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CE

SVHX Series
Servo Drive
User Guide

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Part No: 1600.227.01 April, 1998

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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 terminal on drives before applying mains power.

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

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

	**CAUTION** **VORSICHT** **ATTENTION**	Hot surface. Do not touch. Heisse Oberflache! Nicht beruhren! Surface brulante. Ne pas Toucher.

	**WARNING** **ACHTUNG** **ATTENTION!**	Risk of electric shock if case is not earthed. Connect earth before connecting supply. Entstehung von gerfahrlichen elekrischen Spannungen möglich, falls Gehäuse nicht geerdet ist. Vor Anschluss der externen Versorgungspannung Gerät erden. Risque de choc electrique en cas de non branchement sur la terre. Brancher la terre avant l'alimentation.	

	**WARNING** **ACHTUNG** **ATTENTION!**	High voltages remain after power removed. Do not remove cover. No user-servicable parts inside. Nach Entfernen der Versorgungsspannung können im Gerät noch hohe Spannungen anstehen. Gerät nicht öffnen Gerätemodifikationen und-reparaturen dürfen nur vom Hersteller ausgeführt werden. Hautes tensions résiduiles apres coupure de l'alimentation. Ne pas ôter le boîtier. Eléments internes non disponibles à l'utilisateur.

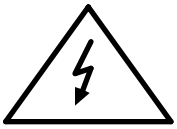
Symbols used on the SVHX series of drives have the following meanings:



Refer to the accompanying documentation



Protective conductor terminal



Risk of electric shock



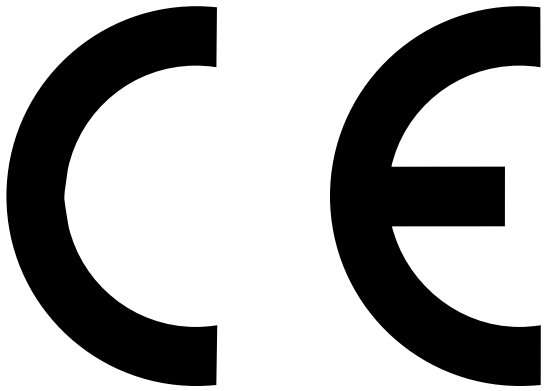
Alternating current



Hot surface



Frame or chassis terminal



Product Type: **SVHX4500S, SVHX8500S**

The above product is in compliance with the requirements of directives

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

The SVHX Series of drives are sold as complex components to professional assemblers, as components they are not compliant with Electromagnetic Compatibility Directive 89/336/EEC unless they are fitted with an external filter.

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Associated Documentation

This User Guide forms part of the documentation required to use the SVHX Series of servo drives, it should be read in conjunction with the **X150 Software Reference User Guide** (Part Number 1600.221.02) which provides details of individual commands.

User Guide Change Summary

This user guide, version 1600.227.01, is the first issue of the SVHX Series Servo Drives User Guide.

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 section is changed, the change bar is located on the outside margin of the section title.

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Section 1. Introduction

Product Description

The SVHX Series of drives combine the use of power servo technology with the X150 based, EMC-compliant, controller.

Powered from a three phase supply, the SVHX Series of servo drives provide an LVD compliant solution for applications requiring controller operation. Two power levels are available:

Drive	Shaft power
SVHX8500S	5.5kW
SVHX4500S	3.5kW

Both drive types are compatible with the HDX motor range.

All drive types incorporate a controller configurable by software and offering a choice of RS232C or RS485 serial link communications (factory set). NPN or PNP output drivers can be selected in software and operate from 24V supplies, allowing integration within a PLC controlled system.

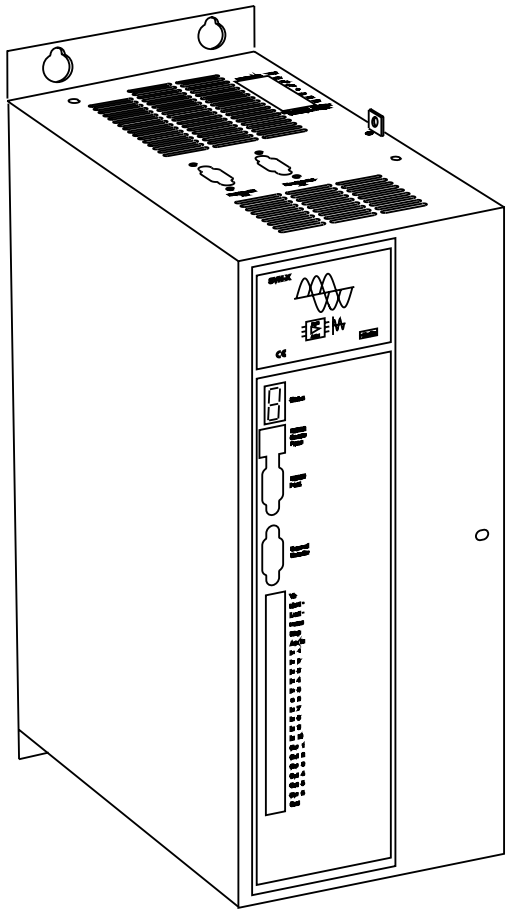


Figure 1-1. SVHX Servo Drive

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Product Features

Fully integrated servo drive, position controller and power supply.

Two current ratings - 6.5A and 12.5A continuous.

Protected IGBT power output stage.

Three phase power input, direct-on-line operation.

Wide supply voltage range (380V to 480V) for worldwide use.

Compatible with a range of proprietary resolvers.

Fully EMC compliant using external filter.

Opto-isolated I/O circuits using PLC-compatible 24V signal levels.

Built-in 24V DC supply for control circuits and motor brake.

Provision for an external 24V DC supply to maintain communication and diagnostics during shutdown.

Position controller equipped with a wide range of advanced motion control functions including maths, variables, registration, following and motion profiling.

Up to 64 motion programs may be stored in a non-volatile memory.

Automatic servo tuning facility.

7-segment diagnostic display.

RS485 and Fieldbus communication options.

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Section 2. Installation

Safety Requirements

This drive is designed to meet the requirements of the EU Low Voltage Directive when installed according to the instructions given in this User Guide into a system which itself meets LVD requirements.

The drive must be installed in an enclosure to protect it from atmospheric contaminants such as oil, moisture, dirt, etc. No operator access should be allowed to the drive while it has AC power applied. Metal equipment cabinets are ideally suited for siting the equipment since they can provide operator protection, EMC screening and can be fitted with interlocks arranged to remove all AC power when the cabinet door is open.

Provision must be made within the installation to contain the spread of fire by the fitting of a flame barrier, as defined in the LVD enclosure requirements. In many applications this requirement will be met simply by installing the drive within a cabinet fitted with a solid metal base. If the cabinet base is ventilated a flame barrier will be required that conforms with the baffle dimensions defined in the European Standard EN 61010-1 (other standards may apply in individual cases).

System Components

A standard shipment will consist of the following system components:

- Drive
- Connectors
- Documentation

Drive types

The SVHX drive types are listed below:

Drive	Shaft power
SVHX4500S	3.5kW
SVHX8500S	5.5kW

Connectors and Leads

Each drive is supplied with mating screw terminal connectors for the front panel Digital I/O connections.

Motor and resolver leads will need to be purchased as separate items, for details of lead types refer to Appendix A.

Documentation

Each drive is supplied with a user guide (this document) part number 1600.227.xx which provides you with the necessary information to set up and install a drive for your application.

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Motor Selection

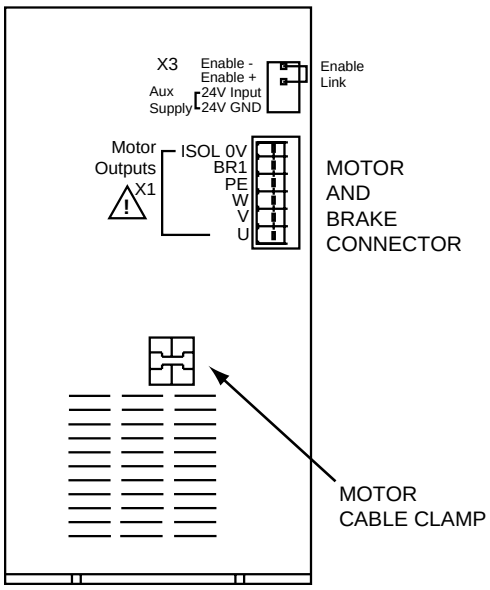
Table 2-1 lists the range of SVHX drive types against the recommended motor types, the rotor inertia for each motor type is also given.

Drive Type	Motor Type	J ($kgmm^2$)	Motor Pole Count
SVHX4500S	HDX92E4-44S	118	4
	HDX115A6-64S	240	6
	HDX115C6-88S	460	6
	HDX115E6-130S	680	6
SVHX8500S	HDX115C6-88S	460	6
	HDX115E6-88S	680	6
	HDX142C6-88S	1150	6
	HDX142E6-88S	1700	6
	HDX142E6-130S	1700	6
	HDX142G6-88S	2200	6

Table 2-1. SVHX Drive Motor Types

Motor Drive Connections (X1 Connector)

Motor drive connections are located on the base of the drive. A 6-way connector provides the W, V and U phase supplies, a motor earth and the motor holding brake supply. For electrical noise reduction reasons, you should clamp the cable screen in the 360° fixing provided.



WARNING - HIGH VOLTAGE

Very high voltages are present on the motor output connections. Ensure all terminals and wires are protected from accidental contact.

Figure 2-1. Drive Motor Connections (Base of Drive)

Motor connection lead and pin-out details are given in Appendix A.

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Auxiliary Supply (X3 Connector)

Both the SVHX8500S and SVHX4500S have built-in power supplies used for powering internal logic and analogue circuits. A supply of +24V is generated internally from which multiple ±15V and 5V lines are derived. In a situation where the drive's controller needs to be kept 'alive' when power is removed from the drive, an external +24V supply can be used. In practice this situation can arise when the drive is mounted in a cabinet and cannot be supplied 3-phase power when the cabinet door is open. By providing an external +24V supply, cabinet doors can be opened without resetting the drive's controller.

When the drive is fed from an external +24V, the internal 24V power supply will shut down. The supply used, should be fuse protected.

The enable connections allow the power output stage of the drive to be disabled. For the SVHX drive **enable +** is always connected to **enable -** , permanently enabling the power output stage. An error message is generated if this link is missing and the front panel LED display will flash a '1' character.

Power Connections (X2 Connector)

Both drives within the SVHX Series are designed to be powered from three phase supplies of 380V to 480V (see Admissible AC Power Connections later in this Section). The direct wire, 3-phase power connections (L1, L2, L3) are located on the top of the drive and are shown in Figure 2-2. The protective earth conductor must be securely fitted to the main protective earth connection point, shown in Figure 2-2.

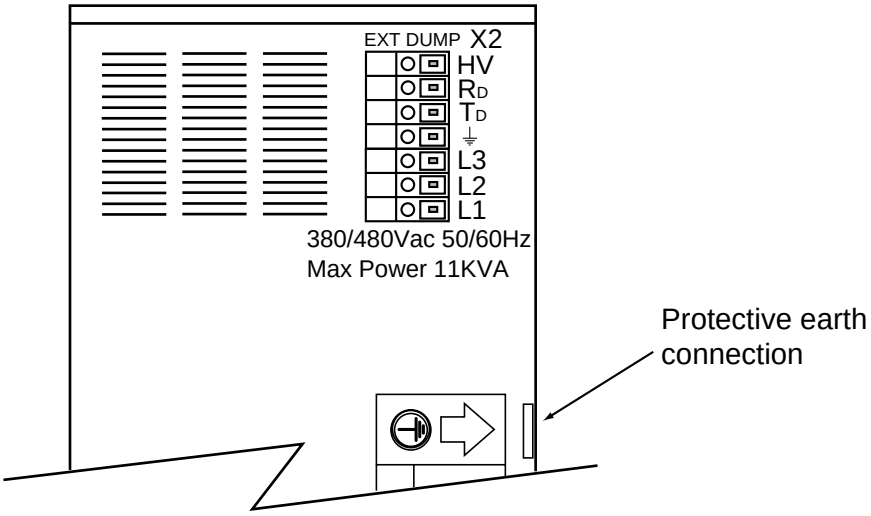


Figure 2-2. Drive Power Connections

Fuse Requirements

The supply will need to be fused as follows:

SVHX4500S	10A
SVHX8500S	16A

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High breaking capacity fuses or equivalent MCB switches equipped with thermal and magnetic trips, should be used, positioned as close as possible to the equipment being protected.

EMC Filter Installation

If you are intending to use the drive with an external EMC filter, it is recommended the filter is mounted next to the drive as shown in Figure 2-3. Both the drive and filter must have good electrical contact with the cabinet metalwork, which can be achieved for the drive, by making use of its un-painted mounting surface areas located on the underside of the top and bottom metalwork fixings. This will require any surface coating to be removed on the panel to which the drive is being mounted, but only over the area making contact with the drive. In a similar fashion, the surface coating of the panel beneath the EMC filter's mounting metalwork will also need to be removed to ensure good electrical contact between the filter and mounting panel.

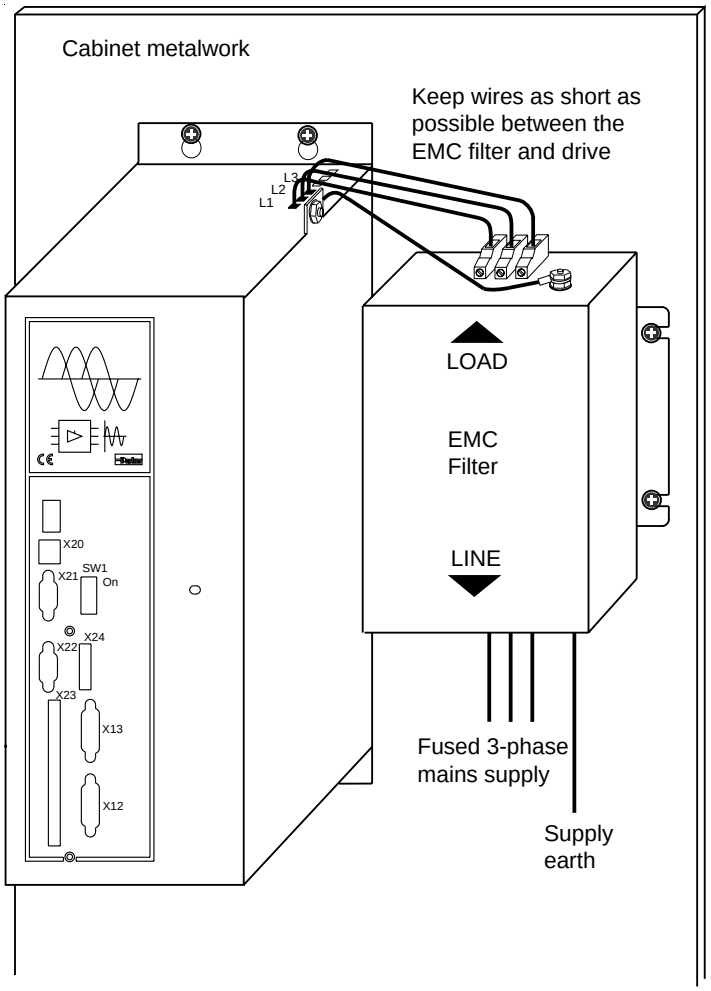


Figure 2-3. EMC Filter Installation

Wiring between the EMC filter and drive needs to be made with 2.5mm^2 (14AWG) wire kept as short as possible. The earth (ground) connection should be made using colour coded, green/yellow 2.5mm^2 (14AWG) wire using crimped ring terminal contacts.. The cable used should be rated for at least 1500V RMS.

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All ring terminal contacts need to be assembled as shown in Figure 2-4, with the split ring washer used to tension the electrical contact.

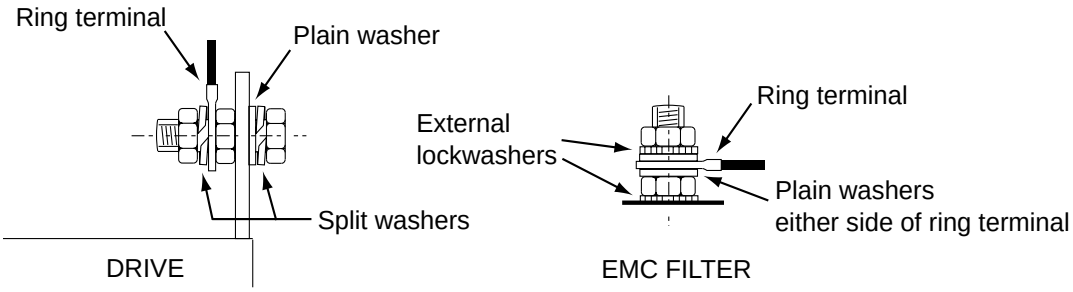


Figure 2-4. Crimp Ring Terminal Fixing Detail

EMC Filter

The recommended filter part is a Corcom 25FCD10, which has the following electrical specification:

3-phase mains EMC filter

Current capacity	25A @ 440V AC phase to phase
Mains frequency	50-60Hz
Voltage rating	250V AC phase to ground
	440V AC phase to phase

Attenuation

Frequency	.03MHz	.1MHz	1.0MHz	10.0MHz	30.0MHz
Line to ground in 50 circuit	26dB	40 dB	75 dB	45 dB	50 dB
Line-to-line in 50 circuit	13dB	46dB	75dB	65dB	60dB

Earth leakage current

Maximum leakage current, each 6A @ 250V AC 50Hz line to ground	4.9mA
Maximum leakage current, each 25A @ 250V AC 50Hz line to ground	9.8mA

Alternative filter types may be used provided the given specification can be met or improved upon.

CAUTION

There are no 3-phase supply input fuses within the drive. Supply fuses will need to be fitted before the EMC filter.

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3-Phase EMC Filter

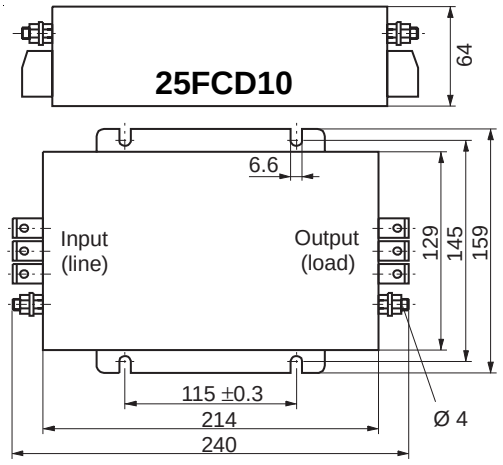


Figure 2-5. EMC Filter for SVHX Series

Surge Protection

Using an EMC mains filter will provide protection against mains surges of 2kV (1.2/50µs rise/fall time). If the drive and filter combination are used in an environment where surge levels greater than 2kV may be expected, or where an EMC filter is not used, additional surge supression systems will need to be provided. Contact Parker or your Automation Technology Centre if your application needs extra surge protection.

Admissible AC Power Connections

Three-phase drives can be powered from the following types of AC power systems:

A TN - mains system type A and B, in which the earth/ground is connected as part of the supply, as shown in Figure 2-6. In this system all exposed conductive parts of the installation are connected to the earth/ground point of the source of the supply.

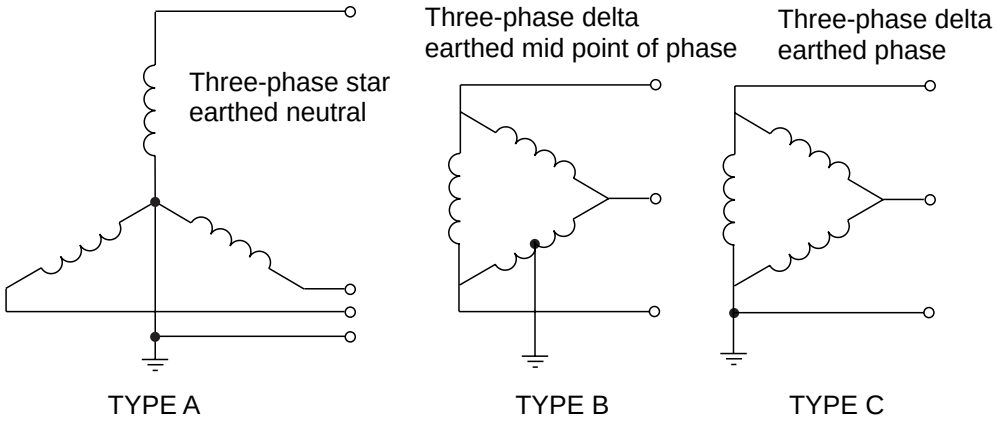


Figure 2-6. TN Mains Supply Systems

The three-phase delta earthed phase (type C) supply will only meet LVD requirements if the line to ground voltage is less than 416V AC.

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IT mains supply systems, where the source of the supply has no direct connection to ground, do not meet European LVD insulation standards if the line-to-line voltage exceeds 416V AC.

Pre-Installation Test

Once the drives power connections and safety earth connections have been made it is worth performing a pre-installation test of the drive to ensure all of the installation work completed so far is working correctly. By checking the installation at this stage you may avoid later commissioning delays. The safety earth connection must be made as shown in Figure 2-7 to minimise the risk of electric shock.

The motor need not be installed in its final position, but it must be securely mounted to prevent its body moving during test and it must not be connected to any mechanical load during pre-installation testing.

Please take note of the warning given at the beginning of this User Guide. Motion control equipment is capable of making rapid unexpected movements of high force, especially during the development of controller programs and the commissioning of equipment.

A recommended pre-installation test circuit for a single axis SVHX drive is shown in Figure 2-7. This pre-installation test assumes you are using a recommended motor part, the configuration data for which has been pre-loaded into the drive.

Note 1 The AC supply must be fused protected.

Note 2 Always check the motor type before energising the drive.

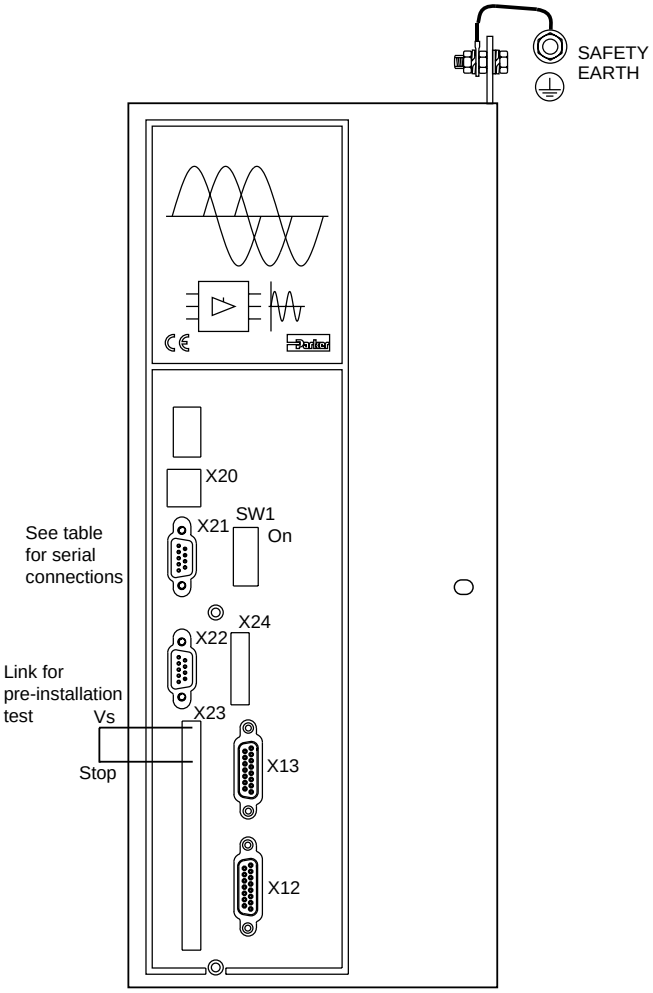


Figure 2-7. SVHX Pre-installation Test Circuit

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Pre-installation Motor Connections

For pre-installation testing the motor can be wired and mounted as shown in Figure 2-8. You must make sure that the motor is firmly mounted to a secure base. The motor housing must be securely connected to earth via the motor cable PE connection.

