

## User Manual



Powering Business Worldwide



July 2010

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## 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.

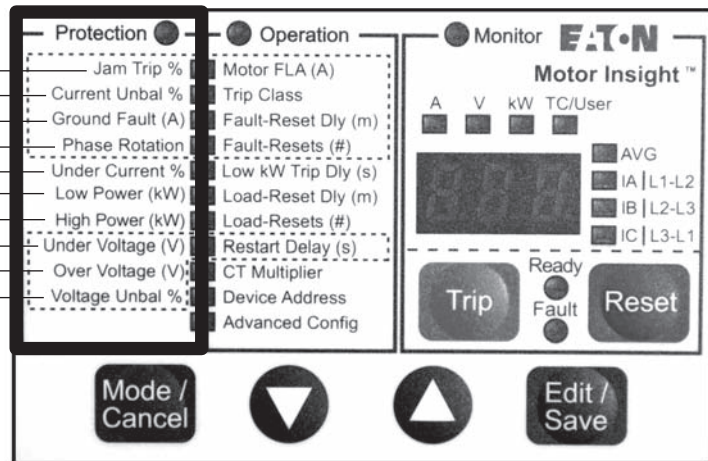
Stand on an insulating pad and make it a habit to use only one hand when checking components. Always work with another person in case an emergency occurs. Disconnect power before checking controllers or performing maintenance. Be sure equipment is properly grounded. Wear safety glasses whenever working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

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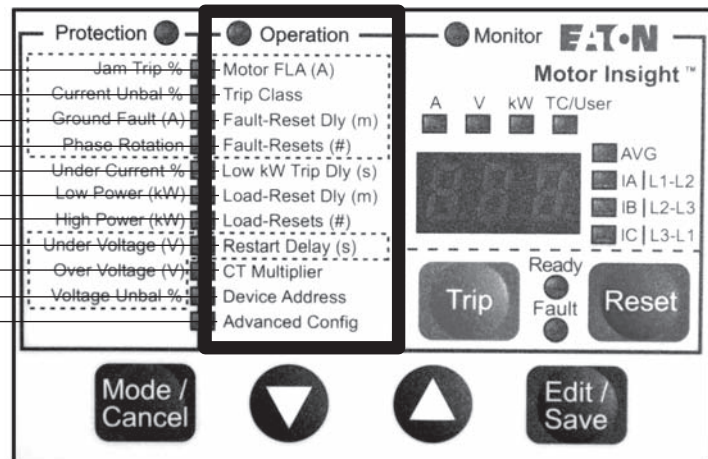
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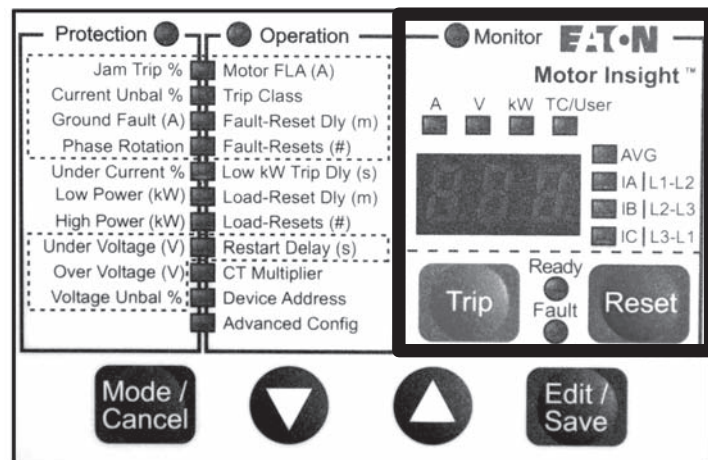
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## Chapter 1 — Introduction

### 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                                                                                                                                                                                                         |
|---------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>C441BA</b>                   | Motor Insight motor protection relay with thermal overload, power measurements, ground fault detection, and communications capability. 1 – 9 A; 240 Vac (170 – 264 Vac) (50/60 Hz)                                                |
| <b>C441BB</b>                   | Motor Insight motor protection relay with thermal overload, power measurements, ground fault detection, and communications capability. 5 – 90 A; 240 Vac (170 – 264 Vac) (50/60 Hz)                                               |
| <b>C441CA</b>                   | Motor Insight motor protection relay with thermal overload, power measurements, ground fault detection, and communications capability. 1 – 9 A; 480 Vac (323 – 528 Vac) (50/60 Hz)                                                |
| <b>C441CB</b>                   | Motor Insight motor protection relay with thermal overload, power measurements, ground fault detection, and communications capability. 5 – 90 A; 480 Vac (323 – 528 Vac) (50/60 Hz)                                               |
| <b>C441DA</b>                   | Motor Insight motor protection relay with thermal overload, power measurements, ground fault detection, and communications capability. 1 – 9 A; 600 Vac (489 – 660 Vac) (50/60 Hz)                                                |
| <b>C441DB</b>                   | Motor Insight motor protection relay with thermal overload, power measurements, ground fault detection, and communications capability. 5 – 90 A; 600 Vac (489 – 660 Vac) (50/60 Hz)                                               |
| <b>C4410109NOUI</b>             | Motor Insight motor protection relay with thermal overload, power measurements, ground fault detection, and communications capability. 1 – 9 A; 120 Vac Control Power; without internal user interface. 170 – 660 Vac (50/60 Hz)  |
| <b>C4410590NOUI</b>             | Motor Insight motor protection relay with thermal overload, power measurements, ground fault detection, and communications capability. 5 – 90 A; 120 Vac Control Power; without internal user interface. 170 – 660 Vac (50/60 Hz) |
| <b>C4410109WUI</b> <sup>①</sup> | Motor Insight motor protection relay with thermal overload, power measurements, ground fault detection, and communications capability. 1 – 9 A; 120 Vac Control Power; with internal user interface. 170 – 660 Vac (50/60 Hz)     |
| <b>C4410590WUI</b> <sup>①</sup> | Motor Insight motor protection relay with thermal overload, power measurements, ground fault detection, and communications capability. 5 – 90 A; 120 Vac Control Power; with internal user interface. 170 – 660 Vac (50/60 Hz)    |

<sup>①</sup> Potential future products.

### 1.1.2 - Motor Protection Features

**Table 1-2: Motor Protection Features**

| Feature                            | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Motor Protection                   | <p><b>Thermal Overload</b></p> <p>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:</p> <ul style="list-style-type: none"> <li>● Adjustable Trip Class setting</li> <li>● Adjustable Motor FLA setting</li> <li>● The thermal capacity of the motor is stored during power cycles to the device</li> <li>● 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.</li> </ul> <p><b>Additional Motor Protection Features</b></p> <ul style="list-style-type: none"> <li>● Jam</li> <li>● Current Unbalance</li> <li>● Phase Loss</li> <li>● Ground Fault (alarm-no-trip setting available)</li> </ul> |
| Motor Protection Reset Modes       | <ul style="list-style-type: none"> <li>● Motor Fault Reset Number of Attempts</li> <li>● 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.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Supply (Voltage) Protection        | <ul style="list-style-type: none"> <li>● Over Voltage</li> <li>● Under Voltage</li> <li>● Voltage Phase Loss</li> <li>● Phase Reversal</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Supply Protection Auto Reset Modes | <p>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.</p>                                                                                                                                                                                                                                                                                                                                                           |
| Load Protection                    | <ul style="list-style-type: none"> <li>● Under Current</li> <li>● Low Power (kW)</li> <li>● High Power (kW)</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Load Protection Auto Reset Modes   | <ul style="list-style-type: none"> <li>● Load Fault Reset Attempts</li> <li>● 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.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

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### 1.1.3 - Control Features

**Table 1-3: Control Features**

| Feature       | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Motor Control | <p>2 Output Relays —<br/>           Motor Insight<br/>           C441B(x), C441C(x), C441D(x)<br/>           1 Form 1C (SPDT) Fault Relay<br/>           1 Form A (SPST) Ground Fault Relay</p> <p>Motor Insight 120 Vac Control Powered<br/>           C4410109(x), C4410590(x)<br/>           1 Form A (SPST) Fault Relay<br/>           1 Form B (SPST) Programmable Auxiliary Relay</p> <p>1 External remote reset terminal</p>                                                                                                                                                                                                        |
| Reset Timers  | <p><b>Power-on Restart Timer</b> — 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.</p> <p><b>Motor Fault Cool-Down Timer</b> — This timer inhibits a restart after a Motor Protection Fault. The time-out period is set in minutes.</p> <p><b>Load Fault Timer</b> — 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.</p> |

### 1.1.4 - Monitoring Features

**Table 1-4: Monitoring Features**

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





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## 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                                                                                                                              |
| Over Voltage Category per UL 508 | III                                                                                                                            |
| Altitude                         | 2000 m                                                                                                                         |
| Vibration                        | Motor Insight C441B(x), C441C(x), C441D(x): 3g in any direction<br>Motor Insight C4410109(x), C4410590(x): 2g 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 (CISPR 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 (CISPR 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<br>10V/m 80 MHz – 1000 MHz<br>80% Amplitude Modulated 1 kHz sine wave.                                                                                                                                                    |
| Conducted Immunity                      | IEC 60947-4-1<br>140 dBuV (10V rms) 150 kHz – 80 MHz                                                                                                                                                                                    |
| Fast Transient Immunity                 | IEC 60947-4-1 (Table 13) IEC 6100-4-4<br>+/-2 kV using direct method.                                                                                                                                                                   |
| Surge Immunity                          | IEC 60947-4-1 (Table 13)<br>IEC 61000-4-5 Class 4.<br>3-Phase Power Inputs:<br>+/-2 kV line-to-line (DM)<br>+/-4 kV line-to-ground (CM)<br>User IO and Communication Lines:<br>+/-1 kV line-to-line (DM)<br>+/-2 kV line-to-ground (CM) |
| Voltage Variations Immunity             | IEC 60947-4-1<br>30% dip, @100 ms<br>60% dip @ 10 ms<br>>95% interrupt @ 5 ms                                                                                                                                                           |
| Power Frequency Magnetic Field Immunity | IEC 60947-4-1<br>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 |                                                                                                                     |                                        |                                                 |
| <b>C441BA</b>                               | 1 to 9             | 240 Vac                | 5,000 A @ 240 Vac                                           | 35 A           | 35 A                     | 100 kA @ 240 Vac<br>100 kA @ 240 Vac                                                                                | 35 A<br>—                              | —<br>FDC3035L                                   |
| <b>C441CA</b>                               | 1 to 9             | 480 Vac                | 5,000 A @ 480 Vac                                           | 35 A           | 35 A                     | 100 kA @ 480 Vac<br>100 kA @ 480 Vac                                                                                | 35 A<br>—                              | —<br>FDC3035L                                   |
| <b>C441DA</b>                               | 1 to 9             | 600 Vac                | 5,000 A @ 600 Vac                                           | 35 A           | 35 A                     | 100 kA @ 600 Vac<br>35 kA @ 600 Vac                                                                                 | 35 A<br>—                              | —<br>FDC3035L                                   |
| <b>C441BB</b>                               | 5 to 90            | 240 Vac                | 10,000 A @ 240 Vac                                          | 350 A          | 350 A                    | 100 kA @ 240 Vac<br>100 kA @ 240 Vac                                                                                | 350 A<br>—                             | —<br>KDC3350                                    |
| <b>C441CB</b>                               | 5 to 90            | 480 Vac                | 10,000 A @ 480 Vac                                          | 350 A          | 350 A                    | 100 kA @ 480 Vac<br>100 kA @ 480 Vac                                                                                | 350 A<br>—                             | —<br>KDC3350                                    |
| <b>C441DB</b>                               | 5 to 90            | 600 Vac                | 10,000 A @ 600 Vac                                          | 350 A          | 350 A                    | 100 kA @ 600 Vac<br>65 kA @ 600 Vac                                                                                 | 350 A<br>—                             | —<br>KDC3350                                    |
| <b>C4410109 NOUI</b><br><b>C4410109 WUI</b> | 1 to 9             | 600 Vac                | 5,000 A @240 Vac<br>5,000 A @480 Vac<br>5,000 A @600 Vac    | 35 A           | 35 A                     | 100 kA @ 240 Vac<br>100 kA @ 240 Vac<br>100 kA @ 480 Vac<br>100 kA @ 480 Vac<br>100 kA @ 600 Vac<br>35 kA @ 600 Vac | 35 A<br>—<br>35 A<br>—<br>35 A<br>—    | —<br>FDC3035L<br>—<br>FDC3035L<br>—<br>FDC3035L |
| <b>C4410590 NOUI</b><br><b>C4410590 WUI</b> | 5 to 90            | 600 Vac                | 10,000 A @240 Vac<br>10,000 A @480 Vac<br>10,000 A @600 Vac | 350 A          | 350 A                    | 100 kA @ 240 Vac<br>100 kA @ 240 Vac<br>100 kA @ 480 Vac<br>100 kA @ 480 Vac<br>100 kA @ 600 Vac<br>65 kA @ 600 Vac | 350 A<br>—<br>350 A<br>—<br>350 A<br>— | —<br>KDC3350<br>—<br>KDC3350<br>—<br>KDC3350    |

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**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 |
| <b>C441BA</b>                                 | 1 to 9             | 240 Vac                | 1,000 A @ 240 Vac                     | 35 A       | EGH3030FFG                |
| <b>C441CA</b>                                 | 1 to 9             | 480 Vac                | 1,000 A @ 480 Vac                     | 35 A       | EGH3030FFG                |
| <b>C441DA</b>                                 | 1 to 9             | 600 Vac                | 1,000 A @ 600 Vac                     | 35 A       | EGH3030FFG                |
| <b>C441BB</b>                                 | 5 to 90            | 240 Vac                | 5,000 A @ 240 Vac                     | 315 A      | LGH3300FAG                |
| <b>C441CB</b>                                 | 5 to 90            | 480 Vac                | 5,000 A @ 480 Vac                     | 315 A      | LGH3300FAG                |
| <b>C441DB</b>                                 | 5 to 90            | 600 Vac                | 5,000 A @ 600 Vac                     | 315 A      | LGH3300FAG                |
| <b>C4410109<br/>NOUI<br/>C4410109<br/>WUI</b> | 1 to 9             | 600 Vac                | 1,000 A                               | 35 A       | EGH3030FFG                |
| <b>C4410590<br/>NOUI<br/>C4410590<br/>WUI</b> | 5 to 90            | 600 Vac                | 5,000 A                               | 315 A      | LGH3300FAG                |

## 2.4 - Electrical Ratings

**Table 2-5: Electrical Ratings**

| Type                                                 | Rating                                             | Description                                                                                           |
|------------------------------------------------------|----------------------------------------------------|-------------------------------------------------------------------------------------------------------|
| Rated Motor Input Voltage — C441B(x)                 | 200 – 240 Vac; (50/60 Hz)                          | Voltage Tolerance: +10%/-15%<br>Frequency Tolerance: +/-5%<br>Bandwidth: 540 Hz<br>Accuracy: 2%       |
| Rated Motor Input Voltage — C441C(x)                 | 380 – 415 Vac; (50/60 Hz) & 440 – 480 Vac; (60 Hz) |                                                                                                       |
| Rated Motor Input Voltage — C411D(x)                 | 575 – 600 Vac; (60 Hz)                             |                                                                                                       |
| Rated Motor Input Voltage — C4410109(x), C4410590(x) | 200 – 600 Vac (50/60 Hz)                           | Accuracy: 2%                                                                                          |
| Rated Current (100% FLA) 90 A Unit                   | 5 – 90 A rms                                       |                                                                                                       |
| Rated Current (100% FLA) 9 A Unit                    | 1 – 9 A rms                                        |                                                                                                       |
| Overload Current Range 90 A Unit                     | 5 A – 720 A rms                                    | Overload protection up to 8 x FLA.                                                                    |
| Overload Current Range 9 A Unit                      | 1 A – 72 A rms                                     |                                                                                                       |
| Line Frequency                                       | 47 – 63 Hz                                         | —                                                                                                     |
| 2 Output Relays                                      | B300 Pilot Duty                                    | 5A Thermal Continuous Current<br>30A Make, 3.00 A Break @ 120 Vac<br>15A Make, 1.50 A Break @ 240 Vac |

## 2.5 - Current Ratings

For the high range model, 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)         |

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## Chapter 3 — Receipt/Unpacking

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 **WARNING**

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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.



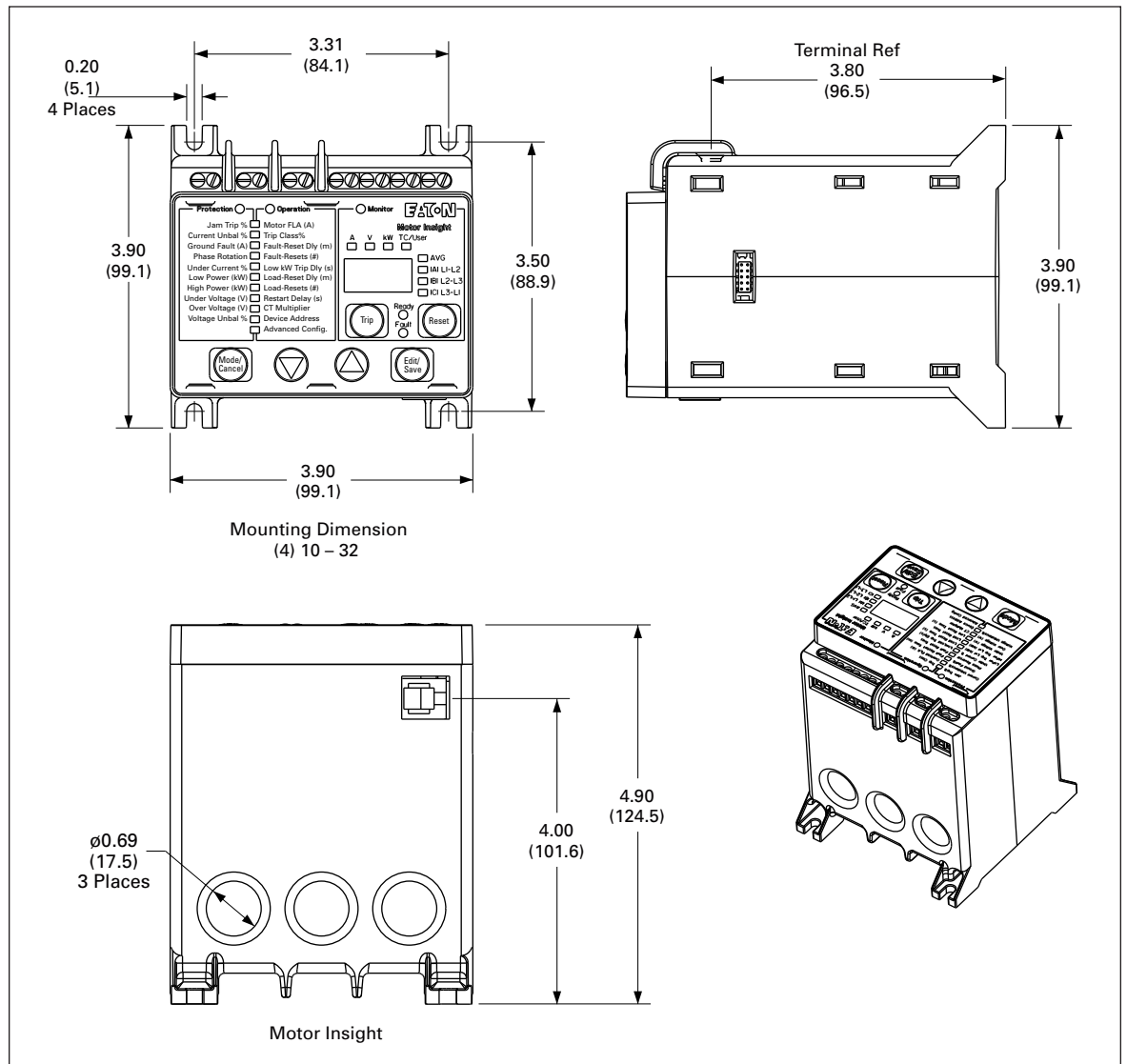
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## Chapter 4 — Installation and Connections

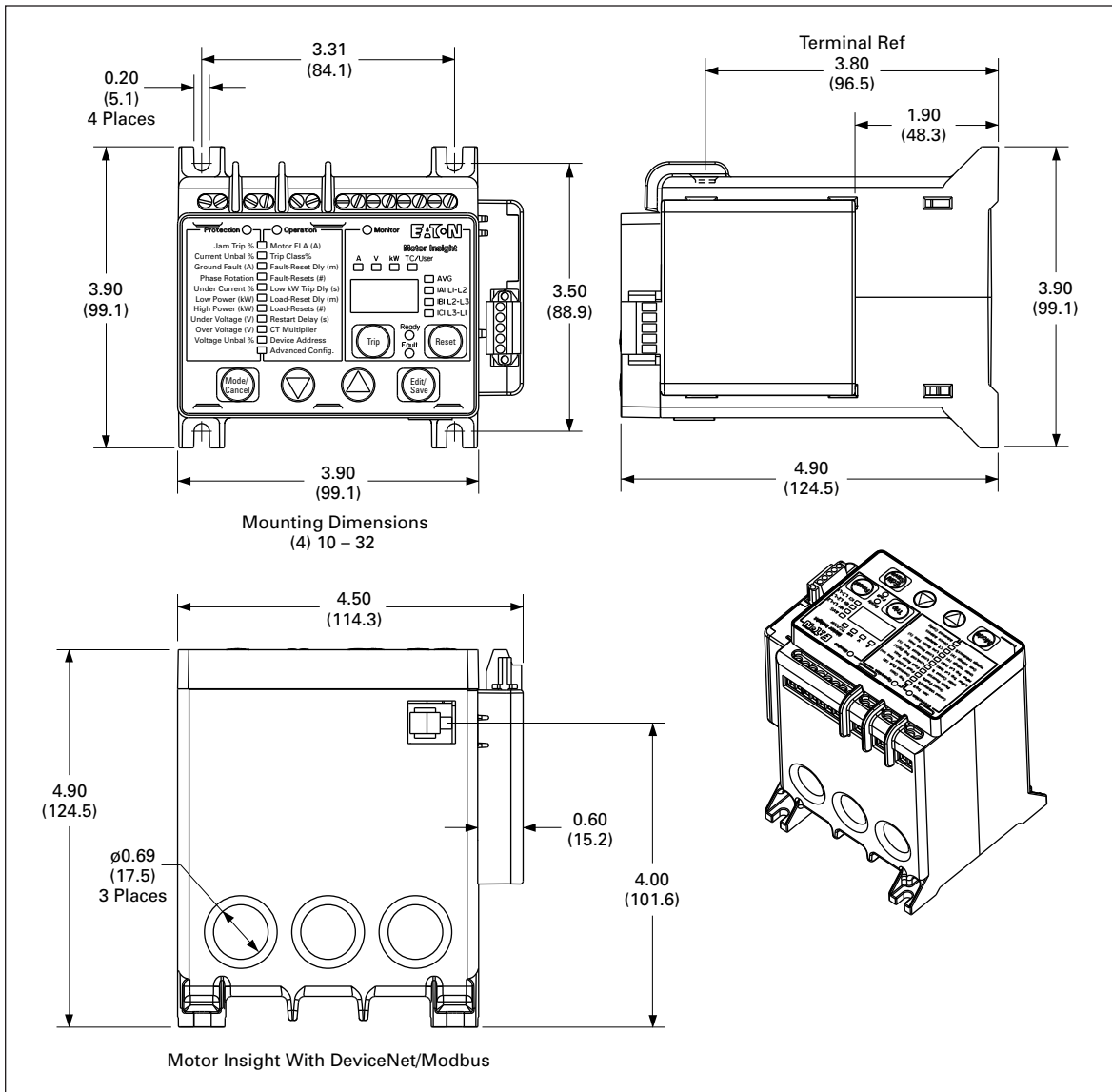
### 4.1 - Mounting

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 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**

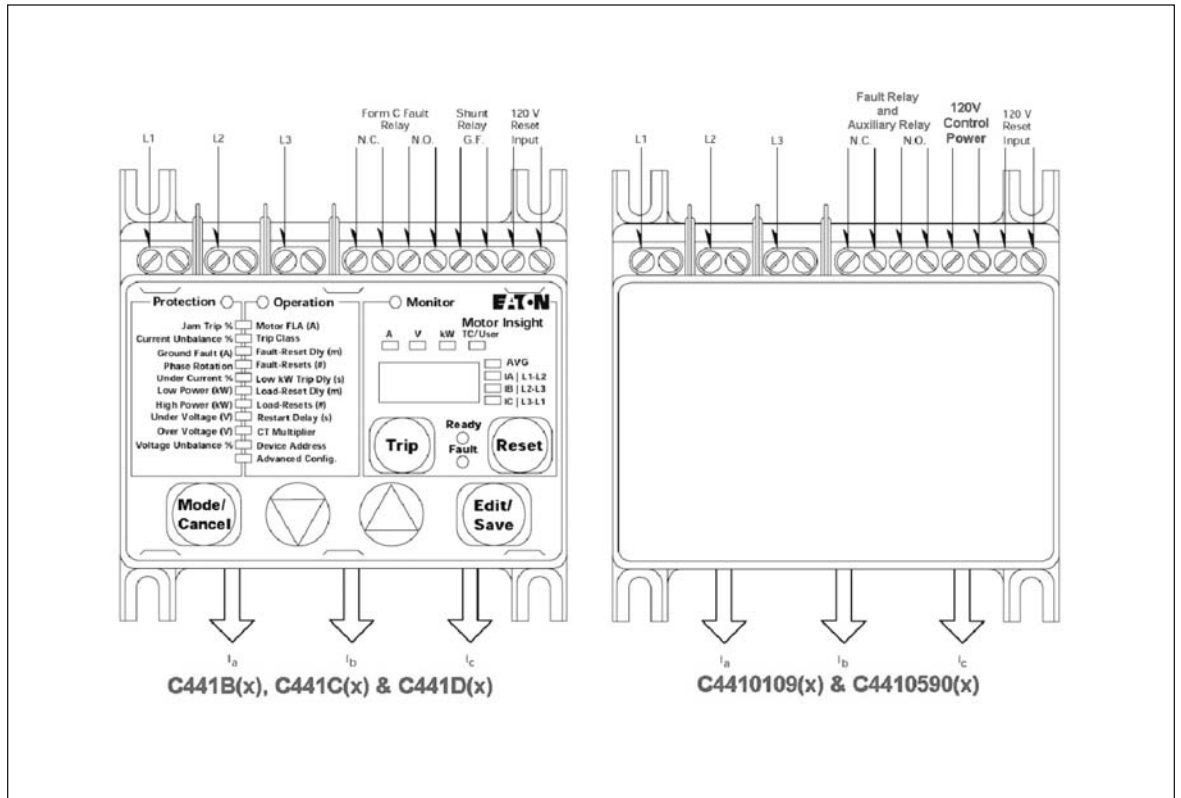
**Note:** All wires must be sized according to applicable standards.



