M-ROTARY OVERVIEW 1

INTRODUCTION

The M-Rotary is a digital motion control device used in continuous rotary cut-to-length or impression print industrial applications. Typical M-Rotary installations include web process cutting, perforating, sealing and sheeting of materials such as paper, plastic wrap, paper towels and plastic sheeting. The M-Rotary always controls the follower device in a lead-follower process. Configuration capabilities of the M-Rotary include controlling either the Rotary or Web speed of an industrial process, and operating in either Non-Sync or Sync modes. Some of the advanced capabilities of the M-Rotary include 8 follower setpoints, trending, high sync rate and control bandwidth, lead and follower sync divide, engineering unit setpointing and synchronized profiling.

Although the M-Rotary 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 providing access to scaling functions. Dedicated keys are provided for SET SPEED, TACH, BATCH COUNT, and STATUS information. Also, the M-Rotary contains an RS-422 communications port, thereby allowing communications between the M-Rotary and a host computer.

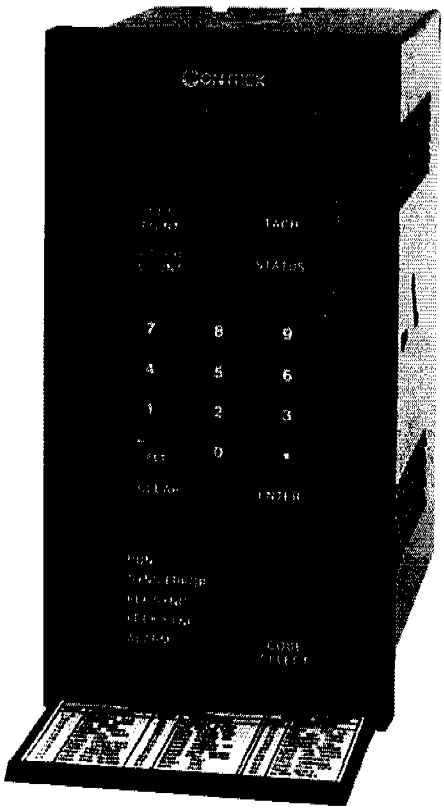


Figure 1-1: M-Rotary

M-ROTARY PRIMARY MODES

The M-Rotary has 4 primary modes:
- o Non-Sync Rotary Follower
- o Non-Sync Web Follower
- o Sync Rotary Follower
- o Sync Web Follower

NON-SYNC ROTARY FOLLOWER

The Non-Sync Rotary Follower mode is typically used in applications where blank material is cut to a specific length by controlling the rotary die speed. In this mode, the web is the lead, and the rotary die is the follower. The M-Rotary is in Non-Sync Rotary Follower whenever CP-14 is set to "1."

Figure 1-2 illustrates a Non-Sync Rotary Follower application.

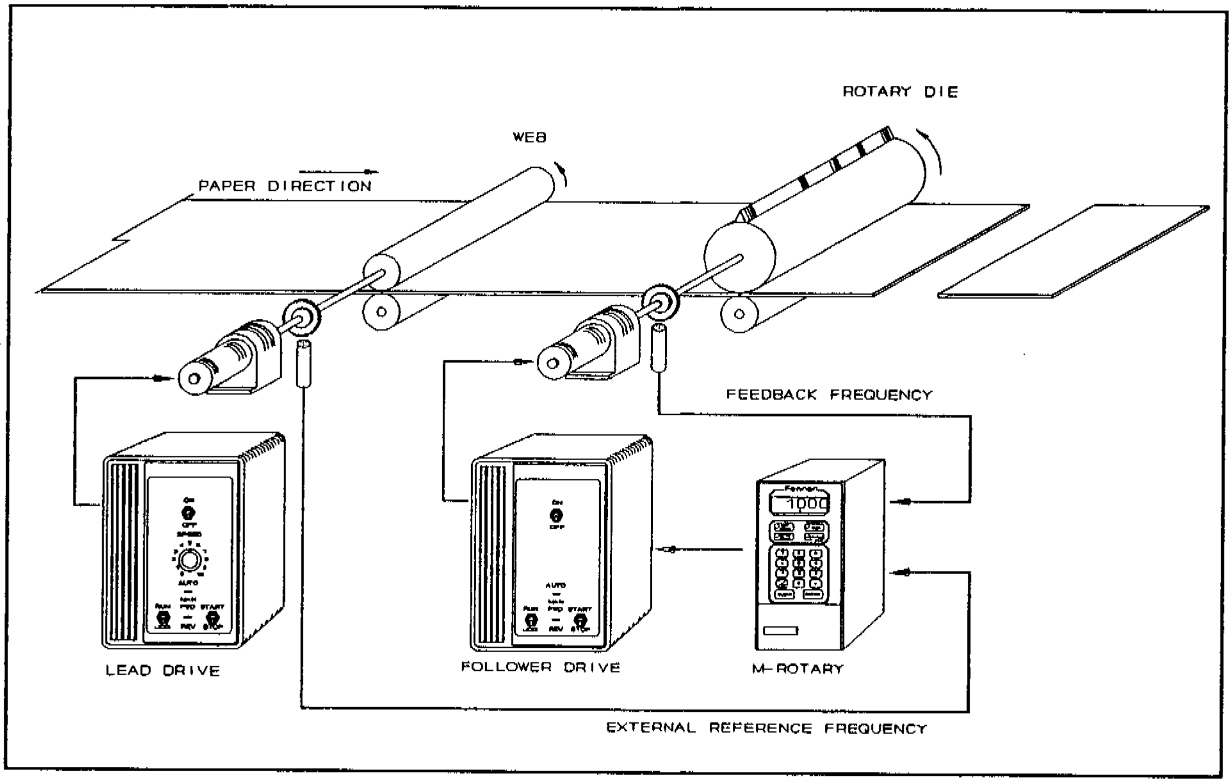


Figure 1-2: Non-Sync Rotary Follower Example

NON-SYNC WEB FOLLOWER

The Non-Sync Web Follower mode is typically used in applications where blank material is cut to a specific length by controlling the web speed. In this mode, the rotary die is the lead, and the web is the follower. The M-Rotary is in Non-Sync Web Follower whenever CP-14 is set to "2."

Figure 1-3 illustrates a Non-Sync Web Follower application.

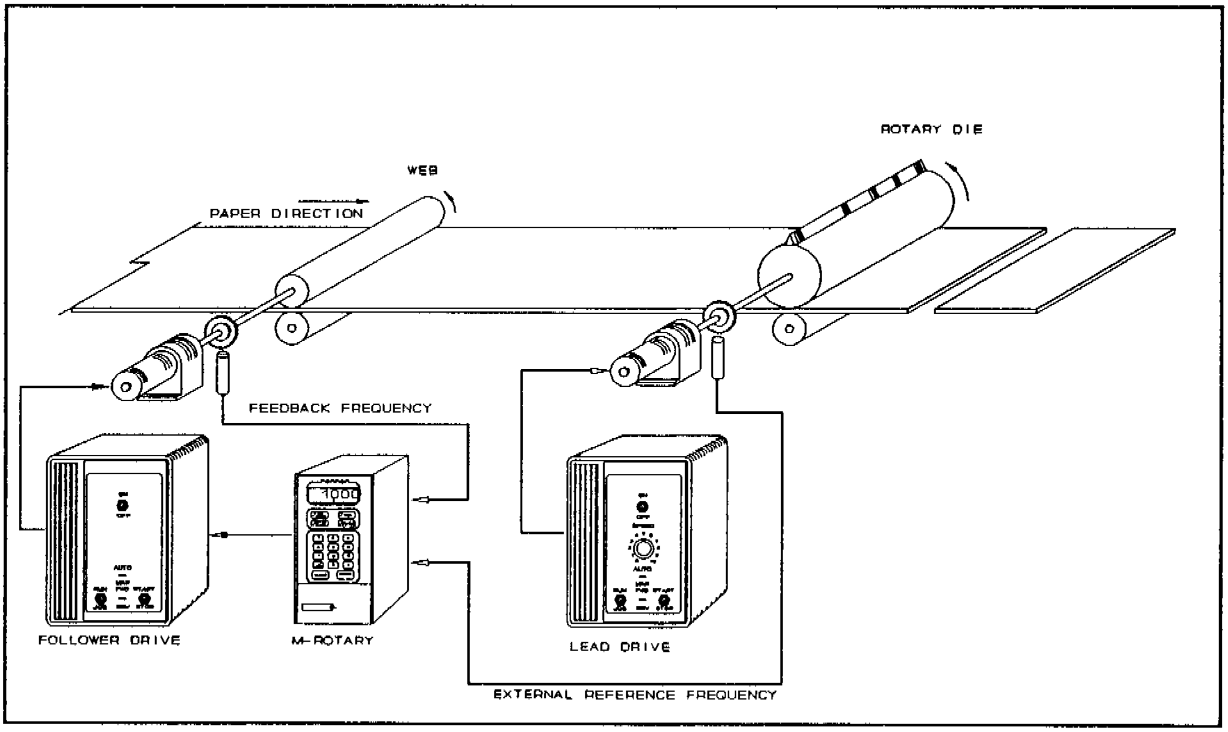


Figure 1-3: Non-Sync Web Follower Example

SYNC ROTARY FOLLOWER

The Sync Rotary Follower mode is typically used in applications where printed material is cut at a specific location by controlling the die speed. This mode operates by synchronizing the rotary die blade with the registration mark on the web. In this mode, the web is the lead, and the rotary die is the follower. The M-Rotary is in Sync Rotary Follower mode whenever CP-14 is set to "3."

Figure 1-4 illustrates a Sync Rotary Follower application.

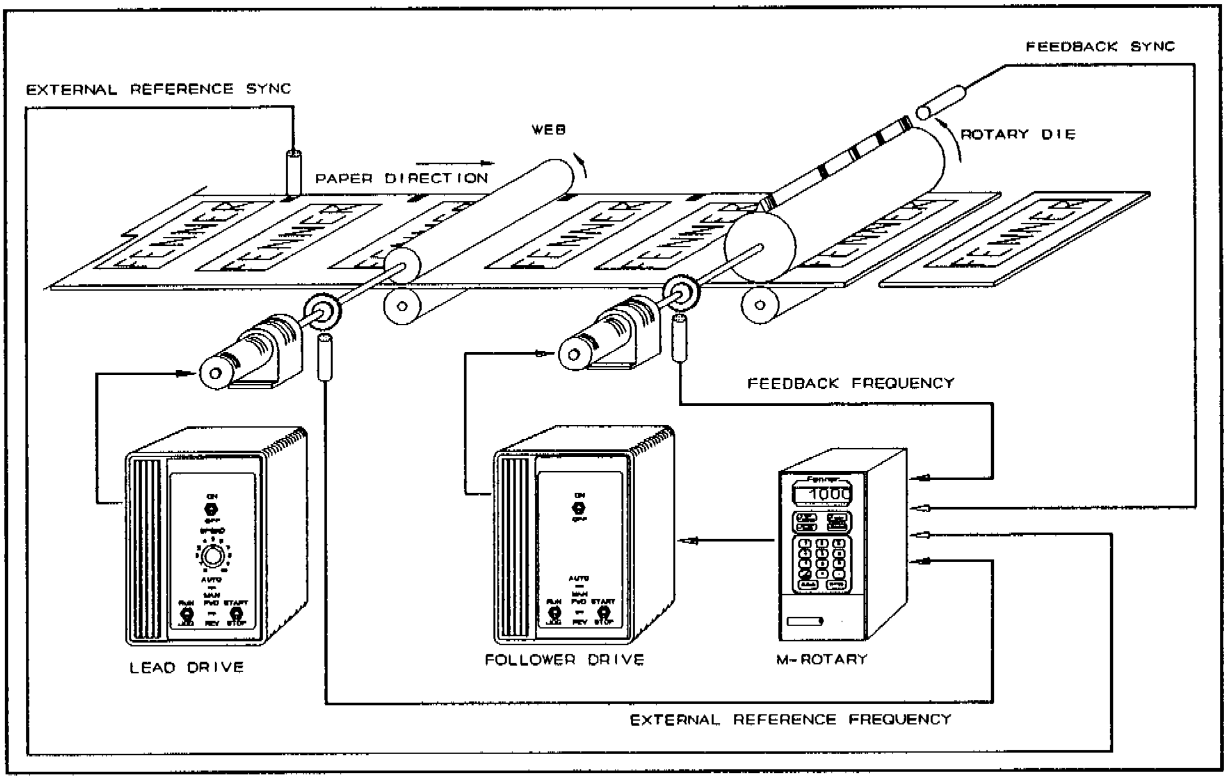


Figure 1-4: Sync Rotary Follower Example

SYNC WEB FOLLOWER

The Sync Web Follower mode is typically used in applications where printed material is cut at a specific length by controlling the web speed. This mode operates by synchronizing the registration mark on the web to the rotary die blade. In this mode, the rotary die is the lead, and the web is the follower. The M-Rotary is in Sync Web Follower mode whenever CP-14 is set to "4."

Figure 1-5 illustrates a Sync Web Follower application.

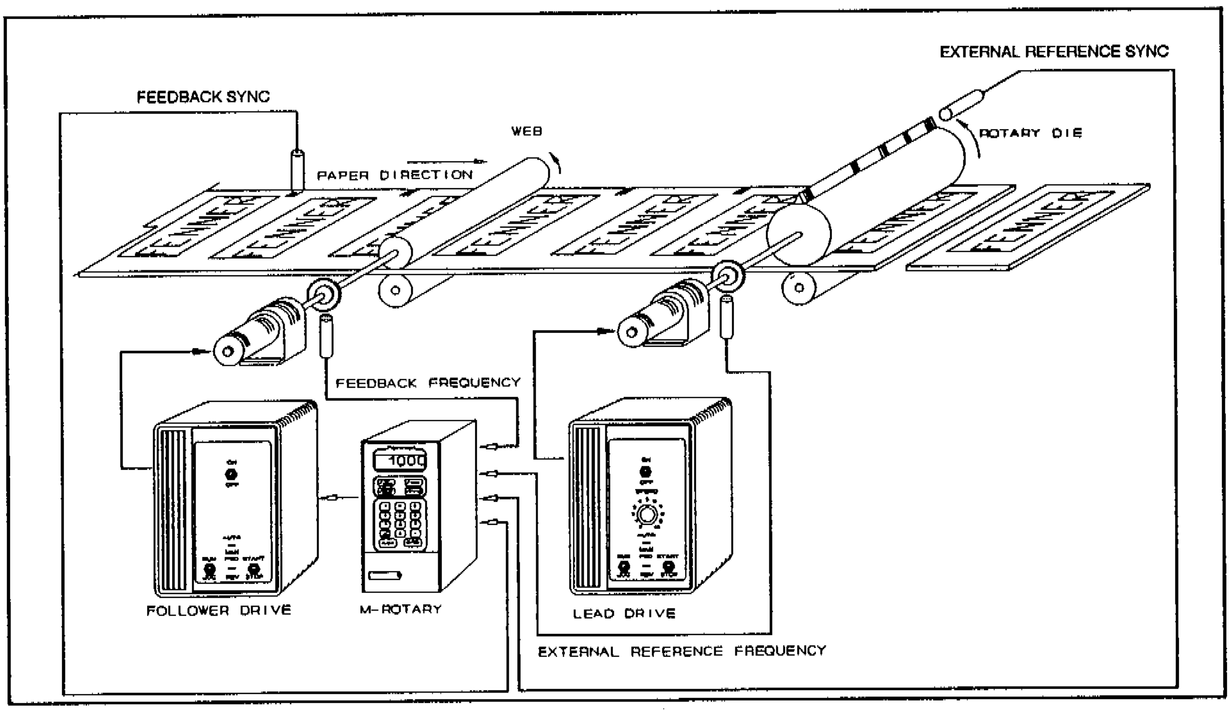


Figure 1-5: Sync Web Follower Example

M-ROTARY SECONDARY MODES

INTRODUCTION

The M-Rotary includes two different secondary modes: Master and Direct. These modes are typically used during machine setup procedures.

MASTER MODE

Master Mode is the most straight forward closed-loop implementation of the M-Rotary. In Master Mode, the setpoint value (in RPMs) is entered by the operator via the front keypad. The M-Rotary 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-Rotary is in Master Mode whenever CP-14 is set to "5."

The M-Rotary ignores the External Reference frequency, External Reference Sync and Feedback Sync inputs while in Master Mode.

DIRECT MODE

Direct Mode differs from the Master Mode in the manner in which the speed command is determined. In Master, the speed command is entered directly by the operator. In Direct Format, the speed command is ignored and the operator enters a direct command to the Isolated Analog Output of the M-Rotary. This is an open-loop control mode that ignores all internal scaling information and all input signals except the Run and Stop logic.

The M-Rotary is in Direct Mode whenever CP-14 is set to "6."

M-ROTARY CONTROL STATES

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

RUN

In the RUN state, the M-Rotary rotates the subject motor at the RPM called for by the relevant setpoints in conjunction with the operative scaling mode. Note that RUN can be entered only from R-STOP or F-Stop (not directly from JOG).

JOG

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

When the JOG state is terminated, the M-Rotary ignores the DECEL rate and brings the speed command immediately to zero. In this manner, the operator can "jog" the motor into position. Note that JOG can be entered only from R-Stop or F-Stop (not directly from RUN).

R-STOP (RAMP STOP)

In the R-STOP state, the M-Rotary decreases the speed command to zero RPMs using the specified DECEL rate.

F-STOP (FAST STOP)

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

NOTES

INTRODUCTION

This chapter contains the information required to hardware configure the M-Rotary for purposes of electrical compatibility. The procedures within this chapter should be completed prior to installing the M-Rotary. 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-Rotary.

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.

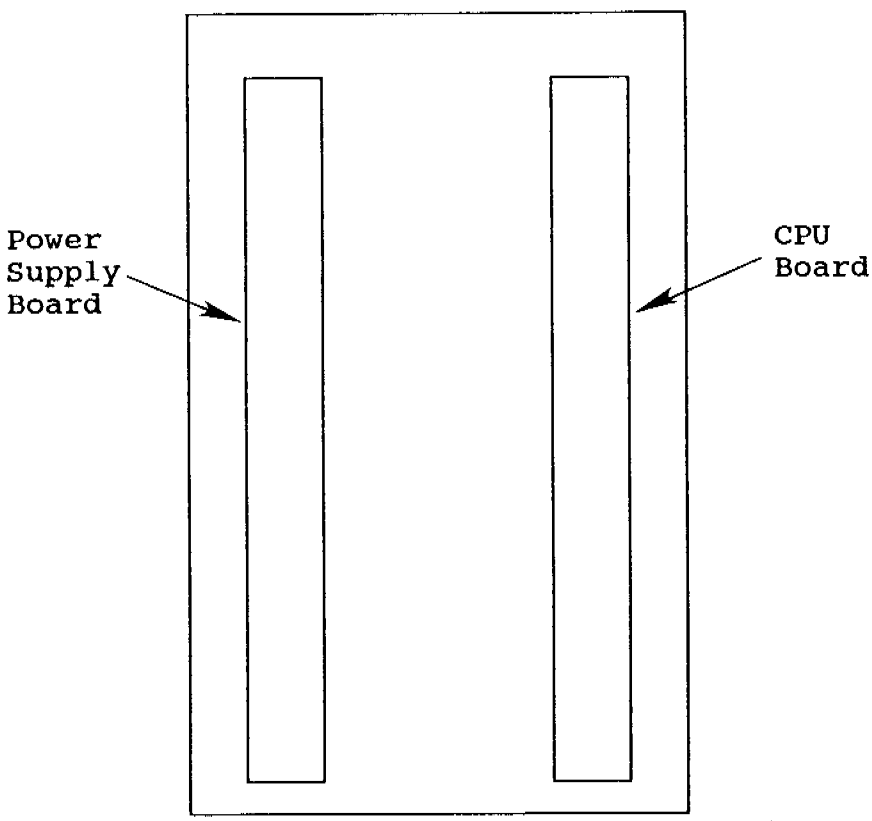


Figure 2-1: M-Rotary Board Location (Rear View)

FREQUENCY INPUTS

The Frequency Input select jumpers are located on the M-Rotary 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-Rotary 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-Rotary will not permit bipolar (forward/reverse) output format.

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.

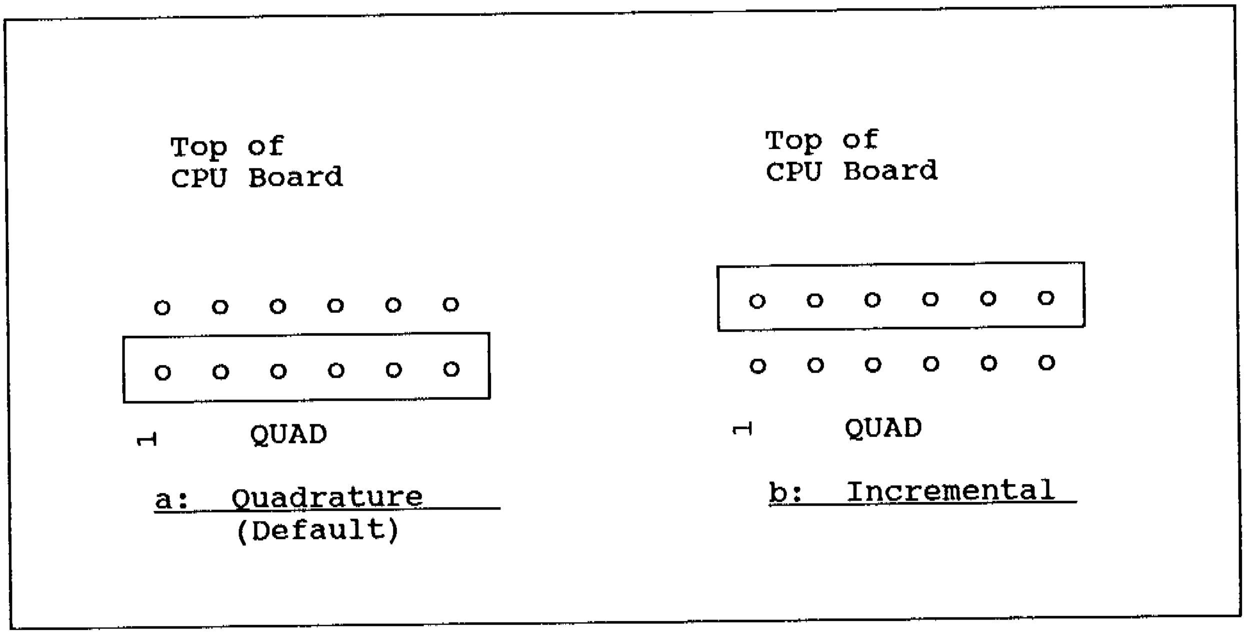


Figure 2-2: Frequency Input Options

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-Rotary 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-Rotary 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-Rotary 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.

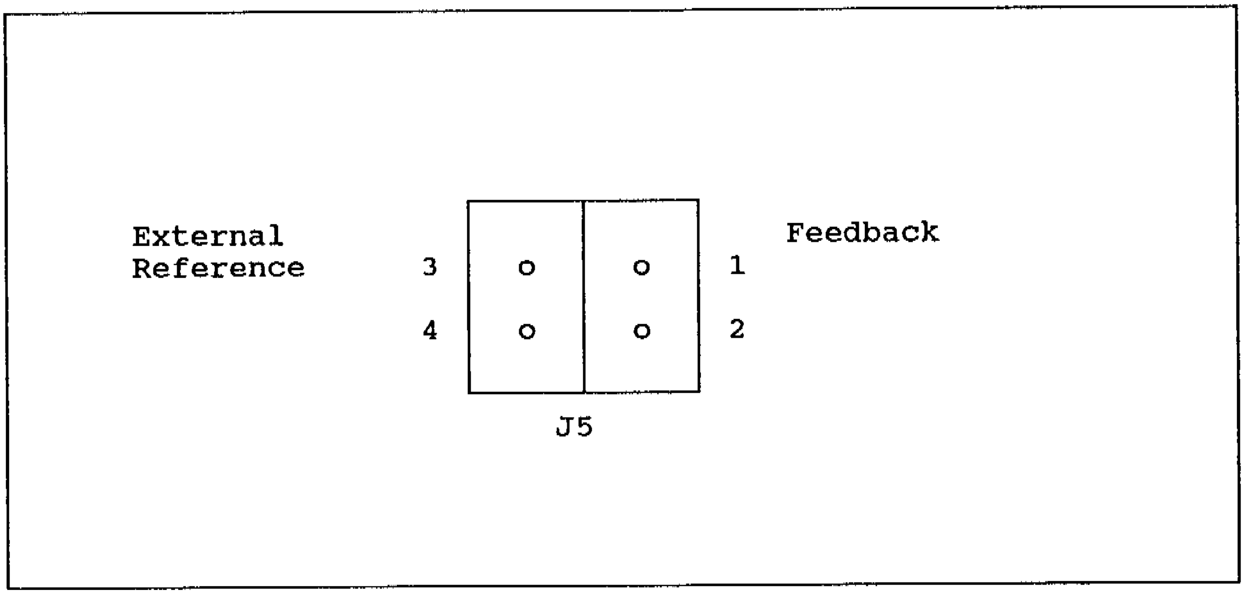


Figure 2-3: Sync Input Filter Option

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-Rotary 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-Rotary. 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.

