M-CUT OVERVIEW 1

INTRODUCTION

The M-Cut is a digital motion control device used in incremental feed cut-to-length industrial applications. Typical M-Cut applications include coil process cutting, forming and sheeting of materials such as aluminum, steel and other heavy-gauge material. The M-Cut can be installed in direct point-to-point, registration reference and shuttle carriage operations.

Some of the advanced capabilities of the M-Cut include 4 separate user-entered velocity profiles, automatic keypad error checking, sophisticated in-position control and $\pm$ 1 encoder line controller accuracy. When entering the M-Cut's velocity profiles, the user only enters the cut length, accel time, decel time and maximum move speed. During operation, the M-Cut automatically calculates the required trapezoidal velocity profile, and executes the profile move without user intervention. The in-position timer outputs activate the cutting operations, then automatically restart the process.

Although the M-Cut contains many advanced features, it is also easy to use. The sealed keypad is divided into two panels: a panel for day-to-day operations, and a panel behind a separate door providing access to scaling functions. Dedicated keys are provided for CUT LENGTH, POSITION, BATCH COUNT, and STATUS information. The M-Cut also contains an RS-422 communications port that allows communications between a host computer and the M-Cut.

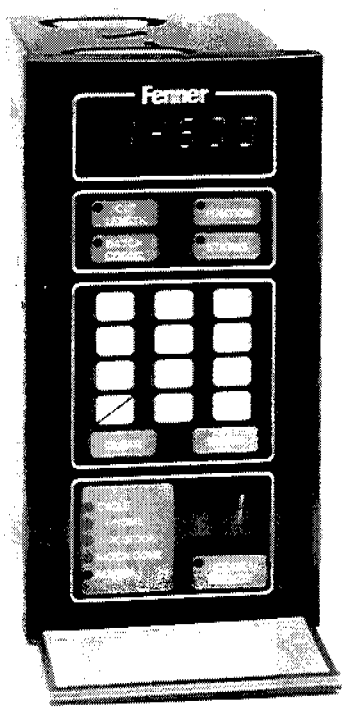


Figure 1-1: M-Cut

TYPICAL INSTALLATION

GUILLOTINE COIL CUTTING WITH REGISTRATION MARK

A common installation for the M-Cut is an incremental feed process application that cuts rolled material to a specific length as determined by the placement of a registration mark. Figure 1-2 illustrates this type of application.

The M-Cut moves the material according to the selected velocity profile, making the final adjustments once the registration index is detected by the sensor. Once in-position, the product gripper holds the material in place, and the guillotine knife cuts the material. The M-Cut repeats this process until the desired number of repetitions are completed.

Note that the M-Cut's In-Pos outputs control the process once the material is in position: In-Pos A controls the product gripper, In-Pos B controls the guillotine knife, and In-Pos C controls the next profile move as it is wired into the Move input.

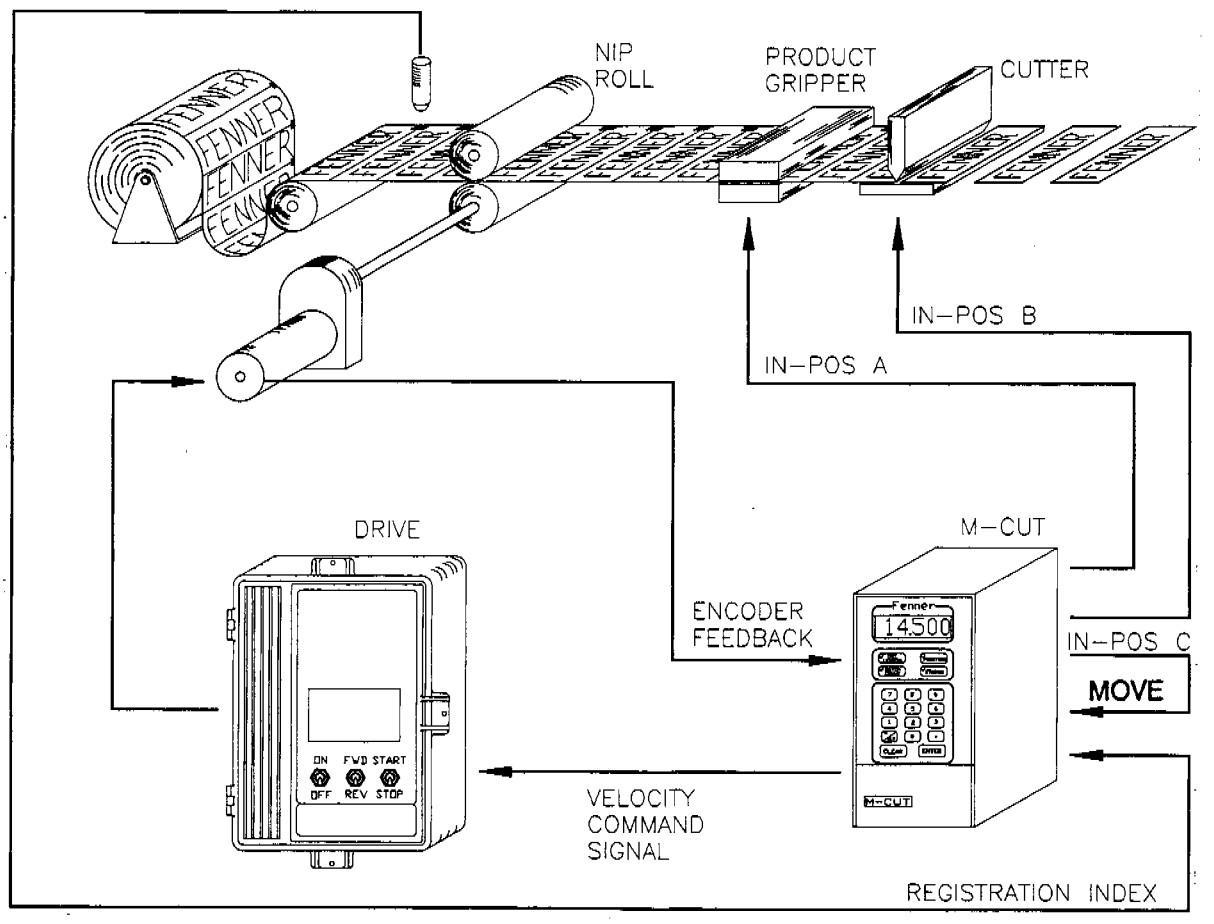


Figure 1-2: Incremental Feed Process with Registration Mark

VELOCITY PROFILE

The M-Cut allows up to 4 separate preset velocity profiles. The M-Cut automatically calculates these velocity profiles using the user-entered cut length, accel time, decel time and maximum move speed.

During a Profile Move, the M-Cut ramps up to the move speed during the Accel Time, remains at the move speed for the calculated duration, then ramps down to zero during the Decel Time. The M-Cut calculates the velocity profile to make this move and also obtains position feedback information every millisecond. Once the registration mark is detected, the M-Cut immediately recalculates the remainder of the velocity profile as illustrated in Figure 1-3. If no registration mark is detected, the M-Cut completes the originally calculated profile move.

Throughout the profile move, the M-Cut monitors position. If the limits are exceeded in either direction, the discrete alarm output is activated and the Alarm LED is lit.

As soon as the M-Cut reaches the in-position band, the In-Position timers are started. One feature of the M-Cut is that after the In-Position band is reached, control is not relinquished. The M-Cut always attempts to reduce the final position error to zero.

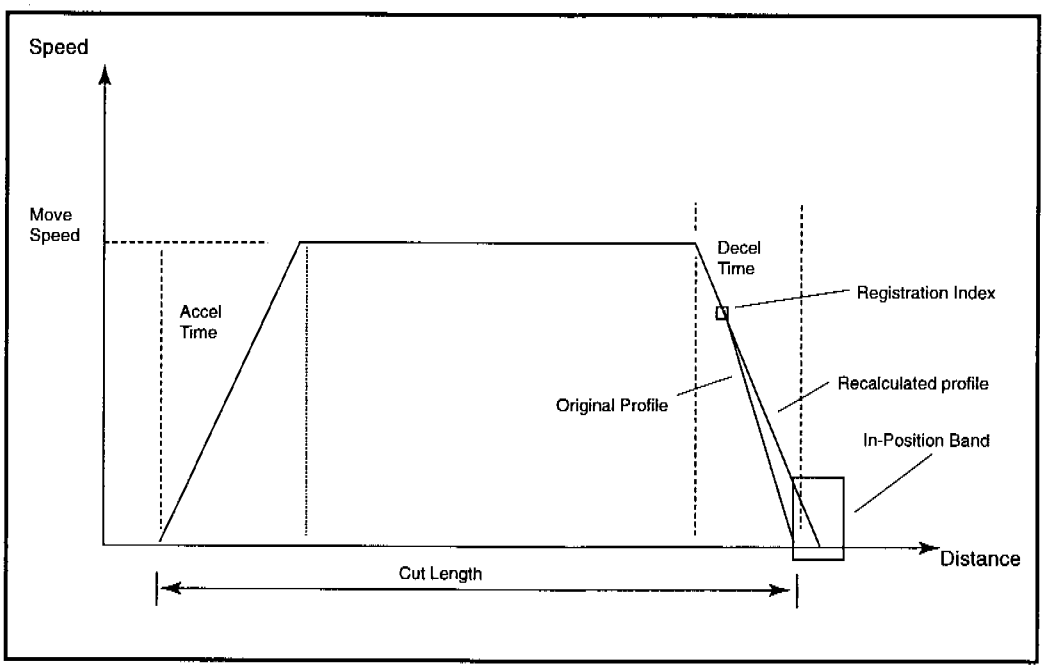


Figure 1-3: M-Cut Profile Move w/ Registration Mark

NOTES

CONFIGURATION 2

INTRODUCTION

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

This chapter is divided into 2 sections: Isolator Voltage Reference and Power Voltage Select. Figure 2-1 below illustrates the location for the CPU board and the Power Supply/Isolator board.

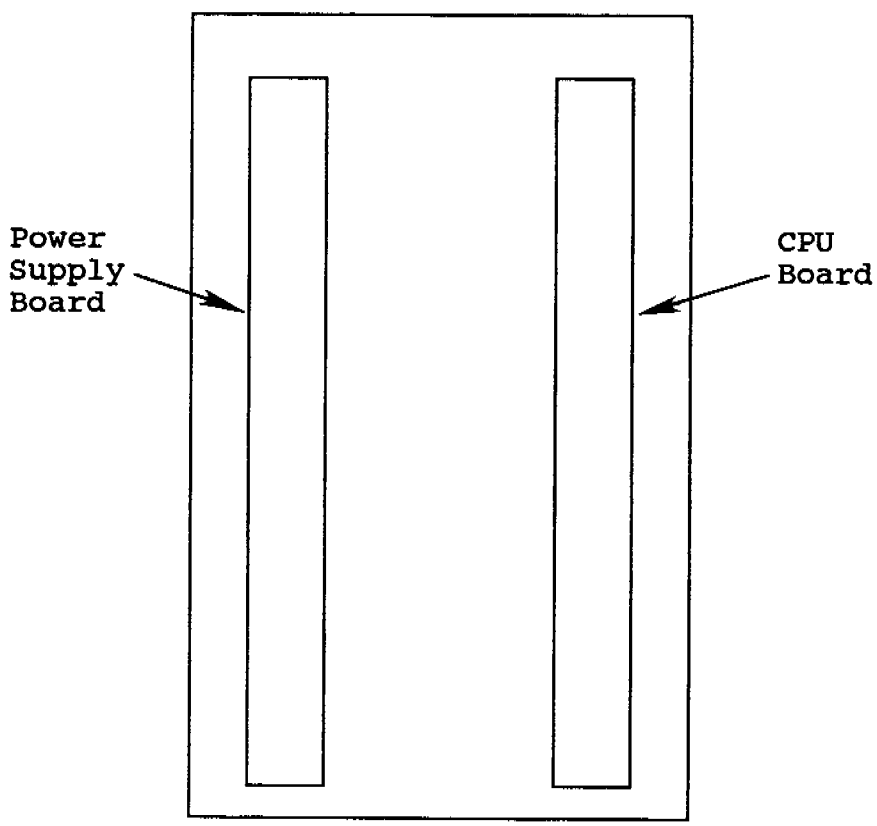


Figure 2-1: M-Cut Board Location (Rear View)

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-Cut. 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 or uses a differential type of input. Figure 2-2 indicates these jumper positions.

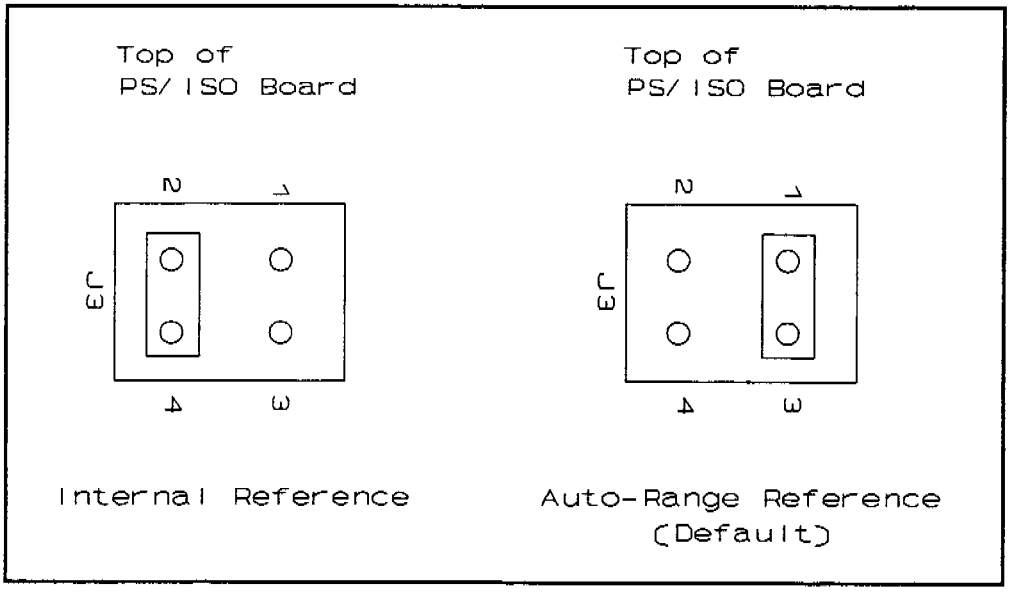


Figure 2-2: Isolator Voltage Reference Options

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

Note to Electricians installing the M-Cut:

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

This chapter is organized into 2 distinct sections:

MOUNTING

WIRING

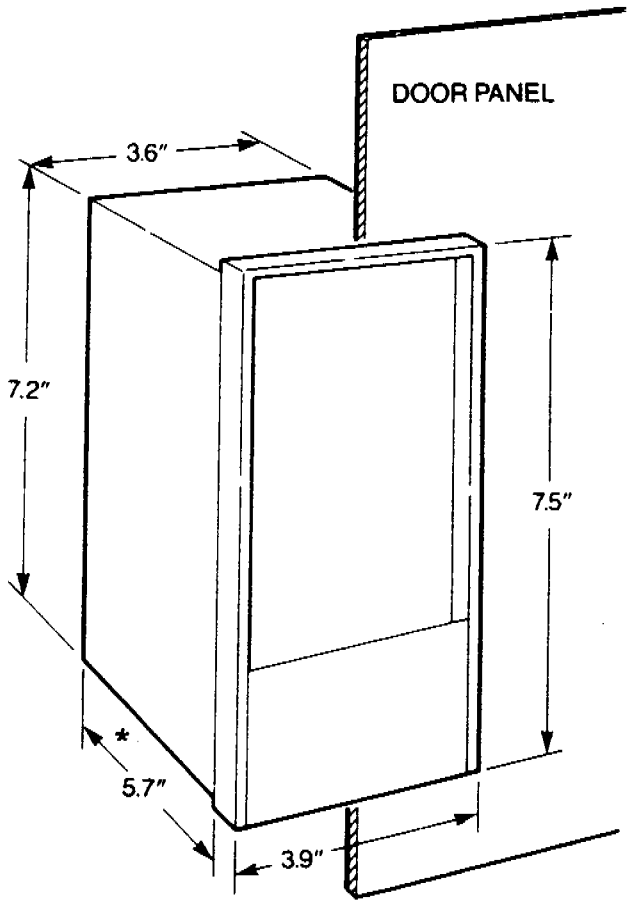
The Mounting section provides drawings and instructions for mounting the M-Cut in an enclosure. The wiring section summarizes the wiring connections for the M-Cut.

MOUNTING

INTRODUCTION

The M-Cut 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-Cut with dimensions.

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

MOUNTING PROCEDURE

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

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

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

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

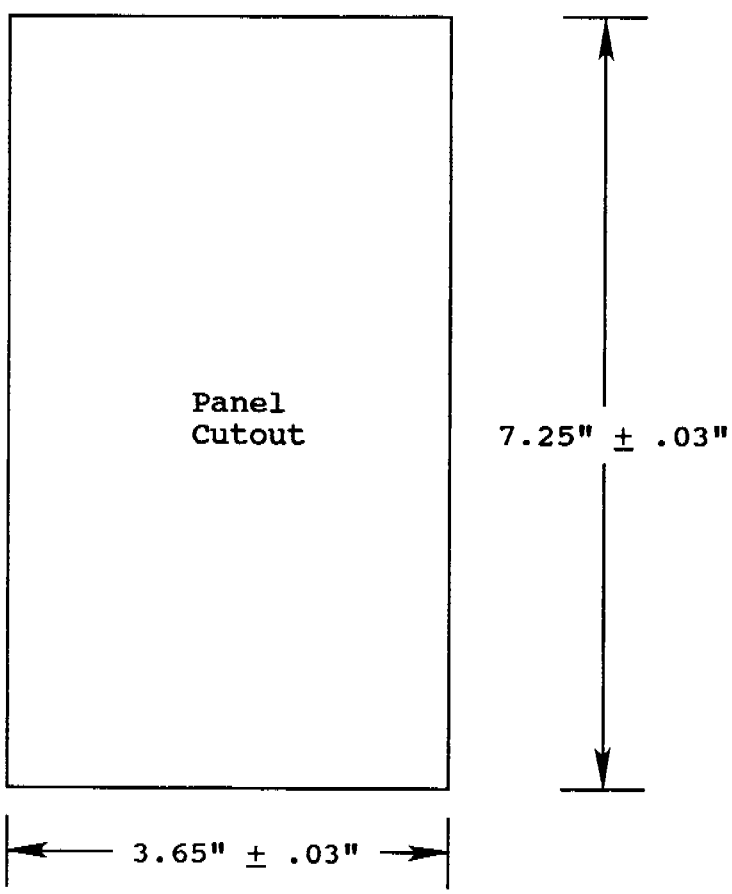


Figure 3-2: Panel Cutout Dimensions

WIRING

INTRODUCTION

The wiring portion of this chapter is divided into three 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 internal signal common (e.g., J3 pin 8) to the chassis ground (J2 pin 1).

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

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

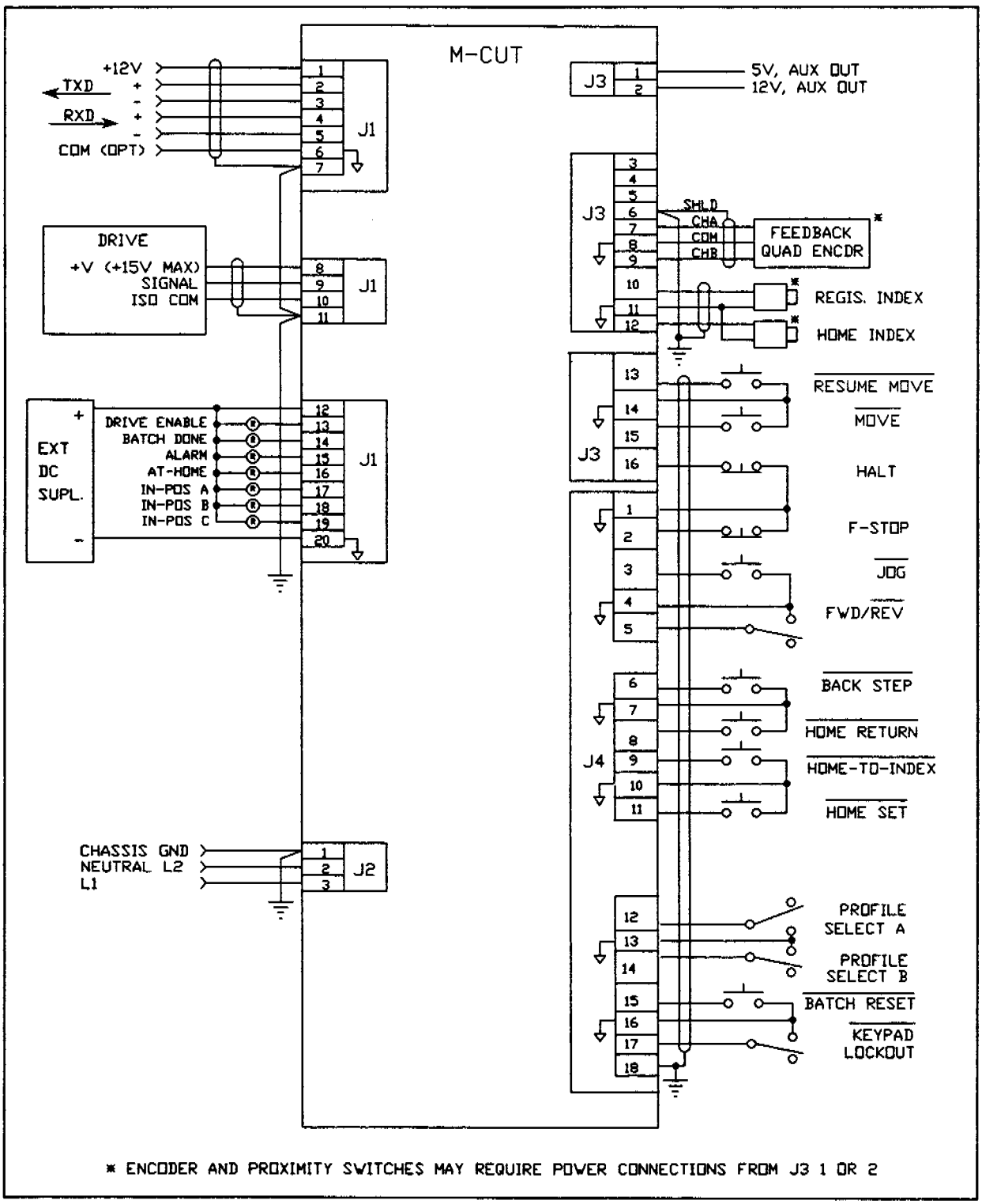


Figure 3-3: M-Cut General Wiring Drawing

M-CUT CONNECTOR LOCATIONS

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

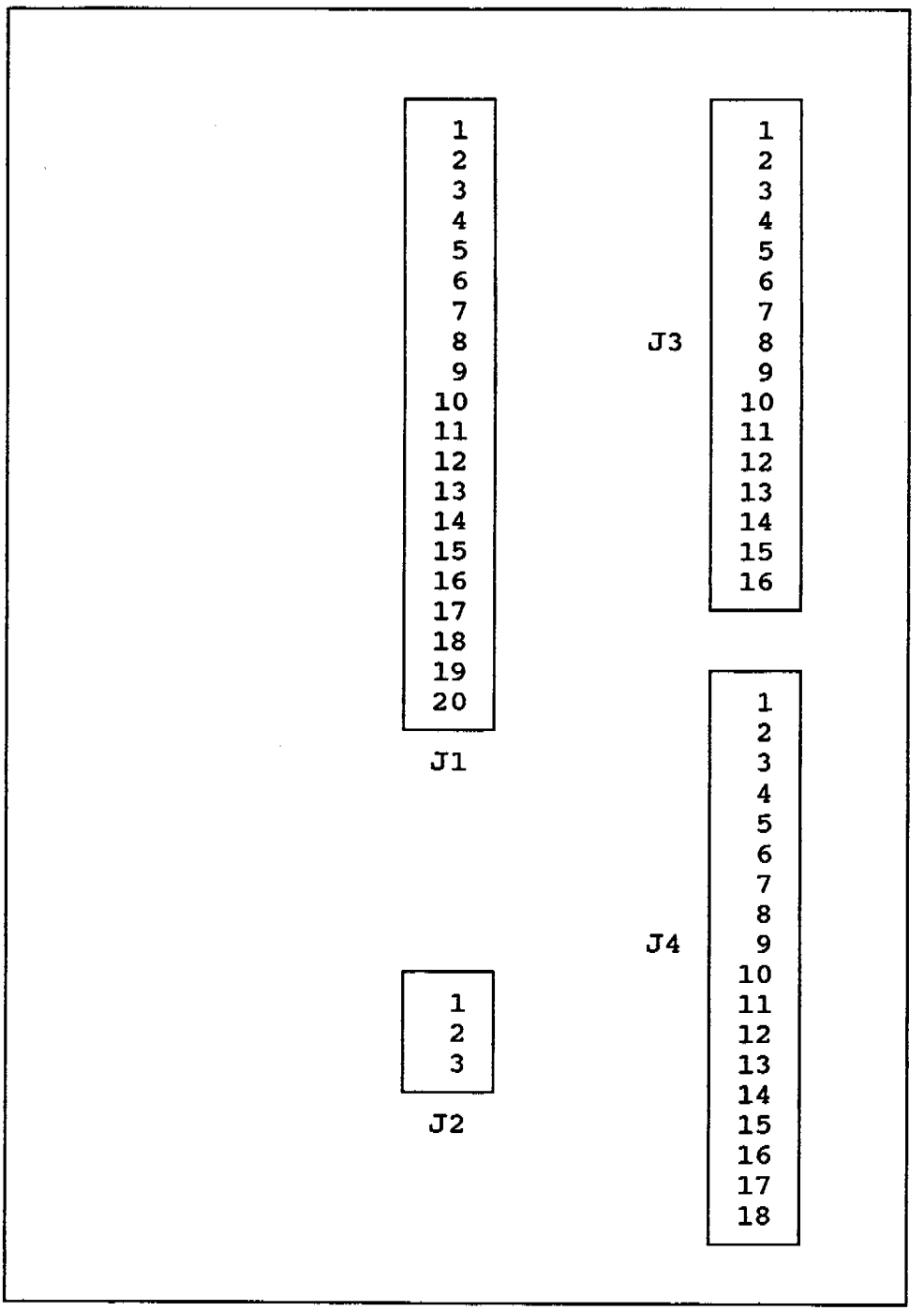


Figure 3-4: Wiring Connector Locations

1) **INPUTS**

INPUT POWER

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

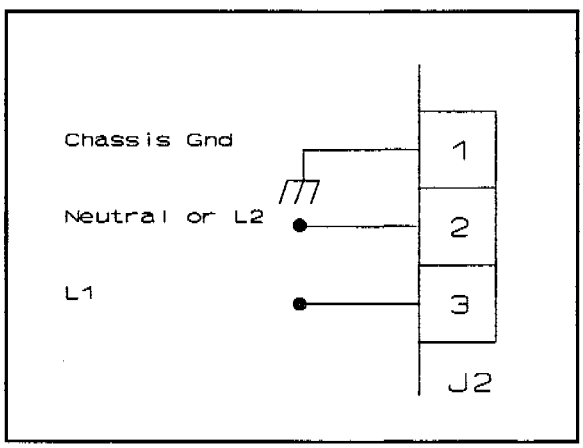


Figure 3-5: Input Power

FEEDBACK FREQUENCY INPUT

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

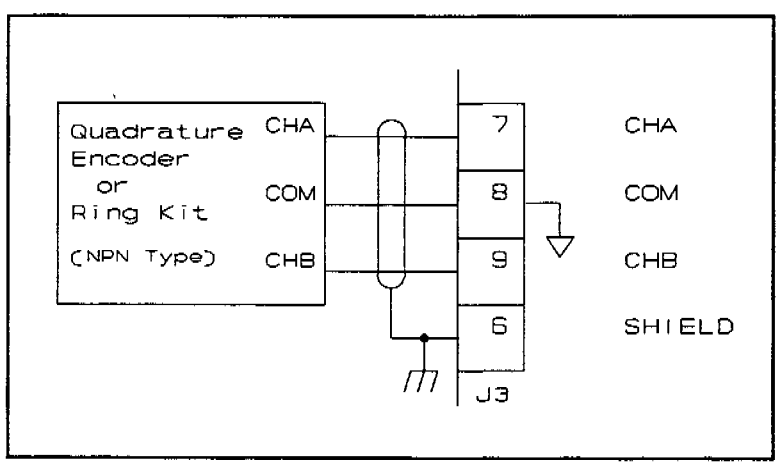


Figure 3-6: Feedback Input Connections

REGISTRATION INDEX

The Registration Index input is a discrete input used to detect the product's registration mark. This input is usually detected by a proximity switch or optical sensor switch (NPN output type).