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**4.2.1 - Overview**

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



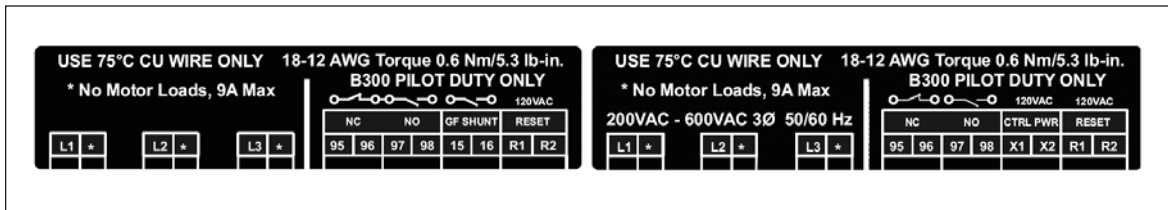
**Figure 4-3: Motor Insight Base Connections**

**4.2.2 - Terminals**

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

C441B(x), C441C(x), C441D(x):

C4410109(x), C4410590(x):



**Figure 4-4: Motor Insight Terminal Block**

**Table 4-1: Terminal Block Connections**

| Name                                | Designation        | Input                | Description                                                                                                                                                                                                                                                        |
|-------------------------------------|--------------------|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Line Voltage                        | L1, L2, L3         | Rated Voltage        | Three-Phase Line Voltage Input: <ul style="list-style-type: none"> <li>• L1, L2, L3 connections must correspond to the respective CT1, CT2, CT3 current leads.</li> <li>• * Terminal provided for wiring control power transformer (9 A max. capacity).</li> </ul> |
| <b>C441B(x), C441C(x), C441D(x)</b> |                    |                      |                                                                                                                                                                                                                                                                    |
| Overload State                      | 95/96              | UL 508 B300          | Form 1C Contact:<br>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:<br>Contact closes when a ground fault is active.                                                                                                                                                                                                   |
| Reset Input                         | R1/R2              | 120 Vac<br>+10%/-15% | Fault Reset Input:<br>IEC 61131-2 Type 1 digital input.                                                                                                                                                                                                            |
| <b>C4410109(x), C4410590(x)</b>     |                    |                      |                                                                                                                                                                                                                                                                    |
| Overload State                      | 95/96              | UL 508 B300          | 95/96 Contact opens when the unit is faulted, or unpowered.                                                                                                                                                                                                        |
|                                     | 96 & 97 (Isolated) |                      | 96 & 97 are isolated.                                                                                                                                                                                                                                              |
|                                     | 97/98              |                      | 97/98 Contact closes when the unit is faulted or unpowered.                                                                                                                                                                                                        |
| Control Power                       | X1/X2              | 120 Vac<br>+10%/-15% | 120 Vac Control Power Input                                                                                                                                                                                                                                        |
| Reset Input                         | R1/R2              | 120 Vac<br>+10%/-15% | Fault Reset Input:<br>IEC 61131-2 Type 1 digital input.                                                                                                                                                                                                            |

By factory default, Motor Insight is to be connected with ACB 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**.

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**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**.

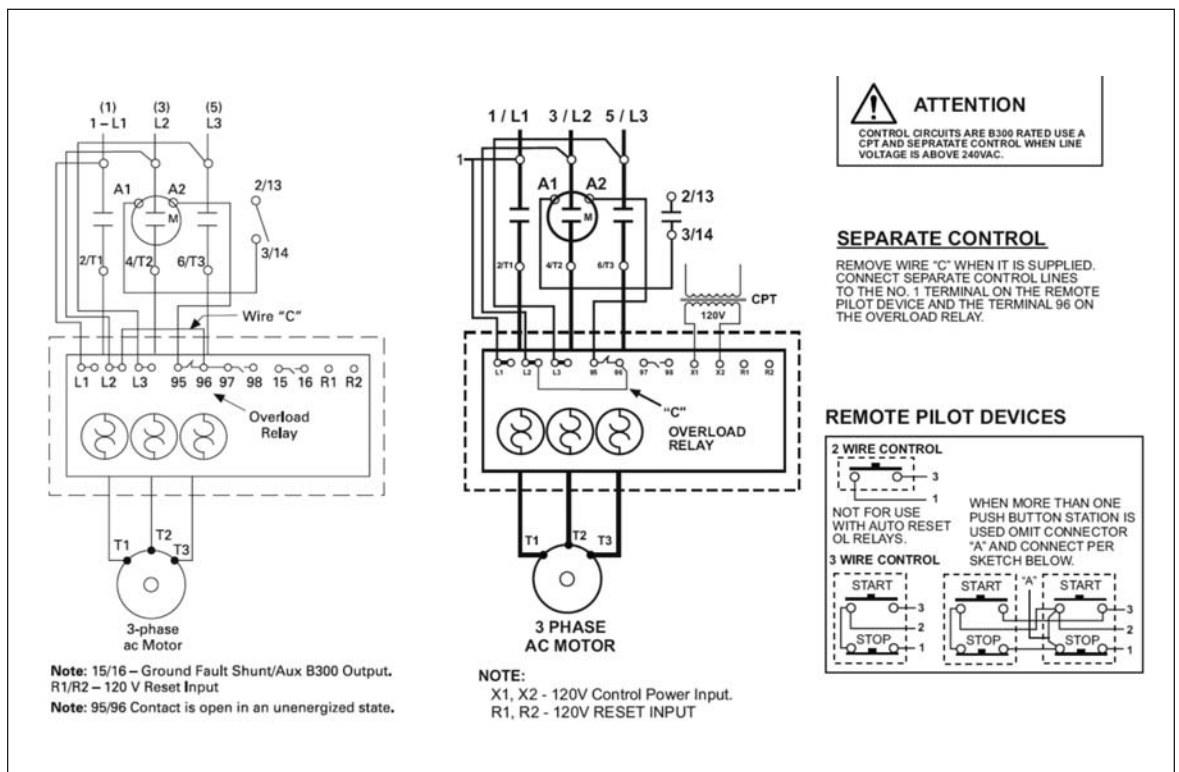
For use on low amperage applications, multiple wraps of the motor power conductors should be made according to **Section 2.5**.

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**

C441B(x), C441C(x), C441D(x):

C4410109(x), C4410590(x):



**Figure 4-5: Typical Starter Application**



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## 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.

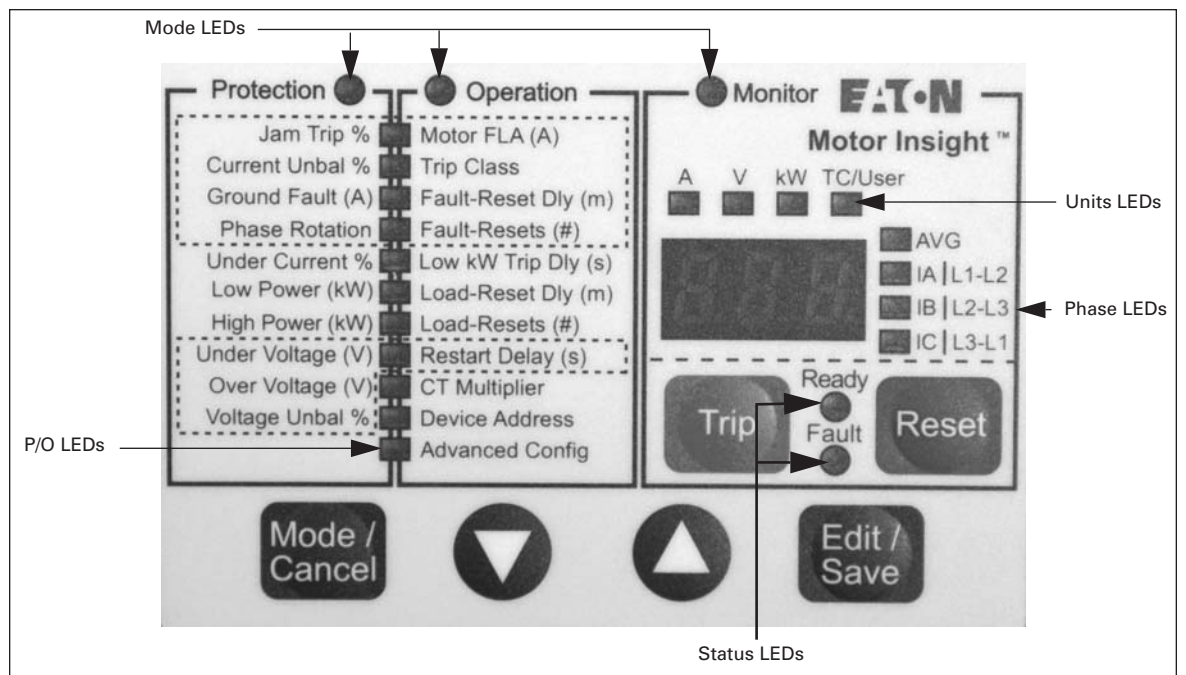


Figure 5-1: Overview of Interface LEDs

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

**Table 5-1: User Interface Components**

| Component | Interface     | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|-----------|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Buttons   | Mode/Cancel   | <ul style="list-style-type: none"> <li>Used to navigate the three operational modes (“Protection”, “Operation”, “Monitor”).</li> <li>Pressing this button when editing a parameter exits the editing mode WITHOUT saving the new parameter value.</li> </ul>                                                                                                                                                                                                                                                                                                              |
|           | Up (Δ)        | <ul style="list-style-type: none"> <li>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.</li> <li>In the “Monitor” mode, this button navigates up through the display parameter list.</li> </ul>                                                                                                                                                                                                         |
|           | Down (▽)      | <ul style="list-style-type: none"> <li>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.</li> <li>In the “Monitor” mode, this button navigates down through the display parameter list.</li> </ul>                                                                                                                                                                                                     |
|           | Edit/Save     | <ul style="list-style-type: none"> <li>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.</li> <li>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.</li> <li>This button has no effect in the “Monitor” mode.</li> </ul>                                                         |
|           | Trip          | <ul style="list-style-type: none"> <li>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. For C441B(x), C441C(x) and C441D(x), holding the button for 5 seconds causes the Ground Fault relay to go to close. For C4410109(x) and C4410590(x), if the auxiliary relay is configured, holding the button for 5 seconds causes the auxiliary relay to go to close.</li> <li>Once pressed, the unit will display the relay off message “rOF.” This setting will be retained through a power cycle.</li> </ul> |
|           | Reset         | <ul style="list-style-type: none"> <li>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.</li> </ul>                                                                                                                                                                                                                                                                                                                                 |
|           | Mode and Trip | <ul style="list-style-type: none"> <li>When the Motor Insight is faulted, the fault history can be accessed by simultaneously pressing the Mode and Trip buttons.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                              |

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**Table 5-1: User Interface Components (Continued)**

| Component     | Interface            | Description                                                                                                                                                                                                                                                                                                                                                                       |
|---------------|----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Discrete LEDs | Status               | <b>Ready Fault</b><br>On Off — indicates that the Motor Insight is not tripped and “Ready” to run.<br>Flash On — indicates that the device is tripped, but will attempt an auto-reset.<br>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. <ul style="list-style-type: none"> <li>• A = amps</li> <li>• V = volts</li> <li>• kW = kilowatts</li> <li>• TC/User = By default the thermal capacity is shown, the user can also configure this parameter. See <b>Table 6-29</b>.</li> </ul> |
|               | Phase                | Indicates the selected phase. Used in conjunction with the Unit LEDs to identify the display parameter. <ul style="list-style-type: none"> <li>• AVG = average of all phases</li> <li>• IA   L1-L2 — phase A current or L1-L2 voltage</li> <li>• IB   L2-L3 — phase B current or L2-L3 voltage</li> <li>• IC   L3-L1 — phase C current or L3-L1 voltage</li> </ul>                |
| 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** ( $\Delta$ ) and **down-button** ( $\nabla$ ) 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<br>xx.x if Avg < 100<br>xxx if Avg $\geq$ 100 | Mode – Monitor<br>Units – A<br>Phase – AVG<br>Status – Ready        |
| Down – ( $\nabla$ ) | Phase A RMS Current                                           | x.xx if Ia < 10<br>xx.x if Ia < 100<br>xxx if Ia $\geq$ 100    | Mode – Monitor<br>Units – A<br>Phase – IA   LI-L2<br>Status – Ready |
| Down – ( $\nabla$ ) | Phase B RMS Current                                           | x.xx if Ib < 10<br>xx.x if Ib < 100<br>xxx if Ib $\geq$ 100    | Mode – Monitor<br>Units – A<br>Phase – IB   L2-L3<br>Status – Ready |
| Down – ( $\nabla$ ) | Phase C RMS Current                                           | x.xx if Ic < 10<br>xx.x if Ic < 100<br>xxx if Ic $\geq$ 100    | Mode – Monitor<br>Units – A<br>Phase – IC   L3-L1<br>Status – Ready |
| Down – ( $\nabla$ ) | Average RMS Voltage                                           | 480                                                            | Mode – Monitor<br>Units – V<br>Phase – AVG<br>Status – Ready        |
| Down – ( $\nabla$ ) | Phase A RMS Voltage                                           | 480                                                            | Mode – Monitor<br>Units – V<br>Phase – IA   LI-L2<br>Status – Ready |
| Down – ( $\nabla$ ) | Phase B RMS Voltage                                           | 480                                                            | Mode – Monitor<br>Units – V<br>Phase – IB   L2-L3<br>Status – Ready |
| Down – ( $\nabla$ ) | Phase C RMS Voltage                                           | 480                                                            | Mode – Monitor<br>Units – V<br>Phase – IC   L3-L1<br>Status – Ready |
| Down – ( $\nabla$ ) | Total Motor Power (kW)                                        | X.XX if kW < 10<br>XX.X if kW < 100<br>XXX if kW $\geq$ 100    | Mode – Monitor<br>Units – kW<br>Phase – AVG<br>Status – Ready       |
| Down – ( $\nabla$ ) | Motor Thermal Capacity/User Selected (see <b>Table 6-29</b> ) | 0 – 250                                                        | Mode – Monitor<br>Units – TC<br>Phase – None<br>Status – Ready      |



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### 5.3.2 - Display Messages

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

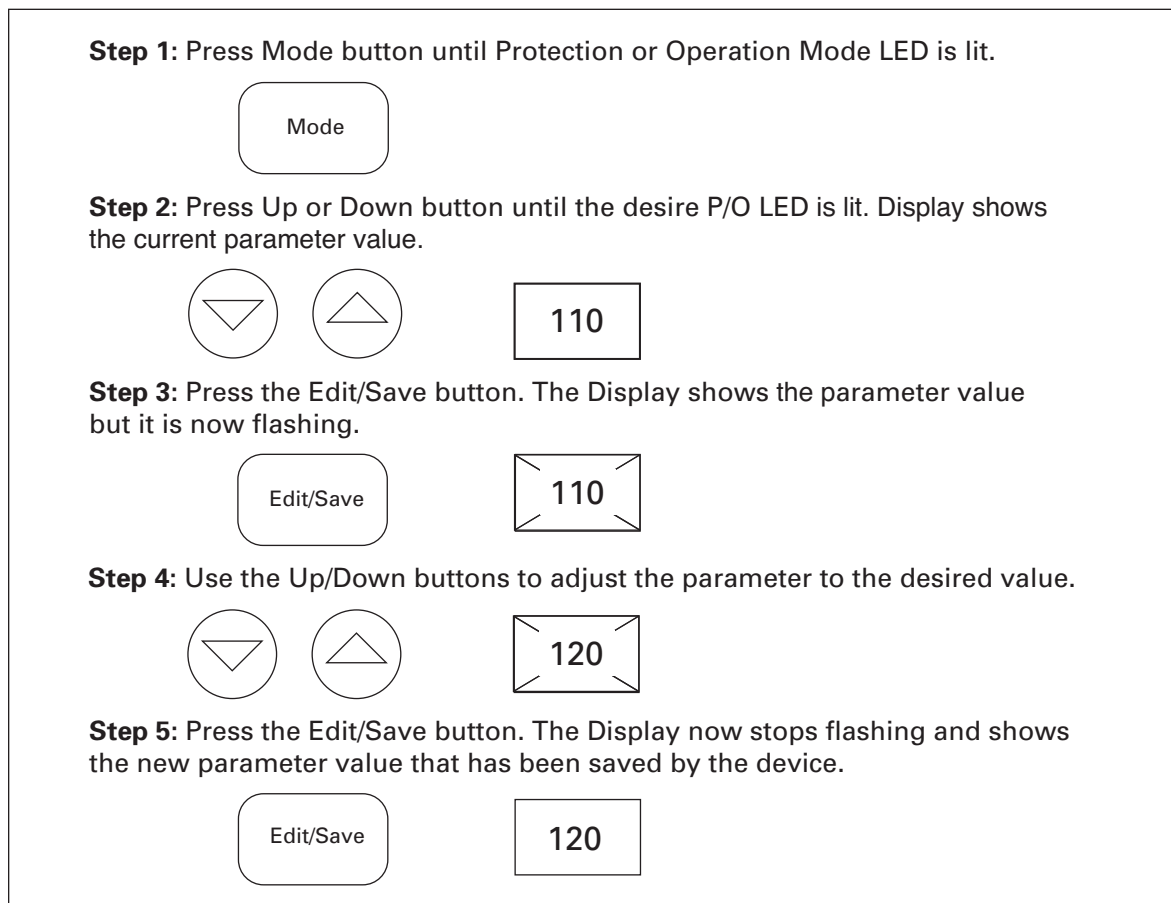
| Message | Description                                                                                                                       |
|---------|-----------------------------------------------------------------------------------------------------------------------------------|
| rOF     | The 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 unbalance 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 <b>Section 5.6</b>                                                                                              |
| E0X     | Error Code — see <b>Section 5.6</b>                                                                                               |
| A.XX    | Auxiliary Relay Codes (120V Control Power models only) – see <b>Section 5.6</b>                                                   |

## 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/Cancel button.



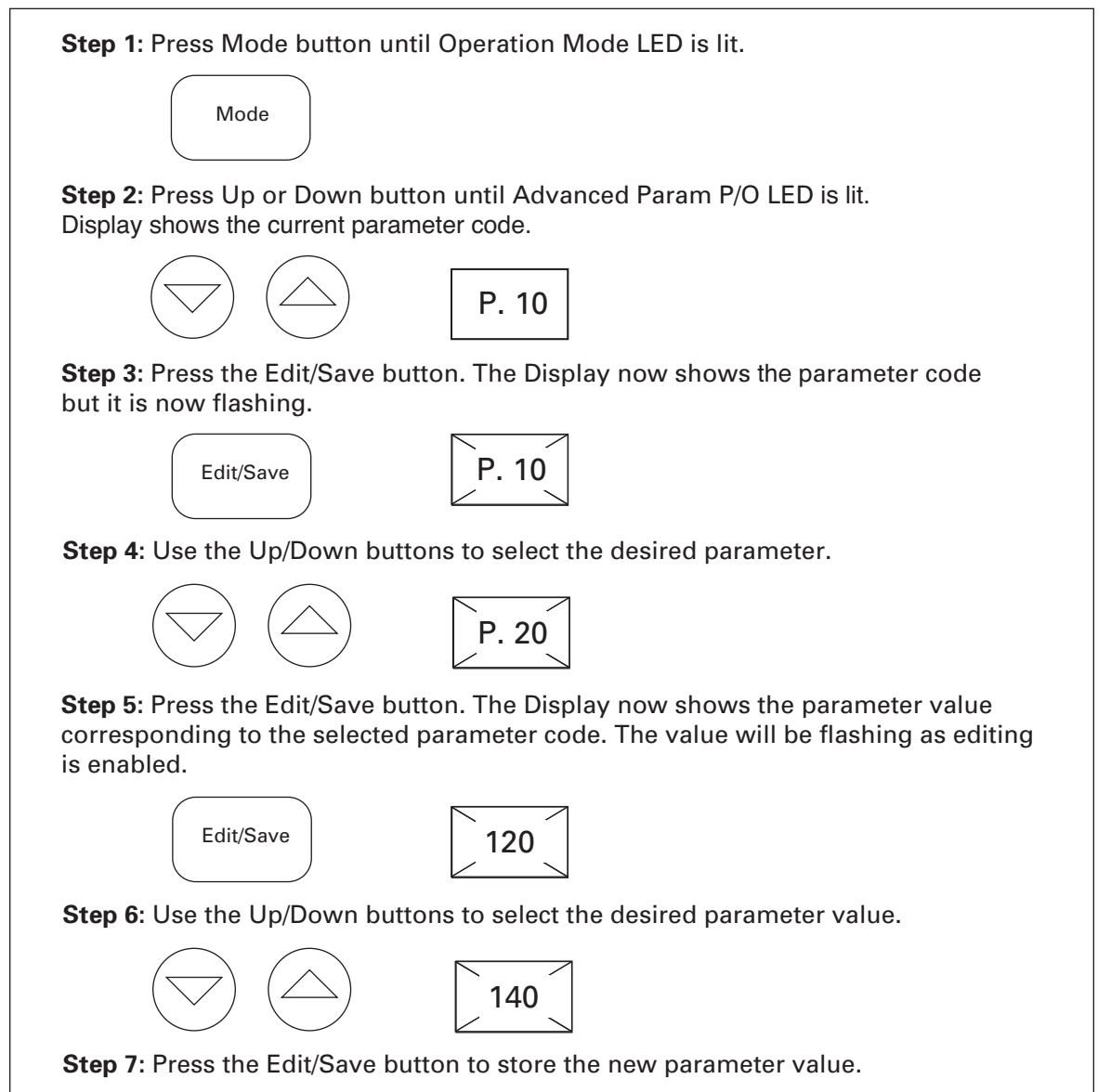
**Figure 5-2: Motor Protection/Basic Programming Set Points**

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## 5.5 - Motor Protection/Advanced 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 6-29** for a table of advanced parameters.

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



**Figure 5-3: Motor Protection/Advanced 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.

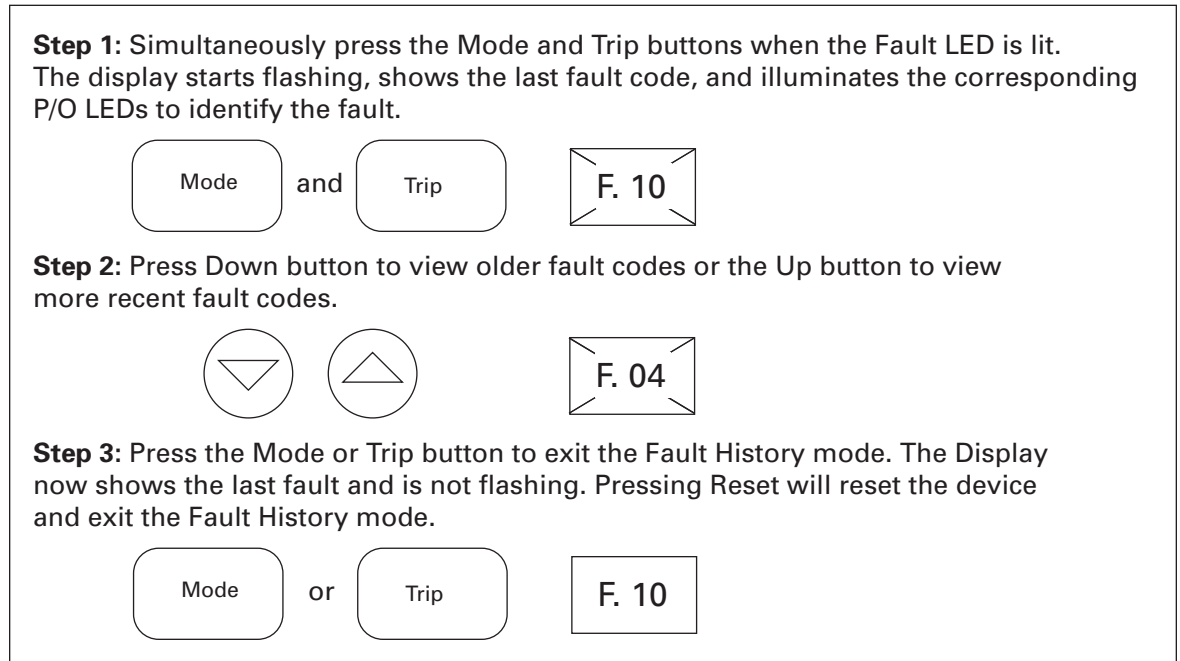
| Fault                       | #   | User Interface |                                      |         | Notes                                                |
|-----------------------------|-----|----------------|--------------------------------------|---------|------------------------------------------------------|
|                             |     | 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                                      |

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**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.



