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HIGH PERFORMANCE MOTORS & DRIVES

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Part # MA2300
List Price $30 US
June 2003
Rev C

Preliminary
Draft Rev C

MA2300

PC2303 Hardware Reference Manual

Single Axis Gcoder™ Based Brushless Servo Drive

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Table of Contents

1 Overview

Introduction

This manual describes an economical, high performance, medium power single axis servo drive meant to go with Gcoder™ equipped brushless 3-phase permanent magnet motors. This system can be configured to control shaft torque or shaft speed.

The PC2303 is ideal for medium to large volume OEM applications but can be readily applied in end user applications. In addition to industry standard capabilities and protection features, the PC2303 drive includes many state of the art industry leading features including:

Unique Features

- All digital DSP-based control including the current loops.
  - All system and application parameters set digitally.
  - All inputs and outputs digital to insure precision and high noise immunity.
- Advanced patented all digital (DRDC) converter interfaces with cost effective Gcoder™ shaft position feedback device with high resolution and smoothness. U.S. Patent Number 5,162,798. Canadian Patent Number 2,069,211.
- Advanced sinusoidal current control for low shaft torque ripple and uniform control dynamics at all shaft speeds.
- Single phase ac line interface allowing 240 Vac or 120 Vac with voltage doubling to maintain consistent bus voltage and system torque speed capability.
- 25,000 hour expected life.
- Emulated pulse speed feedback signal with resolutions up to 4096 PPR.

Standard Features

In addition to the above distinctive features The PC2300 family's many industry standard features include:

- Integral power supply
- Easy to install panel mount packaging
- Extensive protection circuits and diagnostics to ease set-up
- IGBT power stage with inaudible high frequency PWM
- UL-508C, cUL Recognition. CE mark pending
- IR compensation adjustment for increased speed control stiffness
- ISO 9001 designed and manufactured

2 Model Identification

2.1 Basic Servo Drive Package Order Numbering System

P C 2 3 0 3 - 0 0 1 - N
PC2 = Servo Drive Family Designation

3 =	**Ac line Interface**
3 =>	240 Vac or 120 Vac with voltage doubling

0 =	**Command Interface Designation**
0 =>	Base servo with torque or speed control

3 =	**Power Level**
3 =>	9.5 Arms continuous, 14.1 Arms peak

- 001 =	**Customization Code**
001 =>	Standard Unit
XYZ =>	Factory Assigned Hardware Customization

- N =	**Accessories**
N =>	No Accessories

Note: PC2303 replaces the now obsolete PC2302 7.1 Arms cont/10.6 Arms drive unit.

2.2 Accessories

Regeneration Accessory Kit

RA2302	Accessory board for J3 to allow active braking of the motor. For details on this kit see Chapter 8.

PC Interface Accessory Kit

SI2300	PC Setup Interface Kit Including Windows Utility CD

Manual and Documentation Kits

MA2300	*PC2303 Hardware Reference Manual*

3 Electrical Specifications

3.1 Output Power Specifications

	PC2303
Peak Output Current	
3 seconds, up to full 60ºC	14.1 Arms
Continuous Output Current	
With NO External Heat Sink	
25°C Convection Cooling	4.0Arms
50°C Forced Air Cooling	9.5 Arms
50°C Convection Cooling	2.0 Arms
Continuous Output Current	
< 70°C Mounting Surface	9.5 Arms
Peak Output Power	
1 second, up to full 50°C	
@ 240 VAC	6.0 kW
@ 120 VAC	5.0 kW
Continuous Output Power	
@ 240 VAC single phase	
< 70°C Mounting Surface	2.0 kW
25°C Convection Cooling	1.6 kW
50°C Forced Air Cooling	2.0 kW
40°C Convection Cooling	0.86 kW
Continuous Output Power	
@ 120 VAC voltage doubled	
< 70°C Mounting Surface	1.6 kW
25°C Convection Cooling	1.25 kW
50°C Forced Air Cooling	1.6 kW
40°C Convection Cooling	0.7 kW

3.1 Output Power Specifications (Cont'd)

PC2303

Foldback Current Limit Level	67% of peak output current
Power Stage Efficiency @ P_{cont}	>95%
Bus Over Voltage Shutdown	407 Vdc ± 3%
Regen (J3-2) On Threshold	(Bus Over Voltage) – 8 V
Regen (J3-2) Off Threshold	(Regen On Thresh) – 9 V
Bus Capacitance Energy Absorption	
320 V Bus To Bus OV	31 J typical, 20 J minimum
320 V Bus To Regen On Thresh	28 J typical, 18 J minimum
Output Current Ripple Freq f_s	Freq = 40 kHz during normal operation

Rotation	|Iout|	Ripple Freq
Rotating	< Ipeak/3	Freq ÷ 1
Rotating	> Ipeak/2	Freq ÷ 2
Stall	< Ipeak/3	Freq ÷ 2
Stall	> Ipeak/2	Freq ÷ 4

Rotating Elec Freq = 4.7 Hz
= 47 RPM for 12 pole motor

Motor Inductance Range l-l	
Minimum	2.0 mH
Maximum	4 H
Maximum Motor Cable Length	50 m/164 ft
Maximum Motor Electrical Frequency	600Hz

3.2 Input Power Specifications

Overview

The drive is capable of direct line operation. It is appropriately isolated and does not require external isolation transformers. Also, the inrush current on connection to the ac line is internally limited to a safe level for the drive. It is the responsibility of the user to supply appropriate fuses or circuit breakers in the TB1 AC Power lines to comply with local electrical codes. It is also the responsibility of the user to supply appropriate ac line filtering to comply with local EMI regulatory requirements.

AC Power Supply

Model Number	Line Connection	Voltage Range	Transformer Suggested kVA	Maximum AC line* kVA
PC2303	Doubler TB1-2/3,4	65-132 Vac 47-410 Hz	3 to 4 kVA	100 kVA
PC2303	FW Rect TB1-2,3	130-264 Vac 47-410 Hz	3 to 4 kVA	100 kVA

*Maximum AC Line kVA is specified to limit the line surges coupled to the drive.

