# INTEGRA Ri3 digital metering system

**DIN Rail Digital Energy Meter for
Single- and Three-phase Electrical Systems**

# Installation and Operating Instructions

**Important safety information is contained in the Maintenance section.  Familiarise yourself with this information before attempting installation or other procedures.**

Symbols used in this document:

 Risk of Danger:  These instructions contain important safety information: Read them before starting installation or servicing of the equipment

 Caution: Risk of Electric Shock

# Contents

Contents

# 1   Introduction

This document provides operating, maintenance and installation instructions for the Crompton Instruments Integra Ri3 DIN rail mounted energy meter.  The unit measures and displays the characteristics of single phase, three-phase 3-wire or three-phase 4-wire supplies, including voltage, frequency, current, power and real and reactive energy, imported or exported.  Energy is measured in terms of Wh, kWh, MWh, VArh, kVArh and MVArh, since it was last reset.  Maximum demand current can be measured over preset periods of up to 60 minutes.  In order to measure energy, the unit requires voltage and current inputs in addition to the supply required to power the product.  The requisite current input(s) are obtained via current transformers (CT).

The Ri3 can be configured to work with a wide range of CTs, giving the unit a wide range of operation.  Built-in interfaces provide pulse and RS485 Modbus™/JC N2 outputs.  Configuration is password-protected.

The unit can be powered from a separate auxiliary (a.c. or d.c.) supply.  Alternatively it can be powered from the monitored supply, where appropriate.

## 1.1    Unit Characteristics

The Ri3 can measure and display:

- Line voltages and THD% (total harmonic distortion) of all phases
- Line frequency
- Currents, current demands and current THD% of all phases
- Power, maximum power demand and power factor
- Active Energy (Wh, kWh or MWh) imported and exported
- Reactive Energy (VArh, kVArh or MVArh) imported and exported

The unit has password-protected set-up screens for:

- Changing password.
- Supply system selection 1ph, 3ph3w or 3ph4w.
- CT primary current (1 to 9999A)
- Demand interval time
- Reset for cumulative energy and demand measurements
- Pulse output duration and rate divisor
- RS485 serial Modbus™ or JC N2 format

A pulsed relay output indicates real-time energy measurement.  An RS485 output allows remote monitoring from another display or a computer.

## 1.2    Current Transformer Primary Current

The unit can be configured to operate with CT primary current of between 1 and 9999A.  Maximum CT primary current corresponds to a maximum input current to the unit of 5A.

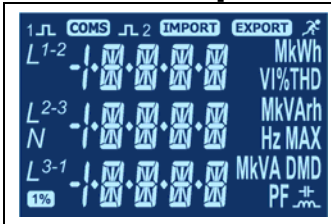## 1.3    RS485 Serial - Modbus™ or JC N2Protocol

This uses an RS485 serial port with Modbus™  or Johnson Controls (JC) N2  protocol to provide a means of remotely monitoring and controlling the Ri3 unit.

Set-up screens are provided for setting up the RS485 port.  See Section 4.8.

## 1.4   Pulse Output

This provides a relay pulse output that clocks up measured active (Wh) or reactive (VArh) energy. The unit can produce one pulse for preset quantity of energy imported or exported. The pulse divisor and pulse width can be set from the Set-up menu as detailed in Section 0.
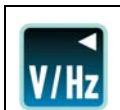
# 2   Start Up Screens

| | |
|---|---|
|  | The first screen lights all display segments and can be used as a display check. |
|  | The second screen indicates the firmware installed in the unit and its build number. This example shows a firmware version of 2.510 and a build number of 21.07. |
|  | Next the unit performs a self-test and indicates if the test passes. |

After a short delay, the last-used measurement screen appears.

# 3   Measurements

The buttons operate as follows:

| | |
|---|---|
|  | Selects the Voltage and Frequency display screens. In Set-up mode, this is the 'Back' button. |
|  | Selects the Current display screens. In Set-up mode, this is the 'Up' button. |
|  | Selects the Power and Power Factor screens. In Set-up mode, this is the 'Down' button. |
|  | Selects the Energy display screens. In Set-up mode, this is the 'Enter' button. |

## 3.1   Voltage and Frequency 

Each successive pressing of the  button selects a new range:
Phase to neutral voltages (not 3p3w mode)
Voltages between phases (three phase supplies only)
Frequency in Hz

Percentage total voltage harmonic distortion (THD%) for each phase to N (not 3p3w mode)
Percentage voltage THD% between phases (three phase supplies only)

## 3.2  Current

Each successive pressing of the [A] button selects a new range:
Current on each phase
Neutral current (three phase supplies only)
Maximum demand currents on each phase since the last Demand reset
Maximum neutral demand current since the last Demand reset (three phase supplies only)
Current THD% for each phase

## 3.3  Power and Power Factor

Each successive pressing of the [P/PF] button selects a new range:

Instantaneous power:

| | |
|---|---|
| 3·108 kW | Power in kW or MW |
| 0·861 kVAr | Reactive Power in kVAr or MVAr |
| 3·610 kVA | Volt-amps in kVA or MVA |

Maximum demanded power since last Demand reset
Power factor

The unit automatically chooses an appropriate unit of power (x1, kilo or Mega).

If the 1% Limit option is set to On (Section 4.10), readings below 1% of maximum for the range will be displayed as zero.

## 3.4  Energy Measurements

Each successive pressing of the [E] button selects a new range:
Imported energy in kWh or MWh
Exported energy in kWh or MWh
Imported reactive energy in kVArh or MVArh
Exported reactive energy in kVArh or MVArh

This is a two-line display that can indicate up to 9999999.9.  This example shows that 20133.7 kWh of energy has been imported since the last energy hours reset.

The blue man symbol flashes during the accumulation of Wh or VArh data at a rate determined by the associated instantaneous power parameter.

The displayed unit/kilo/mega (e.g. Wh, kWh or MWh) parameter is set in Set-up mode (see Section 4.10).

If the 1% Limit option is set to On (Section 4.10). readings below 1% of range maximum will not be included in the energy computation, to prevent meter 'creep'.  The **1%** symbol appearing in the bottom left-hand corner of the display indicates that the 1% Limit option is off and that power values below 1% of range maximum will accrue to the total energy value.

# 4  Setting Up

To enter set-up mode, firmly press the ![V/Hz] and ![E] buttons simultaneously and hold for about 5 seconds, until the password screen appears.  Setting up is password-protected so you must enter the correct password (default '0000') before proceeding.  If an incorrect password is entered, the display reverts to measurement mode.

