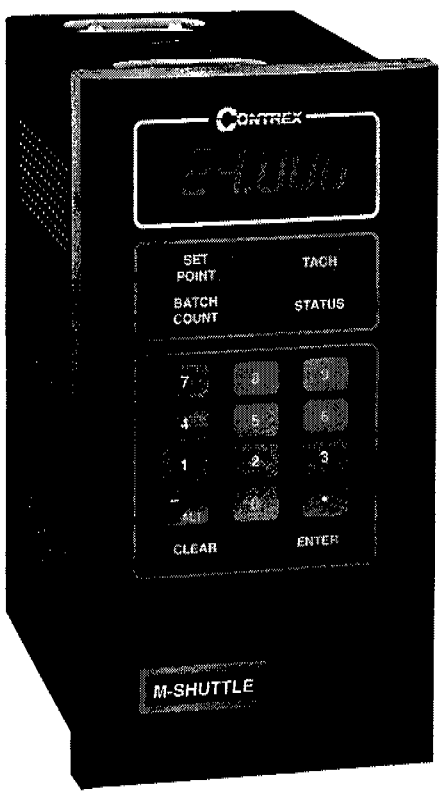
INTRODUCTION

The M-Shuttle is a digital control device designed to be used in reciprocating lead/follower motion industrial applications. These applications are characterized by a constant motion extruded or web product that cannot be halted to be processed (cut, stamped, threaded, etc.). The primary function of the M-Shuttle is to move the process device (saw, grinder, etc.) at the same speed as the product in order to perform the process function at the proper product length. After the process function has been performed, the M-Shuttle moves the process device back to the original home position and the motion profile is repeated. Typical M-Shuttle applications include flying cutoffs of extruded or sheeted types of materials.

Some of the advanced capabilities of the M-Shuttle include four preset engineering unit setpoints (cut lengths), automatic recovery profile generation, keypad error checking, trending, sync registration, batching, and controller accuracy to one encoder line. Three programmed discrete outputs are provided for interfacing to clamping, sawing, grinding, or similar devices. The reverse or recovery portion of the profile is internally calculated using the slowest ramp rate possible to maintain the proper product length and synchronization.

Although the M-Shuttle contains many advanced control features, it has also been designed to be easy to use. The sealed keypad is divided into two panels: a panel for daily operations, and a panel behind a separate door providing access to programming or scaling functions. Dedicated keys are provided for fast access to Setpoint, Batch Count, Tach and Status information. The M-Shuttle also contains an RS-422 serial communications port for supervisory or host monitoring and control.



SHEET WEB FLYING CUTOFF

Another common application for the M-Shuttle is the cutting of sheet web materials such as plywood and foam to specified product lengths. Figure 1-3 illustrates a flying cutoff of sheet web material. Note that with this application, the cutter shuttle is mounted at an angle (typically 60 degrees) to the web.

At the appropriate time based on product length, the M-Shuttle will accelerate the cutter shuttle to a ratioed lead speed based on the sine of the cutting angle. Output A then activates (based on a combination of programmed time and position deviation) the saw blade in order to make the desired cut. Once the cut is complete, the saw blade is deactivated and returned to the Home position. The rate at which the shuttle is returned is matched to the product cut length. The motion profile is then repeated to make the next product cut.

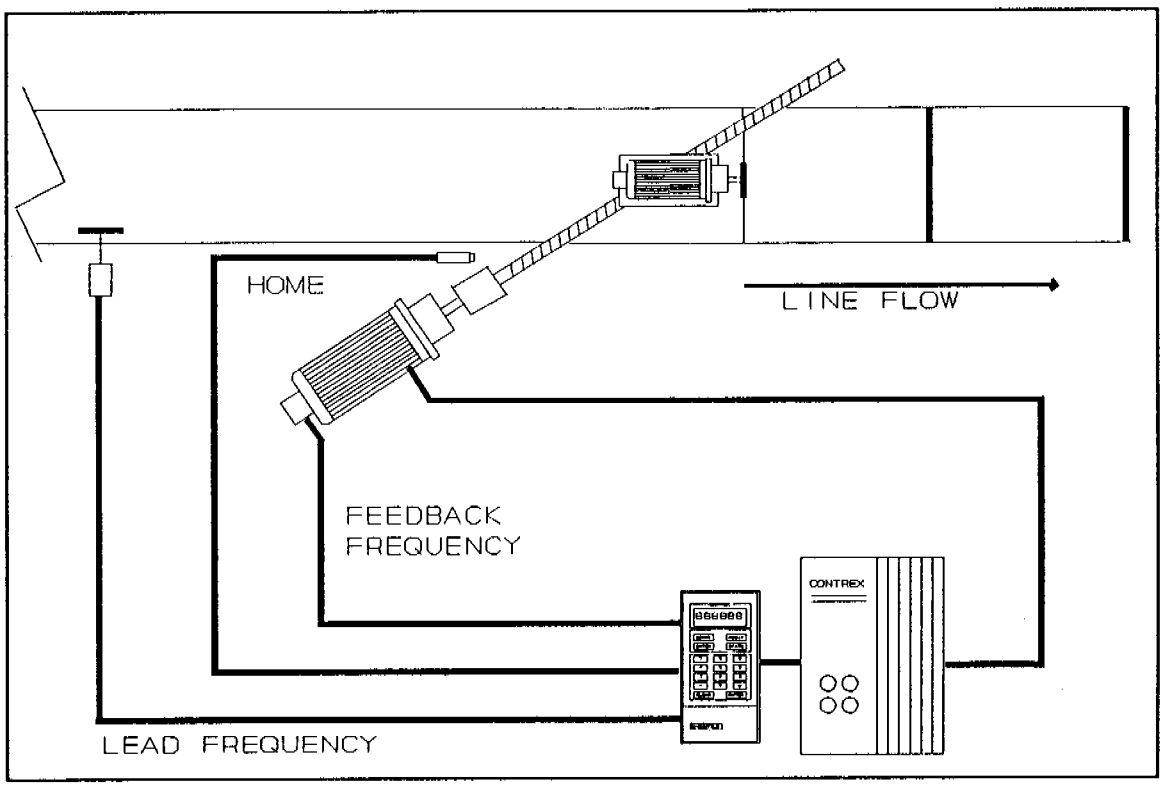


Figure 1-3: Web Flying Cutoff

M-SHUTTLE PROFILE

The M-Shuttle allows up to four preset Follower profiles to be programmed prior to entering the Run state. The active profile is then selected via the Setpoint Select A and Setpoint Select B switch inputs.

Figure 1-4 illustrates a typical M-Shuttle profile. An M-Shuttle profile is defined by the Follower/Lead ratio as a function of Lead encoder lines. The origin of the profile is the point of Follower and Lead synchronization. From this point, the Follower ramps up (Accel Length) to the Process Ratio where the Follower typically matches the Lead speed. This process ratio is maintained for the duration of the process function (Process Length). The ratio is then ramped down (Decel Length) and maintained at zero speed (Forward Dwell) before returning the shuttle to the Home (sync) position in the reverse direction. The negative ratio (reverse) portion of the profile is referred to as the recovery portion of the profile. The ramped recovery portion of the profile is internally calculated by the M-Shuttle. The calculated ramp rates return the shuttle to the Home Sync position at a rate determined by the product length. Shorter product lengths will result in faster recovery profiles. A Reverse Dwell can be entered to maintain the shuttle at zero speed before moving forward again with the next profile.

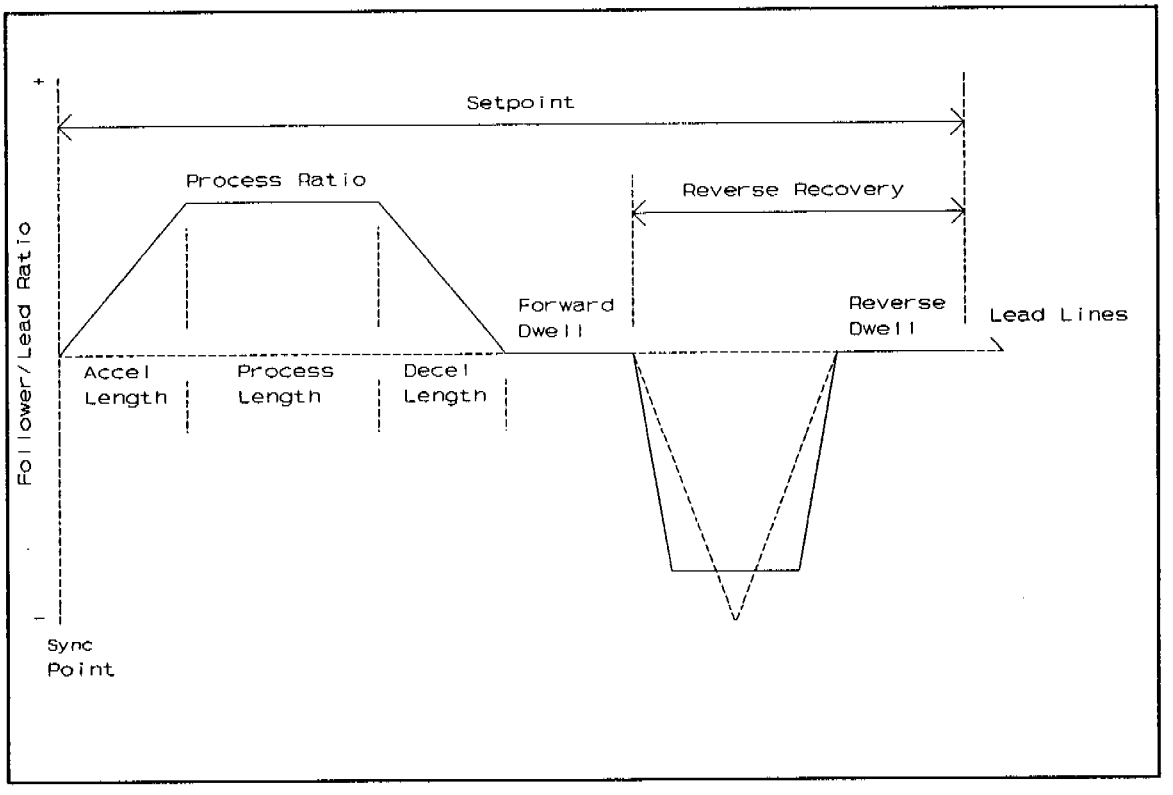


Figure 1-4: M-Shuttle Profile

CONFIGURATION 2

INTRODUCTION

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

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.

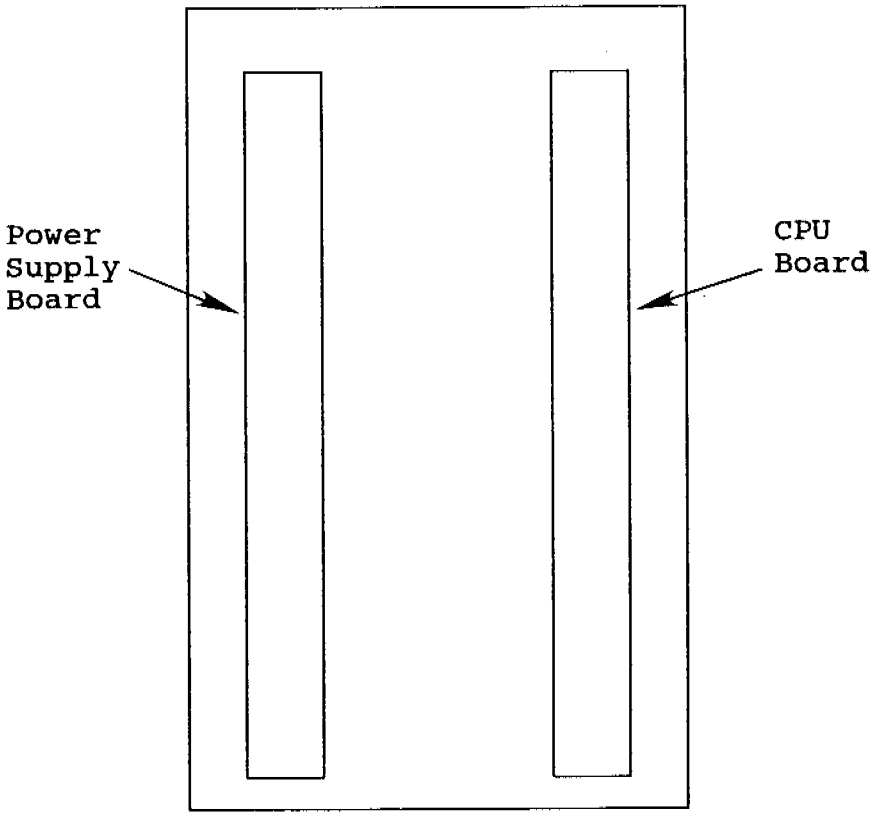


Figure 2-1: M-Shuttle Board Location (Rear View)

FREQUENCY INPUTS

The Frequency Input select jumpers are located on the M-Shuttle CPU board. The M-Shuttle requires this jumper to be placed in the Quadrature position for proper operation. Both the Lead and Follower frequency inputs must supply a quadrature signal format. This shunt will be placed in the Quadrature format position as shipped from the factory.

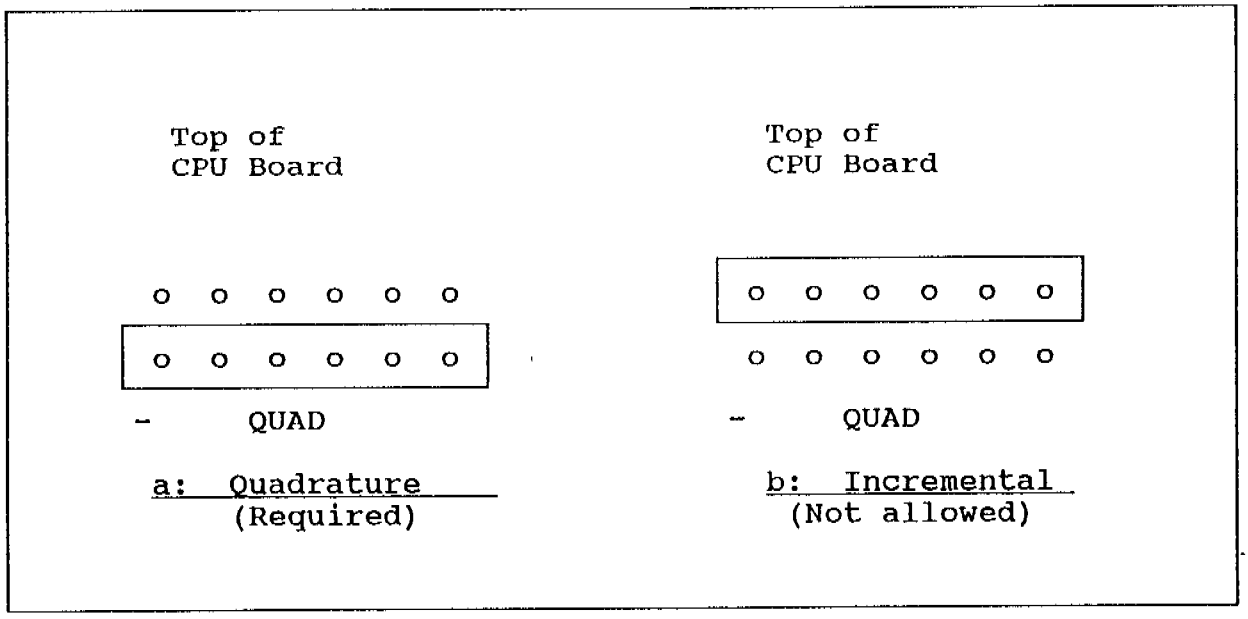


Figure 2-2: Frequency Input Requirements

SYNC INPUT FILTERS

The Lead and Follower 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-Shuttle 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-Shuttle 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-Shuttle is shipped with jumpers enabling both Lead and Follower Sync input filtering. To disable the Lead sync input filtering, remove the shunt between positions 3 and 4 (see Figure 2-3). To disable the Follower Sync input filtering, remove the shunt between positions 1 and 2.

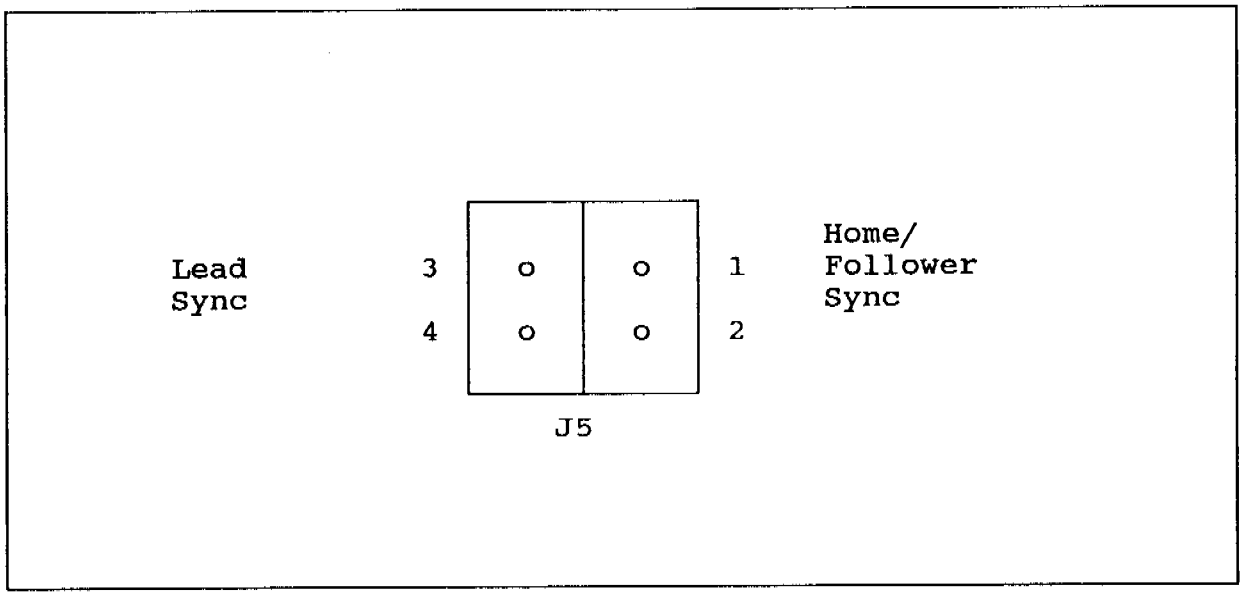


Figure 2-3: Sync Input Filter Option

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-Shuttle 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-Shuttle. 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.

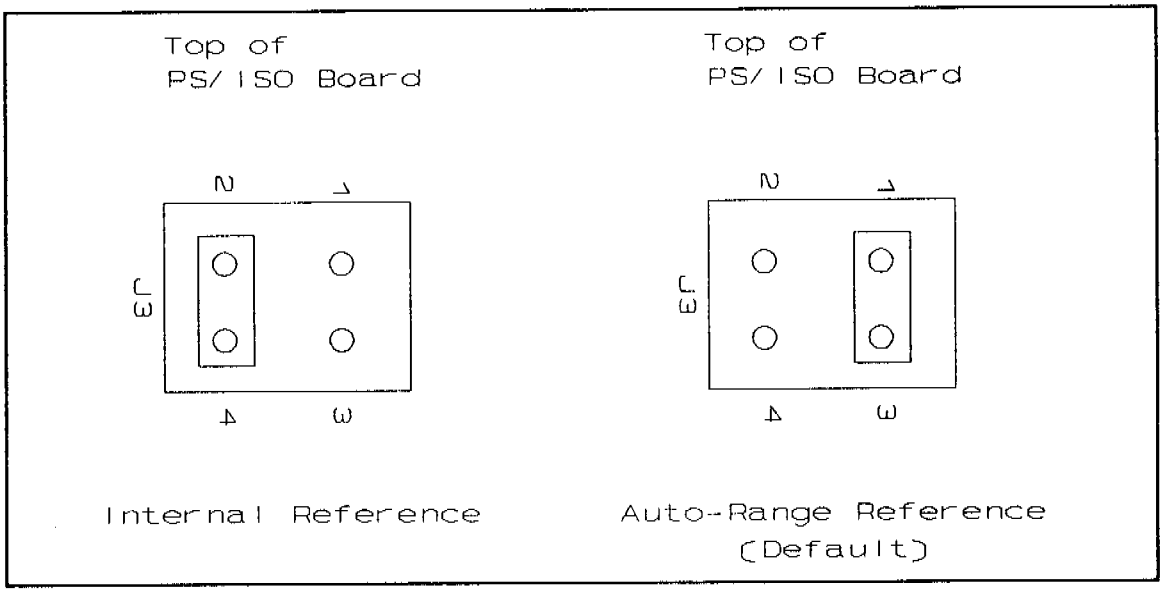


Figure 2-4: Isolator Voltage Reference Options

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-Shuttle. All pages within this chapter must be read to ensure that the appropriate decisions are made prior to the final wiring of the M-Shuttle.

Note to Electricians installing the M-Shuttle:

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

This chapter is organized into 2 distinct sections:

MOUNTING

WIRING

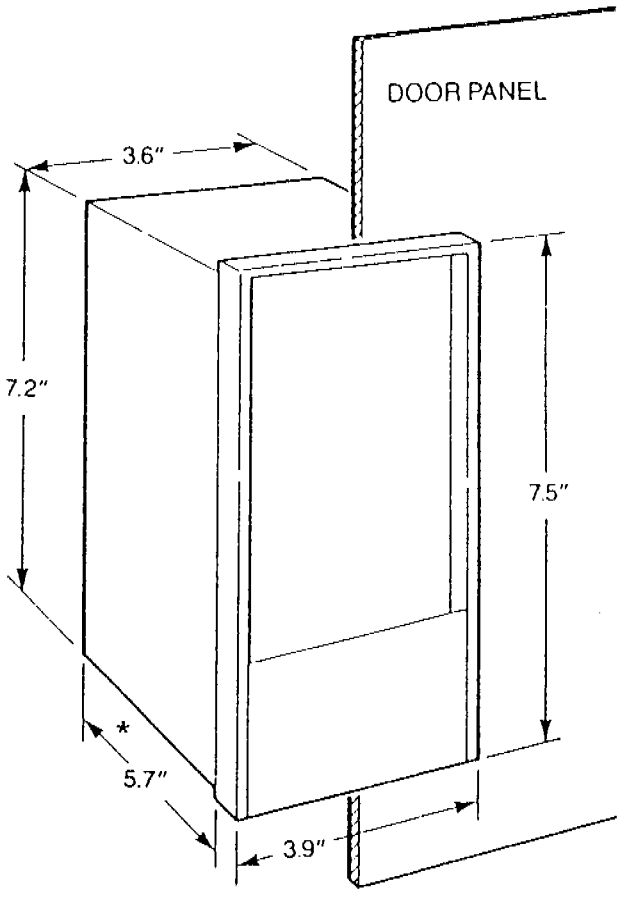
The Mounting section provides drawings and instructions for mounting the M-Shuttle in an enclosure. The wiring section summarizes the wiring connections for the M-Shuttle.

MOUNTING

INTRODUCTION

The M-Shuttle 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-Shuttle with dimensions.

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

MOUNTING PROCEDURE

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

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

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-Shuttle from the panel front up to the bezel or gasket.

4. Connect the two mounting brackets from the rear of the M-Shuttle 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-Shuttle is securely mounted.

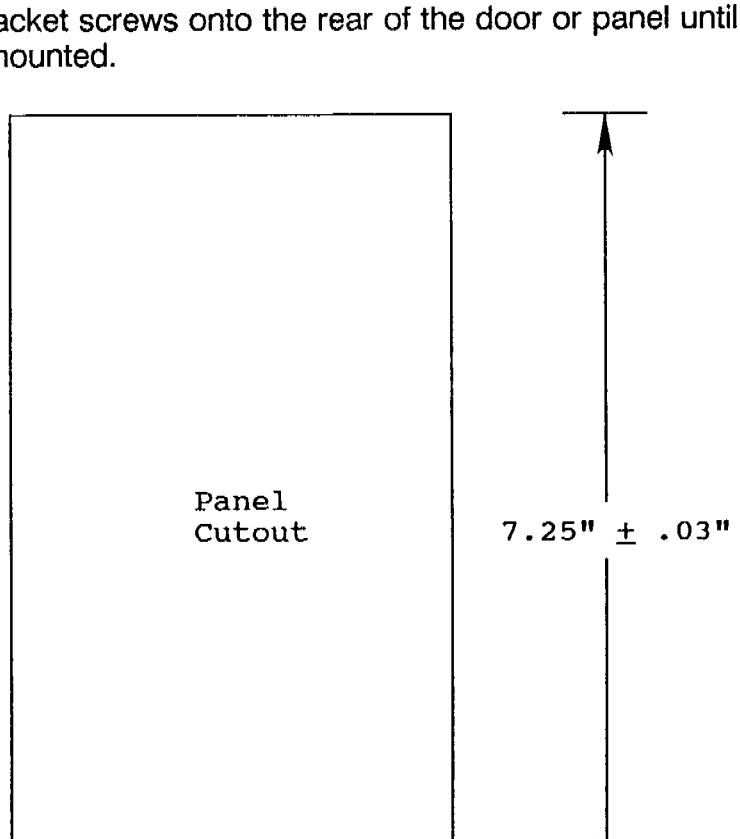


Figure 3-2: Panel Cutout Dimensions

WIRING

INTRODUCTION

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

1. Inputs
2. Outputs
3. Serial Communications

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-Shuttle internal signal commons (e.g, J3 pins 4 or 8) to the chassis ground (J2 pin 1).

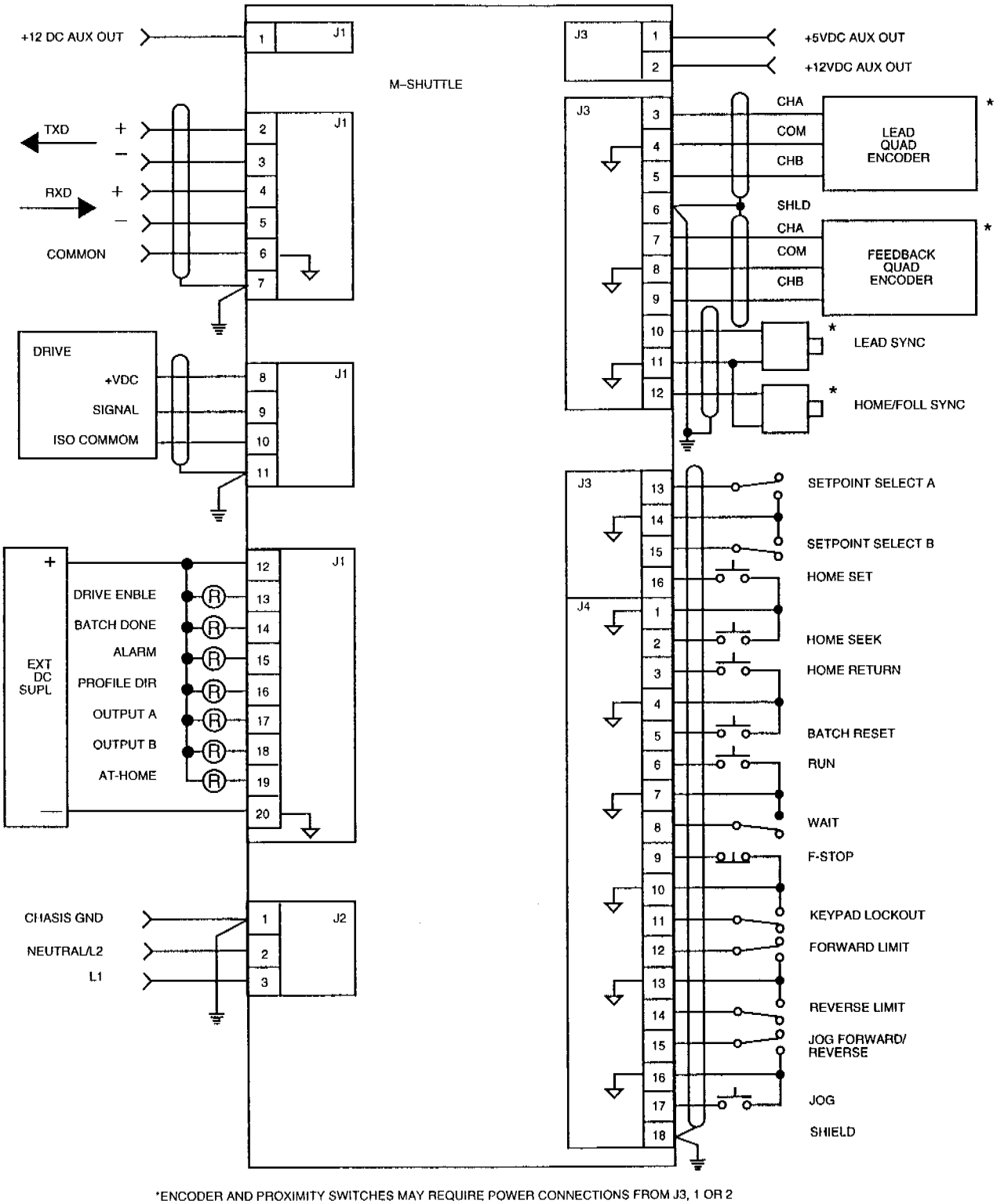
AC power wiring (J2) should be kept physically separated from other wiring on the M-Shuttle. Failure to do so could result in coupled electrical noise and subsequent M-Shuttle malfunction.

