEAR Rotary: rpm, rps, deg/s, (PIN/POUT)/s, rad/s Linear: counts/s, mm/s, µm/s, (PIN/POUT)/s
Range	0.0 to VL.LIMITP
Default Value	0.0
Data Type	Float
See Also	VL.FF, VL.KBUSFF
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	60B1h/0	M_01-00-00-000
Modbus	848	M_01-03-00-000

Description

This parameter displays the velocity loop feedforward value injected by the fieldbus.

Related Topics

11.4 Velocity Loop

VL.CMD

General Information	
Type	R/O Parameter
Description	Reads the actual velocity command; active in opmodes 1 (velocity) and 2 (position) only.
Units	Depends on UNIT.VROTARY or UNIT.VLINEARUNIT.ACCLINEAR Rotary: rpm, rps, deg/s, (PIN/POUT)/s, rad/s Linear: counts/s, mm/s, µm/s, (PIN/POUT)/s
Range	N/A
Default Value	N/A
Data Type	Float
See Also	VL.FB, VL.CMDU, VL.LIMITP, VL.LIMITN
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	606Bh/0	M_01-00-00-000
Modbus	850	M_01-03-00-000

Description

VL.CMD returns the actual velocity command as it is received in the velocity loop entry after all velocity limits (such as VL.LIMITN and VL.LIMITP). See velocity loop design diagram for more details.

Related Topics

10.4 Analog Input

11.4 Velocity Loop

11.5 Position Loop

Block Diagrams

VL.CMDU

General Information	
Type	R/W Parameter
Description	Sets the user velocity command; active in opmodes 1 (velocity) and 2 (position) only.
Units	Depends on UNIT.VROTARY or UNIT.VLINEARUNIT.ACCLINEAR Rotary: rpm, rps, deg/s, (PIN/POUT)/s, rad/s Linear: counts/s, mm/s, µm/s, (PIN/POUT)/s
Range	Range Lower Limit = VL.LIMITN, Range Upper Limit = VL.LIMITP
Default Value	0
Data Type	Float
See Also	VL.FB, VL.CMD, DRV.OPMODE, DRV.CMDSOURCE, VL.LIMITN, VL.LIMITP
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	60FFh/0	M_01-00-00-000
Modbus	852	M_01-03-00-000

Description

VL.CMDU sets the user velocity command.

When DRV.OPMODE is set to 1 (velocity loop) and DRV.CMDSOURCE is set to 0 (TCP/IP channel), then setting this value when the drive is enabled will cause the drive to rotate at the required velocity.

Related Topics

11.4 Velocity Loop

VL.ERR

General Information	
Type	R/O Parameter
Description	Sets the velocity error; active in opmodes 1 (velocity) and 2 (position) only.
Units	Depends on UNIT.VROTARY or UNIT.VLINEAR Rotary: rpm, rps, deg/s, (PIN/POUT)/s, rad/s Linear: counts/s, mm/s, µm/s, (PIN/POUT)/s
Range	N/A
Default Value	N/A
Data Type	Float
See Also	VL.CMD, VL.FB
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3407h/4	M_01-00-00-000
Modbus	854	M_01-03-00-000

Description

VL.ERR sets the velocity error. It is calculated in the velocity loop as the difference between VL.CMD and VL.FB.

Related Topics

11.4 Velocity Loop

VL.FB

General Information	
Type	R/O Parameter
Description	Reads the velocity feedback; active in opmodes 1 (velocity) and 2 (position) only.
Units	Depends on UNIT.VROTARY or UNIT.VLINEARUNIT.ACCLINEAR Rotary: rpm, rps, deg/s, (PIN/POUT)/s, rad/s Linear: counts/s, mm/s, µm/s, (PIN/POUT)/s
Range	N/A
Default Value	N/A
Data Type	Float
See Also	VL.CMDU
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3618h/0 606Ch/0	M_01-00-00-000
Modbus	856	M_01-03-00-000

Description

VL.FB returns the velocity feedback as it is received in the velocity loop.

Related Topics

11.4 Velocity Loop

VL.FBFILTER

General Information	
Type	R/O Parameter
Description	Filters VL.FB value; active in opmodes 1 (velocity) and 2 (position) only.
Units	Depends on UNIT.VROTARY or UNIT.VLINEAR Rotary: rpm, rps, deg/s, (PIN/POUT)/s, rad/s Linear: counts/s, mm/s, µm/s, (PIN/POUT)/s
Range	N/A
Default Value	N/A
Data Type	Float
See Also	VL.FB
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3407h/1	M_01-00-00-000
Modbus	858	M_01-03-00-000

Description

This parameter returns the same value as VL.FB, filtered through a 10 Hz filter.

Related Topics

11.4 Velocity Loop

VL.FBSOURCE

General Information	
Type	NV Parameter
Description	Sets feedback source for the velocity loop; active in opmodes 1 (velocity) and 2 (position) only.
Units	N/A
Range	0 to 1
Default Value	0
Data Type	Boolean
See Also	PL.FBSOURCE
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	860	M_01-03-00-000

Description

This parameter determines the feedback source to be used by the velocity loop. A value of 0 selects the primary feedback, 1 selects the secondary feedback.

Related Topics

11.4 Velocity Loop

VL.FF

General Information	
Type	R/O Parameter
Description	Displays the velocity loop overall feedforward value; active in opmodes 1 (velocity) and 2 (position) only.
Units	Depends on UNIT.ACCROTARY or UNIT.ACCLINEAR Rotary: rpm, rps, deg/s, (PIN/POUT)/s, rad/s Linear: counts/s, mm/s, µm/s, (PIN/POUT)/s
Range	0 to VL.LIMITP
Default Value	0
Data Type	Float
See Also	VL.KBUSFF, VL.KVFF, VL.ACCFFGAIN
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	862	M_01-03-00-000

Description

This parameter displays the velocity loop overall feedforward value.

Related Topics

11.4 Velocity Loop

VL.GENMODE

General Information	
Type	NV Parameter
Description	Selects mode of velocity generation (Observer, d/dt); active in opmodes 1 (velocity) and 2 (position) only.
Units	N/A
Range	0 to 1
Default Value	0
Data Type	Integer
See Also	N/A
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	864	M_01-03-00-000

Description

This parameter is used to select the velocity generator mode.

Mode	Description
0	d/dt mode: The derivative of the mechanical angle of the drive is fed to a first order low pass.
1	Luenberger Observer mode

Related Topics

11.4 Velocity Loop

VL.KBUSFF

General Information	
Type	R/W Parameter
Description	Sets the velocity loop acceleration feedforward gain value; active in opmodes 1 (velocity) and 2 (position) only.
Units	NA
Range	0.0 to 2.0
Default Value	0.0
Data Type	Float
See Also	VL.BUSFF
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3416h	M_01-00-00-000
Modbus	866	M_01-03-00-000

Description

This parameter sets the gain for the acceleration feedforward (a scaled second derivative of the position command is added to the velocity command value).

The nominal feedforward value can be multiplied by this gain value.

This will have affect only when using position mode (DRV.OPMODE = 2).

Related Topics

11.4 Velocity Loop

VL.KI

General Information	
Type	NV Parameter
Description	Sets the velocity loop integral gain for the PI controller; active in opmodes 1 (velocity) and 2 (position) only.
Units	Hz
Range	0 to 1,000 Hz
Default Value	160 Hz
Data Type	Float
See Also	VL.KP
Start Version	M_01-00-00-000

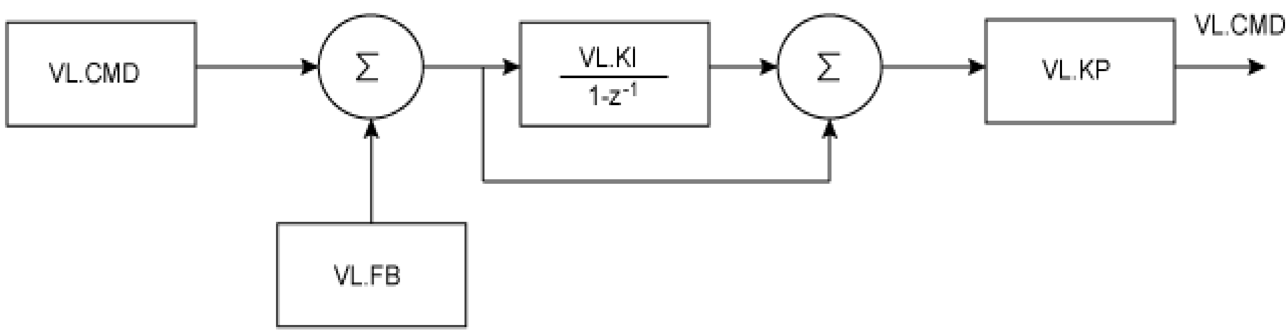
Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	354Dh/0	M_01-00-00-000
Modbus	868	M_01-03-00-000

Description

VL.KI sets the integral gain of the velocity loop.

A factor of 2π is included in the time calculation, therefore a PI velocity loop with a constant error of 1 rps in which VL.KI is set to 160 and VL.KP is set to 1, will take (1000/160)*2π ms to increase the integral gain to 1. Therefore, the total gain is 2 at this time (see velocity loop structure below).

Velocity Loop Structure



Related Topics

11.4 Velocity Loop

VL.KO

General Information	
Type	R/W Parameter
Description	Scales the observer velocity signal; active in opmodes 1 (velocity) and 2 (position) only.
Units	Internal
Range	0 to 65,535
Default Value	0
Data Type	Float
See Also	VL.MODEL
Start Version	M_01-00-01-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	870	M_01-03-00-000

Description

VL.KO is used to scale the observer model to match the load. When VL.KO is tuned properly, Reads the observer velocity signal; active in opmodes 1 (velocity) and 2 (position) only. will match VL.FB, except when there is an unspecified offset between the two.

Related Topics

11.4 Velocity Loop

VL.KP

General Information	
Type	NV Parameter
Description	Sets velocity loop proportional gain for the PI controller; active in opmodes 1 (velocity) and 2 (position) only.
Units	A/(rad/sec)
Range	0.001 to 2,147,483.008
Default Value	1
Data Type	Float
See Also	VL.KI
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3548h/0	M_01-00-00-000
Modbus	872	M_01-03-00-000

Description

VL.KP sets the proportional gain of the velocity loop.

The idealized velocity loop bandwidth in Hz is:

VL.KP *Kt/ (2π *Jm)

Where:

Kt is the motor torque constant and Jm is the total shaft inertia. The units of Kt/Jm are rad/sec^2/A.

See Velocity Controller Environment Block Diagram for more information.

VL.KVFF

General Information	
Type	R/W Parameter
Description	Sets the velocity loop velocity feedforward gain value; active in opmodes 1 (velocity) and 2 (position) only.
Units	NA
Range	0.0 to 2.0
Default Value	0.0
Data Type	Float
See Also	VL.FF
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3407h 354Bh/0	M_01-00-00-000
Modbus	874	M_01-03-00-000

Description

This parameter sets the gain for the velocity feedforward (a scaled derivative of the position command is added to the velocity command value). The nominal feedforward value can be multiplied by this gain value.

This parameter is only used in the position mode (DRV.OPMODE = 2).

Related Topics

11.4 Velocity Loop

VL.LIMITN

General Information	
Type	NV Parameter
Description	Sets the velocity lower limit; active in opmodes 1 (velocity) and 2 (position) only.
Units	Depends on UNIT.VROTARY or UNIT.VLINEAR Rotary: rpm, rps, deg/s, (PIN/POUT)/s, rad/s Linear: counts/s, mm/s, µm/s, (PIN/POUT)/s
Range	Rotary: -12,000.000 to 0.000 rpm -200.000 to 0.000 rps -72,000.000 to 0.000 deg/s -1,000.000 to 0.000 (PIN/POUT)/s -12,56.637 to 0.000 rad/s Linear: -0.200 to 0.000 counts/s -200.000*MOTOR.PITCH to 0.000 mm/s -200,000.000*MOTOR.PITCH to 0.000 µm/sec -1,000.000 to 0.000 (PIN/POUT)/s
Default Value	Rotary: -3,000.000 rpm -50.000 rps -18,000.002 deg/s -250.000 (PIN/POUT)/s -314.159 rad/s Linear: -0.050 counts/s -50*MOTOR.PITCH mm/s -50,000.004*MOTOR.PITCH µm/sec -250.000 (PIN/POUT)/s
Data Type	Float
See Also	VL.LIMITP, VL.CMD
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3623h/0	M_01-00-00-000
Modbus	876	M_01-03-00-000

Description

VL.LIMITN sets the velocity command negative limit.

If the input to the velocity loop is lower than VL.LIMITN, then the actual velocity command VL.CMD is limited by the value of VL.LIMITN.

Related Topics

11.4 Velocity Loop

VL.LIMITP

General Information	
Type	NV Parameter
Description	Sets the velocity high limit; active in opmodes 1 (velocity) and 2 (position) only.
Units	Depends on UNIT.VROTARY or UNIT.VLINEAR Rotary: rpm, rps, deg/s, (PIN/POUT)/s, rad/s Linear: counts/s, mm/s, µm/s, (PIN/POUT)/s
Range	Rotary: 0.000 to 12,000.000 rpm 0.000 to 200.000 rps 0.000 to 72,000.000 deg/s 0.000 to 1,000.000 (PIN/POUT)/s 0.000 to 1256.637 rad/s Linear: 0.000 to 0.200 Counts/s 0.000 to 200.000*MOTOR.PITCH mm/sec 0.000 to 200,000.000*MOTOR.PITCH µm/s 0.000 to 1,000.000 (PIN/POUT)/s
Default Value	Rotary: 3,000.000 rpm 50.000 rps 18,000.002 deg/s 250.000 (PIN/POUT)/s 314.159 rad/s Linear: 0.050 counts/s 50.000*MOTOR.PITCH mm/sec 50,000.004*MOTOR.PITCH µm/sec 250.000 (PIN/POUT)/s
Data Type	Float
See Also	VL.LIMITN, VL.CMD
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	**3622h/0**	M_01-00-00-000
Modbus	878	M_01-03-00-000

Description

VL.LIMITP sets the velocity command positive limit.

If the input to the velocity loop is higher than VL.LIMITP, then the actual velocity command VL.CMD is limited by the value of VL.LIMITP.

Related Topics

11.4 Velocity Loop

VL.LMJR

General Information	
Type	R/W Parameter
Description	Sets the ratio of the estimated load moment of inertia relative to the motor moment of inertia; active in opmodes 1 (velocity) and 2 (position) only.
Units	NA
Range	0 to 100.0
Default Value	0
Data Type	Float
See Also	IL.KACCFF, IL.FF
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	880	M_01-03-00-000

Description

This parameter is used in the internal calculation of the current loop acceleration feed forward gain value.

Related Topics

11.4 Velocity Loop

VL.MODEL

General Information	
Type	R/O Parameter
Description	Reads the observer velocity signal; active in opmodes 1 (velocity) and 2 (position) only.
Units	Depends on UNIT.VROTARY or UNIT.VLINEAR, UNIT.ACCLINEAR Rotary: rpm, rps, deg/s, (PIN/POUT)/s, rad/s Linear: counts/s, mm/s, µm/s, (PIN/POUT)/s
Range	N/A
Default Value	N/A
Data Type	Float
See Also	VL.FB, VL.KO
Start Version	M_01-00-01-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	882	M_01-03-00-000

Description

VL.MODEL is the observer velocity output. When VL.KO is tuned properly, VL.MODEL will match VL.FB, except when there is an unspecified offset between the two.

Related Topics

11.4 Velocity Loop

VL.OBSBW

General Information	
Type	NV Parameter
Description	Sets the bandwidth of the observer in Hz.
Units	Hz
Range	10 to 4,000 Hz
Default Value	30 Hz
Data Type	Float
See Also	N/A
Start Version	M_01-03-00-004

Fieldbus	Index/Subindex	Object Start Version
Modbus	884	M_01-03-00-000

Description

This parameter sets the bandwidth of the observer in Hz. The observer passes the velocity feedback through a PID control loop that behaves like a low-pass filter with a bandwidth of VL.OBSBW.

Related Topics

11.4 Velocity Loop

VL.OBSMODE

General Information	
Type	NV Parameter
Description	Sets the observer operating mode.
Units	N/A
Range	0 to 1
Default Value	0
Data Type	Integer
See Also	N/A
Start Version	M_01-03-004

Fieldbus	Index/Subindex	Object Start Version
Modbus	886	M_01-03-00-000

Description

This parameter sets the observer operating mode. When VL.OBSMODE = 0, the observer is not part of the control loop; that is, VL.FB is used as the velocity feedback signal to the velocity loop. When VL.OBSMODE = 1, the observer is part of the control loop; VL.MODEL is used as the velocity feedback signal.

Related Topics

11.4 Velocity Loop

VL.THRESH

General Information	
Type	NV Parameter
Description	Sets the over speed fault value; active in opmodes 1 (velocity) and 2 (position) only.
Units	Depends on UNIT.VROTARY or UNIT.VLINEAR Rotary: rpm, rps, deg/s, (PIN/POUT)/s, rad/s Linear: counts/s, mm/s, µm/s, (PIN/POUT)/s
Range	Rotary: 0 to 12,000.000 rpm 0 to 200.000 rps 0 to 72,000.000 deg/s 0 to 1,000.000 (PIN/POUT)/s 0.000 to 1,256.637 rad/s Linear: 0.000 to 0.200 counts/s 0.000 to 200.000*MOTOR.PITCH mm/sec 0.000 to 200,000.000*MOTOR.PITCH µm/s 0 to 1,000.000 (PIN/POUT)/s
Default Value	Rotary: 3,600 rpm 60 rps 21,600.000 deg/s 300.000 (PIN/POUT)/s 376.991 rad/s Linear: 0.060 counts/s 60.000*MOTOR.PITCH mm/sec 60,000.04*MOTOR.PITCHMOTOR.PITCHµm/s 300.000 (PIN/POUT)/s
Data Type	Float
See Also	VL.CMD, VL.CMDU
Start Version	M_01-00-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3627h/0	M_01-00-00-000
Modbus	888	M_01-03-00-000

Description

VL.THRESH sets the threshold for the velocity over which an over speed fault is generated.

The value is considered as an absolute value, hence it applies for both negative and positive velocities.

Example

VL.THRESH is set to 600 rpm. A velocity command of 700 rpm will generate an over speed fault.

Related Topics

11.4 Velocity Loop

WS Parameters

WS.ARM

General Information	
Type	Command
Description	Sets wake and shake to start at the next drive enable.
Units	N/A
Range	N/A
Default Value	N/A
Data Type	N/A
See Also	N/A
Start Version	M_01-01-00-101, M_01-02-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3494h/6	M_01-00-00-000
Modbus	890	M_01-03-00-000

Description

This command sets wake and shake to start at the next drive enable. Feedback type is not relevant for this command. If WS.STATE is 0 and the drive is disabled, WS.STATE will change to 1 after issuing WS.CALC. With this command wake and shake can be repeated if desired.

Related Topics

8.3.9 Using Wake and Shake (WS)

WS.DISTMIN

General Information	
Type	R/W Parameter
Description	Sets the minimum movement required for wake and shake.
Units	Actual position units
Range	0 to 36°
Default Value	1°
Data Type	S64
See Also	N/A
Start Version	M_01-01-00-101, M_01-02-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	36D1h/0	M_01-00-00-000
Modbus	896 (64-bit)	M_01-03-00-000

Description

This parameter sets the minimum movement that is required for commutation finding. If this value is too small, the the commutation finding might fail if too little current is used. The larger this value, the more movement is needed in order to avoid F473: "Wake and Shake: Too little movement".

Related Topics

8.3.9 Using Wake and Shake (WS)

WS.IMAX

General Information	
Type	R/W Parameter
Description	Sets maximum current used for wake and shake.
Units	Arms
Range	0 to (lower value of MOTOR.IPEAK and DRV.IPEAK) Arms
Default Value	(half of maximum) Arms
Data Type	U16
See Also	MOTOR.IPEAK, DRV.IPEAK
Start Version	M_01-01-00-101, M_01-02-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3494h/1	M_01-00-00-000
Modbus	900	M_01-03-00-000

Description

This parameter defines the maximum current used for wake and shake. If the selected current is too low, the minimum required movement may not occur. If the selected current is too high, the movement may be too fast (overspeed) or too large (over maximum movement).

The maximum of this parameter is the lower value of MOTOR.IPEAK and DRV.IPEAK. The default value of this parameter is the half of its maximum. This value depends on the specific application.

Related Topics

8.3.9 Using Wake and Shake (WS)

WS.MODE

General Information	
Type	R/W Parameter
Description	Sets the method used for wake and shake.
Units	N/A
Range	0 to 1
Default Value	0
Data Type	U8
See Also	N/A
Start Version	M_01-01-00-101, M_01-02-00-000

Fieldbus	Index/Subindex	Object Start Version
Modbus	902	M_01-03-00-000

Description

This parameter sets the method used for finding commutation.

0 = Standard wake and shake

Two iterations are used to find the correct angle in this mode. Coarse (current mode) and fine (velocity mode) iterations are done in a loop (WS.NUMLOOPS times). The average angle of all loops is calculated and used.

1 = Commutation alignment by fixed commutation vector (Zero Method)

The motor poles are set to 0, current mode is activated, and WS.IMAX is applied. The angle in which the motor settles is used for commutation. Other settings are restored (such as motor poles and operation mode).

Related Topics

8.3.9 Using Wake and Shake (WS)

WS.DISTMAX

General Information	
Type	R/W Parameter
Description	Sets maximum movement allowed for wake and shake.
Units	deg (position units)
Range	0 to 72 deg
Default Value	15 deg
Data Type	S64
See Also	N/A
Start Version	M_01-01-00-101, M_01-02-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3494h/2	M_01-00-00-000
Modbus	892 (64-bit)	M_01-03-00-000

Description

This parameter sets the maximum movement that is allowed for finding commutation. If this value is too small, F475, "Wake and Shake. Too much movement", may occur before wake and shake is finished. The bigger this value, the more movement is allowed for wake and shake. This value is application dependent.

Related Topics

8.3.9 Using Wake and Shake (WS)

WS.NUMLOOPS

General Information	
Type	R/W Parameter
Description	Sets the number of repetitions for wake and shake.
Units	counts
Range	0 to 20 counts
Default Value	5 counts
Data Type	U8
See Also	N/A
Start Version	M_01-01-00-101, M_01-02-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	36E2h/0	M_01-00-00-000
Modbus	904	M_01-03-00-000

Description

Max. number of wake and shake repetitions. MOTOR.PHASE is calculated as mean value of all wake and shake repetitions.

Related Topics

8.3.9 Using Wake and Shake (WS)

WS.STATE

General Information	
Type	R/O Parameter
Description	Reads wake and shake status
Units	N/A
Range	N/A
Default Value	Only valid before the first enable happens. 0 - for feedback types that do not require wake and shake 1 - for feedback types that require wake and shake
Data Type	U8
See Also	N/A
Start Version	M_01-01-00-101, M_01-02-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3494h/5	M_01-00-00-000
Modbus	906	M_01-03-00-000

Description

WS.STATE 0 = wake and shake successful or not configured.

WS.STATE 1 = wake and shake configured and will be done at next enable.

WS.STATE 2 and higher = wake and shake running.

Overview of the mode 0 states:

State	Description
1	- Waiting for drive enable - save original settings - switch to current mode
2	- wait 100ms before continuing - activate real-time (RT) functions RT will switch different current vectors and record position feedback. WS.T and WS.TDEL1 are used for RT switching of current vectors.
3	- wait for RT to finish - calculate coarse angle from RT data
4	- wait WS.TDEL2 before continuing - switch to velocity mode
5	- wait 10ms before continuing - activate RT current feedback filtering
6	- ramp up D-Current up to 75% of WS.IMAX - execute angle fine calculation
7	- check if difference between coarse and fine calculation is lower than 30°, else generate fault "Wake and Shake.Fine-Coarse delta too big." - if this was not the last loop switch to current mode and go to 2

State	Description
8	- check if difference between loops is lower than 30°, else generate fault "Wake and Shake.Loop angle delta too big." - if W&S was successful apply motor.phase and restore other parameters, else restore all parameters
9 (and larger values)	- fault state. Generate fault and apply all original parameters

Related Topics

8.3.9 Using Wake and Shake (WS)

WS.T

General Information	
Type	R/W Parameter
Description	Sets wake and shake current-vector appliance time
Units	ms
Range	1 to 10 ms
Default Value	1 ms
Data Type	U8
See Also	WS.IMAX, WS.DISTMAX
Start Version	M_01-01-00-101, M_01-02-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	36D0h/0	M_01-00-00-000
Modbus	908	M_01-03-00-000

Description

This parameter defines the duration for each different current-vector while the coarse angle calculation. The move distance is proportional to the WS.T and WS.IMAX value.

Related Topics

8.3.9 Using Wake and Shake (WS)

WS.TDELAY1

General Information	
Type	NV Parameter
Description	Delay for wake and shake timing
Units	ms
Range	0 to 200 ms
Default Value	5 ms
Data Type	U8
See Also	N/A
Start Version	M_01-01-00-101, M_01-02-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3683h/0	M_01-00-00-000
Modbus	910	M_01-03-00-000

Description

WS.TDELAY1 defines the delay time of the wake and shake function. This time is a delay time between the switching of different current vectors during the wake and shake procedure. This time should be increased in the case of movement interferences between single current vectors.

Related Topics

8.3.9 Using Wake and Shake (WS)

WS.TDELAY2

General Information	
Type	NV Parameter
Description	Sets the delay for wake and shake timing.
Units	ms
Range	0 to 200 ms
Default Value	50 ms
Data Type	U8
See Also	N/A
Start Version	M_01-01-00-101, M_01-02-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3685h/0	M_01-00-00-000
Modbus	912	M_01-03-00-000

Description

WS.TDELAY2 defines the delay between switching from coarse angle calculation to fine angle calculation during the wake and shake procedure. This time should be increased in the case of interferences between the coarse calculation done in current mode and the fine calculation done in velocity mode. Choosing too large a value increases the wake and shake duration.

Related Topics

8.3.9 Using Wake and Shake (WS)

WS.TDELAY3

General Information	
Type	NV Parameter
Description	Sets the delay for wake and shake between loops in mode 0.
Units	ms
Range	0 to 2,000 ms
Default Value	100 ms
Data Type	U16
See Also	N/A
Start Version	M_01-01-00-102, M_01-02-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3494h/3	M_01-00-00-000
Modbus	914	M_01-03-00-000

Description

WS.TDELAY3 defines the delay between complete loops in mode 0 only. Decreasing this value makes the wake and shake procedure faster, but may lead to problems if the motor moves too long. Increasing this value will make wake and shake significantly longer.

Related Topics

8.3.9 Using Wake and Shake (WS)

WS.VTHRESH

General Information	
Type	NV Parameter
Description	Defines the maximum allowed velocity for Wake & Shake
Units	actual velocity units
Range	0 to 1,000
Default Value	100
Data Type	U16
See Also	N/A
Start Version	M_01-01-00-101, M_01-02-00-000

Fieldbus	Index/Subindex	Object Start Version
EtherCAT COE and CANopen	3494h/4	M_01-00-00-000
Modbus	916	M_01-03-00-000

Description

Defines the maximum allowed velocity that occurs while commutation finding is active. This supervision runs in realtime, but only while wake and shake is active (WS.STATE 1 or greater). If at any time while wake and shake is running a velocity higher than this value is detected, a fault is generated.

For a detailed description of the wake and shake feature, see the User Guide (Using Wake and Shake (WS)).

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Appendix B

Fieldbus Manuals

- AKD *CANopen Manual*
- AKD *EtherCAT Manual*
- AKD *Modbus Manual*

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20 CANopen Manual

AKD™

CANopen Communication

Edition: Revision B, December 2010

Valid for Hardware Revision A

Part Number 903-200004-00

Original Documentation

Keep all manuals as a product component during the life span of the product. Pass all manuals to future users and owners of the product.

Record of Document Revisions:

Revision	Remarks
- ,11/2009	Beta launch version
-, 12/2009	Objects 2018&60FE added, Object dictionary, formatting updated
A, 04/2010	Termination connector "optional", several new objects, Object dictionary split
B, 07/2010	Part number added, several new objects, Object dictionary expanded

Hardware Revision (HR)

Hardware Revision	Firmware	WorkBench	Remarks
A	M_01-03-zz-zzz	1.3.0.zzzzz	Start revision
B	M_01-04-zz-zzz	1.4.0.zzzzz	STO certified

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Current patents:

US Patent 5,646,496 (used in control card R/D and 1 Vp-p feedback interface)

US Patent 5,162,798 (used in control card R/D)

US Patent 6,118,241 (used in control card simple dynamic braking)

Technical changes which improve the performance of the device may be made without prior notice!

Printed in the United States of America

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20.1 General

20.1.1 About this Manual

This manual, *AKD CANopen Communication*, This manual describes the installation, setup, range of functions, and software protocol for the CANopen AKD product series. All AKD CANopen drives have built-in CANopen functionality; therefore an additional option card is not required.

A digital version of this manual (pdf format) is available on the CD-ROM included with your drive. Manual updates can be downloaded from the Kollmorgen website.

Related documents for the AKD series include:

- *AKD Quick Start* (also provided in hard copy). This guide provides instructions for basic drive setup and connection to a network.
- *AKD Installation Manual* (also provided in hard copy). This manual provides instructions for installation and drive setup.
- *AKD Parameter and Command Reference Guide*. This guide provides documentation for the parameters and commands used to program the AKD.
- *AKD EtherCAT Communication*. This manual includes setup information for the EtherCAT interface and describes the EtherCAT profile.

Additional documentation:

- CAN Application (CAL) for Industrial Applications (publisher CiA e.V.)
- Draft Standards 301 (from Version 4.0), 402 (publisher CiA e.V.)
- CAN Specification Version 2.0 (publisher CiA e.V.)
- ISO 11898 ... Controller Area Network (CAN) for high-speed communication

20.1.2 Target Group

This manual addresses personnel with the following qualifications:

- Installation: only by electrically qualified personnel.
- Setup : only by qualified personnel with extensive knowledge of electrical engineering and drive technology
- Programming: Software developers, project-planners

The qualified personnel must know and observe the following standards:

- ISO 12100, IEC 60364 and IEC 60664
- National accident prevention regulations

⚠ WARNING	**During operation there are deadly hazards, with the possibility of death, severe injury or material damage. The operator must ensure that the safety instructions in this manual are followed. The operator must ensure that all personnel responsible for working with the servo drive have read and understand the manual.**

20.1.3 Abbreviations used

Abbreviation	Meaning
BTB/RTO	Ready to operate (standby)
COB	Communication Object
COB-ID	Communication Object Identifier
EEPROM	Electrically erasable/programmable memory
EMC	Electromagnetic compatibility
EMCY	Emergency Objects
ISO	International Standardization Organization
km	1000 m
LED	Light-emitting diode
LSB	Low significant Byte (or Bit)
MSB	Main significant Byte (or Bit)
MB	Megabyte
NMT	Network Management Objects
NSTOP	Limit switch for negative (left) rotation
PC	Personal Computer
PDO	Process Data Object
PSTOP	Limit switch for positive (right) rotation
RAM	Volatile memory
ROD	Incremental position encoder
RXPDO	Receive PDO
SDO	Service Data Object
SYNC	Synchronization Objects
TXPDO	Transmit PDO

20.2 Safety

20.2.1 Safety Instructions

⚠ DANGER	During operation there are deadly hazards, with the possibility of death, severe injury or material damage. Do not open or touch the equipment during operation. Keep all covers and cabinet doors closed during operation. Touching the equipment is allowed during installation and commissioning for properly qualified persons only. • During operation, drives may have uncovered live components, depending on their level of enclosure protection. • Control and power connections may be live, even though the motor is not rotating. • Drives may have hot surfaces during operation. Heat sink can reach temperatures above 80°C.
⚠ WARNING	Electronic equipment is basically not failure-proof. The user is responsible for ensuring that, in the event of a failure of the drive, the drive is set to a state that is safe for both machinery and personnel, for instance with the aid of a mechanical brake. Drives with drives and CANopen expansion cards are remote-controlled machines. They can start to move at any time without previous warning. Take appropriate measures to ensure that the operating and service personnel is aware of this danger. Implement appropriate protective measures to ensure that any unintended start-up of the machines cannot result in dangerous situations for personnel or machinery. Software limit-switches are not a substitute for the hardware limit-switches in the machine.
NOTICE	Install the drive as described in the *Installation Manual*. The wiring for the analog setpoint input and the positioning interface, as shown in the wiring diagram in the *Installation Manual*, is not required. Never break any of the electrical connections to the drive while it is live. This action can result in destruction of the electronics

20.2.2 Use As Directed

Drives are components that are built into electrical plants or machines and can only be operated as integral components of these plants or machines. The manufacturer of the machine used with a drive must generate a hazard analysis for the machine and take appropriate measures to ensure that unforeseen movements cannot cause personnel injury or property damage.

Please observe the chapters "Use as directed" and "Prohibited use" in the *AKD Installation Manual*.

The CANopen interface serves only for the connection of the *AKD* to a master via the CAN bus.

20.2.3 Prohibited Use

Other use than that described in chapter “Use as directed” is not intended and can lead to personnel injuries and equipment damage. The drive may not be used with a machine that does not comply with appropriate national directives or standards. The use of the drive in the following environments is also prohibited:

- potentially explosive areas
- environments with corrosive and/or electrically conductive acids, alkaline solutions, oils, vapors, dusts
- ships or offshore applications

20.3 Installation and Setup

20.3.1 Safety Instructions

⚠ DANGER	Never undo any electrical connections to the drive while it is live. There is a danger of electrical arcing with damage to contacts and serious personal injury. Wait at least seven minutes after disconnecting the drive from the main supply power before touching potentially live sections of the equipment (e.g. contacts) or undoing any connections. Capacitors can still have dangerous voltages present up to7 minutes after switching off the supply power. To be sure, measure the voltage in the DC Bus link and wait until it has fallen below 40 V. Control and power connections can still be live, even if the motor is not rotating.
⚠ WARNING	Electronic equipment is basically not failure-proof. The user is responsible for ensuring that, in the event of a failure of the drive, the drive is set to a state that is safe for both machinery and personnel, for instance with the aid of a mechanical brake. Drives with drives and CANopen are remote-controlled machines. They can start to move at any time without previous warning. Take appropriate measures to ensure that the operating and service personnel is aware of this danger. Implement appropriate protective measures to ensure that any unintended start-up of the machines cannot result in dangerous situations for personnel or machinery. Software limit-switches are not a substitute for the hardware limit-switches in the machine.
NOTICE	Install the drive as described in the *Installation Manual*. The wiring for the analog setpoint input and the positioning interface, as shown in the wiring diagram in the *Installation Manual*, is not required. Never break any of the electrical connections to the drive while it is live. This action can result in destruction of the electronics.
NOTICE	The drive's status must be monitored by the PLC to acknowledge critical situations. Wire the FAULT contact in series into the emergency stop circuit of the installation. The emergency stop circuit must operate the supply contactor.

NOTE	It is permissible to use the setup software to alter the settings of the drive. Any other alterations will invalidate the warranty.
NOTE	Because of the internal representation of the position-control parameters, the position controller can only be operated if the final limit speed of the drive does not exceed: **rotary** at sinusoidal² commutation: 7500 rpm at trapezoidal commutation: 12000 rpm. **linear** at sinusoidal² commutation: 4 m/s at trapezoidal commutation: 6.25 m/s
NOTE	All the data on resolution, step size, positioning accuracy etc. refer to calculatory values. Non-linearities in the mechanism (backlash, flexing, etc.) are not taken into account. If the final limit speed of the motor must be altered, then all the parameters that were previously entered for position control and motion blocks must be adapted.

20.3.2 Guide to Setup

⚠ WARNING	**Only professional personnel with extensive knowledge of control and drive technology are allowed to setup the drive.**
⚠ CAUTION	**Make sure that any unintended movement of the drive cannot endanger machinery or personnel.**

1. Check assembly/installation. Check that all the safety instructions in the product manual for the drive and this manual have been observed and implemented. Check the setting for the station address and baud rate.
2. Connect PC,start WorkBench. Use the setup software WorkBench to set the parameters for the drive.
3. Setup basic functions. Start up the basic functions of the drive and optimize the current, speed and position controllers. This section of the setup is described in the in the online help of the setup software.
4. Save parameters. When the parameters have been optimized, save them in the drive.
5. Start up communication. The altered parameters will only become effective after a reboot (switch off 24V and switch on again). Adjust the transmission rate of the AKD to match the master.
6. Test communication. Check for the bootup-message, when you switch on the drive. Do an SDO read access on index 0x1000 subindex 0 (DeviceType).
7. Setup position controller. Setup the position controller, as described in the WorkBenchonline help.

20.4 CANopen Basics

20.4.1 Basic Features implemented by CANopen

It is assumed that the basic operating functions of the communication profile are known and available as reference documentation. When working with the position controller that is integrated in AKD, the following functions are available:

20.4.1.1 Setup and general functions:

- Homing, set reference point
- Provision of a digital setpoint for speed and torque control
- Support of the following modes of the CANopen Profile DS402:
  - Profile position mode
  - Homing mode
  - Profile torque mode
  - Interpolated position mode
  - Profile velocity mode

20.4.1.2 Positioning functions:

- Execution of a motion task from the motion block memory of the drive
- Execution of a direct motion task
- Absolute trajectory, ip-Mode

20.4.1.3 Data transfer functions:

- Transmit a motion task to the drive's motion block memory. A motion task consists of these elements:
  - Position setpoint (absolute task) or path setpoint (relative task)
  - Speed setpoint
  - Acceleration time, braking time
  - Type of motion task (absolute/relative)
  - Number of a following task (with or without pause)
- Read a motion task from the motion block memory of the drive
- Read actual values
- Read the error register
- Read the status register
- Read/write control parameters

20.4.2 Transmission Rate and Procedure

- Bus connection and bus medium: CAN-standard ISO 11898 (CAN high-speed)
- Transmission rate: max. 1Mbit/s
- Possible settings for the drive: 125 (default), 250, 500 and 1000 kbit/s

20.4.3 Response to BUSOFF Communication Faults

The communication fault BUSOFF is directly monitored and signaled by Level 2 (CAN controller). This message may have various causes. A few examples:

- Telegrams are transmitted, although there is no other CAN node connected
- CAN nodes have different transmission rates
- The bus cable is faulty
- Faulty cable termination causes reflections on the cable.

A BUSOFF is only signaled by the AKD, if another CAN node is connected and at least one object was successfully transmitted to start off with. The BUSOFF condition is signaled by the error message 702. If the output stage is enabled at the moment when this fault occurs, the output stage is disabled.

20.5 CANopen Communication Profile

20.5.1 General Description of CAN

This chapter describes the basic services and communication objects of the CANopen communication profile DS 301, which are used in the AKD.

