INTRODUCTION

The M-Track is a digital control device used to synchronize the position of a Slave process relative to the Master process. The Slave and Master items used to synchronize the continuous moving process can be either two parts of a final product (e.g., bottles and bottle caps) or two parts of a machine (e.g., gear keyway to conveyor flight). Some of the advanced capabilities of the M-Track include 8 preset setpoints, "Learn Mode" self-scaling, trending, high sync rate and control bandwidth, and the capability to provide accurate digital control for virtually any AC, DC, Servo or Clutch drive.

Although the M-Track contains many advanced features, it has also been designed to be easy to use. The sealed keypad is divided into two panels: a panel for day-to-day operations, and a panel behind a separate door containing programming functions. Dedicated keys are provided for SET SPEED, TACH, BATCH COUNT, and STATUS information. Also, the M-Track contains an RS-422 communications port, thereby allowing communications between the M-Track and a host computer.

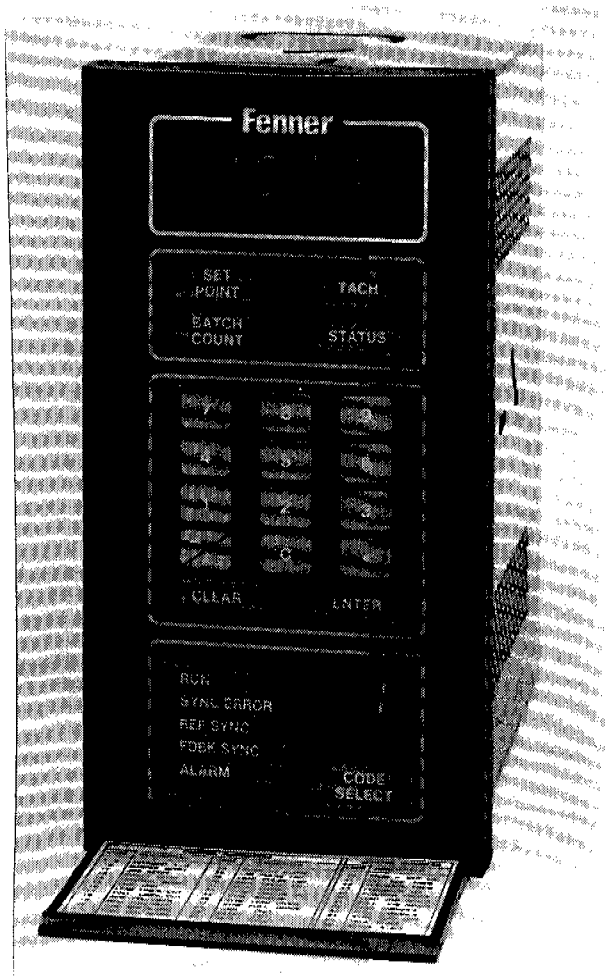


Figure 1-1: M-Track

EXAMPLE IMPLEMENTATION

The M-Track is used in motor control applications requiring one part of a process to "follow" or be "paced" by another part of the process. Many of these problems can be solved by the addition of the M-Track together with suitable feedback and external reference sensors interfaced to the original motor drive.

In a basic M-Track implementation, the M-Track is inserted in place of the original speed POT of the motor drive. The required digital feedback is typically provided by quadrature encoders or ring kits for the external reference and feedback position information and proximity or optical switches for the product sync information.

Figure 1-2 below illustrates this basic M-Track implementation.

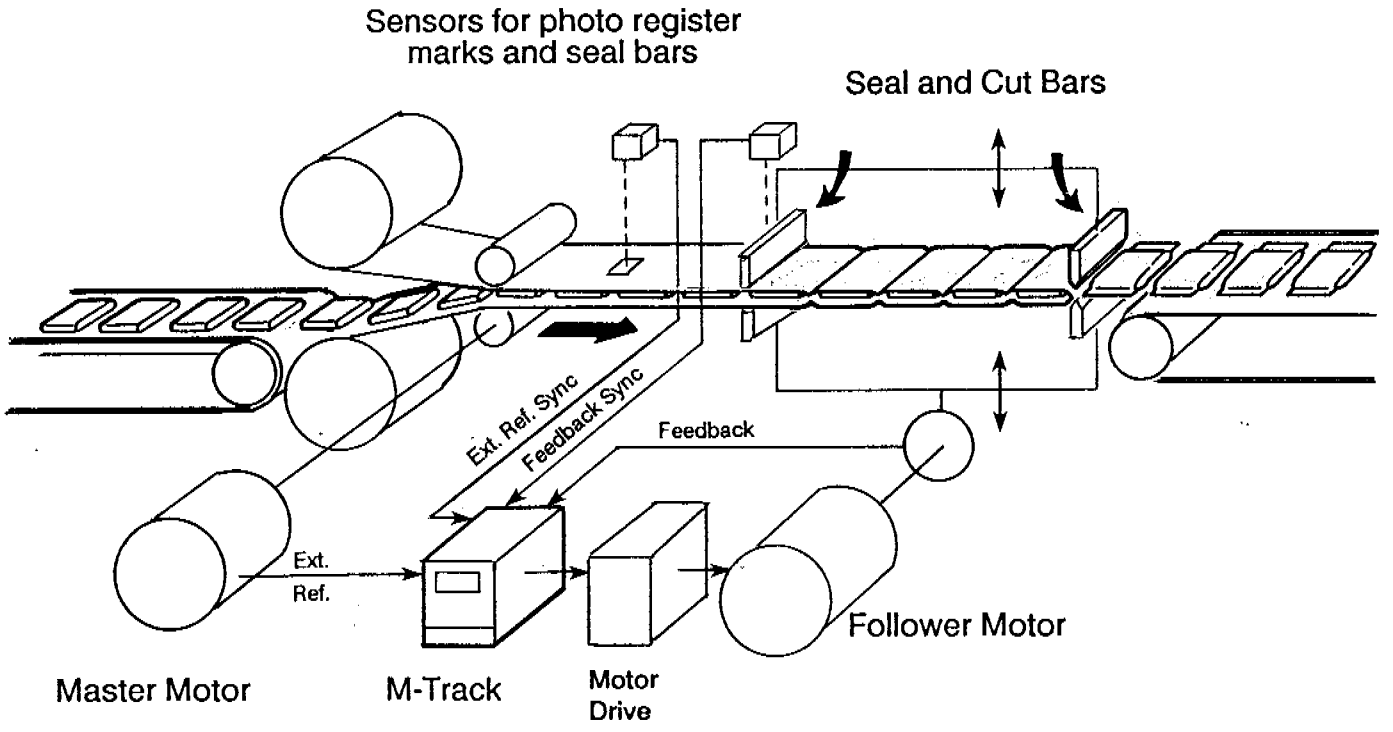


Figure 1-2: Simplified Functional Diagram

M-TRACK FORMATS

INTRODUCTION

Selecting an M-Track Format determines the type of speed control used by the M-Track. There are two different formats which are explained below.

MASTER FORMAT

Master Format is the most straight forward closed-loop implementation of the M-Track. In Master Format, the setpoint value (in RPMs) is entered by the operator via the front keypad. The M-Track compares this setpoint to the actual motor speed (provided by the motor feedback) to determine the error or deviation. The control algorithm then adjusts the Speed command analog output (connected to the motor drive) to reduce the error to zero. The M-Track is in Master Format whenever J4 Pin 2 is not shorted to common.

The Master Format is typically used for machine setup operations. The M-Track ignores the External Reference frequency, External Reference Sync and Feedback Sync inputs while in Master Format.

Detailed examples of using Master Format are provided in Chapter 5 of this manual (Programming).

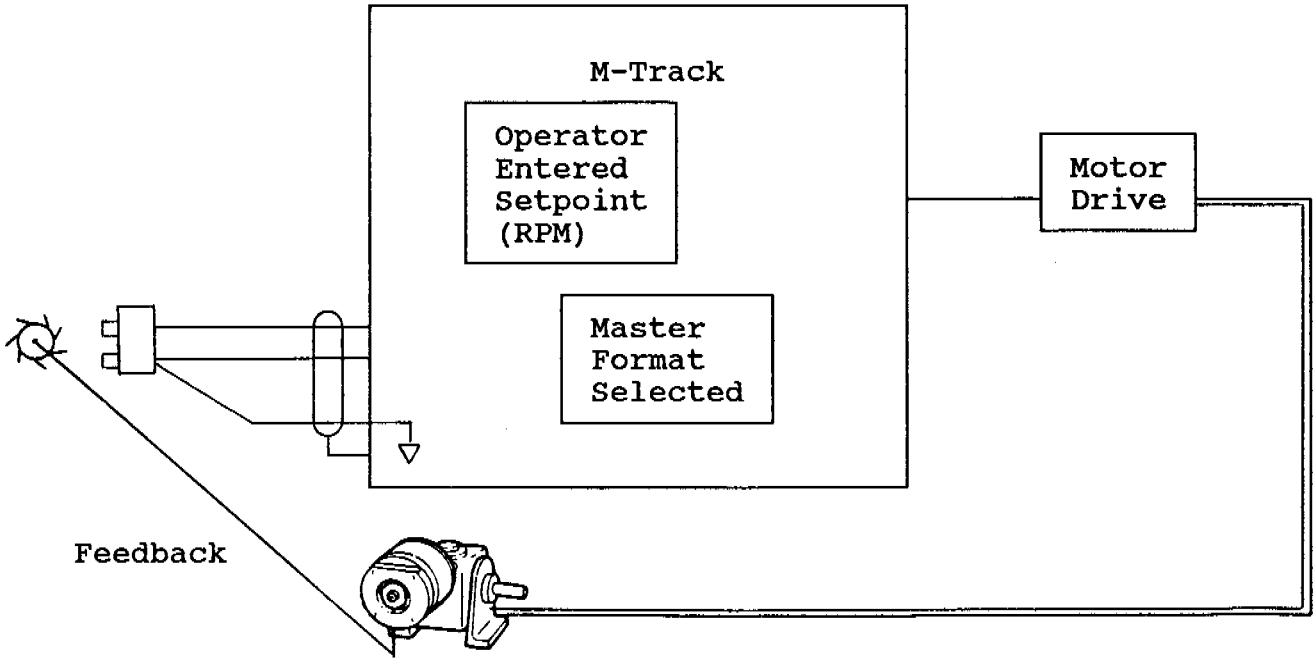


Figure 1-3: Master Format Functional Diagram

FOLLOWER (SYNC) FORMAT

Follower Format is the most commonly used speed control format, and differs from the Master Format in the manner in which the speed command is determined. In Master, the speed command is entered directly by the operator. In Follower, the speed command is continuously adjusted to keep the external reference sync and feedback sync inputs synchronized (aligned).

During the control process, a feature called "trending" continuously adjusts the ratio between the external reference and feedback frequencies to adjust for variances in product spacing, web stretch, etc.

When shipped from the factory, the M-Track is in Follower Format whenever J4 Pin 2 is shorted to common (J4 Pin 1).

Detailed examples of using Follower Format are provided in Chapter 5 of this manual (Programming).

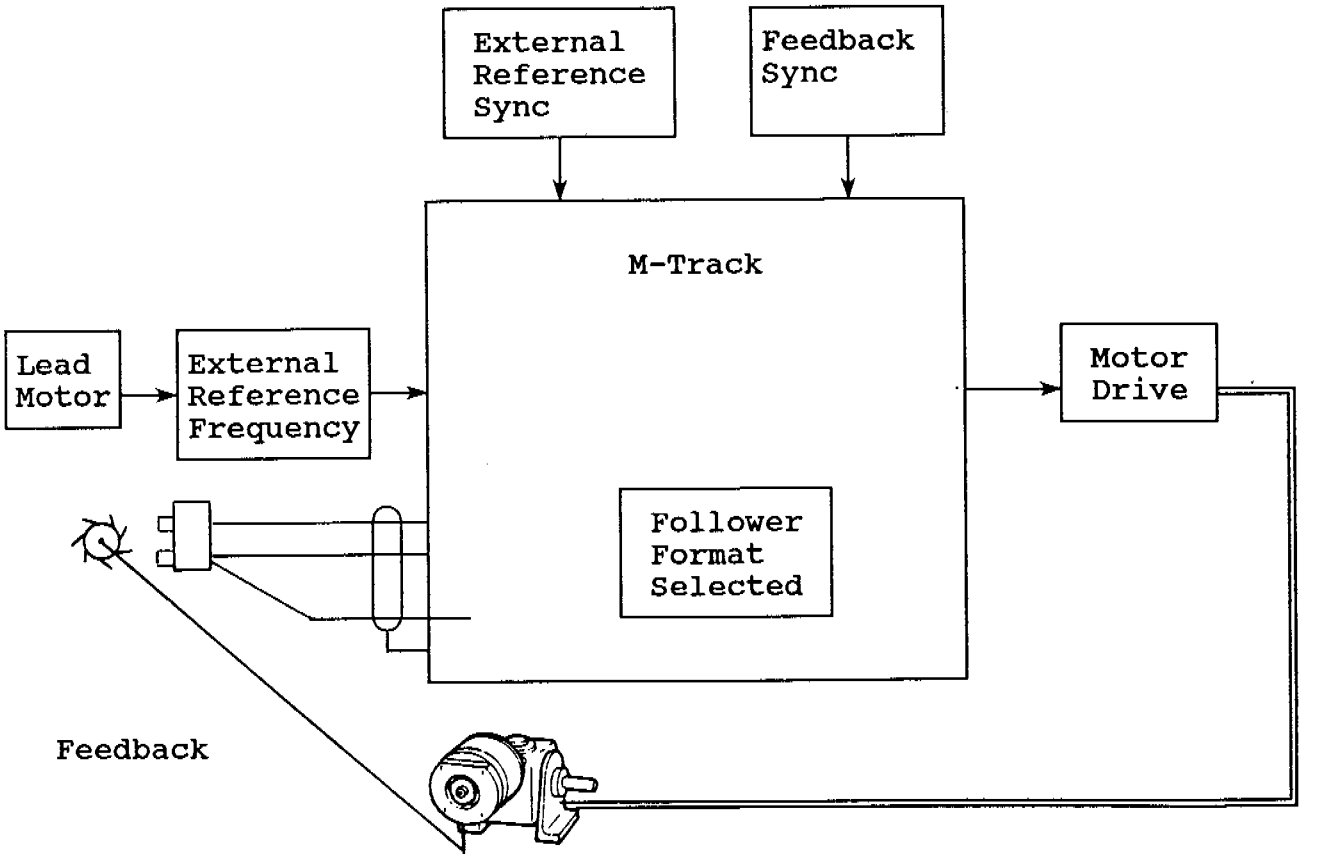


Figure 1-4: Follower Format Functional Diagram

M-TRACK STATES

The M-Track States refer to the operation characteristics of the M-Track--e.g., is the M-Track running? There are only five operating states for the M-Track: RUN, R-STOP, F-STOP, JOG and ALIGN. The M-Track is always in one and only one of these five operating states.

$\overline{\text{RUN}}$

In the $\overline{\text{RUN}}$ state, the M-Track rotates the subject motor at the RPM called for by the relevant setpoints in conjunction with the operative scaling format. Note that RUN can be entered only from R-STOP or F-Stop (not directly from JOG or ALIGN).

Five conditions must be true to put the M-Track into the RUN State:

- o Short J4 pin 9 to common (Inhibits F-STOP)
- o Short J4 pin 8 to common (Inhibits R-STOP)
- o Ensure J4 pin 17 is not connected (Inhibits JOG)
- o Ensure J4 pin 15 is not connected (Inhibits ALIGN)
- o Short J4 pin 6 to common (Initiates RUN)

Note: If the above conditions are all met, there would still be a zero speed command until a non-zero setpoint is entered. If in Follower Format, a non-zero external reference is also required.

JOG

In the JOG state, the M-Track increases the speed of the subject motor (using the specified ACCEL rate) until the subject motor is rotating at the RPM entered for by the Jog Setpoint.

Five conditions must be true to put the M-Track into the JOG State:

- o Short J4 pin 9 to common (Inhibits F-STOP)
- o Short J4 pin 8 to common (Inhibits R-STOP)
- o Short J4 pin 17 to common (Initiates JOG)
- o Ensure J4 pin 6 is not connected (Inhibits RUN)
- o Ensure J4 pin 15 is not connected (Inhibits ALIGN)

When the JOG state is terminated, the M-Track ignores the DECEL rate and brings the speed command immediately to zero. In this manner, the operator can "jog" the motor into position. The JOG state updates the alignment memory to a new value upon completion.

Note that JOG can be entered only from R-Stop or F-Stop (not directly from RUN or ALIGN).

ALIGN

In the ALIGN state, the M-Track rotates the Slave Motor speed to recover alignment in accordance with the alignment memory and sync logic.

Five conditions must be true to put the M-Track in the ALIGN state:

- o Short J4 pin 9 to common (Inhibits F-STOP)
- o Short J4 pin 8 to common (Inhibits R-STOP)
- o Ensure J4 pin 17 is not connected (Inhibits JOG)
- o Ensure J4 pin 6 is not connected (Inhibits RUN)
- o Short J4 pin 15 to common (Initiates ALIGN)

R-STOP (RAMP STOP)

In the R-STOP state, the M-Track decreases the speed command to zero RPM using the specified DECEL rate. The alignment memory is active and continues to monitor the position of the Master process, thereby enabling the Slave process to restore alignment when the RUN state is invoked.

Two conditions must be true to put the M-Track into the R-STOP State:

- o Short J4 pin 9 to common (Inhibits F-STOP)
- o Ensure J4 pin 8 is not connected (Enables R-STOP)

F-STOP (FAST STOP)

In the F-STOP state, the M-Track ignores the specified DECEL rate and immediately brings the speed command to zero.

One condition must be true to put the M-Track into the F-STOP State:

- o Ensure J4 pin 8 is not connected (Enables F-STOP)

As in the R-Stop state, the alignment memory is active and maintained in the F-Stop state.

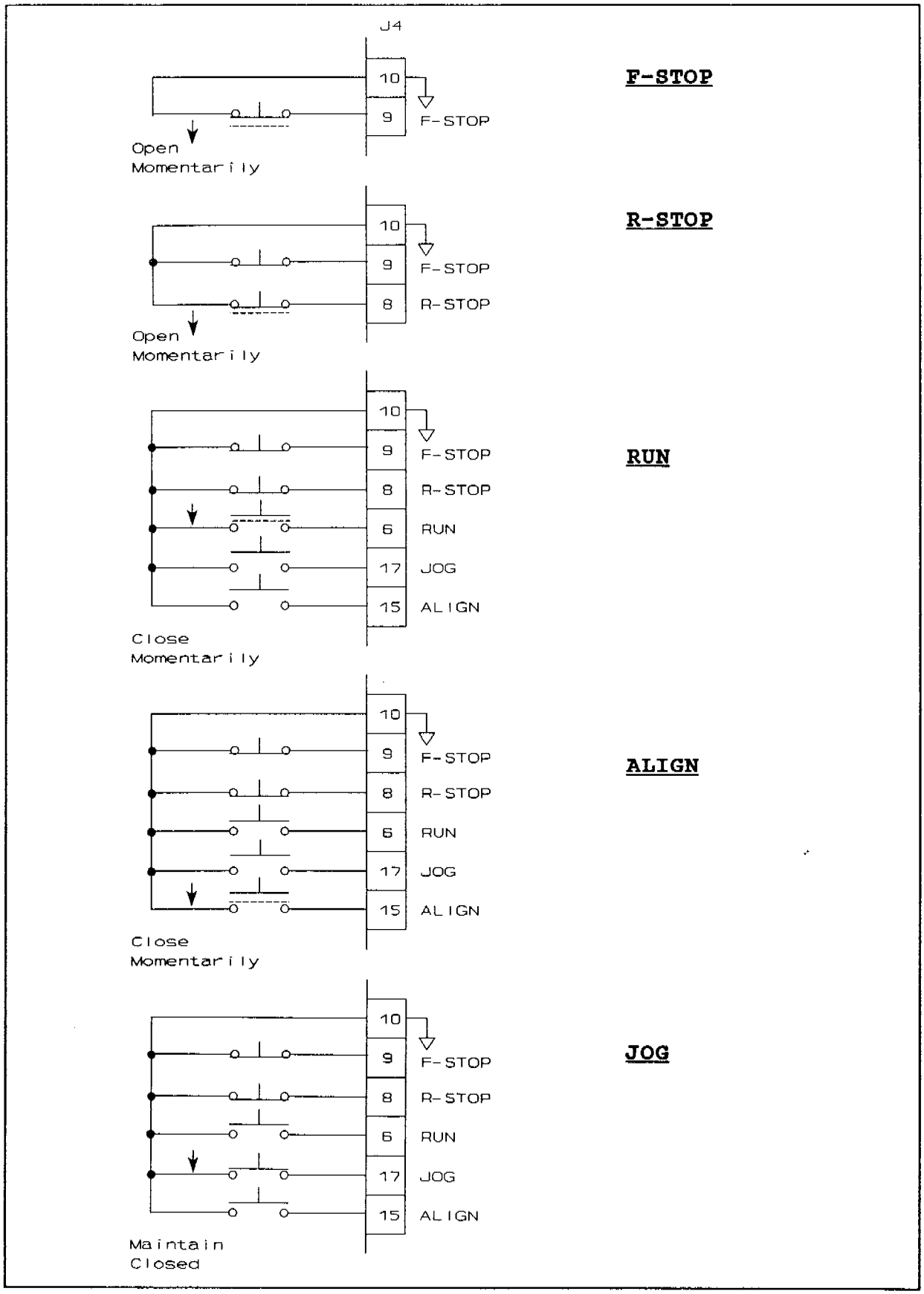


Figure 1-7: Run/Stop Logic

RUN/STOP LOGIC

The RUN/STOP/JOG/ALIGN state is determined by five logic inputs at J4 pins 6, 8, 9, 15 and 17. Pins 8 and 9 control the F-Stop and R-Stop conditions respectively and both must be shorted to common to allow the M-Track to enter the Jog, Align or Run States. Specifically, if pin 9 is open, the M-Track is in the F-Stop state regardless of the state of the other pins. If pin 8 is held low while pin 9 is open, the M-Track is in the R-Stop State.

Pins 6, 15 and 17 control Run, Align and Jog respectively. If pins 8 and 9 are held low, a momentary closure of pin 6 puts the M-Track in the Run state. Alternatively, if pins 8 and 9 are held low and pin 17 is shorted to common, the M-Track is put in the Jog State. A momentary closure of pin 15, while pins 8 and 9 are held low, will cause the M-Track to enter the Align state.

Recall that the M-Track cannot be taken directly from either Jog or Align to Run. In addition, the M-Track cannot be taken directly from Run to Jog or Align. Also note that to enter RUN or ALIGN a momentary closure is sufficient but that the JOG state is invoked only while the closure of J4 pin 17 to common is maintained. Figure 1-7 summarizes the pin status for these 5 Operation States.

POWER UP

When power is first applied to the M-Track, the M-Track enters into a default "R-STOP" state. Some features of this default state are:

- The Speed Command Output is adjusted to maintain zero RPM.
- All Programming parameters and setpoints that were entered before power was removed were stored in memory, and are recovered on Power Up.

OPERATOR KEYPAD

The Operator Keypad refers to the upper section of the front M-Track keypad that is exposed with the lower front door closed. Four dedicated function keys (SET POINT, TACH, BATCH COUNT AND STATUS) provide ready access to these parameters. After the SET POINT key is pressed, the numeric part of the keypad is enabled for set point entry.

FACTORY DEFAULT SCALING

When shipped from the factory, the M-Track is scaled for the following settings:

Follower and Master Motor:	60 tooth gears 2000 RPM maximum speed
Master Format:	Speed setpoint and Tach are scaled in RPM.
Follower Format:	All 8 presets are clear, ready for "Learn Mode" scaling.

For details concerning rescaling the M-Track, refer to the Programming chapter in this manual.

NOTES

CONFIGURATION 2

INTRODUCTION

This chapter contains the information required to hardware configure the M-Track for purposes of electrical compatibility. The procedures within this chapter should be completed prior to installing the M-Track. Note that these procedures do not require power to complete.

Before proceeding with the configuration procedure, read the information below to determine if the factory default configuration is appropriate for your application. In most cases, it will not be necessary to reconfigure the M-Track.

This chapter is divided into 4 sections: Frequency Inputs, Sync Input Filters, Isolator Voltage Reference and Power Voltage Select. Figure 2-1 below illustrates the location for the CPU board and the Power Supply/Isolator board.

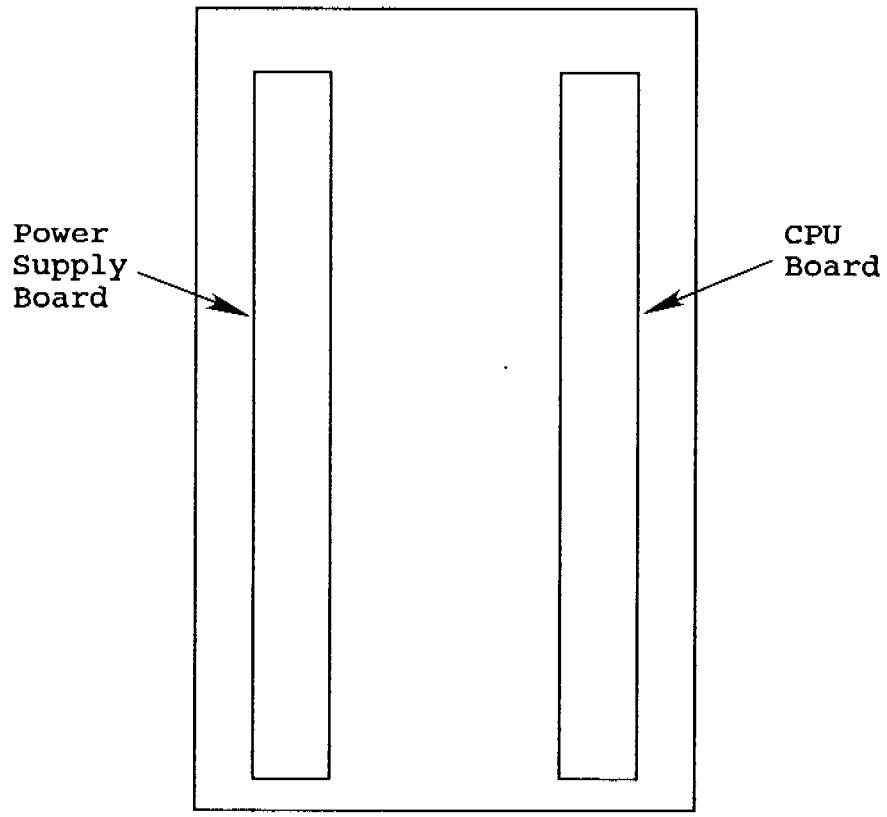


Figure 2-1: M-Track Board Location (Rear View)

FREQUENCY INPUTS

The Frequency Input select jumpers are located on the M-Track CPU board. To gain access to this board, remove (pull off) the screw headers from the rear terminal connecters. Next, remove the four mounting screws and backplate. The CPU board is the right-hand board when viewing the M-Track from the rear (Figure 2-1). Pull this board out approximately 1 inch to expose the Frequency Input select jumpers in the middle component side of the board (marked J2).

Note: Make sure the board assemblies are properly seated in the pin connectors when reassembling the unit.

The Frequency Input select jumper configures the External Reference and Feedback Frequency Inputs for either quadrature encoder or incremental signal compatibility.

If incremental encoder inputs are selected, the M-Track will not permit bipolar (forward/reverse) output format. Torque mode control will also not be operational without quadrature inputs.

Figure 2-2 below illustrates the 2 possible configurations for the Frequency Input select jumpers: Figure 2-2a illustrates the inputs configured for quadrature (default), while Figure 2-2b illustrates the inputs configured for incremental.

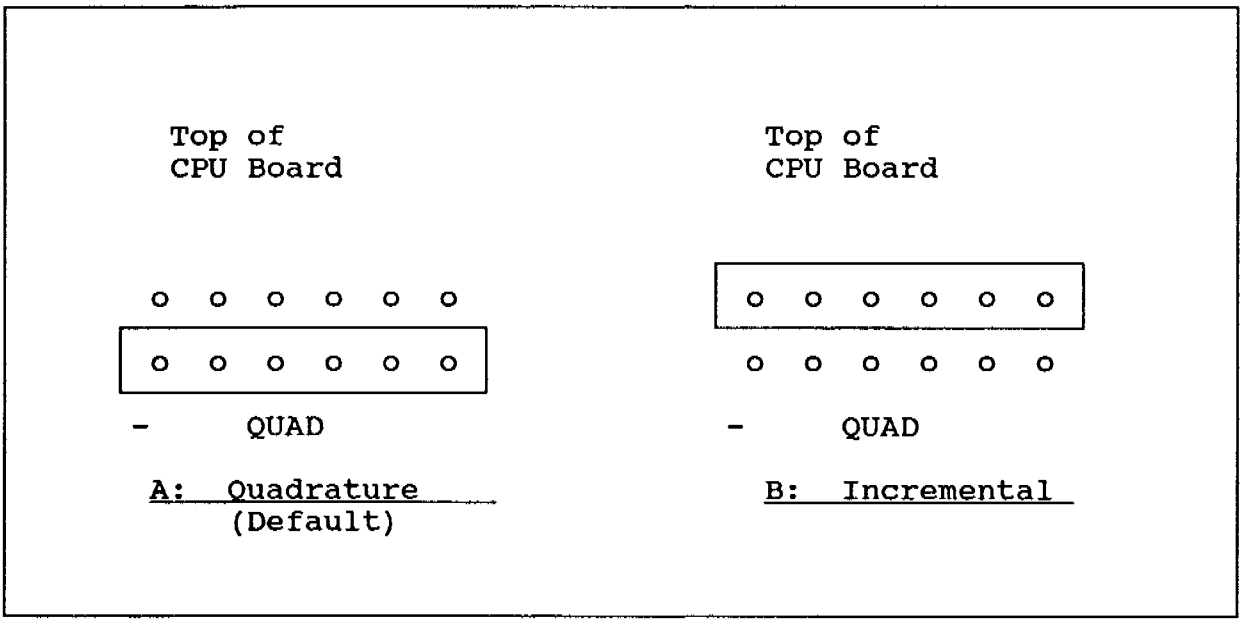


Figure 2-2: Frequency Input Options

SYNC INPUT FILTERS

The External Reference and Feedback Sync Inputs are supplied with signal filters to help prevent false syncing from spurious EMI noise. It may be necessary to disable these filters if the duration of the actual sync pulse is less than 2 milliseconds, such as from an encoder index mark.

