Model iPM – Intelligent Power Monitor

Features

- Monitors Single Phase, Three Phase 4 Wire Wye or Three Phase Delta
- User Specified Voltage Range, Frequency Range and Configuration
- Monitors Phase Sequence, Voltage, Frequency, THD and DC Component
- Designed to MIL-STD-810C
- EMI Filtering per MIL-STD-461
- Transient Protection per MIL-STD-704 & MIL-STD-1399
- EIA RS485 Interface
- Background Self-Test
- Holdup Time
- Hermetically Sealed – Electro Tin Plate

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General Description

The NAI iPM is an advanced, compact, DSP based system power monitor providing a precise instrument grade digital analysis of input power lines. The iPM monitors single phase, three phase 4-wire wye or three phase Delta power lines at various input voltage levels and frequencies. This monitor is equipped with an EIA RS485 compatible serial communications interface that permits additional control functions and readout of diagnostic data. Additionally, it features a background self-test that continuously monitors the health of unit hardware. This NAI power monitor is designed and qualified to the most stringent performance and environmental requirements.

Operation

When the voltage and frequency of the input signal are within prescribed high and low limits, and the phase sequence is ABC, the output relay will energize after the specified "pick-up" time delay. If the high or low voltage limits of any phase are exceeded for a time greater than the specified "drop-out" time delay, the relay de-energizes and remains de-energized until all phase voltages return within limits and remain at normal levels for longer than the specified "pick-up" time delay. If the input frequency exceeds the high or low frequency limits for a time exceeding the "drop-out" time delay, the relay de-energizes and remains de-energized until the frequency returns within limits and remains at normal levels for longer than the "pick-up" time delay. The output relay will not energize if the phase sequence is other than ABC or if any phase is disconnected. When the output relay is energized, loss of any phase will cause the relay to drop out immediately, overriding the time delay circuits.

Electrical Specifications

Input Characteristics:

Input	80-230Vrms: Configurable for Three Phase 4 Wire Wye, Three Phase 3 wire Delta or Single Phase
Frequency Range	47Hz to 800Hz
Input Transient Protection	Per MIL-STD-704, Type 1 (Three Phase and Single Phase) Per MIL-STD-1399, Type 1 (Three Phase Delta)
EMI Filtering	Per MIL-STD-461 CE (Conducted Emissions)

Monitoring Characteristics:

Voltage Band	As Required; See Ordering Information
Frequency Band	As Required; See Ordering Information
Accuracy	1%; Defined as maximum error of factory set trip point, including temperature drift and repetitive operations.
Peak Voltage (Crest Factor)	Default Trip Limit - Factory Set to 200%
Hold-Up Time	50ms
Distortion (THD)	Default Trip Limit - Factory Set to 10%
DC Component	Default Trip Limit - Factory Set to ±5Vdc
Phase Sequence	ABC
Time Delay (Pick-up)	50ms – 9.99 sec; See Ordering Information
Time Delay (Drop-out)	50ms – 9.99 sec; See Ordering Information

Output Contacts:

Contact Form	DPDT or 3PDT
Contact Life	50,000 operations min.
Contact Resistance	7.5 milliohms max.
Dielectric Strength	1000Vdc (all terminals to case)
Insulation Resistance	100 Megohms@500Vdc (all terminals to case)
Dissipation	6 Watts max.
Contact Rating	28Vdc: 10A resistive; *10A inductive* 115Vrms (47-65Hz): 2.5A resistive; *2.5A inductive* 115Vrms (360-880Hz): 10A resistive; *10A inductive*