NOTE **It is assumed that the basic operating functions of the communication profile are known, and available as reference documentation.**

The transmission method that is used here is defined in ISO 11898 (Controller Area Network CAN for high-speed communication).

The Layer-1/2 protocol (Physical Layer/Data Link Layer) that is implemented in all CAN modules provides, amongst other things, the requirements for data.

Data transport or data request is made by means of a data telegram (Data Frame) with up to 8 bytes of user data, or by a data request telegram (Remote Frame).

Communication objects (COBs) are labeled by an 11-bit Identifier (ID) that also determines the priority of objects.

A Layer-7 protocol (Application Layer) was developed, to decouple the application from the communication. The service elements that are provided by the Application Layer make it possible to implement an application that is spread across the network. These service elements are described in the CAN Application Layer (CAL) for Industrial Applications.
The communication profile CANopen and the drive profile are mounted on the CAL.

The basic structure of a communication object is shown in the following diagram:

SOM	COB-ID	RTR	CTRL	Data Segment	CRC	ACK	EOM

SOM	Start of message
COB-ID	Communication Object Identifier (11-bit)
RTR	Remote Transmission Request
CTRL	Control Field (e.g. Data Length Code)
Data Segment	0 to 8byte (Data-COB) 0byte (Remote-COB)
CRC	Cyclic Redundancy Check
ACK	Acknowledge slot
EOM	End of message

20.5.2 Construction of the Communication Object Identifier

The following diagram shows the layout of the COB Identifier (COB-ID). The Function Code defines the interpretation and priority of the particular object.

10	9	8	7	6	5	4	3	2	1	0
Function-Code				Module-ID						

Bit 0 .. 6

Module ID (drive's CAN-bus address, range 1 to 127; is set up in WorkBench or the drive,)

Bit 7 to 10

Function Code (number of the communication object that is defined in the server)

NOTE **If an invalid station number (=0 or >127) is set, then the module will be set internally to 1.**

The following tables show the default values for the COB Identifier after switching on the drive. The objects, which are provided with an index (Communication Parameters at Index), can have a new ID assigned after the initialization phase. The indices in brackets are optional.

Predefined broadcast objects (send to all nodes):

Object	Function code (binary)	Resulting COB-IDs		Communication parameters at index
		Dec.	Hex.	
NMT	0000	0	0	—
SYNC	0001	128	80	(1005)
TIME	0010	256	100	not supported

Predefined Peer-to-Peer objects (node sends to node):

Object	Function code (binary)	Resulting COB-IDs		Communication parameters at index	Priority
		Dec.	Hex.		
EMERGENCY	0001	129..255	81..FF	—	high
TPDO 1	0011	385..511	181..1FF	1800	
RPDO 1	0100	513..639	201..27F	1400	
TPDO 2	0101	641..767	281..2FF	1801	
RPDO 2	0110	769..895	301..37F	1401	
TPDO 3	0110	897..1023	381..3FF	1802	
RPDO 3	1000	1025..1151	401..47F	1402	
TPDO 4	1001	1153..1279	481..4FF	1803	
RPDO 4	1010	1281..1407	501..57F	1403	
SDO (tx*)	1011	1409..1535	581..5FF		
SDO (rx*)	1100	1537..1663	601..67F		
Nodeguard	1110	1793..1919	701..77F	(100E)	low

*tx = direction of transmission: AKD => Master
rx = direction of transmission: Master => AKD

20.5.3 Definition of the Used Data Types

This chapter defines the data types that are used. Each data type can be described by bit-sequences. These bit-sequences are grouped into "Octets" (bytes). The so-called "Little – Endian" format (a.k.a. Intel format) is used for numerical data types (see also: DS301 Application Layer "General Description of Data Types and Encoding Rules").

20.5.3.1 Basic data types

Unsigned Integer

Data in the basic data type UNSIGNEDn define exclusively positive integers.
The value range is from 0 to 2^n-1. The bit sequence b = b_0 to b_{n-1} defines the value
UNSIGNEDn(b) = b_{n-1} 2^{n-1} + to + b_1 2^1 + b_0 2^0
Example: the value 266 = 10Ah is transmitted in the data type UNSIGNED16, in the form of two octets (1st octet = 0Ah, 2nd octet = 01h).

Transmission syntax for the data type UNSIGNEDn

Octet number	1.	2.	3.	4.
UNSIGNED8	b_7 to b_0			
UNSIGNED16	b_7 to b_0	b_{15} to b_8		
UNSIGNED24	b_7 to b_0	b_{15} to b_8	b_{23} to b_{16}	
UNSIGNED32	b_7 to b_0	b_{15} to b_8	b_{23} to b_{16}	b_{31} to b_{24}
UNSIGNED40	b_7 to b_0	b_{15} to b_8	b_{23} to b_{16}	b_{31} to b_{24}
UNSIGNED48	b_7 to b_0	b_{15} to b_8	b_{23} to b_{16}	b_{31} to b_{24}
UNSIGNED56	b_7 to b_0	b_{15} to b_8	b_{23} to b_{16}	b_{31} to b_{24}
UNSIGNED64	b_7 to b_0	b_{15} to b_8	b_{23} to b_{16}	b_{31} to b_{24}

Octet number	5.	6.	7.	8.
UNSIGNED8				
UNSIGNED16				
UNSIGNED24				
UNSIGNED32				
UNSIGNED40	b_{39} to b_{32}			
UNSIGNED48	b_{39} to b_{32}	b_{47} to b_{40}		
UNSIGNED56	b_{39} to b_{32}	b_{47} to b_{40}	b_{55} to b_{48}	
UNSIGNED64	b_{39} to b_{32}	b_{47} to b_{40}	b_{55} to b_{48}	b_{63} to b_{56}

Signed Integer

Data in the basic data type INTEGERn define both positive and negative integers.
The value range is from $-2^{n-1}-1$ to $2^{n-1}-1$. The bit sequence b = b_0 to b_{n-1} defines the value
INTEGERn(b) = $b_{n-2}\ 2^{n-2}$ + to + $b_1\ 2^1$ + $b_0\ 2^0$ with b_{n-1} = 0
Negative numbers are represented as 2's complement, which means:
INTEGERn(b) = - INTEGERn(b) - 1 with b_{n-1} = 1
Example: the value -266 = FEF6h is transmitted in the data type INTEGER16, in the form of two octets (1st octet = F6h, 2nd octet = FEh).

Transmission syntax for the data type INTEGERn

Octet number	1.	2.	3.	4.
INTEGER8	b_7 to b_0			
INTEGER16	b_7 to b_0	b_{15} to b_8		
INTEGER24	b_7 to b_0	b_{15} to b_8	b_{23} to b_{16}	
INTEGER32	b_7 to b_0	b_{15} to b_8	b_{23} to b_{16}	b_{31} to b_{24}
INTEGER40	b_7 to b_0	b_{15} to b_8	b_{23} to b_{16}	b_{31} to b_{24}
INTEGER48	b_7 to b_0	b_{15} to b_8	b_{23} to b_{16}	b_{31} to b_{24}
INTEGER56	b_7 to b_0	b_{15} to b_8	b_{23} to b_{16}	b_{31} to b_{24}
INTEGER64	b_7 to b_0	b_{15} to b_8	b_{23} to b_{16}	b_{31} to b_{24}

Octet number	5.	6.	7.	8.
INTEGER8				
INTEGER16				
INTEGER24				
INTEGER32				
INTEGER40	b_{39} to b_{32}			
INTEGER48	b_{39} to b_{32}	b_{47} to b_{40}		
INTEGER56	b_{39} to b_{32}	b_{47} to b_{40}	b_{55} to b_{48}	
INTEGER64	b_{39} to b_{32}	b_{47} to b_{40}	b_{55} to b_{48}	b_{63} to b_{56}

20.5.3.2 Mixed data types

Mixed data types combine basic data types (INTEGERn, UNSIGNEDn, REAL). Two types of mixed data are distinguished:

- STRUCT: This data type is composed of elements with different data types.
- ARRAY: This data type is composed of elements of the same data type.

20.5.3.3 Extended data types

Extended data types are derived from basic data types and mixed data types. The types of extended data that are supported are defined below.

Octet String

The data type OCTET_STRING is defined with the data type ARRAY. Length is the length of the octet string.

ARRAY[length] OF UNSIGNED8	OCTET_STRINGlength

Visible String

The data type VISIBLE_STRING can be defined with the data type UNSIGNED8 or the data type ARRAY. Permissible values are 00h and the range from 20h to 7Eh. The data are interpreted as 7 bit ASCII code (as per ISO 646-1973(E)). Length is the length of the visible string.

UNSIGNED8	VISIBLE_CHAR
ARRAY[length] OF VISIBLE_CHAR	VISIBLE_STRINGlength

20.5.4 Communication Objects

Communication objects are described with the help of service elements and protocols. Two basic types of service elements are used.

- Unconfirmed services PDO
- Confirmed services SDO

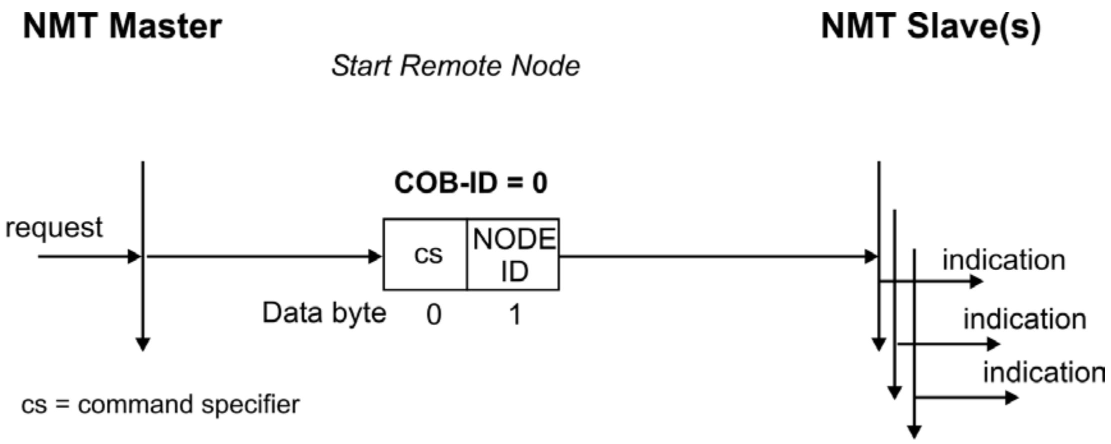
All services require faultless operation of the Data Link and Physical Layer.

AKD supports communication objects that are described in detail in the following sections:

- Network Management Objects (NMT)
- Synchronization Object (SYNC)
- Emergency Object (EMCY)
- Process Data Object (PDO)
- Service Data Object (SDO)
- Nodeguard/Heartbeat

20.5.4.1 Network Management Objects (NMT)

The followind diagram describes the NMT telegram:



The drive supports the following network management functions:

cs=129, reset node:
Causes a cold-start of the drive. This deletes all parameters saved in the RAM and loads the values stored in the EEP-ROM.

cs = 130, reset communication node:
Causes a stop of PDO-communication, gives a new bootup-message

cs = 1, start remote node:
Starts the CAN node. I.e. the PDOs of the drive are enabled for operation. From this moment, transmit-PDOs will be transmitted under event-control, and cyclical process data operation can commence.

cs = 2, stop remote node:
Stops the CAN node, I.e. the drive no longer responds to any received PDOs or transmits any PDOs.

20.5.4.2 Synchronization Object (SYNC)

The SYNC object usually is used as a periodic Broadcast Object and provides the basic clock for the bus. SYNC has a high priority, to ensure constant time intervals. The usage of this protocol is explained in the appendix from page . You can use the SYNC object to start motion task of several axes simultaneously for example.

20.5.4.3 Time-Stamp Object (TIME)

This communication object is not supported by the AKD.

20.5.4.4 Emergency Object (EMCY)

EMCY is event-triggered and generated by an internal fault/error situation. This object is transmitted afresh for every error. Since the error codes are device-dependent, they are described in the Chapter *CANopen Drive Profile*. The last 10 Emergency error codes can be read via object 1003.

Application of the Emergency Object

The reaction in the event of an error or fault depends on the error class and is therefore variable. For this reason, the reaction is described with the aid of an error status machine. The error conditions error- free and error occurred are distinguished. The following transitions are defined:

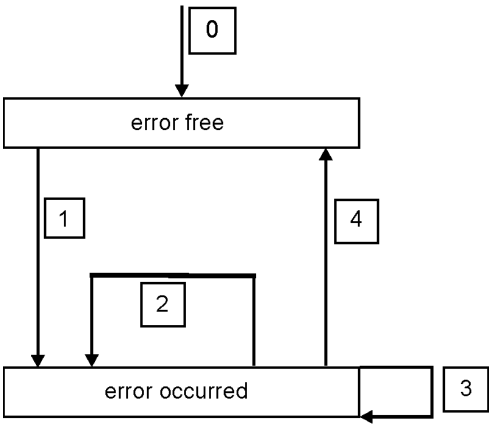
Transition 0: After initialization, the error-free status is taken up if no errors are detected.
No error signal is generated in this condition.

Transition1: The AKD detects an internal error and indicates this in the first three bytes
of the emergency telegram (error code in Bytes 0,1 and error register in Byte 2).

Transition2: One error has been reset, but not all. The EMCY telegram contains error code 0000
and the error register indicates the remaining errors that are present. The manufacture-specific area is set to zero.

Transition3: A new error has occurred. The AKD remains in the error status and transmits an EMCY. Object with the corresponding error code. The new error code is entered into bytes 0 and 1.

Transition4: All errors have been reset. The EMCY telegram contains the error code 0000,
The error register does not indicate any other errors. The manufacture-specific area is set to zero.



Composition of the Emergency Object

The Emergency Object is composed of 8 bytes, divided as follows:

Byte	0	1	2	3	4	5	6	7
Content	Emergency error code		Error register (object 1001	Category	Reserved			

If an Emergency Object is generated, the error condition is then signaled to the status machine (error free/error occurred) by the generation of a second Emergency Object. Only the first four bytes are relevant in this case (Emergency Error code , Error register, Category). Byte 0/1 contains the Emergency Error Code (0000) and Byte 2 indicates if a possible further error is present. If the error register contains 00, the error status is error-free. Byte 3 contains the category. The interpretations of the error numbers (error code) and the error categories are described in the section Emergency Messages. The error register is defined through object 1001. Error register´.

20.5.4.5 Service Data Objects (SDO)

SDOs are used to implement access to the Object Dictionary. The SDOs are required for parametrerization and for status polling. Access to an individual object is made with a multiplexer via the Index and Subindex of the Object Dictionary. The following communication protocols are supported by AKD:

- Initiate SDO Download Protocol
- Download SDO Segment Protocol
- Initiate SDO Upload Protocol
- Upload SDO Segment Protocol
- Abort SDO Transfer Protocol

The definitions of the individual communication services and protocols can be found in DS301.
Examples of the usage of SDOs can be found in the appendix from page .

NOTE	Since a SDO is a confirmed service, the system must always wait for the SDO response telegram before it is allowed to transmit a new telegram.

Composition of the Service Data Object

An SDO consists of the following components:

Byte	1	2	3	4	5	6	7	8
Content	R/W	Index		Subindex	Data			

1. The control byte (Byte 1):

The control byte determines whether the SDO should write or read the content of the entry in the Object Dictionary. A description of the complete Object Dictionary for AKD=> p. 119. Data exchange with the AKD is governed by the *CMS multiplexed domain protocols* standard, as described in the CAN standard DS 202.
To read data, the control byte must be written in the manner shown below:

Bit	7	6	5	4	3	2	1	0
Content	ccs=2			X	X	X	X	X

ccs => client command specifier (ccs = 2 => initiate upload request)
X => free data

So a value of 0100 0000 (binary) or 40h must be transmitted in the control byte.

The drive sends back a corresponding response byte:

Bit	7	6	5	4	3	2	1	0
Content	scs=2			X	n		e	s

scs =>server command specifier (scs = 2 => initiate upload response)
n =>only valid for e = s = 1, if this is so, n contains the number of bytes that do not contain data
X =>free data

If reading is successfull, the response byte always has set the bits 0 and 1 (e = s = 1).

Encoded byte length in the SDO response:
0x43 - 4 bytes
0x47 - 3 bytes
0x4B - 2 bytes
0x4F - 1 byte.

If an error occurs, scs is set to 4, the response byte is 0x80 and the error information is in the four byte data field. The decoding of the error => p. 55

To write data, the control byte must be written in the manner shown below:

Client	*Initiate Domain Download*															**Server**
	Byte 1								**2**	**3**	**4**	**5**	**6**	**7**	**8**	
request	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**								indication
=>	ccs=1			X	n		e	s	m			d	d	d	d	=>
	=> => => => => =>=> => =>=> => =>=> => =>=> => =>=> => =>															

n,e and s are defined like in the reading case, m: index + Subindex, d: 4 bytes data field
The data length of an object can be taken from the object dictionary in the appendix.
The control byte should be:

0x23 for a 4-byte access
0x27 for a 3-byte access
0x2B for a 2-byte access
0x2F for a 1-byte access

Client	<= <= <= <= <= <=<= <= <=<= <= <=<= <= <=<= <= <=<= <= <=															**Server**
	Byte 1								**2**	**3**	**4**	**5**	**6**	**7**	**8**	
confirm	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**								response
<=	scs=3			X					m			reserved				<=

2. Index (Bytes 2 and 3):

The Index is the main entry in the Object Dictionary, and divides the parameters into groups.
(Example: Index 1018h is the Identity Object). As for all CAN data, the Index is stored with the bytes in reverse order.
For example: Index 6040h means Byte 2 = 40h, Byte 3 = 60h)

3. Subindex (Byte 4):

The Subindex divides the parameters within a group of parameters.

4. Data field (Bytes 5 to 8):

These components are used for the exchange of user data. In read-request telegrams to the AKD they are set to 0. They have no content in a write confirmation from the AKD if the transfer was successful, but if the write operation was faulty they contain an error => p. 55.

Initiate SDO Download Protocol

The Initiate SDO Download protocol is used for write access to objects with up to 4 bytes of user data (expedited transfer) or to initiate a segment transfer (normal transfer).

Download SDO Segment Protocol

The Download SDO Segment protocol is used for write access to objects with more than 4 bytes of user data (normal transfer).

Initiate SDO Upload Protocol

The SDO Upload protocol is used for read access to objects with up to 4 bytes of user data (expedited transfer) or to initiate a segment transfer (normal transfer).

Upload SDO Segment Protocol

The Upload SDO Segment protocol is used for read access to objects with more than 4 bytes of user data (normal transfer).

Abort SDO Protocol

The Abort SDO protocol breaks off SDO transmission, and indicates the error that caused the break in transmission through an abort code (error code). The error code is in the format of an UNSIGNED32 value. The following table shows possible reasons for an abort SDO.

Abort Code	Description
0504 0000h	SDO timeout
0504 0001h	Command specifier invalid
0504 0002h	SDO segmented: invalid blocksize
0504 0004h	SDO segmented: invalid block CRC
0504 0005h	SDO segmented: out of memory
0601 0001h	Attempted read access to a write-only object
0601 0002h	Attempted write access to a read-only object
0602 0000h	Object does not exist in Object Dictionary
0604 0041h	Object cannot be mapped to a PDO
0604 0042h	Size and number of mapped objects exceed permissible PDO length
0604 0043h	General parameter incompatibility
0606 0000h	SDO hardware fault
0607 0010h	Data type incompatible, length of service parameter is incompatible
0609 0011h	Subindex does not exist
0609 0030h	Outside value range for the parameter (only for write access)
0609 0031h	Parameter value too high
0609 0032h	Parameter value too low
0800 0020h	Data cannot be transmitted or saved
0800 0022h	Data cannot be transmitted or saved because of device status

Abort Codes not listed above are reserved.

20.5.4.6 Process Data Object (PDO)

PDOs are used for real-time data communication. PDOs can, for instance, be used to set up controllers similar to analog drives. Instead of +/-10VDC setpoints and ROD feedback, digital speed setpoints and position feedback are attained via PDOs in this case.
Transmission is carried out unconfirmed without a protocol "overhead". This communication object uses the unconfirmed communication service.
PDOs are defined via the Object Dictionary for the AKD. Mapping is made during the configuration phase, with the help of SDOs. Length is defined with the mapped objects.

The definition of the PDO service and protocol can be found in DS301. Examples of the usage of PDOs can be found in the appendix.
Basically, two types of PDOs can be distinguished, depending on the direction of transmission:

- Transmit-PDOs (TPDOs) (AKD => Master)
  The TPDOs transmit data from AKD to control system (for example actual value objects, instrument status).
- Receive-PDOs (RPDOs) (Master =>AKD)
  The RPDOs receive data from control system to AKD (for example setpoints).

AKD supports four independent PDO channels for each direction of transmission. The channels are labeled by the channel numbers 1 to 4.
There are two parameter sets each for the configuration of each of the four possible PDOs, and they can be set up through the corresponding SDOs:

1.Mapping parameters, to determine which data are available (mapped) in the selected PDO and to define, which data are contained.

2.Communication parameters, that define whether the PDOs operate in synchronized mode, or event-driven (objects 1400h to 1403h, 1800h to 1803h).

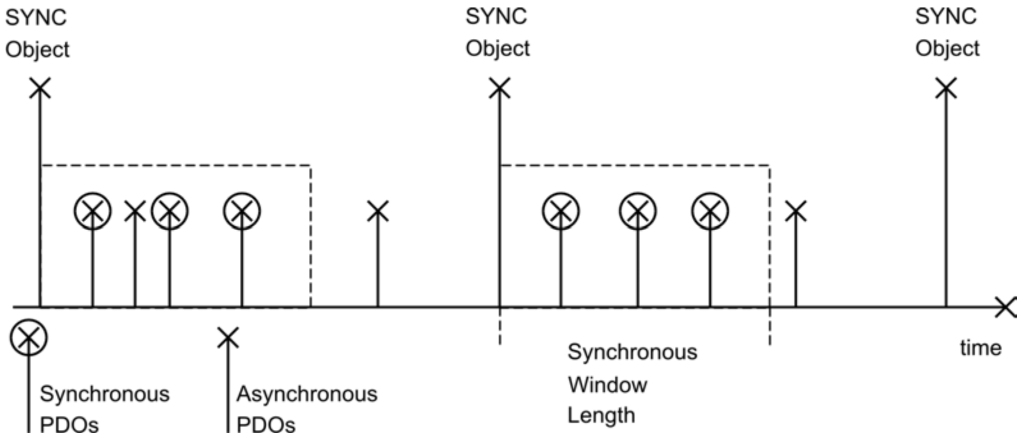
Transmission modes

The following PDO transmission modes are distinguished:

- Synchronous transmission
- Asynchronous transmission

The pre-defined SYNC Object is transmitted periodically (bus clock), to synchronize the drives. Synchronous PDOs are transmitted within a pre-defined time window immediately following the SYNC Object.

The transmission modes are set up with the aid of the PDO communication parameters.



Trigger modes

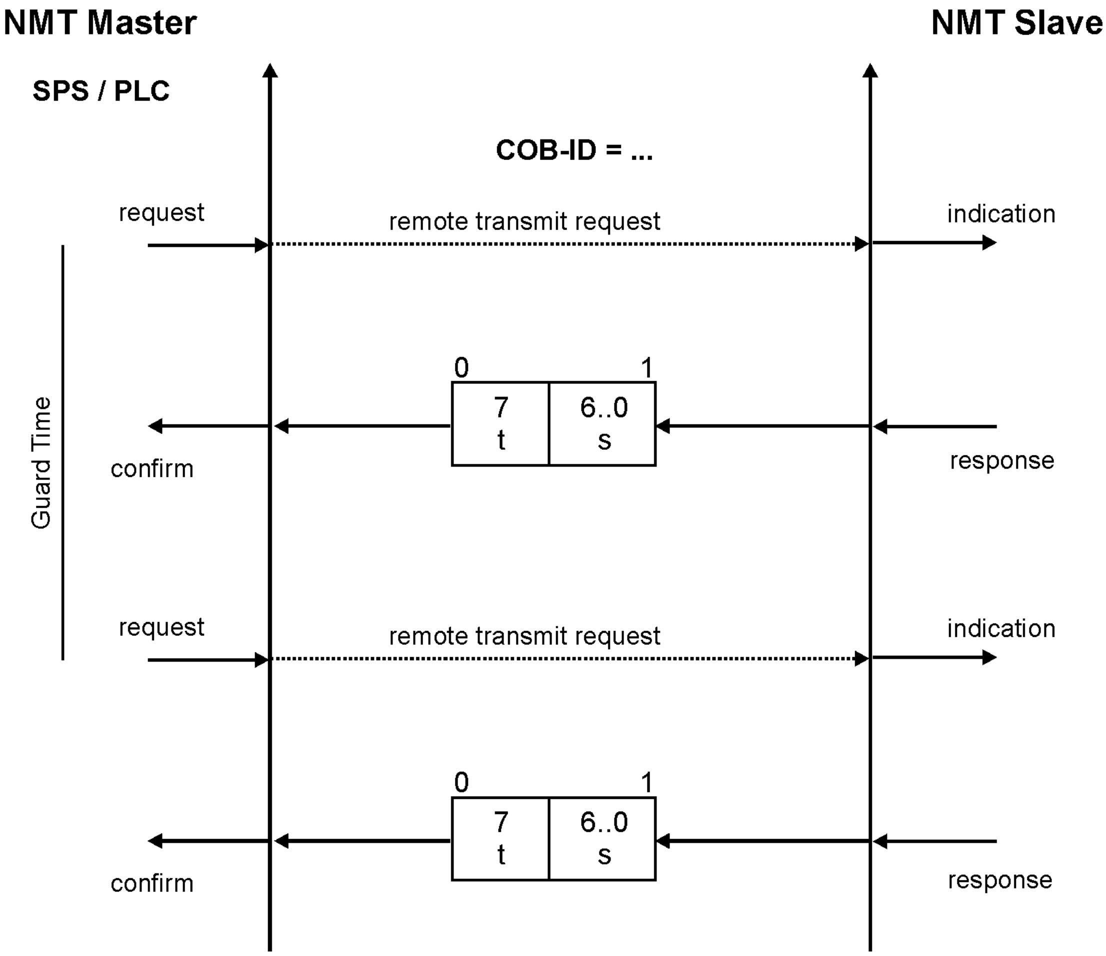
Three different trigger modes are distinguished:

- **Event driven:** The transmission of the telegrams is triggered by an object-specific event.
- **Time driven**: If event driven signals put a high strain on the bus, you can determine the period of time after which a PDO can be transmitted again via the inhibit time (Communication parameter, Subindex 03h)
- **Event Timer driven:** If a PDO shall be sent within a defined time interval, even if it doesn’t change, this interval can be defined by a special SDO.

20.5.4.7 Nodeguard

The Node Guarding protocol is a functional monitoring for the drive. It requires that the drive is accessed at regular intervals by the CANopen master.
The maximum time interval that is permitted between two Nodeguard telegrams is given by the product of the Guard Time (Object 100Ch) and the Life Time Factor (Object 100Dh). If one of these two values is 0, then the response monitoring is de-activated.
If the drive is not accessed within the time defined by objects 100Ch and 100Dh, then fault F129 (response monitoring) appears on the drive, the drive is braked to a stop, and any other movement is prevented.

The time sequence for node guarding is as shown below:



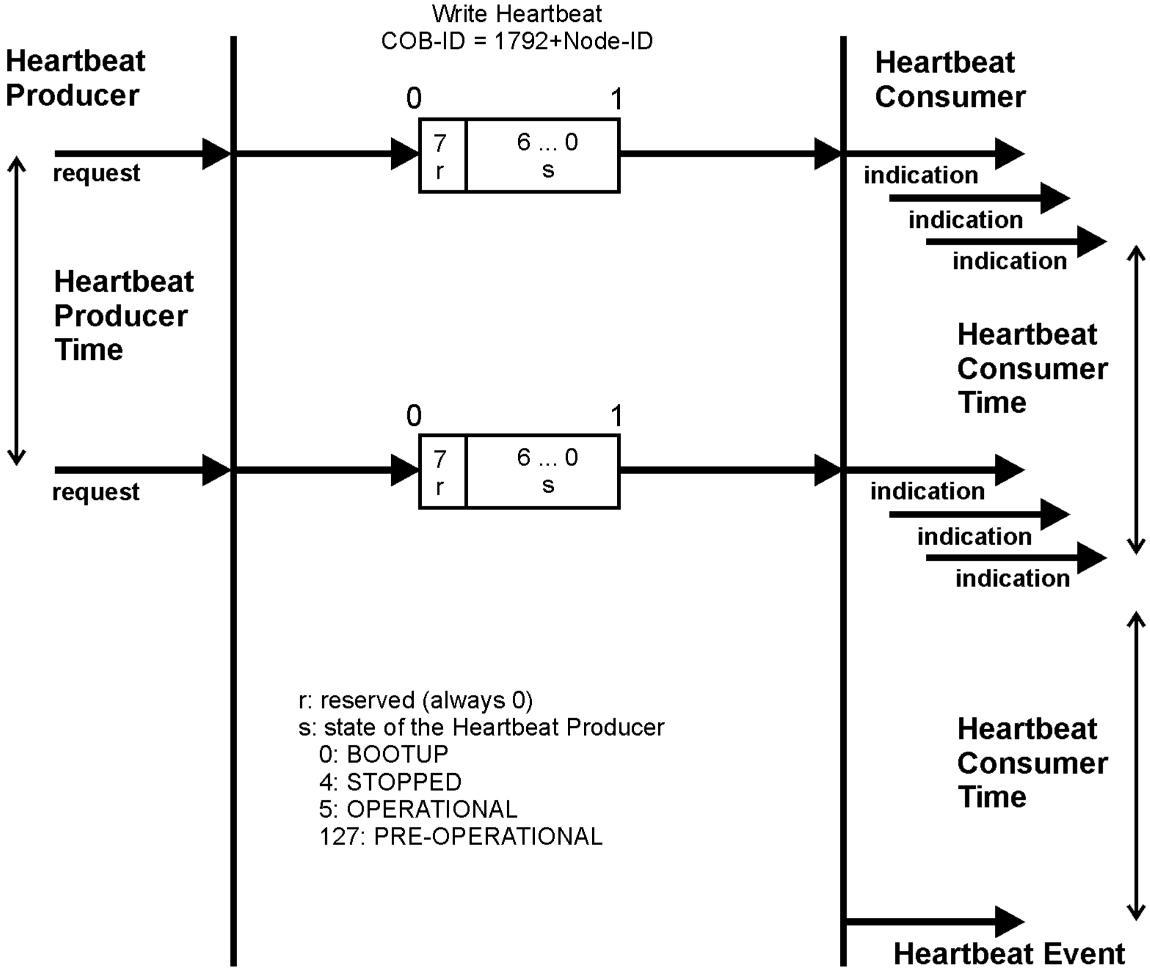
t = toggle Bit, changes its status with every slave telegram
s = status of the NMT slave status machine

Node guarding is carried out by the Master through RTR telegrams with the COB-ID 700h + slave node address.

20.5.4.8 Heartbeat

The Heartbeat Protocol defines an Error Control Service without need for remote frames. A Heartbeat Producer transmits a Heartbeat message cyclically. One or more Heartbeat Consumer receive the indication. The relationship between producer and consumer is configurable via Object 1016h/1017h. The Heartbeat Consumer guards the reception of the Heartbeat within the Heartbeat Consumer Time. If the Heartbeat is not received within the Heartbeat Consumer Time a Heartbeat Event will be generated.

Heartbeat protocol:



20.6 CANopen Drive Profile

20.6.1 CANopen Emergency Messages and Error Codes

Emergency messages are triggered by internal equipment errors. They have a high ID-priority to ensure quick access to the bus. An emergency message contains an error field with pre-defined error/fault numbers (2 bytes), an error register (1byte), the error category (1 byte), and additional information.
Error numbers from 0000h to 7FFFh are defined in the communication or drive profile. Error numbers from FF00h to FFFFh have manufacturer-specific definitions. The following table describes the various error codes:

Error Code	Fault/Warning Code	Description
0x0000	0	Emergency error free
0x3110	523	Bus over voltage
0x3120	-	Bus under voltage
0x3130	503	Phase failure
0x3180	503	Warning: Supply missing phase
0x3210	501	DC link over-voltage
0x3220	502	DC link under-voltage
0x4210	234	Excess temperature, device (control board)
0x4310	235	Excess temperature, drive (heat sink)
0x5113	512	Supply low voltage, U3 = supply +5 V
0x5114	505	Supply low voltage, manufacturer specific: supply 1V2
0x5115	507	Supply low voltage, manufacturer specific: supply 2V5
0x5116	509	Supply low voltage, manufacturer specific: supply 3V3
0x5117	514	Supply low voltage, manufacturer specific: supply 12 V
0x5118	516	Supply low voltage, manufacturer specific: supply -12V
0x5119	518	Supply low voltage, manufacturer specific:supply 3V3 analogue
0x5180	504	Supply overvoltage, manufacturer specific:supply 1V2
0x5181	506	Supply overvoltage, manufacturer specific:supply 2V5
0x5182	508	Supply overvoltage, manufacturer specific:supply 3V3
0x5183	510	Supply overvoltage, manufacturer specific:supply 5V0
0x5184	513	Supply overvoltage, manufacturer specific:supply 12 V
0x5185	104	Supply overvoltage, manufacturer specific:supply -12V
0x5186	517	Supply overvoltage, manufacturer specific:supply 3V3 analogue
0x5510	201	Hardware memory, RAM
0x5530	105	Hardware memory, EEPROM
0x5580	106	Hardware memory, non-volatile memory data
0x5581	202	Hardware memory, external Ram for resident firmware failed
0x5582	203	Hardware memory, code integrity failed for resident firmware
0x5583	102	Hardware memory, resident firmware failed
0x5584	103	Hardware memory, resident FPGA failed
0x5585	104	Hardware memory, operational FPGA failed
0x7180	301	Motor overheat
0x7182	305	Motor open circuit
0x7183	306	Motor short circuit
0x7184	307	Motor brake closed
0x7303	426	Resolver 1 fault
0x7305	417	Incremental sensor 1 fault
0x7380	402	Feedback 1, analogue fault
0x7381	403	Feedback 1, EnDat communication fault
0x7382	404	Feedback 1, illegal hall

Error Code	Fault/Warning Code	Description
0x7383	405	Feedback 1, BiSS watchdog
0x7384	406	Feedback 1, BiSS multi cycle
0x7385	407	Feedback 1, BiSS sensor
0x7386	408	Feedback 1. SFD configuration
0x7387	409	Feedback 1, SFD UART overrun
0x7388	410	Feedback 1, SFD UART frame
0x7389	412	Feedback 1, SFD UART parity
0x738A	413	Feedback 1. SFD transfer timeout
0x738C	415	Feedback 1, SFD mult. corrupt position
0x738D	416	Feedback 1, SFD Transfer incomplete
0x738E	418	Feedback 1, power supply fault
0x738F	401	Feedback 1, failed to set feedback
0x73A0	424	Feedback 2, resolver amplitude low
0x73A1	425	Feedback 2, resolver amplitude high
0x73A2	425	Feedback 2, resolver fault
0x73A3	427	Feedback 2, analogue low
0x73A4	428	Feedback 2, analogue high
0x73A5	429	Feedback 2, incremental low
0x73A6	430	Feedback 2, incremental high
0x73A7	431	Feedback 2, halls
0x73A8	432	Feedback 2, communication
0x73A9	-	Reserved
0x73AA	-	Reserved
0x8130	129	Life Guard Error or Heartbeat Error
0x8311	304	Excess torque
0x8331	524	Torque fault
0x8480	302	Velocity overspeed
0x8580	107	Software limit switch, positive
0x8581	108	Software limit switch, negative
0x8611	439	Following error
0x8780	125	Fieldbus synchronization lost
0xFF00	701	Fieldbus runtime fault
0xFF01	702	Fieldbus communication lost
0xFF02	529	Iu offset limit exceeded
0xFF03	530	Iv offset limit exceeded
0xFF04	521	Stored energy reached critical point
0xFF05	527	Iu detection stuck
0xFF06	528	Iv detection stuck
0xFF07	525	Control output over current
0xFF08	526	Current sensor short circuit
0xFF09	128	Axis dpoles
0xFF0A	531	Power stage fault
0xFF0B	602	Safe torque off
0xFF10	414	Warning: SFD single corrupted position.
0x8380	524	Warning: Drive foldback
0x8387	304	Warning: Motor foldback
0xFF13	438	Warning: Control position deviation
0x8582	107	Warning: Positive software position limit is exceeded.

Error Code	Fault/Warning Code	Description
0x8583	108	Warning: Negative software position limit is exceeded.
0x8684	123	Warning: Motion global warning
0x7786	301	Warning: Motor overheated.
0x4380	234	Warning: Control temperature sensor 1 high
0x4387	235	Warning: Power temperature sensor 1 high.
0x4382	236	Warning: Power temperature sensor 2 high.
0x4393	237	Warning: Power temperature sensor 3 high.
0x4394	240	Warning: Control temperature sensor 1 low.
0x4385	241	Warning: Control temperature sensor 1 low.
0x4396	242	Warning: Power temperature sensor 2 low.
0x4392	243	Warning: Power temperature sensor 3 low.
0x3280	502	Warning: Bus under voltage.
0x3780	503	Warning: Input phase loss.
0x3287	521	Warning: Dynamic Braking I^2T.
0x8787	125	Warning: Fieldbus PLL unlocked.

20.6.2 General Definitions

This chapter describes objects with a general validity (e.g. Object 1000h Device Type). The next section explains the free configuration of Process Data Objects ("free mapping”).

20.6.2.1 General objects

Object 1000h: Device Type (DS301)

This object describes the device type (servo drive) and device functionality (DS402 drive profile). Definition:

MSB		LSB
Additional information		Device profile number
Mode bits	Type	402d=192h
31 24	23 16	15 0

The device profile number is DS402, the type is 2 for drives, the mode bits 28 to 31 are manufacturer specific and may be changed from its actual value of 0. A read access delivers 0x00002192 at the moment.

Index	1000h
Name	device type
Object code	VAR
Data type	UNSIGNED32
Category	mandatory

Access	R/O
PDO mapping	not possible
Value range	UNSIGNED32
Default value	no

Object 1001h: Error register (DS301)

This object is an error register for the device. The device can map internal errors into this byte. It is a part of an Emergency object.

Index	1001h
Name	Error register
Object code	VAR
Data type	UNSIGNED8
Category	mandatory

Access	R/O
PDO mapping	not possible
Value range	UNSIGNED8
Default value	no

Error reasons to be signaled:If a bit is set to 1 the specified error has occurred. The generic error is signaled at any error situation.

