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OC930 Hardware & Software Reference & SC900 Software Reference Manual

Part Number: MA930
Rev G
Firmware Version 1.6

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Table of Contents

1 OVERVIEW

This manual covers the OC930 Serial Communication Option Card hardware and the SC930 drive firmware functionality. The SC930 drive firmware controls the base SC900 drive, whether the OC930 Serial Option Card is installed or not.

1.1 OC930 Serial Communication Option Card

1.1.1 FEATURES

The Serial Communications Option Card (OC930) for your Pacific Scientific SC900 is used to communicate over a 9600 Baud serial link to a host PC. Combined with 930 Dialogue, a menu-driven software support package runs on your PC. The OC930 offers the following features:

- All-digital setup of the current loop, velocity loop, and (when utilized) position loop. There are no pots, DIP switches, plug-on jumpers or components to alter when setting up the servo loops. All parameters are downloaded using an RS-232 or RS-485 port and are saved either in non-volatile memory in the SC900 or on the OC930.
- Automatic drive setup using 930 Dialogue.
- Automatic Analog Command Offset adjustment using 930 Dialogue.
- Simplified uploading, downloading, and disk storage of SC900 parameters for easy cloning and backup documentation.
- Precise readout of motor velocity, position, and other variables using the serial link and 930 Dialogue.
- On-board EEPROM that allows the OC930 to be used as a Personality Module with all non-volatile parameters stored on the OC930 (see Appendix B for additional information.)

Except for using the OC930 as a Personality Module, the OC930 is only required for set up and monitoring of SC900 drive operation. Once set up, the OC930 Option Card can be removed and an OC900 Blank Panel installed with the SC900 drive remaining fully-functional.

1.2 How To Use This Manual

Chapter 2, “Getting Started”, is a step-by-step guide to configuring an SC930 and running your motor within a few minutes. It is strongly recommended that you go through Chapter 2 first to give you a feel for using the SC930 and lay the framework for reading the other chapters. Thoroughly read Chapters 3 through 7 to gain the most from the OC930. If your SC900 will be used as a slave in electronic gearing or driven by step-and-direction inputs, also read Chapter 5. Chapter 7 is an alphabetized listing of commands and variables with detailed descriptions, a very useful reference during setup.

1.3 Warranty

The Pacific Scientific OC930 has a two-year warranty against defects in material and assembly. Products that have been modified by the customer, physically mishandled, or otherwise abused through miswiring, and so on, are exempt from the warranty plan.

If the continuous current rating of the drive is greater than the continuous current rating of the motor being used, it is possible to cause significant damage to the motor. Danaher Motion may not honor the warranty of the motor if it is run under these conditions.

2 GETTING STARTED

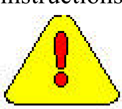
This chapter provides a step-by-step introduction to setting up SC900s with the OC930. This procedure uses the minimum possible equipment to run an unloaded motor and sets motor speed from a PC's serial port. It is strongly recommended that all first time users go through this procedure to become familiar with the OC930 and the 930 Dialogue PC interface software before installing the servo system in a machine.

2.1 Setting Up the Hardware

To go through this product introduction procedure, you will need the following items.

- SC900 Base Servo Drive
- OC930 Serial Com Option Card
- Appropriate Brushless Motor with nothing attached to the shaft
- PC Running Windows 3.1 or higher
- 930 Dialogue Floppy Disk
- Motor Power and Feedback Cables (J2, J3)
- RS-232 Communications Cable (J31)
- DB-25 Connector Mate (J4)
- AC Power Line (J1)

If your OC930 is not already installed in your SC900, use the following instructions to install it.



NEVER insert or remove an Option Card with the Control AC Power (J1-5,6) active. Damage to the base SC900 or the Option Card could occur.

1. Remove Control AC Power from the SC900. The system status LED should be blank.
2. Loosen the two locking screws (counter-clockwise) on the existing face plate or existing Option Card and remove.
3. Position the new Option Card so the silk screen reads the same as the base SC900.
4. Insert the Option Card by sliding it in all the way until it is flush with the base SC900.
5. Tighten the two locking screws (clockwise).

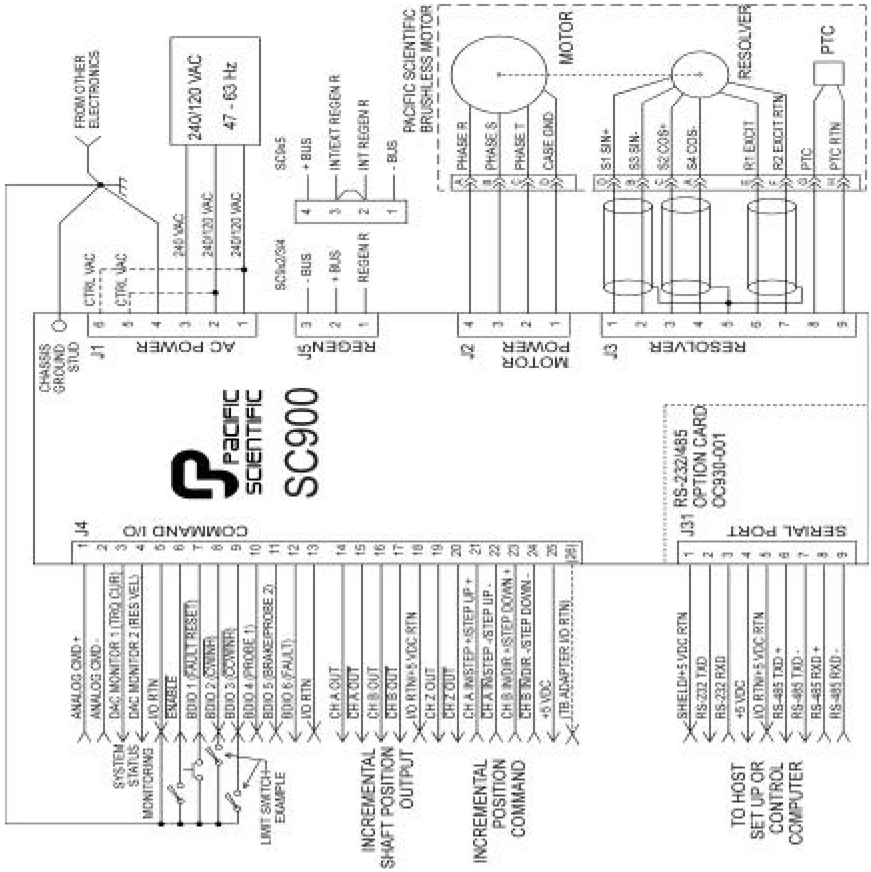
2.2 Wiring Connections

Connect the motor, feedback, and AC Power cables as shown in the Connection Diagram, but do not apply AC Power at this time. It is recommended that Pacific Scientific motor and feedback cables be used during setup since improper cabling is the number one cause of start up problems.

The RS-232 cable made by Danaher Motion (order number CS-232-750) can be used to connect the 9 pin serial port socket on the OC930 to the PC. If this cable is unavailable, a simple 3-wire cable can be made using the wiring diagram shown on page 3-5.

The last connection is to provide the hardware enable to the SC900 via J4-6 and I/O RTN on J4-5. Preferably connect a toggle switch between J4-6 and J4-5. If a toggle switch is not available, a clip lead that can connect or disconnect J4-6 to J4-5 will do.

2.2.1 CONNECTION DIAGRAM

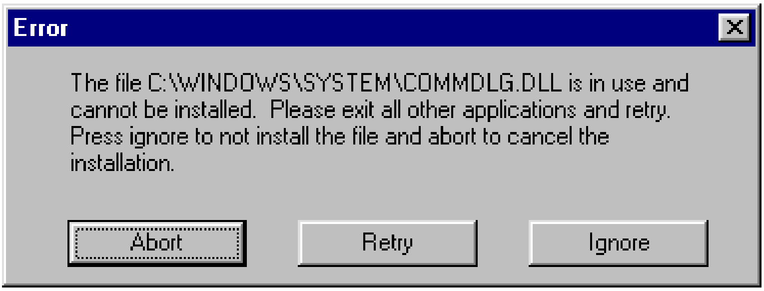


2.3 Installing 930 Dialogue for Windows

To install 930 Dialogue:

1. Insert the 930 Dialogue for Windows diskette in your disk drive (A: or B:).
2. Start Windows and choose **Run** from the **File Menu** of Program Manager.
3. At the Command Line, type **A:\setup930** (or B:\setup930) and press the enter key (↵) or click **OK**.
4. Select the language that you wish to use for the installation process (English or German).
5. Click **OK** to begin the installation of the software on your computer.
6. Windows will then prompt you to select the directory that you would like to have 930 Dialogue installed in. The default is **C:\ProgramFiles\930Win**.

If the following error message appears, click **Ignore**.



When finished, remove the 930 Dialogue disk from the drive and store in a safe place.

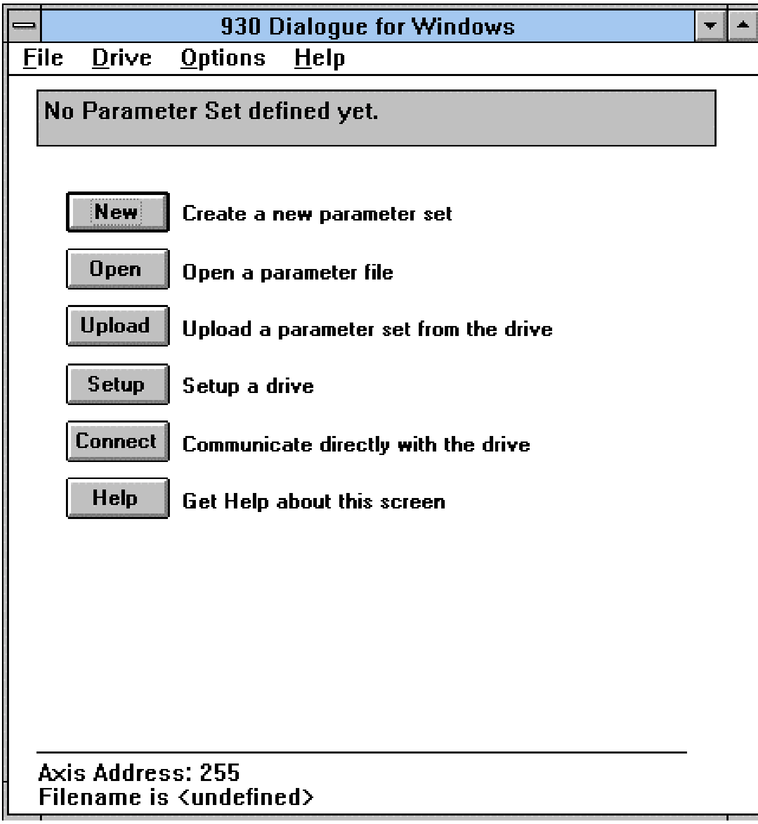
2.4 Starting 930 Dialogue

If not already open, open the **930WIN Group** in Program Manager. Double click on the 930WIN icon to begin using 930 Dialogue for Windows.

2.5 Getting Around in 930 Dialogue

930 Dialogue Main Menu

Once you double-click the 930WIN icon, the following window appears:



Movement keys

930 Dialogue for Windows is a standard Windows application and the normal cursor movement keys operate the same as in all windows applications.

<F1> gives context sensitive on-line help

2.6 Configuring Your System

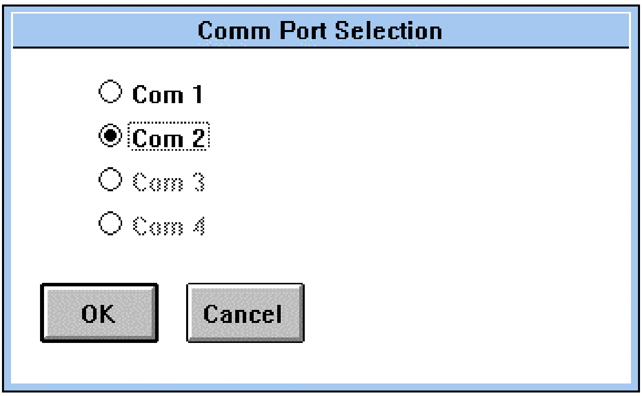
Applying AC Power

Carefully check all wiring connections and ensure that J4-6 is not connected to J4-5. Apply AC power to your controller. The drive status display LED should be alternately flashing *U C* (for unconfigured) after the power up message.

Serial Port

To specify the PC serial port that is connected to the OC930:

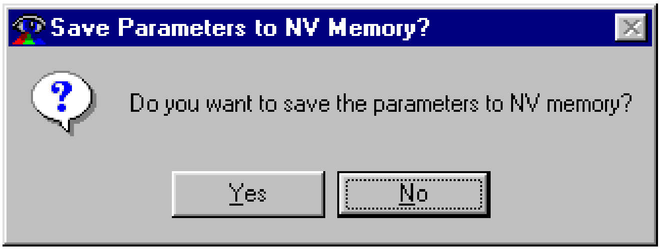
1. Select **Port Configuration** from the **Options Menu**. The following dialogue box appears:



2. Specify the serial port you want to use and click **OK**.
3. Select **New Setup** from the **File** menu and press <**Enter**>.
4. Select **Automatic** for an automatic setup and press ↵.
5. Enter the first four digits of your motor part number. For example, if the part number on your motor name plate is R32GENC-R2-NS-NV-00, type **R32G**, press ↵.
6. Select the AC line voltage being used (120 or 240 VAC) and press ↵.

This option only appears if you are connected to either an SC932 or SC933.

10. After the parameters have been downloaded, select **Yes** when the following window appears:



The drive status display should show a steady *0* for configured and not enabled. To verify that the set up procedure worked, turn power OFF and then ON again. The status LED should repeat its power up message and return a steady *0* . If it is still alternating *U C*, repeat the set up procedure.

The SC930 is configured as a serial port commanded controller. The current loop is compensated properly for the selected motor and the servo parameters are setup to give medium response (approximately 75 Hz velocity loop bandwidth) with the unloaded motor. Additional default settings were also made.

2.6.1 Enabling Drive

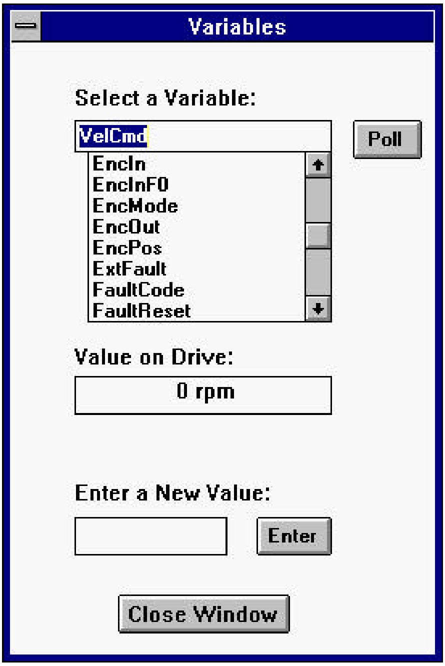
The controller can be enabled at this time by closing the switch between the Enable input (J4-6) and I/O RTN (J4-5). Once enabled, the status LED display should be an *8*. The commanded motor speed is the power up default, set to *0* during configuration. Because the parameters were saved in non-volatile memory, the controller can now be power cycled and, after power-up, be ready to run with the parameters established during this session.

Before proceeding, the motor may need to be attached or temporarily clamped to the table or bench. The inertial forces created during speed steps may make the motor hop around.

2.7 Using the Variables Window

Changing Motor Velocity

Move to the **Drive** menu with the mouse or by typing **<Alt+D>** and select the **Variables** option. The Variables window allows all parameters, variables, and commands to be examined, changed, or actuated as appropriate.



Type the proper key word name in the Select a Variable box or select it from the scrollable alphabetical list of all key words. To change the shaft velocity, type **velcmd** in the Select a Variable box and press ↵. The current value of the motor velocity command in the drive is displayed under Value on Drive.

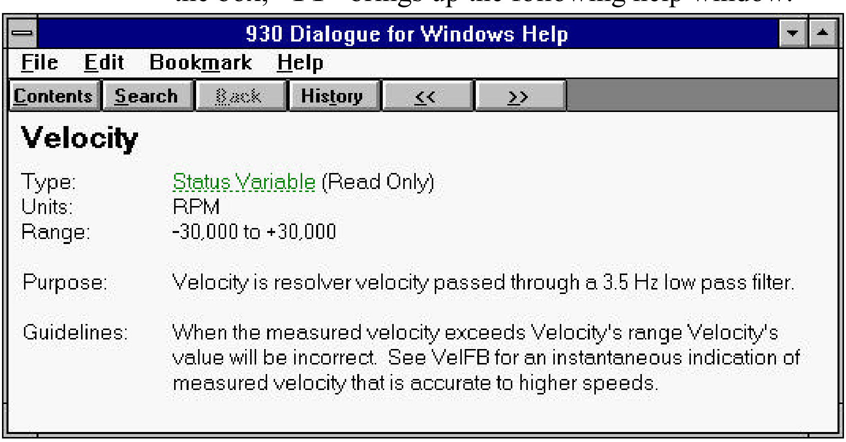
Variable Name Completion

Press the **<Tab>** key or use the mouse, to get the cursor in the Enter a New Value box, enter **100**, and press ↵. The motor shaft should now be spinning at 100 rpm in the clockwise direction when facing the motor shaft. To check the measured motor velocity, type **veloc** in the Select a Variable box and press ↵. 930 Dialogue looked up “veloc”, found it uniquely matched the key word Velocity, completed the spelling automatically, and updated the Value on Drive box.

To continuously read and update the measured velocity, press the **Poll** button via the mouse or by using the **<Tab>** key to move the focus to that button. Pushing the button again stops polling.

Getting Help

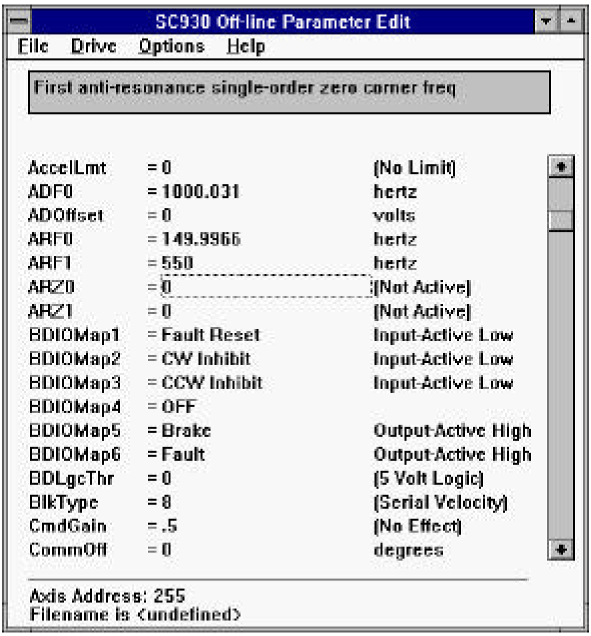
To get help information on a particular key word, press the **<F1>** key while the cursor is located somewhere on the word in the Select a Variable box. With Velocity in the box, **<F1>** brings up the following help window.



2.8 Reviewing and Editing Parameters

Close the Variables window by clicking on **Close Window** or by pressing **<Alt+F4>**.

The SC930 Off-line Parameter Edit window is displayed. The parameter values displayed are based upon selections made during drive set up. These values are stored in the PC's RAM. Changes made using the Variables window do not change the PC's RAM copy.



Getting Help

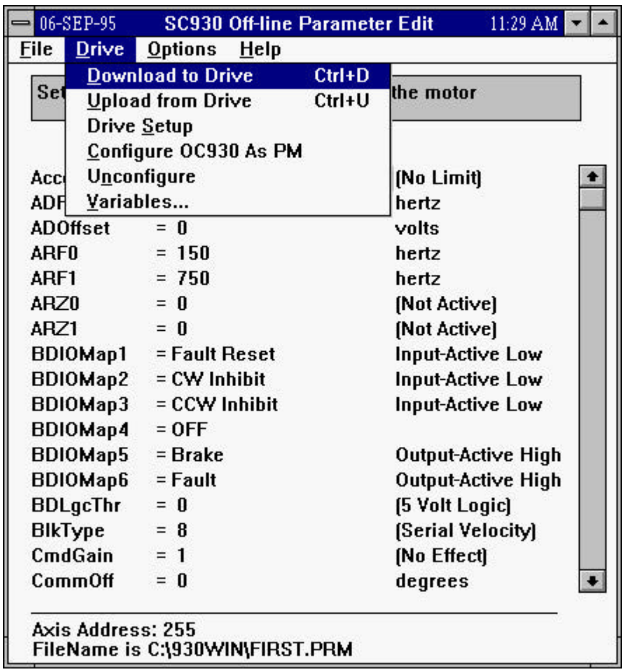
A parameter in the PC's RAM is edited by moving the highlighting bar to a parameter line and typing a new value followed by ↵. For example, move the highlighting bar to ARF1, type **550** and press ↵. The value of ARF1 changes to the new value.

