Motor Insight™ Overload and Monitoring Relay

An Intelligent Power Control Solution

Effective September 2009
Supersedes April 2009

User Manual

Powering Business Worldwide

September 2009

Disclaimer of Warranties and Limitation of Liability

The information, recommendations, descriptions and safety notations in this document are based on Eaton Corporation's ("Eaton") experience and judgment and may not cover all contingencies. If further information is required, an Eaton sales office should be consulted.

Sale of the product shown in this literature is subject to the terms and conditions outlined in appropriate Eaton selling policies or other contractual agreement between Eaton and the purchaser.

THERE ARE NO UNDERSTANDINGS, AGREEMENTS, WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE OR MERCHANTABILITY, OTHER THAN THOSE SPECIFICALLY SET OUT IN ANY EXISTING CONTRACT BETWEEN THE PARTIES. ANY SUCH CONTRACT STATES THE ENTIRE OBLIGATION OF EATON. THE CONTENTS OF THIS DOCUMENT SHALL NOT BECOME PART OF OR MODIFY ANY CONTRACT BETWEEN THE PARTIES. In no event will Eaton be responsible to the purchaser or user in contract, in tort (including negligence), strict liability or otherwise for any special, indirect, incidental or consequential damage or loss whatsoever, including but not limited to damage or loss of use of equipment, plant or power system, cost of capital, loss of power, additional expenses in the use of existing power facilities, or claims against the purchaser or user by its customers resulting from the use of the information, recommendations and descriptions contained herein.

The information contained in this manual is subject to change without notice.

Support Services

Eaton's goal is to ensure your greatest possible satisfaction with the operation of our products. We are dedicated to providing fast, friendly and accurate assistance. That is why we offer you many ways to get the support you need. Whether it's by phone, fax or e-mail, you can access Eaton's support information 24 hours a day, seven days a week. Our wide range of services is listed below.

You should contact your local distributor for product pricing, availability, ordering, expediting and repairs.

Website

Use the Eaton website to find product information. You can also find information on local distributors or Eaton's sales offices.

Website Address

www.eaton.com/electrical

EatonCare Customer Support Center

Call the EatonCare Support Center if you need assistance with placing an order, stock availability or proof of shipment, expediting an existing order, emergency shipments, product price information, returns other than warranty returns, and information on local distributors or sales offices.

Voice: 877-ETN-CARE (386-2273) (8:00 am – 6:00 pm EST)
FAX: 800-752-8602

After-Hours Emergency: 800-543-7038
(6:00 pm – 8:00 am EST)

Technical Resource Center

Voice: 877-ETN-CARE (386-2273) (8:00 am – 5:00 pm EST)

FAX: 828-651-0549

e-mail: TRC@Eaton.com

September 2009

Table of Contents

Table of Contents (Continued)

List of Figures

List of Tables

List of Tables (Continued)

September 2009

Safety

Definitions and Symbols

WARNING

This symbol indicates high voltage. It calls your attention to items or operations that could be dangerous to you and other persons operating this equipment. Read the message and follow the instructions carefully.

This symbol is the "Safety Alert Symbol." It occurs with either of two signal words: CAUTION or WARNING, as described below.

WARNING

Indicates a potentially hazardous situation which, if not avoided, can result in serious injury or death.

CAUTION

Indicates a potentially hazardous situation which, if not avoided, can result in minor to moderate injury, or serious damage to the product. The situation described in the CAUTION may, if not avoided, lead to serious results. Important safety measures are described in CAUTION (as well as WARNING).

Hazardous High Voltage

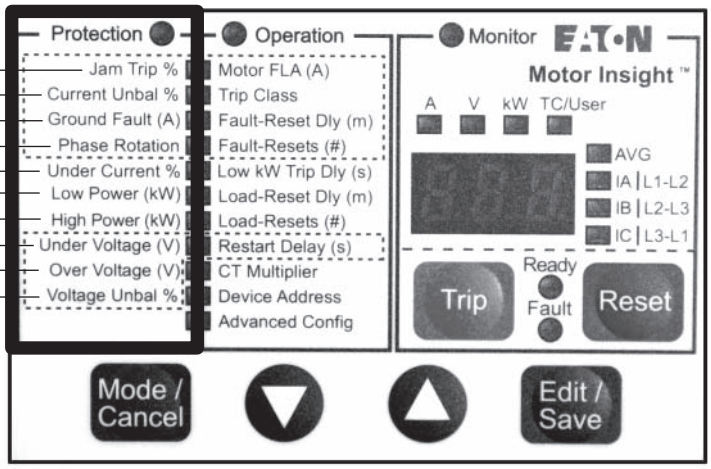
WARNING

Motor control equipment and electronic controllers are connected to hazardous line voltages. When servicing drives and electronic controllers, there may be exposed components with housings or protrusions at or above line potential. Extreme care should be taken to protect against shock.

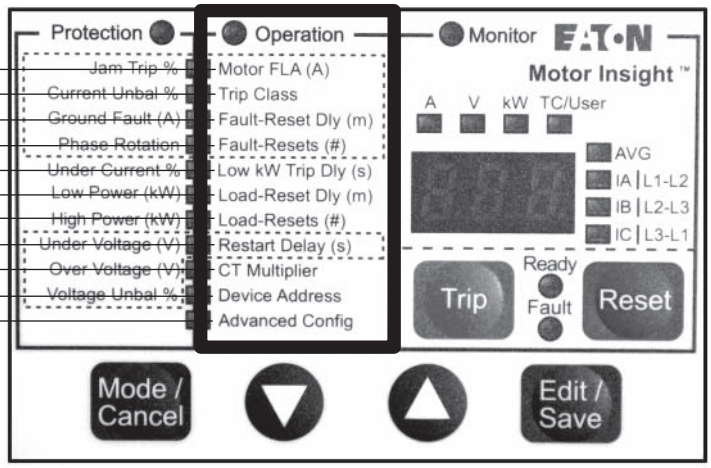
Stand on an insulating pad and make it a habit to use only one hand when checking components. Always work with another person in case an emergency occurs. Disconnect power before checking controllers or performing maintenance. Be sure equipment is properly grounded. Wear safety glasses whenever working on electronic controllers or rotating machinery.

Index

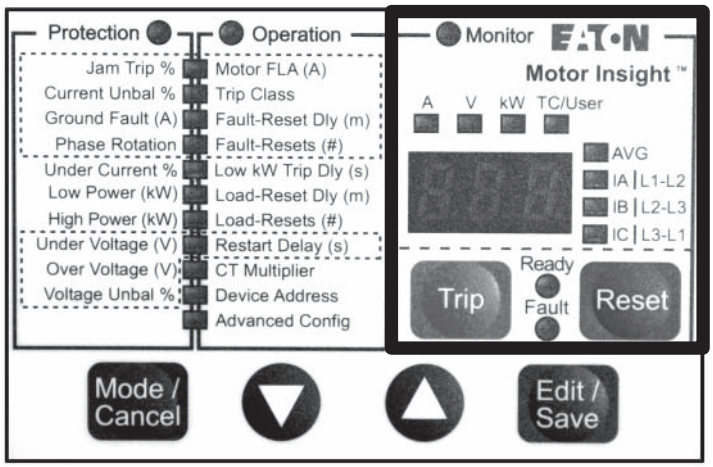
Protection



Operation



Monitoring



Chapter 1 — Introduction

1.1 - System Overview

Motor Insight is an advanced motor protective relay with thermal motor overload, supply and load protection, configurable ground fault detection, power monitoring, an intuitive user interface and optional communications. Motor Insight also provides fault-type logic that enables the user to configure reset behavior based on fault type.

1.1.1 - Sizes and Ratings

The following base units are available. Note that currents other than those listed can be accommodated following the motor lead wrap schedule shown in **Table 2-6** and **Table 2-7**.

Table 1-1: Sizes and Ratings

Catalog Number	Configuration Description
C441BA	Motor protection relay with thermal overload, power measurements, ground fault detection, and communications capability. 2 – 9 A; 240 Vac (170 – 264 Vac) (50/60 Hz)
C441BB	Motor protection relay with thermal overload, power measurements, ground fault detection, and communications capability. 20 – 90 A; 240 Vac (170 – 264 Vac) (50/60 Hz)
C441CA	Motor protection relay with thermal overload, power measurements, ground fault detection, and communications capability. 2 – 9 A; 480 Vac (323 – 528 Vac) (50/60 Hz)
C441CB	Motor protection relay with thermal overload, power measurements, ground fault detection, and communications capability. 20 – 90 A; 480 Vac (323 – 528 Vac) (50/60 Hz)
C441DA	Motor protection relay with thermal overload, power measurements, ground fault detection, and communications capability. 2 – 9 A; 600 Vac (489 – 660 Vac) (50/60 Hz)
C441DB	Motor protection relay with thermal overload, power measurements, ground fault detection, and communications capability. 20 – 90 A; 600 Vac (489 – 660 Vac) (50/60 Hz)

1.1.2 - Motor Protection Features

Table 1-2: Motor Protection Features

Feature	Description
Motor Protection	**Thermal Overload** The overload relay models the thermal characteristics of a motor and trips when the motor is overloaded to prevent motor damage. The overload has the following attributes: ● Adjustable Trip Class setting ● Adjustable Motor FLA setting ● The thermal capacity of the motor is stored during power cycles to the device ● The unit has multiple reset modes (manual and automatic). The device cannot be reset until the thermal capacity in the motor is low enough for a successful restart. **Additional Motor Protection Features** ● Jam ● Current Unbalance ● Phase Loss ● Ground Fault (alarm-no-trip setting available)
Motor Protection Reset Modes	● Motor Fault Reset Number of Attempts ● Motor Fault Reset Time: Time duration between a motor fault event and the next auto restart attempt. This time allows the motor to cool down before a reset is allowed.
Supply (Voltage) Protection	● Over Voltage ● Under Voltage ● Voltage Phase Loss ● Phase Reversal
Supply Protection Auto Reset Modes	By default, the Motor Insight will alarm but not trip on voltage faults when the motor is running, however; the device will inhibit a start into a voltage fault. The alarm-no-trip mode can be disabled through the user interface or over the network. When disabled, the Motor Insight will trip on a voltage fault according to the settings for each line protection parameter. In this mode, the Motor Insight will auto-reset when the voltage or line fault clears.
Load Protection	● Under Current ● Low Power (kW) ● High Power (kW)
Load Protection Auto Reset Modes	● Load Fault Reset Attempts ● Load Fault Reset Time: Time duration between a load fault event and the next auto reset attempt. This time allows the load to recycle prior to allowing a restart.

1.1.3 - Control Features

Table 1-3: Control Features

Feature	Description
Motor Control	2 Output Relays — 1 Form 1C (SPDT) Fault Relay 1 Form A (SPST) Ground Fault Relay 1 External remote reset terminal
Reset Timers	**Power-on Restart Timer** — Following a power outage event, this timer will start when power is restored to the device. The timer will delay the closure of the fault relay for the set point number of seconds. **Motor Fault Cool-Down Timer** — This timer inhibits a restart after a Motor Protection Fault. The time-out period is set in minutes. **Load Fault Timer** — Following a Load fault, this timer inhibits a restart attempt. The time-out period is set in minutes. An automatic mode is available that calculates the reset inhibit period based on the run time of the last motor start.

1.1.4 - Monitoring Features

Table 1-4: Monitoring Features

Feature	Description
Current Monitoring	Per Phase rms Average rms Current Unbalance Percentage Ground Fault Current
Voltage Monitoring	Per Phase rms Average rms Voltage Unbalance Percentage Frequency
Power Monitoring	Motor kW Motor Power Factor (Inductive)
Timers/Counters Other	Run Timers Thermal Capacity Time to Restart Start Count Motor Run Time

Chapter 2 — Ratings and Specifications

2.1 - Environmental

Table 2-1: Environmental

Description	Specifications
Ambient Operating Temperature	-20°C to 50°C
Storage Temperature	-40°C to 85°C
Operating Humidity	5% to 95% non-condensing
Pollution Degree per IEC 60947-1	3
Overvoltage Category per UL 508	III
Altitude	2000 m
Vibration	3g in any direction
Shock	15g in any direction

2.2 - EMC/EMI

Table 2-2: EMC/EMI

Description	Specifications
Radiated Emissions	IEC 60947-4-1 — Table 15, EN 55011 (CISPIR 11) Group 1, Class A, ISM Equipment for Industrial, Scientific, and Medical Equipment. 30 MHz to 1000 MHz.
Conducted Emissions	IEC 60947-4-1 — Table 14, EN 55011 (CISPIR 11) Group 1, Class A, ISM Equipment for Industrial, Scientific, and Medical Equipment. 0.15 MHz to 30 MHz.
ESD Immunity	IEC 60947-4-1 (Table 13), +/-8 kV air, +/-4 kV contact
Radiated Immunity	IEC 60947-4-1 10V/m 80 MHz – 1000 MHz 80% Amplitude Modulated 1 kHz sine wave.
Conducted Immunity	IEC 60947-4-1 140 dBuV (10V rms) 150 kHz – 80 MHz
Fast Transient Immunity	IEC 60947-4-1 (Table 13) IEC 6100-4-4 +/-2 kV using direct method.
Surge Immunity	IEC 60947-4-1 (Table 13) IEC 61000-4-5 Class 4. 3-Phase Power Inputs: +/-2 kV line-to-line (DM) +/-4 kV line-to-ground (CM) User IO and Communication Lines: +/-1 kV line-to-line (DM) +/-2 kV line-to-ground (CM)
Voltage Variations Immunity	IEC 60947-4-1 30% dip, @10 ms 60% dip @ 100 ms >95% interrupt @ 5 ms
Power Frequency Magnetic Field Immunity	IEC 60947-4-1 30 A/m, 50 Hz
Electromagnetic Field	IEC 60947-4-1 Table 13, IEC 61000-4-3. 10V/m

2.3 - Short Circuit Ratings

Table 2-3: Motor Insight Short Circuit Ratings (North America CSA -UL)

Catalog No.	Overload FLA Range	Max. Operating Voltage	Standard-Fault Short Circuit Data			Maximum Withstand Rating	Max. Fuse (RK5)	Eaton T/M Circuit Breaker
			Withstand Rating	Max. Fuse (K5)	Max. T/M Circuit Breaker			
C441BA	2 to 9	240 Vac	5,000 A @ 240 Vac	35 A	35 A	100 kA @ 240 Vac 100 kA @ 240 Vac	35 A –	– FDC3035L
C441CA	2 to 9	480 Vac	5,000 A @ 480 Vac	35 A	35 A	100 kA @ 480 Vac 100 kA @ 480 Vac	35 A –	– FDC3035L
C441DA	2 to 9	600 Vac	5,000 A @ 600 Vac	35 A	35 A	100 kA @ 600 Vac 35 kA @ 600 Vac	35 A –	– FDC3035L
C441BB	20 to 90	240 Vac	10,000 A @ 240 Vac	350 A	350 A	100 kA @ 240 Vac 100 kA @ 240 Vac	350 A –	– KDC3350
C441CB	20 to 90	480 Vac	10,000 A @ 480 Vac	350 A	350 A	100 kA @ 480 Vac 100 kA @ 480 Vac	350 A –	– KDC3350
C441DB	20 to 90	600 Vac	10,000 A @ 600 Vac	350 A	350 A	100 kA @ 600 Vac 65 kA @ 600 Vac	350 A –	– KDC3350

Table 2-4: IEC 60947-4-1 Type 1 Short Circuit Ratings

Catalog No.	Overload FLA Range	Max. Operating Voltage	Standard-Fault "r" Short Circuit Data		
			Withstand Rating	gG/gT Fuse	Eaton T/M Circuit Breaker
C441BA	2 to 9	240 Vac	1,000 A @ 240 Vac	35 A	EGH3030FFG
C441CA	2 to 9	480 Vac	1,000 A @ 480 Vac	35 A	EGH3030FFG
C441DA	2 to 9	600 Vac	1,000 A @ 600 Vac	35 A	EGH3030FFG
C441BB	20 to 90	240 Vac	5,000 A @ 240 Vac	315 A	LGH3300FAG
C441CB	20 to 90	480 Vac	5,000 A @ 480 Vac	315 A	LGH3300FAG
C441DB	20 to 90	600 Vac	5,000 A @ 600 Vac	315 A	LGH3300FAG

2.4 - Electrical Ratings

Table 2-5: Electrical Ratings

Type	Rating	Description
Rated Input Voltage — 240 V Unit	200 – 240 Vac; (50/60 Hz)	Voltage Tolerance: +10%/-15% Frequency Tolerance: +/-5% Bandwidth: 540 Hz Accuracy: 2%
Rated Input Voltage — 480 V Unit	380 – 415 Vac; (50/60 Hz) & 440 – 480 Vac; (60 Hz)	
Rated Input Voltage — 600 V Unit	575 – 600 Vac; (60 Hz)	
Rated Current (100% FLA) 90 A Unit	20 – 90 A rms	Accuracy: 2%
Rated Current (100% FLA) 9 A Unit	2 – 9 A rms	
Overload Current Range 90 A Unit	20 A – 720 A rms	Overload protection up to 8 x FLA.
Overload Current Range 9 A Unit	2 A – 72 A rms	
Line Frequency	47 – 63 Hz	—
2 Output Relays	B300 Pilot Duty	5A Thermal Continuous Current 30A Make, 3.00 A Break @ 120 Vac 15A Make, 1.50 A Break @ 240 Vac

2.5 - Current Ratings

For the 20 – 90 amp current range, the following wire wrap schedule lists the maximum number of wraps needed to retain accuracy of current measurements.

Table 2-6: Model 90 Amp

Motor FLA	Number of Loops	Number of Conductors Through CT Primary	CT Multiplier Setting
5 – 22.5	3	4	4
6.67 – 30	2	3	3
10 – 45	1	2	2
20 – 90	0	1	1

The low range model is ideally suited for use with low HP motors or with motor NEMA size 3 to 5 with the use of external CTs. When using external CTs, pass the 5 ampere secondary through the Motor Insight internal CTs.

Table 2-7: Model 9 Amp

Motor FLA	Number of Loops	Number of Conductors Through CT Primary	CT Multiplier Setting
1 – 5	1	2	2
2 – 9	0	1	1
60 – 135	0	1	150 – (150:5)
120 – 270	0	1	300 – (300:5)
240 – 540	0	1	600 – (600:5)

Chapter 3 — Receipt/Unpacking

⚠ WARNING

Do not service with voltage applied — Lock-out Tags.

3.1 - General

Upon receipt of the unit, verify that the catalog number and unit options stated on the shipping container match those stated on the order/purchase form.

Inspect the equipment upon delivery. Report any crate or carton damage to the carrier prior to accepting the delivery. Have this information noted on the freight bill. Eaton is not responsible for damage incurred in shipping.

3.2 - Unpacking

Remove all packing material from the unit. Check the unit for any signs of shipping damage. If damage is found after unpacking, report it to the freight company. Retain the packaging materials for carrier to review.

Verify that the unit's catalog number and options match those stated on the order/purchase form.

3.3 - Storage

It is recommended that the unit be stored in its original shipping box/crate until it is to be installed.

The unit should be stored in a location where:

- The ambient temperature is -40°C – 85°C.
- The relative humidity is 0% – 95%, non-condensing.
- The environment is dry, clean and non-corrosive.
- The unit will not be subjected to high shock or vibration conditions.

Chapter 4 — Installation and Connections

4.1 - Mounting

Motor Insight does not require any special tools for mounting. Drill and tap holes per mounting hole location as shown.

4.1.1 - Dimensions

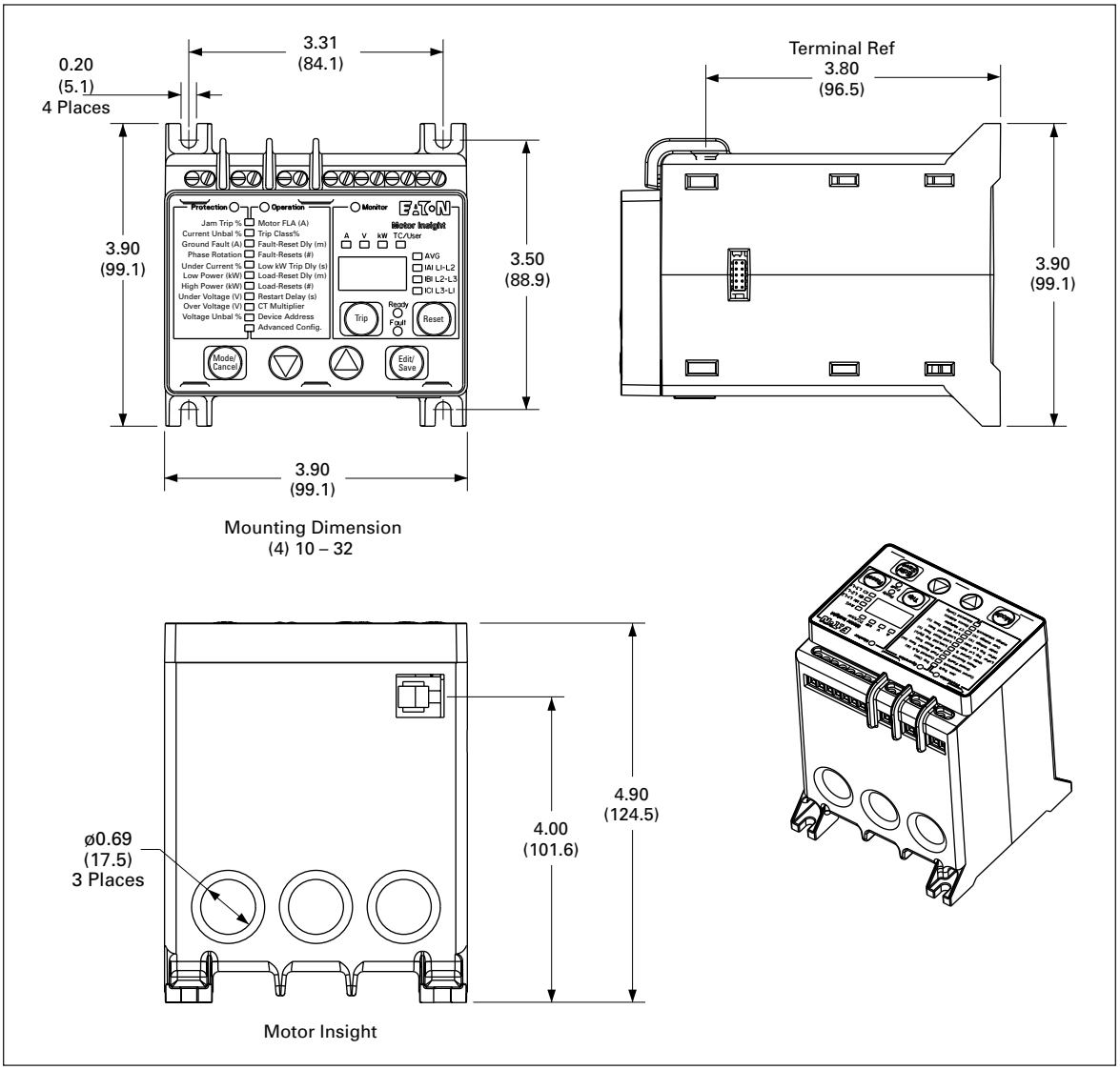


Figure 4-1: Motor Insight Overload (B10-9112) Dimensions
Approximate Dimensions in Inches (mm)