To exit setting-up mode, press ![V/Hz] repeatedly until the measurement screen is restored or hold

![V/Hz] and ![E] buttons simultaneously for 5 seconds.

## 4.1  Set-up Menu Structure

**Change password**
> *nnnn*     4-digit number – default '0000'.

**Supply system**
> 3-phase 4-wire
> 3-phase 3-wire
> single phase.

**CT**  Set the value of the CT primary in use
> *nnnn* – 4-digit number 0001 to 9999.

**dIT**  **Demand Integration Time**
> This is the period in minutes over which the current and power readings are integrated for maximum demand measurement.  Options are: Off, 5, 8, 10, 15, 20, 30 and 60 minutes.

**RSET**  Resets cumulative Energy and/or Demand measurement to zero.

**COMS** - Communication parameters for RS485 interface

> **FMT** - Format

>> **Modb** - Modbus™ protocol
>> Baud rate 2400/4800/9600/19200/38400
>> Parity none/odd/even
>> Stop bits 1 (1 or 2 if parity is None)
>> RS485 network address *nnn* – 3-digit number, 1 to 247
>> Order::Norm/Rev – Indicates if the Modbus™ word order is normal or reversed.

>> **N2**    Johnson Controls (JC) N2 protocol
>> RS485 network address *nnn* – 3-digit number, 1 to 255.

**Rly - Relay pulse output**
> kWh/kVArh (Active/reactive) Import or Export
> Rate 0.001/0.01/0.1/1/10/100/1k/10k kWh or kVArh per pulse
> Pulse width 200/100/60 ms.

**NRGy - Energy**
> Unit/kilo/Mega units selection
> 1% limit on/off. If **on**, power values <1% of range max. will not be included in energy measurements (prevents 'creep').

**Test**
> Display on – all elements on to check display
> dISTG  Display toggle.  Each element is turned on and off alternately
> Phase sequence (V123 I123).

**SOFT** Firmware version and build numbers.

## 4.2    Set-up Entry Methods

Some menu items, such as password and CT, require a four-digit number entry while others, such as supply system, require selection from a number of menu options.

### 4.2.1  Menu Option Selection

1. Use the (up) and (down) keys to select the required item from the menu shown in Section 4.1.  Selection does not roll over between bottom and top of list.

2. Press to confirm your selection.

3. If an item flashes (shown red on these pages), then it can be adjusted by the (up) and (down) keys.  If not, there may be a further layer, e.g. Comms - Baud rate, before adjustment is possible.  Press to select the lower layer.

4. Having selected an option from the current layer, press to confirm your selection.  The SET indicator will appear.

5. Having completed a parameter setting, press to return to a higher menu level.  The SET indicator will be removed and you will be able to use the and keys for further menu selection.

6. On completion of all setting-up, press repeatedly until the measurement screen is restored.

### 4.2.2  Number Entry Procedure

When setting up the unit, some screens require the entering of a number.  In particular, on entry to the setting up section, a password must be entered.  Digits are set individually, from left to right.  The procedure is as follows:

1. The current digit to be set flashes (shown red on these pages) and is set using the (up) and (down) keys.

2. Press to confirm each digit setting.  The SET indicator appears after the last digit has been set.

3. After setting the last digit, press to exit the number setting routine.  The SET indicator will be removed.

## 4.3    Change Password

| | | |
|---|---|---|
| 1. | Use the ▲ A (up) and ▼ P/PF (down) to choose the Change Password option. | CHNG PASS |
| 2. | Press ↵ E to enter the change password routine.  The New Password screen will appear with the first digit flashing. | NPWd 0000 |
| 3. | Use ▲ A and ▼ P/PF to set the first digit and press ↵ E to confirm your selection. The next digit will flash. | |
| 4. | Repeat the procedure for the remaining three digits. | |
| 5. | After setting the last digit, SET will show. | NPWd 0000 SET |
| 6. | Press ◄ V/Hz to exit the number setting routine and return to the Set-up menu. SET will be removed. | CHNG PASS |

## 4.4    Supply System

Use this section to set the type of power supply being monitored.

| | | |
|---|---|---|
| 1. | From the Set-up menu, use the ▲ A (up) and ▼ P/PF (down) keys to select the System option.  The screen will show the currently selected supply option. | SYS 3P4W |
| 2. | Press ↵ E to enter the Supply Selection routine.  The current selection will flash. | SYS 3P4W |
| 3. | Use the ▲ A (up)and ▼ P/PF (down) keys to select the required system option: 3P4W        3P4W      or      3b1M<br>*3-phase 4-wire    3-phase 3-wire        Single phase.* | |
| 4. | Press ↵ E to confirm your selection.  SET indicator will appear. | SYS 3P3W SET |
| 5. | Press ◄ V/Hz to exit the system selection routine and return to the menu.  SET will disappear and you will be returned to the main Set-up menu. | SYS 3P3W |

## 4.5    dIT Demand Integration Time

This sets the period in minutes over which the Current and Power readings are integrated for maximum demand measurement.  The options are Off, 5, 8, 10, 15, 20, 30, and 60 minutes.

| 1. | From the Set-up menu, use the [A] (up) and [P/PF] (down) keys to select the dIT option.  The screen will show the currently selected integration time. | dIT 60 |
|---|---|---|
| 2. | Press [E] to enter the selection routine.  The current time interval will flash. | dIT 60 |
| 3. | Use the [A] (up) and [P/PF] (down) keys to select the required option from **Off** (no integration time) to **60** minutes. | |
| 4. | Press [E] to confirm your selection.  SET indicator will appear. | dIT 30 SET |
| 5. | Press [V/Hz] to exit the dIT selection routine and return to the menu.  The SET indicator will be removed and you will be returned to the main Set-up menu. | dIT 30 |

## 4.6    CT

The CT option sets the maximum primary current (1 to 9999A) of the current transformer (CT) that will give 5A into the meter (the maximum).

| 1. | From the Set-up menu, use the [A] (up) and [P/PF] (down) keys to select the CT option.  The screen will show the current CT primary current value. An 'A' to the right of the lower line indicates that the reading is in amps. | CT 0005 A |
|---|---|---|
| 2. | Press [E] to enter the CT primary current selection routine.  The first digit will flash. | CT 0005 A |
| 3. | Use the method described in Section 4.2.2 to set the 4-digit number to the maximum CT primary current, e.g. 500A. | |
| 4. | On completion of the entry procedure, press [V/Hz] to return to the main Set-up menu. | CT 0005 A |