Physical & Environmental Specifications

Temperature Range	Operating: -55°C to +100°C; Storage: -55°C to +100°C
Shock	Per MIL-STD-810C, Method 516.2, Procedure I, 50g's 11 ±1ms any axis
Vibration	Per MIL-STD-810C, Method 514.2, Procedure I, 10-2000Hz 20g's
Acceleration	Per MIL-STD-810C, Method 513.2, Procedure I & II, ±10g's
Humidity	Per MIL-STD-810C, Method 507.1 Procedure I
Altitude	70,000 feet per MIL-STD-810C, Method 504.1, Category 6 Equipment
Dimensions	Refer to "Mechanical Layout & Wiring Diagram"
Enclosure	Hermetically Sealed
Finish	Electro Tin Plate per ASTM-B545
Interface	Refer to "Mechanical Layout & Wiring Diagram"
Weight	12 oz. max (0.34kg)
Marking	Model number, Date code and Wiring Diagram

Communication & Diagnostics

Description

Model iPM provides an EIA RS485 compatible serial data interface allowing enhanced control features, access to diagnostic data and real-time readout of measured parameters of the AC power input such as frequency, voltage, phase and others.
Since the iPM is designed with common hardware for all versions, the RS485 port is also used at the factory to customize all operating parameters to customer specification (see iPM Ordering Information).

Interface Settings

Baud Rate	115.2K
Data Bits	8
Stop Bits	1
Parity	None
Protocol	None

Command Format

All commands are sent via the RS485 serial interface as ASCII text. Each command is terminated with an ASCII Linefeed character (0x0A) indicated as <lf> in tables below. All commands will have a response message as indicated below. Character string data responses will be terminated with an ASCII Linefeed character. Binary data response messages will not have a terminating character but will terminate when the specified number of bytes has been sent.

Enhanced Control Commands

The following commands permit enhanced control of Model iPM.

Command	Response	Description
OFF<lf>	"OK<lf>" or error message	Command turns off output even if input power is good
RESET<lf>	"OK<lf>" or error message	Command allows output to turn on when power is good
TEST<lf>	"OK<lf>" or error message	Command initiates a comprehensive self-test. Results may be accessed using the BITRESULT? query.

Parameter Measurement Command

Real-time readout of all parameters of the AC power input that is being monitored by model iPM is available using this command. The response to this query is a 34 byte binary message with no terminating character. User program must stop reading when the specified number of bytes has been received.

Command	Response	Description
MEASURE?<lf>	34 bytes, no terminating character (See Response Message below)	Query returns measured values of input power parameters such as voltage, frequency, phase, etc. See message description in "**Response**" column.

Byte	Data
1-2	Frequency (16-bit, lsb = 0.1Hz)
3-4	Reserved
5-6	Temperature (16-bit signed, lsb = 0.1ºC)
7-8	Phase A voltage rms (16-bit, lsb = 0.1 volt)
9-10	Phase B voltage rms (16-bit, lsb = 0.1 volt)
11-12	Phase C voltage rms (16-bit, lsb = 0.1 volt)
13-14	Phase A voltage peak (16-bit, lsb = 0.1 volt)
15-16	Phase B voltage peak (16-bit, lsb = 0.1 volt)
17-18	Phase C voltage peak (16-bit, lsb = 0.1 volt)
19-20	Phase A DC component (16-bit, lsb = 1 mV DC)
21-22	Phase B DC component (16-bit, lsb = 1 mV DC)
23-24	Phase C DC component (16-bit, lsb = 1 mV DC)
25-26	Phase A Phase Angle (16-bit, lsb = 0.1 degree) relative to Phase A
27-28	Phase B Phase Angle (16-bit, lsb = 0.1 degree) relative to Phase A
29-30	Phase C Phase Angle (16-bit, lsb = 0.1 degree) relative to Phase A
31	Phase A THD (8-bit, lsb = 0.1%)
32	Phase B THD (8-bit, lsb = 0.1%)
33	Phase C THD (8-bit, lsb = 0.1%)
34	PowerOK (8-bit, 1 = power good, 0 = no good)

Status of Power Commands

The following commands query the condition of AC input power. PowerOK indicates if all monitored conditions of the input power are good. OpState indicates the operating state of the power monitor such as whether it is tripped or on (reset). Details of reason for trip condition as well as indication of values that are at a cautionary level and status of internal background self-test are also available.