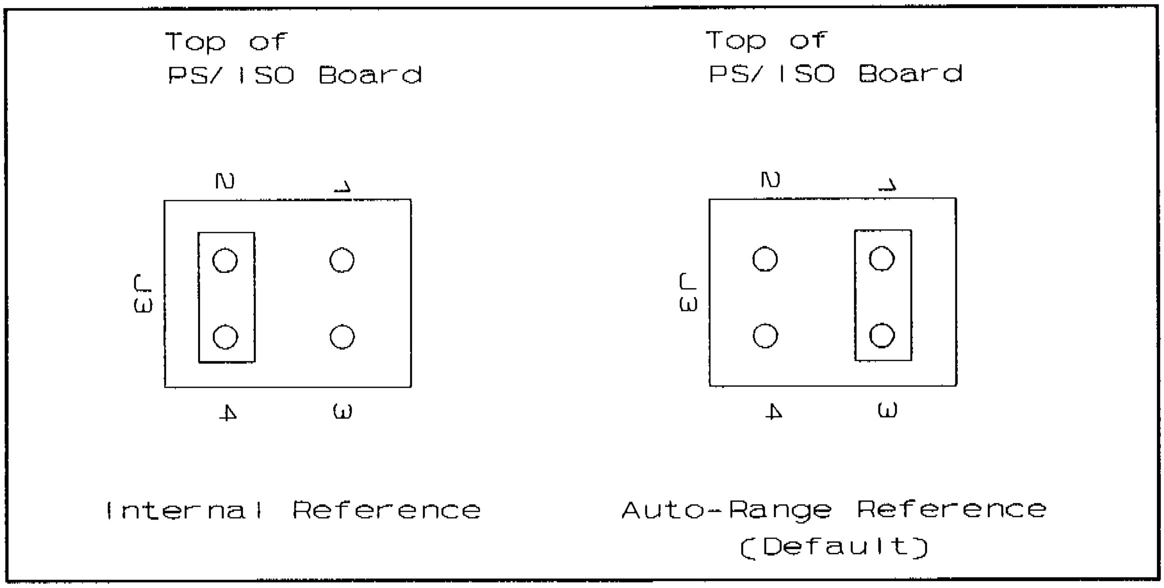


Figure 2-4: Isolator Voltage Reference Options

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.

INTRODUCTION

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

Note to Electricians installing the M-Rotary:

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-Rotary should only be installed by qualified electrical maintenance personnel.

This chapter is organized into 2 distinct sections:

MOUNTING

WIRING

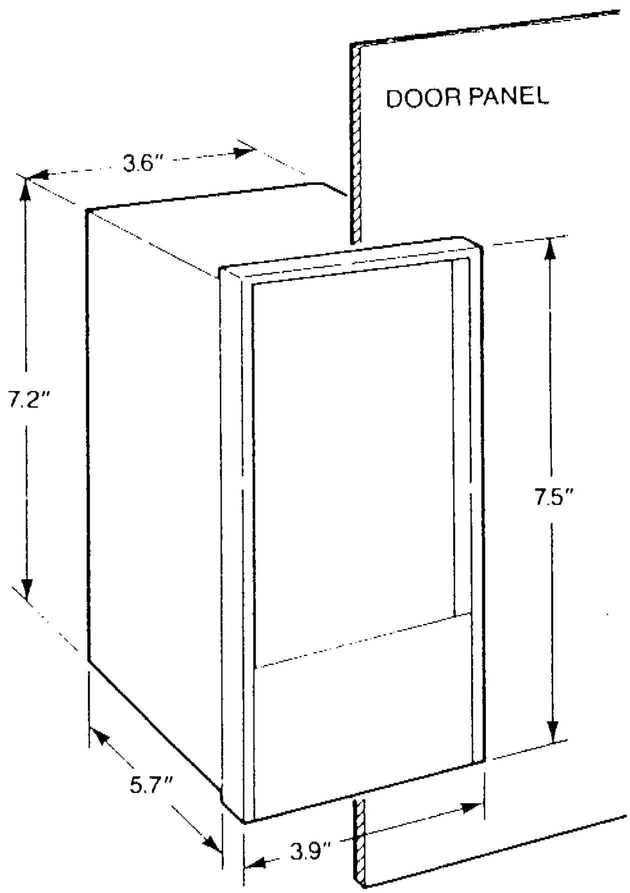
The Mounting section provides drawings and instructions for mounting the M-Rotary in an enclosure. The wiring section summarizes the wiring connections for the M-Rotary.

MOUNTING

INTRODUCTION

The M-Rotary 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-Rotary with dimensions.

Note: Prior to mounting the M-Rotary 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-Rotary Dimensions

MOUNTING PROCEDURE

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

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

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-Rotary from the panel front up to the bezel or gasket.
4. Connect the two mounting brackets from the rear of the M-Rotary 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-Rotary is securely mounted.

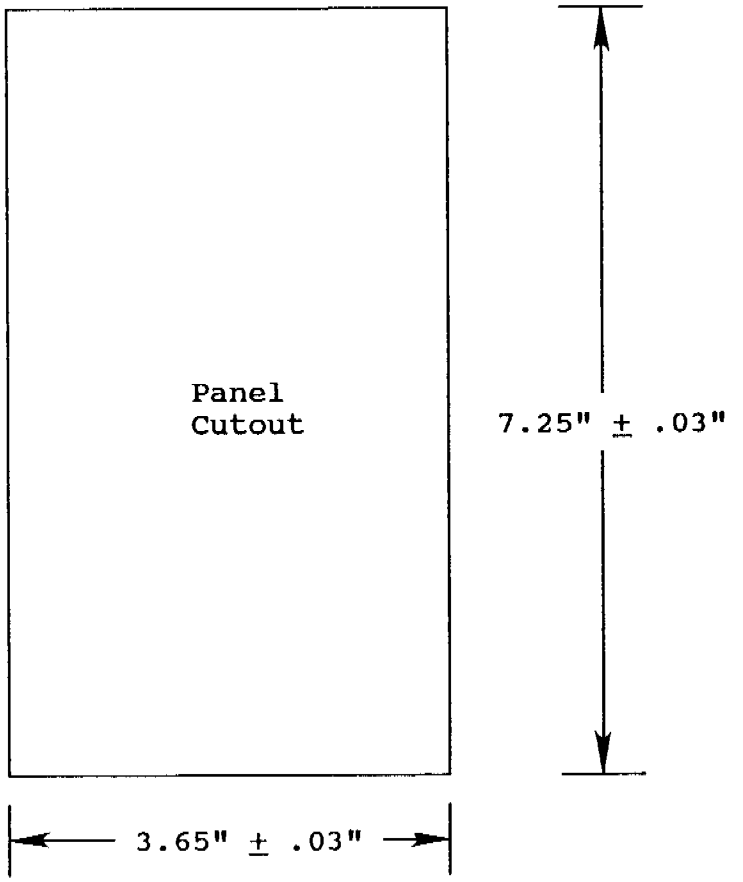


Figure 3-2: Panel Cutout Dimensions

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-Rotary. The optional 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 any M-Rotary internal signal commons (e.g, J3 pins 4 or 8) to the chassis ground (J2 pin 1).

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

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

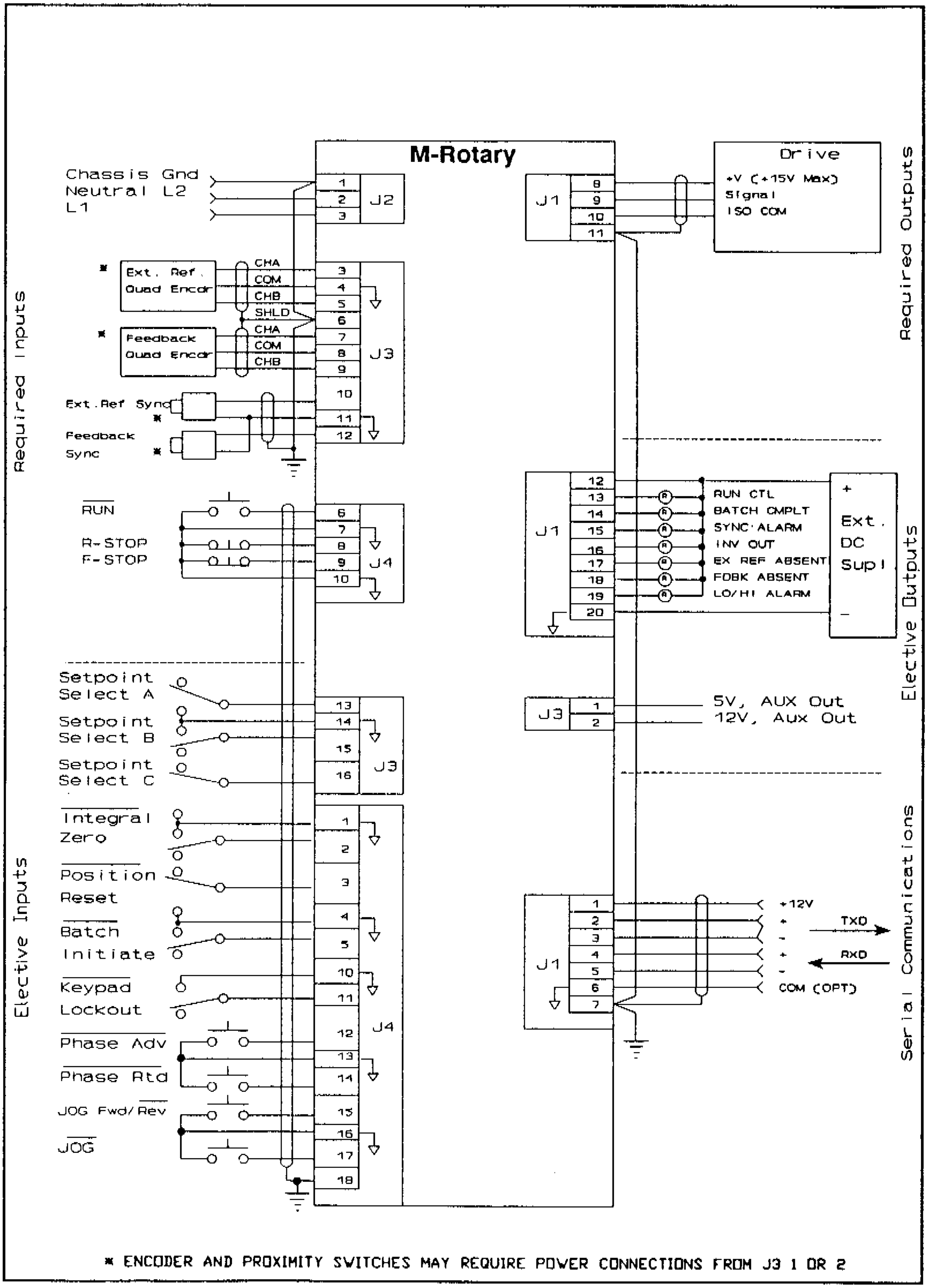


Figure 3-3: M-Rotary General Wiring Drawing

3

M-ROTARY CONNECTOR LOCATIONS

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

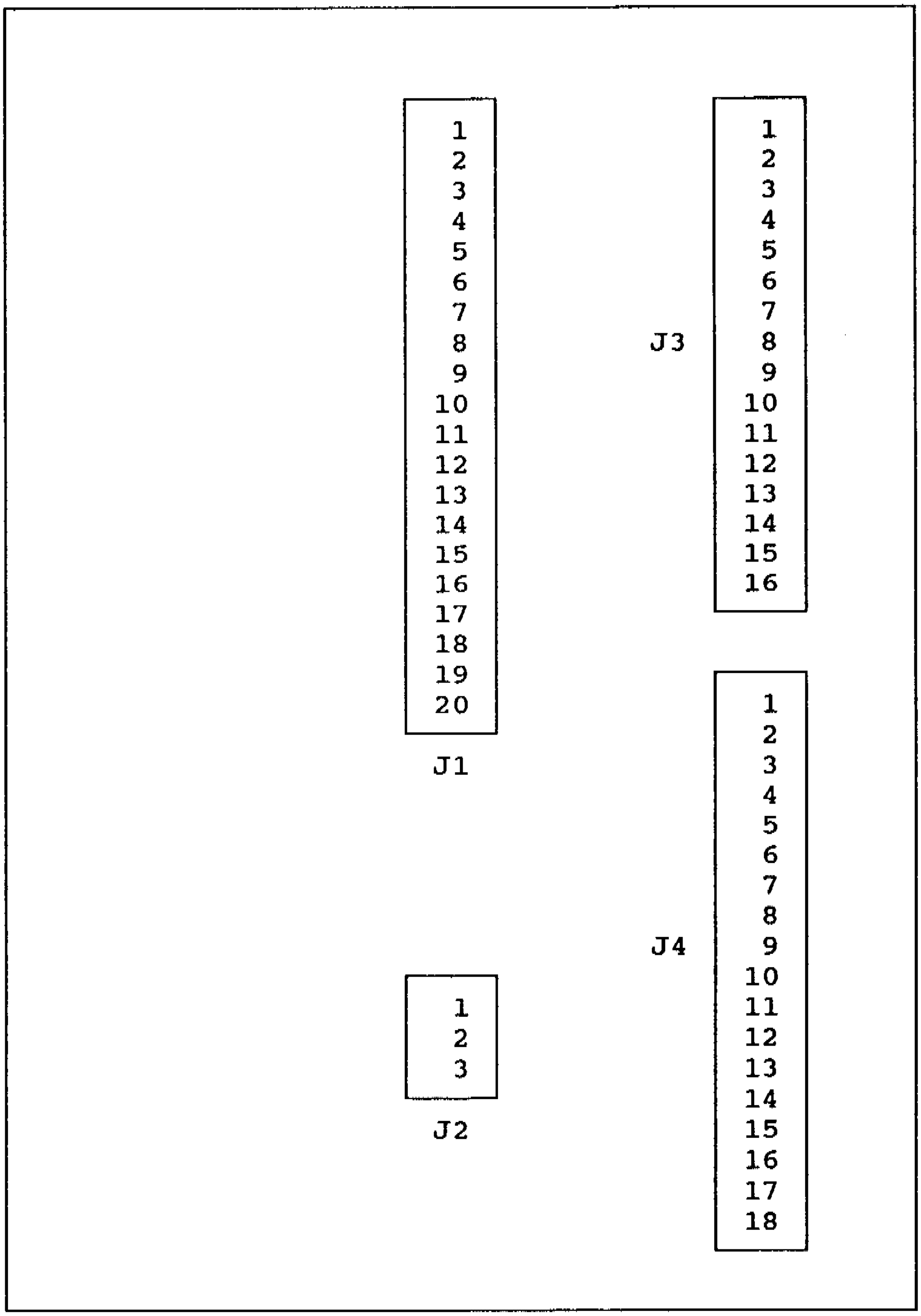


Figure 3-4: Wiring Connector Locations

1) **REQUIRED INPUTS**

INPUT POWER

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

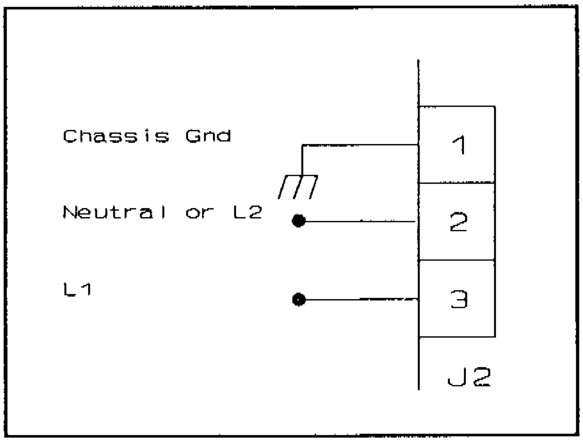


Figure 3-5: Input Power

EXTERNAL REFERENCE FREQUENCY INPUT

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

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

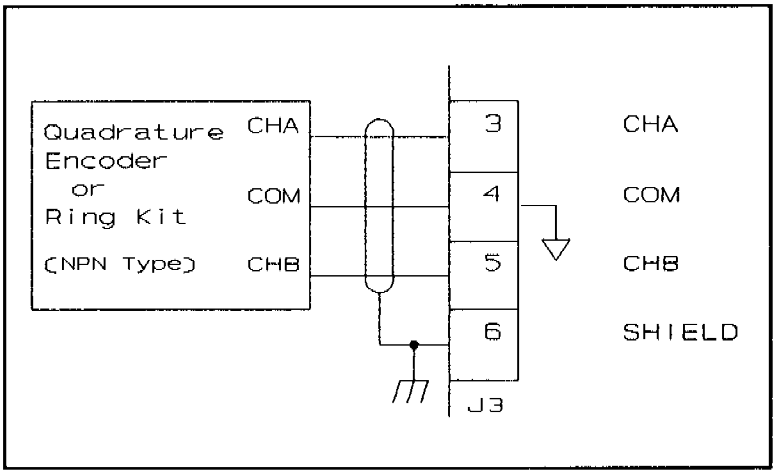


Figure 3-6: External Reference Input Connections

* If incremental encoders are utilized, the M-Rotary will not permit bipolar (forward/reverse) output control.

FEEDBACK FREQUENCY INPUT

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

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

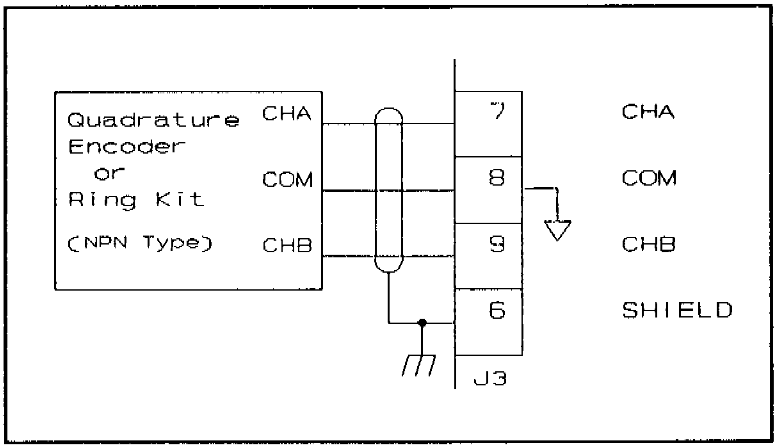


Figure 3-7: Feedback Input Connections

* If incremental encoders are utilized, the M-Rotary will not permit bipolar (forward/reverse) output control.

EXTERNAL REFERENCE SYNC INPUT

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

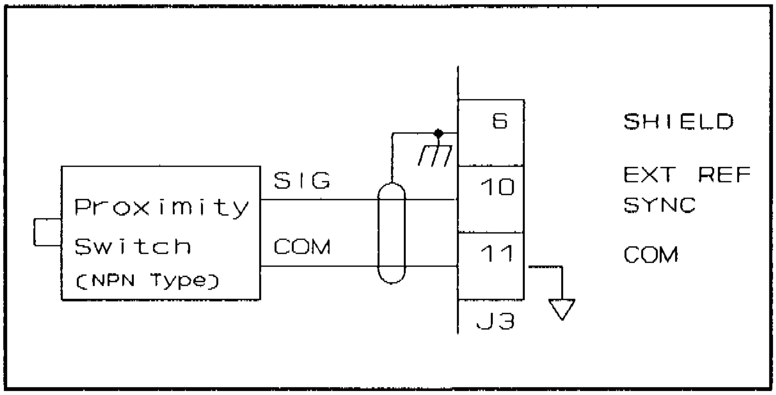


Figure 3-8: External Reference Sync Input

FEEDBACK SYNC INPUT

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

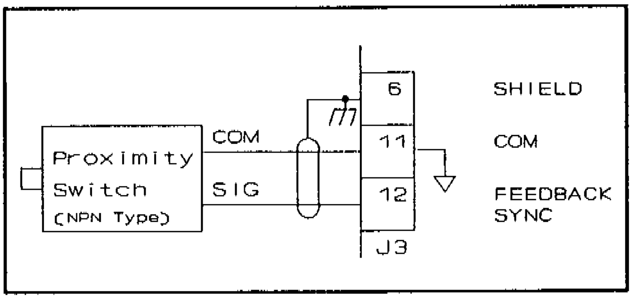


Figure 3-9: Feedback Sync Input

$\overline{\text{RUN}}$

RUN is a momentary input which when closed allows the M-Rotary to run normally. As a momentary input, the RUN state is internally latched and need not be maintained by the operator device.

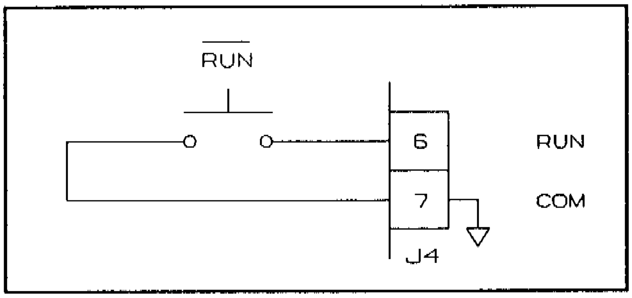


Figure 3-10: Run Input

R-STOP

R-STOP is a momentary input which when opened commands the M-Rotary 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. Position information is maintained in the R-Stop state.

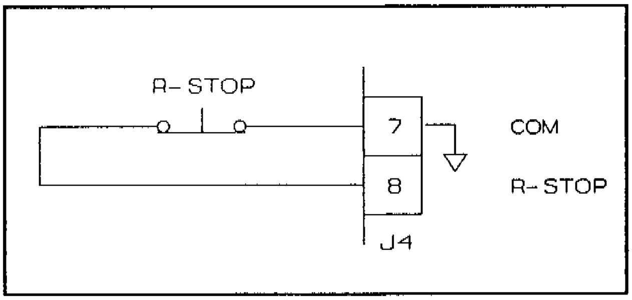


Figure 3-11: R-Stop Input

F-STOP

F-STOP is a momentary input which when opened commands the M-Rotary 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. Position information is maintained in the F-Stop state when entering RUN.

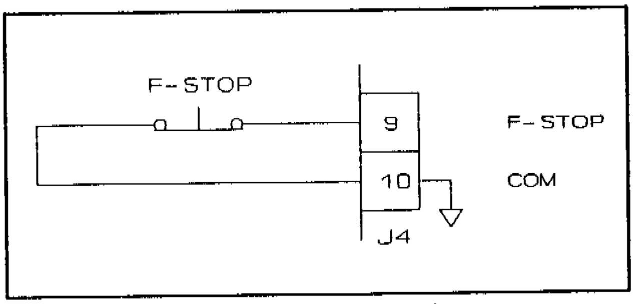


Figure 3-12: F-Stop Input

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-Rotary 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.

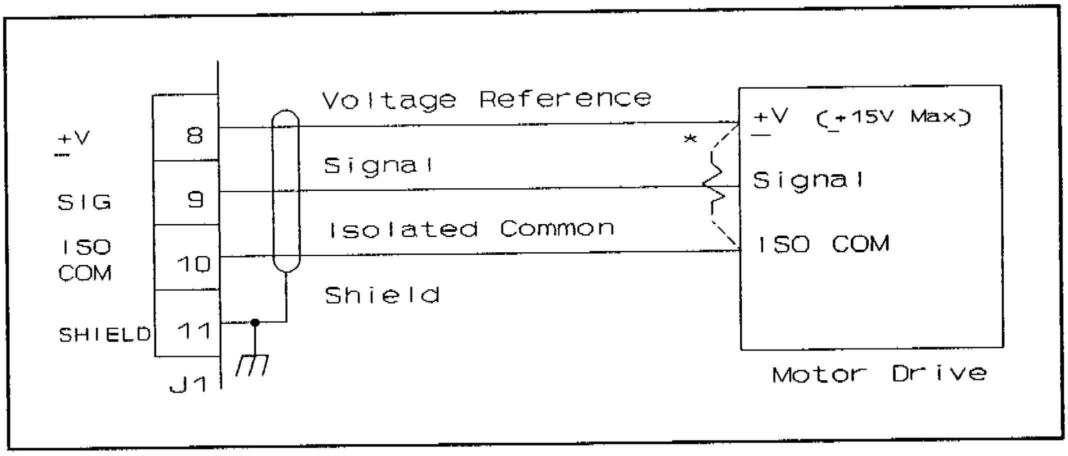


Figure 3-13: Speed Command Output

* Remove Drive Speed Potentiometer

3) **ELECTIVE INPUTS**

SETPOINT SELECT A

The Setpoint Select A input is used in conjunction with the Setpoint Select B and C inputs to select up to eight setpoints in the primary follower modes. The M-Rotary setpoint selection procedure is provided in Chapter 5 of this manual.

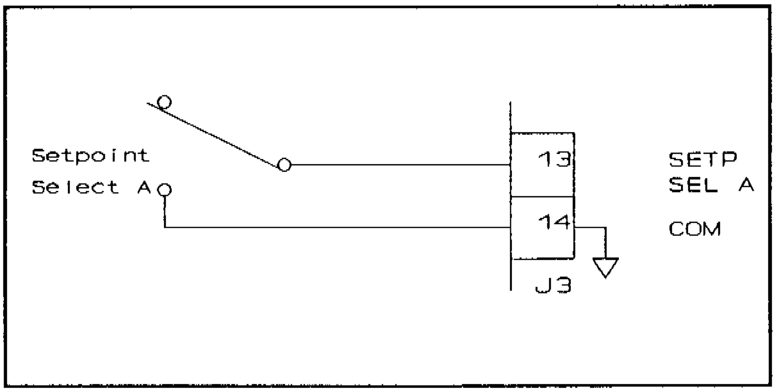


Figure 3-14: Setpoint Select A

SETPOINT SELECT B

The Setpoint Select B input is used in conjunction with the Setpoint Select A and C inputs to select up to eight setpoints in the primary follower modes.

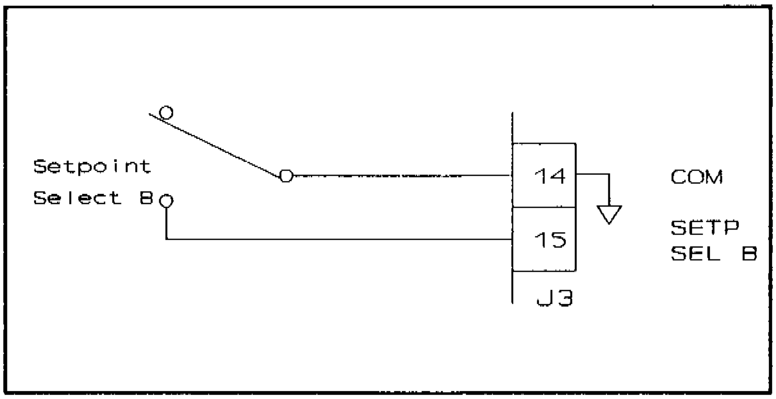


Figure 3-15: Setpoint Select B

SETPOINT SELECT C

The Setpoint Select C input is used in conjunction with the Setpoint Select A and B inputs to select up to eight setpoints in the primary follower modes.