Nominal dc Bus Voltage

240 VAC Input at Half Continuous Rated Power .....325 VDC
120 VAC Input Voltage Doubled at Half Continuous Rated Power.....310 VDC

Inrush Current & Fusing Recommendation

Model Number	Line Connection	Inrush Peak Current	Inrush Pulse Width	Fuse Recommendation
PC2303	Doubler TB1-2/3,4	190 A 0-p	2.5 mSec	20 A 250V Time Delay Bussmann, MDA-20
PC2303	FW Rect TB1-2,3	240 A 0-p	2.0 mSec	20 A 250V Time Delay Bussmann, MDA-20

Note that re-applying the ac line right after high power operation can double the inrush peak current.

3.2.1 AC Line Ground (Protection Earth) Leakage

Some applications require careful control of the ac currents flowing from the line to earth or protective ground. For example, UL standard 1647 Motor Operated Massage and Exercise Machines specifies a very low ac line leakage. Medical applications also often have stringent ground leakage requirements. This section gives information on the leakage possible with the PC2300 drive.

The dc bus is coupled to the chassis via 6000 pF of capacitance. This capacitance will cause leakage current to flow from the ac line to the chassis/protection earth connection. For proper 240 Vac operation or for proper phasing of the 120 Vac line the leakage current when the drive is disabled will be 0.1 mA rms or less. Phasing of the 240 Vac connection does not change the resulting leakage. In the voltage doubler connection, when the 120 Vac phasing is reversed, the drive disabled ground leakage current increases to 0.28 mA rms.

In normal operation, there will also be leakage current conducted to protection earth from the TB2 motor power cable and from the motor capacitance to ground. This leakage term is generally negligible when the drive is disabled but when the drive is enabled can be much larger than the drive only leakage. This component of leakage needs to be evaluated with the particular motor power cable and motor used.

There are many ways to manage ac leakage current. However, the biggest term comes from the motor winding to case capacitance. A very effective way to reduce this component of leakage is to float the case of the motor. That is, do not connect an earth ground wire to the motor and have an insulating mechanical mounting of the motor. When doing this be very sure to protect the motor case from human touch as the case **would** be a shock hazard.

3.2.2 Add Line Choke to Reduce Line Harmonics

European standard EN61000-3-2 became mandatory on Jan. 1, 2001. This standard sets harmonic current emission limits for electrical and electronic equipment having an input current up to and including 16 Arms per phase and intended to be connected to public low-voltage distribution system, *i.e.* supply voltages nominally 230 Vac or 415 Vac 3 phase. PC2303 does not have line harmonic reduction circuitry built in. A 0.5 mH to 2 mH, 10 Arms line choke may be required to meet this standard. The line choke can be inserted between either AC line HOT to TB1-2 (LHOT) or AC line Neutral to TB1-3 (L240N). Refer to Section 4.2, Drive Wiring Diagram for the connection.

3.3 General Specifications

Power Up Turn On Delay

Delay Ac Line On To Fully Operational
- Minimum ..... 0.5 Sec
- Maximum ..... 1.5 Sec

Environmental

Operating Ambient Temperature Convection Cooling No Heat Sink:
- I_{peak}*0.33 continuous rating .....0°C to 25°C
- Linearly derate I_{peak}*0.33 continuous rating per (1 - (T - 25°C)/50°C) .... 25°C to 60°C

Operating Ambient Temperature Forced Air Cooling No Heat Sink:
- I_{peak}*0.66 continuous rating .....0°C to 40°C
- Linearly derate I_{peak}*0.66 continuous rating per (1 - (T - 40°C)/40°C) ...40°C to 60°C

Mounting Surface Temperature With External Convection Heat Sink:
- I_{peak}*0.66 continuous rating .....0°C to 70°C

Storage Temperature ..... -40°C to 70°C

Humidity, non-condensing ..... 10% to 90%

Altitude ..... .1600 m (5280 feet)

4 I/O Terminations

Introduction

All user connections are made on the front edge of the unit. These connections are TB1 AC Power, TB2 Motor Power, J1 Motor Feedback, and J2 Command I/O. All terminations are two piece pluggable connections.

In the below list a "/" after a signal name means that the signal is active low logic. For example, "Enable/" enables the drive when it is pulled low and disables the drive when it is high.

Earth Ground

Protection Earth (PE) connection is available on TB1 and TB2. A PE wire can also be connected to a drive mounting screw or to the PC board mounting screw next to TB1. These alternatives provide a direct chassis connection that may be necessary to meet some regulatory requirements.

4.1 Connector Hardware and Signal Names

For reference, the below connector signal lists place the signals in the order they occur along the front edge of the product from right to left. Note that TB1 pin numerical order is left to right while the others are right to left. See 6—1 drive mechanical outline for order.

J2 COMMAND I/O

10 Contact 0.1" Spaced Right Angle 0.025" Square Pin Header

1 No Connect
2 DOUT2 (EMU A) (Output)
3 DOUT1 (FAULT) (Output)
4 FDOUT1 (DMON1) (Output)
5 I/O RTN (Common)
6 DINP2 (IR ADJ/) (Input)
7 DINP1 (ENABLE/) (Input)
8 PWM CMD (Input)
9 USER +5 RTN (Input)
10 USER +5 VDC (Input)

J1 FEEDBACK

6 Contact 0.1” Spaced Right Angle 0.025” Square Pin Header

1 SHIELD (Output)
2 H3 (Input)
3 H2 (Input)
4 H1 (Input)
5 +5 VDC RTN (Output)
6 +5 VDC (Output)

WARNING: These signals are electrically hot. Shorting any J1 pin to PE/earth GND will always permanently damage the drive.

