MultiCube

Multi-Function Electricity Meter

Installation and Operation

PREFACE

MultiCube400
Operating Guide Revision 1.09
March 2007

This manual represents your meter as manufactured at the time of publication. It assumes standard software. Special versions of software may be fitted, in which case you will be provided with additional details.

Every effort has been made to ensure that the information in this manual is complete and accurate. We revised this manual but cannot be held responsible for errors or omissions.

The apparatus has been designed and tested in accordance with EN 61010-1, 'Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use'. This operating guide contains information and warnings which must be followed by the user to ensure safe operation and to maintain the apparatus in a safe condition.

We reserve the right to make changes and improvements to the product without obligation to incorporate these changes and improvements into units previously shipped.

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1. Safety

1.1 Warning Symbols

This manual provides details of safe installation and operation of the meter. Safety may be impaired if the instructions are not followed. Labels on individual meters give details of equipment ratings for safe operation. Take time to examine all labels on the meter and to read this manual before commencing installation.

CAUTION

Refer to Operating Manual

WARNING

Danger Risk of Electric Shock

Figure 1-1 Safety Symbols

WARNING
The meter contains no user serviceable parts. Installation and commissioning should be carried out by qualified personnel

1.2 Maintenance

The equipment should be maintained in good working order. Damage to the product should be repaired by the manufacturer. The meter may be cleaned by wiping lightly with a soft cloth. No solvents or cleaning agents should be used. All inputs and supplies must be isolated before cleaning any part of the equipment.

2. Meter Operation

2.1 Measurements

The MultiCube makes use of a high speed micro-processor and an Analogue to Digital converter to monitor input signals from three independent phases. Each phase voltage, current and power (kW) are measured directly and a number of other parameters derived from these in software. The measurement process is continuous with all six signals scanned simultaneously at high speed. Unlike many other sampling systems, which sample one phase after another, this ensures that all input cycles are detected. Distorted input waveforms, with harmonics to the 30th are therefore detected accurately.

Derived parameters are calculated and displayed once a second, scaled by user programmed constants for current and voltage transformers.

Instantaneous power parameters are integrated over long time periods providing a number of energy registers. System frequency is detected by digital processing of the phase 1 voltage signal.

2.1.1 Balance Current Measurements

The rms. value of the instantaneous sum of the three phase currents is available on some MultiCube meter types. The total current in a three phase system may be represented as :

$$I_{bal} = I_1 + I_2 + I_3 = I_{LEAK} + I_n$$

I_{LEAK} represents any current leaving the system (e.g. Leakage to earth)

I_n represents current in the neutral (4 wire systems only)

2.1.2 Time Averaged Amps/Volts (T-Avg)

Average values of volts and Amps are calculated over a user programmable time period (10 - 2500 seconds). The displays show the averages for the most recent time period ending at the time the display was last updated. The average period is continuously updated as time progresses.

The largest value of each ***T-Avg*** parameter is recorded, saved to non-volatile memory and displayed as ***Pk hold T-Avg***. These peak values may be reset by the user.

Each ***Average-Period*** is split into 10 sub-periods. The average values of volts and amps are measured during each sub-period and stored in an array. The latest sub-period values replace the oldest in the array as time progresses. The ***T-Avg*** values are calculated as the mean of each corresponding array. The display is updated with the latest ***T-Avg*** parameters at the end of each sub-period (every ***Average-Period***/10 seconds).

2.1.3 Maximum Demand Power (MD)

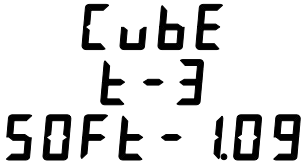
Average values of kW, kVA and kvar (if fitted) are calculated over a user programmable time period (1 - 60 minutes). The displays show the averages for the most recent time period ending at the time the display was last updated. The demand period is continuously updated as time progresses. These parameters are referred to as ***Maximum Demand Powers***.

The largest value of each ***MD*** parameter is recorded, saved to non-volatile memory and displayed as ***Pk hold MD***. These peak values may be reset by the user.

Each ***MD-Period*** is split into 60 sub-periods. The average power values are measured during each sub-period and stored in an array. The latest sub-period values replace the oldest in the array as time progresses. The MD powers are calculated as the mean of each corresponding array. The display is updated with the latest ***MD*** values at the end of each sub-period (every ***MD-Period***/60 seconds).