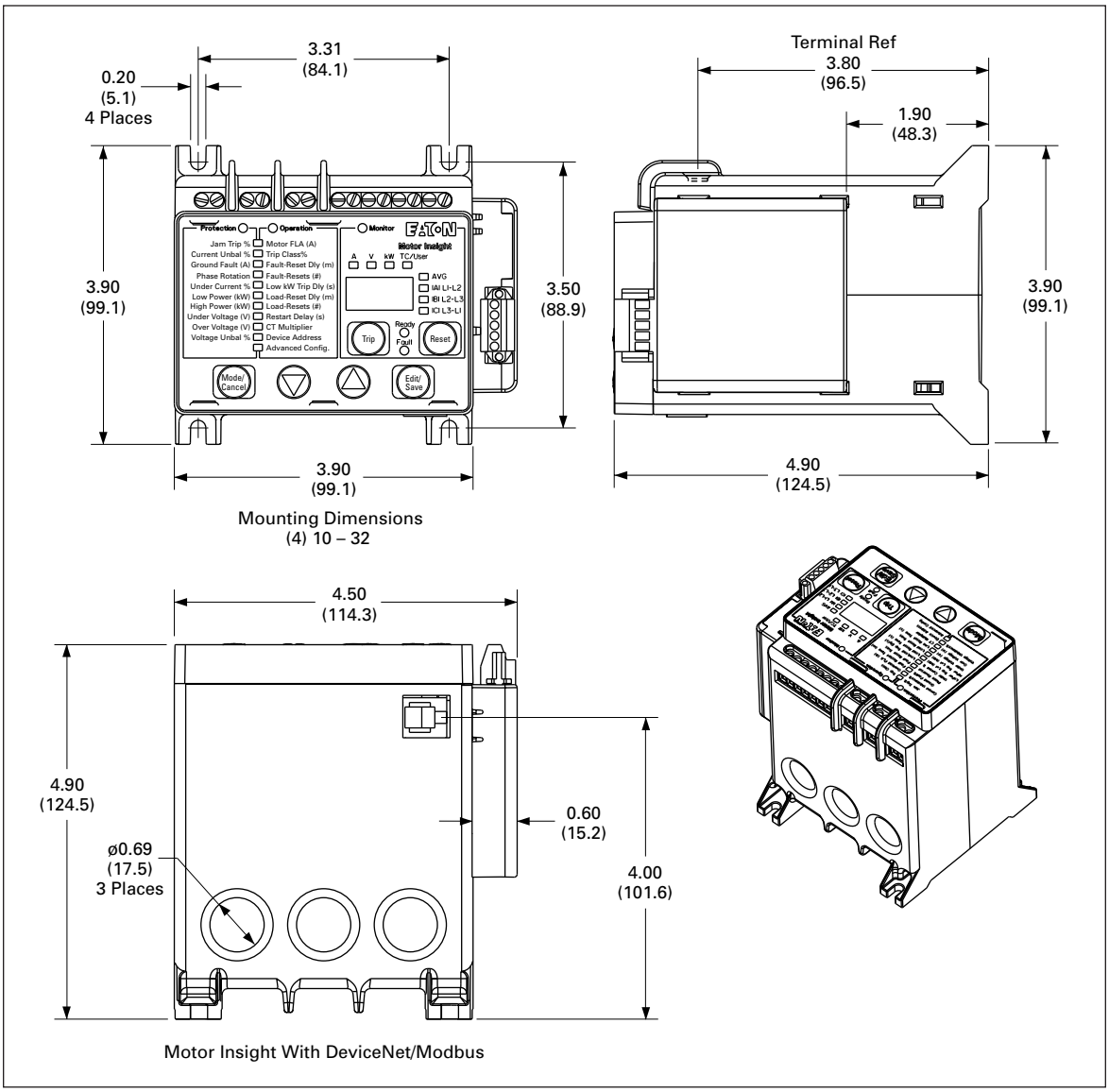


Figure 4-2: Motor Insight With DeviceNet™/Modbus® (B10-9113) Dimensions
Approximate Dimensions in Inches (mm)

4.1.2 - Required Mounting Hardware

Motor Insight can be mounted using #10 – 32 screws, standard #10 Lockwasher and Flat Washer. The required torque is 22 in-lb (2.5 Nm).

4.2 - Connections

Note: All wires must be sized according to applicable standards.

4.2.1 - Overview

The following connections are made to the Motor Insight base unit.

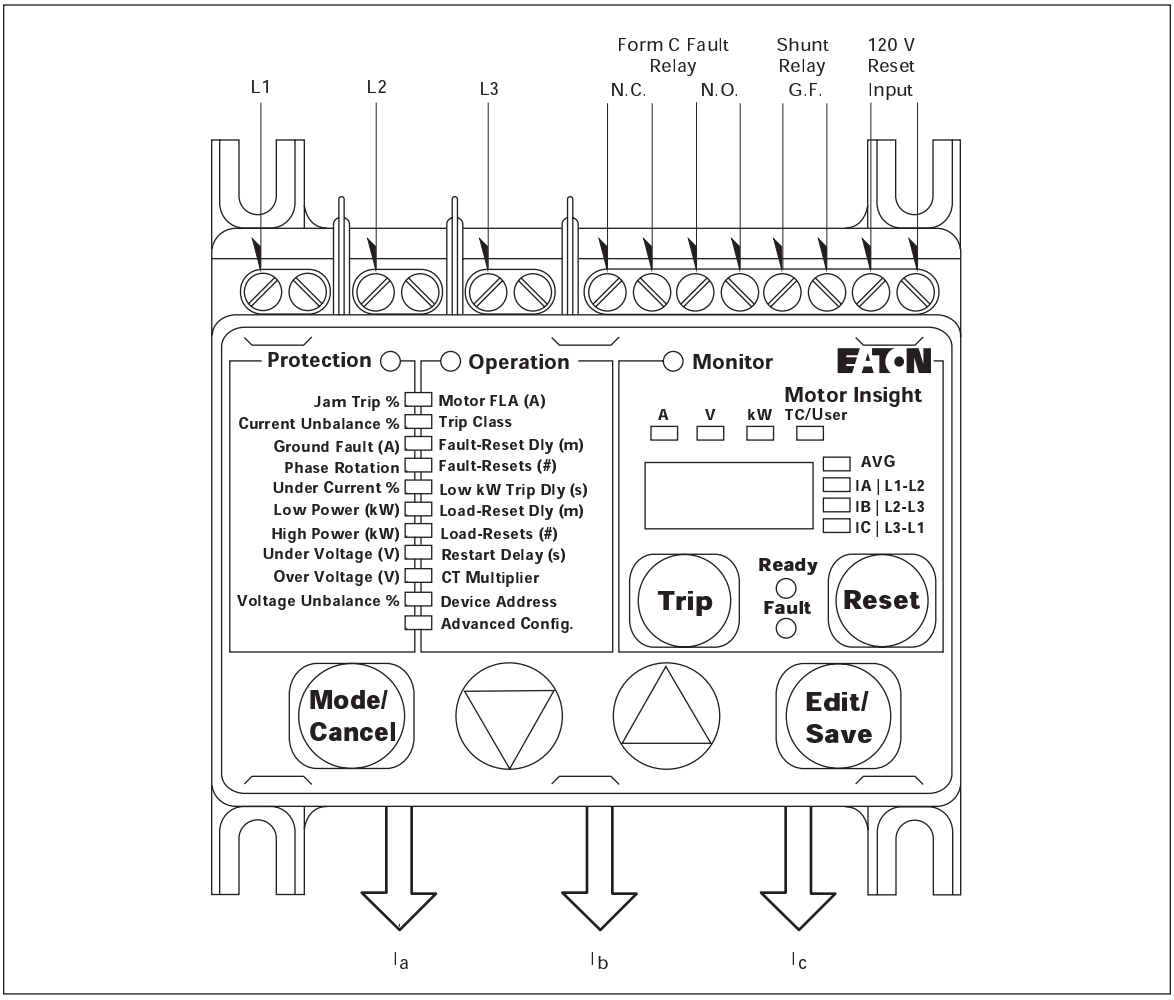


Figure 4-3: Motor Insight Base Connections

4.2.2 - Terminals

Terminal block wiring capacity and torque requirements are 18 – 12 AWG and 5.3 in-lb (0.6 Nm) respectively.

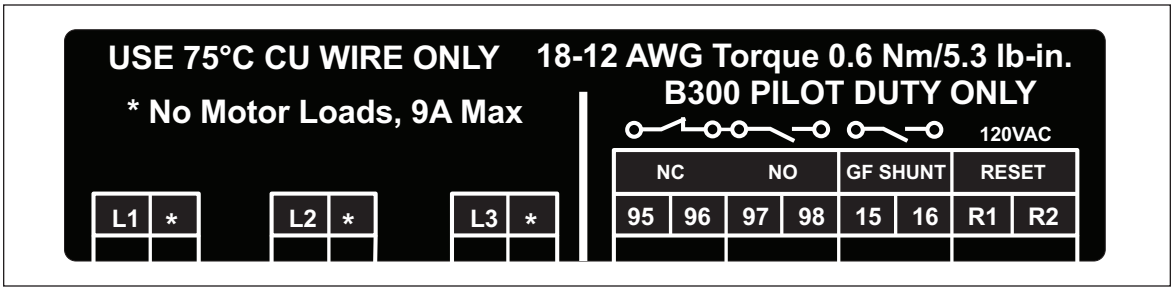


Figure 4-4: Terminal Block

Table 4-1: Terminal Block Connections

Name	Designation	Input	Description
Line Voltage	L1, L2, L3	Rated Voltage	Three-Phase Line Voltage Input: • L1, L2, L3 connections must correspond to the respective CT1, CT2, CT3 current leads. • * Terminal provided for wiring control power transformer (9 A max. capacity).
Overload State	95/96	UL 508 B300	Form 1C Contact: 95/96 Contact opens when the unit is faulted, or unpowered.
	96 & 97 (Common)		96 & 97 are common
	97/98		97/98 Contact closes when the unit is faulted or unpowered.
GF Shunt	15/16	UL 508 B300	Form A Contact: Contact closes when a ground fault is active.
Reset Input	R1/R2	120 Vac +10%/-15%	Fault Reset Input: IEC 61131-2 Type 1 digital input.

By factory default, Motor Insight is to be connected with ABC phase rotation on the incoming line voltage wiring. If the motor turns in the correct direction upon energization, but Motor Insight trips on a voltage phase reversal fault, change the setting of the phase rotation parameter as described in **Section 6.4.4.6.**

4.2.3 - Motor Power

Motor power connections are passed through Motor Insight. For power measurement accuracy, make sure to match Motor Power and Line Power connections as shown in Figure 4-3.

For use on low amperage applications, multiple wraps of the motor power conductors should be made according to **Section 2.5**.

For use on large amperage applications, pass the secondary of external CTs through the feed-through power conductor holes. Refer to **Section 2.5**.

4.2.4 - Typical Wiring Diagram

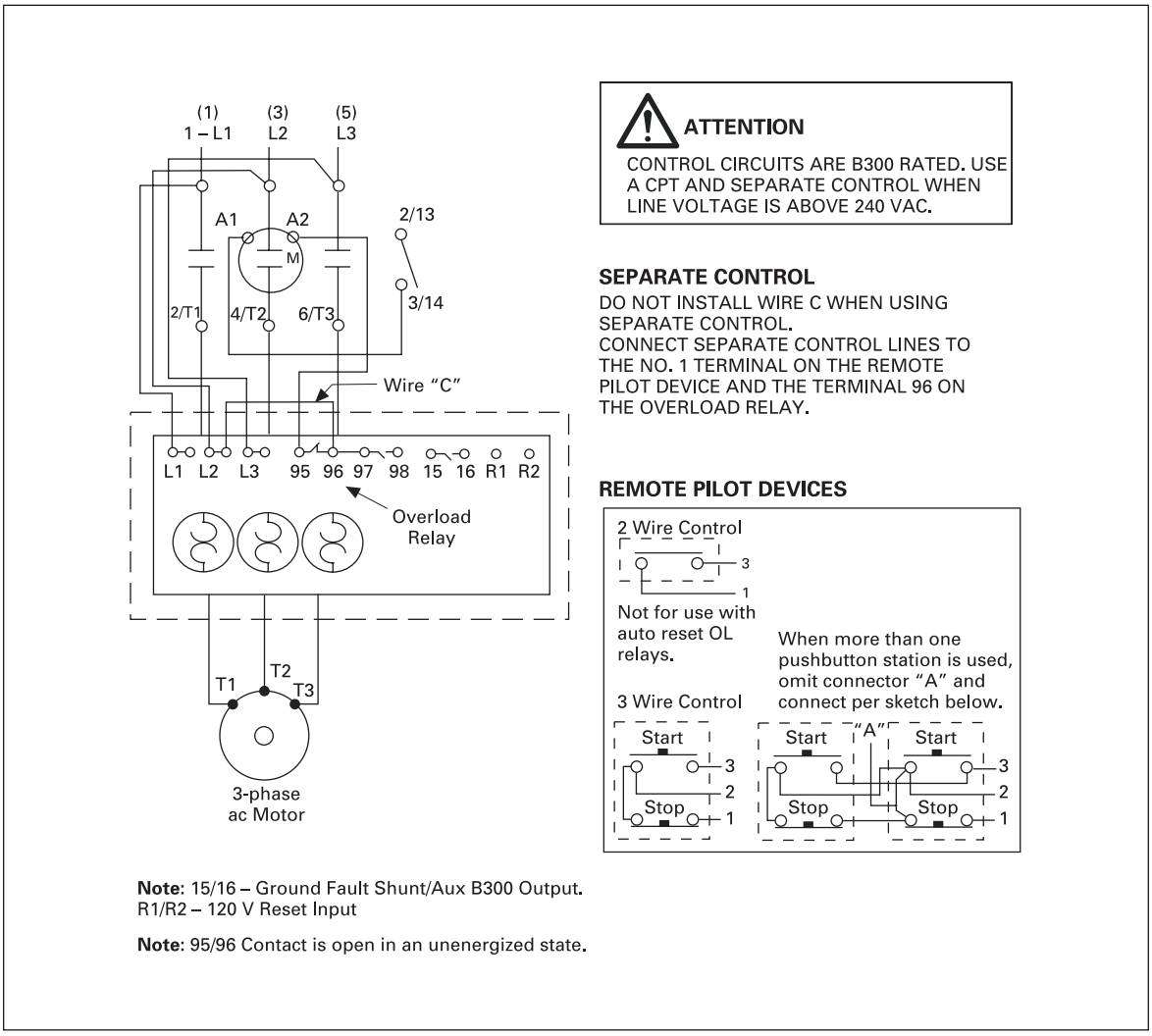


Figure 4-5: Typical Starter Application

Chapter 5 — User Interface (UI)

5.1 - Introduction

The Motor Insight has a wide range of set points to enable coordinated motor and load protection. Commonly used set points are directly accessible through the user interface; advanced configuration of the device must be performed through the Advanced Config operation or over the network.

The unit comes out of the box with default settings that accommodate general induction motor applications that provide very basic motor protection. The user should fine-tune the parameters to their application.

Note: The Motor FLA and CT Multiplier parameters must be configured for the intended application.

5.2 - Overview

The User Interface on the Motor Insight has been designed to allow intuitive configuration of typically used parameters without constant need for references to this manual.

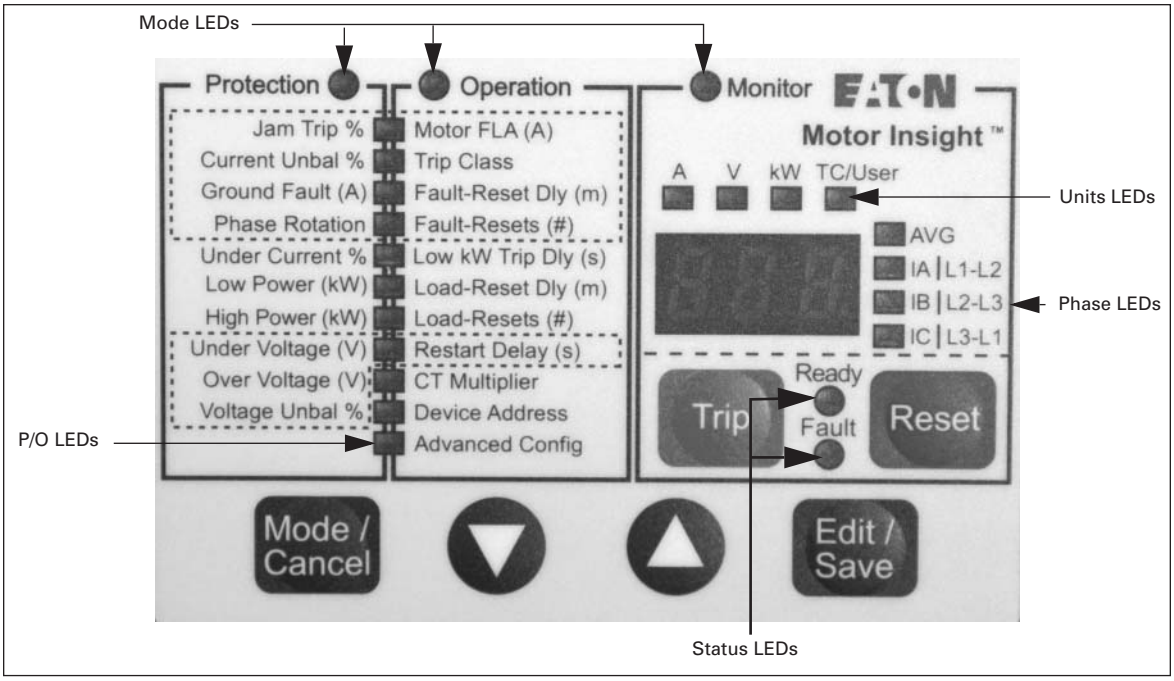


Figure 5-1: Overview of Interface LEDs

The following table describes the discrete components that make up the user interface.

Table 5-1: User Interface Components

Component	Interface	Description
Buttons	Mode	• Used to navigate the three operational modes (“Protection”, “Operation”, “Monitor”). • Pressing this button when editing a parameter exits the editing mode WITHOUT saving the new parameter value.
	Up (△)	• In “Protection” and “Operation” modes, this key is used to navigate up the P/O LED list. After the “Edit/Save” button is pressed in either of these modes, the up button is used to increment the parameter value. • In the “Monitor” mode, this button navigates up through the display parameter list.
	Down (▽)	• In “Protection” and “Operation” modes, this key is used to navigate down the P/O LED list. After the “Edit/Save” button is pressed in either of these modes, the up button is used to decrement the parameter value. • In the “Monitor” mode, this button navigates down through the display parameter list.
	Edit/Save	• In “Protection” and “Operation” modes, the first press of this button enables modification of the selected parameter value. The second press of the button saves the modified parameter value. • When the Advanced Config parameter is selected, the first press enables parameter selection. The second press enables editing of the parameter value. The third press saves the edited value. • This button has no effect in the “Monitor” mode.
	Trip	• Used as a relay test button. One press causes the Form C fault relay to open the N.O. and close the N.C. contact. Holding the button for 5 seconds causes the Ground Fault relay to go to close. • Once pressed, the unit will display the relay off message “rOF.” This setting will be retained through a power cycle.
	Reset	• Trip reset button — the active fault is cleared and the Motor Insight returns to the “Ready” state. Note that both the Fault and GF Shunt Relays are reset when this button is pressed.
	Mode and Trip	• When the Motor Insight is faulted, the fault history can be accessed by simultaneously pressing the Mode and Trip buttons.

Table 5-1: User Interface Components (Continued)

Component	Interface	Description
Discrete LEDs	Status	**Ready** **Fault** On Off — indicates that the Motor Insight is not tripped and "Ready" to run. Flash On — indicates that the device is tripped, but will attempt an auto-reset. Off On — indicates that the device is tripped and requires a manual reset.
	Mode	Indicates the active mode. Used in conjunction with the P/O LEDS to select a parameter for editing or to indicate the reason for trip.
	P/O	Indicates the selected Protection or Operation (P/O) parameter. Used in conjunction with the Mode LED to select a parameter for display/editing or to indicate the reason for trip.
	Units	Indicate the units of the displayed parameters. Used in conjunction with the Phase parameters to identify the displayed parameters. • A = amps • V = volts • kW = kilowatts • TC/User = By default the thermal capacity is shown, the user can also configure this parameter. See **Table 6-27**.
	Phase	Indicates the selected phase. Used in conjunction with the Unit LEDs to identify the display parameter. • AVG = average of all phases • IA | L1-L2 — phase A current or L1-L2 voltage • IB | L2-L3 — phase B current or L2-L3 voltage • IC | L3-L1 — phase C current or L3-L1 voltage
Display	Alphanumeric Display	3 digits, 7-segment alphanumeric display for numeric parameter display and editing (flashing) and fault codes.

Operation of the user interface is broken into three modes listed across the top of the device. Pressing the Mode Key enables mode navigation.

Table 5-2: Interface Mode Keys

Mode	Description
Protection	Used to set motor protection thresholds and/or disable protection parameters.
Operation	Used to set operational parameters, including auto reset modes.
Monitoring	Used to display run-time data parameters.

The Mode and P/O LED are used in conjunction to identify a selected parameter.

5.3 - Monitoring

5.3.1 - Values

In the monitoring mode, the **up-button** (△) and **down-button** (▽) are used to scroll through the parameters that are available for display. When the end of the parameter list is reached (from either direction), the next button press wraps to the beginning or end of the list. The following table describes the operation of the monitoring mode.

Table 5-3: Operation of the Monitoring Mode

Action	Display Parameter	Format (Example)	LEDs ON
Default	Average RMS Current	x.xx if Avg < 10 xx.x if Avg < 100 xxx if Avg ≥ 100	Mode – Monitor Units – A Phase – AVG Status – Ready
Down – (▽)	Phase A RMS Current	x.xx if Ia < 10 xx.x if Ia < 100 xxx if Ia ≥ 100	Mode – Monitor Units – A Phase – IA | LI-L2 Status – Ready
Down – (▽)	Phase B RMS Current	x.xx if Ib < 10 xx.x if Ib < 100 xxx if Ib ≥ 100	Mode – Monitor Units – A Phase – IB | L2-L3 Status – Ready
Down – (▽)	Phase C RMS Current	x.xx if Ic < 10 xx.x if Ic < 100 xxx if Ic ≥ 100	Mode – Monitor Units – A Phase – IC | L3-L1 Status – Ready
Down – (▽)	Average RMS Voltage	480	Mode – Monitor Units – V Phase – AVG Status – Ready
Down – (▽)	Phase A RMS Voltage	480	Mode – Monitor Units – V Phase – IA | LI-L2 Status – Ready
Down – (▽)	Phase B RMS Voltage	480	Mode – Monitor Units – V Phase – IB | L2-L3 Status – Ready
Down – (▽)	Phase C RMS Voltage	480	Mode – Monitor Units – V Phase – IC | L3-L1 Status – Ready
Down – (▽)	Total Motor Power (kW)	X.XX if kW < 10 XX.X if kW < 100 XXX if kW ≥ 100	Mode – Monitor Units – kW Phase – AVG Status – Ready
Down – (▽)	Motor Thermal Capacity/User Selected (see **Section 6.5**)	0 – 250	Mode – Monitor Units – TC Phase – None Status – Ready

5.3.2 - Display Messages

The following display messages may appear on the Motor Insight user interface to indicate status.

Message	Description
rOF	The relay has been turned off.
rSt	The Restart Delay is timing down. Caution — an auto-reset attempt is pending.
rEt	The number of auto-resets attempts has been exceeded. A manual reset is required.
ub	A voltage imbalance has been detected. This message will flash with the displayed parameter in the alarm-no-trip mode.
HI	A high voltage condition has been detected. This message will flash with the displayed parameter in the alarm-no-trip mode.
LO	A low voltage condition has been detected. This message will flash with the displayed parameter in the alarm-no-trip mode.
1PH	A voltage phase loss condition has been detected. This message will flash with the displayed parameter in the alarm-no-trip mode.
gnd	A ground fault condition has been detected. This message will flash with the displayed parameter in the alarm-no-trip mode.
OFF	The protection parameter is disabled.
999	The display parameter exceeds the display range.
F.XX	Fault Codes — see **Section 5.6**
E0X	Error Code — see **Section 5.6**

5.4 - Motor Protection/Basic Programming Set Points

Motor Insight is capable of advanced, intelligent motor protection. Programming the basic protection parameters can be accomplished directly through the user interface. More advanced control and protection parameters can be also programmed using the UI or over network communications.