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-SHUTTLE WIRING DRAWING

Figure 3-3 below illustrates the control installation wiring for the M-Shuttle.



*ENCODER AND PROXIMITY SWITCHES MAY REQUIRE POWER CONNECTIONS FROM J3, 1 OR 2

Figure 3-3: M-Shuttle General Wiring Drawing

M-SHUTTLE CONNECTOR LOCATIONS

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

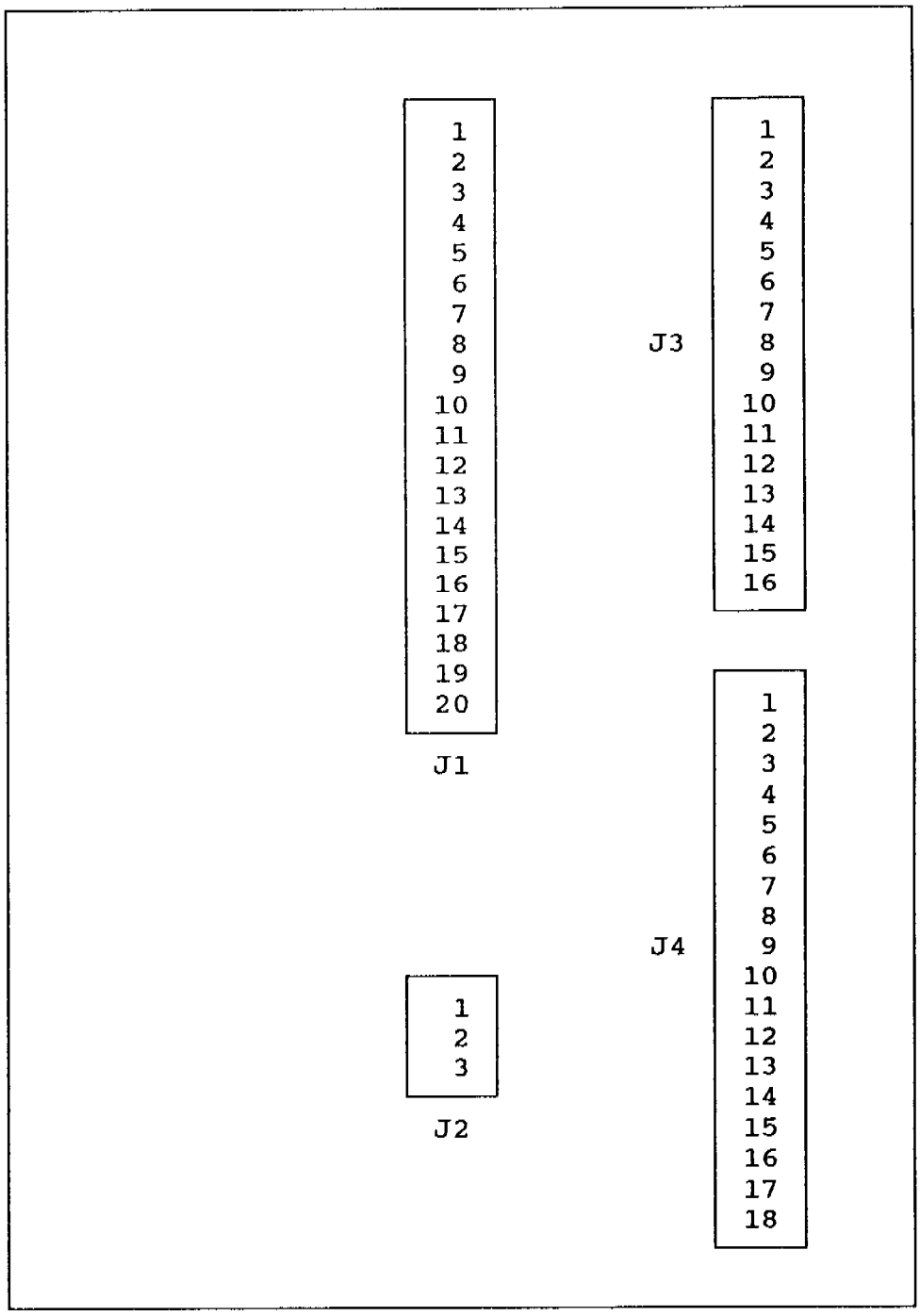


Figure 3-4: Wiring Connector Locations

1) **INPUTS**

INPUT POWER

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

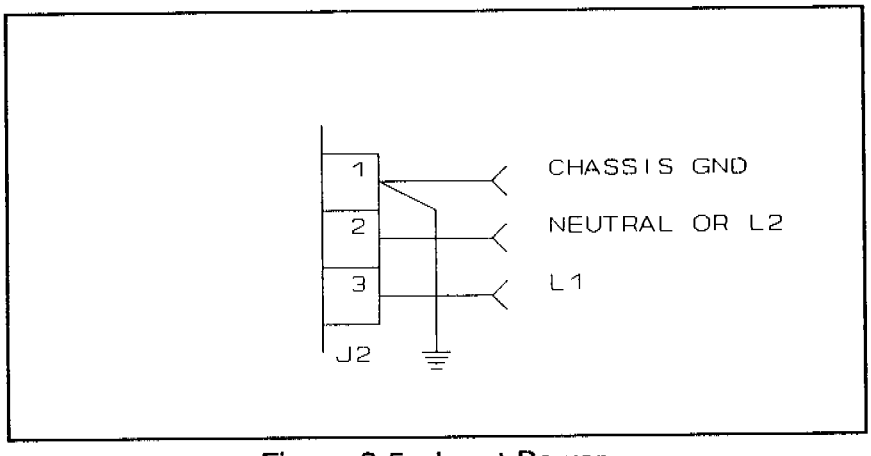


Figure 3-5: Input Power

LEAD FREQUENCY INPUT

The Lead Frequency Input is a pulse train input used by the M-Shuttle to ascertain lead motor speed and position.

The M-Shuttle requires a quadrature signal format on the Lead Frequency Input.

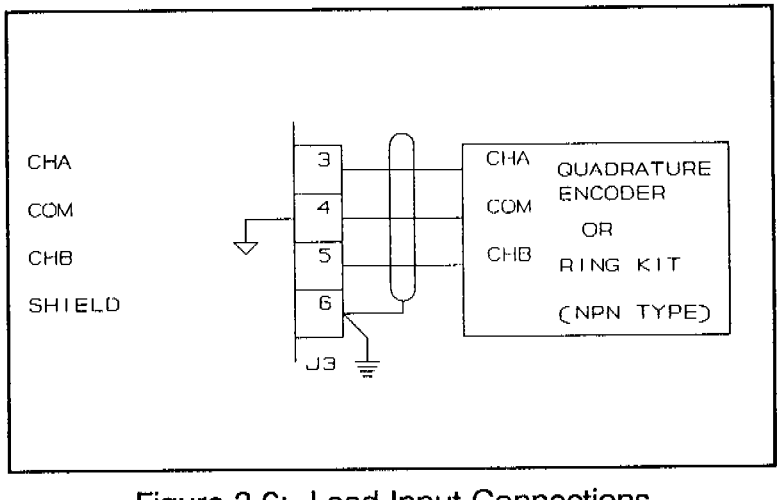


Figure 3-6: Lead Input Connections

FEEDBACK FREQUENCY INPUT

The Feedback Frequency Input is a pulse train input used by the M-Shuttle to ascertain follower motor speed and position.

The M-Shuttle requires a quadrature signal format on the Feedback Frequency Input.

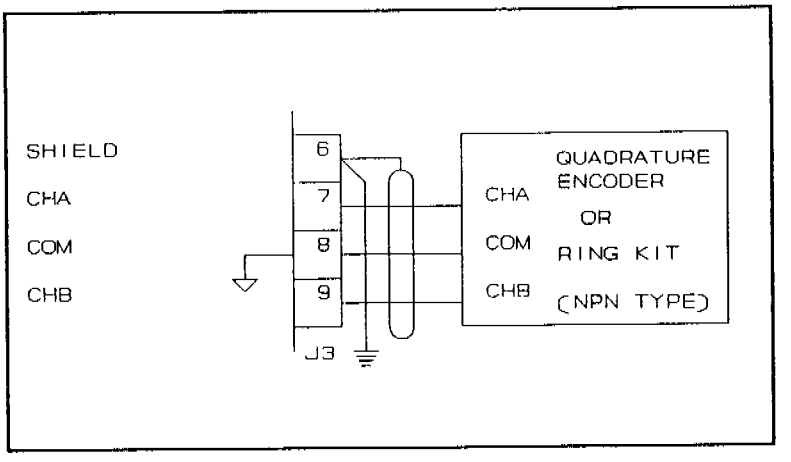


Figure 3-7: Feedback Input Connections

LEAD SYNC INPUT

The Lead Sync input is a pulse 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).

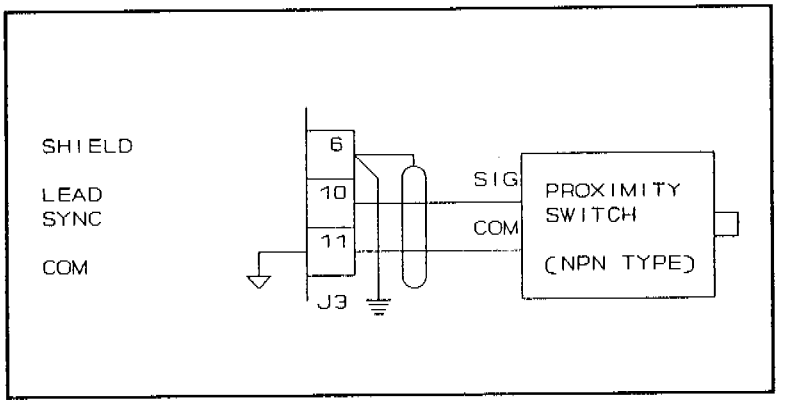


Figure 3-8: Lead Sync Input

HOME/FOLLOWER SYNC INPUT

The Home/Follower Sync Input serves two purposes. It is used to identify the location of "Home" for the Home Seek operations. It is also used to indicate the location of the follower device (shuttle) for synchronization purposes. This input is usually operated by a proximity switch or optical sensor switch (NPN output type).

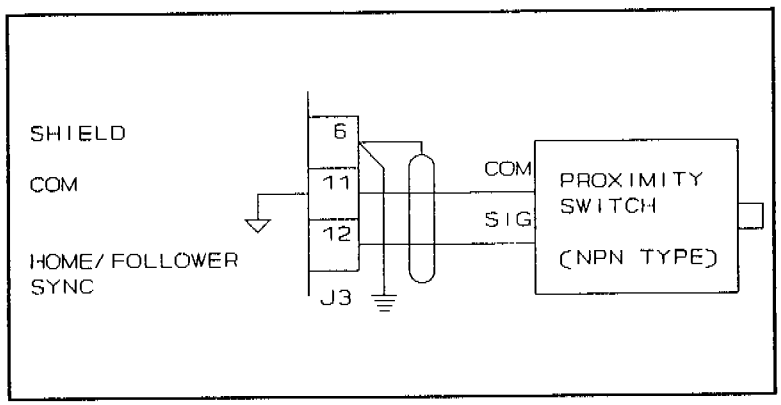


Figure 3-9: Home/Follower Sync Input

PROFILE SELECT A

The Profile Select A input is used in conjunction with the Profile Select B input to select one of four Shuttle profiles:

Profile Select A Input	Profile Select B Input	Selected Profile
Open	Open	Profile 1
Closed	Open	Profile 2
Open	Closed	Profile 3
Closed	Closed	Profile 4

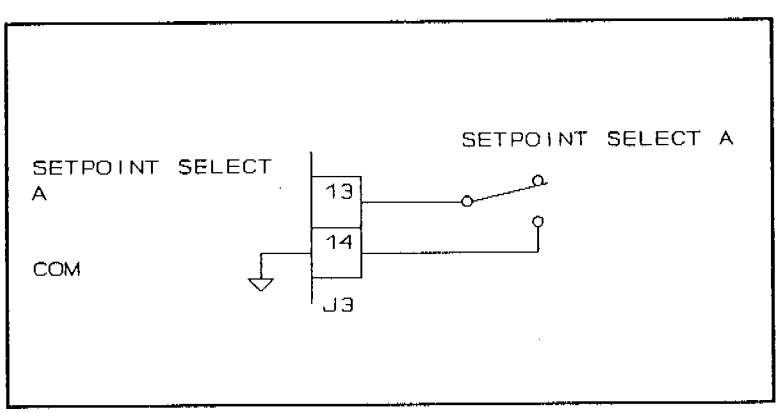


Figure 3-10: Profile Select A

PROFILE SELECT B

The Profile Select B input is used in conjunction with the Profile Select A input to select one of four M-Shuttle profiles.

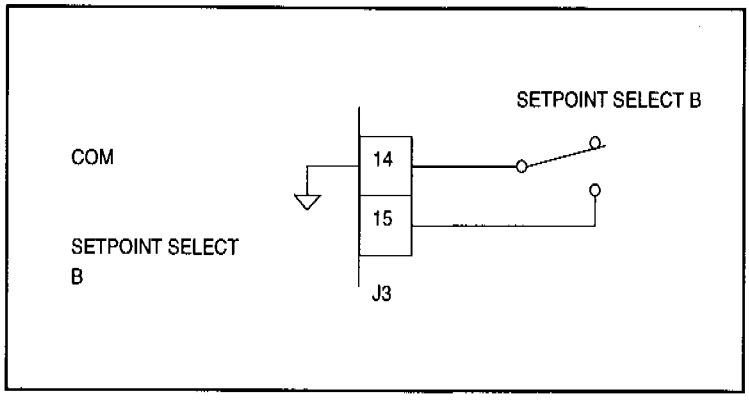


Figure 3-11: Profile Select B

HOME SET

Home Set is a momentary input (edge triggered) which when closed sets the current position as the new Home position. The drive must be stopped to use the Home Set input.

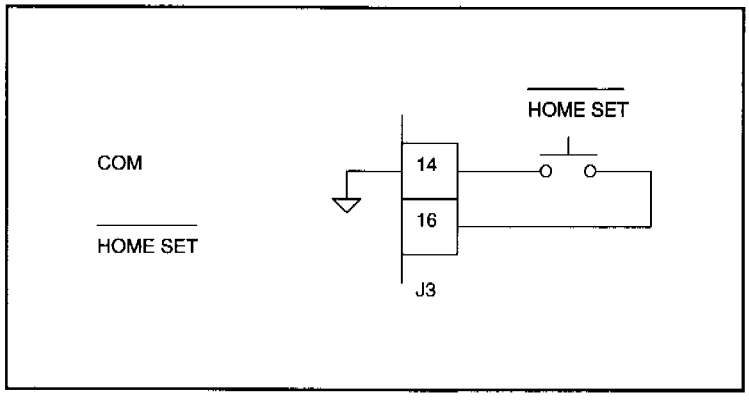


Figure 3-12: Home Set Input

HOME SEEK

Home Seek is a momentary input (edge triggered) which when closed commands the M-Shuttle to make a sustained Jog move until the M-Shuttle receives a Home/Follower Sync input. As a momentary input, the Home Seek input is internally latched and need not be maintained by the operator device.

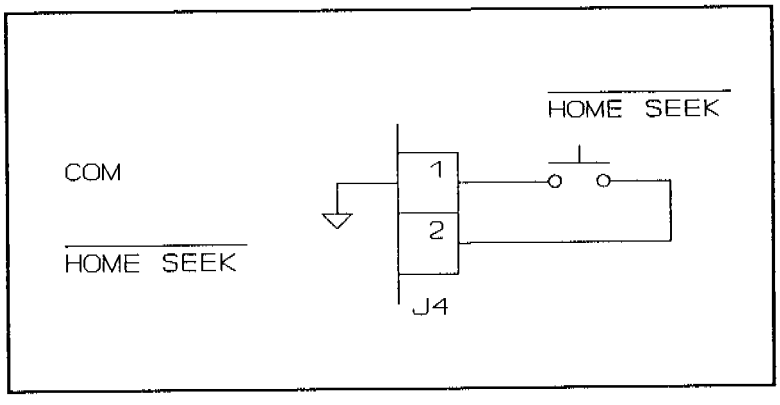


Figure 3-13: Home Seek

HOME RETURN

Home Return is a momentary (edge triggered) input which when closed commands the M-Shuttle to return to the Home Position. As a momentary input, the Home Return input is internally latched and need not be maintained by the operator device.

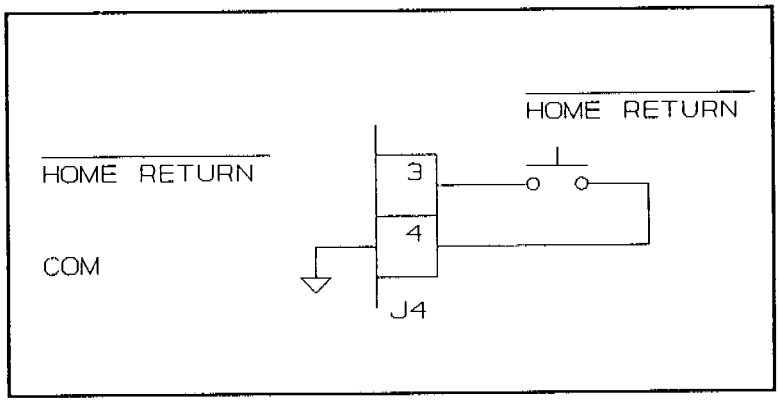


Figure 3-14: Home Return Input

BATCH RESET

The Batch Reset input when closed resets the batch count to zero.

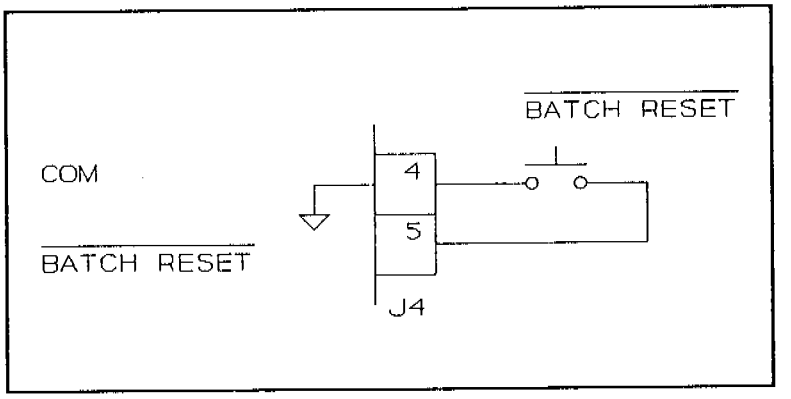


Figure 3-15: Batch Reset

RUN

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

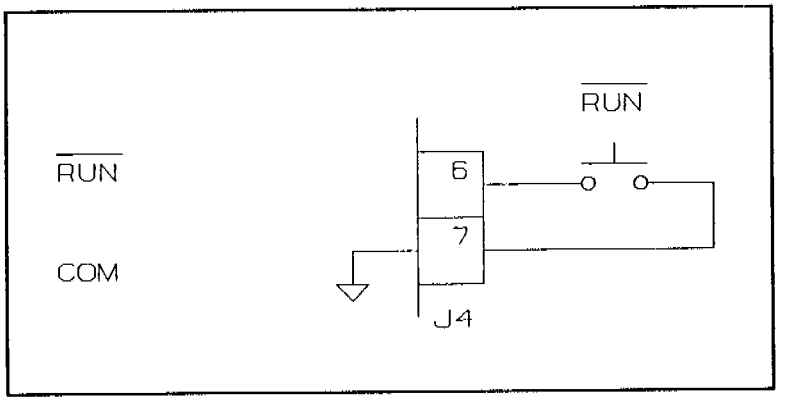


Figure 3-16: Run Input

WAIT

The Wait input is used to command the M-Shuttle to remain at the Home position before proceeding with the next profile if in the Run state. The Wait input is checked every time the shuttle returns to the At-Home position. The Wait input is active low (closed). The keypad Wait LED is "On" whenever the Wait input is active.

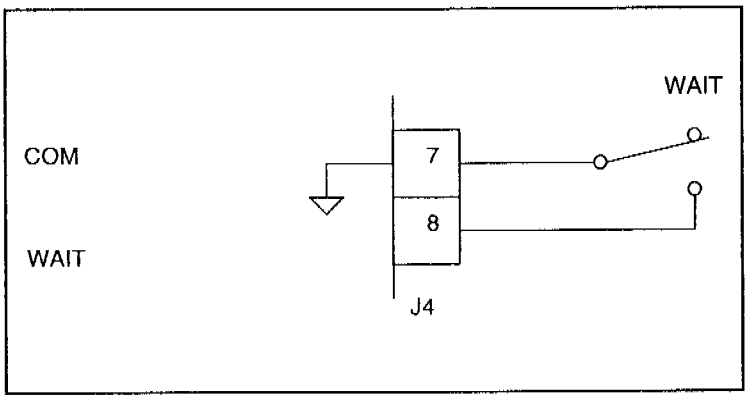


Figure 3-17: Wait

F-STOP

F-STOP is a momentary input which when opened commands the M-Shuttle 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 devise.

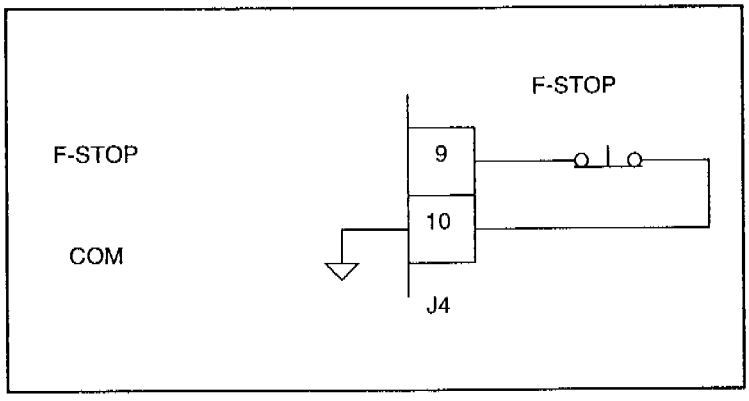


Figure 3-18: F-Stop Input

KEYPAD LOCKOUT

The Keypad Lockout input is used to selectively 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.

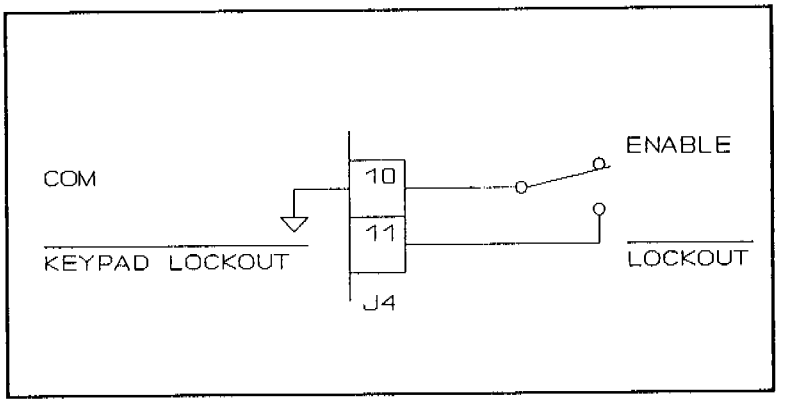


Figure 3-19: Keypad Lockout

FORWARD LIMIT

The Forward Limit prevents the M-Shuttle from moving in the forward direction when activated. The M-Shuttle will go to an F-Stop state from Run, Forward Jog, or Home Seek when the Forward Limit is detected. The M-Shuttle can be moved off the Forward Limit position by any reverse commanded function such as Reverse Jog.

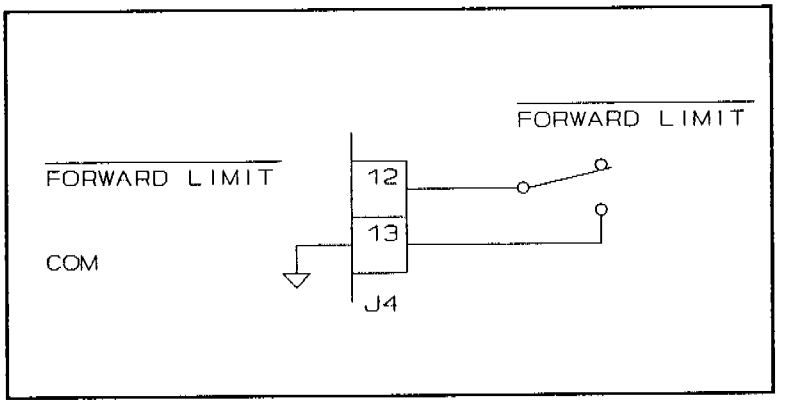


Figure 3-20: Forward Limit

REVERSE LIMIT

The Reverse Limit prevents the M-Shuttle from moving in the reverse direction when activated. The M-Shuttle will enter the F-Stop state from Run, Reverse Jog or Home Seek when the Reverse Limit is detected. The M-Shuttle can be moved off the Reverse Limit by any forward commanded function such as Forward Jog.

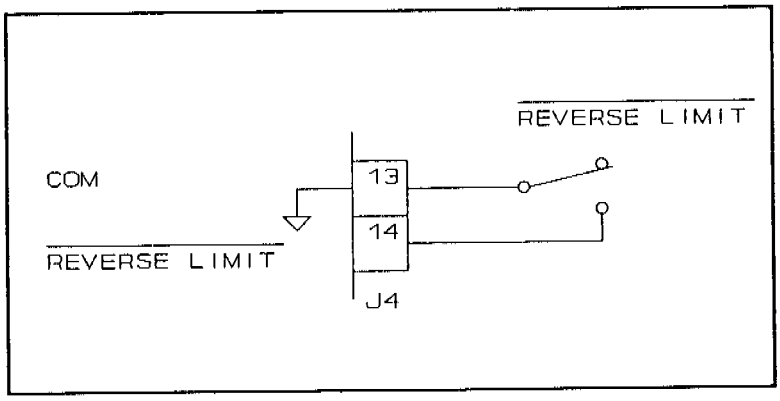


Figure 3-21: Reverse Limit

JOG FORWARD/REVERSE

The Jog Forward/Reverse control input controls the direction of the Speed Command in the Jog state.

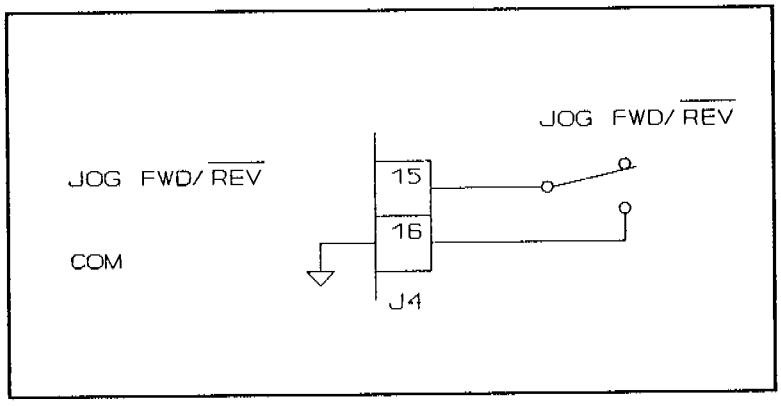


Figure 3-22: Jog Forward/Reverse

$\overline{\text{JOG}}$

$\overline{\text{JOG}}$ is a maintained input which when closed directs a speed command signal to the 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.

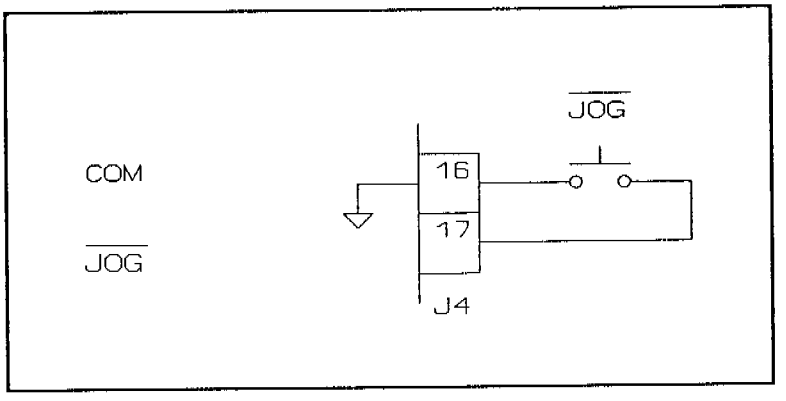


Figure 3-23: Jog Input

2) 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 3-24 below illustrates the SPEED COMMAND OUTPUT connections.