2.2 Power Up

On power up the MultiCube shows the meter type and software issue. The example below shows a MultiCube Type 3 with software issue 1.09.



2.3 Display Pages

To select current measurements press the **I** key repeatedly until the desired page is displayed. The number of pages available is dependant on meter type.

To select voltage measurements press the **V** key repeatedly until the desired page is displayed. The number of pages available is dependant on meter type.

To select power/energy measurements press the **P** key repeatedly until the desired page is displayed. The number of pages available is dependant on meter type.

Automatically scrolling pages showing PF, Volts & Amps on each phase are obtained by pressing **>>** once. This is available on all meter types.

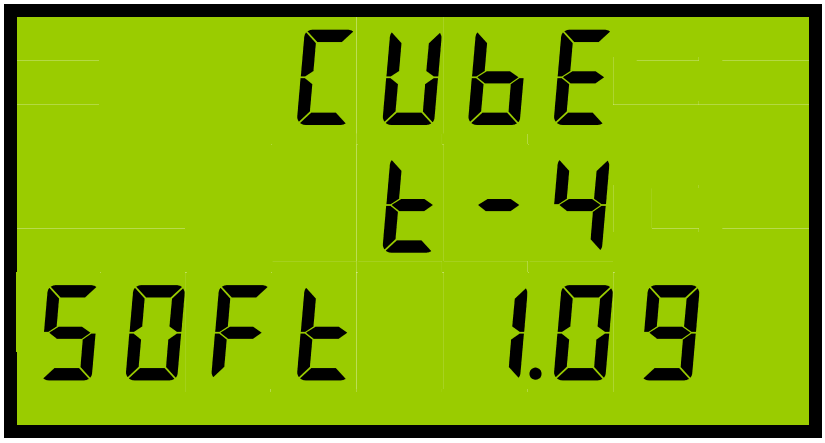
Display pages available on the full range of MultiCube meters are shown below followed by tables showing those available on each standard meter type.

3. Display Pages

Measured data is displayed on numerous pages organised in four Standard Menus as follows:

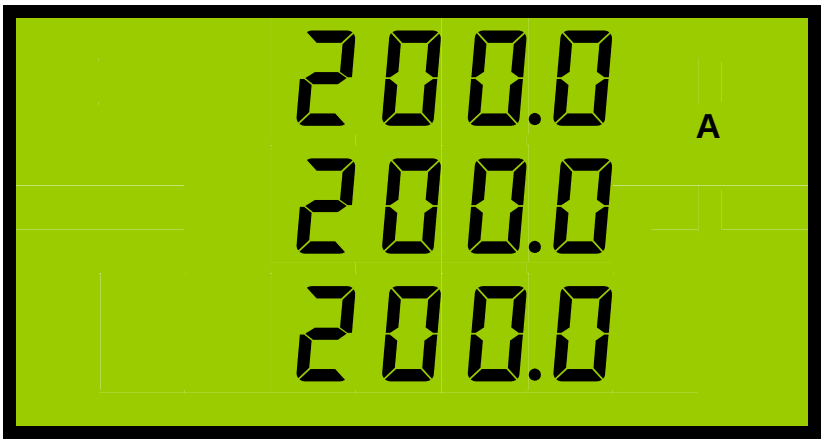
3.1 Power Up

The following screen is shown when auxiliary power is first supplied.



3.2 Current Menu

Press the ***I*** key to select from the available Current Menu pages.



