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EMERSON EMC

POSITIONING DRIVES & MOTORS

- - -

Including IOM-1, PCM-1, PCM-5

T-16, Thumbwheels, and Parallel Programming

Other Manuals available, but bound separately:
T-21 Data Entry Panel

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SERVICE SUPPORT (612) 474-8833

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INTRODUCTION

OVERVIEW

The EMERSON EMC Positioning Drives are the first servo products specifically designed to offer high performance position control without the maze of boards, wires, connectors, pot adjustments and transformers normally associated with servo systems. The DX-Series drives support brushless motors and range in size from 2 in-lbs. To 400 in-lbs., continuous. Special care in motor selection has resulted in drives that have excellent torque to inertia ratios.

The drives consist of ruggedly constructed enclosures which contains all the required components for position and velocity control. The drives also provide connections for interfacing with external machine inputs and outputs, and logic control, along with a serial interface port that is used to program the drive.

Calibration

Calibration of the Positioning Drive is virtually eliminated because all user potentiometer adjustments have been eliminated. The potentiometer adjustments have been replaced by firmware. The software pre-sets the compensation values and continuously adjusts these values during motion. This allows the system to operate over a large inertial range without any manual adjustments or tuning required.

Installation

Installation and wiring is fast and easy because the Positioning Drive operates in most environments directly from an AC line source without requiring a separate isolation transformer. The unit is designed to be back mounted within a standard Nema enclosure typically found in a production facility. The size has also been minimized to allow users to reduce the space requirements for incorporating a servo control into their production machinery.

Motor

Each Positioning Drive includes a high performance servo motor whose characteristics have been matched to the drive amplifier. Thus, the chance for a mismatch between the motor and the Positioning Drive is eliminated.

Programming and Troubleshooting

EMERSON EMC provides an easy to use software programming package with every drive that operates on an IBM PC/XT/AT or compatible computer with 512K bytes of RAM and a serial interface port. This software makes the Positioning Drive simple to program even for first time servo users. It is almost essential that the user of the positioning servo drive have access to a personal computer (PC). The PC can be used to change data, up and down load data and most importantly, help solve problems during operation and startup.

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System Overview

Following are the specific model numbers used in configuring the Positioning Drives.

Table I Positioning Drive Components

DX-202 (2 in-lbs.)	DXA-202 Amplifier DXM-202 Motor TDT-XX Cable
DX-205 (5 in-lbs.)	DXA-205 Amplifier DXM-202 Motor TDT-XX Cable
DX-308 (8 in-lbs.)	DXA-308 Amplifier DXM Motor TDL-XX Cable
DX-318 (18 in-lbs.)	DXA-318 Amplifier DXM Motor TDL-XX Cable
DX-430 (30 in-lbs.)	DXA-430 Amplifer DXM or DXE-430 Motor* TDL-XX Cable
DX-450 (50 in-lbs.)	DXA-450 Amplififer DXM or DXE-430 Motor* TDL-XX Cable
DX-480 (80 in-lbs.)	DXA-480 Amplifier DXM or DXE-480 Motor* TDL-XX Cable
DX-780 (80 in-lbs.)	DXA-780 Amplifier DXM-780 Motor TDL-XX Cable
DX-7120 (120 in-lbs.)	DXA-7120 Amplifier DXM-7120 Motor TDL-XX Cable
DX-6120 (120 in-lbs.)	DXA-6120 Amplifier DXM-6120 Motor RC-XX Cable
DX-6200 (300 in-lbs.)	DXA-6200 Amplifier DXM-6200 Motor RC-XX Cable
DX-6300 (300 in-lbs.)	DXA-6300 Amplifier DXM-6300 Motor RC-XX Cable
DX-8200 (200 in-lbs.)	DXA-8200 Amplifier DXM-8200 Motor
DX-8300 (300 in-lbs.)	DXA-8300 Amplifier DXM-8300 Motor
DX-8400 (400 in-lbs.)	DXA-8400 Amplifier DXM-8400 Motor

NOTE:	The DX-8XXX series motor and Amplifiers are interconnected Via screw terminals so as to allow for customer provided wiring Not to exceed 100ft.
NOTE:	XX = CABLE LENGTH (FT)15 25 25 50 50
*NOTE:	DX-430, DX-450 and DX-480 Drives can be provided with Motors that have either typical English or metric flange and Shaft dimensions. The metric motor is designated with a DXM prefix and the English version is designated with a DXE prefix.

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Introduction to the basic positioning drive amplifier

The Positioning Drive amplifier is different from common analog amplifiers in that it includes a position feedback loop and the electronics to control motion functions. To accomplish this, the motor uses resolver feedback. The resolver converter electronics in the amplifier develops velocity and position feedback signals required for high performance and precise velocity and position control.

In addition the amplifier offers three standard modes of control providing a host of alternatives for implementing real time motion control.

In the ANALOG TORQUE or VELOCITY mode, the amplifier responds to a conventional +/- 10 volt signal. Most variable speed drives and servo amplifiers on the market today receive commands via analog input.

The true power and versatility of the Positioning Drive is best utilized in the additional positioning control modes. In most applications the user will use one of the following modes of operation.

In the PULSE mode, the drive responds to a serial pulse train representing externally generated incremental position change commands. These commands are normally in the form of CW or CCW directional pulses. This mode is commonly used to control DC stepper motors or numeric controlled (CNC) machinery.

The INDEXING mode allows up to thirty-two different indexes or positions to be pre-programmed and stored in a non-volatile memory. These indexes plus other commands such as STOP and JOG are selected easily by the drive's parallel input/output (I/O) lines from devices such as PLCs or operator push buttons. Parallel I/O commands can be used for stand alone operation or, simultaneously in conjunction with any other two control modes.

Another powerful feature of the INDEXING mode allows ASCII commands through the standard RS423 serial interface. This interface port allows the user to down load new dimensional data e.g., position, distance, velocity, etc., and command an internally generated index using those parameters. These ASCII serial commands are well suited to operation from the RS232C serial interface on an IBM Personal Computer (PC) or Programmable Logic Controller (PLC) with ASCII or Basic Module.

For additional stand alone motion control capability, the drive is designed to accept a series of application oriented modules called "PCM" modules. The PCMs can be attached to any drive by simply plugging them onto the front. The PCM is designed to share the power supply inside of the drive and includes 12 additional optically isolated inputs/outputs (making a total of 24). When attached, the PCM module extends the operation of the Positioning Drive system.

The IOM-1, PCM-1, PCM-2 and PCM-5 modules are designed to be plug-on additions to EMERSON EMC's line of Positioning Drives. Each module is intended to enhance a specific performance characteristic of the positioning drives.

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Peripherals

IOM-1 Input/Output Expander Module

The IOM Module mounts to the front of the basic drive to double the I/O capability for those applications where the number of inputs and outputs provided with the basic unit are not adequate for interfacing motion to the machine logic controllers. Each of these lines are optically isolated and can be connected in either a current sinking or current sourcing arrangement. In addition, the IOM-1 includes the parallel interface port required for connecting 1 or 2 thumbwheels and 1 remote display or parallel communications with a PLC.

PCM-1

The PCM-1 module converts the basic Positioning Drive from a "smart" servo drive system with indexing capabilities into a motion control system capable of executing numbered sequences of indexes called motion programs. Each motion program combines basic indexes to achieve complex motion profiles beyond what is possible with the basic drive. In addition, the PCM module greatly increases the non-volatile memory storage capability of the standard digital drive. This allows the user greater flexibility in both the size and the number of programs (and indexes) available. Another advantage of PCM-1 is that it increases the number of input lines from 8 to 16 and the number of output lines is increased from 4 to 8. All inputs and outputs are assignable from a standard list of I/O functions. Lastly, the PCM-1 allows the user to create compound indexes and includes the parallel interface port required for connecting 1 or 2 thumbwheels and 1 remote display or parallel communications with a PLC.

PCM-5

The PCM-5 has most of the capability of the PCM-1. The PCM-5 is able to do electronic synchronized line shafting and ratio control. This is accomplished by using an external encoder or drive representing a lead axis connected to the PCM-5. The drive with the PCM-5 can then be synchronized to the lead device. This mode of operation also allows for pulse counting of the lead device and indexing at velocities proportional to its speed. With this capability, flying shear/cutoff applications can easily be configured.

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Operator Interface

Emerson EMC can provide three different peripheral devices to enhance the operator friendliness of your drive. The T-21 Data Entry Terminal is ideally suited for providing machine operators with the ability to enter and/or alter and display machine motion parameters controlled by Emerson Digital Positioning Servo Drive. The T-16 displays position and velocity parameters using large sized LEDs that are visible from several feet away. Emerson EMC offers a simple thumbwheel interface called a TW-XXX that is offered in many different configurations. The TW-XXX is used to change data of a specific motion parameter or parameters. The thumbwheel option is ideal for applications needing minimum operator interface.

T-21 Data Entry Terminal

The T-21 communicates with any Emerson Positioning Drive using serial ASCII codes and allows the machine designer to access, display, or alter certain motion parameters such as index length. For frequently accessed motion parameters, the operator cam simply depress one of three user programmable function switches located on the front panel. By depressing the correct function key, the proper user created message is displayed. The message can be created to include information as to what setup parameter is being changed, on which axis, etc. If more than 3 operator altered setup parameters are required, a fourth F(x) key allows the user to store up to 95 additional operator alterable setup functions.

T-16 Numeric Display

The T-16 is used to display position or velocity of the drive. The T-16 has 7 large LEDs that are visible from several feet away. This allows the operator to view data shown on the display from different positions on a machine. The T-16 requires the use of the ION-1 or a PCM-1 module. The T-16 plugs into the parallel port on the module.

TW-XXX Thumbwheel Interface

The thumbwheel interface provides the user with a non-serial interface method for making changes to specific motion functions. The user can set up the thumbwheel to change velocities, distances/positions, dwell times, index counts, and acceleration and deceleration times. All the thumbwheels are mounted in a small, self contained enclosure. Cables can be ordered in specific lengths from 3 feet to 50 feet. The TW-XXX requires the user to have an IOM-1 or a PCM-1 module. The TW-XXX plugs into the parallel port on the module.

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FAMILY OF POSITIONING DRIVE PRODUCTS

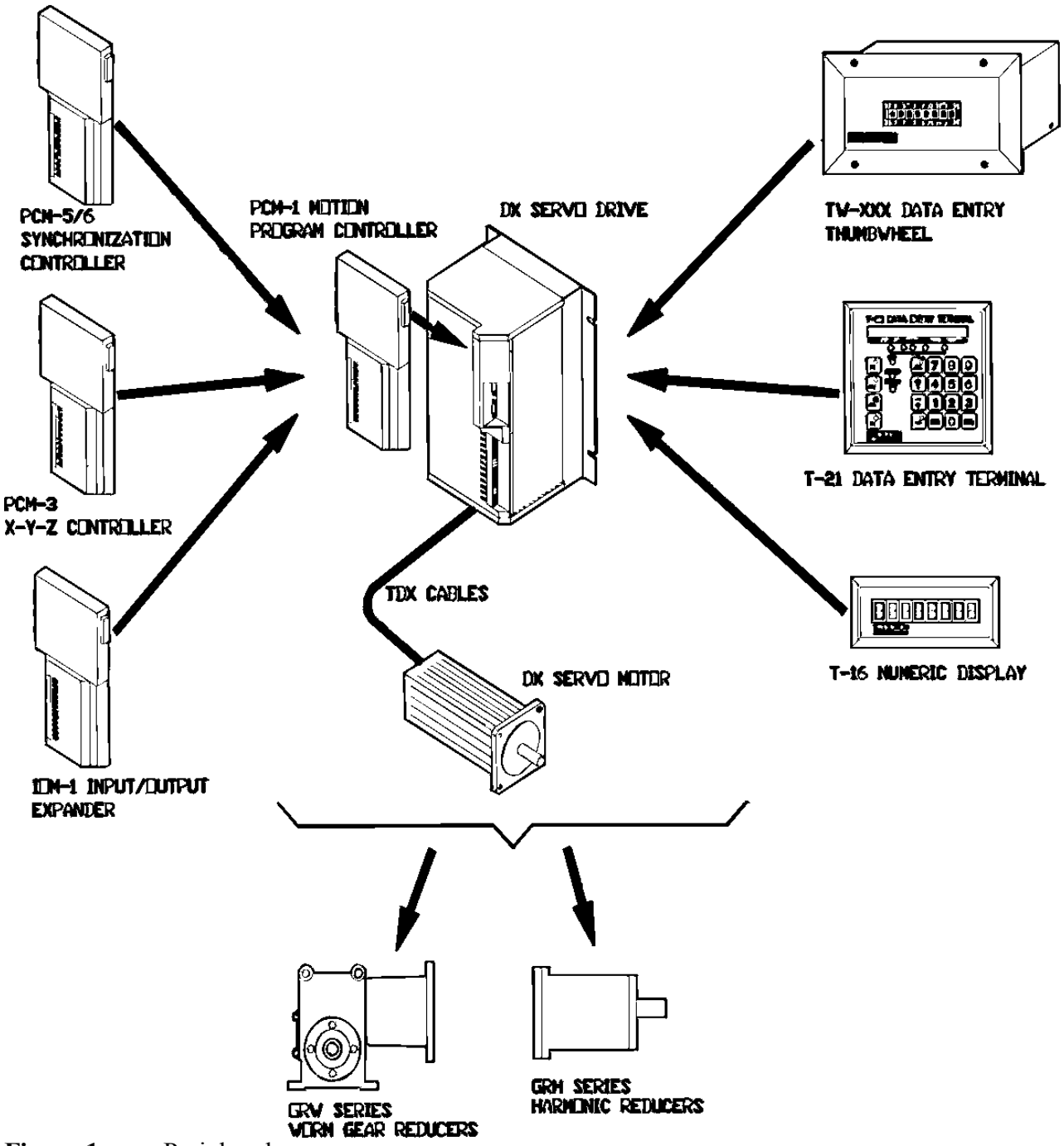


Figure 1 Peripherals

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POSITIONING DRIVE SPECIFICATIONS

Specifications +/- 10%

Table II Positioning Drive Specifications

DRIVE PERFORMANCE Drive Model #	Motor Model #	Torque Cont/Peak IN/LBS	Rotor Interia IN/LBS/SEC	Max. RPM	Bus Fuse	Shunt Fuse	KT IN-LBS/AMP	KE Volts/KRPM	Amplifier Current Ratings
DX-202	DXM-202	2/4	.0000855	3000	7 AMP	2A(S.B.)	1.8	23	1.1/2.2
DX-205	DXM-205	5/10	.000253	3000	7 AMP	2A(S.B.)	1.8	23	3.0/6.0
DX-308	DXM-308	8/16	.0005	3000	7 AMP	2A(S.B.)	2.9	34	2.8/5.6
DX-318	DXM-318	18/36	.001	3000	10 AMP	5A(S.B.)	3.38	40	5.4/10.8
DX-430	DXM-430	30/60	.0026	3000	15 AMP	5A(S.B.)	3.38	40	8.9/17.8
DX-450	DXM-450	50/85	.0052	3000	25 AMP	5A(S.B.)	3.38	40	14.8/24.0
DX-480	DXM-480	80/160	.00772	3000	30 AMP	8A(S.B.)	3.36	42	24/48
DX-780	DXM-780	80/160	.013	3000	30 AMP	8A(S.B.)	3.38	40	24/48
DX-7120	DXM-7120	120/240	.021	2000	30 AMP	8A(S.B.)	5.57	66	24/48
DX-6120	DXM-6120	120/240	.0096	3000	15 AMP	7A	8	100	15/30
DX-6200	DXM-6200	200/400	.0192	3000	20 AMP	7A	8	100	25/50
DX-6300	DXM-6300	300/600	.0268	3000	30 AMP	10A	8	100	38/76
DX-8200	DXM-8200	200/300	.04	3000	20 AMP	7A	7.4	96	27/41
DX-8300	DXM-8300	300/450	.08	3000	30 AMP	10A	7.4	96	40/60
DX-8400	DXM-8400	400/600	.12	3000	40 AMP	10A	7.4	96	54/81

INPUT VOLTAGE: DX-202, DX-205, DX-308, DX-430, DX-450, DX-480, DX-780, DX-7120 = 96-132 VAC, 50/60 Hz, single phase

INPUT VOLTAGE: DX-6120, DX-6200, DX-6300, DX-8200, DX-8300, DX-8400 = 196-264 VAC 3 PHASE 50/60 Hz

SWITCHING FREQUENCY:
- DX-202, DX-205, DX-308, DX-430 = 20 Khz
- DX-450, DX-480, DX-780, DX-7120 = 15 Khz
- DX-6120, DX-6200 = 15 Khz
- DX-6300 = 12 Khz
- DX-8200, DX-8300, DX-8400 = 10 Khz

DEAD BAND: Zero

VELOCITY SIGNAL INPUT: ±10 vdc typical (10 bit resolution speed selection ±10 volt)

TORQUE SIGNAL INPUT: ± vdc typical (10 bit resolution speed selection ±10 volt)

PULSE MODE INPUT: TTL compatible, 500 nsec minimum pulse width, 210 Khz max frequency

ANGULAR ACCURACY:

Cable Length	**15FT**	**50FT**	**100FT**
Minutes	±20	±30	±40

USER UNITS/REV: Programmable Range (200-25000)

AMPLIFIER THERMAL SHUT DOWN AS DETECTED IN POWER STAGE:

All Drives: 80º - 90º C

MOTOR THERMAL SHUT DOWN AS DETECTED IN MOTOR (CASE TEMP):

All Motors: 100º - 115º C

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OPTIONAL FAIL-SAFE BRAKE: (Activated by the Positioning Drive)

Table III Fail Safe Brake

Model	Holding Torque IN-LBS
DX-308	12
DX-318	25
DX-430	45
DX-450	75
DX-480	120
DX-780	120
DX-7120	180
DX-6120	400
DX-6200	400
DX-6300	400
*DX-8200	300
*DX-8300	450
*DX-8400	600
*Special (consult factory)	

COMMAND PULSE: 5-15 vdc

MODE INPUTS: 25-70 milliamps

ANALOG INPUTS: -10 vdc to +10 vdc operating range
-12 vdc to +12 vdc absolute maximum
Different input greater than 9K ohms

SERIAL INTERFACE: RS423 signal compatible
Xmit, Rec, and GND

INPUTS AND OUTPUTS: Outputs: sink or source (2 terminals);
200 Ma max (external current limit required) each

Inputs: 10 to 30 vdc (internal current limit provided)
10, 12, 15 and 24 vdc typical

Table IV User Memory Capacity

User Memory Capacity

	Drive	Drive w/IOM-1	Drive w/PCM-1	Drive w/PCM-5
Jog	2	2	2	2
Home	1	1	1	1
Indexes	32	32	256	256
Programs	0	0	64	64

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Table V Number of User Programs

Number of Required User Programs	Average Number of Available Steps Per Program
1	1000
2	500
3	333
4	250
5	200
-	-
-	-
-	-
62	16
63	15

Table VI Motor Load Specifications

Motor Radial and Axial Load Specifications

Motor	Max Radial Load	Max Axial Load
DXM-202	10 lbs	8 lbs
DXM-205	10 lbs	8 lbs
DXM-308	20 lbs	15 lbs
DXM-318	20 lbs	15 lbs
DX* -430	50 lbs	20 lbs
DX* -450	50 lbs	20 lbs
DX* -480	75 lbs	40 lbs
DXM-780	150 lbs	50 lbs
DXM-7120	150 lbs	50 lbs
DXM-6120	150 lbs	50 lbs
DXM-6200	150 lbs	50 lbs
DXM-6300	150 lbs	50 lbs
DXM-8200	150 lbs	50 lbs
DXM-8300	150 lbs	50 lbs
DXM-8400	150 lbs	50 lbs

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DX-SERIES MOTORS AND AMPLIFIERS TYPICAL SPEED TORQUE CURVES

DX-202, DX-308, DX-318, DX-430, DX-480, DX-780

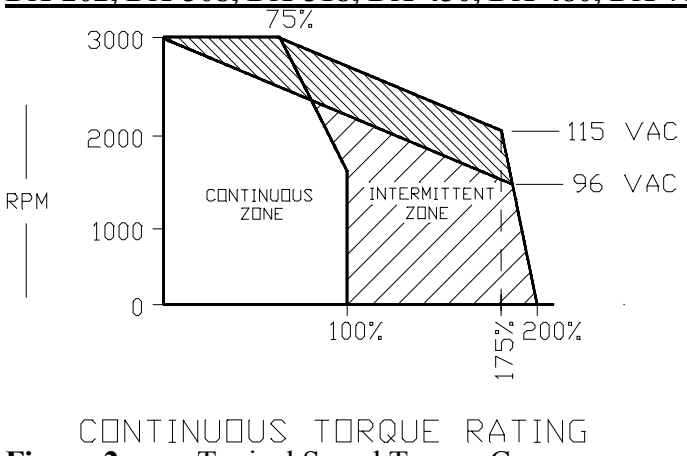


Figure 2 Typical Speed Torque Curve

DX-7120

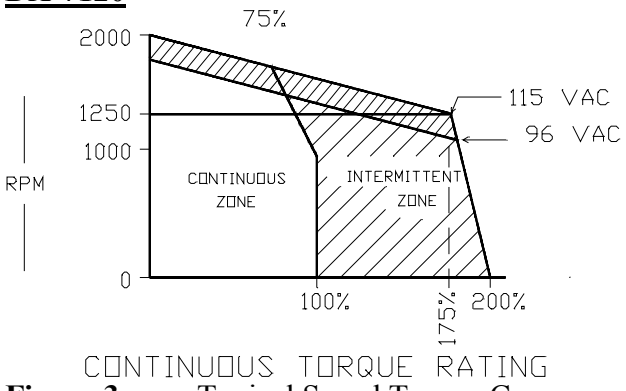


Figure 3 Typical Speed Torque Curve

DX-205

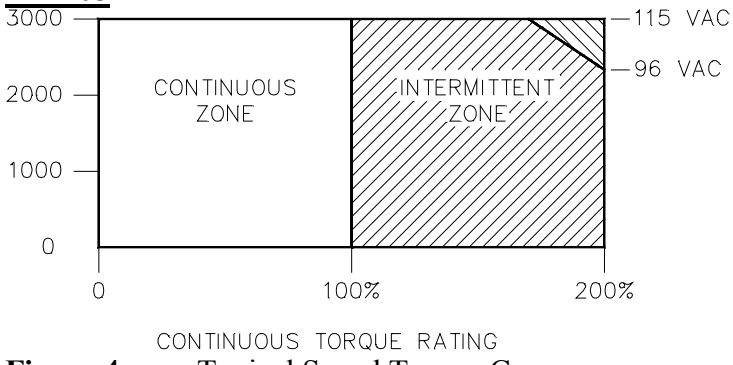


Figure 4 Typical Speed Torque Curve

* Continuous torque rating of the motors is measured using a 10” X 10” X 0.25” mounting plate that acts as a heatsink.
* All specifications are ± 10%.

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DX-450

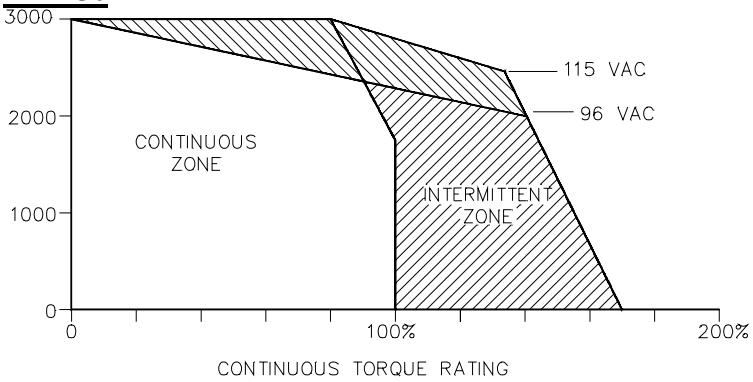


Figure 5 Typical Speed Torque Curve

DX-6120, DX-6200, DX-6300

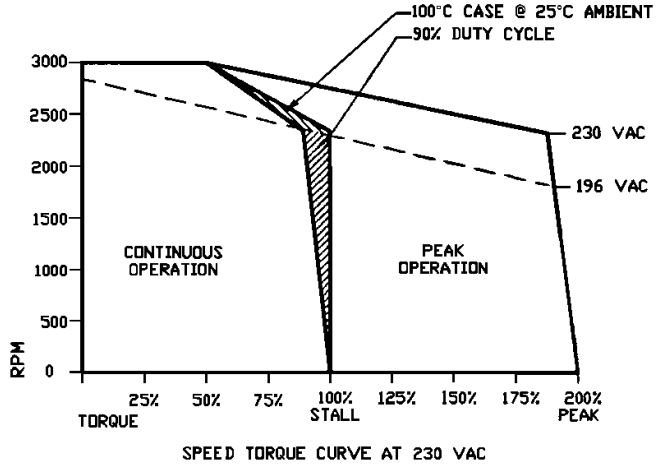


Figure 6 Typical Speed Torque Curve

1) Peak operation is available for ≥1.0 seconds from 0 torque.
2) Speed torque curves are based on 144" sq. by ½" thick aluminum face plate.
3) Derate available torque by 1% per °C for operation above 30°C, to an ambient temperature of 45°C, for motor and amplifier.

DX-8200, DX-8300, DX-8400

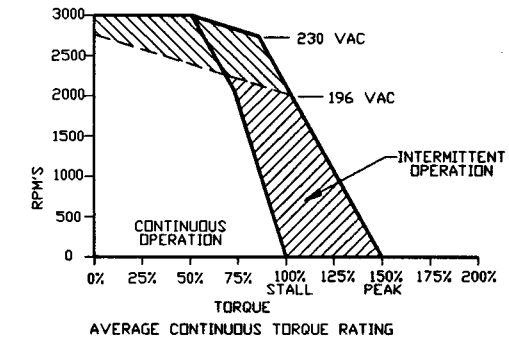


Figure 7 Typical Speed Torque Curve

* Continuous torque rating of the motors is measured using a 10" X 10" X 0.25" mounting plate that acts as a heatsink.
* All specifications are ± 10%.

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INSTALLATION

OVERVIEW

The Positioning Drives were designed with simple installation in mind. The Drive normally back-mounts into a standard NEMA enclosure. Because of its small footprint and no need for external transformers, boards and power supplies, the Positioning Drive saves significant panel space and cost over alternative servo positioning systems. Wiring and connecting the drive is equally simple. AC line power is connected via provided screw terminals. All 120 VAC models use single phase 50/60 Hz power. All 230 VAC models use 3 phase 50/60 Hz power.

Inputs and outputs for control and status are wired to a 12 position, detachable terminal strip (this also makes servicing easy). The RS423 serial interface used for setup, status and control can be connected with a 9 pin D-type connector. The motor connections for the 120 VAC single phase models are accomplished with factory supplied cable and mating connectors. The higher power 230 VAC 3 phase models are connected via screw terminals at the amplifier and motor. This allows the user to supply his own wire.

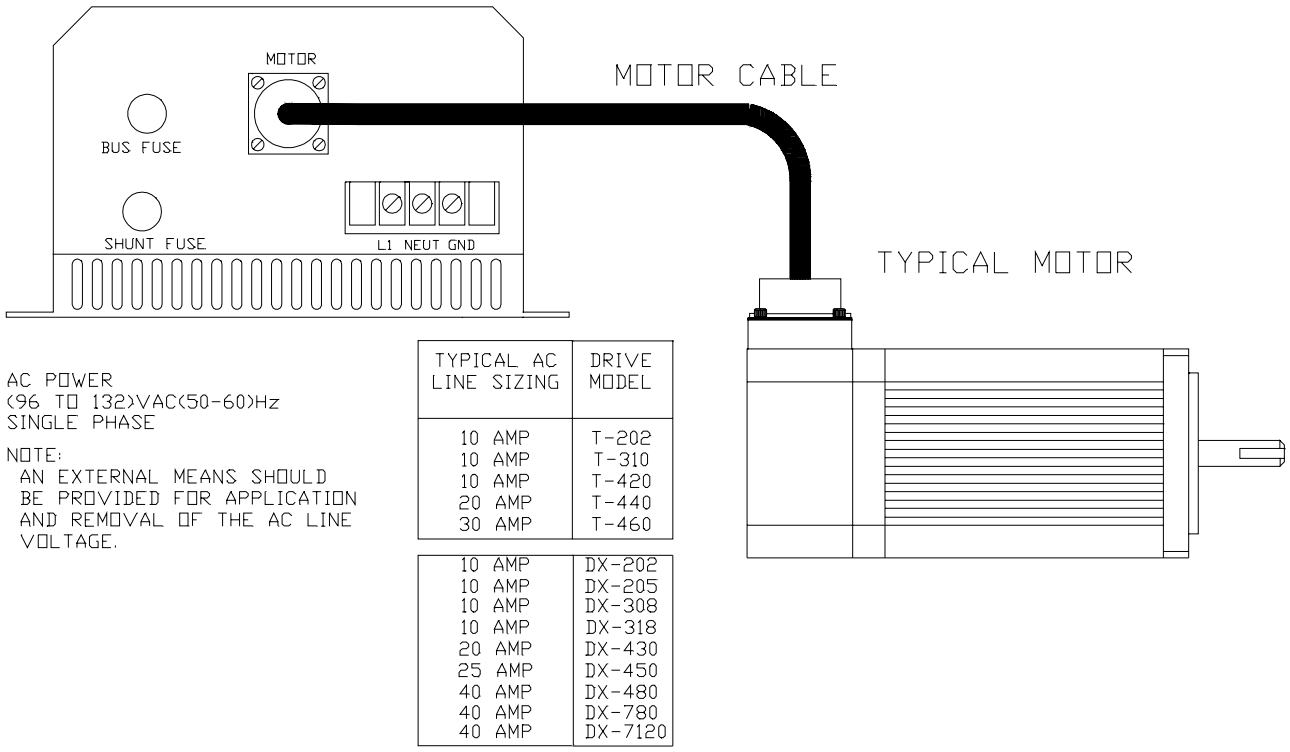
The larger drive motors also have NPT pipe thread holes for metallic raceways. It is a requirement that the stator wiring R, S, T be run in metallic raceways and 1-1/4" pipe conduit holes are provided. The feedback wiring must be done by using shielded cabling with 100% shielding via a foil shield and a braided shield.

ASSEMBLY AND INSTALLATION CONSIDERATIONS

The following procedures outline the methods necessary to assure reliable and trouble free installation of the EMERSON EMC Positioning Drive.

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TYPICAL 120 VAC LINE SIZING (SINGLE PHASE MODELS)



TYPICAL AC LINE SIZING	DRIVE MODEL
10 AMP	T-202
10 AMP	T-310
10 AMP	T-420
20 AMP	T-440
30 AMP	T-460

10 AMP	DX-202
10 AMP	DX-205
10 AMP	DX-308
10 AMP	DX-318
20 AMP	DX-430
25 AMP	DX-450
40 AMP	DX-480
40 AMP	DX-780
40 AMP	DX-7120

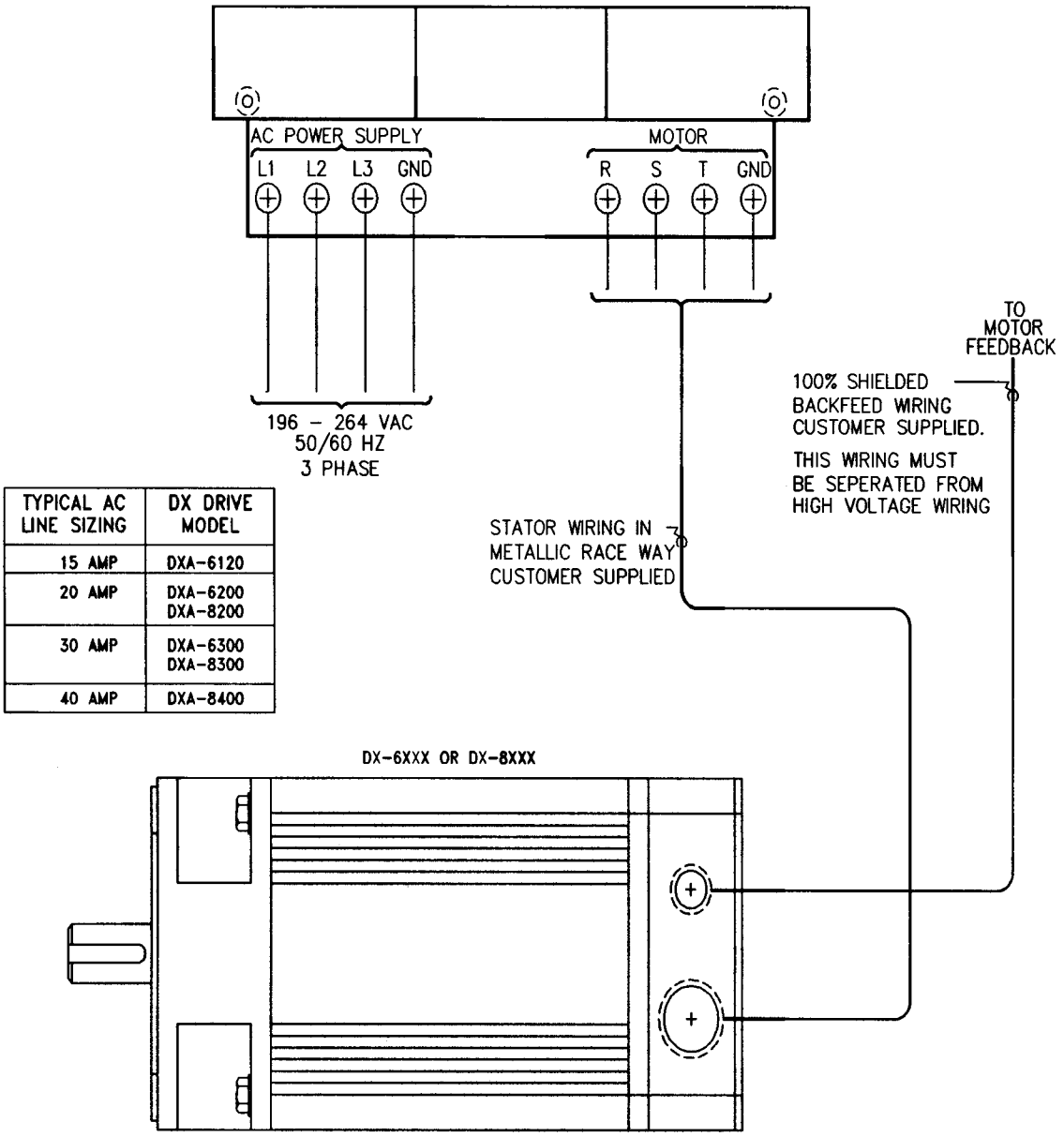
Figure 8 Typical 120 VAC Line Sizing

The approximate AC line source VA rating can be determined by multiplying the AC line sizing by 120 VAC.

Example: DX-780
Line sizing = 40 amp
(40 amps) * (120 VAC) = 4800 VA

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TYPICAL 230 VAC 3 PHASE MODELS



TYPICAL AC LINE SIZING	DX DRIVE MODEL
15 AMP	DXA-6120
20 AMP	DXA-6200 DXA-8200
30 AMP	DXA-6300 DXA-8300
40 AMP	DXA-8400

Figure 9 Typical 230 VAC 3 Phase Connections

The approximate AC line source VA rating can be determined by W = E•I 1.732

Example: DX-8200 = 20 Amps
Watts = 230 VAC • 20 Amps • 1.732 = 7,967

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The following table should be used as a guideline for minimum sizing the AC wiring.

Table VII Typical Line Ampacities & Wire Gauges

Drive	Typical Line Ampacities	Recommended Minimum Wire Gauge
DX-202	10 A	16 AWG
DX-205	10 A	16 AWG
DX-308	10 A	16 AWG
DX-318	10 A	16 AWG
DX-430	20 A	12 AWG
DX-450	25 A	12 AWG*
DX-480	40 A	10 AWG*
DX-780	40 A	10 AWG*
DX-7120	40 A	10 AWG*
DX-6120	15 A	12 AWG*
DX-6200	20 A	12 AWG*
DX-6300	30 A	10 AWG*
DX-8200	20 A	12 AWG*
DX-8300	30 A	10 AWG*
DX-8400	40 A	8 AWG*

* AC power lines that are farther than 50 ft. from the power source, many require a larger gauge that what is recommended above.

Wiring Considerations

If you are not sure of your grounding or signal wiring techniques, you should observe the recommended practices according to the IEEE Ground Book, ANSI Standard C1141 and the National Electric Code.

Wiring of any industrial equipment should be done with some consideration for future troubleshooting and repair. All wiring should be either color coded or tagged with industrial wire tabs.

All I/O wiring must be done with industrial grade insulated wire to withstand the environment of the application. 18 to 24 gauge wire must be used for I/O wiring. The use of larger gauge wire will cause the I/O terminals to prematurely fatigue. Each input and output to the control unit is designed to have high noise immunity. This does not mean that high voltage, noise emitting wiring on the rest of the application can be run adjacent to the control inputs. Precautions should be taken to eliminate any possible noise from reaching the drive.

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Safety Considerations

The user is responsible for emergency interlock switches. Any master interlock should be wired to shut down AC power to all parts of the system. Your system should be designed such that power is disconnected from the output loads any time the equipment is not running, or when the emergency stop is activated.

Brake Option

An additional safety and operational feature can be added by ordering the optional fail-safe brake. The brake allows the motor shaft to be held whenever power is removed from the brake coil (such as in a power failure). The user can control the on/off operation of the brake through either serial commands or an assigned input line. The power supply needed to operate the brake is provided internally in the drive.

Power Line

The lower power 120 VAC (DX-202 thru DX-7120) drives are designed to operate on a 50/60 Hz, single phase AC power line. The AC voltage of this power line must be within the specified range of 96-132 VAC and be free of voltage transients which exceed this range. If it is found that the AC power does not meet these specifications, further AC line conditioning may be required. Also, if there is sensitive electronic equipment (digital computer, test equipment, etc.) operating on the same AC power line as the Drive, additional EMI/RFI filtering may be required to reduce the effects of conducted AC line noise. Operation at 96 VAC will reduce the drive's performance at high (max) speed.

The AC input lines are connected to the drive by means of the 3-position terminal strip located on the bottom plate of the drive. The AC line wires should be connected as shown below. Insufficient or incorrectly applied AC line power is a major cause of drive problems. Wiring sizing and transformer selection (if necessary) should be done carefully.

CAUTION: To insure proper operation after a power down the user should wait a minimum of 10 seconds before reapplication of power.

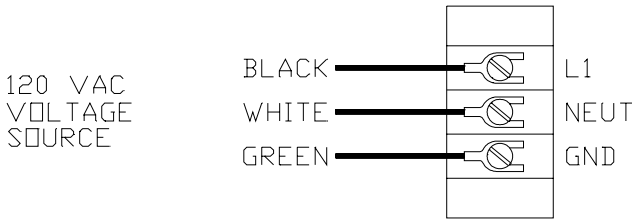


Figure 10 Typical 120 VAC Drives

- L2 is the AC neutral wire and must be grounded (see "Grounding Considerations".)

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The high power 230 VAC (DX-6120, DX-6200, DX-6300, DX-8200, DX-8300, DX-8400) are designed to operate on 3 phase AC power. The AC voltage for these drives must be between 196 to 264 VAC.

The AC input lines are connected to the drive by means of the 4 terminals located on the bottom plate of the drive. The AC line wires should be connected as shown below. Insufficient AC line power from wire size and control transformers is a major cause of drive problems.

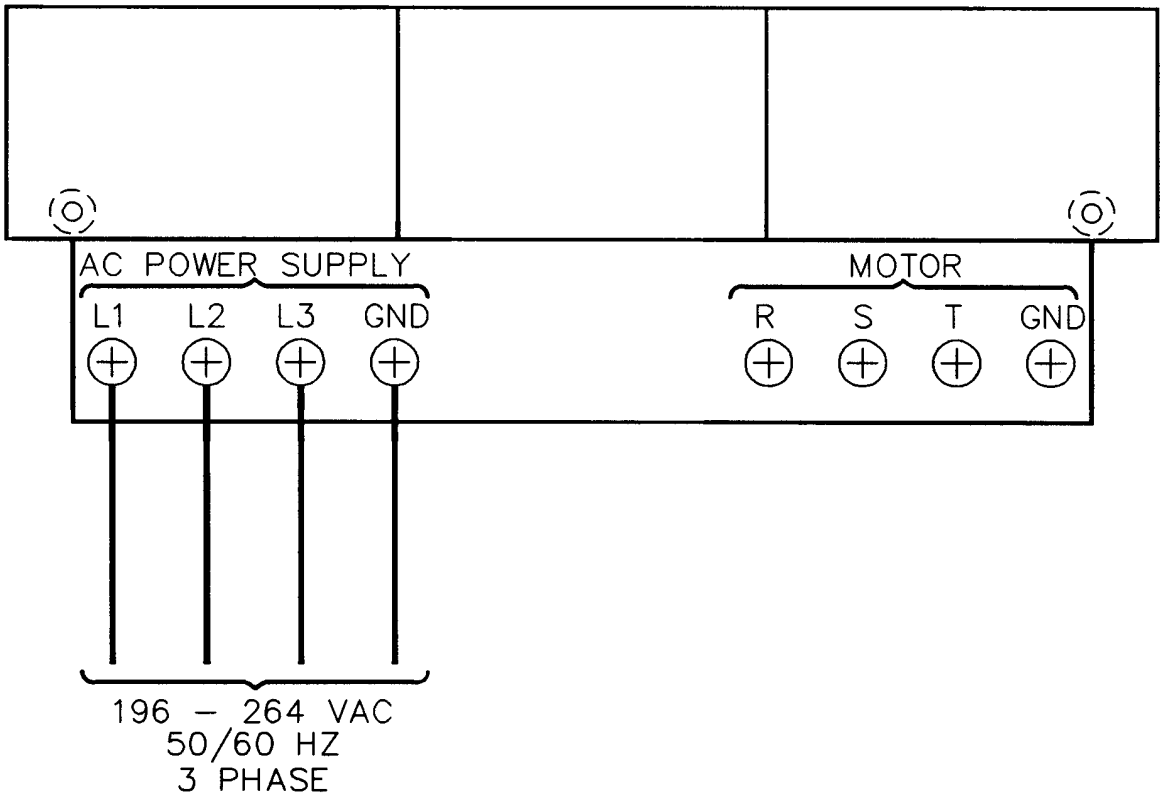


Figure 11 Typical 230 VAC Drives

The GND terminal is bonded to the chassis and must be connected to earth ground.

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Grounding Considerations

The GND terminal of the drive is internally bonded to the frame. The enclosure ground and the drive ground should be a common single point that ultimately is a continuous electrical path to earth ground. The following example illustrates the ideal grounding arrangement of the AC power.

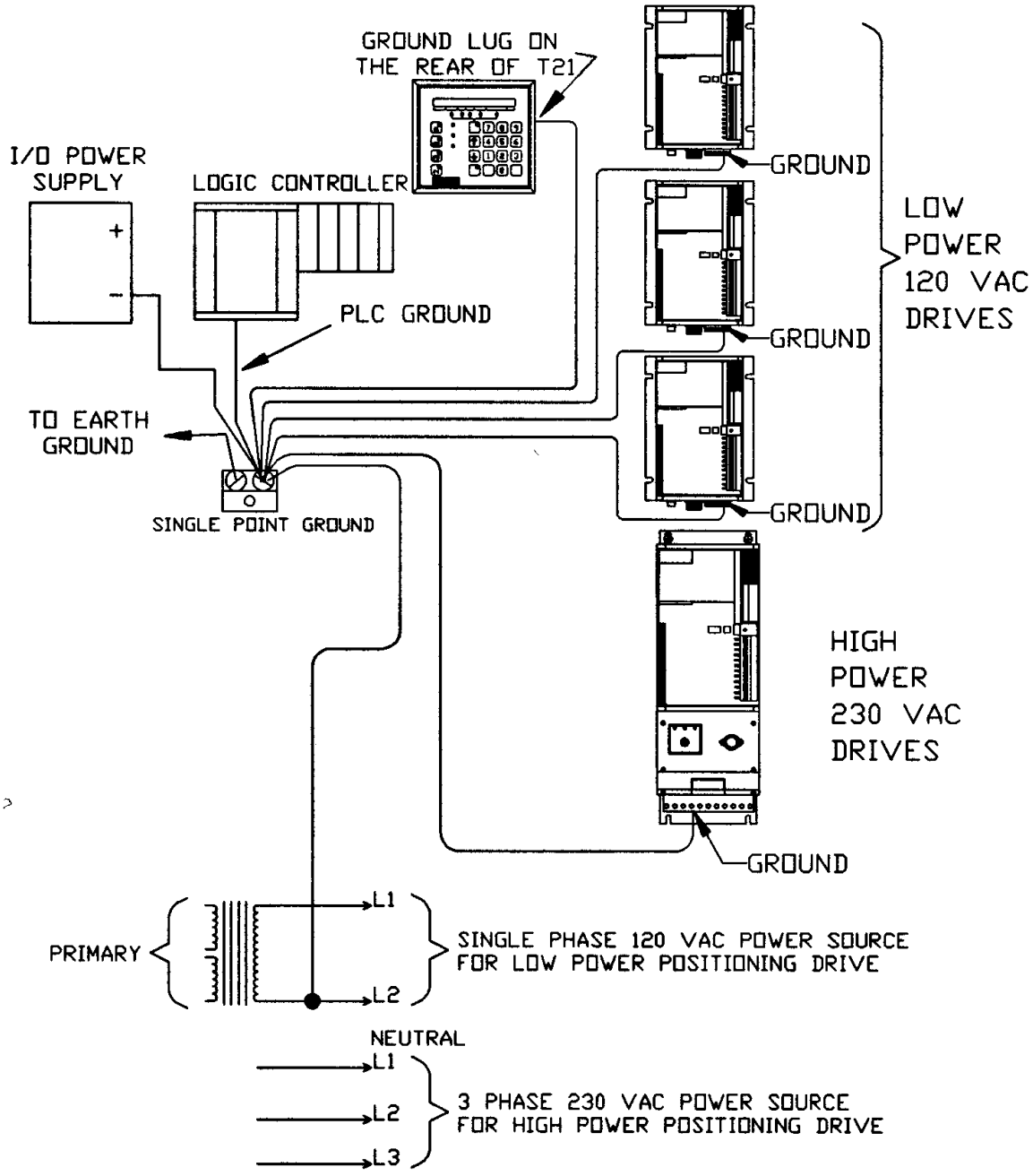


Figure 12 Grounding Illustration

NOTE: These ground wires should not be shared with other equipment. Also note that the neutral (L2) for the 120 VAC source for the low power positioning drive is grounded.

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The following two circuits are given as EMC recommended external disconnecting examples for the 120 VAC low power drives.

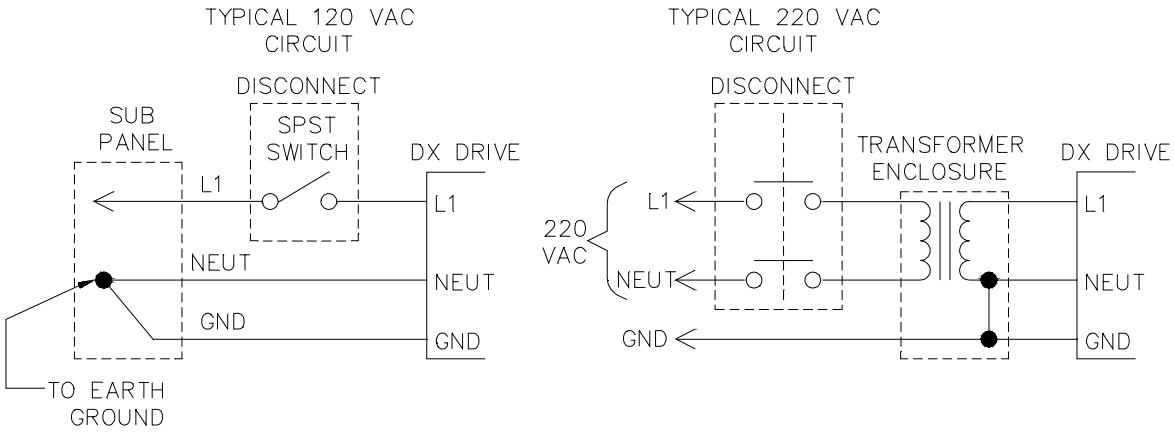


Figure 13 External Disconnect Examples (120 VAC Low Power)

The following examples are for the 230 VAC models. (DX-6XXX's & DX-8XXX's)

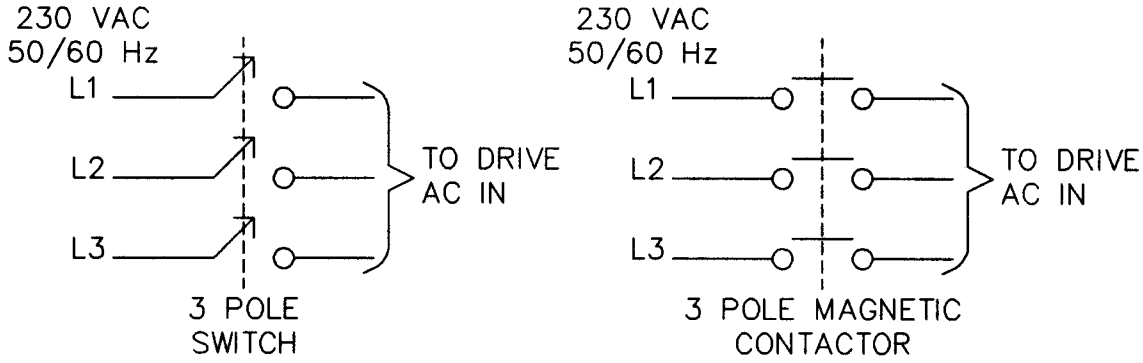


Figure 14 External Disconnect Examples (230 VAC High Power)

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Electrical Noise

Effects of electrical noise on the electronic equipment are greatly reduce when the techniques outlined below are closely followed.

1. Do not run low power control signals and high power wiring in the same raceway.

   NOTE: If mixing wire cannot be avoided, then the low voltage control input and output wiring must be shielded. The shield for these wires should only be connected to ground only at the source end of the signals.

2. Never connect both ends of a shielded cable to ground. This may cause a ground loop condition which could be very difficult to locate.

3. It is suggested that all the wires in the system be kept as short as possible.

Magnetic Coil Noise

In the case of DC relays, a diode is installed across the coil in a direction that will cause the voltage transient to be dissipated through the diode.

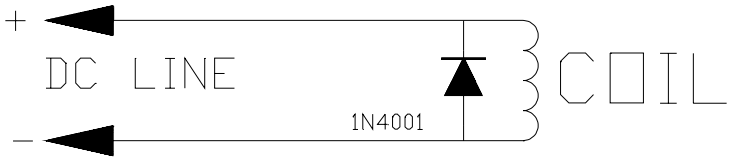


Figure 15 Magnetic Coil Noise (DC Line)

In the case of AC coils a capacitor and resistor are installed across the coil to supress the unwanted transient.

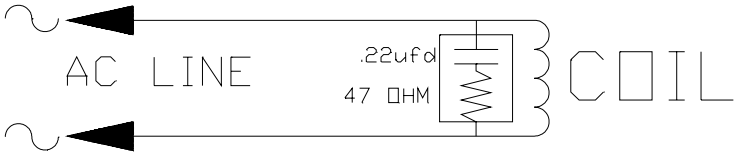


Figure 16 Magnetic Coil Noise (AC Line)

The specific values of resistance and capacitance may vary depending on the inductance of the coil. Consult the relay manufacturer for the proper values to use. These suppressor networks greatly extend the life of the contacts controlling the coil because the transient energy, which can easily reach 1000 volts, shunts through the suppressor's rather than arcing across the controlling contacts as they open.

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Mechanical Consideration

To provide good mechanical alignment the mounting surface of the motor face plate is held perpendicular to the motor shaft to within 0.005 inches of the motor shaft. Projecting above the plane of the mounting surface is a close tolerance circular pilot boss, which, when matched with a pilot hole in the mounting structure, facilitates interchanging the motor, and minimizes the need for mechanical adjustments. The mounting surface is fitted with four holes, equally spaced on a bolt circle pattern.

The mounting panel must be stiff enough so it does not deflect significantly when radial loads are applied to the motor shaft. The mounting panel should also have good thermal conductivity, especially if peak performance is demanded of the motor.

Mechanical shock to the motor case or shaft (e.g., from striking or dropping) must be avoided to prevent damage to the motor. Possible results from striking or dropping include: Misalignment of the resolver; damage to armature bearings; cracking of the motor case; unbonding or demagnetization of the permanent magnets. Any of these would render the motor unserviceable.

Load Coupling

A flexible coupling must be used on the motor shaft to minimize mechanical stress due to radial loads, axial loads and/or misalignment. Radial and axial loading cannot exceed specified values.

Table VIII Load Coupling

Motor	Max Radial Load	Max Axial Load
DXM-202	10 lbs**	8 lbs
DXM-205	10 lbs**	8 lbs
DXM-308	20 lbs**	15 lbs
DXM-318	20 lbs**	15 lbs
DX* -430	50 lbs**	20 lbs
DX* -450	50 lbs**	20 lbs
DX* -480	75 lbs**	40 lbs
DXM-780	150 lbs**	50 lbs
DXM-7120	150 lbs**	50 lbs
DXM-6120	150 lbs**	50 lbs
DXM-6200	150 lbs**	50 lbs
DXM-6300	150 lbs**	50 lbs
DXM-8200	150 lbs**	50 lbs
DXM-8300	150 lbs**	50 lbs
DXM-8400	150 lbs**	50 lbs

* M-(XXX) = Metric E –(XXX) = English
** Maximum radial load is rated at 1 inch from the motor face

Gear Reduce Oil

It is strongly suggested that a synthetic oil is used in the gear reducer or rotary tables. This will reduce the amount of current it takes to drive the motor.

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Selecting An Enclosure

The EMERSON EMC Positioning Drive is designed for the industrial environment. However, no sophisticated electronic system can tolerate certain atmospheric contaminants such as moisture, oils, conductive dust and metallic particles. Therefore, if the drive is going to be subjected to this type of environment, we strongly urge you to mount your drive in a NEMA type 12 enclosure. Proper ventilation and filtering should also be provided. Amplifier losses should be considered for enclosure sizing and ventilation.

Amplifier Losses

The exact power losses in any application depend on the application. The following table losses would represent typical examples. The bridge power losses and shunt power losses can be derated based on any duty cycle for power demand.

The logic supply power consumption varies based on PCM modules. For all 120 VAC models, the logic power consumption is about 60 watts for the 230 VAC models. The consumption is about 100 watts.

The next consideration would be bridge power losses which vary by amplifier size. The table represents losses based on maximum continuous output current to the motor.

In applications where constant acceleration and deceleration occur, additional losses occur in the shunt regulator where energy stored in the rotating inertia is commutated to the drives BUS capacitors. This energy causes the BUS voltage to increase and once sensed, the excess voltage is shorted through a load resistor. These losses could easily equal the bridge power losses.

Table IX Amplifier Losses (By Model)

Model	Logic Supply	Bridge Losses	Shunt Losses	Total
DXA-202	60W	10W	10W	80W
DXA-206	60W	25W	25W	110W
DXA-308	60W	45W	45W	150W
DXA-318	60W	100W	100W	260W
DXA-430	60W	130W	130W	320W
DXA-450	60W	200W	200W	460W
DXA-480	60W	340W	340W	740W
DXA-780	60W	340W	340W	740W
DXA-7120	60W	340W	340W	740W
DXA-6120	100W	400W	400W	900W
DXA-6200	100W	700W	700W	1500W
DXA-6300	100W	1000W	1000W	2100W
DXA-8200	100W	700W	700W	1500W
DXA-8300	100W	1000W	1000W	2100W
DXA-8400	100W	1500W	1500W	3100W

System Troubleshooting

If you encounter a system problem, double check the installation instructions. These instructions eliminate most of the problems encountered. If you have a problem, call EMERSON EMC at (612) 474-8833 and ask for Customer Service Department.

