ML-Drive User Manual

0001-0125

Revision E

Technical Assistance

If you have comments or questions concerning the operation of the ML-Drive, please call. A member of our Technical Support Staff will be happy to assist you. Ask for Technical Support: (763) 424-7800 or 1-800-342-4411

Contrex®
8900 Zachary Lane North
Maple Grove, Minnesota 55369

DANGER

Improper installation can cause severe injury, death or damage to your system.

Integrate this motion control unit into your system with caution.

Operate this motion control unit only under the conditions prescribed in this manual. Any other use shall be deemed inappropriate.

Comply with the National Electrical Code and all applicable local and national codes.

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Introduction

Introducing the ML-Drive

Examples of ML-Drive Applications


CONTREX
1 1750
CODE SELECT
SET POINT
TACH
▲
▼
7
8
9
4
5
6
1
2
3
–
0
•
CLEAR
ENTER

INTRODUCING THE ML-DRIVE

The ML-Drive is a highly accurate, digital, motor drive which can drive 1/4 to 2 horsepower PM DC motors. It has advanced embedded software that is capable of solving a great variety of speed control tasks. It operates as either a stand-alone control of a single motor (Master mode) or as a part of a complex multi-drive system (Follower mode).

The ML-Drive is ideal for motor control applications where your present open loop or rudimentary closed loop operations are inaccurate or where there is inadequate load regulation. The ML-Drive is also at the forefront in digitally accurate Follower applications. See Figure 1-1 and Figure 1-2 for examples of Master and Follower applications.

The ML-Drive is unique among its competition because the ML-Drive has preprogramed software that integrates with your system with little effort from you. The ML-Drive will also allow you to enter data that is unique to your system's specific needs (e.g., maximum RPMs, setpoints, acceleration/deceleration ramp rates). Using Control Parameters (CPs), this data is entered through either the ML-Drive's integrated keypad or though a host computer via the RS485 Serial Communications port. In addition to the Control Parameters that allow you to customize for your systems specific needs, the ML-Drive's Monitor Parameters (MPs) allow you to monitor your system's performance.

The ML-Drive's multiple scaling formats allow you to enter the setpoints and monitor speed in the Engineering Units (e.g., RPMs, gallons per hour, feet per minute) that are unique to your system. Among the ML-Drive's advanced capabilities is the flexibility to preset up to four setpoint entries.

Integrating the ML-Drive's applied intelligence with your system puts precise speeds at your fingertips, quickly, easily and cost effectively.

EXAMPLES OF ML-DRIVE APPLICATIONS

Figure 1-1 is an example of a Master mode of operation for a pump application. The scaling format allows the operator to enter a setpoint in Engineering Units of gallons per minute. The ML-Drive compares the sensor shaft feedback to the scaled setpoint and calculates any speed error. When the ML-Drive finds speed error, the control algorithm adjusts the drive output and reduces the error to zero.

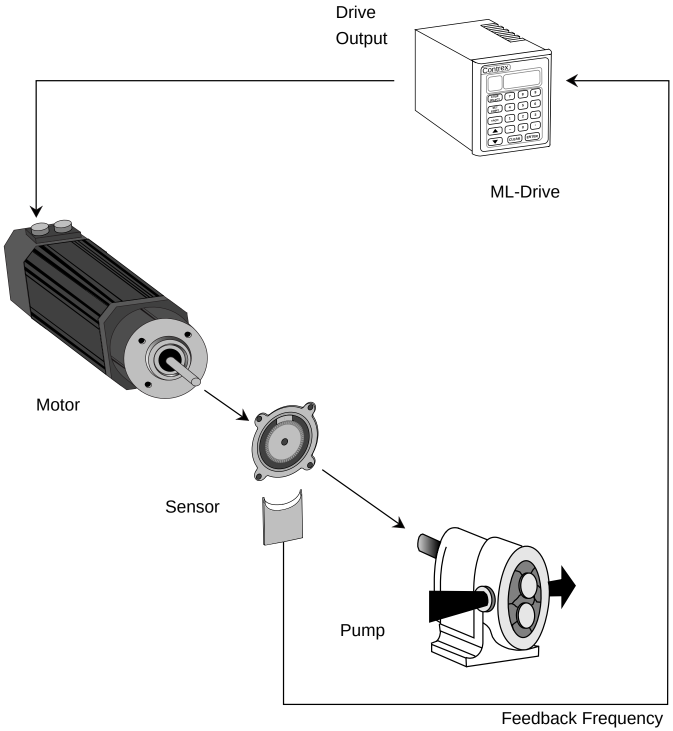


Figure 1-1 ML-Drive Master Mode

Figure 1-2 is an example of the Follower mode of operation in a pump application. The scaling format allows the operator to enter the setpoint as a ratio of ingredient B to ingredient A. The ML-Drive compares the setpoint ratio to the Follower sensor shaft (feedback) and Lead sensor shaft to calculate any speed error. When the ML-Drive finds speed error, the control algorithm adjusts the drive output and reduces the error to zero.

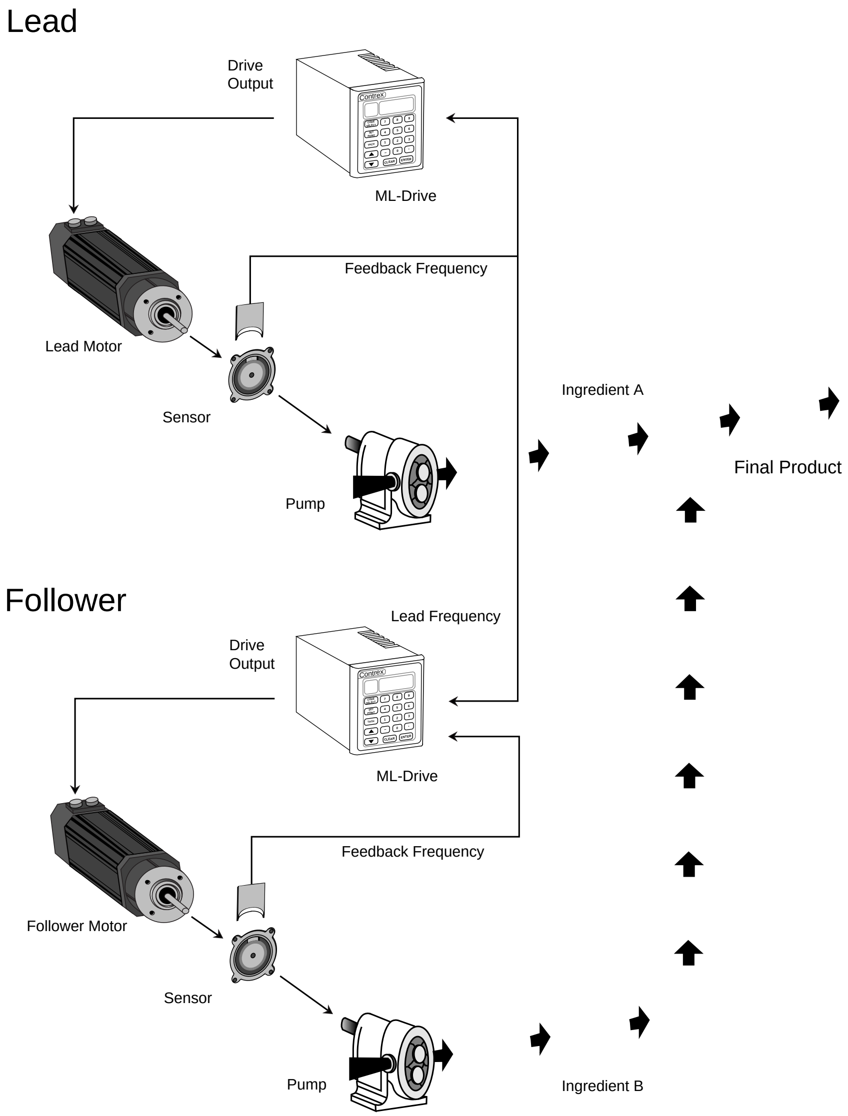


Figure 1-2 ML-Drive Follower Mode

—NOTES—

Installation / Setup

Mounting

Wiring

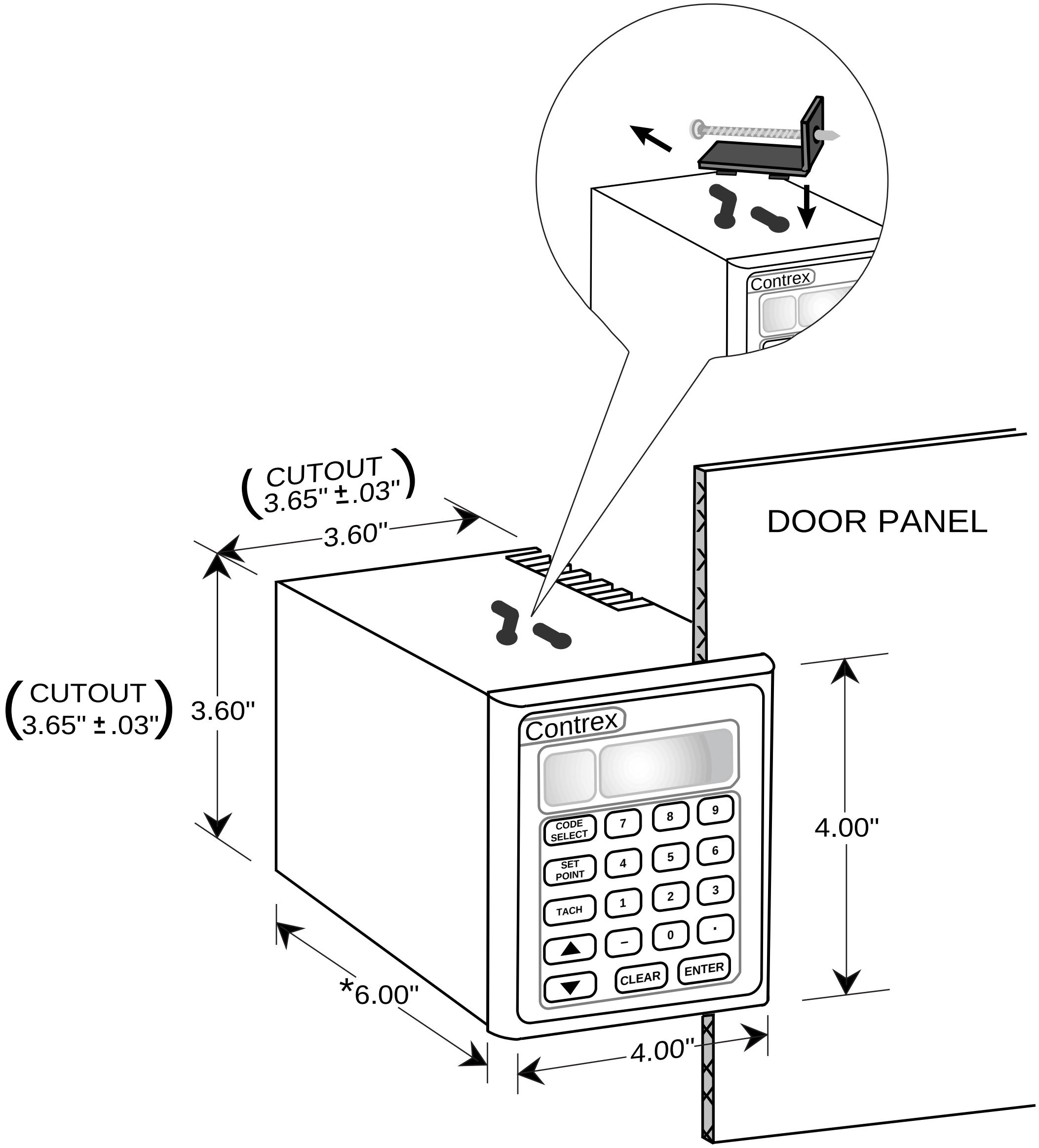
  Inputs

  Outputs

  Serial Communications

Calibration

  Current Limit



* From the rear of the door panel to the back of the connectors

Figure 2-1 ML-Drive Cutout Dimensions and Mounting Guide

MOUNTING

This section contains instructions for mounting the ML-Drive in the door panel of a NEMA Industrial Electrical enclosure. The ML-Drive is packaged in a compact 1/4 DIN Vertical Instrument Enclosure that mounts easily in the door of your Industrial Electrical Enclosure. The Electrical Enclosure must have an IP54 rating or higher to comply with CE installations.

To mount the ML-Drive:

1) The NEMA Industrial Electrical Enclosure that will house the ML-Drive must conform to the following environmental conditions:

   Temperature: 0 - 55 degrees C
   (Internal NEMA enclosure temperature)

   Humidity: 0 - 95% RH non-condensing

   Environment: Pollution degree 2 macro - environment

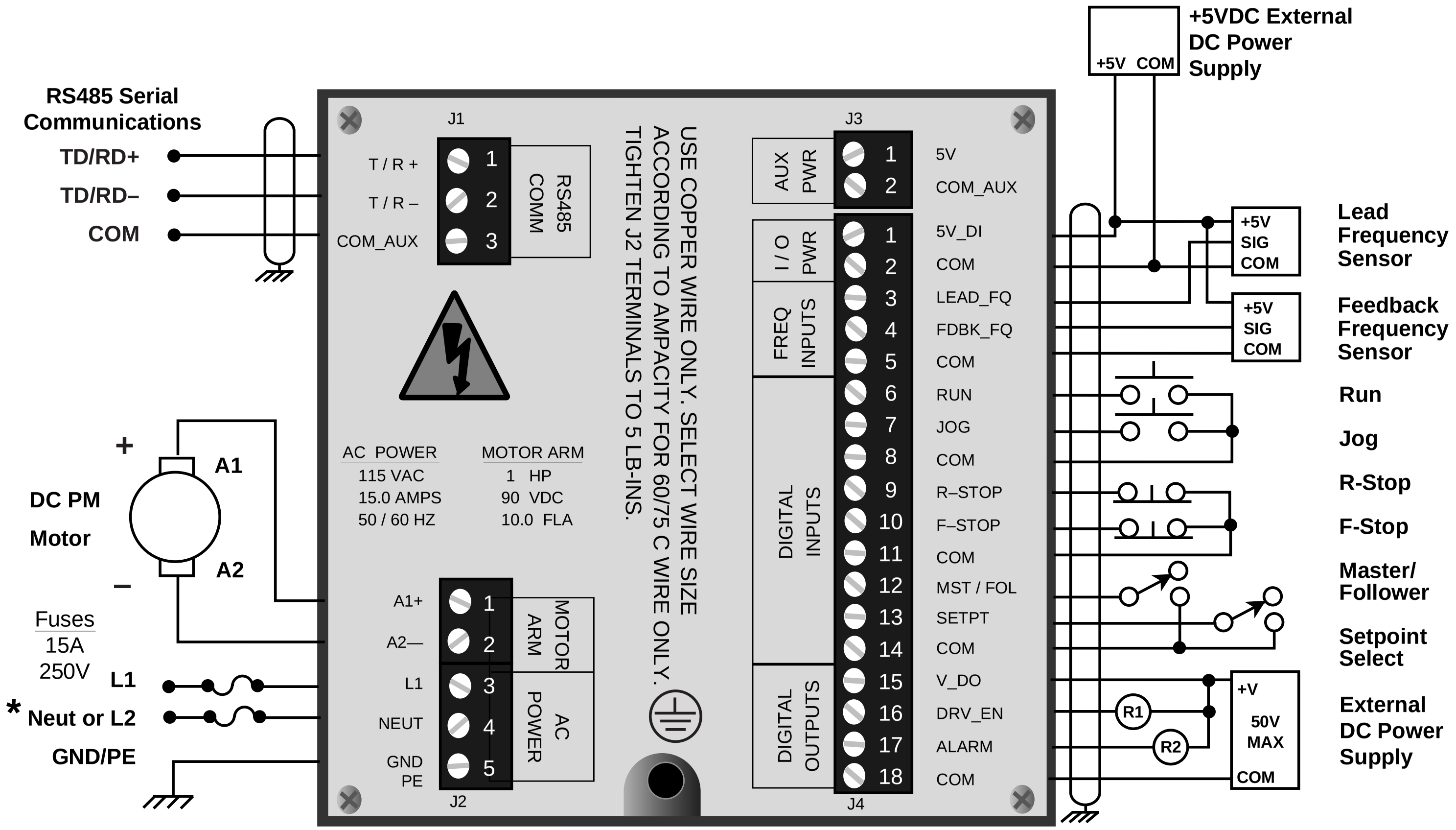
   Altitude: To 3300 feet (1000 meters)

   NOTE: Allow adequate spacing between the ML-Drive and other equipment to provide for proper heat convection. Placing the ML-Drive too close to adjacent equipment could cause the interior ambient temperature to exceed 55 degrees C. Spacing requirements depend on air flow, enclosure construction and applied horsepower.

2) The dimensions for the door panel cutout are 3.65"± .03" x 3.65 ±.03" (see Figure 2-1). Allow two inches of clearance on all sides of the cutout for mounting clamp attachments, wire routing and heat convection.

3) Insert the ML-Drive through the door panel cutout until the gasket and bezel are flush with the door panel (see Figure 2-1).

4) Slide the mounting clamps into the slots that are located on the top and bottom of the ML-Drive. Tighten the mounting screws until the ML-Drive is mounted securely in the NEMA Electrical Enclosure. Do not overtighten.



* Use 115 VAC with ML-Drive model # 3200-1933
Use 230 VAC with ML-Drive model # 3200-1934

Figure 2-2 ML-Drive General Wiring

WIRING

This section contains the power supply, input, and output wiring for the ML-Drive. Please read this section prior to wiring the ML-Drive to ensure that you make the appropriate wiring decisions.

NOTE: 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.

Branch Circuit Protection: “Suitable For Use On A Circuit Capable Of Delivering Not More Than 5,000 rms Symmetrical Amperes, 250 Volt Maximum.”

Class G branch circuit fuses rated 250V, 15A shall be provided in the end application.

Motor overload protection shall be provided in the end installation in accordance with the NEC.

This drive does not provide over-temperature sensing.

Use a minimum wire gauge of 18 AWG.

Use shielded cable to minimize equipment malfunctions from electrical noise.

Keep the AC power wiring (J2) physically separated from all other wiring on the ML-Drive. Failure to do so could result in additional electrical noise and cause the ML-Drive to malfunction.

A hand operated supply disconnect device must be installed in the final application. The primary disconnect device must meet EN requirements.

Inductive coils on relays, contactors, solenoids that are on the same AC power line or housed in the same enclosure should be suppressed with an RC network across the coil. For best results, use resistance (r) values of 50 ohms and capacitance (c) values of 0.1 microfarads.

Install an AC line filter or isolation transformer to reduce excessive EMI noise, such as line notches or spikes, on the AC power line.

WARNING

Hazardous voltages!

Can cause severe injury, death, or damage to equipment.

The ML-Drive should only be installed by a qualified electrician.

—NOTES—

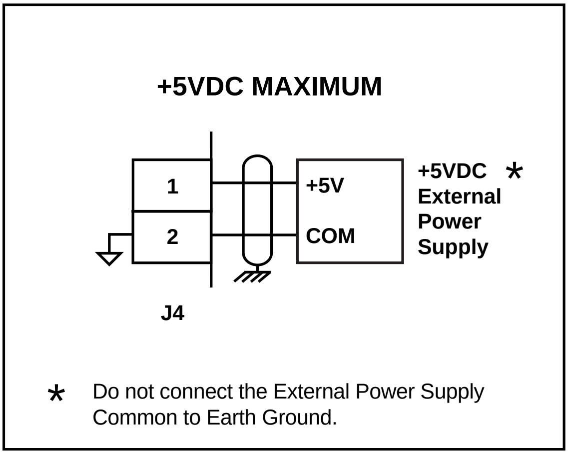
INPUTS

NOTE: The installation of this motor control must conform to area and local electrical codes. See *The National Electrical Code* (NEC,) Article 430 published by the National Fire Protection Association, or *The Canadian Electrical Code* (CEC). Use local codes as applicable.

I/O Power (J4 pins 1, 2)

For isolated operations, the Frequency Inputs (J4 pins 3, 4, 5), the Digital Inputs (J4 pins 6-14) and the Digital Outputs (J4 pins 15-18) require an external source of +5VDC power.

CAUTION: The ML-Drive is shipped from the factory with J3 and J4 jumpers. You must remove the J3 and J4 jumpers before you connect the external power supply or you can damage the equipment. Do not exceed +5VDC on the I/O Power input.



* Do not connect the External Power Supply Common to Earth Ground.

Figure 2-3 I/O Power / Isolated

Use the Auxiliary Power Output (J3 pins 1, 2) to supply power for non-isolated operations. The ML-Drive is shipped from the factory with the wiring defaulted to non-isolated operation.

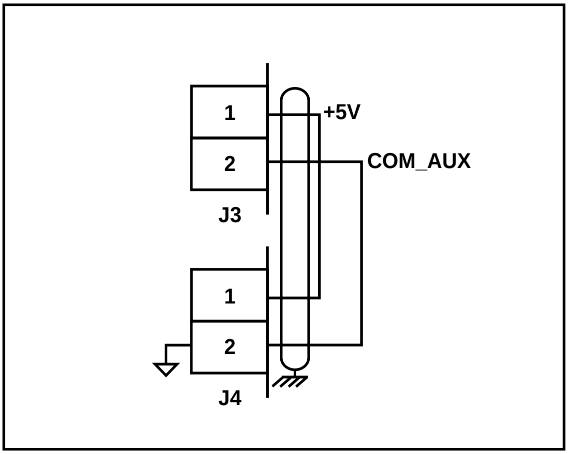


Figure 2-4 I/O Power / Non-Isolated

AC Power (J2 pins 3, 4, 5)

The ML–Drive model #3200-1933 operates on 115 VAC ± 15%, 0.1 Amp., 50/60 Hz. The ML–Drive model #3200-1934 operates on 230 VAC ± 15%, 0.1 Amp., 50/60 Hz.

* Fuse L1 for 115VAC applications. Fuse L1 and L2 for 230VAC applications. Use 15 AMP 250V normal blow fuses.

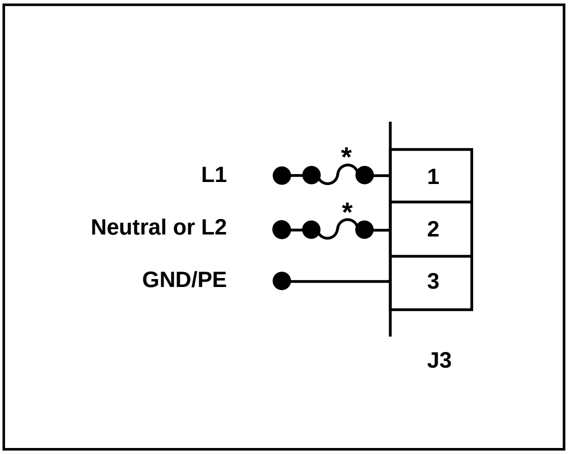


Figure 2-5 Input Power

Lead Frequency (J4 pins 3, 5)

The Lead Frequency is a pulse train input that the ML-Drive uses to determine the speed of the lead motor. For signal level specifications, refer to *References: Appendix A, ML-Drive Specifications,* page A-1

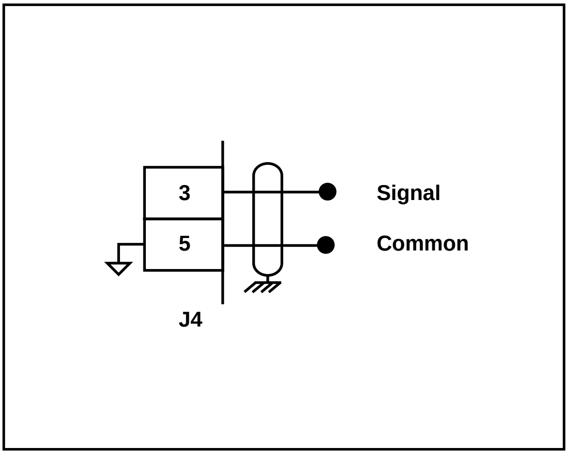


Figure 2-6 Lead Frequency

Feedback Frequency
(J4 pins 4, 5)

The Feedback Frequency is a pulse train input that the ML-Drive uses to determine the speed of the follower motor. For signal level specifications refer to *References: Appendix A*, *ML-Drive Specifications,* page A-1.

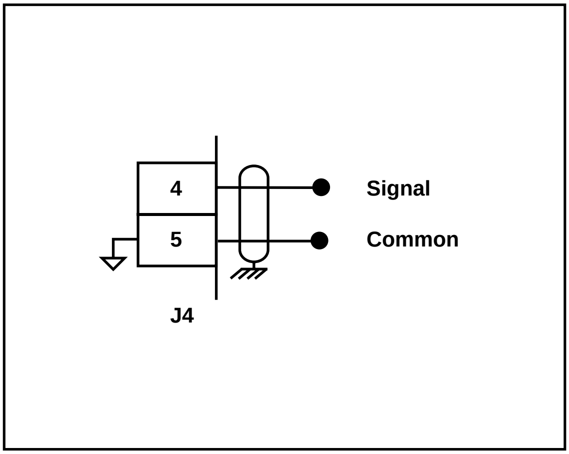


Figure 2-7   Feedback Frequency

DANGER !

If the Feedback Frequency is lost,
the ML-Drive will command a 100% speed out
and the motor will run at 100% capacity.
This can damage your equipment or
cause severe injury or death.

Run (J4 pins 6, 8)

When the Run input (J4 pin 6) is momentarily shorted to common, the ML-Drive enters Run. As a momentary input, Run is internally latched and does not need to be maintained by an operator device.

NOTE: Close the R–Stop and F–Stop inputs prior to entering Run. If you are only using one of the Stop inputs, wire short the other Stop input to common or the ML-Drive will not enter "Run".

