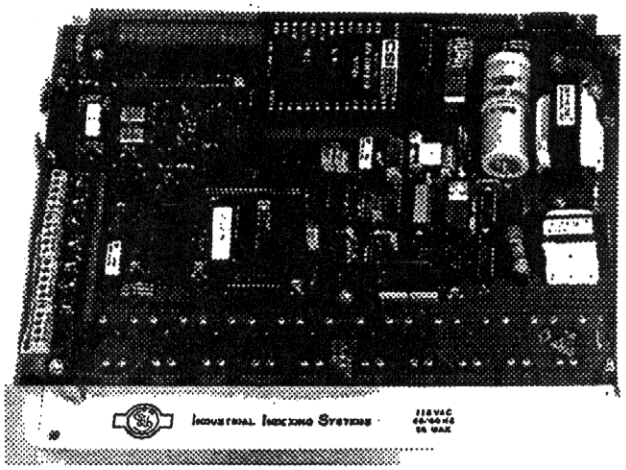
IB-13B001

MOTION CONTROL SYSTEM, MM-10 SERIES

FEBRUARY 1990



MM-10-PLUS AND MM-10-T MOTION MASTER SINGLE AXIS CONTROLLER

USER'S GUIDE

INDUSTRIAL INDEXING SYSTEMS, INC.

ER-6010

ERRATA SHEET, IB-13B001 — OCTOBER 2001

Date	Rev.	ECN No.	DR	CHK	CHK
7/92	0	ECN-92-135 (See Note 1)	MFE	EB	
9/92	A	ECN-92-200 (See Note 2)	MFE	EB	
9/93	B	ECN-93-235 (See Note 3)	EB		
10/93	C	ECN-93-238 (See Note 4)	KY		
10/19/01	D	ECN-01-365 (See Note 5)	KY	WS	

Notes:

1) Section – 5, pages 4, 5 & 7, dated July 1992, supercedes pages 4, 5 & 7, dated November 1991.

2) Section – 2, pages 10-12, dated September 1992, supercedes pages 10-12, dated February 1991.
Section – 3, pages 3 & 4, dated September 1992, supercedes pages 3 & 4, dated February 1991.

3) Section – 3, page 3-3, dated September 1993, supercedes page 3-3, dated September 1992.

4) Appendix A, dated October 1993, supercedes Appendix A, dated February 1990.

5) Section – 5, page 5-4, dated October 2001, supercedes page 5-4, dated July 1992.

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INTRODUCTION

The Industrial Indexing Systems Motion Master (MM-10-PLUS or MM-10-T) is a microprocessor-based, position-loop controller. It is a single-axis, closed-loop controller that works with a separate servo drive and motor to accurately fix the position of the motor shaft. The variety of operating modes and range of programmable parameters make the Motion Master controller suitable for use in many different types of indexing systems.

This manual describes proper installation, operation, and troubleshooting procedures for the MM-10-PLUS and MM-10-T controllers and related peripheral equipment. Section 5 describes serial communications commands and procedures for utilizing the controller with a host computer or programmable logic controller.

The manual assumes no prior knowledge of Industrial Indexing System equipment. It does assume knowledge of proper mechanical, electrical, and electronic maintenance and safety procedures. Sections dealing with serial communications assume knowledge of ASCII code and binary coded decimal programming and communications. Information in this manual is subject to change without prior notification.

The manual uses a variety of highlighted blocks to emphasize important information. Always pay careful attention to this information. The types of highlighted blocks used are:

WARNING

USED TO ALERT THE READER TO ACTIONS OR CONDITIONS WHICH MIGHT PRESENT HAZARDS OR CAUSE INJURY TO PERSONNEL.

CAUTION

USED TO ALERT THE READER TO ACTIONS WHICH MIGHT CAUSE LOSS OF MATERIALS OR DAMAGE TO EQUIPMENT.

NOTE

Used to identify unusual or unexpected conditions or to point out the need for alternate procedures. It is also used for emphasis when a CAUTION or WARNING is not required.

The Motion Master control system is modular in concept. This manual describes the controller and related peripheral devices. For completeness, this manual also describes various aspects of related feedback devices and drives. However, as sold, the MM-10-PLUS/MM-10-T controller only includes the controller, a line cord, and manual. All other items are optional—and must be specified separately—to allow total design flexibility. Connecting cables can be specified with any desired length (although there are some limits on communication cable lengths) or with just connectors and no cable for user assembly.

Industrial Indexing Systems fully supports all equipment it manufactures and supplies. If there are any problems with this equipment or if assistance is required for installation or operation, contact our Integrated Technical Services Department.

Assistance and training is available in our factory, for a fee. In addition, Industrial Indexing Systems can custom configure controllers for O.E.M. applications.

SECTION 1 – DESCRIPTION

The Industrial Indexing System Motion Master (MM-10-PLUS or MM-10-T) is a microprocessor-based, position-loop controller. It is a single-axis, closed-loop controller that works with a separate servo drive and motor to accurately fix the position of the motor shaft.

1.1. INDEXING DRIVE SYSTEM OVERVIEW

An indexing drive system (or indexing system) may be used in a variety of applications where accurate movement or positioning is required. A basic system consists of eight main components as illustrated in **Figure 1.1**.

1) Input Device: The input device provides data to the controller. It is the interface between the operator (or system computer or programmable logic controller) and the indexing system. In a given system, there may actually be several input devices.

2) Controller: The controller receives data from the input device and issues commands to the drive. It also accepts information from the feedback device. The programming and settings of the controller determine what types of commands are issued to the drive in response to the data inputs and feedback.

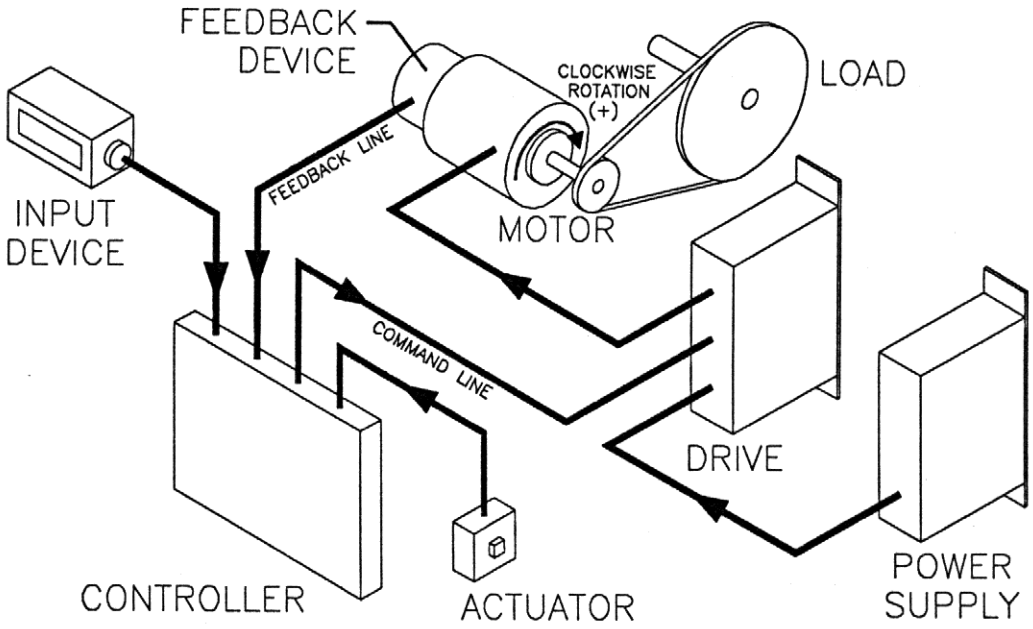


Figure 1.1 - Basic Indexing System

3) Actuator: The actuator supplies the signal which causes the controller to initiate the specified sequences.

4) Power Supply: The power supply converts AC input power into DC power and conditions this secondary power so it can be used by the drive.

5) Drive: The drive (also called a servo-amplifier) amplifies a low voltage velocity command signal from the controller into the necessary voltage and current to cause the motor shaft to rotate. The amount of power and polarity (positive or negative) of the voltage supplied to the motor is determined by the command signals from the controller.

6) Motor: The motor is the device being controlled by the indexing system. The system controls the amount and speed of motor shaft rotation.

7) Load: The load is the object of the motion. It absorbs the work energy of the motor.

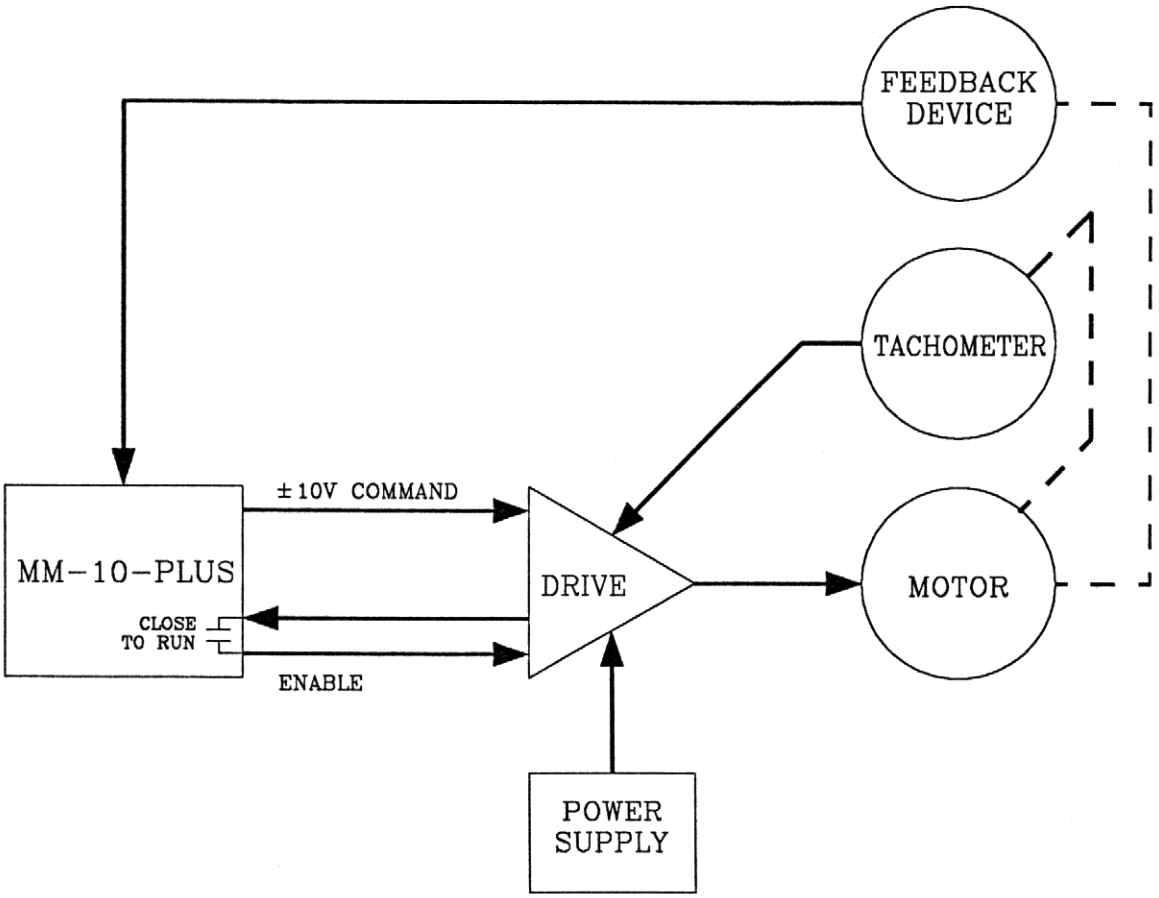


Figure 1.2 - Position Loop

8) Feedback Device: The feedback device (usually a resolver or shaft encoder) monitors the position of the motor shaft and sends this information to the controller.

The components of the basic indexing drive system form two information loops. The position loop is a closed-loop which consists of the controller, drive, motor, and feedback device. The controller, after receiving data from the input device, sends a command to the drive, which causes the motor shaft to move, which is monitored by the feedback device, which sends data to the controller, which sends a command to the drive, etc.

The velocity loop is also a closed-loop system. An input voltage to this loop changes the voltage applied to the motor (the drive output), which changes the speed of the motor-shaft rotation, which changes the speed of the tachometer, which changes the signal to the drive, which influences the drive output, etc.

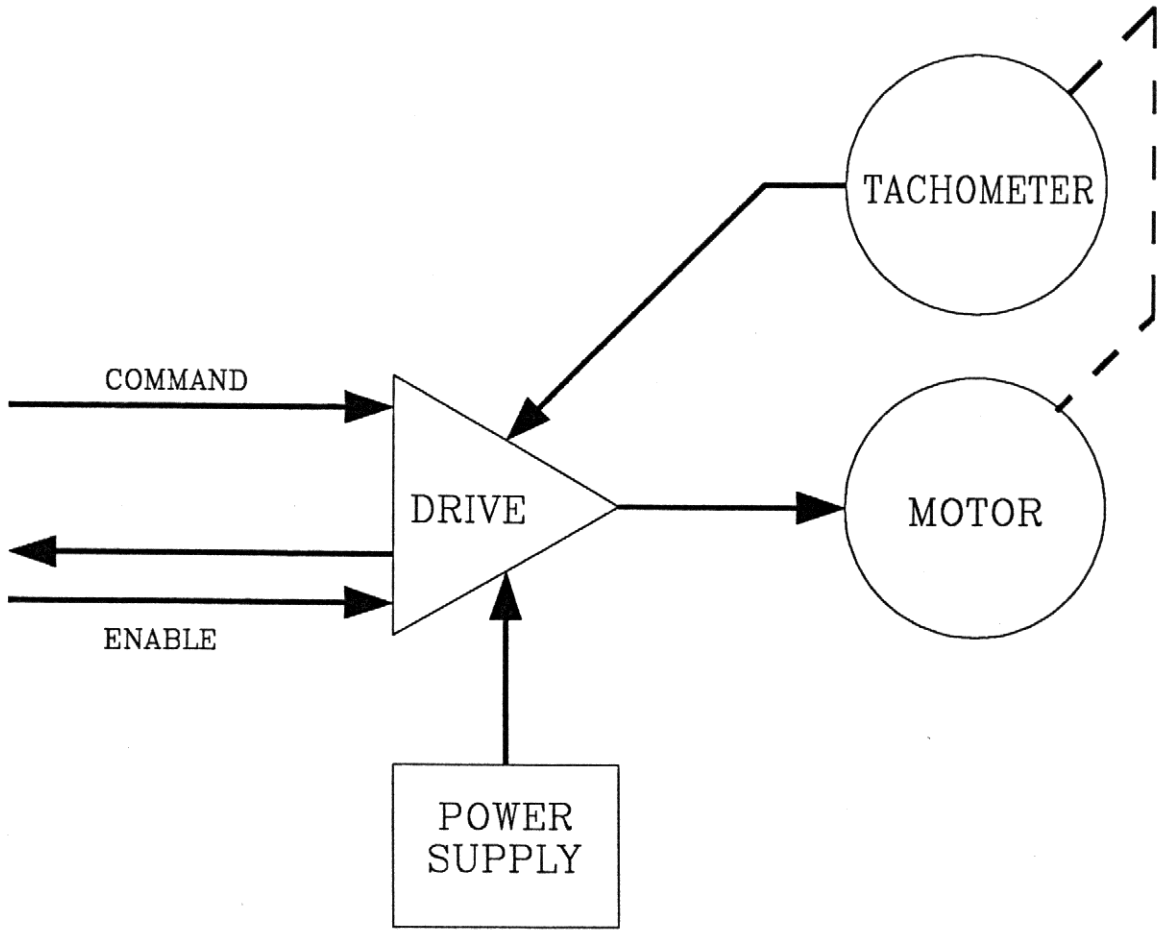


Figure 1.3 - Velocity Loop

The position loop and velocity loop are independent loops, but the controller uses the velocity loop to achieve movement to the desired position. When data is received by the controller specifying a movement, the controller calculates the time required to accelerate to maximum speed and to decelerate from maximum speed. It then calculates the time at maximum speed necessary to complete the movement. This information is then transmitted to the drive by the controller. (Refer to **"Section 3 - Controls and Operations"** for more details on the speed/positioning relationship.)

1.2. SYSTEM FUNCTIONS

The Industrial Indexing Systems Motion Master controller will operate with a full range of Industrial Indexing Systems drive system packages. The MM-10-PLUS is designed for use with Industrial Indexing System resolvers. The MM-10-T controller is designed to operate with a variety of shaft feedback systems.

The controllers can operate in stand-alone systems or as slave controllers to a host computer or programmable logic controller (PLC). As a stand-alone controller, all inputs are direct connections to the MM-10-PLUS/MM-10-T. Peripheral devices and built-in or remote potentiometers supply the data and operating parameters which the controller uses to regulate the motor drive.

As a slave controller, input data comes from a host computer or programmable logic controller. The data is sent as ASCII (American Standard Code for Information Interchange) Serial communications. When used as a slave controller, the MM-10-PLUS/MM-10-T can perform all functions performed as a stand alone controller. In addition, the mode of operation can be changed and peripheral devices can be enabled or disabled from the host serial control.

The Motion Master controllers provide a variety of control functions which allow the indexing system to be customized to meet a wide range of indexing needs.

1) **Indexing/Positioning**: The primary function of the controller is to regulate specific motor shaft movements. The Motion Master controllers will regulate both indexing (movement relative to present position) and positioning (movement relative to fixed reference position).

   The motor is indexed or positioned by energizing the "Index" (or "Home") input. Motion is terminated when the motor reaches the programmed position. Speeds and acceleration/deceleration rates may be programmed through the potentiometers on the MM-10-PLUS/MM-10-T, from external potentiometers, or by serial command.. Distance values are provided by one of the optional peripheral devices, such as a thumb-wheel module, or by serial command.

   The controller allows a variety of "Modes" which determine the type of shaft movement (refer to **"Section 3 - Controls and Operation"**). The system can be set for indexing or positioning. The shaft can be limited to a single revolution or multiple revolutions can be used. The reference ("Home" or 0.00) position can be predetermined (fixed) or can be established by the operator.

2) **Overdraw**: Any of the indexing/positioning functions (except "Home") can be modified with the overdraw function. When this function is active, the motor will move the distance specified by the index or position command. At the end of the specified distance, the motor will only be decelerated to the overdraw speed, rather than to zero. The motor will continue to turn at the overdraw speed until the overdraw sensor is made. (There

is a maximum shaft rotation limitation to prevent continued movement in the event the sensor is not actuated.) This overdraw function is frequently used when feeding materials which stretch. The overdraw allows the positioning to be referenced from a registration mark or similar reference which can be detected by a photoelectric or proximity sensor.

3) **Initialize**: Many types of indexing/positioning require that the equipment "knows" its position. The initialize function allows the equipment to determine its reference position. When this function is activated, the motor rotates in a specific direction, at a specific speed until it identifies its reference position. (This is only required when the controller is first started, after the power has been off. Once initialized, the controller "remembers" where it is.)

   For single revolution applications, initialize finds the "Home" or 0.00 position. For multiple turn applications, the initialize function uses an external sensor to locate the 0.XX revolution (the revolution which has the "Home" or 0.00 position) and then goes to the "Home" or 0.00 position.

4) **Motor Jogging**: The motor may be jogged in either a clockwise or counterclockwise direction at a selected speed and acceleration/deceleration rate which are unrelated to the maximum operating speed during indexing or positioning operations. The motor will continue to move until the jog input is removed — it cannot be stopped until the input is removed.

5) **Force Decel**: Any indexing/positioning function can be terminated early by using the Force Decel (deceleration) function. This causes the drive to immediately start to slow down at the programmed deceleration rate until the motor comes to a stop.

NOTE

The "Force Decel" function has no affect on "Jog" functions. If the motor is being jogged, it will continue to operate at the jog speed until the jog input is removed.

6) **Early Index Complete**: The standard outputs from the MM-10-PLUS/MM-10-T include "Index Complete" and "Home" indicators. For some control purposes, it may be desirable to start an action before the shaft movement is actually stopped. This can be accomplished with the "Early Index Complete" output signal. When this option is programmed, the index complete output will be actuated before the index is actually completed. The amount of early indication may be configured as desired by the user.

1.3.COMPONENTS

The major components of the MM-10-PLUS and MM-10-T controllers are shown in **Figure 1.4** and **Figure 1.5** respectively. With the exception of the interfaces to the drive and feedback devices and the Loop Gain selection switch on the MM-10-T, both controllers have the same components which serve identical functions. (Refer to **"Section 3 - Controls and Operation"** for additional details on components used as controls.)

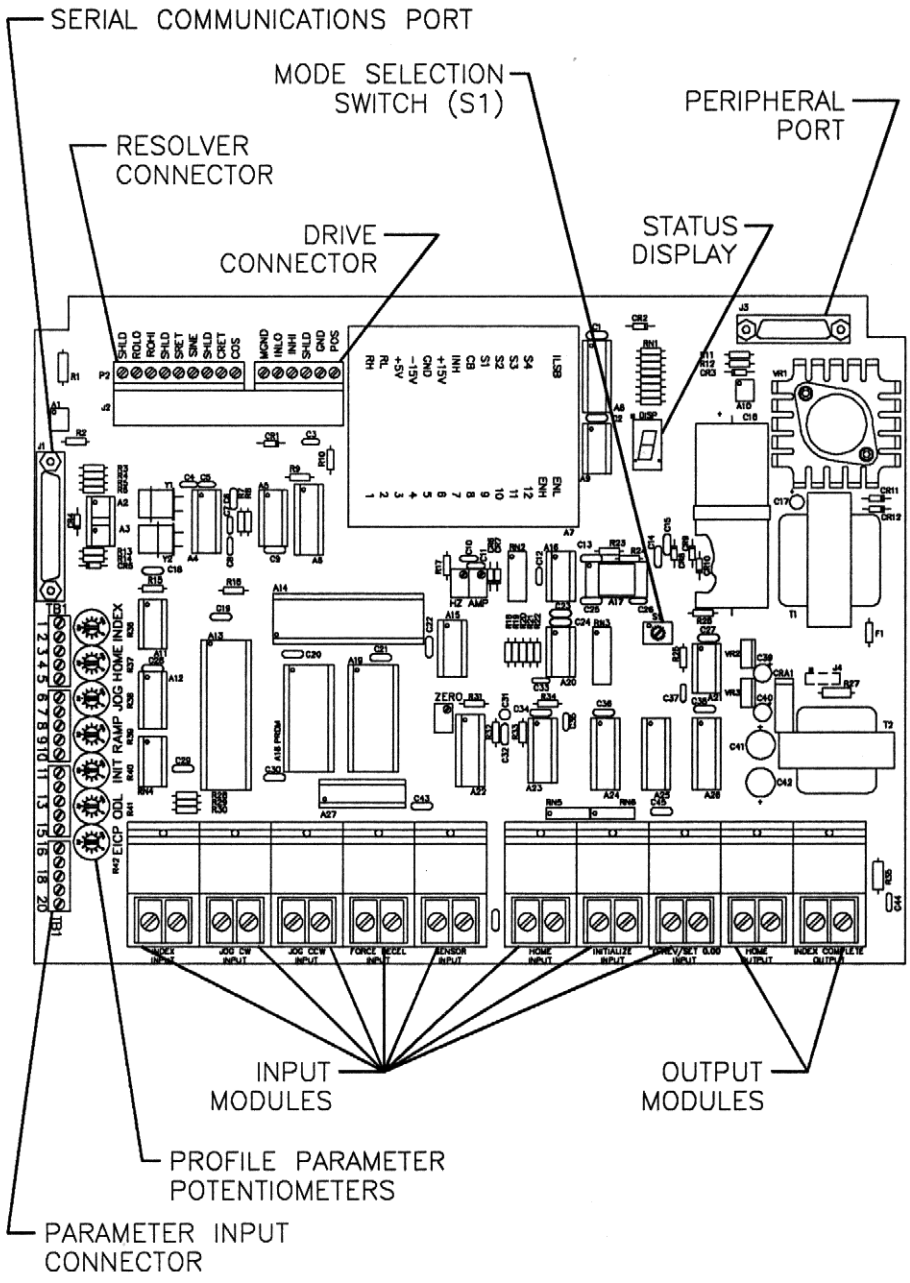


Figure 1.4 - MM-10-PLUS Controller

1) Output Modules: The output modules are either AC or DC, optically-isolated modules. One output is activated when the index is complete. The second is activated when the motor shaft has reached its home position. When the output is activated, it closes the optically-isolated contact. When the output is inactive, the contact is open. The initial power-up state of the modules is off (open). (Refer to **Paragraph 1.5.1** for module specifications.)

2) Input Modules: The input modules are either DC or AC, optically-isolated modules. There are eight input positions: Index, Jog CW, Jog CCW, Force Decel, Sensor, Home, Initialize, and "0"Rev/Set 0.00. The input signal must be applied to one of these inputs for at least 24 milliseconds (.024 seconds), to insure that the controller will respond to the input. (Refer to **Paragraph 1.5.1** for module specifications.)

NOTE

A high response speed module — HSI-850 — is available when a faster response time is required, such as when using operating mode #9 (refer to "Section 3 - Controls and Operations").

3) Profile Parameter Potentiometers: There are seven potentiometers which set motor speed, acceleration/deceleration rates, and rotation limits for overdraw and early index. (Refer to **Paragraph 1.5.3** for operating parameter limits.)

4) Parameter Input Connector: The parameter input connector is a series of 5-terminal, terminal blocks. The output from each of the profile parameter potentiometers is connected to one terminal. These are jumpered to inputs for the controller circuitry through additional terminals on the parameter input connector. This provides a convenient location for connecting external fixed or variable resistors in place of the on-board potentiometers.

5) Serial Port: This connector is the interface between the controller and a host computer or programmable logic controller (or the TPP-400 Touch Panel Programmer). This is a 25-pin, D-type serial connector.

6) Resolver Connector: This connector is the interface between the controller and the resolver on the MM-10-PLUS. (This connector does not exist on the MM-10-T controller.)

7) Drive Connector: This connector is the interface between the controller and the drive on the MM-10-PLUS. (This connector does not exist on the MM-10-T controller.)

8) Mode Selection Switch: This 16-position selector switch sets the mode of operation for the controller. (Changing the selector switch will not change the mode until the power is cycled off and on.) Mode "0" is used for test

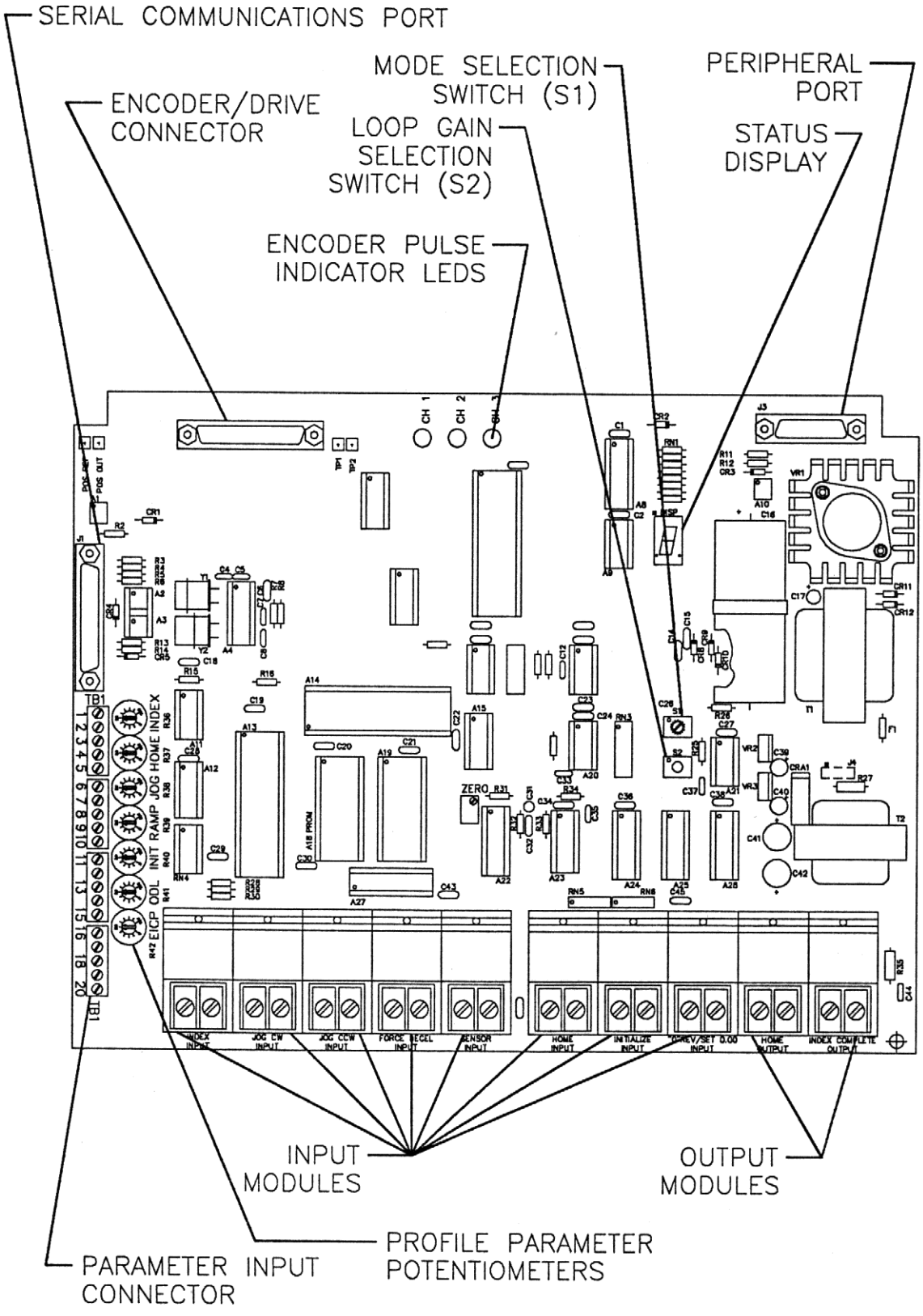


Figure 1.5 - MM-10-T Controller

sequences (refer to **"Section 6 - Troubleshooting"**).

9) Status Display: This (Light Emitting Diode) display shows the current status of the controller. If there is an error message, the display will alternately flash the error number and the letter "e". If there is no error, the display will show the operating mode of the controller. The decimal point on the status display is illuminated when the controller is attempting to enable the drive.

10) Peripheral Port: This 15-pin connector is bi-directional and provides both input and output connection for all peripheral devices. System peripheral devices are daisy-chained (connected in series). Each has one male and one female peripheral port. The cable from the male connector on the first peripheral device connects to the female connector on the controller. The cable from the male peripheral port on each succeeding device connects to the female peripheral port on the previous device. There is no limit to the number of devices which can be connected to the peripheral port.

There are three additional components on the MM-10-T controller which are not included on the MM-10-PLUS controller.

11) Loop Gain Switch: This 16-position selector switch is used to compensate for the differences between encoders which might be used with the drive system (only eight positions are used). The MM-10-T controller is based on a standard encoder having a ±10 VDC range per 1024 quadrature (90° out of phase) pulses per revolution. The Loop Gain Switch multiplies the voltage/pulse of the actual encoder by select values from 0.125 through 4 to equalize the encoder output to this desired stability factor.

12) Encoder/Drive Connector: When an encoder is used as a feedback device, a single 25-pin connector on the MM-10-T replaces the resolver connector and drive connector used on the MM-10-PLUS. This serves as the interface for the drive and the encoder.

13) Encoder Pulse Indicator LEDs: There are three LEDs—one for each encoder channel—located near the encoder/drive connector. These illuminate each time a pulse is received from the encoder.

The MM-10-T may have an additional output module attached to the Encoder/Drive Connector. This module allows use of a C-300yyy connecting cable from the MS-3106A18-IS shaft encoder connector on the motor. This cable has ferrules on the controller end of the cable which makes running the cable through conduit between the motor and controller easier while eliminating the need to solder the cable to a 25-pin connector prior to assembly.

The INT-410 module also provides a configuration switch which is not available on the MM-10-T module to facilitate setup of the controller to match the encoder type. (Refer to **"Section 2 - Installation"** for configuration switch settings.)

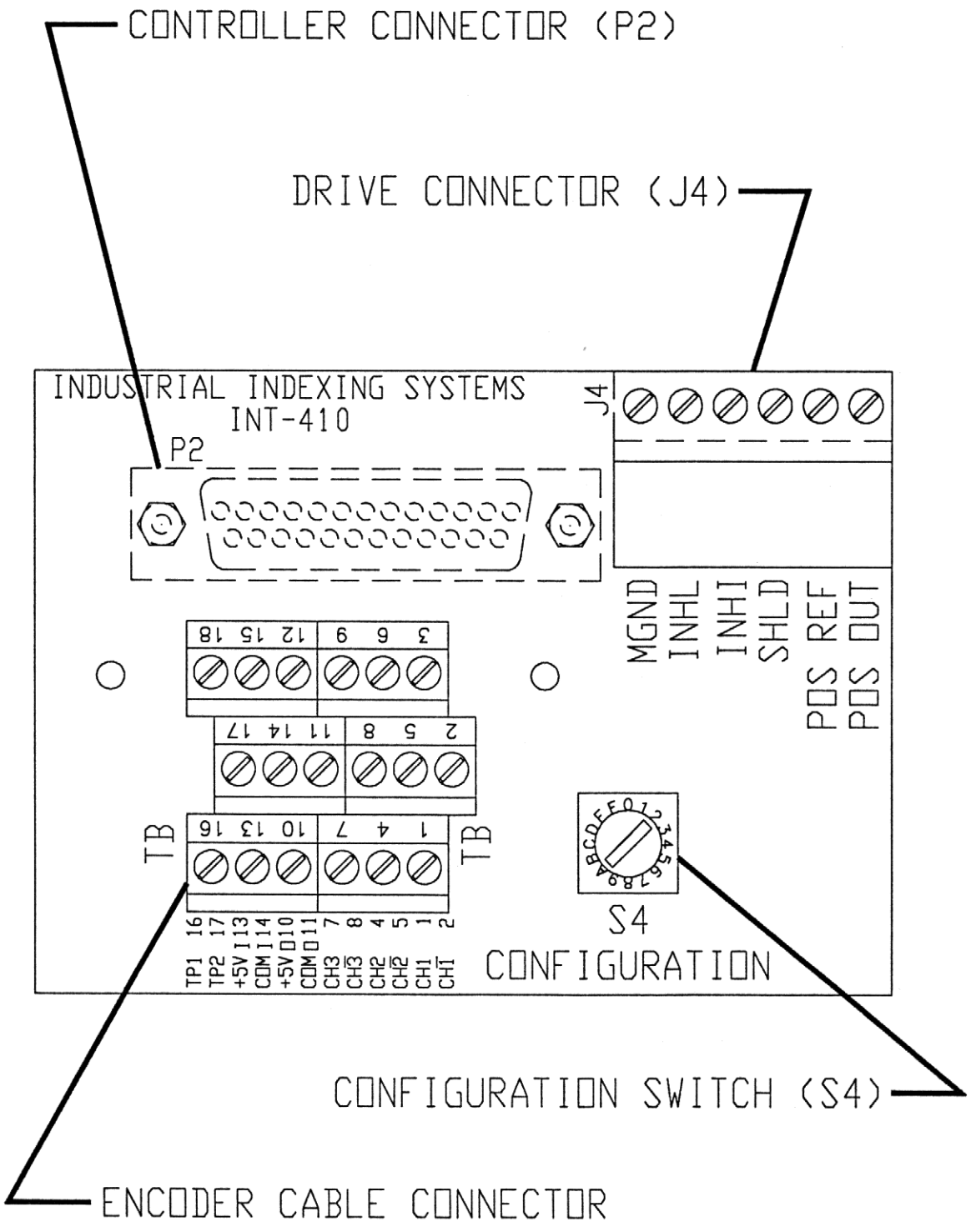


Figure 1.6 - INT-410 Interface Module

14) Controller Connector: This 25-pin connector plugs into the encoder/drive connector on the MM-10-T controller.