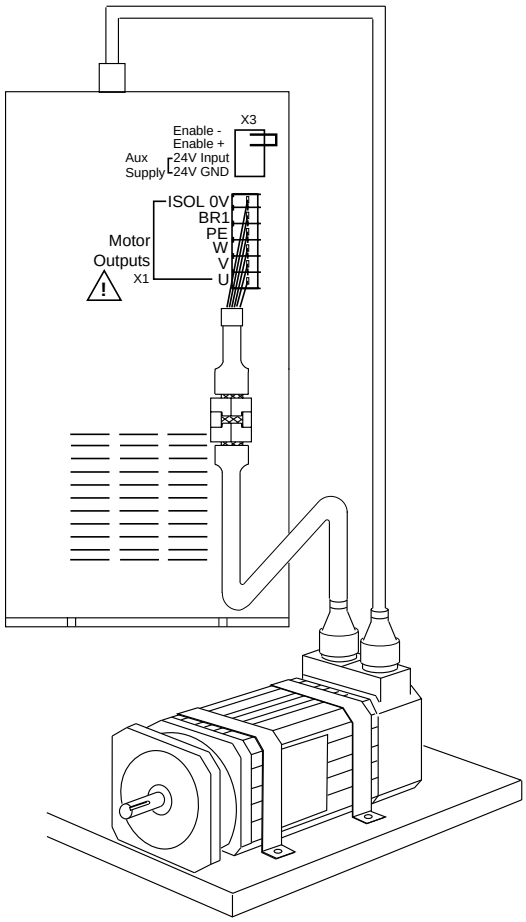


Figure 2-8. Pre-installation Test Motor Connections

Motor and brake connections are located on the base of the drive as shown in Figure 2-8. The resolver connector (X12 15-way female D-type) is located on the drive's front panel and will need to be connected to the motor using a resolver cable type REK 5 for the HDX115 motor or cable type REK 14 for the HDX142 motor.

CAUTION - SUDDEN MECHANICAL MOVEMENT

The motor must be securely clamped in position before the pre-installation test is performed.

CAUTION - HIGH TEMPERATURE

The motor case can reach a temperature of greater than 100°C (212°F).

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Wiring

The pre-installation test circuits should use standard motor and resolver cables (see Appendix A), appropriate for the motor/drive combination being used. AC supply wiring should be made with insulated copper conductors with a cross sectional area of at least 2.5mm^2 (14 AWG tri-rated cable). Other emergency stop, 24V and control wiring can use 7/0.2 mm equipment wire. The protective earth conductor should be at least the same size as the supply wiring.

Minimum RS232 Connections

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

Drive RS232/RS485 9-way D-type Connector (X21)	Computer 9-way D-type	Computer 25-way D-type
3 0V	5	7
4 RxA	3	2
5 TxA	2	3

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.

Testing the SVHX

Use the following procedure to test the drive:

WARNING - ELECTRIC SHOCK HAZARD

Check all wiring before applying AC power to the test circuit.

1. Ensure a link is made between Vs (pin 1) and Stop (pin 5) on the 23-way main controller connector (X23).

2. Make the RS232 connection between the terminal and controller, as detailed above, and set the address bit switch to address 1 (bit 1=ON, 2/3/4/5= OFF).

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

4. Apply power to the drive from a fuse protected supply. See ***Fuse Requirements***.

5. Establish serial communications by sending a 1DR command. 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 and ensure the controller address is set to 1.

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6. Once communications are working, ensure the drive is configured correctly for the motor being used. Configure the motor pole count by using the CPC command. Refer to Table 2-1 to confirm the pole count and send the command:

1CPCn, where n is the pole count from Table 2-1.

For example:

1CPC6 ;Set for 6 pole motor

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

1ON<return>	**;**to ensure the drive is energised
1LD3<return>	**;**disable limit inputs
1D4000<return>	**;**
1G<return>	**;**go

8. 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.

9. Having proved the drive is working correctly, you may isolate all AC supplies and remove the temporary control wiring and continue the final installation of the drive and motor.

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Drive Control and I/O Connections

Wiring Guidelines

Proper grounding of electrical equipment is essential to ensure the safety of personnel. In general, all components and enclosures must be connected to earth ground to provide a low impedance path for ground fault or noise-induced currents. All earth ground connections must be continuous and permanent. A central earth busbar is recommended.

Controller I/O Connections (X23)

The SVHX has 5 dedicated inputs, 10 user defined inputs and 6 user outputs. The configuration of these inputs and outputs is described in ***Setting Up the User I/O***.

Pin No.	Signal	Description	Signal Type
1	Vs	+24V (160mA)	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	24V GND	DC GND RETURN

Table 2-3. Controller Signals

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Signal Type A

Apply to all dedicated and user definable inputs. Signal type A inputs can be operated at 24V and can be configured, by software, for operation as pull-up or pull-down inputs.

Table 2-4 gives the input voltage threshold switching levels for inputs operating at 24V.

Signal	24V Operation (Typical values)	Worst case
Logic high level	>8.8v	>10.8V
Logic low level	<5.7v	<4.0V
Hysteresis (typical)	3.3v	
Max. input voltage range	0-30v	

Table 2-4. 24V Operation for Signal Type A Inputs

Signal Type B

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

Resolver Connections to Drive (X12)

Resolver connections to the drive are made via a 15-way D-type connector (X12) located on the front panel. Connection details are given in Table 2-5.

Pin Number	Signal	Pin Number	Signal
1	housing	9	+5V
2	NC	10	TEMP
3	NC	11	COS-
4	REF-	12	COS+
5	SIN-	13	SIN+
6	NC	14	REF+
7	GND	15	NC
8	NC	-	-

Table 2-5. Resolver Connections

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External Encoder Connector (X22)

This connection is used for following applications (see SIM and CCS commands) or it can be used for positional feedback in place of the motor resolver.

Pin Number	Name	Function
1	A+/CLK+	Secondary encoder
2	A-/CLK-	"
3	B+/DIR+	Secondary encoder
4	B-/DIR-	"
5	Z+	Encoder Z channel
6	Z-	"
7	5V ENC.	Encoder supply (5V @ 100mA)
8	GND	Encoder ground
9	N/C	

Table 2-6. External Encoder Connections

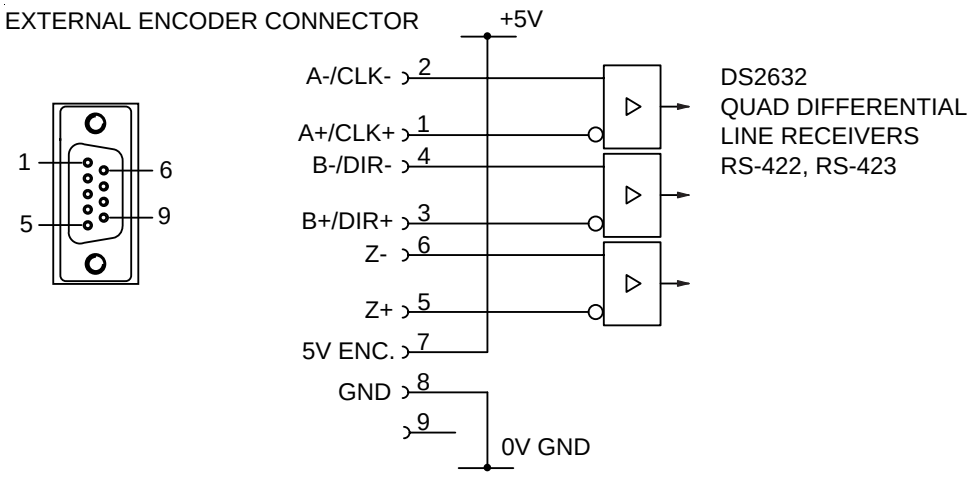


Figure 2-9. External Encoder Inputs

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RS232 Control Panel Connector (X20 Mini DIN)

This socket is normally used for the RP240 Remote Operator Panel, but may also be used as an alternative RS232 connection from the host controller.

Pin Number	Name	Function
1	+5V (RP240)	RP240 +5V supply
2	0V (RP240)	RP240 0V ground return
3	RxB (RP240)	Receive line from RP240
4	N/C	
5	RxA (terminal)	RS232 receive line
6	TxB (RP240)	Transmit line to RP240
7	Screen	
8	TxA (terminal)	RS232 transmit line

Table 2-7. RS232/RP240 Connections

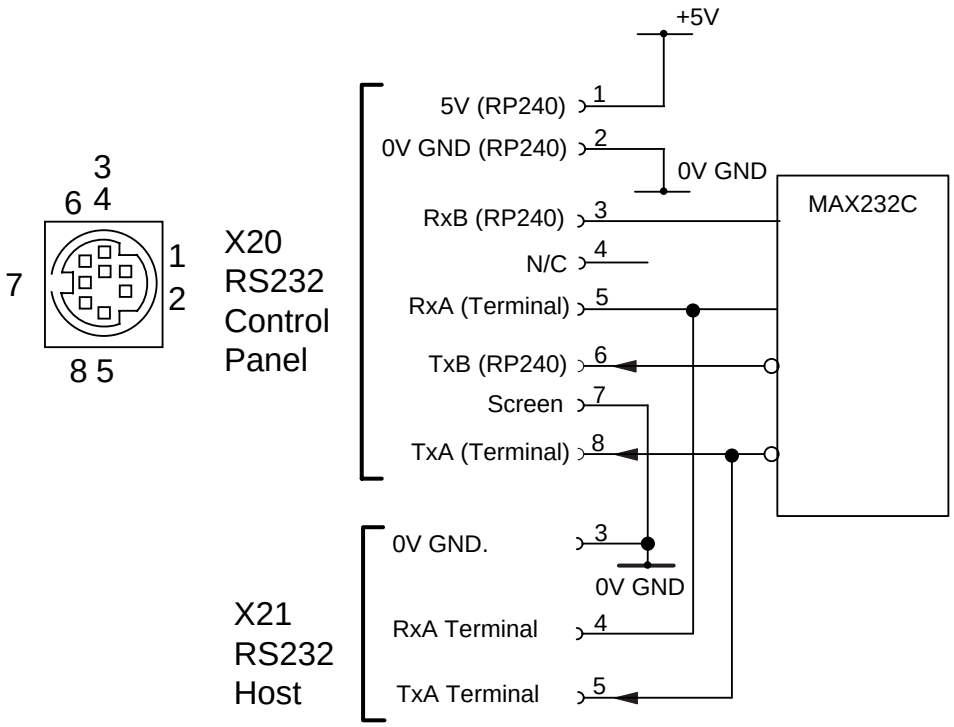


Figure 2-10. Mini DIN Connections

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RS232 Host Connector (X21)

This connector is normally used for serial communications. The serial communication options are factory set as:

RS232C 3-wire (Tx, Rx, Gnd) - default setting
RS485 2-wire (single-ended) or 4-wire differential

Pin Number	Name	Function
1	RxD (RS485)	RS485 non-inverted receive i/p
2	TxD (RS485)	RS485 non-inverted transmit o/p
3	0V	RS232C GND
4	RxA	RS232C receive terminal
5	TxA	RS232C transmit terminal
6	RxD/(RS485)	RS485 inverted receive i/p
7	TxD/(RS485)	RS485 inverted transmit o/p
8	N/C	-
9	Reserved	

Table 2-8. RS232 Host Connections

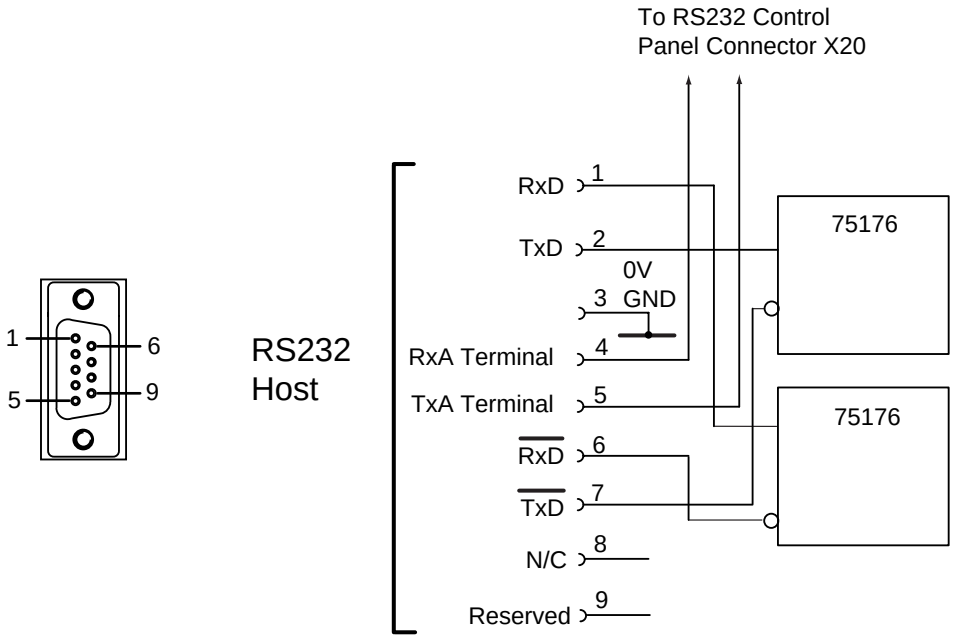


Figure 2-11. RS232 D-type Connections

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Encoder Drive Connector X13 (15-way D-type)

Simulated encoder feedback connector. All encoder signals are differential RS485 (5V) levels.

X13 pin Number	Name	Function
1	N/C	-
2	N/C	-
3	B	Output B
4	A	Output A
5	GND	Ground return for encoder outputs
6	N/C	-
7	N/C	-
8	Reserved	
9	N/C	-
10	$\overline{B}$	Output B inverted
11	$\overline{A}$	Output A inverted
12	N/C	-
13	N/C	-
14	N/C	-
15	N/C	-

Table 2-9. X13 Connections

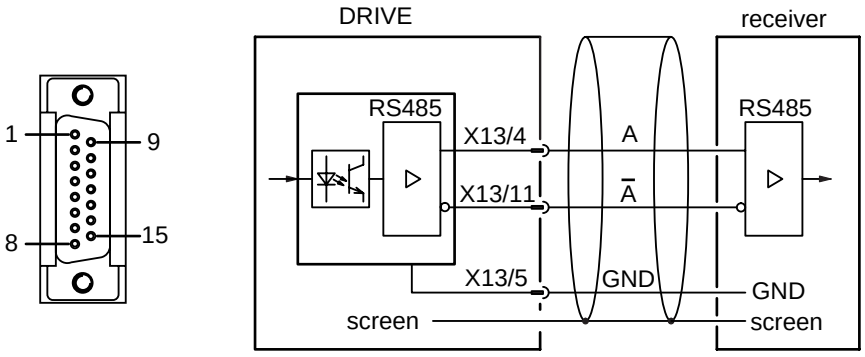


Figure 2-12 Simulated Encoder Outputs

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Drive Connector X24 (7-way Phoenix)

Analogue reference connections.

X24 pin Number	Name	Function
1	GND	Ground
2	TACHO OUT	Tachometer output
3	CURRENT REF.	Current reference output (torque demand)
4	CURRENT U	Current monitor phase U
5	CURRENT V	Current monitor phase V
6	-	Reserved
7	-	Reserved

Table 2-10. X24 Connections

The connections made available on X24 are for factory self test. Apart from the signals on pins 5 and 6, which can be used to achieve alignment of resolver and motor.

The scaling of these various outputs is as follows:

TACHO OUT	1.5V/1000rpm
CURRENT REF.	10V/70A peak
CURRENT U & V	1V/5A peak (SVHX4500S), 1V/10A peak (SVHX8500S)

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RS232 Address Selection

The drive address selection and memory write protect switch is positioned on the under side of the drive. The address is set as a 5-bit binary code, allowing up to 32 drives to be given unique address codes. Figure 2-13 shows address 1 selected and write protection ON. Refer to Table 5-1 for details of device address selection.

With write protection set to the ON position, the SAVE or SV command will be able to save the current set-up of the drive to its internal RAM.

Setting bit switch 8 to the OFF position write protects the internal RAM.



Figure 2-13. Address Switch SW1

Field Bus Interface (9-way D-type)

In addition to the RS232 and RS485 serial ports provided by the main controller, an optional Fieldbus module can be fitted within the SVHX to make available one of the following bus types:

Fieldbus protocol RS485 connection
RS485 4-wire & 2-wire
Interbus-S
CANbus-S
Profibus

Access to a bus module is made via the connectors on the top of the drive. The use of two connectors allows drives to be linked in a daisy chain manner, where multi-axis systems are being used. The address used by the bus interface is taken from the axis to which it is attached. Note: If an axis address is changed (by changing the drive's address switch) the power will need to be recycled for the bus interface card to read the new address.

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Input Field Bus Connections (X5)

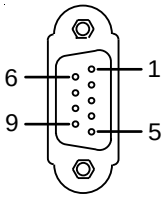


Figure 2-14. Field Bus Input Connector

Pin	Interbus-S	RS485		Profibus	CAN Bus
		4-wire	2-wire		
1	D01	RxD	N/C	N/C	N/C
2	DI1	TxD	RxD/TxD	Data+	CAN-L
3	GND1	GND1	GND1	GND1	CANGND
4	N/C	N/C	N/C	N/C	N/C
5	N/C	N/C	N/C	N/C	N/C
6	$\overline{\text{DO1}}$	$\overline{\text{RxD}}$	N/C	N/C	CANGND
7	$\overline{\text{DI1}}$	$\overline{\text{TxD}}$	$\overline{\text{RxD/TxD}}$	Data-	CAN-H
8	N/C	N/C	N/C	N/C	N/C
9	N/C	N/C	N/C	N/C	N/C

Table 2-11. Fieldbus Inputs

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Output Field Bus Connections (X7)

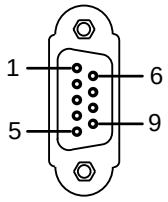


Figure 2-15. Field Bus Output Connector

Pin	Interbus-S	RS485		Profibus	CAN Bus
		4-wire	2-wire		
1	D02	RxD	N/C	N/C	N/C
2	DI2	TxD	RxD/TxD	Data+	CAN-L
3	GND2	GND	GND	GND1	GND
4	N/C	N/C	N/C	N/C	N/C
5	+5V	N/C	N/C	N/C	N/C
6	$\overline{\text{DO2}}$	$\overline{\text{RxD}}$	N/C	N/C	CANGND
7	$\overline{\text{DI2}}$	$\overline{\text{TxD}}$	$\overline{\text{RxD/TxD}}$	Data-	CAN-H
8	N/C	N/C	N/C	N/C	N/C
9	RBST	N/C	N/C	N/C	N/C

Table 2-12. Fieldbus Outputs

Holding Brake Connections (part of X1)

If your application requires a holding brake to be fitted to the motor, wiring connections will need to be made to the ‘BR1’ and ‘ISOL 0V’ connections of the Motor Outputs connector. Standard motor cables detailed in Appendix A incorporate brake wiring.

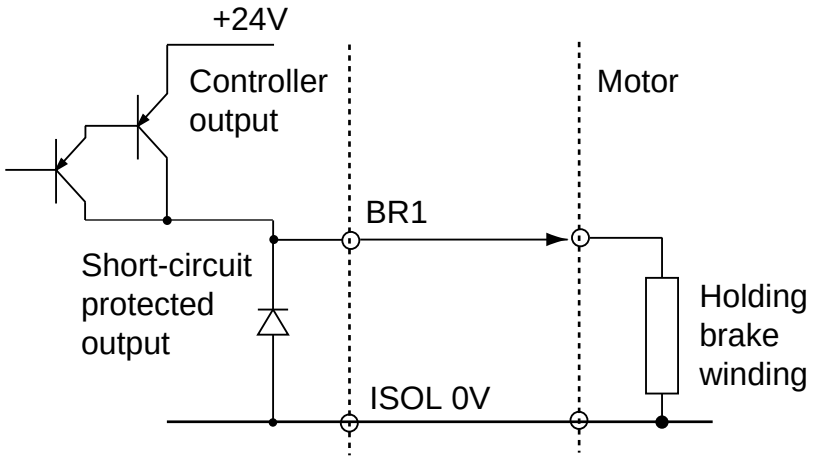


Figure 2-16. Holding Brake Interface

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Brake Circuit Protection

The brake drive circuit is short-circuit protected, but if a short occurs the holding brake will be applied and the drive will be de-energised. Under these conditions error ‘1’ will be reported on the front panel seven segment display.

To recover from a short-circuit of the holding brake output you will need to check that the cause of the short-circuit is removed and then apply and release the brake before re-enegising the drive. Alternatively, re-cycling the power to the drive will also reset the holding brake output circuit.

You control the use of the holding brake using the CBO or BRK command.

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Dimensions and Mounting Details

All drives and power supply units can be mounted directly on to a flat surface, as shown in Figure 2-17. The recommended mounting position is upright, as shown, with a minimum of 100mm clearance above and below the drive for good ventilation.

All dimensions are given in mm.

