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DELTA SERIES

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DELTA PRO



INSTRUCTION BOOK

INDUSTRIAL INDEXING SYSTEMS, Inc.

Revision - C
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- 2) Appendix B, page B-2, dated October 2003, supersedes Appendix B, page B-2, dated June 2003.
- 3) Section 8, page 8-7, dated March 2004, supersedes Section 8, page 8-7, dated June 2003.
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- 4) Section 8, page 8-7, dated June 2004, supersedes Section 8, page 8-7, dated March 2004.
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INDUSTRIAL INDEXING SYSTEMS, Inc.

626 Fishers Run

Tel: (585) 924-9181

Victor, New York 14564

Fax: (585) 924-2169

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APPENDIX A - MOTOR/DRIVER SPECIFICATIONS

APPENDIX B - CABLES AND ACCESSORIES

INTRODUCTION

Thank you for selecting Industrial Indexing Systems' DeltaPro Series products. You join many other companies around the world in your choice of these powerful, flexible motion control products.

The small, lightweight DeltaPro system combines the controller, driver and motor into a single unit. This integrated package delivers the latest in all-digital electronic design, SMT circuit board construction and clever engineering to deliver high performance, advanced features and reasonable cost. Compact, high power density motors provide low rotor inertia, making them the logical choice for all applications including positioning, indexing, master-slave, electronic cam ratios, and S-curve profiling.

The DeltaPro has a wide array of features, including one active servo axis with one-half axis follower fiber optic input, two powerful embedded high speed 32-bit RISC processors, flash ROM and NOVRAM memory, high visibility 5-digit drive status display, 1-digit controller status display, two RS-232 ports, 16 optically isolated inputs (4 dedicated), 8 optically isolated outputs (3 dedicated) that may be used as Programmable limit switches, analog inputs and output, and an optional DeviceNet connection.

The controller is easily programmed using an OPI-50. Plain language on-screen menus walk you through the entire process one step at a time.

SECTION 1 - OVERVIEW

This manual is organized so that information is easy to find and easy to use. It begins by detailing how to identify the DeltaPro package, Delta drives, and Delta motors. Followed by a general description of the product and its components. The basic electrical characteristics of the DeltaPro package including the Delta Motors are described, and comprehensive product specifications are provided.

The operation of the product is then described, complete with signal wiring and parameter set up. Sections on Power Wiring, Regen Resistor selection and Brakes follow. A section describing alarms and the status display can aid you in the unlikely event that anything goes wrong.

Motor and Driver Speed/Torque Curves follow this information, allowing you to match Drivers and Motors to your specific applications. A final section which contains cables and various Mechanical Drawings round out this manual.

1.1 IDENTIFYING DELTAPRO PACKAGES

DeltaPro packages can be identified as follows.

Your DeltaPro package model number uses this designation:

DELTAPRO-XXXXYABCDEFG,

WHERE:

- X = motor series
 - Blank = standard
 - A = A series
 - B = B series
 - C = Custom
 - D = D series
 - E = E series
- YYYY = is the rated mechanical output wattage of the package
 - A = H = 3000 rpm rated motor
 - M = 2000 rpm rated motor
 - L = 1500 rpm rated motor
 - C = custom motor
- B = R = resolver based system
 - RA = absolute resolver sensor based system
 - E = encoder based system
 - EA = absolute encoder sensor based system
- C = A = 220 VAC system, single or three phase
 - B = 120 VAC system, single phase (only for smallest drive and only up to 200 watts)
- D = motor and driver options where
 - B = integral brake option
 - I = 14 bit analog input
 - T = for windings with "Tropical" fungus protection
 - W = wash down
 - 1X = 1 cycle resolver
 - others as defined in future
- EFG = possible various options
 - C = CAN Bus option
 - D = DeviceNet option
 - H = Proprietary
 - S = Sourcing Inputs and Outputs

1.1 IDENTIFYING DELTAPRO PACKAGES (cont'd)

Example: A DeltaPro package designated DELTAPRO-120HRB is a 120-watt motor, with a 3000 rpm rated motor, a resolver based system, 120 VAC system. If this same package was equipped with DeviceNet and sourcing I/O, it would be designated DELTAPRO-120HRBDS.

1.2 IDENTIFYING DELTAPRO DRIVES

DeltaPro Drivers can be identified as follows. This information is on the Driver label:

Your DeltaPro Driver model number uses this designation:

DPRO-CURRENT/ZYEFG,

WHERE:

CURRENT = Peak Driver Current in amps (rms)

Z = feedback method:

R = resolver feedback

E = encoder feedback

RA = absolute resolver feedback

EA = absolute encoder feedback

Y = input voltage:

A = 220 VAC input (single or three phase)

B = 115 VAC input (single phase) - only available up to 200 watts

EFG = possible various options

C = CAN Bus option

D = DeviceNet option

H = Proprietary

I = 14 bit analog input A & D converter

S = Sourcing Inputs and Outputs

Example: A DeltaPro Driver designated DPRO-8.5/RB has a peak current rating of 8.5 A rms, resolver feedback, and 115 VAC 1Ø input voltage.

1.3 IDENTIFYING DELTAPRO MOTORS

DeltaPro Motors can be identified as follows. This information is on the Motor label.

Your DeltaPro Motor model number uses this designation:

DBM-SERIES WATTAGE/SPEED YZ,

WHERE:

| | | |
|---------|---|--|
| SERIES | = | Motor series |
| | | Blank = standard |
| A | = | A series |
| B | = | B series |
| C | = | Custom |
| D | = | D series |
| E | = | E series |
| WATTAGE | = | Rated Motor Power in watts |
| SPEED | = | Rated Motor Speed in hundreds of RPMs |
| Y | = | feedback method: |
| | | R = resolver feedback |
| | | E = encoder feedback |
| | | RA = absolute resolver feedback |
| | | EA = absolute encoder feedback |
| Z | = | B for a motor with an integral brake |
| | | T for windings with "Tropical" fungus protection |
| | | W for washdown sealing |
| | | 1X = 1 cycle resolver |

Example: A DeltaPro Motor designated DBM-120/30R is a 120-watt motor with a 3000 rpm rated speed and resolver feedback. If the same motor was equipped with "Tropical" fungus protection, it would be designated DBM-120/30RT.

SECTION 2 - DESCRIPTION

The DeltaPro product consists of a servo motion controller, containing one active axis and one-half axis fiber optic servo follower and a Delta series drive integrated into one package. The application program that operates the controller is created through an OPI-50 touch pad operator interface and sent serially to the controller via an RS-232 link.

The external connections that exist on the DeltaPro are shown in **Figure 2.1**, and consist of 2 RS-232 ports, 16 digital inputs (4 dedicated) and 8 digital outputs (3 dedicated), 2 analog inputs, 1 analog output and a reference, a fiber optic input, as well as motor, resolver, and power connections. The Delta drive also has an analog monitor output, which is capable of representing either speed or torque as a function of voltage relative to +/- 3 vdc.

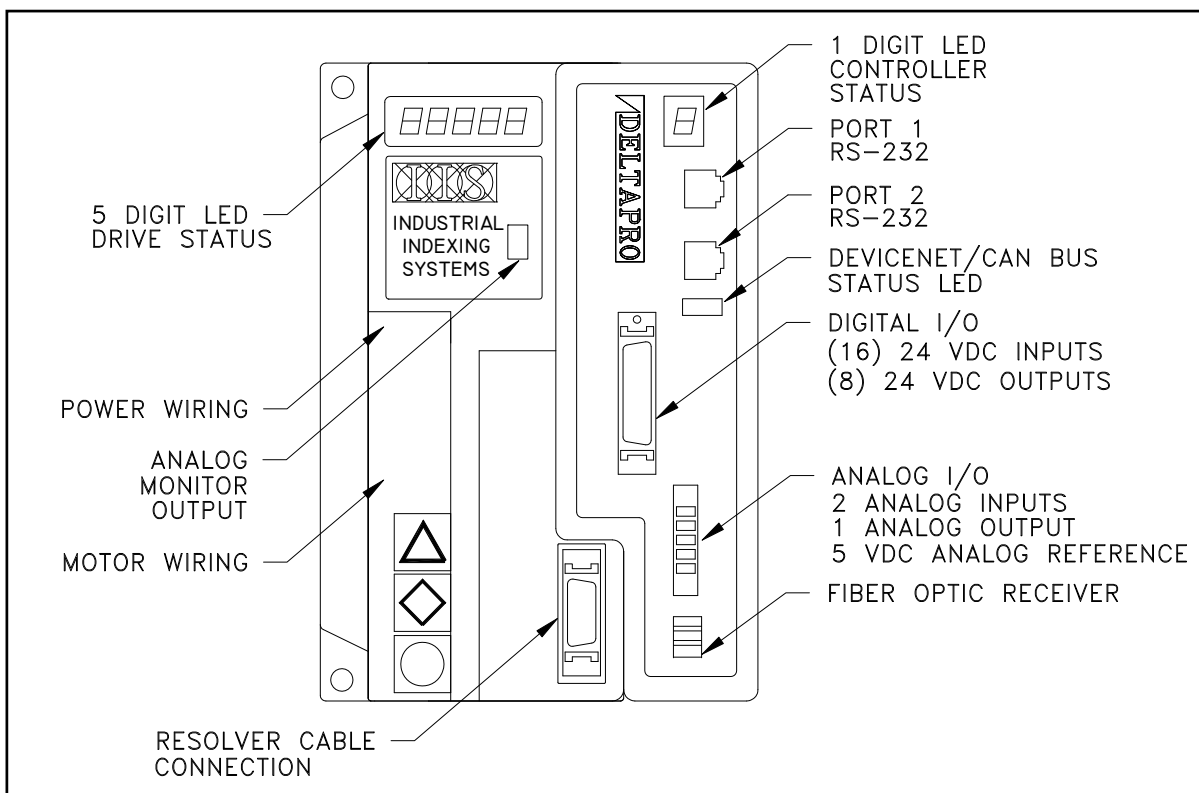


Figure 2.1 - DeltaPro Layout

2.1 COMPONENTS

2.1.1 STATUS INDICATORS

1. Drive Status Display - This is a 5-digit seven segment display which indicates the current status of the Delta driver. A fault on the drive would be represented by AL - ## which indicates an alarm with an associated two digit number. These alarm codes and their descriptions can be found in the **Section 12 - Troubleshooting**.
2. Controller Status Display - This single seven segment LED with decimal point provides status information of various operating conditions. For further information on this display, see **Section 12 - Troubleshooting**.

2.1.2 CONNECTORS

NOTE

For proper pinouts for each connector refer to Section 4 - DeltaPro Wiring.

1. Port 1 - This 6-pin RJ-11 connector is an RS-232 serial communication port. It uses packet protocol to communicate with a PC or ASCII to communicate with other devices.
2. Port 2 - This 6-pin RJ-11 connector is an RS-232 serial communication port. It is used to communicate with the IIS OPI-50.
3. Digital I/O - This connector provides access to the onboard I/O. IIS offers two options to this connector; there is the C-719YYY cable with ferruled ends or the C-716YYY cable, which terminates at the DINT-300, which provides terminal blocks for I/O wiring.
4. Analog Input/Output - This connector provides contacts for two analog inputs, one analog output, and a reference voltage. The program controls use of these inputs and output channel.
5. Fiber Optic Receiver - This connector is used to receive the positional data from the IIS EFC-XXX encoder to fiber optics converter or the RFC-XXX resolver to fiber optics converter. The data being received is in the form for master angle passing.
6. Resolver Cable Connector - This is a 20-pin mini D connector used for resolver feedback from the motor to the drive.
7. Motor/Power wiring terminals - These are terminal blocks used to wire the incoming AC line voltage as well as the motor cable.
8. Monitor Output - This is a connector, which provides access to an analog output signal. The signal is either defined as a conversion of torque or speed and is programmable through the OPI-50.

SECTION 3 - DELTAPRO SPECIFICATIONS

| DeltaPro Driver | DPRO-1.5/RB | DPRO-1.5/RA | DPRO-4.25/RB | DPRO-4.25/RA |
|-----------------|------------------|------------------|------------------|------------------|
| Weight | 3.3 lb 1.5 kg | 3.3 lb 1.5 kg | 3.3 lb 1.5 kg | 3.3 lb 1.5 kg |

| DeltaPro Driver | DPRO-8.5/RB | DPRO-8.5/RA | DPRO-17.5/RA | DPRO-35/RA | DPRO-50/RA | DPRO-70/RA | DPRO-115/RA |
|-----------------|------------------|------------------|------------------|-----------------|-----------------|----------------|----------------|
| Weight | 3.3 lb 1.5 kg | 3.3 lb 1.5 kg | 5.5 lb 2.5 kg | 10 lb 4.5 kg | 10 lb 4.5 kg | 24 lb 11 kg | 35 lb 16 kg |

3.1 MOTOR OUTPUT

| DeltaPro Driver | DPRO-1.5/RB | DPRO-1.5/RA | DPRO-4.25/RB | DPRO-4.25/RA |
|--|-------------------------|-------------|--------------|--------------|
| Motor Output | PWM, 3 Phase, sine wave | | | |
| Continuous Output Current | 1.0 A rms | 1.0 A rms | 2.8 A rms | 2.8 A rms |
| Max. Output Current See Figure 3.3 | 1.5 A rms | 1.5 A rms | 4.25 A rms | 4.25 A rms |
| Motor Ripple Frequency | 20 kHz | 20 kHz | 20 kHz | 20 kHz |

| DeltaPro Driver | DPRO-8.5/RB | DPRO-8.5/RA | DPRO-17.5/RA | DPRO-35/RA | DPRO-50/RA | DPRO-70/RA | DPRO-115/RA |
|---|-------------------------|-------------|--------------|------------|------------|------------|-------------|
| Motor Output | PWM, 3 Phase, sine wave | | | | | | |
| Continuous Output Current | 2.1 A rms | 3.4 A rms | 5.7 A rms | 14.1 A rms | 16.3 A rms | 24.8 A rms | 53.0 A rms |
| Max. Output Current 3 seconds See Figure 3.3 | 8.5 A rms | 8.5 A rms | 17.5 A rms | 35.0 A rms | 50.0 A rms | 70.0 A rms | 115.0 A rms |
| Motor Ripple Frequency | 20 kHz | 20 kHz | 20 kHz | 20 kHz | 20 kHz | 10 kHz | 10 kHz |

3.2 POWER SUPPLY

| DeltaPro Driver | DPRO-1.5/RB | DPRO-1.5/RA | DPRO-4.25/RB | DPRO-4.25/RA |
|----------------------------------|--|---|--|---|
| Main Bus Power Supply Voltage | 1 Phase, Nominal: 110 VAC, Max Range: 85-126 VAC, 50/60 Hz | 1 Phase, Nominal: 220 VAC, Max Range: 170-264 VAC, 50/60 Hz | 1 Phase, Nominal: 110 VAC, Max Range: 85-126 VAC, 50/60 Hz | 1 Phase, Nominal: 220 VAC, Max Range: 170-264 VAC, 50/60 Hz |
| Main Supply Capacity | 350 VA | 350 VA | 350 VA | 350 VA |
| Control Voltage | Powered by main circuit supply | | | |
| Control Capacity | Powered by main circuit supply | | | |
| Main Circuit Heat Loss | 17 W | 17 W | 17 W | 17 W |
| Control Circuit Heat Loss | 23 W | 23 W | 23 W | 23 W |
| Regeneration Absorption Capacity | 13 W + 17 J | 13 W + 17 J | 13 W + 17 J | 13 W + 17 J |

| DeltaPro Driver | DPRO-8.5/RB | DPRO-8.5/RA | DPRO-17.5/RA | DPRO-35/RA | DPRO-50/RA | DPRO-70/RA | DPRO-115/RA |
|----------------------------------|--|---|--------------|---|--------------|--------------|---------------|
| Main Bus Power Supply Voltage | 1 Phase, Nominal: 110 VAC, Max Range: 85-126 VAC, 50/60 Hz | 1 Phase, Nominal: 220 VAC, Max Range: 170-264 VAC, 50/60 Hz | | 3 Phase, Nominal: 220 VAC, Max Range: 170-264 VAC, 50/60 Hz | | | |
| Main Supply Capacity | 570 VA | 1.2 KVA | 2.5 KVA | 5.3 KVA | 6.7 KVA | 13 KVA | 25 KVA |
| Control Voltage | Powered by main circuit supply | | | Single phase, 170-264 VAC, 50/60 Hz | | | |
| Control Capacity | Powered by main circuit supply | | | 70 VA | | 80 VA | 110 VA |
| Main Circuit Heat Loss | 20 W | 27 W | 47 W | 110 W | 130 W | 250 W | 400 W |
| Control Circuit Heat Loss | 23 W | 23 W | 23 W | 26 W | 26 W | 30 W | 60 W |
| Regeneration Absorption Capacity | 17 W + 17 J | 24 W + 17 J | 37 W + 22 J | 160 W + 54 J | 180 W + 54 J | 300 W + 94 J | 480 W + 188 J |

3.3 CONTROL PERFORMANCE

| | |
|---------------------------|---|
| Feedback | Resolver |
| Feedback Resolution | 4096 bits/rev |
| Feedback Accuracy | 18 arc minutes spread for motor with 95 mm mounting face or smaller 8 arc minute spread for all other motors |
| Current Loop Update Rate | 100 μ sec |
| Velocity Loop Update Rate | 400 μ sec |
| Position Loop Update Rate | 800 μ sec |
| Speed Regulation | Load (0%-100%): $\pm 0.02\%$ Power (85-126 VAC or 170-264 VAC): $\pm 0.02\%$ Temperature (50°C/32-122°F): $\pm 0.2\%$ |
| Torque Regulation | Power (85-126 VAC or 170-264 VAC): $\pm 2\%$ Temperature (50°C/32-122°F): $\pm 2\%$ |

| | |
|---------------------------|---|
| Feedback | Encoder |
| Feedback Resolution | 4096 bits/rev |
| Feedback Accuracy | Less than 2 arc minutes |
| Current Loop Update Rate | 100 μ sec |
| Velocity Loop Update Rate | 400 μ sec |
| Position Loop Update Rate | 800 μ sec |
| Speed Regulation | Load (0%-100%): $\pm 0.02\%$ Power (85-126 VAC or 170-264 VAC): $\pm 0.02\%$ Temperature (50°C/32-122°F): $\pm 0.2\%$ |
| Torque Regulation | Power (85-126 VAC or 170-264 VAC): $\pm 2\%$ Temperature (50°C/32-122°F): $\pm 2\%$ |

3.4 ENVIRONMENT

| | |
|-----------------------|--|
| Storage Temperature | -10 to 70°C/14-158°F |
| Operating Temperature | 0 to 50°C/32-122°F |
| Humidity | 35 to 90% Relative Humidity, non-condensing |
| Shock and Vibration | 1 G or less |
| Operating Conditions | Free of dust, liquids, metallic particles and corrosive gases. Use in a pollution degree 2 environment. |
| Drive Enclosure | The drive is rated as "open type equipment" by Underwriters Laboratories, Inc. |

3.5 DIGITAL I/O SIGNALS

| | | STANDARD | OPTIONAL |
|-----------------------|---|----------|----------|
| Control Input | 24 VDC 5 mA, optically isolated | Sinking | Sourcing |
| Control Output | 24 VDC 500 mA, optically isolated (See Figures 3.1 and 3.2) | Sinking | Sourcing |
| External Power Supply | 24 VDC \pm 15% | | |

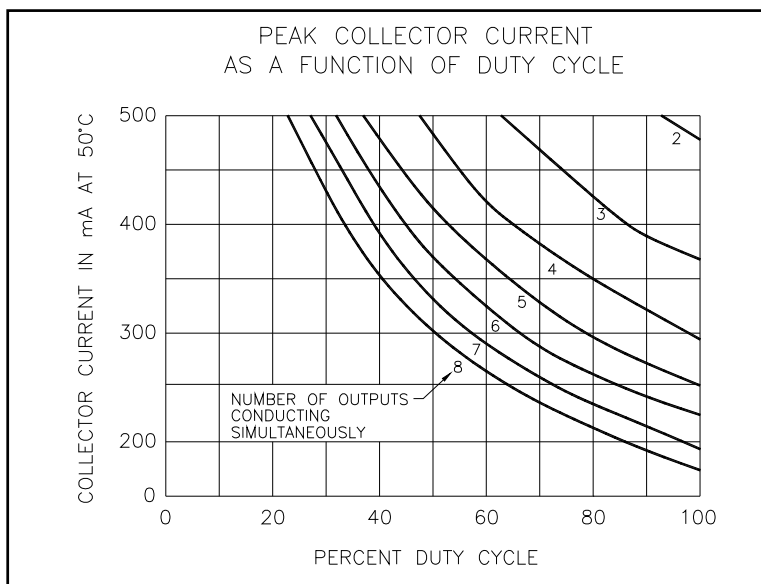


Figure 3.1 - Standard

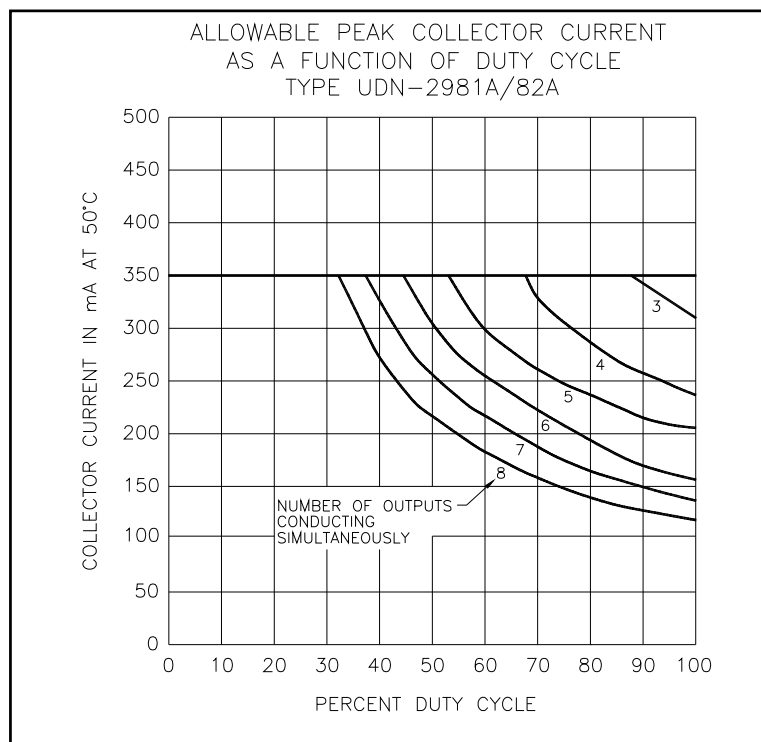


Figure 3.2 - Optional

3.6 ANALOG I/O SIGNALS

| | |
|------------------|---|
| Analog Inputs | Maximum Input Voltage: 0-5 VDC A/D Resolution: 1/1024 10 bit Input Impedance: 20k Ohm Single Ended |
| Analog Output | Maximum Output Voltage: 0-5 VDC D/A Resolution: 1/1024 10 bit Output Current: 5mA |
| Analog Reference | Reference Voltage: 5 VDC / 5 ma |
| Monitor Output | Maximum Voltage Swing: ± 3 VDC at 1 mA Output Impedance: 330 Ω Accuracy: $\pm 8\%$ Monitor Scaling Speed: 3V equals motor rated speed Torque: 3V equals motor peak torque |

3.7 COMMUNICATION PORTS

| | |
|----------------------|--|
| Port 1 | Classification: RS-232 Data Transfer: Packet protocol (default), ASCII Programmable Protocol: 19200 baud, 1 stop bit, 8 data bits, No parity This port can be redefined in setup. |
| Port 2 | Classification: RS-232 Data Transfer: ASCII Protocol: 9600 baud, 1 stop bit, 8 data bits, No parity (default) Dedicated to OPI-50. |
| Fiber Optic Receiver | Classification: Fiber Optics Data Transfer: Master Angle (positional information) Protocol: Proprietary |

3.8 PROTECTION

| | |
|---------------------------------|---|
| Fault Checks | Under Voltage, Over Voltage, Motor Short, Output Short, Feedback Loss, Regeneration Resistor Over Temperature and Malfunction, Driver Over Temperature, Motor rms Torque (motor overheat) Driver Rated Current, Over Speed, Motor Stall, Dynamic or Mechanical Brake Failure, Following Error, Internal Watchdog Timer, Processor Diagnostics |
| Output Short Circuit Protection | The drives are suitable for use on a circuit capable of delivering not more than 5000 rms symmetrical amperes, 240 volts maximum when protected by a circuit breaker having an interrupting rating not less than 5000 rms symmetrical amperes, 240 volts maximum. |

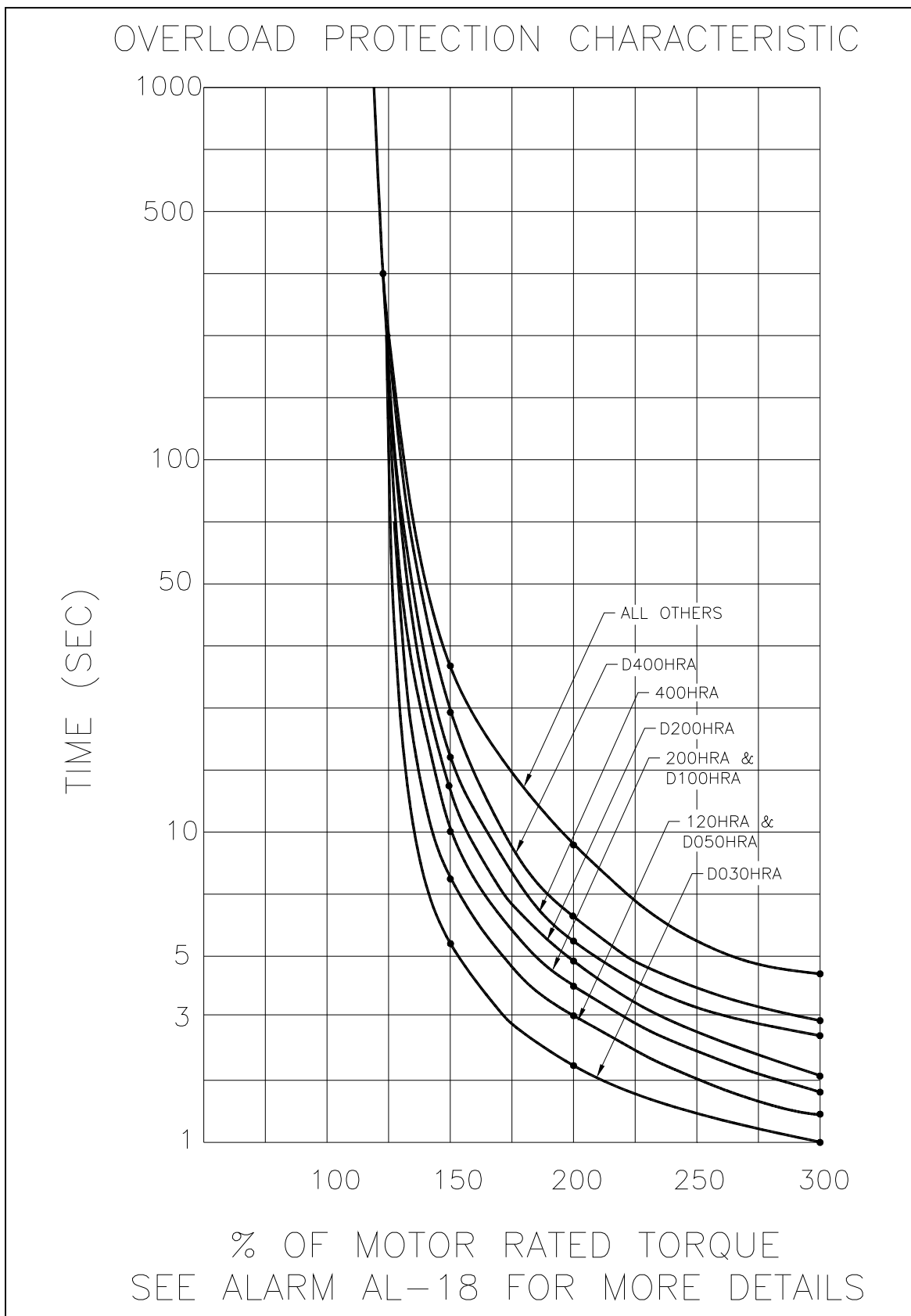


Figure 3.3 - DeltaPro Overload Protection Characteristic

SECTION 4 - DELTAPRO WIRING

4.1 DIGITAL I/O

The system requirements will determine the definition of the 16 digital inputs (4 dedicated) and 8 digital outputs (3 dedicated) see **Figure 4.1**. There are two options for the physical wiring of the I/O circuitry. A discrete cable with flying leads labeled (C-719YYY) may be used or a cable (C-716YYY) which connects to a DINT-300 interface module. The DINT-300 provides terminal blocks for each I/O and for the 24VDC I/O power supply, the configuration of the terminals is shown in **Figure 4.2**.

| DEDICATED INPUT/OUTPUT | | | |
|------------------------|----------------|-----------|------------------|
| INPUT #1 | USER DEFINED | OUTPUT #1 | USER DEFINED |
| INPUT #2 | USER DEFINED | OUTPUT #2 | USER DEFINED |
| INPUT #3 | USER DEFINED | OUTPUT #3 | USER DEFINED |
| INPUT #4 | USER DEFINED | OUTPUT #4 | USER DEFINED |
| INPUT #5 | USER DEFINED | OUTPUT #5 | USER DEFINED |
| INPUT #6 | USER DEFINED | OUTPUT #6 | PROFILE COMPLETE |
| INPUT #7 | USER DEFINED | OUTPUT #7 | CONTROLLER OK |
| INPUT #8 | USER DEFINED | OUTPUT #8 | BLOCK EXECUTING |
| INPUT #9 | USER DEFINED | | |
| INPUT #10 | USER DEFINED* | | |
| INPUT #11 | USER DEFINED* | | |
| INPUT #12 | USER DEFINED** | | |
| INPUT #13 | MANUAL/AUTO | | |
| INPUT #14 | JOG CW | | |
| INPUT #15 | JOG CCW | | |
| INPUT #16 | RESET | | |

* Inputs 10 and 11 can be used for CW and CCW limit switches
See **Section 7.5.15** & **Section 7.5.16** for details

** Input #12 is used for initialization
See **Section 7.5.17** for details

Figure 4.1 - Dedicated Input/Output

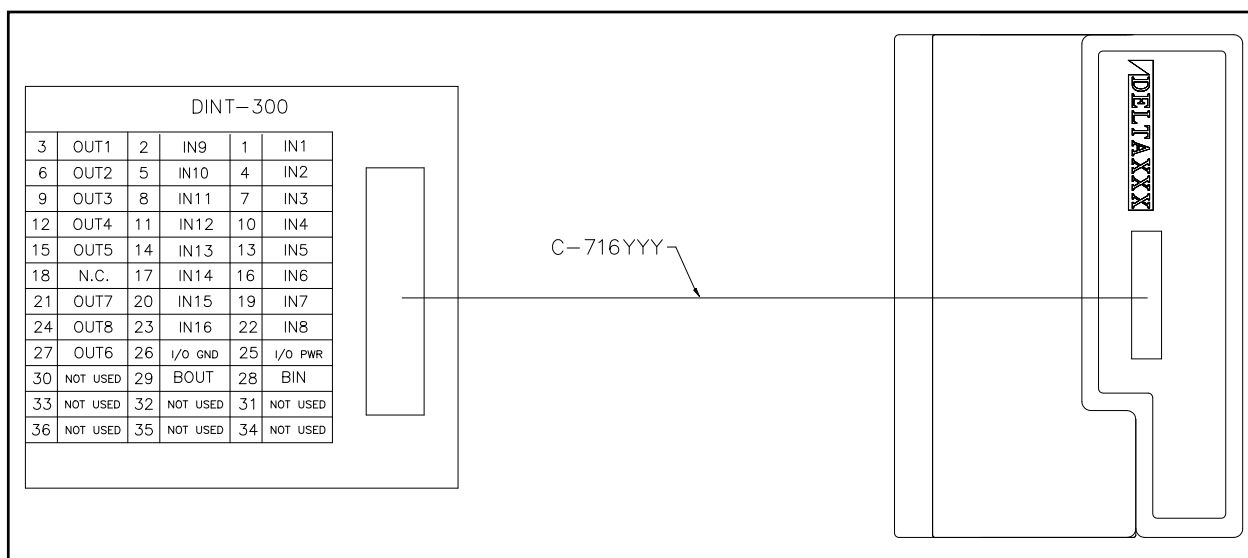


Figure 4.2 - Digital I/O

4.1 DIGITAL I/O (cont'd)

The I/O has two available configurations. The standard configuration has sinking outputs and inputs and the optional configuration has sourcing outputs and inputs. All are shown in **Figure 4.3**.

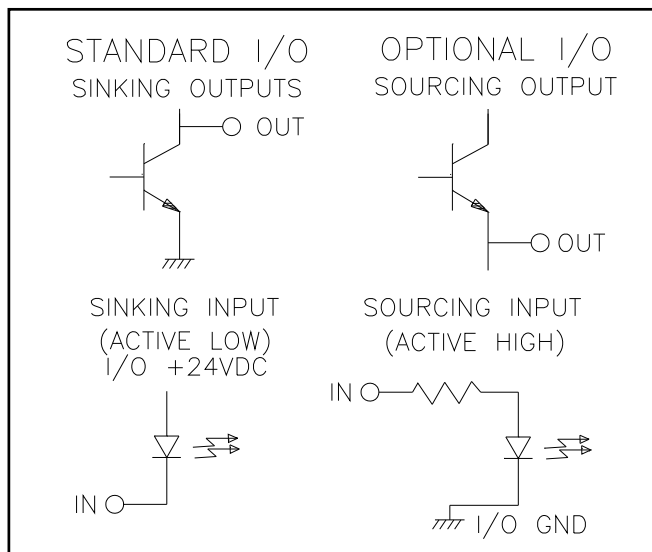


Figure 4.3 - Input & Output Configurations

4.2 ANALOG I/O

There are two single-ended analog inputs and one analog output. All of which have an operating range of 0 - 5 VDC. A reference voltage of 5VDC has also been provided. The analog I/O pinouts are shown in **Figure 4.4**

WARNING

Double check all wiring connections. Make sure all are proper and secure. Improper connections may result in system malfunctions.