15) Drive Connector: This 6-terminal terminal block is used for connections from the controller to the drive.

16) Configuration Switch: This 16-position switch is used to select the type of encoder which the controller is to be configured for.

17) Encoder Cable Connector: This set of 18 terminals is used to connect the C-300yyy cable ferrules to the INT-410 module.

1.4. PERIPHERAL MODULES

The Motion Master may have a variety of peripheral input and output modules. These may serve as primary inputs or outputs when the MM-10-PLUS/MM-10-T is used as a stand alone controller, or they may serve auxiliary functions when the controller is slave to a computer or programmable logic controller. (Refer to **"Section 4 - Peripheral Modules"** for detailed descriptions, and installation and operating instructions.)

All peripheral modules are connected on a common peripheral bus. This bus allows bi-directional data transmission

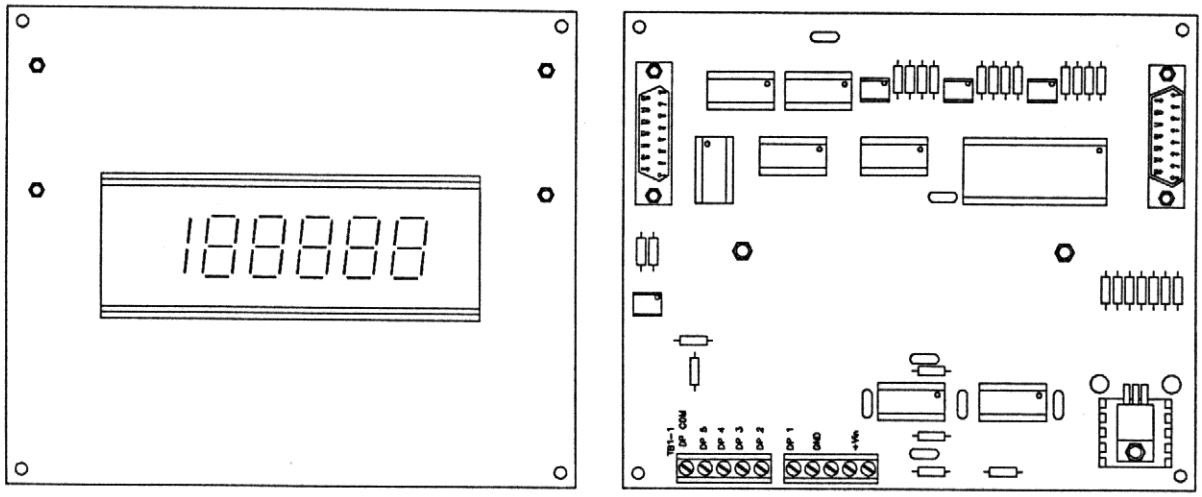
1.4.1. DSP-400 DISPLAY

The DSP-400 Display Module is an output device which provides a visual readout of the index length or position of the motor shaft. The display is a 5-1/2 digit LED display. The decimal point of the display is fixed by the customer. The index or position is shown in "engineering units".

NOTE

"Engineering units" is a programmed quantity which defines units per one complete shaft rotation. It can represent real or artificial distance units. Refer to "Section 3 - Controls and Operation" for details on programming engineering units.

If an error occurs, the display will show the error in place of the distance or index information. An error code is displayed in the format "EN", where "N" is a numeral from "0" to "9". (Refer to **"Section 6.1 - Error Codes"** for error code definitions.)



FRONT VIEW BACK VIEW

Figure 1.7 - DSP-400 Display

1.4.2. TWR-400A THUMB-WHEEL INPUT MODULE

The TWR-400A Thumb-wheel Input Module is an input device which can be used to provide the index or position movement information to the controller. The thumb-wheel contacts are environmentally sealed.

The operator inputs the desired movement by setting the face of the thumb-wheel module to the desired distance. The numbers set express the desired movement in engineering units. There are five digits and a plus or minus sign to indicate rotation direction. The implied decimal point will correspond to the decimal point set when establishing "engineering units".

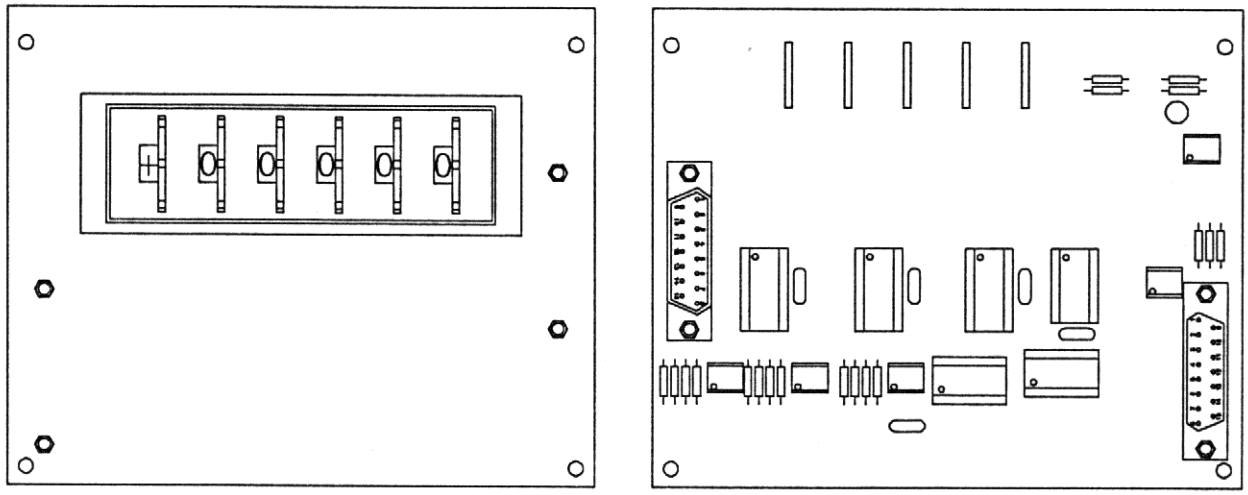


Figure 1.8 - TWR-400A Thumb-wheel Input Module

When the "Index" command is issued to the controller, it will cause the motor shaft to move the indicated distance (based on the operating mode). The same setting will be used each time the index command is received until the thumb-wheel settings are changed.

NOTE

Only one TWR-400A Thumb-wheel Input Module may be used with a single MM-10-PLUS/MM-10-T controller. However it may be combined with one or more TWR-410A Strobed Thumb-wheel Input Modules.

1.4.3. TWR-410A STROBED THUMB-WHEEL INPUT MODULE

The TWR-410A Strobed Thumb-wheel Input Module is similar to the TWR-400A module. It provides the index or position movement information to the MM-10-PLUS/MM-10-T controller. The operator inputs the desired movement by setting the face of the thumb-wheel module to the desired distance. The numbers

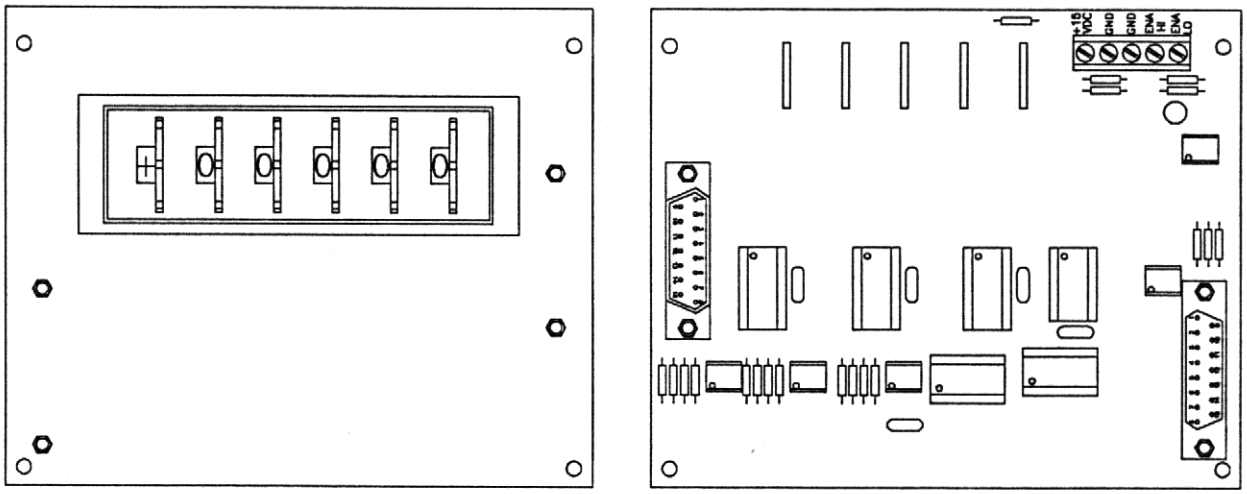


Figure 1.9 - TWR-410A Strobed Thumb-wheel Input Module

set express the desired movement in engineering units. There are five digits and a plus or minus sign to indicate rotation direction. The implied decimal point will correspond to the decimal point set when establishing "engineering units".

The TWR-410A has the added advantage of remote enable/disable. When a TWR-410A Strobed Thumb-wheel Module is enabled, its setting is available for use by the controller. When it is disabled, its setting is not available. Several TWR-410A modules can be daisy-chained to the same controller. The setting of the first (closest to the controller) enabled TWR-410A module will be used for the movement input.

When the "Index" command is issued to the controller, it will cause the motor shaft to move the indicated distance (based on the operating mode). The same setting will be used each time the index command is received until the thumb-wheel settings are changed, the thumb-wheel module is disabled, or a thumb-wheel module closer to the controller in the daisy-chain is enabled.

NOTE

When a TWR-400A module is used with one or more TWR-410A modules, the TWR-400A module must always be farthest from the controller on the daisy-chain since this module cannot be disabled.

1.4.4. BCD-410 PARALLEL INPUT MODULE

The BCD-410 Parallel Input Module provides another alternative for distance input. It acts as the interface between the MM-10-PLUS/MM-10-T controller and a parallel binary coded decimal (BCD) output port of a computer or programmable logic controller (PLC). This module allows the computer or PLC to transfer distance information in the

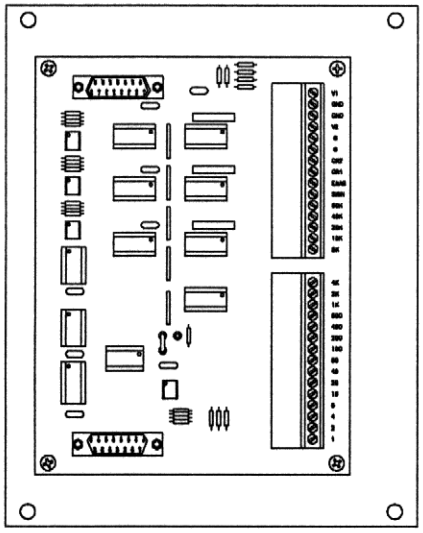


Figure 1.10
BCD-410 Parallel Input Module

form of 5 BCD digits from its program to the controller through the peripheral port of the controller.

When both a BCD-410 module and one or more thumb-wheel input modules are present in the same daisy-chain, the controller is continually scanning between the two types of modules. If an enable signal is present at the BCD-410 module when an "Index" command is received, the controller will accept the input from the BCD-410. If there is no signal present at the BCD-410 module when an "Index" command is received, the controller will accept the input from the first enabled thumb-wheel module.

The distance information supplied by the BCD-410 expresses the desired movement in engineering units. There are five digits and a plus or minus sign to indicate rotation direction. The implied decimal point will correspond to the decimal point set when establishing "engineering units".

The BCD-410 is a very versatile data interface which will work with a wide variety of output devices. It can be configured to accept either "high true" or "low true" data by just changing a jumper on the module. All inputs are provided with pull-up resistors to the interface supply voltage and are, therefore, best driven by pull-down type output interfaces.

1.4.5. BCD-450 PARALLEL OUTPUT MODULE

The BCD-450 Parallel Output Module serves as a data interface between the MM-10-PLUS/MM-10-T controller and a parallel binary coded decimal (BCD) input port of a computer or programmable logic controller (PLC). This module allows the controller to transfer information in the form of BCD digits to the computer or PLC through the peripheral port of the controller.

The BCD-450 is a parallel binary coded decimal output device which supports 5-1/2 BCD digits with sign. These may be read as a single 24-bit word or as three 8-bit words. The output of the module is an open-collector, active low signal with the sign selectable as high or low true. The output from the BCD-450 can be connected as a parallel interface or as a multiplexed interface.

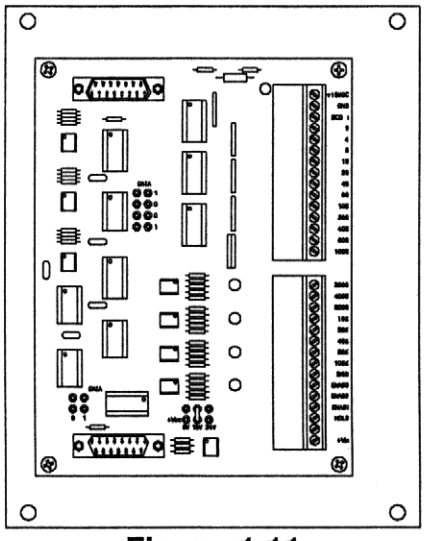


Figure 1.11
BCD-450 Parallel Output Module

1.4.6. IPS-15 POWER SUPPLY

With the exception of the TWR-400A Thumb-wheel Input Module, all of the modules in this section require a separate 15 VDC power supply. The IPS-15 Power Supply is designed to work with each of the other modules. It supplies a maximum 1.5 Amp output at 15 VDC from a 120 VAC input.

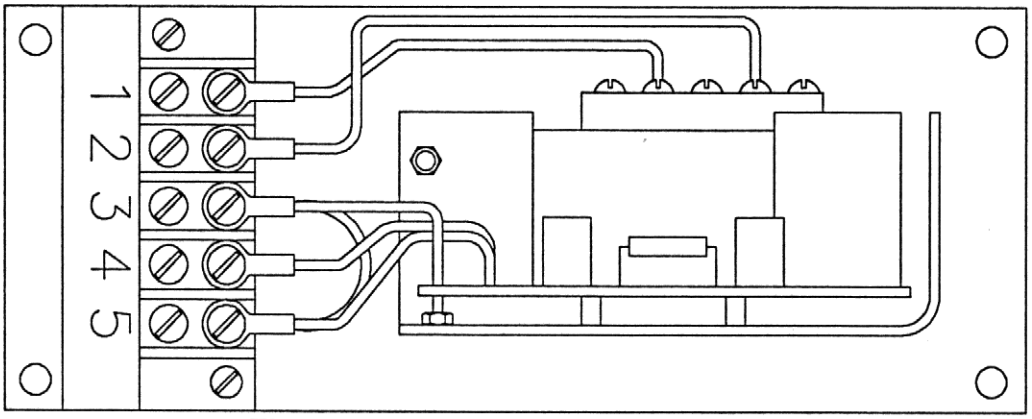


Figure 1.12 - IPS-15 Power Supply

1.4.7. TPP-400 TOUCH PANEL PROGRAMMER

The TPP-400 Touch Panel Programmer is not a true peripheral device in the same sense as the other modules discussed in this section. The TPP-400 will provide serial communications to the controller at 300 Baud. For a complete description and operating instructions, refer to **"Section 4 - Peripheral Devices"**. For programming instructions, refer to **"Appendix A - Programming with TPP-400 Touch Panel Controller"**.

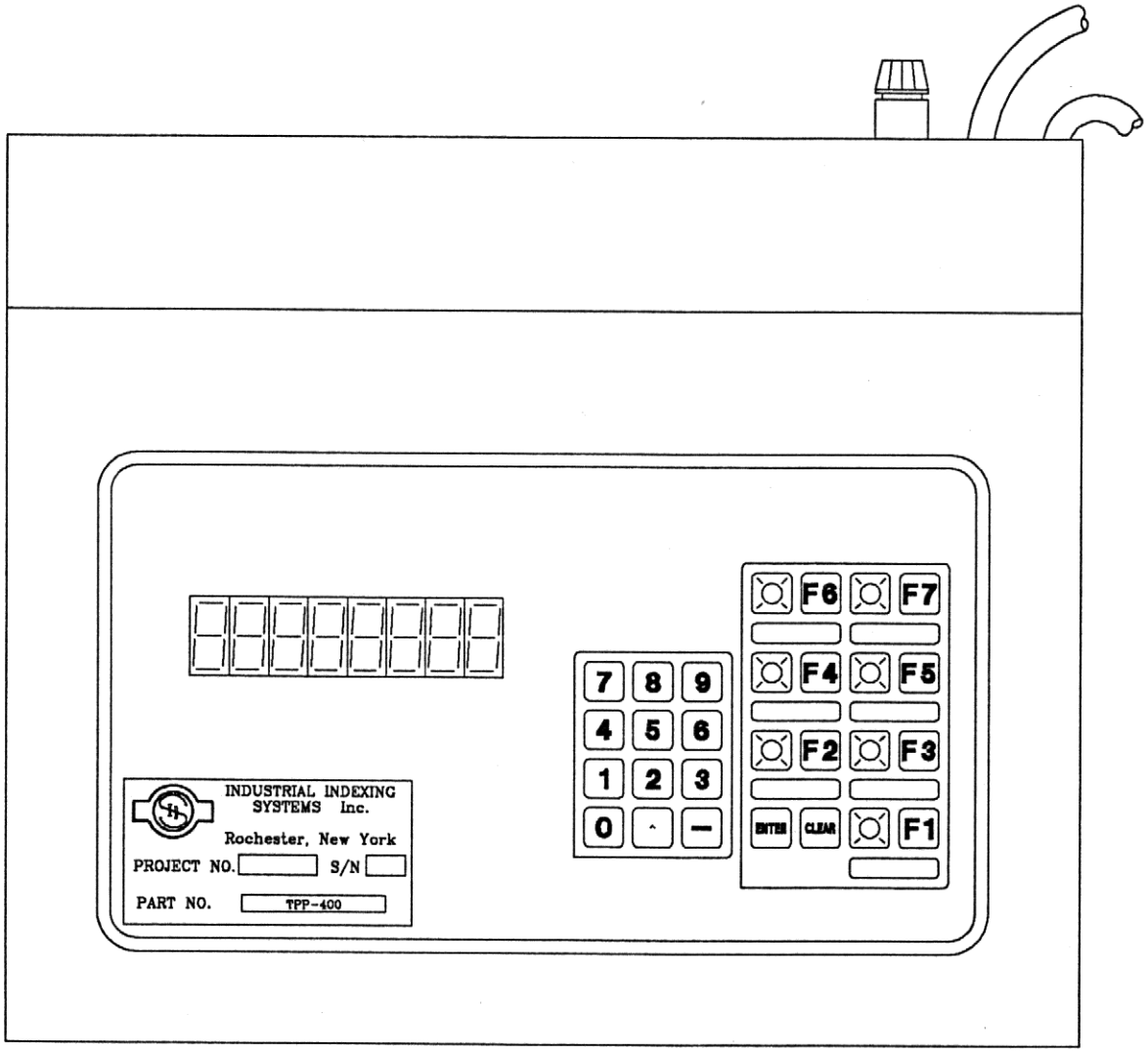


Figure 1.13 - TPP-400 Touch Panel Programmer

1.5. SPECIFICATIONS

1.5.1. PHYSICAL REQUIREMENTS

1) **Environment**

Operating Temperature:	0 to 60°C
Ventilation:	Unit must have 5 inches of free air flow above.
Humidity:	30-90% relative (non-condensing)

2) **Size**

Length:	12.25" (311 mm)
Width:	10.25" (260 mm)
Height:	3.50" (89 mm)
	4.50" (114 mm) with INT-410

3) **Power Requirements**

Input Voltage:	115 VAC ±10%
Frequency:	50-60 Hz
Input Current:	1.0 Amp Maximum

4) **DC Input Module (S410)**

ON Voltage:	10-32 VDC
OFF Voltage:	1 VDC Maximum
ON Current:	25 mA @ 32 VDC
OFF Current (Leakage):	0.8 mA Maximum

5) **AC Input Module (S420)**

ON Voltage:	90-135 VAC
OFF Voltage:	30 VAC Maximum
ON Current:	15 mA @ 120 VAC
Input Impedance:	10K Nominal

6) **AC Input Module (S421)**

ON Voltage:	180-270 VAC
OFF Voltage:	60 VAC Maximum
ON Current:	15 mA @ 240 VAC
Input Impedance:	10K Nominal

7) High Speed DC Input Module (HSI-850)

ON Voltage:	5 VDC (Jumper In) 12-24 VDC (Jumper Cut)
OFF Voltage:	2 VDC Maximum
ON Current:	20 mA Maximum

8) DC Output Module (S430)

Voltage Range:	10-55 VDC
Current Rating:	2.75 Amps Maximum
Voltage Drop ON:	2 VDC Maximum @ 2.75 Amps
OFF Current (Leakage):	10 ma. Maximum @ 55 VDC

9) AC Output Module (S440)

Voltage Range:	30-140 VAC
Current Rating:	2.75 Amps Maximum
Voltage Drop ON:	1.5 VAC Maximum @ 2.75 Amps
OFF Current (Leakage):	4 mA Maximum @ 140 VAC

1.5.2. PERFORMANCE SPECIFICATIONS

1) Positional Range

MM-10-PLUS:	±2047 revolutions in 1/4096 revolution increments.
MM-10-T:	±8,388,608 counts in 1 count increments.

2) Positional Accuracy

MM-10-PLUS:	±10 minutes arc
MM-10-T:	±1 Count

3) Positional Repeatability (MM-10-PLUS)

±5 minutes arc

4) Acceleration/Deceleration Range

MM-10-PLUS:	50 to 500 Revolutions/Sec/Sec (Potentiometer) 3 to 500 Revolutions/Sec/Sec (Serial)
MM-10-T:	204,800 to 2,048,000 Counts/Sec/Sec (Potentiometer) 12,288 to 2,048,000 Counts/Sec/Sec (Serial)

5) **Speed Control Range**

MM-10-PLUS

INDEX:	250 to 3200 RPM (Potentiometer)
	1 to 3600 RPM (Serial)
	125-1600 RPM (Mode 9)
HOME:	1 to 3600 RPM
JOG:	1 to 500 RPM (Potentiometer)
	1 to 3600 RPM (Serial)
OVERDRAW:	1 to 500 RPM
INITIALIZE:	1 to 500 RPM

MM-10-T

INDEX:	17,067 to 218,453 counts/sec (Potentiometer)
	68 to 245,760 counts/sec (Serial)
	8500 to 108,800 counts/sec (Mode 9)
HOME:	68 to 245,760 counts/sec
JOG:	68 to 34,133 counts/sec (Potentiometer)
	68 to 245,760 counts/sec (Serial)
OVERDRAW:	68 to 34,133 counts/sec
INITIALIZE:	68 to 34,133 counts/sec

6) **Speed Accuracy**

±2% of Set Speed (Potentiometer control)
±1% of Set Speed (Serial control)

7) **Speed Resolution**

MM-10-PLUS:	±1 RPM
MM-10-T:	±68 Counts/Sec

8) **Motor Error Output (POS OUT)**

Industrial standard ±10 VDC amplifier drive signal @ 10 mA Maximum. CW rotation of feedback must device result in (+) increase in output voltage.

9) **Drive/Amplifier Enable**

Optical Isolator:	30 VDC Maximum @ 20 mA Maximum (Circuit is closed to enable drive/amplifier.)

1.5.3. SYSTEM PARAMETERS

MM-10-PLUS

Index Speed:	250 - 3200 RPM (Potentiometer) 1 - 3600 RPM (Serial) 125-1600 RPM (Mode 9)
Home Speed:	1 - 3600 RPM
Jog/Overdraw Speed:	1 - 500 RPM (Potentiometer) 1 - 3600 RPM (Serial)
Ramp Rate:	50 - 500 Revs/sec/sec (Potentiometer) 3 - 500 Revs/Sec/Sec (Serial)
Initialize Speed/Direction:	-500 to 500 RPM (50% = 0 RPM)
Overdraw Length:	0 to 4 Revolutions (Potentiometer) 0 to 2 Revolutions (Serial) 0 to 1 Revolutions (Mode 9)
Early Index Distance:	0 to 2 Revolutions

MM-10-T

Index Speed:	17,067 - 218,453 Counts/Sec (Potentiometer) 68 - 245,760 Counts/Sec (Serial) 8500 to 108,800 counts/sec (Mode 9)
Home Speed:	68 - 245,760 Counts/Sec
Jog/Overdraw Speed:	68 - 34,133 Counts/Sec (Potentiometer) 68 - 245,760 Counts/Sec (Serial)
Ramp Rate:	204,800 - 2,048,000 Counts/Sec/Sec (Poten.) 12,288 - 2,048,000 Counts/Sec/Sec (Serial)
Initialize Speed/Direction:	-34,133 to +34,133 Counts/Sec) (50% = 0 Counts/Sec)
Overdraw Length:	0 to 16,384 Counts (Potentiometer) 0 to 8,192 Counts (Serial) 0 to 4,096 Counts (Mode 9)
Early Index Distance:	0 to 8,192 Counts

SECTION 2 – INSTALLATION

The Motion Master controller is one part of a complete indexing control system. As such, its installation is determined by the system designer and may be accomplished in a variety of ways. This section is intended to present basic installation information to assist the system designer and the person responsible for installation.

NOTE

This manual only includes installation information for the MM-10-PLUS/MM-10-T controller and its peripheral devices. Refer to the drive system manual for details on mounting the drive, motor, and feedback device.

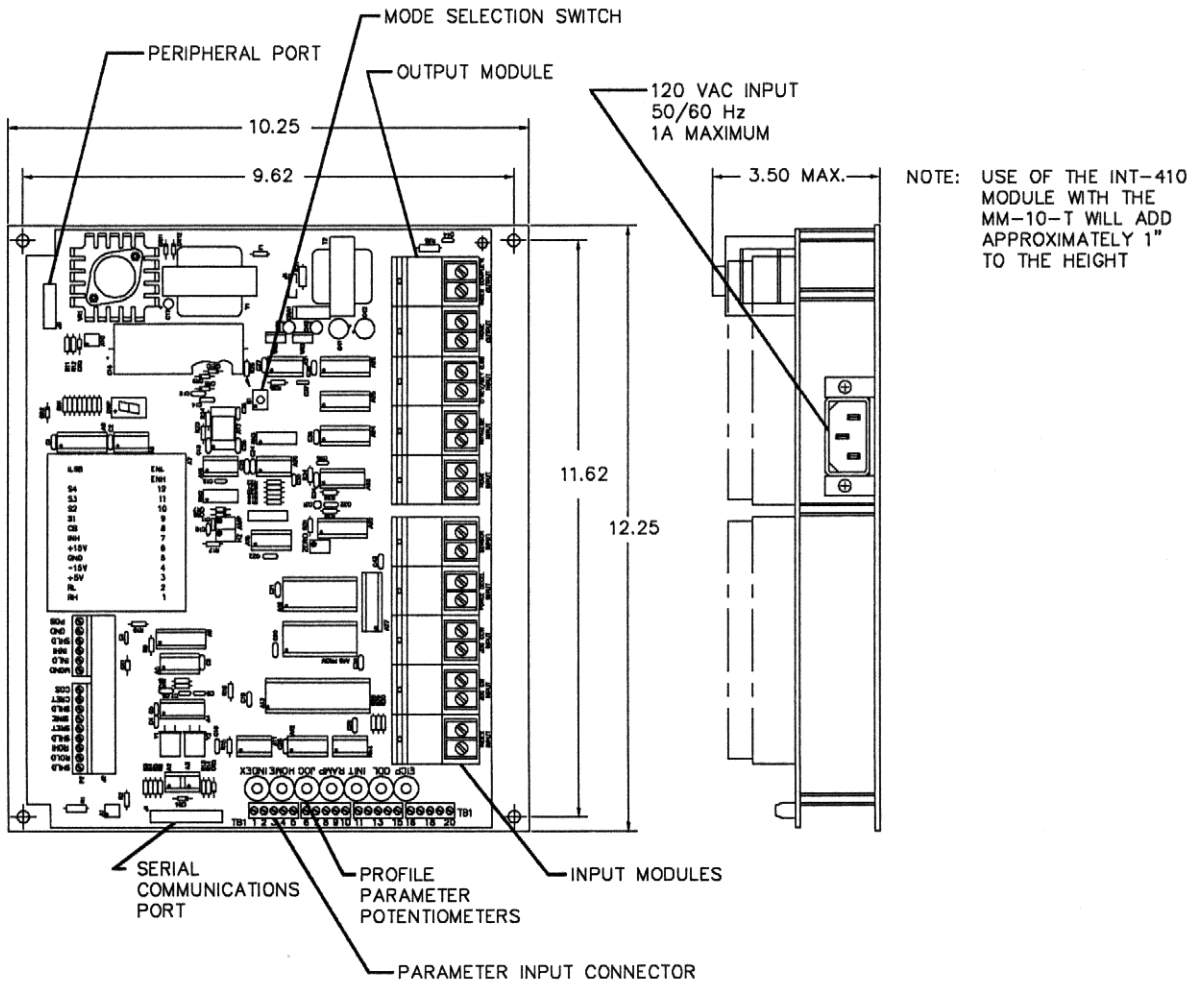


Figure 2.1 - Controller Installation Dimensions

2.1. MOUNTING

The MM-10-PLUS/MM-10-T controller can be mounted in any orientation. For easiest access, consideration should be given to the position of the various input, output, and adjustment features of the controller. **Figure 2.1** shows mounting dimensions for the controller.

1) Attach the controller using (4) #10 screws.

2) Mount any peripheral devices included in the system. (Refer to **"Section 4 - Peripheral Devices"** for mounting dimensions and other details of the peripheral devices.)

NOTE

Any of the parameters controlled by the on-board parameter programming potentiometers may be controlled from an external 10K ohm potentiometer or fixed resistor divider network.

3) Mount any external potentiometers or fixed resistor divider networks which will be used to replace the on-board parameter programming potentiometers.

4) Install the proper input and output modules on the controller. (Refer to **Section 1.5.1.** for module specifications.)

2.2. ELECTRICAL CONNECTIONS

Electrical connections will vary based on the number and type of peripheral devices included in the system and the type of controller (MM-10-PLUS or MM-10-T). The generalizations in this section will be suitable in all cases, except that wiring connections will not be required in a system if the related device is not present. Specific cables will not be listed since these are custom specified for each system based on the physical locations of the various system components. If required, contact the factory for assistance with specifying cables.

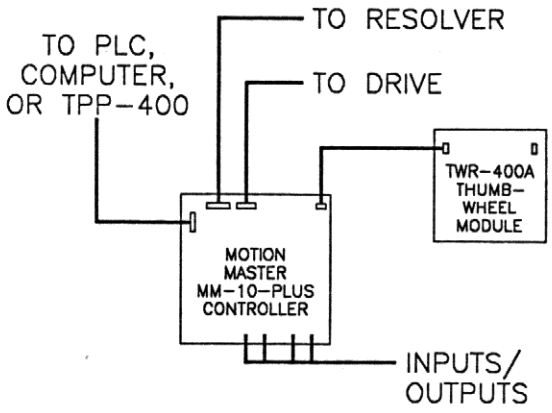


Figure 2.2 - Simple Connection Diagram

2.2.1. CONTROLLER AND PERIPHERAL CONNECTIONS

Figure 2.2 shows a simple controller system installation. The system consists of the MM-10-PLUS controller and a single TWR-400A Thumb-wheel Input Module. It also has a serial connection to a PLC or computer. **Figure 2.3** shows a complex controller system installation consisting of an MM-10-T controller, two TWR-410A Strobed Thumb-wheel Input Modules, and one of each of the other available peripheral modules.

These two figures demonstrate the range of possible electrical connections for controller installation. However, actual connections are very similar for either example.

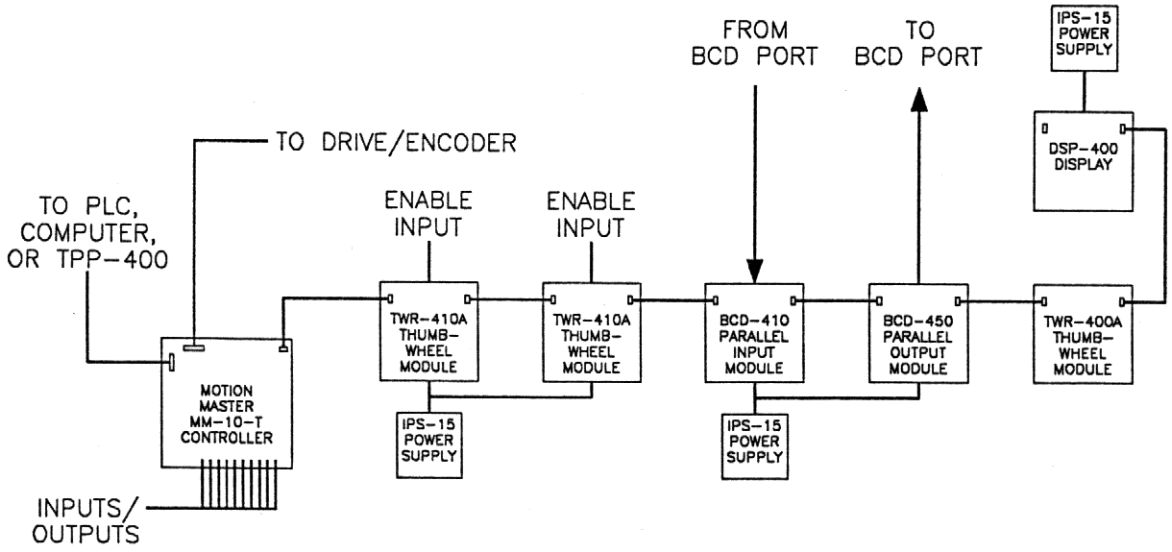


Figure 2.3 - Complex Connection Diagram

WARNING

NEVER APPLY INPUT POWER TO ANY PART OF THE CONTROLLER SYSTEM (OR DRIVE SYSTEM) UNTIL ALL SYSTEM WIRING CONNECTIONS HAVE BEEN COMPLETED.

1) Connect the controller to the drive and feedback device using the appropriate cables. The cable lengths will vary based on component locations. Standard Industrial Indexing Systems, Inc. cables for these applications are available including cable kits with just end connectors and no connecting cable.