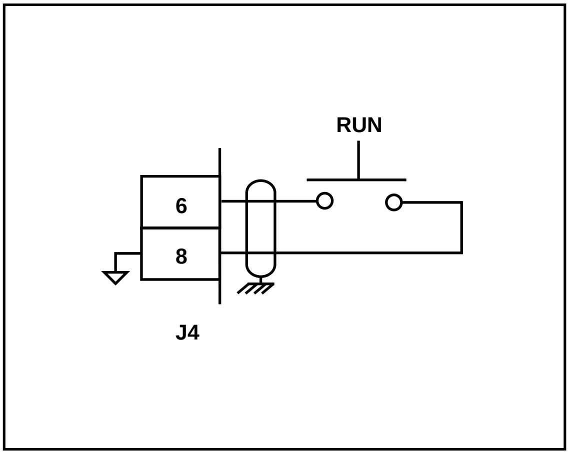


Figure 2-8   Run

Jog (J4 pins 7, 8)

Jog is a maintained input. When Jog is closed, the ML-Drive commands the motor to move at the selected jog speed. As a maintained input, Jog is only active when the operator device is closed.

NOTE: Close the R–Stop and F–Stop inputs and open the Run input, prior to entering Jog. If you are only using one of the Stop inputs, wire short the other Stop input to common or the ML-Drive will not enter Jog.

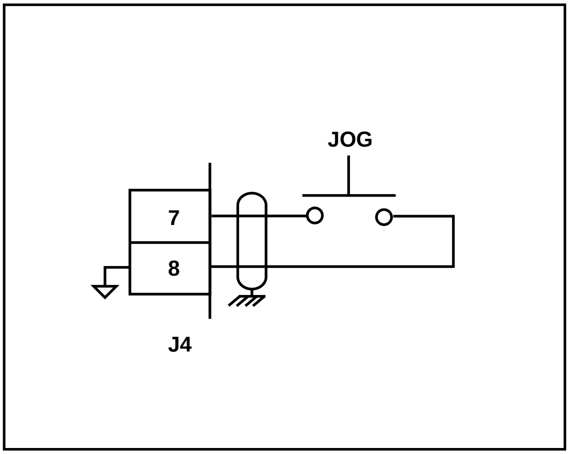


Figure 2-9 Jog

R–Stop (J4 pins 9, 11)

R–Stop is a momentary input. When it is opened, the ML-Drive ramps to zero speed at the specified deceleration rate. As a momentary input, R–Stop is internally latched and does not need to be maintained by an operator device.

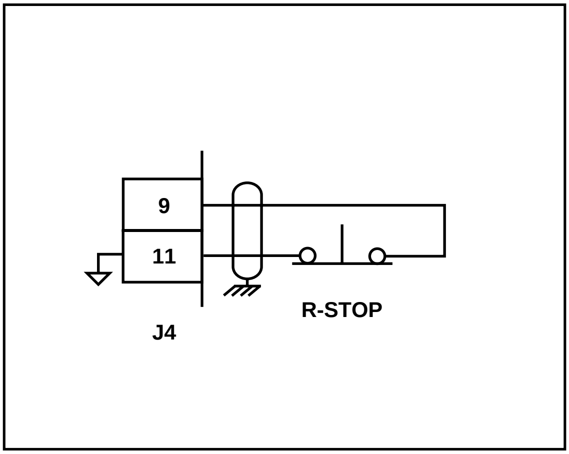


Figure 2-10 R–Stop

F–Stop (J4 pins 10, 11)

F–Stop is a momentary input. When it is open, the ML-Drive stops immediately (zero RPM) and ignores the specified deceleration rate. As a momentary input, F-Stop is internally latched and does not need to be maintained by an operator device.

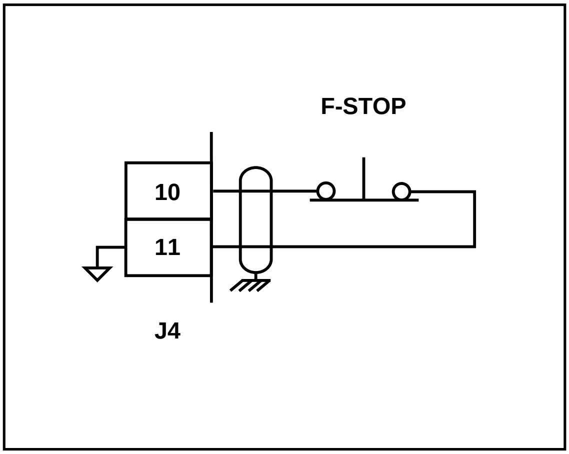


Figure 2-11 F–Stop

Master / Follower

(J4 pins 12, 14)

This input determines the ML–Drive's mode of operation and resulting scaling formula that the control algorithm uses. The ML-Drive is in Master mode when the circuit is open, and Follower mode if the circuit is shorted to the common.

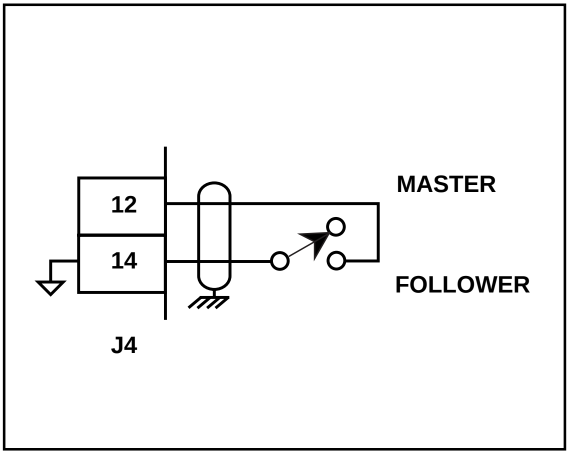


Figure 2-12 Master / Follower

Setpoint Select (J4 pins 13, 14)

The Master and Follower setpoints are determined by the Setpoint Select input combined with the Master, Follower Input. For access to Master Control Parameters 1 and 2 and Follower Control Parameters 3 and 4, refer to the chart below.

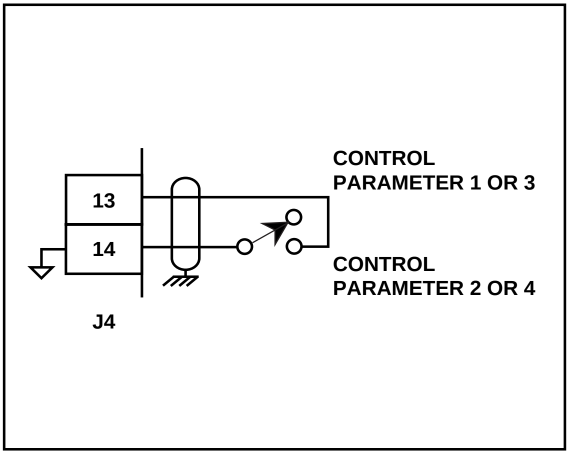


Figure 2-13   Setpoint Select

	Setpoint Select / Open	Setpoint Select / Closed
Master, Follower Input Open	Master Control Parameter 1	Master Control Parameter 2
Master, Follower Input Closed	Follower Control Parameter 3	Follower Control Parameter 4

OUTPUTS

NOTE: The installation of this motor control must conform to area and local electrical codes. See *The National Electrical Code* (NEC,) Article 430 published by the National Fire Protection Association, or *The Canadian Electrical Code* (CEC). Use local codes as applicable.

Drive Output

(J2 pins 1, 2)

Connect the Drive Output (J2 pins 1, 2) to the armature leads (A1 and A2) of your permanent magnet, DC motor. If you reverse the armature leads, then the direction of the motor rotation also reverses.

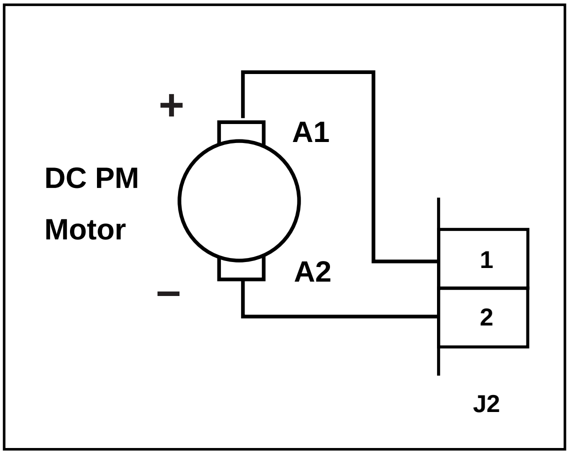


Figure 2-14 Drive Output

Drive Enable (J4 pin 16)

The Drive Enable output is activated (driven low) when the ML-Drive is signaling a nonzero speed to the motor, as defined by Drive Enable Logic (CP-74) The Drive Enable output is driven high (relay deactivated) after Power Up and during R–Stop and F–Stop. See Figure 2-15. Refer to *Operations: Logic Control, Logic Output,* page 3-37 for details.

NOTE: This is an open-collector relay driver. For specification details, see *References: Appendix A* - *ML-Drive Specifications,* page A-1. Use an external DC power supply to power the relays. Free-wheeling diodes are incorporated internally in the ML-Drive and do not need to be added externally.

Alarm (J4 pin 17)

By entering alarm Control Parameters, you can establish circumstances under which the ML-Drive will alert you to potential operating problems. The alarm can be wired to activate a warning light, a warning sound, or to shut down the system under specified conditions. Alarm Format (CP-10) determines which alarm conditions will activate the Alarm output, using the values that are entered in Low Alarm (CP-12), High Alarm (CP-13), Ramped Error (CP-14) and Scaled Error (CP-15). See Figure 2-15. Refer to *Operations: Logic Control, Logic Output,* page 3-37 for details.

NOTE: This is an open-collector relay driver. Use an external DC power supply to power the relays. Free-wheeling diodes are incorporated internally in the ML-Drive and do not need to be added externally.

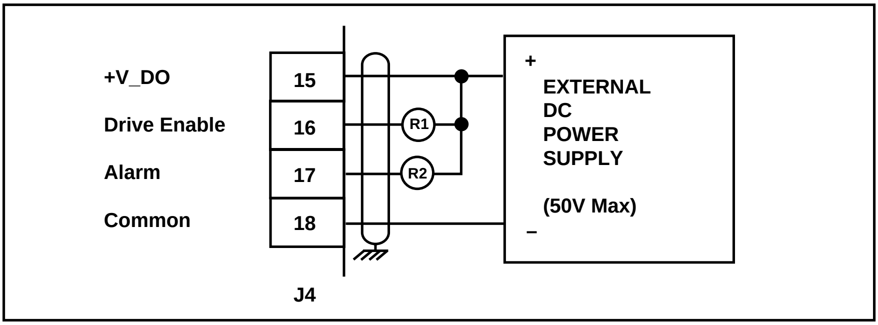


Figure 2-15 Drive Enable and Alarm Outputs

Auxiliary DC Power (J3 pin 1, 2)

The 5 volt output (J3 pin 1) is a DC regulated output that can be used to power encoders or other auxiliary equipment that is used in conjunction with the ML-Drive. If this output is used, it will nullify optical isolation.

WARNING

**Do not exceed
the maximum current output of
150 mA for +5 VDC.**

**Exceeding the maximum
current output
can damage the ML-Drive.**

SERIAL COMMUNICATIONS

NOTE: The installation of this motor control must conform to area and local electrical codes. See *The National Electrical Code* (NEC,) Article 430 published by the National Fire Protection Association, or *The Canadian Electrical Code* (CEC). Use local codes as applicable.

The Serial Communications interface on the ML-Drive complies with EIA Standard RS–485-A for balanced line transmissions. This interface allows the host computer to perform remote computer parameter entry, status or performance monitoring, and remote control of the ML-Drive. See *Operations: Serial Communications,* page 3-49 for information on using Serial Communications. The ML-Drive is designed to use with an isolated RS232 to RS485 converter.

Figure 2-16 illustrates a multidrop installation of the Serial Communications link and Figure 2-17 illustrates the Serial Communications connections.

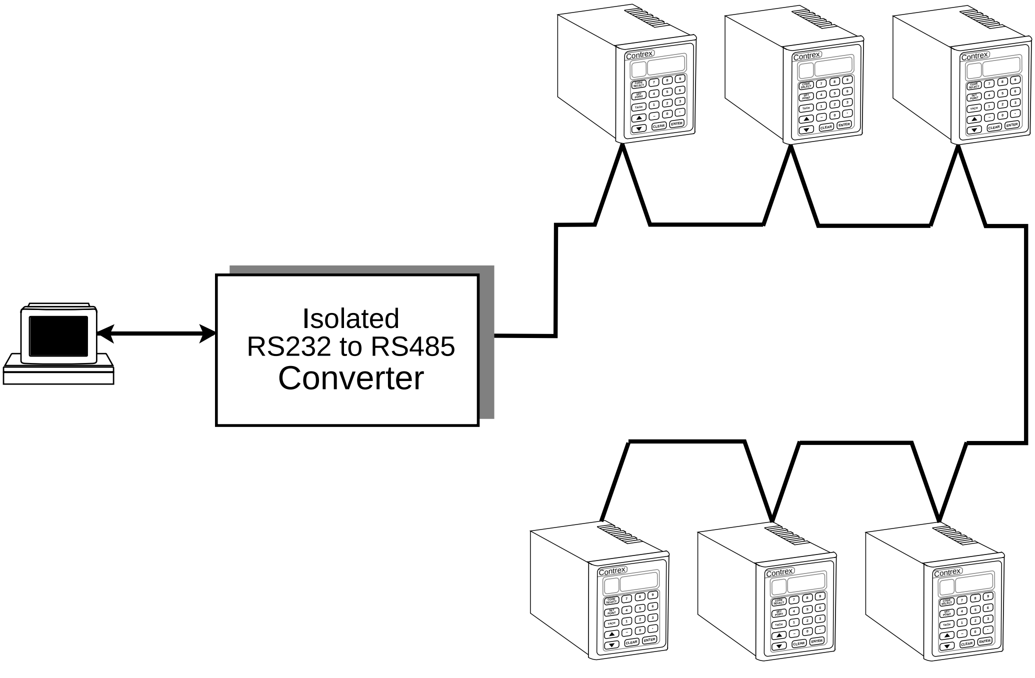
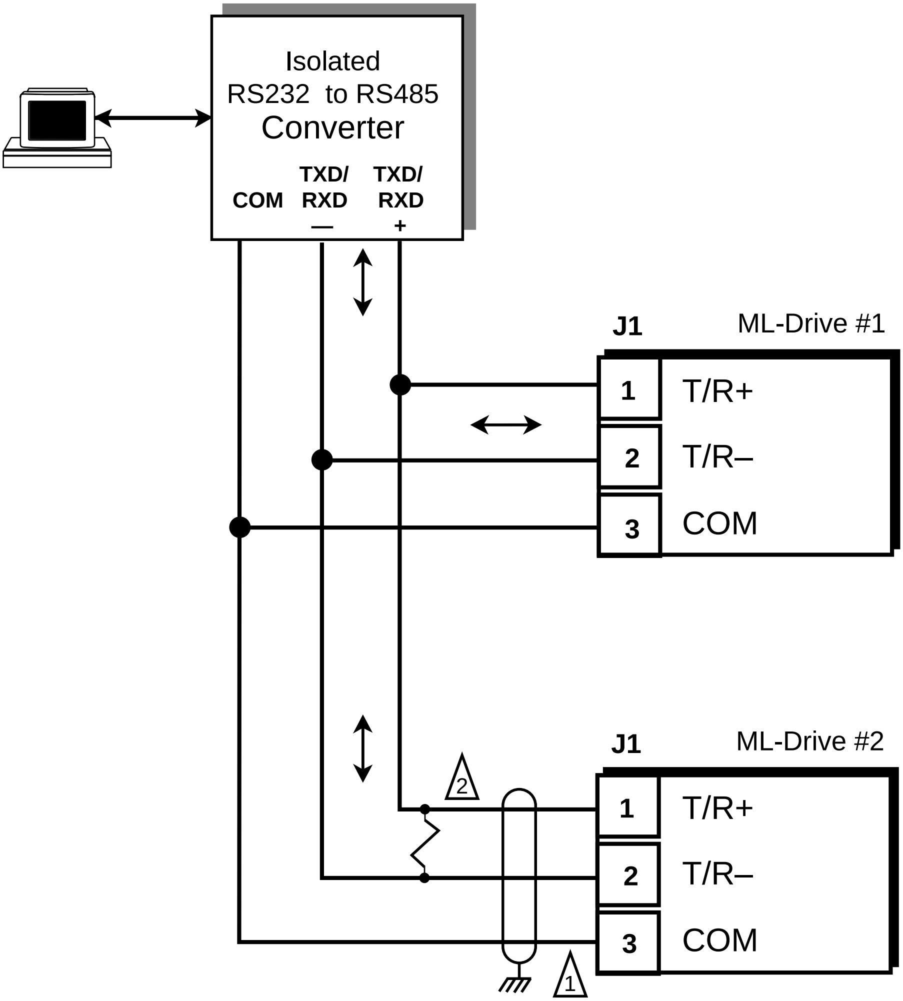


Figure 2-16 ML-Drive Multidrop Installation



1. Shield only at one end of the cable.

2. If you need to terminate the communication line, then terminate it at the unit which is the furthest away from the converter. A 100 ohm, 1/2 Watt resistor will usually terminate successfully. Refer to EIA Standard RS485A, for more information.

Figure 2-17 ML-Drive Serial Communications Connections

CALIBRATION

Calibration sets the ML-Drive's current limit. The ML-Drive must be properly installed prior to calibration. Refer to *Installation/Setup; Mounting,* page 2-3, and *Installation/Setup; Wiring*, page 2-5.

DANGER

Hazardous voltages.

Can cause severe injury, death or damage to the equipment.

Make adjustments with caution.

CURRENT LIMIT

The ML-Drive provides current limiting for both RMS continuous duty and RMS peak intermittent duty. The RMS current limit level is controlled by RMS Current Limit (CP-80). The RMS peak current level is controlled by Peak Current Limit (CP-81). The ML-Drive allows the RMS continuous duty load current to exceed the RMS Current Limit (CP-80) level for an accumulated total of one minute out of ten minutes. If the load current attempts to exceed the RMS Current Limit (CP-80) level for more than one minute, then the ML-Drive will restrict the motor current to the RMS Current Limit (CP-80) level for the remainder of the ten minute period. The RMS peak intermittent duty load current is restricted to a level that is below the value that is entered in Peak Current Limit (CP-81). See below for instructions on entering the RMS Current Limit (CP-80) and the Peak Current Limit (CP-81).

The level of the ML-Drive's RMS Current Limit (CP-80) can be set in the range of 4.0 amps to 10.0 amps. Enter the value (in amps) at which you want to set the RMS Current Limit (CP-80), as follows:

Press “Code Select”
Enter “80” (RMS Current Limit)
Press “Enter”
Enter the value at which you want to set the current limit
(range = 4.0 - 10.0 amps)
Press “Enter”

The level of the ML-Drive's Peak Current Limit (CP-81) can be set in a range of 4.0 amps to 15.0 amps. Enter the value (in amps) at which you want to set the Peak Current Limit (CP-81), as follows:

Press “Code Select”
Enter “81” (Peak Current Level)
Press “Enter”
Enter the value at which you want to set the peak current limit
(range = 4.0 - 15.0 amps)
Press “Enter”

Use Motor Current (MP-82) to display the value, in amps, of the motor armature's current:

Press “Code Select”
Enter “82” (Motor Current)
Press “Enter”
The motor armature's present RMS current is displayed, in amps

Use Current Limit Status (MP-83) to display the present status of the current limit:

Press “Code Select”
Enter “83” (Current Limit Status)
Press “Enter”
The present status of the current limit is displayed
  “0” = The ML-Drive is not in current limit
  “1” = The ML-Drive is current limiting

—NOTES—

Operation

- **Keypad Operation**
- **Keypad Lockout**
- **Control Parameters (CP)**
  - **Direct Mode**
  - **Master Mode**
  - **Follower Mode**
  - **Inverse Master Mode**
  - **Inverse Follower Mode**
  - **Acceleration/Deceleration**
  - **Tuning**
  - **Alarms**
  - **Jog**
- **Logic Control**
  - **Logic Inputs**
  - **Logic Outputs**
- **Monitor Parameters (MP)**
  - **Input Monitoring**
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  - **Performance Monitoring**
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KEYPAD OPERATION

The front panel of the ML-Drive is an easy to use keypad that gives you direct access to the Parameters (Control Parameters and Monitor Parameters) by entering the Parameter Code. You can also use the keypad to change the value of a Control Parameter. The keypad has keys for Code Select, Enter, Clear, and Scroll Up/Down. It also has numeric keys and two dedicated keys: Setpoint and Tach. The LED display is above the keys. Figure 3-1 displays the location of the keys and LED display on the keypad. Table 3-1 demonstrates basic keypad entry.

The keypad functions as follows:

Code Select Key	Press this key prior to entering a Parameter Code (either a Control Parameter or a Monitor Parameter).
Numeric Keys	Use the numeric keys to enter a Parameter Code for either a Control Parameter (CP) or a Monitor Parameter (MP) or to enter a value for a Control Parameter. Use the Enter key after each entry. Use the Clear key to delete your entry.
Dedicated Keys	The Setpoint key and the Tach key are shortcut keys. The Setpoint key accesses the active setpoint variable directly and the Tach key accesses the tach variable directly (rather than manually entering the Code Parameter).
Scroll Up/Down Keys	These keys will change the active setpoint value, even if that setpoint is not displayed in the LED Display. Each time you press the scroll up key, the active setpoint will increase by one increment. Each time you press the scroll down key, the active setpoint value will decrease by one increment. It will also automatically scroll through the increments or decrements if you hold the key down.
LED Display	The two digit Parameter Code is displayed on the left LED Display. The Parameter Code's value is displayed on the right LED display. This value can be up to four digits.

Table 3-1 Basic Keypad Entry

To Enter a Parameter Code:	Press “Code Select”. Enter a Parameter Code (For a Control Parameter or Monitor Parameter). Press “Enter” (within 15 seconds). The Parameter Code and it's current value are displayed on the LED display. The Parameter Code decimal point is illuminated.
To Enter a Parameter Value: **(For Control Parameters only - Monitor Parameters can not be changed manually)**	Follow the steps to enter a Parameter Code. Enter a new value (Use the numeric keys) . Press “Enter” (within 15 seconds). The Parameter Code decimal point turns “Off”.
To Use the Tach Key:	Press “Tach’. The scaled Engineering Unit Feedback is displayed.
To Use the Setpoint Key:	Press “Setpoint”. The active setpoint and its value are displayed.
To Use the Up/Down Scroll Keys:	Press the “Up” scroll key to increase the active setpoint value. Press the “Down” scroll key to decrease the active setpoint value.

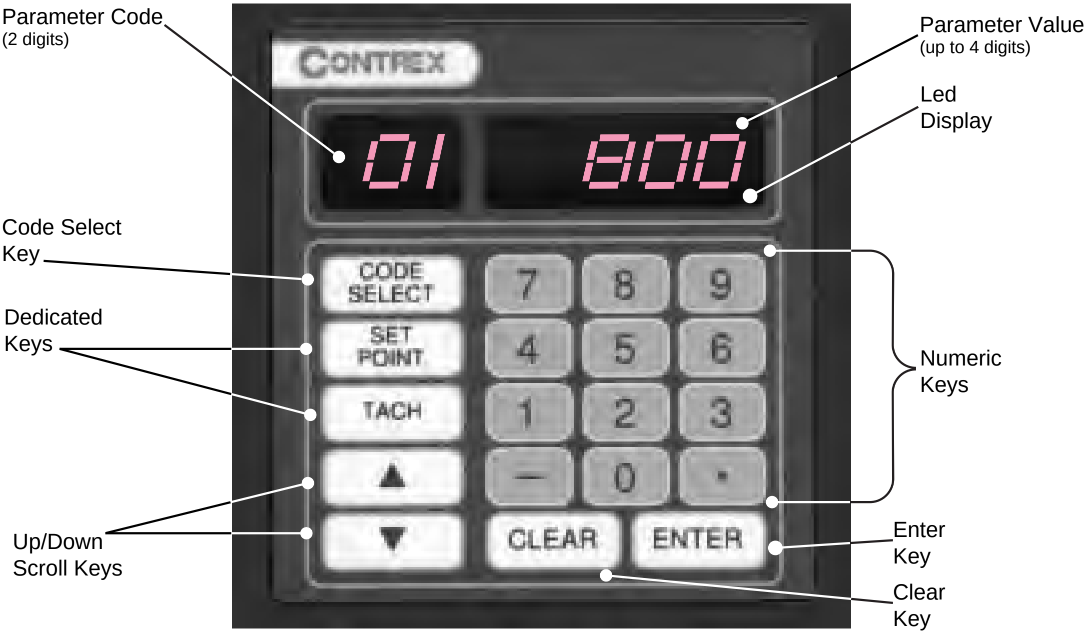
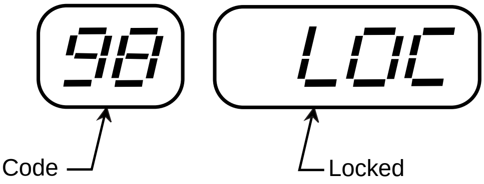


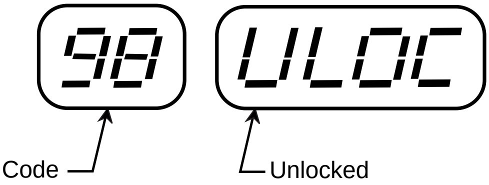
Figure 3-1 The ML-Drive Front Panel

KEYPAD LOCKOUT

Keypad Lockout (CP-98) displays the present status of the keypad lockout. When the keypad is locked, then “LOC” is displayed:



When the Keypad is unlocked, then “ULOC” is displayed:



To lock out the keypad, enter a numerical “password” between “1” and “9999” in Keypad Lockout (CP-98), then press the “enter” key. This numerical password will flash briefly on the screen, then the screen will display “LOC”. To unlock the keypad, enter the same numerical password in Keypad Lockout (CP-98). The number will flash briefly on the screen and then the screen will display “ULOC”. Control Parameters and Monitor Parameters may be monitored during lockout, however, Control Parameters can not be changed during lockout. The Clear/7 procedure will default Keypad Lockout (CP-98) to “ULOC” (unlocked).

