



LM10 Motor Protection System Instruction Manual



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GE Multilin LM10 Motor Protection System instruction manual for revision 1.70.

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LM10 Motor Protection System

Chapter 1: Introduction

1.1 Description

1.1.1 The LM10 Relay

The GE Multilin LM10 Motor Protection System is a modular device designed to protect motors from various fault conditions. This device interfaces with a DeviceNet network. The network will monitor and control the relay status and functions. The relay also has the capability of operating in a standalone mode. Configuration can be accomplished via DIP switches on the front of the relay.

Additionally, the relay has an interface port to communicate to the LM10 programming and display unit (PDU). The PDU is a self-contained device consisting of a membrane switch keypad, a liquid crystal display (LCD), and control electronics for communication with the relay. This unit provides a method of configuring and monitoring the LM10. The PDU incorporates an RS232 interface with a proprietary communications protocol.



DeviceNet is a registered trademark of Open DeviceNet Vendor's Association (ODVA).

1.2 Overview

1.2.1 Features

The LM10 Motor Protection System is a microprocessor-based unit. It takes a 'snapshot' image of the three phases of current, one phase of voltage, and ground. The data is then applied to the algorithms and compared to the device's configuration information. Based on the result of the comparison, the relay may trip one or more of the on-board control relays. When applicable, indicators will be illuminated to show the status of the device. Additionally, up to ten trip events will be stored in non-volatile memory.

The LM10 auxiliary communications port to the PDU is an RS232 interface using a standard four-pin RJ11 style cable. This port will allow the PDU to obtain and display any of the real-world data that is contained in the relay as well as to configure the relay.

The LM10 Motor Protection System supports the DeviceNet protocol and can be interfaced with the PLC DeviceNet mastercard or DCS Scanner card. It supports Polled, Change of State (COS), Cyclic I/O Messaging, and Explicit Messaging.

1.2.2 Current and Voltage Inputs

The relay has inputs for two sets of three-phase current transformers (CTs) and one ground CT. One set will allow for custom 27 A and 90 A CT sensor packs to be connected; the other will allow for 75 to 800:5 A ratio CTs. Dual speed motors will require two separate CTs connected in parallel.

A 100:1 A core-balance CT or 20 A ground fault sensor pack can be connected to the ground CT terminals for ground current measurement.

Provisions have been made to support various CTs for the three-phase measurements.

Voltage input from the control power transformer (CPT) is conditioned and measured by the analog-to-digital converter to determine supply voltage. This signal, in conjunction with the current, is used to calculate power and power factor.

1.2.3 Relay Outputs

The LM10 Motor Protection System contains 4 on-board Form-C relays with NEMA C150 pilot duty ratings. Two relays should be used to control the coils of motor contactor and one to annunciate ground fault status. An additional programmable relay is available for fault status indications.

The two control relays are labeled "RUN 1" and "RUN 2". These relays are enabled on command from the control logic. If the LM10 detects a fault condition the relays will be de-energize, causing the motors to shut down.

The ground fault relay is energized on detection of a ground fault. Upon correction of the ground fault condition, the relay will be de-energized. The output contact can be used to trip a breaker or annunciate to other devices.

The programmable trip relay is energized when the programmed algorithm conditions have been met and can annunciate out to other devices.

1.2.4 Power Supply

The LM10 Motor Protection System has an on-board power supply with a fuse that converts the AC input to the levels necessary to operate this device. The operating range is 96 to 140 V AC, nominal 120 V control power (80% to 117%). The supply has programmable auto-restart capability of up to 4 seconds. This also supplies necessary power to the PDU at a TTL.

For correct measurement of power and power factor, the control power must be connected across phase A and phase B of the three-phase power supply.

1.2.5 Block Diagram

A single line diagram for the LM10 Motor Protection System is shown below.

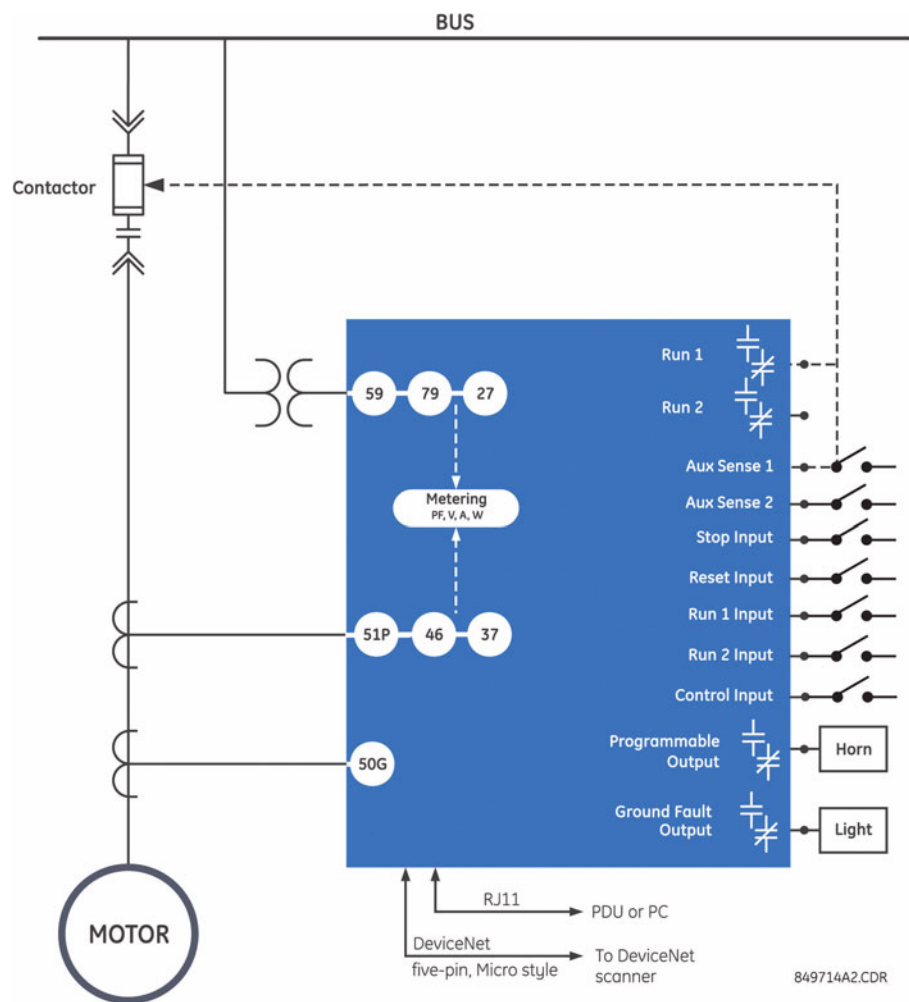


FIGURE 1-1: Functional Block Diagram

1.3 Features

1.3.1 Programming and Display Unit

The main task of the programming and display unit (PDU) is to provide status information to a local user. The PDU can display the requested parameter(s) on the LCD in either English or Spanish. Additionally, the PDU can be used to configure the LM10 via the RS232 serial communications port.

1.3.2 LED Indicators

The LM10 has five (5) LEDs on the front panel. They function as follows:

- **Module Status (MS):** This two-colored LED is used for the DeviceNet module status. Its function is defined in the DeviceNet specification.

LED State	Description
Off	No power
Green	Device operational
Red	Unrecoverable fault

- **Network status (NS):** This two-colored LED is used for the DeviceNet network status. Its function is defined in the DeviceNet specification.

LED State	Description
Off	No power / not online
Flashing green	Online, not connected
Green	Link OK, online, connected
Flashing red	Connection timeout
Red	Critical link failure

- **Overcurrent (OC):** This red LED is illuminated when the relay detects an overcurrent condition in one or more of the power phases.
- **Ground Fault (GF):** This red LED is illuminated when the relay detects a ground fault condition.
- **Current Unbalance (CUB):** This red LED is illuminated when the relay detects a current unbalance between the power phases.

1.3.3 Switches

The following switches are located on the front panel of the LM10. Changes to switch settings will not take effect until power is cycled (on-off).

All other relay features (e.g., the CT sensor pack) can only be programmed via DeviceNet or the RS232 configuration port.

- **MAC ID:** Two rotary DIP switches are used to set the DeviceNet MAC ID. Each unit on the DeviceNet network requires a unique MAC ID. The valid ID range is from 0 to 63, with a factory default of 0. Cycle power after any switch changes.

- Baud rate:** This two-position DIP switch is used to select the DeviceNet baud rate. The valid rates are 125K, 250K and 500K bits per second. The DIP switch is defaulted to 125K baud rate when shipped.

Baud Rate	DIP Switch Position
125 kbps	down - down
250 kbps	up - down
500 kbps	up - up

Changes to switch settings will not take effect until the next power cycle.

- Trip Class (TC):** NEMA overload trip class is selected using a rotary DIP switch. Valid settings are Class 10, 15, 20, or 30. To set the trip class, align the screwdriver slot with the desired value. Do not use the triangle marker on the DIP switch. A screwdriver with a nominal blade width of 0.094 to 0.175 inches should be used. Smaller blades could allow the switch to be set in an invalid position.



Changes to switch settings will not take effect until power is cycled.

Display

Liquid crystal display: four lines of 16 characters per line.

Status

The status sub-menu can display current, motor status, Run 1 and Run 2 data, faults, MAC ID, baud rate, and overload class.

Reset

The relay can be reset from the PDU, pushbutton, or the LAN.

Mounting Flexibility

The relay can be attached to the PDU without hardware to facilitate door mounting.



LEDS

One green LED power indicator and a flashing red trip LED to indicate over/undercurrent, current unbalance, ground fault, under/overvoltage, and trip command.

CONFIG

The relay parameters are programmed via the CONFIG button. The CONFIG sub-menu is similar to the status menu, and allows the user to change relay parameters: CT ratio, PT ratio, fault settings, and time delays.

History

Displays the last ten (10) trip records. The conditions at the time of fault are displayed and can be scrolled through using the UP/DOWN arrow keys.

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FIGURE 1-2: LM10 Features

1.4 Ordering

1.4.1 Order Codes

The order codes for the LM10 Motor Protection System are shown below.

Table 1–1: LM10 Order Codes

	LM10	D*	CT**	GF**	C*	**	
Base unit	LM10						LM10 Motor Protection System
Programmable display unit	X						No display unit
	1						Programmable display unit (with cable)
Thermal overload current transformer			XX				No phase current transformer
			01				Current sensor, NEMA starter size 1, 3-phase, 27 A
			02				Current sensor, NEMA starter size 2 and 3, 3-phase, 90 A
			03				Current sensor, NEMA starter size 4, 3-phase, 200 A
			04				Current sensor, NEMA starter size 5, 1-phase, 300 A
			05				Current sensor, NEMA starter size 6, 1-phase, 600 A
Ground fault sensor				XX			No ground fault sensor
				01			Ground fault sensor: 20 A, 0.44" window
				02			Ground fault sensor: 20 A, 1.56" window
				03			Ground fault sensor: 20 A, 2.08" window
				04			Ground fault sensor: 20 A, 2.50" window
				05			Ground fault sensor: 20 A, 3.31" window
				06			Ground fault sensor: 20 A, 4.62" window
Cable					X		No cable
					1		30-inch communication cable from relay to PC
Reserved						XX	For future use

1.5 Specifications

1.5.1 Protection Elements

OVERCURRENT (ANSI 51)

Curve shapes:NEMA class 10, 15, 20 and 30, hot and cold
Timing accuracy:.....±5% of total trip time + 1 second

GROUND FAULT

Pickup level:0.4 to 20.0 A in steps of 0.2
Pickup accuracy:±5% or ±0.1 A, whichever is greater
Time delay:.....0 to 2.5 seconds in steps of 0.1
Timing accuracy:.....±200 ms

CURRENT UNBALANCE (ANSI 46)

Pickup level:2 to 25% in steps of 1
Pickup accuracy:±5%
Time delay:.....0 to 255 seconds in steps of 1
Timing accuracy:.....±5% of total trip time + 1 second

MECHANICAL JAM

Pickup level:100 to 250% in steps of 1
Pickup Accuracy:±5%
Time delay:.....0 to 1000 seconds in steps of 5
Timing accuracy:.....±5% of total trip time + 1 second

STALL

Pickup level:330 to 600% in steps of 5
Pickup Accuracy:±5%
Time delay:.....0 to 30.0 seconds in steps of 0.5
Timing accuracy:.....±5% of total trip time + 1 second

LOAD LOSS

Pickup level:15 to 100% in steps of 1
Pickup Accuracy:±5%
Time delay:.....0 to 255 seconds in steps of 1
Timing accuracy:.....±5% of total trip time + 1 second

UNDERVOLTAGE/OVERVOLTAGE

Undervoltage pickup level: 80% of nominal voltage (96 V)
Overvoltage pickup level: 117% of nominal voltage (140 V)
Pickup accuracy:±5%
Trip time:.....0.5 second
Timing accuracy:.....±200 ms

1.5.2 Metering

PHASE CURRENT

Resolution:.....0.1 A
Range:.....0.05 to 8 × CT Primary (3200.0 A max.)
Accuracy:±5% of full scale

Ground CT input:.....20 A ground fault sensor or 20:0.2 A ground fault CT

VOLTAGE

PT secondary:.....0 to 120 V

PT primary:200 to 7200 V

CONTACT INPUT

Inputs:7 fixed inputs (Run 1, Run 2, Aux sense 1, Aux sense 2,
Stop, Reset, DeviceNet control)

Recommended Supply voltage:100 to 135 V AC

**NOTE**

When the LM10 contact inputs are connected to the remote devices for the input signal via long cables, induced voltages may be present at the input terminal of LM10 relay. The contact input status could be detected as closed if the induced voltages are greater than 33V. Under these situations it is recommended to use interposing relay or to connect a resistor across the LM10 contact input terminal and ground to provide path for the induced voltages to the ground.

1.5.5 CT Dimensions

Thermal overload CT

Order Code	Description	Window Diameter	Overall Dimensions
CT01	Current Sensor, NEMA Starter Size 1, 3 phase, 27 amp	0.44"	4.625"x2.000"x1.375"
CT02	Current Sensor, NEMA Starter Size 2&3, 3 phase, 90 amp	0.44"	4.625"x2.000"x1.375"
CT03	Current Sensor, NEMA Starter Size 4, 3 phase, 200 amp	0.69"	5.60"x2.38"x1.72"
CT04	Current Sensor, NEMA Starter Size 5, 1 phase, 300 amp	1.50"	4.50"x4.88"x4.68"
CT05	Current Sensor, NEMA Starter Size 6, 1 phase, 600 amp	2.50"	4.57"x4.57"x4.68"

Ground fault CT

Order Code	Description	Window Diameter	Overall Dimensions
GF01	Ground Fault Sensor 1&2, 20 amp, 3x0.44" windows	0.44"	4.625"x2.000"x1.375"
GF02	Ground Fault Sensor 3&4, 20 amp, 1x1.56" window	1.56"	3.53"x3.65"x2.23"
GF03	Ground Fault Sensor 5, 20 amp, 3x2.08" windows	2.08"	9.00"x3.94"x2.23"
GF04	Ground Fault Sensor, Limit Amp, 20 amp, 1x 2.5" window	2.5"	4.57"x4.57"x4.68"
GF05	Ground Fault Sensor, Limit Amp, 20 amp, 1x 3.13" window	3.13"	4.63"x5.10"x5.50"
GF06	Ground Fault Sensor, Limit Amp, 20 amp, 1x 4.62" window	4.62"	7.00"x7.12"x6.82"

1.5.6 Outputs

RELAY OUTPUTS

Relay pilot duty:..... 5 A at 120 V AC
 5 A at 28 V DC

1.5.7 Communications

DEVICENET

Functionality:.....group 2 slave only
 Device type:.....motor starter

Connector type:.....5-pin micro-style molded male connector
 Baud rate:125, 250 and 500 kbps via DIP switches
 Mac id:0 to 63 via DIP switches
 Supports:Poll, COS and Cyclic IO, and explicit messaging
 LEDs:network status and device status

SERIAL COMMUNICATIONS

Serial port:RJ11 4-pin connector for Enervista LM10 Setup software
 or to PDU

PANEL DISPLAY UNIT (OPTIONAL)

Display:16 character × 4 line display

1.5.8 Environmental

AMBIENT TEMPERATURE

Operating temperature:.....0 to 60°C
 Storage temperature:.....-30 to 80°C

HUMIDITY

Humidity:up to 95% non condensing

1.5.9 Approvals/Certification

CERTIFICATION

UL:file number E228903 listed for USA and Canada
 CE:conforms to EN 55011, EN 61000, IEC 68-2
 DeviceNet CONFORMANCE TESTED™

DeviceNet[®]
 CONFORMANCE TESTED



LM10 Motor Protection System

Chapter 2: Installation

2.1 Wiring

2.1.1 DeviceNet

The LM10 has one micro-style (Brad Harrison style) connector that allows the purchase of pre-built cables for attachment to the unit and the ability to daisy chain from one unit to the next. These connectors meet all DeviceNet physical layer requirements.

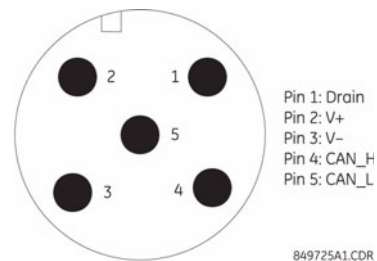


FIGURE 2-1: LM10 DeviceNet Pinout

2.1.2 RS232 Port

The RS232 configuration port uses a standard RJ11 connector to interface with the programming and display unit (PDU) or with a computer. Both communication and power will be provided to the PDU through this connection. Standard RS232 levels are used for the communications.

RJ11 Pin	Description
1	N/A
2	Ground
3	TXD
4	RXD

RJ11 Pin	Description
5	+5 V (PDU use only)
6	N/A

The LM10 base unit and PDU are designed to use a maximum 36-inch cable when the PDU is mounted door-mounted alone. A shorter cable can be used when the two units are door-mounted together.

The connection for the RS232 serial communications port is shown in the following figure. The EnerVista LM10 software can be used to configure and monitor the status of the LM10 through the RS232 port.

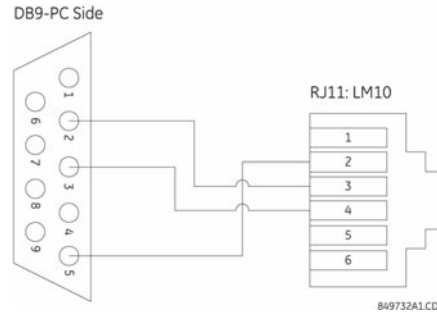


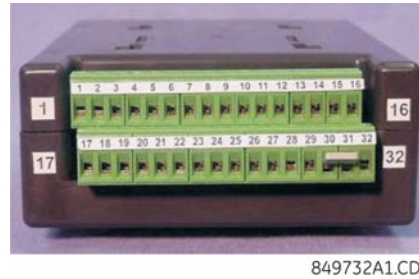
FIGURE 2-2: LM10 RS232 Pinout

2.1.3 Control Terminals

The control terminal block is a phoenix contact style 0.2-inch center, dual-row, 16 points per row removable connector. The connector will be used to make all field connections (other than communications and CT sensors) to the unit. The terminal block has the following connections:

Table 2-1: Control Connections

Upper Signal Row		Lower Signal Row	
1	120 V AC - phase 1	17	Switch input - auxiliary 2
2	120 V AC - phase 2	18	Switch input - auxiliary 1
3	Switch input - stop	19	Switch input - run 2
4	Switch input - reset	20	Switch input - run 1
5	Switch input - common	21	Switch input - DeviceNet control
6	Relay 1 N.O. - run	22	Ground fault relay N.O.
7	Relay 1 common - run	23	Ground fault relay common
8	Chassis ground	24	Programmable relay N.O.
9	Relay 2 N.O. - run	25	Programmable relay N.C.
10	Ground fault relay N.C.	26	Programmable relay common
11	Relay 2 common - run	27	5 A CT 2 phase B
12	5 A CT 1 phase B	28	5 A CT 2 phase A
13	5 A CT 1 phase A	29	5 A CT 2 phase C
14	5 A CT 1 phase C	30	5 A CT 2 common
15	5 A CT 1 common	31	No connection
16	Ground CT 1	32	Ground CT 2



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FIGURE 2-3: LM10 Control Signal Contacts

Service hint: Remove the bottom terminal block first, using a small screwdriver in either end. The top terminal block can then be removed using a coin or any broad-blade tool.

2.1.4 Sensor Pack Input

Connectors S1 and S2 are used to connect to all CT Sensor Packs. 5 A CTs connect via the Phoenix terminal block.

S1/S2 Pins	Description
1	CT phase A
2	CT phase B
3	CT phase C
4	CT phase A common
5	CT phase B common
6	CT phase C common

2.1.5 Wiring Diagram

A typical LM10 wiring diagram is shown below. The relay should be programmed as "Maintained Off" (under "Other Settings") for momentary start input. See page 4-34 for additional details.

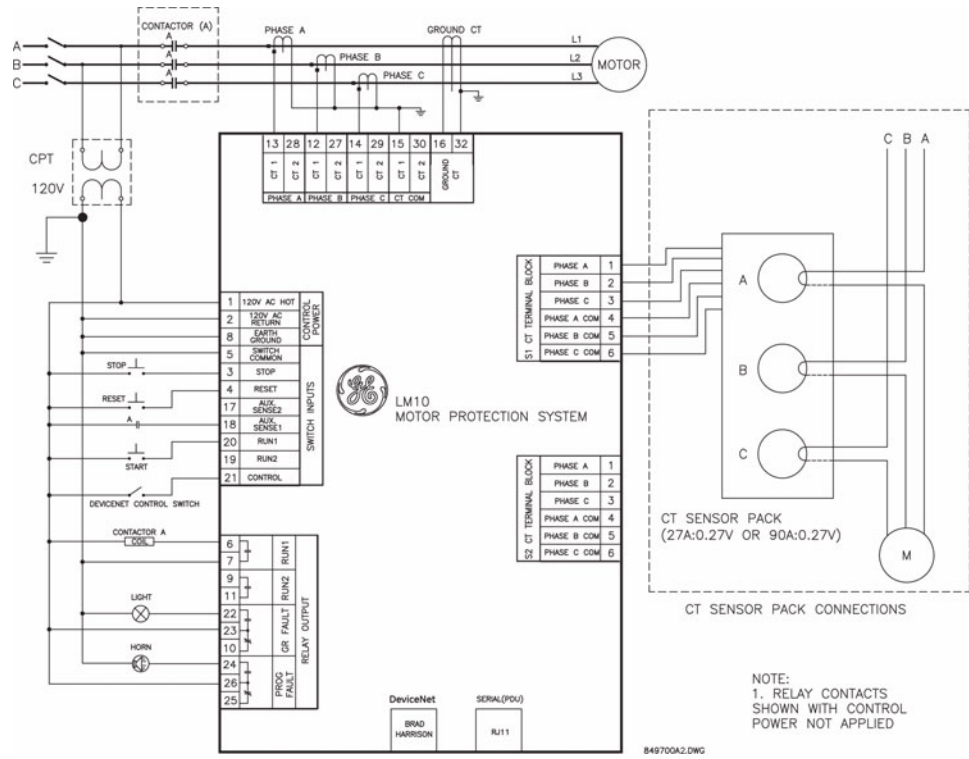


FIGURE 2-4: LM10 Wiring Diagram

2.2 Mounting

2.2.1 LM10 Mounting

Three mounting options are available.