The Sync Input Filter select jumpers are located on the M-Track CPU board. To gain access to the board, remove (pull off) the screw headers from the rear terminal connectors. Next, remove the four mounting screws and backplate. The CPU is the right-hand board when viewing the M-Track from the rear (Figure 2-1). Pull this board out approximately two inches to expose the Sync Input Filter select jumpers in the middle component side of the board (marked J5).

Note: Make sure the board assemblies are properly seated in the pin connector when reassembling the unit.

The M-Track is shipped with jumpers enabling both External Reference and Feedback Sync input filtering. To disable External Reference sync input filtering, remove the shunt between positions 3 and 4 (see Figure 2-3). To disable Feedback Sync input filtering, remove the shunt between positions 1 and 2.

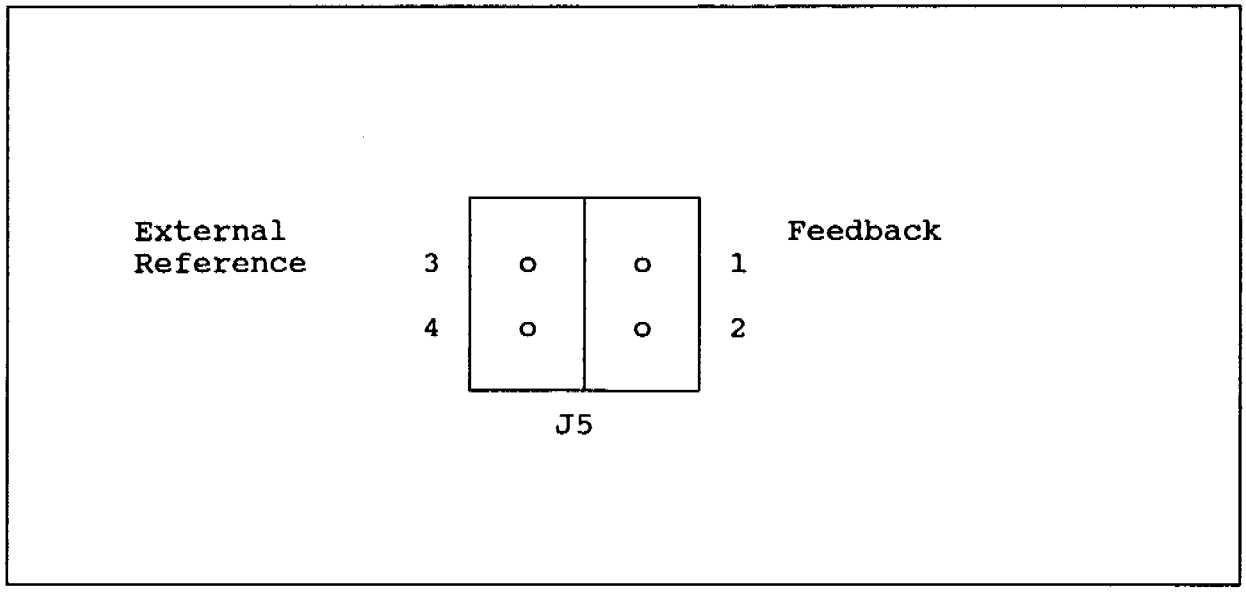


Figure 2-3: Sync Input Filter Option

Note: If Sync Input Filtering is disabled to permit the use of shorter sync pulses, extra precautions regarding EMI noise must be exercised. Shielded twisted pair cable for the sync inputs should be used with the shield grounded at the M-Track end only. Additionally, sync input wiring should be kept physically separated from any AC or other power wiring.

ISOLATOR VOLTAGE REFERENCE

The Isolator Voltage Reference select jumper (J3) is located near the top of the Power Supply/Isolator Board. The Power Supply/ Isolator board is the left-hand board when viewing the back of the M-Track. It is easily identified by the fuse at the bottom.

The Isolator Voltage Reference selector jumper configures the isolated analog output to either be voltage ranged by an internal 15 volt reference or to be auto-ranged by the voltage level of the motor drive potentiometer input.

When the select jumper is between pins 2 and 4, the internal +15 volt reference is selected. When the shunt is between pins 1 and 3, the auto-range voltage reference is selected (default). In general, the default selection is used except when the motor drive does not have a reference voltage. Figure 2-4 indicates these jumper positions.

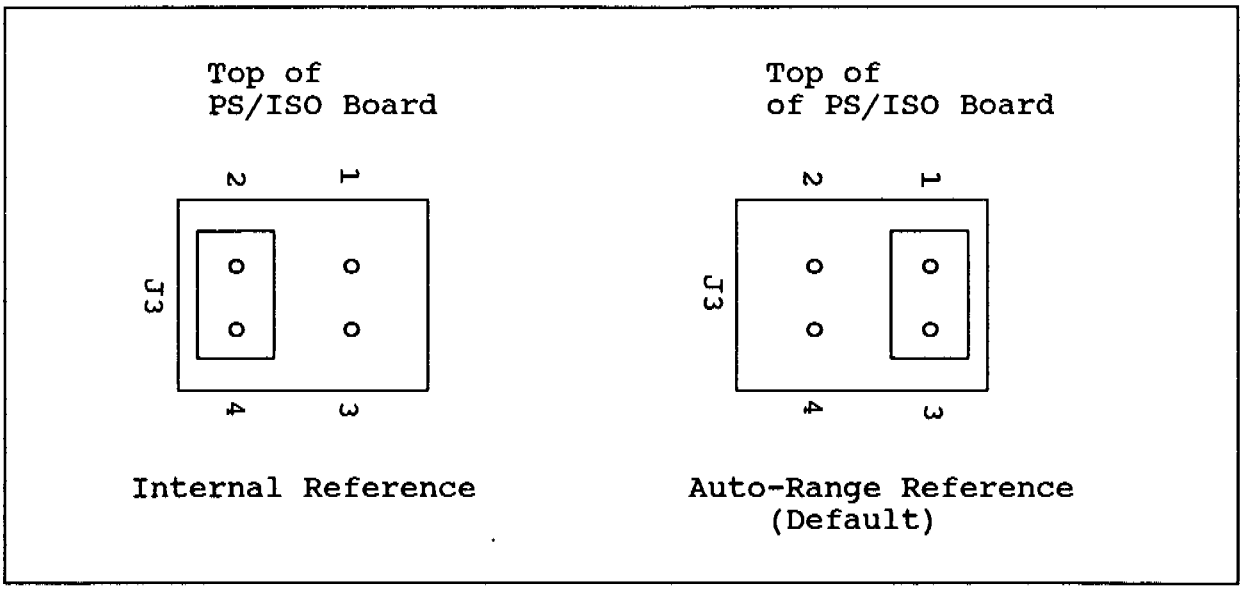


Figure 2-4: Isolator Voltage Reference Options

POWER VOLTAGE SELECT

The Power Voltage Select switch is located on the bottom of the Power Supply/Isolator board, just above the fuse.

This switch selects for either 115 VAC (Default) or 230 VAC power.

The switch is clearly marked for the two available positions.

INSTALLATION 3

INTRODUCTION

This chapter contains the information and procedures required to complete the initial installation and wiring for the M-Track. All pages within this chapter must be read to ensure that the appropriate decisions are made prior to the final wiring of the M-Track.

Note to Electricians installing the M-Track:

The installation of this motor control must conform to area and local electrical codes. For information, refer to the National Electrical Code (NEC) Article 430 published by the National Fire Protection Association, or the Canadian Electrical Code (CEC). Refer to local codes as applicable.

WARNING

Hazardous voltages are present during certain installation procedures. Therefore, the M-Track should only be installed by qualified electrical maintenance personnel.

This chapter is organized into 2 distinct sections:

MOUNTING

WIRING

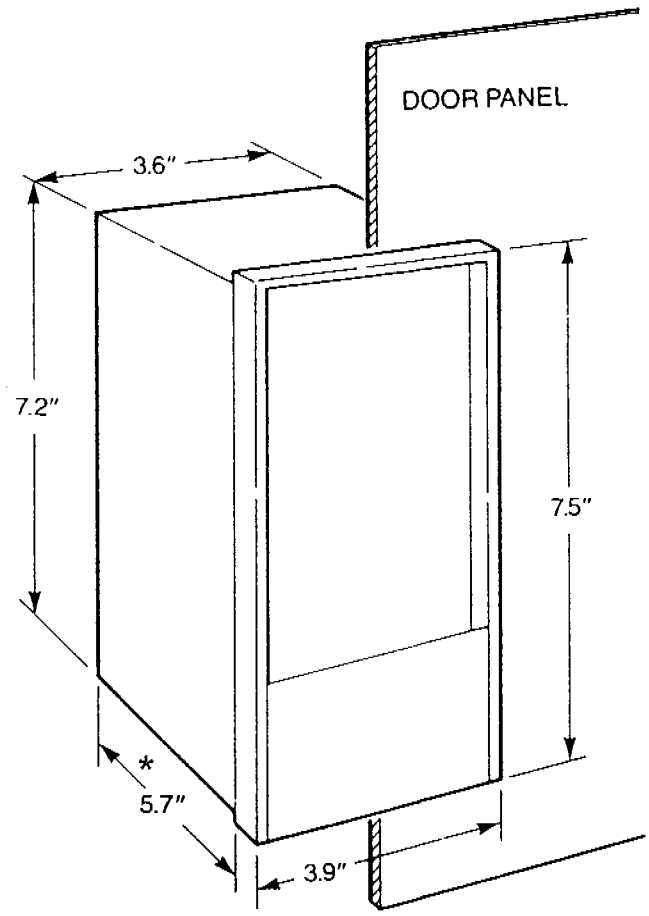
The Mounting section provides drawings and instructions for mounting the M-Track in an enclosure. The wiring section summarizes the wiring connections for the M-Track.

MOUNTING

INTRODUCTION

The M-Track is packaged in a 1/2 DIN Vertical instrument enclosure intended for door mounting in a NEMA enclosure. Figure 3-1 illustrates an installed M-Track with dimensions.

Note: Prior to mounting the M-Track in your enclosure, complete the Configuration Procedures outlined in Chapter 2. The configuration shunts and switches may be less accessible after the device is installed in the enclosure.



* To Rear of Connectors from Front Panel

Figure 3-1: M-Track Dimensions

MOUNTING PROCEDURE

Mount the M-Track into your enclosure according to the following procedure:

1. Ensure the mounting location meets the environmental conditions for the M-Track:

Temperature:	0 - 50 degrees C
Humidity:	0 - 90% RH non-condensing

2. Determine the appropriate door or panel location and make the panel cutout per Figure 3-2 below.

3. Insert the M-Track from the panel front up to the bezel or gasket.

4. Connect the two mounting brackets from the rear of the M-Track on either the sides or the top and bottom.

5. Drive the mounting bracket screws onto the rear of the door or panel until the M-Track is securely mounted.

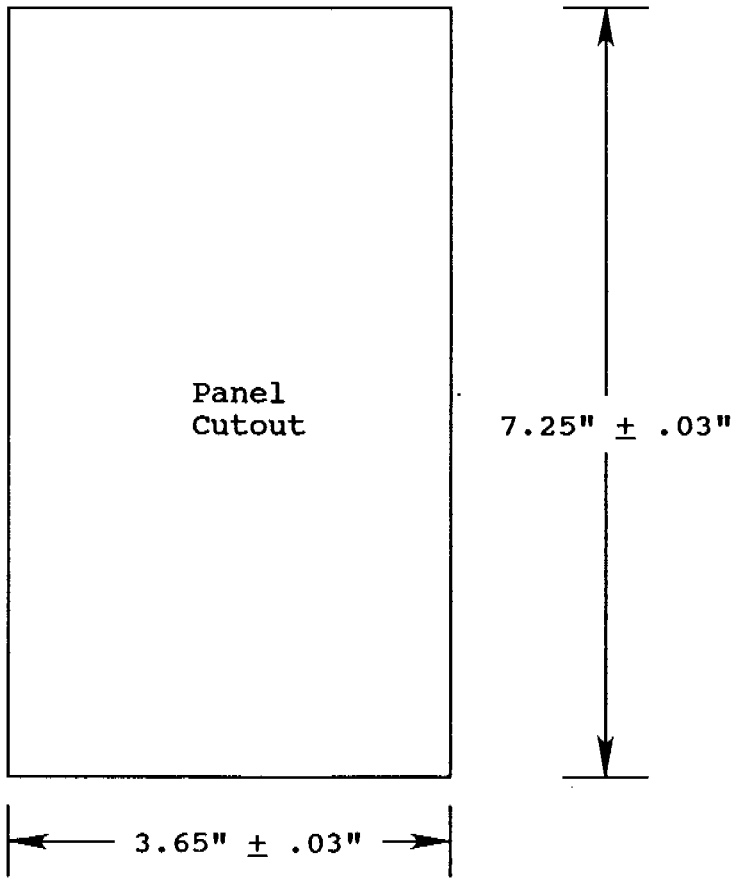


Figure 3-2: Panel Cutout Dimensions

WIRING

INTRODUCTION

The wiring portion of this chapter is divided into five sections:

1. Required Inputs
2. Required Outputs
3. Elective Inputs
4. Elective Outputs
5. Serial Communications

As the titles indicate, the decisions made during the Required sections are mandatory to obtain a properly installed M-Track. The elective sections are completed at the discretion of the User.

The Serial Communications connections are discussed as a separate item in the fifth and final wiring section.

MINIMUM WIRE GAUGE REQUIREMENTS

Note that for the following wiring connections, the recommended minimum wire gauge is 18 AWG.

CAUTION

Where indicated, it is important to use shielded cable to minimize equipment malfunctions due to electrical noise. It is assumed throughout this manual that shields are terminated at the receiving end only.

Proper earth grounding of all electronic equipment is required for successful operation. It is recommended that all shield and chassis ground connections (J2 pin 1) be made to an earth ground to provide proper noise immunity and grounding protection. Do **NOT** connect the internal signal common of the M-Track (J3 pin 4) to the chassis ground (J2 pin 1).

AC power wiring (J2) should be kept physically separated from other wiring on the M-Track. Failure to do so could result in coupled electrical noise and subsequent M-Track malfunction.

Inductive coils from relay, contactors, solenoids, etc. on the same AC power line or in the same enclosure should be suppressed with an RC network across the coil. Best results occur with resistance (r) values of 50 ohms and capacitance (c) values of 0.1 microfarads.

If excessive EMI noise exists on the AC power line, such as line notches or spikes, it may be required to install an AC line filter or isolation transformer to ensure proper operation.

M-TRACK WIRING DRAWING

Figure 3-3 below illustrates the control installation wiring for the M-Track. It is divided into Required Inputs and Outputs, Optional Inputs and Outputs and Serial Communications.

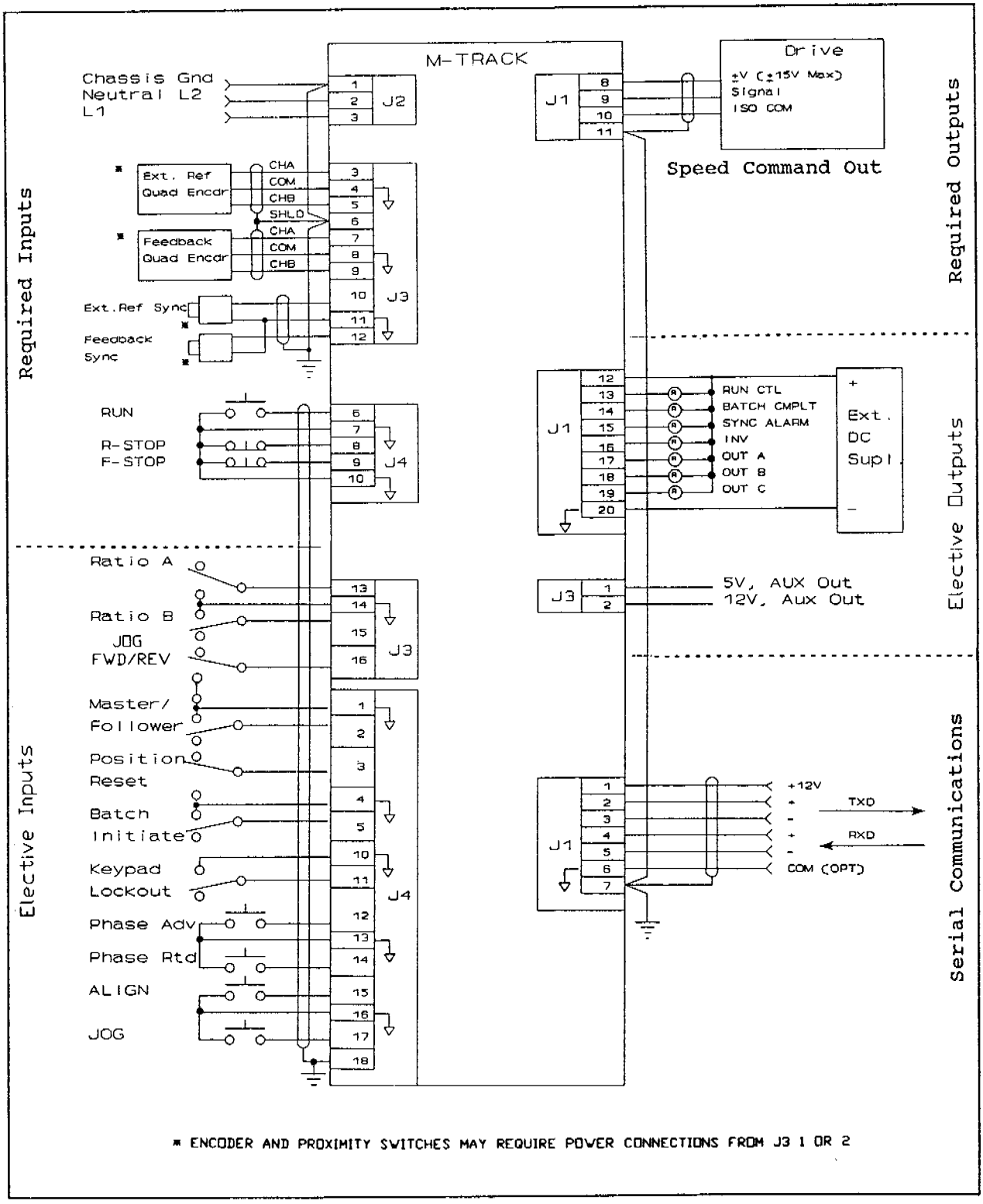


Figure 3-3: M-Track General Wiring Drawing

M-TRACK CONNECTOR LOCATIONS

Figure 3-4 below illustrates the location and numbering of the wiring connectors as viewed from the rear of the M-Track.

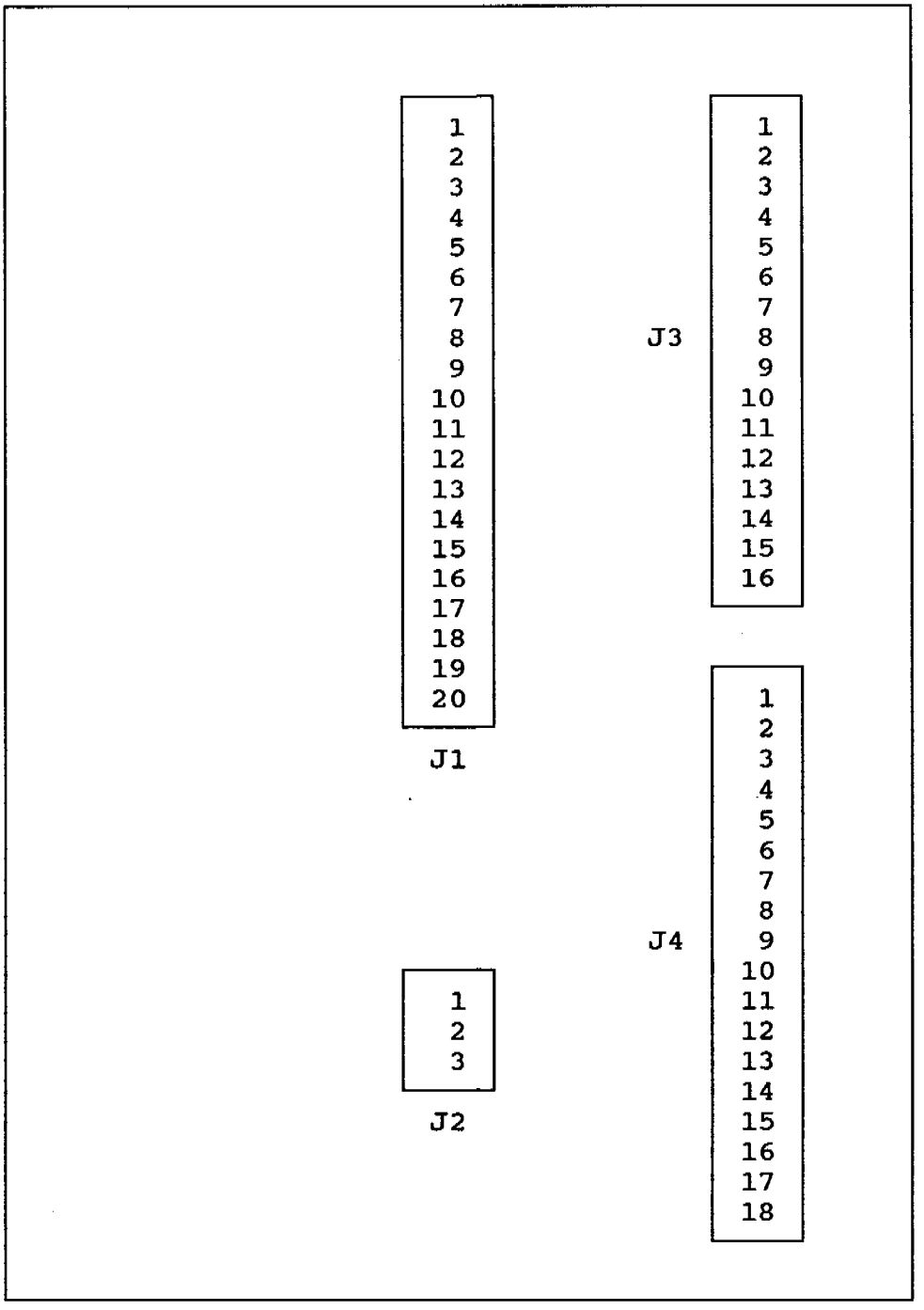


Figure 3-4: Wiring Connector Locations

1) REQUIRED INPUTS

INPUT POWER

The M-Track operates on either 115 VAC or 230 VAC. A separate 3 pin connector (J2) is allocated for the power connection.

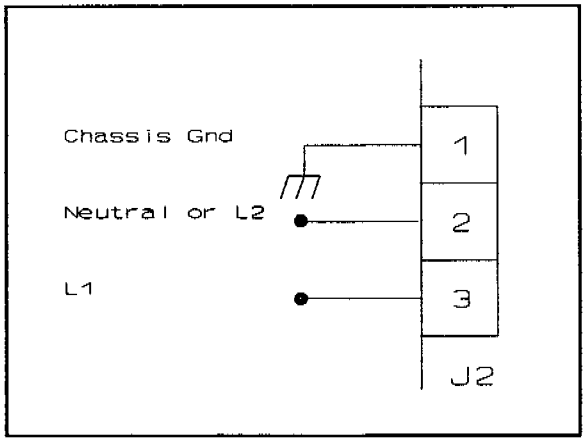


Figure 3-5: Input Power

EXTERNAL REFERENCE FREQUENCY INPUT

The External Reference Frequency Input is a pulse train input used by the M-Track to ascertain lead motor speed.

The specific External Reference input connections to the M-Track depend on whether quadrature or incremental encoders* are utilized. Omit the J3 pin 3 (CHA) connection for incremental format encoders.

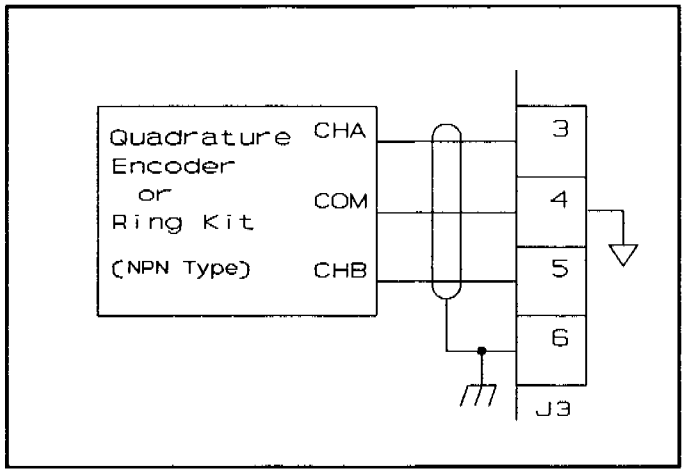


Figure 3-6: External Reference Input Connections

* If incremental encoders are utilized, the M-Track will not permit bipolar (forward/reverse) output control. Torque mode control will also not be operational unless quadrature format encoders are utilized.

FEEDBACK FREQUENCY INPUT

Feedback Frequency Input is a pulse train input used by the M-Track to ascertain slave motor speed.

The specific Feedback Input connections to the M-Track depend on whether quadrature or incremental encoders* are utilized. Omit the J3 pin 7 (CHA) connection for incremental format encoders.

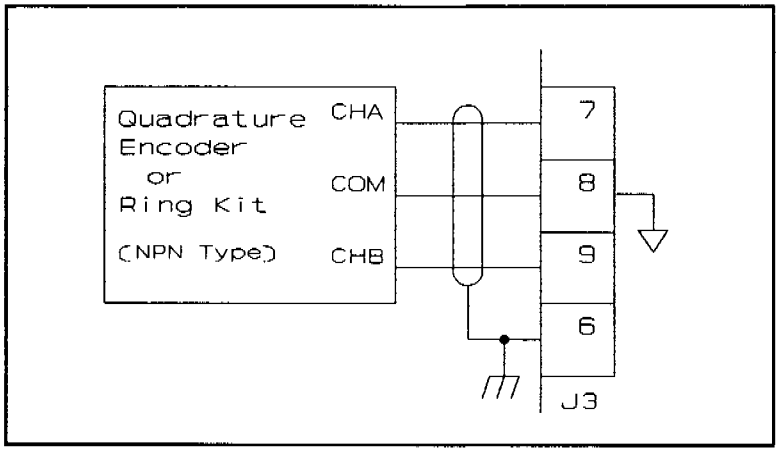


Figure 3-7: Feedback Input Connections

* If incremental encoders are utilized, the M-Track will not permit bipolar (forward/reverse) output control. Torque mode control will also not be operational unless quadrature format encoders are utilized.

EXTERNAL REFERENCE SYNC INPUT

The External Reference Sync input is a frequency input used to indicate the position of the master product or machine part. This input is usually generated by a proximity switch or optical sensor switch (NPN output type).

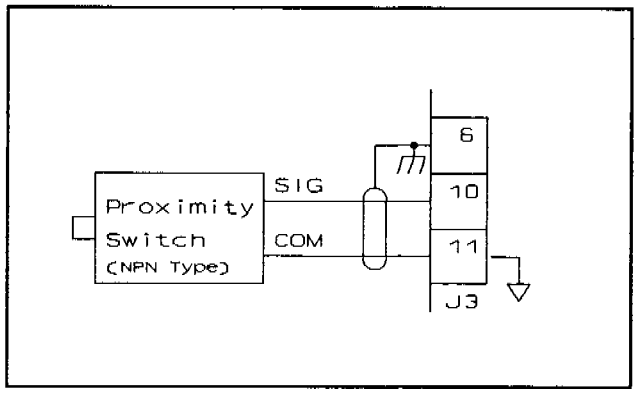


Figure 3-8: External Reference Sync Input

FEEDBACK SYNC INPUT

The Feedback Sync Input is a frequency input used to indicate the position of the slave product or machine part. This input is usually operated by a proximity switch or optical sensor switch (NPN output type).