AMPLIFIER MOUNTING INFORMATION

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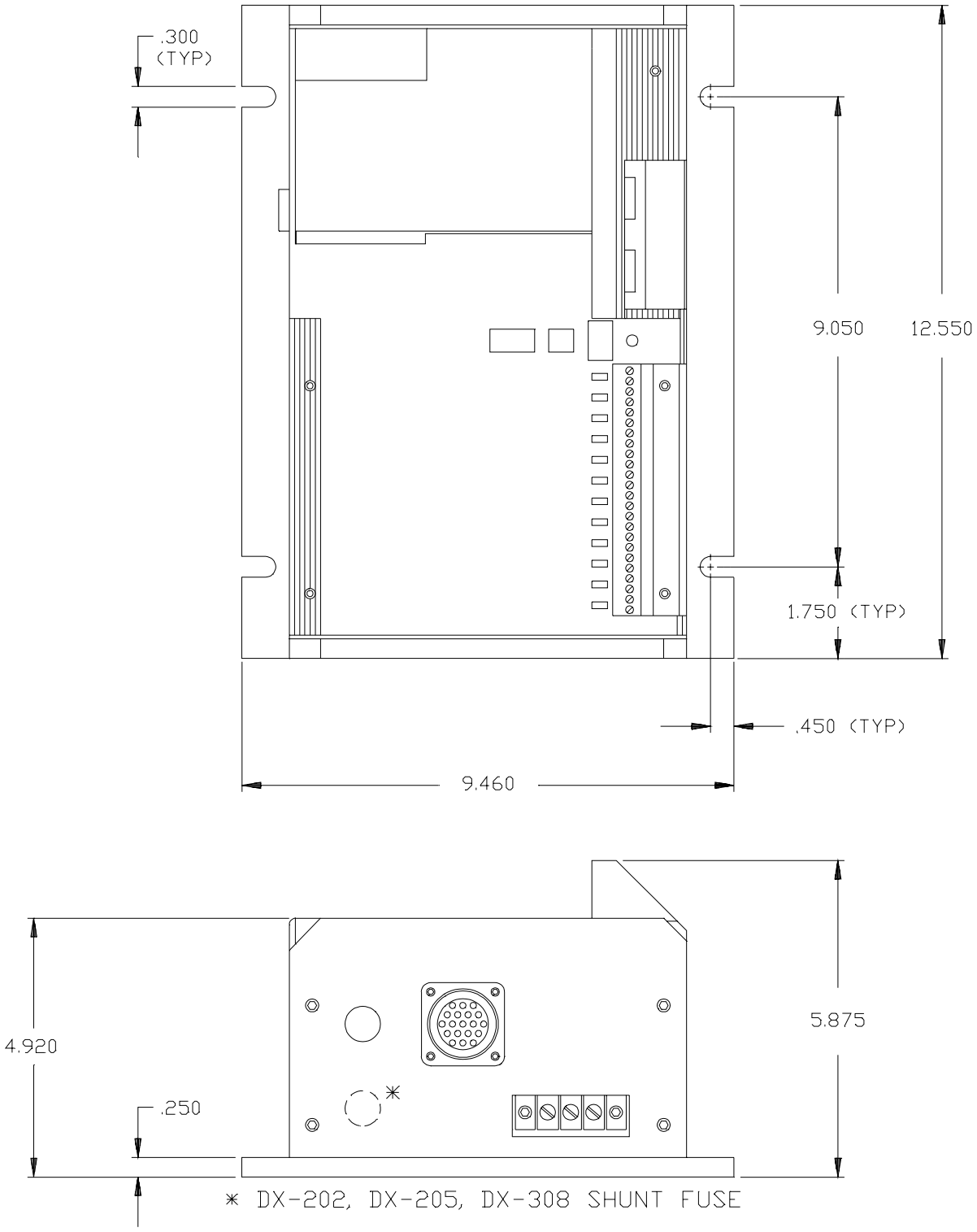
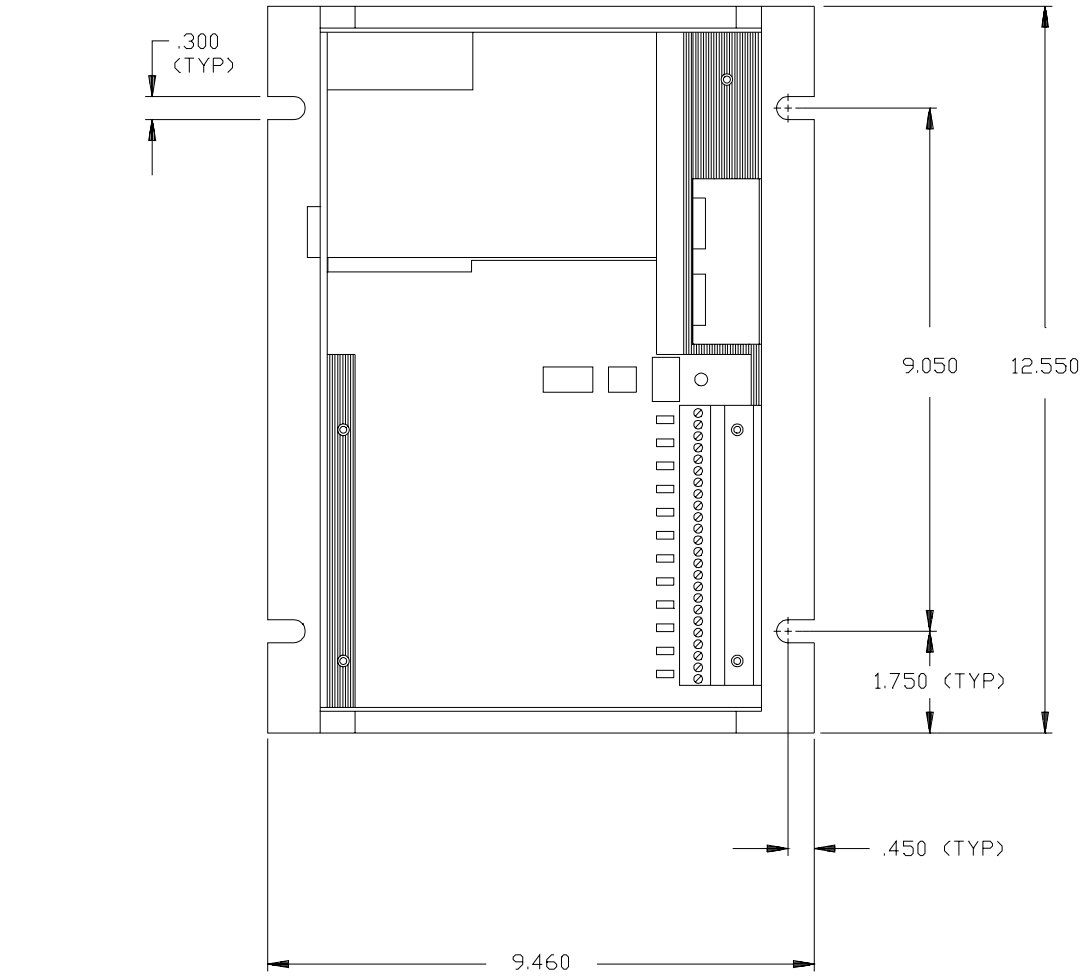


Figure 17 Amplifier Mounting Information (DX-202, DX-205, DX-308)

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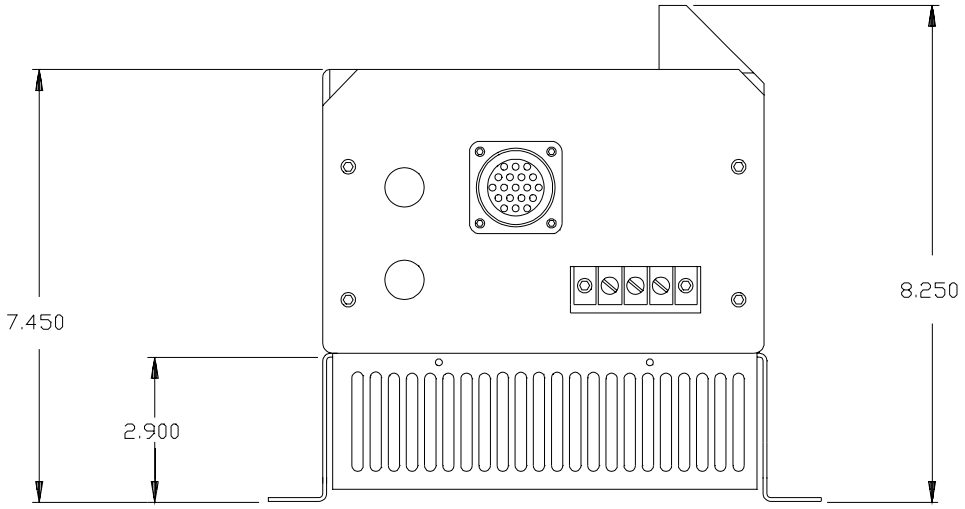


Figure 18 Amplifier Mounting Information (DX-318, DX-430, DX-450)

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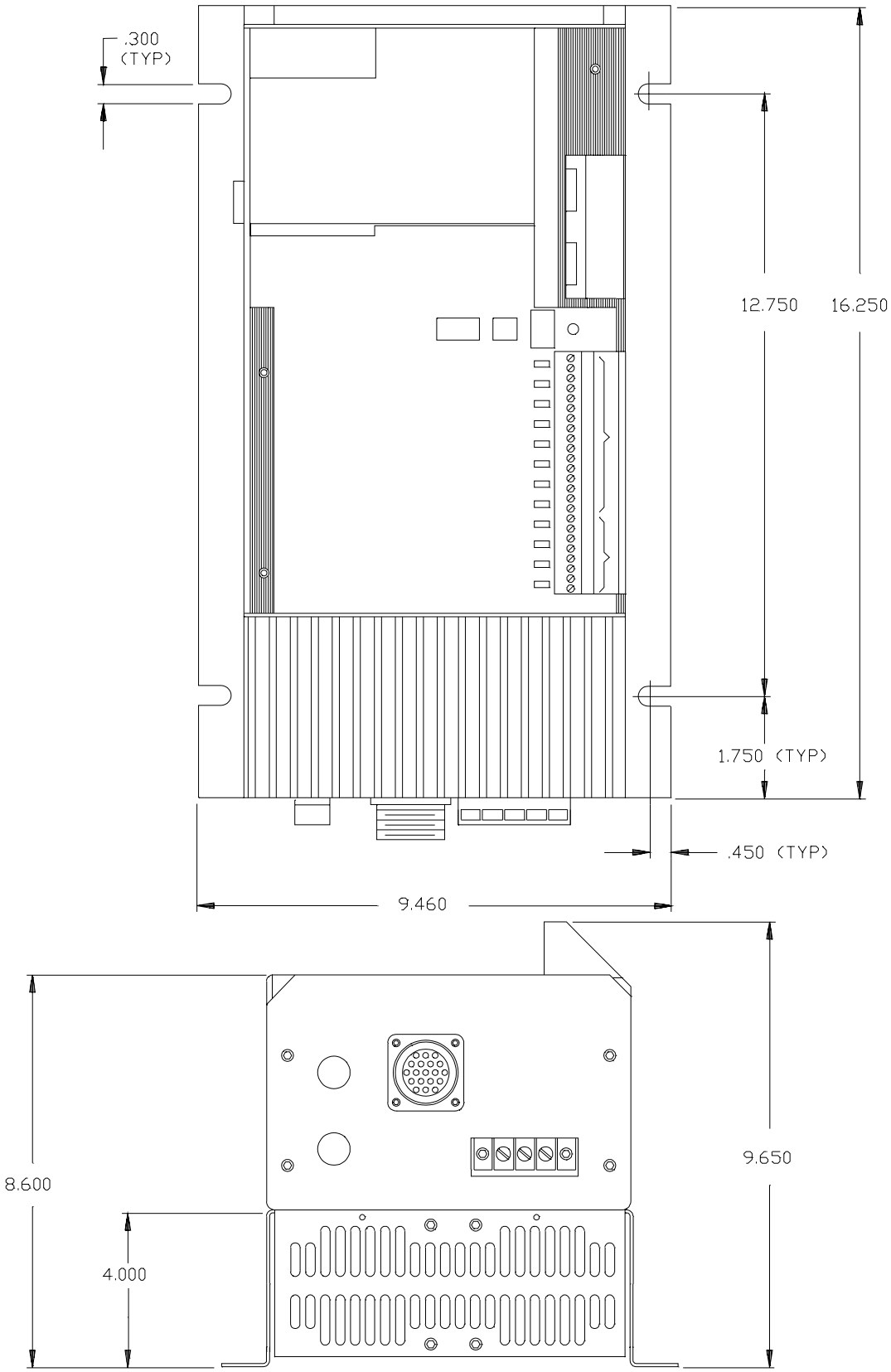


Figure 19 Amplifier Mounting Information (DX-480, DX-780, DX-7120)

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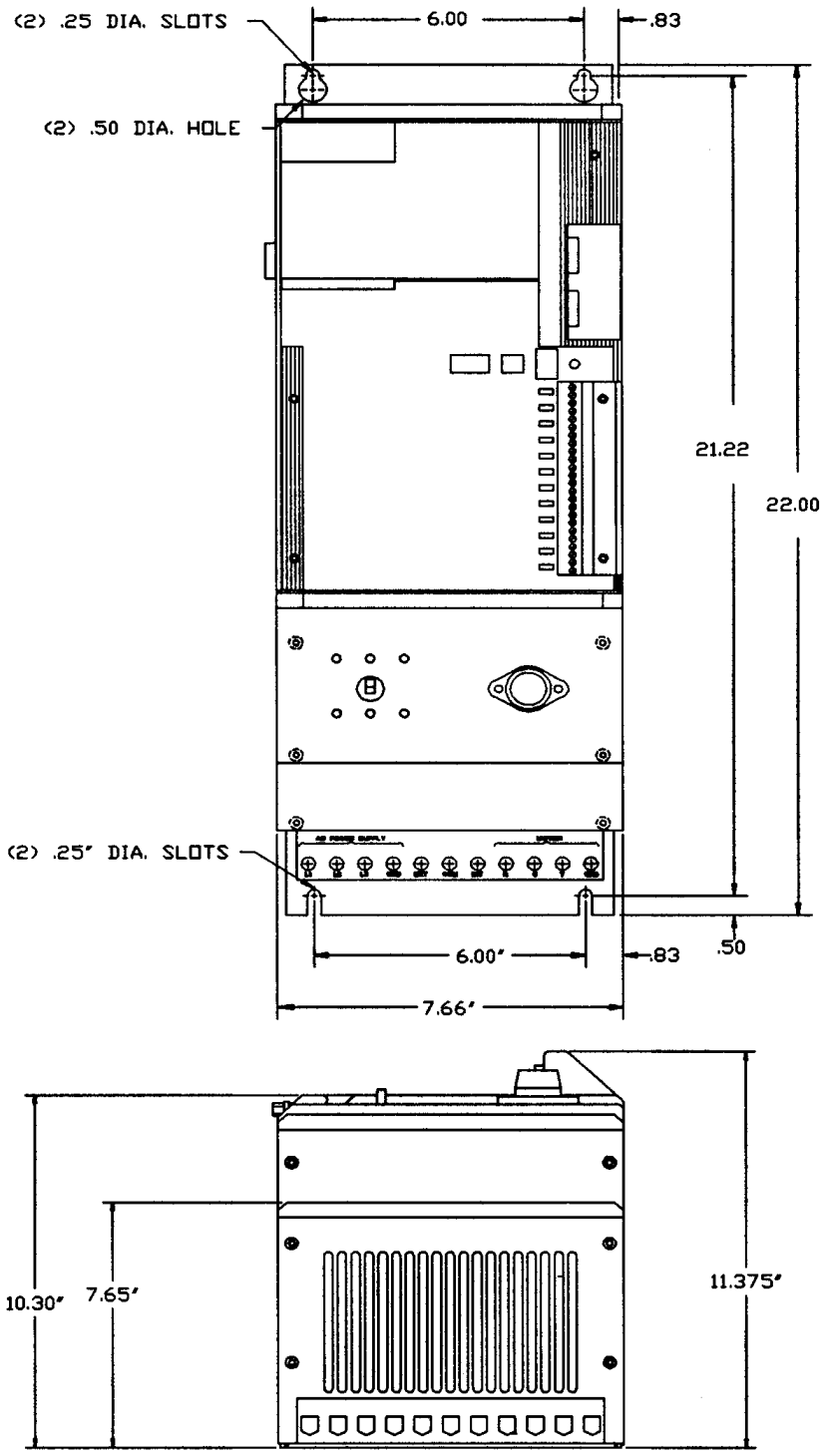


Figure 20 Amplifier Mounting Information (DX-8XXX, DX-6XXX)

CAUTION: These amplifiers cannot be mounted on a combustible surface, as a 1000 watt shunt resistor is located in the base of the chassis. A metal back panel or no back panel is preferred.

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AMPLIFER I/O LOCATIONS

DX-202, DX-205, DX-308

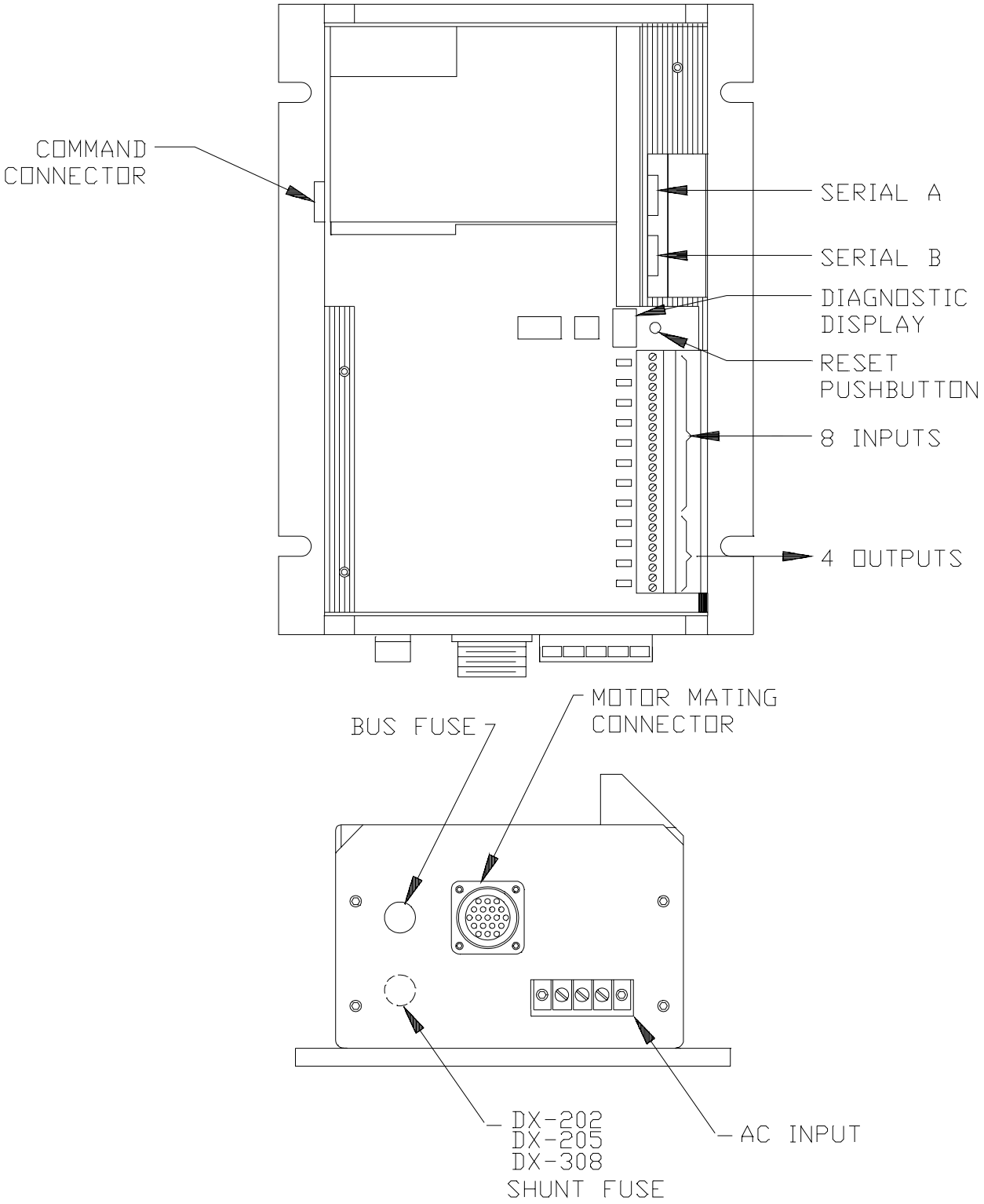


Figure 21 Amplifier I/O Locations (DX-202, DX-205, DX-308)

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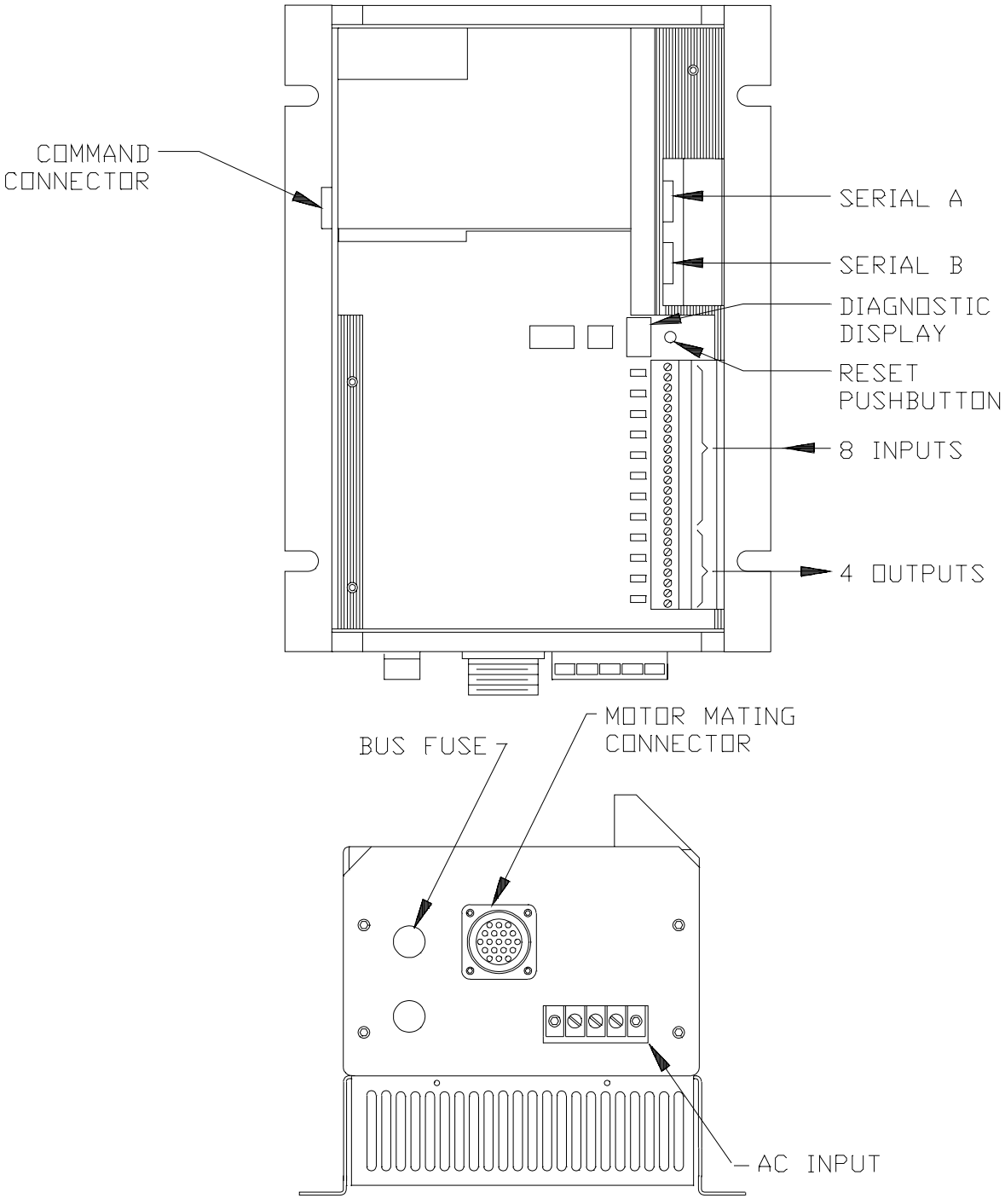


Figure 22 Amplifier I/O Locations (DX-318, DX-430, DX-450)

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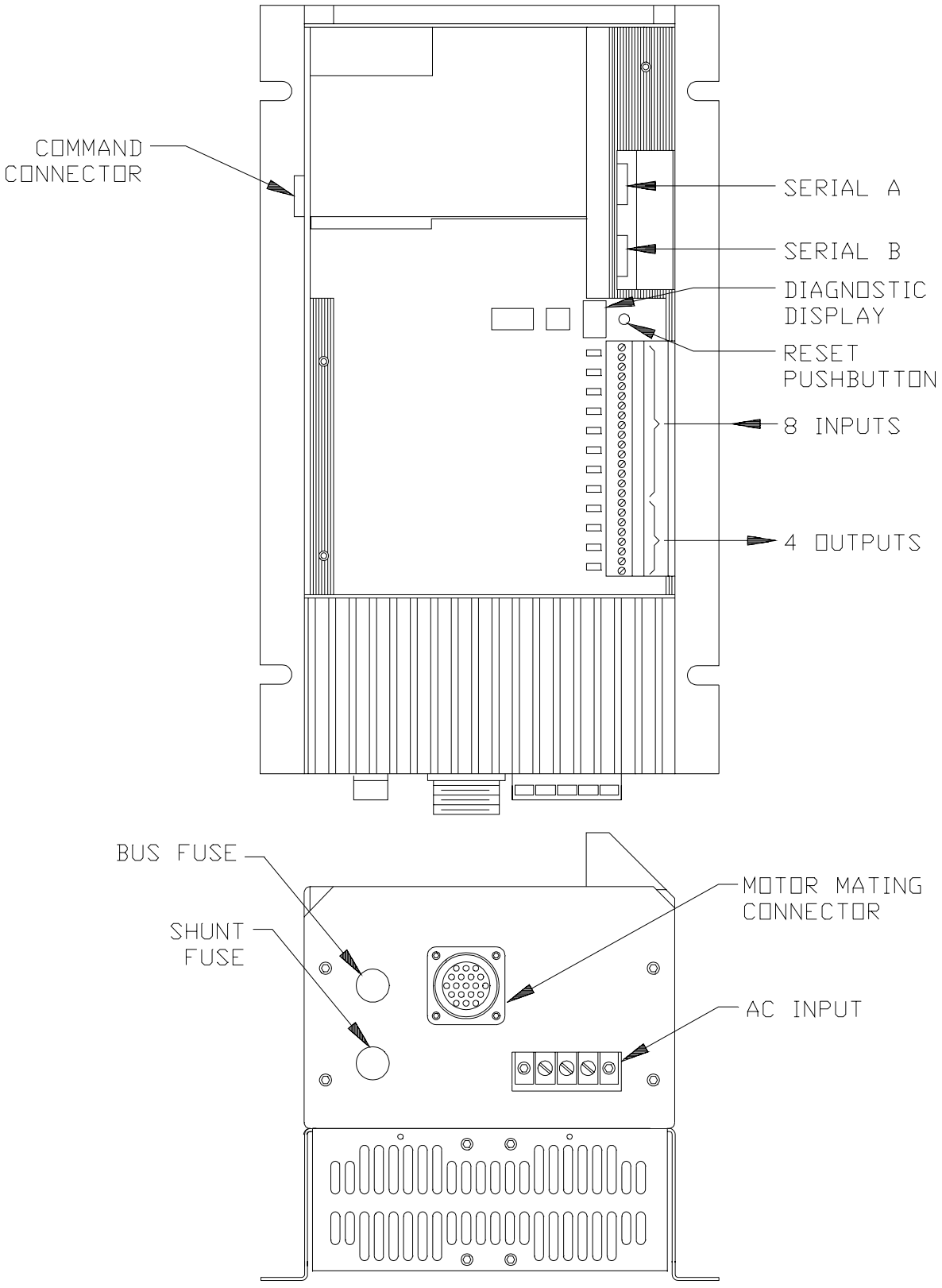


Figure 23 Amplifier I/O Locations (DX-480, DX-780, DX-7120)

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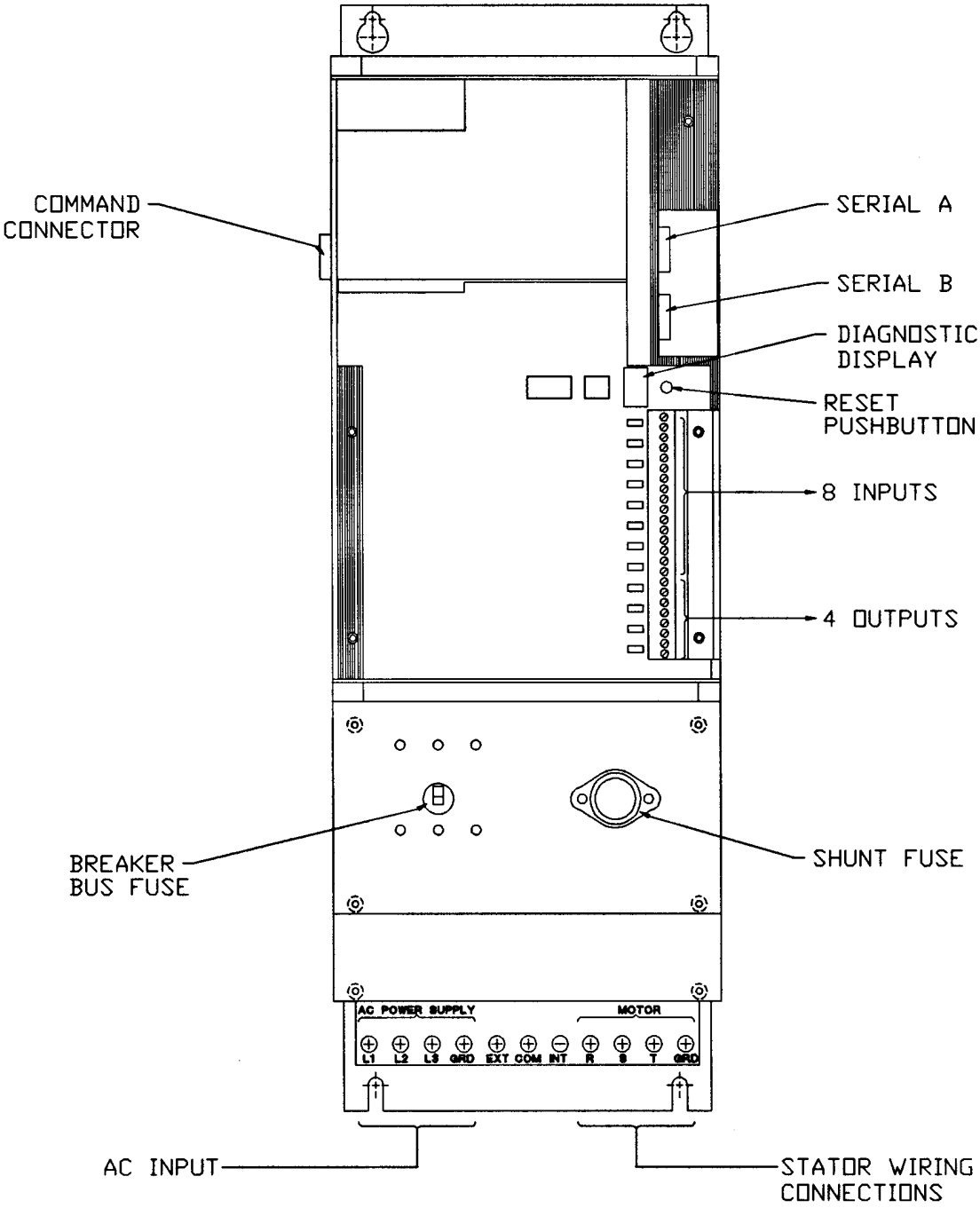
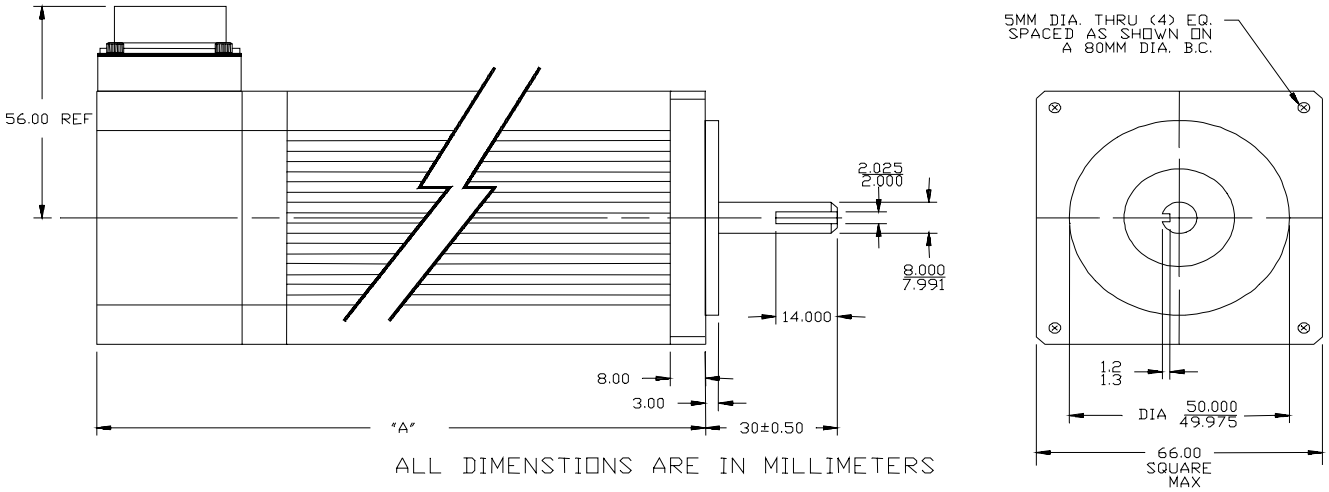


Figure 24 Amplifier I/O Locations (DX-8XXX & DX-6XXX)

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MOTOR MECHANICAL INFORMATION

DXM-202, DXM-205

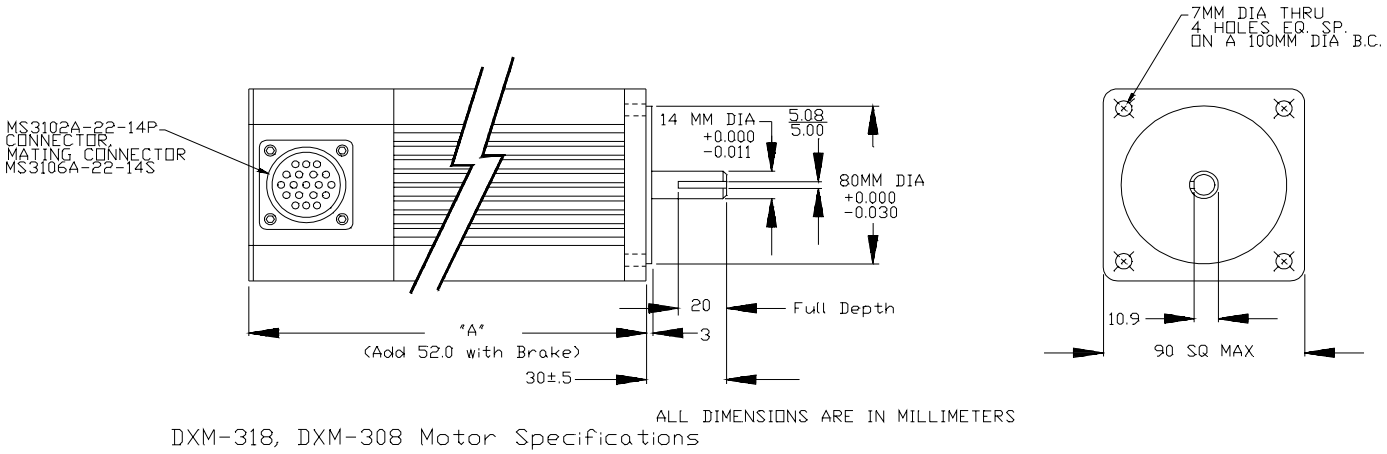


DXM-205, DXM-202 Motor Specifications

MECHANICAL AND ELECTRICAL DATA	DXM-205		DXM-202	
ROTOR MOMENT OF INERTIA	(kg-m²)	.0000285	(kg-m²)	.0000096
	(lb-in-s²)	.000253	(lb-in-s²)	.000086
MAX. CONT. OPERATING SPEED	(RPM)	3000	(RPM)	3000
COMPARATIVE BRUSH MOTOR(KE)	VOLTS/KRPM	23	VOLTS/KRPM	23
COMPARATIVE BRUSH MOTOR(KT)	IN.LB./AMP	1.9	IN.LB./AMP	1.9
CONT. STALL TORQUE	(lb-in)	5	(lb-in)	2
PEAK TORQUE	(lb-in)	10	(lb-in)	4
"A" DIMENSION (LENGTH)	max millimeters	163.0	max millimeters	115.0

Figure 25 Motor Mechanical Information (DXM-202, DXM-205)

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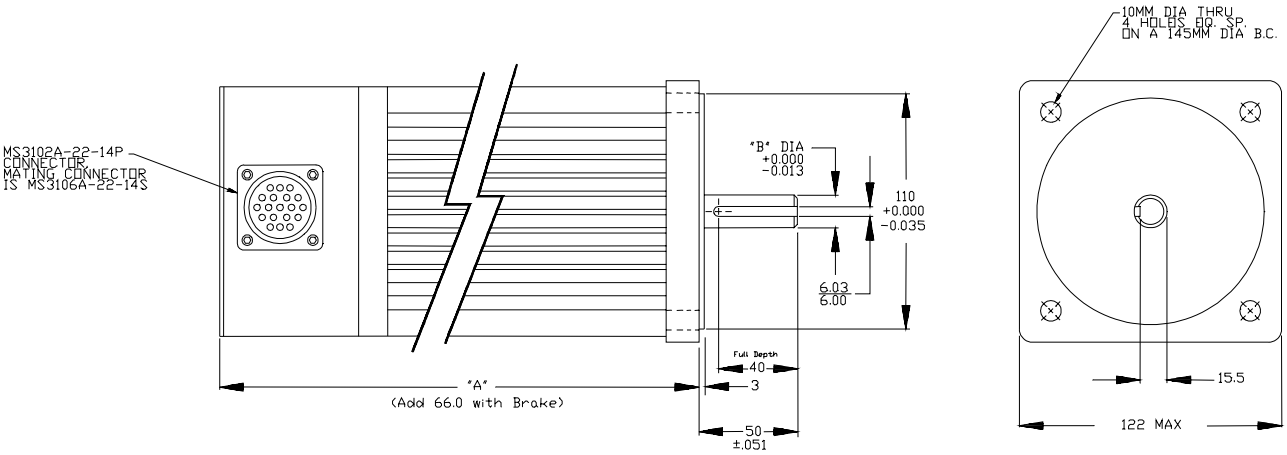


DXM-318, DXM-308 Motor Specifications

MECHANICAL AND ELECTRICAL DATA	DXM-318		DXM-308	
ROTOR MOMENT OF INERTIA	(kg-m²)	.00011	(kg-m²)	.000057
	(lb-in-s²)	.001	(lb-in-s²)	.0005
MAX. CONT. OPERATING SPEED	(RPM)	3000	(RPM)	3000
COMPARATIVE BRUSH MOTOR(KE)	VOLTS/KRPM	43	VOLTS/KRPM	34
COMPARATIVE BRUSH MOTOR(KT)	IN.LB./AMP	3.6	IN.LB./AMP	2.87
CONT. STALL TORQUE	(lb-in)	18	(lb-in)	8
PEAK TORQUE	(lb-in)	36	(lb-in)	16
"A" DIMENSION (LENGTH)	max millimeters	302.3	max millimeters	201.3

Figure 26 Motor Mechanical Information (DXM-308, DXM-318)

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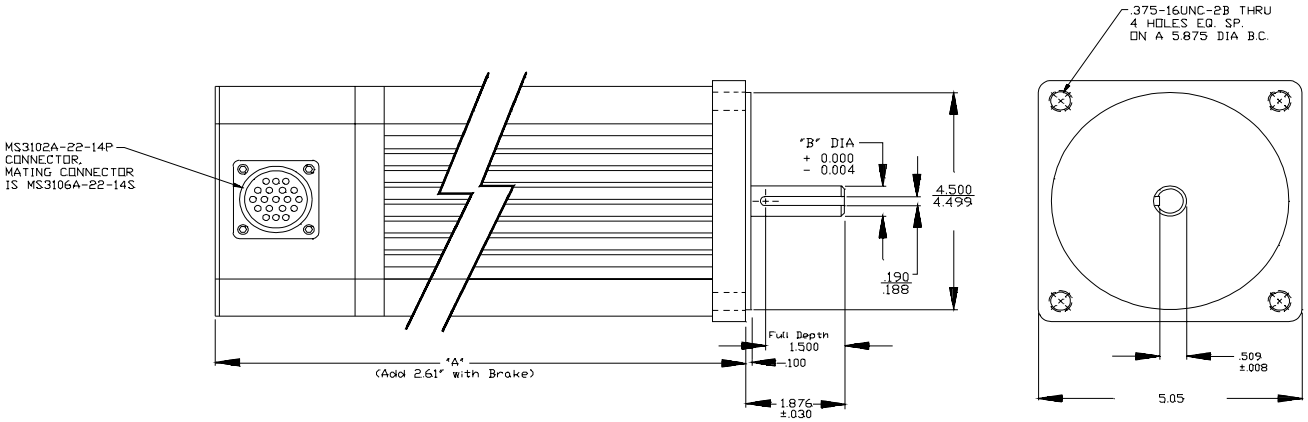


DXM-480, DXM-450, DXM-430 Motor Specifications

MECHANICAL AND ELECTRICAL DATA	DXM-480		DXM-450		DXM-430	
ROTOR MOMENT OF INERTIA	(kg-m²)	.000872	(kg-m²)	.00058	(kg-m²)	.0003
	(lb-in-s²)	.00772	(lb-in-s²)	.0052	(lb-in-s²)	.0026
MAX. CONT. OPERATING SPEED	(RPM)	3000	(RPM)	3000	(RPM)	3000
COMPARATIVE BRUSH MOTOR(KE)	VOLTS/KRPM	43	VOLTS/KRPM	43	VOLTS/KRPM	43
COMPARATIVE BRUSH MOTOR(KT)	IN.LB./AMP	3.6	IN.LB./AMP	3.6	IN.LB./AMP	3.6
CONT. STALL TORQUE	(lb-in)	80	(lb-in)	50	(lb-in)	30
PEAK TORQUE	(lb-in)	160	(lb-in)	100	(lb-in)	60
"A" DIMENSION (LENGTH)	millimeters	305.0	millimeters	263.2	millimeters	213.2
"B" DIMENSION (DIA)	millimeters	24.00	millimeters	19.00	millimeters	19.00

Figure 27 Motor Mechanical Information (DXM-430, DXM-450, DXM-480)

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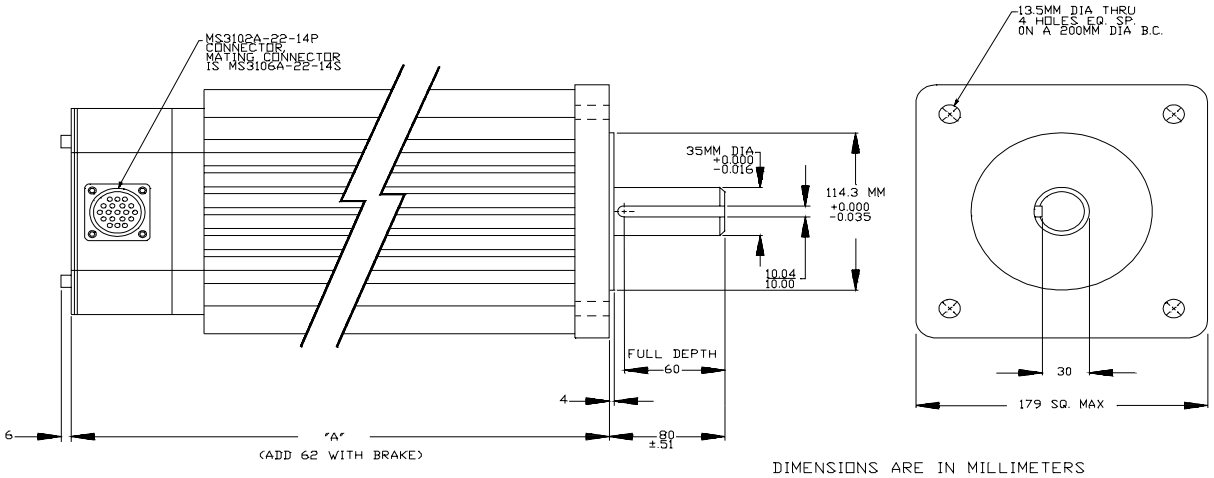


DXE-480, DXE-450, DXE-430 Motor Specifications

MECHNICAL AND ELECTRICAL DATA	DXE-480		DXE-450		DXE-430	
ROTOR MOMENT OF INERTIA	(lb-in-s²)	.000872	(lb-in-s²)	.0052	(lb-in-s²)	.0026
MAXIMUM OPERATING SPEED	(RPM)	3000	(RPM)	3000	(RPM)	3000
COMPARATIVE BRUSH MOTOR(KE)	VOLTS/KRPM	43	VOLTS/KRPM	43	VOLTS/KRPM	43
COMPARATIVE BRUSH MOTOR(KT)	IN.LB./AMPS	3.6	IN.LB./AMPS	3.6	IN.LB./AMPS	3.6
CONT. STALL TORQUE	(lb-in)	80	(lb-in)	50	(lb-in)	30
PEAK TORQUE	(lb-in)	160	(lb-in)	100	(lb-in)	60
"A" DIMENSION (LENGTH)	max inches	12.00	max inches	10.55	max inches	8.37
"B" DIMENSION (DIA)	max inches	.875	max inches	.6245	max inches	.6245

Figure 28 Motor Mechanical Information (DXE-430, DXE-450)

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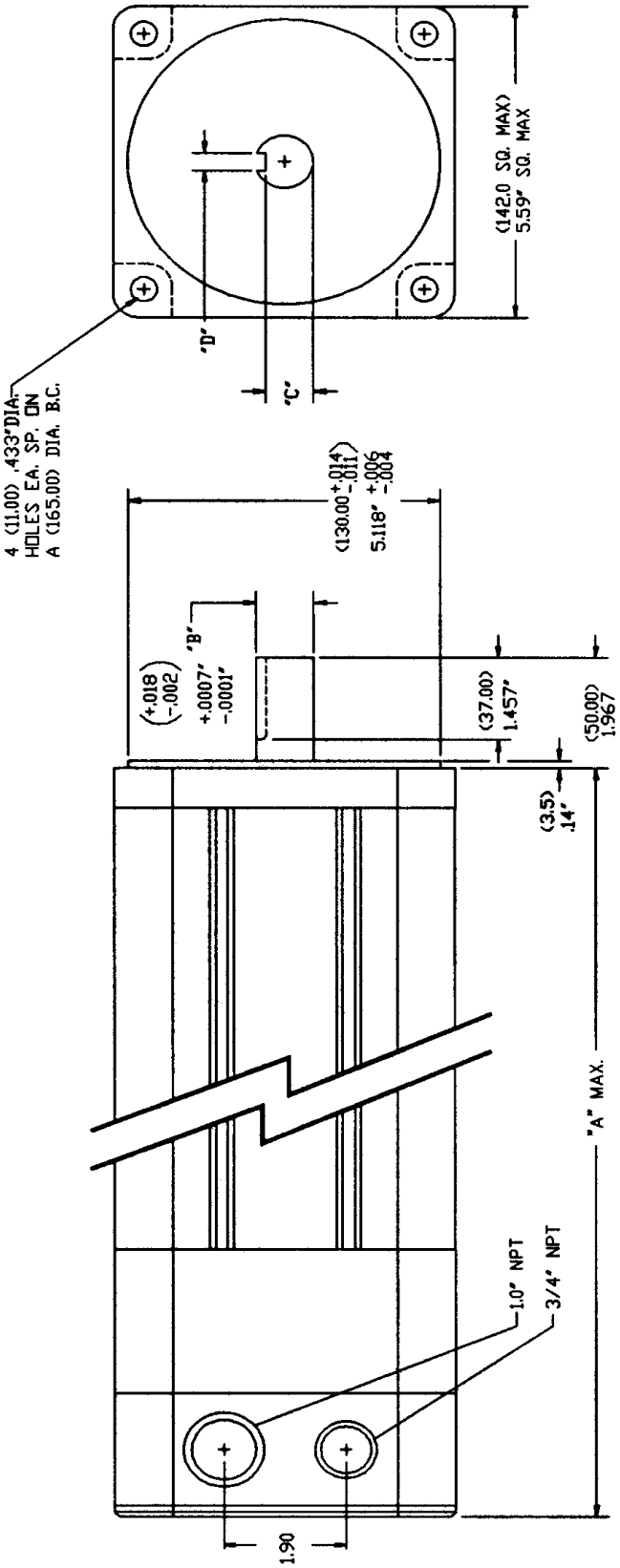
DIMENSIONS ARE IN MILLIMETERS

DXM-780, DXM-7120 Motor Specifications

MECHANICAL AND ELECTRICAL DATA	DXM-7120		DXM-780	
ROTOR MOMENT OF INERTIA	(kg-m²)	.0024	(kg-m²)	.0015
	(lb-in-s²)	.021	(lb-in-s²)	.013
MAX. CONT. OPERATING SPEED	(RPM)	2000	(RPM)	3000
COMPARATIVE BRUSH MOTOR(KE)	VOLTS/KRPM	66	VOLTS/KRPM	43
COMPARATIVE BRUSH MOTOR(KT)	IN.LB./AMP	5.57	IN.LB./AMP	3.6
CONT. STALL TORQUE	(lb-in)	120	(lb-in)	80
PEAK TORQUE	(lb-in)	240	(lb-in)	160
"A" DIMENSION (LENGTH)	millimeters	343	millimeters	266

Figure 29 Motor Mechanical Information (DXM-780, DXM-7120)

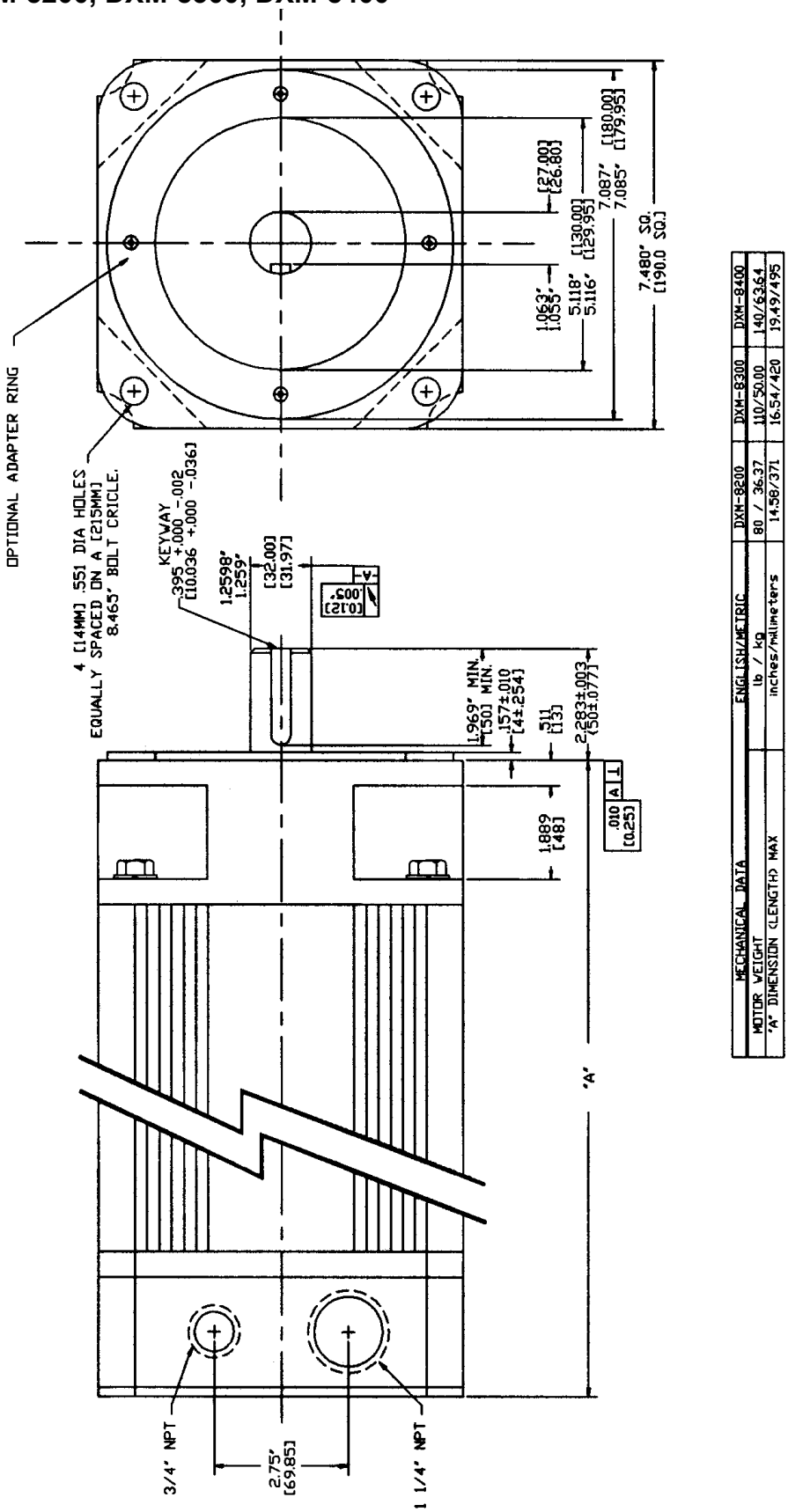
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ELECTRICAL/MECHANICAL DATA	ENGLISH/METRIC	DXM-6120	DXM-6200	DMX-6300
MOTOR WEIGHT	lb / kg	35/16	51/23.2	67/30.5
DIM (A).	IN. / mm	13.35/339	16.05/408	18.75/477
DIM (B)	IN. / mm	.945/24	.945/24	1.26/32.0
DIM (C)	IN. / mm	.787/20	.787/20	1.063/27.00
DIM (D)	IN. / mm	.3149/8	.3149/8	.394/10.0

Figure 30 Motor Mechanical Information (DXM-6120, DXM-6200, DXM-6300)

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MECHANICAL DATA	ENGLISH/METRIC	DXM-8200	DXM-8300	DXM-8400
MOTOR WEIGHT	lb / kg	80 / 36.37	110/50.00	140/63.64
"A" DIMENSION CLENGTH) MAX	inches/millimeters	14.58/371	16.54/420	19.49/495

Figure 31 Motor Mechanical Information (DXM-8200, DXM-8300, DXM-8400)

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MOTOR WIRING
DX* 308,318,430,450,480,780,7120

*English or metric motors.

The diagram below indicates how the motor, resolver, thermostat and optional brake are wired.

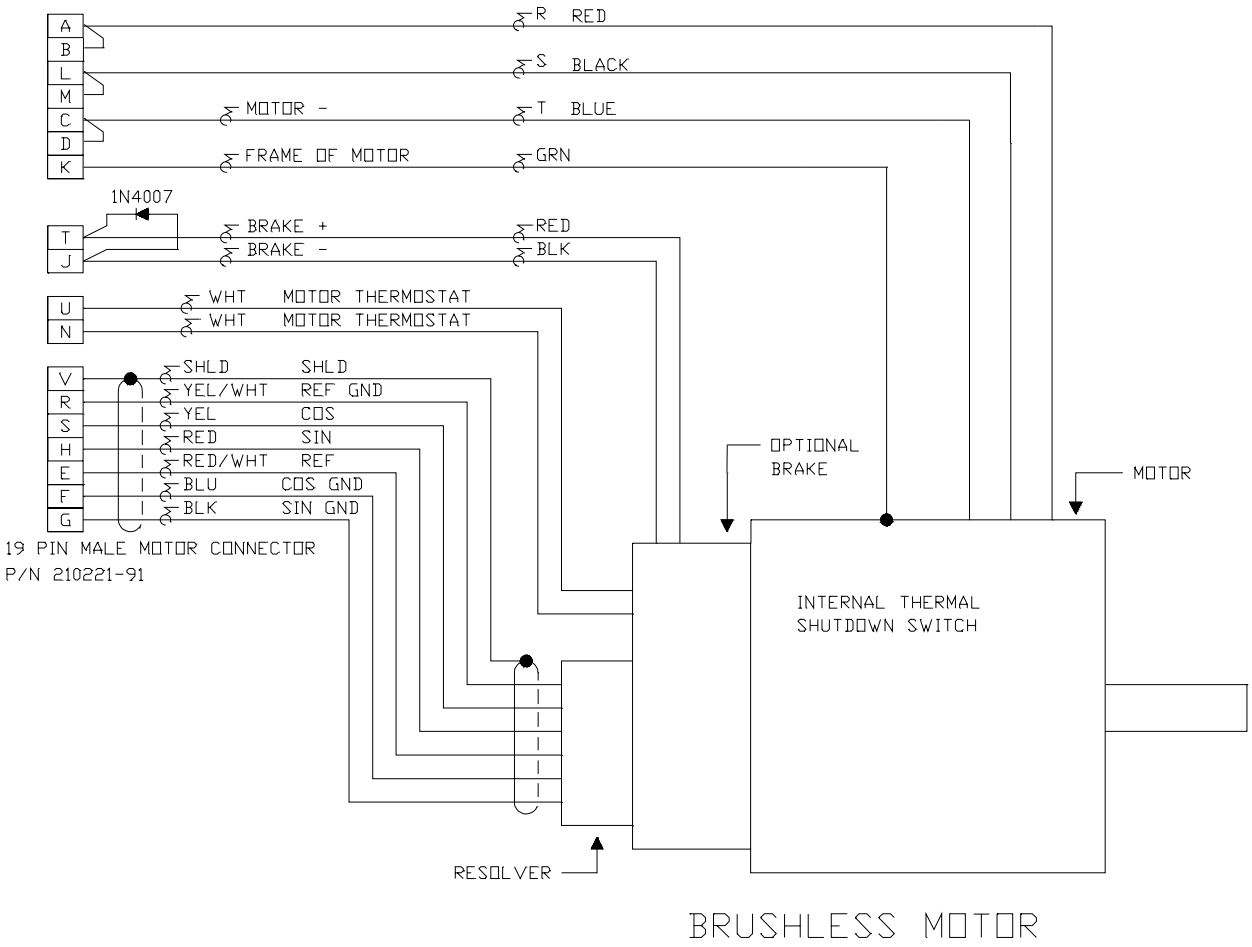


Figure 32 Motor Wiring (DX-308, DX-318, DX-430, DX-450, DX-480, DX-780, DX-7120)

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MOTOR WIRING – DXM 202, DXM-205

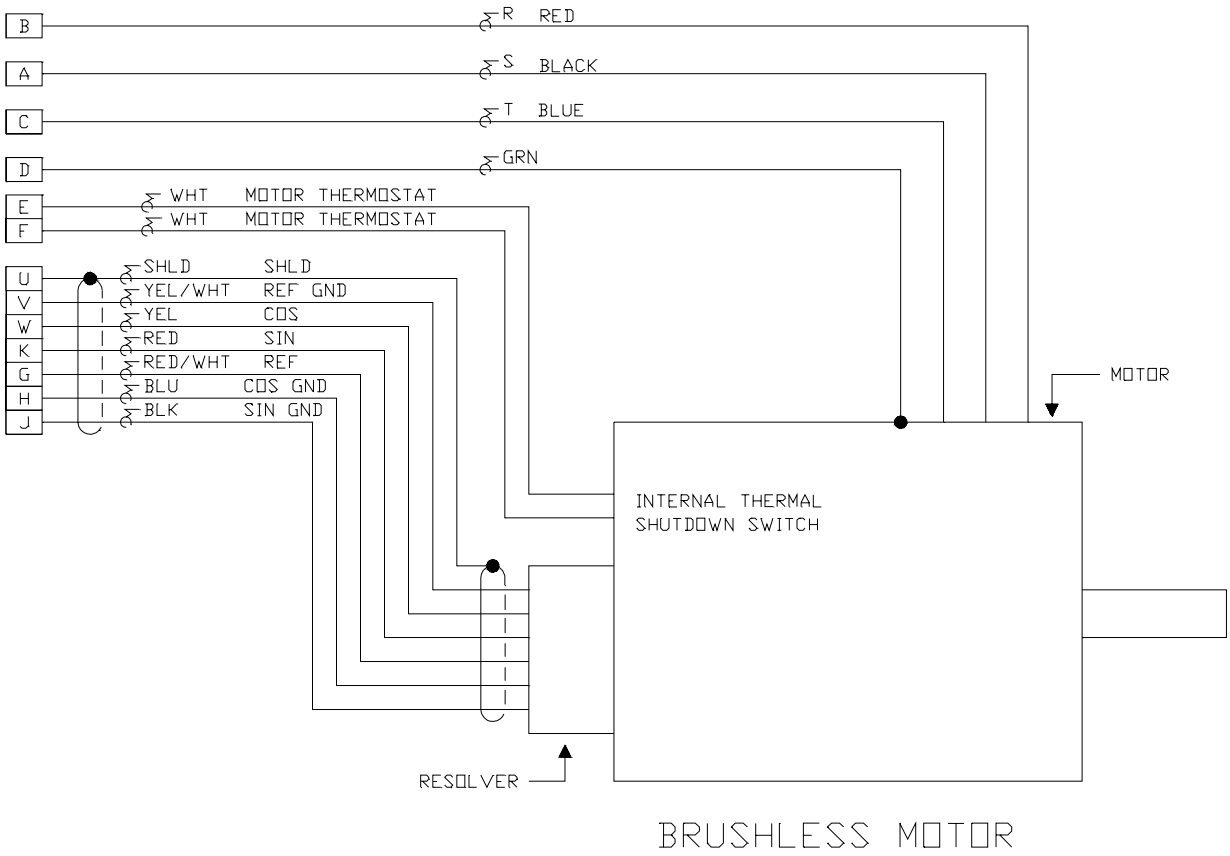
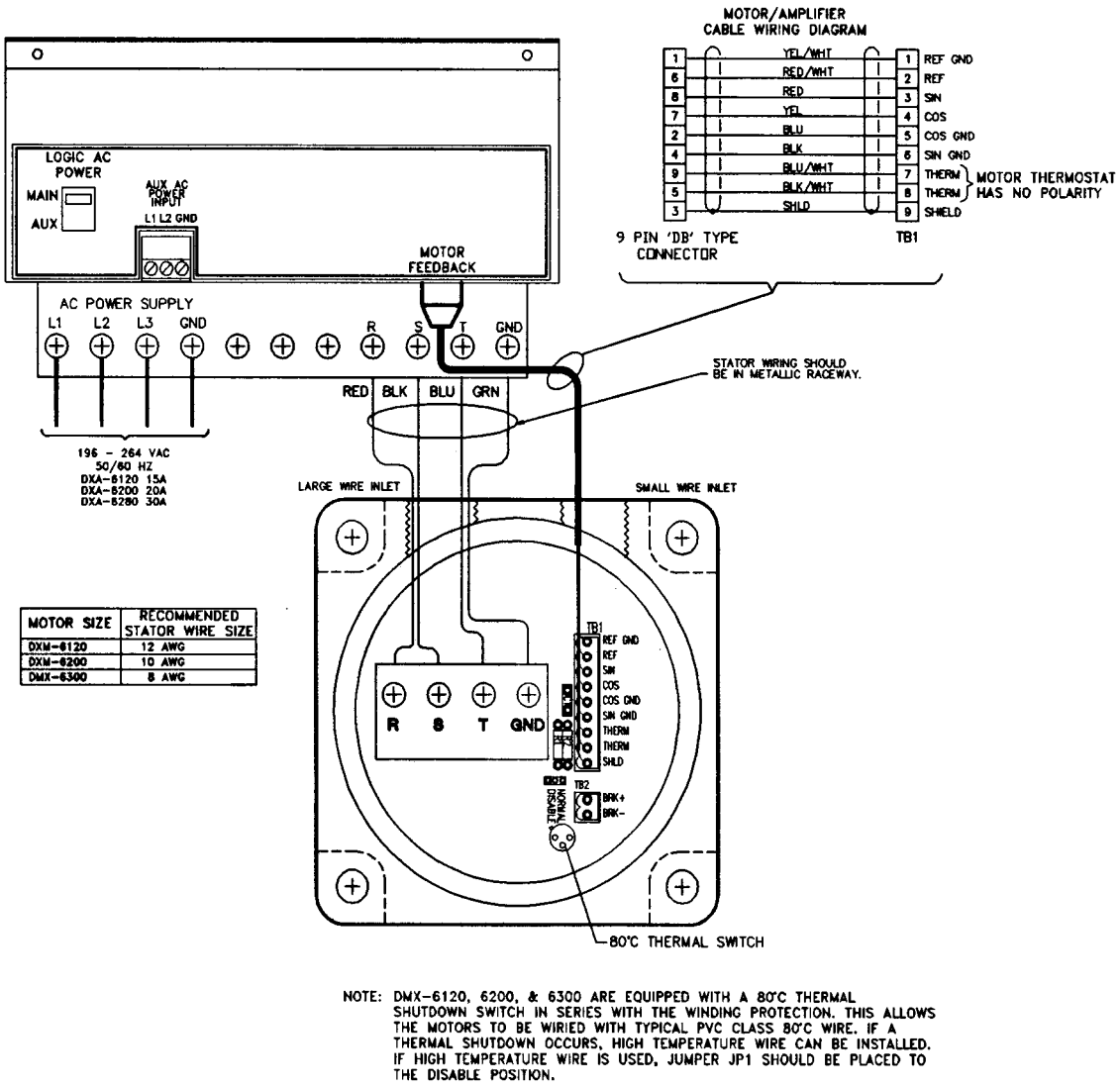


Figure 33 Motor Wiring (DXM-202, DXM-205)

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MOTOR WIRING – DXM 6120, DXM-6200, DXM-6300



MOTOR SIZE	RECOMMENDED STATOR WIRE SIZE
DXM-6120	12 AWG
DXM-6200	10 AWG
DMX-6300	8 AWG

NOTE: DMX-6120, 6200, & 6300 ARE EQUIPPED WITH A 80°C THERMAL SHUTDOWN SWITCH IN SERIES WITH THE WINDING PROTECTION. THIS ALLOWS THE MOTORS TO BE WIRIED WITH TYPICAL PVC CLASS 80°C WIRE. IF A THERMAL SHUTDOWN OCCURS, HIGH TEMPERATURE WIRE CAN BE INSTALLED. IF HIGH TEMPERATURE WIRE IS USED, JUMPER JP1 SHOULD BE PLACED TO THE DISABLE POSITION.