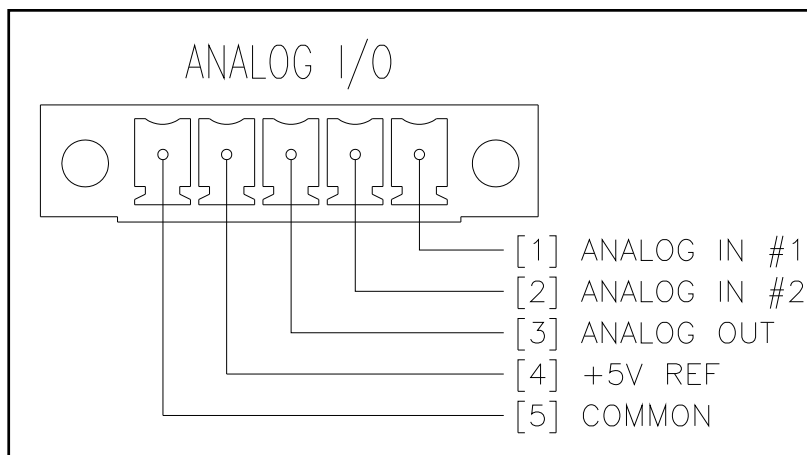


Figure 4.4 - Analog I/O

4.3 PORT 1 & PORT 2

The ports are used for communication and use RJ-11 connectors to interface to respective devices. The port 1 & port 2 pinouts are shown in **Figure 4.5**.

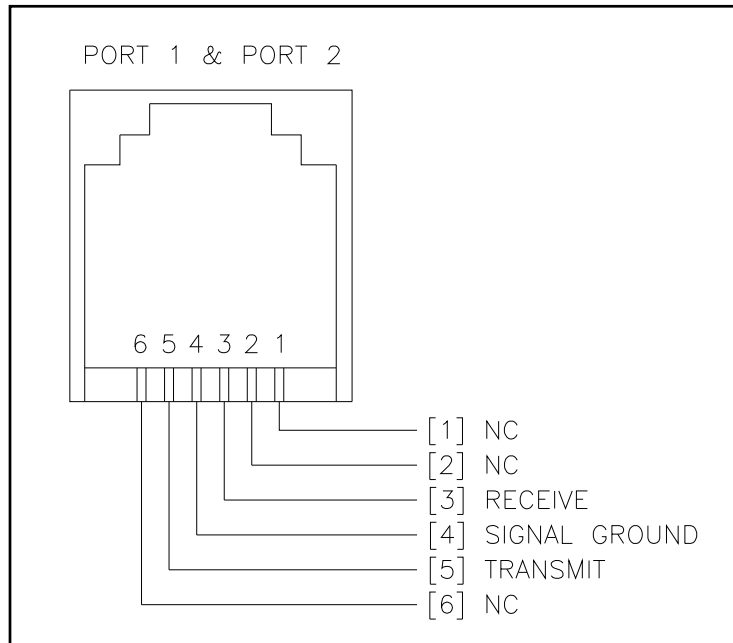


Figure 4.5 - Port 1 & Port 2

4.4 MONITOR OUTPUT

This two-pin connector provides a +3VDC output for monitoring torque or speed. The monitor output pinouts are shown in **Figure 4.6**.

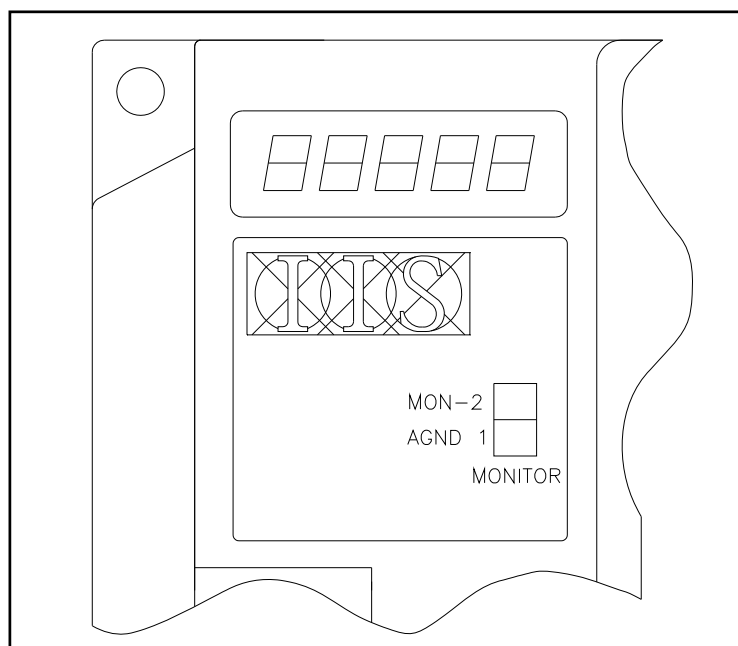


Figure 4.6 - Monitor Output

4.6 ABSOLUTE RESOLVER/ENCODER INTERFACE

The resolver/encoder cable connects the resolver and micro power encoder in the motor to the DeltaPro controller. The resolver provides the absolute position with the main power applied and the micro power encoder tracks the position of the motor shaft with the main power off.

The battery pack supplies 3.6 V to the micro power encoder when the main power is off. The battery life is 5 years. If the battery is replaced with power on the absolute position will be maintained. If the battery is disconnected with power off the absolute position will be lost and an AL-36 will occur.

The battery pack and resolver/encoder wiring are shown in **Figure 4.8**.

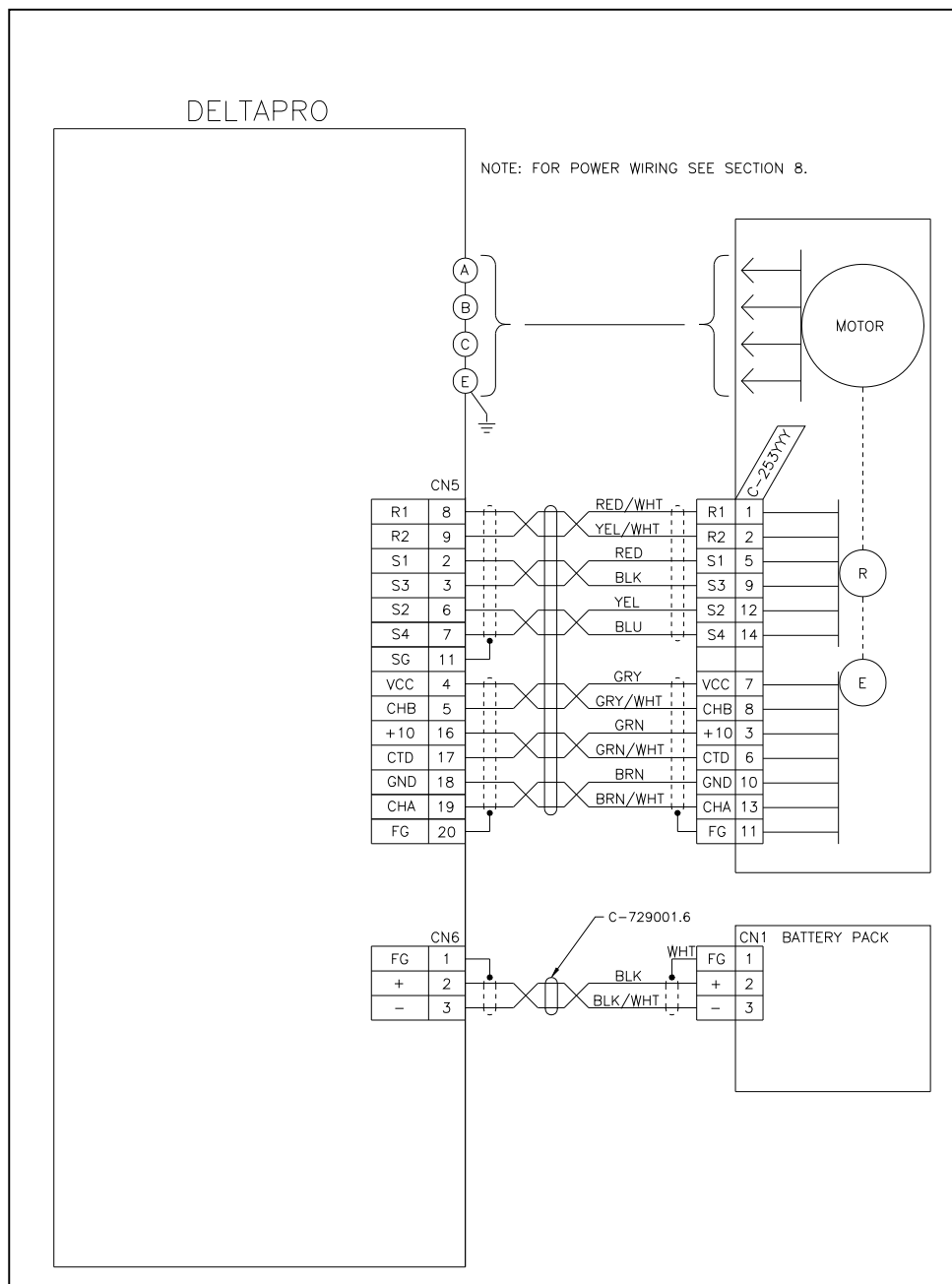


Figure 4.8 – Absolute Resolver/Encoder Interface

SECTION 5 - OPERATIONS

5.1 PROGRAMMING DEVICES

The programming devices associated with the DeltaPro Motion Control System include the operator interface (OPI-50) and MotionPro (Software package). These devices are used for creating programs and defining setup parameters for the DeltaPro.

5.1.1 OPERATOR INTERFACE PROGRAMMING DEVICE

The OPI-50 operator interface device is used for both programming and data input during operations of the DeltaPro Motion Control System. The OPI-50 is a panel-mount device and is usually used as a remote device for programming or occasional parameter changes.

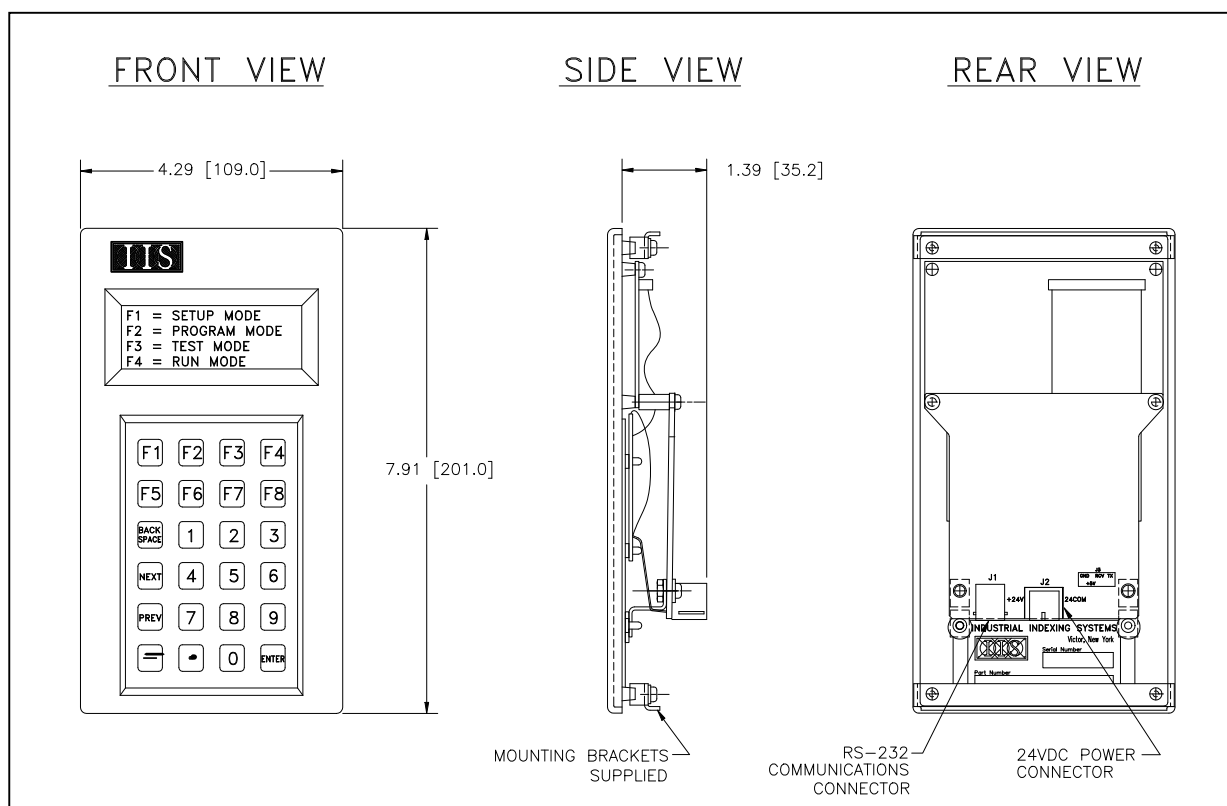


Figure 5.1 - OPI-50 Panel-mount Operator Interface

5.1.1.1 OPI-50 PANEL-MOUNT OPERATOR INTERFACE

Display: The four-line liquid crystal display reflects the menu and programming information used by or entered by the operator.

Keypad: The keypad is used by the operator to enter data and make programming selections. It consists of 10 numeral keys, decimal point, minus sign, eight function keys ([F1] through [F8]) and four special function-programming keys ([BACK SPACE], [NEXT], [PREV] and [ENTER]).

Communications Connector (J1): This six-pin RJ-11 connector is the attachment location for the C-987YYY communications cable, which connects the OPI-50 to the DeltaPro.

Power Connector (J2): This two-pin connector is used to supply the required 24VDC power to operate the OPI-50.

5.1.2 MOTIONPRO

MotionPro is a Windows 95™ based icon driven programming tool. Programs and setup information can be uploaded and downloaded over a RS-232 port by using a RJ-11 communications cable (C-987YYY).

5.2 OPERATING MODES

The DeltaPro Motion Control System has four modes: Setup, Program, Test and Run (which includes automatic and manual).

5.2.1 SETUP MODE

The Setup mode can be initiated by selecting F1 from the DeltaPro's Main Menu screen. A password is required to enter Setup mode if one has been programmed. Once in setup mode the user can change the setup parameters. Please refer to "**Section 7 -Programming With An Operator Interface**".

5.2.2 PROGRAM MODE

Selecting F2 from the Main Menu screen will initiate Program mode. A password is required to enter Program mode if one has been programmed. Programming can be done with an OPI-50 operator interface as described in "**Section 7 - Programming With An Operator Interface**". Refer to the appropriate section for complete programming information.

5.2.3 TEST MODE

The Test mode can be initiated by selecting F3 from the DeltaPro's Main Menu screen. Once in test mode the unit will not execute any stored programs and will only initiate the tests that the user selects. Please refer to "**Section 12 -Troubleshooting**".

5.2.4 RUN MODE

The DeltaPro Motion Control System will operate in run mode when the [F4] key has been pressed on the OPI from the main menu or on power up if Auto Start is enabled. There are two selections available for run mode. They are *Manual Mode* and *Automatic Mode* and are determined by the state of input # 13.

5.2.4.1 MANUAL

In Manual, the DeltaPro will jog in the appropriate direction when one of the jog inputs is activated. When the DeltaPro is not jogging and the [F4] key has been pressed, the OPI will display the Main Menu screen. Changing from Automatic to Manual will stop the currently executing block.

5.2.4.2 AUTOMATIC

In Automatic, the DeltaPro will execute a programmed block when it is triggered. The DeltaPro must be returned to Manual before exiting Run mode.

5.2.4.2.1 TRIGGER METHODS

During automatic, the ON status of inputs #1 through #8 will cause the related program blocks to be executed based on the defined trigger mode. If the trigger mode was defined as "*Input Trigger*", the block numbered the same as one of the inputs will begin executing when the system detects a change in state from OFF to ON for that input. Only block numbers 1 through 8 are permitted.

If the trigger mode was defined as "*Binary Trigger*", Inputs #1 through #7 are assigned a binary number as shown in Figure 5.2. When the system detects a change in state for Input #8 (the "MOVE" input) from OFF to ON, the block will be executed which corresponds to the binary number represented by the sum of the binary number of all the Inputs (#1 through #7) which are ON. The maximum block number is 127 (**NOTE:** "0" is not used.)

| USER I/O # | BINARY CODE |
|------------|-------------|
| 1 | 1 |
| 2 | 2 |
| 3 | 4 |
| 4 | 8 |
| 5 | 16 |
| 6 | 32 |
| 7 | 64 |

Figure 5. 2 - Binary Codes

5.2.4.2.1 TRIGGER METHODS (cont'd)

NOTE

The Binary Trigger definition only applies to the start of block execution. Once a program is running, inputs #1 through #8 may be utilized for the various program functions such as *Wait for I/O* and *Search for Input*. Inputs #1 through #7 will again be viewed as a binary code and Input #8 will again be viewed, as the MOVE input after the block execution is complete. The Input #8 signal must be edge-triggered (the system must see a transition from OFF to ON in Input #8 after the block execution ends) before it will read the other inputs for their binary code and begin execution of a new block.

5.2.4.2.2 ENGINEERING UNITS and MOTOR DIRECTION

All movement data is communicated to the DeltaPro Motion Control System in terms of "Engineering Units". Engineering units are defined as any conversion, which can be expressed as units per motor shaft revolution. They do not have to be a specific distance unit such as inches or millimeters. For example, if a trimming machine can work on pieces that are always located on multiples of 5/16" apart, the engineering units could be the number of 5/16" moves per shaft revolution. (Refer to "**Section 7 - Programming with an Operator Interface**".)

NOTE

The default engineering units value is 1.000. This value will be used by the system if no other value is programmed.

Engineering units may only be positive.

A positive data entry with a CW motor direction specified causes:

Position: Shaft rotation direction will depend on starting position. If the desired position is more positive than the current motor position the shaft will rotate clockwise.

Index: Shaft will rotate clockwise.

A positive data entry with a CCW motor direction specified causes:

Position: Shaft rotation direction will depend on starting position. If the desired position is more positive than the current motor position the shaft will rotate counter clockwise.

Index: Shaft will rotate counter clockwise.

5.3 MANUAL OPERATIONS

Manual operation of the DeltaPro Motion Control System is possible in the RUN mode. To operate the DeltaPro Motion Control System manually, the Auto/Manual Input (Input #13) must be set to manual or OFF.

While in Manual mode, the display will read the current position in Engineering Units relative to a 0.0 position and the commanded motor velocity in RPM.

5.3.1 JOG CLOCKWISE

When the Jog CW Input (Input #14) changes from OFF to ON, the system will:

1. Set the speed and accel rate to the programmed jog speed and accel (refer to "**Section 7 - Programming With An Operator Interface**" for details on programming the jog speed and accel rate.)
2. Command the motor to jog in the clockwise direction.

The system will continue the jog motion until one of the following events occurs:

1. Reset Input (Input #16) goes from OFF to ON.
2. Servo Fault occurs (refer to "**Section 12 - Troubleshooting**").
3. CW Direction Limit Input (Input #10) goes from OFF to ON if it is enabled.
4. Jog CW Input (Input #14) goes from ON to OFF.
5. Changing the Auto/Manual Input (Input #13) from OFF to ON.

In all cases, the system will force the motor to decelerate at the accel rate until the speed is 0 RPM.

5.3.2 JOG COUNTERCLOCKWISE

When the Jog CCW Input (Input #15) changes from OFF to ON, the system will:

1. Set the speed and accel rate to the programmed jog speed and accel rate (refer to "**Section 7 - Programming With An Operator Interface**" and for details on programming the jog speed and accel rate.)
2. Command the motor to jog in the counterclockwise direction.

The system will continue the jog motion until one of the following events occurs:

1. Reset Input (Input #16) goes from OFF to ON.
2. Servo Fault occurs (refer to "**Section 12 - Troubleshooting**").
3. CCW Direction Limit Input (Input #11) goes from OFF to ON if it is enabled.
4. Jog CCW Input (Input #15) goes from ON to OFF.
5. Changing the Auto/Manual Input (Input #13) from OFF to ON.

In all cases, the system will force the motor to decelerate at the accel rate until the speed is 0 RPM.

5.4 AUTOMATIC OPERATIONS

Automatic operation of the DeltaPro Motion Control System is possible in the RUN system-operating mode. To operate the DeltaPro Motion Control System automatically, the Auto/Manual Input (Input #13) must be set to auto or ON. The status window on the DeltaPro unit will indicate 'A' if there is a program running, a 'C' if there is a system reset or 'L' if there is a program loaded.

While in Auto mode, the display will have the current position in Engineering Units relative to a 0.0 position and the commanded motor velocity in RPM. The DeltaPro Motion Control System waits for a change in state of one of the following inputs:

1. **Programmable Input #1 - #8.**
A change from OFF to ON in one of inputs #1 - #8 (in Input Trigger mode) causes execution of the programmed block of steps. In Binary Trigger modes, if any inputs #1 - #7 are on and input #8 changes from OFF to ON. (Refer to "**Section 7 - Programming With An Operator Interface**" on execution modes.)
2. **CW Limit Input** (Input #10).
A change from OFF to ON terminates execution of any motion commands when the *CW Limit Inp #10* command has been executed to be enabled.
3. **CCW Limit Input** (Input #11).
A change from OFF to ON terminates execution of any motion commands when the *CCW Limit Inp #11* command has been executed to be enabled.
4. **ZREV Input** (Input #12).
Is used with the Initialize command to set a home position. When the input is on it indicates that the desired home position is within the current motor revolution.
5. **Auto/Manual Input** (Input #13).
A change from Auto to Manual (ON to OFF) terminates execution of any block steps and places the DeltaPro Motion Control System into the manual operation mode.
6. **Reset Input** (Input #16).
A change from OFF to ON terminates execution of all block steps. Also turns on the drive if a servo fault had occurred (refer to "**Section 12 - Troubleshooting**").

Block steps are executed consecutively without pause unless the step command forces a wait. After a motion command is executed the program continues to execute the steps following the command. If another motion command is encountered the program will display an invalid command fault. A *Wait Until Stop* command should be inserted directly in front of the second motion command. (Refer to "**Section 7 - Programming With An Operator Interface**" for a discussion of block command execution). The block and step number currently being executed is shown in the Operator Interface (OPI) display.

Also while in the automatic operation mode, data entry for command parameter values is possible thru the Operator Interface keypad. (Refer "**Section 7 - Programming With An Operator Interface**" for information on how to designate a parameter value for entry in the RUN system operating mode.)

5.4.1 KEYPAD ENTRY OF PARAMETERS FROM OPERATOR INTERFACE

If **KYPAD** was selected during programming as the method of input during execution for a command parameter value, the DeltaPro Motion Control Unit displays an input screen on the Operator Interface (OPI) while in the RUN system operating mode for the value input. Press the [NEXT/PREV] keys from run mode to display the **KYPAD** entry screen. If more than one command parameter value was selected as **KYPAD** entry, the DeltaPro Motion Control Unit allows a scroll through the input displays using the [NEXT/PREV] keys on the OPI. For example, if **KYPAD** is selected for SPEED in block 1, step 4, and for TIME in block 2, step 10 the OPI display would appear as:

BLOCK.STEP 1.4 *
ENTER SPEED
1400

1. Press [NEXT] or [PREV] to display the BLOCK.STEP 1.4 input screen.
2. Press [ENTER] to access the screen to enter the parameter value.

BLOCK.STEP 1.4
ENTER SPEED
1400

1. Press the numeric keys ([0] - [9]) to display a new parameter value.
2. Press [ENTER] to input the parameter value and display the BLOCK.STEP 1.4 input screen.

BLOCK.STEP 2.10 *
ENTER TIME
5

1. Press [NEXT] or [PREV] to display the BLOCK.STEP 1.4 input screen.
2. Press [ENTER] to access the screen to enter the parameter value.

BLOCK.STEP 2.10
ENTER TIME
5

1. Press the numeric keys ([0] - [9]) to display a new parameter value.
2. Press [ENTER] to input the parameter value and display the BLOCK.STEP 2.10 input screen.

If a value is not entered through the OPI in the RUN system operating mode before block execution, or if the Operator Interface is not connected, the value defaults to the Initial Value entered during programming of the block steps or to the last value entered during execution, whichever was the most previous.

5.4.2 VARIABLES

Variables are input into commands while running. Variables AIN1, AIN2, FOSPD, CMSPD, FERR, AMPOS, CMPOS, and FOPOS are updated every 10 milliseconds. These values can be used in the same calculations to get different results. If a value is placed in AOUT the analog output voltage will change to this value. AOUT uses 0 to 1023 bits to get a voltage range between 0 and 5 volts.

| COMMAND | PARAMETER | BITS USED |
|-----------------|-------------|---------------------------|
| SEARCH FOR I/O: | SRCH DIST | 0,1,2,3,10,11,12,17,18 |
| SEARCH FOR I/O: | POST DIST | 0,1,2,3,10,11,12,17,18 |
| SEARCH FOR I/O: | SPEED | 0,1,2,3,7,8,9,17,18 |
| WAIT TIME: | TIME | 0,1,2,3,17,18 |
| WAIT POS: | POSITION | 0,1,2,3,10,11,12,17,18,24 |
| WAIT DIST: | DISTANCE | 0,1,2,3,10,11,12,17,18,24 |
| POSITION: | POSITION | 0,1,2,3,10,11,12,17,18,24 |
| POSITION: | SPEED | 0,1,2,3,7,8,9,17,18,19 |
| POSITION: | ACCEL | 0,1,2,3,4,5,6,17,18 |
| INDEX: | DISTANCE | 0,1,2,3,10,11,12,17,18,24 |
| INDEX: | SPEED | 0,1,2,3,7,8,9,17,18,19 |
| INDEX: | ACCEL | 0,1,2,3,4,5,6,17,18 |
| DO WHILE: | COUNT | 0,1,2,3,14 |
| DO WHILE: | BATCH | 0,1,2,3,14 |
| PRESET BATCH: | BATCH | 0,1,2,3,14 |
| INITIALIZE: | SPEED | 0,1,2,3,7,8,9,17,18,19 |
| INITIALIZE: | ACCEL | 0,1,2,3,4,5,6,17,18 |
| RATIO: | MASTER GEAR | 0,1,2,3,17,18 |
| RATIO: | SLAVE GEAR | 0,1,2,3,17,18 |
| LOCK: | ACCEL | 0,1,2,3,4,5,6,17,18 |
| LET: | VAR1 | 1 thru 14 |
| LET: | VAR2 | 0 thru 14,17 thru 24 |
| LET: | VAR3 | 0 thru 14,17 thru 24 |
| IF VARIABLE: | VAR1 | 1 thru 14,17 thru 24 |
| IF VARIABLE: | VAR2 | 0 thru 14,17 thru 24 |
| SET PLS ANGLE: | ON ANGLE | 0,1,2,3,10,11,12,22,23,24 |
| SET PLS ANGLE: | OFF ANGLE | 0,1,2,3,10,11,12,22,23,24 |
| F DECEL: | DECEL | 0,1,2,3,4,5,6,17,18 |
| UNLOCK: | DECEL | 0,1,2,3,4,5,6,17,18 |
| TRACK SPEED: | SPEED | 0,1,2,3,7,8,9,17,18,19 |
| TRACK SPEED: | ACCEL | 0,1,2,3,4,5,6,17,18 |

5.4.2 VARIABLES (cont'd)

| VARIABLE | BIT | UNITS | Description |
|----------|-----|-------------|--------------------------|
| "KYPAD" | 0 | N/A | Keypad entry |
| "TEMP1" | 1 | N/A | Undefined |
| "TEMP2" | 2 | N/A | Undefined |
| "TEMP3" | 3 | N/A | Undefined |
| "ACDC1" | 4 | Rev/Sec Sec | Accel 1 |
| "ACDC2" | 5 | Rev/Sec Sec | Accel 2 |
| "ACDC3" | 6 | Rev/Sec Sec | Accel 3 |
| "SPD1" | 7 | Rev/Min | Speed 1 |
| "SPD2" | 8 | Rev/Min | Speed 2 |
| "SPD3" | 9 | Rev/Min | Speed 3 |
| "POS1" | 10 | Distance | Position 1 |
| "POS2" | 11 | Distance | Position 2 |
| "POS3" | 12 | Distance | Position 3 |
| "AOUT" | 13 | Bits | Analog Output |
| "COUNT" | 14 | Count | Batch Count value |
| "SPARE1" | 15 | N/A | Spare 1 |
| "SPARE2" | 16 | N/A | Spare 2 |
| "AIN1" | 17 | Bits | Analog Input 1 |
| "AIN2" | 18 | Bits | Analog Input 2 |
| "FOSPD" | 19 | Rev/Min | Fiber Optic Speed |
| "CMSPD" | 20 | Rev/Min | Commanded Motor Speed |
| "FERR" | 21 | Bits | Following Error |
| "AMPOS" | 22 | Eng Units | Actual Motor Position |
| "CMPOS" | 23 | Eng Units | Commanded Motor Position |
| "FOPOS" | 24 | Bits | Fiber Optic Position |

NOTE

Before variables are used in a step command the parameters ranges are checked. If a variable is outside the desired range, an illegal argument fault will be displayed. Using the LET command to change a variable can result in an overflow condition, and give unexpected results.

Variable values can range from -2,147,483,648 to 2,147,483,647. The variables are stored in terms of the engineering units decimal place. A value entered as 1 with the engineering units set to 3.000 is stored as 1000. If the engineering units are 5.0 and the variable entered is 2.1 the stored value is 21. The way the values are stored must be used to determine if a rollover condition could occur.

5.5 FIRMWARE DOWNLOADING

The DeltaPro operating system has the capability of being updated in the field. To accomplish this requires a computer, special factory available software and a communication cable. The software will run in Windows 3.1, Windows 95, Windows 98, Windows NT, Windows ME and Windows XP and is available on request. The communication cable is identical to the cable used for communicating with the OPI-50 with the exception of an adapter for the PC.

NOTE

Cable connection must be made to Port 1 of the DeltaPro for downloading.

After installing the software on a computer, the process may be started by running the Firmware Downloader. The operator will then need to select the file to download and the comm port to use for the operation before selecting the 'Download' button to initiate the process. The remainder of the procedure is explained using message boxes and during download the status is updated with a completion bar on the computer.

During the Download procedure, the seven-segment controller display will indicate several different statuses. The first being a 'c' for chip erase in process, after which, the file transfer begins which is indicated by a clockwise rotating illuminated segment. When the transfer is complete the new firmware number will be displayed one digit at a time (ex. 3911r04). Ultimately the status will display either an 'A' indicating program running, a 'C' indicating system reset or a 'L' indicating program loaded. Downloading new firmware will not erase the program currently stored in memory.

5.6 ASCII PACKET COMMUNICATIONS

An ASCII Packet consists of a stream of ASCII data.

DATA TRANSFER PROTOCOL

This Protocol allows data to be sent to the DeltaPro from a simple ASCII communication host.

In data communications, the protocol defines the rules for the electrical, physical and functional characteristics of the communications link. The protocol contains procedures required to ensure an orderly exchange of information through the link, to and from the executing programs.

PUT_DATA

The PUT_DATA serial command is used to transmit a new value for a program step variable from the host to the DeltaPro.

Format: [PUT_DATA,block,step,dt,dddd]

5.6 ASCII PACKET COMMUNICATIONS (cont'd)

Where the “[” character signifies the start of an ASCII packet command, “PUT_DATA” is the command to be performed, “block” is an ASCII string representing the Block number to be modified, “step” is an ASCII string representing the Step number to be modified, and dt is an ASCII string representing value that refers to the data type:

| | |
|---|---|
| 01 - position (in user units) | -POSITION, WAIT POSITION |
| 02 - speed (in RPM) | -POSITION, INDEX |
| 03 - accel/decel rate (in revs/sec/sec) | -POSITION, INDEX, TRACK SPEED, INITIALIZE |
| 04 - distance (in user units) | -INDEX, WAIT DISTANCE |
| 05 - search distance (in user units) | -SEARCH FOR INPUT |
| 06 - post distance (in user units) | -SEARCH FOR INPUT |
| 07 - time (in milliseconds) | -WAIT TIME |
| 08 - initialize speed | -INITIALIZE |
| 09 - search speed | -SEARCH FOR INPUT |
| 10 - batch | -DO WHILE (Batch) |
| 11 - count | -DO WHILE (Count) |
| 14 - master gear | -RATIO |
| 15 - preset batch | -PRESET BATCH |
| 16 - slave gear | -RATIO |
| 17 - lock accel | -LOCK |
| 18 - on angle | -SET PLS ANGLE |
| 19 - off angle | -SET PLS ANGLE |
| 20 - if variable 2 | -IF VARIABLE |
| 21 - variable 2 | -LET |
| 22 - variable 3 | -LET |
| 24 - decel | -UNLOCK, FORCE DECEL |
| 25 - track speed speed | -TRACK SPEED |

dddd is a four-byte sign extended value containing the data

NOTE

Data variables containing distance or position information must be scaled properly so that they match the engineering units in the DeltaPro setup data. For example, if engineering units are 1.000 (3 decimal places) and the index distance is 1 unit, then the correct value to transmit in the data variable is 1000.

SECTION 6 - CONTROL AND MOTION CONCEPTS

The DeltaPro Motion Control System provides a full range of single-axis indexing-system functions to allow maximum flexibility for the user.

The primary function of this section is to describe the motion concepts available in the DeltaPro. The system controls the speed and amount of shaft rotation. It also controls the acceleration/deceleration rate so the entire motion of the motor shaft (and, therefore, the load attached to the motor shaft) is under the control of the DeltaPro system. This control depends on the system functions being executed, the controls chosen for the functions, and the setup parameters established for the system.

The sequence of commands can be organized in many ways to take advantage of these concepts when the program is developed. They will remain the same until the program is changed, although a program can have a variety of blocks (program step sequences), which will be implemented based on which inputs are actuated. Thus one program can be written which contains a variety of movement options. The machine controls (or manual controls) can be used to actuate the desired inputs, which will cause each of these blocks to execute.

NOTE

There are a maximum of 200 steps allowed in a program. These steps can be combined into the available 132 blocks as required, but the total of all steps in all blocks is limited to 200. Blocks 128 through 132 are special blocks.

6.1 MOTION & I/O

6.1.1 MOTION & I/O COMMANDS

Index
Position
Search for Input
Turn On/Off
Force Decel
Track Speed

6.1.2 INDEXING/POSITIONING

There are two basic types of incremental movement: indexing and positioning. An "**Index**" is a movement relative to the location of the shaft when the movement is started. A "**Position**" is a movement relative to a fixed 0.0 location. The amount of movement for either **Index** or **Position** can be fixed (established in the program) or can be input from the operator interface during the execution of the program.