**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 unit and user interface has been lost.                                                                                              |
| E01        | The user interface clock has failed. Pressing RESET on the User Interface will allow the user interface to continue to function, but performance will be degraded. |
| E02        | A switch on the user interface is active (stuck) at power-up.                                                                                                      |
| 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.



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## 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 6-29** 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 | 9 Amp Model<br>1, 2, 150, 300, 600<br><br>90 Amp Model<br>1, 2, 3, 4 | N/A                                        | 1                         | Settable from the UI —<br>Mode <u>P/O LED</u><br>Operation <u>CT Multiplier</u><br><br>Modify this setting only if external CTs or multiple passes of motor leads are utilized to extend the current range of the Motor Insight. |
| Motor FLA     | See <b>Tables 6-2</b><br>and <b>6-3</b>                              | .1A (90 Amp Models)<br>.01A (9 Amp Models) | Minimum for Configuration | Settable from the UI —<br>Mode <u>P/O LED</u><br>Operation <u>Motor FLA</u>                                                                                                                                                      |
| Trip Class    | 5 – 30                                                               | 1                                          | 20                        | Settable from the UI —<br>Mode <u>P/O LED</u><br>Operation <u>Trip Class</u>                                                                                                                                                     |

For the 90 amp model, 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: 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: 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.

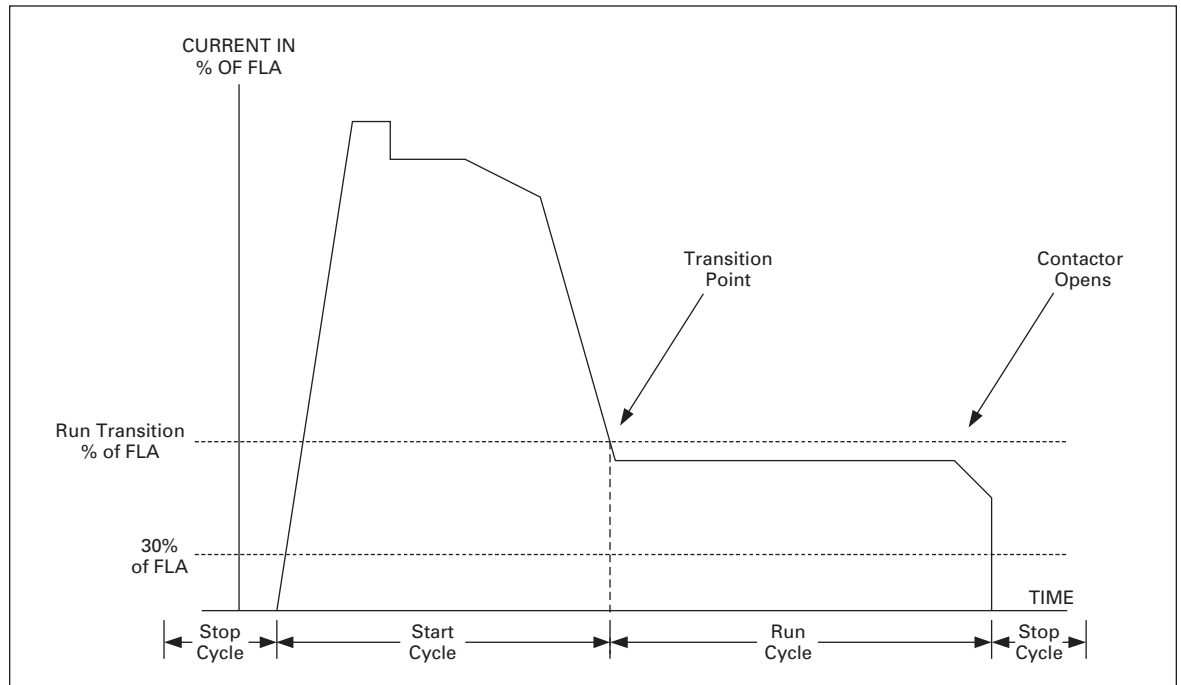
**Note:** Motor Insight will transition to run based on time or current level, whichever comes first.

**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 —<br>Mode <u>P/O LED</u><br>Operation Advanced Config (P.17) |
| Run Transition Time    | 1 – 180 Seconds | 1 Second | 10 Seconds | Settable from the UI —<br>Mode <u>P/O LED</u><br>Operation Advanced Config (P.18) |



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**Figure 6-1: Transition Time Current Curve**

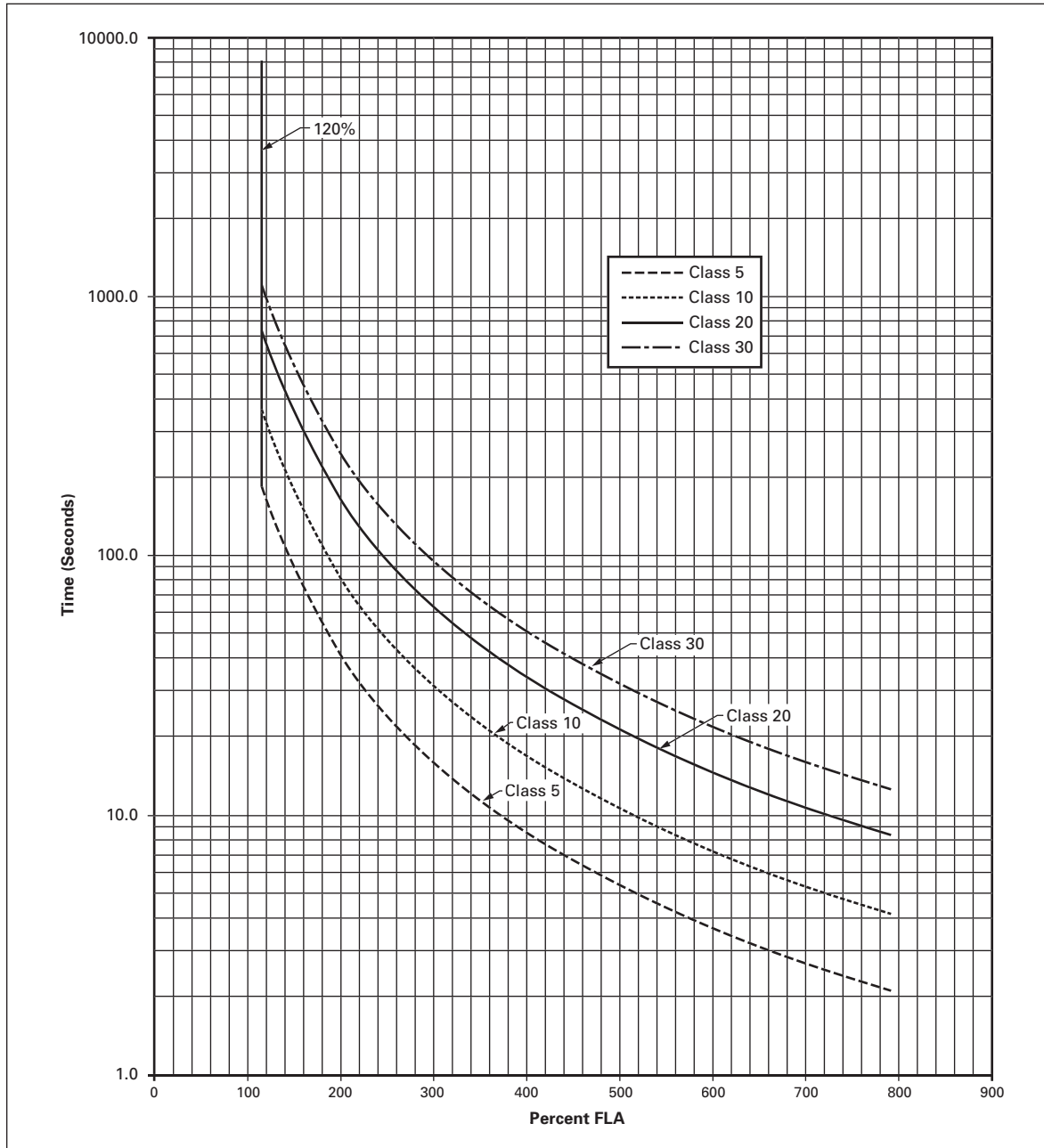
### 6.3 - Thermal Overload

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**

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## 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 sections.

- 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 than 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 —<br>Mode <u>P/O LED</u><br>Operation Fault Reset Dly (m)<br><br>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<br>0L.1 – 0L.4*,<br>0L.A | 1        | 0 = Manual Mode | Settable from the UI —<br>Mode <u>P/O LED</u><br>Operation Fault Resets (#)<br><br>Auto reset number of attempts:<br>0 = Manual reset required.<br>1 – 4 = Attempt desired number of auto resets (semi-automatic mode).<br>A = Automatic Reset Mode.<br><br>The Fault Reset (#) will reset after the motor has been running for 15 minutes.<br>*The OL. Prefix indicates that the setting applies to Overload trips as well as 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<br>(50 – 400% of FLA for 120 Vac Control Power models), OFF | 1%       | 400% of FLA | Settable from the UI —<br>Mode <u>P/O LED</u><br>Protection Jam Trip %            |
| Jam Trip Delay        | 1 – 20 Seconds                                                                | 1 Second | 2 Seconds   | Settable from the UI —<br>Mode <u>P/O LED</u><br>Operation Advanced Config (P.08) |

**6.4.3.3 - Current Unbalance**

Current unbalance is defined using the following equation:

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

**The max. Deviation from avg. (Phase Irms)** is defined as max. (Phase Irms) – avg. (Phase Irms), or avg. (Phase Irms) – min. (Phase Irms), whichever is greater. 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.

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

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**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<br>1 = Alarm-No-Trip Enabled<br><br>Mode Protection      P/O LED Advanced Config (P.06) |

**6.4.4.3 - Under Voltage**

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 under voltage 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 under voltage feature.

**Table 6-12: Under Voltage**

| Parameter                       | Set Point Range                                                                                          | Step     | Default                                          | Notes                                                                        |
|---------------------------------|----------------------------------------------------------------------------------------------------------|----------|--------------------------------------------------|------------------------------------------------------------------------------|
| Under Voltage Trip Pickup Level | 170 – 264 (240 Vac)<br>323 – 528 (480 Vac)<br>489 – 660 (600 Vac)<br>170 – 660 (120 Vac Control Powered) | 1 Volt   | 216 Volts<br>432 Volts<br>540 Volts<br>216 Volts | Settable from the UI —<br>Mode Protection      P/O LED Under Voltage         |
| Under Voltage Trip Delay        | 1 – 20 Seconds                                                                                           | 1 Second | 10 Seconds                                       | Settable from the UI —<br>Mode Operation      P/O LED Advanced Config (P.14) |

**6.4.4.4 - Over Voltage**

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 over voltage 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 over voltage feature.

**Table 6-13: Over Voltage**

| Parameter                      | Set Point Range                                                                                          | Step     | Default                                          | Notes                                                                        |
|--------------------------------|----------------------------------------------------------------------------------------------------------|----------|--------------------------------------------------|------------------------------------------------------------------------------|
| Over Voltage Trip Pickup Level | 170 – 264 (240 Vac)<br>323 – 528 (480 Vac)<br>489 – 660 (600 Vac)<br>170 – 660 (120 Vac Control Powered) | 1 Volt   | 264 Volts<br>528 Volts<br>632 Volts<br>632 Volts | Settable from the UI —<br>Mode Protection      P/O LED Over Voltage          |
| Over Voltage Trip Delay        | 1 – 20 Seconds                                                                                           | 1 Second | 10 Seconds                                       | Settable from the UI —<br>Mode Operation      P/O LED Advanced Config (P.15) |

**6.4.4.5 - Voltage Unbalance**

Voltage unbalance is estimated using the following equation.

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

The max. Deviation from avg. (Phase Vrms) is defined as max. (Phase Vrms) – avg. (Phase Vrms), or avg. (Phase Vrms) – min. (Phase Vrms), whichever is greater. 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 —<br><u>Mode</u> <u>P/O LED</u><br>Protection      Voltage Unbalance %     |
| Voltage Unbalance Trip Delay        | 1 – 20 Seconds  | 1 Second | 10 Seconds | Settable from the UI —<br><u>Mode</u> <u>P/O LED</u><br>Operation        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 —<br><u>Mode</u> <u>P/O LED</u><br>Protection      Phase Rotation<br><br>The settings are mapped to the following:<br>OFF = Ignore Sequencing — No Trip or Warning<br>1 = ACB<br>2 = ABC |
| 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<br>A (Auto) | 1 Minute | 20 Minutes | Settable from the UI —<br><u>Mode</u> <u>P/O LED</u><br>Operation      Load Reset Dly (m)<br><br>2 – 500 minutes = An auto reset may be attempted the set number of minutes after a load fault.<br>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 —<br><u>Mode</u> <u>P/O LED</u><br>Operation      Load Reset Tries<br><br>Auto restart number of attempts:<br>0 = Manual reset required.<br>1 – 4 = Attempt desired number of auto restarts (semi-automatic mode).<br>A = Auto mode             |



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**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 - Under Current**

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 under current feature.

**Table 6-18: Under Current**

| Parameter                       | Set Point Range            | Step     | Default   | Notes                                                                                        |
|---------------------------------|----------------------------|----------|-----------|----------------------------------------------------------------------------------------------|
| Under Current Trip Pickup Level | 10 – 90% of Motor FLA, OFF | 1%       | 50%       | Settable from the UI —<br><u>Mode</u> <u>P/O LED</u><br>Protection    Under Current %        |
| Under Current Trip Delay        | 1 – 60 Seconds             | 1 Second | 5 Seconds | Settable from the UI —<br><u>Mode</u> <u>P/O LED</u><br>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 <b>Tables 6-21</b> through <b>6-28</b> , OFF | —        | Minimum Value for Range | Settable from the UI —<br><u>Mode</u> <u>P/O LED</u><br>Protection    Low Power (kW)    |
| Low Power Trip Delay        | 1 – 60 Seconds                                   | 1 Second | 5 Seconds               | Settable from the UI —<br><u>Mode</u> <u>P/O LED</u><br>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 <b>Tables 6-21</b> through <b>6-28</b> | —    | Maximum Value in Range | Settable from the UI —<br><u>Mode</u> <u>P/O LED</u><br>Protection      High Power (kW)       |
| High Power Trip Delay        | 1 – 60 Seconds                             | 1    | 5                      | Settable from the UI —<br><u>Mode</u> <u>P/O LED</u><br>Operation      Advanced Config (P.10) |

## 6.5 - Power Tables

**Table 6-21: C441BB — 240 Vac, 5 – 90 Amperes**

| CT Multiplier | Low Power Minimum (kW) | Low Power Maximum (kW) | High Power Minimum (kW) | High Power Maximum (kW) |
|---------------|------------------------|------------------------|-------------------------|-------------------------|
| 1             | 1.60                   | 28.7                   | 4.00                    | 39.4                    |
| 2             | 0.80                   | 14.4                   | 2.00                    | 19.7                    |
| 3             | 0.50                   | 9.60                   | 1.30                    | 13.2                    |
| 4             | 0.40                   | 7.20                   | 1.00                    | 9.90                    |

**Table 6-22: C441CB — 480 Vac, 5 – 90 Amperes**

| CT Multiplier | Low Power Minimum (kW) | Low Power Maximum (kW) | High Power Minimum (kW) | High Power Maximum (kW) |
|---------------|------------------------|------------------------|-------------------------|-------------------------|
| 1             | 3.30                   | 59.9                   | 8.30                    | 82.3                    |
| 2             | 1.60                   | 30.0                   | 4.10                    | 41.2                    |
| 3             | 1.10                   | 20.0                   | 2.70                    | 27.5                    |
| 4             | 0.80                   | 15.0                   | 2.10                    | 20.6                    |

**Table 6-23: C441DB — 600 Vac, 5 – 90 Amperes**

| CT Multiplier | Low Power Minimum (kW) | Low Power Maximum (kW) | High Power Minimum (kW) | High Power Maximum (kW) |
|---------------|------------------------|------------------------|-------------------------|-------------------------|
| 1             | 4.00                   | 71.7                   | 9.90                    | 98.6                    |
| 2             | 2.00                   | 35.9                   | 4.90                    | 49.3                    |
| 3             | 1.30                   | 23.9                   | 3.30                    | 32.9                    |
| 4             | 1.00                   | 17.9                   | 2.50                    | 24.7                    |

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**Table 6-24: C441BA — 240 Vac, 1 – 9 Amperes**

| CT Multiplier | Low Power Minimum (kW) | Low Power Maximum (kW) | High Power Minimum (kW) | High Power Maximum (kW) |
|---------------|------------------------|------------------------|-------------------------|-------------------------|
| 1             | 0.10                   | 2.90                   | 0.40                    | 4.00                    |
| 2             | 0.10                   | 1.40                   | 0.20                    | 2.00                    |
| 150 (:5)      | 4.80                   | 43.0                   | 11.9                    | 59.2                    |
| 300 (:5)      | 9.50                   | 86.0                   | 23.9                    | 118                     |
| 600 (:5)      | 19.1                   | 180                    | 47.8                    | 237                     |

**Table 6-25: C441CA — 480 Vac, 1 – 9 Amperes**

| CT Multiplier | Low Power Minimum (kW) | Low Power Maximum (kW) | High Power Minimum (kW) | High Power Maximum (kW) |
|---------------|------------------------|------------------------|-------------------------|-------------------------|
| 1             | 0.30                   | 6.00                   | 0.80                    | 8.30                    |
| 2             | 0.10                   | 3.00                   | 0.40                    | 4.10                    |
| 150 (:5)      | 9.90                   | 89.8                   | 24.9                    | 123                     |
| 300 (:5)      | 19.9                   | 180                    | 49.9                    | 247                     |
| 600 (:5)      | 39.9                   | 377                    | 99.7                    | 494                     |

**Table 6-26: C441DA — 600 Vac, 1 – 9 Amperes**

| CT Multiplier | Low Power Minimum (kW) | Low Power Maximum (kW) | High Power Minimum (kW) | High Power Maximum (kW) |
|---------------|------------------------|------------------------|-------------------------|-------------------------|
| 1             | 0.30                   | 7.20                   | 1.00                    | 9.90                    |
| 2             | 0.20                   | 3.60                   | 0.50                    | 4.90                    |
| 150 (:5)      | 11.9                   | 108                    | 29.8                    | 148                     |
| 300 (:5)      | 23.9                   | 215                    | 59.7                    | 296                     |
| 600 (:5)      | 47.8                   | 451                    | 120                     | 592                     |

**Table 6-27: C4410590NOUI and C4410590WUI — 120 Vac Control Power, 5 – 90 Amperes**

| CT Multiplier | Low Power Minimum (kW) | Low Power Maximum (kW) | High Power Minimum (kW) | High Power Maximum (kW) |
|---------------|------------------------|------------------------|-------------------------|-------------------------|
| 1             | 1.60                   | 71.7                   | 4.00                    | 98.6                    |
| 2             | 0.80                   | 35.9                   | 2.00                    | 49.3                    |
| 3             | 0.50                   | 23.9                   | 1.30                    | 32.9                    |
| 4             | 0.40                   | 17.9                   | 1.00                    | 24.7                    |

**Table 6-28: C4410109NOUI and C4410109WUI — 120 Vac Control Power, 1 – 9 Amperes**

| CT Multiplier | Low Power Minimum (kW) | Low Power Maximum (kW) | High Power Minimum (kW) | High Power Maximum (kW) |
|---------------|------------------------|------------------------|-------------------------|-------------------------|
| 1             | 0.10                   | 7.20                   | 0.40                    | 9.90                    |
| 2             | 0.10                   | 3.60                   | 0.20                    | 4.90                    |
| 150 (:5)      | 4.80                   | 108                    | 11.9                    | 148                     |
| 300 (:5)      | 9.50                   | 215                    | 23.9                    | 296                     |
| 600 (:5)      | 19.1                   | 451                    | 47.8                    | 592                     |

## 6.6 - Advanced Parameters

The following table summarizes all advanced parameters.

**Table 6-29: Advanced Parameters**

| Parameter Code | Parameter Description         | Set Point Range | Default    | Notes                                                                                                                                                                                                                                             |
|----------------|-------------------------------|-----------------|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| P.00           | Modbus Baud Rate              | 1.2 – 115       | 19.2       | 1.2 = 1,200<br>2.4 = 2,400<br>4.8 = 4,800<br>9.6 = 9,600<br>19.2 = 19,200<br>38.4 = 38,400<br>57.6 = 57,600<br>115 = 115,200                                                                                                                      |
| P.01           | Modbus Parity                 | 0 – 2           | 0          | 0 = Even (1 Stop Bit)<br>1 = Odd (1 Stop Bit)<br>2 = No Parity (2 Stop Bits)                                                                                                                                                                      |
| P.02           | User Interface Edit Lock      | 0 – 1           | 0          | 0 = UI Editing Enabled (Unlocked)<br>1 = UI Editing Disabled (Locked)<br>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<br>0 = Thermal Capacity (%)<br>1 = Power Factor (0.0 – 1.0)<br>2 = Voltage Unbalance %<br>3 = Current Unbalance %<br>4 = Ground Current<br>5 = Motor Run Hours<br>6 = Frequency |
| P.04           | Comm Loss Behavior            | 1 – 2           | 1          | 1 = Fault On Comm Loss<br>2 = Hold Last State on a Comm Loss                                                                                                                                                                                      |
| P.05           | Configuration Reset           | 0, 1, 2         | N/A        | 0 = No Change<br>1 = Power Cycle<br>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)<br>1 = Alarm-No-Trip                                                                                                                                               |
| P.07           | Ground Fault Trip Mode        | 0 – 1           | 0          | 0 = Trip On Fault<br>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           | Under Current Trip Delay      | 1 – 60 Seconds  | 5 Seconds  | —                                                                                                                                                                                                                                                 |

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**Table 6-29: Advanced Parameters (Continued)**

| Parameter Code | Parameter Description           | Set Point Range | Default    | Notes                                                                                                                                                                                                                                                                                                                                                        |
|----------------|---------------------------------|-----------------|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| P.14           | Under Voltage 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           | Over Voltage 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 <b>Figure 6-1</b>                                                                                                                                                                                                                                                                                                                                        |
| P.18           | Run Transition Time             | 1 – 180 Seconds | 10 Seconds | See <b>Figure 6-1</b>                                                                                                                                                                                                                                                                                                                                        |
| P.19           | Auxiliary Relay Configuration 1 | 0 – 63 Seconds  | 0          | Only available for 120V Control Power models. Each bit of this configuration parameter enables (value 1) or disables (value 0) a fault for the auxiliary relay. The meanings of the bits are:<br><br>0x01: Ground Fault<br>0x02: Voltage Unbalance<br>0x04: Current Unbalance<br>0x08: Under Current<br>0x10: Phase Loss<br>0x20: Jam                        |
| P.20           | Auxiliary Relay Configuration 2 | 0 – 127 Seconds | 0          | Only available for 120V Control Power models. Each bit of this configuration parameter enables (value 1) or disables (value 0) a fault for the auxiliary relay. The meanings of the bits are:<br><br>0x01: Low Power<br>0x02: High Power<br>0x04: Over Voltage<br>0x08: Under Voltage<br>0x10: Phase Order<br>0x20: Overload<br>0x40: Supply Frequency Fault |
| P.21           | Auxiliary Relay Reset Delay     | 0 – 500 Minutes | 0          | Only available for 120V Control Power models.<br><br>0: Automatic reset of the auxiliary relay disabled<br>1 – 500: automatic auxiliary relay reset delay since last auxiliary relay fault                                                                                                                                                                   |

**Note:** Please refer to **Section 6.7** for details of the auxiliary relay functionalities.

## 6.7 – Auxiliary Relay

The auxiliary relay is only available for the 120V Control Power models. By default, on the 120V Control Power models, the 95/96 and 97/98 relays work together as a Form 1C fault relay. When Auxiliary Relay Configuration 1 (Advanced Parameter P.19) or Auxiliary Relay Configuration 2 (Advanced Parameter P.20) is set to a non-zero value, the 97/98 relay works as a separate auxiliary relay independent from the status of the fault (95/96) relay.

The auxiliary relay functionalities are configured through parameters Auxiliary Relay Configuration 1, Auxiliary Relay Configuration 2, and Auxiliary Relay Reset Delay. One or multiple faults can be mapped to the auxiliary relay by configuring the corresponding bits in the first two parameters according to the notes for P.19 and P.20 in Table 6-29. For example, if ground fault, voltage unbalance, and over voltage need to be mapped to the auxiliary relay, set Auxiliary Relay Configuration 1 as  $0x01+0x02=3$ , and set Auxiliary Relay Configuration 2 as  $0x04$ , or 4. The faults mapped to auxiliary relay use the same trip pickup level and trip delay settings as the faults mapped to the fault relay. However, the auxiliary relay faults do not have an alarm-no-trip mode. If the Auxiliary Relay Reset Delay parameter is set to a non-zero value  $n$ , the auxiliary relay will be reset  $n$  minutes after the fault conditions clear. If this parameter is set to the default value 0, the auxiliary relay can only be reset by manually pressing the reset button, by an automatic reset caused by the fault relay, or by writing  $0xEE$  into the Modbus command register.