Figure 34 Motor Wiring (DXM-6120, DXM-6200, DXM-6300)

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MAIN/AUXILIARY AC POWER

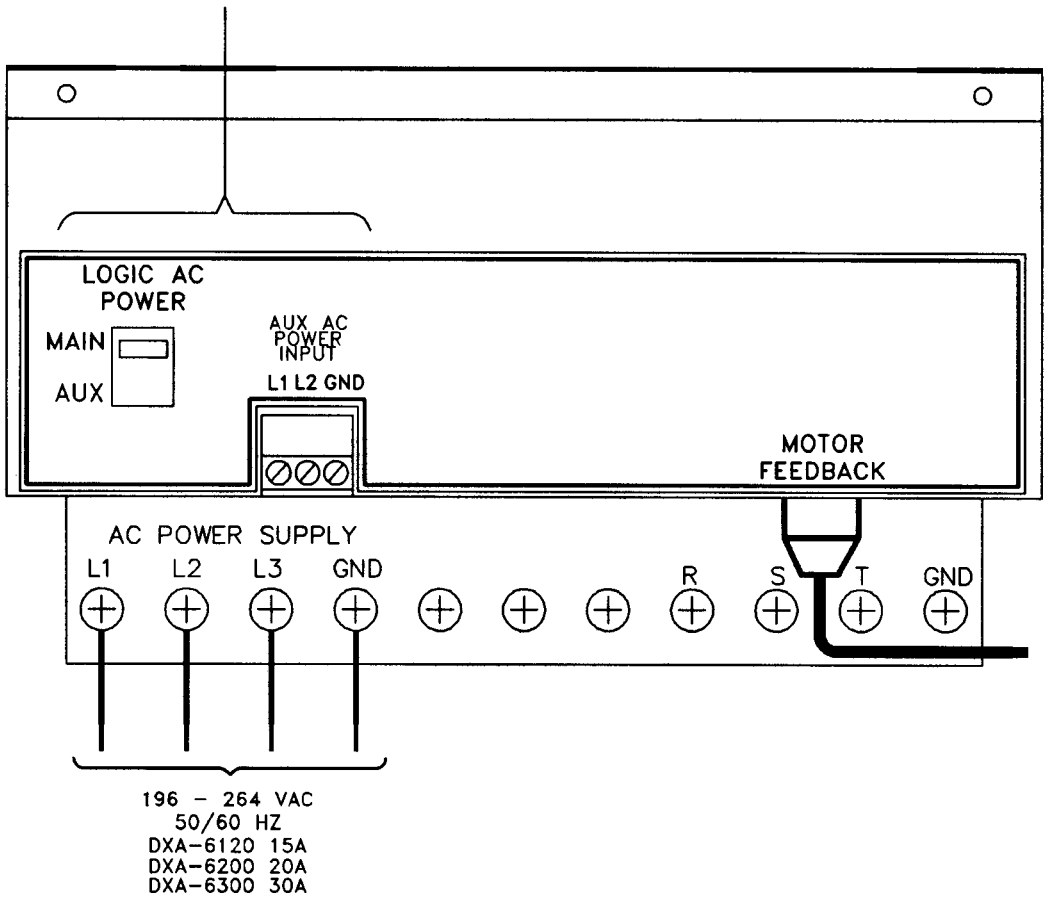


Figure 35 Motor/Amplifier Auxiliary Wiring

An external AC voltage of 220 VAC single phase can be connected to the AUX AX power input to the appropriate terminals (L1, L2 and GND). The main/auxiliary switch can be switched to the AUX position. Power for the logic supplies that power the computer is now separated from the high power circuits that create the motor +BUS voltage. The high current and voltage can now be removed from the three phase L1/L2/L3 and GND terminals, thus eliminating the DC BUS supply voltage source for the motor. Under these conditions, the position feedback from the resolver is in tact, yet high power voltage and current sources for R, S & T are removed. Motor power reduces to nothing as the BUS capacitors discharge after AC power is removed from the "MAIN AC POWER" input. An un-interruptible power supply of 220 VAC at 1 amp is adequate for power to the auxiliary input.

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FEEDBACK WIRING – DXM-8200, DXM-8300, DXM-8400

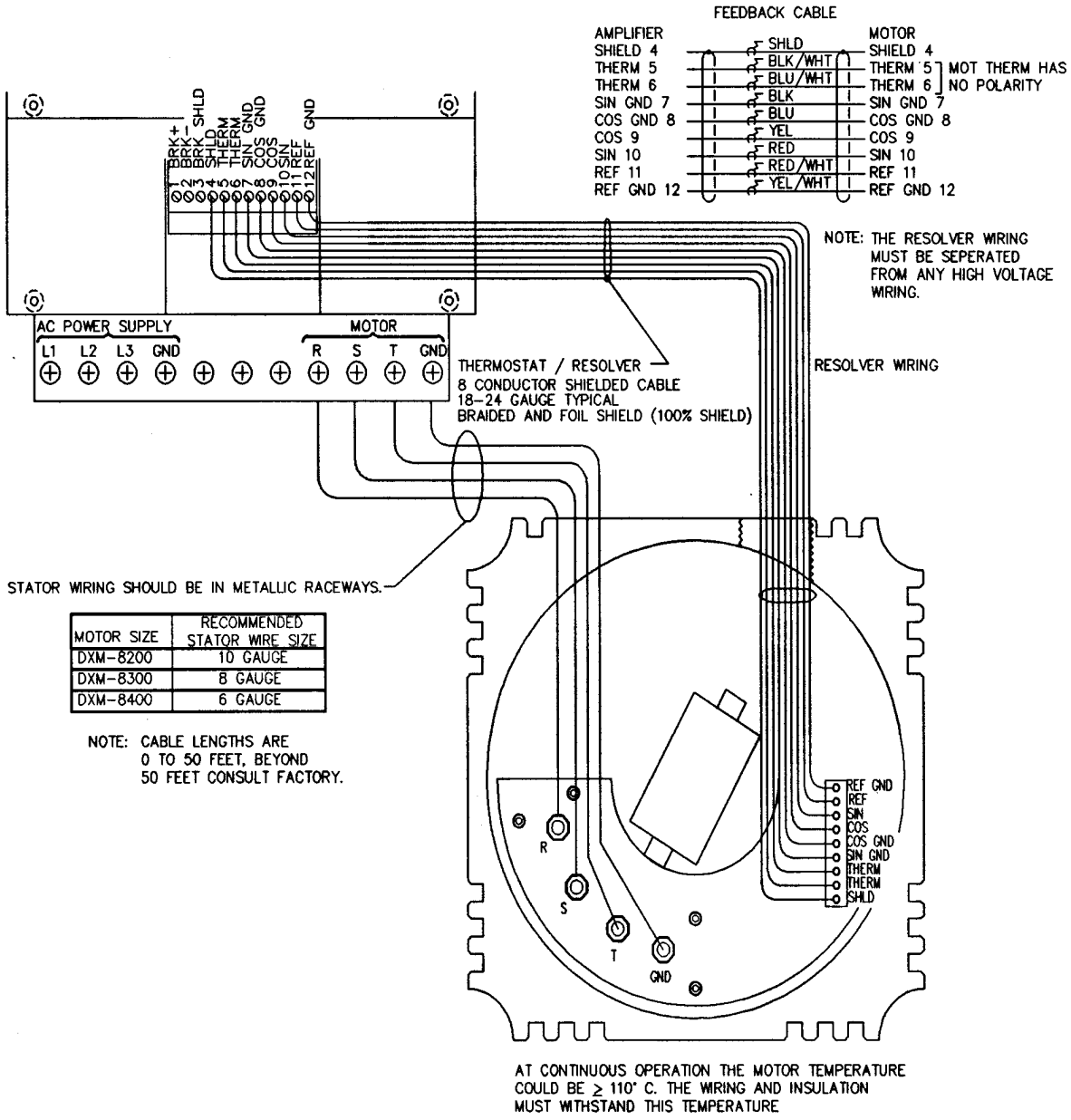


Figure 36 Feedback Wiring (DX-8XXX's)

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CABLE WIRING DIAGRAMS

TDS/TDL CABLE

Shown below is a diagram on how the interconnect cable from the Drive to motor is assembled.

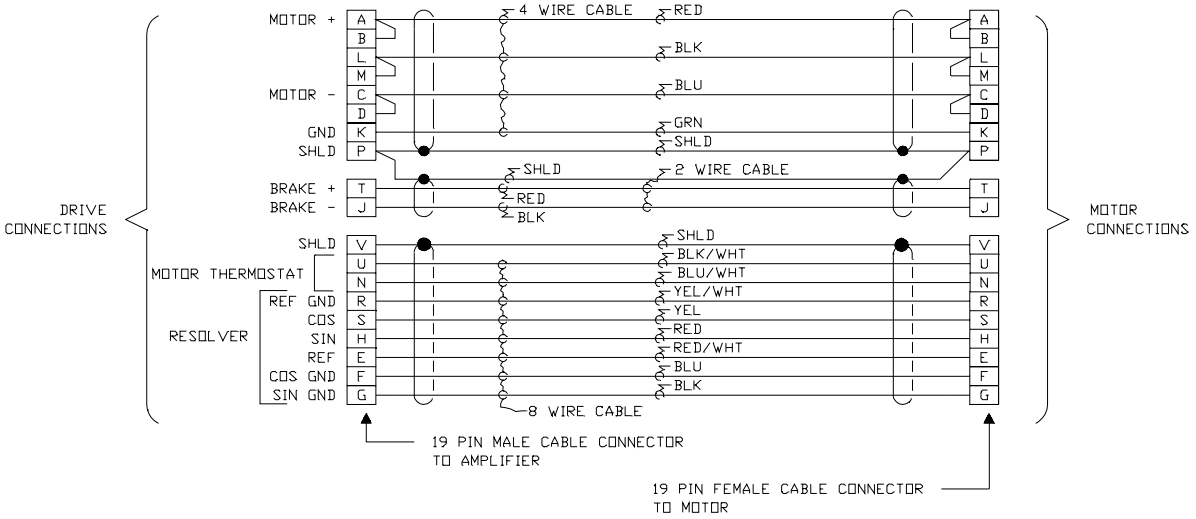


Figure 37 Cable Wiring Diagram (TDS/TDL)

The DX-308 and DX-318 use cable model TDS-XX. The DX-430, DX-450, DX780, and DX-7120 use model TDL-XX.

WHERE XX DESIGNATES LENGTH

XX = LENGTH	(FT)
15	15
25	25
50	50

TDT Cable

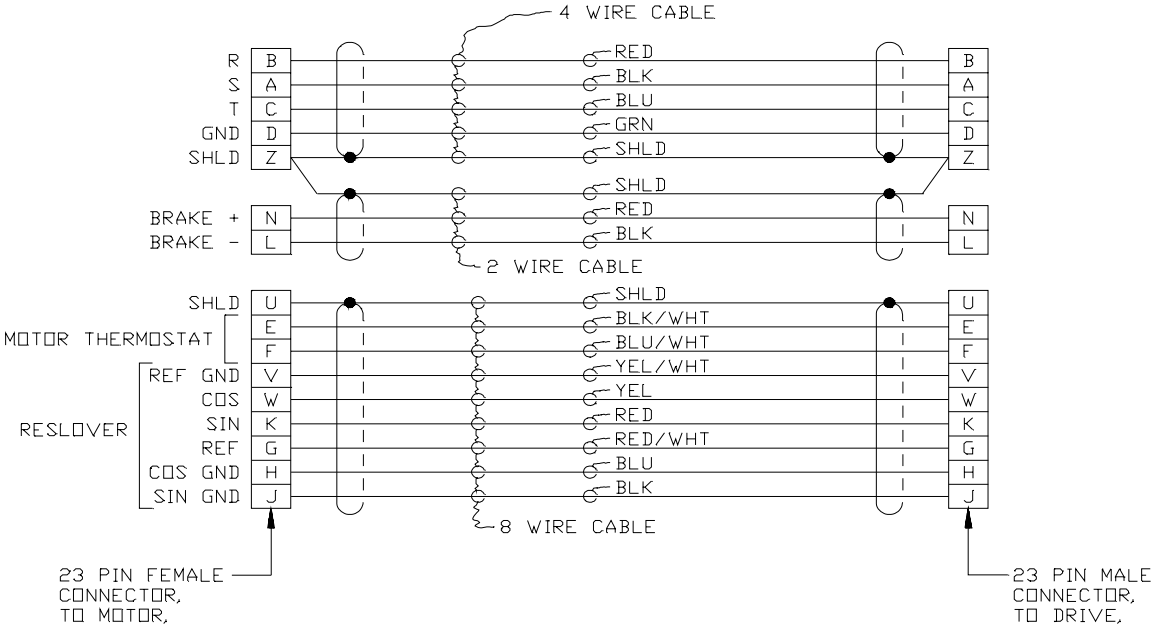


Figure 38 Cable Wiring Diagram (TDT)

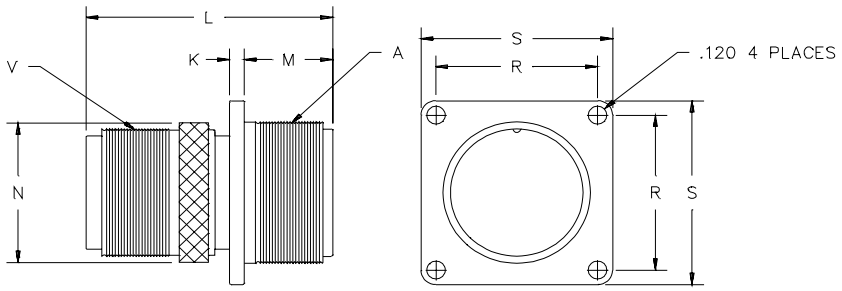
The DX-202, and DX-205 use cable model number TDT-XX

WHERE XX DESIGNATES LENGTH

XX = LENGTH	(FT)
15	15
25	25
51	50

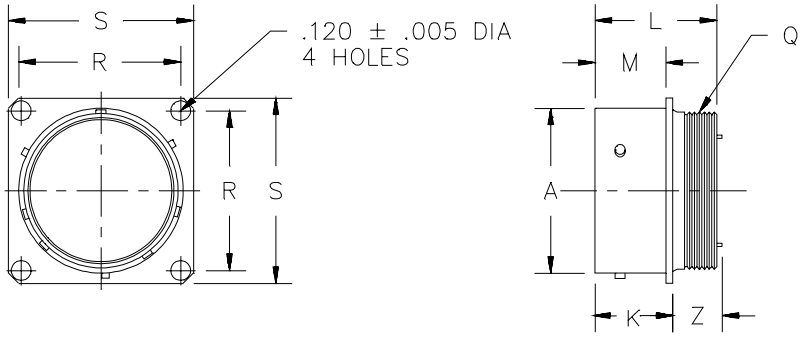
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Optional Bulkhead Connectors



	CONNECTOR SIZE	A COUPLING THREADS	K REF.	L MAX.	M REF.	N REF.	R REF.	S REF.	V FITTING THREADS
INCHES	22	1.375–18	.125	2.125	.75	1.375	1.25	1.625	1.188–18
MM			3.18	53.98	19.05	34.93	31.75	39.67	

Figure 39 Mounting Information, Bulkhead Connector, TDLB Cable



SHELL SIZE	R (TYP)	S MAX	A +.001 −.005	K +.020 −.010	L MAX	M +.010 −.000	Z MAX	Q THREAD CLASS 2A
16	.969	1.219	1.000	.493	.906	.431	.468	.9375–20 UNEF

Figure 40 Mounting Information, Bulkhead Connector, TDTB Cable

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OPERATING MODES

OVERVIEW

The Positioning Drive is differentiated from common analog servo drives in that the amplifier includes a position feedback loop. As a result, the amplifier will provide both precise position and velocity control of the motor. The drive utilizes resolver feedback for both velocity and position feedback. Thus, a tachometer is no longer required.

The drives include three different control modes providing alternatives for implementing motion control. The modes are listed below.

Table X Motion Control Modes

MODE	CONTROL	INTERFACE	COMMAND DEVICE
Analog	Velocity	Zero to +/- 10vdc	Velocity Controller
	Torque	Zero to +/- 10vdc	Torque Controller
Pulse	Position	Pulse & Direction	Motion Generator,
	Increments	+5 to +15V Logic	Indexer, CNC
	Position Increments	CW & CCW Pulses	Motion Generator,
			Indexer, CNC
Indexing	Index, Home, Jog	Inputs & Outputs 10 to +30vdc, Optically Isolated (sink or source)	Relay Logic, Operator Control Panel or a Programmable Logic Controller
	Index, Home, Job and Motion Programming	RS423/422/232C Serial Interface XMIT/REC ASCII	Personal Computer, ASCII Unit on PLC, ASCII Terminal

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MODE SELECTION

There are basically three separate operating modes: ANALOG, PULSE FOLLOWER, and INDEXING. The DIP switches 3 and 4 are used to help configure the operating modes. Units are shipped with DIP switches 3 and 4 OFF.

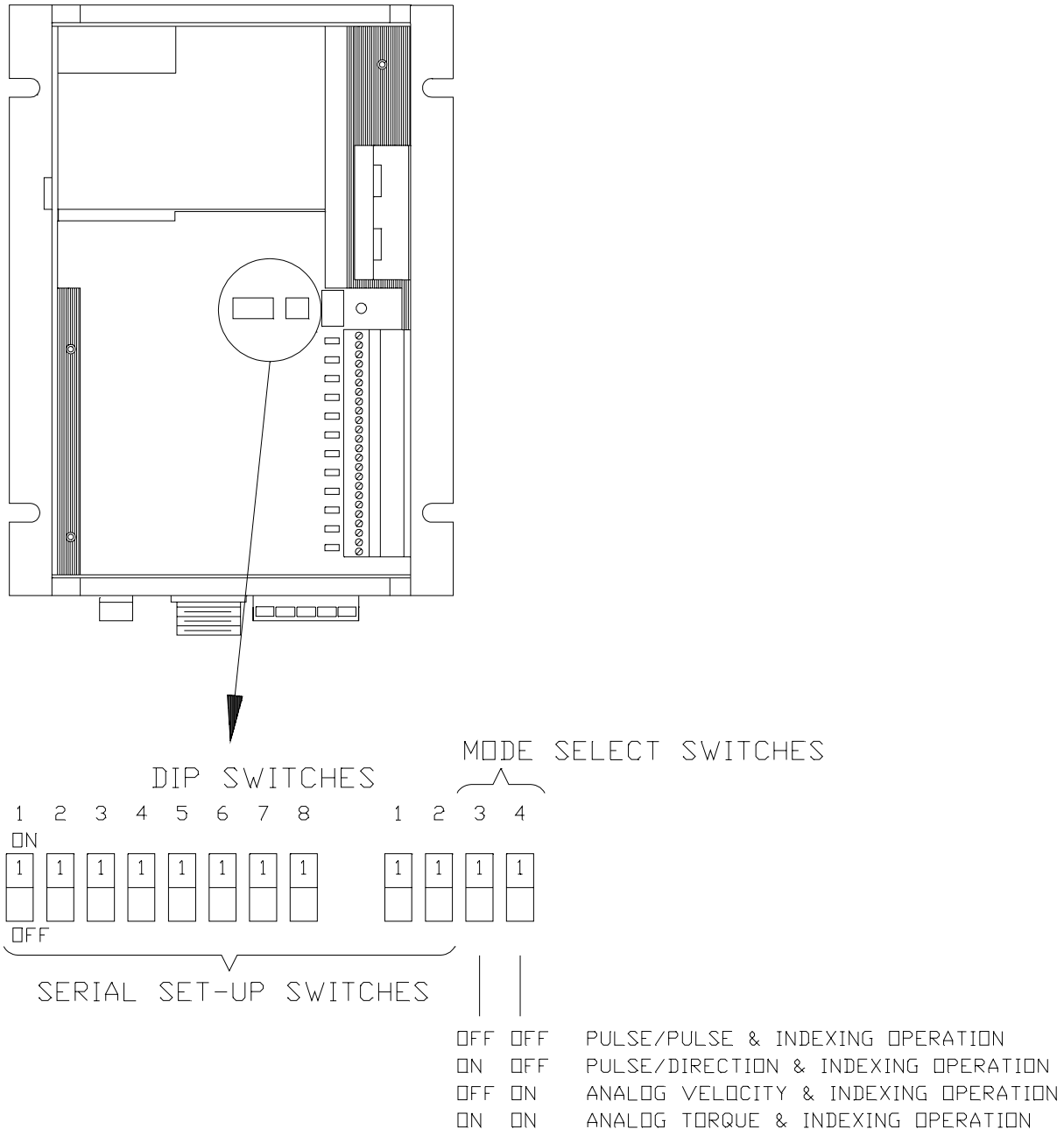


Figure 41 Dipswitches/Mode Selection

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Analog Mode

In the Analog Torque or Velocity mode, the servo amplifier responds to a conventional ±10 volt DC signal. Most variable speed drives and servo amplifiers on the market today receive commands via this type of signal. If the DIP switches are set to enable this mode, the display character of the digital drive will be an (A). In this mode, a ±10 volt command signal is equated to ± velocity or peak torque as determined by the drives preprogrammed velocity (3000 RPM default) or peak torque based on drive size. ±10 = ± peak torque. The external and serial control modes are not ignored if an (A) is on the display. Sending an SC=1 to the drive would disable analog control and enable serial control with an (E) being on the display. If an (A) was on the display and an initiate index home or job from the I/O occurs, then the (A) will be replaced with an (E) and the requested motion occurs. At the end of motion, the display and mode revert to (A).

In either of the two analog modes of operation a (+)/(-) 10 VDC signal is equated to either (CW) or (CCW) maximum programmed velocity in the velocity mode or CW or CCW full peak rating in the torque mode. The mode of operation can be selected via the mode select switches on the front of the servo drive.

NOTE: CW rotation is defined while facing the shaft end of the motor.



Figure 42 Velocity/Torque Mode

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In either mode the ±10 VDC command signal is connected to the command input. The input circuit of the drive is a differential input amplifier with the following characteristics. Application of a + voltage to pin 7 with respect to pin 13 (GRD) will produce either a CW motion or torque in the CW direction as viewed from the shaft end of the motor.

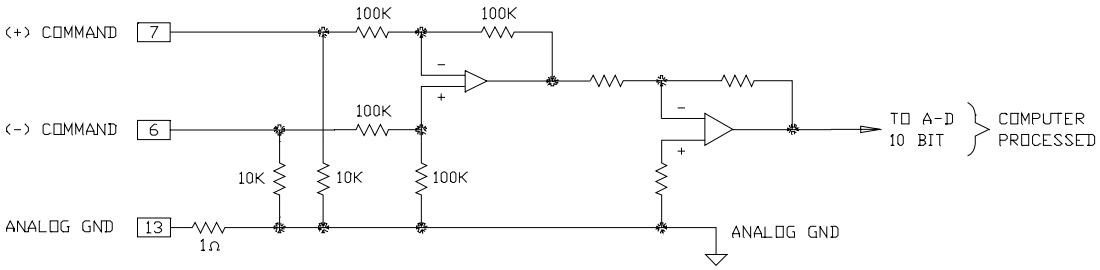


Figure 43 Command Input Circuit

IMPORTANT: Voltages on pins 6 or 7 must not exceed ±12 VDC with respect to analog ground.

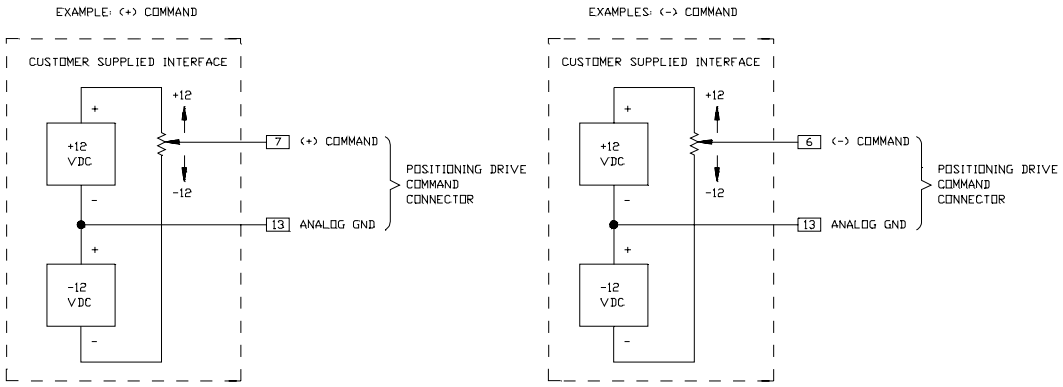


Figure 44 Command Connector

To execute the Analog Mode, the mode select switches must be set correctly for either Analog Velocity or Analog Torque control and apply ±10 volts DC to the command connector on the amplifier.

REMINDER: Both the hardware and software position travel limits are active if they are set up.

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Pulse Mode

In the Pulse mode, the Positioning Drive responds to a serial pulse train representing externally generated incremental position change commands. This mode is commonly used to control DC stepper motors or numeric controlled (CNC) machinery. The PULSE/PULSE or PULSE/DIRECTION operation are provided so that pulse inputs are converted to velocity and distance. The drive can be programmed to allow for pulses per revolution of 200 to 25,000. Once programmed, the total pulses received is converted to the equivalent distance in steps or pulses per revolution and the rate that pulses are received determines velocity. The base number system that the drive uses is binary with a resolution of 4096 per revolution. When using the pulse modes, there is no accumulative error. However, the positional accuracy is based on the lower of ±1 part in 4096 or ±1 of the programming resolution. At very low programming resolution such as 200 pulses per revolution, a dither of 360°/200 or 1.8° is typical. The maximum pulse rate input cannot exceed 204,800 Hz.

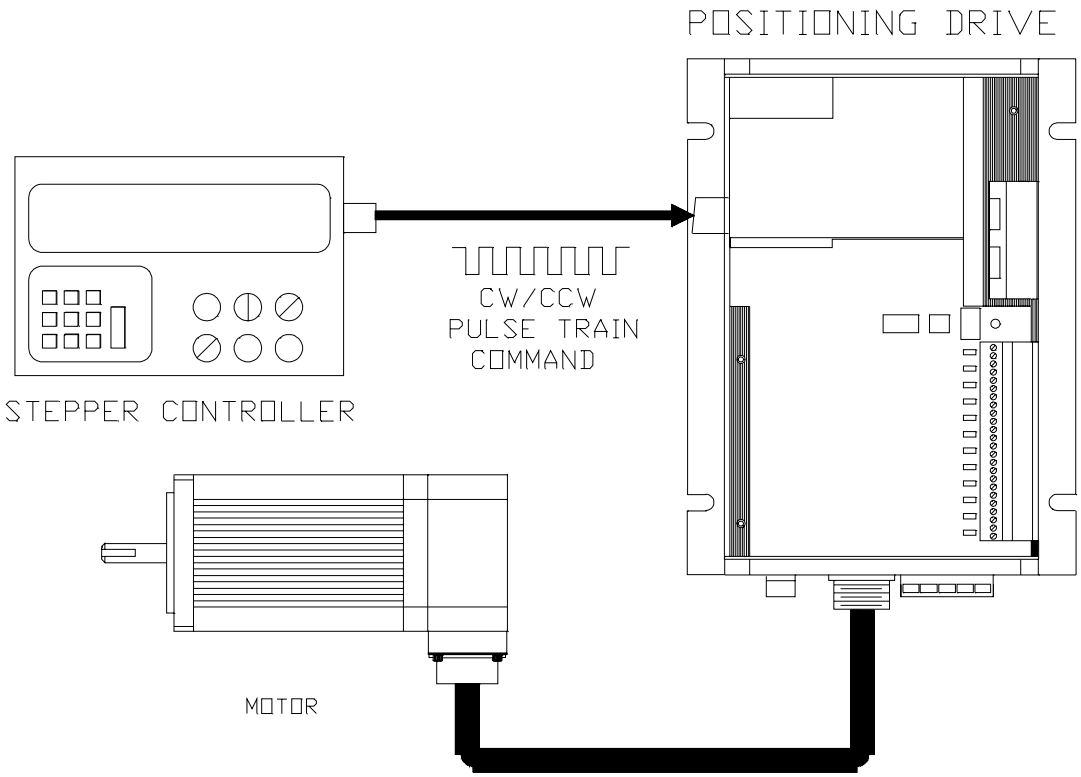


Figure 45 Pulse Mode

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Pulse/Pulse and Pulse/Direction Modes

Pulses on the CW pulse line make the motor rotate CW and pulses on the CCW pulse input line make the motor rotate CCW as viewed from the shaft end of the motor.

To set up the pulses per revolution, select the drive parameters screen using PCX and change the default setting of 4000 steps/revolution to your desired configuration. The mode select switches can be set to operate the drive in the pulse/direction mode. In this mode, the CW pulse input line becomes the pulse input and the CCW pulse line becomes the direction input. If there is no current flowing in the direction input, the pulse input line is interpreted as CCW direction.

In either pulse mode, once motion is initiated with these inputs, motion in the opposite directions can not be achieved until motion in the initiated direction has been stopped as a result of stopping the pulses. Attempts to defeat this may cause erroneous and unpredictable operation.

In a pulse train application, the pulse trains are fed into the CW and CCW inputs on the command connector. The inputs are optically isolated and can be used for sinking or sourcing current; this requires two connections per input. In either case (sinking or sourcing), the noise immunity is improved when the normal state of the input does not cause current to flow in the optical coupler. Current should only flow when a motion pulse is applied by the external pulse generator, and each pulse must be at least between 0.5 to 1.5 micro seconds and between +5 and +15 VDC to be accepted as a valid pulse.

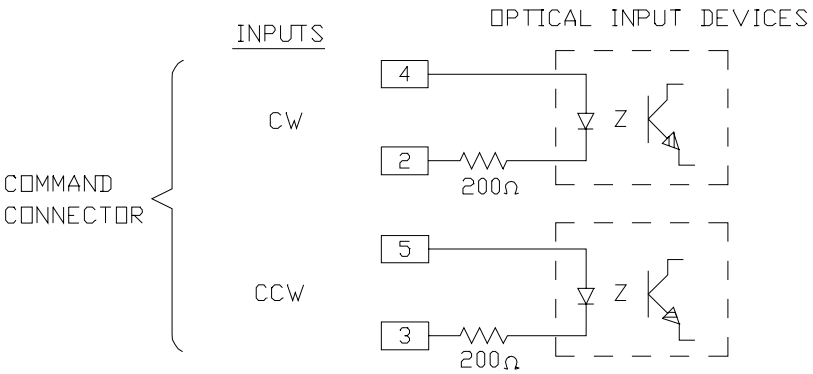


Figure 46 Command Connector Circuit

NOTE: CW rotation of the motor is established with the operator facing the shaft end of the motor.

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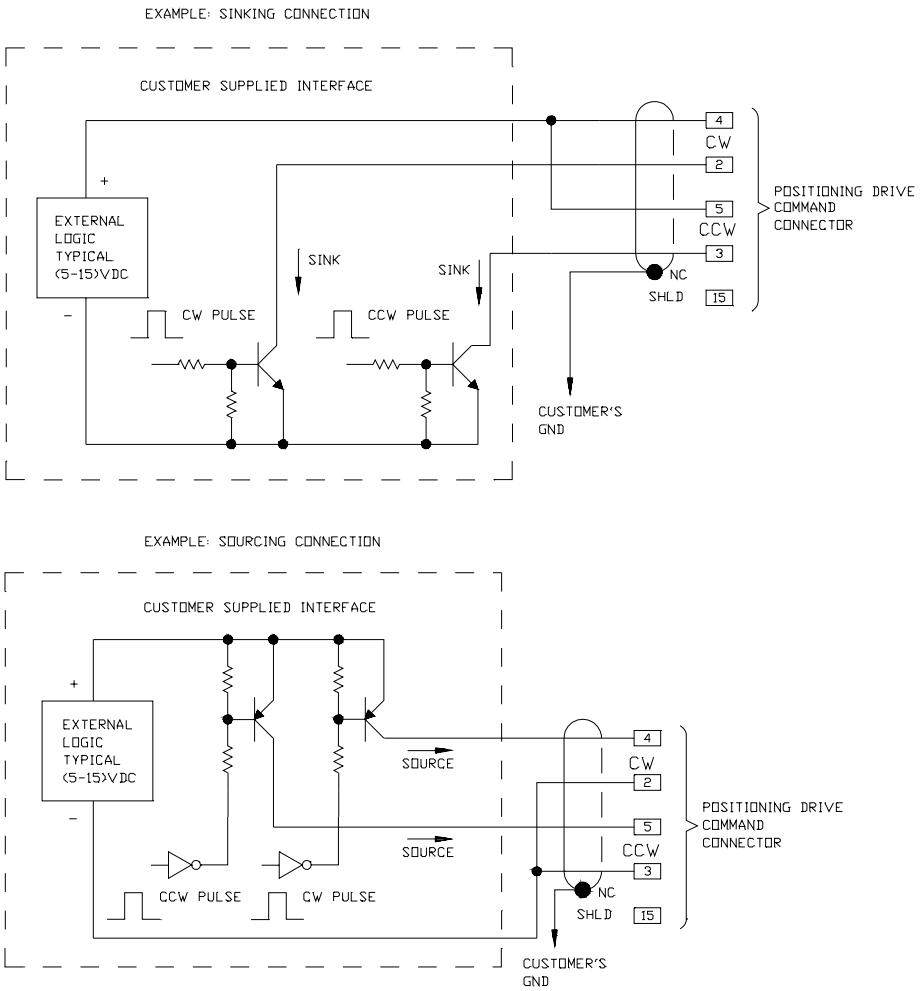


Figure 47 Example of Sinking/Sourcing Connections

NOTE: Any connections between the customer supplied interface (stepper controller, etc.) and the command connector should be made through a shielded cable. The shield of this cable should be connected to the customer interface ground (source end). If no shield connection is available at the source end, then the shield connection on the command connector may be used. Keep in mind that this shield connection is connected internally to chassis ground of the drive.

To execute one of the two Pulse Modes, simply select the desired mode of operation on the mode select dip switches and put pulses into the command connector on the amplifier.

Even though the Pulse Mode of operation is being used, the Indexing Operation Mode functions are active. This means the user could feed pulses into the amplifier and then initiate the Indexing Mode functions from the input terminals. The serial control mode also override the Pulse Mode in this same manner.

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POSITIONING DRIVE CONFIGURATION AND PROGRAMMING

INTRODUCTION

NOTE: SEE MANUAL SUPPLEMENT P/N 400221-01 (PCX PROGRAMMING) FOR PROGRAMMING INFORMATION.

EMERSON EMC's PCX programming software provides a simple, menu-driven format for question/answer set up and programming of EMERSON EMC Positioning Drives. The minimum requirements to successfully run the PCX software are any IBM PC or compatible PC with 512K bytes of RAM, one floppy disk drive and an RS232 serial interface port. The DOS version required by PCX is 3.0 or greater. PCX allows the user to look at set up data found in the Positioning Drive and make changes if desired. Programming data can be uploaded (from the Positioning Drive to the PC) or downloaded (from the PC to the Positioning Drive).

In addition, PCX allows the user to control or monitor motion functions in the Positioning Drive. All commands sent from the PC by PCX are simple two or three character ASCII letters preceded by a single character axis identifier and followed by data if required. In most cases, PCX is used to set up and program a Positioning Drive or PCM controller from a personal computer. After programming, the PC is disconnected and the user program remains in the Positioning Drive's non-volatile memory.

PCX provides descriptive question and answer formatting to assist the user. This allows minimum keystrokes to set up, program, monitor, or control, any Positioning Drive function without requiring an extensive user manual or knowledge of programming.

The PCX program also allows the user to edit files previously uploaded for multiple axes Positioning Drive systems at his desk and save them on a disk, without being connected to the Drive. These parameters can be saved under a file name (user's choice) for later downloading and non-volatile storage into the Positioning Drive.

The PCX software referred to in the manual is 4.5 or greater. Versions with less than 4.5 may not allow for full operation. Contact the factory to obtain the most recent version.

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How To Start

The PCX software is supplied on a floppy diskette. The floppy diskette does not include the Disk Operating System (DOS). A backup copy of PCX should be made before starting. To initiate the PCX program, the user should type the letters "PCX" at the operating system prompt in the directory where PCX.EXE is located. Once the program has been loaded, the PCX diskette is no longer required to be in the disk drive. For certain file options, the user should ensure that a path is available to the COMMAND.COM file. This is accomplished by setting the DOS environment variable PATH or including the COMMAND.COM file in the current directory.

PCX Program Revision

Once the PCX program has been loaded and is executing, the initial screen showing the program revision is displayed.

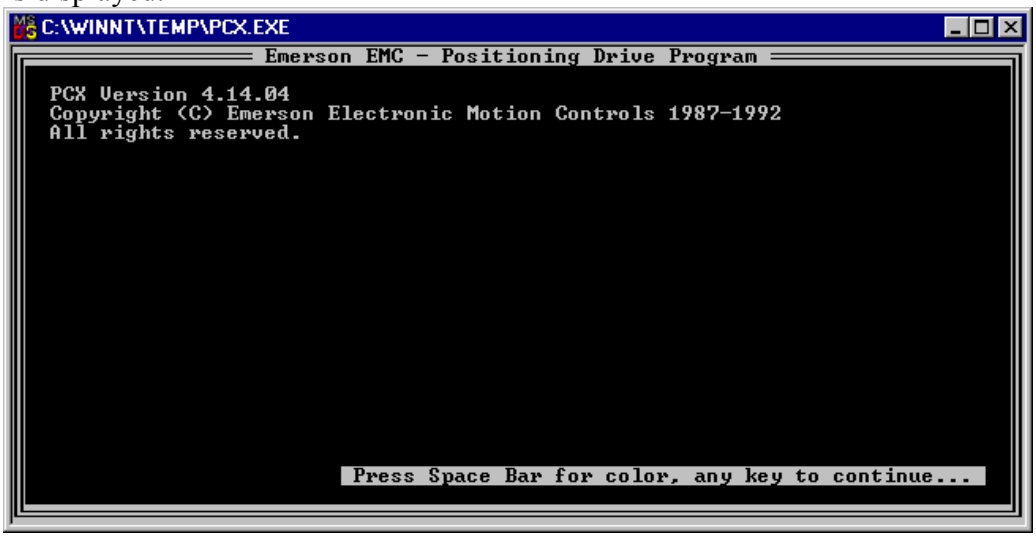


Figure 48 PCX Version 4.10

The PCX program is subject to changes. To assure that files generated with earlier versions of PCX are compatible with the least version, the following procedure should be followed.

1. Using the old PCX, download the file to the positioning drive.
2. Using the new PCX, upload a file from the positioning drive.

The PCX program referred to in this manual is revision 4.10. Revisions with less than 4.10 may not allow for full operation. Contact the factory to obtain the most recent version.

Moving Through The Menus

PCX has a hierarchy system of menus. The top menu is the Main Menu. To proceed into more specific levels, position the cursor on top of the desired option then press the "ENTER" key. There are two methods available to position the cursor. Pressing the first letter of the desired option will cause the cursor to move to that option. Pressing the "UP" and "DOWN" arrow keys will cause the cursor to move accordingly. The user may always back out to the main menu by pressing the "ESC" key. However, the "ESC" key will not cause program termination.

Changing Values In The Data Enter Screens

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At the last level of the menu hierarchy, data entry screens are often presented. All data are validated and saved when the "ENTER" key is pressed. If they are out of range, the minimum or maximum acceptable value will be entered where applicable. Other data fields may require the use of the "LEFT" of "RIGHT" arrow keys to scroll through possible options. If data is not "ENTERED", the previous data will remain unchanged. The "ESC" key will return the user to the previous menu.

USING PCX DISK FILES

PCX provides two types of disk files,

1. Data File

A data file contains all the data in the positioning drive's memory in a transportable disk file. The upload, edit, create, and make options, all work with data files. Data files are always saved with the file extension of ".PCX" so it is not necessary for the user to specify one. Data files are stored in binary files and should only be edited by PCX.

2. List File

A list file contains the values found in the PCX setup screens in an ASCII character text file. It is created from a data file with Make, in the disk file operations. A list file can be used for printing, word processing, troubleshooting, or as documentation. List files are always saved with the file extension of ".LST" so it is not necessary for the user to specify one.

Files that are created require a user file name to save the data. If possible, it is recommended that files be saved in the current directory. When files need to be recalled, PCX displays a list of files that are found in the current directory. To save to the current directory, simply type in a file name of eight characters or less. The correct file extension will automatically be appended. Files can be saved to any directory of any disk drive by specifying a complete file path.

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Main Menu

When a key is pressed while viewing the introductory revision screen, the main menu will appear on the terminal screen.



Figure 49 Main Menu

From the main menu, the user may work directly with a drive or with a disk file. By selecting On-line Operations COM1 or COM2, PCX will automatically attempt serial communications with the drive. By selecting Disk File Operations, the user may setup a data file for a single axis without being hooked to the unit. Necessary values can be saved to a floppy disk for download at a latter time. The serial communications option may be used to manually establish communications with the drive. This option may be helpful at start-up time if communications are not established with the On-line Operations.

On-line Operations

When serial communications have been established with the drive, the On-line Operations menu will be presented on the screen.



Figure 50 On-line Operations

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Drive Setup

The setup options logically group together the necessary positioning drive values into data entry screens for editing. Everything necessary to prepare a drive for use can be accomplished in this option.

Upload Data From Drive

When this option is selected, PCX will PCead the values that are stored in the drives memory. Next, PCX will attempt to save the data to a user specified disk file name. When completed, the newly created file may be used for downloading to another drive or in the off line options, editing and printing. Uploading may take a few minutes to complete depending on the system being read from.

Download Data From Drive

When this option is selected, PCX will attempt to list all files that have the extension of ".PCX" from the current directory. The user may select, from the list, a file to write to the drive. When selected, all values in the drive will be replaced by those from the file specified. If no files are found in the current directory, no downloading may take place. Downloading may take a few minutes to complete, depending on the system being written to.

Diagnostics

When this option is selected, PCX will monitor and display the status of the drive. This mode is useful when troubleshooting a system.

Shell

A DOS shell provides the user with a way to enter DOS commands without exiting PCX. In order for shell to work properly, the COMMAND.COM file must be accessible by PCX; This may be accomplished by using the DOS PATH or COPY command.

Terminal Mode

In this mode, the computer will operate as a dumb terminal. This means that the computer will send and receive ASCII serial commands. These commands can be used in place of the menus described in ON LINE SELECTION. However, this mode does not contain any help screens or instructions on how to program. The user must be cautious in this mode because whatever is typed is sent to the drive. Incorrect entries could be motion commands and if so, the drive would execute them.

NOTE: Programming should be done entirely with the PCX software or through the dumb terminal ASCII serial commands – BUT NOT BOTH. If both programming methods are used, there is a chance that not all the parameters entered through the dumb terminal will be transferred to the PCX software. This may lead to unpredictable behavior of the drive.

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ESTABLISHING COMMUNICATIONS

The On-line Options in PCX require serial communications between the personal computer and the positioning drive. When selecting On-line Options the first time, PCX will attempt to communicate by transmitting a character and then receiving the echo. When the echo is the same as the character transmitted then communications have been established. PCX tries this procedure with all the possible baud rates. Once PCX has established communications, the program will continue by displaying the On-line Options. This procedure will not be called again unless communications are disrupted at a later time.

The following checklist should be addressed before attempting serial communications.

1. The serial cable must be connected to the personal computer serial port and the drive serial A port.

2. On a multi-axis system, the serial cables must be connected as shown below.

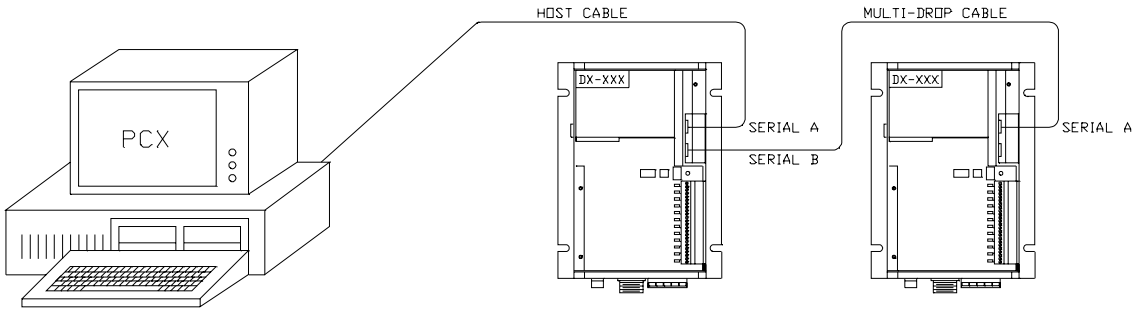


Figure 51 Serial Cable Setup

3. On a multi-axis system, make sure that the baud rate setting on each drive is the same.

4. On a multi-axis system, make sure that each positioning drive has a unique axis identifier.

5. Power to all positioning drives must be on.

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DISK FILE OPERATIONS

When this operation is selected from the Main Menu, the Disk File Operations Menu will be presented on the screen.

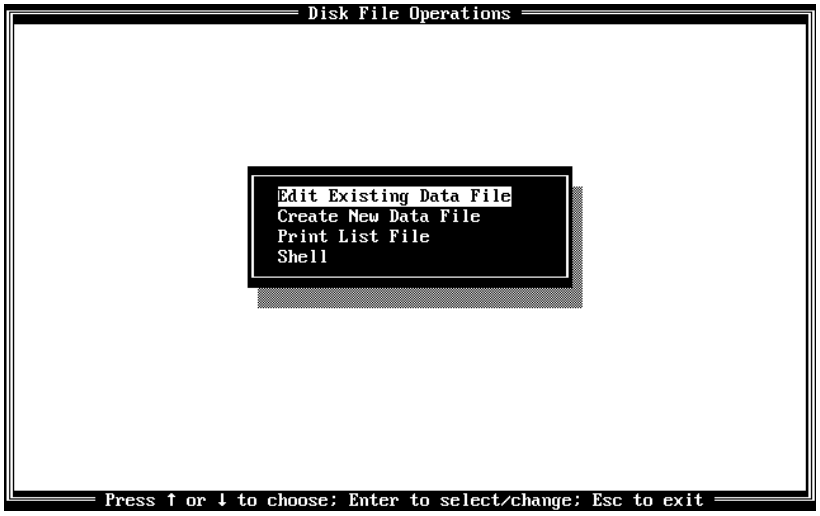


Figure 52 Disk File Operation

Edit Existing Data File

PCX will attempt to list all files that have the extension of ".PCX" from the current directory. The user may select, from the list, a previously saved data file to be recalled. Editing a file is very similar to the On-line Setup options except it allows the user to change any drive values without being connected to the drive. After editing, the file may be saved, renamed, or left unchanged. Editing may only be done on data files that have previously been uploaded or created.

Create New Data File

PCX will allow the user to create a data file. The user must select the controller model and any optional PCM module for the file that is to be created. Once this has been done, the file may be edited and saved under a user file name for later use.

Make A List From A Data File

PCX will attempt to list all files that have the extension of ".PCX" from the current directory. The user may select a data file necessary to produce a list file. PCX will use the same file name but will append the extension ".LST" to the newly created list file. List files are ASCII character text files created from data files (see Using PCX Files).

Print List File

PCX will attempt to list all files that have the extension of ".LST" from the current directory. The user may select a list file to be printed. In order for printing to work properly, the PRINT.COM file must be accessible by PCX; This may be accomplished by using the DOS PATH or COPY command. The printer must also be available and on-line.

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Shell

A DOS shell provides the user with a way to enter DOS commands without exiting PCX. In order for shell to work properly, the COMMAND.COM file must be accessible by PCX; This may be accomplished by using the DOS PATH or COPY command.

DRIVE SETUP

When the Setup, Edit, or Create option is selection, the Drive Setup menu will be displayed on the screen.

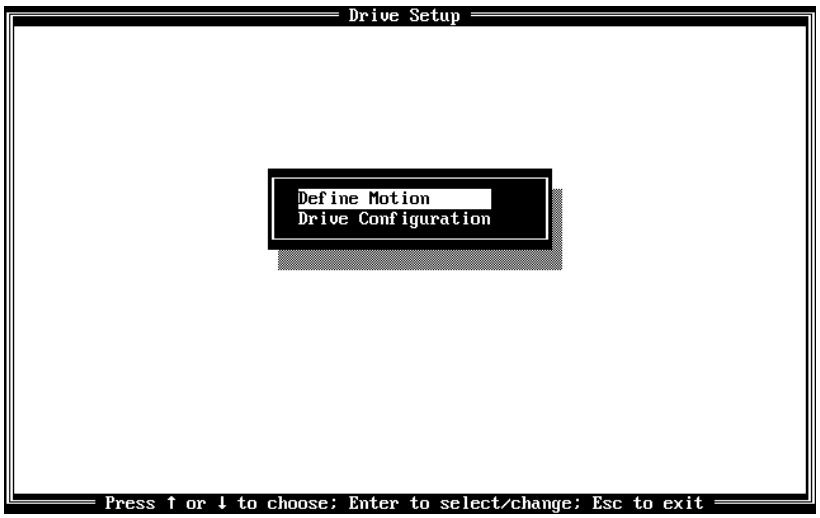


Figure 53 Drive Setup

From the Drive Setup Menu, there are two areas that need to be setup. The Define Motion menu item is where motion related items are setup. Data entry screens for Jog, Home, Index and programs are programmed here. The second option, Drive Configuration, is where all other drive items are located. The drive setup, Input and Output Functions, Parameters, and Limits, are all programmed from this option.



Figure 54 Define Motion

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Figure 55 Drive Configuration

Jog, Index and Home

A drives basic motion functions are programmable by using these data entry screens. When on line with a drive, these options allow motion to be initiated and stopped by pressing the "SPACE BAR". The bottom section provides helpful information such as the range of possible values, available types, valid units, and any other special instructions. These screens are explained in greater detail in the external operating modes. Additional capabilities are described in the IOM and PCM sections of the manual.

Inputs and Outputs

These two screens are used for assigning the input and output lines to a function. Line numbers correspond to those on the top of the drive and PCM modules. A function with a line number of zero designates that it is unused. Multiple functions can be assigned to a single line; it is common to assign all output faults to one output line. The left window allows the user to quickly determine what functions are assigned. The right window may be scrolled up and down to assign additional functions that are physically unable to fit on a screen. Refer to the input and output interface section for physical location and descriptions. Additional I/O capabilities for the IOM and PCM's are in those sections.

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Input Polarity

Input functions that do not affect motion may be assigned as normally off (-, default) or normally on (+). When an input is assigned with "+" polarity, it is active while the input is not on. Input polarity is assigned by pressing the "+" or "-" key on the input function indicated by the cursor.

Input Filtering

By pressing "ALT-F" on the input screen, PCX will pop-up the filtering data entry screen. Input filtering is a form of digital integration. It is not intended to reduce electrical noise or the effects of electrical noise in industrial environments. It is provided to digitally qualify that an input is on for a pre-determined time. The drive services inputs at a minimum rate of .002 seconds. Therefore, the input or input filtering is always subject to a delay of (.0005 to .0025) seconds. The .0005 delay caused by propagation delay of the hardware and .0025 is the sum of the propagation delay plus the service time. The PCX program will only allow for this time to be entered in increments of .002 as this is the minimum service rate. When "ESC" is pressed, PCX will return to the input setup screen.

Parameters

The Parameters screen allows the user to set up parameters for display purposes. These parameters include position units, distance decimal point, location, velocity units, velocity scale and velocity decimal point location. PCX and displays, such as EMERSON EMC's T-21 Data Entry Terminal, use these parameters to display familiar user units. Some examples would be: IN/SEC; RPM; STEPS/REV; FT/MIN, etc.

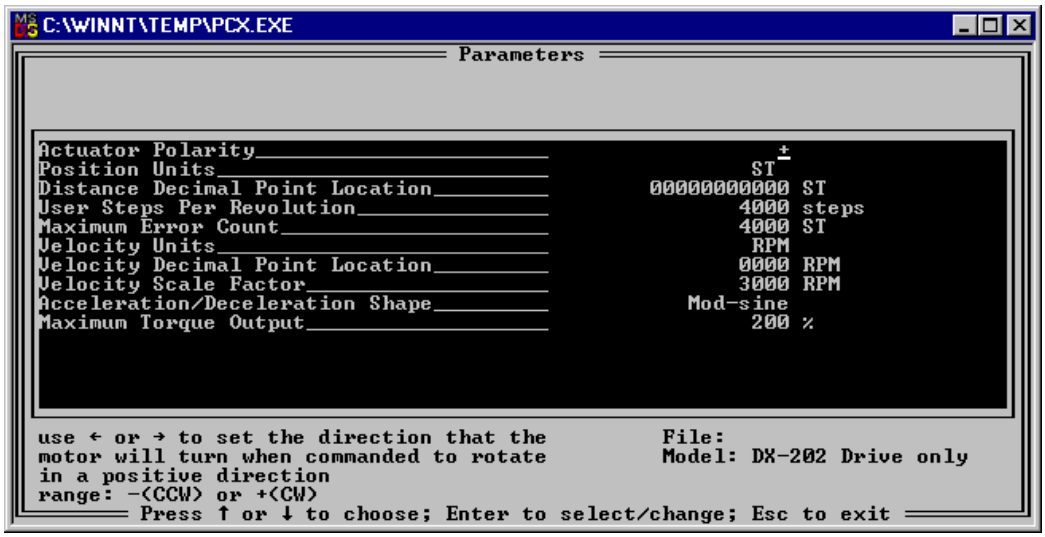


Figure 56 Parameters

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Actuator Polarity

The default (+) of this feature provides for CW rotation of the actuator for positive (+) motion initiation. For example, a CW JOG input will cause CW rotation of the actuator as viewed from the shaft end of the actuator. To change this relationship, a (-) can be programmed. During the time this change occurs using PCX, the bridge is turned OFF and ON to accomplish a smooth transition.

Velocity Units, Velocity Scale Factor, Velocity Decimal Point Location

To make the display data meaningful, the user must set up a conversion between his units and the units that are used by the drive.

Example: The user has a system that direct couples to a lead screw and would like to program velocity in IN/MIN and position inches. He has a pitch (5 REV/IN) LEAD SCREW. To determine the VELOCITY SCALE FACTOR he would have to calculate the following:

$$\frac{\textbf{3000 (MAX MOTOR RPM)}}{\textbf{6 (PITCH)}} = \textbf{600 INCHES PER MINUTE}$$

Since in his system 600 IN/MIN = 3000 RPM, the VELOCITY SCALE FACTOR would be set = 600 or 600.0. If inches per second were desired then division by 60 would yield either 10.000 or 10.00. Once these decisions are made, the numeric value, decimal point and velocity units can be programmed. Velocity units would be either IPM (INCHES PER MINUTE) or IPS (INCHES PER SECOND). Any 3 ASCII characters are accepted.

Distance Decimal Point Location, User Steps Per Revolution

The user may also set up a distance conversion because he is working in inches and the drive works in steps. He can use the USER STEPS PER REV to create this conversion.

We have: **1 IN = 5 LEAD SCREW REVS**
Therefore: **1 IN = 5 MOTOR REVS**

Now the user must decide how many steps per user rev. The drive will accept any number in a range of (200 to 25,000). The easiest way to do this is to divide the one inch by the 5 turns to find the number 0.2. This example yields three possible conversions; either 200, 2000 or 20,000. The number must be between 200 and 25,000.

If 2,000 is chosen, then 2,000 X 5 turns = 10,000 counts per inch. This would provide for a program resolution of .0001 inches. If 20,000 is chosen, then 20,000 X 5 turns = 100,000 counts per inch. This would provide for a program resolution of .00001 inches.

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Once a decision is reached, the value for steps for revolution, decimal point and units can be entered. Low resolutions, less than 1,000, are discouraged as dither is increased. For example, if 200 was selected, 360°/200 = 1.8° of dither. This could be objectionable.

Acell/Decell Shape

This option also allows the user to choose either linear ramps or mod-sine ramps for acceleration or deceleration. The difference is shown below.

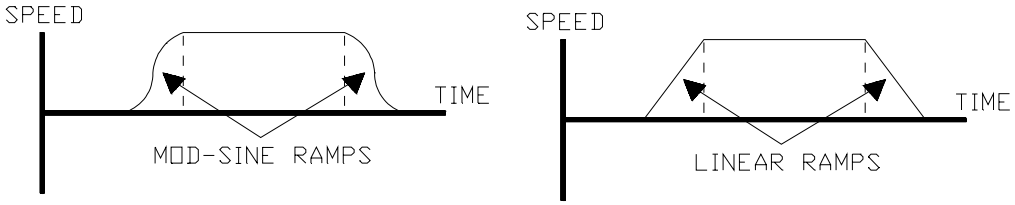


Figure 57 Mod-Sine Ramps/Linear Ramps

Torque Output

The torque output controls the amount of available torque. 200% is the drives peak rating. 100% would be the amplifiers continuous rating. Peak torque is only available for short periods. Consult the MFR. Specs for the amplifier in use.

LIMITS

The Limits screen allows the user to set the maximum and minimum operating parameters.

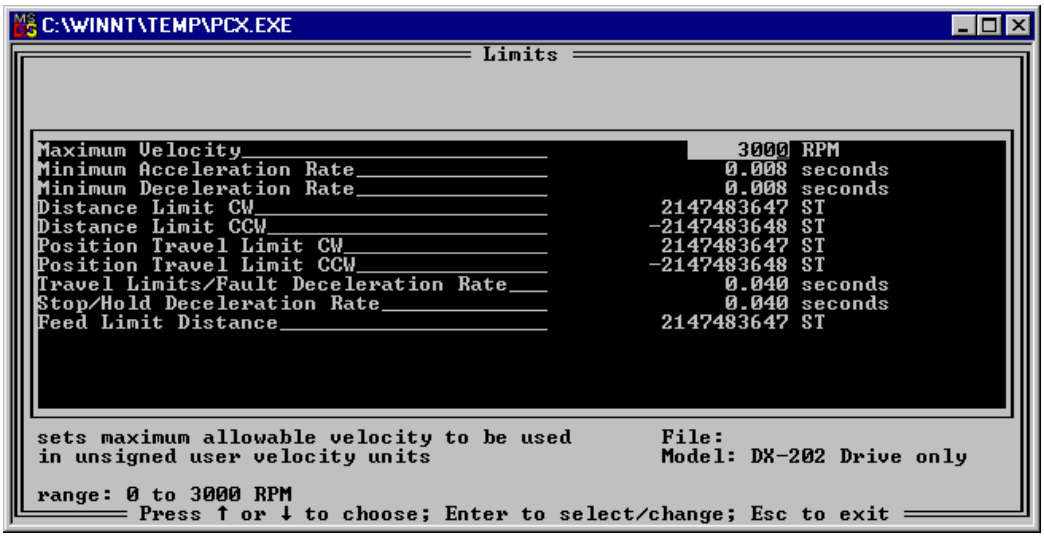


Figure 58 Limits

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Maximum Velocity

MAXIMUM VELOCITY limits velocity entries to the value entered here.

Minimum Acceleration Rate and Minimum Deceleration Rate

Used to limit the minimum time it takes to accelerate and decelerate the motor and load from zero to 3,000 RPM or vice-versa. This time is greatly affected by load inertia and friction. Those factors should be considered when the time limits are set.

Distance Limit CW and Distance Limit CCW

Used to set the maximum distance that can be programmed in an index.

Position (Travel) Limit CW and Distance Limit CW

Used during absolute positioning applications. The limit positions are given with reference to the home position. Because of this, a home cycle must be executed before these travel limits are enabled.

Travel Limits/Fault Deceleration Rate

Used to set the deceleration rate after any fault occurs, or a travel limit (hardware or software) is tripped.

Stop Deceleration Rate

Used as the deceleration rate for a stop command (Serial or I/O).

Feed Limit Distance

Used for feed sensor index applications. The user can limit the distance that the motor will travel after it has been commanded to look for sensor input. This entry prevents excessive travel if a feed sensor or switch fails.

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INDEXING OPERATION MODE

In most applications the user will use the drive in this mode. The INDEXING mode of operation allows the user to execute up to 32 different indexes (distance or position moves) that can be stored in non-volatile memory. These 32 indexes, plus other motion functions such as Stop, Jog and Home, are easily programmed either by entering the proper ASCII commands or by using the PCX programming software supplied with the drive. The PCX software provides descriptive 'prompts' and 'help' menus to make programming easy. Programming through ASCII serial commands tends to be more difficult, but is available for the user who wishes to program without the help of the PCX software.

The INDEXING OPERATION MODE is the most commonly used mode and is accessible by having the mode select DIP switches set for either the PULSE/PULSE or PULSE/DIRECTION settings. Both the PULSE FOLLOWER, and INDEXING OPERATION MODES are operational.