Context-sensitive help is also available in the Parameter Edit Window. Press **<F1>** to get help information about a highlighted variable. Information about all variables is available in this way.

2.9 Downloading Parameters to the 930

Changes to values on the Parameter Edit window only affect the PC RAM copy. Changes made in the Parameter Edit window must be downloaded to the drive in order to take affect.

Select **Download to Drive** in the **Drive Menu** and press **<Enter>**. Select **Yes** to the question "Are You Sure?" and the parameters are downloaded to the OC930. Respond **Yes** to the question "Do an NVSAVE now?" to save the parameters in the SC900's non-volatile memory.



930 Dialogue sets the drive variable Enable to 0 at the beginning of the download. To enable the drive, use the Variables screen to set Enable = 1. If the downloaded parameters were NVSaved, cycling control AC power returns Enable to its default value of 1.

2.10 Uploading Parameters from the OC930

It is also possible to upload the current parameter values in the drive's RAM to the Parameter Edit window on the PC by using the symmetric **Upload from Drive** function.

2.11 Saving Parameters on Disk

Select the **File** menu, select **Save As** and press ↵. Type the file name, **STARTING.PRM,** and press ↵. The Parameter Edit window parameters are saved on disk in a file named **STARTING.PRM**.

2.12 Opening a Disk File

Return to the **File** menu by pressing **<F10>** . Select **Open** and press ↵. Press the **<Tab>** key to move to the list of files. Use the arrow keys to select **STARTING.PRM** and press ↵. The Parameter-Edit screen for **STARTING.PRM** you just saved to disk, is read from the disk and displayed. In this way, you can maintain a record of the drive's parameters. If it is ever required to make a clone, open the file in this way and use the **DownLoad to Drive** option of the **Drive** menu to download the parameters to the new drive.

2.13 Exiting 930 Dialogue

Return to the **File** menu by pressing **<F10>** and select **Exit**. Press ↵ and select **Yes** to the question "Are you SURE?" You then exit 930 Dialogue to Program Manager.

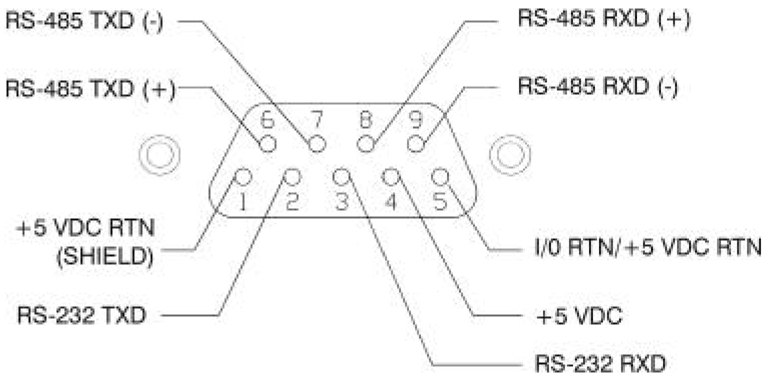
You now know how to start and exit 930 Dialogue, configure your drive, edit and save parameters values, and configure a drive using parameters stored in a disk file.

3 OC930 INTERFACES AND CONNECTIONS

This chapter describes the OC930's serial port (J31) and provides the information required to interface to it. This chapter also describes the serial port address DIP switch on the OC930.

3.1 Serial Port J31

The serial port (J31), utilizes the 9 contact female D subminiature style connector shown below. A brief description of each signal is included in the J31 I/O table on following page. For additional information, please refer to the OC930 Serial Communications Transceiver Schematic at the end of this chapter.



I/O Table		
Input/Output	**Pin #**	**Explanation**
+5 VDC RTN/ Shield	J31-1	Common/shield -serial port interface
RS-232 TXD	J31-2	RS-232 transmitter output (from OC930)
RS-232 RXD	J31-3	RS-232 receiver input (to OC930)
+5 VDC	J31-4	+5 VDC output (200 mA maximum between J31-4 & J4-25)
I/O RTN/+5 VDC RTN	J31-5	Common serial port interface
RS-485 TXD (+)	J31-6	RS-485 transmitter output (from OC930)
RS-485 TXD (-)	J31-7	
RS-485 RXD (+)	J31-8	RS-485 receiver input (to OC930)
RS-485 RXD (-)	J31-9	

The information provided in this section should be used to connect the SC930 to your computer for use with 930 Dialogue (due to the intelligent communications protocol utilized, ***it is not possible to operate the OC930 with a dumb terminal***). Two communication links are available, RS-232 and RS-485. RS-485 allows a single computer to communicate with up to 32 SC930s in multi-axis configurations. A DIP switch on the OC930 selects the communications address for RS-485 communication. 930 Dialogue defaults to communicate with axis 255 upon start up.

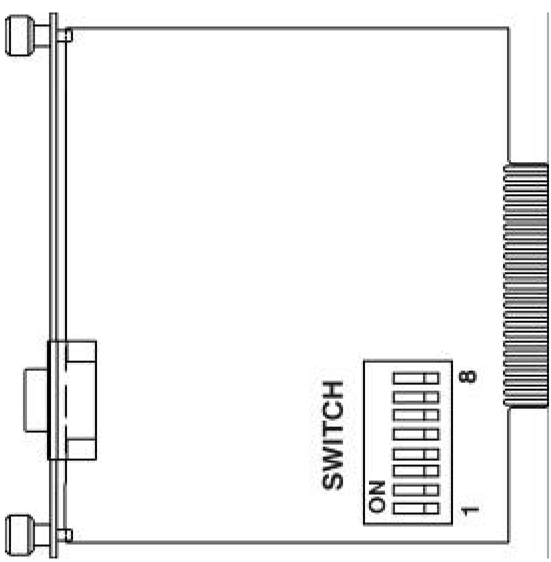
3.2 Setting Up Serial Addresses (Switch S1)

The S1 switch sets the communication address for each OC930. The ability to select different addresses is used with RS-485 for multi-drop communications.

Looking down at the top of the OC930, the following diagram shows the location of switch S1.

Each SC900 subsystem connected to a multi-drop master must have a unique serial address.

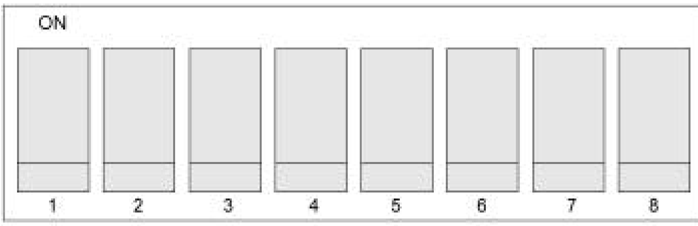
The diagram below shows the S1 default switch settings. The OC930 factory default address is 255.



The switches are:

- On in the up position (away from number)
- Off in the down position (toward number)

When using RS-232 communications, it is recommended to leave the address set at 255.



To change the OC930 Address:

1. Remove power from the SC900 drive.
2. Remove the OC930 from the drive
3. Refer to the table below to set the SC900 to the appropriate address.

Address	1	2	3	4	5	6	7	8
0	On	On	On	On	On	On	On	On
1	Off	On	On	On	On	On	On	On
2	On	Off	On	On	On	On	On	On
3	Off	Off	On	On	On	On	On	On
4	On	On	Off	On	On	On	On	On
5	Off	On	Off	On	On	On	On	On
6	On	Off	Off	On	On	On	On	On
7	Off	Off	Off	On	On	On	On	On
8	On	On	On	Off	On	On	On	On
9	Off	On	On	Off	On	On	On	On
10	On	Off	On	Off	On	On	On	On
250	On	Off	On	Off	Off	Off	Off	Off
251	Off	Off	On	Off	Off	Off	Off	Off
252	On	On	Off	Off	Off	Off	Off	Off
253	Off	On	Off	Off	Off	Off	Off	Off
254	On	Off	Off	Off	Off	Off	Off	Off
255*	Off	Off	Off	Off	Off	Off	Off	Off

****(factory default) recommended for RS-232 operation***

4. Re-connect power to the SC900 drive.

5. Repeat steps 1 through 4 for any other units on the bus. Make sure to give each unit a unique address.

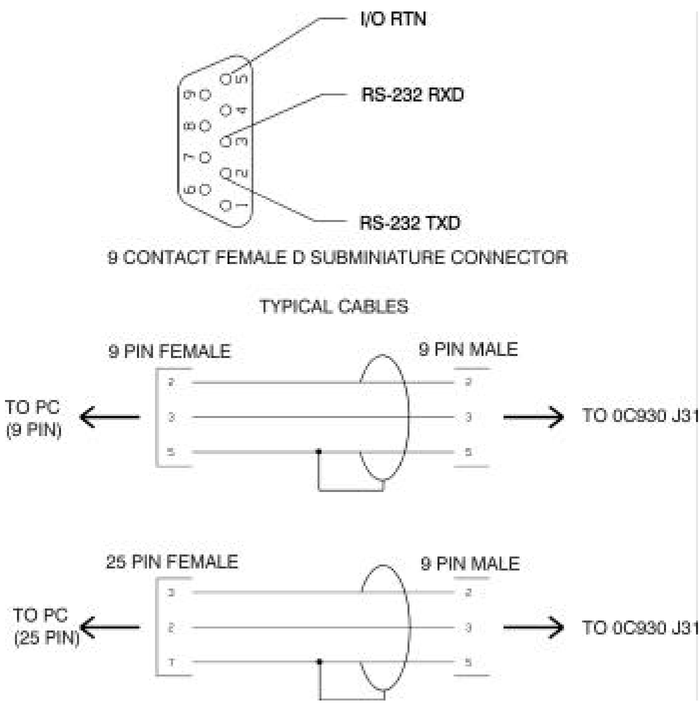
3.3 RS-232 Connections

RS-232 connections on J31 are shown below. Cable wiring required for connecting to either 9 or 25 pin serial ports of most computers are also shown.

Pinouts vary among computer manufacturers. Check the hardware reference manual for your machine before wiring.

3.3.1 CABLING DIAGRAM

A 6 foot (1.8 m) RS-232 Cable with 9 pin connectors and a 9 pin to 25 pin adapter is available from Danaher Motion (part number RS-232-750).



Shielded wiring is recommended for the serial communications cable to minimize potential errors from electrical noise.

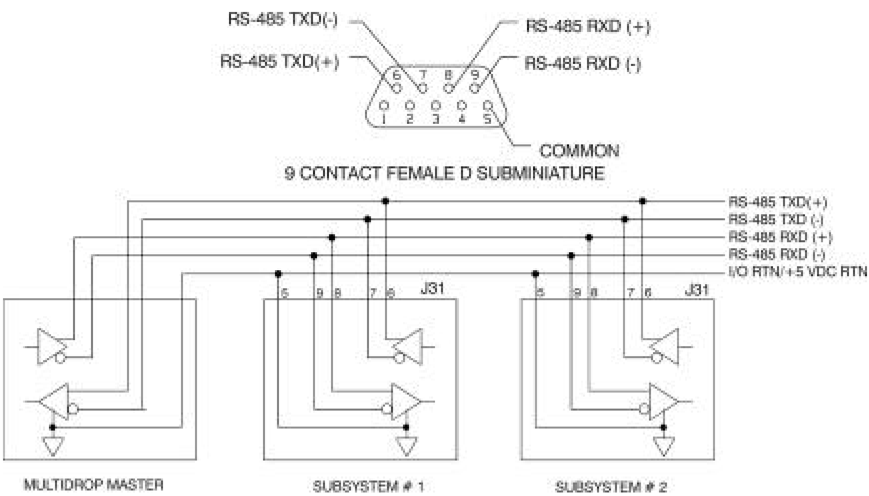
3.4 RS-485/ RS-422 Connections

Up to 32 OC930s can be connected in parallel to a multidrop master. The OC930s must each have a unique address, set using switch S1. Once the address is set, use **Axis Selection** in 930 Dialogue to select the designated axis address. Then, either the RS-232 or the RS-485 link can be used to communicate with the selected axis.

For example, the RS-232 link can be used to completely setup and test an individual axis before connecting it into the multi-axis configuration.

RS-485/RS-422 connections to J31 are shown below. A multidrop interconnection diagram, showing multiple axes connected to a single host is also shown.

3.4.1 CONNECTION DIAGRAM

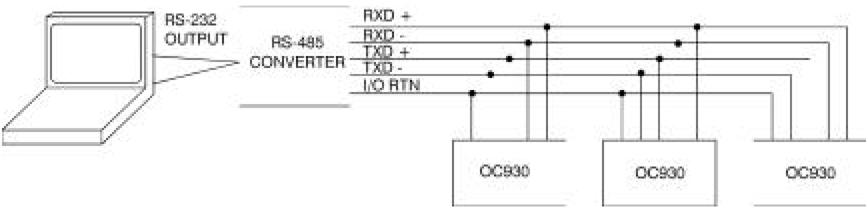


3.5 RS-232/RS-485 Converter Installation

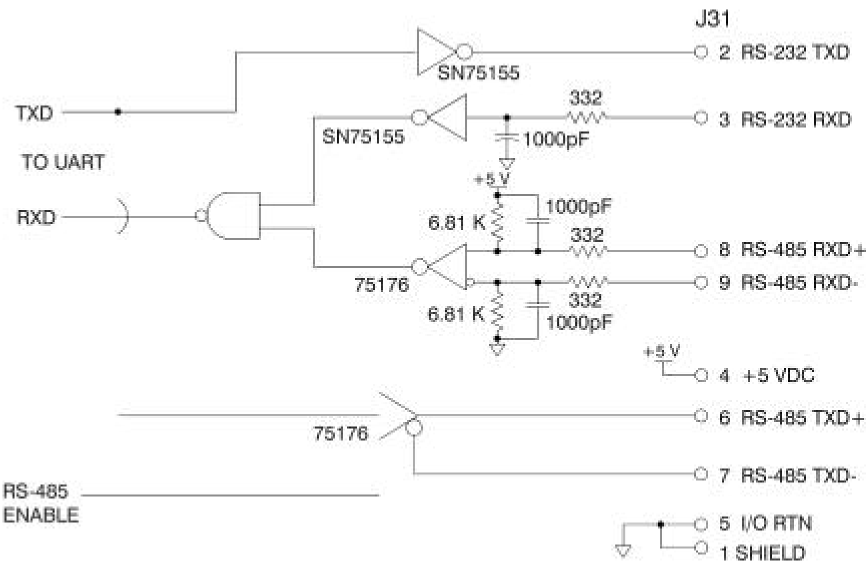
It is often convenient to use an RS-232 to RS-485/RS-422 converter so that an RS-232 port, available on all PCs, can be used to connect to multiple axes. The figure below shows a typical installation, using the B & B Model 422 RS-232 to RS-422 adapter. RS-232 to RS-485/RS-422 adapters are available from many sources.

An adapter can be powered from the serial port +5 VDC output on J31-4 as long as the load current on J31-4 and J4-25 both total less than 200 mA.

3.5.1 INSTALLATION DIAGRAM



3.6 OC930 Serial Communications Transceiver Schematic



4 SELECTING MOTOR CONTROL FUNCTIONALITY

The SC900 family has three distinct modes of controlling the motor shaft and three distinct sources for the shaft command:

Modes

- Torque Control
- Velocity Control
- Position Control

Commands

- Analog Command
- Incremental Digital Pulse Command

4.1 Serial Port Command with OC930

The SC930 implements seven of the nine possible combinations from the above list. The eighth possibility, Serial Port command torque block, is implemented indirectly and the ninth possibility, analog command position block is not implemented. The BlkType parameter sets most of the overall drive functionality. Many other parameters need to be set to ensure smooth and proper operation and this chapter goes over these requirements.

Within these eight combinations of mode and command, additional parameters allow further specialization. For example, BlkType = 1 (analog command velocity block) is further enhanced to be an emulation of a superior performance clutch brake with a number of features.

Most of the drive's operating modes are easily set up using **New Set Up** under the **File** menu or **Drive Set Up** under the **Drive** menu of 930 Dialogue. The others are set up by using the Variables screen to change parameters or by changing appropriate entries in the parameter edit form and down loading the new configuration. The following sections give the details on these eight operating modes.

Refer to Appendix C for control block diagrams. Refer to Chapter 6 for additional information on velocity and position loops.

4.2 Torque Block Modes

4.2.1 ANALOG COMMAND TORQUE BLOCK (BLKTYPE = 0)

This mode allows the differential analog voltage between terminals J4-1 and J4-2 to set the motor's terminal torque current amplitude. Since the actual motor current amplitude (IFB) times the motor's 0-peak line-line torque constant K_T times $\sqrt{3}/2$ is the shaft torque. The analog input directly controls motor shaft torque. The easiest way to set up this mode is to select **Torque Block - Analog Command** when doing **New Set Up** under the **File** menu or **Drive Set Up** under the **Drive** menu of 930 Dialogue. The overall gain of this block (output current amplitude in amps/input volt), is set by the CmdGain parameter directly in amps/volt and is set by the user to the desired value.

Command Processing

Figure 1 in Appendix C Control Block Diagrams shows the analog torque block mode has the same signal processing as a velocity loop except that the velocity error signal (VelErr) is set to VelCmdA - not to (VelCmdA - VelFB) and the VelCmd clamp is bypassed. The analog input goes through a number of signal processing steps before becoming the motor torque current command, ICmd.

1. Analog differential amplifier with 1200 Hz low pass filter.
2. High resolution A/D sampled at the velocity loop update rate and added to the ADOffset parameter.
3. ADF0 adjustable low pass filter to become AnalogIn.
4. Bypass the VelLmtHi, VelLmtLo clamp.
5. d/dt slew limit clamped by the AccelLmt and DecelLmt to become VelCmdA.
6. Velocity error (VelErr) is set equal to VelCmdA.
7. The anti-resonance, second-order velocity loop compensation block controlled by ARF0, ARF1, ARZ0, and ARZ1 become FVelErr.
8. The proportional and integral velocity loop compensation block is controlled by KVP and KVI.
9. Through the IlmtPlus and IlmtMinus current command clamp to become ICmd (motor torque current command).

The options allow tailoring the response to fit a particular application. Typically, most of the signal blocks are set to directly pass the signal so ICmd = CMDGain * (AnalogIn) as directly as possible. The parameters below are set by 930 Dialogue during Analog Torque block set up.

AccelLmt = 0 (no Accel limiting)
DecelLmt = 0 (no Decel limiting)
ADF0 = 100,000 Hz to bypass, 1000 Hz by auto set up
ARF0 = 100,000 Hz
ARF1 = 100,000 Hz
ARZ0 = 0 (not active)
ARZ1 = 0 (not active)
KVP = 1 A/rad/sec
KVI = 0 Hz

KVP must be set to 1 A/rad/sec for the units on CmdGain to be correct. If CmdGain is set to 1 A/V and KVP to 2 A/rad/sec, an analog input of 1 volt incorrectly gives 2 amps of output torque current amplitude.

When changing BlkType from some value to 0 to get an analog torque block, you need to also set KVP to 1, KVI to 0, and the other items in the above list to appropriate values to get the system working as desired.

4.2.2 DIGITAL FREQUENCY COMMAND TORQUE BLOCK (BLKTYPE 4)

Similar to the analog command torque block mode except the command input comes from the Incremental Position Command inputs, J4-21 through J4-24. The frequency on these input terminals is EncFreq and is substituted for the AnalogIn input to the CmdGain scaling. The units on CmdGain for BlkType = 4 become A/kHz. For this mode to work, also set EncMode and EncInF0 appropriately.

4.2.3 SERIAL PORT COMMAND TORQUE BLOCK (BLKTYPE = 0)

Requires the OC930 to work. It is not possible to directly command the current over the serial port. Use the analog command torque block mode to virtually implement it. First, set VelCmdSrc = 1, (sets VelCmd = VelCmd2). Second, send the desired torque current command to VelCmd2. If KVP = 60/2p A/rad/sec, VelCmd2 = 1 rpm commands 1 A.