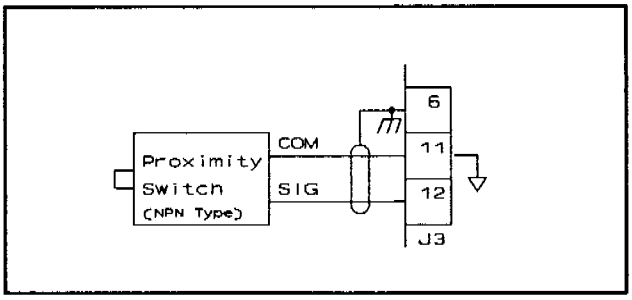


Figure 3-9: Feedback Sync Input

$\overline{\text{RUN}}$

$\overline{\text{RUN}}$ is a momentary input which when closed allows the M-Track to run normally. As a momentary input, the RUN state is internally latched and need not be maintained by the operator device.

CAUTION

The M-Track maintains lead and follower position information during the R-Stop and F-Stop states. When entering the Run state from either R-Stop or F-Stop, the M-Track will attempt to resolve any position error (MV-49) that accumulated during the R-Stop or F-Stop states. The dynamics of this correction will depend on the magnitude of the error and the tuning of the control loop. The Position Reset Input can be used to clear the position error to zero before entering Run.

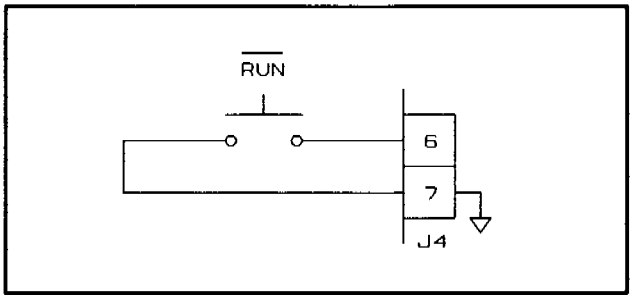


Figure 3-10: Run Input

R-STOP

R-STOP is a momentary input which when opened commands the M-Track to ramp to a zero RPM command at the specified deceleration rate. As a momentary input, the R-STOP state is internally latched and need not be maintained by the operator device. The M-Track maintains position information in the R-Stop state.

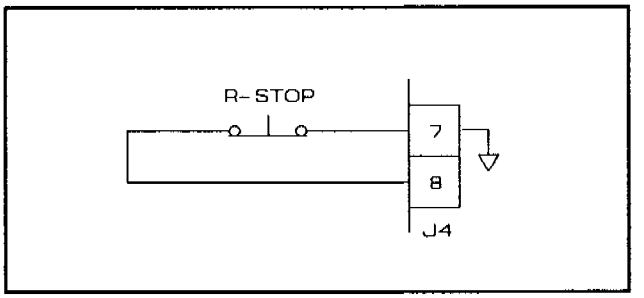


Figure 3-11: R-Stop Input

F-STOP

F-STOP is a momentary input which when opened commands the M-Track to come to an immediate zero RPM command ignoring the specified deceleration rate. As a momentary input, the F-STOP state is internally latched and need not be maintained by the operator device. The M-Track maintains position information in the F-Stop state.

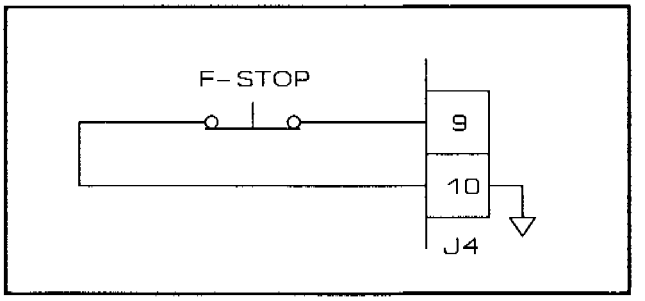


Figure 3-12: F-Stop Input

NOTE

Both the R-STOP and F-STOP inputs must be closed prior to entering the RUN state. If only one of the Stop inputs is used, the other needs to be wire shorted for proper M-Track operation.

2) REQUIRED OUTPUTS

SPEED COMMAND OUT

Speed Command Out is an isolated analog output signal sent to the subject drive which then controls the speed of the motor. It is typically wired into the speed pot input of the drive. Figure 3-13 below illustrates the SPEED COMMAND OUTPUT connections.

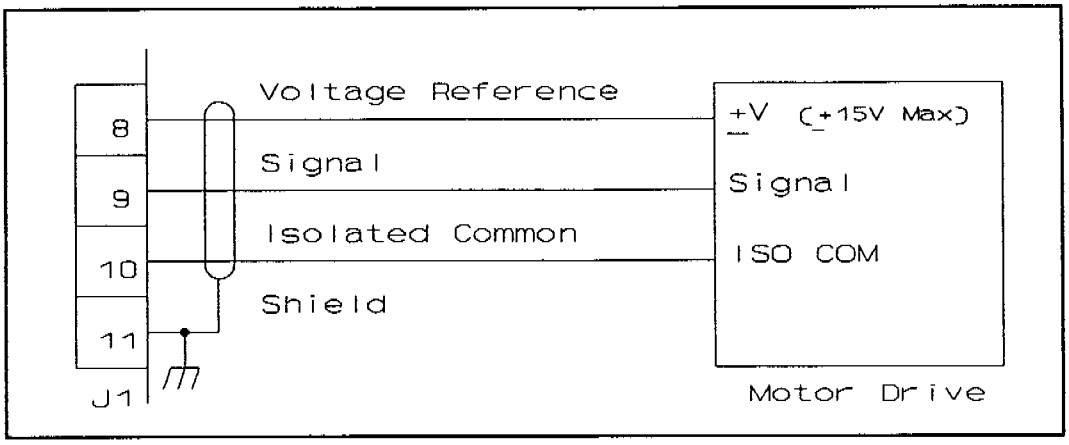


Figure 3-13: Speed Command Output

* Remove Drive Speed Potentiometer

3) ELECTIVE INPUTS

RATIO A (SETPOINT SELECT)

The Ratio A input is used in conjunction with the Ratio B input to select up to three preset setpoints in the follower mode. A detailed discussion of the M-Track setpoint operation is provided in the Programming chapters of this manual.

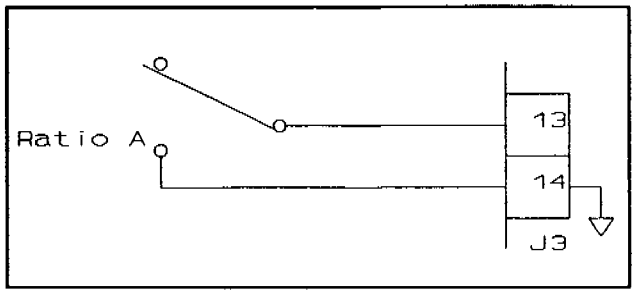


Figure 3-14: Ratio A Setpoint Select

RATIO B (SETPOINT SELECT)

The Ratio B input is used in conjunction with the Ratio A input to select up to three preset setpoints.

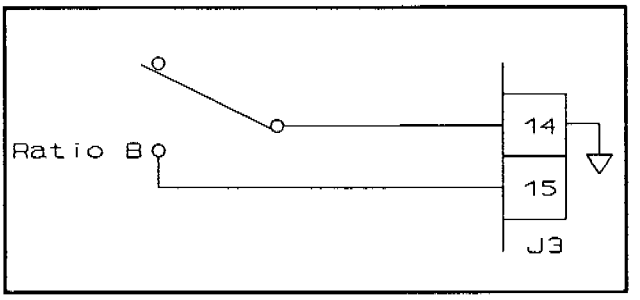


Figure 3-15: Ratio B Setpoint Select

FORWARD/$\overline{\text{REVERSE}}$ (JOG STATE ONLY)

The Forward/$\overline{\text{Reverse}}$ control input controls the voltage polarity of the Speed Command analog output (J1 pin 9) in the Jog state only. This output is sent to the motor drive and subsequently determines the direction of the motor. For this feature to operate correctly, the motor drive must have a bipolar speed setpoint input.

In the Forward (Open) position, the M-Track adjusts the Speed Command analog output to the same voltage polarity present at the Voltage Reference input (J1 pin 8) from the drive. The Reverse (closed) position adjusts the Speed Command to the opposite voltage polarity of that present at the Voltage Reference input.

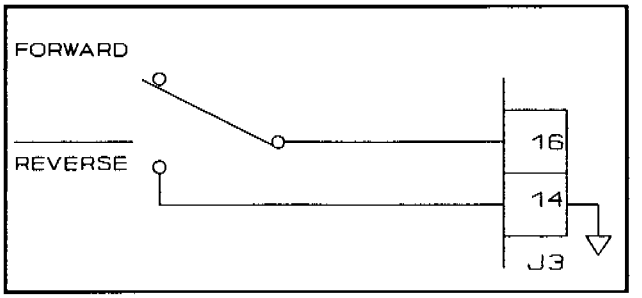


Figure 3-16: Forward/$\overline{\text{Reverse}}$ Input

MASTER/$\overline{\text{FOLLOWER}}$

The Master/$\overline{\text{Follower}}$ input selects the scaling format used by the control algorithm. A detailed discussion of the scaling modes is provided in the Programming chapters of this manual.

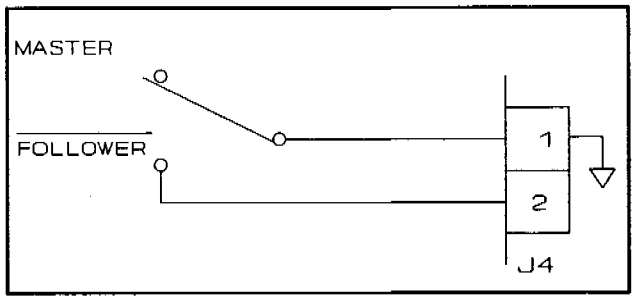


Figure 3-17: Master/$\overline{\text{Follower}}$ Input

POSITION RESET

The Position Reset input is used to reset the alignment (position error) memory to zero. The M-Track maintains position information in the RUN, R-STOP and F-STOP states (resets in JOG). It may be necessary to use the position reset input to clear the alignment memory after stopping the M-Track and manually realigning the machine or product. The position is reset on the high to low transition of this input (edge triggered).

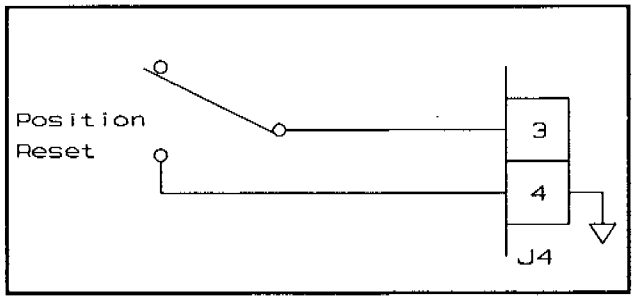


Figure 3-18: Position Reset

BATCH INITIATE

The Batch Initiate input is used to reset the batch counter to zero. The feedback sync input is used to increment the counter.

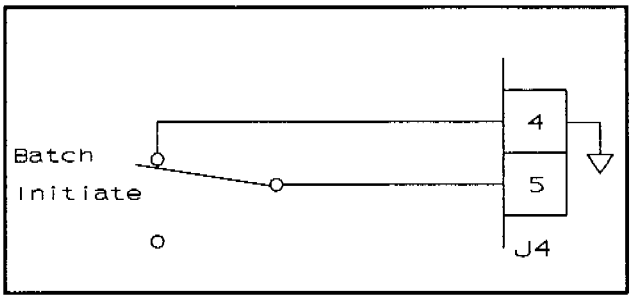


Figure 3-19: Batch Initiate

KEYPAD LOCKOUT

The Keypad Lockout input is used to disable the front operator keypad from making setpoint and other parameter changes.

All functions associated with monitoring or viewing of variables remain enabled during Keypad Lockout.

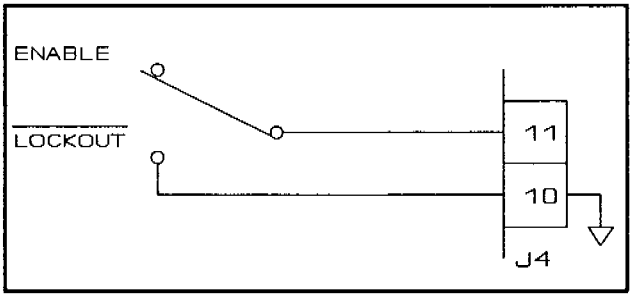


Figure 3-20: Keypad Lockout

PHASE ADVANCE

It may not always be possible to locate the sync detect sensors at the most optimal location. The PHASE ADVANCE and PHASE RETARD inputs are momentary inputs used to increment an internal phase offset counter allowing proper sync alignment.

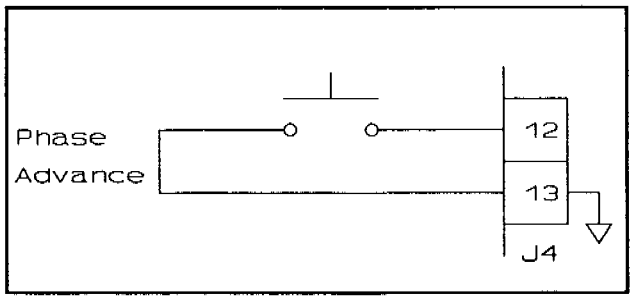


Figure 3-21: Phase Advance

PHASE RETARD

The Phase Retard is a momentary input used in conjunction with the Phase Advance to create a phase offset for sync pulse alignment.

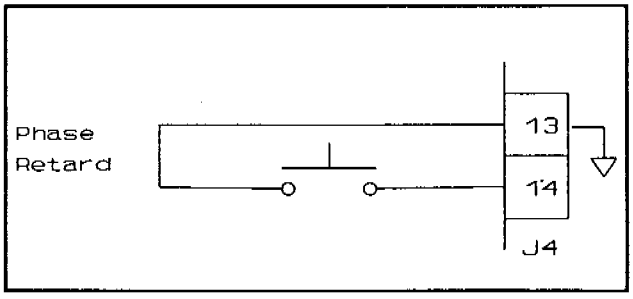


Figure 3-22: Phase Retard

ALIGN

The ALIGN is used to recover position alignment of the Follower Motor. To do this, Align uses the Gross Error control algorithm. The Gross Error control algorithm, when doing an Align, uses the Out of Position (CP-24) to determine if a move will be made. If CP-24 is less than CP-49, the move will be made until CP-49 is reduced to less than CP-24. This move will be in the direction of the Position Error (CP-49). The direction can not be selected by the Sync Logic (CP-30) because the Lead is not moving. CP-15 (Over Speed Allowance) and CP-61 (Gross Error Reset) will have an effect on how fast the move will be made.

There are several conditions that must be met to activate an ALIGN function. These are:

1. Master must not be moving.
2. Must be in Follower mode.
3. Must have Sync enabled.
4. Must be in R-Stop.
5. Must have positive error if output is unipolar.
6. Must have position known.
7. Must have error greater than CP-24.

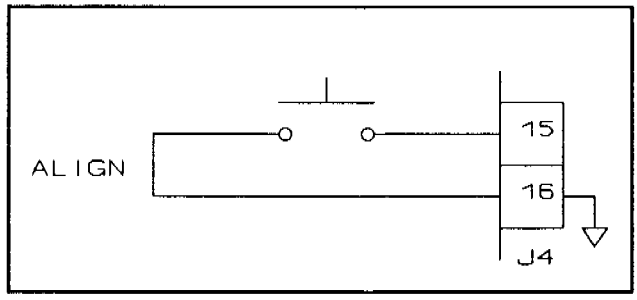


Figure 3-23: Align

$\overline{\text{JOG}}$

$\overline{\text{JOG}}$ is a maintained input which when closed directs a speed command signal to the sync drive at the selected jog speed. As a maintained input, the jog state is only valid for the duration of the time the operator device is held closed. The position memory is reset to zero at the end of the JOG state.

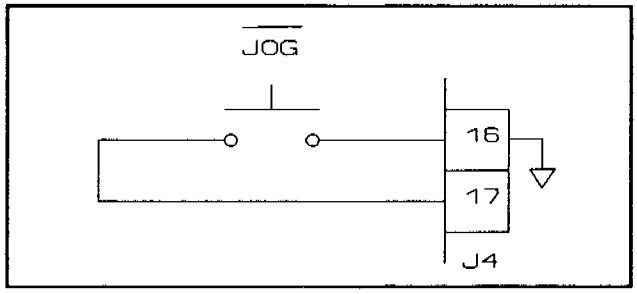


Figure 3-24: Jog Input

4) ELECTIVE OUTPUTS

The M-Track Elective Outputs are all open-collector relay drivers (specs listed on Page viii). An external DC power supply is required to provide power to the relays. Free-wheeling diodes are incorporated and need not be added externally.

Figure 3-25 illustrates the wiring for the first three elective outputs. The remaining outputs follow the same pattern.

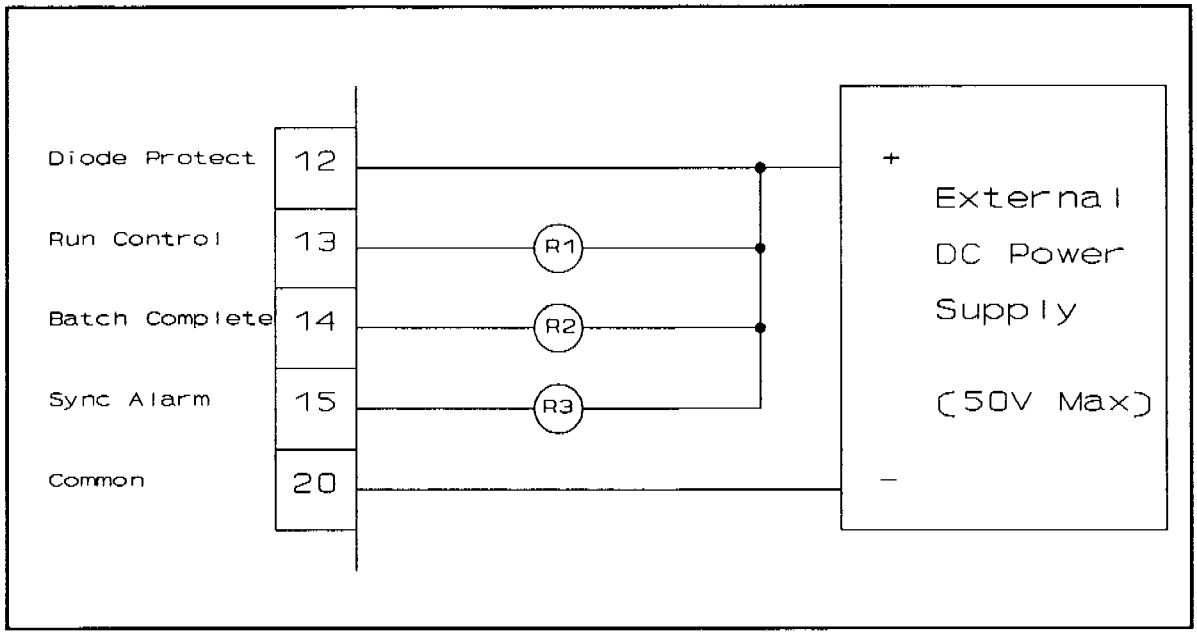


Figure 3-25: Elective Outputs

RUN CONTROL (J1 PIN 13)

The Run Control output is driven low (relay activated) when the M-Track is commanding a speed output to the slave drive in the Run, Jog, Align or Direct States.

BATCH COMPLETE (J1 PIN 14)

The Batch Complete output is driven low (relay activated) when the batch count is reached or exceeded.

SYNC ALARM (J1 PIN 15)

The Sync Alarm output is high (relay deactivated) when the master and slave pulse inputs are in sync. The Sync Alarm output is low (relay activated) when the master and slave pulse inputs are not synchronized.

POSITIVE/$\overline{\text{INVERTED}}$ (J1 PIN 16)

The Positive/Inverted output indicates the polarity of the Speed Command Output relative to the Voltage Reference Input. If they are the same polarity, the output is high (relay not activated). If they are opposite or inverted, the output is driven low (relay activated).

$\overline{\text{OUT A}}$ (EXT. REF. SYNC ABSENT - J1 PIN 17)

The $\overline{\text{OUT A}}$ output is low (relay activated) when the External Reference Sync Pulse is absent from its sync window. The sync flag window must be enabled (CP-37 = 1) for this output to activate.

$\overline{\text{OUT B}}$ (FEEDBACK SYNC ABSENT - J1 PIN 18)

The $\overline{\text{OUT B}}$ output is low (relay activated) when the Feedback Sync Pulse is absent from its sync window. The sync flag window must be enabled (CP-37 = 1) for this output to activate.

$\overline{\text{OUT C}}$ (LOW/HIGH ALARM - J1 PIN 19)

The $\overline{\text{OUT C}}$ output is low when either a low or high alarm condition is present.

AUXILIARY DC POWER

+5 VOLT (J3 PIN 1) The 5 Volt output is a DC regulated output that can be used to power encoders or other auxiliary equipment used in conjunction with the M-Track.

+12 VOLT (J3 PIN 2) The 12 Volt output is a DC regulated output that can be used to power proximity sensors or other auxiliary equipment used in conjunction with the M-Track.

CAUTION

It is imperative that the current draw not exceed the specifications listed on page ix for the 5 Volt and 12 Volt supplies (250 mA @ 5V and 200 mA @ 12V). Excessive current draw will result in damage to the M-Track device.

5) SERIAL COMMUNICATIONS

The Serial Communications interface on the M-Track complies with EIA Standard RS-422-A for balanced line transmissions. This interface is provided to permit remote computer variable programming, status or performance monitoring, and remote control. A detailed discussion of the Serial Communications capability is provided in Chapter 7 of this manual.

Figures 3-26 and 3-27 illustrate a multidrop installation of the Serial Communications link.

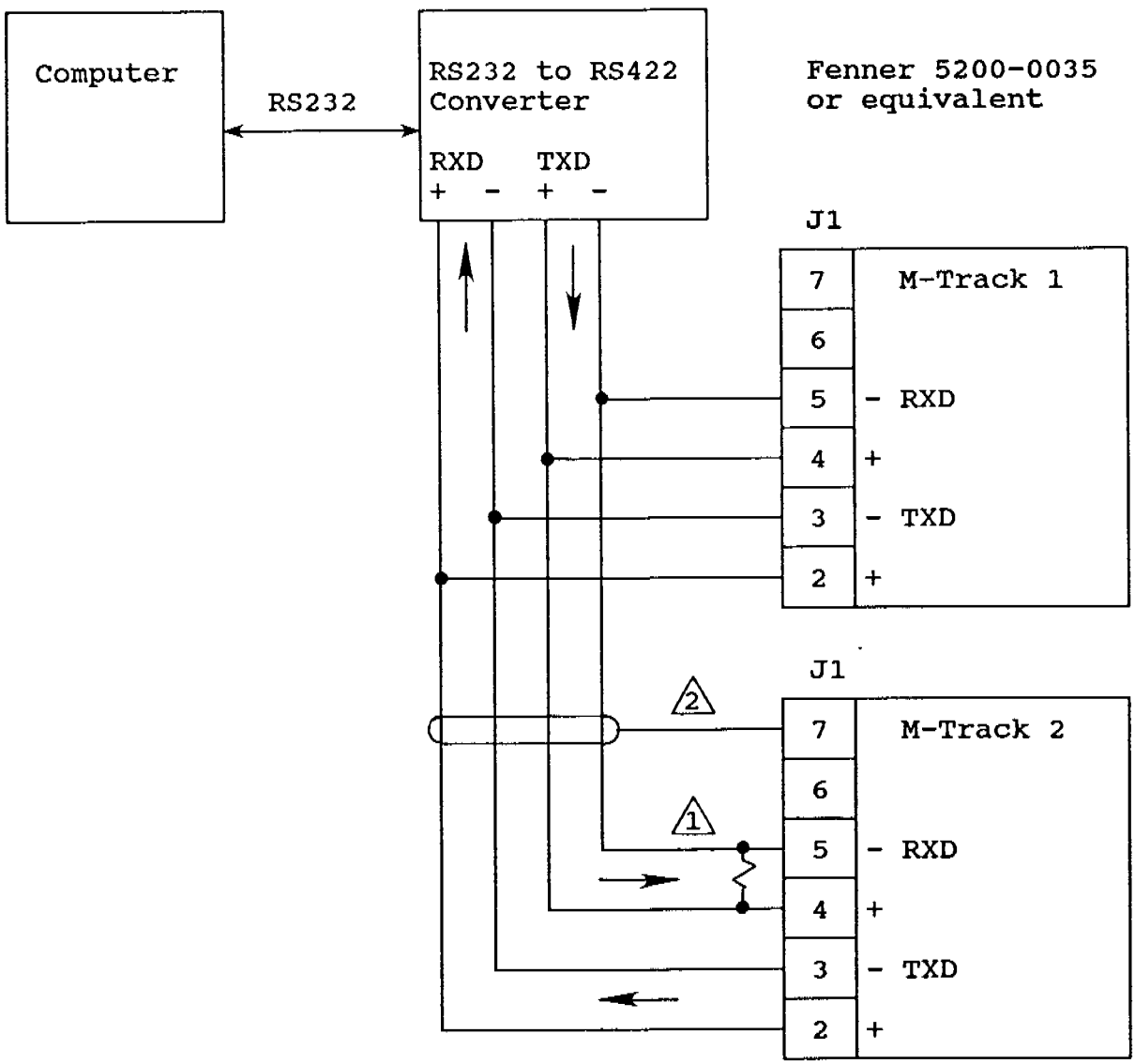


Figure 3-26: Serial Communications Connections

⚠1 It may be necessary to terminate the communication line at the furthest receiving ends only. A 100 ohm, 1/2 Watt resistor is usually adequate for this purpose. For more information, refer to EIA Standard RS-422-A.

⚠2 Shield at one end of cable only.

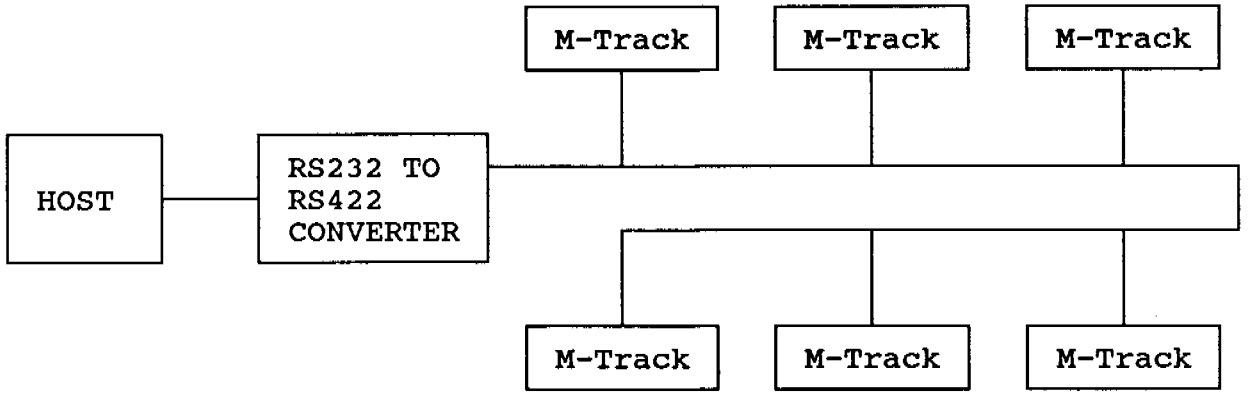


Figure 3-27: Correct M-Track Multidrop Installation

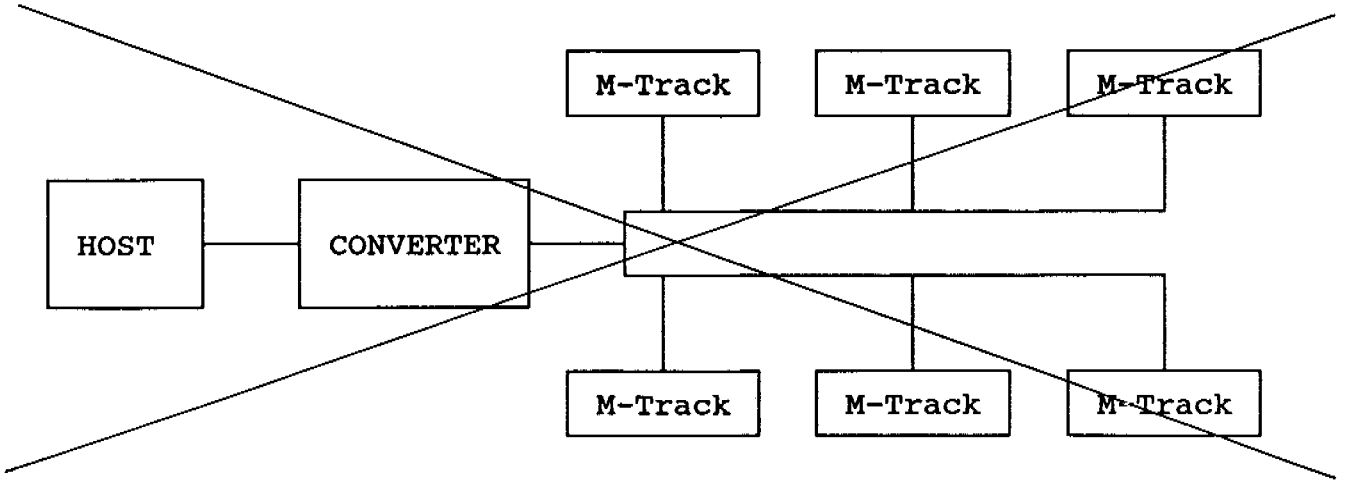


Figure 3-28: Incorrect Installation

CALIBRATION 4

INTRODUCTION

This chapter contains the information required to calibrate the M-Track to the connected motor drive. Prior to using these procedures, the M-Track must be properly configured and installed in accordance with Chapters 2 and 3 of this Manual.

