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CE

BDHX150E/230V &
BDHX75E/230V
Servo Drive
User Guide

For engineering assistance in Europe:
Parker Hannifin plc
Electromechanical Division - Digiplan
21 Balena Close
Poole, Dorset
England, BH17 7DX
Direct Lines for Technical Support
Tel: 01202-699000 Fax: 01202-695750
E-mail: tech.help@digiplan.com

For engineering assistance in the U.S.:
Parker Hannifin Corporation
Compumotor Division
5500 Business Park Drive, Suite D
Rohnert Park, CA 94928
USA
Telephone: (800) 358-9070
Fax: (707) 584-3793
FaxBack System: (800) 936-6939
BBS: (707) 584-4059
E-mail: tech_help@cmotor.com

Part No: 1600.212.01 November, 1996

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IMPORTANT INFORMATION FOR USERS

Installation and Operation of Digiplan Equipment

It is important that Digiplan motion control equipment is installed and operated in such a way that all applicable safety requirements are met. It is your responsibility as an installer to ensure that you identify the relevant safety standards and comply with them; failure to do so may result in damage to equipment and personal injury. In particular, you should study the contents of this user guide carefully before installing or operating the equipment.

The installation, set-up, test and maintenance procedures given in this User Guide should only be carried out by competent personnel trained in the installation of electronic equipment. Such personnel should be aware of the potential electrical and mechanical hazards associated with mains-powered motion control equipment - please see the safety warning below. The individual or group having overall responsibility for this equipment must ensure that operators are adequately trained.

Under no circumstances will the suppliers of the equipment be liable for any incidental, consequential or special damages of any kind whatsoever, including but not limited to lost profits arising from or in any way connected with the use of the equipment or this user guide.



SAFETY WARNING

High-performance motion control equipment is capable of producing rapid movement and very high forces. Unexpected motion may occur especially during the development of controller programs. ***KEEP WELL CLEAR*** of any machinery driven by stepper or servo motors. Never touch it while it is in operation.

This product is sold as a motion control component to be installed in a complete system using good engineering practice. Care must be taken to ensure that the product is installed and used in a safe manner according to local safety laws and regulations. In particular, the product must be enclosed such that no part is accessible while power may be applied.

A permanent mains safety earth connection must be made to the earth stud on the side of the drive case before applying mains power.

If the equipment is used in any manner that does not conform to the instructions given in this manual , then the protection provided by the equipment may be impaired.

EMC INFORMATION

EMC Information is presented in boxed paragraphs (such as this one). Digiplan cannot guarantee compliance unless guidelines are strictly followed.

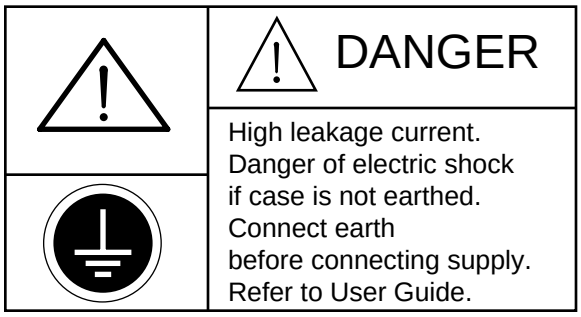
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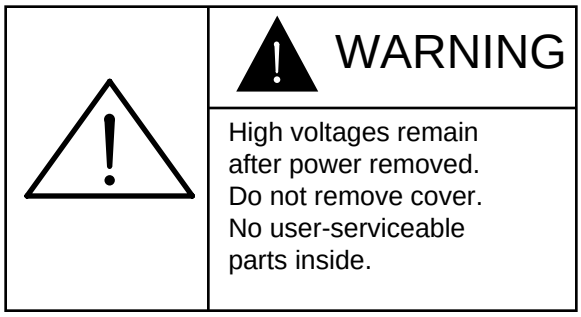
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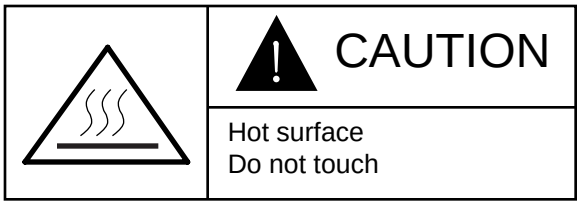
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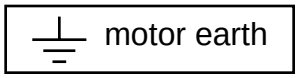
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The following Danger, Warning and Caution labels are fitted to the drive:









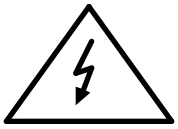
Symbols used on the BDHX-E series of drives have the following meanings:



Refer to the accompanying documentation



Protective conductor terminal



Risk of electric shock



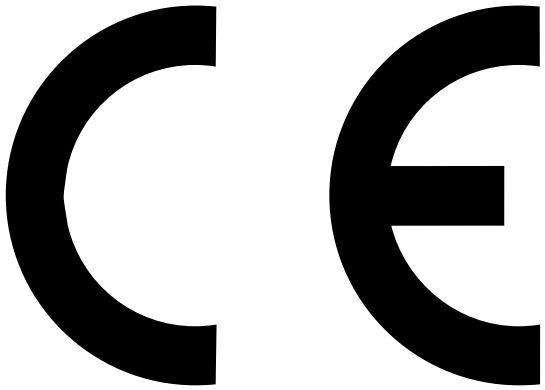
Alternating current



Hot surface



Frame or chassis terminal



Product Type: **BDHX150E/230V, BDHX75E/230V**

The above product is in compliance with the requirements of directives

- **89/336/EEC** **Electromagnetic Compatibility Directive as amended by Directive 92/31/EEC**

The product is intended for use in the Commercial, Light Industrial and Industrial Environments as defined in the relevant EMC standards

This product is compliant with the Low Voltage Directive

- **73/23/EEC** **Low Voltage Directive**
- **93/68/EEC** **CE Marking Directive**

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Associated Documentation

This User Guide forms part of the documentation required to use the BDHX-E Series of servo drives, it should be read in conjunction with the **X150/X150E Software Reference User Guide** (Part Number 1600.221.01) which provides details of individual commands.

User Guide Change Summary

The following is a summary of the primary changes to this user guide since the last version was released.

When a user guide is updated, the new or changed text is differentiated with a change bar in the outside margin (this paragraph is an example). If an entire chapter is changed, the change bar is located on the outside margin of the chapter title.

This is the first release of this user guide.

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Section 1. INTRODUCTION

Product Description

The BDHX-E Series of EMC compliant brushless drives are capable of operating direct-on-line from a 220-240V AC input, with no isolating transformer. A choice of two current ratings are available:

BDHX150E/230V	6A RMS continuous (12A RMS peak)
BDHX75E/230V	3A RMS continuous (6A RMS peak)

Both drive types have high resolution sinusodial commutation and have been designed to be used with 3-phase brushless servo motors.

The drives are equipped with multiple protection circuits which guard against excessive current output over long time periods or at low speed operation. Further circuits protect against overspeed operation, commutation loss, motor feedback loss, overvoltage, undervoltage, supply failure and overtemperature faults.

Both drive types incorporate an X150E, EMC-compliant, controller configurable by software and offering a choice of RS232C or RS485 serial link communications. NPN or PNP output drivers can be selected by software and inputs and outputs can also be configured by software to operate from 5V or 24V supplies, allowing straightforward integration within a PLC controlled system.

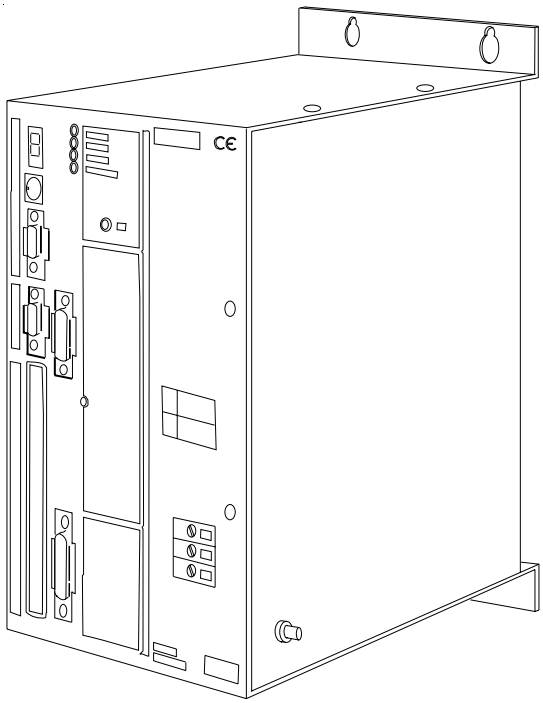


Figure 1-1. BDHX-E Drive

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Product Features

Protection Circuits

Overcurrent
Overspeed
Commutation loss
Overvoltage
Undervoltage
Supply failure
Overtemperature of motor and drive

Function Indicators

It Clamp
Current Limit
Drive Fault
Overtemperature
HV Present

Outputs and Inputs

Reset/Disable
Differential velocity/torque demand input
Fault output
Incremental encoder outputs

Other Features

Power dump

Monitor Circuits

Tachometer output
Current level output

Note: Three internally mounted indicators (visible through slots in top of case) are also provided to allow motor setup. The LEDs are:

Overcurrent
Index
Commutation

Controls and Indicators

LEDs

HV Present LED (Green)

This LED indicates that the DC bus voltage is present, but it does not necessarily mean that the logic supplies are correct.

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Warning - Risk of Electric Shock

When power is removed, the drive terminals should not be touched while the green LED remains alight.

Current Limit LED (Yellow)

Illumination of this LED indicates that the current demand is exceeding the drives maximum programmed current, and is therefore clamped. For adjustment of the current limit level, see Appendix A.

IT Clamp LED (yellow)

The illumination of this LED indicates that the drive has been set to demand too much peak current for too long a time, causing the current limit to be reduced to 6.8A RMS for the BD150E/230V (3.4A RMS for the BD75E/230V) to protect the drive.

Overtemperature LED (Red)

Illumination of this LED indicates that either the drive or motor is operating outside its specified continuous temperature rating, requiring extra cooling to be used or reduction of the operating duty cycle.

Note: the over temperature LED will also be illuminated by faulty motor feedback connections. For more information refer to the Maintenance and Troubleshooting Section.

Drive Fault LED (Red)

This LED indicates one of the following fault conditions:

- Overvoltage
- Undervoltage
- Supply failure
- Overcurrent
- Overspeed

For more information refer to the Maintenance and Troubleshooting Section.

HV Present

This LED indicates that a voltage is present on the High Voltage capacitors.

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Internal Commutation LEDs

Three diagnostic/set-up LEDs are present within the drive, but can be observed through the ventilation slots on top of the drive towards the front panel face. From the front panel face the LEDs are:

Red	Overcurrent
Yellow	Index
Yellow	Commutation

The index LED is illuminated when the index pulse is high and the commutation LED lights when the A channel of the commutation encoder (Com A+) is high. For more information refer to the Commutation sub-section. The red overcurrent LED provides greater diagnostic information under drive fault conditions.

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Section 2. GETTING STARTED

What You Should Have

Upon receipt, you should inspect your BDHX-E Series Drive system for obvious damage to its container. Report any damage as soon as possible. The items listed in Table 2-1 should be present and in good condition. To verify that you have the proper drive model, check the model number listed on the drive serial plate.

Ship Kit Table

Part Description	Part Number
BDHX-E Drive	See drive identification below
BDHX-E User Guide	1600.212.XX
Connector kit	BDHXE/FITKIT
Cable Set	BDCXXXX Where XXXX specifies cable length, for example BDC1500 specifies a 15 metre cable set.

Table 2-1. BDHX-E Drive Ship Kit

Systems may be shipped configured with drives and motors prewired or supplied as separate units.

Identification

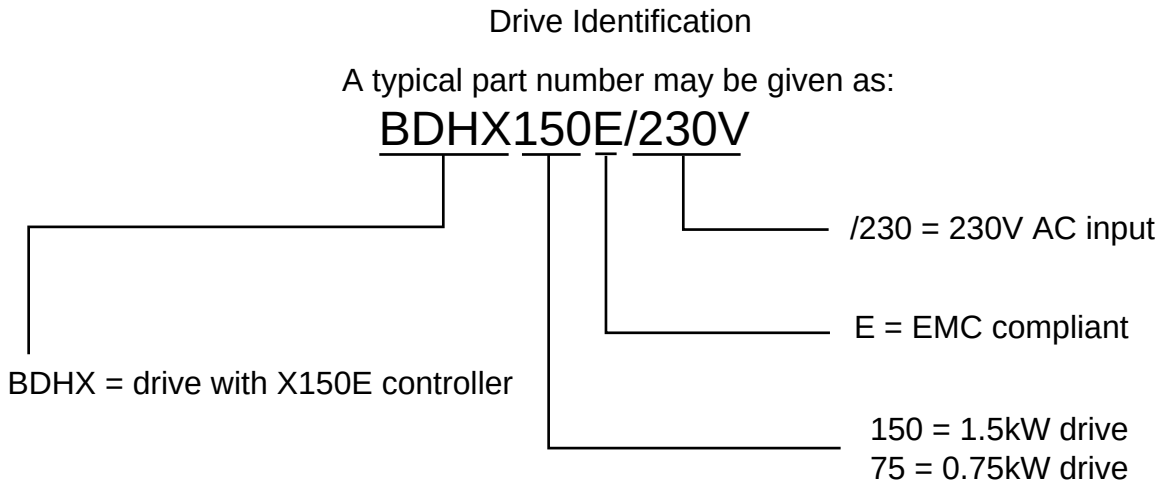


Figure 2-1. Drive Identification

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Warning - risk of electric shock

If the drive mains earth becomes disconnected, the case and signal I/O lines will become live at 120V AC, due to the filter required for EMC compliance. To prevent this happening an additional separate earth lead following the route of the mains lead must be connected before applying power.

Pre-installation Test

This section provides procedures to help you to connect up your BDHX-E drive system for a pre-installation test. Please note the pre-installation test allows you to become familiar with the operation of the drive prior to permanent installation, it should only be set up and used by competent personnel familiar with installation of motion control equipment. The separate safety earth connection must be made as shown to minimise the risk of electric shock.

Figure 2-2 illustrates the pre-installation test configuration for systems operating from a 230V mains supply. Please note the following points:

- The motor should be securely clamped to the test bench before any power is supplied.
- A separate safety earth **must** be provided and connected to the stud on the side of the drive (see Connecting to an AC Supply). Do not rely upon the AC supply mains earth.

Minimum RS232 Connections

You will need to make a connection between a terminal and the drive. The simplest connection that can be made is using a RS232 communicatins link as detailed below.

Drive RS232/RS485 9-way D-type Connector	Computer 9-way D-type	Computer 25-way D-type
3 0V	5	7
4 RxA	3	3
5 TxA	2	2

Table 2-2. Minimum RS232 Connections

Note: The RS232 connections need to be made using a braided screen cable with metal back shells on the D-type connectors to maintain EMC compatibility.

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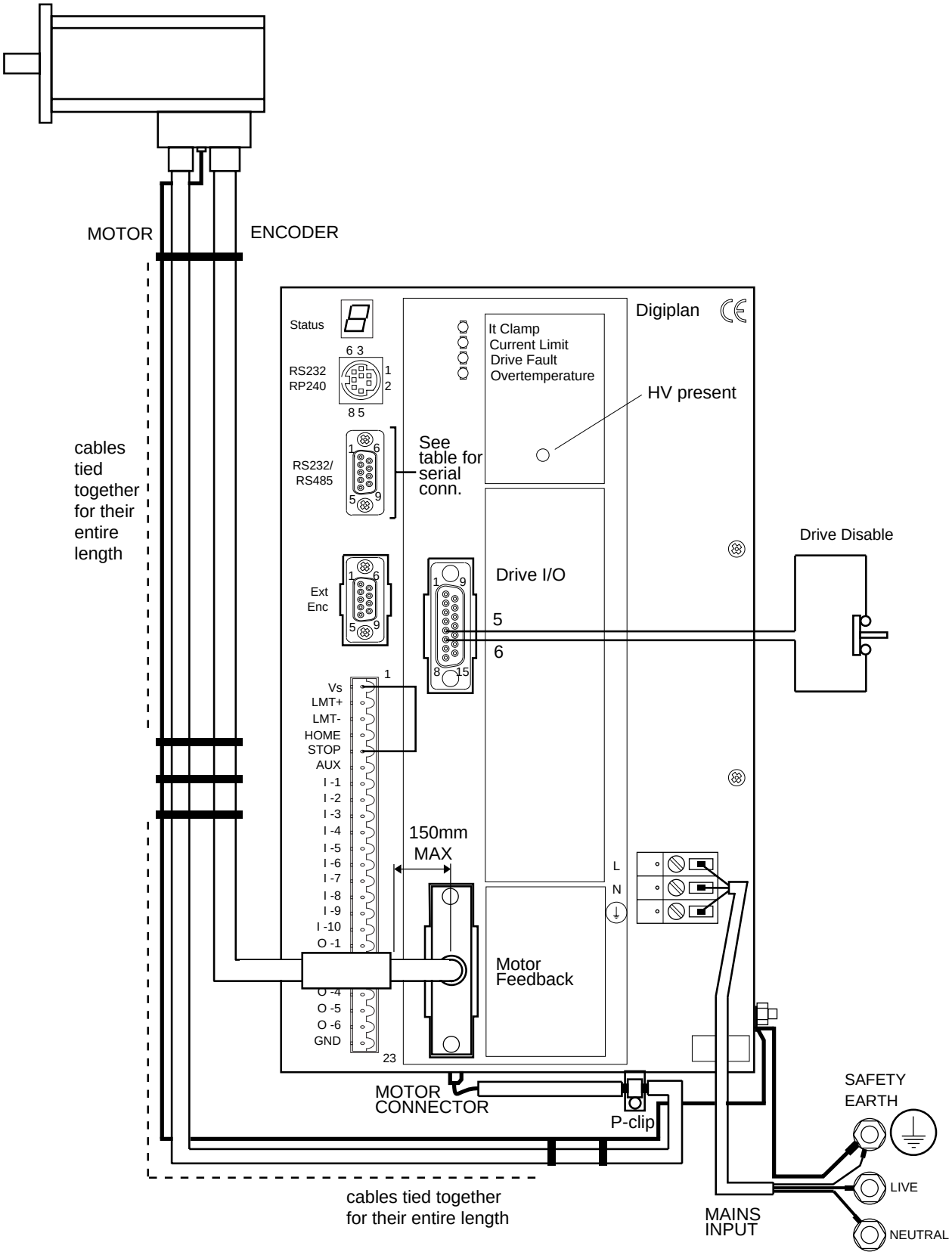


Figure 2-2. Pre-installation Test Configuration

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Motor and AC Power Connections

1. Connect the Motor

WARNING - Electric Shock Hazard

Ensure that AC power is disconnected before attempting to connect or disconnect the motor. Lethal voltages are present on the motor connectors.

Insert the plugs on the motor and encoder cables securely into the mating connectors on the motor housing and ensure that the locking rings are tight. Fit the drive end connectors to the corresponding sockets, ensuring that the motor cable screen is anchored under the P-clip (see Fig 2-2). Connect the motor safety earth as shown using 2.5mm^2 wire.

2. Connecting to an AC Supply

The BDHX-E Series of drives operate direct-on-line from a 220-240V AC input, with no isolating transformer. AC supply connections are made directly to the front panel screw connections using 1.5mm^2 3-core mains cable. Please note that the separate safety earth lead is necessary due to the leakage current through line-to-earth capacitors fitted on the internal filter board. A permanent connection, or an IEC309 connector is required to the main supply.

DO NOT APPLY POWER TO THE DRIVE YET.

Testing the BDHX-E System

1. To ensure there is no start-up sequence loaded in the controller the drive is initially disabled by breaking the connection between pins 5 and 6 of the UserI/O connector.

Note: a connection must be made between pins 5 and 6 of the User I/O connector to enable the drive - see step 7 below.

2. Ensure a link is made between Vs (pin 1) and Stop (pin 5) on the 23-way main controller connector.

3. Make the RS232 connection between the terminal and controller, as detailed above.

4. Configure the terminal to operate at 9600 baud, 8 data bits, 1 stop bit and no parity. Set the keyboard to capitals.

5. Apply power to the drive.

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6. Establish serial communications by sending a 1DR comand. The drive should return a report of the setup of various parameters of the controller. If no response is obtained check the RS232 connections are made correctly.

7. Once serial communications have been established, enable the drive by making the connection between pins 5 and 6 of the UserI/O connector.

8. Correct operation of the drive can be checked by sending the following commands:

LD3<return> disable limit inputs
D 4000<return>
G<return>

9. Motor rotation of 1 revolution confirms that the drive is operating correctly. If the motor fails to rotate, re-check all connections. If you do not discover the cause of the problem refer to the ***Maintenance & Troubleshooting*** section.

10. At the end of testing remove power from the drive and wait until the HV Present LED goes out before removing connectors.

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Section 3. INSTALLATION

Precautions

During installation, take the normal precautions against damage caused by electrostatic discharges. Earthed wrist straps should always be worn.

Environment

The drive system should be installed vertically in an area where there is at least a 50mm air gap all around the package. The distance required is, however, application dependent, and may vary according to the amount of heat generated by equipment mounted below the drive and by the drive itself. An integral fan draws air into the base of the drive and expells it through vents in the top panel. The ambient temperature must not be allowed to exceed 40°C if a user has access to the case, or 50°C if user access is not allowed.

The drive requires a mains supply of Installation Category 2 and can be used in an atmosphere of Pollution Degree 2. Humidity limits are 0-95% non-condensing.

Drive Dimensions

All BDHXE drives are supplied as packaged units. Figure 3-1 shows the overall dimensions of the drive and the distance required between mounting holes.

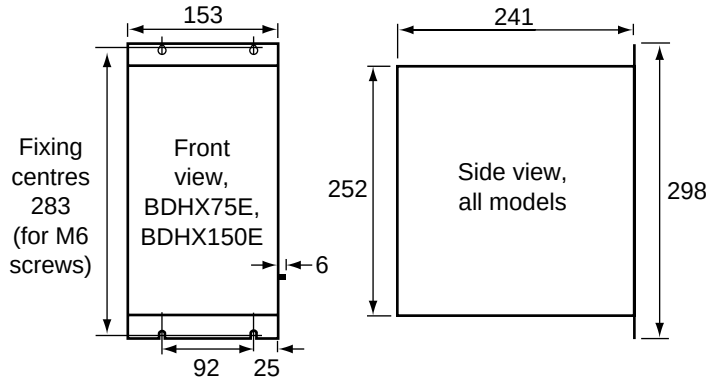


Figure 3-1. Drive Dimensions

Note: The width dimension of 153mm does not include the 6mm earth stud fitted on the side of the drive and dimensions given above do not allow for room occupied by interface connectors.

CAUTION - Under certain operating conditions the top of the case may reach temperatures in excess of 70°C.