The numeric display on the Positioning Drive will indicate an (E) if the external mode is selected. This is also the default mode of operation.

In the INDEXING OPERATION MODE the optically isolated inputs and outputs are the primary source of data to execute motion such as INDEX, JOG, and HOME. With a PCM-1, additional capability in the form of programs is available.

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Four types of indexes can be programmed into the drive as shown below.

INDEX TYPES

Incremental Index: Relative distance and direction from start.

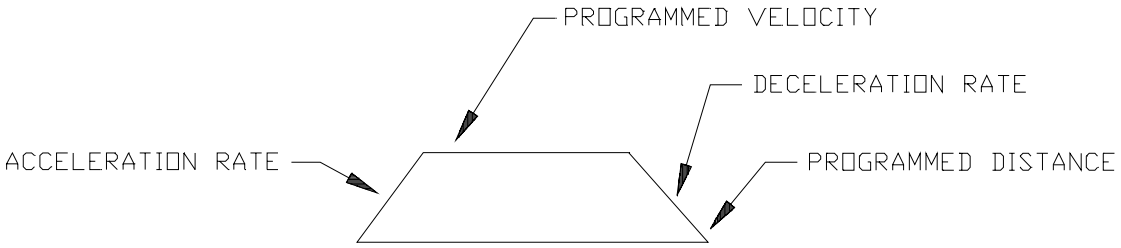


Figure 59 Velocity Vs Time Profiles for 520

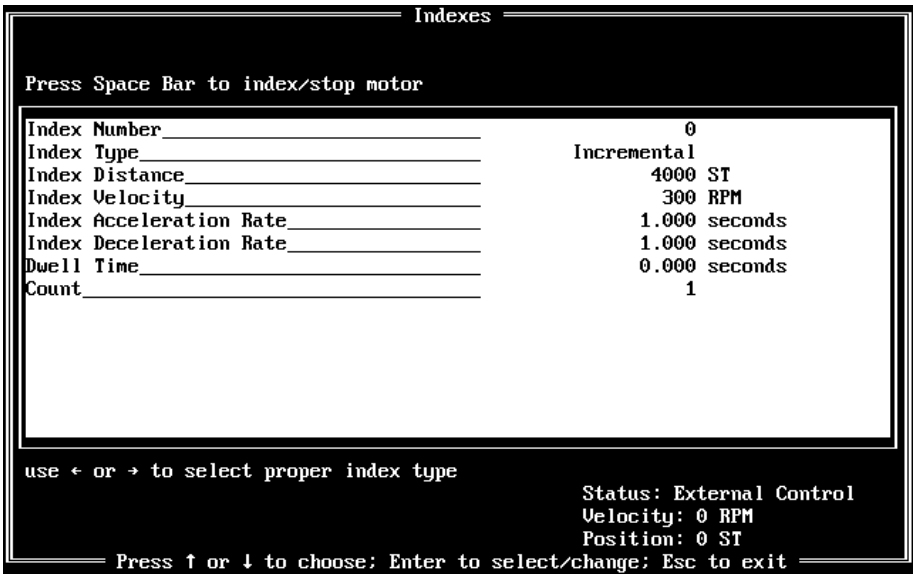


Figure 60 Screen Menu – Index/Incremental

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Absolute Index: End position is absolute coordinate regardless of start.

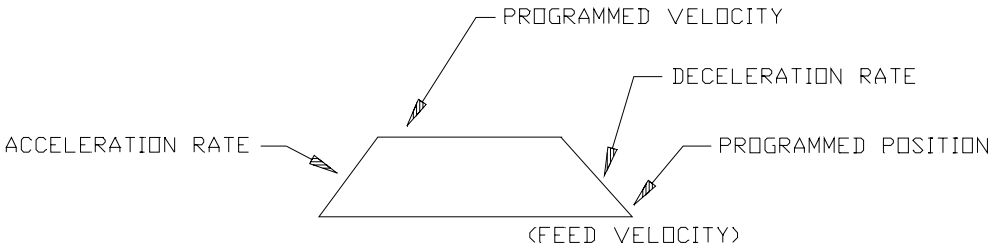


Figure 61 Velocity Vs Time Profiles (Absolute Index)

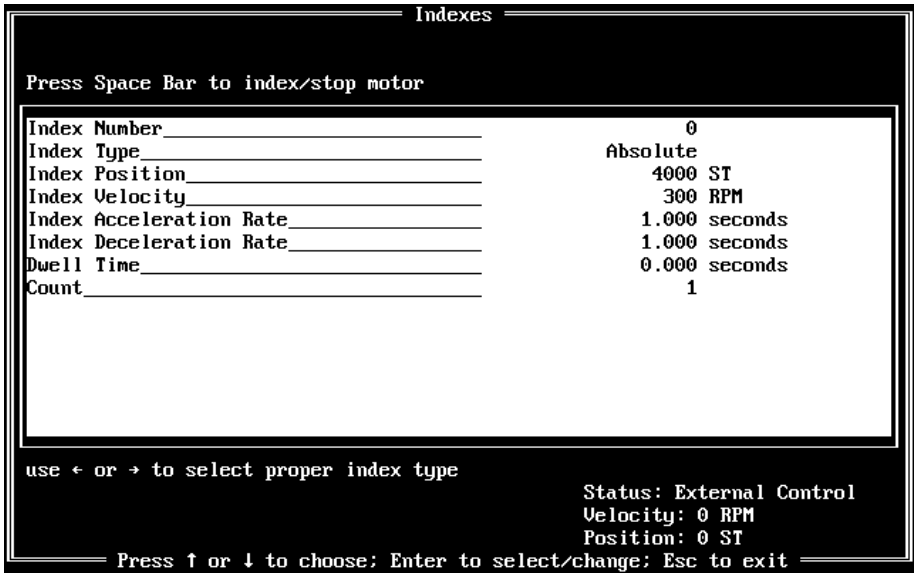


Figure 62 Screen Menu – Index/Absolute

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Registration Index

Run at the sensor velocity until the sensor or limit distance is achieved. Once either of these occurs, the parameters of the index are run. If the limit distance assignable output is programmed, it will com ON when the limit occurs.

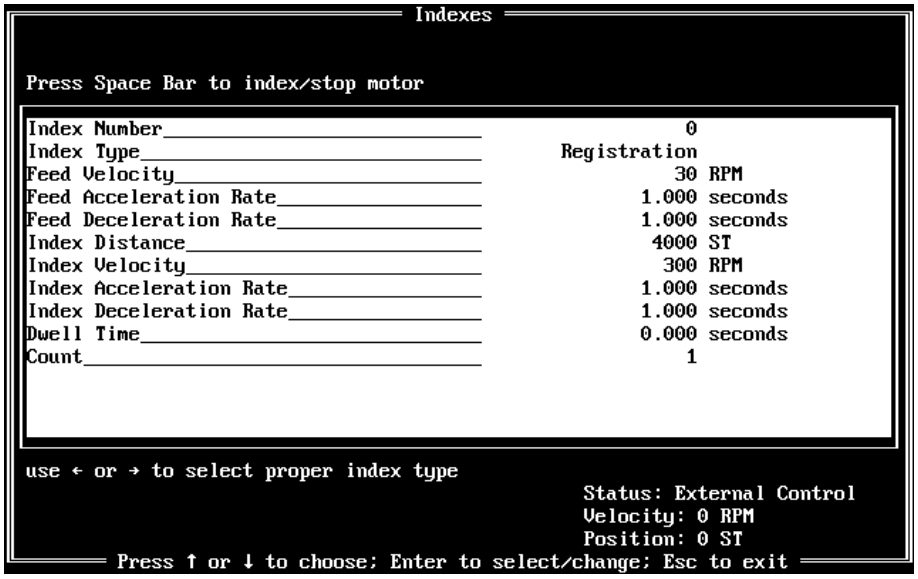


Figure 63 Index/Registration

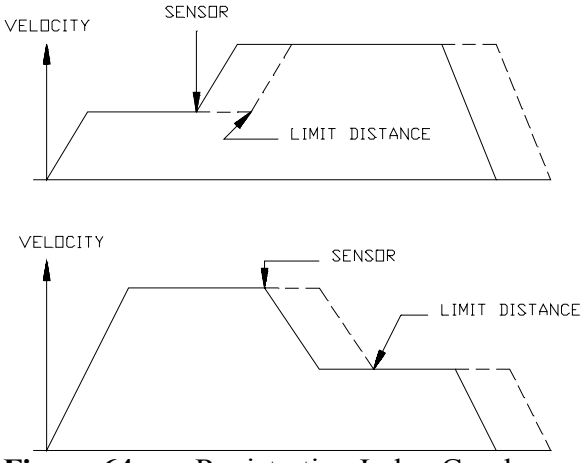


Figure 64 Registration Index Graph

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Feed-To-Sensor Index

Move an amount determined by the index parameters. Once achieved, move at a rate determined by the sensor velocity until either the sensor input or limit distance is achieved. If the limit distance assignable output is programmed, it will also com ON.

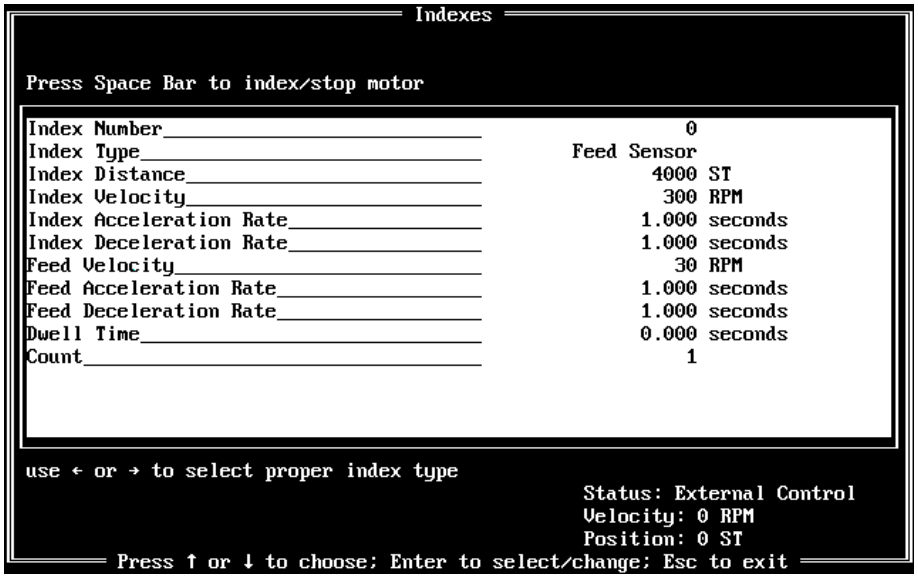


Figure 65 Index/Feed Sensor

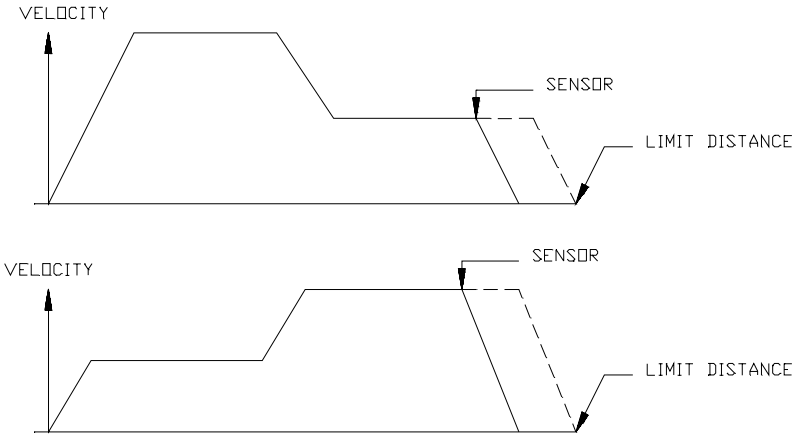


Figure 66 Velocity Vs Time Profiles (Index Feed Sensor)

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JOG

The JOG function is provided to cause CW or CCW motion of the motor at controlled velocities. Initiation of JOG is usually accomplished by inputs connected to the optically isolated inputs although it can also be initiated through serial control and PCX. A FAST/SLOW input function can be programmed. Inputs can be programmed to have either a CW and CCW control or a JOG and a direction select. The default inputs provide for the CW and CCW inputs and JOG is assumed since the FAST/SLOW input isn't assigned. In programming JOG, three velocities can be programmed; SERIAL VELOCITY, JOG FAST, and JOG SLOW. The acceleration time and deceleration times are also programmable, but are used for all velocities programmed.

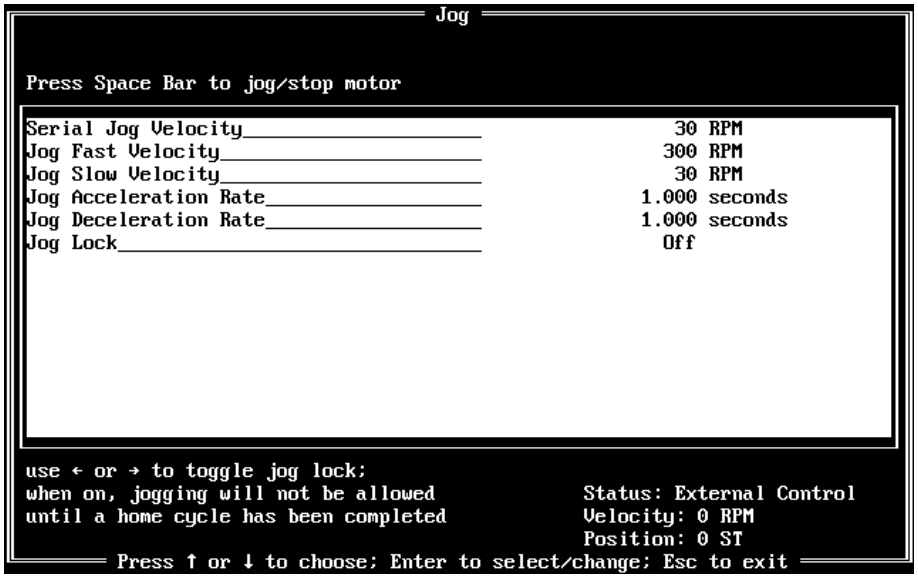


Figure 67 Jog Function

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HOME

The drive is equipped with a capability for six different HOME types:

TYPE

0	OFFSET (HOME TO MARK+ OFFSET)
1	FEED ON (HOME TO SENSOR)
2	FEED ON/OFFSET (HOME TO SENSOR THEN MARK+ OFFSET)
3	FEED ON/OFF (HOME TO SENSOR THEN OFF SENSOR)
4	FEED ON/OFF/OFFSET (HOME TO SENSOR THEN OFF SENSOR THENMARK+ OFFSET)
5	FEED ON/OFF/ON (HOME TO SENSOR THEN OFF SENSOR THEN ON SENSOR)

Home cycles are used in applications that require a starting (HOME) position to locate tooling, fixtures, carriages, etc. that are required as a prerequisite to initiation of other cycles. Two separate inputs can be programmed to accomplish HOME cycles, HOME SENSOR and HOME INITIATE. The integration of motion relative to these inputs is what determines any specific HOME cycle. Any of the HOME cycles may be set up as you program the HOME function with PCX.

An example of a HOME cycle could be demonstrated with a ball screw or rack and pinion drive that converts rotary motion output into linear motion.

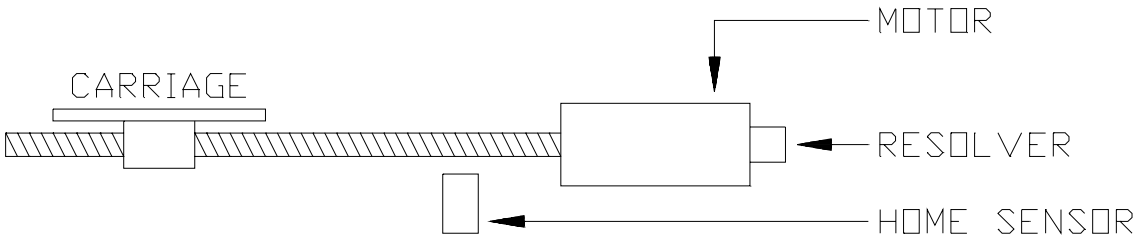


Figure 68 Example of Home Cycle

This particular application would utilize most of the programming features in the HOME setup. In this application, we want to position the carriage to the physical location of the external HOME sensor and then to an offset.

This is a type 4 HOME, FEED ON/OFF/OFFSET (HOME TO SENSOR THEN OFF SENSOR THEN OFFSET).

Notice that an additional feature in programming is the HOME lock ON/OFF. If the HOME lock is ON, then upon powering up, the only request for motion that will be accepted is one for a HOME cycle.

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Assuming the carriage is shown off the HOME sensor and that CCW (-) rotation of the motor causes motion toward the sensor, the following cycle would occur.

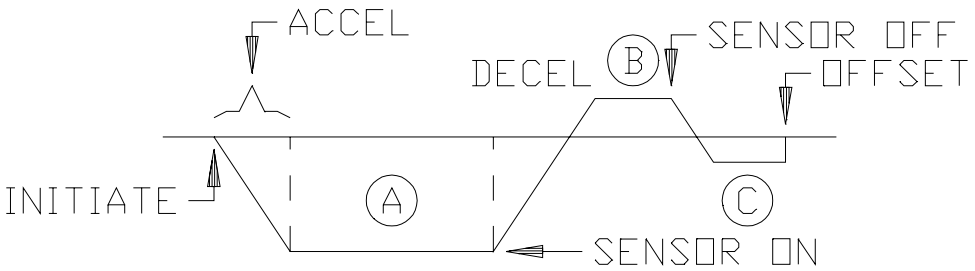


Figure 69 Home Sensor Graph

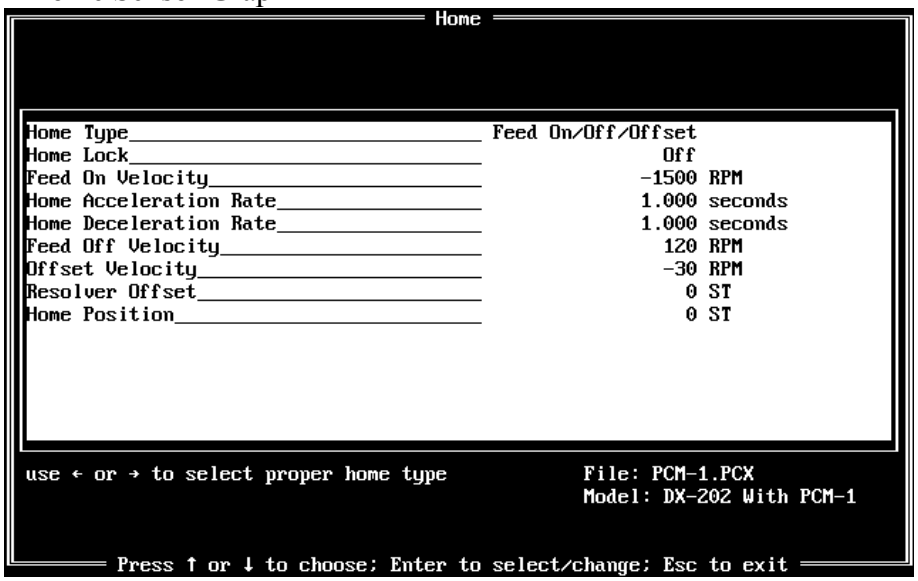


Figure 70 Screen Menu-Home Feed On/Off/Offset

The (A) motion is the -1500 RPM to find the sensor.

The (B) motion is the +120 RPM to find the sensor "OFF".

The (C) motion is the -30 RPM to move to the once per revolution offset.

Note that the last two questions in programming are:

1) MARK+ OFFSET----------
2) HOME POSITION----------

The offset is the amount of user steps within one revolution. The HOME position is the position for reference in programming that you want to assign to HOME. These two values are frequently zero. The 6 home types are explained as follows:

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HOME TYPE 0. OFFSET (HOME TO MARK+ OFFSET)

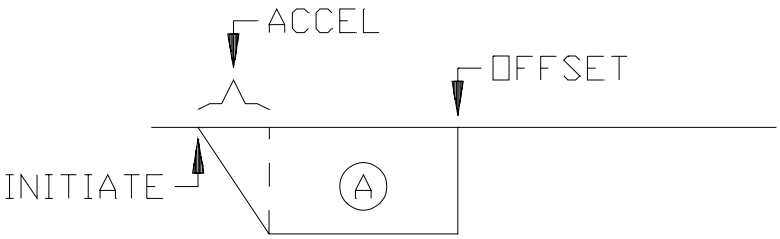


Figure 71 Home To Mark

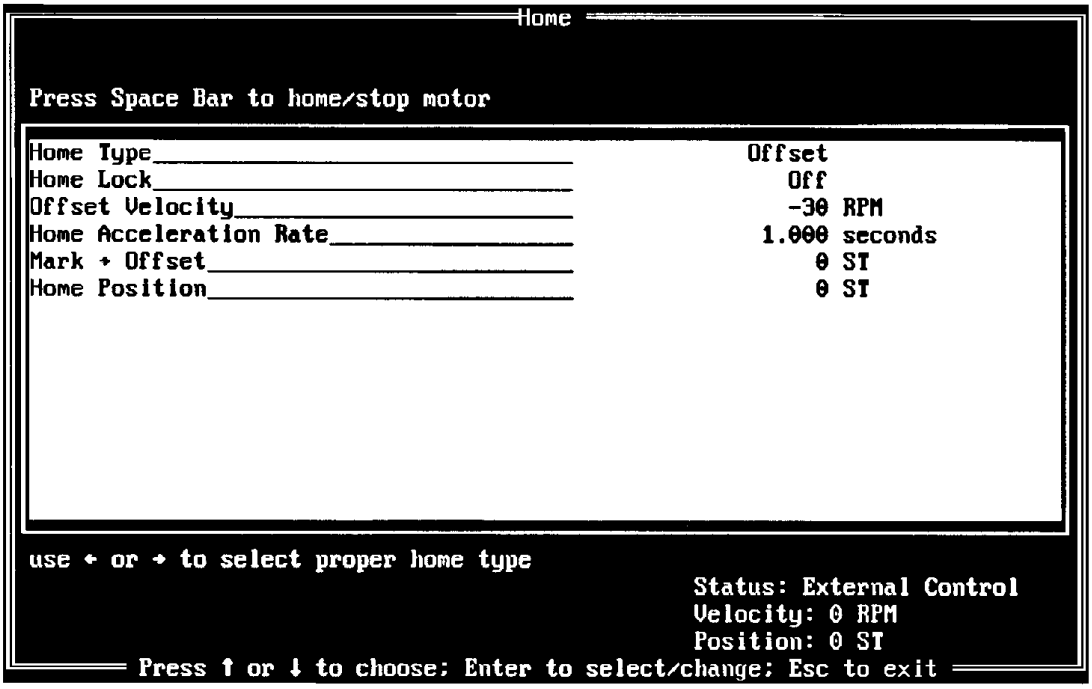


Figure 72 HOME/OFFSET

(A) is the -30 RPM velocity to find the offset.

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HOME TYPE 1. FEED ON (HOME TO SENSOR)

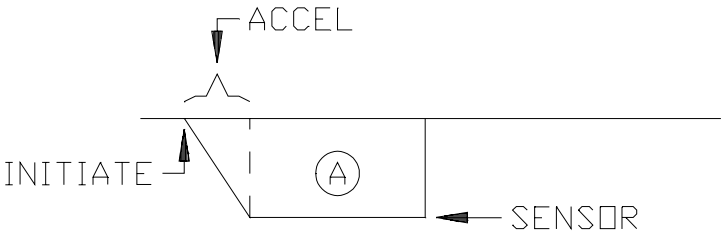


Figure 73 Home To Sensor Graph

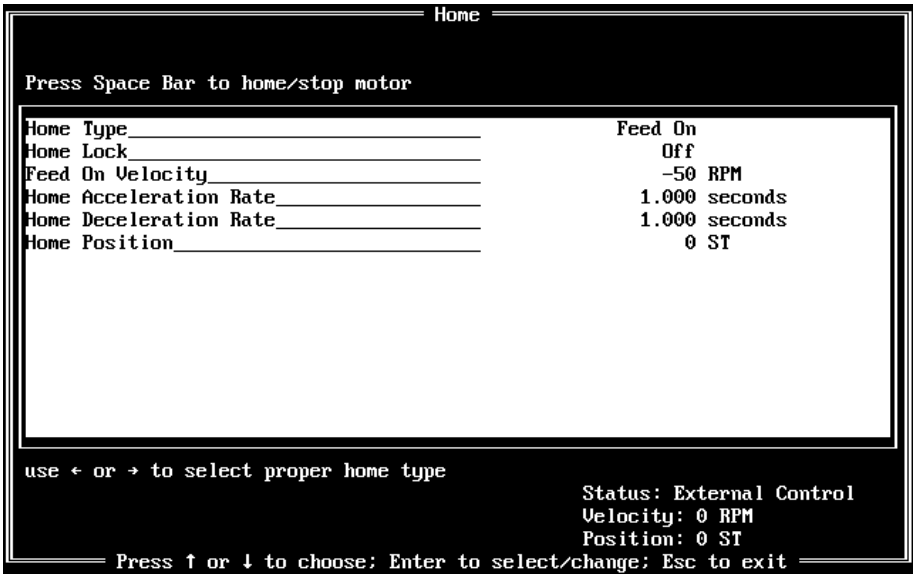


Figure 74 Home to Sensor (Feed On)

(A) is the -50 RPM velocity to find the sensor.

NOTE: THERE IS NO DECEL TIME ONCE THE SENSOR IS REACHED.

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HOME TYPE 2. FEED ON/OFFSET (HOME TO SENSOR THEN OFFSET)

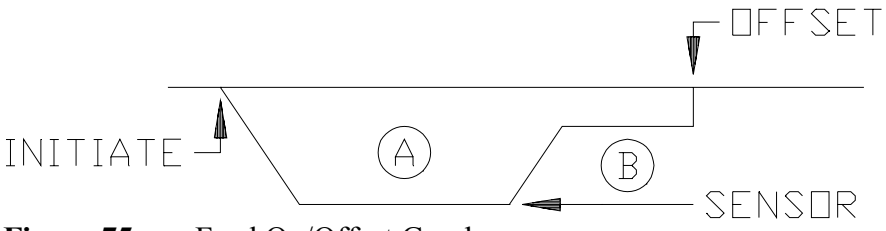


Figure 75 Feed On/Offset Graph

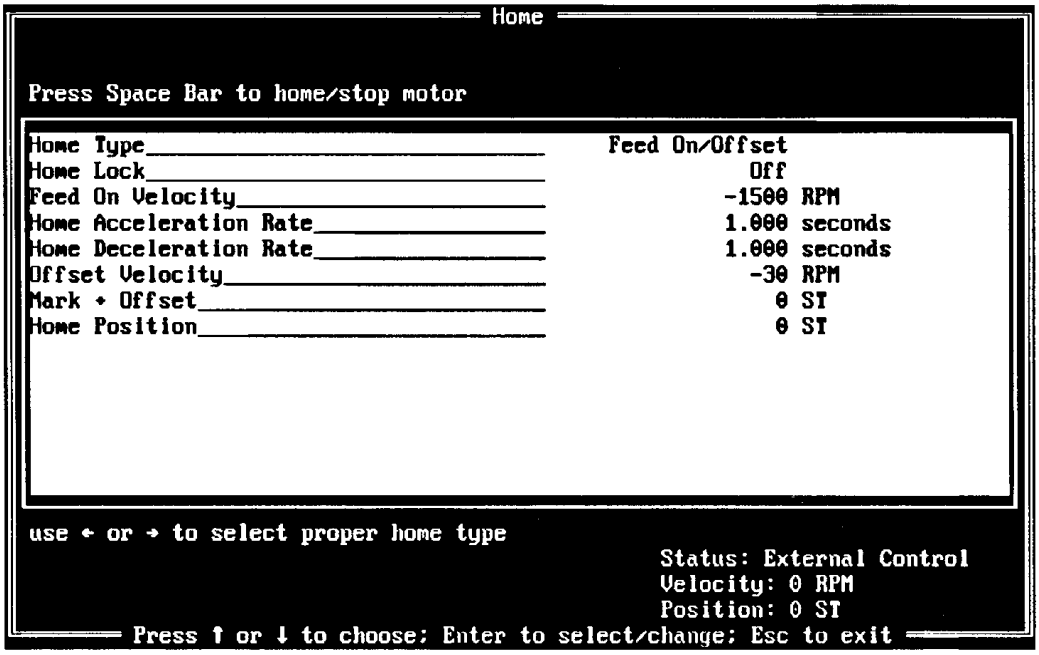


Figure 76 Home Feed On/Offset

(A) is the -1500 RPM velocity to find the sensor.

(B) is the -30 RPM to find the offset.

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HOME TYPE 3. FEED ON/OFF (HOME TO SENSOR THEN OFF SENSOR)

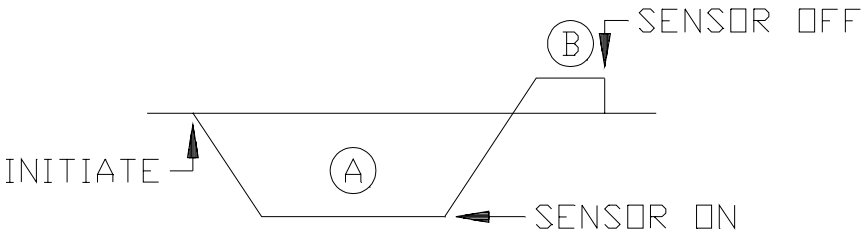


Figure 77 Home Feed On/Off

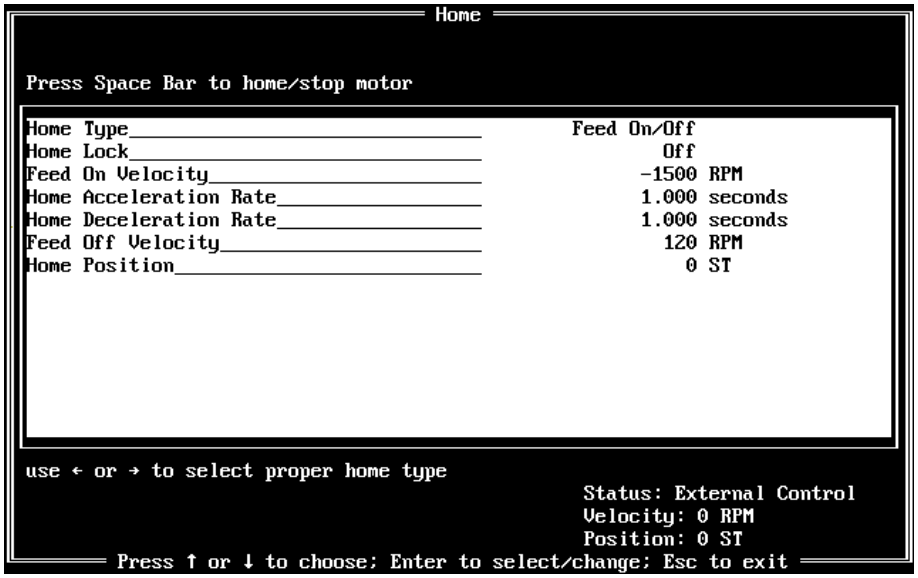


Figure 78 Home Feed On/Off

(A) is the -1500 RPM velocity to find the sensor.

(B) is the +120 RPM velocity to move off the sensor.

NOTE: THERE IS NO DECEL AT THE FINAL OFF POSITION.

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HOME TYPE 4. FEED ON/OFF/OFFSET (HOME TO SENSOR THEN OFF SENSOR THEN MARK+ OFFSET)

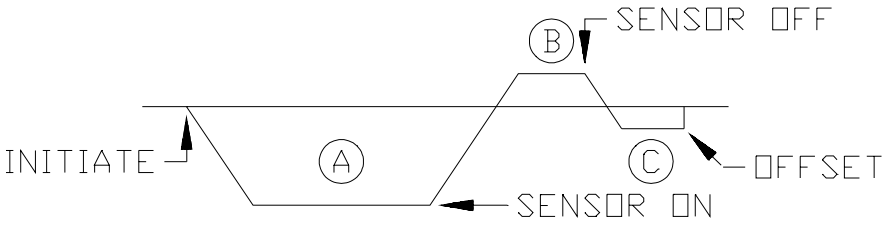


Figure 79 Feed On/Off/Offset

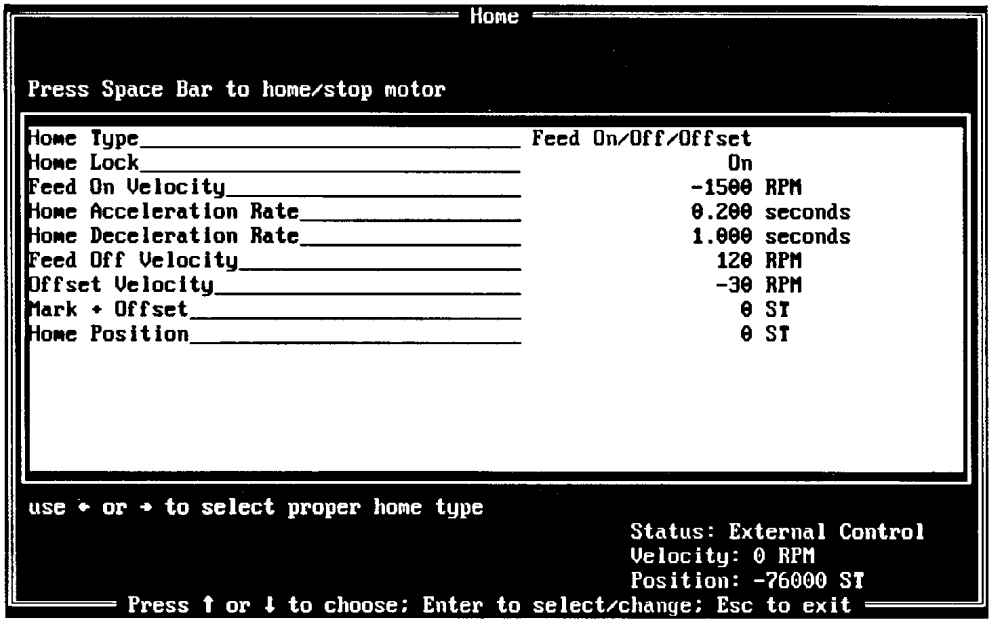


Figure 80 Home Feed On/Off/Offset

(A) is the -1500 RPM velocity to find the sensor.

(B) is the +120 RPM velocity to turn the sensor “OFF”.

(C) is the -30 RPM velocity to find the offset.

NOTE: THERE IS NO DECEL AT THE FINAL POSITION.

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HOME TYPE 5. FEED ON/OFF/ON (HOME TO SENSOR THEN OFF SENSOR ON SENSOR)

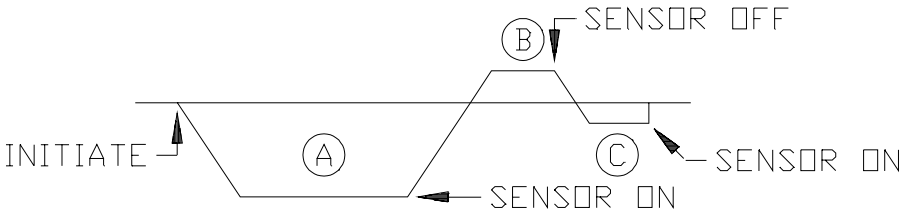


Figure 81 Home To Sensor Graph

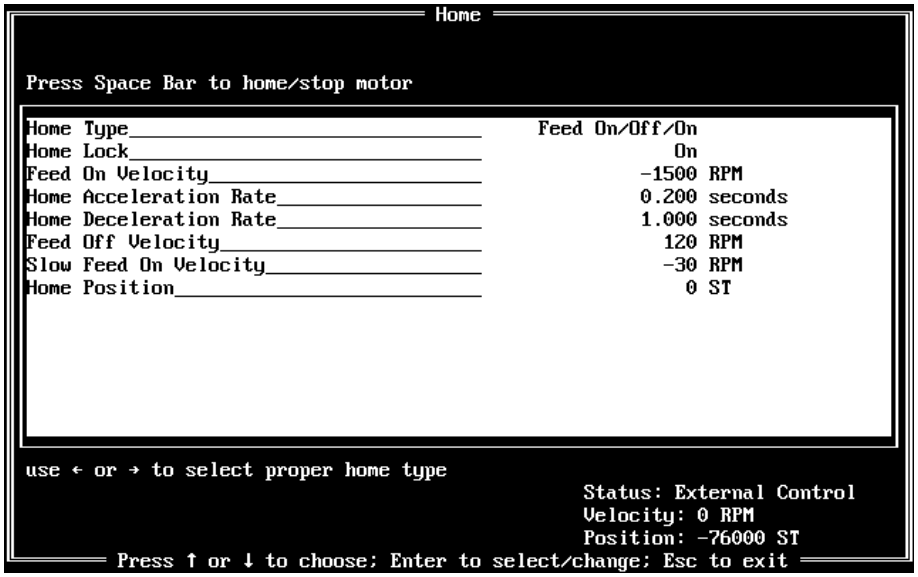


Figure 82 Home Feed On/Off/On

(A) is the -1500 RPM velocity to find the sensor.

(C) is the +120 RPM velocity to turn the sensor “OFF”.

(C) is the -30 RPM velocity to turn the sensor on again.

NOTE: THERE IS NO DECEL AT THE FINAL POSITION.

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OVERVIEW OF BASIC OPERATION MODES

The Indexing Operation Mode allows for different methods for executing the stored functions:

ASCII Serial Mode
PCX Programming Mode
Input/Output Mode

Serial Mode

The serial interface provides a capability that basically is an additional control mode beyond the three basic control modes (ANALOG, PULSE and INDEXING).

The Serial Control Mode can also be used to execute or program motion functions. The user can send the execution serial commands from his programming device through the serial interface to the drive. Common types of programming devices are programmable logic controllers (PLCs) equipped with BASIC or ASCII communication modules.

In Serial Control Mode, the numeric display indicates an (E.). This control mode is accessible via the serial connector "A" on the drive and the protocol is based on ASCII characters. To enter the Serial Control Mode, the digital drive must receive an SC=1 string preceded by an axis I.D. character if the appropriate DIP switches are set.

The serial interface is always accessible via serial ASCII commands. The difference, as far as the display is concerned, is that serial commands to initiate motion will be ignored unless the decimal point after the E is on (E.). If the decimal is on, meaning you are under Serial Control Mode, then motion initiation from the I/O is ignored. Stop commands from either serial or I/O are always accepted and additionally, both hardware or software travel limits are going to work if programmed in the (E) or (E.) modes.

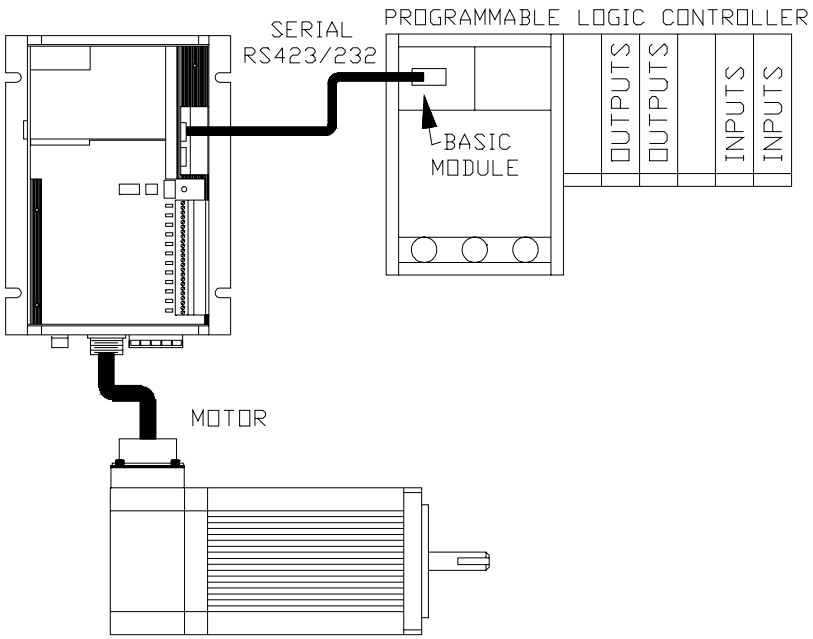


Figure 83 Serial Control Mode

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OVERVIEW

The Drive is equipped with 8 inputs and 4 outputs which are optically isolated for +10 to +30 vdc operation. Each input and output has 2 screw terminals associated with it to provide for either sinking or sourcing operation. The first 8 pairs of designated terminals are inputs and the last 4 pairs of terminals are outputs. The outputs are capable of sinking or sourcing 200 mA. It is the users responsibility to limit the output current to less than or equal to 200 mA.

These inputs and outputs allow for proper timing and coordination between the drive's motion and other machine control functions. The inputs and outputs typically are connected to the machine's programmable logic controller (PLC) or relay logic system. These inputs and outputs are also connected to limit switches, and/or switches and indicators on an operator's control panel.

A large number of input/output control functions are provided. The functions used are assigned to any of the input/output lines. This is accomplished through either serial interface commands or by using the PCX software provided with the drive. Inputs may be programmed as normally off or normally on. In addition, more than one function may be assigned to the same input line. Each Drive comes from the factory with the inputs and outputs predefined for frequently used I/O configurations.

Using the I/O inputs, specific pre-programmed index functions are addressed by coding the 0-31 index number in binary. Receiving the proper binary code prior to an Index Initiate determines the required index. An output function can be programmed on one of the output lines to indicate when the move is completed. Other functions such as Jog and Home have discrete inputs assigned which, when activated, cause that function to execute. The input lines can be used to execute functions which can be activated by the user through switches, sensors, or possibly, a PLC's output. This provides an interface between the drive and other parts of a machine or system.

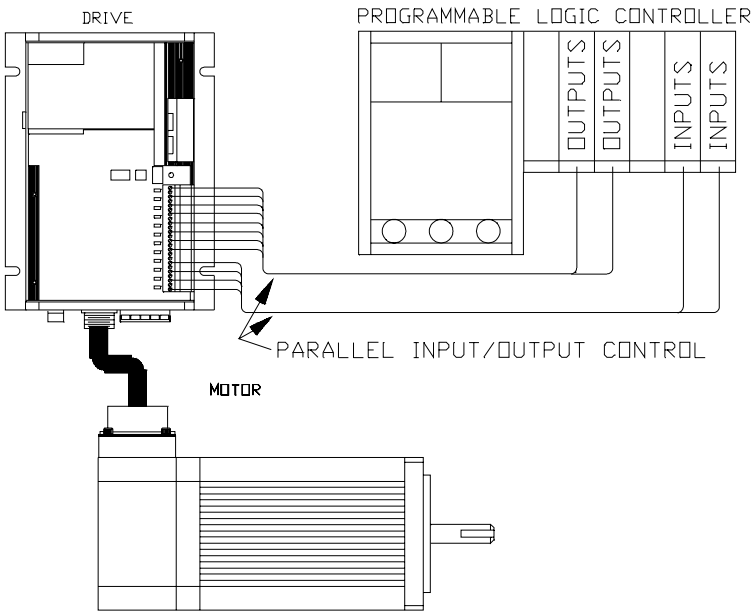


Figure 84 I/O Mode

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An LED indicator is associated with each input and output. The input and output indicators are on if current is flowing in the associated line.

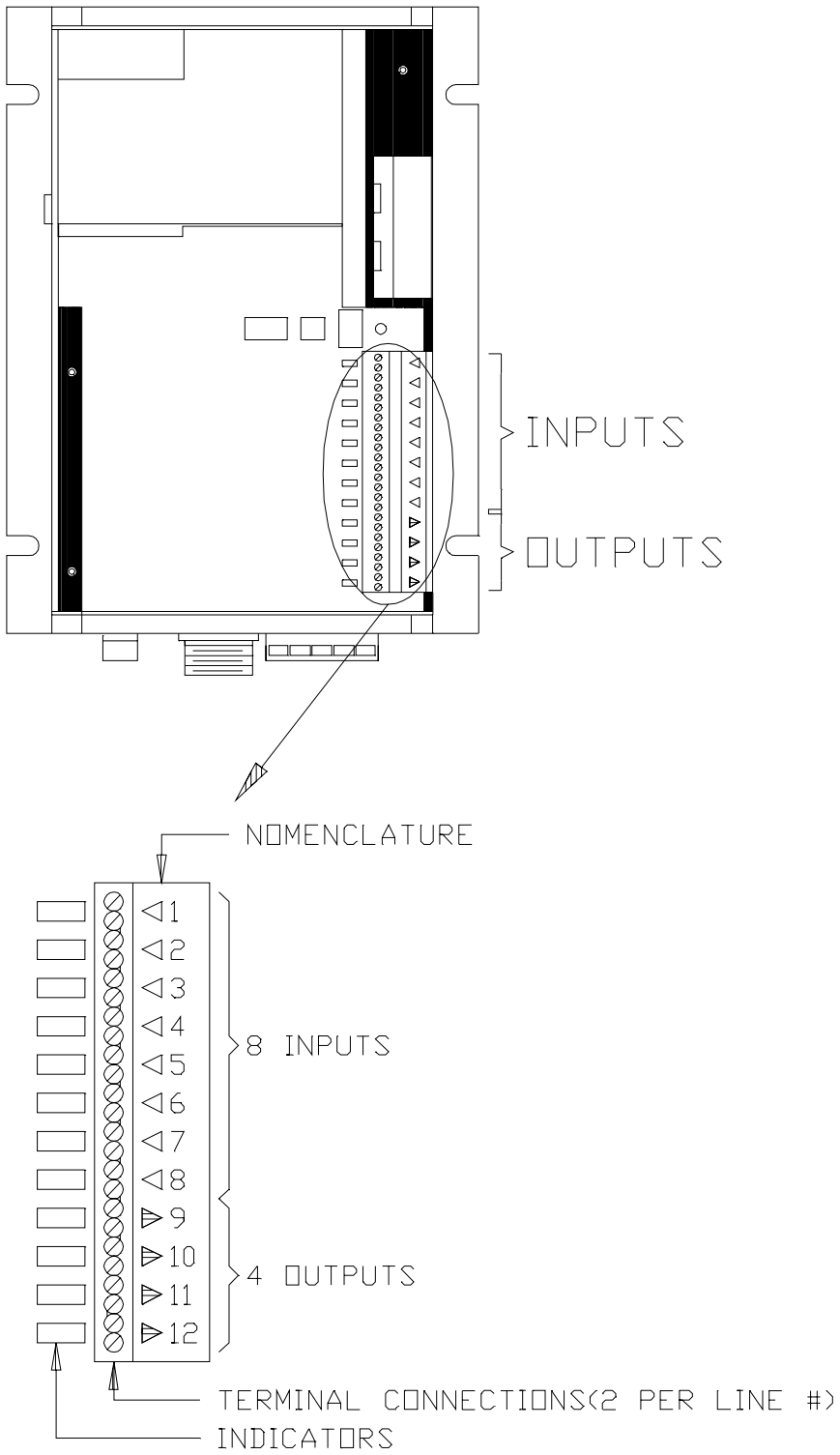


Figure 85 I/O Nomenclature

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Output Functions

Following is the list of output functions provided with the drive.

OUTPUT FUNCTION #	BASIC DRIVE ONLY	DRIVE WITH IOM-1	DRIVE WITH PCM-1
0 – READY	X	X	X
1 – EXTERNAL MODE	X	X	X
2 – IN MOTION	X	X	X
3 – END OF INDEX	X	X	X
4 – END OF HOME	X	X	X
5 – END OF INDEX COUNT	X	X	X
6 – HARDWARE FAULT	X	X	X
7 – TRAVEL LIMIT FAULT	X	X	X
8 – FOLLOWING ERROR FAULT	X	X	X
9 – HOME COMPLETED	X	X	X
10 – SENSOR LIMIT HIT	X	X	X
11 – END OF SEQUENCE			X
12 – PROGRAMMABLE OUTPUTS			X
13 – END OF PROGRAM			X
14 – END OR PROGRAM COUNT			X
15 – IN SUSPEND			X

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Input Functions

Following is the list of input functions are available for use in providing control through the standard I/O interface.

OUTPUT FUNCTION #	BASIC DRIVE ONLY	DRIVE WITH IOM-1	DRIVE WITH PCM-1
0 – INDEX INITIATE	X	X	X
1 – HOME INITIATE	X	X	X
2 – CLEAR TO INITIATE	X	X	X
3 – HOLD INDEX/HOME MOTION	X	X	X
4 – JOG	X	X	X
5 – JOG CW	X	X	X
6 – JOG CCW	X	X	X
7 – JOG DIRECTION	X	X	X
8 – SLOW JOG	X	X	X
9 – CW TRAVEL LIMIT	X	X	X
10 – CCW TRAVEL LIMIT	X	X	X
11 – STOP MOTION	X	X	X
12 – INHIBIT (DRIVE)	X	X	X
13 – BRAKE OVERRIDE	X	X	X
14 – INDEX SELECT	X	X	X
15 – HOME SENSOR	X	X	X
16 – FEED SENSOR	X	X	X
17 – CLEAR END OF INDEX	X	X	X
18 – CLEAR END OF HOME	X	X	X
19 – CLEAR END OF INDEX COUNT	X	X	X
20 – CLEAR SENSOR LIMIT	X	X	X
21 – CLEAR FAULT	X	X	X
22 – ZERO POSITION		X	X
23 – ZERO DISPLAY		X	X
24 – REMEMBER POSITION			X
25 – RETURN TO POSITION			X
26 – CLEAR END OF SEQUENCE			X
27 – CLEAR PROGRAM OUTPUTS			X
28 – EXTERNAL INPUT			X
29 – PROGRAM INITIATE			X
30 – PROGRAM SELECT			X
31 – SUSPEND PROGRAM			X
32 – RESUME PROGRAM			X
33 – CLEAR SUSPEND			X
34 – CLEAR END OF PROGRAM			X
35 – CLEAR END PROGRAM COUNT			X

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Input/Output Connections

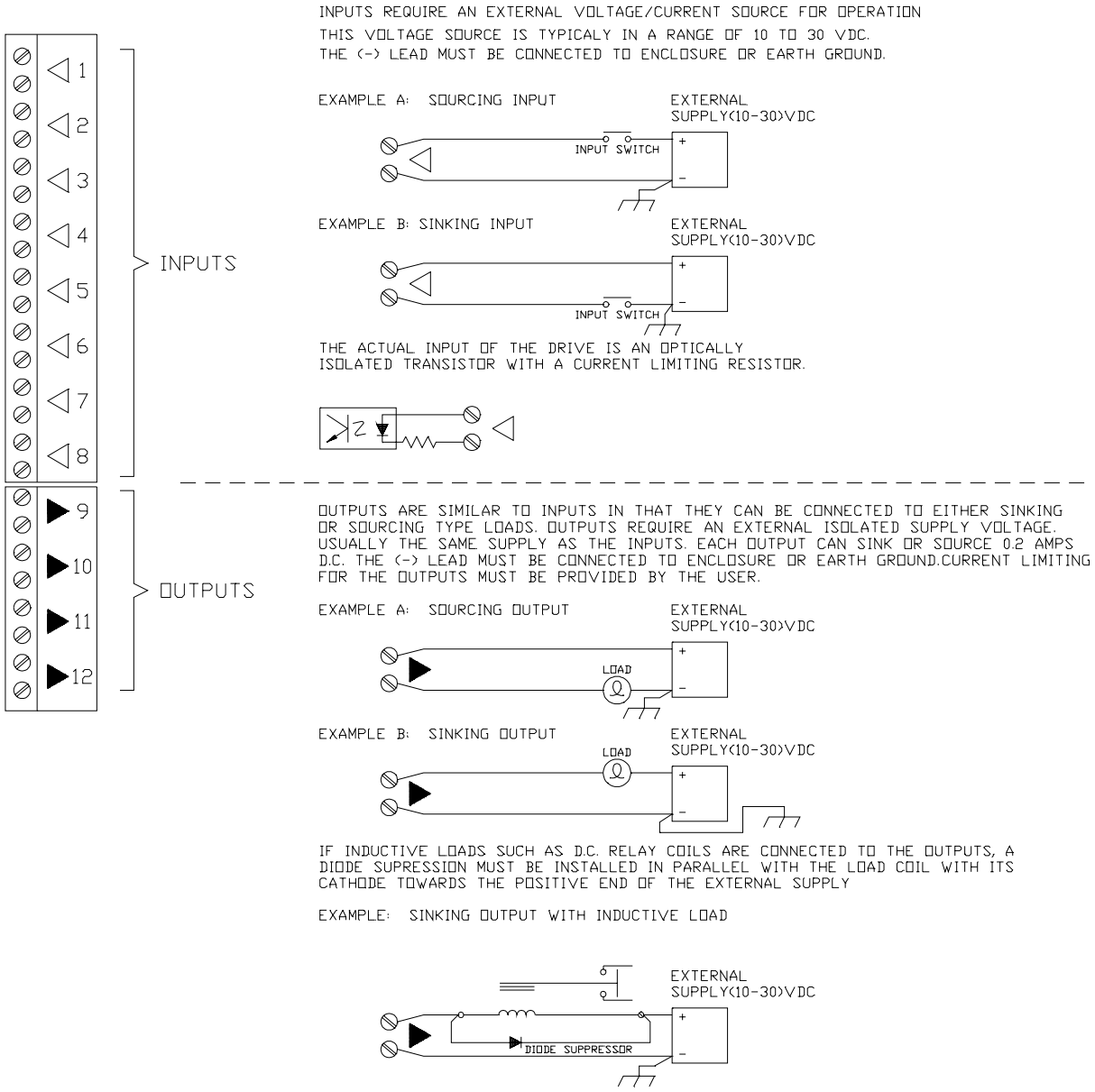


Figure 86 I/O Connections

NOTE: 18 to 24 gauge wire must be used for I/O wiring. The use of larger gauge wire will cause the I/O terminals to prematurely fatigue.

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Detailed Descriptions of I/O Functions

Input Functions

FUNCTION #	DESCRIPTION
0	INDEX INITIATE

Executes the selected index. If function #14 is not set up or there are no active I/O lines, INDEX 00 will initiate.

1 HOME INITIATE

Execute the home cycle.

2 CLEAR TO INITIATE

Informs the drive when it is OK to initiate another home, index or program. Program is for PCM only.

3 HOLD INDEX/HOME MOTION

Stops index or home motion when the switch is pressed and resumes index or home motion when the switch is released.

4 JOG

Starts and stops a jog in the direction specified by the JOG DIRECTION input functions. Defaults to the programmed jog fast velocity.

5 JOG CW

Starts and stops a clockwise jog; motor rotation is defined while facing the shaft end of the motor. Defaults to the programmed jog fast velocity.

6 JOG CCW

Starts and stops a counterclockwise jog; motor rotation is defined while facing the shaft end of the motor. Defaults to the programmed jog fast velocity.

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FUNCTION #	DESCRIPTION
7	JOG DIRECTION Sets the direction for the JOG input function (active = CCW).
8	SLOW JOB Causes the jog slow velocity to be used when JOG, JOG CW, or JOG CCW are executed.
9	CW TRAVEL LIMIT Forces clockwise velocity to zero and inhibits any further clockwise motion.
10	CCW TRAVEL LIMIT Forces counterclockwise velocity to zero and inhibits any further counterclockwise motion.
11	STOP MOTION Stops motion according to the programmed deceleration rate.
12	INHIBIT (DRIVE) Prevents all motion by disabling the drive's bridge transistors and engaging the fail-safe brake.
13	BRAKE OVERRIDE Releases the fail-safe brake when INHIBIT is active. This allows the motor to be rotated by hand.
14	INDEX SELECT Sets the starting input line number for a given number of index select lines. If, for example, you require 4 index select lines and want them assigned to input lines 5, 6, 7, and 8. You would assign INDEX SELECT to input line 5 and program (through PCX or serial commands) the total number of index select lines to be 4.
15	HOME SENSOR Provides a sensor input for home types which require it.

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FUNCTION #	DESCRIPTION
16	FEED SENSOR Provides a sensor input for feed sensor type indexes.
17	CLEAR END OF INDEX OUTPUT Clears the END OF HOME output. If not assigned, the END OF INDEX will automatically clear when the next motion occurs.
18	CLEAR END OF HOME Clears the END OF HOME output. If not assigned, the END OF HOME will automatically clear when the next motion occurs.
19	CLEAR END OF INDEX COUNT OUTPUT Clears the END OF INDEX output. If not assigned, the END OF INDEX COUNT will clear when the next motion occurs.
20	CLEAR SENSOR LIMIT DISTANCE HIT Clears the SENSOR LIMIT HIT output. The sensor limit distance is programmed by PCX or serial commands.
21	CLEAR FAULT Duplicates the function of the reset switch on the front of the digital drive. It will clear non-fatal drive faults.
22	ZERO POSITION Sets the current position of the motor to zero. All absolute positions will be referenced to this set zero position.
23	ZERO DISPLAY This zeroes all position query commands (FP and CP), they become zero and are referenced to this point. Absolute position is unaffected.
24	REMEMBER POSITION Stores the current position of an absolute index.
25	RETURN TO POSITION Returns to the position defined by REMEMBER POSITION.

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FUNCTION #	DESCRIPTION
26	CLEAR END OF SEQUENCE OUTPUT Clears the END OF SEQUENCE output. If not assigned, the END OF SEQUENCE output will automatically clear when the next motion occurs.
27	CLEAR PROGRAMMABLE OUTPUT Clears a (PROGRAMMABLE OUTPUT). Each assigned PROGRAMMABLE OUTPUT will require a separate CLEAR PROGRAMMABLE OUTPUT.
28	EXTERNAL INPUT Used with the WAIT FOR INPUT program function to stop program execution until the input line assigned with EXTERNAL INPUT is activated.
29	PROGRAM INITIATE Executes the selected program.
30	PROGRAM SELECT LINES Sets the starting input line number for a given number of program select lines. Then the number of program select lines is programmed through PCX or serial commands.
31	SUSPEND PROGRAM Stops the execution of a program until the input line assigned with RESUME is activated. Also see I/O Suspend Resume Feature Section in the PCM-1 Section.
32	RESUME PROGRAM Resumes the execution of a suspended program. Also see I/O Suspend Resume Feature Section in the PCM-1 Section.
33	CLEAR SUSPEND Clears the IN SUSPEND output and returns the drive from a suspend cycle to normal operation without the need to “RESUME” and completion of the suspended program. Also see I/O Suspend Resume Feature Section in the PCM-1 Section.

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FUNCTION #	DESCRIPTION
34	CLEAR END OF PROGRAM OUTPUT

Clears the END OR PROGRAM output. If not assigned, the END OF PROGRAM output will automatically clear when further motion is initiated.

35 CLEAR END OF PROGRAM COUNT

Clears the END OF PROGRAM output. If not assigned, the END OF PROGRAM output will automatically clear when the next motion occurs.

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Output Functions

FUNCTION #	DESCRIPTION
0	READY

This output is ON continuously after power up if the microprocessor and its memory are operating correctly. It turns OFF when either A WATCHDOG TIMER FAULT or USER MEMORY FAULT occurs.

1 EXTERNAL MODE

This output is ON when the digital drive is operated from an external source. This output is OFF when the drive is in serial control such as when the drive is executing a HOME, INDEX, JOG or PROGRAM (PROGRAM is for PCM only).

2 IN MOTION

This output is ON whenever the commanded velocity is not zero.

3 END OF INDEX

This output comes ON after the completion of executed index. If this INDEX COUNT is greater than 1, this output will come ON after each index execution. It is turned OFF automatically with the next motion or when the CLEAR END OF INDEX is used.

4 END OF HOME

This output comes ON after the completion of a HOME cycle. It is turned OFF automatically with the next motion or when the CLEAR END OF HOME is used.

5 END OF INDEX COUNT

This output comes ON only after an index is executed the number of times specified by the INDEX COUNT. It is turned OFF automatically with the next motion or when the CLEAR END OF INDEX COUNT is used.

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FUNCTION #	DESCRIPTION
6	HARDWARE FAULT

This output comes ON after the occurrence of a hardware drive fault. The hardware fault is indicated by a number between 0-7 on the diagnostics display. It is turned OFF when all hardware faults are cleared.

7 TRAVEL LIMIT FAULT

This output comes ON when either a hardware or software travel limit is hit and turned OFF when the fault is cleared.

8 FOLLOWING FAULT

This output comes ON when the maximum allowable following error is exceeded and turned OFF when the fault is cleared.

9 HOME COMPLETED

This output comes ON after the completion of a HOME cycle and stays ON continuously unless absolute position is lost.

10 SENSOR LIMIT DISTANCE HIT

This output comes ON during a feed sensor index if the SENSOR LIMIT DISTANCE is exceeded before a sensor signal is received. The only way to turn this output OFF is with the CLEAR SENSOR LIMIT input function.

11 END OF SEQUENCE

This output comes ON after the completion of a motion sequence. A motion sequence is completed when a HOME, INDEX, and/or PROGRAM or a combination thereof, is executed and no further motion commands are given. This output turns OFF automatically with the next motion or when the CLEAR END OF SEQUENCE is used.

12 PROGRAMMABLE OUTPUTS

The output lines assigned this function can be turned ON or OFF with the UPDATE OUTPUTS programming function.

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FUNCTION #	DESCRIPTION

13 END OF PROGRAM

This output comes ON after each completion of a PROGRAM. It turns OFF automatically with the next motion or when the CLEAR END OF PROGRAM is used.