CAUTION:

Make certain that you record your password in the space provided on page 3-6, as your password becomes transparent once you have entered it. If you forget your password, you can use the Clear/7 procedure to revert back to the default “ULOC” (unlocked). Please note, however, that the Clear/7 procedure will revert all of the Control Parameters back to their original default values and you will lose any changes that you have made to the Control Parameters. Therefore, make certain that you have recorded all Control Parameter changes in the space provided in Appendix D before you use the Clear/7 procedure. Refer to *Troubleshooting:Troubleshooting*, page 4-11 for instructions on the Clear/7 procedure. If you are uncertain how to enter a Control Parameter, review the *Operations: Keypad* section, page 3-3.

Record your numeric Keypad Lockout password here:

Please read the “CAUTION” statement on Page 3-5

CONTROL PARAMETERS

Parameters are divided into two classifications; Control Parameters (CP) and Monitor Parameters (MP). The numbered code that represents the Parameter is the Parameter Code. The operational data is the Parameter's value.

Control Parameter 05 = 50 (default)

Parameters =

Monitor Parameter 40 = 200 (arbitrary)

Parameter Code **Parameter Value**

This section is about Control Parameters. Monitor Parameters are explained in *Operation: Monitor Parameters,* page 3-39.

The ML-Drive comes factory pre-loaded with a complete set of default Control Parameters values. The majority of these default settings are suitable for most applications and do not require modification.

Control Parameters allow you to enter data that is unique to your system (e.g., encoder resolution, Lead to Follower ratios) and modify the ML-Drive for your specific needs (e.g., maximum RPMs, setpoints, acceleration/deceleration ramp rates) by entering a parameter value.

The ML-Drive is designed to execute either the Direct mode of operation, the Master (stand-alone) mode of operation or the Follower mode of operation. The values that you enter in the relevant Control Parameters, as well as the manner in which you wire your ML-Drive, determine which of the modes of operation your ML-Drive is set up for. The mode of operation that you use is determined by your systems operational requirements.

The following subsections demonstrate how to enter Control Parameters for the Direct mode, Master (stand-alone) mode or the Follower mode of operation. In addition, Control Parameters for speed change, stability, warning methods and fast forward are addressed in the subsections on Acceleration/Deceleration, Tuning, Alarms, and Jog.

Direct Mode

In the Direct mode of operation, the drive output from the ML-Drive to the motor can be set directly. Direct mode is an open-loop mode of operation. Scaling, Acceleration/ Deceleration, and closed loop compensation (PID) software are not involved in the Direct mode. The Direct mode is used in conjunction with the Run and Stop controls.

The Direct Setpoint (CP-06) is entered as a percentage of the ML-Drive's drive output. To enable or disable Direct mode, use the Direct Enable (CP-61).

The factory default Control Parameters for the Direct mode are found in Table 3-2. To modify the default parameters, refer to Table 3-3. If you are uncertain how to enter a Control Parameter, review the *Operations: Keypad* section, page 3-3.

Table 3-2 Default Direct Mode Control Parameters

CP	Parameter Name	Parameter Value
CP-06	Direct Setpoint	0
CP-61	Direct Enable	0

Table 3-3 Entering Direct Mode Control Parameters

CP	Parameter Name	Parameter Value
CP-06	Direct Setpoint	Enter the percentage of the calibrated full scale drive output at which you want your system to operate.
CP-61	Direct Enable	Enter “1” to enable the Direct Mode. Enter “0” to disable the Direct Mode.

Master Mode

The Master, or stand-alone mode of operation, is a single motor operation. In this simple mode of operation, the entire process is controlled by a single motor and one ML-Drive.

The ML-Drive allows you to control your system in Master Engineering Units (e.g., RPMs, gallons per hour, feet per minute). The Master Engineering Units at which you want the system to operate, are entered into the two available Master Setpoints (CP-01 and CP-02). However, before the ML-Drive can determine how to operate at those setpoints, you must enter Scaling Control Parameters into the ML-Drive. Scaling is a convenient method for translating the relationship of the motor RPMs into Master Engineering Units. The Scaling Control Parameters give the ML-Drive the following information:

Max RPM Feedback (CP-34)

> Measured at the sensor shaft, this number is the maximum RPMs at which you want your system to operate.

PPR Feedback (CP-31)

> The number of gear teeth or number of encoder lines on the feedback sensor per one revolution (pulses per revolution).

Master Engineering Units (CP-20)

> The actual value of the Master Engineering Units if the system were to operate at the maximum RPMs that you entered in Max RPM Feedback (CP-34).

The factory default Control Parameters for Scaling are found in Table 3-4. To modify the default parameters, refer to Table 3-5. If you are uncertain how to enter a Control Parameter, review the *Operations: Keypad* section, page 3-3. Information on setpoint entry follows Table 3-5.

Table 3-4   Default Master Scaling Control Parameters

CP	Parameter Name	Parameter Value
CP-34	Max RPM Feedback	2000
CP-31	PPR Feedback	60
CP-20	Master Engineering Units	2000

Table 3-5   Entering Master Scaling Control Parameters

CP	Parameter Name	Parameter Value
CP-34	Max RPM Feedback	Enter the maximum desired RPMs, measured at the sensor shaft.
CP-31	PPR Feedback	Enter the number of gear teeth or encoder lines on the sensor per one revolution (pulses per revolution).
CP-20	Master Engineering Units	Enter the Master Engineering Units value if the system were to operate at the maximum desired RPMs entered in CP-34.

Now that your scaling has been established, you can enter a value for Master Setpoints 1 and 2. The value that you enter for a setpoint is the Engineering Units (E.U.s) that you want to operate your system at.

The factory default Control Parameters for Master Setpoint 1 and 2 are set at “0”. To modify these default parameters, refer to Table 3-6. You can toggle between the two setpoints, if you have wired the Setpoint Select accordingly. Setpoint Select (located at J4 pins 13, 14) determines which of the two setpoints is active (refer to *Setpoint Select* on page 2-12). If you are uncertain how to enter a Control Parameter, review the *Operations: Keypad* section, page 3-3.

Table 3-6 Entering Master Setpoint Control Parameters

CP	Parameter Name	Parameter Value
CP-01	Master Setpoint 1	Enter the Master Engineering Units value that you want your system to operate at when Setpoint 1 is active.
CP-02	Master Setpoint 2	Enter the Master Engineering Units value that you want your system to operate at when Setpoint 2 is active.

An example of the Master mode of operation is demonstrated on the following page.

Master Mode Example

The following example demonstrates how scaling and setpoint Control Parameters are entered for a typical Master mode of operation:

> A pump delivers 15 gallons/minute when the motor runs at a maximum RPM of 1725. The motor shaft is equipped with a 30 tooth ring kit. The Master Engineering Units are gallons per minute. Master Setpoint 1 will be setup to pump 10 gallons per minute when it is the active setpoint. Master Setpoint 2 will be setup to pump 5 gallons per minute when it is the active setpoint.

Table 3-7 shows the scaling Control Parameters that would be entered in the ML-Drive for this example.

Table 3-7 Master Mode Control Parameters Example

CP	Parameter Name	Parameter Value
CP-34	Max RPM Feedback	1725
CP-31	PPR Feedback	30
CP-20	Master Engineering Units	15
CP-01	Master Setpoint 1	10
CP-02	Master Setpoint 2	5

After the Scaling and the Master Setpoints for your system have been entered, you can enter the Acceleration/Deceleration Control Parameters for the Master mode. The Acceleration/Deceleration Control Parameters are identical for both the Master and the Follower modes of operations. Acceleration/Deceleration is discussed in *Operation: Control Parameters, Acceleration/Deceleration,* page 3-26.

The following section demonstrates how to enter Control Parameters for the Follower mode of operation.

Follower Mode

The Follower mode of operation is the most frequently used mode of operation. It is a multi-motor operation in which the entire process can be controlled by any number of motors and ML-Drives.

The ML-Drive allows you to control your system in Follower Engineering Units (e.g., Follower to Lead ratio or percentage of RPMs, gallons per minute, feet per minute). The Follower Engineering Units that you want the system to operate at are entered into the two available Follower Setpoints (CP-03 and CP-04). However, before the ML-Drive can determine how to operate at these setpoints, you must enter Scaling Control Parameters into the ML-Drive. Scaling is a convenient method for translating the relationship of the Lead and Follower motor RPMs into Follower Engineering Units. Scaling Control Parameters give the ML-Drive the following information:

Max RPM Lead (CP-33)
: Measured at the Lead sensor shaft, this number is the maximum RPMs at which the Lead will operate in your system.

Max RPM Feedback (CP-34)
: Measured at the sensor shaft, this number is the maximum RPMs at which you want the follower to operate when the Lead is operating at its maximum RPMs.

PPR Lead (CP-30)
: The number of gear teeth or number of encoder lines on the Lead sensor per revolution (pulses per revolution).

PPR Feedback (CP-31)
: The number of gear teeth or number of encoder lines on the Follower feedback sensor per revolution.

Follower Engineering Units (CP-21)
: Enter a number that will represent the setpoint Engineering Units when the Lead and Follower are operating at their maximum RPMs. This number is usually either the ratio of Max RPM Feedback (CP-34) to Max RPM Lead (CP-33) or the ratio of Follower to Lead Engineering Units at maximum desired RPM. When this number is also entered as a setpoint (CP-03 or CP-04), the Follower will operate at maximum desired RPM when the Lead is at maximum desired RPM.

The factory default Control Parameters for Scaling are found on Table 3-8. To modify these default parameters, refer to Table 3-9. If you are uncertain how to enter a Control Parameter, review the *Operations: Keypad* section, page 3-3.

Table 3-8 Default Follower Scaling Control Parameters

CP	Parameter Name	Parameter Value
CP-33	Max RPM Lead	2000
CP-34	Max RPM Feedback	2000
CP-30	PPR Lead	60
CP-31	PPR Feedback	60
CP-21	Follower Engineering Units	1.000

Table 3-9 Entering Follower Scaling Control Parameters

CP	Parameter Name	Parameter Value
CP-33	Max RPM Lead	Enter the maximum operating RPM of the Lead motor, measured at the Lead sensor shaft (pulses per revolution).
CP-34	Max RPM Feedback	Enter the maximum desired RPM of the Follower motor, measured at the Follower feedback sensor shaft.
CP-33	PPR Lead	Enter the number of gear teeth or encoder lines on the Lead sensor.
CP-31	PPR Feedback	Enter the number of gear teeth or encoder lines on the Follower feedback sensor.
CP-21	Follower Engineering Units	Enter the Engineering Units value if the Lead (CP-33) is operating at maximum RPM and the Follower (CP-34) is operating at maximum RPM.

With your scaling established, you can enter values for Follower Setpoints 1 and 2 (CP-03, CP-04). The value that you enter for a setpoint is the ratio of the Follower E.U.s at which you want to operate the system, divided by the E.U.s that the Lead is operating at.

$$\textbf{Setpoint} = \frac{\textbf{Follower E.U. desired}}{\textbf{Lead E.U. operation}}$$

You can toggle between the two setpoints, if you have wired the Setpoint Select accordingly. Setpoint Select (located at J4 pins 13, 14), determines which of the two setpoints is active (refer to *Setpoint Select* on page 2-12). The factory preset, default Follower Setpoints 1 and 2 (CP-03 and CP-04) are set at “0”. To modify these default parameters, refer to Table 3-10.

Table 3-10 Entering Follower Setpoint Control Parameters

CP	Parameter Name	Parameter Value
CP-03	Follower Setpoint 1	Divide the Follower E.U. that you want, by the Lead E.U. that the Lead is operating at, and enter that value.
CP-04	Follower Setpoint 2	Divide the Follower E.U. that you want, by the Lead E.U. that the Lead is operating at, and enter that value.

Examples of the Follower mode of operation are demonstrated on the following pages.

Follower Mode Examples A and B

Example A demonstrates how scaling and setpoint Control Parameters are entered for a typical Follower mode of operation that uses a ratio setpoint:

> The Lead pump delivers 10 gallons/minute when the motor is running at a maximum RPM of 1725. The Lead sensor shaft is equipped with a 60 tooth Ring kit. The Follower pump delivers 30 gallons/minute when the motor is running at a maximum RPM of 1800. The Follower sensor shaft is equipped with a 30 tooth ring kit. Follower Setpoint 1 will be set so that when the Lead pump delivers 5 gallons/minute, the Follower pump will deliver 15 gallons/minute. Follower Setpoint 2 will be set so that when the Lead pump delivers 5 gallons/minute, the Follower pump will deliver 22.5 gallons/minute.

Table 3-11 shows the Control Parameters that would be entered in the ML-Drive for Example A.

To find the ratio for the Follower Engineering Units (CP-21) for Example A:

$$\textbf{Follower E.U. (CP-21)} = \frac{\textbf{Follower E.U. at Max Follower RPM}}{\textbf{Lead E.U. at Max Lead RPM}} = \frac{\mathbf{30}}{\mathbf{10}} = \mathbf{3}$$

30 gal / min The Follower Engineering Units when the Follower is operating at the maximum RPM.

Divided by

10 gal / min The Lead Engineering Units when the Lead is operating at maximum RPM.

Equals

3.00 Follower Engineering Units (CP-21) as a ratio of Follower to Lead.

To find Follower Setpoint 1 (CP-03) for Example A:

$$\textbf{Setpoint 1} = \frac{\textbf{Follower E.U. desired}}{\textbf{Lead E.U. operation}} = \frac{15}{5} = 3$$

15 gal/min The Follower Engineering Units (gallon per minute) at which you want the Follower to operate.

Divided by

5 gal/min The Lead Engineering Units that the Lead is operating at.

Equals

3.00 Follower Setpoint 1 (CP-03) value.

To find Follower Setpoint 2 (CP-04) for Example A:

$$\textbf{Setpoint 2} = \frac{\textbf{Follower E.U. desired}}{\textbf{Lead E.U. operation}} = \frac{22.5}{5} = 4.50$$

22.5 gal/min The Follower Engineering Units (gallon per minute) at which you want the Follower to operate.

Divided by

5 gal/min The Lead Engineering Units (gallon per minute) that the Lead is operating at.

Equals

4.50 Follower Setpoint 2 (CP-04) value.

Table 3-11 Follower Mode Control Parameters Example A

CP	Parameter Name	Parameter Value
CP-33	Max RPM Lead	1725
CP-34	Max RPM Feedback	1800
CP-30	PPR Lead	60
CP-31	PPR Feedback	30
CP-21	Follower E.U.	3.00
CP-03	Follower Setpoint 1	3.00
CP-04	Follower Setpoint 2	4.50

The ML-Drive will adjust and monitor the speed of the Follower motor to achieve the desired gallons/minute. This completes the scaling and setpoint information for Example A. Example B is discussed in the following section.

Example B demonstrates how scaling and setpoint Control Parameters are entered for a typical Follower mode of operation that uses a percentage setpoint:

> The Lead pump delivers 20 gallons/minute of ingredient A. The Lead motor's is running at a maximum RPM of 1800 and the Lead sensor shaft is equipped with a 60 tooth ring kit. The Follower pump delivers 10 gallons/minute of ingredient B. The Follower motor is running at a maximum RPM of 1800 and the Follower sensor shaft is equipped with a 60 tooth Ring kit. Follower Setpoint 1 will be set so that when the Lead pump delivers 20 gallons/minute of ingredient A, the Follower will deliver 10 gallons/minute of ingredient B. Setpoint 2 will be set so when the Lead pump delivers 10 gallons/minute of ingredient A, the Follower pump will delivers 7 gallons/minute of ingredient B.

Table 3-12 shows the Control Parameters that would be entered in the ML-Drive for Example B.

To find the ratio for the Follower Engineering Units (CP-21) for Example B:

$$\textbf{Follower E.U. (CP-21)} = \frac{\textbf{Follower E.U. at Max Follower RPM}}{\textbf{Lead E.U. at Max Lead RPM}} = \frac{10}{20} \ \textbf{X} \ \textbf{100(\%)} = \textbf{50}$$

10 gal/min — The Follower Engineering Units when the Follower is operating at maximum RPM

Divided by

20 gal/min — The Lead Engineering Units when the Lead is operating at maximum RPM

Multiplied by 100 (%) equals

50 — Follower Engineering Units (CP-21) as a percent of Follower to Lead.

To find Follower Setpoint 1 (CP-03) for Example B:

$$\textbf{Setpoint 1} = \frac{\textbf{Follower E.U. desired}}{\textbf{Lead E.U. operation}} \times \textbf{100 (\%)}$$

10 gal/min	The Follower Engineering Units (gallons/minute of ingredient B) at which you want the Follower to operate.

Divided by

20 gal/min	The Lead Engineering Units (gallons/minute of ingredient A) that the Lead is operating at.

Multiplied by 100 (%) Equals

50	Follower Setpoint 1 (CP-03) value.

To find Follower Setpoint 2 (CP-04) for Example B:

$$\textbf{Setpoint 2} = \frac{\textbf{Follower E.U. desired}}{\textbf{Lead E.U. operation}} \times \textbf{100 (\%)}$$

7 gal/min	The Follower Engineering Units (gallons/minute of ingredient B) at which you want the Follower to operate.

Divided by

10 gal/min	The Lead Engineering Units (gallons/minute of ingredient A) that the Lead is operating at.

Multiplied by 100(%) Equals

70	Follower Setpoint 2 (CP-04) value.

Table 3-12 Follower Mode Control Parameters Example B

CP	Parameter Name	Parameter Value
CP-33	Max RPM Lead	1800
CP-34	Max RPM Feedback	1800
CP-30	PPR Lead	60
CP-31	PPR Feedback	30
CP-21	Follower E.U.	50
CP-03	Follower Setpoint 1	50
CP-04	Follower Setpoint 2	70

The ML-Drive will adjust and monitor the speed of the motors to achieve the desired gallons/minute. That completes the scaling and setpoint information for Example B.

After the Control Parameters for the Scaling and for the Follower setpoint have been entered, you can enter the Control Parameters for the Acceleration/Deceleration of the Follower mode. The Control Parameters for Acceleration/Deceleration are identical for both the Master and the Follower modes of operations. Acceleration/Deceleration is discussed in *Operation: Control Parameters, Acceleration/Deceleration,* page 3-26.

Inverse Master Mode

The Inverse Master Mode is a variation of the Master Mode. The Inverse Master Mode has an inverted setpoint. If you increase the value of the setpoint (CP-01 or CP-02), then the motor speed will decrease. Inverse Mode setpoints generally use engineering units of time.

With the Inverse Scaling (CP-62) set to “2”, enter values in the Master Setpoints (CP-01 and CP-02) that represent the E.U. at which you want the system to operate. The higher the setpoint value; the slower the motor speed. Inversely, the lower the setpoint value; the higher the motor speed.

The ML–Drive comes factory pre-loaded with the default Control Parameters for the standard Master Mode. These default settings are not suitable for Inverse applications and require modification. The factory default Control Parameters for the standard Master Mode are found in Table 3-13. To modify these default parameters, refer to Table 3-14. If you are uncertain how to enter a Control Parameter, review the *Operations: Keypad* section, page 3-3.

Table 3-13 Default Inverse Master Control Parameters

CP	Parameter Name	Parameter Value
CP-62	Inverse Scaling	1 (Standard Scaling)
CP-20	Master E.U.	2000

Table 3-14 Entering Inverse Master Control Parameters

CP	Parameter Name	Parameter Value
CP-62	Inverse Scaling	Enter “2” for Inverse Scaling.
CP-20	Master E.U.	Enter the minimum Master Engineering Units value if the system were to operate at the maximum RPMs entered in (CP-34).

Inverse Master Mode Example

The Inverse Master Mode Example demonstrates how scaling and setpoint Control Parameters are entered for a typical Inverse Master mode of operation:

> It takes 10 seconds to move a product through a heat treat oven when the conveyor motor is running at 1500 RPM. The conveyor motor shaft is equipped with a 60 tooth ring kit. Set Master Setpoint 1 (CP-01) so that the product is in the oven for 20 seconds. Set Master Setpoint 2 (CP-02) so that the product is in the oven for 15 seconds.

Table 3-15 shows the scaling Control Parameters that would be entered in the ML–Drive for this example.

Table 3-15 Inverse Master Mode Control Parameters Example

CP	Parameter Name	Parameter Value
CP-62	Inverse Scaling	2
CP-31	PPR Feedback	60
CP-34	Max RPM Feedback	1500
CP-20	Master E.U.	10.0
CP-01	Master Setpoint 1	20.0
CP-02	Master Setpoint 2	15.0

After the Scaling and the Master Setpoints for your system have been entered, you can enter the Acceleration/Deceleration Control Parameters for the Inverse Master mode. The Acceleration/Deceleration Control Parameters are identical for both the Inverse Master and the Inverse Follower modes of operations. Acceleration/Deceleration is discussed in *Operation: Control Parameters, Acceleration/Deceleration,* page 3-26.

The following section demonstrates how to enter Control Parameters for the Inverse Follower mode of operation.

Inverse Follower Mode

The Inverse Follower Mode is a variation of the Follower Mode. The Inverse Follower Mode has an inverted setpoint. If you increase the value of the setpoint (CP-03 or CP-04), then the ratio of Follower speed to Lead speed will decrease.

With the Inverse Scaling (CP-62) set to “2”, enter values in the Follower Setpoints (CP-03 and CP-04) that represent the E.U. at which you want the system to operate. The higher the setpoint value; the lower the Follower to Lead ratio speed.

The ML–Drive comes factory pre-loaded with the default Control Parameters for the standard Follower Mode. These default settings are not suitable for Inverse applications and require modification. The factory default Control Parameters for the standard Follower Mode are found in Table 3-16. To modify these default parameters, refer to Table 3-17. If you are uncertain how to enter a Control Parameter, review the *Operations: Keypad* section, page 3-3.

Table 3-16 Default Inverse Follower Control Parameters

CP	Parameter Name	Parameter Value
CP-62	Inverse Scaling	1 (Standard Scaling)
CP-21	Follower E.U.	1.000

Table 3-17 Entering Inverse Follower Control Parameters

CP	Parameter Name	Parameter Value
CP-62	Inverse Scaling	Enter “2” for Inverse Scaling.
CP-21	Follower E.U.	Enter the minimum Engineering Units if the system were to operate at the Max RPM Lead (CP-33) and the Max RPM Feedback (CP-34).

Inverse Follower Mode Example

The Inverse Follower Mode Example demonstrates how the scaling and setpoint Control Parameters are entered for a typical Inverse Follower mode of operation:

> In a wire machine twisiting application, the Follower twists the wire as the Lead pulls the wire. When the Follower is at the maximum revolutions per minute of 1800 RPM and the Lead is at the maximum revolutions per minute of 2000 RPM, then the twist length (lay) is at its minimum of 2.0 inches. The Follower motor uses a 1200 PPR encoder and the Lead motor shaft is equipped with a 60 tooth ring kit. Follower Setpoint 1 is setup for the minimum twist lay of 2.0 inches. Follower Setpoint 2 is setup for a twist lay of 5.0 inches.

Table 3-18 shows the scaling Control Parameters that would be entered in the ML–Drive for this example.

Table 3-18 Inverse Follower Mode Control Parameters Example

CP	Parameter Name	Parameter Value
CP-62	Inverse Scaling	2
CP-30	PPR Lead	60
CP-31	PPR Feedback	1200
CP-33	Max RPM Lead	2000
CP-34	Max RPM Feedback	1800
CP-21	Follower E.U.	2.0
CP-03	Follower Setpoint 1	2.0
CP-04	Follower Setpoint 2	5.0

After the Scaling and the Follower Setpoints for your system have been entered, you can enter the Acceleration/Deceleration Control Parameters for the Inverse Follower mode. The Acceleration/Deceleration Control Parameters are identical for both the Inverse Master and the Inverse Follower modes of operations. Acceleration/ Deceleration is discussed in the following section.

Acceleration/Deceleration

Acceleration/Deceleration (CP-16 and CP-17) control the rate of speed change in response to setpoint changes. These parameters apply to both the Master and Follower modes of operation.

The ML-Drive comes factory pre-loaded with default Control Parameters for Acceleration/Deceleration. Generally, these default settings are suitable for most applications and do not require modification. The factory default Control Parameters for Timing are found in Table 3-19. To modify these default parameters, refer to Table 3-20. If you are uncertain how to enter a Control Parameter, review the *Operations: Keypad* section, page 3-3.

Table 3-19 Default Master or Follower Acceleration/Deceleration Control Parameters

CP	Parameter Name	Parameter Value
CP-16	Acceleration Time	5.0
CP-17	Deceleration Time	5.0

Table 3-20 Entering Master or Follower Acceleration/Deceleration Control Parameters

CP	Parameter Name	Parameter Value
CP-16	Acceleration Time	Enter the desired number of seconds to increase the motor speed from 0 to 2000 RPMs.
CP-17	Deceleration Time	Enter the desired number of seconds to decrease the motor speed from 2000 to 0 RPMs.

After the Control Parameters for Acceleration/Deceleration have been entered, you can enter the Control Parameters for Tuning either the Master or the Follower mode. The tuning Control Parameters are identical for both the Master and the Follower modes of operations. Tuning is discussed in the following section.

Tuning

If your system is unstable, or the speed error is unacceptable, tuning stabilizes speed error differences between the setpoint and feedback. You can achieve a stable system using conservative tuning Control Parameter values, however the speed error may be unacceptable. On the other hand, aggressive tuning Control Parameter values may cause the system to become unstable. The goal is to reduce the speed error to the level that you want, yet maintain the system's stability.

Before you adjust the PID parameters (CP-65,66,67), you will need to set the Feedforward (CP-68). To accomplish this, run the ML-Drive in the Master mode of operation, using the default PID parameters and a setpoint value of 1000 RPM. When the ML-Drive has reached stability at 1000 RPM, enter the value of the PIDF Output (MP-49) into Feedforward (CP-68).

To achieve an acceptable level of speed error, adjust the Gain (CP-65) until the system stabilizes. In systems that require greater accuracy, it may be necessary to adjust the Integral (CP-66) to reduce any remaining speed error. In systems with low inertia, the speed error will be reduced more quickly if you enter low values in Integral (CP-66). An entry that is too low, however, can create instability or overshoot the setpoint before reaching the correct value. Generally, use larger entries for Integral (CP-66) on systems with a large inertia. Sometimes performance can be improved in systems with a large inertia by lowering the Derivative (CP-67). Refer to Table 3-22 to modify the Control Parameters for Tuning.