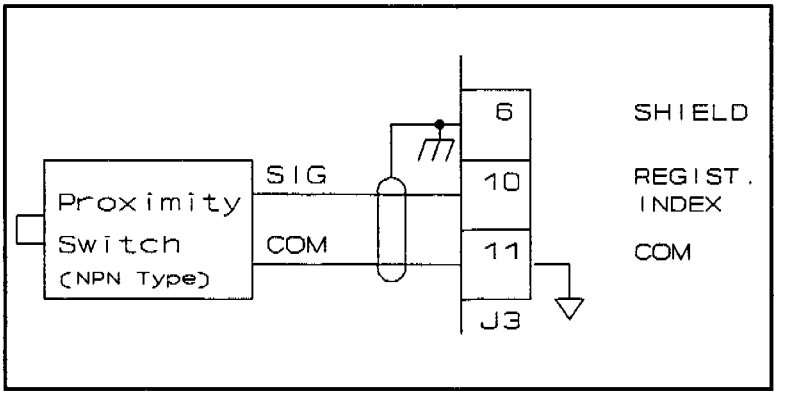


Figure 3-7: Registration Index Input

HOME INDEX

The Home Index Input is a discrete input used to detect when the process reaches the Home Position during a Home-To-Index operation. This input is usually operated by a proximity switch or optical sensor switch (NPN output type).

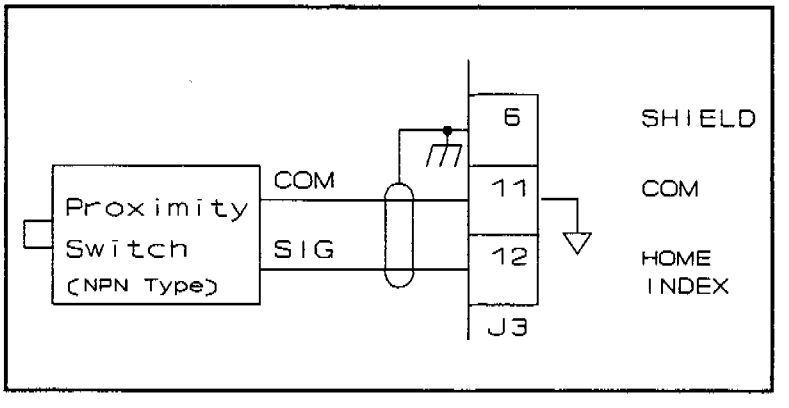


Figure 3-8: Home Index Input

RESUME MOVE

Resume Move is a momentary input (edge triggered) which when closed causes the M-Cut to complete a Move that was interrupted by a Halt or F-Stop command. It can also be used to repeat the previous Move (refer to CP-98 on page C-19 for further details.) Halt and F-Stop need to be closed (logic low) in order for this input to activate.

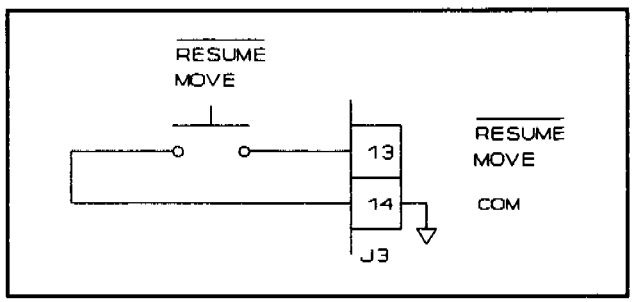


Figure 3-9: Resume Move Input

MOVE

Move is a momentary input (latched, level sensitive) which when closed permits the M-Cut to perform the next move. Halt and F-Stop need to be closed (logic low) in order for this input to activate.

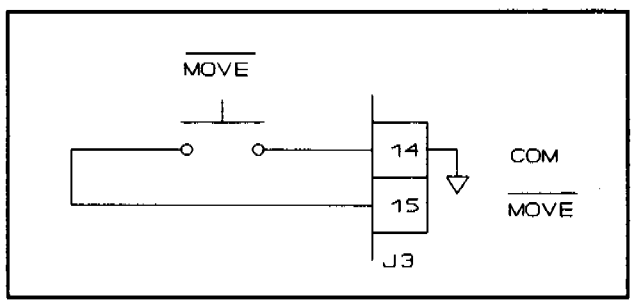


Figure 3-10: Move Input

HALT

Halt is a momentary input (latched, level sensitive) which when opened brings the M-Cut to a halt using the current profile's decel rate. After coming to a stop, Halt holds position, and the drive remains enabled. Halt is recognized by the M-Cut at any time except when F-Stop is active.

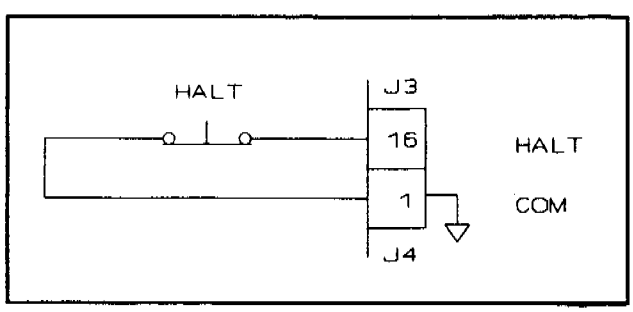


Figure 3-11: Halt Input

F-STOP

F-Stop is a momentary input (latched, level sensitive) which when opened commands the M-Cut to come to an immediate stop. After stopping, F-Stop then deactivates the Drive Enable output. Note that the Drive Enable output is always deactivated within 250 msec after activating the F-Stop input. F-Stop will take priority over the Halt, Move, Resume Move, Jog, Back-Step, Home Return and Home-To-Index functions.

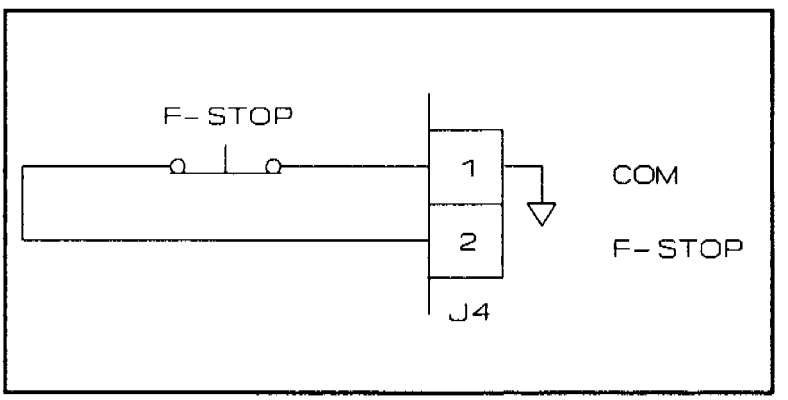


Figure 3-12: F-Stop Input

JOG

$\overline{\text{JOG}}$ is a maintained input which when closed directs a speed command signal to the drive at the selected jog speed. The direction of the Jog speed command is determined by the Forward/Reverse input. As a maintained input, the jog state is only valid for the duration of the time the operator device is held closed. When this input is deactivated (opened) the M-Cut stops immediately and holds position. The Halt and F-Stop inputs need to be closed (logic low) for the Jog input to be recognized. Valid Move Speed, Acceleration, CP-37 and CP-64 entries must also be present for proper jog operation.

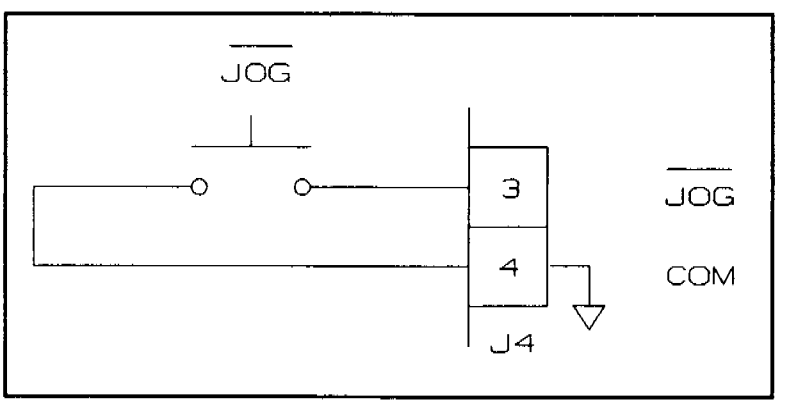


Figure 3-13: Jog Input

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

The Forward/Reverse input determines the direction for JOG and Home-To-Index. The Forward position (open) is the direction of the positive motion (see Page 4-2), while the reverse position (closed) is the opposite direction.

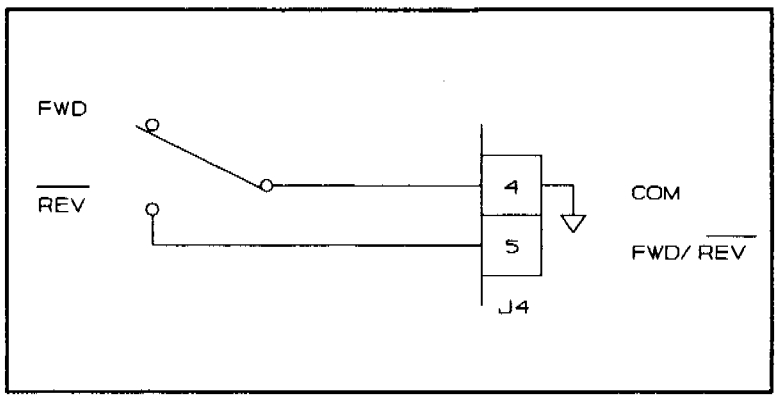


Figure 3-14: Forward/Reverse

BACK STEP

Back Step is a momentary input (edge triggered) which when closed commands the M-Cut to back the product in a reverse profile direction to prevent damage to the cutting blade.

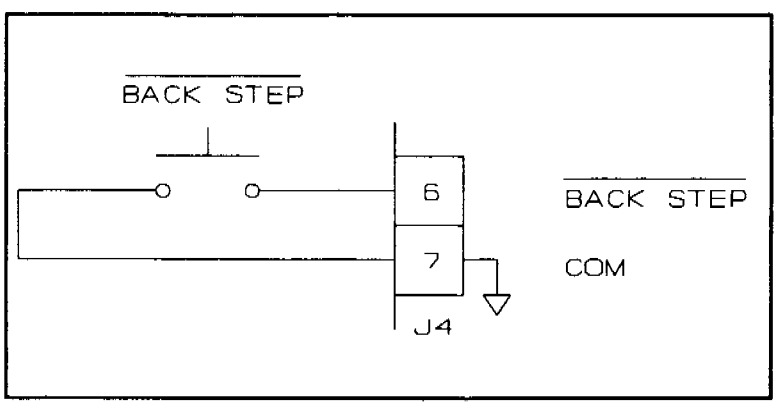


Figure 3-15: Back Step Input

HOME RETURN

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

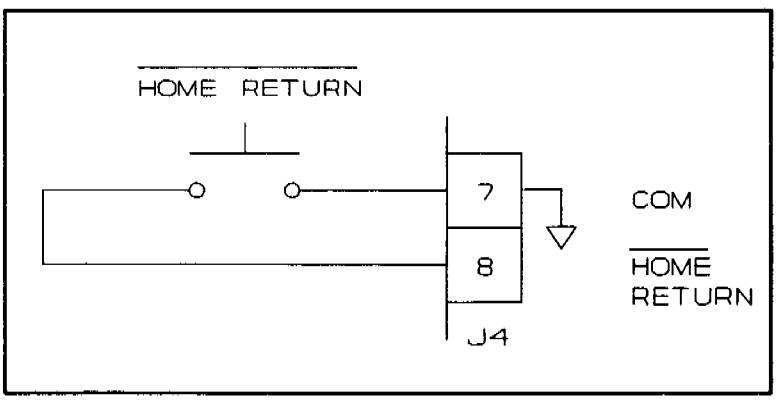


Figure 3-16: Home Return Input

HOME-TO-INDEX

Home-To-Index is a momentary input (edge triggered) which when closed commands the M-Cut to make a sustained Jog move (direction determined by FWD/REV input) until the M-Cut receives a Home Index input. As a momentary input, the Home-To-Index input is internally latched and need not be maintained by the operator device. The Halt and F-Stop inputs need to be closed (logic low) for the Home-To-Index input to be recognized. Valid Move Speed, Acceleration, CP-37 and CP-64 entries must be preset for proper operation.

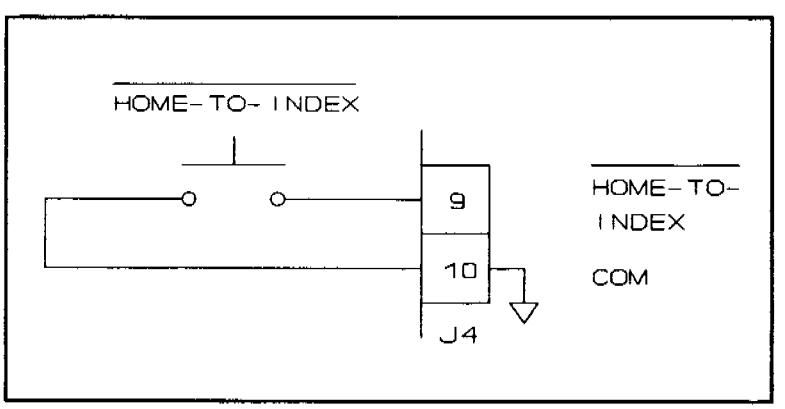


Figure 3-17: Home-To-Index Input

HOME SET

$\overline{\text{Home Set}}$ is a momentary input (edge triggered) which when closed sets the current position as the new Home position. The drive must be stopped and out of cycle mode to use the Home Set input.

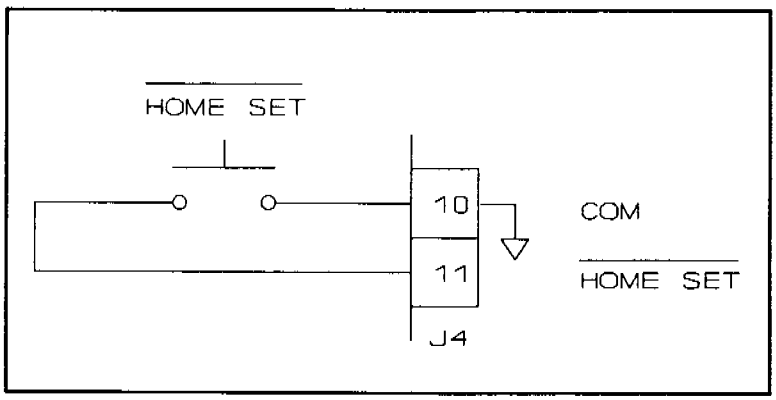


Figure 3-18: Home Set Input

PROFILE SELECT A

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

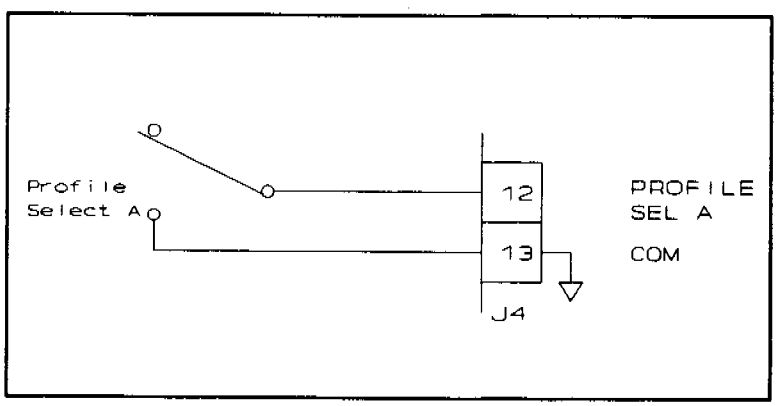


Figure 3-19: Profile Select A

PROFILE SELECT B

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

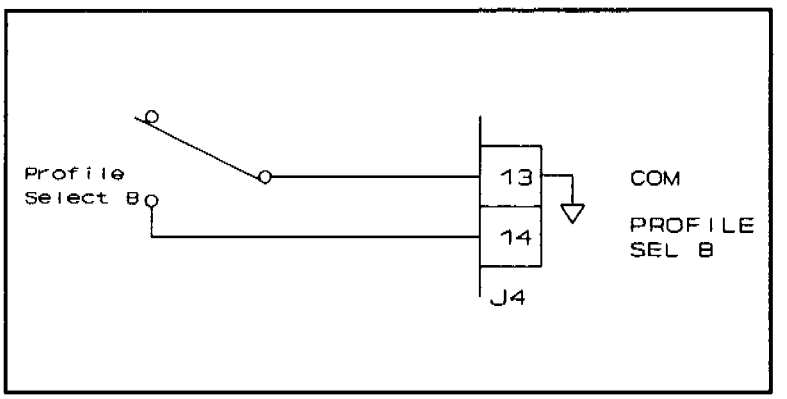


Figure 3-20: Profile Select B

BATCH RESET

The Batch Reset input when closed resets the batch count to zero for all profiles. This input can be closed at any time. Refer to Page 5-23 for details regarding the Batch Reset function.

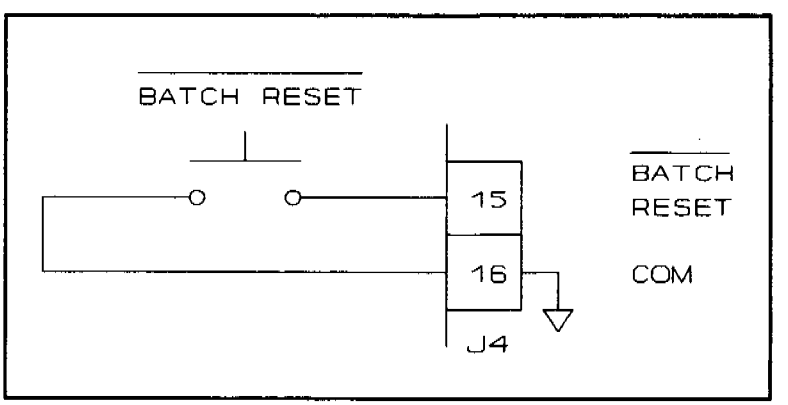


Figure 3-21: Batch Reset

KEYPAD LOCKOUT

The Keypad Lockout input is used to selectively disable the front operator keypad from making setpoint and other parameter changes. Refer to Appendix C (CP-79) to determine which parameters are locked out with this input.

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

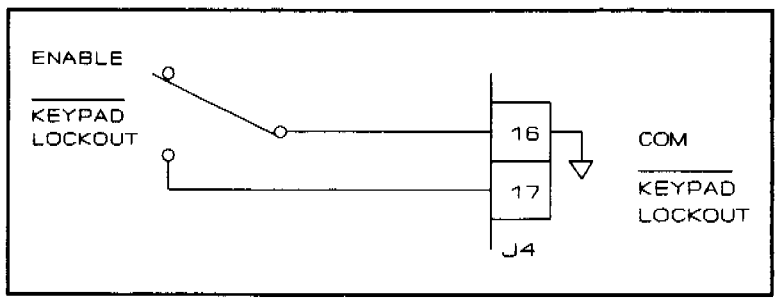


Figure 3-22: Keypad Lockout

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 3-23 below illustrates the Speed Command Output connections.

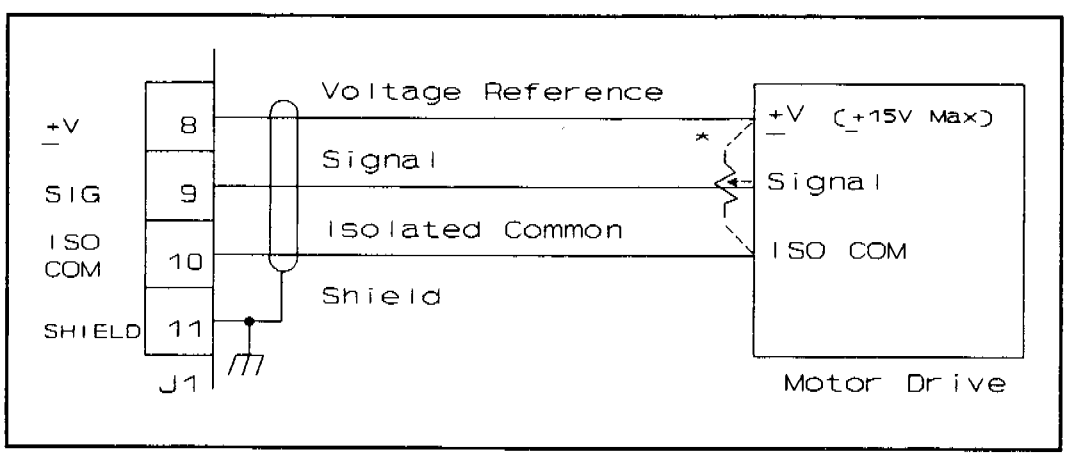


Figure 3-23: Speed Command Output

If the M-Cut is connected to a drive with a differential type of speed input, a two-wire connection should be used (see Isolator Voltage Reference on Page 2-2). Connect J1 pin 9 to the positive differential input and J1 pin 10 to the negative differential input.

* Remove Drive Speed Potentiometer

DISCRETE OUTPUTS

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

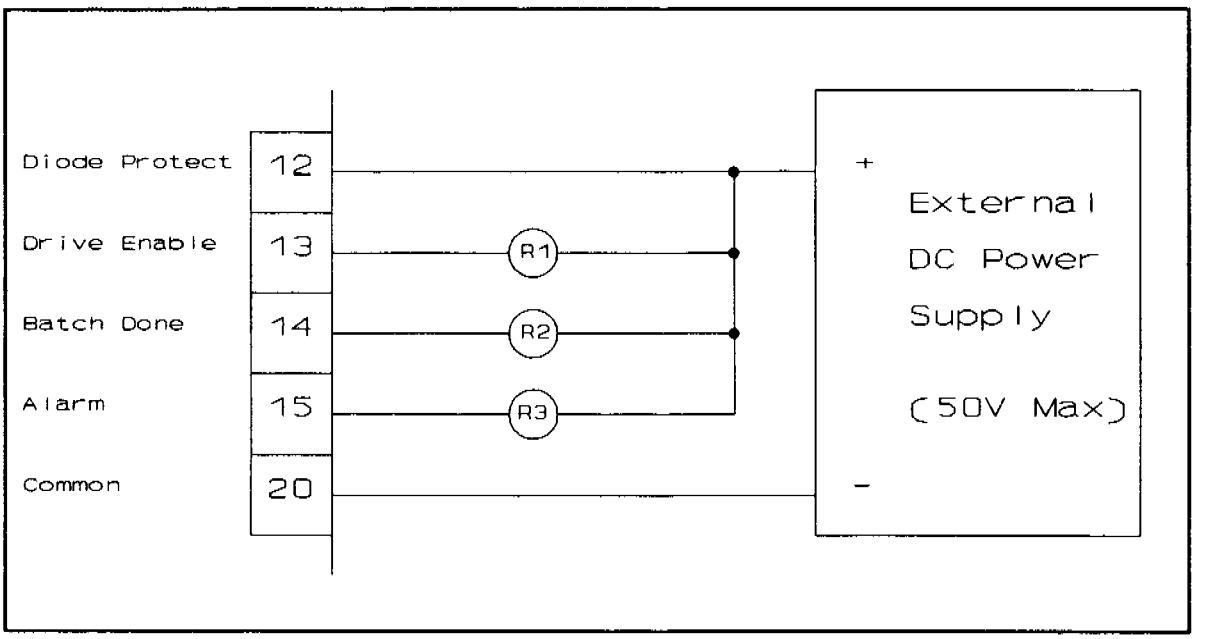


Figure 3-24: Optional Outputs

DRIVE ENABLE (J1 PIN 13)

The Drive Enable output is driven low (relay activated) when the M-Cut is commanding a speed output to the follower drive, including during the Halt state. 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 for the current profile operates to completion.

ALARM (J1 PIN 15)

The Alarm output is driven low (relay activated) whenever a position error occurs (as determined by CP-39) or during a High Speed Alarm Condition (as determined by CP-38).

AT-HOME (J1 PIN 16)

The At-Home output is driven low (relay activated) whenever the M-Cut determines that it has reached the In-Position Band (CP-80) of the Home position at the completion of a Home Return or Home-To-Index operation. The Home Set (when permitted) will also trigger this output.

IN-POSITION A (J1 PIN 17)

The J1-17 output is a time programmable output which is driven low (relay activated) when the final profile position has reached the In-Position Band (CP-80) at the completion of a Move function (or Resume Move as programmed by CP-98) according to the CP-81, CP-82 and CP-83 settings.

IN-POSITION B (J1 PIN 18)

The J1-18 output is a time programmable output which is driven low (relay activated) when the final profile position has reached the In-Position Band (CP-80) at the completion of a Move function (or Resume Move as programmed by CP-98) according to the CP-84, CP-85 and CP-86 settings.

IN-POSITION C (J1 PIN 19)

The J1-19 output is a time programmable output which is driven low (relay activated) when the final profile position has reached the In-Position Band (CP-80) at the completion of a Move function (or Resume Move as programmed by CP-98) according to the CP-87, CP-88 and CP-89 settings.