## 4.7    RSET - Reset

Use this option to restart Energy Hours (kWh, kVArh) and/or Current/Power Demand measurements from zero.  These can be set individually or all together.

| | | |
|---|---|---|
| 1. | From the main Set-up menu, use the [A] (up) and [P/PF] (down) keys to display the Reset screen. | RSET ---- |
| 2. | Press [E].  'dMd' will flash. | RSET dMd |
| 3. | Use the [A] (up) and [P/PF] (down) keys to select which counter(s) you wish to reset: Demand (**dMd**), Energy hours (**hour**), or both (**ALL**). | |
| 4. | Press [E] to reset the selected counter.  RSET will be displayed and the flashing will stop. | RSET ALL RSET |
| 5. | Press [V/Hz] to exit the Reset routine.  RSET will clear and you will be returned to the main Set-up menu. | RSET ---- |

## 4.8    Communications

The RS485 port can be used for communications using either Modbus™ or Johnson Controls (JC) N2 protocol.  For Modbus™, parameters such as Baud rate are selected from the front panel whereas for JC N2 they are fixed.  The RS485 address can be selected for both protocols.

The first section allows you to select either Modbus™ or JC N2 configuration.

| | | |
|---|---|---|
| 1. | From the main Set-up menu, use the [A] (up) and [P/PF] (down) keys to display the Communications screen. | COMS ---- |
| 2. | Press [E].  The Format screen will appear showing the current format – Modb or N2. | COMS FMT Modb |
| 3. | To change the format, press [E].  The format will flash. | COMS FMT Modb |
| 4. | Use the [A] or [P/PF] key to change the format. | COMS FMT N2 |
| 5. | Press [E] to confirm your selection.  SET will be displayed. | COMS FMT N2 SET |

| 6. | Press **V/Hz** to exit the format selection routine. SET will be removed. | COMS FMT N2 |
|---|---|---|

| | If you have selected **N2** format, you can use the **E** or **P/PF** key to select the RS485 address option and set it as detailed on page 14. | |
|---|---|---|
| | If you have selected **ModB** format, set the serial parameters as follows: | |
| 7. | Use the **A** or **P/PF** key to cycle through the Baud, parity, stop bits and address menu options. | COMS bAUd 9600 |

## Baud Rate (not applicable for JC N2)

| 8. | To change the Baud setting, ensure that the display shows the Baud setting and press **E** to enter the setting routine. The digits will flash. | COMS bAUd 9600 |
|---|---|---|
| 9. | Use the **A** and **P/PF** keys to select the desired Baud rate from the available options: 9600, 4800, 2400, 38.4k (38400) and 19.2k (19200). | COMS bAUd 4800 |
| 10. | Press **E** to confirm your Baud rate selection. SET will be displayed. | COMS bAUd 4800 SET |
| 11. | Press **V/Hz** to exit Baud setting routine. SET will go off and the **A** and **P/PF** keys can be used to select a different Comms parameter. | COMS bAUd 4800 |

## Parity (not applicable for JC N2)
Note that if parity is set to Odd or Even, Stop Bits will be set to 1 and cannot be changed.

| 12. | Use the **A** and **P/PF** keys to select the Parity option. | COMS PARI NONE |
|---|---|---|
| 13. | Press **E** to enter the parity setting routine. The parameter will flash. | COMS PARI NONE |
| 14. | Use the **A** and **P/PF** keys to select the desired parity option from None, Even and Odd. | COMS PARI Odd |

| 15. | Press [E] to confirm your selection.  SET will be displayed. | COMS PAR1 Odd SET |
|-----|---|---|
| 16. | Press [V/Hz] to exit parity setting routine.  SET will go off and the [A] and [P/PF] keys can be used to select a different Comms parameter. | COMS PAR1 Odd |

### Stop Bits(not applicable for JC N2)

Note that, if Parity is set to Odd or Even, Stop Bits will be set to 1 and cannot be changed.

| 17. | Use the [A] and [P/PF] keys to select the Stop Bits option. | COMS STOP 1 |
|-----|---|---|
| 18. | Press [E] to enter the Stop Bits setting routine.  The parameter value will flash. | COMS STOP 1 |
| 19. | Use the [A] and [P/PF] keys to select the desired number of Stop Bits – 1 or 2. | COMS STOP 2 |
| 20. | Press [E] to confirm your selection.  SET will be displayed. | COMS STOP 2 SET |
| 21. | Press [V/Hz] to exit Stop Bits setting routine.  SET will go off and the [A] and [P/PF] keys can be used to select a different Comms parameter. | COMS STOP 2 |

### RS485 Address

An RS485 network can accommodate up to 255 different devices, each identified by an address between 1 and 247 (Modbus™) or 1 and 255 (JC N2).

| 22. | Use the [A] and [P/PF] keys to select the Address option. | COMS Addr 1 |
|-----|---|---|
| 23. | Press [E] to enter the Address setting routine.  The first digit will flash. | COMS Addr 001 |
| 24. | Use the method described in Section 4.2.2 to set the 3-digit address to the required number between 1 and 247 for Modbus™ or 1 and 255 for JC N2. | |

**Modbus™ Word Order (not applicable for JC N2)**

| | |
|---|---|
| This screen shows the word order (Hi/Lo) of the 8-bit bytes in the Modbus™ message format.  Normal is Hi first.  This setting can only be changed from the Modbus port.  See the *Cix Communications Guide* for further information | COMS<br>**Ordr**<br>**NOrM** |

## 4.9   Pulse Output

This option allows you to configure the pulse output.  The output can be set to provide a pulse for a defined amount of energy imported or exported.  The energy monitored can be active or reactive and the pulse width can be selected as 200, 100 or 60 ms.

The pulse rate output is limited to a maximum of two pulses per second.  It is not possible to set an energy-per-pulse that will result in a pulse rate that is greater than this.  For example, on a single-phase, two-wire system, a CT setting of 900A with a maximum 289V supply implies a maximum energy imported or exported in an hour of 900 x 289 = 260 kWh which is 72 W.seconds.  A setting of 10Wh per pulse would generate 7 pulses per second.  Since this exceeds 2/s, the unit would not allow such a setting.