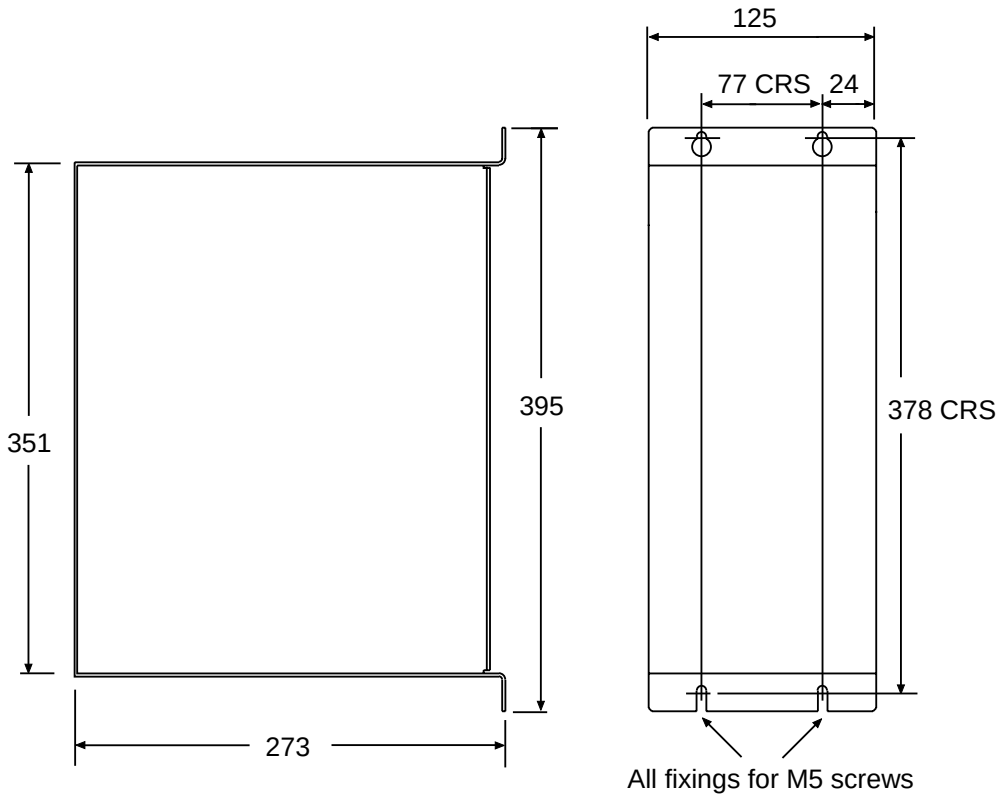


Figure 2-17 Drive Mounting Dimensions

Drive Cooling

The SVHX drive and power supply are fully-enclosed within a metal cases which provides good physical protection and effective electromagnetic shielding. Forced air cooling is used, provided by a fan built into the base of the drive. Air is drawn in via the vents in the base of the drive and expelled through the vents in the top of the drive.

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Section 3. Hardware Reference

	Drive Type	
Parameter	**SVHX8500S**	**SVHX4500S**
Supply Voltage	380-480V AC 3-phase	380-480V AC 3-phase
Supply Tolerance	+5% -10%	+5% -10%
Supply Frequency	50-60Hz	50-60Hz
Supply Fuses	16A	10A
Bus Voltage	560V nominal	560V nominal
Output Continuous Current Rating	12.5A RMS	6.5A RMS
Output Peak Current Rating	25A RMS	13A RMS
Output Current Tolerance	±10%	±10%
Internal Dump Capacity (note 1)	300W	300W
Cooling	Fan	Fan
Temperature Range	0 - 45°C	0 - 45°C
Humidity Range	0 - 95% non-condensing	0 - 95% non-condensing
Housing Protection	IP20	IP20
Installation category	II	II
Pollution degree	2	2
Weight	5.4Kg	5.4Kg

Table 3-1. SVHX Drive Specification

Note 1: an external ballast resistor may be fitted

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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
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 31 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) PLC

Table 3-2. Controller Specification

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Controller Specification (continued)

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	all NPN or all PNP (software selectable) Max. OFF voltage 30V Max. ON current 300mA Max. current from internal supply 160mA

Table 3-2. Controller Specification (continued)

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Section 4. Motion Control

Overview

This section will introduce you to the basic concepts of motion control, the ways in which moves can be described and how X-code commands can be used to produce these moves.

Moves

Mechanical movement, for the purposes of this user guide, is assumed to be caused by the rotary motion of a motor shaft. Consequently, distances moved (programmed using the D command) can be related to the number of steps a motor is commanded to perform. For servo systems, movement steps are the number of steps per revolution generated by a feedback device coupled directly to the motor's shaft. For example, a motor having a 4000 counts per rev encoder resolution set-up will require 6000 steps to turn 1.5 revolutions.

Note: Servo motors are often fitted with encoders giving 1024 lines per revolution; using electronic quadrature techniques this is enhanced to 4096 counts per revolution. But, to make move calculations easier, the command Configure User Resolution (CUR) can be used to allow you to specify the number of steps per revolution. For example, setting CUR to 4000 steps/rev considerably simplifies move calculations. Once specified, the number of steps used to define a move are called user steps.

Preset Moves

A preset move referred to in this user guide is a move of a specified distance (in user steps). Preset moves allow you to position a target or work-piece 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 controller 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, use a preset move with a distance of +6000 steps, assuming a 4000 step per rev user resolution set-up. 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-).
Note: a positive direction is defined as one resulting in clockwise (CW) rotation of the motor shaft when viewed from the flange.

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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 is 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 controller 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. 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 controller 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 will switch the mode from absolute to incremental. The controller 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.

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Motion Profiles

In any motion control application the most important requirement is precise, controlled shaft rotation, whether it be with respect to position, time or velocity. This pattern of movement is called a Motion Profile. Generally, such a profile can be represented graphically in the form of a diagram of time or distance moved plotted against velocity. For example, the triangular shaped profile shown in Figure 4-1 would be obtained if you programmed either a very low acceleration or a very high velocity or both over a relatively short distance.

Triangular Profile

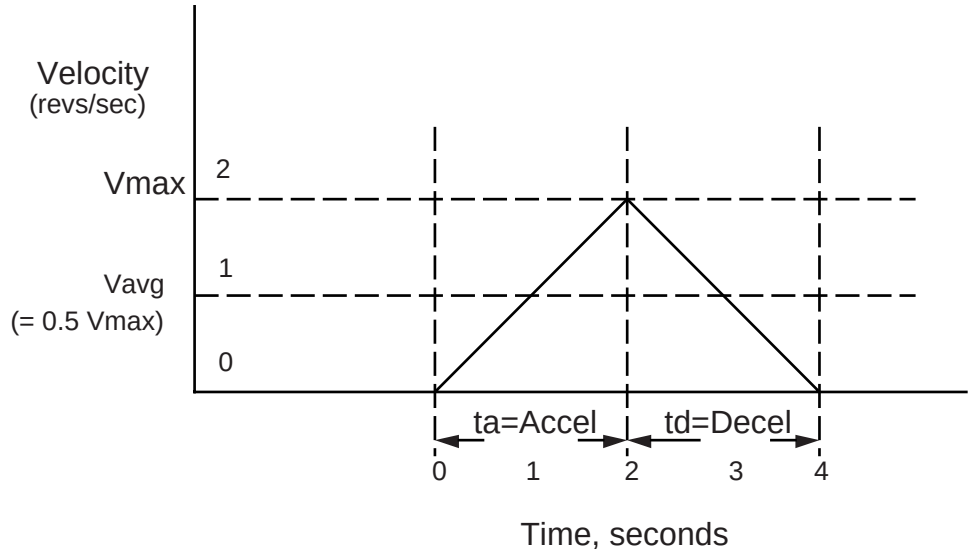


Figure 4-1. Triangular Profile

Setting the acceleration to 1 rev/sec^2 with the velocity set to 5 revs/sec over a distance of 16000 steps (4 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^2.

Trapezoidal Profile

A trapezoidal move profile results when the defined velocity, you have programmed, 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^2, 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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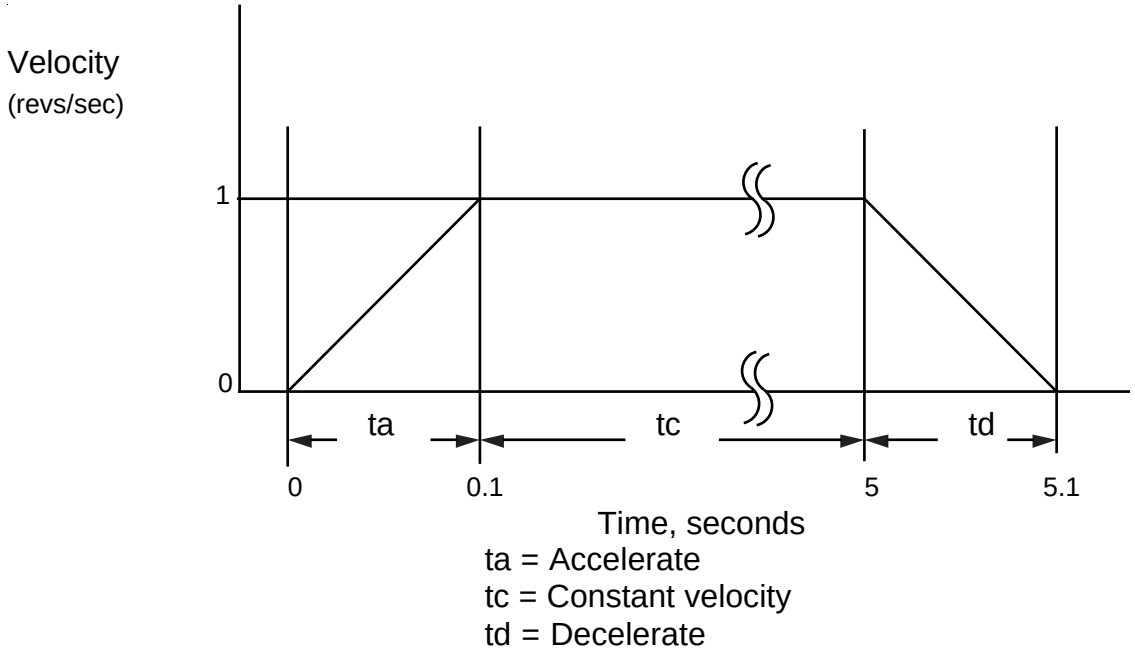


Figure 4-2. Trapezoidal Profile

User Profiles

You may define a move profile using the Mode Continuous (MC) mode. Velocity being programmed on the fly using the Velocity (V) command.

The controller 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 trigger, input trigger or a time delay.

X-Code

Having decided what moves are necessary and what motion profiles are required for a particular application, you will need to code these using X-Code commands. This section has already introduced a number of commands such as D for distance, V for velocity and a number of mode and move commands. Each command is named using a mnemonic set of letters relating to its action. For example, A for acceleration, D for distance, S for stop, PZ for position zero, etc. A complete list of controller commands is contained in a separate document called **X150 Software Reference User Guide** (part number 1600.221.XX).

Individual Commands

An individual controller command controls a single parameter, function, or action such as acceleration, velocity, position, time delay, pause, loop, go, etc.
Individual commands are variable in length. They consist of one or more letters with a delimiter (carriage return or space character) or one or more letters and numbers with a delimiter. Each command is entered as a character/delimiter combination. Some commands include a sign (+ or -) to denote direction of motion. The number of characters

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used depends on the type of command entered. Note, some commands must be preceded by the axis address.

Typical commands have the form:

1E
S
A10
V3
D46000

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 Controller 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
N

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Immediate and Buffered Commands

There are two classes of individual commands, Immediate and Buffered:

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. For example, the distance a motor is travelling can be immediately altered using the ID command, or the velocity changed using the IV command.

Buffered Commands

Commands that are identified as "Buffered" are received by the controller and stored (in the command buffer) if the controller is not free to execute them. Stored commands are executed when the controller gets to them, in the order that they were received. If a HALT command is received, program execution is stopped and the command buffer is cleared.

Note: The <CTRL>H command will allow a backspace to be entered during command input, deleting the last character. It cannot be used with the entry of immediate commands.

Buffer Capacity

You can add any combination of individual commands and command groups into the buffer until the total number of characters currently stored (including the delimiters) equals 2000. The controller 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. The command buffer is not battery backed up, so its contents are lost on power down. The SAVE command can also be used to capture parameter values to the non-volatile RAM.

Multiple Controller Commands

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

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Summary

To summarise this section we can study an example of yet another form of move, termed a registration move. This example demonstrates how you can use X-code commands to build complex motion profile and how external controller inputs can be used to modify the programmed motion.

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 mode. Its use is easiest to understand in the context of an example registration move:

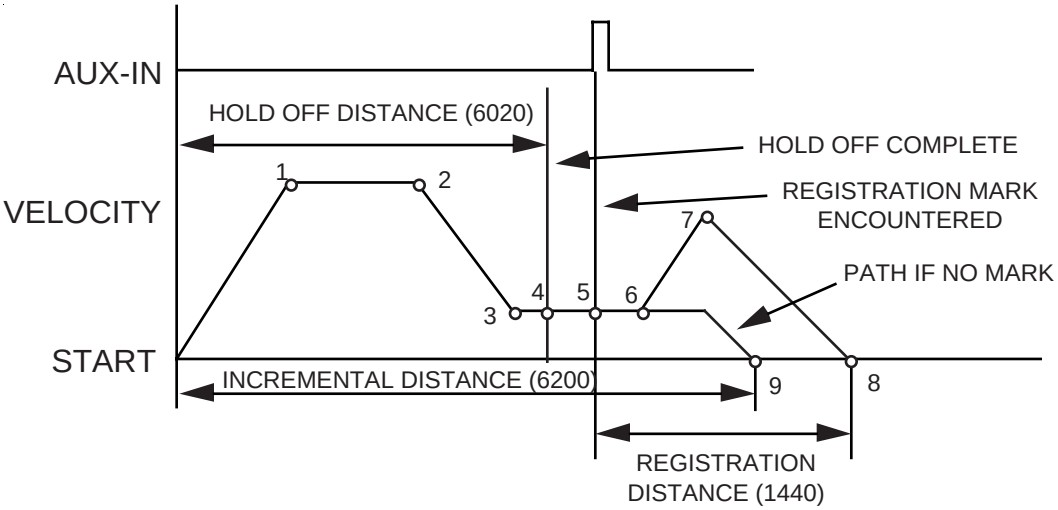


Figure 4-3. Example Registration Move

Example Program

MQ	Select MQ mode
1OUT2T	Set output 2 as 'in position'
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

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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.

Note: When using registration the AUX-IN input cannot make use of the invert input INL command.

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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Section 5. Communicating with the Controller

Section Objectives

The purpose of this section is to enable you to establish a serial communications link with the controller, over which commands can be sent and status and error messages received. If more than one controller is present in the system, details are provided on the connection of multiple controllers using an RS-232 Daisy Chain.

Communication commands are described and the set-up of terminal emulation programs X-WARE and Microsoft Windows's™ Terminal utilities are also covered, allowing the controller to be driven directly from a PC.

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 controller should have its handshaking disabled by either hardware or software.

Communication Parameters

The controller communications protocol is fixed, as follows:

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

Device address: 1-32, set by bit switch.

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. You do not need to keep re-stating the same parameter value.

When you power up the controller, all parameters are assigned default values which may be viewed using the 1DR command. You can change any of these values by entering a new default and then typing the SV (Save) command - see also, the commands RFS and RIFS.

XON, XOFF software handshaking is supported.

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Installing the RS232C

RS232C connections from the terminal or computer to the controller are as shown in Figure 5-1. Note that the Tx and Rx lines are cross-connected so that transmit output is connected to receive input.

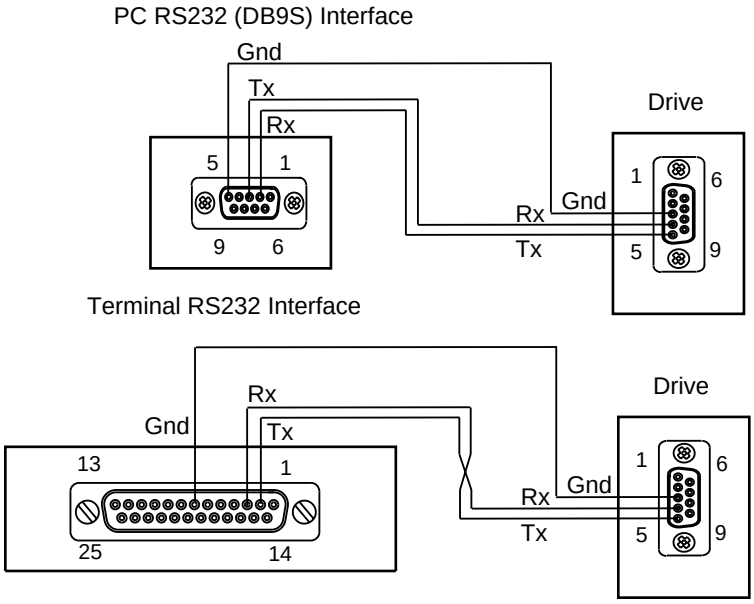


Figure 5-1. RS232 Connections

Input Circuit

The controller's RS232 input circuit is shown in Figure 5-2.

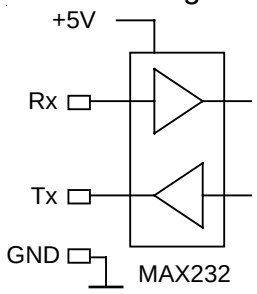


Figure 5-2. RS232 Input Circuit

Address Selection

You will need to assign a unique address to each controller in the chain. Normally controller 1 will be the first in the serial communications link. The controller's address is assigned by configuring the DIL bit switch, mounted on the controller card in each drive. To set the address refer to the Installation Section of this User Guide. Table 5-1 shows the DIL bit switch settings required for each address.

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	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 Switch 5 ON.

Table 5-1. Controller Address Selection

Controller Daisy Chain Wiring

You may daisy chain up to 32 axes. Individual drive addresses are set with the Controller DIP bit switches (see Table 5-1). When daisy chained, the units may be addressed individually or simultaneously. You should establish a unique address for each axis. Refer to Figure 5-3 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.

You need to attach device identifiers to the front of each 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 required controller.

You can identify echoing devices by use of the QS command.

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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 advice is not followed, the command responses will be intertwined, rendering the data useless.

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 5-3 shows a multiple-drive configuration (daisy-chain) of RS-232C ports from one controlling terminal or computer.

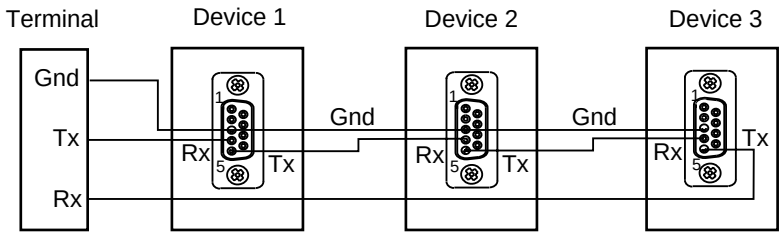


Figure 5-3. RS-232C Daisy Chain Configuration

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.

Enabling Communications

If you have a number of controllers daisy chained together, you can disable and re-enable selected controllers by using the E and F commands. For example:

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Command	Description
F	Disable communications on all axes
1E	Enable communications on axis 1
4E	Enable communications on axis 4
A10	Set acceleration to 10 revs/s^2
V5	Set velocity to 5 revs/sec
D5000	Set distance to 5000 steps
G	Only axes 1 and 4 move

Warning

If you are directly connected to a controller, performing interactive programming, be very careful not to accidentally type the F command. If you do, communications will be disabled effectively locking out the keyboard until the E command is sent.

Mode of Operation

You can use the serial interface in terminal mode or computer mode. Terminal mode operation returns user-friendly messages, which offer information on the commands being used. Computer mode operation avoids sending messages, and is intended to be used when a computer is used directly with a controller. You can switch between modes using the EX command. The default mode being EX1, meaning user messages are sent. In computer mode no “>“ prompt is returned.

Status Report

The status of the serial interface can be examined by sending the R command. The response you get will be *<char>[CR], where the <char> returned indicates the state of the serial interface. For a full description of returned character types, refer to the R command in the ***X150 Software Reference User Guide***.

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Windows™ Terminal Emulation Setup

A terminal emulator is software that allows you to use your PC as though it were an RS232 connected terminal. X-Ware is a terminal emulator that is supplied with the product and can be used on a PC. For an explanation of setting-up and using X-Ware see the section entitled ***Guide to Writing Real Programs***. An alternative terminal emulator is the one within Windows™.

The terminal emulation program is configured as follows:

1. Run the terminal program.

2. From the FILE menu select NEW.

3. From the SETTINGS menu, set-up 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

This configuration will allow communication to take place between the PC and controller using the selected COM port.

Section 6. Basic Operations

Commands

A complete list of commands for the controller is contained in a separate document entitled **X150 Software Reference User Guide** (No. 1600.221.XX). This section gives you an appreciation of how commands are used to create a particular motion profile suitable for your application.

Factory Default Settings

Every product containing an X150 controller has a set of in-built factory settings for defining such things as motor type, resolution settings, etc. If you change any of these settings you can always return to the factory default values by sending the controller the RFS command (Return to Factory Settings). The indexer default values can also be restored by sending the RIFS command.

Communicating with the Controller

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

a) The human interactive mode

b) The computer host mode

In the human interactive mode, selected by the command EX1, the controller will respond to a dumb terminal in an intelligent, user friendly manner providing you with help facilities and error messages. In the host computer mode, selected by the command EX0, all unsolicited output and help information is suppressed so that communication may be handled by software resident in the host computer.

If you use a PC for terminal emulation, you may wish to use the X-Ware software, supplied with the product. The use of X-Ware is explained in a later section, but in essence it's a communications package and a sequence editor. You can use it to turn the PC into a straightforward terminal to communicate from the keyboard, including setting up the communications parameters. And as well as allowing you to edit sequences rather than completely re-type them, the editor will save programs and retrieve them from disc.

Programming Modes

Normal Mode

The command MN selects normal mode. In this mode all the distance moves you enter are set by the D command. Within normal mode there are two further sub-options, absolute mode and incremental mode.

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Absolute Mode

To put the controller into absolute position mode you enter the MPA command. The 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

To enter the incremental mode you use the MPI command. In this mode any D command distance you enter is 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

By entering the command MC you select a continuous mode, in which the motor runs continuously at the specified velocity until you stop it, or program a new velocity. In this mode all distance data is ignored.

Speed Change Mode

The MQ command allows buffered commands to be executed during a preset move. Selecting speed change mode will set the mode of operation from continuous back to preset. Within this mode or mode normal, the TRIP command can be used. This stops any other buffered commands from being executed until the motor has stopped in the error deadband region (defined by CEW) for the in position wait time (defined by CIT).

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Movement can be stopped using the SB stop buffered command, which brings the motor to a stop using the current acceleration value.

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
SB	Motor stops at a rate of 10 revs/sec

Command Types

Start Move Commands

GO Command

To start a motor's shaft turning you will need to send the controller some form of start command. The GO command "G" is the principal buffered command that starts shaft motion. When the buffer reads a GO command, the motor will move in accordance with the move parameters you previously sent to the controller i.e., the commands sent before the Go command is read.

Note: The controller reads and stores individual commands in the order they are entered. Each command is read and executed before the next command is read.

For example, the "A " command would be combined with the Go command to change the acceleration value as follows:

A123 G

These commands instruct the Controller to change the acceleration value to 123 rev/sec/sec and then execute the move using the last mode, velocity, and distance values entered.

When you start from power-up the RS232 controller will need to be initialised using a series of commands of the form " MN An Vn Dn G ". Once this string of commands has been sent you can enter single move parameter commands.

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

G G G G

would instruct the controller to move the motor the same way four times, unless you were in Absolute Mode where the first **G** would complete the move.

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You don't need to re-enter all the shaft motion commands to change one of the parameters. You can simply enter a new motion parameter, 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.

Continue Command

If you sent a PAUSE command, ("PS " or "U ") you will need to send a CONTINUE command to re-start movement. It allows execution of the next command waiting in the command buffer (if any command is stored).