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-Cut.

+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-Cut.

CAUTION

It is imperative that the current draw not exceed the specifications listed on page ix for the 5 Volt and 12 Volt supplies. Excessive current draw will result in damage to the M-Cut device.

3) SERIAL COMMUNICATIONS

The Serial Communications interface on the M-Cut complies with EIA Standard RS-422-A for balanced line transmissions. This interface is provided to permit remote computer variable programming, status or performance monitoring, and remote control. A detailed discussion of the Serial Communications capability is provided in Chapter 6 of this manual.

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

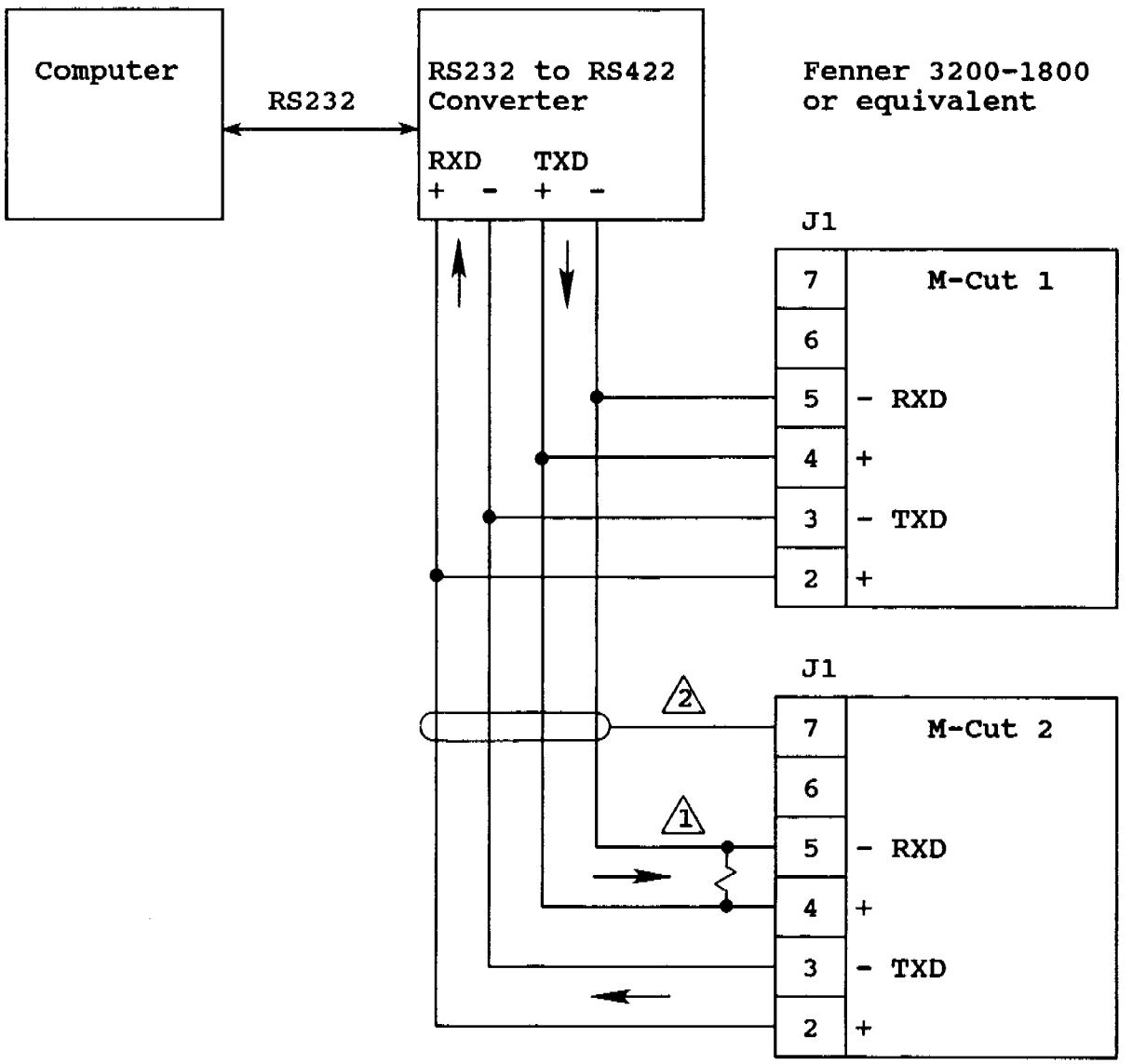


Figure 3-25: Serial Communications Connections

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

⚠2 Shield at one end of cable only.

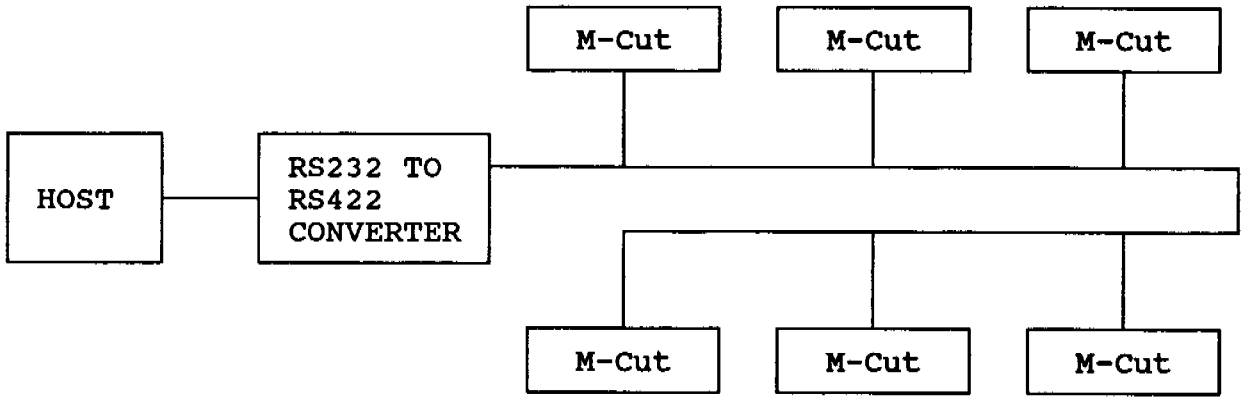


Figure 3-26: Correct M-Cut Multidrop Installation

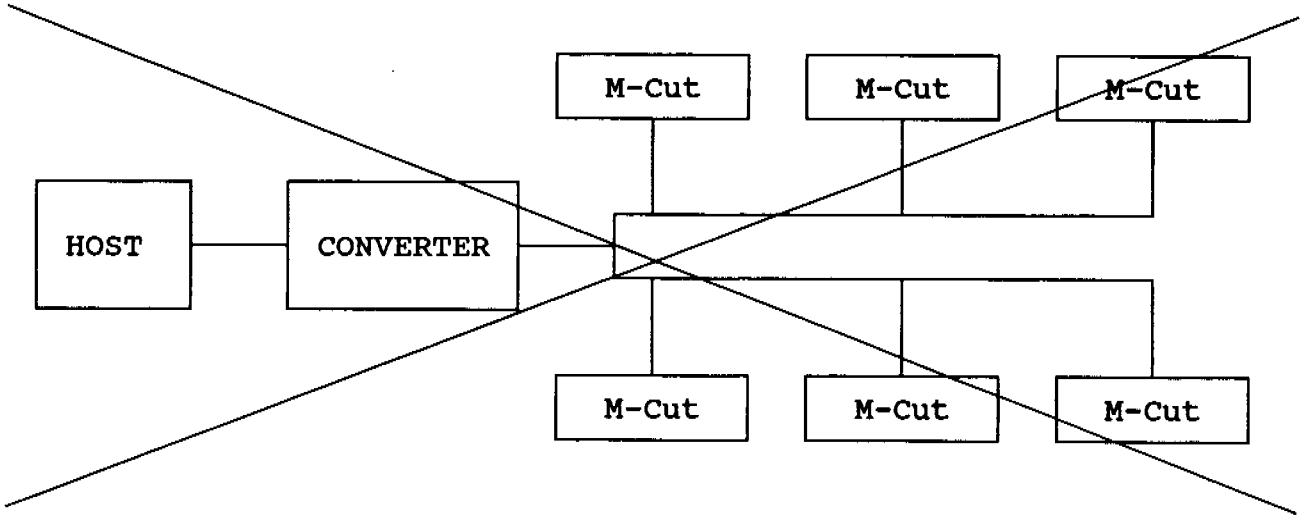


Figure 3-27: Incorrect Installation

NOTES

CALIBRATION 4

INTRODUCTION

This chapter contains the information required to calibrate the M-Cut to the connected motor drive. Prior to using these procedures, the M-Cut must be properly configured and installed in accordance with Chapters 2 and 3 of this Manual. The F-Stop and Halt inputs need to be closed (logic low) for motion to occur.

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

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

1. Enter a "1" into CP-60 (places M-Cut into Direct Scaling Mode and activates the Drive Enable output).

2. Enter "4095" into CP-61 (puts the output to 100% command output level).

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

4. Return the M-Cut to the F-Stop state by entering a zero into CP-60 and CP-61.

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 "0" into CP-61 (0 speed command).

2. Enter "1" into CP-60 (places M-Cut into Direct Scaling Mode).

3. Adjust the On Board Zero Pot until the voltage between J1 Pin 9 and J1 Pin 10 is at zero volts. Adjust the motor drive to eliminate creep with the M-Cut at zero volts output.

4. Enter "0" into CP-60 (places M-Cut into F-Stop).

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. Enter "1" into CP-60 (places M-Cut into Direct Scaling Mode).

2. Enter a positive Direct Mode setpoint of 500 into CP-61 to produce a positive voltage at the motor drive output.

3. If the actual motor direction does not match the forward motor command during normal operation, then rewire the drive/motor to reverse the motor direction. The direction of motion corresponding to a positive M-Cut output is considered forward motion.

   Note: If any wires are moved during Step 3, then repeat Steps 1 and 2 above before proceeding with Step 4.

4. Adjust the encoder polarity by rotating the encoder in the forward direction for normal operation while monitoring MV-46. (It may be necessary to disable the drive to move the encoder.) If the frequency in MV-46 is negative, then exchange the encoder lines on J3 pins 7 and 9.

   Note: If any wires are moved during Step 4, then repeat Step 4 above before proceeding with Step 5.

5. Set the ACCEL and DECEL POTs on the motor drive to the minimum times (maximum rates).

6. Set the I.R.Compensation POT (if present) on the motor drive to its minimum setting.

7. Enter "3686" into CP-61 (places the output command to 90% of the full 4095 level).

8. Adjust the Max Speed POT on the subject motor drive for the desired maximum operating RPMs. (Motor speed can be monitored via the following equation: MV-46 * 60/PPR = speed in RPMs.)

9. Enter "500" into CP-61.

10. Enter "2" into CP-60 (places M-Cut into FF-Adjust Mode, where kff = 90% of true scale.)

11. Wait a few seconds, then exit FF-Adjust Mode by entering a "0" into CP-60. The M-Cut then enters the F-Stop state.

12. Enter "0" into CP-61.

13. Check CP-64 (kff) for a non-zero value. If CP-64 is non-zero, the motor drive set up is complete. Record the CP-64 value in Appendix D, as it will be reset to zero with a "Clear 7" power-up procedure.

    If CP-64 is zero, then the Feedback Frequency is set too low and the encoder is not moving fast enough. Adjust this by entering "1000" into CP-61, then repeat steps 10 through 13.

NOTES

OPERATION 5

INTRODUCTION

This chapter explains how to operate the M-Cut. Basic M-Cut operation consists of:

1) Creating the desired M-Cut velocity profiles by entering values into specific Control Parameters (CP-xx) using the Operator Keypad
2) Opening or closing discrete switch inputs to start desired actions
3) Monitoring the controller and system performance through the numerous Monitor Variables (MV-xx), and
4) Optimizing M-Cut performance by changing selected Tuning Control parameters.

This chapter is divided into six sections:

Operator Keypad (Page 5-2)	Explains how to use and read the operator keypad.
Parameter Entry (Page 5-5)	Explains the procedure to enter Control Parameter values to create the desired velocity profiles.
Tuning (Page 5-13)	Explains how to optimize system performance by tuning the M-Cut.
Operator Sequence (Page 5-16)	Explains the typical procedures for operating the M-Cut.
Operating Restrictions (Page 5-25)	Explains which inputs and Control Parameters cannot be changed during certain operation modes.
Performance Monitoring (Page 5-27)	Explains the methods for using the M-Cut Monitor Variables.

OPERATOR KEYPAD

The Operator Keypad is used to view or change M-Cut CP-xx values, and to view Monitor Variables to verify proper performance.

Figure 5-1 illustrates the M-Cut 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:	Cut Length, Batch Count, Position 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-Cut status.
Lower display:	Typically displays the MV-xx or CP-xx code whose value is shown in the upper display.

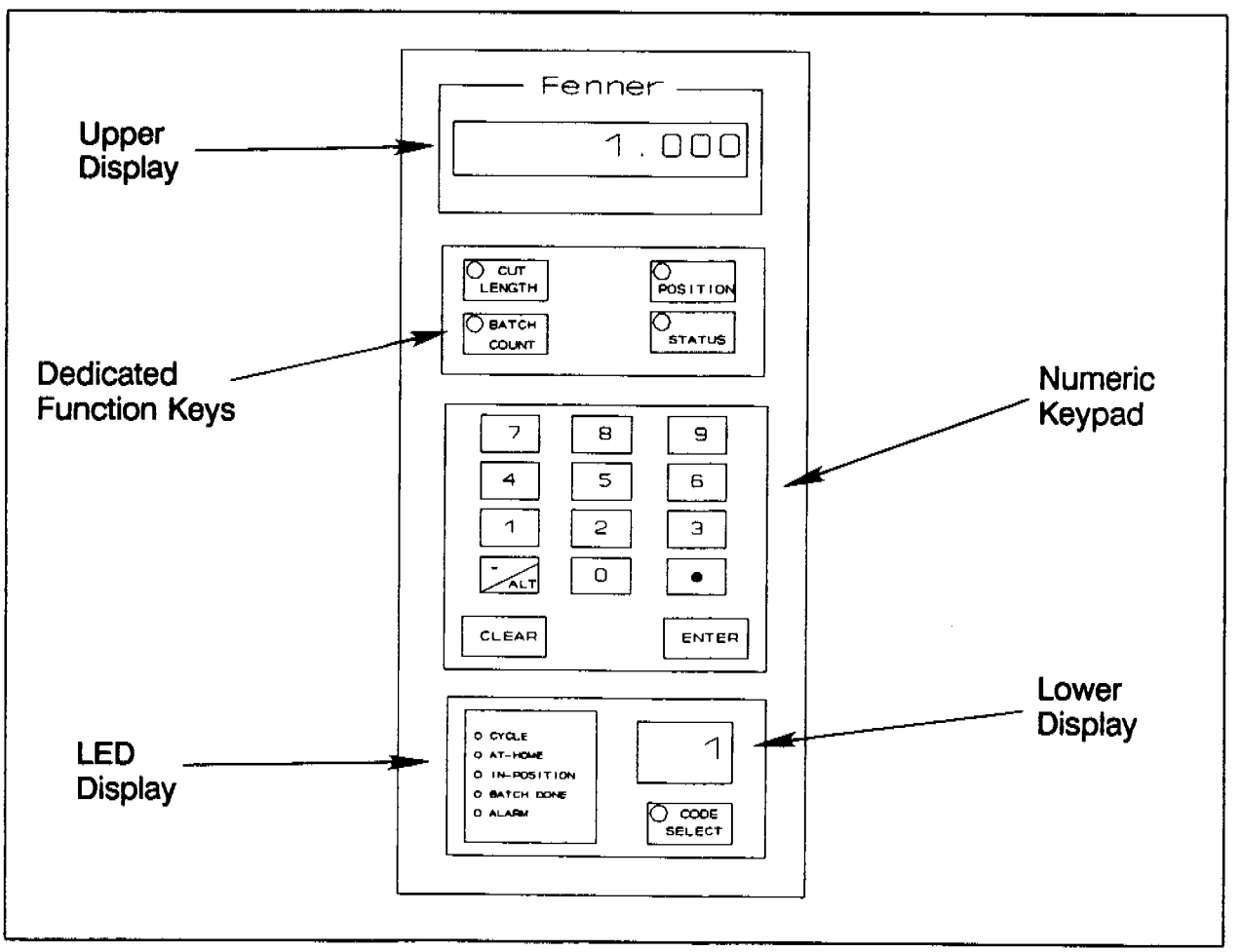


Figure 5-1: Operator Keypad

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

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

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

At this point, the lower window displays the two digit Operation Code and the upper six-digit window displays the existing parameter value. In addition, the keypad is enabled for changing the existing value (if applicable). To make a change, simply enter the new value and press the Enter Key.

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

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

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

DEDICATED FUNCTION KEYS

The dedicated function keys provide quick access to four commonly required M-Cut variables:

CUT LENGTH: This key allows viewing or changing the 4 Cut Length values.

1) Press Cut Length. The lower display indicates the selected cut length (CP-1, CP-8, CP-15 or CP-22), while the upper display shows the current value. The selected cut length is determined by the Profile Select Inputs A and B if Profile Sequence is disabled (CP-33 = 0), or by the profile sequence function if Profile Sequence is enabled (CP-33 is not equal to zero). The numeric keypad is now enabled.
2) Enter the new Cut Length value using the numeric keypad.
3) Press the Enter key within 15 seconds.

BATCH COUNT: When the Batch Count key is pressed, the lower display is 49 (MV-49) and the upper display shows the current batch count **for the selected profile**. The selected profile is determined by the Profile Select Inputs A and B, or the current profile of the profile sequence function.

POSITION: When POSITION is pressed, the lower display is 40 (MV-40), and the upper display shows the M-Cut's current position.

STATUS: When STATUS is pressed, the lower display is 52 (MV-52), and the upper display shows the current alarm status code. See Page C-10 to interpret this code.

LED INDICATORS

When on, these LEDs indicate the following:

LED On	Indicates
CYCLE:	M-Cut is perfoming a Move.
AT-HOME:	M-Cut is within the In-Position Band (CP-80) of the Home position.
IN-POSITION:	M-Cut is within the In-Position Band (CP-80) of the cut position (length).
BATCH DONE:	Current Batch is complete for the selected profile.
ALARM:	An M-Cut alarm condition is present. Press the STATUS function key to view the alarm code.

PARAMETER ENTRY

This section explains how to create up to four velocity profiles by entering values into specific Control Parameters. Typical Control Parameters used include the cut length, move speed, accel time, decel time, batch count, registration length and direction. A complete list of all Control Parameters and item definition is available in Appendix C.

In addition to creating the velocity profiles, this section also explains additional Control Parameters for Scaling, Home, In-Position, Direct Command and Alarm Control.

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

PROFILE PARAMETERS

The M-Cut has 4 profiles: Profile 1, Profile 2, Profile 3 and Profile 4. The active profile is determined by the Profile Select A and Profile Select B inputs, or by the current profile of the profile sequence function.

Each profile uses seven different CP-xx codes to calculate the M-Cut Velocity Profile when that profile is selected. Figure 5-2 illustrates the parameter codes used by each profile. For example, when the Profile Select A input is closed and the Profile Select B input is open, profile 2 is selected. Thus, the CP-8 through CP-14 values are used to calculate the velocity profile during a profile move.

Prof. Sel. A:	Open	Closed	Open	Closed
Prof. Sel. B:	Open	Open	Closed	Closed
	Profile 1	Profile 2	Profile 3	Profile 4
Cut Length	CP-1	CP-8	CP-15	CP-22
Move Speed	CP-2	CP-9	CP-16	CP-23
Accel Time	CP-3	CP-10	CP-17	CP-24
Decel Time	CP-4	CP-11	CP-18	CP-25
Batch Count	CP-5	CP-12	CP-19	CP-26
Reg Length	CP-6	CP-13	CP-20	CP-27
Direction	CP-7	CP-14	CP-21	CP-28

Figure 5-2: M-Cut Profile Chart

CREATE VELOCITY PROFILES

1) The Scale Factor allows the M-Cut to setpoint and view cut length and speed values in Engineering Units. Determine the number of encoder edges that will occur for a cut length of one engineering unit, and enter that value into CP-30. For example:
   - If 100 encoder edges occur for every one inch of cut distance and the engineering parameters are to be interpreted in inches, then enter "100" into CP-30.
   - If for the same system the desired engineering units are feet, then enter "1200" into CP-30.

   When calculating the number of encoder edges per cut, make sure all gear box, belting, etc. reductions are taken into account. Because the M-Cut uses quadrature decoding (x4), there are four encoder edges for every encoder line.

2) Decide whether to use minutes or seconds as the time unit base. Set CP-31 to "1" if the desired time unit is minutes; set CP-31 to "2" if the desired time value is seconds. This permits the speed values to be entered or viewed in either engineering units/minute or engineering units/second.

Note: Steps 3 through 9 assume that the Profile 1 settings are entered first. Also note that Figure 5-3 illustrates how the Cut Length, Move Speed, Accel Time and Decel Time Control Parameters are used to calculate a profile move.

3) Select a cut length and enter its value into CP-1. This value should be entered in Engineering Units including the desired decimal location. For example, a cut length of ten with a resolution to the thousands is entered as 10.000. The value in CP-7 will determine how the setpoint entry is interpreted (magnitude and direction). Refer to item 9 on Page 5-8 for greater detail.

If the Cut Length (CP-1) multiplied by the Scale Factor (CP-30) exceeds 8,388,603 edges, the cut length value will not be accepted. MV-50 then displays a value of 100000 indicating a combination error.

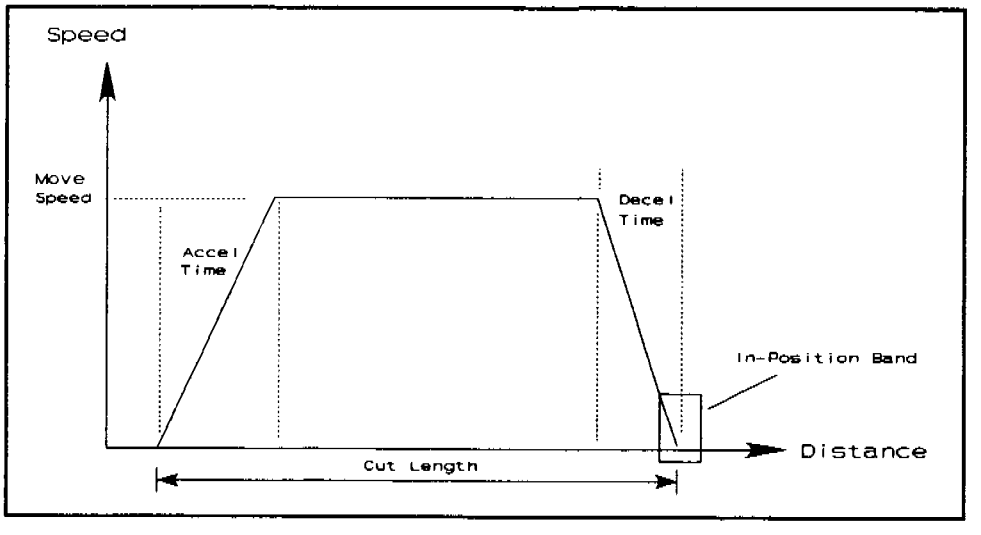


Figure 5-3: M-Cut Profile Move

4) Select a move speed and enter its value into CP-2. The move speed is the maximum allowable speed for this profile entered in engineering units per selected time. The decimal point resolution can be entered to the thousands.

If the move speed (CP-2) multiplied by engineering units/time (CP-30/CP-31) exceeds 480,000 edges/sec, the move speed entry is not accepted. MV-50 then displays a value of 100000 indicating a combination error.

5) Select an accel time and enter its value into CP-3. The accel time is the acceleration time, in seconds, from zero speed to the Move Speed. The decimal resolution for the accel time is fixed to the hundreds.

6) Select a decel time and enter its value into CP-4. The decel time is the deceleration time, in seconds, from the Move Speed down to zero speed. The decimal resolution for the 3decel time is fixed to the hundreds.

7) Select a Batch Count value and enter its value into CP-5. Profile moves are repeated until the internal batch count is equal to the entered Batch Count. A Batch Count entry of zero allows for infinite batching.

8) If present, determine the length from the registration index to the final cut position in engineering units and enter that value into CP-6. When present, the M-Cut recalculates the last portion of a profile move once the registration index is detected. See Figure 5-4. The registration index operation is disabled for profiles with a programmed registration length of zero.

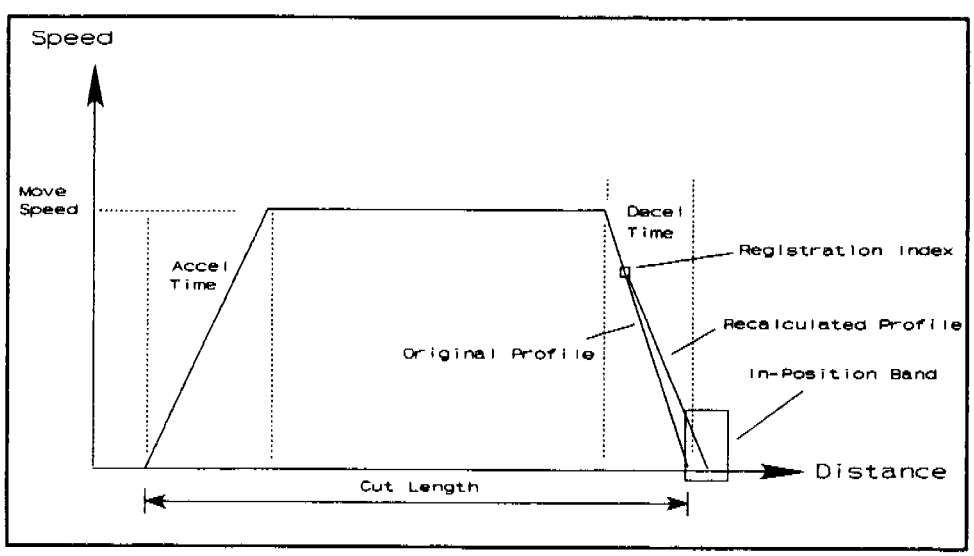


Figure 5-4: Profile Move with Registration Mark.

9) CP-7 and CP-78 define how the Cut Length entry is applied during operation. CP-7 identifies the Cut Length as either Relative or Absolute and Forward or Reverse. CP-78 determines whether or not the Home Position gets automatically reset with the initiation of every Move.

For operations where repetitive cut lengths are desired, CP-7 should be set for either an entry of "1" Relative Forward or "2" Relative Reverse depending on the desired direction of the move. CP-78 should be set to "1" indicating that a new Home Position will be automatically defined at the beginning of every Move request.

Certain operations prefer the Home Position to remain fixed once it is orignally defined. To prevent the automatic reset of the Home Position with every move, set the CP-78 parameter to zero.