A fault may be disabled on the 95/96 fault relay and enabled on the 97/98 auxiliary relay at the same time. For example, if the jam fault needs to be enabled on the auxiliary relay with a pickup level of 200% and disabled on the fault relay, the following steps shall be followed: 1) set the jam pickup level to 200% in the user interface and save; 2) set the jam pickup level to "OFF" in the user interface and save; 3) set the P.19 parameter in the user interface as 32 ( $0x20$ ) and save. The auxiliary relay will use the previously saved pickup level of 200%, although the current pickup level shown in the user interface is "OFF" to indicate that the jam fault is disabled on the 95/96 fault relay. The same results can be achieved by setting corresponding parameters through communication modules.

After Auxiliary Relay Configuration 1, Auxiliary Relay Configuration 2, or Auxiliary Relay Reset Delay is changed, a reset or power cycle is recommended.

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## Chapter 7 — Modbus Module without IO

### 7.1 - Overview

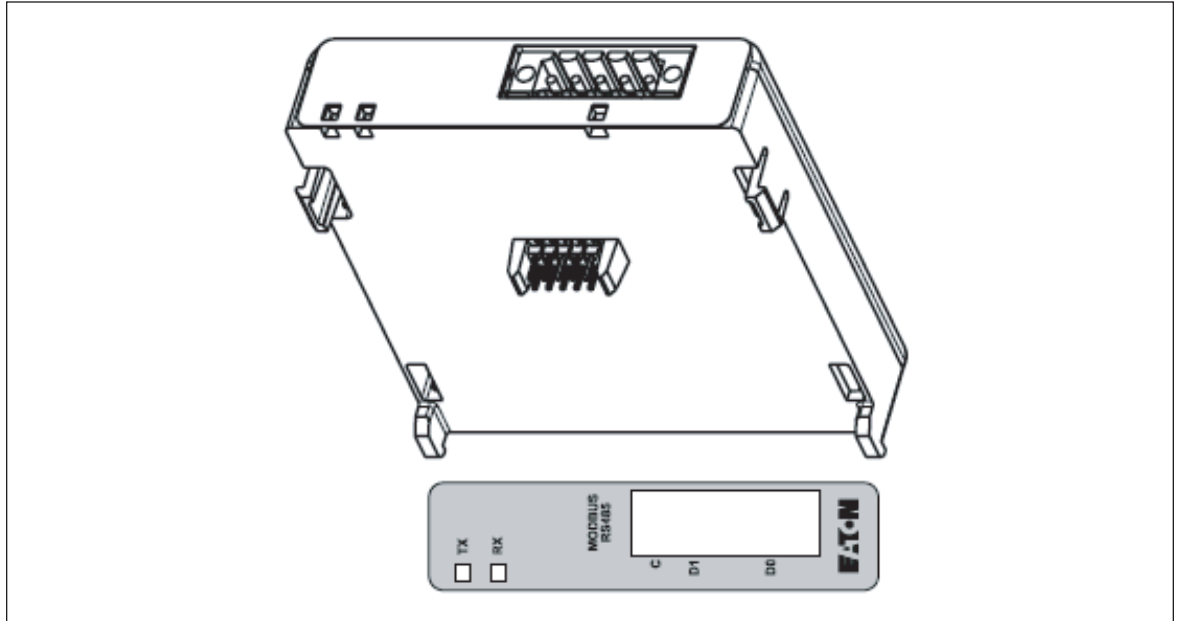


Figure 7-1: Dimensional Drawing

### 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. <sup>①</sup>                              |
| 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.    |

<sup>①</sup> To enable comm. loss behavior, write 0X0088 to register 400.



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**Table 7-2: Parameters and Values**

| Parameter                                    | Value                                                                                                                                                                                                                                                                                                                                                                            |
|----------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Mode                                         | Slave mode only                                                                                                                                                                                                                                                                                                                                                                  |
| Modbus Address/<br>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)<br>Options:<br>8-bit, no parity, 2 stop bits<br>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<br>0x02 Read Discrete Inputs<br>0x03 Read Holding Registers<br>0x04 Read Input Register<br>0x05 Write Single Coil<br>0x06 Write Single Register<br>0x0F Write Multiple Coils (15)<br>0x10 Write Multiple Registers (16)<br>0x17 Read/Write Multiple Registers (23)<br>0x2B/0x0E Read Device Identification Get Device Identity (43/14)<br>(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<br>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 <i>MODBUS over Serial Line Specification and Implementation Guide</i> 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 <i>MODBUS over Serial Line Specification and Implementation Guide</i> 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*

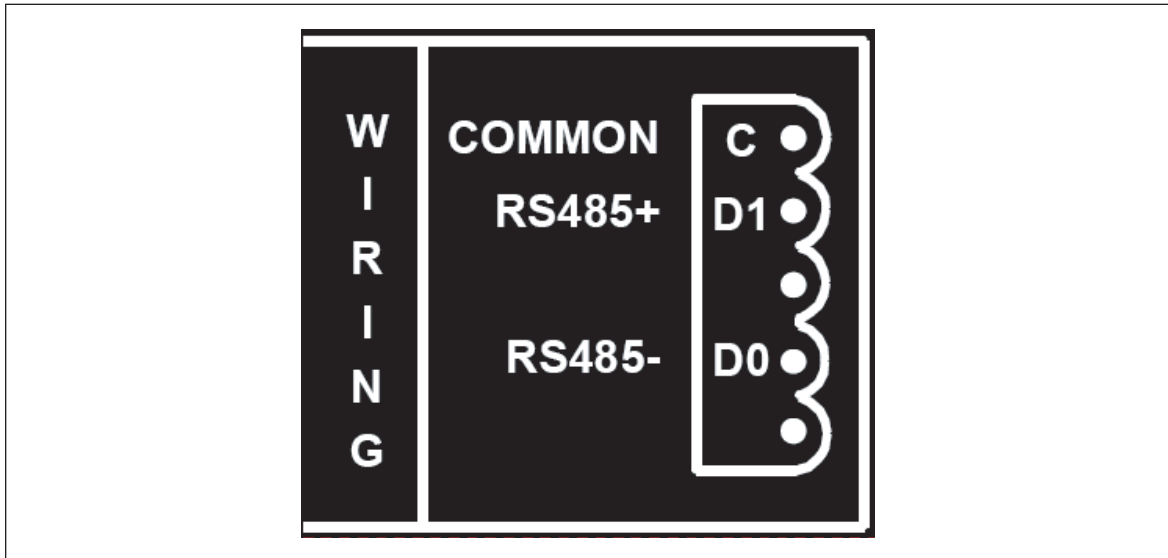
## 7.4 - Modbus Field Wiring

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 <sup>①</sup> | 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                                                                 |

<sup>①</sup> 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.

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## 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        |
| Auxiliary Relay Reset        | EEH        |

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          |                     |

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### 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 (kW x10 for external CTs)                                                    |
|                 | 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 (Fault Relay)                 |                                                                                      |
| 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     | Contactors 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                 | 0x0008                                                 |
| 5301            |                 | R     | Reverse Phase             | 0x0010                                                 |
| 5302            |                 | R     | Current Unbalance         | 0x0020                                                 |
| 5303            |                 | R     | Voltage Single-Phase      | 0x0040                                                 |
| 5304            |                 | R     | Current Single-Phase      | 0x0080                                                 |
| 5305            |                 | R     | Ground Fault              | 0x0100                                                 |
|                 | 333             | R     | Overload Firmware Version |                                                        |
|                 | 334             | R     | UI Firmware Version       |                                                        |

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**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.<br>0x00BA (186) — C441BA<br>0x00BB (187) — C441BB<br>0x00CA (202) — C441CA<br>0x00CB (203) — C441CB<br>0x00DA (218) — C441DA<br>0x00DB (219) — C441DB<br>0x00EA (234) — C4410109(x)<br>0x00EB (235) — C4410590(x)                                                                                                                                                                                        |
|                 | 336             | R     | Trip Reason (Auxiliary Relay) | 120 Vac Control Power models only                                                                                                                                                                                                                                                                                                                                                                                             |
| 5362            |                 | R     | Relay Off Command             | 0x0002 — Relay was turned off                                                                                                                                                                                                                                                                                                                                                                                                 |
| 5363            |                 | R     | Contactors Failure            | 0x0004 — Current phase loss without voltage phase loss                                                                                                                                                                                                                                                                                                                                                                        |
| 5364            |                 | R     | Under Current                 | 0x0008                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 5365            |                 | R     | Overload                      | 0x0010                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 5366            |                 | R     | Ground Fault                  | 0x0020                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 5367            |                 | R     | Current Unbalance             | 0x0040                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 5368            |                 | R     | Current Single-Phase          | 0x0080 — Current phase loss with voltage phase loss                                                                                                                                                                                                                                                                                                                                                                           |
| 5369            |                 | R     | Supply Frequency Fault        | 0x0100                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 5370            |                 | R     | High Power (kW)               | 0x0200                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 5371            |                 | R     | Over Voltage                  | 0x0400                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 5372            |                 | R     | Under Voltage                 | 0x0800                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 5373            |                 | R     | Voltage Unbalance             | 0x1000                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 5374            |                 | R     | Over Current                  | 0x2000                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 5375            |                 | R     | Low Power (kW)                | 0x4000                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 5376            |                 | R     | Phase Reversal                | 0x8000                                                                                                                                                                                                                                                                                                                                                                                                                        |
|                 | 400             | R/W   | Command Register              | 0x0066 — Clear Motor Run Hours<br>0x0077 — Clear Fault Queue 1<br>0x0078 — Clear Fault Queue<br>0x0088 — Network watchdog enable<br>0x0099 — Network watchdog disable<br>0x00AA — Reset Relay<br>0x00BB — Clear Motor Start Count<br>0x00CC — Force Ground Fault<br>0x00DD — Fault Relay OFF<br>0x00EE — Reset Auxiliary Relay<br>(120 Vac Control Power models only)<br><b>Note:</b> Command register will clear after write |
|                 | 401             |       | Reserved                      |                                                                                                                                                                                                                                                                                                                                                                                                                               |
|                 | 402             | R/W   | Configuration Reset           | 1 = Soft Reset (equivalent to a power cycle)<br>2 = Factory Reset<br><b>Note:</b> Register will clear after write                                                                                                                                                                                                                                                                                                             |

Table 7-7: Modbus Register Map (Continued)

| Modbus Coil No. | Modbus Reg. No. | R/W ? | Parameter Name                      | Notes (Default)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-----------------|-----------------|-------|-------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                 | 403             | R/W   | CT Multiplier                       | Cat No C441BB, C441CB, C441DB<br>1-4<br>Cat No C441BA, C441CA, C441DA<br>1, 2, 3 (150:5), 4 (300:5), 5 (600:5)                                                                                                                                                                                                                                                                                                                                                                                                                      |
|                 | 404             | R/W   | Ground Fault Trip Pickup Level      | Setting in Amps x 100<br>Cat No C441BB, C441CB, C441DB<br>3 – 20 A (CT Multiplier = 1)<br>1.5 – 10 (CT Multiplier = 2)<br>1 – 6.66 (CT Multiplier = 3)<br>0.75 – 5 (CT Multiplier = 4)<br><br>Default setting is 10 A<br>Cat No C441BA, C441CA, C441DA<br>0.3 – 2.0 A (CT Multiplier = 1)<br>0.15 – 1.0 (CT Multiplier = 2)<br>9 – 60 (CT Multiplier = 3)<br>18 – 120 (CT Multiplier = 4)<br>36 – 240 (CT Multiplier = 5)<br><br>Default setting is 1 A<br>Use Register 433 to enable/disable<br>Use Register 421 to set trip delay |
|                 | 405             | R/W   | Under Current Trip Pickup Level     | 10 – 90% (50%) of Motor FLA<br>(Register 407)<br>Use Register 433 to enable/disable<br>Use Register 422 to set trip delay                                                                                                                                                                                                                                                                                                                                                                                                           |
|                 | 406             | R/W   | Low kW Trip Level                   | Setting is in kW x 100<br>See <b>Section 6.5</b> for ranges. Default value is the minimum value in the range.<br>Registers 407, Motor FLA, and 403, CT Multiplier, control the range of this parameter.<br>Use Register 433 to enable/disable<br>Use Register 423 to set trip delay                                                                                                                                                                                                                                                 |
|                 | 407             | R/W   | Motor FLA                           | Setting is in Amps x 100<br>Cat No C441BB, C441CB, C441DB<br>5 – 22.5 Amps (CT Multiplier = 4)<br>6.67 – 30 Amps (CT Multiplier = 3)<br>10 – 45 Amps (CT Multiplier = 2)<br>20 – 90 Amps (CT Multiplier = 1)<br><br>Cat No C441BA, C441CA, C441DA<br>1 – 5 Amps (CT Multiplier = 2)<br>2 – 9 Amps (CT Multiplier = 1)<br>60 – 135 Amps (CT Multiplier = 3)<br>120 – 270 Amps (CT Multiplier = 4)<br>240 – 540 Amps (CT Multiplier = 5)                                                                                              |
|                 | 408             | R/W   | Current Unbalance Trip Pickup Level | 1 – 30% (15%)<br>Use Register 433 to enable/disable<br>Use Register 425 to set trip delay                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|                 | 409             | R/W   | Trip Class                          | 5 – 30                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |



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**Table 7-7: Modbus Register Map (Continued)**

| Modbus Coil No. | Modbus Reg. No. | R/W ? | Parameter Name                      | Notes                                                                                                                                                                                                                                                   |
|-----------------|-----------------|-------|-------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                 | 410             | R/W   | Under Voltage Trip Pickup Level     | 170 – 264 V (216 V) C441BA, C441BB<br>323 – 528 V (432 V) C441CA, C441CB<br>489 – 660 V (540 V) C441DA, C441DB<br>Use Register 433 to enable/disable<br>Use Register 426 to set trip delay<br>Use Register 435 to configure supply fault alarm behavior |
|                 | 411             | R/W   | Over Voltage Trip Pickup Level      | 170 – 264 V (264 V) C441BA, C441BB<br>323 – 528 V (528 V) C441CA, C441CB<br>489 – 660 V (540 V) C441DA, C441DB<br>Use Register 433 to enable/disable<br>Use Register 427 to set trip delay<br>Use Register 435 to configure supply fault alarm behavior |
|                 | 412             | R/W   | Voltage Unbalance Trip Pickup Level | 1 – 20% (6%)<br>Use Register 433 to enable/disable<br>Use Register 428 to set trip delay<br>Use Register 435 to configure supply fault alarm behavior                                                                                                   |
|                 | 413             | R/W   | Jam Trip Pickup Level               | 150 – 400% of Motor FLA (register 407)<br>Use Register 433 to enable/disable<br>Use Register 424 to set trip delay                                                                                                                                      |
|                 | 414             | R/W   | High Power Trip Level               | See <b>Section 6.5</b> 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.<br>Use Register 433 to enable/disable<br>Use Register 429 to set trip delay  |
|                 | 415             | R/W   | Phase Rotation                      | 0 = Trip Disabled, 1 = ACB, 2 = ABC (1)                                                                                                                                                                                                                 |
|                 | 416             | R/W   | Restart Delay                       | 0 – 500 (10) Seconds                                                                                                                                                                                                                                    |
|                 | 417             | R/W   | Motor Fault Reset Delay             | 2 – 500 (8) Minutes<br>See Register 434 for application to Overload Fault                                                                                                                                                                               |
|                 | 418             | R/W   | Load Fault Reset Delay              | 2 – 500 (20) Minutes<br>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<br>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                                                                                                                                                                                                                                     |

Table 7-7: Modbus Register Map (Continued)

| Modbus Coil No. | Modbus Reg. No. | R/W ? | Parameter Name                       | Notes                                                                                                                                                                                                                                                                            |
|-----------------|-----------------|-------|--------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                 | 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/<br>Slave Address     | 1 – 247 (1)<br>Change takes effect immediately                                                                                                                                                                                                                                   |
|                 | 432             | R/W   | Modbus Baud Rate Code                | 0 = 1200<br>1 = 2400<br>2 = 4800<br>3 = 9600<br>4 = 19200 — default value<br>5 = 38400<br>6 = 57600<br>7 = 115200<br>8 = Reserved<br>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<br>(Fault Relay) | 0 – 65535 (1815)                                                                                                                                                                                                                                                                 |
| 6913            |                 | R/W   | Enable Ground Fault Trip             | (1)                                                                                                                                                                                                                                                                              |
| 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<br>1 = apply Register 417 and 420 to<br>overload fault                                                                                                                                                                                           |
|                 | 435             | R/W   | Voltage Trip Mode                    | 0 = Trip on supply fault<br>1 = Alarm-no-trip (inhibit start) — default                                                                                                                                                                                                          |
|                 | 436             | R/W   | Ground Fault Trip Mode               | 0 = Trip on ground fault — default<br>1 = Alarm-no-trip                                                                                                                                                                                                                          |
|                 | 437             | R/W   | Run Transition Percent<br>(of FLA)   | 25 – 125% (see <b>Section 6.2.1</b> )                                                                                                                                                                                                                                            |
|                 | 438             | R/W   | Run Transition Time                  | 1 – 180 seconds (see <b>Section 6.2.1</b> )                                                                                                                                                                                                                                      |
|                 | 439             | R     | Network Status                       |                                                                                                                                                                                                                                                                                  |
| 7009            |                 | R/W   | Watchdog enabled                     | 0x0001                                                                                                                                                                                                                                                                           |
| 7010            |                 | R     | Reserved                             |                                                                                                                                                                                                                                                                                  |
| 7011            |                 | R     | Front Panel Locked                   | 0x0004                                                                                                                                                                                                                                                                           |

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**Table 7-7: Modbus Register Map (Continued)**

| Modbus Coil No. | Modbus Reg. No. | R/W ? | Parameter Name                    | Notes                                                                                                                                                                                                                          |
|-----------------|-----------------|-------|-----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 7012            |                 |       | Reserved                          |                                                                                                                                                                                                                                |
| 7013            |                 |       | Reserved                          |                                                                                                                                                                                                                                |
|                 | 440             | R/W   | Comm Loss Timeout                 | 1 – 65,000 (2000) milliseconds                                                                                                                                                                                                 |
|                 | 441             | R/W   | Comm Loss Behavior                | 1 = Fault — default<br>2 = Hold Last State<br>Use Register 400 to enable or disable the network watchdog                                                                                                                       |
|                 | 442             | R/W   | Modbus Parity                     | 0 = Even (1 stop bit) — default<br>1 = odd (1 stop bit),<br>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<br>1 = enabled (See Table 6-17)                                                                                                                                                                         |
|                 | 444             | R/W   | Auxiliary Relay Configuration 1   | 0 – 63 (0), 120 Vac Control Power models only                                                                                                                                                                                  |
| 7089            |                 | R/W   | Enable Ground Fault Trip          | (0)                                                                                                                                                                                                                            |
| 7090            |                 | R/W   | Enable Voltage Unbalance Trip     | (0)                                                                                                                                                                                                                            |
| 7091            |                 | R/W   | Enable Current Unbalance Trip     | (0)                                                                                                                                                                                                                            |
| 7092            |                 | R/W   | Enable Under Current Trip         | (0)                                                                                                                                                                                                                            |
| 7093            |                 | R/W   | Enable Phase Loss Trip            | (0)                                                                                                                                                                                                                            |
| 7094            |                 | R/W   | Enable Jam                        | (0)                                                                                                                                                                                                                            |
|                 | 445             | R/W   | Auxiliary Relay Configuration 2   | 0 – 127 (0), 120 Vac Control Power models only                                                                                                                                                                                 |
| 7105            |                 |       | Enable Low Power Trip             | (0)                                                                                                                                                                                                                            |
| 7106            |                 |       | Enable High Power Trip            | (0)                                                                                                                                                                                                                            |
| 7107            |                 |       | Enable Over Voltage Trip          | (0)                                                                                                                                                                                                                            |
| 7108            |                 |       | Enable Under Voltage Trip         | (0)                                                                                                                                                                                                                            |
| 7109            |                 |       | Enable Phase Order Trip           | (0)                                                                                                                                                                                                                            |
| 7110            |                 |       | Enable Overload Trip              | (0)                                                                                                                                                                                                                            |
| 7111            |                 |       | Enable Supply Frequency Fault     | (0)                                                                                                                                                                                                                            |
|                 | 446             | R/W   | Auxiliary Relay Reset Delay       | 0 – No automatic auxiliary relay reset – default<br>1 – 500 minutes: automatic auxiliary relay reset delay since last auxiliary relay fault                                                                                    |

**Table 7-8: Current Scaling Table**

| <b>Current Range</b> | <b>Catalog Number</b>                     | <b>Motor FLA</b> | <b>CT Multiplier Setting</b> | <b>Scaling</b>             |
|----------------------|-------------------------------------------|------------------|------------------------------|----------------------------|
| 1 – 9 Amperes        | <b>C441BA</b>                             | 2 – 9 Amps       | 1                            | Amps x 100                 |
|                      | <b>C441CA</b>                             | 1 – 5 Amps       | 2                            | Amps x 100                 |
|                      | <b>C441DA</b>                             | 60 – 135 Amps    | 3 (150:5)                    | Amps x 10                  |
|                      | <b>C4410109NOUI</b>                       | 120 – 270 Amps   | 4 (300:5)                    | Amps x 10                  |
|                      | <b>C4410109WUI</b>                        | 240 – 540 Amps   | 5 (600:5)                    | Amps x 10                  |
| 5 – 90 Amperes       | <b>C441BB</b>                             | 20 – 90 Amps     | 1                            | Amps x 10 for all settings |
|                      | <b>C441CB</b>                             | 10 – 45 Amps     | 2                            |                            |
|                      | <b>C441DB</b>                             | 6.67 – 30 Amps   | 3                            |                            |
|                      | <b>C4410590NOUI</b><br><b>C4410590WUI</b> | 5 – 22.5 Amps    | 4                            |                            |

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## Chapter 8 — DeviceNet Module with IO

### 8.1 - Overview

The Motor Insight DeviceNet Modules provide DeviceNet communication to the Motor Insight overload and monitoring relay. The DeviceNet module with 24 Vdc IO (C441L) and the DeviceNet module with 120 Vac IO (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.<br>- The device has not completed the Dup_MAC_ID test yet.<br>- 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.<br>- The device has passed the Dup_MAC_ID test, is online, but has not established connections to other nodes.<br>- 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.<br>- The device is allocated to a master.                                                                                                                       |
| Flashing Red          | Any one or more of the following conditions:<br>- Recoverable fault<br>- One or more I/O Connections are in the Timed-Out state<br>- No network power present                                                                                                                     |
| Solid Red             | The device has an unrecoverable fault; may need replacing.<br>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                | -40°C – 85°C                                   |
|                            | Humidity                   | 5 – 95% non-condensing                         |
| Operating                  | Temperature                | -20°C – 50°C (-40°F – 131°F)                   |
|                            | Humidity                   | 5 – 95% non-condensing                         |
|                            | Altitude                   | Above 2000 meters (6600 feet), consult factory |
|                            | Shock<br>IEC 60068-2-27    | 15G any direction for 11 milliseconds          |
|                            | Vibration<br>IEC 60068-2-6 | 5 – 150 Hz, 5G, 0.7 mm maximum peak-to-peak    |
|                            | Pollution Degree           | 3                                              |

**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)    | +/- 2 kV using direct method                           |
| Surge (IEC61000-4-5)             | +/- 2 kV line-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® (CSA® C22.2 No. 14)                               |
|                                  | CE (Low Voltage Directive)                             |
|                                  | DeviceNet Conformance Tested                           |

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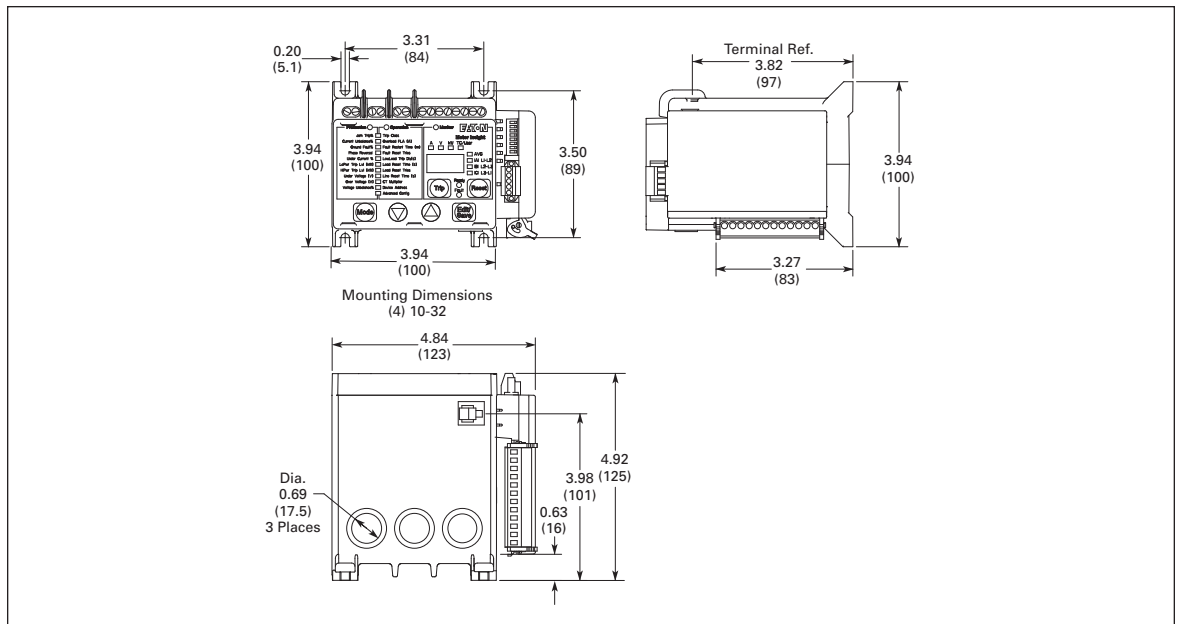
**Table 8-4: Module Electrical Requirements**

| 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**

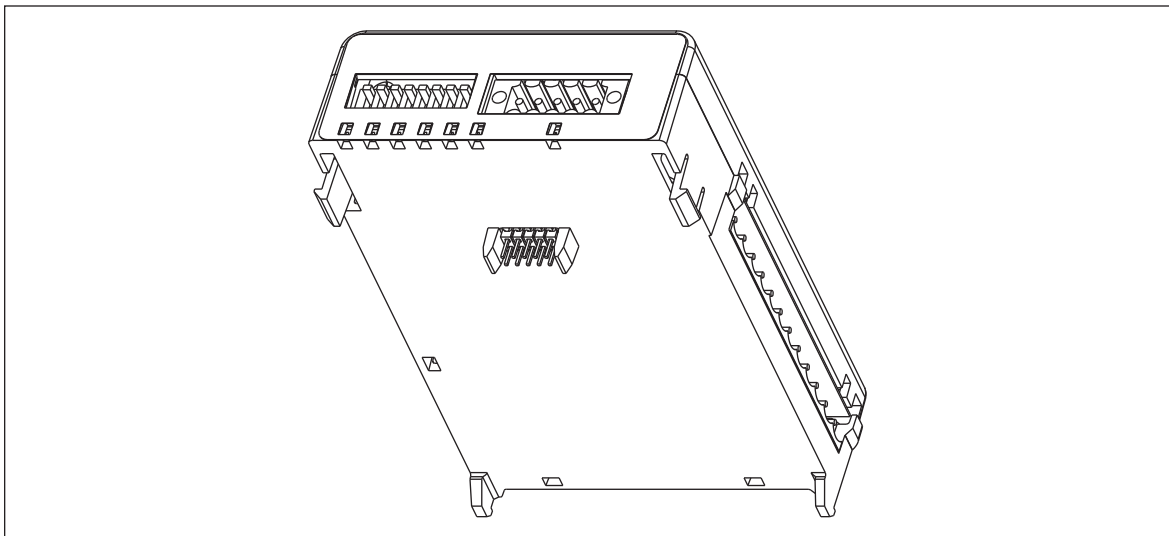
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Only apply 24V dc to the Motor Insight Communication module fieldbus connection. Use of any other voltage may result in personal injury, property damage and damage to the module.