14 END OF PROGRAM COUNT

This output comes ON only after a program is executed the number of times specified by the PROGRAM COUNT. It is turned OFF automatically with the next motion or when the CLEAR END OF PROGRAM COUNT is used.

15 IN SUSPEND

This output is ON when the SUSPEND PROGRAM input function is active.
Also see I/O Suspend Resume Feature Selection.

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DIAGNOSTICS

A single alphanumeric LED display on the front of the Positioning Drive provides status and fault information immediately available to the user. The display aids in quickly identifying problems so that corrective action can be taken and machine downtime can be minimized. In addition, the standard serial interface includes diagnostic status and fault reporting by simple ASCII serial commands. See the Serial Interface Section under Run Time Command section.

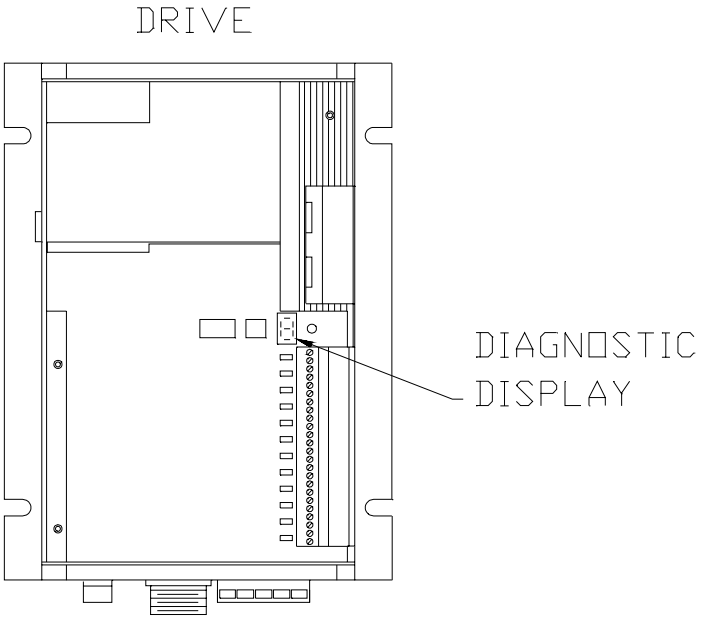


Figure 87 Diagnostic Display

Status Indicator Codes

Following is a list of different status diagnostic indicators.

(.) (Decimal point)

When the decimal point LED is on, this indicates the drive is in Serial Mode. In the Serial Mode, the parallel I/O lines that can initiate motion will not function. All other I/O lines will function.

(P) INDEXING

When the Drive is executing an Index or Dwell after the programmed index, the "P" will be displayed on the status indicator.

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(H) HOMING

An “H” will appear on the status indicator when the drive is executing the Home function or dwelling in the Home function.

(J) JOGGING

When the Drive is executing the Jog function a “J” will be displayed on the status indicator.

(E) EXTERNAL MODE

The Drive is ready to accept pulses, initiate one of the I/O functions (only if decimal point is OFF) or initiate motion from the Serial Interface (only if decimal point is ON). The “E” will be displayed if you are putting pulses into the unit and the motor is rotating.

(A) ANALOG MODE

When the mode select switches are set to either the Analog, Torque or Velocity Modes, an “A” will appear.

(C) CALIBRATE MODE

When the Drive is in a simulated Calibrate Mode, the “C” will appear on the display.

(U) UNINITILIAZED MEMORY FAULT

This occurs when the non-volatile memory of the Drive changes and no longer matches the stored checksum of the non-volatile memory. The major reason for this “U” fault occurring is due to the fluctuating line voltage out of the range of 96-132 VAC. To clear this fault, reset the Drive and download the saved data on your PCX disk into the Drive.

(L) TRAVEL LIMIT

The “L” fault occurs when you hit either a hardware fault travel limit or a software fault travel limit. You must clear the fault before you can initiate motion by a serial, I/O or reset push button.

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(F) POSITION ERROR FAULT

This fault occurs when the motor is out of position by more than the program allowable error (default is one motor revolution). The major reason for this fault occurring is the motor is trying to overcome its torque capability or you are trying to go too fast with a low voltage AC line. Try the following to prevent this fault.

1. Program longer ramp times
2. Check your frictional loading
3. Check for synthetic oil in the gear reducer to minimize frictional loading at higher speeds
4. Read AC line voltage

If the AC line drops to the drive during acceleration then voltage for the motor isn't available and a fault will occur. Typical causes for this are wrong size AC wiring, and insufficient KVA ratings for external transformers used to power the drive electronics.

Example: The wire sizing for a DX-780 amplifier is 10 gauge and 40 amps. The amplifier operates on 120 VAC single phase.

(120 VAC) * (40 amps) = 4800 watts or 4.8 KVA minimum.

The AL wire size for a DX-8200 is 15 AMP. The amplifier operates on 230 VAC 3 phase. (230 VAC) * (15 AMPS) * (1.732) = 5,865 watts or about 5 KVA.

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FAULT INDICATOR CODES

Following is a list of fault diagnostic indicators.

(O) Watch Dog Timer Fault

The drive has a 0.002 second timer that if not internally reset by software, will shut down the operation of the computer. If there is a problem, a "O" is indicated on the diagnostics display on the drive.

POSSIBLE CAUSES OF THE FAULT

1. INCORRECT AC LINE VOLTAGE (SPEC 96 – 132 VAC) FOR SINGLE PHASE DRIVES. (196 – 264 VAC) FOR 3 PHASE DRIVES.

This can be caused by excessive AC line voltage or line voltage transients. The AC line voltage must be within specified range to avoid "false triggering" of this fault indicator.

2. NOISE ON THE AC LINES
3. NOISE ON THE I/O LINES
4. POOR (OR NO) GROUNDING
5. LACK OF NOISE SUPPRESSOR ON COILS AND RELAYS

(I) AVG Current Fault

The drive monitors the current required to move the load. When the average current is greater than the continuous current rating of the drive for more than 1.5 to 5 seconds (see chart below), the drive will shut down and display a "1" fault on the diagnostic display on the drive. If you are producing (1) faults, you must determine what the excess load is and correct it. Excess load can be caused by friction, inertia or cycle times, or a combination of all of these. Continuous resetting of (1) faults without implementing correction will lead to (2) faults which could be catastrophic.

POSSIBLE CAUSES OF THE FAULT

1. THE LOAD ON THE MOTOR IS TO LARGE.
2. MECHANICAL BINDING OF THE MACHINE.
3. MOTION INDEXES ARE EXCEEDING THE DRIVE RATING.

Table XI Load Coupling

% Of Continuous Current	Single Phase Models Approximate Time Before "1" Fault	3 Phase Models Approximate Time Before "1" Fault
100 (Continuous)	No Fault	No Fault
120	5 Sec	3.2 Sec
140	3 Sec	1.9 Sec
160	2 Sec	1.3 Sec
180	1.8 Sec	1.2 Sec
200 (Peak)	1.5 Sec	1.0 Sec

(2) Shorts Fault

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The drive is protected if the motor or the motor cable becomes shorted. If this happens, the diagnostic display on the drive will indicate "2".

POSSIBLE CAUSES OF THE FAULT

1. MOTOR IS SHORTED.
2. MOTOR CABLE IS SHORTED.
3. DRIVE BRIDGE IS DEFECTIVE.

NOTE: In some applications, a servo motor and amplifier are exposed to a condition that the user believes the (1) and (2) faults or electronics can protect. The condition is that the servo motor will be allowed to run into the end of a physical obstruction and cause an instantaneous stop. Neither the motor nor the electronics can withstand this type of misuse. The motion controller has software or hardware travel limits to avoid this.

(3) Resolver Fault

The drive monitors the three resolver signals (REF, SIN, COS). If any of the three signals are lost, the drive will display a "3" on the diagnostics display.

POSSIBLE CAUSES OF THE FAULT

1. MOTOR CABLE IS NOT PLUGGED INTO THE MOTOR.
2. MOTOR CABLE IS SHORTED OR DAMAGED.
3. RESOLVER ON THE REAR OF THE MOTOR HAS FAILED.

(4) Logic Supply Fault

The drive monitors its logic supply to insure that it is at minimum operating level. If any power supply voltage drops below the minimum operating level, the drive will display a "4" on the diagnostics display. The only way to clear a "4" fault is by turning power OFF, then ON.

POSSIBLE CAUSES OF THE FAULT

1. LOW LINE AC LINE VOLTAGE.
2. POWER SUPPLY FAILURE.
3. INSUFFICIENT AC LINE SIZING FOR THE AC WIRE, XFMR (IF REQUIRED) OR BOTH.

(5) Motor Temperature Fault

The motor has a thermal switch mounted internally. If the temperature is excessive, the thermal switch will open. The drive will shut down and display a "5" fault on the diagnostics display.

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POSSIBLE CAUSES OF THE FAULT

1. MOTOR IS NOT BEING OPERATED IN THE MOTORS OPERATING ZONE
2. MOTOR IS NOT BEING STABLE.
3. CABLE IS NOT PLUGGED IN.
4. BROKEN WIRES IN THE CABLE OR MOTOR.
5. DEFECTIVE THERMAL SWITCH ON THE MOTOR.

(6) Bus Fuse or Shunt Fuse Fault or low AC voltage.

If either the shunt fuse, BUS fuse or BUS circuit breaker are open, the drive will display a "6". A "6" fault can also be caused by a low AC line voltage on the single phase drives.

POSSIBLE CAUSES OF THE FAULT

1. EXCESSIVE INERTIAL LOAD HAS CAUSED THE DRIVE TO EXCEED ITS CONTINUOUS RATING.
2. THE LOAD IS BACK-DRIVING THE MOTOR.
3. LOW AC LINE VOLTAGE (IF BOTH FUSES ARE STILL GOOD) AND THE DRIVE IS A 120 VAC SINGLE PHASE MODEL.

(7) Amplifier Bridge Temperature Fault

The drive has a thermal switch mounted on its heat sink. If the heat sink temperature becomes excessive, the thermal switch will open. The drive will shut down and display a "7" fault on the diagnostic display.

POSSIBLE CAUSES OF THE FAULT

1. THE AMBIENT TEMPERATURE INSIDE THE ENCLOSURE IS TOO HIGH.
2. THE DRIVE AND MOTOR ARE TOO SMALL FOR THE LOAD.
3. FAN OR VENTILATION FAILURE.

(8) NON-OPERATIONAL

(8.) The drives does not have a way to produce an (8.) error code. During power up for the first second power is applied an "8." Appears on the display. This means the 16 bit microcontroller is not operational.

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(⎓) High AC Line

If the AC input to the drive is in excess of 264 VAC, this indicator comes on. Voltages in excess of 264 VAC can also cause catastrophic drive failures.

Possible causes of the fault:

1. AC line voltage over 264 VAC.

(⎓) Low AC Line

If the AC input to the drive is under 196 VAC this indicator comes on.

Possible causes of the fault:

1. AC voltage to drive too low (196 VAC or less).

2. During high current load conditions, the AC voltage drops below 196 VAC. This could be because the VA rating of the voltage source is too low or the AC power wiring is inadequate.

(h) High DC Bus (Shunt Regulator)

During deceleration of a motor the load energy is transferred from the load back to the drives DC BUS. The result of this energy transfer is that the DC BUS can charge to voltage levels beyond its normal operating range. Excess voltages are internally sensed and once detected, enable a shunt regulator. This shunt regulator dissipates the unwanted energy in an internal shunt load in such a way as to discharge the unwanted BUS over voltage condition.

For most applications, there is no problem. In applications where load inertia becomes substantial during decel, the internal shunt can only dissipate so much energy and then the shunt fuse goes. The solution isn't to stick in a bigger fuse, the solution is to use the external shunt loads.

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Possible cause of the fault:

1. Unless the regenerative energy is dissipated, the BUS charges to an unacceptable high level and the drive shuts down. Using external shunt resistors and a larger shunt fuse can help.
2. Altering the decel ramps could sufficiently alter the regeneration to an acceptable level.
3. Changing velocity by gear ratios could relieve the problem.

(H) Excess Ambient

As an early indicator that the enclosure ambient temperature is too high, this indicator comes on as a diagnostic indicator.

Possible cause of the fault:

1. Improved ventilation.
2. Increased enclosure size.
3. Air conditioning.

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STABILIZATION OF HIGH INERTIA LOADS

The normal positioning drive's compensation control range is adequate to provide normal operation of loads whose inertias are as much as ten times greater than the drive motor. A guideline of 10 times is acceptable to velocities of 2/3 maximum. At maximum velocity performance with excess inertia is further deteriorated by lack of P.C. BUS voltage. The D.C. BUS is derived from the AC input and low AC input lines would also deteriorate performance with high inertia.

Inertia testing is accomplished at the factory on every drive. Inertia disks of 10 times greater than the test motors rotor are used. 230 VAC amplifiers are tested at 2400 RPM, and the 115 VAC models are tested at 3000 RPM. Over-riding the drive's normal values is not normal.

Generally, abnormal operation of the drive is a result of incorrect programming. Programming ramp times or velocities beyond the drive's physical capability is a major cause of incorrect operation. The drive will make every effort to complete its commanded motion profile. An inability to accomplish this smoothly is almost always diagnosed at some kind of a "servo gain problem" instead of a programming problem.

Instability of a servo system is usually correctly noted if at STOP or at specific velocities, loping occurs. Loping would be noticed oscillation. This could be caused by excess loop gain beyond our present capability to correct. If this is determined, then using PCX and the dumb terminal mode of operation, other values for loop and auto gain could be tested. In the dumb terminal mode "EG" is loop gain and "VG3" is used by the auto gain algorithm. If an axis identifier is used, it must precede the command. A question mark "?" after the command allows for interrogation of the value and an equal sign after the command would allow for a change of the value. The values for either loop gain "EG" or auto gain "VG3" are hexadecimal. You must have cap locks on in the dumb terminal mode.

If instability in the loop is determined, then reducing loop gain "EG" and increasing auto gain "VG3" may affect operation. Values in the following table can be tried.

Table XII Stabilization Of High Inertia Loads

Test	"EG"	"VG3"	Alternative "VG3"
Example	1ØØ	20	
1	FØ	25	(0 – 7F)HEX
2	EØ	30	(0 – 7F)HEX
3	DØ	35	(0 – 7F)HEX
4	CØ	40	(0 – 7F)HEX
5	BØ	45	(0 – 7F)HEX
6	AØ	50	(0 – 7F)HEX
7	9Ø	55	(0 – 7F)HEX
8	8Ø	60	(0 – 7F)HEX
9	7Ø	65	(0 – 7F)HEX
10	6Ø	70	(0 – 7F)HEX
11	5Ø		(0 – 7F)HEX

Instability in the form of cyclic oscillation is generally improved by decreasing gain (EG). "VG3" alters the velocity feedback gain as a function of command velocity. For example, at lower velocities, a larger value in "VG3" increases the velocity feedback. The alternative for "VG3" means that because of load condition for any value of "EG" a value of (⌀ to 7F) HEX could work. Values out of the range listed could cause mis-operation and should not be tried without consulting EMERSON EMC Service department.

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INSTALLATION OF THE IOM-1

INTRODUCTION

The IOM-1 is added to either extend the basic input output capability of a Positioning Drive or facilitate the implementation of the parallel interface. The installation of the IOM-1 module is made easy by a direct "plug-in" design. All the electrical connections between the basic digital drive and the IOM-1 module are made via the 48 position connectors. Figure 1 shows how the 48-pin connectors mate on the Positioning Drive. This is the only electrical connections required between the two units. Once plugged in, the top and bottom handles snap into position to secure the module to the drive.

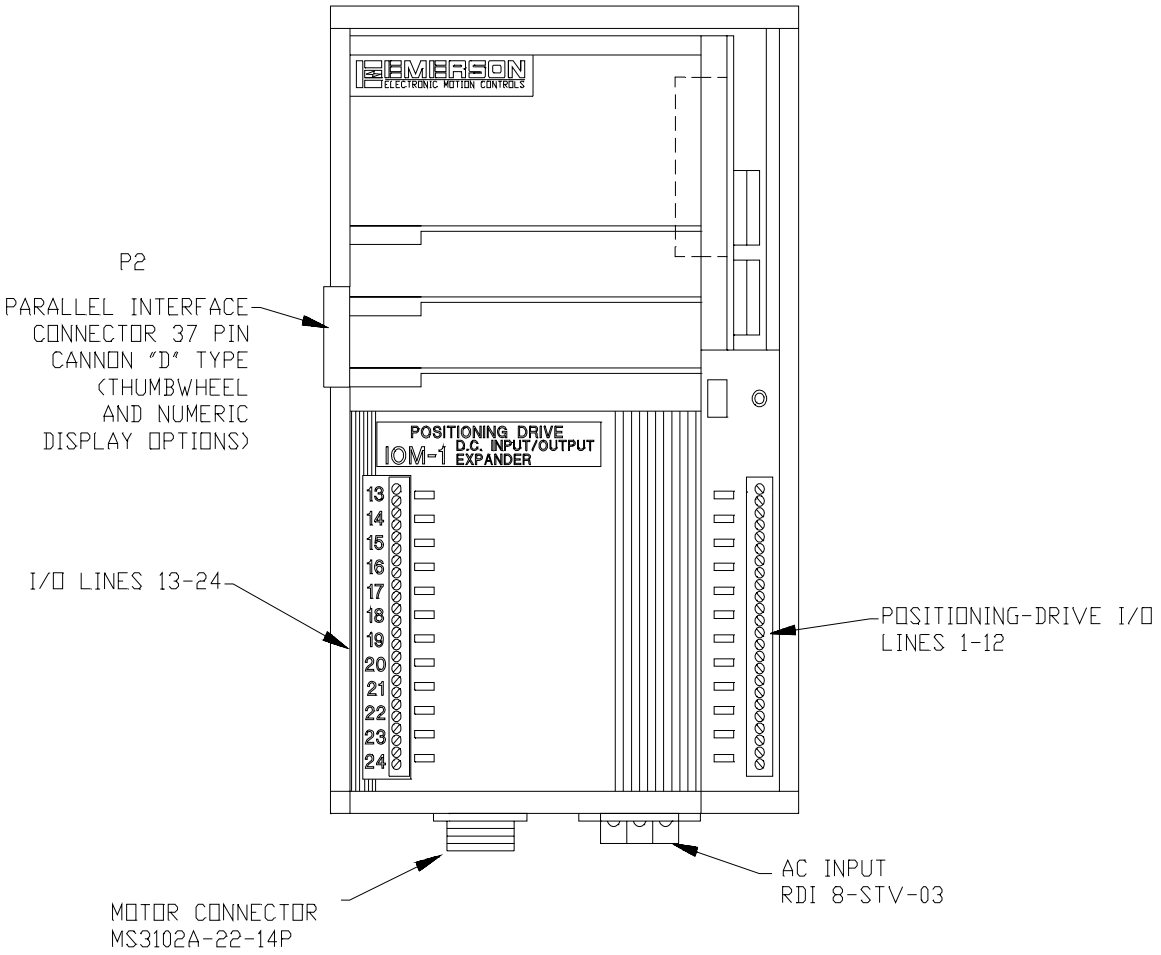


Figure 24 I/O Connections (IOM-1)

The IOM-1 module includes a parallel interface connector. The most common use of this connector is thumbwheel interfacing, numeric display, or parallel programming.

The input and output connections are split between two terminal strips; one strip on the IOM module #13-24 and one on the drive #1-12. Each strip consists of 8 input lines and 4 output lines.

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INPUT/OUTPUT INTERFACE

OVERVIEW

The IOM-1 is equipped with 8 inputs and 4 outputs which are optically isolated for +10 to +30 vdc operation. Each input and output has 2 screw terminals associated with it to provide for either sinking or sourcing operation. The first 8 pairs of designated terminals are inputs and the last 4 pairs of terminals are outputs. The outputs are capable of sinking or sourcing 200 mA. It is the users responsibility to limit the output current to less than or equal to 200 mA.

Adding the IOM-1 module will double the I/O capabilities of the standard digital drive. The number of input liens are increased from 8 to 16 and the number of output lines is increased from 4 to 8.

These inputs and outputs allow for proper timing and coordination between the drive's motion and other machine control functions. The inputs and outputs typically are connected to the machine's programmable logic controller (PLC) or relay logic system. These inputs and outputs are also connected to limit switches, and/or switches and indicators on an operator's control panel.

A large number of input/output control functions are provided. The functions used are assigned to any of the input/output lines. This is accomplished through either serial interface commands or by using the PCX software provided with the drive. Inputs may be programmed as normally off or normally on. In addition, more than one function may be assigned to the same input line.

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An LED indicator is associated with each input and output. The input and output indicators are on if current is flowing in the associated lines.

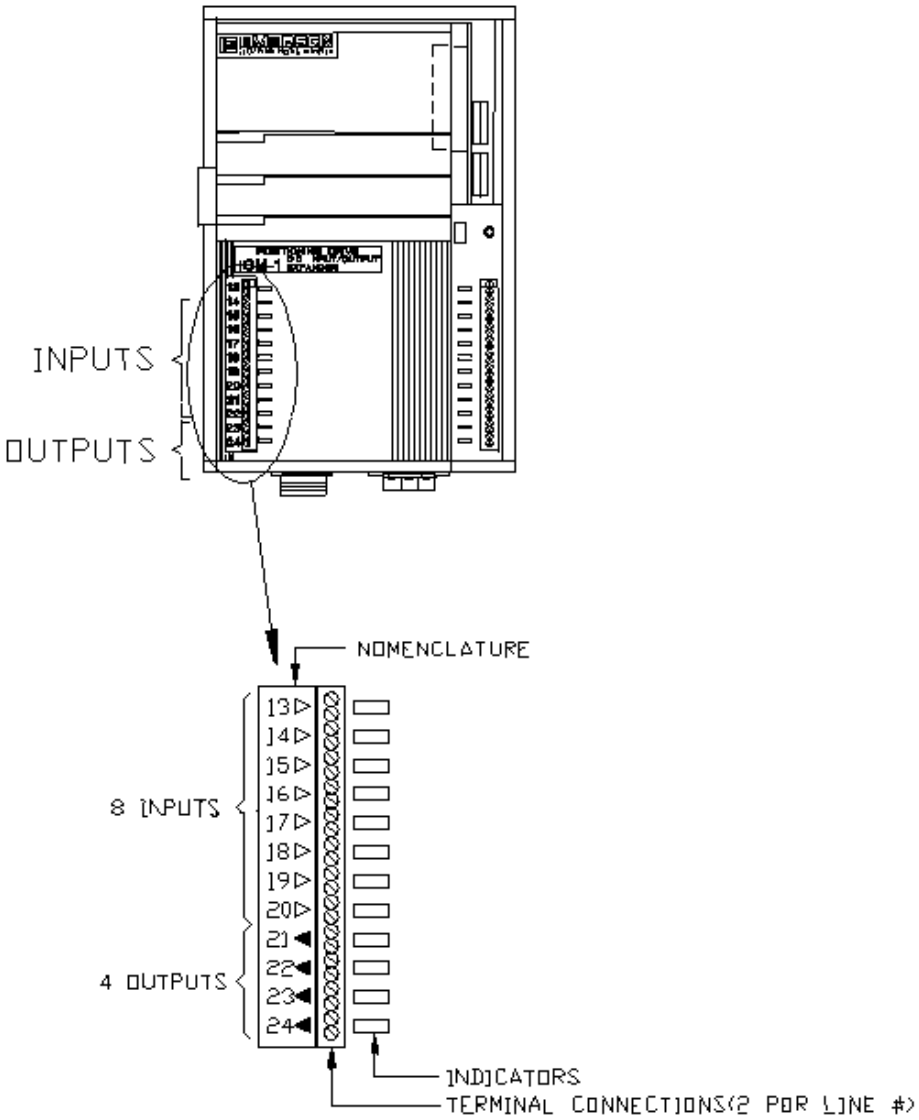


Figure 25 I/O Nomenclature (IOM-1)

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Output Functions

Following is the list of output functions provided with the drive.

OUTPUT FUNCTION #	BASIC DRIVE ONLY	DRIVE WITH IOM-1
0 – READY	X	X
1 – EXTERNAL MODE	X	X
2 – IN MOTION	X	X
3 – END OF INDEX	X	X
4 – END OF HOME	X	X
5 – END OF INDEX COUNT	X	X
6 – HARDWARE FAULT	X	X
7 – TRAVEL LIMIT FAULT	X	X
8 – FOLLOWING ERROR FAULT	X	X
9 – HOME COMPLETED	X	X
10 – SENSOR LIMIT HIT	X	X

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Input Functions

Following is the list of input functions are available for use in providing control through the standard I/O interface. With the expansion of the IOM-1, two additional input functions are available.

OUTPUT FUNCTION #	BASIC DRIVE ONLY	DRIVE WITH IOM-1
0 – INDEX INITIATE	X	X
1 – HOME INITIATE	X	X
2 – CLEAR TO INITIATE	X	X
3 – HOLD INDEX/HOME MOTION	X	X
4 – JOG	X	X
5 – JOG CW	X	X
6 – JOG CCW	X	X
7 – JOG DIRECTION	X	X
8 – SLOW JOG	X	X
9 – CW TRAVEL LIMIT	X	X
10 – CCW TRAVEL LIMIT	X	X
11 – STOP MOTION	X	X
12 – INHIBIT (DRIVE)	X	X
13 – BRAKE OVERRIDE	X	X
14 – INDEX SELECT	X	X
15 – HOME SENSOR	X	X
16 – FEED SENSOR	X	X
17 – CLEAR END OF INDEX	X	X
18 – CLEAR END OF HOME	X	X
19 – CLEAR END OF INDEX COUNT	X	X
20 – CLEAR SENSOR LIMIT	X	X
21 – CLEAR FAULT	X	X
22 – ZERO POSITION		X
23 – ZERO DISPLAY		X

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EXAMPLES OF I/O CONNECTIONS TO THE IOM-1

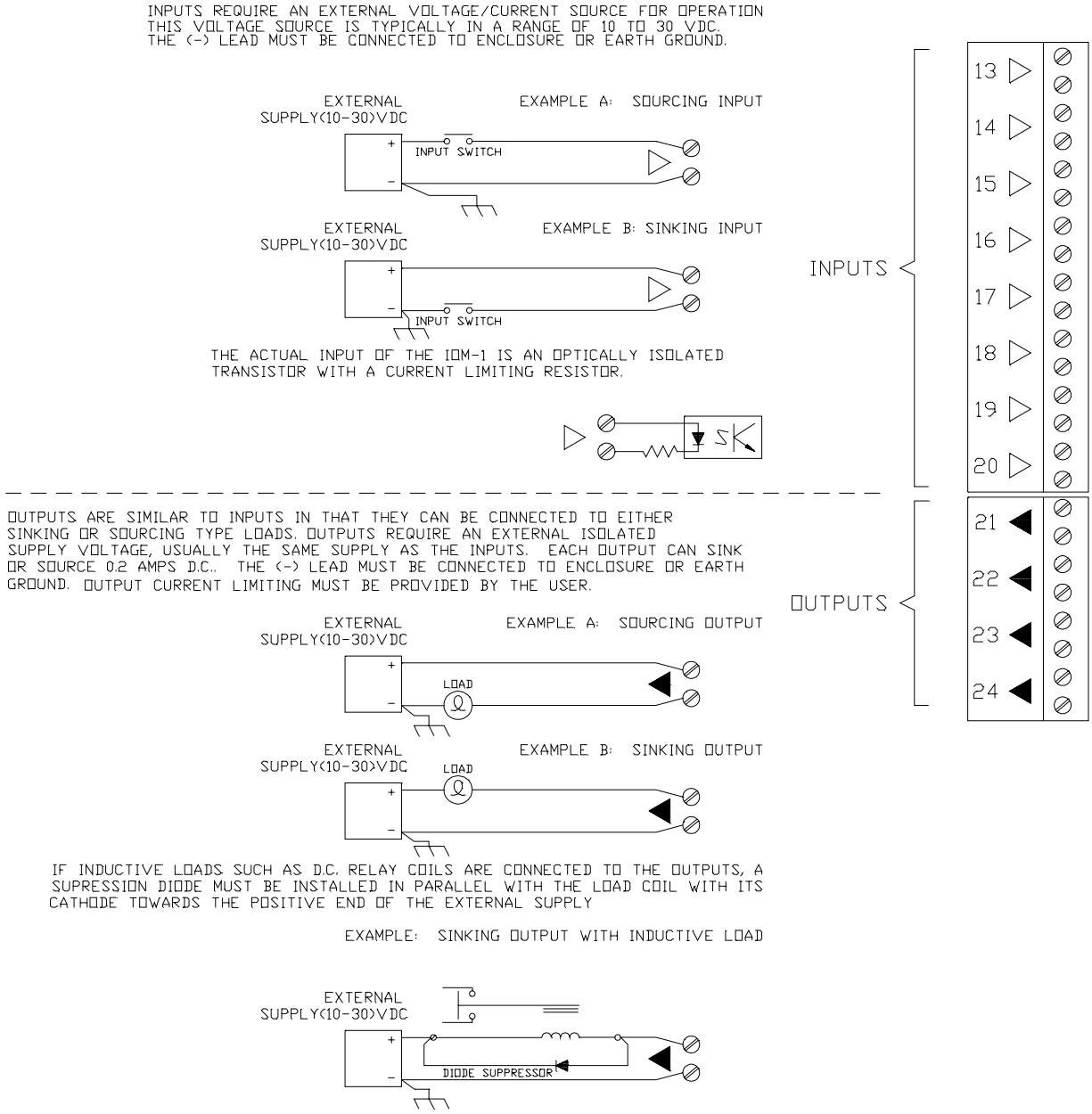


Figure 26 Examples of I/O Connections (IOM-1)

NOTE: 18 to 24 gauge wire must be used for I/O wiring. The use of larger gauge wire will cause the I/O terminals to prematurely fatigue.

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Detailed Description of Additional I/O Functions With the Addition of the IOM-1

Input Functions

FUNCTION #

22 ZERO POSITION

Sets the current position of the motor to zero. All absolute positions will be referenced to this set zero position.

23 ZERO DISPLAY

This zeroes all position query commands (FP and CP), they become zero and are referenced to this point. Absolute position is unaffected.

Output Function

With the addition of the IOM-1 there are no additional outputs.

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PARALLEL INTERFACE

Introduction

The IOM and PCM-1 Modules are equipped with a 37-pin Canon D type female connector for interfacing of customer provided thumbwheels, EMC provided thumbwheels, T-16 numeric displays and a parallel programming interface.

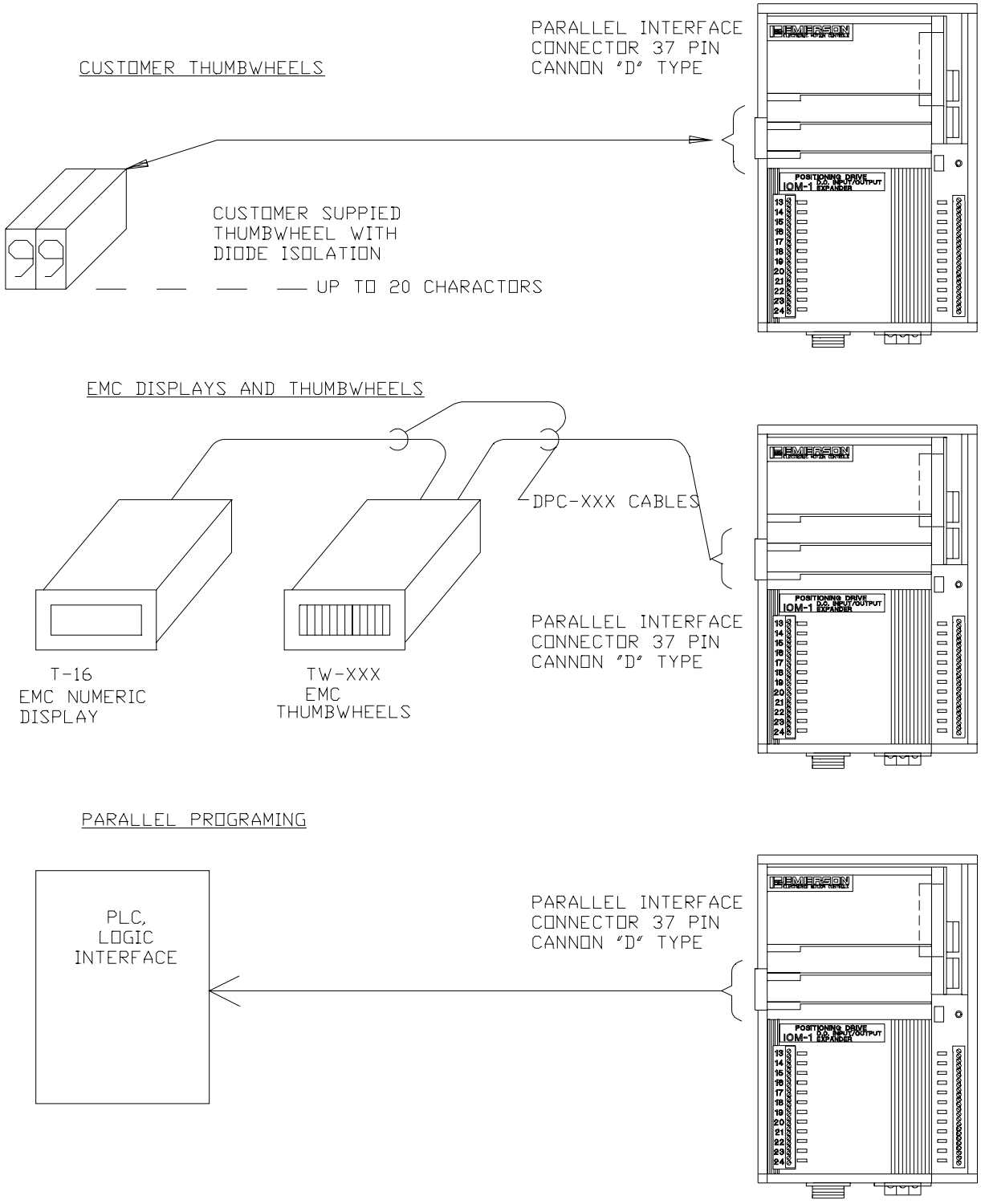


Figure 27 Parallel Interface (with IOM-1)

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CUSTOMER SUPPLIED THUMBWHEEL INTERFACE

Introduction

The thumbwheel interface provides the user with a non-serial interface method for making changes to specific motion functions. The user can set up the thumbwheel to change velocities (in RPM only), distances/positions, dwell times, index counts and acceleration and deceleration times. As many as 20 external BCD characters can be read into the digital drive. Once read, these characters are stored in an internal character buffer. The actual buffer has a capacity for 32 characters to support other parallel interfaces. When customer thumbwheels are used, the 20 possible thumbwheels are read into the first 20 locations of the character buffer designated as (0-19).

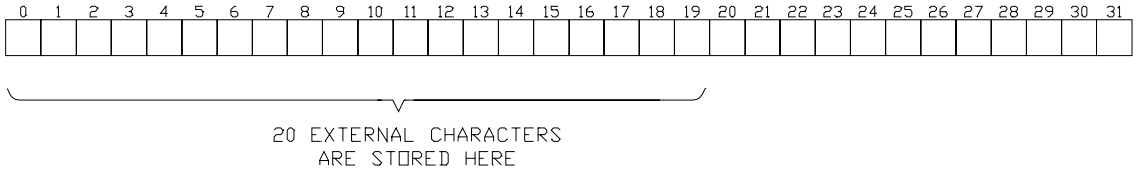


Figure 28 Character Buffer

The character buffer contents can be pre-programmed via serial commands to represent distance, velocity (in RPM only), count, etc. This mode of operations has 8 lines dedicated to transfer data and 10 lines dedicated to selection of data pairs.

Since 8 lines of data are provided and each BCD digit requires 4 lines, thumbwheel digits are read two at a time. The 10 select lines allow the use of up to 10 pairs of digits (20 thumbwheel digits). Once the thumbwheel data is set activating the (EXECUTE) input transfers the new data to its respective function and it becomes the active data.

An output called (ERROR) is provided as a means for the drive to tell an external device that data is out of range.

The inputs and outputs from this parallel interface are not typically isolated and are relatively low voltage (15 VDC). Care must be taken to assure that electrical noise does not enter the digital drive by a careless wiring implementation of this interface. In general, the wiring should be kept short (5 to 20 feet). The wiring should be shielded with the shield connected at pin 37 of the parallel interface connector. The wiring cannot be run adjacent to any high voltage wiring.

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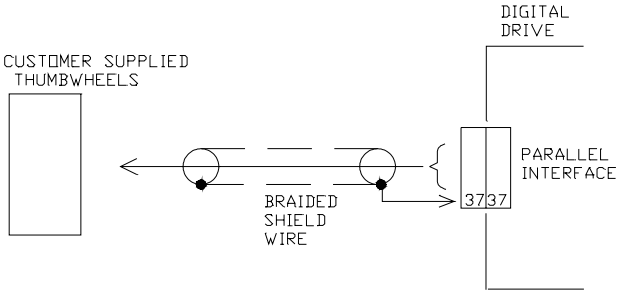


Figure 29 Cable Shielding

In addition to the described signals, the following voltage and ground signals are in the connector.

	Signal	Pin Number
1)	+5	(25, 26, 27, 28)
2)	+15	(34)
3)	GRD (Logic Common)	(29, 30, 31, 32)
4)	+BUS	(33)
5)	SHIELD	(37)

These signals are provided for the parallel interface options only and cannot be used for any other purpose. The thumbwheel multiplexing uses +15, +BUS, GRD and SHIELD.

Thumbwheel Wiring

The 37-pin parallel interface connector and a typical thumbwheel wiring schematic are shown on the following pages. All the necessary connections are shown. However, there are several important considerations:

1. The internal +15VDC logic supply of the drive should be used for the thumbwheel supply voltage. This connection is made by connecting pins 33 and 34 on the 37-pin connector (P2).
2. The cable used to connect the thumbwheel assembly to the 37-pin connector (P2) must not exceed 50 ft. in length. Also, this cable must be shielded with one end of the shield connected to pin 37 of P2. The other end of the shield must not be connected. Typical wire gauges used in this cable would be from 26 AWG to 32 AWG.
3. The thumbwheel digits must have the blocking diodes that are indicated on the wiring schematic. If not, the diodes can be added according to the schematic. A typical diode used for this would be a 1N914.
4. The 1, 2, 4, 8 coding for the data must be accomplished with BCD switches that are active “ON”. These are the most common variety.

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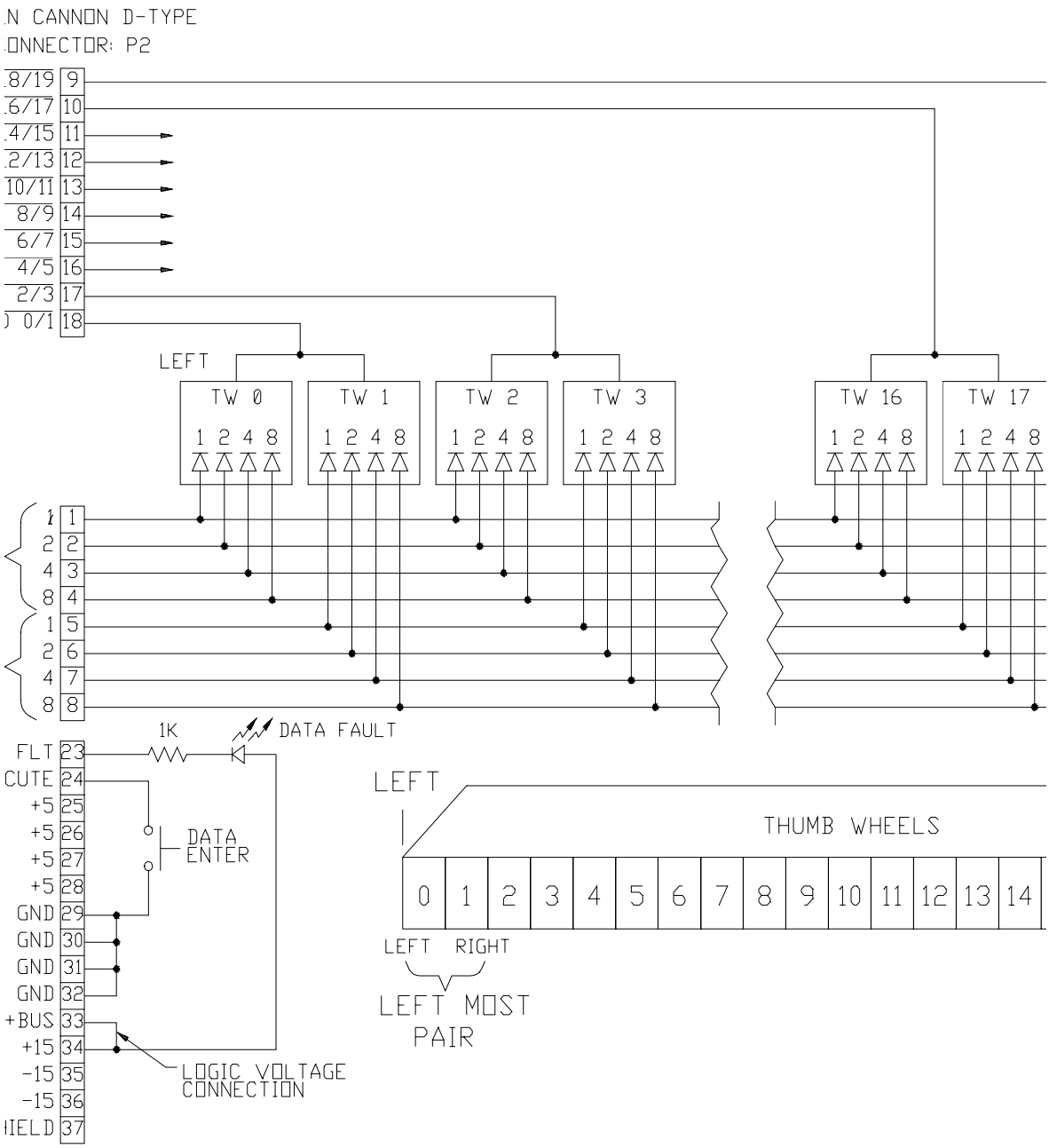


Figure 30 Thumbwheel Wiring

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TW-XXX THUMBWHEELS

Emerson EMC provides thumbwheels in 5 different configurations. The mechanical mounting for all of them is the same. They are designed for panel mounting.

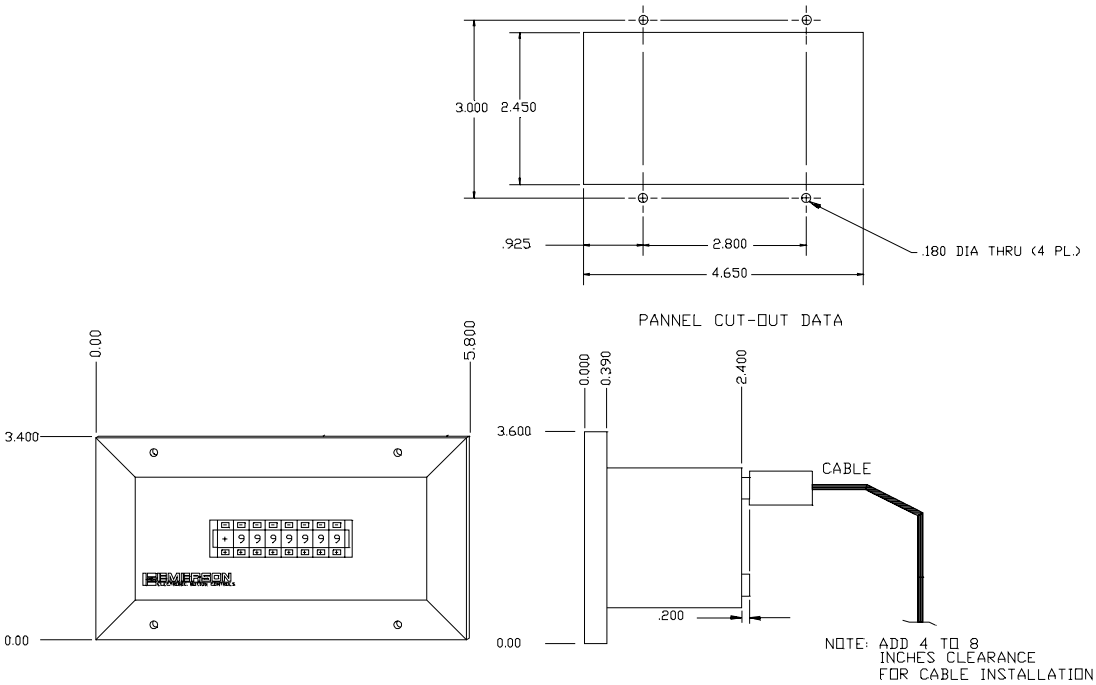


Figure 31 Mounting Information For Thumbwheels

The mechanics of these assemblies provides for up to 10 characters of thumbwheel data. This data is read into the digital drive character buffer. Since the character buffer can handle 20 characters, the thumbwheels have been designed with jumpers that can be switched at the rear of the thumbwheel assembly.

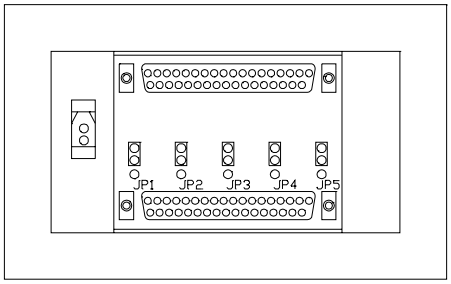


Figure 32 Thumbwheel Jumpers

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With the jumpers connected as shown, the thumbwheel data is read into character positions (0-9) of the digital drive character buffer. Moving the jumper to the bottom will cause the characters to be read into positions (10-19) of the character buffer.

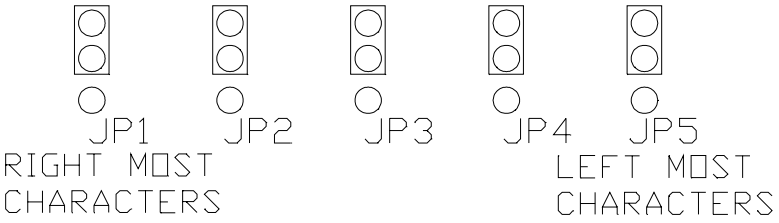


Figure 33 Thumbwheel Jumpers (Character Buffer)

To exclude erroneous data input caused by changing data, each thumbwheel assembly is equipped with an input for a data enter push button. This input must be made for thumbwheel data to transfer to the digital drive. The momentary push button switch must be provided by the customer. The mating Molex connector and pins are provided with the thumbwheel assembly. The connections are made at the rear of the assembly.

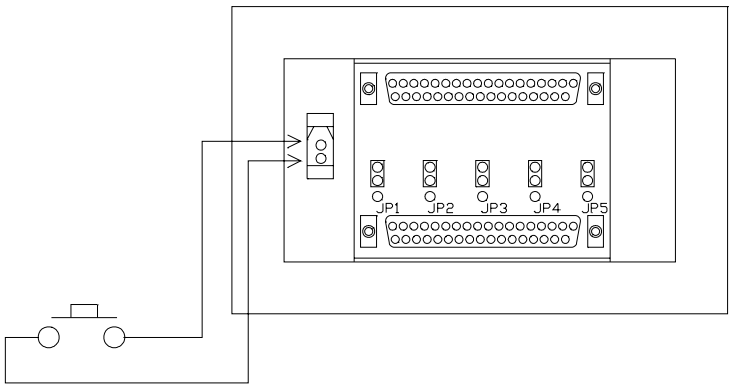


Figure 34 Data Entry Push Button

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Two connectors are provided as a means to daisy chain up to two thumbwheels and a numeric display (T-16) from one port.

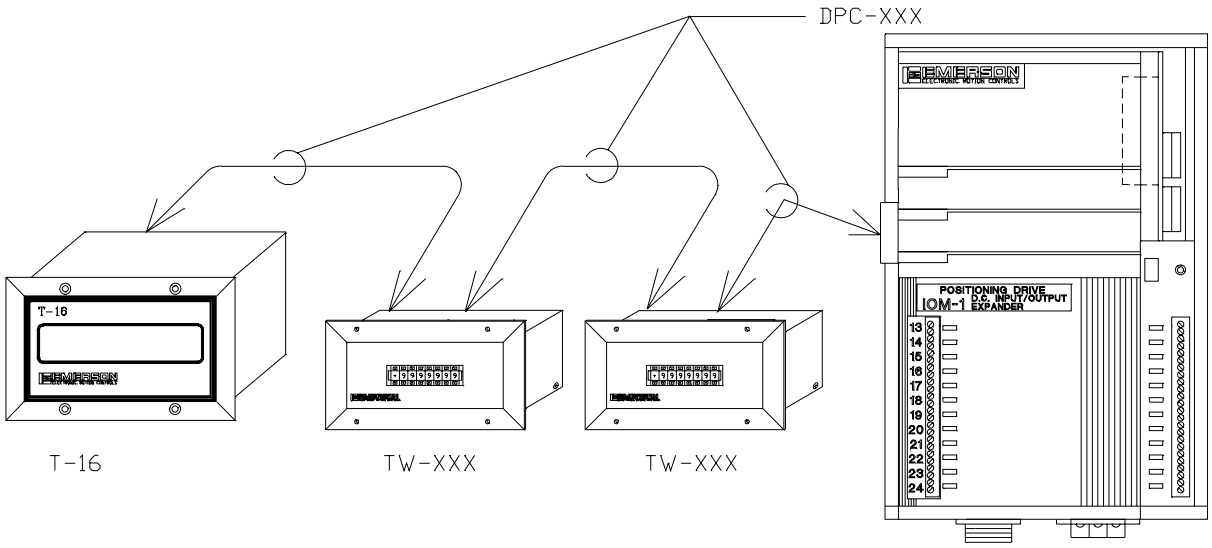


Figure 35 Thumbwheel/T-16/IOM-1 Cable Connections

The connectors on the back of the TW-XXX and T-16 are connected in parallel so the cabling is insensitive to position. The cables themselves can be obtained in different lengths.

DPC-003	3 FT
DPC-006	6 FT
DPC-015	15 FT
DPC-025	25 FT
DPC-050	50 FT

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The TW-XXX is available in five standard configurations.

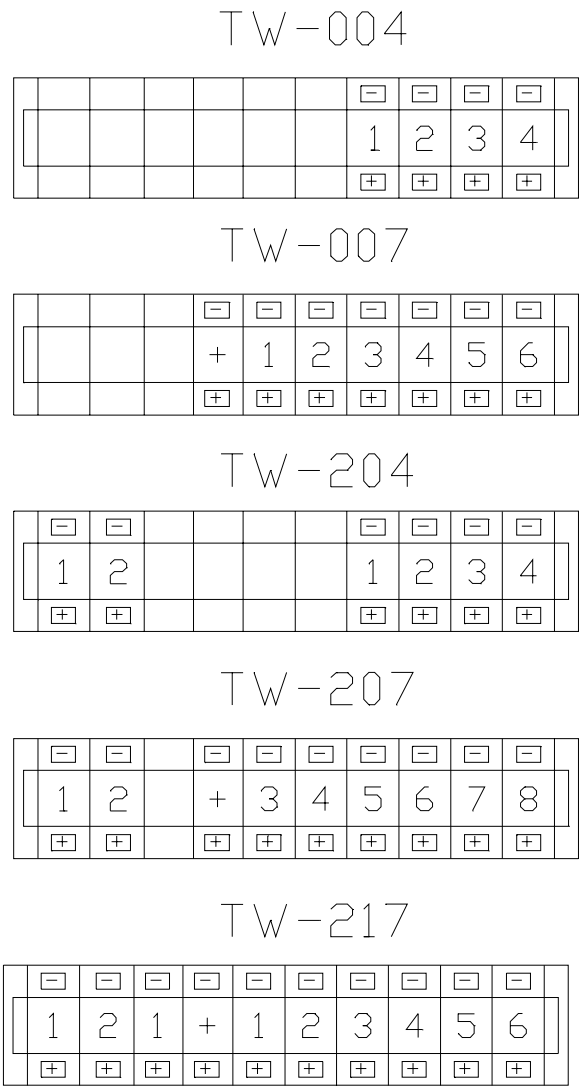


Figure 36 Thumbwheel Configurations

The (+/-) buttons above and below the data windows can be pushed to increment and decrement data.

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Since the physical construction of the thumbwheel is based on 10 characters and the different models are accomplished with spacers, data from the thumbwheels is read into the digital drive character buffer as follows.

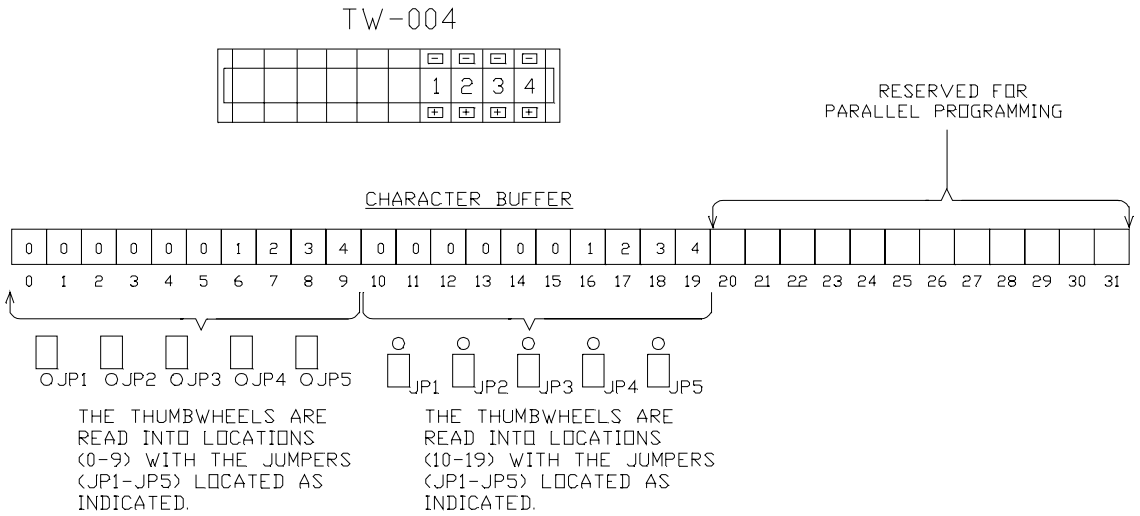


Figure 37 Digital Drive Character Buffer

Programming the 32 character drive character buffer is accomplished with serial commands and PCX.

The red LED indicator on the TW-XXX is provided as a means to tell that data is out of range. For example, if the 4 digits of a TW-004 were programmed as velocity and the data on the thumbwheel is greater than 3000 RPM when the ENTER button is pushed, then the LED will light.

The LED will go out when valid data is entered.

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PARALLEL PROGRAMMING INTERFACE

Another feature of the parallel interface connector is that of a parallel interface that allows for programming. In this mode of operation a character buffer of 32 characters is provided for the user. The characters are designated as ∅ through 31 (see Figure 37).

These 32 characters can be pre-programmed via serial commands to represent distance, velocity (in RPM only), count, etc. The same basic functions and programming capabilities that are provided for thumbwheels are provided for this parallel interface.

The parallel interface has 8 lines dedicated to transfer data and 4 lines dedicated to selection of data pairs.

Since 8 lines of data are provided, each data transfer includes two characters. The additional 4 lines allow for a selection of 16 pairs of characters.

The operation of the data lines is for BCD data. The 4 lines of pair selections are coded in binary.

Four handshake lines are dedicated to accomplish data transfers. Two are inputs and two are outputs. One input (PAIR ENTER) is to tell the digital drive that the data and pair selection lines are ready for transferring to the character buffer. Once the 32-character buffer data content is programmed, another input (EXECUTE) is provided to transfer and start using any new data contained in the entire buffer.

One of the outputs (ACKNOWLEDGE) is provided as a means for the digital drive to tell the external device that it has received the proper input. This output comes ON to acknowledge either of the inputs. (PAIR ENTER) or (EXECUTE).

The second output is called (ERROR) and is provided as a means for the drive to tell an external device that data is out of range. The correct protocol for these handshake lines is to turn on the input, wait for the acknowledge and then shut off the input. The digital drive will than shut off (ACKNOWLEDGE).

The inputs and outputs from this parallel interface are not optically isolated and are relatively low voltage (5 to 15). Care must be taken to assure that electrical noise does not enter the digital drive by a careless wiring implementation of this interface. In general, the wiring should be kept short (5 to 20 feet). The wiring should be shielded with the shield connected at the external device. The wiring cannot be run adjacent to any high voltage wiring.

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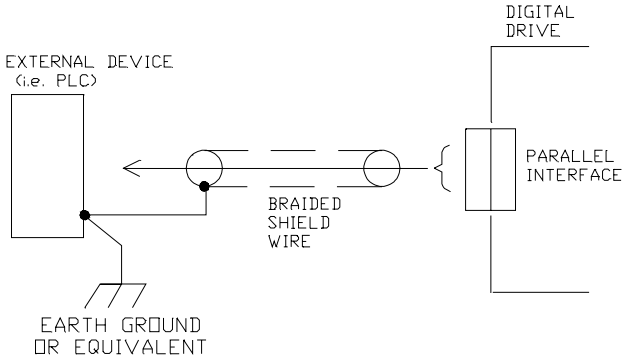


Figure 38 Cable Shielding

In addition to the described signals, the following voltage and ground signals are in the connector.

SIGNAL	PIN NUMBER
+5	(25, 26, 27, 28)
+15	(34)
GRD	(29, 30, 31, 32)
+BUS	(33)
SHIELD	(37)

These signals are provided for level interface only and cannot be used for any other purpose.

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For the purpose of explanation, a circuit representing the inputs and outputs is shown here.

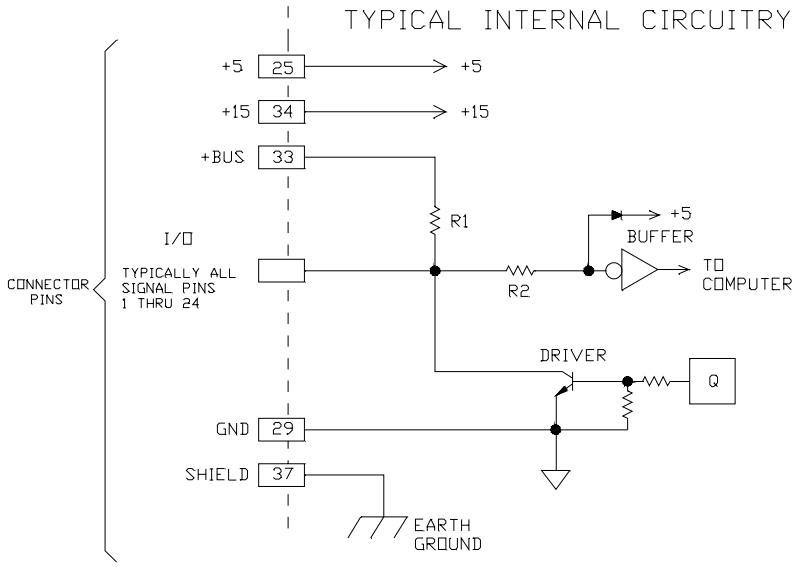


Figure 39 Typical Internal Circuitry

The I/O (typical of all signal pins) has an input buffer and output driver associated with it. This is done to provide a highly flexible hardware implementation. This parallel port is used for implementation of the T-16 numeric display and thumbwheels. Since each of the signal pins can be firmware configured, different features can be achieved.

Each of the I/O pins has a pull up resistor (R1) associated with it. This pull up resistor is connected to the 37 pin connector pin 33 (+BUS). This pin can be connected to pin 25 (+5) for a +5 volt interface. It can be connected to pin 34 (+15) for a +15 volt interface or it can be connected to the positive source of the external device which is the preferred method. The ground connection (29, 30, 31, 32) must be connected to the ground supply of the external device. The shield (37) is provided as an alternative place to connect the cable shield if a connecting place cannot be found at the external device. Never connect the shield at both ends.

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The line number and functional description of each required signal for the parallel programming interface is as follows.

37-PIN PARALLEL INTERFACE CONNECTOR

PIN#		FUNCTION	PIN#		FUNCTION
1	1	LBS	21	PAIR ENTER	(INPUT)
2	2	(BCD) LEFT DIGIT	22	ACKNOWLEDGE	(OUTPUT)
3	4	MSD (INPUTS)	23	ERROR	(OUTPUT)
4	8	MSB	24	EXECUTE	(INPUT)
5	1	LSB	25		
6	2	*BCD) RIGHT DIGIT	26		
7	4	LSD (INPUTS)	27	+5	
8	8	MSB	28		
9			29		
10			30		
11			31	GROUND	(LOGIC COMMON)
12		DO NOT APPLY TO PARALLEL PROGRAMMING INTERFACE	32		
13			33	+BUS	
15			34	+15	
16			35	DO NOT APPLY PARALLEL INTERFACE	
17	1	LSB	36		
18	2	BINARY PAIR	37		
19	4	SELECTION (INPUTS)			
20	8	MSB			

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Inputs to the digital drive are interpreted as ON (active) when an input pin is the grounded (connected to pins 29, 30, 31, 32 of the connector).