NOTE
All distance data is entered in terms of "Engineering Units".

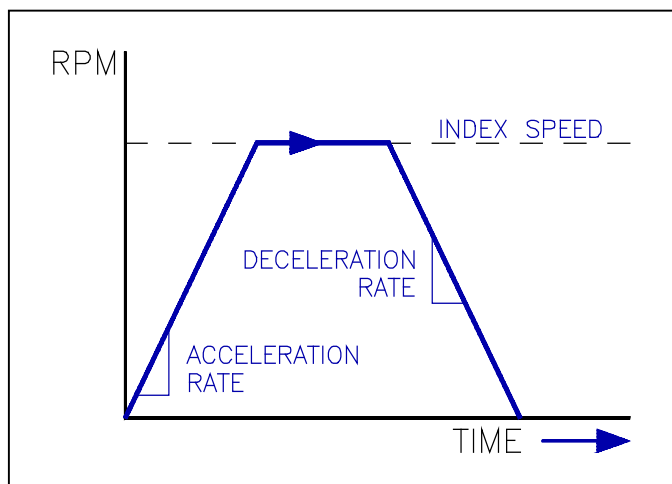


Figure 6. 1 - Normal Index Cycle

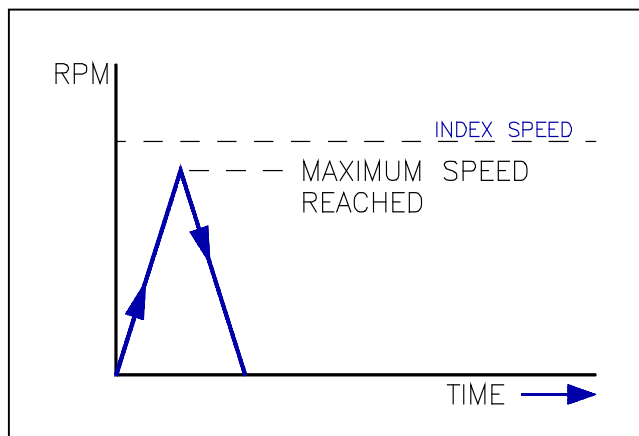


Figure 6. 2 - Short Index Cycle

The command module calculates the time required to reach the set distance allowing for the set acceleration/deceleration rate and controls the motor accordingly. **Figure 6.1** shows a normal motor indexing/positioning motion cycle. **Figure 6.2** shows a cycle where there is not enough time to reach "Index Speed". In this case, the command module only allows the motor to accelerate and decelerate as much as necessary to reach the desired index/position distance. When possible, the system parameters should be set to achieve the type of curve shown in **Figure 6.1** with one-third of the cycle for acceleration, one-third at index speed, and one-third for deceleration. This type of curve minimizes the RMS power required by the system.

6.1.2.1 MODIFIED SINE INDEXING/POSITIONING

The DeltaPro Motion Control System provides the capability of altering the normal trapezoidal ramp shape during *Index* or *Position* commands. This "modified sine" acceleration and deceleration (refer to **Figure 6.3**) helps reduce the torque load on the motor by altering the amount of speed change required as the system starts to accelerate or decelerate, thereby generating less strain on the motor and load.

The system allows nine different "degrees" of modified sine ramp rates in addition to the standard (Degree 0) trapezoidal ramp. The desired degree of modified sine ramp is selected when the system is programmed (refer to "**Section 7 - Programming With An Operator Interface**").

Degree 0 is the normal trapezoidal shape with no modification. Degrees 1 through 9 increasingly modify the ramp shape with 9 being the maximum modification. The proper modified sine ramp for a given system will depend on the operating characteristics of the system including the load, inertia, system losses, and desired speed and acceleration. The proper degree of modified sine must be determined by experimentally trying various settings.

NOTE

The "degree" refers to the relative amount of modification to the shape of the ramp. This "degree" should not be confused with angular degrees.

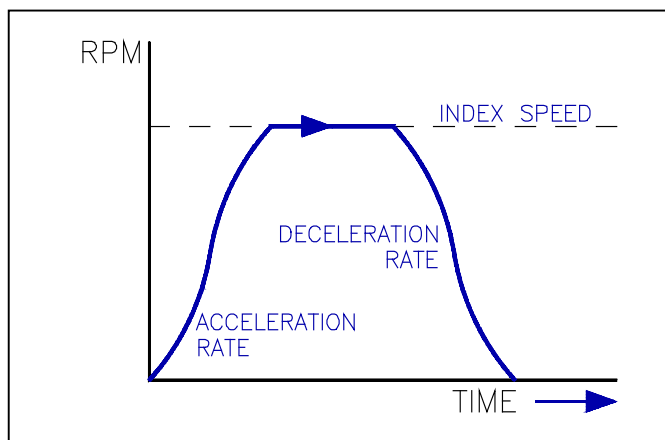


Figure 6. 3 - Modified Sine Index Cycle

6.1.2.2 SEARCH FOR INPUT

The *Index* or *Position* command can be further modified by the use of the *Search For Input* command. The *Search For Input* control function (sometimes referred to as registration) is a "feed-to-sensor" function for indexing or positioning on an external switch or sensor. During the programming operations, a variety of parameters are established which define the *Search For Input* command (refer to "**Section 7 - Programming With An Operator Interface**").

These parameters are:

Input ON/OFF: Which state (ON or OFF) of the input is considered as energized for the purposes of this command.

Search Distance: The maximum distance to be traveled after decelerating to the set speed if the input is not actuated.

Post Distance: The distance to be traveled after the input is actuated.

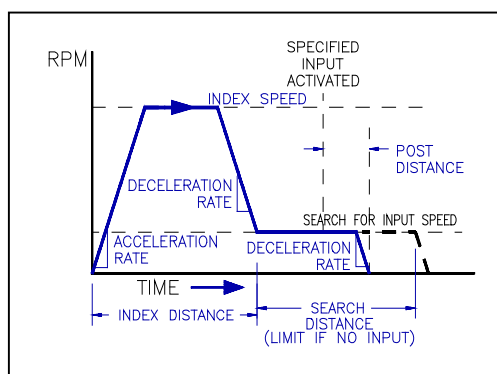
Speed: The speed of the motor at which the *Search for Input* function will start after it decelerates from the index speed.

Input Number: Which input is to be used.

NOTE

The *Search For Input* speed must be equal to or less than the *Index* or *Position* speed for this command to operate properly (or the system will only execute a move command). The system only searches for the input when it is operating at the search speed.

When the *Search For Input* command is used in the program, the *Index* or *Position* command will cause the motor shaft to rotate as it normally does for the specified *Index* or *Position* distance. However, the system will decelerate (at the preset ramp rate) to the *Search For Input* speed instead of decelerating to zero speed. The system will continue to move at this speed until the designated input is actuated. When the input is actuated (either turned ON or OFF as dictated by the "Input ON/OFF" parameter), the system will move and decelerate as necessary to travel the desired "Post Distance". At the end of this distance, the system will be at zero speed.



Index Cycle With Search For Input

If the input does not actuate, the movement will be terminated when the "Search Distance" is reached. The system will immediately decelerate at the preset ramp rate until it reaches zero speed.

6.1.3 FORCE DECEL

The *FORCE DECEL* command is used to bring the system to a controlled stop. At the time this command is executed the system will begin to decelerate at the rate determined by the command. The system will continue to decelerate until zero speed is achieved.

This operation is often used when a recoverable fault occurs and a controlled stop is the desired result.

6.1.4 TRACK SPEED

The *TRACK SPEED* command is used to jog the motor at the desired speed. At the time this command is executed the system will begin to accelerate at the rate determined by the command. The system will continue to jog at the set speed until a *FORCE DECEL* command is issued. While executing a *TRACK SPEED* command another *TRACK SPEED* command can be issued to change the accel rate or jog speed.

6.2 BRANCHING

6.2.1 BRANCHING COMMANDS

Do While
End While
Exit Block
Exit Block if Input
If Busy
If I/O
If Variable

6.2.2 LOOPS

The DeltaPro is capable of creating loops to repeat sections of a program. This can be done by using the Do While command. The boundary of the loop is defined by the End While command. One loop can be executed at a time and nesting of loops is not allowed. There are five conditions to "Do While". The continuous loop of command steps can be terminated by the condition of an input or output, a specific number of repetitions either incrementing (COUNT) or decrementing (BATCH) (Note: The BATCH counter will retain its count after exiting the loop while the COUNT counter will not.) or by an EXIT BLOCK command. In all cases but the EXIT BLOCK command, the program will go on to the next step in the block. If there is no End While, the Do While command has no effect on the execution of the block.

6.2.3 BRANCHING AND IF STATEMENTS

There are commands available to branch to program steps based on conditional factors. These factors can be inputs, outputs, PLSs, variables or the motor being busy with a motion command (IF BUSY). With the use of a branching or If Statement, the command will cause the executing block to jump to a specified step. Branching can only occur within the executing block. Branching commands are available to exit the block, however, this will place the DeltaPro in Auto Mode.

6.3 INITIALIZE

6.3.1 INITIALIZE COMMANDS

CLR 0.0
CCW Limit Input #11
CW Limit Input #10
Initialize
SET 0.0

6.3.2 SET 0.0 AND CLEAR 0.0

All *Position* movements are relative to a 0.0 location. This 0.0 location is relative to the angle of the motor shaft when power is applied to the system. This location can be changed when the system is initialized. Once the initialized command is executed, the system will retain the initialized location as the 0.0 location (angle) until the system power is turned off.

The 0.0 location can also be changed temporarily through the use of the *Set 0.0* command. When this command is executed, the present angle of the motor shaft becomes the 0.0 location. All *Position* commands will be executed relative to the 0.0 location thus established until the system power is turned off, the *Initialize* command is executed, or the *CLR 0.0* command is executed.

The *CLR 0.0* command clears any temporary 0.0 location established with the *Set 0.0* command. The system will return to using the 0.0 location established when power was applied to the system or when the system was initialized.

6.3.3 INITIALIZE

The *Initialize* command calibrates the motor shaft (resolver shaft) to 0.0 angle (refer to "**Section 7 - Programming With An Operator Interface**"). After this command is executed the program will wait until it is finished moving before executing the next step. When this command is completed a SET 0.0 command is automatically executed.

For single-turn applications, when the *Initialize* command is executed, the motor shaft will move at the speed and acceleration specified until it reaches the first 0.0 angle on the resolver. The direction is specified by the SPEED input. The motor will turn in a CW direction if the speed is positive and counter clockwise when the speed is negative. There are two 0.0 angles per motor shaft revolution.

When the system involves multiple turns and it is necessary to find the specific half turn, which has the 0.0 locations, a zero revolution (Z REV) input must be utilized in the system. This input is typically actuated by a switch or sensor, which is configured in the system equipment to indicate which half turn of that equipment has the 0.0 angles in it. This input must be connected to input # 12.

For example, in lead screw systems, locate a zero revolution switch at one end of the lead screw. Set the *Initialize* rotation direction for the rotation, which will drive the lead screw nut toward the switch. When *Initialize* is executed, the motor drives toward the switch. When the switch closes, the 0 rev input is actuated and the command module assign the present motor half rotation as the 0.X rotation. The motor stops, then starts again and moves to the 0.0 absolute angle on the resolver, and stops at 0.0 in the 0.X rotation.

6.3.3 INITIALIZE (cont'd)

CAUTION

THE SWITCH WHICH ACTUATES THE ZERO REV INPUT MUST BE MAINTAINED IN THE ACTUATED STATE FOR ANY SYSTEM POSITION PAST THE SWITCH IN THE DIRECTION OF INITIALIZATION. IF THE SWITCH IS NOT MAINTAINED, THE SYSTEM WILL STILL TRY TO INITIALIZE IN THE SET DIRECTION, EVEN IF IT IS BEYOND THE SWITCH LOCATION, WHICH COULD RESULT IN SYSTEM DAMAGE.

NOTE

If the Zero Rev input is already activated when the *Initialize* command is executed, the motor will first move off the zero revolution switch by turning opposite the programmed direction. It will then reverse direction (to the programmed direction) to activate the Zero Rev input and will finally move to 0.0 on the resolver.

The search for the zero revolution switches can be programmed to occur at a speed up to 5600 RPM. Caution should be used when searching for the zero revolution switches at high speeds because, when the switch closes, the motor will decelerate at the programmed Initialize Ramp rate until it reaches zero speed. At 500 RPM index speed and 10-revolutions/sec/sec deceleration; it takes 0.83 seconds for the motor to reach zero speed. The motor has turned 3.5 turns, causing a 3.5 turn overshoot beyond the zero revolution switch. The system will index back to the 0.0 angle in the 0.0 turn as defined by initial activation of the Zero Rev input.

The DeltaPro system can successfully initialize to 0.0 at any speed up to 5600 rpm, provided the mechanical system can tolerate the overshoot of the 0.0 angle at the higher speeds.

NOTE

If the system does not provide consistent timing for recognition of the Zero Rev input and if the resolver zero is just after the zero revolution switch contact position, the revolution chosen as the 0.X revolution might be inconsistent. This can be corrected by adjusting the zero revolution switch so the contact position occurs earlier.

6.3.4 CW & CCW LIMITS

The CW & CCW limits are for limiting the rotation of the motor by the use of inputs. If input #10 for CW or input #11 for CCW are activated, the motor will stop.

For example, when a DeltaPro system is used for controlling a ballscrew, CW & CCW limits should be used. This will allow the user to define the safe movement area of the ballscrew.

6.4 FOLLOWER

The DeltaPro provides a mode of operation whereby the motion of one axis, called a master axis, can be used to control the motion of a slave axis. The master axis on the DeltaPro is always the fiber optic network.

The slave axis uses the master axis position to determine its position and speed according to one of two methods, either simple lock or cam. In simple lock, or "Electronic Gearing", a simple ratio is applied to the master position data to determine the correct slave axis position. In cam mode, the slave axis moves through a preprogrammed path (electronic cam) dependent on the rotation of the master axis.

The master axis concept is also carried through to the operation of the PLS outputs. The operation of these outputs is dependent on master position information. In the case of the PLS, the positional information can be derived from either the fiber optic network or the motor itself.

6.4.1 FOLLOWER COMMANDS

Cam Start
Cam Segment
Cam End
Lock
Ratio
Set PLS Angle
Unlock
Set Cam Ptr

6.4.2 SIMPLE LOCK (ELECTRONIC GEARING)

The *LOCK* command used with the *simple ratio* option selected provides the electronic equivalent of a gearbox. The electronic gearbox or ratio is driven by the fiber optic data (master). The fiber optic data contains position information which is processed by the specified master / slave gear ratio to drive the DeltaPro (slave) commanded position. Once per millisecond the DeltaPro position is updated based on the new fiber optic position.

$$\frac{(\text{change in fiber optic position} * \text{master gear})}{\text{slave gear}} = \text{change in DeltaPro position}$$

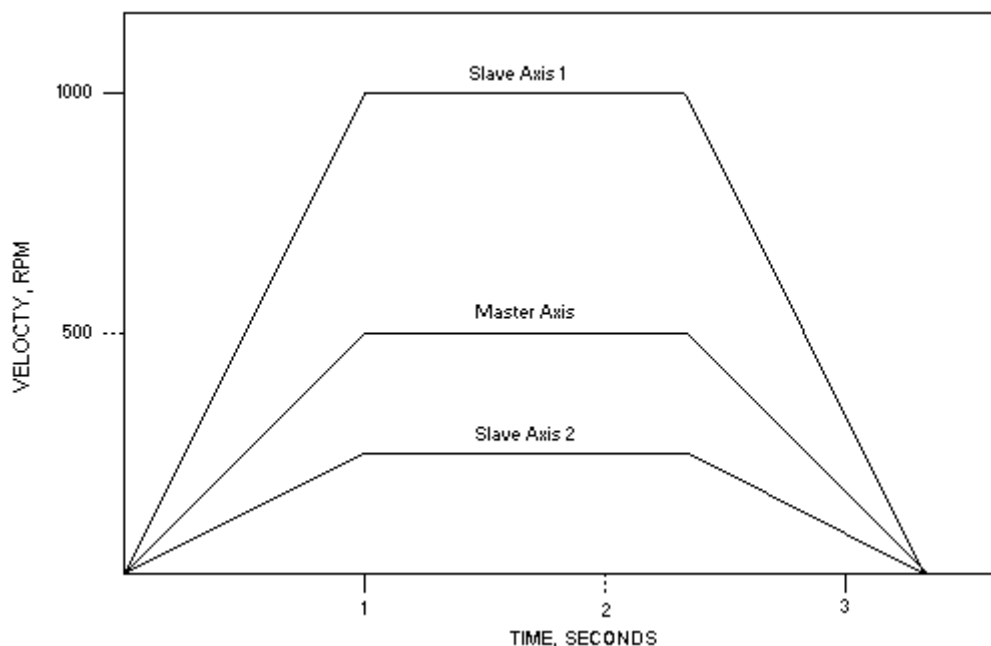


Figure 6.4 - Simple Lock Illustration

The slave motion is limited by the Accel value in the *Lock* command and further limited to a maximum speed of 5600 RPM. The programmer should be careful so that the above equation does not result in the DeltaPro motor exceeding its' maximum speed. The limiting of the slave acceleration rate can be an advantage in systems that have rough or rapidly changing master speeds. The limited acceleration on the DeltaPro dampens the DeltaPro motor and smoothes out the operation.

The *Ratio* command can be executed while already locked. When the new *Ratio* command is executed, the DeltaPro controller stops executing the equation above and reverts to simply slewing at the new Accel rate until it reaches the desired speed based on the master/slave gear ratio. When the speed is matched the above equation begins execution again.

The limiting of the DeltaPro speed and acceleration result in some interesting situations. For example, if the master (fiber optic information) is turning when the *Lock* instruction is executed, the DeltaPro (slave) motor will accelerate at the specified acceleration rate until the equation above is satisfied. In actual practice the slave motor will accelerate above what would appear to be the final speed in order to make up the distance lost during acceleration. The resulting motion profile is shown in **Figure 6.5**.

Since the slave is limited in both speed and acceleration, a situation may occur where the slave can never reach final lock speed. The same situation can occur if the effective master is changing speed faster than the slave can change speed because of the acceleration limit. As a rule of thumb, the slave acceleration rate should be set to at least 5 times the expected rate of change of the master.

6.4.2 SIMPLE LOCK (ELECTRONIC GEARING) (cont'd)

NOTE

If the master gear is programmed for 2 and the slave gear is 1 the DeltaPro axis will move in the same direction and 2 times the speed of the fiber optic input. If the ratios are reversed and the master gear is 1 with the slave gear at 2 the DeltaPro axis will move in the same direction and 1/2 times the fiber optic speed. If one of the gears is negative the DeltaPro axis will move opposite the fiber optic input. If both gears are negative the DeltaPro axis will move in the same direction as the fiber optic input.

Moving Master Profile

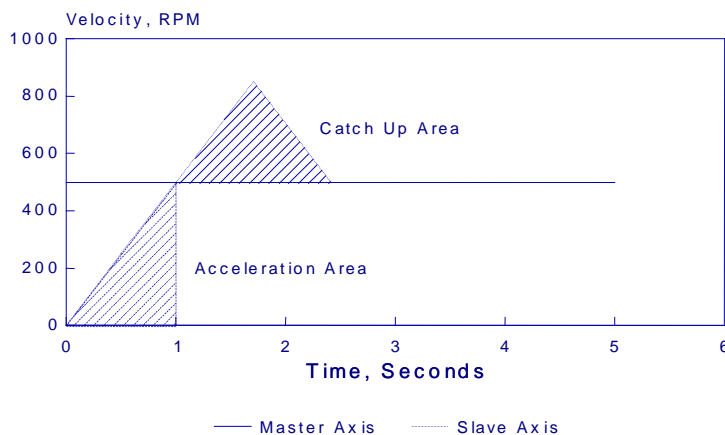


Figure 6.5 - Locking To A Moving Master

6.4.3 ELECTRONIC CAMS

The DeltaPro provides a mode of operation that effectively emulates mechanical cams. In this mode the slave axis will follow a predefined path or profile based on the rotation of the master axis.

Electronic cams are tables of incremental motor moves. Each incremental value occupies one byte of memory in the DeltaPro and has an allowable range of -127 to +127. As the master axis turns, its position is continually transmitted through the fiber optic network. The slave uses the current master position to determine the proper index into the electronic cam array. As the index moves through the cam table, the incremental distances are added together to form the proper slave axis position. Linear interpolation is performed between elements in the cam array. When the end of the cam table is reached, the process begins again at the beginning of the table. The *set cam ptr* commands allows the user to set the point to start executing the cam

An electronic cam sequence must be defined before execution can begin:

| | |
|--------------------|--|
| cam start | master scale, data scale |
| cam segment | profile type, segment distance, start element, end element |
| | . |
| | . |
| | . |
| cam segment | profile type, segment distance, start element, end element |
| cam end | |

Once defined, the electronic cam is executed using the **ratio** and **lock** commands:

| | |
|--------------|-------------------------|
| ratio | master gear, slave gear |
| lock | accel, lock type |

6.4.3.1 MASTER SCALING

Master scaling provides a mechanism to control the rate at which a slave axis proceeds through its cam array relative to the rate at which the master axis turns.

Positional information within the DeltaPro is based on 4096 bits equating to one revolution of the master.

In electronic cam mode, the master scale factor refers to the number of times the master position value is divided by 2 (i.e. shifted right) by the slave processor. For example, if a master scale factor of 12 were used, the slave processor would divide the master position value by 4096 (2^{12}). The slave processor then compares the least significant 12 bits of the scaled value to the previous scaled master position to determine if it has changed. If the value has changed, the cam array index is changed accordingly.

Figure 6.6 summarizes the effect of master scaling.

6.4.3.1 MASTER SCALING (cont'd)

| Master Scale Factor | Cam Array Advances Every |
|---------------------|--------------------------|
| 12 | full turn |
| 11 | 1/2 turn |
| 10 | 1/4 turn |
| 9 | 1/8 turn |
| 8 | 1/16 turn |
| 7 | 1/32 turn |
| 6 | 1/64 turn |
| 5 | 1/128 turn |
| 4 | 1/256 turn |
| 3 | 1/512 turn |
| 2 | 1/1024 turn |
| 1 | 1/2048 turn |
| 0 | 1/4096 turn |

Figure 6.6 - Master Scaling

6.4.3.2 DATA SCALING

In order to insure that each element of an electronic cam is in the range of -127 to +127, it is often necessary to scale the cam data. This is accomplished by dividing the data by 2^n where n is selected to cause the largest element of the cam array to be less than -127 to +127.

An example of when it may be necessary to use a data scale would be if loading the cam results in a calculation error. This indicates that the requested distance was too large for the number of elements, one way to resolve this would be to increase the data scale by 1 or more. When changing the data scale the distance also needs to be adjusted by the appropriate amount.

6.4.3.3 IMPORTANT NOTES REGARDING ELECTRONIC CAMS

The following items should be considered when using electronic cams (Note - These examples assume a positive ratio value is being used):

1. Positive cam data indicates to the slave axis that the slave should travel in the same direction as the master axis.
2. The cam pointer will always start at the beginning of the cam table, unless the **set cam ptr** instruction and lock mode cam on angle and cam immediate are used.
3. The cam pointer will move toward the cam end when the master axis is traveling in the clockwise (CW) direction. The cam data pointer will move away from the cam end when the master axis is traveling in the counterclockwise (CCW) direction.

A few important points regarding the use of electronic cams:

1. Each cam sequence must have a **cam start** command, 1 (or more) **cam segments** and a **cam end** command. These commands must be executed in this order.
2. Although multiple cam sequences can be defined, only 1 cam can be calculated and executed at one time.
3. There are three types of motion profiles available; trapezoidal 1/3, modified sine or a custom profile. The custom profile defaults to a trapezoidal 1/10.

6.4.4 PLS ANGLES

The Programmable Limit Switch (PLS) function consists of outputs defined to turn on and off at defined angles, derived from the rotational position of a master. The source for the PLS can be either the fiber optic data or the motor, and is selected in the setup.

A *Set PLS Angle* command is used to define the ON ANGLE and OFF ANGLE for the selected PLS number. The valid range for the angles is 0 to 4095, which are representing one 360-degree rotation. Once defined the associated outputs will turn on at the defined ON ANGLE and turn off at the defined OFF ANGLE.

The PLS number can range from 1 to 16, with 1-5 corresponding to physical outputs and 6-16 associated with software. The software PLS can be used for a *Wait For I/O* or an *If I/O* command. Once enabled the PLS outputs must be disabled before they can be used as normal outputs.

6.5 MISCELLANEOUS

6.5.1 MISCELLANEOUS COMMANDS

Preset Batch
Wait Distance
Wait for I/O
Wait Position
Wait Time
Wait Until Stop
Let

6.5.2 WAIT COMMANDS

Wait commands are used to pause the sequence steps in a block until a condition has been met. The conditions are relative to I/O, time, motor position or motion command complete.

6.5.3 LET FUNCTIONS

The 'LET' command is used for arithmetic operations and to assign a value to a variable or parameter. The arithmetic operations that are available are +, -, *, ÷. The operations are limited to one per command.

The following example illustrates how to use the AIN1 (analog input #1) variable as a speed value for an index move. The scaling for the AIN1 is 1024 = 5 volts and the range is 0-5v. The desired maximum speed is 750 rpm.

```
let          temp1 = AIN1 * 750
let          spd1 = temp1 / 1024
index        5.00, spd1, 250, 0
```

An example of the use of the analog output is as follows.

```
let          temp1 = actspd * 1024
let          aout = temp1 / 4000
```

The analog output operates in the 0-5v range with 1024 = 5 volts. In this example, the maximum speed could be as high as 4000 rpm.

6.5.4 BATCHING

The batching operation is used in conjunction with the 'DO WHILE' command. When a 'DO WHILE' command is encountered with the 'BATCH' selection, the program will loop through the block of code between the 'DO WHILE' and 'END WHILE' commands the number of times designated by the 'BATCH COUNT'. The counter will be decremented once each loop and will stop looping when the 'BATCH COUNT' value reaches zero. The program execution continues with the command that follows the 'END WHILE'.

When the next DO WHILE BATCH command is encountered and if the BATCH COUNTER is zero, the BATCH COUNTER will be restarted with its specified value. If the batch counter is now zero it will resume counting down from its current value until the BATCH is complete.

If execution of the block is terminated before the DO WHILE BATCH loop has been completed, the BATCH COUNTER will not be modified on restarting a DO WHILE BATCH loop. It will resume counting down from its current value unless a 'PRESET BATCH' command has been executed.

The 'PRESET BATCH' command will reset the BATCH COUNTER to zero and will restart a 'DO WHILE BATCH' with the value programmed. If the value programmed is zero, the 'DO WHILE BATCH' will restart with the original value associated with that command.

SECTION 7 - PROGRAMMING WITH AN OPERATOR INTERFACE

7.1 SETUP PARAMETERS

Setup parameters define system function values in the DeltaPro Motion Control System.

Table 7.1 - Setup Parameter Summary

| # | SETUP PARAMETERS | RANGE / OPTIONS | DEFAULT SETTING | DESCRIPTION |
|---|---|------------------------|----------------------------------|--|
| 1 | <i>Engineering Units</i> | 0.00010 to 9999999 | 1.000 | Units per motor shaft rotation. |
| 2 | <i>Jog Speed</i> <i>Accel</i> | 5 to 5600 5 to 1600 | 5 rpm 5 revs/sec ² | Maximum speed and rate of acceleration and deceleration during Jog operation. |
| 3 | <i>Trigger Mode</i> | Input Binary | Input | Defines how to select the block that is executed during automatic operations. |
| 4 | <i>Erase Blocks</i> | Yes / No | No | Clears all of the blocks currently stored in memory and inserts a DRIVE ON command in block 128 step 1. |
| 5 | <i>Password</i> | 0000-9999 | 0 | Sets up a password for setup and programming protection. |
| 6 | <i>Delta Drive - Load Inertia Ratio</i> | 0-100.0 | 1.0 | Sets the baseline frequency response of the driver using the ratio of the load inertia/motor inertia for a rigidly coupled load. If the load is not rigidly coupled, the value entered may vary from the calculated value. If the value is set too high, the motor and driver may become unstable and oscillate. This parameter is set automatically during auto tuning. |
| 7 | <i>Delta Drive -High Frequency Response</i> | 0.1-20.0 | 1.0 | Sets the high frequency response of the driver. The higher the number the more responsive. If the value is set too high, the motor and driver may become unstable and oscillate. This value works in concert with the Load Inertia Ratio. This parameter is set automatically during auto tuning. |
| 8 | <i>Delta Drive - Position Loop Gain</i> | 1-200 | 30 | Sets the DC gain of the position control loop. A higher value results in stiffer, faster response. If the value is set too high, the motor and driver may become unstable and oscillate. This parameter is set automatically during auto tuning. |
| 9 | <i>Delta Drive - Gain Reduction</i> | 0-10,000 | 0 | Sets the amount of gain reduction at zero speed. |

Table 7.1 - Setup Parameter Summary (cont'd)

| # | SETUP PARAMETERS | RANGE / OPTIONS | DEFAULT SETTING | DESCRIPTION |
|----|---|-----------------------------|--------------------|--|
| 10 | <i>Delta Drive - Feed Forward Gain</i> | 0-2.0 Times | 1.0 times | Sets the feed forward gain in the position loop. A value of 1.0 results in 0.0 following error. Less than 1.0 will produce a lag between the actual motor position and the commanded position and greater than 1.0 produces a lead. The lead or lag will be proportional to speed at non-1.0 settings. |
| 11 | <i>Delta Drive - Notch Filter Frequency</i> | 100-20,000 rad/s | 6000 rad/s | Sets the notch frequency of a velocity loop anti-resonance filter. This filter can be used to cancel machine or servo resonance. Power must be turned OFF then ON for this parameter to take effect. |
| 12 | <i>Motor Code</i> | See Appendix A.1 | Motor not selected | Provides a specific product motor code to the drive. Power must be turned OFF then ON for this parameter to take effect. |
| 13 | <i>Brake Mode</i> | None, Mechanical or Dynamic | None | Selects the type of brake sequencing to be done when the drive is disabled. Power must be turned OFF then ON for this parameter to take effect. |
| 14 | <i>Brake Threshold</i> | 0.0-100.0 % | 100.0 % | When the Brake Mode is set to Mechanical, the mechanical brake is applied when the motor speed falls below this value. This value is % of rated speed. |
| 15 | <i>Monitor Output Type</i> | Speed Torque | Speed | Selects speed or torque to be output to the Monitor test point of the DeltaPro. |
| 16 | <i>Torque Limit</i> | 0.0-100.0 % | 100.0 % | Limits the motor torque. This value is a % of the motor peak torque. |
| 17 | <i>CCW Rotation Torque Limit</i> | 0.0-100.0 % | 100.0 % | This value is only available if the Torque Limit is set to 0. Limits CCW rotation torque. 100% = peak torque. |
| 18 | <i>CCW Rotation Absorption Torque Limit</i> | 0.0-100.0 % | 100.0 % | This value is only available if the Torque Limit is set to 0. Limits CCW rotation absorption (braking) torque. 100% = peak torque. |
| 19 | <i>CW Rotation Torque Limit</i> | 0.0-100.0 % | 100.0 % | This value is only available if the Torque Limit is set to 0. Limits CW rotation torque. 100% = peak torque. |
| 20 | <i>CW Rotation Absorption Torque Limit</i> | 0.0-100.0 % | 100.0 % | This value is only available if the Torque Limit is set to 0. Limits CW rotation absorption (braking) torque. 100% = peak torque. |
| 21 | <i>Auto Tuning</i> | Yes / No | No | This parameter allows the user to enter the auto-tuning mode, which will tune the drive based on frequency, rotation, and speed. The tuning process time will vary from application to application. |
| 22 | <i>Auto Start</i> | On / Off | Off | By switching this option to YES , the unit will start in run mode the next time it is powered up. If this option is NO then the unit will start up at the Main Menu screen. |

Table 7.1 - Setup Parameter Summary (cont'd)

| # | SETUP PARAMETERS | RANGE / OPTIONS | DEFAULT SETTING | DESCRIPTION |
|----|---------------------------|------------------------------------|-----------------|--|
| 23 | <i>Motor Direction</i> | CW / CCW | CW | By selecting CW a positive index value will move the motor in a CW direction. If CCW is selected a positive index distance will rotate the motor in a CCW direction. |
| 24 | <i>ASCII Mode</i> | Disabled Enabled | Disabled | By selecting ENABLED a simple ASCII communication host can send data to port 1 of the DeltaPro. |
| 25 | <i>PLS Source</i> | No Source Axis 1 Fiber Optic | No Source | Determines where the PLS receives the angular position from. |
| 26 | <i>Variable Selection</i> | List of available variables | None | Determines the variables to be displayed while running. While in Auto/Manual mode pressing next will display these configured variables. |
| 27 | <i>Set Absolute Zero</i> | Yes / No | No | Allows the operator to set the motor's absolute home position. This setting only will have an effect on Absolute systems. |
| 28 | <i>Ext Regen Value</i> | 0-100.0 ohms | 0.0 ohms | Value of optional external regen resistor in ohms. When an external regen resistor is used, the value of the resistor is entered to allow the driver to calculate average power into the regen resistor. When the internal regen is used, enter 0.0. Power must be cycled for this parameter to take effect. See Section 11 for details on regen resistor selection. This parameter is used with DSD-35 and larger drives. |
| 29 | <i>Ext Regen Watts</i> | 0-327.67 kw | 0.0 kw | Power rating of the optional external regen resistor in Kw. When an external regen resistor is used, the power rating in Kw of the resistor is entered to allow the driver to calculate average power into the regen resistor. When an internal regen is used, enter 0.0. Power must be cycled for this parameter to take effect. See Section 11 for details on regen resistor selection. This parameter is used with DSD-35 and larger drives. |

7.2 PROGRAMMING SETUP INFORMATION

Press the [F1] key while viewing the Main Menu screen to put the DeltaPro Motion Control System into the Setup mode. Use the Setup mode to change the values of the setup parameters. Also, while in the Setup mode, it is possible to erase all of the existing program blocks. (Refer to "**Section 7.3 - Block Commands**" for more information on program blocks.) Using the password authorization can prevent unauthorized entry into the setup.