Loop Commands

A LOOP command allows a cycle to be repeated continuously by specifying "L". If you need to restrict the number of loops use "Ln", where 'n' is the number of loops required (up to 65535 may be specified). To terminate a looping command cycle use the END-OF-LOOP command "N". When the controller receives the "N" command it stops looping and continues with further commands, provided the number of loops you requested have been completed.

You may also use the "N" command in combination with the "Y" command which allows you to manually intervene to stop a looping pattern of commands. If you only wish to interrupt the Loop you may use the "U" command to temporarily halt the Loop, and when required, the "C" command to continue looping.

Stop Move Commands

The STOP MOVE commands are presented in order of severity of response. Kill Command "K" is the most abrupt stop command, whilst the STOP AT END OF CURRENT LOOP command "Y" is the least abrupt stop command.

Do not use the SOFTWARE RESET "Z" command to stop the motor, as it does not perform a controlled stop. The "Z " command is equivalent to cycling the AC power to the Controller; that is, it disables the communications interface and returns all internal settings to their power-on values. The command buffer is cleared. The "Z " command causes an immediate removal of torque demand from the motor. Z also de-energises and resets the drive ready for re-initialisation at power up. Because all motor control is lost, the stop will be uncontrolled and its use as a means of stopping motion should not be used.

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

Stop at End of Current Loop Y

Whilst looping, you may use the command "Y" to stop and continue with the next command stored in the buffer. Looping will not stop until the command processing reaches the character N at the end of the command loop, but once the command N has been reached you will not be able to restart the loop without re-entering the commands.

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Controlled Stop command S

In the PRESET or CONTINUOUS mode you can use the command “S” to decelerate the motor to a stop at the last used acceleration rate, alternatively the STOP command may be used.

In the MC and MQ mode of operation the “S” command, or a buffered stop “SB” command can be used.

An "S " command will always cause a deceleration to velocity zero at the last used acceleration, it will also clear any remaining commands in the command buffer unless you prevent it 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

To bring the motor to a fast controlled stop you will need to use the “LS” or 'Limit Stop' command to decelerate the motor to a stop. The deceleration rate is defined by the “LA” or 'Limit Acceleration' command.

Kill Command K

The “K” kill command does as its name implies, it stops controller commands to the motor, it terminates all loops, ends a time delay and clears the command buffer.

Pause Commands

There are four types of pause commands:

P S

A common use of the Buffered Pause “PS” command is to hold execution of individual commands in a Command Loop until the entire loop has been loaded. You can re-start the program’s progress by issuing a “C” continue command.

Tnnn

This command allows you to introduce a pause in the processing of commands for the number of seconds defined by ‘nnn’ and then to continue.

U

This command allows you to hold (pause) command execution and wait for continue. This is an immediate command.

TRE/TRN

TRE can be used to synchronise controller operations with external events. The command allows a pause in the processing of buffered commands until a designated TRIGGER condition is met. You can use TRE to implement a "handshaking" function with other devices. See command details for exact syntax.

Status Request Commands

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

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 the response is received. In particular, after a buffered status command, you should not issue an immediate status command until the response has been received by the host. If you don't follow this procedure, the command responses will be intertwined, rendering the information useless.

There are two status commands you can use to request position.

The PR, Position Report 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 controller was at the absolute zero position. Alternatively, if you need position reports that are relative to the beginning of each individual move, you should use the P command.

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

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

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

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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

Trigger Commands

A number of trigger commands exist which can be used to activate controller outputs or to trigger internal actions dependent upon the state of controller inputs. Valid trigger commands are:

TRD	Trigger on Index Distance
TRE	Trigger on Input Equal
TRIP	Trigger on In Position
TRMN	Negative Trigger on Motor Position
TRMP	Positive Trigger on Motor Position
TRN	Trigger on Input Not Equal

You can examine the status of the trigger lines by use of the TRS command.

Drive Energise/De-energise Function

Energising and de-energising the drive is dependent upon both the commands sent to the drive and current error status of the drive. In summary:

The drive will energise if:

The drive is specified

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.

A drive fault occurs.

Before the drive can be re-energised you will need to correct the cause of it de-energising. Once corrected, you can issue a ST0 or ON command to re-energise the drive.

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Homing Function

The GH command causes the motor to rotate in the direction and at the speed you have 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

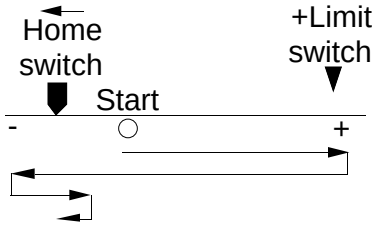
Note: This move is unnecessary if the first move you make after homing is made in absolute mode (MPA). The GH command always makes the home position zero.

Also, if you need to, the SP command can be used after homing to change the accurate home position from zero.

If you don't find the home position in the direction given in the GH command, the limit switch position will be reached. Operation of the switch will then reverse the motor 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 6-1), so a limit switch reversal will take place if the direction given in the GH command is away from the home position (GH+ in the figure).

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

Positive homing from + side of home switch:-



Positive homing from - side of home switch:-

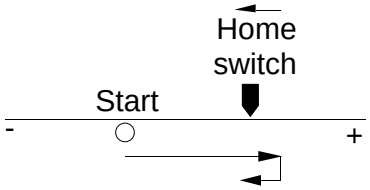
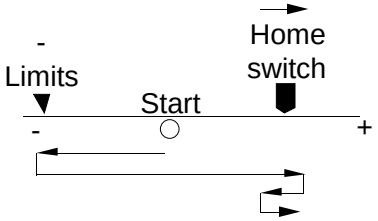


Figure 6-1. Positive Homing

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Negative homing from - side of home switch:-



Negative homing from + side of home switch:-

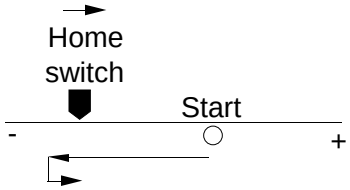


Figure 6-2. Negative Homing

Using the OSA option enables homing to an encoder index mark within the home proximity range, as opposed to the home switch edge. The mark must always be 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.

When performing a Go Home move you can set the acceleration rate using the GA command. The velocity of the final move to the home position can also be set using the GHF command.

Jogging

When you are setting-up limit switches, you may find the ability to control motion using manual controls (jogging) useful. Jogging allows manual positioning of mechanical components within motion control applications. The ability to enable jogging is controlled by the Other Switches OSE command and is hardware dependent, but you do have control of jog velocity using the JV command and jog acceleration using the JA command.

Limits

Quite often you may wish to test the operation of a drive/motor combination without providing limit switch wiring. This can be done by disabling the limits using the LD command.

Sequences

Introduction

A sequence is a series of commands that can be run in order by simply entering the sequence run command for the required (numbered) sequence. For example, the command XR10 will run sequence 10.

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You cannot store immediate commands in a sequence since they cannot be stored in the command buffer. The only "saveable in sequence" commands are buffered commands.

The controller 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 a long sequence 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.

To identify a sequence you need to give it a number; the allowed range is from 1 to 64.

The sequence memory can be given a four figure password (PASS command) which prevents it from being uploaded, once it has been saved.

To verify the existence of a sequence you can use the XSS command.

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

Programming Sequences

New 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 enter the XD command immediately followed by the sequence identifier number (1 to 64) and a delimiter. An XT command is used to end the sequence. Once created, use the save command SV to store the sequence into the controller's non-volatile memory.

If you wish to know how much room is available in the controller’s memory for sequence storage, use the XBS command. The response will return the number of bytes free.

A sequence can be terminated by the XRT command. You can use this command in branched sequences where you must exit the sequence before the XT command. It is often used in conjunction with ‘SKIP’ commands.

The commands you 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.

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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. If all sequences are to be erased, use the XEALL 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 bit switch 8 OFF to write-protect sequences.

Whenever the above sequence is run, the motor will turn 1 revolution CW and then 1 revolution CCW, assuming the resolution is 4000 steps/rev.

Running Sequences

By Command Input

You run a sequence 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, such as the RP240 or TM8 thumbwheel.

You can run a sequence with a pause by use of the XRP command. The pause is only cleared by entering a C command or by pressing the CONTINUE key on the RP240.

A sequence can be selected as a binary pattern applied to the drive's inputs using the INnO command. Once selected, the sequence can be run in response to an input sequence strobe applied to an input using the INnB command.

Example:

Inputs 1 to 4 are to be used as sequence select lines.

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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.

Jumps Within a Sequence

A number of commands exist that allow you to jump to a sequence and to use subroutines within sequences. The XG command is similar to the GOTO command, it allows a jump to a designated sequence, but you cannot return to the original code as you can using an XR or GOSUB command.

Controller inputs can also be used to initiate skips within a sequence to control the execution flow. The SKE command can be used to skip the next command if the user inputs match the SKE command pattern. An alternative SKN command can be used to skip the next command if user inputs do not match the SKN command pattern.

Power On Sequence

One of the stored sequences can be designated to be executed when the device is powered up. You can chose the sequence to be executed by use of the XP command. 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. For example, you could define sequence number 1 as:

XP1 XD1 MN A10 V5 D40000 G XT 1SV

In this example you would not power the unit on until you 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 you apply power to the controller, sequence number 1 will be executed (the motor will turn 10 revolutions in the positive direction). You can stop the sequence using the S command or, if necessary, by using the stop input.

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Executing a Sequence Following a Fault or Kill Condition

A predefined sequence can be executed if a drive fault condition occurs or if a kill command is issued. The XFK command is used to set the sequence to be executed.

Changing a Programmed Sequence

Once a sequence is defined it cannot be redefined until you delete it and then define a new sequence using the same number. A new sequence cannot be downloaded over an existing one.

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. For example:

XE1 erases sequence No.1

Once the sequence is deleted, you may enter a new sequence number 1, but remember it will not be saved to non-volatile memory until the SV command is issued.

Examining the Contents of a Sequence

If you wish to check the contents of a sequence, use the sequence upload command XU. For example to view the contents of sequence number 1, enter:

1XU1

This would cause the controller 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 you do not wish to have the sequence execute on power up, it can be cancelled by issuing either the XP0 or XZ command.

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

Sequence Status Requests

Sequence status commands include XSD, XSR and XSS which can be used to check the validity of sequence commands via the RS232 interface. The XC command can be used to verify that the memory in the back-up RAM has not been corrupted in any way since the last power down. The checksum may be recorded when sequences have been defined, so that it may be used for comparison later, such as each time the controller is powered up.

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.

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- 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

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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

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

Single-Step Mode

You can debug your program with another level of debugging using the Single-Step mode. This 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, by use of the # sign. Enter a # followed by a delimiter, to 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 and trace mode

XST1
XTR1

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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Motion Program Selection

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

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

You can initiate sequences via thumbwheel, RP240, and PLC inputs. Up to 64 user defined sequences can be selected for execution in this way.

Parameter Ranges

Table 6-1 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 6-1. 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 7. Setting Up the User I/O

Introduction

The SVHX controller has been designed to be compatible with a wide range of motion control equipment using 24V logic systems. You can configure inputs to be compatible with logic interface modules or PLC outputs. Signals from the controller can also be configured to provide PNP or NPN outputs.

Bank Arrangement of Inputs

Controller inputs are arranged in groups or banks, each controller has three banks of five inputs. This allows you to apply certain configuration options to a complete bank of inputs, which you will probably need when interfacing to a PLC. The bank 2 inputs have a pre-defined use, but banks 1 and 3 are free for general use. The banks are arranged as follows:

BANK1	BANK2	BANK3
IN1	LMT+	IN6
IN2	LMT-	IN7
IN3	HOME	IN8
IN4	STOP	IN9
IN5	AUX_IN	IN10

The bank configuration options are:

An input can be made pull-up or pull-down

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

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For example

1IN7H Set input 7 as direction toggle.

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

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

Input Circuit Definitions

To avoid confusion, when an input is described as being a pull-up input, it means there is an internal 10K resistor connected between the input pin and an internal pull-up supply rail of +24V. When an input is described as a pull-down input, it means there is an internal 10K resistor connected between the input pin and ground.

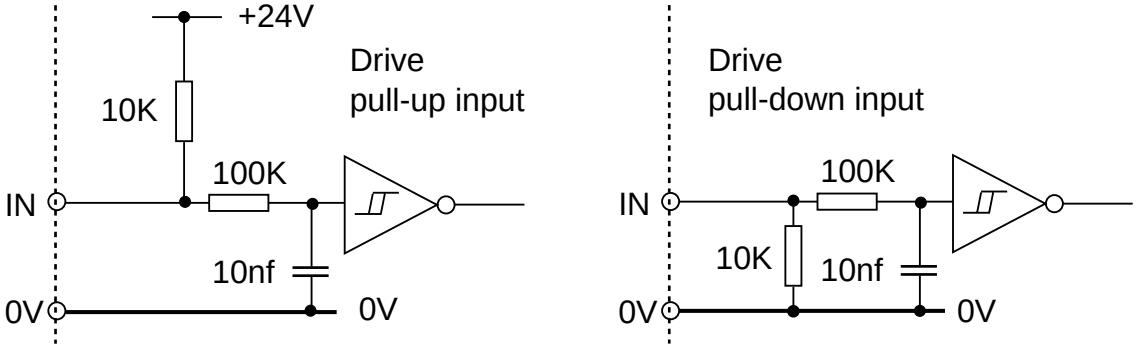


Figure 7-1. Pull-up and Pull-down Inputs

Logic Levels

Throughout this section positive logic operation is assumed, with the levels defined in Table 7-1.

Signal	24V Operation (nominal)	Worst Case
Logic high level	>8.8v	>10.8v
Logic low level	<5.7v	<4.0v
Hysteresis (typical)	3.3v	-
Max. input voltage range	0-30v	-

Table 7-1. Input Logic Levels

Configuration Options

The configuration options are set using software commands (ICON and INL).
Figure 7-2 graphically represents the possible programming configurations made available using the ICON and INL command. Note, no mechanical switches or links exist, switches SW1 and SW2 shown in Figure 7-2, are controlled by software commands only.

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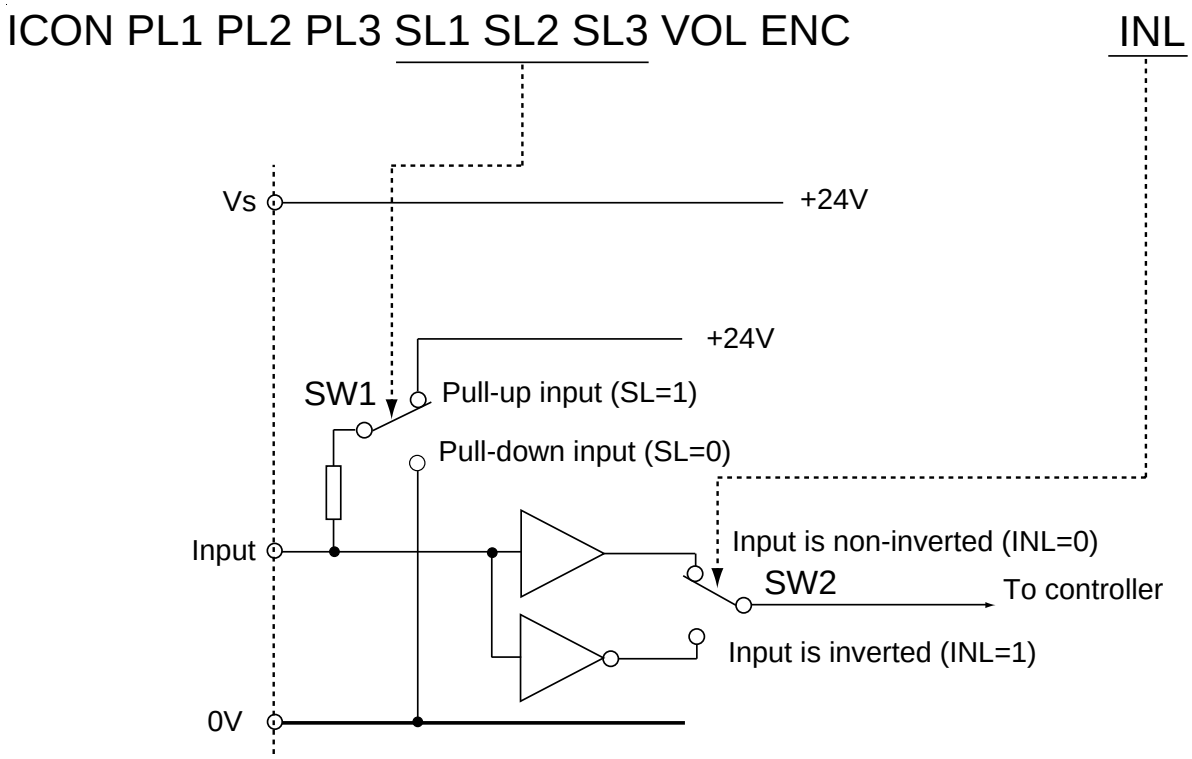


Figure 7-2. User Input Circuit Configuration Options

The SL bits of the ICON command control the state of switch 1 and operate on all inputs sharing the same bank. Switch 2 is controlled by the INL command and can be used on any individual input i.e., it is not restricted to banks of inputs.

The ENC bit of the ICON command controls the connection of the encoder feedback, refer to the ICON command for more details.

The actual input circuit used in the drive's controller is shown in Figure 7-3.

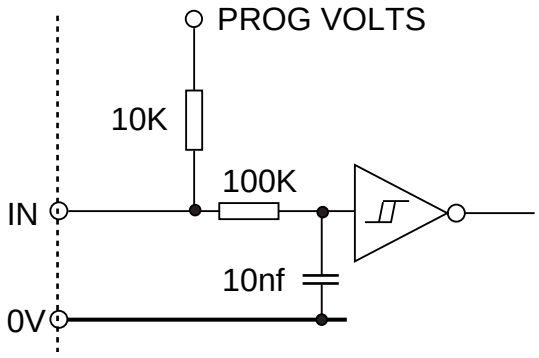


Figure 7-3. User Input Circuit

In reality, the function of switches 1 and 2 is replaced by PROG VOLTS. When PROG VOLTS is set to 0V the 10K resistor is effectively grounded. This is achieved by setting the SL bit of the appropriate bank to 0, using the ICON command. In order to generate a voltage on the input, current must flow from the externally connected output circuit's supply to the input 0V line, as shown in Figure 7-4.

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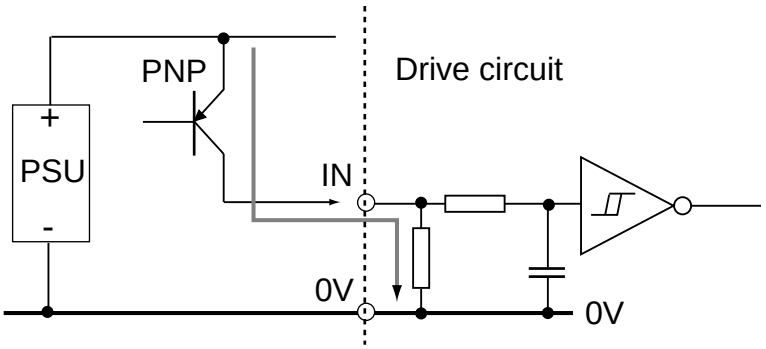


Figure 7-4. Pull-down Input Operation

This current flow can be used to establish a logic level at the drive's input (logic high in this case) which can be logically inverted, depending upon the state of the INL command for that input i.e., for this input if INL is set to a '0' the high logic level would be interpreted as a logic high input.

The circuit configuration shown in Figure 7-5 is programmed by setting the SL bit of the appropriate bank to 1, using the ICON command.

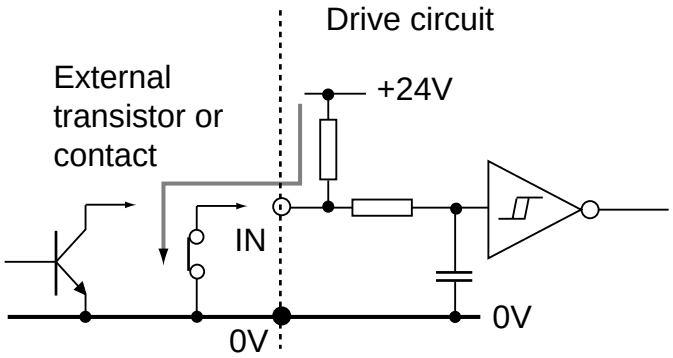


Figure 7-5. Pull-up Input Operation

The current flow can be used to establish a logic level at the drive's input (logic low in this case) which can be inverted, depending upon the state of the INL command for that input i.e., for this input if INL is set to a '1' the low logic level would be interpreted as a logic high input.

Input Status Command (IS)

The IS command reports the actual logic levels present on the controller's input pins. 17 Input Status levels are reported, 15 of which correspond to the user inputs and 2 of which are internally monitored. The 2 internal levels are:

ENG (Energise state of the drive) ENG=1 energised, ENG=0 de-energised.
INDEX (Index pulse detected) INDEX=1 if index pulse is detected, INDEX=0 if no index pulse is detected.

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Set Active Input Level (INL)

You can use the INL command to logically invert the sensed input level. This is useful when you wish to compare an input level against bit settings in a trigger command, such as TRE or SKE. By allowing the inversion of levels, signals sensed at the input pins can be changed to suit particular trigger requirements, enabling normally open switches to appear as normally closed.

Note: The INL command needs to be used with care to avoid confusing input sensing circuit configurations. Remember the IS command senses the logic level at the input pin, whilst the INL command can be used to invert this sensed level before logic comparisons are made within the controller. When sensing input levels always check the state of the INL bit mask to see if any levels are being inverted.

Typical Input Circuit Configurations

In a practical motion control systems, you would typically need the following input interfaces:

PLC controllers
Mechanical switches
Reed relay switches
Hall effect sensors
Inductive proximity detectors

The way in which a particular sensor is configured depends upon what is being sensed. For example, limit switches are normally always closed until a limit is reached, but home switches are generally open until the home position is reached. The ability to configure inputs by program commands allows a drive to be tailored to the types of switches used in a system and to the sense in which they are used.

PLC Controllers

PLC outputs commonly employ PNP transistors arranged as shown in Figure 7-4. This requires a particular bank of inputs to be programmed as pull-down inputs. The input sense level required is +24V. If drive input 1 was connected to a 24V PNP PLC output, the required ICON command would be:

1ICON xxx0xxxx where x = don't care

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To interpret a logic high appearing at the input as a logic ‘1’ level, the INL command would need to be:

1INLxxxxxxx_0xxxxxxx

PLC Summary

Sensor Type	SL1 SL2 SL3	ENC	INL for
	SL		active signal
PLC PNP O/P 24V	0	x	0
PLC NPN O/P 24V	1	x	1

Note: PNP PLC outputs use pull-down inputs
NPN PLC outputs use pull-up inputs
x - don’t care

Busy Delay

If you are using a PLC to control the drive, certain PLCs require an acknowledge signal to be present for a minimum time. The BDL command allows the output on busy (out function G) to be active for a defined time, to meet PLC requirements.