2) Connect all peripheral devices in a daisy-chain series connection as illustrated in **Figure 2.3**.

NOTE

The sequence of peripheral devices is not important except that the TWR-400A Thumb-wheel Input Module, if present, must come after all TWR-410A Strobed Thumb-wheel Input Modules.

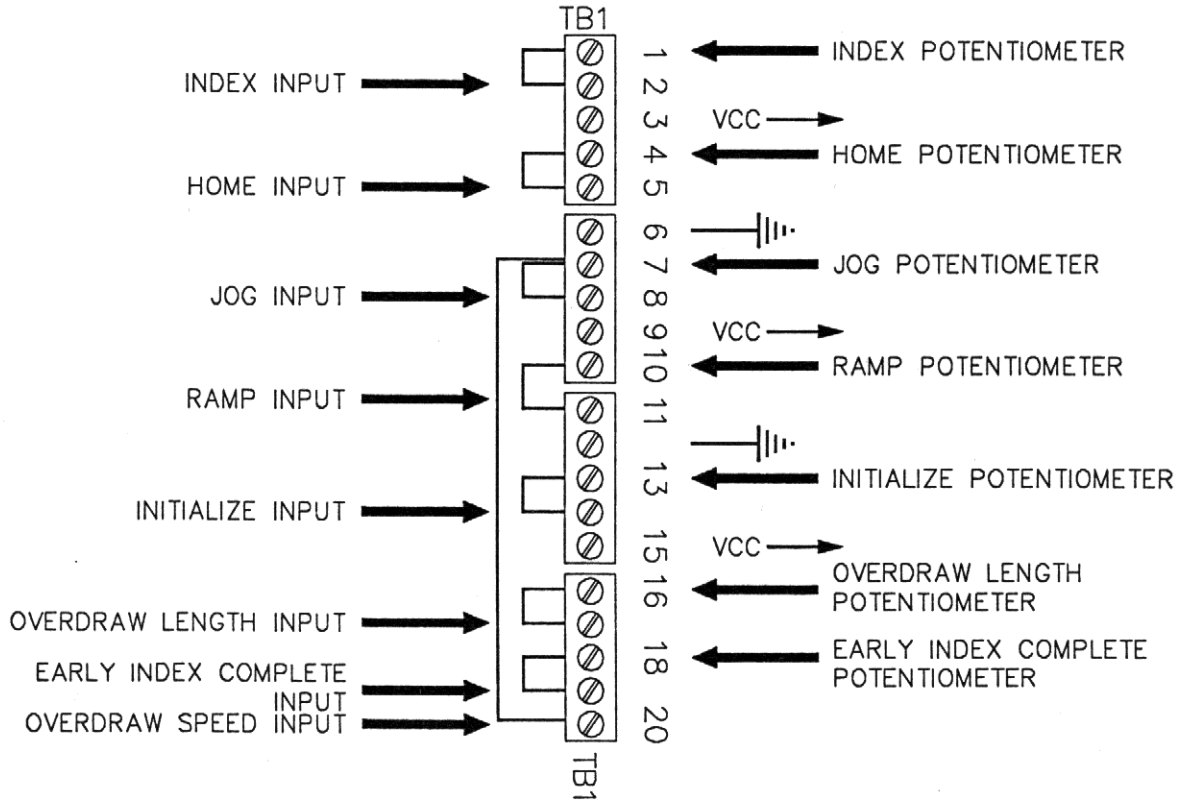


Figure 2.4 - Factory Configuration for Program Input Connector

3) Connect the IPS-15 Power Supply to each peripheral device except the TWR-400A Thumb-wheel Input Module which obtains its power from the MM-10-PLUS/MM-10-T controller itself. Supply input power connections to the power supply, but do not connect any power until all other wiring connections are complete.

Any of the parameters controlled by the on-board profile parameter potentiometers may be controlled from an external 10K ohm potentiometer or fixed resistor divider network. **Figure 2.4** shows the factory configuration for the program input connector. The jumpers on TB1 allow seven potentiometers to control eight parameters. (Jog and overdraw speeds are controlled by the same potentiometer as configured at the factory.)

Figure 2.5 shows external potentiometer connections if all on-board potentiometers are replaced by external potentiometers. However, it is not necessary to replace any on-board potentiometers and, if replacements are made, not all potentiometers must be replaced.. There are three logic operating voltage sources (VCC) and two ground (GND) terminals on TB1. These can be used as desired to connect as few or as many external potentiometers as required.

4) Remove the factory-installed jumper for the parameter to be controlled externally. Connect the external potentiometer to the appropriate terminals.

A profile parameter potentiometer can also be replaced by a fixed resistor divider network if the parameter is to be controlled at a single setting. The maximum

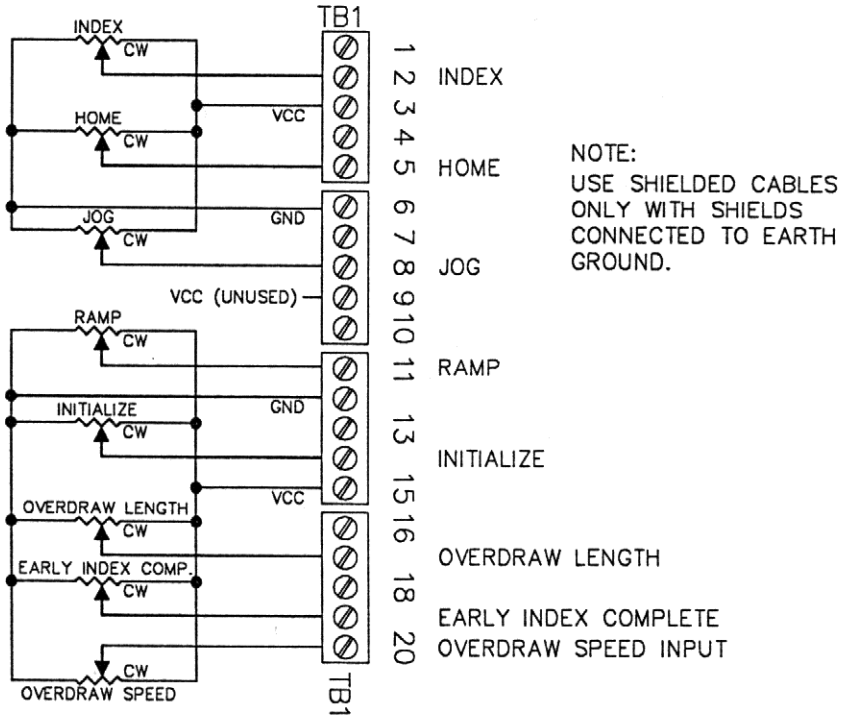


Figure 2.5 - External Potentiometer Connections for TB1

parameter settings are shown in **"Paragraph 1.5.3. - System Parameters"**. The minimum resistance between the logic operating voltage (VCC) and Ground should be 10,000 ohms.

NOTE

The "Initialize" potentiometer is a special situation. 0 volts = -500 RPM (counterclockwise); VCC = 500 RPM (clockwise); VCC/2 = 0 RPM.

5) If serial inputs are to be used, connect the appropriate cable from the serial port on the MM-10-PLUS/MM-10-T controller to the computer, programmable logic controller, or TPP-400 Touch Panel Programmer. Refer to **Figure 2.6** for

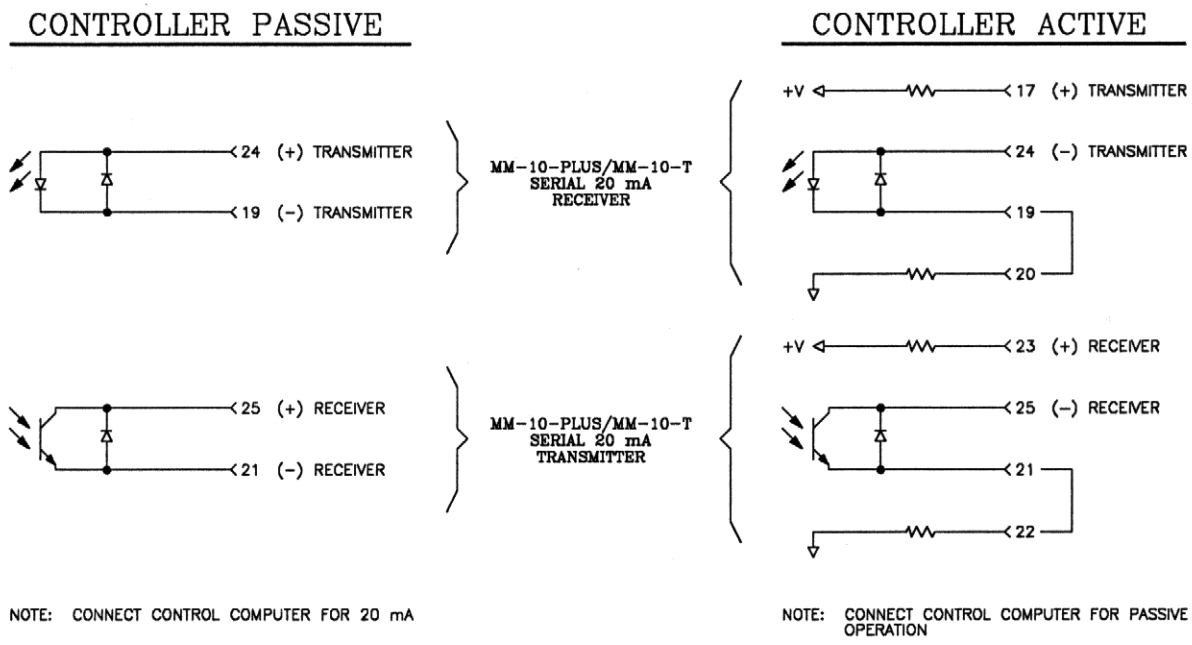


Figure 2.6 - Serial Communication Port Terminal Connections

appropriate pin connections for the controller passive (communications current being supplied by the host computer) or active (communications current supplied by the MM-10-PLUS/MM-10-T controller).

6) Connect the actuating devices to the input modules. (Refer to **Paragraph 1.5.1.** for the module specifications.) Note the positive terminal for DC input modules shown in **Figure 2.7**.

7) Connect the activated devices to the output modules. (Refer to **Paragraph 1.5.1.** for the module specifications.) Note the position of the load to the output module terminals and the diode necessary for the DC output module shown in **Figure 2.7**.

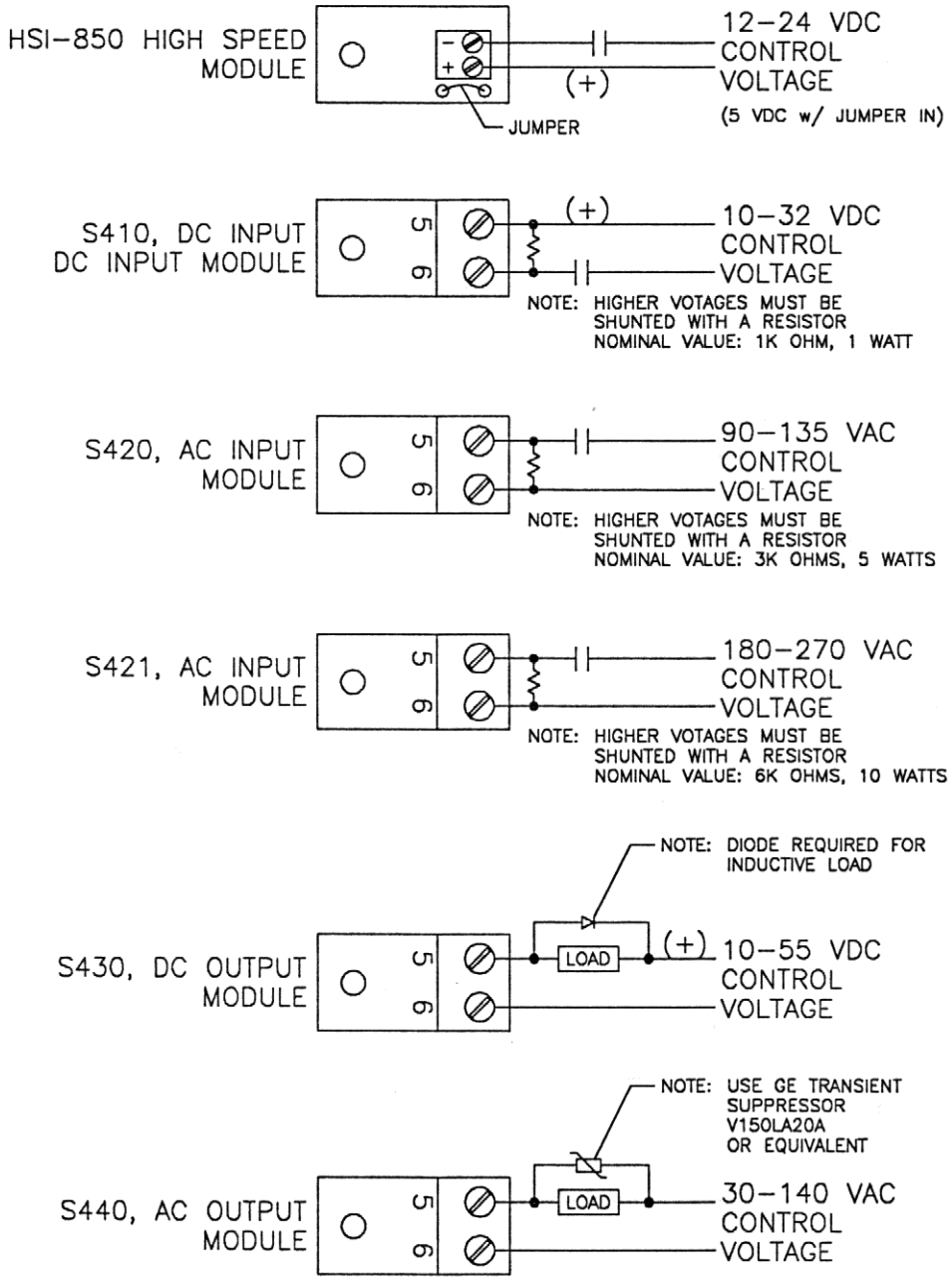


Figure 2.7 - I/O Module Connections

8) Connect the input power cable to the input power socket on the controller.

2.2.2. MM-10-PLUS/DRIVE AND RESOLVER INTERCONNECTIONS

Figure 2.8 shows typical interconnections for the MM-10-PLUS controller. Actual connections to the drive, motor, and resolver will depend on the system components and design.

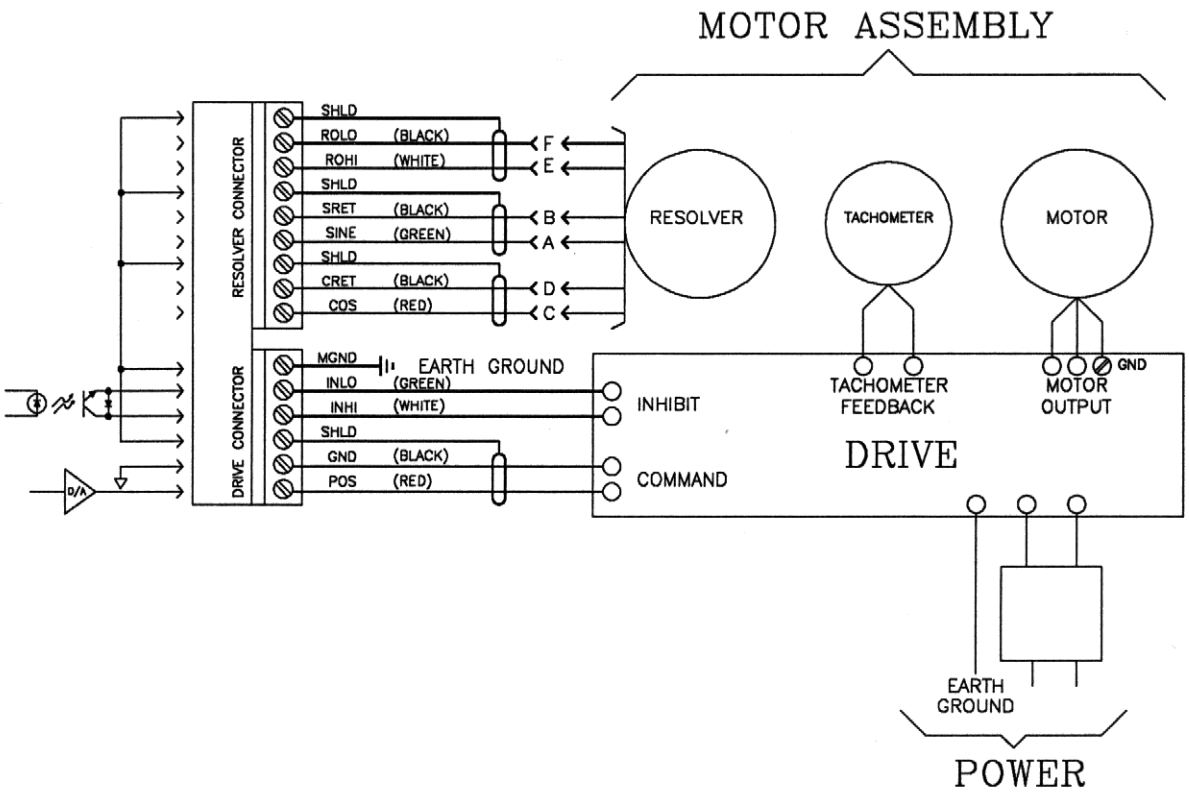


Figure 2.8 - Typical MM-10-PLUS System Interconnections

All connecting wires are shielded pairs to prevent noise and other signal errors. The shields must be connected to earth ground.

NOTE

The Drive and Resolver each have separate connectors. However, in a typical connection application, the wires from both connectors are joined together in a single cable. Wires within the cable are separate shielded pairs. Wire colors shown are for Industrial Indexing Systems cables.

2.2.3. MM-10-T/DRIVE AND ENCODER INTERCONNECTIONS

Figure 2.9 shows typical interconnections for the MM-10-T controller when used without the INT-410 interface module. Actual connections to the drive, motor, and encoder will depend on the system components and design.

The drive inhibit is driven by the output of a 4N33 optical coupler with back diode (closed when enabled). Use less than 20 mA current. The drive/motor velocity loop must be configured to provide clockwise encoder rotation when "POS OUT" signal goes negative. The position loop error voltage is ±10 VDC for ±180° rotation on the encoder with default configurations and line count of 1024 counts/revolution.

The MM-10-T interface to the drive and encoder is a 25-pin connector. Pin connections are shown in **Figure 2.10**. The wiring connections for pins 11, 12, 13,

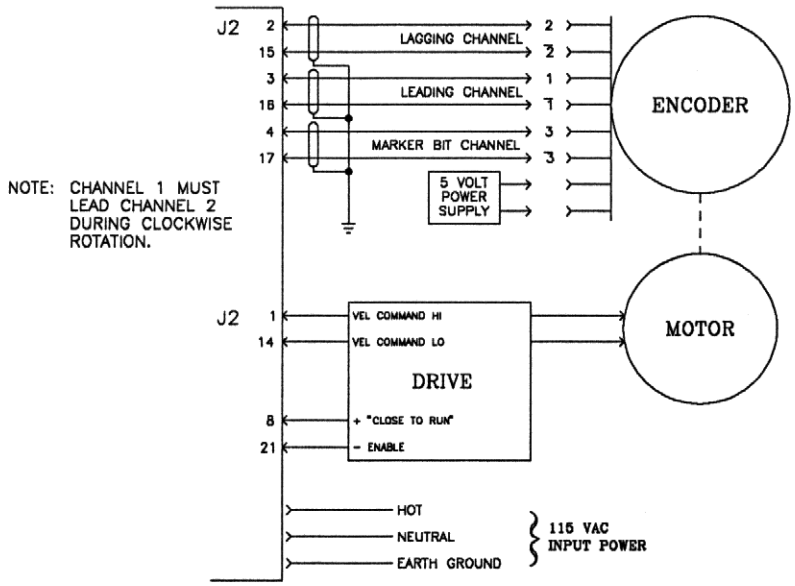
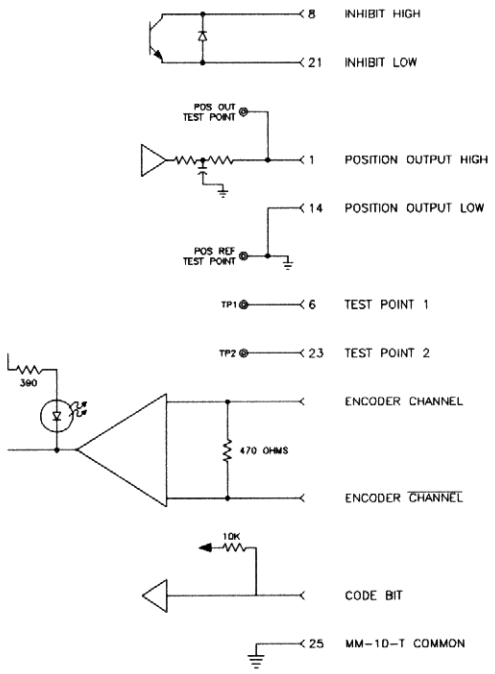


Figure 2.9 - Typical MM-10-T System Interconnections w/o INT-410

and 24 are specific for the type of encoder being used. Settings for the four code bits are shown in **Figure 2.11**. When assembling the connector to the controller, connect the indicated pins to common or allow them to float as necessary to match the encoder being used.

2.2.4. MM-10-T/DRIVE AND ENCODER WITH INT-410

The INT-410 interface simplifies the MM-10-T interconnection wiring process. The INT-410 is designed to work with the C-300yyy encoder cable. This cable is fitted with an MS-3106A18-IS connector for the encoder-end of the cable and ferrules at the controller-end of the cable. This permits both easy installation of the cable in conduit and rapid connection of the ferrule ends at the interface module.



PIN	DESCRIPTION
1	POSITION OUTPUT HIGH
2	ENCODER CHANNEL 2
3	ENCODER CHANNEL 1
4	ENCODER CHANNEL 3 (M)
5	NO CONNECTION
6	TEST POINT 1
7	NO CONNECTION
8	INHIBIT HIGH
9	NO CONNECTION
10	NO CONNECTION
11	CODE BIT 1
12	CODE BIT 2
13	CODE BIT 3
14	POSITION OUTPUT LOW
15	ENCODER CHANNEL $\overline{2}$
16	ENCODER CHANNEL $\overline{1}$
17	ENCODER CHANNEL $\overline{3}$ ($\overline{M}$)
18	NO CONNECTION
19	NO CONNECTION
20	NO CONNECTION
21	INHIBIT LOW
22	NO CONNECTION
23	MM-10-T TEST POINT 2
24	CODE BIT 4
25	MM-10-T COMMON

Figure 2.10 - MM-10-T/Drive and Encoder Interface Pin Assignments

EQUIVALENT CONFIGURATION SWITCH (S4) SETTING	ENCODER TYPE		CODE BIT CONFIGURATION WIRING			
	LINE COUNT	BITS PER REVOLUTION	PIN 11	PIN 12	PIN 13	PIN 24
0	1024	4096	F	F	F	F
1	512	2048	F	F	F	C
2	2048	8192	F	F	C	F
3	4096	16384	F	F	C	C
4	1000	4000	F	C	F	F
5	2000	8000	F	C	F	C
6	1024	4096	F	C	C	F
7	1024	4096	F	C	C	C
8	1024	4096	C	F	F	F
9	1024	4096	C	F	F	C
A	1024	4096	C	F	C	F
B	1024	4096	C	F	C	C
C	1024	4096	C	C	F	F
D	1024	4096	C	C	F	C
E	1024	4096	C	C	C	F
F	1024	4096	C	C	C	C

F = FLOAT (NC)
C = COMMON

Figure 2.11 - Code Bit Settings

When used, the INT-410 is connected to the encoder/drive connector on the MM-10-T controller. Attach the module to the MM-10-T board by using stand-offs between the board and the module. Make sure the connectors are firmly seated. Attach each of the ferrules in the appropriate connector on the INT-410 module. Check all connections to make sure they are tight.

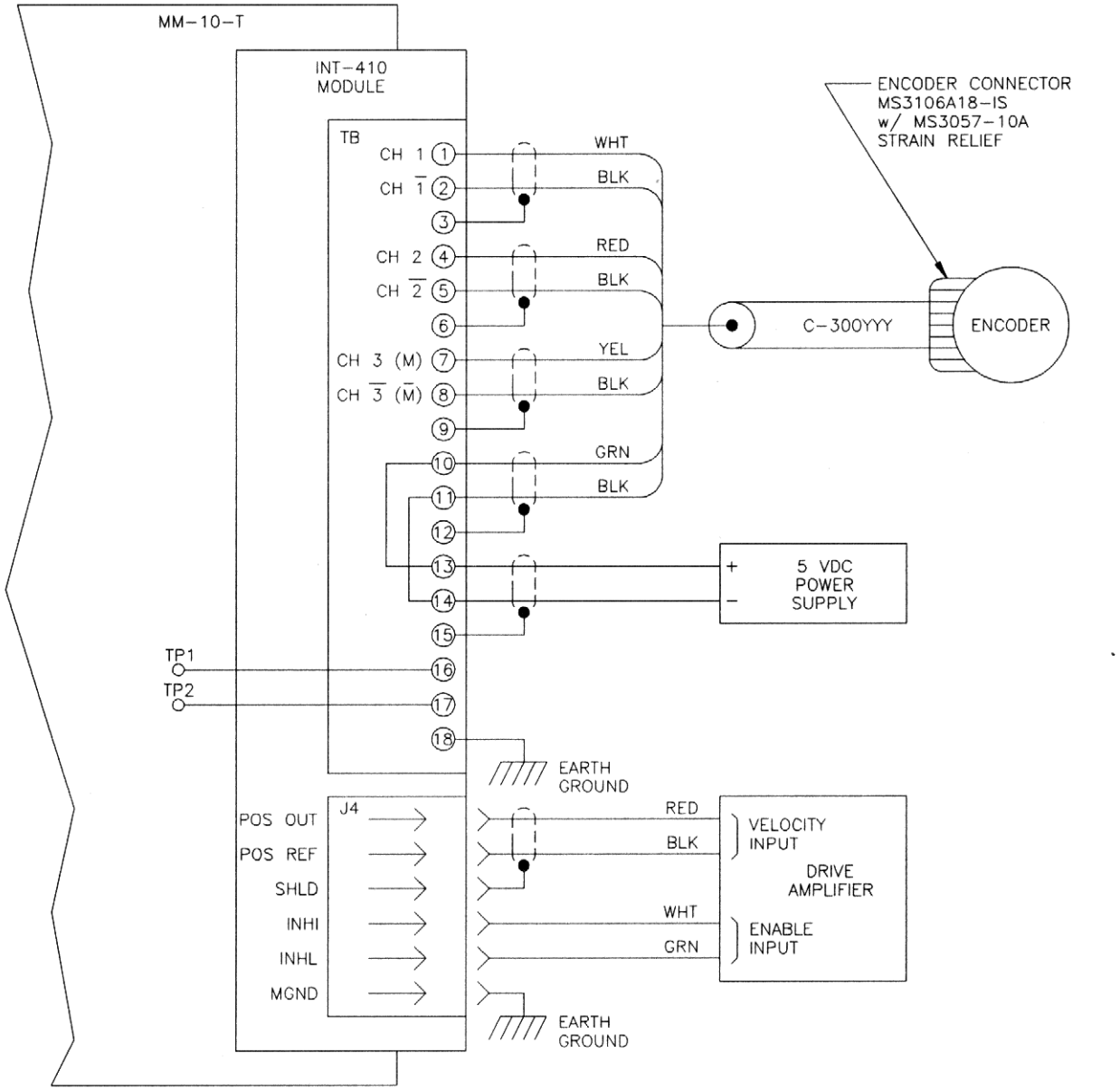


Figure 2.12 - Typical MM-10-T System Interconnections w/ INT-410

Figure 2.12 shows typical interconnections when using the INT-410 module attached to the MM-10-T. The settings for configuration switch S4 which correspond to specific types of encoders are shown in **Figure 2.13**. The configuration switch must be set to the proper

encoder type for the system to function properly.

CONFIGURATION SWITCH (S4) SETTING	ENCODER TYPE	
	LINE COUNT	BITS PER REVOLUTION
0	1024	4096
1	512	2048
2	2048	8192
3	4096	16384
4	1000	4000
5	2000	8000
6	1024	4096
7	1024	4096
8	1024	4096
9	1024	4096
A	1024	4096
B	1024	4096
C	1024	4096
D	1024	4096
E	1024	4096
F	1024	4096

Figure 2.13
Configuration Switch Settings

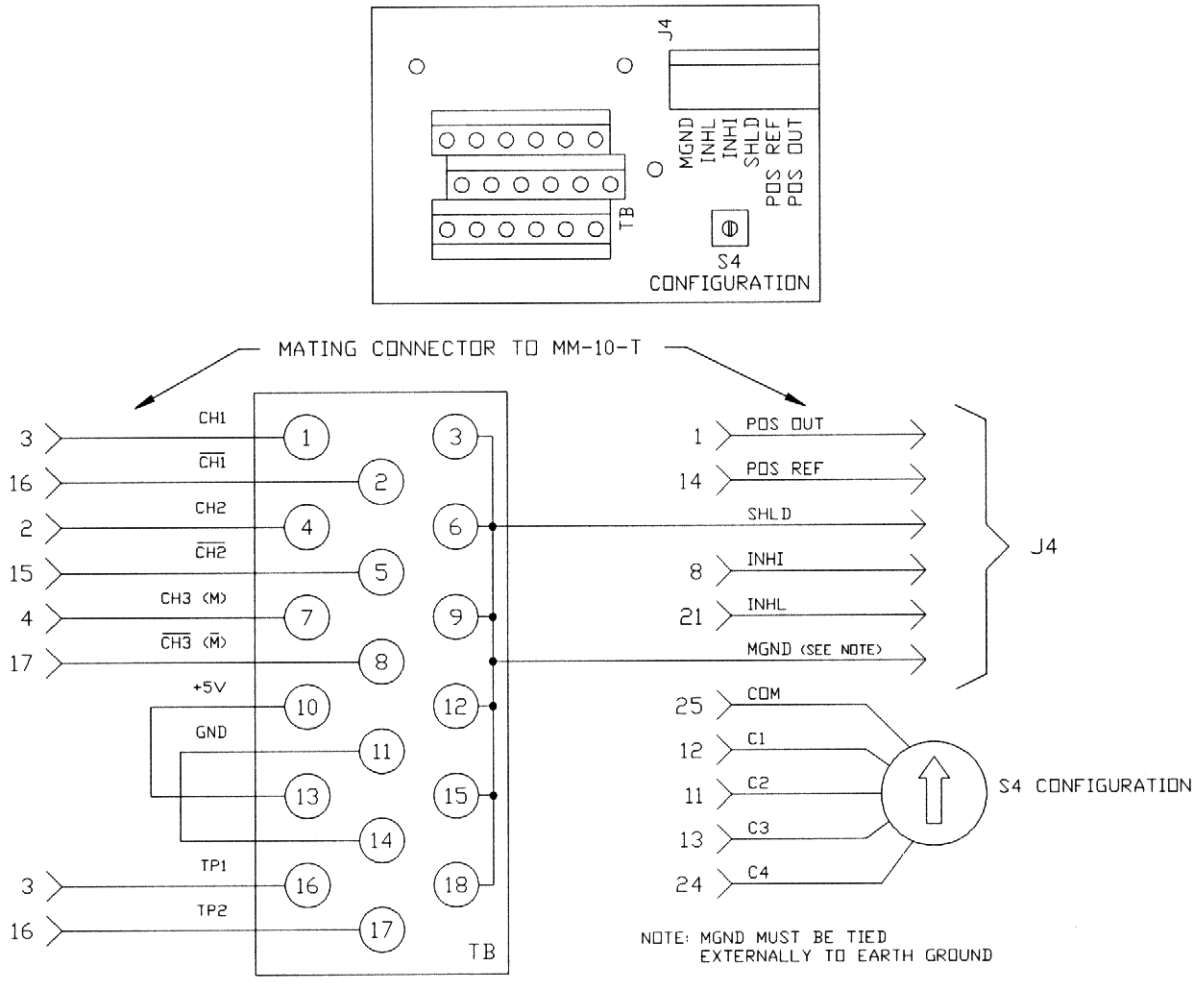


Figure 2.14
INT-410 Interface Board Interconnect

SECTION 3 – CONTROLS AND OPERATION

3.1. CONTROLS

Operating controls for the MM-10-PLUS controller are shown in **Figure 3.1**. Controls for the MM-10-T controller are shown in **Figure 3.2**. The controls for the two are identical with the exception of the additional Loop Gain Switch for the MM-10-T controller.

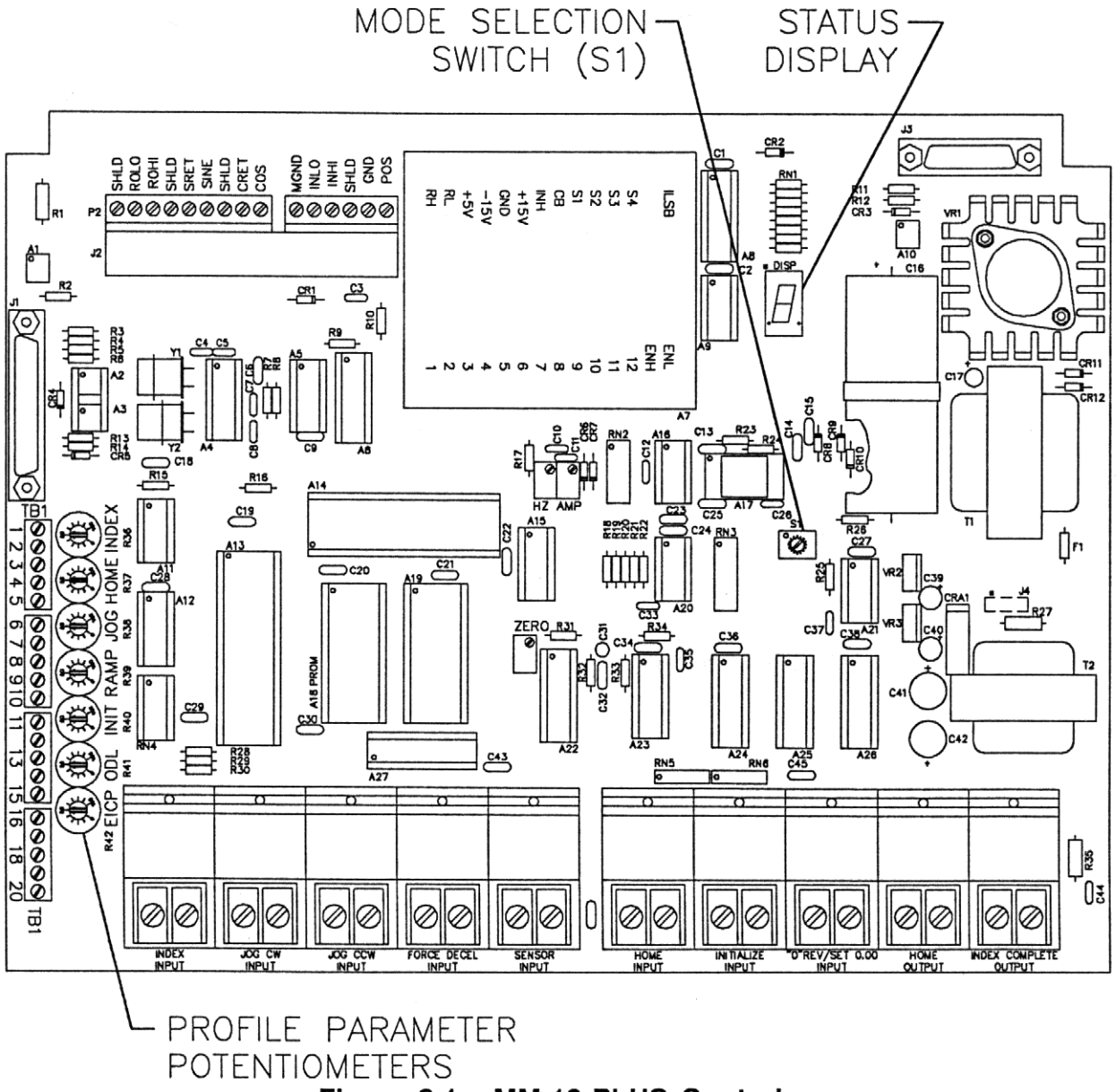


Figure 3.1 - MM-10-PLUS Controls

1) Profile Parameter Potentiometers: There are seven potentiometers which set motor rotation, acceleration/deceleration rates, and rotation limits for overdraw and early index. (Refer to **Paragraph 3.2.1.** for detailed information on each of the potentiometers and to **Paragraph 1.5.3.** for operating parameter limits.)