Viewing and editing protection set points can be performed in the Protection and Operation Mode. The following diagram outlines the procedure for modifying any of the set points.

Note: The editing mode can be exited (without saving the parameter value) by pressing the Mode button.

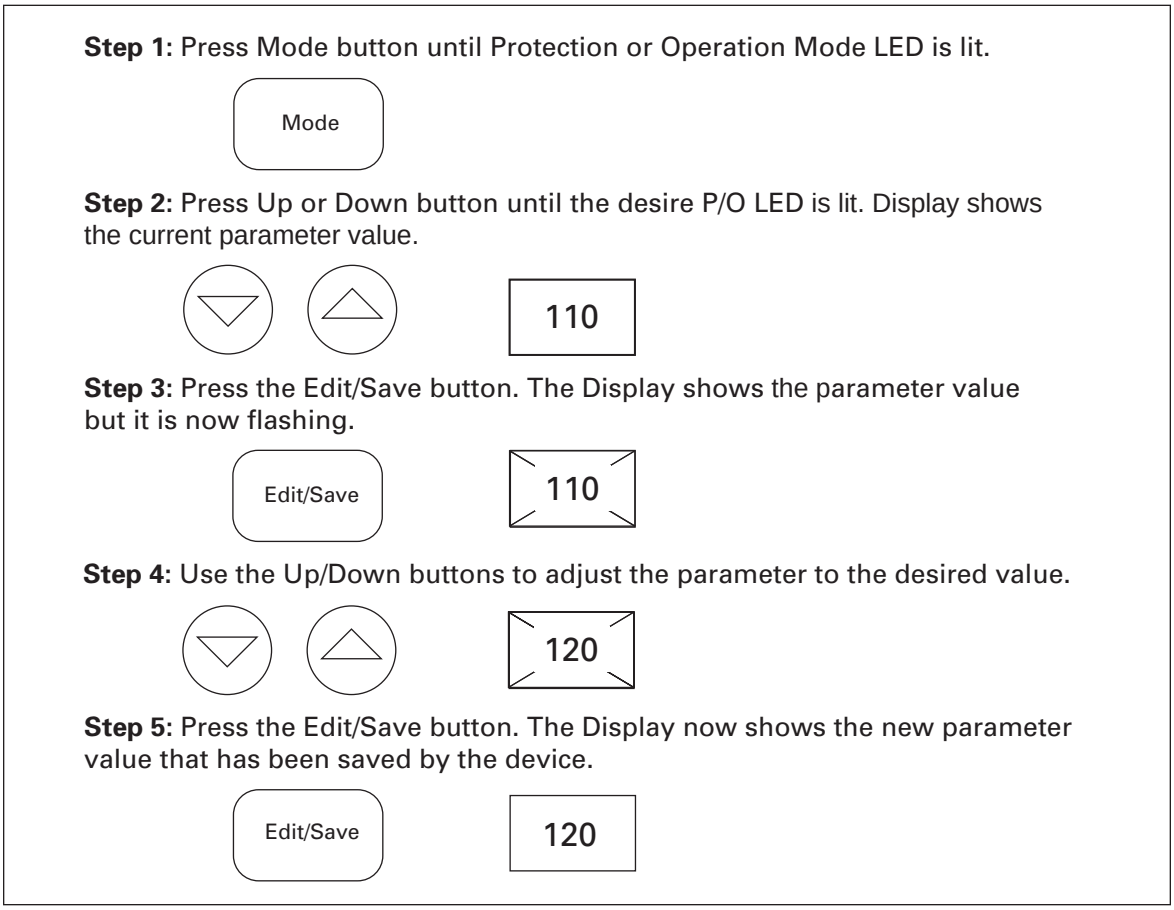


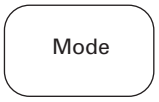
Figure 5-2: Motor Protection/Basic Programming Set Points

5.5 - Motor Protection/Advance Programming Set Points

The basic operation of Motor Insight is fully programmable through dedicated Protection and Operation LEDs (P/O LEDs). More advanced settings are available indirectly (through parameter codes) by selecting the Operation Mode and the Advanced Config Parameter. The following diagram outlines the procedure for editing the advanced set points of Motor Insight. See **Table 6-5** for a table of advanced parameters.

Note: The editing mode can be exited at any time (without saving the parameter value) using the Mode button.

Step 1: Press Mode button until Operation Mode LED is lit.



Step 2: Press Up or Down button until Advanced Param P/O LED is lit.
Display shows the current parameter code.

Step 3: Press the Edit/Save button. The Display now shows the parameter code but it is now flashing.

Step 4: Use the Up/Down buttons to select the desired parameter.

Step 5: Press the Edit/Save button. The Display now shows the parameter value corresponding to the selected parameter code. The value will be flashing as editing is enabled.

Step 6: Use the Up/Down buttons to select the desired parameter value.

Step 7: Press the Edit/Save button to store the new parameter value.

Figure 5-3: Motor Protection/Advance Programming Set Points

5.6 - Fault Display

5.6.1 - Fault Indication

The Motor Insight indicates most faults with a Fault Code and by illuminating the corresponding Mode and P/O LEDs. In addition, the dedicated Fault LED will be illuminated when the device is faulted.

⚠ WARNING

If the Motor Insight is faulted and the Ready LED is flashing, an auto-reset is pending. The motor may start unexpectedly at any time.

Fault	#	User Interface			Notes
		Mode LED	P/O LED	Display	
Number of Restarts Exceeded	1	Operation	Fault Reset Tries & Load Reset Tries	rEt	Could result from excessive motor or load faults
Remote Off	2	None	None	rOF	Relay turned off (network or UI)
Contactor Failure	3	Protection	Current Unbalance %	F.03	Voltage and current phase loss
Under Current	4	Protection	Under Current %	F.04	
Motor Overload	5	Operation	Trip Class	F.05	
Ground Fault	6	Protection	Ground Fault (A)	F.06	
Current Unbalance	7	Protection	Current Unbalance %	F.07	
Current Phase Loss	8	Protection	Current Unbalance %	F.08	
Reserved	9				
High Power (kW)	10	Protection	High Power (kW)	F.10	
Over Voltage	11	Protection	Over Voltage (V)	F.11	
Under Voltage	12	Protection	Under Voltage (V)	F.12	
Voltage Unbalance	13	Protection	Voltage Unbalance %	F.13	
Jam	14	Protection	Jam Trip %	F.14	
Low Power (kW)	15	Protection	Low Power (kW)	F.15	
Phase Rotation	16	Protection	Phase Rotation	F.16	
Device Memory Fault	17	None	None	F.17	Contact factory
Internal Comm Failure	18	None	None	F.18	Contact factory
Line Frequency Out-of-Range	24	None	None	F.24	Line voltage frequency must be within 47-63 Hz range
Calibration Error	27	None	None	F.27	Contact factory
Other	N/A	None	None	F.XX	Contact factory

5.6.2 - Fault History

Motor Insight stores the last 10 fault codes in a queue stored in non-volatile memory. This fault queue can be traversed using the following sequence of button presses.

Note: The Fault history can only be viewed when the device is in the tripped (or OFF) state.

Step 1: Simultaneously press the Mode and Trip buttons when the Fault LED is lit. The display shows the last fault code and illuminates the corresponding P/O LEDs to identify the fault.

Step 2: Press Down button to view older fault codes or the Up button to view more recent fault codes.

Step 3: Press the Mode or Trip button to exit the Fault History mode. The Display now shows the last fault and is not flashing. Pressing Reset will reset the device and exit the Fault History mode.

Figure 5-4: Fault History

5.6.3 - Error Codes

The following table describes error messages and codes that can be generated by the Motor Insight. If these error codes cannot be cleared by a reset or power cycle, contact the factory for service.

Error Code	Description
NC	Communication between the main microprocessor and user interface has been lost.
E01	The user interface clock has failed. The Motor Insight is still functional but performance will be degraded.
E02	A “stuck ON” switch has been detected by the Motor Insight.
E03	The user interface controller has detected an internal error.

5.7 - Locking the User Interface

The ability to modify set-point values from the user interface can be disabled by setting the User Interface Edit Lock parameter (P.02) to one in the Advanced Config parameter. See **Section 6.6** for more information.

Chapter 6 — Functional Description

⚠ WARNING

The Motor Insight may reset at any time enabling a motor start. When faulted (FAULT LED is ON) the READY LED will flash when an auto reset is pending.

Motor Insight monitors motor current and line voltage to provide advanced motor protection. The power and monitoring software contained in Motor Insight is the heart of the product. This software allows you to monitor a wide range of motor, load and line parameters. In this section, various features and protection options are described.

6.1 - Factory Defaults

The default settings for all parameters can be restored following **Table 6-27** or over network communications. See **Table 7-7**.

6.2 - Application Configuration

Application dependent parameters need to be configured so that the monitoring and protection functions can be effective.

Table 6-1: Application Parameters

Parameter	Set Point Range	Step	Default	Notes
CT Multiplier	2 – 9 Amp Model 1, 2, 150, 300, 600 20 – 90 Amp Model 1, 2, 3, 4	N/A	1	Settable from the UI — Mode P/O LED Operation CT Multiplier Modify this setting only if external CTs or multiple passes of motor leads are utilized to extent the current range of the Motor Insight.
Motor FLA	See **Tables 6-2** and **6-3**	.1A (C441_B) .01A (C441_A)	Minimum for Configuration	Settable from the UI — Mode P/O LED Operation Motor FLA
Trip Class	5 – 30	1	20	Settable from the UI — Mode P/O LED Operation Trip Class

For the 20 – 90 amp current range, the following wire wrap schedule lists the maximum number of wraps needed to retain accuracy of current measurements. Motor Insight is for use with contactors up to NEMA Size 5 using external CTs.

Table 6-2: 20 – 90 Amp Model

Motor FLA	Number of Loops	Number of Conductors Through CT Primary	CT Multiplier Setting Settable from Operator Interface
5 – 22.5	3	4	4
6.67 – 30	2	3	3
10 – 45	1	2	2
20 – 90	0	1	1

Table 6-3: 2 – 9 Amp Model

Motor FLA	Number of Loops	Number of Conductors Through CT Primary	CT Multiplier Setting
1 – 5	1	2	2
2 – 9	0	1	1
60 – 135	0	1	150 – (150:5)
120 – 270	0	1	300 – (300:5)
240 – 540	0	1	600 – (600:5)

6.2 - Motor Cycle Operation

Motor Insight monitors the motor during periods of normal operation (see **Figure 6-1**). Normal operation includes the start cycle, run cycle and stop cycle. In general, faults may occur at any time; however, the device will trip during the motor run cycle. For example, in some applications, a normal voltage dip that occurs during a motor start will not cause a trip if the dip is only present during the start cycle.

Note: The thermal overload and ground fault functions are active at all times.

6.2.1 - Start Cycle and Transition Timing

Figure 6-1 shows an example of how Motor Insight reacts to a normal operating-cycle current profile. Initially, the motor is stopped and the current is zero. As long as Motor Insight is not in a trip state, it will permit contactor energization by closing its trip contact in series with the contactor coil. Motor Insight declares a motor start when it measures motor current exceeding 30% of the FLA setting. A motor stop is declared when the current falls below 5% of FLA. Also, Motor Insight detects a transition point, detecting when the large starting currents have fallen below a transition level. The following parameters are defined that control the transition behavior.

Note: Motor Insight will transition to run based on time or current level, whichever comes first.

Table 6-4: Start Cycle and Transition Timing

Parameter	Set Point Range	Step	Default	Notes
Run Transition Percent	25 – 125%	1%	115%	Settable from the UI — Mode P/O LED Operation Advanced Config (P.17)
Run Transition Time	1 – 180 Seconds	1 Second	10 Seconds	Settable from the UI — Mode P/O LED Operation Advanced Config (P.18)

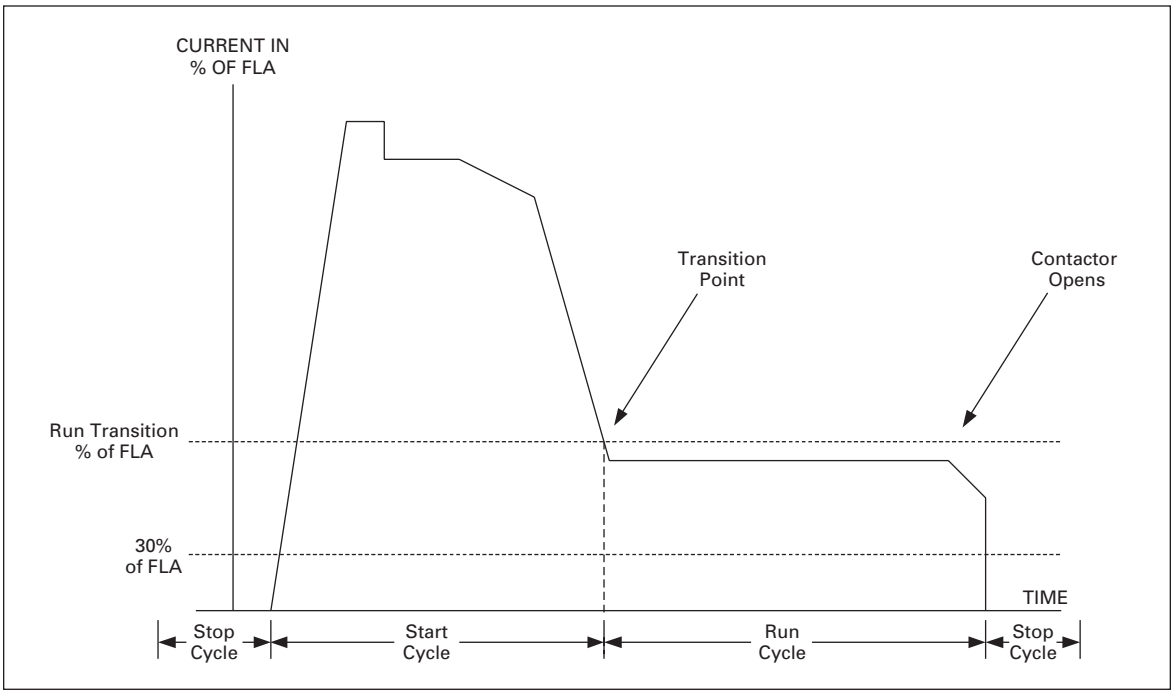


Figure 6-1: Transition Time Current Curve

6.3 - Thermal Overload

Motor Insight's overload function models the thermal characteristics of a motor and faults before motor damage will occur. Trip curves are defined by applicable agency standards. The trip class for any particular overload is adjustable. A thermal capacity value will be calculated to model the motor temperature.

The following items are associated with the electronic overload function of Motor Insight.

- An overload fault will occur when the calculated thermal capacity reaches 100%.
- An overload fault will not be cleared by power cycling the device — the thermal capacity is stored in the device's non-volatile memory.
- Two thermal cool-down models are used. One for cool-down while the coil is energized (motor is running) and a second while the coil is de-energized. The second model has a longer time constant.
- A manual reset button is located on the faceplate of the unit. Depressing this button will clear any overload fault that has been latched, but is no longer present (thermal capacity must be less than 100%). Resets can also be initiated through the communication port.
- An auto-reset option is included. In the auto-reset mode, the Motor Insight's overload will "automatically" reset when the fault has cleared.
- The device meets the "trip-free" requirements of UL 508 Paragraph 141.2.

6.3.1 - Trip Curves

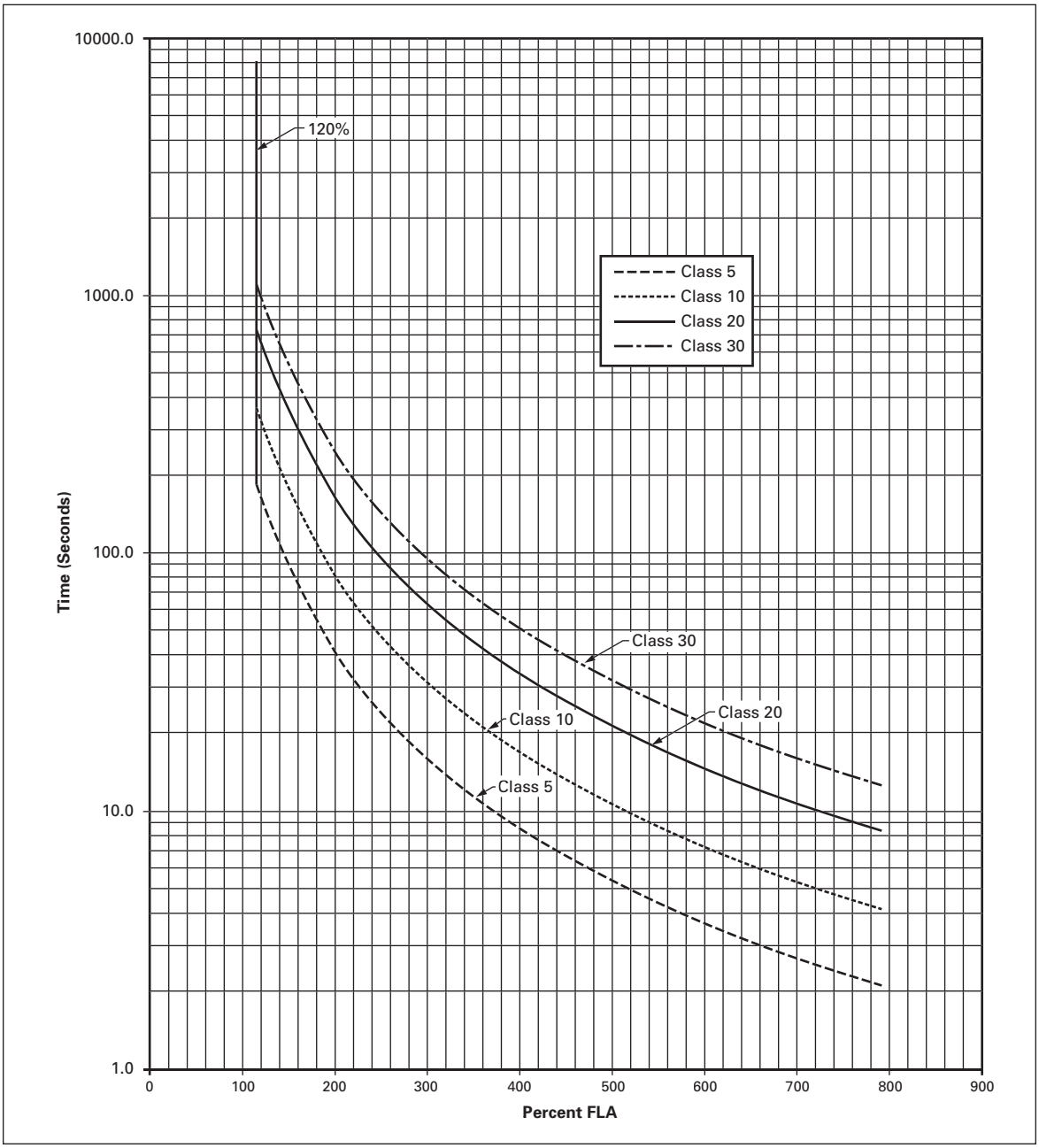


Figure 6-2: Overload Trip Curve

6.4 - Protection

6.4.1 - Overview

In general, motor protection features will be controlled by five user-settable parameters. The parameters are:

- Enable — trips can be turned on or off
- Trip/Pickup Level — Level of a measurement element that will begin the timing of the delay
- Trip Delay — Also known as pickup delays. These delays prevent momentary disturbances in the system from causing nuisance trips
- Auto Restart Inhibit Time — Time delay after a trip before the motor is allowed to auto-restart
- Number of Restarts Tries — Number of auto restarts

These parameters are settable on the user interface and/or accessible over the network interface.

Voltage and ground fault protection can be set to run in an **Alarm-no-trip mode**. In this mode, an alarm will be generated as soon as the fault is detected, however; no trip will occur.

On Motor Insight, the protection features are broken out into the following three categories. This enables advanced protection while minimizing the number of set point parameters. Each category has separate controls for auto reset enables, number of restart tries and restart inhibit delays as described in the following seconds.

- Motor protection
- Supply protection
- Load protection

6.4.2 - Protection Element Enable/Disable

All of the protection elements described can be enabled or disabled from either the user interface or the network.

When setting a protection parameter from the user interface, an OFF option is encountered at the top or bottom of the trip level parameter range. Select this option to disable the parameter. The OFF option is not available if the Alarm-no-trip mode is selected for a given parameter. When the OFF option is selected, the Motor Insight retains the last set-point value.

When using the network, use the TRIP ENABLE/DISABLE register. Setting a trip threshold out-of-range does not disable a parameter.

6.4.3 - Motor Protection

The motor protection features that are listed in this section monitor motor current (average, minimum, or maximum phase currents) to detect various motor running faults. These protections are disabled during a start. These protections are also disabled if the maximum phase current is less that 50% of the Motor FLA set point.

Note: For motor protection features to function appropriately, the motor FLA must be configured for the application.

6.4.3.1 - Motor Protection Auto Reset Operation

The following parameters are used in conjunction with the motor protection features.

Table 6-5: Motor Protection Features

Parameter	Set Point Range	Step	Default	Notes
Motor Fault Reset Time	2 – 500 Minutes	1 Minute	8 Minutes	Settable from the UI — Mode: Operation P/O LED: Fault Reset Dly (m) Reset is inhibited for this period of time to allow the motor to cool-down after a serious fault.
Motor Fault Reset Attempts	0, 1 – 4, A 0L.1 – 0L.4*, 0L.A	1	0 = Manual Mode	Settable from the UI — Mode: Operation P/O LED: Fault Resets (#) Auto reset number of attempts: 0 = Manual reset required. 1 – 4 = Attempt desired number of auto resets (semi-automatic mode). A = Automatic Reset Mode. The Fault Reset (#) will reset after the motor has been running for 15 minutes. *The OL. Prefix indicates that the setting applies to Overload trips only and not the other motor faults.

6.4.3.2 - Jam

Motor Insight monitors the average rms value of the three-phase currents. If the rms value rises above the threshold for the required length of time, a fault is detected and the unit will trip. The Jam settings will only be active during the Motor Running state. The Jam protection feature can be disabled by setting the Jam trip level to OFF on the UI or modifying the TRIP ENABLE/DISABLE register over the network. The following table describes the set points related to the Jam feature.

Table 6-6: Jam/Over Current

Parameter	Set Point Range	Step	Default	Notes
Jam Trip Pickup Level	150 – 400% of FLA, OFF	1%	400% of FLA	Settable from the UI — Mode: Protection P/O LED: Jam Trip %
Jam Trip Delay	1 – 20 Seconds	1 Second	2 Seconds	Settable from the UI — Mode: Operation P/O LED: Advanced Config (P.08)

6.4.3.3 - Current Unbalance

Current unbalance is defined using the following equation:

$$\% \text{ Current Unbalance} = 100 \times \left(\frac{\text{max. (Phase Irms)} - \text{min. (Phase Irms)}}{\text{avg. (Phase Irms)}} \right)$$

Motor Insight monitors the current unbalance. If the value exceeds the threshold for the required length of time, a fault is detected and the unit will trip. The current unbalance protection is enabled only in the Motor Running state. Setting the current unbalance trip level to OFF (UI) or modifying the TRIP ENABLE/DISABLE register will disable the current unbalance protection feature. The following table describes the set points related to the current unbalance feature.