## 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.



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### 8.3 - Input Behavior

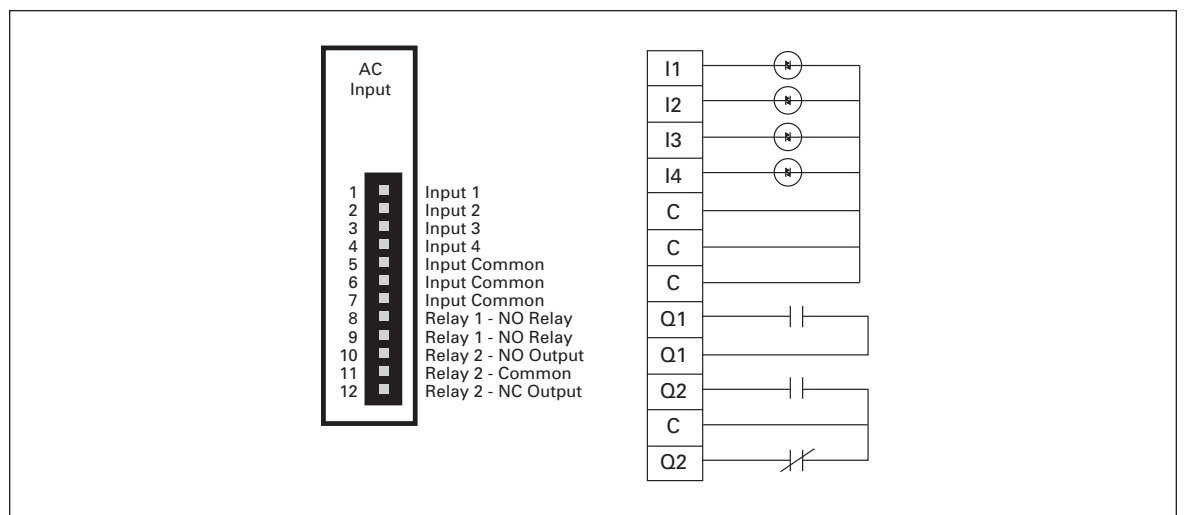
Each terminal of the field connection accepts two wires of the following size:

**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

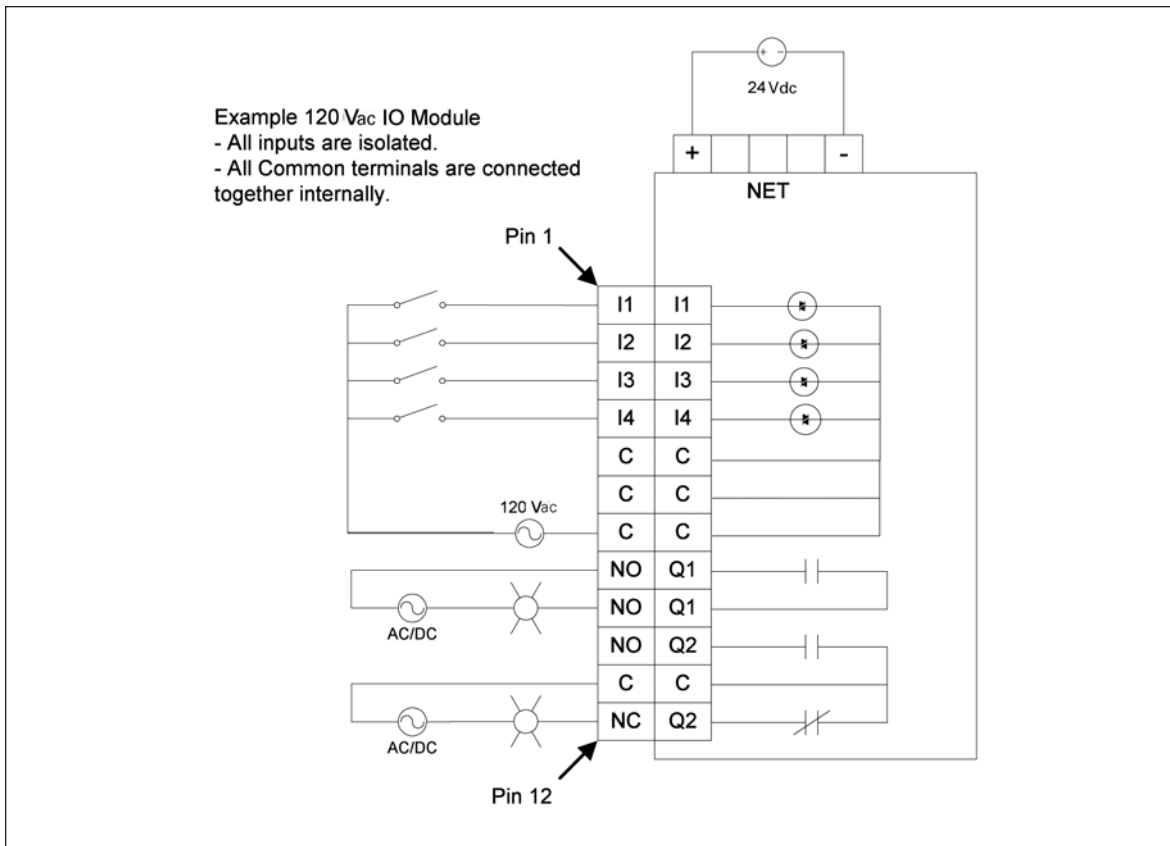
The 120 Vac input is an isolated input. It requires an external AC supply to drive the inputs. There are three common tie points provided for the four inputs.



**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     | 15 mA                       |
| Operating Range     | 80 – 140 Vac                |
| Operating Frequency | 50/60 Hz                    |
| Signal Delay Max    | 30 ms                       |
| Input Type          | IEC 61131-2, type 1 digital |

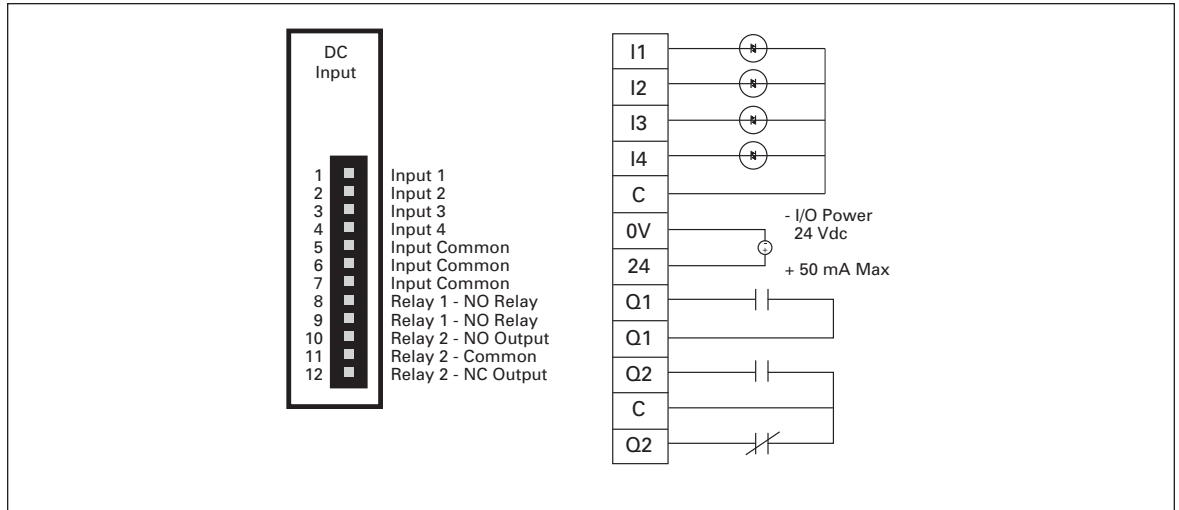


**Figure 8-4: 120 Vac IO Module**

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### 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.

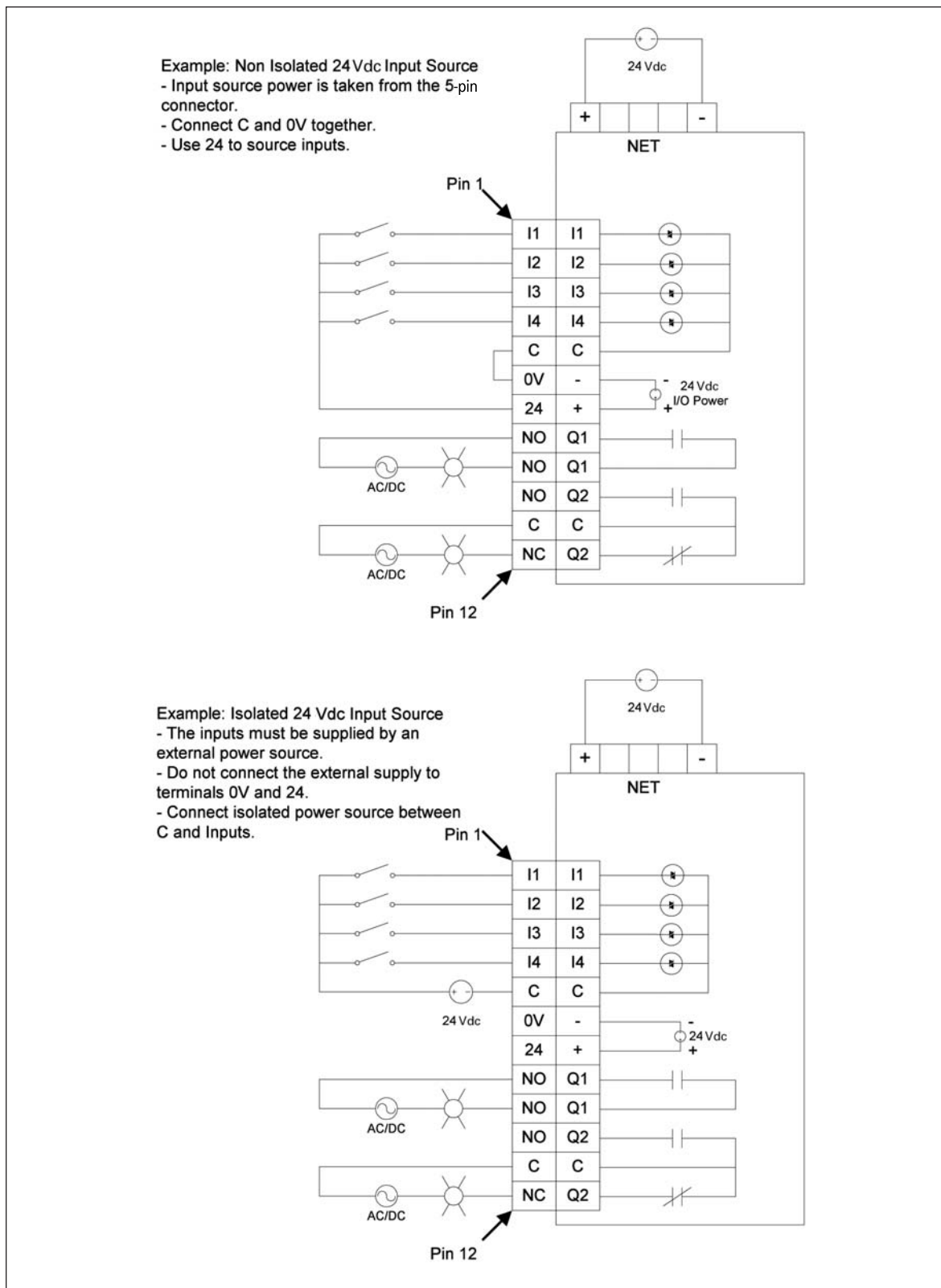


**Figure 8-5: 24 Vdc Input Internal Circuit Diagram**

**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**

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## 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.

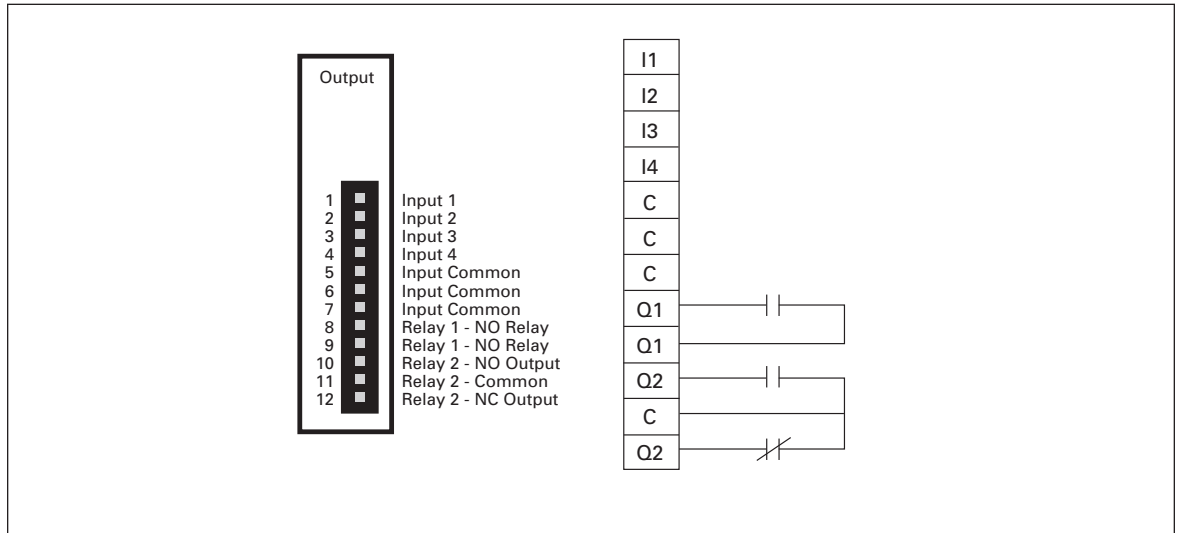


Figure 8-7: Relay Output Module Diagrams

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 <sup>5</sup> operations            |
| Mechanical Life          | 1 x 10 <sup>6</sup> 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: DIP 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).

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### 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 (explicit, polled, bit strobe) |
| 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)                                                                                                                                        |
| 0x05         | Reset                | 101          | Vendor specific reset — perform Intercom divorce. If communication module is not connected to a Motor Insight, the communication module will assume the Discrete IO profile. If the communication module is connected to a Motor Insight, it will marry to the Motor Insight and assume the Overload profile. |
| 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, 0x1102, 0x1122 or 0x1123 |
| 4            |    | Get         | Revision       | STRUCT of:   | Revision of the item the Identity Object represents            |                                               |
|              |    |             | Major Revision | USINT        |                                                                | The constant 0x02                             |
|              |    |             | Minor Revision | USINT        |                                                                | The constant 0x06                             |
| 5            |    | Get         | Status         | WORD         | Summary status of device                                       | See <b>Page 8-14</b> for definitions          |
| 6            |    | Get         | Serial Number  | UDINT        | Serial number of device                                        | See <b>Page 8-14</b> for definitions          |
| 7            |    | Get         | Product Name   | SHORT_STRING | Human readable identification                                  | See <b>Page 8-14</b> for definitions          |



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**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<br>1 = Device Self Testing<br>2 = Standby<br>3 = Operational<br>4 = Major Recoverable Fault<br>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         | UI Firmware Version   | UINT         | Version of UI microcontroller firmware                                     |                                                                                                                                              |
| 179 (0xB3)   | NV | Get         | Unit ID               | UINT         | See <b>Table 7-7</b> , 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 DeviceNet. 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.

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**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<br>Bit 1 - Poll<br>Bit 2 - Bit Strobe |
|         |    |             | Master's MAC ID        | USINT      | MAC ID of Master (from Allocate)       | Range 0 – 63, 255<br>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                                            |

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## 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 <sup>②</sup> | Poll, Bit Strobe | Extended Overload with Discrete Input and Output Points              |
| Input  | 100 <sup>①</sup> | Poll             | User Defined Input Assembly Short                                    |
| Input  | 110              | Poll             | User Defined Input Assembly Long                                     |
| Output | 2                | Poll             | Basic Overload (ODVA Overload Profile)                               |
| Output | 105 <sup>①</sup> | Poll             | Basic Overload with Discrete Output Points                           |
| Output | 111 <sup>②</sup> | Bit Strobe       | Accepts 8 bytes of bit strobe command to trigger bit strobe response |

<sup>①</sup> Indicates default assembly instances used in poll connection

<sup>②</sup> 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 |

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**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 7  | Device Status (Low Byte)<br>(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)<br>(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 (L1 Current)                         |
| 3     | RMS Current IB (L2 Current)                         |
| 4     | RMS Current IC (L3 Current)                         |
| 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<br>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<br>Trip |       |       | Fault<br>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.



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## 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<br>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<br>Default = 0x03                                                                                                                                                                                                                                                                                                                                                                       |
| 2       | Get    |    | instance_type                | USINT     | Indicates either I/O or Messaging Connection<br>Default = 0x00                                                                                                                                                                                                                                                                                                                                              |
| 3       | Get    |    | transportClass_trigger       | BYTE      | Defines behavior of the Connection<br>Default= 0x83                                                                                                                                                                                                                                                                                                                                                         |
| 4       | Get    |    | produced_connection_id       | UINT      | Placed in CAN Identifier Field when the Connection transmits<br>Default = 0x0000<br>(Although this default will never be visible)                                                                                                                                                                                                                                                                           |
| 5       | Get    |    | consumed_connection_id       | UINT      | CAN Identifier Field value that denotes message to be received<br>Default = 0x0000<br>(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<br>Default = 0x21<br>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<br>Default = 500                                                                                     |
| 8          | Get     |    | consumed_connection_size        | UINT      | Maximum number of bytes received across this Connection<br>Default = 500                                                                                        |
| 9          | Get/Set |    | expected_packet_rate            | UINT      | Defines timing associated with this Connection<br>Default = 0x09C4 (2500 milliseconds)                                                                          |
| 10 _<br>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<br>Default = 0x01 (Auto_Delete)                                                                             |
| 13         | Get     |    | produced_connection_path_length | UINT      | Number of bytes in the produced_connection_path attribute<br>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.<br>Default = Null PATH          |
| 15         | Get     |    | consumed_connection_path_length | UINT      | Number of bytes in the consumed_connection_path attribute<br>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.<br>Default = Null PATH |

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**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<br>Default = 0x01                                                                                                                    |
| 2       | Get     |    | instance_type                   | USINT     | Indicates either I/O or Messaging Connection<br>Default = 0x01                                                                                           |
| 3       | Get     |    | transportClass_trigger          | BYTE      | Defines behavior of the Connection<br>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<br>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<br>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<br>Default = 0x00                                                                                    |
| 13      | Get     |    | produced_connection_path_length | UINT      | Number of bytes in the produced_connection_path attribute<br>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<br>Default assembly instance 100<br>"0x62 0x36 0x34"          |
| 15      | Get     |    | consumed_connection_path_length | UINT      | Number of bytes in the consumed_connection_path attribute<br>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<br>Default assembly instance 105<br>"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<br>Default = 0x01                                                                                                                                 |
| 2         | Get     |    | instance_type                   | USINT     | Indicates either I/O or Messaging Connection<br>Default = 0x01                                                                                                        |
| 3         | Get     |    | transportClass_trigger          | BYTE      | Defines behavior of the Connection<br>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<br>Default = 0x02                                        |
| 7         | Get     |    | produced_connection_size        | UINT      | Maximum number of bytes transmitted across this Connection<br>Default and Fixed as 0x08                                                                               |
| 8         | Get     |    | consumed_connection_size        | UINT      | Maximum number of bytes received across this Connection<br>Default and Fixed as 0x08                                                                                  |
| 9         | Get/Set |    | expected_packet_rate            | UINT      | Defines timing associated with this Connection<br>Default = 0x0000                                                                                                    |
| 10_<br>11 |         |    | N/A                             | N/A       | Not used. These attribute IDs have been obsolete and are no longer defined for a Connection Object                                                                    |
| 12        | Get/Set |    | watchdog_timeout_action         | USINT     | Defines how to handle Inactivity/ Watchdog timeouts<br>Default = 0x00                                                                                                 |
| 13        | Get     |    | produced_connection_path_length | UINT      | Number of bytes in the produced_connection_path attribute<br>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<br>Default assembly instance 107<br>"0x62 0x36 0x42"                           |
| 15        | Get     |    | consumed_connection_path_length | UINT      | Number of bytes in the consumed_connection_path attribute<br>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<br>Default and Fixed as assembly instance 111<br>"0x62 0x36 0x46" |

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## 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**

Class: 0x29

**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.    |

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**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)<br>0 = No Faults present                                                                                                                                                                                                                                                                                                                                                                                     |
| 11      |    | Get         | Warning         | BOOL      | 1 = Warning (not latched)<br>0 = No Warnings present                                                                                                                                                                                                                                                                                                                                                                                      |
| 12      |    | Set         | FaultRst        | BOOL      | 0 ≥ 1 = Fault Reset<br>0 = No action<br>(Overload Reset)                                                                                                                                                                                                                                                                                                                                                                                  |
| 13      |    | Get         | FaultCode       | UINT      | If in <b>Faulted</b> state, FaultCode indicates the fault that caused the transition to <b>Faulted</b> state. If not in <b>Faulted</b> state, FaultCode indicates the fault that caused the last transition to the <b>Faulted</b> state.                                                                                                                                                                                                  |
| 17      |    | Set         | ForceFault      | BOOL      | 0 ≥ 1 = Force Fault<br>0 = No action                                                                                                                                                                                                                                                                                                                                                                                                      |
| 101     |    | Get         | Device Status   | WORD      | <b>Device Bit Array</b><br>Bit 0: Trip<br>Bit1: Warn<br>Bit2: Output #1<br>Bit3: Output #2<br>Bit4: Input #1<br>Bit5: Input #2<br>Bit6: Input #3<br>Bit7: Input #4<br>Bit8: Overload Power Lost<br>Bit 9-15: reserved                                                                                                                                                                                                                     |
| 102     |    | Get         | Trip Reason     | WORD      | <b>Fault (Trip) Reason Bit Array</b><br>Bit 0: Fault Lockout<br>Bit1: Relay Off Command<br>Bit2: Contactor Failure<br>Bit3: Under Current<br>Bit4: Overload<br>Bit5: Ground Fault<br>Bit6: Current Unbalance<br>Bit7: Current Single Phase<br>Bit8: Reserved<br>Bit9: High Power (kW)<br>Bit10: Over Voltage<br>Bit11: Under Voltage<br>Bit12: Voltage Unbalance<br>Bit13: Over Current<br>Bit14: Low Power (kW)<br>Bit15: Phase Reversal |
| 103     |    | Get         | Overload Status | WORD      | <b>Overload Status Bit Array</b><br>Bit 0: Overload Trip<br>Bit1: Ground Fault Trip<br>Bit2: High Power Trip<br>Bit3: reserved<br>Bit4: reserved<br>Bit5: reserved<br>Bit6: reserved<br>Bit7: Relay Closed<br>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      | <b>Warning Bit Array</b><br>Bit 0: Low Voltage<br>Bit1: High Voltage<br>Bit2: Voltage Unbalance<br>Bit3: Low Power<br>Bit4: Reverse Phase<br>Bit5: Current Unbalance<br>Bit6: Voltage Single Phase<br>Bit7: Current Single Phase<br>Bit8: Ground Fault Phase<br>Bit9-15: reserved                                                                                                                               |
| 105     | NV | Set         | Comm Fault Trip Action     | BOOL      | Action taken on trip state in Comm Fault state<br>0 = Use Comm Fault Trip Value attribute<br>1 = no affect                                                                                                                                                                                                                                                                                                      |
| 106     | NV | Set         | Comm Fault Trip Value      | BOOL      | User-defined value for use with Comm Fault Trip Action attribute<br>0 = no affect;<br>1 = trip                                                                                                                                                                                                                                                                                                                  |
| 107     | NV | Set         | Idle Trip Action           | BOOL      | Action taken on trip state in Communication Idle state<br>0=Use Idle Trip Value attribute;<br>1=no change                                                                                                                                                                                                                                                                                                       |
| 108     | NV | Set         | Idle Trip Value            | BOOL      | User-defined value for use with Idle Trip Action attribute<br>0 = no affect;<br>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<br>0 = No action                                                                                                                                                                                                                                                                                                                                                                    |
| 120     | NV | Set         | Enable Trip                | WORD      | <b>Trip Enable/Disable bit array</b><br>Bit 0: Enable Ground Fault Trip<br>Bit 1: Enable Voltage Unbalance Trip<br>Bit 2: Enable Current Unbalance Trip<br>Bit 3: Enable Under Current Trip<br>Bit 4: Enable Phase Loss Trip<br>Bit 5: Enable Jam<br>Bit 6: Enable LKW Trip<br>Bit 7: Enable HKW Trip<br>Bit 8: Enable Over Voltage Trip<br>Bit 9: Enable Under Voltage Trip<br>Bit 10: Enable Phase Order Trip |



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

| Attr ID          | NV | Access Rule | Name                    | Data Type | Semantics of Values                             |
|------------------|----|-------------|-------------------------|-----------|-------------------------------------------------|
| 121 <sup>①</sup> | NV | Get/Set     | Aux Relay Config Byte 1 | WORD      | See <b>Table 6-29</b> for details               |
| 122 <sup>①</sup> | NV | Get/Set     | Aux Relay Config Byte 2 | WORD      | See <b>Table 6-29</b> for details               |
| 123 <sup>①</sup> | NV | Get/Set     | Aux Relay Reset Delay   | WORD      | See <b>Table 6-29</b> for details               |
| 124 <sup>①</sup> |    | Get         | Aux Relay Reason        | UINT      | See <b>Table 7-7</b> , Register 336 for details |

<sup>①</sup> Only available for 120V Control Power models.