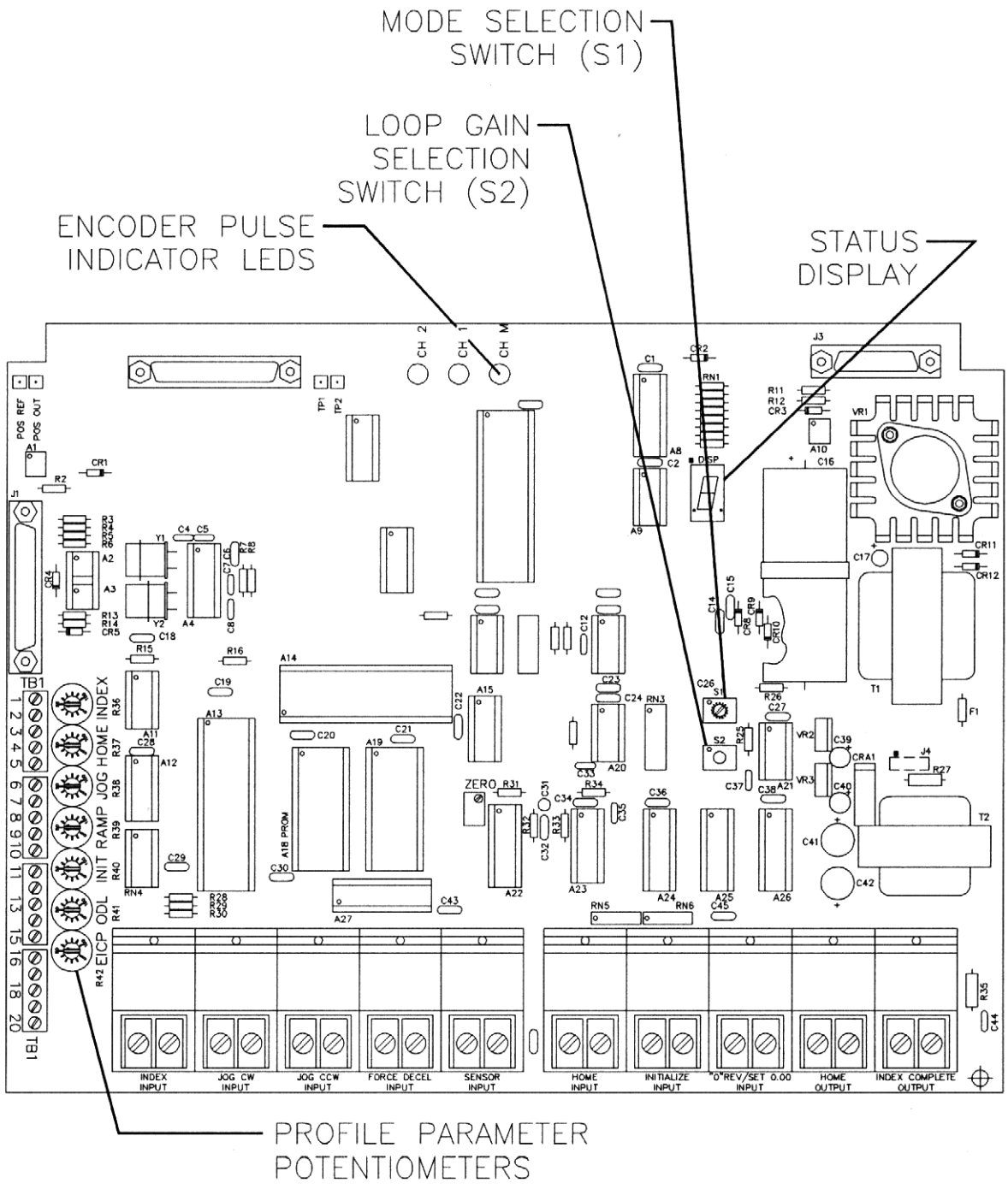


Figure 3.2 - MM-10-T Controls

2) Mode Selection Switch: This 16-position selector switch sets the mode of operation for the controller. (Changing the selector switch will not change the mode until the power is cycled off and on.) The "0" position is used for test sequences (refer to **"Section 6 - Troubleshooting"**). The features of each of the other modes are explained in **"Section 3.4 - Modes of Operation"**.

3) Status Display: This LED (Light Emitting Diode) display shows the current status of the controller. If there is an error message, the display will alternately flash the error number and the letter "e". If there is no error, the display will show the operating mode of the controller.

4) Loop Gain Switch S2 (MM-10-T only): This 16-position selector switch equalizes the voltage per pulse output of various encoders which might be used in the indexing system to the desired stability factor of 20 volts per 1024 quadrature pulses (4096 bits) per revolution. **Table 3.1** shows the gain and allowable following error for each of the settings of the selector switch (positions 8 through F are not used).

Table 3.1 - Loop Gain Switch Settings

SETTING	GAIN EFFECT	FOLLOWING ERROR
0	10 volts/ 2048 bits	2,000 bits
1	10 volts/16384 bits	16,000 bits
2	10 volts/ 8192 bits	8,000 bits
3	10 volts/ 4096 bits	4,000 bits
4	10 volts/ 3072 bits	3,000 bits
5	10 volts/ 1365 bits	1,300 bits
6	10 volts/ 1024 bits	1,000 bits
7	10 volts/ 512 bits	500 bits

5) Encoder Pulse Indicator LEDs (MM-10-T only): The quadrature encoders used with the MM-10-T controller have three pulse streams—the two quadrature streams and a marker pulse which occurs once per revolution. There is one LED for each of these pulse streams. The LEDs for channels 1 and 2 flash each time a pulse is received on the corresponding stream. The LED for channel 3 remains on and goes off

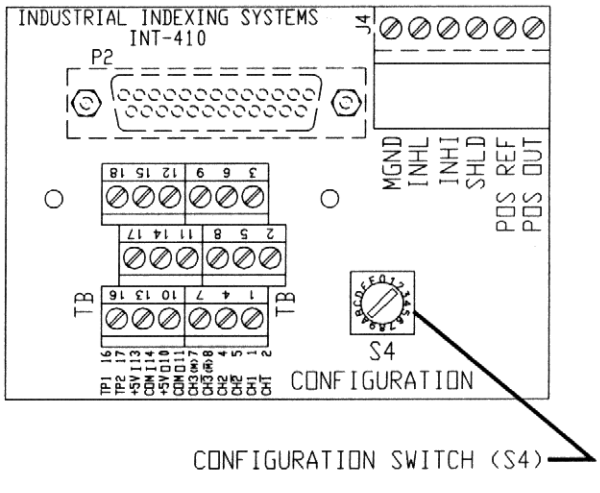


Figure 3.3
INT-410 Interface Module

briefly when a marker pulse is received. For clockwise rotation, channel 1 is the leading quadrature pulse stream; channel 2 is the lagging stream; and channel three is the marker pulse. For counterclockwise rotation, channel 2 is the leading quadrature pulse stream and channel 1 is the lagging stream.

6) Configuration Switch S4 (INT-410): This 16-position selector switch — located on the INT-410 interface module — sets the MM-10-T controller to the proper configuration to match the encoder being used. Both this switch setting and the Code Bits on the Serial Communication Port must be set properly before the MM-10-T will function properly with the Drive (refer to **Figure 3.4**).

CONFIGURATION SWITCH (S4) SETTING	ENCODER TYPE	
	LINE COUNT	BITS PER REVOLUTION
0	1024	4096
1	512	2048
2	2048	8192
3	4096	16384
4	1000	4000
5	2000	8000
6	1024	4096
7	1024	4096
8	1024	4096
9	1024	4096
A	1024	4096
B	1024	4096
C	1024	4096
D	1024	4096
E	1024	4096
F	1024	4096

Figure 3.4 - Configuration Switch Settings

3.2. OPERATING INPUTS

The Motion Master - Plus controller has a number of inputs. Several of the inputs can be obtained from a variety of sources. This section describes the functions of each of the inputs.

NOTE

Any of these inputs can be disabled and control assumed by the host computer or programmable logic controller when the MM-10-PLUS/MM-10-T controller is under serial control.

3.2.1. PROFILE ADJUSTMENTS

NOTE

Any references to motor shaft rotations of clockwise or counterclockwise are relative to viewing the shaft facing the shaft end of the motor.

There are eight parameters which can be programmed from the on-board profile parameter potentiometers (refer to **Figure 3.5**) or from external potentiometers connected through the program input connector.

1) Index Speed: The index speed is the maximum speed at which the motor will turn when it is under an "Index" input command. Refer to **Paragraph 1.5.3.** for the actual operating parameters of the controllers.

2) Home Speed: The home speed is the maximum speed at which the motor will turn when it is under a "Home" input command. Refer to **Paragraph 1.5.3.** for the actual operating parameters of the controllers.

3) Jog Speed: The jog speed is the maximum speed at which the motor will turn when it is under a "Jog CW" or "Jog CCW" command. Refer to **Paragraph 1.5.3.** for the actual operating parameters of the controllers.

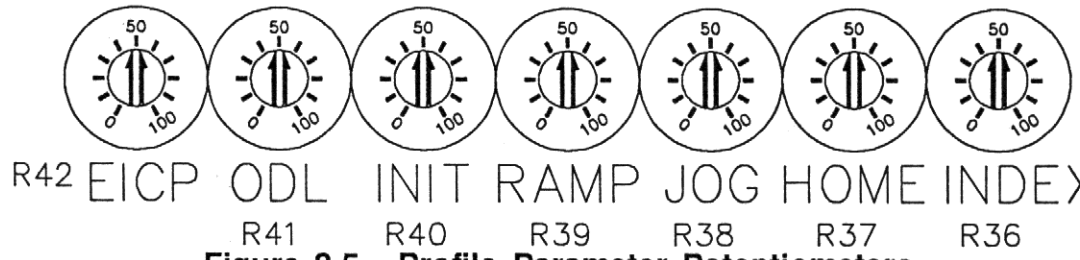


Figure 3.5 - Profile Parameter Potentiometers

NOTE

Under jog sequences, the motor will continue to rotate at the jog speed and will not decelerate until the jog command is removed.

4) Ramp Rate: The ramp rate is the rate of both acceleration and deceleration when the controller is executing any movement sequence including jog sequences. Refer to **Paragraph 1.5.3.** for the actual operating parameters of the controllers.

5) Initialize: Initialize is unique in that both speed and direction of the motor are controlled when an initialize command is received. At 50% on the potentiometer, the speed is zero. If the potentiometer is turned clockwise (toward 100%), the speed will increase to its maximum clockwise speed. If the potentiometer is turned counterclockwise (toward 0%), the speed will increase to its maximum counterclockwise speed. Refer to **Paragraph 1.5.3.** for the actual operating parameters of the controllers.

6) Overdraw Length: Overdraw length limits the amount of overdraw which is allowed if the sensor signal is not received. Refer to **Paragraph 1.5.3.** for the actual operating parameters of the controllers.

7) Early Index Complete: Early index complete controls the limits on how far before the actual completion of an index the "Index Complete" output can be actuated. Refer to **Paragraph 1.5.3.** for the actual operating parameters of the controllers.

8) Overdraw Speed: The overdraw speed is the speed at which the motor will turn when it is in an overdraw sequence (the motor decelerates to this speed at the end of the index/position sequence. As factory configured, the overdraw speed is jumpered to the jog speed and control is received from the same potentiometer. However, a separate external potentiometer could be supplied for overdraw speed. Refer to **Paragraph 1.5.3.** for the actual operating parameters of the controllers.

3.2.2. ENGINEERING UNITS

All input peripheral modules and output peripheral modules communicate movement data with the MM-10-PLUS/MM-10-T controller in terms of "Engineering Units". Engineering units are defined as any conversion which can be expressed as units per motor shaft revolution. They do not have to be a specific distance unit such as inches or millimeters. For example, if a trimming machine can work on pieces that are always

located at multiples of 5/16" apart, the engineering units could be the number of 5/16" moves per shaft revolution.

There are three methods of entering engineering units to the controller. Two of these methods are accessible under serial communications control and are discussed in **"Section 5.3 - Serial Communications, Programming Engineering Units"** and **"Appendix A - Programming with TPP-400 Touch Panel Controller"**. The other method is to enter the engineering units through the thumb-wheel input module or BCD-410 Parallel Input Module. This method is available in operating mode D (refer to **Paragraph 3.4.3.**).

NOTE

Engineering Units must be entered before any movement commands can be processed. If no engineering units have been programmed, the controller will return error message "e3". Most controllers are factory configured to a default engineering units value of 1.000.

3.2.3. DISTANCE INPUT

Distance input information may be entered to the MM-10-PLUS/MM-10-T controller through the TWR-400A Thumb-wheel Input Module, the TWR-410A Strobed Thumb-wheel Input Module, the BCD-410 Parallel Input Module, or serial communications from a host computer, programmable logic controller, or TPP-400 Touch Panel Programmer. As discussed in the previous section, input data is in engineering units.

Distance inputs will have various meanings depending on the operating mode of the controller. "Plus" distances indicate clockwise shaft rotation; "minus" distances indicate counterclockwise shaft rotation.

NOTE

Engineering Units can be negative which will cause the motor shaft rotation to be opposite the standard rotation for the sign of the distance input.

1) Index: The motor will rotate the indicated amount starting from its present position.

2) Position: The motor will rotate enough to reach the position indicated relative to a Home or 0.00 position. The direction of motor rotation will depend on the location of the motor when the position command is initiated.

3.2.4. INPUT MODULE DEFINITIONS

There are eight input modules associated with the MM-10-PLUS/MM-10-T controller. The modules are numbered #1 through #8 (as viewed from left to right in **Figure 3.6**) and are identified by their function. The modules may be either DC or AC modules. (Refer to **Paragraph 1.5.1.** for module specifications.)

To activate an input, a minimum voltage (90 VAC or 10 VDC) must be applied to the input for at least 24 milliseconds (.024 seconds). The exception to this is operating mode 9 where the required input time is 5 milliseconds (.005 seconds).

Input #1: **INDEX**

Causes the MM-10-PLUS/MM-10-T to drive the motor the distance specified by the distance variable. Distance is treated as an incremental or absolute value depending on the operating mode.

The input is "edge triggered". After the input is applied, the controller must see an off-to-on cycle while the motor is stopped before it will activate another index cycle. That is, if the "Index" input is still applied

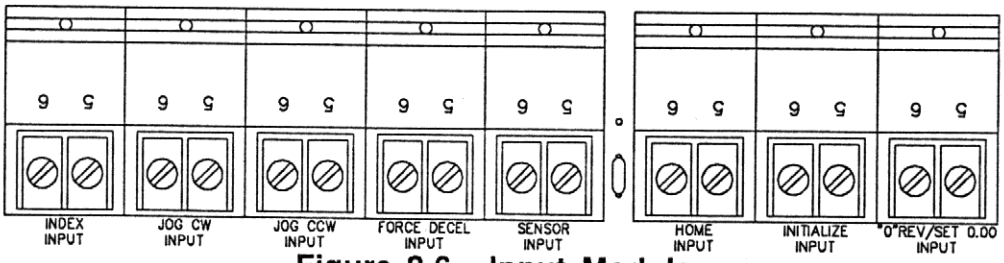


Figure 3.6 - Input Modules

after the index/position movement is completed, or if it is reapplied before the movement is completed, the motor will not repeat the movement because it has not seen the leading edge of the input signal while the motor is stopped. After the input is removed and the motor is stopped, the movement can be repeated by again applying the input.

Input #2: **JOG CLOCKWISE**

Jogs the motor in a clockwise direction at the speed specified by the "Jog Speed" parameter. The motor will accelerate to "Jog Speed" at the "Ramp Rate". It will continue to rotate at "Jog Speed" as long as the input is energized. When the jog input is removed, the motor will decelerate at the "Ramp Rate" until it reaches 0 RPM.

Input #3: **JOG COUNTERCLOCKWISE**

Jogs the motor in a counterclockwise direction at the speed specified by the "Jog Speed" parameter. The motor will accelerate to "Jog Speed" at the "Ramp Rate". It will continue to rotate at "Jog Speed" as long as the

input is energized. When the jog input is removed, the motor will decelerate at the "Ramp Rate" until it reaches 0 RPM.

Input #4: **FORCE DECEL**

Once activated, will force any motor motion (except jog) to be terminated. The motor will immediately begin to decelerate at the "Ramp Rate" until the speed reaches 0 RPM. It will continue to decelerate to a stop even if the input is removed. The "Home" and "Index Complete" outputs are not energized if a "Force Decel" is executed.

NOTE

The "Force Decel" input is also used to reset an "e2" error.

Input #5: **OVERDRAW SENSOR**

Used to stop the motor during an overdraw search sequence. This input is typically connected to a sensor that is searching for a registration mark on moving material.

The overdraw function and, therefore, the "Overdraw Sensor", may be disabled by moving the enable/disable jumper which is wired to input module #5 (Refer to **Figure 3.7**).

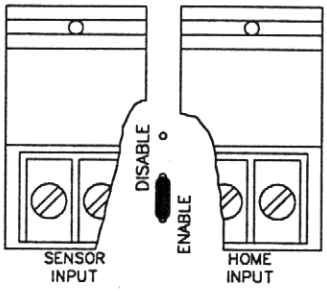


Figure 3.7
Overdraw Jumper

Input #6: **HOME**

Causes the MM-10-PLUS/MM-10-T to drive the motor to the 0.00 or Home location previously established in a "Set 0.00" or "Initialize" sequence. If neither a "Set 0.00" or "Initialize" sequence was executed, the 0.00 point is the nearest feedback-device 0.00 when power was applied.

WARNING

WHEN ENERGIZED, THE INITIALIZE INPUT ALWAYS CAUSES THE MOTOR TO ROTATE, EVEN IF IT IS ALREADY AT THE 0.00 POSITION.

Input #7: **INITIALIZE**

Causes the motor to find (calibrate) its Home or 0.00 location. The "Home" output is energized when the move is complete. (Refer to **Paragraph 3.5.5.** for more details on the "Initialize" function.)

Input #8: **SET 0.00/ZERO REVOLUTION (ZREV)**

In some single turn applications, this input may be used to set the current motor position as the 0.00 or Home location, depending on the operating mode. This input does not cause the motor shaft to move. The "Home" output is energized.

In some multi-turn applications, this input may be used to indicate the 0.00 turn of the system. Refer to **Paragraph 3.5.5** for more information on the use of this input with the initialize function. Refer to **Table 3.2** for identification of the operating modes when this switch is used for each function.

3.2.5. OPERATING MODES

The controller operating mode is determined by the 16-position Mode Selection Switch. After a mode change is selected, the power must be turned off and on again before the mode change is recognized. (These modes can be changed through serial communications without turning off the power.) **Section 3.4** gives complete information on the operating modes. **Table 3.2** shows which inputs and outputs are active in the various operating modes.

Table 3.2 - I/O Summary for MM-10-PLUS/MM-10-T Operating Modes

INPUTS	NO	0 TEST	1 SIMPLE INDEX	2 SIMPLE INDEX WITH MULTI-TURN INITIALIZATION	3 ABSOLUTE INDEX WITH FIXED HOME	4 ABSOLUTE INDEX WITH FIXED HOME & MULTI-TURN INITIALIZATION	5 ABSOLUTE INDEX WITH FLOATING HOME	6 POSITION WITH FIXED HOME	7 POSITION WITH FIXED HOME & MULTI-TURN INITIALIZATION	8 POSITION WITH FLOATING HOME	9 HIGH SPEED FEED DRIVE	A DIVIDER HEAD OR INDEXING TABLE	B NOT ASSIGNED	C NOT ASSIGNED	D THUMB-WHEEL PROGRAM OF ENGINEERING UNITS	E 2400 BAUD SERIAL CONTROL	F 300 BAUD SERIAL CONTROL
INDEX	1	T	A	A	A	A	A	A	A	A	A	A			P	–	–
JOG CW	2	T	A	A	A	A	A	A	A	A	A	A			P	–	–
JOG CCW	3	T	A	A	A	A	A	A	A	A	A	A			P	–	–
FORCE DECEL	4	T	A	A	A	A	A	A	A	A	A	A			P	–	–
OVERDRAW SENSOR	5	T	O	O	O	O	O	O	O	O	O	O			P	–	–
HOME	6	T	–	–	A	A	A	A	A	A	–	A			P	–	–
INITIALIZE	7	T	A	A	A	A		A	A	–	A	A			P	–	–
SET 0.00	8	T	–	–	–	–	A	–	–	A	–	–			P	–	–
"0" REV	8	T	–	A	–	A	–	–	A	–	–	A			P	–	–
DISTANCE INPUT		T	IC	IC	IC	IC	IC	AB	AB	AB	IC	ST			P	–	–
OUTPUTS																	
HOME	9	T	A	A	A	A	A	A	A	A	A	A			–	–	–
INDEX	10	T	A	A	A	A	A	A	A	A	A	A			–	–	–
DISTANCE OUTPUT		T	IC	IC	AB	AB	AB	AB	AB	AB	IC	ST			P	–	–

KEY

O = OPTIONAL
T = USED FOR TESTING
– = NOT ACTIVE
A = ACTIVE
P = USED FOR PROGRAMMING
IC = INCREMENTAL
AB = ABSOLUTE
ST = STATION

3.3. OPERATING OUTPUTS

NOTE

Any of the outputs can be disabled and control assumed by the host computer or programmable logic controller when the MM-10-PLUS/MM-10-T controller is under serial control.

3.3.1. DISTANCE OUTPUT PERIPHERAL MODULES

There are two peripheral devices used to output the distance information. The DSP-400 display is a 5-1/2 digit LED output device. The decimal point of the display is fixed by the customer at installation. The second output peripheral device is the BCD-450 Parallel Output Module. The BCD-450 sends a series of binary coded decimal digits to the customer's interface.

1) Each time an "Index" or "Home" input is received by the controller, the distance output will show the amount of movement. Depending on the operating mode, the output will either reset to zero at the start of the movement or will increment from its starting position.

2) When the controller receives a "Set 0.00" or "Initialize" sequence, the output will reset to zero.

3) When the controller receives a "Jog CW" or "Jog CCW" command, the output will increment from its present position without resetting to zero. The output will increase for "Jog CW" and decrease for "Jog CCW".

3.3.2. OUTPUT MODULES

There are two output modules associated with the MM-10-PLUS/MM-10-T controller. The modules are numbered #9 and #10 (as viewed from left to right in **Figure 3.8**) and are identified by their function. The modules may be either DC (standard) or AC (optional) modules. (Refer to **Paragraph 1.5.1.** for module specifications.)

Output #9: **HOME**

Activated when the motor shaft is at its "Home" or 0.00 position. This output is active in all operating modes but is off at power-up. It is not activated when motion is stopped by a "Force Decel" input or after a following error.

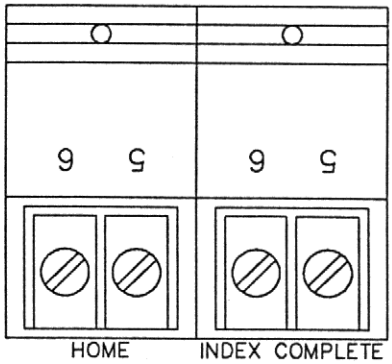


Figure 3.8
Output Modules

Output #10: **INDEX COMPLETE**

Activated when the motor completes the requested move. If an "Early Index Complete" option is in use, this output will be activated before the actual completion of the index as determined by the "Early Index Complete" potentiometer.

The "Index Complete" output is not activated if the move sequence was terminated by a "Force Decel" input. It is also not active at power-up, after a following error, or during a move to "Home". During jog sequences, this output will stay in whatever state it was in before the jog was initiated.

3.4. OPERATING MODES

The operating modes of the MM-10-PLUS/MM-10-T controller are established by the 16-position selector switch, S1. The mode of operation is read from the selector switch when power is applied to the unit. After a mode change is selected, the power must be turned off and on again before the mode change is recognized. (These modes can be changed through serial communications without turning off the power.) **Table 3.2** shows the relationships of the operating modes with the input and output modules and indicates which are active in the various operating modes.

3.4.1. INDEXING

An "Index" movement is one which uses its present location as the starting point. The position read from the input device is relative to that present location starting point. The direction of the movement is controlled by the sign (plus or minus) of the input. There are five indexing operating modes (Mode 1 through Mode 5).

Mode 1: SIMPLE INDEXING

The Simple Indexing Mode is designed for unidirectional applications such as feeding material into a punch press or shear. The drive feeds the incremental length specified by the "Distance" parameter. If an optional DSP-400 Display is being used, it will be cleared at the beginning of the index, and will show the length fed at the completion of the index.

The motor may be driven to the absolute "0" angle on the resolver or encoder using the INITIALIZE input.

Mode 2: SIMPLE INDEXING WITH MULTI-TURN INITIALIZATION

Mode 2 is the same as Mode 1 except the "Zrev" (zero revolution) input is active for multi-turn initialization (refer to **Paragraph 3.5.5**).

Mode 3: ABSOLUTE INDEXING WITH FIXED HOME

Absolute Indexing with Fixed Home Mode is primarily used for applications that require an absolute "Home" or starting location. (For example, an automatic cut-off application that feeds a piece of stock from a fixed loading position into the shear, cuts 20 equal size pieces, and returns to the starting position for reloading would use Mode 3.) The display totals the incremental moves using a fixed "Home" location as 0.00. The "Distance" input is treated as incremental.

The "Home" or 0.00 point is set by "Initializing" the controller to the absolute "0" angle on the feedback device.

3.4. OPERATING MODES

The operating modes of the MM-10-PLUS/MM-10-T controller are established by the 16-position selector switch, S1. The mode of operation is read from the selector switch when power is applied to the unit. After a mode change is selected, the power must be turned off and on again before the mode change is recognized. (These modes can be changed through serial communications without turning off the power.) **Table 3.2** shows the relationships of the operating modes with the input and output modules and indicates which are active in the various operating modes.

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Mode 1: SIMPLE INDEXING

The Simple Indexing Mode is designed for unidirectional applications such as feeding material into a punch press or shear. The drive feeds the incremental length specified by the "Distance" parameter. If an optional DSP-400 Display is being used, it will be cleared at the beginning of the index, and will show the length fed at the completion of the index.

The motor may be driven to the absolute "0" angle on the resolver or encoder using the INITIALIZE input.

Mode 2: SIMPLE INDEXING WITH MULTI-TURN INITIALIZATION

Mode 2 is the same as Mode 1 except the "Zrev" (zero revolution) input is active for multi-turn initialization (refer to **Paragraph 3.5.5**).

Mode 3: ABSOLUTE INDEXING WITH FIXED HOME

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The "Home" or 0.00 point is set by "Initializing" the controller to the absolute "0" angle on the feedback device.

Mode 4: ABSOLUTE INDEXING WITH FIXED HOME AND MULTI-TURN INITIALIZATION

Mode 4 is the same as Mode 3 except the "Zrev" (zero revolution) input is active for multi-turn initialization (refer to **Paragraph 3.5.5**).

Mode 5: ABSOLUTE INDEXING WITH FLOATING HOME

The Absolute Indexing with Floating Home Mode is identical to Mode 3 with the exception of how the "Home" or 0.00 location is established. In this mode, the motor is jogged to a location which is to represent the "Home" or 0.00 position using a gauge block or similar device as necessary. Once the motor is located at the desired 0.00 point, the "Set 0.00" input is energized to establish the "Home" position.

3.4.2. POSITIONING

A "Position" movement is one which uses a fixed location as the starting point. The position read from the input device is relative to that fixed location starting point. The final position is controlled by the sign (plus or minus) of the input, but the direction of movement depends on the starting point relative to the desired final location. There are three positioning operating modes (Mode 6 through Mode 8).

Mode 6: POSITIONING WITH FIXED HOME

The Positioning with Fixed Home Mode is used for positioning applications where the "Distance" variable is treated as an absolute number measured from absolute "Home" or 0.00. A typical application would be a high performance air cylinder replacement. The servo system has basically two positions, one at 0.00 and one at the position specified by the "Distance" variable. The servo is moved back and forth between the two positions by using the "Home" and "Index" inputs.

MODE 7: POSITIONING WITH FIXED HOME AND MULTI-TURN INITIALIZATION

Mode 7 is the same as Mode 6 except the "Zrev" (zero revolution) input is active for multi-turn initialization (refer to **Paragraph 3.5.5**).

MODE 8: POSITIONING WITH FLOATING HOME

The Positioning with Floating Home Mode is identical to Mode 6 with the exception of how the "Home" or 0.00 location is established. In this mode, the motor is jogged to a location which is to represent the "Home" or 0.00 position using a gauge block or similar device as necessary. When the motor is located at the desired 0.00 point, the "Set 0.00" input is energized to establish the "Home" position.

3.4.3. SPECIAL FUNCTION MODES

The remaining operating modes available from the selector switch are either used for special applications or are not assigned.

MODE 9: HIGH SPEED FEED DRIVE MODE

High Speed Feed Drive Mode is the same as Mode 1 except the input response time is reduced from 24 milliseconds to 5 milliseconds (or less than 5 milliseconds when using the HSI-850 input module) with "preprep index" calculations performed ahead of time. Available speeds are limited with the "Index Speed" potentiometer scaled from 125 to 1600 RPM.

Mode A: DIVIDER HEAD

The Divider Head Mode allows the indexing system to accurately position a simple dividing head system. The number of divisions for the system may be programmed from 2 to 2000 and the controller will accurately index the motor one division per "Index" input. (Refer to **Paragraph 3.5.9** more details on operating in "Mode A".)

NOTE

Modes 9 and A will not index through serial commands.

Mode B: [UNASSIGNED]

Mode C: [UNASSIGNED]

Mode D: THUMB-WHEEL PROGRAM OF ENGINEERING UNITS

Mode D is used to change distance scaling through a Thumb-wheel (or BCD-410 Parallel Input Module). Engineering units are programmed by entering the units per feedback-device revolution on the thumb-wheel and activating the input which corresponds to the number of decimal places desired. After the units are programmed, they are stored in nonvolatile memory and do not need to be programmed again. (Refer to **Paragraph 3.5.2** for details of entering engineering units with the thumb-wheel input module.)

Mode E: 20 ma SERIAL PORT CONTROL AT 2400 BAUD

Mode E is 20 ma Serial Port Control at 2400 baud. Refer to **"Section 5 - Serial Communications"** for detailed information on entering data and commands serially.

Mode F: 20 ma SERIAL PORT CONTROL AT 300 BAUD

Mode F is 20 ma Serial Port Control at 300 baud. It is usually only used with the TPP-400 Touch Panel Controller. Refer to **"Section 5 - Serial Communications"** for detailed information on entering data and commands serially, and **"Appendix A"** for information on programming with the TPP-400 Touch Panel Controller.

Mode 0: TEST

The Test Mode is a diagnostic mode for troubleshooting purposes. It is designed for Position Loop and Peripheral Port testing. The following special conditions apply in Test Mode:

1) "Following Error" testing is disabled which facilitates position loop static testing. The position loop output voltage (POSOUT) is proportional to the feedback-device shaft displacement.

2) All inputs are disabled.

3) The Serial Communications Port is disabled.

4) The active input device on the Serial Peripheral Port (TWR-400A, TWR-410A, or BCD-400) is displayed on the Serial Peripheral Port (BCD-450 and DSP-400). This test is very useful in verifying data flow around the Serial Peripheral Bus.

3.5. OPERATIONS

3.5.1. START-UP

The Motion Master controller is part of a drive system and is normally configured to receive power when the system power is turned on. To enable the controller, turn power on to the drive system or otherwise apply the input power to the controller.

When the controller starts (as soon as power is applied to the 120 VAC input) it first scans the selector switch to determine its operating mode. If everything is proper, the operating mode number and a decimal point will appear on the status display. The decimal point indicates that the controller is attempting to enable the drive (whether the drive can actually be enabled or not).

If there is an error, an error code will appear on the status display and the controller will not be enabled.. (There will be no decimal point display for error codes e1 or e2.)

3.5.2. PROGRAMMING ENGINEERING UNITS

To program engineering units, place the controller in operating mode "D". If this is not being done by serial command, the controller must be turned off and re-energized before it will change operating modes. Enter the units per resolver revolution on the thumb-wheel including all decimal places. (For example, to program 1.234 units per feedback-device revolution, enter 01234 on the thumb-wheel.)

Activate the input which corresponds to the number of decimal places desired. (For example, activate input #3 to select 3 decimal places.) When the data is accepted, the status display on the MM-10-PLUS/MM-10-T will flash "U" and the number of decimals selected. If "e" and "0" are flashing (error code "0"), the units are either too large (greater than 40960) or too small (less than 52), or the peripheral is not operating correctly.

After the units are programmed, they are stored in nonvolatile memory and do not need to be programmed again.

3.5.3. INDEXING/POSITIONING

Put the controller into the desired operating mode. Energize the "Index" input to initiate an index/position movement. Depending upon the mode selected, the motor will be moved an incremental distance or positioned to a location relative to a previously established zero reference point ("Home").