<table>
<tr><th>Command</th><th>Response</th><th>Description</th></tr>
<tr><td>POWER?<lf></td><td>“0<lf>” or “1<lf>”</td><td>Query returns PowerOK status. “1” indicates that all monitored parameters of the input AC power are within limits. “0” indicates that at least one monitored parameter exceeds the limit.</td></tr>
<tr><td>STATUS?<lf></td><td>12 bytes, no terminating character
Response Message
<table>
<tr><th>Byte</th><th>Data</th></tr>
<tr><td>1</td><td>OpState (8-bit)</td></tr>
<tr><td>2</td><td>PowerOK (8-bit)</td></tr>
<tr><td>3-6</td><td>TripFlag (32-bit)</td></tr>
<tr><td>7-10</td><td>CautionFlag (32-bit)</td></tr>
<tr><td>11-12</td><td>bitStatus (16-bit)</td></tr>
</table>
Message Details:
OpState - 8-bit ASCII: 0 = OFF (output off); 2 = RESET (allows output on if power is ok); 3 = TRIPPED (output off because power no longer good); 4 = FAILED (output off and unit disabled due to internal self-test fail. Will not turn back on until power is removed and restored).

PowerOK - 8-bit ASCII: 0 = Power No Good or 1 = Power Good

TripFlag & CautionFlag - 32-bit binary register. TripFlag indicates abnormal power conditions exceeding trip limit. CautionFlag indicates marginal power conditions. For each bit of register, “1” indicates value exceeds trip or caution limit, “0” indicates value within limit. Bit definitions follow.
<table>
<tr><th>Bit</th><th>Parameter</th><th>Bit</th><th>Parameter</th></tr>
<tr><td>0</td><td>Improper Phase Sequence</td><td>15</td><td>Ph. A High Peak volt.</td></tr>
<tr><td>1</td><td>High Steady-State Freq.</td><td>16</td><td>Ph. B High Peak volt.</td></tr>
<tr><td>2</td><td>Low Steady-State Freq.</td><td>17</td><td>Ph. C High Peak volt.</td></tr>
<tr><td>3</td><td>Ph. A High Steady-State Volt.</td><td>18</td><td>High Transient Freq.</td></tr>
<tr><td>4</td><td>Ph. A Low Steady-State Volt.</td><td>19</td><td>Low Transient Freq.</td></tr>
<tr><td>5</td><td>Ph. B High Steady-State Volt.</td><td>20</td><td>Ph. A High Transient Volt.</td></tr>
<tr><td>6</td><td>Ph. B Low Steady-State Volt.</td><td>21</td><td>Ph. A Low Transient Volt.</td></tr>
<tr><td>7</td><td>Ph. C High Steady-State Volt.</td><td>22</td><td>Ph. B High Transient Volt.</td></tr>
<tr><td>8</td><td>Ph. C Low Steady-State Volt.</td><td>23</td><td>Ph. B Low Transient Volt.</td></tr>
<tr><td>9</td><td>Ph. A High DC component</td><td>24</td><td>Ph. C High Transient Volt.</td></tr>
<tr><td>10</td><td>Ph. B High DC component</td><td>25</td><td>Ph. C Low Transient Volt.</td></tr>
<tr><td>11</td><td>Ph. C High DC component</td><td>26-31</td><td>Reserved</td></tr>
<tr><td>12</td><td>Ph. A High THD</td><td></td><td></td></tr>
<tr><td>13</td><td>Ph. B High THD</td><td></td><td></td></tr>
<tr><td>14</td><td>Ph. C High THD</td><td></td><td></td></tr>
</table>
bitStatus - 16-bit binary register. Indicates abnormal internal self-test conditions. For each bit of register, “1” indicates value exceeds limit, “0” indicates value within limit. Bit definitions follow.
<table>
<tr><th>Bit</th><th>Parameter</th><th>Bit</th><th>Parameter</th></tr>
<tr><td>0</td><td>Half-Ref voltage Hi or Lo</td><td>6</td><td>Reserved</td></tr>
<tr><td>1</td><td>VREF voltage Hi or Lo</td><td>7</td><td>Phase A input test fail</td></tr>
<tr><td>2</td><td>+5V voltage Hi or Lo</td><td>8</td><td>Phase B input test fail</td></tr>
<tr><td>3</td><td>+5VA voltage Hi or Lo</td><td>9</td><td>Phase C input test fail</td></tr>
<tr><td>4</td><td>Relay Drive voltage Hi or Lo</td><td>10</td><td>Temperature too high</td></tr>
<tr><td>5</td><td>Reserved</td><td>11-15</td><td>Reserved</td></tr>
</table></td><td>Query returns status of input AC power and operational status of power monitor See message description in “Response” column.</td></tr>
</table>