The ML-Drive comes factory pre-loaded with default Control Parameters for Tuning. These default settings are suitable for most applications and do not require modification. The factory preset, default tuning Control Parameters are found in Table 3-21. If you are uncertain how to enter a Control Parameter, review the *Operations: Keypad* section, page 3-3.

Table 3-21 Default Master or Follower Tuning Control Parameters

CP	Parameter Name	Parameter Value
CP-65	Gain (Proportional)	5000
CP-66	Integral	2000
CP-67	Derivative	9000
CP-68	Feedforward	1000

Table 3-22 Entering Master / Follower Tuning Control Parameters

CP	Parameter Name	Parameter Value
CP-65	Gain (Proportional)	With Integral (CP-66) set to “0” , reduce the Gain (CP-65) until the system becomes unstable, then increase it slightly until the system stabilizes. Reduced values will increase Gain. To verify the stability of the speed changes, you can access Tach through either the Tach key or the Monitor Parameter for Tach (MP-40).
CP-66	Integral	While switching between the high and low setpoints, decrease the Integral's default value of “2000” until the speed error is reduced within an acceptable time frame. To verify the stability of the speed changes, you can access Tach through either the tach key or the Monitor Parameter for Tach (MP-40).
CP-67	Derivative	The Derivative should not be adjusted in most systems. However, sometimes in the larger inertia systems you can improve performance by lowering the Derivative term to the point of instability and then increasing it incrementally until the system stabilizes.
CP-68	Feedforward	When the ML -Drive has reached stability at 1000 RPM, enter the value of PIDF Output (MP-49) into Feedforward (CP-68).

After the Control Parameters for Tuning have been entered, you can enter the Control Parameters for the Alarms for either the Master or the Follower mode. Alarms are discussed in the following section.

Alarms

The Control Parameters for Alarms are identical for both the Master and the Follower modes of operations. By entering values in the Control Parameters for the Alarms, you can establish circumstances under which the ML-Drive will alert you to potential operating problems.

Use Alarm Format (CP-10) to establish the circumstances under which the ML-Drive will alert you to potential operating problems. The alarm can be wired to activate a warning light, a warning sound, or to shut down the system under specified conditions, as listed below:

0 = No Alarm
1 = Low Alarm
2 = High Alarm
3 = Low Alarm or High Alarm
4 = Ramped Error
5 = Low Alarm or Ramped Error
6 = High Alarm or Ramped Error
7 = Low Alarm or High Alarm or Ramped Error
8 = Scaled Error
9 = Low Alarm or Scaled Error
10 = High Alarm or Scaled Error
11 = Low Alarm or High Alarm or Scaled Error
12 = Ramped Error or Scaled Error
13 = Low Alarm or Ramped Error or Scaled Error
14 = High Alarm or Ramped Error or Scaled Error
15 = Low Alarm or High Alarm or Ramped Error or Scaled Error

Alarm Format (CP-10) determines which alarm conditions will activate the Alarm output, using the values that you enter in Low Alarm (CP-12), High Alarm (CP-13), Ramped Error Alarm (CP-14) and Scaled Error Alarm (CP-15). In Low Alarm (CP-12), enter the RPMs at or below which you want the Alarm Output to activate. In High Alarm (CP-13), enter the RPMs at or above which you want Alarm output to activate. In Ramped Error Alarm (CP-14) enter the RPM deviation between the ramped setpoint and the feedback that will activate the Alarm output (at or above). In Scaled Error Alarm (CP-15) enter the RPM deviation between the scaled setpoint and the feedback that will activate the Alarm output (at or above).

The ML-Drive comes factory pre-loaded with default Control Parameters for Alarms. These default parameter values are set for widely generic conditions that generally will not activate the alarm. This allows you to either operate your system unfettered by the alarm or design your own alarm conditions that are unique to your system. The factory default Control Parameters for the Alarms are found in Table 3-23 To modify these default parameters, refer to Table 3-24. If you are uncertain how to enter a Control Parameter, review the *Operations: Keypad* section, page 3-3.

Table 3-23 Default Alarms Control Parameters

CP	Parameter Name	Parameter Value
CP-10	Alarm Format	15
CP-12	Low Alarm	0
CP-13	High Alarm	2000
CP-14	Ramped Error Alarm	2000
CP-15	Scaled Error Alarm	2000

Table 3-24 Entering Alarms Control Parameters

CP	Parameter Name	Parameter Value
CP-10	Alarm Format	This Control Parameter determines the circumstances under which the ML–Drive will alert you to potential operating problems. The alarm can be wired to activate a warning light, a warning sound, or to shut down the system under specified conditions. Alarm Format (CP-10) determines which alarm conditions will activate the Alarm output, using the values that are entered in Low Alarm (CP-12), High Alarm (CP-13), Ramped Error Alarm (CP-14) and Scaled Error Alarm (CP-15).
CP-12	Low Alarm	Enter the RPMs at or below which you want the Alarm output to activate.
CP-13	High Alarm	Enter the RPMs at or above which you want the Alarm output to activate.
CP-14	Ramped Error Alarm	Enter the RPM Deviation between the Ramped Reference and the feedback that will activate the Alarm output.
CP-15	Scaled Error Alarm	Enter the RPM Deviation between the Scaled Reference and the feedback that will activate the Alarm output.

Jog

Jog increases the RPMs at the acceleration rate that you specified in Acceleration Time (CP-16) until the Jog Setpoint (CP-05) is achieved. When Jog is terminated, there is no Deceleration Time (CP-17); the drive comes to an immediate stop. The factory default Control Parameter for Jog is found in Table 3-25. To modify this default parameter, refer to Table 3-26. If you are uncertain how to enter a Control Parameter, review the *Operations: Keypad* section, page 3-3.

Table 3-25 Default Jog Control Parameters

CP	Parameter Name	Parameter Value
CP-05	Jog Setpoint	50

Table 3-26 Entering Jog Control Parameters

CP	Parameter Name	Parameter Value
CP-05	Jog Setpoint	Enter the RPM at which you want your system to operate when it is in Jog.

For information on the Jog Logic Input, refer to *Logic Control: Logic Inputs, Jog,* page 3-36.

LOGIC CONTROL

This section addresses the four digital inputs that control the ML-Drive's operating state. Logic Control also addresses one digital output.

The four digital inputs are F–Stop, R–Stop, Run and Jog. When the ML-Drive is powered up, it defaults to R–Stop. If either Run or Jog have been hardwired, the ML-Drive will operate in either Run or Jog instead of R–Stop. Run is hardwired by shorting Run, R–Stop and F–Stop to common. Jog is hardwired by shorting Jog, R–Stop, and F–Stop to common.

The one digital output is Drive Enable. The Drive Enable output indicates the state of the drive output.

The sections that follow demonstrate how to use the digital inputs and the Drive Enable output.

Caution

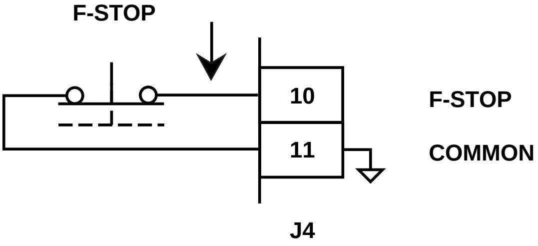
Do not use the AC line power to start or stop the system. Use the Digital Inputs to start or stop the system.

Logic Inputs

F–Stop has priority over the other operating states. F–Stop brings the ML-Drive's drive output to an immediate Zero.

To activate F–Stop:

- Open the F–Stop Input. (F–Stop is latched and does not need to be maintained to remain active.)

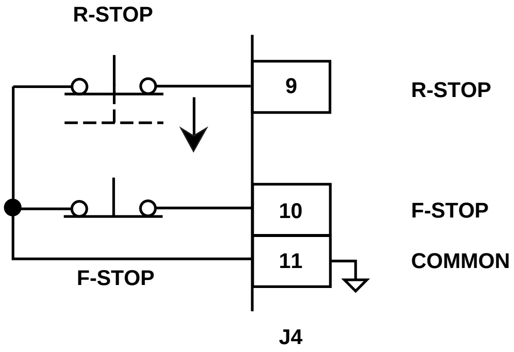


Open Momentarily

R–Stop has the second highest operating priority. R–Stop decelerates the drive output to Zero, using the Deceleration Time (CP-17).

To activate R–Stop:

- Short the F–Stop input to common.
- Open the R–Stop input. (R–Stop is latched and does not need to be maintained to remain active.)

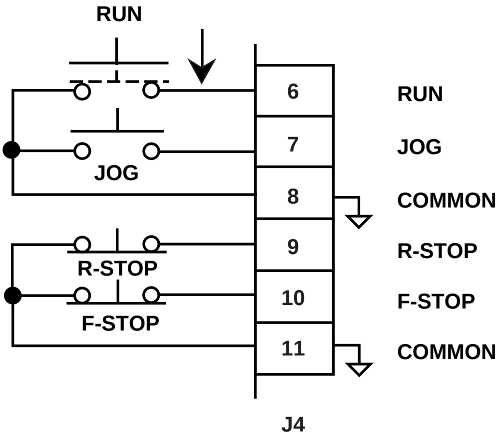


Open Momentarily

Run has the third highest operating priority. Run ramps to the scaled setpoint speed, using the Acceleration Time (CP-16). Run can be activated when the ML-Drive is in R–Stop or F–Stop, however Run cannot be activated when the ML-Drive is in Jog.

To activate Run:

- Short the F–Stop and R–Stop inputs to common.
- Open the Jog input.
- Short the Run input to common. (Run is latched and does not need to be maintained to remain active.)

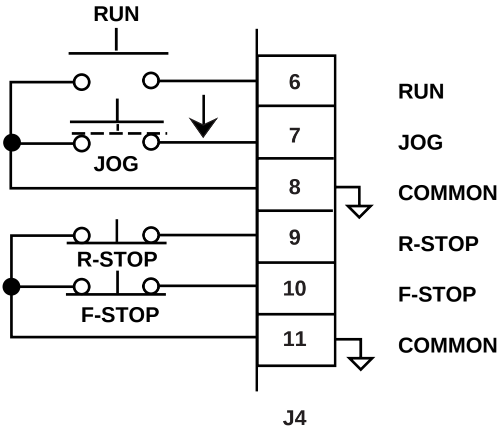


Close Momentarily

Jog has the least operating priority. Jog ramps to the Jog Setpoint (CP-05), using the Acceleration Time (CP-16). When Jog is terminated, the ML-Drive brings the drive output to an immediate Zero. Unlike the other inputs, Jog is not latched and must be sustained to remain active.

To activate Jog:

- Short the F–Stop and R–Stop inputs to common.
- Open the Run input.
- Short the Jog input to common. (Jog must be sustained to remain active).



Maintain Closed

Logic Output

The Drive Enable output is controlled by the Ramped Reference (MP-46) and the feedback. Drive Enable Logic (CP-74) determines which conditions of the Ramped Reference (MP-46) and feedback will control the Drive Enable output. The Ramped Reference (MP-46) is the calculated setpoint that is output from the Acceleration/ Deceleration routine.

The factory default for Drive Enable Logic (CP-74) is found in Table 3-27. To modify this default parameter, refer to Table 3-28. If you are uncertain how to enter a Control Parameter, review the *Operations: Keypad* section, page 3-3.

Table 3-27 Default Drive Enable Logic Control Parameter

CP	Parameter Name	Parameter Value
CP-74	Drive Enable Logic	0

Table 3-28 Entering Drive Enable Logic Control Parameter

CP	Parameter Name	Parameter Value
CP-74	Drive Enable Logic	Enter “0” in CP-74 to **deactivate** the Drive Enable output (output high) when the Ramped Reference is zero, and **activate** the Drive Enable output (output low) when the Ramped Reference is **not** zero. Enter “1” in CP-74 to **deactivate** the Drive Enable output when both the Ramped Reference and the feedback are zero, and **activate** the Drive Enable output when the Ramped Reference is **not** zero.

—NOTES—

MONITOR PARAMETERS

Parameters are divided into two classifications; Control Parameters (CP) and Monitor Parameters (MP). The numbered code that represents the Parameter is the Parameter Code. The operational data is the Parameter's value.

Control Parameter 05 = 50 (default)

Parameters =

Monitor Parameter 40 = 200 (arbitrary)

Parameter Code **Parameter Value**

This section is about Monitor Parameters. Control Parameters are explained in *Operation: Control Parameters,* page 3-7.

The ML-Drive has a number of Monitor Parameters (MPs) that monitor the performance of the ML-Drive and your system, troubleshoot for problems, and confirm the wiring and tuning. MPs can be accessed at any time during the ML-Drive's operation, including during Run, Jog, R–Stop and F–Stop.

Note: Monitor Parameters are status indicators only - you can not directly affect a MP.

There are four categories of Monitor Parameters:

Input Monitoring.
Output Monitoring.
Performance Monitoring.
Status Monitoring.

In the subsections that follow, the Monitor Parameters are listed according to these categories.

Input Monitoring

These MPs monitor the ML-Drive's inputs.

MP-41 LEAD FREQUENCY

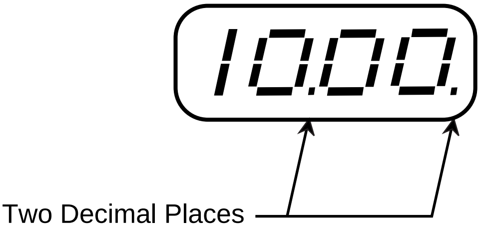
The Lead Frequency (MP-41) displays the frequency of the Lead Frequency Input (J4 pin 3) in units of hertz (pulses per second). The Lead Frequency (MP-41) is not averaged or filtered; it is the ten millisecond frequency calculation prior to the display update. Because the Lead Frequency (MP-41) is not averaged or filtered and because of sensor irregularities, it may appear less stable than Tach (MP-40).

Numbers that are larger than 9999 are displayed with two decimal places. For example, 10,000 hertz is displayed like the figure below in MP-43.

MP-43 FEEDBACK FREQUENCY

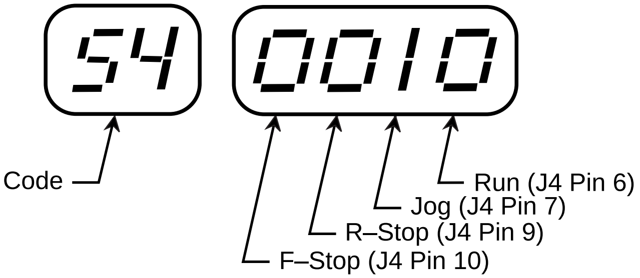
The Feedback Frequency (MP-43) displays the frequency of the Feedback Frequency input (J4 pin 4) in units of hertz (pulses per second). The Feedback Frequency (MP-43) is not averaged or filtered; it is the ten millisecond frequency calculation prior to the display update. Because the Feedback Frequency (MP-43) is not averaged or filtered and because of sensor irregularities, it may appear less stable than Tach (MP-40).

Numbers that are larger than 9999 are displayed with two decimal places. For example, 10,000 hertz is displayed as follows:



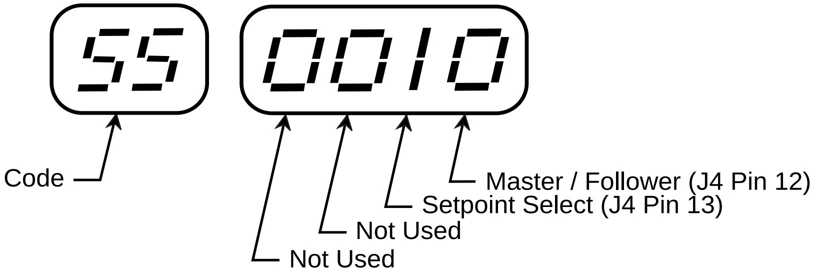
MP-54 LOGIC INPUTS - GROUP A

The Logic Inputs - Group A (MP-54) displays the status of the Run, Jog, R–Stop and F–Stop digital inputs. The number “1” indicates an open, or logic high level. The number “0” indicates a closed, or logic low level (shorted to common). In the example below, “Jog” is the open or logic high level.



MP-55 LOGIC INPUTS - GROUP B

The Logic Inputs - Group B (MP-55) displays the status of the Master/Follower and Setpoint Select digital inputs. The number “1” indicates an open, or logic high level. The number “0” indicates a closed, or logic low level (shorted to common). In the example below, “Setpoint Select” is the open or logic high level.



Output Monitoring

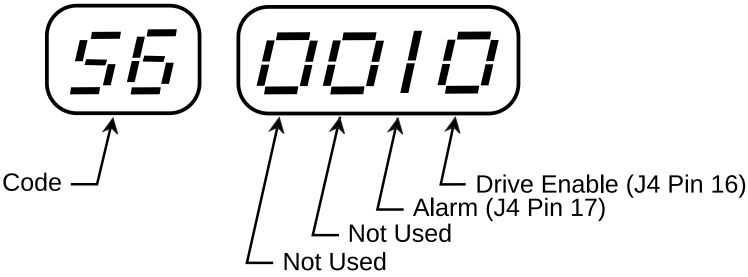
These MPs monitor the ML-Drive's outputs.

MP-47 DRIVE OUTPUT

The Drive Output (MP-47) displays the drive output to the motor (J2 pin 1, 2). Drive Output is displayed as a percentage; 100 represents 100% of the drive output.

MP-56 LOGIC OUTPUTS

The Logic Outputs (MP-56) displays the status of the Drive Enable and the Alarm digital outputs. The number “1” indicates an inactive or de-energized (logic high) level. The number “0” indicates an active or energized (logic low) level. In the example below, “Alarm” is the inactive or de-energized (logic high) level.



Performance Monitoring

Performance Monitor Parameters monitor the performance of the ML-Drive and your system. Figure 3-2 is a block diagram of the internal control structure of the ML-Drive and the Performance Monitor Parameters.

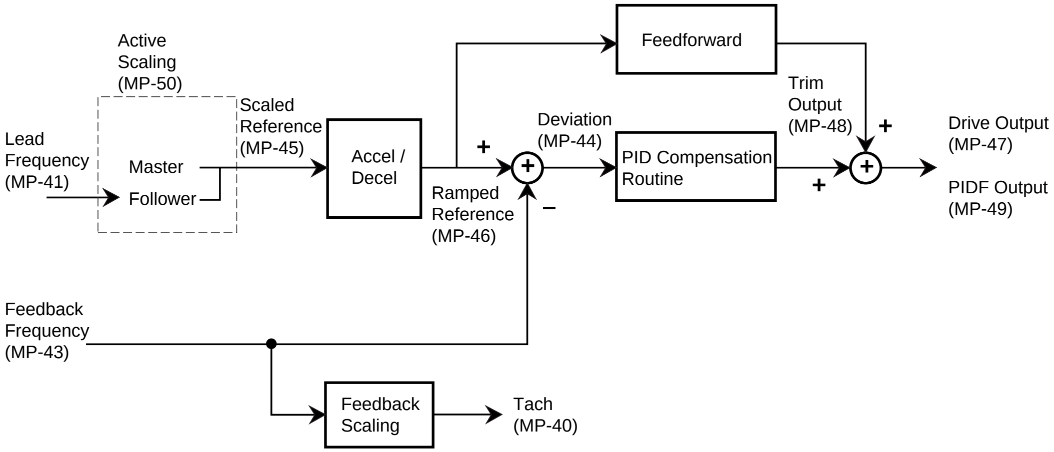


Figure 3-2 ML-Drive Internal Structure

MP-40 TACH

Tach (MP-40) is the feedback displayed in scaled Engineering Units or RPM. In the Master mode, Tach (MP-40) will display the feedback in Master Engineering Units (CP-20). In the Follower mode, Tach (MP-40) will display either Master Engineering Units or the feedback to Lead ratio in Follower Engineering Units (CP-21), depending on the value in Display Mode Follower (CP-64). In Jog or the Direct mode, Tach (MP-40) will display the feedback in RPMs. The feedback is read by the ML-Drive every ten milliseconds. The readings are summed, then averaged for one second before the Tach is displayed.

MP-44 DEVIATION (ERROR)

Deviation (MP-44) displays the difference between the Ramped Reference (MP-46) and the Feedback Frequency (MP-43) measured in units of hertz (pulses per second). Deviation (MP-44) is not averaged or filtered; it is the ten millisecond frequency calculation prior to the display update.

MP-45 SCALED REFERENCE

The Scaled Reference (MP-45) is the scaled setpoint number converted to hertz. It is the calculated value that is input to the Acceleration/Deceleration routine. This parameter may display numbers that are larger than 9999. These larger values are displayed with two decimal places. For example, 10,000 hertz is displayed as “10.00.”.

MP-46 RAMPED REFERENCE

The Ramped Reference (MP-46) is the calculated output of the Acceleration/ Deceleration routine in hertz. It is the setpoint input to the PID compensation routine. This parameter may display numbers that are larger than 9999. These larger values are displayed with two decimal places. For example, 10,000 hertz is displayed as “10.00.”.

MP-47 DRIVE OUTPUT

The Drive Output (MP-47) displays the drive output level to the motor (J2 pin 1, 2). Drive Output is displayed as a percentage; 100 represents 100% of the drive output.

MP-48 TRIM OUTPUT

The Trim Output (MP-48) is the calculated output of the PID Compensation routine. The Trim Output (MP-48) added to the feedforward equals the Drive Output (MP-47). The Trim Output is represented in DAC (Digital-to-Analog Converter) bits where 4096 equals 100% output, 2048 equals 50% output, etc.

MP-49 PIDF OUTPUT

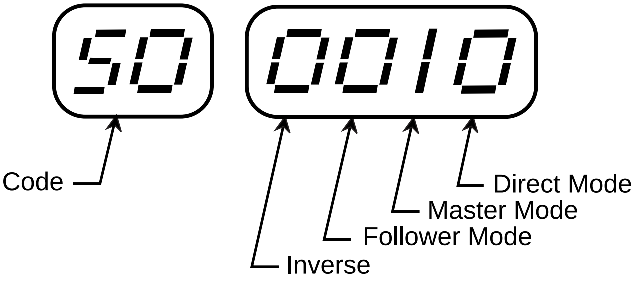
The PIDF Output (MP-49) is the total calculated output of the PID Compensation routine added to the feedforward. The PIDF Output is represented in DAC (Digital-to-Analog Converter) bits where 4096 equals 100% output, 2048 equals 50% output, etc.

Status Monitoring

These MPs monitor the status of the ML-Drive's modes of operation and operating states.

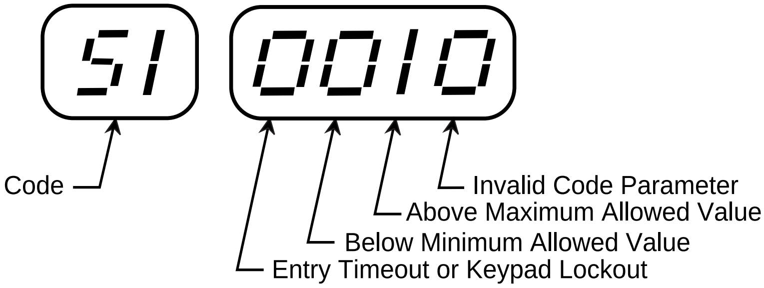
MP-50 ACTIVE SCALING MODE

The digit that displays a number “1” is the active Scaling mode. In the example below, “Master Mode” is the active Scaling mode.



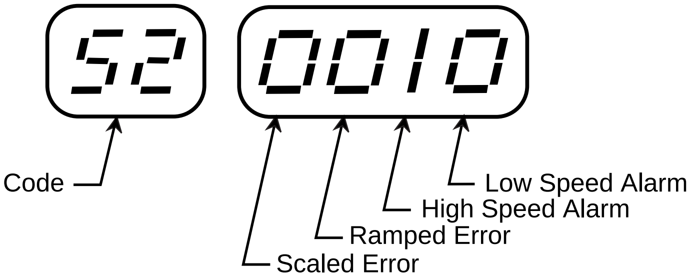
MP-51 KEYPAD ERROR

If a Control Parameter entry has been rejected, Keypad Errors (MP-51) will ascertain the reason that it was rejected. The digit that displays a number “1” is the error. In the example below, “Above Maximum Allowed Value” is the error.



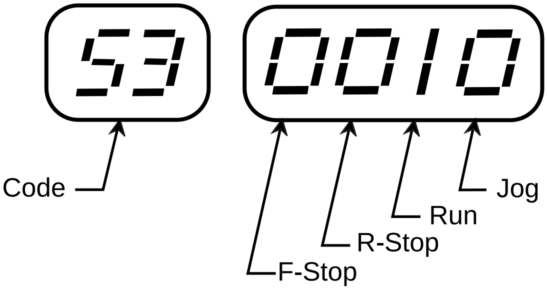
MP-52 ALARM STATUS

The digit that displays a number “1” is the active Alarm. In the example below, “High Speed Alarm ” is the active alarm.



MP-53 CONTROL STATE

The digit that displays a number “1” is the active control state of the ML-Drive. In the example below, “Run” is the active control state.



MP-57 EEPROM STATUS

The Control Parameters are stored in the EEPROM memory chip. EEPROM Status (MP-57) displays the status of the EEPROM memory chip. The number “0” indicates no failure. The number “1” indicates a write verify error. In the event of an error, call Technical Support at (612) 424-7800 or 1-800-342-4411.

MP-59 FREQUENCY OVERFLOW COUNTER

The Frequency Overflow Counter (MP-59) is a counter that increments each time the frequency input to the ML-Drive causes an overflow. To reset the counter to “0”, press the Clear key.

MP-82 MOTOR CURRENT

Motor Current (MP-82) displays the value, in amps, of the motor armature's RMS current.

MP-83 CURRENT LIMIT STATUS

Current Limit Status (MP-83) displays the present status of the current limit . When the ML-Drive is current limiting, then the number “1” is displayed. When the ML-Drive is not in current limit, then the number “0” is displayed.