The controller calculates the time required to reach the set distance allowing for the set acceleration/deceleration ("Ramp") rate and controls the motor accordingly. **Figure 3.9** shows a normal motor indexing/positioning motion cycle. **Figure 3.10** shows a cycle where there is not enough time to reach "Index Speed". In this case,

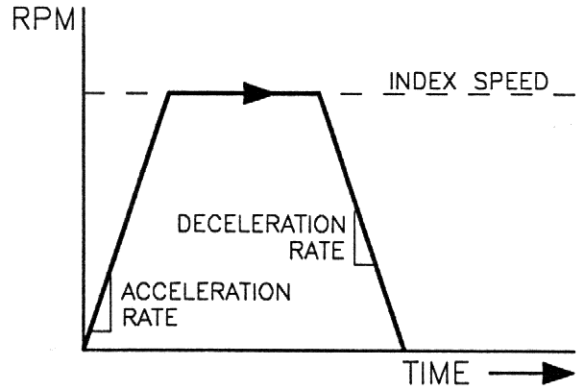

Figure 3.9 - Normal Index Cycle

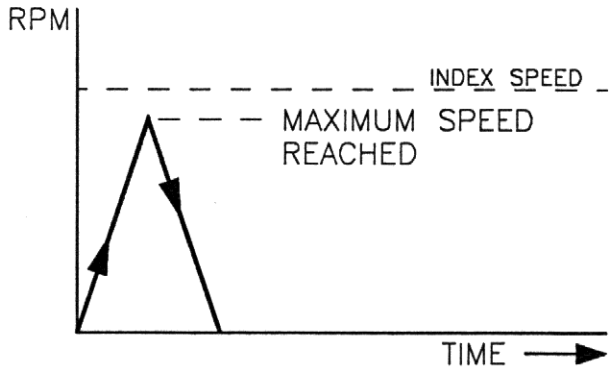

Figure 3.10 - Short Index Cycle

the controller only allows the motor to accelerate and decelerate as much as necessary to reach the desired index/position distance. When possible, the system parameters should be set to achieve the type of curve shown in **Figure 3.9** with one-third of the cycle for acceleration, one-third at index speed, and one-third for deceleration. This type of curve minimizes the RMS power required by the system.

Indexing/positioning can also be initiated by the "Home" input for those operating modes which utilize a "Home" or 0.00 position. The motor will drive to the "Home" or 0.00 position.

Motion is terminated when the motor reaches the programmed position, when the "Force Decel" input is energized, or when the "Overdraw Sensor" is energized in an overdraw situation. Index speed and acceleration/deceleration rate are programmed through the potentiometers on the controller. Index/Position distance is programmed through a peripheral device or by serial commands.

3.5.4. OVERDRAW

The overdraw function is available in all indexing/positioning modes of operation unless it is disabled by the "Overdraw Enable/Disable" jumper. Overdraw (sometimes referred to as registration) is a "feed-to-sensor" function for indexing or positioning on an external switch or sensor.

NOTE

The "Overdraw Speed" must be less than the "Index Speed" to have the overdraw search section of the index cycle occur.

When the "Index" input is energized, the motor executes a normal index/position and decelerates to the "Overdraw Speed". It continues to rotate at this speed until the "Overdraw Sensor" is energized or until the "Overdraw Distance" is reached.

When the "Overdraw Sensor" is energized, the motor decelerates to a stop. The "Overdraw Distance" serves as a default limit. It prevents the search from continuing

past the defined number of revolutions if the "Overdraw Sensor" does not energize and will also cause the unit to decelerate.

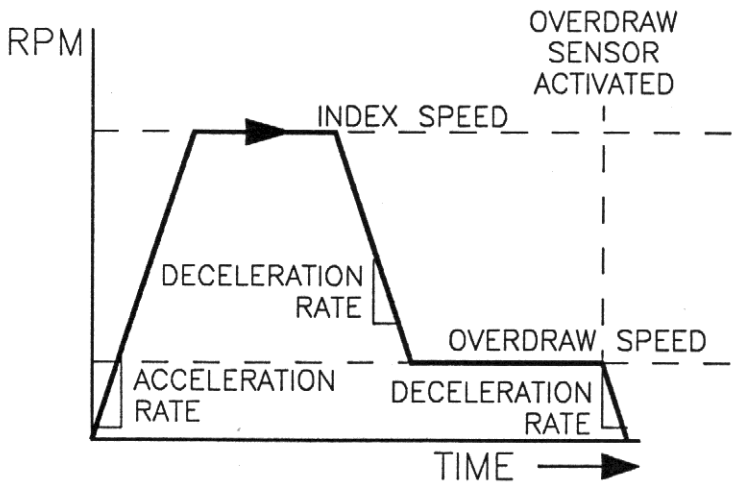

Figure 3.11 - Index Cycle With Overdraw

3.5.5. INITIALIZE

The "Initialize" function calibrates the motor shaft (resolver/encoder shaft) to its 0.00 angle. The initialize speed and direction are programmed by the "Initialize Speed/ Direction" potentiometer. (The center of the potentiometer equals 0 speed. Clockwise of center increases clockwise speed and counterclockwise of center increases counterclockwise speed.)

In indexing applications, to find the "Home" or 0.00 position, energize the "Initialize" input. The motor will move in the direction and at the speed specified until it reaches the 0.00 angle on the resolver/encoder. If the motor is within 5 degrees of the 0.00 angle, the MM-10-PLUS/MM-10-T drives the motor the shortest direction to 0.00.

The 0.00 angle on a resolver cannot be changed. However, a fine tuning of the 0.00 angle and its relationship to the controlled indexing system can sometimes be changed by turning the resolver housing with relation to the motor shaft.

CAUTION

ON SYSTEMS WHERE THE RESOLVER IS MOUNTED ON THE MOTOR, THE RESOLVER MAY NOT BE ABLE TO BE ADJUSTED AND MAINTAIN PROPER SYSTEM OPERATION. THIS IS ESPECIALLY TRUE ON SYSTEMS WHERE THE RESOLVER OUTPUT IS SHARED WITH THE COMMUTATION ON THE DRIVE. IF THERE IS ANY DOUBT ABOUT A PARTICULAR SYSTEM, CONTACT THE FACTORY BEFORE ATTEMPTING RESOLVER ADJUSTMENTS.

To adjust the resolver or encoder rotation, carefully loosen the servo clips holding the resolver or encoder housing to the motor adaptor (refer to **Figure 3.12**). Turn the housing with the system power on. As the housing is turned the motor shaft will track (follow). Turn the housing until the true mechanical 0.00 is reached and tighten the servo clips. The 0.00 point on the resolver or encoder is now aligned with the 0.00 point on the system equipment.

When the system involves multiple turns and it is necessary to find the specific turn which has the "Home" or 0.00 position, a zero revolution ("'0'Rev/Set 0.00" input) must be utilized in the system. This input is typically a switch which is configured in the system equipment to indicate which turn of that equipment has the 0.00 angle in it.

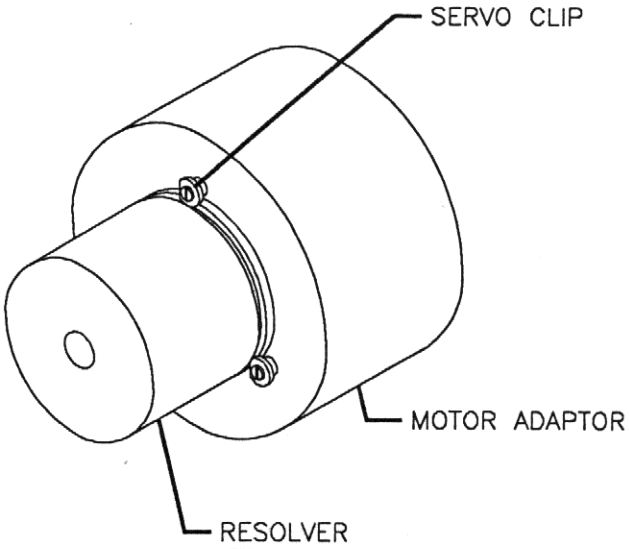

Figure 3.12
Resolver/Encoder Assembly

For example, in lead screw systems, locate a zero revolution switch at one end of the lead screw. Set the "Initialize" potentiometer for the direction which will drive the lead screw nut toward the switch. When "Initialize" is executed, the motor drives toward the switch. When the switch closes, the "'0'Rev/Set 0.00" input is activated and the MM-10-PLUS/MM-10-T assigns the present motor rotation as the 0.XX rotation. The motor continues to move to the 0.00 absolute angle on the resolver and stops at 0.00 in the 0.XX rotation.

CAUTION

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

The search for the zero revolution switch can be programmed to occur at a speed to 500 RPM. Caution should be used when searching for the zero revolution switch at high speeds because, when the switch closes, the motor will decelerate at the programmed "Ramp" rate until it reaches zero speed. At 500 RPM index speed and 10 revolutions/sec/sec deceleration, it takes 0.83 seconds for the motor to reach zero speed. The motor has turned 3.5 turns, causing a 3.5 turn overshoot beyond the zero revolution switch. The MM-10-PLUS/MM-10-T will index back to the 0.00 angle in the 0.00 turn as defined by initial activation of the "'0'Rev/Set 0.00" input.

NOTE

If the "'0'Rev/Set 0.00" input is already activated when "Initialize" is executed, the motor will first move off the zero revolution switch by turning opposite the programmed direction. It will then reverse direction (to the programmed direction) to activate the "'0'Rev/Set 0.00" input and will finally move to 0.00 on the resolver.

The MM-10-PLUS/MM-10-T can successfully initialize to 0.00 at any speed, provided the mechanical system can tolerate the overshoot of the 0.00 angle at the higher speeds.

NOTE

If the system does not provide consistent timing for recognition of the ""0'Rev/Set 0.00" input and if the feedback-device zero is just after the zero revolution switch contact position, the revolution chosen as the 0.XX revolution might be inconsistent. This can be corrected by adjusting the zero revolution switch so the contact position occurs earlier.

The initialization concept of the zero revolution switch and the 0.00 angle on the resolver can be applied to linear motion systems such as lead screws or conveyors, or it can be applied to rotary systems that have an integer gear ratio between the motor/resolver and the load.

3.5.6. MOTOR JOGGING

Energize the "Jog CW" input to jog the motor in a clockwise direction. Energize the "Jog CCW" input to jog the motor in a counterclockwise direction. When energized, the motor will accelerate at the "Ramp" rate. The motor will continue to rotate at the "Jog Speed" until the input is removed. It will then decelerate at the "Ramp" rate.

The speed of rotation is controlled by the "Jog Speed" potentiometer. The rates of acceleration and deceleration are controlled by the "Ramp" potentiometer. The "Jog Speed" can be changed while the motor is in motion.

3.5.7. EARLY INDEX COMPLETE

The Early Index Complete option programs a distance prior to the end of the index or position movement where the "Index Complete" output will be energized. This distance may be programmed through the "EICP" potentiometer on the MM-10-PLUS/MM-10-T controller or may be programmed serially. The distance programmed cannot exceed a maximum of 8192 feedback-device bits (2 resolver revolutions). This feature does not operate in Modes 9 or A.

3.5.8. FORCE DECEL

Activation of the "Force Decel" (Forced Deceleration) input will force any motion under control of the MM-10-PLUS/MM-10-T (except jog) to decelerate to zero speed. The deceleration will occur at the "Ramp Rate" and will continue until all movement is stopped. The "Index Complete" and "Home" outputs will not be activated when movement is stopped in this manner. However, depending on the timing when the

input was actuated, an "Early Index Complete" signal could have actuated the "Index Complete" output prior to the receipt of the "Force Decel" input.

NOTE
Jog is unaffected by the "Force Decel" input.

The "Force Decel" input is also used to reset certain error codes. When used for this purpose, the "Force Decel" input must be actuated for 1.5 seconds to reset the error signal.

3.5.9. DIVIDING HEAD INDEXING

Dividing head indexing is a special application of the MM-10-PLUS/MM-10-T controller for use in accurately moving a partitioned system such as dividing head or indexing table. The system allows tremendous flexibility in that the system can be programmed for any number of divisions from 2 to 2000 and the controller will accurately move the head one division for every "Index" command received.

The head distance for one motor revolution is programmed similarly to programming engineering units.

1) Set the controller to "Mode D".

2) Calculate the bits per cycle.

   Bits/Cycle = (Motor Revs per 360° of system rotation) * 4 * (Line Count)

3) On a thumb-wheel input module or BCD-410 Parallel Input Module, enter the right-most five digits of this number.

4) Energize Input #6 ("Home"). A "U" and "L" will alternately flash on the status display indicating that the data has been accepted.

5) Enter the remaining digits on the thumb-wheel or BCD-410 Parallel Input Module.

6) Energize Input #7 ("Initialize"). A "U" and "O" will alternately flash on the status display indicating that the data has been accepted.

7) Turn the system power off again. The settings will be retained in non-volatile memory.

8) Set the controller to "Mode A".

9) Set the thumb-wheel input module for the desired number of divisions.

10) Energize the system.

NOTE

The number of bits can range from 4096 to 4,095,999. If a number outside this range is used, an error message will flash on the status display.

NOTE

When the system is powered up in "Mode A", the system assumes the present position of the motor is the "Home" or 0.00 position. At start-up, the divisions are read from the thumb-wheel and the "Index" command is enabled. The system must be restarted or a "Home" command must be given before it will recognize a change to the number of divisions.

The controller inputs and outputs will have the following functions when the system is acting as a simple dividing head system:

"Index" The motor will move one division for each "Index" input. This input is "edge triggered". The controller must see an off-to-on transition of this input with the motor stopped before it will accept another "Index" command. If the "Index" input is still applied after the movement is completed or if it is reapplied before the movement is completed, the motor will not repeat the movement because it has not seen the leading edge of the input signal while the motor is stopped.

"Jog CW"/"Jog CCW" The jog inputs retain their normal functions.

"Home" (input) When this input is actuated, the system will send the motor to the "Home" or 0.00 position, read the number of divisions from the thumb-wheel input module.

"Initialize" This function works the same as for other multi-turn operating modes.

"'0'Rev/Set 0.00" This function works the same as for other multi-turn operating modes.

"Index Complete" This output is on when the index command is completed. It is initially turned off at the start of an "Index" command.

"Home" (Output) This input will turn on during the last index of the division cycle when the dividing head is returning to its "Home" or 0.00 position. It will remain actuated while the system remains at the "Home" position.

3.5.10. FOLLOWING ERROR

The Following Error function is an internal operation and is not operator controllable. This function monitors the actual position of the motor versus the controller-commanded position of the motor.

Each incremental movement of the resolver or encoder sends a certain number of bits to the controller. The MM-10-PLUS/MM-10-T controller monitors these bits and compares them to the number of bits it should be seeing to determine the difference in actual versus theoretical positions.

The standard allowable following error for the MM-10-PLUS is 2000 bits. For the MM-10-T controller, allowable error bits depends on the setting on the gain switch (refer to **Table 3.1**). If the following error is greater than the allowable threshold, the controller will disable the drive. An e2 error message will be displayed and the decimal point on the status display will go out.

Since the controller is determining position based on programmed ramp rates and index or jog speeds, an excessive following error normally indicates a mechanical problem with the system. The motor may be operating too fast or too slow because of an electrical or mechanical malfunction. Or something may be preventing the motor from rotating at all. By shutting down the system when the following error exceeds the threshold, the potential for system damage is reduced.

SECTION 4 – PERIPHERAL MODULES

A variety of peripheral modules work with the Motion Master MM-10-PLUS/MM-10-T Controller. When the controller is part of a stand-alone system, these modules are required to provide necessary input and output interfaces with the controller. When the controller is used as a slave to a host computer or programmable logic controller, these peripheral modules are not required, but may be used as alternates to the serial commands.

4.1. DSP-400 DISPLAY

The DSP-400 Display Module is an output device which provides a visual readout of the index or position of the motor shaft.

4.1.1. DESCRIPTION

The display consists of 5-1/2 individual LED digits. The half digit can only be a "1" or no display. (A minus sign can also be displayed.) The other five digits can be any number from "0" to "9". Any one of these five digits may include a leading decimal point. (The display can have from one to five decimal places.) The number displayed represents the index or position in "engineering units".

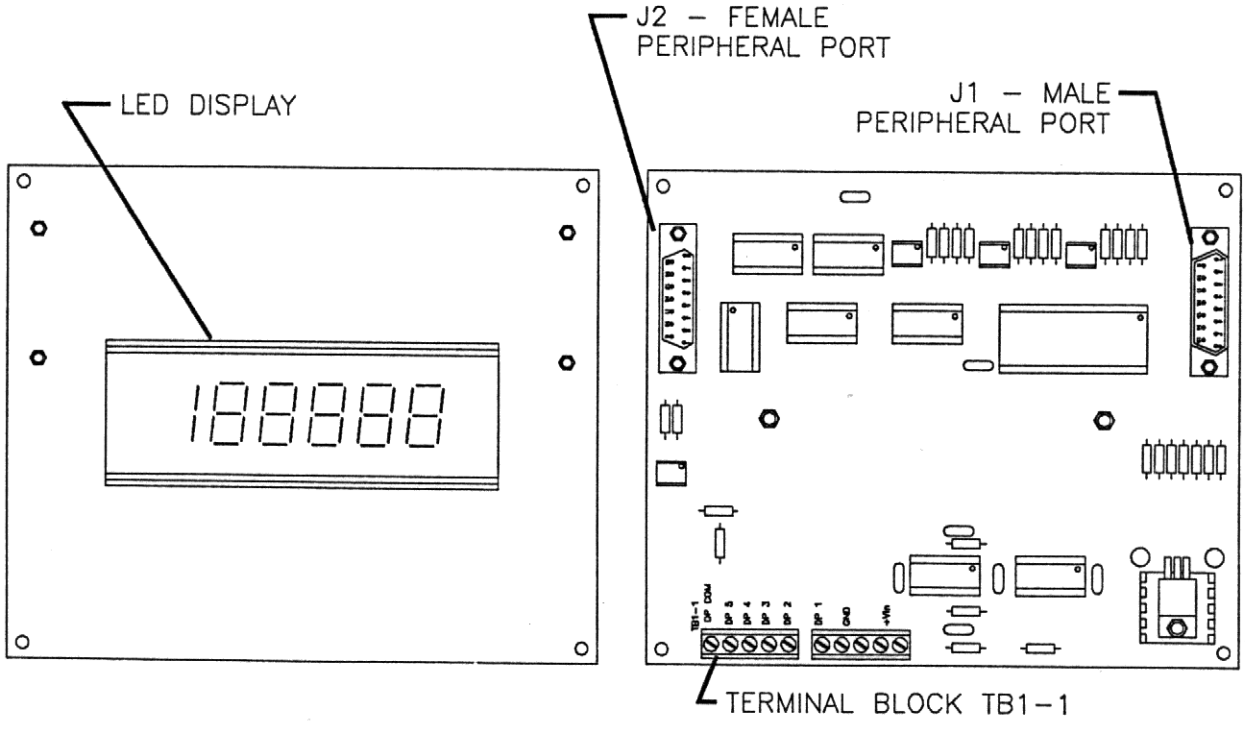

Figure 4.1 - DSP-400 Display

The decimal point of the display is for operator convenience only (it is not actually recognized by the display or the MM-10-PLUS/MM-10-T). It is fixed by the customer to match the decimals set when programming "engineering units" (refer to **Paragraph 4.1.2**) and cannot be changed except by rewiring the display. Terminal block TB1-1 provides the wiring location for the decimal point and also provides the connection point for the 15 VDC, 1.5 Amp external power supply required to operate the display.

NOTE

If an error occurs, the display will show the error in place of the distance or index information. An error code is displayed in the format "EN", where "N" is a numeral from "0" to "9".

The display is daisy-chained (connected in series) with other peripheral devices using the two peripheral ports provided on the module. (These ports are bi-directional serial ports.) The location of the DSP-400 in the daisy chain is not significant. It will work properly at any position.

4.1.2. INSTALLATION

The DSP-400 is designed for mounting to an enclosed panel. Refer to **Figure 4.2** for mounting dimensions.

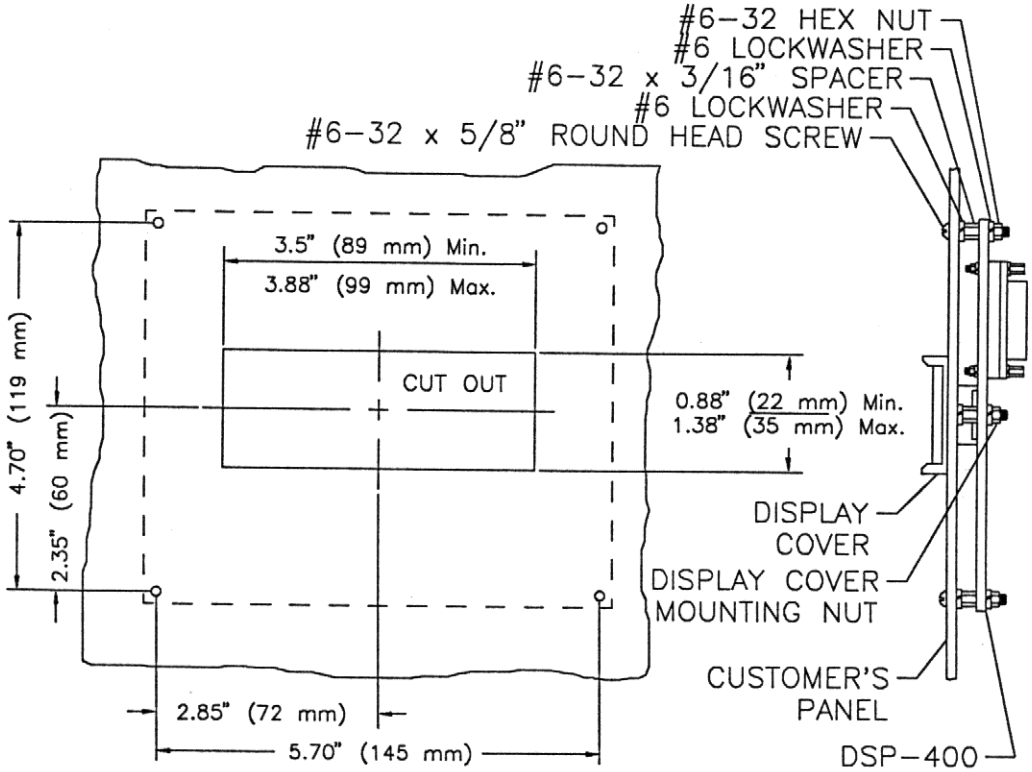

Figure 4.2 - DSP-400 Mounting Dimensions

1) Lay out the locations of the display cutout and the four mounting holes.

2) Drill the four mounting holes (clearance holes for #6 screws) and cut out the hole for the display.

3) Remove the display cover from the DSP-400 module by loosening the two mounting nuts on the back of the module and pulling the display cover (with screws and spacers) away from the module.

4) Mount the module to the back of the panel using four #6 x 5/8" round-head screws with lock washers, spacers, and nuts as shown in **Figure 4.2.**

5) Replace the display cover by sliding the mounting screws and spacers through the front of the panel into the mounting holes on the module.

6) Carefully tighten all nuts. **DO NOT OVER-TIGHTEN!**

7) Connect the positive and negative terminals of the 15 VDC power supply to the "$+V_{IN}$" and "GND" terminals of terminal block TB1-1 (refer to **Figure 4.3**). The DSP-400 requires 1.5 Amps of 15 VDC power.

8) Connect a wire from the "DP COM" terminal of terminal block TB1-1 to the desired DP terminal ("DP 1" to "DP 5") to select the number of decimal places for the display. The decimal point will remain constant at that position. The display will be truncated (not rounded off) at the number of decimal places specified.

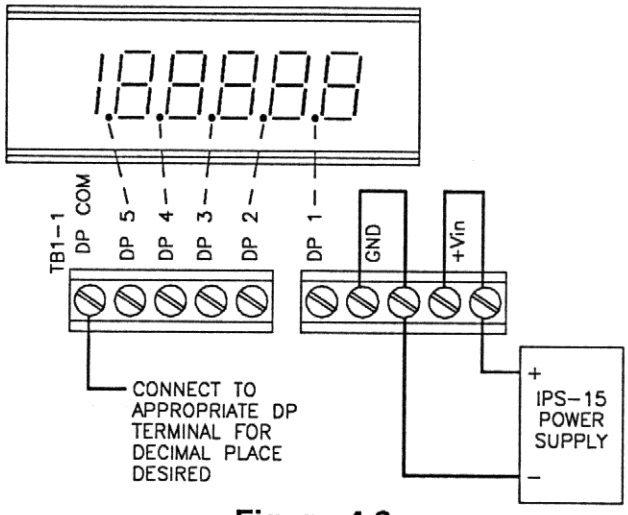

Figure 4.3
Terminal Block TB1-1

9) Connect 15-pin serial connection cables to the peripheral ports as required.

NOTE

The quantity and length of 15-pin connector serial cables required will depend on the location of the module in the daisy chain and the distance from the other modules before and after it.

4.1.3. OPERATION

The DSP-400 Display is an output device which receives its signals from the MM-10-PLUS/MM-10-T controller. No additional system signals or operator inputs are required to operate the display. (The presence of 15 VDC power is necessary for proper operation.) The DSP-400 Display will operate even if a BCD-450 Parallel Output Module is present in the system.

Multiple display modules may be used in the same system if more than one output location is required by the system. Each display must have its own power supply and must be installed as explained in **Paragraph 4.1.2**.

If the DSP-400 is not connected to the controller, it will display a series of "F"s (FFFFF). In operating mode "9", the display will read "di5AbLE" indicating that it has been disabled to reduce the system response time.

NOTE

The DSP-400 and BCD-450 output devices are both disabled in operating mode "9" or when the controller is set into high speed index enable by serial command.

4.2. TWR-400A THUMB-WHEEL INPUT MODULE

The TWR-400A Thumb-wheel Input Module is an input device that can be used to provide the index or position movement information to the controller.

4.2.1. DESCRIPTION

The operator interface of the TWR-400A consists of six sealed thumb-wheel switches. The first switch alternates between a plus and minus sign (used to indicate rotation direction.) The other five switches have digits from "0" to "9".

The thumb-wheel input module is daisy-chained (connected in series) with other peripheral devices using the two peripheral ports provided on the module. (These ports are bi-directional serial ports.) The location of the TWR-400A in the daisy chain is not significant except for its relationship to any TWR-410A modules. The TWR-400A will work properly at any position, but it must be located after any TWR-410A modules or they will not be polled.

NOTE

Only one TWR-400A Thumb-wheel Input Module may be used with a single MM-10-PLUS/MM-10-T controller. However it may be combined with one or more TWR-410A Strobed Thumb-wheel Input Modules.

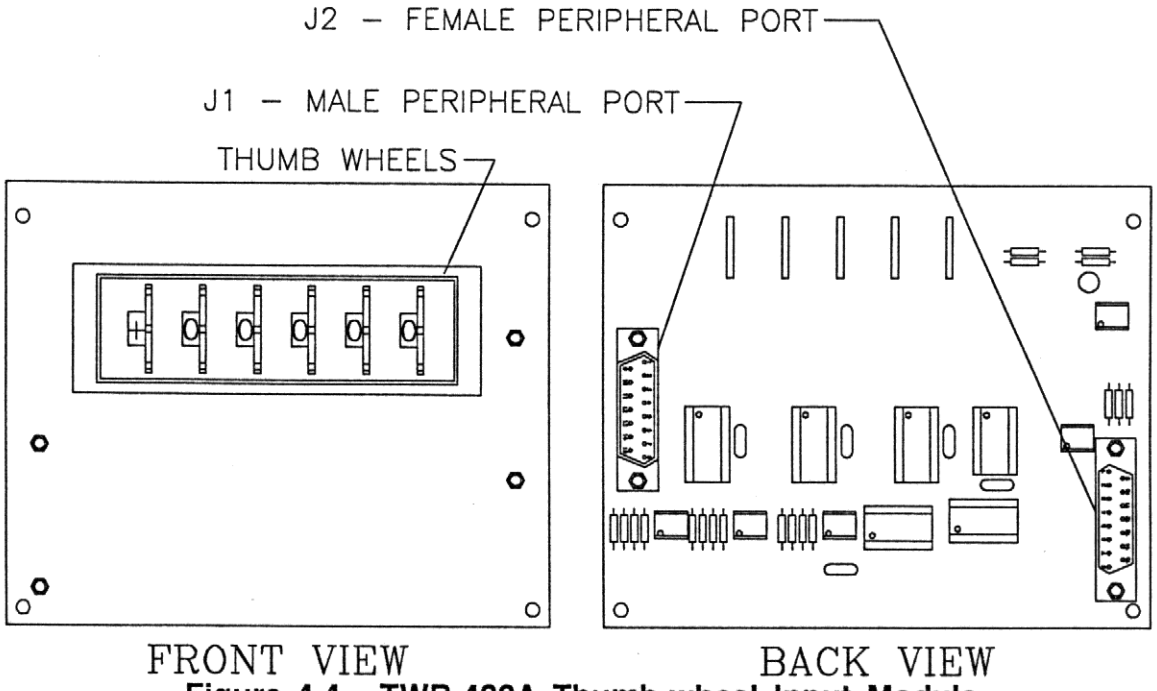

Figure 4.4 - TWR-400A Thumb-wheel Input Module

4.2.2. INSTALLATION

The TWR-400A is designed for mounting to an enclosed panel. Refer to **Figure 4.5** for mounting dimensions.

1) Lay out the locations of the display cutout and the four mounting holes.

2) Drill the four mounting holes (clearance holes for #6 screws) and cut out the hole for the thumb-wheel switches.

3) Mount the module to the back of the panel using four #6 x 1-5/8" round-head screws with lock washers, spacers, and nuts as shown in **Figure 4.5**.

WARNING

THE TWR-400A THUMB-WHEEL INPUT MODULE HAS NO MOUNTING BEZEL OR OTHER COSMETIC FRAME FOR THE THUMB-WHEEL CUTOUT. THEREFORE, IT IS IMPORTANT THAT THE CUTOUT BE MADE ACCURATELY AND THAT ALL EDGES BE LEFT SMOOTH AND FREE OF BURRS TO PREVENT POTENTIAL INJURY.

4) Carefully tighten all nuts. **DO NOT OVER-TIGHTEN!**

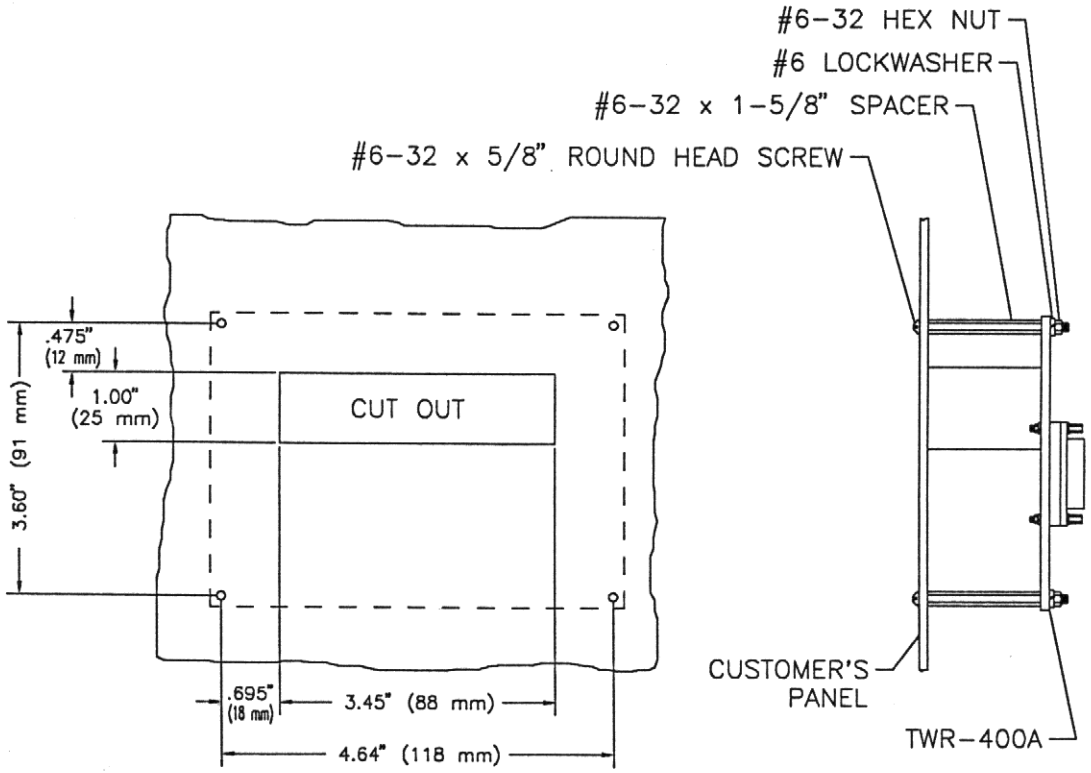

Figure 4.5 - TWR-400A Thumb-wheel Input Module Installation

5) Connect 15-pin serial connection cables to the peripheral ports as required.

NOTE

The quantity and length of 15-pin connector serial cables required will depend on the location of the module in the daisy chain and the distance from the other modules before and after it.

6) If a visible decimal point is desired for reference (and it will never change), drill a small hole into the plastic in front of the appropriate thumb-wheel and fill with white paint or ink.

NOTE

The TWR-400A is the only peripheral module which does not require a separate 15 VDC power supply. Power for this module only is derived from the MM-10-PLUS/MM-10-T controller.

4.2.3. OPERATION

1) Determine the distance required for the index or position movement.

2) Turn the first thumb-wheel to "+" for clockwise rotation or to "-" for counterclockwise rotation (assuming positive engineering units).

3) Turn the other five thumb-wheels to the digits representing the desired movement in "engineering units".

NOTE

The decimal places are fixed when "engineering units" are set. The distance represented by the digits set on the thumb-wheels always has this number of decimal places.

The controller will continuously poll the various input modules to determine the distance to be moved. The highest input priority is the BCD-410 Parallel Input Module. If this module is present and also has an enable input signal present, it will be used to provide the input data.

If there is no BCD-410 module present (or if it is present but has no enable input signal), the MM-10-PLUS/MM-10-T will search for a signal from a TWR-410A or TWR-400A input module. The first module it finds that is enabled, will be used to provide the movement data.

The digits set on the thumb-wheel will cause the motor shaft to move the indicated distance (based on the operating mode) in the indicated direction. The same setting will be used each time the index command is received until the thumb-wheel settings are changed.

NOTE

More than one thumb-wheel input module can be enabled at the same time, but only the module closest to the controller in the daisy chain will be used as the distance input. The TWR-400A Thumb-wheel Input Module is always enabled.

The MM-10-PLUS/MM-10-T controller requires a total of approximately 75 milliseconds to poll the input modules: 24 ms to poll the BCD-410, 24 ms to poll the thumb-wheel modules regardless of quantity, 5 ms to turn the input on, and 20 ms to transfer the input to the controller. However, the system is not delayed this long because the polling is done while the system is performing the current movement.

4.3. TWR-410A STROBED THUMB-WHEEL INPUT MODULE

The TWR-410A Thumb-wheel Input Module is an input device which can be used to provide the index or position movement information to the controller.

4.3.1. DESCRIPTION

The operator interface of the TWR-410A consists of six sealed thumb-wheel switches. The first switch alternates between a plus and minus sign (used to indicate rotation direction.) The other five switches have digits from "0" to "9".