NOTE: The calibration procedures may require the user to first read Chapter 5 (Programming) before proceeding.

MOTOR DRIVE SET UP

In order to provide for proper closed-loop operation, it is necessary to calibrate the motor drive maximum speed and response adjustments according to the following procedure:

1. Set the ACCEL and DECEL POTs on the motor drive to the minimum times (fastest response).
2. Set the I.R.Compensation POT (if present) on the motor drive to its minimum setting.
3. Enter a "1" into CP-19 on the M-Track (places M-Track into Direct Scaling Mode).
4. Enter a "3686" into CP-7 (places the output command to 90% of the full 4095 level).
5. Adjust the Max Speed POT on the subject motor drive for the desired maximum operating RPMs. This value should be the same as the CP-13 variable entry. The speed can be observed in MV-40.
6. Reenter a "0" into CP-19 (places the M-Track out of Direct Scaling Mode).

ON BOARD SCALE POT

For most applications, the On Board Scale POT should be turned fully clockwise (factory default position). The On Board Scale POT is located on the rear of the Power Supply/Isolator board behind the cover plate. (The cover plate must be removed to allow access to this POT.) The Scale POT is the lower POT labeled "R2", just above the AC power connector.

In cases where the subject drive cannot exceed a specific voltage or the M-Track Internal Reference Voltage is utilized (Page 2-3), the On Board Scale POT can be used to range adjust the isolated analog output level of the M-Track. To make this adjustment, follow the procedure below:

1. Enter a "1" into CP-19 (places M-Track into Direct Scaling Mode).

2. Enter "4095" into CP-7 (puts the output to 100% command output level).

3. Enter the M-Track into the "RUN" state.

4. Adjust the On Board Scale POT until the voltage between J1 Pin 9 and J1 Pin 10 is at the desired maximum voltage.

5. Reenter a "0" into CP-19 to place the M-Track out of the Direct Scaling Mode.

ON BOARD ZERO POT

The On Board Zero POT is factory adjusted to provide a zero volt isolated output level to the subject drive with a zero speed command. The Zero POT is located on the rear of the Power Supply/Isolator board behind the cover plate. The Zero POT is the upper POT labeled "R1", just above the Scale POT and the AC power connector.

Should the On Board Zero POT require further adjustment to compensate for drive errors, follow the procedure below:

1. Enter a "1" into CP-19 (places M-Track into Direct Scaling Mode).

2. Enter "0" into CP-7 (0 speed command)

3. Enter the M-Track into the "RUN" state.

4. Adjust the On Board Zero Pot until the voltage between J1 Pin 9 and J1 Pin 10 is at zero volts.

5. Reenter a "0" into CP-19 to place the M-Track out of the Direct Scaling Mode.

INTRODUCTION

This section of the manual explains the use of the code select procedure for changing and viewing the M-Track's Programming Codes. All Programming Codes can be divided into two broad categories: Control Parameters (indicated by a "CP-") and Monitor Variables (indicated by a "MV-"). Programming or Scaling the M-Track is accomplished by entering relevant values into the M-Track's Control Parameters to influence the control behavior of the M-Track. Monitor variables are display variables used to view or monitor system performance during M-Track operation.

This chapter is divided into four sections: Code Select Procedure explains the use of the programmer keypad for gaining entry to the Control Parameters and Monitor Variables. Setpoint Selection and Control explains how the setpoints are used in an M-Track. Learn Mode Scaling explains the M-Track Learn Mode Scaling procedure required to sync follower operation. Tuning provides procedures to tune the M-Track for system stability and optimal performance.

CODE SELECT PROCEDURE

The Code Select Procedure indicates how the operator gains access to the various Control Parameters and Monitor Variables through their unique identification codes. Opening the lower door on the front of the M-Track keypad exposes the programming keypad.

Accessing the desired parameter is a simple procedure:

1) Press the "Code Select" Key.
2) Enter the desired parameter code number.
3) Press the "Enter" Key.

At this point, the two digit Programming Code is displayed in the lower display window and the existing parameter value is displayed in the upper six-digit display window. In addition, the keypad is enabled for changing the desired parameter (if applicable). To make a change, simply enter the new value and press the Enter Key *. Values greater than six digits in length are identified by a preceding "H" (high) for the highest significant digits, and "L" (low) for the lowest significant digits. The "ALT" key is used to switch between the high and low values.

NOTE: If the Enter Key is not pressed within approximately ten seconds of a new value being entered, the display reverts to the previous value.

* Variables CP-11, CP-13, CP-18, CP-19, CP-34, CP-35, CP-36 and CP-37 can only be changed in the R-Stop and F-Stop states. All other variables can be changed while in the Run State.

FOLLOWER SETPOINT SELECTION AND CONTROL (Learn Mode Scaling)

As shipped from the factory, the M-Track is set up for "Learn Mode" Scaling. Learn Mode Scaling is a procedure used by the M-Track to calculate the appropriate follower to lead speed ratio necessary to maintain synchronization between the lead and follower sync pulses. For additional information, refer to the next manual section, "Learn Mode Scaling".

The M-Track is capable of learning and saving the scale ratios for up to eight separate process configurations when set up for Learn Mode Scaling. Each of these configurations is identified by a unique Process Code (1 through 8). These process configuration codes represent the setpoint for the M-Track. The following procedures indicate how the desired process code is selected and activated by the M-Track.

SETPOINT SELECTION

Setpoint Selection for the M-Track is a two step process: preset selection and setpoint activation. To preset select a process code, the unique process code identifier 1 through 8 is entered into either Control Parameter CP-1, CP-2 or CP-3. Any combination of the eight process codes can be preset into parameters CP-1 through CP-3 (See Figure 5-1).

Activation of the preset process code for operation is done through discrete inputs Ratio A (J3 pin 13) and Ratio B (J3 pin 15). If both Ratio A and Ratio B inputs are open (not shorted to common), then the process code preset into CP-1 is activated for control. If only Ratio A is closed (shorted to common), then the process code preset into CP-2 is activated for control. If Ratio B alone or both discrete inputs are closed (shorted to common), then the process code preset into CP-3 is activated for control.

If a process code is preset into CP-1, CP-2 or CP-3 which has not been through the Learn Mode Scaling procedure, the process code will be preceded in the upper display by an "L P" indication. This indicates to the user that the M-Track has not established the proper scale ratio for the selected process setup. As soon as the M-Track has learned the scale ratio during the Learn Mode procedure, the "L P" indicator will disappear from the display.

The scale ratio can be cleared or reset for a given process code by pressing the "ALT" key after the process code has been activated. The "L P" indication will reappear on the upper display to indicate that "Learn Mode Scaling" has not occurred for the selected process code.

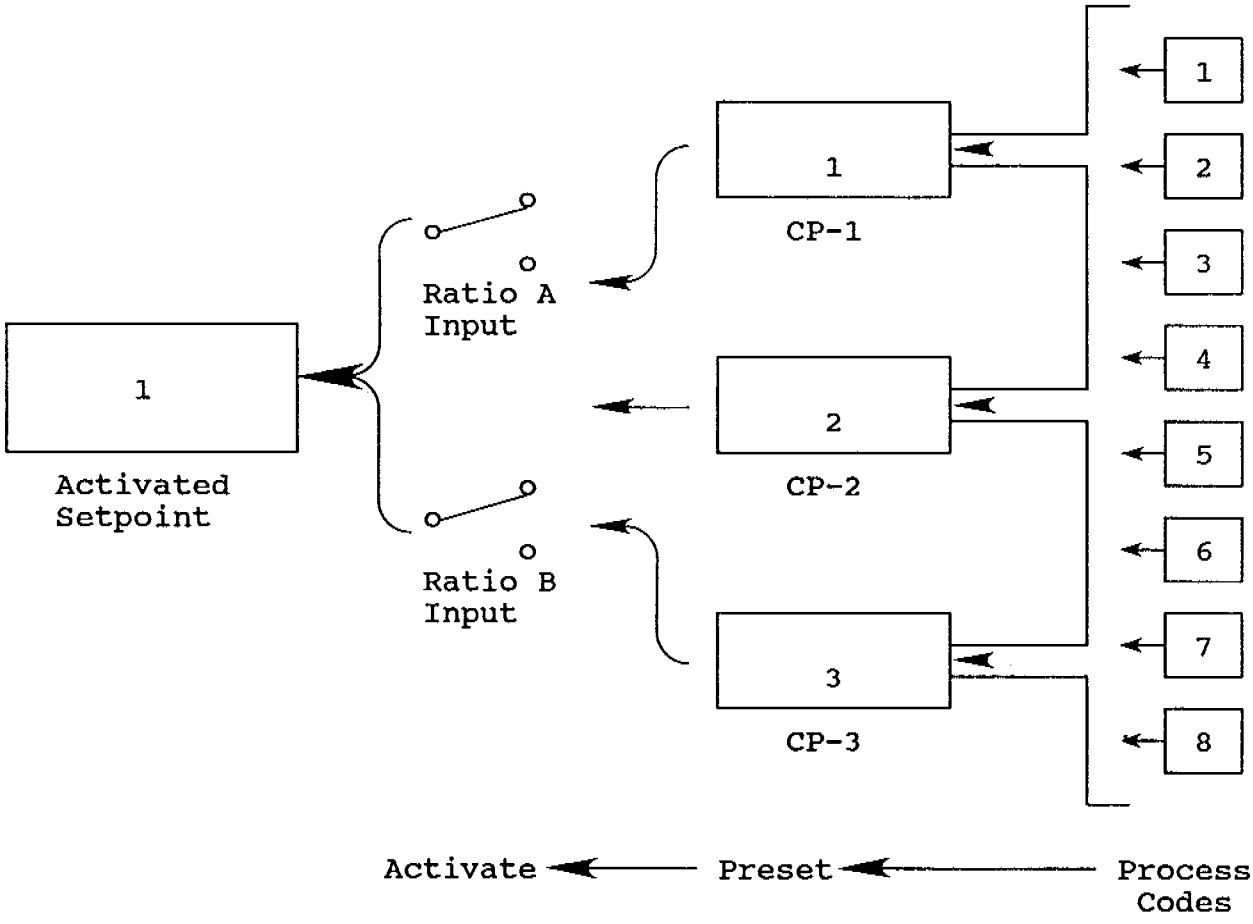


Figure 5-1: Setpoint Selection and Control

LEARN MODE SCALING

Learn Mode Scaling is the procedure by which the M-Track learns or calculates the proper scaling ratio between the lead and follower frequency inputs required to synchronize the sync pulse inputs. Follow the procedure below to establish the process Scaling:

LEARN MODE PROCEDURE

1. Enter the M-Track into Follower mode by shorting the J4 inputs 1 and 2. See Page 3-12.

2. Lead Polarity - Rotate the lead encoder in the direction of normal operation while monitoring MV-41. If MV-41 is negative, then exchange the lead encoder lines on J3 pins 3 and 5.

3. Motor Direction - Put the M-Track into Direct Mode by entering a value of "1" into CP-19. Enter a positive Direct Mode setpoint of 400 into CP-7. Enter the RUN state. If the follower motor direction does not match the motor direction of the lead during normal operation, then rewire the drive/motor to reverse the motor direction. Take the M-Track out of Direct Mode by entering a "0" value into CP-19.

4. Follower Polarity - Rotate the follower encoder in the direction of normal operation as established in step 2 above while observing MV-42. If the frequency in MV-42 is negative, then exchange the follower encoder lines on J3 pins 7 and 9.

5. Follower Encoder Resolution - Enter the resolution (PPRs) of the follower encoder into CP-11.

6. Follower Maximum RPMs - Enter the maximum RPMs that the follower encoder shaft will reach during normal operation into CP-13.

7. Setpoint Select - Follow the Setpoint Selection procedure (Page 5-2) to activate the desired setpoint. To enter Learn Mode Scaling, the setpoint code must be preceded by an "L P" indication in the upper display. If the "L P" indication is not present, then press the "ALT" key to reset the process scaling and enable the Learn Mode Scaling format.

8. Run/Observe - Run the lead motor in the normal direction. Enter the M-Track and connected drive/motor into the RUN state. The M-Track should operate the follower motor at approximately 10% of the Follower Maximum speed entered into CP-13 during Learn Mode (follower speed is independent of lead speed during learn mode). After two lead sync pulses and two follower sync pulses have occurred, the M-Track will have all the information necessary to establish the proper scaling ratio for the process. The "L P" indication on the upper display will disappear to indicate that the M-Track has completed the Learn Mode scaling procedure. At this point, the M-Track will attempt to synchronize the two sync pulse inputs and maintain the in-sync condition.

9. Tuning - If the M-Track is too sluggish and unable to achieve and maintain synchronization or is unstable (erratic operation), proceed to the "Tuning" manual section (Page 5-6).

There are numerous Monitor Variables available to monitor the operation of the M-Track in Follower Mode. These include:

MV-40: TACH

MV-40 displays the feedback speed in RPMs. It is valid for Master and Follower scaling modes.

MV-41: EXTERNAL REFERENCE (LEAD)

MV-41 displays the External Reference Frequency input rate in lines/second. It is a signed number to indicate direction (+ indicates forward direction, - indicates reverse direction).

MV-42: FEEDBACK (FOLLOWER)

MV-42 displays the Feedback Frequency input rate in lines/second. It is a signed number to indicate direction (+ indicates forward direction, - indicates reverse direction).

MV-49: POSITION ERROR

MV-49 indicates the difference between the calculated ideal follower position and the actual follower position in encoder lines.

MV-80: LEAD JOB SPACE

MV-80 indicates the size of the average Lead Job Space as determined by the External Reference Frequency and Sync inputs. Units are in encoder lines.

MV-81: FOLLOWER JOB SPACE

MV-81 indicates the size of the average Follower Job Space as determined by the Feedback Frequency and Sync inputs. Units are in encoder lines.

MV-82: LEAD JOB SPACE VARIANCE

MV-82 indicates the maximum variance in the Lead Job Space in encoder lines. The calculation time period is coincident with the 16 sync pulse period used to establish the trending scale value.

MV-83: FOLLOWER JOB SPACE VARIANCE

MV-83 indicates the maximum variance in the Follower Job Space in encoder lines. The calculation time period is coincident with the 16 sync pulse period used to establish the trending scale value.

MV-84: SYNC FLAG DIFFERENCE

MV-84 indicates the difference, in feedback encoder lines, between the position of the Lead and Feedback Sync pulses.

MV-85: TRUE SCALE FACTOR

MV-85 displays the calculated ratio between the Feedback Frequency Input and the Lead Frequency Input used to maintain alignment between the two sync inputs.

TUNING

Tuning refers to the procedure of setting the tuning parameters of the control algorithm to achieve stable and optimal performance. The default tuning parameters should provide for stable operation in the majority of applications. The tuning instructions below are provided for those applications which require additional M-Track tuning.

TUNING PROCEDURE - SPEED LOOP

The first step in tuning the M-Track is to achieve stable operation without the position (sync) information present. Disable sync operation by setting CP-34 to zero.

CP-65: GAIN (PROPORTIONAL CONSTANT)

To set the Proportional Constant, first set the Integral Constant (CP-66) and Derivative Constant (CP-67) variables to zero. Increase the Proportional number until the system goes unstable (erratic). This is easily tested by moving between two wide spread lead frequency values. When instability is reached, decrease the Proportional Constant number slightly until the system stabilizes.

CP-66: RESET (INTEGRAL CONSTANT)

Using only Proportional, the system may exhibit a phenomenon called proportional droop, whereby the setpoint is never reached due to system losses. Integral should be increased until overshoot is exhibited (overshoot occurs when the feedback goes over the desired setpoint before settling to the desired setpoint value). It is necessary to switch between wide spread lead frequencies to observe overshoot.

CP-67: RATE (DERIVATIVE CONSTANT)

Derivative is only required if the control is still too sluggish after setting the Proportional and Integral parameters. Derivative, like Proportional, should be entered up to the point of instability. After the control has reached the instability point, decrease the derivative number until the control action stabilizes.

TUNING PROCEDURE - POSITION LOOP

The second step in Tuning the M-Track is to introduce back the position (sync) loop and adjust the position tuning variables. Enable the position (sync) loop by entering a "1" into CP-34.

CP-25: LAG PULSE UNIT

The Lag Pulse Limit puts a maximum limit on the position error value when the follower lags the lead in position. Restricting the Lag Pulse Limit value (smaller values) can provide for more stable operation as it limits the error value submitted to the PID algorithm. This may be particularly effective in achieving stability with processes with small job spaces (sync rates less than one second). Units are in encoder lines.

CP-26: LEAD PULSE LIMIT

The Lead Pulse Limit is similar to the Lag Pulse Limit except it restricts the position error value when the follower is ahead of the lead in position. Again, reducing the Lead Pulse Limit value may assist in achieving stability especially for processes with small job spaces.

CP-32: GROSS ERROR BOUNDARY

For processes with large job spaces, it is possible to invoke a separate Gross Error Algorithm when errors exceed a specified value. The Gross Error Algorithm provides a less aggressive but well behaved method of resolving large position errors thereby allowing the PID algorithm to be tuned more aggressively to maintain the in-sync condition. The Gross Error Algorithm will have very limited utility with small job space processes but may be mandatory in achieving stability with large job space processes.

When using the Gross Error Algorithm, always set the Lead and Lag Pulse Limits (CP-25 and CP-26) greater than four times the Gross Error Boundary (CP-32).

CP-32, Gross Error Boundary, determines the error value beyond which the Gross Error control algorithm is substituted in place of the PID control algorithm. If large position errors create system instability, reduce the CP-32 value until stability is reached.

CP-15: OVERSPEED LIMIT

When the M-Track Gross Error algorithm is activated, there are two variables that influence the corrective behavior. The first of these is the Overspeed Limit. The Overspeed Limit puts a limit on the speed by which the follower will exceed the lead to recover the position error. This parameter value is normalized and entered as a percent of maximum follower speed (CP-13).

CP-61: GROSS ERROR RESET

The rate at which the follower reaches the Overspeed limit and later adjusts to the in-sync velocity is determined by the Gross Error Reset (accel/decel only active in Master Mode not Follower Mode).

Increasing the Gross Error Reset value will cause faster rates of velocity correction in the Gross Error control algorithm.

THEORY OF OPERATION 6

INTRODUCTION

This chapter provides a discussion on the M-Track theory of operation. This discussion is restricted to the M-Track basic level of operation, and is not intended to cover the numerous options that are available for more refined control. With a general understanding of the internal operations of the M-Track, it should be easier to utilize and optimize this control for specific applications.

POSITION CONTROL

The primary control function of the M-Track is to establish and maintain the position alignment of the External Reference (Lead) and Feedback (Follower) Sync signal inputs. This synchronization occurs with a one-to-one correlation of one Lead sync pulse to one Follower sync pulse. Although this occurs in a continuous velocity environment, the primary function, and subsequent control algorithm, is one of position and not velocity. On a one millisecond periodic update rate, the M-Track determines the error between the setpointed position and the actual position of the follower device. This error is then submitted to the position control algorithm for corrective action.

POSITION DETERMINATION

The first task of the control algorithm is to determine the External Reference (Lead) and the Feedback (Follower) positions. At power-up, or after a Position Reset input command, the Lead and Follower positions are both set to zero. Every one millisecond, the number of External Reference and Feedback encoder lines that are received (at the M-Track frequency inputs) are added to the Lead and Follower positions, respectively. This is an accumulative process that repeats until a Resync occurs.

RESYNC

The M-Track performs a Resync operation when a pair of flags occur, one Lead and one Follower. When this occurs, the accumulated Lead position is updated with the Lead position at the time the Lead sync pulse occurred, and the Follower accumulated position is updated with the position of the Follower at the time the Follower sync pulse occurred. Note that this can result in an instantaneous change in position error, particularly if synchronization is being established for the first time.

SCALE FACTOR

To derive the commanded or setpointed position, the M-Track multiplies the accumulated Lead position by the Scale Factor (MV-86). The Scale Factor is the ratio of the number of Follower encoder lines per Follower job space (MV-81) divided by the number of Lead encoder lines per Lead job space (MV-80). (A job space is the number of encoder lines that occur from one sync pulse to the next). The Scale Factor can be either directly entered in Fixed and Flex Mode or determined by the M-Track in Learn Mode.

POSITION ERROR

The position error (MV-49) is calculated by subtracting the accumulated Follower position from the commanded or setpointed position (Position Error = Accumulated Lead Position * Scale Factor - Accumulated Follower Position). A positive position error indicates that the Follower is behind or lags the commanded position. A negative position error indicates that the Follower is ahead of or leads the commanded position. The calculated position error may be limited to the Lead (CP-25) and Lag (CP-26) Pulse Limits before being submitted to the compensation algorithm.

COMPENSATION ALGORITHMS

There are two separate compensation algorithms present in the M-Track, the Gross Control Algorithm and the PID Algorithm. If the position error is less than the Gross Error Boundary, the PID algorithm is utilized. However, once the PID algorithm is invoked, the error must reach a value of four times the Gross Error Boundary before control is passed back to the Gross Control Algorithm from the PID Algorithm.

GROSS CONTROL ALGORITHM

The purpose of the Gross Control Algorithm is to gracefully reduce large position errors down to a point where the more aggressive PID algorithm can establish and maintain synchronization. Because the Gross Control Algorithm is a slower dynamic algorithm, it may not be necessary or suitable for high sync rate applications with small job sizes.

Three variables determine the behavior of the Gross Control Algorithm. The first variable, Gross Error Boundary (CP-32), establishes the error band at which the Gross Control Algorithm passes control over to the PID Algorithm. The second variable, Gross Error Reset (CP-61), determines the rate of velocity change used by the Follower device to reduce the position error. The third variable, Overspeed Allowance (CP-15), places a limit on the amount of velocity difference between the Follower and Lead that is permitted to reduce the position error. The calculated result of the Gross Control Algorithm is added to the Feedforward term to provide the velocity command signal to the motor drive.

PID ALGORITHM

The PID Control Algorithm is designed to resolve the final position error to zero and maintain synchronization. It is a more aggressive compensation algorithm typically working with smaller or more limited position errors. Three variables (terms) determine the behavior of the PID Control Algorithm. The proportional (P) term (CP-65) is derived by multiplying the proportional or gain constant by the position error. The integral (I) term (CP-66) is derived by multiplying the integral constant by the integrated or accumulated position error (error * time). The derivative (D) term (CP-67) is derived by multiplying the derivative constant by the derivative or change in the position error. The results of the P, I, and D terms are all added together (MV-48) along with the Feedforward term and output to the motor drive as a velocity command signal (MV-47).

FEEDFORWARD

Whereas the compensation algorithms operates on instantaneous, accumulated and differential changes in error, the Feedforward term is calculated by multiplying the changes in Lead position or setpoint by an internally derived constant. Two of the parameters used to calculate the Feedforward constant are the Follower PPR (CP-11) and the Follower Max RPM (CP-13). It is important that both these values be correctly entered by the user to properly scale the Feedforward term. The purpose of this term is to quickly bring the M-Track output to an approximate level whereby the error compensation algorithms need only converge on the final error. The Feedforward term will not influence system stability.

NOTES

SERIAL COMMUNICATIONS 7

INTRODUCTION

The M-Track serial communications protocol utilizes a polling technique. A message or record is sent to the M-Track from the host computer to establish communications. The M-Track then responds with a confirming or error message.

Messages sent to the M-Track can be categorized into three types:

1. Parameter Send
2. Data Inquiry
3. Control Command Send

The Parameter Send message is used to change any of the control parameters in the M-Track (CP-xx). All of the parameters accessible via the front keypad are also accessible through the serial communications interface.

The Data Inquiry message is used to request the current value of any of the control parameters (CP-xx) or monitor variables (MV-xx) in the M-Track.

The Control Command Send message is used to provide computer control of M-Track Operations - e.g., run, stop, etc.

All M-Track messages use the USA Standard Code for Information Interchange {ASCII} (see Appendix I).

This chapter is divided into seven sections. M-Track Serial Communications Setup describes which CP-xx variables to alter to allow an individual M-Track to utilize serial communications. The next six sections provide a character level description for each of the three message types and their responses:

Parameter Send - Host Transmission
Parameter Send - M-Track Response

Data Inquiry - Host Transmission
Data Inquiry - M-Track Response

Control Command Send - Host Transmission
Control Command Send - M-Track Response

M-TRACK SERIAL COMMUNICATIONS SETUP

The following parameters are used to physically structure a M-Track to utilize the RS422 serial communications network.

70 - DEVICE ADDRESSES

The M-Track's physical address may be set from 1 to 32. This address is used to uniquely identify individual M-Track units on a multidropped RS422 line.

NOTE: Messages using a device address of zero are accepted by all M-Track Units.

71 - BAUD RATE

There are six different baud or data rates for the M-Track:

1 = 300 Baud
2 = 600 Baud
3 = 1200 Baud
4 = 2400 Baud
5 = 4800 Baud
6 = 9600 Baud

72 - CHARACTER FORMAT

The M-Track accepts 3 different character formats:

1 = 8 Data Bits, No Parity, One Stop Bit
2 = 7 Data Bits, Even Parity, One Stop Bit
3 = 8 Data Bits, No Parity, Two Stop Bits

73 - CONTROL MASK

It is possible to allow the computer to control some of the functions associated with the discrete switch inputs. These functions are:

1 = Run/R-Stop
2 = Batch Initiate
4 = Master/Follower

To delegate control of the selected function to the computer, simply add the associated function number to the total. For example, a value of 5 for code 73 would mean the computer has control of the Master/Follower Mode and the Run/R-Stop functions.

NOTE: The computer changes these functions using the Control Command Send Message.

SUMMARY: M-TRACK SERIAL COMMUNICATIONS PROTOCOL

Table 7-1 summarizes the character structure for the M-Track serial communications protocol.

Character #	Description	Codes (Hex)	Codes (ASCII)
1	STX	02	STX
2	Device # 10's	30-39	0-9
3	Device # 1's	30-39	0-9
4	Message Type	31=Command	1
		32=Data Inquiry	2
		33=Parameter	3
5	Variable # 10's	30-39	0-9
6	Variable # 1's	30-39	0-9
7	Data 10,000,000's	30	0
	(Data Inquiry response only:	30-39	0-9)
8	Data 1,000,000's	30	0
	(Data Inquiry response only:	30-39	0-9)
9	Data 100,000's	30-39	0-9
10	Data 10,000's	30-39	0-9
11	Data 1000's	30-39	0-9
12	Data 100's	30-39	0-9
13	Data 10's	30-39	0-9
14	Data 1's	30-39	0-9
15	Data Format	30-3A	0-;
16	ETX	03	ETX

Table 7-1: Receive Queue Format

PARAMETER SEND-HOST TRANSMISSION

CHARACTER 1: STX

The leading STX character must be received by the M-Track to enable the receive buffer. All characters are ignored until the STX character is received.

CHARACTERS 2 & 3: DEV

Characters 2 and 3 are the device number (address) of the M-Track that is to be accessed. This number differentiates the individual M-Track devices on the multidrop RS-422 communications line. Data is only accepted if there is a match between these characters and Control Parameter 70 (the Device Address set on the M-Track). The only exception is device address 00, which is universally accepted by all the M-Tracks on the RS-422 line.

CHARACTER 4: MSG TYPE

Should always be a 3 for a Parameter Send message.

CHARACTERS 5 & 6: PARAMETER NUMBER

These characters are the Parameter Code numbers used to identify which Control Parameter is to be changed.

Appendix D lists all valid Control Parameters and their minimum and maximum values.

CHARACTERS 7 TO 14: DATA

These characters are used to transmit the new data for the selected parameter. Data must be within the range specified by Appendix D.

NOTE: Characters 7 and 8 must always be 0. These locations are only used with a data inquiry response.

CHARACTER 15: DATA FORMAT

The Data Format character determines the sign of the data sent in characters 7 through 14. An ASCII 0 indicates the data is positive, while an ASCII 6 indicates the data is negative.

CHARACTER 16: ETX

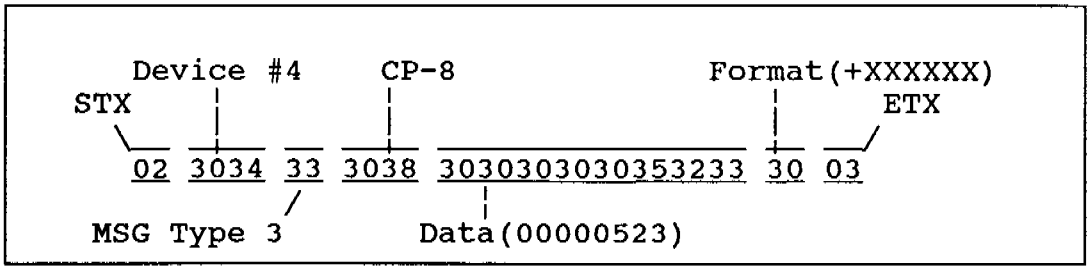
The message or record must always be terminated by the ASCII ETX character.

