Installation and Operating Instructions

Quadratic Integra 1530 Digital Metering Systems

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1. Introduction

This manual provides operating and installation instructions for the Integra 1530 multifunction digital metering system. The Integra will measure and communicate many electrical parameters, including THD values.

Integra 1530 combines a basic accuracy of 0.2% with fast response, a range of output options, and a large clear LED display. The display provides a wide viewing angle without parallax issues and fast response at low ambient temperatures. All voltage and current measurements are true RMS incorporating 31st harmonic of fundamental for accurate measurement of non sinusoidal waveforms.

Not all configurations and options described in this document may be immediately available. Contact your supplier for details of availability.

Integra 1530 configurations and product codes:

System	Product Code
Single Phase 2 Wire	INT-1531
Single Phase 3 Wire	INT-1532
3 Phase 3 Wire	INT-1533
3 Phase 4 Wire	INT-1534
3 Phase 4 Wire + Neutral Current	INT-1535

Set up of the Integra may be carried out by using the display or Integra configurator software – Section 3 of this manual and the user documentation for Integra configurator software gives more information on :

Configuring for use with installed current transformers
Setting Potential Transformer / Voltage Transformer ratios, when used
Demand Integration Time
Resetting demand and energy
Pulsed output set up
Communications (RS485) set up
Analogue output set up
Password protection of set up screens to prevent accidental modification

If required, set up parameters may be manipulated directly via the Modbus interface. The Integra can be powered from an auxiliary a.c. or d.c. supply that is separate from the metered supply. Versions are available to suit 100-250V 50-60 Hz a.c./d.c. and 12-48V d.c supplies.

Some models have a black rear cover. These products omit some features available on models with red translucent rear cover. Where appropriate, these features will be indicated in this document with an ¬ symbol. The 1535 is always configured with a red rear cover. When powered, a low power red light source will be visible through the back cover.

Modbus, Lonworks and Profibus are trademarks of their respective owners. All trademarks are acknowledged.

> **Important safety information is contained in the Installation and Maintenance section. Users must familiarise themselves with this information before attempting installation or other procedures.**

1.1. Measurement Capabilities
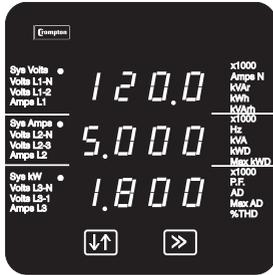
The1530 can measure and display the following:
System voltage (average of all phases)
System current (average of all phases)
Voltage and Current Total Harmonic Distortion
System frequency (Hz)
Voltage line to neutral for each phase (not 3 phase 3 wire systems)
Voltage line to line for each phase Current in each line.
Neutral current (calculated, or metered with 4th CT option ¬)
Power Factor
Active Power (kW)
Reactive Power (kvar)
Apparent Power (kVA)
Active Energy (kWh) Import and Export
Reactive Energy (kvarh) Import and Export
Total System Current Demand (AD)
Total System Active Power Demand (kWD)
Maximum Total System Current Demand (Max AD)
Maximum Total System Active Power Demand (Max kWD)

Default display

1.1.1 Set-up screens

Full-scale current value
Potential transformer - primary and secondary voltages
Demand integration time and energy/demand resets
Pulse output duration and rate divisor (option)
RS485 serial Modbus parameters (option)
Analogue current output (option)

1.1.2 Options

Pulsed relay output, indicating kWh/kvarh, 1 or 2 analogue outputs, an RS485 communications port, Profibus port or LONworks port are available as optional extras. The RS484 communications port option allows remote monitoring from another display a Modbus master or JC N2/Metasys network.

The Analogue output provides a current output that indicates the value of a chosen parameter. Not all options may be fitted to the same unit. Pre sales literature indicates valid option combinations and ordering codes.

1.2 Maximum Power

The 1530 is limited to a maximum power of 360 MW. During set-up, primary voltage and current setting are checked and the unit will not accept entries that breach the 360 MW limit. This is covered in more detail in the sections that show primary voltage and current set-up. The Maximum Power restriction of 360 MW refer to 120% of nominal current and 120% of nominal voltage, i.e. 250 MW nominal system power.

1.3 Secondary Voltage

The 1530 allows the user to specify, within a range, the secondary voltage of the potential transformer (PT) with which it is to be used. In this document the term Potential Transformer and Voltage Transformer are equivalent.

1.4 Demand Calculation.

The maximum power consumption of an installation is often important, as power utilities base some of their charges on it. Many utilities use a thermal maximum demand indicator (MDI) to measure this peak power consumption and the Integra digitally models this thermal response.

Demand Integration Times can be set to 8, 15, 20, 30 or (¬ only) 60 minutes.

Maximum Demand is the maximum power or current demand that has occurred since the unit was last reset as detailed in Section 3.9, Resets.

1.5 RS485 Serial Option

This option uses an RS485 serial port with Modbus or JC N2 protocol to provide a means of remotely monitoring and controlling the Integra unit. Both protocols are supplied in the same unit. Communications automatically configure according to the protocol that is recognized when the master sends a message. The controlling and monitoring unit may also be a remote display.

Where a port is available, it can be connected to a PC for control and monitoring purposes.

When used in Modbus systems, baud rate and data format can be user configured.

1.6 Pulse Output Option

This option provides one or two relay pulse output indications of measured active energy (kWh) and reactive energy consumed (kvarh). The unit can produce one pulse for every 1, 10,100 or 1000kWh/kvarh of energy consumed. The pulse divisor and pulse width (duration) can be user configured. When two pulse outputs are fitted, they share a common divisor value and pulse width.

1.7 Analogue Output Option (R)

This option provides an analogue current output that indicates the value of a chosen parameter. The parameter and active range can be user configured. Units fitted with analogue output option include an extended rear cover.

1.8 Lonworks Option

The Lonworks option provides a standard free topology FTT10A transceiver. Lonworks implementations include a manually operated switch to enable communications to be switched to a Modbus port. This Modbus port is used when setting up the unit from Crompton configuration software.

1.9 Profibus Option

The Profibus option provides an RS485 interface capable of operating at up to 10Mb/s. Profibus implementations include a manually operated switch to enable communications to be switched to a Modbus port. This Modbus port is used when setting up the unit from Crompton configuration software. Units fitted with Profibus option include an extended rear cover.

The screen is used in two main modes: display of measured values and parameter setup.
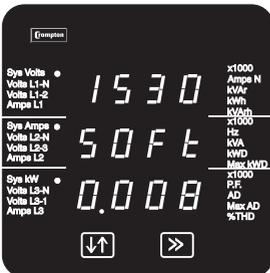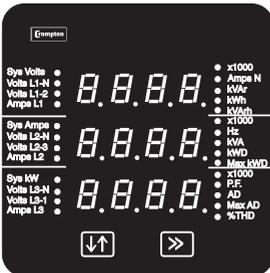
2.1. Layout

In display mode, three measured values can be shown, one on each row. For each row, the LED indicators show the parameter being measured and the units.

The >> button selects display screens in sequence.

Voltage display

In Set up mode, the top row shows an abbreviation of the parameter name, the middle row shows the parameter value being set and the bottom row is used for confirmation of the entered value. In general, the ↓↑ key changes a parameter value and the >> key confirms a value and moves on to the next screen.

This example is the potential transformer primary voltage confirmation screen.

Setup confirmation screen

2.2. Start Up Screens

Initially, when power is applied to the Integra, two screens will appear. The first screen lights the LED's and can be used as a display LED check.

The second screen indicates the firmware installed in the display unit. This example states that the version is 0.008. The version on a particular unit will differ in line with ongoing development and improvements.

After a short delay, the default Display screen will appear.

Use the >> (Next) key to select the next screen in sequence. The sequence depends on the Integra configuration (single phase 2 or 3 wire, 3 phase 3 or 4 wire).

2.3. System Screen

The following sections show 3 and 4 wire systems.

Single phase 2 and 3 wire systems have similar display screens.

The system screen is the default display. It appears when the unit is energised.
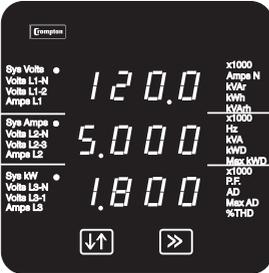
System Average Voltage (Volts) *

System Average Line Current (Amps).

System Total Active Power (kW).

Pressing key >> moves to the next screen

* Line to Line for 3 wire systems, Line to Neutral for 4 wire and single phase 2 or 3 wire systems.

2.4. System %THD Screen
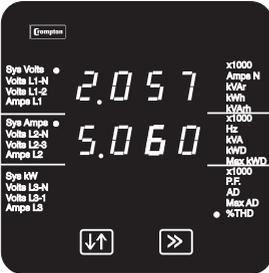
Average % Total Harmonic Distortion for System Voltages.

Average % Total Harmonic Distortion for System Currents.

Key >> moves to next screen.

2.5. Line to Neutral Voltages

Three phase, four wire systems only.

Voltage Line 1 to Neutral (Volts).

Voltage Line 2 to Neutral (Volts).

Voltage Line 3 to Neutral (Volts)

Key >> moves to next screen.

2.6. Line to Neutral Voltage %THD

Three-phase, four wire systems only.

Display:

Sys Volts, Volts L1-N, Volts L1-2, Ampa L1 — `1.803` (x1000, Ampe N, kVAr, kWh, kVArh)

Sys Amps, Volts L2-N, Volts L2-3, Ampa L2 — `2.066` (x1000, Hz, kVA, kWD, Max kWD)

Sys kW, Volts L3-N, Volts L3-1, Ampa L3 — `1.980` (x1000, P.F., AD, Max AD, %THD)
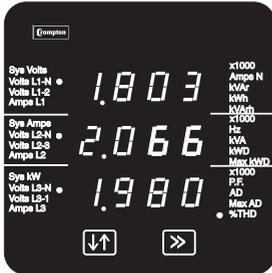
%THD of Line 1 Voltage to Neutral.

%THD of Line 2 Voltage to Neutral

%THD of Line 3 Voltage to Neutral.

Key >> moves to next screen

2.7. Line to Line Voltages

Display:

`207.8`

`207.9`

`208.0`

Voltage Line 1 to Line 2 (Volts).

Voltage Line 2 to Line 3 (Volts).

Voltage Line 3 to Line 1 (Volts).

Key >> moves to next screen.

2.8. Line to Line Voltages %THD

Three-phase, three wire systems only.

Display:

`1.803`

`2.066`

`1.980`
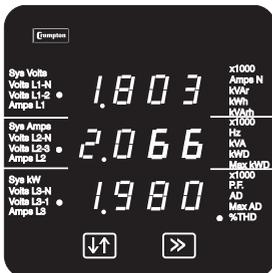
Line 1 to Line 2 Voltage %THD.

Line 2 to Line 3 Voltage %THD.

Line 3 to Line 1 Voltage %THD.

Key >> moves to next screen.

2.9. Line Currents
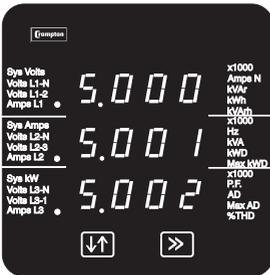
Line 1 Current (Amps).

Line 2 Current (Amps).

Line 3 Current (Amps).