Self-Test Detailed Results Command

The following command queries the measured values for self-test parameters such as internal power supply voltages.

<table>
<tr><th>Command</th><th>Response</th><th>Description</th></tr>
<tr><td>BITRESULT?<lf></td><td>24-bytes, no terminating character

Response Message
<table><tr><td>Byte</td><td>Data</td></tr><tr><td>1-2</td><td>bitStatus (16-bit, see description above)</td></tr><tr><td>3-4</td><td>Half-Ref voltage (16-bit, lsb = 4.89mV)</td></tr><tr><td>5-6</td><td>VREF voltage (16-bit, lsb = 4.89mV)</td></tr><tr><td>7-8</td><td>+5V voltage (16-bit, lsb = 9.78mV)</td></tr><tr><td>9-10</td><td>+5VA voltage (16-bit, lsb = 9.78mV)</td></tr><tr><td>11-12</td><td>Relay Drive voltage (16-bit, lsb = 53.76mV)</td></tr><tr><td>13-14</td><td>Reserved (16-bit)</td></tr><tr><td>15-16</td><td>Reserved (16-bit)</td></tr><tr><td>17-18</td><td>Phase A input test voltage (16-bit, lsb = 4.89mV)</td></tr><tr><td>19-20</td><td>Phase B input test voltage (16-bit, lsb = 4.89mV)</td></tr><tr><td>21-22</td><td>Phase C input test voltage (16-bit, lsb = 4.89mV)</td></tr><tr><td>23-24</td><td>Temperature (16-bit signed, lsb = 0.1ºC)</td></tr></table></td><td>Query returns measured values of internal power supply voltages and other self-test parameters. See message description in “Response” column.</td></tr>
</table>

Product Identification Commands

The following commands query identification of model iPM including serial number, part number and firmware version.

Command	Response	Description
PARTNO?<lf>	Up to 51 character string plus <lf>	Query returns part number of the unit
SERNO?<lf>	Up to 32 character string plus <lf>	Query returns serial number of the unit
VER?<lf>	Up to 32 character string plus <lf>	Query returns firmware version of the unit
MANUF?<lf>	38 character string plus <lf>	Query returns the manufacturer identification, always “North Atlantic Industries www.naii.com”