—NOTES—

SERIAL COMMUNICATIONS

The ML-Drive can interface with a host computer through a RS485 Serial Communications Interface. This interface allows the host computer to perform remote Control Parameter entry, status or performance monitoring, and remote control of the ML-Drive. Refer to *Using Serial Communications,* page 3-50, in this section.

If you are using the M-Host software, your communications network is user ready and does not require any software programming. M–Host software is available through your distributor. If you are designing your own software, refer to *Communications Software Design,* page 3-52, in this section. Once the software is installed, you are ready to establish a link through the Serial Communications Interface.

Using Serial Communications

This section describes how to use the Serial Communications. Before you can apply this section, The ML-Drive must be interfaced with a host computer through a RS485 Serial Communications Interface. The host computer must have the M-Host software or its equivalent installed.

The ML-Drive comes factory pre-loaded with default Control Parameters for Serial Communications Setup. These Control Parameters physically set up the ML-Drive to accommodate the RS485 Serial Communications Interface. Generally, the default settings are suitable for most applications and do not require modification. The factory default Control Parameters for Serial Communications Setup are found in Appendix D. These default parameters can be modified, using the Serial Communications Interface.

CP-70 DEVICE ADDRESS

The ML-Drive has a physical address which can be set from 1 to 32. Each individual ML-Drive on a multidrop RS485 communications link needs a unique Device Address. The address “00” will be globally accepted by all of the ML-Drives on a communications link, however, they will not send a response message back to the host computer when this global address is used.

CP-71 BAUD RATE

There are six different baud rates (data rates) for the ML-Drive. Enter the number, for the required function, as listed below.

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

CP-72 CHARACTER FORMAT

The ML-Drive uses three different character formats. Enter the number for the required format, as listed below.

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

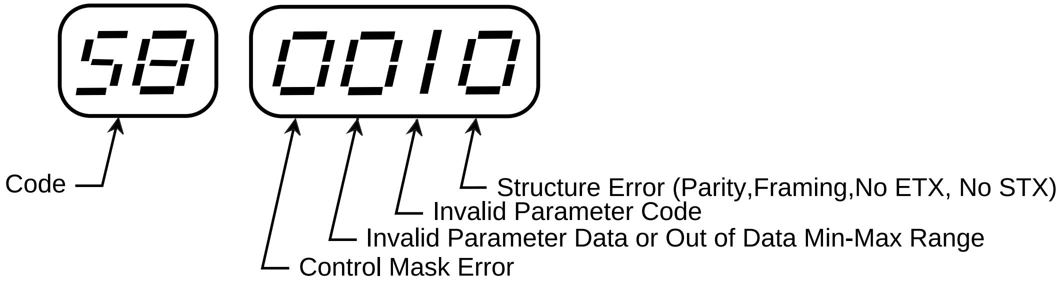
CP-73 CONTROL MASK

The Serial Communications can control some of the digital input functions. Enter the number for the required functions, as listed below.

0 = F–Stop only
1 = F–Stop, Run, R–Stop
2 = F–Stop, Master/Follower, Setpoint Select
3 = All of the Above

MP-58 SERIAL COMMUNICATIONS ERROR

Serial Communications Error identifies errors in the last transmitted message that was sent to the ML-Drive by the host computer. The mode that displays a number “1” indicates the error. In the example below, “Invalid Parameter Code” is the error.



Communications Software Design

The ML-Drive Serial Communications Interface uses a polling technique to establish a link with the host computer. With the exception of Keypad Lockout (CP-98), all of the Control Parameters and Monitor Parameters that are accessible through the ML-Drive's front panel keypad are also accessible through the Serial Communications Interface. The host computer sends a twelve character record to the ML-Drive to establish the link and the ML-Drive responds with either a conformation or an error message. Once the ML-Drive responds, the host computer can send additional transmissions.

All of the ML-Drive's messages use the USA Standard Code for Information Interchange (ASCII). The host computer sends three types of messages;

Parameter Send - To change CPs.
Control Command Send - To control operating states.
Data Inquiry - To monitor CPs and MPs.

These three message types, their character level descriptions in binary and ASCII, as well as the ML-Drive's response record, are outlined in the sections that follow.

Parameter Send

Use the Parameter Send to change any of the ML-Drive's Control Parameters.

Table 3-29 Parameter Send - Host Transmission

Character #	1	2	3	4	5	6	7	8	9	10	11	12
DESC	STX	DEV # 10s	DEV # 1s	MSG TYPE	PAR # 10s	PAR # 1s	DATA 1000s	DATA 100s	DATA 10s	DATA 1s	DATA FORM	ETX
ASCII	STX	0-9	0-9	3	0-9	0-9	0-9	0-9	0-9	0-9	0-8	ETX

The following is a description of the Parameter Send-Host Transmission Characters.

Character 1 - STX:

This is the first character in the character string. None of the other characters will be recognized without this character prefix. Always use the ASCII “STX” character; it enables the ML-Drive's receive buffer.

Characters 2, 3 - Device #:

These characters are the access address of the ML-Drive. This number identifies individual ML-Drives on a mutltidrop system. The ML-Drive will accept data only if this number matches the ML-Drive's address (CP-70), with the exception of a “00” address. The “00” address is universally accepted by all of the ML-Drives that are on the RS485 Serial Communications Interface.

Character 4 - Message Type:

This character should always be “3”.

Character 5, 6 - Parameter Number:

These characters identify the Control Parameter that you want to change (i.e., “16” = CP-16).

Characters 7 through 10 - DATA:

These characters transmit the new value for a Control Parameter that you want to change. The Data must be within the range specified in Appendix D.

Character 11 - Data Format:

Character 11 indicates the decimal location and polarity of the data that was transmitted in characters 7 through 10. Use the following codes to indicate decimal location and polarity:

Code	Format
0	+XXXX
1	+XXX.X
2	+XX.XX
3	+X.XXX
4	-XXXX
5	-XXX.X
6	-XX.XX
7	-X.XXX
8	+XX.XX.

Codes “0 ” through “7” are valid for CP-20 and CP-21. All other Code Parameters have either fixed or derived decimal locations and must use Code “0”. Code “8” does not apply to the parameter send.

Character 12 - ETX:

Always use the ASCII “ETX” character to terminate the character string.

Example of Parameter Send:

A new Acceleration Time of 52.3 seconds is sent to the ML-Drive at address 4.

ASCII character string: “STX0431605230ETX”

Note: The character string has no spaces between the integers.

Table 3-30 Parameter Send - ML-Drive Response

Character #	1	2	3	4	5	6	7	8	9	10	11	12
DESC	STX	DEV # 10s	DEV # 1s	ERROR CODE	PAR # 10s	PAR # 1s	DATA 1000s	DATA 100s	DATA 10s	DATA 1s	DATA FORM	ETX
ASCII	STX	0-9	0-9	@-DEL	0-9	0-9	0-9	0-9	0-9	0-9	0-8	ETX

The following is a description of the Parameter Send-ML-Drive Response Characters.

Character 1 - STX:

This is the first character in the character string.

Characters 2, 3 - Device #:

This is the two character access address for the ML-Drive.

Character 4 - Error Code:

If there are errors in the transmission that the ML-Drive receives from the host computer, the Error Code will display them. Use Table 3-35 (page 3-66) to convert the ASCII code to binary. The binary code can be decoded as follows:

Bit 7	Always “0”.
Bit 6	Always “1”.
Bit 5	1 = Data was out of minimum/maximum range.
Bit 4	1 = Checksum or Decimal Point Error, Invalid Parameter Code.
Bit 3	1 = Receive buffer filled before “ETX” received or Message Format Error.
Bit 2	1 = Invalid Parameter Data.
Bit 1	1 = Parity Error.
Bit 0	1 = Always “0”

Note: The ML-Drive will only accept data if there are no errors. The ASCII error code “@” (Binary code “1000000”) indicates that the Host Transmission contains no errors.

Characters 5,6 - Parameter Number:

The Control Parameter code is sent back to the host computer from the ML-Drive.

Characters 7 through 10 - DATA:

The Control Parameter data is sent back to the host computer from the ML-Drive.

Character 11 - Data Format:

The Data Format character is sent back to the host computer from the ML-Drive.

Character 12 - ETX:

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

Control Command Send

The Control Command Send allows the host computer to control the operating functions of the ML-Drive that are associated with the digital inputs (Run, Stop, Setpoint Select and Master/Follower).

Table 3-31 Control Command Send - Host Transmission

Character #	1	2	3	4	5	6	7	8	9	10	11	12
DESC	STX	DEV # 10s	DEV # 1s	MSG TYPE	PAR # 10s	PAR # 1s	DATA 1000s	DATA 100s	DATA 10s	DATA 1s	DATA FORM	ETX
ASCII	STX	0-9	0-9	1	0	0	0	0	0-1	0-9	0	ETX

The following is a description of the Control Command Send - Host Transmission.

Character 1 - STX:

This is the first character in the character string. None of the other characters will be recognized without this character prefix. Always use the ASCII “STX” character; it enables the ML-Drives receive buffer.

Characters 2, 3 - Device #:

These characters are the access address of the ML-Drive. This number identifies individual ML-Drives on a mutltidrop system. The ML-Drive will accept data only if this number matches the ML-Drive's address (CP-70), with the exception of a “00” address. The “00” address is universally accepted by all ML-Drives that are on the RS485 Serial Communications Interface.

Character 4 - Message Type:

This character should always be “1”.

Characters 5,6 - Parameter Number:

These characters should always be “0”.

Characters 7 through 8 - DATA:

These characters should always be “0”.

Characters 9,10- DATA:

01	F–Stop
02	R–Stop
03	Run
04	Enable Master Mode
05	Enable Follower Mode
06	Not in Use
07	Not in Use
08	Not in Use
09	Not in Use
10	Enable Setpoint 1/3
11	Enable Setpoint 2/4
12	Not in Use
13	Not in Use
14	Not in Use
15	Not in Use

Character 11 - Data Format:

This character should always be “0”.

Character 12 - ETX:

Always use the ASCII “ETX” character to terminate the character string.

Table 3-32 Control Command Send - ML-Drive Response

Character #	1	2	3	4	5	6	7	8	9	10	11	12
DESC	STX	DEV # 10s	DEV # 1s	ERROR CODE	PAR # 10s	PAR # 1s	DATA 1000s	DATA 100s	DATA 10s	DATA 1s	DATA FORM	ETX
ASCII	STX	0-9	0-9	@-DEL	0	0	0	0	0-9	0-9	0	ETX

The following is a description of the Control Command Send-ML-Drive Response Characters.

Character 1 - STX:

This is the first character in the character string.

Characters 2, 3 - Device #:

This is the two character access address for the ML-Drive.

Character 4 - Error Code:

If there are errors in the transmission that the ML-Drive receives from the host computer, the Error Code will display them. Use Table 3-35 (page 3-66) to convert the ASCII code to binary. The binary code can be decoded as follows:

Bit 7	Always “0”.
Bit 6	Always “1”.
Bit 5	1 = Data was out of minimum/maximum range.
Bit 4	1 = Checksum or Decimal Point Error, Invalid Parameter Code.
Bit 3	1 = Receive buffer filled before “ETX” received or Message Format Error.
Bit 2	1 = Invalid Parameter Data.
Bit 1	1 = Parity Error.
Bit 0	1 = Always “0”

Note: The ML-Drive will only accept data if there are no errors. The ASCII error code “@” (Binary code “1000000”) indicates that the Host Transmission contains no errors.

Characters 5,6 - Parameter Number:

These characters will always be “0”.

Characters 7 through 10 - DATA:

These characters will always be “0”.

Character 11 - Data Format:

This character will always be “0”.

Character 12 - ETX:

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

Data Inquiry

Use the Data Inquiry to request the current value for Parameters (i.e., Control Parameters or Monitor Parameters).

Table 3-33 Data Inquiry - Host Transmission

Character #	1	2	3	4	5	6	7	8	9	10	11	12
DESC	STX	DEV # 10s	DEV # 1s	MSG TYPE	PAR # 10s	PAR # 1s	DATA 1000s	DATA 100s	DATA 10s	DATA 1s	DATA FORM	ETX
ASCII	STX	0-9	0-9	2	0-9	0-9	0	0	0	0	0	ETX

The following is a description of the Data Inquiry - Host Transmission Characters.

Character 1 - STX:

This is the first character in the character string. None of the other characters will be recognized without this character prefix. Always use the ASCII “STX” character; it enables the ML-Drives receive buffer.

Characters 2, 3 - Device #:

These characters are the access address of the ML-Drive. This number identifies individual ML-Drives on a mutltidrop system. The ML-Drive will accept data only if this number matches the ML-Drive's address (CP-70), with the exception of a “00” address. The “00” address is universally accepted by all ML-Drives that are on the RS485 Serial Communications Interface.

Character 4 - Message Type:

This character should always be “2”.

Characters 5,6 - Parameter Number:

This is the Control Parameter code (i.e., enter “16” for CP–16).

Characters 7 through 10 - DATA:

These characters should always be “0”.

Character 11 - Data Format:

This character should always be “0”.

Character 12 - ETX:

Always use the ASCII “ETX” character to terminate the character string.

Table 3-34 Data Inquiry - ML-Drive Response

Character #	1	2	3	4	5	6	7	8	9	10	11	12
DESC	STX	DEV # 10s	DEV # 1s	ERROR CODE	PAR # 10s	PAR # 1s	DATA 1000s	DATA 100s	DATA 10s	DATA 1s	DATA FORM	ETX
ASCII	STX	0-9	0-9	@-DEL	0-9	0-9	0-9	0-9	0-9	0-9	0-;	ETX

The following is a description of the Data Inquiry-ML-Drive Response Characters.

Character 1 - STX:

This is the first character in the character string.

Characters 2, 3 Device #:

This is the two character access address for the ML-Drive.

Character 4 -Error Code:

If there are errors in the transmission that the ML-Drive receives from the host computer, the Error Code will display them. Use Table 3-35 (page 3-66) to convert the ASCII code to binary. The binary code can be decoded as follows:

Bit 7	Always “0”.
Bit 6	Always “1”.
Bit 5	1 = Data was out of minimum/maximum range.
Bit 4	1 = Checksum or Decimal Point Error, Invalid Parameter Code.
Bit 3	1 = Receive buffer filled before “ETX” received or Message Format Error.
Bit 2	1 = Invalid Parameter Data.
Bit 1	1 = Parity Error.
Bit 0	1 = Always “0”

Note: The ML-Drive will only accept data if there are no errors. The ASCII error code “@” (Binary code “1000000”) indicates that the Host Transmission contains no errors.

Characters 5,6 - Parameter Number:

The Control Parameter code is sent back to the host computer from the ML-Drive.

Characters 7 through 10 - DATA:

The Control Parameter data that was requested is sent back to the host computer from the ML-Drive.
For an interpretation of the MP-50 through MP-56, and CP-73 data, refer to Table 3-36 (page 3-67). For the ASCII to binary conversion, refer to Table 3-35 (page 3-66).

Character 11 - Data Format:

Character 11 indicates the decimal location and polarity of the data that was transmitted in characters 7 through 10.
Use the following codes to indicate decimal location and polarity:

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

Codes “0” through “7” are valid for CP-20 and CP-21. All other Code Parameters have either fixed or derived decimal locations and must use Code “0”. Code 8 is valid for MP-41 amd MP-43. For codes 9, :, and ; multiply characters 7 through 10 by ten.

Character 12 - ETX:

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

Table 3-35 ASCII to Binary

ASCII	Binary	**ASCII**	Binary	**ASCII**	Binary	**ASCII**	Binary
	Bit 7 Bit 1		Bit 7 Bit 1		Bit 7 Bit 1		Bit 7 Bit 1
NUL	0000000	SP	0100000	@	1000000	'	1100000
SOH	0000001	!	0100001	A	1000001	a	1100001
STX	0000010	"	0100010	B	1000010	b	1100010
EXT	0000011	#	0100011	C	1000011	c	1100011
EOT	0000100	$	0100100	D	1000100	d	1100100
ENQ	0000101	%	0100101	E	1000101	e	1100101
ACK	0000110	&	0100110	F	1000110	f	1100110
BEL	0000111	'	0100111	G	1000111	g	1100111
BS	0001000	(	0101000	H	1001000	h	1101000
HT	0001001	)	0101001	I	1001001	i	1101001
LF	0001010	*	0101010	J	1001010	j	1101010
VT	0001011	+	0101011	K	1001011	k	1101011
FF	0001100	,	0101100	L	1001100	l	1101100
CR	0001101	-	0101101	M	1001101	m	1101101
SO	0001110	.	0101110	N	1001110	n	1101110
SI	0001111	/	0101111	O	1001111	o	1101111
DLE	0010000	0	0110000	P	1010000	p	1110000
DC1	0010001	1	0110001	Q	1010001	q	1110001
DC2	0010010	2	0110010	R	1010010	r	1110010
DC3	0010011	3	0110011	S	1010011	s	1110011
DC4	0010100	4	0110100	T	1010100	t	1110100
NAK	0010101	5	0110101	U	1010101	u	1110101
SYN	0010110	6	0110110	V	1010110	v	1110110
ETB	0010111	7	0110111	W	1010111	w	1110111
CAN	0011000	8	0111000	X	1011000	x	1111000
EM	0011001	9	0111001	Y	1011001	y	1111001
SUB	0011010	:	0111010	Z	1011010	z	1111010
ESC	0011011	;	0111011	[	1011011	{	1111011
FS	0011100	<	0111100	\	1011100	|	1111100
GS	0011101	=	0111101	]	1011101	}	1111101
RS	0011110	>	0111110	^	1011110	~	1111110
US	0011111	?	0111111	–	1011111	DEL	1111111

Position on Binary Code String	Monitor Parameters and Corresponding Binary Numbers															
	MP-50		MP-51		MP-52		MP-53		MP-54		MP-55		MP-56		CP-73	
	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
0	Direct Mode Inactive	Direct Mode Active	Valid Parameter Code	Invalid Parameter Code	No Low Speed Alarm	Low Speed Alarm	No Jog	Jog	Run Low	Run High	Follower	Master	Drive Enable Low	Drive Enable High	Not in Use	F-Stop
1	Master Mode Inactive	Master Mode Active	Below Max	Above Max Value	No High Speed Alarm	High Speed Alarm	No Run	Run	Jog Low	Jog High	Setpoint 1 or 3	Setpoint 2 or 4	Alarm Low	Alarm High	Not in Use	F-Stop Run R-Stop
2	Follower Mode Inactive	Follower Mode Active	Above Mim	Below Min Value	No Ramped Error Alarm	Ramped Error Alarm	No R-Stop	R-Stop	R-Stop Low	R-Stop High	Not in Use	Not in Use	Not in Use	Not in Use	Not in Use	F-Stop Master/ Follower Setpoint Select
3	Inverse Mode Inactive	Inverse Mode Active	No Timeout or Lockout	Entry Timeout or Keypad Lockout	No Scaled Error Alarm	Scaled Error Alarm	No F-Stop	F-Stop	F-Stop Low	F-Stop High	Not in Use	Not in Use	Not in Use	Not in Use	Not in Use	All of Above
4	Always “1”	Always “1”	Always “1”	Always “1”	Always “1”	Always “1”	Always “1”	Always “1”	Always “1”	Always “1”	Always “1”	Always “1”	Always “1”	Always “1”	Always “1”	Always “1”
5	Always “1”	Always “1”	Always “1”	Always “1”	Always “1”	Always “1”	Always “1”	Always “1”	Always “1”	Always “1”	Always “1”	Always “1”	Always “1”	Always “1”	Always “1”	Always “1”
6	Always “0”	Always “0”	Always “0”	Always “0”	Always “0”	Always “0”	Always “0”	Always “0”	Always “0”	Always “0”	Always “0”	Always “0”	Always “0”	Always “0”	Always “0”	Always “0”
7	Always “0”	Always “0”	Always “0”	Always “0”	Always “0”	Always “0”	Always “0”	Always “0”	Always “0”	Always “0”	Always “0”	Always “0”	Always “0”	Always “0”	Always “0”	Always “0”

Table 3-36 Binary to Monitor Parameters

—NOTES—

Troubleshooting

Diagnostics
Troubleshooting
PROM Chip Replacement

DIAGNOSTICS

This section describes how to use the diagnostic routines to verify that the ML-Drive is operating properly as well as to identify any ML-Drive problems. The diagnostic routines are run independently, with the ML-Drive temporarily disconnected from your system. Begin diagnostics with the Clear/4 procedure, then run tests 1-5. Each of the tests can be performed without repeating the Clear/4 procedure, unless you exit diagnostics.

If you need to verify the integrity of the ML-Drive relative to your system, refer to the *Troubleshooting: Troubleshooting* section, page 4-11. If the information in this section does not solve your problem, consult:

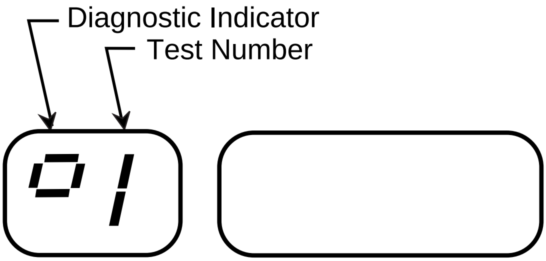
Contrex Technical Support (763) 424-7800 or 800-342-4411

Clear/4 - To Begin the Diagnostic Procedure

To begin the diagnostic procedure, turn the ML-Drive off and disconnect it from your system.

Turn the power on the ML-Drive while simultaneously pressing “Clear” and “4” on the keypad.

The ML-Drive defaults to RAM Test #1. The Diagnostic indicator and the number “1” are visible on the left side of the LED display. If you did not see this indicator, you are not in diagnostics. The example below shows the diagnostic indicator and test number on the LED display.



RAM Test #1 - To Test Random Access Memory

Clear/4 will automatically default to RAM Test #1. The diagnostic indicator and the number “1” will be visible on the left side of the LED display. To enter this test from another diagnostic test, press the UP or DOWN scroll keys until the number “1” is visible in the left side of the LED display.

Press “Enter” to start the test.

> If RAM fails, “---5” is displayed. The test will stop if a failure is detected. Press “Clear ” to exit the test.
>
> IF the RAM is good, the ML-Drive will display “0.0.0.0”

Press “Clear” to exit the test.
Press “CODE SELECT” only if you want to exit diagnostics.

Display Test #2 - To Test the LED Display Panel Segments

Press the “UP” or “DOWN” scroll keys until the diagnostic indicator and the number “2” are visible on the left side of the LED display.

Press “Enter” to start the test.

The ML-Drive will quickly run through all of the display variations. Watch each of the display variations carefully for missing segments. For example, a nine with missing segments could look like a seven. The ML-Drive will display the following:

```
00 0000                    0.0.  0.0.0.0.
11 1111                    1.1. 1.1.1.1.
22 2222                    2.2. 2.2.2.2.
33 3333                    3.3. 3.3.3.3.
44 4444                    4.4. 4.4.4.4.
55 5555                    5.5. 5.5.5.5.
66 6666                    6.6. 6.6.6.6.
77 7777                    7.7. 7.7.7.7.
88 8888                    8.8. 8.8.8.8.
99 9999                    9.9. 9.9.9.9.
❐❐ ❐❐❐❐             ❐        .❐. ❐.❐.❐.❐.
❏❏ ❏❏❏❏             ❏        .❏. ❏.❏.❏.❏.
– –  – – – –               –. –.  –. –. –. –.

– –  – – – –               –. –.  –. –. –. –.

– –  – – – –               –. –.  –. –. –. –.
```

The right side of the LED display will be blank after the ML-Drive has completed the display variations.

The ML-Drive automatically exits the test.
Press “CODE SELECT” only if you want to exit diagnostics.

Keypad Test #3 - To Test the Keypad

Press the “UP” or “DOWN” scroll keys until the diagnostic indicator and the number “3” are visible on the left side of the LED display.

Press “Enter” to start the test. The ML-Drive displays the number “15” for the “Enter” key.

Press each of the keypad keys and verify against the following list:

Press	Display
–	–
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
CODE SELECT	10
SETPOINT	11
TACH	12
▲	13
▼	14
ENTER	15
* CLEAR	No display

* If “Clear” is functioning, pressing “Clear” will take you out of the Keypad test. If “Clear” is not functioning, it will not take you out of the test and the number of the prior key will remain on the LED display.

Press “Clear” to exit the test.
Press “CODE SELECT” only if you want to exit diagnostics.

Input Test #4 - To Test the Logic Inputs

Press the “UP” or “DOWN” scroll keys until the diagnostic indicator and the number “4” are visible on the left side of the LED display.

Press “Enter” to start the test.

The LED display will be blank unless an input has been shorted. If an input has been shorted, it's number will display. For example, if the number three appears in the display, then R–Stop has been shorted. To test an input, short that input and open all of the other inputs.

Input Closure	Display
RUN (J4-6)	1
JOG (J4-7)	2
R–STOP (J4-9)	3
F–STOP (J4-10)	4
MASTER/FOLLOWER (J4-12)	5
SETPOINT SELECT (J4-13)	6

Press CLEAR to exit the test.
Press “CODE SELECT” only if you want to exit diagnostics.

Output Test #5 - To Test the Logic Outputs

Press the “UP” or “DOWN” scroll keys until the diagnostic indicator and the number “5” are visible on the left side of the LED display.

Only the diagnostic indicator and the number “5” will be visible on the LED display during this test. To run this test, connect the outputs to a pull up resistor and either a meter or LED, or connect the outputs to a relay and either lights or sound.

Press “Enter” to start the test.

Press keys 1 - 2 to activate the outputs.

Press	To Activate
1	Drive Enable
2	Alarm

Press “Clear” to exit the test.
Press “CODE SELECT” only if you want to exit diagnostics.

In addition to diagnostic tests 1-5, the ML-Drive automatically performs two power up diagnostic routines during every Power Up.

RAM TEST - Random Access Memory

The ML-Drive performs a pattern read/write test on RAM.

If RAM fails, “---5” Is displayed. The test will stop if a failure is detected. Press “Clear ” to exit the test.

IF the RAM is good, the ML-Drive will begin the PROM test.

PROM TEST

The ML-Drive performs a checksum comparison on the PROM.