Use this section to set up the relay pulse output –
  **Units** Import kWh, export kWh, import kVArh, export kVArh
  **Rate** 0.001/0.01/0.01/0.1/1/10/100/1k/10k kilo/pulse
  **Pulse width** 200/100/60 ms.

| | | |
|---|---|---|
| 1. | From the main Set-up menu, use the [A] (up) and [P/PF] (down) keys to display the Relay screen. | **RLY**<br>**- - - -** |
| 2. | Press [E].  The Relay Import/Export range screen will appear. | IMPORT<br>**RLY**<br>**KWh** |
| 3. | Press [E] to enter the Import/Export range selection routine.  The displayed value will flash. | IMPORT<br>**RLY**<br>**KWh** |
| 4. | Use the [A] (up) and [P/PF] (down) keys to select the required option– none or import/export and units. | IMPORT<br>**RLY**<br>**KVAr** |
| 5. | Press [E] to confirm your selection.  SET will appear. | IMPORT<br>**RLY**<br>**KVAr**<br>**SET** |
| 6. | Press [V/Hz] to exit Output setting routine.  SET will be removed and the [A] and [P/PF] keys can be used to select a different Relay parameter. | IMPORT<br>**RLY**<br>**KVAr** |

## Rate

Use this to set the energy represented by each pulse.  Rate can be set to generate 1 pulse per

| | |
|---|---|
| 0.001 | = 1 Wh/VArh |
| 0.01 | = 10 Wh/VArh |
| 0.1 | = 100 Wh/VArh |
| 1 | = 1 kWh/kVArh |
| 10 | = 10 kWh/kVArh |
| 100 | = 100 kWh/kVArh |
| 1k | = 1 MWh/MVArh |
| 10k | = 10 MWh/MVArh |

The rate cannot be set to a value that could result in more than 2 pulses per second.

| 7. | Use the (up) and (down) keys to select the Rate screen. | RATE 1 |
|---|---|---|
| 8. | Press to enter the Rate setting routine.  The Rate value will flash.  The Rate is the energy that each output pulse represents. | RATE 1 |
| 9. | Use the (up) and (down) keys to select the Rate required for the pulse output. | RATE 100 |
| 10. | Press to confirm your selection.  The SET indicator will appear and the display will stop flashing. | RATE 100 SET |
| 11. | Press V/Hz to exit the Rate setting routine.  The SET indicator will be removed and the A and P/PF keys can be used to select a different Relay parameter. | RATE 100 |

## Pulse Duration

Use this option to set the duration of pulses (in ms).  Pulse duration can be set to 60, 100 or 200 ms.

| 12. | Use the (up) and (down) keys to select the Pulse screen. | PULS 200 |
|---|---|---|
| 13. | Press to enter the Pulse Width setting routine.  The value will flash. | PULS 200 |
| 14. | Use the (up) and (down) keys to select the Pulse Width in ms. | PULS 100 |

| 15. | Press ![E] to confirm your selection.  The SET indicator will appear and the display will stop flashing. | PULS 100 SET |
| 16. | Press ![V/Hz] to exit Pulse Width setting routine.  SET will disappear and the ![A] and ![P/PF] keys can be used to select a different Relay parameter. | PULS 100 |

## 4.10  Energy Units and 1% Limit

Use this option to set the displayed energy units multiplier and to set a 1% limit on measured energy on or off.

The unit multiplier can be set to Wh/VArh (x1), kWh/kVArh (kilo) or MWh/MVArh (Mega).

To prevent noise from being recorded and causing 'meter creep', a 1% limit can be imposed on the measured input such that energy readings less than 1% of maximum are not recorded.  This limit can be turned off so that even small energy increments are recorded.

| 1. | Use the ![A] (up) and ![P/PF] (down) keys to select the Energy screen. | NRGY ---- |
| 2. | Press ![E] to select the Energy menu. | UNIT MEGA |

At this stage, you can use the ![A] and ![P/PF] keys to select either the **Energy Units** or **1% Limit** menu.
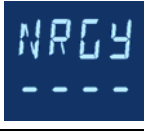
**Energy Units**

| 3. | With the Unit screen selected, press ![E] to enter the Units setting routine.  The currently selected unit flashes. | UNIT MEGA |
| 4. | Use the ![A] (up) and ![P/PF] (down) keys to select the required units: x1, kilo or Mega. | UNIT x1 |
| 5. | Press ![E] to confirm your selection.  SET will appear and the display will stop flashing. | UNIT x1 SET |

| 6. | Press **V/Hz** to exit Units setting routine.  SET will be removed. | UN IT<br>X 1 |
|----|----|----|

## 1% Limit

With the 1% Limit On, line noise below 1% of maximum power will be displayed as zero and will not accrue to the energy reading.  With Limit Off, the 1% symbol will be appear on the power and energy screens to show that low power readings will be displayed and utilised.

| 7. | Use the **A** (up) and **P/PF** (down) keys to select the Limit screen. | L m t<br>ON<br>1% |
|----|----|----|
| 8. | Press **E** to enter the Limit setting routine.  The value will flash. | L m t<br>ON<br>1% |
| 9. | Use the **A** (up) and **P/PF** (down) keys to turn the 1% limit on or off. | L m t<br>OFF<br>1% |
| 10. | Press **E** to confirm your selection.  SET will appear and the display will stop flashing. | L m t<br>OFF<br>SET<br>1% |
| 11. | Press **V/Hz** to exit 1% Limit setting routine.  SET will be removed. | L m t<br>OFF<br>1% |
| 12. | Press **V/Hz** again to exit the Limit menu and return to the main Set-up menu. | NRGY<br>- - - - |

# 4.11  Test

This option provides various test facilities.

| 1. | Use the **A** (up) and **P/PF** (down) keys to select the Test screen. | TEST<br>- - - - |
|----|----|----|
| 2. | Press **E** to enter the Test menu. | TEST<br>d ISP<br>ON |
| 3. | Use the **A** and **P/PF** keys to select the required test option and press **E** to confirm your selection.  The available options are: | |

| | | |
|---|---|---|
| TEST dISP ON | Lights all LED segments so that display segments can be checked. Press V/Hz to exit. | |
| TEST dISP TOGL | Toggles display segments alternately. Press V/Hz to exit. | |
| TEST PHAS SEQ | Shows the voltage and current phase sequences. Press V/Hz to exit. | PSEQ V 123 I 123 |
| 4. | Press V/Hz to exit the selected test display mode. | TEST PHAS SEQ |
| 5. | Press V/Hz again to return to the main Set-up menu. | TEST ---- |

For the voltage and current phase sequence test to operate reliably, voltage and current inputs must be greater than 5% of nominal.