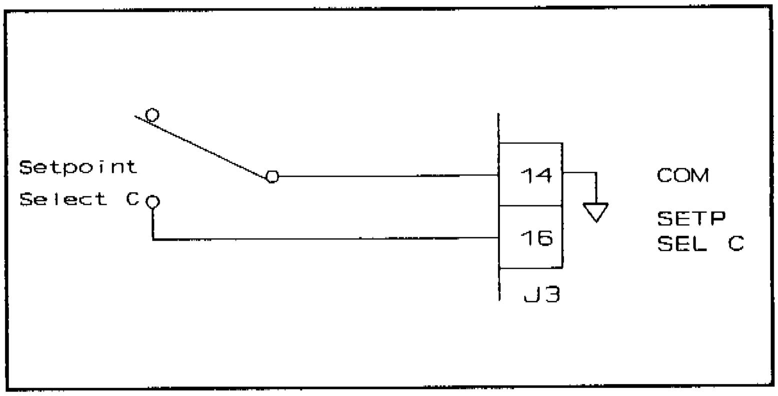


Figure 3-16: Setpoint Select C Input

INTEGRAL ZERO

When J4-2 is shorted to common, the Integral term in the PID compensation loop will be set to zero. Refer to "Tuning" on Page 5-18 for further discussion on the PID compensation algorithm.

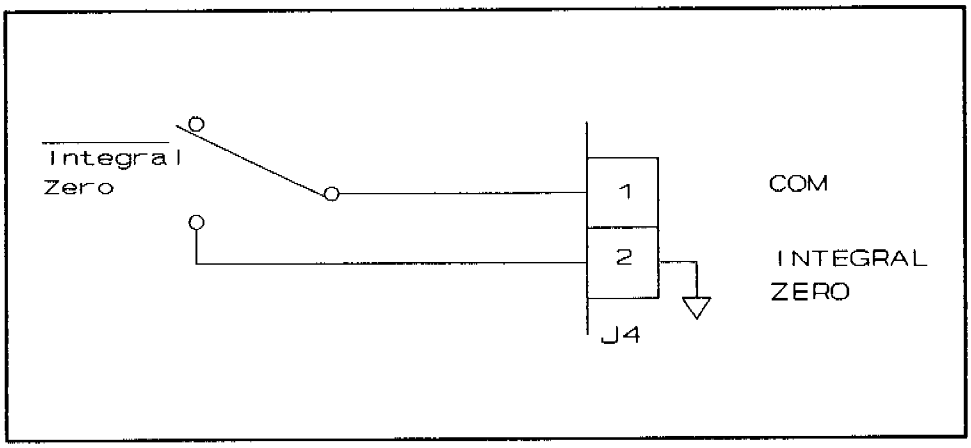


Figure 3-16b: Integral Zero

POSITION RESET

The Position Reset input is used to reset the alignment (position error) memory to zero. The M-Rotary 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-Rotary and manually realigning the machine or product. The position is reset on the high to low transition of this input (edge triggered).

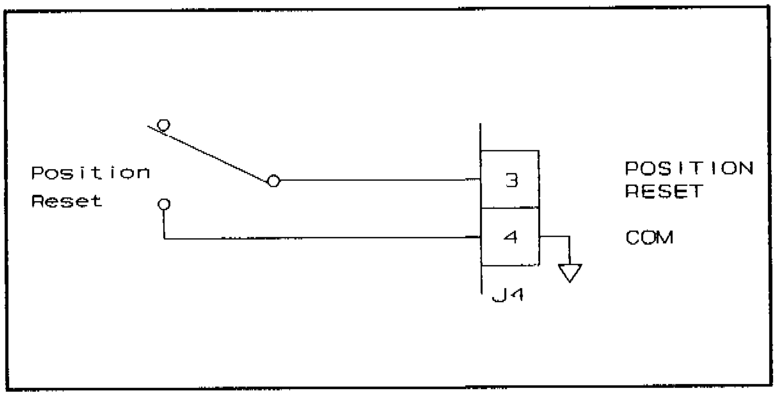


Figure 3-17: Position Reset

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.

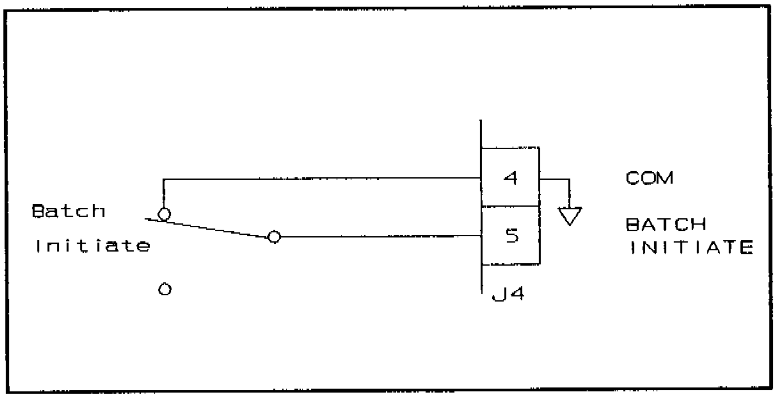


Figure 3-18: Batch Initiate

3

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.

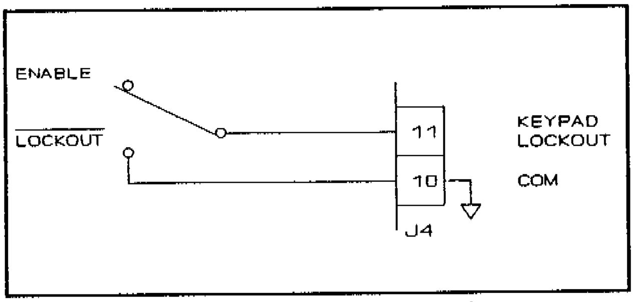


Figure 3-19: Keypad Lockout

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.

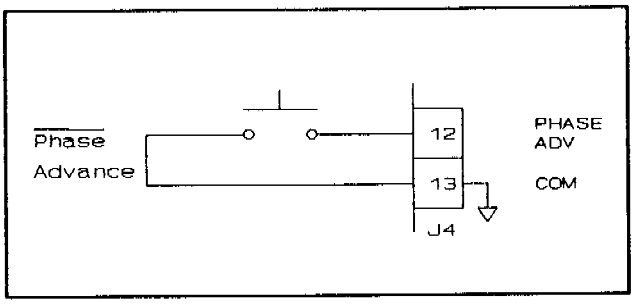


Figure 3-20: Phase Advance

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.

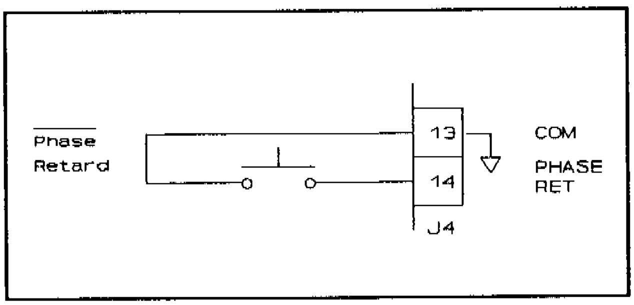


Figure 3-21: Phase Retard

JOG FORWARD/$\overline{\text{REVERSE}}$

The Jog Forward/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-Rotary 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.

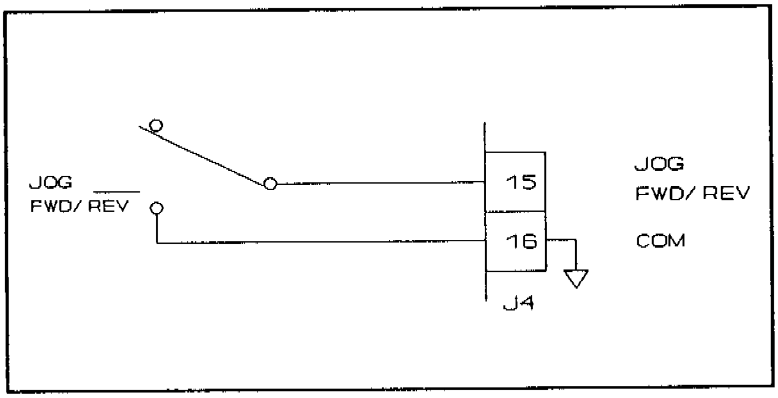


Figure 3-22: Jog Forward/Reverse

$\overline{\text{JOG}}$

$\overline{\text{JOG}}$ 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.

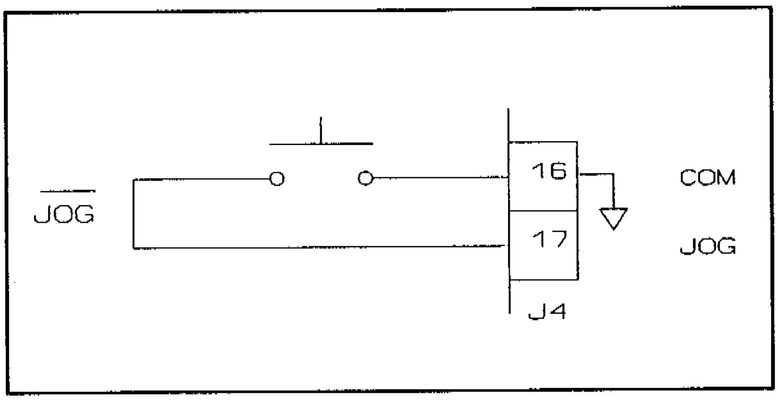


Figure 3-23: Jog Input

4) ELECTIVE OUTPUTS

The M-Rotary 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 3-24 illustrates the wiring for the first three elective outputs. The remaining outputs follow the same pattern.

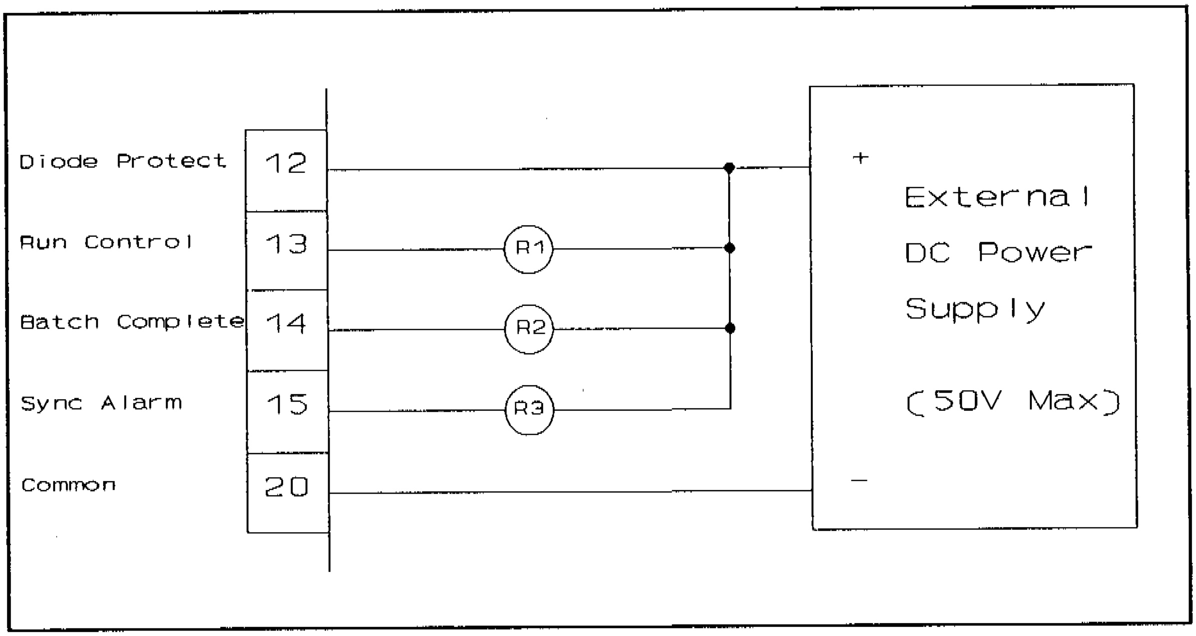


Figure 3-24: Elective Outputs

RUN CONTROL (J1 PIN 13)

The Run Control output is driven low (relay activated) when the M-Rotary is commanding a speed output to the follower drive in the Run, Jog 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 lead and follower pulse inputs are in sync. The Sync Alarm output is low (relay activated) when the lead and follower pulse inputs are not synchronized.

INV OUT (J1 PIN 16)

The INV OUT 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).

EXTERNAL REFERENCE SYNC ABSENT (J1 PIN 17)

The J1-17 output is driven low (relay activated) when the External Reference Sync Pulse is not received within 150% of the lead job space.

3

FEEDBACK SYNC ABSENT (J1 PIN 18)

The J1-18 output is driven low (relay activated) when the Feedback Sync Pulse is not received within 150% of the follower job space.

LO/HI ALARM (J1 PIN 19)

The J1-19 output is driven low (relay activated) when a low or high alarm condition is present based on the programmed setting of CP-28, Alarm Format (refer to page C-5).

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-Rotary.

+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-Rotary.

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-Rotary device.

5) SERIAL COMMUNICATIONS

The Serial Communications interface on the M-Rotary 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 6 of this manual.

Figures 3-25 and 3-26 illustrate a multidrop installation of the Serial Communications link.

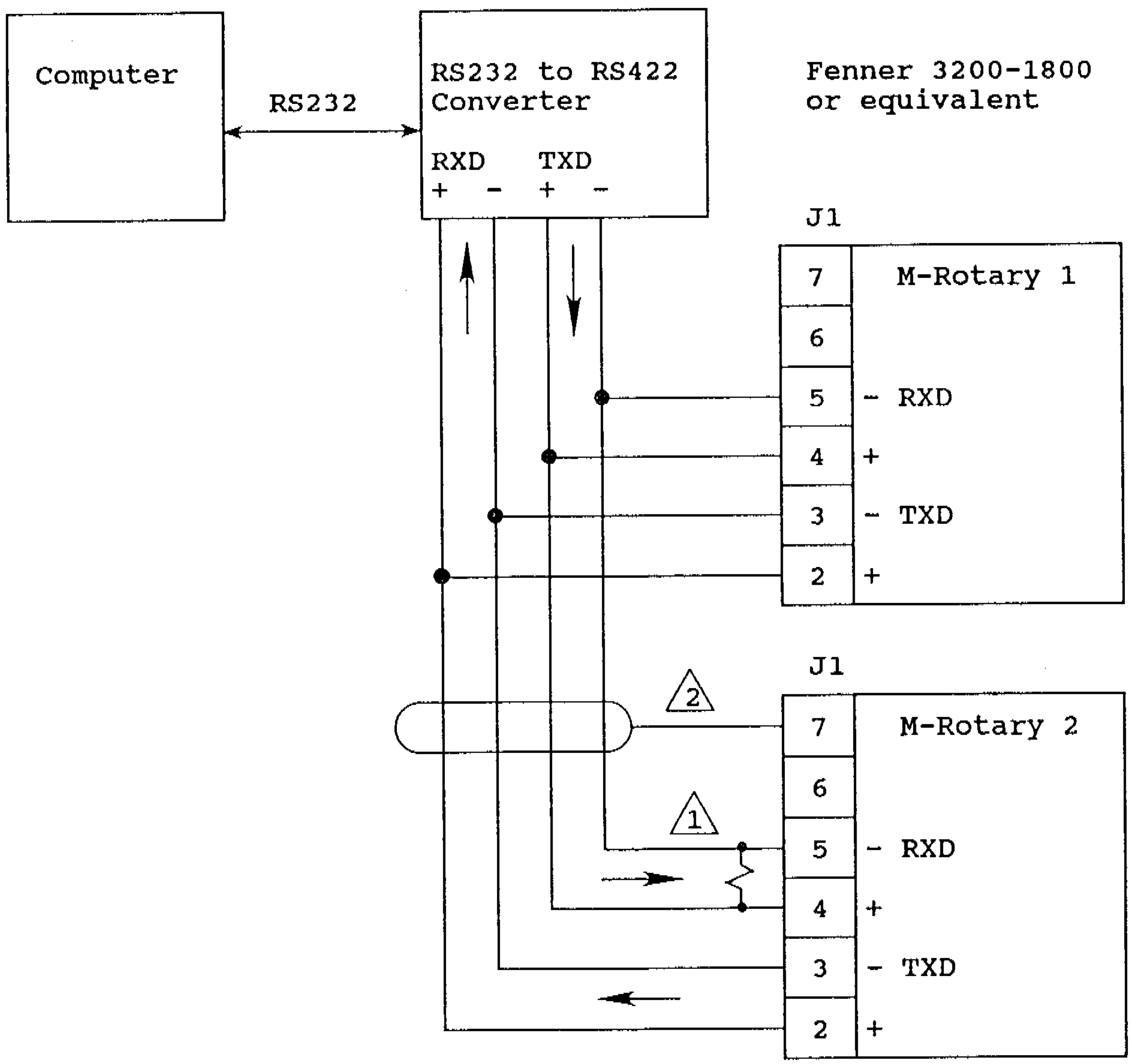


Figure 3-25: Serial Communications Connections

⚠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.

3

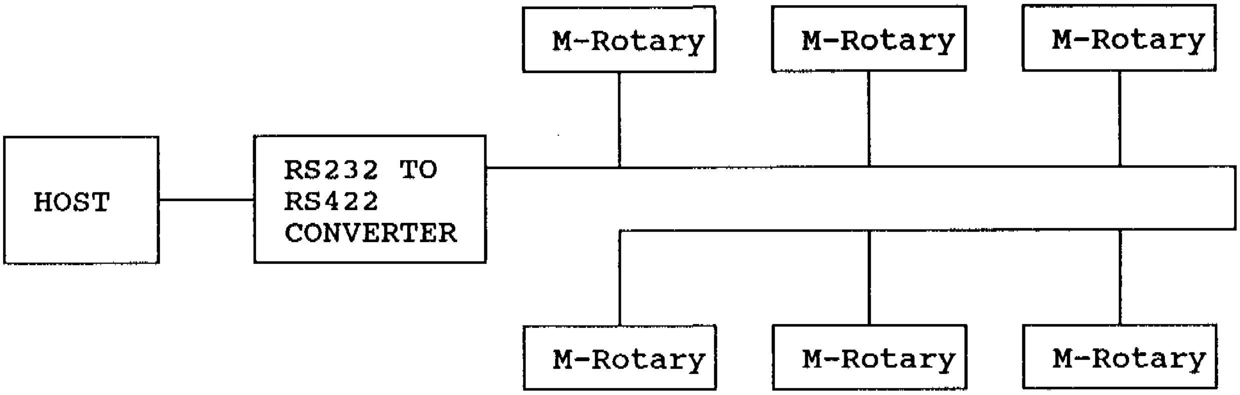


Figure 3-26: Correct M-Rotary Multidrop Installation

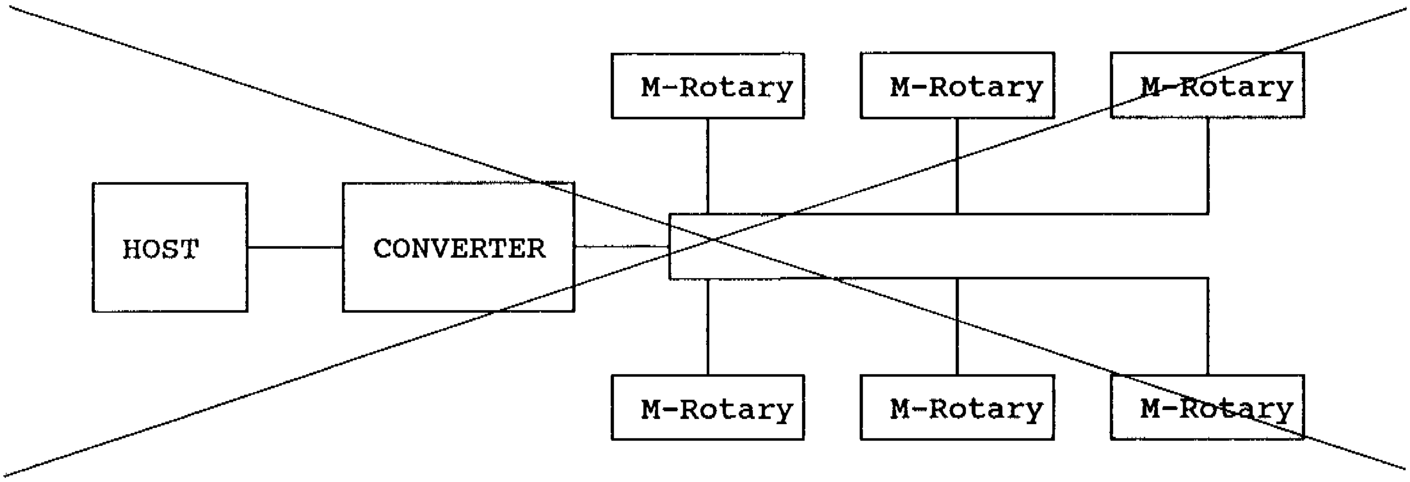


Figure 3-27: Incorrect Installation

NOTES

INTRODUCTION

This chapter contains the information required to calibrate the M-Rotary to the connected motor drive. Prior to using these procedures, the M-Rotary 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 (Operations) 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. Adjust the lead polarity by rotating 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.
2. Enter a "6" into CP-14 (place M-Rotary into Direct Scaling Mode).
3. Enter a positive Direct Mode setpoint of 400 into CP-12.
4. Enter the RUN state (Page 5-11). 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.
5. Adjust the follower polarity by rotating the follower encoder in the direction of normal operation while monitoring MV-42. If the frequency in MV-42 is negative, then exchange the follower encoder lines on J3 pins 7 and 9.
6. Set the ACCEL and DECEL POTs on the motor drive to the minimum times (fastest response).
7. Set the I.R.Compensation POT (if present) on the motor drive to its minimum setting.
8. Enter a "3686" into CP-12 (places the output command to 90% of the full 4095 level).
9. 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-19 variable entry. (The speed can be observed in MV-43 if the correct PPR value is first entered into CP-18.)
10. Return the M-Rotary to its previous mode by entering the original value into CP-14.

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-Rotary 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-Rotary. To make this adjustment, follow the procedure below:

1. Enter a "6" into CP-14 (places M-Rotary into Direct Scaling Mode).
2. Enter "4095" into CP-12 (puts the output to 100% command output level).
3. Enter the M-Rotary 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. Return the M-Rotary to its previous mode by entering the original value into CP-14.

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 "6" into CP-14 (places M-Rotary into Direct Scaling Mode).
2. Enter "0" into CP-12 (0 speed command).
3. Enter the M-Rotary 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. Return the M-Rotary to its previous mode by entering the original value into CP-14.

INTRODUCTION

This section of the manual explains how to operate the M-Rotary. The basic operation of the M-Rotary consists of:

1) Selecting the desired M-Rotary application mode by entering values into required specific Control Parameters (CP-xx) using the Operator Keypad
2) Activate the proper discrete switch inputs to initialize the desired control action
3) Monitoring the controller and system performance through the numerous Monitor Variables (MV-xx) using the Operator Keypad, and
4) Optimizing the controller/system performance by changing selected Tuning Control Parameters.

This chapter is divided into five sections:

Operator Keypad	Explains how to use and read the operator keypad.
Parameter Entry	Explains the procedure to enter in the required Control Parameters for the desired application.
Discrete Switch Inputs	Explains each of the M-Rotary Discrete Inputs
Performance Monitoring	Explains the three methods for using the M-Rotary Monitor Variables (Static Monitoring, Dynamic Monitoring and Sync Mode Monitoring).
Tuning	Explains how to optimize the system performance by Tuning the M-Rotary.
Synchronized Profiling	Explains the how to operate the Synchronized Profiling control option.

OPERATOR KEYPAD

The Operator Keypad is used to view or change M-Rotary CP-xx values (both for selecting the application mode and modifying other Control Parameters) and to view Monitor Variables to verify proper performance.

Figure 5-1 illustrates the M-Rotary Operator Keypad. There are five main sections of this keypad:

Upper Display:	Typically displays the value of the MV-xx or CP-xx code indicated in the lower display.
Dedicated Function Keys:	Set Point, Tach, Batch Count and Status
Numeric Keypad	Used to select the desired MV-xx or CP-xx variable and enter new values for CP-xx codes
LED display	Five LEDs indicate current M-Rotary status
Lower display:	Typically displays the MV-xx or CP-xx code whose value is displayed in the upper display.