TB2 MOTOR POWER

0.250” x 0.032” Faston/Disconnect Tabs

1 CHASSIS GROUND/PROTECTION EARTH
2 MOTOR PHASE W
3 MOTOR PHASE V
4 MOTOR PHASE U

TB1 AC POWER

0.250” x 0.032” Faston/Disconnect Tabs

4 120 VAC NEUTRAL (Voltage Doubler Input)
3 240 VAC NEUTRAL
2 AC LINE HOT
1 CHASSIS GROUND/PROTECTION EARTH

J3 REGENERATION INTERFACE

4 Contact 0.156” Spaced 0.045” Square Pin Header

1 - BUS (Output)
2 REGEN (Output)
3 No Connect
4 + BUS (Output)

4.1.1 Connector Hardware

J1,2 FEEDBACK and COMMAND I/O CONNECTORS

J1: 6 Contact
J2: 10 Contact
Both: 0.1" Spaced Right Angle 0.025" Square Pin Headers With Locking Ramp

J1 and J2 are from the same connector family with different number of positions. Both insulation displacement (IDC) and crimp type mates are available for these connectors. The IDC type is often used in prototypes or high volume applications where cost is the main issue. The crimp types are used where ruggedness is more important.

J1, J2 IDC Types:

J1 Mating 22 AWG Connector 6 Position, Gold Plating	ITW Pancon CE100F22-6-B
J1 Mating Strain Relief Cap	ITW Pancon SCC100F-6
J2 Mating 22 AWG Connector 10 Position, Gold Plating	ITW Pancon CE100F22-10-B
J2 Mating Strain Relief Cap	ITW Pancon SCC100F-10
Hand insertion tool	ITW Pancon MRT-100F
Ratchet type hand insertion tool	ITW Pancon MCT with CTD-100F nose

J1, J2 Crimp Types:

J1 Mating Connector Shell 6 Position, Locking Ramp	Molex Engineering Number 2695 Molex Order Number 22-01-2067
J2 Mating Connector Shell 10 Position, Locking Ramp	Molex Engineering Number 2695 Molex Order Number 22-01-2107
Crimp Terminal 22-30 AWG Gold Plating, 1 per Position	Molex Engineering Number 6459 Molex Order Number 08-65-0814
OR	
Crimp Terminal 22-30 AWG Selective Gold Plating, 1 per	Molex Engineering Number 6459 Molex Order Number 08-65-0816
Hand Crimp Tool	Molex Order Number 63811-1000
Ratcheting Hand Crimp Tool	Molex Order Number 11-01-0185

TB1,2 AC and MOTOR POWER CONNECTIONS

0.250" x 0.032" Faston/Disconnect Tabs

TB1 and 2 connections can use 4 contact housed Faston/Disconnect receptacles as a two piece connector solution or individual insulated Faston/Disconnect connections. Typically the ac power line connections to TB1 are 16 or 14 AWG while motor power connections are typically 18 or 16 AWG.

4 Contact Housed Solution:

Amp 520987-1 Black Nylon 4 circuit 0.250" Faston Housing
Amp 520987-2 White Nylon 4 circuit 0.250" Faston Housing

The white and the black housings work for both TB1 and TB2.
For color coding use black for TB2 and white for TB1.

Amp 63648-2 0.250" 20-14 AWG tin plating Faston uninsulated receptacles, 4 per TB.

NOTE: Standard uninsulated quick disconnect/fastons will snap into the housings and provide working connections. However, the insertion and extraction forces become very large.

Use Faston receptacle hand crimp tool Amp 58524-1 or Amp 90165-1.

Individual Fully Insulated 0.250" Faston/Disconnect Female Connections:

These connections are widely available from many suppliers all over the world. They are available in straight or right angle so-called flag configurations. Two possible straight selections would be:

Panduit DNF18-250	Red Color Code	22-18 AWG
Panduit DNF14-250	Blue color Code	16-14 AWG

Panduit pliers type hand crimp tool part number CT-100
Panduit ratcheting hand crimp tool part number CT-1525

Molex 19003-0001	Red Color Code	22-18 AWG
Molex 19003-0040	Blue Color Code	16-14 AWG

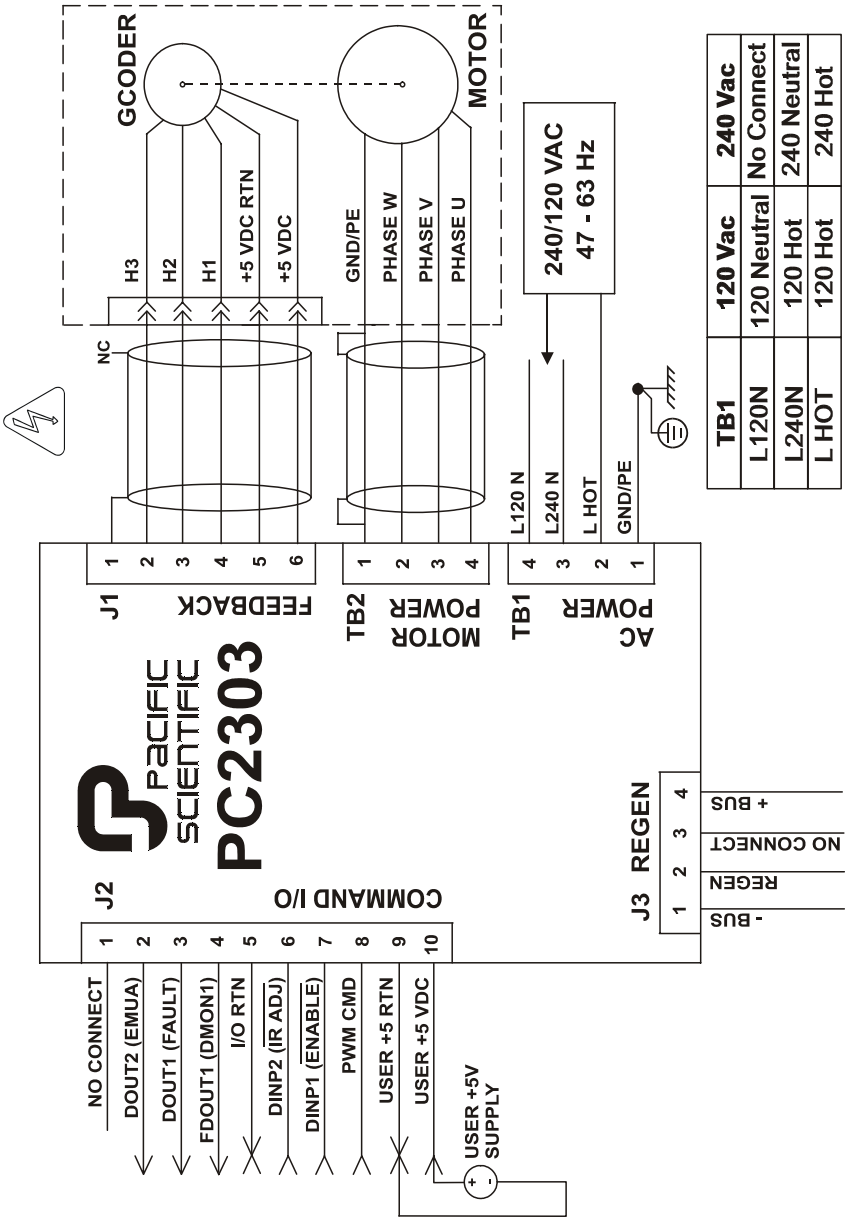
Ratcheting hand crimp tool Molex Order Number 19285-0005