Phase Amps

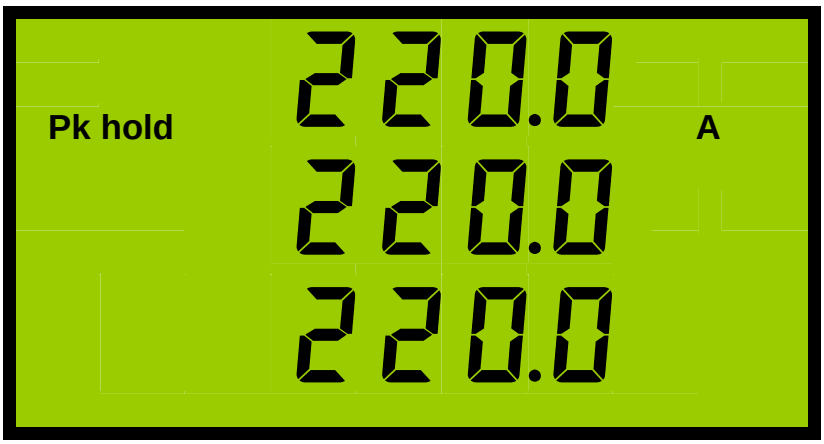
Meter Types 1-4

Phase 1 true rms amps

Phase 2 true rms amps.

Phase 3 true rms amps.

This display is updated every second.



Peak Hold Phase Amps

Meter Type 4 Only

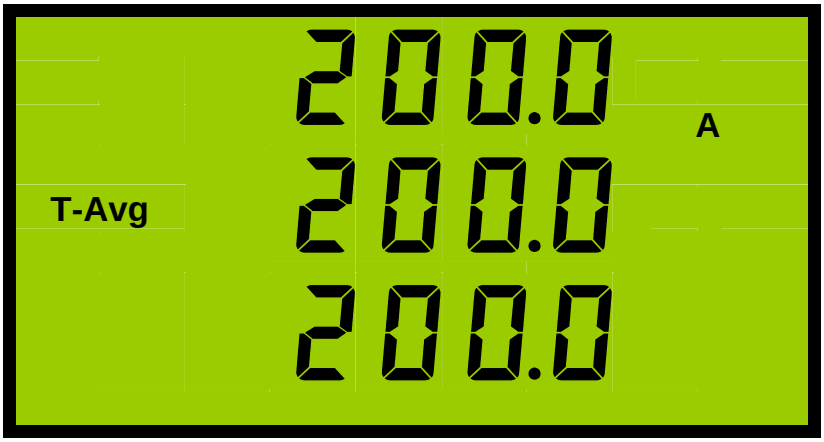
The maximum value of displayed phase amps. These are stored in non-volatile memory when the meter loses auxiliary power

Press ***I*** and ***V*** to reset all three peaks to zero [note 1].

System and Balance Amps
Meter Type 4 Only

Balance Amps - Instantaneous sum of the phase current waveforms. This is a measure of the neutral current + earth leakage.

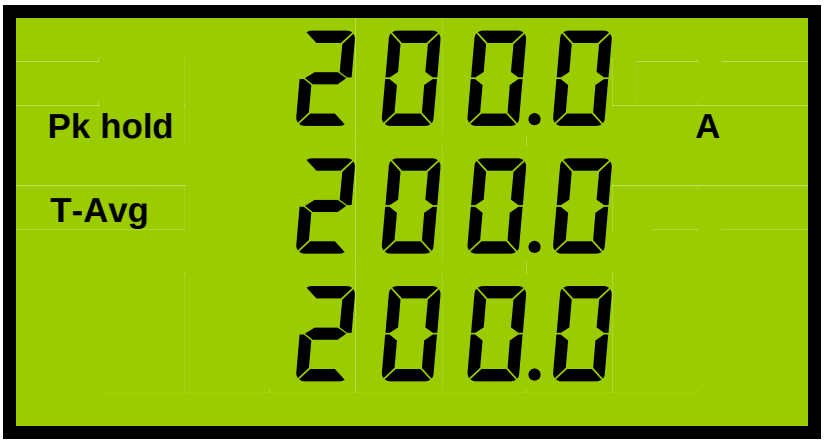
System Average Amps = (Irms1 + Irms2 + Irms3)/3.



Time-Averaged Amps
Meter Types 1-4

The calculated average of phase amps taken over a user definable time period T_{VI} (10s to 2500s).

A rolling time window is used and the display updated every $T_{VI}/10$ with the average of the most recent period displayed.