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Drive Signal Connections

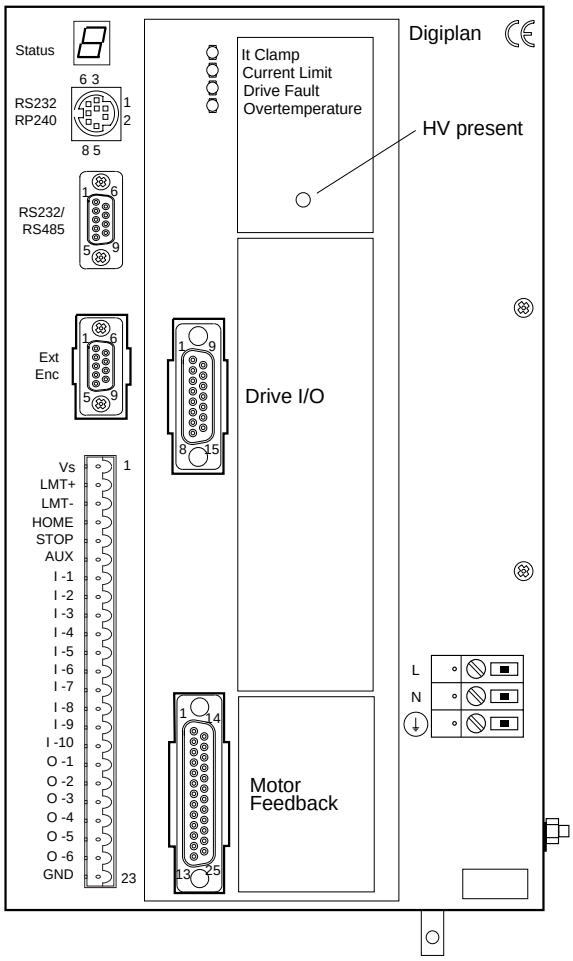


Figure 3-2. I/O Connector Layout

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Drive Signal Types

Drive I/O Connector

User I/O Connector Pin Functions

Pin	Signal Name	Function
3	-15v	Reference voltage (current limited)
4	GND	Ground
5	$\overline{\text{Drive disabled}}$	*Disable
6	+15V	Reference voltage (current limited)
7	Tach Out	Tachometer monitor output
8	Curr. Level Out	Current monitor output
9	$\overline{\text{FT}}$	$\overline{\text{Fault}}$
10	**A+	A output from incremental encoder
11	A-	$\overline{\text{A output}}$
12	B+	B output from incremental encoder
13	B-	$\overline{\text{B output}}$
14	***I+	Z output from incremental encoder
15	I-	$\overline{\text{Z output}}$

* 0V holds drive in permanent disabled condition. 15V allows drive to energise.

** A+ leads B+ for CW motor rotation

*** I+ is a once-per-rev high-going pulse, covering at least $\frac{1}{4}$ of a channel A+ cycle and occuring when A+ and B+ are both high - see below:

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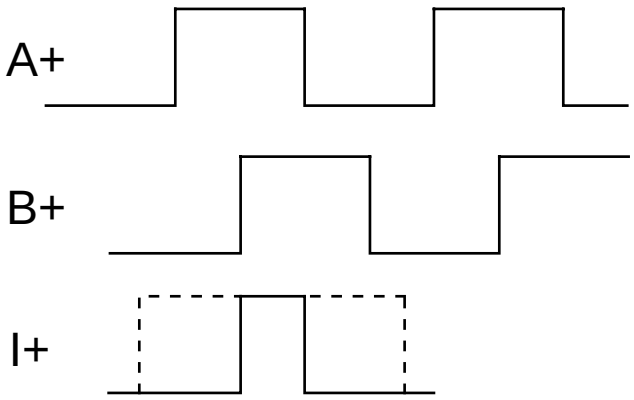


Table 3-1. Drive I/O Connector Pin Functions

User I/O Pin Description

The User I/O connector provides access to the main drive control signals. The function of each pin is described below.

Pin 3 (-15V) & Pin 6 (+15V)

Pins 3 (-15V) & 6 (+15V) are current limited supplies (10mA max.).

Pin 4 0V

Pin 4 is drive ground and is linked to mains earth via a high frequency filter.

Pin 5 Drive Disable

Pin 5 is the drive disable input, when the input is low, the drive is de-energised. Any latched faults remain latched while the input is low and are reset on the high-going edge.

The drive disable input can be configured by the Fail Safe Loop Active command (CFS), with CFS set to '0' the fail safe loop is active. In this condition, to energised the drive, the drive disable input must be connected to +15V (pin 6 of the the user I/O connector) via a switch or a PNP transistor. This is the default setting for the BDHX-E.

Note: normally a connection must be made between pins 5 and 6 of the User I/O connector to enable the drive.

With CFS set to '1' the fail safe loop is inactive, the drive disable input is pulled up to +15V using a 15k ohm resistor and the drive is energised. To de-energise the drive you will need to connect this input to 0V (pin 4 of the user I/O connector).

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Pin 7 Tach Output

Pin 7 is the internally buffered tachometer output. The output produces a signal of approximately 2V/krpm independent of line count. The output polarity is positive for CW motor rotation. This output is not intended for accurate speed calibration, but for use when setting up the drive.

Pin 8 Current Monitor

Pin 8 is a unipolar current monitor signal used to indicate the total motor current with a sensitivity of 2A/V for the BD150 (1A/V for the BD75). This output is not intended for accurate current calibration, but for use when setting up the drive.

Note: the output represents a rectified summation of the 3 actual motor phase currents thus, even when delivering a constant torque, the signal will contain approximately 13% ripple at low shaft speeds.

Pin 9 Fault Output

Pin 9 is an open collector fault output signal which goes low when a fault occurs. The output can be pulled up to a maximum voltage of +28V, and the output transistor can pass a maximum current of 25mA.

Pin 10 to 15 Encoder Outputs

Pins 10 to 15 are buffered encoder outputs using 26LS31 line drivers. Use twisted pair screened cable and 26LS32 line receivers or optos.

Note: Particular care should be paid to these outputs to prevent EMC radiation problems. When using line receivers - connect the screen to earth at both ends of the cable. In this configuration the drive and controller should be mounted close together sharing the same ground plane.
For opto receivers - connect the screen to earth at the drive end only.

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Motor Feedback Connector

Motor Feedback Connector Pin Functions

Pin Number	Function	Lead Colour
1	Reserved	
2 3	0V 5V	Blue Red } Twisted Pair
4	Tach 0V	See description
5	Tach input	See description
6 7	0V Thermistor	Pink Grey } Twisted Pair
8 9	I- I+	Green Yellow } Twisted Pair
10 11	B- B+	White Brown } Twisted Pair
12 13	A- A+	White/Yellow Yellow/Brown } Twisted Pair
14	Reserved	
15 16	0V +5V	White/Pink Pink/Brown } Twisted Pair
17	Reserved	
18 19	N C NC	
20 21	Com C- Com C+	Black Violet } Twisted Pair
22 23	Com B- Com B+	Grey/Red Red/Blue } Twisted Pair
24 25	Com A- Com A+	White/Green Brown/Green } Twisted Pair

Table 3-2. Motor Feedback Connector Pin Functions

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Motor Feedback Pin Description

The user motor feedback connector is a 25-way D-type which carries motor monitoring signals. Connection to the User I/O connector must be made using a metal cased backshell D-type connector and the securing screws must be fully tightened before use.

Pin 2 & 15 0V

0V return for +5V supply.

Pin 3 & 16 +5V

+5V current limited supply (200mA maximum). Take care to minimise any voltage drop when using cables longer than 10 metres.

Pin 4 Tach 0V

Tach input 0V return.

Pin 5 Tach Input

Tach input. The Tach input pins are not normally used. They are reserved for use with a brushed tachometer for high performance applications.

Pin6 0V

0V return for thermistor.

Pin 7 Thermistor

For thermal protection of the motor, a normally closed thermal switch or a PTC thermistor mounted in the motor is connected between pins 6 and 7. The thermistor should have a transition resistance between 100R and 10kΩ.

Pins 8 to 13 Inc Encoder Inputs

The incremental encoder inputs are connected to a 26LS32 line receiver. The setup of the encoder is described in ***Appendix A***.

Pins 20 to 25 Comm Encoder Inputs

The commutation encoder inputs allow the use of commutation encoders other than those used with the MD3450/3475 motors. Commutation encoder setup is described in ***AppendixA***.

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Controller Signals

There are 4 front-panel connectors associated with control inputs and outputs as shown in the diagram. Their functions are as follows:

1. **RS232/RP240** (8-way mini-DIN socket). This socket is normally used for the RP240 Remote Operator Panel but may also be used as an alternative RS232C connection from the host controller. The RS232 connections are in parallel with those on socket 2.

2. **RS232/RS485** (9-way D-connector). This is the connector normally used for serial communication. The initial release of the X150E controller will be supplied with RS232 communication as standard, RS485 being a factory-fitted option. Subsequent issues will allow either RS232 or RS485 to be user-selected.

3. **External encoder** (9-way D-connector). This connection is used for following applications (see SIM and CCS commands) or it can be used for motor feedback in place of the motor encoder (see ICON command).

4. **Main I/O connector** (23-way two-part screw terminal connector). All the user-programmable inputs and outputs, as well as registration, stop, home and limit inputs, appear on this socket.

Controller Signal Types

EXTERNAL ENCODER 9-way D-type

Pin	Signal Name	Function	Signal Type
1	A+/CLK+	Secondary Encoder	C
2	A-/CLK-		
3	B+/DIR+	Secondary Encoder	C
4	B-/DIR-		
5	Z+	Encoder Z channel	C
6	Z-		
7	5V ENC.	Encoder supply	D
8	GND	Encoder GND	D
9	n/c		

Table 3-3. Controller Signal Types

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RS232/RP240 mini DIN	1	+5V (RP240)		
	2	0V (RP240)		
	3	RxB (RP240)		
	4	n/c		
	5	RxA (Terminal)		
	6	TxB (RP240)		
	7	Screen		
	8	TxA (Terminal)		
RS232/RS485 9-way D-type	1	RxD (RS485)	Receive	E
	2	TxD (RS485)	Transmit	E
	3	0V		
	4	RxA (Terminal)		
	5	TxA (Terminal)		
	6	RxD/(RS485)		
	7	TxD/(RS485)		
	8	n/c		
	9	+5V		I
MAIN CONNECTOR	1	Vs	+24/5V (100mA)	DC OUTPUT
	2	LMT+	+Limit Switch Input	A
	3	LMT-	-Limit Switch Input	A
	4	HOME	Home Switch Input	A
	5	STOP	Stop Input	A
	6	AUX	Registration Input	A
	7	I - 1	User Input 1	A
	8	I - 2	User Input 2	A
	9	I - 3	User Input 3	A
	10	I - 4	User Input 4	A
	11	I - 5	User Input 5	A
	12	I - 6	User Input 6	A
	13	I - 7	User Input 7	A
	14	I - 8	User Input 8	A
	15	I - 9	User Input 9	A
	16	I - 10	User Input 10	A
	17	O - 1	User Output 1	B
	18	O - 2	User Output 2	B
	19	O - 3	User Output 3	B
	20	O - 4	User Output 4	B
	21	O - 5	User Output 5	B
	22	O - 6	User Output 6	B
	23	GND	24/5V GND	DC GND RETURN

Table 3-3. Controller Signals (continued)

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Signal Types

Signal Types identified by letters A, B, C, D, E, F, G and I in Table 3-3 are defined below.

Input Circuit Conventions

Inputs may be configured to be active high or active low.
An active high input has a pull-down resistor inside the controller, and must be connected to Vs to turn the input ON, i.e. make the input active. Alternatively, the input may be turned on by connecting it to an external +5V or +24V supply.
An active low input has a pull-up resistor to Vs inside the controller, and must be connected to 0V to make the input active.

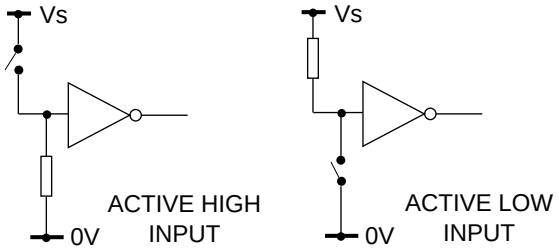


Figure 3-3. Input Circuit Configurations

In either case, the input is OFF (i.e. inactive) when in the open circuit condition. This condition is described as the logic 0 state and will return a '0' in response to the input status request IS.

Signal Type A

Apply to all dedicated and user definable inputs. Signal type A inputs can be operated at 5V or 24V and can be configured, by software, for operation as active high or active low inputs. The input circuit for "A inputs" is shown in Figure 3-4.

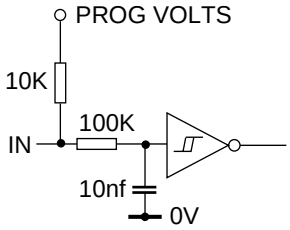


Figure 3-4. Signal Type A Input Circuit

Inputs can be programmed to operate as pull-down (sink) inputs or pull-up (source) inputs. The pull-up voltage may also be programmed as 5V or 24V. This is achieved by using the circuit arrangement shown in Figure 3-4, where PROG VOLTS can be programmed to 0V (pull-down), 5V or 24V (pull-up).

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Table 3-4 defines the required settings for 5V and 24V operation and the different input characteristics between the two settings

	5V Operation		24v Operation	
Signal type	B		A	
Input Characteristics	Active high	Active low	Active high	Active low
Logic 1 level (Input ON)	>3.0v	<2.5v	>9.0v	<5.7v
Logic 0 level (Input OFF)	<2.5v	>3.0v	<5.7v	>9.0v
Hysteresis	0.5v	0.5v	3.3v	3.3v
Max. input voltage range	0-30v	0-30v	0-30v	0-30v

Table 3-4. 5V and 24V Operation for Signal Type A Inputs

Signal type A inputs may be configured as Pull down (sink) inputs or as Pull up (source) inputs. The inputs are programmed using the ICON command. ICON is also used to set the pull up voltage level and the value of Vs supplied to the customer.

Signal Type B

Signal type B outputs can also be defined in software, using the OCON command. Outputs can be programmed as NPN or PNP.

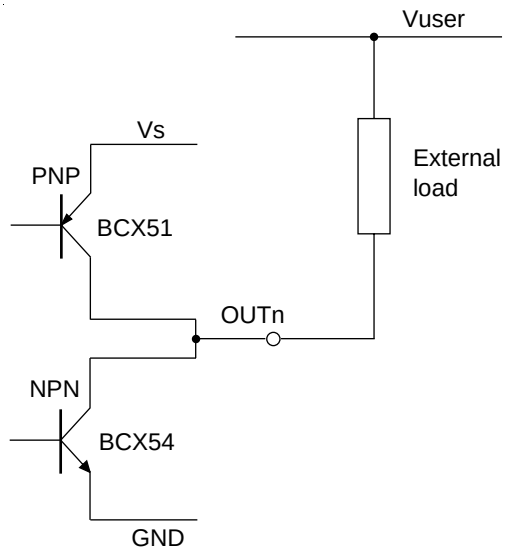


Figure 2-5. NPN or PNP Output Configuration

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Output voltage levels will be determined by the value of the external voltage (Vuser) and the value of the connected load.

Caution - Possibility of equipment damage

The output circuit uses a connected pair of output transistors, consequently when the NPN transistor is used, but is turned OFF, the external user voltage (Vuser) must be no greater than the external voltage (Vs).

The characteristics of each output type are listed in Table 3-5.

	NPN	PNP
Output Characteristics		
Circuit configuration	Common emitter	Common emitter
Output current max.	300mA at 1V	100mA at (V_S-2)V
Max. OFF signal voltage	30V	30V
Mode	Current sinking	Current sourcing

Table 3-5. Signal Type B Output Characteristics

Signal Type C

Signal type C inputs are used for differential, optically isolated, encoder TTL level inputs. The maximum frequency handled by these inputs is 100KHz.

Signal Type D

Encoder supply of +5V DC at 150mA.

Signal Type E

RS232 data signals.

Signal Type F

RP240 RS232 data signals.

Signal Type G

RP240 +5V DC supply (150mA max).

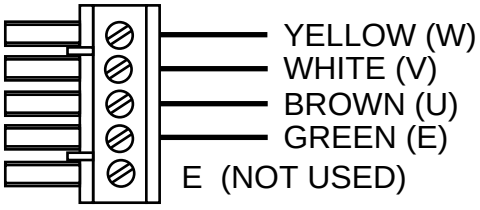
Signal Type I

Signal ground.

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Motor Connections

Motor connections are made via a 5-way spade terminal plug, mounted in the base of the drive. The motor cable terminating plug is shown in Figure 3-6.



CAUTION - Risk of electric shock

HIGH VOLTAGES ARE PRESENT ON THIS CONNECTOR (up to 400V peak)

Figure 3-6 Motor Connector

Motor Connector Pin Functions

Signal Name	Lead Colour *
W	Yellow
V	White
U	Brown
E	Green
E	Not used

Table 3-6. Motor Connector Pin Functions

Rewiring the Motor Connections

The main motor cable has 5 leads and is terminated in a 5-way screw terminal connector. This connector is easily removed and refitted where necessary. The lead colours are shown in Table 3-6; make a note of where each colour wire is connected before proceeding and take particular care that the leads are reconnected correctly.

Extending the motor and encoder leads

Unless the use of bulkhead connectors is unavoidable, it is preferable to make up entirely new leads rather than to extend the cables supplied, but the same connector types must be used and screens must be correctly terminated. The following cable types may be used for this purpose:

Motor cable .....Lapp LiCY 0034804 *Encoder cable*.....Lapp LiCY 0035805

Connection details will be found in Tables 3-1 to 3-2. When making up new cables, make a careful note of how the original cable is terminated and ensure that the new cables are arranged in exactly the same way. Remember that the ferrite absorber must be fitted on the encoder cable close to the drive. Note that the encoder cable is slightly longer than the motor cable to allow for the different connector locations at the drive end. Please consult Digiplan if you propose to extend the motor and feedback leads beyond 30 metres.

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Cabinet Mounting Requirements

Figure 3-7 shows the necessary earthing and EMC compliance wiring arrangements you need to make when installing the drive within an equipment cabinet.

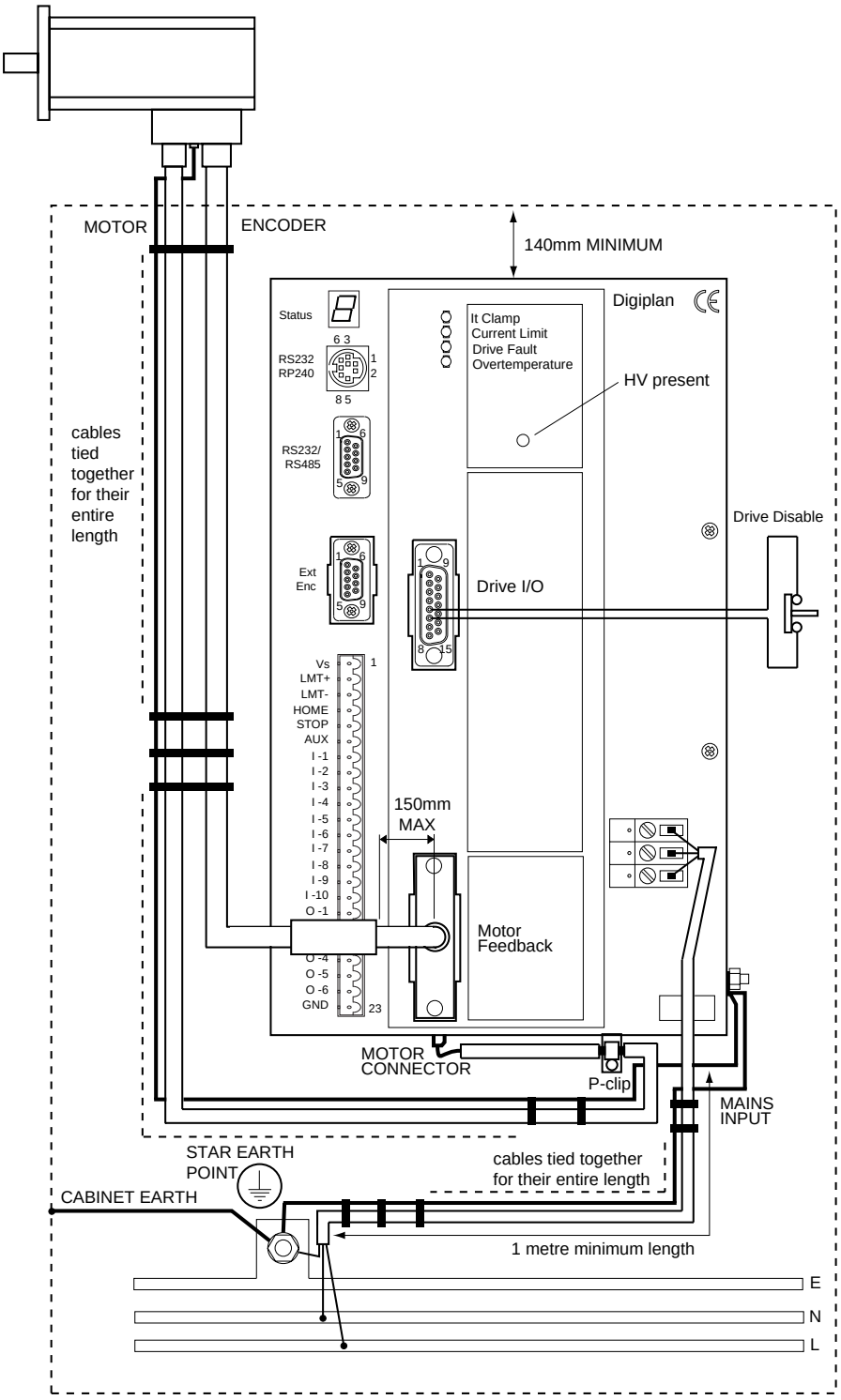


Figure 3-7. Cabinet Installation

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Cable routing

The mains cable should have a minimum length of 1 metre and needs to be terminated close to where the mains earth connection is made. The safety earth lead, connected to the stud on the side of the drive, needs to be closely routed with the mains lead. The motor earth wire, motor and encoder cables must be routed together for their entire length back to the drive. Unless the cables are laid alongside each other in trunking, use cable ties every 500mm to anchor the two cables and earth wire together.

Where the cables have to pass through a panel or bulkhead, the integrity of the screen must be preserved. Where possible, avoid using a connector. If a connector must be used, it should have a full metal shroud which makes a 360° connection to the cable screen on both sides. The body of the connector must be electrically isolated from any earthed metalwork - it may be mounted on a separate panel insulated from the bulkhead.

Motor and Encoder Connections

The encoder cable has a 25-way D connector at the drive end which is plugged into the 'Motor Feedback' socket on the drive. Tighten the jacking screws firmly. The metal housing on this connector must not be removed. The encoder cable is fitted with a ferrite absorber at the drive end which is essential for EMC compliance. This should be kept as close as possible to the drive-end connector and not more than 150mm away.

The 5-way spade connector on the motor cable fits a mating connector on the base of the drive. The exposed cable screen must be securely anchored under the clip adjacent to the connector - this is an essential requirement.

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AC supply connections

If a plug is used for AC supply connections it must conform to IEC309.

Warning - risk of electric shock

If the drive mains earth becomes disconnected, the case and signal I/O lines will become live at 120V AC, due to the filter required for EMC compliance. To prevent this happening an additional separate earth lead following the route of the mains lead must be connected before applying power.

AC power connections should be made directly to the screw terminals on the front panel of the drive using 1.5mm^2 3-core mains cable. Do not wire the AC supply using individual leads running in a conduit. The circuit should be protected by a 13A fuse or 16A circuit breaker, and the isolator must break both the live & neutral lines.

For permanently connected equipment, the switch should be marked as the disconnecting device and should be mounted close to the equipment within easy reach of the operator.

Earth leakage current

The AC supply to the BDHX-E drive is internally filtered to achieve EMC compliance. The filter components create an earth leakage current of the order of 10mA, which is compatible with standard residual-current breakers operating at 30mA. The BDHX-E drive is not suitable for use on supplies employing high-sensitivity RCD breakers. An independent safety earth connection must be made to the stud on the side of the drive as shown in Fig. 3-7. This connection must be in place before power is applied.

Motor safety earth connection

It is essential that there is a safety earth connection to the motor housing. A separate earth lead must therefore be taken from the earth terminal on the motor, routed with the motor and encoder leads and terminated at the safety earth stud on the side of the BDHX-E. The motor earth terminal is located between the motor and encoder sockets. The safety earth lead should be at least 2.5mm^2 in area.

Address Switch

The address of the drive is set using an internally mounted bit switch. The switch may be accessed via the ventilation slots on the top of the drive - see Figure 3-8. Address selection is described in ***Communicating With The Positioner***.