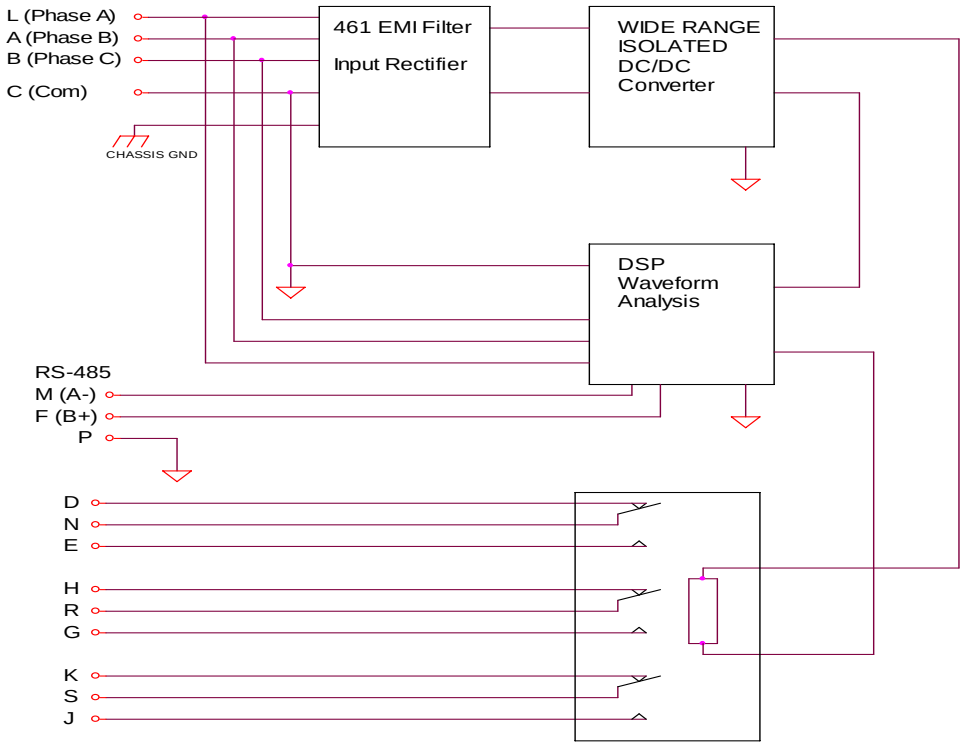
Error Messages

The following error messages may be received if commands do not complete successfully.

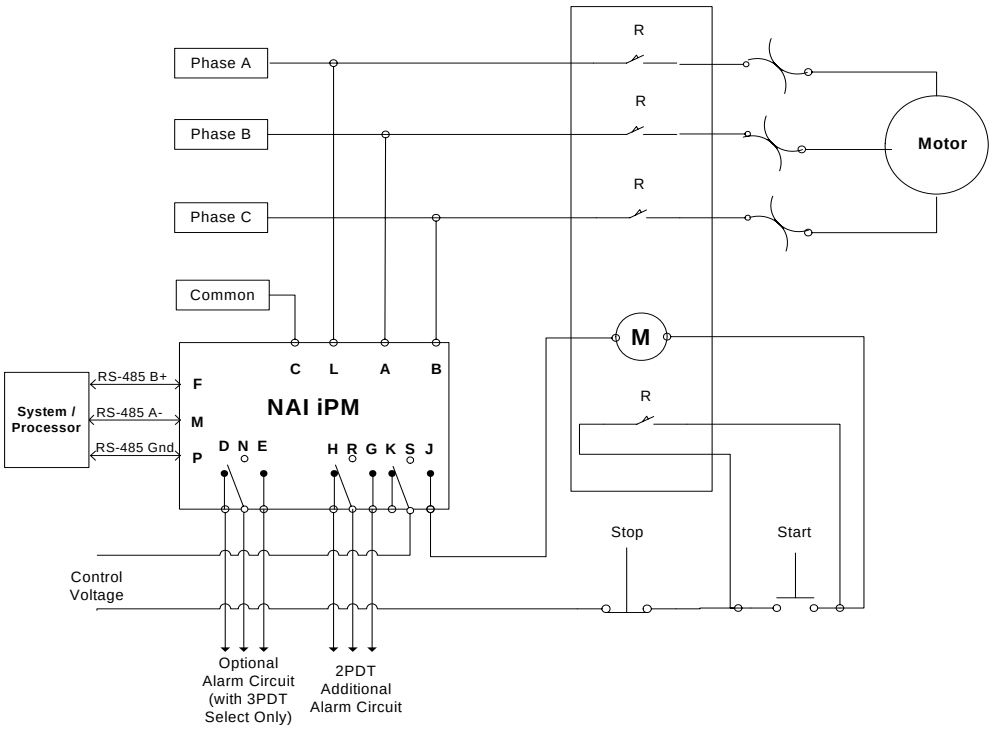
ERR01 - FAILED STATE
ERR03 - CMD NOT SUPPORTED
ERR04 - INVALID PART NUMBER
ERR05 - INVALID SERIAL NUMBER
ERR06 - FAILED TO CAL