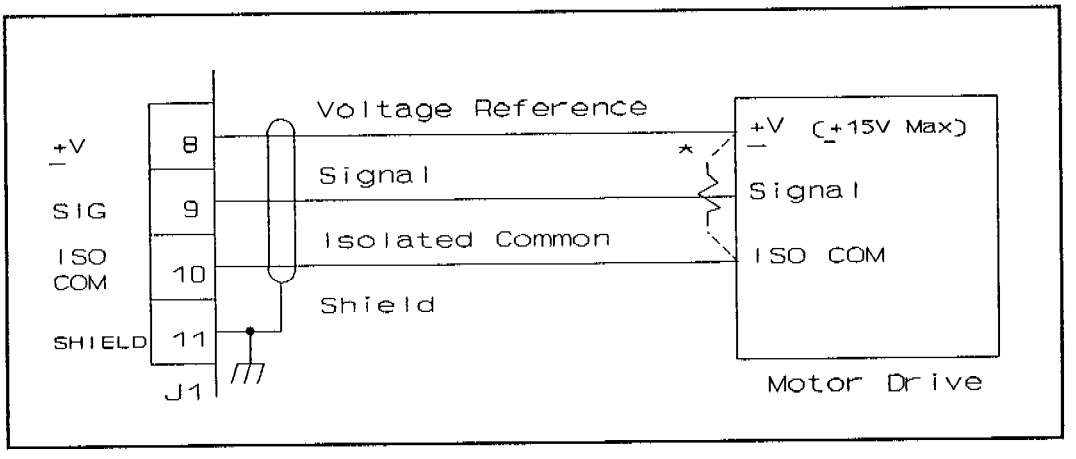


Figure 3-24: Speed Command Output

* Remove Drive Speed Potentiometer

DISCRETE OUTPUTS

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

Figure 3-25 illustrates the wiring for these discrete outputs.

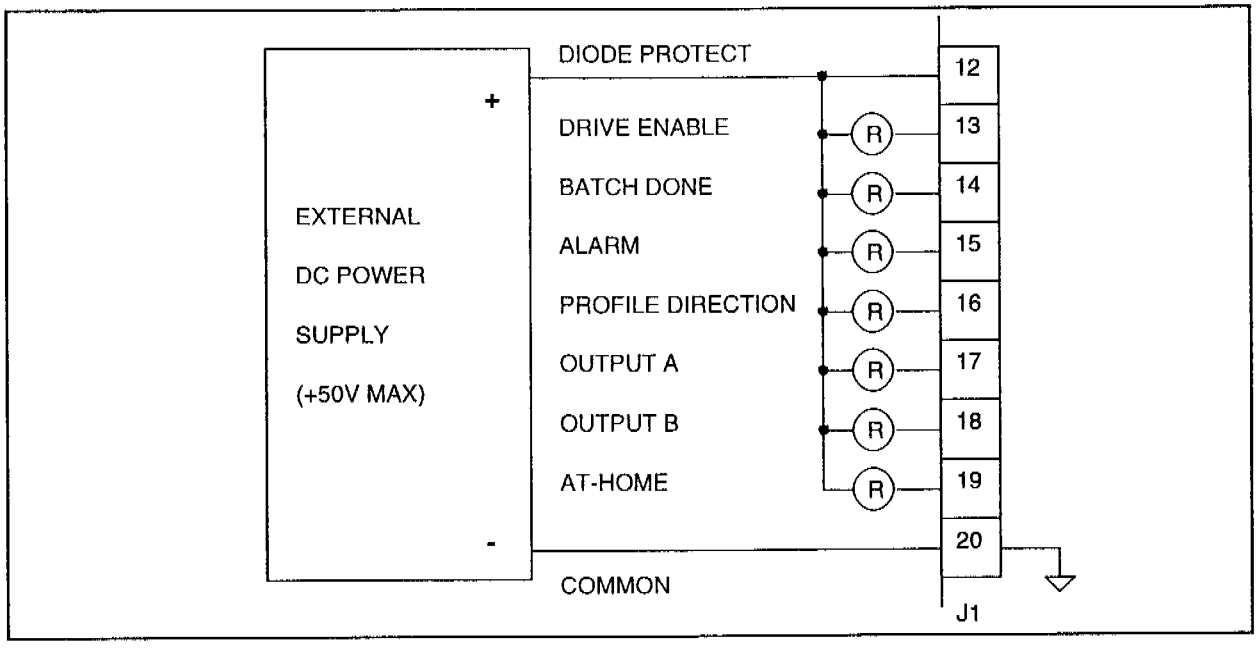


Figure 3-25: Discrete Outputs

DRIVE ENABLE (J1 PIN 13)

The Drive Enable output is driven low (relay activated) when the M-Shuttle is commanding a speed output to the follower drive. The Drive Enable output is only driven high (relay deactivated) following Power Up and during F-Stop.

BATCH DONE (J1 PIN 14)

The Batch Done output is driven low (relay activated) when the Batch Count operates to completion.

ALARM (J1 PIN 15)

The Alarm output is driven low (relay activated) whenever a high speed or position error occurs as determined by the CP-28 entry. Refer to CP-28 in Appendix C for more information.

PROFILE DIRECTION (J1 PIN 16)

The Profile Direction output indicates the commanded direction of the profile. The output is relay deactivated (driven high) when the profile is commanded to move forward. The output is relay activated (driven low) when the profile is commanded to move in reverse.

OUTPUT A (J1 PIN 17)

Output A is a programmable output that can be driven high or low as a function of time or position, and position error. The Output A timer/counter can be initiated at any of the three plateau (non-ramp) segments of the profile. If the position error is not within the programmed position error band at the appropriate time, the output will not be activated.

OUTPUT B (J1 PIN 18)

Output B is a programmable output that can be driven high or low as a function of time or position. The Output B timer/counter can be initiated at any of the three plateau (non-ramp) segments of the profile.

AT-HOME (J1 PIN 19)

In order for this output to function, "Home" must have already been determined (using Home Set or Home Seek). Once "Home" has been determined, this output is relay activated (driven low) when the Shuttle Follower Position is within the At-Home Band specified in CP-30.

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 Shuttle.

+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-Shuttle.

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-Shuttle device.

5) SERIAL COMMUNICATIONS

The Serial Communications interface on the M-Shuttle 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 3-26 and 3-27 illustrate a multidrop installation of the Serial Communications link.

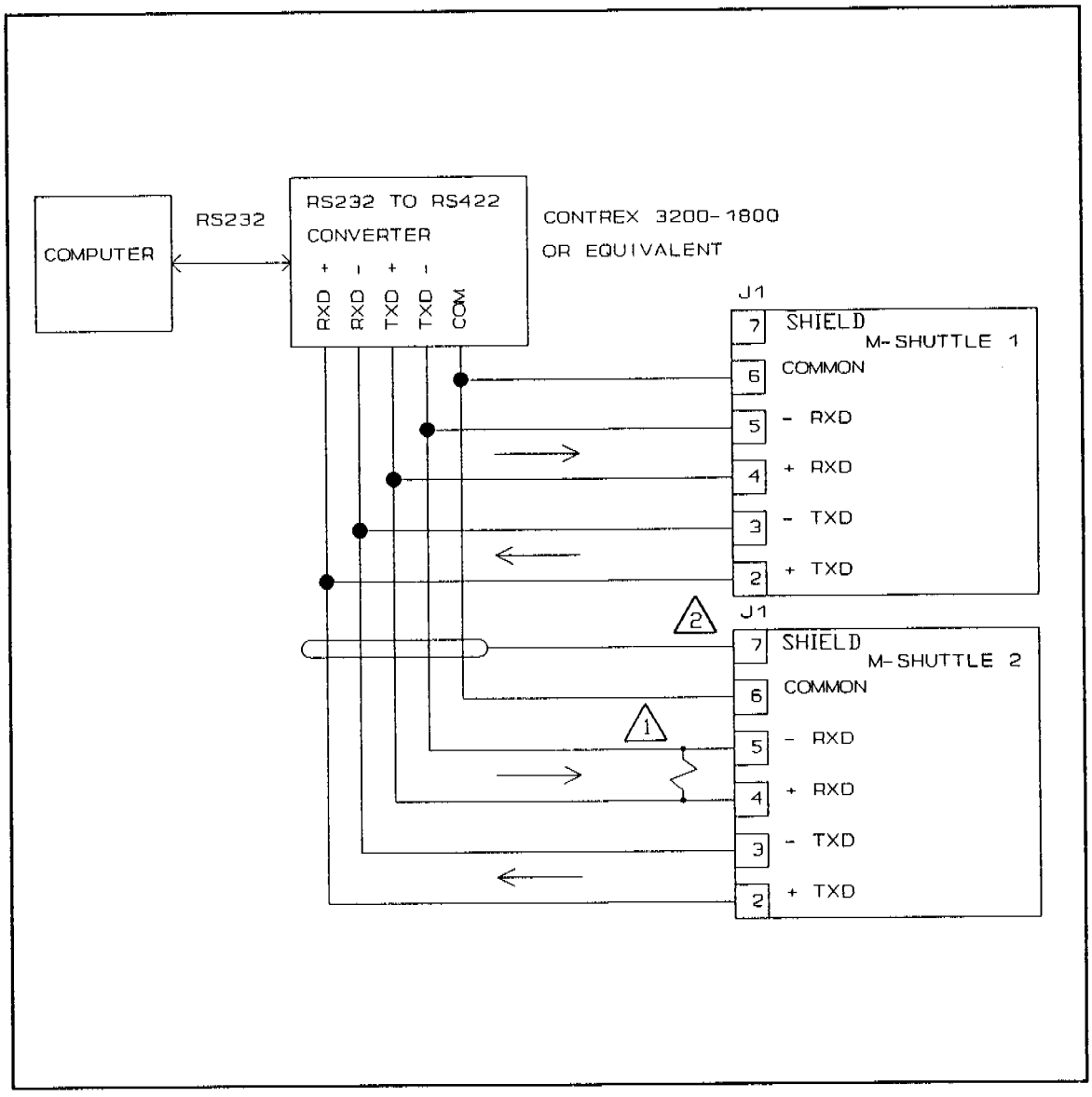


Figure 3-26: Serial Communications Connections

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

⚠2 Shield at one end of cable only.

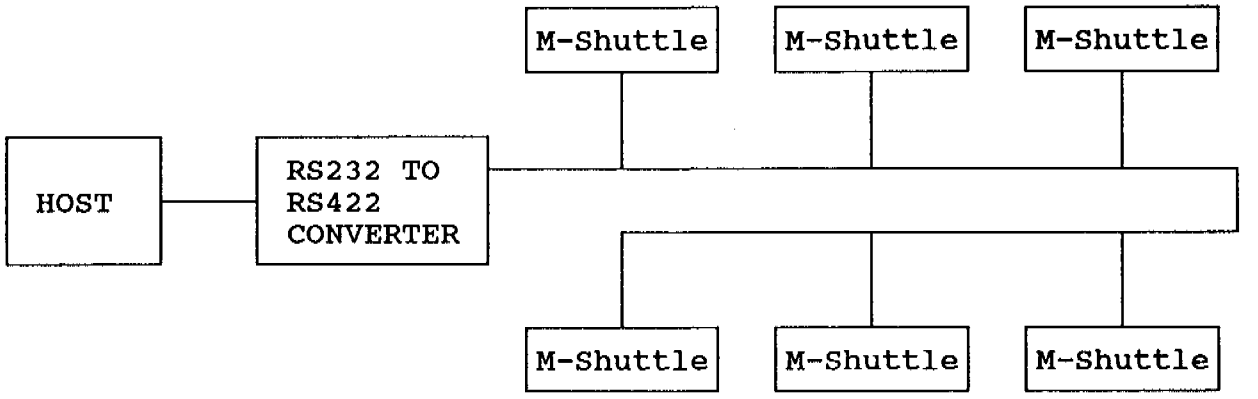


Figure 3-27: Correct M-Shuttle Multidrop Installation

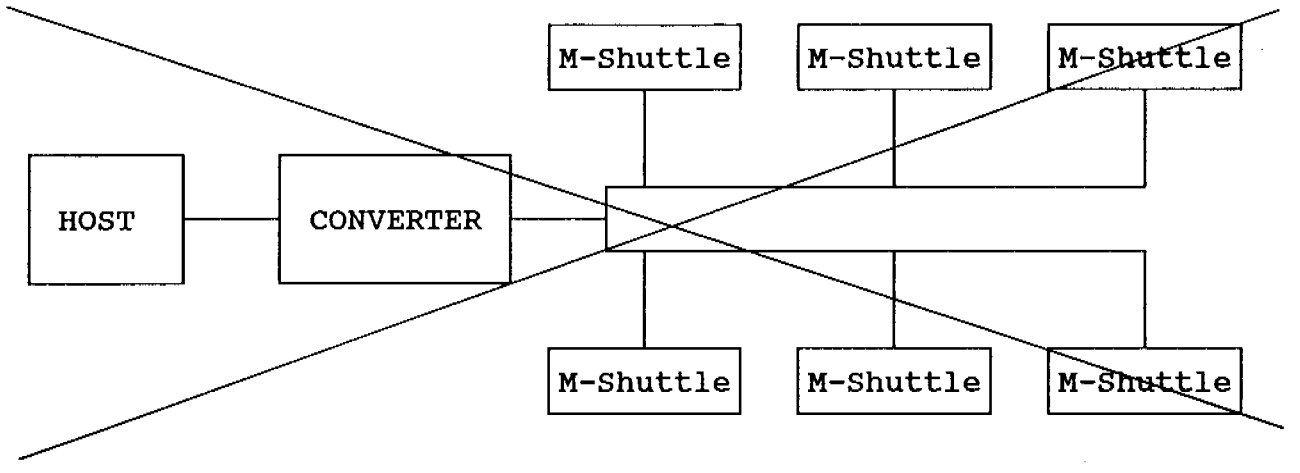


Figure 3-28: Incorrect Installation

INTRODUCTION

This chapter contains the information required to calibrate the M-Shuttle to the connected motor drive. Prior to using these procedures, the M-Shuttle 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 "5" into CP-14 (place M-Shuttle into Direct Scaling Mode).

3. Enter a positive Direct Mode setpoint of 400 into CP-62.

4. Enter the RUN state. If the follower motor direction does not match the motor direction of the lead during normal operation, then rewire the drive/motor to reverse the motor direction.

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-62 (places the output command to 90% of the full 4095 level in the forward direction.) Enter a "-3686" into CP-62 to move in the reverse direction at 90% of full output.

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-40 if the correct PPR value is first entered into CP-18.)

10. Return the M-Shuttle 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-Shuttle 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-Shuttle. To make this adjustment, follow the procedure below:

1. Enter a "5" into CP-14 (places M-Shuttle into Direct Scaling Mode).
2. Enter "4095" into CP-62 (puts the output to 100% command output level).
3. Enter the M-Shuttle 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-Shuttle 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 "5" into CP-14 (places M-Shuttle into Direct Scaling Mode).
2. Enter "0" into CP-62 (0 speed command).
3. Enter the M-Shuttle 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 or the drive/meter is at zero speed.
5. Return the M-Shuttle to its previous mode by entering the original value into CP-14.

INTRODUCTION

This section of the manual explains how to operate the M-Shuttle. This Chapter is divided into the following sections:

Operator Keypad	Explains how to use the Operator Keypad for entering parameters and monitoring performance.
Operational Overview	Explains the various operating modes including Direct, Jog, Home Set, Home Seek, Home Return and Follower.
Parameter Entry	Explains the procedure for entering the required Control Parameters for the desired application.
Performance Monitoring	Explains the use of the Monitor Variables for observing system and control performance.

OPERATOR KEYPAD

The Operator Keypad is used to view or change M-Shuttle 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-Shuttle 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-Shuttle status
Lower display:	Typically displays the MV-xx or CP-xx code whose value is displayed in the upper display.

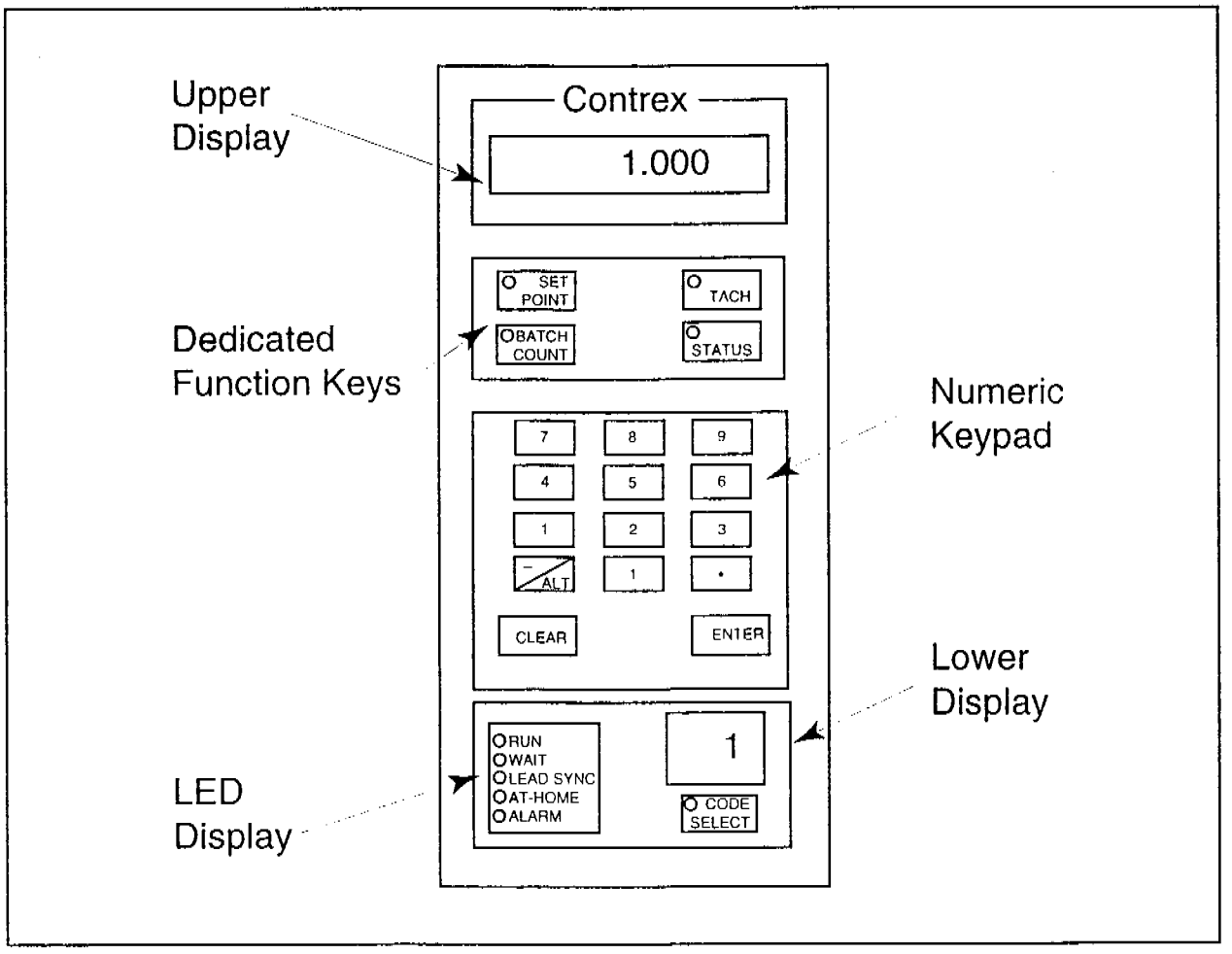


Figure 5-1: Operator Keypad

OPERATIONAL OVERVIEW

The operation of the M-Shuttle can be categorized into three operating states and six operating modes.

OPERATING STATES

The M-Shuttle is always in one of three states: F-Stop, Run or Position Hold.

F-STOP

When in the F-Stop state, the M-Shuttle will be commanding a zero speed command to the drive and the Drive Enable discrete output (J1 Pin 13) will be inactive (drive disabled).
The M-Shuttle enters the F-Stop state on power-up, when the F-Stop input is activated, at the completion of Jog, at the completion of Direct Mode, during Home Set and when the Forward or Reverse Limits are entered.

RUN

When in the Run state, the M-Shuttle will be commanding a speed command in accordance with the selected operating mode and the Drive Enable output will be active.

The M-Shuttle is in the Run state during the Direct, Jog, Home Seek, Home Return, Follower, and Tune modes of operation.

POSITION HOLD

When in the Position Hold state, the M-Shuttle will be commanding a speed command required to hold the current position and the Drive Enable output will be active.

The M-Shuttle enters the Position Hold state at the completion of the Home Seek, Home Return and Home Set modes of operation.

OPERATING MODES

The M-Shuttle has six primary operating functions (modes) including Direct, Tune, Jog, Home Set, Home Seek, Home Return and Follower. The following discussion explains the intended purpose of the various operating functions, how to activate the desired function and the generalized motion sequence for each operational function. The Parameter Entry section of this chapter explains how this generalized motion sequence is influenced by the Control Parameters to meet explicit application requirements.

DIRECT MODE

Direct Mode allows the operator to directly set the signal level of the M-Shuttle analog output to the motor drive. Direct Mode is intended for use during drive calibration (reference chapter 4) and troubleshooting procedures. All internal scaling and closed loop compensation algorithms are bypassed. Direct Mode responds to the Run, F-Stop, Forward Limit and Reverse Limit commands only.

Direct Mode is activated via the Run input (J4 Pin 6) when the Control Parameter (CP-14) is set to 5 . CP-14 changes can only be made while in the F-Stop state.

When the Run state is entered in Direct Mode, the analog output immediately moves to the Direct Analog Command (CP-62) value. Positive setpoint entries define forward motion and negative setpoint changes define reverse motion. All setpoint and state (Run and F-Stop) changes will result in immediate output changes without acceleration or deceleration ramps.

NOTE

If the M-Shuttle encounters a Forward Limit input (J4 Pin 12) when moving in the forward direction, it will immediately enter the F-Stop state (go to zero speed with no decel ramp). This is also true if it encounters a Reverse Limit input (J4 Pin 14) if moving in the reverse direction. The M-Shuttle can be moved away from either of the limits with any control mode that initiates motion in the direction away from the limit. The Forward and Reverse Limits are active for all modes of operation except for Tune Mode as explained below.

TUNE MODE

Tune Mode can be used to help tune the M-Shuttle and connected drive. When in Tune Mode, the M-Shuttle moves back and forth between the Forward and Reverse Limits at the Jog Speed. Tune Mode responds to the Run, F-Stop, Forward Limit and Reverse Limit commands only.

Tune Mode is activated via the Run Input (J4 Pin 6) when Control Parameter 14 (CP-14) is set to 6.

JOG

Jog is intended for use in moving the shuttle to an operator guided position for purposes of mechanical alignment, undoing machine jams, etc.

The Jog Mode is entered and maintained when the Jog input (J4 Pin 17) is activated (shorted to common). Jog can only be entered from the F-Stop state. Deactivating (opening) the Jog input will place the M-Shuttle back into the F-Stop state.

When the Jog Mode is entered, the M-Shuttle will ramp to the Jog Setpoint (CP-61) speed at an acceleration rate defined by the Accel/Decel Length parameter CP-60. The Jog direction is determined via the Jog Forward/Reverse input (J4 Pin 15). The Jog speed is maintained until the Jog input is deactivated and the F-Stop state is entered. There is no deceleration ramp from Jog speed down to zero speed.

HOME SET

The Home Set function is one of two ways to establish the Home position for the Follower device. The Home position is the position from which the profile begins its motion in the forward direction in Follower Mode. The Home position must be established before Follower Mode can be entered. Home is typically identified by a Follower Position (MV-44) of zero.

The Home Set function is activated via the Home Set input (J3 Pin 16) while in the F Stop state. Additionally, CP-14 must be set to either 3 or 4 for Home Set activation (will not recognize Home/Follower Sync input).

When the Home Set input is detected (edge triggered), the M-Shuttle sets the existing Follower position to Home and internally makes note that Home has been established. The M-Shuttle goes into a Position Hold state at the completion of the Home Set function; i.e. the drive is activated.

HOME SEEK

The second method of establishing the Home position is through the use of the Home Seek function. This mode of operation directs the shuttle device along a predefined motion trajectory until the Home/Follower Sync input is detected. The Home position is the Follower position coincident with the Home/Follower Sync input detection.

The Home Seek function is activated via the Home Seek input (J4 Pin 2) while in the F-Stop state. Additionally, CP-14 must be set to either a 1 or 2 for Home Seek activation (Home/Follower Sync input recognized).

When the Home Seek input is detected (edge triggered),the M-Shuttle ramps the shuttle device up to Jog Speed (CP-61) at a rate defined by the Accel/Decel (CP-60) parameter in the reverse direction. When the Home/Follower Sync input (J3 Pin 12) is detected, the current Follower position is set to the Home position (zero) and the shuttle is ramped down (CP-60) to zero speed. The shuttle is then moved forward via a triangulated Accel/Decel profile to the Home position (reduce backlash). The M-Shuttle then goes into a Position Hold state at the Home position (drive active with closed loop on position) and internally makes note that Home has been established.

If a Home Offset Value is entered into CP-31, the shuttle will move past the Home/Follower sync sensor by the Home Offset distance before decelerating from the reverse Jog Speed. It will then move forward to the Home position that is located CP-31 Follower encoder lines in the reverse direction of the Home/Follower Sync sensor.

If the Reverse Limit (J4 Pin 14) is detected before the Home/Follower Sync input, the shuttle goes immediately to zero speed. The shuttle is then ramped to the forward Jog speed until the Home/Follower Sync input is detected. The shuttle is then ramped back down to zero speed and the Home Seek function is reactivated in the reverse direction.

If the Forward Limit (J4 Pin 12) is detected before the Home/Follower Sync input, the Home Seek operation is terminated and the M-Shuttle will enter the F-Stop state.

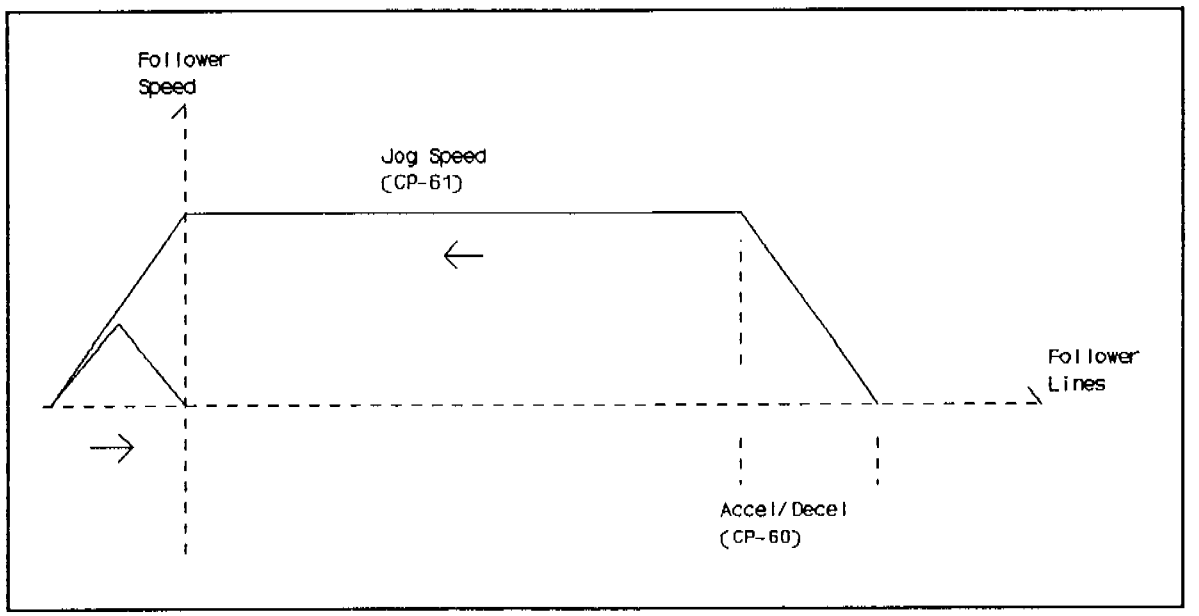


Figure 5-1: Home Seek Operation

HOME RETURN

The Home Return function is used to return the shuttle to the Home position.

Home Return is activated via the Home Return input (J4 Pin 3) while in the F-Stop state. Additionally, Home must have been defined through the Home Set or Home Seek operations before the Home Return function can be activated.

When activated, the Home Return function will ramp the shuttle (CP-60) to the Jog Setpoint speed (CP-61) and, at the appropriate position, ramp down (CP-60) to the Home location. If the M-Shuttle is approaching Home in the reverse direction, it will overshoot the Home position by a distance equal to the At-Home Band (CP-30), then move forward to the Home position (reduce backlash). At the completion of the Home Return profile, the M-Shuttle goes into a Position Hold state at the Home position (drive remains active with closed loop on position).