A CP-7 entry of "3" Absolute Forward (positive position) or "4" Absolute Reverse (Negative Position) will cause the Cut Length to move in reference to the Home Position (not the prior Move). For example, if an Absolute Forward Move of 10.000 is followed by an Absolute Forward Move of 20.000, the fixed position will be 20.000 from the Home Position (assumes that CP-78 is zero).

10) If desired, repeat steps 3-9 above for Profiles 2, 3 and 4 (see Figure 5-2).

ADDITIONAL PROFILE MOVE PARAMETERS

Kerf:

The Kerf function automatically adjusts the profile cut length to compensate for material lost by the blade cut. Determine the length of material lost by the blade cut in engineering units, and enter that value into CP-32.

Profile Sequence:

The M-Cut can automatically sequence through different profiles. To enable this feature, enter the desired profile sequence into CP-33. For example, "312" indicates that the M-Cut will perform the following sequence:

Profile Move 3 (CP-15 through CP-22)
Profile Move 1 (CP-1 through CP-7)
Profile Move 2 (CP-8 through CP-14)

Refer to Page 5-19 for greater detail on the Profile Sequence function.

Index Polarity:

If a registration mark is used, enter into CP-34 the desired index polarity. This control parameter determines the index polarity for both the Registration Index and the Home Index. Setting CP-34 to "1" sets the detection of the mark when the input changes from open to closed (high to low logic transition). Setting CP-35 to "2" sets the detection of the mark when the index changes from closed to open (low to high logic transition).

Back Step Length:

The Back Step function steps the material away from the cut blade after the cut is made and before the blade is returned to its original position. The Back Step function is often directed by the In-Position outputs (Page 5-10). This feature is not required for all processes.

Enter into CP-35 the desired Back Step length in engineering units to a resolution of thousands. Refer to Page 5-26 for Unipolar restrictions to the back step function.

Feedback PPR:

The Feedback PPR (CP-62) parameter determines when the motor controlled by the M-Cut is stopped as defined by less than 10 RPM. Certain control functions are inhibited when the motor speed is in excess of 10 RPMs. This parameter is also used to normalize the Kp and Ki tuning parameters.

Enter into CP-62 the number of encoder lines that will occur on the Feedback Frequency input of the M-Cut for one rotation of the motor shaft.

Note: CP-62 will only equal the PPR resolution of the encoder if the encoder is directly connected to the motor shaft. In all other cases, the PPR of the encoder must be divided by the gear reduction between the motor shaft and encoder shaft before entering into CP-62.

HOME PARAMETERS

Home Offset:

It is not always possible to mount the Home Index sensor where needed for the Home-to-Index function. Using the Home Offset entry, the Home Index sensor can be conveniently located and the desired home position established by adding the CP-36 offset value to the encountered sensor position. Enter into CP-36 the desired Home Offset value in engineering units to the thousands resolution (XXX.XXX).

The Home Offset parameter can also be used to prevent a backup action during the Home-To-Index operation. Refer to Page 5-17 for greater details on the Home-To-Index operation with Home Offset.

Automatic Home Reset:

CP-78 determines whether or not the Home Position is automatically reset at the beginning of every Move (CP-78 = 1, default) or whether the Home Position remains in its original position during repetitive moves (CP-78 = 0).

JOG SPEED

CP-37 determines the speed of the Jog and the Home-to-Index operations. Enter the desired speed in terms of engineering units/time. Resolution is available to the thousands (XXX.XXX). Valid entries for Acceleration, Move Speed, CP-37 and CP-64 must also be present for proper jog operations.

IN-POSITION PARAMETERS

In-Position Band:

CP-80 determines when the M-Cut is considered In-Position **at the end of a profile move.** When the M-Cut enters the in-position band, the timers are started for the In-Pos A, In-Pos B and In-Pos C discrete outputs. Once started, the In-Position discrete outputs continue to activate even if the M-Cut subsequently leaves the In-Position Band.

Determine the number of encoder edges (four edges per line) for the start of the in-position band, and enter that value into CP-80.

One feature of the M-Cut is that once the in-position band is detected, control is not dropped. The M-Cut controls the process until the completion of the profile move, always attempting to reduce the final position error to zero.

In-Position Delay:

The In-Position Delay parameters (CP-81, CP-84, CP-87) set the time delay from when the M-Cut enters the In-Position band, until the In-Position output goes active. Enter the desired time delay in milliseconds. Figure 5-5 illustrates three different delay periods.

In-Position Dwell:

The In-Position Dwell parameters (CP-82, CP-85, CP-88) determine how long the output remains active after the delay time has expired. Enter the desired dwell time in milliseconds. An entry of -1 indicates a continuous energized time period. Figure 5-5 illustrates three different dwell periods.

The In-Position outputs are reset to the inactive state when the following functions are commanded: Move, Home Return, Jog, Home-To-Index, Home Set, F-Stop or Halt. A Back Step function does not reset the In-Position timer outputs.

In-Position Polarity:

The In-Position Polarity parameters (CP-83, CP-86, CP-89) set the polarity of the output. A value of 1 programs the output to go from a high state to a low state during the dwell period. An entry of 2 programs the output to go from a low state to a high state during the dwell period. The output is typically wired to energize an external relay or activate a discrete input when in the low state.

Both polarities are illustrated in Figure 5-5.

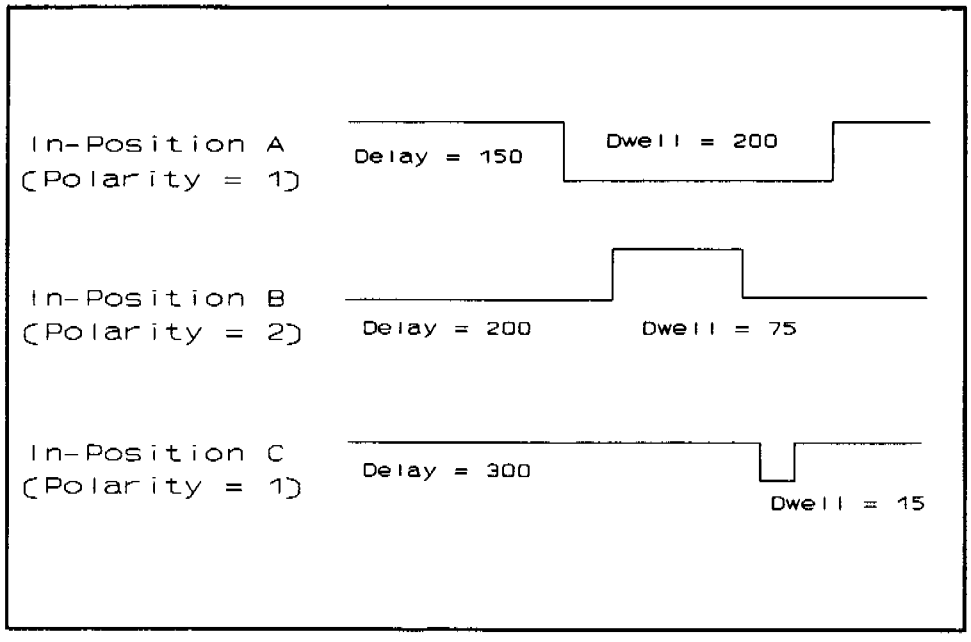


Figure 5-5: Example Delay and Dwell Times

In-Position Enable:

The In-Position Enable parameters (CP-90, CP-91, CP-92) allow the three In-Position timer outputs to be selectively linked to the four different profiles. Each of the four digits of the In-Position Enable parameter corresponds to one of the profiles (Profile 4 is the left-most digit in ascending order to profile 1 being the right most digit.) To allow the In-Position timers to be enabled for the selected profile, place a "1" in the corresponding digit location. A "0" entry prevents the timer output to be activated at the completion of the selected profile.

For example, an entry of 0010 in CP-90 enables the In-Position A Output to go active only after Profile 2 has been executed. It will not be activated at the completion of Profiles 1, 3 or 4.

In-Position C Delay Control:

CP-93 chooses the delay for the In-Position C Output. A value of "1" (default) causes the M-Cut to use the delay entered in CP-87 at the completion of all profiles. A value of "2" causes the M-Cut to use the delays entered in CP-94, CP-95, CP-96 and CP-97 corresponding to the appropriate profile at the completion of the profile. This feature can provide different delays between executed profiles if the In-Position C output is connected to the Ready input.

In-Position C Profile Delay:

These parameters (CP-94, CP-95, CP-96, CP-97) determine the time delays from when the in-position band is entered and the In-Position C output is activated for the selected profile when CP-93 is set to "2." Enter the desired time delay in milliseconds.

DIRECT COMMAND PARAMETERS

Direct Enable:

Entering "1" into CP-60 enables Direct Mode operation when the M-Cut's analog output is controlled by the Direct Command (CP-61). This is an open loop method of operation intended for calibration and trouble-shooting. Direct mode is disabled by the entry of zero into CP-60, or a Halt or F-Stop command.

A value of "2" for CP-60 allows the direct mode to automatically scale the Feedforward term (CP-64) of the control algorithm. Refer to the Tuning section (Page 5-13) for a detailed explanation of this procedure.

Direct Command:

CP-61 sets the DAC (Digital to Analog Converter) output level when in the direct mode of operation. A value of 4095 is a 100% positive command and a value of -4095 is a 100% negative command.

ALARM CONTROL PARAMETERS

High Speed Alarm:

CP-38 determines the velocity level at which the discrete alarm output (J1-15) is activated. Enter in the desired value in terms of engineering units/time. Resolution is available to the thousands place (XXX.XXX). The Alarm output and front panel LED are activated whenever the CP-38 or CP-39 alarm levels are exceeded.

Position Error Alarm:

Whenever the actual position deviates from the desired commanded profile position by the value in CP-39 the discrete Alarm output is activated (J1-15). This is frequently referred to as follower error. Enter the desired position error value in terms of engineering units to a resolution of thousands (XXX.XXX). The Alarm output and front panel LED are activated whenever the CP-38 or CP-39 alarm levels are exceeded.

TUNING

The Tuning Procedure modifies the control algorithm tuning parameters to achieve stable and optimal performance. The default tuning parameters should provide stable operation for most applications. The tuning instructions below are provided for those applications that require additional M-Cut tuning.

TUNING PROCEDURE

CP-63: S-Curve Enable

When the S-Curve function is enabled, the acceleration and deceleration portions of the velocity profiles are modified in a sinusoidal fashion as shown in Figure 5-6. The S-Curve provides a finite jerk move where the acceleration and deceleration moves are continuous, which therefore results in smoother operation and less stress on the machine.

Although the S-Curve function preserves the entered Accel and Decel Times, the actual peak Acceleration and Deceleration rates increase by a factor of 1.571. However, the RMS Acceleration and the RMS Deceleration is only about 1.11 times that of the trapezoidal velocity profile without the S-Curve function.

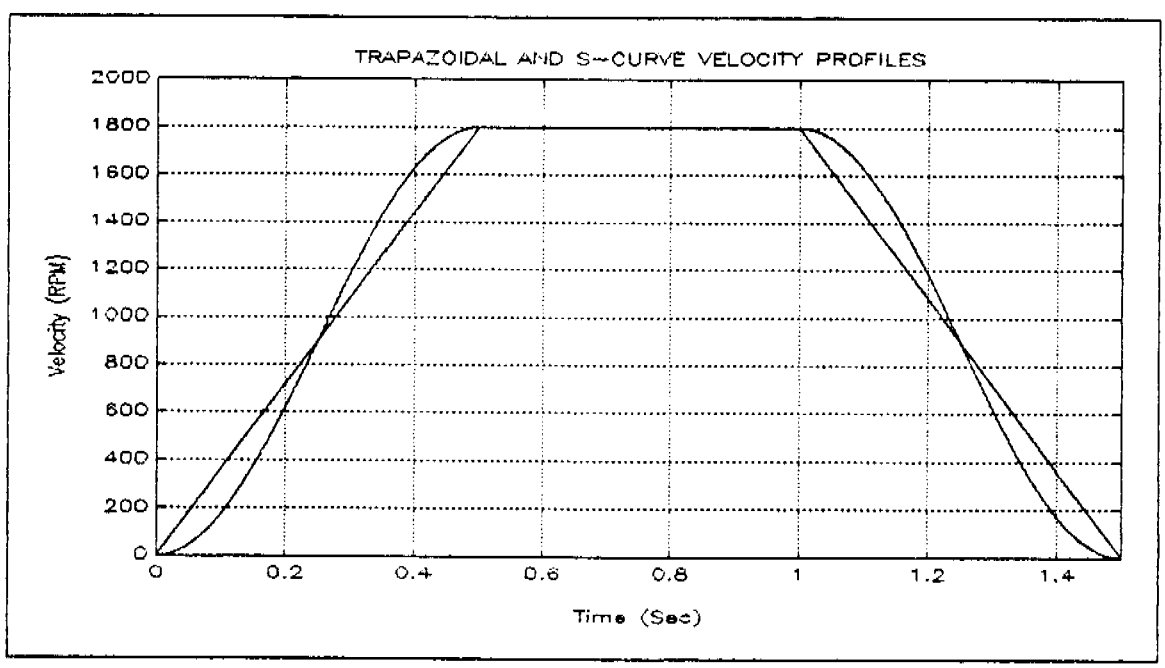


Figure 5-6: Trapezoidal and S-Curve Velocity Profiles

In order to maintain the same peak Acceleration/Deceleration rates as with the trapezoidal velocity profile, the Accel and Decel Times would have to be increased by a factor of 1.571. In this case, the RMS Acceleration and RMS Deceleration is about 0.707 times that of the trapezoidal velocity profile with the shorter Accel/Decel Times.

Typically, the S-Curve function results in less overshoot coming into final position. However, more overshoot may occur if the resulting Accel/Decel rates exceed that of the Drive/Machine capabilities. In these instances, an increase in the drive torque may be necessary.

To enable the S-Curve function, enter "1" into CP-63. To disable the S-Curve function, enter "0" into CP-63.

CP-64: Kff - Feedforward Constant

Kff determines the magnitude of the feedforward term in the compensation algorithm. The feedforward term, unlike the Proportional and Integral terms, is a function of the position command not the position error. It is used to increase the response of the system without affecting system stability. Increasing Kff increases the magnitude of the feedforward term.

There are two methods for determining the correct CP-64 value. The preferred method is by allowing the M-Cut to automatically scale the feedforward via Direct Mode. To enable the automatic feedforward operation, enter "2" into CP-60 (Direct Enable). Next, enter a value into CP-61 (Direct Command) that will operate the motor in excess of 10 RPMs. The M-Cut then learns the correct Kff value and places it into CP-64. Enter a "0" into CP-60 to exit the automatic feedforward operation.

A second method to set the feedforward constant is to directly enter a value into CP-64. This can be done by entering different values into CP-64 while in the Jog Mode. When the jog speed as displayed in MV-43 equals the Jog setpoint entered into CP-37, the value in CP-64 is correct. It may be desirable to reduce this value by approximately 10% to eliminate overshoots in position moves.

CP-65: Kp - Proportional Constant

To set Kp, first set the Integral Constant (CP-66) variable to zero. Increase the Kp number (CP-65) until the system goes unstable (erratic). When instability is reached, decrease the Kp value slightly until the system stabilizes.

CP-66: Ki - Integral Constant

Using only Kp, the system may exhibit a phenomenon called proportional droop, where the position error cannot be resolved to zero (or near zero) due to the offset (balance) or drift of the drive (creep). Increase the integral constant (CP-66) until the position error is reduced to an acceptable value in sufficient time or until the position overshoot becomes excessive.

OPERATOR SEQUENCE

FLOWCHART OF ACTIONS

Figure 5-7 below illustrates the most common sequences of actions that are used to operate the M-Cut. The top part of the figure illustrates actions taken by an operator, while the bottom part of the figure illustrates actions automatically performed by the M-Cut.

The following pages explain in detail each aspect of this figure.

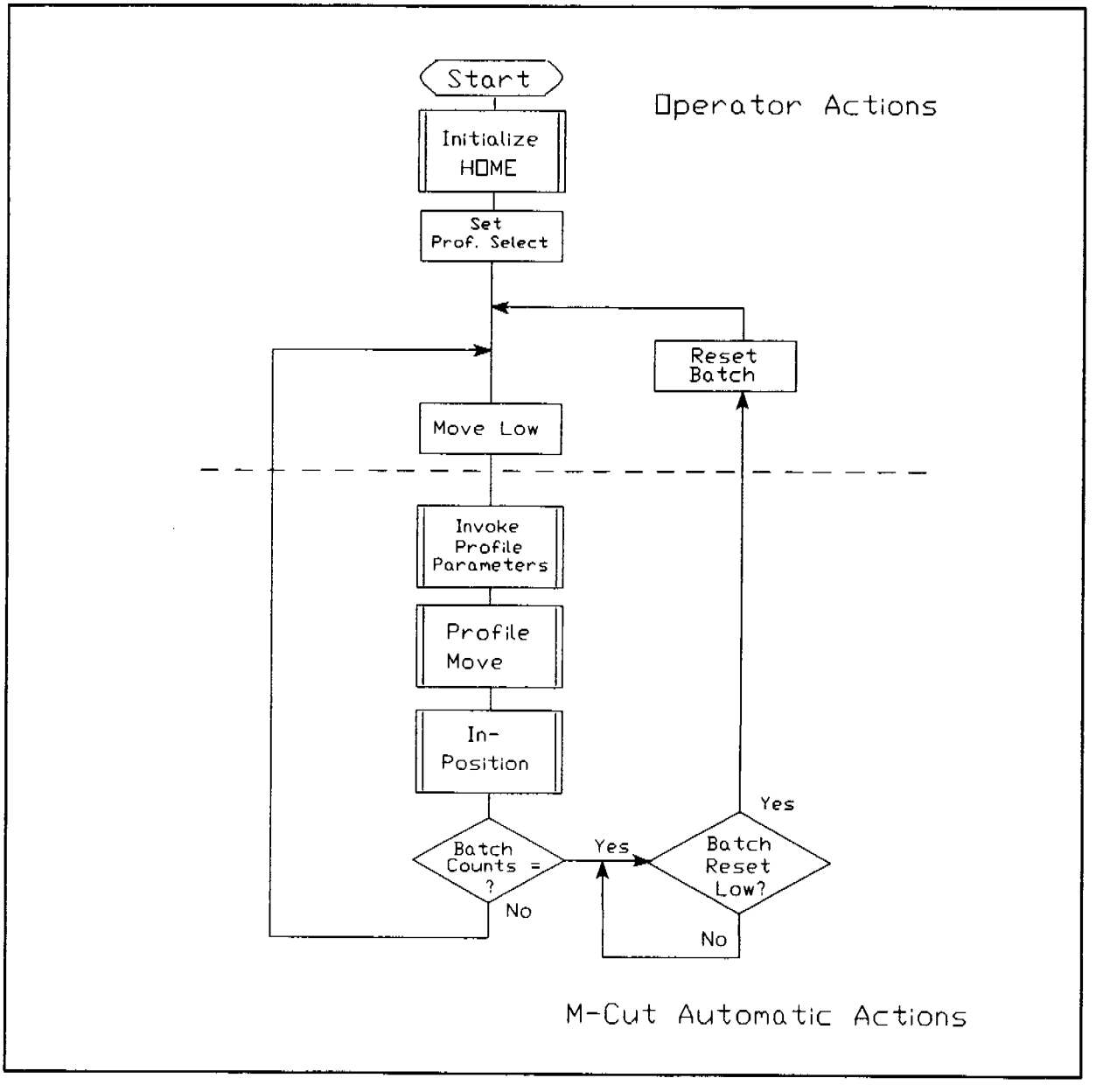


Figure 5-7: Operator Sequence Flowchart

OPERATOR ACTIONS

Initialize Home

The first action by an operator before executing a profile move is to establish an origin or Home position. There are two methods to establish Home: Home Set and Home-To-Index. Home is also established as the current position when power is applied to the M-Cut.

Initialize Home using Home Set:

1) Forward or Reverse Jog the product into the Home position by using the Jog (J3-3) and Fwd/Rev (J3-5) discrete inputs.

2) Close the Home Set discrete input (J4-11). The At-Home position is now set to the current position, the At-Home discrete output is activated and the At-Home LED is lit.

Initialize Home using Home-To-Index:

1) Close the Home-To-Index discrete input (J4-9).* The M-Cut performs a Jog move in the direction indicated by the Fwd/Rev (J3-5) input until the Home Index discrete input is detected.

   When the Home Index is detected (J3-12), the M-Cut decels, halts, reverses past the point of the Home Index, then proceeds forward to the home index position. The At-Home position is now set to the current position, the At-Home discrete output is activated and the At-Home LED is lit.

If there is a nonzero Home Offset in CP-36, the M-Cut decelerates to a stop when the Home Index is detected. It then determines if it needs to reverse or continue forward to reach the Offset Home Position. If a reverse action is required, it moves in reverse beyond the Offset Home Position and then moves forward to the desired final position. In all cases, the M-Cut makes its final approach to the Home Position from the direction indicated by the Fwd/Rev input. A positive CP-36 entry will place the Home Index in the forward direction from Home, a negative entry in the reverse direction.

Note: The M-Cut uses the Acceleration and Deceleration parameters of the currently selected profile when making moves associated with Jog or Home-To-Index operations. All other operations use the Acceleration and Deceleration parameters of the active profile (the last profile initiated by the Move input.)

Refer to Page 5-26 for Unipolar restrictions associated with the Home-To-Index operation.

* The Home-To-Index discrete input is a momentary (edge triggered) input and thus need not be maintained throughout the entire Home-To-Index operation.

Set
Profile Selects

The second operator action is to choose the desired profile. The Profile Select A (J4-12) and Profile Select B (J4-14) inputs are used to select one of four M-Cut 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

Open or Close these two inputs to select the desired profile.

The profile may be alternatively selected by the Profile Sequence function. For additional information concerning Profile Sequence, see Page 5-19.

Move

The last operator action is to close the Move (J3-15) input. The Move input indicates to the M-Cut that the machine or process is ready for the next move and the motion will be initiated.

After the move is complete as determined by the position being within the In-Position band of the cut position, the Move input can be again activated to initiate the next move. An automatic cycle process can be established by wiring the Move input to an In-Position timer output.

M-CUT AUTOMATIC ACTIONS

Invoke Profile Parameters	After the Ready input is activated, the M-Cut invokes the set of parameters associated with the selected profile. If CP-33 is set to zero, the M-Cut invokes the profile parameters as selected by the Profile Select A and Profile Select B inputs (see page 5-18).

If CP-33 is not zero, the profile selection process is determined by the Profile Sequence feature (the Profile Select inputs are ignored). When Profile Sequence is enabled, the M-Cut sequences through the profiles in the order determined by the CP-33 value. For example, "312" indicates that the M-Cut will perform the following sequence:

Profile Move 3 (CP-15 through CP-22)
Profile Move 1 (CP-1 through CP-7)
Profile Move 2 (CP-8 through CP-14)

Each profile move must be initiated by the Move input indicating that the machine or process is ready for the next move. The M-Cut uses the Batch Count entry from the first profile in the sequence for the Batch Counter. The Batch Counter is incremented when the last profile in the sequence completes its move.

Automatic Home Reset

When CP-78 is set to "1" (default), the Home Position will be automatically reset at the beginning of every Move request. A CP-78 entry of "0" will cause the Home Position to remain at its originally defined position with every Move.

Applications desiring repetitive cut lengths should have the CP-78 entry set to 1 for Automatic Home Reset operation.

Profile Move

During a Profile Move, the M-Cut ramps up to the move speed during the Accel Time, remains at the move speed for the calculated duration, then ramps down to zero during the Decel Time. The M-Cut calculates the velocity profile to make this move and also obtains position feedback information every millisecond.

Throughout the profile move, the M-Cut monitors position to ensure that the process is within the position limits set by CP-39 (Position Error Alarm). If the limits are exceeded in either direction the discrete alarm output (J1-15) is activated and the Alarm LED is lit.

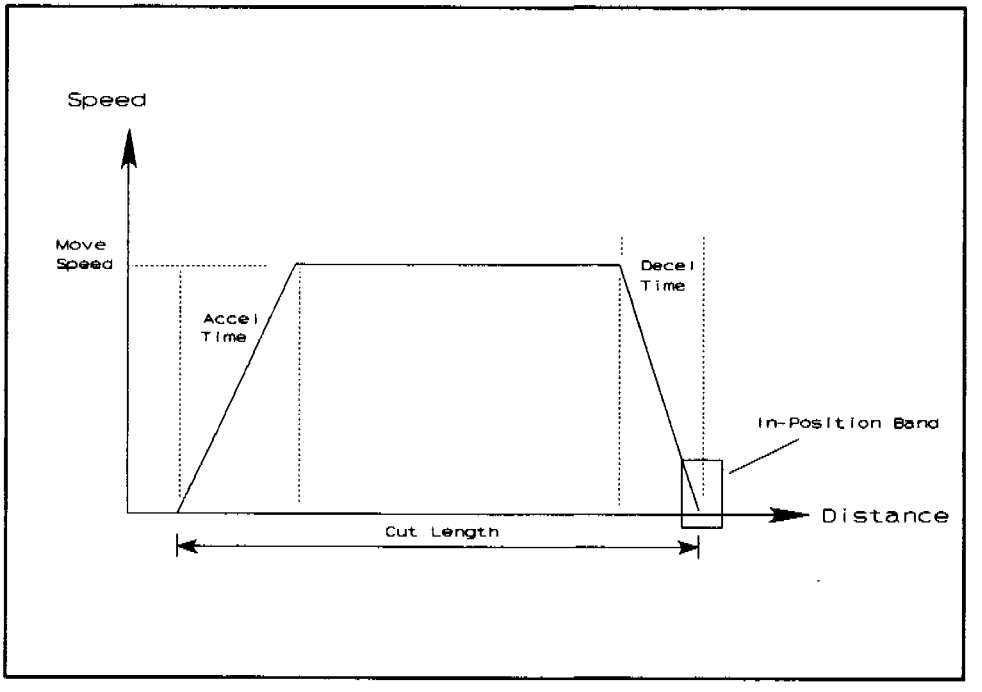


Figure 5-8: M-Cut Profile Move

In-Position

As soon as the position is within the In-Position Band of the cut position at the completion of the velocity profile move, the M-Cut starts all three In-Position output timers (In-Pos A, In-Pos B and In-Pos C). The In-Position outputs will continue to activate even if the In-Position Band is left once it is entered. Each of these timers perform specific actions according to their Delay, Dwell and Polarity values:

Delay: Time delay before the output activates.
Dwell: Duration output remains in the active state following the delay time.
Polarity: Determines whether the active state is high or low.

The three In-Pos outputs are typically wired into tools used to process the end product such as a product gripper, a guillotine cutter and resetting the M-Cut's Move Low input.

For example, assume that the process is a cutting operation where In-Pos A controls the product gripper, In-Pos B controls the guillotine cutter and In-Pos C controls the ready low input:

In-Pos A: Delay time is 0, so the product is gripped as soon as the In-Position band is detected.
In-Pos B: Delay time is 10, which starts the guillotine cutter 10 milliseconds after the band is detected.
In-Pos C: Delay time is 30 which closes the Move input (Move Low) to start the next profile move.