Key >> moves to next screen.

2.10. Line Currents %THD

Line 1 Current %THD

Line 2 Current %THD

Line 3 Current %THD.

Key >> moves to next screen.

2.11. Neutral Current, Frequency and Power Factor
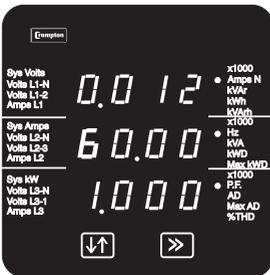
Neutral Current (Amps).
(4-wire and single phase systems only).

Frequency (Hz).

Power Factor (0 to 1, C = Capacitive and L = Inductive).

Key >> moves to next screen.

2.12. Power
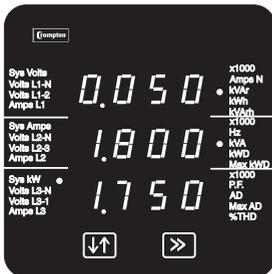
Reactive Power (kvar).

Apparent Power (kVA).

Active Power (kW).

Key >> moves to next screen.

2.13. Active Import Energy (kWh)

This is the energy that has been consumed since the unit was last reset (see Section 3.9, Resets).
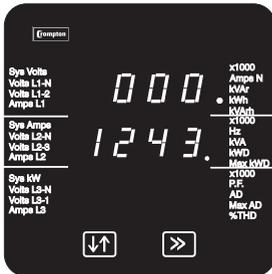
Active Import Energy (kWh)
7 digit reading i.e. 0001243.

Key >> moves to next screen.

2.14. Reactive Import Energy (kvarh)

This is the reactive energy that has been consumed since the unit was last reset reset (see Section 3.9, Resets). The reading shows the energy (kvarh) in the reactive component of the supply.
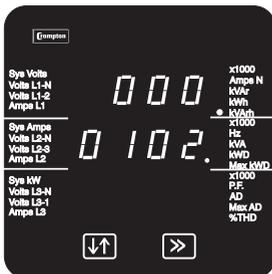
Reactive Import Energy (kvarh)
7 digit reading i.e. 0000102

Key >> moves to next screen.

2.15. Active Export Energy (kWh)

Export energy displays are indicated by an "E" on the bottom line of the display.

This is the active energy that has been exported since the unit was last reset (see Section 3.9, Resets).

Active Export Energy (kWh)
7 digit reading i.e. 0001243.

Key >> moves to next screen.

2.16. Reactive Export Energy (kvarh)

This is the reactive energy that has been exported since the unit was last reset (see Section 3.9, Resets). The reading shows the energy (kvarh) in the reactive component of the energy supplied.
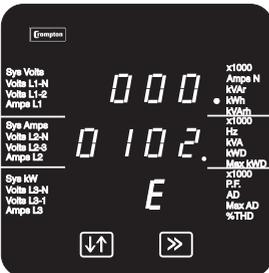
Reactive Export Energy (kvarh)
7 digit reading i.e. 0000102

Key >> moves to next screen.

2.17. Demand

This screen displays the present demand, i.e. the import power and the import current integrated over the defined period. See Section 3.8 Demand Integration Time and Section 7.5 Maximum Demand.

System Total Active Import Power Demand (kWD)

System Total Import Current Demand (AD)

Key >> moves to the next screen.

2.18. Maximum Demand

This screen displays the highest values reached for import power demand and the import current demand that have been recorded since the unit was last reset (see Section 3.9 Resets).
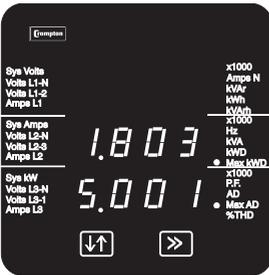
Maximum System Active Import Power Demand (kWD)

Maximum System Total current Demand (AD)

Key >> returns to the start of the sequence with the System Screen

2.19. Over Range

The displayed values must be in the range –999 x 1000 to 9999 x 1000. Any parameter value outside this range will cause the display to show overrange.

This situation will be indicated by displaying four bars in the appropriate line:
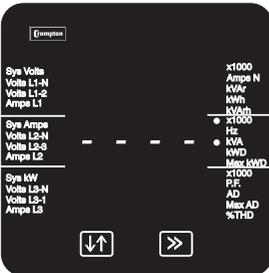
The value on the middle line is over range.

2.20. kWh and kvarh Display Range

The kWh and kvarh display range is limited to 9999999. If the unit is allowed to increment beyond this value the count will either wrap back to zero (if the Integra is set to 7 digit mode) or continue to be updated in the Integra but the display will change to seven bars. The internal value will continue to be available via the Modbus output.
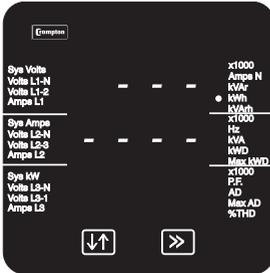
2.21. Error Messages

The display may show Err1 representing a transient internal malfunction . This message may be seen briefly during conditions of extreme electromagnetic interference with the normal display returning once the interference has ceased.

If the Err1 message persists, try interrupting, for ten seconds, the auxiliary supply (or supplies) to the Integra. This may restore normal operation. Also check that auxiliary power reaching the Integra is within specification.

3.1. Introduction

The following sections give step by step procedures for configuring the Integra using the display.

To access the Set-up screens, press and hold the ↓↑ (Adjust) key and the >> (Next) keys simultaneously for five seconds. This displays the password entry screen. (See Section 3.3 Access).

On completion of the last Set-up screen, the program exits Set-up mode and returns to the last selected Display screen. To return to the Display screens at any time during the set up procedures, press the Ø≠ and the >> keys simultaneously for five seconds. Any set up changes that have already been made will be retained.

3.2. Number Entry Procedure

When setting up the unit, many screens require the setting up of a number, usually on the middle row of digits. For example, on entry to the setting up section, a password may be required. The procedure is as follows:

In general, press the ↓↑ (adjust) key to change something on the current screen. Pressing the >> (next) key normally leaves the current screen unchanged and brings up the next screen.

The example below shows how the number 0000 can be changed to 1234.
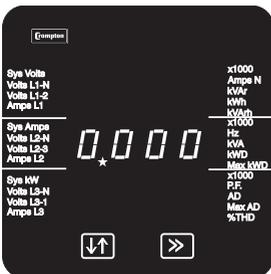
First digit

The digits are set one at a time, from left to right. The decimal point to the right of the digit (* in the picture) flashes to indicate the digit that may be changed currently. It thus acts as a cursor. Where the cursor coincides with a genuine decimal point on the display, the decimal point will flash.

Press the ↓↑ key to scroll the value of the first digit from 0 through to 9, the value will wrap from 9 round to 0. For this example, set it to '1'.

Press the >> key to confirm the setting and advance to the next digit.

On some screens, the digit range may be restricted to prevent out of range entries.
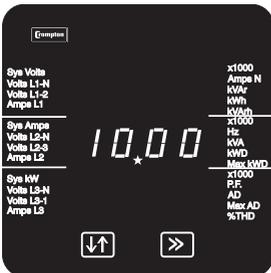
Second digit

Use the ↓↑ key to set the second digit to the required value.

Press the >> key to confirm the selection and advance to the next digit.
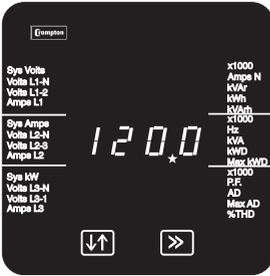
Third digit

Use the ↓↑ key to set the third digit to the required value.

Press the >> key to confirm the selection and advance to the next digit.

Fourth digit

Use the ↓↑ key to set the fourth digit to the required value.

Press the >> key to confirm the selection. If the unit accepts the entry, the Confirmation screen will appear.

If the unit does not accept the entry, e.g. an incorrect password, a rejection screen will appear, with dashes on the bottom line.

Confirmation

The Confirmation screen shows the entered number on the bottom row with all decimal points showing.

If the displayed number is correct, press the >> key to move to the next Set-up screen.

If not, press the ↓↑ key to return to restart the number entry. The first digit entry screen will appear. When entering a password, the ↓↑ key selects "change password" instead of restarting number entry.

3.3. Access

To access the Set-up screens, press the ↓↑ and >> keys simultaneously for five seconds, until the Password Introduction screen appears.

Password protection can be enabled to prevent unauthorised access to Set-up screens. Password protection is not normally enabled when a product is shipped. The unit is protected if the password is set to any four digit number other than 0000. Setting a password of 0000 disables the password protection.

3.3.1. Access with No Password Protection

Press >> from the Password Introduction screen. The 0000 password confirmation screen will appear.
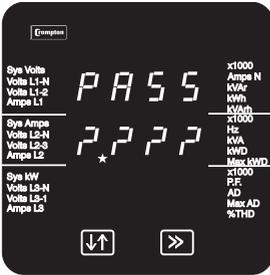
Password introduction

Press >> again to proceed to the first Set-up screen.

0000 Password Confirmation

3.3.2. Access with Password Protection

If the unit is protected by a password, proceed as follows:

Press ↓↑ from the Password Introduction screen. The Password first digit entry screen will appear.

Password introduction

First digit

Enter the four-digit password using the method described in Section 3.2 Number Entry Procedure.

Password Confirmation

On pressing >> to confirm the last digit, the Confirmation screen will appear, provided the password is correct.

From the Password Confirmation screen, there is the option of changing the password, as described in Section 3.4

Setting or Changing the Password.

To proceed to the first Set-up screen, press >>.

Password Incorrect

If the password is incorrect, the Password Reject screen will appear. Press ↓↑ to start a retry or >> to exit to the Display screens.

3.4. Setting or Changing the Password

The option to change the password is only available from the Password Confirmation screen.

Press ↓↑ to start changing the password.

The password screen for the first digit will appear, with the old password on the bottom line.

Password Confirmation

Set up the new password on the bottom line, as described in Section 3.2 Number Entry Procedure.

On pressing >> to confirm the last digit, the Password Confirmation screen will appear.
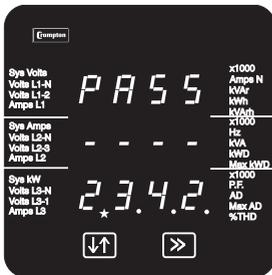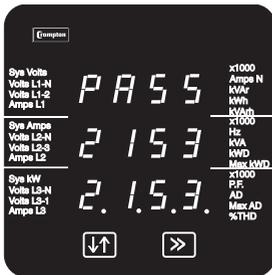
First new password digit

Press >> to confirm the new password. The first Set-up screen will appear.

Press ↓↑ to try again. The first digit screen will appear again.

New password confirmation

3.5. Full Scale Current

This parameter is the value of nominal Full Scale Currents (usually the associated CT primary current rating) that will be displayed as the Line Currents. This screen enables the user to display the Line Currents inclusive of any transformer ratios. The values displayed indicate the current in amps. For example setting 800 on this screen will cause the display to indicate 800 amps when the nominal maximum (typically 5A or factory build option of 1A) current flows through the Integra current inputs. When a 4th (Neutral current) CT is fitted, scaling is the same as for the other 3 (Phase) CTs.

Edit

Press >> to accept the present value and select the next set up screen.