EXAMPLE:

A new acceleration time of 52.3 seconds is sent to the M-Track with device address 4:

ASCII Representation: STX 0 4 3 0 8 0 0 0 0 0 5 2 3 0 ETX

HEX Representation:



NOTE: Spaces are visual clarity only.

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PARAMETER SEND - M-TRACK RESPONSE

CHARACTER 1: STX

The leading character of the Response message is always the ASCII STX.

CHARACTERS 2 & 3: DEV

The next two characters are the device address.

NOTE: If the universal address is used in the Host Transmission, no response message is transmitted back to avoid line contention.

CHARACTER 4: ERROR CODE

The Error Code indicates if any errors existed in the send message received by the M-Track. This character is bit structured and can be decoded as follows:

Bit 0 - Transmit Error (parity, framing, overrun, no STX or no ETX)
Bit 1 - Parameter Error (invalid parameter or message type)
Bit 2 - Data Error (invalid data)
Bit 3 - Minimum/Maximum Error (out of range)
Bit 4 - Control Mask Error
Bit 5 - Not Used
Bit 6 - Always 1
Bit 7 - Always 0

Refer to Table 7-2 to transfer from the ASCII character sent back from the M-Track and the corresponding binary bit structure.

NOTE: The ASCII error code @ (01000000 binary) (40 HEX) indicates that the Host Transmission contained no errors.

The M-Track only accepts data if no errors were encountered.

ASCII	BINARY (Bit 7 … Bit Ø)	ASCII	BINARY (Bit 7 … Bit Ø)
@	Ø1ØØØØØØ	`	Ø11ØØØØØ
A	Ø1ØØØØØ1	a	Ø11ØØØØ1
B	Ø1ØØØØ1Ø	b	Ø11ØØØ1Ø
C	Ø1ØØØ11	c	Ø11ØØ11
D	Ø1ØØØ1ØØ	d	Ø11ØØ1ØØ
E	Ø1ØØØ1Ø1	e	Ø11ØØ1Ø1
F	Ø1ØØØ11Ø	f	Ø11ØØ11Ø
G	Ø1ØØØ111	g	Ø11ØØ111
H	Ø1ØØ1ØØØ	h	Ø11Ø1ØØØ
I	Ø1ØØ1ØØ1	i	Ø11Ø1ØØ1
J	Ø1ØØ1Ø1Ø	j	Ø11Ø1Ø1Ø
K	Ø1ØØ1Ø11	k	Ø11Ø1Ø11
L	Ø1ØØ11ØØ	l	Ø11Ø11ØØ
M	Ø1ØØ11Ø1	m	Ø11Ø11Ø1
N	Ø1ØØ111Ø	n	Ø11Ø111Ø
O	Ø1ØØ1111	o	Ø11Ø1111
P	Ø1Ø1ØØØØ	p	Ø1111ØØØ
Q	Ø1Ø1ØØØ1	q	Ø1111ØØ1
R	Ø1Ø1ØØ1Ø	r	Ø1111ØØ1Ø
S	Ø1Ø1ØØ11	s	Ø1111ØØ11
T	Ø1Ø1Ø1ØØ	t	Ø1111Ø1ØØ
U	Ø1Ø1Ø1Ø1	u	Ø1111Ø1Ø1
V	Ø1Ø1Ø11Ø	v	Ø1111Ø11Ø
W	Ø1Ø1Ø111	w	Ø1111Ø111
X	Ø1Ø11ØØØ	x	Ø11111ØØØ
Y	Ø1Ø11ØØ1	y	Ø11111ØØ1
Z	Ø1Ø11Ø1Ø	z	Ø11111Ø1Ø
[	Ø1Ø11Ø11	{	Ø11111Ø11
\	Ø1Ø111ØØ	|	Ø111111ØØ
]	Ø1Ø111Ø1	}	Ø111111Ø1
^	Ø1Ø1111Ø	~	Ø111111Ø
-	Ø1Ø11111	DEL	Ø1111111

Table 7-2: Error Code Translation -- ASCII to Binary

CHARACTERS 5 & 6: PARAMETER NUMBER

The Parameter Code number from the send message is echoed back in the return message.

CHARACTERS 7 TO 14: DATA

The Data from the send message is echoed back in the return message.

CHARACTER 15: DATA FORMAT

The Data Format character from the send message is echoed back in the return message.

CHARACTER 16: ETX

The return message is always terminated with the ASCII ETX character.

DATA INQUIRY-HOST TRANSMISSION

CHARACTER 1: STX

The leading character must always be the ASCII STX.

CHARACTERS 2 & 3: DEVICE NUMBER

The device address of the M-Track.

CHARACTER 4: MSG TYPE

The message type is the ASCII 2 for a data inquiry message.

CHARACTERS 5 & 6: PARAMETER NUMBER

This is the parameter code number for the desired variable.

CHARACTERS 7 TO 14: DATA

Set to zero in the message to the M-Track.

CHARACTER 15: DATA FORMAT

Set to zero in the message to the M-Track.

CHARACTER 16: ETX

The message should terminate with the ASCII ETX character.

DATA INQUIRY - M-TRACK RESPONSE

CHARACTER 1: STX

The leading character is the ASCII STX.

CHARACTERS 2 & 3: DEVICE NUMBER

The device address is echoed back.

CHARACTER 4: ERROR CODE

The Error Code is transmitted back as appropriate. See Parameter Send - Error Code for the bit pattern of the error code.

CHARACTERS 5 & 6: PARAMETER NUMBER

The Parameter Number is echoed back.

CHARACTERS 7 TO 14: DATA

This is the requested data for the selected parameter. See Data Explanation starting on Page 7-10.

CHARACTER 15: DATA FORMAT

This code tells how to interpret the returned data for positive, negative, and decimal point location.

ASCII Code	Data Format
0	+ XXXXXX.
1	+ XXXXX.X
2	+ XXXX.XX
3	+ XXX.XXX
4	+ XX.XXXX
5	+ X.XXXXX
6	- XXXXXX.
7	- XXXXX.X
8	- XXXX.XX
9	- XXX.XXX
:	- XX.XXXX
;	- X.XXXXX

CHARACTER 16: ETX

The message always terminates with the ASCII ETX character.

DATA EXPLANATION

Most data returned by the M-Track in response to a Data Inquiry command can be easily interpreted via the Data and Data Format fields. However, a few variables return an eight bit coded response which must be decoded to allow interpretation.

To interpret an eight bit coded number, refer to the appropriate Figure below to identify the M-Track information.

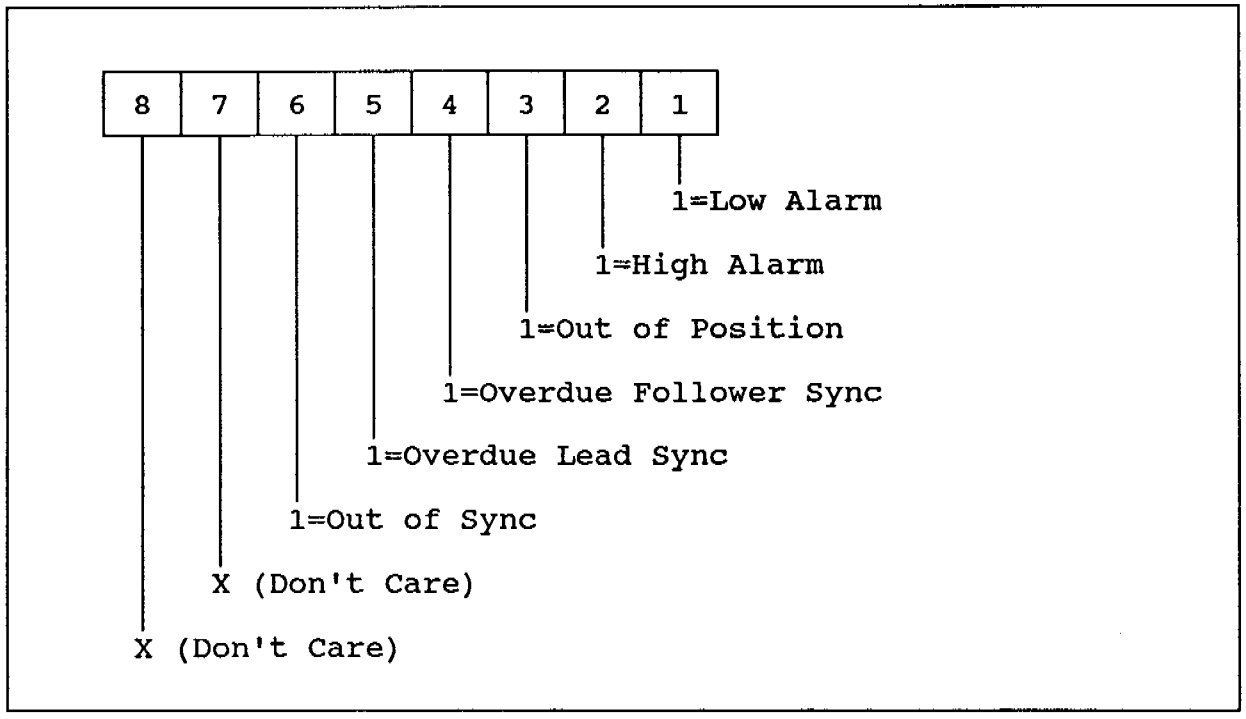


Figure 7-1: MV-51 Interpretation

As above, assume that decimal 5 (HEX 35) is returned by the M-Track in response to MV-51 Data Inquiry Command. Using Table 7-3, the number 5 converts to 00000101:

0	0	0	0	0	1	0	1	(5)
8	7	6	5	4	3	2	1	

Using Figure 7-1 above, 5 can now be interpreted to indicate the following Alarm Status: Low Alarm and Out of Position.

0	00000000	32	00100000
1	00000001	33	00100001
2	00000010	34	00100010
3	00000011	35	00100011
4	00000100	36	00100100
5	00000101	37	00100101
6	00000110	38	00100110
7	00000111	39	00100111
8	00001000	40	00101000
9	00001001	41	00101001
10	00001010	42	00101010
11	00001011	43	00101011
12	00001100	44	00101100
13	00001101	45	00101101
14	00001110	46	00101110
15	00001111	47	00101111
16	00010000	48	00110000
17	00010001	49	00110001
18	00010010	50	00110010
19	00010011	51	00110011
20	00010100	52	00110100
21	00010101	53	00110101
22	00010110	54	00110110
23	00010111	55	00110111
24	00011000	56	00111000
25	00011001	57	00111001
26	00011010	58	00111010
27	00011011	59	00111011
28	00011100	60	00111100
29	00011101	61	00111101
30	00011110	62	00111110
31	00011111	63	00111111

Table 7-3: Decimal to Binary Conversion

The following figures provide the interpretations for the other eight bit coded variables. The technique to interpret these variables is identical to the MV-51 example demonstrated on Page 7-10.

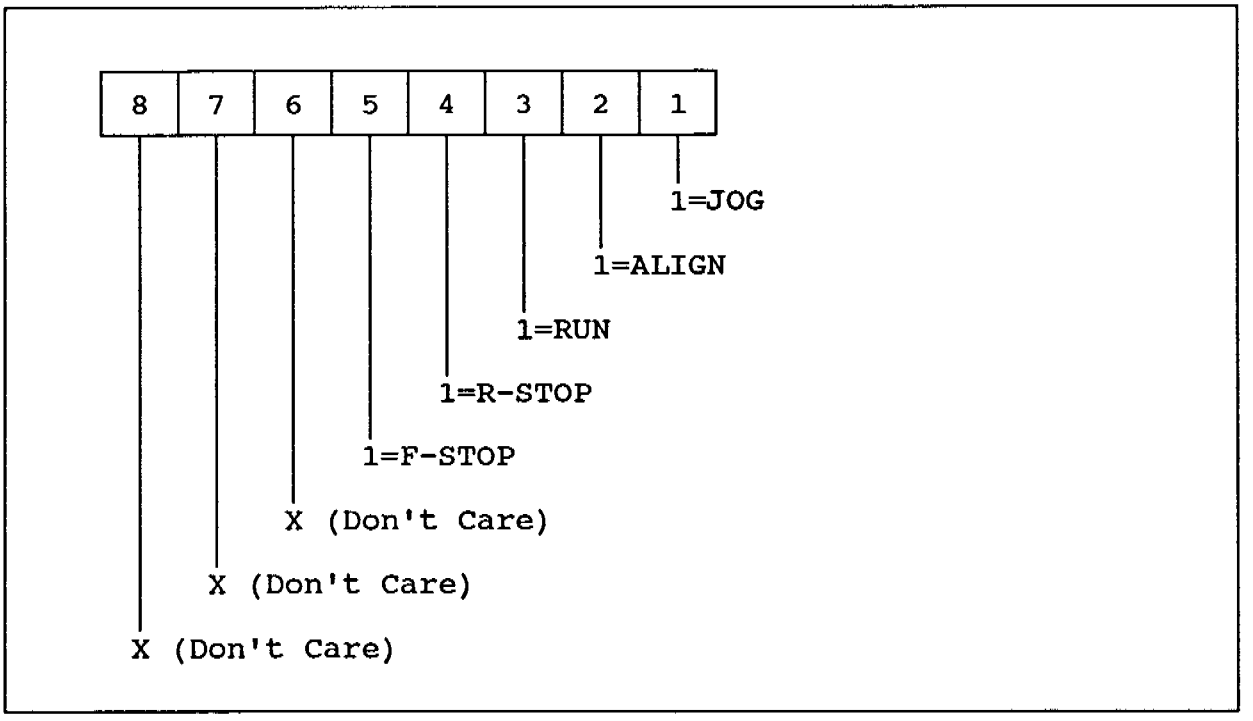


Figure 7-2: MV-52 Interpretation

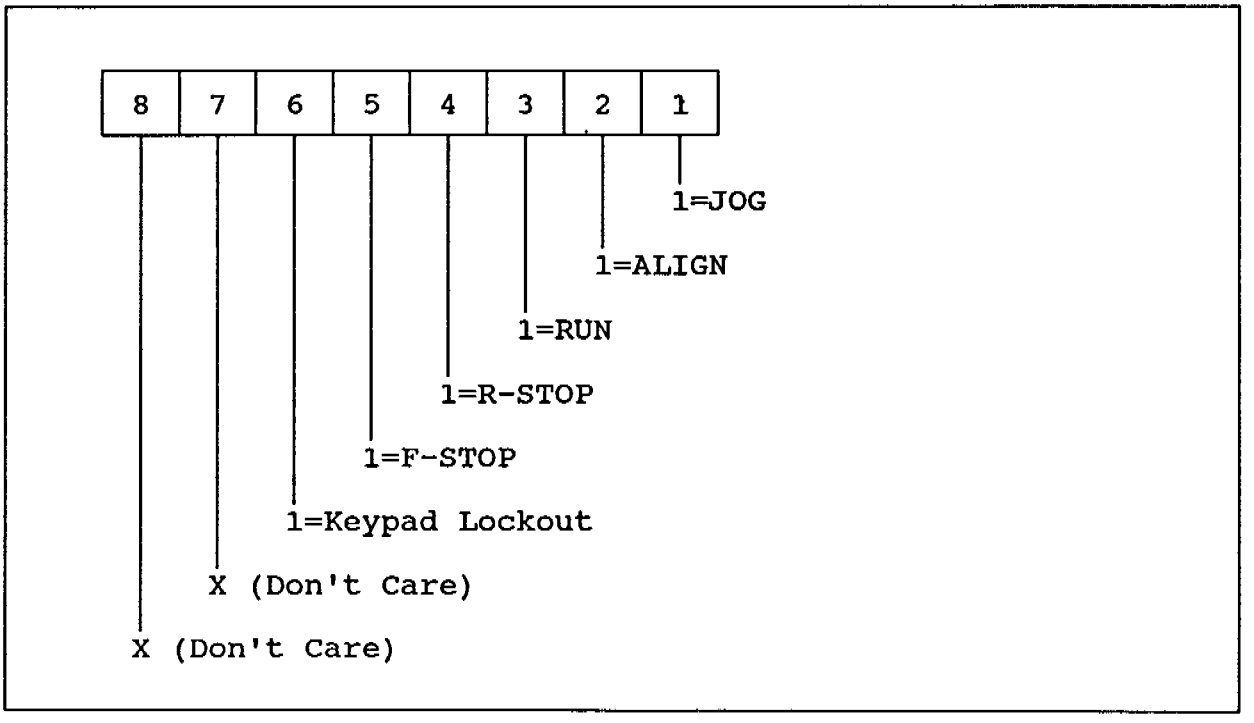


Figure 7-3: MV-53 Interpretation

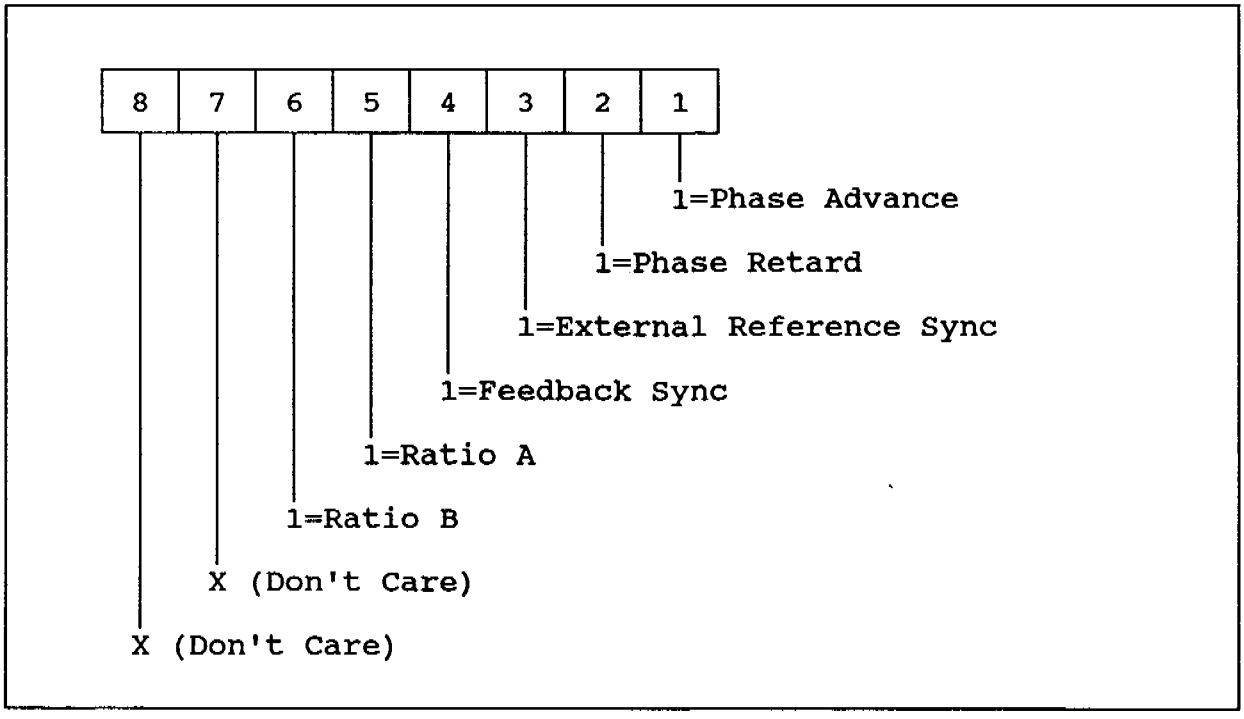


Figure 7-4: MV-54 Interpretation

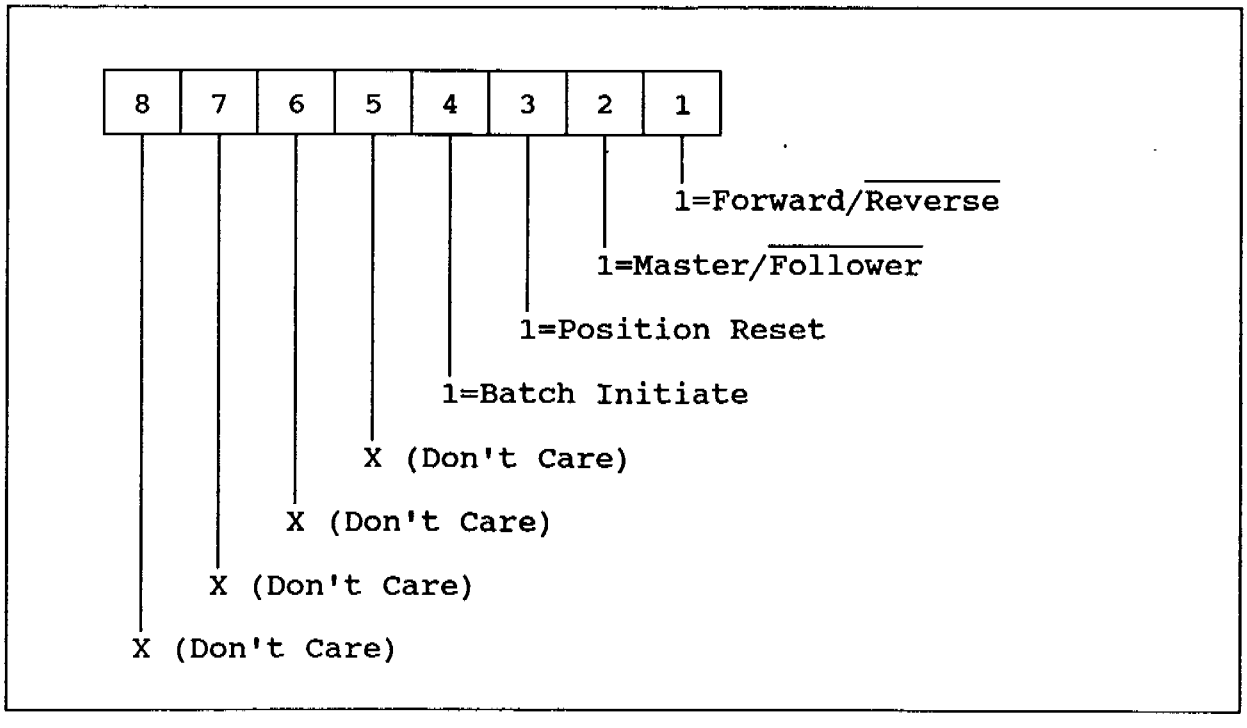


Figure 7-5: MV-55 Interpretation

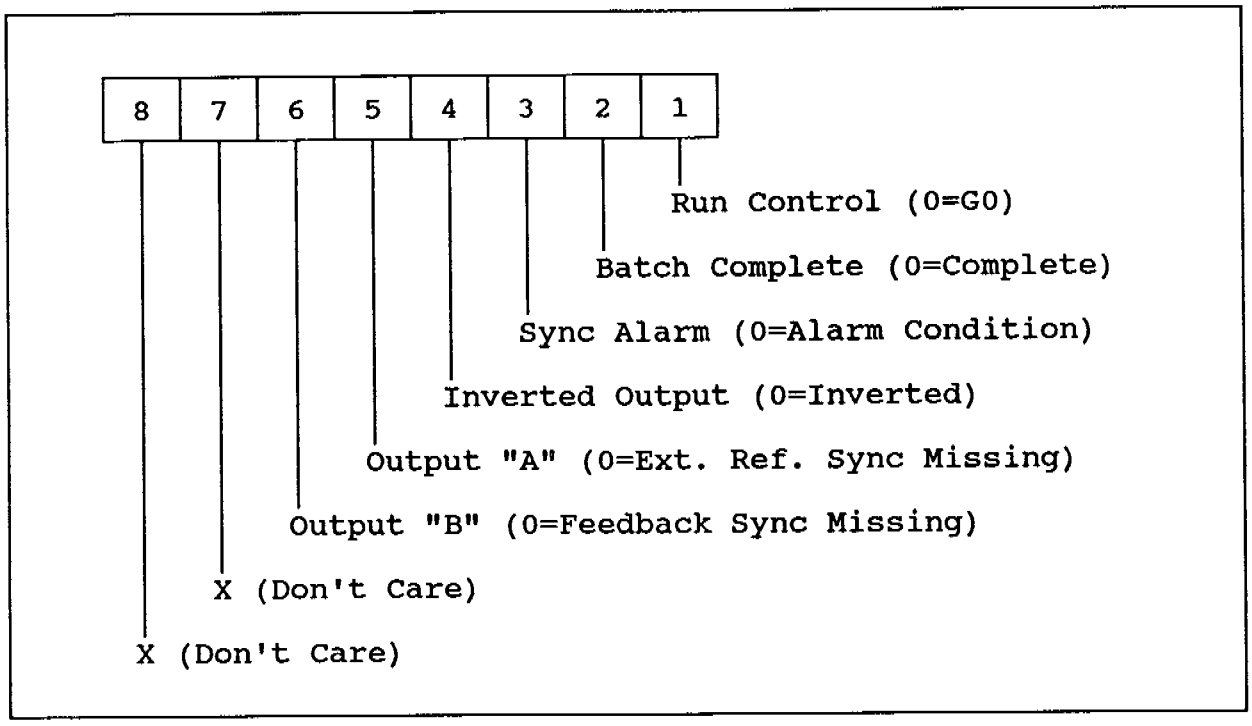


Figure 7-6: MV-56 Interpretation

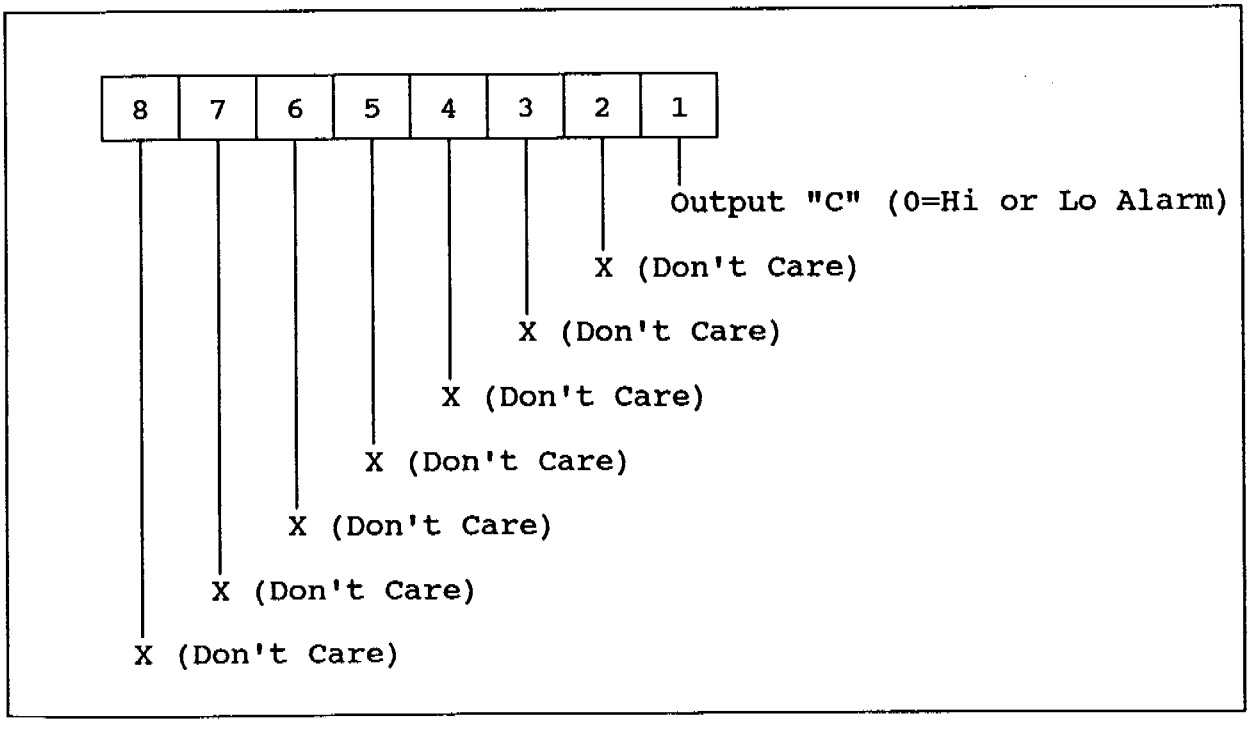


Figure 7-7: MV-57 Interpretation

NOTE: CP-73 indicates whether the computer has control over the listed variables. 1 indicates that the computer has control, 0 indicates the computer does not have control.