4.3 Velocity Block Modes

4.3.1 ANALOG COMMAND VELOCITY BLOCK (BLKTYPE=1)

This mode allows the differential analog voltage between terminals J4-1 and J4-2 to set the motor's shaft velocity (shaft speed). The easiest way to set up this mode is to select **Velocity Block - Analog Command** when doing **New Set Up** under the **File** menu or **Drive Set Up** under the **Drive** menu of 930 Dialogue. The overall gain of this block (output shaft velocity/input volt), is set by CmdGain in krpm/V and is set by the user to the desired value.

Command Processing

The analog input goes through a number of signal processing steps before becoming the actual motor velocity command VelCmdA, as shown by Figure 1 in Appendix C Control Block Diagrams.

1. Analog input differential amplifier with 1200 Hz low pass filter.
2. High resolution A/D sampled at the velocity loop update rate and added to ADOffset.
3. ADF0 adjustable low pass filter to become AnalogIn.
4. Range clamped by VelLmtHi and VelLmtLo.
5. d/dt slew limit clamped by AccelLmt and DecelLmt to become VelCmdA.

Velocity Loop Compensation

The actual velocity command (VelCmdA) is combined with the measured shaft velocity (VelFB) and processed by the velocity loop compensation to create the motor torque current command (ICmd). The detailed signal processing steps to create ICmd are listed below and shown in Figure 2 in Appendix C Control Block Diagrams.

1. VelErr set equal to (VelCmdA - VelFB)
2. The anti-resonance, second-order velocity loop compensation block controlled by ARF0, ARF1, ARZ0, and ARZ1 becomes FVelErr.
3. The proportional and integral velocity loop compensation block is controlled by KVP and KVI, respectively.
4. IlmtPlus and IlmtMinus current command clamp to become ICmd (motor torque current command).

The automated set up capability of 930 Dialogue usually sets them all properly. The only parameters that typically need adjustment are the desired block gain (CmdGain) and velocity loop tuning gain (KVP). For more information on tuning the velocity loop, see *Chapter 6 Servo Loop Parameters*.

4.3.2 DIGITAL FREQUENCY COMMAND VELOCITY BLOCK (BLKTYPE = 5)

This mode is the same as the analog command velocity block mode, except that the command input comes from the Incremental Position Command inputs on J4-21through J4-24. The frequency on these input terminals is EncFreq and is substituted for the AnalogIn input to CmdGain scaling. The units on CmdGain for BlkType = 5 become krpm/kHz. For this mode to work, also set EncMode and EncInF0.

4.3.3 SERIAL PORT COMMAND VELOCITY BLOCK (BLKTYPE = 8)

This mode requires the OC930 to operate. It is the same as the analog command velocity block mode except that the command input is the value of VelCmd set over the serial port.

VelCmd is a non-volatile parameter and when the SC900 base servo powers up in BlkType = 8, the initial value of the velocity command is this non-volatile value. Changing VelCmd over the serial port sets a new volatile velocity command. Changing the non-volatile velocity command requires also issuing the NVSave command.

Clutch Brake Example

One useful variation of this mode is to implement a simple emulation of a mechanical clutch brake. The procedure below lists the steps required to set up this mode. Once set up, clutch brake emulation does not require the OC930 to operate.

1. Set VelCmd to the desired run speed, including direction (in rpm).
2. Set VelCmd2 to 0.
3. Set VelCmdSrc to one of the BDIO discrete inputs.
4. Set AccelLmt and DecelLmt to the desired clutch activation acceleration and brake activation deceleration respectively.

VelCmdSrc selects between the normal source and VelCmd2 for VelCmd. Using the clutch brake emulator is as simple as setting the VelCmdSrc BDIO to the active state to select VelCmd2 for the brake state and VelCmdSrc to inactive for the clutch/run state.

This emulation allows much faster transition times between braking and running than mechanical clutch brakes, has significanty longer life due to near zero mechanical wear, clutch/brake mode transitions are consistently the same, and the run speed regulation is often much better. The only disadvantage to this mode is that in the brake mode, even though the velocity command is digitally 0, there can be a very small offset that could lead to drift. For example, using the drive's worst case digital offset drift of 0.00005 rpm, the shaft only moves 1 degree per hour, or only 0.02 mechanical degrees in one minute. When the drive needs to be out of the clutch-activated mode for extended time periods, disable the drive to ensure no powered drift.

This example could be used with the digital frequency or analog command modes to allow the run speed to be externally adjusted. The analog command mode combined with VelLmtHi and VelLmtLo make a clutch brake emulator with two selectable run speeds (forward and reverse). Set CmdGain and ADOffset so a digital signal connected to the differential analog input exceeds the clamps set with VelLmtHi and VelLmtLo.

It is possible to emulate a clutch brake with no brake drift and no holding torque using RunStop instead of VelCmdSrc. RunStop automatically disables the drive once shaft speed decelerates to 0 or StopTime seconds after RunStop disables the drive independent of speed. See BlkType = 2 for a clutch brake emulation with zero drift in brake state with full position holding torque.

4.4 Position Block Modes

4.4.1 DIGITAL COMMAND POSITION BLOCK (BLKTYPE = 2)

A velocity block mode with VelCmd coming from the position loop. See Figure 3 in Appendix C Control Block Diagrams.

PosError = PosCommand - Position Feedback

$$VelCmd = 2\pi * KPP * PosError + \frac{KVFF}{100} * \left[\frac{d}{dt}(PosCommand)\right]$$

where:

PosCommand is the position command in radians
KPP is the proportional position loop gain in Hz
KVFF is the velocity feed forward gain percentage
VelCmd is the net velocity command in rad/sec.

To finish setting this mode, set EncMode and EncF0 to get the command working and PulsesIn and PulsesOut to the desired block gain using either the **Position Block - Step and Direction** or **Position Block - Electronic Gearing** when doing **New Set Up** under the **File** menu or **Drive Set Up** under the **Drive** menu of 930 Dialogue. See Chapter 5 for additional details on this mode.

When the SC900 is disabled and BlkType = 2, PosCommand is set to the position feedback value. When the drive is enabled, it picks up motion from its present position.

4.4.2 SERIAL COMMAND POSITION BLOCK (BLKTYPE = 2)

Similar to the digital command position block type except that EncMode=3 to hold EncPos and the desired position command is sent over the serial port as PosCmdSet.

Use this mode with extreme care. It is easy to change PosCommand by huge amounts via PosCmdSet. Large changes result in the motor flying off at maximum speed for extended periods of time. Change PosCmdSet only in small incremental amounts to perform a position move.

Zero Drift Clutch Brake With BlkType = 2, VelCmdSrc switches differentiated PosCommand between EncIn and VelCmd2. For detailed information, see the Position Control Block Diagram in Appendix C Control Block Diagrams.

To set up clutch brake emulation, set EncMode = 3 and VelCmd2 to the desired RunSpeed. With VelCmdSrc active, the motor runs at VelCmd2 (clutch active state). With VelCmdSrc inactive, the motor is in a position hold (brake state). The velocity trajectory between clutch and brake states is determined by the control loop dynamics and the accel/decel possible at maximum torque. For example, setting KVFF = 100 always transitions at maximum torque. Setting KVFF = 0, the transition is controlled by KPP.

For Position Control modes (BlkType = 2), AccelLmt and DecelLmt no longer limit the commanded velocity slew rate. AccelLmt and DecelLmt still limit VelCmdA for position loops. VelCmdA is determined only by the position loop. Unless AccelLmt and DecelLmt are turned off with BlkType = 2, there are unacceptable overshoots in the shaft motion.

5 SETTING PARAMETERS FOR ELECTRONIC GEARING

This chapter provides procedures for setting up the SC900 for use as either an electronic gearing slave with a master reference encoder or with a stepper indexer that generates step and direction signals.

Both electronic gearing and stepper emulation modes are based on configuring the SC900 with a position loop, setting the command scale factor via PulsesIn, PulsesOut, PulsesFOut and selecting the proper command pulse stream encoding format. Figure 3 in Appendix C Control Block Diagrams shows command scaling and position loops.

The setup for either mode of operation use **New Setup** from the **File** menu or **Drive Setup** from the **Drive** menu.

5.1 Slaving the SC900 to a Master Encoder

These steps describe how to use 930 Dialogue to set up your SC900 for use as an Electronic Gearing Slave with a Master Reference encoder.

1. Select **New Setup** from the **File** menu.
2. Select **Automatic** for the **Set Up Mode**.
3. Enter your motor part number and press **<Enter>**.
4. Select your drive model number.
5. Select the type of line voltage, if applicable.
6. Select **Position Block-Electronic Gearing** on the Mode of Operation screen.
7. Enter the number of motor resolver counts (1/65536 of a rev) that you want the motor to move for the specified number of input encoder quadrature counts.

Example If the input encoder line count is 2000 (8000 quadrature counts per encoder revolution) and the motor makes one revolution for every three encoder revolutions, then:

1 rev = 65,536 resolver counts per
3 revs = 24,000 encoder counts.

Because 65,536 is greater than the maximum value for PulsesOut, divide both numbers by four. This gives 16,384 motor resolver counts for 6,000 input encoder counts.

If the calculated number of motor resolver counts is a non-integer value, use PulsesFOut in addition to PulsesOut.

8. Press **OK** and make your bandwidth selection.
9. Enter the filename you would like to call your new parameter file.
10. Download the parameter set to the SC900 using **Download to Drive** on the **Drive** drop-down menu.

At this point, when the drive is enabled, it acts as an electronic gearing slave and moves relative to the enable time starting position. The Position Block Electronic Gearing setup mode sets the following parameters to the values listed below:

BlkType = 2
Digital Position
EncMode = 0
Quadrature Decode
Kvff = 0
No velocity feed forward
KPP = BW selected
PulsesOut = Resolver Counts entered
PulsesIn = Encoder Counts entered

In many electronic gearing applications, following error (position loop null error proportional to speed) with Kvff = 0 is a problem. The following error can be eliminated by setting Kvff to 100%. See Section 6.2 for more information of Kvff.

5.2 Controlling the SC900 with a Stepper Indexer

These steps describe how to use 930 Dialogue to set up your SC900 for use with a stepper indexer.

1. Select **New Setup** from the **File** menu.
2. Select **Automatic** for the **Set Up Mode**.
3. Enter your motor part number and press **<Enter>**.
4. Select your drive model number.
5. Select the type of line voltage, if applicable.
6. Select **Position-Block-Step** and **Direction** on the Mode of Operation screen.

7. Specify the number of steps per motor revolution. This number must be evenly divisible by four. For industry standard step sizes, select from the table below.

1.8°/Full Step	Steps/Rev
Full	200
Half	400
1/5	1000
1/10	2000
1/25	5000
1/125	25000
1/250	50000

8. Press **OK** and make your bandwidth selection.
9. Enter the filename you would like to call your new parameter file.
10. Download the parameter set to the SC900 using **Download to Drive** on the **Drive** drop-down menu.

At this point, when the drive is enabled, it is controlled by a stepper indexer feeding it step and direction signals. The Position Block Step and Direction setup mode sets the following parameters to the values listed below:

BlkType = 2
Digital Position
EncMode = 1
Step & Direction
Kvff = 0
No velocity feed forward
KPP = BW selected
PulsesOut = 16834 Resolver counts
PulsesIn = (steps/motor rev)/4

Step and direction applications are typically point-to-point positioning and Kvff=0 works fine. Crisper motion profile “corners” are possible when Kvff is properly adjusted in the rage (typically) of 70-80%.

5.3 Converting From Another Mode

It is not uncommon to start a system as a velocity block to either check out system mechanics or optimize the velocity loop tuning. It is not required to go back and do a **New Setup** to get the SC900 configured to do positioning. By using the Variables screen, set the specific parameters listed at the end of each section.

To set the values of the parameters, use the following procedure while the drive is powered and disabled:

1. Set proper values for each of the six parameters listed.
2. NVSave the parameter set in the drive.
3. Upload the parameter set to the PC and save to a file for future reference.

5.4 Turning Gearing On and Off

VelCmdSrc allows gearing to be turned on or off via a digital input. If VelCmd2=0 and VelCmdSrc is active, the drive does a position hold. Setting VelCmdSrc to inactive returns the drive to normal gearing. See the Control Block Diagram in Appendix C.

When combined with an external computer or PLC, this function is also used for a crude homing routine. Connect the home switch to the BDIO pin mapped to VelCmdSrc and set VelCmd2 to the homing velocity.

6 SERVO LOOP PARAMETERS

This chapter describes setting parameters associated with the velocity and position loops. In many cases, satisfactory operation is achieved using **New Set Up** or **Drive Set Up**. In some cases, you must adjust control loop parameters due to large mismatches between motor and load inertia, mechanical resonances, backlash, etc. This chapter provides guidance for handling these situations.
Review Chapter 4 for a description of the control loop architecture.
Refer to Appendix C for control loop block diagrams.

The two anti-resonant zeroes (ARZ0 and ARZ1) are assumed to both be off (set to zero) for this discussion.

6.1 Velocity Loop

The velocity loop block diagram is shown in Figure 2 of Appendix C Control Block Diagrams. Velocity loop bandwidth is the key indicator of system performance. Systems with fast settling time must have high velocity loop bandwidth. Conversely, if the velocity loop bandwidth is low, attempting to achieve fast settling time by increasing the position loop bandwidth, KPP, leads to overshoot and ringing.

Velocity Loop Bandwidth

The velocity loop bandwidth (f_{VC}) is given by the equation:

$$f_{VC}\,(\mathrm{Hz}) = \frac{KVP * K_T\sqrt{3}/2}{2\pi * J_{TOT}} \approx 0.138 * KVP * \frac{K_T}{J_{TOT}}$$

where:

KVP is the velocity loop proportional gain in amps/(rad/sec)

K_T is the 0-peak line-line motor torque constant in lb-in/amp

J_{TOT} is the total inertia (motor total + load total) in lb-in-sec2.

(Any consistent set of units for K_T, J_{TOT}, such as MKS, that yields K_T/J_{TOT} in rad/sec^2/amp will work).

f_{VC} is the unity gain open-loop crossover frequency of the idealized rigid single mass system. See Hardware Specifications for maximum f_{VC} value.

Default Bandwidths

The **New Setup** and **Drive Setup** utilities set KVP to achieve the velocity loop bandwidths shown below, assuming there is no load on the motor shaft and the motor has no mechanical brake or other secondary devices installed.

The bandwidth depends upon the user's selection for desired system response:

	Gentle	Medium	Stiff
f_{VC} **Velocity Loop Bandwidth (Hz)**	25	75	200

Load Inertia

Bandwidth changes inversely with total inertia. If the load inertia equals the motor plus resolver inertia, the velocity loop bandwidth is half the value shown. If the load inertia is ten times the motor plus resolver inertia, the bandwidths are one eleventh these values. KVP must be increased to compensate for increased load inertia if bandwidth is to be maintained. Typically, load inertias up to 3 (motor + resolver) give acceptable performance without further optimization.

The most common servo setup problem is adding large load inertia without a corresponding increase in KVP.

The value of KVP to achieve a desired bandwidth is easily calculated as:

$$KVP = \frac{2\pi * f_{VC} * J_{TOT}}{K_T \sqrt{3}/2} \approx 7.26 * f_{VC} * \frac{J_{TOT}}{K_T}$$

Example Calculation

For example, to achieve 75 Hz bandwidth with an R32G motor having 20 to 1 load inertia = 0.011 lb-in-sec^2:

J_{TOT} [1]= 0.00055 + 0.011 = 0.01155 lb-in-sec^2

K_T [2]= 4.4 lb-in/amp

$$KVP = 7.26 * 75 * \frac{0.01155}{4.4} = 1.43$$

[1] Motor plus resolver inertia (0.00055 lb-in-sec^2) for the R32G motor is found in the catalog or 930 Dialogue's motor data screen.

[2] K_T is found in the catalog as K_T peak (4.4 lb-in/amp) or by using K_E (52.0 V/krpm) shown on 930 Dialogue's motor data screen in the following formula: $K_T = 0.084 * K_E$ (volts/krpm).

930 Dialogue also makes the calculation. Simply enter the total inertia in place of the motor plus resolver inertia when using **New Setup** or **Drive Setup** and 930 Dialogue calculates the appropriate value for KVP to achieve 25, 75 or 180 Hz bandwidth, depending upon the choice made for system response.

There is no specific answer to the general question, "What should the bandwidth be?" However, the higher the velocity loop bandwidth, the faster the settling time and the better the rejection of torque disturbances (increased stiffness). Typically, velocity loop bandwidths range from 30 to 100 Hz.

A bandwidth too high lowers the damping of resonances in mechanical linkages, causing excessive ringing and/or wear in coupled mechanics. Remember, it is the resulting motion at the end of any mechanical linkages that typically matters - not the response at the motor shaft.

Problems With High Load Inertia

It would seem that setting KVP is simply a matter of increasing its value to compensate for load inertia. Unfortunately, the following problems often interfere, particularly when the load inertia is large compared with the motor's inertia:

1. Mechanical resonances between motor and load cause high frequency oscillation.
2. Backlash between motor and load effectively unload the motor over a small angle. Within this small angle, the increased bandwidth results in oscillations.
3. Ripple in the velocity feedback signal results in large motor ripple current, if KVP is large.

As a general rule, any system with KVP set higher than 5 times the medium bandwidth setting requires adjustment to ARF0 and ARF1.

Resonances

Mechanical resonances are caused by springiness between motor inertia and load inertia. This may result from belts, flexible couplings, or the torsional stiffness of shafts. In general, the stiffer the couplings, the higher the resonance frequency and the easier it is to tune the system for good performance.

If the velocity loop breaks into an oscillation at a frequency well above the calculated velocity loop bandwidth, a resonance problem may exist. A second symptom is that the frequency of oscillation is relatively constant in the presence of changes to ARF0 and ARF1.

ARF0 and ARF1

Two digital anti-resonant low-pass filters ARF0 and ARF1 are included in the velocity loop. Their purpose is to lower the gain above f_{VC} and especially at any resonant frequency $>f_{VC}$ so oscillations do not occur. Default values, also a function of the selected system response, are shown below:

	Gentle	Medium	Stiff
ARF0 (Hz)	100	150	1500
ARF1 (Hz)	200	750	1x105

If the velocity loop bandwidth cannot be raised to an acceptable value without encountering a resonant oscillation, the procedure below is recommended.

1. Set ARF0 and ARF1 to 400 Hz.
2. Set KVP low enough to prevent oscillation.
3. Increase KVP slowly until oscillation at the resonant frequency just begins. Then, reduce KVP slightly until the oscillation just stops. Compute the velocity loop bandwidth using the formula given at the beginning of this section. If the velocity loop bandwidth is less than 0.25 times the value of ARF0 and ARF1, proceed to Step 4. Otherwise, go to Step 5.
4. Decrease both ARF0 and ARF1 by 20% and go back to Step 3.
5. The velocity loop bandwidth should be approximately one quarter the value of ARF0 and ARF1. For margin, reduce KVP, ARF0, and ARF1 by 20%.

Backlash

Some backlash may be unavoidable, especially when gear reduction is used. If backlash is present, the inertia match must be good (load inertia should be roughly equal to motor inertia) for good servo performance. Gearing reduces the inertia reflected to the motor by the square of the gear reduction from motor to load. Select a gear ratio to give the required match.

Current Ripple

The velocity feedback signal in standard SC900 Drives operating with the standard 20 arcmin resolver have up to 3% p-p ripple. The resulting motor torque current ripple, with no ARF0/ARF1 filtering is calculated using the following formula:

$$\text{Current ripple (amps p-p)} = \frac{3}{100} * \text{Speed (rpm)} * \frac{2\pi}{60} * \text{KV}$$

$$\approx 0.003 * \text{Speed (rpm)} * \text{KV}$$

There is cause for concern when the p-p number exceeds 40% of the drive's or motor's current rating. The motor current should be monitored using Dac Monitors on J4-3 insure actual ripple current, with ARF0/ARF1 filtering, is n excessive.

Motor current ripple is often reduced by lowering the ARF ARF1 low-pass filter break frequencies. This benefit is limited by velocity loop bandwidth and stability constraints. Velocity feedback ripple and motor current ripple are also reduced by specifying a higher-accuracy resolver.