To change the Full Scale Current, press Ø≠ and change the current value as detailed in Section 3.2 Number Entry Procedure.

Press >> to accept the new setting and select the next set up screen.

Press Ø≠ to return to the Edit screen.

A combination of primary current and primary voltage that would result in an absolute maximum power (120% of nominal current and voltage) of greater than 360 Megawatts is not permitted. The range of the most significant digit may be restricted, depending on the present primary voltage setting.

The Maximum Power restriction of 360 Megawatts refers to 120% of nominal current and 120% of nominal voltage, i.e. 250 Megawatts nominal system power.

When the least significant digit has been set, pressing the >> key will advance to the Full Scale Current Confirmation stage.

The allowable range is 1 to 9999A. The value will be forced to 1 if the display contains zero when the >> key is pressed.

3.6. Potential Transformer Primary Voltage

This value is the nominal full scale voltage which will be displayed as L1-N, L2-N and L3-N for a four wire system, L1-2, L2-3 and L3-1 in a three wire system or system volts for single phase. This screen enables the user to display the line to neutral or line to line voltages inclusive of any transformer ratios, maximum 400kV. The values displayed represent the voltage in kilovolts (note the x1000 indicator). For example, on a 2.2kV system with 110V potential transformer secondary, set 2.200 at this screen.

If there is no potential transformer (PT) associated with the Integra, i.e. the voltage terminals are connected directly to the metered voltage, leave this value unchanged and skip this set up step.

If the PT primary and secondary values are changed and it is desired to revert to a set-up with no PT, then set both PT primary and secondary values to the nominal maximum voltage for the Integra.

To set up the PT primary, proceed as follows:

Decimal Point

Press >> to accept the currently displayed value and select the next set up screen.

Press ↓↑ to change the PT Primary voltage.

Initially all the digits of the present value will be flashing and the decimal point position will be illuminated. This is to indicate that initially the 'multiplier' must be selected. Press Ø≠ to set the decimal point position.

Note that the x1000 indicator is on.

Press >> to accept the displayed (decimal point position). The digits stop flashing and the PT Primary Value screen appears

Digit Edit

Set the display to read the value of the PT Primary voltage, using the method described in Section 3.2 Number Entry Procedure.

A combination of primary current and primary voltage that would result in an absolute maximum power (120% of nominal current and voltage) of greater than 360 Megawatts is not permitted. The range of primary voltage setting may be restricted, depending on the previously set full scale current value.

After the last digit has been accepted, the Confirmation screen will appear.
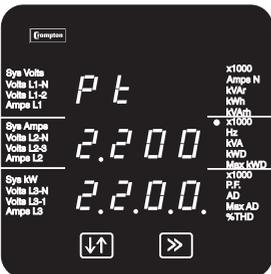
Confirmation

This example confirmation screen shows a primary voltage setting of 2.2 kV.

Press >> to accept the new setting and select the next set up screen.

Press ↓↑ to return to the Edit (Decimal Point) screen.

3.7. Potential Transformer Secondary Value

This value must be set to the nominal full scale secondary voltage which will be obtained from the transformer when the potential transformer (PT) primary is supplied with the voltage defined in Section 3.6 Potential Transformer Primary Voltage. This defines the actual full scale voltage that will be obtained from the PT secondary and measured by the unit. The ratio of the full scale primary to full scale secondary voltage is the transformer ratio. Given full scale primary and secondary voltages, the unit knows what primary voltage to display for any given measured secondary voltage.

The secondary voltage displayed is in volts. Following the previous example, on a 2.2 kV system with 110V PT secondary, set this screen to 110.0.

If there is no PT associated with the Integra, leave this value unchanged and skip this step.

Press >> to accept the displayed PT Secondary Voltage and select the next set up screen.

To change the PT Secondary Voltage display, press ↓↑.

Note that the decimal point edit screen will only appear when this Integra is designed for connection to voltages in the range 57.7 to 139V (L voltage range).

Initially all the digits of the present value will be flashing and the decimal point position will be illuminated. This is to indicate that initially the 'multiplier' must be selected.

Press ↓↑ to change the decimal point position.

Press >> to accept the decimal point position. The Digit Edit screen appears.

Decimal Point

Set the display to read the value of the PT Secondary voltage, as described in Section 3.2 Number Entry Procedure.

After the last digit has been set and accepted, the Confirmation screen will appear.

Digit Edit

Press >> to accept the new setting and select the next set up screen.

Press ↓↑ to return to the Edit (Decimal Point) screen.

The secondary value may only be set to values within the range defined by the factory voltage build option. These nominal rms input voltages are as shown in the specification

Confirmation

3.8. Demand Integration Time

This screen is used to set the period over which current and power readings are integrated (see Section 7.5). The value displayed represents time in minutes.

Value

Press >> to retain the current setting and select the next set up screen.

To change the Demand Integration Time, press ↓↑ and use this key to scroll through the available values.

Select the required value and press >> to accept it. The Confirmation screen will appear. Attempting to set 60 minute dit on a product without a red rear cover will result in an error - a value of 30 minutes will be set and displayed on the confirmation screen.

Confirmation

Press >> to accept the new setting and select the next set up screen.

Press ↓↑ to return to the Edit screen.

3.9. Resets

The following screens allow resetting of the Energy and Demand readings individually or altogether.

Resetting the cumulative Energy (h) resets Active and Reactive Energy import and export registers.

Resetting Demand (d) resets:
Active Import Power Demand
Current Demand
Maximum Active Import Power Demand
Maximum Current Demand

Reset (None)

Press >> to omit resetting and select the next set up screen.

To reset one or more readings press ↓↑ and use this key to select the available options:-

Reset All

h Active and reactive energy
d Demands and maximum demands
None – no reset
All – h and d combined.

Select the option required and press >> to confirm the selection. The appropriate confirmation screen will appear.

The confirmation screen will not appear if None has been selected.

Confirmation

Press >> to reset the selected reading(s) and select the next set up screen.

Press ↓↑ to return to the Reset screen.

3.10. Pulsed Output, Pulse Duration

This applies to the Relay Pulsed Output option only. Units with this option provide pulses to indicate power consumption (kWh, and kvarh where two outputs are available). See Section 3.11 Pulse Rate.

This screen allows the user to set the duration of the relay output pulse. The value displayed represents the pulse duration in milliseconds (ms).
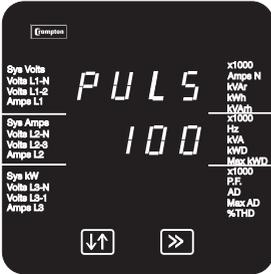
Edit

Press >> to retain the current setting and select the next set up screen.

To change the pulse duration, press ↓↑.

Use the ↓↑ key to scroll through the available values.

Select the value required and press >> to confirm the selection. The confirmation screen will appear.
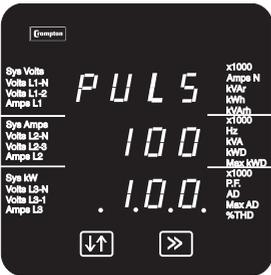
Confirmation

Press >> to accept the new setting and select the next set up screen.

Press ↓↑ to return to the Edit screen.

3.11. Pulse Rate

This applies to the Relay Pulsed Output option only. Units with this option provide pulses to indicate power consumption (kWh, and kvarh where two outputs are available).

This screen allows setting of the pulse rate divisor. By default, the unit produces one pulse per kWh/kvarh. Changing this divisor changes the output pulse rate, as follows:

Divisor	One pulse per:
1	1 kWh/kvarh
10	10 kWh/kvarh
100	100 kWh/kvarh
1000	1000 kWh/kvarh

Press >> to retain the current setting and select the next set up screen.

To change the pulse rate divisor, press ↓↑.

Use the ↓↑ key to scroll through the available values. If the maximum power is greater than 3.6 megawatts, the range of divisors will be restricted to force an upper limit to the number of pulses/hour of 3600.

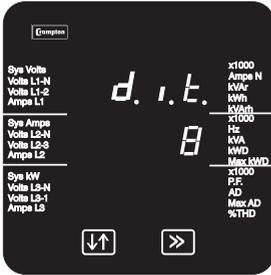Select the required divisor and press >> to confirm the selection. The Confirmation screen will appear.

Edit

Press >> to accept the new setting and select the next set up screen.

Press ↓↑ to return to the Edit screen.

Confirmation

3.12. RS485 Baud Rate

Use this screen to set the Baud Rate of the RS485 Modbus/JC N2 port. The values displayed are in kbaud.

The RS485 Baud Rate option only sets the Baud Rate for an RS485 port that is not communicating with a display unit. The port characteristics for communication with a display are preset.

If the JC N2 protocol is to be used, the baud rate must be set to 9.6. If the Lonworks option is fitted, this setting must be set to 19.2.

If a display is detected on an RS485 port at start-up, any user settings for that port will be ignored. If the Profibus option is fitted, the user set baud rate is ignored at start up. It is recommended that the baud rate is not changed by the user when a Profibus option is fitted is fitted as this will disable the Profibus interface. Normal operation may be resumed by power cycling the Integra.
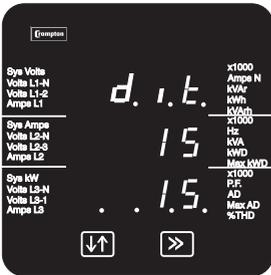
Press >> to retain the current setting and select the next set up screen.

To change the baud rate, press ↓↑.

Use the ↓↑ key to scroll through the available values.

Select the required baud rate and press >> to confirm the selection. The Confirmation screen will appear.

Edit

Press >> to accept the new setting and select the next set up screen.

Press ↓↑ to return to the Edit screen.

Confirmation

3.13. RS485 Parity Selection

This screen allows setting of the parity and number of stop bits of the RS485 Modbus/JC N2 port. **If the Lonworks option is fitted, this setting must be set to no parity two stop bits. If the JC N2 protocol is to be used, this parameter must be set to No parity and One stop bit**.

The RS485 Parity Selection option only sets the parity for a port that is not communicating with a display unit. The port characteristics for communication with a display are preset. If the JC N2 protocol is to be used, this parameter must be set to No parity and One stop bit. If the Profibus option is fitted, the user set parity and stop bits are ignored at start up. It is recommended that the baud rate is not changed by the user when a Profibus option is fitted as this will disable the Profibus interface. Normal operation may be resumed by power cycling the Integra.

Press >> to retain the current setting and select the next set up screen.

To change the parity press ↓↑.

Use the ↓↑ key to scroll through the available values:
E – even parity with one stop bit
odd – odd parity with one stop bit
no 1 - no parity one stop bit,
no 2 - no parity two stop bits.

Select the required setting and press >> to confirm the selection. The Confirmation screen will appear.

Edit

Press >> to accept the new setting and select the next set up screen.

Press ↓↑ to return to the Edit screen.

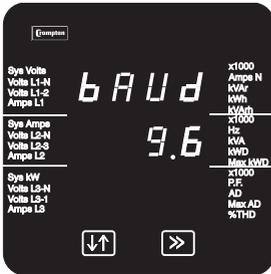Confirmation

3.14. RS485 Modbus , JCN2 or Profibus Address

This screen allows setting of the Modbus/JC N2 or Profibus device address for the instrument.

If the Lonworks option is fitted, this setting must be set to 1.