The thumb-wheel input module is daisy-chained (connected in series) with other peripheral devices using the two peripheral ports provided on the module. (These ports are bi-directional serial ports.) Any number of TWR-410A modules can be included in the peripheral device daisy chain. The locations of the modules in the daisy chain are not significant except for their relationship to a TWR-400A module, if there is one in the system. The TWR-410A modules will work properly at any position, but the controller always takes the input from the first thumb-wheel module which is enabled. Therefore, any TWR-410A modules must be located before the TWR-400A module since the TWR-400A is always enabled.

Terminal Block TB1 provides the connection point for the 15 VDC, 50 mA power supply required to operate the TWR-410A module. It also provides the connection point for the contact required to enable the module. The indicator LED will illuminate whenever the module is enabled.

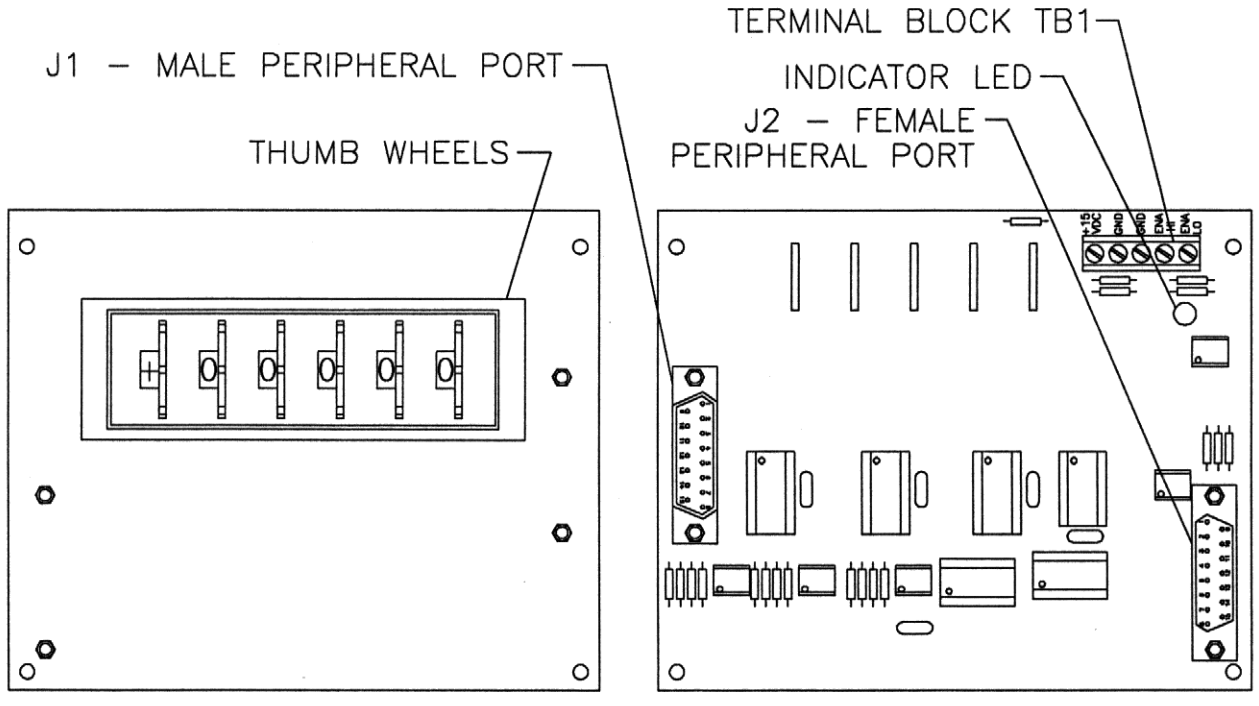

Figure 4.6 - TWR-410A Strobed Thumb-wheel Input Module

4.3.2. INSTALLATION

The TWR-410A is designed for mounting to an enclosed panel. Refer to **Figure 4.7** for mounting dimensions.

1) Lay out the locations of the display cutout and the four mounting holes.

2) Drill the four mounting holes (clearance holes for #6 screws) and cut out the hole for the thumb-wheel switches.

WARNING

THE TWR-410A THUMB-WHEEL INPUT MODULE HAS NO MOUNTING BEZEL OR OTHER COSMETIC FRAME FOR THE THUMB-WHEEL CUTOUT. THEREFORE, IT IS IMPORTANT THAT THE CUTOUT BE MADE ACCURATELY AND THAT ALL EDGES BE LEFT SMOOTH AND FREE OF BURRS TO PREVENT POTENTIAL INJURY.

3) Mount the TWR-410A thumb-wheel module to the back of the panel using four #6-32 x 1-5/8" round-head screws with lock washers, spacers, and nuts as shown in **Figure 4.7**.

4) Carefully tighten all nuts. **DO NOT OVER-TIGHTEN!**

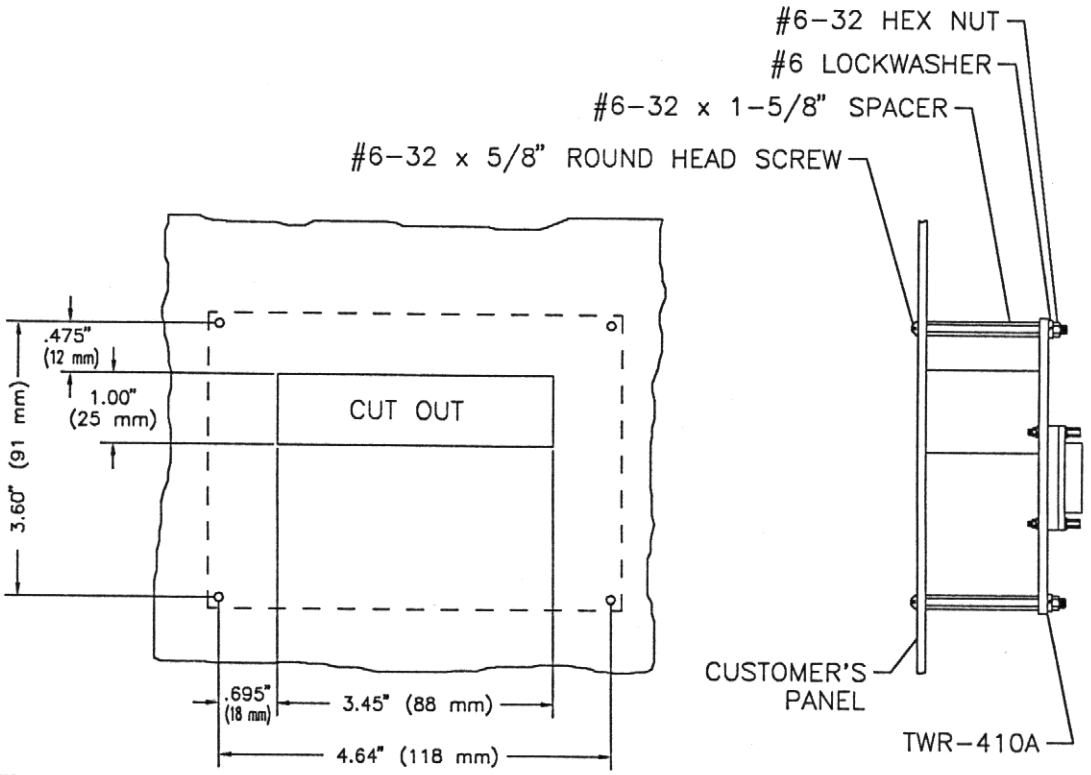

Figure 4.7 - TWR-410A Strobed Thumb-wheel Input Module Installation

5) Connect 15-pin serial connection cables to the peripheral ports as required.

NOTE

The quantity and length of 15-pin connector serial cables required will depend on the location of the module in the daisy chain and the distance from the other modules before and after it.

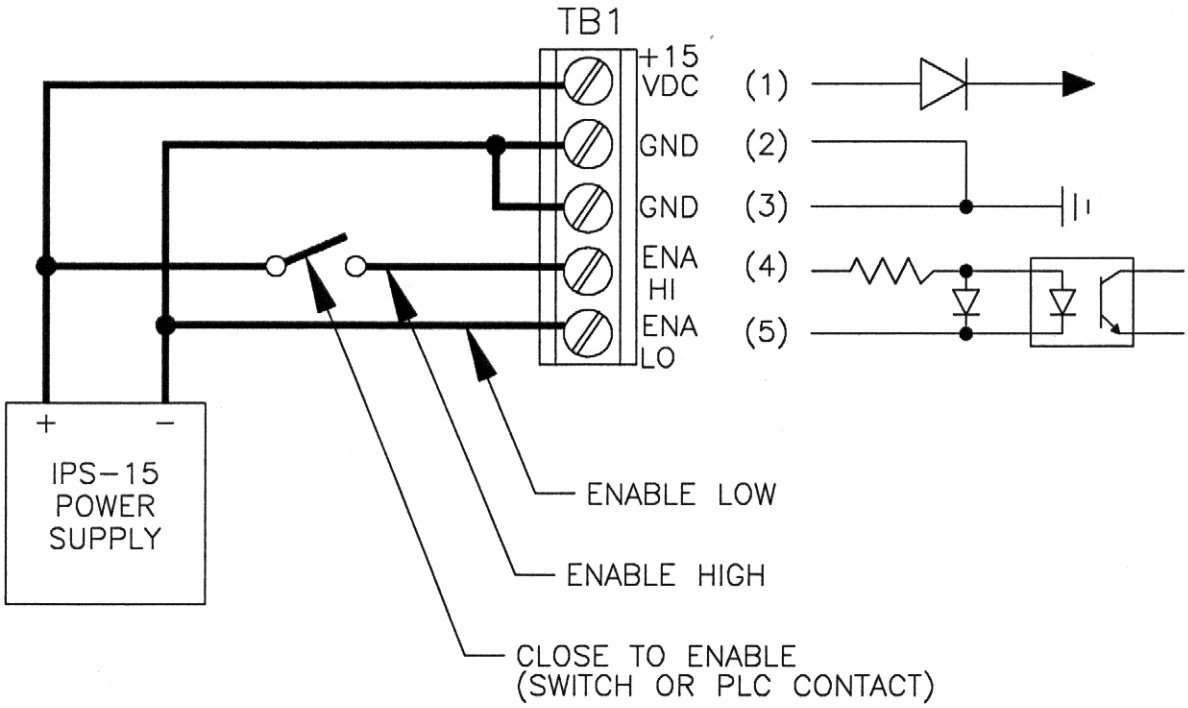

Figure 4.8
Terminal Block TB1 Connections

6) Connect the positive and negative terminals of the 15 VDC power supply to the +15 VDC and GND terminals of terminal block TB1 (refer to **Figure 4.8**). The TWR-410A requires a maximum of 50 mA current.

7) Connect the negative terminal of the 15 VDC power supply to the "ENA LO" terminal of terminal block TB1.

8) Connect the normally-open contact (or PLC contact) to be used for enabling the input module between the positive terminal of the 15 VDC power supply and the "ENA HI" terminal of terminal block TB1.

9) If a visible decimal point is desired for reference (and it will never change), drill a small hole into the plastic in front of the appropriate thumb-wheel and fill with white paint or ink.

4.3.3. OPERATION

1) Determine the distance required for the index or position movement.

2) Turn the first thumb-wheel to "+" for clockwise rotation or to "-" for counterclockwise rotation.

3) Turn the other five thumb-wheels to the digits representing the desired movement in "engineering units".

The controller will continuously poll the various input modules to determine the distance to be moved. The highest input priority is the BCD-410 Parallel Input Module. If this module is present and also has an enable input signal present, it will be used to provide the input data.

If there is no BCD-410 module present (or if it is present but has no input signal), the MM-10-PLUS/MM-10-T will search for a signal from a TWR-410A or TWR-400A input module. The first module it finds that is enabled, will be used to provide the movement data. The digits set on the thumb-wheel will cause the motor shaft to move the indicated distance (based on the operating mode) in the indicated direction. The same setting will be used each time the index command is received until the thumb-wheel settings are changed.

NOTE

More than one thumb-wheel input module can be enabled at the same time, but only the module closest to the controller in the daisy chain will be used as the distance input. The TWR-400A Thumb-wheel Input Module is always enabled.

The MM-10-PLUS/MM-10-T controller requires a total of approximately 75 milliseconds to poll the input modules: 24 ms to poll the BCD-410, 24 ms to poll the thumb-wheel modules regardless of quantity, 5 ms to turn the input on, and 20 ms to transfer the input to the controller. However, the system is not delayed this long because the polling is done while the system is performing the current movement.

NOTE

The decimal places are fixed when "engineering units" are set. The distance represented by the digits set on the thumb-wheels always has this number of decimal places.

4.4. BCD-410 PARALLEL INPUT MODULE

The BCD-410 Parallel Input Module interfaces between the MM-10-PLUS/MM-10-T controller and the binary coded decimal (BCD) output port of a computer or programmable logic controller (PLC) to provide index/position distance information to the controller.

4.4.1. DESCRIPTION

The BCD-410 accepts distance information from the computer or PLC — through the input connector — in the form of 5 binary coded decimal digits. The 24 data lines may be driven with either TTL (+5 volt) logic or Cmos (5-15 volt) logic. Both the BCD-410 and the computer or PLC interface have common grounds. The distance information represents an incremental (index) or absolute (position) number.

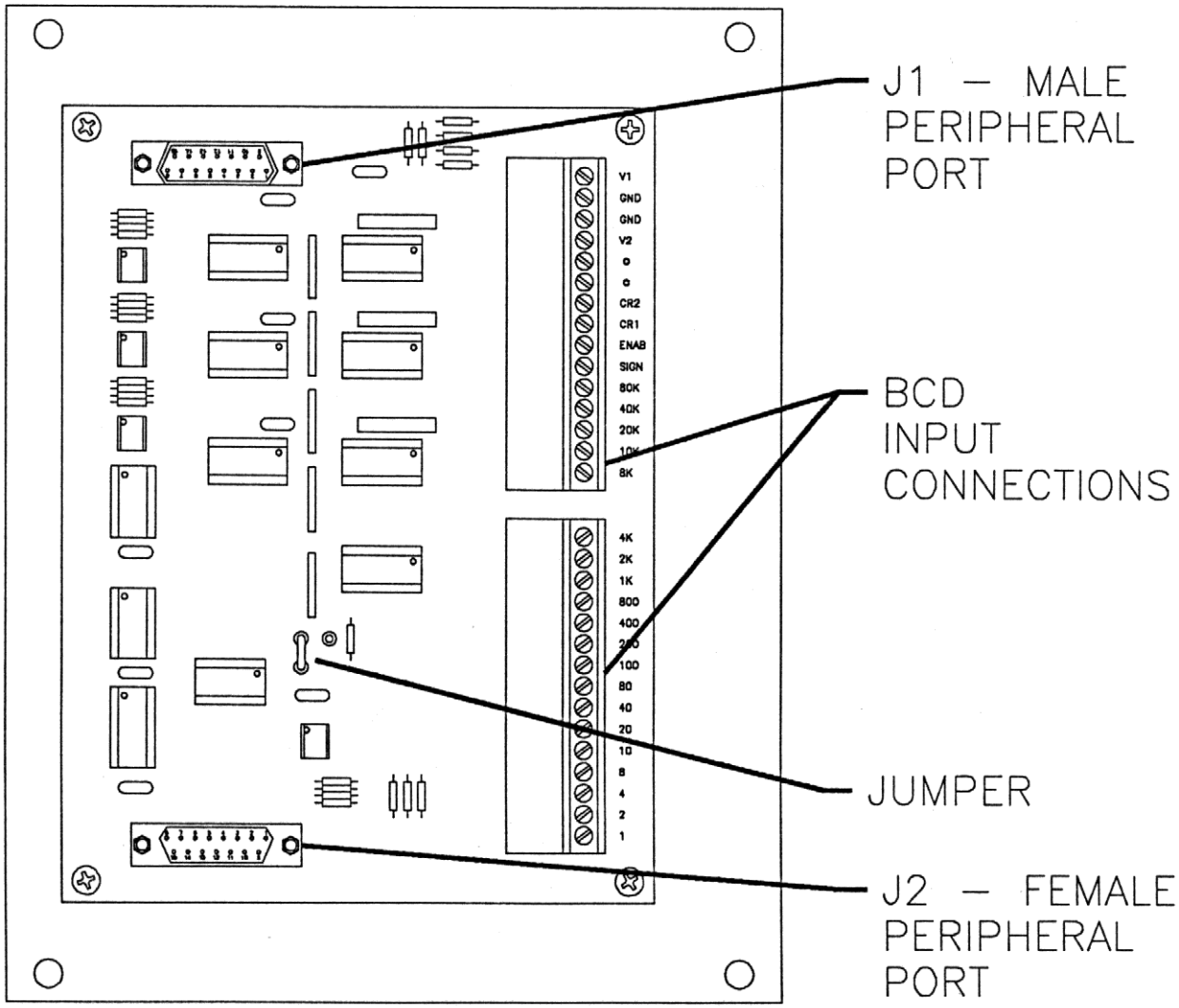

Figure 4.9 - BCD-410 Parallel Input Module

The module is daisy-chained (connected in series) with other peripheral devices using the two peripheral ports provided on the module. (These ports are bi-directional serial ports.) These ports are used to transfer the data received from the computer or PLC to the MM-10-PLUS/MM-10-T controller. The position of the BCD-410 in the daisy chain is not significant. It is optically isolated from the MM-10-PLUS/MM-10-T and any other interface on the peripheral port.

The BCD-410 can accept either "High True Logic" (logic "1" = high voltage) or "Low True Logic" (logic "1" = zero or low voltage) data. The type of input logic being used is defined for the module by the position of the jumper.

To maintain compatibility with a variety of interface voltages, two supply voltage inputs are provided. The "V1" voltage input is used to power the BCD-410 logic interface to the MM-10-PLUS/MM-10-T and must be +15 VDC, 300 mA max. The "V2" input will be the voltage of the computer or PLC interface logic (from 5 to 15 VDC, 220 mA max.). Each data input of the BCD-410 is internally pulled up to V2 by a 2.2K ohm resistor.

4.4.2. INSTALLATION

The BCD-410 is designed for mounting to an enclosed panel. Refer to **Figure 4.10** for mounting dimensions.

1) Lay out the locations of the four mounting holes and drill and tap four holes for #8-32 screws.

2) Place four #8-32 x 5/8" round-head screws through the module and place 3/16" stand-offs between the module and the panel.

3) Attach the module to the panel.

4) Carefully tighten all screws. **DO NOT OVER-TIGHTEN!**

5) Connect 15-pin serial connection cables to the peripheral ports as required.

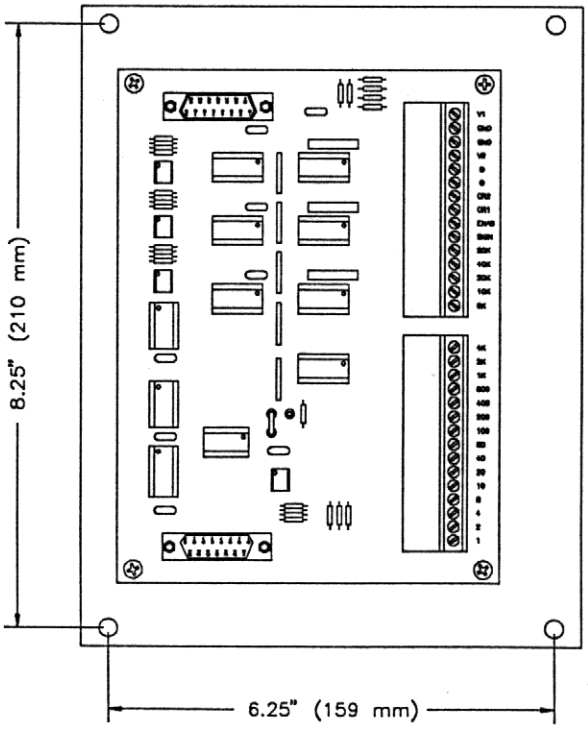

Figure 4.10
BCD-410 Parallel Input Module Installation

NOTE

The quantity and length of 15-pin connector serial cables required will depend on the location of the module in the daisy chain and the distance from the other modules before and after it.

6) Determine whether the data logic to be used is "high true" or "low true". Place the jumper in position "JP1" for high true data and position "JP2" for low true data. (**Figure 4.11** shows the jumper in the JP2 position.)

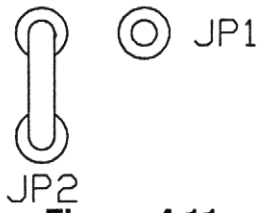

Figure 4.11
Jumper

7) Connect the positive output from the 15 VDC power supply to the "V1" terminal on the BCD-410 connector.

8) Connect the negative output from the 15 VDC power supply to the "GND" terminal on the BCD-410 connector closest to the "V1" terminal.

9) Connect the positive output of the TTL or CMOS logic voltage to the "V2" terminal on the BCD-410 connector.

10) Connect the negative output of the TTL or CMOS logic voltage to the "GND" terminal closest to the "V2" terminal on the BCD-410 connector.

11) Connect the 20 binary coded decimal digit data lines (1 through 80K) from the computer or PLC interface to the data input terminals on the BCD-410 connector.

12) Connect the "ENAB" (enable) line from the computer or PLC interface to the data input terminals on the BCD-410 connector.

13) Connect the "SIGN" line from the computer or PLC interface to the data input terminals on the BCD-410 connector.

NOTE

The "CR1" and "CR2" (Control) inputs are not used with the MM-10-PLUS/MM-10-T controller. They may float as they are internally pulled to voltage V2.

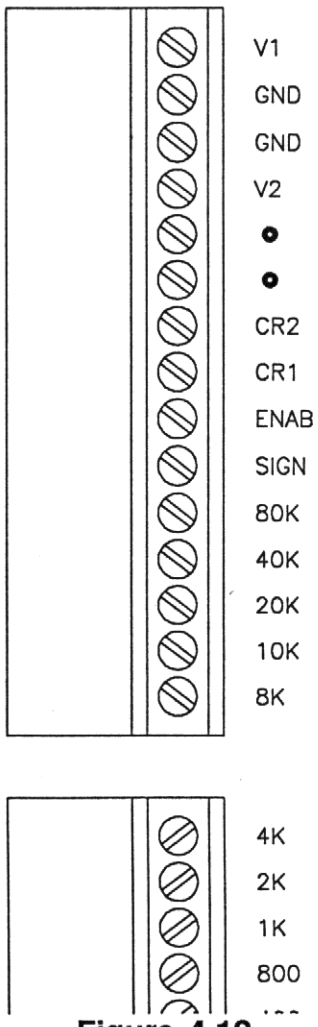

Figure 4.12
Input Connections

4.4.3. OPERATION

The operation of the BCD-410 Parallel Input Module is controlled from the host computer or programmable logic controller. Both 15 VDC and logic power are required for the module to operate. The following paragraphs indicate the types of control communication to the module and, therefore, to the controller:

Input Signal Levels: The BCD-410 requires V_{IN} to be greater than 2.4 VDC to recognize a valid "On" signal. It requires V_{IN} to be less than 1.0 VDC to recognize a valid "Off" signal.

Enable Signal: When an "Index" command is received by the controller, this input must see a "Logic True" input to indicate to the MM-10-PLUS/MM-10-T controller that the data which is present is valid.

If the BCD-410 is enabled, the controller will disregard any other input data and accept the BCD-410 data for its distance. If it is not enabled, the controller will look for the first enabled thumbwheel input to read the input distance.

Sign Signal: The "SIGN" input will indicate movement direction. For an "Index" movement, "Logic False" indicates a clockwise move; "Logic True" indicates a counterclockwise move. For a "Position" movement, "Logic False" indicates movement to the plus side of the 0.00 position; "Logic True" indicates a movement to the minus side of the 0.00 position. The motor will rotate clockwise when traversing in a positive direction.

Signal Timing: The system that is interfacing to the BCD-410 should wait for 40 milliseconds (0.040 seconds) after presenting complete data to the BCD-410 before commanding the MM-10-PLUS/MM-10-T controller to index the motor. After the index is initiated and the "Index Complete" output is off, the value may be changed.

4.5. BCD-450 PARALLEL OUTPUT MODULE

The BCD-450 Parallel Output Module serves as a data interface between the MM-10-PLUS/MM-10-T controller and a binary coded decimal (BCD) input port of a host computer or programmable logic controller. Although designated as a parallel interface, it can also serve in multiplexed interface situations.

4.5.1. DESCRIPTION

The BCD-450 is a parallel BCD output device which supports 5-1/2 binary coded decimal digits with sign. These may be read as a single 24-bit word or as three 8-bit words. (The two "Most Significant" bits are not used.) The BCD-450 sends distance information to the computer or PLC through the input connector. The data lines may be driven with logic voltage of +5 VDC, +15 VDC, or +24 VDC, 550 mA max. The logic voltage being used is determined by the position of the voltage jumper on the module. Both the BCD-450 and the computer or PLC interface have common grounds.

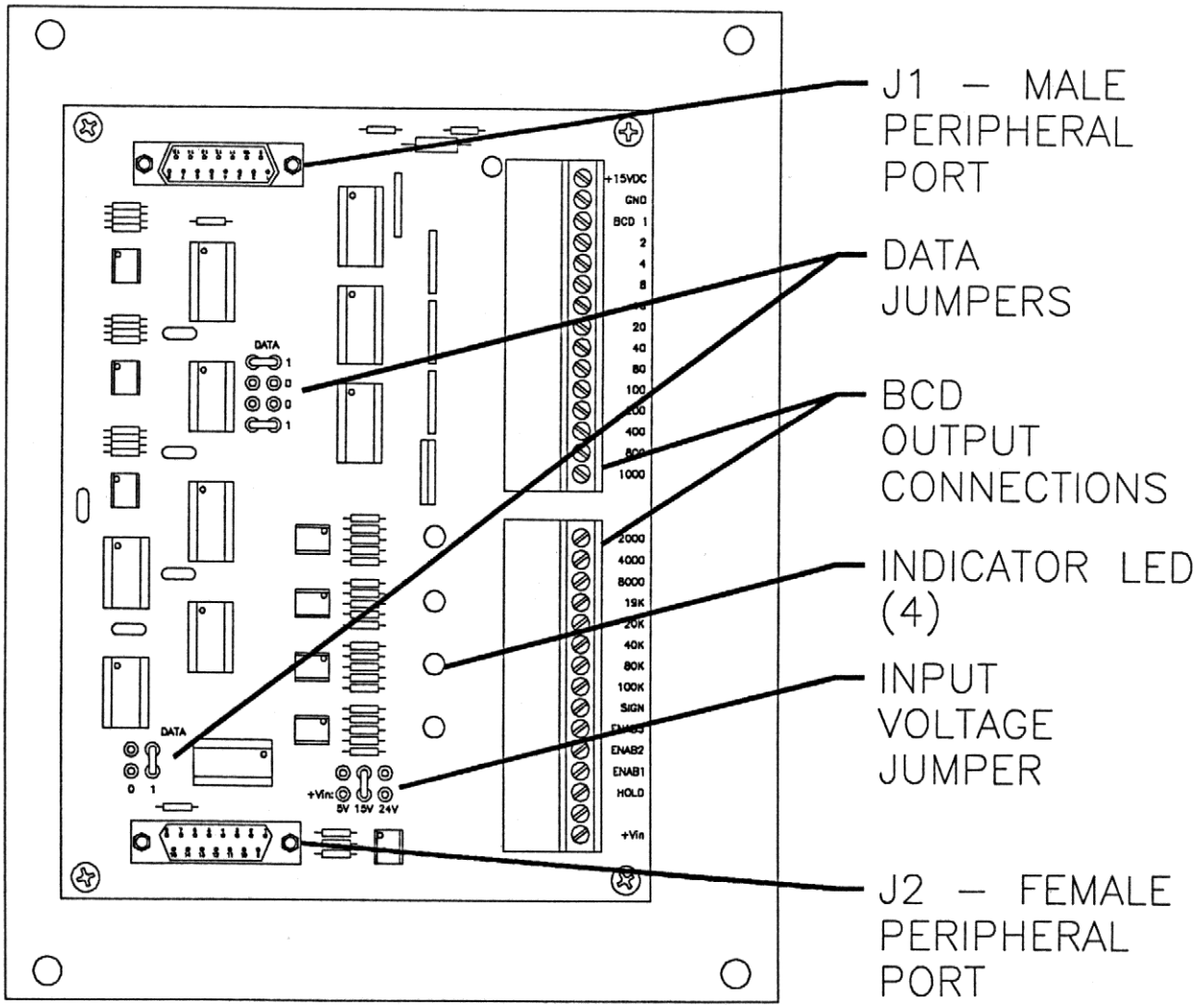

Figure 4.13 - BCD-450 Parallel Output Module

The distance information is a five or six digit (with leading "1") number which represents an incremental (index) or absolute (position) number.

The module is daisy-chained (connected in series) with other peripheral devices using the two peripheral ports provided on the module. (These ports are bi-directional serial ports.) These ports are used to receive data from the MM-10-PLUS/MM-10-T controller. The position of the BCD-450 in the daisy chain is not significant. It is optically isolated from the MM-10-PLUS/MM-10-T and any other interface on the peripheral port.

The BCD-450 outputs are Open Collector, active low with 24 mA maximum current per output. The module will send either "High True Logic" (logic "1" = high voltage) or "Low True Logic" (logic "1" = zero or low voltage) data. The type of output logic being used is defined by the position of the data jumpers on the module. Indicator LEDs illuminate when the "HOLD" and each of the "ENABn" (Enable) terminals are activated.

To maintain compatibility with a variety of interface voltages, two voltage inputs are provided. The "+15 VDC" voltage input is used to power the BCD-450 logic interface to the MM-10-PLUS/MM-10-T and must be regulated +15±1 VDC (250 mA). The "V_{IN}" input will be the voltage of the computer or PLC interface logic (5, 15, or 24 VDC). Each data output of the BCD-450 is internally pulled up to V_{IN} by a 33K ohm resistor.

4.5.2. INSTALLATION

The BCD-450 is designed for mounting to an enclosed panel. Refer to **Figure 4.14** for mounting dimensions.

1) Lay out the locations of the four mounting holes and drill and tap four holes for #8-32 screws.

2) Place four #8-32 x 5/8" round-head screws through the module and place 3/16" stand-offs between the module and the panel.

3) Attach the module to the panel and carefully tighten all screws. **DO NOT OVER-TIGHTEN!**

4) Determine whether the data logic to be used is "high true" or "low true". Place three data jumpers in position "1" for high true data and position "0" for low true data. (**Figure 4.15** shows the jumpers in the "1" positions.)

5) Connect 15-pin serial connection cables to the peripheral ports as required.

NOTE

The quantity and length of 15-pin connector serial cables required will depend on the location of the module in the daisy chain and the distance from the other modules before and after it.

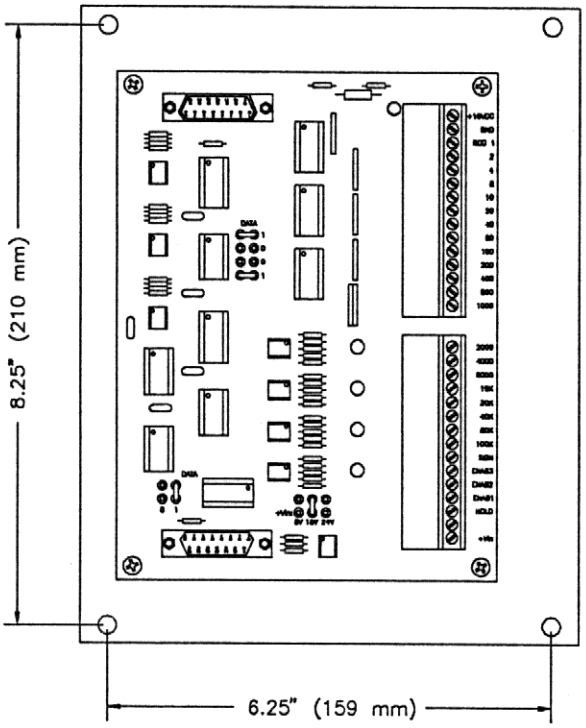

Figure 4.14
BCD-450 Installation Dimensions

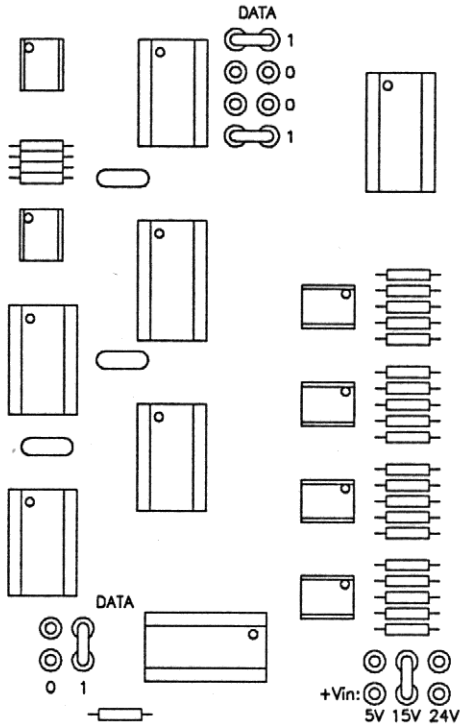

Figure 4.15
BCD-450 Jumpers

6) Connect the positive output from the 15 VDC power supply to the "+15 VDC" terminal on the BCD-450 connector.

7) Connect the negative output from the 15 VDC power supply to the "GND" terminal on the BCD-450 connector.

8) Connect the positive output of the logic voltage to the "$+V_{IN}$" terminal on the BCD-450 connector.

9) Connect the negative output of the logic voltage to the "GND" terminal on the BCD-450 connector (along with the +15 VDC negative output).

10) Place the voltage jumper in the proper location for the logic voltage — +5 VDC, +15 VDC, or +24 VDC (refer to **Figure 4.15**).

11) Connect the 21 binary coded decimal digit data lines (1 through 100K) from the data output terminals on the BCD-450 connector to the computer or PLC interface. These lines may be connected for a parallel interface (refer to **Figure 4.17**) or for a multiplexed interface (refer to **Figure 4.18**).

12) Connect the "SIGN" line from the data output terminal on the BCD-450 connector to the computer or PLC interface.

13) Connect the "HOLD" line from the computer or PLC interface to the data terminals on the BCD-450 connector.

14) Connect the "ENAB1", "ENAB2", and "ENAB3" lines from the computer or PLC interface to the data terminals on the BCD-450 connector.

NOTE

The "HOLD" and "ENABn" (Enable) lines are inputs to the BCD-450 from the host computer or PLC. They control the enabling of the BCD-450 and the type of interface (parallel or multiplexed).

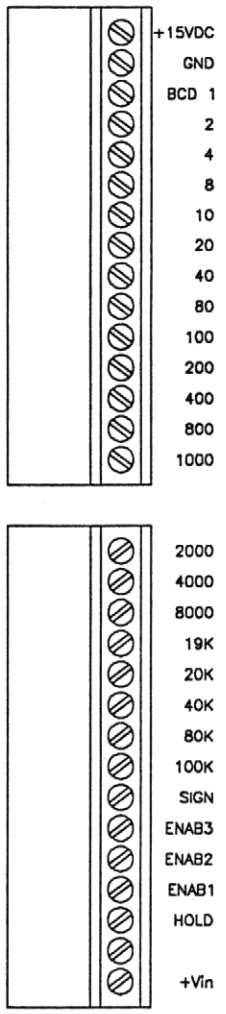

Figure 4.16
Output Connections

4.5.3. OPERATION

The BCD-450 Parallel Output Module is controlled by the MM-10-PLUS/MM-10-T controller and the host computer or programmable logic controller. Both 15 VDC and logic power are required for the module to operate. The BCD-450 output follows the movement of the motor (similar to the DSP-400 display), but the output information is only transferred to the host computer or PLC when the module is polled for information through the receipt of hold and enable signals. The following paragraphs indicate the types of communication to the module:

Hold Signal: The "Hold" line must see a "Low True" input for 3 milliseconds (.003 seconds) before output data is valid. It must be maintained during the entire "read" cycle. An LED will illuminate when the "HOLD" signal is valid.