The Phase Sequence display shows the phase relationships of the supply voltages and currents. To obtain correct power, voltage and current readings, the indicated phase sequences should be '123'.

To obtain sequence test indications, the measured phase relationships must be within the following parameters.

**Three-phase four-wire mode**

Measurements are referenced from L1.

**Voltage:**

For the voltage sequence test, the phase of L2 relative to L1 must be within the window 240 +/- 48 degrees and L3 relative to L1 must be within the window 120 +/- 48 degrees to record the sequence V123.

Alternatively, the phase of L2 relative to L1 must be within the window 120 +/- 48 degrees and L3 relative to L1 must be within the window 240 +/- 48 degrees to record the sequence V132.

The display shows 'V1--' if a voltage phase is outside these parameters.

**Current:**

For the current sequence test, the phase of I1 relative to L1 must be within the window 0 +/- 48 degrees and I2 relative to L1 must be within the window 240 +/- 48 degrees and I3 relative to L1 must be within the window 120 +/- 48 degrees to record the sequence i123.

Alternatively the phase of I1 relative to L1 must be within the window 0 +/- 48 degrees and I2 relative to L1 must be within the window 120 +/- 48 degrees and I3 relative to L1 must be within the window 240 +/- 48 degrees to record the sequence i132.

The display shows 'I --' if a current phase is outside these parameters.]

### Three-phase three-wire mode

Measurements are referenced from L1-L2.

### Voltage:

For the voltage sequence test, the phase of L2-L3 relative to L1-L2 must be within the window 240 +/- 48 degrees and L3-L1 relative to L1-L2 must be within the window 120 +/- 48 degrees to record the sequence V123.

Alternatively, the phase of L2-L3 relative to L1-L2 must be within the window 120 +/- 48 degrees and L3 relative to L1-L2 must be within the window 240 +/- 48 degrees to record the sequence V132.

The display shows 'V1--' if a voltage phase is outside these parameters.

### Current:

For the current sequence test, the phase of I1 relative to L1-L2 must be within the window 330 +/- 48 degrees and I2 relative to L1-L2 must be within the window 210 +/- 48 degrees and I3 relative to L1-L2 must be within the window 90 +/- 48 degrees to record the sequence i123.

Alternatively, the phase of I1 relative to L1-L2 must be within the window 330 +/- 48 degrees and I2 relative to L1-L2 must be within the window 90 +/- 48 degrees and I3 relative to L1-L2 must be within the window 210 +/- 48 degrees to record the sequence i132.

The display shows 'I --' if a current phase is outside these parameters.

## 4.12  Version Information

The last option of the Set-up menu show the versions of firmware and hardware of the unit.  Use the ▲ A and ▼ P/PF keys to scroll through the Set-up menu options.



Firmware version (2.51)

Build (21.07)

# 5  Specification

## 5.1  Measured Parameters

The unit can monitor and display the following parameters of a single phase, 3-phase 3-wire or 3-phase 4-wire supply.

### 5.1.1  Voltage and Frequency

Phase to neutral voltages 100 to 289V a.c. (not for 3p3w supplies)
Voltages between phases 173 to 500V a.c. (3p supplies only)
Frequency in Hz
Percentage total voltage harmonic distortion (THD%) for each phase to N (not for 3p3w supplies)
Percentage voltage THD% between phases (three phase supplies only)

### 5.1.2  Current

Current on each phase – 1 to 9999A range, set by external current transformer(s) (CTs)
Neutral current (calculated) (three phase supplies only)
Maximum demand currents on each phase, since the last Demand reset
Maximum neutral demand current, since the last Demand reset (three phase supplies only)
Current THD% for each phase

### 5.1.3  Power and Power Factor

Instantaneous power:
 Power 0 to 3600 MW
 Reactive Power 0 to 3600 MVAr
 Volt-amps 0 to 3600 MVA
Maximum demanded power since last Demand reset
Power factor

### 5.1.4  Energy Measurements

Imported energy 0 to 9999999.9 Wh, kWh or MWh
Exported energy 0 to 9999999.9 Wh, kWh or MWh
Imported reactive energy 0 to 9999999.9 VArh, kVArh or MVArh
Exported reactive energy 0 to 9999999.9 VAhr, kVArh or MVArh

## 5.2  Measured Inputs

Voltage inputs through 4-way fixed connector with $2 \cdot 5mm^2$ stranded wire capacity.  3-Phase 3- and 4-wire and Single-phase 2-wire unbalanced.  Line frequency measured from L1 voltage or L3 voltage.

Three current inputs (six physical terminals) with $2 \cdot 5mm^2$ stranded wire capacity for connection of external CTs.  Nominal rated input current 5A a.c. rms.

### 5.2.1  Range of Use

Values of measured quantities, components of measured quantities, and quantities which affect measurement errors to some degree, for which the product gives meaningful readings.

Voltage                       5 to 120% of Range Maximum (below 5% of range maximum voltage, current indication may only be approximate)

Current           1 to 120% of nominal

Power factor      1 to 0, leading or lagging

Active power      1 to 144% of nominal, 3600 MW maximum

Apparent power    1 to 144% of nominal, 3600 MVA maximum

Power is only registered when voltage and current are within their respective range of use.

Power factor is only indicated when the measured VA is over 3% of range maximum.

## 5.3    Accuracy

| | |
|---|---|
| Voltage | 0·5% of range maximum |
| Current | 0·5% of nominal |
| Neutral current | 4% or nominal (calculated) |
| Frequency | 0·2% of mid-frequency |
| Power factor | 1% of unity (0.01) |
| Active power (W) | ±1% of range maximum |
| Reactive power (VAr) | ±1% of range maximum |
| Apparent power (VA) | ±1% of range maximum |
| Active energy (Wh) | Class 1 IEC 62053-21 |
| Reactive energy (VARh) | ±1% of range maximum |
| Total harmonic distortion | 1% up to 31$^{st}$ harmonic |
| Temperature co-efficient | Voltage and current = 0.013%/°C typical<br>Active energy = 0·018%/°C, typical |
| Response time to step input | 1s, typical, to >99% of final reading, at 50 Hz. |
| Error change due to variation of an influence quantity in the manner described in Section 6 of IEC 688:1992 | 2 × error allowed for the reference condition applied in the test.  Error due to temperature variation as above. |
| Error in measurement when a measurand is within its measuring range, but outside its reference range | 2 × error allowed at the end of the reference range adjacent to the section of the measuring range, where the measurand is currently operating / being tested. |

## 5.4    Auxiliary Supply

Two-way fixed connector with 2·5mm$^2$ stranded wire capacity.
110 to 400V a.c. 50/60Hz ±10% or 120V to 350V d.c. ±20%.  Consumption < 10W.