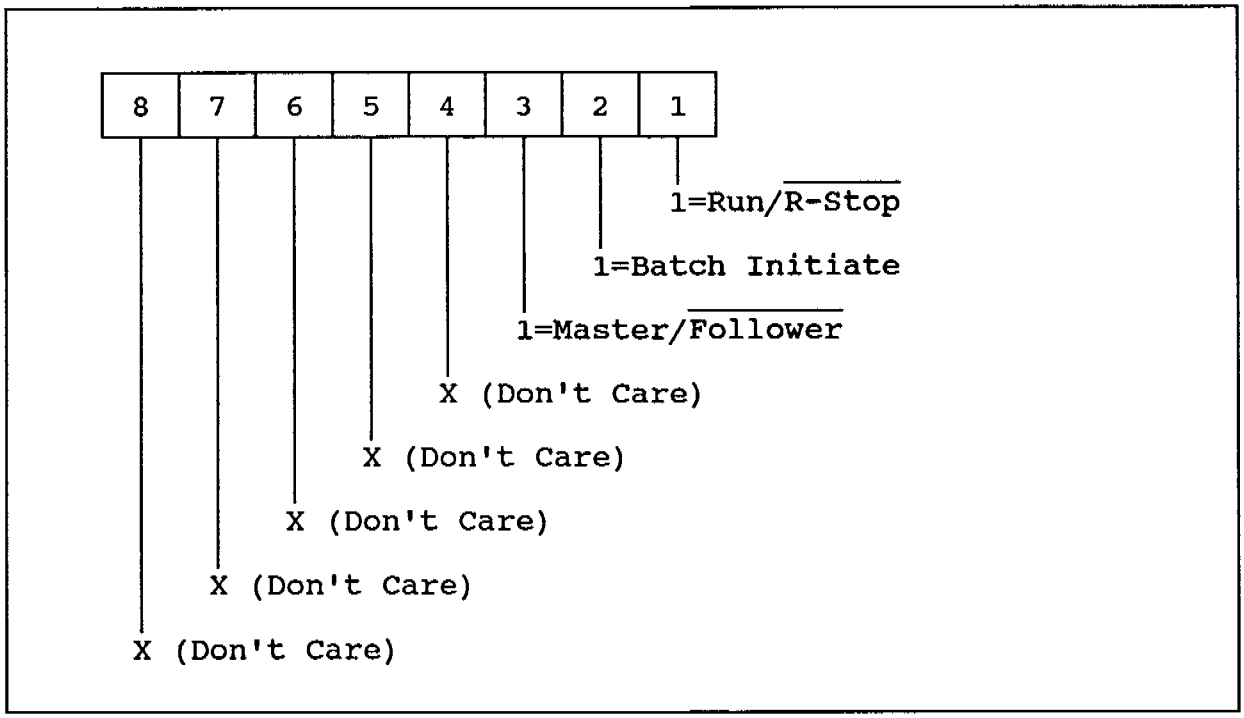


Figure 7-8: CP-73 Interpretation

CONTROL COMMAND SEND - HOST TRANSMISSION

CHARACTER 1: STX

The message always begins with the ASCII STX character.

CHARACTERS 2 & 3: DEVICE NUMBER

The desired M-Track device address. A device number of "00" for characters 2 and 3 will be globally recognized by all devices on the serial communications line.

CHARACTER 4: MESSAGE TYPE

Set to 1 for this message type.

CHARACTERS 5 & 6: PARAMETER NUMBER

Set to 0 for this message type.

CHARACTERS 7 THROUGH 12: DATA 1,000,000s through 100s

Set to 0 for this message type.

Note: If a global command is sent (characters 2 and 3 set to zero), then characters 7 through 10 should be ommitted. This reduces the message to a 12 character format.

CHARACTERS 13 & 14: DATA 10s & 1s

Enter data control command character code as follows:

01 - Fast Stop	09 - Not Used
02 - Ramp Stop	10 - Not Used
03 - Run	11 - Not Used
04 - Enable Master Mode	12 - Not Used
05 - Enable Follower Mode	13 - Not Used
06 - Batch Initiate	14 - Not Used
07 - Not Used	15 - Not Used
08 - Not Used	

CHARACTER 15: DATA FORMAT

Set to 0 for this message type.

CHARACTER 16: ETX

The message always terminates with the ASCII character ETX.

CONTROL COMMAND SEND - M-TRACK RESPONSE

CHARACTER 1: STX

The message always begins with the ASCII STX character.

CHARACTERS 2 & 3: DEVICE NUMBER

The device address of the M-Track.

CHARACTER 4: ERROR CODE

Error Code for the received message.

See Parameter Send - Error Code for the bit pattern to decode the error message.

CHARACTERS 5 & 6: PARAMETER NUMBER

Always 0 for this message type.

CHARACTERS 7 THROUGH 12: DATA 1,000,000s through 100s

Always 0 for this message type.

CHARACTERS 13 & 14: DATA 10s & 1s

The command mode from the receive message is returned by the M-Track.

CHARACTER 15: DATA FORMAT

Always 0 for this message type.

CHARACTER 16: ETX

Message always terminates with the ETX character.

NOTES

ADVANCED PROGRAMMING 8

INTRODUCTION

This chapter explains some of the advanced programming capabilities of the M-Track. These capabilities include three additional Scaling Formats, two Auxiliary Follower functions, Batch Control and Limit and Alarm functions. The four major sections of this chapter are:

Alternative Scaling Formats
Auxiliary Follower Functions
Batch Control
Limits and Alarms

ALTERNATIVE SCALING FORMATS

Chapter 5 explains in detail Learn Mode Follower Scaling. The M-Track has four additional Scaling Formats: Fixed Follower Scaling, Flex Follower Scaling, Master Scaling and Direct Scaling.

FIXED FOLLOWER SCALING

Fixed Follower Scaling is an alternative method of providing the follower/lead scaling ratio to the M-Track. In Learn Mode Scaling, the ratio was calculated by the M-Track during the Learn Mode procedure. With Fixed Follower Scaling, the ratio must be manually calculated for the process and entered as the setpoint.

The first step in using Fixed Follower Scaling is to correctly calculate the Scale Factor for the given process. The Scale Factor is defined as the ratio of the Follower Job Space to the Lead Job Space. It is imperative that all gear ratio reductions, etc. get taken into account when determining the two job spaces. A job space is defined by the number of encoder lines that occur at the respective frequency input (either the External Reference Lead -- J3 pin 5, or the Feedback (Follower) -- J3 pin 9) during the time between two respective sync pulses (External Reference Sync J3 pin 10, or Feedback J3 pin 12).

$$\text{Scale Factor} = \frac{\text{Follower Job Space}}{\text{Lead Job Space}}$$

Where Job Space = number of encoder lines between sync pulses

To enter in the calculated Scale Factor, the Fixed Follower Scaling must first be enabled. To enable Fixed Follower Scaling, enter the value "1" into CP-18.

Note: When enabling Fixed Follower Scaling, all Learn Mode Scaling ratios will be erased and are not recoverable.

Once the Fixed Follower Scaling is enabled, the Scale Factors can be directly entered into CP-1, CP-2 and CP-3. The desired setpoint is activated from CP-1, CP-2 or CP-3 through the Ratio A and Ratio B discrete inputs. With both discrete inputs open, the scale factor entered into CP-1 will be activated. With only Ratio A closed, the CP-2 scale factor is activated. With only the Ratio B or both inputs closed, the CP-3 scale factor is activated.

Unlike Learn Mode, trending is not active with Fixed Follower Scaling. The M-Track will always attempt to use the entered Scale Factor in Fixed Follower Scaling. If the calculated Scale Factor is suspect, MV-85 can be used to monitor the True Scale Factor as determined by the M-Track.

FLEX FOLLOWER SCALING

The Flex Follower Scaling is the same as Fixed Follower Scaling with the exception of an added trending capability.

In Flex Follower Scaling, the original Scale Factor is calculated and entered as with Fixed Follower Scaling (see Page 8-1). However, unlike Fixed Follower Scaling, the active scale factor may be modified by the trending function. Every sixteen job spaces, the M-Track calculates an average scale factor from the Lead and Follower job space calculations. This number is then used as the Active Scale Factor (MV-86). This function is intended to compensate for small or gradual changes in job spaces such as for web stretch.

The Active Scale Factor is always limited to within a one-eighth variance of the entered setpoint scale factor in Flex Follower Scaling.

MASTER SCALING FORMAT

The Master Scaling Format is the simplest M-Track scaling format. The motor speed is controlled by only one variable: the Speed Setpoint. The motor speed is directly proportional to the Speed Setpoint.

In order to properly scale the Master Format, it is necessary to enter the appropriate values into two of the M-Track Control Parameters. First, the PPR (pulses per revolution) of the feedback or slave sensor (encoder) should be entered into CP-11. Second, the maximum RPMs of the feedback shaft containing the feedback sensor should be entered into CP-13.

After the scaling constants have been entered, the Master Format Setpoint in RPMs can be entered via CP-5. The actual feedback RPMs can be monitored at MV-40 or by simply pressing the "TACH" keypad.

This scaling format is called Master because an M-Track operating under Master Format is often used to control the speed of an entire process line, setting the pace for other M-Tracks following the Master at various controlled speed ratios.

DIRECT SCALING FORMAT

The Direct Scaling Format is intended for use in calibration and trouble-shooting procedures. It is not a normal mode of operation. In Direct Scaling, the analog output of the M-Track, connected to the motor drive, can be directly set to a specified level. It is an open-loop control mode that ignores all internal scaling information and all input signals except the Run and Stop logic.

To enable the Direct Scaling Format, enter a value of "1" into CP-19. The Direct Analog Command can then be entered into CP-7. The entry units are DAC bits with 4095 representing a 100% positive output level, 0 representing a 0 analog voltage level and -4095 representing a 100% negative output level.

AUXILIARY FOLLOWER FUNCTIONS

SYNC WINDOWS

The presence of extraneous or invalid sync pulses can cause gross misbehavior in M-Track applications. A feature called sync windows helps prevent stray sync pulses from creating system malfunctions. The Sync window filters out (ignores) all sync pulses that occur outside the specified Sync Window. Also, the M-Track recognizes only the first sync pulse that occurs within the window. All subsequent sync pulses in the window are ignored. If no sync pulse is received during the sync window, the M-Track creates a pulse at the zero degree point in order to maintain synchronization.

To enable the sync window, a value of "1" must first be entered into CP-37. The size of the Sync Flag Window is now entered into CP-33. The units for the Sync Flag Window are in degrees of job space with half of the entered value preceding the calculated sync location and half following the calculated sync location. Therefore, an entered value of 240 for CP-33 would create a Sync Window of 120 degrees prior and 120 degrees following the calculated sync location.

The M-Track automatically fully opens the Sync Flag Windows when it lacks valid position (sync) information such as during the Learn Mode procedure or after a Position Reset. After the sync information is established, the next calculated sync location is known and the windows close to the specified level.

PHASING

In certain process setups, it is difficult to physically align or mount the sync sensors at the desired locations. The M-Track has a feature called "Phasing" that allows the entry of a sync offset to accommodate these situations.

Phasing is activated by entering the desired offset into CP-31. The units for this parameter are encoder lines. The CP-31 value is a bipolar number. Negative numbers will adjust the phase to move the follower further ahead in relation to the lead. Positive CP-31 entries will move the follower behind in relation to the lead.

An alternative method of making the phase adjustment is through the use of the Phase Advance (J4 pin 12) and Phase Retard (J4 pin 14) discrete inputs. Shorting the Phase Advance input to common will add negative numbers to CP-31 and move the follower ahead in relation to the lead. The Phase Retard will add positive numbers to CP-31 and move the follower behind in relation to the lead.

The amount of adjustment made by the Phase Advance and Phase Retard inputs is determined by the CP-29 entry. The CP-29 value is added to CP-31 at the rate of 10 times per second.

BATCH CONTROL

The M-Track has a rudimentary Batch Control feature. An internal batch counter counts the Follower or Feedback Sync pulses (J3 pin 12) and activates an alarm output (J1 pin 14) when the specified Batch Count is reached. The Batch Count is entered into CP-27. The bach counter is initialized or reset to 0 by shorting the Batch Initiate discrete input (J4 pin 5) to common, or after a power up.

The actual batch count can be viewed by pressing the "Batch Count" function key or viewing MV-43. The number of counts remaining before reaching the Batch Limit can be viewed in MV-44.

ALARMS AND LIMITS

LED INDICATORS

Next to the M-Track programming keypad are five LEDs. When on, these LEDs indicate the following:

LED On	Indicates
RUN	M-Track is in the RUN state
SYNC ERROR	M-Track is out of sync
REF SYNC	M-Track Reference Sync signal is present
FDBK SYNC	M-Track Feedback Sync signal is present
ALARM	One of the M-Track alarm conditions is present (View MV-51 to identify alarm condition)

LIMITS

In Master Scaling Format only, it is possible to set both Minimum and Maximum velocity limits. In the RUN State, the M-Track will always attempt to maintain a speed at the setpoint between these limits.

To set the Minimum Limit, enter the desired minimum velocity into CP-20. To set the Maximum Limit, enter the desired maximum velocity into CP-21.

ALARMS

The M-Track has three alarms: Low, High and Position.

The Low and High Alarms are set through parameters CP-22 and CP-23 respectively. If either alarm condition is reached, the Alarm Output C (J1 pin 19) will be activated until the alarm condition is abated.

The Position Alarm is set through CP-24. If the M-Track is out of position (sync) as established by CP-24, then the Position Alarm output is activated (J1 pin 15).

NOTES

INTRODUCTION

This chapter contains information designed to assist in diagnosing and solving M-Track problems, and is divided into the following sections:

Diagnostics — Provides information for running the M-Track Diagnostic Routines.

Noise Recovery — Provides information to recover from EMI noise (indicated by -----1, ------2 or -----3 M-Track display.

Spare Parts List — Lists the available spare parts which can be ordered from the factory.

EPROM Replacement — Contains a procedure for replacing the EPROM.

Restore Settings — Provides a procedure which restores the M-Track to the default factory settings.

If the information in this chapter does not solve your problem with the M-Track, consult the factory.

The Contrex service number is (800) 342-4411.

DIAGNOSTICS

The M-Track contains a number of internal diagnostic routines designed to verify that the M-Track is running correctly, and to identify specific M-Track problems if they occur. The first set of diagnostic routines are initiated by a specific power-up procedure, while the second set of diagnostics involve entering M-Track input values, and verifying subsequent M-Track frequency calculations.

CLEAR/4 POWER UP TESTS

Initiate Test

1. Remove power from the M-Track.
2. While simultaneously pressing "CLEAR" and "4" on the Operator Keypad, apply power to the M-Track.
   Response: "HELP 1" is shown in the upper display.
3. Press the TACH (decrement) or STATUS (increment) keys to select which of the nine tests to initiate. Each of the nine tests can be performed without repeating steps 1 and 2 above.
4. Press CODE SELECT key to exit diagnostics.

1. RSEG TEST

1. Display "HELP 1" in the M-Track upper display.
2. Press ENTER to start test.
3. If RSEG fails, an "EE" is displayed in the lower display. Consult Factory.
4. If RSEG is good, a "PP" is displayed in the lower display.
5. Press CLEAR to eliminate the "PP" from the lower display.

2. DSEG TEST

1. Display "HELP 2" in the M-Track upper display.
2. Press ENTER to start test.
3. If DSEG fails, an "EE" is displayed in the lower display. Consult Factory.
4. If DSEG is good, a "PP" is displayed in the lower display.
5. Press CLEAR to eliminate the "PP" from the lower display.

3. CSEG TEST

1. Display "HELP 3" in the M-Track upper display.
2. Press ENTER to start test.
3. If CSEG fails, an "EE" is displayed in the lower display. Consult Factory.
4. If CSEG is good, a "PP" is displayed in the lower display.
5. Press CLEAR to eliminate the "PP" from the lower display.

4. NUMERIC LED TEST

1. Display "HELP 4" in the M-Track upper display.
2. Press ENTER to start test.
3. M-Track displays the following:

0.0.0.0.0.0.0.0.	0.0.0.0.0.0.0.0.
1.1.1.1.1.1.1.1.	1.1.1.1.1.1.1.1.
2.2.2.2.2.2.2.2.	2.2.2.2.2.2.2.2.
3.3.3.3.3.3.3.3.	3.3.3.3.3.3.3.3.
4.4.4.4.4.4.4.4.	4.4.4.4.4.4.4.4.
5.5.5.5.5.5.5.5.	5.5.5.5.5.5.5.5.
6.6.6.6.6.6.6.6.	6.6.6.6.6.6.6.6.
7.7.7.7.7.7.7.7.	7.7.7.7.7.7.7.7.
8.8.8.8.8.8.8.8.	8.8.8.8.8.8.8.8.
9.9.9.9.9.9.9.9.	9.9.9.9.9.9.9.9.
-.-.-.-.-.-.-.-.	A.A.A.A.A.A.A.A.
E.E.E.E.E.E.E.E.	b.b.b.b.b.b.b.b.
H.H.H.H.H.H.H.H.	C.C.C.C.C.C.C.C.
L.L.L.L.L.L.L.L.	d.d.d.d.d.d.d.d.
P.P.P.P.P.P.P.P.	E.E.E.E.E.E.E.E.
. . . . .	F.F.F.F.F.F.F.F.

"HELP 4" is displayed at the end of the test. (Incorrect display indicates failure).

5. ANNUNCIATOR LED TEST

1. Display "HELP 5" in the M-Track upper display.
2. Press ENTER to start test.
   The following LEDs are illuminated in order: Code Select, Status, Tach, Setpoint, Batch Count, Run, Sync Error, Ref Sync, Fdbk Sync, Alarm

6. KEYPAD TEST

1. Display "HELP 6" in the M-Track upper display.
2. Press ENTER to start test.
3. Press each Operator Keypad Key. The M-Track displays a number according to the key pressed:

Press	Display	Press	Display	Press	Display
-	-	4	4	SETSPEED	10
.	.	5	5	TACH	11
0	0	6	6	BATCH COUNT	12
1	1	7	7	STATUS	13
2	2	8	8	ENTER	14
3	3	9	9	CODE SELECT	15
				CLEAR	

4. Press CLEAR to exit test.

7. INPUT TEST

1. Display "HELP 7" in the M-Track upper display.
2. Press ENTER to start test.
3. Close input switches. The M-Track displays a number according to the input pressed.

Input Closure		Display	Input Closure		Display
REF SYNC	(J3-10)	10	RUN	(J4-6)	02
FDBK SYNC	(J3-12)	11	R-STOP	(J4-8)	03
RATIO A	(J3-13)	12	F-STOP	(J4-9)	04
RATIO B	(J3-15)	13	KEYLOCK	(J4-11)	05
FWD/REV	(J3-16)	14	PHASE ADV	(J4-12)	06
MAST/FOLL	(J4-2)	15	PHASE RET	(J4-14)	07
POS RESET	(J4-3)	16	ALIGN	(J4-15)	01
BATCH INIT	(J4-5)	17	JOG	(J4-17)	00

4. Press CLEAR to exit test.

8. DISCRETE OUTPUT TEST

1. Display "HELP 8" in the M-Track upper display.
2. Press ENTER to start test.
3. Press keys 1 - 7 to enable outputs. Pull-up resistors and meter or LED is required.

Key	Output	Key	Output
1	RUN CTL	5	OUTPUT A
2	BATCH CMPL	6	OUTPUT B
3	SYNC ALARM	7	OUTPUT C
4	INVERSION		

4. Press CLEAR to exit test.

9. SPEED COMMAND OUTPUT TEST

1. Display "HELP 9" in the M-Track upper display.
2. Press ENTER to start test.
3. Use an oscilloscope to view Speed Command Analog Output (J1 Pin 9).
4. Output is a ramp from +10 volts to -10 volts, then back to +10 volts.
5. Press CLEAR to exit test.

10. SERIAL INPUT TEST

Prerequisites: Jump J1 Pin 4 to J1 Pin 2, and Jump J1 Pin 5 to J1 Pin 3.

1. Display "HELP 10" in the M-Track upper display.
2. Press ENTER to start test.
3. Failures:
   M-Track displays 03 if 300 baud failure.
   M-Track displays 24 if 2400 baud failure.
   M-Track displays 96 if 9600 baud failure.
   M-Track displays EE at the end of test if any failures occurred.
4. Pass:
   M-Track displays PP if there were no failures.
5. Exit is automatic.

11. CODE # TEST

1. Display "HELP 11" in the M-Track upper display.
2. Press ENTER to start test.
3. M-Track displays date code of software.
4. Exit is automatic.

VERIFYING M-TRACK QUAD INPUTS

1. Quad Input Test

1. Connect Quad frequency into:
   a) External Reference Channel A and Channel B
   b) Feedback Channel A and Channel B
2. Verify input by checking the following M-Track Monitor Variables:
   a) MV-41 (External Reference Input)
   b) MV-42 (Feedback Input)

NOISE RECOVERY

The M-Track provides three display indications to assist the user in isolating sources of power line failure or EMI noise.

1. -----1 Displayed

   A dashed 1 display on the M-Track indicates that the AC power line voltage is below the specified level for the M-Track. The power line should be checked for AC voltage integrity. MV-59 is provided as a device to monitor line notching.

2. -----2 Displayed

   A dashed 2 display on the M-Track indicates that a CPU watchdog failure has occurred. This generally is a result of EMI or high frequency noise on the power or signal lines. Suggestions to prevent further failures include:

   - Ensure proper chassis and AC power grounding.
   - Shield signal wires with shield ground attached at one end only.
   - If AC line noise is suspected, place a power line filter on the AC line.
   - Ensure isolation of internal signal common (J3 pin 4) and chassis ground (J2 pin 1).

- Place ARC suppressors on relay and contactors in close proximity to the M-Track.
- Physically place (isolate) all signal wires from AC power wiring.

Because the dashed 2 status indicates the CPU has malfunctioned, it is important to restore all the M-Track memory locations to a known status. To recover from a dashed 2 status, use the CLEAR 7 Power-Up procedure explained in the Restore Settings section of this chapter.

3. -----3 Displayed

A dashed 3 display on the M-Track indicates that there is a checksum error in the Parameter Code area of memory.

Perform the same EMI prevention and recovery measures as suggested in the dashed 2 section.

SPARE PARTS LIST

Part Number	Description
6441-0200	Fuse
6340-0021	Shunt Jumper-2 Position (Power Board)
6340-0031	Shunt Jumper-6 Position (CPU Board)
6310-0223	3 Position Terminal Connector (Power Board)
6310-0224	16 Position Terminal Connector (CPU Board)
6310-0228	18 Position Terminal Connector (CPU Board)
6310-0225	20 Position Terminal Connector (Power Board)
Call Factory	PROM Number

EPROM LOCATION

It is possible that the EPROM may be replaced at the customer's location. Figure 9-1 below illustrates the location of this EPROM.

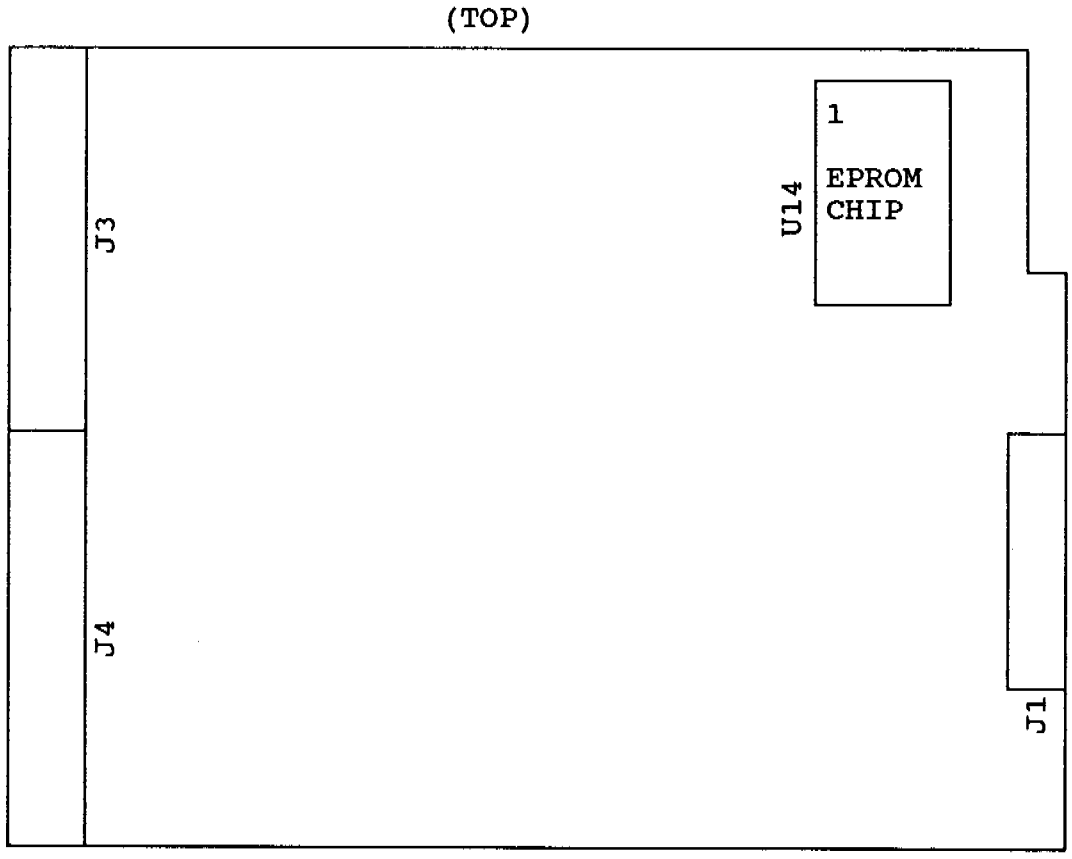


Figure 9-1: EPROM Location

RESTORE SETTINGS

CAUTION: This procedure restores the M-Track to the factory default settings. Any User-entered parameters or programming will be erased.

1. Remove power from the M-Track.

2. While pressing "Clear" and "7" on the Operator Keypad, apply power to the M-Track.
   Response: The M-Track restores the factory default settings, and then performs the Power Up routine.

NOTES

APPENDIX A - FEEDBACK SENSORS A

INTRODUCTION

For the M-Track to accurately control a motor, the M-Track must receive a feedback signal reflecting the actual motor speed. This appendix contains information concerning two methods to provide this signal: Quadrature Ring Kit and Quadrature Encoders.

QUADRATURE RING KIT

A quadrature ring kit (Fenner 7300-1310) is used to provide a hall effect sensor which detects the actual speed of the motor being controlled. This ring kit is typically comprised of 2 parts: A machined aluminum ring with a specific number of gear teeth and a specific bore diameter, and a hall effect sensor which mounts in the ring.

NEMA C-FACE RING MOUNT

Best performance is achieved with a quadrature hall effect sensor mounted in a C-face ring. Shielded cable connections to the sensor are made by soldering and taping inside the conduit adapter box as shown below.

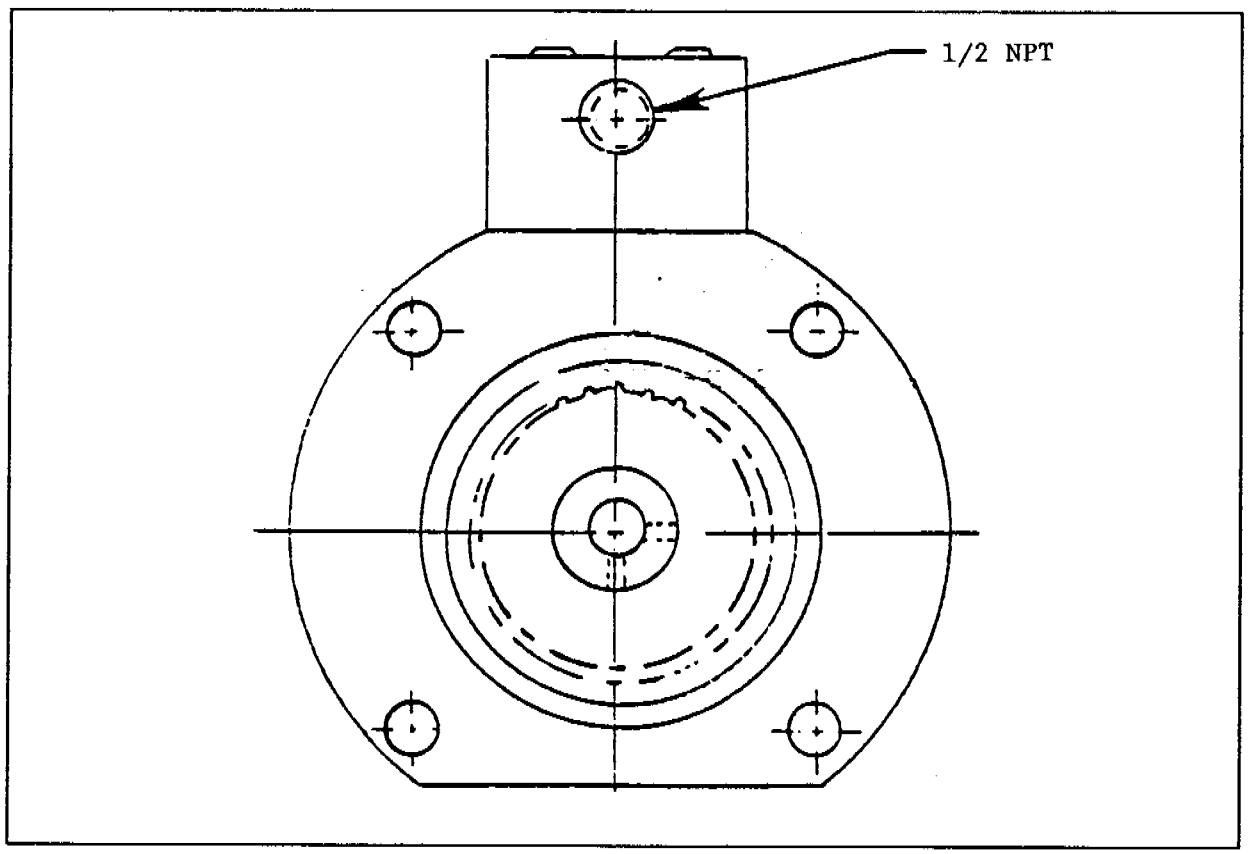


Figure A-1: Hall Effect Ring Kit

QUADRATURE ENCODERS

When the application requires a high resolution of feedback or external reference, it may be necessary to use a quadrature encoder.