Enable Signal: The three enable lines ("ENAB1", "ENAB2", and "ENAB3") must see a "Low True" input to be enabled. When each terminal is enabled, an indicating LED will illuminate.

Each input controls eight bits of the 24-bit BCD word. "ENAB1" controls the "Least Significant" eight bits; "ENAB3" controls the "Most Significant" eight bits. The three enable inputs can be strobed individually for multiplexed reads or individually for parallel reads. Output data is valid after 2 milliseconds (.002 seconds).

Sign Signal: The "SIGN" output may be either "High True" or "Low True". It is selected by the data jumpers along with the BCD outputs. Like the BCD outputs, this output is pulled to $+V_{IN}$ through 33K ohm resistors.

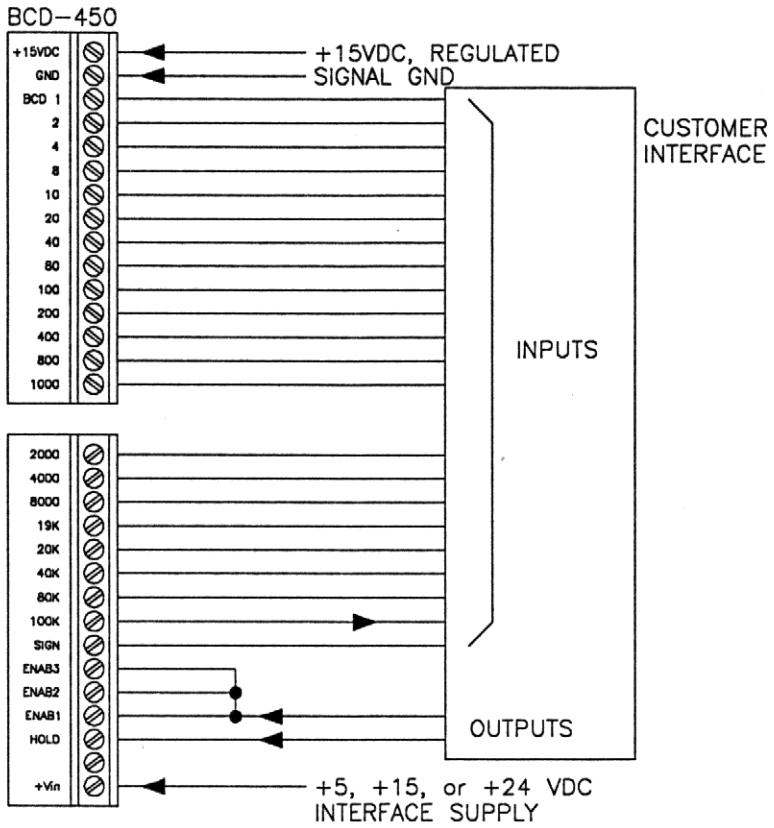

Figure 4.17 - BCD-450 Connections for Parallel Interface

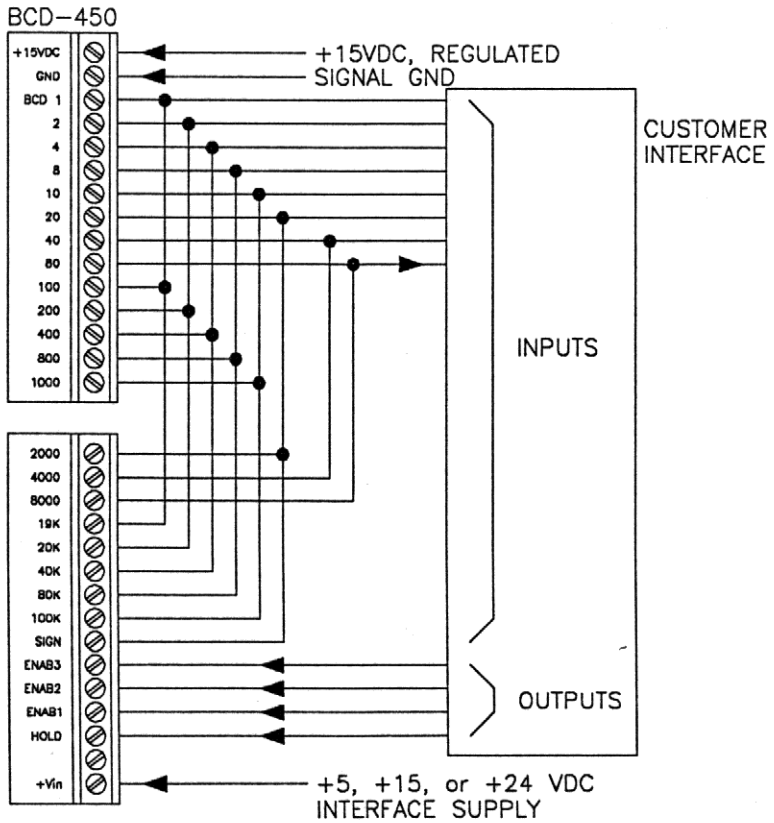

Figure 4.18 - BCD-450 Connections for Multiplexed Interface

The "SIGN" output will indicate movement direction. For an "Index" movement, "Logic False" indicates a clockwise move; "Logic True" indicates a counterclockwise move. For a "Position" movement, "Logic False" indicates movement to the plus side of the 0.00 position; "Logic True" indicates a movement to the minus side of the 0.00 position. (The motor rotates clockwise when traversing in a positive direction.)

4.6. IPS-15 POWER SUPPLY

4.6.1. DESCRIPTION

The IPS-15 Power Supply converts 120 VAC/ 50-60 Hz input voltage to a regulated 15 VDC output voltage. The maximum output current is 1.5 Amperes.

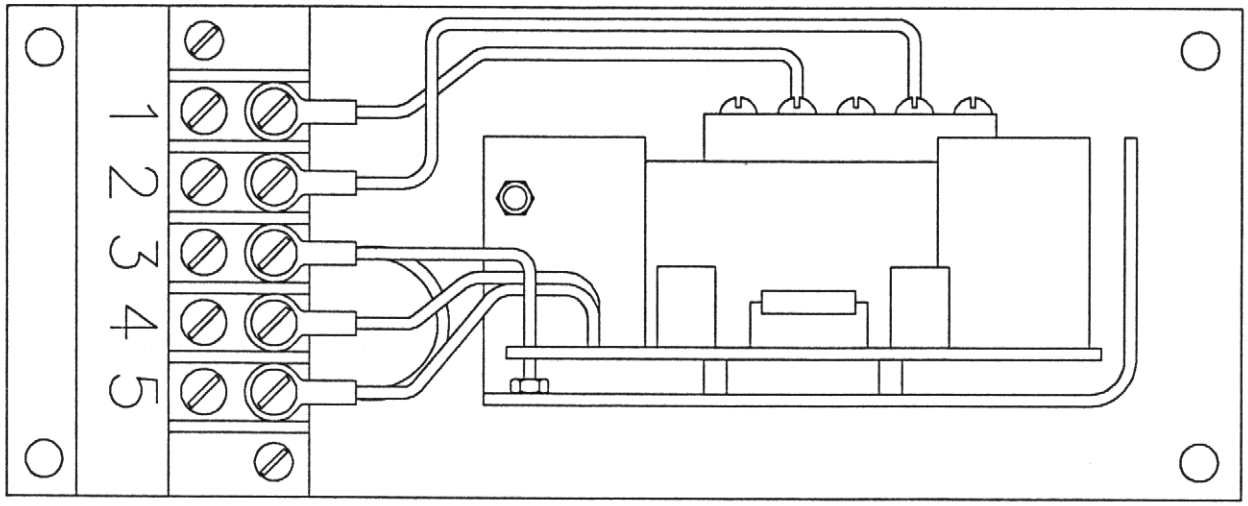

Figure 4.19 - IPS-15 Power Supply

4.6.2. INSTALLATION

The IPS-15 is designed for mounting to an enclosed panel. Refer to **Figure 4.20** for mounting dimensions.

1) Lay out the locations of the four mounting holes and drill and tap four holes for #8-32 screws.

2) Place four #8-32 x 5/8" round-head screws through the module and place 3/16" stand-offs between the module and the panel.

3) Attach the module to the panel and carefully tighten all screws. **DO NOT OVER-TIGHTEN!**

WARNING

DO NOT APPLY INPUT POWER TO THE IPS-15 POWER SUPPLY UNTIL THE OUTPUT IS PROPERLY CONNECTED AND THE ENTIRE SYSTEM IS READY TO OPERATE.

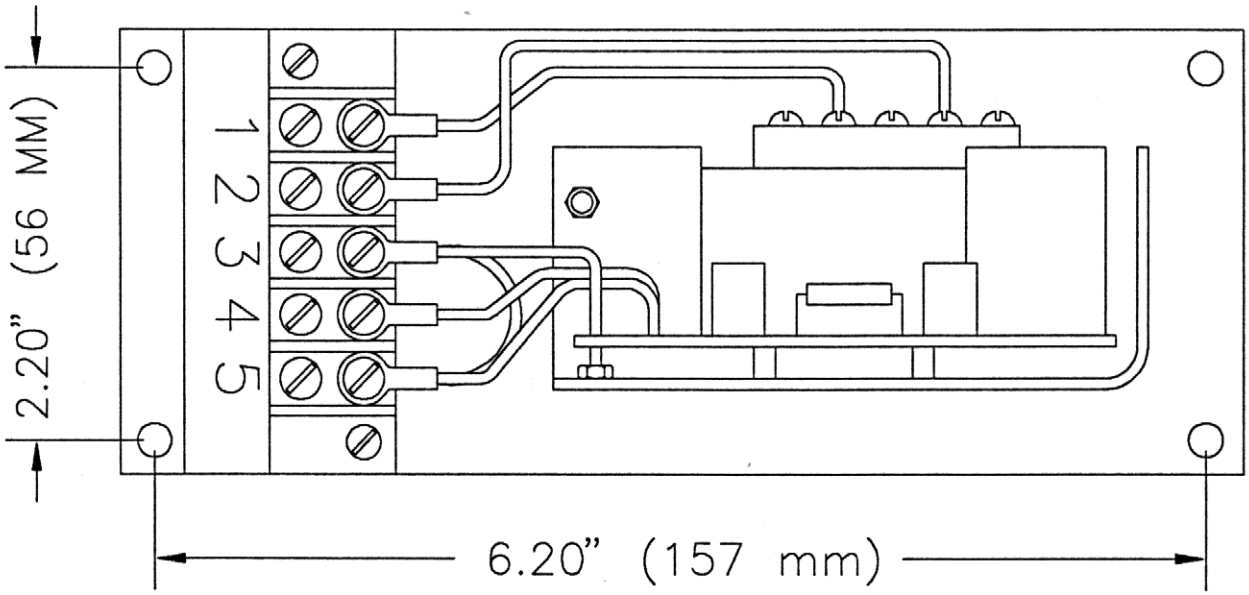

Figure 4.20 - IPS-15 Mounting Dimensions

4) Attach the ground wire from the 120 VAC source to terminal #3 of the power supply terminal board TB1 (refer to **Figure 4.21**).

5) Attach the neutral wire from the 120 VAC source to terminal #1 of the power supply terminal board TB1 (refer to **Figure 4.21**).

6) Attach the hot wire from the 120 VAC source to terminal #2 of the power supply terminal board TB1 (refer to **Figure 4.21**).

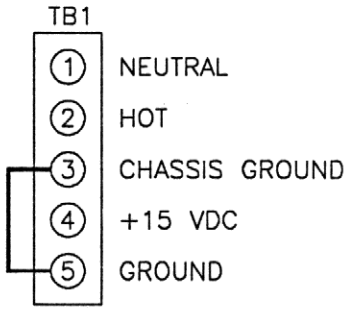

Figure 4.21
Terminal Block TB1

4.6.3. OPERATION

The IPS-15 power supply is a static device. Input power is transformed, rectified, and filtered to produce regulated 15 VDC output power.

4.7. TPP-400 TOUCH PANEL PROGRAMMER

The TPP-400 Touch Panel Programmer is primarily intended to be used as a diagnostic tool. It can, however, be used to program the controller and issue commands through the serial port at 300 baud when the controller is in Mode F.

4.7.1. DESCRIPTION

The programmer consists of a numerical keyboard and seven function keys used to input data to the MM-10-PLUS/MM-10-T controller. Most inputs consist of a sequence of function keys followed by a sequence of numerical entries. An 8-digit, hexadecimal LED display is used to show the entered data plus status information. LED indicators next to the function keys show which of these have been actuated.

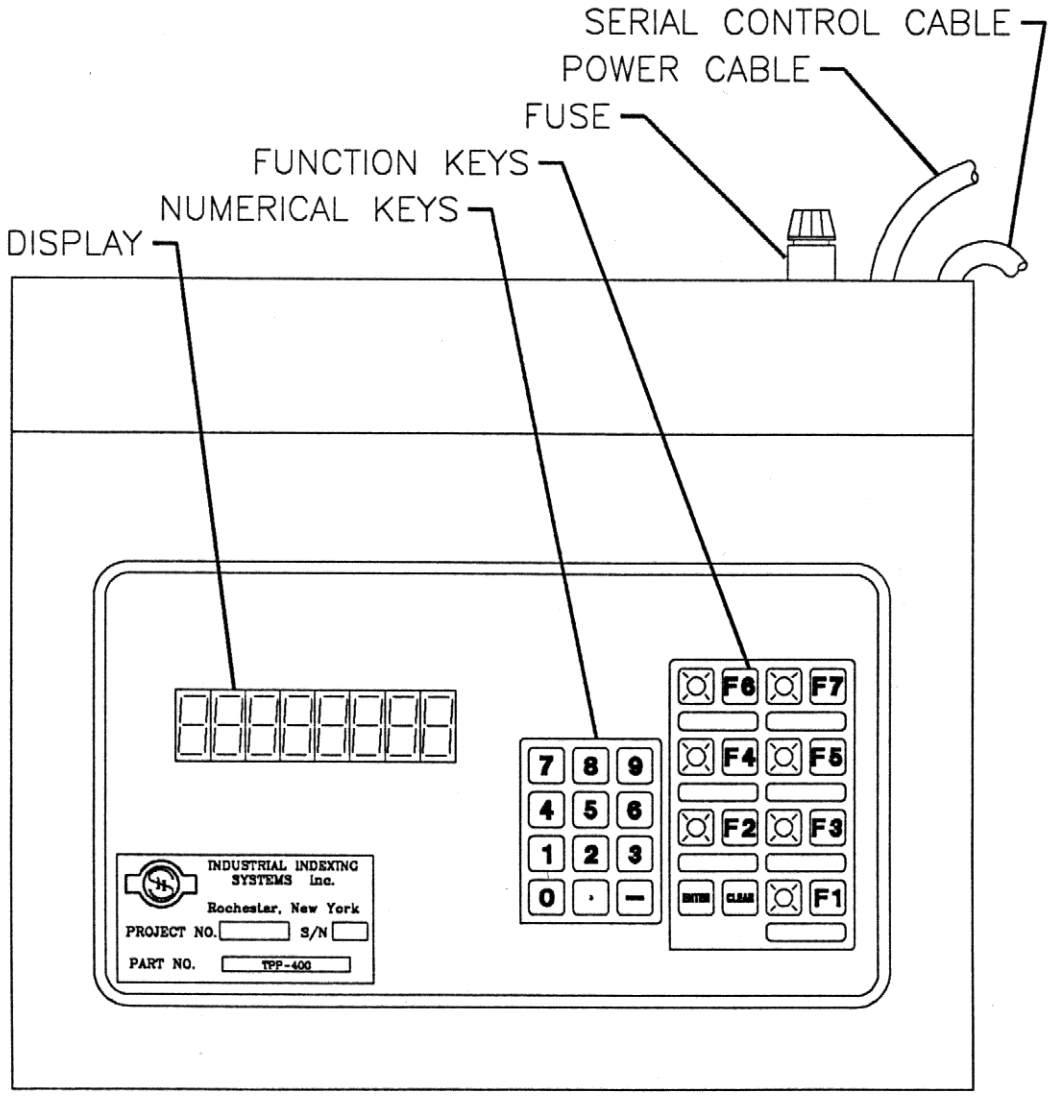

Figure 4.22 - TPP-400 Touch Panel Programmer

The power cable provides 120 VAC input power to the programmer. The serial control cable provides the connection to the controller.

4.7.2. INSTALLATION

The TPP-400 Touch Panel Programmer is a free-standing peripheral device.

1) Plug the serial control cable into the 25-pin serial connector on the MM-10-PLUS/MM-10-T controller.

2) Plug the power cable into a 120 VAC outlet.

4.7.3. OPERATION

1) Turn the mode selector on the MM-10-PLUS/MM-10-T controller to Mode F prior to supplying power to the controller.

2) Activate the controller by applying input power.

3) Enter data by pressing the appropriate function keys and numerical keys. Press the [ENTER] key to send the data.

The TPP-400 transmits and receives ASCII characters using a 20 mA current loop at 300 baud. The hexadecimal display shows what data has been entered. At the end of each entry, it will display an "A" if the data has been entered and received properly. If an improper entry was made or the data was not properly received, an error code will be displayed.

NOTE

Refer to "Appendix A - Programming with TPP-400 Touch Panel Controller" for details of the serial commands to use with the TPP-400 and the responses received when communicating with the MM-10-PLUS/MM-10-T controller.

SECTION 5 – SERIAL COMMUNICATIONS

The MM-10-PLUS can be completely controlled through the Serial Communications Port. Operating modes E and F are designated as serial modes. "Mode E" is for communication at 2400 Baud and "Mode F" is for communication at 300 Baud. The 300 Baud Mode F is primarily for communication with the TPP-400 Touch Panel Programmer, although it can be used by a host computer or programmable logic controller (PLC).

There are two message formats which can be used for communication — short form and long form. Typically the difference between the two is that the short form ends with a carriage return (CR) while the long form ends with a carriage return and a line feed (CR LF). Also, the long form frequently requires an extra CR and LF to fit the communication in the buffer. The specific differences can be seen in **1** and **2**. When the MM-10-PLUS/MM-10-T controller is powered up, "Mode E" defaults to short form communication and "Mode F" defaults to long form communication. The form of communication can be changed by serial command from the host computer or programmable logic controller.

NOTE

The TPP-400 Touch Panel Programmer will only communicate using long form serial commands and will only communicate at 300 baud.

Communication is full duplex and a message may be sent to the controller at any time in "Mode E" or "Mode F". Parameters changed by serial command will not affect an index/position or zeroing sequence which is already in progress. Jog speed can be changed while the motor is being jogged.

NOTE

The balance of this section will only deal with communication from the host computer or PLC (refer to Appendix A for Touch Panel Programmer procedures). Only short form serial commands will be shown in the text (refer to Table 5.2 for long form serial commands).

5.1. ENTERING SYSTEM PARAMETERS

When the MM-10-PLUS/MM-10-T controller is first powered up in "Mode E" or "Mode F", all input and output (I/O) modules are disabled. (A **[0 CR LF]** will be transmitted approximately 600 milliseconds (.600 seconds) after initial application of input power.) All functions and data are powered up (initialized) to the condition where they were when the power was turned off. If the function was under serial control, it remains under serial control.

Any single parameter or group of parameters may be changed using serial commands. Any parameter changed by serial command will remain under serial communications control until the "Clear Serial Parameters" command is sent to the MM-10-PLUS/MM-10-T (or until

engineering units are programmed from a thumb-wheel or BCD-410 module). The "Clear Serial Parameters" command resets all parameters to a condition where they are not under serial control. The "Mode" command must be sent to activate the I/O modules and make the MM-10-PLUS a functional unit.

NOTE

The "Mode" command may be used to go back to "Mode E" or "Mode F" which again disables the I/O Modules (E = 14, F = 15).

NOTE

When engineering units are programmed by a thumb-wheel module or BCD-410 Parallel Input Module, all functions are re-initialized to be not under serial control.

All commands are checked for proper format, parity (in "Mode E" only), and data range. If an error is detected, an error message will be sent from the MM-10-PLUS. The error format is:

[**E X CR**] where **X** is the error number.

Any error having to do with Serial Communications Port control will automatically reset itself in 1.5 seconds. The following message will be sent to indicate error reset:

[**B CR**]

During the 1.5 second reset cycle, the status display on the MM-10-PLUS/MM-10-T will flash "eN", where "N" is an error number from "0" to "9".

The MM-10-PLUS/MM-10-T has a 20 character receive buffer. Should a message be sent without a CR, the buffer will continue to fill and will roll back to the beginning at the 21st character. A message can be aborted at any time by sending two illegal control letters followed by a CR (for example **[P P CR]**. This message will result in an "E9" error message, but it will also reset the receive buffer to the beginning.

NOTE

The controller requires a 20 mA serial communication input signal. An RS-232 to 20 mA input converter is available from Industrial Indexing Systems.

NOTE

The MM-10 Series of controllers maintain nonvolatile data storage. The configuration parameters which configure the MM-10 controller are saved in this memory. There are two methods of clearing the configuration:

A) Use the "Clear Serial Parameters" serial command.

B) Power the MM-10 Controller up in a non-serial mode (modes 1-9).

This procedure should be performed when the MM-10 Controller is to be used in a serial communication mode (mode E or F), both upon initial start-up and upon a change of firmware.

Character formats are as follows:

"Mode E"

Mark = Logic 1 = 20 mA
Space = Logic 0 = 0 mA
2400 BAUD ASCII Format
10 bit word; 1 start bit, 7 data bits, parity bit and 1 stop bit.
Parity checking for even parity.

"Mode F"

Mark = Logic 1 = 20 mA
Space = Logic 0 = 0 mA
300 BAUD ASCII Format
10 bit word; 1 start bit, 7 data bits, parity bit = 0 and 1 stop bit. (Equivalent: 1 start bit, 7 data bits, 2 stop bits)

Table 5.1 - Short Form Serial Communications

FUNCTION		DATA (d-d) RANGE	SHORT FORM TRANSMISSION TO MOTION MASTER	SHORT FORM TRANSMISSION FROM MM-10-PLUS
1.	MODE	1 — 10, 14, 15	dd A P CR	A CR
2.	DISTANCE	0 — ±2,000,000xEngU/1000	(-) dddddd H P CR	A CR
3	.INDEX SPEED	1 — 3600 RPM	dddd H Q CR	A CR
4	.HOME SPEED	1 — 3600 RPM	dddd @ S CR	A CR
5	.JOG SPEED	1 — 500 RPM	ddd @ U CR	A CR
6	.INITIALIZE SPEED/DIRECT.	±1 — ±500 RPM	(-) ddd D Q CR	A CR
7.	OVERDRAW DISTANCE	0 — 9999xEngU/1000	ddddd I P CR	A CR
8.	OVERDRAW SPEED	1 — 500 RPM	ddd A Q CR	A CR
9.	RAMP	3 — 500 Rev/Sec/Sec	ddd @ T CR	A CR
10.	EARLY INDEX COMPLETE DISTANCE	0 — 2000xEngU/1000	dddd O P CR	A CR
11.	RECALL MODE	1 — 10, 14, 15	C P CR	dd CR
12.	RECALL DISTANCE	0 — ±2,000,000xEngU/1000	J P CR	(-) dddddd CR
13.	RECALL INDEX SPEED	1 — 3600 RPM	J Q CR	dddd CR
14.	RECALL HOME SPEED	1 — 3600 RPM	B S CR	dddd CR
15.	RECALL JOG SPEED	1 — 500 RPM	B U CR	dddd CR
16.	RECALL INITIALIZE SPEED	±1 — ±500 RPM	F Q CR	(-) dddd CR
17.	RECALL OVERDRAW DISTANCE	0 — 9999xEngU/1000	K P CR	dddd CR
18.	RECALL OVERDRAW SPEED	1 — 500 RPM	C Q CR	dddd CR
19.	RECALL RAMP	3 — 500 Rev/Sec/Sec	B T CR	dddd CR
20.	RECALL EARLY INDEX COMPLETE DISTANCE	0 — 2,000xEngU/1000	O Q CR	dddd CR
21.	CLEAR SERIAL PARAMETERS	None	A V CR	A CR
22.	E2 RESET	None	D V CR	B CR (O CR)
23.	RESPOND TO INDEX COMPLETE	None	E R CR	A CR (C CR)
24.	RESPOND TO INDEX DATA LOAD	None	C R CR	A CR (D CR)
25.	GO TO LONG FORM	None	X L CR	A CR
26.	READ INPUT MODULE STATUS	None	0 A U CR	dddd CR
27.	ENABLE SELECTED INPUTS	None	ddd A S CR	A CR
28.	READ PRESET POSITION	None	0 I T CR	(-) dddddd CR
29.	MOVE TO INITIALIZE	0	0 I Q CR	A CR
30.	MOVE TO HOME	1	1 I Q CR	A CR
31.	MOVE TO INDEX	2	2 I Q CR	A CR
32.	SET 0.00	3	3 I Q CR	A CR
33.	SET MS E UNITS IN K_{IN}(MS)		ddddddd J V CR	A CR
34.	SET LS E UNITS IN	K_{IN}(LS)	ddddddd J S CR	A CR
35.	SET MS E UNITS OUT	K_{OUT}(MS)	ddddddd NR CR	A CR
36.	SET LS E UNITS OUT	K_{OUT}(LS)	ddddddd KR CR	A CR
37.	INVERT OUTPUTS	None	0 E Q CR	A CR
38.	ENGINEERING UNITS	(±)52 to 40960	dddddd M P CR	A CR
39.	ENGINEERING UNITS DECIMALS	2 — 4	d E T CR	A CR

Table 5.2 - Long Form Serial Communications

	FUNCTION	DATA (d-d) RANGE	LONG FORM TRANSMISSION TO MOTION MASTER	LONG FORM TRANSMISSION FROM MM-10-PLUS
1.	MODE	1 — 10, 14, 15	dd CR LF A P CR LF	A CR LF
2.	DISTANCE	0 — ±2,000,000xEngU/1000	(-) dddddd CR LF H P CR LF	A CR LF
3.	INDEX SPEED	1 — 3600 RPM	dddd CR LF H Q CR LF	A CR LF
4.	HOME SPEED	1 — 3600 RPM	dddd CR LF @ S CR LF	A CR LF
5.	JOG SPEED	1 — 500 RPM	ddd CR LF @ U CR LF	A CR LF
6	.INITIALIZE SPEED/DIRECT.	±1 — ±500 RPM	(-) ddd CR LF D Q CR LF	A CR LF
7.	OVERDRAW DISTANCE	0 — 9999xEngU/1000	ddddd CR LF I P CR LF	A CR LF
8.	OVERDRAW SPEED	1 — 500 RPM	ddd CR LF A Q CR LF	A CR LF
9.	RAMP	3 — 500 Rev/Sec/Sec	ddd CR LF @ T CR LF	A CR LF
10.	EARLY INDEX COMPLETE DISTANCE	0 — 2,000xEngU/1000	dddd CR LF O P CR LF	A CR LF
11.	RECALL MODE	1 — 10, 14, 15	0 CR LF C P CR LF	dd CR LF
12.	RECALL DISTANCE	0 — ±2,000,000xEngU/1000	0 CR LF J P CR LF	(-) dddddd CR LF
13.	RECALL INDEX SPEED	1 — 3600 RPM	0 CR LF J Q CR LF	dddd CR LF
14.	RECALL HOME SPEED	1 — 3600 RPM	0 CR LF B S CR LF	dddd CR LF
15.	RECALL JOG SPEED	1 — 500 RPM	0 CR LF B U CR LF	dddd CR LF
16.	RECALL INITIALIZE SPEED	±1 — ±500 RPM	0 CR LF F Q CR LF	(-) dddd CR LF
17.	RECALL OVERDRAW DISTANCE	0 — 9999xEngU/1000	0 CR LF K P CR LF	dddd CR LF
18.	RECALL OVERDRAW SPEED	1 — 500 RPM	0 CR LF C Q CR LF	dddd CR LF
19.	RECALL RAMP	3 — 500 Rev/Sec/Sec	0 CR LF B T CR LF	dddd CR LF
20.	RECALL EARLY INDEX COMPLETE DISTANCE	0 — 2,000xEngU/1000	0 CR LF O Q CR LF	dddd CR LF
21.	CLEAR SERIAL PARAMETERS	None	0 CR LF A V CR LF	A CR LF
22.	E2 RESET	None	0 CR LF D V CR LF	B CR LF (O CR LF)
23.	RESPOND TO INDEX COMPLETE	None	0 CR LF E R CR LF	A CR LF (C CR LF)
24.	RESPOND TO INDEX DATA LOAD	None	0 CR LF C R CR LF	A CR LF (D CR LF)
25.	GO TO SHORT FORM	None	0 CR LF X S CR LF	A CR
26.	READ INPUT MODULE STATUS	None	0 CR LF A U CR LF	dddd CR LF
27.	ENABLE SELECTED INPUTS	None	ddd CR LF A S CR LF	A CR LF
28.	READ PRESET POSITION	None	0 CR LF I T CR LF	(-) dddddd CR LF
29.	MOVE TO INITIALIZE	0	0 CR LF I Q CR LF	A CR LF
30.	MOVE TO HOME	1	1 CR LF I Q CR LF	A CR LF
31.	MOVE TO INDEX	2	2 CR LF I Q CR LF	A CR LF
32.	SET 0.00	3	3 CR LF I Q CR LF	A CR LF
33.	SET MS E UNITS IN K_{IN}(MS)		ddddddd CR LF J V CR LF	A CR LF
34.	SET LS E UNITS IN	K_{IN}(LS)	ddddddd CR LF J S CR LF	A CR LF
35.	SET MS E UNITS OUT	K_{OUT}(MS)	ddddddd CR LF J V CR LF	A CR LF
36.	SET LS E UNITS OUT	K_{OUT}(LS)	ddddddd CR LF J S CR LF	A CR LF
37.	INVERT OUTPUTS	None	0 CR LF E Q CR LF	A CR LF
38.	ENGINEERING UNITS	(±)52 to 40960	dddddd CR LF M P CR LF	A CR LF
39.	ENGINEERING UNITS DECIMALS	2 — 4	d CR LF E T CR LF	A CR LF

NOTE

a) Data fields in all formats are indicated by dd--dd. The data field is a variable length with leading zeros optional. The last data **d** character received is always treated as the "units" digit.

b) **(-)** indicates an optional minus sign for counterclockwise operation.

c) The servo controller will respond as shown to all serial messages or with an error message.

d) The "E2" reset response has data characters "B" or "0". The "0" is sent if an "E2" was not present and a "B" is sent if an "E2" was present and reset.

e) ASCII "Null" and "Space" characters are ignored by the MM-10-PLUS/MM-10-T.

5.2. SYSTEM RESPONSES

The serial command sequences provide two commands which can be used by the host computer or programmable logic controller to verify that the MM-10-PLUS/MM-10-T is performing the desired indexes properly.

5.2.1. RESPOND TO INDEX COMPLETE

The "Respond to Index Complete" command directs the MM-10-PLUS/MM-10-T controller to respond to the host computer or PLC when an index is complete. The sequence of commands and responses is as follows:

f)	The command to "Respond to Index Complete" is sent from the serial control device to the MM-10-PLUS/MM-10-T controller.	[**O E R CR**]
g)	The controller responds, indicating it has received the command.	[**A CR**]
h)	An "Index" command is sent from the serial control device to the controller.	[**2 I Q CR**]
i)	The controller acknowledges receipt of the command.	[**A CR**]
	OR	
c)	An "Index" command is sent from an external device to the "Index" input module.	
d)	The controller acknowledges receipt of the index command to the serial device.	[**A CR**]
e)	When the index move is complete, the controller sends an additional response message to the serial control device.	[**C CR**] or [**c CR**]

NOTE

The "Respond to Index Complete" command only needs to be sent once. It then remains active and will cause a response from the controller each time an "Index" command is received and executed.

The controller's response to the index complete alternates between [**C CR**] and [**c CR**]. This allows the operator to know that the character in the receive buffer is a new response and not left from a previous index. Early INDEX complete has no effect on transmition of C/c CR response. The response will always be transmitted ay end of INDEX.

5.2.2. RESPOND TO INDEX DATA LOAD

The "Respond to Index Data Load" command directs the MM-10-PLUS/MM-10-T controller to respond each time it receives a new distance data input. The sequence of commands and responses is as follows.

a)	The command to "Respond to Index Data Load" is sent from the serial control device to the MM-10-PLUS/MM-10-T controller.	[**O C R CR**]
b)	The controller responds, indicating it has received the command.	[**A CR**]
c)	A "Distance" command is sent from the serial control device to the controller.	[**(-) ddddd H P CR**]
d)	The controller acknowledges receipt of the data.	[**A CR**]
	OR	
c)	An "distance" command is polled from a thumb-wheel or BCD-410 Input Module.	
d)	The controller acknowledges receipt of the distance data to the serial device.	[**A CR**]
e)	The controller sends an additional response message to the serial control device when it accepts the new data for use.	[**D CR**] or [**d CR**]

NOTE

The "Respond to Index Data Load" command only needs to be sent once. It then remains active and will cause a response from the controller each time an "Index" command is received and registered.

The controller's response to the index complete alternates between [**D CR**] and [**d CR**]. This allows the operator to know that the character in the receive buffer is a new response and not left from a previous data receipt.

5.3. PROGRAMMING ENGINEERING UNITS

Engineering units represent a number of distance units per revolution of the motor (or resolver or encoder which rotate at a one to one ratio with the motor). They may or may not represent actual units of measure such as feet or millimeters.

Because of internal bit transmission limitations, entering engineering units through serial command requires four separate commands to enter the required constants plus a series of calculations to determine the constants. These constants — **K_{IN}(MS)**, **K_{IN}(LS)**, **K_{OUT}(MS)**, and **K_{OUT}(LS)** — set the scale factor of engineering units to resolver (**K_{IN}**) and resolver to engineering units (**K_{OUT}**).

The serial transmission formats for **K_{IN}(MS)**, **K_{IN}(LS)**, **K_{OUT}(MS)**, and **K_{OUT}(LS)** are shown in **1** and **2**. After the four sets of transmissions are made to program the engineering units, the controller may be set to the desired operating mode using the "Mode" command.

K_{IN} is calculated as shown below. After it is determined, it is factored into two parts because there is no provision for transmitting decimal points through the serial transmissions. The integer part of the number represents the "Most Significant" (MS) part of the number. The decimal part of the number represents the "Least Significant" (LS) part of the number. **K_{IN}(MS)** and **K_{IN}(LS)** are determined by multiplying the integer and decimal parts of **K_{IN}** by additional constants.