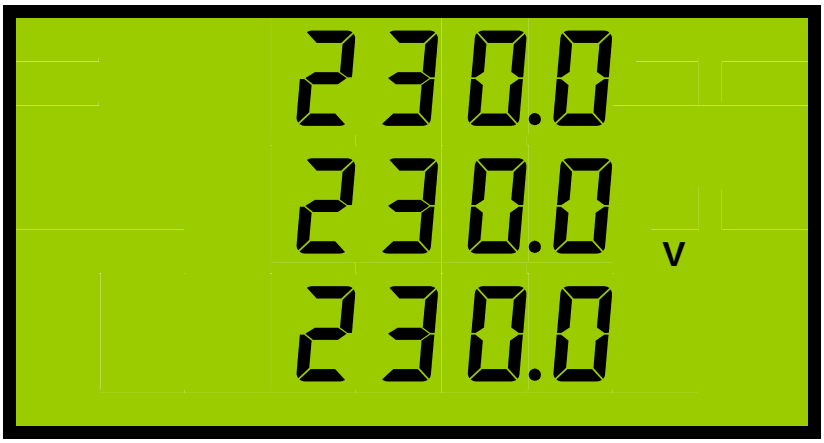
Peak Time-Averaged Amps
Meter Types 1-4

The maximum value of Time-Averaged amps. These are stored in non-volatile memory when the meter loses auxiliary power

Press ***I*** and ***V*** to reset all three peaks to zero [note 1].

3.3 Voltage Menu

Press the ***V*** key to select from the available Voltage Menu pages.



Phase Volts

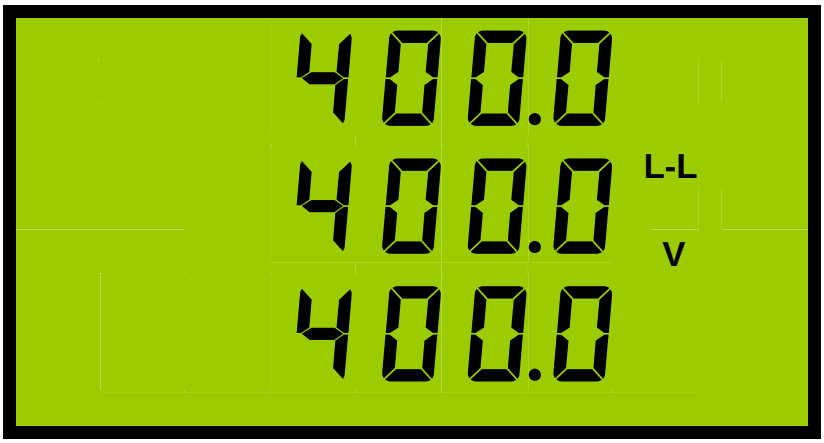
Meter Types 1-4

Phase 1 True rms volts

Phase 2 True rms volts.

Phase 3 True rms volts.

This display is updated every second.



Line Volts

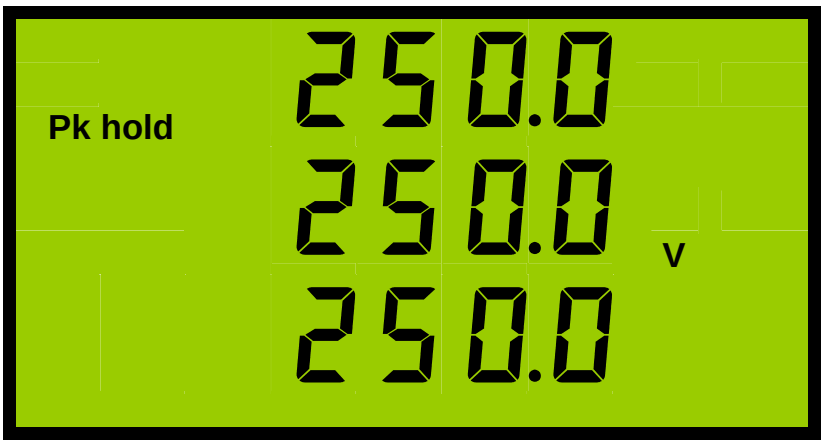
Meter Types 1- 4

Line 1 Volts (Phases 1-2)

Line 2 Volts (Phases 2-3)

Line 3 Volts (Phases 3-1)

This display is updated every second.