If the JC N2 protocol is to be used, the address may not be set higher than 247.

If the Profibus option is fitted, this address must not be set higher than 125, and an address of 0 (zero) is not available. The Profibus interface checks this setting on power up only. If it is necessary to change the Profibus address then the Integra should be power cycled after setting the new address.

The Address option only sets the address for a port that is not communicating with a display unit. The port characteristics for communication with a display are preset.

Edit

Press >> to retain the current setting and select the next set up screen.

To change the address, press ↓↑.

Set the three-digit address using the method described in Section 3.2 Number Entry Procedure. The range of the allowable addresses is 1 to 247. The range of selectable digits is restricted so that no higher number can be set.

Press >> to confirm the selection. The Confirmation screen will appear.

Confirmation

Press >> to accept the new settings. This is the end of the set up sequence and the display returns to the last selected measured values Display screen, unless analogue outputs are fitted. If analogue outputs are fitted, the sequence moves to the screens shown in the following pages.

Press ↓↑ to return to the Edit screen.

3.15. Analogue Output Set Up

3.15.1. Introduction

Set up screens for analogue output option are only shown if this option is fitted. The user may choose what measurement an analogue output is to represent and the input range that the output will represent.

For each analogue output fitted, provision is made for five values to be user selected. These are:
A1r - Parameter, from Table 3.15.5. This is the measured input that is to be represented by the analogue output, for example, Watts or Frequency.
A1rt - Reading Top. This is the value of the electrical parameter that will cause the analogue output to produce 'Output Top'
A1rb - Reading Bottom. This is the value of the electrical parameter that will cause the analogue output to produce 'Output Bottom'.
A1ot - Output Top. This is the value of output that will be reached when the measured electrical parameter is at the reading top value.
A1ob - Output Bottom. This is the value of output that will be reached when the measured electrical parameter is at the reading bottom value.
To illustrate, a simple example is shown in Section 3.15.2.

3.15.1.1. Second Channel

The screens following show the set-up for the first analogue channel. Set-up of the second analogue output is identical except that screens show 'A2' instead of '**A1', i.e. A2r, A2rt, A2rb, A2ot, A2ob**.

At the end of the set up for the second analogue output pressing >> will exit the set up system and enter the display mode.

3.15.1.2. Reverse Operation

It is possible to set reading top below reading bottom. In the example of Section 3.15.2, setting reading top to 195 volts and reading bottom to 245 volts would cause the output current to <u>decrease</u> from 20mA to 4mA as the measured voltage <u>increases</u> from 195 to 245 volts.

3.15.1.3. Reduced output range

Note that if the output values are adjusted to reduce output range, accuracy may be degraded. For example, if a 0-20mA capable output is set to operate over 0-1mA, then the specified accuracy will be degraded by a factor of 20.

3.15.1.4. Fixed output value

By setting output top to equal output bottom, the output current will be set to that value irrespective of the level of the associated input parameter. This may be useful to check the operation of other systems using the analogue signal as an input.

3.15.2. Analogue Output Scaling Example

In this example, the Integra has an output current range of 4 to 20 mA and it is required that this output range represents an 'Average Volts' reading range of 195 to 245V.

Note that when entering values via the Integra display, rounding of the desired values may occur as only 3 significant digits are available. Rounding of the desired values may be made very small by using the Integra configuration software which has more significant digits available.
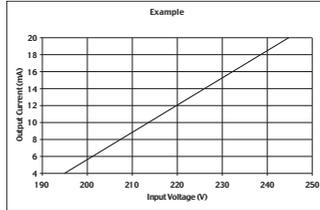
3.15.2.1. Reading (A1r or A2r)

The measured electrical parameter that the analogue output will represent. Example: **Volts Ave** (Average Voltage) - Parameter 22 in table 3.15.5

As shown in the table, any continuously variable parameter (volts, amps, power etc) can be selected for output as an analogue value. The table also shows those values that may be signed (where the value may go negative). Do not attempt to select values not shown in the table. Either the value will be rejected, or the analogue output will show unpredictable results. Normal operation can be restored by selecting a value shown in the table.

3.15.2.2. Reading Top (A1rt or A2rt)

This is the value of the electrical parameter that will cause the analogue output to produce 'Output Top'. Example: **245 volts**.

This value may be set to any value between zero and approximately 120% of nominal. (Or between –120% and +120% of values that may be signed for example var). Depending on the precise value chosen, range may be limited to about 119% of nominal. If the intergra will not accept a value of exactly 120% of nominal, lower the selected value slightly.

3.15.2.3. Reading Bottom (A1rb or A2 rb)

This is the value of the electrical parameter that will cause the analogue output to produce 'Output Bottom'. Example: **195 volts**.

This value may be set to any value between zero and approximately 120% of nominal. (Or between –120% and +120% of values that may be signed for example var)

3.15.2.4. Output

The two Output values specify the analogue current outputs that will represent the top and bottom Reading values. They are included to allow a 0-20mA output to be converted to 4-20mA and to permit additional versatility where particular requirements prevail. However it is suggested that, in most cases, these values should be set to the limits that the hardware can cover. The range of the analogue output(s) for a particular unit is marked on the product label.

3.15.2.5. Output Top (A1ot or A2ot)

This is the value of output that will be reached when the measured electrical parameter is at the reading top value. Example: **20mA**.

3.15.2.6. Output Bottom (A1ob or A2ob)

This is the value of output that will be reached when the measured electrical parameter is at the reading bottom value. Example: **4mA**

3.15.2.7. Summary

In the above example, the analogue output will be 4 mA when the measured voltage is 195 volts, 12 mA at 220 volts and 20 mA at 245 volts.

3.15.3. Power Factor

When analogue output current is used to represent power factor, it can indicate the power factor for an inductive or capacitive load on imported or exported power. This can be shown in two dimensions as follows:
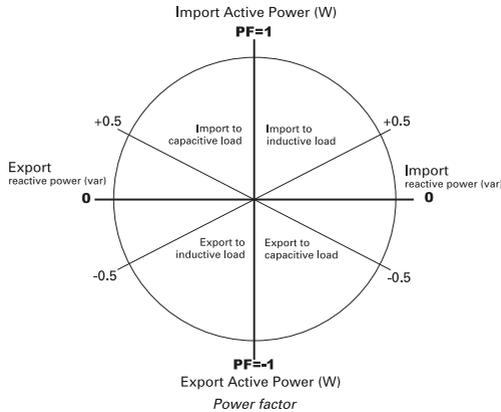
Power factor

The polarity of the power factor reading in the diagram above indicates the direction of active power flow:

Positive   PF relates to imported active power
Negative PF relates to exported active power.

When setting up the analogue output for a power factor reading, the Reading Top value must be in one of the left-hand quadrants and the Reading Bottom value must be in one of the right-hand quadrants. The analogue output range will always include unity PF (=1).
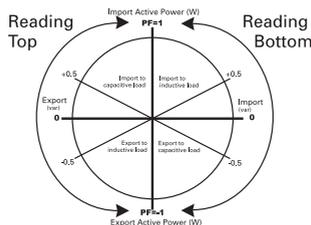
Hence, if the Reading Top value is set to –0.5, this will be a power factor of 0.5 for power exported to an inductive load (bottom **left-hand** quadrant). If a Reading Bottom value of –0.5 is specified, this will represent a power factor of 0.5 for power exported to a **capacitive** load (bottom **right-hand** quadrant). As a power factor of +1 (for true power imported to a resistive load) is always included in the analogue output range, the output would span –0.5 export inductive to –0.5 export capacitive.

In specifying the Output Top and Output Bottom values, there are two conventions – one for European areas of influence and one for North American areas. The two conventions are:

Europe   Output Top greater or more positive than Output Bottom.
USA   Output Top less or more negative than Output Bottom.

The examples below show cases where power is only imported and the load may be either capacitive or inductive. The Reading Top and Reading Bottom values of zero ensure that the whole range of possible (import) power factor readings is covered. The unit in the left-hand example has an analogue output range of +1 to –1 mA and, since the Output Top value (+1 mA) is more positive than the Output Bottom value (-1 mA), this arrangement complies with the European convention. The right-hand example shows the North American convention.
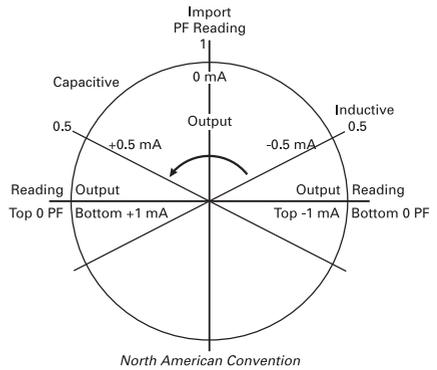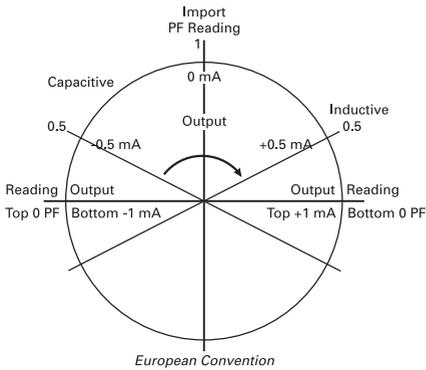
Symmetrical full-range, import only

In the above symmetrical arrangement, 0 mA corresponds to unity power factor. This is not the case with the following asymmetrical arrangement.
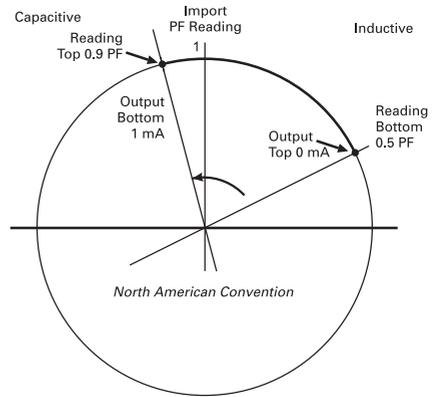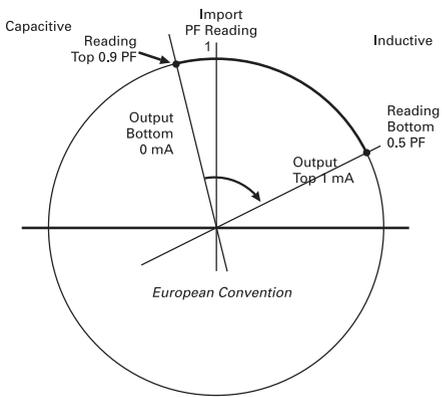
Asymmetrical, import only, mainly inductive

In the example above, the unit has an analogue output range of 0 to 1 mA, all power is imported and the load is inductive. The 1 mA Output range covers a reading power factor range of 0.6, from 0.9 capacitive to 0.5 inductive. The Output to Reading correlation is as follows:

Reading	European convention Output	North American convention Output
0.9 Pf cap.	0 mA	1 mA
1 Pf	0.167 mA	0.833 mA
0.9 Pf ind.	0.333 mA	0.667 mA
0.8 Pf ind.	0.500 mA	0.500 mA
0.7 Pf ind.	0.667 mA	0.333 mA
0.6 Pf ind.	0.833 mA	0.167 mA
0.5 Pf ind.	1 mA	0 mA

Imported Power
PF Reading
1

Import Capacitive   0 mA   Import Inductive

0.5   -0.25 mA   Output   +0.25 mA   0.5

0 PF   -0.5 mA   +0.5 mA   0 PF

-0.75 mA   +0.75 mA

-0.5   Output Bottom -1 mA   Output Top +1 mA   -0.5

Export Inductive   Reading Top -1 PF   Reading Bottom -1 PF   Export Capacitive

European Convention

Imported Power
PF Reading
1

Import Capacitive   0 mA   Import Inductive

0.5   +0.25 mA   Output   -0.25 mA   0.5

0 PF   +0.5 mA   -0.5 mA   0 PF

+0.75 mA   -0.75 mA

-0.5   Output Bottom +1 mA   Output Top -1 mA   -0.5

Export Inductive   Reading Top -1 PF   Reading Bottom -1 PF   Export Capacitive

North American Convention

Symmetrical full-range import/export

In this example, the unit represents the full range of inductive and capacitive loads on imported and exported power. The unit has an analogue output range of –1 to +1 mA. Both Reading Top and Reading Bottom are set to –1 power factor.