Figures A-2 and A-3 provide details on the Fenner 3200-1341 quadrature encoder kit.

SPECIFICATIONS

ELECTRICAL

Code: Incremental
Cycles per Shaft Turn: 600

Output:
3904: current sinking up to 40 mA

Output Format: 2 channels (A&B) in quadrature $\pm 27^{\circ}$ electrical typical

Supply Voltage:
3904: 5Vdc

Current Requirements:
3904: 80 mA typical
Illumination: light emitting diode (LED)
Frequency Response: 100 kHz

MECHANICAL

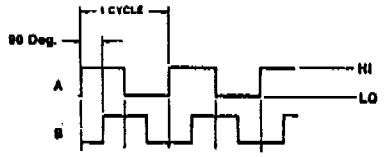
Shaft Diameter: 3/8"
Hollow shaft

Shaft Loading: 80 lbs. axial and 80 lbs. radial
Shaft Runout: .001 T.I.R. maximum
Shaft Torque: 1.0 in-oz maximum at 25 $^{\circ}$ C without shaft seal
Bearings: 52100 bearing steel
Shaft: 303 Stainless steel
Housing and Cover: die cast aluminum with chemical film finish (iridite)
Bearing Life: 1.5×10^{9} revs. at 80 lbs. radial load
Moment of Inertia: 2.0×10^{-4} oz-in-sec^{2}
Maximum RPM: 10,000
(also see frequency response)
Weight: 9 oz. typical

ENVIRONEMENTAL

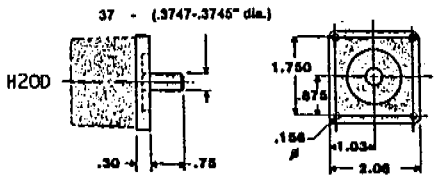
Temperature: Operating: 0 to 70 degrees C standard, extended temperature testing available to -40 $^{\circ}$ C (requires oil lube bearing quadrature +36 $^{\circ}$ C at -40 $^{\circ}$ C).
Storage: -25 to 90 $^{\circ}$ C
Shock: 50 G's for 11 msec duration
Vibration: 5 to 2000 Hz @ 20 G's
Humidity: 99% RH without condensation

FIGURE 1 - OUTPUT WAVEFORMS



DIMENSIONS

HOUSING TYPE



COVER AND TERMINATION

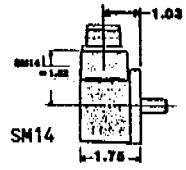
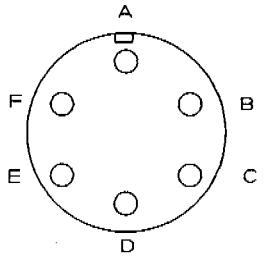


Figure A-2: 3200-1341 Quadrature Encoder: Specifications and Dimensions

CONNECTIONS

OUTPUT TERMINATION



A...POWER SUPPLY COMMON

B...5 VOLT POWER SUPPLY

C...NOT USED

D...CHANNEL B SIGNAL

E...CHANNEL A SIGNAL

F...NOT USED

EX: M-TRACK FEEDBACK

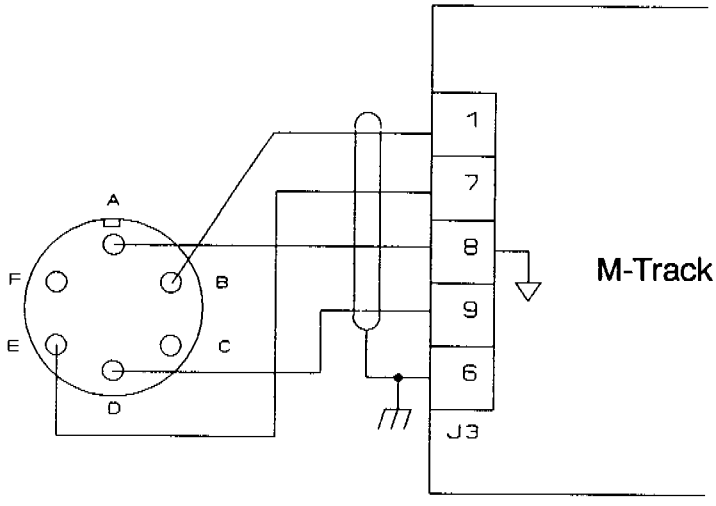


Figure A-3: 3200-1341 Quadrature Encoder Connections

NOTES

APPENDIX B - FORMULAS B

To Be Supplied.

NOTES

APPENDIX C: CODE LIST (COMPLETE TEXT) C

INTRODUCTION

This appendix provides in numeric order a complete list of all control and monitor code select variables present in the M-Track. The Code Select Procedure is also provided.

CODE SELECT PROCEDURE

The Code Select Procedure indicates how the operator gains access to the various control and monitor parameters through their unique identification codes. Opening the lower door on the front of the M-Track keypad exposes the programming keypad.

Accessing the desired parameter is a simple procedure:

1) Press the "Code Select" Key.
2) Enter the desired parameter code number.
3) Press the "Enter" Key.

At this point, the two digit code is displayed in the lower display window and the existing parameter value is displayed in the upper six digit display window. In addition, the keypad is enabled for changing the desired parameter. To make a change, simply enter the new value and press the "Enter" Key.

CP-1: SETPOINT 1

Setpoint 1 is invoked when the Ratio A and Ratio B discrete inputs are both open circuits. Setpoint 1 can be preloaded with any of the eight product codes or recipes, or used to generate a new recipe (ratio) through "Learn Mode" operation.

CP-2: SETPOINT 2

Setpoint 2 is invoked when the Ratio A input is shorted and the Ratio B input is open circuited. Setpoint 2 can be preloaded with any of the eight product codes or recipes, or used to generate a new recipe (ratio) through "Learn Mode" operation.

CP-3: SETPOINT 3

Setpoint 3 is invoked when the Ratio A input is open and the Ratio B input is shorted. Setpoint 3 can be preloaded with any of the eight product codes or recipes, or used to generate a new recipe (ratio) through "Learn Mode" operation.

CP-5: MASTER SETPOINT

CP-5 is used to load the setpoint when in the Master Scaling Format. The units for the Master Setpoint are RPMs.

CP-6: JOG SETPOINT

CP-6 is used to load the setpoint for JOG operation. The units for the JOG setpoint are RPMs.

CP-7: DIRECT ANALOG COMMAND

CP-7 is used to directly command the isolated analog output of the M-Track. Note that CP-19 must be set to "1" to activate the Direct Analog Command Mode. The units for the Direct Analog Command are in DAC bits, with +4095 representing a full positive output, 0 representing 0 volts, and -4095 representing a full negative output.

CP-8: ACCELERATION TIME

CP-8 is used to enter the Acceleration Ramp Time. The entered value is the equivalent time (in seconds) that the M-Track takes to go from 0 to 2000 RPMs. Acceleration Ramps are only active during Jog and Master Scaling (not in Follower Scaling Mode).

CP-9: DECELERATION TIME

CP-9 is used to enter the Deceleration Ramp Time. The entered value is the equivalent time (in seconds) that the M-Track takes to go from 2000 to 0 RPMs. Deceleration is operable in Master Scaling Format only.

CP-11: PPR FOLLOWER (FEEDBACK)

CP-11 is used to load the PPR (pulses per revolution) of the encoder or sensor on the follower (feedback) shaft. New values for CP-11 can only be entered in the R-Stop or F-Stop states.

CP-13: MAXIMUM RPM FOLLOWER (FEEDBACK)

CP-13 is used to enter the maximum RPMs of the feedback encoder shaft. New values for CP-13 can only be entered in the R-Stop or F-Stop states.

CP-15: OVER SPEED ALLOWANCE

The Over Speed Allowance puts an RPM limit on the amount of overspeed the Follower is allowed to exceed the Lead in order to recover position error when out of sync and in the Gross Error control algorithm.

CP-18: FOLLOWER SETPOINT DEFINITION

CP-18 defines how Setpoints 1, 2 and 3 (CP-1, CP-2 and CP-3) operate when in the Follower Mode of operation. If CP-18 is set to a "2", then Learn Mode Scaling will be invoked whereby Setpoints 1 through 3 are loaded with recipe or product codes (8). If CP-18 is set to "1", then Fixed Scaling will be invoked. In Fixed Scaling, Setpoints 1 through 3 are loaded with the ratio of the Feedback Frequency/External Reference Frequency Inputs. If CP-18 is set to "3", then Flex Scaling will be invoked (see Page 8-2).

New values of CP-18 can only be entered in the R-Stop or F-Stop states.

CP-19: DIRECT MODE ENABLE

Entering a value of 1 into CP-19 enables the Direct Scaling Mode. New values for CP-19 can only be entered in the R-Stop or F-Stop states.

CP-20: MINIMUM SPEED

CP-20 determines the minimum speed, in RPMs, that the M-Track will not fall below during RUN State for the Master Mode of operation.

CP-21: MAXIMUM SPEED.

CP-21 determines the maximum speed, in RPMs, that the M-Track will not exceed during RUN State for the Master Mode of operation.

CP-22: LOW SPEED ALARM

CP-22 is used to enter the Low Speed Alarm level in RPMs. If the Feedback RPMs are below the Low Speed Alarm level or above the High Speed Alarm level (CP-23), then the Discrete Out C will be activated.

CP-23: HIGH SPEED ALARM

CP-23 is used to enter the High Speed Alarm level in RPMs. If the Feedback RPMs are above the High Speed Alarm level or below the Low Speed Alarm level (CP-21), then the Discrete Out C will be activated.

CP-24: OUT OF POSITION

CP-24 defines the position error band, in encoder lines, beyond which the M-Track is considered Out of Position (Out of Sync).

CP-25: LAG PULSE LIMIT

CP-25 is used to put a limit on the error value (memory limit) that the M-Track uses when lagging in position (feedback behind lead). The entered value units are encoder lines.

CP-26: LEAD PULSE LIMIT

CP-26 is used to put a limit on the error value (memory limit) that the M-Track uses when leading in position (feedback ahead of lead). The entered value units are encoder lines.

CP-27: BATCH LIMITS

CP-27 sets the limit number that will activate the Batch discrete output when the batch count is reached.

CP-29: PHASE INCREMENT

The value in CP-29 determines the rate of phase change that occurs when the Phase Advance or Phase Retard discrete inputs are activated. When Phase Advance is activated, the value in CP-29 is added to the Phase value (CP-31) every 100 milliseconds. When Phase Retard is activated, the value in CP-29 is subtracted from the CP-31 value every 100 milliseconds.

CP-30: SYNC LOGIC

CP-30 determines the corrective action the M-Track takes when it is out of sync. There are three possible corrective actions:

1) The M-Track can correct to the closest lead pulse either ahead or behind.
2) The M-Track can speed up the follower motor to align with the lead sync pulse which is ahead of the follower pulse.
3) The M-Track can slow down the follower motor to align with the lagging lead sync pulse.

New values for CP-30 can only be entered in the R-Stop or F-Stop states.

CP-31: PHASE

CP-31 can be used to enter an offset, in encoder lines, to the follower sync position. This permits greater flexibility in the mechanical placement of the sync detector sensors. The Phase Advance and Phase Retard momentary discrete inputs can be used to remotely adjust the CP-31 value.

CP-32: GROSS ERROR BOUNDARY

CP-32 sets the error boundary between the PID control algorithm and the Gross Error control algorithm. Units are in encoder lines.

CP-33: SYNC FLAG WINDOW

The Sync Flag Window is used to filter out unwanted External Reference and Feedback Sync signals. Only the first sync pulses in the specified window are used to determine the sync position. The window is defined in degrees, with 360 degrees representing a fully open window, and 0 degrees representing a closed window.

CP-34: SYNC ENABLE

CP-34 can be used to operate the M-Track in a speed ratio mode that ignores the sync pulse position inputs. To disable the Sync mode, change the value of CP-34 from "1" to "0". (The value in CP-34 can only be changed in the R-Stop or F-Stop states.)

CP-35: SPEED/TORQUE SELECT

In most applications the M-Track will be wired to the speed (velocity) input of the connected drive with CP-35 set to 1. It is possible to suppress the feedforward component of the compensation algorithm and wire the M-Track directly to the Torque loop of the drive by setting CP-35 to 2. (The value in CP-35 can only be changed in the R-Stop or F-Stop states.)

CP-36: OUTPUT FORMAT

CP-36 determines if the isolated analog output operates in a unipolar or bipolar format. In unipolar format, the analog output operates between 0 volts and the voltage reference level from the drive. In bipolar format, the output operates from the positive to negative voltage reference level from the drive. Unipolar format is typically used for single direction operation only.

For unipolar operation, set CP-36 to 1; for bipolar operation, set CP-36 to 2. (The value in CP-36 can only be changed in the R-Stop or F-Stop states.)

CP-37: SYNC FLAG WINDOW ENABLE

Setting CP-37 to a value of "1" enables the Sync Flag Window. The value in CP-37 can only be changed in the R-Stop or F-Stop states.

CP-38: SYNC FLAG POLARITY

CP-38 determines the polarity trigger direction for the External Reference and Feedback sync pulses. Both sync inputs can be programmed to trigger on signals going from a low to high voltage level (positive going) or from a high to low voltage level (negative going).

Use this table to select the value of CP-38 for the appropriate sync pulse polarity:

CP-38	External Reference Sync	Feedback Sync
1	Positive Going	Positive Going
2	Negative Going	Negative Going
3	Negative Going	Positive Going
4	Positive Going	Negative Going

(Positive Going = Rising Edge; Negative Going = Falling Edge)

MV-40: TACH

Tach is the feedback displayed in RPMs. The feedback input is read by the M-Track every 500 microseconds. The readings are summed and averaged for one second before displaying.

MV-41: EXTERNAL REFERENCE FREQUENCY INPUT (LEAD)

MV-41 displays the External Reference Frequency input in hertz (pulses per second).

MV-42: FEEDBACK FREQUENCY INPUT (FOLLOWER)

MV-42 displays the Feedback Frequency input in hertz (pulses per second).

MV-43: BATCH COMPLETE

MV-43 displays the number of complete batch counts.

MV-44: BATCH REMAINING

MV-44 displays the number of batch counts remaining until the batch threshold is reached.

MV-47: DAC OUTPUT

The DAC Output represents the level of the isolated analog output to the motor drive. The DAC Output is represented in DAC bits with 4095 indicating a full (100%) positive output, and -4095 indicating a full negative output.

MV-48: TRIM OUTPUT

The Trim Output is the calculated output of the compensation/ control algorithm. It is equivalent to the total output minus the feedforward. The Trim Output is represented in DAC bits where 4095 equals 100% output, 2048 equals 50% output, etc.

MV-49: POSITION ERROR

The Position Error displays the scaled position difference between the ideal slave position and the actual slave position. The units for the Position Error are slave encoder lines. The Position Error dynamically varies during the entire job space as the speed ratio, and subsequent relative positions, of the external reference and feedback sync inputs vary.

MV-50: KEYPAD ERRORS

MV-50 is used to display errors when attempting to enter new values. The display is decoded as follows:

```
    0 - No errors
    1 - Invalid Parameter Code
   10 - Value above Max allowable value
  100 - Value below Min allowable value
 1000 - Keypad lockout enabled
10000 - Entry Timeout or lockout during Run state
```

MV-51: ALARM STATUS

MV-51 is used to display the current status of the alarms in the M-Track. It is decoded as follows:

```
     1 - Low Alarm
    10 - High Alarm
   100 - Out of Position
  1000 - Overdue Follower Sync
 10000 - Overdue Lead Sync
100000 - Out of Sync
```

MV-52: STATE

State is used to display the active state of the M-Track. It is decoded as follows:

```
    1 - Jog
   10 - Align
  100 - Run
 1000 - R-Stop
10000 - F-Stop
```

MV-53: DISCRETE IN - GROUP A

Discrete In A is used to display the value of the following discrete inputs. A "1" indicates an open (high) input. A "0" indicates a shorted (low) input.

```
X X X X X X
| | | | | |
| | | | | Jog
| | | | Align
| | | Run
| | R-Stop
| F-Stop
Keypad Lockout
```

MV-54: DISCRETE IN - GROUP B

Discrete In B is used to display the value of the following discrete inputs. A "1" indicates an open (high) input. A "0" indicates a shorted (low) input.

```
X X X X X X
| | |  | | |
| | |  | | Phase Advance
| | |  | Phase Retard
| | |  External Reference Sync
| | Feedback Sync
| Ratio A
Ratio B
```

MV-55: DISCRETE IN - GROUP C

Discrete In C is used to display the value of the following discrete inputs. A "1" indicates an open (high) input. A "0" indicates a shorted (low) input.

```
X X X X
| | | |
| | | Forward/Reverse
| | Master/Follower
| Position Reset
Batch Initialize
```

MV-56: DISCRETE OUT - GROUP A

Discrete Out A is used to display the condition of the following outputs. A "0" indicates an active output (energized or low).

```
X X X X X X
| | |  | | |
| | |  | | Run Control
| | |  | Batch Complete
| | |  Sync Alarm
| | Inverted Output
| Output "A" - Ext. Ref. Sync Missing
Output "B" - Feedback Sync Missing
```

MV-57: DISCRETE OUT - GROUP B

A "0" in MV-57 indicates that the Output C High/Low alarm output is active (low).

MV-58: ACTIVE SCALING FORMAT

MV-58 indicates the Scaling Format currently active:

1 - Direct Scaling
10 - Master Scaling
100 - Not Used
1000 - Follower Scaling

MV-59: POWER NOTCH COUNTER

MV-59 is a counter display that increments and displays a count every time the AC power line falls below the specified operating level. It can be used to check the integrity of the AC power line. Notches on the line caused by inductive loads (motors, contractors, relays, etc.) will increment the counter if the AC line is too low or not stiff enough. The clear key resets the count to zero.

CP-61: GROSS ERROR RESET

CP-61 is the reset term for the Gross Error control algorithm. Larger numbers will mean a faster rate of recovery when large errors are present and the Gross Error recovery routine is active.

CP-65: GAIN (PROPORTIONAL)

Larger numbers increase the contribution of the Proportional component (of the PID). An entry of "0" eliminates the Gain contribution.

CP-66: RESET (INTEGRAL)

Larger numbers increase the contribution of the Integral component (of the PID). An entry of "0" eliminates the Reset contribution.

CP-67: RATE (DERIVATIVE)

Larger numbers increase the contribution of the Derivative component (of the PID). An entry of "0" eliminates the Rate contribution.

CP-70: DEVICE ADDRESSES

The M-Track's physical address may be set from 1 to 32. This is used to separately identify the individual M-Track units on a multidropped RS422 line. Address references of 0 are globally accepted by all M-Track Units.

CP-71: BAUD RATE

There are six different baud or data rates for the M-Track:

1 = 300 Baud
2 = 600 Baud
3 = 1200 Baud
4 = 2400 Baud
5 = 4800 Baud
6 = 9600 Baud

CP-72: CHARACTER FORMAT

The M-Track accepts 3 different character formats:

1 = 8 Data Bits, No Parity, One Stop Bit
2 = 7 Data Bits, Even Parity, One Stop Bit
3 = 8 Data Bits, No Parity, Two Stop Bits

CP-73: CONTROL MASK

When the computer control is switch selected, it is possible to allow the computer to control some of the functions associated with the discrete switch inputs. For additional information, see Chapter 7.

CP-74: COMMUNICATION ERRORS

CP-74 can be accessed to display any receive errors to the M-Track. See Chapter 7 for details.

MV-80: LEAD JOB SPACE

MV-80 indicates the size of the average Lead Job Space as determined by the External Reference Frequency and Sync inputs. Units are in encoder lines.

A display value of "LP -- 80" indicates that the M-Track has not yet determined the Lead Job Space value or this variable has no meaning in the selected operating mode.

MV-81: FOLLOWER JOB SPACE

MV-81 indicates the size of the average Follower Job Space as determined by the Feedback Frequency and Sync inputs. Units are in encoder lines.

A display value of "LP -- 81" indicates that the M-Track has not yet determined the Follower Job Space value or this variable has no meaning in the selected operating mode.

MV-82: LEAD JOB SPACE VARIANCE

MV-82 indicates the maximum variance in the Lead Job Space in encoder lines. The calculation time period is coincident with the 16 sync pulse period used to establish the trending scale value.

A display value of "LP -- 82" indicates that the M-Track has not yet determined the Lead Job Space variance or this variable has no meaning in the selected operating mode.

MV-83: FOLLOWER JOB SPACE VARIANCE

MV-83 indicates the maximum variance in the Follower Job Space in encoder lines. The calculation time period is coincident with the 16 sync pulse period used to establish the trending scale value.

A display value of "LP -- 83" indicates that the M-Track has not yet determined the Follower Job Space variance or this variable has no meaning in the selected operating mode.

MV-84: SYNC FLAG DIFFERENCE

MV-84 indicates the difference, in follower encoder lines, between the position of the External Reference and Feedback Sync pulses.

A display value of "LP -- 84" indicates that the M-Track has not yet determined the Sync Flag Difference value or this variable has no meaning in the selected operating mode.

MV-85: TRUE SCALE FACTOR

MV-85 displays the calculated ratio between the Feedback Frequency Input and the External Reference Frequency Input used to maintain alignment between the two sync inputs.

A display value of "LP -- 85" indicates that the M-Track has not yet determined the True Scale Factor value or this variable has no meaning in the selected operating mode.

MV-86: ACTIVE SCALE FACTOR

MV-86 displays the Active Scale Factor presently being utilized by the M-Track. In Fixed Mode Scaling, the Active Scale Factor will indicate the entered setpoint value and may not be the same as MV-85, True Scale Factor

A display value of "LP -- 86" indicates that the M-Track has not yet determined the Active Scale Factor value or this variable has no meaning in the selected operating mode.

MV-99: CODE REVISION

MV-99 displays the installed software code revision in the M-Track.

NOTES

APPENDIX D - USER'S ACTUAL CODE RECORD D

CODE-TYPE	DESCRIPTION	MIN	MAX	USER SETTING	UNITS
01F-CP	SETPOINT1 - FIXED	.2000	6.0000	_____	RATIO
01L-CP	SETPOINT1 - LEARN	1	8	_____	CODED
02F-CP	SETPOINT2 - FIXED	.2000	6.0000	_____	RATIO
02L-CP	SETPOINT2 - LEARN	1	8	_____	CODED
03F-CP	SETPOINT3 - FIXED	.2000	6.0000	_____	RATIO
03L-CP	SETPOINT3 - LEARN	1	8	_____	CODED
05 -CP	MASTER SETPOINT	-3600	3600	_____	RPM
06 -CP	JOG SETPOINT	0	3600	_____	RPM
07 -CP	DIRECT COMMAND	-4095	4095	_____	DAC BITS
08 -CP	ACCELERATION TIME	0.1	600.0	_____	SECONDS
09 -CP	DECELERATION TIME	0.1	600.0	_____	SECONDS
11 -CP	PPR - FOLLOWER	30	6000	_____	PPR
13 -CP	RPM - FOLLOWER	100	3600	_____	RPM
15 -CP	OVERSPEED LIMIT	1	100	_____	% OF CP13
18 -CP	FOLLOWER FORMAT	1	3	_____	CODED
19 -CP	DIRECT MODE ENABLE	0	1	_____	CODED
20 -CP	MINIMUM SPEED	0	3600	_____	RPM
21 -CP	MAXIMUM SPEED	0	3600	_____	RPM
22 -CP	LOW SPEED ALARM	0	3600	_____	RPM
23 -CP	HIGH SPEED ALARM	0	3600	_____	RPM
24 -CP	POSITION ALARM	10	999999	_____	LINES
25 -CP	LAG PULSE LIMIT	10	999999	_____	LINES
26 -CP	LEAD PULSE LIMIT	10	999999	_____	LINES
27 -CP	BATCH LIMIT	0	9999	_____	COUNTS
29 -CP	PHASE INCREMENT	1	999999	_____	LINES
30 -CP	SYNC LOGIC	1	3	_____	CODED
31 -CP	PHASE	-99999	99999	_____	LINES
32 -CP	GROSS ERROR BOUNDARY	10	999999	_____	LINES
33 -CP	SYNC FLAG WINDOW	5	360	_____	DEGREES
34 -CP	SYNC ENABLE	0	1	_____	CODED
35 -CP	SPEED/TORQUE SELECT	1	2	_____	CODED
36 -CP	OUTPUT FORMAT	1	2	_____	CODED
37 -CP	SYNC FLAG WINDOW ENAB.	0	1	_____	CODED
38 -CP	SYNC FLAG POLARITY	1	4	_____	CODED
61 -CP	GROSS ERROR RESET	1	60000	_____	N/A
65 -CP	GAIN	0	30000	_____	N/A
66 -CP	RESET	0	30000	_____	N/A
67 -CP	RATE	0	30000	_____	N/A
70 -CP	DEVICE ADDRESS	1	32	_____	N/A
71 -CP	BAUD RATE	1	6	_____	CODED
72 -CP	CHARACTER FORMAT	1	3	_____	CODED
73 -CP	CONTROL MASK	0	7	_____	CODED