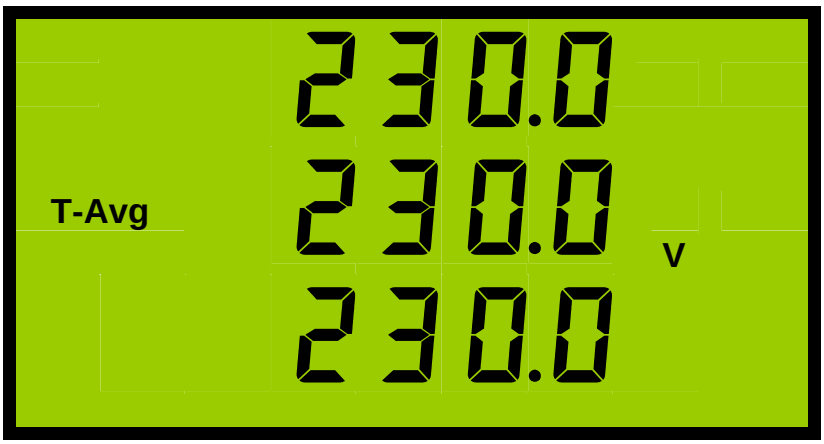


Peak Hold Phase Volts

Meter Type 4 Only

The maximum value of displayed phase volts. These are stored in non-volatile memory when the meter loses auxiliary power

Press ***I*** and ***V*** to reset all three maximums to zero [note 1].

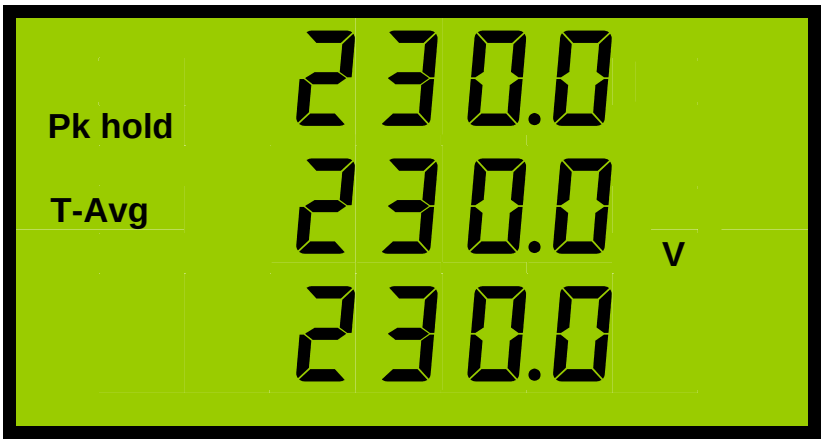


Time-Averaged Volts

Meter Types 1-4

The calculated average of phase volts taken over a user definable time period T_{VI} (10s to 2500s).

A rolling time window is used and the display updated every $T_{VI}/10$ with the average of the most recent period displayed.



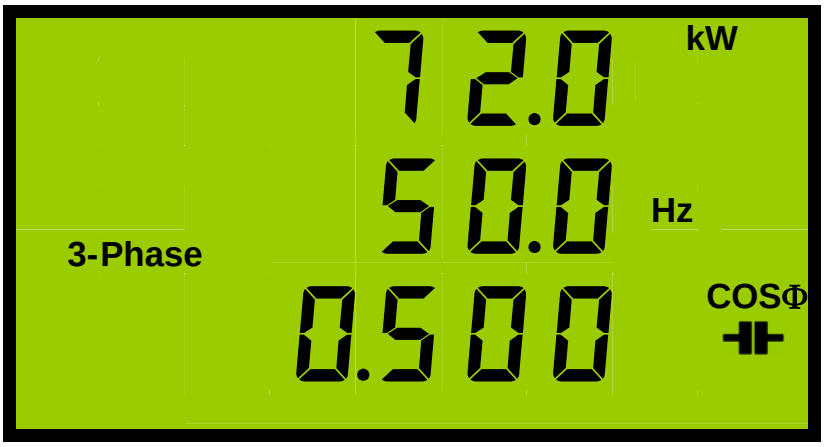
Peak Time-Averaged Volts
Meter Types 1-4

The maximum value of Time-Averaged volts. These are stored in non-volatile memory when the meter loses auxiliary power

Press ***I*** and ***V*** to reset all three maximums to zero [note 1].