The DeltaPro Motion Control System contains default values for some of the setup parameters. It is necessary to program certain setup values to operate the system. For instance, in order for the DeltaPro to function properly it is important to assign the correct motor code to the controller. If the correct motor code is not assigned the unit will not function properly and could possibly damage the drive. After the setup parameter values are programmed, they are stored in nonvolatile memory and do not need to be programmed again, unless they need to be changed. The new parameters are sent to the drive after exiting Setup mode and returning to the Main Menu screen.

Programming the setup parameters through the Operator Interface (OPI) follows a general pattern. (Refer to **Figure 7.1**) This figure shows a block diagram of the steps for changing a setup parameter.

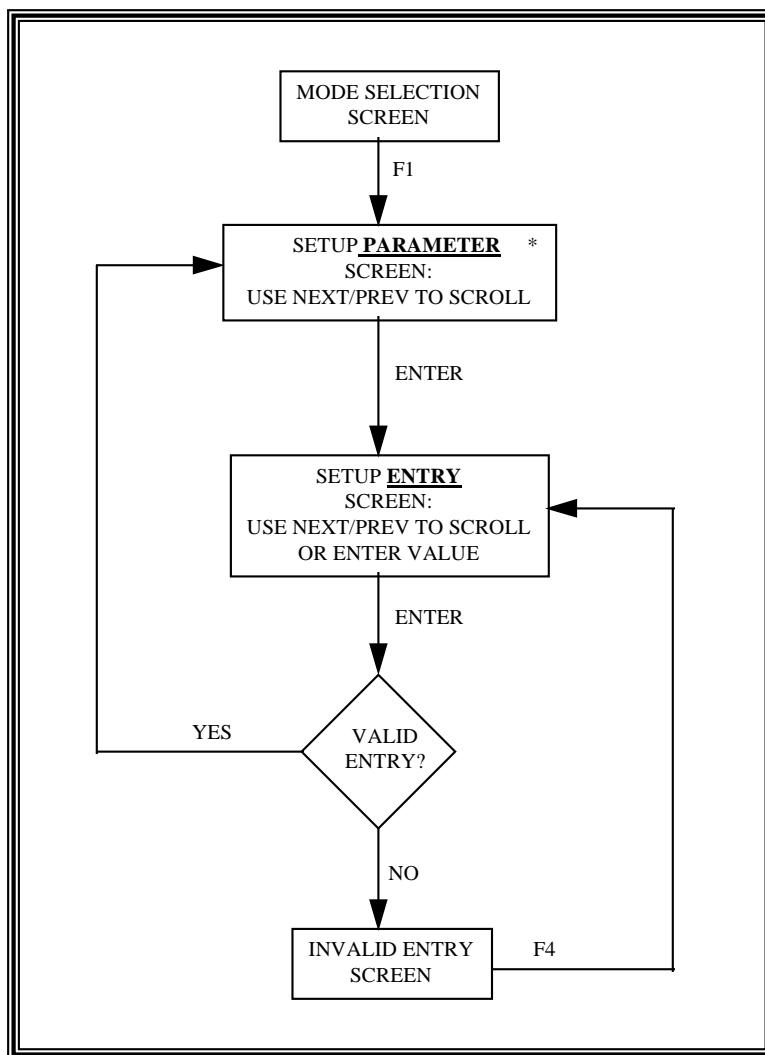


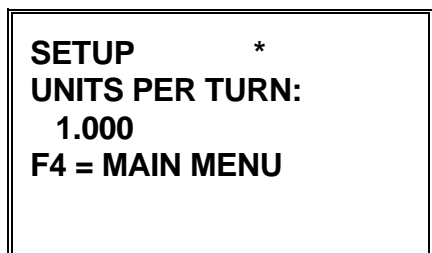
Figure 7.1 - Programming Setup Parameters Block Diagram

7.2 PROGRAMMING SETUP INFORMATION (cont'd)

The steps for changing a setup parameter are:

1. Display the desired Setup *parameter* screen. The "*" on the screen in setup mode indicates a *parameter* screen.
2. Press Enter to access the Setup *entry* screen and change the value of the parameter.

The setup parameter and the current value for that parameter are displayed on a Setup *parameter* screen. The actions that are permitted while the Setup *parameter* screen is displayed are:



1. Press [ENTER] to display the Setup *entry* screen.
2. Press [NEXT] or [PREV] to access a different Setup *parameter* screen.
3. Press [F4] to display the Main Menu.

Figure 7.2 - Setup *Parameter* Screen

Access the different setup parameters by pressing the [NEXT] or [PREV] key while viewing a Setup *parameter* screen. The [NEXT] key displays the parameter, which is next on the list; the [PREV] key displays the previous parameter from the list. The list order of the setup parameters is as follows:

- (1) Engineering Units
- (2) Jog Speed and Accel
- (3) Trigger Mode
- (4) Erase Program Blocks
- (5) Password
- (6) DELTACOMP - Load Inertia Ratio
- (7) DELTACOMP - High Frequency Response
- (8) DELTACOMP - Position Loop Gain
- (9) DELTACOMP - Gain Reduction
- (10) DELTACOMP - Feed Forward Gain
- (11) DELTACOMP - Notch Filter
- (12) Motor Code
- (13) Brake Mode
- (14) Brake Threshold
- (15) Monitor Output Type
- (16) Torque Limit
- (17) CCW Rotation Torque Limit
- (18) CCW Rotation Absorption Torque Limit
- (19) CW Rotation Torque Limit
- (20) CW Rotation Absorption Torque Limit
- (21) Auto Tuning
- (22) Auto Start
- (23) Motor Direction
- (24) ASCII Mode
- (25) PLS Source
- (26) Display Variables
- (27) Set Absolute Zero
- (28) Ext Regen Value
- (29) Ext Regen Watts

7.2 PROGRAMMING SETUP INFORMATION (cont'd)

This list forms a continuous loop so that, if the [NEXT] key is pressed at the Ext Regen Watts *parameter* screen, the Engineering Units *parameter* screen is displayed. Likewise, if [PREV] is pressed at the Engineering Units *parameter* screen, the Ext Regen Watts *parameter* screen is displayed.

The Setup *entry* screen (Refer to the **Figure 7.3**) is displayed by pressing [ENTER] while viewing the Setup *parameter* screen. The actions that are permitted while the Setup *entry* screen is displayed are:

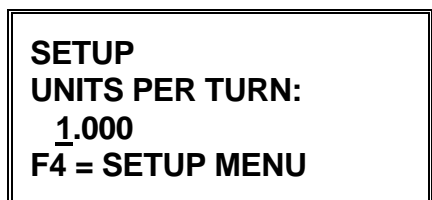


Figure 7.3 - Setup Entry Screen

1. Display a new value using the numeric keys ([0] - [9]) or the [NEXT]/[PREV] keys, depending on the setup parameter.
2. Press [ENTER] to input the currently displayed parameter value and display the Setup *parameter* screen.
3. Press [F4] to display the Setup *parameter* screen without changing the current value of the parameter.

The value can be entered by pressing the number keys [0..9] on the OPI keypad. Using the number keys allows the value to be changed or altered at any time. The user could also make use of the [BACKSPACE] key in order to erase or "rub out" any numbers they did not wish to enter.

If an invalid value is entered for the Setup parameter, the Invalid Entry screen is displayed showing the range of valid values for that parameter (refer to Error! Reference source not found.). The action that is permitted while the Invalid Entry screen is displayed is:



Figure 7.4 - Invalid Entry Screen

1. Press [F4] to display the Setup *entry* screen.

In the following sections, each setup parameter will be shown along with a list of acceptable entries.

7.2.1 ENGINEERING UNITS

Motion commands are communicated with the DeltaPro Motion Control System in terms of "Engineering Units". Engineering units are defined as any conversion, which can be expressed as units per motor shaft revolution. They do not have to be a specific distance unit such as inches or millimeters. If 1234 is entered for engineering units a value of 1234 will need to be entered in an index command to go a full turn on the motor shaft. If the index distance is 617 the motor shaft will rotate 1/2 of a turn.

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|----------------------|---|---------------------------|
| UNITS PER TURN | Conversion factor to relate units per motor shaft revolution. | 0.00010 - 9,999,999 Units |

7.2.2 JOG SPEED AND ACCEL

The jog speed is the maximum speed at which the motor will jog either CW or CCW. The jog accel is the rate of both acceleration and deceleration when the motor is jogging. Refer to "**Section 5.3 - Manual Operations**" for more information on jog operations.

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|----------------------|------------------------------------|--------------------------------|
| JOG SPEED | Speed at which the servo will jog | 1 - 5600 Revs/min |
| JOG ACCEL | Rate at which the servo will ac/dc | 1 - 1600 Revs/sec ² |

Caution is advised to not exceed the maximum speed of the motor when jogging.

NOTE

There are two cursor positions on the Jog Speed and Accel entry screen: one for the Jog Speed input and one for the Jog Accel input.

If a value, which is invalid, is entered for Jog Speed, the Invalid Entry screen is displayed showing that the range of valid values is 1 to 5600 RPM.

If a value, which is invalid, is entered for Jog Accel, the Invalid Entry screen is displayed showing that the range of valid values is 1 to 1600 revs/sec/sec.

7.2.3 TRIGGER MODE

Trigger Mode defines what block the DeltaPro Motion Control System executes during automatic operations (refer to "**Section 5 - Operations**" for a description of automatic operations). While executing a block, inputs 1 through 8 can be utilized within the program. These inputs are only dedicated to trigger the execution of a block when in automatic run mode and not currently executing a block. There are two execution modes:

Input Trigger Mode: Input locations 1 through 8 are scanned. If there is a change of state from OFF to ON, the block number corresponding to the input, which changed state, will begin execution. .

Binary Trigger Mode: Input (#8) is defined as the MOVE input. When the MOVE input changes state from OFF to ON, the block number corresponding to the binary code on Inputs #1 through #7 will begin execution. For example, if Input #2 and Input #6 are ON when MOVE changes from OFF to ON, block number 34 (binary 2 for Input #2 plus binary 32 for Input #6) will begin execution. Refer to **Figure 7.5** for a summary of binary codes. The highest block number (all Inputs ON) is 127.

7.2.3 TRIGGER MODE (cont'd)

| USER INPUT # | BINARY CODE |
|--------------|-------------|
| 1 | 1 |
| 2 | 2 |
| 3 | 4 |
| 4 | 8 |
| 5 | 16 |
| 6 | 32 |
| 7 | 64 |

Figure 7.5 - Binary Trigger Codes Summary

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|----------------------|---|------------------------------------|
| TRIGGER MODE | Selects how block execution will begin. | INPUT TRIGGER or BINARY TRIGGER |

7.2.4 ERASE PROGRAM BLOCKS

CAUTION
**EXECUTING THE ERASE PROGRAM BLOCKS FUNCTION
DESTROYS ALL PROGRAM BLOCK INFORMATION.
PROGRAM BLOCKS WILL NEED TO BE RE-PROGRAMMED
BEFORE AUTOMATIC OPERATIONS CAN RESUME.**

Erase Program Blocks is a function, which allows the user to erase all of the steps (commands) in all of the program blocks except block 128. In block 128 step 1 a Turn Drive On command will be inserted. The only way to delete this command is to go to block 128 and select delete. Refer to "**Section 7.4 - Programming Block Commands**" for information on programming block steps.

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|----------------------|---|---------------|
| ERASE BLOCKS? | This will erase all programs from block 1 to 132 inclusive. | Yes or No |

7.2.5 PASSWORD

This parameter allows the user to change the password from its default setting of zero "0". Since, only personnel with setup password access can enter setup mode, the user was then given the ability to change the password. This password is used for both the setup and program mode.

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|----------------------|--|---------------|
| PASSWORD | Limits access to programs to authorized personnel. | 0 to 9999 |

NOTE

If the user forgets the password, contact IIS for a default password so that the user can enter the setup mode and change the password.

7.2.6 LOAD INERTIA RATIO

This parameter allows the user to change the Load Inertia Ratio. The Load Inertia Ratio sets the baseline frequency response of the driver using the ratio of the load inertia/motor inertia for a rigidly coupled load. If the load is not rigidly coupled, the value entered may vary from the calculated value. If the value is set to high, the motor and driver may become unstable and oscillate. The parameter is set during auto tuning.

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|-----------------------|--|---------------|
| LOAD INERTIA RATIO | Sets the baseline frequency response of the driver using the ratio of the load inertia/motor inertia for a rigidly coupled load. If the load is not rigidly coupled, the value entered may vary from the calculated value. If the value is set to high, the motor and driver may become unstable and oscillate. The parameter is set during auto tuning. | 0.0 to 100.0 |

7.2.7 HIGH FREQUENCY RESPONSE

This parameter allows the user to change the High Frequency Response. The High Frequency Response value is used to set the high frequency response of the driver. The higher the number the more responsive. If the value is set too high, the motor and driver may become unstable and oscillate. This value works in concert with the LOAD INERTIA RATIO. This value is set during auto tuning.

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|----------------------------|---|---------------|
| HIGH FREQUENCY RESPONSE | Sets the high frequency response of the driver. The higher the number the more responsive. If the value is set too high, the motor and driver may become unstable and oscillate. This value works in concert with the LOAD INERTIA RATIO. This value is set during auto tuning. | 0.1 to 20.0 |

7.2.8 POSITION LOOP GAIN

This parameter allows the user to change the Position Loop Gain. The Position Loop Gain is used to set the DC gain of the position control loop. A higher value results in a stiffer, faster response. If the value is set too high, the motor and driver may become unstable and oscillate. This value is set automatically during auto tuning.

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|-------------------------------|--|---------------|
| POSITION LOOP GAIN | Sets the DC gain of the position control loop. A higher value results in a stiffer, faster response. If the value is set too high, the motor and driver may become unstable and oscillate. This value is set automatically during auto tuning. | 1 to 200 |

7.2.9 GAIN REDUCTION

This parameter allows the user to change the Gain Reduction. The Gain Reduction value is used to set the amount of gain reduction at zero speed. The gain is reduced when the motor is below 50 rev/min.

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|-----------------------|--|---------------|
| GAIN REDUCTION | Sets the amount of gain reduction at zero speed. The gain is reduced when the motor is below 50 rev/min. | 0 to 10000 |

7.2.10 FEED FORWARD GAIN

This parameter allows the user to change the feed Forward Gain. The Feed Forward Gain value is used to set the feed forward gain in the position loop. A value of 1.0 results 0.0 following error. Less than 1.0 will produce a lag between the actual motor position and the commanded position and greater than 1.0 produces a lead.

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|------------------------------|--|---------------|
| FEED FORWARD GAIN | Sets the feed forward gain in the position loop. A value of 1.0 results 0.0 following error. Less than 1.0 will produce a lag between the actual motor position and the commanded position and greater than 1.0 produces a lead. | 0.0 to 2.0 |

7.2.11 NOTCH FILTER

This parameter allows the user to change the Notch Filter. The Notch Filter value is used to set the notch frequency of a velocity loop anti-resonance filter. This filter can be used to cancel machine or servo resonance. Power must be turned OFF the ON for this parameter to take effect.

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|----------------------|---|---------------|
| NOTCH FILTER | Sets the notch frequency of a velocity loop anti-resonance filter. This filter can be used to cancel machine or servo resonance. Power must be turned OFF the ON for this parameter to take effect. | 400 to 20000 |

7.2.12 MOTOR CODE

This parameter allows the user to change the Motor Code from its default setting of "Motor Not Selected". This is very important to do in order for the motor and drive to function properly.

7.2.13 BRAKE MODE

This parameter allows the user to change the Brake Mode being used. The Brake Mode selects the type of brake sequencing when the Turn Drive Off command is executed and before the Turn Drive On command is issued (when the drive is disabled and power is applied).

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|----------------------|--|-----------------------------|
| BRAKE MODE | Selects the type of brake sequencing when the drive is disabled. | None, Mechanical or Dynamic |

7.2.14 BRAKE THRESHOLD

This parameter allows the user to change the Brake Threshold being used. When the Brake Mode is set to Mechanical, the mechanical brake is applied when the motor speed falls below this value. This value is % of rated speed

This parameter can only be accessed when the Brake Mode is set to Mechanical.

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|----------------------|--|-----------------------------|
| BRAKE MODE | Selects the type of brake sequencing when the drive is disabled. | None, Mechanical or Dynamic |

7.2.15 MONITOR OUTPUT TYPE

This parameter allows the user to select what gets output to the Monitor test point on the DeltaPro controller. The user can either select Torque or Speed to be output.

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|--------------------------------|--|--------------------|
| MONITOR OUTPUT TYPE | Selects the reference for the $\pm 3V$ signal at the monitor test point. | Speed or Torque |

7.2.16 TORQUE LIMIT

This parameter allows the user to change the Torque Limit. The Torque Limit value is used to limit the motor torque. This value is a % of peak motor torque.

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|----------------------|--|---------------|
| TORQUE LIMIT | Limits the motor torque. This value is a % of the motor peak torque. | 0.0 to 100.0 |

If 0 is entered as the torque limit, CW and CCW Torque limits can be set as described in **Section 7.2.17 - 7.2.20**.

7.2.17 CCW ROTATION TORQUE LIMIT

This parameter allows the user to change the CCW Rotation Torque Limit. The CCW Rotation Torque Limit value is used to limit the CCW rotation torque. This value is a % of peak motor torque.

This parameter can only be accessed when the Torque Limit value is set to 0.0%.

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|--------------------------------------|---|---------------|
| CCW ROTATION TORQUE LIMIT | This value is only available if the torque limit is set to 0. Limits CCW rotation torque. 100% = peak torque. | 0.0 to 100.0 |

7.2.18 CCW ROTATION ABSORPTION TORQUE LIMIT

This parameter allows the user to change the CCW Rotation Absorption Torque Limit. The CCW Rotation Absorption Torque Limit value is used to limit the CCW rotation absorption (braking) torque. This value is a % of peak motor torque.

This parameter can only be accessed when the Torque Limit value is set to 0.0%.

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|--|---|---------------|
| CCW ABSORPTION TORQUE LIMIT | This value is only available if the torque limit is set to 0. Limits CCW absorption (braking) torque. 100% = peak torque. | 0.0 to 100.0 |

7.2.19 CW ROTATION TORQUE LIMIT

This parameter allows the user to change the CW Rotation Torque Limit. The CW Rotation Torque Limit value is used to limit the CW rotation torque. This value is a % of peak motor torque.

This parameter can only be accessed when the Torque Limit value is set to 0.0%.

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|---------------------------------------|--|---------------|
| CW ABSORPTION TORQUE LIMIT | This value is only available if the torque limit is set to 0. Limits CW rotation torque. 100% = peak torque. | 0.0 to 100.0 |

7.2.20 CW ROTATION ABSORPTION TORQUE LIMIT

This parameter allows the user to change the CW Rotation Absorption Torque Limit. The CW Rotation Absorption Torque Limit value is used to limit the CW rotation absorption (braking) torque. This value is a % of peak motor torque.

This parameter can only be accessed when the Torque Limit value is set to 0.0%.

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|---------------------------------------|--|---------------|
| CW ABSORPTION TORQUE LIMIT | This value is only available if the torque limit is set to 0. Limits CW absorption (braking) torque. 100% = peak torque. | 0.0 to 100.0 |

7.2.21 AUTO TUNING

This parameter allows the user to Auto Tune the unit based on its current load. This feature is built into both the hardware and the software. Once auto tuning is initiated the user must wait for the unit's cycle to complete in order to continue with setup.

NOTE

The Auto Tune feature will automatically set values for the Load Inertia Ratio, High Frequency Response and Position Loop Gain. There are two *entry* screens for Auto Tuning.

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|----------------------|--|---------------|
| BEGIN AUTO TUNING | This allows the user to enter the auto-tuning mode, which will time the drive based on frequency, rotation and speed. The tuning process time will vary from application to application. | Yes or No |

Once the user has answered "YES" initiating the Auto Tuning function the second Auto Tuning Entry screen on the next page will be displayed. The user must now enter in the *Frequency, Rotation, and Maximum Speed*. Each of the parameters and their corresponding definitions are presented in the following table.

CAUTION

MAKE SURE WHEN EXECUTING MOTION THAT ALL PERSONNEL ARE CLEAR OF MOVING PARTS AND THAT THE MECHANICAL SYSTEMS WILL PERMIT THE FULL RANGE OF MOTION.

| PARAMETER | DEFINITION | MINIMUM VALUE | MAXIMUM VALUE | DEFAULT VALUE |
|----------------------------------|---|------------------|------------------|------------------|
| Target Frequency Response (Freq) | Sets the desired frequency response. This value is used to set the desired response of the system. If the value is too high, unstable operation may result. | 1 | 1000 Hz | 40 Hz |
| Rotation Amount (Rot) | Sets the amount of reciprocal rotation during the auto tuning sequence. | 0 | 300 Revs | 10 Revs |
| Maximum Speed (Speed) | Sets the speed of the reciprocal rotation during the auto tune sequence. | 1 | 4000 revs/min | 100 revs/min |

7.2.21 AUTO TUNING (cont'd)

Once the parameters have been selected and the auto tuning has been started, the following display can be seen on the OPI.

After pressing [F2] the following screen will appear indicating to the user that the auto tuning is being performed.



Tuning screen

1. The progress bar in the middle of this screen will fluctuate back and forth depending on the speed and its position. This will ensure a proper tuning. After the auto tuning is complete, Initiate Auto Tuning will be set to "NO" and the *parameter* screen will be displayed.

7.2.22 AUTO START

This parameter allows the user to Auto Start the unit on each power up. When this value is set to "YES" the unit will start up in Run mode on the next power up. With Auto Start set to "NO" the DeltaPro will power up to the Main Menu.

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|----------------------|---|---------------|
| AUTO START | By switching this option to YES, the unit will start in "RUN" mode upon powering the unit. If this option is "NO", then the unit will start up at the Main Menu Screen. | Yes or No |

7.2.23 MOTOR DIRECTION

This parameter allows the user to change the direction of index and position commands. When the Motor Direction is "CW" and the index distance is positive the motor will rotate in a CW direction. If the Motor Direction is "CCW" and the index distance is positive the motor will rotate in a CCW direction. If the direction is changed the position display in Run Mode will change signs.

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|----------------------|---|---------------|
| MOTOR DIRECTION | Defines the direction of the servo. CW indicates that a positive index value will rotate the motor in a CW direction while CCW indicates that a negative index value will rotate the motor in a CCW rotation. | CW or CCW |

7.2.24 ASCII MODE

This parameter allows the user to select what type of communications is used on port 1. When ASCII Mode is enabled the user to communicate to port 1 of the DeltaPro from a simple ASCII communication host using the protocol defined below. If ASCII Mode is disabled MotionPro can be used to communicate to port 1.

In data communications, the protocol defines the rules for the electrical, physical, and functional characteristics of the communications link. The protocol contains procedures required to ensure an orderly exchange of information through the link, to and from the executing programs.

The PUT_DATA serial command is used to transmit a new value for a program step variable from the host to the DeltaPro.

Format: [PUT_DATA,block,step,dt,dddd]

Where the "[" character signifies the start of an ASCII packet command, "PUT_DATA" is the command to be performed, "block" is an ASCII string representing the Block number to be modified, "step" is an ASCII string representing the Step number to be modified, and **dt** is an ASCII string representing value that refers to the data type:

| | |
|---|---|
| 01 - position (in user units) | -POSITION, WAIT POSITION |
| 02 - speed (in RPM) | -POSITION, INDEX |
| 03 - accel/decel rate (in revs/sec/sec) | -POSITION, INDEX, TRACK SPEED, INITIALIZE |
| 04 - distance (in user units) | -INDEX, WAIT DISTANCE |
| 05 - search distance (in user units) | -SEARCH FOR INPUT |
| 06 - post distance (in user units) | -SEARCH FOR INPUT |
| 07 - time (in milliseconds) | -WAIT TIME |
| 08 - initialize speed | -INITIALIZE |
| 09 - search speed | -SEARCH FOR INPUT |
| 10 - batch | -DO WHILE (Batch) |
| 11 - count | -DO WHILE (Count) |
| 14 - master gear | -RATIO |
| 15 - preset batch | -PRESET BATCH |
| 16 - slave gear | -RATIO |
| 17 - lock accel | -LOCK |
| 18 - on angle | -SET PLS ANGLE |
| 19 - off angle | -SET PLS ANGLE |
| 20 - if variable 2 | -IF VARIABLE |
| 21 - variable 2 | -LET |
| 22 - variable 3 | -LET |
| 24 - decel | -UNLOCK, FORCE DECEL |
| 25 - track speed speed | -TRACK SPEED |

dddd is a four-byte sign extended value containing the data

NOTE

Data variables containing distance or position information must be scaled properly so that they match the Engineering Units in the DeltaPro setup data. For example, if Engineering Units are 1.000 (3 decimal places) and the index distance is 1 unit, then the correct value in the data variable is 1000.

7.2.24 ASCII MODE (cont'd)

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|----------------------|--|---------------------|
| ASCII MODE | By selecting ENABLED, a simple ASCII communication host can send data to port 1 of the DeltaPro. | ENABLED or DISABLED |

7.2.25 PLS SOURCE

This parameter selects the source for the PLS (Programmable Limit Switch). The PLS can get the positional information for determining which state to be in from either the fiber optic input or the DeltaPro axis. The user can also select "NO SOURCE" to disable the PLS. If the user changes sources all currently defined PLS's will be disabled and turned off.

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|----------------------|--|--|
| PLS SOURCE | Determines where the PLS receives the angular position from. | No Source, Axis 1 or Fiber Optic |

7.2.26 DISPLAY VARIABLES

This parameter selects the variables to be displayed during Manual/Auto modes. Pressing next while on the Manual/Auto screen will display the configured variables.

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|----------------------|------------------------------------|-------------------|
| DISPLAY VARIABLES | Selects variables to be displayed. | List of Variables |

7.2.27 SET ABSOLUTE ZERO

This parameter sets the absolute home for an absolute system. The power must be cycled after setting this value. This value has no effect on non-absolute systems.

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|----------------------|--|---------------|
| SET ABS ZERO | Sets the absolute home for an absolute system. | No or Yes |

7.2.28 EXT REGEN VALUE

This parameter sets the value of an optional external regen resistor in ohms. When an external regen resistor is used, the value of the resistor is entered to allow the driver to calculate average power into the regen resistor. When the internal regen is used, enter 0.0. Power must be cycled for this parameter to take effect. See **Section 11** for details on regen resistor selection. This parameter is used with DSD-35 and larger drives.

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|----------------------|---|---------------|
| EXT REGEN VALUE | Sets the external regen resistor value in ohms. | 0-100.0 ohms |

7.2.29 EXT REGEN WATTS

This parameter sets the power rating of the optional external regen resistor in Kw. When an external regen resistor is used, the power rating in Kw of the resistor is entered to allow the driver to calculate average power into the regen resistor. When an internal regen is used, enter 0.0. Power must be cycled for this parameter to take effect. See **Section 11** for details on regen resistor selection. This parameter is used with DSD-35 and larger drives.

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|----------------------|--|---------------|
| EXT REGEN WATTS | Sets the external regen resistor power rating in Kw. | 0-327.67 kw |

7.3 BLOCK COMMANDS

Block commands are used to define a sequence of actions, which the DeltaPro Motion Control System may execute during automatic operation. Refer to **Figure 7.6** for a summary of commands. The commands are programmed into block steps, which are user defined to fit specific applications.

NOTE

Many block command parameters may be entered during programming or during block execution. If entered during block execution, the value may be input from the Operator Interface keypad. Use the [NEXT]/[PREV] keys during programming to select KYPAD. If a new value is not input during execution the initial value will be used.

Block Command Summary

| COMMAND | PARAMETERS | ENTRY OPTIONS | DESCRIPTION |
|---|---|--|---|
| MOTION & I/O | | | |
| INDEX | Index Top Speed Accel Rate Degree | PROG, RUN, VAR PROG, RUN, VAR PROG, RUN, VAR PROG | An incremental move of the index distance (relative to the current position). |
| POSITION | Position Top Speed Accel Rate Degree | PROG, RUN, VAR PROG, RUN, VAR PROG, RUN, VAR PROG | An absolute move to the desired position (relative to 0.0). |
| SEARCH FOR INPUT INPUT ON INPUT OFF | Search Distance Max. Post Sensor Distance Speed Input # I/O State | PROG, RUN, VAR PROG, RUN, VAR PROG, RUN, VAR PROG PROG | Continue a move until the input is energized or the maximum search distance is traveled. Travel the post distance after the input is energized. |
| TURN ON/OFF OUTPUT ON OUTPUT OFF DRIVE ON DRIVE OFF | Output # | PROG | Turn the specified output or drive amp ON or OFF. |
| TRACK SPEED | Top Speed Accel Rate | PROG, RUN, VAR PROG, RUN, VAR | Jogs the motor at the desired speed. |
| FORCE DECEL | Deceleration | PROG, RUN, VAR | Forces the speed to zero at the set Deceleration Rate. |

| COMMAND | PARAMETERS | ENTRY OPTIONS | DESCRIPTION |
|--|---|--|---|
| PROG = Enter in Program mode RUN = Enter during execution VAR = Use a variable during execution | | | |
| BRANCHING | | | |
| DO WHILE INPUT ON INPUT OFF COUNT UNTIL EXIT BATCH | Input # or Count | PROG PROG, RUN, VAR | Repeat the steps between DO WHILE and END WHILE until the desired condition is satisfied. |
| END WHILE | | | End of DO WHILE loop. |
| EXIT BLOCK | | | Terminate block execution. |
| EXIT BLK IF INPUT INPUT ON INPUT OFF | Input # | PROG | Terminate block execution if the input is energized. |
| IF BUSY | Step Number | PROG | Goes to the specified step number if the controller is busy. |
| IF I/O INPUT ON INPUT OFF PLS ON PLS OFF | I/O Speed I/O Number Step # | PROG PROG PROG | Goes to the specified step within the Block if the condition is met. |
| If VARIABLE VAR1=VAR2 VAR1<>VAR2 VAR1<VAR2 VAR1>VAR2 VAR1<=VAR2 VAR1>=VAR2 | Operand 1 Condition Operand 2 Step | PROG, RUN, VAR PROG PROG, RUN, VAR PROG | Goes to the specified step within the current Block if the condition is met. |
| INITIALIZE | | | |
| CLR 0.0 | | | Clear the SET 0.0 command and return the system to using the absolute 0.0 position. |
| CCW LIMIT INP #11 | | | Enables or disables the CCW limit input #11. |
| CW LIMIT INP #10 | | | Enables or disables the CW limit input #10. |
| INITIALIZE ZREV DISABLE ZREV ENABLE | Speed Accel Rate | PROG, RUN, VAR PROG, RUN, VAR | Initializes the motor to a marker position. There are two markers per motor revolution. |
| SET 0.0 | | | Force current position to be the 0.0 position. |

| COMMAND | PARAMETERS | ENTRY OPTIONS | DESCRIPTION |
|--|--|--|---|
| PROG = Enter in Program mode RUN = Enter during execution VAR = Use a variable during execution | | | |
| FOLLOWER | | | |
| CAM START | Master Scale Data Scale | PROG PROG | Clears Cam table and defines setup information. |
| CAM SEGMENT | Segment Type Distance Start Element End Element | PROG PROG PROG PROG | Defines a Cam segment to be executed by the controller. |
| CAM END | | | Calculates the Cam and displays fault. |
| LOCK | Lock Immediate Ratio Lock Lock on Angle | PROG, RUN, VAR PROG, RUN, VAR PROG, RUN, VAR | Locks to a master position vector with a specified accel/decel rate. |
| RATIO | Master Gear Slave Gear | PROG, RUN, VAR PROG, RUN, VAR | Creates an electronic gearbox between the fiber optic date and the DPRO axis, Accel/Decel limit is applied to the follower. |
| SET PLS ANGLE DISABLE ENABLE | PLS # On Angle Off Angle | PROG PROG, RUN, VAR PROG, RUN, VAR | Turn on and off a hardware (output) or software PLS at the desired angle in bits. |
| SET CAM PTR | Element | PROG | Sets the element to begin the electronic cam at. |
| UNLOCK | Deceleration Rate | PROG, RUN, VAR | Terminates master/slave lock. |
| MISCELLANEOUS | | | |
| LET VAR1=VAR2 VAR1=VAR2+VAR3 VAR1=VAR2-VAR3 VAR1=VAR2*VAR3 VAR1=VAR2/VAR3 | Var1 Var2 Var3 | PROG, VAR PROG, RUN, VAR PROG, RUN, VAR | Places the desired value into a variable. |
| PRESET BATCH | Count | PROG, RUN, VAR | Preset the counter to be used by the DO WHILE BATCH Command. |
| WAIT DISTANCE | Distance | PROG, RUN, VAR | Wait until distance is traveled before executing the next step. |
| WAIT I/O INPUT ON INPUT OFF PLS ON PLS OFF | Input # or PLS # | PROG PROG | Wait for the specified input or PLS condition. |

| COMMAND | PARAMETERS | ENTRY OPTIONS | DESCRIPTION |
|-----------------|------------|--|--|
| | | PROG = Enter in Program mode RUN = Enter during execution VAR = Use a variable during execution | |
| WAIT POSITION | Position | PROG, RUN, VAR | Wait until position is reached before executing the next step. |
| WAIT TIME (ms) | Time | PROG, RUN, VAR | Programmed delay. |
| WAIT UNTIL STOP | | | Wait until motion is done before executing the next step. |

Figure 7.6 - Block Command Summary

7.3.1 BLOCK COMMAND CATEGORIES

Block commands fall into one of three types:

WAIT commands

The specified condition of a wait command must be satisfied before the DeltaPro Motion Control System will execute the next command in the block. The wait commands are:

WAIT TIME (ms)
 WAIT UNTIL STOP
 WAIT POSITION
 WAIT DISTANCE
 WAIT I/O

IMMEDIATE commands

These commands are executed immediately if the system is not executing a wait command. They are executed whether the motor is busy or not. The immediate commands are:

| | |
|-------------------|-------------------|
| EXIT BLK IF INPUT | DO WHILE |
| SET 0.0 | END WHILE |
| CLR 0.0 | EXIT BLOCK |
| TURN ON/OFF | PRESET BATCH |
| CAM START | CW LIMIT INP #10 |
| CAM SEGMENT | CCW LIMIT INP #11 |
| CAM END | SET PLS ANGLE |
| SET CAM POINTER | LET |
| RATIO | IF VARIABLE |
| INDEX | POSITION |
| LOCK | IF I/O |
| IF BUSY | SEARCH FOR INPUT |
| TRACK SPEED | |

7.3.1 BLOCK COMMAND CATEGORIES (cont'd)

PERMANENT commands

These commands are executed immediately and remain active until disabled. Changing modes does not reset the outputs, disable the limit switches or stop the PLS from running. The permanent commands are:

- SET 0.0
- CLR 0.0
- TURN ON/OFF
- CW LIMIT INP #10
- CCW LIMIT INP #11
- SET PLS ANGLE
- LET

The only command that does not fit into any of the above categories is the Initialize.