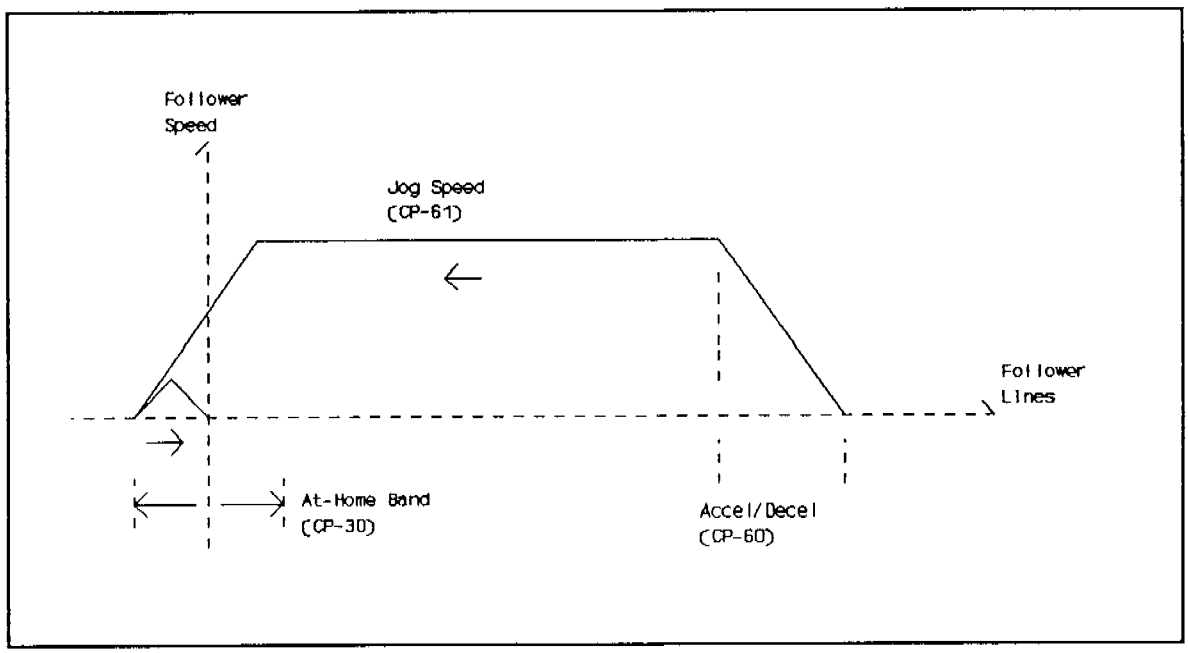


Figure 5-2: Reverse Home Return

FOLLOWER

Follower Mode is the primary M-Shuttle operating mode used to perform the desired process function (cut, stamp, thread, etc.).

The Follower Mode is activated via the Run input (J4 Pin 6) and the "Run" LED illuminates on the keypad, when the following preconditions are met:

1) The Control Mode (CP-14) must be set for Follower Mode (values 1 through 4) and
2) The M-Shuttle must be either in the F-Stop or Position Hold state and
3) The M-Shuttle must be within the At-Home Band (CP-30) of the defined Home position and
4) A valid Follower profile must be present (MV-58 = 0) and
5) The Wait input (J4 Pin 8) must be open (high)

When the Follower Mode is activated, the M-Shuttle accelerates in the forward direction from zero ratio (speed) to the Process Ratio (CP-12) at a rate determined by the Accel/ Decel Length (CP-9). The Process Ratio is maintained for the specified Process Length (CP-2, CP-4, CP-6 or CP-8). The M-Shuttle then decelerates back down to zero ratio (speed) at the rate specified by the Accel/Decel Length (CP-9). The zero ratio is maintained for the specified Forward Dwell (CP-10).

From this location the M-Shuttle begins the reverse direction recovery profile. The recovery profile is calculated such that the Follower returns to the Home position at the same time as the Lead begins feeding the next product. The specified Setpoint Length (CP-1, CP-3, CP-5, CP-7) determines the topography of the recovery profile. Shorter product lengths will thus result in faster recovery profiles.

The recovery profile begins with a triangulated acceleration/ deceleration ramp. The ramp rates are determined by the Setpoint Length. The peak point where the acceleration ends and the deceleration begins is indicated by the Peak Recovery Ratio monitor variable (MV-88). This ratio can be limited by specifying a lower Maximum Recovery Ratio (CP-13). Lowering the peak ratio will result in increased recovery acceleration and deceleration ramps.

Upon the completion of the acceleration/deceleration profile segment, the M-Shuttle will remain at zero ratio (speed) for the specified Reverse Dwell (CP-11) before beginning the next product cycle.

Frequently, it is desirable for the Follower shuttle to synchronize with a registration or sync mark on the Lead product. The Control Mode (CP-14) parameter can be used to specify any combination of synchronization using Lead and/or Follower sync inputs. When the Lead Sync input occurs, the M-Shuttle will immediately alter the Follower position to align the Lead and Follower sync inputs if required.

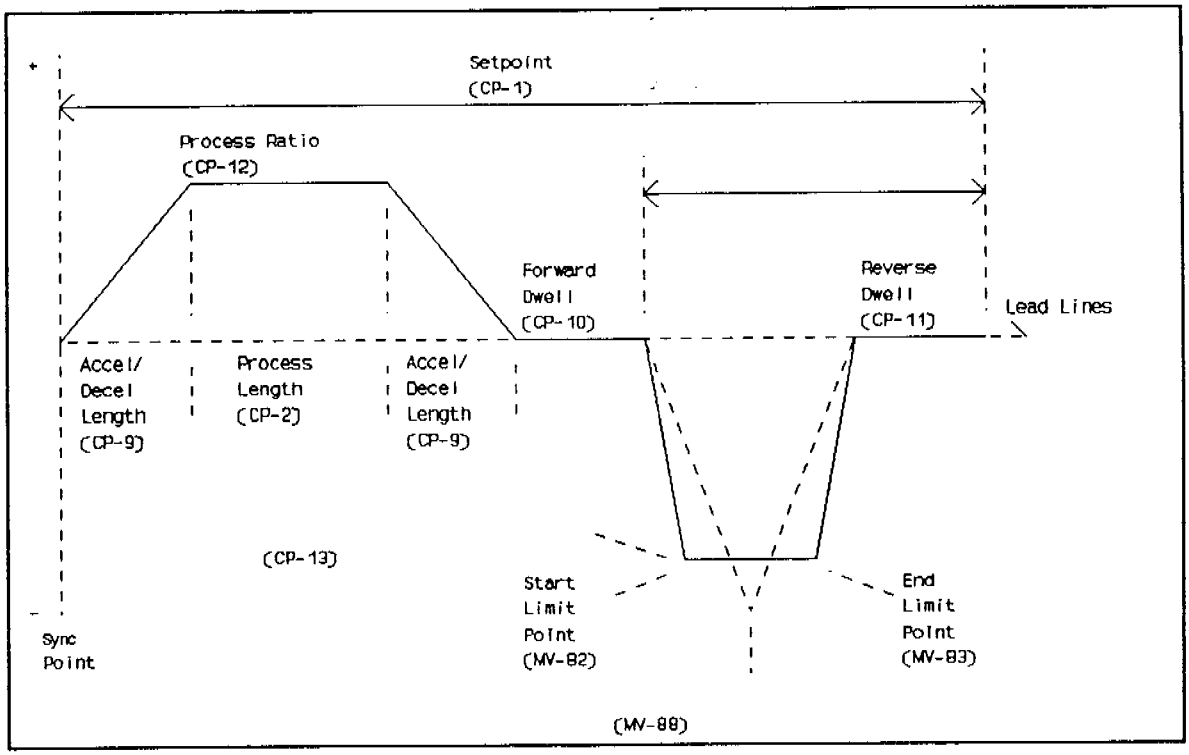


Figure 5-3: Follower Profile

5

PARAMETER ENTRY

This section explains how to modify the various Control Parameters in order to influence the M-Shuttle control behavior to meet the explicit application requirements. Typical Control Parameters include items such as encoder PPRs, acceleration/deceleration ramp rates, Follower to Lead ratios, etc. A complete list of all the Control Parameters and definitions is available in Appendix C.

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

The following discussion indicates what values to enter into the M-Shuttle based on various control topics.

CONTROL MODE

The Control Mode parameter, CP-14, is used to identify either the Direct Mode of operation, or one of the four possible Follower setups (dependent on combination of Lead and Follower sync inputs).

CP-14 Control Mode

Set CP-14 to 1 for Follower Mode of operation when both the Lead and Follower Sync inputs are utilized. The M-Shuttle will synchronize (register the Lead and Follower sync positions) when the Lead Sync input is detected. The Follower Sync input adjusts the Follower position to zero (Home) when detected.

Set CP-14 to 2 for Follower Mode of operation when only the Follower Sync input is utilized and the Lead Sync is absent. The M-Shuttle will not synchronize in this mode. The M-Shuttle will adjust the Follower position to zero when the Follower Sync is detected.

Set CP-14 to 3 for Follower Mode of operation when only the Lead Sync input is utilized and the Follower Sync is absent. The M-Shuttle will synchronize when the Lead Sync input is detected.

Set CP-14 to 4 in Follower Mode of operation when neither the Lead or Follower Sync inputs are utilized. The M-Shuttle will not synchronize in this mode of operation.

Set CP-14 to 5 for the Direct Mode of operation.

Set CP-14 to 6 for the Tune Mode of operation.

SETPOINTS

The M-Shuttle allows the entry of six different setpoints; four Follower, one Direct and one Jog.

CP-1, CP-3, CP-5, CP-7 Follower Setpoints

The Follower Setpoints are entered into Setpoint 1 (CP-1), Setpoint 2 (CP-3), Setpoint 3 (CP-5), and Setpoint 4 (CP-7). The active setpoint in Follower Mode is selected via the Setpoint A (J3 Pin 13) and Setpoint B (J3 Pin 15) inputs:

Setpoint Select A	Setpoint Select B	Active Setpoint
Open	Open	Setpoint 1
Closed	Open	Setpoint 2
Open	Closed	Setpoint 3
Closed	Closed	Setpoint 4

(Closed = shorted to common)

The Follower Setpoint is the product or Lead length entered in Engineering Units (inches, feet, meters, etc.). The CP-15 parameter (see below under Follower Setpoint Scaling) will determine the location of the decimal point for all Follower Setpoints.

CP-61 Jog Setpoint

Enter the Jog Setpoint into CP-61. This setpoint should be entered in terms of RPMs. This setpoint is also used as the velocity for the Home Seek and Home Return functions.

CP-62 Direct Analog Command

Enter the Direct Analog Command into CP-62. The units for this variable are DAC bits where the value 4095 represents a maximum forward command and -4095 represents a maximum reverse command. An entry of zero will command a zero volt output to the drive.

FOLLOWER SETPOINT SCALING

The Follower Setpoints are entered in Engineering Units such as feet, inches, etc. The following two parameters indicate how to scale the M-Shuttle to allow for Engineering Unit setpointing.

CP-15 Engineering Units

Enter into CP-15 a commonly used Follower Setpoint in Engineering Units. Place the decimal point in the desired location for all Follower setpoints.

CP-16 Lead Lines per Engineering Units

Enter into CP-16 the number of Lead encoder lines that will occur on the Lead Frequency input to the M-Shuttle for the setpointed length entered into CP-15. Be sure to consider all gear reductions, etc. when calculating this variable.

This parameter can be determined/checked by using M-Shuttle monitor variables via the following procedure:

1) Place the M-Shuttle in F-Stop.
2) Set CP-14 to either 1 or 3 (enables Lead sync)
3) Display MV-43, Lead Position.
4) Provide a Lead Sync input by shorting the Lead Sync input to common (J3 Pin 10 to J3 Pin 11). MV-43 should go to zero.
5) Move the Lead product the length specified in CP-15.
6) MV-43 should now be the same as CP-16.
7) Return CP-14 to its original value for normal operation.

If the Lead product contains registration marks, the CP-16 variable can be found using the above procedure and moving the product past the starting and ending registration/sync points instead of shorting the sync input. CP-15 should then be entered as the distance between the two registration marks on the Lead product.

FEEDBACK SCALING

The following two parameters are used for scaling the Feedforward term of the compensation algorithn and for control parameters using RPM entries.

CP-18 PPR Follower (Feedback)

Enter into CP-18 the number of pulses per revolution of the feedback encoder (encoder resolution in lines).

CP-19 Maximum RPM Follower (Feedback)

Enter into CP-19 the RPMs of the feedback encoder shaft at the maximum process speed. Take into account all gear box reductions, etc. in determining this entry.

PROFILE DEFINITION

There are eight Control Parameters that are used to help define the Follower profile for the desired application. The forward segments of the profile are user defined. The reverse recovery segments are internally calculated by the M-Shuttle to return the shuttle to the Home position at the same time as the next product begins.

Many of the profile parameters such as Accel/Decel Length, Process Length, Forward Dwell and Reverse Dwell need not be exacting numbers. Close estimates may be adequate for acceptable system performance.

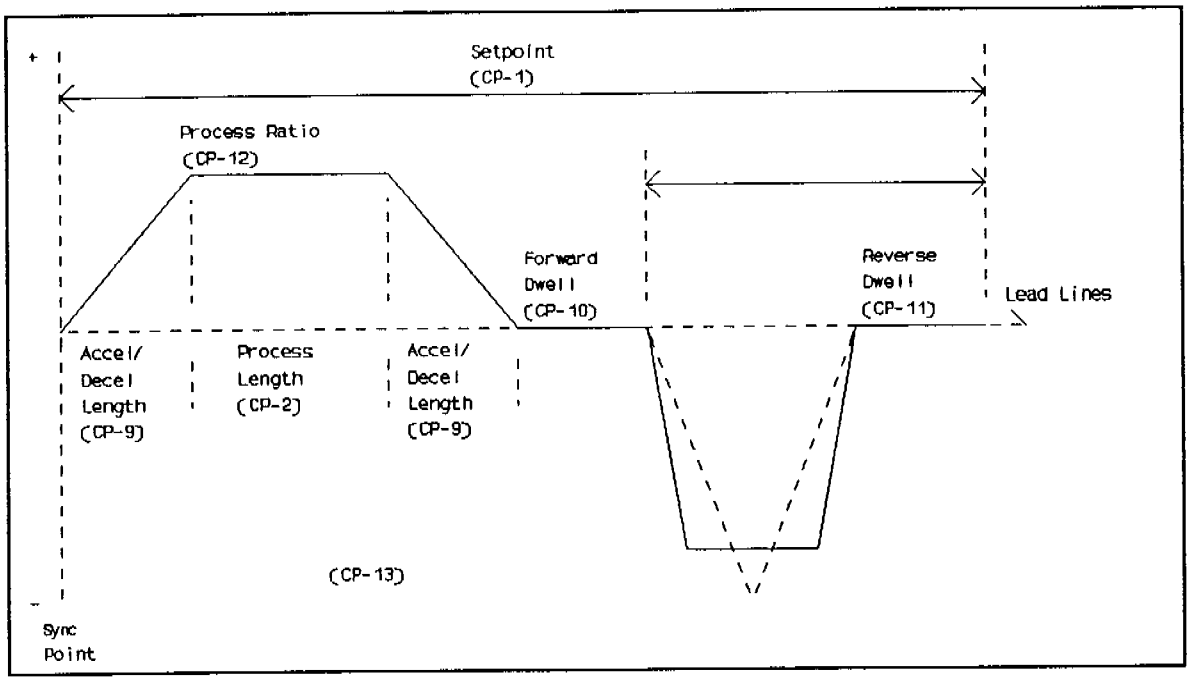


Figure 5-4: Profile Definition

CP-9 Accel/Decel Length

Enter into CP-9 the Accel/Decel Length in terms of Lead Engineering Units. This will be the length that will occur during the time the Follower ramps from a zero ratio (speed) up to the Process Ratio. It also defines the down ramp from the Process Ratio back down to zero.

CP-2, CP-4, CP-6, CP-8 Process Length

Enter into CP-2, CP-4, CP-6 and CP-8 the Process Lengths for the four Follower Setpoints in terms of Lead Engineering Units. The Process Length is the length that will occur during the Process Ratio segment of the profile. Frequently, the four Process Lengths will be the same for all four setpoints.

CP-22 Process Length Timer

The Process Length Timer places a time limit on the Process Length. If a time value (M Sec) is entered in CP-22, then the Process Length will terminate if that time out occurs before the Process Length distance is complete. A value of "0" in CP-22 disables the Process Length Timer.

CP-10 Forward Dwell

The Forward Dwell is the Lead length in Engineering Units that the M-Shuttle will remain at zero ratio (speed) before beginning the reverse recovery part of the profile. This segment is intended to provide a time delay to allow mechanical operations such as cutting blade retractions to occur before moving the shuttle back past the product in the reverse direction.

CP-11 Reverse Dwell

The Reverse Dwell is the Lead length in Engineering Units that the M-Shuttle will remain at zero ratio (speed) at the end of the reverse recovery portion of the profile before beginning the next product cycle in the forward direction. This segment is intended to provide a time delay to allow mechanical operations such as cutting blade activations to occur before moving the shuttle forward from the Home position.

CP-12 Process Ratio

The Process Ratio is the desired ratio of Follower lines to Lead lines (Follower lines/ Lead lines) during the Process Length segment of the profile.

In many applications, the Process Ratio will be the ratio that matches the Follower speed to the Lead speed during the Process Length profile segment. If the speeds are matched, then the distance travelled will also be the same. For these applications, the Process Ratio can be calculated by determining the number of Follower lines that occur for any given distance and dividing it by the number of Lead lines that occur for the same given distance.

The number of Lead lines for a given distance has already been entered into CP-16 for the distance in CP-15. The Follower lines for this distance can be determined/ checked using the Follower Position monitor variable MV-44 using a similar method as the CP-16 parameter calculation:

1) Place the M-Shuttle in F-Stop.
2) Set CP-14 to 1 or 2 (enables Follower sync)
3) Display MV-44, Follower Position.
4) Provide a Follower Sync input by shorting the Follower Sync input to common (J3 Pin 12 to J3 Pin 11). MV-44 should go to zero.)
5) Move (Forward Jog) the Follower shuttle the same distance specified in CP-15.
6) MV-44 should now indicate the number of Follower lines for the CP-15 distance. Divide this number by the number entered into CP-16.
7) Return CP-14 to its original value for normal operation.

CP-1 Maximum Recovery Ratio

The Maximum Recovery Ratio establishes a limit to the ratio used during the recovery part of the profile. If the Maximum Recovery Ratio is entered as a value less than Peak Recovery Ratio (MV-88), the recovery ramp rates will be increased to maintain synchronization.

The Maximum Recovery Ratio is defaulted to the maximum value of 10.000. For most applications, this value need not be changed from the default.

CP-21 Kerf Length

The Kerf Length is the number of Lead lines that are lost from the product by the physical cutting device (blade width). Entering a Kerf Length allows the Setpoint to represent the finished product length after the cutting process. The Kerf Length is added to the Setpoint to calculate the Lead product length (job size).

NOTE

The Kerf Length should be set to zero for Follower Modes CP-14 = 1 or 3 using a Lead Sync input (product registration marks).

CP-30 At-Home Band

The At-Home Band parameter determines when the M-Shuttle Follower position is considered at the Home position. The entered parameter number is interpreted as plus or minus from the Home position. One of the conditions for entering the Follower Mode is that the M-Shuttle is within the At-Home Band of the Home position.

CP-31 Home Offset

It is possible to locate the Home position other than at the location where the Home/Follower Sync sensor is located. If an entry is made in CP-31, the Home position will be located that number of Follower encoder lines in the reverse direction from the Home/Follower Sync sensor.

SYNC MODE

The M-Shuttle has the ability to synchronize or register the Follower shuttle to registration or index marks on the Lead product. This capability is activated when CP 14 is set to either a 1 or 3.

CP-32 Sync Lead Offset

The Sync Lead Offset is used to align the cutting tool or process device with the product registration mark when using the Lead Sync. Enter into CP-32 the distance from the Lead Sync sensor to the cutting tool when the shuttle is At-Home and CP-31 is zero. CP-32 should always be set to be equal to or greater than one half of the Accel Length (CP-09) whenever CP-14 is set to "1" or "3". (CP-32 will automatically compensate for later adjustments to CP-31.)

Enter into CP-32 the desired Lead Sync offset in terms of Engineering Units (inches, feet, etc.).

CP-32 values cannot be changed during the RUN state.

CP-33 Sync Trend Enable

When CP-33 is set to 1, the Lead Trending feature of the M-Shuttle is enabled. Trending allows the M-Shuttle to automatically compensate for slightly varying Lead job spaces such as for web stretch or registration print variations. The Trending feature averages every sixteen Lead job sizes to determine a new Lead job size.

CP-34 Sync Lead Delay

The CP-34 parameter determines whether the M-Shuttle will wait for a Lead Sync input to occur before beginning its acceleration ramp from the Home position.

CP-34	Action
0	No delay for Lead Sync
1	Wait in the At-Home position for the first profile execution only.
2	Wait at the At-Home position after every profile execution until the Lead Sync occurs.

If CP-14 is set to "2" OR "4", then there will be no Sync Lead Delay no matter what value is in CP-34.

CP-35 Sync Flag Polarity

CP-35 determines which edge of the sync pulse, rising or falling is recognized by the M-Shuttle as the sync point. This can be extremely useful when utilizing reflective or transmissive optical sensors with registration marks.

CP-35	Lead Sync	Home/Follower Sync
1	Rising Edge	Rising Edge
2	Falling Edge	Falling Edge
3	Falling Edge	Rising Edge
4	Rising Edge	Falling Edge

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

CP-36 Sync Lead Divide

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

The sync Lead divide counter is reset at power up or when the CP-14 or CP-36 values are changed. CP-36 cannot be changed in the Run state.

CP-37 Sync Lead Window

The CP-37 value helps filter extraneous Lead sync pulses by establishing a Lead Sync window. Lead sync input pulses outside of the Lead Sync window are ignored. Only the first Lead Sync pulses inside the window are considered valid. The Lead Sync window is fully opened when the Run state is entered and then closed to the CP-37 value when the first Lead Sync pulse occurs.

Enter into CP-37 the desired Lead Sync window size in terms of Engineering Units. The CP-37 value is applied as plus or minus (symmetric) around the sync point. Any CP-37 value greater than half of the Lead job size disables the Lead Sync window feature.

CAUTION

The Lead Sync Divide feature has priority over the Lead Sync Window feature. The Lead Sync Window function should only be activated if CP-36 is set to 1.

CAUTION

The Lead Sync Window is shifted according to the first sync pulse received in the window. Multiple consecutive early or late pulses may cause the sync window to be shifted to where valid sync pulses are no longer recognized.

CP-38 Sync Lead Window Format

The Sync Lead Window can be applied according to the CP-37 value or during selected segments of the profile. If CP-38 is set to 1, then the window is applied according to the CP-37 value. If CP-38 is set to 2, then the window is applied during the Process Length segment of the profile only. If CP-38 is set to 3, then the window is applied during the Process Length and the Decel Ramp segments of the profile. No window is applied if CP-38 is set to zero.

BATCHING

CP-27 Batch Limit

The M-Shuttle has an rudimentary Batch Control feature. An internal batch counter counts the number of completed Follower profiles and activates the Batch Done discrete output (J1 Pin 14) when the number in CP-27 is reached. If the Batch Done is connected to the Control Enable input (J4 Pin 8), the M-Shuttle will exit the Run state at the completion of the batch.

The batch counter is cleared to zero at power up or when the Batch Reset discrete input (J4 Pin 5) is activated.

ALARMS

The M-Shuttle has an Alarm discrete output (J1 Pin 15) that can be activated on various combinations of Low or High speed and/or Deviation (position error) conditions.

CP-23 High Speed Alarm

CP-23 sets the High Speed level for the Alarm discrete output. If the Follower RPMs rise above this level and CP-28 is set to a 1 or 3, the Alarm output will be activated until the speed falls back below this level.

CP-28 Alarm Format

CP-28 determines which conditions activate the Alarm output. If CP-28 is set to 1 a High speed condition will activate the Alarm output. If CP-28 is set to 2, then the Deviation Alarm activates the Alarm output (MV-49 > CP-24).

PROGRAMMABLE OUTPUTS

The M-Shuttle has three Programmable Outputs that can be activated at various points in the profile based on various combinations of distance, time and position error. Output A (J1 Pin 17) has the most versatility of the three Programmable Outputs (typically used to activate the process function). Output B (J1 Pin 18) and Output C (J1 Pin 19) have the same functionality.

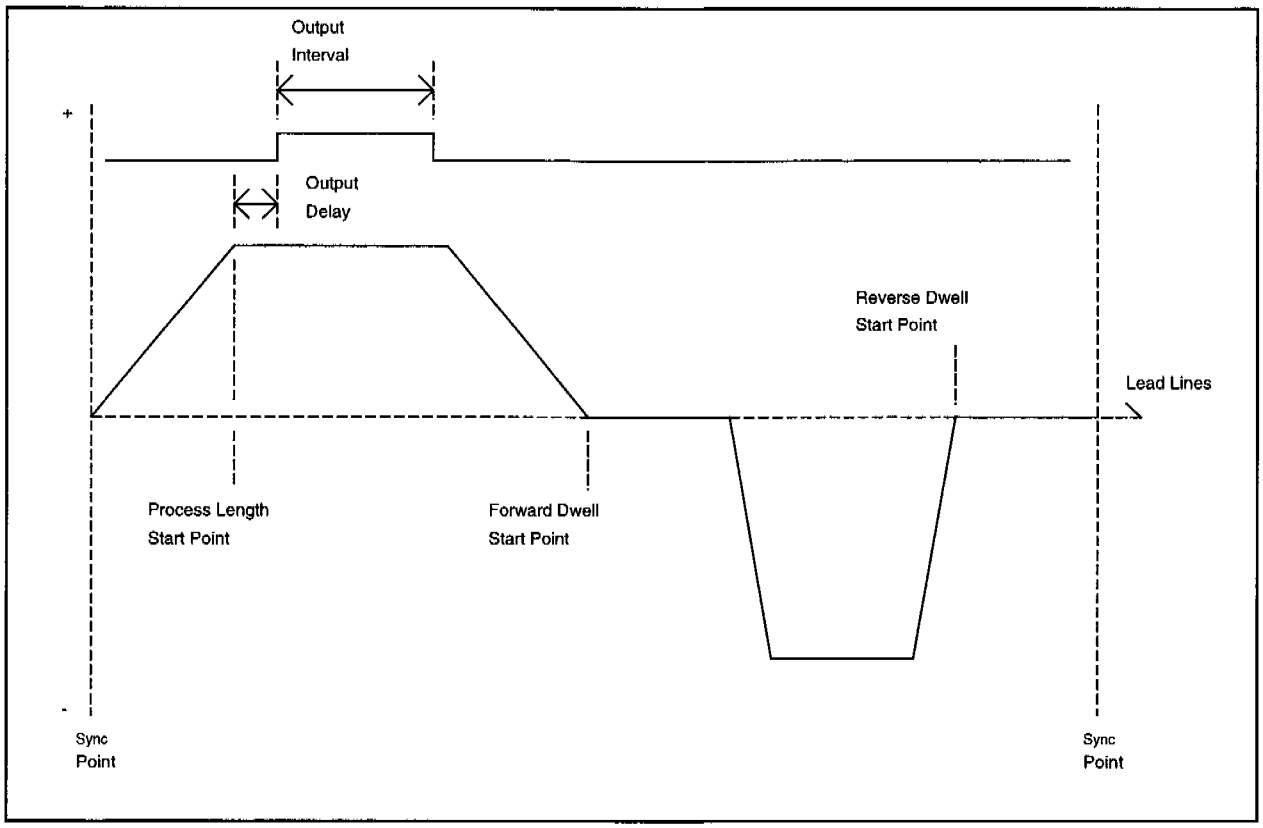


Figure 5-5: Programmable Outputs

CP-24 Deviation Band

Refer to CP-25 discussion below.

CP-25 Deviation Band Interval

Output A can be programmed to conditionally activate as a function of position error. If the position error does not fall within the Deviation Band entered into CP-24 within the Deviation Band Interval specified in CP-25, then Output A will not activate during that profile execution. This feature is only valid if Output A is programmed to start at the beginning of the Process Length segment (see CP-90 below) and CP-24 is not equal to zero. The Deviation Band Interval (CP-25) should always be set less then or equal to the Output A delay (CP-91).

Enter into CP-24 the desired Deviation Band (position error) in terms of encoder lines. CP-25 should be entered as milliseconds or Lead engineering units depending on the value of CP-90. This feature is disabled when CP-24 is set to "0" (default).