Bit	Description	Bit	Description
0	generic error	4	communication error (overrun, error state)
1	current	5	device profile specific
2	voltage	6	reserved (always 0)
3	temperature	7	manufacturer specific

Object 1002h: Manufacturer Status Register (DS301)

The manufacturer status register contains important drive informations.

Index	1002h
Name	Manufacturer Status Register
Object code	VAR
Data type	UNSIGNED32
Category	optional

Access	R/O
PDO mapping	possible
Value range	UNSIGNED32
Default value	no

The following table shows the bit assignment for the status register:

Bit	Description	Bit	Description
0	1 = Movement (positioning, homing) active	16	1 = Homing move active
1	reserved	17	reserved
2	1 = reference switch high (home-position)	18	reserved
3	1 = In Position	19	1 = Emergency stop active
4	reserved	20	reserved
5	reserved	21	reserved
6	reserved	22	reserved
7	reserved	23	1 = Homing move finished
8	Warning active	24	reserved
9	1 = target velocity reached (profile position mode)	25	1 = digital input 1 set
10	reserved	26	1 = digital input 2 set
11	1 = Homing error	27	1 = digital input 3 set
12	reserved	28	1 = digital input 4 set
13	1 = Safety selected	29	1 = digital input hardware enable set
14	1 = Power stage enabled	30	reserved
15	1 = Error state	31	reserved

Object 1003h: Predefined Error Field (DS301)

The object 1003h provides an error history with a maximum size of 10 entries.

Subindex 0 contains the number of errors which have occured since the last reset of the error history, either by startup of the drive or resetting the error history by writing 0 to subindex 0.

A new Emergency-message is written into subindex 1 shifting the old entries one subindex higher. The old content of subindex 8 is lost.

The UNSIGNED32-information written to the subindizes is defined in the field Error Code in the description of the Emergency Messages (=> p. 55).

Index	1003h
Name	pre-defined Error Field
Object code	ARRAY
Data type	UNSIGNED32
Category	optional

Subindex	**0**
Description	Number of entries
Data type	UNSIGNED8
Category	mandatory
Access	R/W
PDO mapping	not possible
Value range	0 to 10
Default value	0

Subindex	**1 to 10**
Description	Standard error field (=> p. 55)
Category	optional
Access	R/O
PDO mapping	not possible
Value range	UNSIGNED32
Default value	no

Object 1005h: COB-ID of the SYNC Message (DS301)

This object defines the COB-Id of the synchronisation object (SYNC).

Index	1005h
Name	COB-ID for the SYNC message
Object code	VAR
Data type	UNSIGNED32
Category	conditional

Access	R/W
PDO mapping	not possible
Value range	UNSIGNED32
Default value	no

Bit coded information:

Bit	Value	Meaning
31 (MSB)	X	—
30	0	Device not generate SYNC message
	1	Device generates SYNC message
29	0	11 Bit ID (CAN 2.0A)
	1	29 Bit ID (CAN 2.0B)
28 to 11	X	—
	0	if Bit 29=0
10 to 0 (LSB)	X	Bit 0 to 10 of SYNC COB-ID

The device does not support the generation of SYNC-messages and only the 11-bit IDs. So the bits 11 to 30 are always 0.

Object 1006h: Communication Cycle Period (DS301)

This object can be used to define the period (in µs) for the transmission of the SYNC telegram.

Index	1006h
Name	Period of the communication cycle
Object code	VAR
Data type	UNSIGNED32
Category	O

Access	R/W
PDO mapping	not possible
Value range	UNSIGNED32
Default value	00h

Object 1008h: Manufacturer Device Name (DS301)

The device name consists of four ASCII characters in the form Yzzz, whereby Y stands for the mains voltage (L, M, H or U, e.g. H for High Voltage) zzz stands for the power stage current.

Index	1008h
Name	Manufacturer Device Name
Object code	VAR
Data type	Visible String
Category	Optional

Access	const
PDO mapping	not possible
Value range	
Default value	no

Object 1009h: Manufacturer Hardware Version

This object will be supported in the future.

Index	1009h
Name	manufacturer hardware version
Object code	VAR
Data type	Visible String
Category	Optional

Access	const
PDO mapping	not possible
Value range	-
Default value	no

Object 100Ah: Manufacturer Software Version (DS301)

The object contains the manufacturer software version (here: the CANopen-part of the drive firmware).

Index	100Ah
Name	Manufacturer Software Version
Object code	VAR
Data type	Visible String
Category	Optional

Access	const
PDO mapping	not possible
Value range	0.01 to 9.99
Default value	no

Object 100Ch: Guard Time (DS301)Response monitoring

The arithmetical product of the Objects 100Ch Guard Time and 100Dh Lifetime Factor is the response monitoring time. The Guard Time is given in milliseconds. The response monitoring is activated with the first Nodeguard object. If the value of the object Guard Time is set to zero, then the response monitoring is inactive.

Index	100Ch
Name	Guard Time
Object code	VAR
Data type	UNSIGNED16
Category	conditional; mandatory, if heartbeat not supported
Access	R/W
PDO mapping	not possible
Value range	UNSIGNED16
Default value	0

Object 100Dh: Lifetime Factor (DS301)

The product of Guard Time and Life Time Factor gives the life time for the nodeguarding protocol. If it’s 0, the protocol is not used.

Index	100Dh
Name	Lifetime Factor
Object code	VAR
Data type	UNSIGNED8
Category	conditional; (mandatory, if heartbeat not supported)
Access	R/W
PDO mapping	not possible
Value range	UNSIGNED8
Default value	0

Object 1010h: Store Parameters (DS301)

This object supports the saving of parameters to a flash EEPROM. Only the subindex 1 for saving of all parameters, which can also be saved in the parameter files via the GUI, is supported.

Index	**1010h**
Name	store parameters (DRV.NVSAVE)
Object code	ARRAY
Data type	UNSIGNED32
Category	optional

Subindex	**0**
Name	number of entries
Object code	VAR
Data type	UNSIGNED8
Category	mandatory
Access	R/O
PDO Mapping	not possible
Value range	1
Default value	1

Subindex	**1**
Name	save all parameters
Object code	VAR
Data type	UNSIGNED32
Category	mandatory
Access	R/W
PDO Mapping	not possible
Value range	UNSIGNED32
Default value	1

Data definition:

Bit	Value	Meaning
31 to 2	0	reserved (=0)
1	0	Device does not save parameters autonomously
	1	Device does save parameters autonomously
0	0	Device does not save parameters on command
	1	Device does not save parameters on command

By read access to subindex 1 the drive provides information about its storage functionality.

This drive provides a constant value of 1 by read access, i.e. all parameters can be saved by writing to Object 1010 sub 1. In general the drive does not save parameters autonomously with the exception of e.g. the special treatment of the homing of multiturn absolute encoders.

Storing of parameters is only done if a special signature ("save") is written to subindex 1. "save" is equivalent to the unsigned32 - number 65766173h.

Object 1014h: COB-ID for Emergency Message (DS301)

This object defines the COB-ID of the Emergency message.

Index	**1014h**
Name	COB-ID emergency message
Object code	VAR
Data type	UNSIGNED32
Category	conditional; mandatory, if Emergency is supported

Access	R/O
PDO mapping	not possible
Value range	UNSIGNED32
Default value	80h + Node - ID

Object 1016h: Consumer Heartbeat Time

The consumer heartbeat time defines the expected heartbeat cycle time (ms) and must be higher than the corresponding producer heartbeat time configured on the device producing this heartbeat. Monitoring starts after the reception of the first heartbeat. If the consumer heartbeat time is 0 ms the corresponding entry is not used.

Index	**1016h**
Name	consumer heartbeat time
Object code	ARRAY
Data type	UNSIGNED32
Category	optional

Subindex	**0**
Description	number of entries
Data type	UNSIGNED8
Category	mandatory
Access	R/O
PDO Mapping	not possible
Value range	1
Default value	1

Subindex	**1**
Description	Consumer heartbeat time
Category	mandatory
Access	R/W
PDO Mapping	not possible
Value range	unsigned 32
Default value	no

Definition of the entry value of Subindex 1

	MSB		LSB
Value	reserved (value: 00)	Node-ID	heartbeat time
Encoded as	-	UNSIGNED8	UNSIGNED16
Bit	31 24	23 16	15 0

Object 1017h: Producer Heartbeat Time

The producer heartbeat time defines the cycle time of the heartbeat in ms. If it’s 0, it is not used.

Index	**1017h**
Name	Producer heartbeat time
Object code	VAR
Data type	UNSIGNED16
Category	conditional; mandatory, if guarding is not supported

Access	R/W
PDO mapping	not possible
Value range	UNSIGNED16
Default value	0

Object 1018h: Identity Object (DS301)

The Identity Object contains general device information.

Index	**1018h**
Name	Identity Object
Object code	RECORD
Data type	Identity
Category	mandatory

Subindex	**0**
Description	Number of entries
Data type	UNSIGNED8
Category	mandatory
Access	R/O
PDO mapping	not possible
Value range	1 to 4
Default value	4

Subindex 1 is a unique number for a device manufacturer.

Subindex	**1**
Description	Vendor ID
Category	mandatory
Access	R/O
PDO mapping	not possible
Value range	UNSIGNED32
Default value	0x6Ah (Danaher Motion)

Subindex 2 contains four ASCII - characters, which determine the voltage range and current class of the device. The voltage range is one character L, M or H for low, medium and high voltage. The next three characters are showing the continuos current of the drive.

Subindex	**2**
Description	Product Code
Category	optional
Access	R/O
PDO mapping	not possible
Value range	e.g. M006 for an MV6 drive
Default value	no

Subindex 3 consists of two revision numbers:

- the major revision number in the upper word containing the CAN-version
- the minor revision number is not used in the AKD. The firmware version can be retrieved as a string via object 0x100A or as numbers voa object 0x2018 subindex 1 to 4.

E.g. a value of 0x0014 0000 means CAN-version 0.20.

Subindex	**3**
Description	Revision Number
Category	optional
Access	R/O
PDO mapping	not possible
Value range	UNSIGNED32
Default value	no

Subindex 4 gives the serial number of the drive. This number contains the following information in it:

- bits 0..14: Board serial number (production in week of year)
- bits 15..20: week of production
- bits 21..24: year of production - 2009
- bits 25..31: ASCII-code of MFR-ID

Subindex	**4**
Description	Serial Number
Category	optional
Access	R/O
PDO mapping	not possible
Value range	UNSIGNED32
Default value	no

Object 1026h: OS Prompt

The OS prompt is used to build up an ASCII - communication channel to the drive.

Index	**1026h**
Name	OS Prompt
Object code	ARRAY
Data type	UNSIGNED8
Category	optional

Subindex	**0**
Description	Number of entries
Data type	UNSIGNED8
Category	mandatory
Access	R/O
PDO mapping	not possible
Value range	2
Default value	2

Subindex 1 is used to send one character to the drive.

Subindex	**1**
Description	StdIn
Category	mandatory
Access	W
PDO mapping	possible
Value range	UNSIGNED8
Default value	—

Subindex 2 is used to receive one character from the drive.

Subindex	**2**
Description	StdOut
Category	mandatory
Access	R/O
PDO mapping	possible
Value range	UNSIGNED8
Default value	0

20.6.2.2 Manufacturer specific objects

Object 2014-2017h: 1st-4th Mask 1 to 4 for Transmit-PDO

In order to reduce the bus loading with event-triggered PDOs, masking can be used to switch off the monitoring for individual bits in the PDO. In this way it can be arranged, for instance, that actual position values are only signaled once per turn.
This Object masks the PDO-channels 1 to 4. If only two bytes have been defined in a PDO, then it masks just two bytes, although 4 bytes of mask information have been transmitted.
An activated bit in the mask means that monitoring is active for the corresponding bit in the PDO.

Index	**2014h** **2015h** **2016h** **2017h**
Name	tx_mask 1 to 4
Object code	ARRAY
Data type	UNSIGNED32

Subindex	**1**
Description	tx_mask1 to 4_low
Mode	independent
Access	R/W
PDO mapping	not possible
Unit	—
Value range	UNSIGNED32
Default value	FFFFFFFFh

Subindex	**2**
Description	tx_mask1 to 4_high
Mode	independent
Access	R/W
PDO mapping	not possible
Unit	—
Value range	UNSIGNED32
Default value	FFFFFFFFh

Object 2018h: Firmware Version

This object gives all information regarding the firmware version.
Example: Firmware version M_01_00_01_005 would show the numbers 1, 0, 1, 5 in the sub-indices 1 to 4.

Index	**2018h**
Name	firmware version
Object code	ARRAY
Data type	UNSIGNED16

Subindex	**1**
Description	major version
Mode	independent
Access	R/O
PDO mapping	not possible
Unit	—
Value range	UNSIGNED16
Default value	0

Subindex	**2**
Description	minor version
Mode	independent
Access	R/O
PDO mapping	not possible
Unit	—
Value range	UNSIGNED16
Default value	0

Subindex	**3**
Description	revision
Mode	independent
Access	R/O
PDO mapping	not possible
Unit	—
Value range	UNSIGNED16
Default value	0

Subindex	**4**
Description	branch revision
Mode	independent
Access	R/O
PDO mapping	not possible
Unit	—
Value range	UNSIGNED16
Default value	0

Object 2026h: ASCII Channel

This object is used to build up an ASCII - communication channel to the drive with 4-byte ASCII-strings.

Index	**2026h**
Name	ASCII Channel
Object code	ARRAY
Data type	Visible String
Category	optional

Subindex	**0**
Description	Number of entries
Data type	UNSIGNED8
Category	mandatory
Access	R/O
PDO mapping	not possible
Value range	2
Default value	2

Subindex 1 is used to send four ASCII-characters to the drive.

Subindex	**1**
Description	Command
Category	mandatory
Access	wo
PDO mapping	no
Value range	Visible String
Default value	—

Subindex 2 is used to receive four characters from the drive.

Subindex	**2**
Description	Response
Category	mandatory
Access	R/O
PDO mapping	no
Value range	Visible String
Default value	-

Object 20A0h: Latch position 1, positive edge

This object is used to output the position or a time, depending on CAP0.MODE, at which the first positive edge occurred on a signal, which can be configured with the command CAP0.TRIGGER. The latch enable must be active for that purpose(see object 20A4 and 20A5). With CAP0.MODE = 3 the latched position of the encoder index pulse is transferred via this object.

Index	**20A0h**
Name	Latch position 1, positive edge, CAP0.PLFB Time capture, CAP0.T
Object code	VAR
Data type	INTEGER32
Category	optional

Access	R/O
PDO mapping	possible
Value range	INTEGER32
Default value	0

Object 20A1h: Latch position 1, negative edge

This object is used to output the position or a time, depending on CAP0.MODE, at which the first negative edge occurred on a signal, which can be configured with the command CAP0.TRIGGER. The latch enable must be active for that purpose(see object 20A4 and 20A5).

Index	**20A1h**
Name	Latch position 1, negative edge, CAP0.PLFB Time capture, CAP0.T
Object code	VAR
Data type	INTEGER32
Category	optional

Access	R/O
PDO mapping	possible
Value range	INTEGER32
Default value	0

Object 20A2h: Latch position 2, positive edge

This object is used to output the position or a time, depending on CAP1.MODE, at which the first positive edge occurred on a signal, which can be configured with the command CAP1.TRIGGER. The latch enable must be active for that purpose(see object 20A4 and 20A5).

Index	**20A2h**
Name	Latch position 2, positive edge, CAP1.PLFB Time capture, CAP1.T
Object code	VAR
Data type	INTEGER32
Category	optional

Access	R/O
PDO mapping	possible
Value range	INTEGER32

Default value	0

Object 20A3h: Latch position 2, negative edge

This object is used to output the position or a time, depending on CAP0.MODE, at which the first negative edge occurred on a signal, which can be configured with the command CAP0.TRIGGER. The latch enable must be active for that purpose(see object 20A4 and 20A5).

Index	**20A3h**
Name	Latch position 2, negative edge, CAP1.PLFB Time capture, CAP1.T
Object code	VAR
Data type	INTEGER32
Category	optional
Access	R/O
PDO mapping	possible
Value range	INTEGER32
Default value	0

Object 20A4h: Latch Control Register

The latch control register is used to enable the latch monitoring of the capture engines 0 and 1. The latch is enabled with a 1 signal and disabled with a 0 signal. Whether or not a latch event has occurred can be recognised by the latch status register (object 20A5).

Index	**20A4h**
Name	Latch Control Register
Object code	VAR
Data type	UNSIGNED16
Category	optional
Access	rww
PDO mapping	possible
Value range	0 to 15
Default value	0

Bit	Value (bin)	Value (hex)	Description
0	00000000 00000001	xx01	Enable extern latch 1 (positive rise)
1	00000000 00000010	xx02	Enable extern latch 1 (negative rise)
2	00000000 00000100	xx04	Enable extern latch 2 (positive rise)
3	00000000 00001000	xx08	Enable extern latch 2 (negative rise)
4	00000000 00010000	xx10	Enable latch of encoder index pulse
5 to 7			Reserve
8	00000001 00000000	01xx	Read external latch 1 (positive rise)
9	00000010 00000000	02xx	Read external latch 1 (negative rise)
10	00000011 00000000	03xx	Read external latch 2 (positive rise)
11	00000100 00000000	04xx	Read external latch 2 (negative rise)
12	00000101 00000000	05xx	Read latched position of encoder index pulse
13 to 15			Reserve

Object 20A5h: Latch Status Register

The latch status register is used to look for the states of the capture engines 0 and 1.

Index	**20A5h**
Name	Latch Status Register
Object code	VAR
Data type	UNSIGNED16
Category	optional

Access	rwr
PDO mapping	possible
Value range	-
Default value	0

Bit	Value (bin)	Value (hex)	Description
0	00000000 00000001	zz01	External latch 1 valid (positive rise)
1	00000000 00000010	zz02	External latch 1 valid (negative rise)
2	00000000 00000100	zz04	External latch 2 valid (positive rise)
3	00000000 00001000	zz08	External latch 2 valid (negative rise)
4	00000000 00010000	z10	Latched position of encoder index pulse valid (positive rise)
5 to 7			Reserve
8 to 11	00000001 00000000	z1zz	Acknowledge value external latch 1 (positive rise)
	00000010 00000000	z2zz	Acknowledge value external latch 1 (negative rise)
	00000011 00000000	z3zz	Acknowledge value external latch 2 (positive rise)
	00000100 00000000	z4zz	Acknowledge value external latch 2 (negative rise)
	00000101 00000000	z5zz	Acknowledge value of latched position of encoder index pulse (positive rise)
12 to 15	00010000 00000000	1zzz	State Digital Input 4
	00100000 00000000	2zzz	State Digital Input 3
	01000000 00000000	4zzz	State Digital Input 2
	10000000 00000000	8zzz	State Digital Input 1

Object 20A6h: Latch position 1, positive or negative edge

This object is used to output the position or a time, depending on CAP0.MODE, at which the first positive or negative edge occurred on a signal, which can be configured with the command CAP0.TRIGGER.

The latch enable must be active for that purpose (see object 20A4 and 20A5).

Index	**20A6h**
Name	Latch position 1, positive or negative, CAP0.PLFB
Object code	VAR
Data type	INTEGER32
Category	optional

Access	ro
PDO mapping	possible
Value range	INTEGER32
Default value	0

Object 20B8h: Reset of changed input information

This object is used in PDOs to reset the state change information for the digital inputs shown in the Bits 24 to 30 in the object 60FD. Bit 0 to 6 are used to reset the information of the digital input 1 to 7.

Index	**20B8h**
Name	Reset of changed input information
Object code	VAR
Data type	UNSIGNED16
Category	optional

Access	rw
PDO mapping	possible
Value range	UNSIGNED16
Default value	0

20.6.2.3 Profile specific objects

Object 60FDh: Digital inputs (DS402)

This index defines simple digital inputs for drives. The manufacturer bits 16 to 22 are used to mirror the digital inputs 1 to 7. The manufacturer bits 24 to 30 are used to show the change of the state of the digital inputs 1 to 7.

Index	**60FDh**
Name	digital inputs
Object code	VAR
Data type	UNSIGNED32
Category	optional

Access	R/O
PDO mapping	possible
Value range	UNSIGNED32
Default value	0

31 16	15 4	3	2	1	0
manufacturer specific	interlock	interlock	home switch	pos. limit switch	neg. limit switch
MSB					LSB

Object 60FEh: Digital outputs (DS402)

This index defines simple digital outputs for drives. The manufacturer bits 16 and 17 are used to mirror the digital outputs 1 and 2.

Index	**60FEh**
Name	digital outputs
Object code	Array
Data type	UNSIGNED32
Category	optional

Subindex	**0**
Description	number of entries
Category	mandatory
Access	R/O
PDO mapping	not possible
Value range	2
Default value	2

Subindex	**1**
Description	physical outputs
Category	mandatory
Access	R/W
PDO mapping	possible
Value range	UNSIGNED32
Default value	0

Subindex	**2**
Description	bit mask
Category	optional
Access	R/W
PDO mapping	possible
Value range	UNSIGNED32
Default value	0

31 18	17	16	15 1	0
manufacturer specific	DOUT2	DOUT1	reserved	set brake
MSB				LSB

Object 6502h: Supported drive modes (DS402)

A drive can support more then one and several distinct modes of operation. This object gives an overview of the implemented operating modes in the device. This object is read only.

Index	**6502h**
Name	supported drive modes
Object code	VAR
Data type	UNSIGNED32
Category	optional
Access	R/O
PDO mapping	possible
Value range	UNSIGNED32
Default value	0x65 (ip hm pv pp)

31 16	15 7	6	5	4	3	2	1	0
manufacturer specific	reserved	ip	hm	reserved	tq	pv	vl	pp
MSB								LSB

20.6.3 PDO Configuration

PDOs are used for process data communication. There are distinguished two types of PDOs: Receive PDOs (RPDOs) and transmit PDOs (TPDOs).
The content of the PDOs is pre-defined (see descriptions on pages and). If the data content is not appropriate for a special application the data objects in the PDOs can be remapped freely.

One data entry in the PDOs looks like this:

MSB		LSB
index (16 bit)	Subindex (8 bit)	data length in bits (8 bit)

The configuration procedure for a free mapping of a PDO looks like this (example for TPDO1):

1. Stop possible transmission of the PDO

COB-ID	Control byte	Index		Sub-	Data	Comment
		Low byte	High byte	index		
601	23	´00	18	01h	81 01 00 C0	Switch-off COB-Id

2. Delete the actual mapping of the PDO by writing a 0 to the subindex 0 of the mapping Object

COB-ID	Control byte	Index		Sub-	Data	Comment
		Low byte	High byte	index		
601	2F	´00	1A	00h	00 00 00 00	Delete actual mapping

3. Build the mapping with object dictionary objects (see page)) which are mappable, e.g.

COB-ID	Control byte	Index		Sub-	Data	Comment
		Low byte	High byte	index		
601	23	00	1A	01h	10 00 41 60	1st entry: CANopen statusword with 16 bits
601	23	00	1A	02h	20 00 02 10	2nd entry: Manufacturer status with 32 bits

3. Write the number of mapped objects to subindex 0 of the mapping Object.

COB-ID	Control byte	Index		Sub-	Data	Comment
		Low byte	High byte	index		
601	2F	00	1A	00h	02 00 00 00	Check for the right number of entries

Mapping shall be done before the network management is switched to OPERATIONAL.

20.6.3.1 Receive PDOs (RXPDO)

Four Receive PDOs can be configured in the drive:

- - configuration of the communication (Objects 1400-1403h)
- - configuration of the PDO-contents (mapping, Objects 1600-1603h)

Objects 1400-1403h: 1st - 4th RXPDO communication parameter (DS301)

Index	**1400h to 1403h for RXPDO 1 to 4**
Name	receive PDO parameter
Object code	RECORD
Data type	PDO CommPar
Category	mandatory

Defined sub-indices

Subindex	**0**
Name	number of entries
Data type	UNSIGNED8
Category	mandatory
Access	R/O
PDO Mapping	not possible
Value Range	2
Default Value	2

Subindex	**1**
Name	COB-ID used by PDO
Category	mandatory
Access	R/W
PDO Mapping	not possible
Value Range	UNSIGNED32
Default Value	Index 1400h: 200h + Node-ID Index 1401h: 300h + Node-ID Index 1402h: 400h + Node-ID Index 1403h: 500h + Node-ID

Subindex 1 contains the COB-Id of the PDO as a bit coded information:

Bit	Value	Meaning
31	0	PDO exists/is valid
	1	PDO does not exist/is not valid
30	0	RTR allowed on this PDO, not to be used (Can in Automation organisation)
	1	RTR not allowed on this PDO
29	0	11 bit-ID (CAN 2.0A)
	1	29 bit-ID (CAN 2.0B), not supported
28 to 11	X	Identifier-bits with 29 bit-ID, not relevant
10 to 0	X	Bits 10-0 of COB-ID

Subindex	2
Name	transmission type
Category	mandatory
Access	R/W
PDO Mapping	not possible
Value Range	UNSIGNED8
Default Value	FFh

Subindex 2 contains the transmission type of the PDO. There are two ways of setting:

- the value FFh or 255 for event-triggered PDO, which is directly interpreted by reception and taken into actions,
- values from 0 to 240, which cause a SYNC-telegram-controlled interpretation of the PDO contents. Values of 1 to 240 mean, that 0 to 239 SYNC-telegrams are ignored, before one is interpreted. The value 0 means, that only the next SYNC-telegram is interpreted.

Objects 1600-1603h: 1st - 4th RXPDO mapping parameter (DS301)

Index	1600h - 1603h for RXPDO 1 .. 4
Name	receive PDO mapping
Object Code	RECORD
Data Type	PDO Mapping
Category	mandatory

Subindex	0
Name	number of entries
Data type	UNSIGNED8
Category	mandatory
Access	R/W
PDO Mapping	not possible
Value Range	0: PDO is not active 1 - 8: PDO activated, mappings are taken only byte-wise
Default Value	PDO1: 1 PDO2: 2 PDO3: 2 PDO4: 2

Subindex	1 - 8
Name	PDO - mapping for the n-th application object
Category	Conditional, depends on number and size of object be mapped
Access	R/W
PDO Mapping	not possible
Value Range	UNSIGNED32
Default Value	See below

Default RXPDO definition

RXPDO 1:

Subindex	Value	Meaning
0	1	One PDO-mapping entry
1	60 40 00 10	Control word

RXPDO 2:

Subindex	Value	Meaning
0	2	Two PDO-mapping entries
1	60 40 00 10	Control word
2	60 60 00 08	Modes of Operation

RXPDO 3:

Subindex	Value	Meaning
0	2	Two PDO-mapping entries
1	60 40 00 10	Control word
2	60 7A 00 20	Target Position (Mode PP)

RXPDO 4:

Subindex	Value	Meaning
0	2	Two PDO-mapping entries
1	60 40 00 10	Control word
2	60 FF 00 20	Target Velocity (Mode PV)

20.6.3.2 Transmit PDOs (TXPDO)

Four Transmit PDOs can be configured in the drive:

- - configuration of the communication (Objects 1800-1803h)
- - configuration of the PDO-contents (mapping, Objects 1A00-1A03h)

Objects 1800-1803h: 1st - 4th TXPDO communication parameter (DS301)

Index	**1800h to 1803h for TXPDO 1 to 4**
Name	transmit PDO parameter
Object code	RECORD
Data type	PDO CommPar
Category	mandatory

Subindex	**0**
Name	number of entries
Data type	UNSIGNED8
Category	mandatory
Access	R/O
PDO Mapping	not possible
Value Range	5
Default Value	5

Subindex	**1**
Name	COB-ID used by PDO
Category	mandatory
Access	R/W
PDO Mapping	not possible
Value Range	UNSIGNED32
Default Value	Index 1800h: 180h + Node-IDIndex 1801h: 280h + Node-ID Index 1802h: 380h + Node-ID Index 1803h: 480h + Node-ID

Subindex	**2**
Name	transmission type
Category	mandatory
Access	R/W
PDO Mapping	not possible
Value Range	UNSIGNED8
Default Value	FFh

Subindex	**3**
Name	inhibit time
Category	optional
Access	R/W
PDO Mapping	not possible
Value Range	UNSIGNED16 (n*1/10ms)
Default Value	0h

Subindex	**4**
Name	reserved
Category	optional
Access	R/W
PDO Mapping	not possible
Value Range	0
Default Value	0

Subindex	**5**
Name	event timer
Category	optional
Access	R/W
PDO Mapping	not possible
Value Range	UNSIGNED16 (0=not used, n*1/10ms)
Default Value	0h

Subindex 1 contains the COB-Id of the PDO as a bit coded information:

Bit-Number	Value	Meaning
31	0	PDO exists/is valid
	1	PDO does not exist/is not valid
30	0	RTR allowed on this PDO, not supported
	1	RTR not allowed on this PDO, not supported
29	0	11 bit-ID (CAN 2.0A)
	1	29 bit-ID (CAN 2.0B), not supported
28 to 11	X	Identifier-bits with 29 bit-ID, not relevant
10 to 0	X	Bits 10-0 of COB-ID

Subindex 2 contains the transmission type of the PDO. There are two ways of setting:

- A value of FFh or 255d for an event-triggered PDO, which is sent immediately after a change in the mapped application objects. Setting of Subindex 3 or 5 has an influence on the sending of a PDO. With Subindex 3 you can configure, in which minimal time the so configured Transmit-PDOs are sent, if PDO-data contents change (reduction of bus-load). With Subindex 5 (event time) a timer is used, which is resetted with every event-triggered sending of this PDO. If there is no change of the PDO-content in this time, the PDO is sent caused by this timer event.
- values from 0 to 240 cause a SYNC-Telegram controlled sending of the PDO.
  Values from 1 to 240 define how often the SYNC-telegram leads to a sending of a PDO.
  The value 0 means, that only the next SYNC-telegram leads to a sending of the so configured PDOs.

Objects 1A00-1A03h: 1st - 4th TXPDO mapping parameter (DS301)

Index	**1A00h - 1A03h for TXPDO 1 .. 4**
Name	transmit PDO mapping
Object Code	RECORD
Data Type	PDO Mapping
Category	mandatory

Subindex	**0**
Name	number of mapped application objects in PDO
Data type	UNSIGNED8
Category	mandatory
Access	R/W
PDO Mapping	not possible
Value Range	0: PDO is not active 1 - 8: PDO activated, mappings are taken only byte-wise
Default Value	PDO1: 1 PDO2: 2 PDO3: 2 PDO4: 2

Subindex	**1 - 8**
Name	PDO - mapping for the n-th application object
Category	Conditional, depends on number and size of object be mapped
Access	R/W
PDO Mapping	not possible
Value Range	UNSIGNED32
Default Value	See below

Default TXPDO definition

TXPDO 1:

Subindex	Value	Meaning
0	1	One PDO-mapping entry
1	60 41 00 10	Status word

TXPDO 2:

Subindex	Value	Meaning
0	2	Two PDO-mapping entries
1	60 41 00 10	Status word
2	60 61 00 08	Modes of Operation display

TXPDO 3:

Subindex	Value	Meaning
0	2	Two PDO-mapping entries
1	60 41 00 10	Status word
2	60 64 00 20	Position actual value

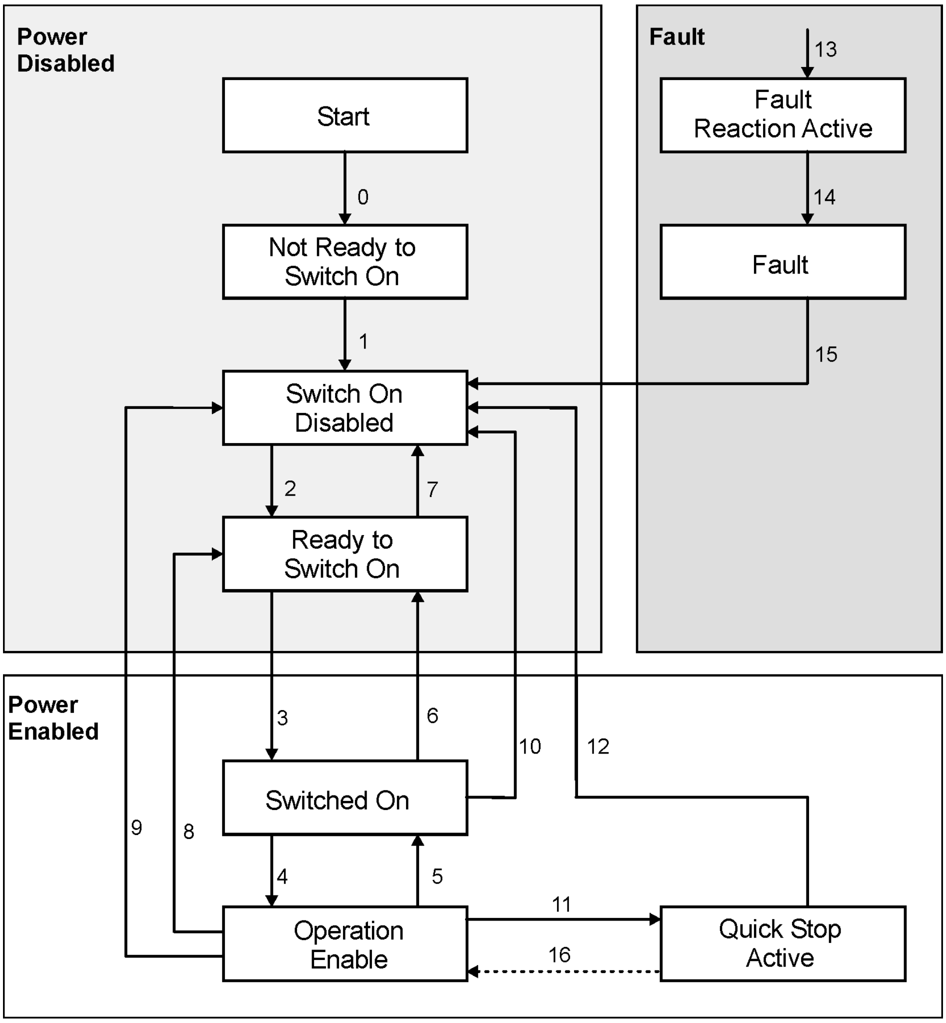
TXPDO 4:

Subindex	Value	Meaning
0	2	Two PDO-mapping entries
1	60 41 00 10	Status word
2	60 6C 00 20	Velocity actual value

20.6.4 Device Control (dc)

The device control of the AKD can be used to carry out all the motion functions in the corresponding modes. The control of the AKD is implemented through a mode-dependent status machine. The status machine is controlled through the control word (=> p. 91).
The mode setting is made through the object "Modes of Operation" (=> p. 94). The states of the status machine can be revealed by using the status word (=> p. 92).

20.6.4.1 Status Machine (DS402)



States of the Status Machine

State	Description
Not Ready for Switch On	AKD is not ready to switch on, there is no operational readiness (BTB/RTO) signaled from the controller program.
Switch On Disable	AKD is ready to switch on, parameters can be transferred, the DC-link voltage can be switched on, motion functions cannot be carried out yet.
Ready to Switch On	DC-link voltage may be switched on, parameters can be transferred, motion functions cannot be carried out yet.
Switched On	DC-link voltage must be switched on, parameters can be transferred, motion functions cannot be carried out yet, output stage is switched on (enabled).
Operation Enable	No fault present, output stage is enabled, motion functions are enabled.
Quick Stop Active	Drive has been stopped with the emergency ramp, output stage is enabled, motion functions are not enabled.
Fault Reaction Active	A fault has occured and the drive is stopped with the quickstop ramp.
Fault	A fault is active, the drive has been stopped and disabled.

Transitions of the status machine

The state transitions are affected by internal events (e.g. switching off the DC-link voltage) and by the flags in the control word (bits 0,1,2,3,7).

Transition	Event	Action
0	Reset	Initialization
1	Initialization completed successfully. AKD is ready to operate.	none
2	Bit 1 Disable Voltage and Bit 2 Quick Stop are set in the control word (Shutdown command). DC-link voltage may be present.	none
3	Bit 0 is also set (Switch On command)	Output stage is switched on (enabled), provided that the hardware enable is present (logical AND). Drive has torque.
4	Bit 3 is also set (Enable Operation command)	Motion function is enabled, depending on the mode that is set.
5	Bit 3 is canceled (Disable Operation command)	Motion function is inhibited. Drive is stopped, using the relevant ramp (mode-dependent). The present position is maintained.
6	Bit 0 is canceled (Shutdown command)	Output stage is disabled. Drive has no torque.
7	Bits 1 and 2 are canceled (Quick Stop/Disable Voltage command)	none
8	Bit 0 is canceled (Shutdown command)	Output stage is disabled. Drive has no torque.
9	Bit 1 is canceled (Disable Voltage command)	Output stage is disabled. Drive has no torque.
10	Bits 1 and 2 are canceled (Quick Stop/Disable Voltage command)	Output stage is disabled. Drive has no torque.
11	Bit 2 is canceled (Quick Stop command)	Drive is stopped with the emergency braking ramp. The output stage remains enabled. Setpoints are canceled (motion block number, digital setpoint, speed for jogging or homing). Bit 2 must be set again before any further motion tasks can be performed.
12	Bit 1 is canceled (‘Disable Voltage’ command)	Output stage is disabled. Drive has no torque.
13	Fault reaction active	Execute appropriate fault reaction
14	Fault reaction is completed	Drive function is disabled. The power section may be switched off.
15	"Fault Reset" command received from host	A reset of the fault condition is carried out if no fault exists currently on the drive.After leaving the state Fault the Bit7 'Reset Fault' of the controlword must be cleared by the host
16	Bit 2 is set	Motion function is enabled again.

NOTE **If the drive is operated through the control word/status word, then no control commands may be sent through another communication channel (RS232, CANopen, ASCII channel, Option board).**

20.6.4.2 Object Description

Object 6040h: Control word (DS402)

The control commands are built up from the logical combination of the bits in the control word and external signals (e.g enable output stage). The definitions of the bits are shown below:

Index	**6040h**
Name	control word
Object code	VAR
Data type	UNSIGNED16
Access	R/W
PDO mapping	possible
Unit	—
Value range	0 to 65535
EEPROM	no
Default value	0

Bit assignment im control word

Bit	Name	Bit	Name
0	Switch on	8	Pause/halt
1	Disable Voltage	9	reserved
2	Quick Stop	10	reserved
3	Enable Operation	11	reserved
4	Operation mode specific	12	reserved
5	Operation mode specific	13	Manufacturer-specific
6	Operation mode specific	14	Manufacturer-specific
7	Reset Fault (only effective for faults)	15	Manufacturer-specific

Commands in the control word

Command	Bit 7 Fault Reset	Bit 3 Enable Operation	Bit 2 Quick Stop	Bit 1 Disable Voltage	Bit 0 Switch on	Transitions
Shutdown	X	X	1	1	0	2, 6, 8
Switch on	X	X	1	1	1	3
Disable Voltage	X	X	X	0	X	7, 9, 10, 12
Quick Stop	X	X	0	1	X	7, 10, 11
Disable Operation	X	0	1	1	1	5
Enable Operation	X	1	1	1	1	4, 16
Fault Reset	1	X	X	X	X	15

Bits marked by an X are irrelevant.