7.3.2 BLOCK COMMAND EXECUTION

During execution of the block commands, the DeltaPro Motion Control System does not necessarily complete a command before the next one is executed. When an immediate command follows a motion command, the system executes the immediate command before the motion command is complete. Immediate commands are always completed before the next command in the list is executed.

For example, consider this block of steps:

- 1.1 INDEX
- 1.2 WAIT TILL STOP
- 1.3 TURN OUTPUT ON

The motor will index the specified distance, wait for the motor to stop moving, and then turn on the specified output. Now, consider this block of steps:

- 1.1 INDEX
- 1.2 TURN OUTPUT ON
- 1.3 WAIT TILL STOP

The motor will start the index, turn the specified output on while the system is still indexing, and then wait for the motor to stop.

7.3.3 BLOCK COMMAND SEQUENCING

During block command programming (refer to "**Section 7.4 - Programming Block Commands**"), commands are inserted and deleted into block steps. The block commands are then executed during automatic operation in sequential order, beginning with the "top", or lowest step number, of the block.

Figure 7.7 example A shows an example of two blocks. Block #1 contains three steps. The WAIT POSITION command is in Step #1 and the TURN ON/OFF command is in Step #2. Step #3 contains the END OF BLOCK command. The END OF BLOCK command is automatically inserted into every block and cannot be deleted. Block #2 has not been programmed with commands and contains only the END OF BLOCK command.

Figure 7.7 example B shows the blocks after the INDEX command is inserted into Block #1, Step #3 - the END OF BLOCK command has moved to Step #4.

7.3.3 BLOCK COMMAND SEQUENCING (cont'd)

Figure 7.7 example C shows what happens after another command - WAIT TIME - is inserted into Block #1, Step #3. Inserting a command into a step "pushes down" the following commands into higher step numbers. Likewise, deleting a command from a step "pushes up" the following commands into lower step numbers.

Figure 7.7 example D shows the blocks after the TURN ON/OFF command is deleted from Block #1, Step #2.

| | | | | | | |
|-----------------|---------------|--|-----------------|--|--|----------|
| BLOCK #1 | | | BLOCK #2 | | | A |
| STEP #1 | WAIT POSITION | | END OF BLOCK | | | |
| STEP #2 | TURN ON/OFF | | | | | |
| STEP #3 | END OF BLOCK | | | | | |
| STEP #4 | | | | | | |
| STEP #5 | | | | | | |
| STEP #6 | | | | | | |
| STEP #7 | | | | | | |
| BLOCK #1 | | | BLOCK #2 | | | B |
| STEP #1 | WAIT POSITION | | END OF BLOCK | | | |
| STEP #2 | TURN ON/OFF | | | | | |
| STEP #3 | INDEX | | | | | |
| STEP #4 | END OF BLOCK | | | | | |
| STEP #5 | | | | | | |
| STEP #6 | | | | | | |
| STEP #7 | | | | | | |
| BLOCK #1 | | | BLOCK #2 | | | C |
| STEP #1 | WAIT POSITION | | END OF BLOCK | | | |
| STEP #2 | TURN ON/OFF | | | | | |
| STEP #3 | WAIT TIME | | | | | |
| STEP #4 | INDEX | | | | | |
| STEP #5 | END OF BLOCK | | | | | |
| STEP #6 | | | | | | |
| STEP #7 | | | | | | |
| BLOCK #1 | | | BLOCK #2 | | | D |
| STEP #1 | WAIT POSITION | | END OF BLOCK | | | |
| STEP #2 | WAIT TIME | | | | | |
| STEP #3 | INDEX | | | | | |
| STEP #4 | END OF BLOCK | | | | | |
| STEP #5 | | | | | | |
| STEP #6 | | | | | | |
| STEP #7 | | | | | | |

Figure 7.7 - Block Command Insertion and Deletion

7.4 PROGRAMMING BLOCK COMMANDS

Press the [F2] key while viewing the Main Menu screen on the Operator Interface and input the correct password to put the DeltaPro Motion Control System into the Program mode. Use the Program mode to program blocks of steps (commands) that define a sequence of actions, which the DeltaPro Motion Control System may execute during automatic operations.

NOTE

Block steps must be programmed before the DeltaPro Motion Control System can operate in the automatic mode.

A total of 200 steps may be programmed. Blocks may contain any number of steps, as long as the total number of steps in all blocks does not exceed 200. There could be 100 blocks defined with two steps each, or there could be 1 block defined with 200 steps, or any combination in between.

After the blocks are programmed they are stored in nonvolatile memory and do not need to be programmed again, unless the application changes. All of the blocks may be erased by using the Erase Program Blocks function in the Setup mode (refer to "**Section 7.2 - Programming Setup Information**").

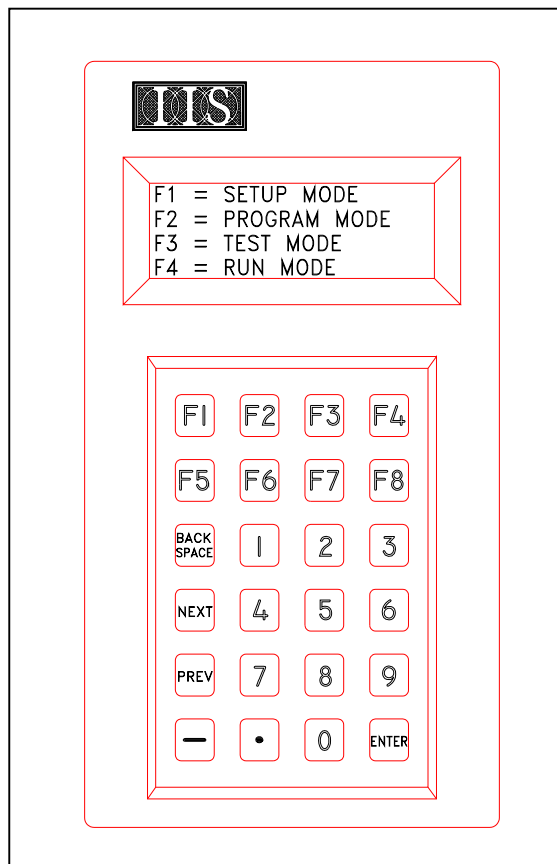


Figure 7.8 - Operator Interface

7.4 PROGRAMMING BLOCK COMMANDS (cont'd)

Programming block steps through the Operator Interface follows a general pattern. Command parameter values are defined and the commands are then entered into the block steps. The command parameter value may be entered during programming or, in many cases; it may be entered through the Operator Interface keypad during execution.

The steps for programming a block are:

1. Enter the block number in the Block Menu screen.
2. Insert and/or delete commands as needed using the Step Menu, the *command* selection screens, and the Command Parameter *entry* screen.

The first screen after pressing [F2] in the Main Menu requires the block number entry. The actions possible while the Block Menu screen is displayed are:

ENTER BLOCK NO.

1

F4 = MAIN MENU

Block Menu Screen

1. Press the numeric keys ([0] - [9]) to display a new block number.
2. Press [ENTER] to display the Step Menu.
3. Press [F4] to display the Main Menu.

If a value, which is invalid, is entered for the block number, the Invalid Entry screen is displayed showing the range of valid values.

INVALID ENTRY

RANGE IS:

1 TO 132

F4 = RE-ENTER

Invalid Entry Screen

1. Press [F4] to return to the Block Menu screen.

Valid block numbers range from 1 to 132 with those above 127 being defined as special blocks. Refer to **Figure 7.9 - DeltaPro Block Execution** to understand how the special blocks are utilized. Any of the commands may be used in these special blocks with the exception of block 132, which is a 'fault recovery' block. Motion commands are ignored in this block.

DeltaPro BLOCK EXECUTION

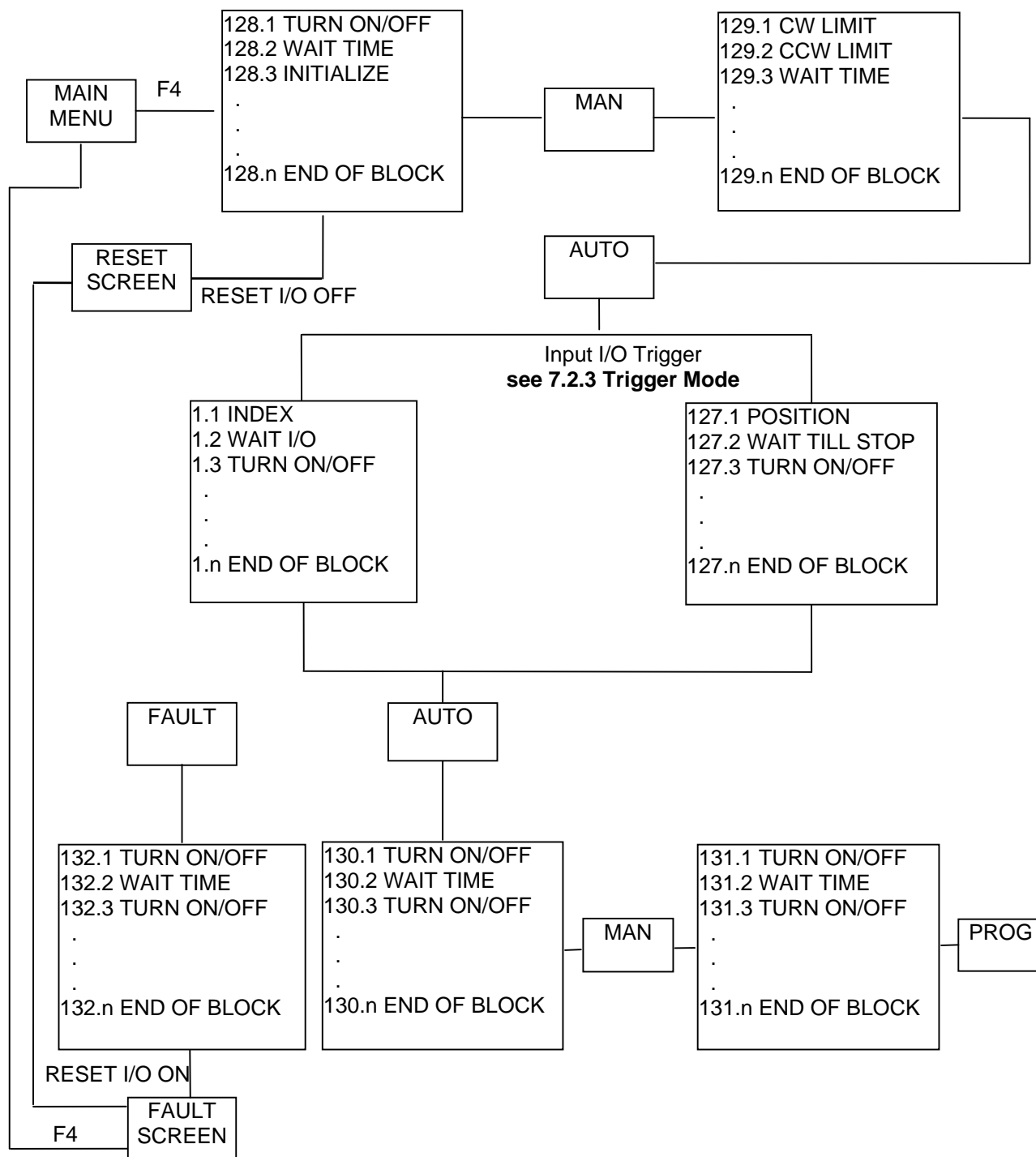


Figure 7.9 - DeltaPro Block Execution

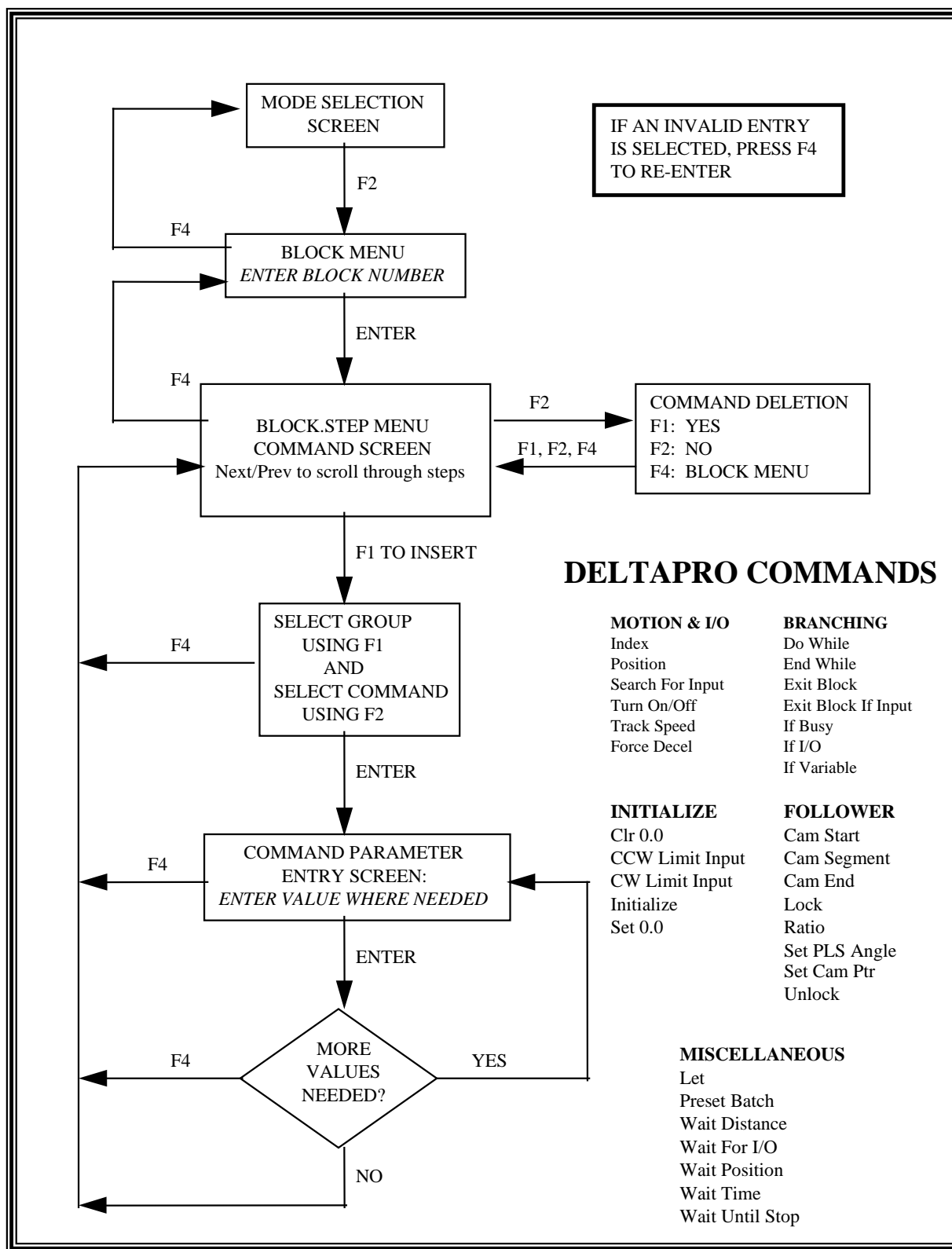


Figure 7.10 - Programming Block.Step Commands

7.5 STEP MENU

The Step Menu displays the command currently in the displayed block and step number. (BLOCK.STEP 1.3 refers to block number 1 and step number 3.) **Figure 7.10** outlines the basic flow for programming the DeltaPro controller.

NOTE

The End Of Block command is automatically inserted into every block and cannot be deleted.

Commands are inserted into the currently displayed step number. Commands already present in the block at the current or later step numbers are "pushed" down. That is, if a command is inserted into step 1, the command that was in step 1 is moved to step 2, the command in step 2 is moved to step 3, and so on. When a command is deleted, the commands are similarly "pushed" up. The actions that are allowed while viewing the Step Menu are on the following page.

BLOCK.STEP 1.1 *
END OF BLOCK
F1 = INS F2 = DEL
F4 = BLOCK MENU

Block Step Menu Screen

1. Press [F1] to display a *command* selection screen.
2. Press [F2] to display the Command Deletion screen. This two-step deletion process prevents accidental deletion if [F2] is pressed by mistake.
3. Press [NEXT] or [PREV] to access the next or previous Step Menu.
4. Press [ENTER] to change or view the parameter values of the command displayed in the current Step Menu.
5. Press [F4] to display the Block Menu.

Press [NEXT] or [PREV] to display the commands in the block. For example, if the Step Menu currently displayed is BLOCK.STEP 1.1, press [NEXT] to display the BLOCK.STEP 1.2 Step Menu or [PREV] to display the last Step Menu in that block. If the Step Menu currently displayed is BLOCK.STEP 3.4, press [NEXT] to display the BLOCK.STEP 3.5 Step Menu or [PREV] to display the BLOCK.STEP 3.3 Step Menu.

The Command Deletion screen permits deletion of the current BLOCK.STEP command. The actions that are allowed while viewing the Command Deletion screen are:

BLOCK.STEP 1.1
ARE YOU SURE?
F1 = YES F2 = NO
F4 = STEP MENU

Command Deletion Screen

1. Press [F1] to delete the current BLOCK.STEP command and display the Step Menu.
2. Press [F2] or [F4] to display the Step Menu without deleting the current BLOCK.STEP command.

7.5 STEP MENU (cont'd)

BLOCK.STEP 1.1 *
WAIT POSITION
(miscellaneous)
F1=GRP F2=CMD
F4=MNU

Group/Command Selection Screen

1. Press [F1] to select the group of commands.
2. Press [F2] to scroll to the desired command.
3. Press [F4] to display the Step Menu.

BLOCK.STEP 1.1 *
WAIT POSITION *

F4 = STEP MENU

Command Selection Screen

1. Press [ENTER] to display the Command Parameter *entry* screen, if the command has parameters associated with it.
OR
To enter the command into the block step and display the Step Menu, if the command does not have parameters associated with it.
2. Press [NEXT] or [PREV] to display a different *command* selection screen.
3. Press [F4] to display the Step Menu.

To access the different commands, the Group/Command selection Screen is used. The commands are divided into five groups. Pressing the [F1] key is used to scroll through the Groups of motion and pressing the [F2] key allows the user to scroll through the commands of the selected Group.

| Motion & I/O | Branching | Initialize | Follower | Miscellaneous |
|------------------|---------------------|-------------------|---------------|-----------------|
| Index | Do While | Clr 0.0 | Cam Start | Let |
| Position | End While | CCW Limit Inp #11 | Cam Segment | Preset Batch |
| Search for Input | Exit Block | CW Limit Inp #10 | Cam End | Wait Distance |
| Turn On/Off | Exit Block If Input | Initialize | Lock | Wait for I/O |
| Track Speed | If Busy | Set 0.0 | Ratio | Wait Position |
| Force Decel | If I/O | | Set PLS Angle | Wait Time |
| | If Variable | | Set Cam Ptr | Wait Until Stop |
| | | | Unlock | |

Each list of commands forms a continuous loop so that, if the [F2] key is pressed while viewing the command Force Decel in the Motion Group, the Index command selection screen will be displayed.

The Command Parameter *entry* screen allows the command parameter value to be entered. The actions possible while viewing the Command Parameter *entry* screen are shown below.

WAIT POSITION
.000

F4 = STEP MENU

Command Parameter *Entry* Screen

1. Press the numeric keys ([0] - [9]) to display a new value.
2. Press [NEXT] or [PREV] to select the option to be used for parameter value input during execution.
3. Press [ENTER] to input the parameter value or the method of parameter value input. The cursor is moved to the next parameter input position. If there are no more parameters, the command is entered into the block step and the Step Menu is displayed.
4. Press [F4] to display the Step Menu without entering the command into the block step.

7.5 STEP MENU (cont'd)

If the **KYPAD** option is chosen as the method of entering the command parameter value during execution, an Initial Value screen is displayed prompting for an initial parameter value.

```
ENTER----->
INITIAL VALUE:
  .000
F4 = RE-ENTER VALUE
```

Initial Value Screen

1. Press the numeric keys ([0] - [9]) to display a new initial command parameter value.
2. Press [ENTER] to input the initial parameter value. The Command Parameter *entry* screen is displayed and the cursor is moved to the next parameter input position. If there are no more parameters, the command is entered into the block step and the Step Menu is displayed.
3. Press [F4] to display the Command Parameter *entry* screen without entering an initial value.

If a value, which is invalid, is entered for the Command Parameter, the Invalid Entry screen is displayed showing the range of valid parameter values. The action that is permitted while viewing the Invalid Entry screen is:

```
INVALID ENTRY
RANGE IS:
  1 TO 5600
F4 = RE-ENTER
```

Invalid Entry Screen

1. Press [F4] to display the Command Parameter *entry* screen.

In the following sections, each *command* is described along with its' parameters.

NOTE

The action options which are listed along the side of the sample screens are options and do not need to be taken. Pressing an Operator Interface key, which is not listed in the action options, will have no effect.

7.5.1 INDEX

An "Index" movement is one, which uses its present location as the starting point. The index, which is programmed, is relative to the present locations starting point. The direction of the movement is controlled by the sign (plus or minus) of the programmed value and the global direction.

NOTE

INDEX, SPEED, and ACCEL can utilize variables or be input during execution from the Operator Interface keypad.

7.5.1 INDEX (cont'd)

The INDEX command requires input of four parameter values:

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|----------------------|--|--|
| INDEX | The position desired relative to the current position. | Position cannot exceed 2000 revs (+ or -). |
| SPEED | The maximum speed the motor will turn during an index movement. | 1 to 5600 RPM. |
| ACCEL | The rate of both acceleration and deceleration during an index movement. | 1 to 1600 revs/sec/sec. |
| DEG (Degree) | The degree of the sine angle modifying the transitions between acceleration and deceleration and the steady-state speeds of the motor. | 0 to 9 degrees. A degree of zero specifies trapezoidal indexing; a degree of 1 - 9 specifies "Modified Sine Indexing". |

7.5.2 POSITION

A "Position" movement is one, which uses "Home", or 0.00 as the starting point. The position, which is programmed, is relative to the "Home" position. The final position is controlled by the sign (plus or minus) of the programmed value and the global direction, but the direction of movement depends on the starting point relative to the "Home" position.

NOTE
POS, SPEED, and ACCEL can utilize variables or be input during execution through the Operator Interface keypad.

The POSITION command requires input of four parameter values:

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|----------------------|--|--|
| POSITION | The position desired relative to the "Home" position. | Position cannot exceed 2000 revs (+ or -). |
| SPEED | The maximum speed the motor will turn during a position movement. | 1 to 5600 RPM. |
| ACCEL | The rate of both acceleration and deceleration during a position movement. | 1 to 1600 revs/sec/sec. |
| DEG (Degree) | The degree of the sine angle modifying the transitions between acceleration and deceleration and the steady-state speeds of the motor. | 0 to 9 degrees. A degree of zero specifies trapezoidal positioning; a degree of 1 - 9 specifies "Modified Sine Positioning". |

7.5.3 SEARCH FOR INPUT

The "Search for Input" function is a "feed-to-sensor" function for indexing or positioning on an external switch or sensor. A position or index movement is continued at the Search for Input function speed until the defined Input location is energized (turned ON or OFF) or until the maximum search distance is traveled. The maximum search distance serves as a limit. It prevents the search from continuing past the defined number of revolutions if the defined input does not energize. The DeltaPro Motion Control System will travel the post distance after the defined input has been energized. The SEARCH FOR INPUT command must come *BEFORE* a POSITION or INDEX command. The Search Speed must be lower than the speed the motor reaches in the POSITION or INDEX command.

The SEARCH FOR INPUT command requires input of five parameter values:

NOTE
SEARCH DIST, POST DIST, and SPEED can utilize variables or be input during execution from the Operator Interface keypad.

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|--|--|--|
| SEARCH DIST (Maximum Search Distance) | The distance the search will continue for if the defined input is not energized. | Position cannot exceed 2000 revs (+ or -). |
| POST DIST (Post Distance) | The distance that will be traveled after the defined input is energized. | Position cannot exceed 2000 revs (+ or -). |
| INPUT | The number of the defined Programmable INPUT. | 1 to 12. |
| INPUT ON/OFF | The state in which the defined input is considered energized. | ON or OFF. |
| SPD (Speed) | The maximum speed of the motor during the Search for I/O function. | 1 to 5600 RPM. |

7.5.4 TURN ON/OFF

The TURN ON/OFF command turns the defined output location or the drive amp ON or OFF.

The TURN ON/OFF command requires input of one or two parameter values (DRIVE ON/OFF or OUTPUT ON/OFF and OUTPUT):

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|--|---|--|
| OUTPUT | The number of the defined output. | 1 to 5. |
| OUTPUT ON/OFF or DRIVE ON/OFF | Specifies the output or drive amp to be turned ON or OFF. | Output ON or Output OFF or DRIVE ON or DRIVE OFF. |

7.5.5 TRACK SPEED

The TRACK SPEED command jogs the motor at the specified speed. The sign of the speed determines the direction. CW is + and CCW is -. If currently executing a TRACK SPEED command another TRACK SPEED command can be issued to change speeds. To stop jogging issue a FORCE DECEL command.

The TRACK SPEED command requires input of two parameter values:

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|----------------------|---|----------------|
| SPEED | The desired jog speed. | -5600 to 5600. |
| ACCEL | The accel rate to get to the desired speed. | 1 to 1600. |

7.5.6 FORCE DECEL

The Force Decel command forces the DeltaPro controller to zero speed at the set deceleration rate. This command is typically used during the occurrence of a fault to bring the DeltaPro system to a controlled stop.

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|----------------------|--|--------------------------------|
| FORCE DECEL | The rate of deceleration in which to stop the motor. | 1 to 1600 rev/sec ² |

7.5.7 DO WHILE

The DO WHILE command is an instruction to repeat the program steps between the DO WHILE command and the END WHILE command until the specified condition is met. There are four conditions in which may be specified to control the execution of the loop:

- 1) INPUT** The DO WHILE loop will be repeated while the INPUT is in the specified state, (State may be specified as ON or OFF). The INPUT state is checked before each pass through the DO WHILE loop.
- 2) COUNT** The DO WHILE loop will be repeated COUNT number of times.
- 3) UNTIL EXIT** The DO WHILE loop will be repeated until a terminating condition occurs. These conditions are:
 - 3.1 Change from AUTO to MANUAL mode.
 - 3.2 RESET input is ON.
 - 3.3 CW or CCW limit switch input is ON if enabled.
 - 3.4 Following error has occurred.

7.5.7 DO WHILE (cont'd)

- 4) BATCH** The BATCH COUNTER for the DeltaPro can be used by different program blocks using the DO WHILE BATCH command.

The BATCH COUNTER is decremented once every loop of the DO WHILE BATCH -> END WHILE portion of the block. The program will stop looping when the BATCH COUNTER reaches the value zero and then execute the next command after the END WHILE. When the next DO WHILE BATCH command is encountered and the BATCH COUNTER is zero, the BATCH COUNTER will be restarted with its specified value.

If execution of the block is terminated before the DO WHILE BATCH loop has been completed, the BATCH COUNTER will not be modified on restarting a DO WHILE BATCH loop. It will resume down counting at its previous count value so the program can complete the batch.

If the situation arises where BATCH COUNTER needs to restart at its' original value or some other value for one loop, the PRESET BATCH can be utilized.

NOTE
COUNT and BATCH can utilize variables or be input during execution from the Operator Interface keypad.

The DO WHILE command requires input of one or two parameter values:

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|--|---|---|
| INPUT | The number of the defined input. | 1 to 12. |
| COUNT | The number of times to repeat the DO WHILE loop. | 1 to 32767. |
| BATCH COUNT | The count value to be used if BATCH COUNTER is zero. | 1 to 32767 |
| INPUT ON/OFF or COUNT or UNTIL EXIT or BATCH | Determines what controls the execution of the DO WHILE loop | INPUT ON or INPUT OFF or COUNT or UNTIL EXIT or BATCH |

7.5.8 END WHILE

The END WHILE command specifies the end of the DO WHILE loop.

NOTE
The END WHILE command does not have any parameters associated with it and there is no END WHILE *entry* screen.

7.5.9 EXIT BLOCK

The EXIT BLOCK command forces termination of block execution.

NOTE
The EXIT BLOCK command does not have any parameters associated with it and there is no EXIT BLOCK *entry* screen.

7.5.10 EXIT BLK IF INPUT

The EXIT BLK IF INPUT command forces termination of block execution if the defined input is energized (turned ON or OFF). The EXIT BLK IF INPUT command requires input of two parameter values:

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|----------------------|---|---------------------------|
| INPUT ON/OFF | The state in which the defined input is considered energized. | INPUT ON or INPUT OFF. |
| INPUT | The number of the defined input. | 1 to 12. |

If a value, which is invalid, is entered for INPUT, the Invalid Entry screen is displayed showing that the range of valid values is 1 to 12.

7.5.11 IF BUSY

The IF BUSY command is used "jump" to a specified step number within a block if the DeltaPro controller is "busy". The IF BUSY command requires the input of one value.

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|----------------------|---|---------------|
| IF BUSY | Goes to the specified step number if the DeltaPro controller is busy. | 1 to 200 |

7.5.12 IF I/O

The IF I/O command is used to test a condition to either “jump” to a specified step in the running block or continue to the next program step. The items can be tested for the ON/OFF status of inputs, outputs or PLS's. If the status is true, the DeltaPro will execute the selected step number programmed. If the condition is false, the next step in the block will be executed.

The IF I/O command requires input of three parameter values:

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|---------------------------------------|--|--|
| INPUT ON/OFF or PLS ON/OFF | The state in which the defined input or PLS is considered energized. | INPUT ON or INPUT OFF or PLS ON or PLS OFF. |
| INPUT # | The number of the defined input. | 1 to 12. |
| PLS # | The number of the defined PLS. | 1 to 16. |
| STEP # | Step to jump too if PLS or the input is energized. | 1 to 200. |

7.5.13 IF VARIABLE

The IF VARIABLE command is used to test a condition to either “jump” to a specified step in the running block or continue to the next program step. The items tested are variables that are defined by the programmer. If the status is true, the DeltaPro will execute the selected step number programmed. If the condition is false, the next step in the block will be executed.

NOTE

VAR2 can utilize variables or be input during execution from the Operator Interface keypad.

7.5.13 IF VARIABLE (cont'd)

The IF VARIABLE command requires input of four parameter values:

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|----------------------|---|---|
| IF EXPRESSION | Determines the type of comparison for the jump. | VAR1 = VAR2 or VAR1 <> VAR2 or VAR1 < VAR2 or VAR1 > VAR2 or VAR1 <= VAR2 or VAR1 >= VAR2. |
| VAR1 | Variable used in comparison. | Variable. |
| VAR2 | Variable or constant used in comparison. | This value is limited to 7 numeric digits. The engineering units determine the number of decimal places. |
| STEP # | Step to jump too if comparison is satisfied. | 1 to 200. |

7.5.14 CLR 0.0

The CLR 0.0 (Clear 0.0) clears the set 0.0 ("floating home") and returns the DeltaPro Motion Control System to using the absolute 0.0 position.

NOTE

The CLR 0.0 command does not have any parameters associated with it and there is no CLR 0.0 entry screen.

7.5.15 CCW LIMIT INP #11

The CCW LIMIT INP #11 command specifies to enable or disable input #11 as a limit switch for motion.

The CCW LIMIT INP #11 command requires input of one parameter value:

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|--------------------------|---|--------------------|
| CCW LIMIT INP #11 | Selects whether input #11 is used to limit the motion in a CCW direction. | ENABLE or DISABLE. |

7.5.16 CW LIMIT INP #10

The CW LIMIT INP #10 command specifies to enable or disable input #10 as a limit switch for motion.

The CW LIMIT INP #10 command requires input of one parameter value:

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|-------------------------|--|--------------------|
| CW LIMIT INP #10 | Selects whether input #10 is used to limit the motion in a CW direction. | ENABLE or DISABLE. |

7.5.17 INITIALIZE

The INITIALIZE command will locate an absolute zero on the motor shaft. There are two zero locations per motor shaft revolution. The ZREV switch can be utilized for multi turn applications. The ZREV input is dedicated to input #12. In multi turn initializations the controller will calculate where the closest absolute zero location in the desired direction is when the ZREV input is triggered. The motor may go past the calculated zero and switch directions to return to the zero. The motor changing direction depends on the ACCEL rate, the speed the motor is traveling and the distance before the zero position. After this command is executed a SET 0.0 command is automatically performed. This block will remain on this step until the motion is completed.

NOTE
SPEED and ACCEL can utilize variables or be input during execution from the Operator Interface keypad.

The INITIALIZE command requires input of three parameter values:

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|--------------------------------|--|-------------------------|
| ZREV ENABLE/DISABLE | Determines if a zero revolution switch is going to be used for the INITIALIZE command. | DISABLE or ENABLE. |
| SPEED | The maximum speed the motor will turn. The sign determines the direction. A positive speed results in the motor rotating CW to find the zero. A negative direction will cause the motor to rotate CCW. | 1 to 5600 RPM (+ or -). |
| ACCEL | The rate of both acceleration and deceleration during an index movement. | 1 to 1600 revs/sec/sec. |

7.5.18 SET 0.0

The SET 0.0 command forces the current position of the motor to be an absolute 0.0 (also referred to as a "floating home"). The "floating home" will be 0.0 for all subsequent positioning movements until a CLR 0.0 (Clear 0.0) command is issued.

NOTE
The SET 0.0 command does not have any parameters associated with it and there is no SET 0.0 *entry* screen.

7.5.19 CAM START

Clears cam table and defines setup information.

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|----------------------|--|---------------|
| MASTER SCALE | Number of times to right shifts the master position as the controller receives it. | 0 to 12 |
| DATA SCALE | Number of times to left shifts each data element. | 0 to 5 |

7.5.20 CAM SEGMENT

Defines a cam segment to be executed by the DeltaPro controller.

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|----------------------|---------------------------------------|--|
| SEGMENT TYPE | Defines the type of CAM | Modified Sine Trapezoidal Custom |
| DISTANCE | Desired distance in engineering units | -2000 to 2000 revs |
| START ELEMENT | Start element of CAM | 1 to 28671 |
| END ELEMENT | End element of CAM | 2 to 28672 |

7.5.21 CAM END

Calculates the cam and displays fault information. This command must be used immediately following the final cam segments to define the cam.