CP-90 Output A Format

CP-90 determines the format for the Output A discrete output. This output can be formatted for Start Point, Output Polarity and Timed or Distance programming. The Start Point determines which profile segment begins the time/distance process; the beginning of the Process Length, the Forward Dwell or the Reverse Dwell. The Output Polarity determines if the output activates Low or High. The Timed or Distance programming allows the Output Delay or Output Interval to be programmed in milliseconds or Lead engineering units.

Enter into CP-90 the desired Output Format according to the table below:

CP-90	Start Point	Output Polarity	Time/Distance
1	Process Length	Active Low	Time
2	Process Length	Active High	Time
3	Process Length	Active Low	Distance
4	Process Length	Active High	Distance
5	Forward Dwell	Active Low	Time
6	Forward Dwell	Active High	Time
7	Forward Dwell	Active Low	Distance
8	Forward Dwell	Active High	Distance
9	Reverse Dwell	Active Low	Time
10	Reverse Dwell	Active High	Time
11	Reverse Dwell	Active Low	Distance
12	Reverse Dwell	Active High	Distance

CP-91 Output A Delay

CP-91 determines how long Output A delays from the starting point before activating. This entry should be made in terms of milliseconds or Lead engineering units depending on the value in CP-90.

CP-92 Output A Interval

CP-92 determines how long Output A will stay active once it is activated. This entry should be made in terms of milliseconds or Lead engineering units depending on the value in CP-90. If Output A is programmed for the Process Length (CP-90 is set to 1, 2, 3 or 4), and the Output A Interval exceeds the Process Length, then Output A will deactivate at the end of the Process Length.

CP-93 Output B Format

CP-93 determines the format for the Output B discrete output. This output can be formatted for Start Point, Output Polarity and Timed or Distance programming. The Start Point determines which profile segment begins the time/distance process; the beginning of the Process Length, the Forward Dwell or the Reverse Dwell. The Output Polarity determines if the output activates Low or High. The Timed or Distance programming allows the Output Delay or Output Interval to be programmed in milliseconds or Lead engineering units.

Enter into CP-93 the desired Output Format according to the table below:

CP-93	Start Point	Output Polarity	Time/Distance
1	Process Length	Active Low	Time
2	Process Length	Active High	Time
3	Process Length	Active Low	Distance
4	Process Length	Active High	Distance
5	Forward Dwell	Active Low	Time
6	Forward Dwell	Active High	Time
7	Forward Dwell	Active Low	Distance
8	Forward Dwell	Active High	Distance
9	Reverse Dwell	Active Low	Time
10	Reverse Dwell	Active High	Time
11	Reverse Dwell	Active Low	Distance
12	Reverse Dwell	Active High	Distance

CP-94 Output B Delay

CP-94 determines how long Output B delays from the starting point before activating. This entry should be made in terms of milliseconds or Lead engineering units depending on the value in CP-93.

CP-95 Output B Interval

CP-95 determines how long Output B will stay active once it is activated. This entry should be made in terms of milliseconds or Lead engineering units depending on the value in CP-93.

TUNING

The Tuning procedure modifies the two control algorithm parameters to achieve optimal system performance and stability. The default tuning parameters in the M Shuttle should provide for stable operation in the majority of applications, but may not achieve the best possible performance for the given system. The procedure below is provided for those applications that are either unstable or not achieving the best possible performance.

Initial tuning can be done by placing the M-Shuttle in Tune Mode (CP-14 = 6). In this mode, the M-Shuttle will move back and forth between the Forward and Reverse Limits at the Jog Speed. Drive adjustments can be made first by setting CP-65 and CP-66 according to zero (feedforward only). After the drive is adjusted, add CP-65 and CP-66 to the procedurebelow.

The two tuning parameters should be checked and final adjustments made while the M-Shuttle is running in the Follower mode. The tuning should be adjusted at the highest process speed and then checked at lower speeds for stability. Nonlinear system components may cause different stability/performance characteristics to be exhibited at different speeds.

CP-65 Gain

The CP-65 adjusts the Gain term in the M-Shuttle control algorithm. The Gain term is the product of the current Position Error (MV-49) times the Gain Constant (CP-65). It is desirable to have the Gain term do most of work in resolving the position error.

To adjust the Gain term, first enter a value of zero into CP-66. With the M-Shuttle running at the maximum process speed, increase the value in CP-65 until the system starts to become unstable (instability can be observed by erratic motion or audible disturbances). Once the point of instability is found, reduce the CP-65 value slightly until the system stabilizes.

CP-66 Integral

Using Gain alone, the system will exhibit a phenomenon called proportional droop, whereby the setpoint is never reached due to system losses. Often these losses are minimal and further tuning is not necessary. If the process accuracy is not acceptable after adjusting the Gain term, then proceed by adjusting the Integral term (CP-66).

With CP-65 properly adjusted and the system running at the maximum process speed, add small increases in Integral (CP-66) while observing changes in the position error (MV-49) during the Process Length portion of the profile. As more Integral term is added, the position error will be decreased. Adding too much Integral term will cause excessive overshoot whereby the Follower position will go beyond the setpoint, particularly at the profile point where the acceleration ramp meets the Profile Length. Add only enough Integral term to minimize position error without creating excessive overshoots.

Note

It will be easier to adjust the Integral term for maximum performance if the position error is minimized at the Home position before accelerating up to the Process Length portion of the profile. By increasing the Reverse Dwell (CP-11) segment of the profile, the M-Shuttle will be able to better reduce the following position error before beginning the next profile execution.

CP-68 Integral Activation

CP-68 determines when the integral term is activated:

1 = Integral is active during Process Length and Dwells only.
2 = Integral is active during Process Length when Output A is off and Dwells only.
3 = Integral is always active.
4 = Integral is always active, except when Output A is on.

PERFORMANCE MONITORING

The M-Shuttle contains numerous Monitor Variables available to monitor controller status and system performance. These Monitor Variables can be sectored into Static, Dynamic and Profile monitoring categories.

STATIC MONITORING

Although the Static Monitor variables can be utilized in any controller state (Run, F Stop, Jog, etc.) they are typically used to verify proper installation. They are also useful to verify fundamental controller operation.

The Static Variables are coded variables displayed as either a zero or one in the various digit locations on the display. The following explains the purpose of each Static Monitor variable and its decoding.

MV-50 Keypad Errors

This variable is used to display errors when attempting to enter new values for Control Parameters. If a Keypad Error occurs while attempting to enter a new parameter value, the new value will not be accepted. MV-50 can be accessed to determine why the new value was rejected.

A "1" in the respective digit location indicates a Keypad Error.

```
X  X  X  X  X  X
|  |  |  |  |  |
|  |  |  |  |  Invalid Parameter Code
|  |  |  |  Value Exceeds Maximum Limit
|  |  |  Value Below Minimum Limit
|  |  Keypad Lockout Enabled or Invalid Ratio
|  Lockout During Run State or Entry Timeout
Not Used
```

MV-51 Alarm Status

This variable is used to indicate various Alarm conditions that can occur during all states of M-Shuttle operation. Although categorized as a Static Monitor variable, it may have greatest utility during normal Run operation.

```
X  X  X  X  X  X
|  |  |  |  |  |
|  |  |  |  |  Home Not Defined
|  |  |  |  High Speed Alarm
|  |  |  Forward or Reverse Limit Alarm
|  |  Deviation Band (Position Error) Alarm
|  Not At-Home
Not Used
```

MV-52 Control State

The MV-52 variable is used to indicate the current Control State of the M-Shuttle.

```
X  X  X  X  X  X
|  |  |  |  |  |
|  |  |  |  |  Jog
|  |  |  |  Run (Follower/Direct)
|  |  |  Home Return
|  |  Home Seek
|  F-Stop
 Wait Active
```

MV-53 Discrete Inputs - Group A

The MV-53 variable is used to indicate the status of certain Discrete (Logic) Inputs. A "1" indicates an open (logic high) level. A "0" indicates a closed (logic low) level.

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

MV-54 Discrete Inputs - Group B

The MV-54 variable is used to indicate the status of certain Discrete (Logic) Inputs. A "1" indicates an open (logic high) level. A "0" indicates a closed (logic low) level.

```
X  X  X  X  X  X
|  |  |  |  |  |
|  |  |  |  |  Forward Limit
|  |  |  |  Reverse Limit
|  |  |  Lead Sync
|  |  Home/Follower Sync
|  Setpoint Select A
Setpoint Select B
```

MV-55 Discrete Inputs - Group C

The MV-55 variable is used to indicate the status of certain Discrete (Logic) Inputs. A "1" indicates an open (logic high) level. A "0" indicates a closed (logic low) level.

```
X  X  X  X  X  X
|  |  |  |  |  |
|  |  |  |  |  Home Set
|  |  |  |  Home Seek
|  |  |  Home Return
|  |  Batch Reset
|  Not Used
Not Used
```

MV-56 Discrete Outputs - Group A

The MV-56 variable is used to indicate the status of certain Discrete (Logic) Outputs. A "1" indicates an inactive or deenergized (logic high) level. A "0" indicates an active or energized (logic low) level.

```
X  X  X  X  X  X
|  |  |  |  |  |
|  |  |  |  |  Drive Enable
|  |  |  |  Batch Done
|  |  |  High or Deviation Alarm
|  |  Profile Direction
|  Programmable Output A
Programmable Output B
```

MV-57 Discrete Outputs - Group B

The MV-57 variable is used to indicate the status of the At-Home Discrete (Logic) Output. A "1" indicates an inactive or deenergized (logic high) level. A "0" indicates an active or energized (logic low) level.

```
X  X  X  X  X  X
|  |  |  |  |  |
|  |  |  |  |  At-Home
|  |  |  |  Not Used
|  |  |  Not Used
|  |  Not Used
|  Not Used
Not Used
```

MV-58 Invalid Profile

The MV-58 variable is used to indicate that an Invalid Profile has been entered. The Run state will be disallowed in Follower mode if an Invalid Profile exists. MV-58 will indicate why the profile cannot be executed.

```
X  X  X  X  X  X
|  |  |  |  |  |
|  |  |  |  |  The Accel/Decel Length, Process Length, Forward Dwell or
|  |  |  |  |  Reverse Dwell exceeds the current Setpoint.
|  |  |  | The Forward Profile Size or Reverse Recovery Size exceeds the
|  |  |  | current Setpoint.
|  |  |  The Forward Profile Size + Reverse Recovery Size exceeds
|  |  |  the current Setpoint + Kerf.
|  |  A Run request in Follower mode was made with an invalid profile.
|  Not Used.
Insufficient Lead Sync Offset for synchronization.  CP-32 must be equal to or
greater than one half of CP-09.
```

MV-59 Line Notch Counter

MV-59 is a counter display that increments every time the AC line falls below the specified minimum level. It can be used to help check the integrity of the AC line. Notches on the line caused by inductive loads (motors, contactors, etc.) will increment the MV-59 counter if the AC line is to low or soft. The Clear key resets the counter to zero.

DYNAMIC MONITORING

Dynamic Monitoring variables are typically used to monitor system performance during the Run state. These variables are calculated and displayed every 250 milliseconds (4 times per second).

MV-40 Tach (Feedback Velocity)

The MV-40 monitor variable, or Tach, indicates the feedback (Follower) velocity in encoder RPMs.

MV-41 Lead Frequency

The MV-41 variable displays the Lead frequency in hertz (encoder lines/sec).

MV-42 Feedback Frequency (Follower)

The MV-42 variable displays the Feedback (Follower) frequency in hertz (encoder lines/sec).

MV-43 Lead Position

The MV-43 variable indicates the Lead position. This is the current Lead distance in Lead encoder lines from the sync or beginning profile point.

MV-44 Follower Position

The MV-44 variable indicates the Follower position. This is the current Follower distance in Follower encoder lines from the Home/Follower sync point.

MV-45 Product Rate

MV-45 displays the Product Rate in terms of cycles (profiles) per minute based on the cycle time for the last completed profile.

MV-46 Process Error

The MV-46 displays the worst (highest) Position Error (MV-49) value that occurred during the time that Output A was active.

MV-47 DAC Output

The DAC Output variable, MV-47, indicates the present level of the analog output command to the motor drive. This output is displayed in DAC bits with 4095 representing a 100% positive output and -4095 representing a 100% negative output.

MV-48 Trim Output

The Trim Output, MV-48, is the calculated output of the compensation (gain plus integral) algorithm. It is the total output (MV-47) minus the feedforward. This output is displayed in DAC bits with 4095 representing a 100% positive output and - 4095 representing a 100% negative output.

MV-49 Position Error (Deviation)

The MV-49 variable displays the current Follower Position Error. This is the difference in Follower encoder lines between the commanded Follower and the actual Follower position. A positive MV-49 value indicated that the Follower position is behind in position (lagging). A negative value indicates the actual position is ahead of the commanded position (leading).

PROFILE MONITORING

A separate category of Monitor Variables is available to display both static and dynamic variables associated with the programmed profile and its execution. The Start Limit Point (MV-82), End Limit Point (MV-83), Follower Length (MV-84), Computed Ratio (MV-86) and Peak Recovery Ratio (MV-88) are all static monitor variables. They are used to display those portions of the Follower profile that are automatically calculated by the M-Shuttle. The Lead Job Size (MV-80), Follower Job Size (MV-81), Trended Ratio (MV-85) and Profile Ratio are dynamic variables that change during Follower mode execution.

MV-80 Lead Job Size

This variable displays the most recent number of Lead encoder lines that occurred between the last two Lead sync inputs. This variable is valid for all modes of operation and can be used to help determine the number of Lead lines per Setpointed cut length.

MV-81 Follower Job Size

This variable displays the most recent number of Follower encoder lines that occurred between the last two Follower Sync inputs. It is the forward traverse distance of the shuttle in Follower encoder lines.

MV-82 Start Limit Point

The M-Shuttle automatically calculates the Reverse Recovery portion of the Profile. The acceleration ramp in the reverse direction may reach the Maximum Recovery Ratio (CP-13). The MV-82 variable is the point where the reverse acceleration ramp meets the Maximum Recovery Ratio. It is displayed in terms of engineering units.

MV-83 End Limit Point

The MV-83 variable displays the profile point where the Maximum Recovery Ratio ends and the deceleration ramp begins in the reverse direction. MV-82 and MV-83 will be the same value if the reverse recovery ratio does not exceed the Maximum Recovery Ratio. It is displayed in terms of engineering units.

MV-84 Follower Profile Length

The MV-84 variable displays the total forward Follower travel length for the entered profile. It is displayed in terms of Follower encoder lines.

MV-85 Trended Ratio

The MV-85 displays the calculated ratio between the Feedback (Follower) Frequency input and the Lead Frequency input required to maintain alignment between the two Sync inputs based on the MV-80 and MV-81 Job Sizes.

A displayed value of "LP--85" indicates that the M-Shuttle has not yet determined the Trended Ratio when Trending is enabled (CP-33=1).

MV-86 Computed Ratio

MV-86 displays the calculated ratio between the Feedback (Follower) frequency input and the Lead frequency input required to maintain synchronization based on the programmed profile job sizes. This is the ratio that is utilized by the M-Shuttle if Trending is disabled.

MV-87 Profile Ratio

The MV-87 variable displays the current (instantaneous) Follower/Lead ratio generated by the M-Shuttle during profile execution.

MV-88 Peak Recovery Ratio

This variable displays the Peak Recovery Ratio used during the recovery portion of the profile. It is the apex or point where the reverse acceleration ramp begins to decelerate. If this value exceeds the Maximum Recovery Ratio (CP-13), then a limit equal to the Maximum Recovery Ratio is applied.

Although this number is mathematically always negative, it is displayed as a positive number with direction inferred.

MV-89 Batch Count

MV-89 displays the number of complete batch counts (profile completions).

SERIAL COMMUNICATIONS 6

INTRODUCTION

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

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

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

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

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

Data Inquiry - Host Transmission
Data Inquiry - M-Shuttle Response

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

M-SHUTTLE SERIAL COMMUNICATIONS SETUP

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

70 - DEVICE ADDRESSES

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

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

71 - BAUD RATE

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

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

72 - CHARACTER FORMAT

The M-Shuttle 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:

0 = F-Stop
1 = F-Stop/Run/Home Return/Home Seek/Home Set
2 = F-Stop/Batch Reset/Setpoint Select 1-4
3 = All of the above.

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

SUMMARY: M-SHUTTLE SERIAL COMMUNICATIONS PROTOCOL

Table 6-1 summarizes the character structure for the M-Shuttle 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 Responce only:	30-39	0-9
8	Data 1,000,000's	30	0
	(Data Inquiry Responce 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-Shuttle 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-Shuttle that is to be accessed. This number differentiates the individual M-Shuttle 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-Shuttle). The only exception is device address 00, which is universally accepted by all the M-Shuttles 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 indicates the data is negative.

CHARACTER 16: ETX

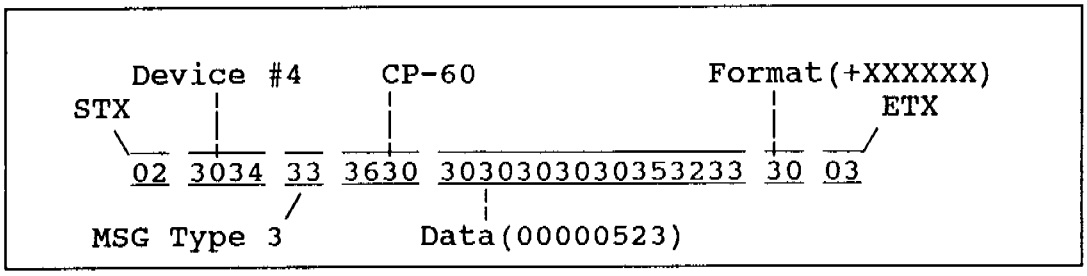
The message or record must always be terminated by the ASCII ETX character.

EXAMPLE:

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

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

HEX Representation:



NOTE: Spaces are visual clarity only.

PARAMETER SEND - M-SHUTTLE 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-Shuttle. 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-Shuttle 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 Bit 7 Bit Ø
@	Ø1ØØØØØØ
A	Ø1ØØØØØ1
B	Ø1ØØØØ1Ø
C	Ø1ØØØ11
D	Ø1ØØØ1ØØ
E	Ø1ØØØ1Ø1
F	Ø1ØØØ11Ø
G	Ø1ØØØ111
H	Ø1ØØ1ØØØ
I	Ø1ØØ1ØØ1
J	Ø1ØØ1Ø1Ø
K	Ø1ØØ1Ø11
L	Ø1ØØ11ØØ
M	Ø1ØØ11Ø1
N	Ø1ØØ111Ø
O	Ø1ØØ1111
P	Ø1Ø1ØØØØ
Q	Ø1Ø1ØØØ1
R	Ø1Ø1ØØ1Ø
S	Ø1Ø1ØØ11
T	Ø1Ø1Ø1ØØ
U	Ø1Ø1Ø1Ø1
V	Ø1Ø1Ø11Ø
W	Ø1Ø1Ø111
X	Ø1Ø11ØØØ
Y	Ø1Ø11ØØ1
Z	Ø1Ø11Ø1Ø
[	Ø1Ø11Ø11
\	Ø1Ø111ØØ
]	Ø1Ø111Ø1
^	Ø1Ø111Ø
-	Ø1Ø1111

ASCII	BINARY Bit 7 Bit Ø
`	Ø11ØØØØØ
a	Ø11ØØØØ1
b	Ø11ØØØ1Ø
c	Ø11ØØ11
d	Ø11ØØ1ØØ
e	Ø11ØØ1Ø1
f	Ø11ØØ11Ø
g	Ø11ØØ111
h	Ø11Ø1ØØØ
i	Ø11Ø1ØØ1
j	Ø11Ø1Ø1Ø
k	Ø11Ø1Ø11
l	Ø11Ø11ØØ
m	Ø11Ø11Ø1
n	Ø11Ø111Ø
o	Ø11Ø1111
p	Ø1111ØØØ
q	Ø1111ØØ1
r	Ø1111Ø1Ø
s	Ø1111Ø11
t	Ø1111ØØ
u	Ø1111Ø1
v	Ø1111Ø11
w	Ø1111Ø111
x	Ø1111ØØØ
y	Ø1111ØØ1
z	Ø1111Ø1Ø
{	Ø1111Ø11
¦	Ø1111ØØ
}	Ø1111Ø1
~	Ø1111Ø
DEL	Ø1111111

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

CHARACTERS 5 & 6: PARAMETER NUMBER

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

CHARACTERS 7 TO 14: DATA

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

CHARACTER 15: DATA FORMAT

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

CHARACTER 16: ETX

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

DATA INQUIRY-HOST TRANSMISSION

CHARACTER 1: STX

The leading character must always be the ASCII STX.

CHARACTERS 2 & 3: DEVICE NUMBER

The device address of the M-Shuttle.

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-Shuttle.

CHARACTER 15: DATA FORMAT

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

CHARACTER 16: ETX

The message should terminate with the ASCII ETX character.

DATA INQUIRY - M-SHUTTLE 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-Shuttle 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-Shuttle information.

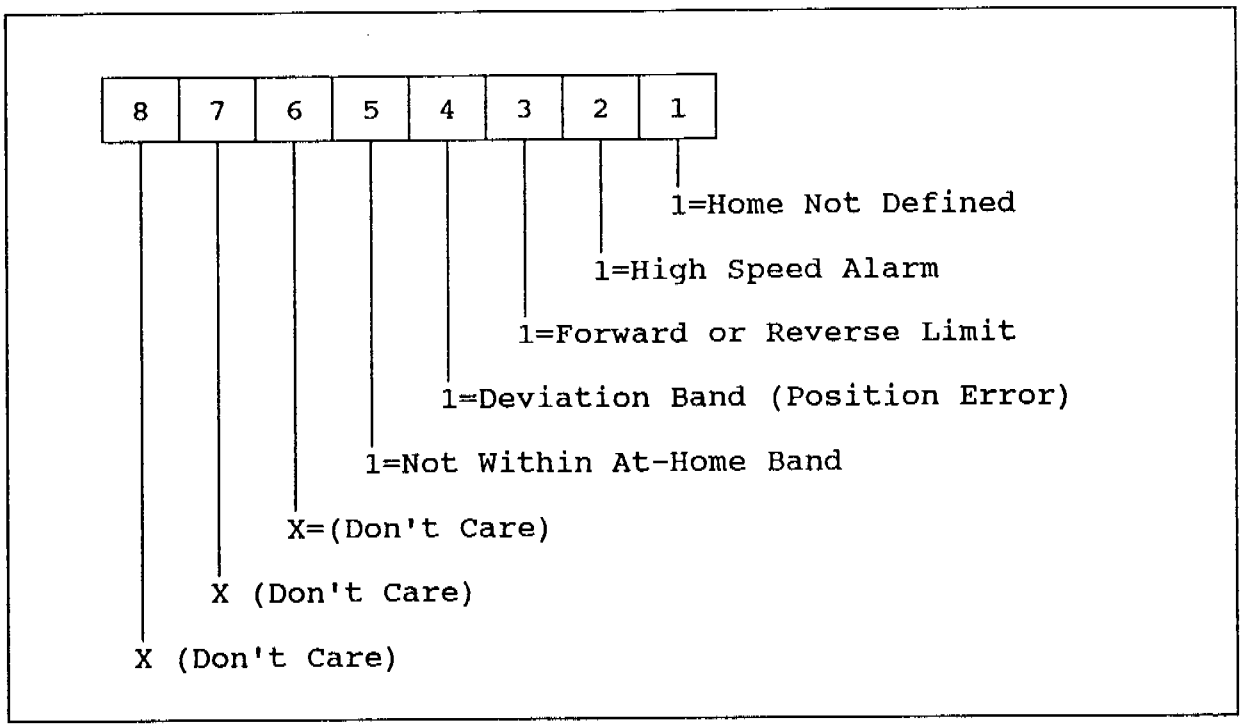


Figure 6-1: MV-51 Interpretation

To illustrate, assume that decimal 20 (HEX 14) is returned by the M-Shuttle in response to MV-51 Data Inquiry Command. Using Table 6-3, the number 20 converts to 00010100:

0	0	0	1	0	1	0	0	(20)
8	7	6	5	4	3	2	1	

Using Figure 6-1 above, 20 can now be interpreted to indicate the following Alarm Status: Not Within At-Home Band and Forward or Reverse Limit.

0 00000000	32 00100000
1 00000001	33 00100001
2 00000010	34 00100001
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

Figure 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.