Table 6-7: Current Unbalance

Parameter	Set Point Range	Step	Default	Notes
Current Unbalance Trip Pickup Level	1 – 30%, OFF	1%	15%	Settable from the UI — Mode P/O LED Protection Current Unbalance %
Current Unbalance Trip Delay	1 – 20 Seconds	1 Second	10 Seconds	Settable from the UI — Mode P/O LED Operation Advanced Config (P.09)

6.4.3.4 - Current Phase Loss

Motor Insight monitors the current unbalance percent for extreme values to detect a current phase loss condition. The current phase loss detection can only be disabled by modifying the TRIP ENABLE/DISABLE register over the communication network. The following table describes the set points related to the current phase loss feature.

Table 6-8: Current Phase Loss

Parameter	Set Point Range	Step	Default	Notes
Current Phase Loss Trip Pickup Level	60% Unbalance (Fixed)	N/A	N/A	The minimum phase current must also be less than 50% of the FLA setting.
Current Phase Loss Trip Delay	1 – 20 Seconds	1 Second	5 Seconds	Settable from the UI — Mode P/O LED Operation Advanced Config (P.10)

6.4.3.5 - Ground Fault

Motor Insight monitors the vector sum of the three-phase currents. If the rms value of the sum goes above the threshold for the required length of time, a fault is detected and the unit will trip. The ground fault protection will only be enabled in the Motor Running state. Setting the trip threshold to OFF or setting the TRIP ENABLE/DISABLE register will disable this protection feature.

Note: A ground fault cannot be auto reset — a manual reset is required.

The following table describes the set points related to the ground fault feature.

Table 6-9: Ground Fault

Parameter	Set Point Range	Step	Default	Notes
Ground Fault Trip Pickup Level	2 – 9 Amp Model 0.3 – 2.0 A (1 Pass)* 0.15 – 1.0 (2 Pass)* 9 – 60 (150:5 Ext) 18 – 120 (300:5 Ext) 36 – 240 (600:5 Ext) OFF 20 – 90 Amp Model 3 – 20 A (1 Pass)* 1.5 – 10 (2 Pass)* 1 – 6.66 (3 Pass)* 0.75 – 5 (4 Pass)* OFF	Range Dependent	2 – 9 Amp Model 1.00 A 20 – 90 Amp Model 10.0 A	Settable from the UI — Mode P/O LED Protection Ground Fault (A) *(Pass) is explained in detail in Tables 6-2 & 6-3
Ground Fault Trip Delay	1 – 60 Seconds	1 Second	30 Seconds	<150% of setting, 1 – 60 seconds ≥150% of setting, 2 seconds ≥250% of setting, 1 second Settable from the UI — Mode P/O LED Operation Advanced Config (P.11)
Ground Fault Alarm-No-Trip Mode	0, 1	1	0	0 = Alarm-No-Trip Disabled 1 = Alarm-No-Trip Enabled Settable from the UI — Mode P/O LED Operation Advanced Config (P.07)

6.4.4 - Supply Protection

Motor Insight monitors the supply voltage to the motor for the faults described below.

6.4.4.1 - Power-up Restart Delay

The Motor Insight can be configured to delay closing the fault relay on power-up using the following setting. This may be useful when multiple motors are brought on-line at the same time following a loss of power.

Table 6-10: Power-up Restart Delay

Parameter	Set Point Range	Step	Default	Notes
Power-up Restart Delay	0 – 500 Seconds	1	10	Settable from the UI — Mode P/O LED Operation Restart Delay(s)

6.4.4.2 - Alarm-no-Trip Operation

By default, Motor Insight supply faults are set in the alarm-no-trip mode; that is, when the motor is running, a fault condition will generate an alarm, but the device will not trip. LEDs and display on the user interface will indicate condition, but fault contacts 95 – 98 will not change state. In this mode, a start will be inhibited if the fault condition is present. Starts will be allowed as soon as the fault condition is cleared.

Note: Even though a fault code is displayed when a start is inhibited, the fault code is not entered into the fault queue.

When the alarm-no-trip mode is disabled, Motor Insight will trip if a voltage fault is detected when the motor is running. The fault relay will be automatically reset when the fault condition is cleared. In this mode, a start will be inhibited if the fault condition is present. Starts will be allowed as soon as the fault condition is cleared.

Table 6-11: Alarm-No-Trip Operation

Parameter	Set Point Range	Step	Default	Notes
Voltage Fault Alarm-No-Trip Mode	0, 1	1	1	0 = Alarm-No-Trip Disabled 1 = Alarm-No-Trip Enabled Mode — P/O LED Protection — Advanced Config (P.06)

6.4.4.3 - Undervoltage

Motor Insight monitors the minimum rms value of the three-phase voltages. If the rms value drops below the threshold for the required length of time, a fault is detected. The under-voltage protection feature can be disabled by setting the undervoltage trip level to OFF on the UI or by appropriately setting the TRIP ENABLE/DISABLE register. The following table describes the set points related to the undervoltage feature.

Table 6-12: Undervoltage

Parameter	Set Point Range	Step	Default	Notes
Undervoltage Trip Pickup Level	170 – 264 (240 Vac) 323 – 528 (480 Vac) 489 – 660 (600 Vac)	1 Volt	216 Volts 432 Volts 540 Volts	Settable from the UI — Mode — P/O LED Protection — Undervoltage
Undervoltage Trip Delay	1 – 20 Seconds	1 Second	10 Seconds	Settable from the UI — Mode — P/O LED Operation — Advanced Config (P.14)

6.4.4.4 - Overvoltage

Motor Insight monitors the maximum rms value of the three-phase voltages. If the rms value rises above the threshold for the required length of time, a fault is detected. The overvoltage protection can be disabled by setting the threshold to OFF or by appropriately setting the TRIP ENABLE/DISABLE register. The following table describes the set points related to the overvoltage feature.

Table 6-13: Overvoltage

Parameter	Set Point Range	Step	Default	Notes
Overvoltage Trip Pickup Level	170 – 264 (240 Vac) 323 – 528 (480 Vac) 489 – 660 (600 Vac)	1 Volt	264 Volts 528 Volts 632 Volts	Settable from the UI — Mode — P/O LED Protection — Overvoltage
Overvoltage Trip Delay	1 – 20 Seconds	1 Second	10 Seconds	Settable from the UI — Mode — P/O LED Operation — Advanced Config (P.15)

6.4.4.5 - Voltage Unbalance

Voltage unbalance is estimated using the following equation.

$$\% \text{ Voltage Unbalance} = 100 \times \left(\frac{\text{max. (Phase Vrms} - \text{min. (Phase Vrms)}}{\text{avg. (Phase Vrms)}} \right)$$

Motor Insight monitors the voltage unbalance. If the value exceeds the threshold for the required length of time, a fault is detected. The voltage unbalance protection will be enabled only in the Motor Running state. The following table describes the set points related to the voltage unbalance feature.

Table 6-14: Voltage Unbalance

Parameter	Set Point Range	Step	Default	Notes
Voltage Unbalance Trip Pickup Level	1 – 20%	1%	6%	Settable from the UI — Mode: Protection P/O LED: Voltage Unbalance %
Voltage Unbalance Trip Delay	1 – 20 Seconds	1 Second	10 Seconds	Settable from the UI — Mode: Operation P/O LED: Advanced Config (P.16)

6.4.4.6 - Phase Rotation

Motor Insight monitors for voltage phase sequence for a reversal in direction.

Table 6-15: Phase Rotation

Parameter	Set Point Range	Step	Default	Notes
Phase Rotation	OFF, 1, 2	1	1	Settable from the UI — Mode: Protection P/O LED: Phase Rotation The settings are mapped to the following: OFF = Ignore Sequencing — No Trip or Warning 1 = ABC 2 = ACB
Phase Rotation Trip Delay	N/A	N/A	1 Second	Not User Settable

6.4.5 - Load Protection

6.4.5.1 - Load Protection Auto Reset Operation

The following parameters are used in conjunction with the load protection features unless otherwise noted.

Table 6-16: Load Protection

Parameter	Set Point Range	Step	Default	Notes
Load Fault Reset Time	2 – 500 Minutes A (Auto)	1 Minute	20 Minutes	Settable from the UI — Mode: Operation P/O LED: Load Reset Dly (m) 2 – 500 minutes = An auto reset may be attempted the set number of minutes after a load fault. A = Auto load fault reset delay calculation mode (See Table 6-17)
Load Fault Reset Attempts	0 – 4, A (Auto)	1	1	Settable from the UI — Mode: Operation P/O LED: Load Reset Tries Auto restart number of attempts: 0 = Manual reset required. 1 – 4 = Attempt desired number of auto restarts (semi-automatic mode). A = Auto mode

Table 6-17: Run Time/Load Fault

Run Time	Load Fault Reset Time
Greater than or equal to 60 Minutes	6 Minutes
Greater than or equal to 30 Minutes	15 Minutes
Greater than or equal to 15 Minutes	30 Minutes
Less than 15 Minutes	60 Minutes

6.4.5.2 - Undercurrent

Motor Insight monitors the average rms value of the three-phase currents. If the rms value drops below the threshold for the required length of time, a fault is detected and the unit will trip. The following table describes the set points related to the undercurrent feature.

Table 6-18: Undercurrent

Parameter	Set Point Range	Step	Default	Notes
Undercurrent Trip Pickup Level	10 – 90% of Motor FLA,OFF	1%	50%	Settable from the UI — Mode P/O LED Protection Undercurrent %
Undercurrent Trip Delay	1 – 60 Seconds	1 Second	5 Seconds	Settable from the UI — Mode P/O LED Operation Advanced Config (P.13)

6.4.5.3 - Low Power

Motor Insight monitors the three-phase real power (kW). If the real power value drops below the threshold for the required length of time, a fault is detected and the unit will trip. This protection feature is only enabled in the Motor Running state. Trip thresholds depends on the motor FLA setting, rated voltage of the model and the CT Multiplier setting.

Table 6-19: Low Power

Parameter	Set Point Range	Step	Default	Notes
Low Power Trip Pickup Level	See **Tables 6-21** through **6-26**, OFF	—	Minimum Value for Range	Settable from the UI — Mode P/O LED Protection Low Power (kW)
Low Power Trip Delay	1 – 60 Seconds	1 Second	5 Seconds	Settable from the UI — Mode P/O LED Operation Low kW Trip Delay

6.4.5.4 - High Power

Motor Insight monitors the three-phase real power. If the real power value is estimated above the threshold for the required length of time, a fault is detected and the unit will trip. This protection feature is only enabled in the Motor Running state. Trip thresholds depends on the motor FLA setting, rated voltage of the model and the CT Multiplier setting.

Table 6-20: High Power

Parameter	Set Point Range	Step	Default	Notes
High Power Trip Pickup Level	See **Tables 6-21** through **6-26**	—	Maximum Value in Range	Settable from the UI — Mode: Protection P/O LED: High Power (kW)
High Power Trip Delay	1 – 60 Seconds	1	5	Settable from the UI — Mode: Operation P/O LED: Advanced Config (P.10)

6.5 - Power Tables

Table 6-21: C441BB — 240 Vac, 20 – 90 Amperes

CT Multiplier	Low Power Minimum (kW)	Low Power Maximum (kW)	High Power Minimum (kW)	High Power Maximum (kW)
1	1.6	28.7	4.0	39.4
2	0.8	14.3	2.0	19.7
3	0.5	9.6	1.3	13.1
4	0.4	7.2	1.0	9.9

Table 6-22: C441CB — 480 Vac, 20 – 90 Amperes

CT Multiplier	Low Power Minimum (kW)	Low Power Maximum (kW)	High Power Minimum (kW)	High Power Maximum (kW)
1	3.3	59.9	8.3	82.3
2	1.7	29.9	4.2	41.2
3	1.1	20.0	2.8	27.4
4	0.8	15.0	2.1	20.6

Table 6-23: C441DB — 600 Vac, 20 – 90 Amperes

CT Multiplier	Low Power Minimum (kW)	Low Power Maximum (kW)	High Power Minimum (kW)	High Power Maximum (kW)
1	4.0	71.7	10.0	98.6
2	2.0	35.9	5.0	49.3
3	1.3	23.9	3.3	32.9
4	1.0	17.9	2.5	24.6

Table 6-24: C441BA — 240 Vac, 2 – 9 Amperes

CT Multiplier	Low Power Minimum (kW)	Low Power Maximum (kW)	High Power Minimum (kW)	High Power Maximum (kW)
1	0.2	2.9	0.4	3.9
2	0.1	1.4	0.2	2.0
150 (:5)	4.8	43.0	12.0	59.2
300 (:5)	9.6	86.0	23.9	118.3
600 (:5)	19.1	172.1	47.8	236.6

Table 6-25: C441CA — 480 Vac, 2 – 9 Amperes

CT Multiplier	Low Power Minimum (kW)	Low Power Maximum (kW)	High Power Minimum (kW)	High Power Maximum (kW)
1	0.3	6.0	0.8	8.2
2	0.2	3.0	0.4	4.1
150 (:5)	10.0	89.8	24.9	123.5
300 (:5)	20.0	179.6	49.9	246.9
600 (:5)	39.9	359.2	99.8	493.8

Table 6-26: C441DA — 600 Vac, 2 – 9 Amperes

CT Multiplier	Low Power Minimum (kW)	Low Power Maximum (kW)	High Power Minimum (kW)	High Power Maximum (kW)
1	0.4	7.2	1.0	9.9
2	0.2	3.6	0.5	4.9
150 (:5)	12.0	107.6	29.9	147.9
300 (:5)	23.9	215.1	59.8	295.8
600 (:5)	47.8	430.2	119.5	591.6

6.6 - Advanced Parameters

The following table summarizes all advanced parameters.

Table 6-27: Advanced Parameters

Parameter Code	Parameter Description	Set Point Range	Default	Notes
P.00	Modbus Baud Rate	0 – 7	4	0 = 1,200 1 = 2,400 2 = 4,800 3 = 9,600 4 = 19,200 5 = 38,400 6 = 57,600 7 = 115,200
P.01	Modbus Parity	0 – 2	0	0 = Even (1 Stop Bit) 1 = Odd (1 Dtop Bit) 2 = No Parity (2 Stop Bits)

Table 6-27: Advanced Parameters (Continued)

Parameter Code	Parameter Description	Set Point Range	Default	Notes
P.02	User Interface Edit Lock	0 –1	0	0 = UI Editing Enabled (Unlocked) 1 = UI Editing Disabled (Locked) This is the only parameter that can be altered when the UI editing is locked.
P.03	User Display Parameter	0 – 6	0	Changes the value displayed in TC/USER LED in the monitoring menu 0 = Thermal Capacity (%) 1 = Power Factor (0.0 – 1.0) 2 = Voltage Unbalance % 3 = Current Unbalance % 4 = Ground Current 5 = Motor Run Hours 6 = Frequency
P.04	Comm Loss Behavior	1 – 2	1	1 = Fault On Comm Loss 2 = Hold Last State on a Comm Loss
P.05	Configuration Reset	0, 1, 2	N/A	0 = No Change 1 = Power Cycle 2 = Restore Factory Default Parameters
P.06	Voltage Trip Mode	0 – 1	1	0 = Trip On Fault (Each voltage fault can be individually enabled or disabled) 1 = Alarm-No-Trip
P.07	Ground Fault Trip Mode	0 – 1	0	0 = Trip On Fault 1 = Alarm-No-Trip
P.08	Jam Trip Delay	1 – 20 Seconds	2 Seconds	—
P.09	Current Unbalance Trip Delay	1 – 20 Seconds	10 Seconds	—
P.10	Current Phase Loss Trip Delay	1 – 20 Seconds	5 Seconds	—
P.11	Ground Fault Trip Delay	1 – 60 Seconds	30 Seconds	—
P.12	High Power Trip Delay	1 – 60 Seconds	5 Seconds	—
P.13	Undercurrent Trip Delay	1 – 60 Seconds	5 Seconds	—
P.14	Undervoltage Trip Delay	1 – 20 Seconds	10 Seconds	Trip delay is only used when alarm-no-trip mode is disabled. Alarm will be generated as soon as the fault is detected.
P.15	Overvoltage Trip Delay	1-20 Seconds	10 Seconds	Trip delay is only used when alarm-no-trip mode is disabled. Alarm will be generated as soon as the fault is detected.
P.16	Voltage Unbalance Trip Delay	1-20 Seconds	10 Seconds	Trip delay is only used when alarm-no-trip mode is disabled. Alarm will be generated as soon as the fault is detected.
P.17	Run Transition Level	25 – 125%	115%	See **Figure 6-1**
P.18	Run Transition Time	1 – 180 Seconds	10 Seconds	See **Figure 6-1**

Chapter 7 — Communication Module C441M

7.1 - Overview

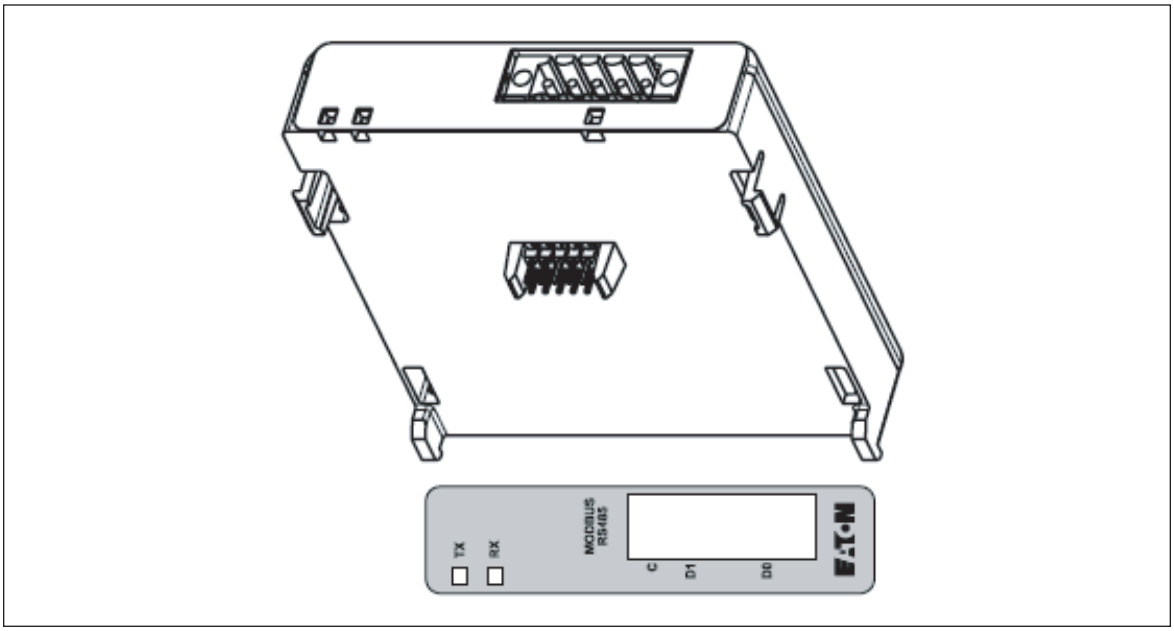


Figure 7-1: Dimensional Drawing

7.2 - Mounting

To mount the Modbus communication module to the Motor Insight base unit, first make sure power is disconnected from the base unit. Next, align the communication module with the base unit, using the 10-pin header as reference for the correct orientation. Hook the lower tabs (furthest from the 10-pin header) into the base unit, and then rotate the communication module into position until a click is heard.

7.3 - Quick Start

The following parameters configure the Modbus communication interface. Parameters may be set either with the user interface or through the Modbus port. For more information on setting the parameters via the user interface, please reference **Chapter 5**.

Table 7-1: Modbus Parameters

Modbus Parameter	UI Interface	Modbus Register	Default	Notes
Modbus Address	Operation Param	431	1	Must be unique and between 1 and 247.
Modbus Baud Rate	Advanced Param P.00	432	19.2k	Requires power cycle reset to take effect.
Modbus Parity	Advanced Param P.01	442	8,e,1	8 data bits, even parity, 1 stop bit. Requires power cycle reset to take effect.
Comm. Loss Behavior	Advanced Param P.04	441	1	Default is 1, for fault on comm. loss. ①
Comm. Loss Timeout	—	440	2000	2 seconds.
Configuration Reset	Advanced Param P.05	402	0, no reset asserted	Set to 1 to give power cycle reset (soft reset). Clears after reset.asserted.

① To enable comm. loss behavior, write 0X0088 to register 400.

Table 7-2: Parameters and Values

Parameter	Value
Mode	Slave mode only
Modbus Address/ Slave Address	1 – 247 (0 for broadcast) (1 is default)
Baud Rate	1200 baud to 115k baud (19,200 baud default)
Byte Characteristics	8-bit, Even parity (default), 1 Stop Bit (default) Options: 8-bit, no parity, 2 stop bits 8-bit, odd parity, 1 stop bit
Slave Response to Master	10 mS plus the time it takes to transmit response (when applicable)
Commands Supported	0x01 Read Coils 0x02 Read Discrete Inputs 0x03 Read Holding Registers 0x04 Read Input Register 0x05 Write Single Coil 0x06 Write Single Register 0x0F Write Multiple Coils (15) 0x10 Write Multiple Registers (16) 0x17 Read/Write Multiple Registers (23) 0x2B/0x0E Read Device Identification Get Device Identity (43/14) (see below for detail)
Protocol Supported	Modbus RTU
Electrical Signaling	RS-485 (ANSI/TIA/EIA-485), Two wire
Checksum	CRC 16-bit 0x8005 (or CRC-CCITT 0x1021)
Max. Data Signaling Error Accepted	2% in reception, 1% in transmission
Max. Number of Devices	32 (1 unit load per RS-485); Note: line polarization will reduce max. number of devices by 4.
LED Indication	Frame Reception (Rx) – Yellow Frame Transmission (Tx) – Yellow
Max. Cable Length	Dependent on baud rate, cable characteristics (gauge, capacitance or impedance), number of loads. 4000 ft. max. theoretical. See *MODBUS over Serial Line Specification and Implementation Guide* and EIA-485 for details.
Max. Number of Writes to Non-volatile Memory	Unlimited
Connector Style	Screw terminal (see below)
Network Topology	Two-Wire Modbus, Daisy-chain and/or repeater
Line Polarization	Not required. See *MODBUS over Serial Line Specification and Implementation Guide* and EIA-485 for more information.

References:

Modbus-IDA - *MODBUS over Serial Line Specification and Implementation Guide Specification and Implementation Guide*

Modbus-IDA - *MODBUS APPLICATION PROTOCOL SPECIFICATION*

ANSI/ TIA/ EIA-485-A-1998 *Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems*

7.4 - Modbus Field Wiring

Modbus field wiring is accomplished with a 5-pin, 3.5 mm pitch, removable screw terminal plug. Terminal block wiring capacity and torque requirements are 28-14 AWG and 2.25 in-lb (0.25 Nm) respectively.

Table 7-3: Field Wiring

Pin #	Circuit	EIA-485 Name	Recommended Wire Color ①	Description
1	Common	C/C'	Grey	Signal and optional power supply comm.
2	D1	B/B'	Yellow	Transceiver terminal 1, V1 Voltage, Data + (V1 > V0 for binary 1 [OFF] state)
3	N/C			No connection
4	DO	A/A'	Brown	Transceiver terminal 0, V0 Voltage, Data - (V0 > V1 for binary 0 [ON] state)
5	N/C			No connection

① Per figure 28, *MODBUS over Serial Line Specification and Implementation Guide Specification and Implementation Guide*.