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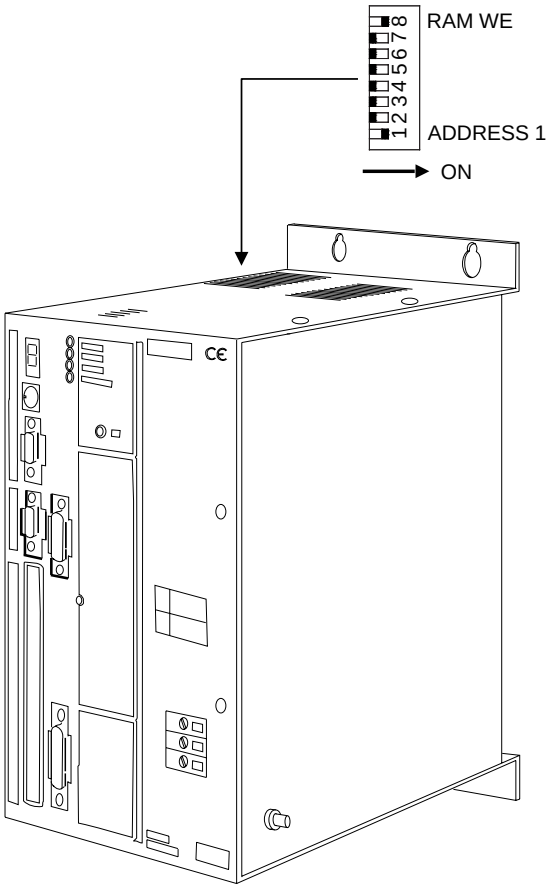


Figure 3-8. Address Switch Location

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Thumbwheel Interface

This section assumes that you are using Parker's TM8 thumbwheel module.

You can use up to 16 digits of the thumbwheel. The controller uses a multiplexed BCD input scheme to read the thumbwheel data. The commands and format that allow for the thumbwheel data entry are :

DRDxyz	Read distance via thumbwheel.
VRDxyz	Read velocity via thumbwheel.
LRDxyz	Read loop count via thumbwheel.
TRDxyz	Read time delay via thumbwheel.
VARDn,xyz	Read variables via thumbwheel.
XRDxyz	Read sequence count via thumbwheel.
FRDxyz	Read following ratio via thumbwheel.

To request 1 digit x=y=the desired digit number.

To request all digits x=0 and y=7 (or do not set xyz fields).

To request a block of digits 0<x<y<7.

The Z field scales the thumbwheel value by 10. When reading digits from the thumbwheel, the least significant digit will be filled first. The z field allows you to position the decimal point were needed.

Note : Either all the fields (xy and z) or none of the fields must be used. Refer to the software section for further explanation.

Using the TM8

THE TM8 REQUIRES A 5V SUPPLY. THE ICON COMMAND MUST BE USED TO SELECT A PULL-UP LEVEL OF +5V OTHERWISE DAMAGE WILL OCCUR. DO NOT CONNECT THE TM8 MODULE TO THE DRIVE UNTIL YOU ARE SURE THE SUPPLY IS SET TO +5V.

Note: The TM8 module is not EMC compliant, consequently when it is used within a permanent installation EMC screening precautions must be taken. Generally, this will require the TM8 module to be mounted within the equipment cabinet housing the drive.

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1. Ensure that the controller is configured with NPN outputs using the OCON command.
2. Using the ICON command, set the following conditions:
   Pull-up level of 5V
   Function set to pull-up
   VOL=0 (5V DC operation)
   ENC set to 0
3. You can define any block of 5 inputs for use with the thumbwheel. Therefore you must decide which inputs you intend to use for data (4 inputs required) and sign bit (1 input required).
4. Configure the defined inputs for TM8 operation using the INnN command.
5. Configure the defined input for the TM8 sign bit using INnW command.
6. Define appropriate outputs for TM8 operation using the OUTnJ command.

The TM8 is now ready for operation.

Example

The TM8 is wired as shown in Figure 3-9.

Inputs 6 to 9 are to be used as data inputs.
Input 10 is to be used as a sign input.
Outputs 3 to 5 are to be used as strobe outputs.

Set up as follows:

1. Set **1OCON 000000** all NPN outputs

2. Set **1ICON 00000100** bank 3 selected as pull-up

3. Set **1IN6N** Input 6 is defined as data input.
   1IN7N Input 7 is defined as data input.
   1IN8N Input 8 is defined as data input.
   1IN9N Input 9 is defined as data input.
   1IN10W Input 10 is defined as sign bit.

4. Set **1OUT3J** Output 3 is defined as data strobe.
   1OUT4J Output 4 is defined as data strobe.
   1OUT5J Output 5 is defined as data strobe.

The thumbwheel is now ready for use. Set the thumbwheel to the desired value and enter the information using one of the data entry commands.

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For example set the thumbwheel to +12345678

Command	Description
1DRD	Request distance data from all TM8 digits
1D	Display the distance read (D+12345678)If you do not receive this response, return to step 1 and retry

For further information relating to Data entry commands refer to the software section.

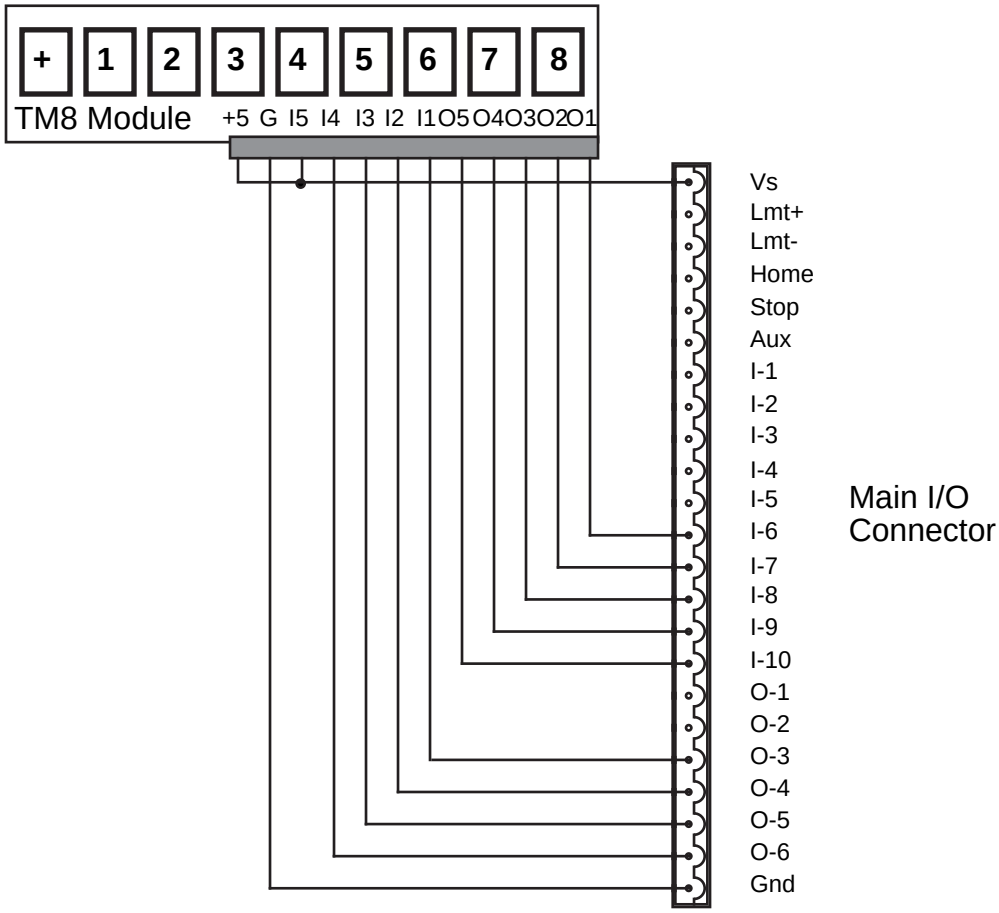


Figure 3-9. Connections to TM8 Thumbwheel Module

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Using two TM8 Thumbwheels

Wire the TM8s as shown in Figure 3-10.

Configure as previously described.

Output 6 is used to select which thumbwheel is to be read.

SET **1OUT6A** Programmable output.

Enter the following commands.

Command	Description
OXXXXX0	Output 6 is low TM8 module #1 is disabled, TM8 module #2 is enabled.
DRD	Request distance data from thumbwheel #2.
1D	Display the distance read.
OXXXXX1	Output 6 is high TM8 module #1 is enabled, TM8 module #2 is disabled.

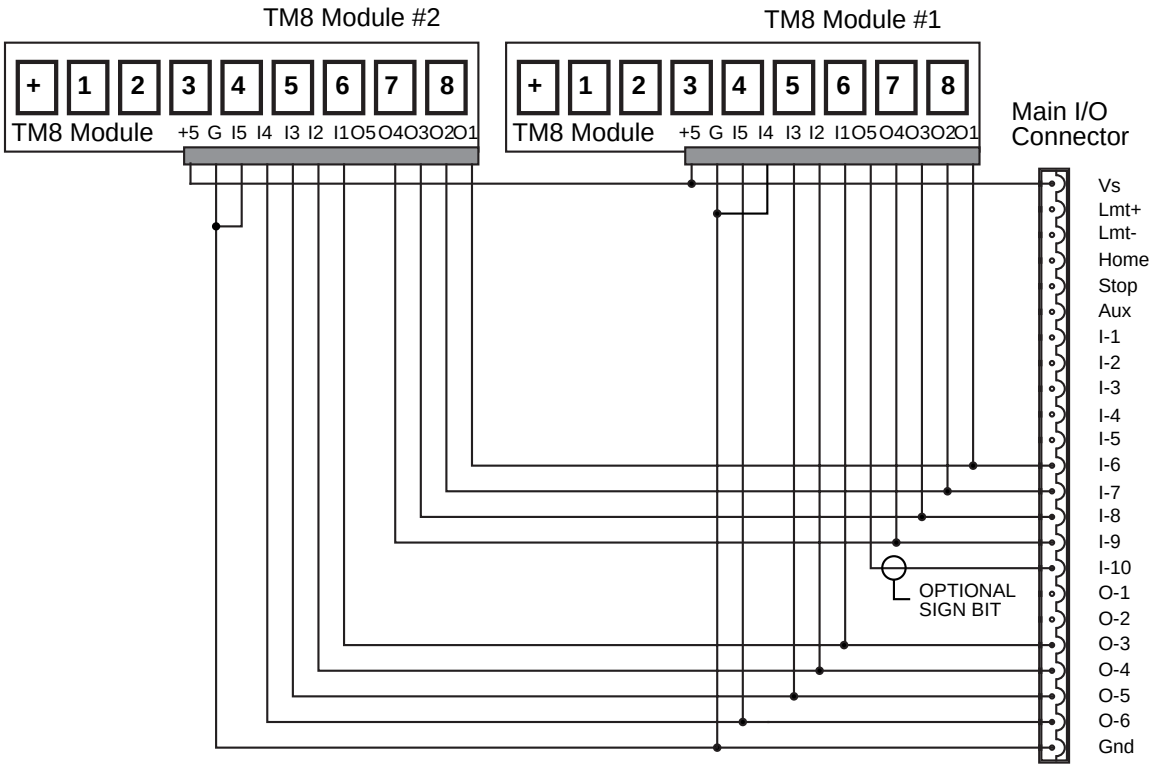


Figure 3-10. Connections to Dual TM8 Thumbwheel Modules

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Section 4. HARDWARE REFERENCE

Drive Specification

Parameter	Value	
	BDHX75E	**BDHX150E**
Continuous Current	3A	6A
Peak current	6A	12A
DC bus Voltage	325V	325V
AC Input Voltage: Nom. Max. Min.	230V 264V 207V	230V 264V 207V
Supply frequency range	47 - 63Hz	47 - 63Hz
Weights kg (lb)	6.5 (14)	6.5 (14)
Motor Options	MD3450/ MD3475	MD3450/ MD3475

Power input	AC direct from mains - single phase
Velocity feedback	Built-in incremental encoder
Switching frequency	10KHz
Max. cont. dump power	96W
Peak dump power	4.5kW
Diagnostic LED's (Front)	IT clamp, current limit, drive fault, overtemperature, HV present
Dimensions	See Figure 2-1

Table 4-1. BDHX-E Servo Drives Specification

Controller Specification

Parameter	Value
Command Input	RS232C (3-wire) or RS485 (2-wire, single-ended or 4-wire, differential)
RS232 Type	3-wire (Tx, Rx, Gnd). Minimum voltage swing = ±3V
Parameters	9600 baud, 8 data bits, 1 stop bit, no parity
Connector	8-way mini DIN or 9-way D-type
Configuration	Up to 32 interfaces can be controlled from a single RS232C port. Device address set up by DIL switch

Table 4-2. Controller Specification

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Controller Specification (continued)

Parameter	Value
RS485/422 Type	2-wire (single ended) or 4-wire (differential)
Parameters	9600 baud, 8 data bits, 1 stop bit, no parity
Connector	9-way D-type
Configuration	Up to 32 interfaces can be controlled from a single RS485/422 port. Device address set up by DIL switch
Operating Ranges	
Position	±1 to 268,435,455 steps
Velocity	0.0001 to 200 revs/sec
Acceleration	0.06 to 999,999 revs/sec^2
Maximum Encoder Frequency	100 kHz (lines/sec before multiplication)
Resolution Ranges	
Feedback encoder	1 to 32,767 counts/rev
User-programmed	1 to 32,767 steps/rev
Co-ordinate System	Incremental or absolute
Operating Modes	Preset, preset with speed change, continuous, registration, electronic gearbox following, preset following
Position Loop Update	Every 2 milliseconds
Motion Program Storage	
Memory Type	Battery-backed RAM
Memory Capacity	8000 characters total
Number of Programs	64
Program Length	Variable up to memory limit
Program Selection	a) Via RS232C/RS485 b) Automatic execution at power up c) Binary address on sequence select inputs d) RP240 e) Thumbwheel (TM8) f) PLC
Digital Servo Loop	
Update Time	500 microseconds
Servo Tuning	Via serial link. Values stored in battery-backed RAM. Servo self-tuning facility.
Tuning Parameters	PIVF or PID options with digital filter
Opto-isolated I/P's	Home, Limits, Aux-in, Stop, 10 user-definable inputs (also used for program selection)
Optically-isolated O/P's	6 programmable
Type of output	NPN or PNP (software selectable)

Table 4-2. Controller Specification (continued)

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Brushless Motor/Drive Packages

The BDHX-E Series drives may be matched with motors in the Digiplan brushless range and supplied as ready-wired motor/drive packages. Details of motors are given in Table 4-3.

Type	Weights	Rotor Inertia Kg-cm^2	Incremental Encoder Line Count
MD-3450/230	4.5Kg	1.6	1024
MD-3475/230	6.0Kg	2.4	1024
BDC10	1.2Kg	-	-

Table 4-3. Brushless Motor and Cable Data

The dimensions of the motors are shown in Figures 4-1.

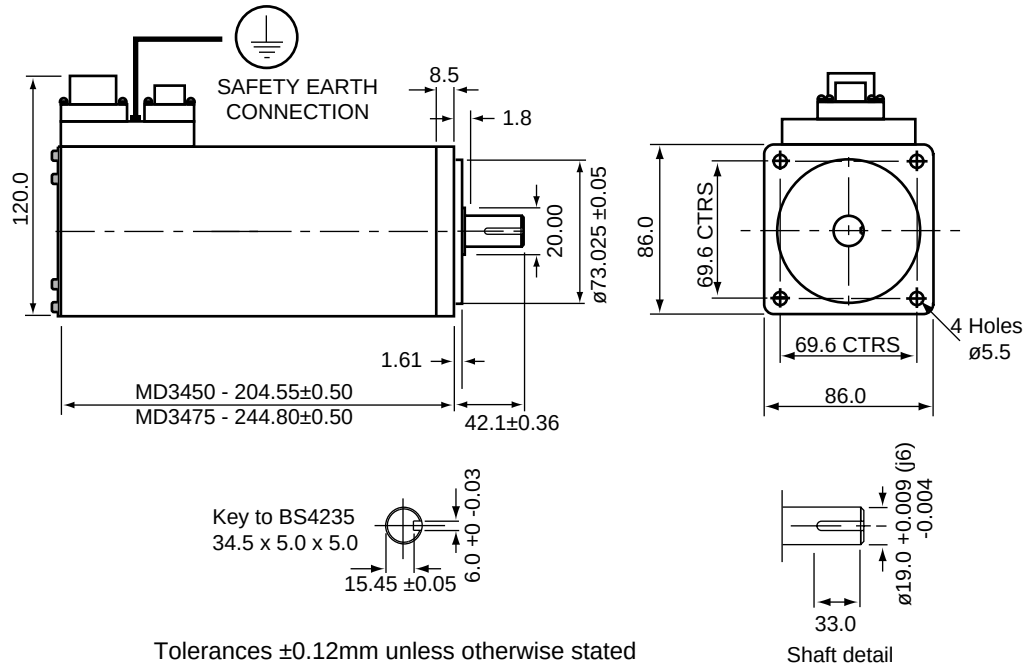


Figure 4-1. Motor Type MD3450/3475 Dimensions

Motor IP rating

The motor has an IP54 rating, except for the shaft.

Caution - High temperatures
Motor temperature will exceed 100°C before the over-temperature trip operates.

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Motor/Drive Package Performance Data

The torque curves for the possible motor/drive combinations are shown in Figure 4-2.

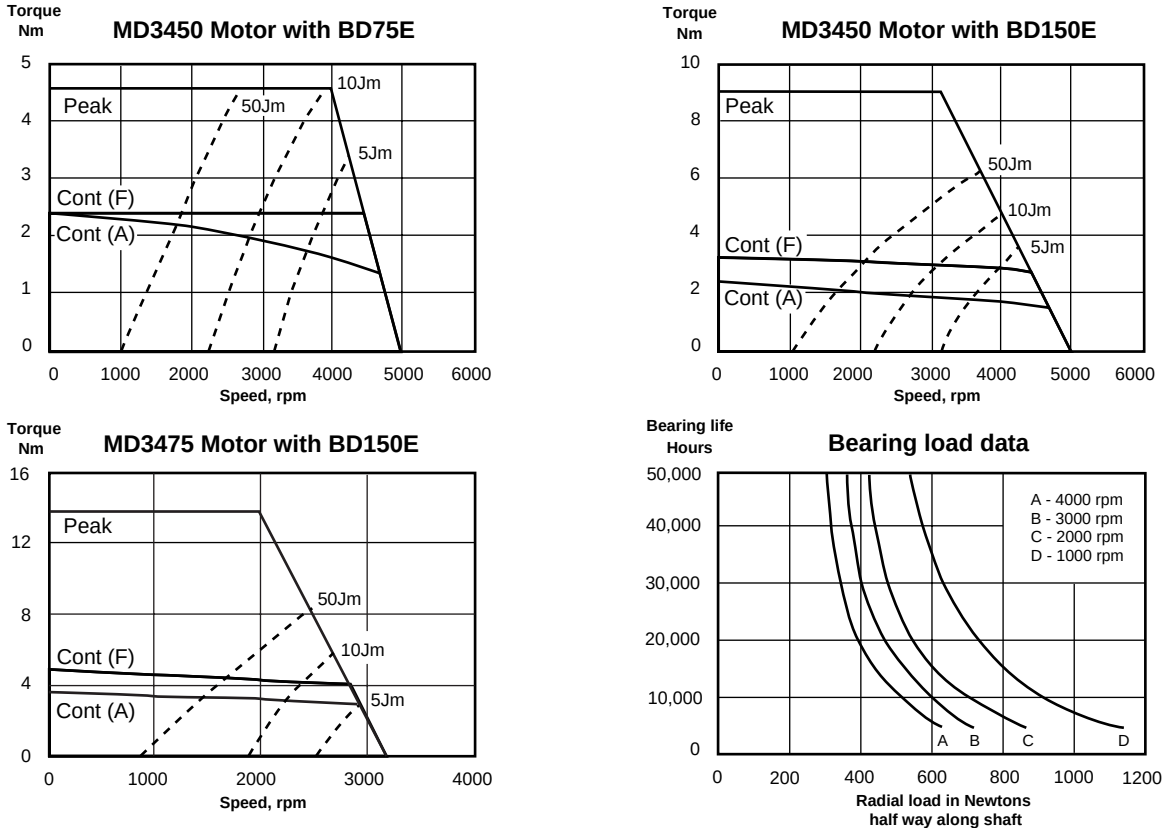


Figure 4-2. Motor/Drive Packages Torque Curves

Regenerative Dump Considerations

The dump circuit fitted to the BD drive operates when the bus voltage exceeds a fixed level, rather than when it exceeds the peak AC input voltage. The dump load has a continuous capacity of 96W and a peak capacity of 4.5kW.

In addition to torque-speed data, the performance graphs also give an indication of the safe operating area of the power dump circuit in repetitive start-stop operation. The data is based on a 'worst case' system performing repeated trapezoidal moves with no dwell in between. The time at maximum speed is as short as the thermal rating of the motor will allow. Under these conditions, for any given load inertia, the power in the ballast resistor depends on the peak torque during deceleration and the maximum speed.

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The broken lines represent different load inertias as a ratio of the motor inertia Jm. When the application requirements have been calculated, plot the point representing peak torque and maximum speed on the performance graph. If this point lies to the left of the corresponding inertia line, the resistor rating will not be exceeded. If it lies to the right, there is not necessarily a problem but further calculation is required to establish the dump power more accurately - please consult your supplier. For example, a peak torque of 3Nm and a maximum speed of 3000 rpm are acceptable with the MD3450 motor and BD75E drive.

Note that this information is for general guidance purposes only and will not apply to light duty cycles.

For a single deceleration in current limit, the maximum system inertia which may be braked from the maximum speed (approximately 55 rps) is 125 kg cm^2, without any danger of blowing the dump fuse.

Radial Loads

The 'Bearing load data' graph shown above, provides an estimate of the maximum radial load that can be tolerated at a particular motor speed, when set against the bearing life of a system. For example, if a typical bearing life expectancy of 20,000 hours was chosen as being reasonable for a system operating at a speed of 2000rpm, the maximum radial load that could be tolerated is 550N.

Fuses

BDHX-E drives are fitted with fuses, but they are not user replaceable. If the drive fails to operate correctly or you suspect a fuse has blown return the drive for repair. See ***Returning The System*** in the ***Maintenance and Troubleshooting*** section.

Cable Sets

Ready-made cable pairs are available in the following lengths:

Part No.	Cable length
BDC-10	3m (10ft)
BDC-25	7.5m (25ft)
BDC-50	15m (50ft)
BDC-100	30m (100ft)

Table 4-4. Cable Sets

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Encoders

The BDE1024/6 is a 1024 line, 6 pole self-contained encoder that can be used with motors from other suppliers.

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Section 5. BASIC MOTION CONTROL CONCEPTS

Chapter Objectives

This chapter describes some of the basic concepts of motion control systems in general and the BDHX-E in particular.

Motion Profiles

In any motion control application the most important requirement is precise shaft rotation, whether it be with respect to position, time or velocity. The type of motion profile needed will depend upon the motion control requirement. The following sections describe the basic types of motion profiles.

Preset Moves

A preset move referred to in this manual is a move of a specified distance (in user steps). Preset moves allow the user to position in relation to the motor's previous stopped position (incremental moves) or in relation to a defined zero reference position (absolute moves).

Incremental Preset Moves

If the positioner is in the incremental mode (MPI command), a preset move will move the shaft of the motor the specified distance (in user steps) from its starting position. For example, to move the motor shaft 1.5 revolutions, a preset move with a distance of +6000 steps would be specified, assuming a 4000 step per rev encoder resolution setup. Every time this move is executed, the motor shaft will move 1.5 revolutions positive from its current position. The direction of the move can be specified at the same time as the distance by using the optional sign (D+6000 or D-6000), or it can be defined separately with the H command (H+ or H-).