1. The relay has four holes in the back to allow securing to a mounting plate with screws by others.
2. When mounted in a GE Evolution Series E9000 Motor Control Center, a mounting bracket (provided separately by GE) has been designed to suspend the LM10 base unit inside the MCC bucket. To install, first remove the plastic mounting plate from the LM10.
3. Front door mounting feature (see *PDU Door Mount* on page 2–18).

MCC hint: Grasp the bottom of the LM10 in one hand, and slide in opposite directions to detach. Attach the mounting plate to the bracket provided using four (4) screws (not included). Once the mounting bracket and plate are installed, slide the LM10 base unit back onto the plate.

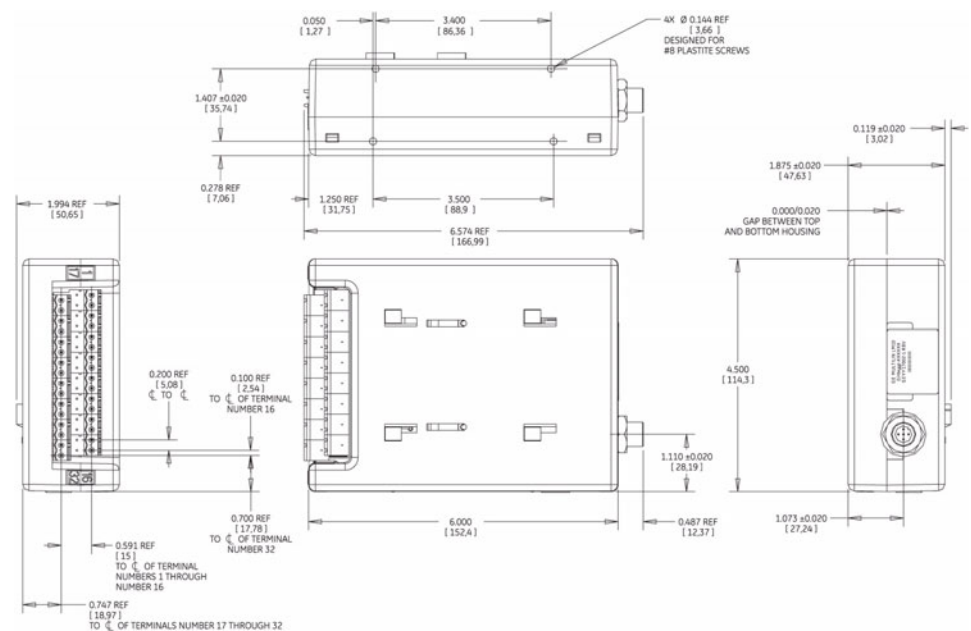


FIGURE 2–5: LM10 Base Unit Dimensions

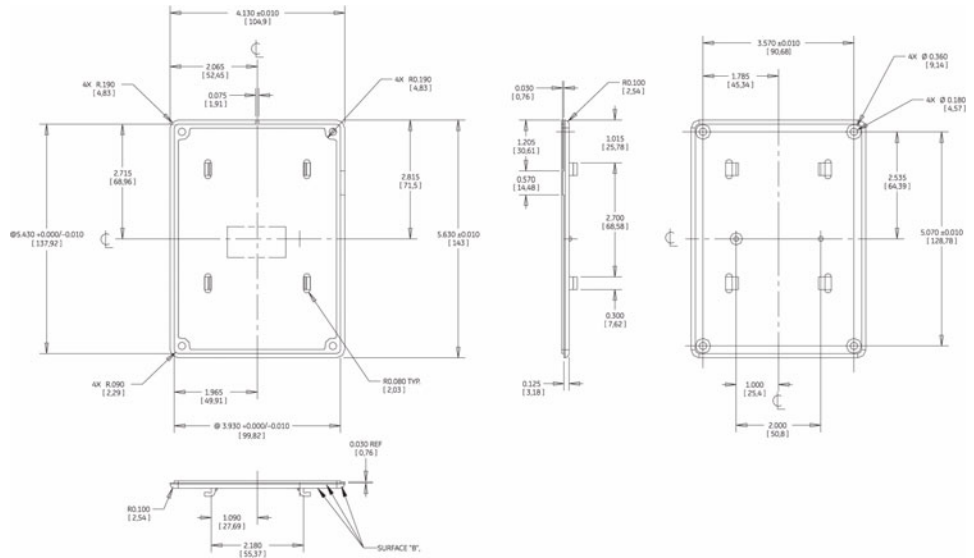


FIGURE 2-6: LM10 Backplate Dimensions

2.2.2 PDU Door Mount

The PDU can be door-mounted using the gasket and six screws provided. The rear of the unit protrudes through a cutout and is accessible from inside the door. Recommended cutout dimensions and screw hole locations are shown below.

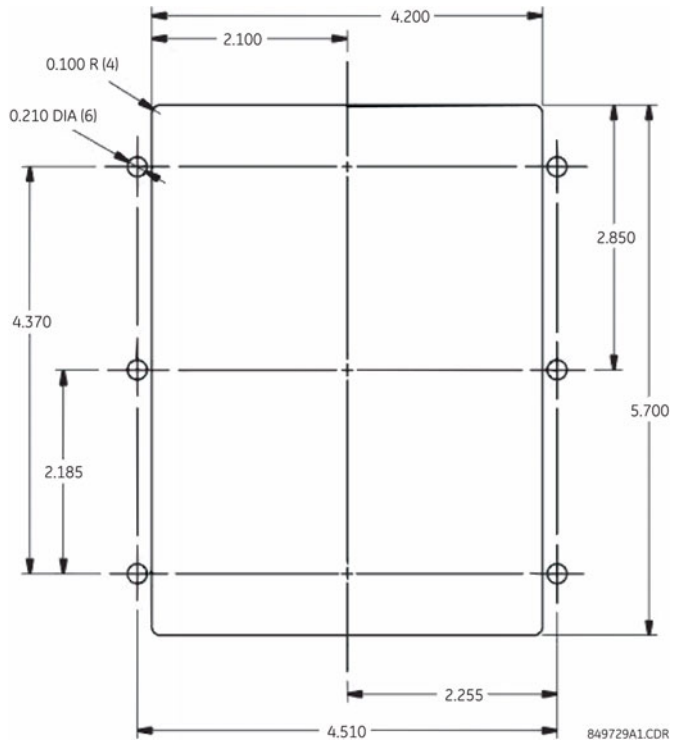


FIGURE 2-7: PDU Door-mount Dimensions



LM10 Motor Protection System

Chapter 3: Interface

3.1 PDU Operations

3.1.1 Liquid Crystal Display

The liquid crystal display is a 5 × 8 font pixelized character type in a 16-character by 4-line format. A yellow-green background offers good readability under direct sunlight and normal room lighting. The display is reflective, not backlit. Display messages can be changed to Spanish.

3.1.2 LEDs

A green LED power indicator and a flashing red LED fault indicator is provided. The green power indicator flashes when in the Configuration mode, and the flashing red LED indicates a trip condition.

3.1.3 Keypad

The keypad consists of seven buttons used to view and select menu items displayed on the LCD. The keypad is for program changes and data display. With the exception of testing, the PDU is not a control keypad.

- **Up and down arrows:** At the main configuration screen, the up and down arrows control the LCD contrast level. At all other screens, they are used to scroll through a list or increase/decrease selected values.
- **Enter:** At the main configuration screen, pressing the Enter button toggles the LCD display from English to Spanish. Pressing again will return the display to English. The Enter button is used to make a selection.
- **History:** Pressing the History button displays the last ten (10) fault history records. Each history record contains a snapshot of conditions when the unit last faulted. The following items are displayed: fault type, phase currents, ground current, voltage,

power factor, kW, average current, and current unbalance. Pressing the History button again advances to the next history record.

- **Status:** Pressing the Status button displays the current conditions of the LM10. The following items are displayed: phase currents, ground current, voltage, kW, power factor, average current, current unbalance, and elapsed motor hours.
- **Config.:** In User mode (default startup condition, no passcode entered), pressing the Config. button displays the following programmed parameters: English or Spanish display, CTs and CPTs, starter type, Run 1 setup, Run 2 setup, time delays, other settings, auxiliary relay faults, and passcode/login.

In Configuration mode (after proper passcode entered), the same Config screens are available to edit. In addition, the following restricted-access options are displayed: run operations and restore factory default configuration.

- **Reset:** At the main startup screen, the Reset button clears fault conditions, thereby allowing the motor to be ready to restart. At all other screens, pressing the Reset button brings the previous menu.

3.2 PDU Screens and Menus

3.2.1 Main Startup Screen

The main startup screen displays the following information. These parameters are not programmable via serial communications, but rather are displayed for convenience. See *Switches* on page 1–4 for setting instructions.

- PDU software version displayed briefly, then replaced by the LM10 software version
- Trip class
- MAC ID
- Baud rate

3.2.2 History Record and Status Screens

See *Keypad* on page 3–19 for details on the history record and status screens.

3.2.3 Configuration Menu

See *Keypad* on page 3–19 for details on the configuration menu list. The configuration menu is used to set all the programmable parameters outlined in *Configuration Settings* on page 4–29.

- **CTs and CPTs Sub-menu:** This menu and its sub-menus are used to select Control Power Transformer (CPT), Current Transformer (CT) or Sensor Pack, and the number of turns through the CT.
- **Starter Type Sub-menu:** This menu is used to select Motor Starter Type.
- **Run 1 and Run 2 Setup Sub-menus:** This Run 1 menu is used to set full load current (FLA) for Run 1. It also contains sub-menus for enable/disable and configures the following optional faults: ground fault, jam, stall, current unbalance, and load loss.

Each fault is configurable not only in magnitude, but also in time delay in which that condition is allowed to exist before the LM10 trips.

The Run 2 Setup menu is laid out identically to Run 1 menu. Unless a custom motor type is selected, Run 2 setup is not necessary.

The full-load current will auto-populate if “Two-Speed” is selected. 2S1W will provide a 4:1 ratio of the FLA and 2S2W will set the FLA to a 2:1 ratio.



NOTE

Only one relay at a time can be on.

- **Time Delays Sub-menu:** The following time delays are set using this menu:
 - Auxiliary sense 1 (contactor closed; opened detects welded contacts)
 - Auxiliary sense 2 (contactor closed; opened detects welded contacts)
 - Run 1 to Run 2 (delay between forward and reverse or between speeds)

Run 2 to Run 1 (delay between forward and reverse or between speeds)

- **Other Settings Sub-menu:** The Other Settings menu is used to enable/disable the following: under/overvoltage, maintained vs. momentary switches, auto restart, DeviceNet fault, and 50 vs. 60 Hz system. It is also used to select the data grouping which is read through DeviceNet polling and to reset elapsed time meter. See Chapter 4 for details.
- **Auxiliary Relay Faults Sub-menu:** The auxiliary or programmable relay can be triggered upon any or all of the following fault conditions: overcurrent, jam, stall, current unbalance, auxiliary sense fault, load loss, power failure, DeviceNet fault, and under/overvoltage.
- **Passcode, Login Screen:** The unit has three passcode levels – User, Configurator, and Calibrator (shown as "change" on the PDU display). The default condition is User mode. It is necessary to login as Configurator in order to change any parameters. The unit is not meant for field calibration, therefore Calibration mode shall not be discussed in this Guide.

To enter a passcode press Config. and scroll down to the Pass Code field. Press enter to select, then use the up/down arrows to scroll to Config: press enter again to login. An incorrect passcode will force the login back to User.

The default Configurator passcode is "0" and can only be changed when in the Config mode. The menu item to change the passcode will become active after a successful login attempt. The Pass Code is a numeric value between 0 and 65535.

- **Run Operations Screen:** Press in Config. Mode and scroll down to Run Operation, this screen allows control of the Run, Stop, and Reset commands via the PDU. It may be used for test purposes.
- **Restore Factory Configuration Screen:** This screen, available only to Configurator or higher login, resets all parameters to factory defaults. The PDU will prompt the user to confirm the request prior to resetting parameters. Default settings are listed in Table 3 Configuration Parameters.

3.3 EnerVista LM10 Software

3.3.1 Description

The EnerVista LM10 software is intended as an interface to the GE Multilin LM10 Motor Protection System. It has all the capabilities of the GE Multilin LM10 Motor Protection System, although some of the operations may differ slightly. The major difference is configuration parameters are not directly changed from the PDU screen, they must be downloaded after modifying. Also data values can be entered directly with the keyboard digits.



FIGURE 3-1: Main software screen

3.3.2 Functional Details

The EnerVista LM10 software has three menus: File, Communication and Help.

The **File** menu has following submenu items:

- **New:** Loads the memory with default values for the LM10 configuration parameters.
- **Load:** Loads the selected file and restores the LM10 configuration and communication parameters from the file.
- **Save:** Saves the LM10 configuration and communication parameters to the selected or entered file.
- **Exit:** Closes the program.

The **Communication** menu has the following submenu items:

- **Download:** Sends the configuration parameters from memory to the connected LM10. Note that you must be logged into the LM10 as a configurator to download configuration parameters.
- **Upload:** Gets the configuration parameters from the connected LM10 and saves them in memory.
- **Port:** Shows the available communications ports. The current selected COM port is indicated by a check mark. The green power LED indicates that communication is currently established with the LM10.

The **Help** menu has following submenu items:

- **Manual:** Opens the enerVista LM10 setup software help file.
- **About:** Displays the enerVista LM10 setup software version and information.

The EnerVista LM10 software uses hot keys for the following that equate to a mouse click on the PDU keys.

Table 3–1: EnerVista Hot Keys

Keys on PDU	Hot Keys
Reset	Esc, R, r
Status	S, s
History	H, h
Config	C, c
Up arrow	'Up arrow' key
Down arrow	'Down arrow'
Enter	'Enter' key



LM10 Motor Protection System

Chapter 4: Functionality

4.1 Overcurrent Fault Conditions

4.1.1 Descriptions

When current for any of the three phases becomes greater than the nominal full load current (FLA), the unit calculates time to trip. The FLA, trip class, CT ratio and number of passes/turns through the CT, and current input readings are taken into account. Separate algorithms are used for “cold” and “hot” motors. Since the LM10 does not measure temperature directly, motor condition is extrapolated from operating current versus the FLA setting.

The FLA value can be set from 1.2 to 800 A in steps of 0.1. This fault value is monitored continuously and can not be disabled.

The motor “hot” condition is determined based a variable algorithm. Once a fault condition is reached, the unit may not be Reset until an appropriate cool-down period has elapsed. This is once again calculated based on FLA, trip class, CT ratio and number of passes/turns through the CT, and current input readings.

The time to trip is a function of percent overcurrent, trip class, and motor condition (cold or hot). The current level must exceed $1.2 \times \text{FLA}$ for the trip timeout to run. This time is cumulative and will not time in unless the level drops below $1.0 \times \text{FLA}$.

A class 10 motor has the shortest trip times while a class 30 has the longest. The trip class should be selected based on motor size and type (see *Switches* on page 1–4 for details on setting the trip class).

The LM10 monitors average current of the three phases over time to determine the motor condition.

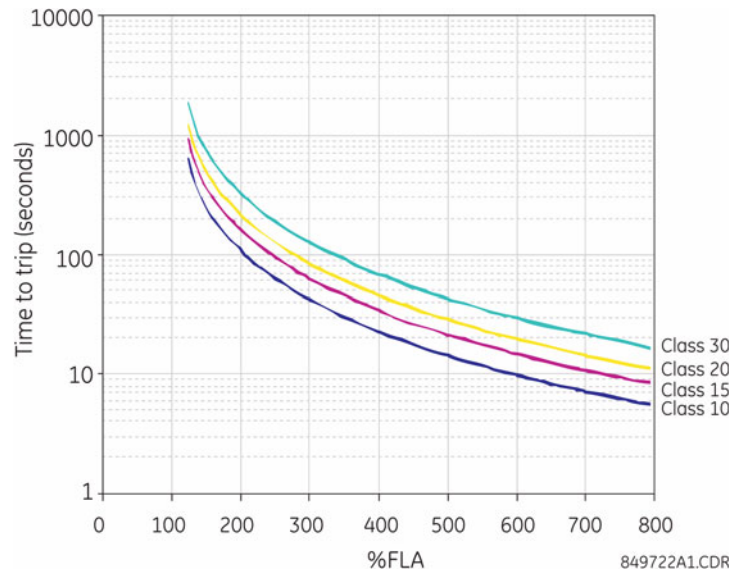


FIGURE 4-1: Cold Motor Trip Curves

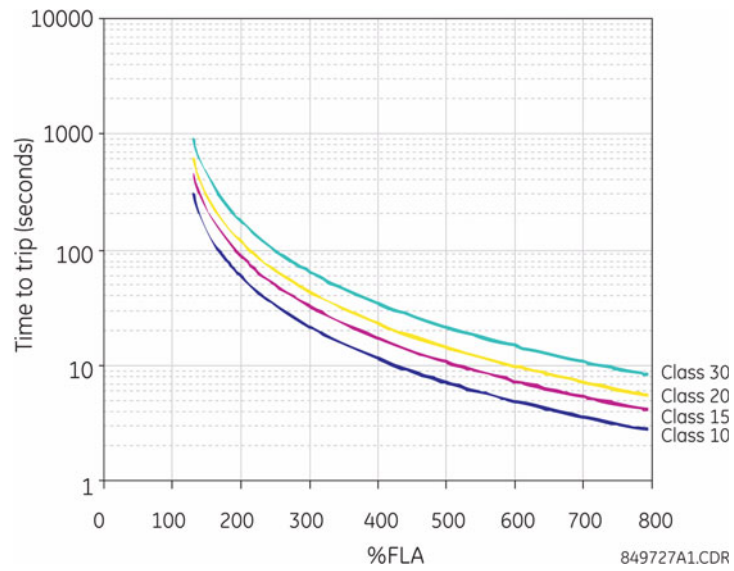


FIGURE 4-2: Hot Motor Trip Curves

4.1.2 Trip Curves Example

A trip curves example with jam and stall enabled is shown below. In this example, we have trip class 20, cold motor, with jam at 150% FLA for 120 seconds, and stall at 600% FLA for 12 seconds.

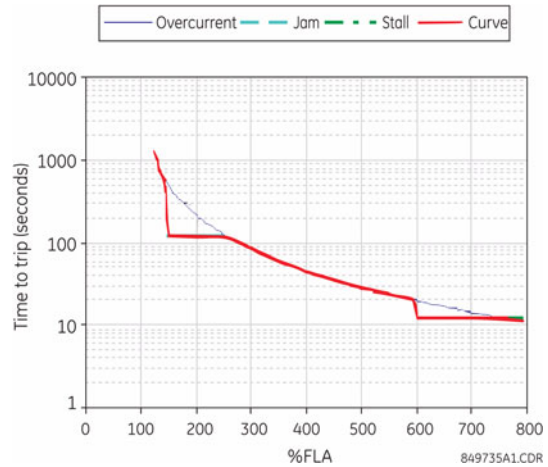


FIGURE 4-3: Trip Curve with Jam and Stall Enabled

The LM10 will trip on a jam or stall condition if these faults are enabled (see *Run 1 and Run 2 Setup* on page 4-32). The overcurrent curve cannot be disabled. Therefore, if the jam or stall values are set greater than the time allowed by the standard trip curve, the LM10 will trip before a jam or stall condition can be reached.

Upon an overcurrent, jam, or stall fault, the LM10 forces a cool-down period before the motor may be restarted. The time to reset is calculated as a function of the trip class and percent of full load current (FLA) at the time of the trip. For example, a class 30 motor tripping on a 6 × FLA fault will take 9 times longer before it is ready to reset than a class 10 motor tripping on a 2 × FLA fault.

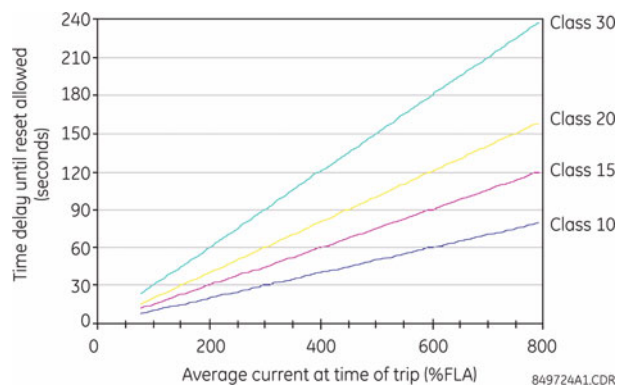


FIGURE 4-4: Cool Down Times

While the motor is in the cool-down time delay, the PDU status screen will display the fault type followed by a number decrementing from 99. When the number counts down to 0, the message "Ready to Run" will be displayed to indicate the RESET button may be pressed. Once the LM10 is successfully reset, the user may activate the run command.

4.2 Configuration Settings

4.2.1 Overview

An overview of the LM10 programmable parameters is shown below.