KVI

KVI sets the "lag-break" frequency of the velocity loop. K is equal to the frequency in Hz where the velocity loop compensation transitions from predominantly integral characteristics to predominantly proportional characteristics. Drive rejection of torque disturbances increase as KVI increases. Default values for KVI are:

	Gentle	Medium	Stiff
KVI (Velocity Loop Lag-Break Freq. (Hz))	1.7	5.0	13.3

If the Drive is to be used within a position loop (either wi BlkType = 2 or when using an external position drive and BlkType = 1), KVI should be equal to or less than 0.1 times the velocity loop bandwidth. If no position loop is used, KVI can be set to 0.25 times the velocity loop bandwidth (higher if some ringing can be tolerated). In general, the response to a velocity command step (or truncated ramp) has velocity overshoot for non-zero values of KVI.

6.2 Position Loop

When BlkType = 2, a position loop is configured outside the velocity loop. Figure 3 in Appendix C Control Block Diagrams illustrates the structure of the position loop. The velocity loop must be set up and evaluated in terms of bandwidth before attempting to setup the position loop.

KPP The position loop proportional gain, KPP, determines the settling time of the position loop. KPP is the bandwidth of the position loop, in Hz, assuming an ideal velocity loop. Default values for KPP are:

	Gentle	Medium	Stiff
KPP (Position Loop Bandwidth (Hz))	5	15	50

In general, the higher the value of KPP, the faster the settling time. Trying to set KPP to a high value with inadequate velocity loop bandwidth results in overshoot and ringing. A good trade off is to set KPP to 0.2 times the velocity loop bandwidth. Slightly higher values can be used if overshoot is tolerated.

KVFF KVFF is the velocity feed forward gain. In the absence of velocity feed forward (KVFF = 0), the commanded velocity is proportional to the position (following) error. The actual position lags the commanded position by a value proportional to the speed. The error is smaller for larger values of KPP. The following table gives a feel for the following error magnitude.

Speed (rpm)	KPP (Hz)	Following Error (revolutions)
1000	10	0.27
2000	10	0.53
5000	10	1.33
1000	20	0.13
2000	20	0.27
5000	20	0.66

The following error can easily exceed one complete motor revolution. In many electronic gearing applications, such following errors are not acceptable (real gears and stepper systems do not have following errors!)

Feed forward takes advantage of the fact that the SC900 DSP knows the frequency of the encoder or step inputs and how fast the motor should be going at a given instant. All or part of this velocity can be added to the velocity command to reduce following error. If KVFF is set to 100%, the steady state following error reduces to zero.

Overshoot Setting KVFF equal to 100% can result in position overshoot. Somewhat lower values are required if this is a problem. KVFF set to 70%-80% typically achieves the fastest step response with no overshoot. However, setting KVFF to less than 100% gives steady state following error when running at constant speed.

6.3 Advanced Velocity Loop Tuning

Continuous Time Transfer The transfer function for the velocity loop compensation block is given below:

For ARx0 > 0 both roots are real and:

$$\omega_x = 2\pi\sqrt{(ARx0)(ARx1)}$$

$$Q_x = \frac{\sqrt{(ARx0)(ARx1)}}{ARx0+ARx1}$$

For ARx0< 0 roots are a complex pair and:

$$\omega_x = -2\pi ARx0$$

$$Q_x = ARx1$$

When ARx0 and ARx1 are both zero, or the numerator of $\frac{FvelErr}{VelErr}$ ***(s) reduces to 1. If ARx0 or ARx1 is individually 1, the numerator reduces to*** $\frac{s}{2\pi ARZx}+1$.

Discrete Time Transfer

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:

$$s \rightarrow \frac{1}{T_S}(1-z^{-1})$$

where T_S = 250 µs.

7 PARAMETER, VARIABLE AND COMMAND REFERENCE

This chapter includes a quick reference guide to all 930 parameters, variables, and commands as well as detailed descriptions of each. The quick reference indicates the page number of the detailed description.

7.1 Quick Reference

The list defines the type of entry, default value, and page number where a detailed description can be found. “NV” in the type field indicates the parameter is stored in non-volatile memory. “MF” in the type field indicates the variable is a mappable function.

A default “value” of set up indicates that the value assigned by 930 Dialogue is a result of the controller set up function.

Name	Type	Default Value	Page #
AccelLmt	NV parameter (float)	set up	7-5
ADF0	NV parameter (float)	set up	7-6
ADOffset	NV parameter (float)	set up	7-6
AInNull	MF variable (integer)	0 if not mapped	7-7
AnalogIn	variable (float R/O)		7-7
AnalogOut1	variable (float)		7-7
AnalogOut2	variable (float)		7-8
ARF0	NV parameter (float)	set up	7-8
ARF1	NV parameter (float)	set up	7-9
ARZ0	NV parameter (float)	set up	7-9
ARZ1	NV parameter (float)	set up	7-10
AxisAddr	variable (integer R/O)		7-10
BDInx	variable (integer R/O)		7-11
BDIOMapx	NV parameter (integer)	set up	7-11
BDLgcThr	NV parameter (integer)	set up	7-12
BDOutx	variable (integer)		7-12
BlkType	NV parameter (integer)	set up	7-13
Brake	variable (integer R/O)		7-14
CCDate	variable (integer R/O)		7-14
CCSNum	variable (integer R/O)		7-14
CcwInh	MF variable (integer)	0 if not mapped	7-15

Name	Type	Default Value	Page #
Cfgd	variable (integer R/O)		7-15
CmdGain	NV parameter (float)	set up	7-16
CmdGain2	NV parameter (float)		7-17
CommEnbl	variable (integer)	1	7-17
CommOff	NV parameter (float)	set up	7-18
CommSrc	NV parameter (integer)	set up	7-18
Cwinh	MF variable (integer)	0 if not mapped	7-19
DecelLmt	NV parameter (float)	set up	7-19
DM1F0	NV parameter (integer)	set up	7-20
DM2F0	NV parameter (integer)	set up	7-20
DM1Gain	NV parameter (float)	set up	7-21
DM2Gain	NV parameter (float)	set up	7-22
DM1Map	NV parameter (float)	set up	7-23
DM2Map	NV parameter (float)	set up	7-24
DM1Out	variable (float R/O)		7-25
DM2Out	variable (float R/O)		7-25
ElecAngTau	NV parameter (integer)	30000	7-26
ElecRev	MF variable (integer R/O)		7-26
Enable	variable (integer)	1	7-27
Enable2	MF variable (integer)	1 if not mapped	7-27
Enabled	MF variable (integer R/O)		7-28
EncAlignDist	NV parameter (integer)	3640	7-28
EncAlignRampIcmd	NV parameter (integer)	1	7-29
EncAlignTime	NV parameter (integer)	3000	7-29
EncFreq	variable (float R/O)		7-30
EncIn	NV parameter (integer)	set up	7-30
EncInF0	NV parameter (float)	highest speed	7-31
EncMode	NV parameter (integer)	set up	7-32
EncOut	NV parameter (integer)	set up	7-32
EncPos	variable (integer R/O)		7-33
ExtFault	variable (integer R/O)		7-34
Fault	MF variable (integer R/O)		7-35
FaultCode	variable (integer R/O)		7-35
FaultReset	MF variable (integer)	0 if not mapped	7-37
FVelErr	variable (float R/O)		7-37
FwV	variable (integer R/O)		7-37
HSTemp	variable (float R/O)		7-38
HwV	variable (integer R/O)		7-38

Name	Type	Default Value	Page #
ICmd	variable (float R/O)		7-38
IFB	variable (float R/O)		7-38
ILmtMinus	NV parameter (integer)	set up	7-39
ILmtPlus	NV parameter (integer)	set up	7-39
Inputs	variable (integer R/O)		7-40
IPEAK	variable (float R/O)		7-40
IR	variable (float R/O)		7-40
IS	variable (float R/O)		7-41
IT	variable (float R/O)		7-41
ItF0	NV parameter (float)	set up	7-41
ItFilt	variable (float R/O)		7-42
ItThresh	NV parameter (integer)	set up	7-42
ItThreshA	variable (integer R/O)		7-43
Ked	NV parameter (integer)	0	7-43
Kei	NV parameter (integer)	0	7-44
Kep	NV parameter (integer)	0	7-44
Kii	NV parameter (float)	set up	7-45
Kip	NV parameter (float)	set up	7-45
Kpp	NV parameter (float)	set up	7-46
Kvff	NV parameter (float)	set up	7-46
Kvi	NV parameter (float)	set up	7-47
Kvp	NV parameter (float)	set up	7-47
MechRev	MF variable (integer R/O)		7-48
Model	NV parameter (integer R/O)		7-48
Motor	NV parameter (integer R/O)	set up	7-48
NVLoad	command		7-49
NVLoadOpt	command		7-49
NVSave	command		7-49
NVSaveOpt	command		7-50
OCDate	variable (integer R/O)		7-50
OCSNum	variable (integer R/O)		7-50
Outputs	variable (integer)		7-51
PoleCount	NV parameter (integer)	set up	7-51
PosCmd Set	variable (integer)		7-52
PosCommand	variable (integer R/O)		7-53
PosError	variable (integer R/O)		7-53
PosErrorMax	NV parameter (integer)	set up	7-54
Position	variable (integer R/O)		7-54

Name	Type	Default Value	Page #
PulsesFOut	NV parameter (integer)		7-55
PulsesIn	NV parameter (integer)		7-55
PulsesOut	NV parameter (integer)		7-56
RemoteFB	NV parameter (integer)		7-56
ResPos	variable (integer R/O)		7-57
RunStop	MF variable (integer)	1 if not mapped	7-57
StopTime	NV parameter (float)	set up	7-57
UncfgDrv	command		7-58
UncfgOpt	command		7-58
VBus	variable (float R/O)		7-58
VBusThresh	NV parameter (float)		7-59
VdCmd	variable (float R/O)		7-59
VelCmd	NV parameter (float)		7-59
VelCmdA	variable (float R/O)		7-60
VelCmd2	NVparameter (float)	set up	7-60
VelCmdSrc	MF variable (integer)		7-61
VelErr	variable (float R/O)		7-61
VelFB	variable (float R/O)		7-61
VelLmtHi	NV parameter (float)	set up	7-62
VelLmtLo	NV parameter (float)	set up	7-63
Velocity	variable (float R/O)		7-63
ZeroSpeedThresh	NV parameter (float)		7-64

7.2 Keyword Reference

This section is an alphabetical reference to SC930 keywords. These keywords give access to:

- parameters
- variables
- commands

The name, type of each keyword, and communications protocol code are listed at the top of the page. For additional information on the Serial Communications Protocol, refer to Appendix A. The keyword is described based on the following categories:

Purpose
Units
Range or Value
Default
Related Parameters/Commands
Guidelines

"NV" indicates the parameter is stored in non-volatile memory.
"MF" indicates the variable is a mappable function.

ACCELLMT

(NV PARAMETER, FLOAT) F276

Units rpm/sec

Range 0 to 1 x 109

Default Set value before last NVSAVE. 930 Dialogue **New Set Up** or **Drive Set Up** sets its value to 0 (no acceleration limiting).

Purpose Slew rate limit on actual velocity command magnitude increases. See VelCmdA for the VelCmd value after slew limiting.

Guidelines Setting AccelLmt to 0 turns off the AccelLmt slew limiting; VelCmdA can immediately increase to equal VelCmd. See DecelLmt for control of VelCmdA magnitude decreases.

For position loops, setting either AccelLmt or DecelLmt to a value is not recommended as it may cause excessive overshoot.

ADF0

(NV PARAMETER, FLOAT) F18

Units Hertz

Range 0.01 to 4.17 x 107

Default Set value before last NVSAVE. 930 Dialogue **New Set Up** or **Drive Set Up** sets its value to 1000.

Purpose ADF0 is the first-order low-pass filter corner frequency for the analog input channel on J4-1 to J4-2.

Guidelines The corner frequency in Hz of the single-order low-pass filter. The purpose of the filter is to attenuate the high frequency components from the digitized input signal. Decreasing ADF0 lowers the response time to input changes, but also increases the effective resolution of AnalogIn by removing more circuit noise.

ADF0	AnalogIn	
	Effective Bits	lsb Size
Max	14	1.6 mV
150	16	0.4 mV
10	18	0.1 mV

ADOFFSET

(NV PARAMETER, FLOAT) F19

Units Volts

Range -15 to +15

Default Set value before last NVSAVE. 930 Dialogue **New Set Up** or **Drive Set Up** sets its value to 0.

Purpose ADOffset adjusts the steady-state value of the analog command input.

Guidelines Equal to the differential voltage between J4-1 and J4-2 plus ADOffset.

AInNull

(Mappable Input Function, Variable, Integer) I283

Range 0 or 1

Default 0 at power up if not mapped to a BDIO point.

Purpose Nulls the DC in AnalogIn.

Guidelines When not mapped to a BDIO, setting AInNull = 1 starts the nulling function by temporarily setting ADF0 to 1 Hz. When AInNull returns to 0 for normal operation, ADF0 is restored and ADOffset is set to the old ADOffset minus AnalogIn sampled at the 1 to 0 transition. This new ADOffset is then stored in NV memory.

AnalogIn

(Variable, Float, Read-Only) F0

Units Volts

Range -13.5 to +13.5

Default none

Purpose The digitized value of the analog input channel, which is the differential voltage of J4-1 (+) relative to J4-2 (-) after ADOffset is added and passed through ADF0 low-pass filter.

Guidelines Can be monitored to check the presence and voltage of signals at the analog input terminals.

AnalogOut1

(Variable, Float) F1

Units Volts

Range -5 to +4.961

Default None

Purpose Directly sets the voltage level of DAC Monitor 1 (J4-3) when DM1Map = 0.

Guidelines When DM1Map is not equal to 0, AnalogOut1 is not used.

ANALOGOUT2

(VARIABLE, FLOAT) F261

Units	Volts
Range	-5 to +4.961
Default	None
Purpose	Directly sets the voltage level of DAC Monitor 2 (J4-4) when DM2Map = 0.
Guidelines	When DM2Map is not equal to 0, AnalogOut2 is not used.

ARF0

(NV PARAMETER, FLOAT) F8

Units	Hertz
Range	0.01 to 10 x 106 -10 x 106 to -0.01
Default	Set value before last NVSAVE. 930 Dialogue **New Set Up** or **Drive Set Up** calculates its value based on the selected motor and drive.
Purpose	First velocity loop compensation anti-resonance low-pass filter corner frequency.
Guidelines	ARF0 is the corner frequency (Hz), of one of two single-order low-pass anti-resonant filters or if < 0 it is the under damped pole-pair frequency in Hz and ARF1 is the pole-pair Q. The purpose of the anti-resonant filters is to attenuate the velocity loop gain at the mechanical resonant frequency. See ARF1, ARZ0, ARZ1 and Chapter 6 for more information.

ARF1

(NV PARAMETER, FLOAT) F9

Units Hertz

Range 0.01 to 10,000,000
1 to 100 (Q)

Default Set value before last NVSAVE. 930 Dialogue **New Set Up** or **Drive Set Up** calculates its value based on the selected motor and drive.

Purpose Second velocity loop compensation anti-resonance low-pass filter corner frequency.

Guidelines ARF1 is the corner frequency (Hz), of one of two single-order low-pass anti-resonant filters or if ARF0 is < 0, then ARF1 is the Q of the under damped pole pair. The purpose of the anti-resonant filters is to attenuate the velocity gain at the mechanical resonant frequency. See ARF0, ARZ0, ARZ1 and Chapter 6 for more information.

ARZ0

(NV PARAMETER, FLOAT) F285

Units Hertz

Range 20 to 1 x 105
-1 x 105 to -35

Default Set value before last NVSAVE. 930 Dialogue **New Set Up** or **Drive Set Up** sets its value to 0.

Purpose First velocity loop compensation zero.

Guidelines ARZ0 is generally not needed and should be set to 0, which eliminates it entirely. For very demanding compensation schemes it can be used to add lead compensation or with ARZ1 to add a notch filter. ARZ0 positive sets a zero frequency in Hz and if < 0 sets an under damped zero pair frequency in Hz while ARZ1 is the zero pair Q. See ARF0, ARF1, ARZ1 and Chapter 6 for more information.

ARZ1

(NV PARAMETER, FLOAT) F286

Units Hertz

Range 20 to 1 x 106
-100 to 100 (Q)

Default Set value before last NVSAVE. 930 Dialogue **New Set Up** or **Drive Set Up** sets its value to 0.

Purpose Second velocity loop compensation zero.

Guidelines ARZ1 is generally not needed and should be set to 0. For very demanding compensation schemes, it is used to add lead compensation or with ARZ0 to add a notch filter. ARZ1 sets a zero frequency in Hz or if ARZ0 is set < 0 then ARZ1 sets the under damped zero pair Q. See ARF0, ARF1, ARZ0 and Chapter 6 for more information.

AXISADDR

(VARIABLE, INTEGER, READ-ONLY) I78

Range 0 to 255

Default Set by hardware DIP switch on OC930 Card.

Purpose Indicates the address of the drive currently selected.

Guidelines The axis address must be set in 930 Dialogue to correspond to the address setting of the dip switch of the SC930 option card. For most applications the default setting of address 255 is recommended.

930 Dialogue provides a find axis feature which can determine the axis setting of an SC930 option card, provided proper serial communications cabling and connections between the PC and the drive have been made.

BDInX

(Variable, Integer, Read-Only) i17-i22

Range 0 or 1

Purpose BDIn1 reads the state of BDIO1, J4-7
BDIn2 reads the state of BDIO2, J4-8
BDIn3 reads the state of BDIO3, J4-9
BDIn4 reads the state of BDIO4, J4-10
BDIn5 reads the state of BDIO5, J4-11
BDIn6 reads the state of BDIO6, J4-12

Guidelines Indicates whether BDIOx input voltage is above or below the logic threshold selected by BDLgcThr.

BDInX = **0** indicates a logic low input

BDInX = **1** indicates a logic high input

BDIOMapX

(NV Parameter, Integer) i270-i275

Range -2,147,483,648 to 2,147,483,648

Default Set value before last NVSAVE. 930 Dialogue **New Set Up** or **Drive Set Up** sets their values as follows:

BDIOMap1	Fault Reset Input Active Low
BDIOMap2	CW Inhibit Input Active Low
BDIOMap3	CCW Inhibit Input Active Low
BDIOMap4	OFF
BDIOMap5	Brake Output Active High
BDIOMap6	Fault Output Active High

Purpose Sets the logical function of the BDIOs on J4-7 to J4-12.

Guidelines Although the value is a 32 bit integer, the value is easily set in the Variables Screen or the Parameter Form by menu pick. First, select Off, Input, or Output. Pick a function and select the logic polarity as active high or low.

Input Functions FaultReset, RunStop, Enable2, VelCmdSrc, CwInh, CcwInh, AInNull, Position Block, Use CmdGain2

Output Functions Fault, Enabled, Brake, ElecRev, MechRev, Zero Speed, PosError Warning

BDLgcThr

(NV Parameter, Integer) i256

Range 0 or 1

Default Set value before last NVSAVE. 930 Dialogue **New Set Up** or **Drive Set Up** sets its value to 0 (5 volt logic).

Purpose Sets the switching threshold of all the discrete inputs and the pull up voltage for the BDIOs.

Guidelines **0** selects 5 volt logic compatibility
1 selects 24 volt logic compatibility

BDLgcThr	Low (volts)	High (volts)	Pull up (volts)
0	2.1	3.1	5.0
1	4.0	5.0	12.0

BDOutX

(Variable, Integer) i35-i40

Range 0 or 1

Default none

Purpose Allows setting the output logic state of BDIO outputs not mapped to an output function via BDIOMap.

BDOut1 sets the state of BDIO1, J4-7
BDOut2 sets the state of BDIO2, J4-8
BDOut3 sets the state of BDIO3, J4-9
BDOut4 sets the state of BDIO4, J4-10
BDOut5 sets the state of BDIO5, J4-11
BDOut6 sets the state of BDIO6, J4-12

Guidelines **0** turns on the pull down transistor
1 turns off the pull down transistor

BLKTYPE

(NV PARAMETER, INTEGER) I85

Range 0, 1, 2, 4, 5 or 8

Default Set value before last NVSAVE. 930 Dialogue **New Set Up** or **Drive Set Up** sets its value to that selected by the user.

Purpose BlkType specifies configuration as a position, velocity, or torque block.

Guidelines Sets the overall control functionality of the drive. For block diagrams of the drive configurations, refer to the manual which describes the alternative BlkType settings. When used in any of the analog modes, the analog control is the differential voltage applied to the Analog Cmd+ and Analog Cmd- inputs (J4-1 and J4-2 respectively).