Absolute Preset Moves

A preset move in absolute mode (MPA command) will move the shaft of the motor the specified distance (in user steps) from the absolute zero position. The absolute position can be set to zero with the PZ or SP commands, for instance at the end of a GO HOME move (GH command). The absolute zero position is initially the power-up position, and will remain that way until changed with a PZ command. Any preset move performed while in the absolute mode will position the motor shaft the defined distance (in user steps) from the absolute zero position. For example, with the positioner at the absolute zero position a move with a distance of +4000 will cause the motor shaft to turn 1 revolution in the positive direction. If a move with the same defined distance is executed immediately after this move, the motor shaft will not turn, since it is already +4000 steps from the absolute zero position.

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The direction of an absolute preset move will depend upon the shaft position at the beginning of the move and the position that it is being commanded to move to. For example, if the motor shaft is at absolute position +12,800, and commanded position is +5000, then the motor shaft will move in the negative direction a distance of 7800 steps to absolute position +5000.

The positioner saves the mode that it was in at power down and powers up again in the same mode. Issuing the MPA command will set the mode to absolute. Issuing the MPI command or MN command will switch the mode from absolute to incremental. The positioner retains the absolute position referenced, even while in incremental mode. However, the counter does have an upper limit just slightly more than 268,400,000 counts.

Continuous Moves

Continuous moves (MC command) cause the motor to accelerate and attain the specified velocity and then continue to move. To change velocity while the motor is moving use the V command. Issuing a stop (the S command) will cause the motor to decelerate to a stop at the last defined acceleration rate. The distance parameter is not used, although it is saved in case the mode is changed back to preset.

This mode is useful for applications which require constant spinning of the load, when the motor must stop after a period of time has elapsed rather than after a fixed distance, or when the motor must be synchronised to external events such as trigger input signals.

Registration Moves

A move may be programmed to end a specified distance after a registration pulse appears at AUX-IN. The mode is selected using the TRR command with the required registration distance in the MQ or MC modes. Its use is easiest to understand in the context of an example registration move:

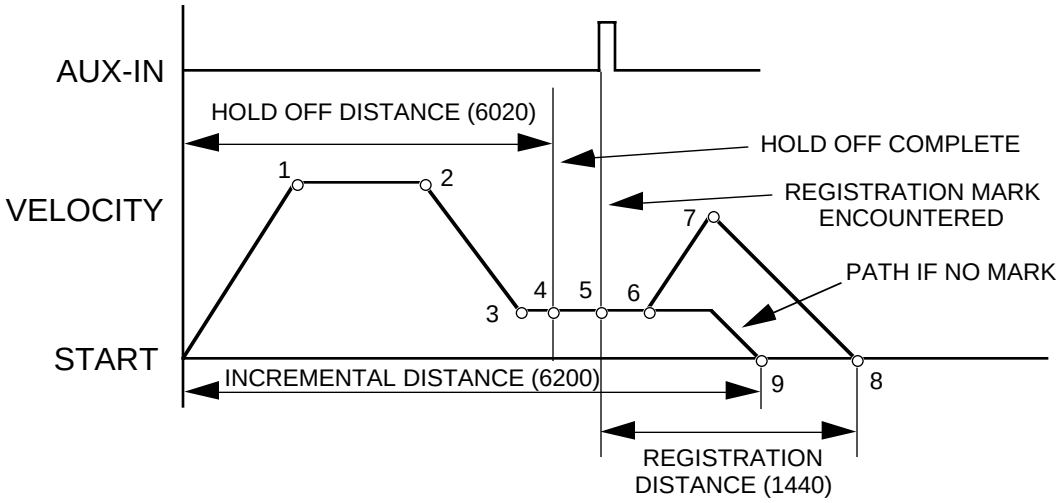


Figure 5-1. Example Registration Move

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Example Program

MQ	Select MQ mode
D6200	Set move distance to 6200 steps
A100	Set all accelerations to 100 revs/sec^2
V10	Set velocity to 10 revs/sec
G	Go
TRD4000	At distance = 4000 steps
V1	Change velocity to 1rev/sec
TRD6020	At distance 6020 look for registration pulse
TRR1440	Travel 1440 steps from registration pulse
V50	At a velocity of 50 revs/sec
TRIP	Set Output 2 when in position

Program Operation

When executing this program, the axis will first accelerate at 100 steps/rev^2 to 10 revs/sec (1) and when it reaches a distance of 4000 steps (2), its speed will be reduced to 1 rev/sec (3) whilst it is waiting for the registration pulse. Shortly after the pulse is received (6), the axis will accelerate towards 50 revs/sec, but will not reach the speed before starting to decelerate (7) to stop at 1440 steps from where the pulse occurred (8).

If the pulse was not received after 6020 steps (4 - the hold off distance) and before 6200 steps (the incremental distance), the axis will stop at 6200 steps (9). This sets a window of 180 steps during which the pulse is expected.

Program Criteria

The distance command (D6200)	This command sets the distance the axis will travel if no registration pulse is received and the maximum distance at which the pulse will be recognised.
Trigger distance command (TRD4000)	The distance at which the axis will start to decelerate to the slower speed of 1 rev/sec (V1), in readiness for the registration pulse, is set by this command.
Trigger distance command (TRD6020)	This command sets the minimum distance at which the system will recognise the registration pulse.
The TRR command (TRR1440)	This command sets up the registration mode and the registration distance (the distance the axis will travel after the pulse is received).
Registration move velocity (V50)	To save time in travelling the registration distance, the axis then accelerates towards 50 revs/sec (V50), but it does not reach that speed before starting to decelerate to stop at 1440 steps from where the pulse occurred.

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Motion Profiles

Velocity, acceleration and distance must be defined before any preset move can be executed. The value of these parameters determines the type of motion profile as either triangular or trapezoidal.

Triangular Profile

A triangular profile will result when the velocity and acceleration are set such that the designed velocity is not attained before half of the specified distance has been travelled. This results from either a very low acceleration or a very high velocity or both over a relatively short distance. For example, if the acceleration is set to 1 rev/sec/sec, velocity is set to 5 revs/sec and distance is set to 16000 steps (2 revs), a triangular motion profile will result. This is because by the time the motor shaft has reached a velocity of 2 revs/sec, it will also have travelled half of the defined distance due to the acceleration setting of 1 rev/sec/sec. The motion profile for this move is shown in Figure 5-2.

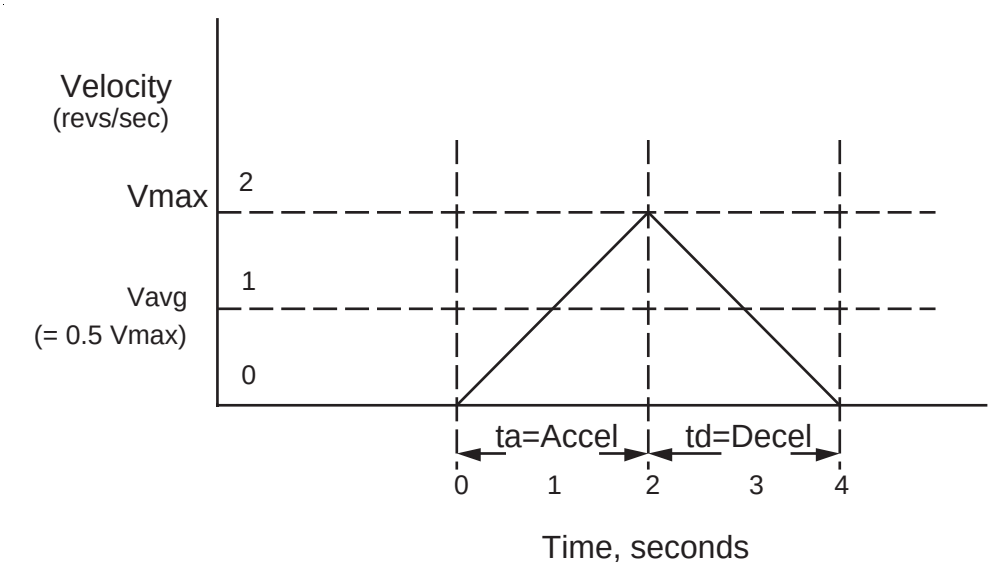
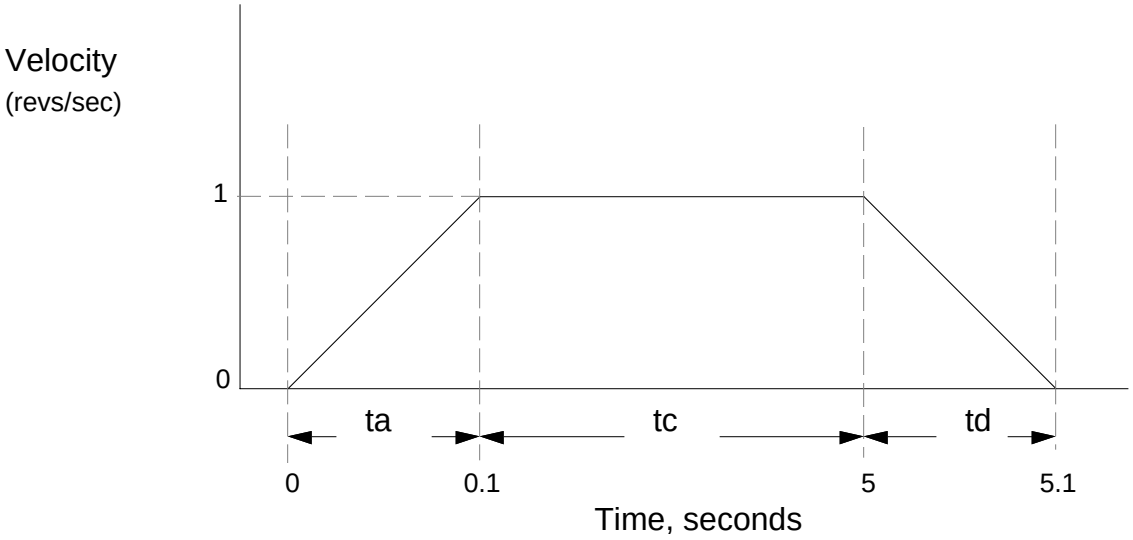


Figure 5-2. Triangular Profile

Trapezoidal Profile

A trapezoidal move profile results when the defined velocity is attained before the motor shaft has moved half of the specified distance. This is due to a defined velocity that is low, a defined acceleration that is high, a move distance that is long, or a combination of all three. For example, if the acceleration is set to 10 revs/sec/sec, velocity is set to 1 rev/sec, and distance is specified as 20000 steps (5 revs), the resulting motion profile would look like this:

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ta = Accelerate
tc = Constant velocity
td = Decelerate

Figure 5-3. Trapezoidal Profile

User Profiles

The user may define a move profile using the MC command to establish the continuous mode. Velocity can be programmed on the fly by the V command.

The positioner also has a mode MQ, which is like the preset move mode in that the move distance is pre-defined, but it is possible to change speed in the middle of the move as required based on a distance, input or time delay trigger.

Encoder Following

The commands SIM and CCS may be used to allow the motor of one axis to follow the encoder of another axis or an externally-generated step and direction signal. When the control module is to be used in following mode, the input from the encoder to be followed should be connected to the External Encoder connector pins 1 - 9. These inputs can be configured using the CCS command as an encoder input (x1, x2 or x4) or as a step and direction input.

Externally generated STEP and DIR signals should be connected to pins 1 - 4 of the External Encoder connector.

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The SIM command may be used to select:

a) Normal indexer operation (SIM0), used for reverting to normal operation by overiding previous SIM commands

b) Encoder following with indexer motion commands inoperative (SIM1).

c) Encoder following with indexer commands operative (SIM2), allowing the superimposing of indexer moves.

d) Software scaled encoder following (SIM3).

e) Software scaled encoder following with direction reversal (SIM4).

f) Preset following index mode (SIM5).

g) Load mounted encoder feedback (SIM6).

For SIM1 and SIM2 operation the motor output rate follows the encoder input, using hardware scaling, at a ratio of 1 or less.

Hardware Scaling

This is the scaling of the second encoder input when using the SIM1 and SIM2 commands to achieve following at a ratio of 1 or less relative to the following input. Scaling is achieved using a hardware rate mutiplier, the division ratio of which is set by the RAT command, at a resolution of 16 bit or 24 bit operation determined by the OSJ command.

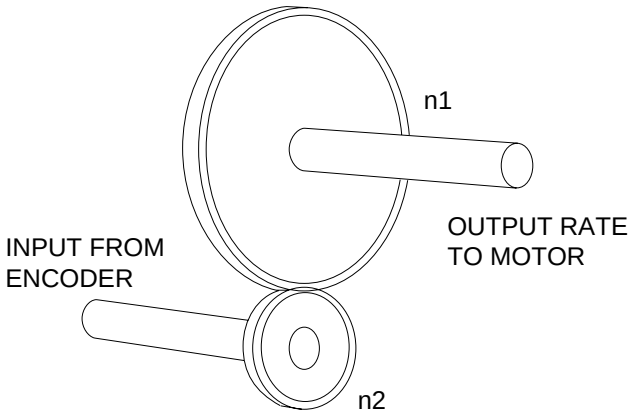


Figure 5-4. Simple Gearbox

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The operation of the rate multiplier can be compared to that of a simple gearbox (see Figure 5-4), where the ratio of output revolutions to the input revolutions (always less than or equal to 1) is determined by the number of teeth on n2 divided by the number of teeth on n1. If the number of teeth on n1 is fixed, but the number of teeth on n2 is allowed to vary (up to a maximum of n1 teeth), the gearbox will provide a variable output rate which is always a fraction of the input rate. The resolution of the gearbox, that is how fine a gear ratio can be set, will be determined by the number of fixed teeth on n1. In the rate multiplier the RAT value sets the number of teeth on n2, and the resolution (n1 teeth) can have one of two fixed values determined by the OSJ command.

Using hardware scaling the output motor rate is determined by :

$$\text{Output Motor Rate} = \text{input rate} \times \frac{n}{65536} \quad \text{for OSJ} = 0$$

or

$$\text{Output Motor Rate} = \text{input rate} \times \frac{n}{16777216} \quad \text{for OSJ} = 1$$

Where n = the RAT value

NOTE: RAT now controls the division ratio, and the direction will be determined by the sign of the RAT value.

As the resolution (set by OSJ) is a large number, very fine adjustment of the ratio can be set by choosing a suitable value for the RAT command.

A limitation of binary hardware scaling is the lack of certain exact following ratios that can be obtained. Since the division ratio can only be a binary fraction it is impossible to choose an exact ratio such as 1:3, although it could be closely approximated if you were to choose a RAT value of 5592405 with 24-bit resolution selected.

Summary of hardware scaling :

The scaling ratio is determined by the RAT value.
Resolution is fixed at 16-bit or 24-bit , determined by the OSJ command.
Non binary fraction exact division ratios cannot be obtained.

Software Scaling

This is the scaling of the encoder input when using the SIM3 or SIM4 commands to achieve following at a ratio greater or less than 1. Unlike hardware scaling, exact following ratios can be achieved by controlling both the numerator and denominator parts of the fraction used to set the scaling ratio, thus ratios such as 3:1 can be obtained.

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The scaling ratio is set using the CMR command value divided by the CUR command value to give :

$$\text{Motor Output Rate} = \text{input rate} \times \frac{CMR}{CUR}$$

Both CMR values and CUR values are individually limited to a range of 1 to 32,767, and when combined as a fraction are further limited, by software scaling to having both numerator and denominator in the range 1 to 255. This results in a maximum division ratio of 1/255, or at the other extreme a maximum multiplication ratio of 255.
Software scaling does not allow the superimposing of indexer moves.

When using SIM3 or SIM 4 operation for short moves it is possible to predict the number of steps the motor will take using the formula :

Number of motor steps to move =

$$\text{INT}\left(\frac{CMR \times \text{no. of pulses received} + \text{prev. remainder}}{CUR}\right)$$

where INT means "take the integer part of", with the value rounded towards zero whether positive or negative. The controller can repeatedly apply this formula to establish an iterative calculation. In situations where short moves have been programmed the ratio of CMR/CUR may only approximate the number of steps the motor is required to move, but since the remainder is carried forward no steps are lost. This allows the CMR/CUR value to better approximate the following ratio in subsequent moves.

In summary, short moves may only approximate the defined following ratio, but no positioning accuracy is lost in later moves.

Buffered Clock Mode

SIM3 or SIM4 work in a buffered clock mode, which allows the controller to buffer an unprofiled following-input pulse stream until the output velocity equals the following input velocity. The controller accelerates the output velocity to match the input velocity using an exponential acceleration profile, the time constant of which is set using the CAG command. The default time constant value of CAG is 1.00ms to accept already profiled follower inputs.

The input pulses are buffered (or stored) at the input resolution, the actual number being stored at any particular instant being termed the following error. This can lead to input pulses being lost above a maximum speed, due to excessive following error.

The maximum number of input pulses that can be buffered is

+/-32767 which requires CAG to be less than $\frac{32767}{\text{input pulse rate}}$ to prevent overflow.

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Comparison of following features

Hardware Scaling SIM1, SIM2	Software Scaling SIM3, SIM4
The motor always moves by the same or fewer pulses than received. The pulse stream is effectively divided.	The motor can move by more or less pulses than received. The input pulse stream can be multiplied or divided.
The ratio is programmed by the RAT command with 16 or 24 bit resolution as a binary fraction.	The RAT command has no effect.
CMR and CUR have no effect.	The ratio is programmed by CMR and CUR.
Superposition onto an additional internally generated indexer motion is available.	Superposition is not available.
The pulse stream is followed directly without additional profiling.	The pulse stream is profiled (filtered) by a programmable exponential characteristic (CAG command)

Preset Following Index Mode

The following mode SIM5 selects indexing at a speed determined by the external input. In this mode the controller sets the motor velocity to a speed in rps determined as a percentage of the following input speed in rps. The percentage following factor is set by the FOL command which can be varied between 0.0 and 5000.0%.

When using this mode the acceleration is fixed to whatever is defined by the A command, and the V command value has no effect since the FOL command percentage value will now control the velocity.

The velocity is dependent on the user resolution (CUR value) and the motor resolution (CMR value). CUR and CMR set the encoder / motor resolution ratio so that the input shaft speed will match the output shaft speed with FOL set to 100%.

The FOL value can be entered from a variable, for example:

1FOL(VAR1)

Pulses must be present at the input when the G command is executed.

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Load Encoder Following (SIM 6)

In certain applications it is beneficial to close the position loop around the actual load position rather than the motor position, in order to improve positional accuracy.
A typical example is a feed-to-length system in which positioning accuracy is adversely affected by slippage and compression of the feed roller.

If we close the position loop around the load then we can compensate for the majority of system errors, such as out of tolerance feed rollers and other transmission devices. This is achieved by mounting an incremental encoder to the load mechanics or via a low inertia wheel in the case of feed to length applications.

Position feedback is taken from this encoder rather than the incremental encoder fitted to the motor. The load position becomes the true closed loop controlled position, compensating for the effect of the indirect coupling between the motor and load.

The load encoder is connected to the EXT ENC 9 way D type. The motor encoder feedback remains in use to provide velocity feedback. Velocity feedback is derived in this manner rather than from the load encoder as the indirect coupling of the load encoder would result in a low bandwidth system and therefore limit performance. In applications were the ratio between the load encoder and the motor is not 1:1 then the velocity feed forward gain (CFG) must be scaled by that ratio.

In order to provide continuity between following modes, the current reported motor position will be retained when switching between modes. This prevents any anomalies when entering and exiting the load encoder following mode.

When using this mode the motor resolution (CMR) should be set to the load encoder resolution. Velocity and acceleration will now be referenced to the load. Set OSO to 1, this will suppress units and will avoid later confusion.

Coupling

In order to gain good system performance care must be taken in selection of the coupling. The quality of the coupling will have considerable effect on performance. Poor coupling will prevent CPG and CVG being set to the optimum, this will therefore affect speed of response, stiffness and accuracy of the system.

Note: As an additional safety feature and to prevent mechanical damage, the motor velocity trip (CVT) should be set to a value just greater than the system requirements. If the coupling should break and the motor race away, once the velocity has reached that set by CVT the motor will de-energise.

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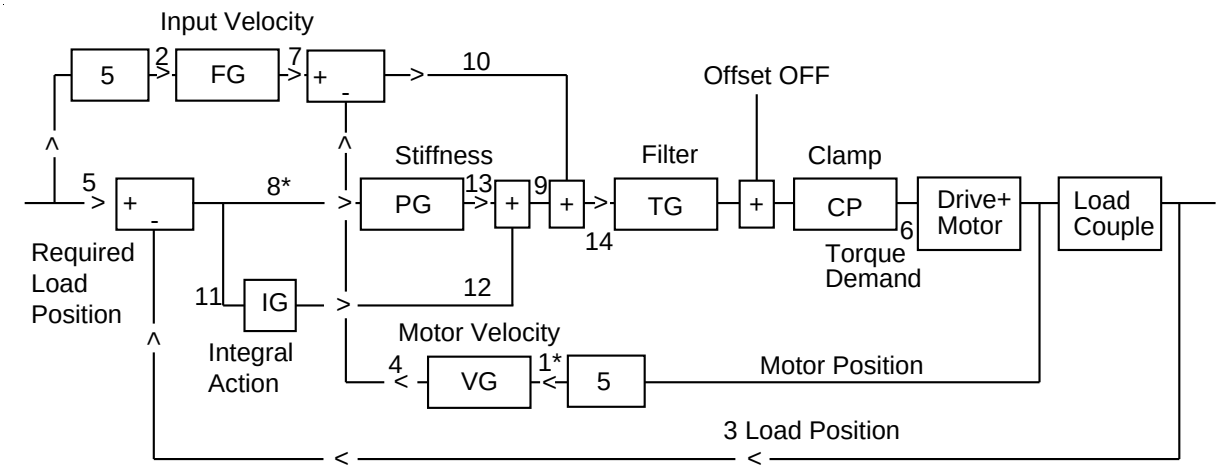


Figure 5-5. SIM6 Operation

Torque control applications

In most applications, the fundamental parameter controlled is position. Velocity, acceleration and direction are all derived from position, so are automatically determined. The value we cannot directly control is torque, since this depends upon the load characteristics as well as the move parameters.

However, there are applications in which the torque is the chief parameter we want to control - winding material onto a drum is one example. When operating as a torque motor we have no control over position, velocity, acceleration or direction, though we can set limits to any of these parameters. (In the same way, we can set a limit to the torque in a position control application).

Tuning the Controller for torque control

Most torque applications need a limit to be placed on velocity should the load torque be less than the programmed value. In the winding application, this would limit the drum speed if the material breaks. We therefore set up the controller as a *velocity* controller but determine the maximum torque using the clamp command CCP.

The proportional gain CPG must be set to zero for velocity control, and we must also set CPE to zero to stop the system tripping out on excessive position error. The feedforward term CFG, which depends on the rate of change of input position, converts the position demand to a velocity demand. We need to use CDG to set the velocity gain because it is essential that the feedforward and feedback terms are the same, otherwise the demanded velocity will not be the same as the programmed V value. The block diagram of the servo is shown in Figure 5-6.