J3 REGENERATION INTERFACE CONNECTOR

4 Contact 0.156” Spaced Straight 0.045” Square Pin Header With Locking Ramp

J3 is a similar connector type to J1, J2 except that it is larger. J3 also has IDC and crimp mating alternatives. J3 is intended to mate with the RA2302 Regeneration Accessory Kit. See Chapter 8 for more details.

4.2 Drive Wiring Diagram



TB1	120 Vac	240 Vac
L120N	120 Neutral	No Connect
L240N	120 Hot	240 Neutral
L HOT	120 Hot	240 Hot

4.3 Detailed Description For J2 Command I/O

The user interface consists of a 10 pin connector, J2. Refer to Figure 4-1 at the end of this section. This interface is fully optically isolated and meets CE reinforced isolation requirements of 3750 Vac between J2 and the ac line. The J2 signals can be floated with respect to chassis/Protection Earth by up to 48 Vdc.

J2-1 NO CONNECT (NC)

Spare pin for future use. Leave open circuited

J2-2 DOUT2 (EMU A) (Output)

This standard speed digital output has a user selectable function and has an open collector output. The default function for DOUT2 produces a pulse output, whose pulse repetition rate is proportional to the motor speed. The number of pulses per mechanical revolution of the motor is programmable. Maximum pull up voltage is 30 Vdc and rated sinking current is 12 mA at Vol of 0.4 V or less. This output is rated to handle continuous shorts to +5 V, but shorts to higher voltages may damage the output. Minimum output pulse width is 15 μSec and maximum recommended operating frequency is 50 kHz. The user must supply a pull up resistor connected to the appropriate supply. The recommended pull up values for various USER +5 VDC voltages are:

User Supply Voltage	User Pull Up Resistance
5 VDC	4.7 kΩ
12 VDC	10 kΩ
24 VDC	22 kΩ

J2-3 DOUT1 (FAULT) (Output)

The default function for DOUT1 indicates whether a drive fault has occurred. When set up to indicate faults the open collector or high output state indicates faults and the low state indicates drive OK.

This standard speed digital output has a user selectable function and has identical electrical specifications to J2-2 DOUT2.

J2-4 FDOUT1 (DMON1) (Output)

The default function for FDOUT1 is the output of a one bit ΣΔ DAC (Digital to Analog Converter). The signal mapped to this DAC output is user selectable and the default is the motor torque current. The DAC is scaled such that 50% duty cycle represents zero signal value. Squaring up this signal with a CMOS logic gate such as a 74HC04 gate and then low pass filtering with an RC network, such as 22 kOhm and 4700 pF, produces a high quality analog output signal.

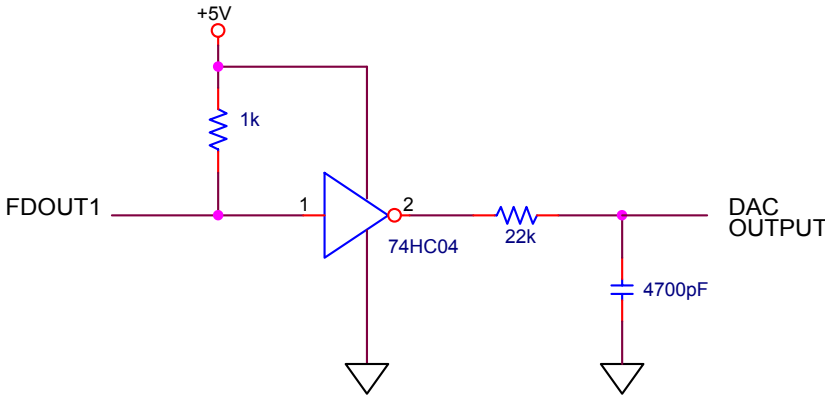


Figure 4.1 Recommended FDOut1 buffering for high quality analog output

This fast digital output has a user selectable function and has an open collector output. Maximum pull up voltage is 28 Vdc and rated sinking current is 5.5 mA at Vol of 0.4 V or less. Minimum output pulse width is 600 nSec and maximum recommended operating frequency is 600 kHz. This output is NOT rated to handle continuous shorts to any pull up supply. All supply shorts will cause damage. The user must supply a pull up resistor to the appropriate supply. The recommended pull up values for various USER +5 VDC voltages are:

User Supply Voltage	User Pull Up Resistance
5 VDC	1.0 kΩ
12 VDC	2.2 kΩ
24 VDC	4.7 kΩ

J2-5 I/O RTN (Common)

Return for interface signals. Electrically shorted to J2-9 +5 RTN.