If the test fails, “---3” is displayed. The test stops if a failure is detected. Press “Clear” to exit the test.

If the PROM is good, exit is automatic. The ML-Drive will begin the initialization routines and normal operation.

—NOTES—

TROUBLESHOOTING

This section contains four troubleshooting flowcharts to help you resolve four possible system operating problems. The four scenarios that are addressed by the flowcharts are:

Motor Does Not Stop
Motor Does Not Run
Motor Runs at Wrong Speed
Motor Runs Unstable

If you need to verify the integrity of the ML–Drive independently, refer to the *Troubleshooting: Diagnostics* section, page 4-3.

If these troubleshooting procedures do not solve your problem, perform a “Clear/7”, as follows:

- Make a record of your current Control Parameter values. When you perform the Clear/7 procedure, all Control Parameters return to the default values.

- Turn off the power to the ML-Drive.

- Press the “Clear” key and the “7” key, then continue to press these keys while you apply power to the ML-Drive. The “Clear 7” procedure restores the factory default settings and automatically performs the Power Up diagnostic routines.

- Reenter the values for your Code Parameters.

If the information in this section does not solve your problem, consult:

Contrex Technical Support (763) 424-7800 or (800) 342-4411

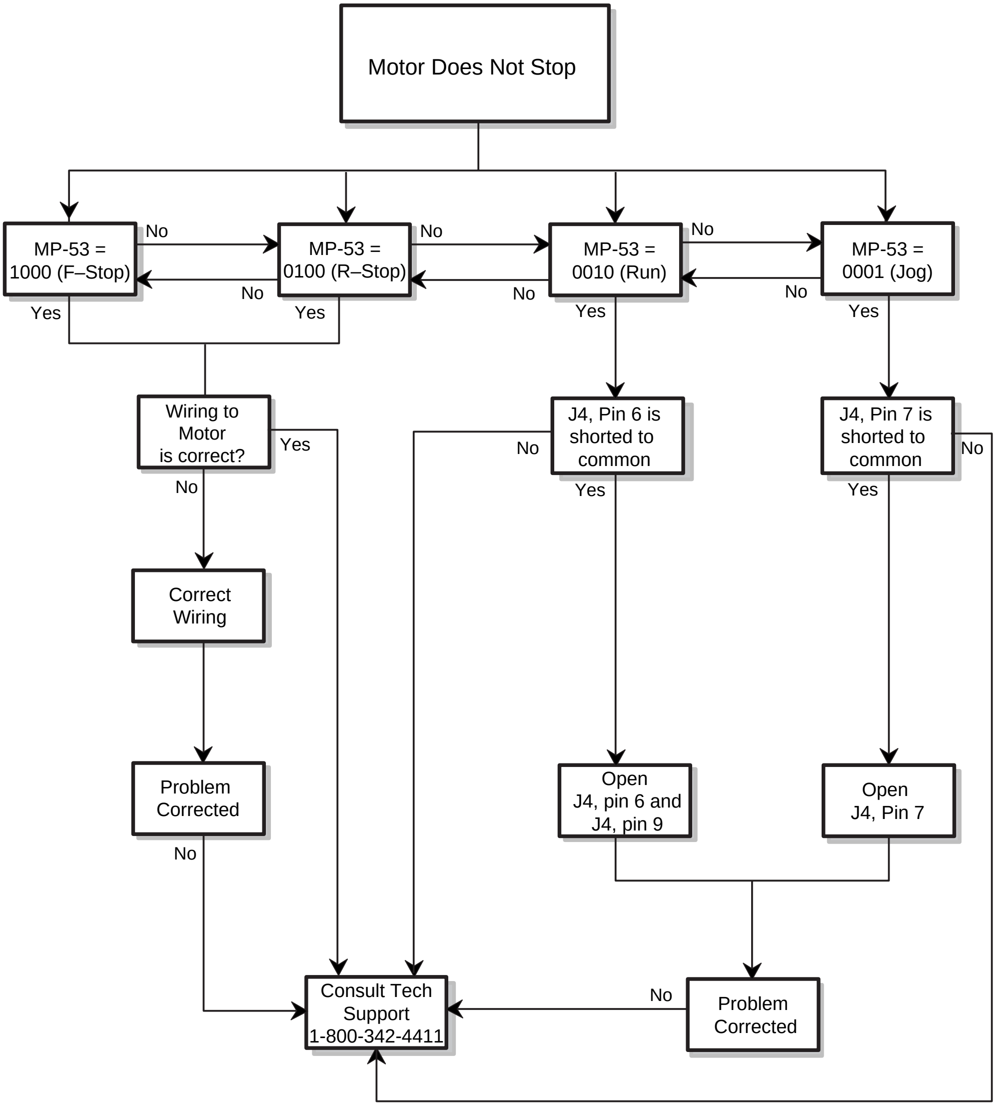


Figure 4-1 Motor Does Not Stop Flowchart

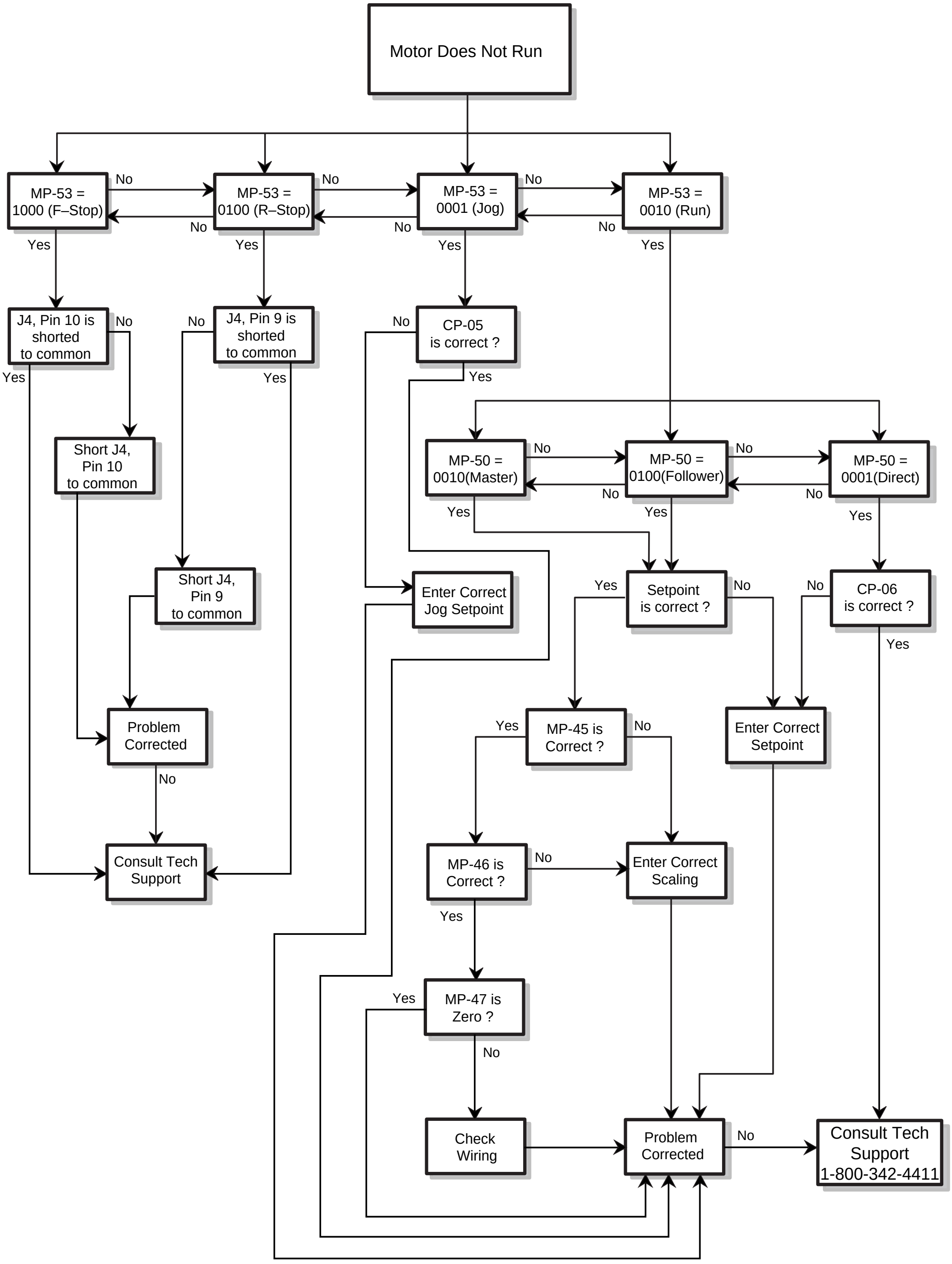


Figure 4-2 Motor Does Not Run Flowchart

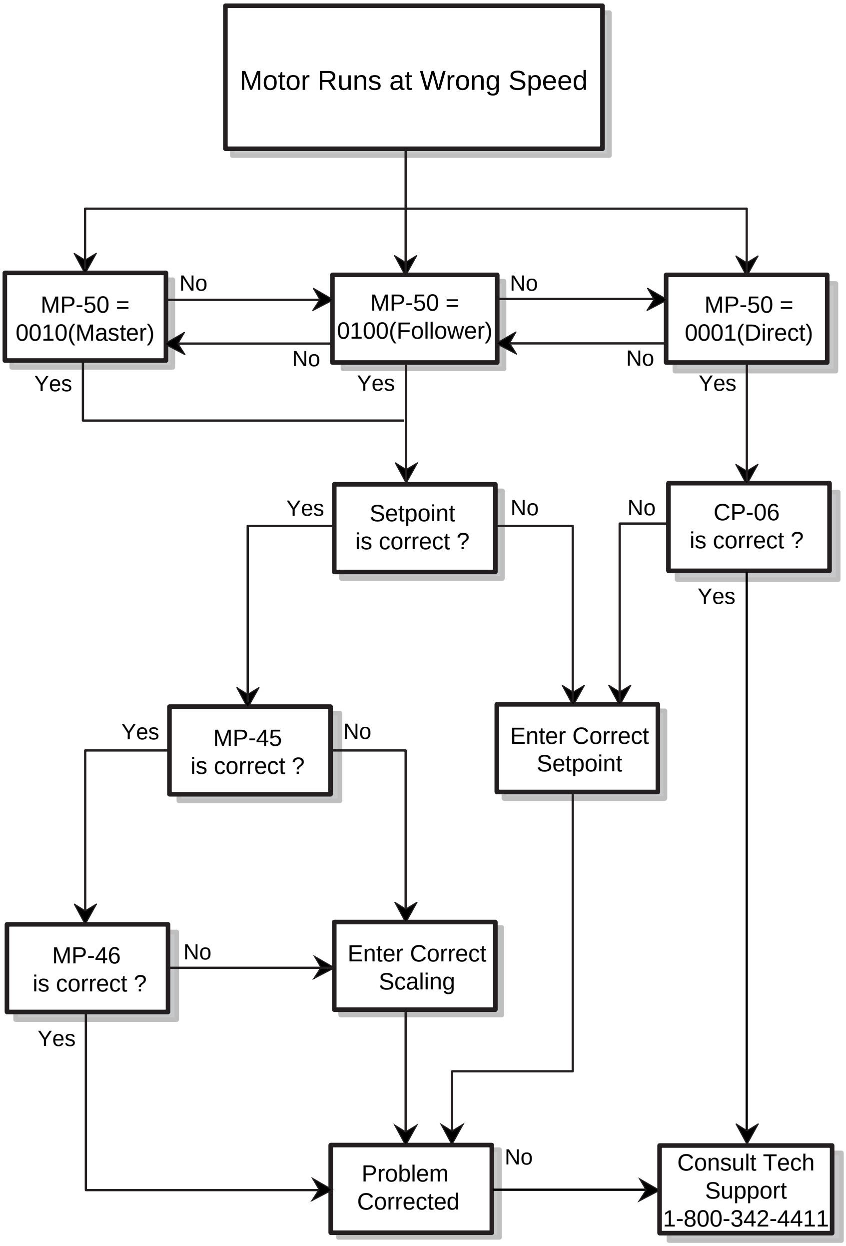


Figure 4-3 Motor Runs at Wrong Speed Flowchart

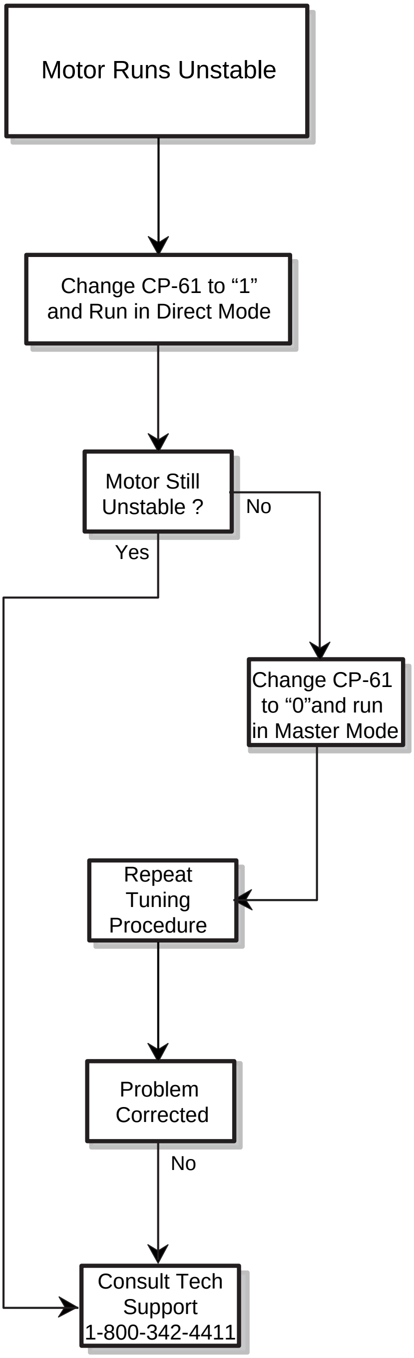


Figure 4-4 Motor Runs Unstable Flowchart

PROM CHIP REPLACEMENT

The PROM (Programmable Read Only Memory) chip is the software for the ML-Drive. See Figure 4-5 for the PROM's location on the CPU Board.

To replace the PROM chip:

- Make a record of your current Control Parameter values; the replacement chip contains default values that will replace your current values when you perform the Clear/7 step.
- Turn off the power to the ML-Drive.
- Remove the back panel.
- Pull out the CPU board.
- Ground yourself - Static electricity can damage the PROM.
- Locate the PROM chip and carefully pry the PROM from the socket. Alternate between the two corners, as noted in figure 4-5.
- Carefully install the replacement PROM in the socket by lining up the beveled corner of the PROM chip with the beveled corner of the socket. Apply even pressure until the PROM is seated.

  NOTE: Incorrect placement can damage the PROM.
- Replace the CPU board.
- Replace the back panel.
- Press the “Clear” key and the “7” key, then continue to press the keys while you apply power to the ML-Drive. The “Clear 7” procedure restores the factory default settings and automatically performs the Power Up diagnostic routines.
- Reenter the values for your Code Parameters.

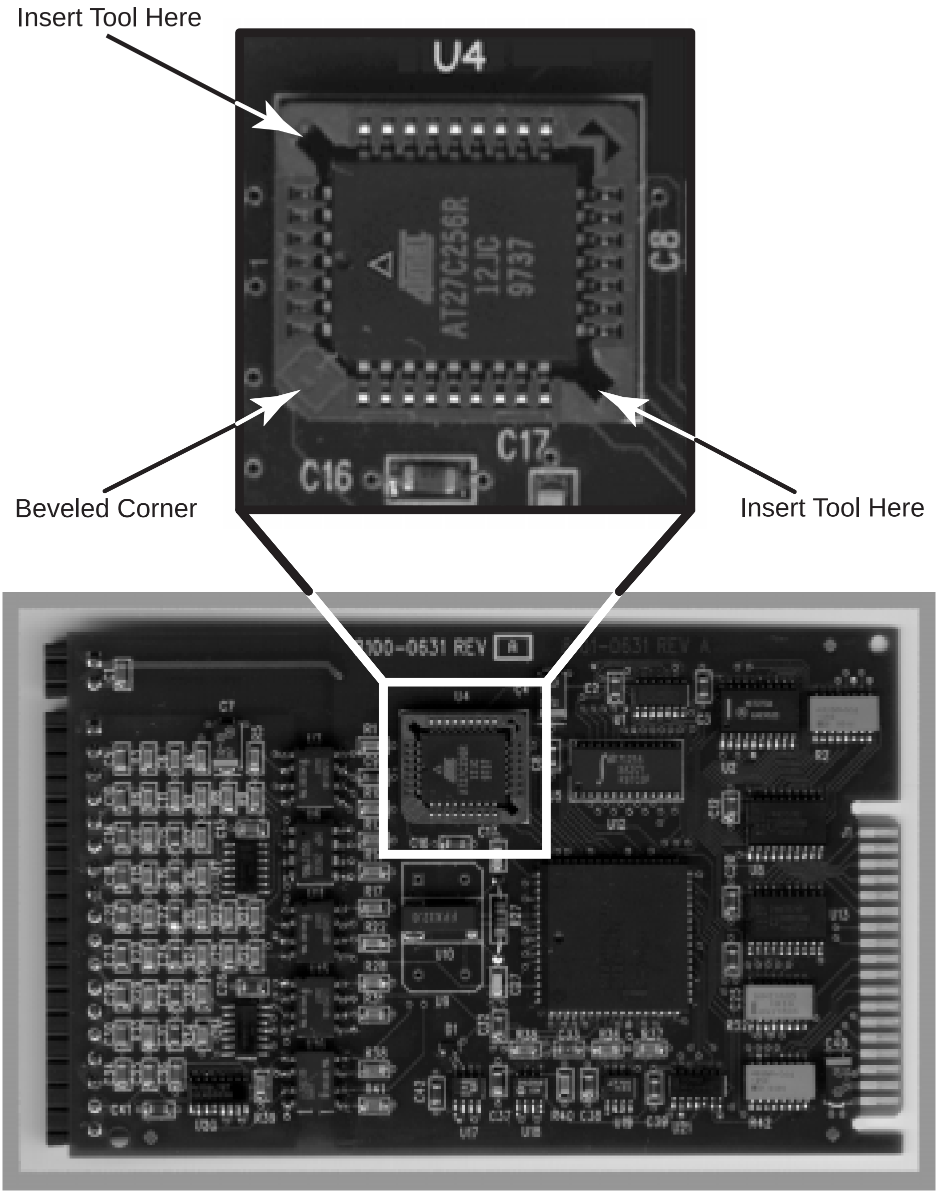


Figure 4-5   PROM Location

—NOTES—

Glossary

GLOSSARY

Acceleration/Deceleration	Acceleration Time (CP-16) and Deceleration Time (CP-17) control the rate of speed change in response to setpoint changes. These parameters apply to both the Master and Follower modes of operation.
Acceleration Time	See Appendix C; CP-16.
Alarms	See Appendix C; CP-10, 12, 13, 14, or 15.
Calibration	Calibration sets the current limit of the ML-Drive and monitors the current limit.
Closed loop	A system that is controlled by manipulating the output based on error (setpoint - feedback).
Closed Loop Compensation (PID) Software	A mathematical term for a control algorithm that resolves the control error (feedback - setpoint) to zero. Output = Kp X Error + $K_I \int$ Error dt + K_D dError/dt PID represents “Proportional + Integral + Derivative”.
Code Select Key	Press this key prior to entering a Parameter Code (either a Control Parameter or a Monitor Parameter).
Control Command Send	The Control Command Send allows the host computer to control the operating functions of the ML-Drive that are associated with the Logic inputs (Run, Stop, Setpoint Select and Master/Follower).
Control Parameters	Control Parameters allow you to enter data that is unique to your system (e.g., encoder resolution, Lead to Follower ratios) and modify the ML-Drive's operation for your specific application (e.g., maximum RPMs, setpoints, acceleration/deceleration ramp rates). There are Control Parameters for Direct mode, Master (stand-alone) mode,

	the Follower mode, Acceleration/Deceleration, Tuning, Alarms, and Jog. The ML-Drive comes factory pre-loaded with a complete set of default Control Parameters.
Data Inquiry	Use the Data Inquiry to request the current value for Parameters (i.e., Control Parameters or Monitor Parameters) in serial communications.
Deceleration Time	See Appendix C;CP-17.
Dedicated Keys	The Setpoint key and the Tach key are shortcut keys. The Setpoint key accesses the active setpoint variable directly and the Tach key accesses the tach variable directly (rather than manually entering the Code Parameter).
Derivative	See Appendix C; CP-67.
Digital Motor Drive	A precision motor drive that uses digital compensation technology.
Direct Mode	In the Direct mode of operation, the drive output from the ML-Drive that is connected to the motor can be set directly. Direct mode is an open-loop mode of operation. Scaling, Acceleration/Deceleration, and closed loop compensation (PID) software are not involved in the Direct mode. The Direct mode is used in conjunction with the Run and Stop controls.
Direct Enable	See Appendix C; CP-61
Direct Setpoint	See Appendix C; CP-06
Display Test	Tests the LED Display Panel Segments.

Drive Enable	The Drive Enable output is activated based on the Ramped Reference (MP-46) and the feedback. The Ramped Reference is the calculated setpoint that is output from the Acceleration/Deceleration routine. See Appendix C; CP-74.
Engineering Units (E.U.)	Master Engineering Units are the units of measure that your system operates at, such as, RPMs, gallons per hour, feet per minute. Follower Engineering Units is the number that will represent the setpoint when the Lead and Follower are operating at maximum capacity. Refer to Appendix C; CP- 20 and CP-21.
EEPROM	The EEPROM is where the default Control Parameters are stored. This is not to be confused with the PROM chip (which is the software for the ML-Drive).
F–Stop	One of four operating states. F–Stop brings the ML-Drive's drive output to an immediate Zero. F–Stop has priority over the other operating states.
Follower Mode	A complex multi-drive system. The scaling format allows the operator to enter the setpoint as either a ratio or percentage. The ML-Drive compares the setpoint ratio or percentage to the Follower sensor shaft feedback and Lead sensor shaft to calculate any speed error. When the ML-Drive finds speed error, the control algorithm adjusts the drive output and reduces the error to zero.
Gain	See Appendix C;CP-65.
Hardwired	Inputs that are wire shorted rather than using push buttons or switches.

Input Monitoring	Lead Frequency (MP-41) Feedback Frequency (MP-43) Logic Inputs, Group A (MP-54) Logic Inputs, Group B (MP-55)
Input Test	Tests the Logic Inputs.
Inputs	AC Power (J2 pins 3, 4, 5) I/O Power (J4 pins 1,2) Lead Frequency (J4 pins 3, 5) Feedback Frequency (J4 pins 4,5) Run (J4 pins 6, 8) Jog (J4 pins 7, 8) R–Stop (J4 pins 9, 11) F-Stop (J4 pins 10, 11) Master or Follower (J4 pins 12, 14) Setpoint Select (J4 pins 13, 14)
Integral	See Appendix C;CP-66.
Jog	One of four operating states. Jog increases the RPMs at the acceleration rate that is specified in Acceleration Time (CP-16) until the Jog Setpoint (CP-05) is achieved. When Jog is terminated, there is no Deceleration Time; the drive motor comes to an immediate stop.
Keypad Test	Tests the Keypad.
LED Display	The two digit Parameter Code is displayed on the left LED Display. The Parameter Code's value is displayed on the right LED display. This value can be up to four digits.
Logic Inputs	F–Stop R–Stop Run Jog Setpoint Select Master/Follower

Master Mode	A stand-alone control of a single motor. The scaling format allows the operator to enter a setpoint in Engineering Units. The ML-Drive compares the sensor shaft feedback to the scaled setpoint and calculates any speed error. When the ML-Drive finds speed error, the control algorithm adjusts the drive output and reduces the error to zero.
Master Setpoints	See Appendix C; CP-01 and CP-02.
Max RPM Feedback	See Appendix C; CP-34.
Max RPM Lead	See Appendix C; CP-33.
Mode of Operation	The scaling method that is used to operate your system (e.g., Direct mode, Master mode, Follower mode, Inverse Master mode or Inverse Follower mode).
Monitor Parameters	Monitor Parameters (MPs) monitor the performance of the ML-Drive and the system which the ML-Drive is controlling. Monitor Parameters also confirm the wiring and the tuning as well as assist with troubleshooting. MPs can be accessed at any time during the ML-Drive's operation, including during Run, Jog, R–Stop and F–Stop. There are four categories of Monitor Parameters: Input Monitoring, Output Monitoring, Performance Monitoring and Status Monitoring.
Numeric Keys	Use the numeric keys to enter a Parameter Code for either a Control Parameter (CP) or a Monitor Parameter (MP) or to enter a value for a Control Parameter. Use the Enter key after each entry. Use the Clear key to delete your entry.
Open Loop	A system that is controlled without feedback.
Operating State	The systems status within a mode of operation, such as Run, R–Stop, F–Stop or Jog.
Output Monitoring	Drive Output (MP-47) Logic Outputs (MP-56)

Output Test	Tests the Logic Outputs.
Outputs	Drive Out (J2 pins 1, 2) Drive Enable (J4 pin 16, 18) Alarm (J4 pin 17, 18)
Parameters	Parameters are divided into two classifications; Control Parameters (CP) and Monitor Parameters (MP).
Parameter Code	The numbered code that represents a Parameter.
Parameter Send	Use the Parameter Send to change any of the ML-Drive's Control Parameters in Serial Communications.
Parameter Value	Parameter values are pre-loaded in the factory, however, you can modify Control Parameter values with operational data that is unique to your system.
Performance Monitoring	Tach Deviation (Error) Scaled Reference Ramped Reference Trim Output
PROM Chip	The PROM (Programmable Read Only Memory) chip is the software for the ML-Drive. This is not to be confused with the EEPROM (which is were the default Control Parameters and Monitor Parameters are stored).
PROM Test	One of the two power up diagnostic routines that the ML-Drive automatically performs during every Power Up.
PPR Feedback	See Appendix C; CP-31.
PPR Lead	See Appendix C; CP-30.