Mechanical Switches

Mechanical switches are usually of the Single Pole Double Throw type and can be used with both pull-down and pull-up inputs. If a drive is being fitted to an existing system remember the INL command can be used to configure the inputs to invert the logic levels appearing at the inputs.

Note 1: the INL command makes no hardware changes to the input circuit of a drive it just allows the logic state of an input to be inverted, therefore it can be used on any individual input regardless of which bank it is in.

The various circuit configurations for mechanical switches are shown in Figure 7-6.

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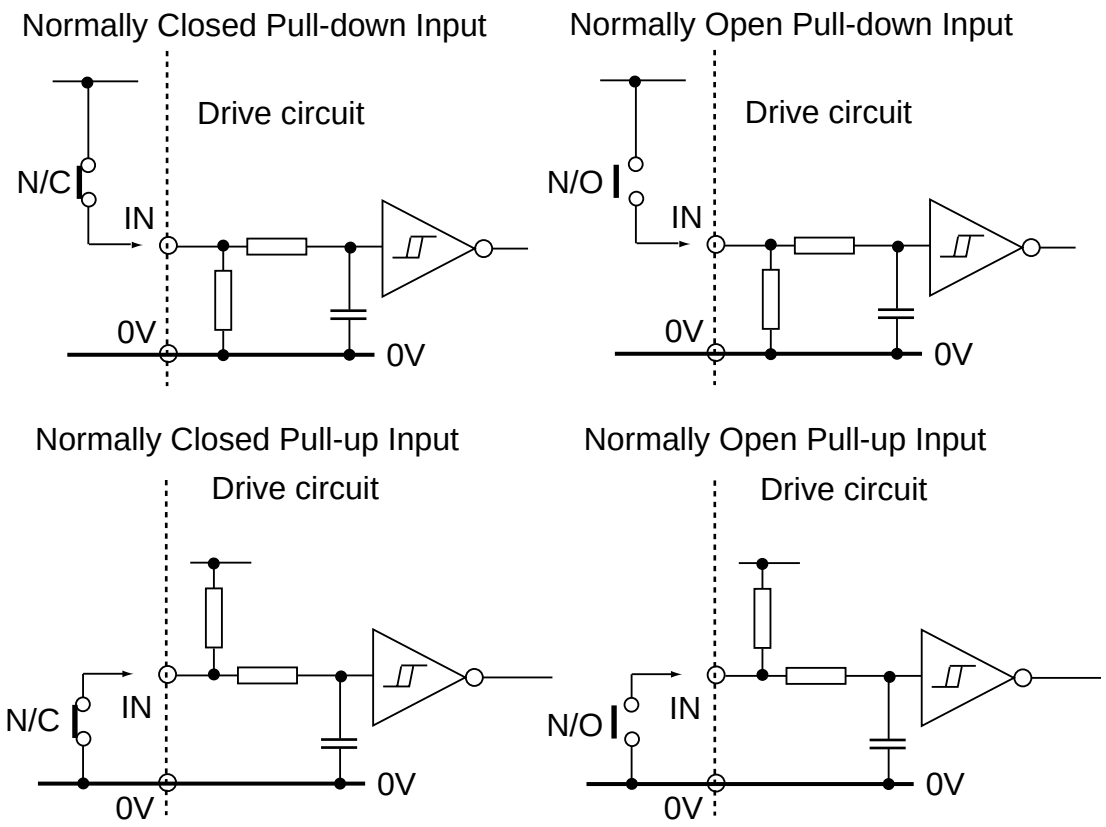


Figure 7-6. Mechanical Switch Configurations

Generally all switch inputs will be operated from 24V lines to preserve high noise immunity.

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Mechanical Switch Summary

Sensor Type	SL1 SL2 SL3	ENC	INL for
	SL		active signal
N/C Pull-down I/P	0	x	1
N/O Pull-down I/P	0	x	0
N/C Pull-up I/P	1	x	0
N/O Pull-up I/P	1	x	1

Note: x - don't care

Reed Relay Switches

This form of switch operates when it is brought close to a magnet and are generally available in a normally open or changeover form. In its normally open form it would need to be wired to a pull-down input to provide a logic high voltage at the input which could be interpreted as a logic '1' input.

Generally all switch inputs will be operated from 24V lines to preserve high noise immunity.

Reed Relay Switch Summary

Sensor Type	SL1 SL2 SL3	ENC	INL for
	SL		active signal
N/C Pull-down I/P	0	x	1
N/O Pull-down I/P	0	x	0

Note: x - don't care

Hall Effect Sensor

Switches of this type change state when brought close to a magnet. Two types of Hall effect sensor are available:

Normally open - output transistor not conducting (turned off)
Normally closed - output transistor conducting (turned on)

The normally closed sensor type is used to detect end limits and the normally open type is used for detecting mid-positions or home. Both types are available with built-in switching transistors, which can be PNP or NPN types. The PNP type would be used with a pull-down input, while the NPN type would be used with a pull-up input, as shown in Figure 7-7.

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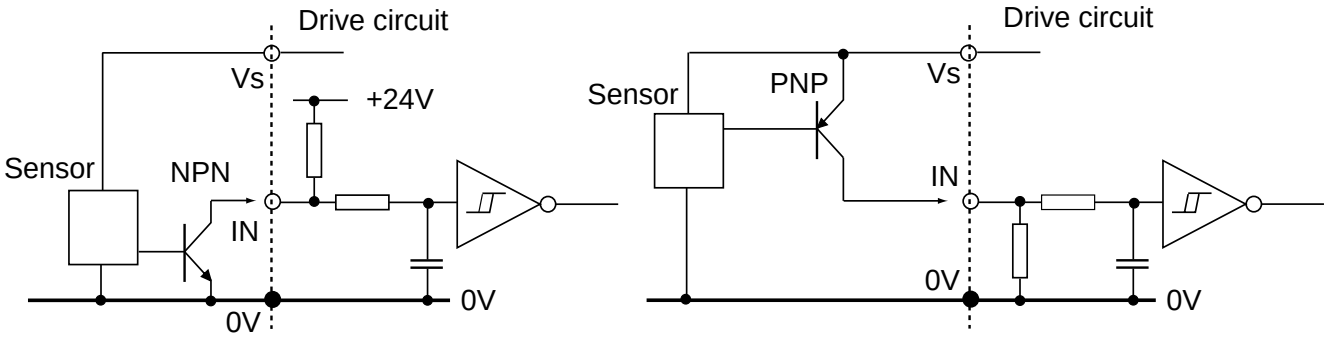


Figure 7-7. Hall Effect Sensor Interface

If a normally closed PNP sensor is used (connected to input 6) with a +24V supply the ICON command required would be:

1ICONxxxxx0xx

With a normally closed sensor (output transistor conducting) input 6 would remain high until a magnet is detected, at which point it would go low (PNP transistor would turn OFF). To use this input pin low logic level as a valid trigger, for say a TRE command, you will need to invert the input logic level by use of the INL command.

1INLxxxxxxx_xxxxx1xxxx

Note 1: in this example the Vs supply is used to power the Hall effect sensor with +24V.

Note 2: When looking for the home position the HOME input cannot make use of the invert input INL command. In this situation the correct switch must be selected to prevent the need for logic inversion of the signal.

Hall Effect Sensor Summary

Sensor Type	SL1 SL2 SL3	ENC	INL for
	SL		active signal
N/O PNP	0	x	0
N/C PNP	0	x	1
N/O NPN	1	x	1
N/C NPN	1	x	0

Note: x - don't care

Inductive Proximity Detectors

Inductive proximity detectors change state when metal is detected. This type of sensor is generally supplied as a normally open device, available as a PNP or NPN output. The input circuits used are the same as the Hall effect sensors, shown in Figure 7-7. The sensor output transistor will conduct when metal is detected.

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Inductive Proximity Sensor Summary

Sensor Type	SL1 SL2 SL3	ENC	INL setting for active TRUE input
	SL		
N/O PNP	0	x	0
N/O NPN	1	x	1

Note: x - don't care

Output Circuit Functional Description

A user output circuit is shown in Figure 7-8. By use of the OCON command, either all PNP or all NPN output transistor may be selected. Outputs cannot be mixed between PNP and NPN types.

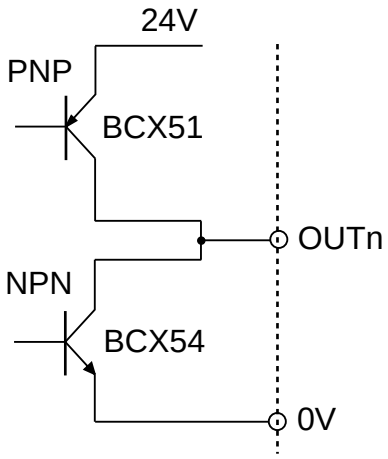


Figure 7-8. User Output Circuit

Open Collector PNP Output

When PNP transistors are selected, the output circuit takes the form shown in Figure 7-9, which is an *Open Collector PNP Output*. The output current flows from the drive's internal Vs rail through the external load to the 0V return.

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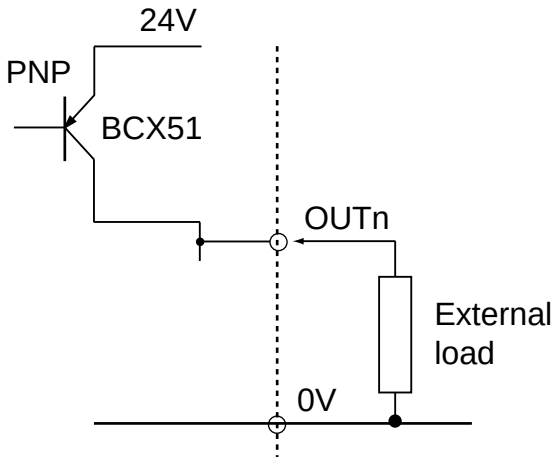


Figure 7-9. PNP Output Circuit

Open Collector NPN Output

A NPN output is shown in Figure 7-10.

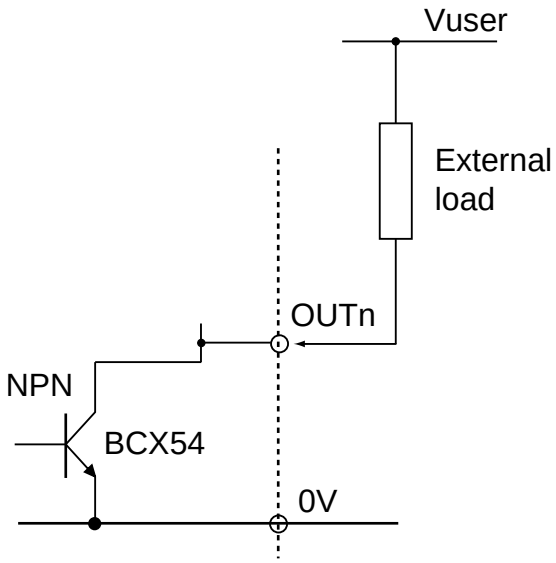


Figure 7-10. NPN Output Circuit

This is an *Open Collector NPN Output*. The output allows current to flow from the external Vuser supply into the 0V line of the drive. The Vuser supply can be provided by the Vs supply, available at pin 1, or it can be an independent interface supply.

Programmable Output

You can program each output, or configure it, to perform to a particular function. There are 6 user definable outputs which are all NPN or all PNP open collector outputs. The function of each output can be programmed using the OUT command.

Individual outputs can have their signal levels inverted using the OUTL command. With OUTL set to a '1' for a particular output, the signal feeding that output is inverted. The actual voltage level at the output will depend upon the choice of PNP or NPN configuration

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selected. Whatever the output logic level is, it will be inverted by setting OUTL to a '1' for that particular output. The default state of OUTL is all zeros.

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 ***X150 Software Reference User Guide***.

Note: An immediate version of the O command, called IO is available.

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, as previously described.

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

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.

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Section 8. Specialised Control Functions

Overview

Section 6 introduced you to basic motion control functions, but as you develop more complex applications advantage can be taken of special control functions which increase the power of X-Code. This Section introduces you to the more specialised aspects of motion control and the commands used to apply these techniques.

Mathematical Functions

Generally, motion control commands are issued as direct integer numbers requesting a particular value of distance, velocity or acceleration, etc. However, you can use variables to define certain commands, for example D(VAR5) will assign the D command the distance value stored in the variable VAR5. So if VAR5 contained 5000, the command D(VAR5) would be the same as issuing the command D5000. For a complete list of variable commands have a look at the VAR command in the ***X150 Software Reference User Guide***.

Once you have loaded a number of variables with data you can perform mathematical operations on their contents. By using the following mathematical operations new numerical values can be obtained:

Addition	VARn=VARn + VARn
Subtraction	VARn=VARn - VARn
Division	VARn=VARn/VARn
Multiplication	VARn=VARn*VARn

Range of values

Each variable can hold a 7 decimal digit floating-point number in the range:

1.18E-38 to 3.4E+38

Example

Command	**Description**
VAR1=50	Load variable #1 with 50
VAR2=10	Load variable #2 with 10
VAR3=VAR1/VAR2	Divide VAR1 by VAR2 and put the result in VAR3
V(VAR3)	Set velocity to the value contained in variable 3

This example illustrates how variables can be assigned values, how these values can be used within a calculation and how the result of the calculation can be used to set a velocity of 5 rev/s. Variable can also be loaded interactively, during sequence execution using the VARn=RSIN command.

Note: during sequence execution a variable can be altered to a new value using the IVAR command.

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Operators

Mathematical operations are available for the following:

>	Greater than
<	Less than
=	Equal to
AND	Logic AND
OR	Logic OR
*	Multiply
+	Addition
-	Subtraction
/	Division

Often, you can use these commands to process data received from operator input modules such as the TM8 or RP240, or from specific variables such as motor resolution from CMR(VARn) or user resolution from CUR(VARn). Certain named constants, such as POS (the present value of the position counter), or ABS (absolute encoder position) can be directly substituted for the operands. For example:

VAR8=POS+50000

Order of Evaluation

Within mathematical operations the order of evaluation is from left to right along the command line. For example if you entered the following calculation:

VAR4=VAR1-VAR2*VAR3

This is evaluated as:

(VAR1-VAR2)*VAR3

Interrogating a Variable

If you wish to know the value of a particular variable enter the variable name followed by a carriage return <CR> or space. For example:

1VAR3<CR>

will return the value of the variable e.g., if it contained the value 15, *15.0000 will be returned.

Conditional Commands

Conditional commands allow you to control the flow of a motion control program by either repeating a certain pattern of commands a set number of times, or repeating a set of commands until a particular external/internal input pattern is achieved. Conditional commands available in X-Code are:

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IF...ELSE...NIF
REPEAT...UNTIL()
WHILE()...NWHILE
WHEN()
XWHEN

IF Commands

You use the IF command to re-direct program flow if a certain condition is met whilst the command is active. It is made in-active by the NIF command. For example, to test the value of a variable you could use:

Command	**Description**
IF(VAR5>50)	If variable 5 is greater than 50 go to sequence 7
GOTO7	Go to sequence 7
NIF	End IF statement

The IF command is commonly used in an IF...ELSE...NIF construction to enable you to make conditional branches of the form:

Command	**Description**
IF(VAR1>5 AND IN_XXXX11)	If variable 1 is greater than 5, and inputs 5 & 6 are active, execute sequence 1, else execute sequence 2
XR1	Sequence 1
ELSE	Else
XR2	Sequence 2
NIF	End IF statement

Note: The use of ELSE is optional.

REPEAT Command

You use the REPEAT..{commands}..UNTIL..{condition} command structure to execute a set of {commands} following the REPEAT. At the UNTIL statement an evaluation of the {condition} is made, if it is false the program flow is re-directed to the beginning of the REPEAT structure. However, if the {condition} is met the program flow is directed to the command following the REPEAT structure and the repeat loop is exited. Using this command, you can request a repeating series of motion commands until a certain position is reached or certain input conditions are met.

When using this form of command, notice that the UNTIL {condition} occurs at the end of the structure so the {commands} following the REPEAT are always performed at least once. Also, any input conditions are only evaluated at the UNTIL {condition} part of the structure, consequently {commands} between REPEAT and UNTIL will not be interrupted.

You can nest up to 16 levels of REPEAT commands.

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Example

Command	Description
REPEAT	Repeat command
XR1	Execute sequence 1
T2	Delay 2 seconds
UNTIL(IN_1)	If input #1 is active, exit the loop and perform the next command, else re-enter the loop and execute sequence #1 again

WHILE Command

You use the WHILE..{condition}..{commands}..NWHILE command structure to execute {commands} only whilst the WHILE {condition} is met. At the beginning of the structure if the WHILE {condition} is met the following {commands} are executed until the WHILE {condition} becomes false. If the WHILE {condition} is not met, the WHILE {command} structure is by-passed and the command following the structure is executed. With this form of command, notice that the conditional test is made at the beginning of the structure, so if the condition is met immediately no commands in the body of the structure are performed at all. The WHILE structure is terminated by the NWHILE command.

You can nest up to 16 levels of WHILE commands.

Example

In this example if input #1 is active sequence 1 is repeatedly executed until input #1 becomes inactive.

Command	Description
WHILE(IN_1)	Repeat command
XR1	Execute sequence 1
NWHILE	End of WHILE

WHEN Command

You can use the WHEN command to continuously monitor a condition until it becomes true, at which point a sequence defined by XWHEN is automatically executed. If another command is currently executing, this will be allowed to finish and the XWHEN defined sequence will execute.

The XWHEN command will only execute once, if you need it to execute every time the condition becomes true, finish the XWHEN sequence with another WHEN command. Otherwise, program control will be returned to the command following the original interruption.

XWHEN Command

The XWHEN command defines the sequence that is executed by a WHEN condition becoming true. XWHEN0 prevents any sequences from being executed.

Note: If you use the XWHEN command you will increase the program execution time.

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Example

Command	Description
XWHEN5	Execute sequence #5 when the WHEN condition is true

Encoder Following

Certain applications require the motor of one axis to follow the encoder of another axis or an externally-generated step and direction signal. If you use encoder following, the lead from the encoder to be followed should be connected to the controller's external encoder input. This input can be configured, using the CCS command, to decode the encoder input by X4, X2 or X1, or to accept step and direction inputs. Generally, a X4 decode is used which converts the output of a 1000 steps/rev encoder to 4000 steps/rev.
You can use the velocity of the following encoder to modify the operation of the program by use of the VARn=SMC command. For a particular sample period, the number of encoder pulses can be loaded into a nominated variable. Tests performed on the contents of this nominated variable can then be used to alter the program flow.

Encoder following can be used in a variety of ways. You can select the style of following you require using the SIM command. The options are:

- Normal indexer operation (SIM0), used for reverting to normal operation by overriding previous SIM commands
- Encoder following with indexer motion commands inoperative (SIM1).
- Encoder following with indexer commands operative (SIM2), allowing the superimposing of indexer moves.
- Software scaled encoder following (SIM3).
- Software scaled encoder following with direction reversal (SIM4).
- Preset following index mode (SIM5).
- 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

You use hardware scaling of the external 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 multiplier, the division ratio of which is set by the RAT command, at a resolution of 16 or 24 bits, determined by the OSJ command.

A rate multiplier is able to generate output pulses at a frequency determined by the input frequency multiplied by the fraction n/(resolution), where n is determined by the RAT command and the resolution is determined by the OSJ command. Consequently, you can determine the output motor rate using:

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$$\text{Output Motor Rate} = \text{input rate} \times \frac{n}{65536} \quad \text{for OSJ = 0 (16 bit resolution)}$$

or

$$\text{Output Motor Rate} = \text{input rate} \times \frac{n}{16777216} \quad \text{for OSJ = 1 (24 bit resolution)}$$

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, you can achieve a very fine adjustment of the ratio 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

Software scaling is used when you require exact following ratios 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.

You set the scaling ratio 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.

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When using SIM3 or SIM 4 operation for short moves you can predict the number of steps the motor will take using the formula :

$$\text{Number of motor steps to move} = \text{INT}\left(\frac{\text{CMR} \times \text{no. of pulses received} + \text{prev. remainder}}{\text{CUR}}\right)$$

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.

Triggering From the Encoder Count

In all following modes, apart from SIM0, normal command execution can be suspended until a pre-defined encoder count is registered. This facility is controlled by the FP command. Take care using it, because if you issue this command and an encoder is not fitted, all buffered commands will be suspended until the correct condition is met. Only the commands ‘S’ and ‘K’ will terminate the FP command.

Buffered Clock Mode

Software scaled encoder following modes SIM3 and SIM4 operate using a buffered clock, 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 buffered input pulses are stored at the input resolution. At any particular instant the number of pulses being stored is called 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.

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.

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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.

Comparison of Scaling Modes

Table 8-1 is included to give you an overview of the differences between hardware and software scaling used by the controller.

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)

Table 8-1. Comparison of Hardware and Software Scaling Modes

Preset Following Index Mode

If you wish to set the speed of the motor being controlled relative to the speed of the external encoder input, you need to use following mode SIM5. 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. You can set the percentage following factor by use of the FOL command which can be varied between 0.0 and 5000.0%.

The following encoder count input can be sampled over a range of rates set in multiples of 2 milliseconds, using the SMP command.

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Whilst you are in 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. However, 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%.

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

1FOL(VAR1)

An immediate version of this command also exists, called IFOL.

Also note:

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

Load Encoder Following (SIM 6)

In certain applications you may find it is beneficial to close the position loop around the actual load position rather than the motor position, in order to improve positional accuracy.

Typically this is required in a feed-to-length system in which positioning accuracy is adversely affected by slippage and compression of the feed roller.

By closing the position loop around the load you can compensate for the majority of system errors, such as out of tolerance feed rollers and other transmission devices. To do this, you need to fit 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.

You fit the load encoder to the controller's EXT ENC 9 way D type input. Existing motor encoder feedback remains in use to provide velocity feedback. This is preferable to obtaining velocity feedback from the load as the indirect coupling of the load encoder would result in a low bandwidth system and therefore limit performance. If you have an application that does not have a 1:1 ratio between the load encoder and motor then the velocity feed forward gain (CFG) needs to be scaled by the ratio in use.

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

Remember, when using load encoder following 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.

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Coupling

In order to gain good system performance you must pay particular attention to the mechanical coupling of components. 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, you should set the motor velocity trip (CVT) 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.

SIM6 Operation

A functional representation of SIM6 operation is illustrated in Figure 8-1.