## 5.5   Interfaces for External Monitoring

Two interfaces are provided:

- an RS-485 communication channel that can be programmed for Modbus™ (the default) or Johnson Controls (JC) N2 protocol
- a relay output indicating real-time measured energy.

The Modbus configuration (Baud rate etc.) and the pulse relay output assignments (kW/kVArh, import/export etc.) are configured through the Set-up screens.

### 5.5.1  Pulse Relay Output

The pulse relay output can be set to generate pulses to represent imported kWh, exported kWh, imported kVArh or exported kVArh.

**Rate** can be set to generate 1 pulse per:

| | |
|---|---|
| 0.001 | = 1 Wh/VArh |
| 0.01 | = 10 Wh/VArh |
| 0.1 | = 100 Wh/VArh |
| 1 | = 1 kWh/kVArh |
| 10 | = 10 kWh/kVArh |
| 100 | = 100 kWh/kVArh |
| 1k | = 1 MWh/MVArh |
| 10k | = 10 MWh/MVArh |

The rate cannot be set to a value that could result in more than 2 pulses per second.

**Pulse width** 200/100/60 ms.

**Relay Rating** 240V ac 50mA

### 5.5.2  RS485 Output  for Modbus™ or JC N2 Protocol

For Modbus™, the following RS485 communication parameters can be configured from the Set-up menu:

**Baud rate** 2400, 4800, , 9600, , 19200, 38400
**Parity** none/odd/even
**Stop bits** 1 or 2
**RS485 network address** *nnn* – 3-digit number, 1 to 247
**Modbus™ Word order**  Hi/Lo byte order is set automatically to normal or reverse. It cannot be configured from the set-up menu.

Note that with odd or even parity set, Stop Bits are forced to one.

For JC N2, only the RS485 network address can be configured.  The range of addresses is 1-255.

## 5.6    Reference Conditions of Influence Quantities

Influence Quantities are variables that affect measurement errors to a minor degree.  Accuracy is verified under nominal value (within the specified tolerance) of these conditions.

| | |
|---|---|
| Ambient temperature | 23°C ±1°C |
| Input waveform | 50 or 60Hz ±2% |
| Input waveform | Sinusoidal (distortion factor < 0·005) |
| Auxiliary supply voltage | Nominal ±1% |
| Auxiliary supply frequency | Nominal ±1% |
| Auxiliary supply waveform (if AC) | Sinusoidal (distortion factor < 0·05) |
| Magnetic field of external origin | Terrestrial flux |

## 5.7    Environment

| | |
|---|---|
| Operating temperature | -10°C to +55°C[*] |
| Storage temperature | -20°C to +70°C[*] |
| Relative humidity | 0 to 90%, non-condensing |
| Altitude | Up to 2000m |
| Warm up time | 1 minute |
| Vibration | 10Hz to 50Hz, IEC 60068-2-6, 2g |
| Shock | 30g in 3 planes |

[*]Maximum operating and storage temperatures are in the context of typical daily and seasonal variation.

## 5.8    Mechanics

| | |
|---|---|
| DIN rail dimensions | 72 x 90 mm (WxH) per DIN 43880 |
| Mounting | DIN rail (DIN 43880) |
| Sealing | IP20 (minimum) |
| Material | Self-extinguishing UL 94 V-0 |

## 5.9    Approval, Certification, and Standards Compliance

RoHS compliant.  (Although this class of product is presently excluded from the RoHS regulations, the unit has been designed and manufactured in compliance with the RoHS regulations.)

| | |
|---|---|
| **EMC Emissions** | BS EN 61326, Class A (Industrial) |
| **EMC Immunity** | BS EN 61326, Class A (Industrial) |
| **Safety** | BS EN 61010-1:2001 |

# 6  Maintenance

**Warning**

- **During normal operation, voltages hazardous to life may be present at some of the terminals of this unit.  Installation and servicing should be performed only by qualified, properly trained personnel abiding by local regulations.  Ensure all supplies are de-energised before attempting connection or other procedures.**

- **Terminals should not be user accessible after installation and external installation provisions must be sufficient to prevent hazards under fault conditions.**

- **This unit is not intended to function as part of a system providing the sole means of fault protection - good engineering practice dictates that any critical function be protected by at least two independent and diverse means.**

- **This unit does not have internal fuses, therefore external fuses must be used for protection and safety under fault conditions.**

In normal use, little maintenance is needed.  As appropriate for service conditions, isolate from electrical power, inspect the unit and remove any dust or other foreign material present.  Periodically check all connections for freedom from corrosion and screw tightness, particularly if vibration is present.

The front of the case should be wiped with a dry cloth only.  Use minimal pressure, especially over the viewing window area.  If necessary wipe the rear case with a dry cloth.  If a cleaning agent is necessary, isopropyl alcohol is the only recommended agent and should be used sparingly.  Water should not be used.  If the rear case exterior or terminals should be contaminated accidentally with water, the unit must be thoroughly dried before further service.  Should it be suspected that water might have entered the unit, factory inspection and refurbishment is recommended.

In the unlikely event of a repair being necessary, it is recommended that the unit be returned to the factory or nearest TE Connectivity/Crompton Instruments service centre.

# 7  Installation

The unit is intended for mounting on a standard DIN rail.  Hook the unit onto the top of the rail and press the bottom of the unit until it locks in place.  To remove the unit from the rail, lever down the black tab at the bottom of the unit to release it from the rail.

The unit is intended for use in a reasonably stable ambient temperature within the range -10 to +55°C.  Do not mount the unit where there is excessive vibration or in excessive direct sunlight.