NOTE
The END CAM command does not have any parameters associated with it and there is no CAM END screen.

7.5.22 LOCK

Locks the DeltaPro controller onto the master position vector with the set acceleration/deceleration rate.

| <u>Lock Method</u> | <u>Description</u> |
|--------------------|---|
| CAM Immediate | Electronic cam mode, slave axis follows digital cams based on the master angle. The current master position is used to determine the proper index into the electronic cam array. The cam will start at the beginning or the element specified in the Set Cam Ptr command. |
| Simple Ratio | Electronic equivalent of a gearbox. The electronic gearbox or ratio is driven by the master angle. The position of the master is used directly to determine the proper slave axis position and speed. |
| CAM-ON Angle | Electronic cam mode based on an angle. The slave axis will begin executing its cam when the master crosses the specified angle. The cam will start at the beginning or the element specified in the Set Cam Ptr command. |

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|----------------------|---------------------|---|
| MODE | Desired Lock method | Cam Immediate Simple Ratio Cam-on Angle |

7.5.23 RATIO

Creates an electronic gearbox between the fiber optic data and the DeltaPro axis. Accel/decel limit is applied to follower.

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|----------------------|---|---------------|
| MASTER GEAR | The ratio of master/slave gear to determine the change in motor position. | +/- 1 to 100 |
| SLAVE GEAR | The ratio of master/slave gear to determine the change in motor position. | +/- 1 to 100 |

7.5.24 SET PLS ANGLE

The SET PLS ANGLE command is used to enable or disable a programmable limit switch (PLS) based on the angle of either the master or slave axis, whichever has been defined in the setup parameter.

NOTE
ON ANGLE and OFF ANGLE can utilize variables or be input during execution from the Operator Interface keypad.

The SET PLS ANGLE command requires input of two or four parameter values:

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|-------------------------|---|-----------------------------------|
| DISABLE / ENABLE | Determines if an output or software flag is used as a PLS. | DISABLE or ENABLE. |
| PLS # | The output or software flag to be turned on and off. Values 1 to 5 are outputs and 6 to 8 are software. | 1 to 8. |
| ON ANGLE | The angle when the software PLS or output turns on. | 0 to 4095 bits (0 to 360 degrees) |
| OFF ANGLE | The angle when the software PLS or output turns off. | 0 to 4095 bits (0 to 360 degrees) |

7.5.25 SET CAM PTR

The SET CAM PTR command is used to start the cam execution from a point other than the beginning of the cam.

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|----------------------|---|---------------|
| ELEMENT | The element that the cam will start executing at when locked. | 1 to 28672 |

7.5.26 UNLOCK

Terminates master/slave lock.

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|--------------------------|--|------------------------|
| DECELERATION RATE | The rate of deceleration to unlock the slave axis. | 1 to 1600 revs/sec/sec |

7.5.27 LET VARIABLE

The LET VARIABLE command allows the user to assign a value (variable or constant) to a variable as well as add, subtract, multiply or divide another variable (or constant) to the equation. Many times when incrementing to decrementing values are required in a system, this command allows the flexibility required.

NOTE

Operand 1 and Operand 2 can utilize variables or be input during execution from the Operator Interface keypad.

The LET command requires input of three or four parameter values:

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|----------------------|---|--|
| LET EQUATION | Selects an equation to use for determining VAR1. | VAR1=VAR2 or VAR1=VAR2+VAR3 or VAR1=VAR2-VAR3 or VAR1=VAR2*VAR3 or VAR1=VAR2/VAR3 |
| RESULT | Variable that is assigned the result of the equation. | Variable. |
| OPERAND 1 | Variable or constant used in equation. | This value is limited to 7 numeric digits. The engineering units determine the number of decimal places. |
| OPERAND 2 | Variable or constant used in equation. | This value is limited to 7 numeric digits. The engineering units determine the number of decimal places. |

NOTE

If the engineering units are 1.0000, the range for the let values is from +999.9999 to -999.9999. If the engineering units are 1, the range is from +9999999 to -999999. The maximum decimal place corresponds to the number of decimal places in the engineering units.

7.5.28 PRESET BATCH

PRESET BATCH command can be used to modify the BATCH COUNTER before the next DO WHILE BATCH loop has been started.

When the next DO WHILE BATCH command starts up, the BATCH COUNTER will be restarted with the value programmed into the PRESET BATCH command.

NOTE

If the value programmed into the PRESET BATCH command is zero, the BATCH COUNTER will reset to zero but the value used to restart the next DO WHILE BATCH command will be the original value associated with that DO WHILE BATCH command.

The preset batch value will only be used once per DO WHILE BATCH command loop. If the PRESET BATCH command has not been executed after finishing the DO WHILE BATCH command loop and another DO WHILE BATCH command is started, the original batch value for that particular DO WHILE BATCH command will be used.

Since the BATCH COUNTER is universal to all blocks, the PRESET BATCH and DO WHILE BATCH commands can be in separate blocks. More than one PRESET BATCH command can be programmed into the DeltaPro at one time.

NOTE

BATCH can utilize variables or be input during execution from the Operator Interface keypad.

The PRESET BATCH command requires input of one parameter value:

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|----------------------|---|---------------|
| COUNT | The value used to modify the BATCH COUNTER before the next DO WHILE BATCH loop. | 1 to 32767. |

7.5.29 WAIT DISTANCE

The WAIT DISTANCE command forces the DeltaPro Motion Control System to wait until the motor travels the specified incremental distance relative to the starting position of the previous initiated move before executing the next step in the block. If the DeltaPro Motion Control System is not moving at the time this command is encountered, the command is ignored. The WAIT POSITION command must follow a POSITION, INDEX or FOLLOWER command.

NOTE
DISTANCE can utilize variables or be input during execution from the Operator Interface keypad.

The WAIT DISTANCE command requires input of one parameter value:

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|----------------------|--|--|
| DISTANCE | The incremental distance to travel relative to the start of the previous motion. | Position cannot exceed 2000 revs (+ or -). |

7.5.30 WAIT I/O

The WAIT I/O command provides a programmed wait until the defined Input or PLS location is energized (turned ON or OFF).

The WAIT I/O command requires input of two parameter values:

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|-----------------------------------|--|--|
| INPUT ON/OFF or PLS ON/OFF | The state in which the defined input or PLS is considered energized. | INPUT ON or INPUT OFF or PLS ON or PLS OFF. |
| INPUT | The number of the defined input. | 1 to 12. |
| PLS | The number of the defined PLS. | 1 to 16. |

7.5.31 WAIT POSITION

The WAIT POSITION command forces the DeltaPro Motion Control System to wait until the motor travels to the specified position relative to the 0.0 locations before beginning execution of the next step in the block. If the DeltaPro Motion Control System is not moving at the time this command is encountered, the command is ignored. The WAIT POSITION command must follow a POSITION, INDEX or FOLLOWER command.

NOTE
POSITION can utilize variables or be input during execution from the Operator Interface keypad.

The WAIT POSITION command requires input of one parameter value:

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|----------------------|--|--|
| POSITION | The position desired relative to the "Home" or 0.0 location. | Position cannot exceed 2000 revs (+ or -). |

7.5.32 WAIT TIME (ms)

The WAIT TIME command provides a programmed delay. When the DeltaPro Motion Control System executes the WAIT TIME command, it will wait the specified number of milliseconds (ms) until it begins execution of the next command.

NOTE
TIME can utilize variables or be input during execution the Operator Interface keypad.

The WAIT TIME command requires input of one parameter value:

| COMMAND PARAMETER | DESCRIPTION | VALID ENTRIES |
|----------------------|---|-------------------------------------|
| TIME | The number of milliseconds the DeltaPro Motion Control System will wait before execution of the next command. | 1 to 10,000 ms. Resolution is 1 ms. |

7.5.33 WAIT UNTIL STOP

The WAIT UNTIL STOP command forces the DeltaPro Motion Control System to wait until the current movement command is complete before executing the next step in the block. This command should not be used when the follower is enabled.

NOTE
The WAIT UNTIL STOP command has no parameters associated with it and there is no WAIT UNTIL STOP *entry* screen.

SECTION 8 - POWER WIRING

The DeltaPro driver and motors have three basic power wiring configurations. Each of the configurations is shown in the following power wiring diagrams (**Figures 8.2 through 8.4**). Each of the diagrams shows recommended circuit breaker, contactor and wire gauge.

8.1 CIRCUIT BREAKER

It is recommended that each driver be provided with a circuit breaker for protection of the driver and motor. All of the drives are suitable for use on a circuit capable of delivering not more than 5000 rms symmetrical amperes, 240 vac maximum when protected by a circuit breaker having an interrupting rating not less than 5000 rms symmetrical amperes, 240 volts maximum. Each of the driver wiring diagrams contains a chart of the recommended circuit breaker for each driver size.

The breaker is sized for the worst-case maximum power draw of the driver at the worst-case low line voltage. The charts contain specific vendor and size recommendations. Other types of circuit breakers or fuses may be used provided the continuous ratings are equivalent, the instantaneous rating is 10 to 15 times continuous and can support 3 times continuous for at least 3 seconds.

Lower rating protection devices may be used that are sized for the motor power rating. Contact the IIS factory for specific recommendations.

8.2 CONTACTOR

The DPRO-1.5 through DPRO-17.5 driver sizes have an internal power bus contactor. The DPRO-35 through DPRO-115 sizes require an external power bus contactor. The driver-wiring diagram for the larger size drivers contains a chart of the recommended contactor for each driver size.

The contactor is sized for the worst-case maximum power draw of the driver at the worst-case low line voltage. The charts contain specific vendor and size recommendations. Other types of contactors may be used provided the continuous ratings are equivalent and the maximum instantaneous rating is 10 to 15 times continuous. The driver is equipped with a soft start circuit to limit the contactor inrush current.

The coil voltage should be the same rating as the incoming line. The maximum current draw for the coil cannot exceed 0.25 amps. The contactor coil must be fitted with a transient voltage protection device. An RC type suppression device is preferred.

8.3 WIRE SIZES

It is required that each driver be installed with the appropriate size wire for proper operation. Each of the driver wiring diagrams contains a chart of the recommended wire gauges and terminal connection tightening torques for each driver size.

The wire is sized for the worst-case maximum power draw of the driver at the worst-case low line voltage. The charts contain specific METRIC and AWG size recommendations for stranded wire. Use only copper wire rated for 60/75 degree C or greater. The driver terminals are specifically designed to handle the recommended wire gauge with lug or ferrule terminations. See wiring diagrams for more details.

8.4 TRANSFORMERS

Isolating the driver from the facility power line with a transformer is recommended but not required. A transformer may be required to step down or step up the facility power line to meet the driver voltage specifications in **Section 3**.

If a transformer is used, select a transformer with the following characteristics:

- Isolation type.
- Load regulation less than 10%.
- Ability to provide 3 times rated current for 3 to 5 seconds without saturation.
- Ability to drive load with a power factor of 0.85.
- Primary or secondary taps to provide -10%; nominal; +10%; supply voltage.

To achieve maximum performance from the driver, the power input to the driver should be as close to nominal driver input voltage rating as possible. The facility line voltage varies through wide ranges in many parts of the world and it is recommended to match the nominal facility voltage to the nominal input voltage rating of the driver with a transformer. This gives the system the maximum operating range with facility line voltage fluctuations.

If the line voltage is too low, intermittent under voltage alarms may occur. A high line voltage will result in excessive regeneration dumping or intermittent over voltage alarms.

Buck boost transformers may be used to optimally match the facility line voltage to the driver line voltage rating. Buck boost transformers can be used with or without an isolation transformer. If buck boost transformers are used in conjunction with an isolation transformer, it is best to put the buck boost transformers on the primary side of the isolation transformer.

As a general rule the transformer rating can be calculated using the following formulas:

For single phase transformer:

$$\text{Transformer Capacity (VA)} = \frac{\text{Rated Mechanical Output (Watts)}}{0.7}$$

Where: Rated Mechanical Output is from DeltaPro Package rating.
0.7 = motor/drive efficiency and single phase full wave rectifier factor

Example: Select transformer for a DeltaPro-200HRA motor/drive package

$$\text{Transformer Capacity (VA)} = \frac{200}{0.7} = .285 \text{ VA}$$

For three phase transformer:

$$\text{Transformer Capacity (Watts)} = \frac{\text{Rated Mechanical Output (Watts)}}{0.85}$$

Where: Rated Mechanical Output is from DeltaPro Package rating.
0.85 is motor/drive efficiency and three phase rectifier factor

8.4 TRANSFORMERS (cont'd)

Example: Select transformer for a DeltaPro-6500HRA motor/drive package

$$\text{Transformer Capacity (VA)} = \frac{6500}{0.85} = 7647 \text{ Watts}$$

One transformer can supply multiple motor/driver packages. Simply add the rated mechanical output of the motor/driver packages together and use the above formulas. If one transformer is used to supply multiple drivers, be sure to protect each driver with the appropriate circuit breaker or fuse.

IIS offers a full line of transformers for various line voltage and frequencies, enclosed and open frame types. Contact IIS Application Engineering Department for full details.

8.5 BRANCH CIRCUIT PROTECTION FOR CONTROL VOLTAGE R0,S0

The DPRO-35 through DPRO-115 require a separate control voltage supply (R0 S0) for proper operation. The R0 S0 circuit is fused internal to the driver and need not be externally fused except to protect the control voltage wiring external to the driver using branch circuit protection guidelines. The control voltage circuit of multiple drivers can be fed from a single branch circuit.

8.6 WIRING PRACTICES AND GROUNDING

All wiring must conform to accepted standards such as NEMA and NEC codes. Signal and low voltage I/O wires must be physically separated from high voltage wires by at least 12 inches or separated by a suitable barrier such as steel conduit or wiring through separators.

The driver must be adequately grounded for proper operation and to provide personal safety. The proper grounding technique is shown in **Figure 8.1** below.

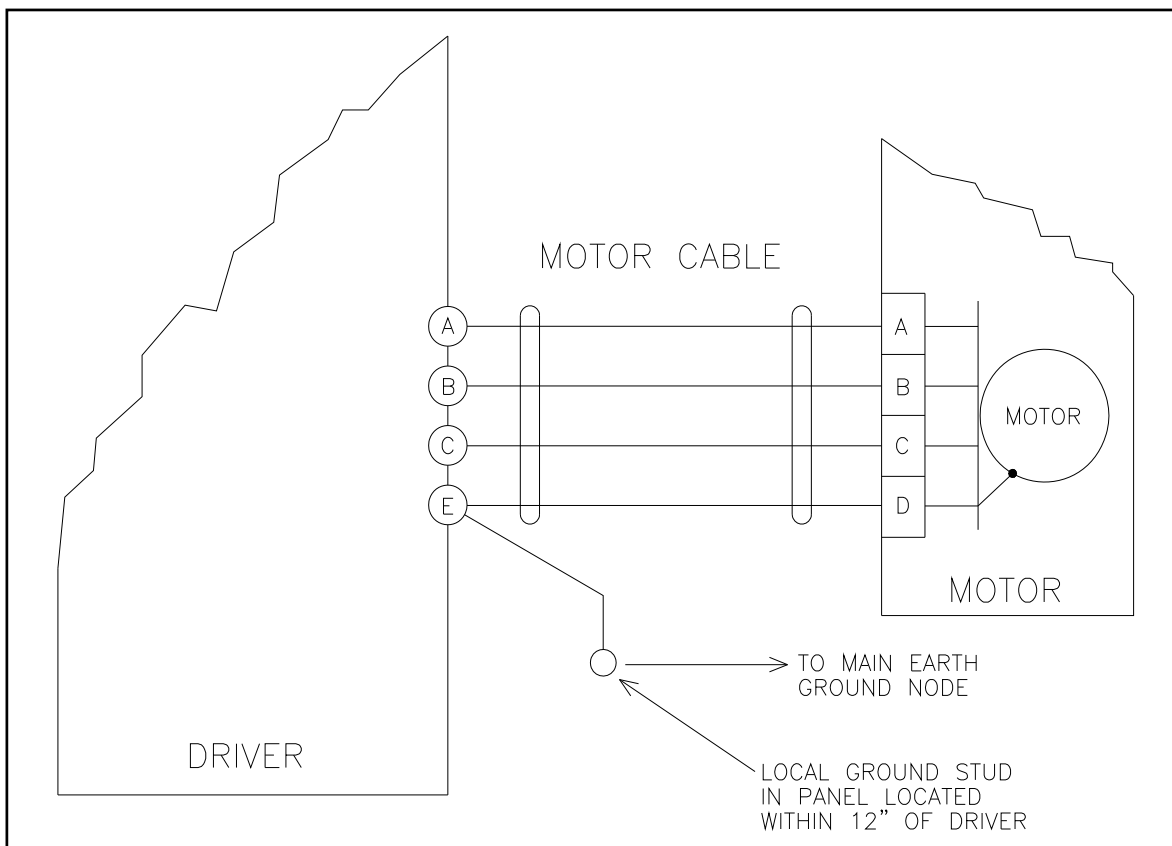


Figure 8.1 - Grounding Technique

NOTE

Multiple drivers can share a local ground stud if it is located within 12" of each driver's (E) terminal. The ground symbol on each drive indicates that a connection must be made between the (E) terminal of the drive and earth ground.



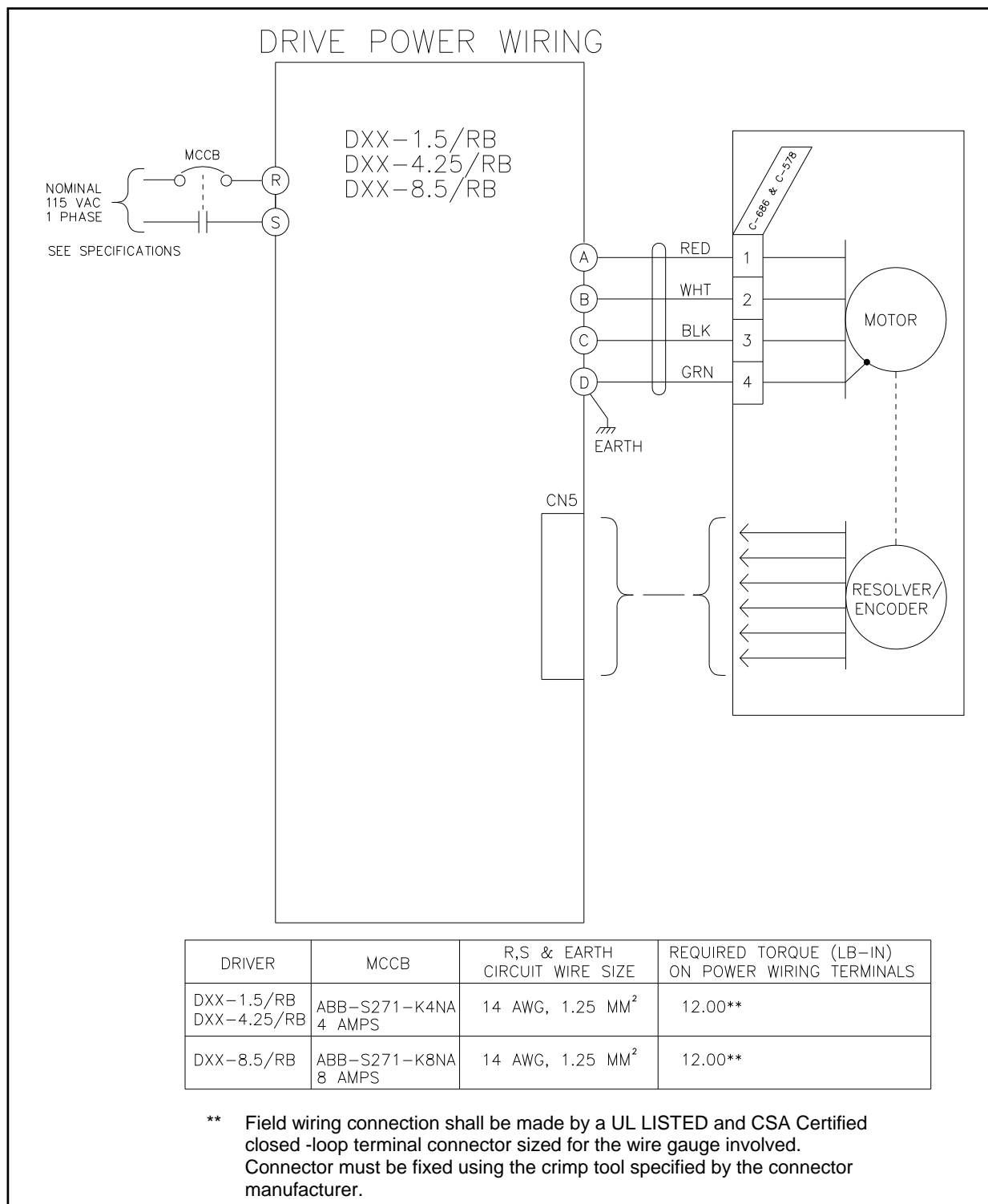


Figure 8.2 - DPRO-1.5/RB Through DPRO-8.5/RB Power Wiring

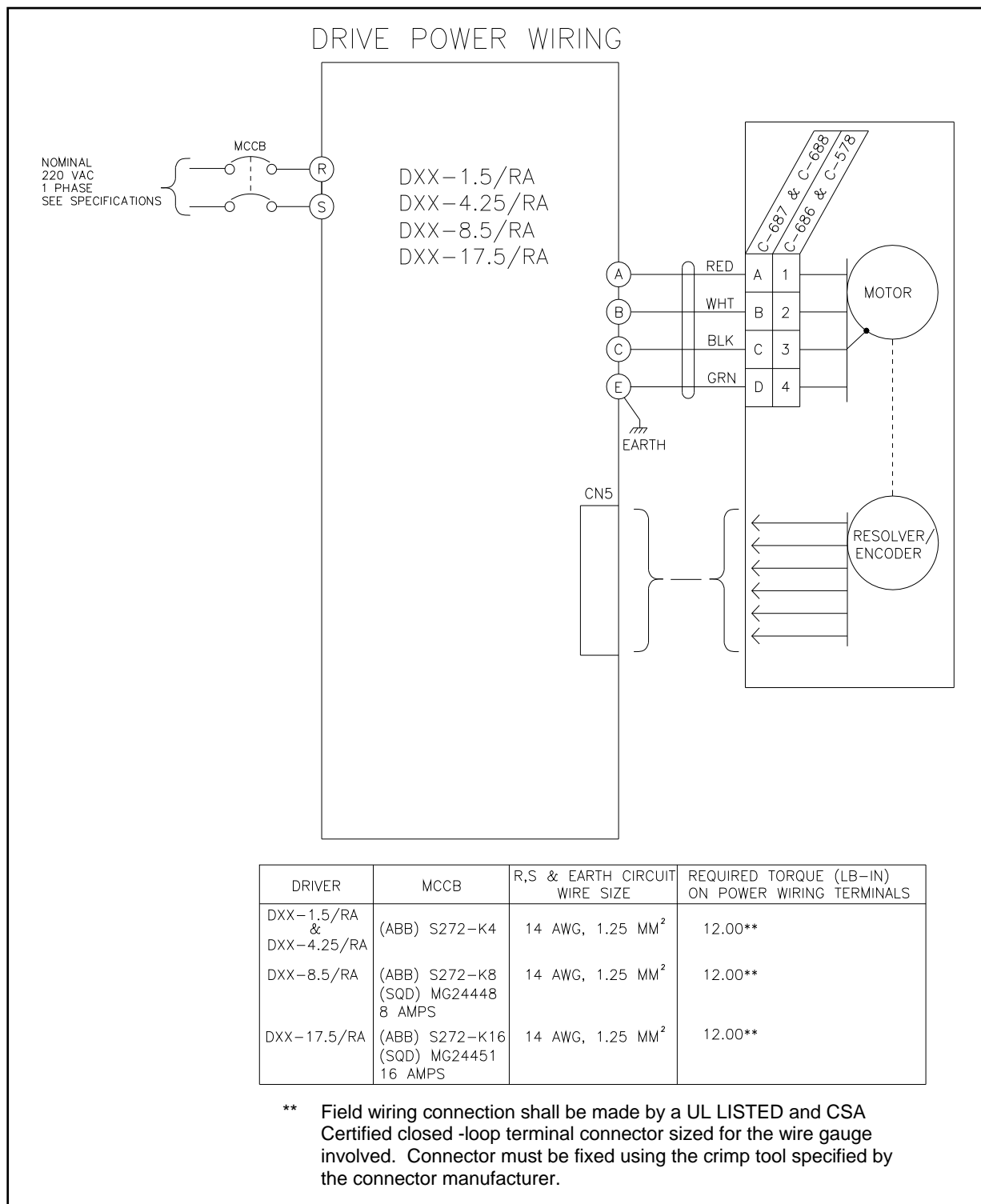


Figure 8.3 - DPRO-1.5/RA Through DPRO-17.5/RA Power Wiring



| BLOCK #1 | | BLOCK #2 | | A |
|----------|----------------------|---------------------|--|---|
| STEP #1 | <u>WAIT POSITION</u> | <u>END OF BLOCK</u> | | |
| STEP #2 | <u>TURN ON/OFF</u> | | | |
| STEP #3 | <u>END OF BLOCK</u> | | | |
| STEP #4 | | | | |
| STEP #5 | | | | |
| STEP #6 | | | | |
| STEP #7 | | | | |
| <hr/> | | | | B |
| BLOCK #1 | | BLOCK #2 | | |
| STEP #1 | <u>WAIT POSITION</u> | <u>END OF BLOCK</u> | | |
| STEP #2 | <u>TURN ON/OFF</u> | | | |
| STEP #3 | <u>INDEX</u> | | | |
| STEP #4 | <u>END OF BLOCK</u> | | | |
| STEP #5 | | | | |
| STEP #6 | | | | |
| <hr/> | | | | C |
| BLOCK #1 | | BLOCK #2 | | |
| STEP #1 | <u>WAIT POSITION</u> | <u>END OF BLOCK</u> | | |
| STEP #2 | <u>TURN ON/OFF</u> | | | |
| STEP #3 | <u>WAIT TIME</u> | | | |
| STEP #4 | <u>INDEX</u> | | | |
| STEP #5 | <u>END OF BLOCK</u> | | | |
| STEP #6 | | | | |
| <hr/> | | | | D |
| BLOCK #1 | | BLOCK #2 | | |
| STEP #1 | <u>WAIT POSITION</u> | <u>END OF BLOCK</u> | | |
| STEP #2 | <u>WAIT TIME</u> | | | |
| STEP #3 | <u>INDEX</u> | | | |
| STEP #4 | <u>END OF BLOCK</u> | | | |
| STEP #5 | | | | |
| STEP #6 | | | | |
| <hr/> | | | | |
| BLOCK #1 | | BLOCK #2 | | |
| STEP #1 | <u>WAIT POSITION</u> | <u>END OF BLOCK</u> | | |
| STEP #2 | <u>WAIT TIME</u> | | | |
| STEP #3 | <u>INDEX</u> | | | |
| STEP #4 | <u>END OF BLOCK</u> | | | |
| STEP #5 | | | | |
| STEP #6 | | | | |
| STEP #7 | | | | |

SECTION 9 - DYNAMIC BRAKES

The DeltaPro driver is equipped with special circuitry and software to sequence a dynamic braking relay connected across the motor windings. It is very important for proper operation that the dynamic braking relay contacts are open before the driver circuitry is turned on and that the driver is off before the dynamic braking relay contacts close. The driver in conjunction with external braking relays provide the proper sequencing to prevent driver damage.

If dynamic braking is not used, tie the BRAKE CONFIRM input ON for the DPRO-1.5 through DPRO-17.5 driver sizes. For DPRO-35 and larger drivers, a jumper must be provided between B11 and B12. A B11 to B12 jumper is installed by the factory and must be removed if dynamic braking is to be used.

Parameter UP-16 should be set to the default value of 0 for dynamic braking or no brake connections.

Be sure to select a dynamic braking resistor with a sufficient peak power rating.

$$\text{Resistor Peak Power} = \frac{150 * V^2}{R}$$

Where V = maximum motor voltage when dynamic braking is applied.

General rule: $V = 300 * (\text{motor speed @ braking}) / (\text{motor maximum speed rating})$

Figures 9.1 and 9.2 show the connections for dynamic braking.





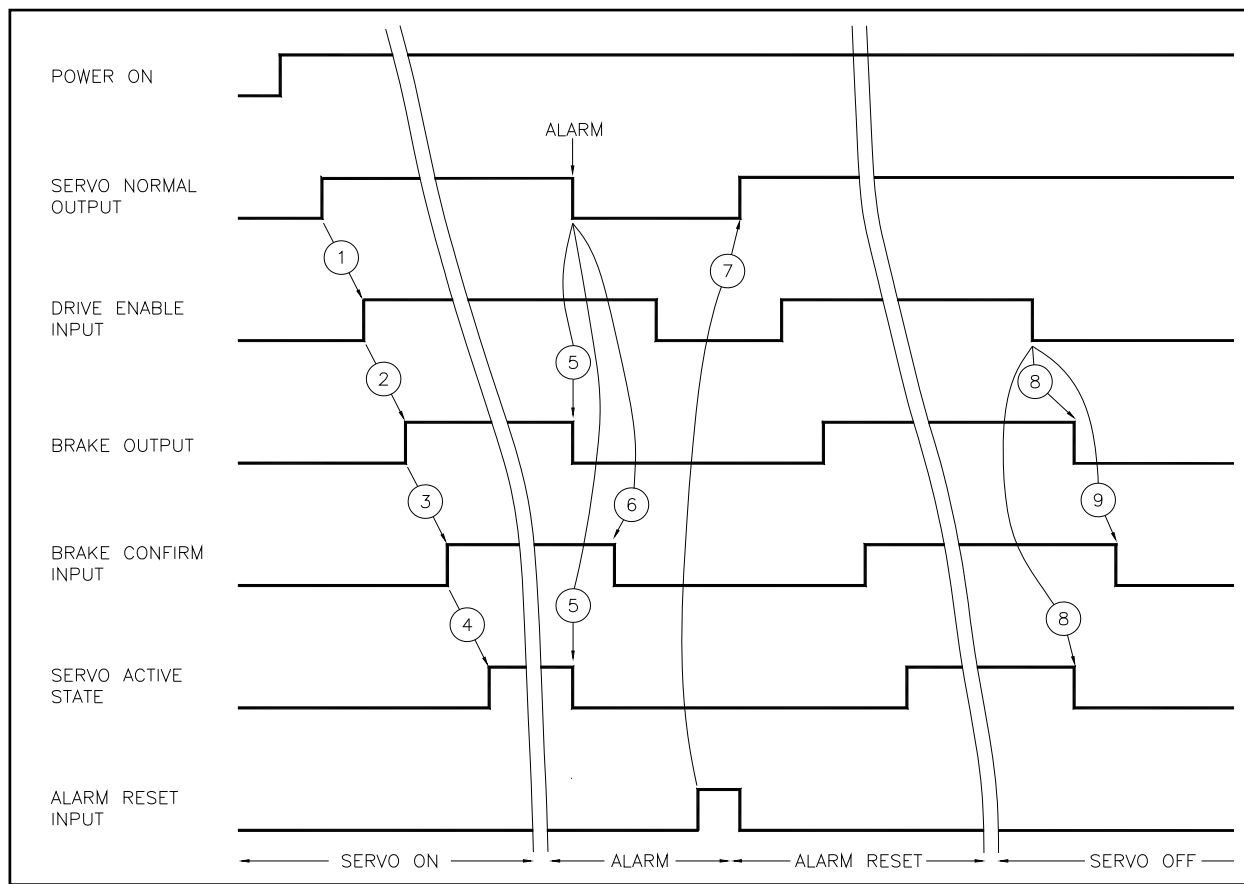


Figure 9.3 - Dynamic Braking Control Signals

1. DRIVE ENABLE may be turned ON within 0.6 seconds of SERVO NORMAL.
2. BRAKE turns on within 800μsec. of DRIVE ENABLE.
3. BRAKE CONFIRM must be returned within 100ms. or AL-14 will be generated.
4. The servo will become active within 800μsec of sensing BRAKE CONFIRM.
5. When an alarm is sensed, the SERVO NORMAL and BRAKE outputs are turned OFF. The DRIVE ENABLE must be turned OFF before alarm clearing can be accomplished.
6. The BRAKE CONFIRM turns OFF indicating the braking relay has toggled and dynamic braking is engaged.
7. ALARM RESET causes driver to check for clearing of the alarm condition and if all alarm states are clear the SERVO NORMAL will turn ON within 30 ms. ALARM RESET should be turned OFF before DRIVE ENABLE is turned ON.
8. The servo becomes inactive and the BRAKE output turns OFF within 800μsec of DRIVE ENABLE being turned OFF.
9. The BRAKE CONFIRM turns OFF indicating the braking relay has toggled and dynamic braking is engaged.

SECTION 10 - MECHANICAL BRAKES

The DeltaPro driver is equipped with special circuitry and software to sequence an electrically released mechanical brake. The full line of DeltaPro motors are available with mechanical brakes to provide mechanical fail safe braking in the case of power loss and driver disable.

It is very important for proper operation to sequence the driver servo lock and mechanical brake to avoid loss of holding torque during the transition. The driver in conjunction with an external relay and brake power supply provide for the optimum sequencing to prevent loss of holding torque or driver damage.

10.1 NO BRAKE

If a mechanical brake is not used for the DPRO-35 and larger drivers, a jumper must be provided between B11 and B12. The factory installs a B11 to B12 jumper.

10.2 MECHANICAL BRAKING WITH SOFT DECEL

The driver sequencing can be set to apply the mechanical brake after the driver has reduced the motor speed to a programmable set point. The holding brake threshold sets the speed setpoint at which the brake is applied.

The mechanical brake is applied immediately upon driver alarm or loss of power.

Connect the braking relay and power supply as shown in **Figures 10.1 or 10.2**. The sequencing will be as shown in **Figure 10.3**.