Table 4-1: LM10 Programmable Parameters

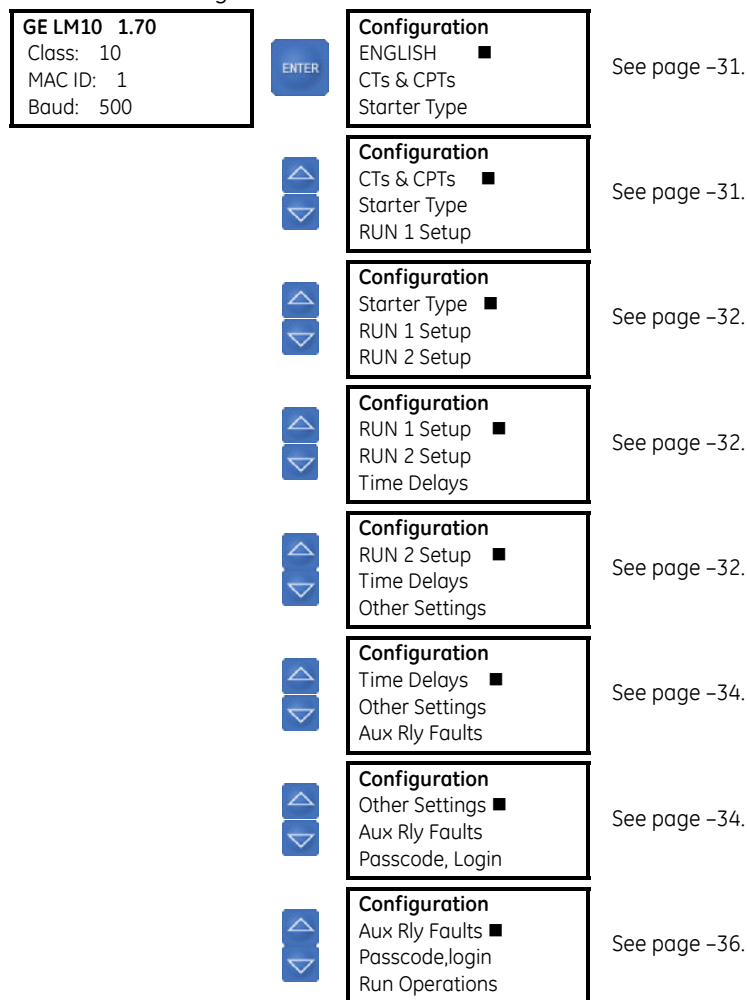
Parameter	Range/Options	Default	Reference
Control power transformer CPT ratio	200:120, 240:120, 480:120, 600:120, 2400:120, 3000:120, 3300:120, 4200:120, 4800:120, 5400:120, 6000:120, 7200:120	240:120	page 4-31
Current transformer CT / sensor pack	27 A Sensor Pack, 90 A Sensor Pack, 75:5, 100:5, 150:5, 200:5, 225:5, 250:5, 300:5, 400:5, 500:5, 600:5, 700:5, 800:5	100:5 Ratio	page 4-31
CT turns	1 to 4 in steps of 1	1	page 4-31
Starter type	FVNR, FVR, RV, 2S1W, 2S2W, Custom	FVNR	page 4-32
FLA (RUN1 and RUN2)	1.2 to 800 A in steps of 0.1	100.0 A	page 4-32
Ground fault level	0.4 to 20 A in steps of 0.2 or Off	Off	page 4-32
Ground fault timeout	0 to 2.5 seconds in steps of 0.1	0.5 sec.	page 4-32
Jam level	100 to 250% of FLA in steps of 1 or Off	Off	page 4-32
Jam timeout	0 to 1000 seconds in steps of 5	120 sec.	page 4-32
Stall level	330 to 600% of FLA in steps of 5 or Off	Off	page 4-32
Stall timeout	0 to 30 seconds in steps of 0.5	10 sec.	page 4-32
Current unbalance level	2 to 25% of FLA in steps of 1 or Off	Off	page 4-32
Current unbalance timeout	0 to 255 seconds in steps of 1	5 sec.	page 4-32
Load loss level	15 to 100% of Full Load in steps of 1 or Off	Off	page 4-32
Load loss timeout	0 to 255 seconds in steps of 1	60 sec.	page 4-32
Undervoltage	96 V fixed (trip delay time 0.5 sec.)	96 V	page 4-34
Overvoltage	140 V fixed (trip delay time 0.5 sec.)	140 V	page 4-34
Aux. sense 1 time delay Aux. sense 2 time delay	0.1 to 25.0 sec. in steps of 0.1 for ON state; 0.0 sec. for Disabled	0.4 sec.	page 4-34
Run 1 to Run 2 time delay; Run 2 to Run 1 time delay	0 to 600 seconds in steps of 1	0 sec.	page 4-34
Under/overvoltage enable	Off, On	On	page 4-34
Maintained input switches	Off = momentary, On = maintained/latched	Off	page 4-34
Auto restart	Off, On	Off	page 4-34

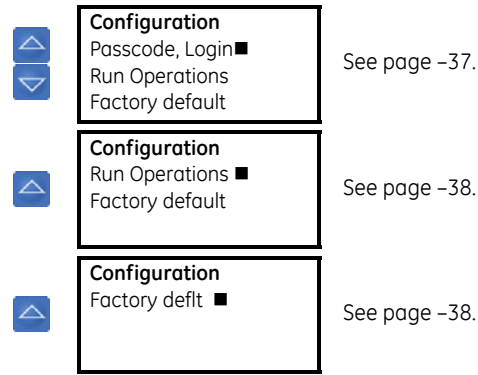
Table 4-1: LM10 Programmable Parameters

Parameter	Range/Options	Default	Reference
DeviceNet fault	Off, On	Off	page 4-34
50 Hz system	Off = 60Hz, On = 50Hz	Off	page 4-34
Poll data	1, 2, 3, 4	1	page 4-34
Reset run hours	Resets on selection	N/A	page 4-34
Administration control	Off, On	On	page 4-34
Auxiliary relay faults independently selectable	OvrCur, JAM, STALL, UnBalCur, AuxSense, LoadLoss, PwrFail, DevNet, Voltage	All Off	page 4-36
Restore factory defaults	Resets on selection	N/A	page 4-38

4.2.2 Main Menu

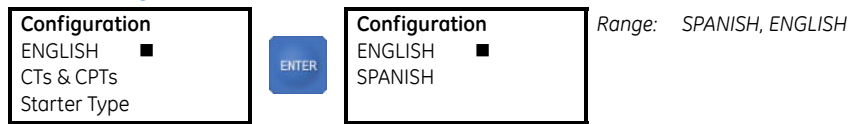
The main menu for the configuration settings is shown below. Press the CONFIG key to access these settings.





4.2.3 Language

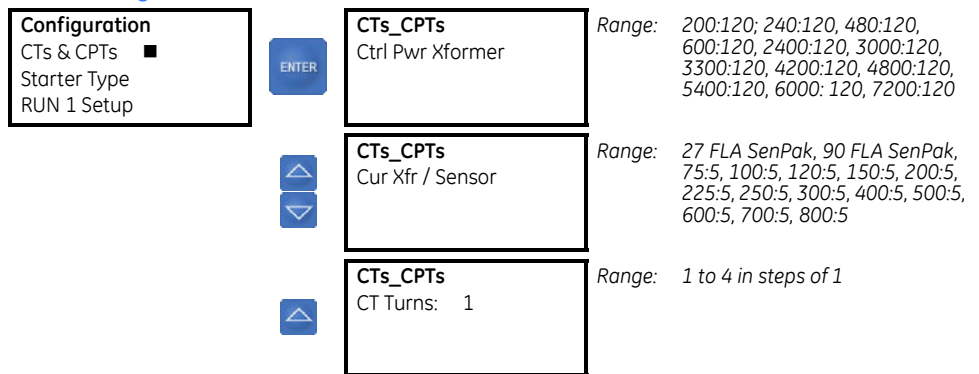
PATH: Configuration ↓ ENGLISH/SPANISH



This setting selects the language (either English or Spanish) to display on the PDU interface.

4.2.4 CTs and CPTs

PATH: Configuration ↓↓ CTs & CPTs



The CT and CPT settings are described below.

- **Ctrl Pwr Xformer** (control power transformer (CPT)): Select a CPT ratio from the choices provided. The default CPT ratio is 240:120.
- **Cur Xfr / Sensor** (current transformer): Select a CT ratio from the choices provided. The first two menu choices refer to sensor packs, while the remaining options are ratios of compatible CTs that might be used with the LM10.
- **CT Turns**: The CT may be configured so that wires are passed through the CT multiple times to increase values. This changes the effective CT ratio. Select a value between 1 and 4 for the number of turns (passes) through the CT.

4.2.5 Starter Type

PATH: Configuration ↓↓↓ Starter Type

Configuration Starter Type ■ RUN 1 Setup RUN 2 Setup	ENTER	Starter Type FVNR .*	Range: FVNR, FVR, RV, 2S1W, 2S2W, Custom
--	-------	--------------------------------	--

Select the motor type from the list. The choices are as follows:

- “FVNR” (full voltage non-reversing)
- “FVR” (full voltage reversing)
- “RV” (reversing)
- “2S1W” (two-speed one winding; Run-2, 4:1 ratio of Run-1)
- “2S2W” (two-speed two winding; Run-2, 2:1 ratio of Run-1)
- “Custom”

Any of the first five allows the LM10 to automatically populate required fields (FLA, etc.) for Run 2 based on Run 1 data. These fields are automatically populated, even for full voltage non-reversing motors, and do not require a separate configuration step. Even if logged into configuration mode, the LM10 will not accept Run 2 configuration changes unless a **Starter Type** of “Custom” is selected. The “Custom” value is for non-standard applications where Run 2 is not a set ratio of Run 1 and may be independently configured.

4.2.6 Run 1 and Run 2 Setup

PATH: Configuration ↓↓↓↓ Run 1 Setup

Configuration RUN 1 Setup ■ RUN 2 Setup Time Delays	ENTER	RUN 1 Setup FLA: 27.0	Range: 1.2 to 800.0 A in steps of 0.1
	▲ ▼	RUN 1 Setup Ground Setup	Range: 0.4 to 20 A in steps of 0.2 or Disabled for Ground Setup Fault; 0 to 2.5 s in steps of 0.1 for Ground Setup Time Delay
	▲ ▼	RUN 1 Setup JAM Setup	Range: 100 to 250% in steps of 1 or Disabled for JAM Setup Fault; 0 to 1000 s in steps of 5 for JAM Setup Time Delay value
	▲ ▼	RUN 1 Setup STALL Setup	Range: 330 to 600% in steps of 5 or Disabled for STALL Setup Fault; 0 to 30.0 s in steps of 0.5 for STALL Setup Time Delay value
	▲ ▼	RUN 1 Setup CurUnB Setup	Range: 2 to 25% in steps of 1 or Disabled for CurUnB Setup Fault value; 0 to 255 s in steps of 1 for CurUnB Setup Time Delay value
	▲	RUN 1 Setup LdLoss Setup	Range: 15 to 100% in steps of 1 or Disabled for LdLoss Setup Fault value; 0 to 255 s in steps of 1 for LdLoss Setup Time Delay value

The Run 1 settings are described below. The settings for Run 2 setup are identical.

- **FLA** (full load current) The LM10 Motor Protection System is designed to work in conjunction with a spectrum of motor starters. Therefore it handles full load currents ranging from 1.2 to 800 amps. The correct FLA for the motor in use must be programmed for relay protection to function properly.

Enter the full load current (FLA) of the motor. The LM10 will not accept full load currents that exceed the CT or sensor pack rating; however, lower values are acceptable. For best results, enter the proper FLA for the motor being used. Refer to *Overcurrent Fault Conditions* on page 4–25 for additional details.

- **Ground Setup:** A zero-sequencing ground fault can be enabled to trip and operate a separate ground fault relay when ground fault current exceeds the **Ground Setup Fault** setpoint. The **Ground Setup Time Delay** setting is from 0.5 to 2.5 seconds. Ground current can be continuously monitored at the PDU or over the network.



NOTE

A ground fault CT or sensor shall be connected for this protection.

- **JAM Setup:** According to NEMA or IEC MG 1-1998 part 12, page 21, “polyphase motors 600 V or less not exceeding 500 hp shall be capable of withstanding a current not less than 1.5 times the full load rated current for not less than two minutes when the motor is at normal operating temperature.” For relatively low overcurrent conditions, particularly on higher NEMA class motors, trip times could be considerably longer than 2 minutes. Therefore, a separate jam fault is available as the standard time overcurrent curve may not protect in this range.

The user may set a **JAM Setup Fault** level of 100 to 250% of FLA or disable this function. The default setting is set to disabled.

The overcurrent curve cannot be disabled. Therefore, if the **JAM Setup Time Delay** is set greater than the time allowed by the standard trip curve, the LM10 will trip before a Jam condition can be reached. See *Trip Curve with Jam and Stall Enabled* on page 4–27 for an example of the effect of trip times.

- **STALL Setup:** Cold motor trip times for a $6 \times$ FLA fault are determined by trip class. For example, a NEMA class 20 motor at $6 \times$ FLA would trip in 20 seconds. A separate Stall fault is available which would allow the user to reduce the trip time for large overcurrent situations.

The user may set a **STALL Setup Fault** level of 330 to 600% of FLA or disable this function. The default setting is disabled.

The overcurrent curve cannot be disabled. Therefore, if the **STALL Setup Time Delay** is set greater than the time allowed by the standard trip curve, the LM10 will trip before a stall condition can be reached. See *Trip Curve with Jam and Stall Enabled* on page 4–27 for an example of the effect of trip times.

- **CurUnB Setup** (current unbalance setup): The LM10 monitors the three current phases and trips if the phases are unbalanced. In addition to phase A, B, and C current, this function takes FLA, CT ratio and number of passes/turns through the CT into account. If the average current exceeds FLA, then this average value is used in the formula instead of the FLA value. The formula is:

$$\Delta = |\text{phase current} - \text{average current}| \quad (\text{EQ 4.1})$$

The next formula uses the largest Δ of the three phases.

$$\text{unbalance level} = (\Delta / \text{FLA}) \times 100\% \quad (\text{EQ 4.2})$$

The default **CurUnB Setup Fault** value is “Disabled” since not every application will require current unbalance monitoring. The current unbalance is programmable between 2 to 25% of FLA.

A 6% voltage unbalance equates to a roughly 25% current unbalance and will frequently cause motor damage.

- **LdLoss Setup** (load loss setup): Load loss is based on watts, defined as follows:

$$\text{watts} = 1.732 \times \text{average current} \times \text{voltage} \times \text{power factor} \quad \text{(EQ 4.3)}$$

The power factor is determined using the phase relationship between voltage and phase C current readings. Full load would be when the average current is at FLA, voltage is at nominal value, and power factor equals 0.85. This would equate to a load loss level of 100%. The **LdLoss Setup Fault** trip point is programmable as a percentage of this value. The motor would need to drop below this level for the preset time to cause the load loss fault. The relay is shipped with this option disabled.

4.2.7 Time Delays

PATH: Configuration ↓↓↓↓↓ **Time Delays**

Configuration Time Delays ■ Other Settings Aux Rly Faults	ENTER	Time Delays AuxSns1 .4	Range: 0.1 to 25.0 s in steps of 0.1 or Disabled
	↑ ↓	Time Delays AuxSns2 .4	Range: 0.1 to 25.0 s in steps of 0.1 or Disabled
	↑ ↓	Time Delays Run1-Run2 0	Range: 0 to 600 s in steps of 1 (0 to 180 s in steps of 1 for revisions 1.40 and lower)
	↑	Time Delays Run2-Run1 0	Range: 0 to 600 s in steps of 1 (0 to 180 s in steps of 1 for revisions 1.40 and lower)

The time delay settings are described below.












- **AuxSns1** and **AuxSns2** (auxiliary sense failure): Should the LM10 detect that a contactor did not open/close according to its command, an auxiliary sense (AuxSns) trip failure will be recorded in the fault record and shut down the run relay. This fault is factory preset at 0.4 seconds. The delay time for closing the relay can be changed however opening time is set at a constant 0.4 seconds to detect contact welding.

Applications requiring a delay between the run command and the starter pulling-in can be accommodated using this feature (for example, fans requiring damper closer before running). The **AuxSns1** and **AuxSns2** time delays can be set to match the damper closure time.

4.2.8 Other Settings

PATH: Configuration ↓↓↓↓↓ **Other Settings**

Configuration Other Settings ■ Aux Rly Faults Passcode,login	ENTER	Other Settings U/O Volt En off	Range: On, off. Not available for revisions 1.40 and lower
--	-------	--	--

 	Other Settings Maintained off	Range: on, off
 	Other Settings Auto Restart off	Range: on, off
 	Other Settings DevNet Fault on	Range: on, off
 	Other Settings 50Hz Sys off	Range: on, off
 	Other Settings Poll Data 1	Range: 1, 2, 3, 4. Not available for revisions 1.40 and lower
	Other Settings Reset Run Hrs.	Range: on, off

One or more optional faults may be enabled after the basic functions are configured.

- U/O Volt En** (undervoltage/overvoltage enable): This setting enables or disables the under/overvoltage element. LM10 revisions 1.40 and lower do not support this setting. Maximum and minimum voltage trip points are hard coded in the device and are not user programmable. These points are approximately 80% and 117% of nominal voltage. This corresponds to 96 V and 140 V with 120 V nominal voltage.
- Maintained** (maintained switching): This setting distinguishes between maintained (latched) versus momentary AC input switches. This is only applicable to Manual control, and has no effect on control via DeviceNet. The default setting is “off” for momentary switches. No seal in contact is required. In the maintained mode a run switch must stay closed if opened the LM10 will stop the motor. The stop switch input for safety reasons will interrupt the run relay in maintained or momentary mode. If the run switch is on when the stop command is given, it will need to be turned off and back on to get the motor running again. The stop command also interrupts the run relay if controlled by the network. The network will need to send another run command to restart the motor.



When using the maintained switching feature, potential safety hazards must be considered and an appropriate setup chosen for each individual application.

- Auto Restart** (power loss when running): The LM10 will be able to recover from a power loss of up to 4 seconds and return to its previous run state. Enabling autorestart allows the unit to restart the motor without operator intervention using a momentary run input. The default condition is “off” – this would require the operator to restart the motor after the LM10 regains power. Other conditions may interfere with this operation. A fault condition like voltage or DeviceNet may trip the LM10. Under the voltage condition the LM10 would be faulted

prior to power loss and not be in run when power is lost, therefore no run state to restart. With the DeviceNet fault enabled, the power recovery would reset the DeviceNet connections and the DeviceNet would act as if it's not communicating thus a DeviceNet fault.



Potential safety hazards must be considered and the appropriate setup chosen for each individual application.

- **DevNet Fault** (DeviceNet fault): If enabled, the LM10 will consider DeviceNet network failures as a fault, tripping relay(s) and recording into the history record. Default condition is enabled.
- **50Hz Sys** (50 Hz system): The default setting is for a 60 Hz system; use this menu item to select a 50 Hz system instead. This does effect the sampling buffer and internal calculations. Setting this improperly will result in some inaccuracies.
- **Poll Data** (poll data group): This setting selects the pre-defined group of parameters in the DeviceNet input poll data. Refer to *Poll Data* on page 5–45 for details. LM10 revisions 1.40 and lower do not support this setting.
For this setting, group 1 is 7 bytes, group 2 is 12 bytes, group 3 is 22 bytes, group 4 is 7 bytes.



Poll group 4 option (7 bytes) is available only for firmware rev 1.70 and higher.

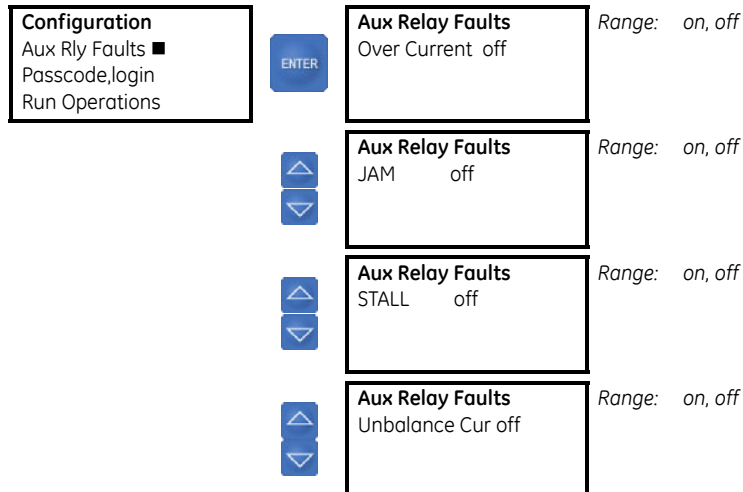











If PDU v1.70 or higher is used for LM10 firmware v1.6x and lower, Poll Data group 4 (which is unavailable in firmware v1.6x and lower) will be displayed in the PDU but cannot be set to the MPR unit.

- **Reset Run Hrs** (reset motor running hour timer): The user may desire to reset the motor running hours after replacement or maintenance. Note that hours are stored in full-hour increments up to 65535. Typical bearing life is less than 50000 hours. Please note that shutting down the unit will lose any partial hour accrued.

4.2.9 Auxiliary Relay Faults

PATH: Configuration ↓↓↓↓↓ Aux Relay Faults







 	Aux Relay Faults Load Loss off	<i>Range: on, off</i>
 	Aux Relay Faults Power Failure off*	<i>Range: on, off</i>
 	Aux Relay Faults Aux Sense off	<i>Range: on, off</i>
 	Aux Relay Faults Device Net off	<i>Range: on, off</i>
	Aux Relay Faults Volt Range off	<i>Range: on, off</i>

* Feature currently not available.

An auxiliary relay can be connected to any number of warning devices. With the settings in this menu, the user can select which combination of trip conditions will activate the auxiliary relay.

4.2.10 Passcode and Login

PATH: Configuration ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ **Aux Relay Faults**

Configuration Passcode,login ■ Run Operations Factory default		Pass Code, Login User:
	 	Pass Code, Login Config:
		Pass Code, Login Change Pass Code

Range: 0 to 65535 in steps of 1

Range: 0 to 65535 in steps of 1

A passcode is required to change configuration parameters. Without a passcode, the display will only indicate configuration parameters, current operating conditions, and history records. This security feature reduces the likelihood of inadvertent changes.

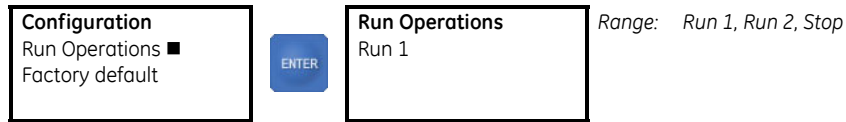
To make any configuration changes, the login level must be set to "Config". The "User" login simply allows viewing of history and current status but will not accept changes to any parameters. As an extra security feature, the login level can automatically be set to "User" via DeviceNet communications. Refer to Assembly Object, Class Code 4, Instance 100 for more information.

Entering a passcode at the **Pass Code, Login** screen will change the login indicated by an asterisk at the end of the line. The default passcode is "0". You must be logged in as "Config" to be able to change the passcode. The green power LED will flash while logged in as configurator. The unit will stop any run relay when in configuration mode. The LM10 must be returned to user mode before beginning normal operations.