Mode-dependent bits in the control word

The following table shows the mode-dependent bits in the control word. Only manufacturer-specific modes are supported at present. The individual modes are set by Object 6060_h Modes of operation.

Operation mode	No.	Bit 4	Bit 5	Bit 6
Profile Position Mode (pp)	01h	new_setpoint	change_set_immediately	absolute/relative
Profile Velocity Mode (pv)	03h	reserved	reserved	reserved
Profile Torque Mode (tq)	04h	reserved	reserved	reserved
Homing Mode (hm)	06h	homing_operation_start	reserved	reserved
Interpolated Position Mode (ip)	07h	Enable Interpolation	reserved	reserved
Cyclic sync position Mode (csp)	08h	reserved	reserved	reserved

Description of the remaining bits in the control word

The remaining bits in the control word are described below.

Bit 8 Pause If Bit 8 is set, then the drive halts (pauses) in all modes. The setpoints (speed for homing or jogging, motion task number, setpoints for digital mode) for the individual modes are retained.
Bit 9,10 These bits are reserved for the drive profile (DS402).
Bit 13, 14, 15 These bits are manufacturer-specific, and reserved at present.

Object 6041h: Status word (DS402)

The momentary state of the status machine can be read out with the aid of the status word.

Index	**6041h**
Name	Status word
Object code	VAR
Data type	UNSIGNED16

Access	R/W
PDO mapping	possible
Unit	—
Value range	0 to 65535
EEPROM	yes
Default value	0

Bit assignment in the status word

Bit	Name	Bit	Name
0	Ready to switch on	8	Manufacturer-specific (reserved)
1	Switched on	9	Remote (always 1)
2	Operation enabled	10	Target reached
3	Fault	11	Internal limit active
4	Voltage enabled	12	Operation mode specific (reserved)
5	Quick stop	13	Operation mode specific (reserved)
6	Switch on disabled	14	Manufacturer-specific (reserved)
7	Warning	15	Manufacturer-specific (reserved)

States of the status machine

State	Bit 6 switch on disabled	Bit 5 quick stop	Bit 3 fault	Bit 2 operation enabled	Bit 1 switched on	Bit 0 ready to switch on
Not ready to switch on	0	X	0	0	0	0
Switch on disabled	1	X	0	0	0	0
Ready to switch on	0	1	0	0	0	1
Switched on	0	1	0	0	1	1
Operation enabled	0	1	0	1	1	1
Fault	0	X	1	0	0	0
Fault reaction active	0	X	1	1	1	1
Quick stop active	0	0	0	1	1	1

Bits marked by X are irrelevant

Description of the remaining bits in the status word

Bit 4: voltage_enabled The DC-link voltage is present if this bit is set.

Bit 7: warning There are several possible reasons for Bit 7 being set and this warning being produced. The reason of a warning can be seen by the Error code of the Emergency message, which is sent on the bus caused by this warning.

Bit 9: remote is always set to 1, i.e. the drive can always communicate and be influenced via the RS232 - interface.

Bit 10: target_reached This is set when the drive has reached the target position.

Bit 11: internal_limit_active This bit specifies that a movement was or is limited. In different modes, different warnings cause the bit to be set. The following assignments exist:

Mode of operation	Warnings which set Bit 11
all	n04, n06, n07, n10, n11, n14
0x1 (PP), 0x88	n03, n08, n09, n20

Object 6060h: Modes of Operation (DS402)

This object is used to set the mode, which can be read out by Object 6061h. Two types of operating mode are used:

- manufacturer-specific operating modes
- operating modes as per CANopen drive profile DS402

These operating modes are defined in the CANopen drive profile DS402. After the mode has been changed, the corresponding setpoint must be set once more (for instance, the homing velocity in the mode homing_setpoint). If the position or jogging mode is stored, then the Homing mode is set after a RESET of the drive.

NOTE	**An operating mode only becomes valid when it can be read by Object 6061h.**
WARNING	**Never change the mode while the motor is running! The drive could move unexpectedly. When the drive is enabled, a mode change is only permissible at zero speed. Set the speed setpoint to 0 before changing over.**

Index	**6060h**
Name	mode of operation
Object code	VAR
Data type	INTEGER8

Category	mandatory
Access	R/W
PDO mapping	possible
Value range	1, 3, 4, 6, 7, 8
Default value	—

Supported modes (negative values are manufacturer specific modes):

Value (hex)	Mode
1	Profile position mode
3	Profile velocity mode
4	Profile torque mode
6	Homing mode
7	Interpolated position mode
8	Cyclic sync position mode

Object 6061h: Modes of Operation Display (DS402)

This object can be used to read the mode that is set by Object 6060h. An operating mode only becomes valid when it can be read by Object 6061h (see also Object 6060h).

Index	**6061h**
Name	mode of operation display
Object code	VAR
Data type	INTEGER8

Category	mandatory
Access	R/O
PDO mapping	possible
Value range	1, 3, 4, 6, 7, 8
Default value	—

20.6.5 Factor Groups (fg) (DS402)

The "factor groups" define the units of position-, velocity- and acceleration setpoints. These values are converted into drive-specific parameters.

NOTE	**The drive parameters for the unit definitions should be set as follows:** **UNIT.PROTARY= 3 (UNIT.PIN/UNIT.POUT)** **UNIT.VROTARY = 3 (UNIT.PIN/UNIT.POUT/s)** **UNIT.ACCROTARY = 3 (c UNIT.PIN/UNIT.POUT/s²)**

20.6.5.1 General Information

Factors

You can convert between physical dimensions and sizes, and the internal units used in the device (increments). Several factors can be implemented. This chapter describes how these factors influence the system, how they are calculated and which data are necessary to build them.

Relationship between Physical and Internal Units

The factors defined in the factor group set up a relationship between device-internal units (increments) and physical units.

The factors are the result of the calculation of two parameters called dimension index and notation index. The dimension index indicates the physical dimension, the notation index indicates the physical unit and a decimal exponent for the values. These factors are directly used to normalize the physical values.

The notation index can be used in two ways:

- For a unit with decimal scaling and notation index < 64, the notation index defines the exponent/decimal place of the unit.
- For a unit with non-decimal scaling and notation index > 64, the notation index defines the subindex of the physical dimension of the unit.

20.6.5.2 Objects for position calculation

Object 608Fh: Position encoder resolution (DS402)

The position encoder resolution defines the ratio of encoder increments per motor revolution.

Index	**608Fh**
Name	Position encoder resolution
Object Code	ARRAY
Data Type	UNSIGNED 32
Category	optional

Subindex	**0**
Name	number of entries
Data type	UNSIGNED8
Category	mandatory
Access	R/O
PDO Mapping	not possible
Value Range	2
Default Value	2

Subindex	**1**
Name	Encoder increments
Category	mandatory
Access	R/W
PDO Mapping	possible
Value Range	UNSIGNED 32
Default Value	2^20

Subindex	**2**
Name	Motor revolutions
Category	mandatory
Access	R/W
PDO Mapping	possible
Value Range	UNSIGNED 32
Default Value	1

Object 6092h: Feed constant (DS402)

The feed constant defines the ratio of feed in position units per driving shaft revolutions. This includes the gear if present.

Index	**6092h**
Name	Feed constant
Object Code	ARRAY
Data Type	UNSIGNED 32
Category	optional

Subindex	**0**
Name	number of entries
Data type	UNSIGNED8
Category	mandatory
Access	R/O
PDO Mapping	not possible
Value Range	2
Default Value	2

Subindex	**1**
Name	Feed
Category	mandatory
Access	R/W
PDO Mapping	possible
Value Range	UNSIGNED 32
Default Value	1

Subindex	**2**
Name	Shaft revolutions
Category	mandatory
Access	R/W
PDO Mapping	possible
Value Range	UNSIGNED 32
Default Value	1

20.6.6 Profile Velocity Mode (pv) (DS402)

20.6.6.1 General Information

The profile velocity mode enables the processing of velocity setpoints and the associated accelerations.

Objects that are defined in this section

Index	Object	Name	Type	Access
606Ch	VAR	velocity actual value	INTEGER32	R/O
60FFh	VAR	target velocity	INTEGER32	R/W

Objects that are defined in other sections

Index	Object	Name	Type	Section
6040h	VAR	control word	INTEGER16	dc (=> p. 91)
6041h	VAR	status word	UNSIGNED16	dc (=> p. 92)
6063h	VAR	position actual value*	INTEGER32	pc (=> p. 102)
6083h	VAR	profile acceleration	UNSIGNED32	pp (=> p. 116)
6084h	VAR	profile deceleration	UNSIGNED32	pp (=> p. 116)

20.6.6.2 Object description

Object 606Ch: velocity actual value (DS402)

The object velocity actual value represents the actual speed.

Index	**606Ch**
Name	velocity actual value, VL.FB
Object code	VAR
Data type	INTEGER32
Mode	pv

Access	R/O
PDO mapping	possible
Unit	velocity units (SDO is in user units and the PDO is in RPM
Value range	(-2^{31}) to (2^{31}-1)
Default value	—
EEPROM	no

Object 60FFh: target velocity (DS402)

The speed setpoint (target velocity) represents the setpoint for the ramp generator.

Index	**60FFh**
Name	target velocity, VL.CMDU
Object code	VAR
Data type	INTEGER32
Mode	pv

Access	R/W
PDO mapping	possible
Unit	increments
Value range	(-2^{31}) to $(2^{31}-1)$
Default value	—
EEPROM	no

20.6.7 Profile Torque Mode (tq) (DS402)

20.6.7.1 General Information

The profile torque mode enables the processing of torque setpoints and the associated current.

Objects that are defined in this section

Index	Object	Name	Type	Access
6071h	VAR	Target torque	INTEGER16	R/W
6073h	VAR	Max current	UNSIGNED16	R/W
6077h	VAR	Torque actual value	INTEGER16	R/O

Objects that are defined in other sections

20.6.7.2 Object description

Object 6071h: Target torque (DS402)

This parameter is the input value for the torque controller in profile torque mode and the value is given per thousand (0.001%) of rated torque.

Index	**6071h**
Name	Target torque
Object code	VAR
Data type	INTEGER16
Category	conditional; mandatory, if tq supported
Access	R/W
PDO mapping	possible
Value range	INTEGER16
Default value	0

Object 6073h: Max current (DS402)

This value represents the maximum permissible torque creating current in the motor and is given per thousand (0.001%) of rated current.

Index	**6073h**
Name	Max current
Object code	VAR
Data type	UNSIGNED16
Category	optional
Access	R/W
PDO mapping	possible
Value range	UNSIGNED16
Default value	0

Object 6077h: Torque actual value (DS402)

The torque actual value corresponds to the instantaneous torque in the drive motor. The value is given per thousand (0.001%) of rated torque.

Index	**6077h**
Name	Torque actual value
Object code	VAR
Data type	INTEGER16
Category	optional
Access	R/O
PDO mapping	possible
Value range	INTEGER16
Default value	0

20.6.8 Position Control Function (pc) (DS402)

20.6.8.1 General Information

This section describes the actual position values that are associated with the position controller of the drive. They are used for the profile position mode.

Objects that are defined in this section

Index	Object	Name	Type	Access
6063h	VAR	position actual value*	INTEGER32	r
6064h	VAR	position actual value	INTEGER32	r
6065h	VAR	following error window	UNSIGNED32	R/W

Objects that are defined in other sections

Index	Object	Name	Type	Section
607Ah	VAR	target position	INTEGER32	pp (=> p. 115)
607Ch	VAR	home-offset	INTEGER32	hm (=> p. 109)
607Dh	ARRAY	software position limit	INTEGER32	pp (=> p. 115)
6040h	VAR	control word	INTEGER16	dc (=> p. 91)
6041h	VAR	status word	UNSIGNED16	dc (=> p. 92)

20.6.8.2 Object Description

Object 6063h: position actual value* (DS402)

The object position actual value provides the momentary actual position in increments.
The resolution is defined with Object 608F as power-of-two number.

Index	**6063h**
Name	position actual value
Object code	VAR
Data type	INTEGER32
Mode	pc, pp

Access	R/W
PDO mapping	possible
Unit	increments (1 turn = 2^{PRBASE})
Value range	(-2^{31}) to $(2^{31}-1)$
Default value	2^{20}
EEPROM	no

Object 6064h: position actual value (DS402)

The object position actual value provides the actual position. The resolution can be altered by the gearing factors of the position controller (Object 6092).

Index	**6064h**
Name	position actual value, PL.FB
Object code	VAR
Data type	INTEGER32
Mode	pc, pp
Access	R/W
PDO mapping	possible
Unit	position units
Value range	(-2^{31}) to $(2^{31}-1)$
Default value	—
EEPROM	no

Object 6065h: Following error window

The following error window defines a range of tolerated position values symmetrically to the position demand value. A following error might occur when a drive is blocked, unreachable profile velocity occurs, or at wrong closed loop coefficients. If the value of the following error window is 0, the following control is switched off.

Index	**6065h**
Name	Following error window
Object code	VAR
Data type	UNSIGNED32
Category	optional
Access	R/W
PDO mapping	no
Value range	UNSIGNED32
Default value	0

Object 60F4h: Following error actual value (DS402)

This object returns the current value of the following error in units defined by the user.

Index	**60F4h**
Name	Following error actual value
Object code	VAR
Data type	Integer32
Category	optional
Access	R/O
PDO mapping	possible
Value range	INTEGER32
Default value	0

20.6.9 Interpolated Position Mode (ip) (DS402)

20.6.9.1 General information

The interpolated position mode is implemented in a simple, straightforward way. Single position setpoints must be transmitted in the interpolation time period and are taken over on every defined SYNC - telegram sent. A linear interpolation is used between the setpoints.

Objects defined in this section

Index	Object	Name	Type	Access
60C0h	VAR	Interpolation sub mode select	INTEGER16	R/W
60C1h	ARRAY	Interpolation data record	INTEGER32	R/W
60C2h	RECORD	Interpolation time period	Interpolation time period	R/W
60C4h	RECORD	Interpolation data configuration record	Interpolation data configuration record	R/W

Objects defined in other sections

20.6.9.2 Object description

Object 60C0h: Interpolation sub mode select

In the AKD the linear interpolation between position setpoints is supported. The only allowed value is 0.

Index	**60C0h**
Name	Interpolation sub mode select
Object code	VAR
Data type	INTEGER16
Category	optional

Access	R/W
PDO mapping	possible
Value range	0
Default value	0

Object 60C1h: Interpolation data record

In the AKD a single setpoint is supported for the interpolated position mode. For the linear interpolation mode each interpolation data record simply can be regarded as a new position setpoint.
After the last item of an interpolation data record is written to the devices input buffer, the pointer of the buffer is automatically incremented to the next buffer position.

Index	**60C1h**
Name	Interpolation data record
Object code	ARRAY
Data type	INTEGER32
Category	optional

Subindex	**0**
Description	number of entries
Data type	UNSIGNED8
Category	mandatory
Access	R/O
PDO mapping	not possible
Value range	1
Default value	no

Subindex	**1**
Description	x1the first parameter of ip function fip(x1, .. xN)
Category	mandatory
Access	R/W
PDO mapping	possible
Value range	INTEGER32
Default value	no

Object 60C2h: Interpolation time period

The interpolation time period is used for the PLL (phase locked loop) synchronized position modes. The unit (sub-index 1) of the time is given in $10^{\text{interpolation time index}}$ seconds.
Only multiples of 1 ms are allowed. The two values define the internal ASCII - parameter PTBASE (given in multiples of 250 Mikroseconds). Both values must be written to fix a new interpolation time period. PTBASE will only be updated then.

Index	**60C2h**
Name	Interpolation time period
Object code	RECORD
Data type	Interpolation time period record (0080h)
Category	optional

Subindex	**0**
Description	number of entries, FBUS.SAMPLEPERIOD
Category	mandatory
Access	R/O
PDO mapping	not possible
Value range	2
Default value	2

Subindex	**1**
Description	Interpolation time units
Category	mandatory
Access	R/W
PDO mapping	possible
Value range	UNSIGNED8
Default value	1

Object 60C4h: Interpolation data configuration

Only a single position setpoint is supported in the AKD. Therefore only the value 1 in Subindex 5 is possible. All other subindices are set to 0.

Index	**60C4h**
Name	Interpolation data configuration
Object code	RECORD
Data type	Interpolation data configuration record (0081h)
Category	optional

Subindex	**0**
Description	number of entries
Category	mandatory
Access	R/O
PDO mapping	not possible
Value range	6
Default value	6

Subindex	**1**
Description	Maximum buffer size
Category	mandatory
Access	R/O
PDO mapping	not possible
Value range	UNSIGNED32
Default value	0

Subindex	**2**
Description	Actual buffer size
Category	mandatory
Access	R/W
PDO mapping	possible
Value range	UNSIGNED32
Default value	0

Subindex	**3**
Description	Buffer organization
Category	mandatory
Access	R/W
PDO mapping	possible
Value range	UNSIGND8
Default value	0

Subindex	**4**
Description	Buffer position
Category	mandatory
Access	R/W
PDO mapping	possible
Value range	UNSIGNED16
Default value	0

Subindex	**5**
Description	Size of data record
Category	mandatory
Access	W
PDO mapping	possible
Value range	1 to 254
Default value	1

Subindex	**6**
Description	Buffer clear
Category	mandatory
Access	W
PDO mapping	possible
Value range	UNSIGNED8
Default value	0

20.6.10 Homing Mode (hm) (DS402)

20.6.10.1 General information

This section describes the various parameters which are required to define a homing mode.

Objects that are defined in this section

Index	Object	Name	Type	Access
607Ch	VAR	HOME.P: home offset	INTEGER32	R/W
6098h	VAR	HOME.MODE, HOME.DIR:homing method	INTEGER8	R/W
6099h	ARRAY	HOME.V: homing speeds	UNSIGNED32	R/W
609Ah	VAR	HOME.ACC, HOME.DEC: homing acceleration/deceleration	UNSIGNED32	R/W

Objects that are defined in other sections

Index	Object	Name	Type	Section
6040h	VAR	control word	INTEGER16	dc (=> p. 91)
6041h	VAR	status word	UNSIGNED16	dc (=> p. 92)

20.6.10.2 Object Description

Object 607Ch: homing offset (DS402)

The reference offset (home offset) is the difference between the zero position for the application and the zero point of the machine. All subsequent absolute motion tasks take account of the reference offset.

Index	**607Ch**
Name	home offset, HOME.P
Object code	VAR
Data type	INTEGER32
Mode	hm
Access	R/W
PDO mapping	possible
Unit	user-defined
Value range	(-2^{31}) to $(2^{31}-1)$
Default value	0

Object 6098h: homing method (DS402)

Index	**6098h**
Name	homing method, HOME.MODE, HOME.DIR
Object code	VAR
Data type	INTEGER8
Mode	hm
Access	R/W
PDO mapping	possible

Unit	position units
Value range	-128 to 127
Default value	0

Description of the homing methods

Choosing a homing method by writing a value to homing method (Object 6098h) will clearly establish:

- the homing signal (P-Stop, N-Stop, reference switch)
- the direction of actuation

and where appropriate

- the position of the index pulse.

The reference position is give by the reference offset (Object 607Ch).

A detailed description of the types of homing movement can be found in the description of WorkBench.

The following homing methods are supported:

Method as per DS402	Brief description: Homing	command
-128 to -1	reserved	—
0	reserved	—
1	homing to negative limit switch, with zeroing, negative count direction	HOME.MODE=2, HOME.DIR=0
2	homing to positive limit switch, with zeroing, positive count direction	HOME.MODE=2, HOME.DIR=1
3 to 7	not supported	—
8	homing to reference switch, with zeroing, positive count direction	HOME.MODE=5, HOME.DIR=1
9 to 11	not supported	—
12	homing to reference switch, with zeroing, negative count direction	HOME.MODE=5, HOME.DIR=0
13 to 14	not supported	—
15 to 16	reserved	—
17	homing to negative limit switch, without zeroing, negative count direction	HOME.MODE=1, HOME.DIR=0
18	homing to negative limit switch, without zeroing, positive count direction	HOME.MODE=1, HOME.DIR=1
19 to 23	not supported	—
24	homing to reference switch, without zeroing, positive count direction	HOME.MODE=4, HOME.DIR=1
25 to 27	not supported	—
28	homing to reference switch, without zeroing, negative count direction	HOME.MODE=4, HOME.DIR=0
29 to 30	not supported	—
31 to 32	reserved	—
33	homing within a single turn, negative count direction	HOME.MODE=7, HOME.DIR=0
34	homing within a single turn, positive count direction	HOME.MODE=7, HOME.DIR=1
35	set reference point at present position	HOME.MODE=0, HOME.DIR=0
36 to 127	reserved	—

Object 6099h: homing speeds (DS402)

Index	**6099h**
Name	homing speeds
Object code	ARRAY
Data type	UNSIGNED32

Subindex	**1**
Description	speed during search for switch, HOME.V
Mode	hm
Access	R/W
PDO mapping	possible
Unit	velocity units
Value range	0 to (2^{32}-1)
Default value	equivalent 60 rpm

Subindex	**2**
Description	speed during search for zero, HOME.FEEDRATE
Mode	hm
Access	R/W
PDO mapping	not possible
Unit	velocity units
Value range	0 to (2^{32}-1)
Default value	1/8 * Object 6099 sub 1

Object 609Ah: homing acceleration (DS402)

Index	**609Ah**
Name	homing acceleration
Object code	VAR
Data type	UNSIGNED32
Mode	hm

Access	R/W
PDO mapping	possible
Unit	acceleration units
Value range	0 to (2^{32}-1)
Default value	0

Homing Mode Sequence

The homing movement is started by setting Bit 4 (positive edge). The successful conclusion is indicated by Bit 12 in the status word (" Object 6041h: Status word (DS402)" (=> p. 92)). Bit 13 indicates that an error occurred during the homing movement. In this case, the error code must be evaluated (error register: " Object 1001h: Error register (DS301)" (=> p. 59)," Object 1003h: Predefined Error Field (DS301)" (=> p. 61), manufacturer status: " Object 1002h: Manufacturer Status Register (DS301)" (=> p. 60)).

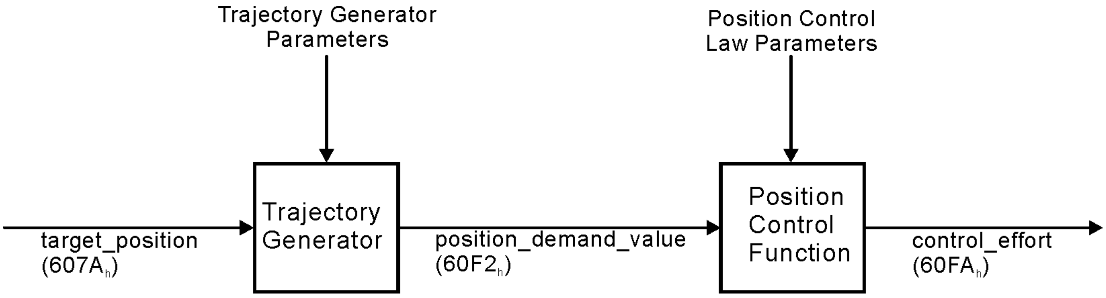
Bit 4	Meaning
0	homing inactive
0 => 1	start homing movement
1	homing active
1 => 0	interruption of homing movement

Bit 13	Bit 12	Meaning
0	0	reference point not set, or homing movement not yet finished
0	1	reference point set, homing movement finished
1	0	homing movement could not be successfully concluded (lag error)
1	1	impermissible state

20.6.11 Profile Position Mode (pp)

20.6.11.1 General Information

The overall structure for this mode is shown in this figure:



The special handshake procedure for the control word and status word is described in "Functional Description" (=> p. 117)

Objects that are defined in this section

Index	Object	Name	Type	Access
607Ah	VAR	target position	INTEGER32	R/W
607Dh	ARRAY	software position limit	INTEGER32	R/W
6081h	VAR	profile velocity	UNSIGNED32	R/W
6083h	VAR	profile acceleration	UNSIGNED32	R/W
6084h	VAR	profile deceleration	UNSIGNED32	R/W

Objects that are defined in other sections

Index	Object	Name	Type	Section
6040h	VAR	control word	INTEGER16	dc (=> p. 91)
6041h	VAR	status word	UNSIGNED16	dc (=> p. 92)

20.6.11.2 Object Description

Object 607Ah: target position (DS402)

The object target position defines the target position for the drive. The target position is interpreted as a relative distance or an absolute position, depending on Bit 6 of the control word. The type of relative movement can be further defined by the manufacturer-specific parameter 35B9h Subindex 1.
The mechanical resolution is set by the gearing factors Object 6093h Subindex 1 and 2.

Index	**607Ah**
Name	target position, MT.P
Object code	VAR
Data type	INTEGER32
Mode	pp

Access	R/W
PDO mapping	possible
Unit	user-defined
Value range	$-(2^{31}-1)$ to $(2^{31}-1)$
Default value	—

Object 607Dh: Software position limit (DS402)

Software position limit contains the sub-parameters min position limit and max position limit. New target positions are checked against these limits. The limits are relative to the machine home position, which is the result of homing (including the home offset (Object 607Ch)). As default the software position limits are switched off. Changed values must be saved and the drive must be restarted to take enable the new the software limits.

Index	**607Dh**
Name	Software position limit, SWLS.LIMIT0
Object code	ARRAY
Data type	INTEGER32
Category	optional

Subindex	**0**
Description	number of entries
Category	mandatory
Access	R/O
PDO mapping	not possible
Value range	2
Default value	2

Subindex	**1**
Description	min position limit, SWLS.LIMIT0
Category	mandatory
Access	R/W
PDO mapping	possible
Value range	INTEGER32
Default value	0 (switched off)

Object 6081h: profile velocity (DS402)

The profile velocity is the final velocity that should be reached after the acceleration phase of a motion task.

Index	**6081h**
Name	profile velocity, MT.V
Object code	VAR
Data type	UNSIGNED32
Mode	pp

Access	R/W
PDO mapping	possible
Unit	speed units
Value range	0 to (2^{32}-1)
Default value	10

Object 6083h: profile acceleration (DS402)

The acceleration ramp (profile acceleration) is given in units that are defined by the user (position units per s²). They can be transformed with the acceleration factor defined by Object 6097 sub1 & 2. The type of acceleration ramp can be selected as a linear ramp or a sin² ramp (see Object 6086h).

Index	**6083h**
Name	profile acceleration, MT.ACC
Object code	VAR
Data type	UNSIGNED32
Mode	pp

Access	R/W
PDO mapping	possible
Unit	acceleration units
Value range	0 to (2^{32}-1)
Default value	0

Object 6084h: profile deceleration (DS402)

The braking/deceleration ramp is handled in the same way as the acceleration ramp (" Object 6083h: profile acceleration (DS402)" (=> p. 116)).

Index	**6084h**
Name	profile deceleration, MT.DEC
Object code	VAR
Data type	UNSIGNED32
Mode	pp

Access	R/W
PDO mapping	possible
Unit	deceleration units
Value range	0 to (2^{32}-1)
Default value	0

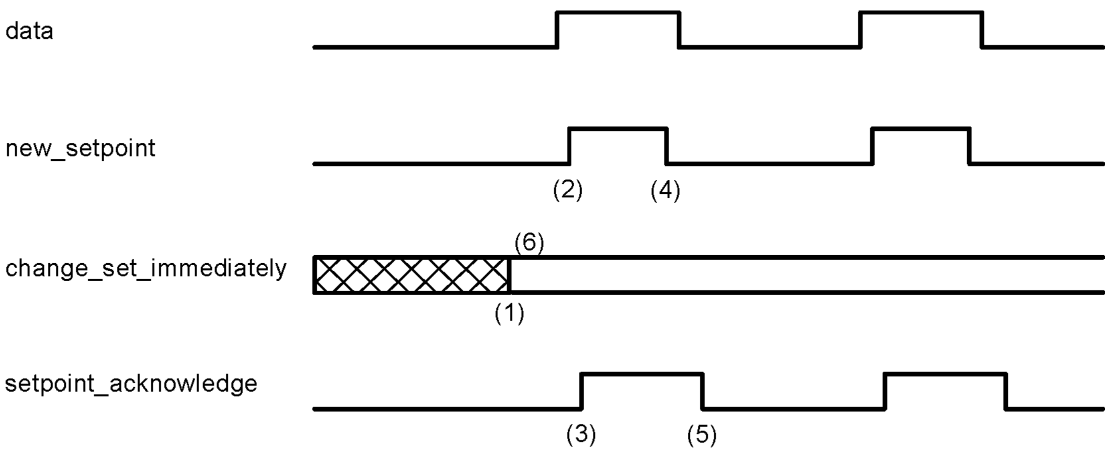
Functional Description

Two different ways to apply target positions to a drive are supported by this device profile.

Set of setpoints:
After reaching the target_position, the drive device immediately processes the next target position, which results in a move where the velocity of the drive normally is not reduced to zero after achieving a setpoint. With AKD, this is only possible if trapezoidal ramps are used.

Single setpoints:
After reaching the target_position, the drive device signals this status to a host computer and then receives a new setpoint. After reaching a target_position, the velocity is normally reduced to zero before starting a move to the next setpoint.

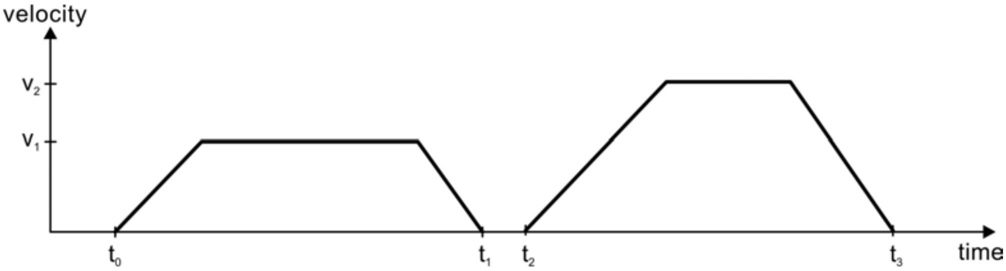
The two modes are controlled by the timing of the bits for new_setpoint and change_set_immediately in the control word, and setpoint_acknowledge in the status word. These bits allow the setting up of a request-response mechanism in order to prepare a set of setpoints while another set is still being processed in the drive unit. This minimizes reaction times within a control program on a host computer.



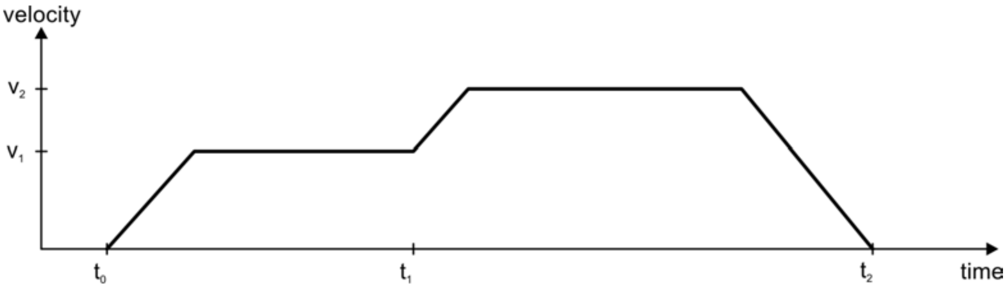
The figures show the difference between the set_of_setpoints mode and the single setpoint mode. The initial status of the bit change_set_immediately in the control word determines which mode is used. To keep these examples simple, only trapezoidal moves are used.

If the bit change_set_immediately is "0” a single setpoint is expected by the drive (1). After data is applied to the drive, a host signals that the data is valid by changing the bit new_setpoint to "1" in the control word (2). The drive responds with setpoint_acknowledge set to "1" in the status word (3) after it has recognized and buffered the new valid data. Now the host can release new_setpoint (4) and subsequently the drive will signal through setpoint_ acknowledge = "0" its ability to accept new data again (5).

In the figure below this mechanism results in a velocity of zero after ramping down to reach a target_position X1 at t1. After signaling to the host, that the setpoint has been reached as described above, the next target_position is processed at t2 and reached at t3.



With change_set_immediately set to "1" (6), the host instructs the drive to apply a new setpoint immediately after reaching the previous one. The relative timing of the other signals is unchanged. This behavior causes the drive to process the next setpoint X2 in advance, and to hold its velocity when it reaches the target_position X1 at t1. The drive then moves immediately to the next target_position X2 that has already been calculated.



Bits in the control word:		Bits in the status word:	
Bit 4	new_setpoint (positive edge!)	Bit 12	setpoint acknowledge
Bit 5	change_set_immediately	Bit 13	lag/following error
Bit 6	absolute/relative		

Notes on motion task type relative:

If Bit 6 is set, then the motion task type is relative, and activated according to the last target position or actual position. If other types of relative motion are required, these must be activated in advance through the ASCII-object O_C (Object 35B9 sub 1).

Notes on profile position mode:

Functional description for the profile position mode

The drive profile DS402 distinguishes between two methods of moving to a target position. These two methods are controlled by the bits for new_setpoint and change_set_immediately in the control word, and setpoint_ acknowledge in the status word. These bits can be used to prepare a motion task while another is still being carried out (handshake).

Moving to several target positions without an intermediate halt

After the target position has been reached, the drive moves immediately to the next target position. This requires that new setpoints are signaled to the drive. This is done through a positive transition of the new_setpoint bit. In this case, the setpoint_acknowledge bit must not be active (=1) in the status word (see also Handshake DS402). The velocity is not reduced to zero when the first setpoint is reached.

Moving to a single target position

The drive moves to the target position, whereby the velocity is reduced to zero. Reaching the target position is signaled by the bit for target_reached in the status word.

20.7 Appendix

20.7.1 Object Dictionary

The following table describes all objects reachable via SDO or PDO. (i.p. = in preparation).

Abbreviations:

U	= UNSIGNED	RO	= Read only
INT	= INTEGER	RW	= Read and Write
VisStr	= Visible String	WO	= Write only
		const	= Constant

20.7.1.1 Float Scaling

The scaling applied to objects which match floating-point parameters in WorkBench/Telnet are listed in the column "Float Scaling."

For example, index 607Ah is listed as 1:1 - this means that commanding a value of 1000 in SDO 607Ah is equivalent to entering MT.P 1000.000 in Workbench. On the other hand, index 3598h is listed as 1000:1 - this means that commanding a value of 1000 in SDO 3598h is equivalent to entering IL.KP 1.000 in Workbench.

A few parameters are listed as variable (var), because the scaling depends on other settings.