J2-6 DINP2 (IR ADJ/) (Input)

The default function for DINP2 adjusts the IR compensation magnitude used in velocity control mode. IR compensation adjusts the stiffness of the speed regulation. Open circuit/logic high provides no IR compensation and a logic low provides the maximum IR compensation. The IR ADJ input is meant to be pulse width modulated to smoothly adjust between no and maximum IR compensation. The recommended IR ADJ PWM frequency is between 2 kHz and 15 kHz with 5 kHz being a good nominal.

This standard speed digital input has a user selectable function and is the series connection of a 2.2 kΩ resistor and an opto LED with the LED anode tied to the USER +5 VDC J2-10. Logic low drive should be $\leq$ 0.8 V. Sinking more than 0.9 mA will switch the opto isolator output. Absolute maximum pin current is 7.0mA; 1.5mA nominal is recommended. Minimum input pulse width is 15 μSec and maximum recommended operating frequency is 50 kHz. This input must not be pulled more than 2.0 volts higher than USER +5 VDC J2-10. For example, this input should not be driven high to 5 volts when USER +5 VDC J2-10 is tied to USER +5 RTN J2-9. The recommended external padding resistors for various USER +5 VDC voltages are:

User Supply Voltage	External Pad Resistance	Logic Low Sourcing Current		
		Min	Typ	Max
5 VDC	0 Ω	1.2 mA	1.6 mA	2.1 mA
12 VDC	4.7 kΩ 1/8 W	1.3 mA	1.5 mA	1.8 mA
24 VDC	10 kΩ 1/8 W	1.5 mA	1.8 mA	2.2 mA

J2-7 DINP1 (ENABLE/) (Input)

This standard speed digital input has a user selectable function and has identical electrical specifications to J2-6 DINP2.

The default function for DINP1 enables and disables power flow to the motor. Active low input enables the motor controller. When this signal is high or opened circuit, no current will be produced in the motor and any latched faults will be reset.

J2-8 PWM_CMD (Input)

This signal is a pulse width modulated signal that represents the current or velocity command of the motor. The drive can be set up for either single or four quadrant operation. In single quadrant mode this input is typically setup so the default or open circuit (i.e. cable disconnected) condition is zero command. PWM frequency

can be from 5 Hz to 125 kHz. 10 to 20 kHz is the recommended range. Duty cycle is defined as percent of opto LED current flow per cycle. Example: no current equals 0% duty cycle, current flowing ½ the time equals 50% duty cycle.

This fast digital input is the series connection of a 300 Ω resistor and an opto LED with the LED anode tied to the USER +5 VDC J2-10 and a 2.21 kΩ resistor from this input directly to USER +5 VDC J2-10. Logic low drive should be ≤ 0.8 V. Sinking more than 5 mA will switch the opto isolator output. Absolute maximum pin current is 20 mA and 11 mA nominal is recommended. Minimum input pulse width is 750 nSec and maximum recommended operating frequency is 125 kHz. This signal is sampled at 10 MHz after the input opto. This input must not be pulled more than 2.0 volts higher than USER +5 VDC J2-10. For example, this input should not be driven high to 5 volts when USER +5 VDC J2-10 is tied to USER +5 RTN J2-9. The recommended external padding resistors for various USER +5 VDC voltages are:

User Supply Voltage	External Pad Resistance	Logic Low Sourcing Current		
		Min	Typ	Max
5 VDC	0 Ω	8.0 mA	12.5 mA	17 mA
12 VDC	470 Ω ¼ W	11 mA	14 mA	17 mA
24 VDC	1.5 kΩ ½ W	10 mA	12.5 mA	15 mA

J2-9 User +5 RTN **(Input)**

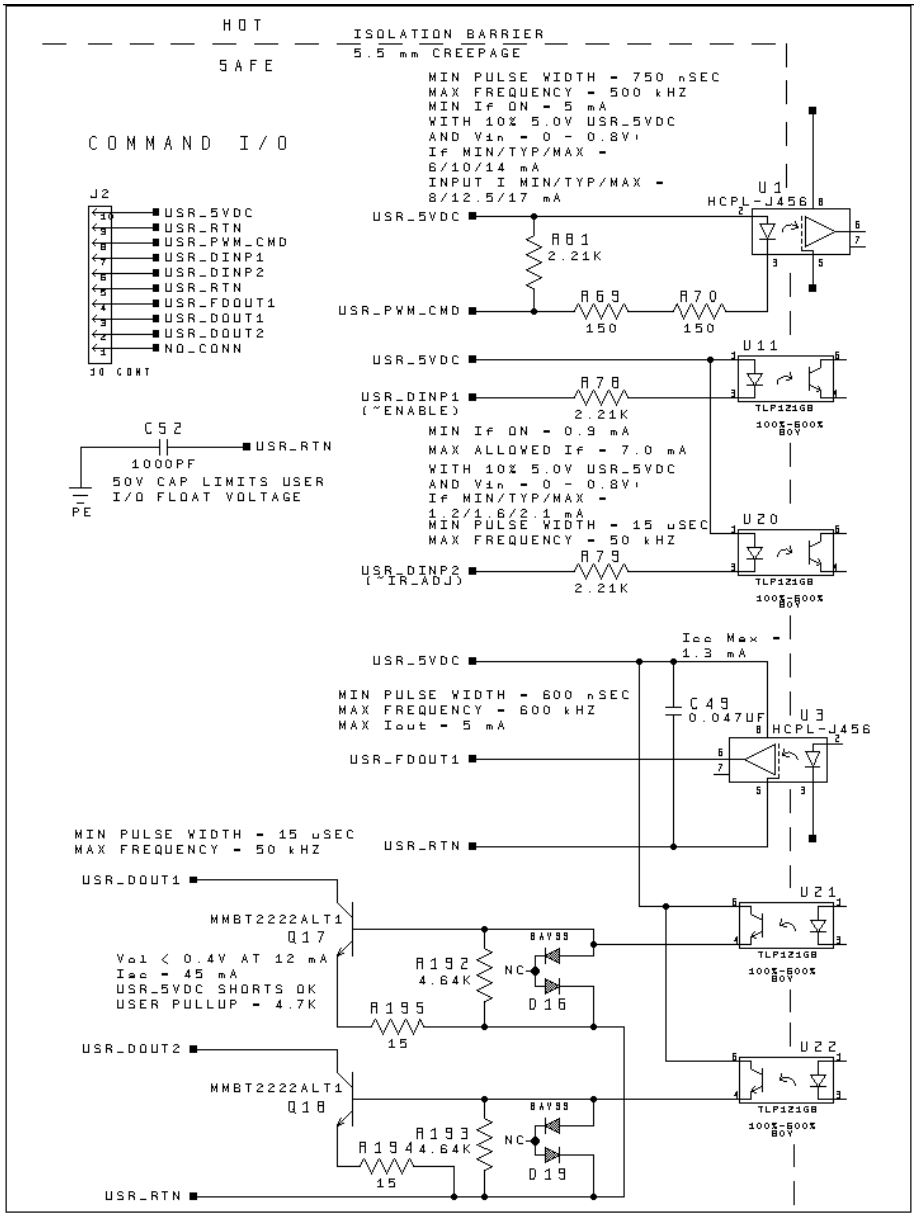
Return for +5 Volts opto supply. Electrically shorted to J2-5 I/O RTN.