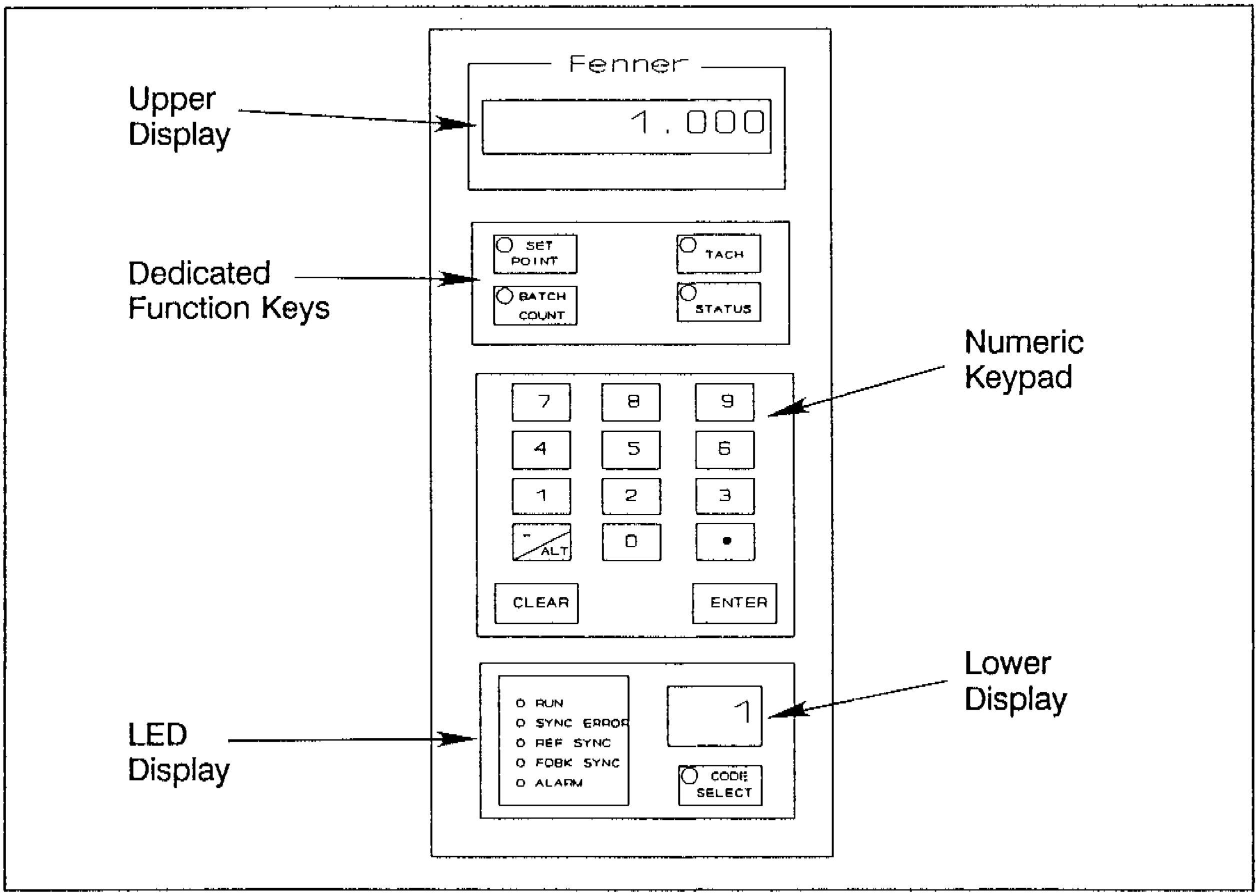


Figure 5-1: Operator Keypad

MONITOR VARIABLES (MV-xx) AND CONTROL PARAMETERS (CP-xx)

All M-Rotary Operation Codes are either Control Parameters (indicated by a "CP-") or Monitor Variables (indicated by a "MV-"). The lower section of the M-Rotary keypad allows access to these Operation Codes through their unique identification codes. Use the following procedure to access these variables:

1) Open the M-Rotary's door to exposes the lower keypad.
2) Press the "Code Select" Key.
3) Enter the desired parameter code number using the numeric keypad.
4) Press the "Enter" Key.

At this point, the two digit Operation 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 existing value (if applicable). To make a change, simply enter the new value and press the Enter Key. Monitor Variables 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.

If the new CP value is not accepted when the Enter Key is pressed, access MV-50 (Keypad Errors) to determine the reason. Possible reasons for not accepting a new value include invalid parameter code, out of range, keypad locked out or not allowed during the Run State.

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

Appendix C provides detailed descriptions for all CP-xx and MV-xx variables. Appendix E contains a table which illustrates all operating codes, their minimum allowed value, their maximum allowed value, and their default value.

DEDICATED FUNCTION KEYS

The dedicated function keys provide quick access to the most commonly required M-Rotary variables:

SET POINT: This key allows viewing or changing the value for each of the 8 follower setpoints, the Master Setpoint and the Direct Setpoint.

The procedure for using the Set Point key varies depending on the value in CP-14. To change a setpoint value when CP-14 = {1,2,3,4}:

1) Select the desired setpoint using the Setpoint Selection Inputs A, B and C (see Setpoint Selection on Page 5-9).
2) Press Setpoint. The lower display indicates the current setpoint (1-8), and the upper display indicates the current value. The numeric keypad is now enabled.
3) Enter the new setpoint value using the numeric keypad.
4) Press the enter key within 15 seconds.

When CP-14 = {5,6), the Setpoint Select inputs are ignored. When CP-14=5, the lower display indicates 10, and the upper display indicates the current Master Setpoint value. When CP-14=6, the lower display indicates 12, and the upper display indicates the current direct analog command value. Skip Step #1 above when changing either the Master Setpoint or the Direct Analog Value.

TACH: When TACH is pressed during follower mode, 40 is indicated in the lower display (MV-40), and the current cut length value is indicated in the upper display. When TACH is pressed during master mode, 43 is indicated in the lower display (MV-43), and the current feedback encoder RPMS is indicated in the upper display.

STATUS: When STATUS is pressed, 51 is indicated in the lower display (MV-51), and the current alarm status code is indicated in the upper display. See Page C-9 to interpret this code.

BATCH COUNT: When the Batch Count key is pressed, 45 is indicated in the lower display (MV-45) and the current batch count is displayed in the upper display.

LED INDICATORS

When on, these LEDs indicate the following:

LED On	Indicates
RUN	M-Rotary is in the RUN state
SYNC ERROR	M-Rotary is Out-Of-Sync in Sync Follower Mode
REF SYNC	M-Rotary Reference Sync signal is present
FDBK SYNC	M-Rotary Feedback Sync signal is present
ALARM	One of the M-Rotary alarm conditions is present (Press STATUS to view alarm code (MV-51).

PARAMETER ENTRY

This section explains the procedure to select the desired control function by entering values into specific Control Parameters. Typical Control Parameters used include the number of lead encoder lines per cut, the number of follower encoder lines per cut and the pulse per revolution of the feedback sensor. A complete list of all Control Parameters and item definition is available in Appendix C.

On initial power-up (or after the Clear-7 procedure explained on page 7-7), the M-Rotary internally loads a set of default Control Parameters. The default Control Parameter values are identified in Appendix E. In many cases, these default values may be suitable for the specific application and do not require further modification. It is also not necessary to change M-Rotary Control Parameters that are not utilized in the specific application.

The following discussion indicates what values to enter into the M-Rotary for the various modes of operation.

SETPOINT SCALING PARAMETERS

The Setpoint scaling process allows the M-Rotary to use setpoint values in engineering units such as inches per cut, millimeters per cut, etc.

Caution: Failure to enter exact Setpoint Scaling values may result in faulty or erratic control operation. Check all values before entry.

In general, the scaling procedure consists of entering the correct number of Lead Encoder lines per cut (CP-16) and Follower Encoder lines per cut (CP-17) for a given Engineering Unit Cut Length (CP-15). Two alternative scaling procedures are listed below. Select and perform the procedure that appears to be easiest for your application.

Note: The M-Rotary can be set up to count the number of lines between sync flags on a system that this information is not known. Set up the M-Rotary for Non-Sync Follower (CP-14), a standard cut length in CP-15 and CP-1, with CP-16 and CP-17 at default (1000) and also include CP-36 and CP-37 if a sync divide is required (see Page 5-10). Then advance the system a minimum of two sync flags per lead and follower. MV-80 (Lead Job Space) and MV-81 (Follower Job Space) will display the actual number of lines between flags. These numbers can now be entered into CP-16 (Lead Lines/Cut) and CP-17 (Follower Lines/Cut). After completion of these steps resume the scaling procedure.

5

SCALING PROCEDURE A

The four follower Modes of operation are Non-Sync Rotary Follower, Non-Sync Web Follower, Sync Rotary Follower and Sync Web Follower. Each of these follower modes are explained in Chapter 1. The Scaling procedure is the same for all four follower modules. Enter the values in the following order:

1) Enter the appropriate number into CP-14 to select the desired follower mode: (CP-14 cannot be changed during the RUN state.)

   1 = Non-Sync Rotary Follower
   2 = Non-Sync Web Follower
   3 = Sync Rotary Follower
   4 = Sync Web Follower

2) Determine the number of encoder lines that occur for one rotation of the rotary die. Be sure to include any gear reductions in determining this value. Enter this value into CP-17 for Rotary Follower modes of operation or CP-16 for Web Follower modes of operation.

3) Determine the number of encoder lines that occur for one rotation of the web nip roll used to advance the web. Be sure to include any gear reductions in determining this value. Enter this value into CP-16 for Rotary Follower operation modes or CP-17 for Web follower operation modes.

4) Determine the distance that the web travels for one rotation of the nip roll. This can be calculated by the formula:

   $$\text{Web Distance} = 2\pi R$$

   where: $\pi = 3.1416$
   R = radius of the nip roll

   Enter this distance into CP-15 using the same engineering units used for the setpoint entries (i.e., inches, feet, meters, etc.)

5) Enter the desired setpoint into CP-1. Note that the decimal point entered during Step 4 above automatically determines the decimal location for the setpoint entry.

SCALING PROCEDURE B

The four follower Modes of operation are Non-Sync Rotary Follower, Non-Sync Web Follower, Sync Rotary Follower and Sync Web Follower. Each of these follower modes are explained in Chapter 1. The Scaling procedure is the same for all four follower modules. Enter the values in the following order:

1) Enter the appropriate number into CP-14 to select the desired follower mode: (CP-14 cannot be changed during the RUN state.)

   1 = Non-Sync Rotary Follower
   2 = Non-Sync Web Follower
   3 = Sync Rotary Follower
   4 = Sync Web Follower

2) Select a standard cut length and enter its value into CP-15. This value should be entered in Engineering Units including the desired decimal location. For example, a cut length of ten is entered as 10.000.

3) Determine the number of lead encoder lines that will appear on the External Reference Frequency Input during the standard cut length entered into CP-15. Enter the Lead Encoder Lines per cut value into CP-16.

   When calculating the number of lead encoder lines per cut, make sure all gear box,belting, etc. reductions are taken into account. During sync modes of operation, the actual cut value can be monitored using MV-80 or MV-87 (Lead Job Space).

4) Determine the number of follower lines that will appear on the Feedback Frequency Input during the standard cut length entered into CP-15. Enter the Follower Encoder Lines per cut into CP-17.

   When calculating the number of follower lines per cut, make sure all gear box, belting, etc. reductions are taken into account. During sync modes of operation, the actual value can be monitored using MV-81 or MV-88 (Follower Job Space). Enter the same cut length into CP-1 that was entered into CP-15. Note that the decimal point entered during Step 2 above automatically determines the decimal position for CP-1.

Note: The M-Rotary checks the CP-15, CP-16, CP-17 and setpoint entries (CP-1 throughCP-8) to ensure that the follower/lead ratio does not exceed a value of 10.000. If any of these parameters are not accepted by the M-Rotary when the Enter Key ispressed, enter a value of zero into CP-1 through CP-8 and then enter new values for CP-15, CP-16 and CP-17 in their respective order.

5

FEEDBACK SCALING PARAMETERS

Two follower feedback scaling parameters must be entered in order to properly scale the Master Mode, Jog and Feedforward components of the compensation loop:

1) Enter the resolution of the follower feedback sensor device (ring kit or encoder) that appears on the Feedback Frequency Input into CP-18. The units for this variable are Pulses Per Revolution (PPR).

2) Determine the number of maximum RPMs of the follower feedback sensor device that appears on the Feedback Frequency Input when the follower motor is operating at full speed. Enter this value into CP-19.

SETPOINT PARAMETERS

The M-Rotary permits entry of up to 11 different setpoints; 8 Follower Modes, 1 Master Mode, 1 Jog and 1 Direct Mode.

Follower Setpoints: The Follower Mode preset setpoints are entered into CP-1 through CP-8 in Engineering Units (cut length). The selection and activation of the 8 Follower setpoints occurs through the use of the three Setpoint Select inputs as explained in the Discrete Switch Input section of this chapter (see Page 5-9).

Master Setpoint: The Master Setpoint is entered into CP-10. The units of entry are encoder RPMs. This setpoint becomes active when CP-14 is equal to 5.

Jog Setpoint: The Jog setpoint is entered into CP-11. The units of entry are encoder RPMs. This setpoint becomes active when the Jog state is entered as explained in the Discrete Switch Input section of this manual.

Direct Setpoint: The Direct Mode setpoint is entered into CP-12. The units for this entry are DAC bits. An entry of 4095 directly commands the Isolated Analog Output to a 100% output level; 0 produces a 0% output level, and -4095 produces a -100% output level. The Direct Mode setpoint is active whenever CP-14 is set to 6. Note that the Direct Mode setpoint is automatically reset to 0 when CP-14 is not at 6.

FOLLOWER SYNC MODE PARAMETERS

The M-Rotary contains nine control parameters used to modify the behavior of the M-Rotary when operating in the Follower Sync Mode:

Out-Of-Sync: CP-24 defines the position error band that is considered out-of-sync. The CP-24 value also establishes the level at which the Out-Of-Sync LED on the Operator Keypad is lit, and also determines when the Sync Error Discrete output is activated. The units for this entry are in encoder lines.

Lag Pulse Limit: CP-25 establishes a limit to the position error when the follower is behind or lags the lead when the sync flags occur. Position errors greater than the CP-25 limit are set to the CP-25 limit. Units are in encoder lines.

Lead Pulse Limit: CP-26 establishes a limit to the position error when the follower is ahead of or leads the lead when the sync flags occur. Position errors greater than the CP-26 value are set to the CP-26 limit. Units are in encoder lines.

Sync Trend Enable: When CP-30 is set to 1, the trending feature of the M-Rotary is enabled. Trending allows the M-Rotary to automatically compensate for slightly varying process job spaces such as for web stretch or web print variations. The trending feature averages the lead and follower job spaces and makes an adjustment every 16 job spaces. The trending feature allows the lead-to-follower ratio to vary up to 1/64th of the originally entered value per 16 job spaces. (CP-30 cannot be changed in the RUN state.)

Sync Phase: Often it is difficult to mechanically mount the sync sensors at the desired location in the system. The Sync Phase feature allows the lead and follower sync sensors to be conveniently mounted. The sync point of the M-Rotary can then be phased ahead or behind by entering positive or negative values into CP-31. The units for this entry are in encoder lines.

Sync Phase Increment: In addition to directly entering the Sync Phase adjustment into CP-31, the value can be increased or decreased via the Sync Advance and Sync Retard Discrete Switch Inputs. The magnitude of change that occurs on CP-31 when these inputs are activated is adjusted by the CP-32 entry.

5

Sync Flag Polarity: CP-35 determines which edge of the sync pulse, rising or falling, is recognized by the M-Rotary as the Sync Point. This is particularly useful when using reflective or transmissive optical sensors on web registration marks. Enter the appropriate value into CP-35 according to the following table:

CP-35	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)

Sync Lead Divide: CP-36 reduces the sync rate of the M-Rotary for those applications where the sync rate exceeds the 20 pulses per second limit. It can also discriminate between different sync marks by ignoring undesired sync marks if they are repetitive in nature (web print). The lead sync pulses are divided by the CP-36 value before being submitted to the M-Rotary synchronization routine. For example, if CP-36 is set to 3, the M-Rotary recognizes the first, fourth, seventh, tenth, etc. lead pulses.

The sync lead divide counter is reset at power up, when the external Position Reset input is activated, or when a CP-14 or CP-36 value is entered. (CP-36 cannot be changed in the RUN state.)

Sync Follower Divide: CP-37 sets the divide quantity for the follower sync input. It operates the same as the CP-36 Sync Lead Divide.

The sync follower counter is reset at power up, when the external Position Reset is activated, or when a CP-14 or CP-37 value is entered. (CP-37 cannot be changed in the RUN state.)

MASTER MODE PARAMETERS

The M-Rotary contains four Control Parameters used to influence the control behavior when in the Master Mode of operation.

Master Minimum Speed: CP-20 sets the minimum speed (in RPMs) for the M-Rotary.

Master Maximum Speed: CP-21 sets the maximum speed (in RPMs) for the M-Rotary.
Acceleration Time: CP-60 sets the desired time in seconds to accelerate the follower encoder from 0 to 2000 RPMs. Units are in seconds.

Deceleration Time: CP-61 sets the desired time in seconds to decelerate the follower encoder from 2000 to 0 RPMs. It also defines the deceleration time for the R-Stop State. Units are in seconds.

OUTPUT CONTROL PARAMETERS

Low Speed Alarm: CP-22 sets the low level for the Lo/Hi Alarm discrete output. If the follower encoder RPMs are below this level and CP-28 is set to 1 or 2, the Lo/Hi alarm output is activated until the speed increases above this alarm level.

High Speed Alarm: CP-23 sets the high level for the Lo/Hi Alarm discrete output. If the follower encoder RPMs are above this level and CP-28 is set to 1 or 3, the Lo/Hi alarm output is activated until the speed decreases below this alarm level.

Batch Limit: The M-Rotary has an easy to use Batch Control feature. An internal batch counter counts the Follower Sync Pulses and activates the Batch Complete discrete output when the number entered into CP-27 is reached. The batch counter is reset to zero by the Batch Initiate discrete input.

Alarm Format: CP-28 determines which of the Low Speed and High Speed conditions activates the Lo/Hi Alarm Output. If CP-28 is set to 1, either a Low or High Alarm will activate the output. If CP-28 is set to 2, only the Low Speed alarm will activate the output. If CP-28 is set to 3, only the High Speed alarm will activate the output.

Output Format: CP-29 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. (CP-29 cannot be changed in the RUN state.)

DISCRETE SWITCH INPUTS

Typically, the M-Rotary inputs are installed as push buttons, toggle switches, rotary switches or wired shorts. In addition, these inputs can also be installed as part of a PLC (programmable logic control) system or controlled by an industrial PC (personal computer).

SETPOINT SELECTION AND CONTROL

Follower Setpoint Selection for the M-Rotary is a determined by the open/closed status of three M-Rotary Inputs: Setpoint Select A, Setpoint Select B and Setpoint Select C. One common method for selecting these inputs is utilizing an 8-position coded rotary switch (mechanical).

The following chart indicates the open/close binary progression to select a setpoint:

Set.Sel A	Set.Sel B	Set.Sel C	Selected Setpoint
Open	Open	Open	Setpoint 1 (CP-1)
Shorted	Open	Open	Setpoint 2 (CP-2)
Open	Shorted	Open	Setpoint 3 (CP-3)
Shorted	Shorted	Open	Setpoint 4 (CP-4)
Open	Open	Shorted	Setpoint 5 (CP-5)
Shorted	Open	Shorted	Setpoint 6 (CP-6)
Open	Shorted	Shorted	Setpoint 7 (CP-7)
Shorted	Shorted	Shorted	Setpoint 8 (CP-8)

Note that the Follower Setpoint Select inputs only determines which setpoint is currently selected. The value of that setpoint is stored in the Control Parameter (CP-1 through CP-8).

INTEGRAL ZERO

The Integral Zero input is used to set the Integral term of the PID control algorithm to zero. If a position error is present that cannot be corrected for by the M-Rotary (such as a disabled drive), this input can keep the M-Rotary output from integrating upward.

POSITION RESET

The Position Reset input is used to reset the alignment (position error) memory to zero. It may be necessary to use the position reset input to clear the alignment memory after stopping the M-Rotary and manually realigning the machine or product. The M-Rotary maintains the position information in the Run, R-Stop and F-Stop states. This position information is cleared in the Jog states.

BATCH INITIATE

Closing the Batch initiate input resets the batch count (MV-45) to zero. The batch count indicates the number of complete batches since the last batch initiate closure.

KEYPAD LOCKOUT

Closing the Keypad Lockout input disables the operator keypad from making control parameter changes. Monitoring or viewing variables remain enabled when this input is closed.

PHASE ADVANCE/PHASE RETARD

The Phase Advance and Phase Retard inputs are momentary inputs used to increment or decrement the internal phase offset counter allowing proper sync alignment. These inputs can be used to adjust the sync location when it is not possible to mechanically locate the sync sensors at the proper alignment location.

JOG FORWARD/REVERSE

The Jog Forward/Reverse control input controls the voltage polarity of the Speed Command analog output (J1 pin 9) in the Jog state only. For this feature to operate correctly, the motor drive must be in bipolar output format (CP-29=2).

In the Forward (Open) position, the M-Rotary 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.

$\overline{\text{RUN}}$

In the $\overline{\text{RUN}}$ state, the M-Rotary 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).

Four conditions must be true to put the M-Rotary 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 open	(Inhibits JOG)
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.

The Run Control discrete output is activated whenever the M-Rotary is in the Run or Jog States.

JOG

In the JOG state, the M-Rotary 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. The selected JOG speed is set via CP-11. As a maintained input, the jog state is only valid for the duration of the time the operator device is held closed.

Four conditions must be true to put the M-Rotary 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 open (Inhibits RUN)

When the JOG state is terminated, the M-Rotary 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 resets the alignment memory to zero upon completion (clear position information).

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

R-STOP (RAMP STOP)

In the R-STOP state, the M-Rotary decreases the speed command to zero RPM using the specified DECEL rate.

Two conditions must be true to put the M-Rotary into the R-STOP state:

- o Short J4 pin 9 to common (Inhibits F-STOP)
- o Ensure J4 pin 8 is open (Enables R-STOP)

Position information is maintained in the R-STOP state.

F-STOP (FAST STOP)

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

One condition must be true to put the M-Rotary into the F-STOP state:

- o Ensure J4 pin 9 is not connected (Enables F-STOP)

Position information is maintained in the F-STOP state.

CAUTION

The M-Rotary 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-Rotary 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.

PERFORMANCE MONITORING

The M-Rotary provides numerous Monitor Variables available to monitor the controller and system performance. These Monitor Variables are divided into Static, Dynamic and Sync Mode monitoring categories.

STATIC MONITORING

Static Monitoring variables can be checked when the M-Rotary is in a Stop or Run State. These variables are typically used to verify proper wiring.

MV-53: Discrete In - Group A

MV-53 check the status of the Jog, Jog Forward/Reverse, RUN, R-Stop, F-Stop and Keypad Lockout Discrete Switch Inputs. A "1" indicates an open (high) input. A "0" indicates a shorted (low) input.

```
X X X X X X
| | | | | |
| | | | | Jog
| | | | Jog Forward/Reverse
| | | Run
| | R-Stop
| F-Stop
Keypad Lockout
```

MV-54: Discrete In - Group B

Discrete In B displays 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
| Setpoint Select A
Setpoint Select B
```

MV-55: Discrete In - Group C

Discrete In C displays 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
| | | |
| | | Setpoint Select C
| | Integral Zero
| Position Reset
Batch Initialize
```