20.7.1.2 Communication SDOs

Index	Sub-index	Data Type	Float Scaling	Access	PDO mapp.	Description	ASCII object
1000h	0	U32		RO	no	Device type	—
1001h	0	U8		RO	no	Error register	—
1002h	0	U32		RO	yes	Manufacturer-specific status register	—
1003h		ARRAY				Pre-defined error field	—
1003h	0	U8		RW	no	Number of errors	—
1003h	1 to 10	U32		RO	no	standard error field	—
1005h	0	U32		RW	no	COB—ID SYNC message	—
1006h	0	U32		RW	no	Communication cycle period	—
1008h	0	VisStr		const	no	Manufacturer device name	—
1009h	0	VisStr		const	no	Manufacturer hardware version	—
100Ah	0	VisStr		const	no	Manufacturer software version	—
100Ch	0	U16		RW	no	Guard time	—
100Dh	0	U8		RW	no	Lifetime factor	—
1010h		ARRAY				Number of entries	—
1010h	0	U8		RO	no	Number of entries	—
1010h	1	U32		RW	no	Saves the drive parameters from the RAM to the NV.	DRV.NVSAVE
1014h	0	U32		RW	no	COB—ID for the Emergency Object	—
1016h		RECORD				Consumer heartbeat time	
1016h	0	U8		RO	no	Number of entries	—
1016h	1	U32		RW	no	Consumer heartbeat time	—
1017h	0	U16		RW	no	Producer heartbeat time	—
1018h		RECORD				Identity Object	—
1018h	0	U8		RO	no	Number of entries	—
1018h	1	U32		RO	no	Vendor ID	—

Index	Sub-index	Data Type	Float Scaling	Access	PDO mapp.	Description	ASCII object
1018h	2	U32		RO	no	Product Code	—
1018h	3	U32		RO	no	Revision number	—
1018h	4	U32		RO	no	Serial number	
1026h		ARRAY				OS prompt	—
1026h	0	U8		RO	no	Number of entries	—
1026h	1	U8		WO	no	StdIn	—
1026h	2	U8		RO	no	StdOut	—
1400h		RECORD				RXPDO1 communication parameter	—
1400h	0	U8		RO	no	Number of entries	—
1400h	1	U32		RW	no	RXPDO1 COB — ID	—
1400h	2	U8		RW	no	Transmission type RXPDO1	—
1401h		RECORD				RXPDO2 communication parameter	—
1401h	0	U8		RO	no	Number of entries	—
1401h	1	U32		RW	no	RXPDO2 COB—ID	—
1401h	2	U8		RW	no	Transmission type RXPDO2	—
1402h		RECORD				RXPDO3 communication parameter	—
1402h	0	U8		RO	no	Number of entries	—
1402h	1	U32		RW	no	RXPDO3 COB—ID	—
1402h	2	U8		RW	no	Transmission type RXPDO3	—
1403h		RECORD				RXPDO4 communication parameter	—
1403h	0	U8		RO	no	Number of entries	—
1403h	1	U32		RW	no	RXPDO4 COB—ID	—
1403h	2	U8		RW	no	Transmission type RXPDO4	—
1600h		RECORD				RXPDO1 mapping parameter	—
1600h	0	U8		RO	no	Number of entries	—
1600h	1 to 8	U32		RW	no	Mapping for n—th application object	—
1601h		RECORD				RXPDO2 mapping parameter	—
1601h	0	U8		RO	no	Number of entries	—
1601h	1 to 8	U32		RW	no	Mapping for n—th application object	—
1602h		RECORD				RXPDO3 mapping parameter	—
1602h	0	U8		RO	no	Number of entries	—
1602h	1 to 8	U32		RW	no	Mapping for n—th application object	—
1603h		RECORD				RXPDO4 mapping parameter	—
1603h	0	U8		RO	no	Number of entries	—
1603h	1 to 8	U32		RW	no	Mapping for n—th application object	—
1800h		RECORD				TXPDO1 communication parameter	—
1800h	0	U8		RO	no	Number of entries	—
1800h	1	U32		RW	no	TXPDO1 COB—ID	—
1800h	2	U8		RW	no	Transmission type TXPDO1	—
1800h	3	U16		RW	no	Inhibit time	—
1800h	4	U8		const	no	reserved	—
1800h	5	U16		RW	no	Event timer	—
1801h		RECORD				TXPDO2 communication parameter	—
1801h	0	U8		RO	no	Number of entries	—
1801h	1	U32		RW	no	TXPDO2 COB—ID	—
1801h	2	U8		RW	no	Transmission type TXPDO2	—
1801h	3	U16		RW	no	Inhibit time	—
1801h	4	U8		const	no	reserved	—

Index	Sub-index	Data Type	Float Scaling	Access	PDO mapp.	Description	ASCII object
1801h	5	U16		RW	no	Event timer	—
1802h		RECORD				TXPDO3 communication parameter	—
1802h	0	U8		RO	no	Number of entries	—
1802h	1	U32		RW	no	TXPDO3 COB—ID	—
1802h	2	U8		RW	no	Transmission type TXPDO3	—
1802h	3	U16		RW	no	Inhibit time	—
1802h	4	U8		const	no	reserved	—
1802h	5	U16		RW	no	Event timer	—
1803h		RECORD				TXPDO4 communication parameter	—
1803h	0	U8		RO	no	Number of entries	—
1803h	1	U32		RW	no	TXPDO4 COB—ID	—
1803h	2	U8		RW	no	Transmission type TXPDO4	—
1803h	3	U16		RW	no	Inhibit time	—
1803h	4	U8		const	no	reserved	—
1803h	5	U16		RW	no	Event timer	—
1A00h		RECORD				Mapping parameter TXPDO1	—
1A00h	0	U8		RO	no	Number of entries	—
1A00h	1 to 8	U32		RW	no	Mapping for n—th application object	—
1A01h		RECORD				Mapping parameter TXPDO2	—
1A01h	0	U8		RO	no	Number of entries	—
1A01h	1 to 8	U32		RW	no	Mapping for n—th application object	—
1A02h		RECORD				Mapping parameter TXPDO3	—
1A02h	0	U8		RO	no	Number of entries	—
1A02h	1 to 8	U32		RW	no	Mapping for n—th application object	—
1A03h		RECORD				Mapping parameter TXPDO4	—
1A03h	0	U8		RO	no	Number of entries	—
1A03h	1 to 8	U32		RW	no	Mapping for n—the application object	—

20.7.1.3 Manufacturer specific SDOs

Index	Sub-index	Data Type	Float Scaling	Access	PDO mapp.	Description	ASCII object
2014h		ARRAY				Mask TxPDO Channel 1	—
2014h	1	U32		RW	no	Mask (Byte 0..3)	—
2014h	2	U32		RW	no	Mask (Byte 4..7)	—
2015h		ARRAY				Mask TxPDO Channel 2	—
2015h	1	U32		RW	no	Mask (Byte 0..3)	—
2015h	2	U32		RW	no	Mask (Byte 4..7)	—
2016h		ARRAY				Mask TxPDO Channel 3	—
2016h	1	U32		RW	no	Mask (Byte 0..3)	—
2016h	2	U32		RW	no	Mask (Byte 4..7)	—
2017h		ARRAY				Mask TxPDO Channel 4	—
2017h	1	U32		RW	no	Mask (Byte 0..3)	—
2017h	2	U32		RW	no	Mask (Byte 4..7)	—
2018h		ARRAY				Firmware version	—
2018h	0	U16		const	no	Number of entries	—
2018h	1	U16		const	no	Major version	—
2018h	2	U16		const	no	Minor version	—
2018h	3	U16		const	no	Revision	—
2018h	4	U16		const	no	Branch version	—
2050h	0	INT32	1:1	RO	no	Position, secondary feedback	DRV.HANDWHEEL
20A0h	0	INT32	var	RO	yes	Latch position 1, positive edge	CAP0.PLFB, CAP0.T
20A1h	0	INT32	var	RO	yes	Latch position 1, negative edge	CAP0.PLFB, CAP0.T
20A2h	0	INT32	var	RO	yes	Latch position 2, positive edge	CAP1.PLFB, CAP1.T
20A3h	0	INT32	var	RO	yes	Latch position 2, negative edge	CAP1.PLFB, CAP1.T
20A4h	0	U16		RW	yes	Latch control register	—
20A5h	0	U16		RW	yes	Latch status register	—
20A6h	0	INT32	var	RO	yes	Sets captured position value	CAP0.PLFB
20B8h	0	U16		RW	no	Clear changed digital input information	—
3405h		ARRAY				VL.ARTYPE	—
3405h	0	U8		RO	no	Number of entries	—
3405h	1	U8		RW	no	Calculation method for BiQuad filter 1	VL.ARTYPE1
3405h	2	U8		RW	no	Calculation method for BiQuad filter 2	VL.ARTYPE2
3405h	3	U8		RW	no	Calculation method for BiQuad filter 3	VL.ARTYPE3
3405h	4	U8		RW	no	Calculation method for BiQuad filter 4	VL.ARTYPE4
3406h		ARRAY				VL BiQuad	—
3406h	0	U8		RO	no	Number of entries	—
3406h	1	U32	1000:1	RW	no	Natural frequency of pole of anti-resonance (AR) filter 1	VL.ARPF1
3406h	2	U32	1000:1	RW	no	Natural frequency of pole of anti-resonance (AR) filter 2	VL.ARPF2
3406h	3	U32	1000:1	RW	no	Natural frequency of pole of anti-resonance (AR) filter 3	VL.ARPF3

Index	Sub-index	Data Type	Float Scaling	Access	PDO mapp.	Description	ASCII object
3406h	4	U32	1000:1	RW	no	Natural frequency of pole of anti-resonance (AR) filter 4	VL.ARPF4
3406h	5	U32	1000:1	RW	no	Q of pole of anti-resonance (AR) filter 1	VL.ARPQ1
3406h	6	U32	1000:1	RW	no	Q of pole of anti-resonance (AR) filter 2	VL.ARPQ2
3406h	7	U32	1000:1	RW	no	Q of pole of anti-resonance (AR) filter 3	VL.ARPQ3
3406h	8	U32	1000:1	RW	no	Q of pole of anti-resonance (AR) filter 4	VL.ARPQ4
3406h	9	U32	1000:1	RW	no	Natural frequency of zero of anti-resonance (AR)filter 1	VL.ARZF1
3406h	A	U32	1000:1	RW	no	Natural frequency of zero of anti-resonance (AR)filter 2	VL.ARZF2
3406h	B	U32	1000:1	RW	no	Natural frequency of zero of anti-resonance (AR)filter 3	VL.ARZF3
3406h	C	U32	1000:1	RW	no	Natural frequency of zero of anti-resonance (AR)filter 4	VL.ARZF4
3406h	D	U32	1000:1	RW	no	Q of zero of anti-resonance filter 1	VL.ARZQ1
3406h	E	U32	1000:1	RW	no	Q of zero of anti-resonance filter 2	VL.ARZQ2
3406h	F	U32	1000:1	RW	no	Q of zero of anti-resonance filter 3	VL.ARZQ3
3406h	10	U32	1000:1	RW	no	Q of zero of anti-resonance filter 4	VL.ARZQ4
3407h		STRUCT				Velocity Filter	—
3407h	0	U8		RO	no	Number of entries	—
3407h	1	INT32	1000:1	RW	no	10 Hz filtered VL.FB	VL.FBFILTER
3407h	2	U32	1000:1	RW	no	Gain for the velocity feedforward	VL.KVFF
3407h	3	U32		RW	no	Gain for the acceleration feed-forward	VL.KBUSFF
3407h	4	U32	1:1	RW	no	Sets the velocity error	VL.ERR
3412h	0	INT8		RW	no	Type of brake resistor	REGEN.TYPE
3414h	0	U8		RW		Returns and sets the brake resistor fault level temperature.	REGEN.WATTEXT REGEN.WATTEXT
3406h	0	U8		RO	no	Number of entries	—
3406h	1	U32	1000:1	RW	no	Natural frequency of pole of anti-resonance (AR) filter 1	VL.ARPF1
3406h	2	U32	1000:1	RW	no	Natural frequency of pole of anti-resonance (AR) filter 2	VL.ARPF2
3406h	3	U32	1000:1	RW	no	Natural frequency of pole of anti-resonance (AR) filter 3	"VL.ARPF3" (=> p. 621)
3406h	4	U32	1000:1	RW	no	Natural frequency of pole of anti-resonance (AR) filter 4	VL.ARPF4
3406h	5	U32	1000:1	RW	no	Q of pole of anti-resonance (AR) filter 1	VL.ARPQ1
3406h	6	U32	1000:1	RW	no	Q of pole of anti-resonance (AR) filter 2	VL.ARPQ2
3406h	7	U32	1000:1	RW	no	Q of pole of anti-resonance (AR) filter 3	VL.ARPQ3
3406h	8	U32	1000:1	RW	no	Q of pole of anti-resonance (AR) filter 4	VL.ARPQ4

Index	Sub-index	Data Type	Float Scaling	Access	PDO mapp.	Description	ASCII object
3406h	9	U32	1000:1	RW	no	Natural frequency of zero of anti-resonance (AR)filter 1	VL.ARZF1
3406h	A	U32	1000:1	RW	no	Natural frequency of zero of anti-resonance (AR)filter 2	VL.ARZF2
3406h	B	U32	1000:1	RW	no	Natural frequency of zero of anti-resonance (AR)filter 3	VL.ARZF3
3406h	C	U32	1000:1	RW	no	Natural frequency of zero of anti-resonance (AR)filter 4	VL.ARZF4
3406h	D	U32	1000:1	RW	no	Q of zero of anti-resonance filter 1	VL.ARZQ1
3406h	E	U32	1000:1	RW	no	Q of zero of anti-resonance filter 2	VL.ARZQ2
3406h	F	U32	1000:1	RW	no	Q of zero of anti-resonance filter 3	VL.ARZQ3
3406h	10	U32	1000:1	RW	no	Q of zero of anti-resonance filter 4	VL.ARZQ4
3407h		STRUCT				Velocity Filter	—
3407h	0	U8		RO	no	Number of entries	—
3407h	1	INT32	1000:1	RW	no	10 Hz filtered VL.FB	VL.FBFILTER
3407h	2	U32	1000:1	RW	no	Gain for the velocity feedforward	VL.KVFF
3407h	3	U32		RW	no	Gain for the acceleration feed-forward	VL.KBUSFF
3407h	4	U32	1:1	RW	no	Sets the velocity error	VL.ERR
3412h	0	INT8		RW	no	Type of brake resistor	REGEN.TYPE
3414h	0	U8		RW		Returns and sets the brake resistor fault level temperature.	REGEN.WATTEXT REGEN.WATTEXT
3415h	0	U32	1000:1	RO	no	Thermal brake resistor time constant	REGEN.TEXT
3416h	0	U32		RO	no	Gets brake resistor's calculated power	REGEN.POWER
3420h	0	U16	1000:1	RW	no	Sets the foldback fault level.	IL.FOLDFTHRESH
3421h	0	U32	1000:1	RW	no	Sets the user value for the fold-back fault level.	IL.FOLDFTHRESHU
3422h	0	U32	1000:1		no	Sets friction compensation value.	IL.FRICTION
3423h	0	INT32	1000:1		no	A constant current command added to compensate for gravity.	IL.OFFSET
3424h	0	U16			no	Enables/disables the integrator part of the PI loop.	IL.INTEN (Password Protected)
3425h	0	U32	1000:1	RO	no	Reads the overall foldback current limit	IL.IFOLD
3426h	0	U32	1000:1	RW	no	Sets current loop acceleration feedforward gain value	IL.KACCFF
3430h	0	U8		RW	no	Sets the direction for absolute motion tasks.	PL.MODPDIR
3431h	0	U16		RW	no	Sets the motion task in the drive	MT.SET
3440h		ARRAY				Controlled stop parameters	—
3440h	0	U8		RO	no	Number of entries	—
3440h	1	U32	1:1	RW	no	Sets the deceleration value for a controlled stop.	CS.DEC
3440h	2	U32	1:1	RW	no	Sets the velocity threshold for a controlled stop.	CS.VTHRESH

Index	Sub-index	Data Type	Float Scaling	Access	PDO mapp.	Description	ASCII object
3440h	3	U32		RW	no	Sets the time value for the drive velocity to be within CS.VTHRESH.	CS.TO
3441h	0	U8		RO	no	Controlled stop state	CS.STATE
3443h	0	U16		RO	no	Returns the possible reason for a drive disable	DRV.DIS
3444h	0	U16	1000:1	RO	no	Maximum current for dynamic braking	DRV.DBILIMIT
3445h	0	U32		RO	no	Emergency timeout for braking	DRV.DISTO
3450h	0	U8		WO	no	Release or enable brake	MOTOR.BRAKERLS
3451h	0	U8		RW	no	Determines which drive parameters are calculated automatically.	MOTOR.AUTOSET
3452h	0	U16		RW	no	Sets the motor maximum voltage	MOTOR.VOLTMAX
3453h	0	U32		RW	no	Sets the motor temperature warning level	MOTOR.TEMPWARN
3454h	0	U32	1000:1	RW	no	Sets the thermal constant of the motor coil	MOTOR.CTF0
3455h	0	U32	1000:1	RW	no	Sets the line-to-line motor Lq	MOTOR.LQLL
3456h	0	U32	1000:1	RW	no	Sets the stator winding resistance phase-phase in ohms	MOTOR.R
3460h		RECORD				Capture engines parameters	—
3460h	0	U8		RO	no	Number of entries	—
3460h	1	U8		RW	no	Specifies the trigger source for the position capture.	CAP0.TRIGGER
3460h	2	U8		RW	no	Specifies the trigger source for the position capture.	CAP1.TRIGGER
3460h	3	U8		RW	no	Selects the captured value.	CAP0.MODE
3460h	4	U8		RW	no	Selects the captured value.	CAP1.MODE
3460h	5	U8		RW	no	Controls the precondition logic.	CAP0.EVENT
3460h	6	U8		RW	no	Controls the precondition logic.	CAP1.EVENT
3460h	7	U8		RW	no	Selects the capture precondition edge.	CAP0.PREEDGE
3460h	8	U8		RW	no	Selects the capture precondition edge.	CAP1.PREEDGE
3460h	9	U8		RW	no	Sets the precondition trigger.	CAP0.PRESELECT
3460h	A	U8		RW	no	Sets the precondition trigger.	CAP1.PRESELECT
3470h		RECORD					—
3470h	0	U8		RO	no	Number of entries	—
3470h	1	INT8		RW	no	Sets the analog output mode.	AOUT.MODE
3470h	2	INT16	1000:1	RW	yes	Reads the analog output value.	AOUT.VALUE
3470h	3	INT16	1000:1	RW	yes	Reads and writes the analog output value.	AOUT.VALUEU
3470h	4	INT16	1000:1	RO	yes	Reads the value of the analog input signal.	AIN.VALUE
3470h	5	U32	1000:1	RW	no	Sets velocity scale factor for analog output	AOUT.VSCALE
3471h	0	U32	1:1	RW	no	Sets the analog position scale factor	"AOUT.PSCALE" (=> p. 286)

Index	Sub-index	Data Type	Float Scaling	Access	PDO mapp.	Description	ASCII object
3472h	0	U32	1:1	RW	no	Sets analog pscale factor	"AIN.PSCALE" (=> p. 272)
3480h	0	U32	1000:1	RW	no	Integral gain of position regulator PID loop	PL.KI
3481h		ARRAY				PL.INTMAX	—
3481h	0	U8		RO	no	Number of entries	—
3481h	1	U32	1:1	RW	no	Input saturation	PL.INTINMAX
3481h	2	U32	1:1	RW	no	Output saturation	PL.INTOUTMAX
3482h	0	INT32	1:1	RO	no	Maximum value of following error in homing	HOME.PERRTHRESH
3483h	0	INT32	1:1	RW	no	Sets the position error warning level	PL.ERRWTHRESH
3490h	0	INT32	1:1	RO	no	Position feedback offset	FB1.OFFSET
3491h	0	U32		RO	no	Location of index pulse on EEO	DRV.EMUEMTURN
3492h	0	U32		RO	no	Motion status of the drive	DRV.MOTIONSTAT
3493h	0	U8		RO	no	Direction of EEO (emulated encoder output)	DRV.EMUEDIR DRV.EMUEDIR
3494h		RECORD				WS parameters	—
3494h	0	U8		RO	no	Number of entries	—
3494h	1	INT16	1000:1	RW	no	Sets maximum current used for wake and shake	WS.IMAX
3494h	2	INT32	1:1	RW	no	Sets the maximum movement required for wake and shake	WS.DISTMAX
3494h	3	U16		RW	no	Sets the delay for wake and shake between loops in mode 0	WS.TDELAY3
3494h	4	INT32	1:1	RW	no	Defines the maximum allowed velocity for Wake & Shake	WS.VTHRESH
3494h	5	U8		RO	no	Reads wake and shake status	WS.STATE
3494h	6	U8		RW	no	Arm Wake and Shake to start	WS.ARM
34A0h		ARRAY				PLS Position	
34A0h	0	U8		RO	no	Number of entries	—
34A0h	1	INT32	1:1	RW	no	Limit switch 1 compare value	PLS.P1
34A0h	2	INT32	1:1	RW	no	Limit switch 2 compare value	PLS.P2
34A0h	3	INT32	1:1	RW	no	Limit switch 3 compare value	PLS.P3
34A0h	4	INT32	1:1	RW	no	Limit switch 4 compare value	PLS.P4
34A0h	5	INT32	1:1	RW	no	Limit switch 5 compare value	PLS.P5
34A0h	6	INT32	1:1	RW	no	Limit switch 6 compare value	PLS.P6
34A0h	7	INT32	1:1	RW	no	Limit switch 7 compare value	PLS.P7
34A0h	8	INT32	1:1	RW	no	Limit switch 8 compare value	PLS.P8
34A1h		ARRAY				PLS Width	—
34A1h	0	U8		RO	no	Number of entries	—
34A1h	1	INT32	1:1	RW	no	Sets Limit Switch1 Width	PLS.WIDTH1
34A1h	2	INT32	1:1	RW	no	Sets Limit Switch 2 Width	PLS.WIDTH2
34A1h	3	INT32	1:1	RW	no	Sets Limit Switch 3 Width	PLS.WIDTH3
34A1h	4	INT32	1:1	RW	no	Sets Limit Switch 4 Width	PLS.WIDTH4
34A1h	5	INT32	1:1	RW	no	Sets Limit Switch 5 Width	PLS.WIDTH5
34A1h	6	INT32	1:1	RW	no	Sets Limit Switch 6 Width	PLS.WIDTH6
34A1h	7	INT32	1:1	RW	no	Sets Limit Switch 7 Width	PLS.WIDTH7

Index	Sub-index	Data Type	Float Scaling	Access	PDO mapp.	Description	ASCII object
34A1h	8	INT32	1:1	RW	no	Sets Limit Switch 8 Width	PLS.WIDTH8
34A2h		ARRAY				PLS Time	—
34A2h	0	U8		RO	no	Number of entries	—
34A2h	1	U16		RW	no	Sets limit switch 1 time	PLS.T1
34A2h	2	U16		RW	no	Sets limit switch 2 time	PLS.T2
34A2h	3	U16		RW	no	Sets limit switch 3 time	PLS.T3
34A2h	4	U16		RW	no	Sets limit switch 4 time	PLS.T4
34A2h	5	U16		RW	no	Sets limit switch 5 time	PLS.T5
34A2h	6	U16		RW	no	Sets limit switch 6 time	PLS.T6
34A2h	7	U16		RW	no	Sets limit switch 7 time	PLS.T7
34A2h	8	U16		RW	no	Sets limit switch 8 time	PLS.T8
34A3h		ARRAY				PLS Configuration	—
34A3h	0	U8		RO	no	Number of entries	—
34A3h	1	U16		RW	no	Enables the limit switches	PLS.EN
34A3h	2	U16		RW	no	Resets limit switches	PLS.RESET
34A3h	3	U16		RW	no	Selects limit switch mode	PLS.MODE
34A3h	4	U16		RW	no	Reads the limit switch state	PLS.STATE
34A4h	0	U8		RW	no	Sets limit switch units	PLS.UNITS
3501h	0	INT32	1:1	RW	no	Acceleration ramp	DRV.ACC
3502h	0	INT32	1:1	RW	no	Acceleration ramp for homing/jog modes	HOME.ACC
3506h	0	INTEGER			no	Action that hardware enable digital input will perform.	DRV.HWENMODE
3509h	0	INT32	1000:1	RO	no	Analog input voltage	AIN.VALUE
3522h	0	INT32	1:1	RW	no	Deceleration rate	DRV.DEC
3524h	0	INT32	1:1	RW	no	Deceleration ramp for homing/jog modes	HOME.DEC
352Ah	0	INT32		RW	no	Direction of movements	DRV.DIR
3533h	0	U32		RO	no	Resolution of motor encoder	FB1.ENCRES
3534h	0	U32		RO	no	Mode of EEO connector	DRV.EMUEMODE
3535h	0	U32		RO	no	Resolution of EEO	DRV.EMUERES
3537h	0	U32		RO	no	Location of EEO index pulse	DRV.EMUEZOFFSET
353Bh	0	INT32		RO	no	Selection of the feedback type	FB1.SELECT
3542h	0	U32	1000:1	RW	no	Position Control Loop: Proportional Gain	PL.KP
3548h	0	U32	1000:1	RW	no	Velocity Control Loop: Proportional Gain	VL.KP
354Bh	0	INT32	1000:1	RW	no	Sets the velocity loop velocity feedforward gain value	VL.KVFF
354Dh	0	INT32	1000:1	RW	no	Velocity Control Loop: I-Integration Time	VL.KI
3558h	0	INT32	1000:1	RO	no	Current Monitor	IL.FB
3559h	0	INT32	1000:1	RO	no	Drive Ifold	IL.DIFOLD
355Ah	0	INT32	1000:1	RW	no	I2T Warning	IL.FOLDWTHRESH
3562h	0	INT32		RW	no	Function of Digital Input 1	DIN1.MODE
3565h	0	INT32		RW	no	Function of Digital Input 2	DIN2.MODE
3568h	0	INT32		RW	no	Function of Digital Input 3	DIN3.MODE
356Bh	0	INT32		RW	no	Function of Digital Input 4	DIN4.MODE

Index	Sub-index	Data Type	Float Scaling	Access	PDO mapp.	Description	ASCII object
356Eh	0	INT32	1000:1	RW	no	Application Peak Current, positive direction	IL.LIMITP
356Fh	0	INT32	1000:1	RW	no	Application Peak Current, negative direction	IL.LIMITN
3586h	0	U32		RW	no	Sets the motor temperature fault level	MOTOR.TEMPFAULT
3587h	0	INT32		RW	no	Select Motor Holding Brake	MOTOR.BRAKE
358Eh	0	U32	1000:1	RW	no	Motor Continuous Current Rating	MOTOR.ICONT
358Fh	0	U32	1000:1	RW	no	Motor Peak Current Rating	MOTOR.IPEAK
3593h	0	U32	1000:1	RW	no	Sets the torque constant of the motor	MOTOR.KT
3596h	0	U32	1000:1	RO	no	Sets the proportional gain of the d-component current PI-regulator as a percentage of IL.KP	IL.KPDRATIO
3598h	0	INT32	1000:1	RW	no	Absolute Gain of Current Control loop	IL.KP
359Ch	0	U32		RW	no	Sets the motor phase.	MOTOR.PHASE
359Dh	0	U32		RW	no	Sets the number of motor poles	MOTOR.POLES
35A3h	0	U32		RW	no	Sets the maximum motor speed	MOTOR.VMAX
35A4h	0	INT32	1000:1	RW	no	Maximum motor current	IL.MIFOLD
35ABh	0	U32	1000:1	RW	no	Sets the motor inertia	MOTOR.INERTIA
35AFh	0	U32		RW	no	Sets the digital output 1 mode	MT.CNTL
35B2h	0	U32		RW	no	Sets the digital output 2 mode	MT.MTNEXT
35B4h	0	INT32		RW	no	Operating Mode	DRV.OPMODE
35BCh	0	INT32		RW	no	Next Task Number for Motion Task 0	MT.MTNEXT
35C2h	0	INT32		RW	no	Select Brake Resistor	REGEN.REXT
35C5h	0	INT32	1:1	RO	no	Actual Following Error	PL.ERR
35C6h	0	INT32	1:1	RW	no	In-Position Window	MT.TPOSWND
35C7h	0	INT32	1:1	RW	no	Max. Following Error	PL.ERRFTHRESH
35CAh	0	INT32		RW	no	Position Resolution (Numerator)	UNIT.PIN
35CBh	0	INT32		RW	no	Position Resolution (Denominator)	UNIT.POUT
35CFh	0	INT32		RW	no	reserved	PL.MODPEN
35E2h	0	U32	1:1	RW	no	Sets the current limit during homing procedure to a mechanical stop	HOME.IPEAK
35EBh	0	INT32		WO	no	Save Data in EEPROM	DRV.NVSAVE
35F0h	0	INT32		WO	no	Set Reference Point	HOME.SET
35FEh	0	INT32		WO	no	Stop Motion Task	DRV.STOP
35FFh	0	U32		RW	no	Selects between disable immediately or stop and then disable	DRV.DISMODE
3610h	0	INT32		RO	no	Ambient Temperature	DRV.TEMPERATURES
3611h	0	INT32		RO	no	Heat Sink Temperature	DRV.TEMPERATURES
3612h	0	INT32		RO	no	Motor Temperature	MOTOR.TEMP
3618h	0	INT32	1:1	RO	no	Actual Velocity	VL.FB
361Ah	0	INT32		RO	no	DC-bus voltage	VBUS.VALUE
3622h	0	INT32	1:1	RW	no	Max. Velocity	VL.LIMITP

Index	Sub-index	Data Type	Float Scaling	Access	PDO mapp.	Description	ASCII object
3623h	0	INT32	1:1	RW	no	Max. Negative Velocity	VL.LIMITN
3627h	0	INT32	1:1	RW	no	Overspeed	VL.THRESH
3629h	0	INT32	1000:1	RW	no	SW1 Velocity Scaling Factor	AIN.VSCALE
3637h	0	INT32	1:1	RW	no	reserved	PL.MODP1
3638h	0	INT32	1:1	RW	no	reserved	PL.MODP2
3656h	0	U64	1:1	RW	no	Initial feedback position	FB1.ORIGIN
3659h	0	INT32		RW	no	Type of acceleration setpoint for the system	UNIT.ACCROTARY
365Bh	0	INT32		RW	no	Presetting for motion task that is processed later	MT.NUM
365Fh	0	INT32		RW	no	Systemwide Definition of Veloc-ity/Speed	UNIT.VROTARY
3660h	0	INT32		RW	no	Set Resolution of the Position	UNIT.PROTARY
366Eh	0	INT32		RW	no	Disable Delaytime with Holding Brake	MOTOR.TBRAKEAPP
366Fh	0	INT32		RW	no	Enable Delaytime with Holding Brake	MOTOR.TBRAKERLS
3683h	0	U16		RW	no	Delay for wake and shake timing	WS.TDELAY1
3685h	0	U16		RW	no	Sets delay for wake and shake timing	WS.TDELAY2
36D0h	0	U16		RW	no	Sets wake and shake current-vec-tor appliance time	WS.T
36D1h	0	U32	1:1	RW	no	Sets the minimum movement required for wake and shake	WS.DISTMIN
36E2h	0	U8		RW	no	Sets the number of repetitions for wake and shake	WS.NUMLOOPS
36E5h	0	U32		RW	no	CAN baud rate selection	FBUS.PARAM01
36E6h	0	U32		RW	no	pll synchronization	FBUS.PARAM02
36E7h	0	U32		RW	no	-	FBUS.PARAM03
36E8h	0	U32		RW	no	SYNC surveillance	FBUS.PARAM04
36E9h	0	U32		RW	no	-	FBUS.PARAM05
36EAh	0	U32		RW	no	-	FBUS.PARAM06
36EBh	0	U32		RW	no	-	FBUS.PARAM07
36ECh	0	U32		RW	no	-	FBUS.PARAM08
36EDh	0	U32		RW	no	-	FBUS.PARAM09
36EEh	0	U32		RW	no	-	FBUS.PARAM10
36F6h	0	INT32		RW	no	Function of Digital Input 5	DIN5.MODE
36F9h	0	INT32		RW	no	Function of Digital Input 6	DIN6.MODE
36FCh	0	U32		RW	no	Function of Digital Input 7	DIN7.MODE
3856h	0	INT32	1:1	RW	no	velocity window for profile posi-tion mode	MT.TVELWND

20.7.1.4 Profile specific SDOs

Index	Sub-index	DataType	Float Scaling	Access	PDO mapp.	Description	ASCII object
6040h	0	U16		WO	yes	Control word	—
6041h	0	U16		RO	yes	Status word	—
6060h	0	INT8		RW	yes	Modes of Operation	—
6061h	0	INT8		RO	yes	Modes of Operation Display	—
6063h	0	INT32		RO	yes	Position actual value (increments)	—
6064h 6064h	0	INT32	1:1	RO	yes	Position actual value (position units)	PL.FB
6065h	0	U32	1:1	RW	no	Following error window	PL.ERRFTHRESH
606Bh	0	INT32	1:1	RO	yes	Velocity demand value	VL.CMD
606Ch	0	INT32	1000:1	RO	yes	Velocity actual value (PDO in RPM)	VL.FB
606Dh	0	U16		RW	yes	Velocity window	
606Eh	0	U16		RW	yes	Velocity window time	
6071h	0	INT16		RW	yes	Target torque	—
6072h	0	U16		RW	yes	Max torque	—
6073h	0	U16		RW	no	Max current	
6077h	0	INT16		RO	yes	Torque actual value	—
607Ah	0	INT32	1:1	RW	yes	Target position	MT.P
607Ch	0	INT32	1:1	RW	no	Reference offset	HOME.P
607Dh		ARRAY				Software position limit	
607Dh	0	U8		RO	no	Number of entries	
607Dh	1	INT32	1:1	RW	no	Software position limit 1	SWLS.LIMIT0
607Dh	2	INT32	1:1	RW	no	Software position limit 2	SWLS.LIMIT1
6081h 6081h	0	U32	1:1	RW	yes	Profile Velocity	MT.V
6083h	0	U32	1:1	RW	yes	Profile Acceleration	MT.ACC
6084h	0	U32	1:1	RW	yes	Profile Deceleration	MT.DEC
6086h	0	INT16		RW	yes	Motion profile type	MT.CNTL
608Fh		ARRAY				Position encoder resolution	—
608Fh	0	U8		RO	no	Number of entries	—
608Fh	1	U32		RW	no	Encoder increments	—
608Fh	2	U32		RW	no	Motor revolutions	
6092h		ARRAY				Feed constant	—
6092h	0	U8		RO	no	Number of entries	—
6092h	1	U32		RW	no	Feed	UNIT.PIN
6092h	2	U32		RW	no	Shaft revolutions	UNIT.POUT
6098h 6098h	0	INT8		RW	no	Homing type	HOME.MODE HOME.DIR
6099h		ARRAY				Homing velocity	—
6099h	0	U8		RO	no	Number of entries	—
6099h	1	U32	1:1	RW	no	Speed while searching for limit switch	HOME.V
6099h	2	U32		RW	no	Speed while searching for zero mark	HOME.FEEDRATE
609Ah	0	U32	1:1	RW	no	Homing acceleration	HOME.ACC HOME.DEC
60B1h	0	INT32	1:1	RW	yes	Velocity offset	"VL.BUSFF" (=> p. 629)
60B2h	0	INT16		RW	yes	Torque offset (PDO only)	

Index	Sub-index	DataType	Float Scaling	Access	PDO mapp.	Description	ASCII object
60C0h	0	INT8		RW	no	Interpolation submode select	—
60C1h		ARRAY				Interpolation data record	—
60C1h	0	U8		RO	no	Number of entries	—
60C1h	1	INT32		RW	yes	x1, first parameter of ip function	—
60C2h		RECORD				Interpolation time period	—
60C2h	0	U8		RO	no	Number of entries	FBUS.SAMPLEPERIOD
60C2h	1	U8		RW	no	Interpolation time units	—
60C2h	2	INT16		RW	no	Interpolation time index	—
60C4h		RECORD				Interpolation data configuration	—
60C4h	0	U8		RO	no	Number of entries	—
60C4h	1	U32		RO	no	Maximum buffer size	—
60C4h	2	U32		RW	no	Actual buffer size	—
60C4h	3	U8		RW	no	Buffer organization	—
60C4h	4	U16		RW	no	Buffer position	—
60C4h	5	U8		WO	no	Siza of data record	—
60C4h	6	U8		WO	no	Buffer clear	—
60F4h	0	INT32		RO	yes	Following error actual value	PL.ERR
60FDh	0	U32		RO	yes	Digital inputs	DIN1.MODE TO DIN7.MODE
60FEh		ARRAY				Digital outputs	
60FEh	0	U8		RO	no	Number of entries	
60FEh	1	U32		RW	yes	Physical outputs	
60FEh	2	U32		RW	no	Bit mask	
60FFh	0	INT32		RW	yes	Target velocity	VL.CMDU
6502h	0	U32		RO	no	Supported drive modes	—

20.7.2 Examples

20.7.2.1 Examples, setup

All examples are valid for the AKD. All values are hexadecimal.

Basic testing of the connection to the AKD controls

When the AKD is switched on, a boot-up message is transmitted over the bus. The telegram continues to be transmitted, as long as it has not yet found a suitable receiver in the bus system.
If a CAN master is unable to recognize this message, then the following measures can be taken to test communication:

- Check the bus cable: correct characteristic impedance, correct termination resistors at both ends?
- With a multimeter: check the quiescent level of the bus cables CAN-H and CAN-L against CAN-GND (approx. 2.5 V).
- With an oscilloscope: check the output signals on CAN-H and CAN-L at the AKD. Are signals being transmitted on the bus? The voltage difference between CAN-H and CAN-L for a logical "0" is approx. 2-3 V.
- Does signal transmission stop if the master is connected?
- Check the master hardware.
- Check the master software!

Example: Operating the Status Machine

NOTE	**The status machine must be used sequentially during boot-up period. Leaving out a state (except for state “switched on”) is not possible.**

When the AKD is switched on and the boot-up message has been detected, communication via SDOs can be initiated. For example: all the parameters can be read out or written to, or the status machine for the drive can be controlled.

The state of the status machine can be obtained through the query of Object 6041h Sub 0.

Directly after switch-on, a value will be returned, such as 0240h. This corresponds to the status "Switch on disabled".

The following data would then be visible on the CAN bus:

COB-ID	Control	Index		Sub-	Data	Comment
	byte	Low byte	High byte	index		
603	40	41	60	00h	40 00 00 00	
583	4B	41	60	00h	40 02 00 00	response telegram
	2 bytes of data				status	

If the supply power is present and the hardware enable is at the High level (24 V to DGND) then you can try to switch the drive to the state "Switched on" by writing the Control word (Object 6040 Sub 0). If this is successful, there will be a positive acknowledgement in the SDO reply (control byte 0 in the data field = 60h).

Switch on

The messages then appear as follows:

COB-ID	Control	Index		Sub-	Data	Comment
	byte	Low byte	High byte	index		
603	2B	40	60	00h	06 00 00 00	Shut down
583	60	40	60	00h	00 00 00 00	response telegram
603	2B	40	60	00h	07 00 00 00	Switch on
583	60	40	60	00h	00 00 00 00	response telegram

control word = 0x0007 meaning:
Bit 0, Bit 1, Bit 2 set => Switch On,
Disable Voltage off, Quick Stop off

Status query 2

The new status can then be queried again, and returns the following result:

COB-ID	Control	Index		Sub-	Data	Comment
	byte	Low byte	High byte	index		
603	40	41	60	00h	—	query status
583	4B	41	60	00h	33 02 00 00	response telegram

Status = 0x0233 meaning:
Bit 0, Bit 1, Bit 5 set => ready to Switch On,
Bit 9 set => remote, operation possible via RS232

Example: Jog Mode via SDO

The motor shall work with constant velocity.

COB-ID	Control byte	Index Low byte	Index High byte	Sub-index	Data	Comment
603	2F	60	60	00h	03 00 00 00	Mode of operation “Profile Velocity”
583	60	60	60	00h	00 00 00 00	response telegram
603	23	FF	60	00h	00 00 00 00	setpoint=0
583	60	FF	60	00h	00 00 00 00	response telegram
603	2B	40	60	00h	06 00 00 00	shutdown
583	60	40	60	00h	00 00 00 00	response telegram
603	2B	40	60	00h	07 00 00 00	switch on
583	60	40	60	00h	00 00 00 00	response telegram
603	2B	40	60	00h	0F 00 00 00	enable operation
583	60	40	60	00h	00 00 00 00	response telegram
603	23	FF	60	00h	00 41 00 00	velocity setpoint
583	60	FF	60	00h	00 00 00 00	response telegram
603	2B	40	60	00h	0F 01 00 00	Intermediate Stop
583	60	40	60	00h	00 00 00 00	response telegram

Example: Torque Mode via SDO

The motor shall work with constant torque. CAN data:

COB-ID	Control byte	Index Low byte	Index High byte	Sub-index	Data	Comment
603	2F	60	60	00h	04 00 00 00	Mode of operation “Torque”
583	60	60	60	00h	00 00 00 00	response telegram
603	2B	71	60	00h	00 00 00 00	setpoint=0
583	60	71	60	00h	00 00 00 00	response telegram
603	2B	40	60	00h	06 00 00 00	shutdown
583	60	40	60	00h	00 00 00 00	response telegram
603	2B	40	60	00h	07 00 00 00	switch on
583	60	40	60	00h	00 00 00 00	response telegram
603	2B	40	60	00h	0F 00 00 00	enable operation
583	60	40	60	00h	00 00 00 00	response telegram
603	2B	71	60	00h	90 01 00 00	setpoint 400 mA
583	60	71	60	00h	00 00 00 00	response telegram
603	2B	40	60	00h	0F 01 00 00	intermediate Stop
583	60	40	60	00h	00 00 00 00	response telegram

Example: Jog Mode via PDO

It is useful to disable unused PDOs. In Operation Mode "Digital Velocity" a digital speed setpoint is transmitted via RXPDO. Actual position and actual speed is read via a TXPDO triggered by SYNC.