### 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<br>5 to 30                                      |                       |
| 5       |    | Get         | AvgCurrent                  | INT       | Average of the three phase currents<br>Units: See <b>Table 7-8</b> |                       |
| 6       |    | Get         | %PhImbal                    | USINT     | % Phase Unbalance                                                  |                       |
| 7       |    | Get         | %Thermal                    | USINT     | % Thermal Capacity                                                 |                       |
| 8       |    | Get         | Current L1                  | INT       | Actual motor phase current L1<br>Units: See <b>Table 7-8</b>       |                       |
| 9       |    | Get         | Current L2                  | INT       | Actual motor phase current L2<br>Units: See <b>Table 7-8</b>       |                       |
| 10      |    | Get         | Current L3                  | INT       | Actual motor phase current L3<br>Units: See <b>Table 7-8</b>       |                       |
| 11      |    | Get         | Ground Current              | INT       | Ground Current<br>Units: 100 mA                                    |                       |
| 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 <b>Table 7-7</b> Reg 403 and <b>Tables 2-6</b> and <b>2-7</b>  |                       |
| 104     |    |             | Reserved                    |           |                                                                    |                       |
| 105     | NV | Set         | Motor FLA                   | UINT      | <b>Table 6-1</b>                                                   |                       |
| 106     |    | Get         | Power Factor                | UINT      | PFx100                                                             |                       |
| 107     |    | Get         | Motor Power (kW)            | UINT      | kWx100 (kWx10 for external CTs)                                    |                       |
| 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      | <b>Table 6-16</b>                                                  |                       |

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**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, Register 434                       |       |
| 131     | NV | Set         | Load Fault Reset Delay Calculator          | BOOL      | 0=disable - default<br>1=enabled (Table 6-17) |       |

## 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)<br>1 = Alarm-no-trip |       |
| 8       | NV | Set         | Under Voltage Pickup Level         | UINT      | <b>Table 6-13</b>                                                                                   |       |
| 9       | NV | Set         | Under Voltage Pickup Delay Seconds | UINT      | <b>Table 6-13</b>                                                                                   |       |
| 10      | NV | Set         | Over Voltage Pickup Level          | UINT      | <b>Table 6-12</b>                                                                                   |       |
| 11      | NV | Set         | Over Voltage Pickup Delay Seconds  | UINT      | <b>Table 6-12</b>                                                                                   |       |
| 12      | NV | Set         | V Unbalance Pickup Level           | UINT      | <b>Table 6-14</b>                                                                                   |       |
| 13      | NV | Set         | V Unbalance Pickup Delay Seconds   | UINT      | <b>Table 6-14</b>                                                                                   |       |
| 14      | NV | Set         | Phase Order                        | UINT      | <b>Table 6-15</b>                                                                                   |       |
| 15      | NV | Set         | Restart Delay                      | UINT      | <b>Table 6-10</b>                                                                                   |       |
| 16      | NV | Get         | Supply Fault Time to Restart       | UINT      | Seconds remaining                                                                                   |       |

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## 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<br>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,<br>1 = 250k,<br>2 = 500k<br>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;<br>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;<br>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;<br>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;<br>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).

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## Chapter 9 — Modbus with IO

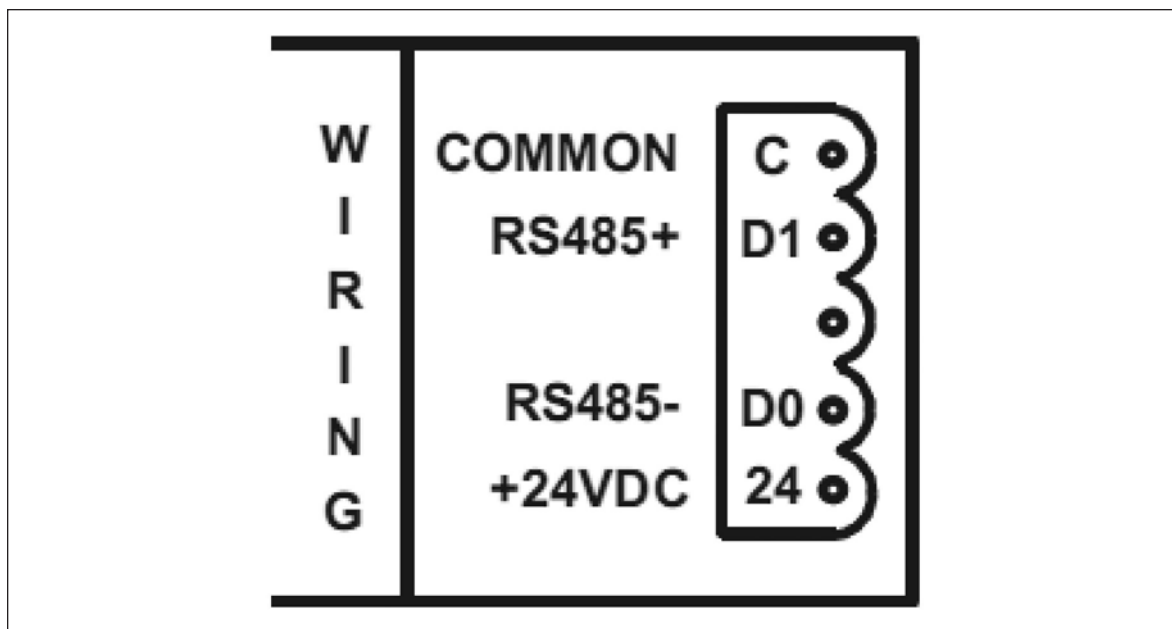
The Modbus with IO Module Provides Expanded IO Functionality to the base Motor Insight.

**Table 9-1: Modbus with IO Functionality**

| Parameter                                    | Value                                                                                                                                                                                                                                                                                                                                                  |
|----------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Mode                                         | Slave mode only                                                                                                                                                                                                                                                                                                                                        |
| Byte Characteristics                         | RTU: 8Bit, Even Parity, 1 stop bit<br>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<br>0x02 Read Discrete Inputs<br>0x03 Read Holding Registers<br>0x04 Read Input Register<br>0x05 Write Single Coil<br>0x06 Write Single Register<br>0x0F Write Multiple Coils (15)<br>0x10 Write Multiple Registers (16)<br>0x17 Read/Write Multiple Registers (23)<br>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 <i>MODBUS-IDA over Serial Line Specification and Implementation Guide</i> 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 <i>MODBUS over Serial Line Specification and Implementation Guide</i> 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     | D0      | 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 RS-485 and Power Connection**



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## 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 32 bit 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.                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|                    | 112                    | R/W | Remote Modbus Parity                | 0: Even parity, 1 stop bit<br>1: Odd parity, 1 stop bit<br>2: No parity, 2 stop bits<br>3: Even parity, 2 stop bits<br>4: Odd parity, 2 stop bits<br>5: No parity, 1 stop bit                                                                                                                                                                                                                                                                                                                                                              |
|                    | 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             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

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## Chapter 10 — PROFIBUS Module with IO

### 10.1 - Overview

The C441 PROFIBUS communication adapter is a DPV0 slave device used to connect the C441 Motor Insight protective relay to a PROFIBUS network. The Motor Insight is a mid-range motor protective relay with the additional ability to measure voltage and calculate power. The Motor Insight also provides a limited amount of fault logic that enables the user to control simple applications with fault-reset timers. The C441 PROFIBUS adapter connects to the side of the Motor Insight and allows the user to access setup parameters and IO data of the Motor Insight over a PROFIBUS network.

The C441 PROFIBUS communication adapters will give the user the ability to:

- Configure C441 Motor Insight setup parameters over a PROFIBUS network.
- Create custom IO assemblies based upon their applications needs.
- Exchange IO between a master and slave over a PROFIBUS network.
- Read out diagnostic information concerning the health of the C441 Motor Insight device.

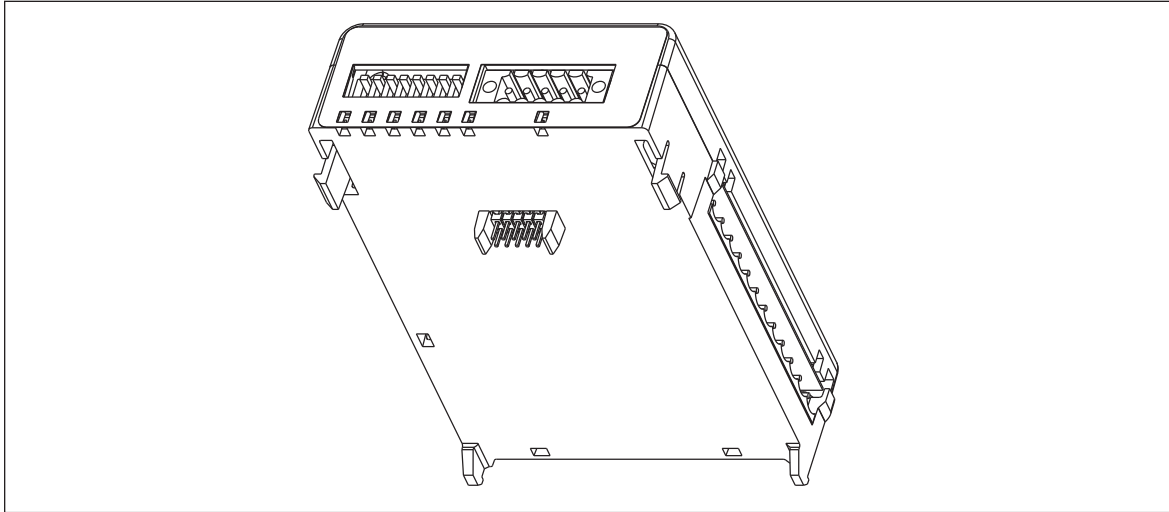
### 10.2 - PROFIBUS Specifications

**Table 10-1: PROFIBUS Specifications**

|                                   |                                                                 |
|-----------------------------------|-----------------------------------------------------------------|
| PROFIBUS Communications           | DPV0                                                            |
| Vendor Identification Number      | 0x019D                                                          |
| PNO Identification Number         | 0x0C98                                                          |
| Maximum IO Modules                | 28                                                              |
| Maximum Input Data                | 100 bytes                                                       |
| Maximum Output Data               | 20 bytes                                                        |
| Maximum Diagnostic Message Length | 21 bytes                                                        |
| Supported PROFIBUS Data Rates     | 9.6k, 19.2k, 45.5k, 93.75k, 187.5k, 500k, 1.5M, 3M, 6M, 12M     |
| Optional Features                 | Freeze; Sync; and Fail-safe supported                           |
| GSD File                          | 019D0C98.gsd @ <a href="http://www.eaton.com">www.eaton.com</a> |

## 10.3 - Mounting

The C441 PROFIBUS adapters are designed to be installed on the right side of the Motor Insight base unit.



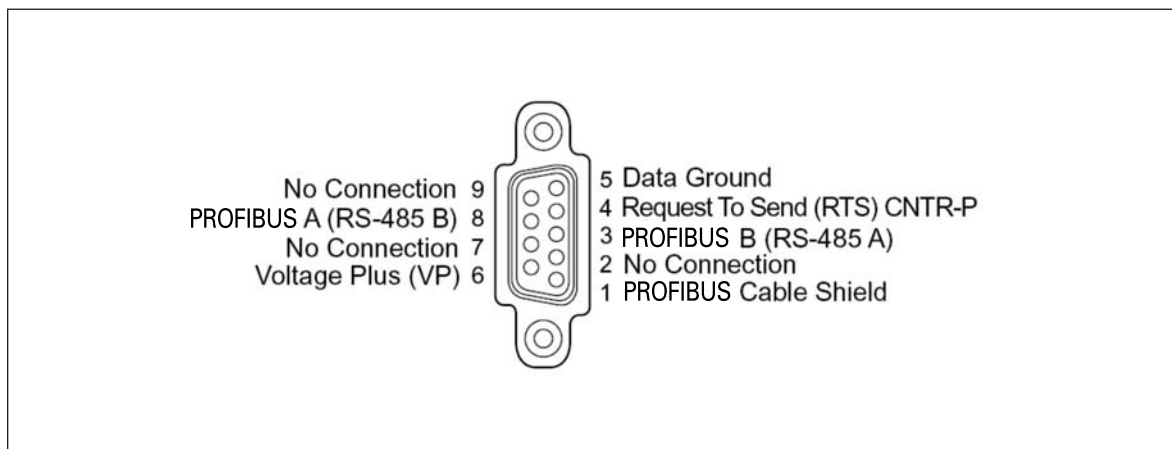
**Figure 10-1: Installation Diagram**

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 24 Vdc power, PROFIBUS cable, and IO connector if desired.

## 10.4 - Connections

### 10.4.1 PROFIBUS Connection

The PROFIBUS port uses the standard DB9 PROFIBUS connection. Refer to the figure below for details on the pin out of this connector.



**Figure 10-2: Pin Out for PROFIBUS DB9**

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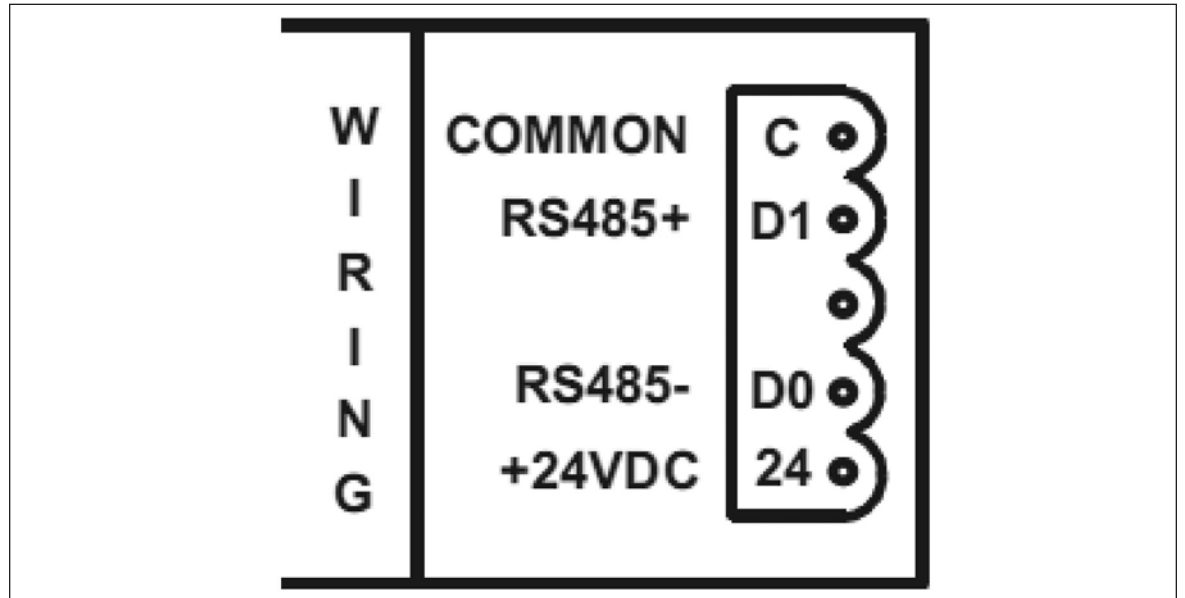
**10.4.2 24 Vdc Power**

The C441 PROFIBUS adapter is powered from an external 24 Vdc supply wired into the 5-pin black header (J2) located on the top of the adapter next to the 8 pos DIP switch.

**Note:** Connections to pins 2 and 4 are only required if Modbus communications are to be implemented.

**Table 10-2: 24 Vdc Supply Connection**

| Pin # | Circuit | Description                                                                                                        |
|-------|---------|--------------------------------------------------------------------------------------------------------------------|
| 1     | Common  | 24 Vdc common input connection                                                                                     |
| 2     | D1      | Transceiver terminal 1, V1 Voltage, Data + (V1 > V0 for binary 1 [OFF] state)<br>Connection for Remote Modbus Port |
| 3     |         | NC                                                                                                                 |
| 4     | D0      | Transceiver terminal 0, V0 Voltage, Data - (V0 > V1 for binary 0 [ON] state)<br>Connection for Remote Modbus Port  |
| 5     | +24 Vdc | +24 Vdc supply input connection                                                                                    |



**Figure 10-3: Power and Modbus RS-485 Connections**

## 10.5 - Quick Start

### Install C441 PROFIBUS Adapter

1. Mount the C441 PROFIBUS communication adapter to the Motor Insight relay. See **Section 9.3**.
2. Connect the PROFIBUS network cable to the DB9 connector. See **Section 9.4.1**.
3. Connect 24 Vdc power to the 5-pin connector located on the top of the C441 adapter. See **Section 9.4.2**.

**Note:** The D1 and D0, RS-485 connections are only required if Modbus is used.

4. Set the DIP switches located on the top of the C441 adapter to the PROFIBUS slave address for the C441. See **Section 9.6.1**.

**Note:** The PROFIBUS address is only updated during power up.

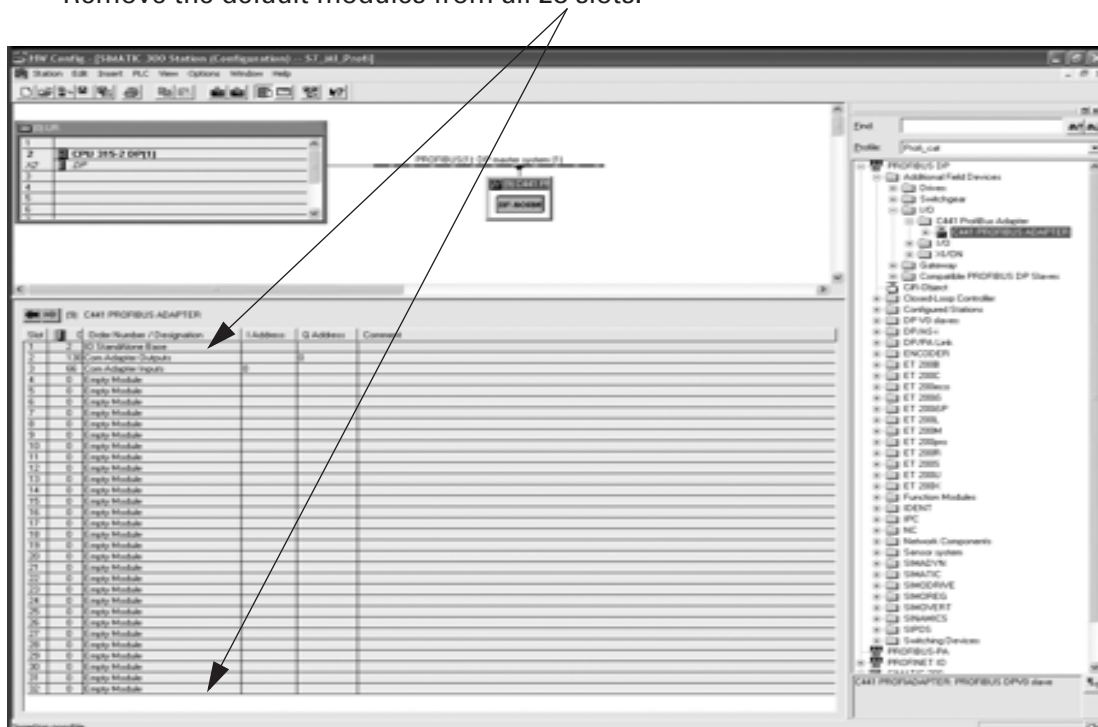
5. Apply 24 Vdc power to the C441 PROFIBUS adapter and C441 Motor Insight protective relay.

### Configure C441 PROFIBUS Adapter

**Note:** The C441 PROFIBUS adapter and device parameters for the C441 Motor Insight protective relay can be configured through the Master's configuration tool.

**Example:** In Siemens' Simatic Manager – The C441 PROFIBUS adapter can be configured through the "HW Config" page.

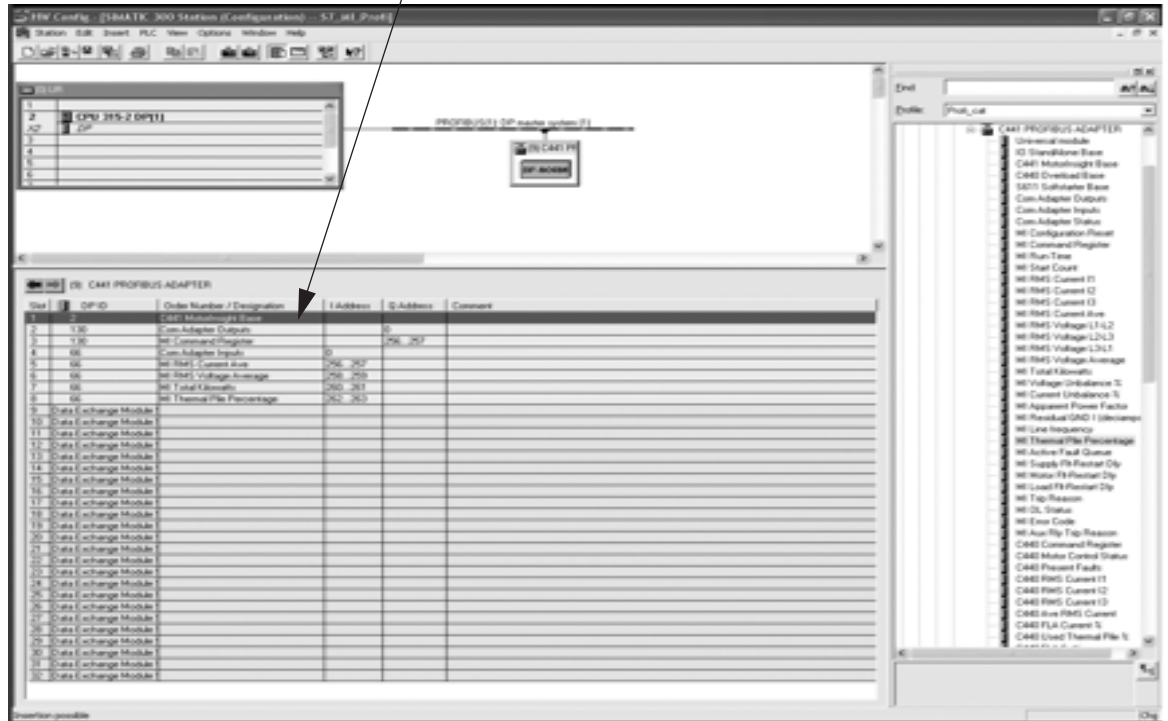
1. In the Master's configuration tool, add the C441 PROFIBUS adapter to the network configuration.
2. The default configuration for the C441 PROFIBUS adapter is a standalone IO base. Remove the default modules from all 28 slots.



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3. Select and add the C441 Motor Insight base module to slot 1 of the C441 PROFIBUS adapter configuration.

**Note:** The C441 Motor Insight base module **MUST** be placed in slot 1 of the configuration. Failure to do so will cause configuration to fail.



4. Select and add the desired modules for data exchange in slots 2 – 28. Select only those modules supported by the base module. (See Section 10.6.6 for a list of supported modules.)