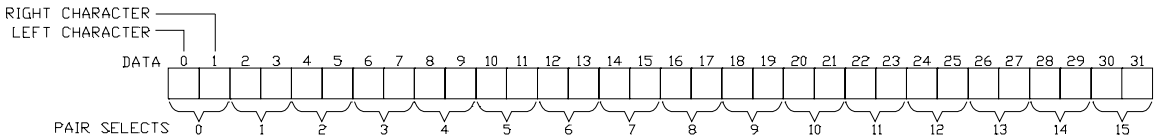


Figure 40 Character Data

There can be 32 characters designated as (⌀ to 31) entered in pairs designated as (⌀ to 15).

If, for example, no wires were hooked up to the data lines (1 through 8) or pair selects (17 through 20) and a wire was connected from pin 21 (PAIR ENTER) to pin 29 (GROUND) the motion controller would assume the user is trying to enter the data ⌀, ⌀ for characters ⌀ and 1 and would in turn, turn ON the (ACKNOWLEDGE). The character data must be input in simple BCD form.

Table XIII Character Data

LSD	MSD	DATA								
		LEFT				RIGHT				
		LSB			MSB	LSB				MSB
		1	2	3	4	5	6	7	8	→ PIN #
⌀,	⌀	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	
1,	1	GRD	OPEN	OPEN	OPEN	GRD	OPEN	OPEN	OPEN	
2,	2	OPEN	GRD	OPEN	OPEN	OPEN	GRD	OPEN	OPEN	
3,	3	GRD	GRD	OPEN	OPNE	GRD	GRD	OPEN	OPEN	
4,	4	OPEN	OPEN	GRD	OPEN	OPEN	OPEN	GRD	OPEN	
5,	5	GRD	OPEN	GRD	OPEN	GRD	OPEN	GRD	OPEN	
6,	6	OPEN	GRD	GRD	OPEN	OPEN	GRD	GRD	OPEN	
7,	7	GRD	GRD	GRD	OPEN	GRD	GRD	GRD	OPEN	
8,	8	OPEN	OPEN	OPEN	GRD	OPEN	OPEN	OPEN	GRD	
9,	9	GRD	OPEN	OPEN	GRD	GRD	OPEN	OPEN	GRD	
+,	+	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	
-,	-	OPEN	OPEN	GRD	OPEN	OPEN	OPEN	GRD	OPEN	

NOTE: Do not enter data greater than 9 per digit. For example, all grounded inputs are not allowed. If the character is used as a sign (+ or -) for Index Distance or Position, the input lines (GRD/OPEN) pattern is shown.

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The pair selection inputs are in simple binary form.

Table XIV Pair Selection Inputs

SELECTED 17	18	19	20	-> PIN #
∅	OPEN	OPEN	OPEN	OPEN
1	GRD	OPEN	OPEN	OPEN
2	OPEN	GRD	OPEN	OPEN
3	GRD	GRD	OPEN	OPEN
4	OPEN	OPEN	GRD	OPEN
5	GRD	OPEN	GRD	OPEN
6	OPEN	GRD	GRD	OPEN
7	GRD	GRD	GRD	OPEN
8	OPEN	OPEN	OPEN	GRD
9	GRD	OPEN	OPEN	GRD
10	OPEN	GRD	OPEN	GRD
11	GRD	GRD	OPEN	GRD
12	OPEN	OPEN	GRD	GRD
13	GRD	OPEN	GRD	GRD
14	OPEN	GRD	GRD	GRD
15	GRD	GRD	GRD	GRD

For both truth tables "GRD" means ON or Logic 1 and "OPEN" means OFF or Logic ∅. Both inputs, (PAIR ENTER) and (EXECUTE), are activated and turned on by connecting them to ground.

Both outputs (ACKNOWLEDGE) and (ERROR), are the equivalent of open collector NPN transistors whose emitters are connected to ground. The load for these outputs can be connected from the +BUS pin (DC voltage source) to the output pin. When the output is ON, current will flow through the sinking NPN's collector to ground. These transistors can sink a maximum of .04 amps DC and the +BUS voltage should not be greater than 15 VDC.

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THUMBWHEEL AND PARALLEL PROGRAMMING SETUP AND OPERATION

The procedure for setting up thumbwheels and parallel programming is identical with the exception of the character buffer size. Thumbwheels have 20 digits and parallel programming has 32. When the parallel option is selected from the PCX drive configuration menu, the following screen will be displayed.

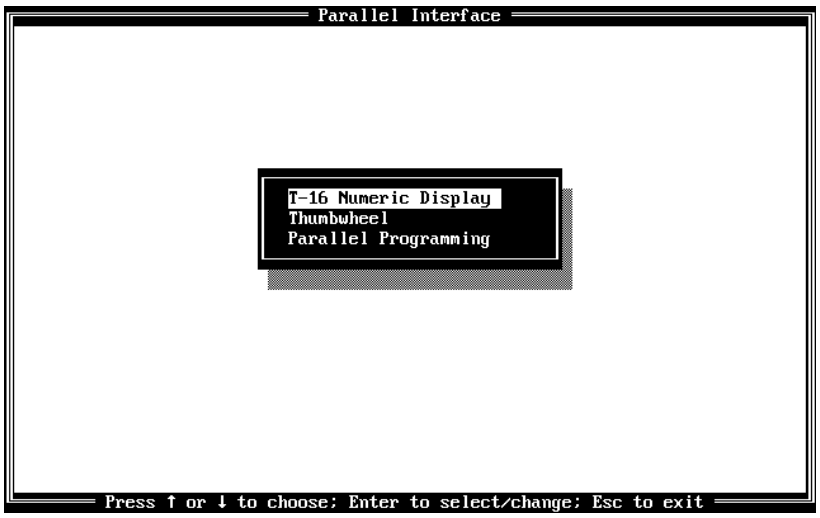


Figure 41 Parallel Interface Options

THUMBWHEEL AND PARALLEL PROGRAMMING INTERFACE

For either of these options to work, they must be enabled. Neither the thumbwheels or the numeric display can be used if the parallel interface is enabled.

DATA FIELD NUMBER

There are eight (0-7) unique groupings of digits that may be set up. Each group or field, has a corresponding "packet" of data associated with it. When a new data field will be displayed and ready to edit.

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DATA FIELD PURPOSE

This packet item determines what the data field is to be used for. The fields may be setup to represent any of the following positioning drive functions.

Index Accel
Index Decel
Index Velocity
Index Dist/Pos (+/-)
Index Dist/Pos
Index Dwell
Index Count
Fast Jog Velocity
Slow Job Velocity
Sensor Accel
Sensor Decel
Sensor Velocity
*Field Functions

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INDEX NUMBER

*The field function is applied with another data field. Data entered in the other field would be used with the field function. The field function data field would usually be setup as a two digit field.

Field Function	Apply Data To:
0	Index Accel
1	Index Decel
2	Index Velocity
3	Index Dist/Pos (+/-)
4	Index Dist/Pos
5	Index Dwell
6	Index Count
7	Fast Jog Velocity
8	Slow Jog Velocity
9	Sensor Accel
10	Sensor Decel
11	Sensor Velocity
12	Index Number

FIRST DIGIT IN DATA FIELD

This packet item specifies where the data field is to start. Left most digits start at number 0. On Emerson thumbwheels, simply count any leading blank digits from the left to determine the start of the data field.

NUMBER OF DIGITS IN DATA FIELD

This packet item simply specifies how many digits the field data consists of.

DATA FIELD MULTIPLIER

This packet item may be used to add zero's to the right of the data entered. This may be useful if digits need to be conserved and the data resolution is not critical. For example, Accel times may be entered from 0 to 65.535 seconds. If it is only necessary to make steps of 1 second or more, use only 2 digits (Number of Digits) with a multiplier of 1000.

APPLY TO INDEX NUMBER

This packet item specifies the first index to apply the data field to.

NUMBER OF ADDITIONAL INDEX

This packet item is used in conjunction with the "APPLY TO INDEX NUMBER" item. It specifies how many more indexes, from the starting index, that the data field is to apply to (if any).

APPLY TO DATA FIELD

Some data field purposes (field function and Index Number) require a corresponding data field for additional information. When this is needed, enter a data field number from 0 to 7.

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NUMBER OF ADDITIONAL DATA FIELDS

This packet item is used in conjunction with the "APPLY TO DATA FIELD" item. Continuous data fields can be applied to the field function and index number. See the parallel programming example for more detail.

THUMBWHEEL EXAMPLE

In this typical application, an Emerson thumbwheel is being used to set up index velocity and distance. Two data fields are needed; field 0 and 1.

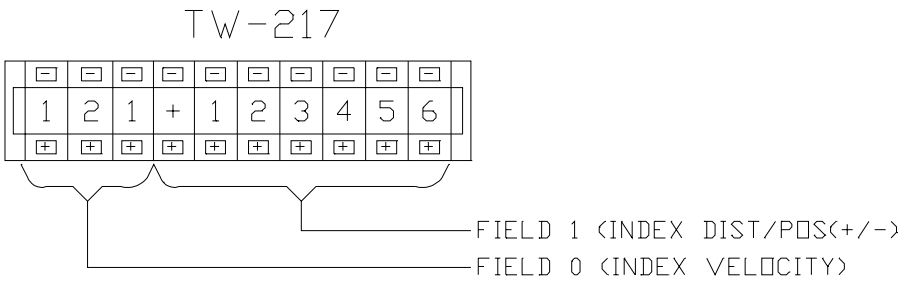


Figure 42 Thumbwheel Example

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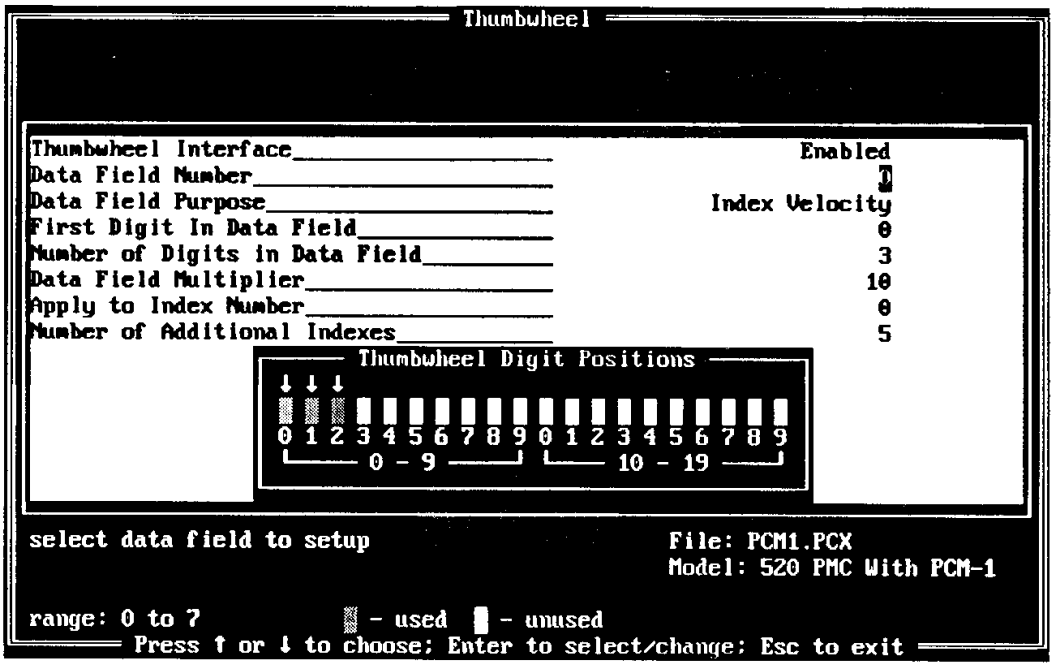


Figure 43 Index Velocity (Thumbwheel)

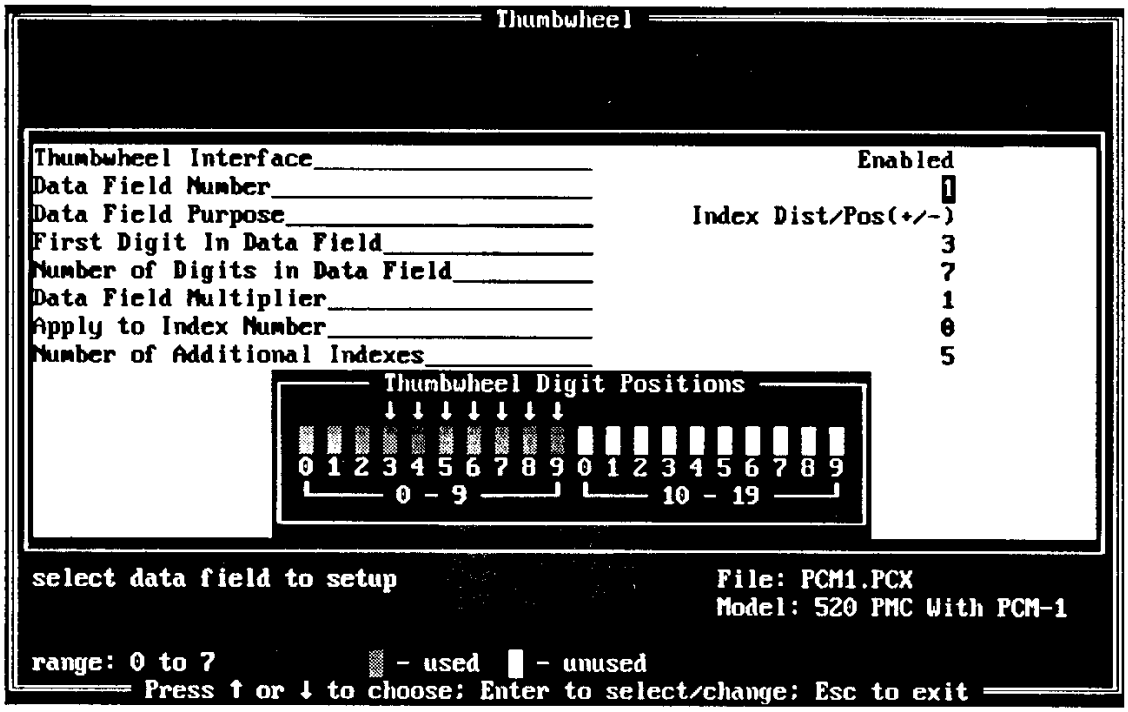


Figure 44 Index Dist/pos(+/-) (Thumbwheel)

Index velocities are multiplied by 10 before being sent to the positioning drive. Signed distances are used when a sign digit is available on the thumbwheel. When the above data is entered, the following values will be sent to indexes 0, 1, 2, 3, 4, and 5.

Index Velocity = 1210
Index Distance = 123456

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PARALLEL PROGRAMMING EXAMPLE

In this application, the parallel interface character buffer is being used to set up indexes. Three data fields will be used.

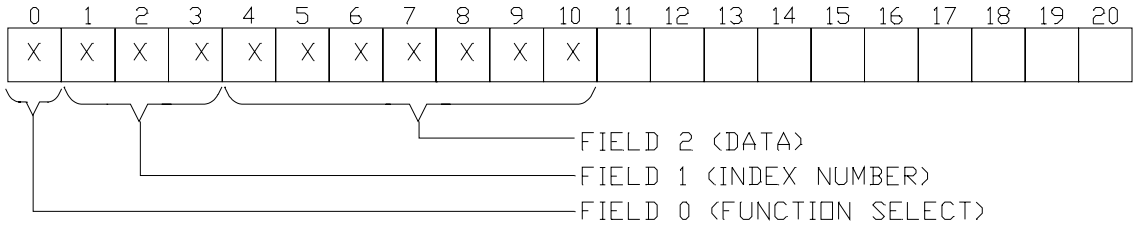


Figure 45 Parallel Programming Example

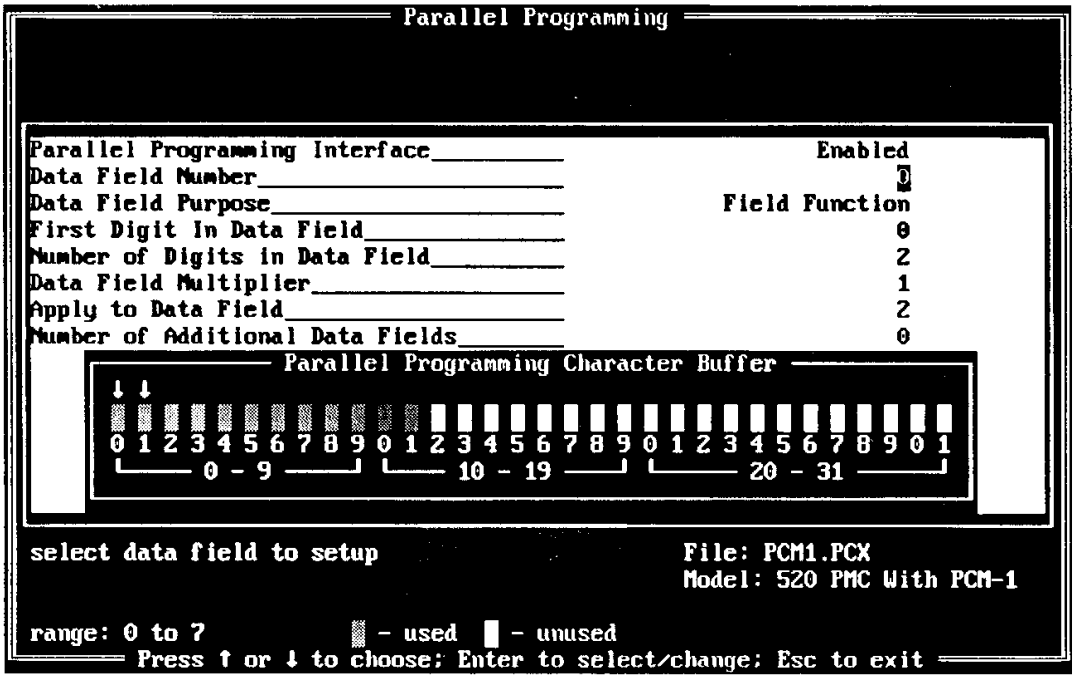


Figure 46 Field Function (Thumbwheel)

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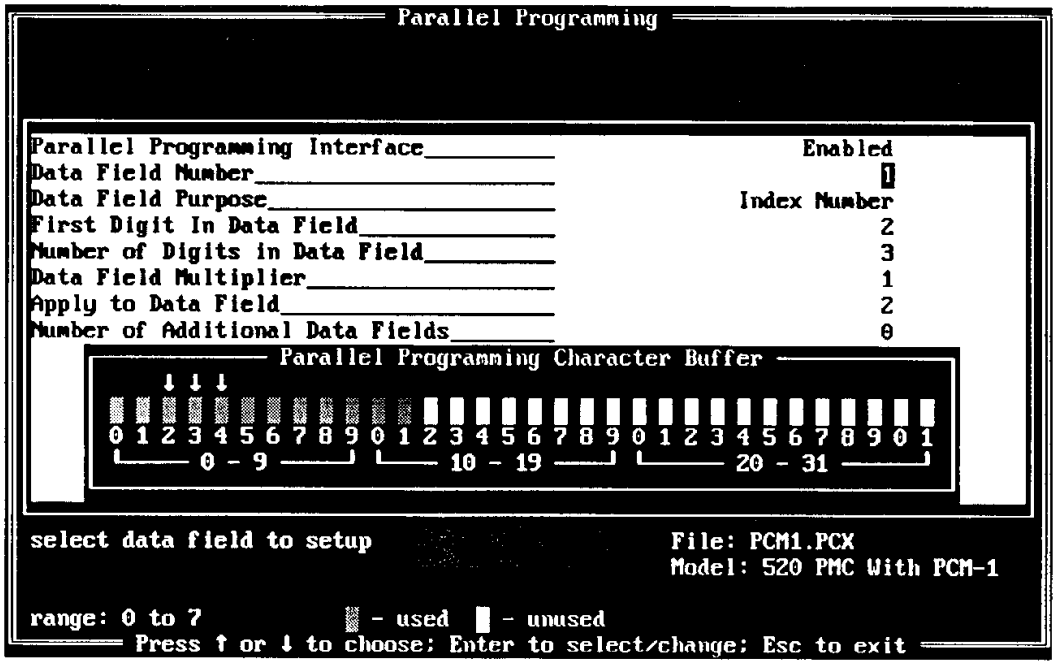


Figure 47 Index Number (Thumbwheel)

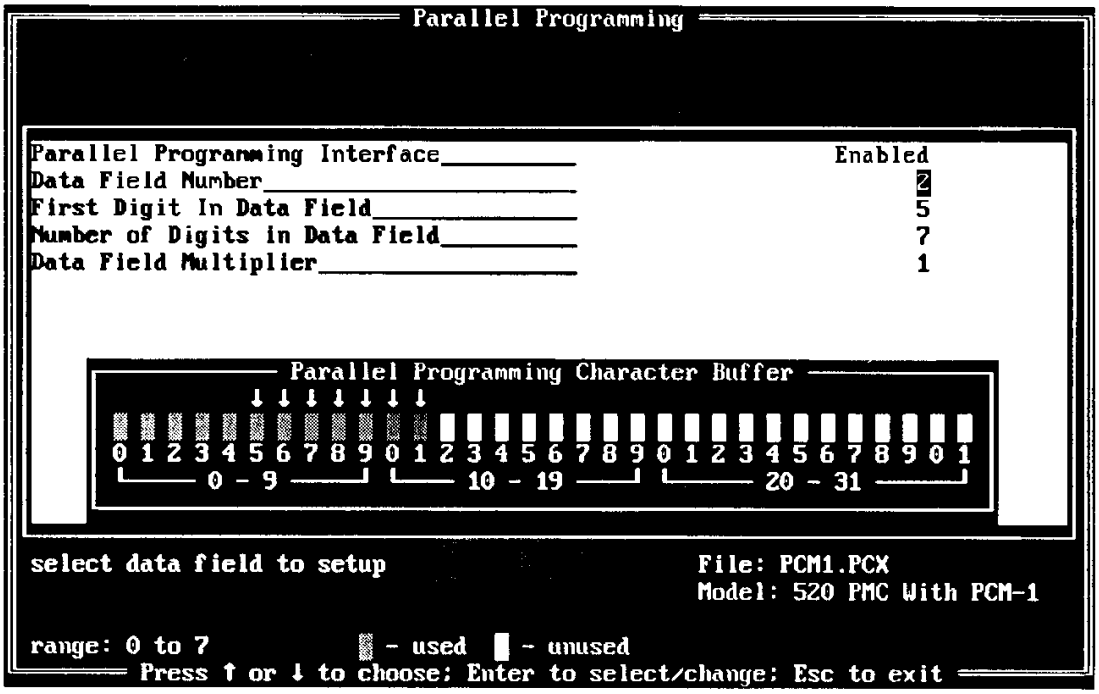


Figure 48 Thumbwheel Programming

The left two digits of the character buffer represent the Field Function (Data Field 0). The field function applies only for the digits setup in Data Field 2. In Data Field 1, digits 2-4 represent the index number that the data in Field 2 is also to use. Data Field 2 is the general purpose field that is used in conjunction with the other data fields. When the above data is entered as shown, the index velocity (Field Function 2) of index number 55 will be changed to 1200.

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T-16 SETUP AND OPERATION

The T-16 data entry screen is located in the parallel options in the PCX Setup Menu. Upon selection of the Numeric Display option, the following screen will be displayed.

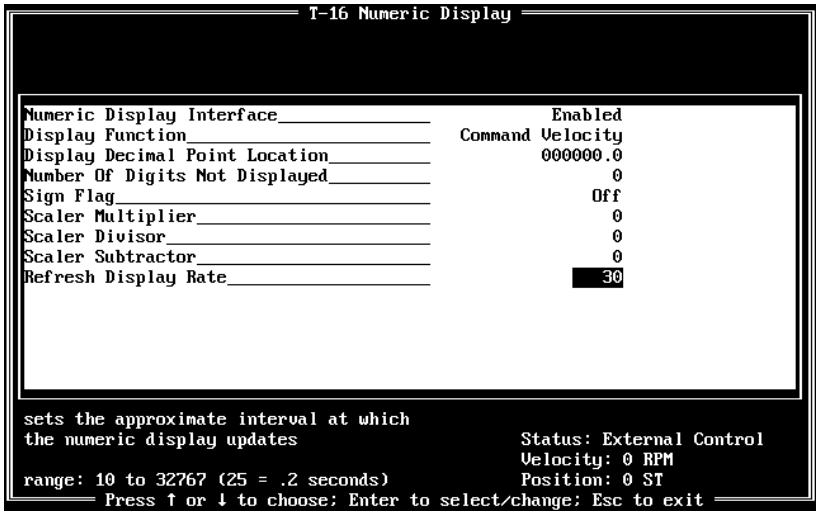


Figure 49 Screen Menu T-16 Numeric Display

NUMERIC DISPLAY INTERFACE

In order for the numeric display to function it must be enabled. Neither the thumbwheels or the numeric displays can be used if the parallel interface is enabled.

DISPLAY FUNCTION

The numeric display may be setup to display any of the following positioning drive functions:

command position
command velocity
index count
index dwell time
motor current

DISPLAY DECIMAL POINT LOCATION

The user may place a decimal point at a fixed location on the numeric display. This option can be used to make the display show meaningful information.

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NUMBER OF DIGITS NOT DISPLAYED

Sometimes the least significant digits on the numeric display are insignificant. This option provides a way to drop digits (right to left) before they are displayed.

SIGN FLAG

If the sign flag is off, positive values will be displayed without a "+" sign. Negative values are always displayed with the "-" sign.

SCALER MULTIPLIER, DIVISOR, AND SUBTRACTOR

These items are provided to scale the normal positioning drive values before they are displayed. This option can be used to make the display show meaningful information (command position or command velocity).

$$\text{DISPLAY} = \frac{(\text{Value} - \text{Subtractor}) * \text{Multiplier}}{\text{Divisor}}$$

These items may be any value from –32768 to 32767. A value of 0 disables any item without error.

REFRESH DISPLAY RATE

This option determines the approximate interval at which the numeric display updates. The actual rate may change depending on what else the positioning drive is doing. The default value of 25 represents a .1 second rate (50 would be .2 seconds, etc.).

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INSTALLATION AND CONNECTIONS OF THE PCM-1

INTRODUCTION

The PCM-1 allows for memory and I/O expansion as well as parallel in, and compound indexing. The installation of the PCM-1 module is made easy by a direct "plug-in" design. All the electrical connections between the basic drive and the PCM-1 module are made via the 48 position connectors. Figure 1 shows how the 48-pin connectors mate on the Positioning Drive. This is the only electrical connection required between the two units. Once plugged in, the top and bottom handles snap into position to secure the module to the drive.

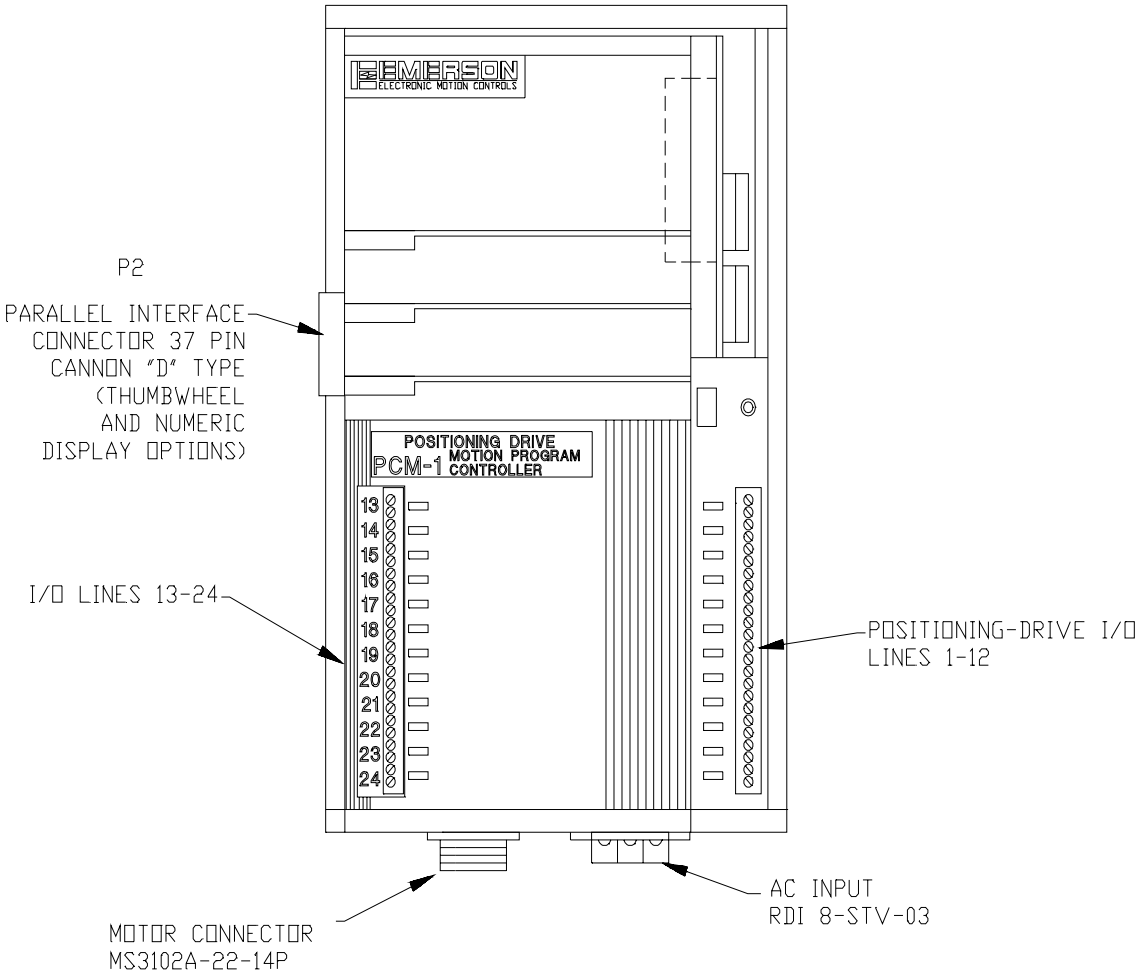


Figure 50 I/O Locations PCM-1

The PCM-1 module includes a parallel interface connector. The most common use of this connector is for thumbwheel interfacing and numeric display.

The input and output connections are split between two terminal strips; one strip on the PCM module #13-24 and one on the digital drive #1-12. Each strip consists of 8 input lines and 4 output lines.

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INPUT/OUTPUT INTERFACE (PCM-1)

OVERVIEW

The PCM-1 is equipped with 8 inputs and 4 outputs that are optically isolated and operate on +10 to +30 VDC. Each input and output has 2 screw terminals associated with it to provide for either sinking or sourcing operation. The first 8 pairs of designated terminals are inputs and the last 4 pairs of terminals are outputs. The outputs are capable of sinking or sourcing a maximum of 200 mA. The user is responsible for limiting the output current to less than or equal to 200 mA.

Adding the PCM-1 module will double the I/O capabilities of the standard 520 PMC. The number of input lines are increased from 8 to 16 and the number of output lines are increased from 4 to 8.

These inputs and outputs allow for proper timing and coordination between the drives, motion, and other machine control functions. The inputs and outputs can be connected to the machine's programmable logic controller (PLC) or relay logic system. These inputs and outputs can also be connected to limit switches, or switches and indicators on an operator's control panel.

A large number of input/output control functions are provided. The functions needed can be assigned to any of the input/output lines. This is accomplished through either serial interface commands or by using the PCX software provided with the drive. Inputs may be programmed as normally off or normally on. More than one function may be assigned to the same input line. After the I/O lines have been set to the desired configuration, power should be cycled to the 520 PMC to ensure proper I/O operation. Each 520 comes from the factory with the inputs and outputs predefined for frequently used I/O configurations.

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An LED indicator is associated with each input and output. The input and output indicators are on if current is flowing in the associated line.

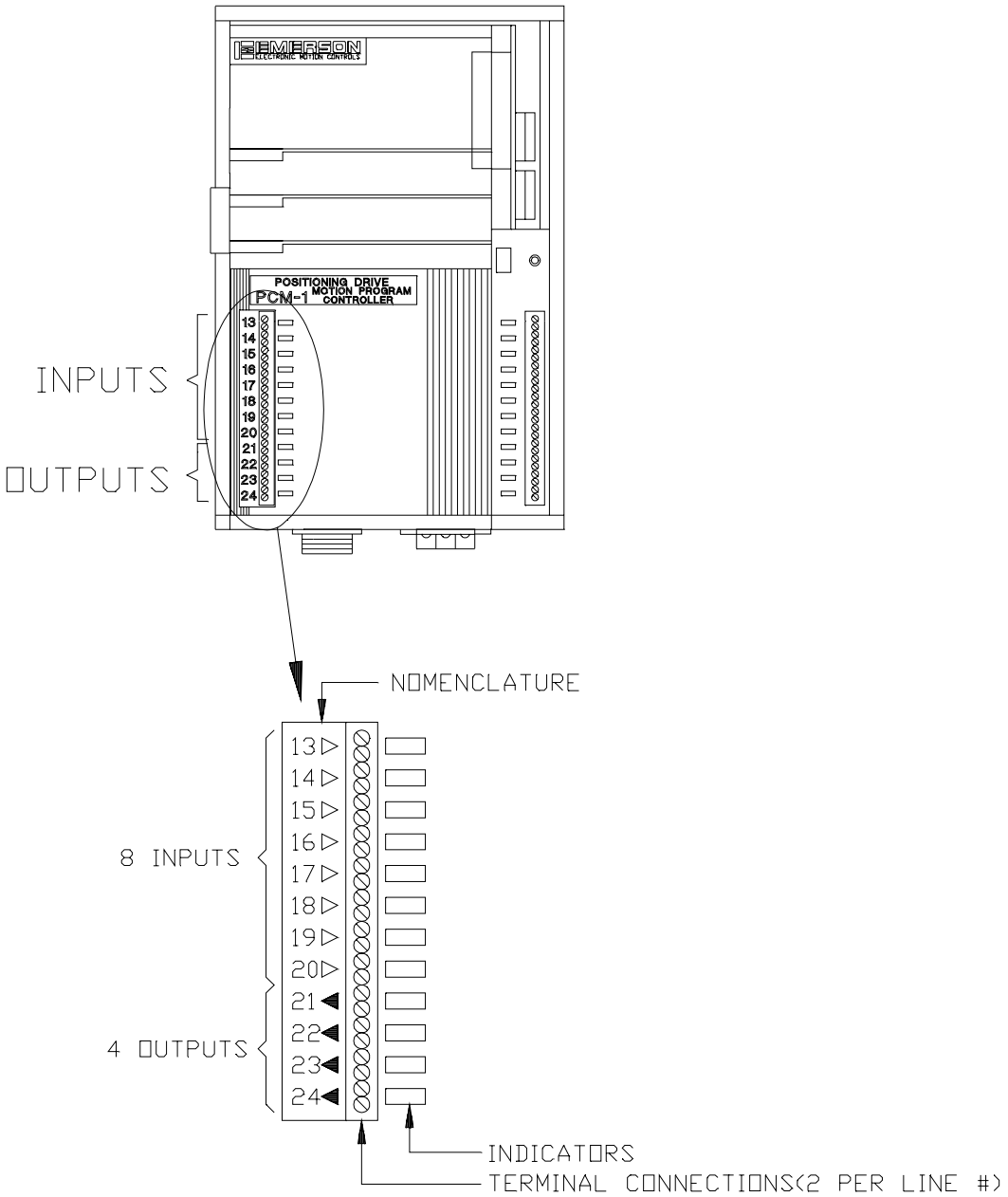


Figure 51 PCM-1 Connections

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Output Functions

Following is the list of output functions provided with the drive and PCM-1.

OUTPUT FUNCTIONS #	BASE DRIVE ONLY	WITH PCM-1	DRIVE
0-READY	X	X	
1-EXTERNAL MODE	X	X	
2-IN MOTION	X	X	
3-END OF INDEX	X	X	
4-END OF HOME	X	X	
5-END OF INDEX COUNT	X	X	
6-HARDWARE FAULT	X	X	
7-TRAVEL LIMIT FAULT	X	X	
8-FOLLOWING ERROR FAULT	X	X	
9-HOME COMPLETED	X	X	
10-SENSOR LIMIT HIT	X	X	
11-END OF SEQUENCE		X	
12-PROGRAMMABLE OUTPUTS			X
13-END OF PROGRAM			X
14-END PROGRAM COUNT		X	
15-IN SUSPEND			X

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Input Functions

Following is a list of the input functions provided with the base drive and PCM-1.

OUTPUT FUNCTION #	BASIC DRIVE ONLY	WITH PCM-1	DRIVE
0 – INDEX INITIATE	X	X	
1 – HOME INITIATE	X	X	
2 – CLEAR TO INITIATE	X	X	
3 – HOLD INDEX/HOME MOTION	X	X	
4 – JOG	X	X	
5 – JOG CW	X	X	
6 – JOG CCW	X	X	
7 – JOG DIRECTION	X	X	
8 – SLOW JOG	X	X	
9 – CW TRAVEL LIMIT	X	X	
10 – CCW TRAVEL LIMIT	X	X	
11 – STOP MOTION	X	X	
12 – INHIBIT (DRIVE)	X	X	
13 – BRAKE OVERRIDE	X	X	
14 – INDEX SELECT	X	X	
15 – HOME SENSOR	X	X	
16 – FEED SENSOR	X	X	
17 – CLEAR END OF INDEX	X	X	
18 – CLEAR END OF HOME	X	X	
19 – CLEAR END OF INDEX COUNT	X	X	
20 – CLEAR SENSOR LIMIT	X	X	
21 – CLEAR FAULT	X	X	
22 – ZERO POSITION		X	
23 – ZERO DISPLAY		X	
24 – REMEMBER POSITION		X	
25 – RETURN TO POSITION		X	
26 – CLEAR END OF SEQUENCE		X	
27 – CLEAR PROGRAM OUTPUTS		X	
28 – EXTERNAL INPUT		X	
29 – PROGRAM INITIATE		X	
30 – PROGRAM SELECT		X	
31 – SUSPEND PROGRAM		X	
32 – RESUME PROGRAM		X	
33 – CLEAR SUSPEND		X	
34 – CLEAR END OF PROGRAM		X	
35 – CLEAR END PROGRAM COUNT		X	

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Examples of I/O Connections to PCM-1

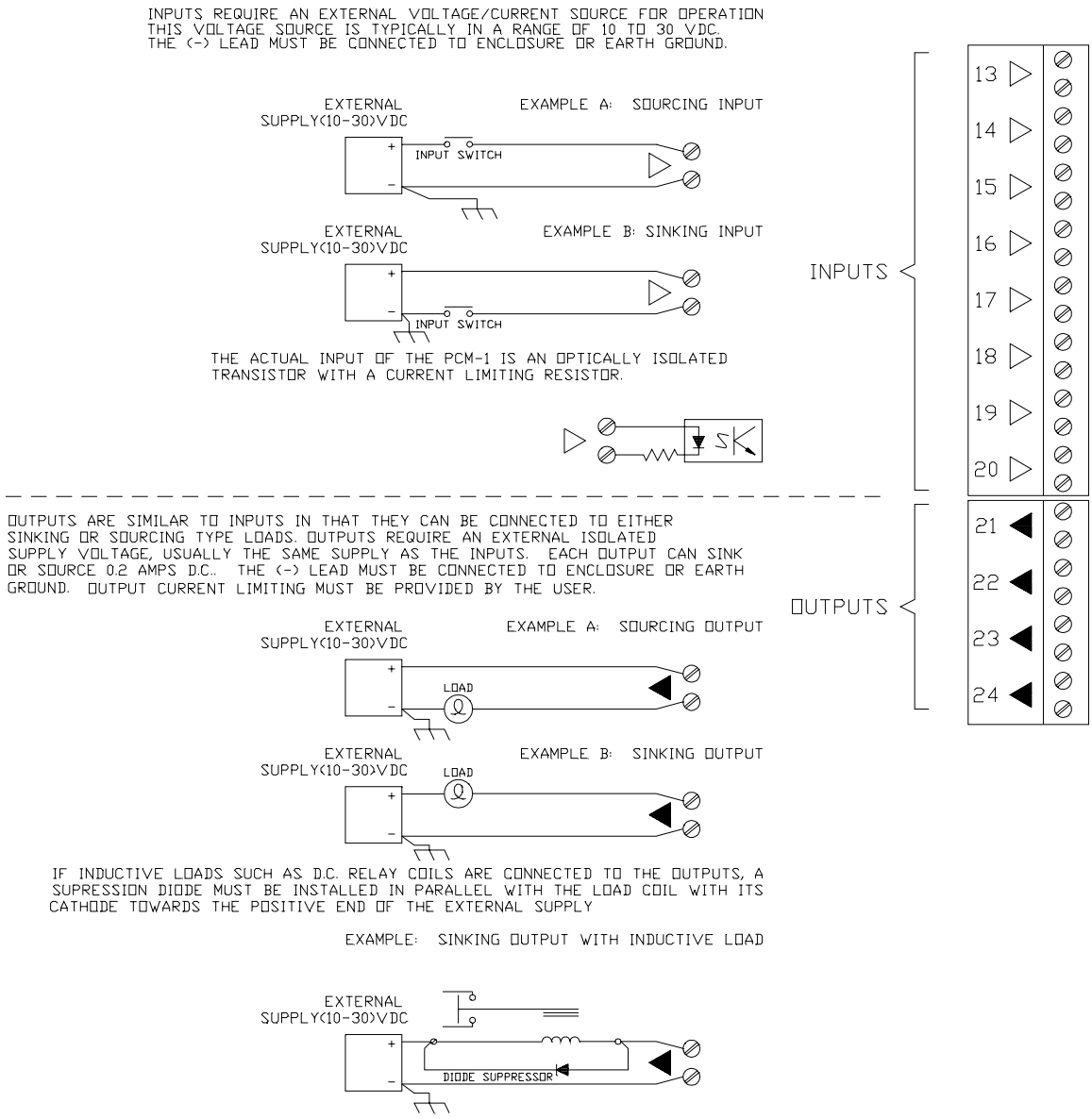


Figure 52 Examples Of Connections To PCM-1

NOTE: 18 to 24 gauge wire must be used for I/O wiring. The use of larger gauge wire will cause the I/O terminals to prematurely fatigue.

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Input Functions

FUNCTION #	DESCRIPTION
22	ZERO POSITION
	Sets the current position of the motor to zero. All absolute positions will be referenced to this set zero position.
23	ZERO DISPLAY
	This zeroes all position query commands (FP and CP), they become zero and are referenced to this point. Absolute position is unaffected.
24	REMEMBER POSITION
	Stores the current position of an absolute index.
25	RETURN TO POSITION
	Returns to the position defined by REMEMBER POSITION.
26	CLEAR END OF SEQUENCE OUTPUT
	Clears the END OF SEQUENCE output. If not assigned, the END OF SEQUENCE output will automatically clear when the next motion occurs.
27	CLEAR PROGRAMMABLE OUTPUT
	Clears a (PROGRAMMABLE OUTPUT). Each assigned PROGRAMMABLE OUTPUT will require a separate CLEAR PROGRAMMABLE OUTPUT.
28	EXTERNAL INPUT
	Used with the WAIT FOR INPUT program function to stop program execution until the input line assigned with EXTERNAL INPUT is activated.
29	PROGRAM INITIATE
	Executes the selected program.

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FUNCTION #	DESCRIPTION
30	PROGRAM SELECT LINES Sets the starting input line number for a given number of program select lines. Then the number of program select lines is programmed through PCX or serial commands.
31	SUSPEND PROGRAM Stops the execution of a program until the input line assigned with RESUME is activated. Also see I/O Suspend Resume Feature Section in the PCM-1 Section.
32	RESUME PROGRAM Resumes the execution of a suspended program. Also see I/O Suspend Resume Feature Section in the PCM-1 Section.
33	CLEAR SUSPEND Clears the IN SUSPEND output and returns the drive from a suspend cycle to normal operation without the need to "RESUME" and completion of the suspended program. Also see I/O Suspend Resume Feature Section in the PCM-1 Section.
34	CLEAR END OF PROGRAM OUTPUT Clears the END OR PROGRAM output. If not assigned, the END OF PROGRAM output will automatically clear when further motion is initiated.
35	CLEAR END OF PROGRAM COUNT Clears the END OF PROGRAM output. If not assigned, the END OF PROGRAM output will automatically clear when the next motion occurs.

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Output Functions

FUNCTION #	DESCRIPTION
11	END OF SEQUENCE

This output comes ON after the completion of a motion sequence. A motion sequence is completed when a HOME, INDEX, or PROGRAM or a combination thereof, is executed and no further commands are pending. This output turns OFF automatically with the next motion or when the CLEAR END OF SEQUENCE is used.

12 PROGRAMMABLE OUTPUTS

The output lines assigned this function can be turn ON or OFF with the UPDATE OUTPUTS programming function.

13 END OF PROGRAM

This output comes ON after each completion of a PROGRAM. It turns OFF automatically with the next motion or when the CLEAR END OF PROGRAM is used.

14 END OF PROGRAM COUNT

This output comes ON only after a program is executed the number of times specified by the PROGRAM COUNT. It is turned OFF automatically with the next motion or when the CLEAR END OF PROGRAM COUNT is used.

15 IN SUSPEND

This output is ON when the SUSPEND PROGRAM input function is active. (See I/O Suspend Resume Feature Section.)

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From the "Define Motion" screen of the PCX, two additional features are available, Programs and Suspend.



Figure 53 Define Motion

WHAT ARE PROGRAMS?

In order to understand what a PCM-1 motion "program" is, the user must first be familiar with what an "index" is. Basic index types were described in an earlier section of the manual. These index types are used as the "building blocks" to form a program. The set up program sequence involves taking the individual indexes that have been programmed and combining them into a complete motion program sequence.

Besides allowing the sequencing of indexes, the PCM-1 also provides a programming feature known as Compound Indexing. Compound Indexing allows the user to combine indexes of different velocities without stopping motion. Examples of this feature are shown below. Whenever an index number is used in a compound index, it cannot be used again in any program if it is designated by the same index number.

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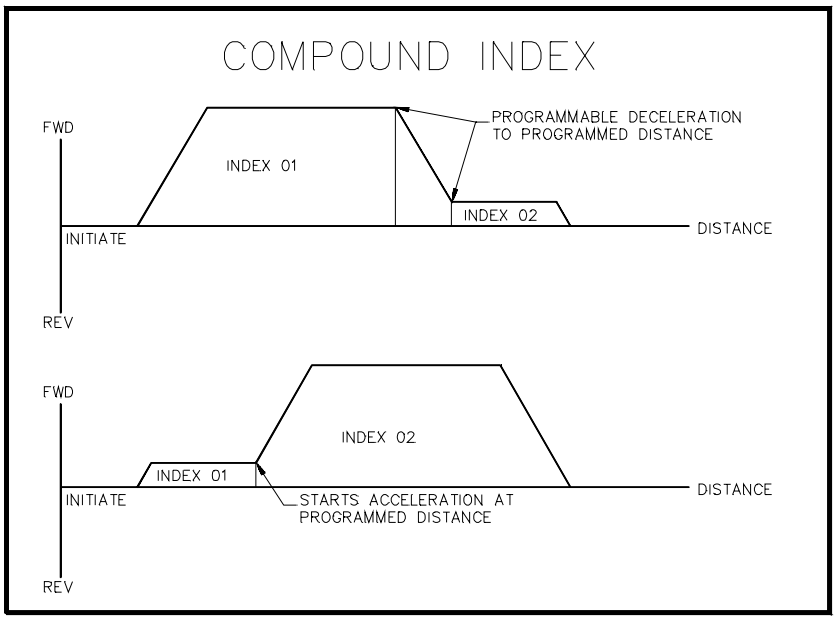


Figure 54

In addition to the index and compound index execution capabilities, the user can do the following:

- Execute a home cycle
- Wait for input line to be changed
- Dwell for a chosen period of time
- Execute a program within a program
- Update output lines

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DESCRIPTION OF PROGRAMMING FUNCTIONS

HOME

The HOME types available with PCM-1 are identical to the HOME types available with the standard drive. A HOME cycle can be executed only after the motor velocity is brought to zero or before motion has begun.

WAIT FOR INPUT

The WAIT FOR INPUT function allows the user to wait for a change in the input line that has been assigned the EXTERNAL INPUT function. This function can be executed after a HOME cycle, after an INDEX, after a PROGRAM, after a DWELL time, and after an OUTPUT UPDATE.

DWELL TIME

The DWELL TIME function allows the user to create a dwell time (sec) between other program functions. A dwell time can be added after a HOME cycle, after INDEX, after a PROGRAM, after a WAIT FOR INPUT, and after an OUTPUT UPDATE.

UPDATE OUTPUTS

The UPDATE OUTPUT function allows the user to change the status of one or all of the 8 output lines. This function is also called 'programmable outputs' and can be executed after a HOME cycle, after an INDEX, after a PROGRAM, after a WAIT FOR INPUT, and after a DWELL.

EXECUTE INDEX

The EXECUTE INDEX function is used to initiate the execution of an index. When this function is used, the index number must also be given.

EXECUTE PROGRAM

The EXECUTE PROGRAM function is used to initiate the execution of a program. When this function is used, the program number must also be given.

EXECUTE COMPOUND INDEX

This function is used to create compound indexes. The index number given with this function will be executed before the index number defined in the next program step. For instance, if index 3 is being compounded into index 8; index 3 will be executed before index 8. Motion will not be stopped between the execution of both indexes.

END

This function is used to designate the end of a program.

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Program Function Codes

Each of the previous program functions has a designated function code that will be used when creating a program with PCX software. The following is a list of these codes.

FUNCTION DESCRIPTION	FUNCTION CODE
GO HOME	H
WAIT FOR INPUT	W
DWELL TIME	D
UPDATE OUPUTS	O
EXECUTE INDEX	I
EXECUTE PROGRAM	P
EXECUTE COMPOUND INDEX	C
END	E

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HOW TO CREATE A PROGRAM

A program sequence is created by listing the program functions in the order in which they are to be executed. PCX software provides a standard program format in which the program functions can be easily listed. The program sequence list is made up of single digit function codes designed to minimize the key strokes. The function codes are automatically described on the computer screen so the user can easily read through the program sequence. The function data (index numbers, program numbers, dwell times, etc.) is also displayed after each function description.

Figure 55 illustrates an example of the programming concepts.

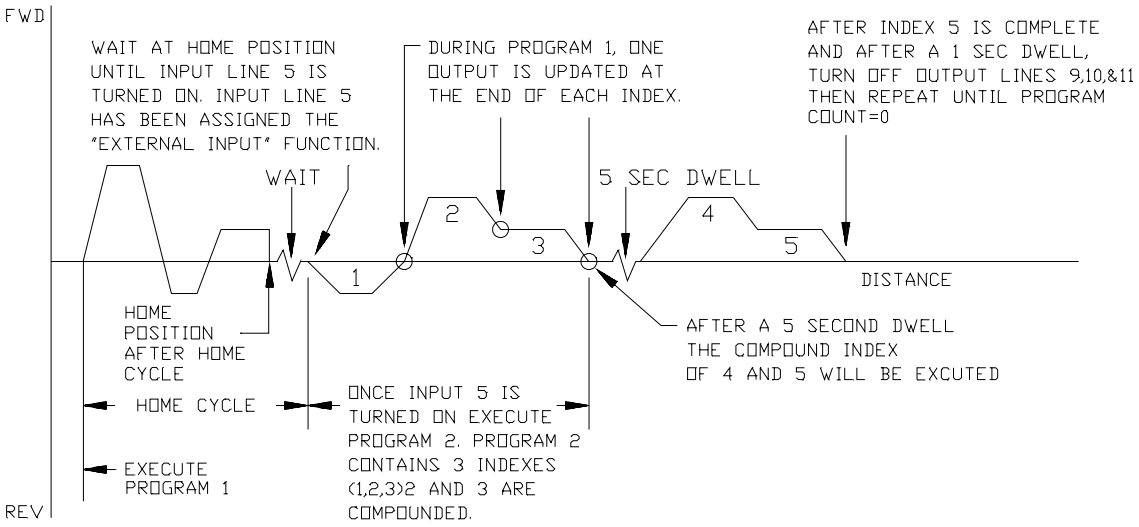


Figure 55 Sample Program

The selection of program and index numbers is arbitrary within the constraint of the memory capacity. The home cycles and indexes are preprogrammed prior to creating the desired program. The selection of inputs and outputs is preprogrammed. Programs provide the means of constructing a sequence. Although this sequence could be constructed using just one program, two programs are used to show the use of the execute program (P) commands. For this example, program numbers 1 and 2 are used and index numbers 1,2,3,4, and 5 are used.

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The two PCX screens that show this example are shown in Figure 56 and Figure 57. These demonstrate how easily a motion program can be set up when using the PCX software. The user must first choose a program number between 0 and 63. Then the user must set the program count. The program count determines how many times the program will be executed. If the program number is set equal to zero, the program will not be executed; and if the program number is set equal to 65535, the program will be executed indefinitely. For this example, the program will be executed 10 times. Everything within Program 1 will repeat 10 times including Program 2.

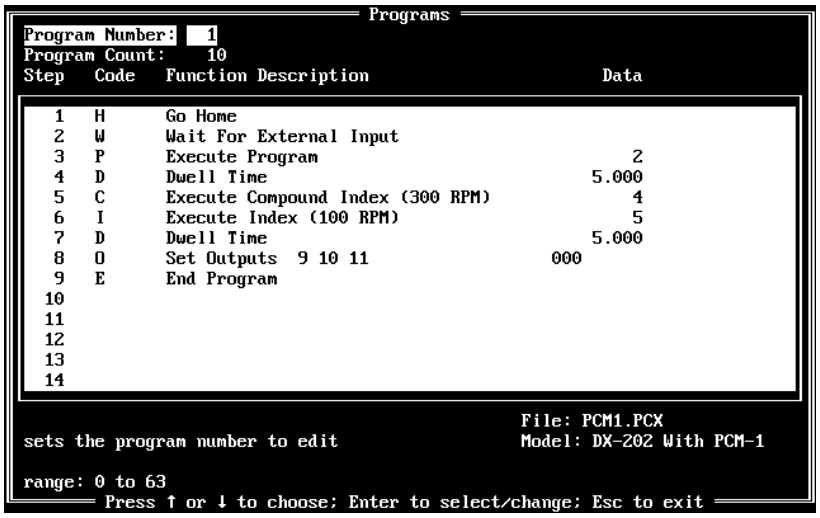


Figure 56 Programming

Program 2 is called from within Program 1 from step 3 of Program 1.

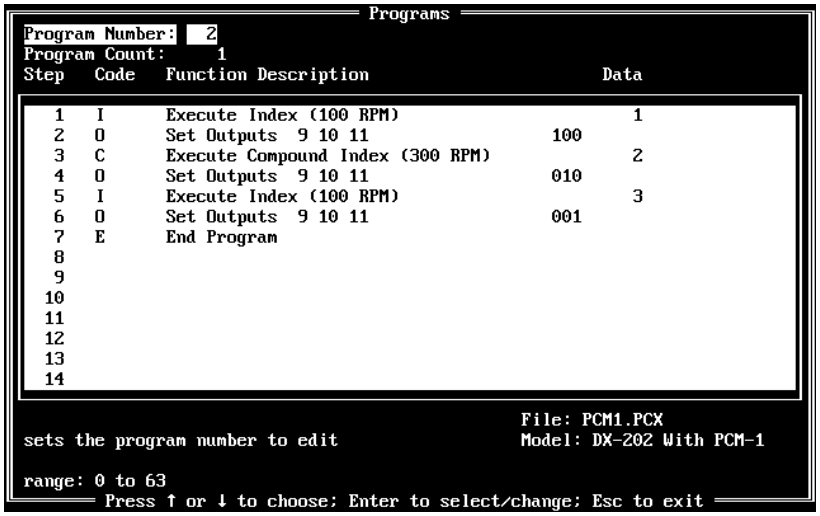


Figure 57 Programming

NOTE: COMMANDS "T", "S", and "R" are not valid with a PCM-1.
The program sequence is stored in non-volatile memory under PROGRAM 1 and 2; shown in the upper left portion of the menu screen. After PROGRAM 1 is executed ten times (PROGRAM COUNT = 10), the controller will wait for the next command.

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Before the UPDATE OUTPUTS function can be used, the output function "PRGRAMMABLE OUTPUTS (12)" must be assigned to the output lines. Once the outputs have been assigned, the UPDATE OUTPUTS will be valid. The data field for programmable outputs displays only the assigned output lines and is organized as shown below.

		DATA							
		X	X	X	X	X	X	X	X
SET OUPUTS	(9, 10, 11, 12, 21, 22, 23, 24)	9	10	11	12	21	22	23	24

For example, if output lines 9, 10 and 11 were to be updated, the data field would appear as follows:

		DATA		
		X	X	X
SET OUPUTS	(9, 10, 11)	9	10	11

Each "X" would be a "1" or a "0", depending on how the outputs are set up.
1 = ON and 0 = OFF.

Like the UPDATE OUTPUTS function, the WAIT FOR INPUT function must have the input function EXTERNAL INPUT (28) assigned to an input line before WAIT FOR INPUT can be used as a program step.

Also, it should be noted that an index that is used in a compound index cannot be used again. If the user must use an identical index, it must be set up and stored under a new index number.

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PROGRAMMING CAPABILITIES

Because there is a limited amount of non-volatile user memory, there are limitations to the number of available indexes, programs, and the average number of steps per program. The default number of available indexes is 256. The number of available programs and average number of steps per program are directly related to each other. The memory is set up such that should the user require 64 programs (maximum), they can have an average of 15 program steps. The following table will illustrate this concept more clearly.

Table XV Number of Required User Program

NUMBER OF REQUIRED USER PROGRAMS	AVERAGE NUMBER OF AVAILABLE STEPS PER PROGRAM
1	1000
2	500
3	333
4	250
5	200
-	-
-	-
-	-
62	16
63	15
64	15

WHERE: AVERAGE NUMBER OF AVAILABLE STEPS = $\frac{1000}{\text{NUMBER OF PROGRAMS}}$

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SUSPEND/RESUME FUNCTIONS

Overview

The SUSPEND/RESUME functions included with the PCM-1 adds a powerful control structure to the unit when executing programs. The SUSPEND input may be used to temporarily suspend the current program that is executing. If operating in the serial control mode, an SP execution command will perform the same function. (A suspend will not be accepted while a hold cycle is active or while a previous suspend cycle is still active).

Once suspended, the controller will stop motion using the programmed stop/hold decel ramp, if necessary, and store the stopped position in the distance field of the current "RETURN TO POSITION" index. (This is INDEX 0 by default but may be changed, if desired, with the RI command.) The controller will remember the current task that was executing within the program and return control to the current execution mode.

At this point, the controller will accept and execute new motion commands (JOG, INDEX, HOME, PROGRAM) until a RESUME input is received. (If in serial control mode, a second SP execution command is used to resume.)

Once resumed, the controller will restart the original program with the task that was executed when the SUSPEND was received. If a DWELL cycle was executing, the remaining dwell time will begin to count down. If a HOME or ASBSOLUTE INDEX was executing the home or index will be restarted from the beginning. If an INCREMENTAL INDEX was executing, the distance that was left to run in the index will now be completed. For the end point of the incremental index to match what would have been the original end point, the controller must be returned to where motion was suspended before issuing the RESUME command. This may be accomplished by executing the "return to position" index, placing the "return to position index" as the last motion step of a program executed during the suspend cycle, or by using the RETURN TO POSITION input in the external control mode. The user must insure that the "return to position" index is set up as an absolute index with the desired velocity/ramps used.

When the RESUME is accepted, the SUSPEND cycle is complete and another SUSPEND input will be accepted. Any STOP command will cancel an active SUSPEND cycle. A suspend cycle may also be cancelled with the CLEAR SUSPEND input or, in serial control mode, with the CL command. Clear commands will only be accepted when motion commands would be accepted (i.e., when no other motion command is active).

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Extended Suspend/Resume Programming

There are additional features available for use with programs concerning the suspend and resume capabilities. These features may be accessed by PCX when setting up any PCM module except for the PCM-3. When entering the "Define Motion" screen in PCX, the Suspend option appears just below the Programs option.



Figure 58 Suspend/Resume Programming

Upon selection of the Suspend option, the Suspend data entry screen is displayed.

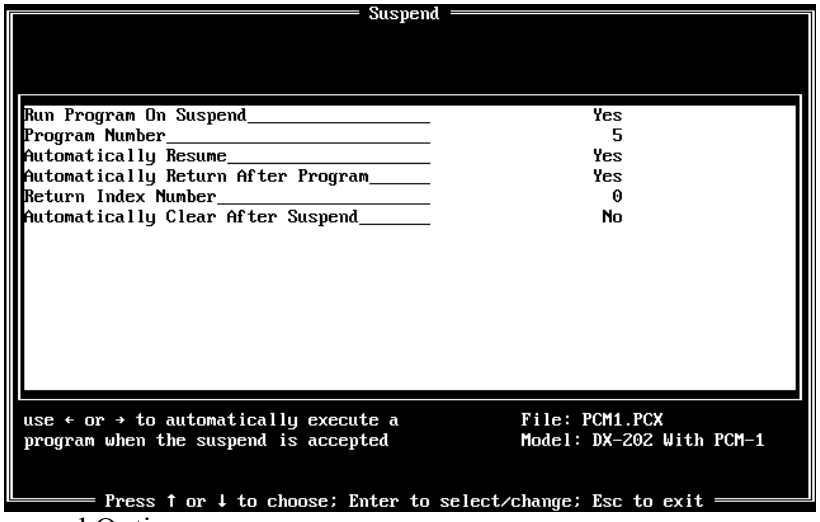


Figure 59 Suspend Option

Run Program On Suspend

This feature allows another program to be automatically initiated when a suspend is accepted. After stopping, the program specified by the "Program Number" will be executed without the need for a program initiate.