3.15.4. Phase Angle

The Phase Angle analogue outputs are treated in a similar manner to Power Factor, with values specified in degrees. The following figure shows the relationship between phase angle in degrees and power factor.

Degrees

Power factor   0.98   1   0.98   Power factor
0.9   0.9
0.8   11.4   0   -11.4   0.8
0.7   25.6   -25.8   0.7
36.6   -36.6
45.5   -45.5
0.5   0.5
60   -60
0.3   72.5   -72.5   0.3
Import to capacitive load   Import to inductive load
0.1   84.2   -84.2   0.1
0   90   Import   -90   0
0.1   95.7   Export   -95.7   0.1
107.4   -107.4
0.3   Export to inductive load   Export to capacitive load   0.3
120   -120
0.5   0.5
134.4   -134.4
143.1   -143.1
0.7   154.1   -154.1   0.7
0.8   168.5   +   -   -168.5   0.8
180
Power factor   0.9   0.98   1   0.98   0.9   Power factor

Degrees

3.15.5. Parameters available for analogue outputs

Parameter Number	Parameter	3 Ø 4 wire	3 Ø 3 wire	1 Ø 3 wire	1 Ø 2 wire	+/-
1	Volts 1 (L1 – N 2/4W or L1 – L2 3W)	✓	✓	✓	✓	
2	Volts 2 (L2 – N 2/4W or L2 – L3 3W)	✓	✓	✓		
3	Volts 3 (L3 – N 2/4W or L3 – L1 3W)	✓	✓			
4	Current 1	✓	✓	✓	✓	
5	Current 2	✓	✓	✓		
6	Current 3	✓	✓			
7	kW Phase 1	✓		✓	✓	✓
8	kW Phase 2	✓		✓		✓
9	kW Phase 3	✓				✓
10	kVA Phase 1	✓		✓	✓	
11	kVA Phase 2	✓		✓		
12	kVA Phase 3	✓				
13	kvar Phase 1	✓		✓	✓	✓
14	kvar Phase 2	✓		✓		✓
15	kvar Phase 3	✓				✓
16	Power Factor Phase 1	✓		✓	✓	✓
17	Power Factor Phase 2	✓		✓		✓
18	Power Factor Phase 3	✓				✓
19	Phase Angle Phase 1	✓		✓	✓	✓
20	Phase Angle Phase 2	✓		✓		✓
21	Phase Angle Phase 3	✓				✓
22	Volts Ave	✓	✓	✓	✓	
24	Current Ave	✓	✓	✓	✓	
25	Current Sum	✓	✓	✓	✓	
27	kWatts Sum	✓	✓	✓	✓	✓
29	kVA Sum	✓	✓	✓	✓	
31	kVAr Sum	✓	✓	✓	✓	✓
32	Power Factor Ave	✓	✓	✓	✓	✓
34	Average Phase Angle	✓	✓	✓	✓	✓
36	Frequency (range 40-70Hz)	✓	✓	✓	✓	
43	kW Demand Import	✓	✓	✓	✓	
44	kW Max. Demand Import	✓	✓	✓	✓	
53	A Demand	✓	✓	✓	✓	
54	A Max. Demand	✓	✓	✓	✓	
101	V L1-L2	✓		✓		
102	V L2-L3	✓				
103	V L3-L1	✓				
104	Average Line to Line Volts	✓		✓		
113	Neutral Current	✓		✓	✓	
118	THD Volts 1	✓	✓	✓	✓	
119	THD Volts 2	✓	✓	✓		
120	THD Volts 3	✓	✓			
121	THD Current 1	✓	✓	✓	÷	
122	THD Current 2	✓	✓	✓		
123	THD Current 3	✓	✓			
125	THD Voltage Mean	✓	✓	✓	✓	
126	THD Current Mean	✓	✓	✓	✓	

3.15.6. Reading (Parameter Selection) - A1r or A2r
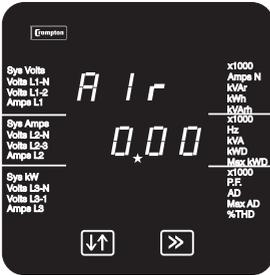
Use this screen to choose the parameter that the analogue Output current will represent. The number displayed on the screen is the Parameter Number shown in table 3.15.5.

Press >> to retain the current setting and select the next set up screen.

To change the Parameter Number, press ↓↑ and set the three-digit number using the method described in Section 3.2 Number Entry Procedure.

Press >> to confirm the selection. The Confirmation screen will appear.
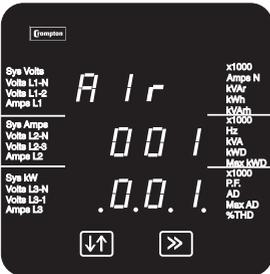
Parameter Selection

Press >> to accept the new setting and select the next set up screen.

If the parameter selected is not available for the present configuration, the confirmation screen will show "0".

Press ↓↑ to return to the Edit screen.

Confirmation

3.15.7. Reading Top – A1rt or A2rt

The top reading may be set to any value up to approximately 120% of the nominal maximum value of the parameter (except phase angle and power factor). For example, a 230V nominal can be adjusted from 0 to 276V. The minimum is zero for unsigned parameters or –120% if the parameter is signed, again excepting phase angle and power factor.

This screen allows a negative value to be specified as the top reading. It will only be available if the parameter selected on the previous screen can be negative. For these parameters, the +/- column of the table has a tick (√).

Press >> to accept the current sign ('-' for negative, no symbol for positive), and select the next screen.

Use ↓↑ to select the '-' sign for a negative Reading or no symbol for a positive Reading.

Press >> to accept the new setting and select the next set up screen.

Sign edit

Decimal Point Position

Use this screen to set the position of the decimal point. This screen will not appear when the selected parameter is frequency, as there is no choice of decimal point position.

Pressing the ↓↑ key will advance the decimal point position to the right, illuminating the x1000 indicator as necessary and wrapping the decimal point position when the highest available position for the currently selected reading has been exceeded. (Maximum resolution is 3 digits of the metered value.)

Select the required decimal point position and press >> to confirm the selection. The next screen will appear.

Value Entry

Use this screen to set the value of the Reading Top

Set the three-digit Reading Top value using the method described in Section 3.2 Number Entry Procedure.

Press >> to confirm the selection. The Confirmation screen will appear.

Confirmation

Press >> to accept the new setting and select the next set up screen.

Press ↓↑ to return to the Edit screen.

3.15.8. Reading Bottom - A1rb or A2rb

Use these screens to specify the value for the Reading Bottom parameter, usually minimum or most negative output value.

The method of setting the Reading Bottom screens is the same as for setting the Reading Top screens, as described in Section 0. The Reading Bottom screens show A1rb (or A2rb for the Analogue output 2) on the top line.

3.15.9. Output Top – A1ot or A2ot

Use these screens to set the maximum analogue output current (in mA). This current will represent the highest reading value. You cannot specify a greater current than the actual value that the unit can supply, e.g. 1 mA.

The method of setting the Output Top screens is the same as for setting the Reading Top screens, as described in Section 0. The Output Top screens show A1ot (or A2ot for the Analogue output 2) on the top line.

3.15.10. Output Bottom – A1ob or A2ob

Use these screens to set the minimum or most negative analogue output current (in mA). This current will represent the lowest or most negative reading value. The current cannot be set to a value that exceeds the actual capability of the unit, e.g. it cannot be set it to –10 mA if the unit can only handle –1 mA.

The method of setting the Output Bottom screens is the same as for setting the Reading Top screens, as described in Section 0. These screens show A1ob (or A2ob for Analogue output 2) on the top line.

On reaching the confirmation screen for A2ob, press >> to accept the new setting and exit the set-up mode, returning to the last selected measured values Display screen.

Press ↓↑ to return to the Edit screen.

4. Serial Communications

4.1. RS485 Communications Port – Modbus , JC N2 or Display

This optional port can be used as an RS485 Modbus RTU port, as a Johnson Controls N2 protocol slave or connected to a remote Integra display unit. Choice of reply protocol is made by the Integra on the basis of the format of request, so that a Modbus request receives a Modbus reply, and an N2 protocol request receives an N2 protocol reply.

4.1.1. Remote Display auto detect

A remote Integra display can be connected to the RS485 port to enable display of more parameters simultaneously or for observations at a remote location. For about five seconds after power on the instrument will attempt to determine if a display is attached to the RS485 port. If it detects an Integra display unit is powered up and attached, the communication settings on that port will be fixed to display operation until the instrument is powered down.

If the display detection period expires without a display unit being detected, the Integra will configure the port to use the communication parameters previously set for that port. If a display is subsequently connected to the port, it will generally not function correctly. Power cycle the Integra to restore correct display operation. As recommended in the installation section, ideally the Integra and any associated display should share a common auxiliary supply so that the detection mechanism can function properly. If this is not possible, then either the display auxiliary should start first, or the port communications parameters should be set to 9600 baud, two stop bits, no parity.

4.1.2. Remote Communications Parameter Set Up

Communications parameter options set from the Integra configurator software or another Modbus master affect the port on which the Modbus master is connected. Changes take effect only when the Integra is power cycled. For example, if the baud rate is currently set to 9600 baud and is then changed to 4800 baud, by a Modbus master , the acknowledgement and any subsequent communications are at 9600 baud. After the Integra has been power cycled, communications will be at 4800 baud. Communications parameters may be checked from the Integra front panel display

Communications parameter options (baud rate, stop bits, parity, address) changed from a remote Integra display unit will have no effect.

More information. Further information is contained in the RS485 communication guide for the Integra 1530. This document is available on the Crompton Instruments website (see back cover for address). E-mail support for specific issues is also available, however, this support is limited to integrating the Integra into a functional system. We are not able to provide more generalised support on communications systems that are better tackled by a local systems integrator.

4.2. LonWorks Interface

Integra is also available with an optional LonWorks interface for connection into twisted pair free topology networks. Wiring connections are shown in section 10.2.5. Ensure that communications parameters are set as recommended in section 3.12, 3.13 and 3.14. Further details of this interface are contained in the separate Integra Lonworks Communications guide available from the Crompton Instruments website. The Integra.xif file is also available from the website. E-mail support for specific issues is also available, however, this support is limited to integrating the Integra into a functional system. We are not able to provide more generalised support on communications systems that are better tackled by a local systems integrator.