MV-56: Discrete Out - Group A

Discrete Out A displays 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
| External Reference Sync Missing
Feedback Sync Missing
```

MV-57: Discrete Out - Group B

A "0" in MV-57 indicates that the Lo/Hi alarm output is active (low).

DYNAMIC MONITORING

Dynamic Monitoring variables are typically used to observe the system performance during the RUN state.

MV-40: Tach Cut Length

MV-40 displays the actual cut length based on the present ratio of the the follower to lead speed and the entered scaling parameters.

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: Feedback Velocity

Feedback Velocity is the feedback displayed in RPMs. The feedback input is read by the M-Rotary every 250 microseconds. The readings are summed and averaged for one second before displaying.

MV-44: Product Rate

MV-44 displays the number of cuts per minute.

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 follower position and the actual follower position (error = ideal - actual). The units for the Position Error are follower 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 inputs vary. A negative error means the follower is ahead of the ideal position. A positive error indicates the follower is behind the ideal position.

MV-51: Alarm Status

MV-51 displays the current status of the alarms in the M-Rotary. 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

SYNC MODE MONITORING

Sync Mode Monitoring variables are used exclusively to monitor Sync Mode performance.

MV-80: Lead Job Space - Average

MV-80 displays the number of encoder lines that are occurring on the External Reference Frequency input between the time the Lead Sync pulses occur. This number is averaged over 16 job spaces. In sync mode, when Run is first entered and 16 Lead Sync pulses have not occurred, MV-80 will display the calculated Lead Job Space (refer to Page B-4) until 16 flags have gone by. In non-sync mode, the calculated Lead Job Space is displayed until two Lead Sync pulses have occurred, then the actual encoder line count is displayed with every new lead sync pulse.

MV-81: Follower Job Space - Average

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. In sync mode, when Run is first entered and 16 Follower Sync pulses have not occurred, MV-81 will display the calculated Follower Job Space (refer to Page B-4) until 16 Follower Flags have occurred. In non-sync mode, the calculated Follower Job Space is displayed until two Follower Sync pulses have occurred, then the actual encoder line count is displayed with every new follower sync pulse.

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

MV-82 will display a value of zero until the first 16 Lead Sync flags have occurred.

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-Rotary has not yet determined the Follower Job Space variance or this variable has no meaning in the selected operating mode.

MV-83 will display a value of zero until the first 16 Follower Sync flags have occurred.

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-Rotary 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-Rotary 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-Rotary. 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

MV-87: Lead Job Space - Present

MV-87 displays the most recent number of encoder lines that occurred on the External Reference Frequency input between the time the last two lead Sync pulse occurred. This variable is only operable when the M-Rotary is in the Follower mode and the Run state.

MV-88: Follower Job Space - Present

MV-88 displays the most recent number of encoder lines that occurred on the Feedback Frequency input between the time the last two Follower Sync pulses occurred. This variable is only operable when the M-Rotary is in the Follower mode and the Run state.

TUNING

The Tuning Procedure modifies the control algorithm tuning parameters 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-Rotary tuning.

TUNING PROCEDURE - SPEED LOOP

The first step in tuning the M-Rotary is to achieve stable operation without the position (sync) information present. Disable sync operation by setting CP-14 to 1 or 2 depending on the follower operation mode.

<u>CP-65: Gain</u> (Kp)

To set the Gain, first set the Integral (CP-66) and Derivative (CP-67) variables to zero. Increase the Gain 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 Gain number slightly until the system stabilizes.

<u>CP-66: Integral</u> (Ki)

Using only Gain, 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.

<u>CP-67: Derivative</u> (Kd)

Derivative is only required if the control is still too sluggish after setting the Gain and Integral parameters. Derivative like Gain, 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-Rotary is to introduce back the position (sync) loop and adjust the position tuning variables. Enable the position (sync) loop by setting CP-14 to 3 or 4 depending on the application.

<u>CP-25: Lag Pulse Unit</u>

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 times 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-62: Gross Error Overspeed

When the M-Rotary 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-19). The Gross Error Overspeed is not active when Synchronized Profiling is activated (see Page 5-22).

CP-63: 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.

The Gross Error Reset is not active when Synchronize Profiling is activated (see Page 5-22)

CP-64: 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. The Gross Error Algorithm is not active when Synchronized Profiling is activated (see Page 5-22).

When using the Gross Error Algorithm, always set the Lead and Lag Pulse Limit values (CP-25 and CP-26) greater than four times the value of the Gross Error Boundary (CP-64).

CP-64, 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-64 value until stability is reached.

SYNCHRONIZED PROFILING

INTRODUCTION

For certain rotary applications, it is desirable or necessary for the speed of the rotary die to match the speed of the web for a portion of the rotary cycle. Two of these applications include the rotary die cutting of films and impression roll printing. A mismatch in speed when cutting certain products, such as films, can rip or tear the product instead of providing a clean cut. Similarly, speed mismatches with impression roll printing may cause smeared print. An embedded feature of the M-Rotary, call Synchronized Profiling, allows a speed match for a portion of the rotary cycle and then recovers during the remainder of the cycle to maintain synchronization between the web and the rotary die.

Figure 5-2 illustrates the Synchronized Profiling feature of the M-Rotary. The profile is defined in terms of speed ratio (follower/lead speed) as a function of lead position (lead encoder lines). The origin or beginning point of the profile is the lead and follower synchronization point. The profile can be separated into two sections, the speed match section and the recovery section. The speed match section is defined by the operator via three Entry Parameters: the Start Match Point (CP-93), the End Match Point (CP-94) and the Speed Match Ratio (CP-90). The recovery section of the profile required to maintain synchronization is automatically generated by the M-Rotary. The recovery section of the profile will consist of a triangular ramp profile that either speeds up or slows down the follower to maintain synchronization. The ramps generated in the triangular profile are at the least rate possible to maintain synchronization thus putting the minimum requirement on drive torque and minimum stress on the mechanical system.

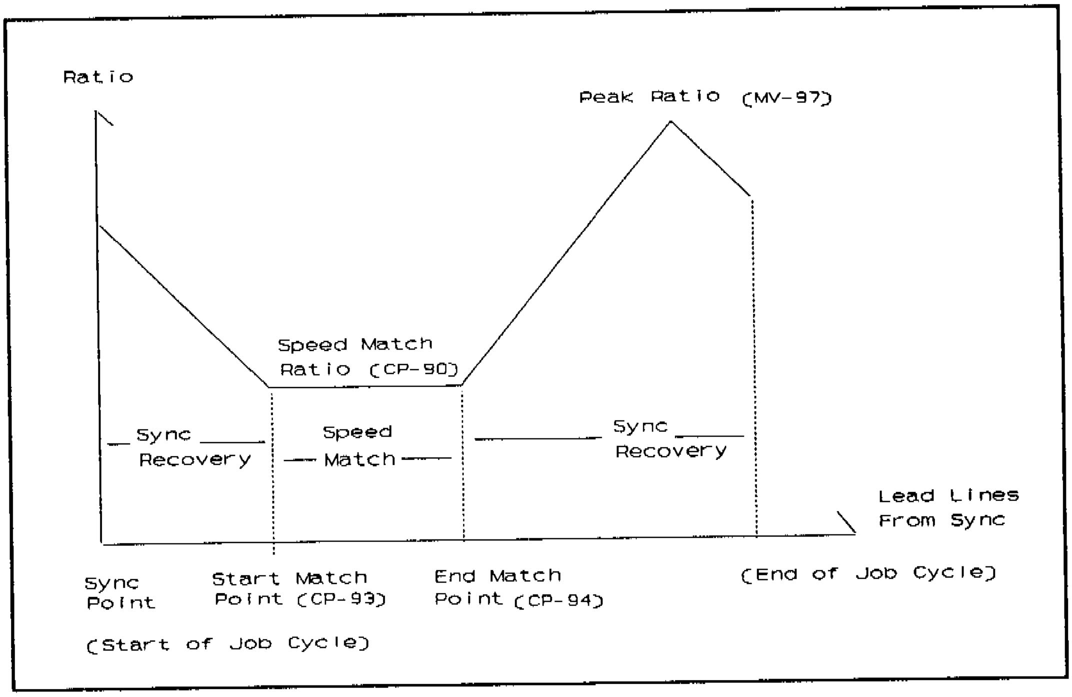

Figure 5-2: M-Rotary Synchronized Profiling

RECOVERY LIMITS

Certain applications may further require the recovery section of the profile to stay below a Maximum Profile Ratio (CP-92) or above a Minimum Profile Ratio (CP-91). When a Minimum Profile Ratio is specified by the operator, The M-Rotary will calculate a new profile with increased ramp rates necessary to maintain synchronization. As stated earlier, the ramp rates utilized are the least rate necessary to maintain synchronization.

Figure 5-3 illustrates Synchronized Profiling with a slow down recovery to a Minimum Ratio.

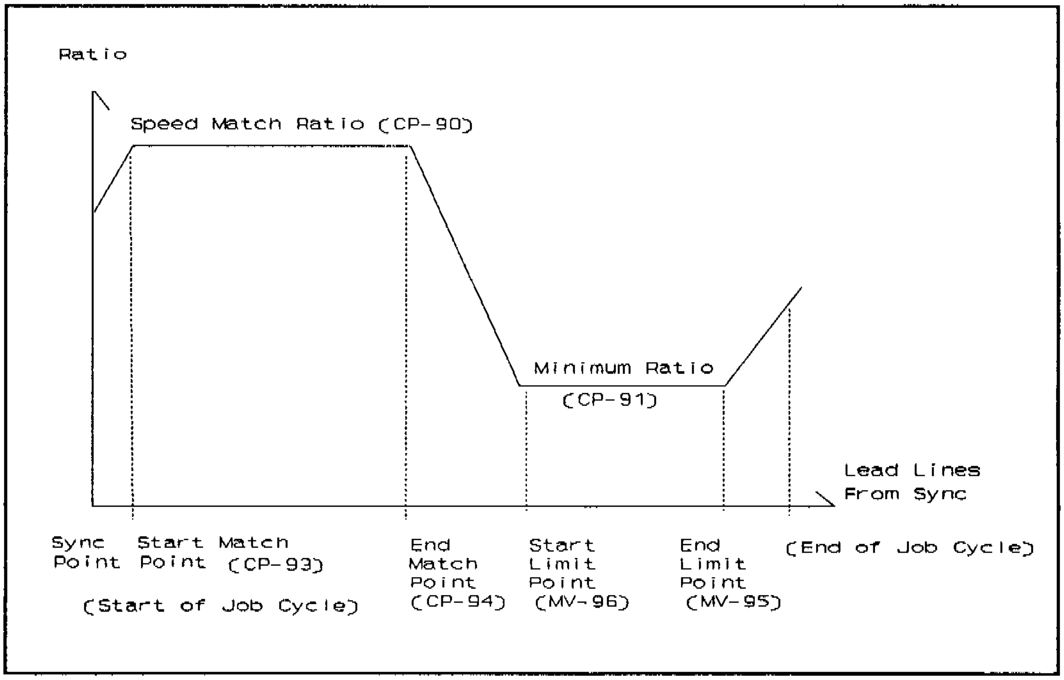

Figure 5-3: Synchronized Profiling with Slow-Down Recovery and Minimum Rates

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SYNCHRONIZED PROFILING CONTROL PARAMETERS

The following is a step-by-step procedure for entering the Control Parameters associated with Synchronized Profiling. Several of these variables have already been discussed under the scaling procedures present on pages 5-5 and 5-6. They are briefly reviewed again this section as they further pertain to scaling associated with the Synchronized Profiling feature.

CP-1 to 8: SETPOINT (Cut Length)

Enter the desired product cut lengths into CP-1 through CP-8. The M-Rotary will adjust the recovery portion of the profile to accommodate changes in product length. When originally setting up the Synchronized Profiling function, it will be easiest to monitor system performance if one of the cut lengths is set the same as CP-15, Engineering Units.

Note: When changing setpoints by way of the logic inputs (Setpoint Select A, B and C), the transfer to the new profile will not occur until the sync point (see Figure 5-2) is reached. To ensure a smooth transfer CP-93 must = zero. If CP-93 does not = zero, any phase change between the old profile and the new profile will result in a possible large sync correction at the time of the transfer. This transfer will **ONLY** happen if the M-Rotary is in the Run state, Sync Profiling is enabled and CP-33 (Sync Lead Auto Enable) =1.

CP-14: CONTROL MODE

CP-14 must be set to either 3 (Sync Rotary Follower Mode) or 4 (Sync Web Follower Mode) in order to utilize Synchronized Profiling. It is possible to use Synchronized Profiling when cutting blank web material (sheeting). For these applications, CP-14 must be set to 3 (Sync Rotary Follower) and CP-33 set to 1 (see CP-33 below).

CP-15: ENGINEERING UNITS

The CP-15 parameter should be set equal to the desired cut length for the setup procedure. It is convenient to set this to one of the most typical product cut lengths used during production.

CP-16: LEAD LINES/CUT

Enter into CP-16 the number of lead encoder lines that occur for the cut length specified by CP-15. Refer to pages 5-5 and 5-6 for greater detail on calculating the CP-16 parameter.

CP-17: FOLLOWER LINES/CUT

Enter into CP-17 the number of Follower encoder lines that occur for the cut length specified by CP-15. In most applications, this will be the number of encoder lines for one rotation of the rotary die. Refer to pages 5-5 and 5-6 for greater detail on calculating the CP-17 parameter.

CP-31: SYNC PHASE

CP-31 is used to adjust the alignment of the follower profile in reference to the follower sync sensor location. When invoking the Synchronized Profiling function, it will typically be necessary to readjust the CP-31 parameter in order to get the Speed Match portion of the rotary profile to occur at the desired rotational location of the rotary. This can be done by either entering the CP-31 value directly via the keypad, or by using the Phase Advance and Phase Retard logic inputs (refer to page 3-14). The CP-31 value is the number of follower lines between the location of the follower sync sensor and the desired location where the follower will begin the speed match with the lead (Start Match Point, CP-93). The M-Rotary will automatically adjust the sync phase to accommodate changes in setpoint (cut length) when using Synchronized Profiling.

5

CP-33: SYNC LEAD AUTO ENABLE

This feature can be used when a lead marker (sync flag) is not available. When enabled (CP-33 = 1), this feature generates an internal lead sync flag at the end of the lead job space. This, along with the follower sync flag from the rotary die allows the user to Synchronize with blank web material.

The following restrictions apply to the Sync Lead Auto Enable feature:

1. This feature should only be used in the Sync Rotary Follower Mode (CP-14=3).
2. CP-33 cannot be changed in the Run state.
3. Input Lead sync pulses are ignored when CP-33 is set to 1.

At the same time the Lead Sync flag is generated, the J1-17 output is driven low (relay activated) for a period of 40 milliseconds. This allows external access to the Lead Sync flag.

CP-90: SPEED MATCH RATIO

The Speed Match Ratio (CP-90) is the ratio of follower encoder lines to lead encoder lines that occur when the follower and lead web surface speeds are the same.

The general procedure for calculating this parameter is to determine the number of lead lines and follower lines that will occur for a given web travel and then divide the follower lines by the lead lines.

The following examples illustrates how the Speed Match Ratio can be calculated:

- The web is driven by a nip roll with a 3-inch radius.
- The nip roll is connected to the motor with a 10:1 gear box.
- The encoder for the nip roll is attached to the motor and has a resolution of 1000 PPR.
- The rotary die has a 6-inch radius.
- The rotary die is connected to the motor via a 20:1 belt reduction.
- The encoder for the rotary die is connected to the motor and has a resolution of 500 PPR.
- The rotary die is the follower (Rotary Follower configuration).

1. The Speed Match Ratio can be calculated for any given travel distance of the web, however, it is easiest to use a distance equal to the circumference of either the nip or the rotary die. Because the rotary die has the larger circumference, let's use this circumference as our web travel distance:

   Web Travel = 2 * π * Radius = 2 * 3.14 * 6 = 37.68 inches

2. The number of follower lines for this distance is now easily calculated as the number of lines for one rotation of the rotary die:

   Follower Lines = Rotations * Gear Box Ratio * Encoder PPR
   = 1 * 20 * 500 = 10000

3. To determine the number of lead lines for the selected web travel, the number of nip rotations must first be determined.

   Nip Rotations = Web Travel / Nip Circumference
   = Web Travel / 2 * π * Nip Radius
   = 37.68 / 2 * π * 3
   = 2

4. The number of lead lines for the given web travel can now be easily calculated:

   Lead Lines = Rotations * Belt Reduction * Encoder PPR
   = 2 * 10 * 1000
   = 20000

5. The final calculation is to divide the follower lines by the lead lines to arrive at the desired ratio:

Speed Match Ratio = Follower Lines / Lead Lines
= 10000 / 20000
= .500

A Web Follower configuration would utilize the same general calculations with the exception of the nip rolls being the follower and the rotary die the lead.

Note: The M-Rotary allows the entry of Speed Match Ratios from 10.000 down to 0.000. It is highly recommended to use ratios between 0.100 and 10.00 or 0.000. With values between 0.000 and 0.100 it may be difficult to achieve good dynamic stability at match speed.

CP-91: MINIMUM PROFILE RATIO

The CP-91 parameter places a lower limit on the minimum ratio that will be used during the recovery section of the profile. This ratio is calculated by dividing the minimum number of permissible follower lines by the maximum number of lead lines. The default Minimum Profile Ratio is 0.

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CP-92: MAXIMUM PROFILE RATIO

The CP-92 parameter places an upper limit on the maximum ratio that will be used during the recovery section of the profile. This ratio is calculated by dividing the maximum number of permissible follower lines by the minimum number of lead lines. The default Maximum Profile Ratio is 10.000.

CP-93: START MATCH POINT

The CP-93 value defines the starting point in the profile where the Speed Match Ratio is applied. This value is entered in terms of lead encoder lines from the sync point. It is recommended that the Start Match Point value be entered slightly ahead of where the actual speed match is required to allow the speed to dynamically stabilize. The Start Match Point does not change with changes in setpoint (cut length).

Synchronized Profiling is disabled when the CP-93 and CP-94 values are set to zero.

CP-94: END MATCH POINT

The CP-94 parameter defines the end point in the profile where the Speed Match Ratio is applied and the beginning of the recovery section of the profile. The End Match Point does not change with changes in setpoint (cut length).

Note: CP-90 through CP-94 cannot be changed in the RUN state when Synchronized Profiling is invoked.

Note: In order to facilitate parameter entry, the M-Rotary permits entry of Synchronized Profile parameters in any order. When the RUN state is entered, the M-Rotary checks for an illegal profile (negative accel and decel ramps, CP-91 > MV-86, CP-92 < MV-86). If an illegal profile is present, Run is not allowed and MV-50 displays a value of "10000." Reenter new profile parameters until a valid profile is present.

CAUTION

The M-Rotary when in the Run state, will be forced into an R-Stop state when a stepoint change is entered which generates an illegal profile.

SYNCHRONIZED PROFILING MONITOR VARIABLES

In addition to the MV-80s set of sync monitor variables and the MV-40s general performance monitor variables, four additional monitor variables have been provided to monitor the performance of the Synchronized Profiling feature.

MV-95: END LIMIT POINT

MV-95 is a static display of the calculated end point of the limit portion of the recovery profile (as limited by CP-91 or CP-92) and the beginning point of the recovery ramp leading to the Start Match Point (CP-93). The distance of the recovery ramp can be determined by subtracting MV-95 from CP-93 (see Figure 5-3).

MV-96: START LIMIT POINT

MV-96 is a static display of the calculated starting point of the limit section of the recovery profile (as limited by CP-91 or CP-92) and the end point of the recovery ramp that occurs after the End Match Point (see Figure 5-3).

MV-97: PEAK RATIO

MV-97 is a static display of the calculated peak ratio during the recovery portion of the profile. If the peak recovery ratio becomes limited by the CP-91 (Minimum Profile Ratio) or CP-92 (Maximum Profile Ratio), then MV-97 will display the relevant CP-91 or CP-92 value.

MV-98: PROFILE RATIO

MV-98 is a dynamic display of the generated (commanded) profile ratio as it is applied throughout the profile cycle. It may be necessary to slow down the lead input frequency (process speed) in order to accurately monitor the profile ratio as it is being generated.

NOTES

INTRODUCTION

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

Messages sent to the M-Rotary 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-Rotary (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-Rotary.

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

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

This chapter is divided into seven sections. M-Rotary Serial Communications Setup describes which CP-xx variables to alter to allow an individual M-Rotary 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-Rotary Response

Data Inquiry - Host Transmission
Data Inquiry - M-Rotary Response

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

6

M-ROTARY SERIAL COMMUNICATIONS SETUP

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

70 - DEVICE ADDRESSES

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

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

71 - BAUD RATE

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

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

72 - CHARACTER FORMAT

The M-Rotary 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

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-ROTARY SERIAL COMMUNICATIONS PROTOCOL

Table 6-1 summarizes the character structure for the M-Rotary 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 6-1: Receive Queue Format

PARAMETER SEND-HOST TRANSMISSION

CHARACTER 1: STX

The leading STX character must be received by the M-Rotary 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-Rotary that is to be accessed. This number differentiates the individual M-Rotary 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-Rotary). The only exception is device address 00, which is universally accepted by all the M-Rotarys 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 7 indlcates 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-Rotary with device address 4:

ASCII Representation: STX 0 4 3 6 0 0 0 0 0 0 5 2 3 0 ETX

HEX Representation:

```
   Device #4     CP-60                Format(+XXXXXX)
STX      |         |                        |     ETX
 \__   __|__  __ __|__  __________________ _|_ __/
   02  3034  33  3630  3030303030353233  30  03
             /              |
  MSG Type 3           Data(00000523)
```

NOTE: Spaces are visual clarity only.

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PARAMETER SEND - M-ROTARY 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

Character 4 is an ASCII Error Code which indicates if any errors existed in the send message received by the M-Rotary. Refer to Table 6-2 to transfer from the ASCII character to the 8-bit binary code.

The 8-bit binary code 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/Lockout During RUN State
Bit 5 - Not Used
Bit 6 - Always 1
Bit 7 - Always 0

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

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

The ASCII Error Code for the last Response Message can also be viewed via MV-74.

ASCII	BINARY	ASCII	BINARY
	Bit 7 Bit 0		Bit 7 Bit 0
@	01000000	`	01100000
A	01000001	a	01100001
B	01000010	b	01100010
C	01000011	c	01100011
D	01000100	d	01100100
E	01000101	e	01100101
F	01000110	f	01100110
G	01000111	g	01100111
H	01001000	h	01101000
I	01001001	i	01101001
J	01001010	j	01101010
K	01001011	k	01101011
L	01001100	l	01101100
M	01001101	m	01101101
N	01001110	n	01101110
O	01001111	o	01101111
P	01010000	p	01110000
Q	01010001	q	01110001
R	01010010	r	01110010
S	01010011	s	01110011
T	01010100	t	01110100
U	01010101	u	01110101
V	01010110	v	01110110
W	01010111	w	01110111
X	01011000	x	01111000
Y	01011001	y	01111001
Z	01011010	z	01111010
[	01011011	{	01111011
\	01011100	|	01111100
]	01011101	}	01111101
^	01011110	~	01111110
_	01011111	DEL	01111111

Table 6-2: Error Code Translation -- ASCII to Binary

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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-Rotary.

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-Rotary.

CHARACTER 15: DATA FORMAT

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

CHARACTER 16: ETX

The message should terminate with the ASCII ETX character.

DATA INQUIRY - M-ROTARY 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 6-10.

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-Rotary 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 in Character 14 which must be decoded to allow interpretation.

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

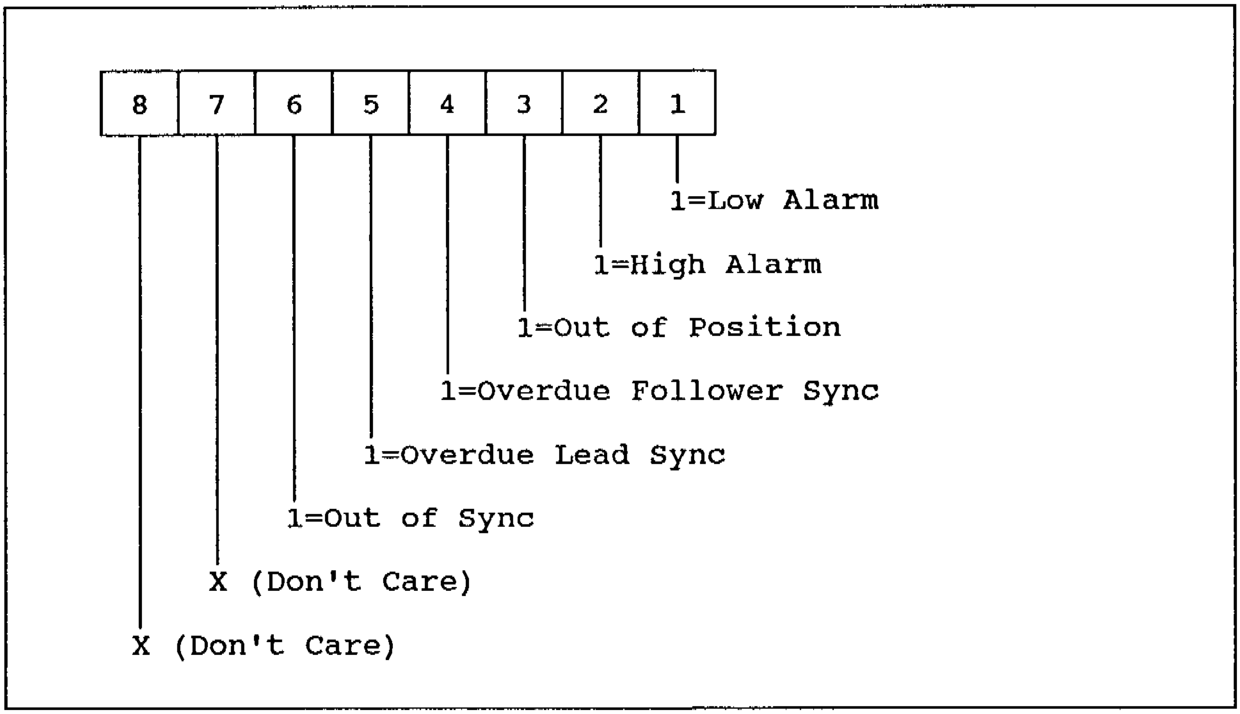

Figure 6-1: MV-51 Interpretation

To illustrate, assume that decimal 5 (HEX 35) is returned by the M-Rotary in response to MV-51 Data Inquiry Command. Using Table 6-3, 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 6-1 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 6-3: 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 6-10.

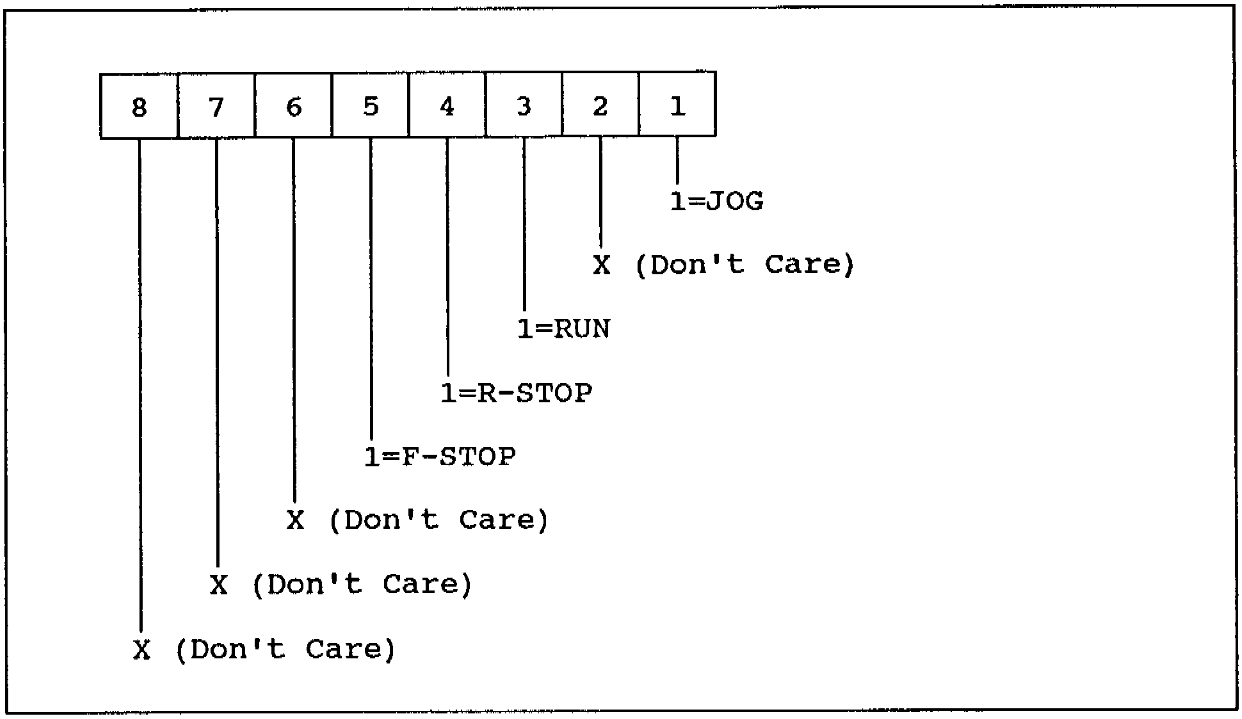

Figure 6-2: MV-52 Interpretation

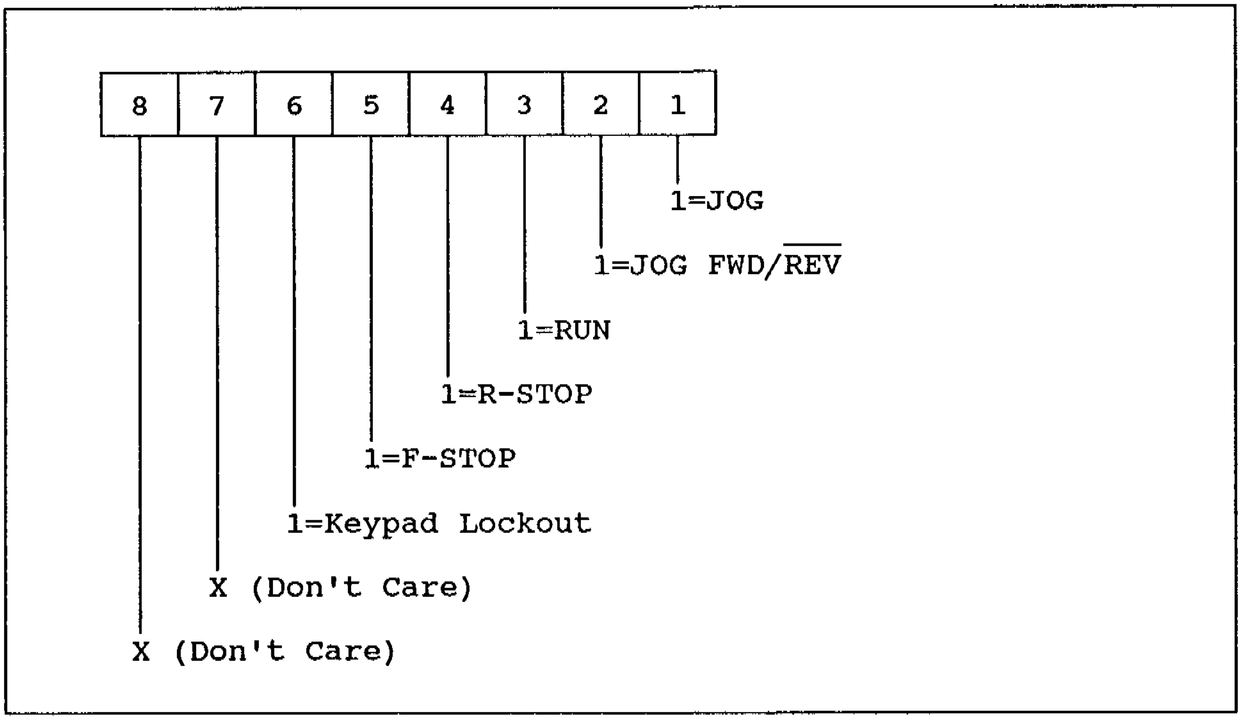

Figure 6-3: MV-53 Interpretation

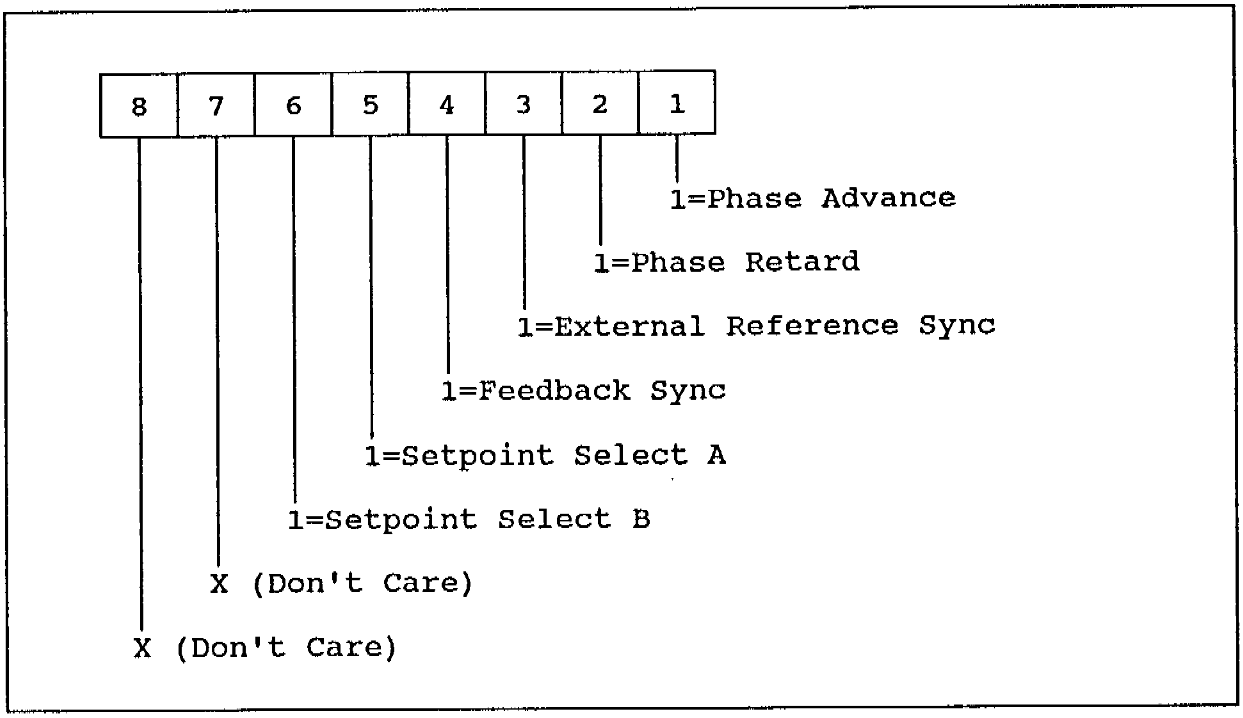

Figure 6-4: MV-54 Interpretation

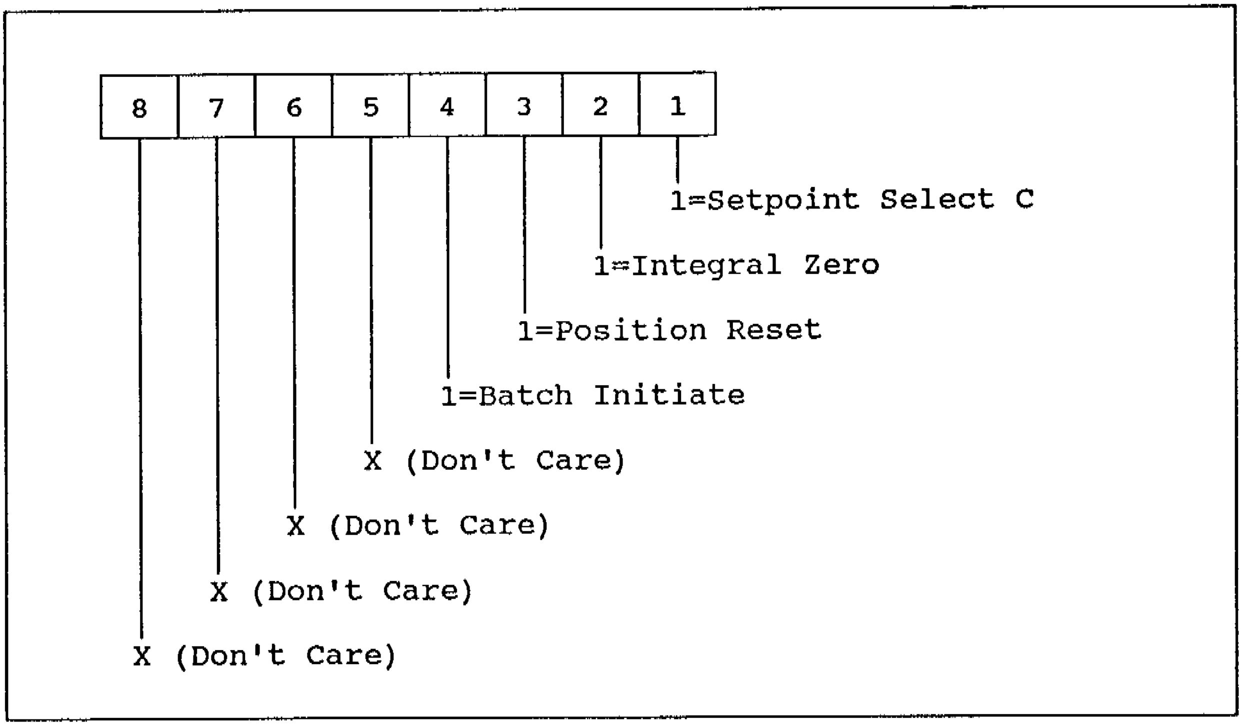

Figure 6-5: MV-55 Interpretation

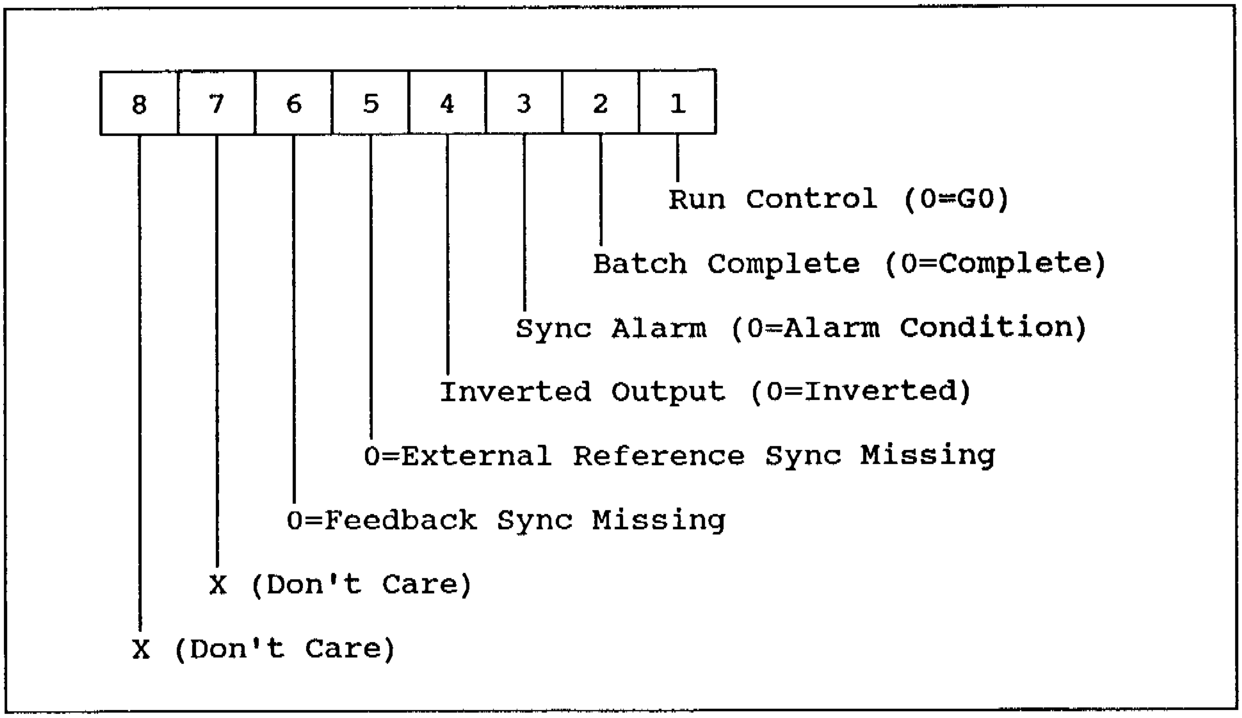

Figure 6-6: MV-56 Interpretation

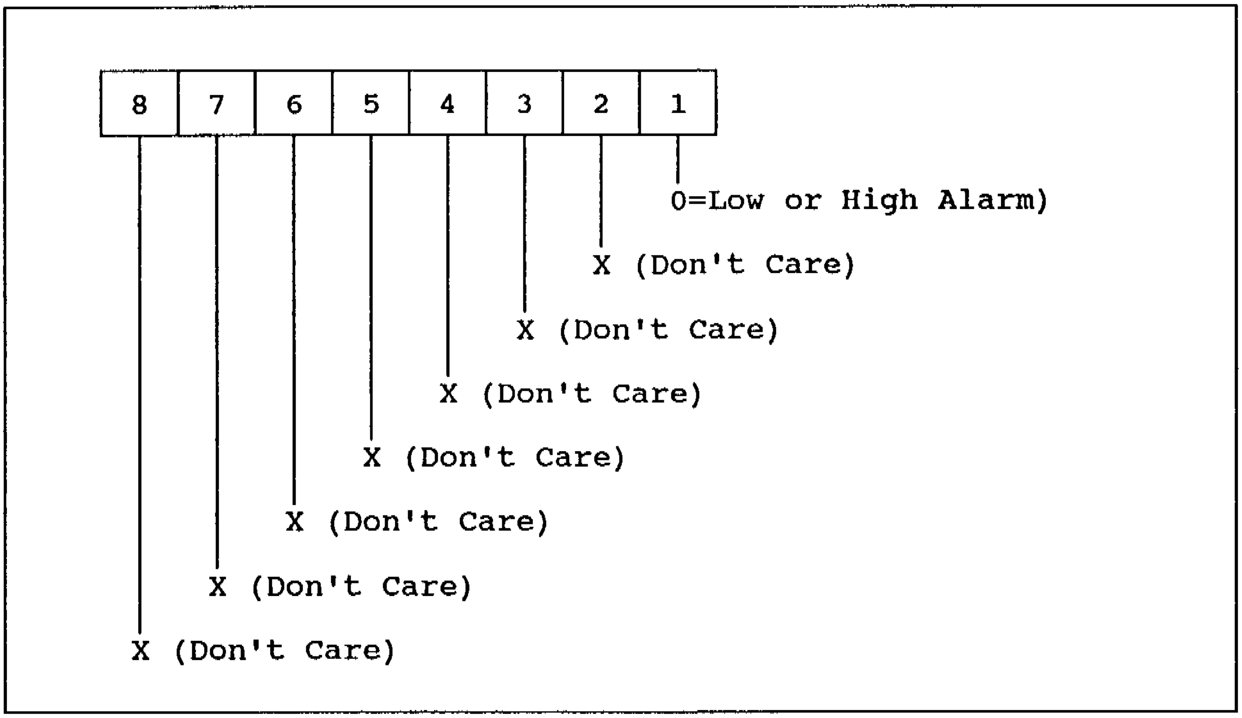

Figure 6-7: MV-57 Interpretation

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.

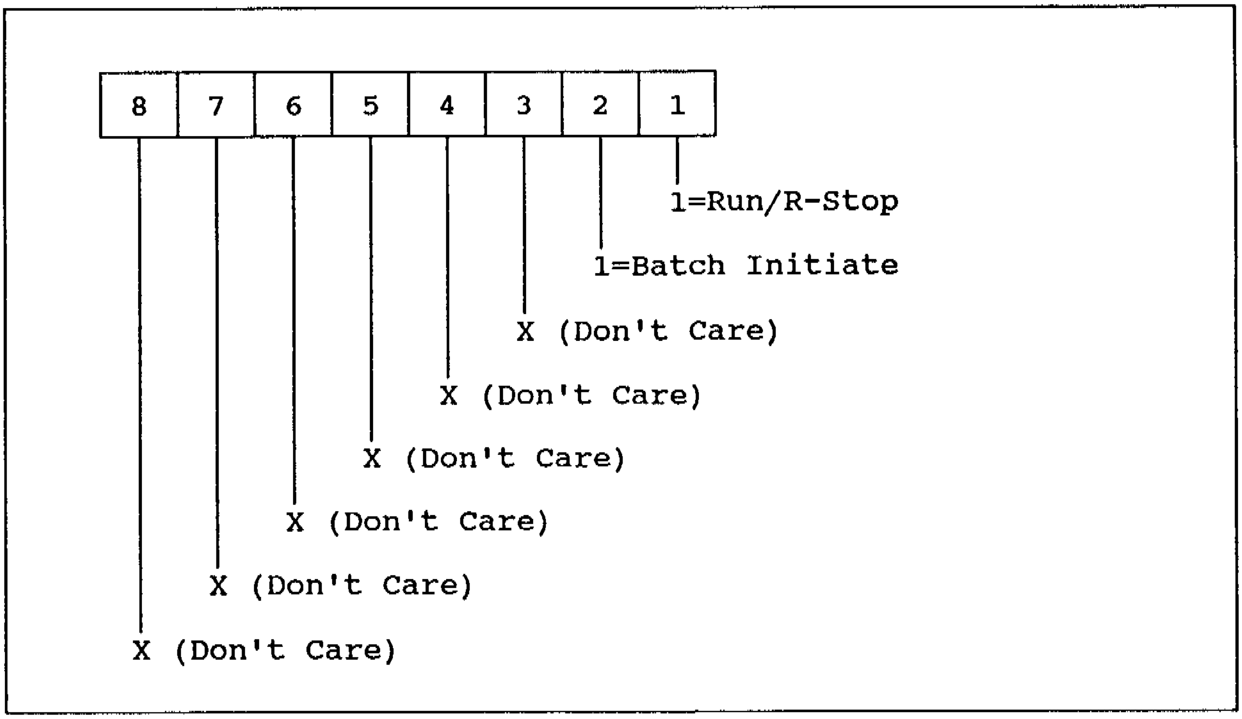

Figure 6-8: CP-73 Interpretation

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-Rotary device address. A device number of "00" for characters 2 and 3 will be recognized by all devices on the 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 used (Characters 2 and 3 set to zero), then Characters 7 through 10 should be omitted. This will reduce 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 - Not Used	12 - Not Used
05 - Not Used	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-ROTARY RESPONSE

CHARACTER 1: STX

The message always begins with the ASCII STX character.

CHARACTERS 2 & 3: DEVICE NUMBER

The device address of the M-Rotary.

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.

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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-Rotary.

CHARACTER 15: DATA FORMAT

Always 0 for this message type.

CHARACTER 16: ETX

Message always terminates with the ETX character.

NOTES

INTRODUCTION

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

Diagnostics	Provides information for running the M-Rotary Diagnostic Routines.
Noise Recovery	Provides information to recover from EMI noise (indicated by -----1, ------2 or -----3 M-Rotary 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-Rotary to the default factory settings.

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

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

DIAGNOSTICS

The M-Rotary contains a number of internal diagnostic routines designed to verify that the M-Rotary is running correctly, and to identify specific M-Rotary 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-Rotary input values, and verifying subsequent M-Rotary frequency calculations.

CLEAR/4 POWER UP TESTS

Initiate Test

1. Remove power from the M-Rotary.
2. While simultaneously pressing "CLEAR" and "4" on the Operator Keypad, apply power to the M-Rotary.
   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.

7

1. RSEG TEST

1. Display "HELP 1" in the M-Rotary 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-Rotary 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-Rotary 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-Rotary upper display.
2. Press ENTER to start test.
3. M-Rotary 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-Rotary 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-Rotary upper display.
2. Press ENTER to start test.
3. Press each Operator Keypad Key. The M-Rotary 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-Rotary upper display.
2. Press ENTER to start test.
3. Close input switches. The M-Rotary 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
SET.SEL A	(J3-13)	12	F-STOP	(J4-9)	04
SET.SEL B	(J3-15)	13	KEYLOCK	(J4-11)	05
SET.SEL C	(J3-16)	14	PHASE ADV	(J4-12)	06
INTEGRAL ZERO	(J4-2)	15	PHASE RET	(J4-14)	07
POS RESET	(J4-3)	16	JOG FWD/REV	(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-Rotary 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	EXT. REF. SYNC ABSENT
2	BATCH CMPL	6	FEEDBACK SYNC ABSENT
3	SYNC ALARM	7	LOW/HIGH ALARM
4	INV OUT		

4. Press CLEAR to exit test.

9. SPEED COMMAND OUTPUT TEST

1. Display "HELP 9" in the M-Rotary 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-Rotary upper display.
2. Press ENTER to start test.
3. Failures:
   M-Rotary displays 03 if 300 baud failure.
   M-Rotary displays 24 if 2400 baud failure.
   M-Rotary displays 96 if 9600 baud failure.
   M-Rotary displays EE at the end of test if any failures occurred.
4. Pass:
   M-Rotary displays PP if there were no failures.
5. Exit is automatic.

VERIFYING M-Rotary 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-Rotary Monitor Variables:
   a) MV-41 (External Reference Input)
   b) MV-42 (Feedback Input)

NOISE RECOVERY

The M-Rotary 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-Rotary indicates that the AC power line voltage is below the specified level for the M-Rotary. 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-Rotary 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-Rotary.
   - 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-Rotary 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-Rotary 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	EPROM Number

EPROM LOCATION

It is possible that the EPROM may be replaced at the customer's location. Figure 7-1 below illustrates the location of this EPROM.

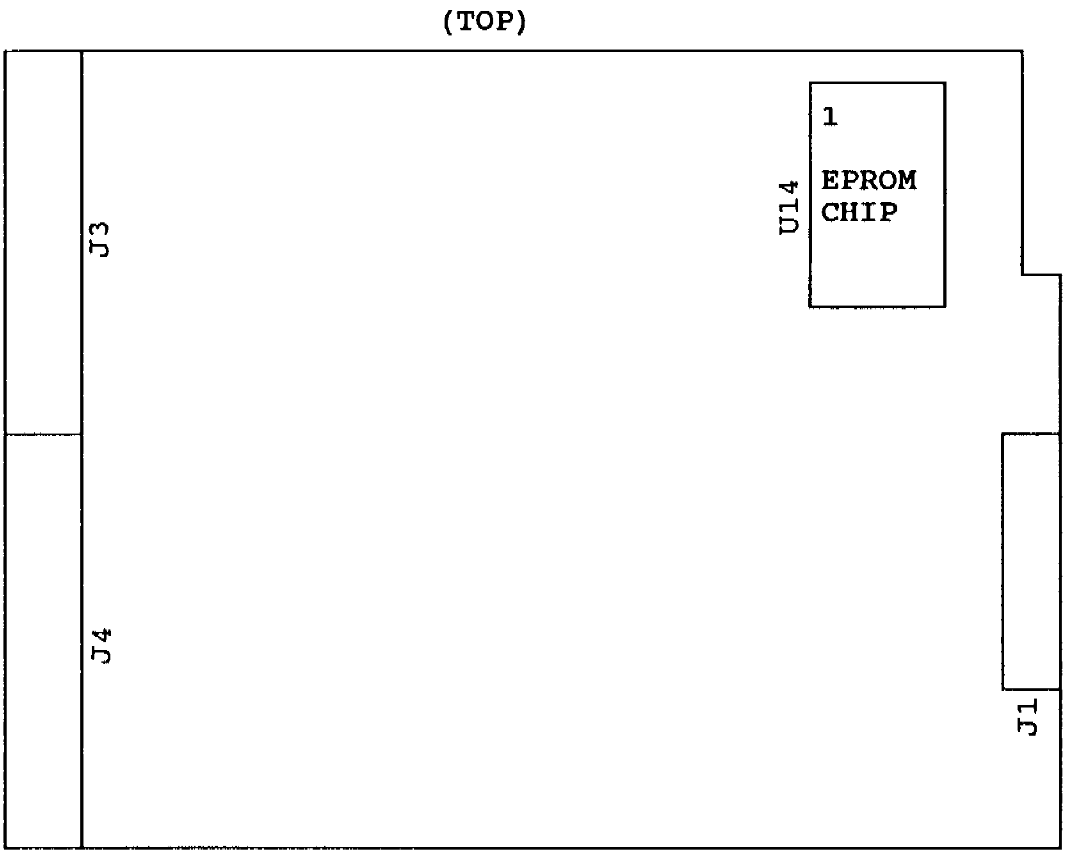

Figure 7-1: EPROM Location

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RESTORE SETTINGS

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

1. Remove power from the M-Rotary.

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

NOTES

INTRODUCTION

For the M-Rotary to accurately control a motor, the M-Rotary 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.

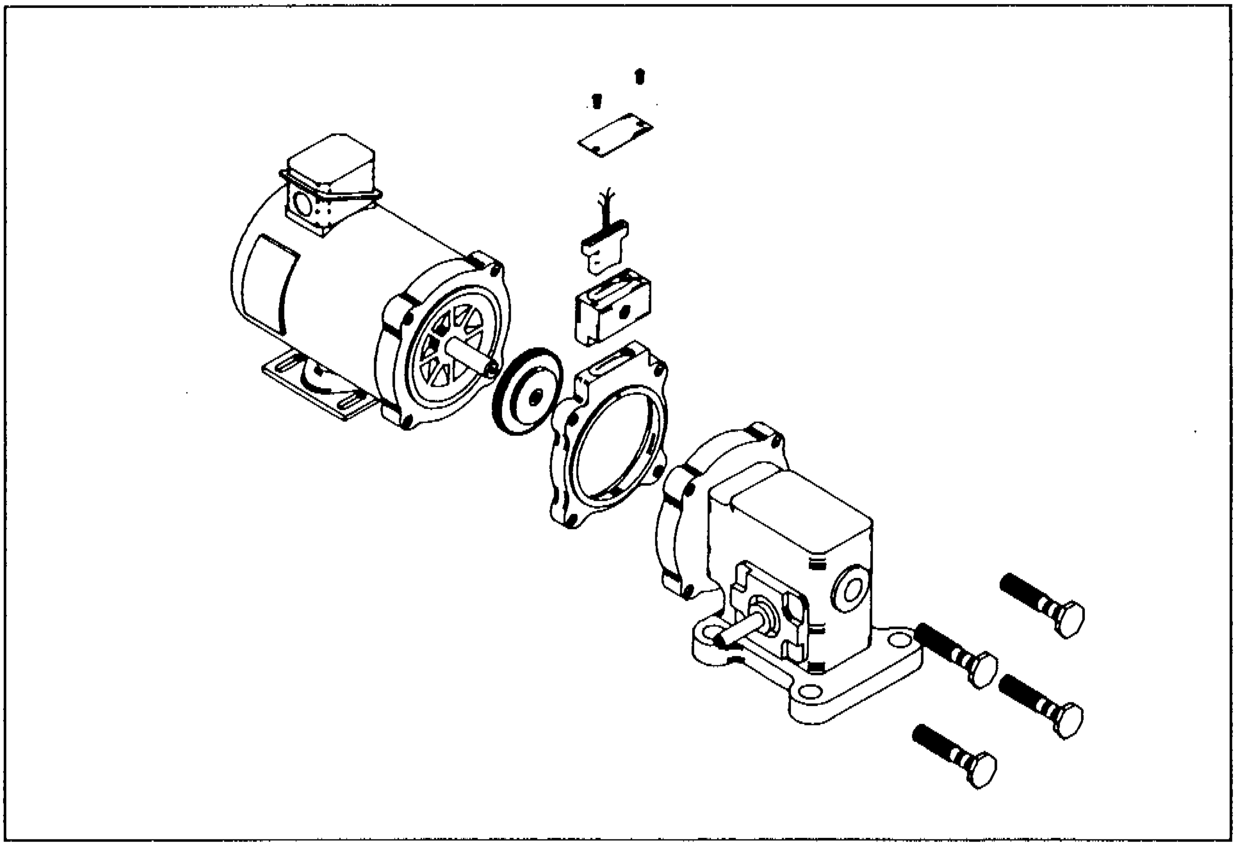


Figure A-1: Hall Effect Ring Kit

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

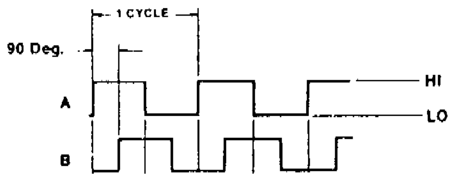
Shaft Diameter: 3/8"
Hollow shaft

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 x 10^{9} revs, at 80 lbs, radial load
Moment of Inertia: 2.0 x 10^{-4} oz-in-sec^{2}
Maximum RPM: 10,000
(also see frequency response)
Weight: 9 oz. typical

ENVIRONMENTAL

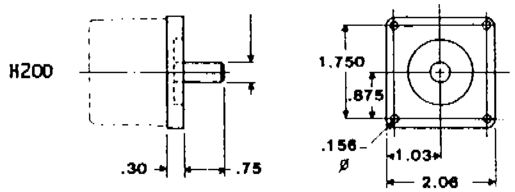
Temperature: Operating: 0 to 70 degrees C standard, extended temperature testing available to -40 $^{\circ}$C (requires oil lube bearing quadrature $\pm 36^{\circ}$C at -40 $^{\circ}$C).
Storage: -25 to 90 $^{\circ}$C
Shock: 50 G's for 11 msec duration
Vibration: 5 to 2000 Hz @ 20 G's
Humidity: 99% RH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

FIGURE 1 - OUTPUT WAVEFORMS



DIMENSIONS

HOUSING TYPE



COVER AND TERMINATION

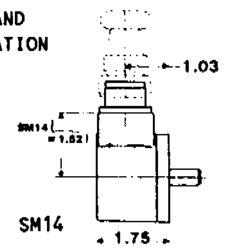
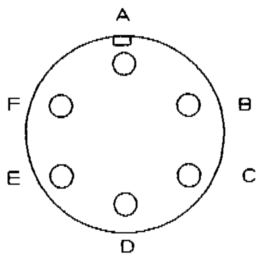


Figure A-2: 3200-1341 Quadrature Encoder: Specifications and Dimensions

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-ROTARY FEEDBACK

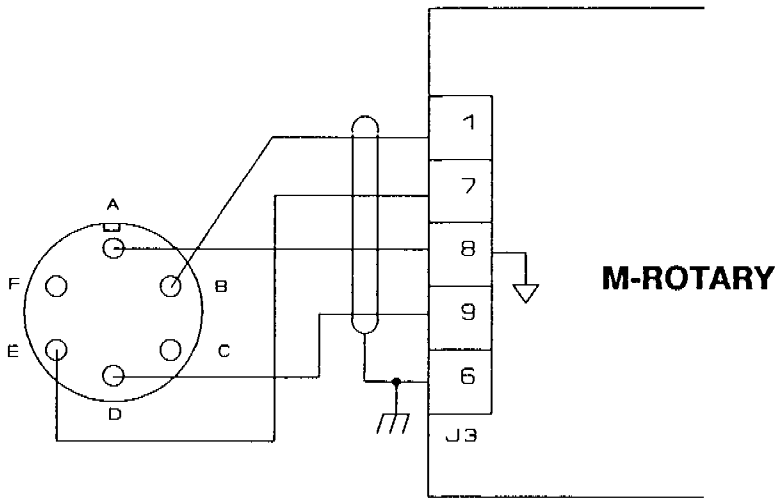


Figure A-3: 3200-1341 Quadrature Encoder Connections

NOTES

APPENDIX B - FORMULAS

INTRODUCTION

This appendix contains the actual formulas used to calculate M-Rotary Speed Control values, and is divided into four sections: Tach, Product Rate Display, Engineering Unit Setpointing and Job Space.

TACH - CUT LENGTH DISPLAY (MV-40)

MV-40 displays the tach or cut length value. The first equation below illustrates the verbal description of this equation, while the second equation illustrates the coded version of this equation. The third equation illustrates the ratio calculation.

$$\text{Cut Length} = \frac{\text{Eng. Units}}{\text{Ratio}} * \frac{\text{Follower Lines/Cut}}{\text{Lead Lines/Cut}}$$

$$\text{MV-40} = \frac{\text{CP-15}}{\text{MV-42/MV-41)}} * \frac{\text{CP-17}}{\text{CP-16}} \quad \text{; for Rotary Follower}$$

$$\text{MV-40} = \frac{\text{CP-15}}{\text{(MV-41/MV-42)}} * \frac{\text{CP-16}}{\text{CP-17}} \quad \text{; for Web Follower}$$

PRODUCT RATE DISPLAY (MV-44)

MV-44 displays the calculated Product Rate (cuts/minute). The calculation used to determine this value depends on whether the M-Rotary is in Sync or Non-Sync Mode. For each of these modes, both verbal descriptions and coded versions are illustrated.

SYNC MODE

$$\textit{Prod Rate} = \frac{\textit{Feedback Freq.}}{\textit{Follower Job Space}} * 60$$

$$\textit{MV-44} = \frac{\textit{MV-42}}{\textit{MV-81}} * 60$$

NON-SYNC MODE

$$\textit{Prod Rate} = \frac{\textit{Feedback Freq.}}{\textit{Follower Lines/Cut}} * 60$$

$$\textit{MV-44} = \frac{\textit{MV-42}}{\textit{CP-17}} * 60$$

ENGINEERING UNIT SETPOINTING

This section contains calculations for Engineering Unit Setpointing and Inverted Setpoint Scaling. These calculations apply to both Sync and Non-Sync modes.

ROTARY

$$\textit{Scale Factor (MV-86)} = \frac{\textit{Eng. Unit}}{\textit{Selected Setpoint}} * \frac{\textit{Follower Lines/Cut}}{\textit{Lead Lines/Cut}}$$

$$= \frac{\textit{CP-15}}{\textit{Selected Setpoint}} * \frac{\textit{CP-17}}{\textit{CP-16}}$$

WEB

$$\textit{Scale Factor (MV-86)} = \frac{\textit{Selected Setpoint}}{\textit{Eng. Unit}} * \frac{\textit{Lead Lines/Cut}}{\textit{Follower Lines/Cut}}$$

$$= \frac{\textit{Selected Setpoint}}{\textit{CP-15}} * \frac{\textit{CP-16}}{\textit{CP-17}}$$

JOB SPACE

The following equations are used to determine the Lead and Follower job spaces in Rotary Follower and Web Follower modes.

ROTARY FOLLOWER

$$\text{Lead Job Space (MV-80)} = \frac{\text{Selected Setpoint}}{\text{Eng. Unit}} * \text{Lead Lines/Cut}$$

$$= \frac{\text{Selected Setpoint}}{\text{CP-15}} * \text{CP-16}$$

$$\text{Follower Job Space (MV-81)} = \text{Follower Lines/Cut}$$

$$= \text{CP-17}$$

WEB FOLLOWER

$$\text{Lead Job Space (MV-80)} = \text{Lead Lines/Cut}$$

$$= \text{CP-16}$$

$$\text{Follower Job Space (MV-81)} = \frac{\text{Selected Setpoint}}{\text{Eng. Unit}} * \text{Follower Lines/Cut}$$

$$= \frac{\text{Selected Setpoint}}{\text{CP-15}} * \text{CP-17}$$

APPENDIX C: CODE LIST (COMPLETE TEXT) C

INTRODUCTION

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

CODE SELECT PROCEDURE

The Code Select Procedure allows access to the Control Parameters and Monitor Variables through their unique identification codes. Use the following procedure to access these variables:

1) Open the lower door on the front of the M-Rotary keypad to expose the lower keypad.
2) Press the "Code Select" Key.
3) Enter the desired parameter code number using the numeric keypad.
4) 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 (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 fifteen seconds of a new value being entered, the display reverts to the previous value.

SETPOINTS 1 THROUGH 8

The values for the 8 setpoints below are entered in Engineering Units, and each of these setpoints are utilized by the 4 Primary Follower Modes.

CP-1: SETPOINT 1

Setpoint 1 is invoked when the Setpoint Select A, Setpoint Select B and Setpoint Select C discrete inputs are all open circuits.

CP-2: SETPOINT 2

Setpoint 2 is invoked when the Setpoint Select A input is shorted, and both Setpoint Select B and Setpoint Select C inputs are open circuited.

CP-3: SETPOINT 3

Setpoint 3 is invoked when the Setpoint Select A and Setpoint Select C inputs are open, and the Setpoint Select B input is shorted.

CP-4: SETPOINT 4

Setpoint 4 is invoked when the Setpoint Select A and Setpoint Select B inputs are shorted, and the Setpoint Select C input is open.

CP-5: SETPOINT 5

Setpoint 5 is invoked when the Setpoint Select A and Setpoint Select B inputs are open, and the Setpoint Select C input is shorted.

CP-6: SETPOINT 6

Setpoint 6 is invoked when the Setpoint Select A and Setpoint Select C inputs are shorted, and the Setpoint Select B input is open.

CP-7: SETPOINT 7

Setpoint 7 is invoked when the Setpoint Select A input is open, and the Setpoint Select B and Setpoint Select C inputs are shorted.

CP-8: SETPOINT 8

Setpoint 8 is invoked when the Setpoint Select A, B and C inputs are all shorted.

CP-10: MASTER SETPOINT

CP-10 is used to load the setpoint when in the Master Scaling Mode. The units for the Master Setpoint are encoder RPMs. Note that CP-14 must be set to "5" to activate the Master Mode.

CP-11: JOG SETPOINT

CP-11 is used to load the setpoint for JOG operation. The units for the JOG setpoint are encoder RPMs.

CP-12: DIRECT ANALOG COMMAND

CP-12 is used to directly command the isolated analog output of the M-Rotary. Note that CP-14 must be set to "6" 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-14: CONTROL MODE

CP-14 is used to determine the current M-Rotary control mode. Chapter 1 explains the primary function for each of these control modes.

Use the table below to select the CP-14 value to determine the desired control mode.

CP-14 Value	Control Mode Selected
1	Non-Sync Rotary Follower
2	Non-Sync Web Follower
3	Sync Rotary Follower
4	Sync Web Follower
5	Master Mode
6	Direct Mode

CP-14 values cannot be changed during the RUN state.

CP-15: ENGINEERING UNITS

CP-15 contains the normalized engineering unit value to be used in the M-Rotary scaling calculations. CP-15 is used to establish the proper magnitude for the Engineering Unit Setpointing. Refer to Page 5-5 for a complete discussion of the scaling procedure.

CP-16: LEAD LINES/CUT

The CP-16 value is used in the M-Rotary scaling calculations. It is the number of lead lines that occur on the External Reference Frequency Input when cutting the length entered in CP-15. Refer to Page 5-5 for a complete discussion of the scaling procedure. (CP-16 cannot be changed during Run Mode.)

CP-17: FOLLOWER LINES/CUT

The CP-17 value is used in the M-Rotary scaling calculations. It is the number of follower lines that occur on the Feedback Frequency Input when cutting to the length entered in CP-15. Refer to Page 5-5 for a complete discussion of the scaling procedure. (CP-17 cannot be changed during Run Mode.)

CP-18: PPR FOLLOWER (FEEDBACK)

CP-18 is used to load the PPR (pulses per revolution) of the encoder or sensor on the follower (feedback) shaft. The CP-18 value is used in feedforward and Tach calculations. New values for CP-18 can only be entered in the R-Stop or F-Stop states.

CP-19: MAXIMUM RPM FOLLOWER (FEEDBACK)

CP-19 is used to enter the maximum RPMs of the feedback encoder shaft. The CP-19 value is used in feedforward calculations. New values for CP-19 can only be entered in the R-Stop or F-Stop states.

CP-20: MASTER MINIMUM SPEED

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

CP-21: MASTER MAXIMUM SPEED

CP-21 determines the maximum speed, in encoder RPMs, that the M-Rotary 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 encoder RPMs. If the Feedback RPMs are below the Low Speed Alarm level and CP-28 is set to a value of one or two, then the Lo/Hi Alarm (J1-19) will be activated.

CP-23: HIGH SPEED ALARM

CP-23 is used to enter the High Speed Alarm level in encoder RPMs. If the Feedback RPMs are above the High Speed Alarm level and CP-28 is set to a value of one or three, then the Lo/Hi Alarm (J1-19) will be activated.

CP-24: OUT OF POSITION

CP-24 defines the position error band, in encoder lines, beyond which the M-Rotary 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-Rotary 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-Rotary uses when leading in position (feedback ahead of lead). The entered value units are encoder lines.

CP-27: BATCH LIMIT

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

CP-28: ALARM FORMAT

CP-28 determines which of the Low Speed and High Speed conditions activate the Lo/Hi Alarm Output. If CP-28 = 1, then either a Low or High Alarm activates the output. If CP-28 = 2, then only the Low Speed Alarm activates the output. If CP-28 = 3, then only the High Speed alarm activates the output.

CP-29: OUTPUT FORMAT

CP-29 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-29 to 1; for bipolar operation, set CP-29 to 2.

CP-29 values cannot be changed during the RUN state.

CP-30: SYNC TREND ENABLE

CP-30 can be used to add a trending capability to the M-Rotary. When CP-30="1," the active scale factor is modified by the trending function. Every sixteen job spaces, the M-Rotary 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.

CP-30 values cannot be changed during the RUN state.

CP-31: SYNC 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. The CP-31 entry will create different results if Synchronized Profiling is enabled (refer to Page 5-25 for details).

CP-32: SYNC PHASE INCREMENT

The value in CP-32 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-32 is added to the Phase value (CP-31) every 100 milliseconds. When Phase Retard is activated, the value in CP-32 is subtracted from the CP-31 value every 100 milliseconds.

CP-33: SYNC LEAD AUTO ENABLE

This feature is used with Synchronized Profiling to generate an internal lead sync pulse at the end of the Lead job size. This feature is used for cutting blank material where no cut registration mark is available. Set CP-33 to "1" to enable the Sync Lead Auto Enable feature. See Page 5-25 for additional details.

CP-33 cannot be changed in the RUN state.

CP-35: SYNC FLAG POLARITY

CP-35 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 the table below to select the value of CP-35 for the appropriate sync pulse polarity:

CP-35	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.)

CP-36: SYNC LEAD DIVIDE

CP-36 can be used to reduce the sync rate of the M-Rotary for those processes that may need the maximum sync rate of 20 pulses per second. The lead sync pulses are divided by the CP-36 value before being submitted to the synchronization routine. For example, if CP-36 is set to 3, then every third pulse will be submitted for synchronization. The other two pulses are ignored by the M Rotary. CP-36 is only valid for Sync Web or Sync Rotary Follower Modes. See page 5-9 for additional details.

CP-36 values cannot be changed during the RUN state.

CP-37: SYNC FOLLOWER DIVIDE

CP-37 can be used to reduce the sync rate of the M-Rotary for those processes that may need the maximum sync rate of 20 pulses per second. The follower sync pulses are divided by the CP-37 value before being submitted to the synchronization routine. For example, if CP-37 is set to 3, then every third pulse will be submitted for synchronization. CP-37 is only valid for Sync Web or Sync Rotary Follower Modes. See page 5-9 for additional details.

CP-37 values cannot be changed during the RUN state.

MV-40: TACH - CUT LENGTH

Displays the actual engineering unit cut length during the four primary follower modes. Master and Direct modes display the feedback encoder RPMs.

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: FEEDBACK VELOCITY

Feedback Velocity is the feedback displayed in encoder RPMs. The feedback input is read by the M-Rotary every 250 microseconds. The readings are summed and averaged for one second before displaying.

MV-44: PRODUCT RATE

Displays the number of cuts per minute.

MV-45: BATCH COUNT

MV-45 displays the number of complete batch counts.

MV-46: BATCH REMAINING

MV-46 displays the number of batch counts remaining until the batch limit 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 follower position and the actual follower position (error = ideal - actual). The units for the Position Error are follower 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 inputs vary. A negative error means the follower is ahead of the ideal position. A positive error indicates the follower is behind the ideal position.

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 or invalid scale factor
10000 - Entry Timeout, lockout during Run state or invalid profile

MV-51: ALARM STATUS

MV-51 is used to display the current status of the alarms in the M-Rotary. 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: CONTROL STATE

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

1 - Jog
10 - Not Used
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
| | |  | Jog Forward/Reverse
| | |  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
| Setpoint Select A
Setpoint Select 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
| | | |
| | | Setpoint Select C
| | Integral Zero
| 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
| External Reference Sync Missing
Feedback Sync Missing
```