**Warning**

- **During normal operation, voltages hazardous to life may be present at some of the terminals of this unit.  Installation and servicing should be performed only by qualified, properly trained personnel abiding by local regulations.  Ensure all supplies are de-energised before attempting connection or other procedures.**

- **Terminals should not be user accessible after installation and external installation provisions must be sufficient to prevent hazards under fault conditions.**

- **This unit is not intended to function as part of a system providing the sole means of fault protection - good engineering practice dictates that any critical function be protected by at least two independent and diverse means.**

- **The unit does not have internal fuses therefore external fuses must be used for protection and safety under fault conditions.**

- **Never open-circuit the secondary winding of an energized current transformer.**

- **This product should only be operated with the CT secondary connections Earthed.**

- **If this equipment is used in a manner not specified by the manufacturer, protection provided by the equipment may be impaired.**

- **Auxiliary circuits (communication & relay outputs) are separated from metering inputs and 110-400V auxiliary circuits by at least basic insulation.  Such auxiliary circuit terminals are only suitable for connection to equipment which has no user accessible live parts.  The insulation for such auxiliary circuits must be rated for the highest voltage connected to the instrument and suitable for single fault condition.  The connection at the remote end of such auxiliary circuits should not be accessible in normal use.  Depending on application, equipment connected to auxiliary circuits may vary widely.  The choice of connected equipment or combination of equipment should not diminish the level of user protection specified.**

## 7.1  Safety

The unit was designed in accordance with BS EN 61010-1:2001 (IEC 61010-1:2001) – Permanently connected use, Normal condition.  Installation category III, pollution degree 2, basic insulation for rated voltage.  Measurement Category III.

## 7.2  EMC Installation Requirements

Whilst this unit complies with all relevant EU EMC (electro-magnetic compatibility) regulations, additional precautions necessary to provide proper operation of this and adjacent equipment will be installation dependent and so the following can only be general guidance:

- Avoid routing wiring to this unit alongside cables and products that are, or could be, a source of interference.

- The auxiliary supply to the unit should not be subject to excessive interference.  In some cases, a supply line filter may be required.

- To protect the product against incorrect operation or permanent damage, surge transients must be controlled. It is good EMC practice to suppress transients and surges at the source. The unit has been designed to automatically recover from typical transients; however in extreme circumstances it may be necessary to temporarily disconnect the auxiliary supply for a period of greater than 5 seconds to restore correct operation.

- Screened communication leads are required.  These and other connecting leads may require the fitting of RF suppression components, such as ferrite absorbers, line filters etc., if RF fields cause problems.

- It is necessary to wind the three current inputs through separate ferrite rings, example part number Würth Elektronik 742 701 110, a minimum of 6 times.

- It is good practice to install sensitive electronic instruments that are performing critical functions in EMC enclosures that protect against electrical interference causing a disturbance in function.

## 7.3    Case Dimensions
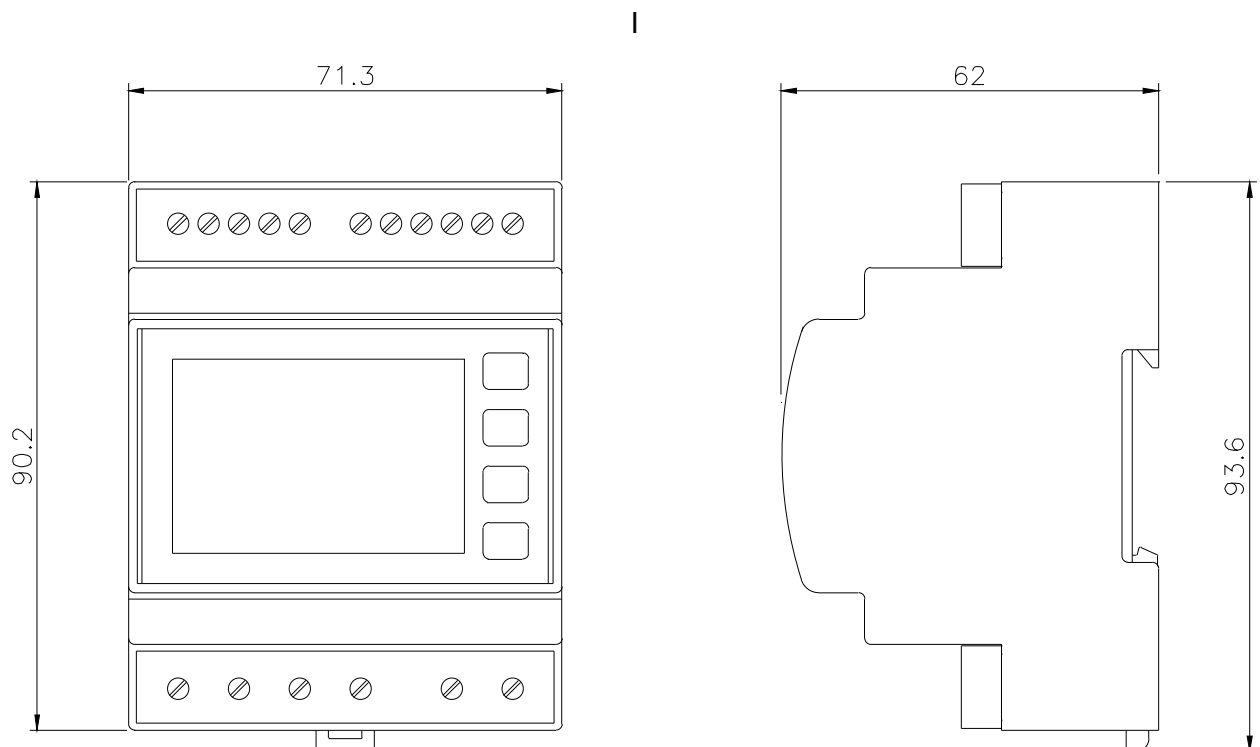


## 7.4    Wiring

Input connections are made to screw clamp terminals.  Choice of cable should meet local regulations for the operating voltage and current.

**The current inputs of these products are designed for connection into systems via current transformers only.**

All negative current inputs are commoned inside the unit and grounding should be at one point only.

To minimise measurement errors, the CTs should be grounded as shown in the wiring diagram in Section 7.8.

CT secondaries must be grounded in accordance with local regulations. It is desirable to make provision for shorting links to be made across CTs to permit easy replacement of a unit should this ever be necessary.

### 7.4.1  Additional considerations for three wire systems

The neutral terminal (terminal N) is indirectly connected to the voltage input terminals (terminals L1, L2, L3). When connected to a three wire system the neutral terminal will adopt a potential somewhere between the remaining lines.

If external wiring is connected to the neutral terminal it must be connected to either the neutral line or earth (ground) to avoid the possibility of electric shock from the neutral terminal.

## 7.5  Auxiliary Supply

The Integra Ri3 should ideally be powered from a dedicated supply; however it may be powered from the signal source providing the source will always be within tolerance for the auxiliary supply voltage range.

Requirements: 110 to 400Va.c. 50/60Hz ±10% or 120V to 350Vd.c. ±20%. Consumption <10W.