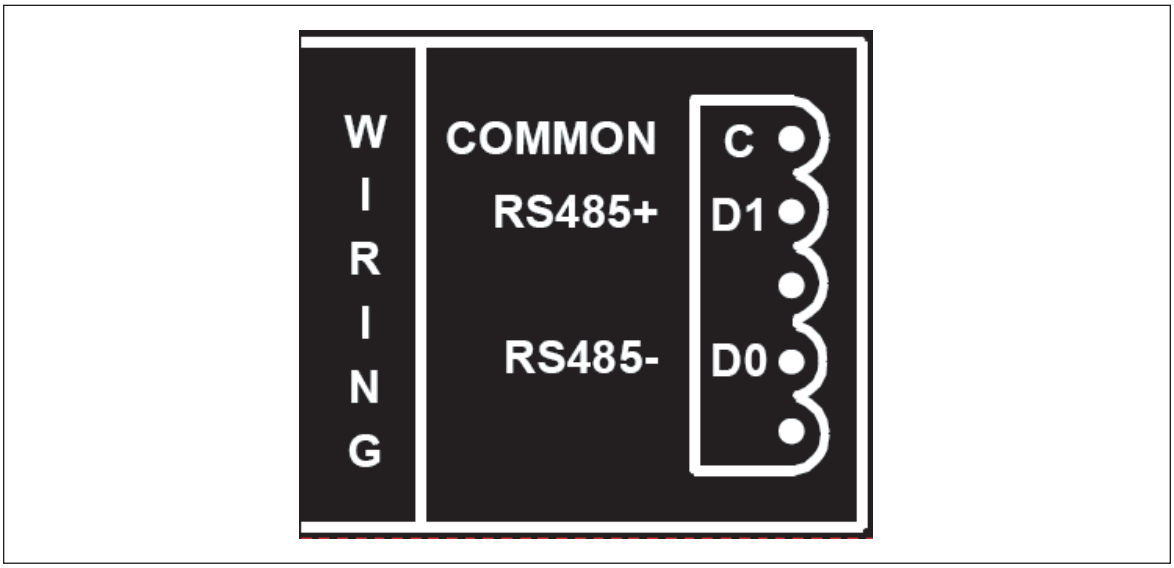


Figure 7-2: Terminal Drawing

Shielded cable must be used and one end of the shield must be connected to protective ground. Wire gauge must be chosen sufficiently large enough to permit the maximum length of 1,000 m. AWG 24 is always sufficient for Modbus data lines.

7.5 - Modbus Addressing

The default Modbus slave address is 1. Care must be taken to ensure that there are not two devices with the same address. In such a case, an abnormal behavior of the whole serial bus can occur. The Master may not be able to communicate with all present slaves on the bus. A change to the Modbus address will take effect immediately.

7.6 - Modbus Baud Rate and Parity

Baud rate and parity can be set through both the user interface and the Modbus port. The changes do not take effect until the next power cycle reset or soft reset, but they will be reported via their respective registers, or on the user interface. A soft reset can be requested by writing a 1 to the Configuration Reset Register 402.

For example, assume that the unit is configured to communicate at 19.2k. A read of register 432, Modbus Baud Rate Code, will return a “4” for 19.2k baud. If a subsequent write of “7” is made to register 432, to change the baud rate to 115.2k, the unit will return “7” when register 432 is read, but continue to communicate at 19.2k baud until either power cycle reset or soft reset is asserted. Once the unit receives either a power cycle reset, or a soft reset is asserted, the unit will communicate at 115.2k baud and will return “7” on reads to register 432. The same behaviors apply to the parity settings as well.

7.7 - 0x2B/0x0E Read Device Identification Get Device Identity (43/14) Details

Device ID Codes 1, 2 and 4 are implemented. Device ID code 3 (extended info) is not implemented.

Object IDs

0 VendorName

1 ProductCode

2 MajorMinorRevision

3 VendorURL

4 ProductName

5 ModelName

6 UserApplicationName

7.8 - Modbus Command Register (400)

Table 7-4: Command Codes

Command	Code (Hex)
Clear Motor Run Hours	66H
Delete Last Fault From Queue	77H
Comm Watch Dog Enable	88H
Comm Watch Dog Disable	99H
Fault Reset	AAH
Clear Motor Start Count	BBH
Force Ground Fault	CCH
Remote Off	DDH

Command register will clear after being written to.

7.9 - Configuration Reset Register (402)

Table 7-5: Reset Codes

Action	Reset Code
Power Cycle Reset	1
Factory Reset	2

7.10 - Range Checking

Many configuration parameters are range checked. When implemented, if value is greater than the maximum allowed value, the parameter is set to its maximum. Likewise, if a parameter is set to a value less than its minimum value, the parameter will be set to its minimum value. For function code 0x06, when the range checking causes a value to be different from what is requested to be written, the Modbus response to the 0x06 command returns the requested value, not what was actually written. A subsequent read of this parameter will return the actual value that it was set to.

7.11 - Comm Loss Timeout (Reg 440)

Default = 2 seconds

Comm Loss Timeout is the delay between loss of communication (between a comm. module and the base unit) and implemented the comm. loss behavior.

Range is **1 – 65 seconds**, in 1 millisecond increments. For example, to set the comm. loss timeout to 3 seconds, send 3000 to this register.

7.12 - Comm Loss Behavior (Reg 441)

Comm Loss Behavior determines what the device should do in the event that communication is lost. If the behavior is enabled, the behavior is implemented after an amount of time equal to the Comm Loss Timeout (Reg 440). Comm Loss Behavior is enabled by writing 88H (Comm Watch Dog Enable) to the Command Register (see Modbus Command Register). Comm Loss Behavior is disabled by writing 99H (Comm Watch Dog Disable) to the Command Register.

Table 7-6: Comm Loss Behavior

Behavior	Reset Code	Notes
Fault	1	Default, if enabled
Hold Last State	2	

7.13 - Modbus Register Map

Table 7-7: Modbus Register Map

Modbus Coil No.	Modbus Reg. No.	R/W ?	Parameter Name	Notes
	300	R	Phase A RMS Current	*See current scaling table (**7-8**)
	301	R	Phase B RMS Current	*See current scaling table (**7-8**)
	302	R	Phase C RMS Current	*See current scaling table (**7-8**)
	303	R	Average RMS Current	*See current scaling table (**7-8**)
	304	R	Phase A RMS Voltage (L1-L2)	Volts
	305	R	Phase B RMS Voltage (L2-L3)	Volts
	306	R	Phase C RMS Voltage (L3-L1)	Volts
	307	R	Average RMS Voltage	Volts
	308	R	Motor Power (kW)	kW x100
	309	R	Voltage Unbalance %	
	310	R	Current Unbalance %	
	311	R	Power Factor	Power Factor x100 (inductive 0 – 100)
	312	R	Ground Fault Current	Amps x100
	313	R	Frequency	Hz x100
	314	R	Motor Thermal Capacity (Thermal Overload)	Displayed in percentage — 0% cold motor, 100% will cause and overload trip (0 – 255)
	315	R	Fault Queue 1	The fault queue can be cleared using register 400
	316	R	Fault Queue 2	
	317	R	Fault Queue 3	
	318	R	Fault Queue 4	
	319	R	Fault Queue 5	
	320	R	Fault Queue 6	
	321	R	Fault Queue 7	
	322	R	Fault Queue 8	
	323	R	Fault Queue 9	
	324	R	Fault Queue 10	
	325	R	Supply Fault — Time To Restart	Seconds remaining
	326	R	Motor Fault — Time to Restart	Seconds remaining
	327	R	Load Fault — Time to Restart	Seconds remaining
	328	R/W	Motor Run Time	Hours — can be reset using register 400
	329	R	Start Count	Can be reset using register 400
	330	R	Trip Reason	
5265		R	Fault Lockout	0x0001 — Number of restarts attempts exceeded – manual reset is required
5266		R	Relay Off Command	0x0002 — Relay was turned off over network or through UI

Table 7-7: Modbus Register Map (Continued)

Modbus Coil No.	Modbus Reg. No.	R/W ?	Parameter Name	Notes
5267		R	Contactor Failure	0x0004 — Current phase loss without voltage phase loss
5268		R	Under Current	0x0008
5269		R	Overload	0x0010
5270		R	Ground Fault	0x0020
5271		R	Current Unbalance	0x0040
5272		R	Current Single-Phase	0x0080 — Current phase loss with voltage phase loss
5273		R	Reserved	Will report zero
5274		R	High Power (kW)	0x0200
5275		R	Over Voltage	0x0400
5276		R	Under Voltage	0x0800
5277		R	Voltage Unbalance	0x1000
5278		R	Over Current	0x2000
5279		R	Low Power (kW)	0x4000
5280		R	Phase Reversal	0x8000
	331	R	Over Load Status	
5281		R	Overload	0x0001 — Overload Tripped
5282		R	Ground Fault	0x0002 — Ground Fault Tripped
5283		R	High Power	0x0004 — High Power Tripped
5284		R	Reserved	
5285		R	Reserved	
5286		R	Reserved	
5287		R	Reserved	
5288		R	Running	0x0080 — Relay Status
	332	R	Error Status	Warning/Alarm Indications
5297		R	Low Voltage	0x0001
5298		R	High Voltage	0x0002
5299		R	Voltage Unbalance	0x0004
5300		R	Low Power	0x0010
5301		R	Reverse Phase	0x0020
5302		R	Current Unbalance	0x0040
5303		R	Voltage Single-Phase	0x0080
5304		R	Current Single-Phase	0x0100
5305		R	Ground Fault	0x0200
	333	R	Overload Firmware Version	
	334	R	UI Firmware Version	

Table 7-7: Modbus Register Map (Continued)

Modbus Coil No.	Modbus Reg. No.	R/W ?	Parameter Name	Notes
	335	R	Unit ID	Unit ID Cat No. 0x00BA (186) — C441BA 0x00BB (187) — C441BB 0x00CA (202) — C441CA 0x00CB (203) — C441CB 0x00DA (218) — C441DA 0x00DB (219) — C441DB
	400	R/W	Command Register	0x0066 — Clear Motor Run Hours 0x0077 — Clear Fault Queue 1 0x0078 — Clear Fault Queue 0x0088 — Network watchdog enable 0x0099 — Network watchdog disable 0x00AA — Reset Relay 0x00BB — Clear Motor Start Count 0x00CC — Force Ground Fault 0x00DD — Relay OFF **Note:** command register will clear after write
	401		Reserved	
	402	R/W	Configuration Reset	1 = Soft Reset (equivalent to a power cycle) 2 = Factory Reset **Note:** register will clear after write
	403	R/W	CT Multiplier	Cat No C441BB, C441CB, C441DB 1-4 Cat No C441BA, C441CA, C441DA 1, 2, 3 (150:5), 4 (300:5), 5 (600:5)
	404	R/W	Ground Fault Trip Pickup Level	Setting in Amps x 100 Cat No C441BB, C441CB, C441DB 3 – 20 A (CT Multiplier = 1) 1.5 – 10 (CT Multiplier = 2) 1 – 6.66 (CT Multiplier = 3) 0.75 – 5 (CT Multiplier = 4) Default setting is 10A Cat No C441BA, C441CA, C441DA 0.3 – 2.0 A (CT Multiplier = 1) 0.15 – 1.0 (CT Multiplier = 2) 9 – 60 (CT Multiplier = 3) 18 – 120 (CT Multiplier = 4) 36 – 240 (CT Multiplier = 5) Default setting is 1A Use Register 433 to enable/disable Use Register 421 to set trip delay
	405	R/W	Under Current Trip Pickup Level	10 – 90% (50%) of Motor FLA (register 407) Use Register 433 to enable/disable Use Register 422 to set trip delay

Table 7-7: Modbus Register Map (Continued)

Modbus Coil No.	Modbus Reg. No.	R/W ?	Parameter Name	Notes (Default)
	406	R/W	Low kW Trip Level	Setting is in kW x 100 See Section 6.5 for ranges. Default value is the minimum value in the range. Registers 407, Motor FLA, and 403, CT Multiplier, control the range of this parameter. Use Register 433 to enable/disable Use Register 423 to set trip delay
	407	R/W	Motor FLA	Setting is in Amps x 100 Cat No C441BB, C441CB, C441DB 5 – 22.5 Amps (CT Multiplier = 4) 6.67 – 30 Amps (CT Multiplier = 3) 10 – 45 Amps (CT Multiplier = 2) 20 – 90 Amps (CT Multiplier =1) Cat No C441BA, C441CA, C441DA 1 – 5 Amps (CT Multiplier = 2) 2 – 9 Amps (CT Multiplier = 1) 60 – 135 Amps (CT Multiplier = 3) 120 – 270 Amps (CT Multiplier = 4) 240 – 540 Amps (CT Multiplier = 5)
	408	R/W	Current Unbalance Trip Pickup Level	1 – 30% (15%) Use Register 433 to enable/disable Use Register 425 to set trip delay
	409	R/W	Trip Class	5 – 30
	410	R/W	Under Voltage Trip Pickup Level	170 – 264 V (216 V) CC441BA, C441BB 323 – 528 V (432 V) C441CA, C441CB 489 – 660 V (540 V) C441DA, C441DB Use Register 433 to enable/disable Use Register 426 to set trip delay Use Register 435 to configure supply fault alarm behavior
	411	R/W	Over Voltage Trip Pickup Level	170 – 264 V (264 V) C441BA, C441BB 323 – 528 V (528 V) C441CA, C441CB 489 – 660 V (540 V) C441DA, C441DB Use Register 433 to enable/disable Use Register 427 to set trip delay Use Register 435 to configure supply fault alarm behavior
	412	R/W	Voltage Unbalance Trip Pickup Level	1 – 20% (6%) Use Register 433 to enable/disable Use Register 428 to set trip delay Use Register 435 to configure supply fault alarm behavior
	413	R/W	Jam Trip Pickup Level	150 – 400% of Motor FLA (register 407) Use Register 433 to enable/disable Use Register 424 to set trip delay

Table 7-7: Modbus Register Map (Continued)

Modbus Coil No.	Modbus Reg. No.	R/W ?	Parameter Name	Notes
	414	R/W	High Power Trip Level	See Section 6.5 for ranges. Default value is the maximum value in the range. Registers 407 (Motor FLA) and 403 (CT Multiplier) control the range of this parameter. Use Register 433 to enable/disable Use Register 429 to set trip delay
	415	R/W	Phase Rotation	0 = Trip Disabled, 1 = ABC, 2 = ACB (1)
	416	R/W	Restart Delay	0 – 500 (10) Seconds
	417	R/W	Motor Fault Reset Delay	2 – 500 (8) Minutes See Register 434 for application to Overload Fault
	418	R/W	Load Fault Reset Delay	2 – 500 (20) Minutes See Register 443 to enable Automatic Load Fault Reset Delay calculator
	419	R/W	Load Fault Number of Reset Attempts	0 = Manual Mode, 1 – 4, 5 = Auto reset mode
	420	R/W	Motor Fault Number of Attempts	0 = Manual, 1 – 4, 5 = Auto reset mode See Register 434 for application to Overload Fault
	421	R/W	Ground Fault Trip Delay	1 – 60 (30) Seconds
	422	R/W	Under Current Trip Delay	1 – 60 (5) Seconds
	423	R/W	Low Power Trip Delay	1 – 60 (5) Seconds
	424	R/W	Jam Trip Delay	1 – 20 (2) Seconds
	425	R/W	Current Unbalance Trip Delay	1 – 20 (10) Seconds
	426	R/W	Under Voltage Trip Delay	1 – 20 (10) Seconds
	427	R/W	Over Voltage Trip Delay	1 – 20 (10) Seconds
	428	R/W	Voltage Unbalance Trip Delay	1 – 20 (10) Seconds
	429	R/W	High Power Trip Delay	1 – 60 (5) Seconds
	430	R/W	Current Phase Loss Trip Delay	1 – 20 (10) Seconds
	431	R/W	Modbus Address/ Slave Address	1 – 247 (1) Change takes effect immediately
	432	R/W	Modbus Baud Rate Code	0 = 1200 1 = 2400 2 = 4800 3 = 9600 4 = 19200 — default value 5 = 38400 6 = 57600 7 = 115200 8 = Reserved Change takes effect upon next power cycle reset. Unit will report “new” value immediately, before being implemented by a power cycle reset.
	433	R/W	Trip Enable/Disable	0 – 65535 (1815)
6913		R/W	Enable Ground Fault Trip	(1)

Table 7-7: Modbus Register Map (Continued)

Modbus Coil No.	Modbus Reg. No.	R/W ?	Parameter Name	Notes
6914		R/W	Enable Voltage Unbalance Trip	(1)
6915		R/W	Enable Current Unbalance Trip	(1)
6916		R/W	Enable Under Current Trip	(0)
6917		R/W	Enable Phase Loss Trip	(1)
6918		R/W	Enable Jam	(0)
6919		R/W	Enable Low Power Trip	(0)
6920		R/W	Enable High Power Trip	(0)
6921		R/W	Enable Over Voltage Trip	(1)
6922		R/W	Enable Under Voltage Trip	(1)
6923		R/W	Enable Phase Order Trip	(1)
	434	R/W	Overload Reset Mode	0 = manual reset mode — default 1 = apply register 417 and 420 to overload fault
	435	R/W	Voltage Trip Mode	0 = Trip on supply fault 1 = Alarm-no-trip (inhibit start) — default
	436	R/W	Ground Fault Trip Mode	0 = Trip on ground fault — default 1 = Alarm-no-trip
	437	R/W	Run Transition Percent (of FLA)	25 – 125% (see Section 6.2.1)
	438	R/W	Run Transition Time	1 – 180 seconds (see Section 6.2.1)
	439	R	Network Status	
7009		R/W	Watchdog enabled	0x0001
7010		R	Reserved	
7011		R	Front Panel Locked	0x0004
7012			Reserved	
7013			Reserved	
	440	R/W	Comm Loss Timeout	1 – 65,000 (2000) milliseconds
	441	R/W	Comm Loss Behavior	1 = Fault — default 2 = Hold Last State Use Register 400 to enable or disable the network watchdog
	442	R/W	Modbus Parity	0 = Even (1 stop bit) — default 1 = odd (1 stop bit), 2 = no parity (2 stop bits); Requires power cycle reset to take effect. Unit will report “new” value immediately, before being implemented by a power cycle reset.
	443	R/W	Load Fault Reset Delay Calculator	0 = disabled — default 1 = enabled (See Table 6-17)

Table 7-8: Current Scaling Table

Current Range	Catalog Number	Motor FLA	CT Multiplier Setting	Scaling
2 – 9 Amperes	**C441BA** **C441CA** **C441DA**	2 – 9 Amps 1 – 5 Amps 60 – 135 Amps 120 – 270 Amps 240 – 540 Amps	1 2 3 (150:5) 4 (300:5) 5 (600:5)	Amps x 100 Amps x 100 Amps x 10 Amps x 10 Amps x 10
20 – 90 Amperes	**C441BB** **C441CB** **C441DB**	20 – 90 Amps 10 – 45 Amps 6.67 – 30 Amps 5 – 22.5 Amps	1 2 3 4	Amps x 10 for all settings

Chapter 8 — DeviceNet Module

8.1 - Overview

The Motor Insight DeviceNet Modules provide DeviceNet communication to the Motor Insight overload and monitoring relay. The DeviceNet module with 24VIO (C441L) and the DeviceNet module with 120VIO (C441K) provide four inputs and two B300 relay outputs.

Conformance

The Motor Insight DeviceNet adapter will conform to the ODVA DeviceNet and CIP specification.

The Motor Insight DeviceNet adapter only supports a single bi-color green/red Module/ Network status LED.

Table 8-1: Indicator LEDS

Usage	
Module/Network status	
Off	Device is not online. - The device has not completed the Dup_MAC_ID test yet. - The device may not be powered.
Flashing Green	The device is operating in a normal condition and the device is online with no connections in the established state. - The device has passed the Dup_MAC_ID test, is online, but has not established connections to other nodes. - The device is not allocated to a master.
Green	The device is operating in a normal condition and the device is online with connections in the established state. - The device is allocated to a master.
Flashing Red	Any one or more of the following conditions: - Recoverable fault - One or more I/O Connections are in the Timed-Out state - No network power present
Solid Red	The device has an unrecoverable fault; may need replacing. Failed communication device. The device has detected an error that has rendered it incapable of communicating on the network (Duplicate MAC ID, or Bus-off)

Assemblies

I/O Assemblies

There are multiple input and output assemblies available for use to suit the need of specific users. The assemblies to be active are user selectable via the vendor-specific DeviceNet interface object (0x94).

Status Assembly

The production of a status assembly will be triggered by the receipt of a status trigger. The trigger contains no data.

Configuration By Software Tool

The Motor Insight DeviceNet adapter will be configurable by CH Studio and any other tool that does explicit messaging based on the provided EDS file.

The DeviceNet Module includes the following significant features:

- Control and monitoring of the Motor Insight
- No special software application required for normal setup. MAC ID and baud rate are set with DIP switches
- Four isolated or unisolated 24 Vdc inputs or four isolated 120 Vac inputs
- Two B300 relay outputs controllable from DeviceNet

Table 8-2: Environmental Ratings of the Module

Description		Rating
Transportation and Storage	Temperature	-50°C – 80°C (-58°F – 176°F)
	Humidity	5 – 95% non-condensing
Operating	Temperature	-40°C – 55°C (-40°F – 131°F)
	Humidity	5 – 95% non-condensing
	Altitude	Above 2000 meters (6600 feet), consult factory
	Shock IEC 60068-2-27	15G any direction for 11 milliseconds
	Vibration IEC 60068-2-6	5 – 150 Hz, 5G, 0.7 mm maximum peak-to-peak
	Pollution Degree	2

Table 8-3: Approvals/Certifications

Electrical/EMC	Rating
ESD Immunity (IEC61000-4-2)	+/- 8 kV Air, +/- 4 kV contact
Radiated Immunity (IEC61000-4-3)	10 V/m 80 – 1000 MHz, 80% amplitude modulation @ 1 kHz
Fast Transient (IEC61000-4-4)	+/- 1 kV communications
Surge (IEC61000-4-5)	+/- 1 kV shield-to-ground
RF Conducted (IEC61000-4-6)	10 V, 0.15 – 80 MHz
Ingress Protection Code	IP20
Radiated and Conducted Emissions	EN55011 Class A
Agency Certifications	UL® 508
	cUL® (CSAT C22.2 No. 14)
	CE (Low Voltage Directive)
	DeviceNet Conformance Tested

Table 8-4: Module Electrical Requirements

Description	Requirement
Voltage Range	18 – 30 Vdc
Current Draw	Approx. 18 mA

Table 8-5: Product Selection

Description	Catalog Number
Motor Insight DeviceNet Module with 24 Vdc Inputs and 120 Vac/24 Vdc Relay Outputs	C441L
Motor Insight DeviceNet Module with 120 Vac Inputs and 120 Vac/24 Vdc Relay Outputs	C441K

Physical Description and Dimensions

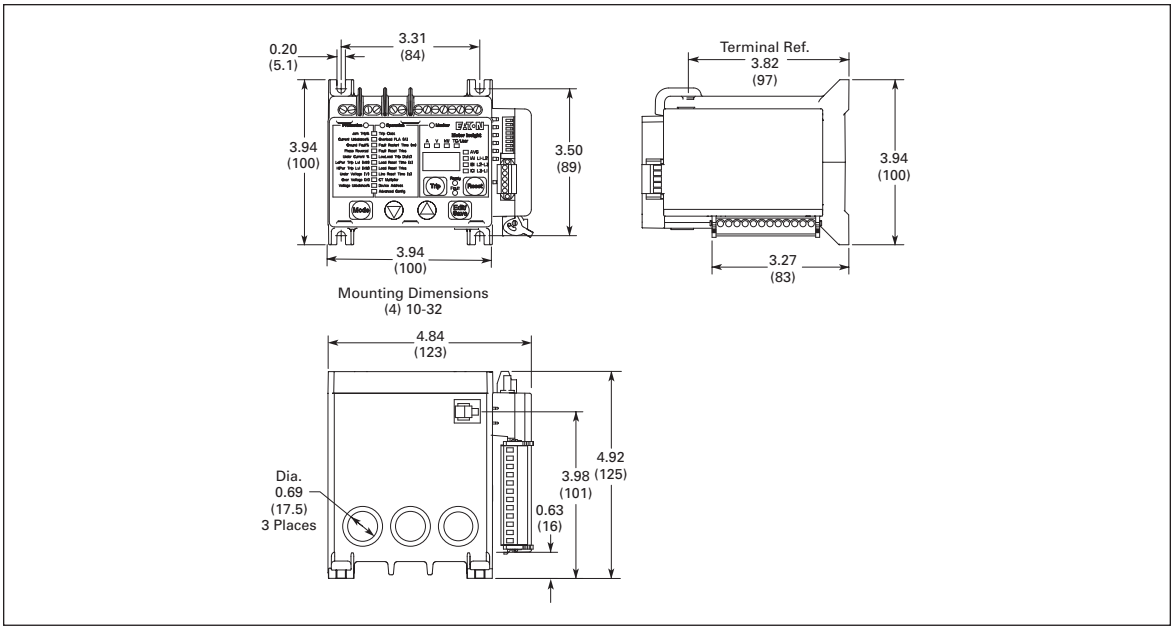


Figure 8-1: DeviceNet Module

Power Source

The Motor Insight DeviceNet Module is powered off the 24 Vdc DeviceNet subnet. The Motor Insight base unit is powered by the system line voltage. The DeviceNet communication module does not power the Motor Insight base unit and therefore will remain active when the line voltage is disconnected.