Once the passcode is changed, the PDU will retain it in memory and will automatically login when the CONFIG button is held/pressed upon plugging in the RJ11 connector or on power up. This is handy when using a hand held PDU for multiple relay program changes.

4.2.11 Run Operations

PATH: Configuration ↓↓ ↓↓ ↓↓ ↓↓ ↓↓ ↓↓ ↓↓ ↓↓ **Run Operations**



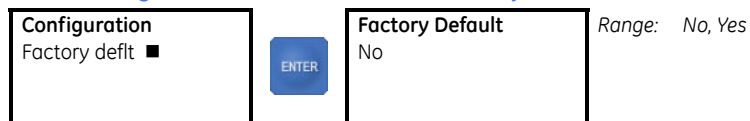
Input terminal 21 selects how the run command is controlled. If power is applied to the relay, then the network has run control. If not the hard-wired switches control. Note that a PDU logged in for configuration will disable run commands from both DeviceNet and hard-wired switches.



With DeviceNet fault enabled and scanner connections not yet established, switching to DeviceNet will cause the DeviceNet fault and stop any run condition of the LM10. Hard-wired Stop will always have priority. If stop terminal 3 is powered, the LM10 will not run.

4.2.12 Factory Default

PATH: Configuration ↓↓ ↓↓ ↓↓ ↓↓ ↓↓ ↓↓ ↓↓ ↓↓ **Factory Default**

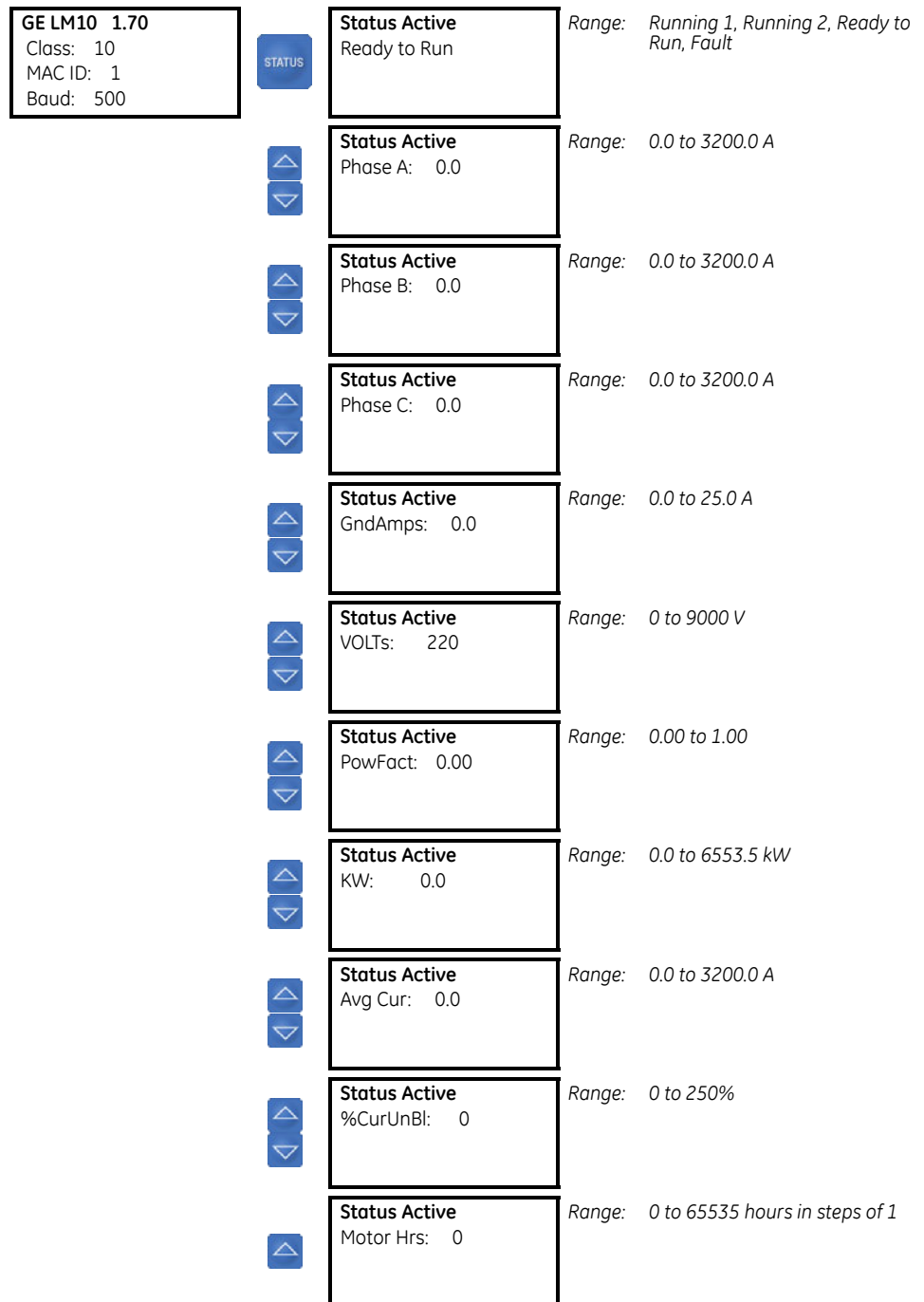


Select "Yes" to restore the factory values.

4.3 Status Values

4.3.1 Main Menu

The main menu for the status values is shown below. Press the STATUS key to access these values.



- **Motor Hrs:** The LM10 keeps a running tally of motor operation time, incremented hourly up to 65535 hours. Upon power loss, the unit will retain any whole number of hours already recorded. This feature is a great service tool. An example is for bearing change; the typical maximum bearing life is 50000 hours.

This value can be reset via the **Reset Run Hrs** configuration setting.

4.4 History Values

4.4.1 Last Trip Data

Data for the last ten trips is stored in the LM10. Press the HISTORY key to access these values. Pressing the HISTORY key multiple times scrolls between trips 1 to 10.

GE LM10 1.70 Class: 10 MAC ID: 1 Baud: 500	HISTORY	Last Trip #1 Overcurrent	<i>Range: Overcurrent, Gr. Fault, Jam, Stall, CuUnbalance, LdLoss, DevNet Fault, Dev Stop, Voltage, Aux Sense</i>
	▲	Last Trip #1 Phase A: 0.0	<i>Range: 0.0 to 3200.0 A</i>
	▼	Last Trip #1 Phase B: 0.0	<i>Range: 0.0 to 3200.0 A</i>
	▲	Last Trip #1 Phase C: 0.0	<i>Range: 0.0 to 3200.0 A</i>
	▼	Last Trip #1 GndAmps: 0.0	<i>Range: 0.0 to 25.0 A</i>
	▲	Last Trip #1 VOLTS: 220	<i>Range: 0 to 9000 V</i>
	▼	Last Trip #1 PowFact: 1.00	<i>Range: 0.00 to 1.00</i>
	▲	Last Trip #1 KW: 0.0	<i>Range: 0.0 to 6553.5 kW</i>
	▼	Last Trip #1 Avg Cur: 0.0	<i>Range: 0.0 to 3200.0 A</i>
	▲	Last Trip #1 %CurUnBl: 0	<i>Range: 0 to 250%</i>

4.5 Motor Start/Stop Logic

LM10 is designed to run in RUN1 and RUN2 mode. However, to illustrate this, only RUN1 mode is described below. The block logic diagram for RUN1 operation is shown in fig. 4-5.

Motor Status: Running 1

The relay can receive the RUN1 Start command as follows:

1. Start command through hardware RUN1 switch input
2. The RUN1 command is selected from the PDU in the configuration mode (used for Test only)
3. Autorestart: the LM10 automatically returns to RUN1 operation after a power loss of up to 4 seconds provided the autorestart setpoint has been enabled and motor was running in RUN1 mode before the power loss
4. A start command is issued remotely through DeviceNet.

A PDU logged-in for configuration will disable run commands from both DeviceNet and hardwired switches.

Motor Stop

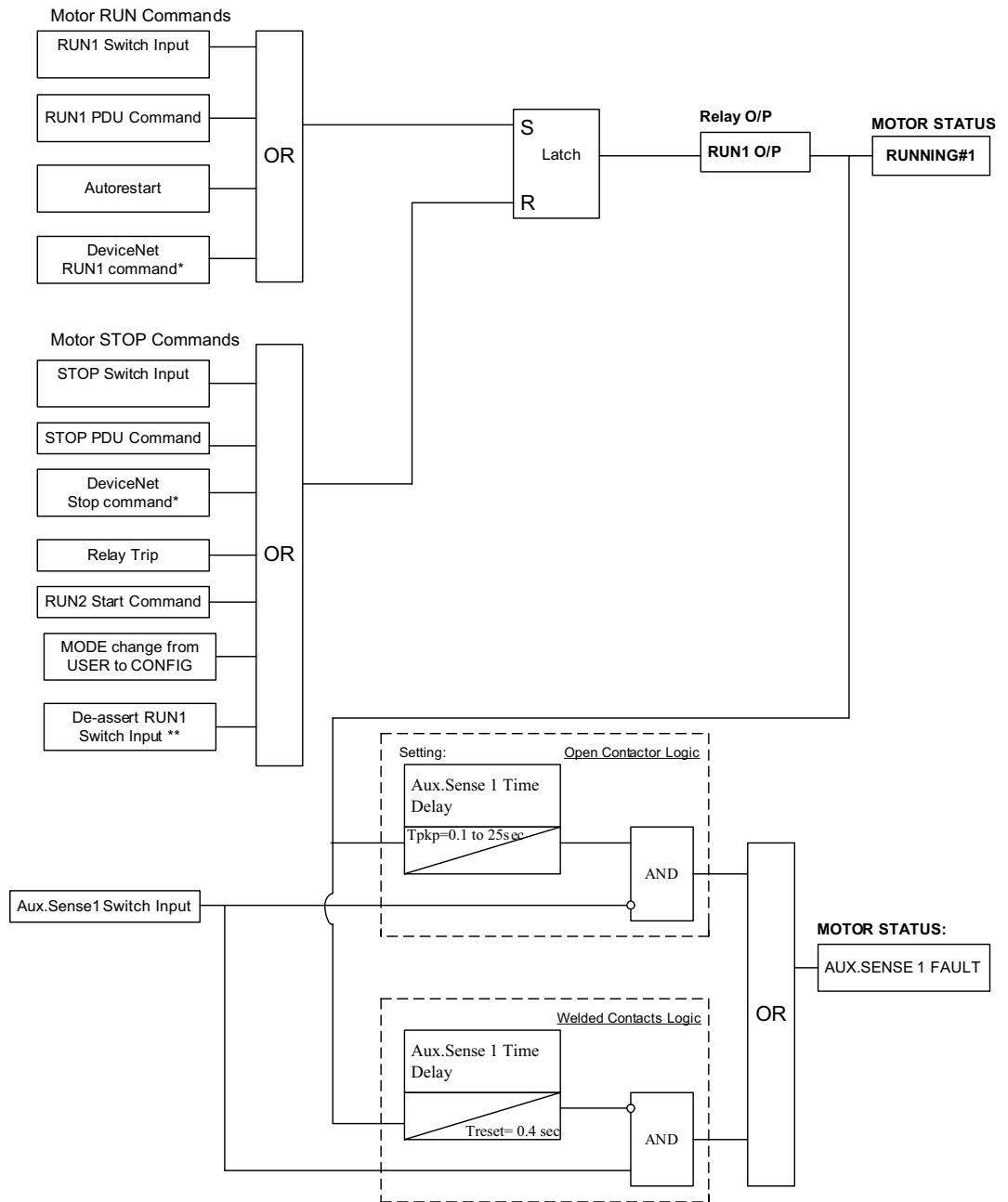
Once the motor is in RUN1, it can be stopped as follows:

1. User asserts a hardware STOP switch Input
2. User de-asserts the RUN1 Hardware switch input (Maintained switch setting set to ON)
3. A STOP command issued through a PDU Running Operations command (When RUN1 command issued from PDU)
4. A stop command issued through DeviceNet
5. The relay trips on a protection function operation
6. RUN2 start command issue
7. The relay changed from USER mode to CONFIGURATION mode.

AUX Sense 1 Fault

Aux. Sense 1 fault for open contactor is detected if the main contactor status is still open after 0.1 to 25.0 seconds (user settable) of the RUN1 O/P signal has been issued. The contactor status is fed back to the relay through the AUX. Sense switch Input.

AUX. Sense 1 fault detects a welded contactor when the contactor fails to open within 0.4 seconds after the RUN1 O/P signal goes off.



Note:
 * Devicenet Commands can be issued only if the Devicenet control switch input is asserted
 ** The Maintained switch setting should be set to ON

FIGURE 4-5: Motor RUN1 Start/Stop Logic



LM10 Motor Protection System

Chapter 5: Communications

5.1 DeviceNet Operations

5.1.1 Description

The device profile is an extension of the Motor Starter Device Profile (0x16). It is a group 2 only server. It has two (2) LEDs (NET status, Module status), and hardware selectable only MAC ID and baud rate DIP switches. The Poll function will accept a single byte of command data and return one of three possible groups of data, according to the value of the **Poll Data Group** setting.

The LM10 supports Polling, COS, and Cyclic IO data operations, and is certified as ODVA DeviceNet CONFORMANCE TESTED™. The COS/CYC operation returns one byte of device status described under the Assembly object, class 4, instance 54. Refer to the following section for polling data.

5.1.2 Poll Data

The polling function accepts one byte of command data defined under the Assembly object, class 4, instance 100. The polling input bytes can be selected from four predefined groups of parameters with the **Poll Data Group** setting (refer to *Other Settings* on page 4–34 for details). The list of parameters in each group is given below



Revisions 1.40 and lower do not support **Poll Data Group** setting. The input polling data returns 7 bytes, The list of parameters is as given in group 1 below

Table 5-1: Poll Data Group 1

Bytes	Data Length	Name/Description	Data Format	Value
7 bytes	1 byte	Motor status	F21	---
	1 word	Phase A current	UINT	× 0.1 A
	1 word	Phase B current	UINT	× 0.1 A
	1 word	Phase C current	UINT	× 0.1 A

This data group can also be retrieved via explicit messaging to the Assembly object, class 4, instance 102, attribute 3.

Table 5-2: Poll Data Group 2

Bytes	Data Length	Name/Description	Data Format	Value
12 bytes	1 word	Motor status	F22	---
	1 word	Cause of trip	F20	---
	1 word	Average phase current	UINT	× 0.1 A
	1 word	Ground current	UINT	× 0.1 A
	1 word	Current unbalance	UINT	%
	1 word	Power	UINT	× 0.1 kW

This data group can also be retrieved via explicit messaging to the Assembly object, class 4, instance 103, attribute 3.

Table 5-3: Poll Data Group 3

Bytes	Data Length	Name/Description	Data Format	Value
22 bytes	1 word	Motor status	F22	---
	1 word	Cause of trip	F20	---
	1 word	Phase A current	UINT	× 0.1 A
	1 word	Phase B current	UINT	× 0.1 A
	1 word	Phase C current	UINT	× 0.1 A
	1 word	Ground current	UINT	× 0.1 A
	1 word	Voltage	UINT	volts
	1 word	Power factor	UINT	× 0.01
	1 word	Power	UINT	× 0.1 kW
	1 word	Average current	UINT	× 0.1 A
	1 word	Current unbalance	UINT	%

This data group can also be retrieved via explicit messaging to the Assembly object, class 4, instance 104, attribute 3.

Table 5-4: Poll Data Group 4

Bytes	Data Length	Bytes	Name/Description	Data Format	Value
7 bytes	1 byte	1	Motor status	F21	---
	1 word	2 (Hi), 3 (Lo)	Phase A current	UINT	× 0.1 A
	1 word	4 (Hi), 5 (Lo)	Phase B current	UINT	× 0.1 A
	1 word	6 (Hi), 7 (Lo)	Phase C current	UINT	× 0.1 A

The Hi and Lo bytes of the phase current A, B and C are reversed as compared to poll group 1 to make it compatible with the format of Firmware revision 1.40 polling data.

This data group also can be retrieved via explicit messaging to the assembly object class 4, instance 105, attribute 3.



UINT = 16 bit unsigned integer.

See *Data Formats* on page 5–57 for details on the F20, F21, and F22 data formats.

5.1.3 Identity object

Identity Object, Class Code 1, Services:

Code	Name and Description of Services Available to this Object
0x05	Reset: Reset the device to power up configuration
0x0E	Get_Attribute_Single: Returns the contents of the given attribute

Identity Object, Class Code 1, Attributes:

Attribute	Access	Name/Description	Data Type	Value
none	---	---	---	---

Identity Object, Class Code 1, Instance 1, Attributes:

Attribute	Access	Name/Description	Data Type	Value
1	Get	Vendor	UINT	928
2	Get	Device type	UINT	22
3	Get	Product code	UINT	77
4	Get	Revision (major, minor)	BYTE[2]	0x013C

5.1.4 Message Router

The message router (Class Code 2) object provides a messaging connection point through which a client may address a service to any object or instance residing in the physical device. There is no external visible interface to the message router object.

5.1.5 DeviceNet Object

DeviceNet Object, Class Code 3, Services:

Code	Name and Description of Services Available to this Object
0x0E	Get_Attribute_Single: Returns the contents of the given attribute.
0x4B	Allocate: Creates predefined M/S connections.
0x4C	Release: Deletes predefined M/S connections.

DeviceNet Object, Class Code 3, Attributes:

Attribute	Access	Name/Description	Data Type	Value
1	Get	Revision	UINT	2

DeviceNet Object, Class Code 3, Instance 1, Attributes:

Attribute	Access	Name/Description	Data Type	Value
2	Get	Baud Rate, value 0 to 2 (125, 250, and 500 kbps)	UINT	from DIP switches
5	Get	Allocation information	STRUCT	from service

5.1.6 Assembly Object

The assembly objects bind attributes of multiple objects to allow data to or from each object to be sent or received over a single connection. There are 8 instances of the assembly object for the device. The instance attribute is always 3 in this class.

Assembly Object, Class Code 4, Services:

Code	Name and Description of Services Available to this Object
0x0E	Get_Attribute_Single: Returns the contents of the given attribute.
0x10	Set_Attribute_Single: Sets the contents of the given attribute.
0x4C	Release: Deletes predefined M/S connections.

Assembly Object, Class Code 4, Attributes:

Attribute	Access	Name/Description	Data Type	Value
none	---	---	---	---

Assembly Object, Class Code 4, Instance 3:

Attribute	Access	Name/Description	Data Type	Value
3	Set	Device outputs (see format and mapping below)	byte	see below

Data Formats for Device Outputs		
Bit Position	Name	Value
Bit 7	Reserved	---
Bit 6	Reserved	---
Bit 5	Reserved	---
Bit 4	Reserved	---
Bit 3	Reserved	---
Bit 2	Reset	---
Bit 1	Reserved	---
Bit 0	Run 1	---

Assembly Object, Class Code 4, Instance 4:

Attribute	Access	Name/Description	Data Type	Value
3	Set	Extended device outputs (see format and mapping below)	byte	see below

Data Formats for Extended Device Outputs		
Bit Position	Name	Value
Bit 7	Reserved	---
Bit 6	Reserved	---
Bit 5	Reserved	---
Bit 4	Reserved	---

Data Formats for Extended Device Outputs		
Bit Position	Name	Value
Bit 3	Reserved	---
Bit 2	Reserved	---
Bit 1	Run 2	---
Bit 0	Run 1	---

Assembly Object, Class Code 4, Instance 5:

Attribute	Access	Name/Description	Data Type	Value
3	Set	Extended device outputs (see format and mapping below)	byte	see below

Data Formats for Extended Device Outputs		
Bit Position	Name	Value
Bit 7	Reserved	---
Bit 6	Reserved	---
Bit 5	Reserved	---
Bit 4	Reserved	---
Bit 3	Reserved	---
Bit 2	Reset	---
Bit 1	Run 2	---
Bit 0	Run 1	---

Assembly Object, Class Code 4, Instance 52:

Attribute	Access	Name/Description	Data type	Value
3	Get	Device inputs (see format/mapping below)	byte	see below

Data Formats for Device Inputs		
Bit Position	Name	Value
Bit 7	Reserved	---
Bit 6	Reserved	---
Bit 5	Reserved	---
Bit 4	Reserved	---
Bit 3	Reserved	---
Bit 2	Running 1	---
Bit 1	Reserved	---
Bit 0	Fault	---

Assembly Object, Class Code 4, Instance 53:

Attribute	Access	Name/Description	Data Type	Value
3	Get	Device inputs (see format/mapping below)	byte	see below

Data Formats for Device Inputs		
Bit Position	Name	Value
Bit 7	Reserved	---
Bit 6	Reserved	---
Bit 5	Control from Net	---

Data Formats for Device Inputs		
Bit Position	Name	Value
Bit 4	Reserved	---
Bit 3	Reserved	---
Bit 2	Running 1	---
Bit 1	Warning	---
Bit 0	Fault	---

Assembly Object, Class Code 4, Instance 54. Use this object for data received by the master from the slave device.

Attribute	Access	Name/Description	Data Type	Value
3	Get	Device inputs (see format/mapping below)	byte	see below

Data Formats for Device Inputs		
Bit Position	Name	Value
Bit 7	Aux Sense 2 unput status	---
Bit 6	Aux Sense 1 unput status	---
Bit 5	Control from Devicenet	---
Bit 4	Reserved	---
Bit 3	Running 2	---
Bit 2	Running 1	---
Bit 1	Reserved	---
Bit 0	Fault	---

Assembly Object, Class Code 4, Instance 100. Use this object for data transmitted from the master to the slave device.

Attribute	Access	Name/Description	Data Type	Value
3	Set	Control (see format below)	byte	see below

Data Formats for Device Inputs		
Bit Position	Name	Value
Bit 7	Reserved	---
Bit 6	Reserved	---
Bit 5	Security to Min*	---
Bit 4	Reserved	---
Bit 3	Stop	---
Bit 2	Fault Reset	---
Bit 1	Run 2	---
Bit 0	Run 1	---



* If the LM10 has been put into Admin mode via the PDU display and this bit is set to '1', the PDU display will continue to appear to be in Config mode but no settings will be able to be changed. The LM10 will now be in 'User' mode.