## 7.6  Fusing

This unit must be fitted with external fuses in voltage and auxiliary supply lines. Voltage input lines must be fused with a quick blow fuse 1A maximum. Auxiliary supply lines must be fused with a slow blow fuse rated 1A maximum. Choose fuses of a type and with a breaking capacity appropriate to the supply and in accordance with local regulations.

A suitable switch or circuit breaker should be included in the installation. It should be positioned so as to be easy to operate, in close proximity to the equipment, and clearly identified as the disconnecting device.

## 7.7  Earth/Ground Connections

For safety reasons, current transformer secondary connections should be grounded in accordance with local regulations. Under no circumstances should this product be operated without this Earth connection.

## 7.8  Connection Diagrams



Single Phase, 2 wire

3 Phase, 3 wire    3 Phase, 4 wire
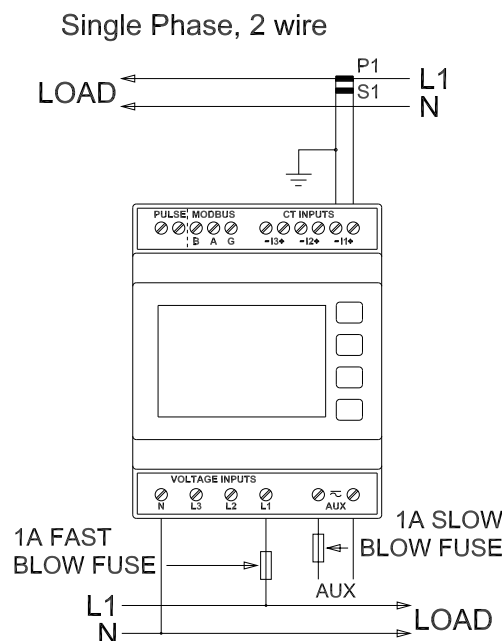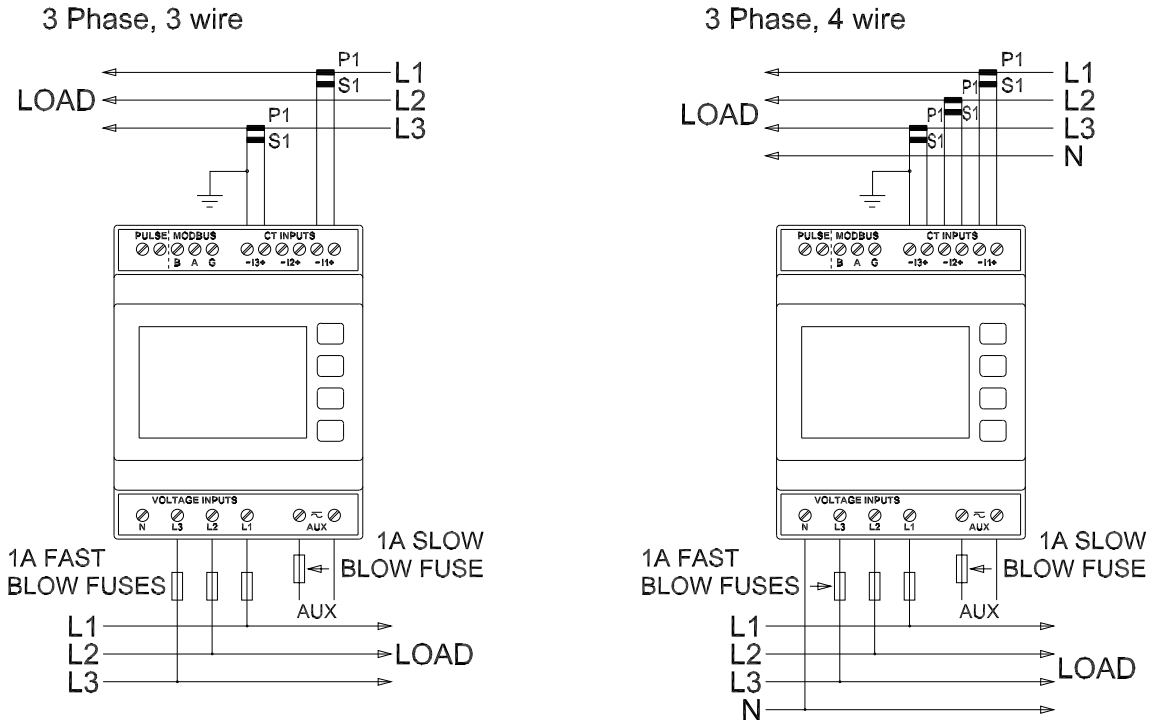
Voltage lines and auxiliary supply must be fused - see above.

## 7.9  RS485 and Modbus™ or JC N2 Protocol

The RS485 interface in conjunction with the Modbus™ or JC N2 protocol allows the unit to be interrogated and provide a response detailing the readings it has taken.  This can be used for remote monitoring by a PC or SCADA system.

An RS485 and Modbus™ Protocol Guide is available for download from the Crompton Instruments web site at http://www.crompton-instruments.com/ci_range/Ci1_Ci3_Comms_guide.pdf

## 7.10  Operation Check



After installation, use the test display to check for incorrect wiring of the voltage and current transformer inputs (see Section 4.11).  The displayed voltage (V) and current (I) sequences must be '*123*' to obtain the correct power, voltage and current readings.

In the event of a voltage phase error, e.g. the same phase connected to two meter inputs, the display will show '*V1--*'.

In the event of a current phase error, e.g. a current transformer connected the wrong way round or to the wrong phase, the display will read '*I --*'.

If the display shows the correct V and I sequence (123), check that the meter shows correctly that energy is being imported or exported.  An incorrect import/export indication means that all current transformers are connected the wrong way round.

The meter has a certain tolerance in order to correctly identify phase errors, as described in Section 4.11.

# 8  Glossary

| | |
|---|---|
| Active energy | Accumulated energy (Watt hours). |
| CT | Current Transformer.  Transforms a (usually) high current to a value that can be monitored by the meter. |
| Firmware | Software installed on a permanent medium. |
| Johnson Controls (JC) N2 | A master - slave serial communication protocol with fixed communication parameters. |
| Modbus™ | A proprietary communications protocol used for control and monitoring. |
| Reactive energy | The energy (VArh) in the reactive component of the supply.  The current and voltage in the reactive component are mutually 90° out of phase - capacitive or inductive – resulting in a supply power factor of zero. |
| RS485 | A serial communication system linking multiple addressed terminals. |
| SCADA | Supervisory Control And Data Acquisition system. |

# 9 Index