COB-ID	Control byte	Index Low byte	Index High byte	Sub-index	Data	Comment
603	2F	60	60	00h	03 00 00 00	mode of operation “Profile Velocity”
583	60	60	60	00h	00 00 00 00	response telegram
603	2F	00	16	00h	00 00 00 00	delete entries for the first RXPDO
583	60	00	16	00h	00 00 00 00	response telegram
603	23	00	16	01h	20 00 FF 60	mapping RXPDO1, Object 60FF, Subindex 0 speed setpoint, data length 32bit
583	60	00	16	01h	00 00 00 00	response telegram
603	2F	00	16	00h	01 00 00 00	confirm number of mapped objects
583	60	00	16	00h	00 00 00 00	response telegram
603	2F	00	1A	00h	00 00 00 00	delete entries for the first TXPDO
583	60	00	1A	00h	00 00 00 00	response telegram
603	23	00	1A	01h	20 00 64 60	mapping TXPDO1/1, Object6064, Subindex 0 current position value in SI units, data length 32bit
583	60	00	1A	01h	00 00 00 00	response telegram
603	23	00	1A	02h	20 00 6C 60	mapping TXPDO1/2, Object606C, Subindex 0 current speed value, data length 32bit
583	60	00	1A	02h	00 00 00 00	response telegram
603	2F	00	1A	00h	02 00 00 00	check number of mapped objects
583	60	00	1A	00h	00 00 00 00	response telegram
603	2F	00	18	02h	01 00 00 00	set TXPDO1 to synchronous, transmission with every SYNC
583	60	00	18	02h	00 00 00 00	response telegram
603	23	01	18	01h	83 02 00 80	disable TPDO2, set bit 31 (80h)
583	60	01	18	01h	00 00 00 00	response telegram
603	23	02	18	01h	83 03 00 80	disable TPDO3
583	60	02	18	01h	00 00 00 00	response telegram
603	23	03	18	01h	83 04 00 80	disabled TPDO4
583	60	03	18	01h	00 00 00 00	response telegram
603	23	01	14	01h	03 03 00 80	disabled RPDO2
583	60	01	14	01h	00 00 00 00	response telegram
603	23	02	14	01h	03 04 00 80	disabled RPDO3
583	60	02	14	01h	00 00 00 00	response telegram
603	23	03	14	01h	03 05 00 80	disabled RPDO4
583	60	03	14	01h	00 00 00 00	response telegram
000					01 03	enable NMT
603	2B	40	60	00h	06 00 00 00	shutdown
583	60	40	60	00h	00 00 00 00	response telegram
603	2B	40	60	00h	07 00 00 00	switch on
583	60	40	60	00h	00 00 00 00	response telegram
603	2B	40	60	00h	0F 00 00 00	enable operation
583	60	40	60	00h	00 00 00 00	response telegram
203					00 40	velocity setpoint
080						send SYNC

COB-ID	Control byte	Index Low byte	Index High byte	Sub-index	Data	Comment
183					FE 45 01 00 A6 AB 1A 00	response
603	2B	40	60	00h	0F 01 00 00	intermediate stop
583	60	40	60	00h	00 00 00 00	response telegram

Example: Torque Mode via PDO

It is useful to disable unused PDOs. The first TX_PDO shall transmit the actual current value with every SYNC.

COB-ID	Control byte	Index Low byte	Index High byte	Sub-index	Data	Comment
603	2F	60	60	00h	04 00 00 00	Mode of operation “Torque”
583	60	60	60	00h	00 00 00 00	response telegram
603	2F	00	16	00h	00 00 00 00	delete entry for the first RXPDO
583	60	00	16	00h	00 00 00 00	response telegram
603	23	00	16	01h	10 00 71 60	mapping RXPDO1, Object6071,Subindex 0 current setpoint, data length 16bit
583	60	00	16	01h	00 00 00 00	response telegram
603	2F	00	16	00h	01 00 00 00	check number of mapped objects
583	60	00	16	00h	00 00 00 00	response telegram
603	2F	00	1A	00h	00 00 00 00	delete entry for TXPDO1
583	60	00	1A	00h	00 00 00 00	response telegram
603	23	00	1A	01h	10 00 77 60	mapping TXPDO1, Object6077,Subindex 0 actual current value, Data length16bit
583	60	00	1A	01h	00 00 00 00	response telegram
603	2F	00	1A	00h	01 00 00 00	number of mapped objects
583	60	00	1A	00h	00 00 00 00	response telegram
603	2F	00	18	02h	01 00 00 00	set TXPDO1 to synchronous, transmission with every SYNC
583	60	00	18	02h	00 00 00 00	response telegram
603	23	01	18	01h	83 02 00 80	disable TPDO2, set bit 31 (80h)
583	60	01	18	01h	00 00 00 00	response telegram
603	23	02	18	01h	83 03 00 80	disable TPDO3
583	60	02	18	01h	00 00 00 00	response telegram
603	23	03	18	01h	83 04 00 80	disabled TPDO4
583	60	03	18	01h	00 00 00 00	response telegram
603	23	01	14	01h	03 03 00 80	disabled RPDO2
583	60	01	14	01h	00 00 00 00	response telegram
603	23	02	14	01h	03 04 00 80	disabled RPDO3
583	60	02	14	01h	00 00 00 00	response telegram
603	23	03	14	01h	03 05 00 80	disabled RPDO4
583	60	03	14	01h	00 00 00 00	response telegram
000					01 03	enable NMT
603	2B	40	60	00h	06 00 00 00	shutdown
583	60	40	60	00h	00 00 00 00	response telegram
603	2B	40	60	00h	07 00 00 00	switch on
583	60	40	60	00h	00 00 00 00	response telegram
603	2B	40	60	00h	0F 00 00 00	enable operation
583	60	40	60	00h	00 00 00 00	response telegram
203					12 02	setpoint 530 mA
080						send SYNC
183					19 02	actual value 537 mA
603	2B	40	60	00h	0F 01 00 00	intermediate stop
583	60	40	60	00h	00 00 00 00	response telegram

Example: Homing via SDO

When the AKD is operated as a linear axis, a reference/homing point must be defined before positioning tasks can be executed. This must be done by executing a homing run in the Homing mode (0x6).

This example shows the procedure in the Homing mode.

Now some of the parameters that affect the homing movement are set via the bus. If you can be absolutely certain that no-one has altered the parameters in the servoamplifier, then this part can be omitted, since the servoamplifier save the data in non-volatile memory. The inputs must be configured as limit switches.

Because the dimension parameters are not finally defined in DS402, you must select these units:

UNIT.PROTARY = 3
UNIT.VROTARY = 3
UNIT.ACCROTARY = 3

The basic setup of the servoamplifier must be done with the help of the setup software before starting the homing run. The resolution has been set to 10000 µm/turn in this example.

COB-ID	Control	Index		Sub-	Data	Comment
	byte	Low byte	High byte	index		
703	00					boot-up message
603	40	41	60	00h	00 00 00 00	read profile status
583	4B	41	60	00h	40 02 00 00	response : 0240h
603	23	99	60	01h	10 27 00 00	v_{ref}=10000 counts/s until limit switch is reached
583	60	99	60	01h	00 00 00 00	response telegram
603	23	99	60	02h	88 13 00 00	v_{ref}=5000 counts/s from limit switch to zero mark
583	60	99	60	02h	00 00 00 00	response telegram
603	23	9A	60	00h	10 27 00 00	Decel. and Accel. ramp 1000counts/s²
583	60	9A	60	00h	00 00 00 00	response telegram
603	23	7C	60	00h	A8 61 00 00	Reference offset 25000counts
583	60	7C	60	00h	00 00 00 00	response telegram

Homing type (6098h)

COB-ID	Control byte	Index Low byte	Index High byte	Sub-index	Data	Comment
603	2F	60	60	00h	06 00 00 00	mode of operation = homing
583	60	60	60	00h	00 00 00 00	response telegram
603	40	41	60	00h	00 00 00 00	read profile status, response: 0250h Voltage Enabled
583	4B	41	60	00h	40 02 00 00	response : 0240h
603	2B	40	60	00h	06 00 00 00	Control word Transition_2,"ready to switch on". Shutdown
583	60	40	60	00h	00 00 00 00	response telegram
603	2B	40	60	00h	07 00 00 00	Transition_3, "switch on". switch on
583	60	40	60	00h	00 00 00 00	response telegram
603	2B	40	60	00h	0F 00 00 00	Transition_4,"operation enable"
583	60	40	60	00h	00 00 00 00	response telegram
603	40	41	60	00h	00 00 00 00	read profile status
583	4B	41	60	00h	37 02 00 00	response telegram
603	2B	40	60	00h	1F 00 00 00	Homing_operation_start
583	60	40	60	00h	00 00 00 00	response telegram
603	40	41	60	00h	00 00 00 00	read profile status, response: homing not fin-ished
583	4B	41	60	00h	37 02 00 00	response: homing not finished
603	40	41	60	00h	00 00 00 00	read profile status, response: homing fin-ished
583	4B	41	60	00h	37 16 00 00	response:homing finished

Bit 12 in SDO 6041 indicates, whether homing is finished. Reading of the profile status is not necessary.

Example: Using the Profile Position Mode

This example shows the operation of the Profile position mode. For this, the PDOs are set as follows:
First RPDO. No special mapping necessary, because the default mapping enters the controlword RXPDO1.
Second RPDO

COB-ID	Control	Index		Sub-	Data	Comment
	byte	Low byte	High byte	index		
603	2F	01	16	00h	00 00 00 01	RPDO2: delete mapping
583	60	01	16	00h	00 00 00 00	response telegram
603	23	01	16	01h	20 00 7A 60	RPDO2, entry 1: target_position
583	60	01	16	01h	00 00 00 00	response telegram
603	23	01	16	02h	20 00 81 60	RPDO2, entry 2: profile_velocity
583	60	01	16	02h	00 00 00 00	response telegram
603	2F	01	16	00h	02 00 00 00	enter number of mapped objects
583	60	01	16	00h	00 00 00 00	response telegram

First TPDO

COB-ID	Control	Index		Sub-	Data	Comment
	byte	Low byte	High byte	index		
603	2F	00	1A	00h	00 00 00 01	TPDO1: delete mapping
583	60	00	1A	00h	00 00 00 00	response telegram
603	23	00	1A	01h	10 00 41 60	TPDO1, entry 1: profile statusword
583	60	00	1A	01h	00 00 00 00	response telegram
603	2F	00	1A	00h	01 00 00 00	enter number of mapped objects
583	60	00	1A	00h	00 00 00 00	response telegram

Second TPDO

COB-ID	Control	Index		Sub-	Data	Comment
	byte	Low byte	High byte	index		
603	2F	01	1A	00h	00 00 00 01	TPDO2: delete mapping
583	60	01	1A	00h	00 00 00 00	response telegram
603	23	01	1A	01h	20 00 64 60	TPDO2, entry 1: position_actual_value
583	60	01	1A	01h	00 00 00 00	response telegram
603	23	01	1A	02h	20 00 6C 60	TPDO2, entry 2: velocity_actual_value
583	60	01	1A	02h	00 00 00 00	response telegram
603	2F	01	1A	00h	02 00 00 00	enter number of mapped objects
583	60	01	1A	00h	00 00 00 00	response telegram

The second TPDO should be sent with every SYNC by the servoamplifier.

COB-ID	Control byte	Index Low byte	Index High byte	Sub-index	Data	Comment
603	2F	01	18	02h	01 00 00 00	TPDO2 with every SYNC
583	60	01	18	02h	00 00 00 00	response telegram

Disable unused TPDOs

COB-ID	Control byte	Index Low byte	Index High byte	Sub-index	Data	Comment
603	23	02	18	01h	83 03 00 80	disable TPDO3
583	60	02	18	01h	00 00 00 00	response telegram
603	23	03	18	01h	83 04 00 80	disable TPDO4
583	60	03	18	01h	00 00 00 00	response telegram

Disable unused RPDOs

COB-ID	Control byte	Index Low byte	Index High byte	Sub-index	Data	Comment
603	23	02	14	01h	03 04 00 80	disable RPDO3
583	60	02	14	01h	00 00 00 00	response telegram
603	23	03	14	01h	03 05 00 80	disable RPDO4
583	60	03	14	01h	00 00 00 00	response telegram

Define mechanical resolution via Object 6092h, Subindex 01h and 02h. Default values are the motion specific factors PGEARI and PGEARO:

COB-ID	Control byte	Index Low byte	Index High byte	Sub-index	Data	Comment
603	23	93	60	01h	00 00 10 00	2E20 increments
583	60	93	60	01h	00 00 00 00	response telegram
603	23	93	60	02h	A0 8C 00 00	3600 user units
583	60	93	60	02h	00 00 00 00	response telegram

After defining the PDOs they can be released with the NMT:

COB-ID		Data	Comment
000		01 03	enable NMT
183		40 02	profile status

Now the homing can be set and started.

COB-ID	Control	Index		Sub-	Data	Comment
	byte	Low byte	High byte	index		
603	2F	60	60	00h	06 00 00 00	Operation mode = homing
583	60	60	60	00h	00 00 00 00	response telegram
603	2F	98	60	00h	0C 00 00 00	homing type 12, negative direction (DS402)
583	60	98	60	00h	00 00 00 00	response telegram
603	23	99	60	01h	40 19 01 00	homing speed 72000 units/s=2s-1
583	80	99	60	01h	31 00 09 06	response telegram
603	2B	40	60	00h	06 00 00 00	Transition_2,"ready to switch on".Shutdown
583	60	40	60	00h	00 00 00 00	response telegram
183					21 02	response telegram
603	2B	40	60	00h	07 00 00 00	Transition_3,"switch on".Switch on
583	60	40	60	00h	00 00 00 00	response telegram
183					33 02	response telegram
603	2B	40	60	00h	0F 00 00 00	Control word: Operation Enable
583	60	40	60	00h	00 00 00 00	response telegram
183					37 02	response telegram
603	2B	40	60	00h	1F 00 00 00	start homing response telegram response: target reached response: homing attained
583	60	40	60	00h	00 00 00 00	response telegram
183					37 06	
183					37 16	

Finish homing with Control word 1_RPDO

COB-ID		Data	Comment
203		0F 00	

Switch to Profile Position Mode and set ramps for positioning

COB-ID	Control	Index		Sub-	Data	Comment
	byte	Low byte	High byte	index		
603	2F	60	60	00h	01 00 00 00	Profile Positioning Mode
583	60	60	60	00h	00 00 00 00	response telegram
603	23	83	60	00h	32 00 00 00	50ms acceleration time
583	60	83	60	00h	00 00 00 00	response telegram
603	23	84	60	00h	32 00 00 00	50ms deceleration time
583	60	84	60	00h	00 00 00 00	response telegram

Setpoint

COB-ID		Data	Comment
303		20 4E 00 00	Pos 8CA0 =36000µm ; V= 20000 µm/s
080			send a SYNC
283		BB F8 FF FF	response telegram

Set controlword with „new setpoint“ by bit (bit 4)

COB-ID		Data	Comment
203		1F 00	

Wait

COB-ID		Data	Comment
183		37 12	setpoint acknowledge

Reset controlword with „new setpoint“ by bit (bit 4) reset

COB-ID		Data	Comment
203		0F 00	
183		37 02	reset Setpoint acknowledge

Wait

COB-ID		Data	Comment
183		37 06	response: target reached
080			SYNC
283		92 FC FF FF	response: 92 FC position , FF FF speed

Example: ASCII Communication

This example sets P gain of the velocity controller to 6. The ASCII command for this is "GV 6".

COB-ID	Control	Index		Sub-	Data	Comment
	byte	Low byte	High byte	index		
603	2F	26	10	01h	47 00 00 00	send ASCII code "G"
583	60	26	10	01h	00 00 00 00	response telegram
603	2F	26	10	01h	56 00 00 00	send ASCII code "V"
583	60	26	10	01h	00 00 00 00	response telegram
603	2F	26	10	01h	20 00 00 00	send ASCII code "SP" (space)
583	60	26	10	01h	00 00 00 00	response telegram
603	2F	26	10	01h	36 00 00 00	send ASCII code "6"
583	60	26	10	01h	00 00 00 00	response telegram
603	2F	26	10	01h	0D 00 00 00	send ASCII code "CR"
583	60	26	10	01h	00 00 00 00	response telegram
603	2F	26	10	01h	0A 00 00 00	send ASCII code "LF"
583	60	26	10	01h	00 00 00 00	response telegram

Test for SYNC telegrams

Configuration

- Assign Target Position and Profile Velocity to a PDO (2nd receive-PDO)
- Assign Actual Position to a PDO (1st transmit-PDO), generated with every 2nd SYNC.
- Assign Status word and Manufacturer Status to a PDO (2nd transmit-PDO), generated with every 3rd SYNC.

Telegrams with the corresponding responses:

COB-ID	Control byte	Index		Sub-index	Data	Comment
		Low byte	High byte			
603	2F	01	16	00h	00 00 00 00	RPDO2: delete mapping
583	60	01	16	00h	00 00 00 00	
603	23	01	16	01h	20 00 7A 60	RPDO2, entry 1: target position
583	60	01	16	01h	00 00 00 00	
603	23	01	16	02h	20 00 81 60	RPDO2, entry 2: profile velocity
583	60	01	16	02h	00 00 00 00	
603	2F	01	16	00h	02 00 00 00	RPDO2: enter number of mapped objects
583	60	01	16	00h	00 00 00 00	
603	2F	00	1A	00h	00 00 00 00	TPDO1: delete mapping
583	60	00	1A	00h	00 00 00 00	
603	23	00	1A	01h	20 00 64 60	TPDO1: entry 1: Actual Position
583	60	00	1A	01h	00 00 00 00	
603	2F	00	1A	00h	01 00 00 00	TPDO1: enter number of mapped objects
583	60	00	1A	00h	00 00 00 00	
603	2F	00	18	02h	02 00 00 00	TPDO1: send with every 2nd SYNC
583	60	00	18	02h	00 00 00 00	
603	2F	01	1A	00h	00 00 00 00	TPDO2: delete mapping
583	60	01	1A	00h	00 00 00 00	
603	23	01	1A	01h	10 00 41 60	TPDO2: entry 1: Status word
583	60	01	1A	01h	00 00 00 00	
603	23	01	1A	02h	20 00 02 10	TPDO2: entry 2: Manufacturer Status
583	60	01	1A	02h	00 00 00 00	
603	2F	01	16	00h	02 00 00 00	TPDO2: enter number of mapped objects
583	60	01	16	00h	00 00 00 00	
603	2F	01	18	02h	03 00 00 00	TPDO2: send with every 3rd SYNC
583	60	01	18	02h	00 00 00 00	

SYNC-Object

COB-ID	Comment
080	Object 181 (TPDO 1) appears at every 2nd SYNC Object 281 (TPDO 2) appears at every 3rd SYNC

Emergency-Object

If, for instance, the resolver connector is disconnected, a serious error will be caused in the controller. This results in an Emergency telegram.

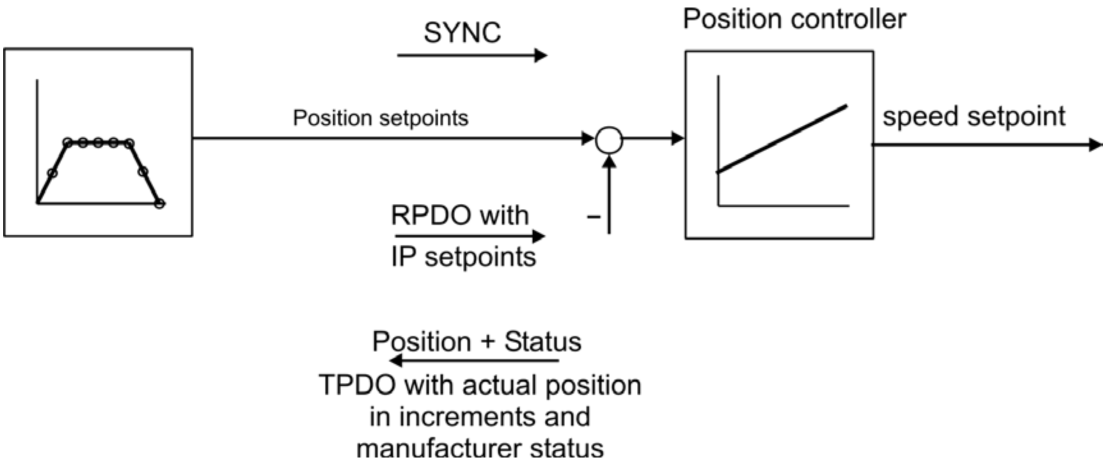
COB-ID	Emergency error		Error register		
	Low	High			
081	10	43	08	00 00 00 00	motor temperature, temperature, manufacturer specific
081	00	00	88	00 00 00 00	

20.7.2.2 Examples, special applications

Example: External Trajectory with Interpolated Position Mode

This example shows the possible application for giving two axes position setpoints within one PDO.

Controller structure for the position controller within the drive:



All data are hexadecimal. In the example, the two axes in the system have the station addresses 1 and 2.

Before you begin this procedure, complete the following items:

- The internal syncronisation must be used for the IP-mode.For that purpose the parameter SYNCSRC (Object 3683 sub 1) must be set to 3.
- The parameters must be saved to EEPROM.
- A coldstart must be done to enable the syncronisation possibility.
- The axes are homed (for this example).

The common PDO contains 2 IP (interolpated position) – setpoints and can be transmitted simultaneously to two stations, whereby each station can extract the relevant data. The other data can be made ignored by using dummy entries (Object 2100 sub 0). For this purpose both axes must react on the same RPDO-COB-ID.

Action

Do the RPDO2-mapping for both axis:

Axis 1:

COB-ID	Control byte	Index Low byte	Index High byte	Sub-index	Data	Comment
601	2F	01	16	00h	00 00 00 00	RPDO2: delete mapping
581	60	01	16	00h	00 00 00 00	
601	23	01	16	01h	20 01 C1 60	RPDO2, entry 1: IP setpoint axis 1
581	60	01	16	01h	00 00 00 00	
601	23	01	16	02h	20 00 00 21	RPDO2, entry 2: Dummy entry 4 bytes
581	60	01	16	02h	00 00 00 00	
601	2F	01	16	00h	02 00 00 00	RPDO2, enter number of mapped objects
581	60	01	16	00h	00 00 00 00	

Axis 2:

COB-ID	Control byte	Index Low byte	Index High byte	Sub-index	Data	Comment
602	2F	01	16	00h	00 00 00 00	RPDO2: delete mapping
582	60	01	16	00h	00 00 00 00	
602	23	01	16	02h	20 00 00 21	RPDO2, entry 1: Dummy entry 4 bytes
582	60	01	16	02h	00 00 00 00	
602	23	01	16	01h	20 01 C1 60	RPDO2, entry 2: IP setpoint axis 2
582	60	01	16	01h	00 00 00 00	
602	2F	01	16	00h	02 00 00 00	RPDO2, enter number of mapped objects
582	60	01	16	00h	00 00 00 00	
602	23	01	16	01h	01 03 00 00	RPDO2: Set COB-ID identical to axis 1
582	60	01	16	01h	00 00 00 00	

Now both axis react to the same COB-identifier 0x301, axis 1 takes byte 0 to 3 as IP setpoint, axis 2 takes byte 4 to 7. The second TPDOs shall contain the actual position in increments and the manufacturer status.

Mapping configuration for axis 1:

COB-ID	Control byte	Index Low byte	Index High byte	Sub-index	Data	Comment
601	2F	01	1A	00h	00 00 00 00	TPDO2: delete mapping
581	60	01	1A	00h	00 00 00 00	
601	23	01	1A	01h	20 00 63 60	TPDO2, entry 1: actual position in increments
581	60	01	1A	01h	00 00 00 00	
601	23	01	1A	02h	20 00 02 10	TPDO2, entry 2: Dummy entry 4 bytes
581	60	01	1A	02h	00 00 00 00	
601	2F	01	1A	00h	02 00 00 00	TPDO2, enter number of mapped objects
581	60	01	1A	00h	00 00 00 00	

The same must be done for axis 2.

Here it is assumed that both drives accept new trajectory values with every SYNC command, and must return their incremen tal position and manufacturer status values. The communication parameters must be set accordingly.

Axis 1:

COB-ID	Control byte	Index Low byte	Index High byte	Sub-index	Data	Comment
601	2F	01	14	02h	01 00 00 00	RPDO2 axis 1, reaction on every sync
581	60	01	14	02h	00 00 00 00	
602	2F	01	14	02h	01 00 00 00	RPDO2 axis 2, reaction on every sync
582	60	01	14	02h	00 00 00 00	
601	2F	01	18	02h	01 00 00 00	TPDO2 axis 1, reaction on every sync
581	60	01	18	02h	00 00 00 00	
602	2F	01	18	02h	01 00 00 00	TPDO2 axis 2, reaction on every sync
582	60	01	18	02h	00 00 00 00	

The other Tx-PDOs 3 and 4 should be switched off to minimize bus-load:

COB-ID	Control byte	Index Low byte	Index High byte	Sub-index	Data	Comment
601	23	02	18	01h	81 03 00 80	Switch off TPDO3
581	60	02	18	01h	00 00 00 00	
601	23	03	18	01h	81 04 00 80	Switch off TPDO4
581	60	03	18	01h	00 00 00 00	

The same must be done for axis 2.

In order to be able to make trajectory movements, both drives must be operating in the appropriate mode. This is set through Index 6060h:

COB-ID	Control byte	Index Low byte	Index High byte	Sub-index	Data	Comment
601	2F	60	60	00h	07 00 00 00	Set IP mode for axis 1
581	60	60	60	00h	00 00 00 00	
602	2F	60	60	00h	07 00 00 00	Set IP mode for axis 2
582	60	60	60	00h	00 00 00 00	

The cycle interval for the IP-mode shall be 1 ms. This must be defined with Object 60C1 sub 1 and 2:

COB-ID	Control byte	Index Low byte	Index High byte	Sub-index	Data	Comment
601	2F	C2	60	01h	01 00 00 00	Interpolation time unit 1
581	60	C2	60	01h	00 00 00 00	
601	2F	C2	60	02h	FD 00 00 00	Interpolation time index -3 -> Cycle time = $1 * 10^{-3}$ s
581	60	C2	60	02h	00 00 00 00	

The same must be done for axis 2.

To start up the axes, the drives must be put into the operational status (operation enable) and the network management functions must be started.

The network management functions enable the application of the Process Data Objects (PDOs) and are initia lized by the following telegram for both axes:

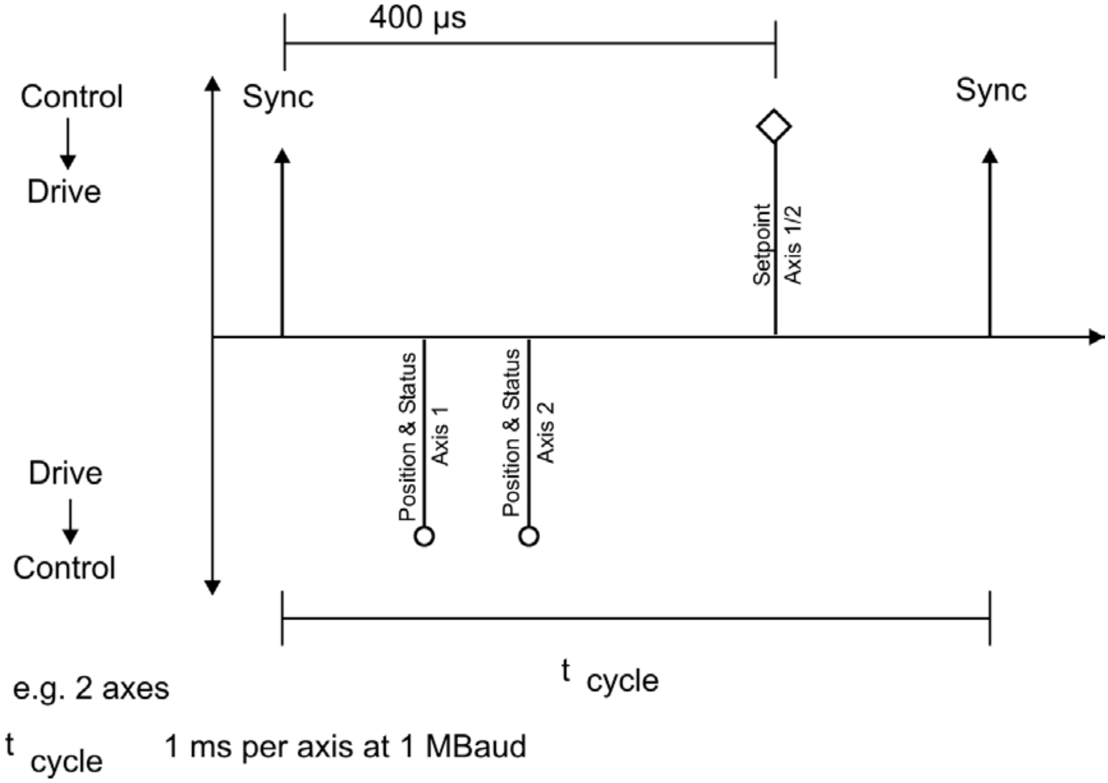
Switch the NMT (Network Management) status machine to operation enable:

COB-ID	Command specifier (CS)	Node-ID	Comment
0	1	1	NMT enable for all axes

Next, power is applied to each drive, and they are put into the operation enable condition. This should be done in steps with waiting for the appropriate reaction of the drive (e.g. axis 1):

COB-ID	Data	Comment
201	06 00	Shutdown command
181	31 02	State Ready_to_switch_on
201	07 00	Switch_on command
181	33 02	State Switched_on
201	0F 00	Enable_operation command
181	37 02	State Operation_enabled
201	1F 00	Enable IP-mode
181	37 12	IP-mode enable

The configuration above now enables a cyclical sequence, as shown in the diagram:



RPDO 2 can now be used to supply trajectory data for both axes, e.g.:

COB-ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
301	F4	01	00	00	E8	03	00	00

In this example, the first axis receives a trajectory value of 500 increments (Bytes 0 to 3) and the second axis receives a trajectory value of 1000 increments.

The axes accept these values, and the positioning is made when the next SYNC telegram is received.

SYNC telegram

COB-ID
080

Afterwards, both axes send back their incremental positions and the contents of their status registers when the SYNC Object with the COB-ID for the 2nd TPDO is received.

COB-ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Comment
181	23	01	00	00	00	00	03	44	position + manufacturer status register for axis1
182	A5	02	00	00	00	00	03	44	position + manufacturer status register for axis2

If an error occurs during operation, the axis concerned transmits an Emergency message, which could appear like this:

Emergency Object

COB-ID	Emergency error		Error register	Category		
	Low	High				
081	10	43	08	01	00 00 00 00	motor temperature, temperature, manufacturer-specific
081	00	00	08	00	00 00 00 00	

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21 Ethercat Manual

AKD™

EtherCAT Communication

Edition: Revision B, December 2010

Valid for Hardware Revision A

Part Number 903-200005-00

Original Documentation

Keep all manuals as a product component during the life span of the product. Pass all manuals to future users and owners of the product.

Record of Document Revisions:

Revision	Remarks
-, 11/2009	Beta launch version
-, 12/2009	Minor formatting changes
A, 07/2010	FBUS.PARAM04 added, part number added, page format, release information
B, 10/2010	Setup for KAS added

Hardware Revision (HR)

Hardware Revision	Firmware	WorkBench	Remarks
A	M_01-03-zz-zzz	1.3.0.zzzzz	Start revision
B	M_01-04-zz-zzz	1.4.0.zzzzz	STO certified

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Current patents:

US Patent 5,646,496 (used in control card R/D and 1 Vp-p feedback interface)

US Patent 5,162,798 (used in control card R/D)

US Patent 6,118,241 (used in control card simple dynamic braking)

Technical changes which improve the performance of the device may be made without prior notice!

Printed in the United States of America

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21.1 General

21.1.1 About this Manual

This manual, *AKD EtherCAT Communication*, describes the installation, setup, range of functions, and software protocol for the EtherCAT AKD product series. All AKD EtherCAT drives have built-in EtherCAT functionality; therefore an additional option card is not required.

A digital version of this manual (pdf format) is available on the CD-ROM included with your drive. Manual updates can be downloaded from the Kollmorgen website.

Related documents for the AKD series include:

- *AKD Quick Start* (also provided in hard copy). This guide provides instructions for basic drive setup and connection to a network.
- *AKD Installation Manual* (also provided in hard copy for EU customers). This manual provides instructions for installation and drive setup.
- *AKD Parameter and Command Reference Guide*. This guide provides documentation for the parameters and commands used to program the AKD.
- *AKD CANopen Communication*. This manual includes setup information for the CAN interface and describes the CANopen profile.

Additionally, an EtherCAT XML file, entitled *AKD EtherCAT Device Description*, describes the drive SDO and PDO. This file is available on the Kollmorgen website:

http://www.kollmorgen.com/website/com/eng/products/drives/ac_servo_drives/akd_drives_akd_software_tab.php

21.1.2 Target Group

This manual addresses personnel with the following qualifications:

- Installation: only by electrically qualified personnel.
- Setup: only by qualified personnel with extensive knowledge of electrical engineering and drive technology
- Programming: Software developers, project-planners

The qualified personnel must know and observe the following standards:

- ISO 12100, IEC 60364 and IEC 60664
- National accident prevention regulations

WARNING	**During operation there are deadly hazards, with the possibility of death, severe injury or material damage. The operator must ensure that the safety instructions in this manual are followed. The operator must ensure that all personnel responsible for working with the servo drive have read and understand the manual.**

21.1.3 Abbreviations Used

Abbreviation	Meaning
AL	Application Layer: the protocol that directly used by the process entities.
Cat	Category – classification for cables that is also used in Ethernet.
DC	Distributed Clocks Mechanism to synchronize EtherCAT slaves and master
DL	Data Link(=Layer 2). EtherCAT uses Ethernet, which is standardized as IEEE 802.3.
FPGA	Field Programmable Gate Array
FTP	File Transfer Protocol
HW	Hardware
ICMP	Internet Control Message Protocol: Mechanisms for signaling IP errors.
IEC	International Electrotechnical Commission: The international standards
IEEE	Institute of Electrical and Electronics Engineers, Inc.
LLDP	Link Layer Discovery Protocol
MAC	Media Access Control
MII	Media Independent Interface: Standardized interface Ethernet controller <-> routing equipment.
MDI	Media Dependant Interface: Use of connector Pins and Signaling.
MDI-X	Media Dependant Interface (crossed): Use of connector Pins and Signaling with crossed lines.
OSI	Open System Interconnect
OUI	Organizationally Unique Identifier – the first 3 Bytes of an Ethernet-Address, that will be assign to companies or organizations and can be used for protocoll identifiers as well (e.g. LLDP)
PDI	Physical Device Interface: set of elements that allows access to ESC from the process side.
PDO	Process Data Object
PDU	Protocol Data Unit: Contains protocol information transferred from a protocol instance of trans-parent data to a subordinate level
PHY	Physical interface that converts data from the Ethernet controller to electric or optical signals.
PLL	Phase Locked Loop
PTP	Precision Time Protocol in accordance with IEEE 1588
RSTP	Rapid Spanning Tree Protocol
RT	Real-time, can be run in Ethernet controllers without special support.
RX	Receive
RXPDO	Receive PDO
SNMP	Simple Network Management Protocol
SPI	Serial Peripheral Interface
Src Addr	Source Address: Source address of a message.
STP	Shielded Twisted Pair
TCP	Transmission Control Protocol
TX	Transmit
TXPDO	Transmit PDO
UDP	User Datagram Protocol: Non-secure multicast/broadcast frame.
UTP	Unshielded Twisted Pair
ZA ECAT	Access mode EtherCAT
ZA Drive	Acces mode drive

21.2 Safety

21.2.1 Safety Instructions

⚠ DANGER	During operation there are deadly hazards, with the possibility of death, severe injury or material damage. Do not open or touch the equipment during operation. Keep all covers and cabinet doors closed during operation. Touching the equipment is allowed during installation and commissioning for properly qualified persons only. • During operation, drives may have uncovered live components, depending on their level of enclosure protection. • Control and power connections may be live, even though the motor is not rotating. • Drives may have hot surfaces during operation. Heat sink can reach temperatures above 80°C.
⚠ WARNING	Electronic equipment can fail. The user is responsible for ensuring that, in the event of a failure of the servo amplifier, the drive is set to a state that is safe for both machinery and personnel, for instance with the aid of a mechanical brake. Drives with servo amplifiers and EtherCAT are remote-controlled machines. They can start to move at any time without previous warning. Take appropriate measures to ensure that the operating and service personnel is aware of this danger. Implement appropriate protective measures to ensure that any unintended start-up of the machines cannot result in dangerous situations for personnel or machinery. Software limit-switches are not a substitute for the hardware limit-switches in the machine.
NOTICE	Install the drive as described in the *Installation Manual*. Never break any of the electrical connections to the drive while it is live. This can result in destruction of the electronics
NOTICE	Do not connect the Ethernet line for the PC with the set up software to the EtherCAT interface X5/X6. The set up Ethernet cable must be connected to the service interface on X11

21.2.2 Use as directed

Drives are components that are built into electrical plants or machines and can only be operated as integral components of these plants or machines. The manufacturer of the machine used with a drive must generate a hazard analysis for the machine and take appropriate measures to ensure that unforeseen movements cannot cause personnel injury or property damage.

- Observe the chapters "Use as directed” and "Prohibited use" in the *AKD Installation Manual*.
- The EtherCAT interface serves only for the connection of the *AKD* to a master with EtherCAT connectivity.

21.2.3 Prohibited use

Other use than that described in chapter “Use as directed” is not intended and can lead to personnel injuries and equipment damage. The drive may not be used with a machine that does not comply with appropriate national directives or standards. The use of the drive in the following environments is also prohibited:

- potentially explosive areas
- environments with corrosive and/or electrically conductive acids, alkaline solutions, oils, vapors, dusts
- ships or offshore applications

The connectors X5 and X6 of the AKD EtherCAT drive may not be used for any ethernet protocol except EtherCAT (CoE, Can over EtherCAT).

21.3 Installation and Setup

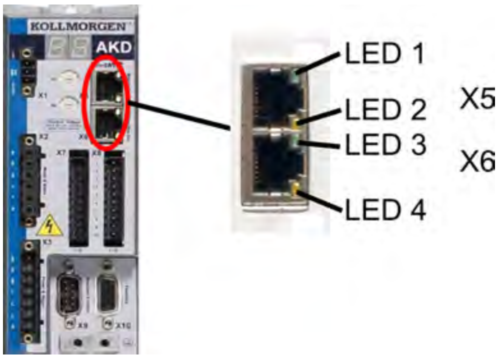
21.3.1 Safety Instructions

DANGER	Never disconnect any electrical connections to the drive while the drive is live. There is a danger of electrical arcing with damage to contacts and serious personal injury. Wait at least seven minutes after disconnecting the drive from the main supply power before touching potentially live sections of the equipment (e.g. contacts) or undoing any connections. Capacitors can still have dangerous voltages present up to 7 minutes after switching off the supply power. To be sure, measure the voltage in the DC Bus link and wait until it has fallen below 40 V. Control and power connections can still be live, even if the motor is not rotating.
WARNING	Electronic equipment can fail. The user is responsible for ensuring that, in the event of a failure of the servo amplifier, the drive is set to a state that is safe for both machinery and personnel, for instance with the aid of a mechanical brake. Drives with servo amplifiers and EtherCAT are remote-controlled machines. They can start to move at any time without previous warning. Take appropriate measures to ensure that the operating and service personnel is aware of this danger. Implement appropriate protective measures to ensure that any unintended start-up of the machines cannot result in dangerous situations for personnel or machinery. Software limit-switches are not a substitute for the hardware limit-switches in the machine.
NOTICE	Install the drive as described in the *Installation Manual*. The wiring for the analog setpoint input and the positioning interface, as shown in the wiring diagram in the *Installation Manual*, is not required. Never break any of the electrical connections to the drive while it is live. This action can result in destruction of the electronics.
NOTICE	The drive's status must be monitored by the PLC to acknowledge critical situations. Wire the FAULT contact in series into the emergency stop circuit of the installation. The emergency stop circuit must operate the supply contactor.