BlkType	Servo Configuration
0	Analog Torque Block
1	Analog Velocity Block
2	Digital Position Block
4	EncFreq Torque Block
5	EncFreq Velocity Block
8	Serial Port Command Velocity block

If Position Block Input Select is mapped to a BDIO input and the input is asserted, the active Block Type is Position Block (BlkType = 8). If the input is not asserted, the active Block Type is controlled by BlkType.

BRAKE

(MAPPABLE OUTPUT FUNCTION, VARIABLE, INTEGER, READ-ONLY) I277

Range 0 or 1

Purpose Output function to indicate when the motor is not powered and a mechanical brake is needed to hold the motor.

Guidelines **0** = the motor is powered and the brake should be off
1 = the mechanical brake should engage

To insure that a mechanical brake is engaged when a drive's control power is removed, the Brake function should be mapped active high to a BDIO pin.

CCDATE

(VARIABLE, INTEGER, READ-ONLY) I280

Range 0 to 2^31

Default none

Purpose Gives the Control card date code.

CCSNUM

(VARIABLE, INTEGER, READ-ONLY) I279

Range 0 to 2^31

Default none

Purpose Gives the control card serial number.

CcwInh

(Mappable Input Function, Variable, Integer) I164

Range 0 or 1 (0 is normal operation; 1 is function activated)

Default 0 at power up if not mapped

Purpose Selects between normal operation and clamping VelCmdA to be only positive.

Guidelines When CcwInh = 1, counter-clockwise rotation is inhibited (VelCmdA is clamped to be only positive). For positioning BlkType, PosError must return to near 0 or be positive to exit this mode. When CcwInh and CwInh are both active, VelCmdA is set to 0 and the first inactive inhibit stops that inhibit immediately, independent of BlkType.

While actively inhibiting CCW motion, the status LED alternates 8 . With Both CCW and CwInh active, the LED alternates 8 .

CfgD

(Variable, Integer, Read-Only) I3

Range -32,768 to 0

Purpose Configuration state of the drive's RAM. 0 is a fully configured drive. -1 is a completely unconfigured drive. All other minus numbers indicate partial configuration.

CMDGAIN

(NV PARAMETER, FLOAT) F22

Range	BlkType = 0 A/V	±1010 * I_{PEAK}
	BlkType = 1 krpm/V	±1010
	BlkType = 2 Not Applicable	(see PulsesIn, PulsesOut)
	BlkType = 4 A/kHz	±108 * II_{PEAK}
	BlkType = 5 krpm/kHz	±107
	BlkType = 8 Not Applicable	

Default Set value before last NVSAVE. 930 Dialogue **New Set Up** or **Drive Set Up** calculates its value based on the selected motor and drive.

Purpose CmdGain sets the scale factor of the analog input.

Guidelines CmdGain is a floating-point variable that sets the command gain of the analog input (voltage from J4-1 to J4-2) for BlkType's 0 (Analog torque block), and 1 (Analog velocity block) and the encoder input frequency for BlkType's 4 (EncFreq Torque) and 5 (EncFreq Velocity).

If Use CmdGain2 is mapped to a BDIO Input and the input is asserted, the active value for Command Gain is CmdGain2. If the input is not asserted, the active value for Command Gain is CmdGain.

CMDGAIN2

(NV PARAMETER, FLOAT) F323

Range	BlkType = 0 A/V	±1010 * I_{PEAK}
	BlkType = 1 krpm/V	±1010
	BlkType = 2 Not Applicable	(see PulsesIn, PulsesOut)
	BlkType = 4 A/kHz	±108 * II_{PEAK}
	BlkType = 5 krpm/kHz	±107
	BlkType = 8 Not Applicable	

Default Set value before last NVSAVE. 930 Dialogue **New Set Up** or **Drive Set Up** sets this parameter to 0.0.

Purpose Sets the scale factor of the analog input when a BDIO Input mapped to CmdGain2 function is asserted.

Guidelines CmdGain2 is a floating-point variable that sets the command gain of the analog input (voltage from J4-1 to J4-2) for BlkType's 0 (Analog torque block), and 1 (Analog velocity block) and the encoder input frequency for BlkType's 4 (EncFreq Torque) and 5 (EncFreq Velocity).

COMMENBL

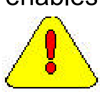
(VARIABLE, INTEGER) I131

Range 0 or 1

Default 1

Purpose Allows and disallows normal commutation.

Guidelines **0** disables commutation. Commutation angle set only by CommOff
1 enables normal commutation



CommEnbl must always be 1 for normal operation. Leaving CommEnbl at 0 can overheat and possibly damage the motor.

CommOff

(NV Parameter, Float) F23

Units Electrical Degrees

Range 0 to 360

Default Set value before last NVSAVE. 930 Dialogue **New Set Up** or **Drive Set Up** sets its value to 0 degrees.

Purpose CommOff sets the origin for the electrical commutation angle.

Guidelines The value for standard Pacific Scientific motors is 0.

For CommSrc = 1 (incremental encoder commutation) CommOff is set to 0 on every power up, independent of the value in the non-volatile memory. Drive RAM value is always read/write.

CommSrc

(NV Parameter, Integer) I265

Range 0 or 1

Default Set value before last NVSAVE. 930 Dialogue **New Set Up** or **Drive Set Up** sets its value to 0 (commutate from motor resolver feedback).

Purpose Selects between resolver or incremental encoder feedback for motor commutation.

Guidelines **0** selects resolver feedback commutation and PoleCount set to number of motor poles

1 selects incremental encoder feedback commutation PoleCount set to number of quadrature encoder counts per electrical cycle.

CwInh

(Mappable Input Function, Variable, Integer) I163

Range 0 or 1 (0 is normal operation; 1 is function activated)

Default 0 at power up if not mapped

Purpose CwInh selects between normal operation and clamping VelCmdA to be only negative.

Guidelines When CwInh = 1, clockwise rotation is inhibited (VelCmd is clamped to be only negative). For positioning, BlkType's PosError must return to near 0 or be negative to exit this mode. When CwInh and CcwInh are both active, VelCmdA is set to 0 and the first inactive inhibit stops that inhibit immediately, independent of BlkType.

While actively inhibiting CW motion, the status LED alternates 8 . With Both CCW and CwInh active, the LED alternates 8 .

DecelLmt

(NV Parameter, Float) F277

Units rpm/s

Range 0 to 1 x 109

Default Set value before last NVSAVE. 930 Dialogue **New Set Up** or **Drive Set Up** sets it value to 0 (no deceleration limiting).

Purpose Slew rate limit on actual velocity command magnitude decreases. See VelCmdA for the VelCmd value after slew limiting.

Guidelines Setting DecelLmt to 0 turns off DecelLmt slew limiting. VelCmdA immediately decreases to equal VelCmd. See AccelLmt for control of VelCmdA magnitude increases.

For position loops, setting either AccelLmt or DecelLmt to a value causes excessive overshoot.

DM1F0

(NV PARAMETER, FLOAT) F17

Units Hertz

Range 0.01 to 4.17 x 107

Default Set value before last NVSAVE. 930 Dialogue **New Set Up** or **Drive Set Up** sets its value to 1000.

Purpose Sets the frequency (Hz) of a single pole low-pass filter on the DAC Monitor 1 output (J4-3).

Guidelines Used to attenuate high frequency components from the DM1Map selected signal. Setting DM1F0 to 1 Hz and using DM1Out to examine the filtered value accurately measures the selected signal's DC value.

DM2F0

(NV PARAMETER, FLOAT) F266

Units Hertz

Range 0.01 to 4.17 x 107

Default Set value before last NVSAVE. 930 Dialogue **New Set Up** or **Drive Set Up** sets its value to 1000.

Purpose Sets the frequency (Hz) of a single pole low-pass filter on the DAC Monitor 2 output (J4-4).

Guidelines Used to attenuate high frequency components from the DM2Map selected signal. Setting DM2F0 to 1 Hz and using DM2Out to examine the filtered value accurately measures the selected signal's DC value.

DM1GAIN

(NV PARAMETER, FLOAT) F21

Default Set value before last NVSAVE. 930 Dialogue **New Set Up** or **Drive Set Up** calculates its value based on the selected motor and drive.

Purpose Sets the multiplicative scale factor applied to the DM1Map selected signal before outputting on DAC Monitor 1 (J4-3).

Guidelines Changing DM1Map changes DM1Gain's value unless DM1Map changes to a signal with identical units, such as VelCmdA to VelFB (DM1Map = 1 to 2). Set DM1Gain to keep the signal in the DAC Monitor ± 5 volt range. The table elow lists units when DM1Gain = 1.

Monitor#	Scale Factor	Monitor#	Scale Factor
0	No effect	15	1 V/cycle
1	1 V/krpm	16	1 V/A
2	1 V/krpm	17	1 V/A
3	1 V/krpm	18	1 V/A
4	1 V/krpm	19	1 V/100%
5	1 V/rev	20	1 V/100%
6	1 V/rev	21	1 V/100%
7	1 V/rev	22	1 V/V
8	1 V/A	23	1 V/rev
9	1 V/A	24	1 V/A
10	1 V/V	25	1 V/A
11	1 V/Hz	26	1 V/100%
12	10 V/4096	27	1 V/100%
13	1 V/100%	28	1 V/krpm
14	1 V/°C		

See also DM1Map, DM1F0, and DM1Out.

DM2GAIN

(NV PARAMETER, FLOAT) F263

Default Set value before last NVSAVE. 930 Dialogue **New Set Up** or **Drive Set Up** calculates its value based on the selected motor and drive.

Purpose Sets the multiplicative scale factor applied to the DM2Map selected signal before outputting on DAC Monitor 2 (J4-4).

Guidelines Changing DM2Map changes DM2Gain's value unless DM2Map changes to a signal with identical units, such as VelCmdA to VelFB (DM2Map = 1 to 2). Set DM1Gain to keep the signal in the DAC Monitor +- 5 volt range. The table below lists units when DM2Gain = 1.

Monitor#	Scale Factor	Monitor#	Scale Factor
0	No effect	15	1 V/cycle
1	1 V/krpm	16	1 V/A
2	1 V/krpm	17	1 V/A
3	1 V/krpm	18	1 V/A
4	1 V/krpm	19	1 V/100%
5	1 V/rev	20	1 V/100%
6	1 V/rev	21	1 V/100%
7	1 V/rev	22	1 V/V
8	1 V/A	23	1 V/rev
9	1 V/A	24	1 V/A
10	1 V/V	25	1 V/A
11	1 V/Hz	26	1 V/100%
12	10 V/4096	27	1 V/100%
13	1 V/100%	28	1 V/krpm
14	1 V/°C		

See also DM2Map, DM2F0, and DM2Out.

DM1MAP

(NV PARAMETER, INTEGER) I7

Range 0 to 65,537

Default Set value before last NVSAVE. 930 Dialogue **New Set Up** or **Drive Set Up** sets its value to 9 (IFB).

Purpose Selects the signal sent to the DAC Monitor 1 output on J4-3.

Guidelines See table below.

Monitor #	Mnemonic	Monitor #	Mnemonic
0	AnalogOut1	16	IR
1	VelFB	17	IS
2	VelCmdA	18	IT
3	VelErr	19	VR
4	FVelErr	20	VS
5	Position*	21	VT
6	PosError*	22	VBus
7	PosCommand*	23	ResPos*
8	ICmd	24	Non-Trq Icmd
9	IFB	25	Non-Trq IFB
10	AnalogIn	26	Trq VCmd
11	EncFreq	27	Non-Trq Vcmd
12	EncPos*	28	VelCmd
13	ItFilt	65536	Clamp Off†
14	HSTemp	65537	Clamp On†
15	Comm Ang*		

***** - Wraps around when signal exceeds output voltage range.***

† - The value of the selected signal does not change.

See also DM1Gain, DM1F0, and DM1Out

DM2MAP

(NV PARAMETER, INTEGER) I258

Range 0 to 65,537

Default Set value before last NVSAVE. 930 Dialogue **New Set Up** or **Drive Set Up** sets its value to 1 (VelFB).

Purpose Selects the signal sent to the DAC Monitor 2 output on J4-4.

Guidelines See table below.

Monitor #	Mnemonic	Monitor #	Mnemonic
0	AnalogOut2	16	IR
1	VelFB	17	IS
2	VelCmdA	18	IT
3	VelErr	19	VR
4	FVelErr	20	VS
5	Position*	21	VT
6	PosError*	22	VBus
7	PosCommand*	23	ResPos*
8	ICmd	24	Non-Trq Icmd
9	IFB	25	Non-Trq IFB
10	AnalogIn	26	Trq VCmd
11	EncFreq	27	Non-Trq Vcmd
12	EncPos*	28	VelCmd
13	ItFilt	65536	Clamp Off†
14	HSTemp	65537	Clamp On†
15	Comm Ang*		

**** Wraps around when signal exceeds output voltage range.***
† The value of the selected signal does not change.

See also DM2Gain, DM2F0, and DM2Out

DM1OUT

(VARIABLE, FLOAT, READ-ONLY) F31

Range Depends on selected DM1Map signal.

Purpose Indicates the value of the selected, filtered variable output to DAC Monitor 1 (J4-3). The value is reported in the units of the selected variable. For example, DM1Map = 1 selects VelCmdA and the units are rpm.

Guidelines With DM1F0 set low (such as 1 Hz), DM1Out's value accurately measures the selected DM1Map signal's DC component. DM1Out is also used to examine variables that cannot be directly queried, such as motor phase voltage duty cycle, DM1Map = 19, 20, or 21.

DM2OUT

(VARIABLE, FLOAT, READ-ONLY) F256

Range Depends on the selected DM2Map signal.

Purpose Indicates the value of the selected, filtered variable output to DAC Monitor 2 (J4-4). The value is reported in the units of the selected variable. For example, DM2Map = 1 selects VelCmdA and the units are rpm.

Guidelines With DM2F0 set low (such as 1 Hz), DM2Out's value accurately measures the selected DM2Map signal's DC component. DM2Out is also used to examine variables that cannot be directly queried, such as motor phase voltage duty cycle, DM2Map = 19, 20, or 21.

ELECANGTAU

(NV PARAMETER, INTEGER) I30

Range 0 to 65535

Purpose Sets the encoder alignment control loop first-order low pass filter break frequency.

Guidelines The default value of 30000 is sufficient for most applications.

Use ElecAngTau as an anti-resonance filter to attenuate the loop gain at a resonance frequency.

ElecAngTau is in internal units. To convert the low pass filter break frequency from Hz to internal units, use the following formula:

ElecAngTau (internal units) =
Break Frequency (Hz) / (Break Frequency (Hz) + 79.58)

ELECREV

(MAPPABLE OUTPUT FUNCTION, VARIABLE, INTEGER, READ-ONLY)

Not accessible over the serial port

Range 0 or 1

Purpose Square wave whose frequency is equal to the motor's electrical frequency.

Guidelines There are PoleCount/2 motor electrical revolutions (cycles) per mechanical revolution.

$$\text{ElecRev(Hz)} = \frac{\text{(Shaft rpm)}}{60} * \frac{\text{Polecount}}{2}$$

ENABLE

(VARIABLE, INTEGER) I10

Range 0 or 1

Default Set to 1 at power up

Purpose Enable = 0 prevents power from flowing out of the motor's power terminals (J2).

0 (to disable the drive)

1 (to enable the drive)

Guidelines Before power can flow to the motor, verify that the following conditions are all true:

1. Drive is not faulted. (Status display 0 or 8)
2. $\overline{\text{ENABLE}}$ input (J4-6) connected to I/O RTN.
3. Enable2 function is = 1.
4. Enable variable is = 1.

See also Enabled.

ENABLE2

(MAPPABLE INPUT FUNCTION, VARIABLE, INTEGER) I266

Range 0 or 1

Default 1 at power up if not mapped

Purpose Second drive enable function mapped to a BDIO pin with programmable polarity.

Guidelines **0** disables the drive
1 allows the drive to enable if other conditions permit

For incremental encoder based commutation Enable2 should be mapped to a BDIO and be used to enable/disable motion since the dedicated hardware enable J4-6 is used to start commutation alignment.

Before applying power to the motor, verify that the following conditions are true:

1. Drive is not faulted. (Status display 0 or 8)
2. $\overline{\text{ENABLE}}$ input (J4-6) connected to I/O RTN.
3. Enable2 function is = 1.
4. Enable variable is = 1.

ENABLED

(MAPPABLE OUTPUT FUNCTION, VARIABLE, INTEGER, READ-ONLY) I11

Range 0 or 1

Purpose Indicates whether power can flow to the motor.

0 (drive disabled)

1 (drive enabled)

Guidelines Before power can flow to the motor, verify that the following conditions are all true:

1. Drive is not faulted. (Status display 0 or 8)
2. $\overline{\text{ENABLE}}$ input (J4-6) connected to I/O RTN.
3. Enable2 function is = 1.
4. Enable variable is = 1.

ENCALIGNDIST

(NV PARAMETER, INTEGER) I31

Units 360/65536 electrical degrees

Range 364 (2 electrical degrees) - 65535 (360 electrical degrees)

Purpose Sets the distance the motor moves to test whether the encoder alignment algorithm is successful.

Guidelines After the encoder alignment control loop is run, a final test is conducted by commanding the motor to move from the present electrical angle to (present electrical angle + EncAlignDist). If the motor does not settle within the range of present electrical angle + 0.5*EncAlignDist to present electrical angle + 1.5*EncAlignDist, a fault is declared.

EncAlignDist must be large enough that the system (motor and load) actually moves. For high friction systems, commanding “small” motion (EncAlignDist = small value) results in commanded torque less than the system’s friction torque. This results in no motion, and the final test declares an error. For low friction systems, set EncAlignDist to 910 (5 electrical degrees). For high friction systems, use the default value of 3640 (20 electrical degrees).

See Appendix E, Encoder Alignment for additional information.

EncAlignRampIcmd

(NV Parameter, Integer) I34

Range 0 (step current into motor)
1 (ramp current into motor)

Default 1

Purpose Determines whether the current is ramped or stepped into the motor.

See Appendix E, Encoder Alignment for additional information.

EncAlignTime

(NV Parameter, Integer) I32

Units 2 milliseconds

Range 0 - 65535

Default 3000 (6 seconds)

Purpose The amount of time the encoder alignment control loop is active.

Guidelines Set EncAlignTime large enough that the system (motor and load) can settle. If the system does not settle after EncAlignTime has expired, the encoder alignment fails and a fault is declared.

EncAlignTime sets the time for encoder alignment control loop, not the entire alignment algorithm. The entire encoder alignment algorithm is approximately 3 seconds longer than EncAlignTime.

See Appendix E, Encoder Alignment for additional information.

ENCFREQ

(VARIABLE, FLOAT, READ-ONLY) F2

Units (if EncMode = 0) Quadrature encoder counts per second
(if EncMode = 1, 2) Steps per second

Range -3,000,000 to +3,000,000

Purpose The frequency in quadrature pulses per second of the external encoder, (or steps per second if step-and-direction format is used).

Calculation EncFreq = Encoder Speed (rpm) * Encoder Line Count / 15

Guidelines Calculated from delta EncPos at position loop update rate. Although the values returned do not have fractional parts, this variable is communicated as a floating-point quantity.

See EncInF0 for recommended maximum count frequencies.

ENCIN

(NV PARAMETER, INTEGER) I12

Units (if EncMode = 0) Encoder line count
(if EncMode = 1) Steps per quarter-revolution

Range 1 to 65535

Default Set before value last NVSAVE. 930 Dialogue **New Set Up** or **Drive Set Up** sets its value to 1024.

Purpose Specifies the line count of the encoder being used, (or one-fourth the steps/revolution if step-and-direction input format is used).

Guidelines Used to insure proper units in KPP, KVP, VelFB when using an encoder for Servo feedback. See also RemoteFB.

When RemoteFB = 0, EncIn is not used.

EncInF0

(NV Parameter, Float) f287

Units Hertz

Range 4 values, depending on EncMode.

EncInF0 (Hz)	Max Hardware Quad Count limit (Hz)	Min Hardware Pulse Width (μs)
1,600,000	3,333,333	0.6
800,000	952,400	2.1
400,000	476,200	4.2
200,000	238,100	8.4

EncInF0 (Hz)	Max Hardware Count limit (Hz)	Min Hardware Pulse Width (μs)
800,000	833,333	0.6
200,000	238,000	2.1
100,000	119,000	4.2
50,000	59,500	8.4

Default Set value before last NVSave. 930 Dialogue **New Set Up** or **Drive Set Up** sets its value to 1,600,000 Hz.

Purpose Selects digital low pass filter frequency on the incremental encoder input connected to J4-21 through J4-24.