Assembly Object, Class Code 4, Instance 101:

Attribute	Access	Name/Description	Data Type	Value
3	Get	Fault and status (see format below)	byte	see below

Data Formats for Device Inputs		
Bit Position	Name	Value
Bit 7	DeviceNet Stop Issued Last	---
Bit 6	Reserved	---
Bit 5	DeviceNet Control	---
Bit 4	Reserved	---
Bit 3	Running 2	---
Bit 2	Running 1	---
Bit 1	Reserved	---
Bit 0	Fault	---

Assembly Object, Class Code 4, Instance 102

Attribute	Access	Name/Description	Data Type	Value
3	Get	Poll Data Group 1	see below	see below

Data Formats for Device Inputs				
Bytes	Data Length	Name/Description	Data Format	Value
7 bytes	1 byte	Motor status	F21	---
	1 word	Phase A current	UINT	× 0.1 A
	1 word	Phase B current	UINT	× 0.1 A
	1 word	Phase C current	UINT	× 0.1 A

Assembly Object, Class Code 4, Instance 103

Attribute	Access	Name/Description	Data Type	Value
3	Get	Poll Data Group 2	see below	see below

Data Formats for Device Inputs				
Bytes	Data Length	Name/Description	Data Format	Value
12 bytes	1 word	Motor status	F22	---
	1 word	Cause of trip	F20	---
	1 word	Average phase current	UINT	× 0.1 A
	1 word	Ground current	UINT	× 0.1 A
	1 word	Current unbalance	UINT	%
	1 word	Power	UINT	× 0.1 kW

Assembly Object, Class Code 4, Instance 104

Attribute	Access	Name/Description	Data Type	Value
3	Get	Poll Data Group 3	see below	see below

Data formats for device inputs				
Bytes	Data Length	Name/Description	Data Format	Value
22 bytes	1 word	Motor status	F22	---
	1 word	Cause of trip	F20	---
	1 word	Phase A current	UINT	× 0.1 A
	1 word	Phase B current	UINT	× 0.1 A
	1 word	Phase C current	UINT	× 0.1 A
	1 word	Ground current	UINT	× 0.1 A
	1 word	Voltage	UINT	volts
	1 word	Power factor	UINT	× 0.01
	1 word	Power	UINT	× 0.1 kW
	1 word	Average current	UINT	× 0.1 A
	1 word	Current unbalance	UINT	%

Assembly Object, Class Code 4, Instance 105

Attribute	Access	Name/Description	Data Type	Value
3	Get	Poll Data Group 4	see below	see below

Data Formats for Device Inputs					
Bytes	Data Length	Bytes	Name/Description	Data Format	Value
7 bytes	1 byte	1	Motor status	F21	---
	1 word	2 (Hi), 3 (Lo)	Phase A current	UINT	× 0.1 A
	1 word	4 (Hi), 5 (Lo)	Phase B current	UINT	× 0.1 A
	1 word	6 (Hi), 7 (Lo)	Phase C current	UINT	× 0.1 A

5.1.7 Connection Object

The connection objects manage the characteristics of each communication connection. There are three instances of the connection object in the device. Explicit connection (< 50ms response), input/output connection poll, (< 10ms response), and input/output connection Cos/Cyc (< 10ms response)

Connection Object, Class Code 5, Services:

Code	Name and Description of Services Available to this Object
0x05	Reset the connection - restart timer
0x0E	Get_Attribute_Single: Returns the contents of the given attribute.
0x10	Set_Attribute_Single: Sets the contents of the given attribute

Connection Object, Class Code 5, Attributes:

Attribute	Access	Name/Description	Data	Value
none	---	---	---	---

Connection Object, Class Code 5, Instance 1 (explicit message connection):

Attribute	Access	Name/Description	Data Type	Value
1	Get	State	BYTE	0x03
2	Get	Instance_type	BYTE	0x00, 0x01
3	Get	Export class trigger	BYTE	0x83

Attribute	Access	Name/Description	Data Type	Value
4	Get	Produced connection ID	UINT	MAC ID
5	Get	Consumed connection ID	UINT	MAC ID
6	Get	Initial comm. characteristics	UINT	0x21
7	Get	Produced connection size	UINT	0x12
8	Get	Consumed connection size	UINT	0x12
9	Get/Set	Expected package rate	UINT	0x00
12	Get/Set	Watchdog timeout action	UINT	0x00
13	Get	Produced path length	UINT	0x0000
14	Get	Produced path	BYTE [6]	<null>
15	Get	Consumed path length	UINT	0x0000
16	Get	Consumed path	BYTE [6]	<null>
17	Get	Production inhibit timer	UINT	0x0000

Connection Object, Class Code 5, Instance 2 (polled input/output connection):

Attribute	Access	Name/Description	Data type	Value
1	Get	State	BYTE	0x03
2	Get	Instance_type	BYTE	0x01
3	Get	Export class trigger	BYTE	0x80, 0x82
4	Get	Produced connection ID	UINT	MAC ID
5	Get	Consumed connection ID	UINT	MAC ID
6	Get	Initial comm. characteristics	UINT	0x01, 0xF1
7	Get	Produced connection size	UINT	0x01
8	Get	Consumed connection size	UINT	0x01
9	Get/Set	Expected package rate	UINT	0x00
12	Get/Set	Watchdog timeout action	UINT	0x00
13	Get	Produced path length	UINT	0x0006
14	Get	Produced path	BYTE [6]	*
15	Get	Consumed path length	UINT	0x0006
16	Get	Consumed path	BYTE [6]	0x20, 0x04, 0x24, 0x64, 0x30, 0x03
17	Get	Production inhibit timer	UINT	0x0000

*The Produced path will vary depending on the setting for Poll Data Group:

Poll Group 1: 0x20, 0x04, 0x24, 0x66, 0x30, 0x03 (Class 4, Inst. 102, Attr. 3)

Poll Group 2: 0x20, 0x04, 0x24, 0x67, 0x30, 0x03 (Class 4, Inst. 103, Attr. 3)

Poll Group 3: 0x20, 0x04, 0x24, 0x68, 0x30, 0x03 (Class 4, Inst. 104, Attr. 3)

Poll Group 4: 0x20, 0x04, 0x24, 0x69, 0x30, 0x03 (Class 4, Inst. 105, Attr. 3)

Connection Object, Class Code 5, Instance 4 (COS/Cyc input/output connection):

Attribute	Access	Name/Description	Data Type	Value
1	Get	State	BYTE	0x03
2	Get	Instance_type	BYTE	0x01
3	Get	Export class trigger	BYTE	0x00, 0x02, 0x10, 0x12
4	Get	Produced connection ID	UINT	MAC ID
5	Get	Consumed connection ID	UINT	MAC ID
6	Get	Initial comm. characteristics	UINT	0x01

Attribute	Access	Name/Description	Data Type	Value
7	Get	Produced connection size	UINT	0x0008
8	Get	Consumed connection size	UINT	0x0000
9	Get/Set	Expected package rate	UINT	0x00
12	Get/Set	Watchdog timeout action	UINT	0x00
13	Get	Produced path length	UINT	0x0006
14	Get	Produced path	BYTE [6]	<null>
15	Get	Consumed path length	UINT	0x0004
16	Get	Consumed path	BYTE [6]	<null>
17	Get	Production inhibit timer	UINT	0x0000

5.1.8 ACK Handler Object

The 'acknowledge handler object' manages the reception of message acknowledgments.

ACK handler Object, Class Code 0x2B, Services:

Code	Name and Description of Services Available to this Object
0x0E	Get_Attribute_Single: Returns the contents of the given attribute.
0x10	Set_Attribute_Single: Sets the contents of the given attribute

ACK handler Object, Class Code 0x2B, Attributes:

Attribute	Access	Name/Description	Data	Value
none	---	---	---	---

ACK handler Object, Class Code 0x2B, Instance 1:

Attribute	Access	Name/Description	Data Type	Value
1	Get/Set	Acknowledge Timer	UINT	16
2	Get/Set	Retry Limit	USINT	1
3	Get	COS Connection Instance	UINT	4



USINT = 8-bit unsigned integer
UINT = 16-bit unsigned integer

5.1.9 Overload Object

The overload object allows the getting of the active parameter values.

Overload Object, Class Code 0x2C, Services:

Code	Name and Description of Services Available to this Object
0x0E	Get_Attribute_Single: Returns the contents of the given attribute.

Overload Object, Class Code 0x2C, Attributes:

Attribute	Access	Name/Description	Data	Value
none	---	---	---	---

Overload Object, Class Code 0x2C, Instance 1:

Attribute	Access	Name/Description	Data Type	Value
3	Get	FLA	INT	---
4	Get	Trip Class	USINT	---
5	Get	Average Current	INT	---
6	Get	Phase Unbalance	USINT	---
8	Get	Current Phase A	INT	---
9	Get	Current Phase B	INT	---
10	Get	Current Phase C	INT	---
11	Get	Ground Current	INT	---
12	Get	Current Scale (fixed at 100 mA)	SINT	1



UINT = 16-bit unsigned integer

5.1.10 Extension Object

The extension handler object manages the access to settings and parameters not provided for in the standard device type 0x16. It has one instance. It uses instance attributes for all of its functions and data.

Data present in class 0x64 is accessed via explicit messaging.

Extension object, class code 0x64, Services:

Code	Name and Description of Services Available to this Object
0x0E	Get_Attribute_Single: Returns the contents of the given attribute.
0x10	Set_Attribute_Single: Sets the contents of the given attribute
0x32	History, read data from active and history records
0x33	Login, user level
0x4A	Call, process function operation

Extension object, Class Code 0x64, attributes:

Attribute	Access	Name/Description	Data	Value
none	---	---	---	---

Extension object, class code 0x64, instance 1:

Attribute	Access	Name/Description	Data Type	Value
0x00	Get	Series and model	BYTE [2]	
0x01	Get	Version and revision	BYTE [2]	
0x02	Get/set	User setting, FLA, Run 1, (word)	F1	× 0.1 A
0x03	Get/set	User setting, FLA, Run 2, (word)	F1	× 0.1 A
0x04	Get/set	User setting, Run 1 ground fault	F2	Trip, Time
0x05	Get/set	User setting, Run 2 ground fault	F2	Trip, Time
0x06	Get/set	User setting, Run 1, jam	F3	Trip, Time
0x07	Get/set	User setting, Run 2, jam	F3	Trip, Time
0x08	Get/set	User setting, Run 1, stall	F4	Trip, Time

Attribute	Access	Name/Description	Data Type	Value
0x09	Get/set	User setting, Run 2, stall	F4	Trip, Time
0x0A	Get/set	User setting, Run 1, unbalance	F5	Trip, Time
0x0B	Get/set	User setting, Run 2, unbalance	F5	Trip, Time
0x0C	Get/set	User setting, Run 1, load loss	F6	Trip, Time
0x0D	Get/set	User setting, Run 2, load loss	F6	Trip, Time
0x0E	Get/set	User setting, power transformers	F7	0 to 11
0x0F	Get/set	User setting, current transformers	F8	1 to 15
0x10	Get/set	User setting, auxiliary sense 1 timer	F9	0.1 × (0 to 250)
0x11	Get/set	User setting, auxiliary sense 2 timer	F10	0.1 × (0 to 250)
0x12	Get/set	User setting, auxiliary relay flags	F11	16 bits
0x15	Get	Motor run time hours	UINT	Hours
0x1A	Get/set	Configure passcode	UINT	Code (0)
0x24	Get/set	User setting, motor type	F12	Type 0 to 5
0x25	Get/set	User setting, loops through CT	F13	1 to 4
0x26	Get/set	Flags (Mrun, AutoRestart, O/V Volt Enable, DNFault, 50 Hz)	F14	16 bits
0x2E	Call	Reset LM10*	N/A	---
0x1C	Call	Reset factory default user settings	N/A	---
0x2F	Get	Trip class	F17	---
0x30	Get	MAC ID	F18	---
0x31	Get	DeviceNet baud rate	F19	---
0x34	Get	Input switch status	F25	16 bits
0x38	Get	Remaining cool-down period	F26	16 bits
0x39	Get/set	Poll data group	F15	1 to 4
0x3A	Get/set	Run1-Run2 time delay	F16	0 to 600 sec.
0x3B	Get/set	Run2-Run1 time delay ²	F16	0 to 600 sec.
0x40	History	Status (send data byte 0 for current, 1 to 10 for history)	F24	---
0x41	History	Phase A current	F23	× 0.1 A
0x42	History	Phase B current	F23	× 0.1 A
0x43	History	Phase C current	F23	× 0.1 A
0x44	History	Ground current	F23	× 0.1 A
0x45	History	Voltage	UINT	volts
0x46	History	Power factor	UINT	percent
0x47	History	Watts	F23	0.1 kW
0x48	History	Operating current	F23	× 0.1 A
0x49	History	Current unbalance	UINT	percent
0x50	Login	User	---	---
0x51	Login	Configuration	UINT	Passcode
0x52	Login	Calibration	UINT	Passcode

*This call function has the same result as pressing the Reset key on the PDU display
Applies to revisions 1.50 and higher

The data type format codes for class code 0x64, instance 1 are shown below.

5.1.11 Data Formats

F1: Full Load Current (16-bit unsigned integer)

Range: 0x000C to 0x1F40 (i.e. 1.2 to 800.0 A)

Multiplying factor: 0.1

Example: 123.4 stored as 1234

F2: Ground Fault

Format: two bytes in format 0xHHLL, where LL is the pickup level and HH is the time delay

Byte LL range: 0x00, 0x02 to 0x64 (i.e. 0.4 to 20.0 A), where 0x00 is disabled

Byte LL multiplying factor: 0.2 (i.e. actual = byte LL in decimal × 0.2 amps)

Byte HH range: 0x00 to 0x19 (i.e. 0 to 2.5 seconds)

Byte HH multiplying factor: 0.1 (i.e. actual = byte HH in decimal × 0.1 seconds)

F3: Jam

Format: two bytes in format 0xHHLL, where LL is the pickup level and HH is the time delay

Byte LL range: 0x00, 0x64 to 0xFA (i.e. 100 to 250%), where 0x00 is disabled

Byte HH range: 0x00 to 0xC8 (i.e. 0 to 1000 seconds)

Byte HH multiplying factor: 5 (i.e. actual = byte HH in decimal × 5 seconds)

F4: Stall

Format: two bytes in format 0xHHLL, where LL is the pickup level and HH is the time delay

Byte LL range: 0x00, 0x42 to 0x78 (i.e. 330 to 600%), where 0x00 is disabled

Byte LL multiplying factor: 5 (i.e. actual = byte LL in decimal × 5%)

Byte HH range: 0x00 to 0x3C (i.e. 0 to 30.0 seconds)

Byte HH multiplying factor: 0.5 (i.e. actual = byte HH in decimal × 0.5 seconds)

F5: Current Unbalance

Format: two bytes in format 0xHHLL, where LL is the pickup level and HH is the time delay

Byte LL range: 0x00, 0x02 to 0x19 (i.e. 2 to 25%), where 0x00 is disabled

Byte HH range: 0x00 to 0xFF (i.e. 0 to 255 seconds)

F6: Load Loss

Format: two bytes in format 0xHHLL, where LL is the pickup level and HH is the time delay

Byte LL range: 0x00, 0x0F to 0x64 (i.e. 15 to 100%), where 0x00 is disabled

Byte HH range: 0x00 to 0xFF (i.e. 0 to 255 seconds)

F7: Power Transformer

Format: two bytes in format 0xHHLL, where LL is the PT ratio and HH is reserved

Byte LL enumeration:

Value	PT Ratio	Value	PT Ratio
0	200:120	6	3300:120
1	240:120	7	4200:120
2	480:120	8	4800:120
3	600:120	9	5400:120
4	2400:120	10	6000:120
5	3000:120	11	7200:120

F8: Current Transformer

Format: two bytes in format 0xHHLL, where LL is the CT ratio and HH is reserved

Byte LL enumeration:

Value	CT Ratio	Value	CT Ratio
1	27 A sensor pack	9	250:5

Value	CT Ratio	Value	CT Ratio
2	90 A sensor pack	10	300:5
3	75:5	11	400:5
4	100:5	12	500:5
5	120:5	13	600:5
6	150:5	14	700:5
7	200:5	15	800:5
8	225:5		

F9: Auxiliary Sense 1 / Run1-Run2 Time Delays

Format: two bytes in format 0xHHLL, where LL is the auxiliary sense 1 time delay and HH is the Run1-Run2 time delay (Run1-Run2 time delay for revisions 1.40 and lower only)

Byte LL range: 0x00 to 0xFA (i.e. 0.0 to 25.0 seconds), where 0x00 is disabled

Byte LL multiplying factor: 0.1 (i.e. actual = byte LL in decimal × 0.1 seconds)

Byte HH range: 0x00 to 0xB4 (i.e. 0 to 180 seconds)

F10: Auxiliary Sense 2 / Run2-Run1 Time Delays

Format: two bytes in format 0xHHLL, where LL is the auxiliary sense 2 time delay and HH is the Run2-Run1 time delay (Run2-Run1 time delay for revisions 1.40 and lower only)

Byte LL range: 0x00 to 0xFA (i.e. 0.0 to 25.0 seconds), where 0x00 is disabled

Byte LL multiplying factor: 0.1 (i.e. actual = byte LL in decimal × 0.1 seconds)

Byte HH range: 0x00 to 0xB4 (i.e. 0 to 180 seconds)

F11: Auxiliary Relay Faults (16-bit bitmask)

Bitmask	Fault
-----1	Overcurrent
-----1-	Reserved
-----1--	Jam
-----1---	Stall
-----1----	Current unbalance
-----1-----	Aux sense
-----1-----	Load loss
-----1-----	Reserved
-----1-----	Reserved
-----1-----	DeviceNet
-----1-----	Voltage range

F12: Starter Type

Format: two bytes in format 0xHHLL, where LL is the motor type and HH is reserved

Byte LL enumeration:

Value	Starter Type
0	FVNR (full voltage non-reversing)
1	FVR (full voltage reversing)
2	RV (reversing)
3	2S1W (two-speed one winding; Run-2, 4:1 ratio of Run-1)
4	2S2W (two-speed two winding; Run-2, 2:1 ratio of Run-1)
5	Custom

F13: CT Turns

Format: two bytes in format 0xHHLL, where LL is the number of CT turns and HH is reserved

Byte LL range: 0x01 to 0x04 (i.e. 1 to 4 turns)

F14: Other Settings (16-bit Bitmask)

Bitmask	Other Settings
-----1	Maintained input switch
-----1-	Auto restart
-----1--	Under/overvoltage enable
-----1---	DeviceNet fault
-----1----	Reserved
-----1-----	Reserved
-----1-----	Reserved
-----1-----	Reserved
-----1-----	50 Hz system on

F15: Poll Data Group (enumeration; 16-bit unsigned integer)

Value	Poll Group
1	Poll 1 (7 bytes)
2	Poll 2 (12 bytes)
3	Poll 3 (22 bytes)
4	Poll 4 (7 bytes)

F16: Run1-Run2 and Run2-Run1 Time Delay (16-bit unsigned integer)

Range: 0x0000 to 0x0258 (i.e. 0 to 600 seconds)

F17: Trip Class

Format: two bytes in format 0xHHLL, where LL is the trip class and HH is reserved

Byte LL enumeration:

Value	Trip Class
0A	Trip class 10
0F	Trip class 15
14	Trip class 20
1E	Trip class 30

F18: MAC ID

Format: two bytes in format 0xHHLL, where LL is the MAC ID and HH is reserved

Byte LL range: 0x00 to 0x3F (i.e. 0 to 63)

F19: Baud Rate (enumeration: 16-bit unsigned integer)

Range: 0x007D, 0x00FA, 0x01F4 (i.e. 125, 250, and 500 kbps)

F20: Cause of Trip (16-bit bitmask)

Bitmask	Cause of Trip
-----1	No trip
-----1-	Overcurrent
-----1--	Ground fault
-----1---	Jam
-----1----	Stall
-----1-----	Current unbalance
-----1-----	Aux sense
-----1-----	Load loss
-----1-----	Reserved
-----1-----	DeviceNet stop

Bitmask	Cause of Trip
----1--	DeviceNet fault
----1---	Reserved
---1----	Under/overvoltage

F21: Motor Status (8-bit Bitmask)

Bitmask	Status
----1	Fault
----1-	Reserved
----1--	Running 1
----1---	Running 2
---1----	Reserved
--1----	Control from DeviceNet
-1-----	Aux Sense 1 input status
1-----	Aux Sense 2 input status

F22: Motor Status (16-bit bitmask)

Bitmask	Other Settings
-----1	Fault
-----1-	Reserved
-----1--	Running 1
-----1---	Running 2
-----1----	Reserved
-----1-----	Control from DeviceNet
-----1-----	Aux Sense 1 input status
-----1-----	Aux Sense 2 input status
-----1-----	Stop switch input status
-----1-----	Reset switch input status 2
-----1-----	Run 1 switch input status
-----1-----	Run 2 switch input status

F23: 16-bit Unsigned Integer

Multiplying factor: 0.1

Example: 123.4 stored as 1234

F24: Status Word (16-bit bitmask)

The first, second, and fourth 4-bit sections of the 16-bit status word are bitmasks that indicate the following:

Bitmask	Status
-----1	Fault (cause indicated by 2nd byte, see below)
-----1-	Warning
-----1--	1 is running
-----1---	2 is running
-----1----	Reserved
-----1-----	DeviceNet control
-----1-----	DeviceNet active
-----1-----	DeviceNet issued last stop
-----1-----	Reserved
-----1-----	Reserved
-----1-----	Login > user

Bitmask	Status
1-----	Motor hot at time of fault

The third 4-bit section is an enumeration which indicates the cause of the fault.

Value	Bitmask	Status
0	---- 0000 ----	None
1	---- 0001 ----	Overcurrent
2	---- 0010 ----	Ground fault
3	---- 0011 ----	Jam lock
4	---- 0100 ----	Stall aux
5	---- 0101 ----	Current unbalance
6	---- 0110 ----	Aux sense
7	---- 0111 ----	Load loss
8	---- 1000 ----	Reserved
9	---- 1001 ----	Reserved
10	---- 1010 ----	DeviceNet
11	---- 1011 ----	Operating voltage

F25: Input Switch Status (16-bit value; use only lower byte)

Format: two bytes in format 0xHHLL, where LL is the Switch Input status and HH is Reserved.

Bitmask (LL)	Status
----1	Stop switch input switch
----1-	Reset switch input switch
----1--	Run1 switch input switch
----1---	Run2 switch input switch
---1----	Auxsense1 switch input switch
--1----	Auxsense2 switch input switch

F26: Remaining Cool-Down Period - Format: two bytes in format 0xHHLL, where LL is the Remaining Cool-Down Period and HH is Reserved. Byte LL Range: 0 to 99

5.1.12 Special Application

The LM10 Motor Protection System has a DeviceNet interface. The DEVICENET CONTROL input will set the RUN control to be operated using the DeviceNet interface. For this application we will assume this input to be tied active. This will disable any hard-wired 120 V AC RUN inputs from being accepted as a command to the LM10. The LM10 can read the state of these inputs through the DeviceNet protocol.