NOTE	Use WorkBench to alter drive settings. Any other alterations will invalidate the warranty.
NOTE	Because of the internal representation of the position-control parameters, the position controller can only be operated if the final limit speed of the drive does not exceed: **rotary** at sinusoidal² commutation: 7500 rpm at trapezoidal commutation: 12000 rpm. **linear** at sinusoidal² commutation: 4 m/s at trapezoidal commutation: 6.25 m/s
NOTE	All the data on resolution, step size, positioning accuracy etc. refer to calculatory values. Non-linearities in the mechanism (backlash, flexing, etc.) are not taken into account. If the final limit speed of the motor must be altered, then all the parameters that were previously entered for position control and motion blocks must be adapted.

21.3.2 EtherCAT Onboard

Connection to the EtherCAT Network via X5 (in port) and X6 (out port).



21.3.2.1 LED functions

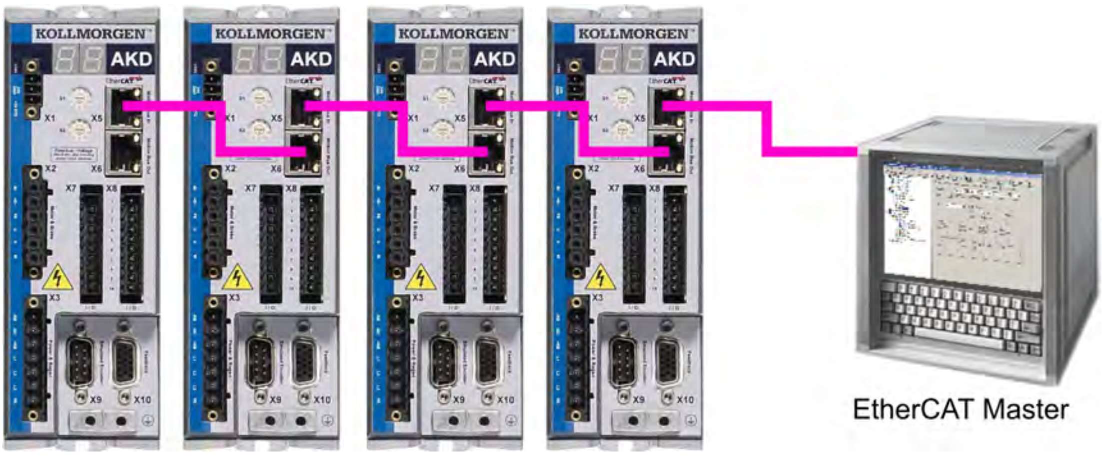
The communication status is indicated by the built-in LEDs.

Connector	LED#	Name	Function
X5	LED1	IN port Link	ON = active OFF= not active
	LED2	RUN	ON = running OFF = not running
X6	LED3	OUT port Link	ON = active OFF = not active
	LED4	-	-

21.3.2.2 Connection technology

You can connect to the EtherCAT network using RJ-45 connectors.

21.3.2.3 Network Connection Example



21.3.3 Guide to Setup

⚠ WARNING	**Only professional personnel with extensive knowledge of control and drive technology are allowed to setup the drive.**
⚠ CAUTION	**Make sure that any unintended movement of the drive cannot endanger machinery or personnel.**

1. Check assembly/installation. Check that all the safety instructions in the product manual for the drive and this manual have been observed and implemented. Check the setting for the station address and baud rate.
2. Connect PC,start WorkBench. Use the setup software WorkBench to set the parameters for the drive.
3. Setup basic functions. Start up the basic functions of the drive and optimize the current, speed and position controllers. This section of the setup is described in the in the online help of the setup software.
4. Save parameters. When the parameters have been optimized, save them in the drive.

21.3.4 Setup via TwinCAT NC/PTP System Manager

Before you set up the drive, make sure the following have been completed:

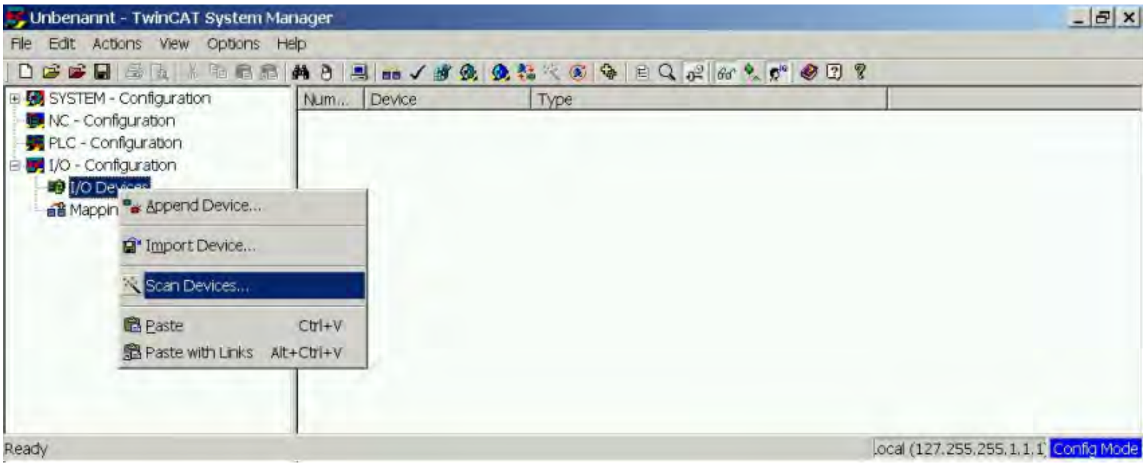
- The AKD is configured with WorkBench and the servomotor is able to move
- A correctly configured EtherCAT card is present in the master.
- TwinCAT software from Beckhoff (NC/PTP-Mode setup) is installed. Install first the TwinCAT System Manager, restart your PC, then install the option package NC/PTP-Mode.
- The XML description of the drive is available (the XML file on the CD-ROM or on the Kollmorgen website).
- An AKD EtherCAT slave is connected to the EtherCAT master PC.
- The TwinCAT system manager resides in Config-Mode. The current mode of the system manager is displayed of the bottom right side of the TwinCAT main-screen window.

Copy the XML description of the drive to the TwinCAT system (usually to the folder c:\TwinCAT\IO\EtherCAT) and restart the TwinCAT system since TwinCAT analyzes all device description files during start-up.

The following example explains the automatic EtherCAT network setup. The network setup can also be done manually; please refer to the TwinCAT manual for more details.

21.3.4.1 Scan devices

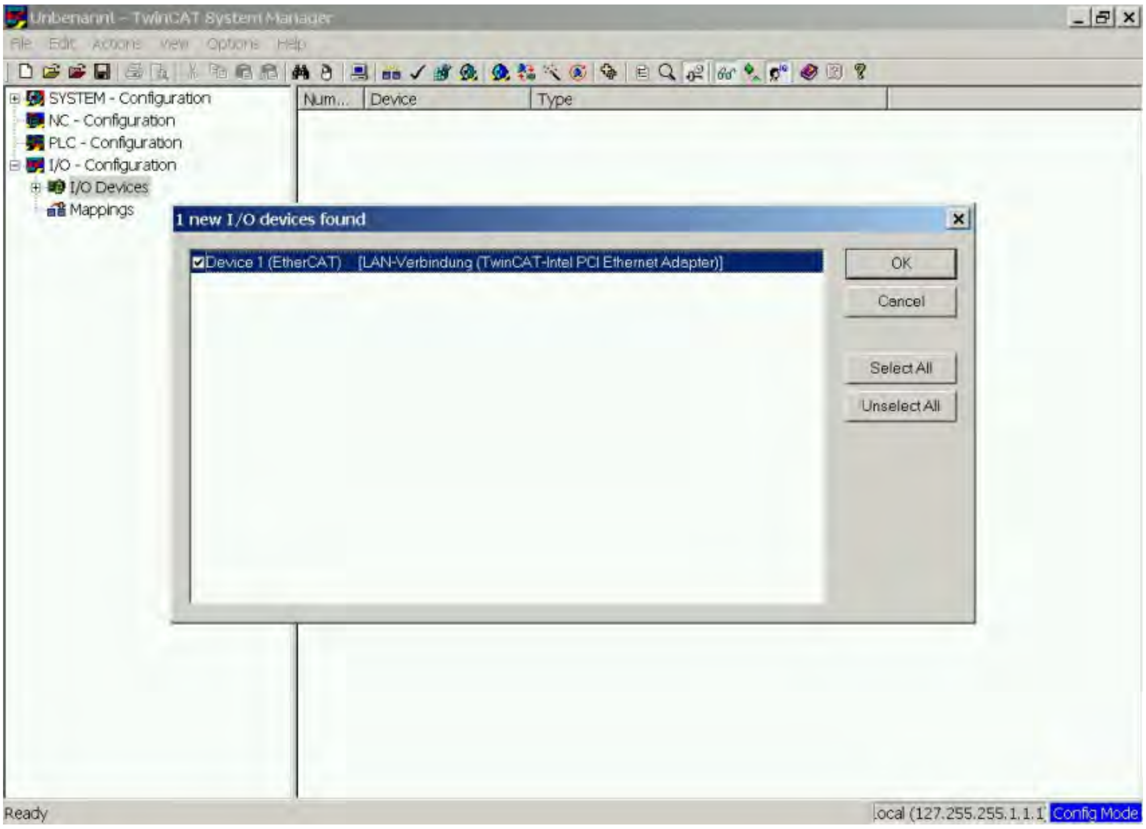
First ensure that the EtherCAT master is physically connected to the EtherCAT AKD. Create a new (empty) project. Right click I/O-Devices and scan for the devices. An example is included in the EtherCAT network card, which is plugged into the PC.



A pop-up window informs you that not all devices can be detected by the TwinCAT software.
Click **OK** to continue.

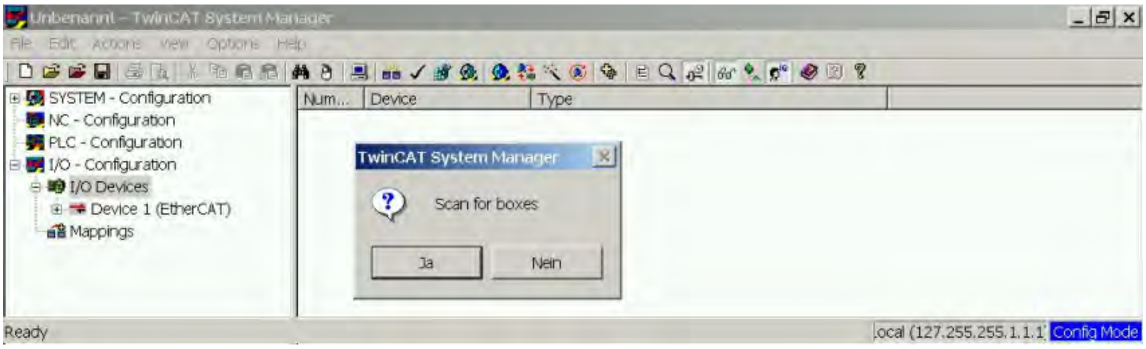
21.3.4.2 Select the device

TwinCAT must be able to find the EtherCAT network card. An EtherCAT slave must be connected to the network card; otherwise TwinCAT will find a real-time EtherNET card instead of the EtherCAT card. Press the **OK** button.



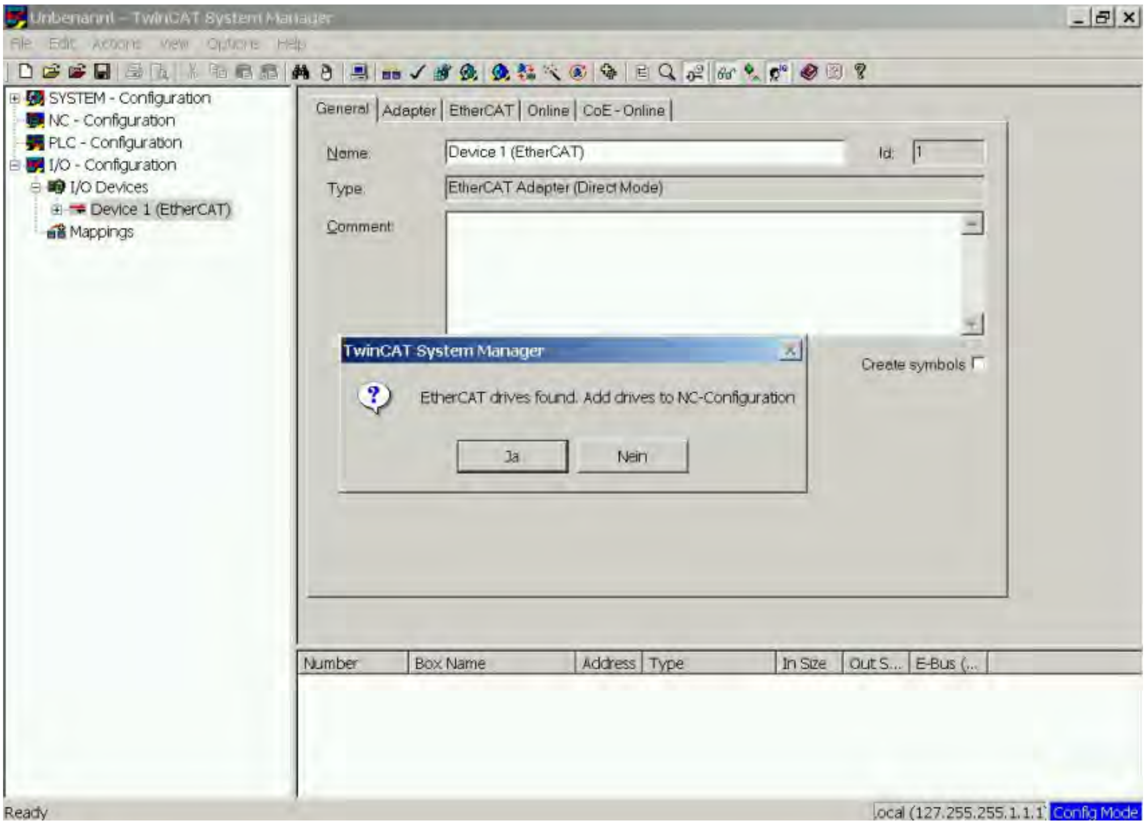
21.3.4.3 Scan for boxes

Click **Yes** to allow TwinCat to scan for boxes. A *box* is an alias for a slave device and is always used in Beckhoff software products.



21.3.4.4 Add Slaves to NC tasks

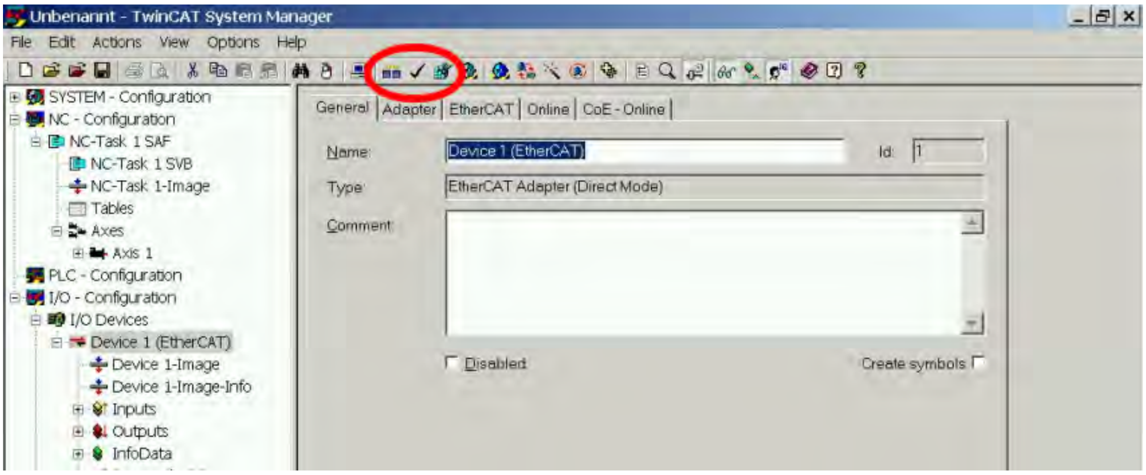
TwinCAT should now have identified the AKD according to the Device Description file. TwinCAT next asks if the slaves should be connected to NC tasks. Click **Yes** to continue. An NC task can, for example, contain a PLC program, which can be programmed by the user.



21.3.4.5 Enable the network configuration

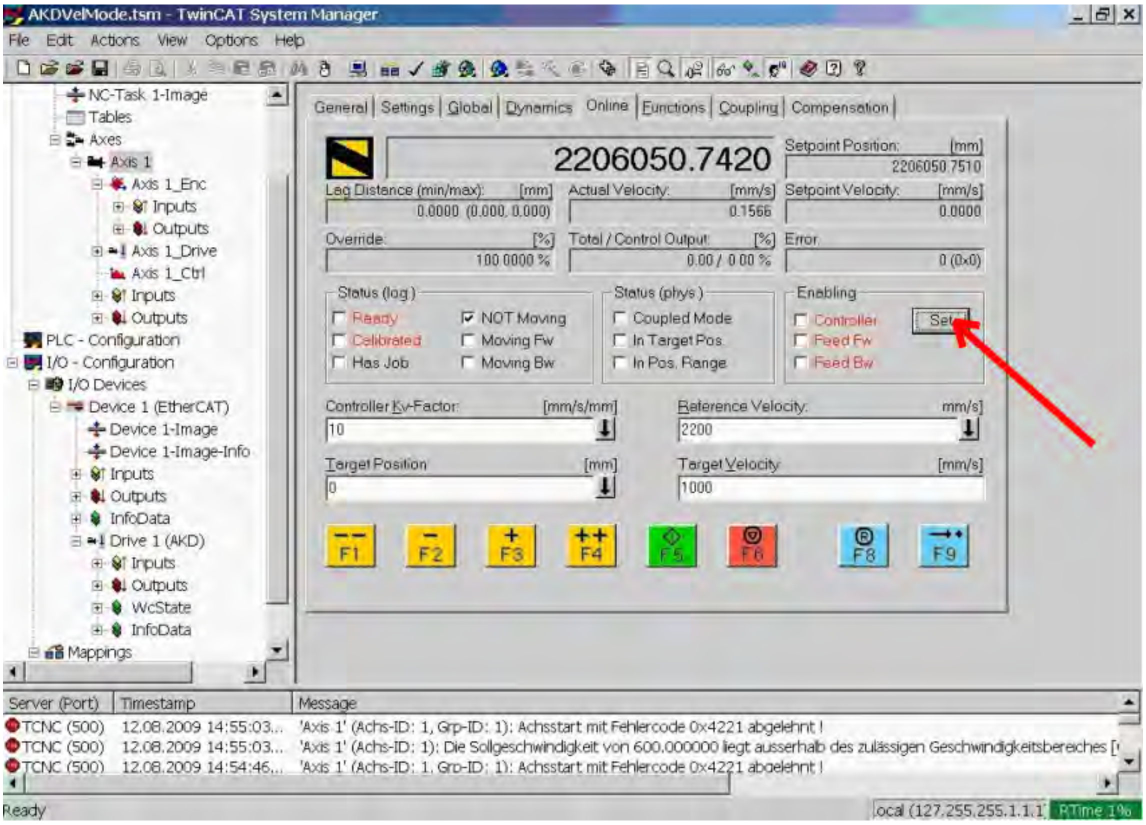
Confirm that the AKD appears in the device tree. Next, enable the network configuration Press first the button in order to generate the mappings, afterwards press the button in order to let TwinCAT check the configuration and use finally the button in order to step into run-mode.

Confirm afterwards that TwinCAT is allowed to jump into run-mode.



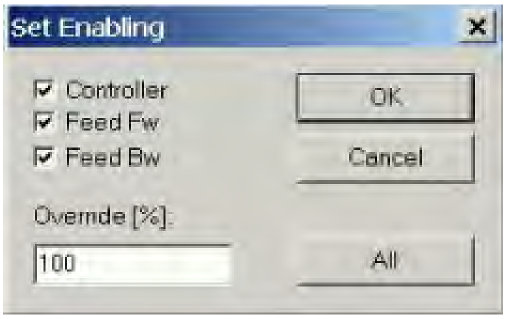
21.3.4.6 Enable the axis and move the axis

The Axis can be enabled by a mouse-click on the Set button within the Online window inside of each Axis, see also the next picture.



Afterwards a pop-up window appears.

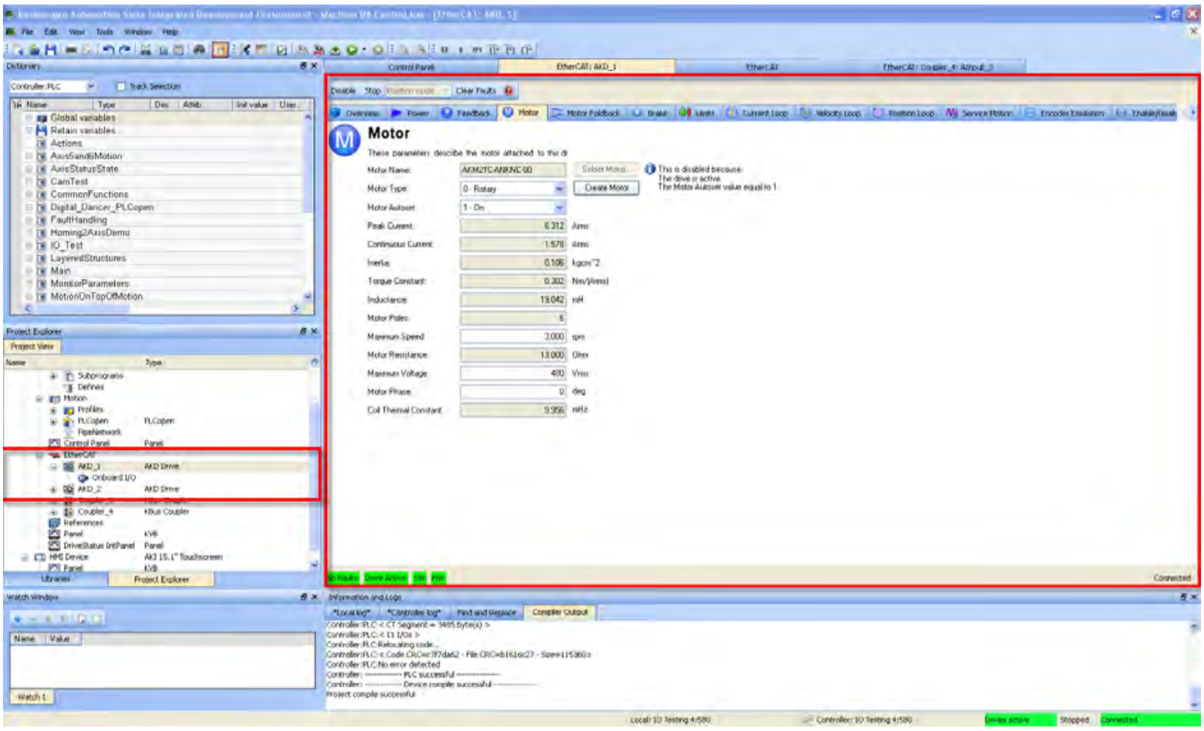
The following setting enables the drive and allows command values in both directions.



Afterwards the motor should move in positive or negative direction as soon as the clicks on the following yellow buttons within the Online window:

21.3.5 Setup via KAS IDE

If you are using a Kollmorgen Automation Suite (KAS) system, the AKD setup is completely integrated into the KAS Integrated Development Environment (IDE), as shown below:



For further information on the setup for a KAS system, see the following sections in the KAS documentation:

- *KAS IDE User Manual*: See section 4.2.3 Add and Configure Drive.
- *KAS Online Help*: See **Using the KAS IDE> Creating a Project> Step 3 - Add and Configure Drive**.

21.4 EtherCAT Profile

21.4.1 Slave Register

The table below gives the addresses of individual registers in the FPGA memory. The data is provided in little-endian format, with the 'least significant byte' occupying the lowest address. A detailed description of all registers and FPGA memory locations is available in the "EtherCAT Slave Controller" description of the EtherCAT user organization (www.EtherCAT.org).

Address	Length (Byte)	Description	ZA ECAT*	ZA Drive*
0x0120	2	AL Control	R/W	R/O
0x0130	2	AL Status	R/O	R/W
0x0134	2	AL Status Code	R/O	R/W
0x0204	2	Interrupt Enable Register	R/O	R/W
0x0220	2	AL Event (IRQ Event)	R/W	R/O
0x0800	8	Sync Manager 0 (Mail Out Control Register)	R/W	R/O
0x0808	8	Sync Manager 1 (Mail In Control Register)	R/W	R/O
0x0810	8	Sync Manager 2 (Process data Output Control Register)	R/W	R/O
0x0818	8	Sync Manager 3 (Process data Input Control Register)	R/W	R/O
0x0820	8	Sync Manager 4	R/W	R/O
0x0828	8	Sync Manager 5	R/W	R/O
0x0830	8	Sync Manager 6	R/W	R/O
0x0838	8	Sync Manager 7	R/W	R/O
0x0840	8	Sync Manager 8	R/W	R/O
0x1100	Max. 64	ProOut Buffer (Process data Output, setpoints ECAT)	R/W	R/O
0x1140	Max. 64	ProIn (Process data Input, act. values ECAT)	R/O	R/W
0x1800	512	Mail Out Buffer (Object Channel Buffer ECAT, byte-length is specified in the device description file)	R/W	R/O
0x1C00	512	Mail In Buffer (Object Channel Buffer Drive, byte-length is specified in the device description file)	R/O	R/W

* ZA ECAT = Access mode EtherCAT

* ZA Drive = Access mode drive

21.4.2 AL Event (Interrupt Event) and Interrupt Enable

Communication between the drive and the EtherCAT FPGA can be interrupt-driven. The interrupt enable register and the AL event register are responsible for the EtherCAT interface interrupt functionality.

There are two events which lead also to a HW interrupt within the drive, the EEPROM emulation event and the SyncManager 2 event. The actual values of the drive (SyncManager 3 data) are written without any AL event request during each HW IRQ, e.g. triggered by a SyncManager 2 event. The Mailbox exchange between the master and the AKD is completely handled by polling the AL event register within the background task of the drive.

The drive activates individual EtherCAT interface events when the corresponding bit of the interrupt enable register is set to 1. When it is set to 0, the hardware interrupts for the specific events are deactivated.

21.4.2.1 Interrupt Enable Register (Address 0x0204:0x0205)

Parameter	Address	Bit	ZA Drive	ZA ECAT	Description
AL Control Event	0x204	0	R/W	R/O	Activation of AL control event for phase run-up
-	0x204	1	R/W	R/O	Reserved
Sync0 DC Distributed Clock	0x204	2	R/W	R/O	Activation of distributed clock (DC) sync 0 interrupts for entire communication
Sync1 DC Distributed Clock	0x204	3	R/W	R/O	Activation of distributed clock (DC) sync 1 interrupts for entire communication
SyncManager activation register change	0x204	4	R/W	R/O	Activation of ‘SyncManager activation register change’ IRQ.
EEPROM emulation event	0x204	5	R/W	R/O	Activation of the EEPROM emulation interrupts.
-	0x204	3 to 7	R/W	R/O	Reserved
Sync Manager 0 Event (Mail Out Event)	0x205	0	R/W	R/O	Activation of output event mailbox (SDO, Sync Manager 0) for object channel.
Sync Manager 1 Event (Mail In Event)	0x205	1	R/W	R/O	Activation of input event mailbox (SDO, Sync Manager 1) for object channel.
Sync Manager 2 Event (Pro Out Event)	0x205	2	R/W	R/O	Activation of output event process data (PDO, card's cyclical setpoints)
Sync Manager 3 Event (Pro In Event)	0x205	3	R/W	R/O	Activation of input event process data (PDO, drive's cyclical actual values)
-	0x205	4 to 7	R/W	R/O	Reserved

21.4.2.2 AL Event Request (Address 0x0220:0x0221)

When the relevant bit of the AL event request register is set to 1, the EtherCAT interface tells the drive which event it should process by the AKD.

Parameter	Address	Bit	ZA Drive	ZA ECAT	Description
AL Control Event	0x220	0	R/O	R/W	Processing of AL control event for phase run-up
Sync0 Distributed Clock (DC) Event	0x220	2	R/O	R/W	Processing of a distributed clock (DC) event
Sync1 Distributed Clock (DC) Event	0x220	3	R/O	R/W	Processing of a distributed clock (DC) event
SyncManager activation register change	0x220	4	R/O	R/W	The content of the SyncManager activation register has been changed.
EEPROM emulation event	0x220	5	R/O	R/W	Processing of an EEPROM emulation event in order to identify the AKD within the network.
-	0x220	6 to 7	R/O	R/W	Reserved
Sync Manager 0 Event	0x221	0	R/O	R/W	Mailbox request (SDO, Sync Manager 0) for object channel.
Sync Manager 1 Event	0x221	1	R/O	R/W	Mailbox response (SDO, Sync Manager 1) for object channel.
Sync Manager 2 Event	0x201	2	R/O	R/W	Process data output (PDO, card's cyclical setpoints)
Sync Manager 3 Event	0x201	3	R/O	R/W	Process data input (PDO, drive's cyclical actual values)
Sync Manager 4 –					
Sync Manager 7 Event	0x221	4 to 7	R/O	R/W	Reserved
Sync Manager 8 –					
Sync Manager 15 Event	0x222	0…7	R/O	R/W	Reserved

21.4.3 Phase Run-Up

The AL control, AL status and AL status code registers are responsible for communication phase run-up (also referred to as EtherCAT status change), for current status display and for any fault messages. The drive responds to every EtherCAT interface transition request made by the AL control register via the AL Status and AL Status Code registers. Any fault messages are displayed in the AL status code register.

A status change within the AL control register is polled within the AKD, which means that an AL control event does not lead to a HW interrupt within the drive.

21.4.3.1 AL Control (Address 0x0120:0x0121)

Parameter	Address	Bit	ZA Drive	ZA ECAT	Description
Status	0x120	3 to 0	R/O	W/O	0x01: Init Request
0x02: PreOperational Request					
0x03: Bootstrap Mode Request					
0x04: Safe Operational Request					
0x08: Operational Request					
Acknowledgement	0x120	4	R/O	W/O	0x00: No fault acknowledgement 0x01: Fault acknowledgement (positive edge)
Reserved	0x120	7 to 5	R/O	W/O	-
Applic. specific	0x120	15 to 8	R/O	W/O	-

21.4.3.2 AL Status (Address 0x0130:0x0131)

Parameter	Address	Bit	ZA Drive	ZA ECAT	Description
Status	0x130	3 to 0	W/O	R/O	0x01: Init
0x02: PreOperational					
0x03: Bootstrap Mode					
0x04: Safe Operational					
0x08: Operational					
Status change	0x130	4	W/O	R/O	0x00: Acknowledgement 0x01: Error, e.g. forbidden transition
Reserved	0x130	7 to 5	W/O	R/O	-
Applic. specific	0x130	15 to 8	W/O	R/O	-

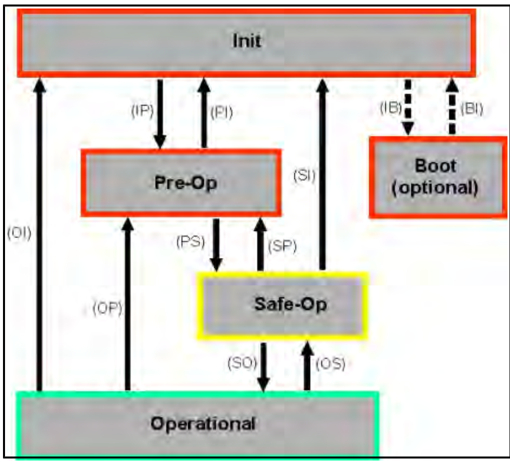
21.4.3.3 AL Status Code (Address 0x0134:0x0135)

Parameter	Address	Bit	ZA Drive	ZA ECAT	Description
Status	0x134	7 to 0	W/O	R/O	See table below
Status	0x135	7 to 0	W/O	R/O	See table below

Code	Description	Current Status (Status change)	Resulting Status
0x0000	No error	All	Current Status
0x0011	Invalid requested state change	I -> S, I -> O, P -> O, O -> B, S -> B, P -> B	Current Status + E
0x0017	Invalid sync manager configuration	I -> P, P -> S	Current Status + E

No other codes are supported.

21.4.3.4 EtherCAT communication phases



INIT:
Initialization, no communication. EEPROM emulation will be activated.

PRE-OP:
Mailbox active, slave parameterization and startup parameters

SAVE-OP:
Cyclical actual values are transferred and the drive tries to synchronize.

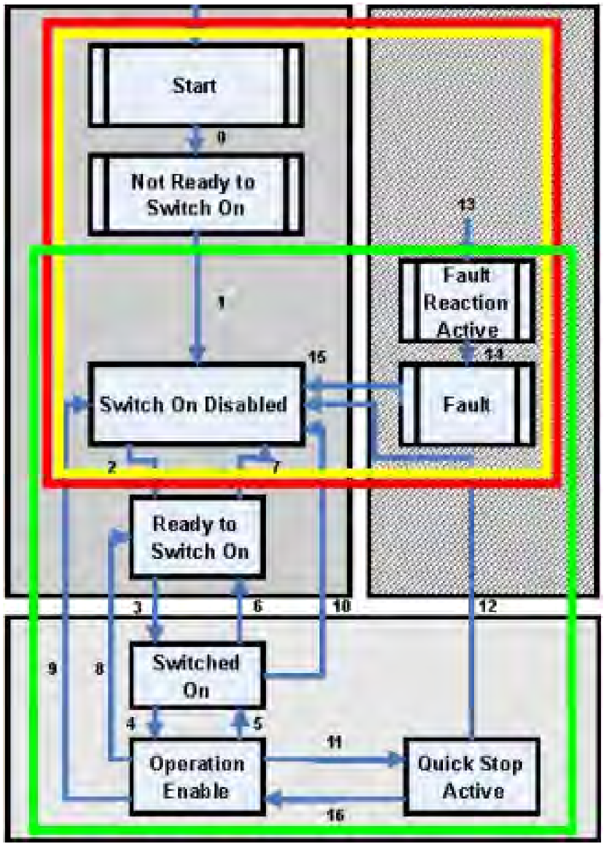
OPERATIONAL:
Cyclical setpoints are processed, torque enable can be activated and the drive must be synchronized.

Individual communication transitions

Transition	AL Control (Bit 3 to 0)	Description
(IB)	0x03	-
(BI)	-	-
(IP)	0x02	AKD reads the SyncManager 0 & 1 configuration and verifies the value of the start-address and the length. The AKD prepares itself for handling SyncManager 0 events.
(PI)	0x01	-
(PS)	0x04	AKD reads the SyncManager 2 & 3 configuration and verifies the value of the start-address and the length.
(SP)	0x02	-
(SI)	0x01	-
(SO)	0x08	The SnycManager 2 hardware interrupt will be enabled by the drive.
(OS)	0x04	Deactivation of SyncManager 2 hardware interrupt.
(OP)	0x02	Deactivation of SyncManager 2 hardware interrupt..
(OI)	0x01	Deactivation of SyncManager 2 hardware interrupt.

21.4.4 CANopen over EtherCAT (CoE) Status Machine

The status machine for the control and status words corresponds to the CANopen status machine in accordance with DS402. CANopen control and status words are captured in every instance of fixed PDO mapping (see chapter entitled 'Fixed PDO Mapping', page).



21.4.4.1 Status Description

Status	Description
Not Ready to Switch On	The drive is not ready to switch on; the controller has not indicated readiness for service. The drive is still in the boot phase or in fault status.
Switch On Disable	In 'Switch On Disable' status, the amplifier cannot be enabled via the EtherCAT interface, because (for example) there is no connection to a power source.
Ready to Switch On	In 'Ready to Switch On' status, the drive can be enabled via the control word.
Switched On	In 'Switched On' status, the amplifier is enabled, but the setpoints of the EtherCAT-interface are not yet transferred. The amplifier is idle, and a positive edge in bit 3 of the control word activates setpoint transfer (transition to 'Operation Enable' status).
Operation Enable	In this status, the drive is enabled and setpoints are transferred from the EtherCAT interface.
Quick Stop Active	The drive follows a quick stop ramp.
Fault Reaction Active	The drive responds to a fault with an emergency stop ramp.
Fault	A fault is pending, the drive is stopped and disabled.

21.4.4.2 Commands in the Control Word

Bit assignment in the control word

Bit	Name	Bit	Name
0	Switch on	8	Pause/halt
1	Disable Voltage	9	reserved
2	Quick Stop	10	reserved
3	Enable Operation	11	reserved
4	Operation mode specific	12	reserved
5	Operation mode specific	13	Manufacturer-specific
6	Operation mode specific	14	Manufacturer-specific
7	Reset Fault (only effective for faults)	15	Manufacturer-specific

Commands in the control word

Command	Bit 7 Fault Reset	Bit 3 Enable Operation	Bit 2 Quick Stop	Bit 1 Disable Voltage	Bit 0 Switch on	Transitions
Shutdown	X	X	1	1	0	2, 6, 8
Switch on	X	X	1	1	1	3
Disable Voltage	X	X	X	0	X	7, 9, 10, 12
Quick Stop	X	X	0	1	X	7, 10, 11
Disable Operation	X	0	1	1	1	5
Enable Operation	X	1	1	1	1	4, 16
Fault Reset	1	X	X	X	X	15

Bits labeled **X** are irrelevant. **0** and **1** indicate the status of individual bits.

Mode-dependent bits in the control word

The following table shows the mode-dependent bits in the control word. Only manufacturer-specific modes are supported at present. The individual modes are set by Object 6060h Modes of operation.

Operation mode	No.	Bit 4	Bit 5	Bit 6
Profile Position Mode (pp)	01h	new_setpoint	change_set_ immediately	absolute/relative
Profile Velocity Mode (pv)	03h	reserved	reserved	reserved
Profile Torque Mode (tq)	04h	reserved	reserved	reserved
Homing Mode (hm)	06h	homing_operation_start	reserved	reserved
Interpolated Position Mode (ip)	07h		reserved	reserved
Cyclic synchronous position mode	08h	reserved	reserved	reserved

Description of the remaining bits in the control word

Bit 8: (Pause) If Bit 8 is set, then the drive halts (pauses) in all modes. The setpoints (speed for homing or jogging, motion task number, setpoints for digital mode) for the individual modes are retained.