5. Pulsed Output Option

One or two pulsed outputs are optionally available. (ℝ - Check with your distributor for availability)

These relays output pulses at a rate proportional to the measured Active import Energy (kWh) and Reactive import Energy (kvarh). When only one relay is fitted, it is configured for kWh.

When one relay is the only output option fitted, normally open contacts are available on the main terminal block, with terminal Identification 13 and 14.

On the 1535, terminals 13 and 14 are used for connection of the 4th CT.

On the 1535 if pulsing relays are fitted then change over contacts are available on detachable terminal connections.

The pulse width and pulse rate are both user definable from the display or where a Modbus communications option is available from Integra configurator software or other Modbus master.

More details of relay set-up are contained in section 3.10 and 3.11 of this document, the 1530 Modbus guide and the Integra configurator software user guide

The output relays provide fully isolated, volt free contacts and connection is made via screw clamp terminals.

6. Analogue Output Option

Integra optionally provides one or two d.c. isolated outputs. Where two outputs are fitted, they share a common return (0v) These outputs can be individually assigned to represent any one of the available continuously variable parameters.

Output range limits are factory set as one of the options in the table below. The mA range for both channels is the same.

Range	Load	Compliance Voltage
0/20mA	0Ω-1kΩ	10V
-1/0/+1mA	0-10kΩ	10V

Parameters can be adjusted to suit the application and are not fixed to the system value. Top and bottom readings can be adjusted and a variety of outputs achieved, for example:-

Normal zero e.g. 0/1mA = 0/100kW
Inverse zero e.g. 1mA/0 = 0/100kW
Offset zero 0/1mA = 50/100kW
Live zero 4-20mA = 0-100kW or 4-12-20mA = -100/0/+100kW
Bipolar outputs, e.g. -1/0/+1mA = -100/0/+100kW

Example

Mode	0kW	50kW	100kW
Normal	0mA	0.5mA	1mA
Inverse	1mA	0.5mA	0
Offset	0	0	1mA
Live	4mA	12mA	20mA

More details of analogue output set-up are contained in section 3.15 of this document, the 1530 Modbus guide and the Integra configurator software user guide.

7. Basis of measurement and calculations

7.1. Phase to Phase voltages on 4 wire and single phase 3 wire products

Phase to phase voltages are calculated from Phase to Neutral voltages. The calculation makes the assumption that the Phases are 120 degrees apart (4 wire) or 180 degrees apart (single phase 3 wire). Errors will arise if the phase angle is significantly different from 120 degrees. (This description applies only to products with a black rear cover)

ℛ Phase to Phase voltages are measured directly and calculated as RMS values. Situations where the phases are not spaced 120 degrees apart (e.g. 4 wire open delta) are indicated correctly. (This description applies only to products with a red rear cover)

7.2. Reactive and Apparent Power

Active powers are calculated directly by multiplication of voltage and current. Reactive powers are calculated using frequency corrected quarter phase time delay method. Apparent power is calculated as the square root of sum of squares of active and reactive powers.

7.3. Energy resolution

Cumulative energy counts are reported using the standard IEEE floating point format. Reported energy values in excess of 16MWh may show a small non cumulative error due to the limitations of the number format. Internally the count is maintained with greater precision. The reporting error is less than 1 part per million and will be automatically corrected when the count increases.

7.4. Power Factor

The magnitude of Per Phase Power Factor is derived from the per phase active power and per phase reactive power. The power factor value sign is set to negative for an inductive load and positive for a capacitive load.

The magnitude of the System Power Factor is derived from the sum of the per phase active power and per phase reactive power. Individual phases whose apparent power is less than 2% of nominal are not included in power factor determinations. The system power factor value sign is set to negative for an inductive load and positive for a capacitive load. The load type, capacitive or inductive, is determined from the signs of the sums of the relevant active powers and reactive powers. If both signs are the same, then the load is inductive, if the signs are different then the load is capacitive.

The magnitude of the phase angle is the ArcCos of the power factor. It's sign is taken as the opposite of the var's sign.

7.5. Maximum Demand

The maximum power consumption of an installation is provided as power utilities often levy related charges. Many utilities use a thermal maximum demand indicator (MDI) to measure this peak power consumption. An MDI averages the power consumed over a number of minutes, reflecting the thermal load that the demand places on the supply system.

Integra uses a sliding window algorithm to simulate the characteristics of a thermal MDI instrument, with the demand period being updated every minute.

Time Integration Periods can be set to 8, 15, 20 or 30 minutes (ℛ or 60 minutes).

Note: During the initial period when the "sliding window" does not yet contain a full set of readings (i.e. the elapsed time since the demands were last reset or the elapsed time since Integra was switched on is less than the selected demand period) then maximum demands may not be true due to the absence of immediate historical data.

The Time Integration Period can be user set either from the display or by using the communications option, where fitted.

<u>Maximum</u> Demand is the maximum power or current demand that has occurred since the unit was last reset as detailed in Section 3.9 Resets. This is maintained as a continuous record of the highest demand value that has been reached.

7.6. Total Harmonic Distortion

The calculation used for the Total Harmonic Distortion is:

THD = ((RMS of total waveform – RMS of fundamental) / RMS of total waveform) x 100

This is often referred to as THD – R

The figure is limited to the range 0 to 100% and is subject to the 'range of use' limits. Integra may give erratic or incorrect readings where the THD is very high and the fundamental is essentially suppressed.

For low signal levels the noise contributions from the signal may represent a significant portion of the "RMS of total waveform" and may thus generate unexpectedly high values of THD. To avoid indicating large figures of THD for low signal levels the product will produce a display of 0 (zero). Typically, display of THD will only produce the 0 (zero) value when the THD calculation has been suppressed due to a low signal level being detected.

It should also be noted that spurious signals (for example, switching spikes) if coincident with the waveform sampling period will be included in the "RMS of the total waveform" and will be used in the calculation of THD. The display of THD may be seen to fluctuate under these conditions.

8. Specification

8.1. Inputs

Nominal rated input voltage

	Voltage range L	Voltage range M
Single phase two wire	57 - 139V L-N	140 - 277V L-N
Single phase three wire	57 - 139V L-N (114 - 278V L-L)	140 - 240V L-N (279 - 480V L-L)
Three phase three wire	100 - 240V L-L	241 - 480V L-L
Three phase four wire	100 - 240V L-L (57 - 139V L-N)	241 - 480V L-L (140 - 277V L-N)

Voltages above are expressed as RMS values and relate to sinusoidal waveforms and corresponding instantaneous peak values. "Range Maximum" for a particular instrument refers to the upper end of the relevant voltage range.

Max continuous input voltage	120% of range maximum.
Max short duration input voltage	2* range maximum (1s application repeated 10 times at 10s intervals)
Nominal input voltage burden	0.2VA approx. per phase
Nominal input current	1 or 5A a.c. rms
System CT primary values	Integer values up to 9999A (1 or 5 Amp secondaries)
System VT ratios	Any value up to 400kV(subject to an overall power limit of 250 MW nominal, 360MW maximum and the 4 significant digit limitation of the display unit, where this is used for setup)
Max continuous input current	120% of nominal
Max short duration current input	20* nominal (1s application repeated 5 times at 5 min intervals)
Nominal input current burden	0.6VA approx. per phase

8.2 Auxiliary

Standard supply voltage	100 - 250V AC nominal ±15% (85 - 287V AC absolute limits) or 100V to 250V DC nominal +25%, -15%(85 - 312V DC absolute limits)
a.c. supply frequency range	45 to 66 Hz
a.c. supply burden	3W / 6VA
Optional auxiliary d.c.supply	12 - 48V DC. nominal +25%, -15%(10.2 – 60VDC absolute limits)
d.c. supply burden	3W / 6 VA

8.3 Measuring Ranges

Values of measured quantities for which accuracy is defined.

Voltage	80 .. 120% of nominal (any voltage within the specified range – eg 45.6V to 166.8V L-N 4 wire L range)
Current	5 .. 120% of nominal
Frequency	45 .. 66 Hz
Active power (Watt)	5 .. 120% of nominal, bi-directional, 360 MW Max
Reactive power (var)	5 .. 120% of nominal, bi-directional, 360 Mvar Max
Apparent power (VA)	5 .. 120% of nominal, 360 MVA Max
Power Factor	0.8 lagging .. 1 .. 0.8 leading,

| Total Harmonic Distortion | Up to 31st Harmonic 0%-40%, with typical harmonic content distribution, defined to be less than 15% of fundamental amplitude in harmonics content above 15th |

Voltage and current ranges assume that crest values are less than 168% of rms nominal.

8.4 Accuracy

Voltage	0.17 % of Range Maximum
Current	0.17 % of nominal
Neutral current (calculated)	0.95 % of nominal
Neutral current (1535 only)	0.17 % of nominal
Frequency	0.15% of mid frequency
Power factor	1% of Unity (0.01)
Active power (W)	±0.2 % of Range Maximum
Reactive power (var)	±0.5 % of Range Maximum
Apparent power (VA)	±0.2% of Range Maximum
Active energy (Wh)	0.3% of Range Maximum* Exceeds class 1 IEC1036 Sect 4.6
Reactive energy (varh)	0.6% of Range Maximum*
Total Harmonic Distortion	1%, up to 31st harmonic
Temperature coefficient	0.013%/°C V,I typical
	0.018% W, var, VA typical
Response time to step input	0.5 seconds plus Modbus response time (to within twice accuracy specification of final value), at 50Hz. 60Hz response time is faster. This parameter is measured via the Modbus port)
Error change due to variation of an influence quantity in the manner described in section 6 of IEC688:1992	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.

*Error in energy readings is expressed as a percentage of the energy count that would result from applying range maximum voltage and nominal current for the same measurement period.

8.5 Reference conditions of influence quantities

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

Ambient temperature	23°±1°C
Input frequency	50 or 60 Hz ±2%
Input waveform	Sinusoidal (distortion factor < 0.005)
Auxiliary supply voltage	Nominal ±1%
Auxiliary supply frequency	Nominal ±1%
Auxiliary supply (if AC) waveform	Sinusoidal (distortion factor < 0.05)
Magnetic field of external origin	Terrestrial flux

8.6 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 .. 120% of Range Maximum (below 5% of Range Maximum voltage, current indication may be only approximate.)
Current	0.1 .. 120% of nominal
Frequency	45 .. 66 Hz
Power Factor	1 .. 0 leading or lagging
Active power (Watt)	1 .. 144% of nominal, 360MW Max
Reactive power (var)	1 .. 144% of nominal, 360Mvar Max
Apparent power (VA)	1 .. 144% of nominal, 360MVA Max
Harmonic distortion (voltage)	Max 40% THD up to 31st harmonic

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. Voltage THD is only indicated when the measured voltage is over 5% of Range Maximum, and full accuracy only when measured voltage >25% of Range Maximum. Current THD is only registered when the measured current is over 5% of nominal, and full accuracy only when measured current is over 20% of nominal

8.7 Standards

Terms, Definitions and Test Methods	IEC688:1992 (BSEN 60688)
EMC Emissions	EN61326 – Emission class A (Industrial)
EMC Immunity	EN61326 – Immunity Annex A (Industrial)
Safety	IEC1010-1 (BSEN 61010-1) Permanently connected use, Normal Condition Installation category III, pollution degree 2, Basic Insulation, for rated voltage.