NOTE

For correct conversion, K_{IN} must be less than 80 but greater than 0.10. If K_{IN} is not within this range, it will be necessary to choose a different decimal value or different engineering units.

To calculate **K_{IN}**:

$$K_{IN} = \frac{[(4096) \times (\text{X of Feedback Device})]}{[(\text{Engineering Units}) \times (\text{Decimal})]}$$

where:

(X of Feedback Device) = Number of feedback device counts per revolution.
(Decimal) = Decimal point placement

(Decimal) =	1 for	XXXXX.
(Decimal) =	10 for	XXXX.X
(Decimal) =	100 for	XXX.XX
(Decimal) =	1000 for	XX.XXX
(Decimal) =	10000 for	X.XXXXX

From the calculated value of K_{IN}, determine K_{IN}**(MS)** and K_{IN}**(LS)**:

K_{IN}**(MS)** = Integer Part of {$K_{IN} \times 65536$}

K_{IN}**(LS)** = Integer Part of {Decimal Part of [$K_{IN} \times 65536$] $\times$ 65536}

Calculations for K_{OUT}, K_{OUT}**(MS)**, and K_{OUT}**(LS)** are performed in a similar manner:

NOTE

For correct conversion, K_{OUT} must be less than 10 but greater than 0.0125. If K_{OUT} is not within this range, it will be necessary to choose a different decimal value or different engineering units. (If K_{IN} is correct, K_{OUT} will be correct.)

To calculate K_{OUT}:

$$K_{OUT} = \frac{1}{K_{IN}} = \frac{[(\text{Engineering Units}) \times (\text{Decimal})]}{[(4096) \times (\text{X of Feedback Device})]}$$

where:

(X of Feedback Device) = Number of feedback device counts per revolution.
(Decimal) = Decimal point placement

(Decimal) =	1 for	XXXXX.
(Decimal) =	10 for	XXXX.X
(Decimal) =	100 for	XXX.XX
(Decimal) =	1000 for	XX.XXX
(Decimal) =	10000 for	X.XXXXX

From the calculated value of K_{OUT}, determine K_{OUT}**(MS)** and K_{OUT}**(LS)**:

K_{OUT}**(MS)** = Integer Part of {$K_{OUT} \times 65536$}

K_{OUT}**(LS)** = Integer Part of {Decimal Part of [$K_{OUT} \times 65536$] $\times$ 65536}

NOTE

Engineering Units may also be programmed from the TWR-400A, TWR-410A, and BCD-410 Input Modules (refer to Section 3) and the TPP-400 Touch Panel Programmer (refer to Appendix A).

5.4. ENABLE/DISABLE I/O MODULES

When the MM-10-PLUS/MM-10-T controller is powered up in “Mode E” or “Mode F”, all I/O modules are disabled. The “Enable Selected Inputs” may be used to enable specific input modules. The **ddd** field in the command is used to select which modules are active. The **ddd** field is weighted as follows:

DATA		INPUT MODULE
1	=	INDEX
2	=	JOG CW
4	=	JOG CCW
8	=	FORCE DECEL
32	=	HOME
64	=	INITIALIZE
128	=	SET 0.00
256	=	HIGH SPEED INDEX ENABLE (INTERRUPT)

When the command is entered, the value for the **ddd** field is the sum of the values for the inputs which are to be enabled.

CALCULATIONS

SECTION 6 – TROUBLESHOOTING

This section is designed to assist trained personnel in identifying and correcting controller malfunctions. A prerequisite to the use of this troubleshooting guide is a thorough knowledge of the MM-10-PLUS/MM-10-T controller. When a problem occurs, first read the appropriate sections of this manual to make sure that the controller is installed properly and that it is being operated correctly.

6.1. ERROR CODES

The controller system provides ten error codes to assist in troubleshooting controller problems. If an error condition exists, the status display on the MM-10-PLUS/MM-10-T controller will change from a display of the operating mode to an alternately flashing "e" and a numeral from "0" to "9". If there is a DSP-400 Display in the system, it will also display an error code in the format "En", where "n" is the error code number from "0" to "1".

ERROR CODE	DESCRIPTION
e0 (or E0)	Out of range engineering units entered serially or from a thumb-wheel module.
e1 (or E1)	MM-10-PLUS self test error or resolver failure. Power must be cycled off and on to reset. If "e1" persists, proceed to the system test procedures in **Section 6.3**.
e2 (or E2)	Motor "Following Error" is too great. This error could be caused by a motor or drive failure or by an overload condition on the motor. The error is reset by energizing the "Force Decel" input module for a minimum of 1.5 seconds. If "e2" persists, proceed to the system test procedures in **Section 6.3**. This error can also be cleared with serial commands.
e3 (or E3)	Nonvolatile memory failed "Check Sum" test. Change to "Mode D"; cycle power; and re-program the engineering units.
e4 (or E4)	Transmitter overrun. Error is automatically reset in 1.5 seconds.
e5 (or E5)	A Serial Communications Port break has been detected or a line is open. Error will reset when fault on line is corrected.

ERROR CODE	DESCRIPTION
e6 (or E6)	Parity error in "Mode E" only. Error is automatically reset in 1.5 seconds.
e7 (or E7)	Data field in Serial Communications is out of range. Error is automatically reset in 1.5 seconds.
e8 (or E8)	Function requested cannot be executed when motor is moving. Error is automatically reset in 1.5 seconds.
e9 (or E9)	Improper control code received in a Serial Communication. Error is automatically reset in 1.5 seconds.

6.2. BASIC SYSTEM CHECKS

Most problems with the controller can be readily found by following a systematic sequence of observations and tests. Many start-up problems can be associated with improperly installed devices, loose or improper wiring connections, or improper settings on the various parameter potentiometers and input controls.

All troubleshooting should include an initial check of various basic areas. For the MM-10-PLUS/MM-10-T controller, some of the areas to be checked include the following:

1) If this is an initial installation, check all installation procedures to make sure they have been followed properly.

2) Check to make sure 120 VAC power is being supplied to the controller and all system power supplies. Check to make sure plugs are securely inserted in their respective sockets and supply disconnects are turned on. Check all fuses.

3) Check the status display to see if an error message is being displayed. Take appropriate corrective actions if an error message is displayed.

4) Check for loose or broken wires.

5) Check all serial and peripheral cable connectors to make sure they are securely seated in their respective sockets.

6) Check all input devices for proper settings.

NOTE

The MM-10-PLUS/MM-10-T controller will not function if engineering units have not been programmed.

7) Check the profile parameter potentiometers on the MM-10-PLUS/MM-10-T controller to make sure they are set properly.

NOTE

The MM-10-PLUS/MM-10-T controller will always read the first thumb-wheel input it sees (closest to the controller on the daisy-chain) which is enabled. A TWR-400A Thumb-wheel Input Module is always enabled and must come after all TWR-410A modules on the daisy chain.

8) If the system contains multiple distance input devices and is not moving the proper distance, check to make sure the proper device is being read.

9) Check the output voltages of each of the system power supplies to make sure power is being transmitted to the peripheral devices.

10) Check the position of all jumpers including the "Overdraw Enable/Disable" jumper.

11) Check for a loose mechanical coupling between the motor and the resolver or encoder.

If the system problems are not resolved after checking these areas, proceed to the "Mode 0" test procedures detailed in **Section 6.3**.

6.3. SYSTEM TESTS

The tests in this section are designed to be followed sequentially until the problem is found.

6.3.1. VELOCITY LOOP TEST

The velocity loop test removes the controller from the loop for the purpose of testing the motor, amplifier, and power supply. In this test, the amplifier is manually enabled and a velocity command voltage is applied to the amplifiers by means of a Volt Ohm Meter (V.O.M.) command input.

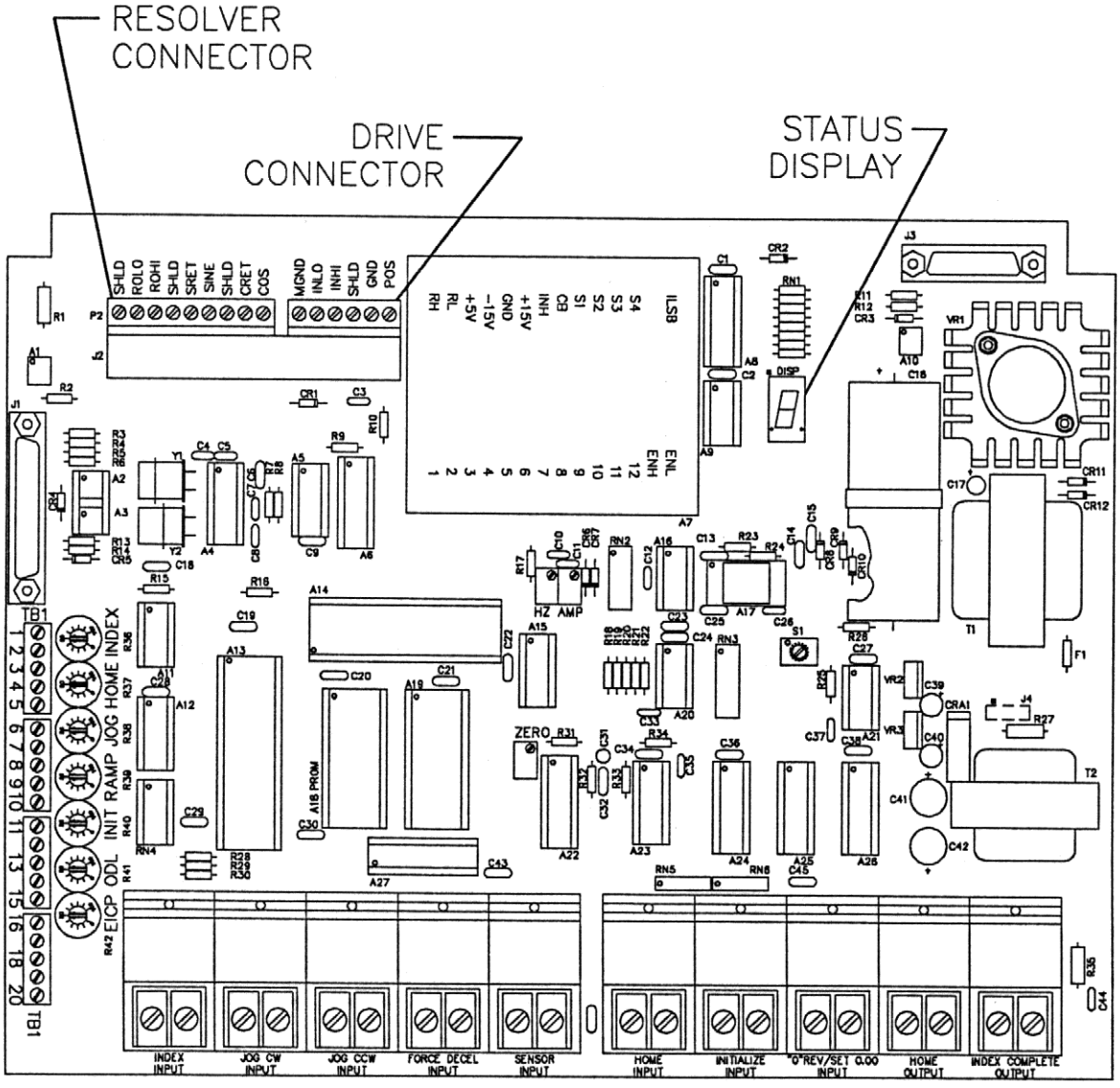

Figure 6.1 - MM-10-PLUS Controller

WARNING

THIS TEST CAUSES THE MOTOR TO TURN. MAKE SURE THAT THE MECHANICAL LOAD WILL ACCEPT MOVEMENT IN BOTH DIRECTIONS WITHOUT DAMAGE TO THE EQUIPMENT AND THAT ALL PERSONNEL ARE CLEAR BEFORE STARTING THIS TEST.

1) Remove system power.

2) Remove the 6-Pin drive connector from the controller.

3) Using a short jumper wire, temporarily short together the "INLO" (green wire) and "INHI" (white wire) terminals on the drive connector. This step causes the drive (amplifier) to turn "On" manually.

4) Apply system power. The motor should be stationary and should resist any attempt to turn the motor shaft.

NOTE

Since this is a feedback system, there will always be some slight drift to the motor shaft when it is tested in this manner. However, the motor will not be free to be turned by hand.

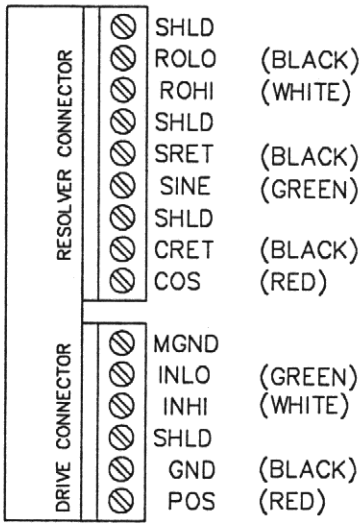

Figure 6.2
Controller Connectors

5) Set a V.O.M. for use as an ohmmeter using the R×1 resistance scale.

6) Connect the positive meter lead to the "POS" (red wire) drive connector terminal and the negative meter lead to the "GND" (black wire) drive connector terminal. This applies voltage (approximately 0.5 volts) into the amplifier input acting as a velocity command.

RESULT: **The motor should accelerate sharply to a controlled speed in a clockwise direction and decelerate sharply when either meter lead is removed.**

7) Reverse the meter leads to the "POS" and "GND" drive connector terminals. This changes polarity of the velocity command.

RESULT: **The motor should accelerate sharply to a controlled speed in a counterclockwise direction and decelerate sharply when either meter lead is removed.**

8) If all tests pass, the velocity loop is functioning correctly.

9) Remove all temporary jumpers, replace all disconnected wires, and connect the drive connector to the controller.

Items to check if test fails:

a) Troubleshoot velocity loop according to manufacturer's recommendations.
b) Power supply voltages.
c) Motor armature wiring and polarity.
d) Tachometer wiring and polarity.

6.3.2. POSITION LOOP TEST

The position loop test is used to verify that the MM-10-PLUS/MM-10-T controller and feedback device are functioning properly. The controller and feedback device are

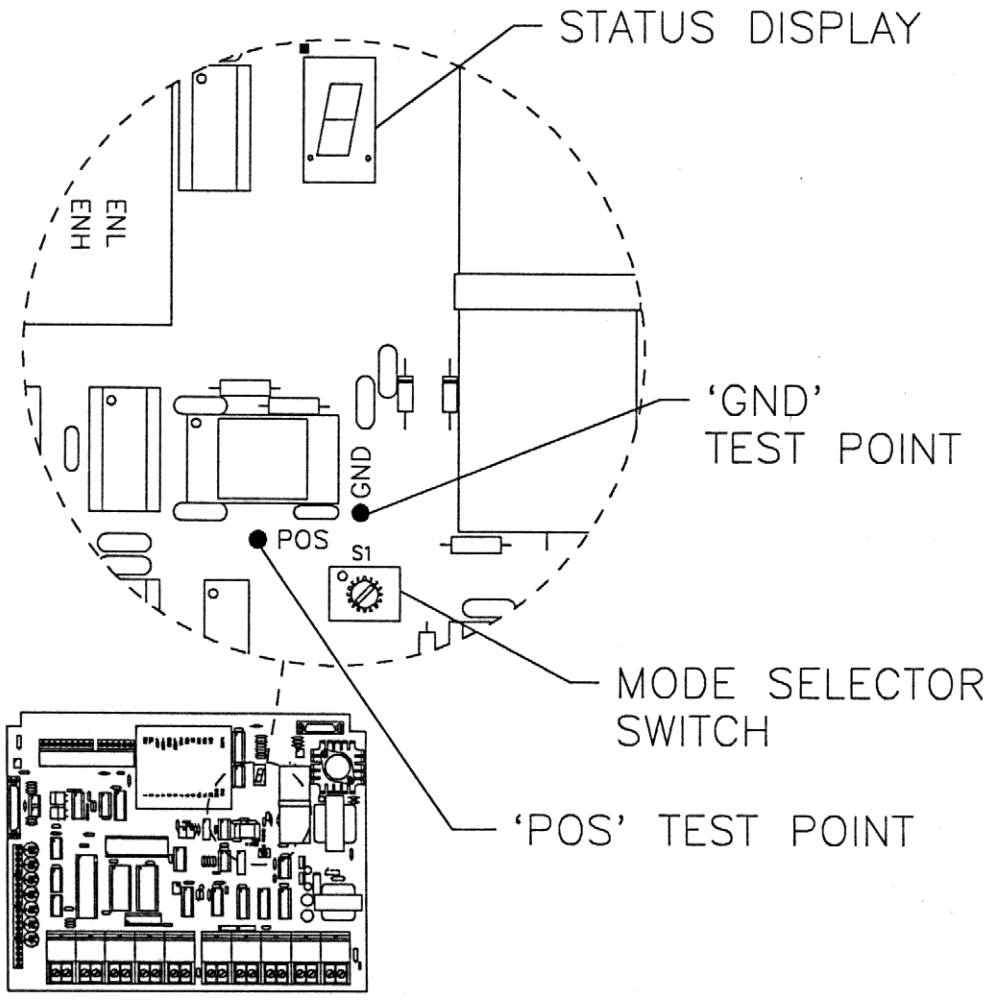

Figure 6.3 - Controller Test Points

placed in a condition where the feedback-device signals are fed back to the controller. As the feedback device is rotated, a corresponding voltage can be measured at the test points on the controller.

1) Remove system power.

WARNING

THE DRIVE CONNECTOR MUST BE DISCONNECTED FROM THE CONTROLLER TO MAKE SURE THAT THE AMPLIFIER DOES NOT BECOME ENABLED.

2) Remove the 6-pin drive connector from the controller.

3) Connect a DC volt meter to the test points on the MM-10-PLUS/MM-10-T controller. Connect the positive meter lead to the "POS" test point and the negative meter lead to the "GND" test point.

NOTE

Full scale voltage for this test should not exceed ±10 VDC.

4) Set the controller 16-position selector switch (S1) to "Mode 0".

5) Apply system power.

6) Manually turn the motor shaft until the meter reading is 0.0 VDC ±0.1 VDC.

7) Turn the motor shaft 1/4 turn clockwise. The volt meter should indicate a voltage of +5 VDC ±1 VDC.

8) Turn the motor shaft back to the starting point. The volt meter should indicate 0.0 VDC ±0.1 VDC.

9) Turn the motor shaft 1/4 turn counterclockwise. The volt meter should indicate a voltage of -5 VDC ±1 VDC.

10) Continue to turn the motor shaft in a counterclockwise direction. The voltage should increase negatively to -10.0 VDC ±1 VDC. When the motor has been turned 180 degrees from the starting point, the voltage will suddenly change polarity to +10 VDC. As the motor continues turning in a counterclockwise direction, the voltage will decrease toward 0.0 VDC. When the motor has been turned 360 degrees (back to the starting point), the voltage should again be 0.0 VDC ±1 VDC. The cycle should repeat if the motor shaft continues to be turned in a counterclockwise direction.

11) Remove all temporary jumpers, replace all disconnected wires, and connect the drive connector to the controller.

12) Failure of the above test (as shown by incorrect voltages or no voltages) indicates a problem in the position sensing circuitry (resolver/encoder, cable, or controller.

Items to check if test fails:

a) Secure resolver connections at motor.
b) Resolver reference and resolver feedback signals.
c) Failed MM-10-PLUS/MM-10-T controller board.
d) Failed resolver/encoder.
e) Open or shorts in feedback device cables.

6.3.3. RESOLVER TEST

The resolver test is used to verify the presence of a 2600 HZ, 8.0 VAC reference signal generated on the MM-10-Plus board to drive the resolver. It is also used to verify the two return signals from the resolver to the MM-10-Plus.

WARNING

THE FOLLOWING VOLTAGE MEASUREMENTS MUST BE MADE ON THE RESOLVER CONNECTOR WHILE THE SYSTEM IS OPERATING.

1) Connect an AC volt meter across the "ROHI" and "ROLO" terminals of the resolver connector. Voltage should read 8.0 VAC ±2 VAC. This voltage should not vary more than 0.5 VAC when the motor shaft is turned. This is the resolver reference signal that drives the resolver.

2) If the voltage is okay, go to Step 3. If the voltage is low, disconnect the resolver connector at the motor and re-measure the voltage. If the voltage is still low, replace the controller. If the voltage drops below 6.0 VAC when a resolver is connected but is correct when the resolver is disconnected, check the resolver cable for possible shorts. If the problem still exists, replace the motor assembly.

3) Connect an AC volt meter to the "SINE" and "SRET" terminals on the resolver connector. As the

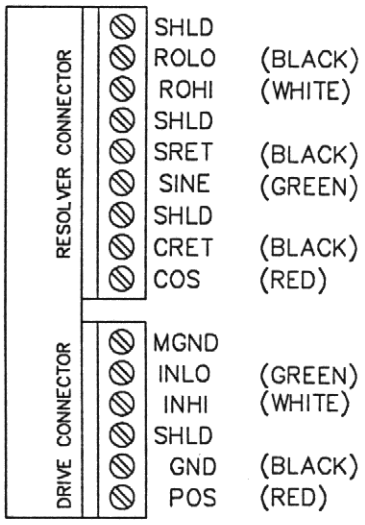

Figure 6.4
Controller Connectors

motor shaft is turned, the voltage should vary from 10.0 VAC ±2 VAC to less than 1.0 VAC.

4) Connect an AC volt meter to the "COS" and "CRET" terminals on the resolver connector. As the motor shaft is turned, the voltage should vary from 10.0 VAC ±2 VAC to less than 1.0 VAC.

Items to check if test fails:

a) Be sure that resolver connector is secure.
b) Check the cable for shorts.
c) Check the cable for breaks.

6.3.4. ENCODER TEST

When using the MM-10-T controller with an encoder, perform the following test instead of the Resolver Test.

1) Put the MM-10-T into operating mode "0".

2) Apply power to the controller.

3) Rotate the encoder (motor) slowly.

RESULT: **The channel 1 and channel 2 encoder pulse LEDs should flash at the same rate, but not at the same time. The channel 3 encoder pulse LED should flash once per revolution.**

Items to check if test fails:

a) Check that drive power is on for a shared encoder.
b) Be sure that resolver connector is secure.
c) Check the cable for shorts.
d) Check the cable for breaks.
e) Troubleshoot the drive of a shared encoder according to the manufacturer's instructions.

APPENDIX A
PROGRAMMING WITH TPP-400 TOUCH PANEL PROGRAMMER

The TPP-400 is a portable, serial interface device for use with the MM-10-PLUS/MM-10-T controller. It transmits and receives ASCII characters using a 20 mA current loop at 300 baud and functions with "Mode F" on the controller only.

Programming consists of entering the data followed by a sequence of function key entries. **Table A.1** shows function keys to be used for each command. Always press the function keys in the sequence shown.

Engineering units can also be programmed from the TPP-400 programmer. To program engineering units, enter the units per resolver revolution including all decimal places. (For example, to program 1.234 units per resolver revolution, enter 1234.) When the digits are entered, press the [F1], [F3] and [F4] function keys.

NOTE

The engineering units may be a positive or negative number.

Enter the number of decimal places desired. When the digit is entered, press the [F1], [F3] and [F7] function keys.

When the data is accepted, the status display on the MM-10-PLUS/MM-10-T will flash "U" and the number of decimals selected. If "e" and "0" are flashing (error code "0"), the units are either too large or too small.

Table A.1 - TPP-400 Programming Function Key Commands

FUNCTION	TPP-100 FUNCTION KEYS	DATA RANGE
MODE	F1	0 -- 9, 13 -- 15
DISTANCE	F4	0 -- 200000 EngU/1000
EARLY INDEX COMPLETE DISTANCE	F1, F2, F3, F4	0 -- 2000 Turns/1000
INDEX SPEED	F4, F5	1 -- 3600 RPM
HOME SPEED	F5, F6	1 -- 3600 RPM
JOG SPEED	F5, F7	1 -- 500 RPM
INITIALIZE SPEED/DIRECTION	F3, F5	±1 RPM -- ±500 RPM
OVERDRAW DISTANCE	F1, F4	0 -- 9999 Turns/1000
OVERDRAW SPEED	F1, F5	1 -- 1000 RPM
RAMP	F7	3 -- 500 Rev/Sec/Sec
RECALL MODE	F1, F2	
RECALL DISTANCE	F2, F4	
RECALL INDEX SPEED	F2, F4, F5	
RECALL HOME SPEED	F2, F5, F6	
RECALL JOG SPEED	F2, F5, F7	
RECALL INITIALIZE SPEED	F2, F3, F5	
RECALL OVERDRAW SPEED	F1, F2, F5	
RECALL RAMP	F2, F7	
RECALL EARLY INDEX DISTANCE	F1, F2, F3, F4, F5	
CLEAR SERIAL PARAMETERS	F1, F6, F7	
E2 RESET	F3, F6, F7	
RESPOND TO INDEX COMPLETE	F1, F3, F6	
RESPOND TO DATA LOAD	F1, F2, F6	
READ INPUT MODULE STATUS	F1, F5, F7	
ENABLE SELECTED INPUTS	F1, F5, F6	
READ PRESENT POSITION	F1, F4, F7	
MOVE TO INITIALIZE	F1, F4, F5	0
MOVE TO HOME	F1, F4, F5	1
MOVE TO INDEX	F1, F4, F5	2
SET 0.00	F1, F4, F5	3
SET MS E_UNITS IN	F2, F4, F6, F7	K_{IN}(MS)
SET LS E_UNITS IN	F2, F4, F5, F6	K_{IN}(LS)
SET MS E_UNITS OUT	F2, F3, F4, F6	K_{OUT}(MS)
SET LS E_UNITS OUT	F1, F2, F4, F6	K_{OUT}(LS)
INVERT OUTPUTS	F1, F3, F5	
ENGINEERING UNITS	F1, F3, F4	52 -- 40960/# Decimals
ENGINEERING UNITS DECIMALS	F1, F3, F7	2 -- 4

APPENDIX B
COMMAND CODE CROSS REFERENCE

@S	HOME SPEED
@T	RAMP
@U	JOG SPEED
AP	MODE
AQ	OVERDRAW SPEED
AS	ENABLE SELECTED INPUTS
AU	READ INPUT MODULE STATUS
AV	CLEAR SERIAL PARAMETERS
BS	RECALL HOME SPEED
BT	RECALL RAMP
BU	RECALL JOG SPEED
CP	RECALL MODE
CQ	RECALL OVERDRAW SPEED
CR	RESPOND TO INDEX DATA LOAD
DQ	INITIALIZE SPEED/DIRECTION
DV	E2 RESET
EQ	INVERT HOME & INDEX COMPLETE OUTPUTS
ER	RESPOND TO INDEX COMPLETE
ET	ENGINEERING UNITS NUMBER OF DECIMALS
FQ	RECALL INITIALIZE SPEED
HP	DISTANCE
HQ	INDEX SPEED
IP	OVERDRAW DISTANCE
0IQ	MOVE TO INITIALIZE
1IQ	MOVE TO HOME
2IQ	MOVE TO INDEX
31Q	SET 0.00
IT	READ PRESENT POSITION
JP	RECALL DISTANCE
JQ	RECALL INDEX SPEED
JS	SET LS E_UNITS IN
JV	SET MS E_UNITS IN
KP	RECALL OVERDRAW DISTANCE
KR	SET LS E_UNITS IN
MP	ENGINEERING UNITS
NR	SET MS E_UNITS OUT
OP	EARLY INDEX COMPLETE
OQ	RECALL EARLY INDEX
XL	GOTO LONG FORM
XS	GOTO SHORT FORM

NOTES

APPENDIX C
ASCII CONVERSION TABLE

This appendix lists the ASCII character set and the hexadecimal representation for each character code.

GRAPHIC OR CONTROL	HEX CODE	GRAPHIC OR CONTROL	HEX CODE
NUL	00	&	26
SOH	01	'	27
STX	02	(	28
ETX	03	)	29
EOT	04	*	2A
ENQ	05	+	2B
ACK	06	,	2C
BEL	07	-	2D
BS	08	.	2E
HT	09	/	2F
LF	0A	0	30
VT	0B	1	31
FF	0C	2	32
CR	0D	3	33
SO	0E	4	34
SI	0F	5	35
DLE	10	6	36
DC1	11	7	37
DC2	12	8	38
DC3	13	9	39
DC4	14	:	3A
NAK	15	;	3B
SYN	16	<	3C
ETB	17	=	3D
CAN	18	>	3E
EM	19	?	3F
SUB	1A	@	40
ESC	1B	A	41
FS	1C	B	42
GS	1D	C	43
RS	1E	D	44
US	1F	E	45
[space]	20	F	46
!	21	G	47
"	22	H	48
#	23	I	49
$	24	J	4A
%	25	K	4B

GRAPHIC OR CONTROL	HEX CODE	GRAPHIC OR CONTROL	HEX CODE
L	4C	f	66
M	4D	g	67
N	4E	h	68
O	4F	i	69
P	50	j	6A
Q	51	k	6B
R	52	l	6C
S	53	m	6D
T	54	n	6E
U	55	o	6F
V	56	p	70
W	57	q	71
X	58	r	72
Y	59	s	73
Z	5A	t	74
[	5B	u	75
\	5C	v	76
]	5D	w	77
^	5E	x	78
_	5F	y	79
`	60	z	7A
a	61	{	7B
b	62	|	7C
c	63	}	7D
d	64	~	7E
e	65	DEL	7F

APPENDIX D
GLOSSARY

ASCII: American Standard Code for Information Interchange

BAUD: The number of bits per second that can be transmitted in computer communications.

BCD: Binary Coded Decimal System. A system of number representation in which each digit of a decimal number is represented by a binary number.

Check Sum: A sum of digits or numbers used in a summation check. (A summation check is an error-detecting procedure involving adding together all the digits of some number and comparing this sum to a previously computed value of the same sum.)

Closed Loop: A regulating device in which the actuator position is sensed, and a signal proportional to this position (feedback position) is compared with a signal proportional to the desired actuator position (command position). The difference between these signals is the error signal. The error signal causes a change in the actuator so as to force this difference to be zero.

Communications: The transmission of information from one device to another. The information can take many forms such as command signals, device status and fault conditions.

Controller: The device which receives data from various input devices and issues commands to the drive.

Daisy Chain: A means of connecting devices to a central processor by input/output buses which transmit in both directions simultaneously.

Edge triggered: An electronic circuit which must sense the initial change in a voltage before it is actuated.

Encoder: A converter in which the exact angular position of a shaft is sensed and converted to digital form.

Engineering Units: The type of units by which distance or position in a system are measured. Entered as the number of units per revolution of the feedback device.

Feedback Device: Device which monitors shaft position by sending signals to the controller as the shaft rotates.

Full Duplex: A method of operating a communications circuit so that each end can simultaneously transmit and receive.

Gain: A multiplication factor. When used with the MM-10-T controller, it is the factor used to increase or decrease the apparent number of counts per revolution.

High True: A binary coded decimal condition where the binary digit "1" is the high logic voltage.

Home: Absolute 0.00 or the point from which all absolute points are measured.

Host Computer: A computer system whose function is to monitor and coordinate the processes of other devices. A host computer will typically coordinate motion control functions as well as their interaction with other machine processes.

Index: To move the motor shaft an incremental distance from the current position.

Initialize: To move in order to find a "Home" or absolute 0.00 reference.

Instruction: A command to be executed by the MM-10-PLUS/ MM-10-T controller.

I/O: Input/Output. (Pertaining to all equipment and activity that transfers information into or out of a computer or similar device — such as the MM-10-PLUS/MM-10-T controller.)

Jog: A move sequence in which the motor shaft only rotates as long as it receives an input.

K_{IN}: A constant value used to convert engineering units to feedback-device counts.

K_{OUT}: A constant value used to convert feedback-device counts to engineering units.

Least Significant Bit: The bit that carries the lowest value or weight in the binary notation for a numeral. The right-most bit in the binary word (notation).

LED: Light-Emitting Diode. Also known as solid-state lamp. A semiconductor diode that converts electric energy to light.

Low True: A binary coded decimal condition where the binary digit "1" is the low logic voltage.

LS: Least Significant. Used, when programming engineering units, to represent the decimal part of a number.

Mode: The way in which the MM-10-PLUS/MM-10-T executes instructions. It is determined by the position of a 16-position selector switch.

Most Significant Bit: The bit that carries the greatest value or weight in the binary notation for a numeral. The left-most bit in the binary word (notation).

MS: Most Significant. Used, when programming engineering units, to represent the integer part of a number.

Nonvolatile Memory: A computer storage medium that retains information in the absence of power.

Optically Isolated: Indicates an I/O which uses a coupling device in which a light-emitting diode, energized by an input signal, is optically coupled to a photodetector.

Overdraw Search Sequence: A sequence in which the MM-10-PLUS/ MM-10-T will continue motion at the end of an index at a pre-programmed speed until the "Overdraw Sensor" input is energized. If the input is not activated in the "Overdraw Distance", the overdraw is terminated.

Parameters: Predefined data which is used in the execution of instructions.

Peripheral: Various kinds of devices that operate in combination or conjunction with the MM-10-PLUS/ MM-10-T but are not physically part of the controller.

PLC: Programmable Logic Controller.

Position: To move the motor to an absolute position in reference to a previously established 0.00 point ("Home").

POS OUT: Position Output (motor error output).

Programmable Logic Controller: An electronic device that scans on/off type inputs and controls on/off type outputs. The relationship between the inputs and outputs are programmable by the user.

Quadrature: When relating to a shaft encoder, indicates that there are two oscillating outputs whose frequencies are 90° out of phase.

Resolver: A type of feedback device which converts mechanical position into an electrical signal. A resolver is a variable transformer that divides the impressed AC signal into a sine and cosine output signal. The phase of these two signals represent the absolute position of the resolver shaft.

Smart Slave Controller: An MM-10-PLUS/MM-10-T controller operating under the control of another device such as a PLC or host computer.

Stand Alone Controller: An MM-10-PLUS/MM-10-T controller operating without the control of a host computer or PLC.

Strobed: Pulsed. Refers to a peripheral device which is periodically checked for its status.

V_{IN}: Input voltage.

Zrev: Zero Revolution - The turn where absolute 0.00 ("Home") exists. A proximity switch is usually used in an initialize sequence to determine where this turn exists.

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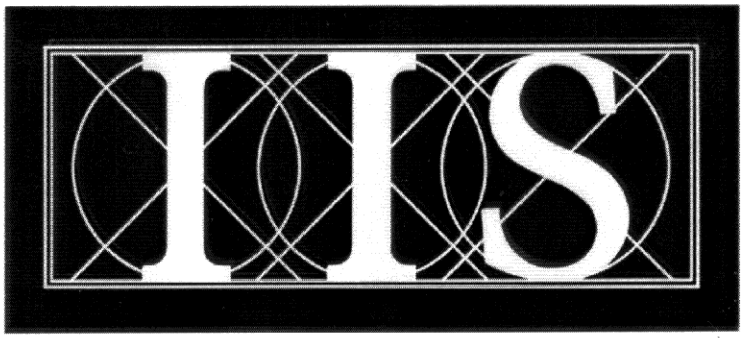

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PRINTED IN USA