Guidelines The maximum recommended count frequency for reliable operation. If the maximum input frequency is < EncInF0, lowering it gives better noise rejection.

The maximum hardware count limits require ideal timing with exact 50% duty cycle, perfect quadrature symmetry, etc. The recommended EncInF0 count takes real-world signal tolerances into account. With the SC900's emulated encoder out wired to another SC900's encoder in, and EncInF0 = 1,600,000 Hz, the count frequency can work reliably up to 2,000,000 Hz.

ENCMODE

(NV PARAMETER, INTEGER) I71

Range 0, 1, 2, or 3

Default Set value before last NVSAVE. 930 Dialogue **New Set Up** or **Drive Set Up** sets its value to 0.

Purpose Specifies the type of digital command expected at the incremental position command port.

Guidelines BlkType = 2 uses the incremental position command port (J4-21, J4-22, J4-23, J4-24) for its position command.

Value of EncMode	Description
0	Selects quadrature encoder pulses
1	Selects step-and-direction input signals
2	Selects up/down count input signals
3	Ignores input signal, EncPos value held

ENCOUT

(NV PARAMETER, INTEGER) I69

Units Emulated encoder line count

Range 0, 128, 256, 512, 1024, 2048, 4096, 8192, 16384, 125, 250, 500, 1000, 2000, 4000, 8000, 16000

Default Set value before last NVSAVE. 930 Dialogue **New Set Up** or **Drive Set Up** sets its value to 1024.

Purpose Selects the resolution of the incremental encoder shaft position output (J4-14, J4-15, J4-16, J4-17, and J4-19, J4-20) emulated from the resolver.

Guidelines EncOut = 0 cross connects the incremental position command port input (J4-21, J4-22 and J4-23, J4-24) to the incremental shaft position output port to provide buffering. CH Z out (J4-19, J4-20) is held fixed for EncOut = 0.

ENCPOS

(VARIABLE, INTEGER, READ-ONLY) I13

Units	EncMode = 0 Quadrature encoder counts EncMode = 1, 2 Steps
Range	-2,147,483,648 to +2,147,483,647
Purpose	Indicates the position of the external encoder or the accumulation of step inputs if step-and-direction input format is used. For example, with a 1024 line encoder, each increment of EncPos is equal to 1/4096 of a revolution of the encoder shaft.
Guidelines	See EncInF0 for maximum count frequencies. See EncMode for input decoding mode.

EXTFAULT

(VARIABLE, INTEGER, READ-ONLY) I133

Range 0-22

Purpose ExtFault provides additional information on FaultCode Blinking 1 (1) or E (14) and Alternating F 3 (243), 0 otherwise.

Guidelines In the variables window, poll the value of ExtFault for additional fault information. Values listed below:

LED Display	Value of ExtFault	Description
1	1	
	2	
E	0	No ExtFault information
E	1	Resolver Calibration data corrupted
E	2	Excessive DC offset in current feedback sensor
E	3	DSP incompletely reset by line power dip
E	6	Excessive DC offset in Analog Command A/D
E	7	Unable to determine option card type
E	8	DSP stack overflow
E	10	Firmware and control card ASIC incompatible
E	11	Actual Model does not match value in non-volatile memory
E	12	Unable to determine power stage
E	15	RAM failure
E	16	Calibration RAM failure
F 3	13	Control card non-volatile parameters corrupt
F 3	14	Option card non-volatile parameters corrupt
E 3	18	No Motion
E 3	19	Excessive Motion
E 3	20	Motor not settled
E 3	21	Alignment test failed
E 3	22	Motion Overflow (excessive motion)

FAULT

(MAPPABLE OUTPUT FUNCTION) I286

Range 0 or 1

Purpose Fault indicates whether the drive has faulted and is disabled.

Guidelines **0** is not faulted, normal operation
1 is faulted, no power flow to motor

See FaultCode and ExtFault for further information.

FAULTCODE

(VARIABLE, INTEGER, READ-ONLY) I14

Range 0 to 255

Purpose Indicates a fault has occurred. When the status display is not zero or eight, a fault has occurred. Reset the drive by asserting the fault reset signal or cycling drive AC power.

Guidelines Under HELP menu, see Index topic FAULTCODES for remainder of fault codes. Value is 0/8 unless faulted.

Status LED	Value	No Fault Meaning
0 (Solid)	0	Not Faulted/Not Enabled
8 (Solid)	0	Not Faulted/Enabled
8 (Alternating)	0	Not Faulted/Enabled/CwInh active
8 (Alternating)	0	Not Faulted/Enabled/CCwInh active
8 (Alternating)	0	Not Faulted/Enabled/CwInh & CCwInh active

FAULTCODES		
Status LED	**Value**	**Fault Meaning**
(Blinking) 1	1	Velocity feedback (VelFB) over speed
(Blinking) 2	2	Motor Over-Temp
(Blinking) 3	3	Drive Over-Temp
(Blinking) 4	4	Drive I*t
(Blinking) 5	5	I-n Fault (9x3)
(Blinking) 6	6	Control +12 V supply under voltage
(Blinking) 7	7	Output over current or bus over voltage
(Blinking) 9	9	Shunt Regulator Overload
(Blinking) A	10	Bus OV detected by DSP
(Blinking)	11	Auxiliary +5 V Low
(Blinking) C	12	Not assigned
(Blinking) D	13	Not assigned
(Solid) E*	14	Processor throughput fault
(Blinking) E*	14	Power Up Self Test Failure
(Alternating) E1	225	Bus UV, Bus Voltage VBUSTHRESH
(Alternating) E2	226	Ambient Temp Too Low
(Alternating) E3	227	Encoder commutation align failed (Only CommSrc=1)
(Alternating) E4	228	Drive software incompatible with NV memory version
(Alternating) E5*	229	Control Card hardware not compatible with drive software version
(Alternating) E6	230	Drive transition from unconfigured to configured while enabled
(Alternating) E7	231	Two AInNull events too close together
(Alternating) F1	241	Excessive Position Following Error Jam
(Alternating) F2	242	User Program Checksum Error (Memory Fault)
(Alternating) F3	243	Parameter Checksum Error (Memory Error)

*** FaultReset cannot reset these faults**

See ExtFault for further information on Blinking E, Blinking 1, and Alternating E 3 and F 3.

FAULTRESET

(MAPPABLE INPUT FUNCTION, VARIABLE, INTEGER) I263

Range 0 or 1

Default 0 at power up if not mapped

Purpose Allows drive faults to be reset.

Guidelines Automatically disables the drive when active. When not mapped to a BDIO, setting FaultReset = 1 via the serial port resets the latched fault condition. If the fault persists when FaultReset is active, the drive remains faulted. If the fault condition does not persist, setting FaultReset = 1 clears the latched fault. Returning FaultReset = 0 resumes normal operation.

FVELERR

(VARIABLE, FLOAT, READ-ONLY) F30

Units rpm

Range -48000 to +48000

Purpose Commanded velocity - measured velocity (VelCmdA - VelFB) after being processed by the velocity loop compensation anti-resonant filter section. See also ARF0, ARF1, ARZ0, ARZ1.

FWV

(VARIABLE, INTEGER, READ-ONLY) I84

Range 1000 to 65535

Purpose Indicates the 930 firmware version number. For example: FwV = 1100 is version 1.1

HSTEMP

(VARIABLE, FLOAT, READ-ONLY) F269

Units Degrees Centigrade

Range -10 to +150

Purpose Indicates the drive heat sink temperature.

Guidelines The drive heat sink temperature is monitored to determine if the drive is within a safe operating region for the power electronics. This variable is used to see how much thermal margin remains for a given application. See also ItThresh.

HWV

(VARIABLE, INTEGER, READ-ONLY) I130

Range > 0

Purpose Indicates the drive's control electronics hardware version number.

Guidelines 12 = first production control card version

ICMD

(VARIABLE, FLOAT, READ-ONLY) F28

Units Amperes

Range $-I_{PEAK}$ to $+I_{PEAK}$

Purpose ICmd indicates the commanded motor torque current.

ILmtMinus and ILmtPlus limit the range of this variable.

IFB

(VARIABLE, FLOAT, READ-ONLY) F29

Units Amperes

Range $-I_{PEAK}$ to $+ I_{PEAK}$

Purpose Indicates the measured motor torque current value.

Guidelines Monitor IFB to observe the actual torque current flowing in the motor. IFB should equal ICmd.

ILMTMINUS

(NV PARAMETER, INTEGER) I4

Units % (Percentage) of peak current rating of drive

Range 0 to 100

Default The default value, for New Set Up and Drive Set Up menu picks, is based upon the selected motor and drive.

Purpose ILmtMinus (Counter-Clockwise Current Limit) sets the maximum allowable torque current amplitude in the counter-clockwise direction. This is a percentage of the drive's peak current rating (I_{PEAK}).

Guidelines Enter only integer values - no fractional numbers.

If ILmtMinus*0.01*I_{PEAK} > twice the motor's continuous current rating, the motor's over-temperature sensor is not guaranteed to always respond fast enough to prevent motor winding damage.

ILMTPLUS

(NV PARAMETER, INTEGER) I5

Units % (Percentage) of peak current rating of drive

Range 0 to 100

Default The default value, for **New Set Up** and **Drive Set Up** menu picks, is based upon the selected motor and drive.

Purpose ILmtPlus (Clockwise Current Limit) sets the maximum allowable torque current amplitude in the clockwise direction. This is a percentage of the drive's peak current rating (I_{PEAK}).

Guidelines Only integer values may be entered (i.e., no fractional numbers).

If ILmtPlus*0.01*I_{PEAK} > twice the motor's continuous current rating, the motor's over-temperature sensor is not guaranteed to always prevent motor winding damage.

INPUTS

(VARIABLE, INTEGER, READ-ONLY) I33

Range 0 to 63 (6 BDIOs)

Purpose Reads the state of BDIO inputs in parallel. This variable is determined by the voltage levels applied to the BDIO input pins J4-7 to J4-12.

Guidelines The value is weighted so BDIO 1's individual value is x1, BDIO 2's is x2, BDIO 3's is x4, etc. 0 corresponds to a low input, while 1 corresponds to a high input. Inputs = 12 means that BDIO 1, 2, 5, 6 are low and BDIO 3, 4 are high. See BDIn1-6 to query inputs individually.

Inputs = 1xBDIO1 + 2xBDIO2 + 4xBDIO3 + 8xBDIO4 + 15xBDIO5 + 32xBDIO6

I_{PEAK}

(VARIABLE, FLOAT, READ-ONLY) F20

Units Amperes

Range Single value (see Default below)

Default	
Model Number	**I_{PEAK}**
932	7.5
933	15.0
934	30.0
935	60.0

Purpose The drive's maximum 0-peak current rating.

IR

(VARIABLE, FLOAT, READ-ONLY) F270

Units Amps

Purpose The measured current flowing in Motor Phase R, J2-4.

IS

(VARIABLE, FLOAT, READ-ONLY) F271

Units Amps

Purpose The measured current flowing in Motor Phase S, J2-3.

IT

(VARIABLE, FLOAT, READ-ONLY) F272

Units Amps

Purpose The measured current flowing in Motor Phase T, J2-2.

ItF0

(NV PARAMETER, FLOAT) F11

Units Hertz

Range Lower limit set by Model
Upper limit > 10

Default Set value before last NVSAVE. 930 Dialogue **New Set Up** or **Drive Set Up** sets its value based on the selected drive.

Purpose Specifies the corner frequency of the low-pass filter implementing the I*t drive thermal protection circuit.

Guidelines In conjunction with ItThresh, specifies the thermal protection circuit for the drive. ItF0 is the corner frequency of a low-pass filter which processes an estimate of the drive's power dissipation. Increasing ItF0 makes the response more sensitive to over-current conditions.

The minimum frequency for ItF0 (slowest to fault) is limited to protect the drive's power electronics.

ITFILT

(VARIABLE, FLOAT, READ-ONLY) F25

Units % (Percentage) of drive peak current

Range 0 to 100

Purpose The drive's output current amplitude low pass filtered by ItF0 and normalized by I_{PEAK} to a percentage. ItFilt is the input to the drive's I*t thermal protection fault.

Guidelines Provides a means of evaluating the I*t protection circuit. When ItFilt exceeds the threshold specified by ItThreshA, the drive faults with FaultCode 4.

$$\text{ItFilt} = \text{ItF0 low pass filter of } (|I_r| + |I_s| + |I_t|)\ \frac{100}{2 * I_{PEAK}}$$

ITTHRESH

(NV PARAMETER, INTEGER) I82

Units % (Percentage) of drive peak current.

Range 0 to 100 (Actual upper limit depends on Model.)

Default Set value before last NVSAVE. 930 Dialogue **New Set Up** or **Drive Set Up** calculates its value based on the selected motor and& drive.

Purpose Sets the desired maximum continuous output current, as a percentage of I_{PEAK}, before the I*t thermal protection faults the drive.

Guidelines In conjunction with ItF0, specifies the thermal protection fault for the drive. The actual I*t fault threshold may be lowered if the heat sink temperature (HSTemp) gets too high. See ItThreshA.

The maximum value for ItThresh is limited to protect the drive's power electronics.

ITTHRESHA

(VARIABLE, FLOAT, READ-ONLY) F316

Units percent

Range 0 to 100%

Default None

Purpose The maximum continuous output current, as a percentage of I_{PEAK}, trip level for the I*T thermal protection fault.

Guidelines Sets the desired value for ItThreshA and the two are equal for lower heat sink temperatures, i.e. lower HSTemps. At higher HSTemps, ItThreshA may be clamped to protect the power stage. When ItFilt exceeds ItThreshA, the drive I*t faults. While doing a worst case motion profile examining ItThreshA, ItFilt and HSTemp indicate how much drive thermal margin remains.

KED

(NV PARAMETER, INTEGER) I29

Range 0 - 65535

Default 0

Purpose Sets the encoder alignment control loop derivative gain.

Guidelines For most applications, Ked = 0 (with Kep = 0 and Kei = 0) is sufficient.

The internal units of Ked are [K(Hz) / 500 * (360/65536)]

See Encoder Alignment Overview for additional information.

KEI

(NV PARAMETER, INTEGER) I28

Range 0 - 65535

Default 0

Purpose Sets the encoder alignment control loop integral gain.

Guidelines For most applications, Kei = 0 (with Kep = 0 and Ked = 0) is sufficient.

The internal units of Kei are [K(Hz) * 500 * (360/65536)]

See Encoder Alignment Overview for additional information.

KEP

(NV PARAMETER, INTEGER) I27

Range 0 - 65535

Default 0

Purpose Sets the encoder alignment control loop proportional gain.

Guidelines For most applications, Kep = 0 (with Kei = 0 and Ked = 0) is sufficient.

The internal units of Kep are:
[360/65536 electrical degrees/ encoder count].

KII

(NV PARAMETER, FLOAT) F264

Units Hertz

Range 0 to 2546

Default Set value before last NVSAVE. 930 Dialogue **New Set Up** or **Drive Set Up** sets its value to 50 Hz.

Purpose Kii sets the integral gain of the current loops.

Guidelines The current loop's integral gain. It defines the frequency where the current loop compensation transitions from predominantly integral characteristics (gain decreasing with frequency) to predominantly proportional characteristics (constant gain with frequency). This value should typically be less than 10% of the current loop's bandwidth. See Kip for more information.

KIP

(NV PARAMETER, FLOAT) F257

Units V/

Range 0 to 161,712/I_{PEAK}

Default Set value before last NVSAVE. 930 Dialogue **New Set Up** or **Drive Set Up** calculates its value based on the selected motor.

Purpose Sets the proportional gain of the current loop.

Guidelines 930 dialogue automatically sets Kip as long as the motor being used is in 930 Dialogue's motor database or the motor inductance is entered in Manual entry mode. Current loop bandwidth in Rad/sec is Kip/L, where L is the motor's line-to-line inductance (in henries). Recommended bandwidth is 2ð*1000 rad/sec, maximum bandwidth is 2ð*1500 rad/sec.

KPP

(NV PARAMETER, FLOAT) F14

Units Hertz

Range 0 to 159.4

Default Set value before last NVSAVE. 930 Dialogue **New Set Up** or **Drive Set Up** calculates its value based on the selected system response.

Purpose Sets the proportional gain of the position loop.

Guidelines Defined by the following relationship:

VelCmd (rad/sec) = 2ð * KPP * VelErr (radians)

KVFF

(NV PARAMETER, FLOAT) F16

Units % (Percentage)

Range 0 to 199.9

Default Set value before last NVSAVE. 930 Dialogue **New Set Up** or **Drive Set Up** sets its value to 0.

Purpose Sets the proportion of velocity feed forward signal added to the velocity command from differentiated position command.

Guidelines Functional only for positioning modes, BlkType = 2.

When Kvff = 0 the net velocity command in positioning mode results entirely from PosError. For this case, there is a static non-zero PosError commanding a constant shaft speed. This error is known as the following error. Velocity feed forward adds a term to VelCmd proportional to delta PosCommand at the position loop update rate that reduces following error.

Increasing Kvff reduces steady state following error and gives faster response time. However, if Kvff is too large, it causes overshoot. Typically, do not set Kvff larger than 80% for smooth dynamics and acceptable overshoot. In electronic gearing applications, it may be necessary to set it to 100% for minimum following error.

KVI

(NV PARAMETER, FLOAT) F10

Units Hertz

Range 0 to 636.6

Default Set value before last NVSAVE. 930 Dialogue **New Set Up** or **Drive Set Up** calculates its value based on the selected velocity loop bandwidth.

Purpose Sets the integral gain of the velocity loop.

Guidelines The velocity loop integral gain. It defines the frequency where the velocity loop compensation transitions from predominantly integral characteristics (gain decreasing with frequency) to predominantly proportional characteristics (constant gain with frequency). This value should typically be less than 10% of the velocity loop bandwidth. See KVP.

KVP

(NV PARAMETER, FLOAT) F15

Units A/(rads/s)

Range 0 to I_{PEAK} * 12.6

Default Set value before last NVSAVE. 930 Dialogue **New Set Up** or **Drive Set Up** calculates its value based on the selected velocity loop bandwidth.

Purpose Sets the proportional gain of the velocity loop.

Guidelines Defined by the following relationship:

Kvp = Commanded motor torque current / Velocity Error;

where Commanded motor torque current has units of (amperes), and Velocity Error has units of (radians/second).

Kvp must be adjusted for total load inertia and motor torque constant as described in Chapter 6.

Idealized velocity loop bandwidth (in Rad/sec) equals Kvp * Kt / J, where J is the total shaft inertia and Kt/J units are rad/sec2/A . Maximum recommended idealized bandwidth is 2ð*400 Rad/sec.

MECHREV

(MAPPABLE OUTPUT FUNCTION, VARIABLE, INTEGER, READ-ONLY)

NOT ACCESSIBLE OVER THE SERIAL PORT

Range 0 or 1

Purpose Square wave whose frequency is equal to the resolver's electrical frequency (typically equal to the mechanical rev/s).

Guidelines Resolvers can have multiple electrical cycles per mechanical revolution, usually specified as the resolver speed.

$$\text{MechRev (Hz)} = \frac{\text{Shaft (rpm)}}{60} * \text{Resolver Speed}$$

The resolver speed is nearly always 1, so MechRev frequency is usually mechanical rev/sec. See also ElecRev.

MODEL

(NV PARAMETER, INTEGER, READ-ONLY) I77

Range 932, 933, 934, 935

Purpose Model indicates the drive model number (power level).

MOTOR

(NV PARAMETER, INTEGER, READ-ONLY) I134

Range Up to any 4 ASCII characters.

Default Set value before last NVSAVE. 930 Dialogue **New Set Up** or **Drive Set Up** calculates its value based on the selected motor.

Purpose Motor indicates the first 4 characters of the motor part number used to determine the Signature Series current waveshape used to eliminate torque constant ripple.

Guidelines A read-only parameter that is only set by 930 Dialogue's **Drive Setup**, **New Setup**, or **Drive Download**.

NVLOAD

(COMMAND) 256

Purpose Loads all NV parameters to working memory (RAM) from the control card non-volatile memory.

Guidelines Use NVLoad to update all NV parameters. This is useful if you have changed one or more parameters using the serial link and now wish to restore the original values (assuming the NVSave command was NOT issued after changing parameters). See also NVLoadOpt.

NVLOADOPT

(COMMAND) 258

Purpose Loads all NV parameters to working memory (RAM) from the option card non-volatile memory.