**Table 10-3: Example Configuration**

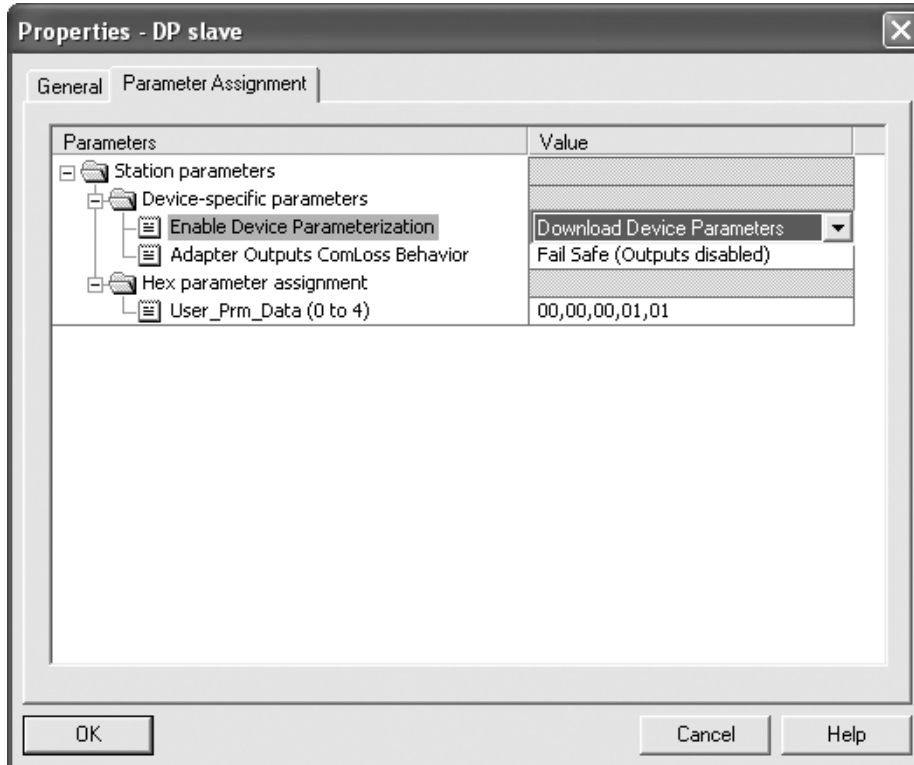
| IO Module               | Type             | Description                   |
|-------------------------|------------------|-------------------------------|
| C441 Motor Insight Base | Base – no IO     | Attached device               |
| Com Adapter Outputs     | Output – 1 byte  | Controls C441 adapter output  |
| MI Command Register     | Output – 2 bytes | Controls MI relay-start/stop  |
| Com Adapter Inputs      | Input – 1 byte   | Status of C441 adapter inputs |
| MI RMS Current Ave      | Input – 2 bytes  | Average rms current reading   |
| MI RMS Voltage Ave      | Input – 2 bytes  | Average rms voltage reading   |
| MI Total Kilowatts      | Input – 2 bytes  | Total power reading           |

**Note:** Data Exchange modules can be placed in any order in slots 2 – 28.

**Configure C441 PROFIBUS Adapter Device Parameters**

1. Select the C441 PROFIBUS adapter to display its device parameters.
2. Set the “Enable Device Parameters and Adapter Outputs ComLoss Behavior” parameters.

**Note:** To enable the download of the C441 Motor Insight device parameters, the “Enable Device Parameters” must be set to “Download Device Parameters.”

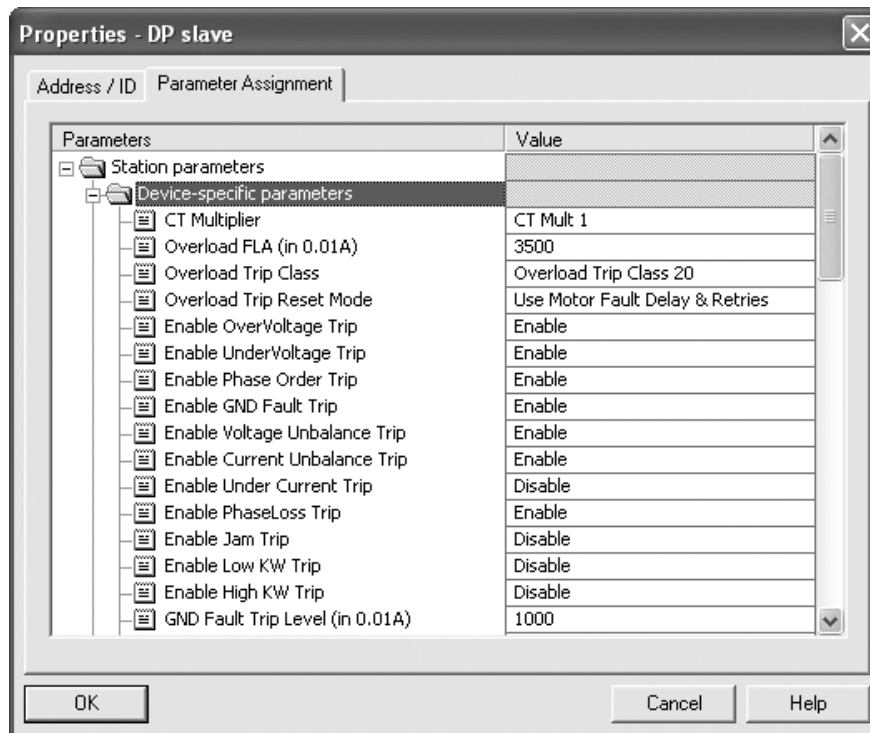




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### Configure the C441 Motor Insight Device Parameters

1. Select the C441 Motor Insight base module to display its device parameters.



At a minimum, the following parameters should be set according to the application needs.

#### C441 Profibus Adapter Parameters

- Enable Device Parameterization (must be set to download device parameters)

#### C441 Motor Insight Parameters

- CT Multiplier
- Overload FLA
- Overload Trip Class
- GND Fault Trip Level
- Low kW Trip Level
- High kW Trip Level
- Under Voltage Trip Level
- Over Voltage Trip Level

**Note:** If the Motor Insight relay was configured locally through the user interface, this step can be skipped. The "Download Device Parameter" parameter should be set to "Ignore User Data."

- After all configuration is complete, save and download the new configuration settings to the Master (PLC).
- If everything is okay, the C441 PROFIBUS adapter should automatically go into Data Exchange when the Master is brought online.

## 10.6 - Operation

### 10.6.1 PROFIBUS Address

The PROFIBUS address is set using the DIP switches located on the top of the C441 communication adapter. The address can only be set through setting the hardware DIP switches. The address is in binary with the major units numbered to the right of the switch on the label. Adding up the major units set to ON will provide the address of the adapter on the PROFIBUS network.

#### Notice

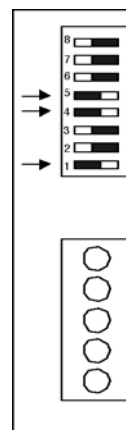
The address specified in the switches is only used by the adapter at the time the adapter is powered on or power cycle reset. Changing these switches during operation will have no affect until the next power cycle or reset.

#### Notice

A PROFIBUS address setting of 0 will result in the C441 using the default Station Address of 125. Any PROFIBUS Station Address setting greater than 125 will result in the C441 using the default Station Address of 125.

**Table 10-4: PROFIBUS DIP Switch Settings**

| DIP Switch | Value |
|------------|-------|
| 7          | 64    |
| 6          | 32    |
| 5          | 16    |
| 4          | 8     |
| 3          | 4     |
| 2          | 2     |
| 1          | 1     |



**Example:** To set a MAC ID of 25, DIP switches 5, 4, and 1 need to be turned ON, with all others OFF.

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### 10.6.2 PROFIBUS Status LEDs

There are three LED indicators (ON, BF, and SF) to clarify the working state of the PROFIBUS module/network.

**Table 10-5: PROFIBUS Status LEDs**

| ON (GREEN, the left one) | BF (RED, the middle one) | SF (RED, the right one) | Fault Condition                         |
|--------------------------|--------------------------|-------------------------|-----------------------------------------|
| ON                       | OFF                      | OFF                     | Everything OK                           |
| ON                       | ON                       | OFF                     | No communication                        |
| ON                       | Blinking                 | OFF                     | Communication, but not in data exchange |
| ON                       | ON                       | ON                      | Configuration not OK                    |

### 10.6.3 Inputs

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

**Table 10-6: Field Terminal Wire Capability**

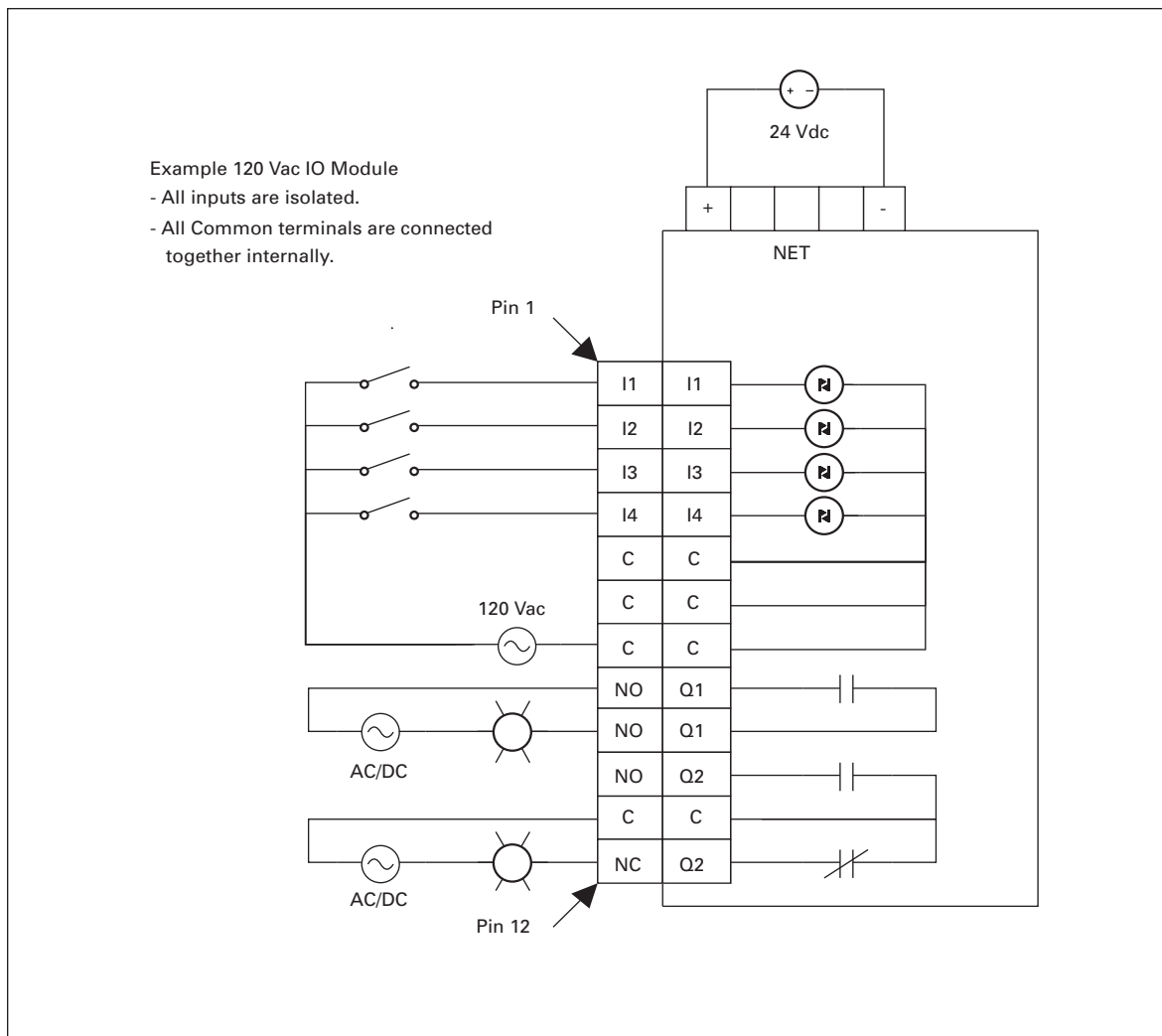
| Wire Type          | Wire Size | Terminal Torque |
|--------------------|-----------|-----------------|
| Solid Cu — 75°C    | #14 – #22 | 4.5 in-lbs      |
| Stranded Cu — 75°C | #16 – #22 | 4.5 in-lbs      |

#### 10.6.3.1 120 Vac Inputs

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.

**Table 10-7: 120 Vac Input Specification**

| Specification       | Value                       |
|---------------------|-----------------------------|
| Number of Inputs    | 4                           |
| Nominal Voltage     | 120 Vac                     |
| Nominal Current     | 15 mA                       |
| Operating Range     | 80 – 140 Vac                |
| Operating Frequency | 50/60 Hz                    |
| Signal Max Delay    | 30 ms                       |
| Input Type          | IEC 61131-2, type 1 digital |

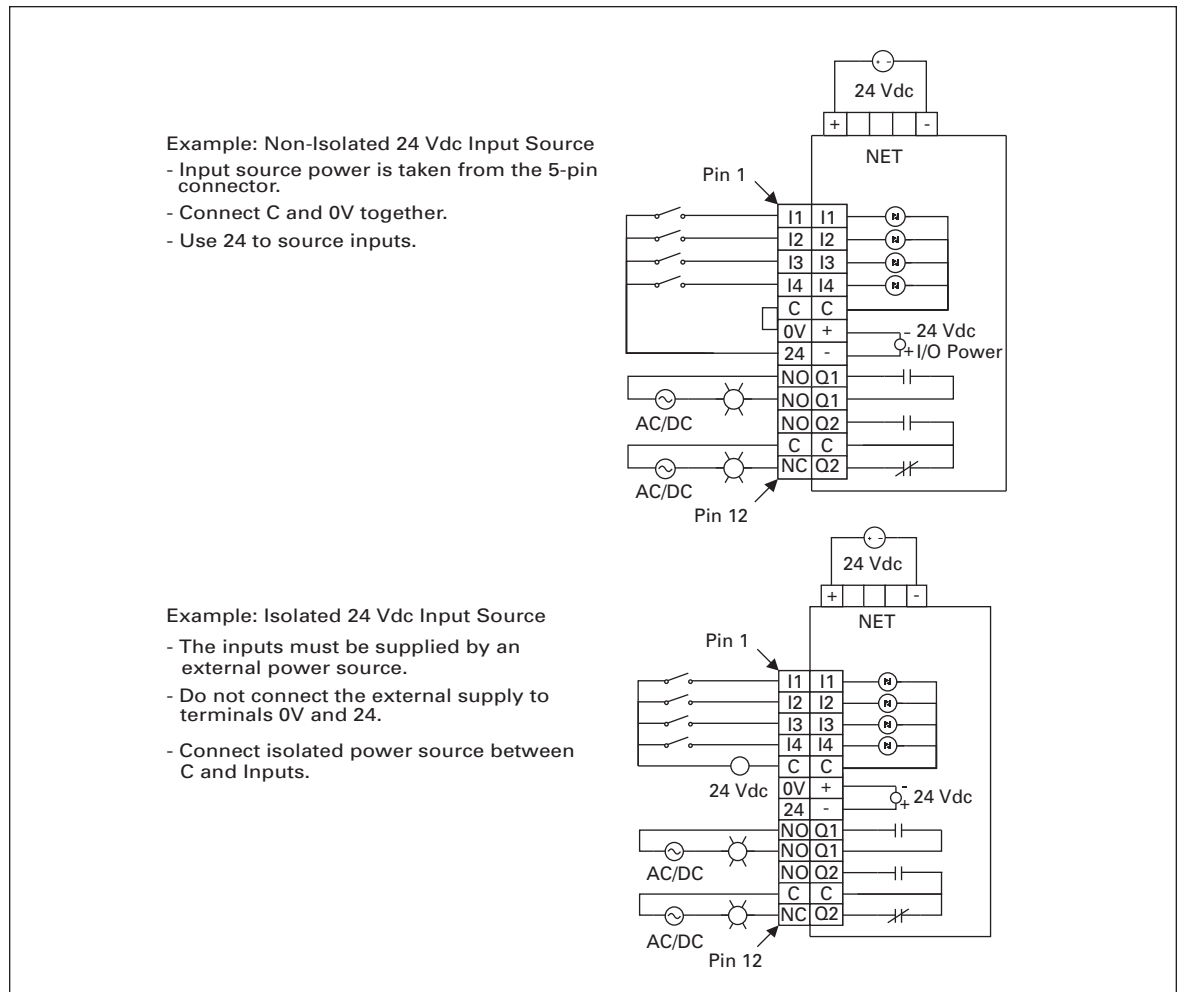


**Figure 10-4: 120 Vac Wiring Diagram**

**10.6.3.2 24 Vdc Inputs**

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.

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**Figure 10-5: 24 Vdc Wiring Diagrams**

**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 diagram **Figure 10-5**. Any device using the provided 24 Vdc input supply must have 500V isolation from ground. Example devices include pushbuttons and auxiliary contacts.

**Table 10-8: 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 |
| Maximum 24 Vdc Source Current | 50 mA                       |
| Isolation Voltage             | 250 Vac                     |

### 10.6.4 Relay Output Behavior

Two relay outputs are provided, one Form A (NO) and one Form C (NO, NC). See **Figure 10-4** and **Figure 10-5** for wiring diagrams.

**Table 10-9: Relay Specifications**

| Specification             | Value                                      |
|---------------------------|--------------------------------------------|
| Number of Contacts        | 2 independent relays (1 Form C, 1 Form A ) |
| Thermal Contact           | 5A                                         |
| Rated Insulated Voltage   | 300 Vac                                    |
| Maximum Operating Voltage | 120 Vac                                    |
| Electrical Life           | 1 x 10 <sup>5</sup> operations             |
| Mechanical Life           | 1 x 10 <sup>5</sup> operations             |

### 10.6.5 Parameterization

The C441 PROFIBUS adapters give the user the ability to enable/disable protections, set up trip thresholds, set up trip delays, and reset delays for the C441 Motor Insight relay over a PROFIBUS network.

Upon reception of the parameterization telegram, device parameter data is range checked. If the data is outside the range specified in the GSD file, the parameterization will be rejected and parameterization will fail. Data for parameters such as Overload FLA, Low kW Trip Level, High kW Trip Level, and GND Fault Trip Level whose ranges vary based on model will be "adjusted." If the value is greater than the maximum allowed value, the parameter is set to its maximum value. Likewise, if a parameter is set to a value less than its minimum value, the parameter will be set to its minimum value.

**Note:** Values must still fall within the range specified in the GSD file for parameterization to be successful.

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#### Notice

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The "Enable Device Parameterization" parameter must be enabled for the Motor Insight device parameters to be downloaded into the Motor Insight relay. If the "Enable Device Parameterization" parameter is set to "Ignore" (0), Motor Insight device parameters are "ignored" by the C441 PROFIBUS adapter and are not downloaded into the C441 Motor Insight Relay.

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The parameters available for setup through the device parameters and parameterization message are as follows:

**Table 10-10: Motor Insight Device Parameters Available During Parameterization**

| Parameter Name                       | Location      | Notes                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|--------------------------------------|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Enable Device Parameterization       | Adapter       | 0 – Ignore user data,<br>1 – Download Device Parameters                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Com Adapter Outputs ComLoss Behavior | Adapter       | 0 – Fail Safe (outputs disabled),<br>1 – Hold Last state                                                                                                                                                                                                                                                                                                                                                                                                                      |
| CT Multiplier                        | Motor Insight | See Tables 6-1, 6-2, & 6-3 for settings<br>Cat No C441BB, C441CB, C441DB<br>1-4<br>Cat No C441BA, C441CA, C441DA<br>1, 2, 3 (150:5), 4 (300:5), 5 (600:5)                                                                                                                                                                                                                                                                                                                     |
| Overload FLA                         | Motor Insight | See Tables 6-1, 6-2, & 6-3 for settings<br>Setting is in Amps x 100<br>Cat No C441BB, C441CB, C441DB<br>5 – 22.5 Amps (CT Multiplier = 4)<br>6.67 – 30 Amps (CT Multiplier = 3)<br>10 – 45 Amps (CT Multiplier = 2)<br>20 – 90 Amps (CT Multiplier = 1)<br>Cat No C441BA, C441CA, C441DA<br>1 – 5 Amps (CT Multiplier = 2)<br>2 – 9 Amps (CT Multiplier = 1)<br>60 – 135 Amps (CT Multiplier = 3)<br>120 – 270 Amps (CT Multiplier = 4)<br>240 – 540 Amps (CT Multiplier = 5) |
| Overload Trip Class                  | Motor Insight | 5 – 30                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Overload Reset Mode                  | Motor Insight | 0 = manual reset mode — default<br>1 = Apply Motor Fault Reset Delay and Motor Faults Number of Restarts                                                                                                                                                                                                                                                                                                                                                                      |
| Over Voltage Trip Enable             | Motor Insight | 1 – Trip Enabled; 0 – Warning only                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Under Voltage Trip Enable            | Motor Insight | 1 – Trip Enabled; 0 – Warning only                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Phase Order Trip Enable              | Motor Insight | 1 – Trip Enabled; 0 – Warning only                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| GND Fault Trip Enable                | Motor Insight | 1 – Trip Enabled; 0 – Warning only                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Voltage Unbalance Trip Enable        | Motor Insight | 1 – Trip Enabled; 0 – Warning only                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Current Unbalance Trip Enable        | Motor Insight | 1 – Trip Enabled; 0 – Warning only                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Under Current Trip Enable            | Motor Insight | 1 – Trip Enabled; 0 – Warning only                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Phase Loss Trip Enable               | Motor Insight | 1 – Trip Enabled; 0 – Warning only                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Jam Trip Enable                      | Motor Insight | 1 – Trip Enabled; 0 – Warning only                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Low kW Trip Enable                   | Motor Insight | 1 – Trip Enabled; 0 – Warning only                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| High kW Trip Enable                  | Motor Insight | 1 – Trip Enabled; 0 – Warning only                                                                                                                                                                                                                                                                                                                                                                                                                                            |

**Table 10-10: Motor Insight Device Parameters Available During Parameterization (Continued)**

| Parameter Name                 | Location      | Notes                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|--------------------------------|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| GND Fault Trip Level           | Motor Insight | Setting in Amps x 100<br>Cat No C441BB, C441CB, C441DB<br>3 – 20 A (CT Multiplier = 1)<br>1.5 – 10 (CT Multiplier = 2)<br>1 – 6.66 (CT Multiplier = 3)<br>0.75 – 5 (CT Multiplier = 4)<br>Default setting is 10A<br>Cat No C441BA, C441CA, C441DA<br>0.3 – 2.0 A (CT Multiplier = 1)<br>0.15 – 1.0 (CT Multiplier = 2)<br>9 – 60 (CT Multiplier = 3)<br>18 – 120 (CT Multiplier = 4)<br>36 – 240 (CT Multiplier = 5)<br>Default setting is 1A |
| GND Fault Trip Delay           | Motor Insight | 1 – 60 seconds (30) default                                                                                                                                                                                                                                                                                                                                                                                                                   |
| GND Fault Trip Mode            | Motor Insight | 0 = Trip on GND fault<br>1 = Alarm-no-trip — default                                                                                                                                                                                                                                                                                                                                                                                          |
| Under Current Trip Level       | Motor Insight | 10% – 90% of FLA (50) default                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Under Current Trip Delay       | Motor Insight | 1 – 60 seconds (5) default                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Low Power Trip Level           | Motor Insight | Setting is in kW x 100<br>See Section 6.5 for ranges. Default value is the minimum value in the range.                                                                                                                                                                                                                                                                                                                                        |
| Low Power Trip Delay           | Motor Insight | 1 – 60 seconds (5) default                                                                                                                                                                                                                                                                                                                                                                                                                    |
| High Power Trip Level          | Motor Insight | Setting is in kW x 100<br>See Section 6.5 for ranges. Default value is the maximum value in the range.                                                                                                                                                                                                                                                                                                                                        |
| High Power Trip Delay          | Motor Insight | 1 – 60 seconds (5) default                                                                                                                                                                                                                                                                                                                                                                                                                    |
| % Current Unbalance Trip Level | Motor Insight | 1% – 30% (15%) default                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Current Unbalance Trip Delay   | Motor Insight | 1 – 20 seconds (10) default                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Under Voltage Trip Level       | Motor Insight | 170 – 264 V (216 V) CC441BA, C441BB<br>323 – 528 V (432 V) C441CA, C441CB<br>489 – 660 V (540 V) C441DA, C441DB                                                                                                                                                                                                                                                                                                                               |
| Under Voltage Trip Delay       | Motor Insight | 1 – 20 seconds (10) default                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Over Voltage Trip Level        | Motor Insight | 170 – 264 V (264 V) C441BA, C441BB<br>323 – 528 V (528 V) C441CA, C441CB<br>489 – 660 V (540 V) C441DA, C441DB                                                                                                                                                                                                                                                                                                                                |
| Over Voltage Trip Delay        | Motor Insight | 1 – 20 seconds (10) default                                                                                                                                                                                                                                                                                                                                                                                                                   |
| % Voltage Unbalance Trip Level | Motor Insight | 1% – 20% (6%) default                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Voltage Unbalance Trip Delay   | Motor Insight | 1 – 20 seconds (10) default                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Voltage Faults Trip Mode       | Motor Insight | 0 = Trip on voltage fault<br>1 = Alarm-no-trip (inhibit start) — default                                                                                                                                                                                                                                                                                                                                                                      |
| Jam Fault Trip Level           | Motor Insight | 150% – 400% of FLA (300%) default                                                                                                                                                                                                                                                                                                                                                                                                             |
| Jam Fault Trip Delay           | Motor Insight | 1 – 60 seconds (5) default                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Phase Loss Trip Delay          | Motor Insight | 1 – 20 seconds (10) default                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Restart Delay                  | Motor Insight | 0 – 500 seconds (10) default                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Motor Fault Reset Delay        | Motor Insight | 2 – 500 minutes (8) default                                                                                                                                                                                                                                                                                                                                                                                                                   |