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Program Number

This value determines which program is to be initiated when a suspend is accepted and the "Run Program On Suspend" feature is used.

Automatically Resume

This feature will allow the controller to resume a suspended program without the need for a resume input. When used with the "Run Program On Suspend" feature, the automatic program will be executed before the automatic resume occurs.

Automatically Return After Program

This feature allows the "Return Index Number" index to be automatically initiated when a resume input is accepted. When a suspend input is accepted and the motor stops, the current position is stored in the index position specified by the "Return Index Number" value. When this index is setup as an absolute index with a count, the motor will return to the position where the suspend occurred and then will continue with the original program.

Return Index Number

This value determines which index is to be initiated when a resume is accepted and the "Automatically Return After Program" feature is used. When a suspend input is accepted, the current position will be saved to this index. All other index information should be setup by the user.

Automatically Clear After Suspend

This feature may be used to automatically terminate a suspend cycle. When used with the "Run Program On Suspend" feature, the automatic program will be executed before the automatic clear occurs. Once a suspend cycle is cleared, the original program will not be resumed and the controller will be free to accept another suspend input. When this feature is not used, a resume input is needed to clear the suspend cycle.

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INSTALLATION AND CONNECTIONS OF PCM-5

INTRODUCTION

The PCM-5 allows for memory and I/O expansion, program storage and synchronization of an axis or multiple axis to an external lead axis. The installation of the PCM-5 module is made easy by a direct "plug-in" design. All the electrical connections between the basic digital drive and either module are made via the 48 position connectors. Figure 60 shows where the 48-pin connectors mates on the Positioning Drive. This is the only electrical connection required between the two units. Once plugged in, the top and bottom handles snap into position to secure the module to the drive.

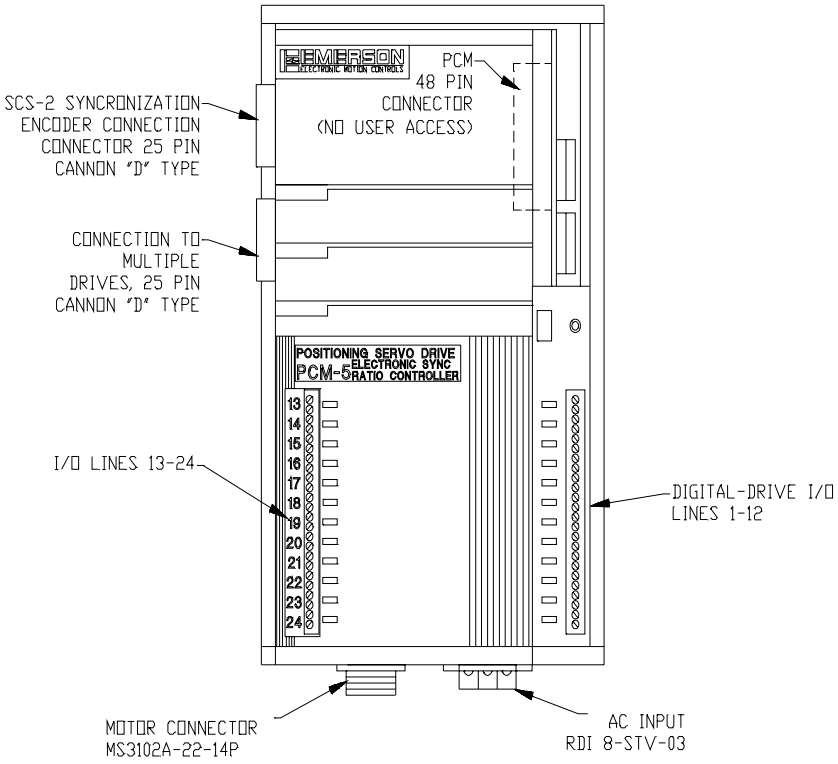


Figure 60 PCM-5 Installation & Connections

The input and output connections are split between two terminal strips; one strip on the PCM module #13-24 and one on the digital drive #1-12. Each strip consists of 8 input lines and 4 output lines.

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SYNCHRONIZATION CABLE
(ENCODER TO 1ST AXIS) MSC-XXX

If an external encoder is used as the method of accomplishing synchronization. As many as 10 axis can be synchronized to this encoder. The connection of the external encoder to the first axis is accomplished with this sync cable (see Figure 61).

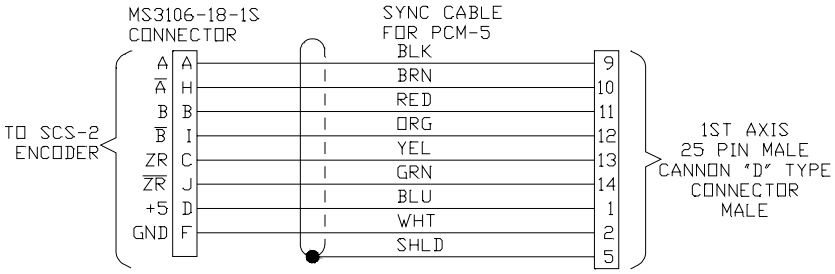


Figure 61 MSC-XXX Cable

The MSC-XXX cable is provided in different lengths.

MSC-015	15 FT.
MSC-025	25 FT.
MSC-050	50 FT.

For some applications, it may be an advantage to not have an external encoder as the source of synchronization. Instead, another digital drive could be the source. This is the purpose of the second connector on the PCM-5.

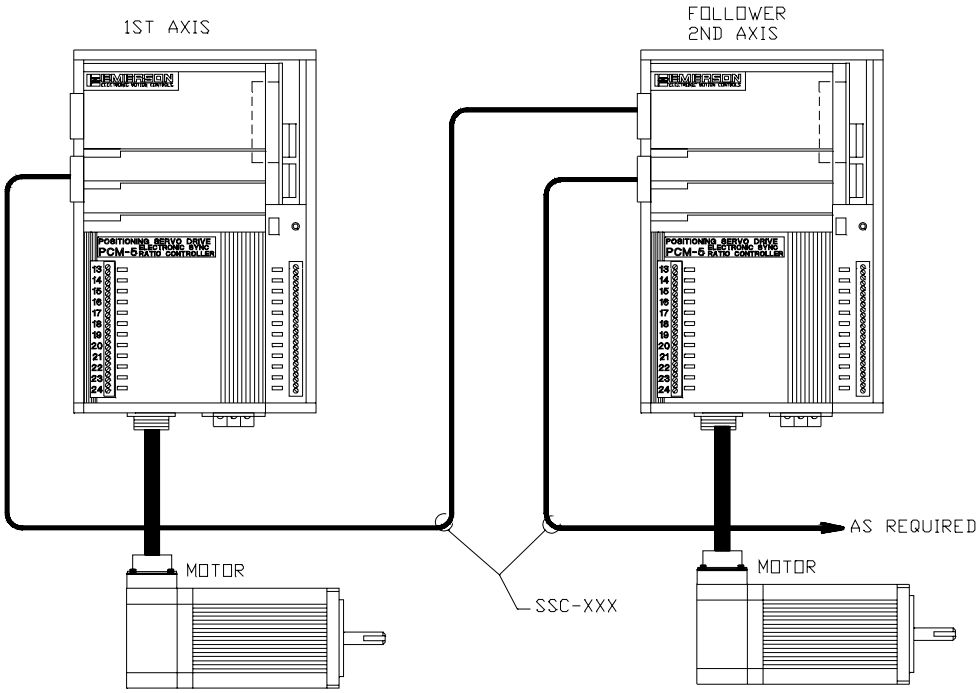


Figure 62 2nd Axis Application/PCM-5

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The first axis can provide the source of synchronization for the second axis. The interconnecting cable for this is an SSC-XXX cable and is available in different lengths.

SSC-003	3 FT.
SSC-006	6 FT.
SSC-010	10 FT.

The SSC-XXX cable is basically a symmetrical cable and its ends can be interchanged.

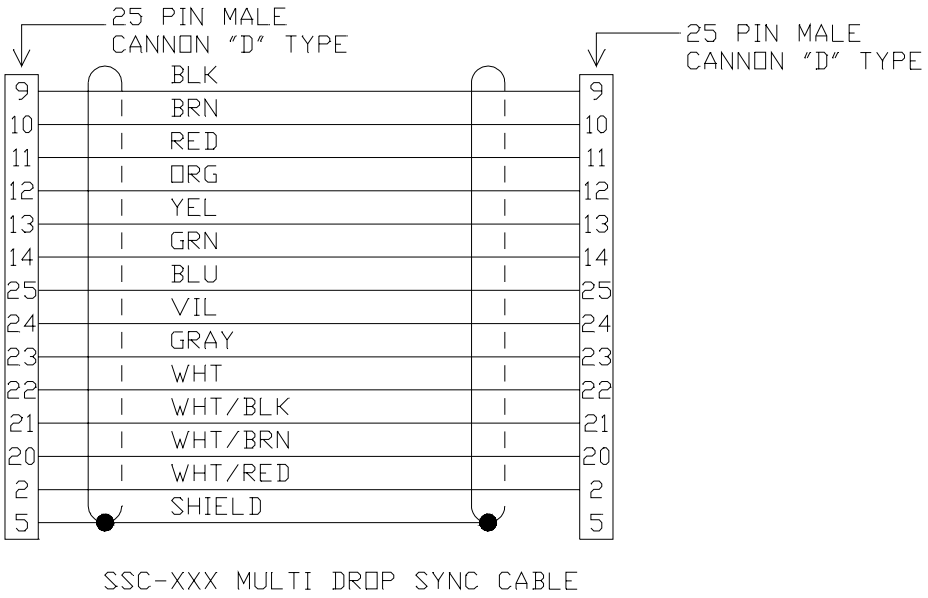
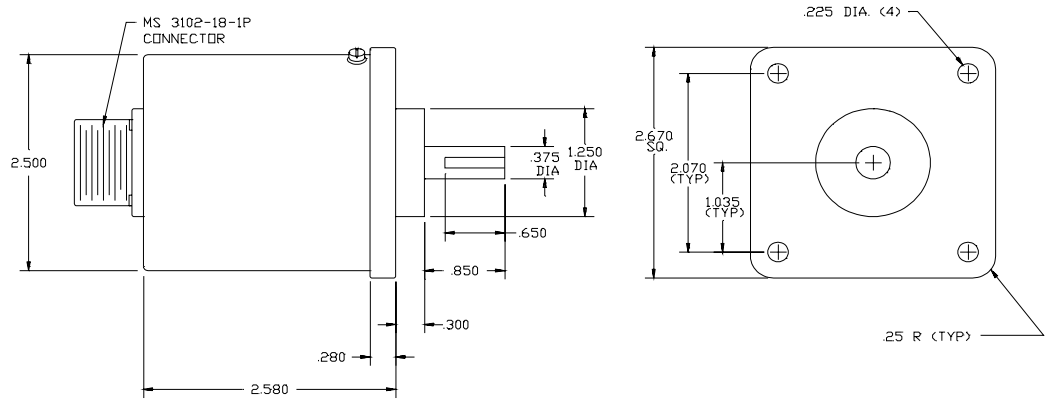


Figure 63 SSC-XXX Multi Drop Sync Cable

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SCS-2 SYNC ENCODER
MECHANICAL AND ELECTRICAL



SPECIFICATIONS:

POWER REQUIREMENTS: 5VDC ±5%, .2 AMPS MAX.
SIGNAL CODE: 2 CHANNEL AMPLIFIED SINE, MARK COMPLIMENTARY
RESOLUTION: 1,000 LINES PER. CHANNEL PER REVOLUTION
OUTPUT: OP-AMP.

CONNECTOR: MS 3102-18-1P

PIN	SIGNAL
A	A
B	B
C	ZR
D	+5
E	
F	GND
G	
H	$\overline{A}$
I	$\overline{B}$
J	$\overline{ZR}$

MATING CONNECTOR
MS 3106-18-1S

MECHANICAL CHARACTERISTICS

MAX SPEED: 3000 RPM
AXIAL LOAD: 40 LBS
RADIAL LOAD: 35 LBS
RUN OUT: .0005"
INERTIA: 4.1 X 10^{-4} OZ IN. SEC^2

ENVIRONMENTAL CHARACTERISTICS

OPERATING TEMPERATURE: 0° TO 70° C
RELATIVE HUMIDITY: 0% TO 95% NON-CONDENSING

Figure 64 SCS-2 Encoder Mech/Ele Info.

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BASIC OPERATION

The external lead axis can, by programming, become the basic source for motion control of a second follower axis. Most of the capabilities of the IOM and PCM-1 are available with one additional input function (JOB SYNC) added and two additional outputs (AT SYNC) and (SYNC FAULT) added. The basis of operation is determined by the relationship of the external lead encoder, or drive, to the follower axis drive motor. The relationship is established based on the programmable ratio of follower axis turns to lead axis turns over a programmable sync ratio range of (.125 to 20). For example, if the user programs a sync ratio of "2", what is being asked is for two turns of the follower axis for every one turn of the lead.

The SCS-2 sync encoder is a two channel amplified sine wave encoder. Each of the channels has 1000 lines. The PCM-2 inputs are A, A {compliment}, B and B {compliment}. Quadrature encoding of these two signals produces a 4 times result so that one revolution of the sync encoder produces the equivalent of 4000 counts/steps per revolution. For resolving distance counting from the sync encoder, 4000 counts per turn becomes important.

The base number system used for the digital drive is binary and 12 bits. Resolution is one part in 4096. Since this number may be difficult to work with because of units, the drive electronics allow for a conversion of this to any number from 200 to 25,000 with the default being 4000. This is provided as a means to achieve meaningful units. When a follower axis is receiving its synchronization source from a digital drive lead axis, then the count source becomes the binary 4096 counts per turn.

There are mathematical limitations and hardware limitations to the precision of the ratio feature. An example is provided. The drive uses a term SR1. To compute the relationship (SR1 can be any whole integer from 200 to 32,000). The PCX software provides a user friendly conversion by asking for the number of follower turns wanted to equal lead turns.

$$\frac{N}{(TURNS)} = SR1$$

N = 4000 if lead count source is an encoder
= 4096 if lead count source is another digital drive

TURNS is the number you enter from PCX.

Consider you enter: 3.000

$$\frac{4000}{3} \text{ (Assume encoder for N)} = 1333\ 1/3 = SR1$$

But SR1 must be a whole integer between a range of 200 to 32,000 so PCX will use 1333 for the value going to the drive for SR1 and replace the value 3.000 you programmed with 3.0007502 -> {infinity}. PCX will also inform you that a perfect match does not exist. The number 4000 in the above example is a constant based on the SCS-2 encoder. This constant changes to 4096 if you select the lead axis to be a digital drive.

Some Application Examples

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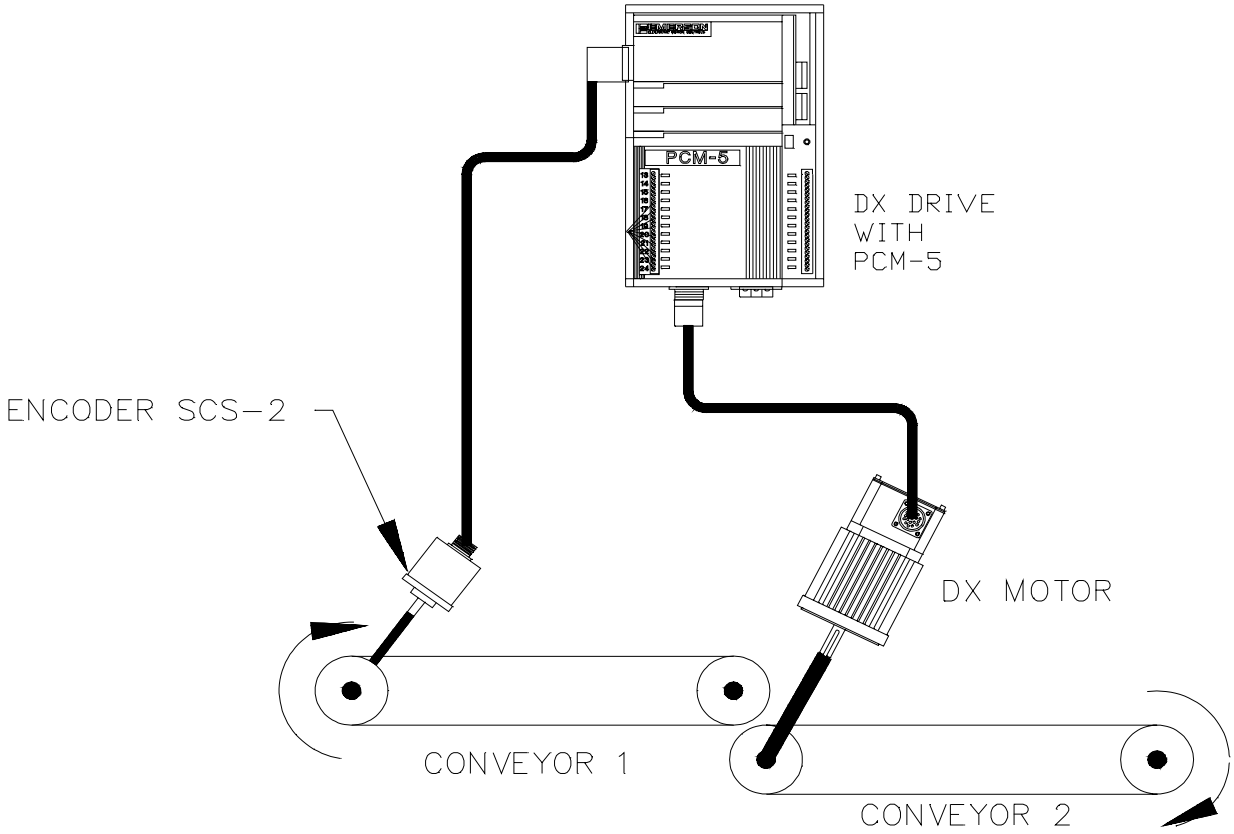


Figure 65 Conveyor Application W/PCM-5

Conveyor 1 and conveyor 2 must run at the same surface velocity. Conveyor 1 is driven with a simple variable speed drive.

Solution: Mount the SCS-2 sync encoder on conveyor 1 and use the drive with the PCM-5 for conveyor 2.

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To synchronize a second drive to a first drive, both the lead and follower axis would be equipped with a PCM-5.

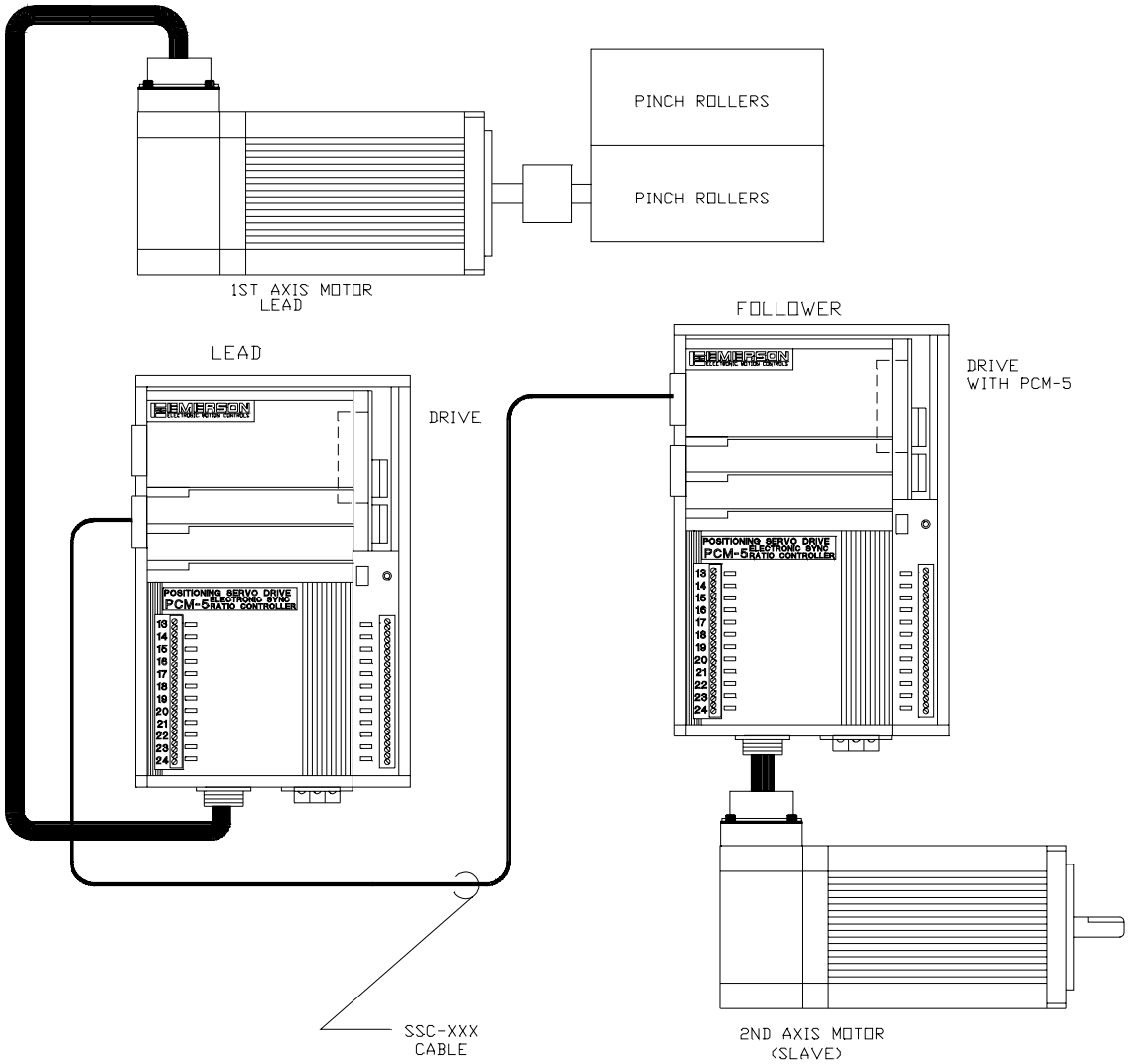


Figure 66 PCM-5 Application (Second Drive)

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If multiple axis of drives are to be synchronized or ratioed to a lead encoder, then all axes would be equipped with a PCM-5. The lead encoder signals would effectively be in parallel.

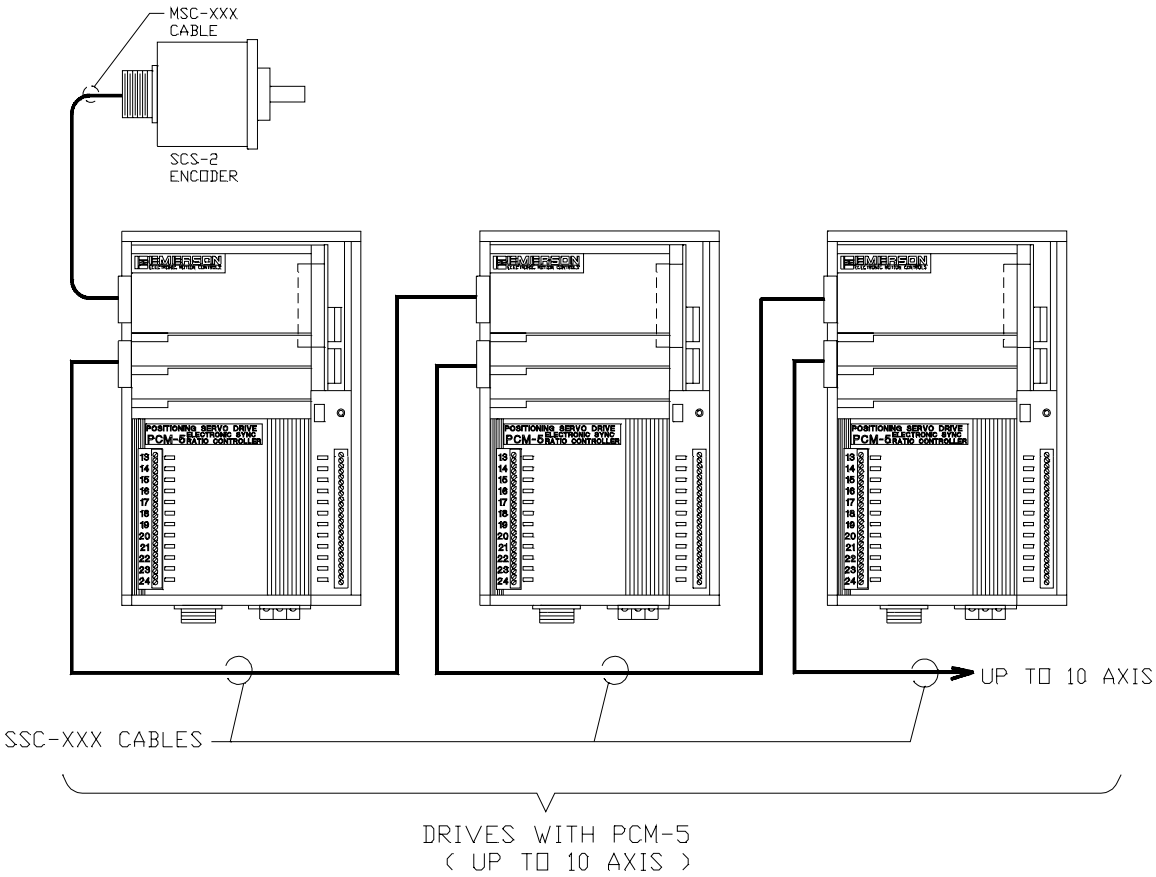


Figure 67 PCM-5 Application (Multiple Axes)

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One of the most common applications of synchronization is to accomplish synchronization a repetitive number of times based on a programmable number of pulses/counts from an external lead axis (encoder or digital drive). For these applications, with the PCM-5 properly programmed, the encoder can provide both synchronization control and the PCM-5 can be programmed to cause automatic cycle initiations at the completion of a programmable number of external axis counts. This is accomplished in the program set up mode with PCX. There are three additional codes that allow for this.

A (T) code allows you to insert (in front of an INDEX, PROGRAM, or DWELL), a choice for a time base. T = Time Base (TMBAS) and your choice is internal, being normal, or external, meaning the external encoder.

A (S) code allows you to start counting the external encoder pulses. The SCS-2 with 2 (1000 line) channels produces 4000 counts/steps per revolution. S = Start Counter (ST CT).

An (R) code allows you to wait for the desired number of counts before starting again. R = Wait for counter (WT CNT). When programming the (R) code you must program the desired number of counts in the data field and counting is determined by CW (+) rotation of the sync encoder as viewed from the shaft end of the sync encoder and CCW (-) counting is the opposite. The count is based from the last start external counter (S) or wait for counter (R) code.

A specific application of this is a flying shear cut where a ball screw is connected to an EMC motor and a drive with a PCM-15. The lead encoder is connected to a shaft that rotates pinch rolls. Material is fed through the pinch rolls at varying line feed speeds. The drive must start from a HOME position (a Positioning Drive feature), accelerate to the same linear velocity as the material (a PCM-5 feature), perform a machine operation such as cut, punch, print, etc., at line speed, then decelerate to zero velocity and return to the starting place by either homing or indexing back. Once back, it must wait for re-initiation from a programmed count (a PCM-5 feature).

The motion cycle would appear as follows:

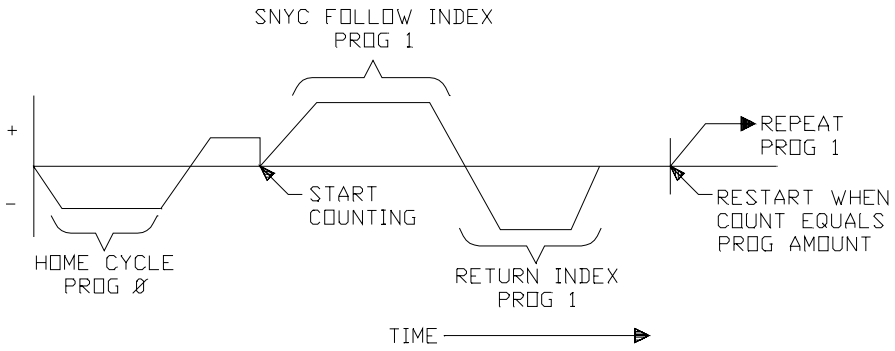


Figure 68 Motion Cycle Graph

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The cycle is accomplished by using two programs.

Program 0/ contains a HOME, initializes the external counter for the first count, and then executes Program 1.

Program 1 contains the T = Time Base (EXT) I = INDEX, (sync Index), T = Time Base (INT), I = INDEX (return to HOME), and R = wait for count. Program 0/ would have a count of 1 and Program 1 would be programmed to count forever. The values for XX in the data field of the index are the selected index numbers.

Initiation of Program 0/ starts the cycle.

Table XVI Added Output Functions

	STEP	CODE	FUNCTION	DWA
PROG	1	H	HOME	
0/	2	S	START EXTERNAL COUNTER	
COUNT=1	3	P	EXECUTE PROGRAM	1
	4	E	END	
	1	T	TIME BASE	ENCODER
	2	I	INDEX (SYNC)	XX
PROG	3	T	TIME BASE	INTERNAL
1	4	I	INDEX (BACK TO HOME)	XX
COUNT = XXXXXXX	5	R	WAIT FOR EXTERNAL COUNT	+ / -
(INFINITY)	6	E	END	

This same example provides the best description of the added output functions at SYNC and SYNC FAULT. The at SYNC output would come on at the end of acceleration of the first index in program 1 and could be used as an initiation source for external control. The SYNC FAULT would come on if the WAIT FOR EXTERNAL COUNT program step was encountered and the specified count had already accumulated in the counting registers. This is an indication that the unit was not back to the HOME position in time to initiate the next auto restart (i.e., the cycle is too short or the return is too slow). The SYNC FAULT output will be reset when either the CLEAR FAULT input or the RESET pushbutton are activated.

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BI-POLAR SYNCHRONIZATION

A special feature of the PCM-5 is Bi-Polar Synchronization. The added input enables this mode. In this mode of operation a complete bi-polar mode of following exists between the lead axis and follower axis. In other words, clockwise rotation of the lead axis causes CW rotation of the follower drive motor and CCW rotation causes CCW motor motion. The ratio between the two is programmable by the value of the sync ratio in the drive parameter setup with PCX. The range is (.125 to 20) turns of the follower axis to 1 turn of the lead axis. The lead axis can be either an external encoder or digital drive.

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INPUT/OUTPUT INTERFACE

OVERVIEW

The PCM-5 is equipped with 8 inputs and 4 outputs which are optically isolated for +10 to +30 vdc operation. Each input and output has 2 screw terminals associated with it to provide for either sinking or sourcing operation. The first 8 pairs of designated terminals are inputs and the last 4 pairs of terminals are outputs. The outputs are capable of sinking or sourcing 200 mA. The user is responsible for limiting the output current to less than or equal to 200 mA.

Adding the PCM-5 module will double the I/O capabilities of the standard digital drive. The number of input lines are increased from 8 to 16 and the number of output lines is increased from 4 to 8.

These inputs and outputs allow for proper timing and coordination between the drive's motion and other machine control functions. The inputs and outputs typically are connected to the machine's programmable logic controller (PLC) or relay logic system. These inputs and outputs are also connected to limit switches, and/or switches and indicators on an operator's control panel.

A large number of input/output control functions are provided. The functions used are assigned to any of the input/output lines. This is accomplished through either serial interface commands or by using the PCX software provided with the drive. Inputs may be programmed as normally off or normally on. In addition, more than one function may be assigned to the same input line. Each drive comes from the factory with the inputs and outputs predefined for frequently used I/O configurations (see Figure 69).

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An LED indicator is associated with each input and output. The input and output indicators are on if current is flowing in the associated line.

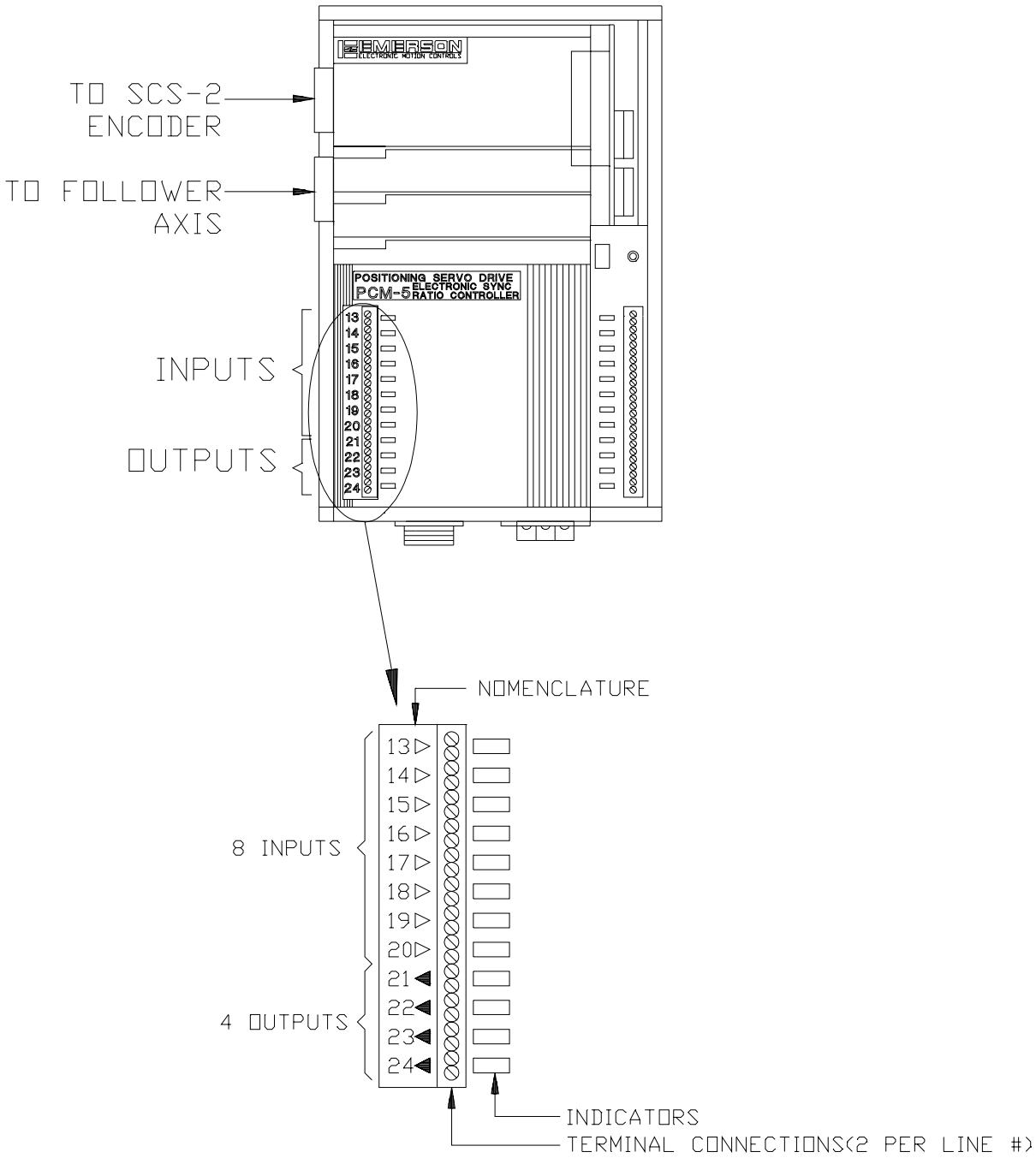


Figure 69 I/O Nomenclature (PCM-5)

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Output Functions

Following is the list of output functions provided with the drive and PCM-5.

OUTPUT FUNCTION #	BASIC DRIVE ONLY	DRIVE WITH PCM-5
0 – READY	X	X
1 – EXTERNAL MODE	X	X
2 – IN MOTION	X	X
3 – END OF INDEX	X	X
4 – END OF HOME	X	X
5 – END OF INDEX COUNT	X	X
6 – HARDWARE FAULT	X	X
7 – TRAVEL LIMIT FAULT	X	X
8 – FOLLOWING ERROR FAULT	X	X
9 – HOME COMPLETED	X	X
10 – SENSOR LIMIT HIT	X	X
11 – END OF SEQUENCE		X
12 – PROGRAMMABLE OUTPUTS		X
13 – END OR PROGRAM		X
14 – END PROGRAM COUNT		X
15 – IN SUSPEND		X
16 – RESERVED		
17 – AT SYNC		X
18 – SYNC FAULT		X

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Input Functions

The following list of input functions are available for use in providing control through the standard I/O interface. With the expansion of the PCM-5, fourteen more input functions are available.

INPUT FUNCTION #	BASIC DRIVE ONLY	DRIVE WITH PCM-1
0 – INDEX INITIATE	X	X
1 – HOME INITIATE	X	X
2 – CLEAR TO INITIATE	X	X
3 – HOLD INDEX/HOME MOTION	X	X
4 – JOG	X	X
5 – JOG CW	X	X
6 – JOG CCW	X	X
7 – JOG DIRECTION	X	X
8 – SLOW JOG	X	X
9 – CW TRAVEL LIMIT	X	X
10 – CCW TRAVEL LIMIT	X	X
11 – STOP MOTION	X	X
12 – INHIBIT (DRIVE)	X	X
13 – BRAKE OVERRIDE	X	X
14 – INDEX SELECT	X	X
15 – HOME SENSOR	X	X
16 – FEED SENSOR	X	X
17 – CLEAR END OF INDEX	X	X
18 – CLEAR END OF HOME	X	X
19 – CLEAR END OF INDEX COUNT	X	X
20 – CLEAR SENSOR LIMIT	X	X
21 – CLEAR FAULT	X	X
22 – ZERO POSITION		X
23 – ZERO DISPLAY		X
24 – REMEMBER POSITION		X
25 – RETURN TO POSITION		X
26 – CLEAR END OF SEQUENCE		X
27 – CLEAR PROGRAM OUTPUTS		X
28 – EXTERNAL INPUT		X
29 – PROGRAM INITIATE		X
30 – PROGRAM SELECT		X
31 – SUSPEND PROGRAM		X
32 – RESUME PROGRAM		X
33 – CLEAR SUSPEND		X
34 – CLEAR END OF PROGRAM		X
35 – CLEAR END PROGRAM COUNT		X
36 – RESERVED		
37 – RESERVED		
38 – BIPOLAR SYNC		X

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Examples of I/O Connections to PCM-5

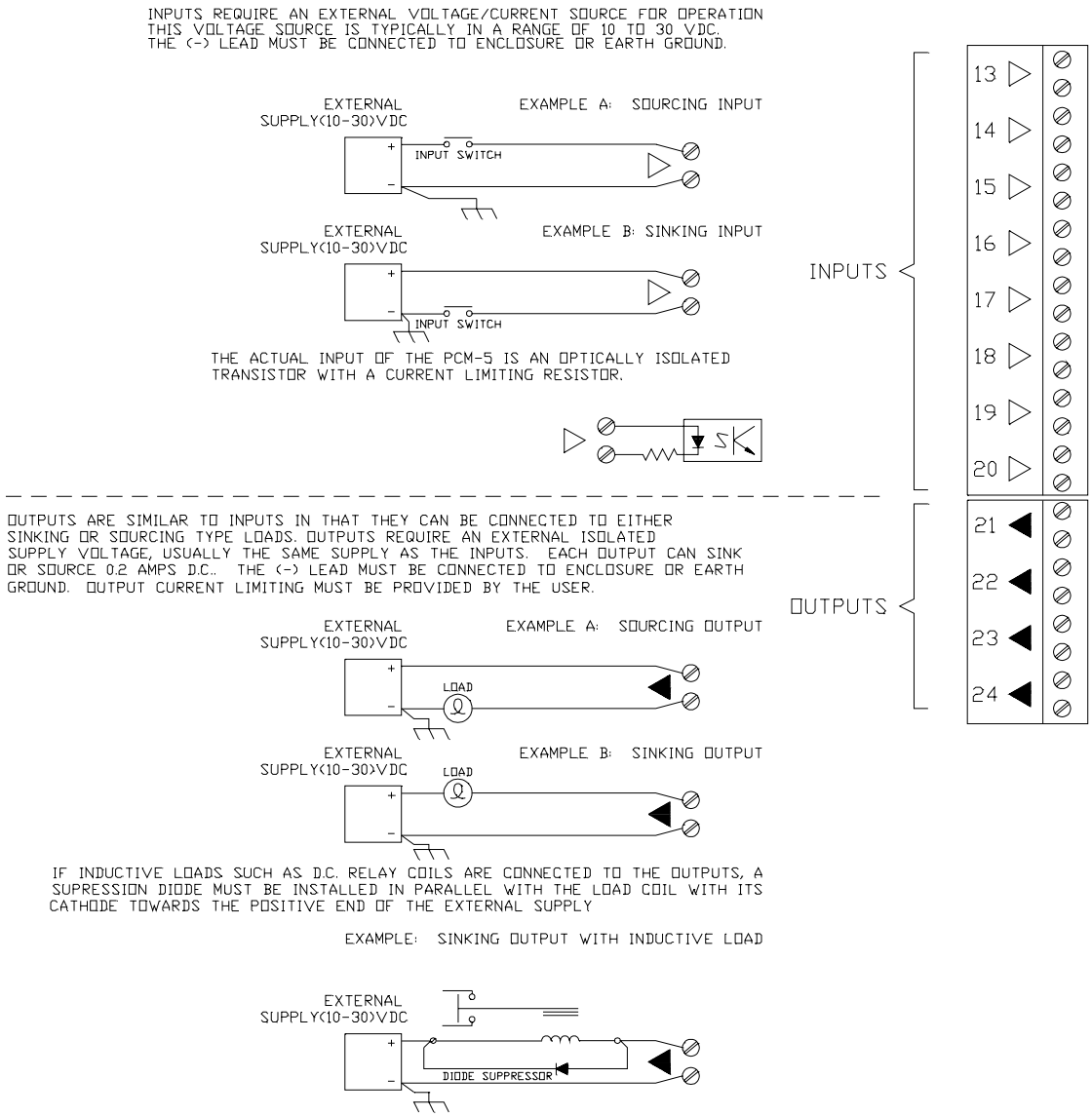


Figure 70 Examples Of I/O To PCM-5

NOTE: 18 to 24 gauge wire must be used for I/O wiring. The use of larger gauge wire will cause the I/O terminals to prematurely fatigue.

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Detailed Descriptions of Additional I/O Functions With the PCM-5

Input Functions

FUNCTION #	DESCRIPTION
22	ZERO POSITION

Sets the current position of the motor to zero. All absolute positions will be referenced to this set zero position.

23	ZERO DISPLAY

This zeroes all position query commands (FP and CP), they become zero and are referenced to this point. Absolute position is unaffected.

24	REMEMBER POSITION

Stores the current position of an absolute index.

25	RETURN TO POSITION

Returns to the position defined by REMEMBER POSITION.

26	CLEAR END OF SEQUENCE OUTPUT

Clears the END OF SEQUENCE output. If not assigned, the END OF SEQUENCE output will automatically clear when the next motion occurs.

27	CLEAR PROGRAMMABLE OUTPUT

Clears a (PROGRAMMABLE OUTPUT). Each assigned PROGRAMMABLE OUTPUT will require a separate CLEAR PROGRAMMABLE OUTPUT.

28	EXTERNAL INPUT

Used with the WAIT FOR INPUT program function to stop program execution until the input line assigned with EXTERNAL INPUT is activated.

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FUNCTION #	DESCRIPTION
29	PROGRAM INITIATE Executes the selected program.
30	PROGRAM SELECT LINES Sets the starting input line number for a given number of program select lines. Then the number of program select lines is programmed through PCX or serial commands.
31	SUSPEND PROGRAM Stops the execution of a program until the input line assigned with RESUME is activated. Also see I/O Suspend Resume Feature Section in the PCM-1 Section.
32	RESUME PROGRAM Resumes the execution of a suspended program. Also see I/O Suspend Resume Feature Section in the PCM-1 Section.
33	CLEAR SUSPEND Clears the IN SUSPEND output and returns the drive from a suspend cycle to normal operation without the need to "RESUME" and completion of the suspended program. Also see I/O Suspend Resume Feature Section in the PCM-1 Section.
34	CLEAR END OF PROGRAM OUTPUT Clears the END OR PROGRAM output. If not assigned, the END OF PROGRAM output will automatically clear when further motion is initiated.
35	CLEAR END OF PROGRAM COUNT Clears the END OF PROGRAM output. If not assigned, the END OF PROGRAM output will automatically clear when the next motion occurs.
38	BI-POLAR SYNC An active input allows for BI-POLAR ratioing of the sync encoder to the drive motor.

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Output Functions

FUNCTION #	DESCRIPTION
11	END OF SEQUENCE

This output comes ON after the completion of a motion sequence. A motion sequence is completed when a HOME, INDEX, or PROGRAM or a combination thereof, is executed and no further commands are pending. This output turns OFF automatically with the next motion or when the CLEAR END OF SEQUENCE is used.

12 PROGRAMMABLE OUTPUTS

The output lines assigned this function can be turn ON or OFF with the UPDATE OUTPUTS programming function.

13 END OF PROGRAM

This output comes ON after each completion of a PROGRAM. It turns OFF automatically with the next motion or when the CLEAR END OF PROGRAM is used.

14 END OF PROGRAM COUNT

This output comes ON only after a program is executed the number of times specified by the PROGRAM COUNT. It is turned OFF automatically with the next motion or when the CLEAR END OF PROGRAM COUNT is used.

15 IN SUSPEND

This output is ON when the SUSPEND PROGRAM input function is active. (See I/O Suspend Resume Feature Section.)

17 AT SYNC

This output is on AT SYNC speed match as determined by the programmed ratio.

18 SYNC FAULT

If an auto cycle restart is used based on external encoder counts, this fault occurs if the count register is satisfied when a WAIT FOR EXTERNAL COUNT program step is encountered. This output is cleared with the CLEAR FAULT input or the RESET pushbutton.

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ADDITIONAL PCM-5 PROGRAMMING

PARAMETERS

Five additional questions can be answered when using a PCM-5 with a drive.

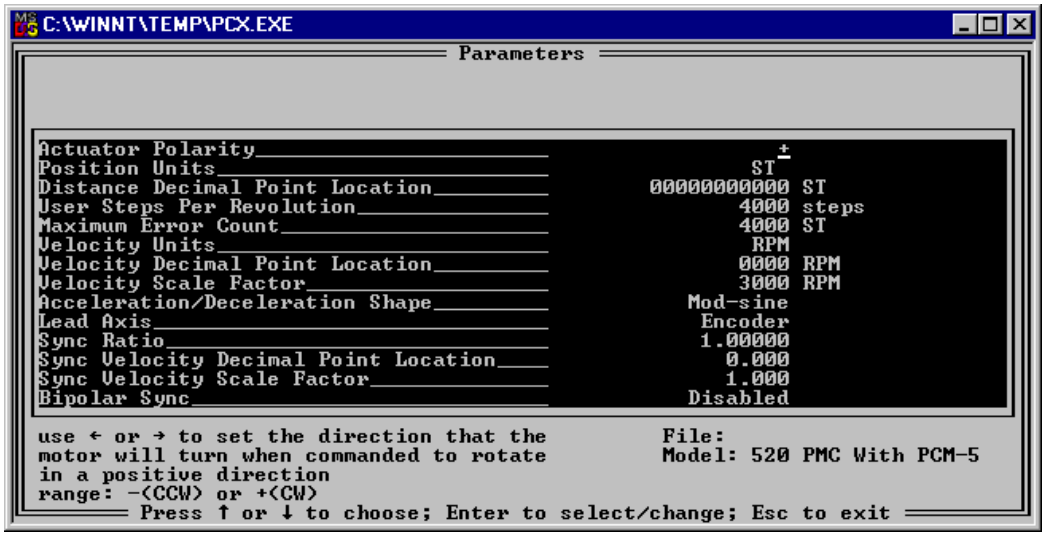


Figure 71 PCM-5 Drive Parameters

LEAD AXIS

The default condition (ENC) means that the SCS-2 will generate the sync pulses. Selecting (DRV) means that the lead axis is a digital drive.

SYNC RATIO

SYNC RATIO establishes the relationship of the follower axis to the lead axis. The relationship to establish is: How many turns of the follower axis equal one turn of the lead? The range is programmable from (.125 to 20) turns. Since, in a digital system, counting is based on bits with no way to resolve numbers between these bits, infinite resolution is not possible. PCX will convert, if required, your entry to the closest possible ratio. Since the standard SCS-2 encoder produces 4000 counts per revolution, and a digital drive is based on 12 bits binary (4096) then 4000 or 4096, become constants in the calculation. The digital drive through serial control, needs a numeric value in a range of 200 – 32,000. This is stored as "SR1". The relationship of these terms is

$$\frac{N}{SR1} = \text{TURNS OF FOLLOWER AXIS TO TURNS OF LEAD AXIS}$$

WHERE N IS 4000 IF LEAD AXIS IS AN ENCODER
WHERE N IS 4096 IF LEAD AXIS IS A DIGITAL DRIVE

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PCX allows the more user friendly turns to be entered by transposing.

$$\frac{N}{TURNS} = SR1$$

And then sends to the drive the required value of SR1. If the computed value of SR1 has a fractional remainder, it will round it off and display the closest possible value to your entry.

Example:

You enter a value of 3, meaning you would like 3 turns of the follower axis for every turn of the lead.

PCX computes

$$\frac{4000}{3} \text{ (Assume encoder for lead axis)} = 1333\ 1/3$$

The 1/3 is dropped

$$\frac{4000}{1333} = 3.0007502 = TURNS$$

This is the closest possible ratio based on an SR1 of 1333 and an encoder of 4000.

SYNC VELOCITY SCALE FACTOR AND SYNC VELOCITY DECIMAL POINT

These setups are provided for programming velocities which are used for synchronization. When using the sync feature, the motor's speed is a ratio of the lead axis speed. The default values are 1000 for sync scale factor with 3 as the decimal point. This produces a sync velocity of 1.000 for programming INDEX and HOME. What this means is, that when synchronization of follower axis and motor occurs (based on your sync ratio), you are at 1 to 1. These numbers can change to suit your application.

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BI-POLAR SYNC ENABLED

If this is answered with a yes (Y), the motor will follow the sync encoder at the programmed sync ratio if the bi-polar sync input is programmed and active.

INDEX, HOME

With a PCM-5, one additional question of TIME BASE (INT/EXT) can be answered.

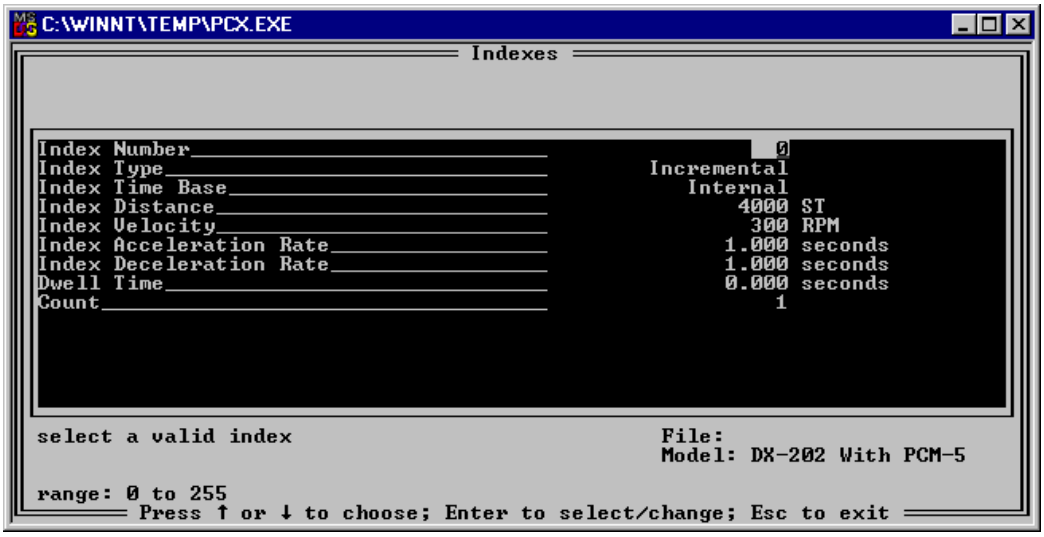


Figure 72 Index (PCM-5)

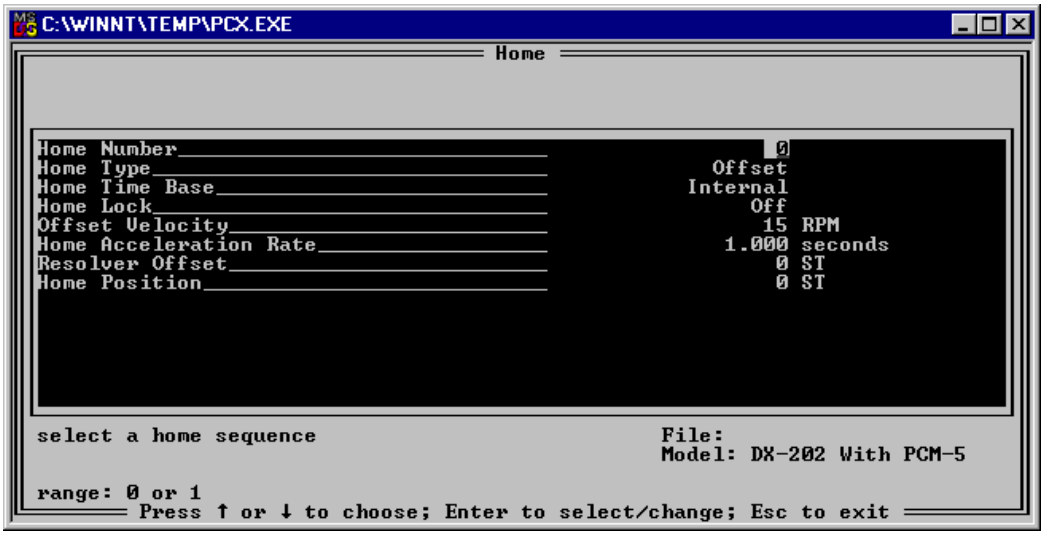


Figure 73 Home (PCM-5)

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The TIME BASE (EXT/INT) relates to the velocity scale factor and decimal point pre-determined by drive parameters and is for display and programming purposes. If the TIME BASE is external, meaning you want sync, then you would program based on the sync scale factor. This becomes a more useful item when using INDEXes and HOMEs in programs. The program screens will show the chosen scale factors based on INT or EXT.

PROGRAMS

Several added features are shown on the program screen.

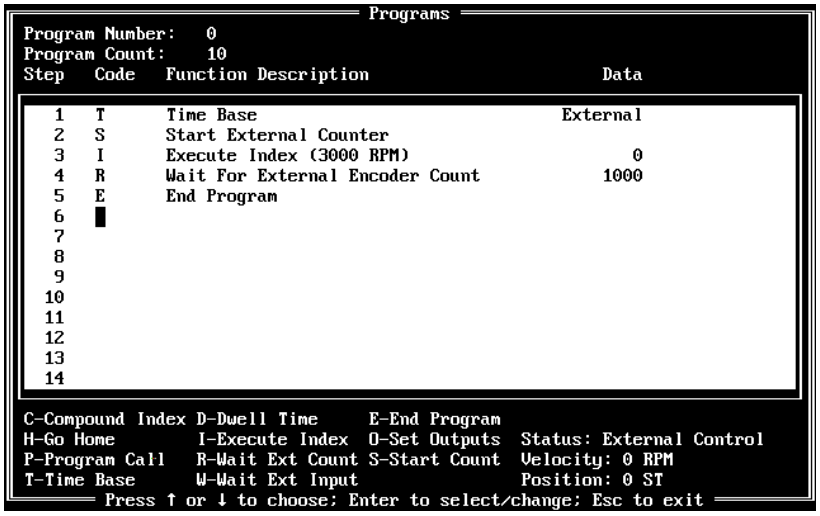


Figure 74 Program (PCM-5)

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Three new codes are added.

T – TIME BASE (TMBAS)

This code determines whether the TIME BASE is external (sync encoder) or internal (normal) for anything after it, including DWELLs and HOMEs. It is important to remember that if you want just one thing done in sync, that you restore the TIME BASE to internal.

Example:

TABLE XVII PCM-5 Function (TIME BASE)

STEP	CODE	FUNCTION	DATA
1	T	TIME BASE	EXT
2	I	INDEX (SCALE FACTOR)	XX
3	T	TIME BASE	INT
4	E	END	

The XX in the data field for the STEP 2 INDEX is to specify what index number. When programming this index, you would choose what scale factor you wanted for display purposes. This program sample would (regardless of scale factor) cause this index to be ratioed to the sync encoder by the sync ratio turns determined in drive parameters. This happens because of the TIME BASE = EXT for STEP 1. At the end of the index, you would immediately be returned to the internal TIME BASE (NORMAL) because of STEP 3 TIME BASE = INT.

S = START COUNTER (ST CT)
R = WAIT FOR COUNT (WTCNT)

For repetitive synchronization of indexes based on a fixed number of counts from the external encoder, these two codes are provided.

TABLE XVIII PCM-5 Function (S = START COUNTER) (ST CT)

STEP	CODE	FUNCTION	DATA
1	S	START COUNTER	EXT
2	T	TIME BASE	XX
3	I	INDEX (SCALE FACTOR)	INT
4	T	TIME BASE	YY
5	I	INDEX (SCALE FACTOR)	+/- (NUM)
6	R	WAIT FOR ENCODER COUNT	

This program example would start a counter, execute a synchronized index specified by XX, execute a normal index specified by YY, and wait for the programmed count. As soon as the count is satisfied, the program would repeat 10 times because of the program count of 10. The encoder count is based on the SCS-2 encoder producing 4000 counts per revolution. Plus/minus (+/-) are determined by the physical rotation of the SCS-2. Plus (+) is CW rotation of the encoder as viewed from the shaft end.

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SERIAL INTERFACE

The Positioning Drive includes extensive capability for providing two way communication with an external intelligent controller or computer via an RS423 serial interface port. Complete programming of the motion parameters, input/output functions, operating modes, indexes, and set up parameters can be accomplished through this port. Status and current position information is also available through this interface.

In addition to programming and editing, the serial interface may be used as the real-time control interface as an alternative to I/O. Due to transmission time, consideration must be given to system performance requirements prior to applying this method for real-time control.

The serial interface is RS423, RS232C and RS422 signal compatible. It has programmable baud rates from 110 to 19200 bps and can be connected using a simple three wire hook-up; transmitter, receiver and signal ground. Transmission is accomplished using standard, printable ASCII characters. This means that the Drive can communicate over the serial interface with a dumb terminal.

The connection to this serial interface is made through the 9-pin Canon D connector designated as SERIAL "A". All programming is done through this connector.

The basic drive also includes a second 9 pin, RS423 serial connector (designated as "SERIAL B") is used for a multi-drop networking scheme to other drives. This second connector cannot be used for programming other than in a multi-drop set up.

When using the multi-drop, the drive can automatically detect when there are other units "down the line" and redirect its serial signals to the appropriate drives. The serial commands are sent to the appropriate drives based on the axis identifier switch settings.