Guidelines Use NVLoadOpt to update all NV parameters from the Option Card. This is useful if you have changed one or more parameters using the serial link and now wish to restore the original values (assuming the NVSaveOpt command was NOT issued after changing parameters). See also NVLoad.

NVSAVE

(COMMAND) 257

Purpose Stores all NV parameters from RAM (working memory) to the control card non-volatile memory.

Guidelines Use NVSave when you wish to save all parameters in non-volatile memory. The 930 utilizes these values even after the power cycles. The NVRAM utilized is rated to allow 100,000 write cycles, far greater than should ever be needed. Avoid repeated use of NVSave from a host computer. See also NVSaveOpt.

NVSaveOpt

(Command) 259

Purpose Stores all NV parameters from RAM (working memory) to the option card non-volatile memory.

Guidelines Use NVSaveOpt when you wish to save all parameters in non-volatile memory on the option card. Saving the parameters to the option card non-volatile memory allows the drive control card to function with a removable Personality Module (the option card) when the drive control card non-volatile memory is not configured. The 930 utilizes these values even after the power cycles. The NVRAM utilized is rated to allow 100,000 write cycles, far greater than should ever be needed. Avoid repeated use of NVSaveOpt from a host computer. See also NVSave.

OCDate

(Variable, Integer, Read-Only) i282

Range 0 to 2^31

Default None

Purpose Gives the Option card date code.

OCSNum

(Variable, Integer, Read-Only) i281

Range 0 to 2^31

Default None

Purpose Gives the Option card serial number.

OUTPUTS

(VARIABLE, INTEGER) I47

Range 0 to 63 (6 BDIOs)

Purpose For BDIO outputs not mapped to an output function via BDIOMap, allows setting their output logic state in parallel.

Guidelines Outputs' value is weighted so that BDIO 1's individual value is x1, BDIO 2's is x2, BDIO 3's is x4, etc. 0 turns on the corresponding pull down transistor while 1 turns off the pull down transistor. Outputs = 12 pulls down BDIO 1, 2, 5, 6 and open circuit BDIO 3, 4.

BDIOs mapped to output functions via their BDIOMap are determined by that function and their value in Outputs are ignored.

See BDOut1-6 to set outputs individually.

Outputs = 1xBDIO1 + 2xBDIO2 + 4xBDIO3 + 8xBDIO4 + 15xBDIO5 + 32xBDIO6

POLECOUNT

(NV PARAMETER, INTEGER) I72

Units Motor poles

Range 2 to 65534 (even #'s only)
1 to 65535 Encoder Counts per electrical cycle

Default Set value before last NVSAVE. 930 Dialogue **New Set Up** or **Drive Set Up** calculates its value based on the selected motor.

Purpose Matches the drive for the appropriate motor pole count or encoder quadrature counts per motor electrical cycle.

Guidelines For CommSrc = 0 sets the number of motor poles

For CommSrc = 1 sets the number of encoder quadrature counts/motor cycle

When the PoleCount set does not match the actual pole count, the motor's operation is erratic.

POSCMDSET

(VARIABLE, INTEGER) I257

Units Counts (same units as position feedback)

Range -2,147,483,648 to +2,147,483,647

Purpose Used to change the commanded position and allows position control over the serial link.

Guidelines Used to change the commanded position, PosCommand, and allows position control using the serial link.

When RemoteFB = 0, PosCommand is in resolver counts.

When RemoteFB = 1 or 2, PosCommand is in EncPos units.

Caution should be used when changing PosCmdSet. The new value becomes the input to the position loop (no profiling). Large changes to PosCommand via PosCmdSet result in violent motion and, very likely, large overshoot.

If PosCmdSet is to be used for position control over the serial port, a sequence of closely-spaced position commands should be issued over time to create a motion profile that can be followed by the drive, motor, and load.

This variable only makes sense for position control blocks, (i.e. when BlkType = 2).

PosCommand

(Variable, Integer, Read-Only) I54

Units Counts (same units as position feedback)

Range -2,147,483,648 to +2,147,483,647

Purpose The position loop command input.

Guidelines Used to determine the position being commanded. It is a read-only variable and cannot be used to change the commanded position. PosCmdSet allows PosCommand to be changed using the serial link.

When RemoteFB = 0, PosCommand is in resolver counts.

When RemoteFB = 1 or 2, PosCommand is in EncPos units.

This variable only makes sense for position control blocks, (i.e. when BlkType = 2).

PosError

(Variable, Integer, Read-Only) I55

Units Counts (same units as position feedback)

Range -134,217,728 to +134,217,727

Purpose PosError (Actual Position Error) is equal to the difference between the position command (PosCommand) and the actual position (Position).

When RemoteFB = 0, PosError is in resolver counts.

When RemoteFB = 1 or 2, PosError is in EncPos units.

This variable only makes sense for position control blocks, (i.e. when BlkType = 2).

POSERRORMAX

(NV PARAMETER, INTEGER) I285

Units Counts (same units as position feedback)

Range 0 to 294,912,000 (4500 revs)

Default Set value before last NVSAVE. 930 Dialogue **New Set Up** or **Drive Set Up** sets its value to 4096.

Purpose Sets the maximum value in position feed back counts for the position loop following error fault.

Guidelines The following error fault compares PosError with the PosError predicted from EncFreq and Kvff if the magnitude of the difference is larger than PosErrorMax continuously for longer than 1 second or statistically larger over half the time the drive following error faults (“F 1 ”). This output activates and the following error fault (“F 1 ”) disables If you have mapped one of the BDIO outputs as PosErrorWarning.

POSITION

(VARIABLE, INTEGER, READ-ONLY) I57

Units Resolver Counts

Range -2,147,483,648 to +2,147,483,647

Purpose Indicates the measured resolver position, including integral resolver cycles since power up.

Guidelines The measured resolver position.

PULSESFOUT

(NV PARAMETER, INTEGER) I292

Units 2-16 resolver counts

Range 0 to 65535

Default Set value before last NVSave. Powering up an unconfigured drive sets this parameter to 0.

Purpose Specifies the fractional number of resolver counts the motor moves for each PulsesIn number of EncPos command counts. Fractional part of numerator of the exact electronic gearing ratio.

Guidelines PosCommand(New) = PosCommand(Old) + Ratio*(EncPos (New) - EncPos (Old))

$$\text{Ratio} = \frac{\text{PulsesOut} + (2^{-16} * \text{PulsesFOut})}{\text{PulsesIn}}$$

calculated once per position loop update period.

PULSESIN

(NV PARAMETER, INTEGER) I58

Units (if EncMode = 1) Steps
(if EncMode = 0) Quadrature counts of encoder input

Range 1 to 32,767

Default Set value before last NVSAVE. 930 Dialogue **New Set Up** or **Drive Set Up** sets its value to 1.

Purpose Sspecifies the number of steps, or quadrature encoder counts, used for selecting an exact gear ratio.

Guidelines PosCommand(New) = PosCommand(Old) + Ratio*(EncPos (New) - EncPos (Old))

$$\text{Ratio} = \frac{\text{PulsesOut} + (2^{-16} * \text{PulsesFOut})}{\text{PulsesIn}}$$

Calculated once per position loop update period.

PulsesIn specifies the number of EncPos command counts required to increase PosCommand by PulsesOut resolver counts.

PULSESOUT

(NV PARAMETER, INTEGER) I59

Units Resolver counts

Range -32,768 to +32,767

Default Set value before last NVSAVE. 930 Dialogue **New Set Up** or **Drive Set Up** sets its value to 1.

Purpose Specifies the number of resolver counts the motor moves for each PulsesIn number of EncPos command counts. Integral part of numerator of the exact electronic gearing ratio.

Guidelines PosCommand(New) = PosCommand(Old) + Ratio*(EncPos (New) - EncPos (Old))

$$\text{Ratio} = \frac{\text{PulsesOut} + (2^{-16} * \text{PulsesFOut})}{\text{PulsesIn}}$$

calculated once per position loop update period.

REMOTEFB

(NV PARAMETER, INTEGER) I267

Range 0, 1, or 2

Default Set value before last NVSAVE. 930 Dialogue **New Set Up** or **Drive Set Up** sets it value to 0 (all loops closed around resolver).

Purpose Selects the source of the feedback signal for the loops.

Guidelines **0** Resolver velocity and resolver position feedback
1 Resolver velocity and encoder position feedback
2 Encoder velocity and encoder position feedback

When RemoteFB is not equal 0, make sure EncIn is set to the proper value so that scaling of KPP, KVP, and VelFB is in default units.

RESPOS

(VARIABLE, INTEGER, READ-ONLY) I56

Units Resolver Counts

Range 0 to 65535

Purpose The absolute mechanical orientation of the resolver relative to the motor housing.

Guidelines Varies from zero to maximum range and back to zero as the motor rotates clockwise through one complete resolver electrical cycle. Standard resolvers have one electrical cycle per mechanical revolution.

RUNSTOP

(MAPPABLE INPUT FUNCTION, VARIABLE, INTEGER) I264

Range 0 or 1

Default 1 at power up if not mapped

Purpose Selects between normal operation and setting the velocity command to zero and disabling the drive once VelFB goes to 0.

Guidelines A specialized form of mechanical clutch brake emulation where the shaft is left with no holding torque (brake and clutch off), once the speed drops to zero or once the StopTime is exceeded.

STOPTIME

(NV PARAMETER, FLOAT) F262

Units seconds

Range 0.002 to 65.534

Default Set value before last NVSAVE. 930 Dialogue **New Set Up** or **Drive Set Up** sets it value to 0.

Purpose Maximum time out to disable the drive for the RunStop mappable BDIO function.

Guidelines When entering the stop state, a timer starts. If the actual shaft velocity has not reached 0 by StopTime, the drive is disabled.

UNCFGDRV

(COMMAND) 260

Purpose Sets the control card non-volatile memory to the unconfigured state.

UNCFGOPT

(COMMAND) 261

Purpose Sets the option card non-volatile memory to the unconfigured state.

VBUS

(VARIABLE, FLOAT, READ-ONLY) F275

Units Volts

Range 0 to 1000

Purpose The voltage of the high voltage DC supply, rectified from the AC line, used to power the motor.

Guidelines Monitoring this variable detectd the presence of the AC line power for the motor DC supply.

For 115 VAC line power the Bus is nominally 160 VDC.

For 240 VAC line power the Bus is nominally 330 VDC.

For 480 VAC line power the Bus is nominally 670 VDC.

VBusThresh

(NV Parameter, Float) F274

Units Volts

Range -1 to +1000

Default Set value before last NVSAVE. 930 Dialogue **New Set Up** or **Drive Set Up** sets its value to -1 (fault is disabled).

Purpose An adjustable parameter to allow the drive to fault if the AC line power for the motor DC supply is low.

Guidelines When VBus VBusThresh, the drive faults and displays a blinking “E 1 ”. This allows the drive to have an interlock so it will not try to move the motor unless there is sufficient motor bus voltage.

VBusThresh = 255 is a good value to detect a 230 VAC line more than 15% low.

A value of 1 disables the Bus Under voltage Fault (“E 1 ”).

VdCmd

(Variable, Float, Read-Only) F320

Units % (percentage)

Range -300 to 300

Purpose Motor terminal voltage PWM duty cycle amplitude command of the torque producing current control loop.

Guidelines VA fraction of the motor power DC bus voltage. See VBus.

VelCmd

(NV Parameter, Float) F26

Units rpm

Range VelLmtLo to VelLmtHi -21,000 to +21,000

Default Parameter value set before last NVSAVE. 930 Dialogue New Set Up or Drive Set Up sets it value to 0.

Purpose VelCmd is the net desired velocity loop command input. See VelLmtHi, VelLmtLo, AccelLmt, DecelLmt, and VelCmdA.

VELCMDA

(VARIABLE, FLOAT, READ-ONLY) F268

Units rpm

Range VelLmtLo to VelLmtHi

Purpose Actual velocity loop command.

Guidelines VelCmdA is VelCmd (or VelCmd2 if VelCmdSrc = 1) after being slew limited by AccelRate, DecelRate and potentially clamped by CwInh and/or CcwInh.

VELCMD2

(NV PARAMETER, FLOAT) F267

Units rpm

Range VelLmtLo to VelLmtHi

Default Set value before last NVSAVE. 930 Dialogue **New Set Up** or **Drive Set Up** sets it value to 0.

Purpose Non-volatile second velocity command selected when VelCmdSrc = 1.

Guidelines Allows easy emulation of mechanical clutch brake functionality. If VelCmd2 = 0 then VelCmdSrc = 1 corresponds to VelCmd = 0 and the brake engaged while VelCmdSrc = 0 corresponds to the brake off and the clutch engaged.

VelCmdSrc

(Mappable Input Function, Variable, Integer) i276

Range 0 or 1

Default 0 at power up if not mapped

Purpose Controls whether VelCmd source is determined by BlkType or is set to VelCmd2.

Guidelines **0** = selected by BlkType
1 = VelCmd2 for all BlkTypes

Allows easy emulation of mechanical clutch brake functionality. If VelCmd2 = 0 then VelCmdSrc = 1 corresponds to VelCmd = 0 and the brake engaged while VelCmdSrc = 0 corresponds to the brake off and the clutch engaged.

VelErr

(Variable, Float, Read-Only) f27

Units rpm

Range -48000 to +48000

Purpose Commanded velocity - measured velocity (VelCmdA - VelFB).

VelFB

(Variable, Float, Read-Only) f34

Units rpm

Range -48,000 to +48,000 for resolver
-30,000 to +30,000 for encoder

Default None

Purpose Instantaneous value of the velocity feedback.

Guidelines For normal operation, RemoteFB = 0 or 1, VelFB is the resolver velocity. For RemoteFB = 2, VelFB is based on delta EncPos at position loop update rate.

VELLMTHI

(NV PARAMETER, FLOAT) F279

Units rpm

Range -21,039 to +21,039

Default Set value before last NVSAVE. 930 Dialogue **New Set Up** or **Drive Set Up** calculates its value based on the selected motor and drive.

Purpose Sets the highest VelCmdA value allowed and a VelFB overspeed fault threshold.

Guidelines For BlkTypes with a velocity loop (BlkType = 1, 2, 5, 8), VelCmd and VelCmd2 are clamped to be less than VelLmtHi. In torque control (BlkTypes= 0, 4), VelLmtHi has no clamping function. If VelLmtHi is reduced to below the current value of VelCmd2 or VelCmd, VelCmd2 and/or VelCmd are reduced to VelLmtHi.

For all BlkTypes, a fault with FaultCode = 1 occurs if .

|VelFB| > 1.5 * max of (|VelLmtLo|, |VelLmtHi|)

See also VelLmtLo.

VELLMTLO

(NV PARAMETER, FLOAT) F280

Units rpm

Range -21,039 to +21,039

Default Set value before last NVSAVE. 930 Dialogue **New Set Up** or **Drive Set Up** calculates its value based on the selected motor and drive.

Purpose Sets the smallest VelCmdA value allowed and a VelFB overspeed fault threshold.

Guidelines For BlkTypes with a velocity loop (BlkType = 1, 2, 5, 8), VelCmd and VelCmd2 are clamped to be greater than VelLmtLo. In torque control (BlkTypes = 0, 4), VelLmtLo has no clamping function. If VelLmtLo is increased to above the current value of VelCmd2 or VelCmd, then VelCmd2 and/or VelCmd are increased to VelLmtHi.

For all BlkTypes, a fault with FaultCode = 1 occurs if .

|VelFB| > 1.5 * max of (|VelLmtLo|, |VelLmtHi|)

See also VelLmtHi.

VELOCITY

(VARIABLE, FLOAT, READ-ONLY) F6

Units rpm

Range -30,000 to +30,000

Purpose Velocity is VelFB passed through a 3.5 Hz low pass filter.

Guidelines When the measured velocity exceeds Velocity's range, Velocity's value is incorrect. See VelFB for an instantaneous indication of measured velocity that is accurate to higher speeds.

ZeroSpeedThresh

(NV Parameter, Float) F324

Units rpm

Range 0 to 16,000

Default Set value before last NVSAVE. 930 Dialogue **New Set Up** or **Drive Set Up** sets this parameter to 30.

Purpose Sets the threshold speed for turning the ZeroSpeed output on or off. If the absolute value of the motor speed is below ZeroSpeedThresh, ZeroSpeed output turns on. If the absolute value of the motor speed is greater than ZeroSpeedThresh, ZeroSpeed output turns off.

Guidelines To use this function, map a BDIO point to the ZeroSpeed function.

This function may be used as a general speed indicator instead of as a zero speed indicator.

APPENDIX A OC930 COMMUNICATIONS PROTOCOL

Described are the communications protocol governing communications between the OC930 and any host device (typically a PC). This is the same protocol the 930 Dialogue uses tocommunicate with the OC930.

Message Format To the Drive:

Field Name	Width in Bytes
Header	2
Target Address	2
Command Code	2
Message Length	4
Message Data	Variable
Checksum	2

Response Format From the Drive:

Field Name	Width in Bytes
Header	2
Drive Address	2
Command Code	2
Message Length	4
Message Data	Variable
Checksum	2

Header

The message header sequence delimits the beginning of every message and response. It is always the two characters, ^A^B (<01><02>).

Target Address/ Drive Address

The address field contains the ASCII Hex number corresponding to the address of the drive to which the message is being sent. For response messages, the address field contains the ASCII Hex number corresponding to the address of the drive generating the response.

Command Code

The command code field of a message from the PC to a drive contains an ASCII Hex number specifying the type of message being sent. The types of messages are:

05 Read a Variable from the Drive
06 Write a New Value to the Drive
0B Execute a Command

Response Code The response code field of a response message from a drive to the PC contains an ASCII hex number indicating whether or not the corresponding message from the PC was received properly by the drive. The values for the response code are:

00	Message received properly
01	Message contained an error

Message Length The message length field contains an ASCII Hex number corresponding to the number of characters in the Data Field of the message or response. The message length field contains the most significant byte first.

Message Data The message data field is message-dependent. Read Messages and Write Messages are described below.

Checksum The checksum field contains the ASCII Hex number corresponding to the modulo-256 sum of the ASCII values of all characters in the message. An example checksum calculation for a Read Message is:

Header	^A^B	01 + 02
Address	FF	70 + 70
Command Code	05	48 + 53
Data Length	0005	48 + 48 + 48 + 53
Data	D000E	68 + 48 + 48 + 48 + 69

The sum of all the ASCII characters in the message is 722. The modulo-256 value of 722 is 210. This is equal to the hex number D2. The checksum for this message is D2. The complete message is:

^A^B FF 05 0005 D000E D2

Read Messages Read Messages are used to read the value of variables in the drive. To read the value of a variable, specify its type (Integer or Floating Point) and its Identifier Number.

Message Data The data field of a Read Message consists of five characters. The first character specifies whether the variables is Integer (D) or floating point (C). The next four characters are the ASCII hex value for the variables Identifier Number.

Response Data

The data field for a Read Message Response consists of eight characters. The meaning of these characters is different depending upon whether the variable is integer or floating point.

If the variable being read is an integer variable, the eight bytes are the ASCII hex representation of the 32 bit value for the variable. The ASCII hex number is least-significant-byte-first format.

If the variable is a floating point variable, the eight bytes are the ASCII hex representation of the 32 bit IEEE-754 Single-Precision, Floating-Point value for the variable.

Write Messages

Write Messages are used to change the value of a variable on the drive.

Message Data

The Write Message data field consists of 13 characters. One character specifies whether the variable is an Integer (D) or a floating point (C). The next four characters specify the particular variables Identifier Number in 16 bit ASCII hex format. The remaining 8 characters specify the value to be written to the variable (described below).

If the variable being written is an integer variable, the eight bytes are the ASCII hex representation of the new 32 bit value for the variable. The ASCII hex number is least-significant-byte-first format. All eight bytes must be sent, even if most of the characters are zeros.

If the variable is a floating-point variable, the eight bytes are the ASCII hex representation of the new 32 bit IEEE-754 Single-Precision, Floating-Point value for the variable.

Response Data

The response's data field to a Write Message is the two characters, 00, if the message was properly received.

Examples

Read FaultCode from the Drive.

FaultCode is an Integer Variable (D). FaultCode's Identifier Number is 000E. For this example, we'll assume the value of FaultCode is 3.

Message: ^A^B FF 05 0005 D 000E D2
Response: ^A^B FF 00 0008 03 00 00 00 3A

Read Velocity from the Drive.

Velocity is a Floating-Point Variable (C). Velocity's Identifier Number is 0006. For this example, we'll assume the value of Velocity is 1000.1.