Bit 9,10: These bits are reserved for the drive profile (DS402).

Bit 13, 14, 15: These bits are manufacturer-specific, and reserved at present.

21.4.4.3 Status Machine Bits (status word)

Bit assignment in the status word

Bit	Name	Bit	Name
0	Ready to switch on	8	Manufacturer-specific (reserved)
1	Switched on	9	Remote (always 1)
2	Operation enable	10	Target reached
3	Fault	11	Internal limit active
4	Voltage enabled	12	Operation mode specific (reserved)
5	Quick stop	13	Operation mode specific (reserved)
6	Switch on disabled	14	Manufacturer-specific (reserved)
7	Warning	15	Manufacturer-specific (reserved)

States of the status machine

State	Bit 6 switch on disable	Bit 5 quick stop	Bit 3 fault	Bit 2 operation enable	Bit 1 switched on	Bit 0 ready to switch on
Not ready to switch on	0	X	0	0	0	0
Switch on disabled	1	X	0	0	0	0
Ready to switch on	0	1	0	0	0	1
Switched on	0	1	0	0	1	1
Operation enabled	0	1	0	1	1	1
Fault	0	X	1	0	0	0
Fault reaction active	0	X	1	1	1	1
Quick stop active	0	0	0	1	1	1

Bits labeled **X** are irrelevant. **0** and **1** indicate the status of individual bits.

Description of the remaining bits in the status word

Bit 4: voltage_enabled The DC-link voltage is present if this bit is set.

Bit 7: warning There are several possible reasons for Bit 7 being set and this warning being produced. The reason for this warning can be revealed by using the Object 20subindex manufacturer warnings.

Bit 9: remote is always set to 1, i.e. the drive can always communicate and be influenced via the RS232 - interface.

Bit 10: target_reached This is set when the drive has reached the target position.

Bit 11: internal_limit_active This bit specifies that a movement was or is limited. In different modes, different warnings cause the bit to be set.

21.4.5 Fixed PDO Mappings

Various ready-to-use mappings can be selected for cyclic data exchange via SDO's of the object 0x1C12 and 0x1C13. Using object 0x1C12 subindex 1 (Sync Manager 2 assignment), a fixed mapping for the cyclic command values can be set with the values 0x1701, 0x1702, 0x1720 and 0x1721. Using object 0x1C13 subindex 1 (Sync Manager 3 assignment), a fixed mapping for the cyclic actual values can be set via the data 0x1B01, 0x1B02, 0x1B20 and 0x1B21.

The following sequence describes how to select the fixed command value mapping 0x1701 via SDO's:

1. SDO write access to object 0x1C12Sub0 Data:0x00
2. SDO write access to object 0x1C12Sub1 Data:0x1701
3. SDO write access to object 0x1C12Sub0 Data:0x01

The following fixed mappings are supported:

Position interface:

0x1701	Position command value (4 bytes), Control word (2 bytes), total (6 bytes)
0x1720	Control Word (2 bytes), Interpolated position command value (4 bytes), Latch control word (2 bytes), Torque feed forward (2 bytes), Digital outputs (2 bytes)
0x1721	Interpolated position command value (4 bytes), Control Word (2 bytes), Torque feed forward (2 bytes)
0x1B01	Position actual value (4 bytes), Status word (2 bytes), total (6 bytes)
0x1B21	Position Actual Internal Value (4 bytes), Status word (2 bytes)

Velocity interface:

0x1702	Velocity command value (4 bytes), Control word (2 bytes), total (6 bytes)
0x1B02	Position actual value (4 bytes), Status word (2 bytes), total (6 bytes)

21.4.6 Supported Cyclical Setpoint and Actual Values

Supported cyclical setpoint values

Name	CANopen object number	Data type	Description
Position command value	0x60C1 sub 1	INT32	Interpolation data record in IP-mode
Velocity command value	0x60FF sub 0	INT32	
CANopen control-word	0x6040 sub 0	UINT16	CANopen control word.
Latch Control word	0x20a4 sub 0	UINT16	
Torque feed forward	0x60B2 sub 0	INT16	
Digital outputs	0x60FE sub 1	UINT32	

Supported cyclical actual values

Name	CANopen object number	Data type	Description
Position actual internal value	0x6063 sub 0	INT32	
Velocity actual value	0x606c sub 0	INT32	
CANopen status-word	0x6041 sub 0	UINT16	CANopen status word.
Second position feedback	2050 sub 0	INT32	
Digital inputs	60FD sub 0	UINT32	
Following error actual value	60F4 sub 0	INT32	
Latch position positive edge	20a0 sub 0	INT32	
Torque actual value	6077 sub 0	INT16	
Latch status	20A5 sub 0	UINT16	
Analog input value	3470 sub 0	INT16	

21.4.7 Supported Operation Modes

CANopen mode of operation	AKD mode of operation	Description
Profile velocity	DRV.OPMODE 2 DRC.CMDSOURCE 1	0x6060Sub0 Data: 3 In this mode of operation the EtherCAT master sends cyclic velocity command values to the AKD.
Interpolated position	DRV.OPMODE 2 DRV.CMDSOURCE 1	0x6060Sub0 Data: 7 In this mode of operation the EtherCAT master sends cyclic position command values to the AKD. These command values are interpolated by the AKD according to the fieldbus sample rate.
Homing mode	DRV.OPMODE 2 DRV.CMDSOURCE 0	0x6060 sub 0 data : 6 In this mode an AKD-internal homing can be done.

21.4.8 Adjusting EtherCAT Cycle Time

The cycle time to be used in the drive for the cyclical setpoints and actual values can either be stored in the FBUS.SAMPLEPERIOD parameter in the amplifier or configured in the startup phase.

This takes place via SDO mailbox access to CANopen objects 60C2 subindex 1 and 2.

Subindex 2, known as the interpolation time index, defines the power of ten of the time value (e.g. -3 means 10-3 or milliseconds) while subindex 1, known as interpolation time units, gives the number of units (e.g. 4 means 4 units).

You can run a 2 ms cycle using various combinations. For example,

Index = -3, Units = 2
or
Index = -4, Units = 20 etc.

The FBUS.SAMPLEPERIOD parameter is counted in multiples of 62.5us microseconds within the device. This means, for example that 2 ms equates to FBUS.SAMPLEPERIOD value of 32.

21.4.9 Maximum Cycle Times depending on operation mode

The minimum cycle time for the drive is largely dependent on the drive configuration (second actual position value encoder latch functionality enabled and so on)

Interface	Cycle time AKD
Position	≥ 0.25 ms (≥ 250 µs)
Velocity	≥ 0.25 ms (≥ 250 µs)
Torque	≥ 0.25 ms (≥ 250 µs)

21.4.10 Synchronization

On all drives, the internal PLL is theoretically able to even out an average deviation of up to 4800 ppm in the cycle time provided by the master. The drive checks once per fieldbus cycle a counter within the drive internal FPGA, which is cleared by a Sync0 (Distributed clock) event. Depending of the counter value, the drive extends or decreases the 62.5 µs MTS signal within the drive by a maximum of 300 ns.

The theoretical maximum allowed deviation can be calculated by using the following formula:

$$max_{de}v = \frac{300[ns]}{62.5[\mu s]} \cdot 1{,}000{,}000 = 4800 \text{ [ppm]}$$

The synchronization functionality within the drive can be enabled via setting bit 0 of the FBUS.PARAM02 parameter to high. Therefore FBUS.PARAM02 must be set to the value of 1. Furthermore the distributed clock functionality must be enabled by the EtherCAT master in order to activate cyclic Sync0 events.

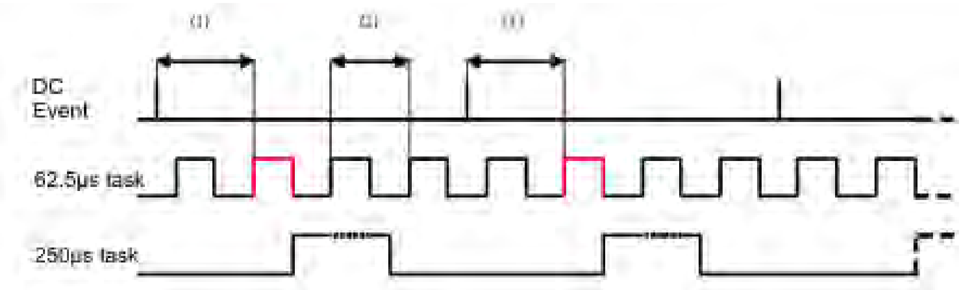
21.4.10.1 Synchronization behavior with distributed clocks (DC) enabled

When the EtherCAT master enables distributed clocks, a distributed clock (DC) event is created in the AKD once per fieldbus cycle. An assigned 62.5 µs real-time task in the AKD monitors the elapsed time between the DC events and the AKD System time and extends or reduces the 62.5 µs strobe to the CPU as necessary.

The following fieldbus parameters are used for the synchronization feature:

1. FBUS.SYNCDIST = Expected time delay of the AKD PLL-code to the DC event.
2. FBUS.SYNCACT = Actual time delay of the AKD PLL-code to the DC event.
3. FBUS.PLLTHRESH = Number of consecutive successful synchronized PLL cycles of the AKD before the Drive is considered as synchronized.
4. FBUS.SYNCWND = Synchronization window in which the AKD is considered to be synchronized. The Drive is considered synchronized as long as the following statement is true is true for FBUS.PLLTHRESH consecutive cycles:
   FBUS.SYNCDIST-FBUS.SYNCWND < FBUS.SYNCACT < FBUS.SYNCDIST+FBUS.SYNCWND

Example with a 4kHz fieldbus sample rate:



Explanation:

The red-marked 62.5[µs] real-time task displays the AKD 62.5 µs real-time task within one fieldbus cycle which is responsible for calling the AKD PLL-code. The time delay (1) shows the actual delay to the previous DC event, which is ideally close to the adjusted FBUS.SYNCDIST parameter. Depending on (1) the AKD slightly extends or reduce the 62.5[µs] IRQ generation of the high-priority real-time task in order to either increase or decrease the measured time delay to the DC event (1) for the next PLL cycle. The time distance (2) shows the 62.5[µs] ± x[ms] realtime task of the AKD.

21.4.10.2 Synchronization behavior with distributed clocks (DC) disabled

The AKD fieldbus synchronization algorithm is similar to that used by Distributed Clocks. The difference is that the AKD synchronizes to a SyncManager2 event instead of the DC event. A SyncManager2 event is created when the EtherCAT Master sends a new package of command values to the drive while the network is in the Operational state. This occurs once per fieldbus cycle.

21.4.11 Latch Control Word and Latch Status Word

Latch Control word (2 Byte)

Bit	Value (bin)	Value (hex)	Description
0	00000000 00000001	zz01	Enable extern latch 1 (positive rise)
1	00000000 00000010	zz02	Enable extern latch 1 (negative rise)
2	00000000 00000100	zz04	Enable extern latch 2 (positive rise)
3	00000000 00001000	zz08	Enable extern latch 2 (negative rise)
4			
5-7			Reserve
8-12	00000001 00000000	01zz	Read external latch 1 (positive rise)
	00000010 00000000	02zz	Read external latch 1 (negative rise)
	00000011 00000000	03zz	Read external latch 2 (positive rise)
	00000100 00000000	04zz	Read external latch 2 (negative rise)
13-15			Reserve

Latch Status word (2 Byte)

Bit	Value (bin)	Value (hex)	Description
0	00000000 00000001	zz01	External latch 1 valid (positive rise)
1	00000000 00000010	zz02	External latch 1 valid (negative rise)
2	00000000 00000100	zz04	External latch 2 valid (positive rise)
3	00000000 00001000	zz08	External latch 2 valid (negative rise)
4			
5-7			Reserve
8-11	00000001 00000000	z1zz	Acknowledge value external latch 1 (positive rise)
	00000010 00000000	z2zz	Acknowledge value external latch 1 (negative rise)
	00000011 00000000	z3zz	Acknowledge value external latch 2 (positive rise)
	00000100 00000000	z4zz	Acknowledge value external latch 2 (negative rise)
12-15	00010000 00000000	1zzz	Zustand Digital Input 4
	00100000 00000000	2zzz	Zustand Digital Input 3
	01000000 00000000	4zzz	Zustand Digital Input 2
	10000000 00000000	8zzz	Zustand Digital Input 1

21.4.12 Mailbox Handling

With EtherCAT, acyclical data traffic (object channel or SDO channel) is called mailbox. This system is based around the master:

Mailbox Output:

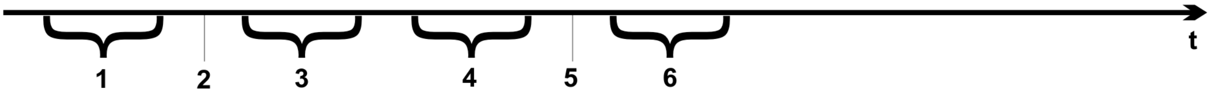
The master (EtherCAT controller) sends data to the slave (drive). This is essentially a (read/write) request from the master. Mailbox output operates via Sync Manager 0.

Mailbox Input:

The slave (drive) sends data to the master (EtherCAT controller). The master reads the slave's response. Mailbox input operates via Sync Manager 1.

Timing diagram

The timing diagram illustrates the mailbox access process:



1. The EtherCAT master writes the mailbox request to the mail-out buffer.
2. On the next interrupt, the EtherCAT interface activates a Sync Manager 0 event (mailbox output event) in the AL event register.
3. The drive reads 16 bytes from the mail-out buffer and copies them to the internal mailbox output array.
4. The drive identifies new data in the internal mailbox output array and performs an SDO access to the object requested by the EtherCAT interface. The response from the drive is written to an internal mailbox input array.
5. The drive deletes all data in the internal mailbox output array so that a new mailbox access attempt can be made.
6. The drive copies the response telegram from the internal mailbox input array to the mail-in buffer of the EtherCAT interface.

21.4.12.1 Mailbox Output

An interrupt by the EtherCAT-interface with a Sync Manager 0 - Event starts a Mailbox Output Process. A 1 in the Mail Out Event-Bit of the AL Event register signalizes the drive, that the EtherCAT-interface wants to send a Mailbox message and that it has already stored the required data in the Mail Out Buffer. Now 16 Byte data are read by the drive with the IRQ process. The bytes are defined as follows

<table>
<tr><th colspan="8">Address 0x1800</th><th colspan="8">Address 0x180F</th></tr>
<tr><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td></tr>
<tr><td colspan="8">CAN over EtherCAT specific data
(CoE Header)</td><td colspan="8">CAN specific data
(standard CAN SDO)</td></tr>
</table>

Byte 0	Length of the data (Low Byte)	
Byte 1	Length of the data (High Byte)	
Byte 2	Address (Low Byte)	
Byte 3	Address (High Byte)	
Byte 4	Bit 0 to 5: Channel Bit 6 to 7: Priority	
Byte 5	Bit 0 to 3: Type	1 = Reserved: ADS over EtherCAT 2 = Reserved: Ethernet over EtherCAT 3 = Can over EtherCAT…)
	Bit 4 to 7: Reserved	
Byte 6	PDO Number (with PDO transmissions only, Bit 0 = LSB of the PDO number, see Byte 7 for MSB)	
Byte 7	Bit 0: MSB of the PDO number, see Byte 6	
	Bit 1 to 3: Reserved	
	Bit 4 to 7: CoE specific type	0: Reserved
		1: Emergency message
		2: SDO request
		3: SDO answer
		4: TXPDO
		5: RxPDO
		6: Remote transmission request of a TxPDO
		7: Remote transmission request of a RxPDO
		8…15: reserved
Byte 8	Control-Byte in the CAN telegram:	
	write access:	0x23=4Byte, 0x27=3Byte, 0x2B=2Byte, 0x2F=1Byte
	read access:	0x40
Byte 9	Low Byte of the CAN object number (Index)	
Byte 10	High Byte of the CAN object number (Index)	
Byte 11	Subindex according to CANopen Specification for the drive	
Byte 12	Data with a write access (Low Byte)	
Byte 13	Data with a write access	
Byte 14	Data with a write access	
Byte 15	Data with a write access (High Byte)	

The drive answers every telegram with an answer in the Mailbox Input buffer.

21.4.12.2 Mailbox Input

The drive answers every CoE telegram with a 16 byte answer telegram in the Mailbox Input buffer. The bytes are defined as follows:

Address 0x1C00								Address 0x1C0F							
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CAN over EtherCAT specific data (CoE Header)								CAN specific data (standard CAN SDO)							

Byte 0	Length of the data (Low Byte)	
Byte 1	Length of the data (High Byte)	
Byte 2	Address (Low Byte)	
Byte 3	Address (High Byte)	
Byte 4	Bit 0 to 5: Channel Bit 6 to 7: Priority	
Byte 5	Bit 0 to 3: Type	1 = Reserved: ADS over EtherCAT 2 = Reserved: Ethernet over EtherCAT 3 = Can over EtherCAT…)
	Bit 4 to 7: Reserved	
Byte 6	PDO Number (with PDO transmissions only, Bit 0 = LSB of the PDO number, see Byte 7 for MSB)	
Byte 7	Bit 0: MSB of the PDO number, see Byte 6	
	Bit 1 to 3: Reserved	
	Bit 4 to 7: CoE specific type	0: Reserved
		1: Emergency message
		2: SDO request
		3: SDO answer
		4: TXPDO
		5: RxPDO
		6: Remote transmission request of a TxPDO
		7: Remote transmission request of a RxPDO
		8…15: reserved
Byte 8	Control-Byte in the CAN telegram:	
	write access OK:	0x60
	read access OK + length of answer:	0x43 (4 Byte), 0x47 (3 Byte), 0x4B (2Byte), 0x4F (1Byte)
	error with read- or write access:	0x80
Byte 9	Low Byte of the CAN object number (Index)	
Byte 10	High Byte of the CAN object number (Index)	
Byte 11	Subindex according to CANopen Specification for Kollmorgen drive	
Byte 12	Data (Low Byte)	
Byte 13	Data	error code Fehlercode according to CANopen Specification in case of an error
Byte 14	Data	data value of the object in case of successfull read access
Byte 15	Data (High Byte)	

21.4.12.3 Example: Mailbox Access

In the example below, PDOs 0x1704 are mapped (see Chapter # “Fixed PDO Mappings”):

The master sends this mailbox output message:

Byte 0	0x0A	The next 10 Bytes contain data (Byte 2 to Byte 11)
Byte 1	0x00	The next 10 Bytes contain data (Byte 2 to Byte 11)
Byte 2	0x00	Address 0
Byte 3	0x00	Address 0
Byte 4	0x00	Channel 0 and Priority 0
Byte 5	0x03	CoE Object
Byte 6	0x00	PDO Number 0
Byte 7	0x20	PDO Number 0 and SDO-Request
Byte 8	0x2B	2 Byte write access
Byte 9	0x12	SDO-Object 0x1C12
Byte 10	0x1C	SDO-Object 0x1C12
Byte 11	0x01	Subindex 1
Byte 12	0x04	Data value 0x00001704
Byte 13	0x17	Data value 0x00001704
Byte 14	0x00	Data value 0x00001704
Byte 15	0x00	Data value 0x00001704

The drive returns the following message:

Byte 0	0x0E	The next 14 Bytes contain data (Byte 2 to Byte 15)
Byte 1	0x00	The next 14 Bytes contain data (Byte 2 to Byte 15)
Byte 2	0x00	Address 0
Byte 3	0x00	Address 0
Byte 4	0x00	Channel 0 and Priority 0
Byte 5	0x03	CoE Object
Byte 6	0x00	PDO Number 0
Byte 7	0x20	PDO Number 0 and SDO-Answer
Byte 8	0x60	Successful write access
Byte 9	0x12	SDO-Object 0x1C12
Byte 10	0x1C	SDO-Object 0x1C12
Byte 11	0x01	Subindex 1
Byte 12	0x00	Data value 0x00000000
Byte 13	0x00	Data value 0x00000000
Byte 14	0x00	Data value 0x00000000
Byte 15	0x00	Data value 0x00000000

21.4.13 Fieldbus Parameters

The AKD holds several fieldbus-specific, general purpose parameters. Some of them contain the following EtherCAT relevant data:

- **FBUS.PARAM02**: This parameter activates the synchronization feature of the AKD. The DC feature must be activated in order to allow the AKD to get synchronized with the master. A value of 1 enables the drive internal PLL functionality, a value of 0 deactivates this feature.
- **FBUS.PARAM03**: This parameter contains the Configured Station Alias address of the AKD. An EEPROM emulation write access to the Configured Station Alias address forces the AKD to store the drive parameters automatically using the DRV.NVSAVE command.
- **FBUS.PARAM04**: This parameter enables (1) or disables(0) the synchronization supervision of the CANOpen or EtherCAT fieldbus.
  Default values for this parameter are as follows:
  CANopen drive: disabled (0)
  EtherCAT drive: enabled (1)
  Synchronization supervision is active when FBUS.PARAM 04 = 1 and the first CANOpen Sync message or first EtherCAT frame is received. When more than three CANOpen sync messages or seven EtherCAT frames have not been received and the drive is enabled, fault F125 (“Synchronization lost“), occurs.

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22 Modbus

22.1 Overview

Modbus is a simple communication protocol often used for reporting data from an industrial device to an HMI or PLC. Modbus TCP extends the protocol to TCP/IP networks by embedding the same Protocol Data Unit within TCP/IP packets.

The AKD supports a Modbus TCP service channel for up to 3 simultaneous client connections, alongside the WorkBench configuration software.

Most drive parameters are supported over Modbus TCP, with the exception of commands which output character strings. For information about the Modbus protocol, please see: http://www.Modbus.org/specs.php.

22.2 Modbus Installation and Setup

Modbus TCP is provided over the service port on the top of the drive (X11 connector, the connector used for WorkBench). Connect the drive and a client device such as an HMI to a working Ethernet network. For ease of testing and configuration, connect a PC running WorkBench to the same network.

After booting, the drive will flash its Ethernet IP address on the front display. The drive can be accessed at this address for Modbus on port 502. WorkBench uses the same address, but a different port number.

Once the devices are connected, the client device can open a connection to the AKD using these settings:

- IP Address: read from drive display or Workbench connect screen
- Port: 502
- Add Modbus CRC code: No

22.3 Overview of Messaging

All parameters with an internal data width of 32-bit and lower are mapped to Modbus as 32-bit (2 register) values. The contents of both registers must be read or written in the same message, by setting the Starting Address to the lowest index of the parameter and the Quantity of Registers to two.

All parameters with an internal data width of 64-bit are mapped to Modbus as 64-bit (4 register) values. The contents of all four registers must be read or written in the same message by setting the Starting Address to the lowest index of the parameter and the Quantity of Registers to four.

Parameters are scaled as in the Terminal window of WorkBench, but note that floating point values are scaled by an additional factor of 1,000 to retain precision. Drive commands which do not accept or return a value (such as DRV.EN) are executed by writing to the parameter. The data value is ignored and read attempts will result in an error response.

22.4 Supported Functions

Two Modbus functions are currently supported:

- Read Holding Registers. Function code = 0x03 (3).
- Write Multiple Registers. Function code = 0x10 (16).

To allow only 32-bit and 64-bit access, the quantity of registers is limited to two registers for 32-bit variables and four registers for 64-bit variables. Other quantities return an exception response.

22.5 Read Holding Registers (0x03)

This function code is used to read all registers of one drive parameter.

Request

Function Code	1 Byte	0x03
Starting Address	2 Bytes	0x0000-0xFFFF (see 23 Modbus Parameter Table)
Quantity of Registers	2 Bytes	Two 32-bit values or four 64-bit values

Normal Response

Function Code	1 Byte	0x03
Byte Count	1 Byte	2 x N*
Register Value	N* x 2 Bytes	Data

*N = Quantity of Registers

Error Response

Function Code	1 Byte	0x83
Exception Code	1 Byte	See Exception Response Codes

Following is an example of reading the position loop feedback PL.FB at index 588 (0x024C), with an actual value of 0x1 2A05 F200.

Request

Function	03
Starting Address Hi	02
Starting Address Lo	4C
Quantity of Registers Hi	00
Quantity of Registers Lo	04

Response

Function	03
Byte Count	08
Register 588 Hi	00
Register 588 Lo	00
Register 589 Hi	00
Register 589 Lo	01
Register 590 Hi	2A
Register 590 Lo	05
Register 591 Hi	F2
Register 591 Lo	00

22.6 Write Multiple Registers (0x10)

This function code is used to write all registers of one drive parameter.

Request

Function Code	1 Byte	0x10
Starting Address	2 Bytes	0x0000-0xFFFF (see Modbus index in parameter lists)
Quantity of Registers	2 Bytes	2 (32-bit values) or 4 (64-bit values)
Byte Count	1 Byte	2 x N*
Register Value	N* x 2 Bytes	Data

*N = Quantity of Registers

Normal Response

Function Code	1 Byte	0x10
Starting Address	2 Bytes	0x0000-0xFFFF
Quantity of Registers	2 Bytes	2 or 4

Error Response

Function Code	1 Byte	0x90
Exception Code	1 Byte	See Exception Response Codes

Following is an example of setting the mode of digital input 1 (DIN1.MODE) at index 122 (0x007A) to a value of 3.

Request

Function	10
Starting Address Hi	00
Starting Address Lo	7A
Quantity of Registers Hi	00
Quantity of Registers Lo	02
Byte Count	04
Register 122 Hi	00
Register 122 Lo	00
Register 123 Hi	00
Register 123 Lo	03

Response

Function	10
Starting Address Hi	00
Starting Address Lo	7A
Quantity of Registers Hi	00
Quantity of Registers Lo	02

22.7 Exception Response Codes

Standard Codes

Description	Exception Code
Illegal Function	1
Illegal data address	2
Illegal Data Value	3
Slave Device Failure	4
Acknowledge	5
Slave Device Busy	6
Memory Parity Error	8
Gateway Path Unavailable	10
Gateway Target Device Failed To Respond	11

Manufacturer Codes

Description	Exception Code
Illegal Block Size (must be two registers for 32-bit and four registers for 64-bit parameters)	32
Unknown Parameter (bad address)	33
Error Processing Command (such as "Data value is greater than maximum")	34
Byte Count field is invalid in request	35

23 Modbus Parameter Table

The parameters with an entry in the last column have a 64- size. All others are 32-bit.

Modbus Register Address	Parameter	64-bit
0	AIN.CUTOFF	
2	AIN.DEADBAND	
4	AIN.ISCALE	
6	AIN.OFFSET	
8	AIN.PSCALE	64-bit
12	AIN.VALUE	
14	AIN.VSCALE	
16	AIN.ZERO	
18	AOUT.ISCALE	
20	AOUT.MODE	
22	AOUT.OFFSET	
24	AOUT.PSCALE	64-bit
28	AOUT.VALUE	64-bit
32	AOUT.VALUEU	64-bit
36	AOUT.VSCALE	
38	BODE.EXCITEGAP	
40	BODE.FREQ	
42	BODE.IAMP	
44	BODE.INJECTPOINT	
46	BODE.MODE	
48	BODE.MODETIMER	
50	BODE.PRBDEPTH	
52	BODE.VAMP	
54	CAP0.EDGE	
56	CAP0.ENABLE	
58	CAP0.EVENT	
60	CAP0.FILTER	
62	CAP0.MODE	
64	CAP0.POSITION	64-bit
68	CAP0.PREEDGE	
70	CAP0.PREFILTER	
72	CAP0.PRESELECT	
74	CAP0.STATE	
76	CAP0.T	
78	CAP0.TRIGGER	

Modbus Register Address	Parameter	64-bit
80	CAP1.EDGE	
82	CAP1.ENABLE	
84	CAP1.EVENT	
86	CAP1.FILTER	
88	CAP1.MODE	
90	CAP1.POSITION	64-bit
94	CAP1.PREEDGE	
96	CAP1.PREFILTER	
98	CAP1.PRESELECT	
100	CAP1.STATE	
102	CAP1.T	
104	CAP1.TRIGGER	
106	CS.DEC	64-bit
110	CS.STATE	
112	CS.TO	
114	CS.VTHRESH	
116	DIN.ROTARY	
118	DIN.STATES	
120	DIN1.INV	
122	DIN1.MODE	
124	DIN1.PARAM	64-bit
128	DIN1.STATE	
130	DIN2.INV	
132	DIN2.MODE	
134	DIN2.PARAM	64-bit
138	DIN2.STATE	
140	DIN3.INV	
142	DIN3.MODE	
144	DIN3.PARAM	64-bit
148	DIN3.STATE	
150	DIN4.INV	
152	DIN4.MODE	
154	DIN4.PARAM	64-bit
158	DIN4.STATE	
160	DIN5.INV	
162	DIN5.MODE	
164	DIN5.PARAM	64-bit
168	DIN5.STATE	
170	DIN6.INV	
172	DIN6.MODE	
174	DIN6.PARAM	64-bit

Modbus Register Address	Parameter	64-bit
178	DIN6.STATE	
180	DIN7.INV	
182	DIN7.MODE	
184	DIN7.PARAM	64-bit
188	DIN7.STATE	
190	DOUT.CTRL	
192	DOUT.RELAYMODE	
194	DOUT.STATES	
196	DOUT1.MODE	
198	DOUT1.PARAM	64-bit
202	DOUT1.STATE	
204	DOUT1.STATEU	
206	DOUT2.MODE	
208	DOUT2.PARAM	64-bit
212	DOUT2.STATE	
214	DOUT2.STATEU	
216	DRV.ACC	64-bit
220	DRV.ACTIVE	
222	DRV.CLRFAULTHIST	
224	DRV.CLRFAULTS	
226	DRV.CMDSOURCE	
228	DRV.DBILIMIT	
230	DRV.DEC	64-bit
234	DRV.DIR	
236	DRV.DIS	
238	DRV.DISMODE	
240	DRV.DISSOURCES	
242	DRV.DISTO	
244	DRV.EMUEDIR	
246	DRV.EMUEMODE	
248	DRV.EMUEMTURN	
250	DRV.EMUERES	
252	DRV.EMUEZOFFSET	
254	DRV.EN	
256	DRV.ENDEFAULT	
258	DRV.HANDWHEEL	
260	DRV.HWENMODE	
262	DRV.ICONT	
264	DRV.IPEAK	
266	DRV.IZERO	
268	DRV.MOTIONSTAT	

Modbus Register Address	Parameter	64-bit
270	DRV.OPMODE	
272	DRV.RSTVAR	
274	DRV.STOP	
276	DRV.TYPE	
278	DRV.ZERO	
280	FB1.BISSBITS	
282	FB1.ENCRES	
284	FB1.IDENTIFIED	
286	FB1.INITSIGNED	
288	FB1.MECHPOS	
290	FB1.OFFSET	64-bit
294	FB1.ORIGIN	64-bit
298	FB1.PFIND	
300	FB1.PFINDCMDU	
302	FB1.POLES	
304	FB1.PSCALE	
306	FB1.RESKTR	
308	FB1.RESREFPHASE	
310	FB1.SELECT	
312	FB1.TRACKINGCALC	
	FB2.ENCRES	
	FB2.MODE	
	FB2.SOURCE	
314	FBUS.PARAM01	
316	FBUS.PARAM02	
318	FBUS.PARAM03	
320	FBUS.PARAM04	
322	FBUS.PARAM05	
324	FBUS.PARAM06	
326	FBUS.PARAM07	
328	FBUS.PARAM08	
330	FBUS.PARAM09	
332	FBUS.PARAM10	
334	FBUS.PARAM11	
336	FBUS.PARAM12	
338	FBUS.PARAM13	
340	FBUS.PARAM14	
342	FBUS.PARAM15	
344	FBUS.PARAM16	
346	FBUS.PARAM17	
348	FBUS.PARAM18	

Modbus Register Address	Parameter	64-bit
350	FBUS.PARAM19	
352	FBUS.PARAM20	
354	FBUS.PLLTHRESH	
356	FBUS.SAMPLEPERIOD	
358	FBUS.SYNCACT	
360	FBUS.SYNCDIST	
362	FBUS.SYNCWND	
364	FBUS.TYPE	
366	GEAR.ACCMAX	64-bit
370	GEAR.DECMAX	64-bit
374	GEAR.IN	
376	GEAR.MODE	
378	GEAR.MOVE	
380	GEAR.OUT	
382	GEAR.VMAX	
384	HOME.ACC	64-bit
388	HOME.AUTOMOVE	
390	HOME.DEC	64-bit
394	HOME.DIR	
396	HOME.DIST	64-bit
400	HOME.FEEDRATE	
402	HOME.IPEAK	64-bit
406	HOME.MODE	
408	HOME.MOVE	
410	HOME.P	64-bit
414	HOME.PERRTHRESH	64-bit
418	HOME.SET	
420	HOME.V	
422	HWLS.NEGSTATE	
424	HWLS.POSSTATE	
426	IL.BUSFF	
428	IL.CMD	
430	IL.CMDU	
432	IL.FB	
434	IL.FF	
436	IL.FOLDFTHRESH	
438	IL.FOLDFTHRESHU	
440	IL.FOLDWTHRESH	
442	IL.FRICTION	
444	IL.IFOLD	
446	IL.IUFB	

Modbus Register Address	Parameter	64-bit
448	IL.IVFB	
450	IL.KACCFF	
452	IL.KBUSFF	
454	IL.KP	
456	IL.KPDRATIO	
458	IL.KVFF	
460	IL.LIMITN	
462	IL.LIMITP	
464	IL.MFOLDD	
466	IL.MFOLDR	
468	IL.MFOLDT	
470	IL.MIFOLD	
472	IL.OFFSET	
474	IL.VCMD	
476	IL.VUFB	
478	IL.VVFB	
480	MOTOR.AUTOSET	
482	MOTOR.BRAKE	
484	MOTOR.BRAKERLS	
486	MOTOR.CTF0	
488	MOTOR.ICONT	
490	MOTOR.IDDATAVALID	
492	MOTOR.INERTIA	
494	MOTOR.IPEAK	
496	MOTOR.KT	
498	MOTOR.LQLL	
500	MOTOR.PHASE	
502	MOTOR.PITCH	
504	MOTOR.POLES	
506	MOTOR.R	
508	MOTOR.RTYPE	
510	MOTOR.TBRAKEAPP	
512	MOTOR.TBRAKERLS	
514	MOTOR.TEMP	
516	MOTOR.TEMPFAULT	
518	MOTOR.TEMPWARN	
520	MOTOR.TYPE	
522	MOTOR.VMAX	
524	MOTOR.VOLTMAX	
526	MT.ACC	64-bit
530	MT.CLEAR	

Modbus Register Address	Parameter	64-bit
532	MT.CNTL	
534	MT.CONTINUE	
536	MT.DEC	64-bit
540	MT.EMERGMT	
542	MT.LOAD	
544	MT.MOVE	
546	MT.MTNEXT	
548	MT.NUM	
550	MT.P	64-bit
554	MT.SET	
556	MT.TNEXT	
558	MT.TNUM	
560	MT.TPOSWND	64-bit
564	MT.TVELWND	
566	MT.V	
568	MT.VCMD	
570	PL.CMD	64-bit
574	PL.ERR	64-bit
578	PL.ERRMODE	
580	PL.ERRFTHRESH	64-bit
584	PL.ERRWTHRESH	64-bit
588	PL.FB	64-bit
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594	PL.INTINMAX	64-bit
598	PL.INTOUTMAX	64-bit
602	PL.KI	
604	PL.KP	
606	PL.MODP1	64-bit
610	PL.MODP2	64-bit
614	PL.MODPDIR	
616	PL.MODPEN	
618	PLS.EN	
620	PLS.MODE	
622	PLS.P1	64-bit
626	PLS.P2	64-bit
630	PLS.P3	64-bit
634	PLS.P4	64-bit
638	PLS.P5	64-bit
642	PLS.P6	64-bit
646	PLS.P7	64-bit
650	PLS.P8	64-bit

Modbus Register Address	Parameter	64-bit
654	PLS.RESET	
656	PLS.STATE	
658	PLS.T1	
660	PLS.T2	
662	PLS.T3	
664	PLS.T4	
666	PLS.T5	
668	PLS.T6	
670	PLS.T7	
672	PLS.T8	
674	PLS.UNITS	
676	PLS.WIDTH1	64-bit
680	PLS.WIDTH2	64-bit
684	PLS.WIDTH3	64-bit
688	PLS.WIDTH4	64-bit
692	PLS.WIDTH5	64-bit
696	PLS.WIDTH6	64-bit
700	PLS.WIDTH7	64-bit
704	PLS.WIDTH8	64-bit
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710	REC.DONE	
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714	REC.NUMPOINTS	
716	REC.OFF	
718	REC.STOPTYPE	
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722	REC.TRIGPOS	
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728	REC.TRIGTYPE	
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746	SM.I1	
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750	SM.MODE	
752	SM.MOVE	
754	SM.T1	
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Modbus Register Address	Parameter	64-bit
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760	SM.V2	
762	STO.STATE	
764	SWLS.EN	
766	SWLS.LIMIT0	64-bit
770	SWLS.LIMIT1	64-bit
774	SWLS.STATE	
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778	UNIT.ACCROTARY	
780	UNIT.PIN	
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784	UNIT.POUT	
786	UNIT.PROTARY	
788	UNIT.VLINEAR	
790	UNIT.VROTARY	
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794	VBUS.OVFTHRESH	
796	VBUS.OVWTHRESH	
798	VBUS.RMSLIMIT	
800	VBUS.UVFTHRESH	
802	VBUS.UVMODE	
804	VBUS.UVWTHRESH	
806	VBUS.VALUE	
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810	VL.ARPF2	
812	VL.ARPF3	
814	VL.ARPF4	
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818	VL.ARPQ2	
820	VL.ARPQ3	
822	VL.ARPQ4	
824	VL.ARTYPE1	
826	VL.ARTYPE2	
828	VL.ARTYPE3	
830	VL.ARTYPE4	
832	VL.ARZF1	
834	VL.ARZF2	
836	VL.ARZF3	
838	VL.ARZF4	
840	VL.ARZQ1	
842	VL.ARZQ2	

Modbus Register Address	Parameter	64-bit
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846	VL.ARZQ4	
848	VL.BUSFF	
850	VL.CMD	
852	VL.CMDU	
854	VL.ERR	
856	VL.FB	
858	VL.FBFILTER	
860	VL.FBSOURCE	
862	VL.FF	
864	VL.GENMODE	
866	VL.KBUSFF	
868	VL.KI	
870	VL.KO	
872	VL.KP	
874	VL.KVFF	
876	VL.LIMITN	
878	VL.LIMITP	
880	VL.LMJR	
882	VL.MODEL	
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902	WS.MODE	
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