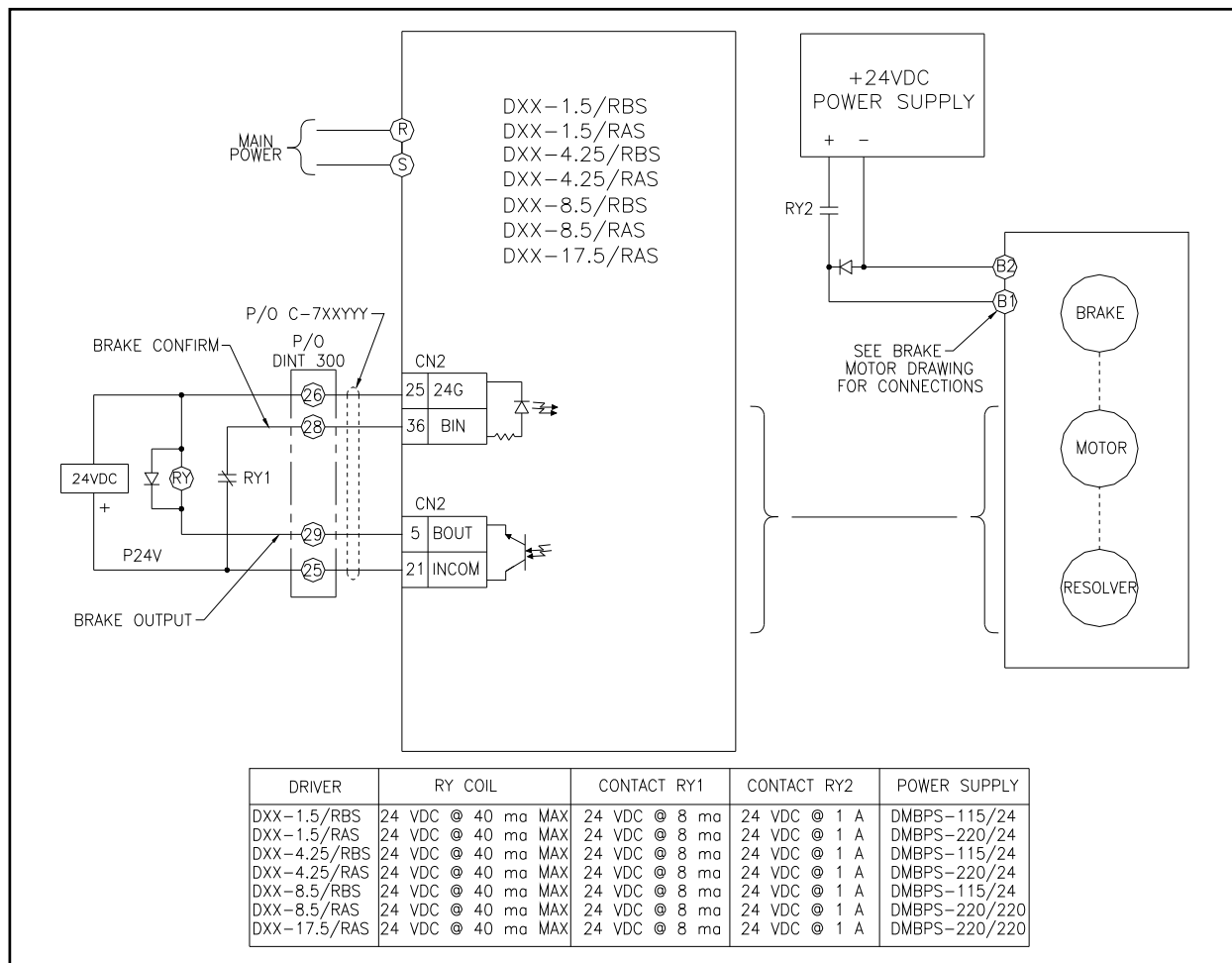


Figure 10.1 - Mechanical Brake Connection for the DPRO-1.5 Through DPRO-17.5 Drivers with a Sourcing I/O Board

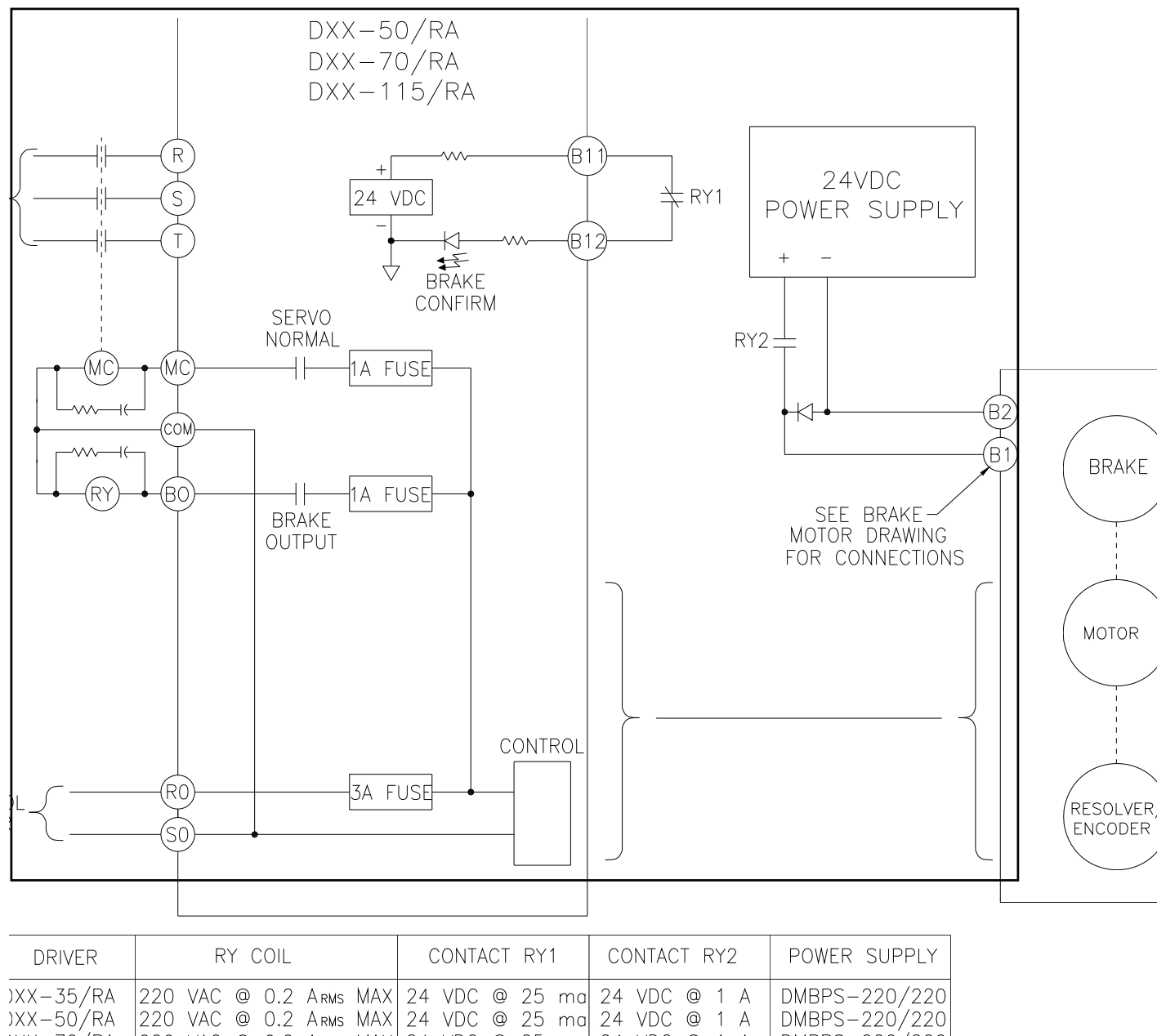


Figure 10.2 - Mechanical Brake Connection for the DPRO-35 Through DPRO-115 Drivers

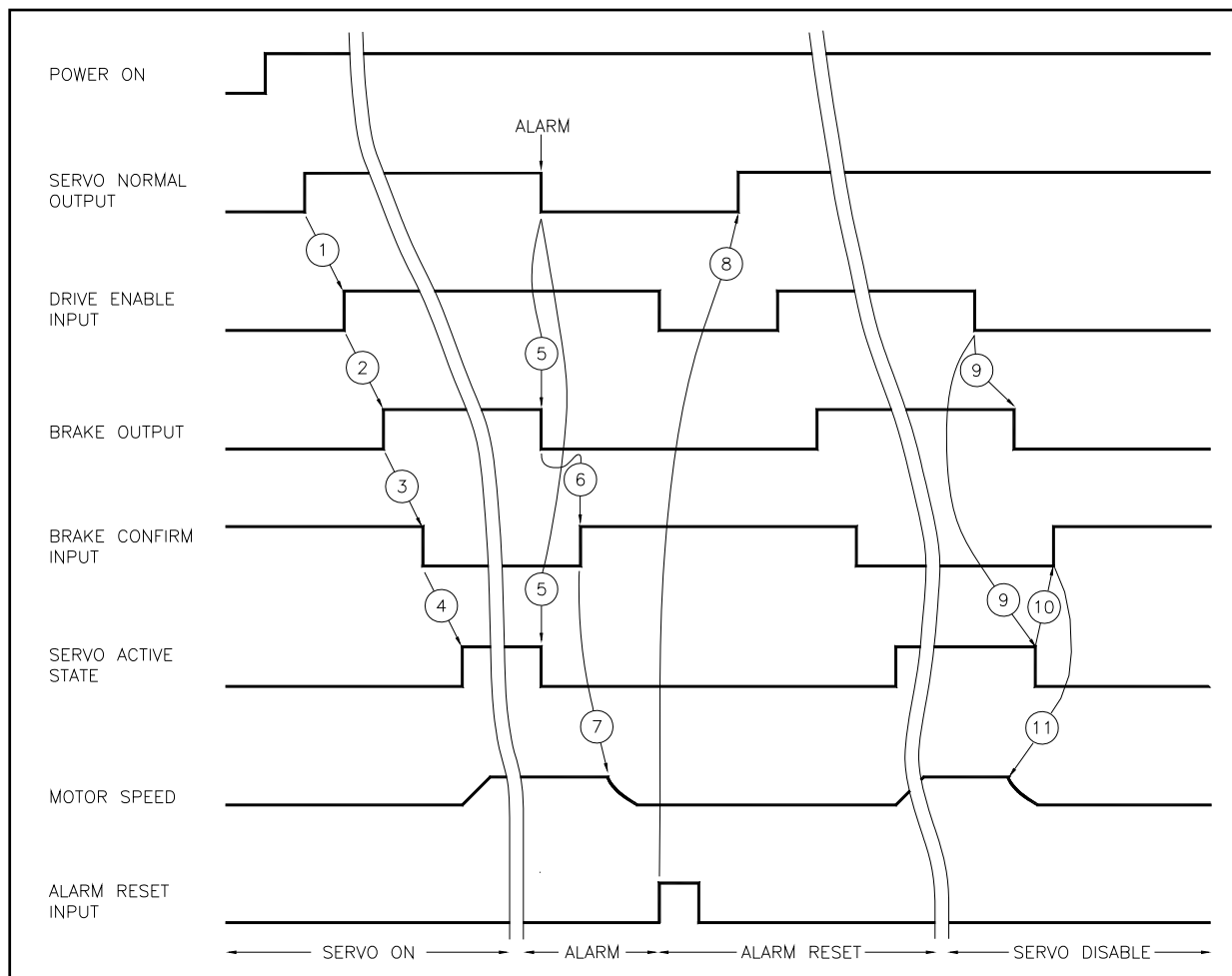


Figure 10.3 - Mechanical Brake Sequencing

1. DRIVE ENABLE may be turned ON within 0.6 seconds of SERVO NORMAL.
2. BRAKE turns on within 800μsec. of DRIVE ENABLE.
3. BRAKE CONFIRM must be returned within 100ms or AL-14 will be generated.
4. The servo will become active within 800μsec of sensing BRAKE CONFIRM.
5. When an alarm is sensed, the SERVO NORMAL and BRAKE outputs are turned OFF and the servo becomes inactive.
6. The BRAKE CONFIRM turns ON indicating the braking relay has toggled.
7. The mechanical brake engages after a delay in the braking mechanism.
8. The DRIVE ENABLE must be turned OFF before alarm clearing can be accomplished. ALARM RESET causes driver to check for clearing of the alarm condition and if all alarm states are clear the SERVO NORMAL will turn ON within 30 ms. ALARM RESET should be turned OFF before DRIVE ENABLE is turned ON.
9. The servo starts to decelerate within 800μsec of DRIVE ENABLE being turned OFF.
10. The servo becomes inactive and the BRAKE output turns OFF within 800μsec of the motor speed dropping below the holding brake threshold value.
11. The BRAKE CONFIRM turns ON indicating the braking relay has toggled.
12. The mechanical brake engages after a delay in the braking mechanism.

10.3 MECHANICAL BRAKE POWER SUPPLY

| <u>DRAWING NUMBER</u> | <u>DESCRIPTION</u> |
|-----------------------|-------------------------------|
| DMBPS-115/24 | Mechanical Brake Power Supply |
| DMBPS-220/24 | Mechanical Brake Power Supply |
| DMBPS-220/220 | Mechanical Brake Power Supply |

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SECTION 11 - REGEN RESISTOR SELECTION

11.1 DELTAPRO DRIVER REGENERATION CAPACITIES

The DeltaPro motor and driver have the ability to act as a brake for a rotating load. This condition typically occurs during the deceleration of the load or when the system is stopping a vertical load such as an elevator or lift. In both cases, the driver may have to absorb the mechanical and potential energy in the system. The driver must absorb the energy if the energy in the load exceeds to mechanical losses in the system.

The driver has 3 ways to absorb the energy from the load.

- Store the energy by charging the internal main DC bus capacitors (E_C)
- Use the energy internally to power the driver control circuitry (P_D)
- Dissipate the energy using a regeneration resistor (P_R)

The Delta driver energy absorption capacities are as shown in **Table 11.1**.

| DRIVER SIZE | INTERNAL REGEN CAPACITY (P_R) | INTERNAL POWER CONSUMPTION (P_D) | CHARGING CAPACITY (E_C) |
|--------------|-----------------------------------|--------------------------------------|-----------------------------|
| DPRO-1.5/RB | 0 W | 13 | 17 |
| DPRO-1.5/RA | 0 W | 13 | 17 |
| DPRO-4.25/RB | 0 W | 13 | 17 |
| DPRO-4.25/RA | 0 W | 13 | 17 |
| DPRO-8.5/RA | 0 W | 24 | 17 |
| DPRO-8.5/RB | 0 W | 17 | 17 |
| DPRO-17.5/RA | 0 W | 37 | 22 |
| DPRO-35/RA | 80 W | 80 | 38 |
| DPRO-50/RA | 80 W | 100 | 54 |
| DPRO-70/RA | 100 W | 200 | 94 |
| DPRO-115/RA | 180 W | 300 | 188 |

Table 11.1 - Energy Absorption Capabilities

The DeltaPro drivers are equipped with internal circuitry to detect a rise in the main DC power bus indicating energy absorption. If the DC power bus reaches approximately 400 VDC, the regeneration circuit is turned on to prevent the main DC power bus from rising to 420 VDC which will result in an over voltage alarm AL-02.

11.2 SELECTION OF REGENERATION RESISTOR

The amount of energy stored in the moving components of the system must be calculated and compared to the energy absorption capacity of the driver to determine if an external regeneration resistor is required.

The stored energy is of two basic types, kinetic energy in the form of a moving mass and potential energy of a mass being held against gravity.

$$E_k = 0.5 * (J_M + J_L) * (2 * \pi * N / 60)^2$$

$$E_P = (2 * \pi * N * T_g * t_b / 60)$$

Calculate the system losses in the motor, driver and friction.

$$E_L = (P_M + P_D + (\pi * N * T_f / 60)) * t_a$$

Calculate the regeneration power.

$$P_R = (E_k + E_P - E_L - E_C) / t_c$$

If regeneration power P_R is greater than 0.0, a regeneration resistor will be needed to prevent the main DC power bus from generating an over voltage alarm AL-02.

Where:

- E_k = Net kinetic energy Joules
- E_P = Net Potential energy Joules
- E_L = Energy loss due to friction Joules
- E_C = Driver charging capacity Joules (See **Table 11.1**)
- J_M = Motor rotor inertia kg-m^2
- J_L = Load inertia kg-m^2
- N = Motor speed in RPM
- P_M = Motor loss watts (10% of motor rating)
- P_D = Driver internal power consumption watts (See **Table 11.1**)
- T_f = System friction torque N-m
- T_g = Net torque to hold up load against gravity N-m
- P_R = Regen power watts (See **Table 11.1**)
- t_a = Deceleration time
- t_b = Move time
- t_c = Cycle time

See **Figure 11.1**

* The above equations are reasonable approximations.

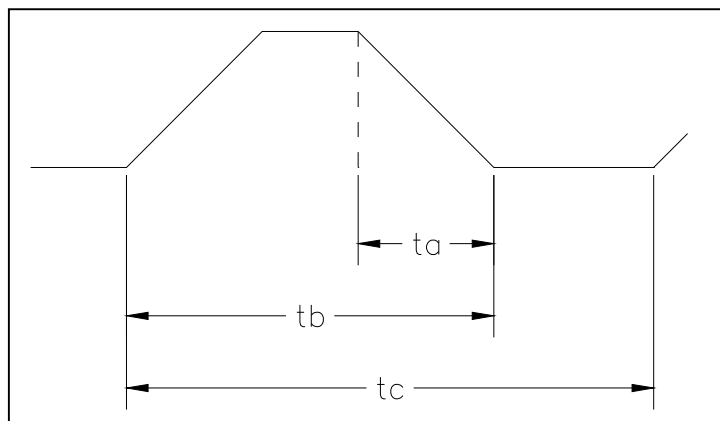


Figure 11.1

11.2 SELECTION OF REGENERATION RESISTOR (cont'd)

DeltaPro Drivers DPRO-1.5, DPRO-4.25, DPRO-8.5 and DPRO-17.5 do not contain an internal regeneration resistor. If a regeneration resistor is required, an external resistor with a power rating of at least P_R watts must be connected.

DeltaPro Drivers DPRO-35 through DPRO-115 contains internal regeneration resistors. If the internal regeneration resistor capacity is greater than P_R watts, no external resistor is needed. If the internal resistor is not large enough, an external resistor with a power rating of at least P_R watts must be connected. If an external regeneration resistor is needed, the setup parameters for Ext Regen Value and Wattage must be set to the values of the external resistor.

The external resistor specifications are shown in **Table 11.2**.

| DRIVER SIZE | RESISTANCE | MAX WATTAGE | WIRE GAUGE |
|--------------|--------------|-------------|-----------------------------|
| DPRO-1.5/RA | 30~100 Ohms | 300 W | 14 AWG 1.25 mm ² |
| DPRO-1.5/RB | 30~100 Ohms | 300 W | 14 AWG 1.25 mm ² |
| DPRO-4.25/RA | 30~100 Ohms | 300 W | 14 AWG 1.25 mm ² |
| DPRO-4.25/RB | 30~100 Ohms | 300 W | 14 AWG 1.25 mm ² |
| DPRO-8.5/RA | 30~100 Ohms | 300 W | 14 AWG 1.25 mm ² |
| DPRO-8.5/RB | 30~100 Ohms | 300 W | 14 AWG 1.25 mm ² |
| DPRO-17.5/RA | 30~70 Ohms | 400 W | 14 AWG 1.25 mm ² |
| DPRO-35/RA | 12.5~25 Ohms | 2.4 KW | 12 AWG 3.5 mm ² |
| DPRO-50/RA | 12.5~25 Ohms | 3 KW | 12 AWG 3.5 mm ² |
| DPRO-70/RA | 10~15 Ohms | 5.5 KW | 10 AWG 5.5 mm ² |
| DPRO-115/RA | 6~15 Ohms | 11 KW | 8 AWG 16 mm ² |

Table 11.2 - External Resistor Specifications

Figures 11.2 and 11.3 shows how to connect an external regeneration resistor to the DeltaPro drivers.

11.2 SELECTION OF REGENERATION RESISTOR (cont'd)

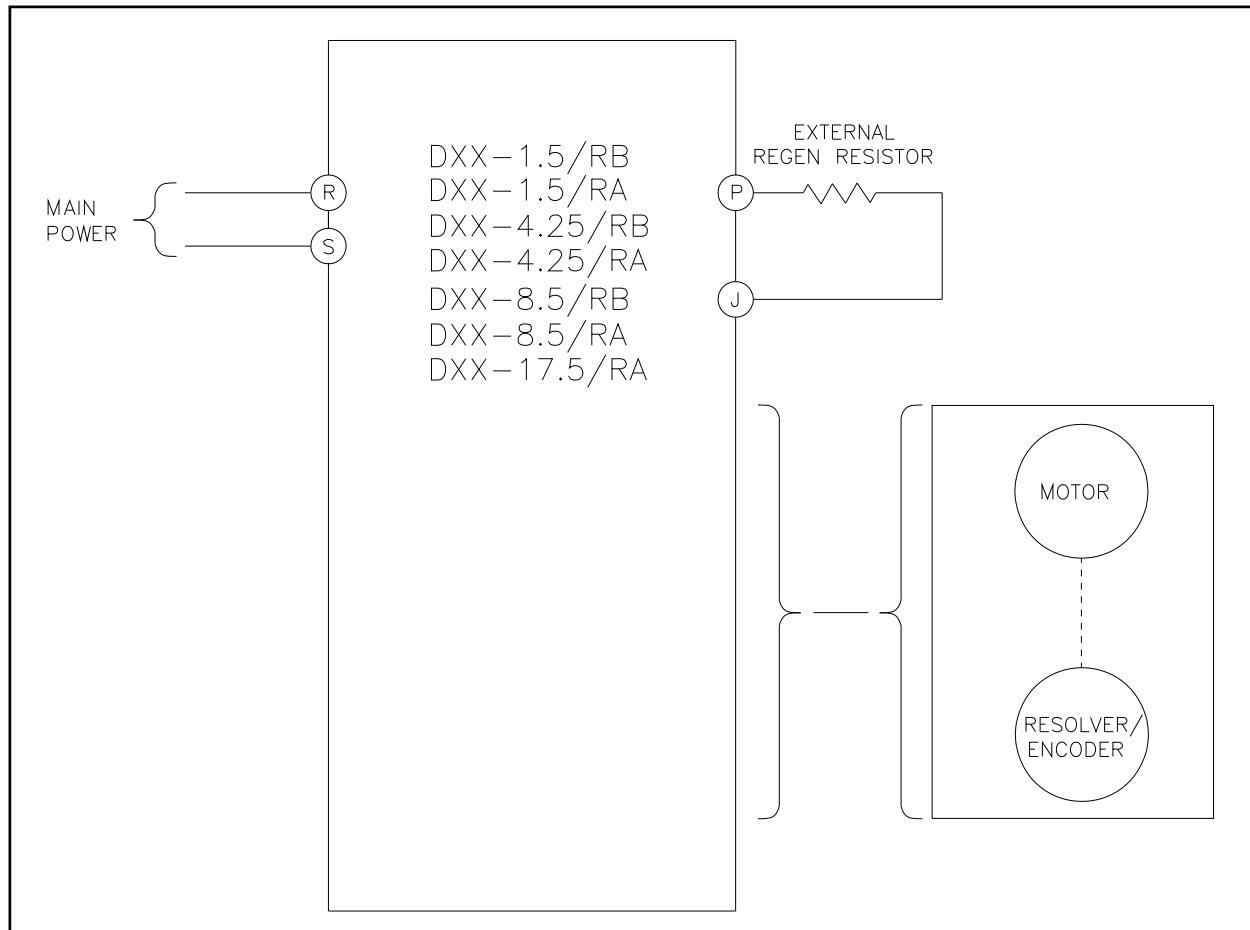


Figure 11.2 - Connection of an External Regen Resistor for DeltaPro Driver Sizes DPRO-1.5 Through DPRO-17.5

11.2 SELECTION OF REGENERATION RESISTOR (cont'd)

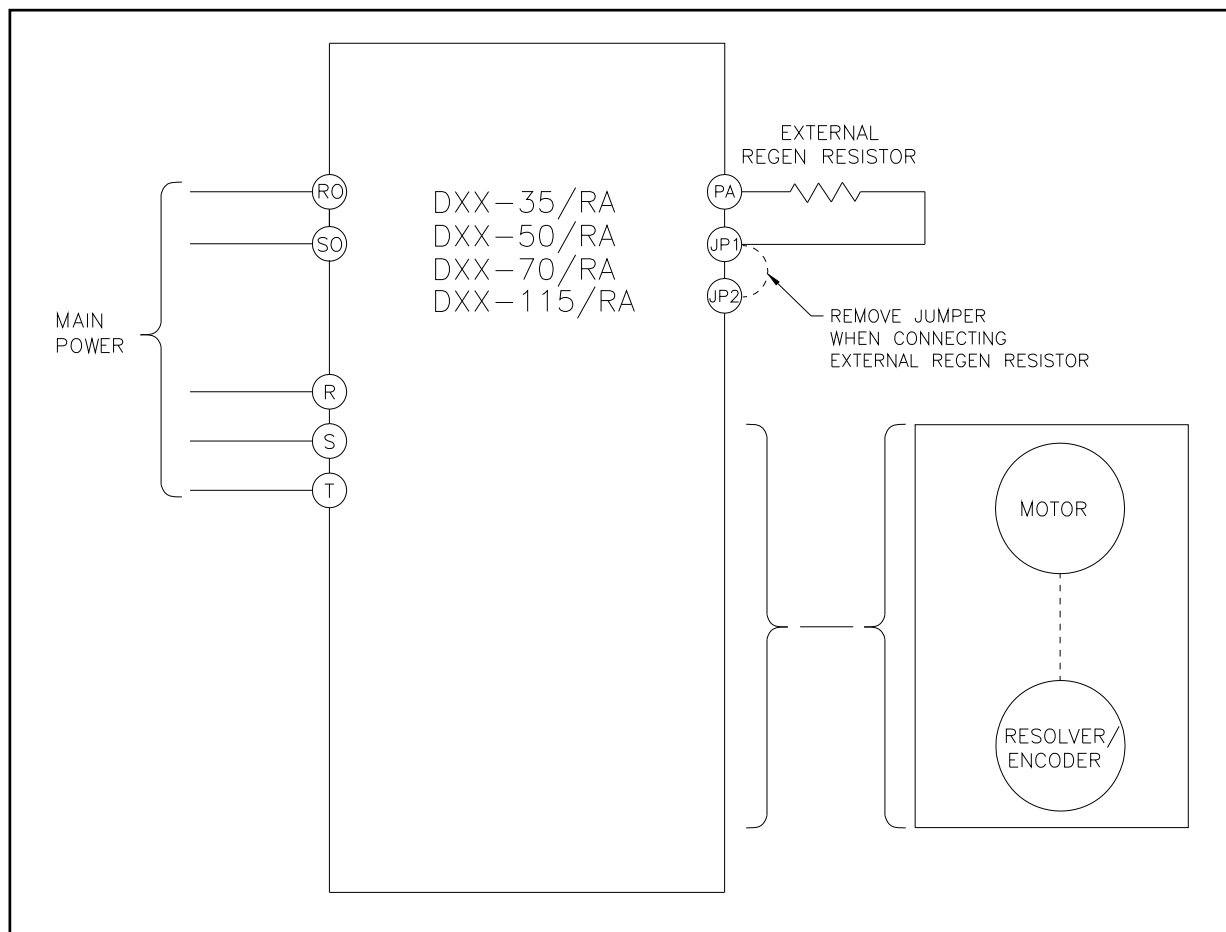


Figure 11.3 - Connection of an External Regen Resistor for DeltaPro Driver Sizes DPRO-35 and Larger

The regeneration resistor is subjected to severe peak power loads during regeneration. The driver switches the regeneration resistor across the DC power bus using PWM techniques to regulate the DC power bus voltage during regeneration dumping. When the driver's switch is on the regeneration resistor is subjected to the following peak power:

$$\text{PEAK POWER} = (400 \text{ VDC})^2 / \text{RESISTOR VALUE in ohms}$$

Be sure to select a regeneration resistor that can sustain the required peak power and continuous power ratings.

11.3 STANDARD REGENERATION RESISTOR PACKAGES

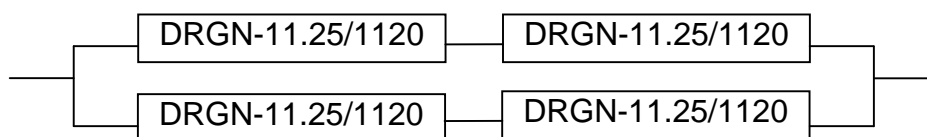
In general, wound metal ribbon resistors are recommended for this type of application. IIS offers a complete line of enclosed panel mounted regen resistor units to complement the DeltaPro driver. Various combinations of series and parallel connections are allowed to provide adequate regen resistor capacity.

| IIS P/N | Description |
|-----------------|----------------------|
| MFS30A300J* | 30 Ohm 30 Watts |
| RGH200-30* | 30 Ohm 200 Watts |
| DRGN-20/400 | 20 Ohm 400 Watts |
| DRGN-45/420 | 45 Ohm 420 Watts |
| DRGN-22.5/655 | 22.5 Ohm 655 Watts |
| DRGN-15/880 | 15 Ohm 880 Watts |
| DRGN-11.25/1120 | 11.25 Ohm 1120 Watts |

*Not UL/CE approved

EXAMPLE CALCULATION:

If 4 KW of regen were needed on a DPRO-115 driver, four (4) DRGN-11.25/1120 units could be connected as follows to yield 11.25 Ohms at 4480 Watts.



DRAWING NUMBER

MFS30A300J
RGH200-30
DRGN-20/400
DRGN-45/420
DRGN-45/420-2
DRGN-22.5/655
DRGN-15/880
DRGN-11.25/1120

DESCRIPTION

Resistor
Regen Resistor
Regen Resistor
Regen Resistor
Regen Resistor
Regen Resistor
Regen Resistor
Regen Resistor

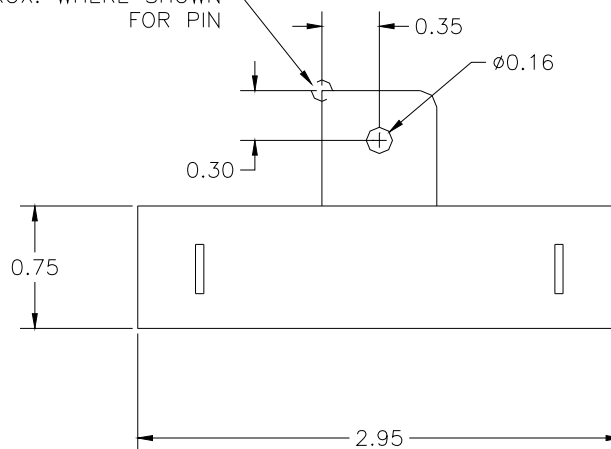
NOTES:

- 1.) THIS RESISTOR IS NOT UL OR CE APPROVED.
- 2.) RESISTOR MUST BE SECURELY MOUNTED ON LARGE HEATSINK SUCH AS ENCLOSURE WALL OR BACKPANEL.

SPECIFICATIONS

| | |
|------------------------|----------|
| RESISTANCE: | 30 Ohms |
| CONTINUOUS POWER: | 30 Watts |
| MAXIMUM VOLTAGE: | VDC |
| MAXIMUM PULSE CURRENT: | 15 A |
| MAXIMUM RMS CURRENT: | 1 A |
| DUTY CYCLE | 6 % |

DRILL ϕ .13 HOLE ON MOUNTING
PANEL APPROX. WHERE SHOWN
FOR PIN



INDUSTRIAL INDEXING SYSTEMS, Inc.

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TITLE
RESISTOR, 30 OHM, 30W

DRAWING NUMBER
MFS30A300J

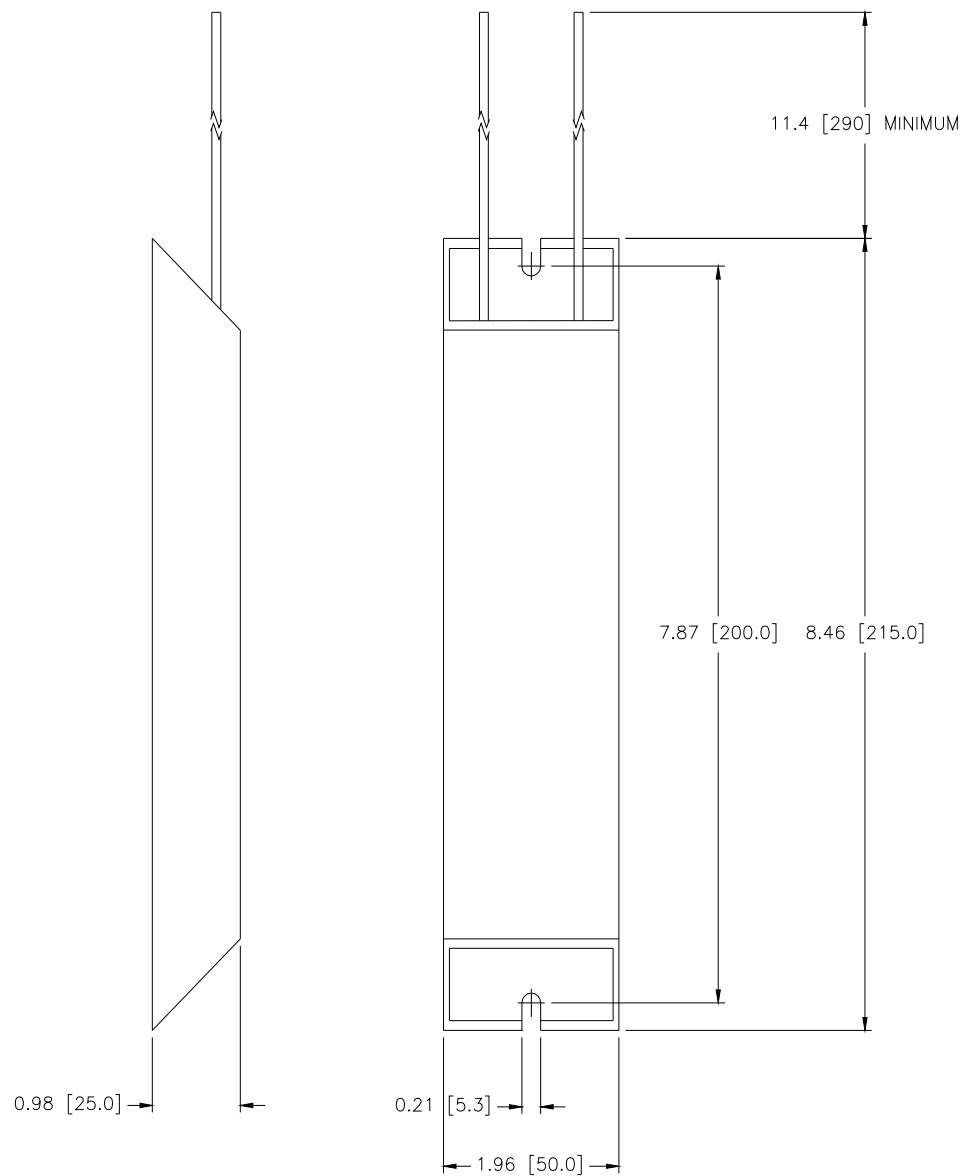
DIMENSIONS ARE INCHES [mm] TOLERANCES X.XX ± --- X.XXX ± --- Δ ± --- REV 0 ECN 03-322 DATE 16JUL03 SH. 1 OF 1

NOTES:

- 1.) RESISTOR MUST BE MOUNTED ON A FLAT SURFACE
AT LEAST 12" X 12" IN FREE AIR TO MEET THE
200 WATT POWER DISSIPATION.
- 2.) THIS RESISTOR IS NOT UL OR CE APPROVED.