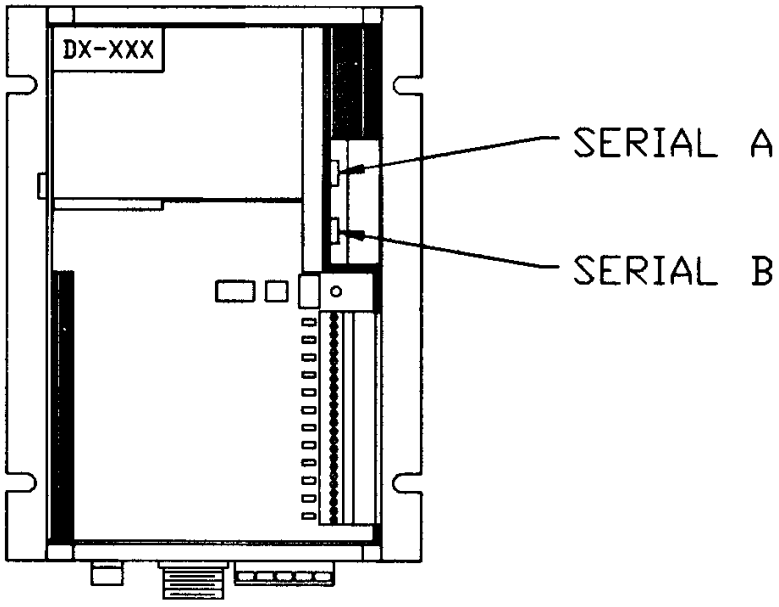


Figure 75 DX Serial Ports

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EXAMPLE OF A SERIAL MULTI-DROP CONNECTION

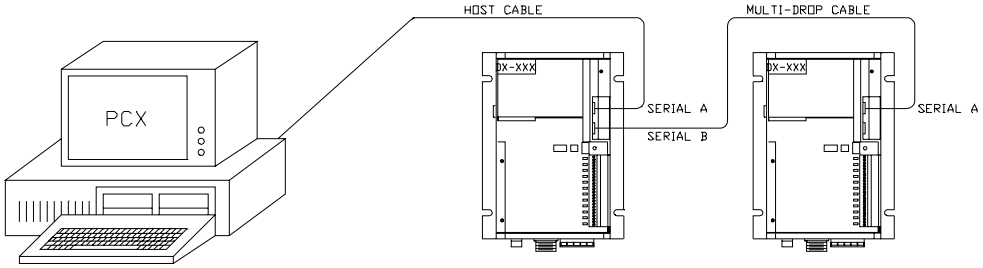
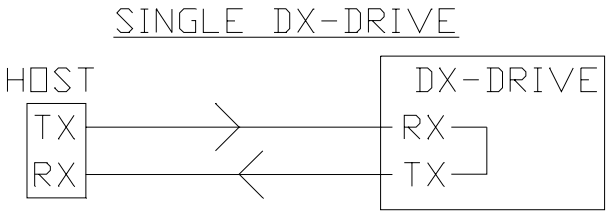


Figure 76 Multi-Drop Connection

SERIAL SIGNAL FLOW DIAGRAMS



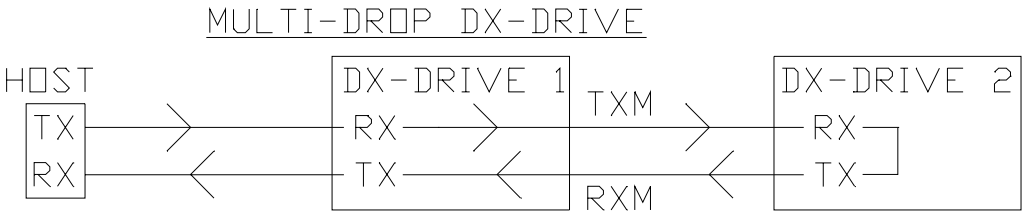


Figure 77 Serial Signal Flow Diagrams

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SETTING UP THE SERIAL INTERFACE SWITCHES AND PROTOCOL

The DIP switch numbers and their corresponding functions are shown on the following page and a description of each function will be given here.

LOCATIONS OF SWITCHES

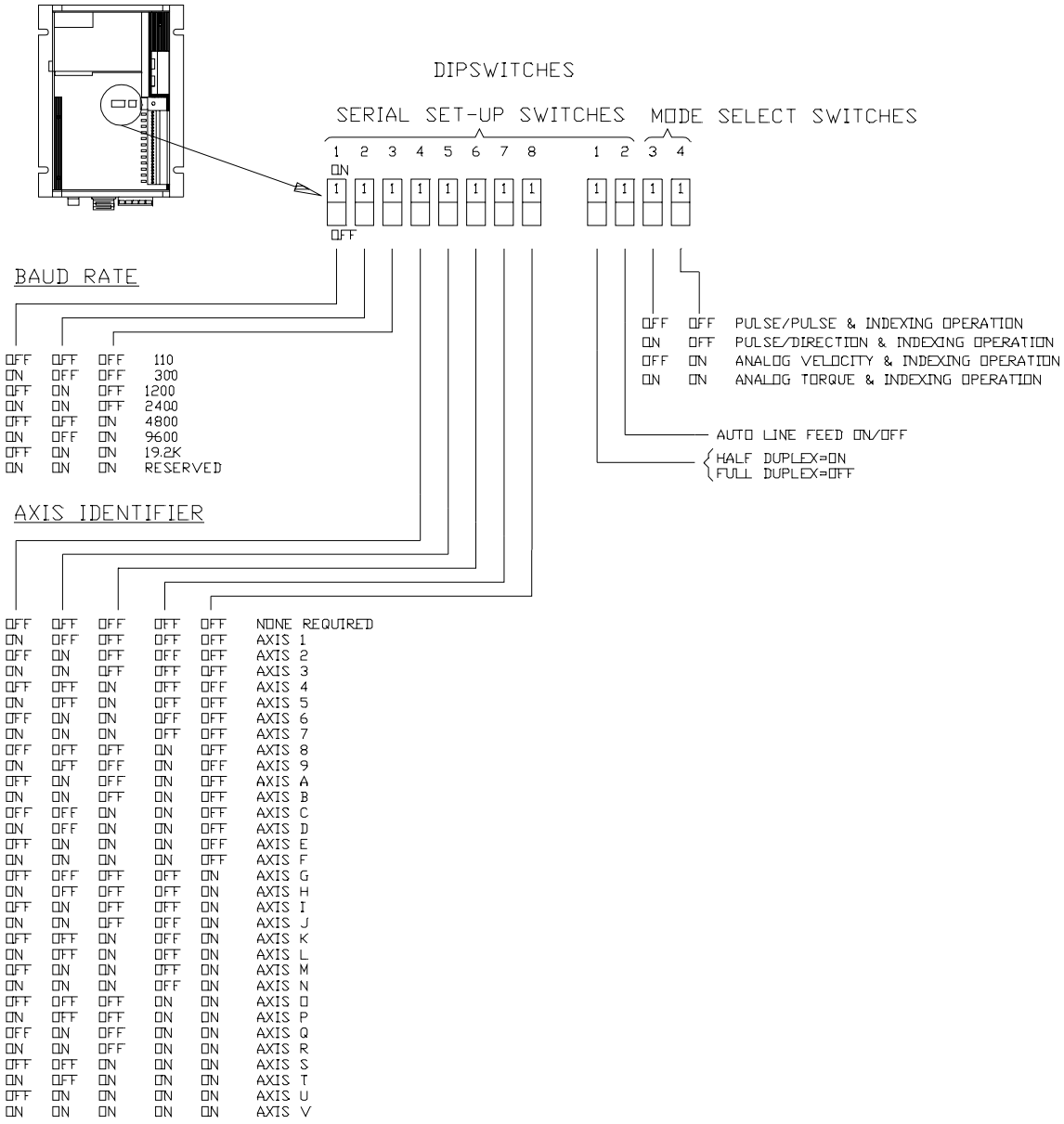


Figure 78 Dipswitches

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Baud Rate Switches

Switches 1, 2 and 3 of the eight position DIP switch are used to match the baud rate of the drive to the baud rate of the programming device. If the two baud rates are not the same, serial communication will not be possible.

Axis Identifier Switches

Switches 4, 5, 6, 7 and 8 are used to distinguish between drives in a multi-axis application. This allows each axis to be programmed individually over the same mutli-drop serial cable.

Duplex Switch

Switch 1 of the four position DIP switch sets either Half or Full Duplex Mode. In Half Duplex Mode the serial data is not echoed back to the programming device for conformation or display. In Full Duplex Mode the data is echoed back to the programming device, allowing the data to be verified. In most cases Full Duplex is the preferred mode of operation.

Auto Line Feed

Switch 2 is used to determine if a line feed character should be echoed back to the programming device when a carriage return is received. This will alter the line spacing on the programming monitor.

NOTE: Switches 3 and 4 have been discussed previously in the "Optional Operating Modes" section.

Framing Information

When using serial communication, the data must be sent as a string of continuous bits. This string of data bits must be "framed" by start and stop bits so that valid data can be recognized.

The framework which the drive will recognize is as follows:

1 start bit
8 data bits
1 stop bit

The high order data bit is ignored by the drive. A parity bit may therefore be sent to the drive along with only seven data bits. When transmitting, the drive will always send a zero for the eighth data bit.

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SERIAL CABLES

The below listed cables are standard cables available from EMC. Also shown below and on the following page are the wiring diagrams should you prefer to make your own cables.

MODEL	DESCRIPTION
TD-25	T-21 TO DRIVE SERIAL CABLE, 25 FEET LONG
TIX-25	T-21 OR DRIVE TO IBM XT SERIAL CABLE, 25 FEET LONG. IBM END CONNECTOR IS FEMALE 25 PIN DB.
TIA-25	T-21 OR DRIVE TO IBM AT SERIAL CABLE, 25 FEET LONG. IBM END CONNECTOR IS FEMALE 9 PIN DB.
DD-6	DRIVE TO DRIVE SERIAL CABLE 6 FEED LONG (MULTI-DROP CABLE)

Wiring Diagrams From Computer to Drive

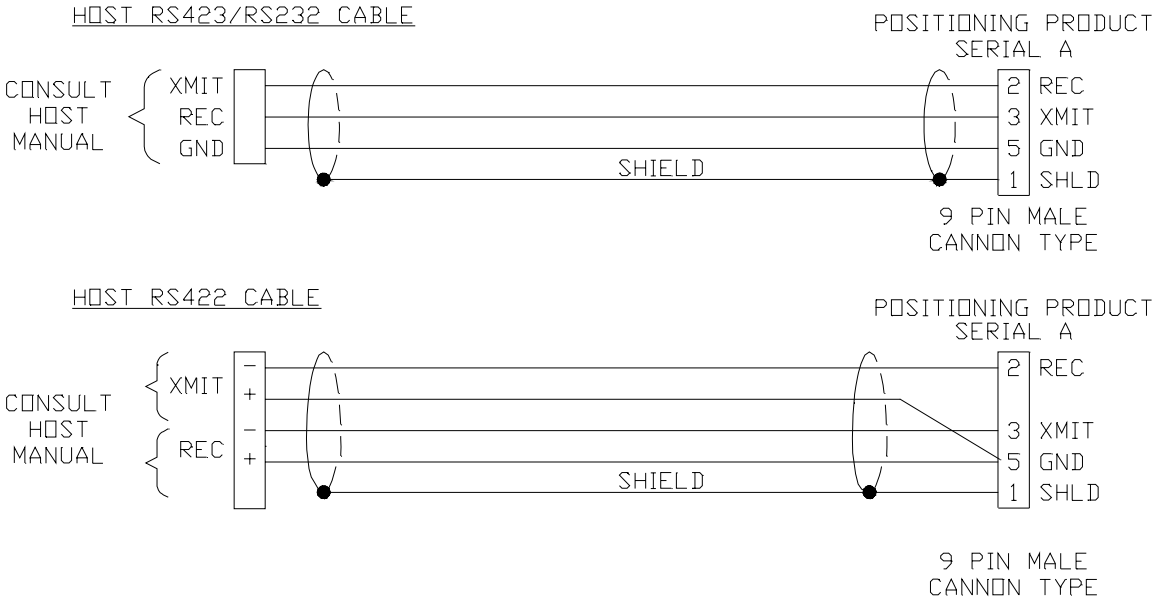


Figure 79 Serial Cable Wiring Diagrams

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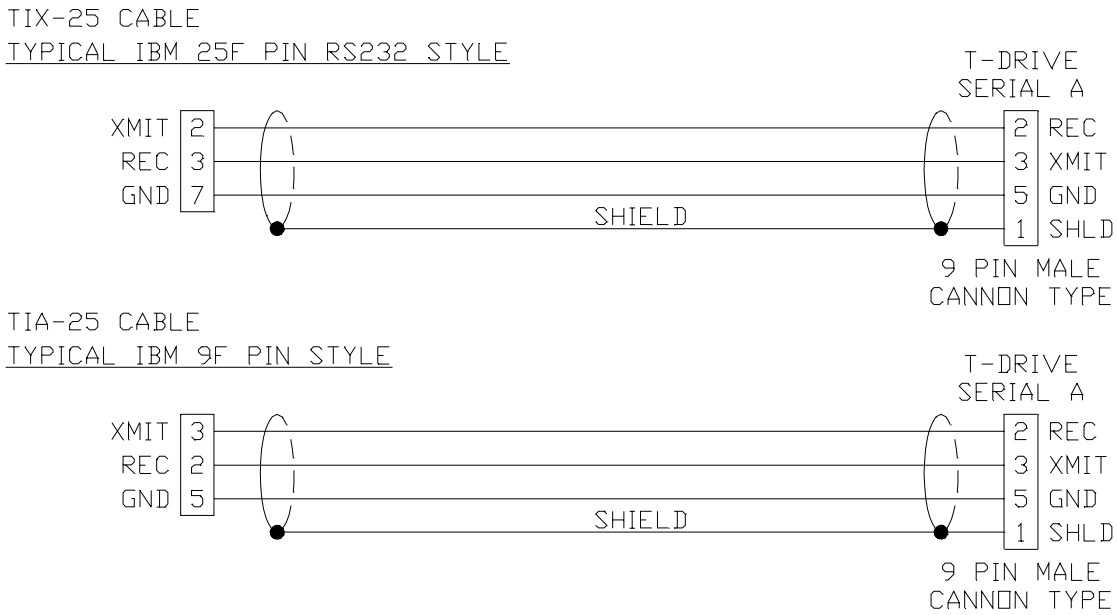


Figure 80 Wiring Diagrams – TIX-25 Cable

Wiring Diagram for DD-XXX Multi-Drop Cable

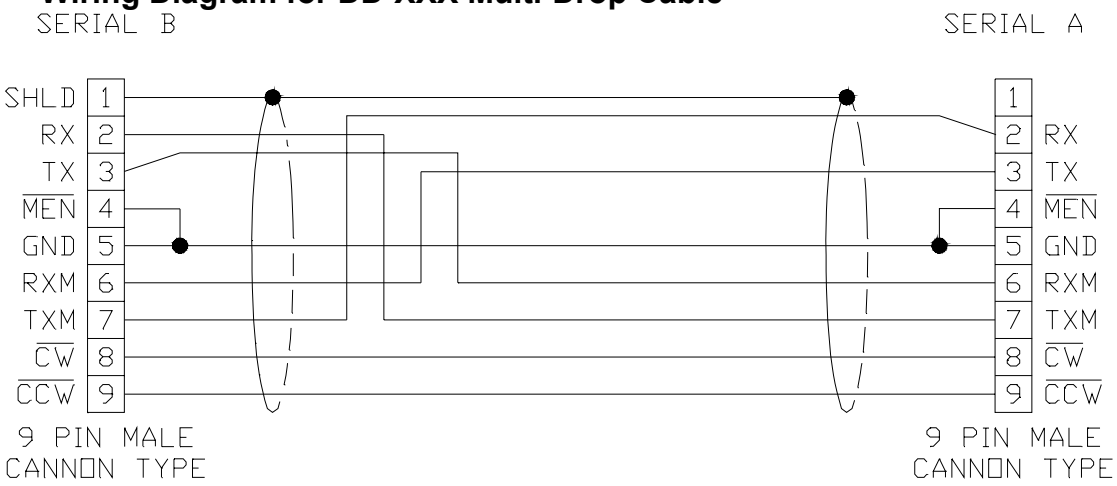


Figure 81 Wiring Diagram – Multi-Drop Cable

NOTE: The cable may be plugged in either direction and it will function properly.

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SERIAL INTERFACE CONTROL

Most major programmable logic controllers (PLCs) are available with user programmable Basic or ASCII communications modules allowing the user to easily program and transmit serial commands or programming data to other serial devices. The positioning Drive's RS423 serial interface provides a direct connection to these PLC modules for programming and control. In addition, the capability of this serial interface to be multi-dropped to as many as 31 axes of drives, plus the use of the optically isolated inputs and outputs on each drive, provides an easy method to accomplish multiple axis positioning control.

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ASCII COMMANDS

Overview

All programming done without PCX software must use the provided ASCII serial commands. There are presently three types of serial commands: Execution, set up, and query. Some commands may be only one type and others may be all three types.

In general, an execution command is one that requires the drive to take action. This may be in the form of starting motion, stopping motion, or changing status (example: Changing velocity). Execution commands should only be used after all motion functions have been programmed through the set up commands.

Set up commands are used to program motion functions such as indexes, home cycle and job parameters. These commands provide the means to change velocities, accel/decel rates, and distances. Set up commands are also used for I/O assignment, initilization and run time control.

Query commands are used to ask for information from the drive. The drive will respond with the value, mode type, or status that has been programmed into memory. Query commands are useful during both set up and execution.

All three types of serial commands must follow a format that can be recognized by the drive. The format used for all serial commands is given below. If a command is not recognized or cannot be carried out, the drive will respond with a "?" as an error indication.

	{"?" }
[ID] COMMAND [MODIFIER]	{"=" (INFO)} CR [LF]
	{(NULL) }
ID – AXIS IDENTIFIER	An axis identifier is only needed when more than one drive is on the serial line, otherwise the axis identifier should not be transmitted in the command string. If axis identifiers are being used, an axis identifier of "0" in the transmitted command string will address all axes.
COMMAND	All serial commands consist of two ASCII characters.
MODIFIER	Some serial commands require a number modifier to identify the particular parameter being addressed with the command.

"?" Indicates a Query command. The axis will send a response in the format used for the setup command.

"=" Indicates a Setup command. The axis will respond with a "*".

(NULL) If either a "?" or "=" is present the command is assumed to be an execution command that requires some action.

CR All commands are terminated with a carriage return.

LF An optional line feed may be sent with the command. The line feed will always be sent after the CR if auto line feed is set on the DIP switches.

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Program Commands

COMMAND	TYPE OF COMMAND	DESCRIPTION

PRXX EXECUTION ONLY PROGRAM EXECUTION (PCM only)

Starts execution of Program XX. If no program number is included in the command, Program 0 will execute.

PR SET UP/QUERY NO SELECT LINE PROGRAM # (PCM only)

Sets the default program number that will be executed when an initiate input is received if no program select lines are assigned. The default is program number 0.

NP SET UP/QUERY NUMBER OF PROGRAMS (PCM only)

Sets the number of programs available for PCM modules. The default is 64 and the maximum is 256. Reducing the number of programs available will increase the number of steps available for each program. If the number is changed, all program information will be initialized (empty programs). If the setup command does not change the current value of NP is will have no affect.

SP EXECUTION/SET UP/QUERY SUSPEND/RESUME (PCM only)

As an execution command will toggle the current suspend/resume state of a program. If a program is running and a suspend state is not active, the program will enter the suspend state. If the suspend state is active, the original program that was suspended will be resumed.

CL EXECUTION ONLY CLEAR SUSPEND (PCM only)

Clears a suspend cycle in the same manner as a clear suspend input.

SG SET UP/QUERY SUSPEND FLAGS (PCM only)

Sets various flags used for suspend/resume (hexadecimal).

bit 0 – set for auto program execution on suspend
1 – set for auto resume
2 – set for auto return (exec retn to position index) on resume
3 – set for auto clear after suspend/auto program

Example: SG=7 will set bits 0, 1, and 2 causing auto program execution, auto return to position, and auto resume to all occur upon receipt of a suspend input.

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Index Commands

All index commands may include a modifier indicating the particular index to which the command is directed. If no modifier is present in the command an index number of zero will be assumed. For example, the commands "DS=1000" and "DS0=1000" would both set the distance information of index zero to 1000, while the command "IN5" would execute index five. The modifier will be left out in the following index command summary for the sake of clarity and all commands will be discussed as if they were addressed to index zero.

COMMAND	TYPE OF COMMAND	DESCRIPTION
IN	EXECUTION ONLY	EXECUTE SELECTED INDEX

Starts index execution. The specified index will run with the programmed parameters for the number of times set in the index count parameter.

IN	SET UP/QUERY	NO SELECT LINE INDEX #

Set the default index number that will be executed when an initiate input is received if no index select lines are assigned. The default is index number 0.

IT	SET UP/QUERY	INDEX TYPE

Selects the type of index from the following list:

0 – Incremental Distance Index
1 – Linear Absolute Position Index
2 – Feed Sensor Index
3 – Registration Index
4 – Rotary Absolute Position Shortest Path Index
5 – Rotary Absolute Position (forced direction CW)
6 – Rotary Absolute Position (forced direction CCW)

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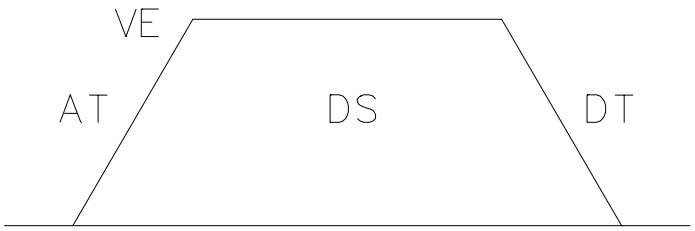


Figure 82 (0) Incremental Distance Index

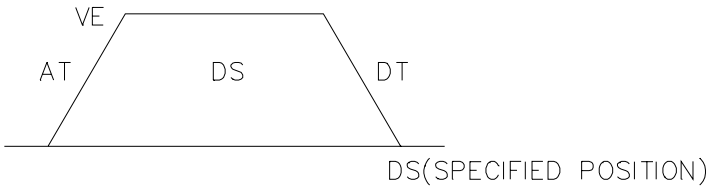


Figure 83 (1) Linear Absolute Position Index

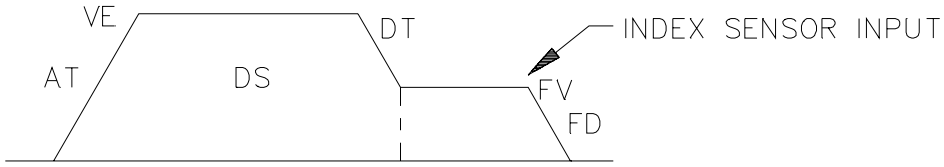


Figure 84 (2) Feed To Sensor Index

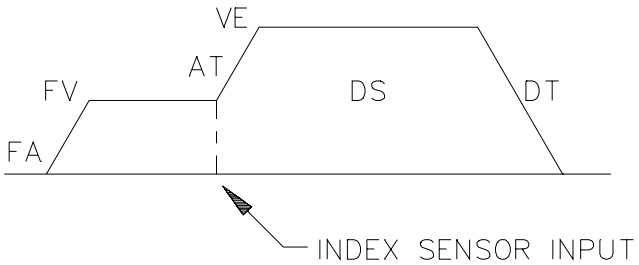


Figure 85 (3) Registration Index

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COMMAND	TYPE OF COMMAND	DESCRIPTION

DS SET UP/QUERY INDEX DISTANCE/POSITION

Sets the index distance and direction for incremental index or the index position for absolute type indexes. "DS" is a signed quantity in user units.

VE SET UP/QUERY INDEX VELOCITY

Sets the maximum allowable velocity for the index. "VE" is an unsigned quantity in rpm (see "VU" command), since polarity for the index is set with the "DS" command.

AT/DT SET UP/QUERY INDEX ACCEL/DECEL RAMP

Sets the acceleration/deceleration ramp slopes for the index. Ramp slopes are programmed in milliseconds to the maximum system velocity. Note that the slopes are independent of index velocity. "VE" may be changed without affecting the index ramp slopes. All drives have a maximum system velocity of 3000 rpm and unless this is reprogrammed by the user, all acceleration and deceleration rates will be calculated from zero to 3000 rpm.

Example:

The user would like to reach an index velocity of 1500 rpm in 0.5 seconds. Since the acceleration rate is based on the maximum system velocity of 3000 rpm, the following ratio can be set up to find the desired acceleration time (AT).

$$\frac{\text{Desired Index Velocity}}{\text{Desired Time for Acceleration}} = \frac{\text{Maximum System Velocity}}{\text{Acceleration Time to be Programmed}}$$

ie: $\frac{1500 \text{ rpm}}{0.5 \text{ sec}} = \frac{3000}{AT}$

gives: $AT = \frac{3000\ (0.5)}{1500} = 1 \text{ sec}$

NOTE: Acceleration and deceleration times are limited by load inertia, friction and system torque. This must be remembered when accelerating and decelerating large loads.

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COMMAND	TYPE OF COMMAND	DESCRIPTION

DW SET UP/QUERY INDEX DWELL

Sets the dwell time for the index in milliseconds. When index motion is completed and the index is in position, the unit will wait the specified amount of time before continuing.

FV SET UP/QUERY INDEX FEED SENSOR VELOCITY

The "FV" command is used to set up the index feed sensor velocity and is only needed for the sensor type indexes (types 2 and 3). Feed velocity is a signed quantity which specifies both velocity (in rpm) and direction.

FA/FD SET UP/QUERY INDEX FEED SENSOR ACCEL/DECEL RAMPS

Sets the feed sensor acceleration/deceleration ramp slopes for sensor type indexes. This information is programmed in milliseconds to maximum velocity and is only needed for index types 2 and 3.

CO SET UP/QUERY INDEX COUNT

Sets the index count. When initiated, the index will execute the number of times set for this parameter. If the index count is set to zero, the index will not be initiated. If the index count is set to 65535, the index will repeat indefinitely.

NI SET UP/QUERY NUMBER OF INDEXES (PCM only)

Sets the number of indexes available. For basic drives, the number of indexes is fixed at 32 and cannot be changed. For PCM modules, the default is the maximum of 256 indexes. Reducing the number of indexes will increase the program space available. If the number is changed, all index and program information will be initialized to default values. If the setup command does not change the current value of NI it will have no affect.

RI SET UP/QUERY RETURN TO POSITION INDEX #

Sets the index number to be used as the return to position index. The default is index 0. If the return to position feature of the controller is being used, either directly through the return to position input or indirectly within the suspend/resume sequence, it is up to the user to set up the index with all necessary parameters other than position. This index will normally be set up as an absolute index. The distance/position field of this index will be automatically changed upon receipt of a remember position input or upon receipt of a suspend input.

LD SET UP/QUERY SENSOR LIMIT DISTANCE

Sets the sensor limit distance (unsigned) to be used for all sensor type indexes.

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OM SET UP/QUERY PROGRAMMABLE OUTPUT MASK

Sets the pattern mask which determines which programmable outputs will be updated (affected) at the completion of the index. (Note that in order for the update to actually take place, the proper number of programmable output lines must have been set up with the SL command and the programmable output function must be assigned to the starting line number with the OF command.) The mask is set with a hexadecimal bit pattern of up to eight bits. Also see "SC" and "OF" commands.

Example: OM21-OF will cause the low four programmable outputs (if assigned) to be updated at the end of index 21. If more than four programmable output lines are being used, only the low order four lines will be affected and the others will not be changed.

OP SET UP/QUERY PROGRAMMABLE OUTPUT PATTERN

Sets the output pattern to be set on the programmable output lines that have been selected to be updated by the index. Using the above example, OP21=03 will cause the low order two programmable output lines to be turned on and the high order two lines to be turned off. The pattern is a hexadecimal number.

OT SET UP/QUERY PROGRAMMABLE OUTPUT PULSE WIDTH

Sets the pulse width of active programmable outputs which are put out by the index. The pulse width is in milliseconds. A pulse width of 0 (the default) indicates that the pattern has infinite pulse width. In this case any outputs turned on will remain on until changed by another output pattern or until a programmable output reset is received for the line. The number programmed should be between 0 and 65535.

OD SET UP/QUERY PROGRAMMABLE OUTPUT DELAY

Sets the time delay (in milliseconds) from the end of index for the programmable output pattern update to take place. The number should be between –32768 and +32767 with 0 (the default) indicating an update at the completion of the index. A negative delay indicates that the update should be made before the end of index. If a negative delay is longer than the decel ramp of the index, the update will take place at the beginning of the decel ramp.

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Home Commands

COMMAND	TYPE OF COMMAND	DESCRIPTION
HM	EXECUTION ONLY	EXECUTE HOME CYCLE

Starts execution of the Home cycle.

HT	SET UP/QUERY	HOME TYPE

Selects the type of Home cycle from the following list:

0 – Home to resolver offset
1 – Home to sensor
2 – Home to sensor then resolver offset
3 – Home to sensor then off sensor
4 – Home to sensor then off sensor then resolver offset
5 – Home to sensor then off sensor then on sensor

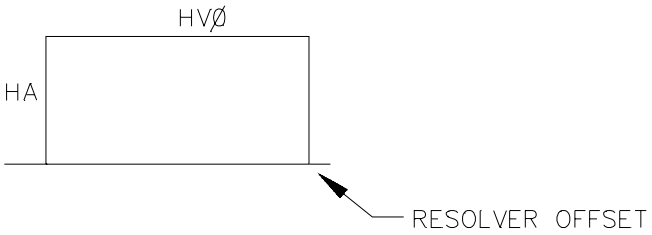


Figure 86 (0) – Home to Resolver Offset

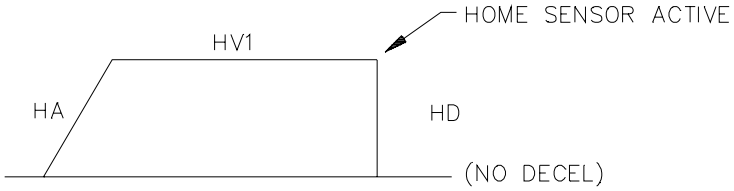


Figure 87 (1) – Home to Sensor

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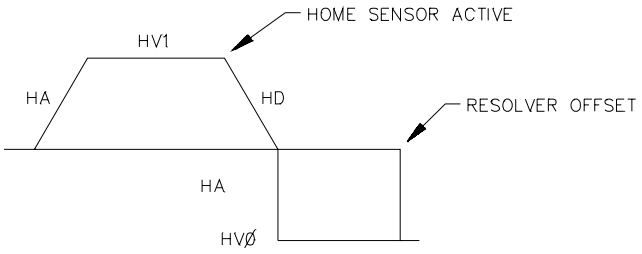


Figure 88 (2) – Home to Sensor then Resolver Offset\

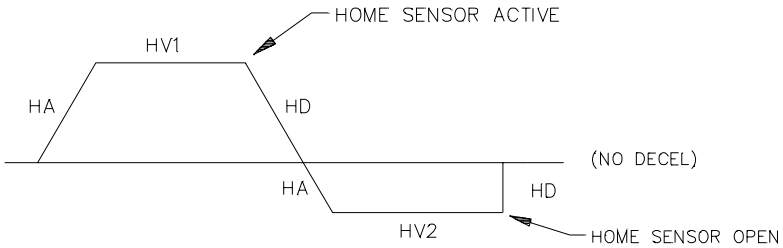


Figure 89 (3) – Home to Sensor then Off Sensor

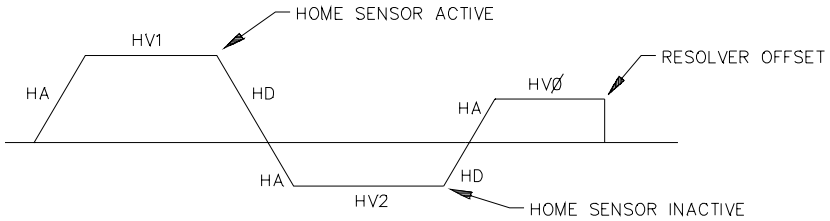


Figure 90 (4) – Home to Sensor then off Sensor then Resolver Offset

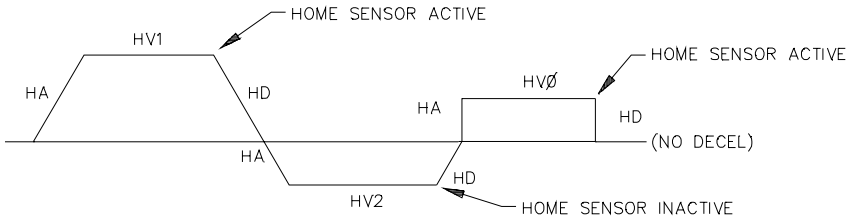


Figure 91 (5) – Home to Sensor then Off Sensor then 0n Sensor

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HR/HI/HO SET UP/QUERY HOME VELOCITIES

Sets the velocity to be used for a segment of the Home cycle in user velocity units. Select the desired segment velocity based on the following:

HR – mark velocity
HI – feed on sensor velocity
HO – feed off sensor velocity

These are signed quantities specifying both velocity and direction for the particular Home segment.

HA/HD SET UP/QUERY HOME ACCEL/DECEL RAMPS

Sets the acceleration/deceleration ramp slopes to be used during the Home cycle in milliseconds to maximum velocity. Note that no deceleration is used at the end of the Home cycle, therefore the final Home segment velocity should be set low enough for the application requirements. No acceleration ramp is used during resolver offset cycle, so the resolver offset results should also be kept minimal.

HP SET UP/QUERY ABSOLUTE POSITION AFTER HOME

Sets the Home reference position in user units. At the conclusion of the Home cycle this will be the absolute position of system. Any index moves to an absolute position (index types 1, 4 and 5) will be referenced from this position. Any software travel limits are also referenced from this position. HP is a signed quantity.

RO SET UP/QUERY RESOLVER OFFSET

Sets the resolver offset in user units from the resolver zero position. RO is an unsigned quantity and must be less than the number of user units of distance per revolution. (See the SR command.) Since the resolver zero position is dependent on the mounted position of the resolver on the motor shaft, the "RO" command lets the user adjust the mark position within one revolution without having to make physical adjustments. This offset is used only during Home cycles that move to the resolver mark (types 0, 2, 4).

HL SET UP/QUERY HOME LOCK

Selects whether the power up Home Lock feature of the drive is enabled (HL=1) or disabled (HL=0). When enabled, no motion other than Home execution will be allowed until a Home cycle has been successfully completed. Since software travel limits are not enabled until the completion of a Home cycle, the Home Lock feature is a method that ensures the enabling of the software travel limits before allowing other motion commands.

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Jog Commands

COMMAND	TYPE OF COMMAND	DESCRIPTION

JG EXECUTION/SET UP/QUERY JOG

When used as an execution command, "JG" will start Job motion at the current serial Jog velocity.

As a setup command, "JG" sets the current serial Jog velocity. If the drive is already executing a serial Jog when a new serial Jog velocity is issued, the drive will ramp to the new velocity. Serial Jog velocity is a signed quantity in rpm.

JF/JS EXECUTION/SET UP/QUERY JOG FAST/SLOW

When used as an execution command, "JF" and "JS" will start Jog motion at the current fast Jog or slow Jog velocity respectively. The direction for the Jog may be specified by adding a "+" (clockwise) or "-" (counterclockwise) after the command. If no direction is specified, clockwise motion will be assumed.

As setup commands "JF" sets the fast Jog velocity and "JS" set the slow Jog velocity in unsigned rpm. If the velocity is changed while executing the appropriate Jog, the drive will ramp to the new velocity.

JA/JD SET UP/QUERY JOG ACCEL/DECEL RAMPS

Sets the acceleration/deceleration ramp slopes to be used for Jog motion. The ramps are programmed in milliseconds to maximum system velocity.

SJ EXECUTION ONLY JOG STOP

Stops Jog motion along with Jog decel ramp slope. This command is an alternative to the "ST" command which is usually programmed with a faster deceleration slope.

JL SET UP/QUERY POWER UP JOG LOCK

Selects whether the power up Jog Lock feature of the drive is enabled (JL=1) or disabled (JL=0). When enabled, jogging will not be allowed after power up until a home cycle has been successfully completed.

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COMMAND	TYPE OF COMMAND	DESCRIPTION
TD/SD	SET UP/QUERY	TRAVEL LIMIT/STOP ACCEL RAMPS

"TD" sets the decel ramp slope for faults and travel limits. "SD" sets the decel ramp slope to be used to stop. Both ramps are programmed in milliseconds from maximum system velocity.

TL	SET UP/QUERY	PROGRAMMABLE TRAVEL LIMITS

Sets the software travel limits. A modifier of 0 (TL0=…) sets the minimum (CCW) allowable absolute position and a modifier of 1 (TL1=…) sets the maximum (CW) allowable absolute position. Limits are set in signed user units and are referenced from the Home position. Software travel limits are not active until a Home cycle has been completed.

PL	SET UP/QUERY	PROGRAMMABLE INDEX POSITION/DISTANCE LIMITS

Sets the limits for index distances or positions in the same manner as the "TL" command. Any attempt to program an index distance or position that is outside the specified range will generate an error.

VL	SET UP/QUERY	PROGRAMMABLE VELOCITY LIMITS

Sets the maximum allowable velocity which may be programmed in unsigned user velocity units. Any attempt to program a velocity of greater magnitude than this velocity limit will generate an error.

AL/DL	SET UP/QUERY	PROGRAMMABLE ACCEL/DECEL RAMP LIMITS

Sets the minimum (fastest) allowable acceleration/deceleration slope which may be programmed in milliseconds to maximum system velocity. Any attempt to program a faster accel/decel slope will generate an error.

SR & SR1	SET UP/QUERY	STEPS/USER REV

SR sets the number of user steps per user turn. SR1 sets the number of external steps per user turn (PCM only) used to determine the external/internal ratio for synchronization. The default setting for both values is 4000. The number programmed should be between 200 and 30000.

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TR SET UP/QUERY TURNS/USER REV

Sets the number of motor turns per user revolution. The default setting of 1 indicates that 1 motor turn is 1 user turn. An SR value of 4000 would then mean that there are 4000 user steps per motor revolution. In rate instances it may be desirable to program other than a 1:1 motor turn/user turn ratio. If, for instance, due to gear box ratioing three motor turns was equal to 10 inches, the user could program TR=3 and SR=10000 allowing for programming in .001 inch increments with no cumulative error. Without the TR parameter the user would be forced to set SR=3333 but would have cumulative error of .001 inch every three motor turns. For the most part, this parameter can be ignored and the SR parameter may then be thought of as steps per motor revolution.

IMX EXECUTION ONLY INITIALIZE MEMORY PARAMETERS

Initializes various system/memory parameters.

X = 0 – initialize entire system
1 – initialize PCM information only
2 – initialize I/O information only
3 – initialize index information only
4 – initialize program arrays only
5 – initialize gain information only
6 – initialize limit information only

PF SET UP/QUERY POWER UP FLAGS

Sets a bit flag pattern used on power up. (Default = 0) (HEX)

bit 0 – set to 1 to power up under serial control
1 – set to 0 for mode to be follow dip switches
set to 1 for mode to be set to EM2 parameter on power up
and for mode to be controlled through serial
2 – set to ∅ for PCM-5 or PCM-6 pulses to come from an external encoder
set to ∅ for pulses to come from a master axis

example: PF=01 will cause future power ONs to immediately force the serial control mode of operation.

PY SET UP/QUERY ACTUATOR POLARITY

Sets the directional polarity of the system. PY=0 (default) causes CW rotation of the actuator for positive motion. PY=1 causes CCW rotation of the actuator for positive motion.

RPX SET UP/QUERY ROTARY POSITION LIMITS

Sets the rotary absolute position limits of the system. When absolute position passes the positive limit (RP1) it will roll over to the negative limit (RPO). Similarly, when the negative limit is passed, absolute position will roll over to the positive limit. The default settings are RPO= -2147483648 and RP1= +2147483647 which is the largest absolute position range that the system

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can maintain. In linear environments these limits will normally not need to be changed. In rotary applications, however, it may be convenient to keep absolute position within small bounds (eg. 0 to 359.99 or –179.99 to 180.00). These limits are used for rotary shortest path index types to determine shortest path.

EMX SET UP/QUERY OPERATING MODE

0 – Sets/queries the current mode. (Note the setup command will not be accepted if mode is set from dip switches.)
1 – Sets the mode to be entered when the alternate mode input is active (example EM1=4)
2 – Sets the power up mode (if not from dip switches). (See PF command.)

Valid modes are:

0 – pulse/pulse
1 – pulse/dir
2 – analog velocity
3 – analog torque
4 – encoder following (ratio)
5 – analog velocity, encoder time base

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COMMAND	TYPE OF COMMAND	DESCRIPTION

ST EXECUTION ONLY STOP

Causes the drive to stop motion. The drive will decel along the programmed stop decel ramp (SD). Another motion initiate command must be issued to restart motion.

QU QUERY ONLY CURRENT STATUS OF THE T-DRIVE

Causes a single ASCII letter to be returned indicating the current status of the drive according to the following list:

S – Drive is in serial control and ready for a command
E – Drive is in external Operating Mode
P – Drive is Profiling (indexing)
H – Drive is in a Home cycle
J – Drive is Jogging
F – Drive is faulted
L – Power up Home Lock is active
C – Drive is in Calibrate Mode

FE QUERY ONLY FOLLOWING ERROR

Returns the current following error of the drive in signed user units. Following error is equal to (command position minus feedback position).

CV QUERY ONLY CURRENT VELOCITY

Return the current velocity of the drive in signed user velocity units.

CI QUERY ONLY CURRENT INDEX

Returns the number of the index that is currently executing.

CD QUERY ONLY CURRENT DWELL

Returns the dwell time in milliseconds that is left to count down.

FS QUERY ONLY FAULT STATUS

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Returns a hexadecimal number (FS-XX) with the current fault status of the drive. If the number is not zero the active bit position indicates a fault according to the following list.

Bit
0 Watchdog time out failure
1 Power up memory fault
2 Hardware fault on dirve
3 Position error fault
4 CW travel limit
5 CCW travel limit
6 (unused)
7 (unused)

CP QUERY ONLY COMMANDED POSITION

Returns the current command position of the drive in signed user units.

FP QUERY ONLY FEED BACK POSITION

Returns the current feedback position of the drive in signed user units.

CC QUERY ONLY CURRENT COUNT

Returns the count of the number of indexes that are left to execute.

AF SET UP/QUERY AUTO FAULT REPORTING

Enables (AF=1) or disables (AF=0) the automatic fault reporting feature of the drive. If enabled the drive will issue the single character "F" when any fault condition occurs.

AP SET UP/QUERY AUTO END OF INDEX COUNT REPORTING

Enables (AP=1) or disables (AP=0) the automatic end of index count feature of the drive. If enabled, the drive will issue the single character "P" when an index has completely finished (all counts are complete). This may be used as an indication that the drive is ready for another execution command.

FH QUERY ONLY HARDWARE FAULT STATUS

When a hardware fault has taken place, the FH command may be used to determine the type of fault. The number returned will match the hardware fault number that will be shown on the 7-segment display (other than 0).

0 – no fualt
1 – rms
2 – shorts
3 – resolver
4 – supply
5 – motor temp
6 – fuse or low AC line voltage
7 – bridge temp

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ZA EXECUTION ONLY ZERO ABSOLUTE POSITION

Zeroes the current absolute position. This command has the same affect as if a home command has completed (without moving) with the home position set at

0.ZR EXECUTION ONLY ZERO RELATIVE POSITION

Zeroes the relative position causing position/distance information returned through CP and FP commands to be referenced from this point without affecting the actual absolute position of the system. Any absolute moves executed will still be referenced from the last home position.

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Miscellaneous Commands

COMMAND	TYPE OF COMMAND	DESCRIPTION
SC	SET UP/QUERY	SERIAL CONTROL

This command puts the drive into (SC=1) or takes the drive out of (SC=0) the Serial Control Mode of operation. No motion execution commands will be accepted until the drive is in the Serial Control Mode, although set up and query command may be issued at any time.

BK	SET UP/QUERY	ACTIVATE BRAKE

Enables (BK=1) or disables (BK=0) the brake override if the motor is so equipped.

RS	EXECUTION ONLY	RESET DRIVE

Resets the drive after any drive fault. This command has the same effect as using the push-button reset.

LR	SET UP/QUERY	LINEAR RAMPS

Selects the linear (LR=1) or nonlinear (LR=0) method of ramping. The nonlinear method uses a haversine ramp function when changing velocity. This results in slightly smoother ramp endings, but requires more current during the middle stages of acceleration/deceleration.

CKX	QUERY ONLY	CHECKSUMS

Returns a hexadecimal checksum of the desired area of system memory:

0 – prom
1 – all non-volatile memory parameters (T-drive/PCM if present)
2 – PCM nvm only
3 – index/home info only
4 – program info only

The prom checksum returned should always be the same. The other checksums may change as information is programmed.

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I/O Commands

COMMAND	TYPE OF COMMAND	DESCRIPTION
IF/OF	SET UP/QUERY	INPUT/OUTPUT FUNCTION LINE NUMBERS

If PCX software is not being used, the I/O lines can still be assigned through direct serial commands. These commands are sent to the drive by any ASCII serial device via the serial A connector. The serial commands for I/O assignment are given below:

IFXX=L, where "XX" is the input function number (0-26)
where "L" is the input line number (1-8)

OFYY=L, where "YY" is the output function number (0-11)
Where "L" is the input line number (9-12)

IFXX=0, will unassign input function "XX"

OFYY=0, will unassign output function "YY"

To set input function polarity use the following commands.

IPXX=0, normally OFF default, where "XX" = input function number

IPXX=1, normally ON default, where "XX" = input function number

For example, to assign a Stop function to input line number 4. Using the ASCII serial device, type:

IF11=4, where 11 = Stop function and 4 = input line 4.

The following notes are important to remember while the I/O lines are being assigned.

1. If the clear index/clear home outputs are not assigned the outputs will clear on the next commanded motion.
2. If the clear to initiate input is not assigned the only safeguard on re-initiation of short indexes is that the initiate must go off before another one will be accepted.
3. More than one input may be assigned to the same line such as Jog CW/Slow, or Clear Index Output/Clear Home Output.
4. The clear fault input duplicates the function of the pushbutton.

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COMMAND	TYPE OF COMMAND	DESCRIPTION

IP SET UP/QUERY INPUT FUNCTION POLARITY

This command selects the active polarity for input functions. The format is

IPXX = 0 {normally off}
IPXX = 1 {normally on}

where XX is the input function number.

SLX SET UP/QUERY SELECT LINES

Sets the number of lines to be used for multi-line I/O functions:

0 – index select lines
1 – program select lines
2 – programmable output lines
3 – programmable output reset lines

The number of lines should be between 0 and 8.

The following table shows how many select lines should be set:

Table XIX Set Up Select Lines

MAX TO SELECT	NUMBER OF SELECT LINES NEEDED
1	0 (use index 0)
2	1
3-4	2
5-8	3
9-16	4
17-32	5

DD SET UP/QUERY MINIMUM INPUT SIGNAL WIDTH

This command sets the minimum pulse width of an input signal that will be recognized as valid. The format is:

DDXX = PW where XX = input line number
where PW = pulse width in two millisecond increments

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IOX SET UP/QUERY HARDWARE INPUT/OUTPUT

This command allows direct access to system I/O functions. All information is in hexadecimal.

X	QUERY	SET UP
0	Debounced user inputs	User inputs*
1	Actual user input status	Actual user outputs*
2	24-bit I/O port (low 8 bits)	24-bit I/O port (low 8 bits)***
3	24-bit I/O port (mid 8 bits)	24 bit I/O port (mid 8 bits)***
4	24-bit I/O port (high 8 bits)	24 bit I/O port (high 8 bits)***
5	Dip switch status (16 bits)	
6	Resolver (16 bit)	
7	External encoder (16 bits)	

* Any outputs set should be unassigned from any output function.
** User I/O must be killed (KI=1), used for factory testing only.
*** Parallel port must be killed (KI1-1), used for testing only.

KI SET UP/QUERY KILL INPUT/OUTPUT

This command kills (inhibits) access to user I/O from the system to do direct user I/O. This is normally only done for testing.

(Outputs should be set to zero before re-enabling.)

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SUMMARY OF SERIAL COMMANDS

E – EXECUTION COMMAND
Q – QUERY COMMAND (XX?)
S – SET UP COMMAND (XX=)

NOTE: IF AXIS I.D. IS NOT ZERO THEN ALL COMMANDS MUST BE PRECEDED WITH AN AXIS IDENTIFIER (WHICH MAY BE 0 TO ADDRESS ALL DRIVES IN CHAIN). IF AXIS I.D. IS ZERO THEN NO AXIS IDENTIFIER MAY BE USED (SINGLE AXIS).

CMD	EQS	DESCRIPTION
AF	QS	AUTO FAULT REPORT ON(1)/OFF(0)
AL	QS	USER PROGRAMMABLE ACCEL LIMIT
AP	QS	AUTO END OF INDEX COUNT REPORT ON(1)/OFF(0)
ARX	QS	ANALOG CHANNEL RESPONSE (HEX) (0-7)
ATX	QS	ACCEL RAMP (MS TO MAX RPM)
AV	QS	ANALOG COMMAND CHANNEL VELOCITY FULL SCALE (HEX)
BK	QS	ACTIVATE BRAKE(1)/DEACTIVATE BRAKE(0) OVERRIDE
BR	QS	INHIBIT BRIDGE(1)/ENABLE BRIDGE(0)
CC	Q	CURRENT COUNT
CD	Q	CURRENT DWELL
CFX	QS	ANALOG CHANNEL FULL SCALE (HEX)
CG	QS	CURRENT GAIN (HEX)

NOTE: A MODIFIER (0,1,2) MAY BE PRESENT WITH THE NV,EG,VG,DG,LG,CG COMMANDS. IF NO MODIFIER IS PRESENT THE CURRENT SETTING IS SELECTED.

EXAMPLE: VG1? (QUERY ONLY)
0 – MINIMUM VALUE FOR DRIVE MODEL
1 – MAXIMUM VALUE FOR DRIVE MODEL
2 – DEFAULT VALUE FOR DRIVE MODEL

CMD	EQS	DESCRIPTION
CHX	Q	ANALOG CHANNEL READING (0-5) (HEX)
CI	Q	CURRENT INDEX
CKX	Q	CHECKSUMS
CL	E	SERIAL CONTROL MODE CLEAR OF SUSPEND
CM	QS	CALIBRATE MODE
	CM = 0	NORMAL OPERATING MODE
	CM = 1	CALIBRATE MODE
CNX	QS	ANALOG CHANNEL NULL (HEX)
COX	QS	INDEX COUNT (0-65534) (65535 OR> = COUNT INFINITY)
CP	Q	COMMANDED POSITION (USER STEPS)
CTX	E	EXECUTE CALIBRATION TEST
	CT1	SET NULL VELOCITY
	CT2	SET VELOCITY GAIN (TACH SCALE FACTOR)

CAUTION: CT2, CAUSES THE MOTOR TO RUN AND THERE MUST BE FREE TRAVEL.

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CV	Q	CURRENT VELOCITY (RPM)
DBX	QS	ANALOG CHANNEL DEAD BAND (HEX)
DDX	QS	MINIMUM INPUT SIGNAL PULSE WIDTH
	X =	INPUT LINE NUMBER

EXAMPLE: DD4 = 5 INPUT LINE 4 MUST HAVE A SIGNAL PULSE LONGER THAN 10 MILLISECONDS TO BE RECOGNIZED AS VALID AND MUST BE OFF FOR 10 MILLISECONDS.

EXAMPLE: DD4 = 10 WOULD GIVE A 20 MILLISECOND TIME BEFORE VALIDATING THE INPUT

DEFAULT = 0 (IE. NOT USED)

DG	QS	DIFFERENTIAL GAIN (HEX)
DL	QS	USER PROGRAMMABLE DECEL LIMIT
DP	QS	USER DISTANCE DECIMAL POINT
DSX	QS	INDEX DISTANCE/POSITION
DTX	QS	DECEL RAMP (MS TO MAX RPM)
DU	QS	USER DISTANCE UNITS (3 LETTERS ASCII)
DWX	QS	INDEX DWELL (MS)
EG	QS	LOOP GAIN (HEX) (100H=1 TO 1)
EMX	QS	EXTERNAL OPERATION MODE (∅-5)
ET	QS	PARALLEL INTERFACE ENABLE

∅ - NOT ENABLED
1 – THUMBWHEELS
2 – NUMERIC DISPLAY
3 – THUMBWHEELS AND NUMERIC DISPLAY
4 – PARALLEL PROGRAMMING INTERFACE

FAX	QS	FEED SENSOR ACCEL RAMP (MS TO MAX RPM)
FDX	QS	FEED SENSOR DECEL RAMP (MS TO MAX RPM)
FE	Q	FOLLOWING ERROR
FG	QS	INDEX TIME BASE (HEX)
FH	Q	HARDWARE FAULT STATUS (0-9)
FH	Q	HARDWARE FAULT STATUS (0-8)

0 – NO FAULTS
1 – RMS
3 – ENCODER
4 – LOGIC SUPPLY
8 – EXT INPUT #1
9 – EXT INPUT #2

FP	Q	FEEDBACK POSITION (USER STEPS)
FS	Q	FAULT STATUS (HEX 0 TO FFFF) BITS 0-8 SET INDICATE CURRENT FAULTS

0 – WATCHDOG TIME-OUT FAULT
1 – POWER UP MEMORY FAULT (UN-INITIALIZE)
2 – HARDWARE FAULT ON DRIVE
3 – POSITION ERROR FAULT

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4 – HARDWARE CW TRAVEL LIMIT
5 – HARDWARE CCW TRAVEL LIMIT
6 – SOFTWARE CW TRAVEL LIMIT
7 – SOFTWARE CCW TRAVEL LIMIT
8 – EXTERNAL DISTANCE FAULT

FVX	QS	FEED SENSOR VELOCITY (RPM) (SIGNED) (ONLY FOR SENSOR TYPE INDEXES)
HA	QS	HOME CYCLE ACCEL RAMP (MS TO MAX RPM)
HD	QS	HOME CYCLE DECEL RAMP (MS TO MAX RPM)
HF	QS	HOLD FUNCTION FOR INDEX (0/1)

"HF=1" = HOLD."HF = ∅ = HOLD OFF

HG	QS	INDEX TIME BASE (HEX)
HI	QS	FEED ON HOME SENSOR VELOCITY
HL	QS	POWER UP HOME LOCK ON(1)/OFF(0)
HM	E	EXECUTE HOME CYCLE
HO	QS	FEED OFF HOME SENSOR VELOCITY
HP	QS	ABSOLUTE POSITION AFTER HOME
HR	QS	MARKER VELOCITY (ALSO HV)
HT	QS	HOME TYPE

0 – HOME TO MARKER
1 – HOME TO HOME SENSOR
2 – HOME TO HOME SENSOR THEN MARKER
3 – HOME TO/OFF HOME SENSOR
4 – HOME TO/OFF HOME SENSOR THEN MARKER
5 – HOME TO/OFF/TO HOME SENSOR

ID	Q	DRIVE IDENTIFIER
IFX	QS	INPUT FUNCTION LINE NUMBER

WHERE X = INPUT FUNCTION NUMBER
EXAMPLE: IFO = 7 ASSIGNS INPUT FUNCTION 0 TO INPUT LINE 7

IMX	E	SET DEFAULT MEMORY PARAMETERS
IN	QS	SETS INDEX TO EXECUTE ON INIT IF NO SELECT LINES ASSIGNED
IN	QS	NO SELECT LINE INDEX
INX	E	EXECUTE SELECTED INDEX (X)
IPX	QS	INPUT FUNCTION POLARITY (0 OR 1)

WHERE X = INPUT FUNCTION NUMBER
0 SET NORMALY OFF (DEFAULT) POLARITY
1 SETS NORMALLY ON POLARITY

EXAMPLE: IPO = 1 SETS THE POLARITY OF INPUT FUNCTION 0 TO NORMALLY ON (INPUT FUNCTION 0 WILL BE ACTIVE WHEN THE INPUT IS OFF)

NOTE: ASSIGNING AN INPUT OR OUTPUT FUNCTION TO LINE 0 WILL HAVE THE EFFECT OF UNASSIGNING THE FUNCTION FROM ANY LINE.

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ITX	QS	INDEX TYPE
	0 – INCREMENTAL DISTANCE	
	1 – LINEAR ABSOLUTE POSITION	
	2 – FEED SENSOR (INDEX THEN SENSOR)	
	3 – REGISTRATION (SENSOR THEN INDEX)	
	4 – SHORTEST PATH ROTARY ABSOLUTE	
	5 – FORCED – DIRECTION ROTARY ABSOLUTE CW	
	6 – FORCED – DIRECTION ROTARY ABSOLUTE CCW	
JA	QS	JOG ACCEL RAMP (MS TO MAX RPM)
JD	QS	JOG DECEL RAMP (MS TO MAX RPM)
JF	QS	JOG FAST VECOLITY (RPM) (UNSIGNED)
JF+	E	EXECUTE CW JOG AT FAST JOG VELOCITY (ALSO JF)
JF-	E	EXECUTE CCW JOG AT FAST JOG VELOCITY
JG	E	EXECUTE JOG AT SERIAL JOG VELOCITY
JG	QS	SERIAL JOG VELOCITY (RPM) (SIGNED)
JL	QS	POWER UP HOME LOCK ON (1)/OFF (0) FOR JOG MOTION
JS	QS	JOG SLOW VELOCITY (RPM) (UNSIGNED)
JS+	E	EXECUTE CW JOG AT JOG SLOW VELOCITY (ALSO JS)
JS-	E	EXECUTE CCW JOG AT JOG SLOW VELOCITY
LD	QS	FEED SENSOR LIMIT DISTANCE (UNSIGNED)
LG	QS	LEAD GAIN (HEX)
LP	QS	POSITION LOOP ON(1)/OFF(0)
LR	QS	RAMPS
	0 – MOD-SINE RAMPS	
	1 – LINEAR RAMPS	
MA	Q	MINIMUM ACCEL TIME
MD	Q	MINIMUM DECEL TIME
ME	QS	MAXIMUM ALLOWABLE FOLLOWING ERROR
MV	QS	MAXIMUM VELOCITY (DEFAULT = 3000 RPM)
NDX	QS	NUMERIC DISPLAY PARAMETERS
	∅ - DISPLAY FUNCTION (∅=COMMAND POSITION, 1=COMMAND VELOCITY)	
	1 – DECIMAL POINT POSITION	
	2 – DIGITS HIDDEN	
	3 – ∅=SHOW SIGN, 1=SHOW ONLY “-“ SIGN	
	4 – MULTIPLIER	
	5 – DIVISOR	
	6 – SUBTRACTOR	
	7 – UPDATE DELAY	
NI	QS	NUMBER OF INDEXES (PCM ONLY)
NP	QS	NUMBER OF PROGRAMS (PCM ONLY)
NV	QS	NULL VELOCITY (HEX) (800H MID)
ODXX (+/-)	QS	PROGRAMMABLE OUTPUT DELAY FROM END OF INDEX
OFX	QS	OUTPUT FUNCTION LINE NUMBER (9-12)
	WHERE X = OUTPUT FUNCTION NUMBER	
	EXAMPLE: OF2 = 0 ASSIGNS OUTPUT FUNCTION 2 TO OUTPUT LINE 9	

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OMXX	QS	PROGRAMMABLE OUTPUT MASK (HEX)
OPXX	QS	PROGRAMMABLE OUTPUT PATTERN (HEX)
OTXX	QS	PROGRAMMABLE OUTPUT PULSE WIDTH (0=LEAVE ON TILL RESET)
PF	QS	POWER UP FLAGS (HEX)
PL	QS	USER PROGRAMMABLE INDEX POS/DIST LIMIT (0-MIN,1-MAX)
PR	QS	SETS PROGRAM TO EXECUTE ON INITIATE IF NO SELECT LINES ASSIGNED
PRXX	E	INITIATES PROGRAM XX
PY	QS	POLARITY (0=+VOLTAGE cw/1=+VOLTAGE CCW)
Q	-	QUERY COMMAND (XX?)
QU	Q	CURRENT STATUS OF THE T-DRIVE
	S – SERIAL CONTROL (READY FOR COMMAND)	
	E – EXTERNAL CONTROL	
	C – CALIBRATE MODE	
	P – INDEXING	
	H – HOMING	
	J – JOGGING	
	F – FAULTED (USE FS COMMAND TO GET EXACT FAULT TYPE)	
	L – HOME LOCK	
RI	QS	RETURN TO POSITION INDEX NUMBER (DEFAULT=0)
RL	QS	EXTERNAL DRIVE POSITIONAL LOOP GAIN RANGE
RO	QS	RESOLVER OFFSET POSITION FOR HOME TO MARKER
RPX	QS	ROTARY ABSOLUTE POSITION LIMITS (0-MIN(CCW),1-MAX(CW)
RS	E	RESET DRIVE
S	-	SETUP COMMAND (XX=)
SC	QS	SERIAL CONTROL
	SC = 0 NORMAL EXTERNAL OPERATION (PULSE)	
	SC = 1 PUT UNIT UNDER SERIAL CONTROL FOR MOTION	
SD	QS	STOP/HOLD DECEL RAMP (MS TO MAX RPM)
SG	QS	SUSPEND FLAGS (HEX) (DEFAULT=0)
SJ	E	STOP JOG ALONG JOG DECEL SLOPE
SLX	QS	NUMBER OF SELECT LINES 131
SP	EQS	SUSPEND/RESUME (E), SUSPEND PROGRAM NO. (Q/S) (DEFAULT=0)
SRX	QS	STEPS PER USER REV (0=INTERNAL/1=EXTERNAL) (DEFAULT=4000)
ST	E	STOP MOTION ALONG STOP/HOLD DECEL SLOPE
TD	QS	TRAVEL LIMIT/FAULT DECEL RAMP (MS TO MAX RPM)
TL	QS	USER PROGRAMMABLE TRAVEL LIMITS (0-MIN,1-MAX)
TR	QS	MOTOR TURNS PER USER REV (DEFAULT=1)
VC	QS	USER CALIBRATION (FULL SPEED) VELOCITY (0/1)
VEX	QS	INDEX VELOCITY (RPM) (UNSIGNED)
VG	QS	VELOCITY GAIN (HEX) (TACH SCALE FACTOR)
VL	QS	USER PROGRAMMABLE VELOCITY LIMIT

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VP	QS	USER VELOCITY DECIMAL POINT (0/1)
VU	QS	USER VELOCITY UNITS (3 LETTERS ASCII)
XC	QS	EXTERNAL DRIVE CURRENT FEEDBACK SCALING (HEX)
XP	QS	EXTERNAL DRIVE INPUT POLARITY (HEX)
XT	QS	EXTERNAL DRIVE VELOCITY/CURRENT OPERATING MODE (HEX)
XV	QS	EXTERNAL DRIVE TACH SCALE FACTOR (HEX)
ZA	E	ZERO ABSOLUTE POSITION
ZR	E	ZERO RELATIVE POSITION (DISPLAY)

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