This device is for use with an Eaton UL Listed Power Supply, Catalog Nos. PSS55A, PSS55B, PSS55C, or PS160E.

Note: Any UL Listed power supply with an isolated 30 Vdc voltage output may be used, provided that a UL Listed or Recognized Fuse rated no more than 4 A. maximum be installed.

Power Requirements

18 mA steady state at 24 Vdc.

⚠ WARNING

Only apply 24V dc to the Motor Insight Communication module fieldbus connection. Use of any other voltage may result in personal injury, property damage and damage to the module.

8.2 - Mounting

Attachment instructions

The Motor Insight DeviceNet modules are designed to be installed on the right side of the Motor Insight base unit.

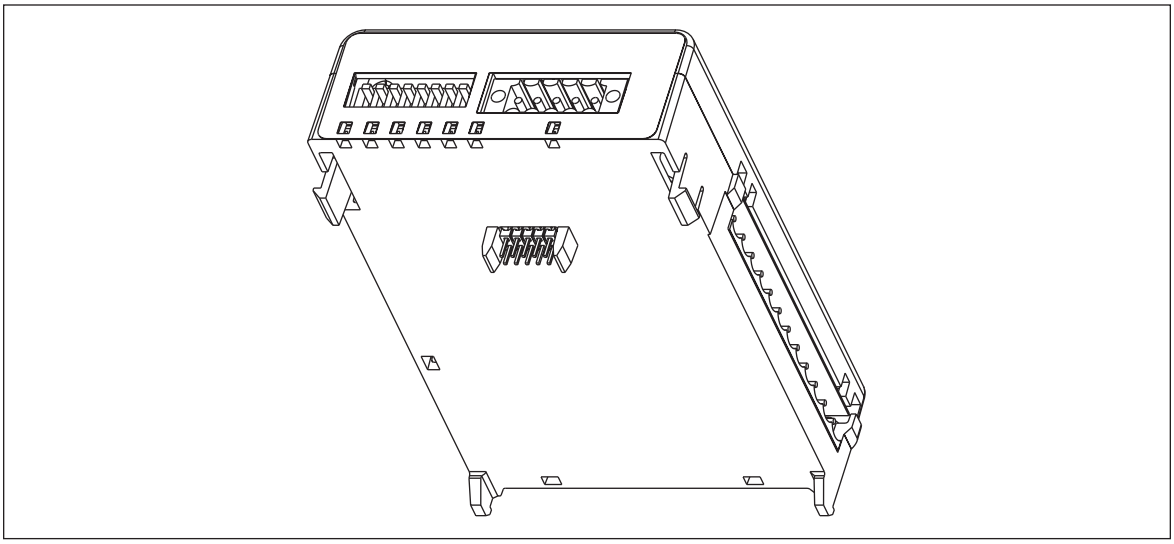


Figure 8-2: Installation Diagram

1. Align module with side of Motor Insight base unit.
2. Slide module bottom pegs into appropriate slots.
3. Rotate module up and gently click the base unit and module together.
4. Connect DeviceNet cable and IO connector if desired.

8.3 - Input Behavior

Each terminal of the field connection accepts two wires of the following size:

Table 8-6: Field Terminal Wire Capability

Wire Type	Wire Size	Terminal Torque
Solid Cu – 90C	#14 – #22	4.5 in-lbs
Stranded Cu – 90C	#16 – #22	4.5 in-lbs

120 Vac Input Requirements

The 120 Vac input is an isolated input. It requires an external AC supply to drive the inputs. There are three common tie points provided for the four inputs.

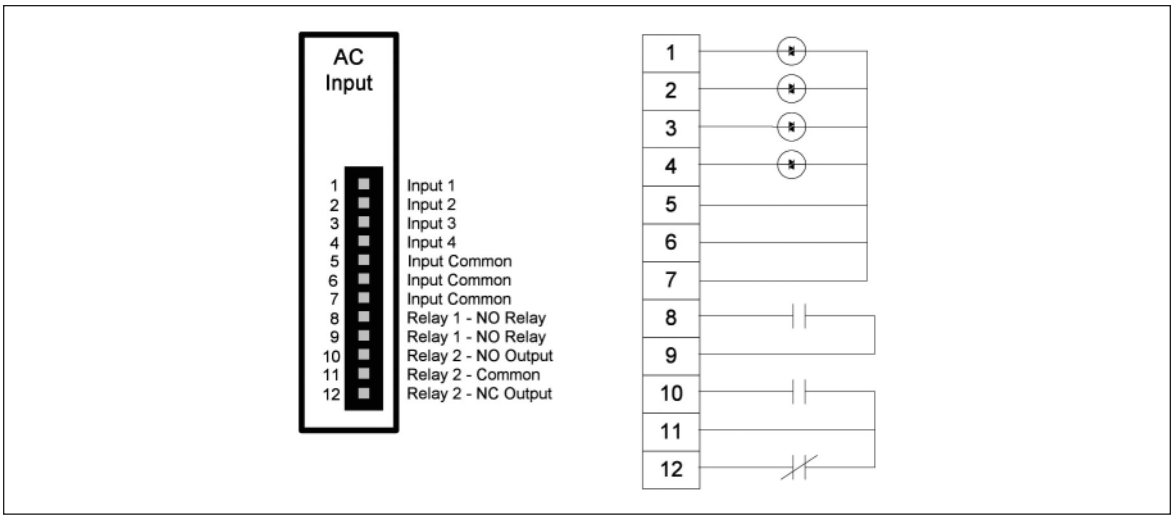


Figure 8-3: 120 Vac Input Diagram

Table 8-7: 120 Vac Input Specification

Specification	Value
Number of Inputs	4
Nominal Voltage	120 Vac
Nominal Current	7mA
Operating Range	80-140 Vac
Operating Frequency	50/60 Hz
Signal Delay Max	30 ms
Input Type	IEC 61131-2, type 1 digital

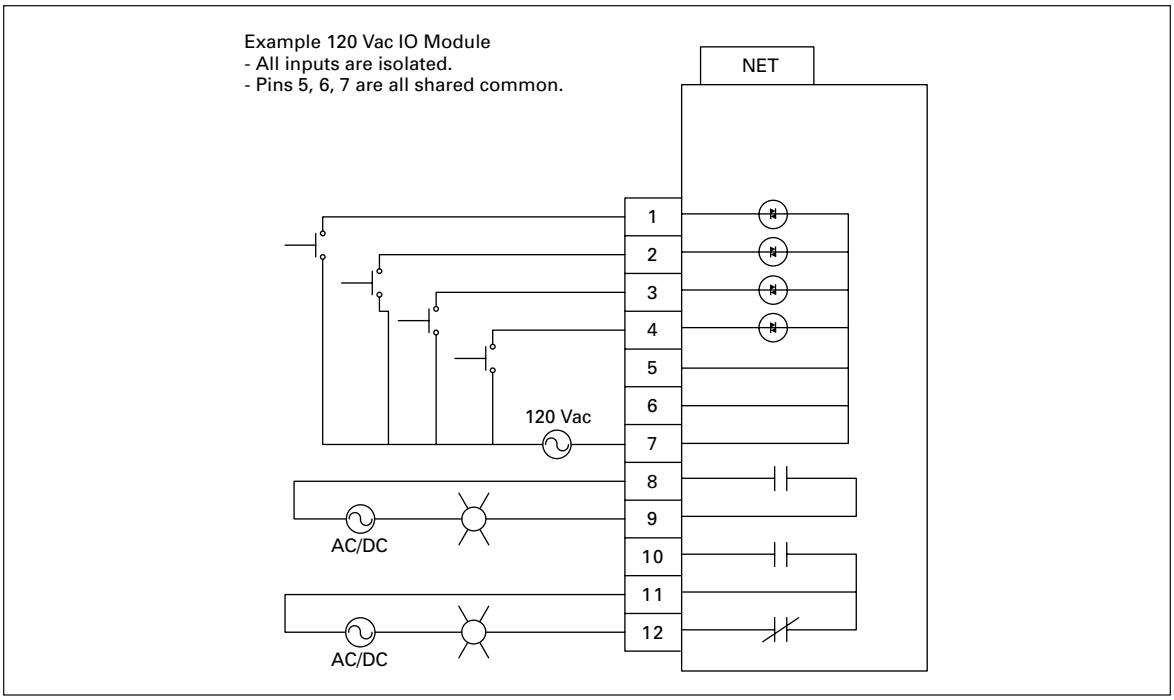


Figure 8-4: 120 Vac IO Module

24 Vdc Input Requirements

The 24 Vdc input circuit is capable of both isolated and unisolated behavior. The isolated inputs share a single common tie point. A 24 Vdc current limited source/ground is provided in situations that require locally supplied input signal voltage. To use the unisolated inputs tie the 24 Vdc ground/common to the isolated common.

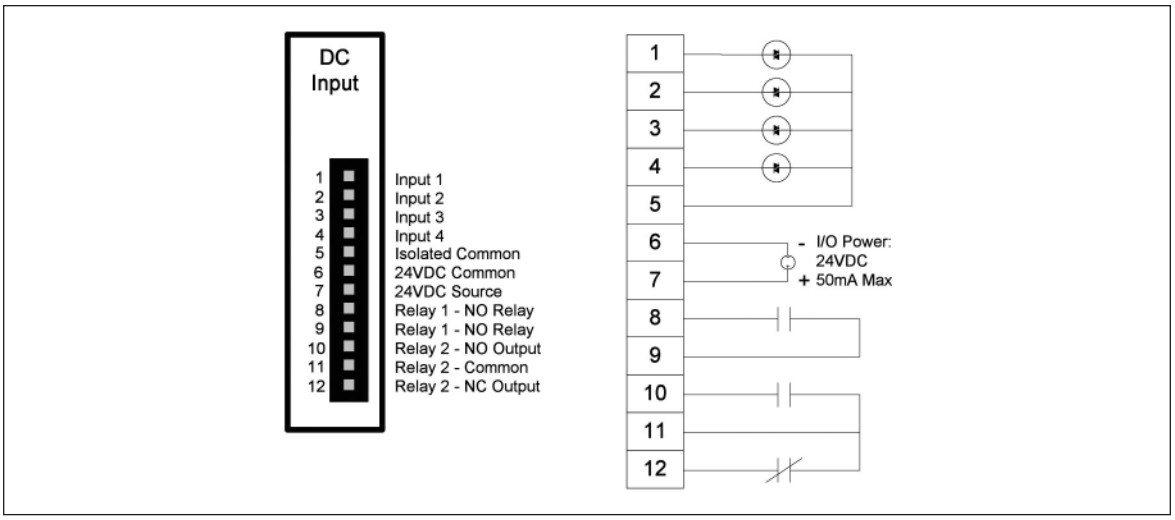


Figure 8-5: 24 Vdc Input Internal Circuit Diagram

Note: Do not connect a 24 Vdc source to pins 6 and 7. The "I/O Power: 24 Vdc" is to be used only in conjunction with the inputs. It is a 24 Vdc output intended to only supply signal power for the inputs. When using the 24 Vdc input supply, Pin 6 should only be connected to Pin 5 (24 Vdc input supply common to input common). See example wiring diagrams **Figures 8-5** and **8-6**. Any device using the provided 24 Vdc input supply must have 500 V isolation from ground. Example devices include pushbuttons and auxiliary contacts.

Table 8-8: 24 Vdc Input Specification

Specification	Value
Number of Inputs	4
Nominal Voltage	24 Vdc
Nominal Current	5 mA
Type	Current sinking
Input Type	IEC 61131-2, type 1 digital
Max 24 Vdc Source Current	50 mA
Isolation Voltage	250 Vac

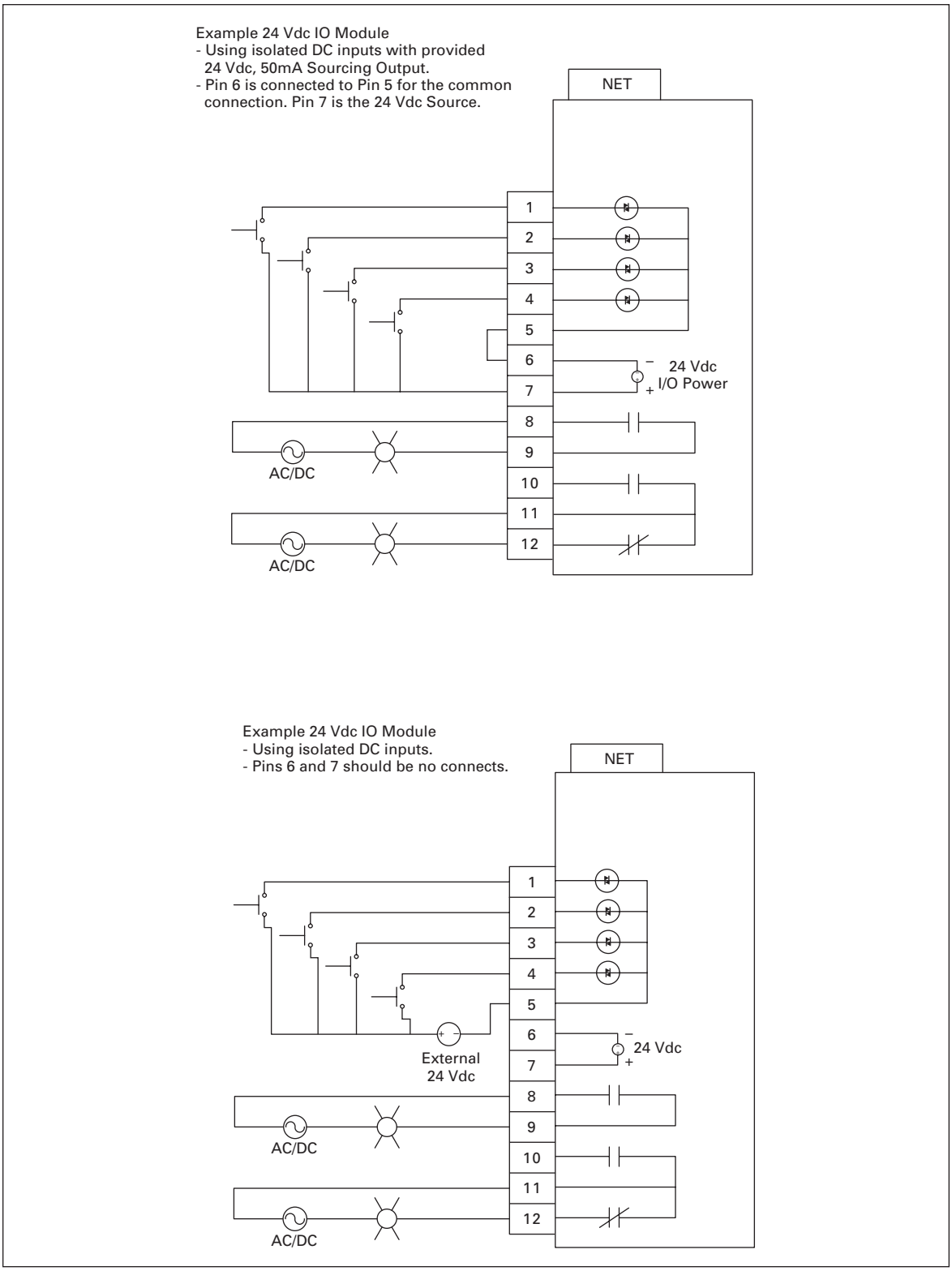


Figure 8-6: 24 Vdc IO Module

8.4 - Relay Output Behavior

Relay Outputs

Two relay outputs are provided, one Form A (NO) and one Form C (NO, NC). See wiring guide below.

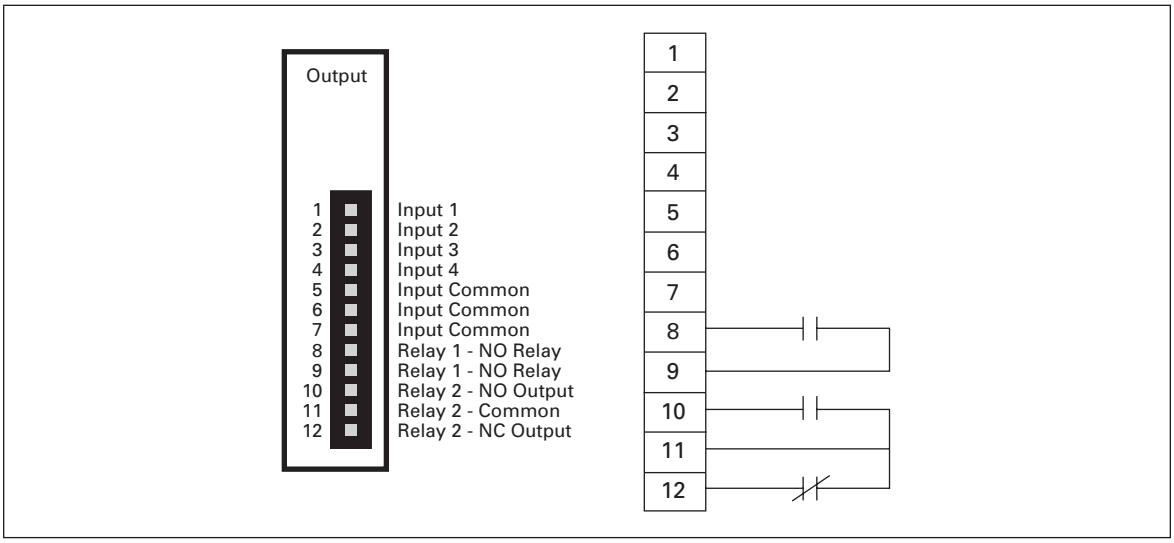


Figure 8-7: Relay Output Module Diagrams

Table 8-9: Relay Specification

Specification	Value
Num Contacts	2 independent relays (1 Form C, 1 Form A)
Thermal Contact	5 A
Rated Insulation Voltage	300 Vac
Max Operating Voltage	120 Vac
Max Operating Current	5 A
Electrical Life	1 x 10^5 operations
Mechanical Life	1 x 10^7 operations

Table 8-10: Pilot Duty Relay Requirements

Specification	Value
Pilot Duty Rating	B300
Thermal Continuous Test Current	5 A
Maximum Current (120 Vac) - Make/Break	30 A / 3 A
Max VA (Volt-Amperes) — Make/Break	3600 Va / 360 Va

8.5 - Communication Behavior

DeviceNet

8.5.1 - DeviceNet Baud Rate Configuration DIP Switches 7,8

The DeviceNet baud rate is configured using the DIP switches on the face of the device.

Table 8-11: TDIP Switch Baud Rate Selection

B0 (Sw7)	B1 (Sw8)	Baud
OFF	OFF	125k (Default)
ON	OFF	250k
OFF	ON	500k
ON	ON	Software configuration

8.5.2 - DeviceNet MAC ID Selection

The DeviceNet MAC ID is configured using the DIP switches on the face of the device.

Table 8-12: DIP Switch Behavior

DIP Switch	Value
6	32
5	16
4	8
3	4
2	2
1	1

To set a MAC ID of 25, DIP switches 5, 4 and 1 need to be turned on, with all others off. Default is Mac ID 63 (all on).

8.5.3 - DeviceNet Profile

Full Profile

The device is composed of a collection of standard objects and Eaton-specific objects. The “standard” objects are those that are defined by the ODVA. These standard objects always exhibit the same behavior and basic content regardless of the source of the device containing the object.

Table 8-13: Standard Objects

Class	Object	Number of Instances
0x01	Identity	1
0x02	Message Router	1
0x03	DeviceNet	1
0x04	Assembly	(See assembly object details)
0x05	Connection	3
0x08	Discrete Input Point	4
0x09	Discrete Output Point	2
0x29	Control Supervisor	1
0x2C	Overload	1
0x93	Voltage Monitor	1
0x94	DeviceNet Interface	1

Object Details

Identity Object

Class: 0x01

Table 8-14: Instance Services

Service Code	Service Name	Service Data	Description
0x05	Reset	0	Instance 1: Initializes adapter to the Power-up state
0x05	Reset	1	Instance 1: Writes default values to all instance attributes AND then saves all non-volatile attributes to FLASH memory AND then performs the equivalent of a Reset(0)
0x0E	Get_Attribute_ Single	n/a	Returns the value of the specified attribute
0x10	Set_Attribute_ Single	value	Sets the “value” into the specified attribute

Table 8-15: Identity Instance Attributes

Attribute ID	NV	Access Rule	Name	Data Type	Description of Attribute	Semantics of Values
1		Get	Vendor ID	UINT	Identification of each vendor by number	The constant 68.
2		Get	Device Type	UINT	Indication of general type of product	The constant 3 for overload.
3		Get	Product Code	UINT	Identification of a particular product of an individual vendor	The constant 0x1101 or 0x1102
4		Get	Revision	STRUCT of:	Revision of the item the Identity Object represents	
			Major Revision	USINT		The constant 0x01
			Minor Revision	USINT		The constant 0x01
5		Get	Status	WORD	Summary status of device	See **Page 8-14** for definitions
6		Get	Serial Number	UDINT	Serial number of device	See **Page 8-14** for definitions
7		Get	Product Name	SHORT_ STRING	Human readable identification	See **Page 8-14** for definitions

Table 8-15: Identity Instance Attributes (Continued)

Attribute ID	NV	Access Rule	Name	Data Type	Description of Attribute	Semantics of Values
8		Get	State	USINT	Present state of the device as represented by the state transition diagram	0 = Nonexistent 1 = Device Self Testing 2 = Standby 3 = Operational 4 = Major Recoverable Fault 5 = Major Unrecoverable Fault
176 (0xB0)	NV	Get/Set	User Label (Tag Name)	SHORT_ STRING	User Assigned ASCII string of 16 characters or less	
177 (0xB1)	NV	Get	DSP Firmware Version	UINT	Version of MI base unit DSP firmware	
178 (0xB2)	NV	Get	PIC Firmware Version	UINT	Version of MI PIC board version	
179 (0xB3)	NV	Get	Unit ID	UINT	See **Table 7-7**, register 335	

Status

This attribute represents the current status of the entire device. Its value changes as the state of the device changes. The Status attribute is a WORD, with the following bit definitions:

Table 8-16: Bit Definitions for Instance #1, Status Attribute of Identity Object

Bit(s)	Called	Definition
0	Owned	
1		Reserved, set to zero.
2	Configured	TRUE indicates that the application of the device has been configured to do something different than the "out-of-box" default. This does not include configuration of the communications.
3		Reserved, set to zero.
4 – 7		Reserved, set to zero.
8	Minor Recoverable Fault	TRUE indicates that the device detected a problem with itself, which is thought to be recoverable. The problem does not cause the device to go into one of the faulted states.
9	Minor Unrecoverable Fault	TRUE indicates that the device detected a problem with itself, which is thought to be unrecoverable. The problem does not cause the device to go into one of the faulted states.
10	Major Recoverable Fault	TRUE indicates that the device detected a problem with itself, which caused the device to go into the "Major Recoverable Fault" state.
11	Major Unrecoverable Fault	TRUE indicates that the device detected a problem with itself, which caused the device to go into the "Major Unrecoverable Fault" state. See Behavior section.
12, 13		Reserved, set to zero.
14, 15		Reserved, set to zero.