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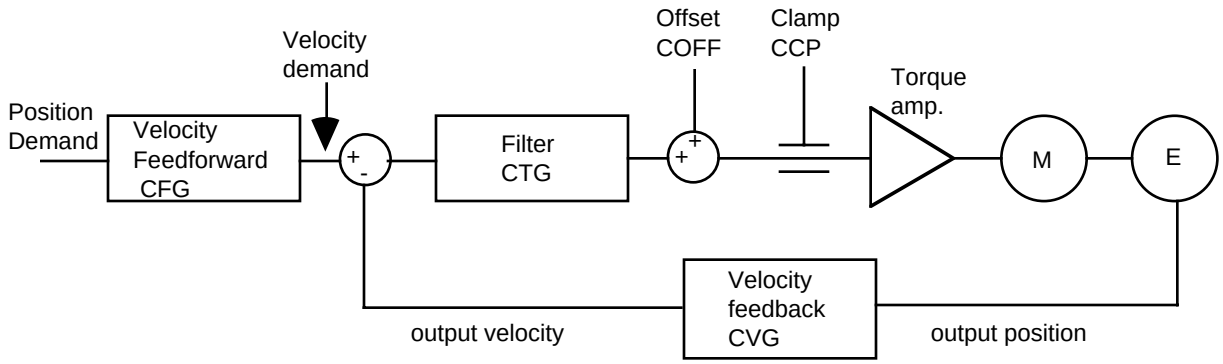


Figure 5-6. Torque Control Operation

The clamp command CCP can now be used to determine the torque - a value of 1023 will correspond with the peak torque available from the motor & drive. When the G is issued, the motor will accelerate at the programmed A value until the load torque matches the CCP level. If the load torque is less than the CCP value, the motor will run at the speed programmed by V. In practice there will be a small velocity error generating the torque necessary to keep the motor running at this speed; setting CDG to a high value will minimise this error. It will usually be necessary to increase the filter time constant CTG in order to reduce the bandwidth when using a high velocity gain.

The programmed D value will limit the overall distance if you are using the indexing mode MN. If there is no preset limit to the total travel you can use the continuous mode MC.

Switching between position and velocity modes

In an application like the closing and clamping of an injection mould, we need to switch between position control (when the mould is opening) to torque-limited velocity control during the closing process. This switchover demands a significant change to the tuning values on the fly, and could result in a large discontinuity in position or torque. The command **RST1** allows the torque demand to be frozen momentarily while we make the tuning changes, which effectively opens the control loop. **RST0** then releases the torque demand and closes the loop again. Between the RST1 and RST0 commands will be the new tuning values entered as buffered commands, for example:

```
RST1  BCPG0  BCDG100  BCTG3  RST0
```

When switching between control modes, the difficulty arises in maintaining continuity of the torque demand before and after the switch. In position mode, the torque demand arises primarily from a position error; in velocity mode it comes from a velocity error which is comparatively small because gains are usually higher. So when switching modes, the correct error conditions must be established *before* the torque demand can be unfrozen.

The RST0 command achieves this by setting either a position error or a torque offset as appropriate. When the new value of CPG is zero (as in the example), the controller is

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considered to be entering velocity mode and a torque offset is introduced (COFF command) equivalent to the previous torque demand under position control. When the new value of CPG is greater than zero, the controller must be returning to position mode; the demand position is adjusted so that previously-existing torque is now generated by a position error.

The following points should be kept in mind when switching between control modes:

Aim to switch from position to velocity mode when there is no torque on the shaft, preferably when stationary. This will minimise the COFF value introduced.

You can switch from velocity to position mode on the fly provided that the system is under velocity control at the time, i.e. the load torque is less than the CCP value. You should not allow the system to become saturated (i.e. CCP-limited) in position mode; this will cause a position error to build up.

If your application requires mode-switching we recommend that you request programming assistance from Digiplan.

Program Storage

The non-volatile program memory is battery backed up RAM with memory retention of 10,000 hours. The RAM has 8K characters available for sequence storage and a write protect facility is provided.
Programs are stored in variable length buffers and the total length cannot exceed 8K.

Write Protection

A write protection facility is incorporated for the protection of stored sequences and parameters, stored by the SV command. If switch 8 (on top of the drive) is ON then the memory is not write protected. An attempted SV command when the switch is OFF will result in the following error message being displayed:

```
#15 BACKUP RAM IS WRITE PROTECTED
```

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Motion Program Selection

The system may be set up so that no sequence is executed at power-up. In this case sequence execution would be initiated from the controller over the RS232C.

Alternatively, a single sequence to be automatically executed at power-up can be programmed. After that sequence is executed, control can pass to another sequence or to the RS232C interface.

Sequence selection may also be initiated via thumbwheel, RP240, and PLC inputs. Up to 64 user defined sequences can be selected for execution in this way.

Parameter Ranges

Table 5-1 gives the internal arithmetic positioner limits based on 4000 encoder steps/rev. These parameters apply only to the positioner, the motor/drive combination will not necessarily be able to respond to the full ranges stated:

	Position	Velocity	Acceleration
Smallest	1 step	0.488 steps/sec 0.000122 RPS 0.00732 RPM	244 steps/sec/sec 0.061 RPS^2 3.66 RPM/sec
Largest	±268,435,455 steps ±67,108 revs at 4000 steps/rev	4×10^6 steps/sec 999 RPS	4×10^9 steps/sec/sec 999,999 RPS^2

Table 5-1. Parameter Ranges

NOTE: Longer distances than 268,435,455 steps can be achieved using a sequence of incremental moves or continuous motion mode.

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Section 6. COMMUNICATING WITH THE POSITIONER

Chapter Objectives

The information contained in this chapter will enable you to set up communications with the positioner. If more than one positioner is present in the system, details are provided on the connection of multiple positioners using the RS-232 Daisy Chain.

Command Interface

The interface is a three wire implementation (Tx, Rx, Ground) of RS232C. The Tx and Rx lines require a minimum voltage swing of ±3 volts.

Hardware handshaking is not supported in any form. The computer or terminal sending characters to the positioner should have its handshaking disabled by either hardware or software.

Communication Parameters

The positioner communications protocol is fixed and as follows:-

9600 baud, 8 data bits, no parity, 1 start bit, 1 stop bit

Device address: 1-32

Echo function: all characters received are immediately re-transmitted. This function can be enabled using the SSA0 command or disabled using the SSA1 command.

Once entered, a parameter will be remembered until power down. It is not necessary to keep re-stating the same parameter value.

When you power up the positioner, all parameters are assigned default values which the 1DR command will show you. You can change any of these and then make them the new default value by typing the SV (Save) command - see also commands RFS and RIFS.

XON, XOFF software handshaking is supported.

Installing the RS232C

RS232C connections from the controller to the positioner are as shown in Figure 6-1. Note that the Tx and Rx lines are cross-connected so that transmit output is connected to receive input.

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Address Selection

A unique address must be assigned to each positioner in the chain. Normally positioner 1 will be the first in the serial communications link. The positioner's address is assigned by configuring the DIL switch on top of the drive in a binary pattern as shown in Table 6-1.

The DIL switch can be accessed through the ventilation slots in the top of the drive using a small screwdriver or similar tool. Make sure that the AC power is disconnected before attempting to change the switch settings. SW1 is nearest to the front of the drive.

	Switch settings for addresses 1 to 16 (switch 5 off)			
Address	**Sw 1**	**Sw 2**	**SW 3**	**Sw 4**
1 (17)	ON	OFF	OFF	OFF
2 (18)	OFF	ON	OFF	OFF
3 (19)	ON	ON	OFF	OFF
4 (20)	OFF	OFF	ON	OFF
5 (21)	ON	OFF	ON	OFF
6 (22)	OFF	ON	ON	OFF
7 (23)	ON	ON	ON	OFF
8 (24)	OFF	OFF	OFF	ON
9 (25)	ON	OFF	OFF	ON
10 (26)	OFF	ON	OFF	ON
11 (27)	ON	ON	OFF	ON
12 (28)	OFF	OFF	ON	ON
13 (29)	ON	OFF	ON	ON
14 (30)	OFF	ON	ON	ON
15 (31)	ON	ON	ON	ON
16 (32)	OFF	OFF	OFF	OFF

For addresses in brackets (17 to 32), turn on Switch 5.

Table 6-1. Positioner Address Selection

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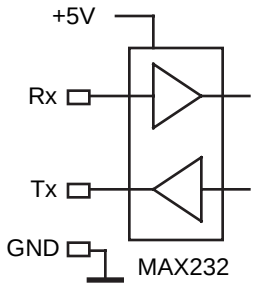


Figure 6-1. RS232 Input Circuit

Controller Daisy Chain Wiring

You may daisy chain up to 32 axes. Individual drive addresses are set with the Controller DIP switches (see Table 6-1). When daisy chained, the units may be addressed individually or simultaneously. You should establish a unique address for each axis. Refer to Figure 6-2 for Controller daisy chain wiring configuration.

Commands prefixed with a device address command only the unit specified. Commands without an address command all units on the daisy chain. The general rule is: *Any command that causes the drive to transmit information from the RS-232C port (such as a status or report command), must be prefixed with a device address*. This prevents daisy chained units from all transmitting at the same time.

Attach device identifiers to the front of the command. The Go (G) command instructs all units on the daisy chain to go, while 1G tells only unit #1 to go.

When you use a single communications port to control more than one Controller, all units in the daisy chain receive and echo the same commands. Each device executes these commands, unless this command is preceded with an address that differs from the units on the daisy chain. This becomes critical if you instruct any indexer to transmit information. To prevent all of the units on the daisy chain from responding to a command, you must precede the command with the device address of the designated unit.

No Controller executes a device-specific command unless the unit number specified with the command matches the Controller unit number. Device-specific commands include both buffered and immediate commands.

You must use status-request commands in an orderly fashion. Commands should only be issued when the host is ready to read the response. You should not send new commands until you receive a response from the previous status-request command. In particular, you should not issue an immediate-status command until the host receives a buffered command status response. If this is not followed, the command responses will be intertwined, rendering the data useless.

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If you enable the Interactive mode (EX1), the Controller that is currently echoing will respond with a prompt (>). This prevents all the Controllers from sending out > in a daisy chain. Typically, you should disable the Interactive mode when you use a host computer with the Controller. The default for the EX command is enabled (EX1).

Figure 6-2 shows a multiple-drive configuration (daisy-chain) of RS-232C ports from one controlling terminal or computer.

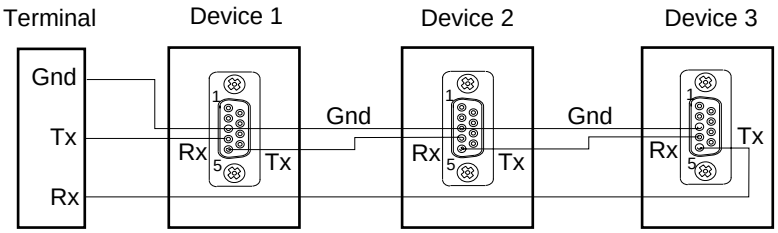


Figure 6-2. RS-232C Daisy Chain Configuration

Example

Three Controllers are connected to an RS-232C daisy chain. Send the following commands:

Command	Description
MN	Sets unit to Preset mode for all three controllers
A5	Sets acceleration to 5 rps^2 for all three controllers
V10	Sets velocity to 10 rps for all three controllers
LD3	Disables limits (if they are not connected)
1D25000	Sets axis 1 distance to 25,000 steps
2D50000	Sets axis 2 distance to 50,000 steps
3D100000	Sets axis 3 distance to 100,000 steps
G	Moves all axes

Unit 1 moves 25,000 steps, unit 2 moves 50,000 steps and unit 3 moves 100,000 steps. All three units use the same acceleration and velocity rates.

Interactive operation with a PC/PLC

To create a reliable, trouble free interactive RS232 communications control program between a PC/PLC and the serial interface you should note the following points :

- Use the X-WARE package for terminal emulation on an IBM PC or equivalent computer system.

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- The interface should only be operated in computer mode to suppress error messages and extended text output.

- The program should operate the interface with a response check during critical processes, such as sequence download. The response check will need to detect :

    - No response at all
    - Incorrect characters
    - More characters than expected
    - Less characters than expected
    - Control characters such as EOF caused by errors
    - Correct response

The response expected should be either echoback, or characters returned by interrogation commands, or a sequence of the two.

- If there is no check for echoback on each character, you should include a delay of up to 1ms between each character sent . This may require characters to be sent individually rather than as strings.

- You should not use the simple BASIC INPUT statement as this 'hangs' the link without time out if an error causes no carriage-return character to be received from the interface.

- Interpreted BASIC should not be used, as it is too slow for most applications.

- Interrupt error handling, such as the BASIC 'ON ERROR" statement, should be enabled.

- Commands such as SV, Z, RFS and RIFS take several seconds to execute. This also applies to status commands like DR and HELP. It is recommended you insert a suitable delay after these commands to allow them to fully execute their intended function without corrupting immediately following commands, although the use of these commands in an interactive situation is unlikely.

- If problems arise, the communications error responses actioned by the R command will help diagnosis. In some cases a recovery can be attempted by sending the command again (such as the R command itself). But this may not always be appropriate, for example LD3 altered to L3 would not be fully corrected by simply sending LD3 again.

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- A routine that breaks some of these rules may appear to work satisfactorily, but is not necessarily safe. The worst case communications response condition may involve a number of coincidences, such as sending a status request just as the interface hits a limit, just as it starts decelerating. Any motion control requirement explicitly takes priority over communications under these circumstances, and can therefore cause a communications problem unless you wait for echoback. Also different issues of software may have different execution time characteristics which can make a routine based on delays work at one software issue, and not another.

Accurate defensive programming is required if safety constraints are to be met and possible damage to hardware prevented.

Using Windows™

Microsoft Windows™ comes with a terminal emulation program which can be used in place of XWARE. The terminal emulation program is configured as follows:

Run the terminal program.

From the FILE menu select NEW.

From the SETTINGS menu, setup the following options:

Terminal emulation sub-menu	DEC VT-100 (ANSI)
Terminal preferences sub-menu	Terminal modes Line wrap ON
	Local echo OFF
	CR_>CR/LF Inbound ON
Communications sub-menu	Baud rate 9600
	Data bits 8
	Stop bits 1
	Parity NONE
	Flow control NONE

Also choose the appropriate connector

These basic configurations will allow operation with the terminal only.

Interactive Programming

To help you achieve reliable, trouble free interactive programming between a Controller Positioner and a PC/PLC the following guidelines will be useful.

- The interface should be operated in terse mode (EX0) to suppress unsolicited error messages and extended text output. This will also allow for extra communication time.

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- The program should include an interface response check, especially during critical processes such as sequence download. Checks should be made for:

  *No response at all
  *Incorrect characters
  *More or less characters than expected
  *Control characters such as EOF formed by errors
  *The correct response

Where the correct response is the echoback of the transmitted characters or characters returned by interrogation commands or a combination of the two.

- The command buffer is 256 characters long. When it has filled up, the interface will echo a <CTRL>G instead of the correct character. Subsequent characters received will ‘overwrite’ the last character in the buffer until a ‘free’ space occurs.

- Given the above, it is preferable to transmit one character and wait for correct echoback before transmitting the next character. This enables an error to be rectified immediately.

- When monitoring the echoback characters in verbose mode (EX1), some are echoed as a combination of characters, for example:

  <CR> is echoed as <CR> <LF>.

This is not the case in terse mode (EX0).

- If there is no check for echoback on each individual character, an explicit delay of at least 1ms between each character must be included. This may mean sending characters individually rather than in strings.

- Certain interface commands, notably ON, Z etc. take some time to execute and consequently momentarily interfere with communications. An explicit delay (several seconds is typical) should be inserted after these commands before another is sent.

- This interference of communications can involve temporarily not servicing the RS-232 interrupt on the Controller, allowing subsequent characters received by the UART, during this condition, to cause an overrun error within the UART.

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- The status request command (R) can be used to provide helpful diagnostics. The responses generated by the interface are as follows:
  *R<CR> - ready for a command with no errors
  *S<CR> - ready for a command with function error
  *T<CR> - ready for a command with previous comms error
  *U<CR> - ready for a command with function error and previous comms error
  *B<CR> - busy performing a move with no errors
  *C<CR> - busy performing a move with function error
  *D<CR> - busy performing a move with previous comms error
  *E<CR> - busy performing a move with function error and previous comms error

- The average execution time of commands is approximately 1.5ms. The execution time is dependent upon the activity of the indexer. When performing a move, especially during acceleration and deceleration, there is generally less time available for command execution. This time will delay the execution of subsequent commands, and hence reduce the rate at which the command input buffer is cleared.

- The interface will correctly respond to XON/XOFF protocol, but will not be able to generate the XON/XOFF signals when the command input buffer is full.

- If the control program does not use the echo back facility provided by the interface it may be disabled by sending the command SSA1. This will speed up the character handling routine a little, but will stop any commands from being transmitted to axes further down the chain, so should be used with care.

The fact that a routine that breaks some of these rules 'works' is irrelevant. Worst case communication response conditions may involve a number of coincidences such as sending a status request just as the interface hits a limit, just as it starts to decelerate, just as the servo is responding to a load glitch etc. Any motion control requirement explicitly takes priority over communications under these circumstances and can therefore cause a communication problem unless you wait for echoback.

If the Controller echoback is turned off by accident, causing an apparent loss of communication (hanging), it may be re-enabled by typing the following sequence:

CTRL-Q<space>E<space>1R<carriage return>

Note:

[1] This sequence is case sensitive - make sure you are in upper case.

[2] CTRL-Q means hold the 'control' key down and press the Q key at the same time. This sends the X-ON ASCII character. The Controller obeys the X-ON X-OFF communications protocol which is used to hold up communications if an interface is sending too much data too quickly. This means that if X-OFF is sent down the chain (the character CTRL-S) all communications from the axes stop until CTRL-Q (X-ON) is sent down the chain. This includes echoback of commands. If CTRL-Q is never sent the system will 'hang'.

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[3] You may type CTRL-S by mistake. This condition can be cleared by cycling the power.

[4] The E command is the enable RS-232 command which can easily be mis-typed as the F command which will lock out the keyboard. Cycling the power will not cure this problem since SV cannot be typed following a keyboard lock out.

[5] The <space>1 in <space>1R is important. It sets axis 1 as the echoback device (as would <carriage return>1). If you make a typing error, such as TRD<space>3000 instead of TRD3000 the <space>3 sets axis 30 as the echoback device, where R can be any command.

Certain 'tidy up' commands can be useful. For example:

- If you are not getting the typed characters echoed back you may need to use the SSA0 command.
- To get a prompt ($ or >) you may need to use the EX1 command.
- To get out of a $ prompt (indicating a sequence definition) type XT.
- If buffered commands are being ignored, type S in case the indexer is busy. You should avoid typing Z or cycling the power.

In summary:

- Don't type CTRL-S
- Avoid accidental use of the command F
- Don't address a non-existent axis
- Don't rubout a device address
- Type carefully

None of the above conditions is an error so the status LED on the Controller will not indicate a fault and the axis may well be energised or even moving.

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Programming With the RP240

Prompting an Operator or Displaying Information

In many motion control applications, the most important requirement is the operator interface. Presenting information to an operator in a desired format is often difficult. The RP240 has two visual indicators to help present information to the operator . The simplest indicator is the set of 8 LEDs on the panel. These LEDs can be turned on or off with the DLED command. The LEDs can be used in conjunction with the outputs to show the state of an output, or they can be used to show status, such as motor moving, specific sequences in progress, etc.

If a DLED10001011 command is issued, the LEDs shown below would be illuminated. These eight LEDs can be labelled, using the slide in card provided, to represent cycle status, output status, etc.

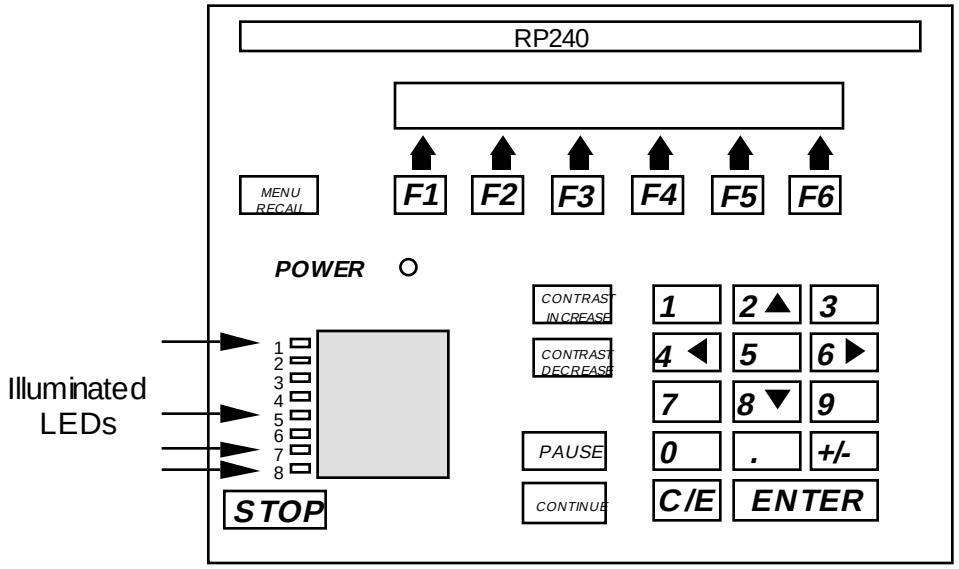


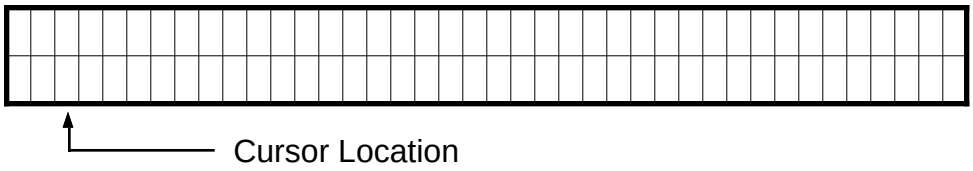
Figure 6-3. Status LEDs

The other indicator is the two line, 40 character LCD display. This display can be controlled with specific Extended X Code commands. The Position Cursor (DPC) command allows the user to program the location of the cursor on the LCD display. The 'Display Text Data on RP240 Display (DTXT) command allows the user to place text, beginning at the current cursor location, on the LCD display. For example: A user wishes their operator to see the message ENTER THE CYCLE COUNT. The user wants this message placed on line two, starting after two spaces in from the left. Following the message by three spaces the cycle count is to be entered and stored in variable 1. Below are the steps required to accomplish this.

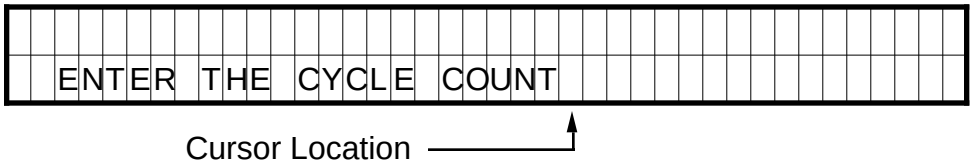
The cursor does not appear on the display. The cursor is displayed when the VARn=NUM or DPC commands are used.

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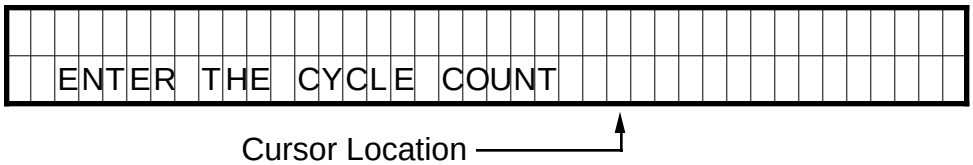
Step 1 Issue the DPC202 command (line 2, position 02).



Step 2 Issue the DTXT"ENTER THE CYCLE COUNT" command.

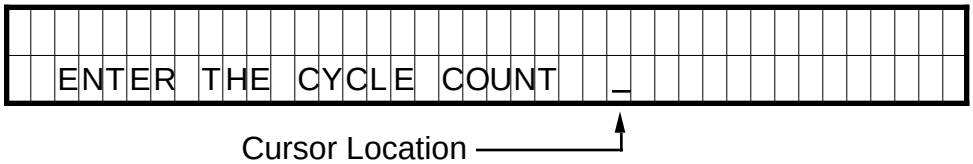


Step 3 Issue the DPC225 command (line 2, position 25).