MV-57: DISCRETE OUT - GROUP B

A "0" in MV-57 indicates that the Lo/Hi alarm output is active (low).

MV-59: LINE 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-60: ACCELERATION TIME

CP-60 is used to enter the Acceleration Ramp Time. The entered value is the equivalent time (in seconds) that the M-Rotary takes to go from 0 to 2000 RPMs. Acceleration Ramps are only active during Jog and Master Mode (not in Follower Scaling Mode).

CP-61: DECELERATION TIME

CP-61 is used to enter the Deceleration Ramp Time. The entered value is the equivalent time (in seconds) that the M-Rotary takes to go from 2000 to 0 RPMs. Deceleration is operable in Master Mode or during an R-Stop.

CP-62: GROSS ERROR OVERSPEED

The Gross Error Overspeed 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-63: GROSS ERROR RESET

CP-63 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-64: GROSS ERROR BOUNDARY

CP-64 sets the error boundary between the PID control algorithm and the Gross Error control algorithm. Units are in encoder lines.

CP-65: GAIN (Kp)

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

CP-66: INTEGRAL (Ki)

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

CP-67: DERIVATIVE (Kd)

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

CP-70: DEVICE ADDRESSES

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

CP-71: BAUD RATE

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

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

CP-72: CHARACTER FORMAT

The M-Rotary 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:

1 = RUN/R-STOP
2 = Batch Initiate

MV-74: COMMUNICATION ERRORS

MV-74 can be accessed to display any receive errors to the M-Rotary. See Page 6-6.

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.

In Sync mode, when RUN is first entered and 16 lead sync pulses have not occurred, MV-80 will display the calculated Lead Job Space (refer to Page B-4) until 16 flags have gone by. In non-sync mode, MV-80 is updated between every pair of Lead Sync flags.

A display value of "LP -- 80" indicates that the M-Rotary 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.

In Sync mode, when RUN is first entered and two Follower Sync Flags have not occurred, MV-81 will display the calculated Follower Job Space (refer to Page B-4) until two Follower Flags have occurred. In non-sync mode, MV-81 is updated between every pair of follower sync flags.

A display value of "LP -- 81" indicates that the M-Rotary 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.

MV-82 will display a value of zero until the first 16 Lead Sync flags have occurred.

A display value of "LP -- 82" indicates that the M-Rotary 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.

MV-83 will display a value of zero until the first 16 Follower Sync flags have occurred.

A display value of "LP -- 83" indicates that the M-Rotary 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-Rotary 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-Rotary 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-Rotary. 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

MV-87: LEAD JOB SPACE - PRESENT

MV-87 displays the most recent number of encoder lines that occurred on the External Reference Frequency input between the time the last two head Sync pulse occurred. This variable is only operable when the M-Rotary is in the Follower mode and the Run state.

MV-88: FOLLOWER JOB SPACE - PRESENT

MV-88 displays the most recent number of encoder lines that occurred on the Feedback Frequency input between the time the last tow Follower Sync pulses occurred. This variable is only operable when the M-Rotary is in the Follower mode and the Run state.

CP-90: SPEED MATCH RATIO

The Speed Match Ratio is the ratio of follower encoder lines divided by lead encoder lines desired during the speed match portion of the synchronized profile. CP-90 cannot be changed in the RUN state.

CP-91: MINIMUM PROFILE RATIO

The CP-91 value is the minimum follower to lead ratio that will be used during the sync recovery portion of the cycle. CP-91 cannot be changed in the RUN state.

CP-92: MAXIMUM PROFILE RATIO

The CP-92 value is the maximum follower to lead ratio that will be used during the sync recovery portion of the cycle. CP-92 cannot be changed in the RUN state.

CP-93: START MATCH POINT

The CP-93 value defines the starting point in the cycle that the CP-90 Speed Match Ratio is applied. This value is entered as lead encoder lines from the Sync Point. Synchronized Profiling is disabled when the CP-93 and CP-94 values are set to zero. CP-93 cannot be changed in the RUN state.

CP-94: END MATCH POINT

The CP-94 value defines the end point in the cycle where the Speed Match Point is applied. This value is entered as lead encoder lines from the Sync Point. CP 94 cannot be changed in the RUN state.

MV-95: END LIMIT POINT

MV-95 displays the calculated beginning point of the recovery ramp leading the Start Match Point (CP-93). The distance of the leading recovery ramp can be determined by subtracting MV-95 from CP-93.

MV-96: START LIMIT POINT

MV-96 displays the calculated end point of the recovery ramp that occurs after the End Match Point (CP-94). The distance of the trailing recovery ramp can be determined by subtracting CP-94 from MV-96.

MV-97: PEAK RATIO

MV-97 indicates the calculated peak ratio during the recovery portion of the cycle.

CP-98: PROFILE RATIO

MV-98 displays the generated profile ratio as it is applied throughout the profile cycle.

MV-99 SOFTWARE CODE REVISION

MV-99 displays the code revision number of the M–Rotary's software (EPROM).

MV-00 SOFTWARE PART NUMBER

MV-00 displays the last four digits of the eight digit part number for the M–Rotary's software (EPROM). The first four digits are assumed to be “1000”.