A variation on the above example uses both In-Pos A and In-Pos B outputs as explained, but rather than using the In-Pos C output to close the ready input, a contact switch that detects when the guillotine cutter returns from the cutting operation is used to close the Ready Input.

Another example uses Back Step and two detect switches:

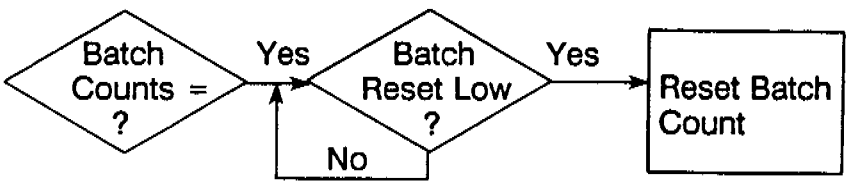
In-Pos A: Delay time is 10, so the product is gripped 10 milliseconds after the In-Position band is detected.
In-Pos B: Delay time is 20, which starts the guillotine cutter 20 milliseconds after the band is detected.

Detect Switch: Contact switch which detects when the guillotine cutter has finished the cut. This switch is wired into the Back Step (J4-6) input to back the product .04 millimeters.

In-Pos C: Delay time is 30, which returns the guillotine cutter 30 milliseconds after the band is detected.

Detect Switch: Contact switch which detects when the guillotine cutter has cleared the product cutting area. This switched is wired to close the Move input to start the next product move.

Note that the method for using the In-Pos switches typically changes for each application, and they do not need to be used as illustrated above. For example, some applications wire an In-Pos output to the Home Return input.



The Batch Count test determines whether to perform the next profile move, or to stop the process. The M-Cut compares the internal batch count (MV-49) to the previously entered Batch Count for this profile (CP-5, CP-12, CP-19 or CP-26).

If the batch counts are not equal, the M-Cut waits for a Move low input. If the batch counts are equal, the entered number of moves has been accomplished and the M-Cut stops the process and waits for a Batch Reset input. Note that the motor drive remains energized during stop, and product position is maintained.

A Batch Count entry of "0" allows for infinite batching. The Batch Count continues to increment, but wraps around from 999,999 to 0.

MOVE INTERRUPTIONS

There are two methods to interrupt a Move once it has started: Halt and F-Stop.

Halt:

Opening J3-16 places the M-Cut into the HALT state. The Halt state ramps the M-Cut speed to zero using the Decel rate, and maintains position. Note that the motor drive remains energized during the Halt State.

There are no operator restrictions for activating the Halt command.

F-Stop:

Opening J4-2 places the M-Cut into the F-STOP state. Once J4-2 is opened, an immediate stop command occurs, and position is not held. In addition, the Drive Enable output always deactivates within 250 msec after opening the F-Stop input.

Before continuing with any new product moves after an F-Stop, Home position should be reestablished via the Home Return or one of the Home Initializing functions. (see Page 5-17). The existing move can be completed with a Resume command.

There are no operator restrictions for activating the F-Stop command. Note that F-Stop has priority over Halt.

Batch Completion and Reset:

Profile Moves are not possible whenever the internal Batch Count is equal to the entered Batch Count for the current profile.

To restart the M-Cut after completing the Batch, perform the following actions:

1) Close the Batch Reset (J4-15) input to re-initialize the batch count.

2) Close the Move (J3-15) input to initiate the first move.

Note: If the Batch Reset input is activated during a move, the Batch Count will not be incremented at the end of the profile move. Also, a maintained Batch Reset input will place the M-Cut into an infinite Batch mode where the Batch count is never incremented.

ADDITIONAL INPUTS

Home Return

Home Return (J4-8) is a momentary input (edge triggered) that when closed commands the M-Cut 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.

Home Return is typically used to reestablish Home after a Halt, or can also be used in conjunction with the In-Pos outputs in shuttle feed applications.

Resume Move

The Resume input is used to complete an interrupted profile Move. It will activate the In-Position outputs and increment the Batch Count upon completion just as the Move would have. The Profile Sequence will continue as if the Move was completed.

CP-98 dictates the action taken if the Resume is requested under certain circumstances. A Job-Space is defined as the position from where the Active profile started to its final cut position (plus the in-pos band). Job Space for absolute Moves is from Home to Absolute Postiion.

CP-98=0: The Resume will be recognized outside of the current Job Space. The In-Position timers will not be reset if already at an absolute position. If the Active profile is relative, this option works the same as 1.

CP-98=1: The Resume will be recognized outside of the current job space. The In-Position timers will always be reset. This option is used if Resume is used to repeat the last profile Move if it has been completed.

CP-98=2: The Resume will only be recognized if the position is within the current Job space. In addition, the In-Position timers will not be reset if they are already active. This ensures only one cut-process is done if Resume held active.

CP-98=3: The Resume will only be recognized if the position is within the current Job space. In addition, the In-Position timers will be reset even if they are already active - thus repeating the cut-process. This is convenient if an F-Stop interrupted a cut-process before it was complete.

Back Step:

The Back Step function steps the material away from the cut blade after the cut is made and before the blade is returned to its original position. The Back Step function is often directed by the In-Position outputs (Page 5-21). This feature is not required for all processes.

The Back Step input is a momentary (edge triggered) input.

If the Back Step length (CP-35) multiplied by the Scale Factor (CP-30) exceeds 65,536 edges, the back step length will not be accepted. MV-50 then displays a value of 100000 indicating a combination error.

Refer to Page 5-26 for Unipolar restrictions to the back step function.

OPERATING RESTRICTIONS

UNIVERSAL RESTRICTIONS AND RULES

The following lists restrictions and rules associated with M-Cut operation:

1. An F-Stop operation can be executed at any time.
2. Halt can be executed at anytime except when an F-Stop is continually active (F-Stop input maintained open).
3. Batch Reset can be executed anytime.
4. Home Set can be executed anytime the motor is stopped (feedback less than 10 RPMs) and all other functions are complete. However, the At-Home output will not be activated if Halt or F-Stop is active.
5. Back Step must be At-Home or In-Position to be recognized.
6. The remaining functions can only be executed if all other functions are complete and F-Stop and Halt are not continually active.

UNIPOLAR OPERATION RESTRICTIONS

Setting CP-68 to "1" puts the M-Cut into unipolar operation. Unipolar puts restrictions on both M-Cut operation and on the types of valid entries. During unipolar operation, the M-Cut will not output negative velocity commands, will not execute reverse position moves, and prevents negative integral windup that would result from the inability to resolve negative position errors due to overshoots, etc.

The entry restrictions:

1. Cannot use reverse profile directions. (CP-7, CP-14, CP-21, CP-28 cannot be set to "2.")
2. Back Step Length (CP-35) must equal zero.
3. Cannot enter a negative Home Offset (CP-36).
4. Cannot enter a negative Direct Command (CP-61).
5. In addition, in order to change to unipolar mode (CP-68 = "1"), conditions 1 through 4 above must be met.

The operating restrictions:

1. The DAC output is restricted to positive voltage only.
2. The Integral term is only allowed to accumulate in the positive direction -- will not allow negative windup.
3. Jog in the Reverse direction is not allowed.
4. Home Return in the Reverse direction is not allowed.
5. The Back Step function is not allowed.
6. The Home-To-Index function in the Reverse direction is not allowed.
7. In addition, the Home-To-Index function (in the Forward direction) will not Back Up. When the product comes to a stop after detecting the Home Index, the M-Cut decides if the final Home Position (Index Position plus the Home Offset, CP-36) requires forward motion or reverse motion. If forward motion is required, the M-Cut proceeds as normal. If reverse motion is required, the M-Cut stays at that stopped position, calls that the new Home Position, and holds position there.

PERFORMANCE MONITORING

The M-Cut provides numerous Monitor Variables available to verify wiring and monitor the controller and system performance.

MV-40: Position

MV-40 displays the current position as referenced from Home. The engineering units and resolution for this variable are the same as the Cut Length variable for the active profile (CP-1, CP-8, CP-15 or CP-22).

MV-41: Position Command

MV-41 displays the current commanded position from the M-Cut. During a profile move, this commanded position is calculated by the trajectory generator function of the M-Cut.

MV-42: Position Error

MV-42 displays the difference between the position command and the current position (MV-41 - MV-40). This is frequently referred to as "follower" error as it indicates how well the servo system can follow the commanded position profile. Positive position errors occur when the actual position is less than (or lags) the position command; negative position errors occur when the actual position is greater than (or leads) the position command.

MV-43: Speed

MV-43 displays the current speed. The engineering units and resolution for this variable are the same as the Move Speed parameter for the active profile (CP-2, CP-9, CP-16 or CP-23), or the Jog Speed (CP-37) if in Jog Mode.

MV-44: Speed Command

MV-44 displays the commanded speed from the M-Cut. The engineering units and resolution for this variable are the same as the Cut Speed parameters for the active profile (CP-2, CP-9, CP-16 or CP-23) or the Jog Speed (CP-37) if the M-Cut is in Jog Mode.

MV-45: Index Position

MV-45 displays the last position of the Registration Index or Home Index. The engineering units and resolution for this variable are the same as the Cut Length parameter for the active profile (CP-1, CP-8, CP-15 or CP-22).

MV-46: Feedback Frequency

MV-46 displays the Feedback Frequency from the feedback encoder. The unit for this variable is hertz (lines/second).

MV-47: DAC Output

MV-47 displays the command level to the output DAC (Digital to Analog Converter) in units of DAC bits. A value of 4095 equals a 100% positive command, 2048 equals 50% output, -4095 equals a 100% negative command, etc.

MV-48: Trim Output

The Trim Output is the calculated output of the compensation/ control algorithm. It is equivalent to the total output (MV-47) minus the feedforward term. The Trim Output is represented in DAC bits where 4095 equals 100% output, 2048 equals 50% output, etc.

MV-49: Batch Count

MV-49 displays the number of batch counts (completed moves) that have occurred in the cycle for the active profile. When the actual Batch Count reaches the entered Batch Count for the active profile, the Batch Done output and LED are activated and Cycle Mode is terminated.

MV-50: Keypad Errors

MV-50 displays errors that occur when entering new values. The display is decoded as follows:

0	- No errors
1	- Invalid parameter code
10	- Value above maximum allowable value
100	- Value below minimum allowable value
1000	- Keypad lockout enabled
10000	- Entry timeout or lockout during Cycle Mode
100000	- Combinational check error/data error

MV-51: Active Profile

MV-51 displays the active profile, 1-4. This is the last profile initiated by the Move input; i.e., the profile currently in motion, just interrupted or just completed. It is not necessarily the next profile to be executed.

MV-52: Alarm Status

MV-52 displays the current M-Cut alarm status. It is decoded as follows:

0 - No Errors
1 - Position Alarm (Position error exceeds CP-39 value)
10 - Velocity Error (Speed exceeds CP-38 value)

MV-53: Control State

MV-53 displays the current M-Cut control state. It is decoded as follows:

000000 - F-Stop or Power-Up State (drive disabled)
000001 - Position Hold (zero velocity with drive enabled)
000010 - Halt State
000100 - Home Return
001000 - Home-To-Index
010000 - Jog
100010 - Profile Move
100100 - Resume Move

MV-54: Discrete In A

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

```
X X X X X X
| | | | | |
| | | | | Keypad Lockout
| | | | Batch Reset
| | | Back Step
| | Home Return
| Home-to-Index
Home Set
```

MV-55: Discrete In B

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

```
X X X X X X
| | | | | |
| | | | | Profile Select A
| | | | Profile Select B
| | | Registration Index
| | Home Index
| Resume Move
Move
```

MV-56: Discrete In C

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

```
X X X X
| | | |
| | | Halt
| | F-Stop
| Jog
Forward/Reverse
```

MV-57: Discrete Out - Group A

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

```
X X X X X X
| | | | | |
| | | | | Drive Enable
| | | | Batch Done
| | | Alarm
| | At-Home
| In-Position A
In-Position B
```

MV-58: Discrete Out - Group B

MV-58 indicates the status of the In-Position C output. A "0" indicates an active output (energized or low).

SERIAL COMMUNICATIONS 6

INTRODUCTION

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

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

The Control Command Send message is used to provide computer control of M-Cut Operations - e.g., cycle, halt etc.

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

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

Data Inquiry - Host Transmission
Data Inquiry - M-Cut Response

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

M-CUT SERIAL COMMUNICATIONS SETUP

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

70 - DEVICE ADDRESSES

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

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

71 - BAUD RATE

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

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

72 - CHARACTER FORMAT

The M-Cut 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 relinquish control of some of the discrete switch inputs to the host computer via the serial communications link:

1 = FWD/REV
2 = Profile Select
3 = FWD/REV and Profile Select

To delegate control of the selected function to the computer, simply add the associated function number to the total. For example, a value of 3 for code 73 would mean the computer has control of the FWD/REV and the Profile Select functions.

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

SUMMARY: M-CUT SERIAL COMMUNICATIONS PROTOCOL

Table 6-1 summarizes the character structure for the M-Cut serial communications protocol.

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

Table 6-1: Receive Queue Format

PARAMETER SEND-HOST TRANSMISSION

CHARACTER 1: STX

The leading STX character must be received by the M-Cut 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-Cut that is to be accessed. This number differentiates the individual M-Cut 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-Cut). The only exception is device address 00, which is universally accepted by all the M-Cuts 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 and decimal point location sent in characters 7 through 14. An ASCII 0 indicates the data is positive, while an ASCII 6 indicates the data is negative.

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

Note that parameters with fixed decimal points (CP-3, CP-4, CP-10, CP-11, CP-17, CP-18, CP-24, CP-25 and CP-64) should always have the data format set to 0.

CHARACTER 16: ETX

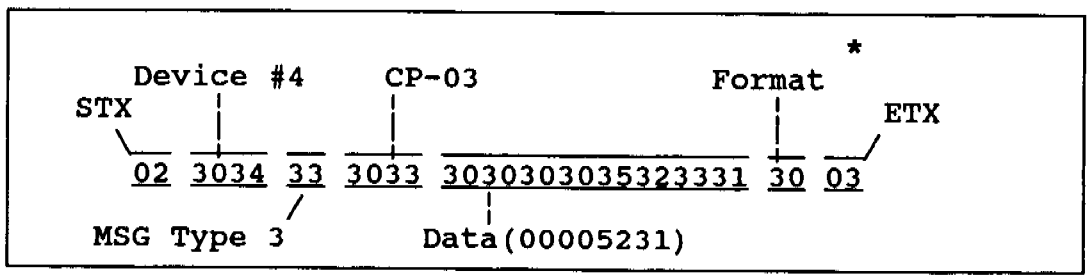
The message or record must always be terminated by the ASCII ETX character.

EXAMPLE:

A new Profile 1 acceleration time of 52.31 seconds is sent to the M-Cut with device address 4:

ASCII Representation: STX 0 4 3 0 3 0 0 0 0 5 2 3 1 0 ETX

HEX Representation:



NOTE: Spaces are visual clarity only.

* Data format is sent as an ASCII 0 because of fixed decimal location. Refer to Character 15 discussion above.

PARAMETER SEND - M-CUT 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-Cut. 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) / Combination Check Error
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-Cut 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
@	Ø	1000000
A	Ø	1000001
B	Ø	1000010
C	Ø	1000011
D	Ø	1000100
E	Ø	1000101
F	Ø	1000110
G	Ø	1000111
H	Ø	1001000
I	Ø	1001001
J	Ø	1001010
K	Ø	1001011
L	Ø	1001100
M	Ø	1001101
N	Ø	1001110
O	Ø	1001111
P	Ø	1010000
Q	Ø	1010001
R	Ø	1010010
S	Ø	1010011
T	Ø	1010100
U	Ø	1010101
V	Ø	1010110
W	Ø	1010111
X	Ø	1011000
Y	Ø	1011001
Z	Ø	1011010
[	Ø	1011011
\	Ø	1011100
]	Ø	1011101
^	Ø	1011110
-	Ø	1011111

ASCII	BINARY Bit 7	Bit Ø
`	Ø	1100000
a	Ø	1100001
b	Ø	1100010
c	Ø	1100011
d	Ø	1100100
e	Ø	1100101
f	Ø	1100110
g	Ø	1100111
h	Ø	1101000
i	Ø	1101001
j	Ø	1101010
k	Ø	1101011
l	Ø	1101100
m	Ø	1101101
n	Ø	1101110
o	Ø	1101111
p	Ø	1110000
q	Ø	1110001
r	Ø	1110010
s	Ø	1110011
t	Ø	1110100
u	Ø	1110101
v	Ø	1110110
w	Ø	1110111
x	Ø	1111000
y	Ø	1111001
z	Ø	1111010
{	Ø	1111011
¦	Ø	1111100
}	Ø	1111101
~	Ø	1111110
DEL	Ø	1111111

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-Cut.

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-Cut.

CHARACTER 15: DATA FORMAT

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

CHARACTER 16: ETX

The message should terminate with the ASCII ETX character.

DATA INQUIRY - M-CUT 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	+ XXXXX.
1	+ XXXX.X
2	+ XXX.XX
3	+ XX.XXX
4	+ X.XXXX
5	+ .XXXXX
6	- XXXXX.
7	- XXXX.X
8	- XXX.XX
9	- XX.XXX
:	- X.XXXX
;	- .XXXXX

CHARACTER 16: ETX

The message always terminates with the ASCII ETX character.

DATA EXPLANATION

Most data returned by the M-Cut in response to a Data Inquiry command can be easily interpreted via the Data and Data Format fields. However, a few variables return an eight bit coded response which must be decoded to allow interpretation. In general this number is between "0" and "63" decimal and is received as a six character ASCII representation of the decimal number. As an example, the bit structured value 00011011 binary = 27 decimal, and would be received as 0 0 0 0 2 7 ASCII or 30 30 30 30 32 37 HEX. This data structure applies to the MV-52 through MV-58 variables.

To interpret an eight bit coded number, first convert it to binary using Table 6-2 on Page 6-11. Then refer to the appropriate Figure below to identify the M-Cut information.

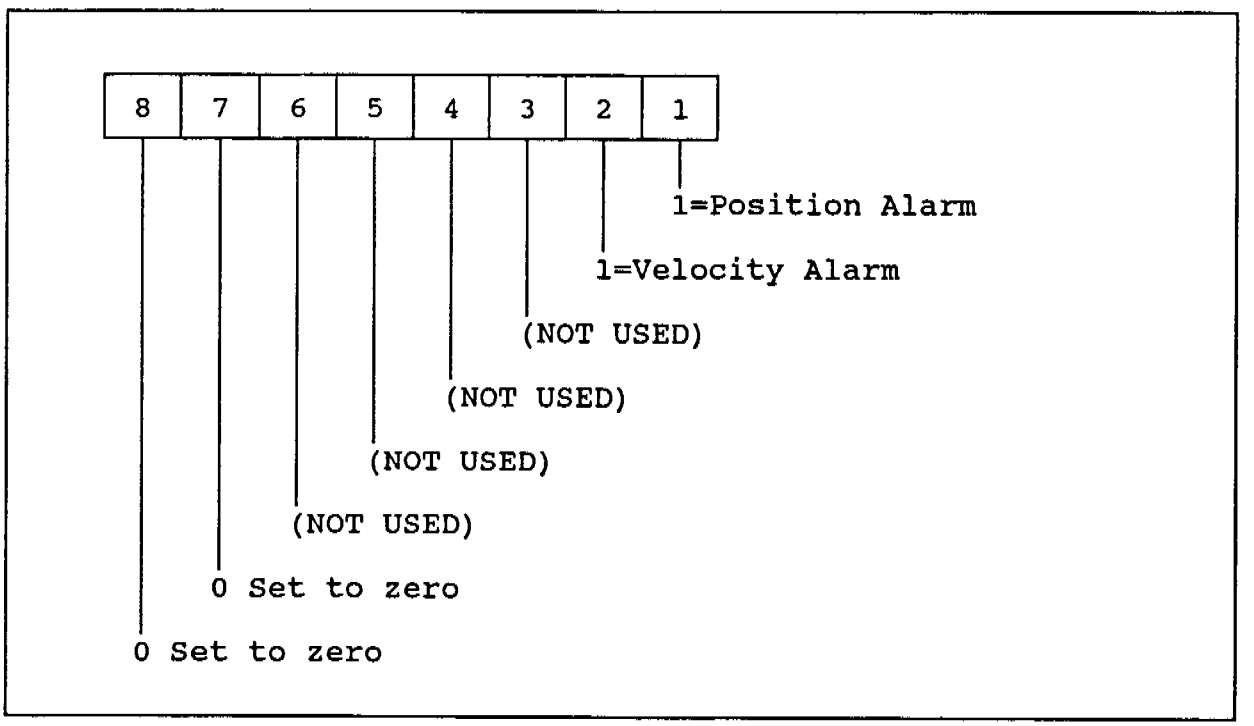
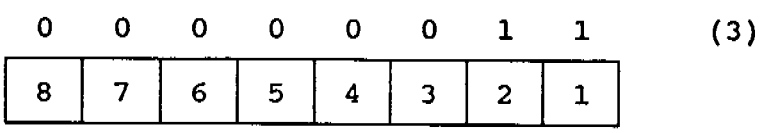


Figure 6-1: MV-52 Interpretation

As above, assume that 3 is returned by the M-Cut in response to MV-52 Data Inquiry Command. Using Table 6-3, the number 3 converts to 00000011:



Using Figure 6-1 above, 3 can now be interpreted to indicate the following Alarm Status: Position Alarm and Velocity Alarm.

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

Table 6-3: Decimal to Binary Conversion

Unlike the other variables, the binary code for MV-53 uses multiple set bits to indicate the control status. It is decoded as follows:

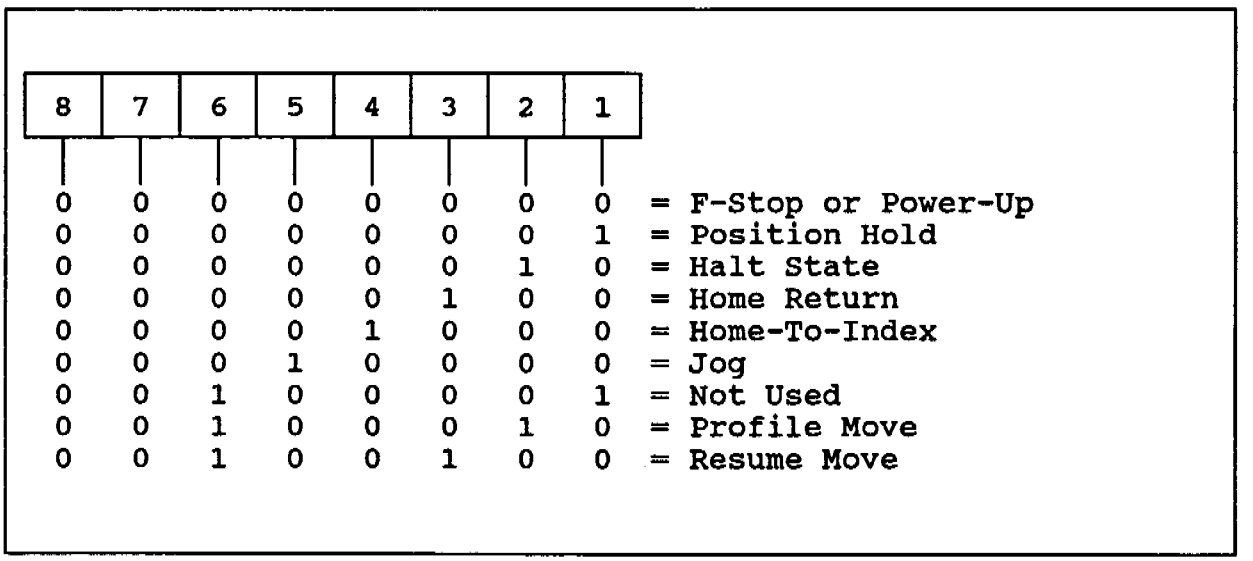


Figure 6-2: MV-53 Interpretation

The following figures provide the interpretations for the other eight bit coded variables. The technique to interpret these variables is identical to the MV-52 example demonstrated on Page 6-10.