J2-10 User +5 VDC **(Input)**

User supplied +5 Volts. This voltage is used to source current to the opto couplers LED. Typical load current is 15 mA, worst case is 20 mA not including current in external output pull up resistors. With recommended external pull up resistor currents included the supply load is 25 mA worst case. Note that supplying reverse voltage polarity between J2-9 and J2-10 will cause damage.

Recommended operating value is 5.0 VDC ± 5%. However, the COMMAND I/O interface can use a supply voltage up to 24 V with appropriate changes in digital output pull up resistances and by externally padding the digital inputs with extra resistance. See digital output and digital input descriptions for details.

4.4 J2 Command I/O Interface Schematic



5 PC Set-up Interface Tool

The drive has set up parameters controlling its operation that are stored in non volatile EEPROM (NV memory) in the drive. There is a PC set-up interface tool SI2300 that enables setting these parameters. The SI2300 interface kit includes a hardware box to connect a PC parallel port to the drive hardware and Windows software, 2300 Tools, to communicate with the drive. Using this tool, the motor set up parameters and drive control variables can be sent to the drive, and the user can monitor the status of the drive and motor system.

Please refer to the help file of the 2300 Tools for detailed information. Included here is just a short list of the parameters and a diagram showing the processing of the user PWM command on J2-8 into the drive actual torque or speed command.

5.1 Parameter and Variable List

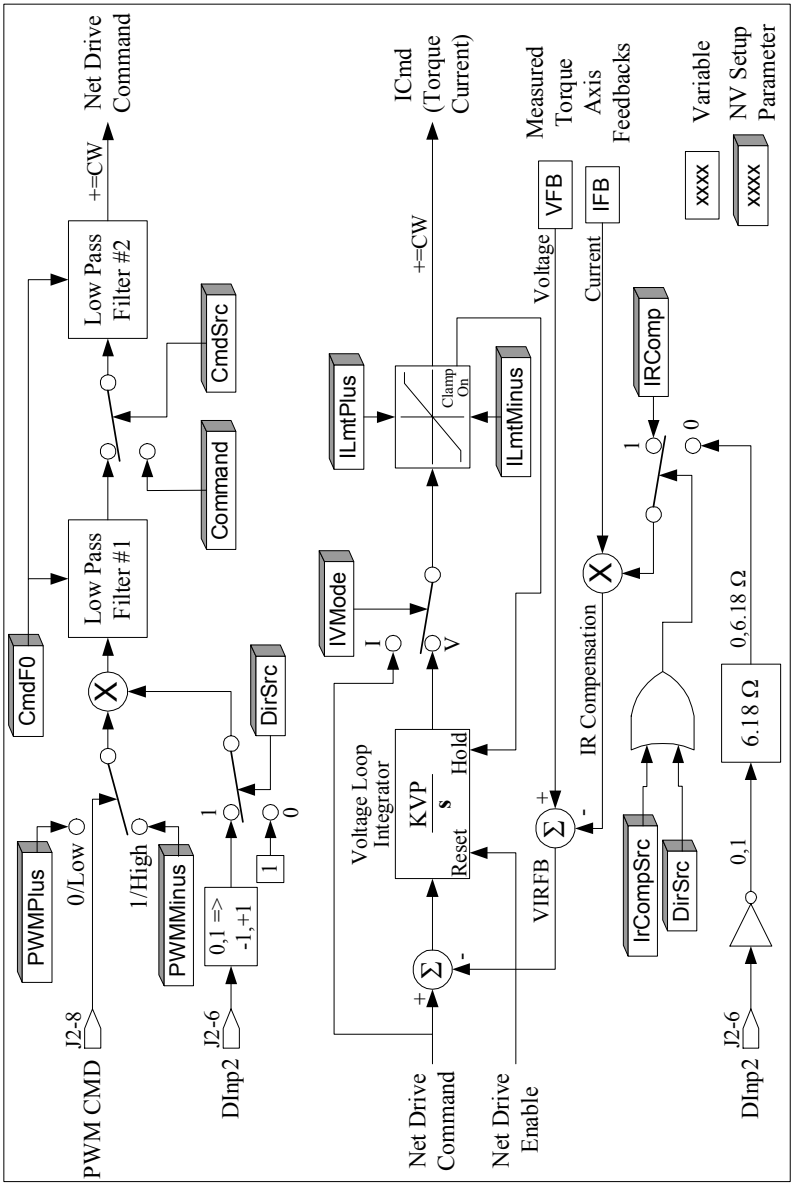
All operations, commands, and status information in the PC2300 are accessed through variables referenced by key words. These variables can be divided into three categories depending on their functionality. These categories are:

NV Parameter	Value stored in drive NV memory
Status Variable	Variable giving present state of the drive, usually read only
Control Variable	Controls a particular drive function and is not stored in NV memory

A list of the key words is given below.