APPENDIX D - USER'S ACTUAL CODE RECORD D

CODE-TYPE	DESCRIPTION	MIN	MAX	USER SETTING	UNITS
01 -CP	SETPOINT 1	000.000	999999	________	Cut Length
02 -CP	SETPOINT 2	000.000	999999	________	Cut Length
03 -CP	SETPOINT 3	000.000	999999	________	Cut Length
04 -CP	SETPOINT 4	000.000	999999	________	Cut Length
05 -CP	SETPOINT 5	000.000	999999	________	Cut Length
06 -CP	SETPOINT 6	000.000	999999	________	Cut Length
07 -CP	SETPOINT 7	000.000	999999	________	Cut Length
08 -CP	SETPOINT 8	000.000	999999	________	Cut Length
10 -CP	MASTER SETPOINT	-30000	30000	________	RPM
11 -CP	JOG SETPOINT	0	30000	________	RPM
12 -CP	DIRECT ANALOG COMMAND	-4095	4095	________	DAC BITS
14 -CP	CONTROL MODE	1	6	________	CODED
15 -CP	ENGINEERING UNITS	000.000	999999	________	ENG. UNITS
16 -CP	LEAD LINES/CUT	000000	999999	________	LINES
17 -CP	FOLLOWER LINES/CUT	000000	999999	________	LINES
18 -CP	PPR - FOLLOWER	30	6000	________	PPR
19 -CP	RPM - FOLLOWER	100	30000	________	RPM
20 -CP	MASTER MINIMUM SPEED	0	30000	________	RPM
21 -CP	MASTER MAXIMUM SPEED	0	30000	________	RPM
22 -CP	LOW SPEED ALARM	0	30000	________	RPM
23 -CP	HIGH SPEED ALARM	0	30000	________	RPM
24 -CP	OUT OF POSITION	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
28 -CP	ALARM FORMAT	1	3	________	CODED
29 -CP	OUTPUT FORMAT	1	2	________	CODED
30 -CP	SYNC TREND ENABLE	0	1	________	CODED
31 -CP	SYNC PHASE	-99999	99999	________	LINES
32 -CP	SYNC PHASE INCREMENT	1	999999	________	LINES
33 -CP	SYNC LEAD AUTO ENABLE	0	1	________	CODED
35 -CP	SYNC FLAG POLARITY	1	4	________	CODED
36 -CP	SYNC LEAD DIVIDE	1	255	________	CODED
37 -CP	SYNC FOLLOWER DIVIDE	1	255	________	CODED
60 -CP	ACCELERATION TIME	0.1	600.0	________	SECONDS
61 -CP	DECELERATION TIME	0.1	600.0	________	SECONDS
62 -CP	GROSS ERROR OVERSPEED	1	100	________	% OF CP-19
63 -CP	GROSS ERROR RESET	1	60000	________	N/A
64 -CP	GROSS ERROR BOUNDARY	10	999999	________	LINES
65 -CP	GAIN (Kp)	0	30000	________	N/A
66 -CP	INTEGRAL (KI)	0	30000	________	N/A
67 -CP	DERIVATIVE (Kd)	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	3	________	CODED
90 -CP	SPEED MATCH RATIO	O.100	10.000	________	RATIO
91 -CP	MINIMUM PROFILE RATIO	0.000	10.000	________	RATIO
92 -CP	MAXIMUM PROFILE RATIO	0.000	10.000	________	RATIO
93 -CP	START MATCH POINT	0	999999	________	LINES
94 -CP	END MATCH POINT	0	999999	________	LINES

NOTES

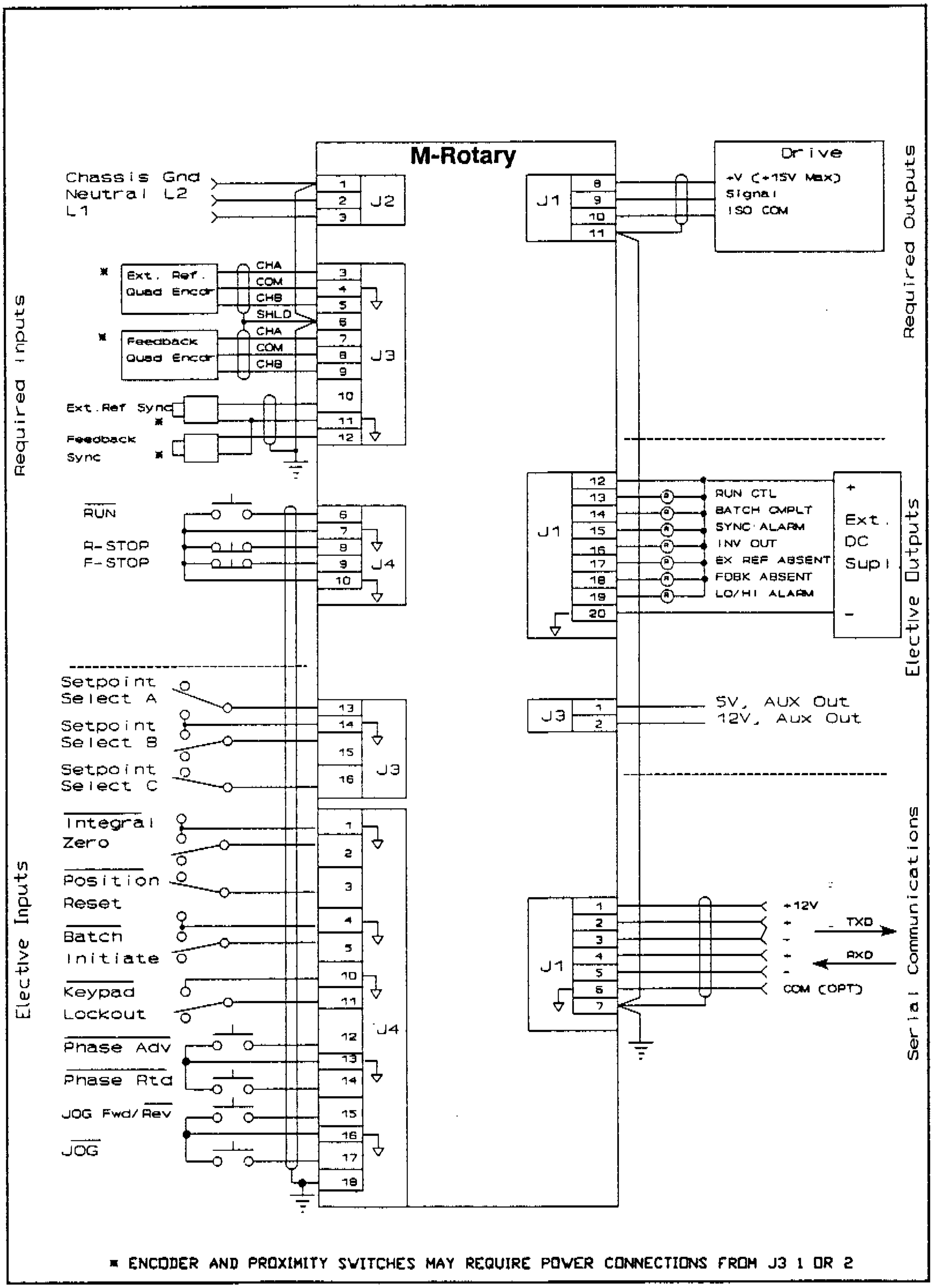
APPENDIX E: CODE LIST QUICK REFERENCE

CODE-TYPE	DESCRIPTION	MIN	MAX	DEFAULT	UNITS
01 -CP	SETPOINT 1	000.000	999999	0	CUT LENGTH
02 -CP	SETPOINT 2	000.000	999999	0	CUT LENGTH
03 -CP	SETPOINT 3	000.000	999999	0	CUT LENGTH
04 -CP	SETPOINT 4	000.000	999999	0	CUT LENGTH
05 -CP	SETPOINT 5	000.000	999999	0	CUT LENGTH
06 -CP	SETPOINT 6	000.000	999999	0	CUT LENGTH
07 -CP	SETPOINT 7	000.000	999999	0	CUT LENGTH
08 -CP	SETPOINT 8	000.000	999999	0	CUT LENGTH
10 -CP	MASTER SETPOINT	-30000	30000	0	RPM
11 -CP	JOG SETPOINT	0	30000	50	RPM
12 -CP	DIRECT ANALOG COMMAND	-4095	4095	0	DAC BITS
14 -CP	CONTROL MODE	1	6	1	CODED
15 -CP	ENGINEERING UNITS	000.000	999999	0	ENG. UNITS
16 -CP	LEAD LINES/CUT	000000	999999	1000	LINES
17 -CP	FOLLOWER LINES/CUT	000000	999999	1000	LINES
18 -CP	PPR - FOLLOWER	30	6000	60	PPR
19 -CP	RPM - FOLLOWER	100	30000	2000	RPM
20 -CP	MASTER MINIMUM SPEED	0	30000	0	RPM
21 -CP	MASTER MAXIMUM SPEED	0	30000	3600	RPM
22 -CP	LOW SPEED ALARM	0	30000	0	RPM
23 -CP	HIGH SPEED ALARM	0	30000	2000	RPM
24 -CP	OUT OF POSITION	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
28 -CP	ALARM FORMAT	1	3	1	CODED
29 -CP	OUTPUT FORMAT	1	2	1	CODED
30 -CP	SYNC TREND ENABLE	0	1	0	CODED
31 -CP	SYNC PHASE	-99999	99999	0	LINES
32 -CP	SYNC PHASE INCREMENT	1	999999	1	LINES
33 -CP	SYNC LEAD AUTO ENABLE	0	1	0	CODED
35 -CP	SYNC FLAG POLARITY	1	4	1	CODED
36 -CP	SYNC LEAD DIVIDE	1	255	1	CODED
37 -CP	SYNC FOLLOWER DIVIDE	1	255	1	CODED
40 -MV	TACH - CUT LENGTH	0.0	99999.9	---	CUT LENGTH
41 -MV	EXTERNAL REFER. FREQ.	-99999	120000	---	HZ
42 -MV	FEEDBACK FREQUENCY	-99999	120000	---	HZ
43 -MV	FEEDBACK VELOCITY	-30000	30000	---	RPM
44 -MV	PRODUCT RATE	0.0	999999	---	CUTS/MIN
45 -MV	BATCH COUNT	0	9999	---	COUNTS
46 -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	11111	---	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
59 -MV	LINE NOTCH COUNTER	0	999999	---	COUNTS

Continued

CODE-TYPE	DESCRIPTION	MIN	MAX	DEFAULT	UNITS
60 -CP	ACCELERATION TIME	0.1	600.0	5.0	SECONDS
61 -CP	DECELERATION TIME	0.1	600.0	5.0	SECONDS
62 -CP	GROSS ERROR OVERSPEED	1	100	10	% of CP-19
63 -CP	GROSS ERROR RESET	1	60000	10000	N/A
64 -CP	GROSS ERROR BOUNDARY	10	999999	999999	LINES
65 -CP	GAIN (Kp)	0	30000	3000	N/A
66 -CP	INTEGRAL (Ki)	0	30000	5000	N/A
67 -CP	DERIVATIVE (Kd)	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	3	0	CODED
74 -MV	COMM. ERRORS	0	10000	----	CODED
80 -MV	LEAD JOB SPACE -AVE	0	14400000	----	LINES
81 -MV	FOLLOWER JOB SPACE -AVE	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	0.1000	10.0000	----	RATIO
86 -MV	ACTIVE SCALE FACTOR	0.1000	10.0000	----	RATIO
87 -MV	LEAD JOB SPACE - PRESENT	0	14400000	----	LINES
88 -MV	FOL. JOB SPACE - PRESENT	0	14400000	----	LINES
90 -CP	SPEED MATCH RATIO	0.100	10.000	1.000	RATIO
91 -CP	MINIMUM PROFILE RATIO	0.000	10.000	0.000	RATIO
92 -CP	MAXIMUM PROFILE RATIO	0.000	10.000	10.000	RATIO
93 -CP	START MATCH POINT	0	999999	0	LINES
94 -CP	END MATCH POINT	0	999999	0	LINES
95 -MV	END LIMIT POINT	0	999999	----	LINES
96 -MV	START LIMIT POINT	0	999999	----	LINES
97 -MV	PEAK RATIO	0	10.0000	----	RATIO
98 -MV	PROFILE RATIO	0	10.0000	----	RATIO
99 -MV	SOFTWARE CODE REV	--	--	----	----

APPENDIX F - M-ROTARY PIN OUT



NOTES

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.

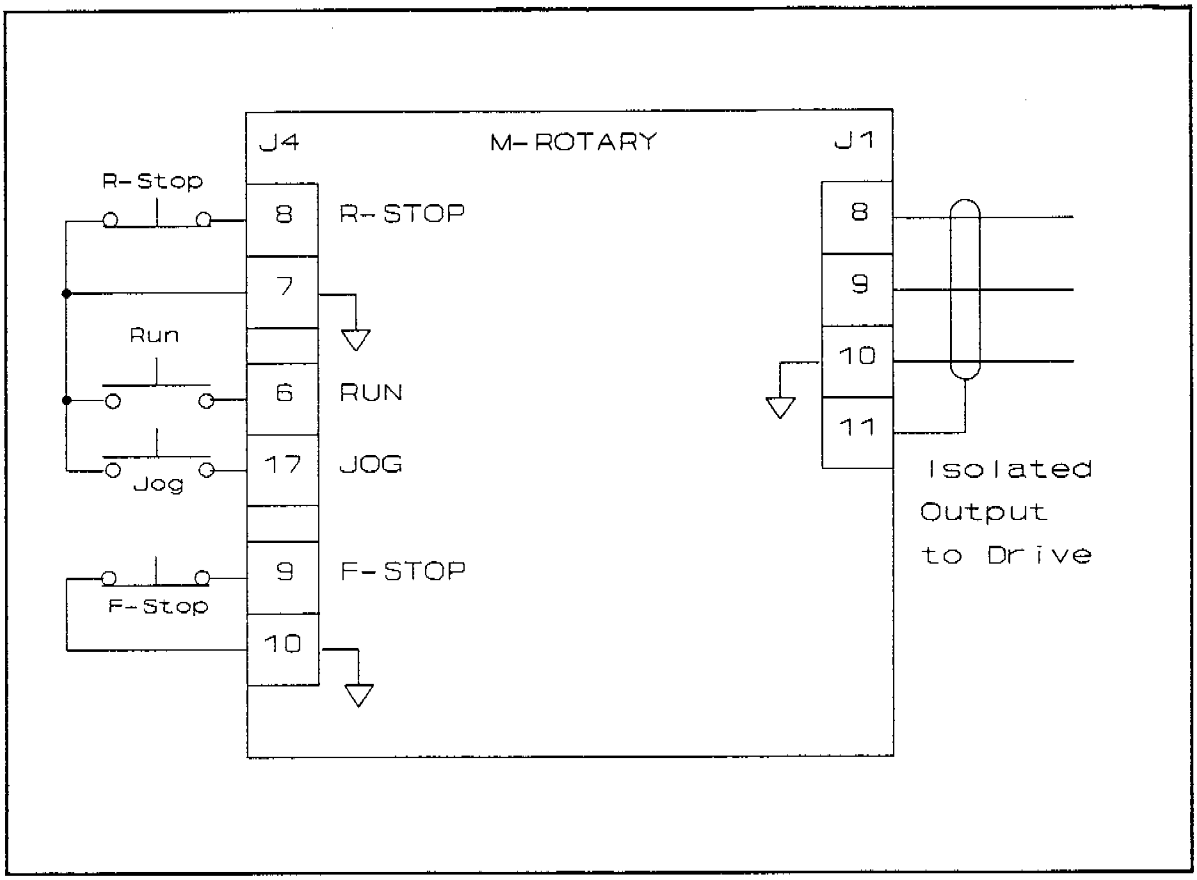


Figure G-1: M-Rotary Wiring Connections without Relays

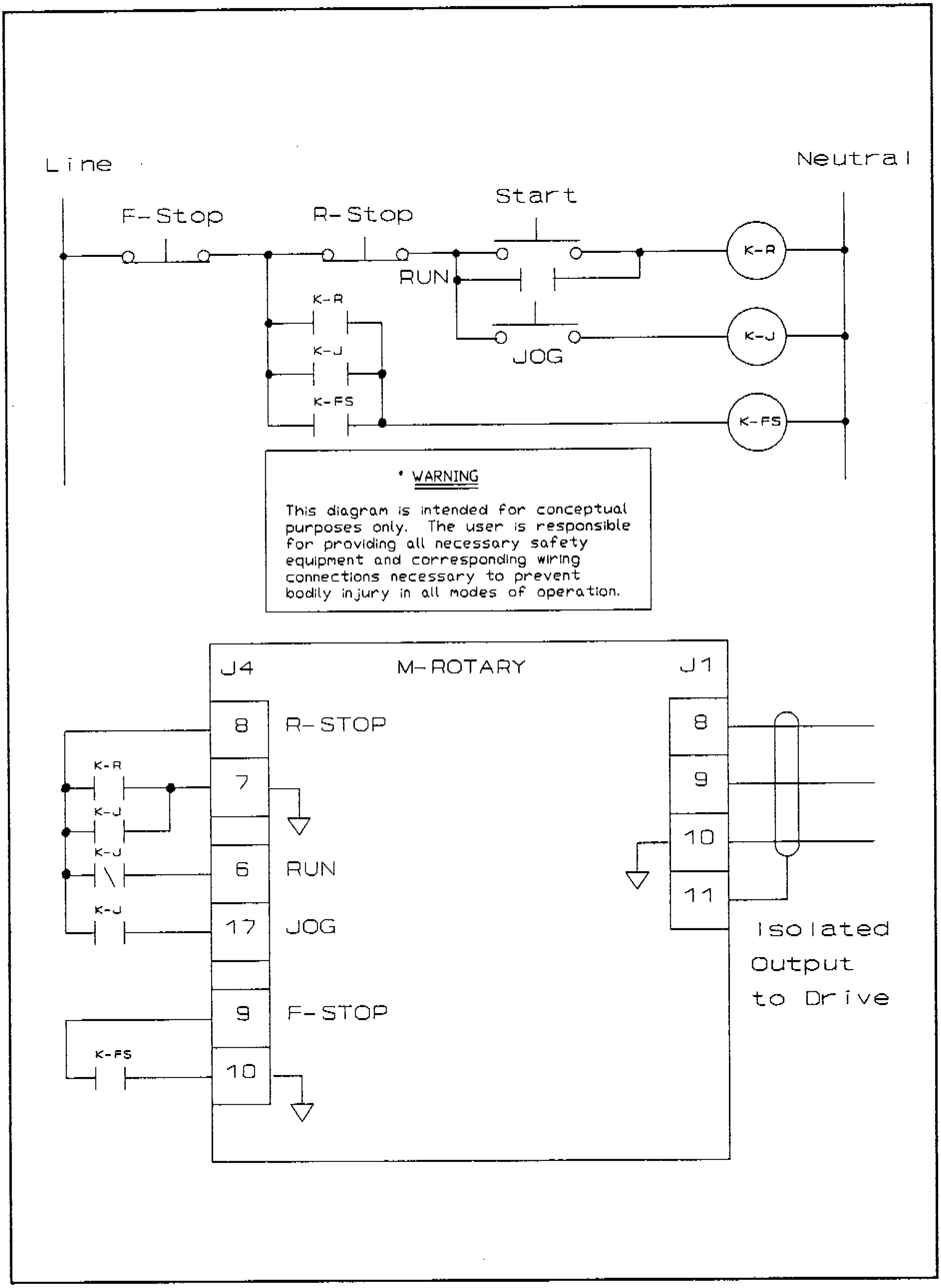


Figure G-2: Relay Start and Stop Wiring Connections

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.

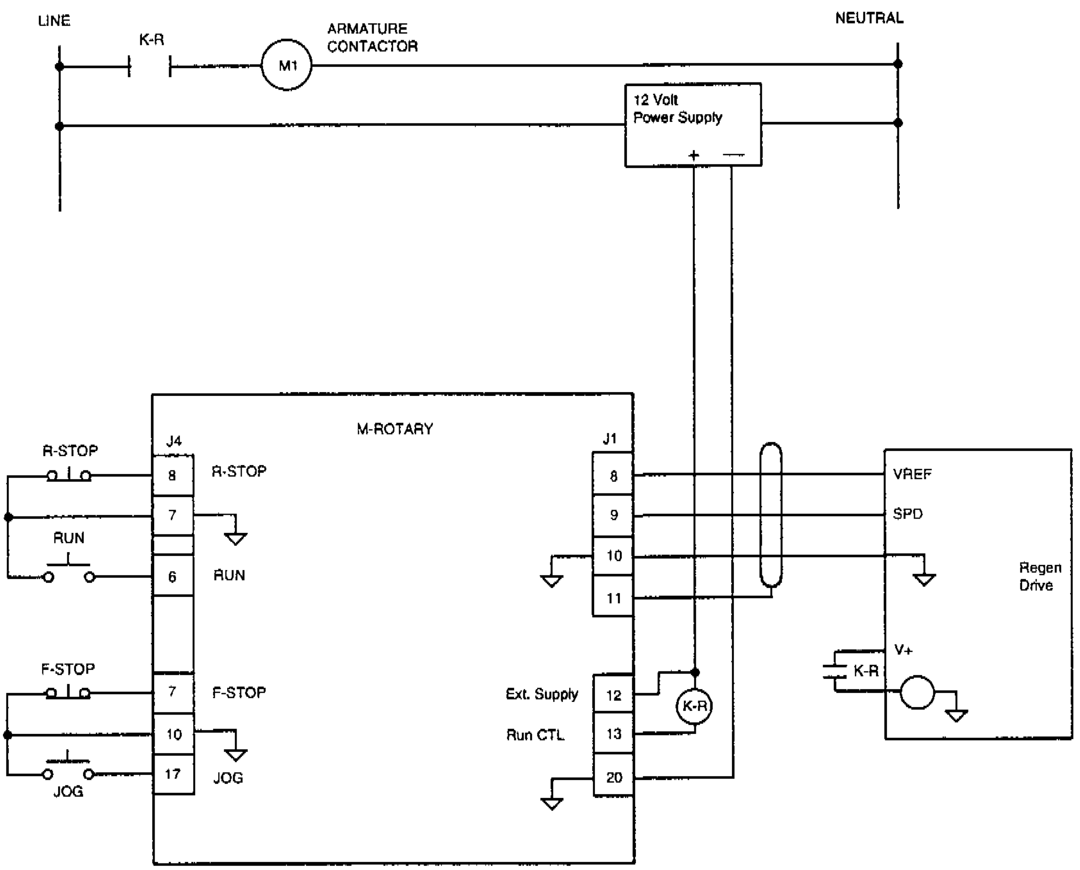


Figure G-3: Start/Stop for Regen with Armature Contactor

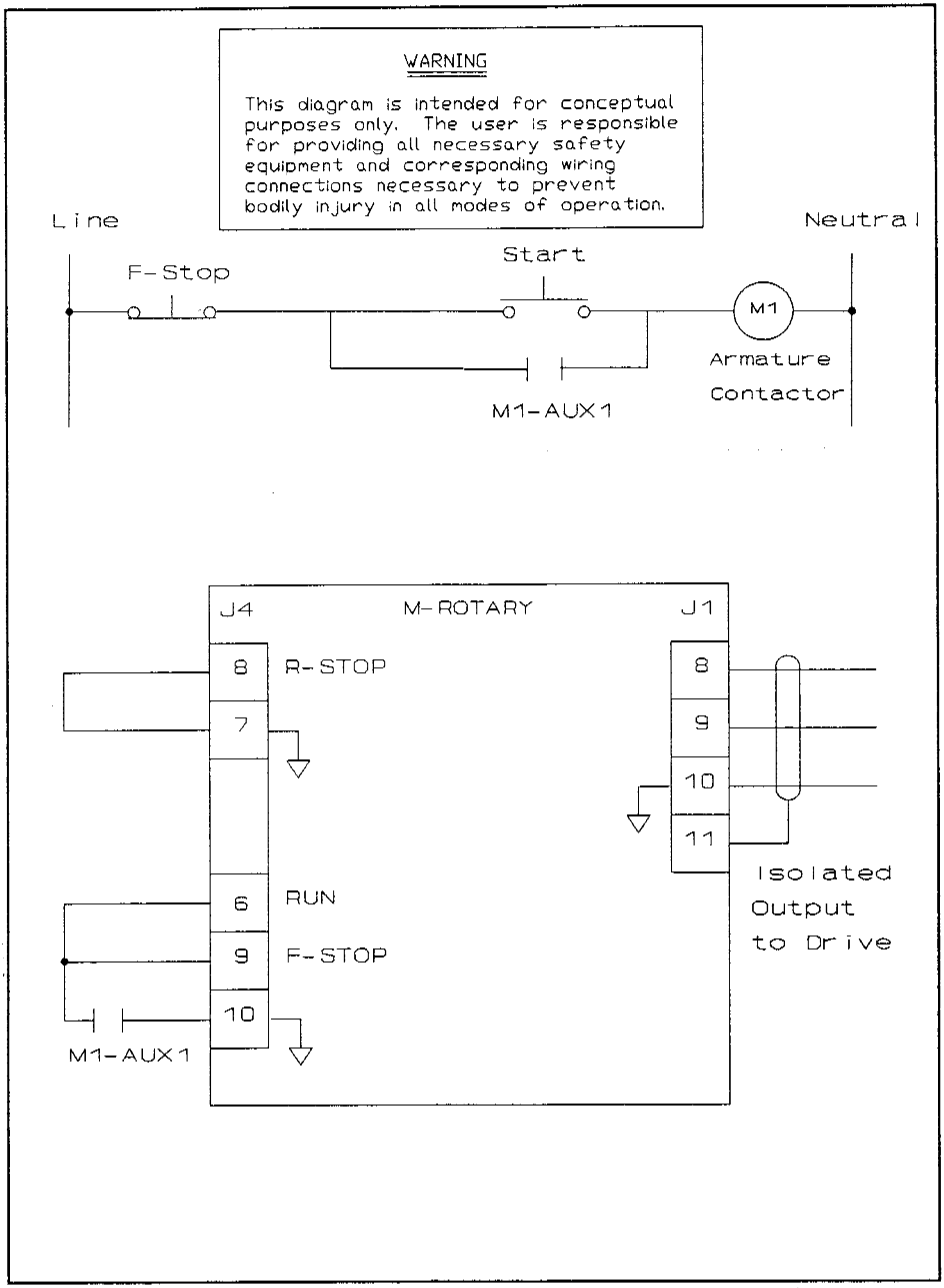


Figure G-4: Start/Stop for Non-Regen with Armature Contactor

INTRODUCTION

This appendix identifies which CP- (Control Parameter) Codes are required for specific scaling modes. If a specific value is required for a Control Parameter code, that value is indicated via an "=" sign.

CONTROL CODES

ITEM	REQUIRED CODES
Primary Follower Modes	
Control Mode	CP-14 = 1 (Non-Sync Rotary Follower) = 2 (Non-Sync Web Follower) = 3 (Sync Rotary Follower) = 4 (Sync Web Follower)
Engineering Units	CP-15
Lead Lines/Cut	CP-16
Follower Lines/Cut	CP-17
PPR Feedback	CP-18
RPM Feedback Max	CP-19
Follower Setpoints	CP-1, CP-2, CP-3, CP-4, CP-5, CP-6, CP-7, CP-8
Master Format	
Control Mode	CP-14 = 5
PPR Feedback	CP-18
RPM Feedback Max	CP-19
Master Setpoint	CP-10
Direct Format	
Control Mode	CP-14 = 6
Direct Analog Command	CP-12

NOTES

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

Bits b_7 b_6 b_5					0 0 0	0 0 1	0 1 0	0 1 1	1 0 0	1 0 1	1 1 0	1 1 1
b_4	b_3	b_2	b_1	COLUMN / ROW	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

Batch Complete: An output used to indicate when the batch count is reached or exceeded.

Batch Initiate: A discrete input used to reset the batch counter to zero.

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

Direct Mode: One of two M-Rotary Secondary Modes. Direct Mode is an open-loop control mode where the operator enters a direct command to the M-Rotary's Isolated Analog Output.

External Reference Frequency Input: A pulse train input used by the M-Rotary to ascertain lead motor speed.

External Reference Sync Input: A frequency input used to indicate the position of the lead product or machine part.

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

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

Feedback Sync Input: A frequency input used to indicate the position of the follower product or machine part.

Lo/Hi Alarm: An output used to indicate when either a low or high alarm condition is present.

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

Jog Forward/Reverse: A digital input which when shorted to common reverses the polarity of the Speed Command Analog Output signal during the Jog State.

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.

INV OUT: An output indicating the polarity of the Speed Command output relative to the Voltage Reference Input.

Master Mode: One of two M-Rotary secondary Modes. Master mode is the most straight forward closed-loop implementation of the M-Rotary. The speed is determined only by the entered setpoint value.

Non-Sync Rotary Follower: One of four M-Rotary primary modes. Non-Sync Rotary Follower is typically used in applications where blank material is cut to a specific length by controlling the rotary die speed.

Non-Sync Web Follower: One of four M-Rotary primary modes. Non-Sync Web Follower is typically used in applications where blank material is cut to a specific length by controlling the web speed.

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

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

RUN: One of four M-Rotary states. In the RUN state, the M-Rotary 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: An output which indicates whether or not the motor should be moving.

Setpoint Selects: Three discrete inputs used to select one of eight setpoints in the primary follower modes.

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

Sync Rotary Follower: One of four M-Rotary primary modes. Sync Rotary Follower is typically used in applications where printed material is cut at a specific location by controlling the rotary die speed.

Sync Web Follower: One of four M-Rotary primary modes. Sync Web Follower is typically used in applications where printed material is cut at a specific location by controlling the web speed.

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.

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.

CONTREX
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