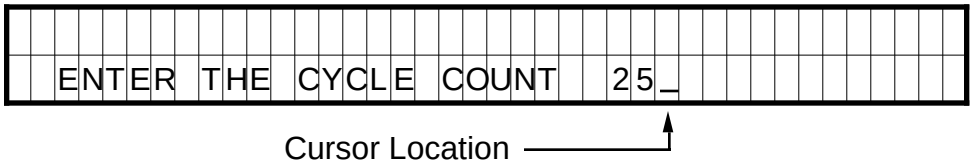


Once the operator has been provided with the prompting message, the actual cycle count data is provided using the Read and Enable Numeric Keypad (VARn=NUM) or Read and Enable Function Keys (VARn=FUN). The VARn=NUM command will enable the numeric keypad and allow the operator to enter information. The numbers, as entered, will be displayed at the current cursor location. Once the ENTER key is pressed, the number will be accepted by the Controller.

Step 4 Issue the VAR1=NUM command.



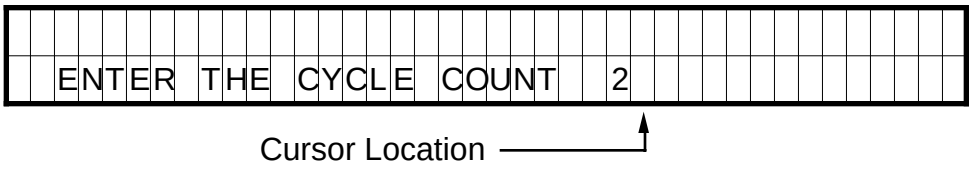
Step 5 Press a 2, followed by a 5.



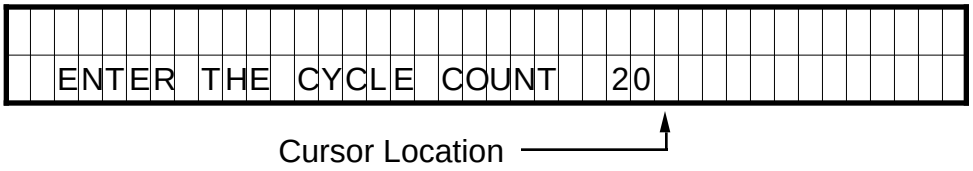
If the wrong value is entered press the C/E key and re-enter the value.

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Step 6 Press the C/E key.

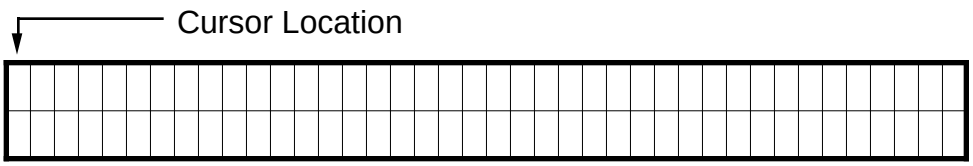


Step 7 Press a 0 followed by an ENTER.

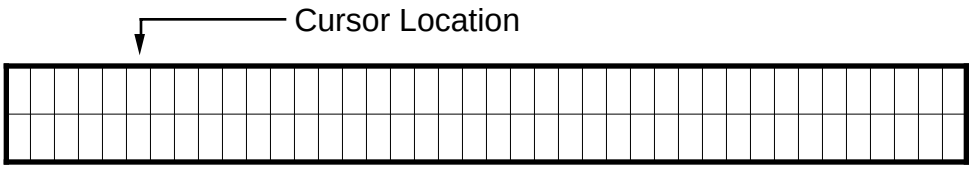


Once the cycle count has been entered, clear the display and enter text which allows an operator to choose a particular function (in this case a choice of parts).

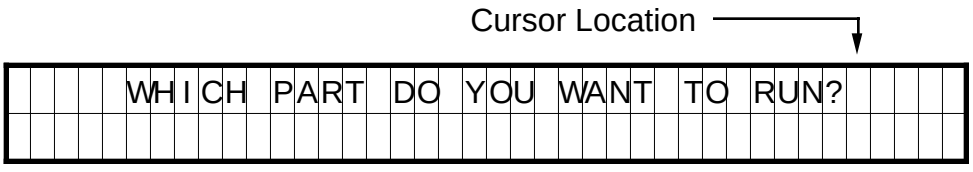
Step 8 DCLR0 command is issued.



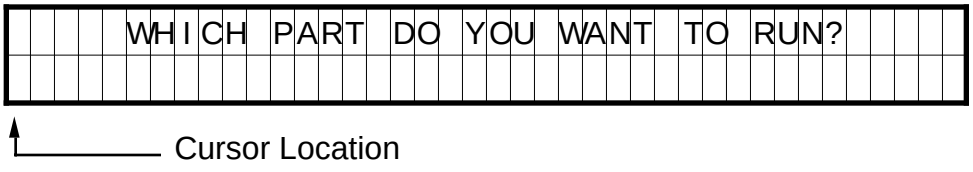
Step 9 Issue the DPC105 command (line 1, position 05).



Step 10 Issue the DTXT"WHICH PART DO YOU WANT TO RUN?" command.

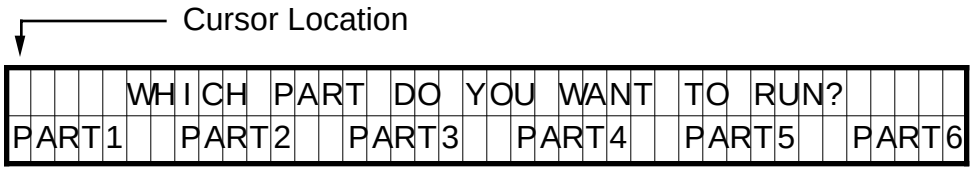


Step 11 Issue the DPC200 command (line 2, position 0).



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Step 12 Issue the DTXT"PART1 PART2 PART3 PART4 PART5 PART6" command. This text serves as an operator menu for the function keys.



Step 13 Issue the VAR2=FUN command.

The VARn=FUN command enables the function (F1 - F6), and the MENU RECALL keys. When any of these keys are pressed, the number corresponding to the function key will be transmitted from the RP240 to the Controller. Function keys 1 - 6 will return the values 1 - 6. The MENU RECALL key will return a zero.

Step 14 Press F1

After the F1 key is pressed, the RP240 will transmit the value 1 to the Controller. This value will be stored in variable 2.

Processing Information

Variables can be used in conditional statements like IF, WHILE and REPEAT or as data values in D, V, A, L, or T commands. In step 7 above, the value 20 was entered and stored in variable 1 to be used as the cycle count. The following is a command example:

Command	Description
D2400	Set distance to 2400 steps
V1	Set velocity to 1 rps
L(VAR1)	Loop the number of times as specified by variable 1
G	Initiate motion
T1	Wait one second
N	End the loop

In step 14 above, the operator pressed the F1 key. This value was stored in variable 2, and was used to select PART1. The following is a command example:

Command	Description
REPEAT	loop
IF(VAR2=1) XR11 NIF	Branch to sequence 11 if F1 is pressed
IF(VAR2=2) XR12 NIF	Branch to sequence 12 if F2 is pressed
IF(VAR2=3) XR13 NIF	Branch to sequence 13 if F3 is pressed
IF(VAR2=4) XR14 NIF	Branch to sequence 14 if F4 is pressed

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Example continued

Command	Description
IF(VAR2=5) XR15 NIF	Branch to sequence 15 if F5 is pressed
IF(VAR2=6) XR16 NIF	Branch to sequence 16 if F6 is pressed
UNTIL(VAR2=0)	End loop on menu recall pressed

For further information on the commands used in the example above, refer to the software reference guide for the Controller.

Enabling STOP and PAUSE Keys

In addition to the function keys and numeric keypad, there are three other keys. The STOP key, and the PAUSE and CONTINUE keys are enabled by default, and can be disabled by user commands.

Typically, if an application uses the STOP key, the key will be enabled (DSTP1) in the power-up sequence. However, the STOP key can be enabled and disabled in any sequence, and at any time.

The PAUSE and CONTINUE keys can be enabled in any sequence. The DCNT command enables the PAUSE and CONTINUE keys.

If SSH is enabled (SSH1), the STOP key will function as a controlled stop. After motion is halted, the Controller will resume command processing with the command directly following the command that was stopped with the STOP key.

Sample Program

This section provides an example of an RP240 application program. Refer to the Software Reference Guide for a more detailed description of the commands.

Power-up Sequence

A configuration sequence can be used to initialize the Controller to a state compatible with the RP240 and used to initialize variables.

```
XE63
XD63
LD3 1DSTP1
VAR20=5
VAR21=1
XR21
XT
```

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Sequence #21 In this example sequence #21 provides the main menu for a demonstration program. Control is transferred to another sequence based on a function key input.

```
XE21
XD21
1DCLR0
1DPC106
1DTXT"DIGIPLAN'S RP240 DEMO PROGRAM"
1DPC200
1DTXT"ACCESS"
1DPC235
1DTXT"EXIT"
VAR1=FUN
IF(VAR1=1)
        XG22
ELSE
        IF(VAR1=6)
                1DCLR0
                HALT
        ELSE
                1DPC220
                1DTXT"WRONG BUTTON!"
                T1
                XG21
        NIF
NIF
XT
```

Sequence #22 Prompts you for a password, and then transfers control to sequence #23. If the password is incorrect, control is passed to sequence #21.

```
XE22
XD22
1DCLR0
1DPC100
1DTXT"ENTER CODE NUMBER xxxx"
1DPC118
VAR1=NUM
IF(VAR1<1234 OR VAR1>1234)
        1DPC220
        1DTXT"WRONG NUMBER"
        T1
        XG21
ELSE
        XG23
NIF
XT
```

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Sequence #23 asks you to make a selection via the function keys. Control is passed to a sequence based upon the function key pressed.

```
XE23
XD23
1DCLR0
1DPC101
1DTXT"JOG  I/O   TEACH  MAKE  FEED        EXIT"
1DPC201
1DTXT"AXIS  TEST  MODE   MOVE  TO LENGTH"
VAR1=FUN
IF(VAR1=1)
        XR24
ELSE
        IF(VAR1=2)
                XR25
        ELSE
                IF(VAR1=3)
                        XR26
                ELSE
                        IF(VAR1=4)
                                XR27
                        ELSE
                                IF(VAR1=5)
                                        XG28
                                ELSE
                                        IF(VAR1=6)
                                                XG21
                                        NIF
                                NIF
                        NIF
                NIF
        NIF
NIF
XG23
XT
```

Note a more compact form of the IF, ELSE code would be:

```
.
IF(VAR1=1) XR24 NIF
IF (VAR1=2) XR25 NIF
IF (VAR1=3) XR26 NIF
.
etc
```

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Sequence #24 simulates jogging. You can select CW or CCW jog options of either high or low velocity. The default jog velocities are stored in variables 20 and 21, which were assigned in sequence #63. The MENU RECALL key is used to exit Jog mode.

```
XE24
XD24
A75
VAR1=0
1DCLR0
1DPC101
1DTXT"CW   CW    CCW   CCW  STOP"
1DPC201
1DTXT"LOW  HIGH  LOW   HIGH  MOTION"
MC
VAR1=FUN
REPEAT
        VAR3=0
        WHILE(VAR3=0)
                IF(VAR1=1) H+ V(VAR21) G NIF
                IF(VAR1=2) H+ V(VAR20) G NIF
                IF(VAR1=3) H- V(VAR21) G NIF
                IF(VAR1=4) H- V(VAR20) G NIF
                IF(VAR1=5) 1DCLR0 1DPC212 1DTXT"INVALID SELECTION" T1 XG23
NIF             VAR3=1
        NWHILE
        REPEAT
                VAR1=FUN
        UNTIL(VAR1=6)
        SB
        T0.3
        VAR1=FUN
UNTIL(VAR1=0)
V0
MN
XT
```

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Sequence #25 provides input status information and changes the state of LEDs.

```
XE25
XD25
1DCLR0
1DPC100
1DTXT"INPUT STATUS"
1DPC200
1DTXT"UPDATES"
1DPC233
1DTXT"OUTPUTS"
REPEAT
        VAR1=FUN
        1DPC113
        IF(IN_1) 1DTXT"1" ELSE 1DTXT"0" NIF
        IF(IN_X1) 1DTXT"1" ELSE 1DTXT"0" NIF
        IF(IN_XX1) 1DTXT"1" ELSE 1DTXT"0" NIF
        IF(IN_XXX1) 1DTXT"1" ELSE 1DTXT"0" NIF
        IF(IN_XXXX1) 1DTXT"1" ELSE 1DTXT"0" NIF
        IF(IN_XXXXX1) 1DTXT"1" ELSE 1DTXT"0" NIF
        IF(IN_XXXXXX1) 1DTXT"1" ELSE 1DTXT"0" NIF
        IF(IN_XXXXXXX1) 1DTXT"1" ELSE 1DTXT"0" NIF
        IF(IN_XXXXXXXX1) 1DTXT"1" ELSE 1DTXT"0" NIF
        IF(IN_XXXXXXXXX1) 1DTXT"1" ELSE 1DTXT"0" NIF
UNTIL(VAR1=6)
1DCLR0
1DPC100
1DTXT"THE LEDS BELOW WILL CHANGE STATE"
1DLED00000001 T1
1DLED00000011 T1
1DLED00000111 T1
1DLED00001111 T1
1DLED00011111 T1
1DLED00111111 T1
1DLED01111111 T1
1DLED11111111 T1
1DLED00000000 T1
VAR=0
XT
```

The 10 input bits in sequence #25 correspond to the total number of Controller user inputs.

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Sequence #26 sets up the learning mode for moves.

```
XE26
XD26
MPA
MN
VAR30=1
VAR29=1
VAR28=33
REPEAT
        1DCLR0
        1DTXT"HOW MANY MOVES TO TEACH?_x"
        1DPC200
        1DTXT"(MAXIMUM OF THREE MOVES)"
        1DPC125
        VAR30=NUM
UNTIL(VAR30>0 AND VAR30<4)
L(VAR30)
PZ
1DCLR0
1DTXT"PLEASE MAKE MOVE# "
1DVO29,2,0,0
1DPC200
T1
XR24
XR(VAR28)
VAR29=VAR29+1
VAR28=VAR28+1
N
VAR1=0
XT
```

Sequence #27 runs the pre-programmed moves defined by sequence #28.

```
XE27
XD27
A100
MPI
PZ
V10
VAR29=40
L(VAR30)
XR(VAR29)
G
VAR29=VAR29+1
N
VAR1=0
XT
```

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Sequence #28 prompts the operator to select the feed length, maximum speed and to count the number of items to be cut.

```
XE28 XD28
1DCLR0 1DPC100
1DTXT"SELECT FEED LENGTH, MAX SPEED, AND COUNT"
T2 1DCLR1
REPEAT
        VAR30=0
        1DPC102
        1DTXT"ENTER FEED LENGTH IN INCHES: (0-99.9)"
        1DPC212
        1DTXT"FEED LENGTH=xx.x"
        1DPC224
        VAR2=NUM
        IF(VAR2>99.9 OR VAR2<0)
                1DCLR0
                1DPC215
                1DTXT"OUT OF RANGE"
                T2
                1DCLR2
                VAR30=1
        NIF
        IF(VAR30=0)
                1DCLR0
                1DPC112
                1DTXT"FEED LENGTH="
                1DPC125
                1DVO2,2,1,0
                1DPC202
                1DTXT"YES"
                1DPC236
                1DTXT"NO"
                VAR22=FUN
        NIF
        IF(VAR22>1)
                1DCLR0
                1VAR30=1
        NIF
UNTIL(VAR30=0)
1DCLR0
REPEAT
        VAR30=0
        1DPC101
        1DTXT"ENTER MAX SPEED (RPM): (0-2400RPM)"
        1DPC215
        1DTXT"MAX SPEED=xxxx"
        1DPC225
        VAR3=NUM
        IF(VAR3>2400 OR VAR3<0)
                1DCLR0
                1DPC215
                1DTXT"OUT OF RANGE"
                T2
                1DCLR2
                VAR30=1
        NIF
        IF(VAR30=0)
                1DCLR0
                1DPC114
                1DTXT"MAX SPEED"
                1DPC125
                1DVO3,4,2,0
```

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```
                1DPC202
                1DTXT"YES"
                1DPC236
                1DTXT"NO"
                VAR22=FUN
        NIF
        IF(VAR22>1)
                1DCLR0
                VAR30=1
        NIF
UNTIL(VAR30=0)
1DCLR0
REPEAT
        VAR30=0
        1DPC103
        1DTXT"ENTER TOTAL NUMBER OF CUTS: (1-100)"
        1DPC210
        1DTXT"TOTAL # OF CUTS=xxx"
        1DPC226
        VAR4=NUM
        IF(VAR>4100 OR VAR4<1)
                1DCLR2
                1DPC215
                1DTXT"OUT OF RANGE"
                T2
                1DCLR2
                VAR30=1
        NIF
        IF(VAR30=0)
                1DCLR0
                1DPC113
                1DTXT"# OF CUTS="
                1DPC124
                1DVO4,3,0,0
                1DPC202
                1DTXT"YES"
                1DPC236
                1DTXT"NO"
                VAR22=FUN
        NIF
        IF(VAR22>1)
                1DCLR0
                VAR30=1
        NIF
UNTIL(VAR30=0)
1DCLR0
1DPC201
1DTXT"START"
1DPC235
1DTXT"EXIT"
REPEAT
        VAR22=FUN
        IF(VAR22<6 AND VAR22>1)
                1DCLR0
                1DPC212
                1DTXT"INVALID SELECTION"
                T2
                1DCLR0
        NIF
UNTIL(VAR22=6 OR VAR22=1)
IF(VAR22=6)
        XG23
NIF
1DCLR0
```

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```
VAR5=VAR2*25000
VAR6=VAR3/60
VAR7=VAR4
LD3 MN A100 V(VAR6) D(VAR5) 1DPC211 1DTXT"# LEFT TO CUT:"
L(VAR4) 1DPC225 1DVO7,3,0,0
G VAR7=VAR7-1
T.1 N
1DCLR0 1DPC213 1DTXT"JOB COMPLETED!" T1.5 1DCLR0 XG23
XT
```

Short service sequences used to set up distances in the self learn mode.

```
XE33 XD33
VAR6=POS XT
XE34 XD34
VAR7=POS XT
XE35 XD35
VAR8=POS XT
XE40 XD40
D(VAR6) XT
XE41 XD41
D(VAR7) XT
XE42 XD42
D(VAR8) XT
```

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Section 7. PROGRAMMING

Commands

The complete command list for the X150/X150E controller is contained in a separate document entitled **X150/X150E Software Reference User Guide** (No. 1600.221.XX).

Communicating with the Positioner

The positioner is designed to work in one of two modes:

a) The human interactive mode

b) The computer host mode

The command EX1 enables the first of these and the command EX0 the second. In the human interactive mode, the positioner will respond to a dumb terminal in an intelligent, user friendly manner and provide the user with help facilities and error messages if errors occur. In the host computer mode all unsolicited output and help information is suppressed so that communication may be handled by software resident in the host computer.

If a computer is to be used for the terminal function, terminal emulation software will be required. The X-Ware program available from Digiplan for use with IBM PC's and compatibles is suitable for this purpose. X-Ware is supplied with the product.

Individual Commands

An individual positioner command controls a single parameter, function, or action such as acceleration, velocity, position, time delay, pause, loop, go, etc. There are two classes of individual commands, Immediate and Buffered.

Individual commands are variable in length. They can consist of one or more letters with a delimiter (carriage return or space character) and one or more letters and numbers with a delimiter. Each command is entered as a character/delimiter combination. Some commands include a sign (±) to denote direction of motion. The number of characters used depends on the type of command entered.

Typical commands have the form:

1E
S
A10
V3
D46000

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When two or more individual commands are entered on the same line, they are separated by spaces, and multiple command entries will be displayed on a single line of your terminal screen.

The example below shows a set of individual command entries with space delimiters on the same line:

MN A10 V2 D25000 L10 G N

If spaces are used as the delimiter and a large number of multiple command entries are made, you could exceed the ability of your terminal to display characters as a single line (80 characters per line is a typical value). When the carriage return is used as a delimiter, the cursor returns to the beginning of the next line.

NOTE: The Positioner will normally echo carriage return with carriage return line feed in terminal mode. If you get double line spacing you need to turn off the auto line feed facility on your terminal. In computer mode (EX0) only the characters received are echoed.

The example that follows shows the effect of using carriage return as the delimiter when the terminal is not in auto line feed.

MN
A10
V2
D25000
L10
G

Immediate Commands

Commands that are identified as "Immediate" are executed immediately on receipt and will take priority over whatever operation is in progress. These commands include various Stop commands that clear the command buffer, and various Status Request commands that have no effect on the command buffer.

Buffered Commands

Commands that are identified as "Buffered" are received by the positioner and stored (in the command buffer) if the positioner is not free to execute them. Stored commands are executed as soon as the positioner gets to them, in the order that they were received.

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Buffer Capacity

Any combination of individual commands and command groups can be entered in the buffer until the total number of characters currently stored (including the delimiters) equals 2000. The positioner uses a first-in-first-out serial buffer. As the commands are read from the buffer, additional commands can be entered to replace them. Therefore, the possibility exists that a command set could actually consist of more than 2000 characters. Examples of command sets that might be used for different applications are presented later.

The sequence buffer is different from the command buffer in that it can be copied to battery backed up RAM using the SV command, while the command buffer is not battery backed up, so its contents are lost on power down.

Multiple Positioner Commands

When multiple positioners are on the communications daisy chain, commands like the previous example are executed by all positioners on the chain. To send commands to a single positioner, the device address of that positioner should be put in front of the instruction. The device address is set using the DIP switch on the individual positioner.

Example:

Three positioners are on an RS232C chain. They are sent the following commands:

MN A10 V10 1D25000 2D50000 3T1 3D100000 G

Unit 1 moves 25000 steps, unit 2 moves 50000 steps, and unit 3 waits 1 second and moves 100000 steps. All three use the same move profile rates.

During sequence download to one axis in a chain, all of the other axes must have their communication switched off by use of the F command. The alternative is to make each command in the sequence device specific by adding the device address.

Programming Modes

Normal Mode

The command MN selects normal mode. In this mode moves are set by the D command. Within normal mode there are two options, absolute mode and incremental mode.

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Absolute Mode

The command MPA puts the positioner into absolute position mode. Distances entered using the D command are interpreted as absolute positions relative to absolute zero.

Example:

MPA	Sets absolute mode
PZ	Sets current position to be absolute zero
D4000	Sets move to absolute position 4000
G	Execute move
D2500	Sets move to absolute position 2500
G	Executes move of 1500 steps CCW

Incremental Mode

The command MPI puts the positioner into incremental positioning mode. D command distances are interpreted as the number of steps to move from the current position.

Example:

1MPI	Sets incremental mode
1PR	Response=1500 (current position)
1D4000	Sets move to be 4000 steps CW
1G	Executes move to position 5500
1D-3000	Sets move to 3000 steps CCW
1G	Executes move to position 2500

Continuous Mode

The command MC selects continuous mode in which the motor runs continuously at the specified velocity until stopped or a new velocity is programmed. Distance data is ignored.

Example:

MC	Sets continuous mode
D4000	Ignored in continuous mode
A50	Sets acceleration to 50 revs/sec^2
V20	Sets velocity to 20 revs/sec
G	Motor runs at 20 revs/sec continuously
V10	Motor speed changes to 10 revs/sec
S	Motor stops

Speed Change Mode

The MQ command allows speed changes to be made during a preset move. The speed changes can be triggered at a set distance using the TRD command or by an input using the TRE command.