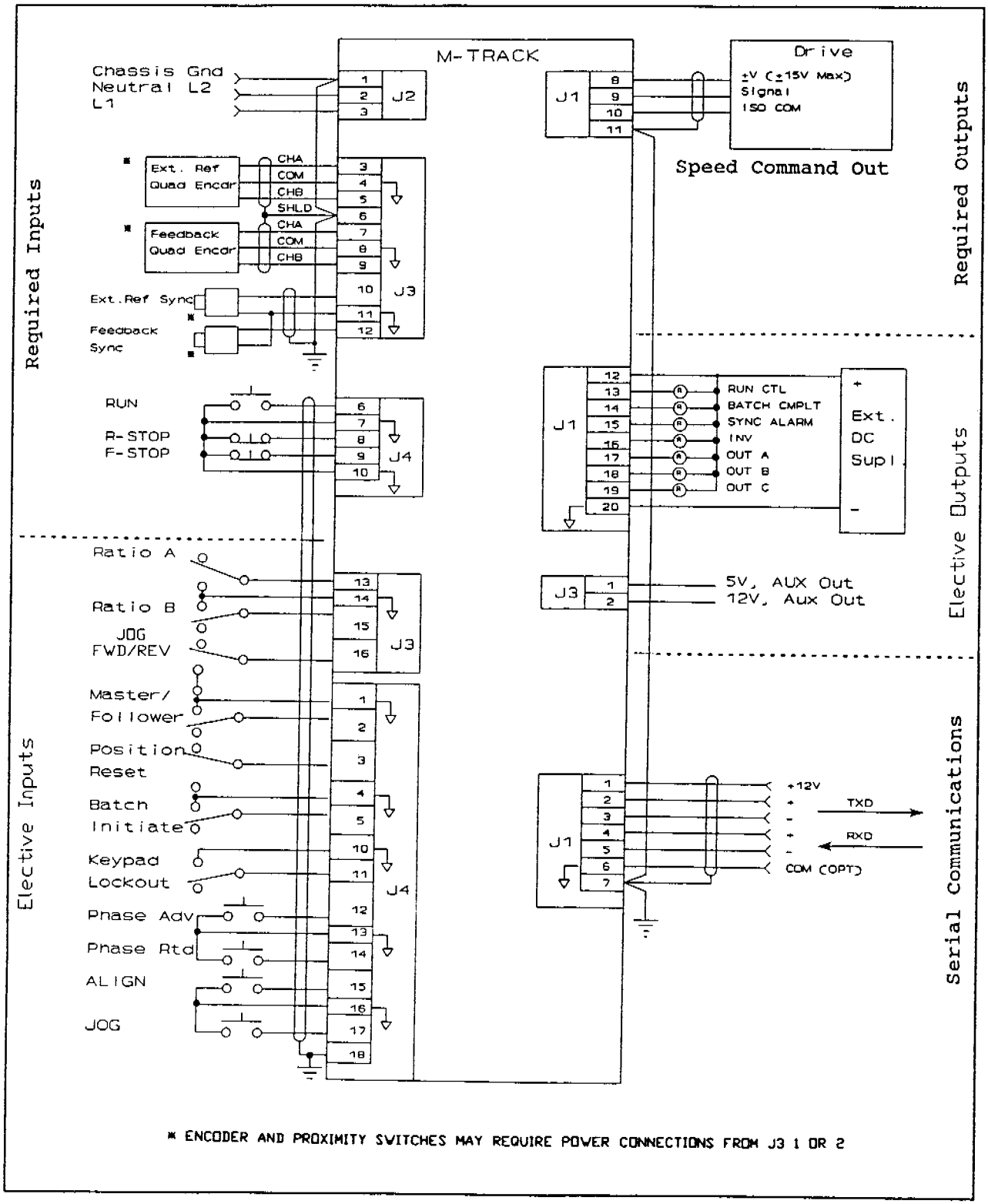
NOTES

APPENDIX E: CODE LIST QUICK REFERENCE E

CODE-TYPE	DESCRIPTION	MIN	MAX	DEFAULT	UNITS
01F-CP	SETPOINT1 - FIXED	.2000	6.0000	1.0000	RATIO
01L-CP	SETPOINT1 - LEARN	1	8	1	CODED
02F-CP	SETPOINT2 - FIXED	.2000	6.0000	1.0000	RATIO
02L-CP	SETPOINT2 - LEARN	1	8	2	CODED
03F-CP	SETPOINT3 - FIXED	.2000	6.0000	1.0000	RATIO
03L-CP	SETPOINT3 - LEARN	1	8	3	CODED
05 -CP	MASTER SETPOINT	-3600	3600	0	RPM
06 -CP	JOG SETPOINT	0	3600	50	RPM
07 -CP	DIRECT COMMAND	-4095	4095	0	DAC BITS
08 -CP	ACCELERATION TIME	0.1	600.0	5.0	SECONDS
09 -CP	DECELERATION TIME	0.1	600.0	5.0	SECONDS
11 -CP	PPR - FOLLOWER	30	6000	60	PPR
13 -CP	RPM - FOLLOWER	100	3600	2000	RPM
15 -CP	OVERSPEED LIMIT	1	100	10	% OF CP13
18 -CP	FOLLOWER FORMAT	1	3	2	CODED
19 -CP	DIRECT MODE ENABLE	0	1	0	CODED
20 -CP	MINIMUM SPEED	0	3600	0	RPM
21 -CP	MAXIMUM SPEED	0	3600	3600	RPM
22 -CP	LOW SPEED ALARM	0	3600	0.	RPM
23 -CP	HIGH SPEED ALARM	0	3600	2000	RPM
24 -CP	POSITION ALARM	10	999999	1000	LINES
25 -CP	LAG PULSE LIMIT	10	999999	2000	LINES
26 -CP	LEAD PULSE LIMIT	10	999999	2000	LINES
27 -CP	BATCH LIMIT	0	9999	0	COUNTS
29 -CP	PHASE INCREMENT	1	999999	1	LINES
30 -CP	SYNC LOGIC	1	3	1	CODED
31 -CP	PHASE	-99999	99999	0	LINES
32 -CP	GROSS ERROR BOUNDARY	10	999999	999999	LINES
33 -CP	SYNC FLAG WINDOW	5	360	360	DEGREES
34 -CP	SYNC ENABLE	0	1	1	CODED
35 -CP	SPEED/TORQUE SELECT	1	2	1	CODED
36 -CP	OUTPUT FORMAT	1	2	1	CODED
37 -CP	SYNC FLAG WINDOW ENABLE	0	1	0	CODED
38 -CP	SYNC FLAG POLARITY	1	4	1	CODED
40 -MV	TACH	-3600	3600	—	RPM
41 -MV	EXTERNAL REFERENCE	-99999	120000	—	HZ
42 -MV	FEEDBACK	-99999	120000	—	HZ
43 -MV	BATCH COMPLETE	0	9999	—	COUNTS
44 -MV	BATCH REMAINING	0	9999	—	COUNTS
47 -MV	DAC OUTPUT	-4095	4095	—	DAC BITS
48 -MV	TRIM OUTPUT	-4095	4095	—	DAC BITS
49 -MV	POSITION ERROR	-14400000	14400000	—	LINES
50 -MV	KEYPAD ERRORS	0	11111	—	CODED
51 -MV	ALARM STATUS	0	111111	—	CODED
52 -MV	CONTROL STATE	1	10000	—	CODED
53 -MV	DISCRETE IN A	0	111111	—	CODED
54 -MV	DISCRETE IN B	0	111111	—	CODED
55 -MV	DISCRETE IN C	0	1111	—	CODED
56 -MV	DISCRETE OUT A	0	111111	—	CODED
57 -MV	DISCRETE OUT B	0	1	—	CODED
58 -MV	ACTIVE SCALING	1	1000	—	CODED
59 -MV	LINE NOTCH COUNTER	0	999999	—	COUNTS
61 -CP	GROSS ERROR RESET	1	60000	10000	N/A
65 -CP	GAIN	0	30000	3000	N/A
66 -CP	RESET	0	30000	5000	N/A
67 -CP	RATE	0	30000	0	N/A
70 -CP	DEVICE ADDRESS	1	32	1	N/A
71 -CP	BAUD RATE	1	6	6	CODED
72 -CP	CHARACTER FORMAT	1	3	2	CODED
73 -CP	CONTROL MASK	0	7	0	CODED
74 -MV	COMM. ERRORS	10	10000	—	CODED
80 -MV	LEAD JOB SPACE	0	14400000	—	LINES
81 -MV	FOLLOWER JOB SPACE	0	14400000	—	LINES
82 -MV	LEAD JOB SPACE VAR.	0	14400000	—	LINES
83 -MV	FOLLOWER JOB SPACE VAR.	0	14400000	—	LINES
84 -MV	SYNC FLAG DIFFERENCE	-14400000	14400000	—	LINES
85 -MV	TRUE SCALE FACTOR	0.2000	6.000	—	LINES
86 -MV	ACTIVE SCALE FACTOR	0.2000	6.000	—	LINES
99 -MV	SOFTWARE CODE REV	–	–	—	—

NOTES

APPENDIX F - M-TRACK PIN OUT F



NOTES

APPENDIX G - TYPICAL WIRING DIAGRAMS G

WARNING

This diagram is intended for conceptual purposes only. The user is responsible for providing all necessary safety equipment and corresponding wiring connections necessary to prevent bodily injury in all modes of operation.

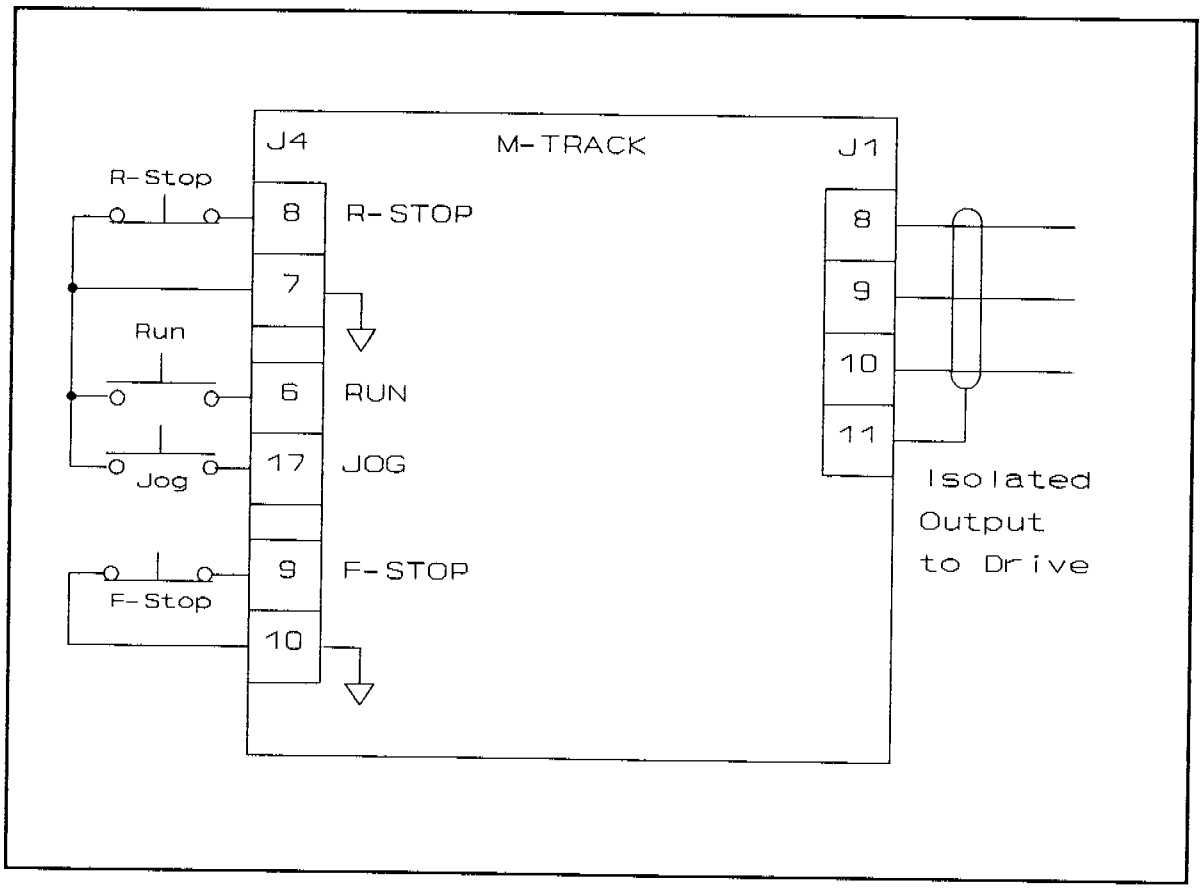


Figure G-1: M-Track Wiring Connections without Relays

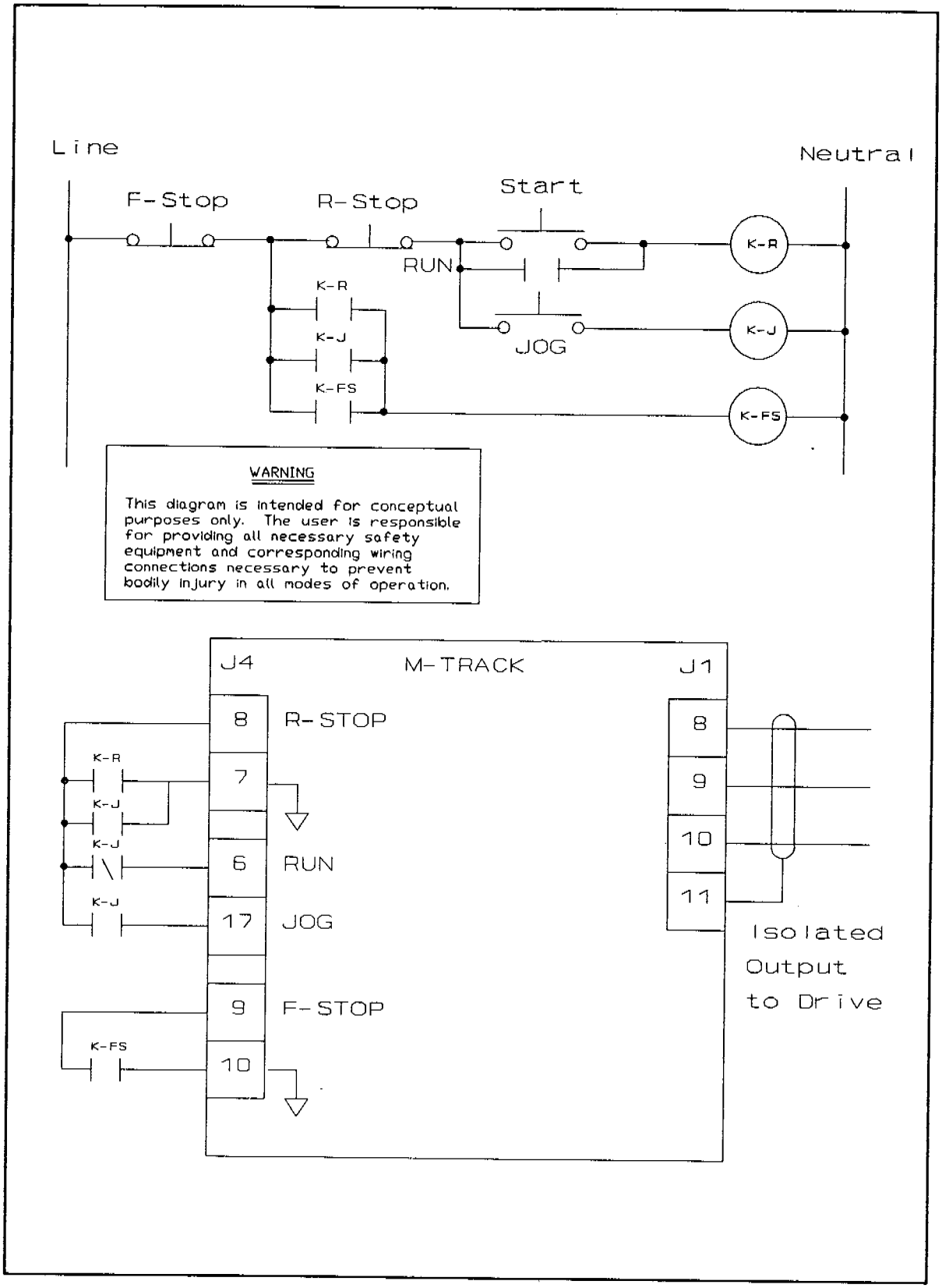


Figure G-2: Relay Start and Stop Wiring Connections

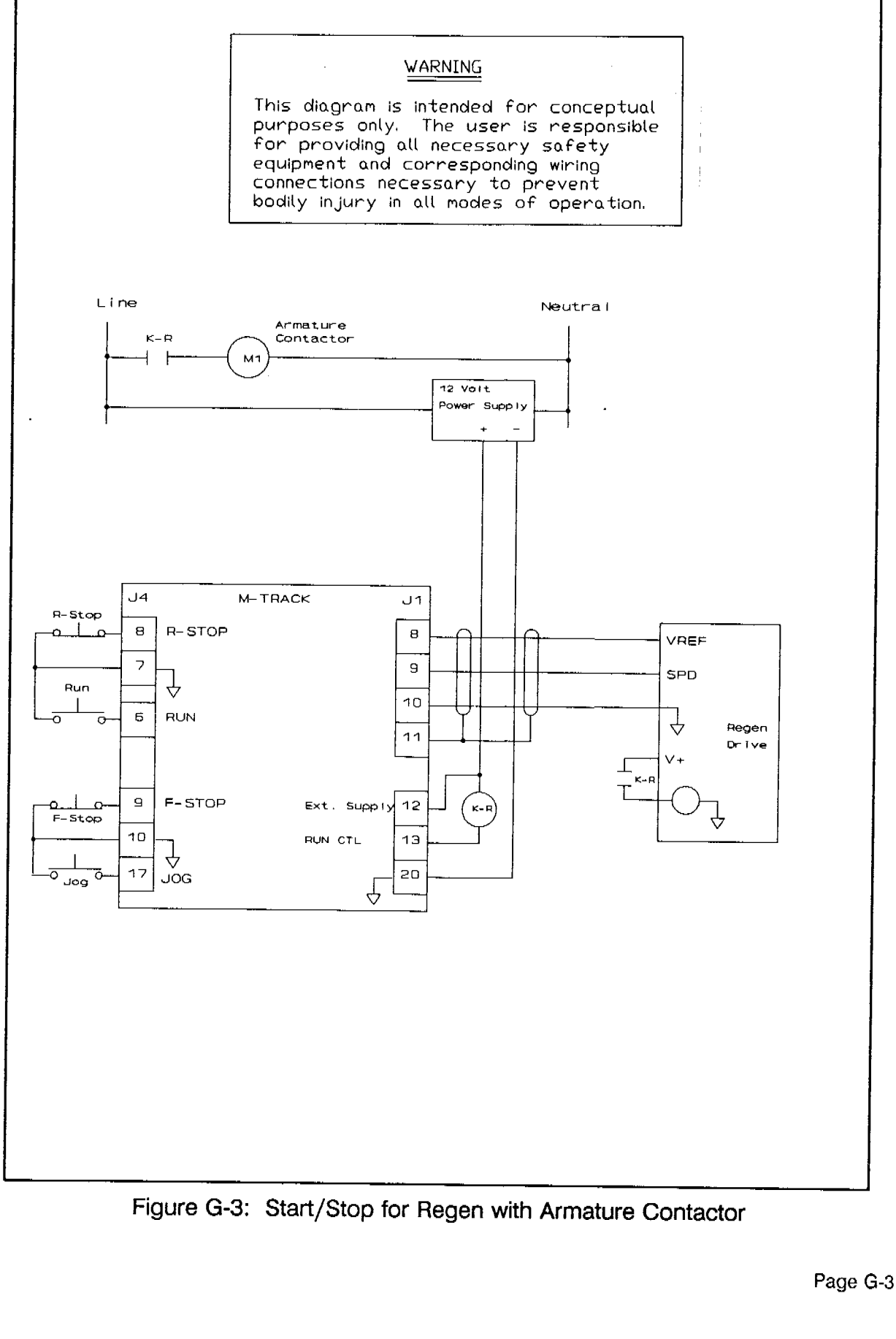


Figure G-3: Start/Stop for Regen with Armature Contactor

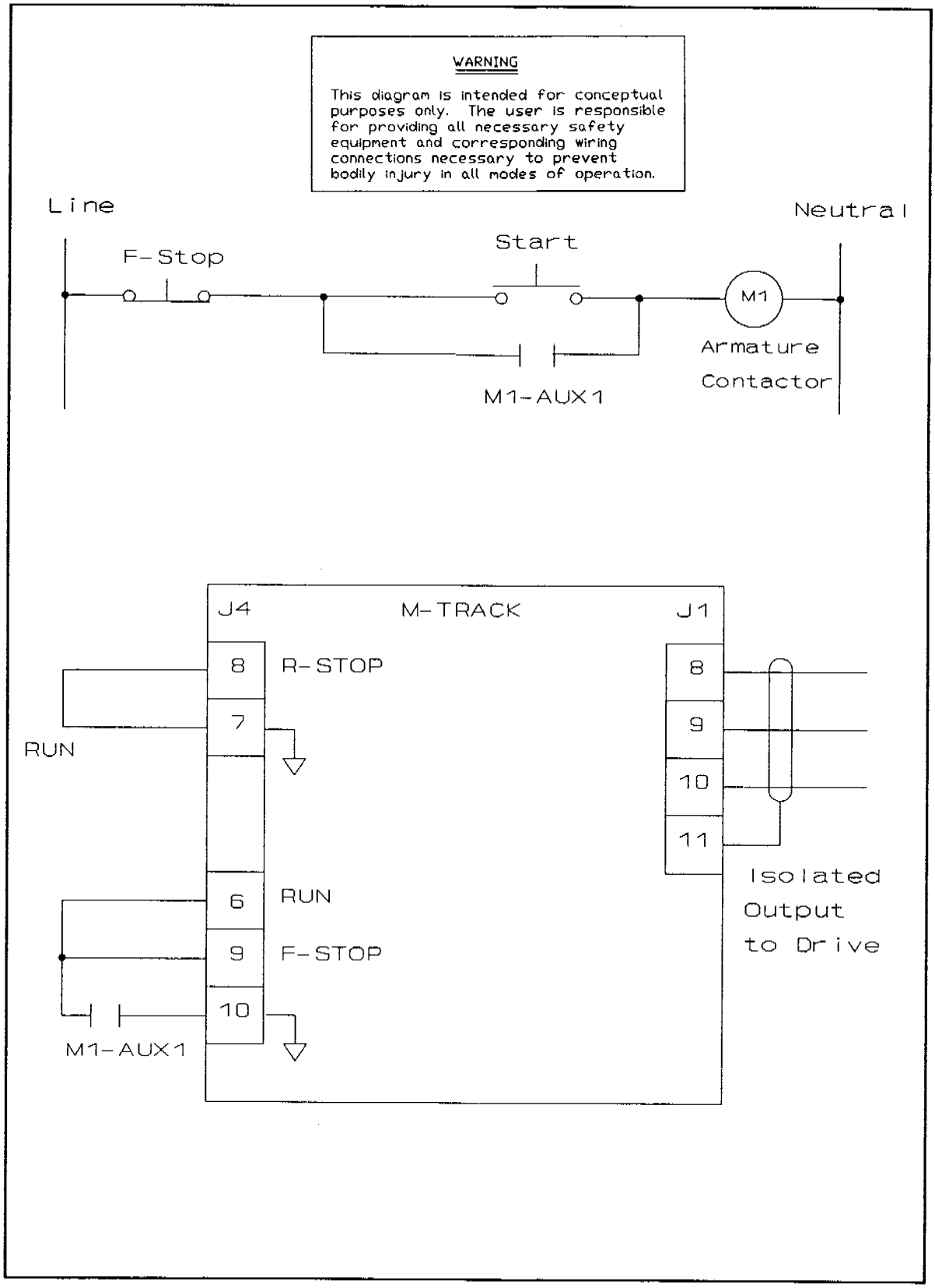


Figure G-4: Start/Stop for Non-Regen with Armature Contactor

APPENDIX H - PROGRAMMER'S AIDE H

INTRODUCTION

This appendix identifies which CP- Programming Codes are required for specific scaling formats. When applicable, if a specific value is required for a Programming Code, that value is indicated via an "=" sign.

CONTROL CODES

ITEM	PRIMARY
Direct Format	
	CP-19 = 1
Direct Analog Command	CP-7
Master Format	
	CP-19 = 0
PPR Feedback	CP-11
RPM Feedback Max	CP-13
Master Setpoint	CP-5
Follower Format	
	CP-19 = 0
PPR Feedback	CP-11
RPM Feedback Max	CP-13
Follower Setpoints	CP-1, CP-2, CP-3

NOTES

APPENDIX I

USA Standard Code for Information Interchange

1. Scope

This coded character set is to be used for the general interchange of information among information processing systems, communication systems, and associated equipment.

2. Standard Code

b7 b6 b5 / Bits				COLUMN / ROW	0 0 0	0 0 1	0 1 0	0 1 1	1 0 0	1 0 1	1 1 0	1 1 1
b4	b3	b2	b1		0	1	2	3	4	5	6	7
0	0	0	0	0	NUL	DLE	SP	0	@	P	`	p
0	0	0	1	1	SOH	DC1	!	1	A	Q	a	q
0	0	1	0	2	STX	DC2	"	2	B	R	b	r
0	0	1	1	3	ETX	DC3	#	3	C	S	c	s
0	1	0	0	4	EOT	DC4	$	4	D	T	d	t
0	1	0	1	5	ENQ	NAK	%	5	E	U	e	u
0	1	1	0	6	ACK	SYN	&	6	F	V	f	v
0	1	1	1	7	BEL	ETB	'	7	G	W	g	w
1	0	0	0	8	BS	CAN	(	8	H	X	h	x
1	0	0	1	9	HT	EM	)	9	I	Y	i	y
1	0	1	0	10	LF	SUB	*	:	J	Z	j	z
1	0	1	1	11	VT	ESC	+	;	K	[	k	{
1	1	0	0	12	FF	FS	,	<	L	\	l	|
1	1	0	1	13	CR	GS	-	=	M	]	m	}
1	1	1	0	14	SO	RS	.	>	N	^	n	~
1	1	1	1	15	SI	US	/	?	O	_	o	DEL

NOTES

APPENDIX J - GLOSSARY J

Caution: A method to denote a procedure or task which may result in equipment damage if performed incorrectly. Compare with Note and Warning.

Closed/Open Loop: A digital input which determines whether or not the M-Track adjusts the speed command to bring the difference between the actual feedback and the ideal feedback to zero (Closed Loop) or ignores the feedback (open loop).

Direct Format: A motor control format where all scaling and feedback conditions are ignored, which thereby allows the operator to directly control the M-Track output. Typically used for System trouble-shooting.

External Reference: A frequency input that acts as the lead signal when the M-Track is in Follower Format.

F-STOP: (Fast Stop) One of four M-Track states. In the F-Stop state, the M-Track ignores the specified DECEL rate and immediately brings the speed command to zero. Compare with RUN, JOG and R-STOP.

Feedback Input: A pulse train input used by the M-Track to ascertain motor speed.

Format: Any of several algorithms used to calculate the Scaled Reference.

Follower Format: The most commonly used speed control algorithm. The slave motor speed is adjusted to bring and maintain the External Reference and Feedback Sync inputs in alignment.

Forward/$\overline{\text{Reverse}}$: A digital input which when shorted to common reverses the polarity of the Speed Command Analog Output signal.

High Alarm: An output used to indicate when the motor speed equals or exceeds the High Alarm level.

JOG: One of five M-Track states. In the JOG state, the M-Track rotates the subject motor at the RPM entered for the JOG setpoint. Compare to RUN, R-STOP and F-STOP.

Keypad Lockout: A digital input used to disable portions of the front keypad.

Low Alarm: An output used to indicate when the motor speed is at or below the Low Alarm level.

Master Format: The simplest generally used speed control algorithm. The speed is determined by and is directly proportional to only one variable: The Setpoint.

Positive/Inverted: An output indicating the polarity of the Speed Command output relative to the Voltage Reference Input.

Note: A method to denote additional attention to a procedure or task. Compare with Caution and Warning.

R-STOP: (Ramp Stop) One of five M-Track states. In the R-Stop state, the M-Track decreases the speed command to zero using the specified DECEL rate. Compare to RUN, JOG and F-STOP.

RUN: One of five M-Track states. In the RUN state, the M-Track rotates the subject motor at the RPM called for as determined by the setpoints and the operative scaling format. Compare to JOG, R-STOP and F-STOP.

Run Control: A digital output which indicates whether or not the motor should be moving.

Speed Command Output: An Analog Output signal sent to the subject drive which then controls the speed of the motor.

Warning: A method to denote a procedure or task which may result in bodily injury or death if performed incorrectly. Compare with Note and Caution.

service policy

Contrex, Inc., recognizes that with each sale of its product there are certain product obligations. This document defines the limits of such obligations and provides guidelines for the performance of related services.

Applicability

This Service Policy shall apply to all product sales of Contrex, Inc. However, it may be modified by mutual consent. Thus, whenever an accepted proposal contains wording inconsistent with this policy, the proposal will prevail with respect to specific sale or series of sales involved. Applicability of this policy is also somewhat limited in cases where products are sold to an OEM for resale to user. See paragraph below entitled *OEM Service.*

Service Personnel

Contrex, Inc., has a staff whose primary responsibility is service - both factory service and field (on-site) service. Personnel of this department are usually available for service on a 24 hour notice. To facilitate quicker handling of service requests, either written or by phone, such requests should be directed to the Contrex, Inc., Technical Services Department.

Service Charges

Contrex, Inc., reserves the right to charge for all services performed at the customers request with the exception of factory service performed under warranty. All on-site service is charged at flat-rate per diem rates plus expenses. Any Contrex, Inc., product developing defects as defined in the warranty during its effective period will be repaired or replaced without charge, providing it is shipped, prepaid, to Contrex, Inc., 8900 Zachary Lane North, Maple Grove, Minnesota 55369.

Spare Parts

Contrex, Inc., will usually have an adequate inventory of spare parts and circuit boards for all standard products. However, purchasers are encouraged to maintain a nominal supply of spare parts to insure immediate on-site accessibility.

Instruction Manuals

Instructions for installation, maintenance and troubleshooting are included in manuals that are provided with the equipment. Repairs may be performed in the field by competent customer personnel; but in order to not invalidate the warranty they must be made in strict accordance with published instructions, and ONLY AFTER obtaining approval of the Technical Service Department (such repairs are usually limited to the replacement of circuit boards and major subassemblies, not the repair of these items).

OEM Service

In many instances Contrex, Inc., products are sold to the original equipment manufactures or integrators for inclusion in larger systems. In such cases the obligations of Contrex, Inc., extend only to that original purchaser. It is the latter's responsibility to handle any service required by his customer, the end user. Such problems can usually be solved by field replacement of complete units. OEM's are encouraged to buy and maintain a supply of "loaners" for this purpose. Contrex, Inc., will provide factory overhaul service at nominal charges to support that OEM. Users of Contrex, Inc., products that were acquired as components of larger systems may buy service or spare parts directly from Contrex, Inc., at standard prices, but they must appeal through the OEM for warranty service.

If Contrex, Inc., encounters trouble in the field which appears to be the result of fault or inadequacy of the system, Contrex, Inc., reserves the right to recover service charges from the party that authorized the service activity.

CONTREX
Contrex, Inc.
8900 Zachary Lane North, Maple Grove, MN 55369 USA
Phone (763) 424-7800 Fax (763) 424-8734

warranty

Contrex, Inc., guarantees this device against defects in workmanship and materials for a period of one (1) year from the date of purchase. Any parts or components that fail during the warranty period will be replaced or repaired without charge. This guarantee is void if the device has been damaged by improper installation or operation, tampering, careless handling or accident.

When a device fails to function in accordance with standards set forth in the instruction manual, the purchaser should contact an authorized representative of Contrex, Inc., 8900 Zachary Lane North, Maple Grove, Minnesota 55369. Whether repairs will take place in the field or at the factory will be solely the prerogative of Contrex, Inc.

If inspection reveals defects that are caused by faulty materials or workmanship, Contrex, Inc., reserves the right to either replace the device or rebuild the device using new or refurbished warranted parts and components. In either instance, the device that is returned to the purchaser meets full factory standards for new device performance. If there is less than 90 days remaining on the warranty period at the time of the repair, the warranty will extend to 90 days after the repair.

Parts and services outside the scope of this warranty will be available at Contrex, Inc., current market price.

Contrex's liability for a device or it's use, whether in warranty or not, shall not in any instance exceed the cost of correcting the defects of the device. Contrex, Inc., assumes no responsibility for damage to property or injuries to persons from improper use of this device.

No express warranties and no implied warranties whether of merchantability or otherwise (except as to title), other than those set forth above , which are expressly made in lieu of all other warranties, shall apply to any devise sold by Contrex, Inc.

Contrex, Inc., reserves the right to change or improve its devices without imposing any obligation upon Contrex, Inc., to make changes or improvements in previously manufactured devices.

This warranty statement is a summary of Contrex, Inc's policy. Further limits of liability are contained in the Contrex, Inc's purchase order acknowledgments and invoices.

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