Serial Number

This attribute is a number used in conjunction with the Vendor ID to form a unique identifier for each device on Ethernet. Each vendor is responsible for guaranteeing the uniqueness of the serial number across all of its devices.

Product Name

This text string should represent a short description of the product/product family represented by the product code in attribute 3. The same product code may have a variety of product name strings. The maximum number of characters in this string is 32.

State

This attribute is an indication of the present state of the device. Note that the nature of a Major Unrecoverable Fault could be such that it may not be accurately reflected by the State attribute.

This attribute reflects the dynamic status of the adapter. The defined states are:

Table 8-17: Defined States

Value	State Name	Description
0	Non-existent	This state will never be visible from within a device. This state is principally intended for a tool to be able to represent the lack of an instance in a physical device.
1	Device Self Testing	Power-up or Reset operation. Will not be visible from within a device because communications are not active in this state.
2	Standby	This state is reported while needs commissioning due to an incorrect or incomplete configuration
3	Operational	This state is reported when the adapter is powered up, configured and operating normally.
4	Major Recoverable Fault	
5	Major Unrecoverable Fault	

Message Router Object

Class: 0x02

No class or instance attributes are supported.

DeviceNet Object

Class: 0x03

Table 8-18: Instance Services

Service Code	Service Name	Service Data	Description
0x0E	Get_Attribute_Single	n/a	Returns the value of the specified attribute
0x4B	Allocate	values	Allocate_Master/Slave_Connection_Set
0x4C	Release	value	Release_Group_2_Identifier_Set

Table 8-19: DeviceNet Instance Attributes

Attr ID	NV	Access Rule	Name	Data Type	Brief Description of Attribute	Semantics of Values
5		Get	Allocation Information	STRUCT of:		
			Allocation Choice Byte	BYTE	Indicates which connections are active	Bit 0 - Explicit Bit 1 - Poll Bit 2 - Bit Strobe
			Master's MAC ID	USINT	MAC ID of Master (from Allocate)	Range 0 – 63, 255 Modified via Allocate only
8		Get	MAC ID Switch Value	USINT	Actual value of Node Address switches	Range 0 – 63
9		Get	Baud Rate Switch Value	USINT	Actual value of Baud Rate switches	Range 0 – 3

Assembly Object

Class: 0x04

The Assembly Object binds attributes of multiple objects, which allows data to or from each object to be sent or received over a single connection. Assembly objects can be used to bind input data or output data. The terms ”input” and ”output” are defined from the network’s point of view. An input will produce data on the network and an output will consume data from the network. Various data sets can be exchanged using I/O messaging. The data set to be exchanged is determined by selecting an input and an output assembly.

The adapter is designed with 2 I/O connections (poll and bit strobe). These connections use the assemblies selected in the vendor specific DeviceNet Interface object (0x94).

Table 8-20: Instance Services

Service Code	Service Name	Service Data	Description
0x0E	Get_Attribute_Single	n/a	Returns the value of the specified attribute
0x10	Set_Attribute_Single	value	Sets the "value" into the specified attribute

Table 8-21: Instance Attributes

Attr ID	NV	Access Rule	Name	Data Type	Description of Attribute	Semantics of Values
3		Set	Data	ARRAY of BYTE		

Table 8-22: Assembly Instances

The following assemblies are defined for the Motor Insight DeviceNet Adapter.

Type	Instance	Usage	Name
Input	50	Poll, Bit Strobe	Basic Overload (ODVA Overload Profile)
Input	51	Poll, Bit Strobe	Extended Overload (ODVA Overload Profile)
Input	107 ②	Poll, Bit Strobe	Extended Overload with Discrete Input and Output Points
Input	100 ①	Poll	User Defined Input Assembly Short
Input	110	Poll	User Defined Input Assembly Long
Output	2	Poll	Basic Overload (ODVA Overload Profile)
Output	105 ①	Poll	Basic Overload with Discrete Output Points
Output	111 ②	Bit Strobe	Accepts 8 bytes of bit strobe command to trigger bit strobe response

① Indicates default assembly instances used in poll connection
② Indicates default assembly instances used in bit strobe connection

Table 8-23: Input Assembly 50

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0								Faulted

Table 8-24: Input Assembly 51

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0							Warning	Faulted

Table 8-25: Input Assembly 107

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Input 4	Input 3	Input 2	Input 1	Output 2	Output 1	Warning	Faulted

Table 8-26: Input Assembly 100
Values are selected from the list defined below.

Byte	Word	Value	Default Value
0	0	Value selected by DeviceNet interface object, attribute 9	Device Status (Low Byte) (See Control Supervisor Object)
1			Device Status (High Byte)
2	1	Value selected by DeviceNet interface object, attribute 8	L1 Current (Low Byte)
3			L1 Current (High Byte)
4	2	Value selected by DeviceNet interface object, attribute 9	L2 Current (Low Byte)
5			L2 Current (High Byte)
6	3	Value selected by DeviceNet interface object, attribute 10	L3 Current (Low Byte)
7			L3 Current (High Byte)

Table 8-27: Input Assembly 110
Values are selected from the list defined below.

Byte	Word	Value	Default Value
0	0	Value selected by DeviceNet interface object, attribute 12	Device Status (Low Byte) (See Control Supervisor Object)
1			Device Status (High Byte)
2	1	Value selected by DeviceNet interface object, attribute 13	L1 Current (Low Byte)
3			L1 Current (High Byte)
4	2	Value selected by DeviceNet interface object, attribute 14	L2 Current (Low Byte)
5			L2 Current (High Byte)
6	3	Value selected by DeviceNet interface object, attribute 15	L3 Current (Low Byte)
7			L3 Current (High Byte)
8	4	Value selected by DeviceNet interface object, attribute 16	Field Inputs (Low Byte)
9			Field Inputs (High Byte)
10	5	Value selected by DeviceNet interface object, attribute 17	RMS Current Ave (Low Byte)
11			RMS Current Ave (High Byte)
12	6	Value selected by DeviceNet interface object, attribute 18	RMS Voltage VAB (Low Byte)
13			RMS Voltage VAB (High Byte)
14	7	Value selected by DeviceNet interface object, attribute 19	RMS Voltage VBC (Low Byte)
15			RMS Voltage VBC (High Byte)
16	8	Value selected by DeviceNet interface object, attribute 20	RMS Voltage VCA (Low Byte)
17			RMS Voltage VCA (High Byte)
18	9	Value selected by DeviceNet interface object, attribute 21	RMS Voltage Ave (Low Byte)
19			RMS Voltage Ave (High Byte)

Table 8-28: Input Assembly 100 and 110 Selection List

Value	Description
0	Assembly Terminator
1	Device Status Data — See control supervisor object)
2	RMS Current IA
3	RMS Current IB
4	RMS Current IC
5	RMS Current Average
6	RMS Voltage VAB
7	RMS Voltage VBC
8	RMS Voltage VCA
9	RMS Voltage Average
10	Total KW
11	Voltage Unbalance Percent
12	Current Percent
13	Apparent Power Factor
14	Residual Ground Current Deciamps
15	Frequency
16	Overload Thermal Pile
17	Trip Reason
18	Overload Status
19	Error Code
20	Field Inputs

Table 8-29: Output Assembly 2

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0						Fault Reset		

Table 8-30: Output Assembly 105

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0			Remote Trip			Fault Reset	Out 2	Out 1

Output Assembly 111 – Bit Strobe command

Sixty-four bits of strobe data, one per MAC ID. The data is ignored by the Motor Insight DeviceNet adapter.

Connection Object

Class: 0x05

Common Instance Information

Table 8-31: Instance Services

Service Code	Service Name	Service Data	Description
0x05	Reset	n/a	Resets the Inactivity/Watchdog timer Transitions from Timed Out or Deferred Delete state to established
0x0E	Get_Attribute_Single	n/a	Returns the value of the specified attribute
0x10	Set_Attribute_Single	value	Sets the "value" into the specified attribute

Table 8-32: Connection Instance #1 Attributes (Explicit Messaging)

The Predefined Master/Slave Connection Set requires the explicit messaging connection be the instance numbered one.

Attr ID	Access	NV	Attribute Name	Data Type	Brief Description of Attribute
1	Get		state	USINT	State of the object Default = 0x03
2	Get		instance_type	USINT	Indicates either I/O or Messaging Connection Default = 0x00
3	Get		transportClass_trigger	BYTE	Defines behavior of the Connection Default= 0x83
4	Get		produced_connection_id	UINT	Placed in CAN Identifier Field when the Connection transmits Default = 0x0000 (Although this default will never be visible)
5	Get		consumed_connection_id	UINT	CAN Identifier Field value that denotes message to be received Default = 0x0000 (Although this default will never be visible)
6	Get		initial_comm_characteristics	BYTE	Defines the Message Group(s) across which productions and consumptions associated with this Connection occur Default = 0x21 This indicates that the Slave's Explicit Messaging connection produces and consumes across Message Group 2. Additionally, this value indicates that the Slave's MAC ID appears in the CAN Identifier Fields of the Group 2 messages that the slave consumes and produces.

Table 8-32: Connection Instance #1 Attributes (Explicit Messaging) (Continued)

Attr ID	Access	NV	Attribute Name	Data Type	Brief Description of Attribute
7	Get		produced_connection_size	UINT	Maximum number of bytes transmitted across this Connection Default = 500
8	Get		consumed_connection_size	UINT	Maximum number of bytes received across this Connection Default = 500
9	Get/Set		expected_packet_rate	UINT	Defines timing associated with this Connection Default = 0x09C4 (2500 milliseconds)
10 _ 11			N/A	N/A	Not used. These attribute IDs have been obsoleted and are no longer defined for a Connection Object
12	Get/Set		watchdog_timeout_action	USINT	Defines how to handle Inactivity/ Watchdog timeouts Default = 0x01 (Auto_Delete)
13	Get		produced_connection_path_ length	UINT	Number of bytes in the produced_connection_path attribute Default = 0x0000
14	Get		produced_connection_path	EPATH	Specifies the Application Object(s) whose data is to be produced by this Connection Object. See DeviceNet Volume I, Appendix I. Default = Null PATH
15	Get		consumed_connection_path_ length	UINT	Number of bytes in the consumed_connection_path attribute Default = 0x00
16	Get		consumed_connection_path	EPATH	Specifies the Application Object(s) that are to receive the data consumed by this Connection Object. See DeviceNet Volume I, Appendix I. Default = Null PATH

Table 8-33: Connection Instance #2 Attributes (Polled I/O)

Attr ID	Access	NV	Attribute Name	Data Type	Brief Description of Attribute
1	Get		state	USINT	State of the object Default = 0x01
2	Get		instance_type	USINT	Indicates either I/O or Messaging Connection Default = 0x01
3	Get		transportClass_trigger	BYTE	Defines behavior of the Connection Default = 0x83
4	Get		produced_connection_id	UINT	Placed in CAN Identifier Field when the Connection transmits
5	Get		consumed_connection_id	UINT	CAN Identifier Field value that denotes message to be received
6	Get		initial_comm_characteristics	BYTE	Defines the Message Group(s) across which productions and consumptions associated with this Connection occur Default = 0x01
7	Get		produced_connection_size	UINT	Maximum number of bytes transmitted across this Connection
8	Get		consumed_connection_size	UINT	Maximum number of bytes received across this Connection
9	Get/Set		expected_packet_rate	UINT	Defines timing associated with this Connection Default = 0x0000
10 _ 11			N/A	N/A	Not used. These attribute IDs have been obsoleted and are no longer defined for a Connection Object
12	Get/Set		watchdog_timeout_action	USINT	Defines how to handle Inactivity/ Watchdog timeouts Default = 0x00
13	Get		produced_connection_path_ length	UINT	Number of bytes in the produced_connection_path attribute Default and Fixed as 0x03
14	Get/Set	NV	produced_connection_path	EPATH	Specifies the Application Object(s) whose data is to be produced by this Connection Object Default assembly instance 100 “0x62 0x36 0x34”
15	Get		consumed_connection_path_ length	UINT	Number of bytes in the consumed_connection_path attribute Default and Fixed as 0x03
16	Get/Set	NV	consumed_connection_path	EPATH	Specifies the Application Object(s) that are to receive the data consumed by this Connection Object Default assembly instance 105 “0x62 0x36 0x39”

Table 8-34: Connection Instance #3 Attributes (Bit Strobe I/O)

Attr ID	Access	NV	Attribute Name	Data Type	Brief Description of Attribute
1	Get		state	USINT	State of the object Default = 0x01
2	Get		instance_type	USINT	Indicates either I/O or Messaging Connection Default = 0x01
3	Get		transportClass_trigger	BYTE	Defines behavior of the Connection Default = 0x83
4	Get		produced_connection_id	UINT	Placed in CAN Identifier Field when the Connection transmits
5	Get		consumed_connection_id	UINT	CAN Identifier Field value that denotes message to be received
6	Get		initial_comm_characteristics	BYTE	Defines the Message Group(s) across which productions and consumptions associated with this Connection occur Default = 0x02
7	Get		produced_connection_size	UINT	Maximum number of bytes transmitted across this Connection Default and Fixed as 0x08
8	Get		consumed_connection_size	UINT	Maximum number of bytes received across this Connection Default and Fixed as 0x08
9	Get/Set		expected_packet_rate	UINT	Defines timing associated with this Connection Default = 0x0000
10 _ 11			N/A	N/A	Not used. These attribute IDs have been obsoleted and are no longer defined for a Connection Object
12	Get/Set		watchdog_timeout_action	USINT	Defines how to handle Inactivity/ Watchdog timeouts Default = 0x00
13	Get		produced_connection_path_ length	UINT	Number of bytes in the produced_connection_path attribute Default and Fixed as 0x03
14	Get/Set		produced_connection_path	EPATH	Specifies the assembly instance whose data is to be produced by this Connection Object Default assembly instance 107 “0x62 0x36 0x4B”
15	Get		consumed_connection_path_ length	UINT	Number of bytes in the consumed_connection_path attribute Default and Fixed as 0x03
16	Get/Set		consumed_connection_path	EPATH	Specifies the Application Object(s) that are to receive the data consumed by this Connection Object Default and Fixed as assembly instance 121 “0x62 0x37 0x39”

Discrete Input Point Object

Class: 0x08

The Discrete Input Point (DIP) Object models discrete inputs in a product. Note that the term "input" is defined from the network's point of view. An input will produce data on the network. The input is sampled from the input terminal (e.g., screw terminal) and the data is stored in this object's VALUE attribute.

Table 8-35: Instance Services

Service Code	Service Name	Service Data	Description
0x0E	Get_Attribute_Single	n/a	Returns the value of the specified attribute
0x10	Set_Attribute_Single	value	Sets the "value" into the specified attribute

Table 8-36: Discrete Input Point Instance Attributes

Attr ID	NV	Access Rule	Name	Data Type	Brief Description of Attribute	Semantics of Values
3		Get	Value	BOOL	Input point value	0 = off; 1 = on
101		Set	Debounce	UDINT	Debounce time	Milliseconds

Input point value

The input point value shall reflect the current state of the associated input terminal.

Discrete Output Point Object

Class: 0x09

The Discrete Output Point (DOP) Object models discrete outputs in a product. Note that the term "output" is defined from the network's point of view. An output will consume data from the network. The output is read from this object's VALUE attribute and applied to the output terminal.

Table 8-37: Instance Services

Service Code	Service Name	Service Data	Description
0x0E	Get_Attribute_Single	n/a	Returns the value of the specified attribute
0x10	Set_Attribute_Single	value	Sets the "value" into the specified attribute

Table 8-38: Discrete Output Point Instance Attributes

Attr ID	NV	Access Rule	Name	Data Type	Brief Description of Attribute	Semantics of Values
3		Set	Value	BOOL	Output point value	0 = off; 1 = on
5	NV	Set	Fault Action	BOOL	Action taken on output's value in Communication Fault state	0 = Fault Value attribute; 1 = no change
6	NV	Set	Fault Value	BOOL	User-defined value for use with Fault Action attribute	0 = off; 1 = on
7	NV	Set	Idle Action	BOOL	Action taken on output's value in Communication Idle state	0 = Idle Value attribute; 1 = no change
8	NV	Set	Idle Value	BOOL	User-defined value for use with Idle Action attribute	0 = off; 1 = on

Output point value

The output is read from this object's VALUE attribute and applied to the output terminal.

Communication fault action

Determines the action to be taken at the output terminal when a communications fault occurs.

If this attribute is set to "0," then output terminal will be set to the state determined by attribute "Communications fault value."

If the attribute is set to "1," then the output terminal is not changed due to a communications fault.

Default: "0"

Communication fault value

Determines the value to be applied to the output terminal if a communications fault occurs AND the "Communication fault action" attribute is set to "0."

Default: 0.

Idle action

Determines the action to be taken at the output terminal when communications idle occurs.

If this attribute is set to "0," then output terminal will be set to the state determined by attribute "Idle value."

If the attribute is set to "1," then the output terminal is not changed due to a communications idle event.

Default: "0"

Idle value

Determines the value to be applied to the output terminal if a communications idle event occurs AND the "Idle action" attribute is set to "0."

Default: 0.

Class: 0x29

This object models all the management functions for devices within the "Hierarchy of Motor Control Devices."

Control Supervisor Object

Table 8-39: Control Supervisor Instance Services

Service Code	Service Name	Service Data	Description
0x0E	Get_Attribute_Single	n/a	Returns the value of the specified attribute
0x10	Set_Attribute_Single	value	Sets the "value" into the specified attribute
0x05	Reset	n/a	Resets the overload to the start-up state.

Table 8-40: Control Supervisor Instance Attributes

Attr ID	NV	Access Rule	Name	Data Type	Semantics of Values
10		Get	Faulted/Tripped	BOOL	1 = Fault Occurred (latched) 0 = No Faults present
11		Get	Warning	BOOL	1 = Warning (not latched) 0 = No Warnings present
12		Set	FaultRst	BOOL	0 ≥ 1 = Fault Reset 0 = No action (Overload Reset)
13		Get	FaultCode	UINT	If in **Faulted** state, FaultCode indicates the fault that caused the transition to **Faulted** state. If not in **Faulted** state, FaultCode indicates the fault that caused the last transition to the **Faulted** state.
17		Set	ForceFault	BOOL	0 ≥ 1 = Force Fault 0 = No action
101		Get	Device Status	WORD	**Device Bit Array** Bit 0: Trip Bit1: Warn Bit2: Output #1 Bit3: Output #2 Bit4: Input #1 Bit5: Input #2 Bit6: Input #3 Bit7: Input #4 Bit8: Overload Power Lost Bit 9-15: reserved
102		Get	Trip Reason	WORD	**Fault (Trip) Reason Bit Array** Bit 0: Fault Lockout Bit1: Relay Off Command Bit2: Contactor Failure Bit3: Under Current Bit4: Overload Bit5: Ground Fault Bit6: Current Unbalance Bit7: Current Single Phase Bit8: Reserved Bit9: High Power (kW) Bit10: Over Voltage Bit11: Under Voltage Bit12: Voltage Unbalance Bit13: Over Current Bit14: Low Power (kW) Bit15: Phase Reversal
103		Get	Overload Status	WORD	**Overload Status Bit Array** Bit 0: Overload Trip Bit1: Ground Fault Trip Bit2: High Power Trip Bit3: reserved Bit4: reserved Bit5: reserved Bit6: reserved Bit7: Relay Closed Bit 8-15: reserved

Table 8-40: Control Supervisor Instance Attributes (Continued)

Attr ID	NV	Access Rule	Name	Data Type	Semantics of Values
104		Get	Warning Status	WORD	**Warning Bit Array** Bit 0: Low Voltage Bit1: High Voltage Bit2: Voltage Unbalance Bit3: Low Power Bit4: Reverse Phase Bit5: Current Unbalance Bit6: Voltage Single Phase Bit7: Current Single Phase Bit8: Ground Fault Phase Bit9-15: reserved
105	NV	Set	Comm Fault Trip Action	BOOL	Action taken on trip state in Comm Fault state 0 = Use Comm Fault Trip Value attribute 1 = no affect
106	NV	Set	Comm Fault Trip Value	BOOL	User-defined value for use with Comm Fault Trip Action attribute 0 = no affect; 1 = trip
107	NV	Set	Idle Trip Action	BOOL	Action taken on trip state in Communication Idle state 0=Use Idle Trip Value attribute; 1=no change
108	NV	Set	Idle Trip Value	BOOL	User-defined value for use with Idle Trip Action attribute 0 = no affect; 1 = trip
109		Get	Fault Log 0	UINT	
110		Get	Fault Log 1	UINT	
111		Get	Fault Log 2	UINT	
112		Get	Fault Log 3	UINT	
113		Get	Fault Log 4	UINT	
114		Get	Fault Log 5	UINT	
115		Get	Fault Log 6	UINT	
116		Get	Fault Log 7	UINT	
117		Get	Fault Log 8	UINT	
118		Get	Fault Log 9	UINT	
119		Set	Clear Last Fault Log Entry	BOOL	0 ≥ 1 = Fault Entry Cleared 0 = No action
120	NV	Set	Enable Trip	WORD	**Trip Enable/Disable bit array** Bit 0: Enable Ground Fault Trip Bit 1: Enable Voltage Unbalance Trip Bit 2: Enable Current Unbalance Trip Bit 3: Enable Under Current Trip Bit 4: Enable Phase Loss Trip Bit 5: Enable Jam Bit 6: Enable LKW Trip Bit 7: Enable HKW Trip Bit 8: Enable Overvoltage Trip Bit 9: Enable Undervoltage Trip Bit 10: Enable Phase Order Trip

Faulted/Tripped

A condition exists that is out of the normal operating range of the device. This condition has been configured to cause the device to enter the faulted or tripped state.

Warning

A condition exists that is out of the normal operating range of the device. This condition has been configured to provide a warning.

Table 8-41: Fault Reset
Commands the device out of the faulted state. A transition from 0 to 1 will cause the fault reset.

Initial Value	Commanded Value	Result
0	0	No Action
0	1	Reset Fault
1	0	No Action
1	1	No Action

Fault Code

Indicates the condition that caused the most recent transition to the faulted state. The fault code is not cleared by Fault reset.

The fault codes used are the Abbreviated 8-bit code as specified by the default Fault/Warning Code Style attribute in the control supervisor.

Warning Code

Indicates the presence of a warning condition. This is not latched and only displays while the warning state is active. If multiple warning conditions exist, then only the lowest number warning code is displayed.