Block Diagram &Typical Application

Block Diagram

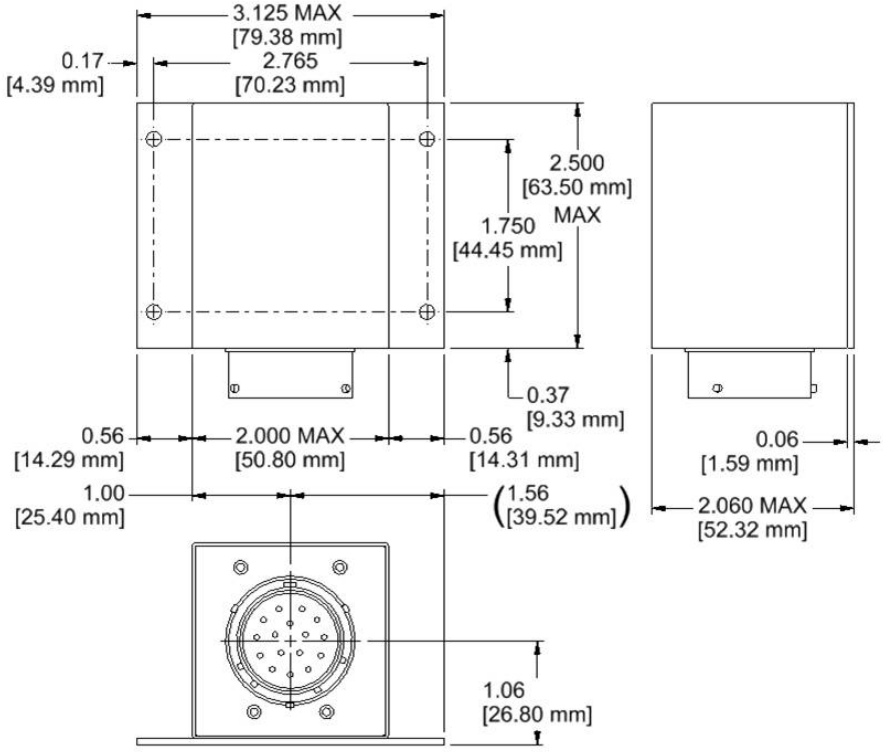


Typical Application



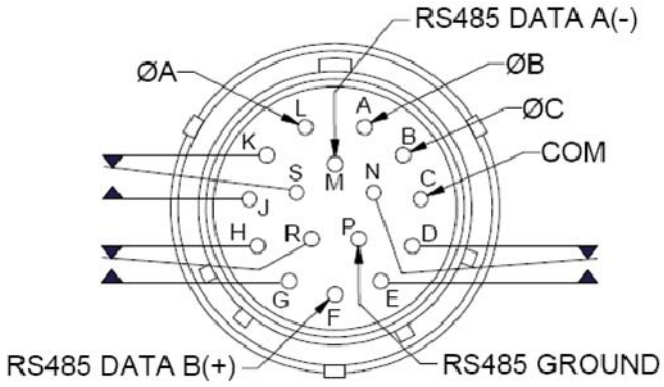
Mechanical Layout &Wiring Diagram

Mechanical Layout



Wiring Diagram

(Refer below to installation information*)



***Installation Information:**

1. Wiring diagram shown above depicts the output contacts in the de-energized position.
2. For single phase operation, use Pins L & A.
3. For DPDT Operation, do not use pins D, E & N
4. **CAUTION** – NOTE THAT PIN C (COM) IS NOT TIED INTERNALLY TO CHASSIS.