SPECIFICATIONS

| | |
|------------------------|-----------|
| RESISTANCE: | 30 Ohms |
| CONTINUOUS POWER: | 200 Watts |
| MAXIMUM VOLTAGE: | 425 VDC |
| MAXIMUM PULSE CURRENT: | 14.0 A |
| MAXIMUM RMS CURRENT: | 5.0 A |
| DUTY CYCLE | 50% |



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TITLE

REGEN RESISTOR

DRAWING NUMBER

RGH200-30

DIMENSIONS ARE INCHES [mm]

TOLERANCES X.XX±0.01

X.XXX±0.005

± ---

REV 0

ECN 01-067

DATE 27FEB01

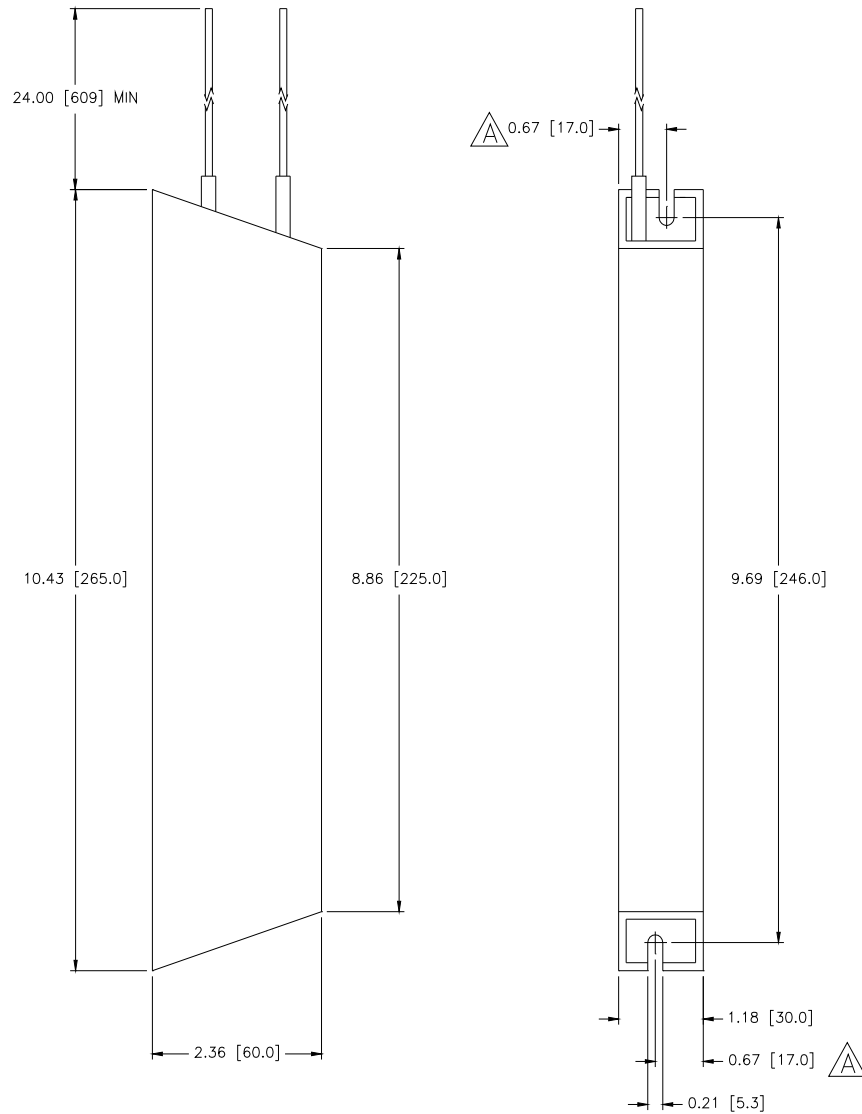
SH. 1 OF 1

NOTES:

- 1.) RESISTOR MUST BE MOUNTED ON A FLAT SURFACE
AT LEAST 12" X 12" IN FREE AIR TO MEET THE
200 WATT POWER DISSIPATION.
- 2.) THIS RESISTOR IS NOT UL OR CE APPROVED.
- 3.) RESISTOR MUST BE SECURELY MOUNTED ON LARGE
HEATSINK SUCH AS ENCLOSURE WALL OR BACKPANEL.

SPECIFICATIONS

| | |
|------------------------|-----------|
| RESISTANCE: | 20 Ohms |
| CONTINUOUS POWER: | 400 Watts |
| MAXIMUM VOLTAGE: | 425 VDC |
| MAXIMUM PULSE CURRENT: | 22 A |
| MAXIMUM RMS CURRENT: | 4.5 A |
| DUTY CYCLE | 15 % |



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TITLE

REGEN RESISTOR

DRAWING NUMBER

DRGN-20/400

DIMENSIONS ARE INCHES [mm]

TOLERANCES X.XX±0.01

X.XXX±0.005

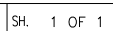
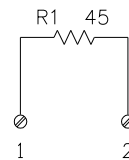
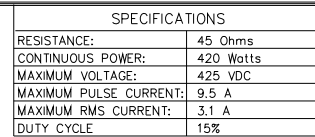
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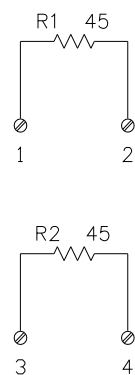
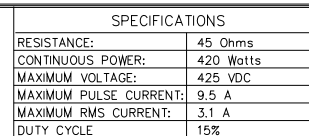
REV A

ECN 01-259

DATE 28JUN01

SH. 1 OF 1

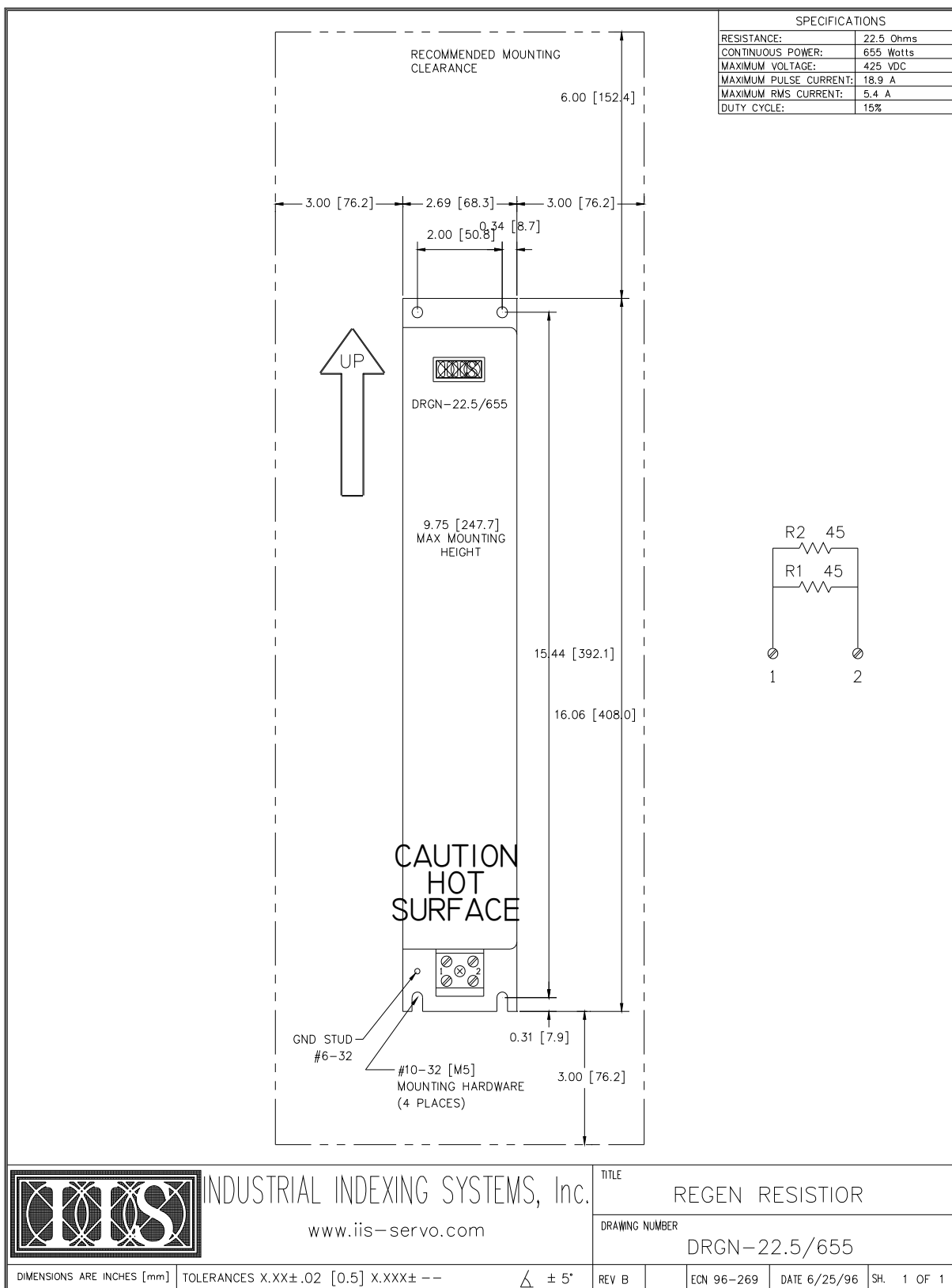


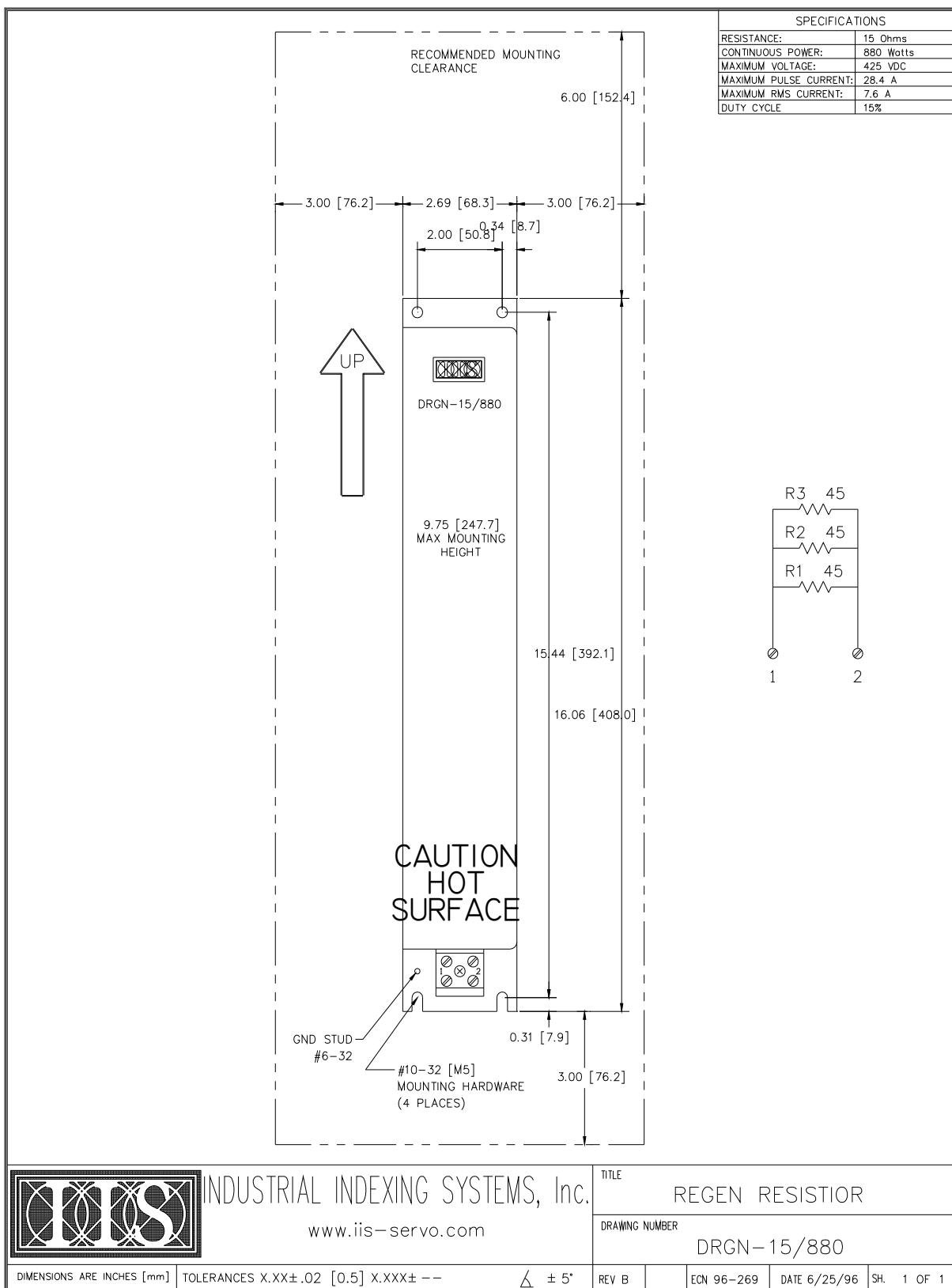


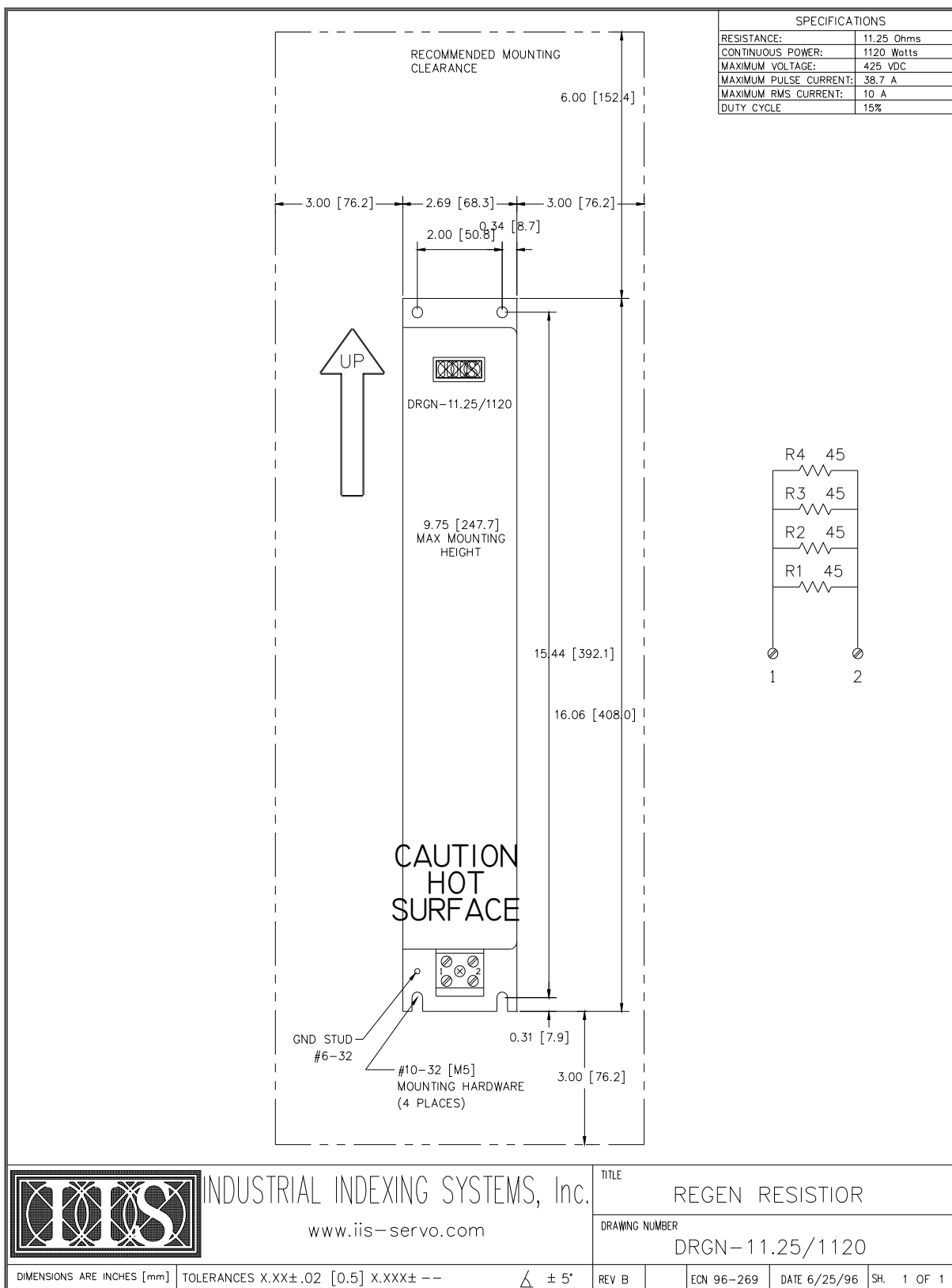
REGEN RESISTIOR

DRGN-45/420-2

SH. 1 OF 1







SECTION 12 - TROUBLESHOOTING

The Industrial Indexing Systems DeltaPro Motion Control Systems are designed to provide reliable service with minimum down time and maintenance. In case of failure, the system is designed for replacement of an entire component. It is recommended that an inventory of spare parts be maintained for the system.

NOTE

To prevent system problems, inspect the system frequently to make sure all connections are tight. Also check for motor vibration and overheating.

12.1 ALARM CODES

| ALARM CODE | DESCRIPTION | REMEDY |
|--|---|--|
| HALT | Driver fatal fault | Replace driver. |
| AL -01 Internal Power Module Error | Driver has detected the following: <ul style="list-style-type: none"> Overcurrent Overheat Gate voltage drop | Check if the motor wire (A/B/C) is shorted or grounded. Ambient temperature over 55° C. Indicates a fatal fault in the driver power stage. If motor wires are not shorted and temperature is below 55° C contact IIS factory. |
| AL -02 Overvoltage | DC power bus exceeds 420 VDC. | Power line voltage fluctuation above 264 VAC for "A" model drivers or 126 VAC for "B" model drivers. Excessive regeneration energy. Check line voltage fluctuations. Add additional external regeneration resistor. |
| AL -03 Under Voltage | DC power bus below 200 VDC. | Power line voltage fluctuation below 170 VAC for "A" model drivers or 85 VAC for "B" model drivers. Check line voltage fluctuations. Check for missing phase of AC line power for 3 phase models DSD-35 and above. |
| AL -06 Resolver Open | Resolver feedback signal (R1, R2) drops below 0.34 VAC. | Check for broken resolver wire or loose connection. Voltage between R1-R2 must be above 0.34VAC. |
| AL -07 Power Stage Error | Main control unit identifies a fault in the power stage of the driver. | Indicates a fatal fault in the driver power stage. Contact IIS factory. |
| AL -09 Regen Resistor Over Temperature | Excessive regen energy being dissipated by the internal or external regeneration resistor. | The frequency or rate of acceleration/deceleration may be too high. Excessive power line voltage. Add additional regen resistor capacity. |
| AL -10 Regen Resistor Open (DSD-35 and above only) | Regen transistor is ON for more than 50ms. | WITH POWER OFF: If an internal regen resistor is used, check that the resistance from P to JP2 is less than 20-30 ohms and that a jumper is installed from JP1 to JP2. If an external regen resistor is used, verify the regen resistor is the proper value and that all wiring to the resistor is secure. |
| AL -12 Watchdog timer | Internal CPU clock has stopped. | Unit is damaged. Contact IIS factory. |
| AL -14 Brake Alarm | Sequencing of the static or dynamic brake is faulty. | Check wiring connections of the static or dynamic brake. Verify that the external braking relay is functional. |
| AL -15 Excessive Current | Motor current exceeds the rating by 120%. | Check if the motor wire (A/B/C) is shorted or grounded. Verify that motor shaft or machine system is not jammed. Verify the motor selected in setup. |

12.1 ALARM CODES (cont'd)

| ALARM CODE | DESCRIPTION | REMEDY |
|----------------------------------|--|---|
| AL -16 Speed amp Saturated | Internal speed loop is saturated and max. torque is applied for more than 3 sec. | Verify that motor shaft or machine system is not jammed. Verify the motor selected in setup. Accel/decel rate is too large for the inertia load on the motor causing maximum torque during accel/decel. |
| AL -17 Motor overload | Calculated motor temperature exceeds rating 110%. | <p>Verify that the average torque required to drive the load does not exceed the motor/driver continuous rating. Check if the duty cycle of the machine is too high. Verify the motor selected in setup.</p> $t = -T_m \left(\frac{1.05^2}{1 - \left(\frac{I}{I_R} \right)^2} \right)$ <p>Where: t = time in minutes I = motor current I_R = motor rated current T_M = thermal time constant of motor</p> <p>Status display oL is $\frac{I}{I_R} \times 100$</p> <p>See Section 3.</p> |
| AL -18 Driver Overload | Motor current exceeds intermittent rating of driver or motor whichever is less. | <p>Verify that motor shaft or machine system is not jammed.</p> <p>Check setup for the proper motor. Accel/decel rate is too large for the inertia load on the motor causing maximum torque during accel/decel.</p> $t = \frac{K}{\left(\frac{I}{I_R \cdot 1.2} \right)^2 - 1}$ <p>Where: t = time in seconds I = motor current I_R = motor rated current K = 1.5 for DeltaPro-D30HRA 2.0 for DeltaPro-120HRA & DeltaPro-D50HRA 2.5 for DeltaPro-200HRA & DeltaPro-D100HRA 3.0 for DeltaPro-D200HRA 3.5 for DeltaPro-400HRA 4.0 for DeltaPro-D400HRA 6.0 for all others</p> <p>See Overload Protection Characteristic Curve in Section 3.</p> |

12.1 ALARM CODES (cont'd)

| ALARM CODE | DESCRIPTION | REMEDY |
|---|---|--|
| AL -19 Resolver Error | Resolver feedback error. | Check resolver cable and connectors. Check if resolver is loose on motor shaft. Verify that resolver cable is separated from power wiring to prevent noise coupling to resolver signals. |
| AL -20 Overspeed | Motor speed exceeds maximum rating by 120%. | Check resolver cable and connectors. Check if resolver is loose on motor shaft. Verify that resolver cable is separated from power wiring to prevent noise coupling to resolver signals. Overshoot is generated due to improper setting of Load Inertia Ratio, High Frequency Response and Position Loop Gain parameters. |
| AL -21 Deviation counter overflow | Motor is unable to follow the commanded profile. Deviation counter exceed $\pm 2^{21}$. | Excessive load. Load inertia is too large for acceleration/deceleration rate. Position gain is too high. Torque limit is too low. |
| AL-22 Absolute encoder phase error | Absolute encoder CHA and CHB have been detected out of phase. | Replace motor. |
| AL-23 Absolute encoder disconnected | Absolute encoder connection is broken. | Check absolute encoder/resolver cable, C-253YYY. If cable is OK, replace motor. |
| AL-25 Option | Self-diagnostic checks of options failed. | 14-bit A/D converter not functioning to specification. Return to factory. |
| AL-26 Parameter setting error | The motor code is set improperly. | The motor code must be set to operate. Set the motor, then cycle power to have the parameters take effect. |
| AL-27 Absolute encoder fault | CHA or CHB of absolute encoder is non-functional. | Check absolute encoder/resolver cable, C-253YYY. If cable is OK, replace motor. |
| AL-32 Absolute Home Position not set | Absolute Home Position has not been established using the Motionpro Software tools or OPI-50. Also set with AL-6, 19, 22, 23. | Check for cause of fault in the case of AL-6, 19, 22, 23. Correct fault and set Absolute Home Position. |
| AL-33 Absolute Home Position setting error | Absolute Home setting procedure is not correctly completed. Also set with AL-6, 19, 22, 23, 27. | Check for cause of fault in the case of AL-6, 19, 22, 23, 27. Correct fault and set Absolute Home Position. |
| AL-36 Battery Missing | Battery has been disconnected when the power was OFF. | Check for detached battery or cable short. |
| AL-40 Encoder Signal Short | A, B, Z, U, W or V phases of encoder not functional. | Check encoder cable and connections. |
| AL-41 Encoder Communication error | Communication problem with absolute encoder | Check encoder cable, replace driver, motor. |

12.1 ALARM CODES (cont'd)

| ALARM CODE | DESCRIPTION | REMEDY |
|---------------------------------|--|---------------------------|
| AL-42 Encoder Power | Absolute encoder backup power low | Replace battery. |
| AL-43 Encoder Checksum | Encoder communication checksum error at power up | Replace motor/encoder. |
| AL-44 Battery Low | Absolute battery voltage has fallen below 2.8V. | Replace absolute battery. |
| AL-45 Absolute encoder error | Signal sequencing problem in the absolute encoder. | Replace motor. |

12.2 CONTROLLER STATUS

| | |
|--|---|
| <p>SYSTEM STATUS</p> <p><input type="checkbox"/> PROCESSOR FAILURE (DECIMAL PT ONLY)</p> <p><input checked="" type="checkbox"/> PROGRAM RUNNING DRIVE ON</p> <p><input checked="" type="checkbox"/> PROGRAM RUNNING</p> <p><input type="checkbox"/> SYSTEM RESET</p> <p><input checked="" type="checkbox"/> TEST MODE</p> <p><input type="checkbox"/> PROGRAM LOADED</p> <p><input type="checkbox"/> LOSS OF PROGRAM</p> <p><input checked="" type="checkbox"/> FLASHING, MOTOR-ID CHANGED, CYCLE POWER</p> <p><input checked="" type="checkbox"/> FLASHING, DRIVE PARAMETERS CHANGED, CYCLE POWER</p> <p><input type="checkbox"/> NO OPERATING SYSTEM</p> <p><input checked="" type="checkbox"/> OPERATING SYSTEM LOADED</p> <p><input type="checkbox"/> NO FIRMWARE, SYSTEM READY FOR DOWNLOAD</p> <p><input type="checkbox"/> WATCH DOG TIMER OVERFLOW</p> <p><input checked="" type="checkbox"/> CPU FAULT</p> <p><input type="checkbox"/> CPU TRAP FAULT</p> <p><input checked="" type="checkbox"/> CPU HALT</p> <p><input type="checkbox"/> FLASH CHIP ERASE IN PROGRESS</p> <p><input type="checkbox"/> LOW POWER STATUS</p> | <p>PROGRAM ERRORS (P + DIGIT -WILL DISPLAY IN ALTERNATING MANNER AT .5 SEC INTERVALS)</p> <p>P + <input checked="" type="checkbox"/> DIVIDE BY ZERO</p> <p>P + <input type="checkbox"/> ILLEGAL COMMAND</p> <p>P + <input type="checkbox"/> NOT USED</p> <p>P + <input type="checkbox"/> NOT USED</p> <p>P + <input type="checkbox"/> NOT USED</p> <p>P + <input type="checkbox"/> NOT USED</p> <p>P + <input type="checkbox"/> ILLEGAL ARGUMENT</p> <p>P + <input type="checkbox"/> NOT USED</p> <p>P + <input type="checkbox"/> NOT USED</p> <p>SYSTEM ERRORS (E + DIGIT -WILL DISPLAY IN ALTERNATING MANNER AT .5 SEC INTERVALS)</p> <p>E + <input type="checkbox"/> PROGRAM TIMEOUT</p> <p>E + <input type="checkbox"/> AXIS FOLLOWING ERROR</p> <p>E + <input type="checkbox"/> NO ENCODER FEEDBACK</p> <p>E + <input type="checkbox"/> COM 1 ERROR</p> <p>E + <input type="checkbox"/> COM 2 ERROR PRINT BUFFER OVERFLOW</p> <p>E + <input type="checkbox"/> FIBER OPTIC ERROR</p> <p>E + <input type="checkbox"/> DRIVER SERIAL COMMUNICATIONS FAILED</p> <p>E + <input type="checkbox"/> DRIVER FAULT</p> |
|--|---|

Figure 12.1 - Controller Status

If an illegal command or illegal argument is detected, the block will stop executing and display the block and step number where the fault occurred. Pressing F4 or reset will exit you from the fault screen. Illegal argument is caused by a value being out of range when the command is executed. See **Section 12.4** for a list of illegal commands.

12.3 TEST MODE

The system test operations provide a diagnostic tool in which the operator interface is used to display the current status of the DeltaPro system. Pressing F3 from the MAIN MENU will activate TEST MODE. When entering TEST MODE the drive will be disabled. It will return to its previous state when exiting TEST MODE.

Test operations contain four screens. Press [NEXT] or [PREV] to move between the four screens. Press [F4] to return to the MAIN MENU. The screens are displayed on the Operator Interface in the order shown below:

INPUT STATUS:

(1-8) 01110000

(9-16) 10000000

F4 = MAIN MENU

1. The first diagnostic screen dynamically displays the state of all the Inputs. A "1" indicates that the input is ON. A "0" indicates that the input is OFF.

OUTPUT TEST:

1 2 3 4 5 6 7 8

0 0 0 1 0 0 0 1

F4 = MAIN MENU

2. The Output Test permits changing the state of an output. The current output states are displayed in the following screen. A "1" indicates that the output is ON. A "0" indicates that the output is OFF. Press the corresponding keypad number to toggle that output. After exiting this screen the outputs will be returned to their previous state.

FEEDBACK TEST:

AXIS POSITION: 2100

FIBER OPTIC: 900

F4 = MAIN MENU

3. The third screen dynamically displays the resolver position (the resolver position will be between 0 and 4095:

KEYPAD TEST:

XX

F4 = MAIN MENU

4. The final screen is a keypad test. When a key is pressed the value is then echoed to the display. F4, PREV and NEXT are used to exit this screen and are not echoed to the display.

12.4 ILLEGAL COMMANDS

The DeltaPro controller will prompt the user if a program error has occurred. Program errors consist of illegal arguments, illegal commands, and division by zero or calculation errors. The BLOCK.STEP number where the error occurs will be displayed on the Operator Interface (OPI-50).

The following chart lists the possible illegal commands and the causes of the error:

| COMMAND | CAUSE OF ERROR |
|---|--|
| TURN ON/OFF | <ul style="list-style-type: none"> • Try to turn on or off an enabled PLS • If busy and turn on or off the drive • If in fault block and turn drive on or off |
| UNLOCK | <ul style="list-style-type: none"> • Must be currently locked |
| SEARCH FOR INPUT POSITION INDEX | <ul style="list-style-type: none"> • Can not issue in fault block • Drive must be enabled • Drive must not be busy |
| CAM SEGMENT CAM START SET CAM POINTER | <ul style="list-style-type: none"> • Drive can not be busy • Can not issue in fault block |
| TRACK SPEED | <ul style="list-style-type: none"> • Can not issue in a fault block • Drive must be enabled • Drive can not be busy except for running track speed currently |
| WAIT POSITION WAIT DISTANCE WAIT UNTIL STOP | <ul style="list-style-type: none"> • Can not issue in a fault block |
| CAM END | <ul style="list-style-type: none"> • Not all the calculation where correct for the cam segments. • Drive can not be busy • Can not issue in a fault block |
| LOCK | <ul style="list-style-type: none"> • Can not issue in the fault block • Drive must be enabled • Drive must not be busy • No cam segments exist |
| INITIALIZE | <ul style="list-style-type: none"> • Can not issue in fault block • Drive must be enabled • Drive must not be busy • Can not use with an absolute system |

12.5 ILLEGAL ARGUEMENTS

ILLEGAL ARGUMENTS can occur for the following commands:

| | |
|------------------|---------------|
| FORCE DECEL | POSITION |
| UNLOCK | INDEX |
| WAIT DISTANCE | IF VARIABLE |
| WAIT POSITION | LET |
| WAIT TIME | DO WHILE |
| RATIO | IF BUSY |
| PRESET BATCH | IF INPUT |
| SET CAM POINTER | INITIALIZE |
| SEARCH FOR INPUT | SET PLS ANGLE |
| TRACK SPEED | |

An illegal argument means that some portion of the data for the command is out of range. This includes jumping to a step that doesn't exist in the current block. The DeltaPro controller will prompt the user as to what Block.Step command has the illegal argument.

12.6 OTHER ERRORS

Divide by Zero: There is a let calculation that divides by zero - let_____/ 0

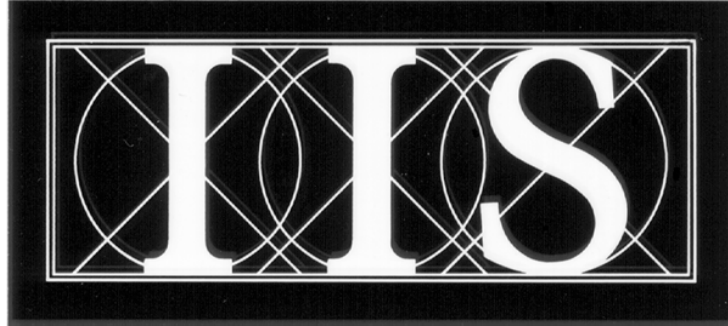
Calculation Error: There is an error in the cam calculation of a cam segment.

Drive Alarm: An alarm has occurred on the drive. Check the drive display for correct alarm code.

Following Error: The motor actual and commanded position was outside the desired range. The system should be checked to see if anything would limit the motors motion. The tuning should also be checked.

APPENDIX A (MOTOR/DRIVER SPECIFICATIONS) AND
APPENDIX B (CABLES AND ACCESSORIES)
DOCUMENTS ARE SAVED UNDER **IB-19B001**.

| | | |
|--|-----------|--|
| | IB-19B004 | |
| | | |



INDUSTRIAL INDEXING SYSTEMS INC.

**626 FISHERS RUN
VICTOR, NEW YORK 14564**

**(585) 924-9181
FAX: (585) 924-2169**

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