8.8 Insulation

CT primary to voltage circuits	2.2kV rms 50Hz for 1 minute
Relay contact to voltage circuits	2.2kV rms 50Hz for 1 minute
RS485 to voltage circuits	3.1kV DC for 1 minute
Analogue to voltage circuits	3.1kV DC for 1 minute
Auxiliary supply to voltage circuits	2.7kV rms 50Hz for 1 minute
CT primary to CT primary	CT circuits are galvanically isolated from each other, resistance typically in excess of 100k ohms tested with a nominal voltage of 10VDC.

8.9 Environmental

Operating temperature	-20 to +60°C *
Storage temperature	-30 to +80°C *
Relative humidity	0 .. 90% non condensing
Warm up time	1 minute
Shock	30g in 3 planes
Vibration	10 .. 15 Hz, 1.5mm amplitude peak to peak, 15Hz to 150 Hz @ 1g

* Maximum operating and storage temperatures are in the context of typical daily and seasonal variation. This product is not designed for permanent operation or long term storage at maximum specified temperatures.

8.10 Enclosure

Sealing	IP 54, front face only, when used with panel gasket.
Mounting	DIN 96 panel mounting, Length < 125mm excluding terminations, plastic moulded case

8.11 Serial Communications Option

Baud rate	19200, 9600, 4800 or 2400 (programmable)
Parity	None, Odd or Even, with 1 stop bit,
	or None with 1 or 2 stop bits.
Protocol	Modbus (RS485) or Johnson Controls N2 Ver A 1996

(Note Johnson Controls N2 specifies fixed baud rate and parity)
Programmable Modbus word order at user option.

8.12 Active Energy Pulsed Output Option

Default pulse rate	1 per kWh/ kvarh
Pulse rate divisors	10 (yielding 1 pulse per 10 kWh/ kvarh)
	100 (yielding 1 pulse per 100 kWh/ kvarh)
	1000 (yielding 1 pulse per 1MWh/ Mvarh)
Pulse duration	60ms, 100ms or 200ms
Pulse rate	3600 Pulses per Hour max

8.13 Analogue Outputs Option

1 or 2 channels either	0/20mA (user configurable as 4-20mA)
	-1/-0/+1mA
	For 2 channel option both ranges must be identical.

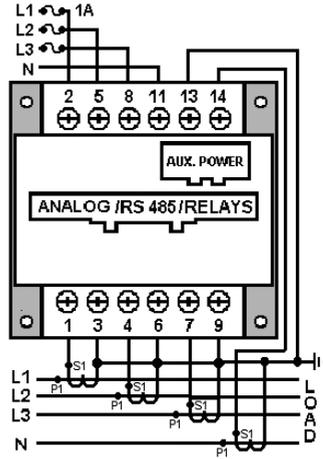# 9. Metered Supply Connection Diagrams

European Style

3-PHASE - 4 WIRE UNBALANCED LOAD
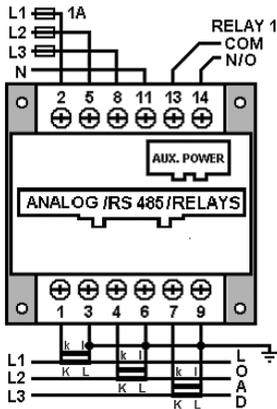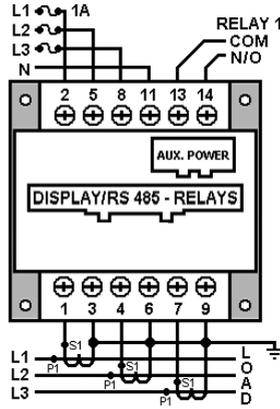with metered neutral
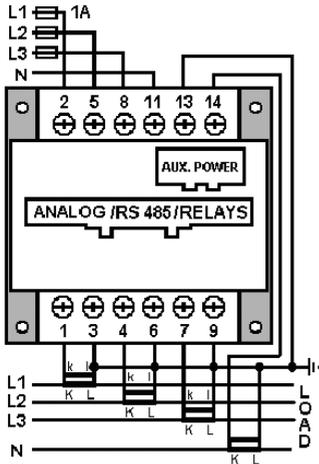
USA Style

3-PHASE - 4 WIRE UNBALANCED LOAD
with metered neutral

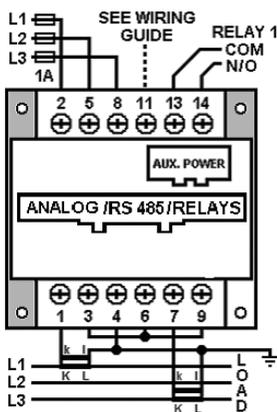

3-PHASE - 4 WIRE UNBALANCED LOAD
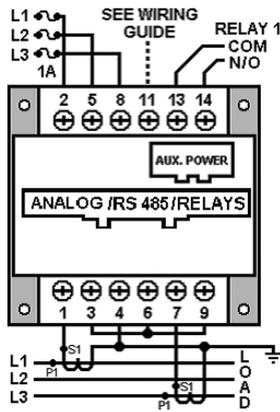

3-PHASE - 4 WIRE UNBALANCED LOAD

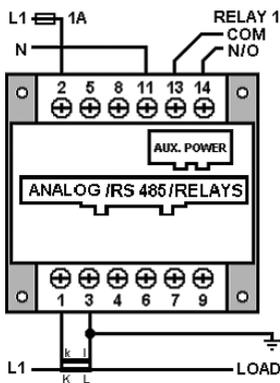**European Style**

3-PHASE - 3 WIRE UNBALANCED LOAD
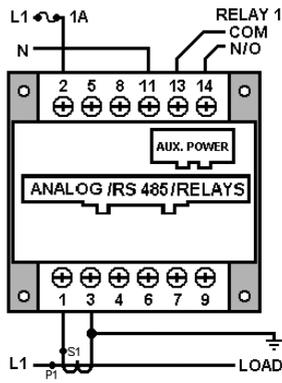

USA Style

3-PHASE - 3 WIRE UNBALANCED LOAD

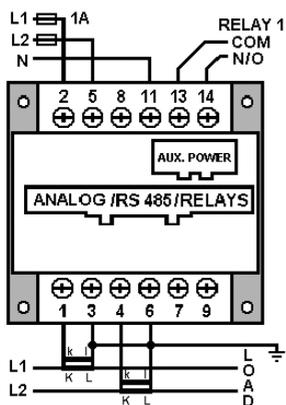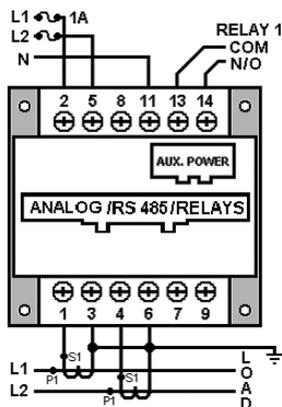SINGLE PHASE - 2 WIRE

SINGLE PHASE - 2 WIRE

European Style

SINGLE PHASE - 3 WIRE


USA Style

SINGLE PHASE - 3 WIRE

10. Auxiliary and Output Connections

10.1. Auxiliary Supply

There are two auxiliary supply alternatives available as factory build options. The auxiliary supply is marked on the unit rating label. The Integra should ideally be powered from a dedicated supply, however when the 100-250 V auxiliary option is fitted it may be powered from the signal source, providing the source remains within tolerance of the medium voltage auxiliary range.

The auxiliary supply connection has terminals for both medium voltage and low voltage auxiliary. Depending on the supply option fitted either the 12-48 pair or the 100-250v pair will be operational. For 100-250 V auxiliary, connect the supply to the outer two terminals marked L and N. For 100-250 V, connections are polarity insensitive. For 12-48 V auxiliary, connect to centre and right hand (as viewed from instrument rear) terminals marked - and +. Polarity reversal will not cause damage but the instrument will not function.

|		
100-250V AC or DC		100-250V AC or DC
N	**-**	**L+**
	12-48V negative	12-48V Positive
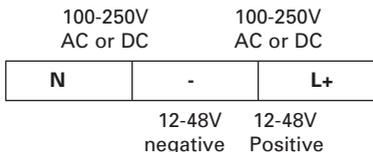
It is recommended that if used with a remote Integra display, a common auxiliary supply is used for both the display and Integra. If this arrangement is not implemented then the Integra communications parameters may be configured as detailed in the preceding section 4.1.1 "Remote Display auto detect". The Integra establishes contact with a remote display in the first 5 seconds after power up, and may not operate correctly with the display if the display is powered several seconds after the Integra is powered, unless the communications parameters are set appropriately.

10.2. Output Connections

Output connections are made directly to a two part, detachable screw clamp style connector. Detachable terminal connector screws should be tightened to 0.9Nm or 0.7 ft/lbf only. General guidance on cable selection and wiring practice is given in section 11.1.

10.2.1. RS 485 and relay outputs

This option has a flat back cover and is fitted when RS485, pulsing relays or both are required.
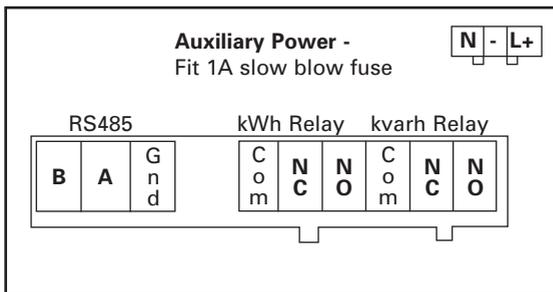
10.2.2. Relay connections

When the centre output connector is fitted, Relay 2 and Relay 3 provide output pulses with change over contacts. When only a single pulsing relay is specified, the 6 way Relay 2 / Relay 3 connector shown on the preceding diagram may not be fitted. On this variant, Relay 1 normally open contacts are available (except 1535) on the main terminal block at terminals 13 and 14 as shown on the wiring diagrams in section 9.

10.2.3. RS485 or additional display

The connections between an Integra and RS485 master or optional display are made directly to a two-part detachable screw clamp style connector. The recommended cable between the RS485 master or display and Integra is two core screened cable. Preferably select a cable specifically recommended for RS485 use (for example Belden 9860, 8761) although for shorter distances of a few metres most two core screened cables will often be satisfactory. As the remote device to Integra communication uses RS485, cable length (transmission distance) can be up to 1200 metres in good conditions. Electrical interference or other adverse conditions may reduce the maximum cable length possible for reliable operation.

10.2.4. Analogue or Analogue and RS485 options
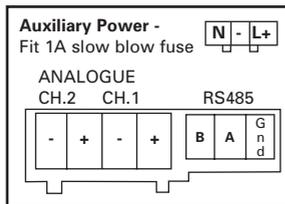
Note that the return(–ve) terminal for analogue outputs is common between both channels. The analogue return is isolated from the RS485 ground.

The polarity indicated above is correct for positive designated currents. On –1 .. 0 .. +1 mA outputs, polarity will be reversed when the relevant parameter is below half scale. On purely positive going configured outputs (0..20mA), it is possible that a small reverse current may be registered when the input parameter is below reading bottom. If the application cannot tolerate such reverse currents, fitting of an external silicon diode is suggested.