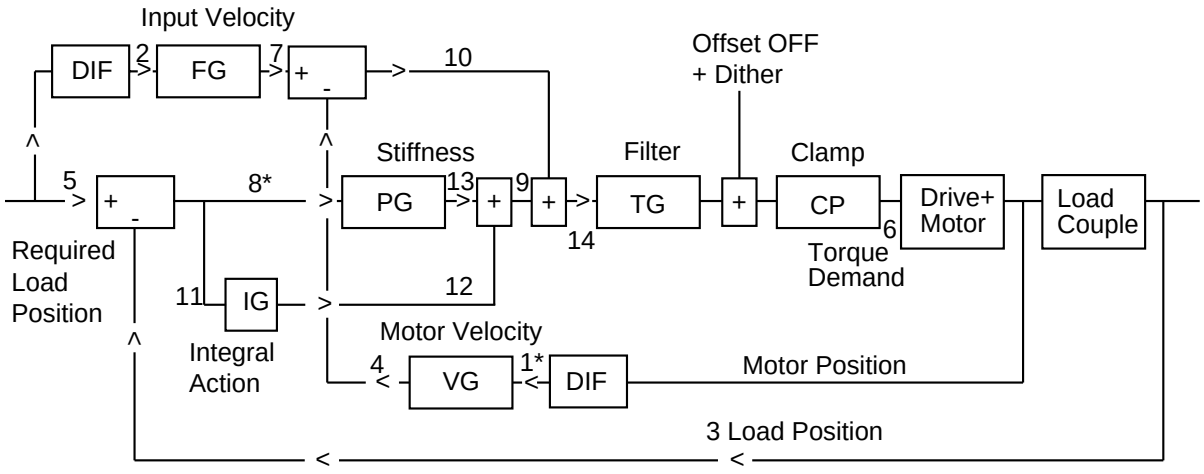


Figure 8-1. SIM6 Operation

Torque control applications

In the majority of applications, the fundamental parameter you need to control is position. Velocity, acceleration and direction are all derived from position, so are automatically determined. The value you cannot directly control is torque, since it depends upon the load characteristics as well as the move parameters.

However, there are applications in which the torque is the chief parameter you want to control - winding material onto a drum is one example. When operating as a torque motor you have no control over position, velocity, acceleration or direction, though you can set limits to any of these parameters. (In the same way, you 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. You therefore set up the controller as a *velocity* controller but determine the maximum torque using the clamp command CCP.

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The proportional gain CPG must be set to zero, and 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. You 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 8-2.

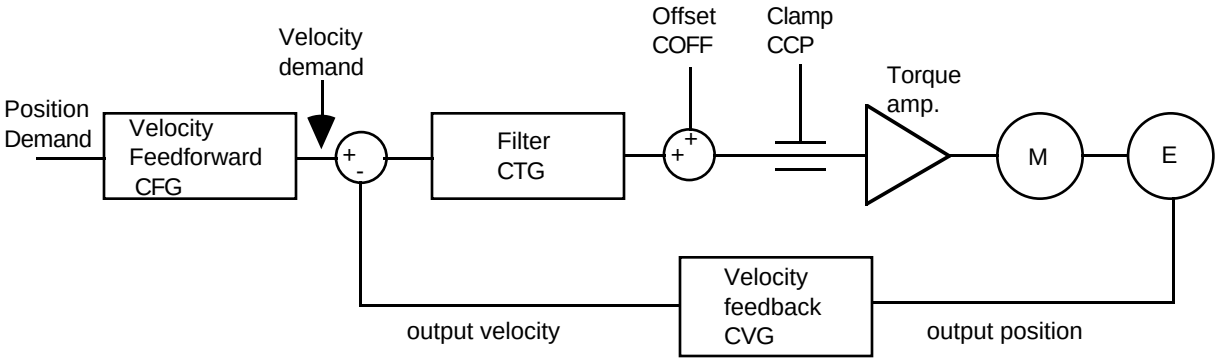


Figure 8-2. Torque Control Operation

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 and 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.

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Switching between position and velocity modes

In an application like the closing and clamping of an injection mould, you will 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 you 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 considered to be entering torque-limited 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.

When you need to switch between control modes, take note of the following points:

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

•2. You can switch from torque-limited velocity control 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 (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.

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Speed Change Mode

The MQ command allows you to make speed changes 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:

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

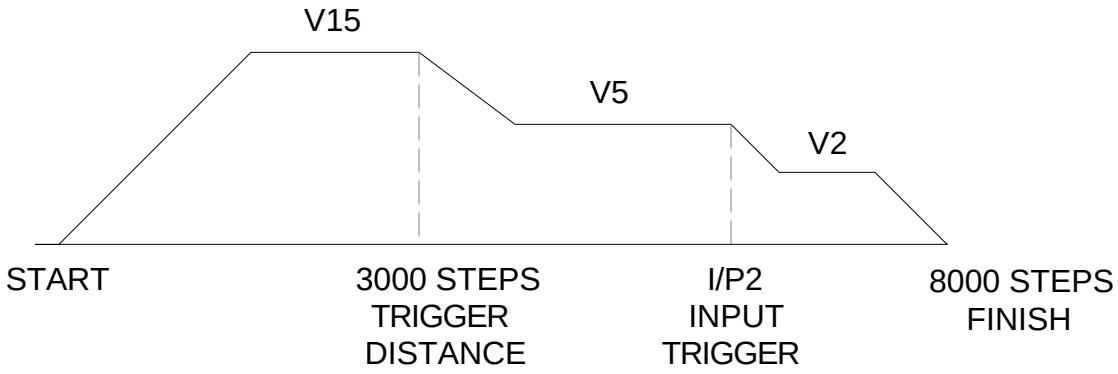


Figure 8-3. Speed Change Mode

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Section 9. Operator Interfaces

Introduction

When you require a mechanical system to perform repetitive moves using stored sequences and the use of PLCs or computers cannot be justified you may consider using operator controls such as the RP240 Interface Module.

The RP240 is a versatile input/output module incorporating a numeric entry keyboard, a 40 character LCD display and 8 individual LED indicators which may be labelled as required. Using an extensive range of control commands you can use the RP240 Module for interactive control of many motion control applications.

RP240 Module

Programming With the RP240

Prompting an Operator or Displaying Information

In motion control applications, one of the most important requirements is to present the right information to an operator at the right time. The RP240 provides many facilities which allows you to keep the operator informed about the state of the process being controlled and also allows the operator to enter information to re-direct the process, if required.

Operator displays include 8 LEDs on the panel, which may be turned ON or OFF using 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 you issued a DLED10001011 command, the LEDs shown in Figure 9-1 would be illuminated. These eight LEDs can be labelled, using the slide in card provided, to represent cycle status, output status, etc.

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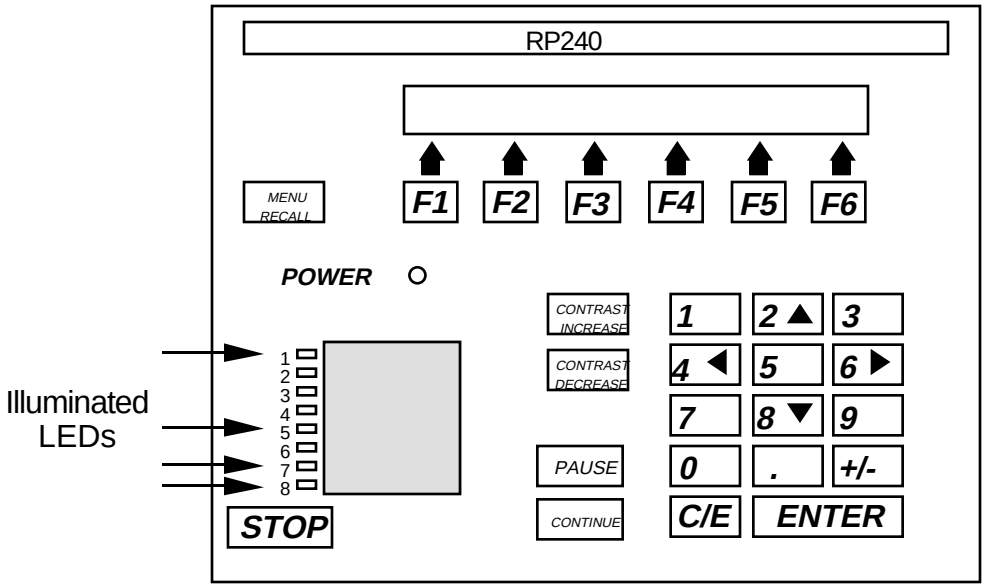
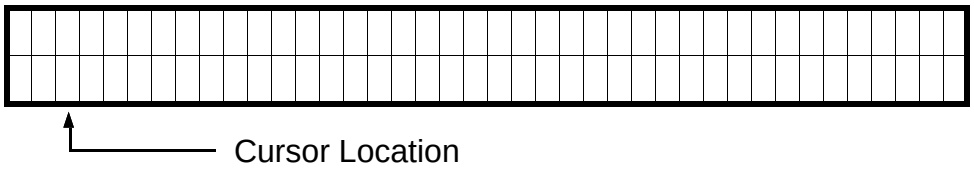


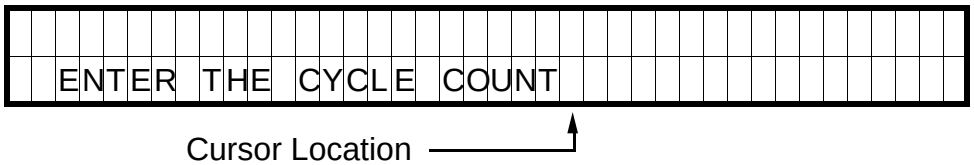
Figure 9-1. Status LEDs

You may also use the RP240's 40 character LCD display. The display can be controlled with specific Extended X Code commands. The Position Cursor (DPC) command allows you to program the location of the cursor on the LCD display. Use the DTXT command to place text, beginning at the current cursor location, on the LCD display. For example, if you wanted to display the message ENTER THE CYCLE COUNT on line two, starting after two spaces in from the left and you wished the actual count to be entered into the three spaces following the message (to be stored in variable 1), you will need to enter the following code: The cursor does not appear on the display, it only appears when the VARn=NUM or DPC commands are used.

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

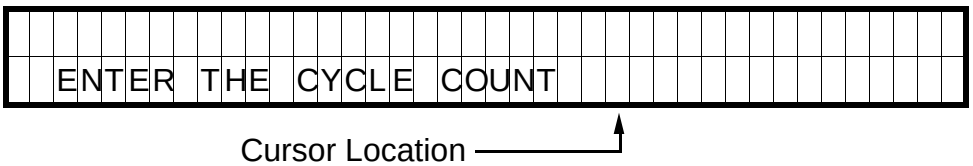


Step 2 Issue the DTXT"ENTER THE CYCLE COUNT" command.



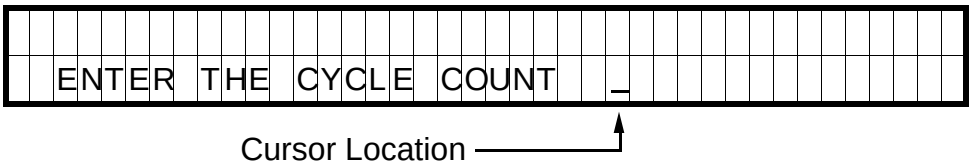
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Step 3 Issue the DPC225 command (line 2, position 25).

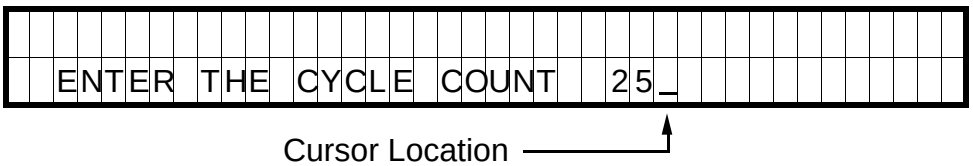


Once you have provided the operator with the prompting message, the actual cycle count data is provided using the Read and Enable Numeric Keypad (VARn=NUM) or Read and Enable Function Keys (VARn=FUN). The VARn=NUM command will enable the numeric keypad and allow the operator to enter information. The 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.

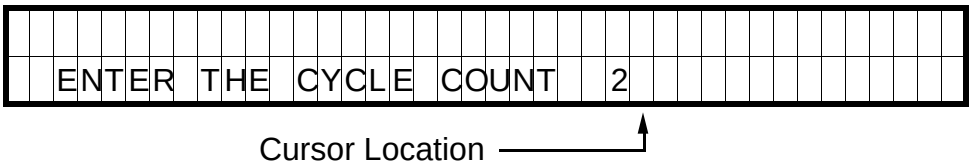


Step 5 Press a 2, followed by a 5.

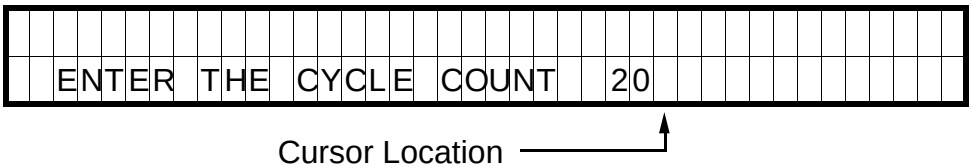


If the wrong value is entered press the C/E key and re-enter the value.

Step 6 Press the C/E key.



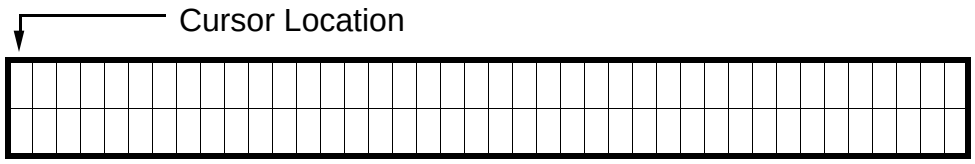
Step 7 Press a 0 followed by an ENTER.



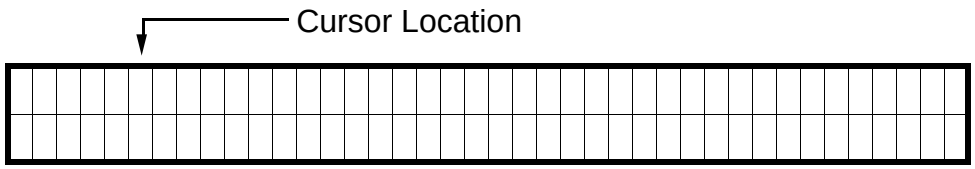
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Once the cycle count has been entered, clear the display and enter text which allows an operator to choose a particular function (in this case a choice of parts).

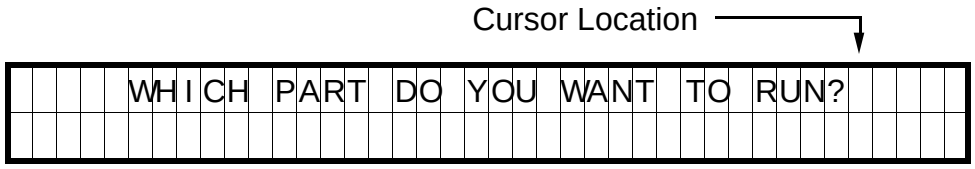
Step 8 DCLR0 command is issued to clear the display.



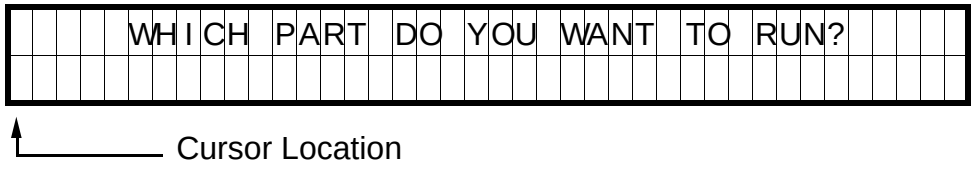
Step 9 Issue the DPC105 command (line 1, position 05).



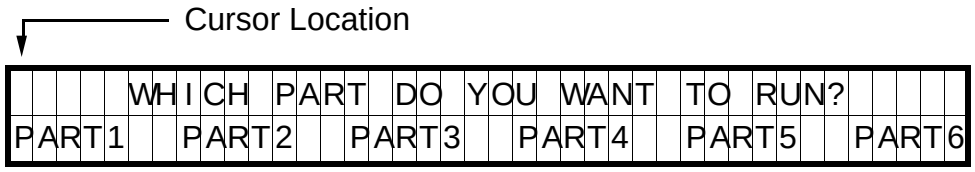
Step 10 Issue the DTXT"WHICH PART DO YOU WANT TO RUN?" command.



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



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



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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
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 ***X150 Software Reference User Guide***.

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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.

Displaying a Variable

You can display the contents of any variable on the LCD display using the command DVO. The variable number, the number of whole and fractional digits displayed and the sign of the digit can all be defined. The position of the cursor on the LCD display can be defined using the DPC command. For example:

Command	**Description**
DPC205	Position the cursor on line 2, column 5
DVO2,2,1,1	Place variable 2 at the current cursor position

If variable 2 contained the number 53.23, the display would appear as shown in Figure 6-4.

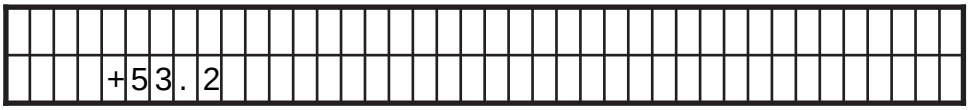


Figure 9-4. Variable Display

Transmitting a Variable Plus a String

If you are using two or more daisy chained drives, only one of which is fitted with an RP240, you could have a requirement to generate commands for other axes using the RP240. In this situation you can make use of the TX command which allows you to transmit a variable plus a string over the RS232 serial link.

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The command format is TXn,m,p,x, where:

n = The variable number
m = 1 if the sign is to be sent, 0 if the sign is not to be transmitted
p = The number of digits to be sent after the decimal point
x = The ASCII string that is transmitted prior to the variable contents

For example:

Command	Description
VAR1=50.63	Set variable #1
1TX1,0,1,T	T50.6 is transmitted via the serial port

Section 10. Guide to Writing Real Programs

Introduction

Application programs written for the SVHX use a programming language called X-Code. The code allows you to program motion control moves using a series of mnemonic character codes. For example:

Command	Description
A	Acceleration
D	Distance
MN	Mode Normal
IF	IF Boolean

Each command can be assigned a prefix device address, a numerical value and a delimiter. For a complete description of Command Structure and Command Descriptions refer to the ***X150 Software Reference User Guide*** (document number 1600.221.xx).

If you wish to send the controller commands from a PC, you can use X-Ware software which is supplied with the controller, alternatively you can use any other terminal emulation program, such as the one supplied with Windows™.

Note: Set-up of the Windows™ terminal emulation is described in the section entitled ***Communicating With the Controller***.

Program Storage

Rather than saving programs as a software file, you also have the option of saving a particular program within the controller's non-volatile RAM. This consists of a battery backed-up memory with a 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.

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Write Protection

You may write protect the storage RAM by placing bit switch 8 of the address switch in the OFF position. An attempted SV command when the switch is OFF will result in the following error message being displayed:

#15 BACKUP RAM IS WRITE PROTECTED

X-Ware

X-Ware has two basic functions - it's a communications package and a sequence editor. You can use it to turn the PC into a straightforward terminal to communicate from the keyboard, including setting up the communications parameters. And as well as allowing you to edit sequences rather than completely re-type them, the editor will save programs and retrieve them from disc.

Media

X-Ware is supplied on a single high density 3.5 inch diskette.

Installation

You can run X-Ware on a PC running DOS or Windows™.

Insert the X-Ware disk into drive A and select drive A (i.e., C>a:<Enter>).

For Windows™ installation run the program called “Setup” :

Setup<Enter>

For DOS installation run “Dosetup”:

Dosetup< Enter >

Where < Enter > means press the *Enter* or *Return* key.

X-Ware Operation

When the main menu screen appears press the F10 function key and use the cursor direction keys to highlight the required selection and press the *Enter* key, or you can type the initial letter of the selection. For example, typing a ‘T’ will get you straight to the terminal mode. You can use *Esc* to get back to the main menu.

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Menu Options

The menus available are:

File
Edit
Search
Windows
Terminal
Utilities
About

File Menu

The File Menu is used to save or print your motion programs, or to open a program you created previously. It allows you to Open a saved program, open a New Edit window, Save a modified program or Save it as a new name, Delete a program from your hard drive, Print a program to the printer, Exit X-Ware (this prompts you to save any program modifications) or Quick exit (without saving).

Edit

Use the Edit Menu when you are creating or altering programs. It allows you to Undo an action (such as accidentally deleting text), Cut an item from memory and put it on the clipboard, Copy an item to the clipboard, Paste an item from the clipboard to the current cursor location, Show the contents of the clipboard and Clear text without putting it on the clipboard.

Search

Using the Search menu you can search a file for a text string, automatically Replace a text string with another one or Search again for another occurrence.

Windows

The Windows menu lets you Zoom a window to full screen, Tile all windows onto one screen, Cascade all windows, choose either the Next or the Previous used window, Close a window or Close all open windows.

Terminal

Choose the Terminal menu when you want to use your computer as an RS232 terminal. You can configure the Settings on the RS232 port, Connect directly with a product, Load the terminal Buffer into a new window for saving, etc., or Log all responses to a file.

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Utilities

As well as sundry additional functions, the Utilities Menu is used to transfer programs to or from an X-Code product. This menu allows you to select a particular Product, Download and Upload files to and from that product, pull up an alphabetic list of Commands for that product, run an RP240 simulator for use with the SX, ZX and 500, Set user definable colours and return to the Default colours.

About

About X-Ware provides you with the version number of the X-Ware software.

Getting the Communications Right

Guidelines

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

[1] 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.

[2] 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.

Note: 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).

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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.

[3] Certain interface commands, notably ON, Z, etc. take some time to execute and consequently momentarily interrupt 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.

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 command with no errors
C<CR> - busy performing a command with function error
D<CR> - busy performing a command with previous comms error
E<CR> - busy performing a command with function error and previous comms error

[4] The average execution time of commands is approximately 1.5ms. The execution time is dependent upon the activity of the controller. 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.

Do not be mislead by a routine that breaks some of these rules. 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>

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Note:

[1] This sequence is case sensitive - make sure you select 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 miss 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>3000 sets axis 30 as the echoback device.

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 controller is busy. You should avoid typing Z or cycling the power.

In summary:

- Try to avoid typing CTRL-S
- Avoid accidental use of the command F
- Try to avoid addressing 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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Information commands

By use of X-Code information commands you can accumulate a great deal of knowledge upon the state of the drive and controller. Commands range from RV, which report the revision of the software being used, to PIC, which displays the servo loop diagram.

Buffer Commands

When you need to know the status of the command buffer, for example to see how much room is left following the loading of a long series of commands, you can use the B or BS command. The B command will tell you if more or less than 10% of the command buffer is free for use, whilst the BS command returns the number of bytes remaining.

Display Commands

A variety of Display commands exist which allow you to interrogate various distance, speed, parameter or position values. Note: The display commands described in this section will return a response to your terminal or the controller's 7-segment display. The RP240 has its own set of display commands which are described in the ***Operator Interfaces*** section.

Display Indexer Flags

Indexer status flags can be examined by use of the DFX command. Up to 36 bits get reported, some of which are reserved for future use.

Display Indexer Counter

When you issue a DIC command, you are requesting the contents of the index counter to be displayed as a single value in steps defined by the user resolution. The value is effectively the programmed D value.

Display Position Actual

A continuous display of actual position (in user steps) can be displayed by use of the DPA command. The command will respond with the number of steps issued by the controller since it was enabled, set to position zero or a set position command (SP) was issued.

Note: the reported position will only be true provided the motor has not de-synchronised.

Display Position Error

The DPE command provides a continuous display of the difference between the setpoint and the actual position, in user steps.

Display Position Setpoint

If you wish to know the absolute number of pulses sent to the drive from the controller, use the DPS command.