AutoDis
CommOff
EncOut
IlmtPlus
Kip
PWMMinus
CmdF0
DirSrc
FltDiag
IrComp
LogicVer
PWMPlus
CmdSrc
DM1MapHVF
IrCompSrc
Model
PWMTimeOut
Command
DriveStatus
IlmtMinus
IVMode
PoleCount
SWEnable

5.2 Drive Command Generation Diagram



6 Diagnostics and Protection Circuits

Introduction

The drive is fully protected against "normal" abuse and has a green LED visible on the front edge of the unit just above J2 to indicate drive status. The base servo drive has the following specific protections.

- Output motor (TB2) short circuit protection line-to-line and line-to-neutral.
- Internal monitoring of the power stage heat sink temperature for drive over temperature.
- Bus over voltage detection.
- AC line under voltage fault via control supply voltage check.
- Excessive current I*t fault/fold back. Depending on drive set-up, when excessive I*t is detected either the peak output current limit is dropped to 67% of maximum .
- Invalid Gcoder shaft feedback signal.
- Optional Illegal/Stuck Command Fault

The following sequence occurs when a fault is detected by the protection circuits:

1. The fault source is latched.
2. The output stage is disabled.
3. The Fault mappable output function is activated
4. The status display begins indicating the appropriate blinking fault code.

Self resetting faults are stretched 50-100 mSec; that is the drive stays disabled and does not return to normal operation until 50-100 mSec after the self resetting fault condition clears. This pulse stretching also insures that the mapped Fault digital output minimum pulse width is 50 mSec no matter how short the actual fault condition might be.

Latched faults can be cleared by setting the Enable/ ("/" indicates active low logic) digital input to the disable state or by cycling the 120/240 VAC Control Power. Note that the large motor power bus capacitors store a fair bit of energy. Therefore, to use cycling the ac power to reset a fault, the ac line must be off at least 30 seconds to insure that the fault resets.

The below lists the status display codes shown on the System Status LED. When the drive is faulted the Status LED is blinks out the fault code. That is, the Status LED blinks the proper number of times, pauses with the Status LED off, and then repeats the blink code.

Status LED Code List

Status Code	Description	Fault Retention
No Blink	No faults, power stage enabled	-
Fast Blink	No faults, power stage disabled	-
LED Off	Ac line power insufficient	-
1 Blink	PWM_CMD Stuck Low	Latched
2 Blink	Gcoder™ Feedback Error	Latched
3 Blink	Not Used	-
4 Blink	Output Over Current	Latched
5 Blink	Control Supply Under Voltage	Self Resetting
6 Blink	Drive Over Temperature	Latched
7 Blink	Bus Over Voltage	Self Resetting
8 Blink	Output Short Circuit	Latched

7 Mounting Specifications

The PC2303 packaging is single axis panel mount. The figure on the next page gives the key dimensions for use in physically mounting the product. When mounting multiple units on one panel there should be at least 10 mm (0.4") of air space on the sides and 25 mm (1") or air space above and below the unit.

The PC2303 is meant to be mounted on a user supplied heat sink or have forced air cooling to achieve its full ratings. The heat dissipated by the drive is roughly proportional to the output current magnitude and is mostly independent of output voltage or motor speed. At the rated 7.1 Arms full continuous current the power devices dissipate approximately 50 Watts. For other operating conditions use the approximation that the drive will dissipate 7 Watts/Arms of output current.

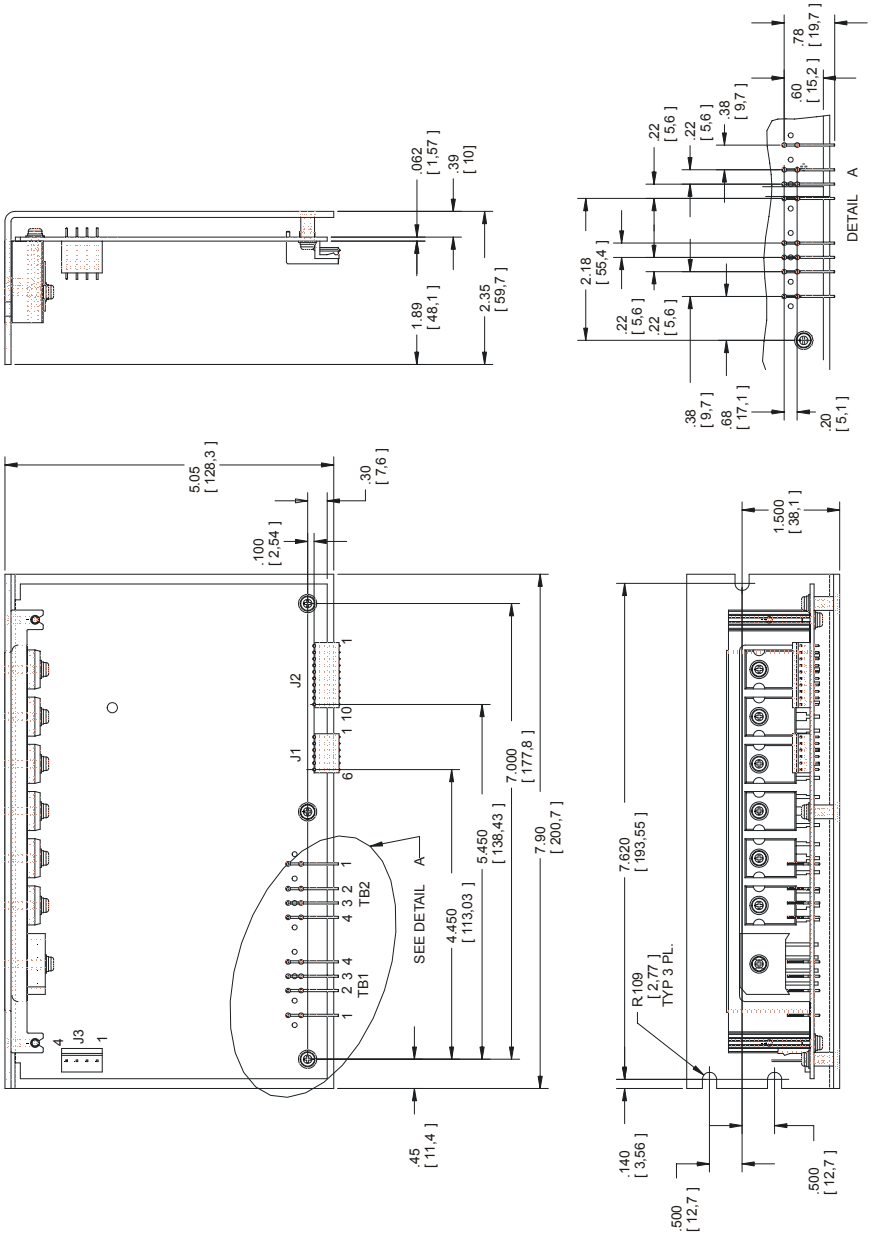
To insure that the drive is mounted with adequate cooling, it is recommended that the machine be run with the highest required current for normal operation. While running this test, measure the temperature of the power transistor mounting bar along the rear of the unit. The transistor mounting bar must be less than 70°C under all conditions or the drive will shut down. If the test is run at room temperature, remember to add the difference between the test ambient and the maximum ambient rating of the machine to the measured mounting bar temperature and make sure that the net temperature is less than 70°C.