10.2.5. LON option

Integra with LonWorks option has two ports. The LonWorks port is designed for connection into a LON twisted pair free topology network and is based around the FTT-10A interface. It is recommended that FTT-10 guidelines are followed in configuring the network. The detail of these guidelines is beyond the scope of this document.

The RS 485 port is intended for setting up the Integra using the configuration software. To use the configuration software, disconnect auxiliary power and the LON network, set the switch under the auxiliary connector to RS485 position. Connect the configuration software PC RS485 connection to the RS485 socket on the back of the Integra. Apply auxiliary power and configure the unit. When finished, reverse the above procedure. Note that when the switch is in the RS485 position, the LON interface will be unable to return electrical readings from the Integra, and may give rise to unexpected results from the LON interface.

Both ports are electrically isolated from the metering circuits, but not from each other.
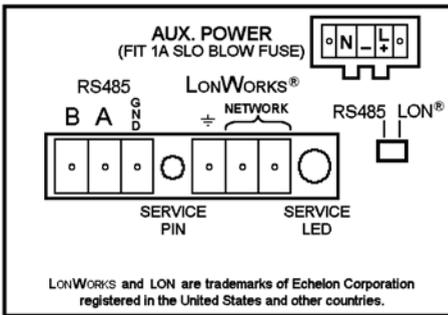
The service LED provides basic diagnostic information for the LON interface:

Continuously on	Probable hardware fault within the LON interface
Continuously off	Probable hardware fault within the LON interface, or no auxiliary power to the Integra.
Single 1 second flash, 2 seconds off and then continuously on after applying auxiliary power	Possible LON node memory corruption.
Repeated 1 second on followed by 2 second off	Probable hardware fault within the LON interface, or LON node memory corruption.

All of the above problems (with the exception of no auxiliary power) require service attention to the Integra LON interface.

Repeated 1 second on, 1 second off flashing	Node unconfigured. Node must be reinstalled and commissioned before correct operation.
Brief flash on, off for 6 seconds, and then continuously on	Node configured and running normally

10.2.6 Profibus Interface

Integra with Profibus option has two ports.   The Profibus port is designed for connection into a Profibus network via 9 pin D connector.   The earth tag (fuseblade) is intended for local earth bonding if electrical interference may be an issue.

The RS 485 port is intended for setting up the Integra using the configuration software. To use the configuration software, disconnect auxiliary power and the Profibus network, set the switch next to the auxiliary connector to RS485 position, with the slider adjacent to the RS485 connector. Connect the configuration software PC RS485 connection to the Modbus/RS485 socket on the back of the Integra. Apply auxiliary power and configure the unit. When finished, reverse the above procedure.   Note that when the switch is in the RS485 position, the Profibus interface will be unable to return electrical readings from the Integra, and may give rise to unexpected results from the Profibus interface.

When the Profibus interface is fitted, the Profibus address corresponds to the Modbus address set using the front panel. Note that only addresses in the range 1-125 are valid. The user interface will allow addresses outside this range to be set, as these are valid if a Modbus interface is used, but the Profibus interface will then respond to address one. The Profibus interface checks this setting on power up only. If it is necessary to change the Profibus address then the Integra should be power cycled after setting the new address.

Both ports are electrically isolated from the metering circuits, and galvanically from each other. This means that they do not share a ground, but safety rated insulation between the ports is not implied.

There are three signalling LEDs visible through the moulded back cover slots viewed from behind and above.

- The left hand LED (closest to the Profibus connector) should normally be steadily on – Flashing indicates an internal malfunction.

- The (centre) red LED should normally be flashing to indicate Profibus traffic. If this LED is permanently on, it indicates the Profibus interface cannot detect any Profibus traffic.

- The right hand green LED (closest to the RS485 connector) should be continuously on, which indicates normal Profibus operation.
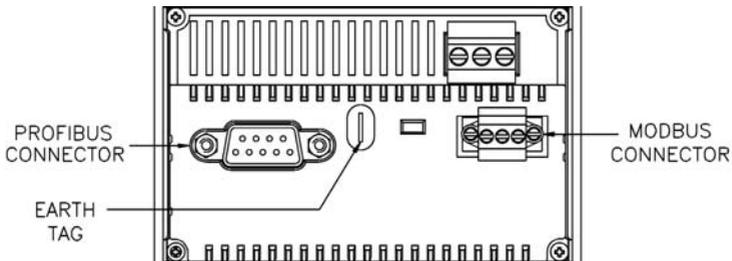
11 Installation and Maintenance

11.1 Location and mounting

Units should be installed in a dry position, where the ambient temperature is reasonably stable and will not be outside the range -20 to +60°C. Vibration should be kept to a minimum. Preferably, mount the Integra so that the display contrast is not reduced by direct sunlight or other high intensity lighting.

The Integra may be mounted in a standard DIN 96 panel up to a maximum thickness of 5 mm. Mounting is by corner clamps and thumb screws. It may be convenient to use a 7mm screwdriver style nut driver to engage the thumb screws, particularly when starting the thread, but great care must be taken not to over tighten. It is very easy to cause damage with excessive torque when using a nut driver, so final tightening should be performed with finger pressure only. Consideration should be given to the space required behind the instrument to allow for connectors and associated cables.

If IP54 ingress protection is required, a panel gasket must be used. The terminals at the rear of the product must be protected from liquids or other contamination.

These units are intended for indoor use only at an altitude of less than 2000m.
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.

It is recommended adjustments be made with the supplies de-energised, but if this is not possible, then extreme caution should be exercised.

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.

Never open circuit the secondary winding of an energised current transformer.

Auxiliary circuits (12-48V auxiliary, communications, relay and analogue outputs, where applicable) are separated from metering inputs and 100-250V 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.

This unit is not intended to provide safety rated isolation between the 12-48V auxiliary terminals and communications or analogue output circuits. Galvanic isolation is provided, but one of the 12-48V inputs should be at or near earth potential.

11.2 Electromagnetic Compatibility

This unit has been designed to provide protection against EM (electro-magnetic) interference in line with requirements of EU and other regulations. 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 differential surges to 2kV or less 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 and small signal leads are recommended and may be 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 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.

11.3 Metered Supply Wiring

11.3.1 Input wiring and fusing

Input connections are made to screw clamp terminals. Choice of cable should meet local regulations for the operating voltage and current. Terminals for both current and voltage inputs will accept one or two 3mm2 or less cross sectional area cables. This unit must be fitted with external fuses in voltage and auxiliary supply lines. Voltage input lines must be fused with a quick blow AC 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.

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

A switch or circuit breaker allowing isolation of supplies to the unit must be provided.
Main terminal screws should be tightened to 1.35Nm or 1.0 ft/lbf only.

11.3.2 Additional considerations for three wire systems

If this product is used in a system with an a.c. auxiliary where the frequency of the auxiliary may be different to the frequency of the signals being measured it will be necessary to connect the neutral terminal (terminal number 11) either to the system neutral connection or to an earth (ground) connection in order to achieve the published specifications.

The neutral terminal (terminal number 11) is indirectly connected to the voltage input terminals (terminals 2, 5 and 8). When connected to a three wire system where one of the lines has become disconnected 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.

Standard CT wiring configurations for 3 wire systems include a commoning point. A maximum of two units, fed from a single set of CTs and with a single earth point may be wired in this way. If more units must be run from a single set of CTs then use 3 CTs and wire CT connections as for 4 wire systems. In this configuration, the number of units that may be connected is limited by the permissible CT burden.

11.4 Underwriters Laboratories (UL) Installation Requirements

The following points are mandatory in any installation where UL approval is required. They may be considered as good practice recommendations in other applications.

11.4.1 Wire type

Voltage and current measuring terminal blocks are suitable for use with copper wire only.

11.4.2 Wire size

Voltage and current measuring terminal blocks will accept one or two 3mm2 or less cross sectional area cables [up to 12 AWG]. Main terminal screws should be tightened to 1.35Nm or 1.0 ft/lbf only.

11.4.3 Mounting position

Instruments are intended for panel mounting. Terminals must be enclosed within the panel. Use National Electrical Code Handbook [NEC] Class 1 wiring, rated at 600 V for main terminals.

11.5 Maintenance

The front of the case should be wiped with a dry cloth only. Use minimal pressure, and do not apply any pressure over the grey tinted display 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 accidentally be contaminated with water, the unit must be thoroughly dried before further service. Should it be suspected that water or other contaminants might have entered the unit, factory inspection and refurbishment is recommended.

In normal use, little maintenance is needed. As appropriate for service conditions, isolate 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 display window also acts as an insulating barrier. It is not possible to touch, by hand, any live part, even if the window is completely missing, but if the window is perforated or significantly damaged in any other way, repair is required.

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

## 11.6 Outline Dimensions - Flat rear Cover

All dimensions below are in mm (inches) and relate to products with Modbus / RS485, pulsing relays or Lonworks interfaces.

SIDE VIEW

REAR VIEW
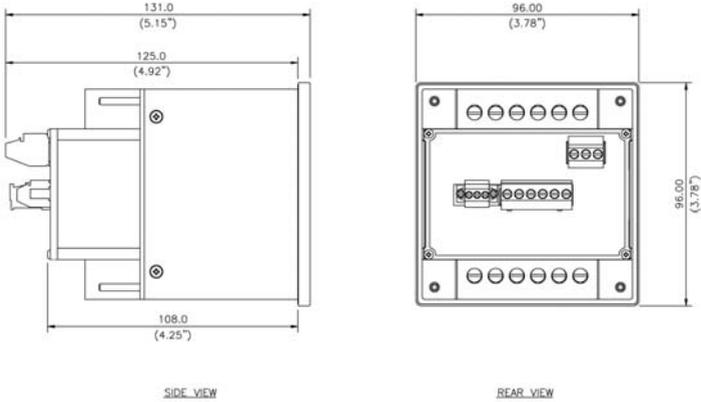
11.7 Outline Dimensions - Extended rear Cover

The dimensions below relate to products with Analogue and Analogue/RS485 and Profibus options

Note that the overall space required behind the panel for Profibus option models will depend on the (user supplied) Profibus connector chosen.

SIDE VIEW

REAR VIEW
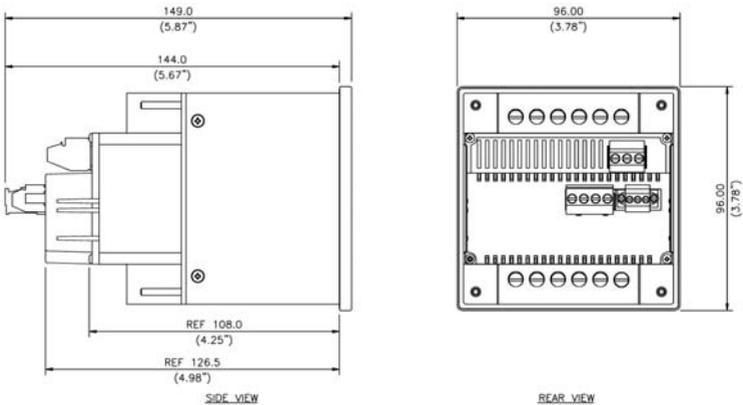
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