Note: Contact factory for other case styles / connector options.

iPM Ordering Information

TO ORDER, SPECIFY ALL PARAMETERS USING THE PART NUMBERING SYSTEM SHOWN BELOW:

	F1	F2	F3	F4	F5	F6	F7	F8		F9	F10		F11	F12		F13	F14
Example Part Number →	iPM	4	2	A	0	1	0	1	(047	- 812)	(087	- 211)	(005	- 999)	00		

PHASE (F1)
Enter one of the following options in Field 1 **(F1)**.
1 = Single Phase
3 = Three Phase, 3 Wire Delta (Line-to-Line)
4 = Three Phase, 4 Wire Wye (Line-to-Common)

CONTACT FORMS (F2)
Enter one of the following options in Field 2 **(F2)**.
2 = DPDT (double pole, double throw)
3 = 3PDT (triple pole, double throw)

MILITARY STANDARDS (F3)
Enter one of the following options in Field 3 **(F3)**.
A = Option Not Selected: Continue to specify remaining part number parameters.
B = MIL-STD-704: 115Vrms @ 400Hz (Wye), Nominal; For this option, customer must select one of the following pre-configured part numbers:
iPM42B0000 (000-000) (000-000) (000-000) 00 (Part number configured for DPDT contact form)
iPM43B0000 (000-000) (000-000) (000-000) 00 (Part number configured for 3PDT contact form)
C = MIL-STD-1399: 115Vrms @ 60Hz (DELTA), Nominal; For this option, customer must select one of the following pre-configured part numbers:
iPM32C0000 (000-000) (000-000) (000-000) 00 (Part number configured for DPDT contact form)
iPM33C0000 (000-000) (000-000) (000-000) 00 (Part number configured for 3PDT contact form)

PHASE SEQUENCE TOLERANCE (F4)
Enter one of the following options in Field 4 **(F4)**.
0 = Option Not Selected
1 = 6° Phase Sequence Tolerance
2 = 15° Phase Sequence Tolerance
3 = 30° Phase Sequence Tolerance
4 = 45° Phase Sequence Tolerance

THD (F5)
Enter one of the following options in Field 5 **(F5)**.
0 = Option Not Selected
1 = Option Selected (Trip on THD)

DC (F6)
Enter one of the following options in Field 6 **(F6)**.
0 = Option Not Selected
1 = Option Selected (Trip on DC)

PEAK (F7)
Enter one of the following options in Field 7 **(F7)**.
0 = Option Not Selected
1 = Option Selected (Trip on PEAK)

FREQUENCY SENSE BAND (F8 & F9)
Enter three digit value (1 Hz increments) for lower frequency limit in Field 8 **(F8)** - (i.e. 47 Hz = 047); For "No Frequency Monitoring", enter XXX in Field 8 **(F8)**.
Enter three digit value (1 Hz increments) for upper frequency limit in Field 9 **(F9)** - (i.e. 812 Hz = 812); For "No Frequency Monitoring", enter XXX in Field 9 **(F9)**.

VOLTAGE SENSE BAND (F10 & F11)
Enter three digit value (1 Volt increments) for lower voltage limit in Field 10 **(F10)** - (i.e. 87 Vrms = 087); For "No Voltage Monitoring", enter XXX in Field 10 **(F10)**.
Enter three digit value (1 Volt increments) for upper voltage limit in Field 11 **(F11)** - (i.e. 211 Vrms = 211); For "No Voltage Monitoring", enter XXX in Field 11 **(F11)**.

PICK-UP/DROP-OUT TIME (F12 & F13)
Enter two digit value (10 msec increments) for pick-up time in Field 12 **(F12)** - (i.e. 50 msec = 005).
Enter two digit value (10 msec increments) for drop-out time in Field 13 **(F13)** - (i.e. 9.99 sec = 999).

OPTIONS (F14)
00 = No Option; Enter "00" in Field 14 **(F14)**.