With the use of this read request the DeviceNet scanner (PLC or Master) can check the state of the local switches. After evaluating that all conditions of the system are appropriate the RUN command can be sent to the LM10 through the DeviceNet link. The RESET and STOP inputs do remain active at all times. The STOP input will command the LM10 to stop the motor even though the DeviceNet is the controlling input. The DeviceNet scanner would be able to detect this stop by monitoring the LM10 status. The status word can be polled or setup as a Cos/Cyclic.

Auxiliary sense inputs are also activated by a 120 V AC signal. If the end user desires, he may use these inputs for an alternate purpose if the Auxiliary Sense capability of the LM10 is disabled. The data is part of the same word as the RUN inputs.

This data was initially setup for development purposes. An explicit message through the custom class 100(0x64) is the only way to access this data. The DeviceNet message to read this data is: service 0x0e, class 0x64, instance 1, and attribute 0x34. The response will be a 16-bit word with MACID switches in the high byte and AC switch input bits in the low byte.

- Sent by scanner: CANID, MACID, 0x0E, 0x64, 0x01, 0x34
- Response from the LM10: CANID, MACID, 0x8E, LBY, HBY

The format of this data follows F25: Input Switch Status. The high byte (HBY) is not used in this application. The low byte (LBY) is the input data we are looking for. The seven hard wired inputs map to bits 0 to 6 as DeviceNet Control, AxSn2, AxSn1, RUN2, RUN1, Reset, Stop. To watch for RUN1 one would test for bit 2 being on. EX: LBY and 0x04 is not equal to 0x00.



Do not switch out of DeviceNet Control while the motor is running. In such a case the LM10 will issue a Stop command under the assumption that the network is down.

5.2 Serial Port

5.2.1 Description

This is a standard RS232 port to handle the serial messages. It has a fixed port settings of 19200, 8, N, 1. The PDU uses this port. The protocol for request and response of data is a fixed 8-byte packet. It will always start with SOH and end with a simple checksum (\sim sum + 1). The packets will include all the functionality found in the DeviceNet Extension object. The data is in 'big endian' format here (big end first: MSB-LSB). The packet is outlined below:

Bit Position	Name
Bit 7	SOH
Bit 6	Service
Bit 5	Attribute
Bit 4	Data 3
Bit 3	Data 2
Bit 2	Data 1
Bit 1	Data 0
Bit 0	Checksum



LM10 Motor Protection System

Chapter 6: Miscellaneous

6.1 Revision History

6.1.1 Release Dates

Table 6-1: Release Dates

Manual	GE Part Number	LM10 Revision	Release Date
GEK-106642	1601-0165-A1	1.37	25 October 2004
GEK-106642A	1601-0165-A2	1.40	17 December 2004
GEK-106642B	1601-0165-A3	1.50	22 February 2006
GEK-106642C	1601-0165-A4	1.60	19 January 2007
GEK-106642D	1601-0165-A5	1.70	14 August 2007

6.1.2 Changes to the Manual

Table 6-2: Changes to Manual Since Release A4

Section Number	Revision
	Update Manual to A5 and Firmware (and Firmware references) to v1.70
1.5.4	Wording change... Added note.

Table 6-3: Changes to Manual Since Release A4

Section Number	Revision
	Update Manual to A5 and Firmware (and Firmware references) to v1.70
1.3.3	Change revision in the images of the product from 1.60 to 1.0
1.5.2	Change Phase Current range
1.5.2	Change Average Current range

Table 6-3: Changes to Manual Since Release A4

Section Number	Revision
3.2.4	Move section to 5.1.10
5.1.2	Add Poll Data 4
5.1.6	Add Assembly Object, Class Code 4, Instance 105 (Poll Data Group 4)
5.1.8	Control Supervisor Object - Delete Section
5.1.11	Change format code F15 to include Poll Data Group 4
5.1.11	Add bit locations to format codes F21 and F22

Table 6-4: Changes to Manual Since Release A3

Section Number	Revision
	Update Manual to A4 and Firmware (and Firmware references) to v1.60
1.3.3	Change revision in the images of the product from 1.50 to 1.60
1.4.1	Table 1-1 - LM10 Order Code text changed
1.5.1	Change Ground Fault, Jam, Stall, Current Unbalance, Load Loss specifications
3.2.3	Change text "The unit has three passcode levels..."
4.2.1	Changes to Ground Fault Level, Stall Level, Load Loss Level, Undervoltage, Overvoltage
4.2.6	Changes to Ground Setup, Stall Setup
4.2.6	Change to equation 4-3
5.1.6	Assembly Object, Class Code 4, Instance 100 "Security to Min" in Control Byte clarified. Note added.
5.1.6	Change to Assembly Object, Class Code 4, Instance 101, Attribute 3, Bit 6
5.1.11	Change to format code F20
5.1.11	Change to format code F24
5.1.2	Change to Identity Object, Class Code 1, Instance 1, Attributes
5.1.11	Add attribute (Attribute: 0x34)
5.1.11	New format code: F25 - Input Switch Status
5.1.11	Add attribute (Attribute: 0x38)
5.1.11	New format code: F26 - Remaining Cool-Down Period
5.1.6	Change to Assembly Object, Class Code 4, Instance 52
5.1.11	Change text description for attribute 0x26
5.1.11	Correction to F14 format
5.1.7	Changes to Connection Object, Class Code 5, Instance 2 (polled...)
5.1.11	Change the ranges for the delays to match range shown in Chapter 4
5.1.5	Add three additional tables before the "Connection Object" section
5.1.6	Assembly Object, Class Code 4, Instance 100 Change bit 5 from "Reserved" to "Security to Min" Add note at the bottom of the table
5.1.11	Extension Object, Class Code 0x64, Instance 1 Add a note to "Reset LM10" at attribute 0x2E
5.1.1 - 5.1.5	Miscellaneous text/table changes

6.2 Warranty

6.2.1 GE Multilin Warranty

General Electric Multilin (GE Multilin) warrants each device it manufactures to be free from defects in material and workmanship under normal use and service for a period of 24 months from date of shipment from factory.

In the event of a failure covered by warranty, GE Multilin will undertake to repair or replace the device providing the warrantor determined that it is defective and it is returned with all transportation charges prepaid to an authorized service centre or the factory. Repairs or replacement under warranty will be made without charge.

Warranty shall not apply to any device which has been subject to misuse, negligence, accident, incorrect installation or use not in accordance with instructions nor any unit that has been altered outside a GE Multilin authorized factory outlet.

GE Multilin is not liable for special, indirect or consequential damages or for loss of profit or for expenses sustained as a result of a device malfunction, incorrect application or adjustment.

For complete text of Warranty (including limitations and disclaimers), refer to GE Multilin Standard Conditions of Sale.



LM10 Motor Protection System

Appendix A

A.1 DeviceNet Overview

A.1.1 Description

DeviceNet™ is an open low-cost digital, multi-drop network based on the reliable CAN technology to interconnect industrial devices (such as limit switches, photoelectric sensors, valve manifolds, motor starter, process sensors, panel displays, etc.) via a single network. This eliminates expensive wiring and failure due to the increase of number of connections. It also reduces the cost and time to install industrial automation devices while providing reliable interchangeability of components from multiple vendors. The direct connectivity provides improved communication between devices as well as important device-level diagnostics not easily accessible or available through hard-wired input/output interfaces.

DeviceNet systems can be configured to operate in a master-slave or a distributed control architecture using peer-to-peer communication. DeviceNet systems offer a single point of connection for configuration and control by supporting both input/output and explicit messaging. DeviceNet also has the unique feature of having power on the network. This allows devices with limited power requirements to be powered directly from the network, reducing connection points and physical size.

DeviceNet permits the interchangeability of simple devices while making interconnectivity for more complex devices possible. In addition to reading the state of discrete devices, DeviceNet provides the capability of reading analog data such as temperatures, load current or to count the number of items that have passed on a conveyor belt in the given period.

A.1.2 Controller Area Network (CAN)

The Controller Area Network (CAN) is a broadcast-oriented communications protocol. DeviceNet uses CAN for its data link layer. The CAN protocol has a fast response and high reliability for demanding applications such as control of anti-lock brakes and air-bags. Devices are now available for the industrial automation market demanding stability in high temperature and high noise immunity.

A.1.3 DeviceNet Operations

DeviceNet is a connection based protocol; that is, all devices should establish a connection prior to exchanging information. DeviceNet adopts the object modelling approach – all information is structured in different objects. Services (such as Get and Set) can be applied to these objects to extract/change information. The following are the typical object classes found in a DeviceNet product:

1. **Identity** object. Identification information (such as vendor ID, device profile, revision, etc.) of a device are stored in this object. Users can identify a particular object by remotely access to this object.
2. **Message Router** object. This object handles the explicit messages received by routing it to the proper destination objects.
3. **DeviceNet** object. A DeviceNet product will typically have a single instance of the DeviceNet object. This instance would have as attributes: node, address, or MAC ID, baud rate, bus-off action, bus-off counter, allocation choice, and the master MAC ID. The only required service is Get_Attribute_Single.
4. **Connection** object. This object handles the connection of the module, such as Explicit Messaging or Input/Output Messaging. Explicit messages contain attribute addressing, attribute values and a service code describing the desired action. Input/output messages contain nothing but data. In an input/output message, all information about how to process the data is contained in the Connection object associated with that I/O message
5. **Assembly** object(s). A DeviceNet product typically has one or more optional Assembly objects. The primary purpose of these objects is to group different attributes (data) from different application objects into a single Attribute.
6. **Parameter** object. The optional Parameter object is used in parameter-based devices. One instance would be presented for each configurable parameter. The Parameter object provides a standard method for a configuration tool to access all parameters. Attributes of the Parameter object could include values, ranges, text strings, and limits.
7. **Application** objects. Usually at least one application object besides those from the Assembly or Parameter class will be present in a device. There are a number of standard objects in the DeviceNet object library.

Each object has its own parameters called attributes (such as vendor ID). The behavior of a device is governed by these attributes.

Once the connection is established, all the data exchanged across this connection are handled by the corresponding connection instance.

A.1.4 Explicit Messaging and Input/Output (I/O) Messaging

Explicit messages contain information such as vendors, parameters, etc. of a device. This information is comparatively less important than the I/O message; as such, it is sent with a higher CAN identifier as not to disturb the exchange of I/O messages on the bus.

Input/Output (I/O) messages contain the real-time I/O information of a device. In order to achieve “real time”, these messages are sent as quick as possible; therefore, they are sent with a lower CAN identifier than explicit messages.

A.1.5 Pre-defined Master/Slave Connection Set

A set of connection identifiers known as the Pre-defined Master/Slave Connection Set has been specified to simplify the movement of I/O configuration-type data typically seen in a master/slave architecture. An important benefit is that the establishment of connections from the pre-defined set is simplified considerably. Only a few messages are required to have I/O connections up and running. The pre-defined set contains one explicit messaging connection and allows several different I/O connections including:

- bit strobed command/response
- polled command/response
- change of state
- cyclic

A.1.6 DeviceNet Features

DeviceNet's features include:

1. Low cost.
2. High speed. DeviceNet supports 3 baud rates: 125 kbps, 250 kbps, and 500 kbps. This meets 95% of typical industrial requirements.
3. Reliability. DeviceNet uses the well proven CAN protocol with application layers that have undergone strict conformance testing to ensure reliability.
4. Support of up to 64 active nodes.
5. Easy installation.
6. Removal and replacement of devices from the network under power.
7. 0 to 8 byte data packets.
8. Linear (trunk line/drop line) bus topology, with power and signal on the same network cable.

A.1.7 Maximum Cable Lengths for DeviceNet

DeviceNet defines the maximum cable lengths (trunk and drop cables) to ensure the propagation of the transmitted message falls within the acceptable limits. The upper boundaries of the trunk cable and drop cable length are shown below.

Table A-1: Trunk Cable Length Specification

Baud rate	100% thick cable	100% thin cable	Flat cable
125 kbps	500 meters	100 meters	420 meters
250 kbps	250 meters	100 meters	200 meters
500 kbps	100 meters	100 meters	100 meters

Table A-2: Drop Cable Length Specification

Baud rate	Maximum	Cumulative
125 kbps	6 meters	156 meters
250 kbps	6 meters	78 meters
500 kbps	6 meters	39 meters

A.1.8 DeviceNet Specification Highlights

Description:

The DeviceNet specification defines a network communication system for transferring data between elements of an industrial control and automation system. The specification is divided into two volumes and defines the following elements:

Volume 1:

- DeviceNet communication protocol and application (Layer 7: Application layer)
- CAN and its use in DeviceNet (Layer 2: Data Link Layer)
- DeviceNet physical layer and media (Layer 1: Physical Layer)
- Volume 2:
- Device profiles for interoperability and interchangeability among like products

CAN defines the syntax or form of the data transfer. The DeviceNet application layer defines the semantics or meaning of the data transferred

Communication Protocol and Application:

Standard or application specific objects are combined together into Device Profiles by the applications using DeviceNet. The Device Profile defines the device as viewed from the network: DeviceNet specifications contains a library of objects and Device Profiles. ODVA coordinates the work of industry experts in the development of both new Object and Device Profile specifications.

DeviceNet supports strobed, polled, cyclic, change-of-state, and application-triggered data transfer. The user can choose master/ slave, multi-master and peer-to-peer, or a combination depending on device capability and application requirements. The choice of data transfer can significantly speed up system response time. One popular application for DeviceNet is to use a standard, predefined set of connections that allow devices to operate in a master/slave connection set.

Connections:

The DeviceNet communication protocol is based on the idea of connections. Connections must be established with a device in order to exchange information with that device.

The Object Model:

The Object Model provides a template for organizing and implementing the Attributes, Services and Behaviors of the components of a DeviceNet product.

The model provides an addressing scheme for each Attribute consisting of four components i.e Node Address, Object Class Identifier, Instance Number, and Attribute Number. This four-level address is used in conjunction with an Explicit Messaging Connection to transfer the data from one place to another on a DeviceNet network.

Device Profiles:

To promote the interchangeability of alike devices, a “Device Profile” of main device classes for industrial automation have to be specified that secure the same basic (“standard”) behavior of devices of different manufacturers.

Beside a description of the device functionality, the device model must also provide a description of the device identity, version number, status, diagnostic information, communication facilities, and configuration parameters.

A DeviceNet device profile must contain the following information:

- An object model for the device type.
- The I/O data format for the device type.
- Configuration data and the public interfaces to that data. This information is contained in an Electronic Data Sheet (EDS file) included with the device.

The DeviceNet specification defines an Electronic Data Sheet which is a simple file format that allows product-specific information to be made available by vendors for all other vendors. This makes possible user-friendly configuration tools that can be easily updated without having to constantly revise the configuration software tool.

A.2 LM10 and GE Fanuc 90-30 with DeviceNet™

A.2.1 Overview

This section describes an example communications setup between the LM10 Motor Protection System and the GE Fanuc 90-30 PLC via the DeviceNet protocol.

- Explicit Messaging: for configuration and monitoring.
- All the values mentioned in DeviceNet™ object model (voltage, current, power factor, trip class, FLA settings, etc.) can be monitored.
- Polling Input/Output Connection: commands to the slave device and status from the slave device.
- Data for assemblies #5 and #54. With polling, the Run1 and Run 2 contactors can be controlled. Note that only one relay output can be energized a time.
- COS (Change of State) and Cyclic Input/Output Connection: for alarm/event notifications

Essentially, the COS/Cyclic connection is intended for monitoring the status of the Run1 and Run2 contactors.

A.2.2 GE Fanuc 90-30 PLC Hardware

The hardware for the setup example is indicated below:

- Main Rack (Base 10 Slot or Base 5 Slot IC693CHS391/7)
- Power Supply (IC693PWR XXX)
- CPU (IC693CPU XXX) except CPU321 & CPU340
- DeviceNet Master Module (IC693DNM200)
- GE Fanuc Software: Cimplicity ME version 4.00
- DeviceNet Slave Module: GE Multilin LM10 Motor Protection System

A.2.3 Network Configuration

To connect the LM10 Motor Protection System to the DeviceNet™ master card (IC693DNM200), refer to chapter 2 of the Series 90-30 Programmable Controller manual (publication number GFK-2196).

A.2.4 Configuration Procedure

- ▷ Complete the basic setup of the rack, power supply, and CPU.
- ▷ Add the DeviceNet™ master card (IC693DNM200) to any non-CPU slots 2 to 10.
- ▷ Start the GE Fanuc Cimplicity ME software.
- ▷ Add the slave device by right-clicking on the slot containing the DeviceNet™ master card, then click **Add Slave**. A slave catalog will be displayed.

- ▷ Select **GE LM10** under **GE Multilin**.

If the slave is not displayed in the slave catalog, it can be added using the EDS file:

- ▷ Click the **Have Disk** tab in the slave catalog, then open the EDS file for the LM10.

We can also add the slave device to the master card from Tool Chest:

- ▷ Click the **Tool Chest** icon in the tool bar.
- ▷ Open the drawer of DeviceNet™ devices, select the LM10 slave device under the GE Multilin folder, and drag it onto the DeviceNet™ master card.
- ▷ Set the **MAC ID** on LM10 module equal to the one displayed under the **General** tab of the **Slave Properties** window.
- ▷ To see the slave properties window, right click on the **Slave Device**, add it to the Master, and select **Network Setting**.
- ▷ Right-click on **Slot 2** where the master card is added.
- ▷ Select **Network Setting** to view the DN9030 master properties.
- ▷ Right-click on the LM10 slave device added under the master card for **Setting Slave Properties**.
- ▷ Set the baud rate in DN9030 master properties window equal to baud rate of the LM10 slave device.
The LM10 has three (3) baud rate settings: 125, 250, and 500 kbps (125 kbps is the default value).
- ▷ Connect the LM10 as per *Wiring Diagram* on page 2–15.
As well, energize terminal pin 21 with 120 V to enable network control.



NOTE

To determine the correct slave input register (%I00xx) and slave output register (%Q00xx), double-click the added slaves under the master and note register 3 for connections 1 and 2.

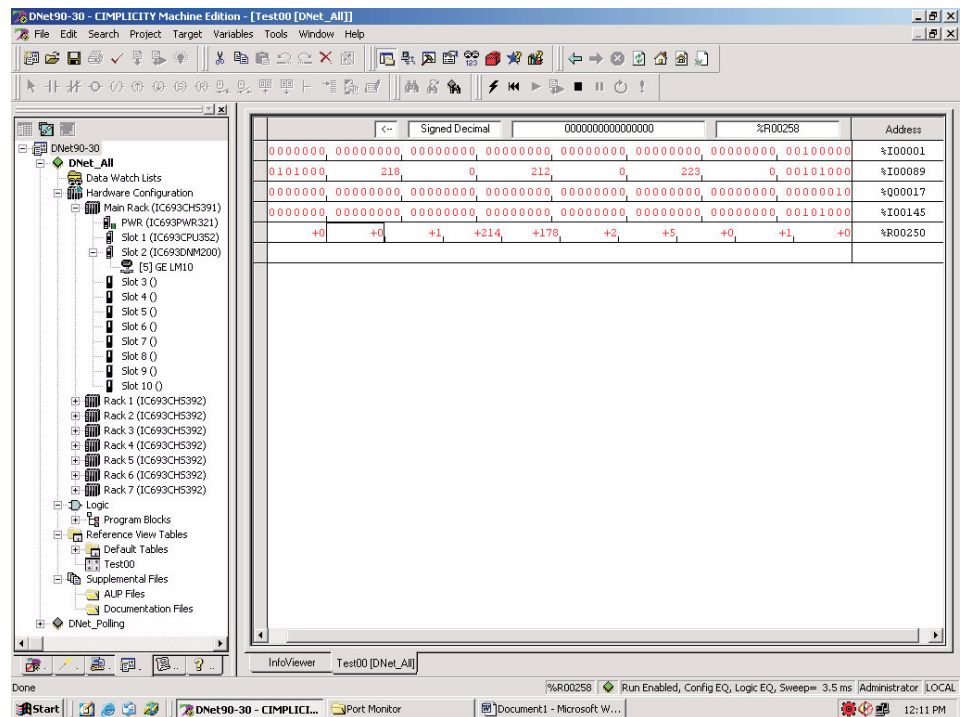
A.2.5 Polling Input/Output Connection

Input/output messaging is for time-critical, control-oriented data. It provides a dedicated, special purpose communication path between a producing application and consuming application.

The Polling Input/Output Connection will accept 1 byte of command data and returns 1 byte of device status data and 6 bytes of current metering data for poll data group 1 (2 bytes each for phase A, B, and C currents).

- ▷ Set the network to **polling mode** on the master side.
- ▷ Under the **General** tab, set the baud rate equal to the baud rate of the slave device.
- ▷ Also, set the **Scan Interval** and **Reconnect Time**.
- ▷ Select the **Polled** option under the **Connection 1** tab.

- ▷ Enter a value of 7 bytes under input resource and 1 byte under output resource.
This is the size of the slave status data and command data.
- ▷ Make changes to the slave side settings.
- ▷ Under the **General** tab, set the **MAC ID** equal to the MAC ID of the slave device.
- ▷ Select the **Polled** option under the **Connection 1** tab.
The input and output byte size are defined and connection type is Status and Control.
- ▷ Place the PLC online and download the hardware and logic to the PLC.
- ▷ Observe the DeviceNet™ master module LEDs.
All three LEDs for NET POWER, MOD STATUS, and NET STATUS should turn solid green.
- ▷ Open a new **Reference View Table** to monitor and control the slave device, then add address %I00001 (Slave Status Bit Array).
Addresses %I00001 to %I00064 will display the status of all slave devices connected to master card.
 - For example, if the master card detects an LM10 slave device with MAC ID 1, then address %I00002 will read "1". Similarly, if a slave is connected with MAC ID 2, then address %I00002 will read "2".
- ▷ **Start the PLC.**
The NS LED on the LM10 (MAC ID 1) will turn solid green once the connection is established, and address %I00001 will read "1".
- ▷ Double-click on **GE LM10** to view the data areas.
For Connection 1 inputs (to master), address %I00081 will display the status. For Connection 1 outputs (from master), address %Q00017 will contain the command for the slave.
- ▷ Add the **%I00081** and **%Q00017** registers to the Reference View Table.
The reference view table for the LM10 is shown below.



Phase A values are displayed in %I00105 (223×0.1 amps).

Phase B values are displayed in %I00121 (212×0.1 amps).