Message: ^A^B FF 05 0005 C 0006 C2
Response: ^A^B FF 00 0008 66067A44 69

Write New Value for ILmtPlus to the Drive

IlmtPlus is an Integer Variable (D). IlmtPlus's Identifier Number is 0005. For this example, we'll write a new value of 50 percent (decimal 50 = 32 hex).

Message: ^A^B FF 06 000D D 0005 32 00 00 00 57
Response: ^A^B FF 00 0002 00 11

Write New Value for AccelLmt

AccelLmt is a Floating-Point Variable (C). AccelLmt's Identifier Number is 276. This corresponds to 0114 in hexadecimal. For this example, we'll write a new value of 10,000.

Message: ^A^B FF 06 000D C 0114 00401C46 74
Response: ^A^B FF 00 0002 00 11

Restore Parameters from NV Memory

NVLoad's Identifier Number is 256, which corresponds to 0100 in hexadecimal.

Message: ^A^B FF 0B 004 0100 86
Response: ^A^B FF 00 0002 00 11

APPENDIX B CONFIGURING OC930 AS PERSONALITY MODULE

You can use the OC930 Communications Option Card two ways:

- As a communication card only

In the communications option card configuration, the OC930 is used only to allow serial communications to the SC900 Servo Drive. All non-volatile parameters are stored on the control card of the SC900. The OC930 is not required to operate the drive.

- As a Personality Module

In the Personality Module configuration, all non-volatile parameters are stored on the OC930, and the NV memory on the SC900 control card is unconfigured. On power-up, the SC900 reads the value of each non-volatile parameter from the OC930. In this configuration, the OC930 must be installed in order to operate the drive. The AInNull mappable function saves the new ADOffset to the NV memory on the OC930 when configured as a Personality Module.

Procedure

To configure an OC930 as a Personality Module, follow these steps:

1. Select **Configure OC930** as PM from the **Drive** drop-down menu.
2. A screen appears to confirm that you want to do this. Type **YES** and press the **<Enter>** key.

Drive status LED continues to flash U - C until control AC power is cycled.

APPENDIX C CONTROL BLOCK DIAGRAMS

This chapter contains control block diagrams. Be sure to review them carefully.

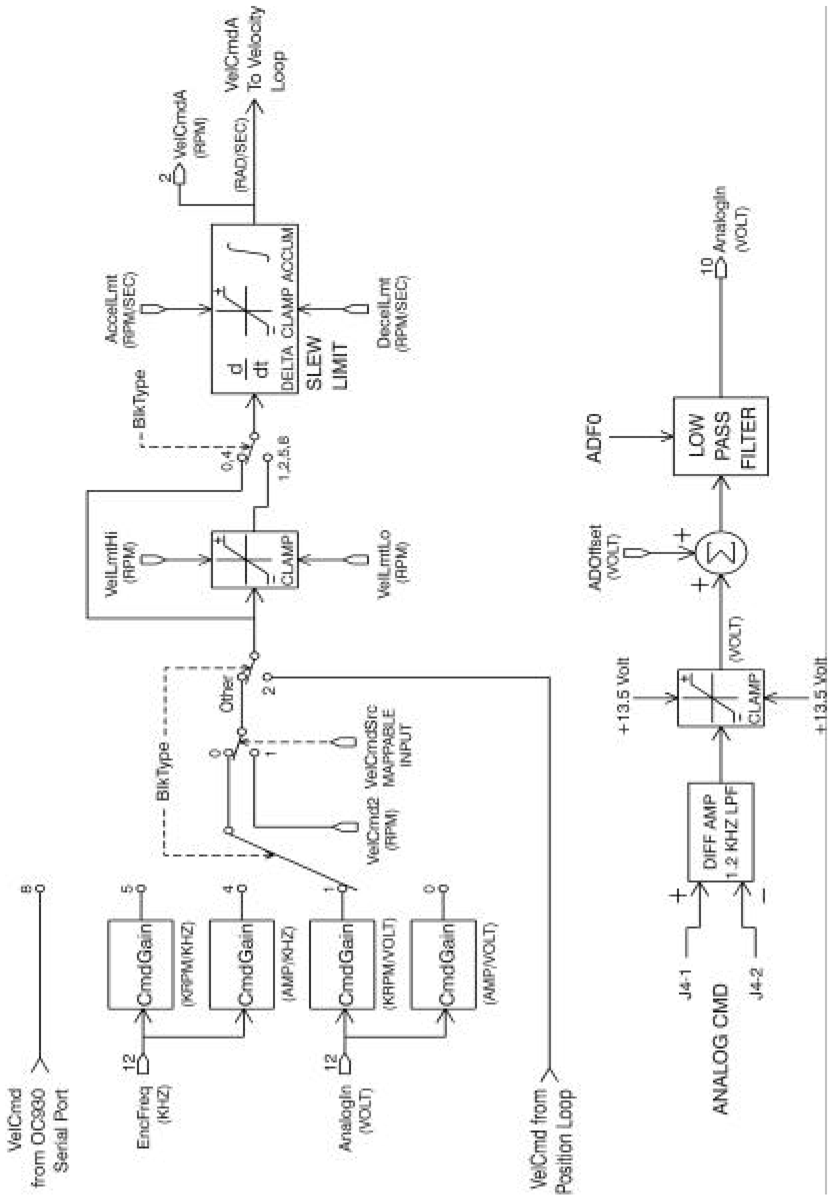

VelCmd from OC930 Serial Port
EncFreq (KHZ)
AnalogIn (VOLT)
VelCmd from Position Loop
CmdGain
(KRPM/KHZ)
(AMP/KHZ)
(KRPM/VOLT)
(AMP/VOLT)
BlkType
VelCmd2 (RPM)
VelCmdSrc MAPPABLE INPUT
Other
VelLmtHi (RPM)
VelLmtLo (RPM)
CLAMP
AccelLmt (RPM/SEC)
DecelLmt (RPM/SEC)
DELTA CLAMP ACCUM
SLEW LIMIT
VelCmdA (RPM)
(RAD/SEC)
VelCmdA To Velocity Loop
ANALOG CMD
J4-1
J4-2
DIFF AMP 1.2 KHZ LPF
+13.5 Volt
(VOLT)
ADOffset (VOLT)
ADF0
LOW PASS FILTER
AnalogIn (VOLT)

Figure 1

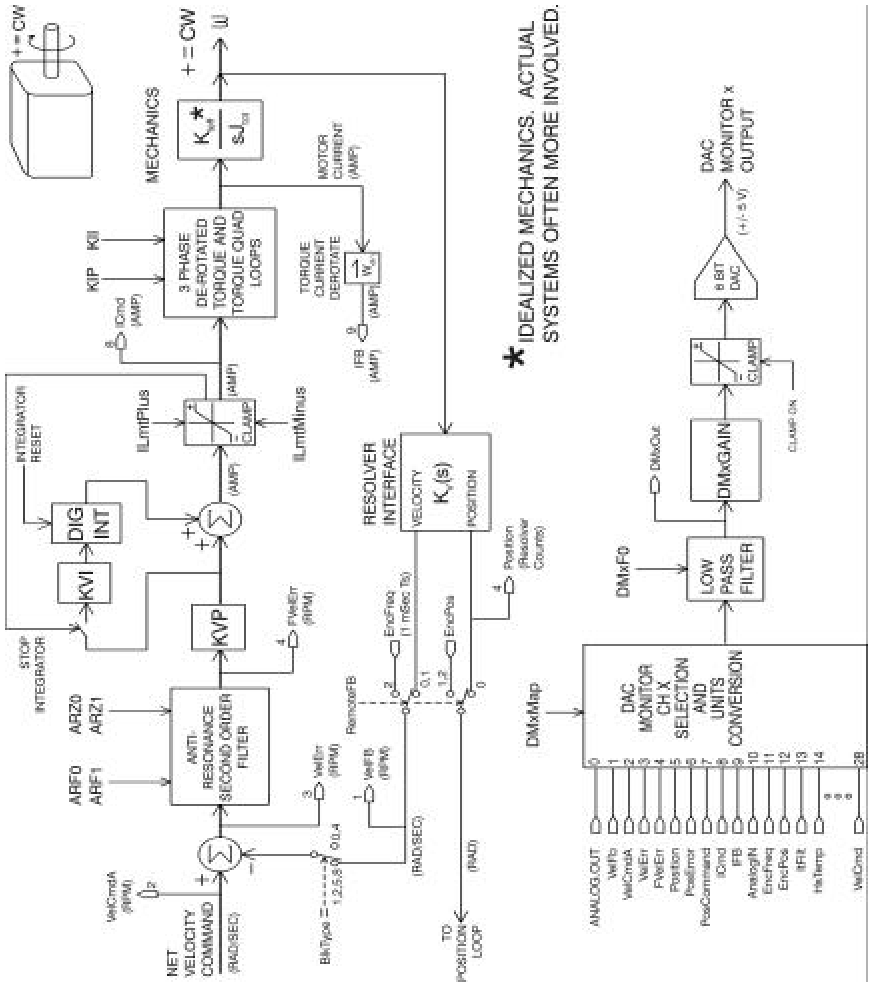

NET VELOCITY COMMAND (RAD/SEC)
VelCmdA (RPM)
ARF0 ARF1
AR20 AR21
ANTI-RESONANCE SECOND ORDER FILTER
STOP INTEGRATOR
INTEGRATOR RESET
KVI
DIG INT
KVP
FVelErr (RPM)
VelErr (RPM)
VelFB (RPM)
ILmtPlus
ILmtMinus
CLAMP
(AMP)
ICmd (AMP)
KIP KII
3 PHASE DE-ROTATED TORQUE AND TORQUE QUAD LOOPS
TORQUE CURRENT DEROTATE
MOTOR CURRENT (AMP)
IFB (AMP)
MECHANICS
+ = CW
ω
RESOLVER INTERFACE
VELOCITY
POSITION
Position (Resolver Counts)
EncFreq (1 mSec Ts)
EncPos
RemoteFB
BlkType
(RAD/SEC)
(RAD)
TO POSITION LOOP
IDEALIZED MECHANICS. ACTUAL SYSTEMS OFTEN MORE INVOLVED.
DMxMap
DAC MONITOR CH X SELECTION AND UNITS CONVERSION
ANALOG.OUT
VelFb
VelCmdA
VelErr
FVelErr
Position
PosError
PosCommand
ICmd
IFB
AnalogIN
EncFreq
EncPos
ItFilt
HsTemp
VelCmd
DMxF0
LOW PASS FILTER
DMxOut
DMxGAIN
CLAMP ON
8 BIT DAC
(+/- 5 V)
DAC MONITOR x OUTPUT

Figure 2

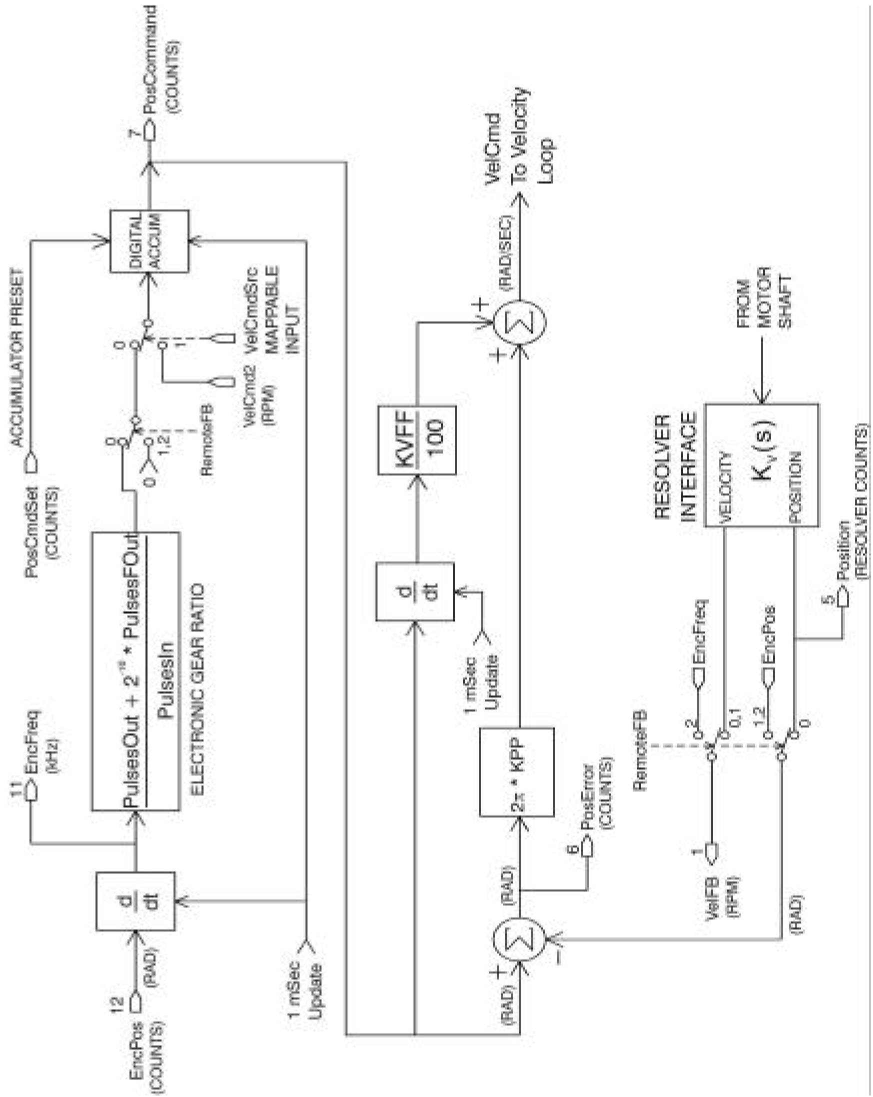

ACCUMULATOR PRESET
PosCmdSet
(COUNTS)
11
EncFreq
(kHz)
7
PosCommand
(COUNTS)
DIGITAL
ACCUM
VelCmdSrc
MAPPABLE
INPUT
VelCmd2
(RPM)
RemoteFB
PulsesOut + 2^-16 * PulsesFOut
PulsesIn
ELECTRONIC GEAR RATIO
d/dt
12
EncPos
(COUNTS)
(RAD)
1 mSec
Update
VelCmd
To Velocity
Loop
(RAD/SEC)
KVFF
100
2π * KPP
6
PosError
(COUNTS)
RESOLVER
INTERFACE
VELOCITY
POSITION
Kv(s)
FROM
MOTOR
SHAFT
5
Position
(RESOLVER COUNTS)
EncFreq
EncPos
1
VelFB
(RPM)

Figure 3

APPENDIX D TROUBLESHOOTING AND FAULT DIAGNOSTICS

The following table of problems, causes and appropriate actions complements the list of SC900 fault codes found in Section 7 (page 7-56).

PROBLEM & STATUS DISPLAY	POSSIBLE CAUSE	ACTION
Velocity feedback over speed fault (blinking 1)	Loose or open circuit wiring to the resolver feedback connector J3.	Check connections. Tighten tb screws on J3.
	VelFB > 1.5 * [max of (|VelLmtLo| or |VelLmtHi|)] or VelFB > 21,000 rpm	Limit VelCmd appropriately. **Note**: ***For encoder velocity feedback (CommSrc = 1 or 2), check that EncIn is set properly to correctly scale VelFB units.***
Motor over temperature fault (blinking 2)	Loose or open circuit wiring to motor PTC thermal sensor J3-8 and J3-9).	Check connections. Tighten TB screws on J3-8 and J3-9.
	High ambient temperature at motor.	Lower ambient temperature.
	Insufficient motor heat sinking from motor mounting.	Increase motor mounting heat sinking.
	Operating above the motor's continuous current rating.	Operate within continuous torque rating.
	Inoperative motor cooling fan.	Return to factory for fan replacement.
Drive over temperature fault (blinking 3) **Note:** ***See HSTemp,ItFilt, ITThresh , andITF0 for information on measuring thermal margin in an application.***	High drive ambient temperature.	Lower ambient temperature to below 50°c (60°c if IOut is derated)
	Restriction of cooling air due to insufficient space around unit.	Provide sufficient cooling space.
	Operating above the drive's continuous current rating.	Operate within continuous current rating.
	Inoperative cooling fan.	Return to factory for fan replacement.

PROBLEM & STATUS DISPLAY	POSSIBLE CAUSE	ACTION
Drive I*t fault (blinking 4)	Mechanically jammed motor. Motion profile accelerations too high. Machine load on the motor increased (friction increased). Problem with wiring between drive and motor yielding improper motion. Drive and/or motor under-sized for application.	Ensure motor shaft is not jammed. Change profile or load. **Note**: ***See HSTemp, ItFilt, ITThresh , and ITF0 for information on determining the continuous current margin in an application.***
Line-neutral fault (blinking 5)	Short circuit in the motor and/or drive motor cable.	Check cable.
	Motor power cable is longer than the data sheet specification by enough to cause excessive motor line to earth ground/neutral capacitance.	Shorten power cable.
Control ± 12 V supply under voltage fault (blinking 6)	Insufficient control AC voltage on voltage on J1-5 to J1-6.	Check voltage with meter.
	Internal drive failure.	Contact distributor.
Output over current or bus over voltage fault (blinking 7)	Motor power wiring (J2-2, 3, or 4) short circuit.	Check for short.
	Line-to-line or line-to-ground/neutral internal motor winding short circuit.	Check for short.
	Insufficient motor inductance for output over current faults.	Check motor inductance against drive minimum specification.
	Motor AC power input voltage too high.	Reduce AC input voltage to within specification.
	Disconnected regeneration resistor on J5, or external regeneration resistor ohmage too small for bus over voltage fault.	Check the connections on J5.

PROBLEM & STATUS DISPLAY	POSSIBLE CAUSE	ACTION
Shunt regulator overload	Excessive regen in application.	Increase cycle time. Reduce the inertia. Add external regen with higher wattage.
	Improper external regen wiring or components on J5.	Check connections on J5.
Bus over-voltage detected by DSP (blinking A)	Actual bus over-voltages are usually detected and displayed as a blinking 7 fault, see that entry for more information.	Contact distributor. Return to factory.
	Drive improperly set up in the factory.	
Auxiliary +5V supply fault (blinking b)	Short circuited wiring on the output.	Check for short.
	Load exceeds the current rating of this supply.	Reduce load.
Processor throughput fault (solid E)	Drive hardware failure.	Cycle control power.
	Drive software bug.	Cycle control power.
Power up self test failure (blinking E)	Internal drive software error.	See extfault for further information about the exact failure. The drive control power must be cycled to clear this fault.
Bus voltage fault (alternating E, 1)	Motor power bus voltage dropped below VBusThresh.	Check the measured bus voltage vbus and the fault threshold VBusThresh.
Ambient temperature too low fault (alternating E, 2)	Ambient temperature is below drive specification.	Raise ambient temperature above 0°C.
	Drive's internal temperature sensor has a wiring problem.	Contact distributor. Return to factory.
Encoder commutation alignment fault (alternating E, 3)	Problems with encoder feedback wiring to J4.	Check wiring.
	Load inertia more than 100 times the motor inertia leading to settling times long compared to the 2.0 second alignment.	Artificially extend the alignment time by pulsing the hardware enable (J4-6).

PROBLEM & STATUS DISPLAY	POSSIBLE CAUSE	ACTION
Firmware version incompatible with nv memory version (alternating E, 4)	Oc930-001-01 (drive software upgrade card) was used to set up an old drive and then removed.	Re-install oc930-001-01 (drive software upgrade card).
Firmware version incompatible with hardware (alternating E, 5)	Non-volatile parameter memory was written with a newer drive software than the drive just powered up with.	Check the drive software version via theFwV status variable. Contact factory for upgrade details.
Attempted to configure with drive enabled (alternating E, 6)	Unconfigured drive (status led alternates *U, C*) was fully configured with the drive motor power enable active.	This fault can be reset or the control AC power cycled to get the drive motor operating.
Two AInNull events too close together (alternating E, 7)	AInNull was re-activated too soon after going inactive.	Ensure at least 0.5 second pause between AInNull activations. Check for switch bounce.
Excessive position following error fault (alternating F, 1)	Motor is either stalled or partially jammed.	Ensure motor is not jammed.
	PosErrorMax is set too sensitive.	Increase the value of PosErrorMax.
Parameter checksum error fault (alternating F, 3)	Glitch while last saving the NV parameters.	Download parameters again and NVSave.
	Option card has corrupted NV memory contents.	See extfault status variable to determine whether NV memory corruption is inside the drive or on the option card.
	Hardware problem with the NV memory.	Cycle power.

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