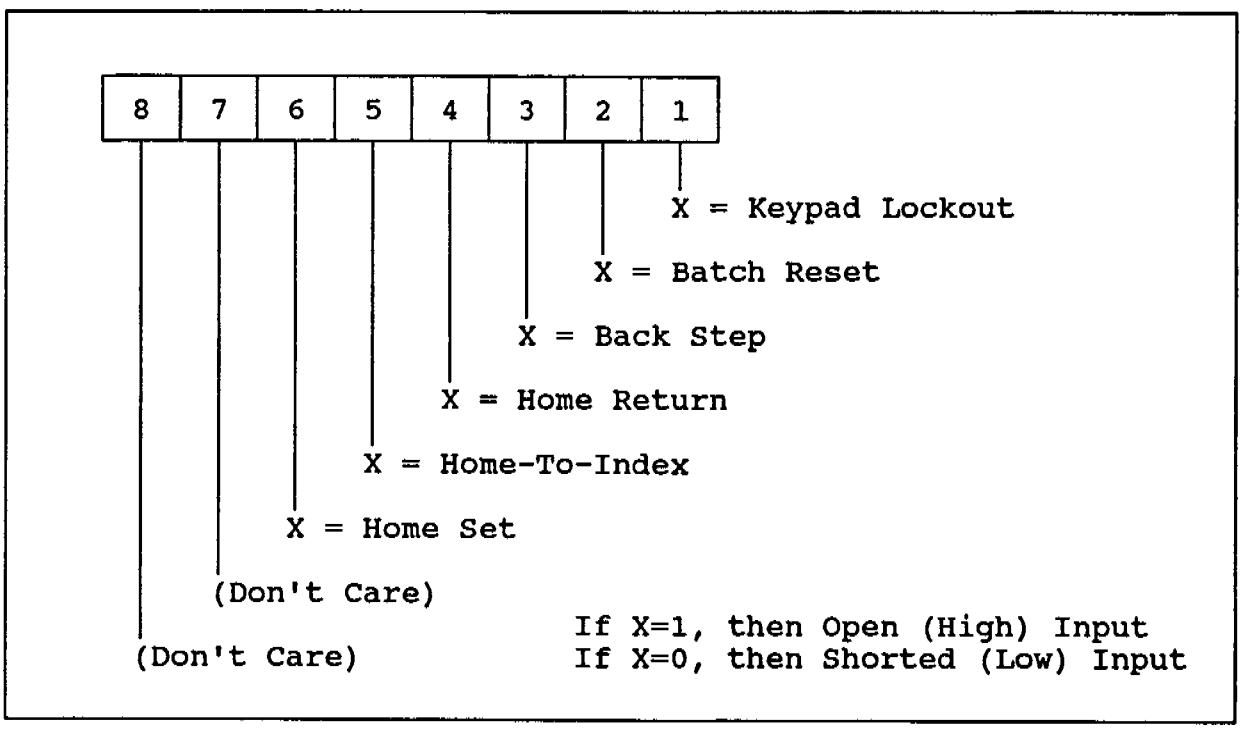


Figure 6-3: MV-54 Interpretation

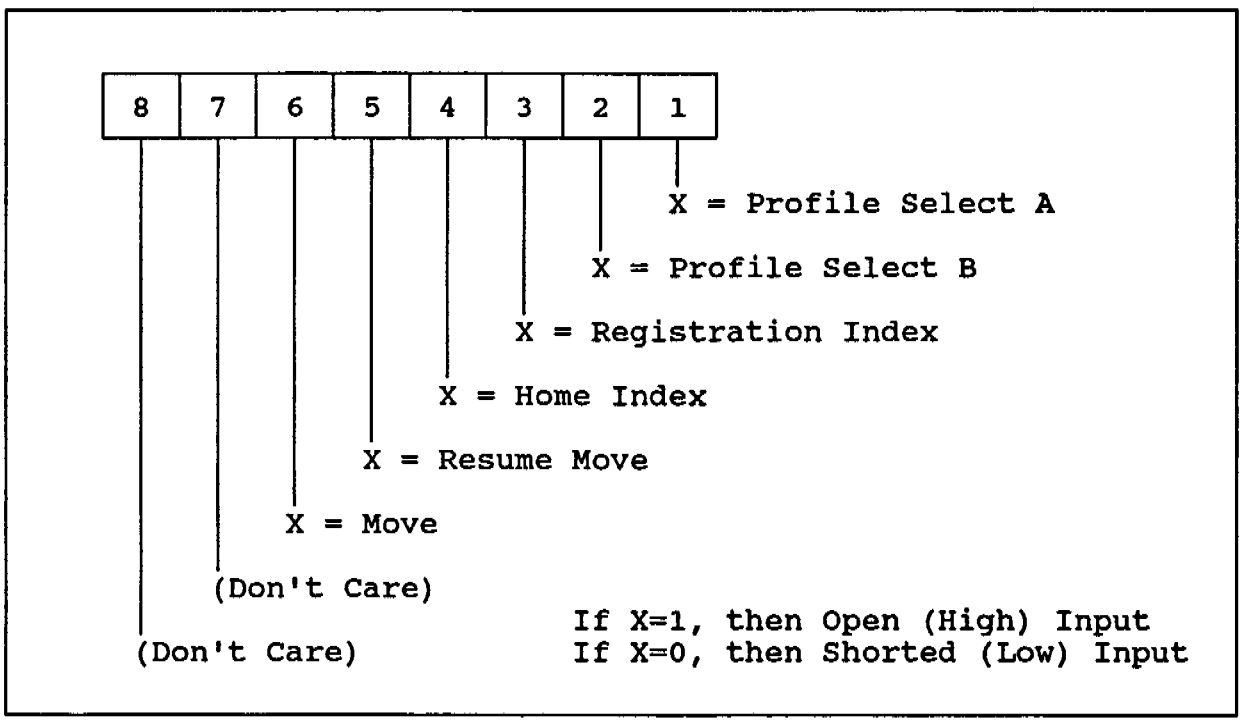


Figure 6-4: MV-55 Interpretation

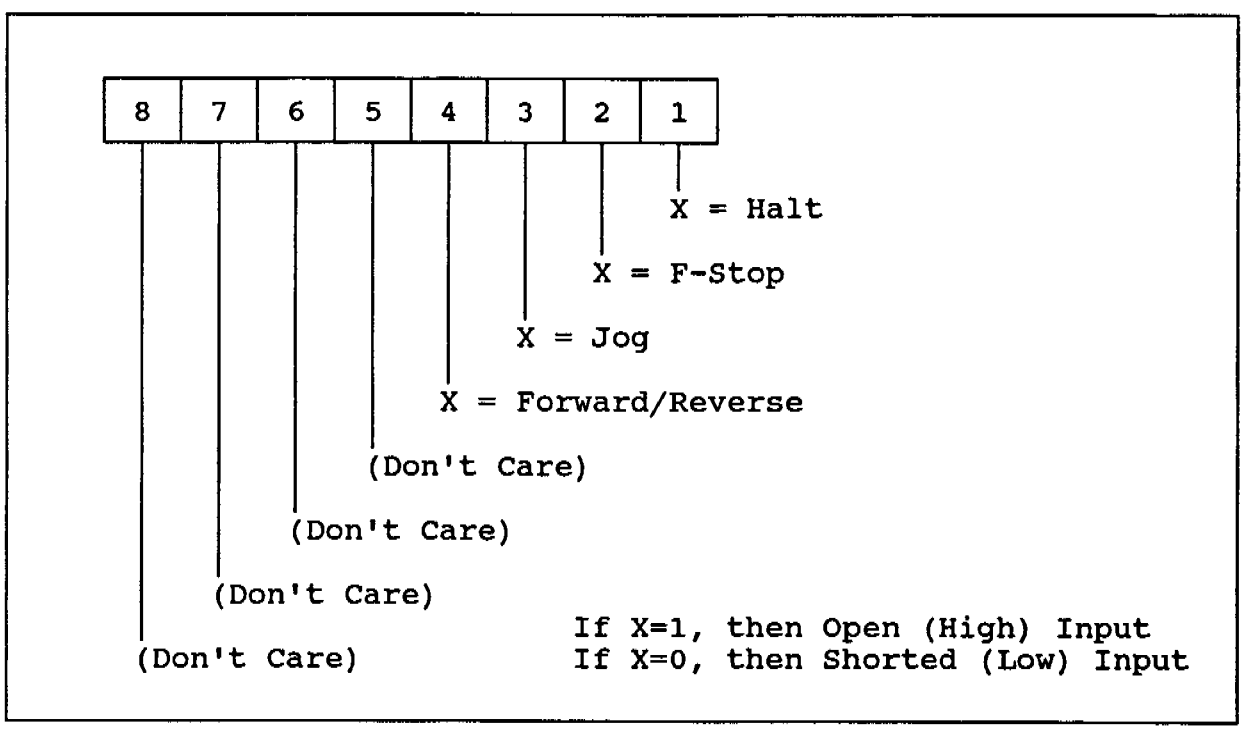


Figure 6-5: MV-56 Interpretation

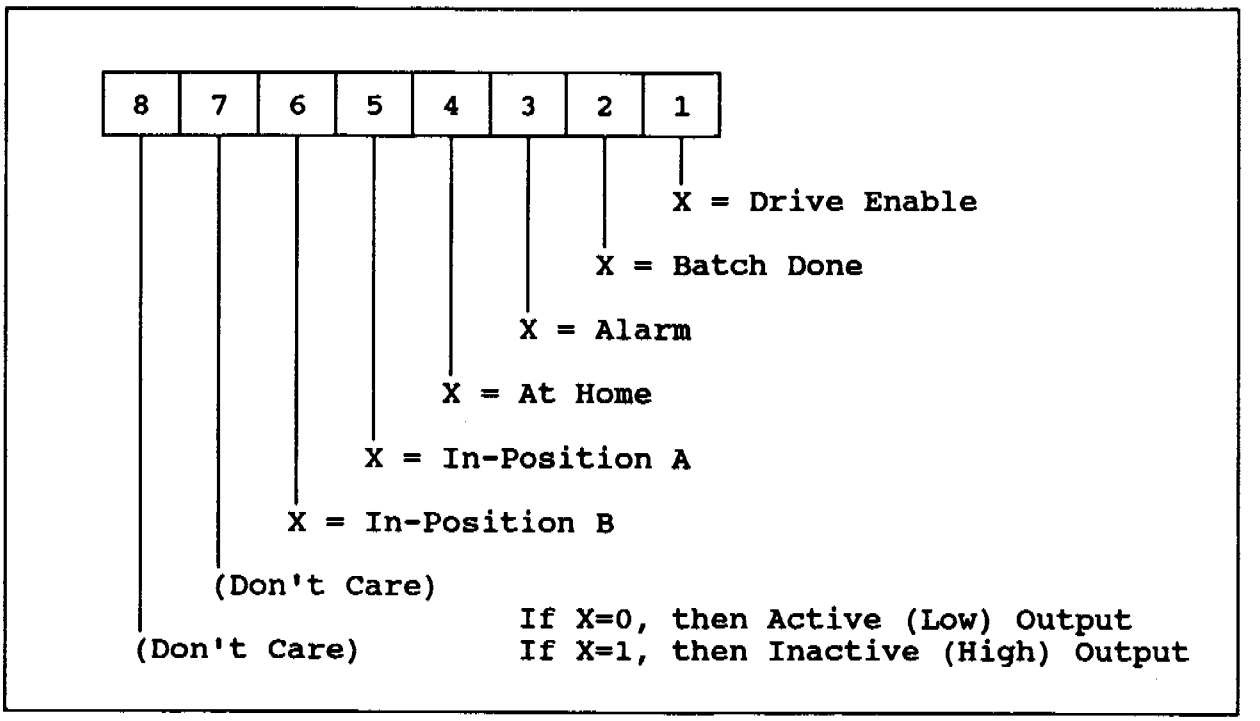


Figure 6-6: MV-57 Interpretation

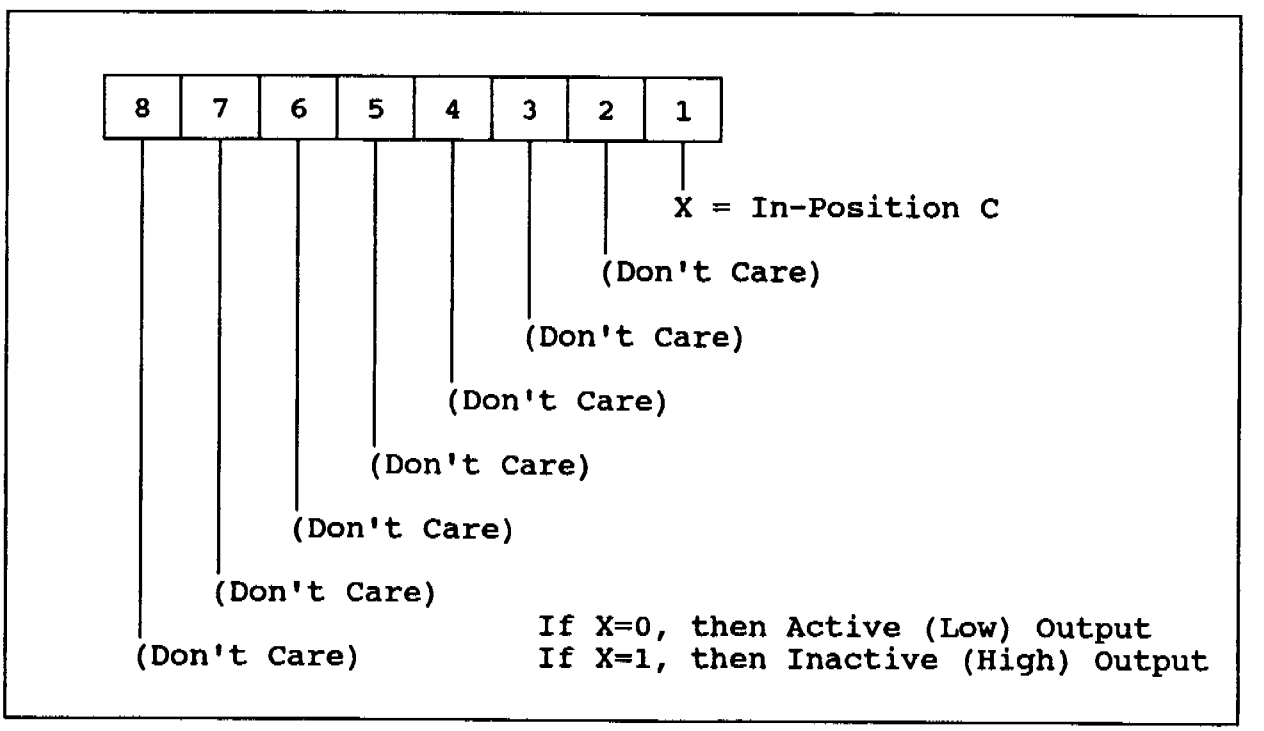


Figure 6-7: MV-58 Interpretation

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.

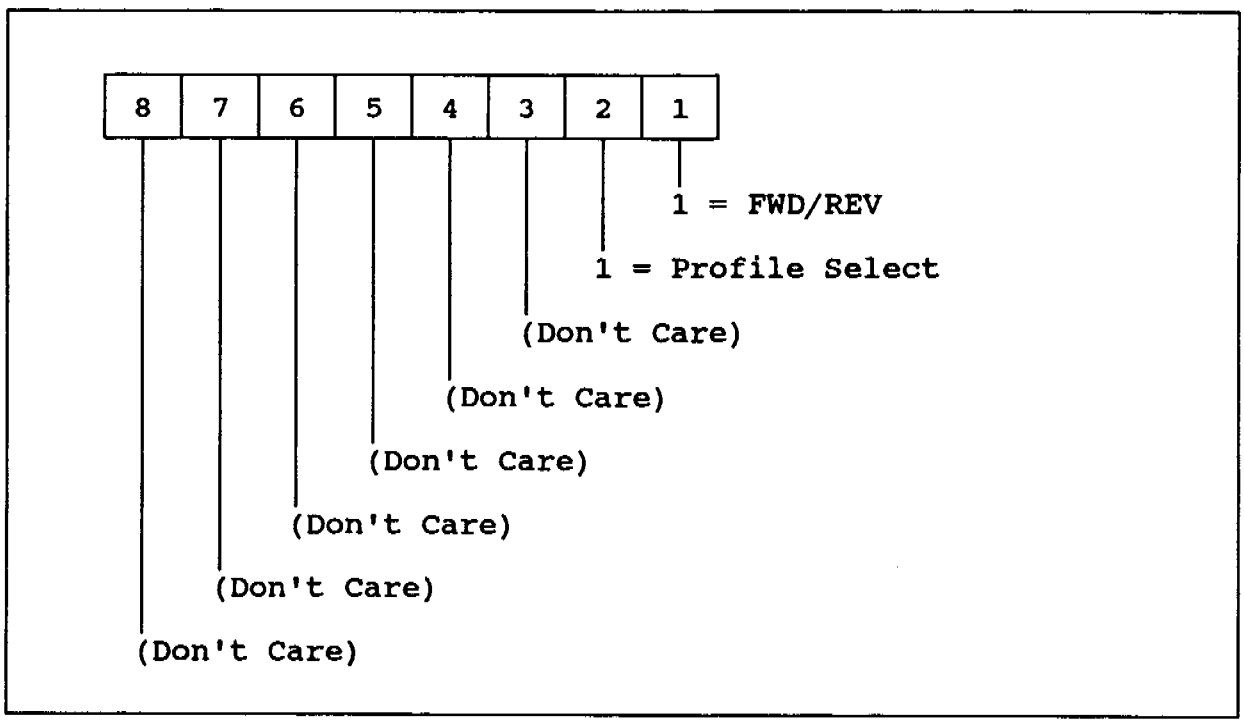


Figure 6-8: CP-73 Interpretation

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-Cut device address.

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 control command is used (Characters 2 and 3 set to 00), 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 - Stop
02 - Halt
03 - Batch Reset
04 - Resume Move
05 - Move
06 - Home Return
07 - Back Step
08 - Home-To-Index
09 - Home Set
10 - Jog Start
11 - Jog Stop
12 - Forward Select
13 - Reverse Select
14 - Profile 1 Select
15 - Profile 2 Select
16 - Profile 3 Select
17 - Profile 4 Select

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-CUT RESPONSE

CHARACTER 1: STX

The message always begins with the ASCII STX character.

CHARACTERS 2 & 3: DEVICE NUMBER

The device address of the M-Cut.

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-Cut.

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 Cut problems, and is divided into the following sections:

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

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

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

DIAGNOSTICS

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

CLEAR/4 POWER UP TESTS

Initiate Test

1. Remove power from the M-Cut.
2. While simultaneously pressing "CLEAR" and "4" on the Operator Keypad, apply power to the M-Cut.
   Response: "HELP 1" is shown in the upper display.
3. Press the POSITION (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-Cut 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-Cut 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-Cut 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-Cut upper display.
2. Press ENTER to start test.
3. M-Cut 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-Cut upper display.
2. Press ENTER to start test.
   The following LEDs are illuminated in order: Code Select, Status, Position, Cut Length, Batch Count, Cycle, At-Home, In-Position, Batch Done, Alarm

6. KEYPAD TEST

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

Press	Display	Press	Display	Press	Display
-	-	4	4	CUT LENGTH	10
.	.	5	5	POSITION	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-Cut upper display.
2. Press ENTER to start test.
3. Close input switches. The M-Cut displays a number according to the input pressed.

Input Closure		Display	Input Closure		Display
REG. INDEX	(J3-10)	10	BACK STEP	(J4-6)	02
HOME INDEX	(J3-12)	11	HOME RETURN	(J4-8)	03
RESUME MOVE	(J3-13)	12	HOME-TO-INDEX	(J4-9)	04
MOVE	(J3-15)	13	HOME SET	(J4-11)	05
HALT	(J3-16)	14	PROFILE SEL A	(J4-12)	06
F-STOP	(J4-2)	15	PROFILE SEL B	(J4-14)	07
JOG	(J4-3)	16	BATCH RESET	(J4-15)	01
FWD/REV	(J4-5)	17	KEYPAD LOCKOUT	(J4-17)	00

4. Press CLEAR to exit test.

8. DISCRETE OUTPUT TEST

1. Display "HELP 8" in the M-Cut 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	IN-POSITION A
2	BATCH DONE	6	IN-POSITION B
3	ALARM	7	IN-POSITION C
4	AT-HOME		

4. Press CLEAR to exit test.

9. SPEED COMMAND OUTPUT TEST

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

VERIFYING M-CUT QUAD INPUTS

1. Quad Input Test

1. Connect Quad frequency into Feedback Channel A and Channel B
2. Verify input by checking the MV-46 Monitor Variable (Feedback Frequency)

NOISE RECOVERY

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

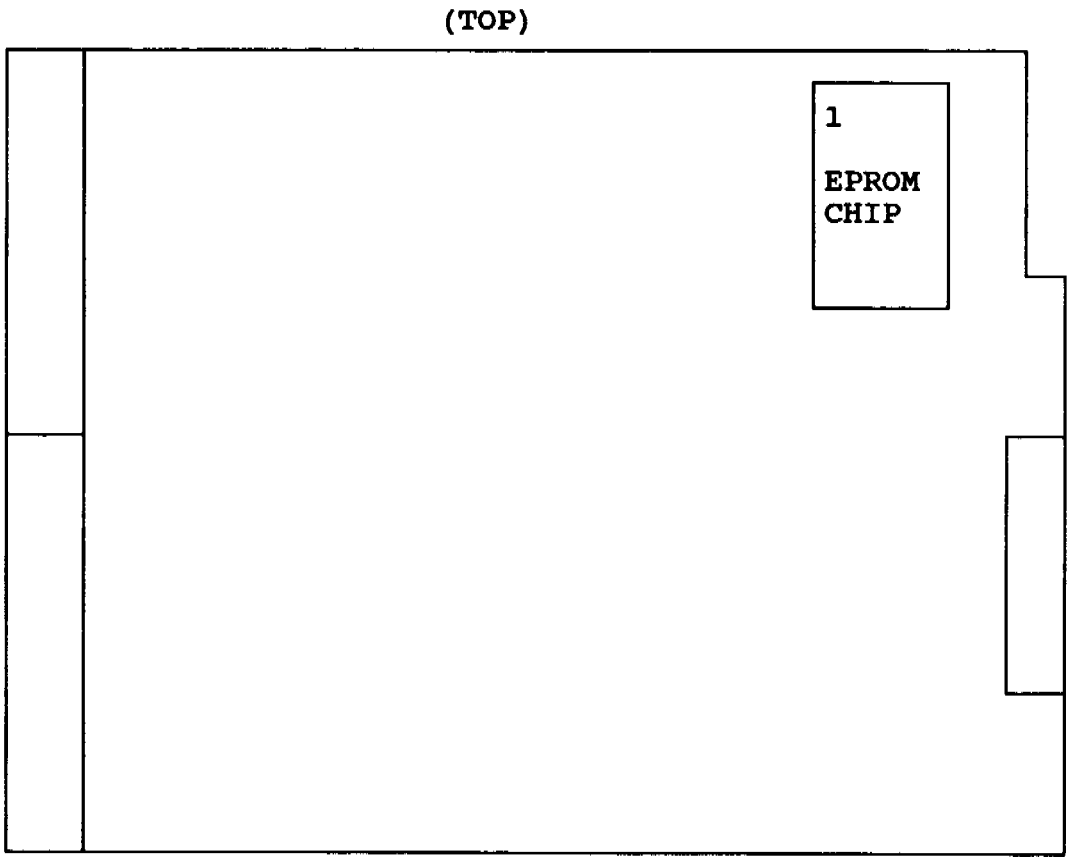


Figure 7-1: EPROM Location

7

RESTORE SETTINGS

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

1. Remove power from the M-Cut.

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

NOTES

APPENDIX A - FEEDBACK SENSORS A

INTRODUCTION

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

QUADRATURE RING KIT

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

NEMA C-FACE RING MOUNT

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

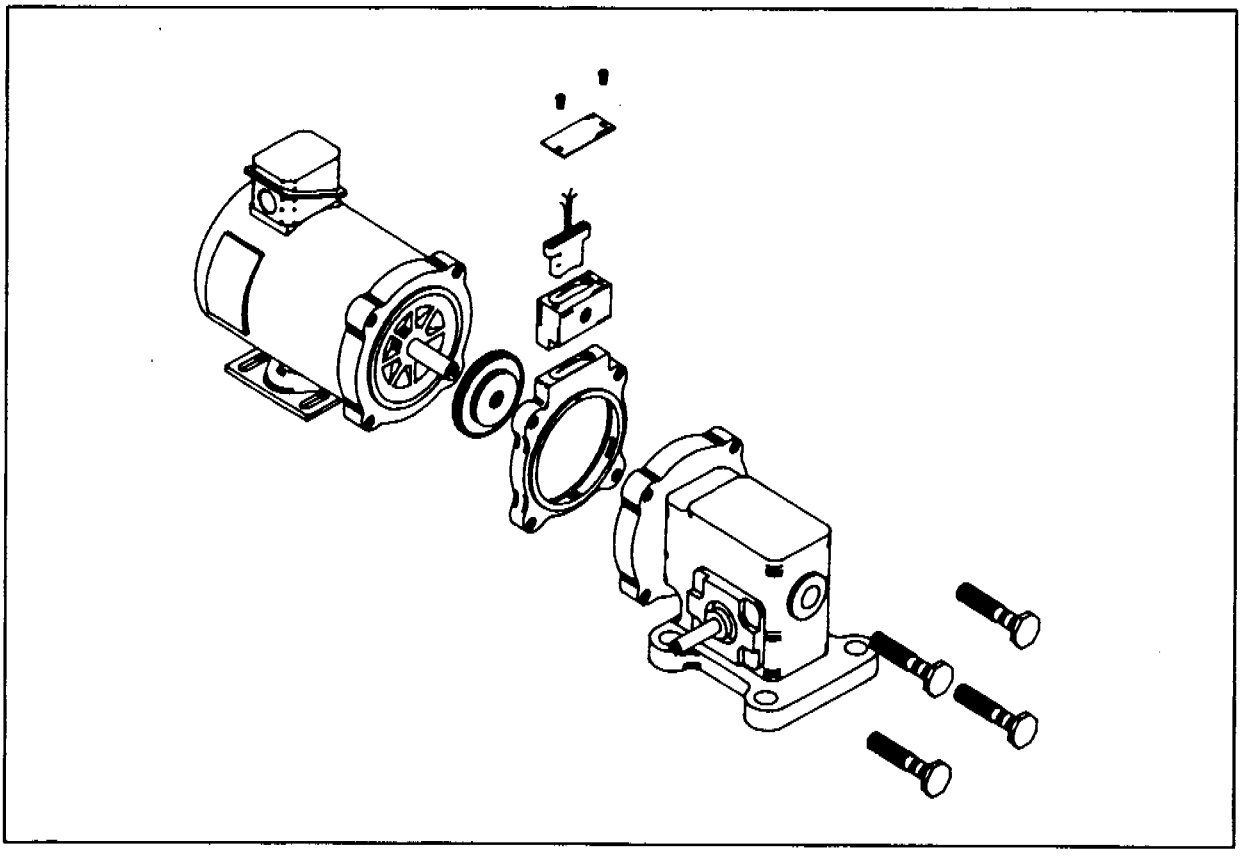


Figure A-1: Hall Effect Ring Kit

QUADRATURE ENCODERS

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

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

SPECIFICATIONS

ELECTRICAL

Code: Incremental
Cycles per Shaft Turn: 600

Output:
3904: current sinking up to 40 mA

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

Supply Voltage:
3904: 5Vdc

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

MECHANICAL

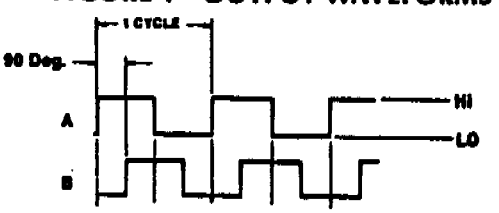
Shaft Diameter: 3/8"
Hollow shaft

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

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

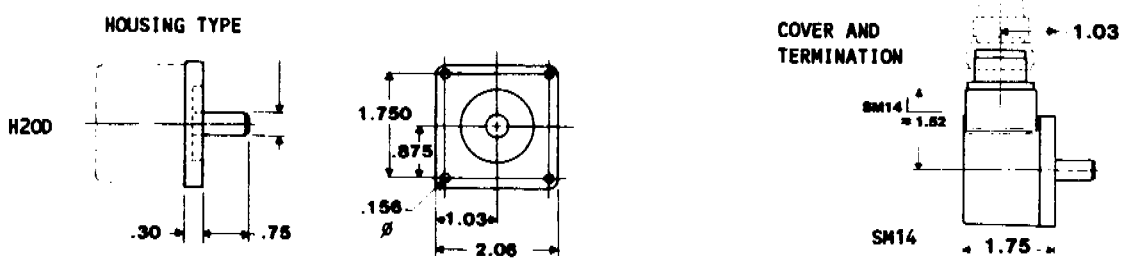
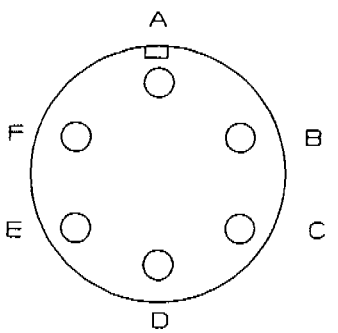


Figure A-2: 3200-1341 Quadrature Encoder: Specifications and Dimensions

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-CUT FEEDBACK

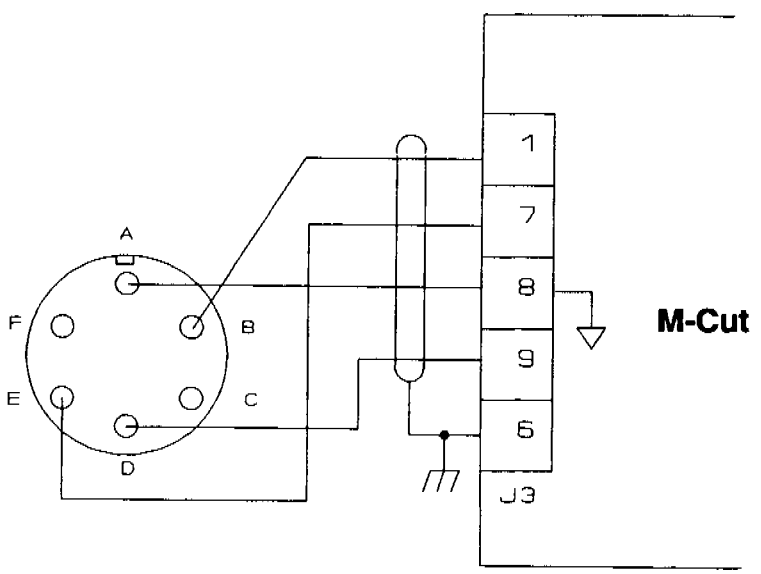


Figure A-3: 3200-1341 Quadrature Encoder Connections

NOTES

APPENDIX B - FORMULAS B

INTRODUCTION

This appendix contains three formulas used to calculate M-Cut control functions. Both verbal and coded descriptions are provided for each formula.