Example:

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3MQ	Set MQ mode for axis 3
3A50	Set axis 3 acceleration to 50 revs/sec^2
V15	Set velocity to 15 revs/sec
D8000	Set move distance to 8000 steps
G	Start move
TRD3000	Go to next command at D = 3000 steps
V5	Change velocity to 5 revs/sec
TRE_X1	Go to next command when Input 2 goes high
V2	Change velocity to 2 revs/sec

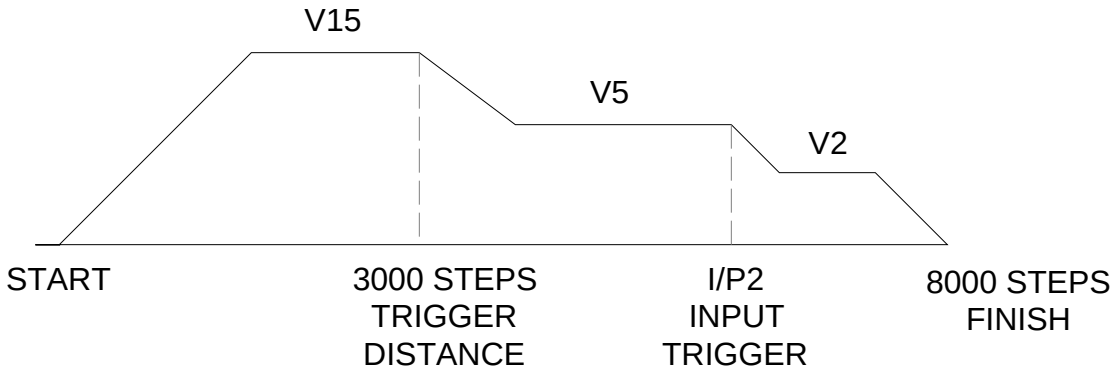


Figure 7-1. Speed Change Mode

Command Types

Start Move Commands

The positioner reads and stores individual commands in the order they are entered. Each command is read and executed before the next command is read. The GO command "G" is the principal buffered command that initiates shaft motion. When the buffer reads a GO command, the motor will then move in accordance with the move parameters that reside in the positioner at the time the Go command is read.

When the Go command is read, the positioner will incorporate any motion parameter command that was encountered prior to the Go command. For example, the "A " command would be combined with the Go command to change the acceleration value as follows:

A123 G

These commands instructs the Positioner to change the acceleration value to 123 rev/sec/sec and then execute the move using the last mode, velocity, and distance values that were previously entered.

When the RS232C positioner is initially activated, a series of commands of the form " MN An Vn Dn G " is required. These commands set up the initial operating conditions for the positioner. After the positioner has been initialised, single move parameter commands can be used.

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If only "G " is entered, the positioner will repeat the previous motion pattern. For example, a string of Go commands:

G G G G

would instruct the positioner to move the motor the same way four times.

There is no need to re-enter all the shaft motion commands to change one of the variables. If one or more of the motion parameters is changed by a command entry and the Go command is then entered, the prior pattern will be repeated using the new motion parameter(s) that were entered prior to the latest GO command.

For example:

A14 G V2.6 G D-27634 G

would change acceleration to 14 and move, then change velocity to 2.6 and move with 14 as the acceleration value, then change position and move again using 14 and 2.6 as the acceleration and velocity values.
The CONTINUE command "C " is used following execution of a PAUSE command, "PS " or "U ". CONTINUE will allow execution of the next command waiting in the command buffer (if any command is stored).

Loop Commands

The LOOP command allows a cycle to be repeated continuously "L" or a given number of times "Ln" up to 65535. The END-OF-LOOP command "N" indicates where the loop ends. The "N" command can be used to indicate that the positioner should proceed with further commands after the designated numbers of loops have been executed, or in combination with the "Y" command to indicate where execution is to stop. The "U" command may be used to temporarily halt Loop execution, the C command will then cause the loop to resume execution.

Stop Move Commands

The STOP MOVE commands are presented in order of severity of response. SOFTWARE RESET "Z" command is the most abrupt and severe stop command you can use. The STOP AT END OF CURRENT LOOP command "Y" is the least abrupt and severe stop command.

Stop at End of Current Loop Y

Also the 'stop sequence' command.

This command will not halt processing until command processing reaches the character N at the end of the command loop. At that time, the Positioner will execute the next command in the buffer after N, if any. The command loop cannot be restarted without re-entering the commands.

Controlled Stop command S

In the PRESET or CONTINUOUS mode this command will decelerate the motor to a stop at the last used acceleration rate.

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An "S " command will always cause a deceleration to velocity zero at the last used acceleration.

The "S " command clears any remaining commands in the command buffer unless prevented from doing so via the SSH command.

NOTE: Normally, the motor is decelerated to a stop at the same rate as it was accelerated.

Controlled Stop command LS

The LS or 'Limit Stop' command will decelerate the motor to a stop at the deceleration rate defined by the LA or 'Limit Acceleration' command.

Kill Command K

This command stops positioner commands to the motor. In addition it terminates a loop, ends a time delay, and aborts a command sequence download in progress (XD command). The command buffer is also cleared.

Software Power-on Reset Z

The "Z " command is equivalent to cycling the AC power to the Positioner; that is, it disables the communications interface and returns all internal settings to their power-on values. The command buffer is cleared. Like the "K " command, "Z " causes an immediate cessation of torque signal to the motor. Z also de-energises and resets the drive ready for re-initialisation at power up.

NOTE: When the "Z " command is used, the Positioner is busy for up to 2 sec and will ignore any commands. The status indicator will be blank for this period.

Pause Commands

There are four types of pause commands available as follows:-

Pause and wait for continue command C to continue. A common use of the Buffered Pause PS is to hold execution of individual commands in a Command Loop until the entire loop has been loaded.

Tnnn

Pause in processing commands for a given number of seconds and then continue.

U

Hold (pause) now and wait for continue. This is an immediate command.

TRE

Pause in processing commands until the designated TRIGGER condition is met.

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Triggers are used to synchronise positioner operations with external events. They can be used to implement a "handshaking" function with other devices. See command details for exact syntax.

Status Request Commands

All status request commands result in data being returned to the controller from the positioner. To prevent multiple positioners from all responding at once, the status request commands are given the classification "Device Specific" meaning that the device address of the responding positioner must be placed in front of the command. No positioner will execute a Device Specific command without its device number.

The use of status request commands must be conducted in an orderly fashion. Commands should only be issued when the host is ready to read the response. New commands should not be sent until the response is received. In particular, after a buffered status command, an immediate status command should not be sent until the response has been received by the host. If this procedure is not followed, the command responses will be intertwined, rendering the information useless.

There are two status commands that can be used to request position.

The DPA Command will report how many steps the motor has moved relative to the absolute zero position. This position is calculated by summing the total number of moves commanded since the positioner was at the absolute zero position. If position reports are needed that are relative to the beginning of each individual move, the PR command should be used.

Using the Evaluation Commands

The IF, WHILE and UNTIL commands contain fields that are evaluated to provide conditional program flow. The evaluation statement is contained in parentheses after the IF, WHILE and UNTIL commands. A space or underscore (_) indicates each comparison.

```
IF(condition)..commands..ELSE..commands..NIF
REPEAT..commands..UNTIL(condition)
WHILE(conditional)..commands..NWHILE
```

The conditions take the form of a set of evaluation statements:

1. INnnnnn_nnnnnnnnnn: compare to input status

   ```
   LMT+  LMT-  HOME  AUX_IN  STOP  _
   IN1  IN2  IN3  IN4  IN5  IN6  IN7  IN8  IN9  IN10
   ```

2. Variable compares:

   ```
   VARn>VARn
   VARn=VARn
   VARn<VARn
   ```

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A constant, POS (the present value of the position counter), ABS (the present value of the absolute position) or FEP (follower encoder position) can be substituted for the variable.

3. AND: Boolean AND operation

4. OR: Boolean OR operation

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Example

Command	Description
IF(IN_10 OR VAR1=3)	If input 1 is active and input 2 inactive or the user variable 1 equals 3 then execute sequence 1, else execute sequence 2
XR1	Execute sequence 1
ELSE	ELSE command
XR2	Execute sequence 2
NIF	End of IF
VAR5=POS	Set variable 5 to current indexer position
REPEAT	Repeat command
XR5	Execute sequence 5
T5.0	Delay 5 seconds
H	Change direction
UNTIL(POS>VAR5 AND IN_00)	If inputs 1 and 2 are inactive and the position counter is greater than VAR5, execute the next command. Else, jump to the repeat command
VAR6=POS	Set variable 6 to current indexer position
WHILE(ABS>VAR6 AND IN_00)	If the absolute position is greater than VAR6 and inputs 1 and 2 are inactive, execute the following commands, else execute the command following the NWHILE command
XR7	Execute sequence 7
T2.0	Delay 2 seconds
NWHILE	End of WHILE - jump to WHILE command

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Drive Energise/De-energise Function

Energising and de-energising the drive is subject to the commands given and error status as follows:

The drive will energise if:-

The ST0 or ON command is given when the WATCHDOG signal is inactive.

The drive will de-energise if :-

The ST1 or OFF command is given.

The WATCHDOG signal become operative.

An EXCESSIVE POSITIONING ERROR or an EXCESS TORQUE demand occurs.

The de-energising signal must be restored, then the ST0 or ON command must be given to re-energise the drive.

Homing Function

The GH command causes the motor to rotate in the direction and at the speed specified until the home position is reached. In practice, it continues a little beyond this point but you can locate the home position accurately by then using the commands:

MPA D0 G

This move is unnecessary if the first move after homing is made in absolute mode (MPA). (The GH command always makes the home position zero)

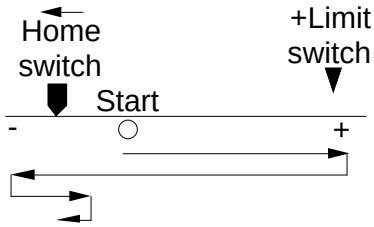
The SP command can be used after homing to change the accurate home position from zero if required.

If the home position is not found in the direction given in the GH command, the limit switch position will be reached and the switch will be operated. The motor will then reverse and seek the home position in the opposite direction. For recognised home detection, the home switch must always be activated from the direction specified in the command (shown by the arrow in Figure 7-2), so as illustrated in this figure, a limit switch reversal will take place if the direction given in the GH command is away from the home position (GH+ in the illustration).

If the limit switches are activated and no home position is found, the homing routine is aborted and an error message is returned.

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Positive homing from + side of home switch:-



Positive homing from - side of home switch:-

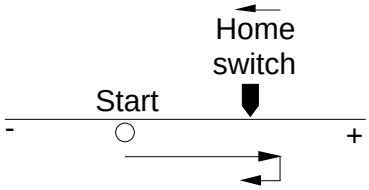
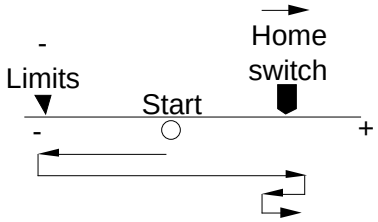


Figure 7-2. Positive Homing

Negative homing from - side of home switch:-



Negative homing from + side of home switch:-

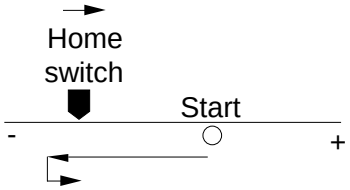


Figure 7-3. Negative Homing

Option OSA enables homing to an encoder index mark within the home proximity range, as opposed to the home switch edge. The mark is always approached from the specified direction. Using an index mark to determine the stopping point results in the home position remaining fixed even if there are small variations in the operating point of the home switch. The final home position will be the leading edge of the first index pulse following detection of the home switch edge.

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Basic Programming Guide

This section uses examples of simple programs as an introduction to programming and explains the use of the command language.

The system configuration is a brushless servo motor with a 500 line/rev encoder. 4X decoding is used and the user resolution has been set to 2000 steps/rev. Tuning the servo loop is dealt with in the section headed "Servo Tuning", so we will assume that it has been completed. The address select switch has been set for unit 1. The motor starting position is 400 steps CW from the home position.

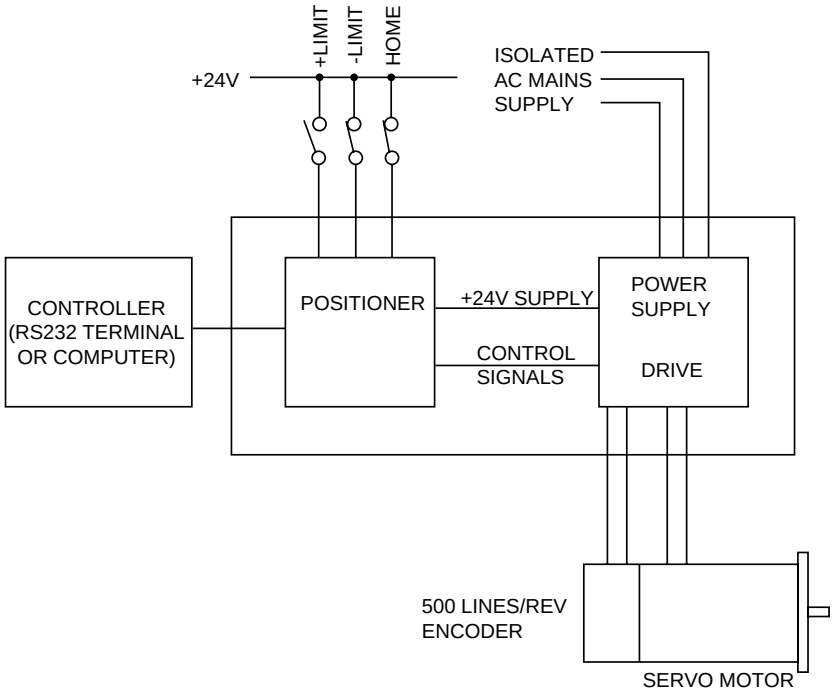


Figure 7-4. System Used in Example Programs

Example 1

In this simple example the requirement is to cause the motor to perform two revolutions in a CW direction and stop.

The following commands in the order shown will fulfil the requirement:-

Command	Purpose
MN	Set move mode to normal
1A10	Set acceleration motor 1 = 10
1V5	Set velocity motor 1 = 5
1D8000	Set move distance motor 1 = CW 2 revs
1G	Start move - motor 1 moves 2 revs CW

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Description

Commands cause motor 1 to accelerate at 10 revs/sec^2 to a velocity of 5 RPM, travelling CW for 8000 steps (2 revs) at the G command.

Example 2

This example causes axis 1 to go to the home position, then turn 5 revolutions CCW at 10 revs/sec and set the resulting position as absolute zero. The motor finally turns 8 revolutions CW to finish at absolute position 32000.

Command	Purpose
ST1	Energise the drive
A10	Set acceleration to 10 revs/sec^2
V10	Set velocity to 10 revs/sec
GH-2	Send axis 1 to go home (2 revs/sec CCW)
1D-20000	Set axis 1 to go 5 revs CCW
G	The axis moves to the required absolute position
MPA	Set absolute position mode
PZ	Set position to absolute zero
1D32000	Set move to abs. position 32000 (8 revs CW)
G	Move to position 32000 (1 rev CW from starting position)
1PR	Report absolute position

Description

Commands 2 - 6 cause the motor to go to the home position and then turn 5 revolutions CCW. Command 7 sets the absolute positioning mode and Command 8 sets the resulting position as absolute zero. Commands 9 and 10 cause the motor to turn 8 revolutions CW to absolute position 32000.

Programmable I/O Functions

Programmable Inputs

You can program each input or define them to correspond to a function. To define an input to a particular function use the IN command. The user definable inputs are labelled 1 to 10 on the front panel. The remaining inputs are dedicated as Limit+, Limit-, Home, Stop and Aux-In.

All input functions have been assigned a letter - refer to the IN command in the software section.

To program an input to perform a function, use the IN command followed by the input number and the corresponding function letter.

For example

1IN7H Set input 7 as direction toggle.

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The active input level and the type of input (pull-up or pull-down) can be programmed using the ICON command.

To view the current status of the user definable inputs type 1IN. All user definable inputs will be displayed.

Programmable Input Levels

Inputs can be programmed to operate as pull-down (sink) inputs or pull-up (source) inputs. The pull-up voltage may also be programmed as 5V or 24V. This is achieved by using the circuit arrangement shown in Figure 7-5, where PROG VOLTS can be programmed to 0V (pull-down), 5V or 24V (pull-up).

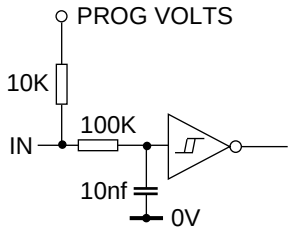


Figure 7-5 Input Circuit

Inputs are configured in 3 banks of 5 inputs, allowing each bank to be programmed independently. The three banks are:

BANK 1	BANK 2	BANK3
IN1	LMT+	IN6
IN2	LMT-	IN7
IN3	HOME	IN8
IN4	STOP	IN9
IN5	AUX_IN	IN10

If you need further information refer to the ICON command.

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Verifing Input Wiring

To verify that you have wired the inputs correctly for your application use the IS command. This command reports the active state of all inputs regardless of the function assigned to them.

Command	Response
1IS	000000_0000000000

This indicates that no inputs are active.

The switching level and active state of the inputs can be configured using the ICON command. The active level of the input will be affected by the ICON command, however the IS command will always indicate the on/off status of any input regardless of the input state programming command.

Command	Response
1IS	000000_1000000000

This indicates that input 1 is active.

Set Up Example

The limit inputs are to be connected to PNP normally closed proximity switches. The Home switch is connected to a normally open PNP proximity switch. Input 4 is to be configured as a kill input active when 0V is applied to the input. Inputs 6,7 and 8 are sequence select lines and input 9 is a sequence strobe line which is connected to the PNP ouput stages of a PLC. The stop input is active when 0V is applied to the input. All inputs operate at 24V dc.

This is achieved using the ICON command, as follows:

ICON 11111110

All bank 1, 2 and 3 inputs are programmed to +24V DC sense, active low. Vs is set to +24V and the primary feedback is from the MD motor encoder.

Configure inputs as follows :

1IN4C	Configure input 4 as kill input
1IN6N	Configure input 6 as a data input
1IN7N	Configure input 7 as a data input
1IN8N	Configure input 8 as a data input
1IN9N	Configure input 9 as a data input
1IN10W	Configure input 10 as a sign bit
1OUT3J	Configure output 3 as a strobe output
1OUT4J	Configure output 4 as a strobe output
1OUT5J	Configure output 5 as a strobe output

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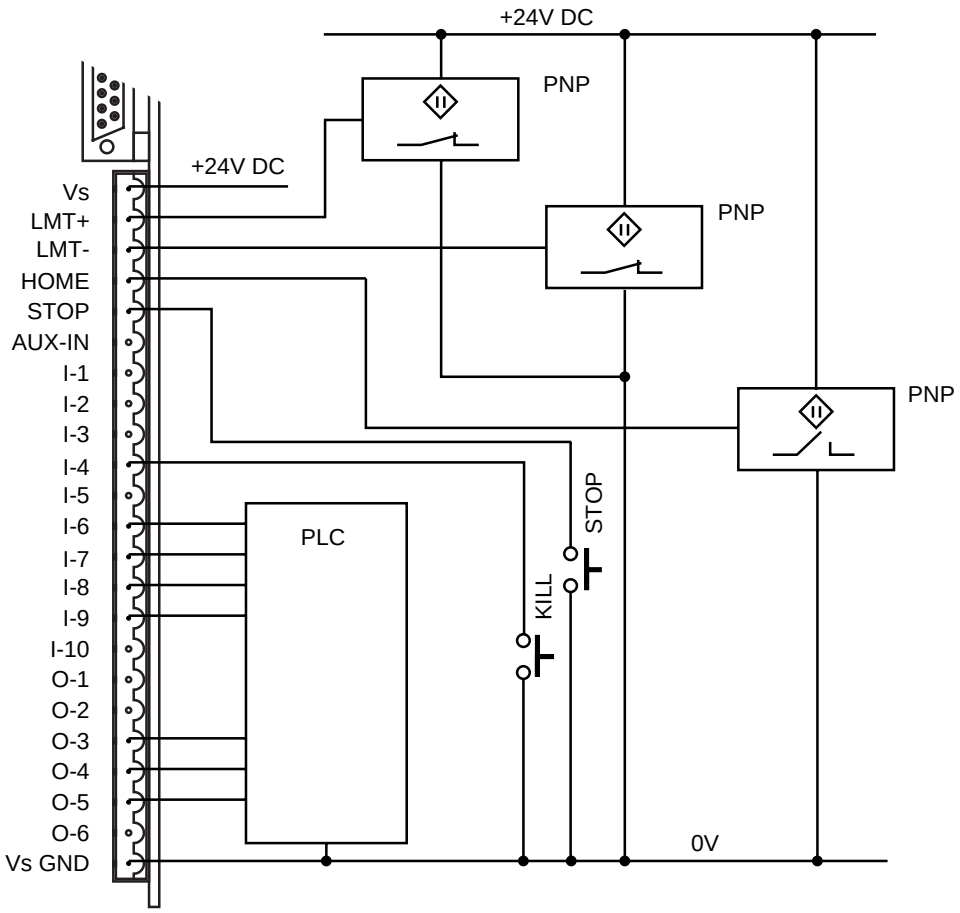


Figure 7-6 Input Example

Programmable Output

You can program each output, or configure it, to perform to a particular function. There are 6 user definable outputs which can be programmed as either NPN or PNP open collector outputs.

To allocate an output to a particular function use the OUT command. The user definable outputs are labelled OUT1 to OUT6 on the front panel. All output functions have been assigned a letter, refer to the OUT command in the software section.

To program an output to perform a function, use the OUT command followed by the output number and the corresponding function letter.

For example

1OUT3T Set output 3 as in position.

The choice of NPN or PNP output can be programmed using the OCON command.

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To view the current status of the user definable output type 1OUT. All user definable outputs will be displayed.

The response of the output to an active level will depend upon the programmed state of that output.

Note: Although it has been stated that all output functions can be defined using the OUT command there is one exception to this:

OUTPUT 1 can be configured as a composite fault output using the SSD command. When SSD is set to 1 then output 1 is configured as a composite fault output and overrides the function defined by OUT. SSD must be set to 0 for output 1 to be configured using the OUT command.

Programmable Output Levels

Outputs can be programmed as NPN or PNP open collector outputs. The circuit arrangement shown in Figure 7-7 is used. Output voltage levels will be determined by the value of the external voltage (Vs) and the value of the connected load.

The selection of NPN or PNP outputs is made using the OCON command. For example:

1OCON000111

Sets OUT1-3 to be NPN and OUT4-6 to be PNP. Only 6 bits can be set using this command.

Note: the output circuit uses a connected pair of output transistors, consequently when the NPN transistor is used, but is turned OFF, the external user voltage (Vuser) must be no greater than Vs, otherwise the PNP output may become reverse biased.

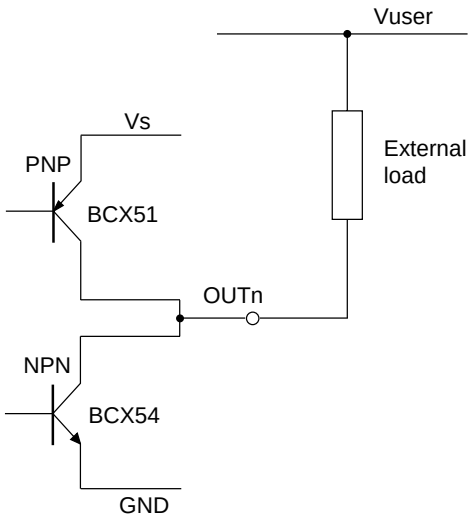


Figure 7-7 Output Example

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If Vuser is greater than Vs but less than 30V then it can be connected to Vs providing it is accessible. If you use this arrangement, it is recommended that the supply lead is fused.

Verifying Output Operation

You can directly control each output using the output command 0. Using this command you can force any output to the desired state, in order to do this the output must be configured as a programmable output (function A).

Command	Description
> 1O1X0	Turn output 1 on, ignore output 2 and turn off output 3.