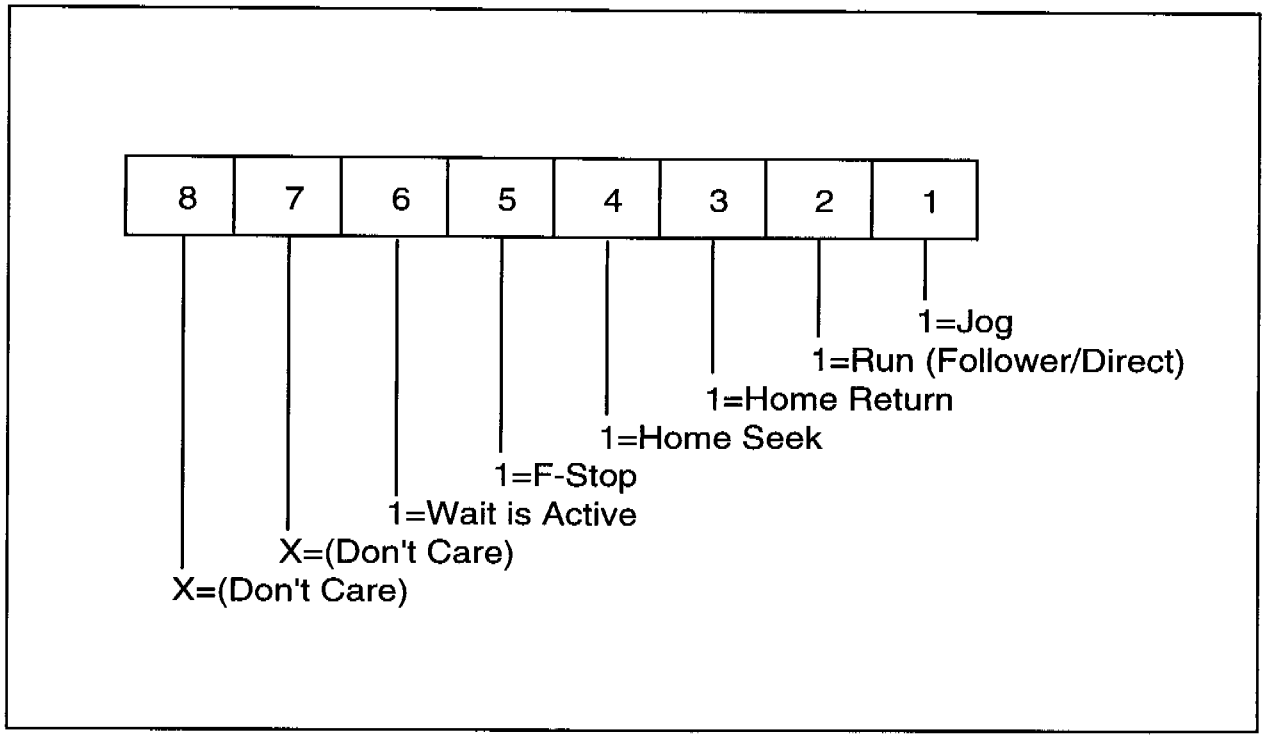


Figure 6-2: MV-52 Interpretation

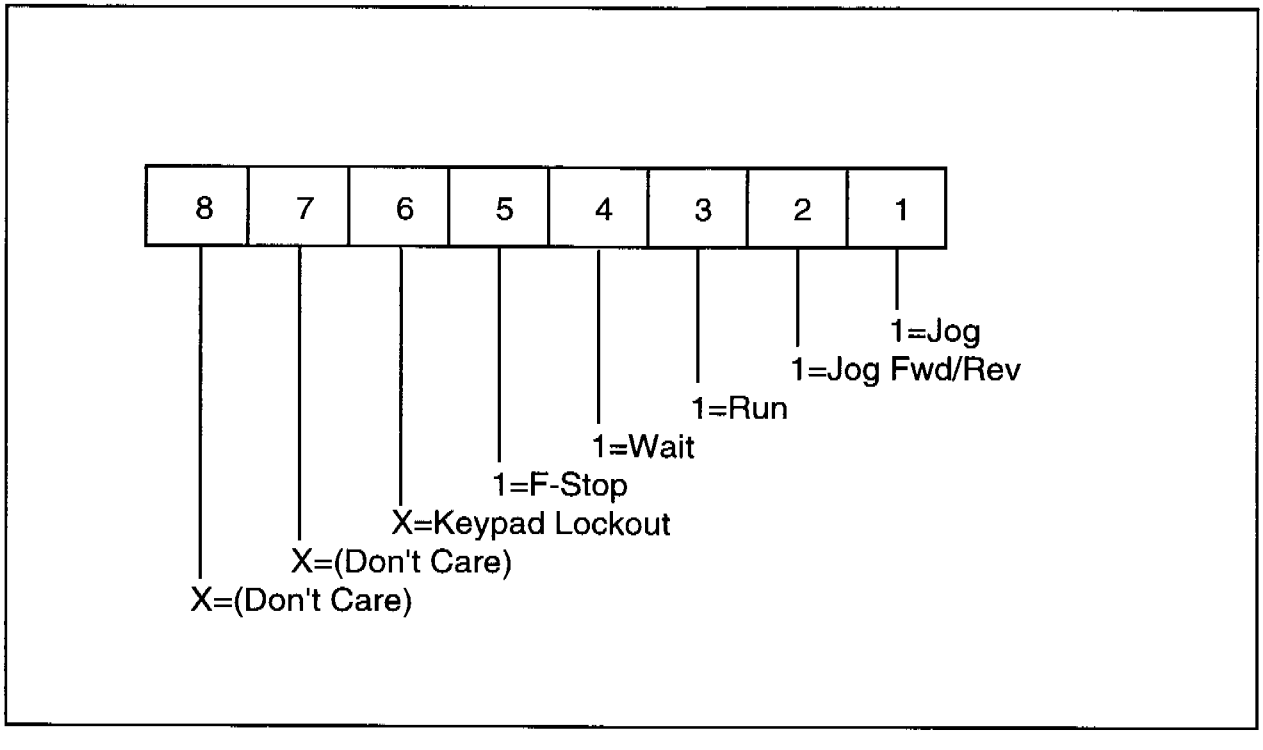


Figure 6-3: MV-53 Interpretation

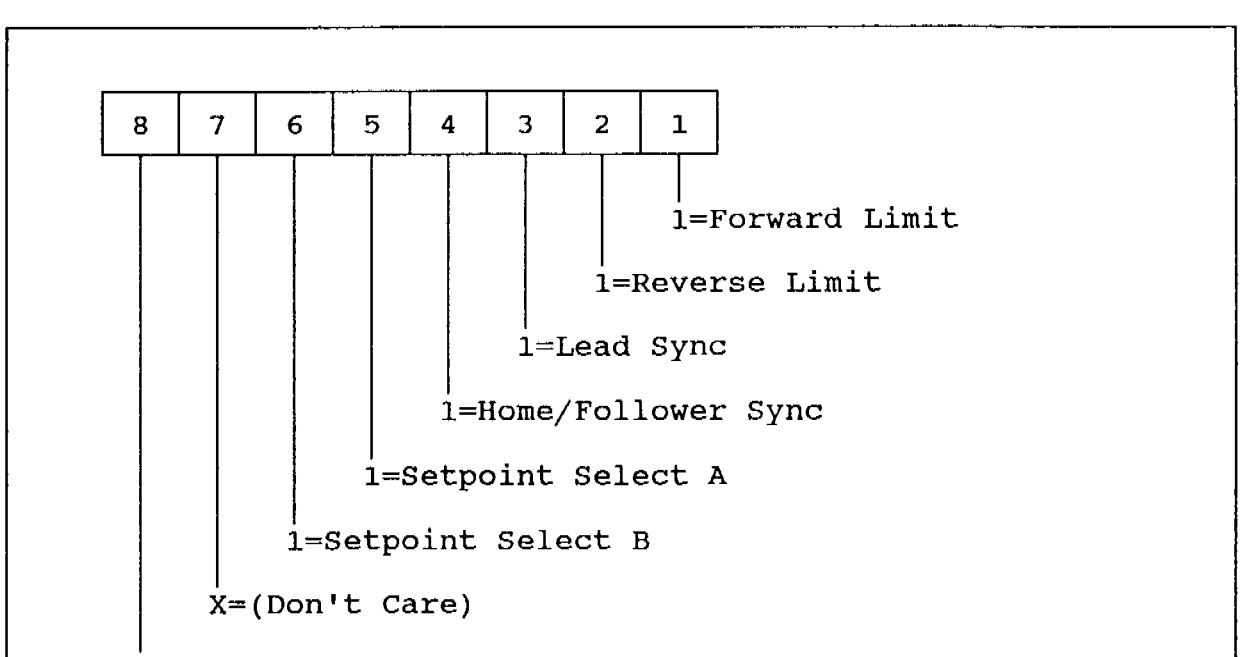


Figure 6-4: MV-54 Interpretation

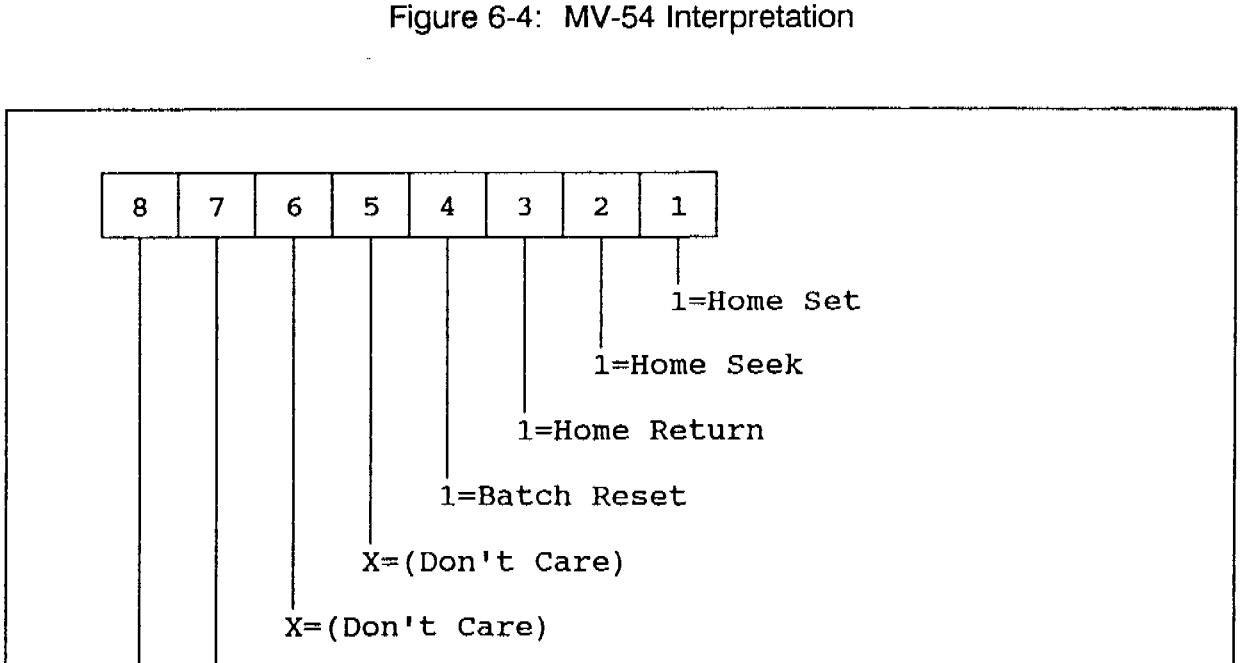


Figure 6-5: MV-55 Interpretation

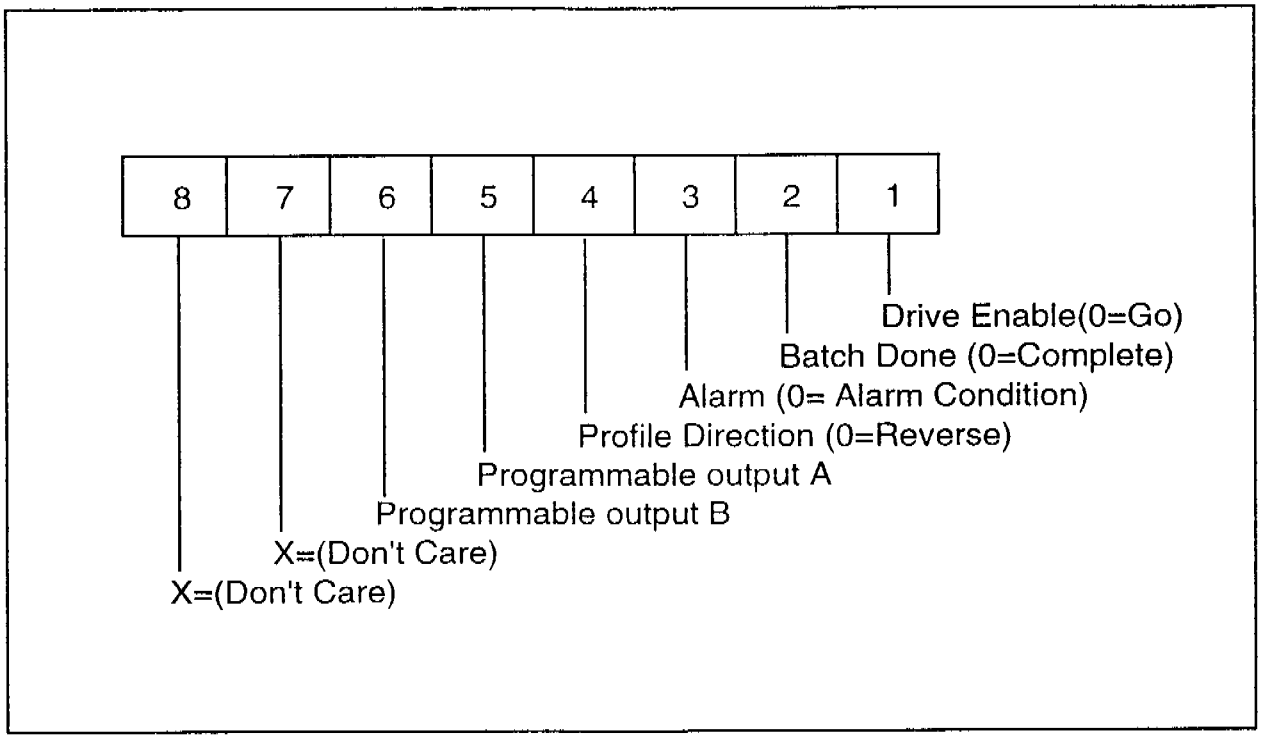


Figure 6-6: MV-56 Interpretation

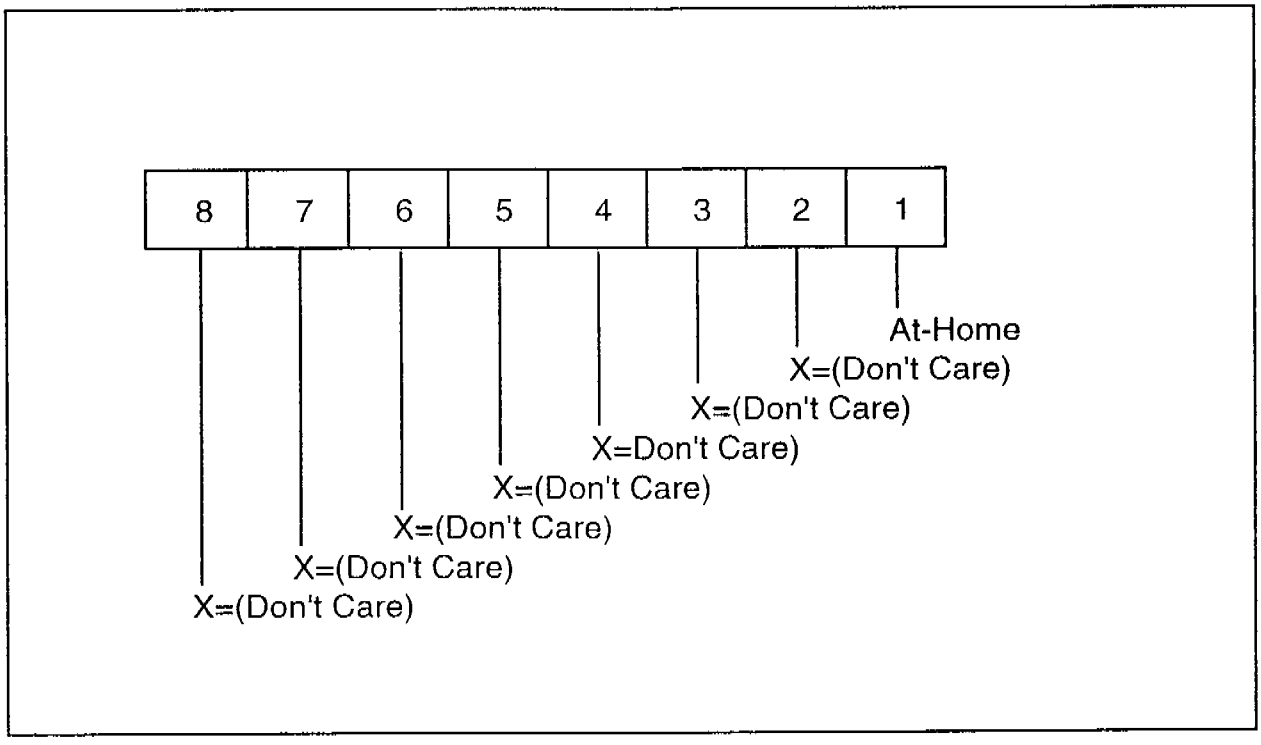


Figure 6-7: MV-57 Interpretation

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.

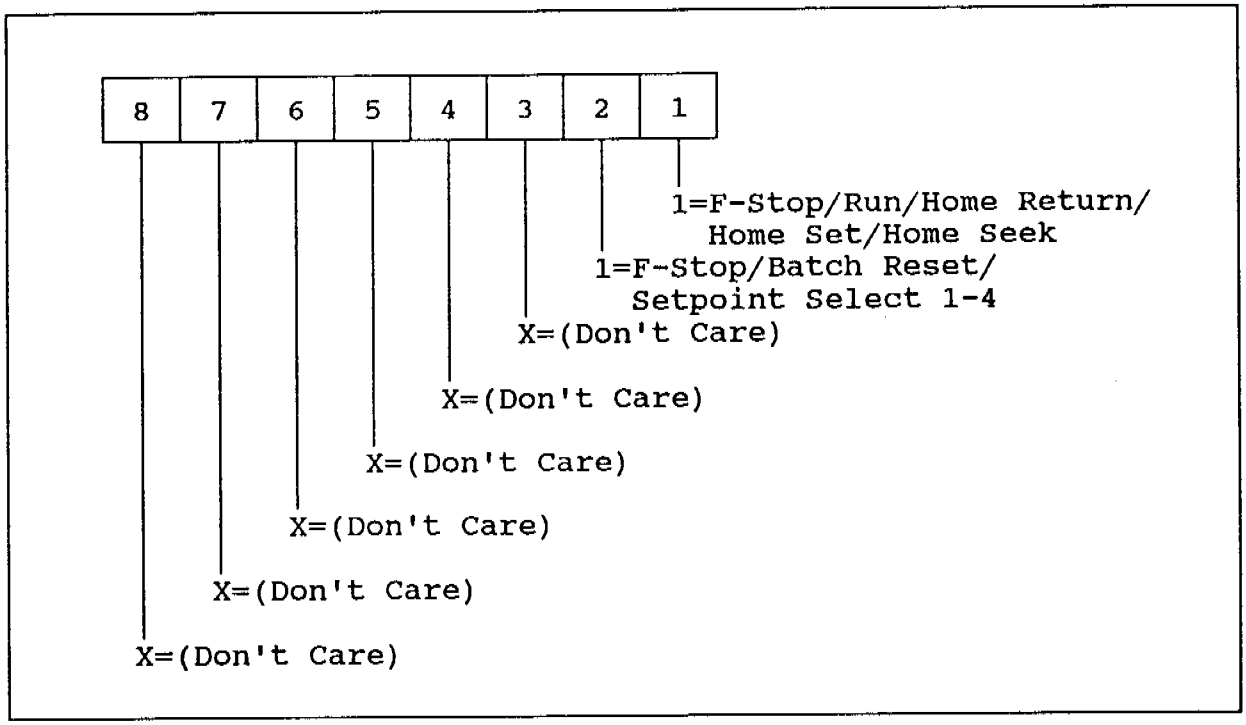


Figure 6-8: CP-73 Interpretation

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-Shuttle 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 - Setpoint Select 2
02 - Not Used	10 - Setpoint Select 3
03 - Run	11 - Setpoint Select 4
04 - Home Return	12 - Not Used
05 - Home Seek	13 - Not Used
06 - Home Set	14 - Not Used
07 - Batch Reset	15 - Not Used
08 - Setpoint Select 1	

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-SHUTTLE RESPONSE

CHARACTER 1: STX

The message always begins with the ASCII STX character.

CHARACTERS 2 & 3: DEVICE NUMBER

The device address of the M-Shuttle.

CHARACTER 4: ERROR CODE

Error Code for the received message.

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

CHARACTERS 5 & 6: PARAMETER NUMBER

Always 0 for this message type.

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

Always 0 for this message type.

CHARACTERS 13 & 14: DATA 10s & 1s

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

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-Shuttle problems, and is divided into the following sections:

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

Noise Recovery — Provides information to recover from EMI noise (indicated by -----1, ------2 or -----3 M-Shuttle 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-Shuttle to the default factory settings.

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

The Contrex service number is 1-800-342-4411.

DIAGNOSTICS

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

CLEAR/4 POWER UP TESTS

Initiate Test

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

1. RSEG TEST

1. Display "HELP 1" in the M-Shuttle 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-Shuttle 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-Shuttle 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-Shuttle upper display.
2. Press ENTER to start test.
3. M-Shuttle 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-Shuttle upper display.
2. Press ENTER to start test.
   The following LEDs are illuminated in order: Code Select, Status, Tach, Setpoint, Batch Count, Run, Cntl Enbl, Lead Sync, At-Home, Alarm.

6. KEYPAD TEST

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

Press	Display	Press	Display	Press	Display
-	-	4	4	SETPOINT	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-Shuttle upper display.
2. Press ENTER to start test.
3. Close input switches. The M-Shuttle displays a number according to the input pressed.

Input Closure	Display	Input Closure	Display
LEAD SYNC (J3-10)	10	RUN (J4-6)	02
HOME/FOLL SYNC (J3-12)	11	WAIT (J4-8)	03
SET.SEL A (J3-13)	12	F-STOP (J4-9)	04
SET.SEL B (J3-15)	13	KEYLOCK (J4-11)	05
HOME SET (J3-16)	14	FWD LIMIT (J4-12)	06
HOME SEEK (J4-2)	15	REV LIMIT (J4-14)	07
HOME RETURN (J4-3)	16	JOG FWD/REV (J4-15)	01
BATCH RESET (J4-5)	17	JOG (J4-17)	00

4. Press CLEAR to exit test.

8. DISCRETE OUTPUT TEST

1. Display "HELP 8" in the M-Shuttle 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	DRIVE ENABLE	5	OUTPUT A
2	BATCH DONE	6	OUTPUT B
3	ALARM	7	AT-HOME
4	PROFILE DIRECTION		

4. Press CLEAR to exit test.

9. SPEED COMMAND OUTPUT TEST

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

VERIFYING M-SHUTTLE QUAD INPUTS

1. Quad Input Test

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

NOISE RECOVERY

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

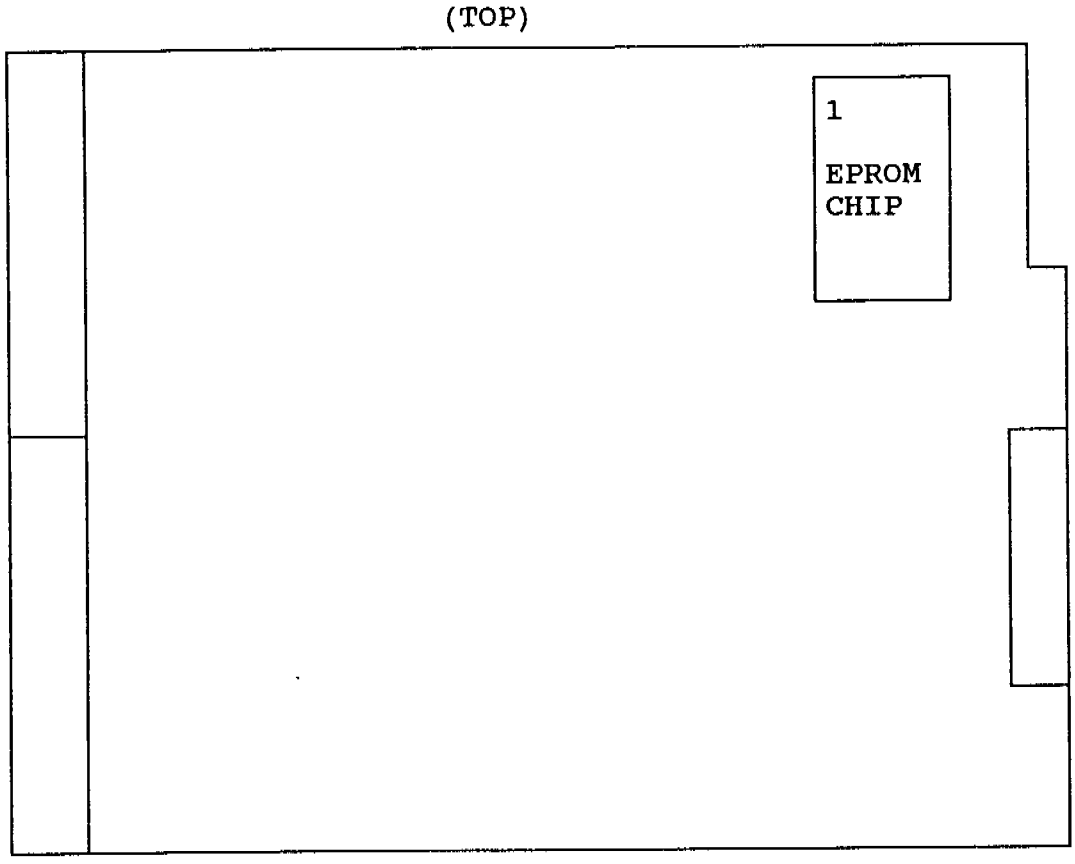


Figure 7-1: EPROM Location

RESTORE SETTINGS

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

1. Remove power from the M-Shuttle.

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

NOTES

APPENDIX A - FEEDBACK SENSORS A

INTRODUCTION

For the M-Shuttle to accurately control a motor, the M-Shuttle 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 (Contrex 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.

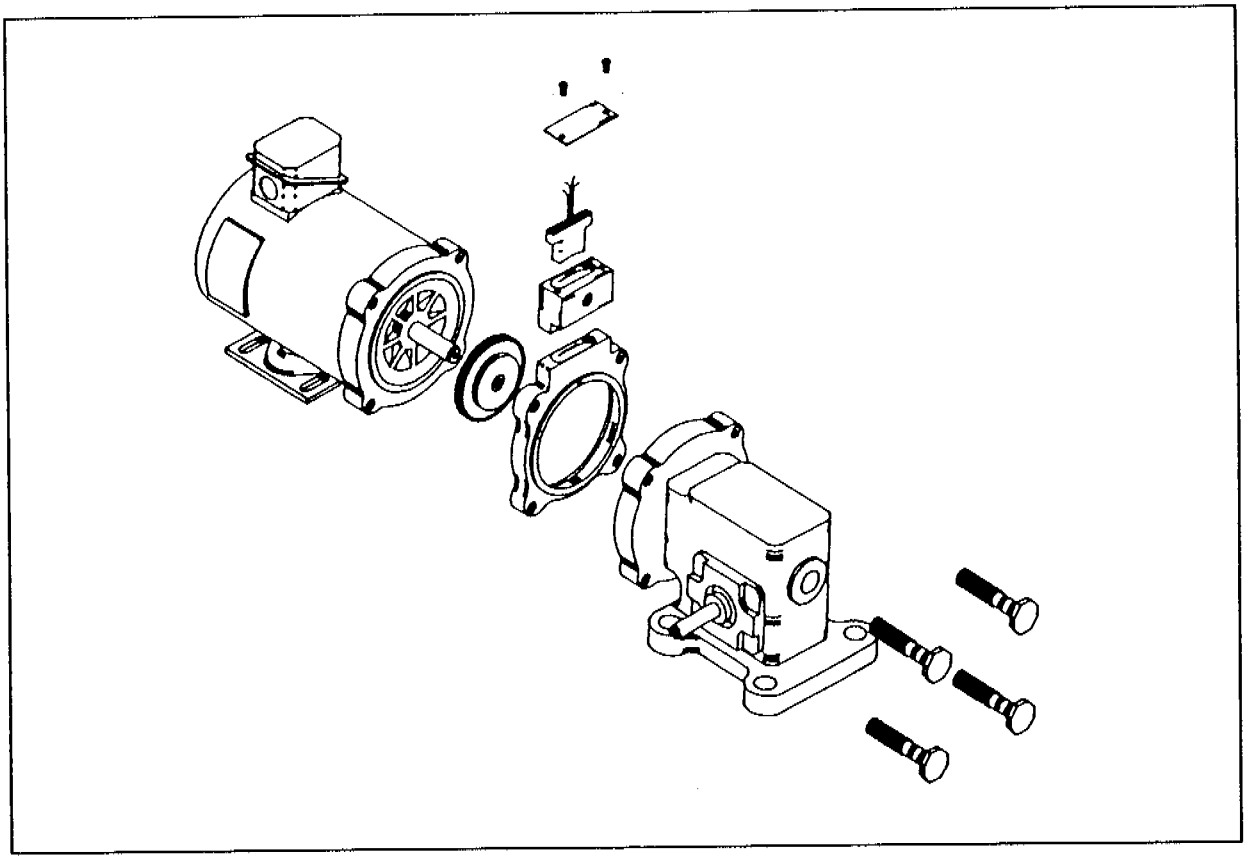


Figure A-1: Hall Effect Ring Kit

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 Contrex 3200-1341 quadrature encoder kit.

SPECIFICATIONS

ELECTRICAL

Code: Incremental
Cycles per Shaft Turn: 600

Output:
3904: current sinking up to 40 mA

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

Supply Voltage:
3904: 5Vdc

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

MECHANICAL

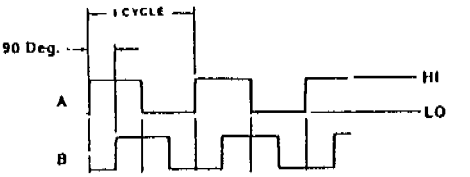
Shaft Diameter: 3/8"
Hollow shaft

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

ENVIRONMENTAL

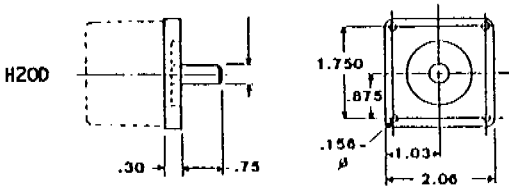
Temperature: Operating: 0 to 70 degrees C standard, extended temperature testing available to -40 $^{\circ}$ C (requires oil lube bearing quadrature $\pm 36^{\circ}$ C at -40 $^{\circ}$ C). Storage: -25 to 90 $^{\circ}$ C
Shock: 50 G's for 11 msec duration
Vibration: 5 to 2000 Hz @ 20 G's
Humidity: 99%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

FIGURE 1 - OUTPUT WAVEFORMS



DIMENSIONS

HOUSING TYPE



COVER AND TERMINATION

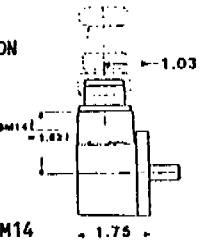
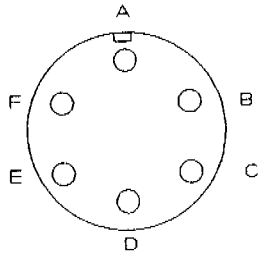


Figure A-2: 3200-1341 Quadrature Encoder: Specifications and Dimensions

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-SHUTTLE FEEDBACK

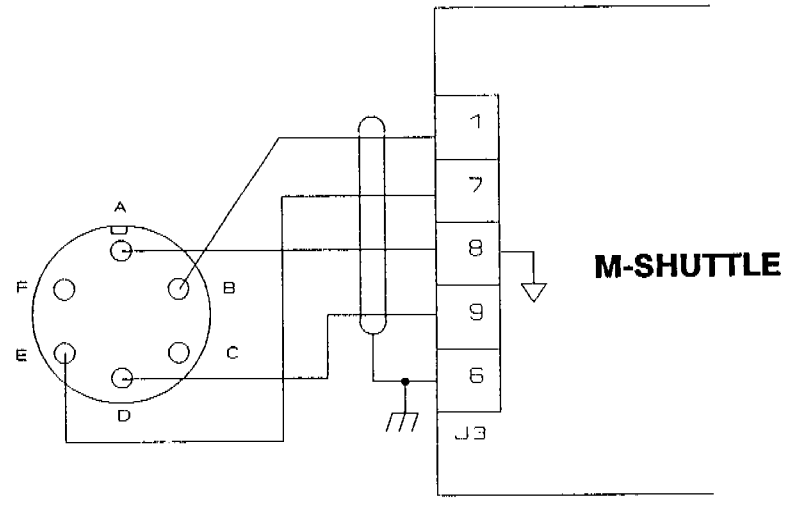


Figure A-3: 3200-1341 Quadrature Encoder Connections

NOTES

APPENDIX B - FORMULAS B

INTRODUCTION

This appendix contains the actual formulas used to calculate M-Shuttle Speed Control values, and is divided into two sections: Tach and Engineering Unit Setpointing.