The warning codes used are the Abbreviated 8-bit code as specified by the default Fault/Warning Code Style attribute in the control supervisor.

Fault Status

Displays the Motor Insight fault status register.

Warning Status

Displays the Motor Insight warning status register.

Device Status

Displays the Motor Insight status as described in the instance attributes table.

Overload Object

Class: 0x2C

This object models the functions specific to an AC motor overload protection device.

Table 8-42: Instance Services

Service Code	Service Name	Service Data	Description
0x0E	Get_Attribute_Single	n/a	Returns the value of the specified attribute
0x10	Set_Attribute_Single	value	Sets the “value” into the specified attribute

Table 8-43: Overload Instance Attributes

Attr ID	NV	Access Rule	Name	Data Type	Semantics of Values	Value
4	NV	Set	TripClass	USINT	Trip Class Setting 5 to 30	
5		Get	AvgCurrent	INT	Average of the three phase currents Units: See **Table 7-8**	
6		Get	%PhImbal	USINT	% Phase Imbalance	
7		Get	%Thermal	USINT	% Thermal Capacity	
8		Get	Current LI	INT	Actual motor phase current L1 Units: See **Table 7-8**	
9		Get	Current L2	INT	Actual motor phase current L2 Units: 1See **Table 7-8**	
10		Get	Current L3	INT	Actual motor phase current L3 Units: See **Table 7-8**	
11		Get	Ground Current	INT	Ground Current Units: 100ma	
101	NV	Set	Motor Run Time	UINT		Reset by writing zero
102	NV	Set	Start Count	UINT		Reset by writing zero
103	NV	Set	CT Multiplier	UINT	See MI DSP User Guide.doc	
104			Reserved			
105	NV	Set	Motor FLA	UINT	Table 6-1	
106		Get	Power Factor	UINT	PFX100	
107		Get	Motor Power (kW)	UINT	KWX100	
108		Get	Motor Fault Time to restart	UINT	Seconds remaining	
109		Get	Load Fault Time to restart	UINT	Seconds remaining	
110	NV	Set	Load Fault Reset Delay	UINT	Table 6-16	

Table 8-43: Overload Instance Attributes (Continued)

Attr ID	NV	Access Rule	Name	Data Type	Semantics of Values	Value
111	NV	Set	Load Fault Num Restart Attempts	UINT	Table 6-16	
112	NV	Set	Motor Fault Reset Delay	UINT	Table 6-5	
113	NV	Set	Motor Fault Num Restarts Attempts	UINT	Table 6-5	
114	NV	Set	Run Transition Time Seconds	UINT	Table 6-4	
115	NV	Set	Run Transition Percent of FLA	UINT	Table 6-4	
116	NV	Set	Ground Fault Trip Mode	UINT	Table 6-9	
117	NV	Set	Ground Fault Pickup Delay Seconds	UINT	Table 6-9	
118	NV	Set	Ground Fault Pickup Level	UINT	Table 6-9	
119	NV	Set	Current Unbalance Run Delay Seconds	UINT	Table 6-7	
120	NV	Set	Current Unbalance Pickup Level Percent FLA	UINT	Table 6-7	
121	NV	Set	Jam Pickup Delay Seconds	UINT	Table 6-6	
122	NV	Set	Jam Pickup Level	UINT	Table 6-6	
123	NV	Set	Current Phase Loss Pickup Delay	UINT	Table 6-8	
124	NV	Set	High Kw Trip Time	UINT	Table 6-20	
125	NV	Set	High Kw Trip Limit	UINT	Table 6-20	
126	NV	Set	Low Power Pickup Delay Seconds	UINT	Table 6-19	
127	NV	Set	Low Power Pickup Level	UINT	Table 6-19	
128	NV	Set	Under Current Pickup Delay Seconds	UINT	Table 6-18	
129	NV	Set	Under Current Pickup Level	UINT	Table 6-18	
130	NV	Set	Overload Reset Mode	UINT	Table 7-7, Reg 434	
131	NV	Set	Load Fault Reset Delay Calculator	BOOL	0=disable - default 1=enabled (Table 6-17)	

Output point value

The output is read from this object's VALUE attribute and applied to the output terminal.

Voltage Monitor Object

Class: 0x93

The Voltage Monitor object.

Table 8-44: Instance Services

Service Code	Service Name	Service Data	Description
0x0E	Get_Attribute_Single	n/a	Returns the value of the specified attribute
0x10	Set_Attribute_Single	value	Sets the “value” into the specified attribute

Table 8-45: Voltage Monitor Instance Attributes

Attr ID	NV	Access Rule	Name	Data Type	Semantics of Values	Value
1		Get	Rms Voltage Vab	UINT	L1-L2 RMS Voltage	
2		Get	Rms Voltage Vbc	UINT	L2-L3 RMS Voltage	
3		Get	Rms Voltage Vca	UINT	L3-L1 RMS Voltage	
4		Get	Rms Voltage Avg	UINT	Average RMS Voltage	
5		Get	Voltage Unbalance Percent	UINT		
6		Get	Frequency	UINT	HZ x 100	
7	NV	Set	Voltage Faults Trip Mode	UINT	0 = Trip on fault (each voltage fault can be individually enabled or disabled) 1 = Alarm-no-trip	
8	NV	Set	Under Voltage Pickup Level	UINT	Table 6-13	
9	NV	Set	Under Voltage Pickup Delay Seconds	UINT	Table 6-13	
10	NV	Set	Over Voltage Pickup Level	UINT	Table 6-12	
11	NV	Set	Over Voltage Pickup Delay Seconds	UINT	Table 6-12	
12	NV	Set	V Unbalance Pickup Level	UINT	Table 6-14	
13	NV	Set	V Unbalance Pickup Delay Seconds	UINT	Table 6-14	
14	NV	Set	Phase Order	UINT	Table 6-15	
15	NV	Set	Restart Delay	UINT	Table 6-10	
16	NV	Get	Supply Fault Time to Restart	UINT	Seconds remaining	

DeviceNet Interface Object

Class: 0x94

The DeviceNet Interface object is used to advertise and configure attributes that will affect the DeviceNet interface of the Motor Insight adapter.

Table 8-46: Instance Services

Service Code	Service Name	Service Data	Description
0x0E	Get_Attribute_Single	n/a	Returns the value of the specified attribute
0x10	Set_Attribute_Single	value	Sets the "value" into the specified attribute

Table 8-47: DeviceNet Interface Instance Attributes

Attr ID	NV	Access Rule	Name	Data Type	Semantics of Values	Value
1	NV	Set	MAC ID	USINT	MAC ID in use when baud rate switch is set to 3 (B0: on, B1: on)	Range: 0 – 63 Default = 63
2	NV	Set	Baud Rate	USINT	Baud rate in use when baud rate switch is set to 3 (B0: on, B1: on)	0 = 125k, 1 = 250k, 2 = 500k Default = 0
3	NV	Set	Poll Input Assembly Select	USINT	Poll Connection Input Assembly instance that is active	Default = 100
4	NV	Set	Bit Strobe Input Assembly Select	USINT	Bit Strobe Connection Input Assembly instance that is active	Default = 107
5	NV	Set	Poll Output Assembly Select	USINT	Poll Connection Output Assembly instance that is active	Default = 105
6		Get	Short Assembly User Input, Size	USINT	Total size of assembly 100 as determined by user selected input list items	Determined by the placement of the "0" below
7	NV	Set	Short Assembly User Input, Word 0 Param	USINT	Data item assigned to Word 0 of short user input assembly	Default = 1; Device Status (Control Supervisor Attr 101)
8	NV	Set	Short Assembly User Input, Word 1 Param	USINT	Data item assigned to Word 1 of short user input assembly	Default = 2; L1 Current
9	NV	Set	Short Assembly User Input, Word 2 Param	USINT	Data item assigned to Word 2 of short user input assembly	Default = 3; L2 Current
10	NV	Set	Short Assembly User Input, Word 3 Param	USINT	Data item assigned to Word 3 of short user input assembly	Default = 4; L3 Current

Table 8-47: DeviceNet Interface Instance Attributes (Continued)

Attr ID	NV	Access Rule	Name	Data Type	Semantics of Values	Value
11		Get	Long Assembly User Input, Size	USINT	Total size of assembly 110 as determined by user selected input list items	Determined by the placement of the "0" below
12	NV	Set	Long Assembly User Input, Word 0 Param	USINT	Data item assigned to Word 0 of long user input assembly	Default = 1; Device Status (Control Supervisor Attr 101)
13	NV	Set	Long Assembly User Input, Word 1 Param	USINT	Data item assigned to Word 1 of long user input assembly	Default = 2; L1 Current
14	NV	Set	Long Assembly User Input, Word 2 Param	USINT	Data item assigned to Word 2 of long user input assembly	Default = 3; L2 Current
15	NV	Set	Long Assembly User Input, Word 3 Param	USINT	Data item assigned to Word 3 of long user input assembly	Default = 4; L3 Current
16	NV	Set	Long Assembly User Input, Word 4 Param	USINT	Data item assigned to Word 4 of long user input assembly	Default = 20 Field Inputs
17	NV	Set	Long Assembly User Input, Word 5 Param	USINT	Data item assigned to Word 5 of long user input assembly	Default = 5 Current Ave
18	NV	Set	Long Assembly User Input, Word 6 Param	USINT	Data item assigned to Word 6 of long user input assembly	Default = 6 Voltage VAB
19	NV	Set	Long Assembly User Input, Word 7 Param	USINT	Data item assigned to Word 7 of long user input assembly	Default = 7 Voltage VBC
20	NV	Set	Long Assembly User Input, Word 8 Param	USINT	Data item assigned to Word 8 of long user input assembly	Default = 8 Voltage VCA
21	NV	Set	Long Assembly User Input, Word 9 Param	USINT	Data item assigned to Word 9 of long user input assembly	Default = 9 Voltage Ave

MAC ID

The MAC ID is to be used in combination with Baud Rate (below) when the baud rate switches are set to value 3 (B0 = ON & B1 = ON).

Baud Rate

The Baud Rate is to be used in combination with MAC ID (above) when the baud rate switches are set to value 3 (B0 = ON & B1 = ON).

Chapter 9 — Modbus with IO Behavior

The Modbus with IQ Module Provides Expanded IQ Functionality to the Base Motor.

Table 9-1: Modbus with IO Functionality

Parameter	Value
Mode	Slave mode only
Byte Characteristics	RTU: 8Bit, Even Parity, 1 stop bit ASCII: 7Bit, Even Parity, 1 stop bit
Slave Response to Master	10 ms plus the time it takes to transmit response (when applicable)
Commands Supported	0x01 Read Coils 0x02 Read Discrete Inputs 0x03 Read Holding Registers 0x04 Read Input Register 0x05 Write Single Coil 0x06 Write Single Register 0x0F Write Multiple Coils (15) 0x10 Write Multiple Registers (16) 0x17 Read/Write Multiple Registers (23) 0x2B/0x0E Read Device Identification Get Device Identity (43/14)
Protocol Supported	ASCII or RTU
Electrical Signaling	RS-485 (ANSI/TIA/EIA-485), Two-wire
Checksum	CRC 16bit 0x8005 (or CRC-CCITT 0x1021)
Max. Data Signaling Error Accepted	2% in reception, 1% in transmission
Max. Number of Devices	32 (1 unit load per RS-485): Note: Line polarization will reduce max. # of devices by 4.
LED Indication	Device Busy
Max. Cable Length	Dependent on baud rate, cable characteristics (gauge, capacitance or impedance), number of loads, 4000 ft. max. theoretical. Reference *MODBUS-IDA over Serial Line Specification and Implementation Guide* and EIA-485 for details
Max. Number of Writes to Non-volatile Memory	Unlimited
Connector Style	Screw terminal
Network Topology	Two-wire Modbus, Daisy-chain and/or repeater
Line Polarization	Not required. Reference *MODBUS* over *Serial Line Specification and Implementation Guide* and EIA-485 for more information.

Table 9-2: Circuit Descriptions

Pin #	Circuit	EIA-485 Name	Recommended Wire Color	Description
1	Common	C/C	Grey	Power Supply Common
2	D1	B/B	Yellow	Transceiver terminal 1, V1 Voltage, Data + (V1 > VO for binary 1 [OFF] state)
3	N/C			
4	DO	A/A	Brown	Transceiver terminal 0, VO Voltage, Data - (VO > V1 for binary 0 [ON] state)
5	24 Vdc	—	Red	Power supply Positive

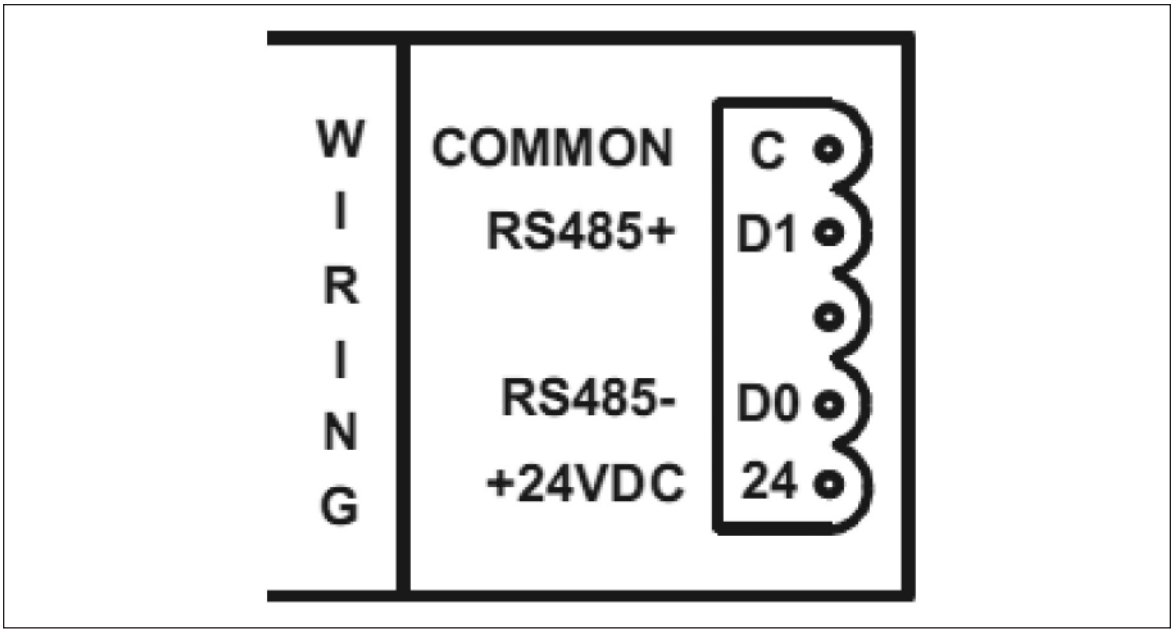


Figure 9-1: Modbus RS485 and Power Connection

9.1 - Additional Modbus Registers

The following Modbus data is provided in addition to the previously listed Modbus registers.

Note: The Modbus Register Address is -1 of the Modbus Register Number.

Note: All 32bit values are Low word first LLLLHHHH. Example: Register 7 = Low Word of Serial Number; Register 8 = High Word of Serial Number.

Table 9-3: Modbus Registers

Modbus Coil Number	Modbus Register Number	R/W	Parameter Name	Description
	1	R	Field Inputs	This is a bitfield of inputs. Bit 0 corresponds with input 1, bit1 corresponds with input 2, etc.
1				Field Input 1
2				Field Input 2
3				Field Input 3
4				Field Input 4
	2	R	Control Voltage (24 Vdc)	The control voltage register is displayed in millivolts.
	3	R	Ambient Board Temperature	Temperature is displayed in degrees celsius.
	4	R	Maximum PC Board Temperature	The maximum ambient temperature seen by the PCB.
	5	R	Dip Switch Value	Present value of the configuration dip switch.
	6	R	Configuration CRC	A CRC is calculated on the non-volatile configuration values. The CRC value is intended to provide a quick assessment of configuration state.
	7	R	Communication Module Serial Number	The serial number of the communication module.
	9	R	Communication Module Firmware Revision	Present firmware revision of the communication adapter.
	11	R	Communication Module Hardware Revision	Present hardware revision for the communication adapter PCB.
	101	R/W	Field Relay Outputs	The relay output register is a bitfield. Bit 0 corresponds to relay out 1 and bit 1 corresponds to relay out 2.
1601				Field Relay Output 1

Table 9-3: Modbus Registers (Continued)

Modbus Coil Number	Modbus Register Number	R/W	Parameter Name	Description
1602				Field Relay Output 2
	102	R/W	Field Input 1 Debounce Time	The input debounce can be set for each input point. The debounce value is set in milliseconds. Minimum time is 1 ms. Maximum debounce time is 1000 ms.
	104	R/W	Field Input 2 Debounce Time	
	106	R/W	Field Input 3 Debounce Time	
	108	R/W	Field Input 4 Debounce Time	
	110	R/W	Modbus Comm Loss Timeout Value (ms)	Modbus communication loss timeout. The timeout can be set from 0 ms (disabled) to 65535 ms.
	1000	R/W	Modbus Production List	The Production and Consumption registers can be used to create custom Modbus interface ranges. An example: If field inputs register address 0 is put into the first slot of the production list, the field inputs register value will be available in the first slot of the Modbus Production Data Register range. Production data is data provided by the device and Consumption data is for data provided (written) to the device. Note that the values must be Modbus Register Address (i.e., Register Number - 1) not Register Number.
	2000	R	Modbus Production Data	
	3000	R/W	Modbus Consumption List	
	4000	R/W	Modbus Consumption Data	

Appendix A — Modbus Map by Protection

UI Group

Table A-1: UI Group

Configuration						Status					
Fault	**Thresh-old**	**Enable**	**Trip Mode**	**Trip Time**	**Off Time**	**Re-starts**	**Lock-out**	**OL Status**	**Error**	**Trip Reason**	**Fault Code**
Jam	R:413 % FLA	C:6918 R:433, 0x0020 True	N/A	R:424 Seconds	R:417 Minutes	R:420 0 – 4 5:Auto	C:5265 R:330, 0x0001 True	C:5288 R:331, 0x0080 False	N/A	C:5278 R:330, 0x2000 True	R:315 14
Current Unbalance	R:408 % FLA	C:6915 R:433, 0x0004 True	N/A	R:425 Seconds	R:417 Minutes	R:420 0 – 4 5:Auto	C: 5265 R:330, 0x0001 True	C:5288 R:331, 0x0080 False	C:5302 R:332, 0x0020 True	C:5271 R:330, 0x0040 True	R:315 7
Ground Fault	R:404 10 mA	C:6913 R:433, 0x0001 True	R:436 0:Trip 1:Alarm no Trip	R:421 Seconds	N/A	N/A	N/A	C:5282 R:331, 0x0002 True ①	C:5305 R:332, 0x0100 True	C:5270 R:330, 0x0020 True	R:315 6
Overload	R:407 10 mA	N/A	N/A	R:409 Class 5, 10, 15, 20, 30	R:417 Minutes ②	R:420 0 – 4 5:Auto ④	⑤	C:5281 R:331, 0x0001 True ①	N/A	C:5269 R:330, 0x0010 True	R:315 5
Phase Rotation	R:415 1:ABC, 2:ACB 0:Don't Care	C:6923 R:433, 0x0400 True	R:435 0:Trip 1:Alarm no Trip ③	N/A	R:416 Seconds	N/A	N/A	N/A	C:5301 R:332, 0x0010 True	C:5280 R:330, 0x8000 True	R:315 16
N/C Current	R:405 100 mA	C:6916 R:433, 0x0008 True	N/A	R:422 Seconds	R:418 Minutes	R:419 0 – 4 5:Auto	C:5265 R:330, 0x0001 True	C:5288 R:331, 0x0080 False	C:5300 R:332, 0x0008 True	C:5268 R:330, 0x0008 True	R:315 4
Low Power	R:406 0.01 KW	C:6919 R:433, 0x0040 True	N/A	R:423 Seconds	R:418 Minutes	R:419 0 – 4 5:Auto	C:5265 R:330, 0x0001 True	C:5288 R:331, 0x0080 False	C:5300 R:332, 0x0008 True	C:5268 R:330, 0x0008 True	R:315 4
High Power	R:414 0.01 KW	C:6920 R:433, 0x0080 True	N/A	R:429 Seconds	R:418 Minutes	R:419 0 – 4 5:Auto	C:5265 R:330, 0x0001 True	C:5283 R:331, 0x0004 True ①	N/A	C:5274 R:330, 0x0200 True	R:315 10
Under Voltage	R: 410 Volts	C:6922 R:433, 0x0200 True	R:435 0:Trip 1:Alarm no Trip ③	N/A	R:416 Seconds	N/A	N/A	N/A	C:5297 R:332, 0x0001 True	C:5276 R:330, 0x0800 True	R:315 12
Over Voltage	R: 411 Volts	C:6921 R:433, 0x0100 True	R:435 0:Trip 1:Alarm no Trip ③	N/A	R:416 Seconds	N/A	N/A	N/A	C:5298 R:332, 0x0002 True	C:5275 R:330, 0x0400 True	R:315 11
Voltage Unbalance	R: 412 %	C:6914 R:433, 0x0002 True	R:435 0:Trip 1:Alarm no Trip ③	N/A	R:416 Seconds	N/A	N/A	N/A	C:5299 R:332, 0x0004 True	C:5277 R:330, 0x1000 True	R:315 13

① Also causes C:5288 (R:331, 0x0080) to be False and fault relay to be open.
② R:314 (thermal memory) will dominate unless R:417 time is greater than cooling time.
③ Inhibits start, indicates error when running.
④ Register 434 set to 1 enables, 0 disables.
⑤ If enabled (434 = 1), C:5265, R: 330 0x0001 True.

Comm Group

Table A-2: Comm Group

Configuration						Status					
Fault	**Threshold**	**Enable**	**Trip Mode**	**Trip Time**	**Off Time**	**Restarts**	**Lockout**	**OL Status**	**Error**	**Trip Reason**	**Fault Code**
Voltage Phase Loss	—	—	R:435 0:Trip 1:Alarm no Trip ①	N/A	N/A	N/A	—	C:5288 R:331, 0x0080 False	C:5303 R:332, 0x0040 True	N/A	R:315 15
Relay Off	N/A	N/A	N/A	N/A	N/A	N/A	—	C:5288 R:331, 0x0080 False	N/A	C:5266 R:330, 0x0002 True	R:315 2
Contactor Failure	N/A	—	N/A	N/A	N/A	N/A	—	C:5288 R:331, 0x0080 False	N/A	C:5267 R:330, 0x0004 True	R:315 3
Current Single Phase	N/A	N/A	N/A	N/A	N/A	N/A	—	C:5288 R:331, 0x0080 False	C:5304 R:332, 0x0080 True	C:5272 R:330, 0x0080 True	R:315 8

① Inhibits start, indicates error when running.

September 2009

Eaton's Electrical Sector is a global leader in power distribution, power quality, control & automation and monitoring products. When combined with Eaton's full-scale engineering services, these products provide customer-driven PowerChain Management® solutions to serve the power system needs of the data center, industrial, institutional, government, utility, commercial, residential, IT, mission critical and OEM markets worldwide.

PowerChain Management solutions help enterprises achieve sustainable and competitive advantages through proactive management of the power system as a strategic, integrated asset throughout its life cycle, resulting in enhanced safety, greater reliability and energy efficiency. For more information, visit www.eaton.com/electrical.

Eaton Corporation
Electrical Sector
1111 Superior Ave.
Cleveland, OH 44114
United States
877-ETN-CARE (877-386-2273)
Eaton.com

Printed in USA
Publication No. MN04209001E / Z9168
September 2009

PowerChain Management®

Powering Business Worldwide