CUT LENGTH

$$\text{Cut Length in lines} = \frac{\text{Edges}}{\text{Engineering Unit (Scale Factor)}} * \frac{\text{1 Line}}{\text{4 Edges}} * \text{Engineering Unit (Setpoint)}$$

$$= CP\text{-}30 * \frac{1}{4} * CP\text{-}1$$

POSITION

$$\text{Position} = \text{Encoder Lines} * \frac{\text{4 Edges}}{\text{1 Line}} * \frac{\text{Engineering Unit}}{\text{Edges}}$$

$$MV\text{-}40 = \text{Encoder Lines} * \frac{4}{1} * \frac{1}{CP\text{-}30}$$

MOTOR RPM

$$\text{RPM Motor} = \text{Feedback Frequency} * 60 * \frac{1}{\text{PPR (Motor)}}$$

$$= MV\text{-}46 * 60 * \frac{1}{CP\text{-}62}$$

where CP-62 = PPR (Encoder) / Gear Reduction (Motor-To-Encoder)

NOTES

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-Cut. 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-Cut 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: CUT LENGTH 1

Cut Length 1 is the end product cut length for the first profile entered in engineering units. The decimal point resolution can be entered to the thousands (XXX.XXX). This Cut Length is selected when the Profile Select A and Profile Select B discrete inputs are both open circuits (logic high).

CP-2: MOVE SPEED 1

Move Speed 1 is the maximum allowable move speed for the first profile entered in engineering units per time. The time units, seconds or minutes, is selected using CP-31. The decimal point resolution can be entered to the thousands (XXX.XXX). This Move Speed is selected when the Profile Select A and Profile Select B discrete inputs are both open circuits.

CP-3: ACCEL TIME 1

Accel Time 1 is the first profile's acceleration time from zero speed to Cut Speed 1 (CP-2). The resolution for the acceleration time is fixed to the hundreds (XX.XX). The time unit is seconds. This Accel Time is selected when the Profile Select A and Profile Select B discrete inputs are both open circuits.

CP-4: DECEL TIME 1

Decel Time 1 is the first profile's deceleration time from Cut Speed 1 (CP-2) down to zero speed. The resolution for the deceleration time is fixed to the hundreds (XX.XX). The time unit is seconds. This Decel Time is selected when the Profile Select A and Profile Select B discrete inputs are both open circuits.

CP-5: BATCH COUNT 1

The profile moves can be repeated until the batch count is reached. Batch Count 1 sets the number of product moves for Profile 1. This Batch Count is selected when the Profile Select A and Profile Select B discrete inputs are both open circuits. A Batch Count entry of "0" allows for infinite batching.

CP-6: REGISTRATION LENGTH 1

The M-Cut has the ability to adjust the final cut length according to the placement of a registration index mark on the product. Enter the desired length from the registration index mark to the final cut in engineering units. The resolution for this parameter can be entered to the thousands (XXX.XXX). Registration Length 1 is selected when the Profile Select A and Profile Select B discrete inputs are both open circuits.

CP-7: DIRECTION 1

CP-7 defines the first profile: "1" = Relative Forward; "2" = Relative Reverse; "3" = Absolute Forward; and "4" = Absolute Reverse. Refer to Page 5-8 for further details.

CP-8: CUT LENGTH 2

Cut Length 2 is the end product cut length for the second profile entered in engineering units. The decimal point resolution can be entered to the thousands (XXX.XXX). This Cut Length is selected when the Profile Select A discrete input is shorted to common (logic low) and the Profile Select B discrete input is an open circuit (logic high).

CP-9: MOVE SPEED 2

Move Speed 2 is the maximum allowable move speed for the second profile entered in engineering units per time. The time units, seconds or minutes, is selected using CP-31. The decimal point resolution can be entered to the thousands (XXX.XXX). This Move Speed is selected when the Profile Select A discrete input is shorted to common (logic low) and the Profile Select B discrete input is an open circuit (logic high).

CP-10: ACCEL TIME 2

Accel Time 2 is the second profile's acceleration time from zero speed to Cut Speed 2 (CP-9). The resolution for the acceleration time is fixed to the hundreds (XX.XX). The time unit is seconds. This Accel Time is selected when the Profile Select A discrete input is shorted to common (logic low) and the Profile Select B discrete input is an open circuit (logic high).

CP-11: DECEL TIME 2

Decel Time 2 is the second profile's deceleration time from Cut Speed 2 (CP-9) down to zero speed. The resolution for the deceleration time is fixed to the hundreds (XX.XX). The time unit is seconds. This Decel Time is selected when the Profile Select A discrete input is shorted to common (logic low) and the Profile Select B discrete input is an open circuit (logic high).

CP-12: BATCH COUNT 2

The profile moves can be repeated until the batch count is reached. Batch Count 2 sets the number of product moves for Profile 2. This Batch Count is selected when the Profile Select A discrete input is shorted to common (logic low) and the Profile Select B discrete input is an open circuit (logic high). A Batch Count of "0" allows for infinite batching.

CP-13: REGISTRATION LENGTH 2

The M-Cut has the ability to adjust the final cut length according to the placement of a registration index mark on the product. Enter the desired length from the registration index mark to the final cut in engineering units. The resolution for this parameter can be entered to the thousands (XXX.XXX). Registration Length 2 is selected when the Profile Select A discrete input is shorted to common (logic low) and the Profile Select B discrete input is an open circuit (logic high).

CP-14: DIRECTION 2

CP-14 defines the second profile: "1" = Relative Forward; "2" = Relative Reverse; "3" = Absolute Forward; and "4" = Absolute Reverse. Refer to Page 5-8 for further details.

CP-15: CUT LENGTH 3

Cut Length 3 is the end product cut length for the third profile entered in engineering units. The decimal point resolution can be entered to the thousands (XXX.XXX). This Cut Length is selected when the Profile Select A discrete input is an open circuit (logic high) and the Profile Select B discrete input is shorted to common (logic low).

CP-16: MOVE SPEED 3

Move Speed 3 is the maximum allowable move speed for the third profile entered in engineering units per time. The time units, seconds or minutes, is selected using CP-31. The decimal point resolution can be entered to the thousands (XXX.XXX). This Move Speed is selected when the Profile Select A discrete input is an open circuit (logic high) and the Profile Select B discrete input is shorted to common (logic low).

CP-17: ACCEL TIME 3

Accel Time 3 is the third profile's acceleration time from zero speed to Cut Speed 3 (CP-16). The resolution for the acceleration time is fixed to the hundreds (XX.XX). The time unit is seconds. This Accel Time is selected when the Profile Select A discrete input is an open circuit (logic high) and the Profile Select B discrete input is shorted to common (logic low).

CP-18: DECEL TIME 3

Decel Time 3 is the third profile's deceleration time from Cut Speed 3 (CP-16) down to zero speed. The resolution for the deceleration time is fixed to the hundreds (XX.XX). The time unit is seconds. This Decel Time is selected when the Profile Select A discrete input is an open circuit (logic high) and the Profile Select B discrete input is shorted to common (logic low).

CP-19: BATCH COUNT 3

The profile moves can be repeated until the batch count is reached. Batch Count 3 sets the number of product moves for Profile 3. This Batch Count is selected when the Profile Select A discrete input is an open circuit (logic high) and the Profile Select B discrete input is shorted to common (logic low). A Batch Count of "0" allows for infinite batching.

CP-20: REGISTRATION LENGTH 3

The M-Cut has the ability to adjust the final cut length according to the placement of a registration index mark on the product. Enter the desired length from the registration index mark to the final cut in engineering units. The resolution for this parameter can be entered to the thousands (XXX.XXX). Registration Length 3 is selected when the Profile Select A discrete input is an open circuit (logic high) and the Profile Select B discrete input is shorted to common (logic low).

CP-21: DIRECTION 3

CP-21 defines the third profile: "1" = Relative Forward; "2" = Relative Reverse; "3" = Absolute Forward; and "4" = Absolute Reverse. Refer to Page 5-8 for further details.

CP-22: CUT LENGTH 4

Cut Length 4 is the end product cut length for the forth profile entered in engineering units. The decimal point resolution can be entered to the thousands (XXX.XXX). This Cut Length is selected when the Profile Select A and Profile Select B discrete inputs are both shorted to common (logic low).

CP-23: MOVE SPEED 4

Move Speed 4 is the maximum allowable move speed for the forth profile entered in engineering units per time. The time units, seconds or minutes, is selected using CP-31. The decimal point resolution can be entered to the thousands (XXX.XXX). This Move Speed is selected when the Profile Select A and Profile Select B discrete inputs are both shorted to common (logic low).

CP-24: ACCEL TIME 4

Accel Time 4 is the forth profile's acceleration time from zero speed to Cut Speed 4 (CP-23). The resolution for the acceleration time is fixed to the hundreds (XX.XX). The time unit is seconds. This Accel Time is selected when the Profile Select A and Profile Select B discrete inputs are both shorted to common (logic low).

CP-25: DECEL TIME 4

Decel Time 4 is the forth profile's deceleration time from Cut Speed 4 (CP-23) down to zero speed. The resolution for the deceleration time is fixed to the hundreds (XX.XX). The time unit is seconds. This Decel Time is selected when the Profile Select A and Profile Select B discrete inputs are both shorted to common (logic low).

CP-26: BATCH COUNT 4

The profile moves can be repeated until the batch count is reached. Batch Count 4 sets the number of product moves for Profile 4. This Batch Count is selected when the Profile Select A and Profile Select B discrete inputs are both shorted to common (logic low). A Batch Count of "0" allows for infinite batching.

CP-27: REGISTRATION LENGTH 4

The M-Cut has the ability to adjust the final cut length according to the placement of a registration index mark on the product. Enter the desired length from the registration index mark to the final cut in engineering units. The resolution for this parameter can be entered to the thousands (XXX.XXX). Registration Length 4 is selected when the Profile Select A and Profile Select B discrete inputs are both shorted to common (logic low).

CP-28: DIRECTION 4

CP-28 defines the fourth profile: "1" = Relative Forward; "2" = Relative Reverse; "3" = Absolute Forward; and "4" = Absolute Reverse. Refer to Page 5-8 for further details.

CP-30: SCALE FACTOR

CP-30 determines how to interpret the engineering unit parameters and variables. It also correlates the magnitude of the engineering unit entries to the number of Feedback Frequency input encoder edges. Enter into CP-30 the number of encoder edges that will occur for a cut length of one engineering unit. For example, if 100 encoder edges occur for every one inch of cut distance and the engineering parameters and variables are to be interpreted in inches, then enter "100" into CP-30. If for the same system the desired engineering units were feet, then enter "1200" into CP-30. The resolution for this parameter can be entered to the thousands (XXX.XXX).

CP-31: TIME UNIT (MIN/SEC)

Several parameters and variables are expressed in engineering units/time (inches/sec, feet/min, etc). Set CP-31 to "1" if the desired time unit is minutes; set CP-31 to "2" if the desired time value is seconds.

CP-32: KERF

The M-Cut can automatically adjust the profiled cut length to compensate for material lost by the blade cut. Enter into CP-32 the length of material lost by the blade cut in engineering units. Resolution is available to the thousands (XXX.XXX).

CP-33: PROFILE SEQUENCE

The M-Cut can automatically sequence through different profiles. To enable this feature, enter the desired profile sequence into CP-33. For example, "312" indicates that the M-Cut will perform the following sequence:

Profile Move 3	(CP-15 through CP-22)
Profile Move 1	(CP-1 through CP-7)
Profile Move 2	(CP-8 through CP-14).

This sequence is repeated until the batch count of the first profile in the sequence has been reached (Profile Move 3 in the above example). Setting CP-33 to "0" disables this sequencing feature.

CP-34: INDEX POLARITY

CP-34 determines which polarity the Registration Index and Home Index discrete inputs initiate their respective functions. If CP-34 is set to a 1, then the respective functions will be initiated when the discrete input goes from a circuit open to a circuit shorted to common (high to low logic transition). If CP-34 is set to a 2, then the respective function will be initiated when the discrete input goes from a shorted to common to an open circuit state (low to high logic transition).

CP-35: BACK-STEP LENGTH

CP-35 back steps the material away from the cut blade after the cut is made and before the blade is returned to its original position. Enter into CP-35 the desired Back Step Length in engineering units to a resolution of thousands (XXX.XXX). The back step function is initiated upon the shorting to common (high to low logic transition) of the Back Step discrete input. This function can only be initiated from an in-position or at-home status.

CP-36: HOME OFFSET

It is not always possible to mount the Home Index sensor where needed for the Home-to-Index function. Using the Home Offset entry, the Home Index sensor can be conveniently located and the desired home position established by adding the CP-36 offset value to the encountered sensor position. Enter into CP-36 the desired Home Offset value in engineering units to the thousands resolution (XXX.XXX).

CP-37: JOG SPEED

CP-37 determines the speed of operation for the Jog Mode and the Home-to-Index operation. Enter the desired speed in terms of engineering units/time. Resolution is available to the thousands (XXX.XXX).

CP-38: HIGH SPEED ALARM

CP-38 determines the velocity level at which the discrete alarm output (J1-15) is activated. Enter in the desired value in terms of engineering units/time. Resolution is available to the thousands place (XXX.XXX). The Alarm output is activated whenever the CP-38 or CP-39 alarm levels are exceeded.

CP-39: POSITION ERROR ALARM

Whenever the actual position deviates from the desired profile position by the value in CP-39 the discrete Alarm output is activated (J1-15). This is frequently referred to as follower error. Enter the desired position error value in terms of engineering units to resolution of thousands (XXX.XXX). The Alarm output is activated whenever the CP-38 or CP-39 alarm levels are exceeded.

MV-40: POSITION

MV-40 indicates the current position as referenced from Home. The engineering units and resolution for this variable are the same as the Cut Length variable for the active profile (CP-1, CP-8, CP-15 or CP-22).

MV-41: POSITION COMMAND

MV-41 indicates the current commanded position from the M-Cut. During a profile move, this commanded position is calculated by the trajectory generator function of the M-Cut.

MV-42: POSITION ERROR

MV-42 displays the difference between the position command and the current position (MV-41 - MV-40). This is frequently referred to as "follower" error as it indicates how well the servo system is able to follow the commanded position profile. Positive position errors occur when the actual position is less than (or lags) the position command; negative position errors occur when the actual position is greater than (or leads) the position command.

MV-43: SPEED

MV-43 indicates the current speed. The engineering units and resolution for this variable are the same as the Move Speed parameter for the active profile (CP-2, CP-9, CP-16 or CP-23) or the Jog Speed if in Jog Mode.

MV-44: SPEED COMMAND

MV-44 indicates the commanded speed from the M-Cut. The engineering units and resolution for this variable are the same as the Move Speed parameters for the active profile (CP-2, CP-9, CP-16 or CP-23) or the Jog Speed if in Jog Mode.

MV-45: INDEX POSITION

Depending on which occurred last, MV-45 displays either the position of the Registration Index or the position traveled from the start of the Home-To-Index function to the Home Index. The engineering units and resolution for this variable are the same as the Cut Length parameter for the active profile (CP-1, CP-8, CP-15 or CP-22).

MV-46: FEEDBACK FREQUENCY

MV-46 displays the Feedback Frequency from the feedback encoder. The unit for this variable is hertz (lines/second).

MV-47: DAC COUNT

MV-47 indicates the command level to the output DAC (Digital to Analog Converter) in units of DAC bits. A value of 4095 indicates a 100% positive command, 2048 equals 50% output, etc.

MV-48: TRIM OUTPUT

The Trim Output is the calculated output of the compensation/ control algorithm. It is equivalent to the total output (MV-47) minus the feedforward. The Trim Output is represented in DAC bits where 4095 equals 100% output, 2048 equals 50% output, etc.

MV-49: BATCH COUNT

MV-49 displays the number of batch counts that have occurred in the cycle for the active profile. When the actual Batch Count reaches the entered Batch Count for the active profile, the Batch Done output is activated and the cycle is terminated.

MV-50: KEYPAD ERRORS

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

```
     0 - No errors
     1 - Invalid parameter code
    10 - Value above maximum allowable value
   100 - Value below minimum allowable value
  1000 - Keypad lockout enabled
 10000 - Entry timeout or lockout during Cycle Mode
100000 - Combinational Check Error
```

MV-51: ACTIVE PROFILE

MV-51 displays the active profile, 1-4. This is the last profile initiated by the Move input; i.e., the profile currently in motion, just interrupted or just completed. It is not necessarily the next profile to be executed.

MV-52: ALARM STATUS

MV-52 displays the current M-Cut alarm status. It is decoded as follows:

```
     0 - No Errors
     1 - Position Alarm    (Position error exceeds CP-39 value)
    10 - Velocity Error    (Speed exceeds CP-38 value)
```

MV-53: CONTROL STATE

MV-53 displays the current M-Cut control state. It is decoded as follows:

```
000000 - F-Stop or Power-Up State (drive disabled)
000001 - Position Hold (zero velocity with drive enabled)
000010 - Halt State
000100 - Home Return
001000 - Home-To-Index
010000 - Jog
100010 - Profile Move
100100 - Resume Move
```

MV-54: DISCRETE IN A

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

```
X X X X X X
| | | | | |
| | | | | Keypad Lockout
| | | | Batch Reset
| | | Back Step
| | Home Return
| Home-to-Index
Home Set
```

MV-55: DISCRETE IN B

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

```
X X X X X X
| | | | | |
| | | | | Profile Select A
| | | | Profile Select B
| | | Registration Index
| | Home Index
| Resume Move
Move
```

MV-56: DISCRETE IN C

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

```
X X X X
| | | |
| | | Halt
| | F-Stop
| Jog
Forward/Reverse
```

MV-57: DISCRETE OUT - GROUP A

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

```
X X X X X X
| | | | | |
| | | | |  Drive Enable
| | | |  Batch Done
| | |  Alarm
| |  At-Home
|  In-Position A
In-Position B
```

MV-58: DISCRETE OUT - GROUP B

MV-58 indicates the status of the In-Position C output. A "0" indicates an active output (energized or low).

MV-59: LINE NOTCH COUNTER

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

CP-60: DIRECT ENABLE

Direct Enable provides an open loop mode of operation intended for calibration and trouble-shooting. Entering "1" into CP-60 enables the direct mode whereby the analog output of the M-Cut is controlled by the Direct Command (CP-61). Entering "2" into CP-60 causes the M-Cut to automatically calculate Kff (CP-64). Note that the direct command value in CP-61 should be large enough to move the motor/encoder faster than 10 RPM. Direct mode is disabled by the entry of zero into CP-60, or a Halt or F-Stop command. Entering "0" into CP-60 immediately outputs "0" at the DAC output, implements an F-Stop and deactivates the drive enable output.

CP-61: DIRECT COMMAND

CP-61 sets the DAC (Digital to Analog Converter) output level when in the direct mode of operation. A value of 4095 is a 100% positive command and a value of -4095 is a 100% negative command.

CP-62: FEEDBACK PPR

Enter into CP-62 the number of pulses of the feedback encoder that occur per one revolution of the motor. This value determines the cutoff point for the stop state (10 RPMs) and also scales the Kp and Ki terms.

CP-63: S-CURVE ENABLE (FINITE JERK)

Entering "1" into CP-63 enables the M-Cut S-Curve or Finite Jerk feature. This feature adds an S shape to the acceleration and deceleration ramps thus reducing mechanical wear caused by sudden changes in velocity. The acceleration and deceleration times are maintained with the S-Curve feature enabled. When the S-Curve is enabled, the peak rate of acceleration and deceleration increases by approximately 1.6 times the linear rate without the S-Curve, and may subsequently require an increase in the drive torque.

CP-64: KFF (FEEDFORWARD CONSTANT)

Kff determines the magnitude of the feedforward term in the compensation algorithm. The feedforward term, unlike the PI terms, is a function of the position command not the position error. It is used to increase the response of the system without affecting system stability. Increasing Kff increases the magnitude of the feedforward term. Kff can be automatically determined via Direct Mode's Kff adjust mode (CP-60 = 2).

CP-65: Kp (PROPORTIONAL CONSTANT)

Kp determines the magnitude of the proportional term in the PI compensation algorithm. Increasing the Kp value increases the magnitude of the proportional term. The Kp value should be increased until the system response is adequate or until the position overshoot becomes unacceptable.

CP-66: Ki (INTEGRAL CONSTANT)

Ki determines the magnitude of the integral term in the PI compensation algorithm. The integral term is activated at the end of the profile to eliminate the final position error. Not all systems may require or desire the use of the integral term. Increasing the Ki value increases the magnitude of the integral term. The Ki value, if employed, should be increased to a point where the position overshoot is no longer acceptable.

CP-68: UNIPOLAR/BIPOLAR

CP-68 determines the operation mode for the M-Cut's drive output. Setting CP-68 to "1" puts the M-Cut in Unipolar mode. See Page 5-26 for a discussion concerning Unipolar Mode restrictions. Set CP-68 to "2" for normal Bipolar output mode (default).

CP-70: DEVICE ADDRESSES

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

CP-71: BAUD RATE

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

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

CP-72: CHARACTER FORMAT

The M-Cut accepts 3 different character formats:

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

CP-73: CONTROL MASK

When the computer control is switch selected, it is possible to allow the computer to control some of the functions associated with the discrete switch inputs:

1 = Fwd/Rev
2 = Profile Select
3 = Fwd/Rev and Profile Select

MV-74: COMMUNICATION ERRORS

MV-74 displays any M-Cut serial communication errors from the host computer. Refer to Page 6-6 for details.

CP-78: AUTOMATIC HOME RESET

When CP-78 is set to "1" (default) the Home Position will automatically reset at the beginning of every new Move. A CP-78 entry of "0" will allow the Home Position to remain at its original position.

CP-79: KEYPAD LOCKOUT MASK

This mask is only in effect when the Keypad Lockout input is active (Low). The value of CP-79 determines which CP's are locked out.

0 = Only Cut Lengths and Batch Counts can be changed
1 = No Code Parameter can be changed (Global Lockout)
2 = CP-30 and above are locked out
3 = Only Cut Lengths, Batch Counts and Move Speeds can be changed.

CP-80: IN-POSITION BAND

CP-80 determines when the M-Cut is considered In-Position at the end of the profile. When the M-Cut enters the in-position band, the timers are initiated for the In-Pos A, In-Pos B and In-Pos C discrete outputs. CP-80 also determines the at-home status.

CP-81: IN-POSITION A DELAY

CP-81 establishes the time delay from when the M-Cut enters the In-Position state (see CP-80), until the In-Position A output is energized. Enter the desired time delay in milliseconds.

CP-82: IN-POSITION A DWELL

CP-82 determines how long the In-Position A output remains energized after the delay time has expired. Enter the desired dwell time in milliseconds. An entry of -1 indicates a continuous energized time period. The In-Position outputs are reset when the next move profile is initiated.

CP-83: IN-POSITION A POLARITY

CP-83 establishes the polarity of the In-Position A output. A value of 1 programs the output to go from a high state during the delay period to a low state during the dwell period. An entry of 2 programs the output to go from a low state during the delay period to a high state during the dwell period. The output is typically wired to energize an external relay or activate a discrete input when in the low state.

CP-84: IN-POSITION B DELAY

CP-84 establishes the time delay from when the M-Cut enters the In-Position state (see CP-80), until the In-Position B output is energized. Enter the desired time delay in milliseconds.

CP-85: IN-POSITION B DWELL

CP-85 determines how long the In-Position B output remains energized after the delay time has expired. Enter the desired dwell time in milliseconds. An entry of -1 indicates a continuous energized time period. The In-Position outputs are reset when the next move profile is initiated.

CP-86: IN-POSITION B POLARITY

CP-86 establishes the polarity of the In-Position B output. A value of 1 programs the output to go from a high state during the delay period to a low state during the dwell period. An entry of 2 programs the output to go from a low state during the delay period to a high state during the dwell period. The output is typically wired to energize an external relay or activate a discrete input when in the low state.

CP-87: IN-POSITION C DELAY

CP-87 establishes the time delay from when the M-Cut enters the In-Position state (see CP-80), until the In-Position C output is energized. Enter the desired time delay in milliseconds. Note that this variable is ignored if CP-93 = "2."

CP-88: IN-POSITION C DWELL

CP-88 determines how long the In-Position C output remains energized after the delay time has expired. Enter the desired dwell time in milliseconds. An entry of -1 indicates a continuous energized time period. The In-Position outputs are reset when the next move profile is initiated.

CP-89: IN-POSITION C POLARITY

CP-89 establishes the polarity of the In-Position C output. A value of 1 programs the output to go from a high state during the delay period to a low state during the dwell period. An entry of 2 programs the output to go from a low state during the delay period to a high state during the dwell period. The output is typically wired to energize an external relay or activate a discrete input when in the low state.