TACH - FEEDBACK VELOCITY (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.

$$\textit{Feedback Velocity} = \frac{\textit{Feedback Frequency} * 60}{\textit{PPR Follower}}$$

$$\textit{MV-40} = \frac{\textit{MV-42} * 60}{\textit{CP-18}}$$

ENGINEERING UNIT SETPOINTING

This section contains calculations for Engineering Unit Setpointing.

$$\textit{Computed Ratio} = \frac{\textit{E.U. * (Follower Profile Length/Lead Lines per CP-15)}}{\textit{Setpoint + Kerf}}$$

$$\textit{MV-86} = \frac{\textit{CP-15 * (MV-84/CP-16)}}{\textit{CP-1 + CP-21}}$$

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-Shuttle. 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-Shuttle 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.

CP-1: SETPOINT 1 (Follower)

Setpoint 1 is the product length (cut length) for the first profile entered in Engineering Units. The resolution for the Follower setpoints is determined by the CP-15 parameter. Setpoint 1 is selected when the Setpoint Select A and Setpoint Select B inputs are both open (high).

CP-2: PROCESS LENGTH 1

The Process Length is the Lead length in Engineering Units during which the process function (cut) is to be performed.

CP-2 values cannot be changed during the RUN state.

CP-3: SETPOINT 2 (Follower)

Setpoint 2 is the product length (cut length) for the second profile entered in Engineering Units. The resolution for the Follower setpoints is determined by the CP 15 parameter. Setpoint 2 is selected when the Setpoint Select A input is closed (low) and the Setpoint Select B input is open (high).

CP-4: PROCESS LENGTH 2

The Process Length is the Lead length in Engineering Units during which the process function is to be performed.

CP-4 values cannot be changed during the RUN state.

CP-5: SETPOINT 3 (Follower)

Setpoint 3 is the product length (cut length) for the third profile entered in Engineering Units. The resolution for the Follower setpoints is determined by the CP-15 parameter. Setpoint 3 is selected when the Setpoint Select A input is open (high) and the Setpoint Select B input is closed (low).

CP-6: PROCESS LENGTH 3

The Process Length is the Lead length in Engineering Units during which the process function (cut) is to be performed.

CP-6 values cannot be changed during the RUN state.

CP-7: SETPOINT 4 (Follower)

Setpoint 4 is the product length (cut length) for the fourth profile entered in Engineering Units. The resolution for the Follower setpoints is determined by the CP 15 parameter. Setpoint 4 is selected when both the Setpoint Select A and the Setpoint Select B inputs are closed (low).

CP-8: PROCESS LENGTH 4

The Process Length is the Lead length in Engineering Units during which the process function (cut) is to be performed.

CP-8 values cannot be changed during the RUN state.

CP-9: ACCEL/DECEL LENGTH

The Accel/Decel Length is used to accel from Zero Ratio to the beginning of the Process Ratio. This length is also used to decel from the Process Ratio to Zero Ratio. Values are entered in Engineering Units.

CP-09 values cannot be changed during the RUN state.

CP-10: FORWARD DWELL

The Forward Dwell is the Lead length that the Follower remains at a Zero Ratio at the end of the Forward Process Profile before beginning the Reverse Recovery Profile. Values are entered in Engineering Units.

CP-10 values cannot be changed during the RUN state.

CP-11: REVERSE DWELL

The Reverse Dwell is the length that the Follower remains at a Zero Ratio at the end of the Reverse Recovery Profile before beginning the Forward Process Profile. Values are entered in Engineering Units.

CP-11 values cannot be changed during the RUN state.

CP-12: PROCESS RATIO

The Process Ratio is the ratio of the Follower lines to Lead lines during which the process function is performed (Process Length).

CP-12 values cannot be changed during the RUN state.

CP-13: MAXIMUM RECOVERY RATIO

CP-13 is the maximum ratio of Follower lines to Lead lines permitted during the Reverse Recovery Profile.

CP-13 values cannot be changed during the RUN state.

CP-14: CONTROL MODE

The Control Mode parameter, CP-14, is used to identify either the Direct Mode of operation, one of the four possible Follower setups (dependent on combination of Lead and Follower sync inputs), or Tune Mode.

Set CP-14 to 1 for Follower Mode of operation when both the Lead and Follower Sync inputs are utilized. The M-Shuttle will synchronize when the Lead Sync input is detected. The Follower Sync input adjusts the Follower position to zero (Home) when detected.

Set CP-14 to 2 for Follower Mode of operation when only the Follower Sync input is utilized and the Lead Sync is absent. The M-Shuttle will not synchronize in this mode. The M-Shuttle will adjust the Follower position to zero when the Follower Sync is detected.

Set CP-14 to 3 for Follower Mode of operation when only the Lead Sync input is utilized and the Follower Sync is absent. The M-Shuttle will synchronize when the Lead Sync input is detected.

Set CP-14 to 4 in Follower Mode of operation when neither the Lead or Follower Sync inputs are used. The M-Shuttle will not synchronize in this mode of operation.

Set CP-14 to 5 for the Direct Mode of operation.

Set CP-14 to 6 for the Tune Mode of operation.

CP-15: ENGINEERING UNITS

CP-15 contains the normalized Engineering Unit value to be used in the M-Shuttle scaling calculations. CP-15 is used to establish the proper resolution (decimal point) for the Engineering Unit Setpointing.

CP-15 values cannot be changed during the RUN state.

CP-16: LEAD LINES per ENGINEERING UNITS

The CP-16 value is used in the M-Shuttle scaling calculations. It is the number of Lead lines that occur on the Lead Frequency Input for the Engineering Unit length entered in CP-15.

CP-16 values cannot be changed during the RUN state.

CP-9: ACCEL/DECEL LENGTH

The Accel/Decel Length is used to accel from Zero Ratio to the beginning of the Proc

CP-18: PPR FOLLOWER (FEEDBACK)

Enter into CP-18 the number of pulses per revolution of the feedback encoder shaft. This value is used to determine the cutoff point for the stop state (10 RPMs). It is also to scale the Feedforward, Kp and Ki terms.

CP-18 values cannot be changed during the RUN state.

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 the scaling of the Feedforward, Kp and Ki terms.

CP-19 values cannot be changed during the RUN state.

CP-21: KERF LENGTH

The Kerf Length represents the lost material from the cut blade width. This length is added to the Setpoint prior to calculating the Follower profile. Values are entered in Engineering Units (Lead).

CP-21 values cannot be changed during the RUN state.

CP-22: PROCESS LENGTH TIMER

The Process Length Timer places a time limit on the Process Length. If a time value (M Sec) is entered in CP-22, then the Process Length will terminate if that time out occurs before the Process Length distance is complete. A value of "0" in CP-22 disables the Process Length Timer.

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 Alarm output (J1-19) will be activated.

CP-24: DEVIATION BAND

CP-24 is used to enter the Deviation Band (Position Error Band) in Follower encoder lines. If the Position Error exceeds the CP-24 entry and CP-28 is set to 2, then the Alarm output (J1-19) will be activated.

CP-24 is also used to conditionally activate the Output A (J1-17) programmable output. If the Position Error does not fall below the CP-24 level within the Deviation Band Interval specified by CP-25 then Output A will not activate during that profile execution.

CP-25: DEVIATION BAND INTERVAL

CP-25 is used to establish the Deviation Band Interval for the conditional activation of the Output A programmable output. The units (milliseconds or encoder lines) is established by the CP-90 parameter.

CP-27: BATCH LIMIT

CP-27 sets the limit number (profile counts) that will activate the Batch Done output when the batch count is reached.

CP-28: ALARM FORMAT

CP-28 determines which alarm conditions will activate the Alarm Output (J1-15). If CP 28 = 1, then a High Speed Alarm activates the output. If CP-28 = 2, then the Deviation Alarm activates the output.

CP-29: UNIPOLAR/BIPOLAR

The M-Shuttle can operate with either single quadrant (direction) drives or with bi-directional drives that use bipolar voltage commands (positive and negative) to indicate direction.

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: AT-HOME BAND

The At-Home Band parameter determines when the M-Shuttle Follower position is considered at the Home position. The entered parameter number is interpreted as plus or minus from the Home position. One of the conditions for entering the Follower Mode is that the M-Shuttle is within the At-Home Band of the Home position.

CP-31: HOME OFFSET

It is possible to locate the Home position other than at the location where the Home/Follower Sync sensor is located. If an entry is made in CP-31, the Home position will be located that number of Follower encoder lines in the reverse direction from the Home/Follower Sync sensor.

CP-31 can only be changed in the F-STOP state. It is necessary to reestablish the Home position (Home Seek or Home Return) whenever CP-31 is changed.

CP-32: SYNC LEAD OFFSET

The Sync Lead Offset is used to align the cutting tool or process device with the product registration mark when using the Lead Sync. Enter into CP-32 the distance from the Lead Sync sensor to the cutting tool when the shuttle is At-Home and CP-31 is zero. CP-32 must be greater than or equal to one half of the Accel Length (CP-09) whenever CP-14 is set at "1" or "3". (CP-32 will automatically compensate for later adjustments to CP-31.)

Enter into CP-32 the desired Lead Sync offset in terms of Engineering Units (inches, feet, etc.).

CP-32 values cannot be changed during the RUN state.

CP-33: SYNC TREND ENABLE

When CP-33 is set to 1, the Lead Trending feature of the M-Shuttle is enabled. Trending allows the M-Shuttle to automatically compensate for slightly varying Lead job sizes such as for web stretch or registration print variations. The Trending feature averages every sixteen Lead job sizes to determine a new Lead job size.

CP-33 values cannot be changed during the RUN state.

CP-34: SYNC LEAD DELAY

The CP-34 parameter determines whether the M-Shuttle will wait for a Lead Sync input to occur before beginning its acceleration ramp from the Home position.

CP-34	Action
0	No delay for Lead Sync
1	Wait in the At-Home position for the first profile execution only.
2	Wait at the At-Home position after every profile execution until the Lead Sync occurs.

If CP-14 is set to "2" OR "4", then there will be no Sync Lead Delay no matter what value is in CP-34.

CP-35: SYNC FLAG POLARITY

CP-35 determines which edge of the sync pulse, rising or falling, is recognized by the M-Shuttle as the sync point. This can be extremely useful when utilizing reflective or transmissive optical sensors with registration marks.

CP-35	Lead Sync	Home/Follower Sync
1	Rising Edge	Rising Edge
2	Falling Edge	Falling Edge
3	Falling Edge	Rising Edge
4	Rising Edge	Falling Edge

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

CP-36: SYNC LEAD DIVIDE

CP-36 can be utilized to discriminate between different sync marks by ignoring undesired Lead sync marks if they are repetitive in nature (web print). The Lead pulses are divided by the CP-36 value before being submitted to the M-Shuttle synchronization routine. For example, if CP-36 is set to three, the M-Shuttle recognizes the first, fourth, seventh, tenth, etc. Lead pulses.

The sync Lead divide counter is reset at power up or when the CP-14 or CP-36 values are changed.

CP-36 cannot be changed in the Run state.

CP-37: SYNC LEAD WINDOW

The CP-37 value helps filter extraneous Lead sync pulses by establishing a Lead sync window. Lead sync input pulses outside of the Sync Lead window are ignored. Only the first Lead sync pulse inside the window is considered valid. The Sync Lead window is fully opened when the Run state is entered and then closed to the CP-37 value when the first Lead sync pulse occurs.

Enter into CP-37 the desired Lead sync window size in terms of Engineering Units. The CP-37 value is applied as plus or minus (symmetric) around the sync point. Any CP-37 value greater than half of the Lead job size disables the Sync Lead Window feature.

CAUTION

The Sync Lead Window is shifted according to the first sync pulse received in the window. Multiple consecutive early or late pulses may cause the sync window to be shifted to where valid sync pulses are no longer recognized.

CP-38: SYNC LEAD WINDOW FORMAT

The CP-38 value determines where in the profile the sync window is applied. If CP 38=1, then the window is applied according to CP-37. If CP-38=2, then the window is applied during the Process Length part of the profile only. If CP-38=3, then the window is applied during the Process Length and Decel part of the profile. No sync window is applied if CP-38 is set to zero.

MV-39: FORWARD/REVERSE LIMIT POLARITY

The Forward/Reverse Polarity Limit (CP-36) parameter allows you to choose between rising edge polarity (positive going signal) or falling edge polarity (negative going signal) so that the Follower mechanism will not travel beyond the traverse length limit. This feature is extremely useful when you use reflective or transmissive optical sensors for the Home sensor. Enter "1" in CP-35 for a rising edge, or "2" for a falling edge.

MV-40: TACH - (FEEDBACK VELOCITY)

The Tach or Feedback Velocity is the feedback displayed in encoder RPMs. The feedback input is read by the M-Shuttle every 250 microseconds. The readings are summed and averaged for 250 milliseconds before displaying.

MV-41: LEAD FREQUENCY

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

MV-42: FEEDBACK FREQUENCY (FOLLOWER)

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

MV-43: LEAD POSITION

This monitor variable will display the Lead Position as referenced from the Lead sync point in terms of Lead encoder lines.

MV-44: FOLLOWER POSITION

This monitor variable will display the Follower Position as referenced from the Follower sync point (Home) in terms of Follower encoder lines.

MV-45: PRODUCT RATE

MV-45 displays the Product Rate in terms of cycles (profiles) per minute based on the cycle time of the last completed profile.

MV-46: PROCESS ERROR

MV-46 displays the worst (highest) Position Error (MV-49) value that occurred during the time that Output A was active.

MV-47: DAC OUTPUT

The DAC Output represents the level of the isolated analog output (J1-9) 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. The units for the Position Error are Follower encoder lines. The Position Error dynamically varies during the entire job size as the speed ratio, and subsequent relative positions, of the Lead and Follower positions vary.

MV-50: KEYPAD ERRORS

This variable is used to display errors when attempting to enter new values for Control Parameters. If a Keypad Error occurs while attempting to enter a new parameter value, the new value will not be accepted. MV-50 can be accessed to determine why the new value was rejected.

A "1" in the respective digit location indicates a Keypad Error.

```
X  X  X  X  X  X
|  |  |  |  |  |
|  |  |  |  |  Invalid Parameter Code
|  |  |  |  Value Exceeds Maximum Limit
|  |  |  Value Below Minimum Limit
|  |  Keypad Lockout Enabled or Invalid Ratio
|  Lockout During Run State or Entry Timeout
Not Used
```

MV-51: ALARM STATUS

This variable is used to indicate various Alarm conditions that can occur during all states of M-Shuttle operation. Although categorized as a Static Monitor variable, it may have greatest utility during normal Run operation.

```
X  X  X  X  X  X
|  |  |  |  |  |
|  |  |  |  |  Home Not Defined
|  |  |  |  High Speed Alarm
|  |  |  Forward or Reverse Limit Alarm
|  |  Deviation Band (Position Error) Alarm
|  Not Within At-Home Band
Not Used
```

MV-52: CONTROL STATE

The MV-52 variable is used to indicate the current Control State of the M-Shuttle.

```
X  X  X  X  X  X
|  |  |  |  |  |
|  |  |  |  |  Jog
|  |  |  |  Run (Follower)
|  |  |  Home Return
|  |  Home Seek
|  F-Stop
Wait is active.
```

MV-53: DISCRETE INPUTS - GROUP A

The MV-53 variable is used to indicate the status of certain Discrete (Logic) Inputs. A "1" indicates an open (logic high) level. A "0" indicates a closed (logic low) level.

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

MV-54: DISCRETE INPUTS - GROUP B

The MV-54 variable is used to indicate the status of certain Discrete (Logic) Inputs. A "1" indicates an open (logic high) level. A "0" indicates a closed (logic low) level.

```
X  X  X  X  X  X
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  Forward Limit
|  |  |  |  Reverse Limit
|  |  |  Lead Sync
|  |  Home/Follower Sync
|  Setpoint Select A
Setpoint Select B
```

MV-55: DISCRETE INPUTS - GROUP C

The MV-55 variable is used to indicate the status of certain Discrete (Logic) Inputs. A "1" indicates an open (logic high) level. A "0" indicates a closed (logic low) level.

```
X  X  X  X  X  X
|  |  |  |  |  |
|  |  |  |  |  Home Set
|  |  |  |  Home Seek
|  |  |  Home Return
|  |  Batch Reset
|  Not Used
Not Used
```

MV-56: DISCRETE OUTPUTS - GROUP A

The MV-56 variable is used to indicate the status of certain Discrete (Logic) Outputs. A "1" indicates an inactive or deenergized (logic high) level. A "0" indicates an active or energized (logic low) level.

```
X  X  X  X  X  X
|  |  |  |  |  |
|  |  |  |  |  Drive Enable
|  |  |  |  Batch Done
|  |  |  High Speed or Deviation Alarm
|  |  Inverted Drive Analog Output
|  Programmable Output A
Programmable Output B
```

MV-57: DISCRETE OUTPUTS - GROUP B

The MV-57 variable is used to indicate the status of the At-Home Discrete (Logic) Output. A "1" indicates an inactive or deenergized (logic high) level. A "0" indicates an active or energized (logic low) level.

```
X  X  X  X  X  X
|  |  |  |  |  |
|  |  |  |  |  At-Home
|  |  |  |  Not Used
|  |  |  Not Used
|  |  Not Used
|  Not Used
Not Used
```

MV-58: INVALID PROFILE

The MV-58 variable is used to indicate that an Invalid Profile has been entered. The Run state will be disallowed in Follower mode if an Invalid Profile exists. MV-58 will indicate why the profile cannot be executed.

```
X  X  X  X  X  X
|  |  |  |  |  |
|  |  |  |  |  The Accel/Decel Length, Process Length, Forward Dwell or
|  |  |  |  |  Reverse Dwell exceeds the current Setpoint.
|  |  |  |  The Forward Profile Size or Reverse Recovery Size exceeds the
|  |  |  |  current Setpoint.
|  |  |  The Forward Profile Size + Reverse Recovery Size exceeds
|  |  |  the current Setpoint + Kerf.
|  |  A Run request in Follower mode was made with an invalid profile.
|  Not Used.
Insufficient Lead Sync Offset for Synchronization.  CP-32 must be equal to or
greater than one half of CP-09.
```

MV-59: LINE NOTCH COUNTER

MV-59 is a counter display that increments every time the AC line falls below the specified minimum level. It can be used to help check the integrity of the AC line. Notches on the line caused by inductive loads (motors, contactors, etc.) will increment the MV-59 counter if the AC line is to lowor soft. The Clear key resets the counter to zero.

CP-60: ACCEL/DECEL

Accel/Decel is the acceleration time from zero speed to Jog Speed (CP-61) or the deceleration time from Jog Speed to zero speed. The decimal point resolution can be entered to the tenths of a second (XXX.X).

CP-60 values cannot be changed during the RUN state.

CP-61: JOG SETPOINT

CP-61 determines the speed of operation for the Jog Mode, Home Return and Home Seek operation. Enter the desired speed in terms of RPMs.

CP-62: DIRECT ANALOG COMMAND

CP-62 sets the DAC (Digital to Analog Converter) output level when in the Direct mode of operation. Note that CP-14 must be set to "5" to activate the Direct Mode. A value of 4095 is a 100% positive command and a value of -4095 is a 100% negative command.

CP-65: GAIN (Kp)

The Gain term is used in the closed loop compensation algorithm to reduce the position error. The output of the Gain term is the Gain constant (CP-65) multiplied by the instantaneous Position Error (MV-49). Larger numbers increase the contribution of the Gain component of the compensation algorithm). An entry of "0" eliminates the Gain contribution.

CP-66: INTEGRAL (Ki)

The Integral term is used in the closed loop compensation algorithm to eliminate the remaining position error that cannot be resolved via the Gain term alone. Larger numbers increase the contribution of the Integral component of the compensation algorithm. An entry of "0" eliminates the Integral contribution.

CP-68: INTEGRAL ACTIVATION

CP-68 determines when the integral term is activated:

1 = Integral is active during Process Length and Dwells only.
2 = Integral is active during Process Length when Output A is off and Dwells only.
3 = Integral is always active.
4 = Integral is always active, except when Output A is on.

CP-70: DEVICE ADDRESS

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

CP-71: BAUD RATE

There are six different baud or data rates available for use with the M-Shuttle serial communications:

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

CP-72: CHARACTER FORMAT

There are three different character formats available for use with the M-Shuttle serial communications:

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:

0 = F-Stop
1 = F-Stop/Run/Home Return/Home Seek/Home Set
2 = F-Stop/Batch Reset/Setpoint Select 1 - 4
3 = All of the above

MV-74: COMMUNICATIONS ERRORS

MV-74 can be accessed to display any receive errors to the M-Shuttle.

0	-	No errors
1	-	Transmit Error (parity, framing, overrun, no STX or no ETX)
10	-	Parameter Error (invalid parameter message type)
100	-	Data Error (invalid data)
1000	-	Minimum/Maximum Error (out of range)
10000	-	Control Mask Error/Lockout During Run State
100000	-	Not Used

MV-79: KEYPAD LOCKOUT MASK

Keypad Lockout Mask is active when the Keypad Lockout input (J4, pins 10,11) is closed. The value that you enter in CP-79 determines which CPs are locked out and inaccessible to the operator. Enter the number for the required format, as listed below.

1 = All CPs are locked out (Global lockout).
2 = All CPs except 01-08 (Setpoints and Traverse Lengths) are locked.

MV-80: LEAD JOB SIZE

This monitor variable displays the most recent number of Lead encoder lines between the last two consecutive Lead sync flags.

MV-81: FOLLOWER JOB SIZE

This monitor variable displays the number of Follower encoder lines in the forward profile direction. It is the forward shuttle traverse distance in Follower encoder lines.

MV-82: START LIMIT POINT

This is the start point of the limit plateau created by the Maximum Recovery Ratio. If the recovery ratio is less than the Maximum Recovery Ratio, then the Start Limit and End Limit Points will indicate the apex of the triangular accel/decel recovery profile.

MV-83: END LIMIT POINT

This is the end point of the limit plateau created by the Maximum Recovery Ratio. If the recovery ratio is less than the Maximum Recovery Ratio, then the Start Limit and End Limit Points will indicate the apex of the triangular accel/decel recovery profile.

MV-84: FOLLOWER PROFILE LENGTH

The MV-84 variable displays the total calculated forward Follower travel length for the entered profile. It is displayed in terms of Follower encoder lines.

MV-85: TRENDED RATIO

The MV-85 displays the calculated ratio between the Feedback (Follower) Frequency input and the Lead Frequency input required to maintain alignment between the two Sync inputs based on the MV-80 and MV-81 Job Sizes.

A display value of "LP--85" indicates that the M-Shuttle has not yet determined the Trended Scale Factor when trending is enabled (CP-33 = 1).

MV-86: COMPUTED RATIO

MV-86 displays the calculated ratio between the Feedback (Follower) frequency input and the Lead frequency input required to maintain synchronization based on the programmed profile job sizes. This is the ratio that is utilized by the M-Shuttle if Trending is disabled.

MV-87: PROFILE RATIO

The MV-87 variable displays the current (instantaneous) Follower/Lead ratio generated by the M-Shuttle during profile execution.

MV-88: PEAK RECOVERY RATIO

This is the calculated Peak Recovery Ratio required to maintain synchronization (negative value inferred). If this value exceeds the Maximum Recovery Ratio (CP-13), a limit equal to the Maximum Recovery Ratio is imposed.

CP-89: BATCH COUNT

MV-89 displays the number of complete batch counts (profile completions).

CP-90: OUTPUT A FORMAT

CP-90 determines the format for the Output A discrete output. This output can be formatted for Start Output Polarity and Timed or Distance programming. The Start Point determines which profile segment begins the time/distance process; the beginning of the Process Length, the Forward Dwell or the Reverse Dwell. The Output Polarity determines if the output activates Low or High. The Timed or Distance programming allows the Output Delay or Output Interval to be programmed in milliseconds or Lead engineering units.

Enter into CP-90 the desired Output Format according to the table below:

CP-90	Start Point	Output Polarity	Time/Distance
1	Process Length	Active Low	Time
2	Process Length	Active High	Time
3	Process Length	Active Low	Distance
4	Process Length	Active High	Distance
5	Forward Dwell	Active Low	Time
6	Forward Dwell	Active High	Time
7	Forward Dwell	Active Low	Distance
8	Forward Dwell	Active High	Distance
9	Reverse Dwell	Active Low	Time
10	Reverse Dwell	Active High	Time
11	Reverse Dwell	Active Low	Distance
12	Reverse Dwell	Active High	Distance

CP-91: OUTPUT A DELAY

CP-91 determines how long Output A delays from the starting point before activating. This entry should be made in terms of milliseconds or Lead engineering units depending on the value in CP-90.

CP-92: OUTPUT A INTERVAL

CP-92 determines how long Output A will stay active once it is activated. This entry should be made in terms of milliseconds or Lead engineering units depending on the value in CP-90. If Output A is programmed for the Process Length (CP-90 is set to 1, 2, 3 or 4), and the Output A Interval exceeds the Process Length, then Output A will deactivate at the end of the Process Length.

CP-93: OUTPUT B FORMAT

CP-93 determines the format for the Output B discrete output. This output can be formatted for Start Point, Output Polarity and Timed or Distance programming. The Start Point determines which profile segment begins the time/distance process; the beginning of the Process Length, the Forward Dwell or the Reverse Dwell. The Output Polarity determines if the output activates Low or High. The Timed or Distance programming allows the Output Delay or Output Interval to be programmed in milliseconds or Lead engineering units.

Enter into CP-93 the desired Output Format according to the table below:

CP-93	Start Point	Output Polarity	Time/Distance
1	Process Length	Active Low	Time
2	Process Length	Active High	Time
3	Process Length	Active Low	Distance
4	Process Length	Active High	Distance
5	Forward Dwell	Active Low	Time
6	Forward Dwell	Active High	Time
7	Forward Dwell	Active Low	Distance
8	Forward Dwell	Active High	Distance
9	Reverse Dwell	Active Low	Time
10	Reverse Dwell	Active High	Time
11	Reverse Dwell	Active Low	Distance
12	Reverse Dwell	Active High	Distance

CP-94: OUTPUT B DELAY

CP-94 determines how long Output B delays from the starting point before activating. This entry should be made in terms of milliseconds or Lead engineering units depending on the value in CP-93.

CP-95: OUTPUT B INTERVAL

CP-95 determines how long Output B will stay active once it is activated. This entry should be made in terms of milliseconds or Lead engineering units depending on the value in CP-93.