Using Programmable Outputs

Programmable outputs can be used to interface with other parts of the system in order to indicate such things as in position, sequence in progress, fault or a user defined function.

The following steps demonstrate how you can configure these outputs.

Example

Output 1 is to be configured as a composite fault output. Output 3 is to indicate when the motor is moving and Output 5 is to indicate when the motor is in position.

1SSD1	Set output 1 as composite fault
1OUT3B	Set output 3 as moving / not moving
1OUT5T	Set output 5 as in position output

Typing 1OUT will display

```
;Output 01 Function F
;Output 02 Function A
;Output 03 Function B
;Output 04 Function A
;Output 05 Function T
;Output 06 Function A
```

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Sequences

Introduction

A sequence is a series of commands that is executed in order whenever the sequence is run. Immediate commands cannot be stored in a sequence since they cannot be stored in the command buffer. *The only "saveable in sequence" commands are buffered commands.*

The positioner has a section of non-volatile RAM totalling 8000 characters allocated for storing up to 64 sequences. The sequence buffers are of variable length, so they can store long sequences of up to 8000 characters or several shorter ones, provided that the total length of all sequences does not exceed the allocated 8000 character space.

During normal operation a command can specify the execution of any sequence stored in memory.

Sequence identifiers: number from 1 - 64.

When a sequence is programmed, the controller automatically calculates a checksum for the sequence and stores the length of the sequence and its checksum in an internal directory.

The command XSS can be used to verify the existence of a sequence.

If a power-on sequence is used, the sequence and its sequence number are stored in the non-volatile RAM.

Programming Sequences

Sequences are programmed by first sending a sequence definition command XD, which places the commands following XD in the sequence buffer. This continues until an end of sequence command (XT) is received. Any condition which prevents proper recording of the sequence is saved and can be accessed with the status command XSD. The programmed sequence can be tested with the run sequence command XR, which executes any specified sequence.

Note: A sequence cannot be defined whilst there are buffered commands still waiting to be executed i.e., while the drive is in an active state.

The XU command can be used to read back the entered sequence.

To begin the programming of a sequence, the XD command immediately followed by sequence identifier number (1 to 64) and a delimiter must be entered. An XT command ends the sequence. The save command SV should be used to store the sequence into the controller's non-volatile memory.

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The commands entered after the XD command and before the XT command will be executed in the order in which they were entered when the sequence is run.

Example:

NOTE: The ">" prompt is replaced by the "$" prompt when in sequence edit mode. If the numbered sequence already exists, it must first be erased using the XE command.

XE1	Erase previous sequence No.1
XD1	Begin definition of sequence No.1
A10	Set acceleration to 10 revs/sec/sec
V10	Set velocity to 10 revs/sec
D4000	Set move distance to 4000 steps
G	Go
H	Reverse next move
G	Go
XT	End of sequence

* The definition of sequence No.1 is terminated by XT but the sequence is NOT stored in non-volatile memory until the save command SV is given.

NOTE: Turn off switch 8 (on top of the drive) to write-protect sequences.

Whenever the above sequence is run, the motor will turn 1 revolution CW and then 1 revolution CCW.

Running Sequences

By Command Input

A sequence can be run by entering the XR command immediately followed by a sequence identifier number (1 - 64) and a delimiter.

Example:

XR3[space] runs sequence No.3

Standalone Operation

Stored sequences may be automatically executed when you power up the system or executed by remote switches, RP240, TM8 and thumbwheel.

A sequence selected as a binary pattern, set on inputs using the INnO command can be run in response to a sequence strobe set on an input using the INnB command.

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Example

Inputs 1 to 4 are to be used as sequence select lines.
Input 5 is to be used as a sequence strobe line.
Programs have been stored in sequences 1 to 16.

```
LSD   1IN1O Set input 1 as sequence data input
  .   1IN2O Set input 2 as sequence data input
  .   1IN3O Set input 3 as sequence data input
  .   1IN4O Set input 4 as sequence data input
MSD   1IN5B Set input 5 as sequence strobe input.
```

A binary pattern is configured on the inputs corresponding to the decimal sequence number. On a logic 0 to 1 transition of the sequence strobe input, the sequence corresponding to the binary pattern will be executed.

If a sequence is already running when the sequence strobe is activated the sequence strobe will be ignored. A sequence in progress must be terminated before execution of the next sequence strobe.

Power On Sequence

One of the stored sequences can be designated to be executed when the device is powered up. The sequence to be executed can be selected by prior RS232C command (XP1-64). The single sequence specified is executed once; control then passes to the RS232 link. Alternatively, power-on execution can be disabled with either the XP0 or XZ commands.

It is possible to have the controller execute a sequence on power up by defining the commands within a sequence using the XD, XT and XP commands. To define sequence No.1 the operator enters:

XP1 XD1 MN A10 V5 D40000 G XT 1SV

In this example the operator would not power the unit on until they were ready for the sequence to begin. The XP1 command enables a single run of sequence No.1 after power on. The XD1 command signifies the start of the definition of sequence No.1 and the XT command signifies the end of the sequence No.1 definition. When the operator applies power to the positioner, sequence number 1 will be executed (the motor will turn 10 revolutions in the positive direction). The sequence can be stopped using the S command or, if necessary, by using the emergency stop.

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Changing a Programmed Sequence

Once a sequence is defined it cannot be redefined until it has been deleted. A new sequence cannot be downloaded over an existing one.

To change a sequence, it must be deleted from memory and then redefined as a new sequence using the same number.

First, the sequence must be deleted from memory using the XE command. It will not be deleted from back-up RAM unless the SV command is used after the XE.

Example:

XE1 erases sequence No.1

The changed sequence should then be entered. It will not be saved to non-volatile memory until the SV command is issued.

Examining the Contents of a Sequence

If the operator wishes to check the contents of the sequence, they would enter:

1XU1

This would cause the positioner to send the contents of sequence number 1 to the terminal's screen. The 1 preceding the XU command is the device address which must be present since the XU command is a "device specific" command. After issuing this command the following will be displayed on the terminal's screen:

;Sequence 1 is: MN A10 V5 D40000 G

This is the command string that is performed when sequence number 1 is executed.

If the operator does not wish to have the sequence execute on power up, it can be cancelled by issuing either the XP0 or XZ command.

Sequence no.1 can also be run manually using the XR command.

Sequence Status Requests

Sequence status commands include XC, XSD, XSP, XSR, XSS. The XC command can be used to verify that the memory in the back-up RAM has not been corrupted in any way since last power down. The XC command will cause the positioner to send a checksum in the form of three decimal digits (000 - 255) to the terminal. The checksum may be recorded when sequences have been defined, so that it may be used for comparison later, such as each time the positioner is powered up.

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Sequence Debugging Tools

After creating your sequences, you may need to debug them to ensure that they are performing properly. The Controller provides several debugging tools.

- In trace mode, you can trace a sequence as it is executing
- You can single step through a program
- Error messages can be enabled explaining why the Controller has stopped execution

Trace Mode

You can use the trace mode to debug a sequence or a program of sequences. The trace mode allows you to track, command by command, the entire sequence. It displays to your terminal, over the RS-232C serial link, all of the commands as they are executed. The following example demonstrates the trace mode.

Step 1 Create the following sequence:

Command	Description
XE1	Erases sequence #1
XD1	Begins definition of sequence #1
A10	Acceleration is 10 rps^2
V5	Velocity is 5 rps
L5	Loop 5 times
GOSUB3	Jump to sequence #3
N	Ends the loop
XT	Ends the definition of sequence #1

Step 2 Define the sequence #3.

Command	Description
XE3	Erases sequence #3
XD3	Begins definition of sequence #3
D50000	Sets the distance to 50000 steps
G	Initiates motion
XT	Ends the definition of sequence #3

Step 3 Enter the following command to enable the Trace mode.

Command	Description
1XTR1	Enable the trace mode

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Step 4 You will now execute the sequence. The commands will be displayed on the terminal as each command in the sequence is run. Enter the following command:

Command	Description
XR1	Run sequence #1 - response is:

```
*SEQUENCE 001 COMMAND A10
*SEQUENCE 001 COMMAND V5
*SEQUENCE 001 COMMAND L5
*SEQUENCE 001 COMMAND GOSUB3 LOOP COUNT 1
*SEQUENCE 003 COMMAND D50000 LOOP COUNT 1
*SEQUENCE 003 COMMAND G LOOP COUNT 1
*SEQUENCE 003 COMMAND XT LOOP COUNT 1
*SEQUENCE 001 COMMAND N LOOP COUNT 1
*SEQUENCE 001 COMMAND GOSUB3 LOOP COUNT 2
*SEQUENCE 003 COMMAND D50000 LOOP COUNT 2
*SEQUENCE 003 COMMAND G LOOP COUNT 2
*SEQUENCE 003 COMMAND XT LOOP COUNT 2
*SEQUENCE 001 COMMAND N LOOP COUNT 2
*SEQUENCE 001 COMMAND GOSUB3 LOOP COUNT 3
*SEQUENCE 003 COMMAND D50000 LOOP COUNT 3
.
.
.
.
.
*SEQUENCE 003 COMMAND G LOOP COUNT 5
*SEQUENCE 003 COMMAND XT LOOP COUNT 5
*SEQUENCE 001 COMMAND N LOOP COUNT 5
*SEQUENCE 001 COMMAND XT
```

The format for the trace mode display is:

Sequence Number Command Loop Count

Step 5 To exit the trace mode, enter the following command:

Command	Description
XTR0	Exits Trace mode

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Single-Step Mode

You can debug your program with another level of debugging using the Single-Step mode. Single-Step mode allows you to execute one command at a time when you want the command to be executed. Use the XST command to enable Single-Step mode. Once you are in the mode, you can execute a sequence one command at a time. To execute a command, you must use the # sign. By entering a # followed by a delimiter, you will execute the next command in the sequence. If you follow the # sign with a number (n) and a delimiter, you will execute the next n commands. The following steps illustrate the use of Single Step mode:

Step 1 Enter Single-Step mode

XST1

Step 2 Begin execution of sequence #1

XR1

Step 3 You will not execute any commands until you use the # command. Type the following:

Command	Description
#	Executes one command

The response will be:

*SEQUENCE 001 COMMAND A10

Step 4 To execute more than one command at a time, follow the # sign with the number of commands you want executed.

Command	Description
#3	Executes 3 commands, then pauses sequence execution

To complete the sequence, use the # sign until all the commands are completed. To exit Single-Step mode, type:

XST0

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Section 8. MAINTENANCE & TROUBLESHOOTING

Drive Maintenance

Routine maintenance is not necessary, but occasional checking of the following points is recommended.

Motor Maintenance

Periodically check the motor to ensure that no bolts or couplings have become loose during operation, and check the motor cable or leads periodically for signs of wear. Do not make very tight bends or pull on the cable during normal operation. Check all cable connectors and the safety earth connection.

Drive Maintenance

Check that the drive is clear of loose material and has a free flow of air through the ventilation slots. Enclosures must be connected to earth ground to provide a low-impedance path for ground-fault or noise-induced currents. Check the security of the ground connections.

Fuses

BDHXE drives are fitted with fuses which limit circuit damage in the event of a fault occurring, they are not user replaceable. If the drive fails to operate correctly or you suspect a fuse has blown return the drive for repair. Warranty is void if the case is opened.

Troubleshooting

Drive or system problems may be indicated by one of the front panel LEDs lighting up whilst the drive is operating.

Note: The central 'HV Present' LED will always be alight whilst the DC bus voltage is present. This does not necessarily mean that the internal logic supplies are present. The LED will remain alight even when mains power is removed, as the high voltage capacitors will still be charged.

WARNING - Danger of electric shock

Lethal voltages are present on the mains input connector and the motor phase outputs. After removing AC power, wait for the 'HV Present' LED to go out before touching the drive terminals. Do not remove the drive cover, there are no user-serviceable parts inside.
Removal of the cover voids the warranty and EMC compliance.

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Protection Circuits

The BDHX-E Drive has a number of protection circuits which automatically prevent damage ocurring during fault conditions. If a fault does occur it will cause a front panel LED to light up and may de-energise the drive.

The front panel LED indicators are described below.

IT Foldback

If the IT foldback yellow LED comes on, it means the drive has been required to deliver too much current for too long a time period. In this situation the drive will automatically reduce the motor current to below 60% of the peak current.

IT foldback will occur if the drive is required to deliver its full output current for more than 5ms at a speed of less than 6rps. The full current limit will be restored as soon as the conditions causing IT foldback have been removed.

This condition may cause a shutdown due to excessive position error.

Current limit

The yellow I limit LED indicates that the current demand is exceeding the drives maximum current capability.

Drive Fault

The red drive fault LED can indicate one of the following faults:

- Overvoltage
- Undervoltage
- Supply failure
- Overcurrent
- Overspeed

An overvoltage condition may be caused by:

- Excessive AC power input voltage
- A fault in the dump circuit
- The application requires a larger dump capacity

An under voltage condition may occur if the AC input power voltage drops when the maximum drive power is drawn from the supply i.e. poor AC supply regulation.

A supply failure may indicate a short circuit exists in the encoder or other external wiring, or it could be due to a fault in the internal power supply. If the fault is still being indicated when all external wiring is disconnected, the drive is probably faulty.

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An overcurrent fault, indicated by the illumination of the drive fault LED and the red overcurrent LED mounted within the case, can be caused by a shorted motor winding or a drive fault. If the fault is still indicated when the motor is unplugged, the drive may be faulty.

An overspeed fault means that the motor has exceeded the factory-set overspeed threshold. If your application requires very high speed performance, please contact Digiplan for advice.

Overtemperature

The overtemperature LED will come on if the drive or motor is operating outside its specified continuous rating, requiring the duty cycle to be reduced.

If the motor feedback connector becomes disconnected, the thermal switch will appear to have opened and the drive will de-energise, indicating an overtemperature fault. This fault condition is latched until the drive is reset.

Controller problems

The 7-segment display on the drive front panel gives an indication of a number of possible fault conditions. The fault codes are listed below. Under normal operating conditions the display will show 0.

Code 0 - No faults, drive is energised.

Code 1 - No faults, drive is de-energised.

Code 2 - Drive fault. When code 2 is displayed, the Drive Fault LED should also be on. Please refer to ‘Fault LED’ earlier in this section.

Code 3 - Changed memory map (factory use only)

Code 4 - Excessive positioning error. Check mechanics and system parameters.

Code 5 - Checksum error. This indicates a failure in the battery-backed RAM. It may be caused by the unit remaining unused for an exceptionally long period (e.g. several months).

Code 7 - Torque demand exceeded. Ensure drive is capable of producing required torque.

Code 8 - Watchdog failure - the processor has ‘hung’, which will shut down the drive. This may be caused for instance by excessive interference from neighbouring equipment. Cycle power to restart.

Code E - Exception error. This is caused by a hardware or firmware malfunction resulting in incorrect operation of the user program.. Cycle power to recover.

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Code P - Power failure. The motor supply in the drive has fallen below the minimum level.

Code U - UART error. This is normally caused by ASCII characters being transmitted in an incorrect format (baud rate, number of start or stop bits). Reset by typing address followed by R.

No communication

Perhaps the commonest controller problem, especially during initial commissioning, is apparent lack of communication with the terminal or host controller.

If the Controller echoback is turned off by accident, causing an apparent loss of communication (hanging), it may be re-enabled by typing the following sequence:

CTRL-Q<space>E<space>1R<carriage return>

Note:

[1] This sequence is case sensitive - make sure you are in upper case.

[2] CTRL-Q means hold the 'control' key down and press the Q key at the same time. This sends the X-ON ASCII character. The Controller obeys the X-ON X-OFF communications protocol which is used to hold up communications if an interface is sending too much data too quickly. This means that if X-OFF is sent down the chain (the character CTRL-S) all communications from the axes stop until CTRL-Q (X-ON) is sent down the chain. This includes echoback of commands. If CTRL-Q is never sent the system will 'hang'.

[3] You may type CTRL-S by mistake. This condition can be cleared by cycling the power.

[4] The E command is the enable RS-232 command which can easily be mis-typed as the F command which will lock out the keyboard. Cycling the power will not cure this problem since SV cannot be typed following a keyboard lock out.

Certain 'tidy up' commands can be useful. For example:

- If you are not getting the typed characters echoed back you may need to use the SSA0 command.
- To get a prompt ($ or >) you may need to use the EX1 command.
- To get out of a $ prompt (indicating a sequence definition) type XT.
- If buffered commands are being ignored, type S in case the indexer is busy. You should avoid typing Z or cycling the power.

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In summary:

- Don’t type CTRL-S
- Don’t type the command F
- Don’t address a non-existent axis
- Don’t rubout a device address
- Type carefully

None of the above conditions is an error so the status LED on the Controller will not indicate a fault and the axis may well be energised or even moving.

Internal Fuses

Three internal fuses are fitted to limit circuit damage in the event of an internal failure. Should any of these fuses blow the drive should be returned for repair. Users should not replace fuses.

Returning the System

In the event that the drive is considered to be faulty, it should be returned for repair. Do not attempt to open the case - there are no user-serviceable parts inside. Opening the case not only voids the warranty but may also invalidate the EMC compliance.

Contact the Parker Automation Technology Centre or the machinery manufacturer who supplied the product. Equipment for repair should NOT be returned directly to Digiplan without prior authorisation. Repairs will be carried out by Digiplan but will be processed via your supplier.

Digiplan may at their discretion authorise direct shipment to and from Poole or Rohnert Park, but only by prior arrangement with your supplier. Existing UK and USA customers who purchase equipment directly from Digiplan should contact Poole or Rohnert Park for further information (contact numbers are at the front of this User Guide).

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Appendix A. ENCODER SETUP

Introduction

This section is applicable when the BDHX-E drive is not used with Digiplan MD Series motors.

BDHX-E drives are designed to operate with 3-phase brushless servo motors which have both a commutation encoder (Hall effect encoder) and an incremental encoder fitted. The commutation encoder must have Com A leading Com B by 120° electrical and Com B leading Com C by 120° electrical, and must have the same pole count as the motor. The incremental encoder must have 512 or 1024 lines, with A+ leading B+ for clockwise (CW) motor rotation. The I+ output is a high going pulse that occurs when A+ and B+ are high and is shorter than one complete cycle of A+ (see Table 3-1 waveform diagram).

Commutation

When power is first applied to the drive, the commutation encoder is used to establish a torque angle of approximately 90° electrical, so that 87% smooth motor torque can be achieved immediately. Once the motor has moved through 180° electrical, it will have passed an edge of Com A, achieving a more accurate setting of the torque angle, allowing 95% torque to be obtained. Following a complete revolution, the motor will have received an index pulse which provides the most accurate position information allowing 100% torque to be applied. The index pulse also acts as a continual check on the electrical position.

Encoder Setup

When setting up the encoders, you should disconnect the motor cable from the drive, but leave the encoder cable connected and the drive powered up but de-energised. Select any motor phase, say 'u' in Figure A-1, and take it to the negative connection of a DC power supply, as shown. Connect the other two motor phases to the power supply positive connection via power diodes.

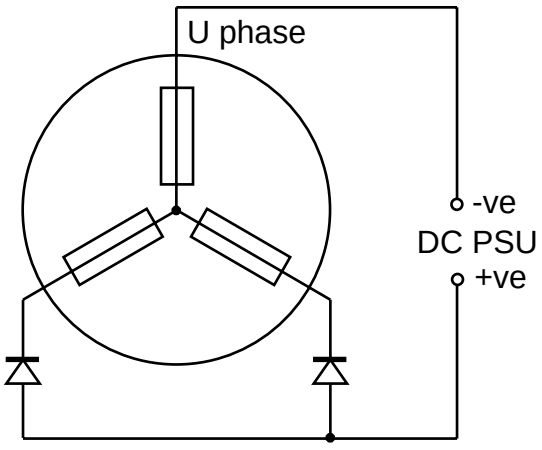


Figure A-1. Encoder Set-up Circuit

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The DC power supply should be set to provide a current approximately equal to the motor's stall current. This will pull the rotor into the index position.

To identify the 'v' or 'w' phase, disconnect one of the diode connected phases, if the motor moves CW the 'v' phase has just been disconnected. If the motor moves CCW, you have just removed the 'w' phase.

The index position can be confirmed by the illumination of the middle yellow LED on the top of the drive. The commutation A LED will also light up when the motor is turned CW indicating the rising edge of Comm A+.

Drive Setup

The BDHX-E Series of drives can be configured for different motor types using software commands. The following configurations are possible:

Motor Pole Number

Command CPC can be used to set the number of motor pole pairs as follows:

> <a>CPCn, where n is the number of motor pole pairs and can be 4, 6 or 8.
> The default value of n is 6.

Encoder Resolution

The BDHX-E drive can be used with incremental encoders having a resolution of 512 or 1024 lines per revolution. After processing, the encoders would effectively produce 2048 and 4096 steps/rev respectively.
Command CDR is used to set the encoder resolution to 1024 or 512 lines.

Note: Digiplan 3.4 inch motors are fitted with a 1024 line encoder.

Polarity of the 'Drive disable' Input

The drive disable input circuit can be configured with the CFS command as a normally open (pull-up) or a normally closed (pull-down) input, as shown in Figure A-3. With Configure Fail Safe (CFS) active (CFS0), the pull down circuit configuration is selected, i.e. the cicuit needs to be broken to disable the drive.

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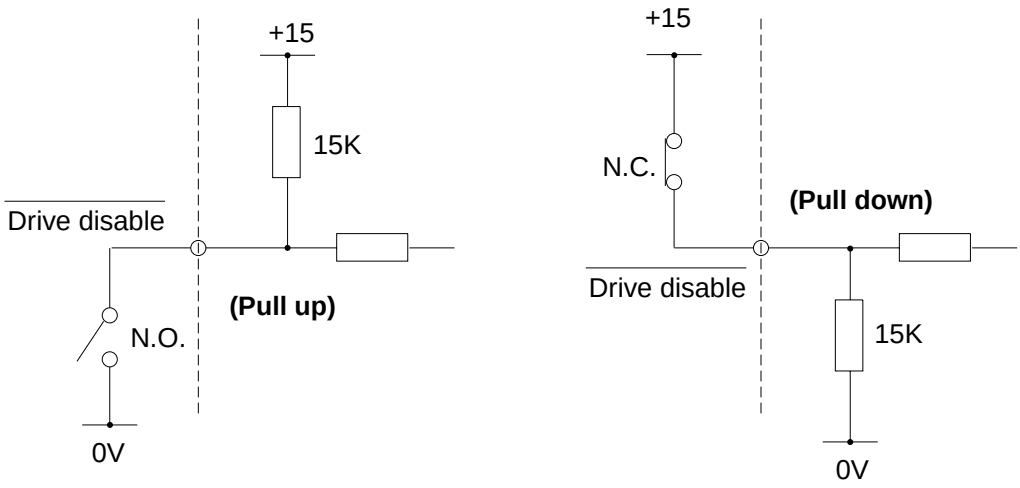


Figure A-3. Drive Disable Input Circuit Options

Current Limit

If you wish to use motors with a current rating of less than the MD3450/230V or MD3475/230V the peak output current of the drive will need to be limited using the Configure Command Peak (CCP) command. The value of 'n' to use with CCP will depend upon the drive type and the peak RMS current of the motor you wish to use. The following calculations will need to be performed to give the required value of 'n'.

For the BDHX75E:

$$n = \frac{I_{peak(RMS)} \times 1023}{6}$$

For the BDHX150E:

$$n = \frac{I_{peak(RMS)} \times 1023}{12}$$

Where $I_{peak(RMS)}$ is the peak motor current required, measured in Amps.

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For example: BDHX150E set for a peak current of 8A

$$n = \frac{8 \times 1023}{12} = 682$$ Therefore sending CCP682 will set a peak current of 8A.

Caution

If your application uses the CCP command to limit the motor torque, new values of 'n' will need to be calculated where necessary. Remember not to exceed the values as calculated above.

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