When mounted to a heat sink the rear mounting surface of the drive should use some form of thermally conductive interface material to insure good heat transfer. Two examples of this material would be heat sink grease or Bergquist's Sil-Pad 400 0.007 inch thick Silicon rubber pad. For mounting surfaces that are extruded or machined to be smooth and flat thermal grease is a good choice. For less flat surfaces such as sheet metal or simple mounting plates the Sil-Pad type material gives better results. It is not recommended that the drive be mounted on a painted surface because paint tends to partially insulate thermally and paint is usually not very flat.

The overall drive panel dimensions and the mounted depth not including mating connectors is listed in the below chart. The extra depth for mating connectors is 1.0" or less.

Model	Height	Width	Depth
PC2303	200 mm/7.9"	60 mm/2.35"	129 mm/5.1"

7.1 Drive Mechanical Outline



8 Regeneration Option

RA2302, the regeneration accessory board is shown in Figure 1. Two connections, P3 and J1, are on top of the board. P3 is a 4-pin plug header, which mates with J3 on PC2303 drive. J1 is a 2-pin header providing access to Regeneration resistor. A metal bracket not shown in the schematic is mounted on the bottom of the board. The function of the bracket is two fold: First, it provides heat sink for IGBT Q1; second it mounts the Regeneration board to the thermal bar of the PC2303 drive.

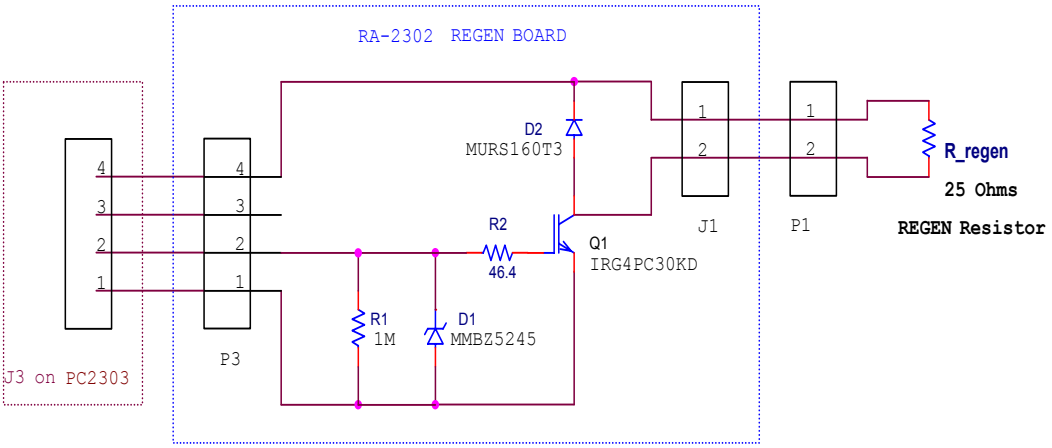


Fig. A1 Schematic of Regeneration Accessory Board with Connections

Mounting Instructions

Connect P3 to J3 on PC2303 drive.
Mount the metal bracket to the thermal bar on PC2303 drive using the mounting screw provided with the package. Note that the provided screw is of roll form type that will form threads in the drive spreader bar the first time it is screwed in.

J1 Resistor Connection

2 Contact 0.156" Spaced Straight 0.045" Square Pin Header
J1 is a similar connector type to J3 on PC2303 drive. It also has IDC and crimp mating alternatives. P1 in Fig. 1 represents the mating connector for J1.

J1 IDC Type:
J1 Mating 18 AWG Connector ITW Pancon CE156F18-2

2 Position, Tin Plating	
J1 Mating Strain Relief Cap	ITW Pancon SCC156F-2
Hand insertion tool	ITW Pancon MRT-156F
Ratchet type hand insertion tool	ITW Pancon MCT with CTD-156F nose

J1Crimp Type:

J1 Mating Connector Shell	Molex Engineering Number 2139
2 Position, Locking Ramp	Molex Order Number 09-50-3021
Crimp Terminal 18-20 AWG	Molex Engineering Number 2478
Tin Plating, 1 per Position	Molex Order Number 08-52-0072
Universal Hand Crimp Tool	Molex Order Number 63811-1000
Ratcheting Hand Crimp Tool	Molex Order Number 11-01-0026

Regeneration Resistor Selection

Resistance from J1-1 to J1-2 should be 25 ±20% Ω power resistor and have a high enough rating for the application. For example, if the regeneration duty cycle is 8%, the power dissipation in the resistor will be 41± 20% W. For this situation a 25 Ω 50W, resistor will work fine.