Display Report

By use of the DR command you can display a report of the controller's parameters. Three different reports can be selected:

General status

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Status of drive and indexer
Status of the system switches

For example, sending 1DR1 could report the following:

```
>1DR
;Product 1X, SVHX  8500 S servo drive. Indexer mode is MN,MPI
;Axis setup is indexer mode.
;No daughter boards fitted.              RP240 interface connected.
;Indexer position .....=0                Programmed Distance.....D=4000
;Programmed Velocity.. V=1               Programmed Acceleration....A=10.01358
;Go Home Final vel'y.GHF=0.1000165  Go Home Acceleration.....GA=10.01358
;Jog Velocity.....JV=1                   Jog Acceleration.....JA=99.00331
;Limit Acceleration....LA=899.9705       Limit Disable.....LD=0
;User resolution..... UR=4000            Motor (fb) resolution....MR=4096
;Proportional Gain.....PG=5              Velocity Feedback.....VG=2
;Filter Time Constant....TG=1.00         Velocity Feed Forward.....FG=2
;Integral Action Gain....IG=0            Amplifier offset.....OFF=0
;Dynamic Error Limit.....PE=4000         Int. action window.....IW=39
;In position wait time...IT=20           In pos window(deadband) EW=49
;Position Error.....=1                   Command peak(clamp).....CP=538
;Velocity Trip.....VT=149.90             Cont. motor current(mA) CCM=13000
;Following Acc'n Gain....AG=1.00         Following percent.....FOL=100
;PRESS SPACE BAR TO CONTINUE OR RETURN TO EXIT
```

Display Signal

Controller variable parameter values can be displayed using the DS command. The parameters available are:

DS1	Motor velocity	DS10	Velocity action difference
DS2	Input velocity	DS11	Integral of position error
DS3	Motor position	DS12	Integral action
DS4	Feedback velocity	DS13	Error times gain (= torque)
DS5	Input position	DS14	Torque demand
DS6	Filtered torque demand	DS15	Unfiltered unscaled following count
DS7	Input velocity action	DS16	Filtered unscaled following count
DS8	Position error	DS17	Filtered scaled following count
DS9	Demand less filtered velocity		

Display Velocity Actual

You can use the DVA command to display the actual velocity of the motor. The velocity is measured by counting the encoder pulses over a 500µs period.

Display Velocity Setpoint

The signal being sent to the velocity part of the servo loop by the servo algorithm is called the velocity setpoint. You can display it's value using the DVS command. The value displayed will be repeatedly updated until you press <return>.

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Monitor Command

You can continuously monitor a display command or capture one value depending upon the state of the OSC command. For example:

Command	Description
1OSC1	Report only one value
1DPA	Display actual position

would display a single distance value, say '+123000456'. The default value for OSC is '0', allowing values to be continuously reported.

Position Report Commands

You may use two commands to report position:

P	Reports position relative to the start of the last index
PR	Reports the current absolute position

Picture Command

The PIC command will display a block diagram of the servo control loop including the signal monitor numbers listed by the DS command. To monitor a value use the DS command.

Identify an Echoing Controller

If you send a series of universal commands to daisy chained drives, the QS command can be used to identify which drive performed the commands sent. The response consists of an asterisk, a two digit device address, an exclamation mark and a carriage return. For example, a typical response could be:

***02!**

Meaning the commands were actioned by the controller set to address 2.

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Report Commands

A number of commands are used to report the status of the controller, the power ON time, any error conditions and the revision of the software being used. You can select the required report from the following command types:

Report Serial Interface Status

You can examine the status of the controller's serial interface by sending an R command. The response will be an asterisk, followed by a character code, followed by a carriage return. The character codes have the following meaning:

*R [CR]	- ready for a command with no errors.
*S [CR]	- ready for a command with function errors.
*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 command with no errors.
*C [CR]	- busy performing a command with function error.
*D [CR]	- busy performing a command with previous comms error.
*E [CR]	- busy performing a command with function error and previous comms error.

For example, you may receive the response: *** D**

Meaning a command is being performed and a previous communications error still exists.

Report A - Limit Status Request

You can use the RA command when the motor will not move, if you suspect the last move was stopped by a limit switch becoming active or if the current move is disabled by a limit. The command reports back to you a character which identifies if the last move was terminated by a positive or negative limit and if the current move is limited by a positive or negative limit. See the command description for a complete list of returned character codes and their meanings.

Report B - Misc. Status Request

The Report B - Misc. Status Request informs you about the status of a loop, a pause, a shutdown or an input. When you issue an RB command the response is a character that identifies what is presently active i.e., a loop, a pause, a shutdown or an input. See the command description for a complete list of returned character codes and their meanings.

Drive Status Request

You can use the RE command to check the energised/de-energised status of a drive. The response is *@ if the drive is energised or *B if the drive is de-energised.

Report Go Home Status

The RG command can be used to report the status of the last GO HOME attempted. If you receive a *@ the attempt failed, whilst a *A means the attempt was successful.

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Report Power ON Time

If you need to know the controller power ON time, send the controller an RPO command. The controller will respond with the ON time in hours. For example, the controller could respond with a time of 45.8 hrs.

Report Sequence Status

Using the RS command you can request the status of the last sequence execution. The controller will respond with the following characters to indicate sequence start or end condition:

Response	Sequence Start	Sequence Ended
*@	NO	NO
*A	YES	NO
*C	YES	YES
*D	NO	YES

Note: A ***D** response is reported when the number of loops in a sequence does not equal the number of loop terminators in a sequence.

Report Servo Errors

If you instruct the controller to report servo errors by sending an RSE command, a status code will be displayed on the controller's 7-segment display and a bit pattern will be returned to the terminal. See the command description for a complete list of returned error character codes and their meanings.

Revision Level

To discover what revision of software your controller is using (i.e., the software revision level of the installed EPROMs) use the RV command. The controller will respond with a message of the form:

***ISSUE:6.1 DATE: 11-Jun-96 10:45 [CR]**

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Set Switch and Other Switch Commands

The controller software allows you to enable or disable certain features using software switches. They are called switches because the commands can have only one of two values n=0 or n=1 i.e., ON or OFF. Three sets of switches are provided, called:

Other Switches
Set Switches
Encoder Specific Switches

Other Switches

Other Switch commands include a mixture of commands, only some of which apply to stepper systems. Other switch commands are:

OSA Home at Index Pulse (only applicable to servo systems)
OSB Integral Action Selection (only applicable to servo systems)
OSC Monitor Command Reporting
OSE Jog Enable
OSJ Select 24/16 bit Gearbox
OSK Check integrity of optical encoder
OSL Allows direction of encoder to be followed in SIM5 mode
OSM Set sensitivity of integral action
OSO Suppress Units

Entering the Other Switches, OS command, will report upon the present state of the switches with the response *bbbb_bbbb_bbbb_bbbb where the bits are in the following order:

ABCD_EFGH_IJKL_MNOP

Note: the letter options do not report the bits in a linear sequence. The order followed is:

A=IDX_HOME	B=SWITCH_IACT	C=SINGLE_DS	N/A
E=JOG_ENABLE	N/A	N/A	N/A
N/A	J=24BIT_GBOX	K=IDX_CHECK	N/A
M=FAST_IACT	N/A	O=NOUNIT	N/A

Set Switches

Set Switch commands include:

SSA RS232 Echo Control
SSD Set Output 1 as Composite Fault Signal
SSG Save Command Buffer on Limit
SSH Save Command Buffer on Stop
SSK Enable/Disable De-energise on Stop
SSP Hide Variable Entry

Entering the Set Switches, SS command, will report upon the present state of the switches with the response *bbbb_bbbb_bbbb_bbbb where the bits are in the following order:

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ABCD_EFGH_IJKL_MNOP

Note: the letter options do not report the bits in a linear sequence. The order followed is:

A=RS232_ECHO	N/A	N/A	D=01(WDOG)
N/A	N/A	G=LIM_SV	H=STOP_SV
N/A	N/A	K=STOP_EN	N/A
N/A	N/A	N/A	RP240_ECHO

Encoder Specific Switches

Encoder switches are generally used in stepper motor applications, however two of the switches, RESET and OFFSET can be used with servo systems.

Command FSH will reset the encoder count to zero immediately, avoiding any software delays introduced by the use of the PFZ command. When the encoder specific switch H is set to 1 (FSH=1) the encoder count is set to zero once the target encoder count has been reached.

Command FSJ introduces an offset in the encoder count to compensate for sampling errors when reading the encoder. For more information see the description of the FSJ command. When the encoder specific switch J is set to 1 (FSJ=1) the encoder count is offset by the difference between the target encoder count and the sampled encoder count, once the target encoder count has been reached.

Configuration Commands

Configuration Commands allow you to alter gains and resolutions within the software, generally fine control of settings is provided, but commands such as CDR will only allow one of two discrete values to be entered. Certain Configuration Commands are only applicable to servo systems. The commands available are:

CAG Configure Acceleration Gain (only applicable to servo systems)
CBO Configure brake operation (only applicable to servo systems)
CBR Configure time for Brake Release (only applicable to servo systems)
CBT Configure Time for Brake engage (only applicable to servo systems)
CCM Configure Current in the Motor (only applicable to servo systems)
CCP Configure Command Peak (only applicable to servo systems)
CCR Configure Command Peak Ratio (only applicable to servo systems)
CCS Configure Command Source
CDG Configure Derivative Gain (only applicable to servo systems)
CDR Configure Drive Resolution (only applicable to servo systems)
CER Configure Encoder Resolution
CET Configure Energise Time

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CEW Configure In-Position Window (only applicable to servo systems)
CFG Configure Feedforward Gain (only applicable to servo systems)
CFS Configure Fail Safe (only applicable to the BDHXE)
CIG Configure Integral Gain (only applicable to servo systems)
CIT Configure In-Position Time
CIW Configure IntegralAction Window (only applicable to servo systems)
CIX Configure Index Mark Resolution (only applicable to servo systems)
CMR Configure Motor Resolution
COFF Configure Amplifier Offset (only applicable to servo systems)
CPC Configure Motor Pole Count (only applicable to servo systems)
CPE Configure Position Error Limit
CPG Configure Proportional Gain (only applicable to servo systems)
CRR Configure Resolver Resolution (only applicable to servo systems)
CTG Configure Filter Time Constant (only applicable to servo systems)
CUR Configure User Resolution
CUV Override Under-Voltage fault
CVG Configure Velocity Gain (only applicable to servo systems)
CVT Configure Velocity Trip (only applicable to servo systems)

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Section 11. Servo Tuning

Tuning the Drive with a Positioner

The positioner is designed to operate with the drive configured as a torque amp, and this is the usual mode of operation described here.

Tuning Positioner with Drive in Torque Amp

To obtain smooth rotation at optimum speed and accurate positioning of the motor without overshoot or oscillation, with the motor connected to your system, you must tune the gain and damping characteristics of the servo loop. The TUNET command provides a self-tuning feature but for some applications the best results will be obtained by manual tuning using the commands listed at the end of this section, together with those from the ***X150 Software Reference User Guide***. Refer to the servo loop block diagram shown in Figure 11-1. The parameters affecting tuning are as follows.

Tuning Parameters

Proportional gain (CPG command)

Proportional gain determines the amount of torque produced in response to a given position error. It sets the stiffness of the system and affects the following error. A high proportional gain gives a stiff, responsive system but results in overshoot and oscillation which require damping.

Velocity gain (CVG command)

Velocity feedback is a signal which increases with shaft speed. It acts in a negative sense opposing the proportional action and helping to stabilise the motion. The damping action of velocity feedback allows a higher proportional gain to be used.

Integral gain (CIG command)

Proportional action may be insufficient to overcome static position errors due to friction. Integral action accumulates a steady state error until sufficient torque is produced to move the load. It improves overall positioning accuracy but may produce low frequency oscillation around the commanded position.

Feedforward gain (CFG command)

The opposing action of proportional and velocity gains result in a position error which depends on speed. This is called "following error". Feedforward gain can be used to offset the following error and improve tracking accuracy. This is important in contouring applications.

Filter time constant (CTG command)

Fast positioning systems need high proportional and velocity gains. By limiting the bandwidth, the digital filter prevents a high gain system from becoming too lively. The filter also serves to average the effects of the digital control loop, reducing the jitter at standstill and the audible noise. The value of CTG should be kept as low as possible.

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You can examine these parameters by using the DR command.

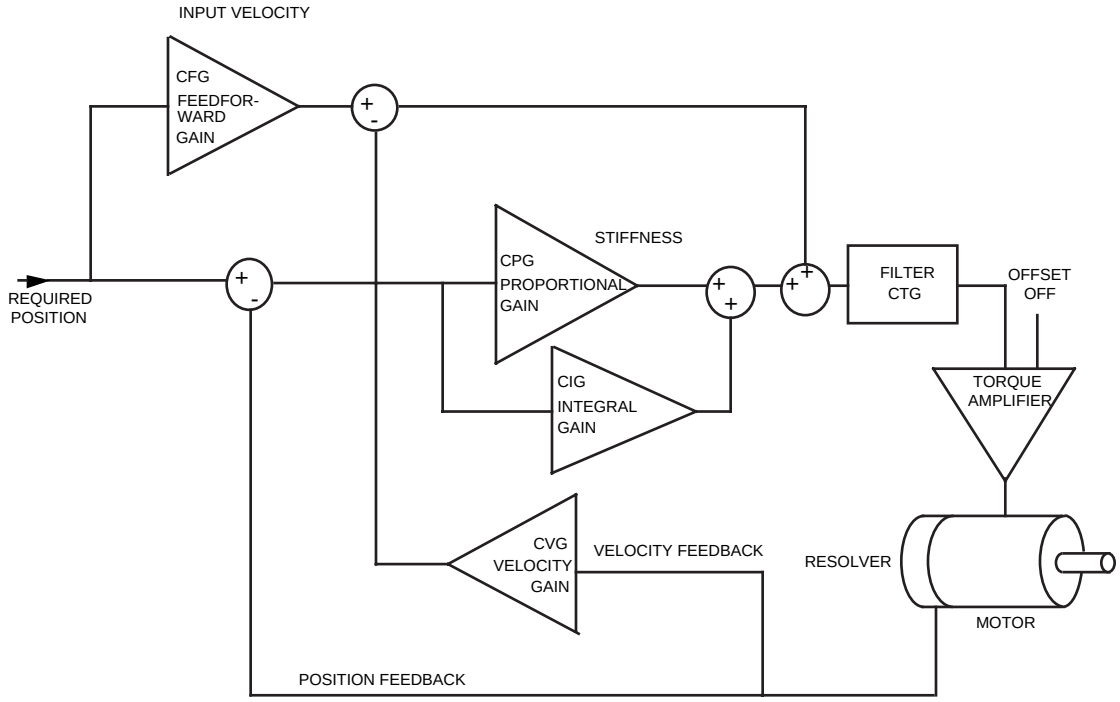


Figure 11-1. Servo Control Loop

Terminal/Computer

The terminal/computer communication should be set to 9600 baud, no parity, full duplex (not local), 1 stop bit.

After power up, the sign on message "DON'T PANIC Type HELP"' and the > prompt will appear on the screen unless you have previously set the positioner into the terse computer communications mode using EX0. In any case using the command 1DR will display the status of the positioner.

Connecting the Loop

Safety

It is advisable to have the STOP input wired to a stop switch located in an easily accessible position so that the system can be halted quickly in the event of instability causing oscillation. An alternative is to disable the drive using the command OFF[CR] but this takes longer.

Unless you have saved data in the past while the motor was energised, the positioner will power on without attempting to move or energise the motor.

If any of the motor or encoder connections have been re-made or changed, the first step is to check the integrity and polarity of the motor connections. Proceed as follows:

Make sure the axis is de-energized, type OFF[CR], if in doubt. Use the command :

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aDS3[CR]

where a = the device address
to display the feedback position continuously (approximately 0).

Turn the motor shaft CW and check that the displayed value increases, turn the shaft CCW and it should decrease. If this does not happen you must not close the loop with ON at any time since the feedback will be positive.

Press [CR] to restore the > prompt.

Manual Tuning Procedure

1. Initial Setting Up

Type the commands CFG0 CPG0 CVG0 COFF0 CIG0 CTG0 to software disable the servo. Check the result of these commands with the command 1DR.

When the axis is energised, it will be open loop with a slight torque demand due to amplifier offsets. This may cause motion of the motor. You may have to restrain the axis and be prepared to switch off, or type OFF[CR]. In any case there is an automatic software limit set by the command CPE on the distance it will drift.

2. Position Error Window Setting

The drive is disabled to protect the system if the position error goes outside of the position error window. The window can be set to a low number of steps to avoid damage due to overshoot or oscillation.

The value of CPE defines the size of the window in steps. It can be displayed by using the CPE command.

During tuning, CPE is normally set to 4000 steps i.e. 1 rev either way at the usual 4000 steps/rev. If in doubt set a lower value. The effect of going beyond the set error limit will be to automatically de-energise the motor.

Type the command RSE (report servo errors). This may show quite a list of errors. "Drive disabled by software command", "error limit exceeded" and "failed checksum of backup ram" are all acceptable at this point but "Drive fault" should not come up. If it does, check the LED on the drive front panel and try powering down the system and then powering it up again.

DO NOT PROCEED IF A DRIVE FAULT PERSISTS

3. Energising the Axis

Energise the axis by typing ON [CR]. You may find it convenient to restrain the axis to stop it drifting out of the error limit and de-energising. If it does de-energise, it can be restarted by typing ON.

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4. Cancelling Drift

Cancel any offset using the command aCOFF<value>[CR]. Negative values stop CW drift; positive values stop CCW drift. Values should be in the range of -1024 to 1023. Only small values are normally required, for example 1COFF10.

Check that making COFF more positive tends to turn the motor CW and making it more negative tends to turn it CCW. If this does not happen, do not proceed, as the loop will have a net positive feedback and will oscillate (although probably slowly) when the loop is closed.

5. Closing the Loop

Set a small position error limit (2000 steps for example) so that if oscillation occurs during tuning, the resulting overshoot producing large position errors will exceed the limit set by CPE and shut down the drive.

If necessary, first move the axis to a good starting point, then type ON[CR] to energise the motor and CPG1[CR] to close the loop. If a slight vibration appears at this point, it indicates positive feedback. This should only occur if you have changed the motor or encoder connections. Taking care, displace the axis slightly and then let go. You should experience a slight spring effect and the axis should return to its original position - approximately. The closed loop is now working.

Setting Up Servo Parameters

NOTE: When setting up servo parameters, do not allow the motor to go unstable for more than a second or two.

Tracking Applications

For tracking applications (PID tuning), where minimum following error is required, velocity feedforward should be used to improve the tracking accuracy. This can be set using the CFG command or the CDG command can be used to set feedforward gain and velocity feedback gain to the same value.

Point to Point Positioning Applications

For fast point to point positioning applications (PIVF tuning), a high proportional gain (CPG) damped by velocity gain (CVG) should be used.

Help Setting Loop Parameters

A guide to servo loop parameter settings for a fully damped non-oscillating response is provided in HELP 11. To use HELP 11 you will need to be in terminal mode (EX set to 1) and you will need to provide a terminal address for the CJL and CTQ commands for the entry of inertia and torque data.

HELP 11 uses the maximum low speed motor torque entered by the CTQ command and the total moment of inertia entered by the CJL command in calculating suggested settings for the loop parameters.

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First enter the values of CTQ and CJL (Motor + load inertia) for your system, then use HELP 11 to display recommended servo loop parameter settings calculated from the data you have entered. For example, if 3.6 is entered for the CTQ command to indicate a maximum torque of 3.6 Nm available and 1.6 is entered for the CJL command indicating a total inertia of 1.6 Kg/cm^2 , the following table will be displayed:

Gain CPG	Velocity Gain CVG/CFG /CDG	Stiffness mNm/ step	Error @ maximum torque (fb steps)	Doubled T Constant (msecs)	1/2 moved time (msecs)	Closed loop bandwidth (3db) (Hz)
1000	190	110	33	1	2	67
500	130	55	66	2	3	48
250	95	27	130	3	5	34
120	67	14	260	7	7	24
62	47	6	520	6	10	17

Table 11-1. HELP 11 - Servo Setup Table

Each successive line of the table corresponds to a less highly tuned servo system with reduced stiffness and speed of response. These reduced values may be used in matching the servo to lower specification mechanics.

The following describes in more detail the terms used in the table:

Velocity Gain

The settings of CVG, CDG and CFG depend upon the application as described above.

For the figures in the rest of the line of the table to apply, the CDG or CVG setting should be as in column 2.

For Position Integral Derivative (PID) applications, setting CDG to the figure quoted in the table will automatically set CVG and CFG to the same value.

Stiffness

Stiffness is the restoring force per unit of displacement. The force is dependent on the number of steps displaced from the demanded position. For example, a displacement of 100 steps with a stiffness of 10 mNm/step would produce a restoring force of 1 Nm.

Error at Maximum Torque

As the axis is increasingly displaced from the demanded position, the restoring torque increases at the quoted stiffness until the maximum available torque is applied. The Error at Max Torque is the number of steps of displacement required to produce a restoring force of the maximum available torque.

Doubled T Constant

When the damping is critical, the response of the servo loop is that of two simple filters in series, each having a time constant T. The value of T is quoted in the table.

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1/2 Moved Time

The following is an example move using servo values taken from the top line of the HELP 11 table to show the 1/2 moved time. The move is at maximum acceleration and velocity and it is initiated by the command string: **D100 A0 V0 G**

Figure 11-2 represents instantaneous position plotted against time for the resulting servo movement .

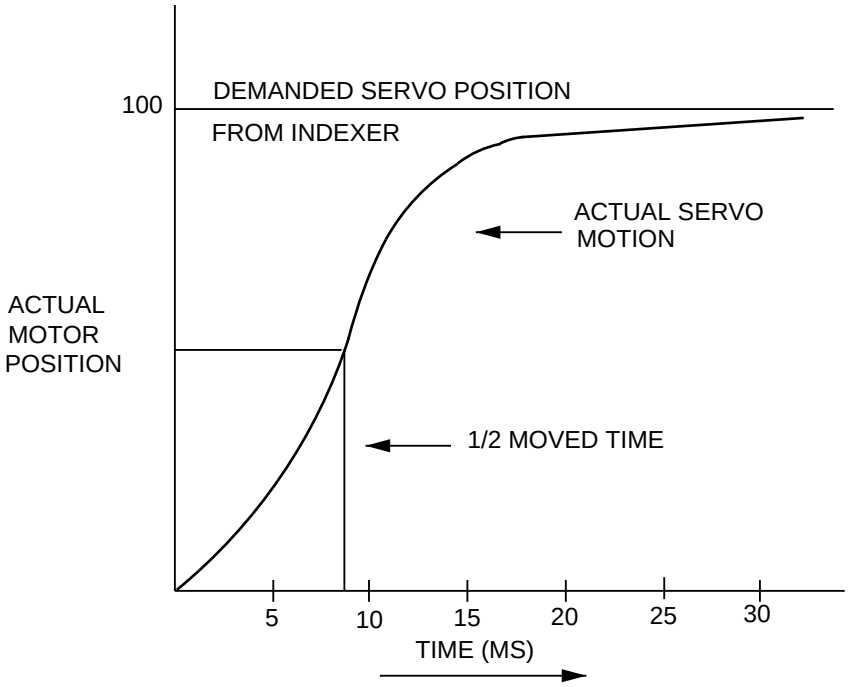


Figure 11-2. Example Servo Response Curve

The 1/2 moved time is the time taken to complete half of the move, 50 steps in this example.