Phase C values are displayed in %I00137 (218×0.1 amps).

The Control Byte via Polled I/O is displayed in %Q00017.

The Status Byte via COS is displayed in %I00145.

The value displayed in register %R0256 is the voltage parameter received by the master from the LM10 via Explicit Messaging.

- To interpret the bit array displayed in Reference View Table, refer to *Assembly Object* on page 5–48, in particular instances 54 and 100. Instance 54 is for status and Instance 100 is for control.

- To control the contactors and reset the LM10 from the fault state:

In Reference View Table, address %I00086 will read logic 1, indicating control from the network.

To switch on the Run1 contactor, right-click on address %Q00017 and select **Turn On**. Once the contactor is switched on, address %I00083 will read logic 1, indicating that the Run1 contactor is on.

To switch off the Run1 contactor, set address %Q00017 to “0” and address %Q00020 to “1”. This changes address %I00083 to read “0”, indicating that the Run1 relay is off.

When the LM10 goes into a fault condition, address %I00081 will toggle to “1”. To reset the LM10 after recovering from the fault state, toggle address %Q00019. Once the LM10 is in the “Ready to Run” state, address %I00081 will set to “0” and the module CUB LED will turn off.

A.2.6 COS (Change of State) Input/Output Connection

With change of state, a device will produce data only when it changes state.

The Change of State Input/Output (COS I/O) connection is primarily used for alarm and status notification. In the LM10, COS data is described in Object Class 4, instance 54.

Use the following procedure to establish the COS I/O connection between the LM10 and PLC.

- ▷ Under the **Connection 2** tab in the DN9030 master properties, select **COS**.
- ▷ Enter Input Resources size as 1 byte (since the LM10 has 1 status byte).
Note that we have established Connection 1 as a Polled Input/Output connection.
- ▷ To set the slave COS, go to Connection 2 under Mac ID1 Properties (GE LM10, Slave ID:1) and select COS under the **Connection 2** tab.
- ▷ Select the default input size of 1 bytes and the connection type as "Status".
- ▷ Double-click the added slave device to view the data area for Connection 2.
- ▷ Open the Reference View Table and add address %I00089.
- ▷ To interpret the 1 byte of status information for address %I00097, refer to Object Class 4, Instance 54 in *Assembly Object* on page 5-48.

A.2.7 Cyclic Input/Output Connection

The Cyclic Input/Output Connection option reduces unnecessary traffic and packet processing. Instead of a slave device scanned dozens of times each second, it can be set to report data on a regular basis consistent with the rate of change it can detect.

Basically, the same data is available in both COS and Cyclic connections. The primary difference is in the way the data is reported to the DeviceNet™ master. The Cyclic I/O connection is also used for alarm and status notification. In the LM10 system, cyclic data is described in Object Class 4, Instance 54.

Use the following procedure to establish the Cyclic Input/Output connection between the LM10 and PLC.

- ▷ Under the **Connection 2** tab in the DN9030 master properties, select **COS** and enter Input Resources size as 1 byte (since the LM10 has 1 status byte).
Note that we have established Connection 1 as a Polled Input/Output connection.
- ▷ To set the slave COS, go to Connection 2 under Mac ID1 Properties (GE LM10, Slave ID:1) and select COS under the **Connection 2** tab.
- ▷ Select the default input size of 1 bytes and the connection type as "Status".

- ▷ Double-click the added slave device to view the data area for Connection 2.
- ▷ Open the Reference View Table and add address %I00089.
- ▷ To interpret the 1 byte of status information for address %I00097, refer to Object Class 4, Instance 54 in *Assembly Object* on page 5-48.

A.2.8 Explicit Messaging

Description:

Explicit messaging provides multi-purpose, point-to-point communication paths between two devices. It typically provides request/response-oriented network communication used to perform node configuration and problem diagnosis.

In the GE Multilin LM10 Motor Protection System, explicit messaging is used for configuration and monitoring.

Use the following procedure to set the network for explicit messaging:

- ▷ For the master side: In the **Network Setting > DN9030 Master Properties** menu, disable connections 1 and 2 by selecting **Enable Explicit Connection**.
- ▷ Set the Message Request Size and Message Response Size to 20 bytes.
- ▷ For the slave side: In the **Network Setting > Disable Connection 1 & 2** window, select Explicit Message Size set the value as 20 bytes.
- ▷ Connect the PLC and download the hardware logic. The configuration should be shown as = EQ.
- ▷ Observe the DeviceNet master module LEDs. All three LEDs for NET POWER, MOD STATUS, and NET STATUS should turn solid green. Refer to *LEDs* on page 3-19 to interpret the device LED status.

Explicit messaging between the DeviceNet master module and LM10 slave takes place using COMMREQ ladder instructions.

A communication request begins when a COMMREQ ladder instruction is activated in the PLC application program. The CPU sends the COMMREQ to the DeviceNet™ master module in the PLC system. The module receives the command and performs the requested function.

Monitoring Data:

The ladder logic for monitoring data from the GE LM10 Motor Protection System using COMMREQ is shown in *Ladder Logic for Data Monitoring* on page A-13. The ladder logic is configured as follows:

- Rung 1 and 2 have a timer (thousands), as well as set and reset coils, which toggle the T1 contact after the timer PV value overflows. With the values shown, the T1 contact will toggle every five (5) seconds.

- Rung 3 has a Block Move word, 3 blocks.
- Rung 4 has the COMMREQ ladder instruction.

Refer to Chapter 5: Communications for a complete description of each word.

In the ladder below, the Trip Class is read from the slave (LM10 device) MAC ID 1. Some key word settings to obtain the LM10 Trip Class from Slave 1 are shown below:

- Word 11: Slave MAC ID setting (for example, 1)
- Word 13: Get Attribute (for example, 16#0E to read)
- Word 14: Object Class to which the Request is directed (for example, 16#64)
- Word 15: Instance of Object Class (for example, 1)
- Word 17: Attribute (for example, 16#2F00)



To get parameters under the access type history, Word 13 will be 16#32.

To **read** the operating voltage, change following words:

- Word 13: 16#32
- Word 17: 16#4500

To **view** the parameters in a Reference View Table, create a new Reference Table then add addresses %R00250 and %R00256. The control voltage will be displayed in address %R00256. Change the display format to unsigned decimal.

To **view** the slave number of slaves connected to master card, add address %I00001 to the new reference table. Now, address %I00002 will read "1", since the LM10 is connected to the master as slave 1 (MAC ID 1).

Also in the Reference View Table, add the input register %I00xx and output register %Q000xx for Connection 1 and Connection 2, respectively.

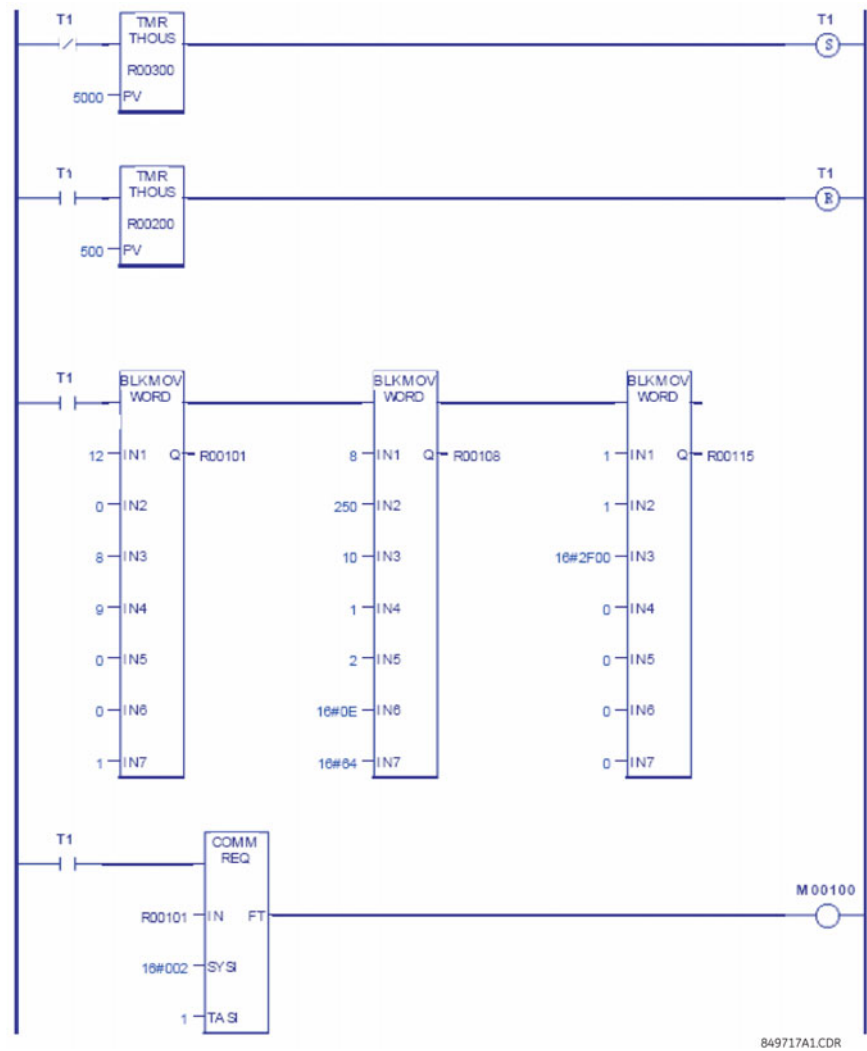


FIGURE A-1: Ladder Logic for Data Monitoring

Login (Configuration Level) to the LM10:

The ladder logic for configuring (login, user level, and entry configuration mode) the LM10 using COMMREQ is shown below. The ladder logic is configured as follows:

- Rung 1 and 2 have a timer (thousands), as well as set and Reset coils, which toggles the T1 contact after the value in timer PV overflows. With the values indicated, the T1 contact will toggle every five (5) seconds.
- Rung 3 has a Block Move word, 3 blocks.
- Rung 4 has the COMMREQ ladder instruction.

Refer to DeviceNet Object Model Class 64 instance for additional details.

In the ladder shown, we are logging in, setting the user level, and entering the configuration mode of the LM10 relay set to MAC ID 9. Some key word settings to login to the LM10 from Slave 9 are shown below:

- Word 11: Slave MAC ID setting (for example, 9)

- Word 13: Login, User Level (for example, 16#33 [Login, User Level])
- Word 14: Object Class to which the Request is directed (for example, 16#64)
- Word 15: Instance of Object Class (for example, 1)
- Word 17: Attribute (for example, 16#5100 [Configuration])
- Word 18: Passcode, value: 1

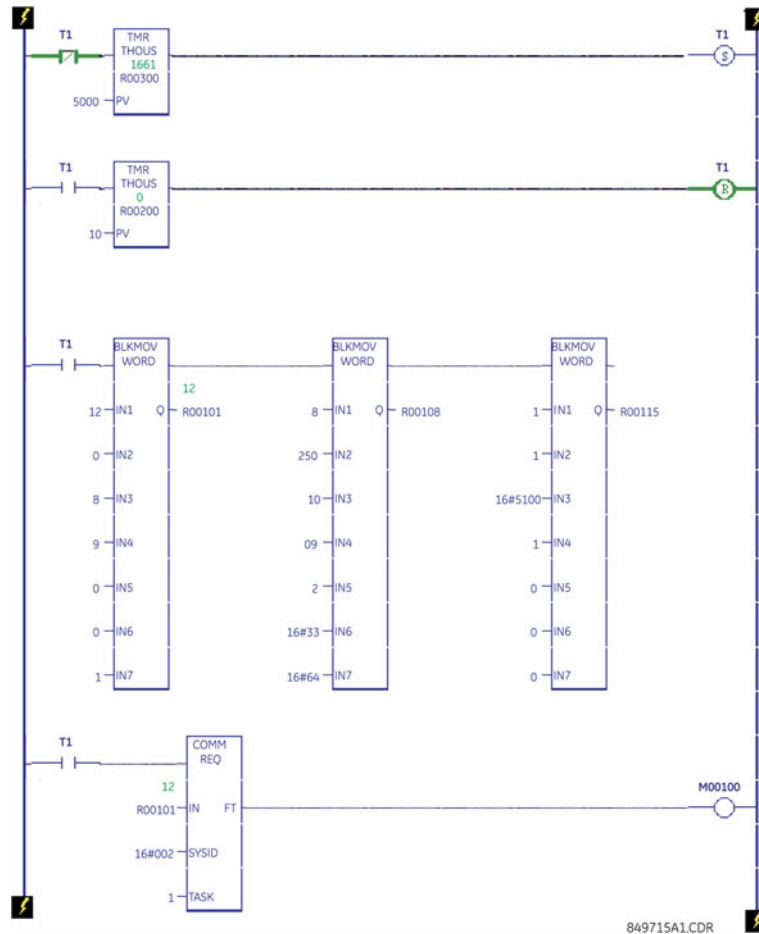


FIGURE A-2: Ladder Logic for Login (Configuration)

Making Setting Changes:

The ladder logic for making setting changes in the LM10 using COMMREQ is shown below. The logic shows the FLA Run1 parameter being set using COMMREQ. The ladder logic is configured as follows:

Refer to DeviceNet Object Model Class 64, Instance for additional details.

In the ladder shown, we are setting the FLA Run1 parameter of the LM10 relay from slave 9 (MAC ID 9). Some key word settings are shown below:

- Word 11: Slave MAC ID setting (for example, 9)
- Word 13: SET Attribute (for example, 16#10 to write)
- Word 14: Object Class to which the Request is directed (for example, 16#64)
- Word 15: Instance of Object Class (for example, 1)

- Word 17: Attribute (for example, 16#0200 [FLA Run1])
- Word 18: Attribute (for example, 77 [77 × 0.1 amps])

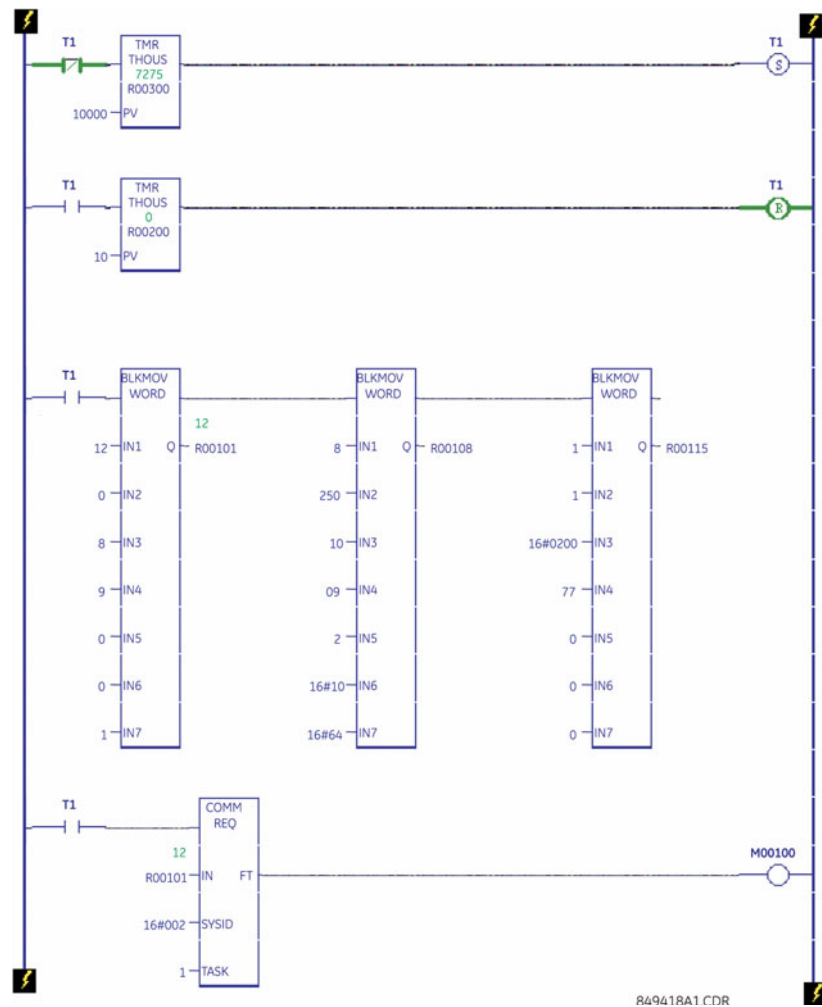


FIGURE A-3: Ladder Logic for Setting Changes

Login (User Level) to the LM10:

The ladder logic for login (user level) to the LM10 using COMMREQ is shown below. Some key word settings to login (user level) to the LM10 from Slave 9 are shown below:

- Word 11: Slave MAC ID setting (for example, 9)
- Word 13: Login, User Level (for example, 16#33 [Login, User Level])
- Word 14: Object Class to which the Request is directed (for example, 16#64)
- Word 15: Instance of Object Class (for example, 1)
- Word 17: Attribute (for example, 16#5000 [User])
- Word 18: Passcode, value: 1

The changed parameters will be reflected in Reference View Table at address %R00256 and the FLA Run1 parameter will be displayed. Change the display format to unsigned decimal.

To view the slave number of slaves connected to master card, add address %I00001 to the new reference table. Now, address %I000010 will read "1", since the LM10 is connected to the master as slave 1 (MAC ID 1).

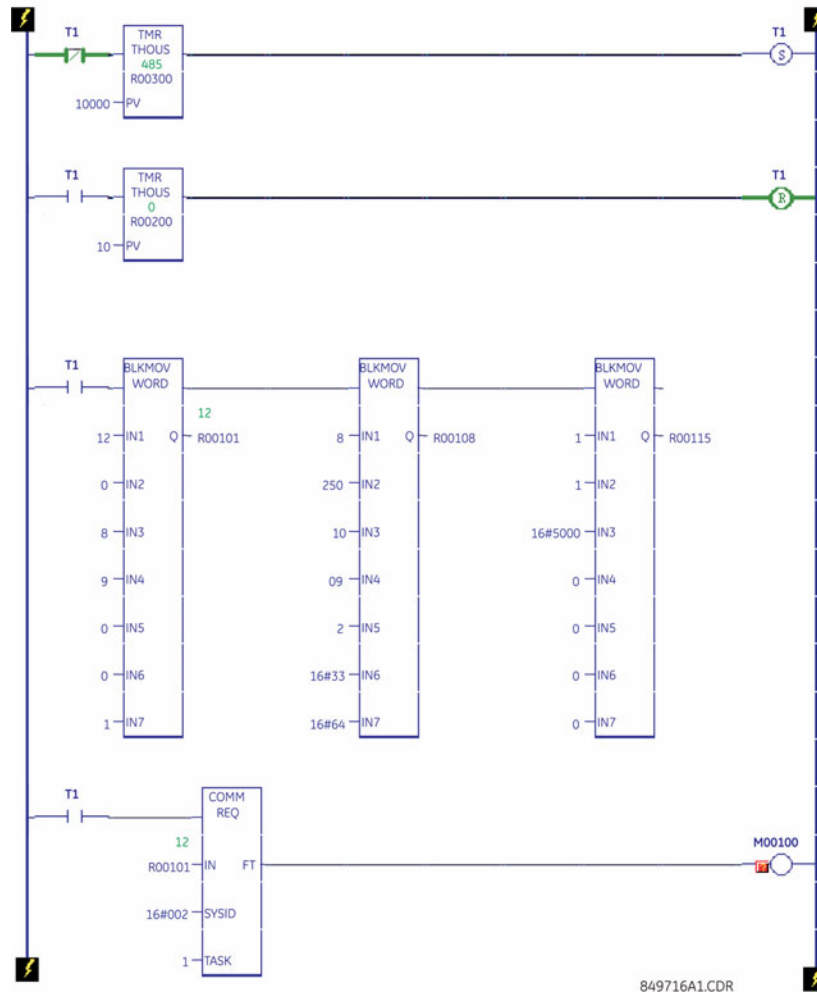


FIGURE A-4: Ladder Logic for Login (User)

A.3 LM10 and Allen-Bradley SLC500 via DeviceNet™

A.3.1 Description

This section describes DeviceNet communications between the Allen-Bradley SLC500 PLC card with the GE Multilin LM10 Motor Protection System.

The application example shows how to establish communications between Allen-Bradley SLC500 PLC (1747-SDN DeviceNet Scanner) card with the LM10 via Polled I/O Messaging, COS I/O Messaging, and Explicit Messaging.

A.3.2 System Setup

The hardware for the setup example is indicated below:

- PLC: Allen-Bradley SLC500
- CPU: 5/03
- Power Supply: 1746-P1
- DeviceNet Scanner Card: 1747-SDN
- 4 Slot Rack: 1746-A4
- Interface Adapter DeviceNet to RS232: 1770-KFD
- The following Rockwell automation software is used:
 - RSLogix 500
 - RSNetworkx for DeviceNet
 - RSLinx
- The following settings are stored in the LM10:
 - MAC ID: 09
 - Baud Rate: 125
 - Pin 21 (control input) connected to 110 V

A.3.3 Initial Steps

Before setting up the DeviceNet network, perform the following steps.

- ▷ **Start the RSLinx, RSNetworkx, and RSLogix software and load the corresponding drivers in RSLinx.**
- ▷ **Establish Polled I/O, COS I/O, and Explicit Messaging between the slave LM10 relay and the DeviceNet scanner card 1747-SDN.**

The Polled I/O messaging is for control and monitoring. The COS I/O messaging is for monitoring only. Explicit Messaging is used to retrieve byte wide data (for example, motor run time in hours, line voltage).

A.3.4 Setting Up the DeviceNet Network

Set up the DeviceNet network as follows:

- ▷ Once the DeviceNet connection (consisting of the 1747-SDN Scanner card, 1770-KFD, and LM10 relay) is complete, click the **Online** icon and upload the network.

Scanning for the Nodes on the Network will start. Using the EDS Wizard, add the LM10 to the hardware list in RSNetworkx. A sample screen of RSNetworkx with 3 nodes is shown below.