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**Table 10-10: Motor Insight Device Parameters Available During Parameterization (Continued)**

| Parameter Name                                 | Location      | Notes                                                                                                 |
|------------------------------------------------|---------------|-------------------------------------------------------------------------------------------------------|
| Motor Faults — Number of Restarts              | Motor Insight | 0 = Manual, 1 – 4, 5 = Auto reset mode                                                                |
| Load Faults Reset Delay                        | Motor Insight | 2 – 500 minutes (20) default                                                                          |
| Load Faults — Number of Restarts               | Motor Insight | 0 = Manual, 1 – 4, 5 = Auto reset mode                                                                |
| Enable Load Faults Reset Delay Auto Calculator | Motor Insight | See Table 6-17 for Reset Delay Times<br>0 — Reset Delay Auto Calc Off<br>1 — Reset Delay Auto Calc On |
| Run Transition % of FLA                        | Motor Insight | 25% – 125% (see section 6.2.1)                                                                        |
| Run Transition Time                            | Motor Insight | 1 – 180 seconds (see section 6.2.1)                                                                   |
| Phase Order                                    | Motor Insight | 0x0000 — Phase Order Trip Disabled<br>0x0001 — ACB Phase Order<br>0x0002 — ABC Phase Order            |
| MI ComLoss Timeout                             | Motor Insight | 0 – 65000 (msec)                                                                                      |
| MI ComLoss Behavior                            | Motor Insight | 0x0001 — Fault (Fail Safe) Relay Off<br>0x0002 — Hold Last State                                      |
| Adapter Outputs ComLoss Behavior               | Motor Insight | 0x0001 — Fail Safe (Outputs Disabled)<br>0x0002 — Hold Last State                                     |
| Enable MI AuxRly GND Trip Indication           | Motor Insight | 1 — Indication Enabled; 0 — No Indication (CP models only)                                            |
| Enable MI AuxRly V Unbal Indication            | Motor Insight | 1 — Indication Enabled; 0 — No Indication (CP models only)                                            |
| Enable MI AuxRly I Unbal Indication            | Motor Insight | 1 — Indication Enabled; 0 — No Indication (CP models only)                                            |
| Enable MI AuxRly Under I Indication            | Motor Insight | 1 — Indication Enabled; 0 — No Indication (CP models only)                                            |
| Enable MI AuxRly PhLoss Trip Indication        | Motor Insight | 1 — Indication Enabled; 0 — No Indication (CP models only)                                            |
| Enable MI AuxRly Jam Trip Indication           | Motor Insight | 1 — Indication Enabled; 0 — No Indication (CP models only)                                            |
| Enable MI AuxRly LowKW Trip Indication         | Motor Insight | 1 — Indication Enabled; 0 — No Indication (CP models only)                                            |
| Enable MI AuxRly HighKW Trip Indication        | Motor Insight | 1 — Indication Enabled; 0 — No Indication (CP models only)                                            |
| Enable MI AuxRly HighV Trip Indication         | Motor Insight | 1 — Indication Enabled; 0 — No Indication (CP models only)                                            |
| Enable MI AuxRly LowV Trip Indication          | Motor Insight | 1 — Indication Enabled; 0 — No Indication (CP models only)                                            |
| Enable MI AuxRly PhRev Trip Indication         | Motor Insight | 1 — Indication Enabled; 0 — No Indication (CP models only)                                            |
| Enable MI AuxRly Overload Indication           | Motor Insight | 1 — Indication Enabled; 0 — No Indication (CP models only)                                            |
| Enable MI AuxRly Freq Fault Indication         | Motor Insight | 1 — Indication Enabled; 0 — No Indication (CP models only)                                            |
| MI AuxRly Reset Delay                          | Motor Insight | 0 – 500 (minutes) (CP models only)                                                                    |

### 10.6.6 Configuration

The C441 PROFIBUS adapters are modular devices; in that, modules can be added and/or removed based on customer needs. The C441 PROFIBUS adapter supports up to 28 slots. 1 Base module slot and 31 additional slots for data exchange modules. Slot #1 is reserved for the “base module” and data exchange modules can be loaded into slots #2 – 28.

#### Notice

The “C441 Motor Insight Base Module” must appear in slot #1 of the configuration. If the base module appears in any other slot and/or the incorrect base module is selected, the configuration will fail.

**Table 10-11: C441 Motor Insight Configuration Modules**

| IO     | Size (in bytes) | Configuration Modules   | Notes                                                                                                                                                                                                                                                                                                                                   |
|--------|-----------------|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| N/A    | 0               | C441 Motor Insight Base | Base module for C441 Motor Insight protective relay.<br>Note: Base module must be loaded into slot 1 of the configuration. This MUST be the first module listed in the configuration.                                                                                                                                                   |
| output | 1               | Com Adapter Outputs     | 0x01 – Turn on Relay1<br>0x02 – Turn on Relay2                                                                                                                                                                                                                                                                                          |
| output | 1               | Com Adapter Inputs      | 0x01 – I0 enabled<br>0x02 – I1 enabled<br>0x04 – I2 enabled<br>0x08 – I3 enabled                                                                                                                                                                                                                                                        |
| output | 1               | Com Adapter Status      | 0x0001 – Adapter Connected<br>0x0002 – Message Error<br>0x0004 – Adapter Married                                                                                                                                                                                                                                                        |
| output | 2               | MI Configuration Reset  | 0x0001 – Soft Reset (power cycle)<br>0x0002 – Factory Reset<br>Note: Configuration reset will clear after write                                                                                                                                                                                                                         |
| output | 2               | MI Command Register     | 0x0066 - Clear Motor Run Hours<br>0x0077 - Clear Fault Queue 1<br>0x0078 - Clear Fault Queue<br>0x0088 - Network watchdog enable<br>0x0099 - Network watchdog disable<br>0x00AA - Reset Relay<br>0x00BB - Clear Motor Start Count<br>0x00CC - Force Ground Fault<br>0x00DD - Relay OFF<br>Note: Command register will clear after write |
| input  | 2               | MI Run-Time             | Hours ( Run Time can be reset via the MI Command Register)                                                                                                                                                                                                                                                                              |
| input  | 2               | MI Start Count          | Start Count can be reset via the MI Command Register                                                                                                                                                                                                                                                                                    |

**Table 10-11: C441 Motor Insight Configuration Modules (Continued)**

| IO    | Size (in bytes) | PROFIBUS IO Modules                | Notes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-------|-----------------|------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| input | 2               | MI RMS Current I1                  | See current scaling table (7-8)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| input | 2               | MI RMS Current I2                  | See current scaling table (7-8)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| input | 2               | MI RMS Current I3                  | See current scaling table (7-8)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| input | 2               | MI RMS Current Ave                 | See current scaling table (7-8)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| input | 2               | MI RMS Voltage L1-L2               | Volts                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| input | 2               | MI RMS Voltage L2-L3               | Volts                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| input | 2               | MI RMS Voltage L3-L1               | Volts                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| input | 2               | MI RMS Voltage Average             | Volts                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| input | 2               | MI Total Kilowatts                 | kW x 100                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| input | 2               | MI Voltage Unbalance Percentage    | (Max Deviation from Ave / Ave) x 100                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| input | 2               | MI Current Unbalance Percentage    | (Max Deviation from Ave / Ave) x 100                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| input | 2               | MI Apparent Power Factor           | Power Factor x 100 (inductive 0 – 100)                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| input | 2               | MI Residual GND I (deciamps)       | Amps x 100                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| input | 2               | MI Line frequency                  | Hz x 100                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| input | 2               | MI Thermal Pile Percentage         | 0% cold, 100% = overload trip (0 – 255)                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| input | 20              | MI Active Fault Queue              | Last 10 faults                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| input | 2               | MI Supply Flt-Remaining Rstart Dly | Seconds remaining before fault can be reset                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| input | 2               | MI Load Flt-Remaining Rstart Dly   | Seconds remaining before fault can be reset                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| input | 2               | MI Load Flt-Remaining Rstart Dly   | Seconds remaining before fault can be reset                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| input | 2               | MI Trip Reason                     | 0x0001 – Restart Attempts Exceeded<br>0x0002 – Relay turned off (network/UI)<br>0x0004 – Contactor Failure<br>0x0008 – Under Current Trip<br>0x0010 – Overload Trip<br>0x0020 – GND Fault Trip<br>0x0040 – Current Unbalance Trip<br>0x0080 – Current Single Phase<br>0x0100 – Reserved (0)<br>0x0200 – High Power Trip<br>0x0400 – Over Voltage Trip<br>0x0800 – Under Voltage Trip<br>0x1000 – Voltage Unbalance Trip<br>0x2000 – Over Current Trip<br>0x4000 – Low Power Trip<br>0x8000 – Phase Reversal Trip |
| input | 2               | MI OL Status                       | 0x0001 – Overload Tripped<br>0x0002 – GND Fault Tripped<br>0x0004 – High Power Tripped<br>0x0080 – Running                                                                                                                                                                                                                                                                                                                                                                                                       |

**Table 10-11: C441 Motor Insight Configuration Modules (Continued)**

| IO    | Size (in bytes) | PROFIBUS IO Modules                                       | Notes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-------|-----------------|-----------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| input | 2               | MI Error Code                                             | 0x0001 – Low Voltage Warning<br>0x0002 – High Voltage Warning<br>0x0004 – Voltage Unbalance Warning<br>0x0008 – Low Power Warning<br>0x0010 – Reverse Phase Warning<br>0x0020 – Current Unbalance Warning<br>0x0040 – Voltage Single Phase Warning<br>0x0080 – Current Single Phase Warning<br>0x0100 – GND Fault Warning                                                                                                                                                                     |
| input | 2               | MI Aux Relay Trip Reason (120V Control Power models only) | 0x0001 – NA<br>0x0002 – Relay turned off (network/UI)<br>0x0004 – Contactor Failure<br>0x0008 – Under Current Trip<br>0x0010 – Overload Trip<br>0x0020 – GND Fault Trip<br>0x0040 – Current Unbalance Trip<br>0x0080 – Current Single Phase<br>0x0100 – Mains Freq Fault<br>0x0200 – High Power Trip<br>0x0400 – Over Voltage Trip<br>0x0800 – Under Voltage Trip<br>0x1000 – Voltage Unbalance Trip<br>0x2000 – Over Current Trip<br>0x4000 – Low Power Trip<br>0x8000 – Phase Reversal Trip |

### 10.6.7 Diagnostics

The C441 PROFIBUS adapters provide the user with status information along with fault and warning data relevant to the operation of the C441 Motor Insight protective relay. Fault and warning information is presented to the user through extended diagnostics. All fault information is sent to the Master as high priority diagnostic messages (ext. diag. bit set in diagnostic message). All warning information is sent as low priority diagnostic messages (ext diag. bit clear). Low priority diagnostic messages are issued as the fault condition clears.

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#### Notice

The ext.diag. bit will remain set as long as there is a fault condition present in the C441 PROFIBUS adapter or C441 Motor Insight relay.

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#### Notice

The user should monitor extended user diagnostic byte 8 bit 0 – Adapter Connected / Unconnected to determine when data presented during data exchange becomes valid.

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**Table 10-12: C441 Diagnostic Telegram**

| Byte | Bit   | Description                                                        | Ext Diag Bit                                     |
|------|-------|--------------------------------------------------------------------|--------------------------------------------------|
| 1    | 0     | Diag.station: Station does not exist (set by Master)               |                                                  |
|      | 1     | Diag.station_not_ready: Station is not ready for data exchange     |                                                  |
|      | 2     | Diag.cfg_fault: Configuration data does not agree                  |                                                  |
|      | 3     | Diag.ext: Slave has extended diagnostic data                       |                                                  |
|      | 4     | Diag.not_supported: Requested function is not supported            |                                                  |
|      | 5     | Diag.invalid_slave_response: Sets slave to 0, fixed                |                                                  |
|      | 6     | Dig.prm_fault: Incorrect parameterization                          |                                                  |
| 2    | 7     | Diag.master_lock: Slave is parameterized by different master       |                                                  |
|      | 0     | Diag.prm_req: Slave has to be re-parameterized                     |                                                  |
|      | 1     | Diag.stat_diag: Static diagnosis                                   |                                                  |
|      | 2     | Fixed at 1                                                         |                                                  |
|      | 3     | Diag.WD_on: Threshold monitoring activated                         |                                                  |
|      | 4     | Diag.freeze_mode: Freeze command received                          |                                                  |
|      | 5     | Diag.sync_mode: Sync command received                              |                                                  |
|      | 6     | Reserved                                                           |                                                  |
| 3    | 7     | Diad.deactivated (sets master)                                     |                                                  |
|      | 0 – 6 | Reserved                                                           |                                                  |
| 4    |       | Master address after parameterization (FF before parameterization) |                                                  |
| 5    |       | Ident Number (MSB)                                                 |                                                  |
| 6    |       | Ident Number (LSB)                                                 |                                                  |
| 7    |       | Header byte — Device Data                                          |                                                  |
|      | 0     | Length of User Ext Diagnostic Data                                 |                                                  |
|      | 1     |                                                                    |                                                  |
|      | 2     |                                                                    |                                                  |
|      | 3     |                                                                    |                                                  |
|      | 4     |                                                                    |                                                  |
|      | 5     |                                                                    |                                                  |
|      | 6     | 0 — Device Data                                                    |                                                  |
|      | 7     | 0 — Device Data                                                    |                                                  |
|      | 8     | 0                                                                  | 1 — Adapter Connected; 0 — Adapter Not Connected |
| 1    |       | Reserved                                                           |                                                  |
| 2    |       | 1 — Adapter Married                                                | S/S                                              |
| 3    |       | Reserved                                                           |                                                  |
| 4    |       | Reserved                                                           |                                                  |
| 5    |       | Reserved                                                           |                                                  |
| 6    |       | Reserved                                                           |                                                  |
| 7    |       | Reserved                                                           |                                                  |

**Table 10-12: C441 Diagnostic Telegram (Continued)**

| Byte | Bit | Description                         | Ext Diag Bit |
|------|-----|-------------------------------------|--------------|
| 9    | 8   | 1 — Overload Trip                   | F/S          |
|      | 9   | 1 — GND Fault Trip                  | F/S          |
|      | 10  | 1 — High Power Trip                 | F/S          |
|      | 11  | Reserved                            |              |
|      | 12  | Reserved                            |              |
|      | 13  | Reserved                            |              |
|      | 14  | Reserved                            |              |
|      | 15  | 1 — Relay Running                   | S/S          |
| 10   | 16  | Reserved                            |              |
|      | 17  | Reserved                            |              |
|      | 18  | Reserved                            |              |
|      | 19  | Reserved                            |              |
|      | 20  | Reserved                            |              |
|      | 21  | Reserved                            |              |
|      | 22  | Reserved                            |              |
|      | 23  | Reserved                            |              |
| 11   | 24  | 1 — Restart Attempts Exceeded Fault | F/S          |
|      | 25  | 1 — Relay Off Command (Network/UI)  |              |
|      | 26  | 1 — Contactor Failure               | F/S          |
|      | 27  | 1 — Under Current Fault             | F/S          |
|      | 28  | 1 — Overload Fault                  | F/S          |
|      | 29  | 1 — GND Fault                       | F/S          |
|      | 30  | 1 — Current Unbalance Fault         | F/S          |
|      | 31  | 1 — Current Single-Phase Fault      | F/S          |
| 12   | 32  | Reserved                            |              |
|      | 33  | 1 — High Power Fault                | F/S          |
|      | 34  | 1 — Over Voltage Fault              | F/S          |
|      | 35  | 1 — Under Voltage Fault             | F/S          |
|      | 36  | 1 — Voltage Unbalance Fault         | F/S          |
|      | 37  | 1 — Over Current Fault              | F/S          |
|      | 38  | 1 — Low Power Fault                 | F/S          |
|      | 39  | 1 — Phase Reversal Fault            | F/S          |

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**Table 10-12: C441 Diagnostic Telegram (Continued)**

| Byte | Bit | Description                      | Ext Diag Bit |
|------|-----|----------------------------------|--------------|
| 13   | 40  | 1 — Low Voltage Warning          | S/S          |
|      | 41  | 1 — High Voltage Warning         | S/S          |
|      | 42  | 1 — Voltage Unbalance Warning    | S/S          |
|      | 43  | 1 — Low Power Warning            | S/S          |
|      | 44  | 1 — Reverse Phase Warning        | S/S          |
|      | 45  | 1 — Current Unbalance Warning    | S/S          |
|      | 46  | 1 — Voltage Single-Phase Warning | S/S          |
|      | 47  | 1 — Current Single-Phase Warning | S/S          |
| 14   | 48  | 1 — GND Fault Warning            | S/S          |
|      | 49  | Reserved                         |              |
|      | 55  | Reserved                         |              |
| 15   |     | Reserved                         |              |
| 16   |     | Reserved                         |              |
| 17   |     | Reserved                         |              |
| 18   |     | Reserved                         |              |
| 19   |     | Reserved                         |              |
| 20   |     | Reserved                         |              |
| 21   |     | Reserved                         |              |

**Ext Diag Bit Key**

| Code | Bit Sets / Clears                       |
|------|-----------------------------------------|
| F/S  | Ext diag bit sets / Ext diag bit clears |
| S/S  | Ext diag bit clear / Ext diag bit clear |

**10.6.8 Optional Features***10.6.8.1 Freeze Mode*

Freeze Mode is supported in the C441 PROFIBUS adapter.

*10.6.8.2 Sync Mode*

Sync Mode is supported in the C441 PROFIBUS adapter.

*10.6.8.3 Fail Safe Mode*

Fail Safe Mode is supported in the C441 PROFIBUS adapter. On the reception of a Clear Data frame from the Master, the C441 PROFIBUS adapter outputs will go to fail safe mode – outputs disabled. The C441 Motor Insight relay will also turn off.

**10.7 Remote Modbus Port**

The C441 also incorporates an RS-485 Modbus port. This port can be used for monitoring purposes. All registers listed in Section 7.13 — Modbus Register Map are accessible through this port. See **Figure 10-3** for Modbus connections.





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## Appendix A — Modbus Map by Protection

### UI Group

**Table A-1: UI Group**

| Configuration        |                                             |                                    |                                                    |                                        |                               | Status                                |                                     |                                                 |                                    |                                    |               |
|----------------------|---------------------------------------------|------------------------------------|----------------------------------------------------|----------------------------------------|-------------------------------|---------------------------------------|-------------------------------------|-------------------------------------------------|------------------------------------|------------------------------------|---------------|
| Fault                | Thresh-<br>old                              | Enable                             | Trip<br>Mode                                       | Trip<br>Time                           | Off<br>Time                   | Re-<br>starts                         | Lock-<br>out                        | OL<br>Status                                    | Error                              | Trip<br>Reason                     | Fault<br>Code |
| Jam                  | R:413<br>% FLA                              | C:6918<br>R:433,<br>0x0020<br>True | N/A                                                | R:424<br>Seconds                       | R:417<br>Minutes              | R:420<br>0 – 4<br>5:Auto              | C:5265<br>R:330,<br>0x0001<br>True  | C:5288<br>R:331,<br>0x0080<br>False             | N/A                                | C:5278<br>R:330,<br>0x0000<br>True | R:315<br>14   |
| Current<br>Unbalance | R:408<br>% FLA                              | C:6915<br>R:433,<br>0x0004<br>True | N/A                                                | R:425<br>Seconds                       | R:417<br>Minutes              | R:420<br>0 – 4<br>5:Auto              | C: 5265<br>R:330,<br>0x0001<br>True | C:5288<br>R:331,<br>0x0080<br>False             | C:5302<br>R:332,<br>0x0020<br>True | C:5271<br>R:330,<br>0x0040<br>True | R:315<br>7    |
| Ground<br>Fault      | R:404<br>10 mA                              | C:6913<br>R:433,<br>0x0001<br>True | R:436<br>0:Trip<br>1:Alarm<br>no Trip              | R:421<br>Seconds                       | N/A                           | N/A                                   | N/A                                 | C:5282<br>R:331,<br>0x0002<br>True <sup>①</sup> | C:5305<br>R:332,<br>0x0100<br>True | C:5270<br>R:330,<br>0x0020<br>True | R:315<br>6    |
| Overload             | R:407<br>10 mA                              | N/A                                | N/A                                                | R:409<br>Class 5,<br>10, 15,<br>20, 30 | R:417<br>Minutes <sup>②</sup> | R:420<br>0 – 4<br>5:Auto <sup>④</sup> | ⑤                                   | C:5281<br>R:331,<br>0x0001<br>True <sup>①</sup> | N/A                                | C:5269<br>R:330,<br>0x0010<br>True | R:315<br>5    |
| Phase<br>Rotation    | R:415<br>1:ACB,<br>2:ABC<br>0:Don't<br>Care | C:6923<br>R:433,<br>0x0400<br>True | R:435<br>0:Trip<br>1:Alarm<br>no Trip <sup>③</sup> | N/A                                    | R:416<br>Seconds              | N/A                                   | N/A                                 | N/A                                             | C:5301<br>R:332,<br>0x0010<br>True | C:5280<br>R:330,<br>0x8000<br>True | R:315<br>16   |
| N/C<br>Current       | R:405<br>100 mA                             | C:6916<br>R:433,<br>0x0008<br>True | N/A                                                | R:422<br>Seconds                       | R:418<br>Minutes              | R:419<br>0 – 4<br>5:Auto              | C:5265<br>R:330,<br>0x0001<br>True  | C:5288<br>R:331,<br>0x0080<br>False             | C:5300<br>R:332,<br>0x0008<br>True | C:5268<br>R:330,<br>0x0008<br>True | R:315<br>4    |
| Low<br>Power         | R:406<br>0.01 kW                            | C:6919<br>R:433,<br>0x0040<br>True | N/A                                                | R:423<br>Seconds                       | R:418<br>Minutes              | R:419<br>0 – 4<br>5:Auto              | C:5265<br>R:330,<br>0x0001<br>True  | C:5288<br>R:331,<br>0x0080<br>False             | C:5300<br>R:332,<br>0x0008<br>True | C:5268<br>R:330,<br>0x0008<br>True | R:315<br>4    |
| High<br>Power        | R:414<br>0.01 kW                            | C:6920<br>R:433,<br>0x0080<br>True | N/A                                                | R:429<br>Seconds                       | R:418<br>Minutes              | R:419<br>0 – 4<br>5:Auto              | C:5265<br>R:330,<br>0x0001<br>True  | C:5283<br>R:331,<br>0x0004<br>True <sup>①</sup> | N/A                                | C:5274<br>R:330,<br>0x0200<br>True | R:315<br>10   |
| Under<br>Voltage     | R: 410<br>Volts                             | C:6922<br>R:433,<br>0x0200<br>True | R:435<br>0:Trip<br>1:Alarm<br>no Trip <sup>③</sup> | N/A                                    | R:416<br>Seconds              | N/A                                   | N/A                                 | N/A                                             | C:5297<br>R:332,<br>0x0001<br>True | C:5276<br>R:330,<br>0x0800<br>True | R:315<br>12   |
| Over<br>Voltage      | R: 411<br>Volts                             | C:6921<br>R:433,<br>0x0100<br>True | R:435<br>0:Trip<br>1:Alarm<br>no Trip <sup>③</sup> | N/A                                    | R:416<br>Seconds              | N/A                                   | N/A                                 | N/A                                             | C:5298<br>R:332,<br>0x0002<br>True | C:5275<br>R:330,<br>0x0400<br>True | R:315<br>11   |
| Voltage<br>Unbalance | R: 412<br>%                                 | C:6914<br>R:433,<br>0x0002<br>True | R:435<br>0:Trip<br>1:Alarm<br>no Trip <sup>③</sup> | N/A                                    | R:416<br>Seconds              | N/A                                   | N/A                                 | N/A                                             | C:5299<br>R:332,<br>0x0004<br>True | C:5277<br>R:330,<br>0x1000<br>True | R:315<br>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                      | Thresh-<br>old | Enable | Trip<br>Mode                                       | Trip<br>Time | Off<br>Time | Re-<br>starts | Lock-<br>out | OL<br>Status                        | Error                              | Trip<br>Reason                     | Fault<br>Code |
| Voltage<br>Phase<br>Loss   | —              | —      | R:435<br>0:Trip<br>1:Alarm<br>no Trip <sup>①</sup> | N/A          | N/A         | N/A           | —            | C:5288<br>R:331,<br>0x0080<br>False | C:5303<br>R:332,<br>0x0040<br>True | N/A                                | R:315<br>15   |
| Relay<br>Off               | N/A            | N/A    | N/A                                                | N/A          | N/A         | N/A           | —            | C:5288<br>R:331,<br>0x0080<br>False | N/A                                | C:5266<br>R:330,<br>0x0002<br>True | R:315<br>2    |
| Contact<br>Failure         | N/A            | —      | N/A                                                | N/A          | N/A         | N/A           | —            | C:5288<br>R:331, 0x0080<br>False    | N/A                                | C:5267<br>R:330,<br>0x0004<br>True | R:315<br>3    |
| Current<br>Single<br>Phase | N/A            | N/A    | N/A                                                | N/A          | N/A         | N/A           | —            | C:5288<br>R:331,<br>0x0080<br>False | C:5304<br>R:332,<br>0x0080<br>True | C:5272<br>R:330,<br>0x0080<br>True | R:315<br>8    |

<sup>①</sup> Inhibits start, indicates error when running.

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