MV-99: SOFTWARE CODE REV

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

MV-00: SOFTWARE ART NUMBER

MV-00 displays the last four digits of the eight digit part number for the M–Traverse'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	_____	E.U. -Lead
02-CP	PROCESS LENGTH 1	000.000	999999	_____	E.U. -Lead
03-CP	SETPOINT 2	000.000	999999	_____	E.U. -Lead
04-CP	PROCESS LENGTH 2	000.000	999999	_____	E.U. -Lead
05-CP	SETPOINT 3	000.000	999999	_____	E.U. -Lead
06-CP	PROCESS LENGTH 3	000.000	999999	_____	E.U. -Lead
07-CP	SETPOINT 4	000.000	999999	_____	E.U. -Lead
08-CP	PROCESS LENGTH 4	000.000	999999	_____	E.U. -Lead
09-CP	ACCEL/DECEL LENGTH	000.000	999999	_____	E.U. -Lead
10-CP	FORWARD DWELL	000.000	999999	_____	E.U. -Lead
11-CP	REVERSE DWELL	000.000	999999	_____	E.U. -Lead
12-CP	PROCESS RATIO	0.000	10.000	_____	Ratio
13-CP	MAXIMUM RECOVERY RATIO	0.000	10.000	_____	Ratio
14-CP	CONTROL MODE	1	6	_____	Coded
15-CP	ENGINEERING UNITS	000.000	999999	_____	Eng. Units
16-CP	LEAD LINES per CP-15	000000	999999	_____	Lines -Lead
18-CP	PPR - FOLLOWER	60	6000	_____	PPR
19-CP	MAX RPM - FOLLOWER	100	30000	_____	RPM
21-CP	KERF LENGTH	000.000	999999	_____	E.U. -Lead
22-CP	PROCESS LENGTH TIMER	0	999999	_____	M Sec
23-CP	HIGH SPEED ALARM	0	30000	_____	RPM
24-CP	DEVIATION BAND	0	999999	_____	Lines
25-CP	DEV. BAND INTERVAL	0	60000	_____	MSec/Lines
27-CP	BATCH LIMIT	0	9999	_____	Counts
28-CP	ALARM FORMAT	1	2	_____	Coded
29-CP	UNIPOLAR/BIPOLAR	1	2	_____	Coded
30-CP	AT-HOME BAND	1	60000	_____	Lines -Foll
31-CP	HOME OFFSET	0	99999	_____	Lines -Foll
32-CP	SYNC LEAD OFFSET	0	99999	_____	E.U. -Lead
33-CP	SYNC TREND ENABLE	0	1	_____	Coded
34-CP	SYNC LEAD DELAY	0	2	_____	Coded
35-CP	SYNC FLAG POLARITY	1	4	_____	Coded
36-CP	SYNC LEAD DIVIDE	1	255	_____	Coded
37-CP	SYNC LEAD WINDOW	000.000	999999	_____	E.U. -Lead
38-CP	SYNC LEAD WINDOW FRMT	0	3	_____	Coded
39-CP	FWD/REV LIMIT POLARITY	1	2	_____	Coded
60-CP	ACCEL/DECEL	0.1	600.0	_____	Seconds
61-CP	JOG SETPOINT	0	30000	_____	RPM
62-CP	DIRECT ANALOG COMMAND	-4095	4095	_____	DAC Bits
65-CP	GAIN (Kp)	0	30000	_____	N/A
66-CP	INTEGRAL (Ki)	0	30000	_____	N/A
68-CP	INTEGRAL ACTIVATION	1	4	_____	Coded
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
79-CP	KEYPAD LOCKOUT MASK	1	2	_____	Coded
90-CP	OUTPUT A FORMAT	1	12	_____	Coded
91-CP	OUTPUT A DELAY	0	999999	_____	MSec-Lead
92-CP	OUTPUT A INTERVAL	0	999999	_____	MSec-Lead
93-CP	OUTPUT B FORMAT	1	12	_____	Coded
94-CP	OUTPUT B DELAY	0	999999	_____	MSec-Lead
95-CP	OUTPUT B INTERVAL	0	999999	_____	MSec-Lead

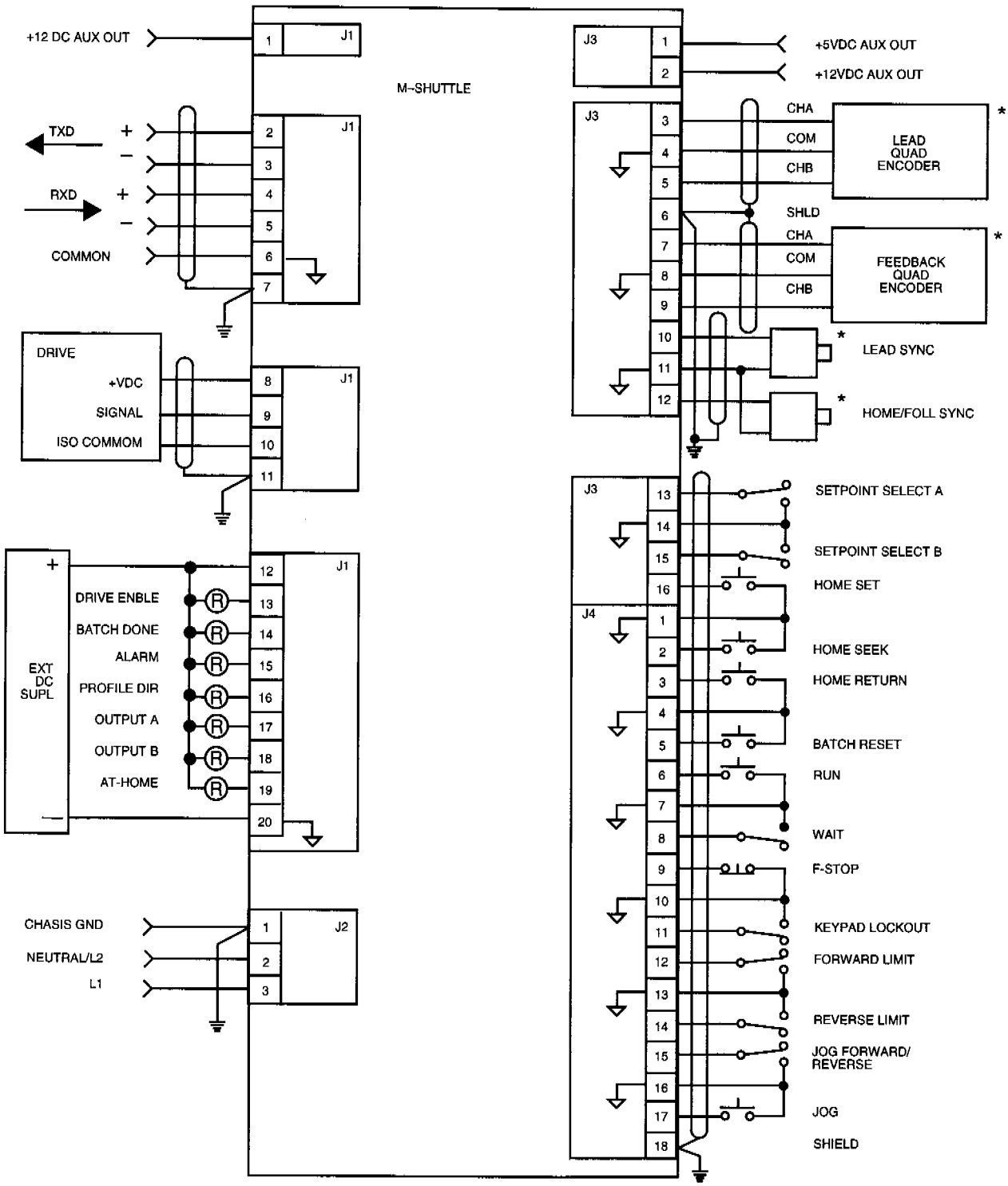
NOTES

APPENDIX E: CODE LIST QUICK REFERENCE E

CODE-TYPE	DESCRIPTION	MIN	MAX	DEFAULT	UNITS
01-CP	SETPOINT 1	000.000	999999	0	E.U. -Lead
02-CP	PROCESS LENGTH 1	000.000	999999	0	E.U. -Lead
03-CP	SETPOINT 2	000.000	999999	0	E.U. -Lead
04-CP	PROCESS LENGTH 2	000.000	999999	0	E.U. -Lead
05-CP	SETPOINT 3	000.000	999999	0	E.U. -Lead
06-CP	PROCESS LENGTH 3	000.000	999999	0	E.U. -Lead
07-CP	SETPOINT 4	000.000	999999	0	E.U. -Lead
08-CP	PROCESS LENGTH 4	000.000	999999	0	E.U. -Lead
09-CP	ACCEL/DECEL LENGTH	000.000	999999	0	E.U. -Lead
10-CP	FORWARD DWELL	000.000	999999	0	E.U. -Lead
11-CP	REVERSE DWELL	000.000	999999	0	E.U. -Lead
12-CP	PROCESS RATIO	0.000	10.000	0.000	Ratio
13-CP	MAXIMUM RECOVERY RATIO	0.000	10.000	10.000	Ratio
14-CP	CONTROL MODE	1	6	1	Coded
15-CP	ENGINEERING UNITS	000.000	999999	0	Eng. Units
16-CP	LEAD LINES per CP-15	0	999999	1000	Lines -Lead
18-CP	PPR - FOLLOWER	60	6000	60	PPR
19-CP	MAX RPM - FOLLOWER	100	30000	2000	RPM
21-CP	KERF LENGTH	000.000	999999	0	E.U. -Lead
22-CP	PROCESS LENGTH TIMER	0	999999	0	M Sec
23-CP	HIGH SPEED ALARM	0	30000	2000	RPM
24-CP	DEVIATION BAND	0	999999	0	Lines
25-CP	DEV. BAND INTERVAL	0	60000	0	MSec/EU Lead
27-CP	BATCH LIMIT	0	9999	0	Counts
28-CP	ALARM FORMAT	1	2	1	Coded
29-CP	UNIPOLAR/BIPOLAR	1	2	2	Coded
30-CP	AT-HOME BAND	1	60000	4	Enc. Edges
31-CP	HOME OFFSET	0	99999	0	Line -Foll
32-CP	SYNC LEAD OFFSET	0	99999	0	E.U. -Lead
33-CP	SYNC TREND ENABLE	0	1	0	Coded
34-CP	SYNC LEAD DELAY	0	2	1	Coded
35-CP	SYNC FLAG POLARITY	1	4	1	Coded
36-CP	SYNC LEAD DIVIDE	1	255	1	Coded
37-CP	SYNC LEAD WINDOW	000.000	999999	0	E.U. -Lead
38-CP	SYNC LEAD WINDOW FRMT	0	3	2	Coded
39-CP	FWD/REV LIMIT POLARITY	1	2	1	Coded
40-MV	TACH - VELOCITY	-3600	3600	------	RPM
41-MV	LEAD FREQUENCY	-99999	120000	------	HZ
42-MV	FEEDBACK FREQUENCY	-99999	120000	------	HZ
43-MV	LEAD POSITION	-14400000	14400000	------	Lines
44-MV	FOLL POSITION	-14400000	14400000	------	Lines
45-MV	PRODUCT RATE	0.0	9999.9	------	Cycles/Min
46-MV	PROCESS ERROR	-14400000	14400000	------	Lines
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
58-MV	INVALID PROFILE	0	100	------	Coded
59-MV	LINE NOTCH COUNTER	0	999999	------	Counts
60-CP	ACCEL/DECEL	0.1	600.0	5.0	Seconds
61-CP	JOG SETPOINT	0	3600	50	RPM
62-CP	DIRECT ANALOG COMMAND	-4095	4095	0	DAC Bits
65-CP	GAIN (Kp)	0	30000	3000	N/A
66-CP	INTEGRAL (Ki)	0	30000	1	N/A
68-CP	INTEGRAL ACTIVATION	1	4	1	Coded
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
79-CP	KEYPAD LOCKOUT MASK	1	2	1	Coded
80-MV	LEAD JOB SIZE	0	14400000	------	Lines
81-MV	FOLL JOB SIZE	0	14400000	------	Lines
82-MV	START LIMIT POINT	000.000	999999	------	E.U. -Lead
83-MV	END LIMIT POINT	000.000	999999	------	E.U. -Lead
84-MV	FOLL PROFILE LENGTH	0	999999	------	Lines
85-MV	TRENDED RATIO	0.0000	10.0000	------	Ratio
86-MV	COMPUTED RATIO	0.0000	10.0000	------	Ratio
87-MV	PROFILE RATIO	0.0000	10.0000	------	Ratio
88-MV	PEAK RECOVERY RATIO	0.0000	10.0000	------	Ratio
89-MV	BATCH COUNT	0	9999	------	Counts
90-CP	OUTPUT A FORMAT	1	12	1	Coded
91-CP	OUTPUT A DELAY	0	999999	0	MSec/EU Lead
92-CP	OUTPUT A INTERVAL	0	999999	0	MSec/EU Lead
93-CP	OUTPUT B FORMAT	1	12	1	Coded
94-CP	OUTPUT B DELAY	0	999999	0	MSec/EU Lead
95-CP	OUTPUT B INTERVAL	0	999999	0	MSec/EU Lead
99-MV	SOFTWARE CODE REV	-------	-------	------	------
00-MV	SOFTWARE PART NUMBER	-------	-------	------	------

APPENDIX F - M-SHUTTLE PIN OUT F



*ENCODER AND PROXIMITY SWITCHES MAY REQUIRE POWER CONNECTIONS FROM J3, 1 OR 2

NOTES

APPENDIX G - TYPICAL WIRING DIAGRAMS G

WARNING

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

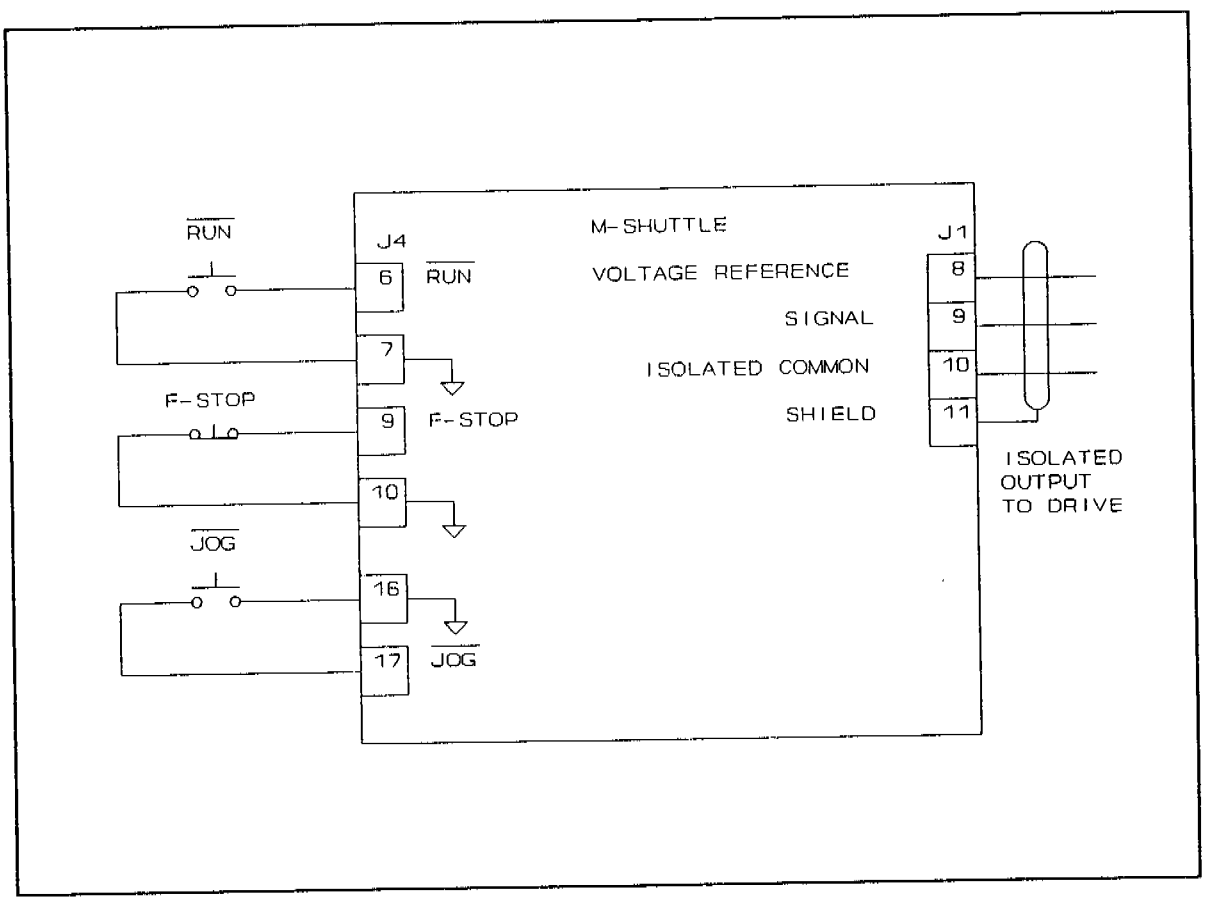


Figure G-1: M-Shuttle Wiring Connections without Relays

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.

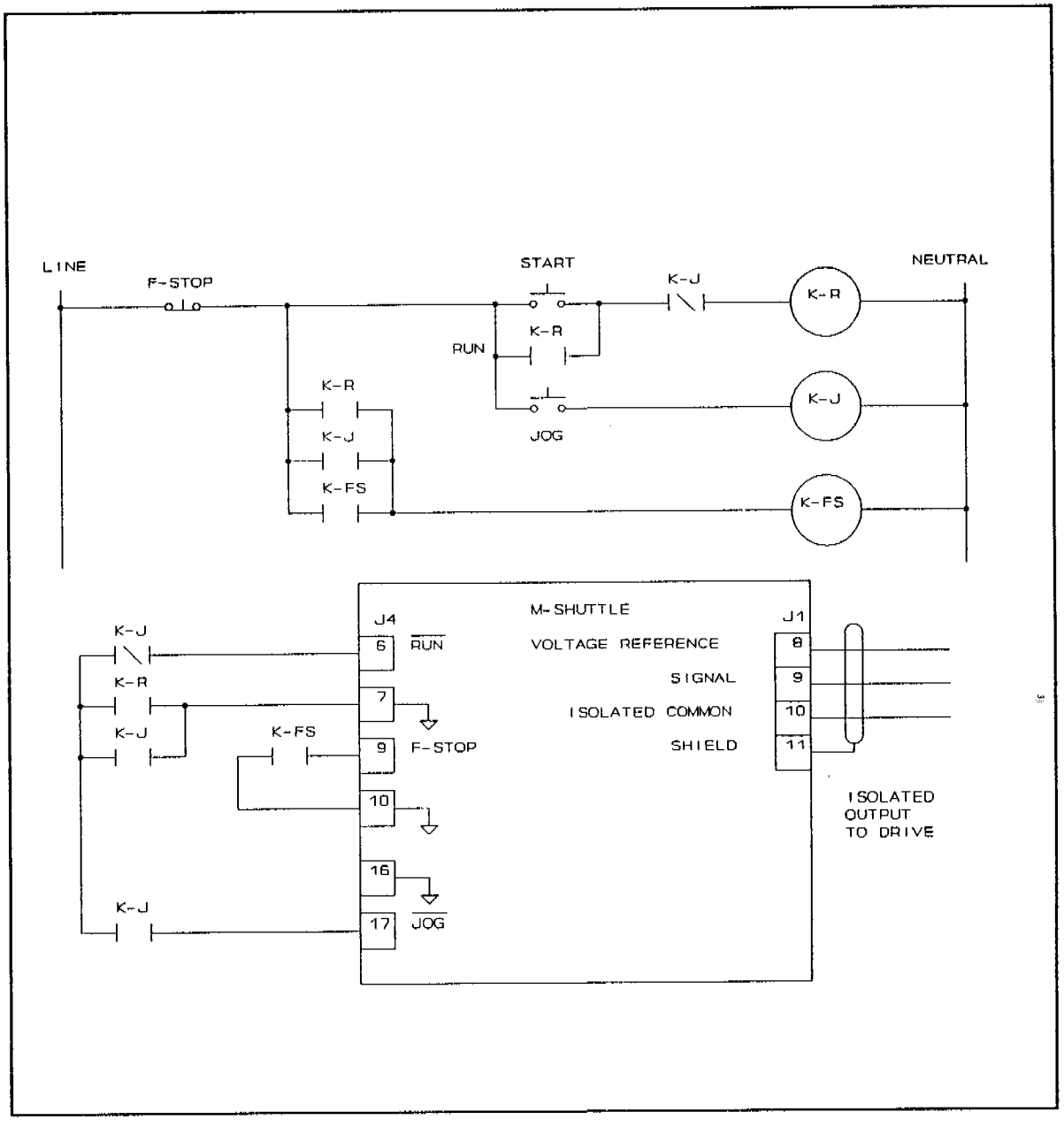


Figure G-2: Relay Start and Stop Wiring Connections

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.

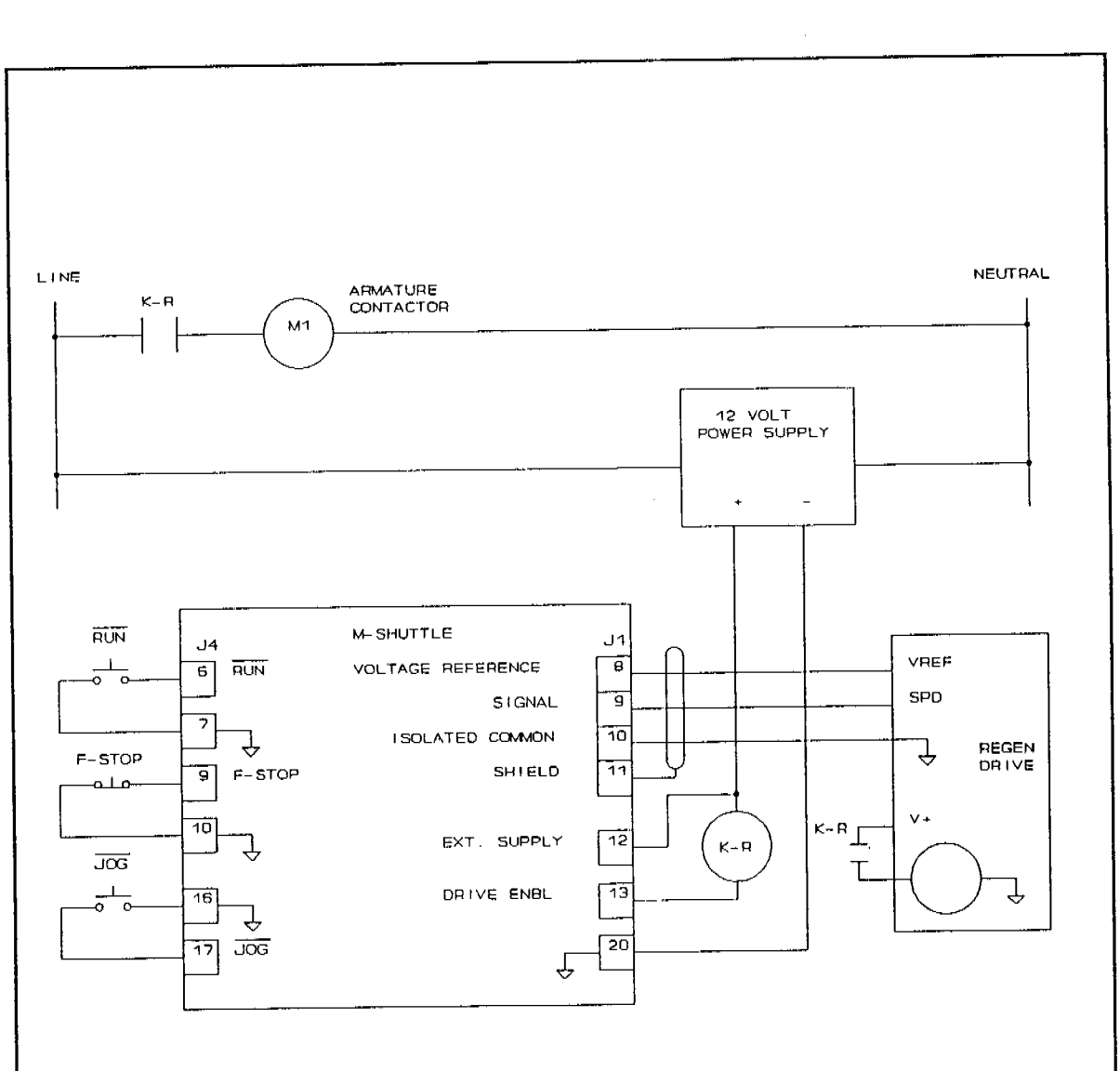
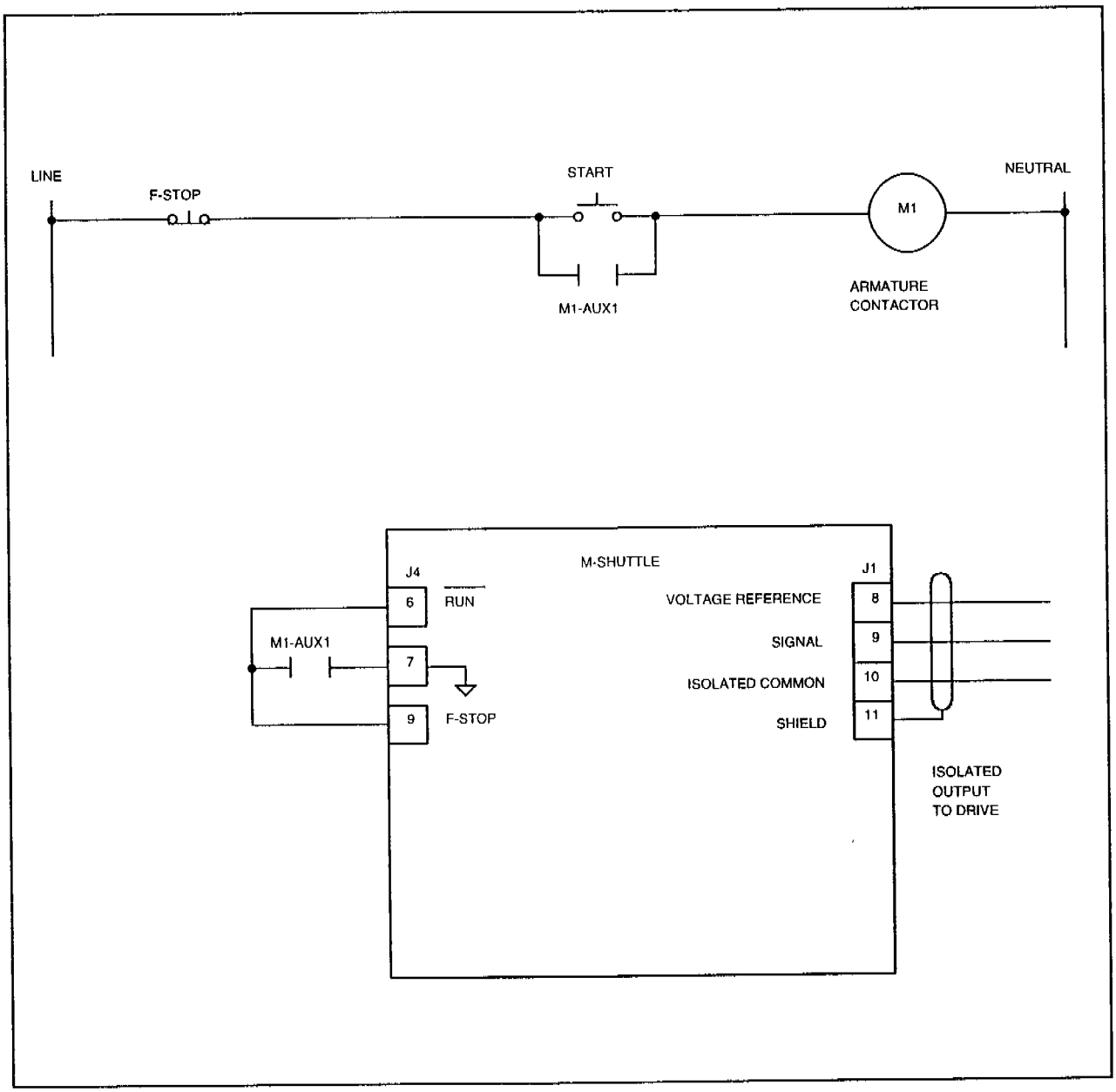


Figure G-3: Start/Stop for Regen with Armature Contactor

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.



APPENDIX H - OPERATOR'S AIDE H

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 (Both Syncs Used) = 2 (Follower Sync Only) = 3 (Lead Sync Only) = 4 (Neither Sync Used)
Engineering Units	CP-15
Lead Lines/Eng Units	CP-16
PPR Follower	CP-18
RPM Follower Max	CP-19
Follower Setpoints	CP-1, CP-3, CP-5, CP-7
Direct Format	
Control Mode	CP-14 = 5
Direct Analog Command	CP-62

NOTES

APPENDIX I

USA Standard Code for Information Interchange

1. Scope

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

2. Standard Code

b7 b6 b5 / Bits b4 b3 b2 b1 / COLUMN / ROW	0 0 0	0 0 1	0 1 0	0 1 1	1 0 0	1 0 1	1 1 0	1 1 1
	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

Alarm: An output used to indicate when either a high speed or deviation alarm condition is present.

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

Batch Reset: 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-Shuttle Secondary Modes. Direct Mode is an open-loop control mode where the operator enters a direct command to the M-Shuttle's Isolated Analog Output.

Drive Enable: An output which indicates whether or not the motor should be moving.

F-STOP: (Fast Stop) In the F-Stop state, the M-Shuttle ignores the specified DECEL rate and immediately brings the speed command to zero.

Feedback Frequency Input: A frequency input used by the M-Shuttle to ascertain follower motor speed.

Home/Follower Sync Input: A pulse input used to indicate the position of the follower product or machine part.

PROFILE DIRECTION: An output indicating the commanded direction of the Speed Command output.

JOG: In the JOG state, the M-Shuttle rotates the subject motor at the RPM entered for the JOG setpoint.

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.

Lead Frequency Input: A frequency input used by the M-Shuttle to ascertain lead motor speed.

Lead Sync Input: A pulse input used to indicate the position of the lead product or machine part.

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

RUN: In the RUN state, the M-Shuttle rotates the subject motor at the RPM called for as determined by the setpoints and the follower scaling format.

Setpoint Selects: Two discrete inputs used to select one of four setpoints in the follower mode.

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

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

service policy

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

Applicability

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

Service Personnel

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

Service Charges

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

Spare Parts

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

Instruction Manuals

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

OEM Service

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

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

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

warranty

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

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

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

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

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

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

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

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

CONTREX
Contrex, Inc.
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