- LM10 Motor Protection System: MAC ID 09
- 1770-KFD: MAC ID 62
- 1747SDN Scanner Card: MAC ID 63

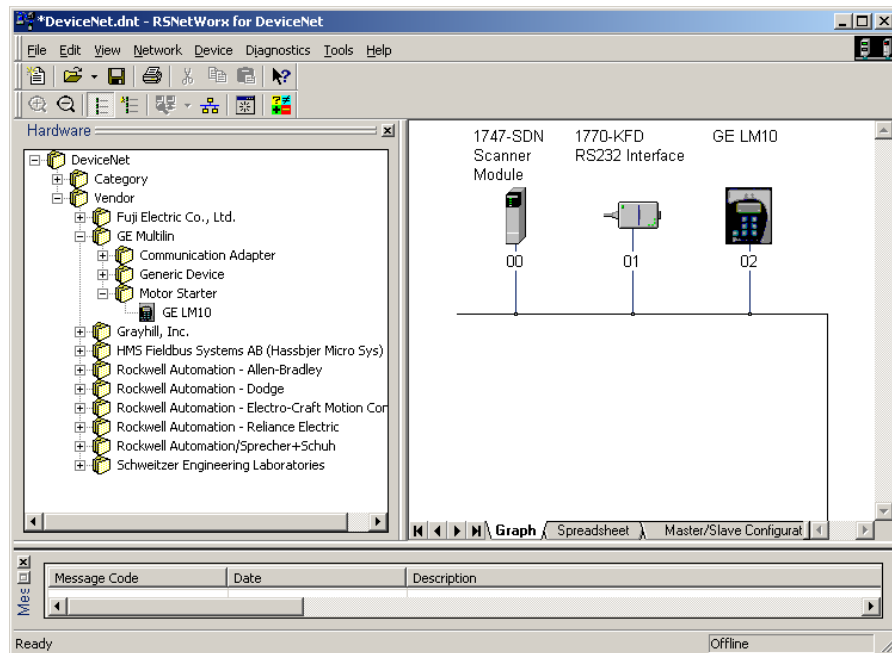


FIGURE A-5: Example RSNetworkx Screen

A.3.5 Changing the Mode of Operation

Use the following procedure to change the mode of operation.

- ▷ In RSLogix 500 open the Force File O0 Output.

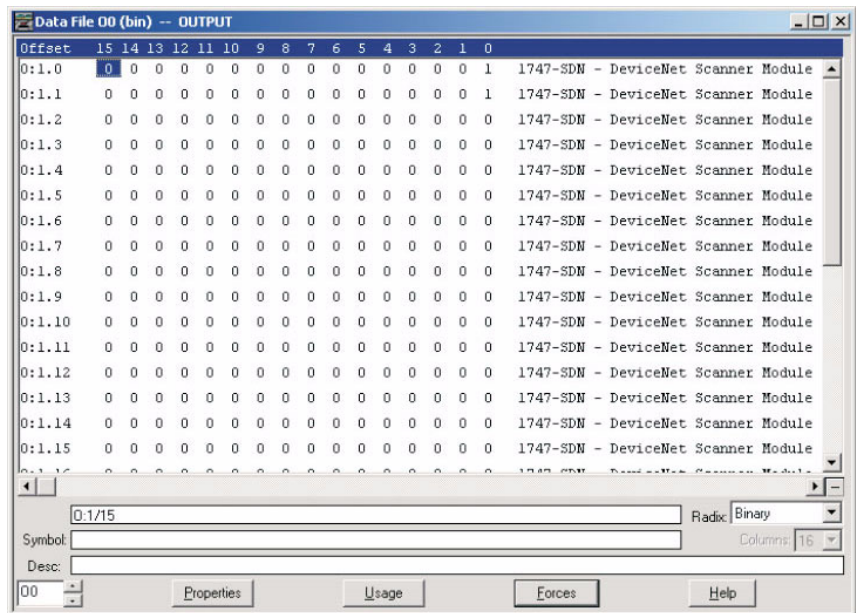


FIGURE A-6: Sample Force File

- ▷ To place the 1747-SDN scanner in Run Mode, toggle the bit O:1/0 to 1 in the O0-output force file.
The CPU will change to the Run state.

When the scanner is in Run mode and the network is healthy, the node number of the scanner is displayed on the 7-segment indicator on the module. In this case, “63” will be displayed.

- ▷ Toggle the O:1/0 to 0 in the O0-output force file to place/force the Scanner to Idle mode.
The scanner will also change to Idle mode when CPU mode is changed to Prog (programming).

When the scanner is in Idle mode, the 7-segment indicator will flash code “80” and the NS (Network Status) LED indicator on the LM10 changes to flashing green, indicating Online, Not Connected.

If the Run1 contactor is switched on via O:1/16, then Run1 will drop/turn off when the scanner changes to Idle mode. The Run1 contactor will pickup again (ON) when the scanner goes from Idle to Run mode.

A.3.6 Configuring the Slave Device

Use the following procedure to configure the slave device.

- ▷ Double-click on the scanner icon in RSNetworkx.
This will display a configuration screen related to 1747-SDN scanner (see below).

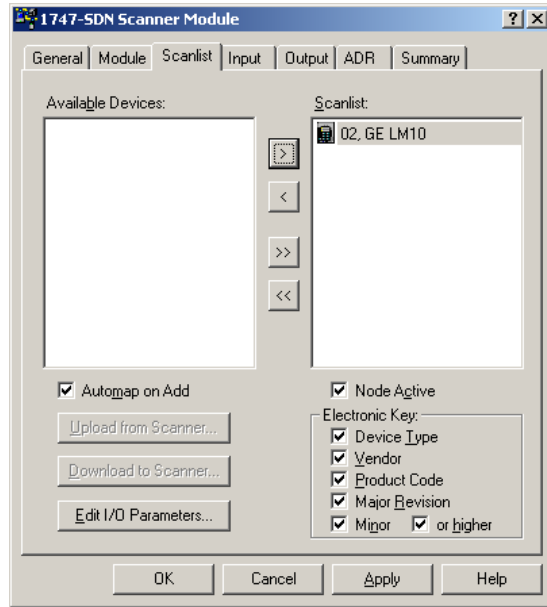
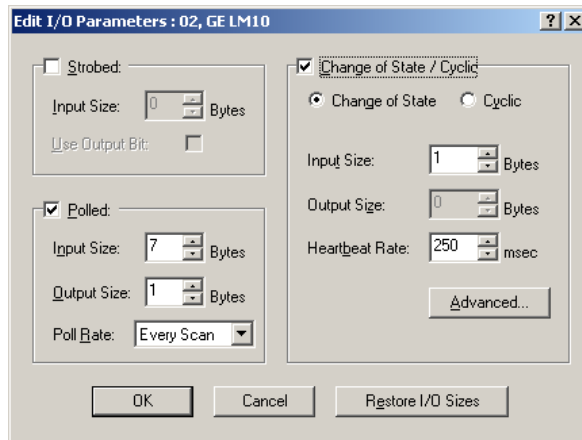


FIGURE A-7: Scanner Module Scanlist

- ▷ Click on **Scanlist** tab.
The LM10 will be shown under Available Devices.
- ▷ Click the **right arrow** to move under 'scanlist'. Double-click on **LM10-1** icon to edit the input/output parameters.



- ▷ Select **Polled** and add 1 byte for the **Input Size** and **Output Size**.
After adding the input/output parameters, you will be prompted for downloading to node 9

A.3.7 Control and Monitoring of the LM10

Polling I/O messaging is for control and monitoring of LM10 relay parameters.

- ▷ In RSLogix 500, open the **O0-Output** and **I1-Input** force files.

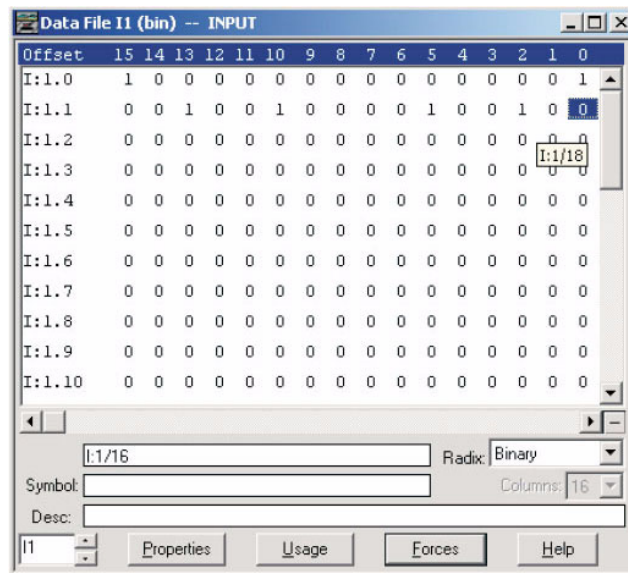


FIGURE A-8: Input Force File

- ▷ To turn on the Run1 contactor, toggle the O:1/16 bit to **1**. To turn off Run1, set this bit to **0**.

The status of the Run1 contactor is indicated by the I:1.1/18 bit.

The remote (DeviceNet) control is indicated by the I:1.1/21 bit.

The COS I/O messaging data is available in the I1-Input file, bits I:1.1/24 and onwards.

A.3.8 Explicit Messaging with the LM10 Relay

Explicit messages are stored in the data table of the SLC processor in hexadecimal format. An M0 copy instruction is used to send the message to the 1747-SDN-scanner module. The scanner module takes the data and formats it into the proper protocol for transmission on the DeviceNet network. The destination device (node) receives the message, takes the appropriate action depending upon the type of command, and formats a reply message for transmission on the network. The scanner module receives the message that contains information on the success or failure of the command. The SLC processor uses an M1 copy instruction to get the message response information from the scanner module. The status information is placed in the SLC processor data table.

The discussion of Explicit Messaging will be limited to only the elements necessary to allow this application to function and those that are necessary to provide basic understanding of the application logic.

Explicit Messaging uses Class, Instance, and Attribute data to build its message structure.

Upon completion of a successful transaction, the logic automatically increments the TXID# and is ready for the next transaction. Also, the Status data received will be reflected in Status Word I:s:0 Bit-15. A "1" will be shown for successful message completion. Refer to the table below for all Status codes as provided by ODVA specification.

Table A-3: Status Codes Provided by ODVA Specification

Status Data	Definition
0	Transaction Block Empty
1	Transaction successful
2	Transaction in progress
3	Slave not in scan list
4	Slave offline
5	DeviceNet port disabled
6	Transaction TXID unknown
7	Unused
8	Invalid command
9	Scanner out of buffers
10	Other transaction in progress
11	Could not connect to slave device
12	Response data too large for block
13	Invalid port
14	Invalid size specified
15	Connection bust

A.3.9 Data Table Layout

The data table layout is shown below.

Table A-4: Data Table Layout

Data Location	High Byte	Low Byte
N X:0	TXID	Command
N X:1	Port	Size
N X:2	Service	MAC ID
N X:3	Class (high byte)	Class (low byte)
N X:4	Instance (high byte)	Instance (low byte)
N X:5	Attribute (high byte)	Attribute (low byte)
N X:6	Data (high byte)	Data (low byte)

Note that X will be any number set in the data file.

The TXID high byte is used for message tracking and is incremented and checked by ladder logic. The Command low byte is defined as follows:

- 1 = Execute the block
- 2 = Clear response buffer (1747-SDN only)
- The Port high byte is defined as follows:
 - 0 = Channel A
 - 1 = Channel B

The Port byte is always "0" for the 1747-SDN.

The Size low byte represents the number of bytes in the transaction body. Essentially, this is the number of bytes following the MAC ID field.

The Service high byte is defined as follows:

- 0E (hex), 14 (decimal) = Get Attribute Single (read a single parameter)
- 10 (hex), 16 (decimal) = Set Attribute Single (write a single parameter)
- 32 (hex), 50 (decimal) = Get Attribute Multiple (read multiple parameters)

The MAC ID low byte is destination code 09.

The transaction body consists of the Class, Instance, Attribute, and Data bytes.

A.3.10 Ladder Logic

This discussion refers to the Ladder Logic diagrams shown on the following pages.

1. Rung 0000 to Rung 0004 are used to toggle the Bit B4/0 every 1 second; this is the input to BSL (Bit Shift Left).
2. For every 1 second toggle of B4/0, left-shift the N9:0 register.
3. The bits in the N9:0 register are used to enable Rungs 0007 to 0012.
4. Rung 0006 is used to reload the N9:0 register after overflow.
5. The COP function is used to copy the contents of the M1 file to a specific N register and transfer the values to the M0 file.

Table A–5: Data to Get Trip Class

Address	Data (hex)	Description
N31:0	0101	TXID / Command
N31:1	0008	Port / Size
N31:2	0E09	Service / MAC ID (Node 09)
N31:3	0064	Class
N31:4	0001	Instance
N31:5	002F	Attribute (Trip Class)

Table A–6: Data for Explicit Message Response, M1 Transferred to N20

Address	Data (hex)	Description
N32:0	0101	TXID / Command
N32:1	0002	Port / Size
N32:2	8E09	Service / MAC ID (Node = 09)
N32:3	Trip Class Value	Service Response Data

Table A-7: Data to Get Motor Run Time

Address	Data (hex)	Description
N19:0	0101	TXID / Command
N19:1	0008	Port / Size
N19:2	0E09	Service / MAC ID (destination = 63)
N19:3	0064	Class
N19:4	0001	Instance
N19:5	0015	Attribute (Motor Run Time)

Table A-8: Data for Explicit Message Response, M1 Transferred to N20

Address	Data (hex)	Description
N20:0	0101	TXID / Command
N20:1	0002	Port / Size
N20:2	8E09	Service / MAC ID (Node = 09)
N20:3	Motor Run Time Value	Service Response Data



Refer to the DeviceNet Object Model of the LM10 relay for detail information on Class, Instance, and Attribute.

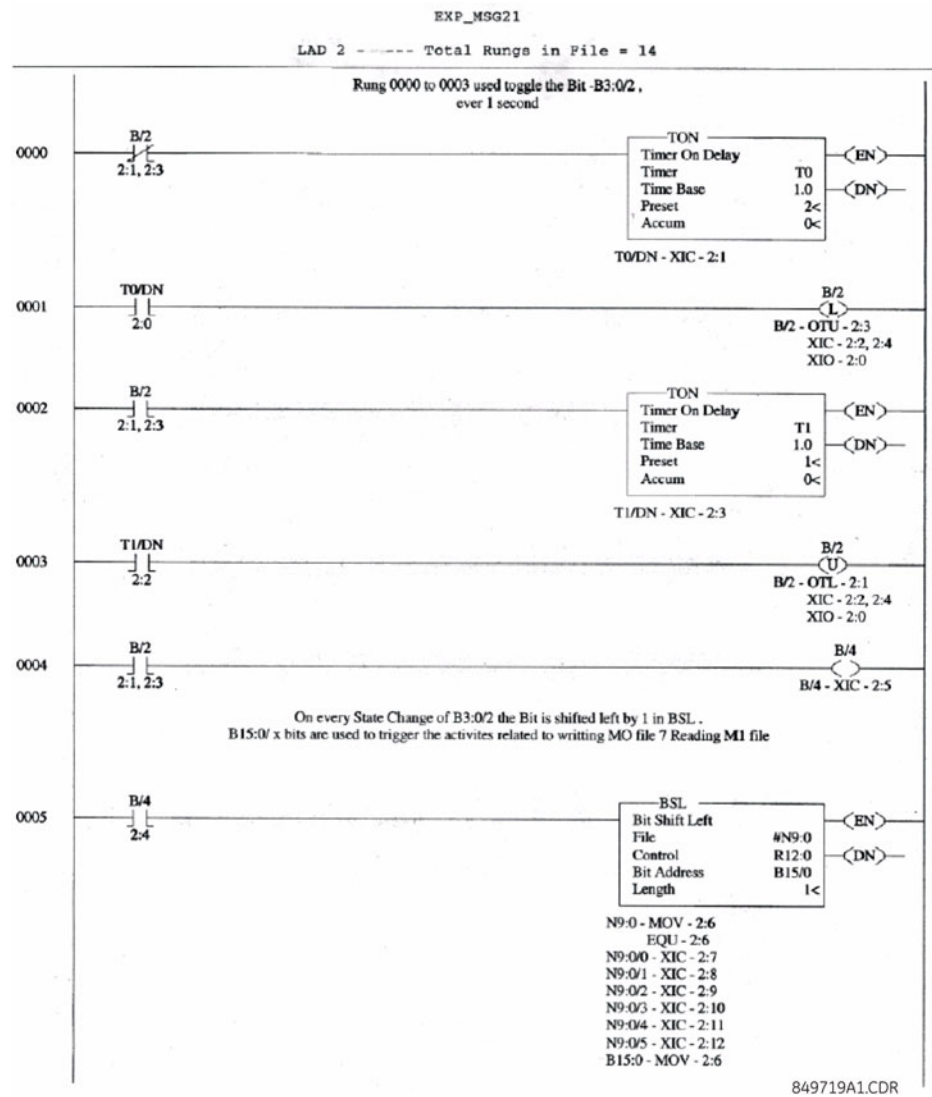


FIGURE A-9: Ladder Logic, Rungs 0000 to 0005

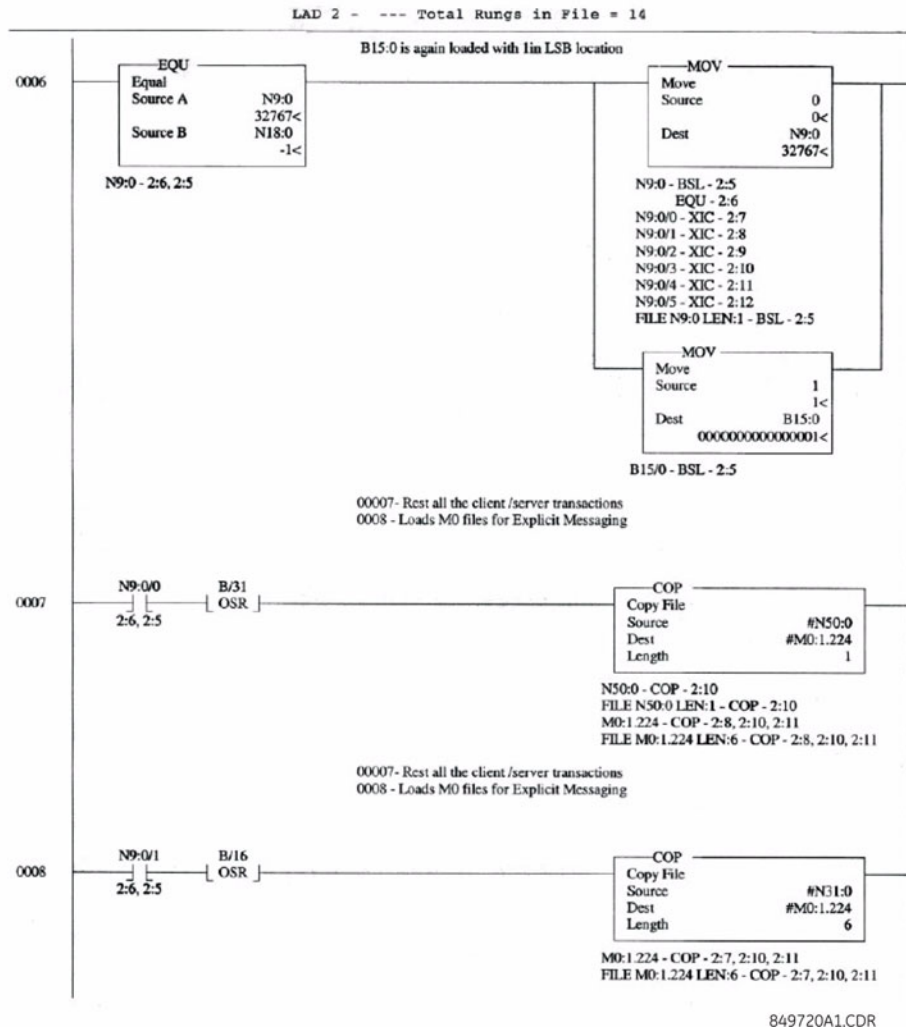


FIGURE A-10: Ladder Logic, Rungs 0006 to 0008

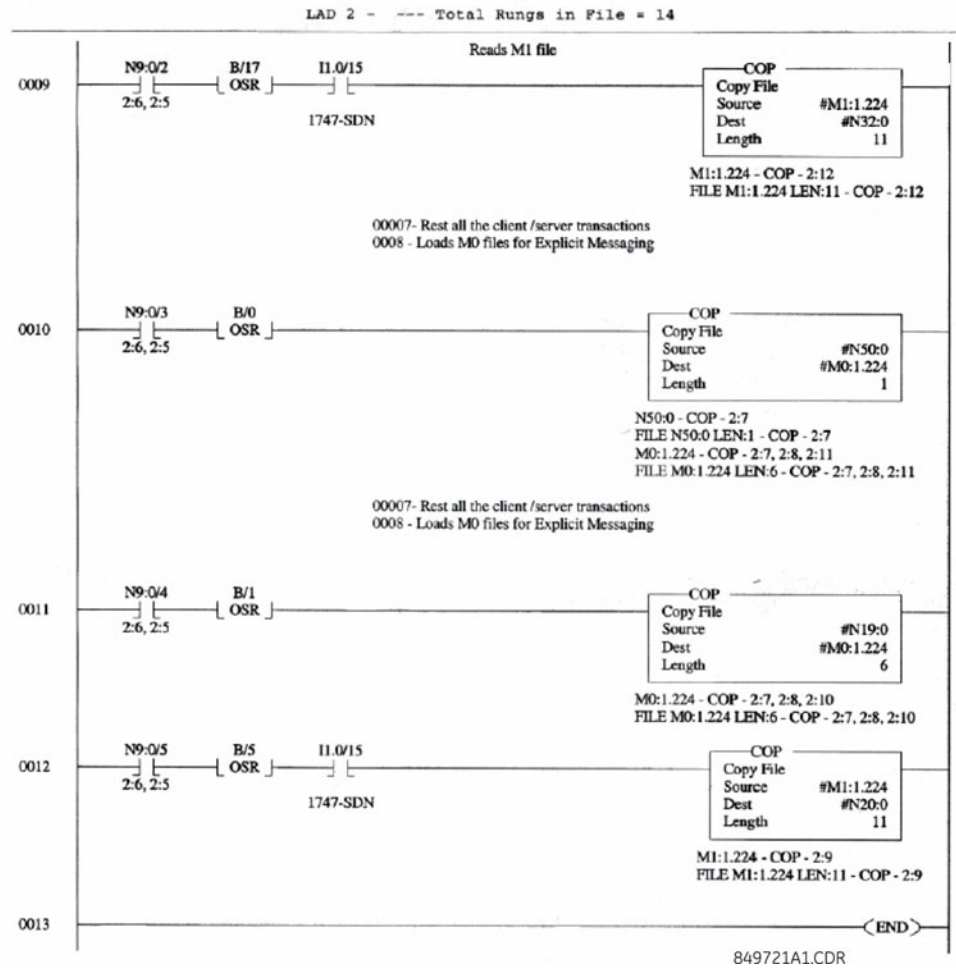


FIGURE A-11: Ladder Logic, Rungs 0009 to 0013

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