CP-90: IN-POSITION A ENABLE

CP-90 allows selective enabling of the In-Position A Output with respect to the just executed profile. A "1" allows the In-Position A Output to go active at the end of the corresponding profile, while a "0" prevents the output from ever going active. The order of the digits entered are illustrated below. To illustrate, a CP-90 value of 0010 enables the In-Position A Output to go active only after Profile 2 has executed, otherwise it is deactivated.

```
X X X X
| | | |
| | | Profile 1
| | Profile 2
| Profile 3
Profile 4
```

CP-91: IN-POSITION B ENABLE

CP-91 allows selective enabling of the In-Position B Output with respect to the just executed profile. A "1" allows the In-Position B Output to go active at the end of the corresponding profile, while a "0" prevents the output from ever going active. The order of the digits entered are illustrated below. To illustrate, a CP-91 value of 0010 enables the In-Position B Output to go active only after Profile 2 has executed, otherwise it is deactivated.

```
X X X X
| | | |
| | | Profile 1
| | Profile 2
| Profile 3
Profile 4
```

CP-92: IN-POSITION C ENABLE

CP-92 allows selective enabling of the In-Position C Output with respect to the just executed profile. A "1" allows the In-Position C Output to go active at the end of the corresponding profile, while a "0" prevents the output from ever going active. The order of the digits entered are illustrated below. To illustrate, a CP-92 value of 0010 enables the In-Position C Output to go active only after Profile 2 has executed, otherwise it is deactivated.

```
X X X X
| | | |
| | | Profile 1
| | Profile 2
| Profile 3
Profile 4
```

CP-93: IN-POSITION C DELAY CONTROL

CP-93 determines the In-Position C Output delay(s). When CP-93 = "1" (default), the M-Cut uses the delay entered in CP-87 at the completion of all four profiles. When CP-93 = "2," the M-Cut uses the delays entered in CP-94, CP-95, CP-96 and CP-97 at the completion of the corresponding profile. This feature is typically used to provide different delays between the execution of each profile when In Position Output C is connected to the Move Input.

CP-94: IN-POSITION C DELAY 1

When CP-93 = "2," the CP-94 variable establishes the time delay from when the M-Cut enters the In-Position state at the end of Profile 1 until the In-Position C output is activated. Enter the desired delay in milliseconds.

CP-95: IN-POSITION C DELAY 2

When CP-93 = "2," the CP-95 variable establishes the time delay from when the M-Cut enters the In-Position state at the end of Profile 2 until the In-Position C output is activated. Enter the desired delay in milliseconds.

CP-96: IN-POSITION C DELAY 3

When CP-93 = "2," the CP-96 variable establishes the time delay from when the M-Cut enters the In-Position state at the end of Profile 3 until the In-Position C output is activated. Enter the desired delay in milliseconds.

CP-97: IN-POSITION C DELAY 4

When CP-93 = "2," the CP-97 variable establishes the time delay from when the M-Cut enters the In-Position state at the end of Profile 4 until the In-Position C output is activated. Enter the desired delay in milliseconds.

CP-98: RESUME IN-POS CONTROL

There are four possible choices for CP-98 that determine how the Resume function and IN-POS Control operates:

CP-98 = 0: The Resume function is not limited by the Job Space and thus can be used to repeat moves. The In-Position timers will not be reset if already In-Position and the timers started.

CP-98 = 1: The Resume function is not limited to the Job Space and thus can be used to repeat moves. The In-Position timers will always be reset.

CP-98 = 2: The Resume function is limited to the Job Space. The In-Position timers will not be reset.

CP-98 =3: The Resume function is limited to the Job Space. The In-Position timers will be reset.

The job space for a Relative Move is defined as the start of the Move to the final cut position. The job space for an Absolute Move is from 0 (Home) to the final position.

MV-99: CODE REVISION

MV-99 displays the M-Cut's installed software code revision.

NOTES

APPENDIX D - USER'S ACTUAL CODE RECORD D

CODE-TYPE	DESCRIPTION	MIN	MAX	USER SETTING	UNITS
01 -CP	CUT LENGTH 1	000.000	999999	_____	Eng Units
02 -CP	MOVE SPEED 1	000.000	999999	_____	Eng Units/Time
03 -CP	ACCEL TIME 1	0.01	60.00	_____	Seconds
04 -CP	DECEL TIME 1	0.01	60.00	_____	Seconds
05 -CP	BATCH COUNT 1	0	999999	_____	Counts
06 -CP	REG LENGTH 1	000.000	999999	_____	Eng Units
07 -CP	DIRECTION 1	1	4	_____	Coded
08 -CP	CUT LENGTH 2	000.000	999999	_____	Eng Units
09 -CP	MOVE SPEED 2	000.000	999999	_____	Eng Units/Time
10 -CP	ACCEL TIME 2	0.01	60.00	_____	Seconds
11 -CP	DECEL TIME 2	0.01	60.00	_____	Seconds
12 -CP	BATCH COUNT 2	0	999999	_____	Counts
13 -CP	REG LENGTH 2	000.000	999999	_____	Eng Units
14 -CP	DIRECTION 2	1	4	_____	Coded
15 -CP	CUT LENGTH 3	000.000	999999	_____	Eng Units
16 -CP	MOVE SPEED 3	000.000	999999	_____	Eng Units/Time
17 -CP	ACCEL TIME 3	0.01	60.00	_____	Seconds
18 -CP	DECEL TIME 3	0.01	60.00	_____	Seconds
19 -CP	BATCH COUNT 3	0	999999	_____	Counts
20 -CP	REG LENGTH 3	000.000	999999	_____	Eng Units
21 -CP	DIRECTION 3	1	4	_____	Coded
22 -CP	CUT LENGTH 4	000.000	999999	_____	Eng Units
23 -CP	MOVE SPEED 4	000.000	999999	_____	Eng Units/Time
24 -CP	ACCEL TIME 4	0.01	60.00	_____	Seconds
25 -CP	DECEL TIME 4	0.01	60.00	_____	Seconds
26 -CP	BATCH COUNT 4	0	999999	_____	Counts
27 -CP	REG LENGTH 4	000.000	999999	_____	Eng Units
28 -CP	DIRECTION 4	1	4	_____	Coded
30 -CP	SCALE FACTOR	1.000	99999	_____	Edges/Eng Unit
31 -CP	TIME UNIT (MIN/SEC)	1	2	_____	Coded
32 -CP	KERF	000.000	999999	_____	Eng Units
33 -CP	PROFILE SEQUENCE	0	444444	_____	Coded
34 -CP	INDEX POLARITY	1	2	_____	Coded
35 -CP	BACK-STEP LENGTH	000.000	999999	_____	Eng Units
36 -CP	HOME OFFSET	-99999.	999999	_____	Eng Units
37 -CP	JOG SPEED	000.000	999999	_____	Eng Units/Time
38 -CP	HIGH SPEED ALARM	000.000	999999	_____	Eng Units/Time
39 -CP	POSITION ERROR ALARM	000.000	999999	_____	Eng Units
60 -CP	DIRECT ENABLE	0	2	_____	Coded
61 -CP	DIRECT COMMAND	-4095	4095	_____	DAC Bits
62 -CP	FEEDBACK PPR	60	4096	_____	PPR
63 -CP	S-CURVE ENABLE	0	1	_____	Coded
64 -CP	Kff	0.00	9999.99	_____	N/A
65 -CP	Kp	0	10000	_____	N/A
66 -CP	Ki	0	10000	_____	N/A
68 -CP	UNIPOLAR/BIPOLAR	1	2	_____	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

(Continued)

78 -CP	AUTOMATIC HOME RESET	0	1	_____	Coded
79 -CP	KEYPAD LOCKOUT MASK	0	3	_____	Coded
80 -CP	IN-POSITION BAND	1	60000	_____	Enc. Edges
81 -CP	IN-POSITION A DELAY	0	60000	_____	MSeconds
82 -CP	IN-POSITION A DWELL	-1	60000	_____	MSeconds
83 -CP	IN-POSITION A POLARITY	1	2	_____	Coded
84 -CP	IN-POSITION B DELAY	0	60000	_____	MSeconds
85 -CP	IN-POSITION B DWELL	-1	60000	_____	MSeconds
86 -CP	IN-POSITION B POLARITY	1	2	_____	Coded
87 -CP	IN-POSITION C DELAY	0	60000	_____	MSeconds
88 -CP	IN-POSITION C DWELL	-1	60000	_____	MSeconds
89 -CP	IN-POSITION C POLARITY	1	2	_____	Coded
90 -CP	IN-POSITION A ENABLE	0000	1111	_____	Coded
91 -CP	IN-POSITION B ENABLE	0000	1111	_____	Coded
92 -CP	IN-POSITION C ENABLE	0000	1111	_____	Coded
93 -CP	IN-POS C DELAY CONTROL	1	2	_____	Coded
94 -CP	IN-POS C PROF 1 DELAY	0	60000	_____	MSeconds
95 -CP	IN-POS C PROF 2 DELAY	0	60000	_____	MSeconds
96 -CP	IN-POS C PROF 3 DELAY	0	60000	_____	MSeconds
97 -CP	IN-POS C PROF 4 DELAY	0	60000	_____	MSeconds
98 -CP	RESUME IN-POS CONTROL	0	3	_____	Coded

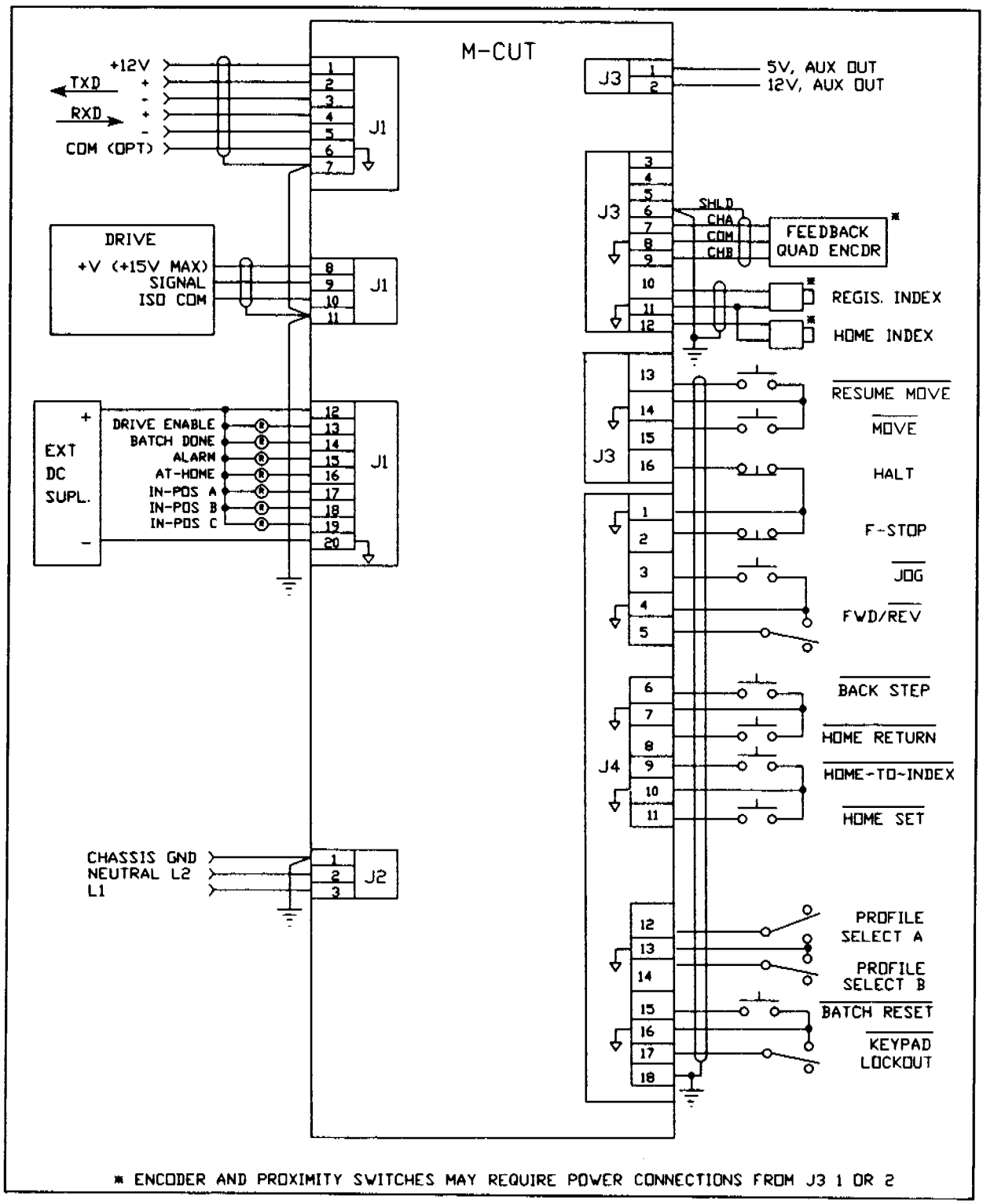
APPENDIX E: CODE LIST QUICK REFERENCE E

CODE-TYPE	DESCRIPTION	MIN	MAX	DEFAULT	UNITS
01 -CP	CUT LENGTH 1	000.000	999999	0	Eng Units
02 -CP	MOVE SPEED 1	000.000	999999	0	Eng Units/Time
03 -CP	ACCEL TIME 1	0.01	60.00	1.00	Seconds
04 -CP	DECEL TIME 1	0.01	60.00	1.00	Seconds
05 -CP	BATCH COUNT 1	0	999999	1	Counts
06 -CP	REG LENGTH 1	000.000	999999	0	Eng Units
07 -CP	DIRECTION 1	1	4	1	Coded
08 -CP	CUT LENGTH 2	000.000	999999	0	Eng Units
09 -CP	MOVE SPEED 2	000.000	999999	0	Eng Units/Time
10 -CP	ACCEL TIME 2	0.01	60.00	1.00	Seconds
11 -CP	DECEL TIME 2	0.01	60.00	1.00	Seconds
12 -CP	BATCH COUNT 2	0	999999	1	Counts
13 -CP	REG LENGTH 2	000.000	999999	0	Eng Units
14 -CP	DIRECTION 2	1	4	1	Coded
15 -CP	CUT LENGTH 3	000.000	999999	0	Eng Units
16 -CP	MOVE SPEED 3	000.000	999999	0	Eng Units/Time
17 -CP	ACCEL TIME 3	0.01	60.00	1.00	Seconds
18 -CP	DECEL TIME 3	0.01	60.00	1.00	Seconds
19 -CP	BATCH COUNT 3	0	999999	1	Counts
20 -CP	REG LENGTH 3	000.000	999999	0	Eng Units
21 -CP	DIRECTION 3	1	4	1	Coded
22 -CP	CUT LENGTH 4	000.000	999999	0	Eng Units
23 -CP	MOVE SPEED 4	000.000	999999	0	Eng Units/Time
24 -CP	ACCEL TIME 4	0.01	60.00	1.00	Seconds
25 -CP	DECEL TIME 4	0.01	60.00	1.00	Seconds
26 -CP	BATCH COUNT 4	0	999999	1	Counts
27 -CP	REG LENGTH 4	000.000	999999	0	Eng Units
28 -CP	DIRECTION 4	1	4	1	Coded
30 -CP	SCALE FACTOR	1.000	99999	1	Edges/Eng Unit
31 -CP	TIME UNIT (MIN/SEC)	1	2	1	Coded
32 -CP	KERF	000.000	999999	0	Eng Units
33 -CP	PROFILE SEQUENCE	0	444444	0	Coded
34 -CP	INDEX POLARITY	1	2	1	Coded
35 -CP	BACK-STEP LENGTH	000.000	999999	0	Eng Units
36 -CP	HOME OFFSET	-99999.	999999	0	Eng Units
37 -CP	JOG SPEED	000.000	999999	0	Eng Units/Time
38 -CP	HIGH SPEED ALARM	000.000	999999	2000	Eng Units/Time
39 -CP	POSITION ERROR ALARM	000.000	999999	1.000	Eng Units
40 -MV	POSITION	-99999	999999	----	Eng Units
41 -MV	POSITION COMMAND	-99999.	999999	----	Eng Units
42 -MV	POSITION ERROR	-99999	999999	----	Eng Units
43 -MV	SPEED	000.000	999999	----	Eng Units/Time
44 -MV	SPEED COMMAND	000.000	999999	----	Eng Units/Time
45 -MV	INDEX POSITION	-99999.	999999	----	Eng Units
46 -MV	FEEDBACK FREQUENCY	-99999.	120000	----	HZ
47 -MV	DAC OUTPUT	-4095	4095	----	DAC Bits
48 -MV	TRIM OUTPUT	-4095	4095	----	DAC Bits
49 -MV	BATCH COUNT	0	999999	----	Counts
50 -MV	KEYPAD ERRORS	0	111111	----	Coded
51 -MV	ACTIVE PROFILE	1	4	----	Coded
52 -MV	ALARM STATUS	0	000011	----	Coded
53 -MV	CONTROL STATE	1	100100	----	Coded

(Continued)

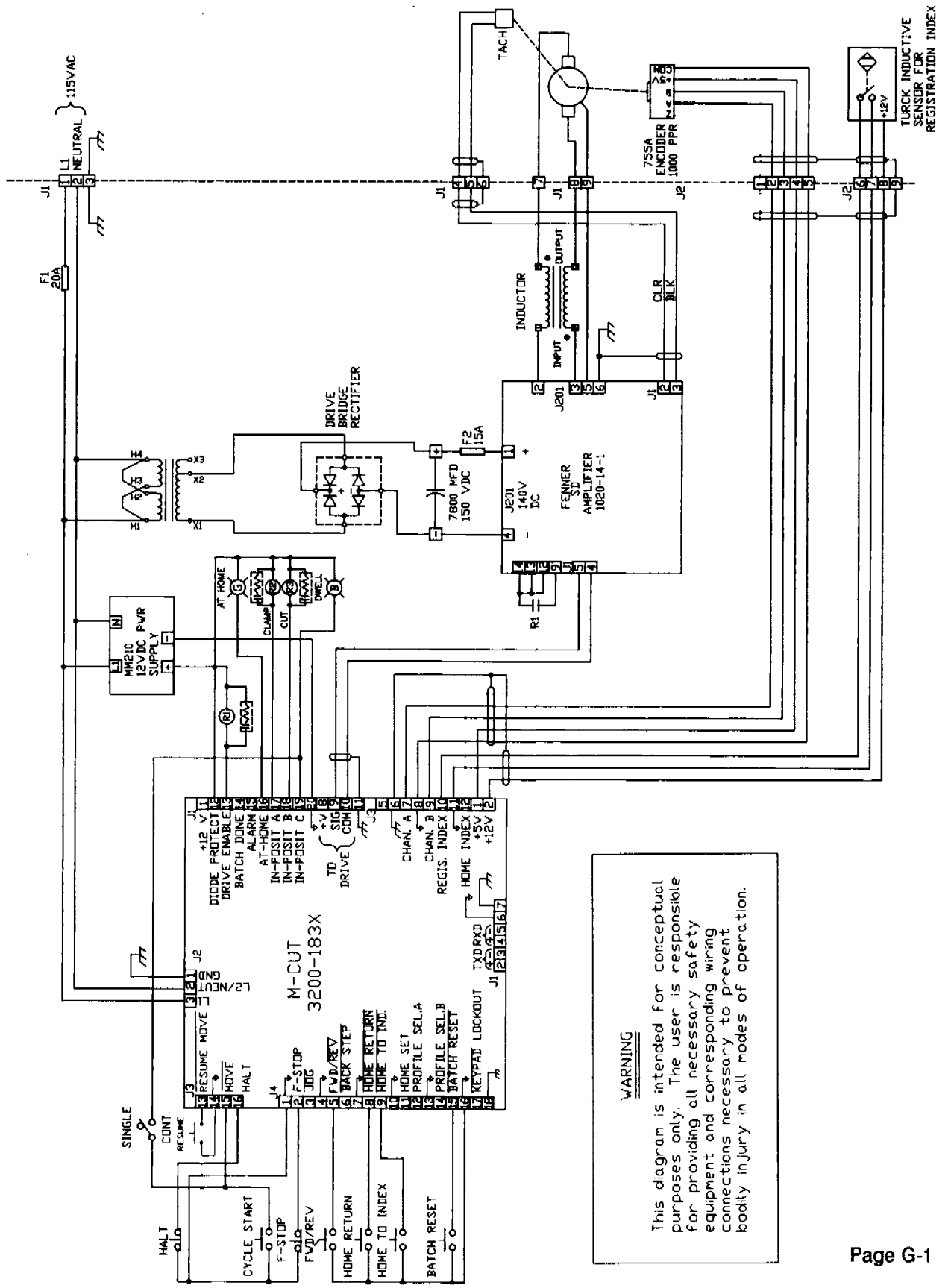
54 -MV	DISCRETE IN A	0	111111	----	Coded
55 -MV	DISCRETE IN B	0	111111	----	Coded
56 -MV	DISCRETE IN C	0	1111	----	Coded
57 -MV	DISCRETE OUT A	0	111111	----	Coded
58 -MV	DISCRETE OUT B	0	1	----	Coded
59 -MV	LINE NOTCH COUNTER	0	999999	----	Counts
60 -CP	DIRECT ENABLE	0	2	0	Coded
61 -CP	DIRECT COMMAND	-4095	4095	0	DAC Bits
62 -CP	FEEDBACK PPR	60	4096	1000	PPR
63 -CP	S-CURVE ENABLE	0	1	0	Coded
64 -CP	Kff	0.00	9999.99	0.00	N/A
65 -CP	Kp	0	10000	100	N/A
66 -CP	Ki	0	10000	100	N/A
68 -CP	UNIPOLAR/BIPOLAR	1	2	2	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
78 -CP	AUTOMATIC HOME RESET	0	1	1	Coded
79 -CP	KEYPAD LOCKOUT MASK	0	3	1	Coded
80 -CP	IN-POSITION BAND	1	60000	4	Enc. Edges
81 -CP	IN-POSITION A DELAY	0	60000	0	MSeconds
82 -CP	IN-POSITION A DWELL	-1	60000	60000	MSeconds
83 -CP	IN-POSITION A POLARITY	1	2	1	Coded
84 -CP	IN-POSITION B DELAY	0	60000	0	MSeconds
85 -CP	IN-POSITION B DWELL	-1	60000	60000	MSeconds
86 -CP	IN-POSITION B POLARITY	1	2	1	Coded
87 -CP	IN-POSITION C DELAY	0	60000	0	MSeconds
88 -CP	IN-POSITION C DWELL	-1	60000	60000	MSeconds
89 -CP	IN-POSITION C POLARITY	1	2	1	Coded
90 -CP	IN-POSITION A ENABLE	0000	1111	1111	Coded
91 -CP	IN-POSITION B ENABLE	0000	1111	1111	Coded
92 -CP	IN-POSITION C ENABLE	0000	1111	1111	Coded
93 -CP	IN-POS C DELAY CONTROL	1	2	1	Coded
94 -CP	IN-POS C PROF 1 DELAY	0	60000	0	MSeconds
95 -CP	IN-POS C PROF 2 DELAY	0	60000	0	MSeconds
96 -CP	IN-POS C PROF 3 DELAY	0	60000	0	MSeconds
97 -CP	IN-POS C PROF 4 DELAY	0	60000	0	MSeconds
98 -CP	RESUME IN-POS CONTROL	0	3	2	Coded
99 -MV	Software Code Revision	---	---	---	---

APPENDIX F - M-CUT PIN OUT F



NOTES

APPENDIX G - TYPICAL WIRING DIAGRAM G



NOTES

APPENDIX H

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

NOTES

APPENDIX I - GLOSSARY I

Alarm LED: Indicates when on, that an alarm is present in the M-Cut (either a position alarm or a high speed alarm).

Alarm Output: Indicates (when driven low) that an alarm is present in the M-Cut (either a position alarm or a high speed alarm).

At-Home LED: Indicates when on, that the M-Cut is within the In-Position Band of the Home position.

At-Home Output: Indicates (when driven low) that the M-Cut is within the In-Position Band of the Home position at the completion of Home Return or Home-To-Index or a Home Set.

Back Step Input: An input which when closed steps the material away from the cut blade after the cut is made and before the blade is returned to its original position.

Batch Count: Each profile has it's own user-entered batch count setting. In addition, the M-Cut internally tracks the number of profile moves since the last closure of the batch reset input for each profile.

Batch Done LED: Indicates when on, that the current batch is complete for the selected profile.

Batch Done Output: Indicates (when driven low) that the current batch is complete for the selected profile.

Batch Reset Input: An input which when closed resets the batch count to zero for all profiles.

Bipolar Operation: The default operation of the M-Cut, where the M-Cut can send analog drive signals moving the process or machine in both a forward and reverse direction.

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

Cycle LED: Indicates when on, that the M-Cut is performing a Move.

Direct Mode: An open loop method of operating the M-Cut's analog output, typically used for System trouble-shooting. The M-Cut's direct mode can also be used to scale the M-Cut's Kff feedforward term.

Drive Enable Output: An output which is driven low when the M-Cut is commanding a speed output to the motor drive, including during the Halt state. The Drive Enable output is only driven high following Power Up and during F-Stop.

F-STOP Input: An input which when opened commands the M-Cut to an immediate stop. Position is not maintained, and the drive enable output is deactivated.

Forward/$\overline{\text{Reverse}}$: An input which when shorted to common reverses the direction of the Jog and Home-To-Index.

Halt Input: An input which when opened commands the M-Cut to slow to a halt using the decel rate of the selected profile. Position is maintained, and the drive remains enabled.

Home Index: A sensor used to detect the Home Index Mark during the Home-To-Index operation.

Home Return Input: When this input is closed, the M-Cut returns to the Home position.

Home Set Input: An input which when closed sets the current position as the Home Position.

Home-To-Index Input: When this input is momentarily closed, the M-Cut performs a jog move in the direction indicated by the Fwd/Rev input until the Home Index is detected.

In-Pos A, B, C Outputs: Three position programmable outputs often used to direct gripping and cutting activities after a profile move has reached the in-position band.

In-Position Band: Determines when the M-Cut is considered In-Position at the end of a profile move. When the M-Cut enters the in-position band, the timers are started for the In-Pos A, In-Pos B and In-Pos C discrete outputs.

In-Position Delay: Sets the time delay (in milliseconds) from when the M-Cut enters the In-Position Band until the In-Position output goes active.

In-Position Dwell: Determines the duration (in milliseconds) the output remains active after the delay time has expired.

In-Position LED: Indicates when on, that the M-Cut is within the In-Position Band of the cut position (cut length).

In-Position Polarity: Sets the polarity of the In-Position output.

JOG Input: An input which when closed directs a speed command signal to the drive at the selected jog speed. The direction of the Jog speed command is determined by the Forward/Reverse output.

Kerf: An M-Cut feature which automatically adjusts the profile cut length to compensate for material lost by the blade cut.

Keypad Lockout: An input used to disable control parameter entries from the front keypad.

Kff: An M-Cut tuning parameter that determines the magnitude of the feedforward term of the compensation algorithm.

Ki: An M-Cut tuning parameter that determines the Integral Constant.

Kp: An M-Cut tuning parameter that determines the Proportional Constant.

Move Input: An input used to start the next profile move.

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

Profile: The M-Cut can define up to four profiles (Profiles 1, 2, 3 and 4). Each profile uses up to 7 different user-selected parameters (cut length, move speed, accel time, decel time, batch count, registration length and direction) to generate a trapezoidal velocity profile used during a profile move.

Profile Select A and B Inputs: When Profile Sequence is disabled, the Profile Select Inputs A and B are used to determine which profile is active.

Profile Sequence: A method to automatically sequence through different profiles during cycle mode.

Ready Input: An input used in cycle mode to start the next profile move.

Registration Index: A discrete input used to detect the product's registration mark.

Resume Move: An input used to initiate Resume Move.

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

Unipolar Operation: A method of operating the M-Cut where drive signals can be sent in the forward direction only.

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.

NOTES

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