Tuning	Tuning stabilizes speed error differences between the setpoint and feedback.
Ring Kits	Ring Kits are flange motor mounted sensors that measure the pulses per revolution (PPR) of the motor shaft.
R–Stop	One of four operating states. R–Stop uses Deceleration Rate (CP-17) to decelerate the drive output to zero. R–Stop has the second highest operating state priority.
RAM Test	Tests Random Access Memory. This test can be run as part of the diagnostic tests. It is also one of the two power up diagnostic routines that the ML-Drive automatically performs during every Power Up.
RPM Feedback	The speed of the feedback sensor in revolutions per minute.
RPM Lead	The speed of the lead sensor in revolutions per minute.
Run	One of four operating states. Run ramps to the scaled setpoint speed using the acceleration and deceleration rate values in Acceleration Time (CP-16) and Deceleration Time (CP-17). Run can be activated when the ML-Drive is in R–Stop or F–Stop, however Run cannot be activated when the ML-Drive is in Jog. Run has the third highest operating state priority.
Scaling	Scaling Control Parameters supply the ML-Drive with the information that it needs to calculate the ratio of RPM's to Engineering Units and run at the entered setpoint.
Scroll Up/Down Keys	These keys change the active setpoint value **even if the active setpoint is not displayed in the LED display**. Each time you press the Scroll Up key, the active setpoint will increase by one increment. Each time you press the Scroll Down key, the active setpoint value will decrease by one increment. Press and hold the key to automatically scroll through the increments or decrements .

Appendices

Appendix A - ML-Drive Specifications
Appendix B - Formulas
Appendix C - Parameter Summary - Numeric Quick Reference
Appendix D - Control Parameter Reference
Appendix E - Monitor Parameter Reference
Appendix F - Fax Cover Sheet
Appendix G - Wiring Diagram Examples
Appendix H - Revision Log

APPENDIX A: ML-DRIVE SPECIFICATIONS

Accuracy:	.01% Set Speed
Response:	10 millisecond control loop update
Tuning:	Separately adjustable Gain, Integral and Derivative parameters for stability and response
Scaling Formats:	Direct - Direct set of Drive Output Master - Absolute Setpoint entry Follower - Ratio Setpoint calculation Inverse Master - Absolute Setpoint entry Inverse Follower - Ratio Setpoint calculation
Setpoints:	Six Total: (2) Master (2) Follower (1) Direct (1) Jog
Engineering Units:	Engineering Unit Setpoint and Display
Accel/Decel:	0 to 600.0 seconds
Frequency Inputs:	74HC14 Schmitt Trigger Vin, MAX ≤ 24 VDC * Vin, LOW ≤ 1.0 VDC (Logic Low) Vin, HIGH ≥ 3.5 VDC (Logic High) 0 - 30 KHz Feedback & Lead 4.99 KΩ Pullup to 5V Optically Isolated
Digital Inputs:	74HC14 Schmitt Trigger Vin, MAX ≤ 24 VDC * Vin, LOW ≤ 1.0 VDC (Logic Low) Vin, HIGH ≥ 3.5 VDC (Logic High) 4.99 KΩ Pullup to 5V Optically Isolated Run, R-Stop, F-Stop, Jog Master/Follower, Setpoint Select

*** Caution:**
Do not exceed +5VDC on the I/O Power Input (J4 pins 1,2) or equipment damage will occur.

Digital Outputs:	Open-Collector Driver (ULN2003) (50 VDC max, 200 mA continuous, 500 mA peak) Optically Isolated Drive Enable Alarm
Drive Output:	Phase Fired - Single Quadrant 0 - 90 VDC, 10.0 FLA, 1/4 to 1 HP (115V version) 0 - 180 VDC, 10.0 FLA, 1/2 to 2 HP (230V version) PM Motors
Current Limit:	4.0 to 10.0 Amps RMS 4.0 to 15.0 Amps Peak
Aux Supply:	+5VDC ± 5% 150 mA, Max non-isolated
Serial Interface:	RS485 300 to 9600 Baud Full parameter access and control
Power Requirements:	115 ±15% VAC (model # 3200-1933) 230 ±15% VAC (model # 3200-1934) 50/60 Hz 0.1 Amp + motor current
Line Loss:	10 mSec ride through
Operating Temperature:	0° to 55° C Int. Enclosure 0° to 40° C Ext. Ambient temperature when installed in an enclosure no smaller than 12" X 10" X 8"
Storage Temperature:	-25° to 70° C
Humidity:	0 to 95% non-condensing
Physical Dimensions:	4.0 inches height 4.0 inches width 6.0 inches depth (Interior Panel)
Faceplate Rating:	Nema 4, 4X, 12, 13 IP65
Environment:	The ML-Drive shall be installed in a pollution degree 2 macro - environment.
Altitude:	To 3,300 Feet (1000 meters)
Weight:	46 ounces

APPENDIX B: FORMULAS

Use the following formulas to calculate Speed Control:

MASTER MODE	
General	$\frac{\text{Setpoint}^{(CP\text{-}1,2)}_{\text{Master}}}{\text{E.U.}^{(CP\text{-}20)}_{\text{Master}}} = \frac{\text{RPM}_{\text{Feedback}}}{\text{RPM}^{(CP\text{-}34)}_{\text{Max Feedback}}}$
RPM	$\frac{\text{Setpoint}^{(CP\text{-}1,2)}_{\text{Master}}}{\text{E.U.}^{(CP\text{-}20)}_{\text{Master}}} \text{ X } \text{RPM}^{(CP\text{-}34)}_{\text{Max Feedback}} = \text{RPM}_{\text{Feedback}}$
HZ	$\frac{\text{Setpoint}^{(CP\text{-}1,2)}_{\text{Master}}}{\text{E.U.}^{(CP\text{-}20)}_{\text{Master}}} \text{ X } \frac{\left(\text{RPM}^{(CP\text{-}34)}_{\text{Max Feedback}}\right)\left(\text{PPR}^{(CP\text{-}31)}_{\text{Feedback}}\right)}{60} = \text{HZ}_{\text{Feedback}}$

FOLLOWER MODE	
General	$\frac{\text{Setpoint}^{(CP\text{-}3,4)}_{\text{Follower}}}{\text{E.U.}^{(CP\text{-}21)}_{\text{Follower}}} \text{ X } \frac{\text{RPM}_{\text{Lead}}}{\text{RPM}^{(CP\text{-}33)}_{\text{Max Lead}}} = \frac{\text{RPM}_{\text{Feedback}}}{\text{RPM}^{(CP\text{-}34)}_{\text{Max Feedback}}}$
RPM	$\frac{\text{Setpoint}^{(CP\text{-}3,4)}_{\text{Follower}}}{\text{E.U.}^{(CP\text{-}21)}_{\text{Follower}}} \text{ X } \frac{\left(\text{RPM}^{(CP\text{-}34)}_{\text{Max Feedback}}\right)\left(\text{RPM}_{\text{Lead}}\right)}{\text{RPM}^{(CP\text{-}33)}_{\text{Max Lead}}} = \text{RPM}_{\text{Feedback}}$
HZ	$\frac{\text{Setpoint}^{(CP\text{-}3,4)}_{\text{Follower}}}{\text{E.U.}^{(CP\text{-}21)}_{\text{Follower}}} \text{ X } \frac{\left(\text{HZ}_{\text{Lead}}\right)\left(\text{RPM}^{(CP\text{-}34)}_{\text{Max Feedback}}\right)\left(\text{PPR}^{(CP\text{-}31)}_{\text{Feedback}}\right)}{\left(\text{RPM}^{(CP\text{-}33)}_{\text{Max Lead}}\right)\left(\text{PPR}^{(CP\text{-}30)}_{\text{Lead}}\right)} = \text{HZ}_{\text{Feedback}}$

—NOTES—

APPENDIX C: PARAMETER SUMMARY - NUMERIC QUICK REFERENCE

CP-01 MASTER SETPOINT 1

The Engineering Units value that you want your system to operate at when Master Setpoint 1 (CP-01) is active. If the Master Setpoint is equal to the Master Engineering Units (CP-20) then the system will run at its maximum RPMs, or Max RPM Feedback (CP-34). The factory default Master Setpoint Control Parameters are set at “0”.

CP-02 MASTER SETPOINT 2

The Engineering Units value that you want your system to operate at when Master Setpoint 2 (CP-02) is active. If the Master Setpoint is equal to the Master Engineering Units (CP-20) then the system will run at its maximum RPMs, or Max RPM Feedback (CP-34). The factory default Master Setpoint Control Parameters are set at “0”.

CP-03 FOLLOWER SETPOINT 1

The Engineering Units value that you want your system to operate at when Follower Setpoint 1 (CP-03) is active.   The Follower setpoint values are the ratio of Follower speed to Lead speed.

CP-04 FOLLOWER SETPOINT 2

The Engineering Units value that you want your system to operate at when Follower Setpoint 2 (CP-04) is active. The Follower setpoint values are the ratio of Follower speed to Lead speed.

CP-05 JOG SETPOINT

In Jog Setpoint (CP-05), enter the RPM at which you want your system to operate when it is in Jog. Jog increases the RPMs at the acceleration rate that you specified in Acceleration Time (CP-16) until the Jog Setpoint (CP-05) is achieved.   When Jog is terminated, there is no Deceleration Time; the drive comes to an immediate stop.

CP-06 DIRECT SETPOINT

Use the Direct Setpoint (CP-06) to set the drive output that is used when the ML-Drive is in the Direct Mode of operation. Direct mode is an open-loop mode of operation. Scaling, Acceleration/Deceleration, and closed loop compensation (PID) software are not involved in the Direct mode. The Direct mode is used in conjunction with the Run and Stop controls.

CP-10 ALARM FORMAT

By entering alarm Control Parameters, you can establish circumstances under which the ML-Drive will alert you to potential operating problems. The alarm can be wired to activate a warning light, a warning sound, or to shut down the system under specified conditions. Alarm Format (CP-10) determines which alarm conditions will activate the Alarm output, using the values that are entered in Low Alarm (CP-12), High Alarm (CP-13), Ramped Error (CP-14) and Scaled Error (CP-15).

0 = No Alarm
1 = Low Alarm
2 = High Alarm
3 = Low Alarm or High Alarm
4 = Ramped Error
5 = Low Alarm or Ramped Error
6 = High Alarm or Ramped Error
7 = Low Alarm or High Alarm or Ramped Error
8 = Scaled Error
9 = Low Alarm or Scaled Error
10 = High Alarm or Scaled Error
11 = Low Alarm or High Alarm or Scaled Error
12 = Ramped Error or Scaled Error
13 = Low Alarm or Ramped Error or Scaled Error
14 = High Alarm or Ramped Error or Scaled Error
15 = Low Alarm or High Alarm or Ramped Error or Scaled Error

CP-12 LOW ALARM

Low Alarm (CP-12) is the RPMs at or below which you want the Alarm output to activate.

CP-13 HIGH ALARM

High Alarm (CP-13) is the RPMs at or above which you want the Alarm output to activate.

CP-14 RAMPED ERROR ALARM

The Ramped Error Alarm (CP-14) is the RPM deviation between the ramped reference and the feedback that will activate the Alarm output (at or above).

CP-15 SCALED ERROR ALARM

The Scaled Error Alarm (CP-15) is the RPM deviation between the scaled reference and the feedback that will activate the Alarm output (at or above).

CP-16 ACCELERATION TIME

Acceleration Time (CP-16) controls the rate of speed change in response to setpoint changes. This Control Parameter applies to both the Master and Follower modes of operation. Enter the desired number of seconds to increase the motor speed from 0 to 2000 RPMs.

CP-17 DECELERATION TIME

Deceleration Time (CP-17) controls the rate of speed change in response to setpoint changes. This Control Parameter applies to both the Master and Follower modes of operation. Enter the desired number of seconds to decrease the setpoint in the range of 2000 to 0 RPMs.

CP-20 MASTER ENGINEERING UNITS

The actual value of the Master Engineering Units (CP-20) if the system were to operate at the desired maximum RPMs (refer to CP-34). This is not to be confused with the Setpoint, which is the Master Engineering Units at which you want the system to operate.

CP-21 FOLLOWER ENGINEERING UNITS

In Follower Engineering Units (CP-21), enter a number that will represent the setpoint Engineering Units when the Lead and Follower are operating at the maximum desired RPM. This number is usually the ratio of Max RPM Feedback (CP-34) to Max RPM Lead (CP-33). When this number is also entered as a setpoint (CP-03 or CP-04), the Follower will operate at Max RPM Feedback (CP-34) when the Lead is at Max RPM Lead (CP-33).

CP-30 PPR LEAD

PPR Lead (CP-30) is the number of gear teeth or number of encoder lines on the Lead sensor per revolution (pulses per revolution).

CP-31 PPR FEEDBACK

PPR Feedback (CP-31) is the number of gear teeth or number of encoder lines on the Follower feedback sensor per revolution (pulses per revolution).

CP-33 MAX RPM LEAD

Measured at the Lead sensor shaft, Max RPM Lead (CP-33) is the maximum RPMs at which the Lead will operate your system. This number is not to be confused with the full capacity at which the Lead is capable of running. A system is not generally run at full capacity.

CP-34 MAX RPM FEEDBACK

Measured at the sensor shaft, Max RPM Feedback (CP-34) is the maximum RPMs at which you want your system to operate and is not to be confused with the full capacity at which your system is capable of running. A system is not generally run at full capacity.

MP-40 TACH

In the Master mode, Tach (MP-40) will display the feedback in Master Engineering Units (CP-20). In the Follower mode, Tach (MP-40) will display either the Master Engineering Units or the feedback to Lead ratio in Follower Engineering Units (CP-21), depending on the value in Display Mode Follower (CP-64). In Jog or the Direct mode, Tach (MP-40) will display the feedback in RPMs. The feedback is read by the ML-Drive every ten milliseconds. The readings are summed, then averaged for one second before the Tach is displayed.

MP-41 LEAD FREQUENCY

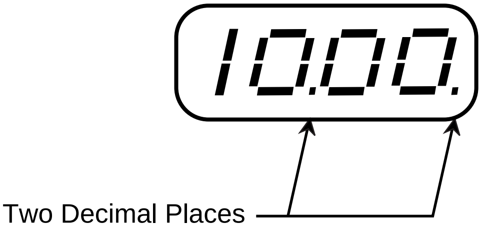
The Lead Frequency (MP-41) displays the frequency of the Lead Frequency Input (J4 pin 3) in units of hertz (pulses per second). Lead Frequency (MP-41) is not averaged or filtered; it is the ten millisecond frequency calculation prior to the display update. Because Lead Frequency (MP-41) is not averaged or filtered and because of sensor irregularities, it may appear less stable than Tach (MP-40).

Numbers that are larger than 9999 are displayed with two decimal places. For example, 10,000 hertz is displayed like the figure in Feedback Frequency, MP-43.

MP-43 FEEDBACK FREQUENCY

The Feedback Frequency (MP-43) displays the frequency of the Feedback Frequency Input (J4 pin 4) in units of hertz (pulses per second). Feedback Frequency (MP-43) is not averaged or filtered; it is the ten millisecond frequency calculation prior to the display update. Because Feedback Frequency (MP-43) is not averaged or filtered and because of sensor irregularities, it may appear less stable than Tach (MP-40).

Numbers that are larger than 9999 are displayed with two decimal places. For example, 10,000 hertz is displayed as follows:



MP-44 DEVIATION (ERROR)

Deviation (MP-44) displays the difference between the Ramped Reference (MP-46) and the Feedback Frequency (MP-43) measured in units of hertz (pulses per second). Deviation is not averaged or filtered; it is the ten millisecond frequency calculation prior to the display update.

MP-45 SCALED REFERENCE

The Scaled Reference (MP-45) is the scaled setpoint number converted to hertz. It is the calculated value that is input to the Acceleration/Deceleration routine. This parameter may display numbers that are larger than 9999. These larger values are displayed with two decimal places. For example, 10,000 hertz is displayed as “10.00.”.

MP-46 RAMPED REFERENCE

The Ramped Reference (MP-46) is the calculated output of the Acceleration/Deceleration routine in hertz. It is the setpoint input to the PID compensation routine. This parameter may display numbers that are larger than 9999. These larger values are displayed with two decimal places. For example, 10,000 hertz is displayed as “10.00.”

MP-47 DRIVE OUTPUT

The Drive Output (MP-47) displays the drive output level to the motor (J2 pin 1, 2). Drive Output is displayed as a percentage; 100 represents 100% of the drive output.

MP-48 TRIM OUTPUT

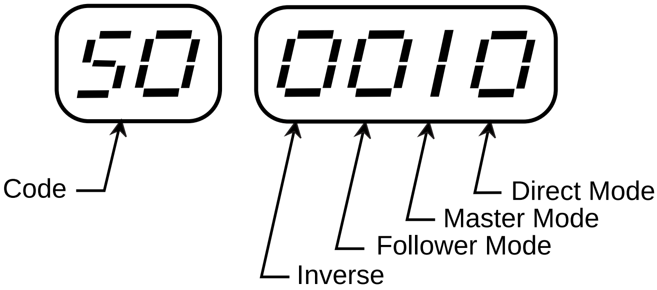
The Trim Output (MP-48) is the calculated output of the PID Compensation routine. The Trim Output added to the feedforward equals the Drive Output (MP-47). The Trim Output (MP-48) is represented in DAC (Digital-to-Analog Converter) bits, for example 4095 equals 100% output, 2048 equals 50% output.

MP-49 PIDF OUTPUT

The PIDF Output (MP-49) is the total calculated output of the PID Compensation routine added to the feedforward. The PIDF Output is represented in DAC (Digital-to-Analog Converter) bits where 4096 equals 100% output, 2048 equals 50% output, etc.

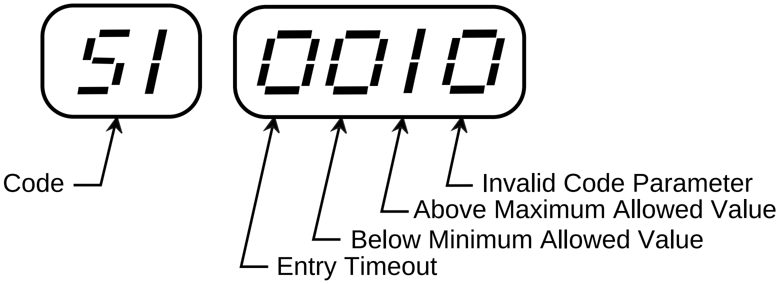
MP-50 ACTIVE SCALING MODE

Active Scaling Mode (MP-50) displays a number “1” to indicate the active scaling mode. In the example below, “Master Mode” is the active scaling mode.



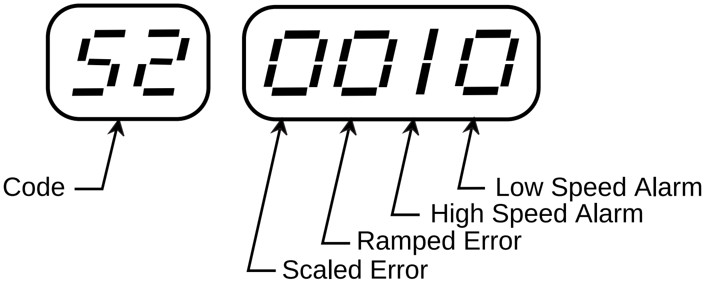
MP-51 KEYPAD ERROR

If a Control Parameter entry has been rejected, Keypad Error (MP-51) will ascertain the reason that it was rejected. Keypad Error (MP-51) displays a number “1” to indicate the error. In the example below, “Above Maximum Allowed Value” is the error.



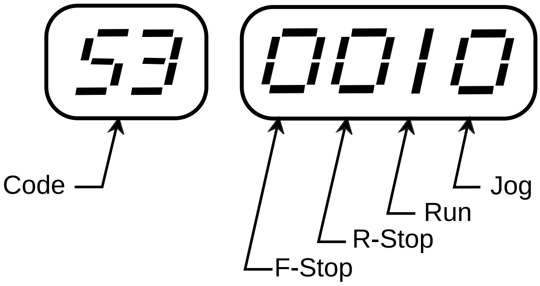
MP-52 ALARM STATUS

Alarm Status (MP-52) displays a number “1” to indicate the active Alarm. In the example below, “High Speed Alarm ” is the active alarm.



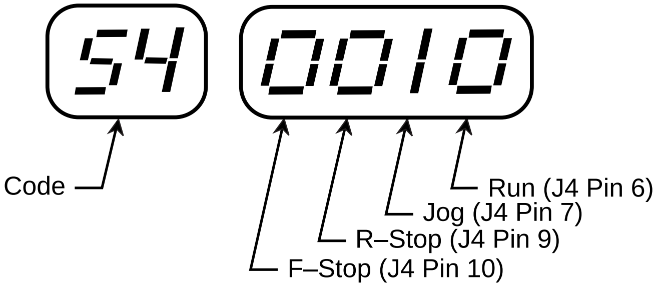
MP-53 CONTROL STATE

Control State (MP-53) displays a number “1” to indicate the active control state of the ML–Drive. In the example below, “Run” is the active control state.



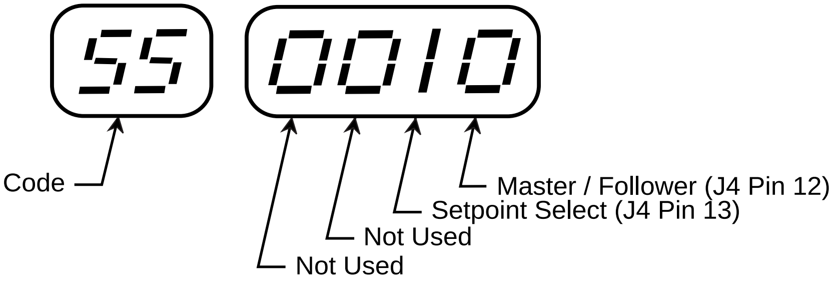
MP-54 LOGIC INPUTS - GROUP A

The Logic Inputs - Group A (MP-54) displays the status of the Run, Jog, R–Stop and F–Stop logic inputs. The number “1” indicates an open, or logic high level. The number “0” indicates a closed, or logic low level (shorted to common). In the example below, “Jog” is the open or logic high level.



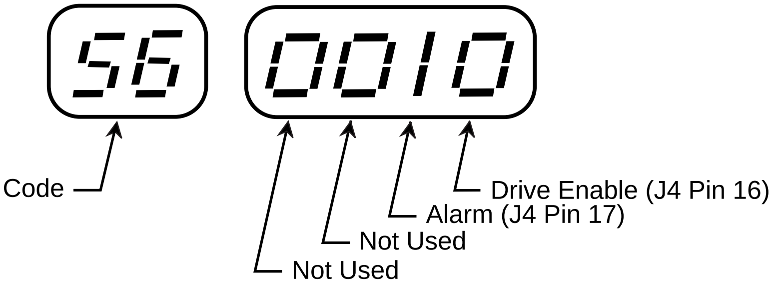
MP-55   LOGIC INPUTS - GROUP B

The Logic Inputs - Group B (MP-55) displays the status of the Master/Follower and Setpoint Select logic inputs. The number “1” indicates an open, or logic high level. The number “0” indicates a closed, or logic low level (shorted to common). In the example below, “Setpoint Select” is the open or logic high level.



MP-56   LOGIC OUTPUTS

The Logic Outputs (MP-56) displays the status of the Drive Enable and Alarm logic outputs. The number “1” indicates an inactive or de-energized (logic high) level. The number “0” indicates an active or energized (logic low) level. In the example below, “Alarm” is the inactive or de-energized (logic high) level.

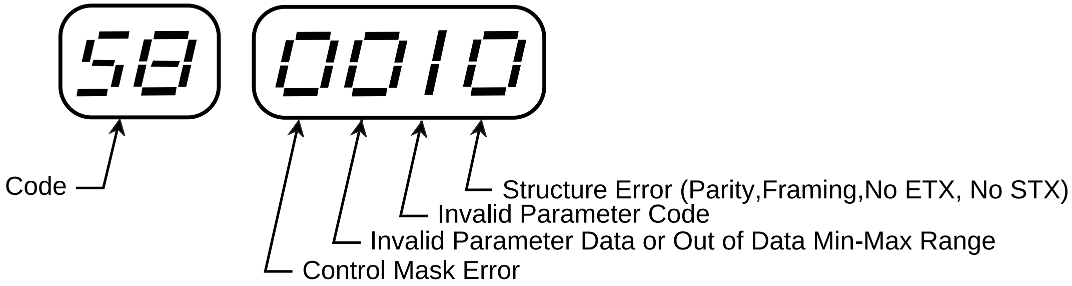


MP-57   EEPROM STATUS

The Control Parameters are stored in the EEPROM memory chip. EEPROM Status (MP-57) displays the status of the EEPROM memory chip. The number “0” indicates no failure. The number “1” indicates a write verify error. In the event of an error, call Technical Support at (612) 424-7800 or 1-800-342-4411.

MP-58   SERIAL COMMUNICATIONS ERROR

Serial Communications Error (MP-58) identifies errors in the last transmitted message that was sent to the ML-Drive by the host computer. The mode that displays a number “1” indicates the error. In the example below, “Invalid Parameter Code” is the error.



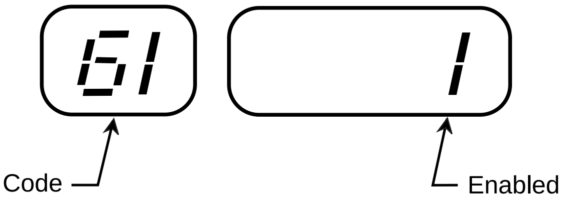
MP-59   FREQUENCY OVERFLOW COUNTER

The Frequency Overflow Counter (MP-59) is a counter that increments each time the frequency input to the ML-Drive causes an overflow. To reset the counter to “0”, press the Clear key.

CP-61   DIRECT ENABLE

In the Direct mode of operation, the drive output from the ML-Drive that is connected to the motor can be set directly. Direct mode is an open-loop mode of operation. Use Direct Enable (CP-61) to either enable or disable the Direct mode.