The move will be half complete in the time 1.7T (column 6 of the table) or 1.7 x 5 = 8 milliseconds approx.

The move will be 96% complete at time 5T. In the example, the motor will have moved 96 steps in 25ms.

Bandwidth

The bandwidth of the servo system is the range of frequencies at which a sine wave move pattern input will be followed within 3db by the actual motion of the motor. Figure 11-3 shows the sine wave position demand input and the graphical representation of the motor movement.

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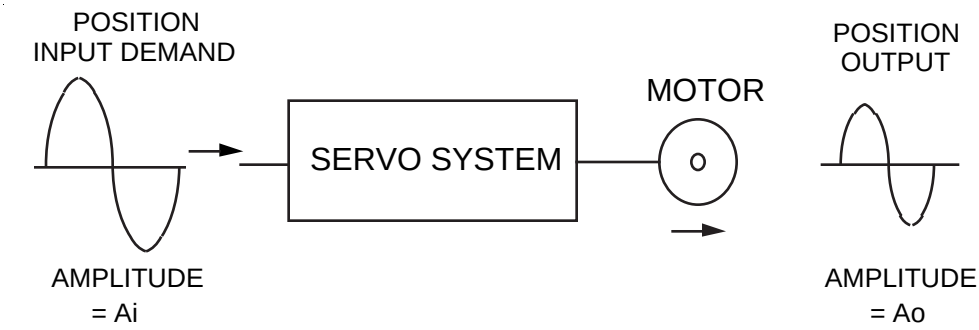


Figure 11-3. Servo System Bandwidth

As the frequency of the sine wave of demanded positions at the input (Ai) increases, the ability of the servo system to follow is reduced and the amplitude of the sine wave of the resulting output positions (Ao) decreases. The frequency at which it is reduced by 3db is the upper limit of the bandwidth.

Coarse Tuning the Loop

Attach a nylon cable tie to the shaft of the motor. The loose end can be used as a coarse indicator for overshoot and oscillation.

Use the command string A0 V0 D200 G to produce a short, sharp rotation of the shaft. Observe the movement, watching the cable tie for overshoot and oscillation. Repeat the movement, increasing CPG using the settings suggested in HELP11 until overshoot just occurs.

Balance the increasing gain with damping by setting CVG to 10, 20, 40 ... Increase it until the oscillation and overshoot indicated by the cable tie ceases.

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Fine Tuning

After coarse tuning the loop, continue balancing the gain and damping, monitoring the overshoot at the terminal by typing:

aDPE [space] G [space] [CR]

where a = the device address.

The CR should be entered quickly after typing the space following the G command - this will stop the position error display with the final positioning readings on screen to allow you to analyse them. Overshoot is indicated by the position error reading passing through zero at the end of the movement, then returning back through zero in the opposite direction, oscillating with decreasing error readings about the zero position before finally settling within the position error window. The damping should be increased to the point where overshoot just disappears. Too much damping will result in a sluggish movement.

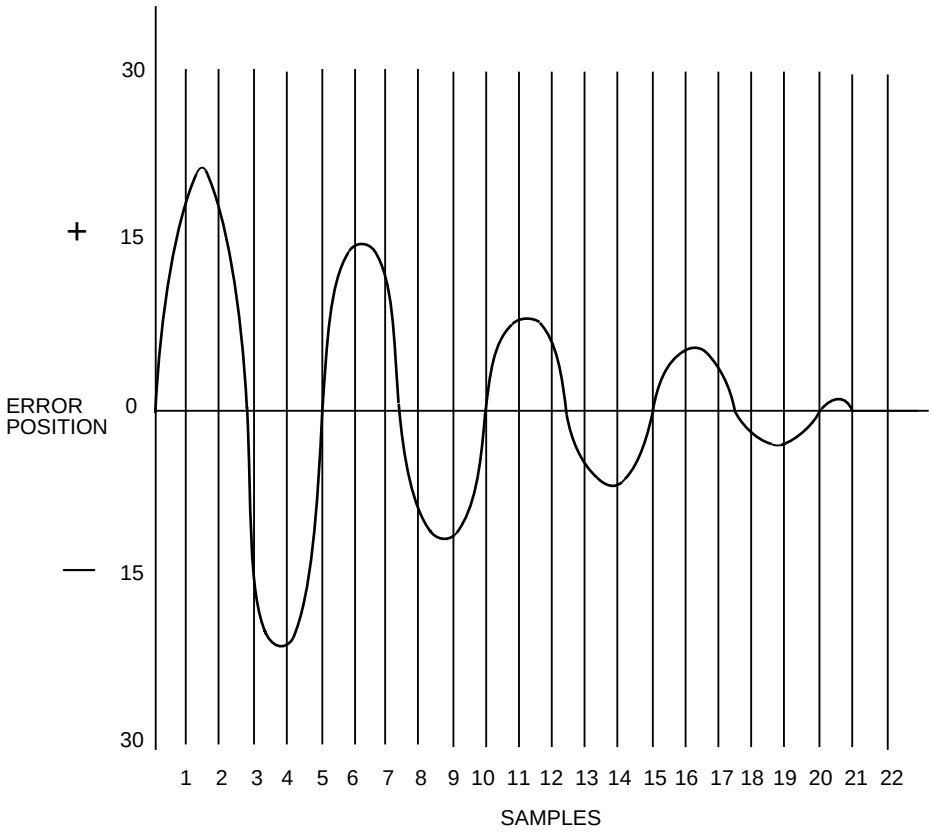


Figure 11-4. Overshoot During Positioning

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The following table shows the DPE readings for the final positioning graph of Figure 11-4. This is only an example to illustrate the general principles involved in tuning - in practice, the resulting figures may differ considerably from those given, but they will follow the general pattern shown. The overshoot shown here is rather more severe than might be generally expected.

Samples	Readings						
1 - 7	23	22	-17	-20	-5	14	12
8 - 14	-7	-10	0	6	4	-3	-4
15 - 21	-2	4	3	-2	-3	-1	0

Table 11-2. DPE Readings During Final Positioning

Notes on Tuning

The TUNE command will show how much torque was used, with 1023 corresponding to saturation. If the maximum torque demand is significantly less than 1023 you should try increasing CPG. You will normally need to increase CVG as well in order to prevent overshoot. Make sure that the maximum torque never exceeds about 1000 to guarantee that the servo loop does not saturate.

The TUNE command also shows the time taken for the complete move as well as the settling time. This information is also useful in optimising the response.

To summarise:

1. Use DPE to look for overshoot and oscillation.
2. Use TUNE to check maximum torque demand, move time and settling time.

CFG, the feedforward gain should never be set very much larger than the velocity feedback gain (CVG). A setting of 20% more than CVG is the largest practical value.

An increase in gain is always best matched by an increase in damping; when this is no longer true you have reached the optimum values. A useful guideline is that an increase of times X in gain is best matched by an increase of times square root X in velocity feedback (think of this as an X% increase in gain matches an X/2% increase in damping e.g. 30% more gain matches 15% more damping). This will keep the shape of the response the same and just increase its frequency (you are holding a quantity called the damping ratio constant).

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Servo Self-tuning

A facility for self-tuning the servo is included in the positioner software, using the command TUNET. The servo parameters are set at the time that they are executed and there is no continuous on-going adjustment (known as adaptive control).

Tuning is for the following characteristics:

- Stability - does not oscillate as it moves or settles
- Maximised stiffness and accuracy - deflects as little as possible in response to external forces
- Maximised bandwidth and speed of response - settles to the commanded position as quickly as possible at the end of a move
- Does not overshoot the end position in a move
- Minimal sound during motion or when holding position
- Tracks a profile of constantly changing position or velocity with as little error as possible
- Resistant to change as friction and other load characteristics vary from time to time, machine to machine, application to application and with production variations
- Operates for smaller loads than that used for tuning down to no load.

There are a number of other move related requirements:

- Make full use of the torque and power available so that the longest, fastest move possible can be made
- Perform equally well for fast or slow motions and for short or long moves
- Minimise heating effects in the motor and drive

It is not correct to adjust the servo loop parameters to meet these requirements as the general servo performance would be adversely affected. They are best met by adjusting the move profile (D, V and A values) and possibly the feedforward CFG value whilst watching for saturation effects.

If the application is purely velocity control with no requirement for positioning, then the tuning is best carried out manually. The self-tuning settings provided by the TUNEV command will work, but they will not produce the best achievable results.

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Section 12. 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

SVHX drives are fitted with internal 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

The SVHX Drive has a number of protection circuits which automatically prevent damage ocurring during fault conditions. If a problem occurs within the power stage of the drive it will be reported via the code 2 appearing on the 7-segment display. You will need to interrogate the drive over the RS232 link with the 1RSE command to obtain more information on the nature of the fault. For the SVHX, possible error messages are:

#81 Drive disabled by power loss
#82 Drive disabled by motor over temperature
#83 Drive disabled by drive over temperature
#84 Drive disabled by HT over voltage
#85 Drive disabled by drive over current
#88 Drive disabled due to resolver fault
#80 Drive disabled by composite drive fault
#144 Drive PSU module fault
#87 Drive disabled by drive logic supply fault
#95 Magnetostrictive feedback fault - see note 1
#86 Drive disabled by drive specific fault (refer to manual) - see note 2
#89 Drive disabled by non-specific fault - see note 2

Note:

[1] This type of fault is only possible when a magnetostrictive position sensor is fitted

[2] The drive has detected a fault condition, but cannot identify the cause. If this message is received check the drive setup and ensure all connections are correct and secure.

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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. A flashing 1 indicates the drive has attempted to energise, but has been de-energised by a system fault. Use the RSE command to get more information.

Code 2 - Drive fault. When code 2 is displayed, you will need to interrogate the drive over the RS232 link with the 1RSE command, i.e. report servo errors.

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 - STOP input is active. If the display is flashing it means the drive is still energised. When de-energised, the flashing will stop.

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.

Code P - Power failure. The +24V supply in the drive has fallen below a 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 the address followed by R.

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No communication

Perhaps the commonest controller problem, especially during initial commissioning, is apparent lack of communication with the terminal or host controller. The section ***Guide to Writing Real Programs*** contains guidelines on ***Getting the Communications Right*** which is worth reading if you are having problems. The essential points are:

[1] 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:

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

CTRL-Q means hold the 'control' key down and press the Q key at the same time. This sends the X-ON ASCII character.

[2] If you type CTRL-S by mistake it can be cleared by cycling the power.

[3] 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. Re-enable communications by typing an E 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.

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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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. Motor and Resolver Cables

Introduction

Depending upon the motor being used, you will require one of the following motor and resolver cables listed in Figure A-1.

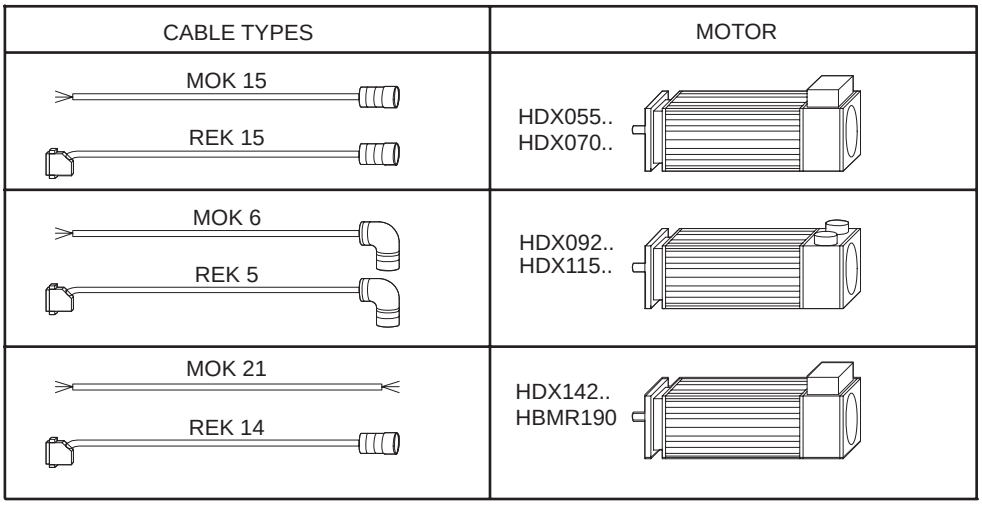


Figure A-1. Motor and Resolver Cables

CAUTION - HIGH TEMPERATURE

The motor case can reach a temperature of greater than 100°C (212°F).

Motor Cables

MOK 15/.. Cable

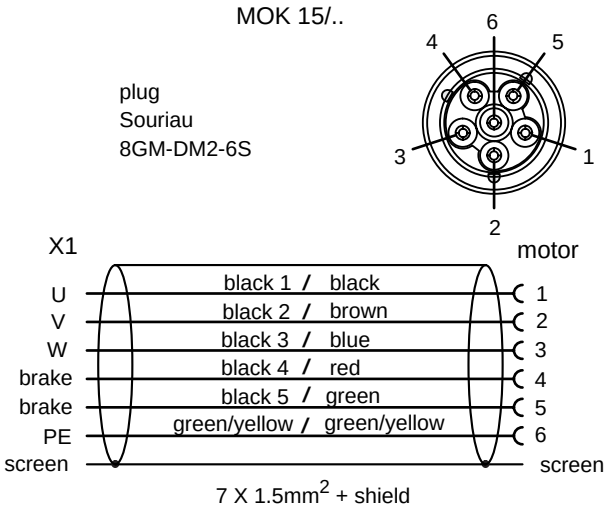


Figure A-2. MOK 15 Motor Cable

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MOK 6/.. Cable

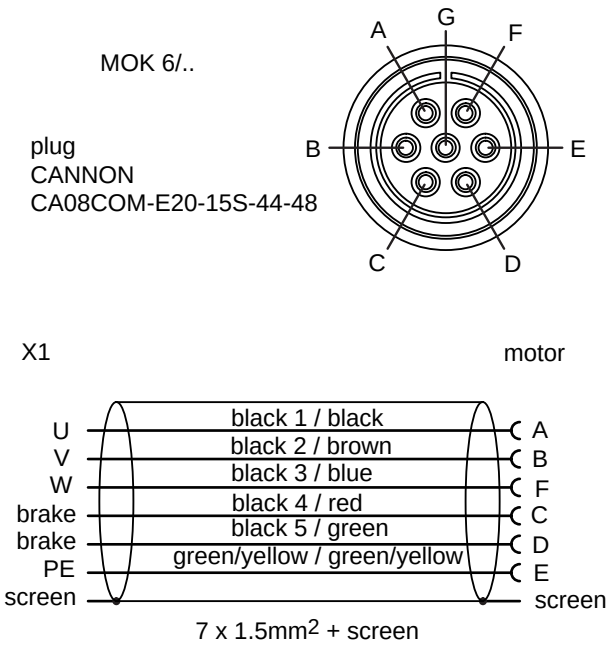


Figure A-3. MOK 6 Motor Cable

MOK 21/.. Cable

The MOK 21/.. motor cable is the same as the MOK 6/.. cable, but the conductors are increased to 7 x 2.5mm2 to give a current capability of 18.9A.

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Motor Connections

Motors supplied with MOK 6/.. and MOK 21/.. size cables are connected to the motor via small DIN rail connectors, mounted inside the motor's connection box. The connections required are shown in Figure A-4.

When removing the cover of the motor's connection box, take care not to disturb the thin sealing gasket.

Note: Even if a motor holding brake is not fitted the brake cables (4 & 5) must still be fitted, to prevent accidental contact with the main motor connections.

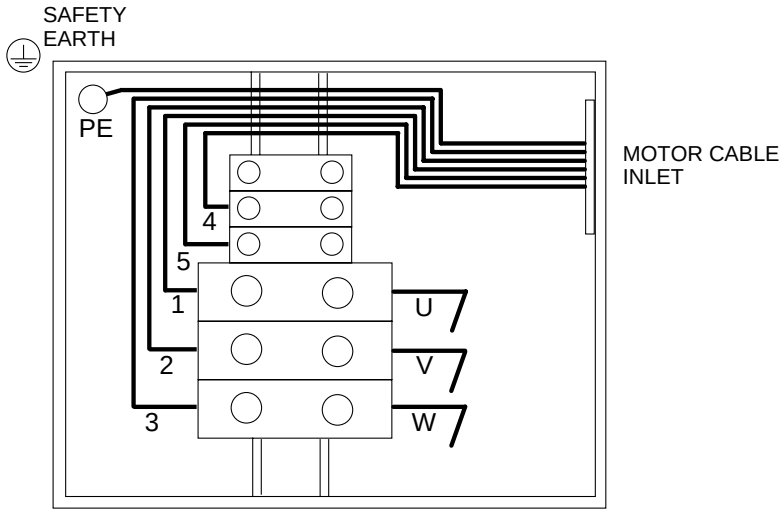


Figure A-4. Motor Connections

Gland Assembly

The MOK 6/.. and MOK 21/.. cables are supplied with a cable gland to seal the motor inlet cable when it enters the motor's connection box. It is important that you assemble this gland correctly, positioning the canted coil spring over the exposed braided screen of the cable. Figure A-5 shows an exploded view of the gland assembly.

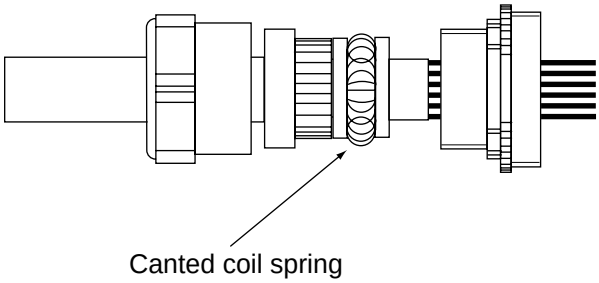


Figure A-5. Gland Assembly

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Resolver Cables

REK15/.. Cable

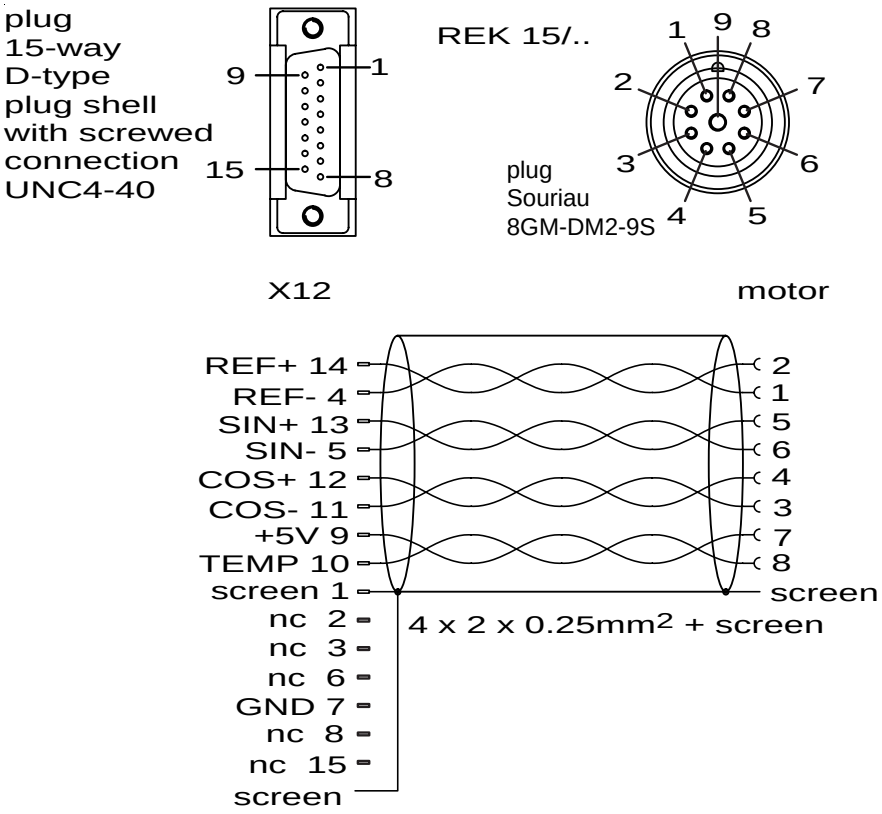


Figure A-6. REK 15 Resolver Cable

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REK 5/.. Cable

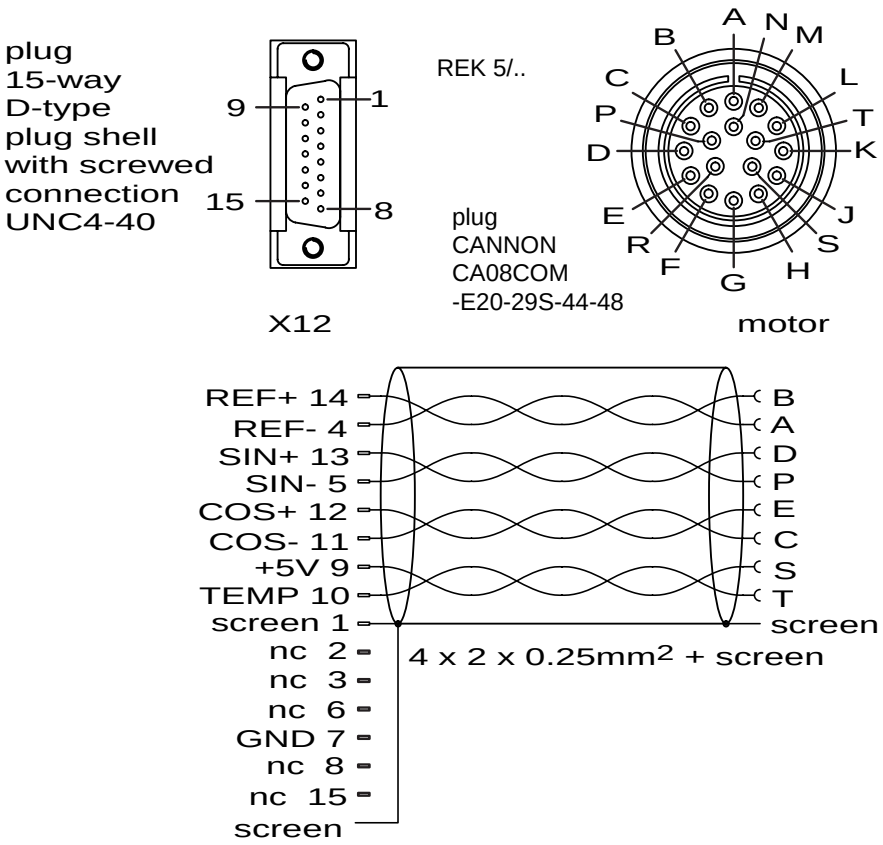


Figure A-7. REK 7 Resolver Cable

REK 14/.. Cable

Resolver cable REK 14/.. is the same as the REK 5/.. cable, but a straight-in-line plug is fitted at the motor end of the cable.

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