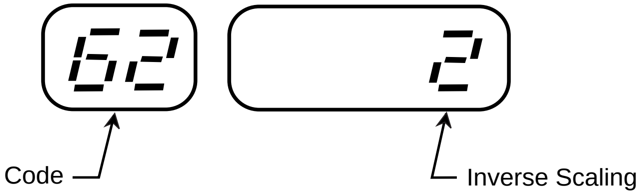
Enter "1" to enable the Direct Mode.
Enter “0” to disable the Direct Mode.



CP-62 INVERSE SCALING

Use Inverse Scaling (CP-61) to select either the Standard or the Inverse setpoint scaling format.

Enter “2” for Inverse Scaling.
Enter "1" for Standard Scaling.



CP-64 DISPLAY MODE FOLLOWER

In the Follower mode of operation, Display Mode Follower (CP-64) determines how the data will display in Tach (MP-40).

Enter "2" to display the ratio of feedback to lead, in E.U.(Follower)
Enter "1" to display the feedback in E.U.s/Time (Master)

CP-65 GAIN

To achieve an acceptable level of speed error, adjust Gain (CP-65) until the system stabilizes. With Integral (CP-66) and Derivative (CP-67) set to “0”, reduce the Gain (CP-65) until the system becomes unstable, then increase it slightly until the system stabilizes. Reduced values will increase Gain (CP-65). To verify the stability of the speed changes, you can access Tach through either the Tach key or the Control Parameter for Tach (MP-40).

CP-66 INTEGRAL

In systems that require greater accuracy, it may be necessary to adjust the value of Integral (CP-66) to reduce any remaining speed error. In systems with low inertia, the speed error will be reduced more quickly if you enter low values in Integral (CP-66). An entry that is too low, however, can create instability or overshoot the setpoint before reaching the correct value. Generally, use larger entries for Integral (CP-66) on systems with a large inertia. While switching between the high and low setpoints, decrease the Integral's default value of “2000” until the speed error is reduced within an acceptable time frame. To verify the stability of the speed changes, you can access Tach through either the Tach key or the Control Parameter for Tach (MP-40).

CP-67 DERIVATIVE

In systems with a very large inertia, use Derivative (CP-67) to reduce the overshoot from the integral term. Decrease the value of Derivative (CP-67) until the overshoot is acceptable. The system may operate erratically or become unstable if the value of Derivative (CP-67) is too small.

CP-68 FEEDFORWARD

To adjust the Feedforward (CP-68), run the ML-Drive in the Master mode of operation, using the default PID parameters and a setpoint value of 1000 RPM. When the ML-Drive has reached stability at 1000 RPM, enter the value of the PIDF Output (MP-49) into Feedforward (CP-68).

CP-70 DEVICE ADDRESS

Device Address (CP-70) is the physical address of the ML-Drive, which can be set from 1 to 32. Each individual ML-Drive on a multidrop RS485 communications link needs a unique Device Address. The address “00” will be globally accepted by all of the ML-Drives on a communications link, however, they will not send a response message back to the host computer when this global address is used.

CP-71 BAUD RATE

There are six different baud rates (data rates) for the ML-Drive. Enter the number for the required function in Baud Rate (CP-71), as listed below.

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

CP-72 CHARACTER FORMAT

The ML-Drive uses three different character formats. Enter the number for the required format in Character Format (CP-72), as listed below.

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 Bit

CP-73 CONTROL MASK

The Serial Communications can control some of the logic input functions. Enter the number for the required functions in Control Mask (CP-74), as listed below.

0 = F-Stop only
1 = F-Stop, Run, R-Stop
2 = F-Stop, Master/Follower, Setpoint Select
3 = All of the above

CP-74 DRIVE ENABLE LOGIC

Drive Enable Logic (CP-74) determines which conditions of the Ramped Reference (MP-46) and the feedback will control the Drive Enable digital output.

Enter "0" to deactivate the Drive Enable digital output (output high) when the Ramped Reference is zero, and activate the Drive Enable digital output (output low) when the Ramped Reference is not zero.

Enter "1" to deactivate the Drive Enable digital output when both the Ramped Reference and the feedback are zero, and activate the Drive Enable digital output when both the Ramped Reference and the feedback are not zero.

CP-80 RMS CURRENT LIMIT

RMS Current Limit (CP-80) determines the level at which the ML-Drive will limit the motor armature's RMS current. The ML-Drive achieves this limit by reducing the phase angle firing. For additional information about current limit, refer to *Installation/Setup: Calibration*, page 2-17.

CP-81 PEAK CURRENT LIMIT

Peak Current Limit (CP-81) determines the level at which the ML-Drive will limit the motor armature's RMS peak current. The ML-Drive achieves this limit by reducing the phase angle firing. For additional information about current limit, refer to *Installation/Setup: Calibration*, page 2-17.

MP-82 MOTOR CURRENT

Motor Current (MP-82) displays the value, in amps, of the motor armature's RMS current.

MP-83 CURRENT LIMIT STATUS

Current Limit Status (MP-83) displays the present status of the current limit. When the ML-Drive is current limiting, then the number “1” is displayed. When the ML-Drive is not in current limit, then the number “0” is displayed.

CP-98 KEYPAD LOCKOUT

Keypad Lockout (CP-98) displays the present status of the keypad lockout. When the keypad is locked, then “LOC” is displayed. When the Keypad is unlocked, then “ULOC” is displayed. To lock out the keypad, enter a numerical “password” between “1” and “9999” in Keypad Lockout (CP-98). This numerical password will flash briefly on the screen, then the screen will display “LOC”. To unlock the keypad, enter the same numerical password in Keypad Lockout (CP-98). The number will flash briefly on the screen and then the screen will display “ULOC”. Control Parameters and Monitor Parameters may be monitored during lockout, however, Control Parameters can not be changed during lockout. The Clear/7 procedure will default Keypad Lockout (CP-98) to “ULOC” (unlocked).

CAUTION: Make certain that you record your password, as it becomes transparent once you have entered it. If you forget your password, you can use the Clear/7 procedure to revert back to the default “ULOC” (unlocked). Please note, however, that the Clear/7 procedure will revert all of the Control Parameters back to their original default values and you will lose any changes that you have made to the Control Parameters. Therefore, make certain that you have recorded all Control Parameter changes in the space provided in Appendix D before you use the Clear/7 procedure. Refer to *Troubleshooting:Troubleshooting*, page 4-11 for instructions on the Clear/7 procedure.

MP-99 SOFTWARE CODE REVISION

Software Code Revision (MP-99) displays the code revision number of the ML-Drive software (PROM).

MP-00 SOFTWARE PART NUMBER

Software Part Number (MP-00) displays last four digits of the software part number for the ML-Drive. The first four digits of the part number are assumed to be “1000”.

APPENDIX D: CONTROL PARAMETER REFERENCE

CODE	DESCRIPTION	MIN	MAX	DEFAULT	USER RECORD	UNITS
CP-01	Master Setpoint 1	0000	9999	0000		ENG
CP-02	Master Setpoint 2	0000	9999	0000		ENG
CP-03	Follower Setpoint 1	0000	9999	0000		ENG
CP-04	Follower Setpoint 2	0000	9999	0000		ENG
CP-05	Jog Setpoint	0000	9999	50		RPM
CP-06	Direct Setpoint	0	+100	0		%
CP-10	Alarm Format	0	15	15		CODED
CP-12	Low Alarm	0000	9999	0000		RPM
CP-13	High Alarm	0000	9999	2000		RPM
CP-14	Ramped Error Alarm	0000	9999	2000		RPM
CP-15	Scaled Error Alarm	0000	9999	2000		RPM
CP-16	Acceleration Time	000.0	600.0	5.0		SEC
CP-17	Deceleration Time	000.0	600.0	5.0		SEC
CP-20	Master Eng. Units	0.000	9999	2000		ENG
CP-21	Follower Eng. Units	0.000	9999	1.000		ENG
CP-30	PPR Lead	1	9999	60		PPR
CP-31	PPR Feedback	1	9999	60		PPR
CP-33	Max RPM Lead	1	9999	2000		RPM
CP-34	Max RPM Feedback	1	9999	2000		RPM
CP-61	Direct Enable	0	1	0		CODED
CP-62	Inverse Scaling	1	2	1		CODED
CP-64	Display Mode Follower	1	2	2		CODED
CP-65	Gain	0	9999	5000		—
CP-66	Integral	0	9999	2000		—
CP-67	Derivative	0	9999	9000		—
CP-68	Feedforward	500	2000	1000		DAC bit
CP-70	Device Address	1	32	1		—
CP-71	Baud Rate	1	6	6		CODED
CP-72	Character Format	1	3	2		CODED
CP-73	Control Mask	0	3	0		CODED
CP-74	Drive Enable Logic	0	1	0		CODED
CP-80	RMS Current Limit	4.0	10.0	10.0		AMPS
CP-81	Peak Current Limit	4.0	15.0	10.0		AMPS
CP-98	Keypad Lockout	1	9999	0		CODED

—NOTES—

APPENDIX E: MONITOR PARAMETER REFERENCE

CODE	DESCRIPTION	MIN	MAX	UNITS
MP-40	Tach	0	9999	ENG.
MP-41	Lead Frequency	0	9999	HZ
MP-43	Feedback Frequency	0	9999	HZ
MP-44	Deviation (Error)	0	9999	HZ
MP-45	Scaled Reference	0	9999	HZ
MP-46	Ramped Reference	0	9999	HZ
MP-47	Drive Output	0	+100	%
MP-48	Trim Output	-4095	4095	DAC bits
MP-49	PIDF Output	0	4095	DAC bits
MP-50	Active Scaling Mode	0	1100	CODED
MP-51	Keypad Error	0	1000	CODED
MP-52	Alarm Status	0	1110	CODED
MP-53	Control State	0	1000	CODED
MP-54	Logic Inputs - Group A	0	1111	CODED
MP-55	Logic Inputs - Group B	0	0011	CODED
MP-56	Logic Outputs	0	0011	CODED
MP-57	EEPROM Status	0	1	CODED
MP-58	Serial Comm Error	0	1111	CODED
MP-59	Frequency Overflow Counter	0	9999	COUNTS
MP-82	Motor Current	0	15.0	AMPS
MP-83	Current Limit Status	0	1	CODED
MP-99	Software Code Revision	—	—	—

—NOTES—

APPENDIX F: ML-DRIVE FAX COVER SHEET

Date: ______________________

Atten: Contrex Technical Support
Fax Number: 1-763-424-8734

From:
Name ____ Ext___________________

Company _______________ Telephone #________________ Fax # _________________

We have ______ ML-Drive(s) that are used for: ____________________________________

____

____

Serial Communication Hookup: _____Yes _____No

Brief Description of the Problem: ____

____

____

____

____

____

____

____

We are transmitting _____ pages, including:
this (two sided) Fax Cover Sheet,
a sketch of the system that the ML-Drive is integrated with.

Please turn the page to record any CPs that you have changed from the default value—>

Please record the Control Parameters that you have changed from the default value:

Code#	Description	User Record	Code#	Description	User Record
CP-01	Master Setpoint 1		CP-33	Max RPM Lead	
CP-02	Master Setpoint 2		CP-34	Max RPM Feedback	
CP-03	Follower Setpoint 1		CP-61	Direct Enable	
CP-04	Follower Setpoint 2		CP-62	Inverse Scaling	
CP-05	Jog Setpoint		CP-64	Display Mode Follower	
CP-06	Direct Setpoint		CP-65	Gain	
CP-10	Alarm Format		CP-66	Integral	
CP-12	Low Alarm		CP-67	Derivative	
CP-13	High Alarm		CP-68	Feedforward	
CP-14	Ramped Error Alarm		CP-70	Device Address	
CP-15	Scaled Error Alarm		CP-71	Baud Rate	
CP-16	Acceleration Time		CP-72	Character Format	
CP-17	Deceleration Time		CP-73	Control Mask	
CP-20	Master Eng. Units		CP-74	Drive Enable Logic	
CP-21	Follower Eng. Units		CP-80	RMS Current Limit	
CP-30	PPR Lead		CP-81	Peak Current Limit	
CP-31	PPR Feedback		CP-98	Keypad Lockout	

Please record what the relevant Monitor Parameters display when the problem occurs:

Code#	Description	Displayed	Code#	Description	Displayed
MP-40	Tach		MP-53	Control State	
MP-41	Lead Frequency		MP-54	Logic Inputs - Group A	
MP-43	Feedback Frequency		MP-55	Logic Inputs - Group B	
MP-44	Deviation (Error)		MP-56	Logic Outputs	
MP-45	Scaled Reference		MP-57	EEPROM Status	
MP-46	Ramped Reference		MP-58	Serial Comm Error	
MP-47	Drive Output		MP-59	Freq. Overflow Counter	
MP-48	Trim Output		MP-82	Motor Current	
MP-49	PIDF Output		MP-83	Current Limit Status	
MP-50	Active Scaling Mode		MP-99	Software Code Revision	
MP-51	Keypad Error		MP-00	Software Part Number	
MP-52	Alarm Status				

APPENDIX G: WIRING DIAGRAM EXAMPLES

DANGER

This diagram is for conceptual purposes only!
Use safety equipment.
Make wiring connections carefully.
Incorrect use of equipment or connections can cause injury or death.

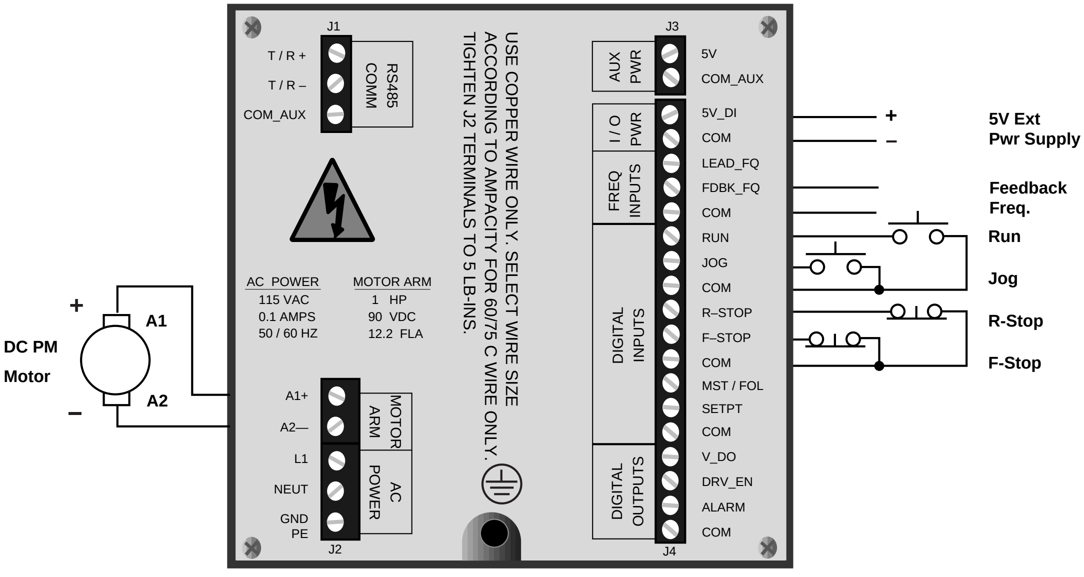


Figure G-1 ML-Drive Wiring Connections without Relays

DANGER

This diagram is for conceptual purposes only!
Use safety equipment.
Make wiring connections carefully.
Incorrect use of equipment or connections can cause injury or death.

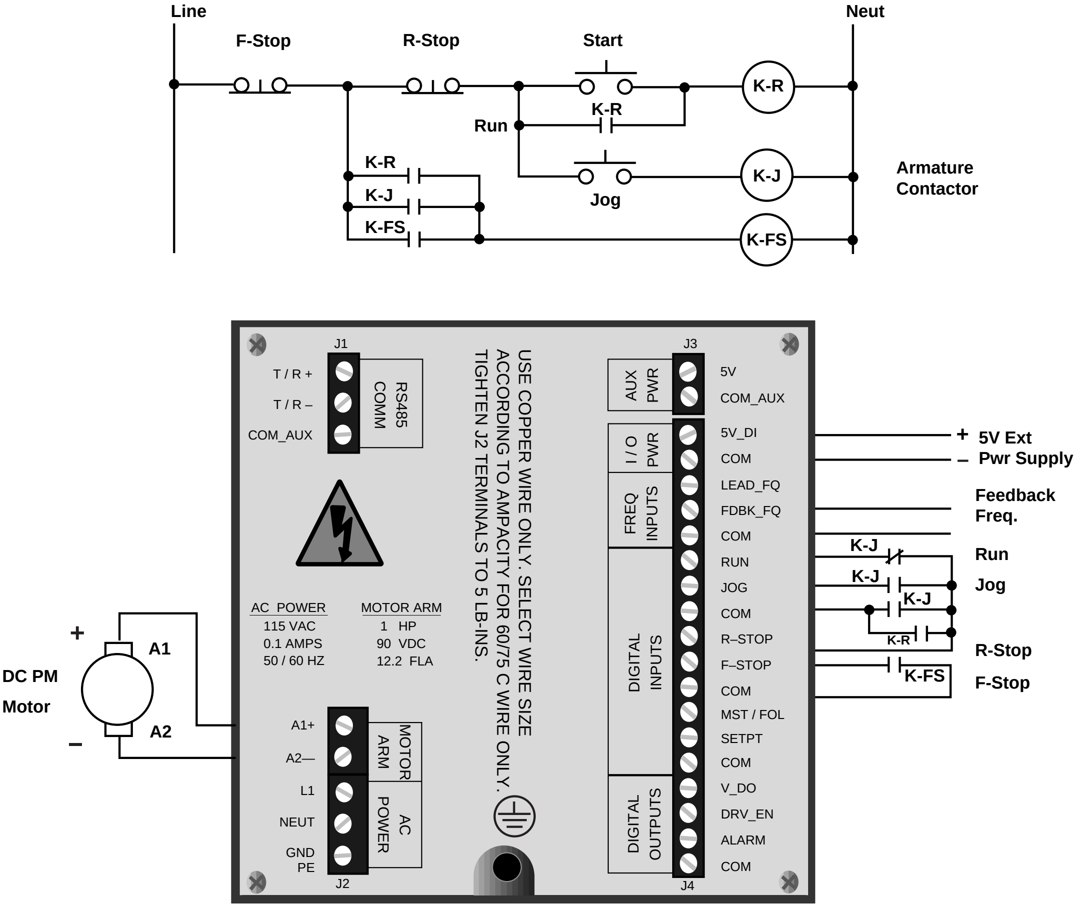


Figure G-2 Relay Start/Stop Wiring Connections

DANGER

This diagram is for conceptual purposes only!
Use safety equipment.
Make wiring connections carefully.
Incorrect use of equipment or connections
can cause injury or death.

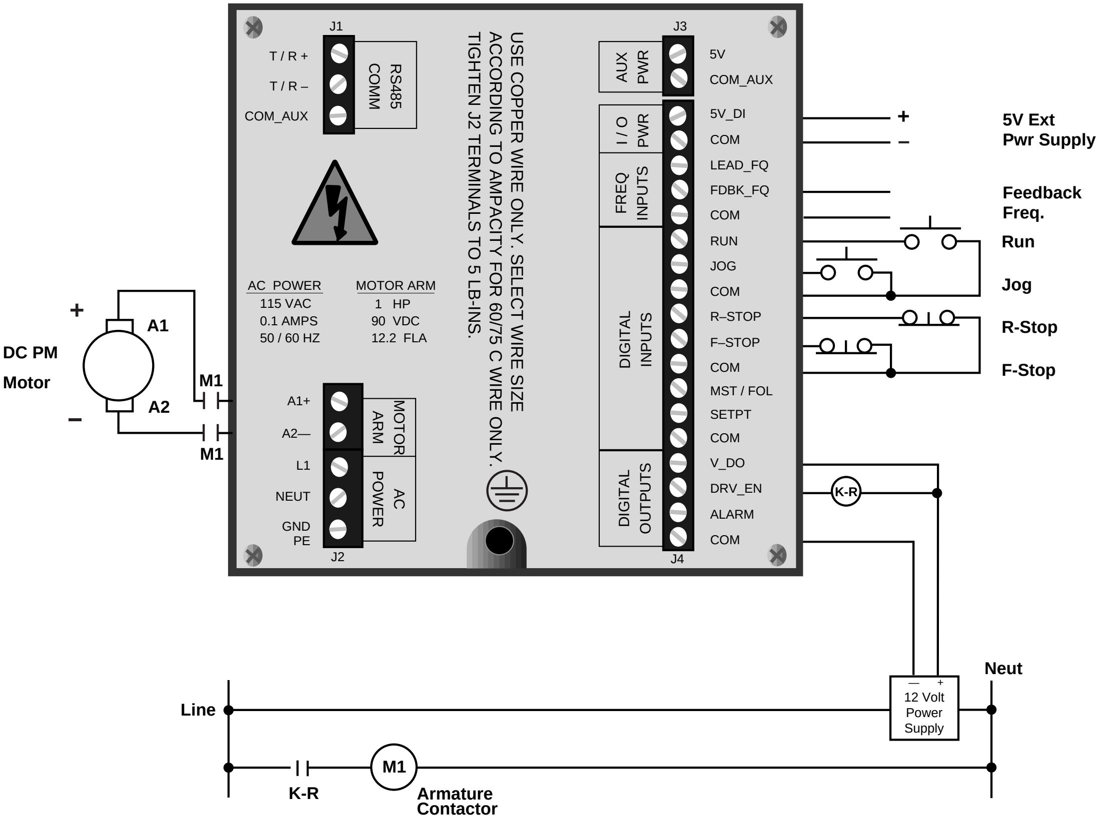


Figure G-3 Start/Stop with Armature Contactor

DANGER

This diagram is for conceptual purposes only!
Use safety equipment.
Make wiring connections carefully.
Incorrect use of equipment or connections
can cause injury or death.

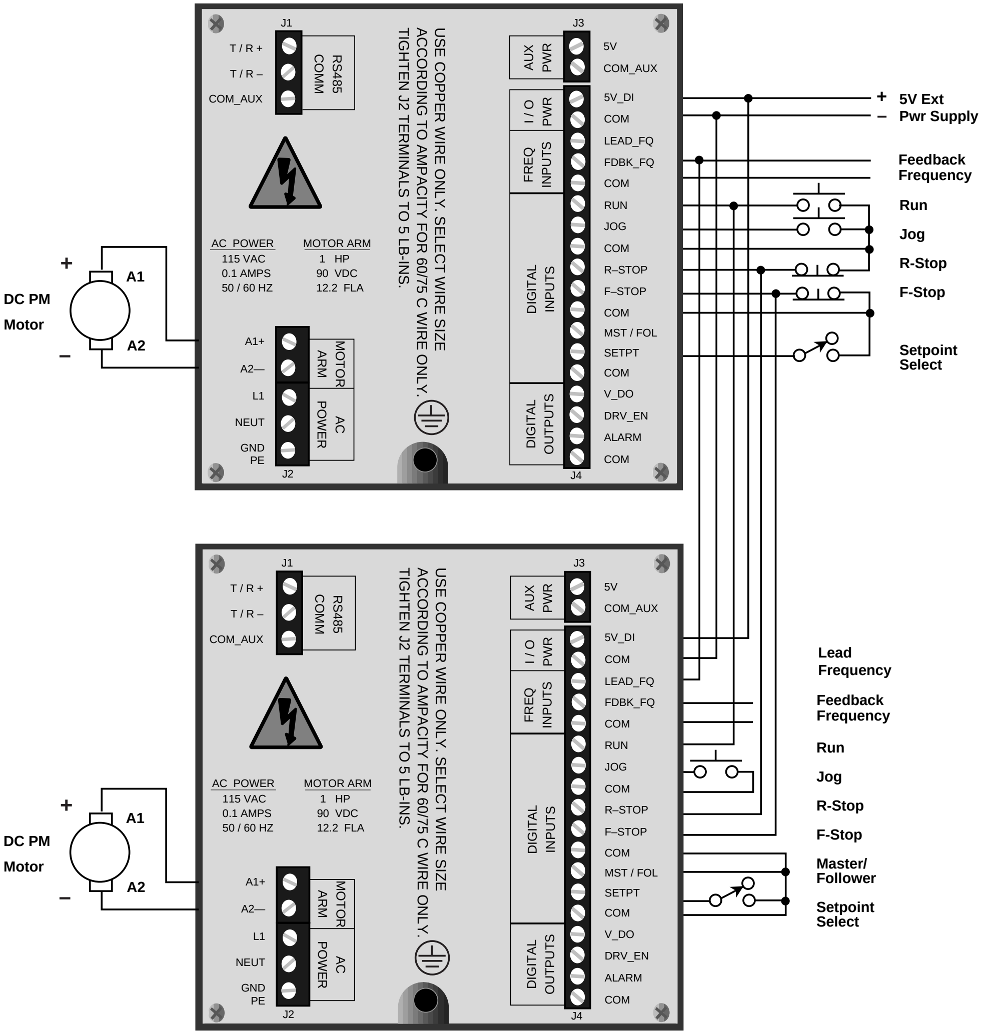


Figure G-4 Two Channel Start/Stop - Lead/Follower Logic

APPENDIX H: REVISION LOG

Manual Revision	ECO Number	Revision Date	Corresponding * Software Rev.	Pages Changed
1	—	1/98	1000-7699 Rev. 0.1	New Manual Release, xerox edition
2	—	3/98	1000-7699 Rev. 0.5	Added current limit, misc update and corrections.
A	—	6/98	1000-7699 Rev. 1.0	Class B release; misc update and corrections. added Feedforward.
B	6513	10/98	1000-7699 Rev. 1.1	Misc updates and corrections. Additions for CE compliance including CP-98, Keypad Lockout
C	6552	7/99		Add Branch Circuit Protection Statement
D	6581	5/00		Misc updates and corrections.
E	---	04/13	---	Update Page 2-5 for Motor Over-temp protection

* Software revisions may not mandate manual changes. If your software revision is more recent than what is reflected here, use the the most current revision of the manual.

—NOTES—

Warranty

Service Policy
Warranty

SERVICE POLICY

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

Applicability

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

Service Personnel

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

Service Charges

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

Spare Parts

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

Instruction Manuals

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

OEM Service

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

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

WARRANTY

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

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

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

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

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

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

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

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