3.4 Power Menu

Press the ***P*** key to select from the available Power Menu pages.



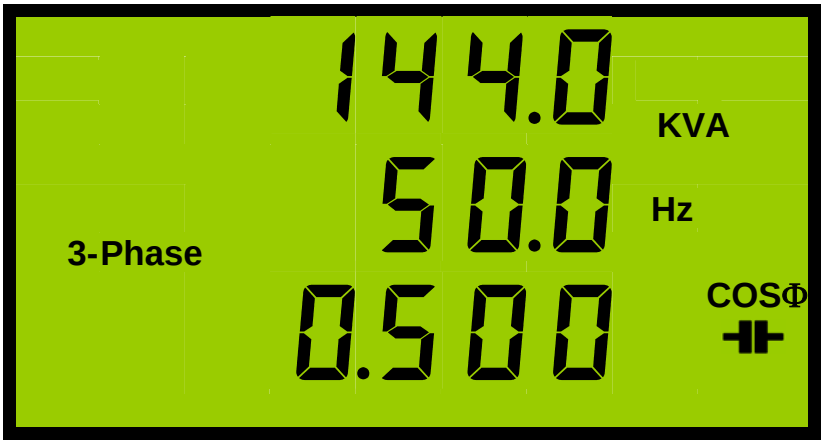
System Power (kW)
Meter Types 1-4

System Real Power (Watts)

Frequency (Measured on V1)

System, PF

A symbol after the PF value indicates a capacitive load.



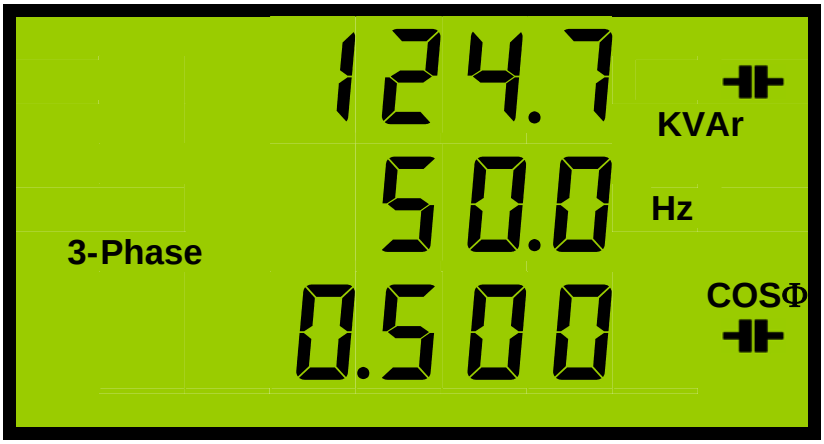
System Power (kVA)
Meter Type 4 Only

System Apparent Power (VA)

Frequency (Measured on V1)

System, PF

A symbol after the PF value indicates a capacitive load.



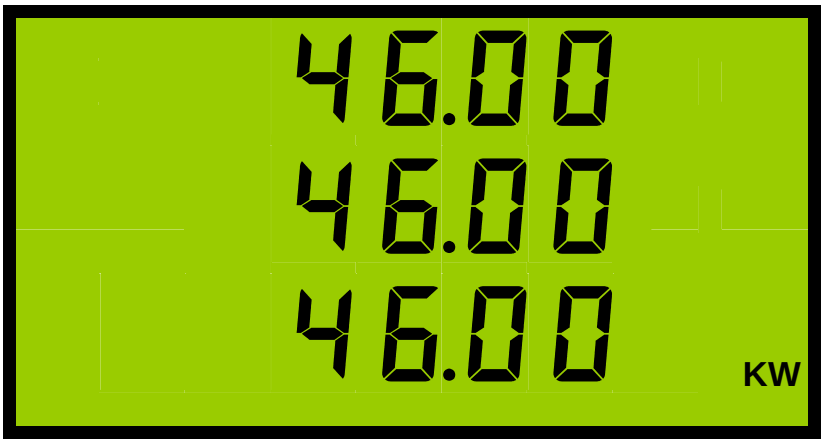
System Power (kvar)
Meter Types 3-4 Only

System Reactive Power (VAr)

Frequency (Measured on V1)

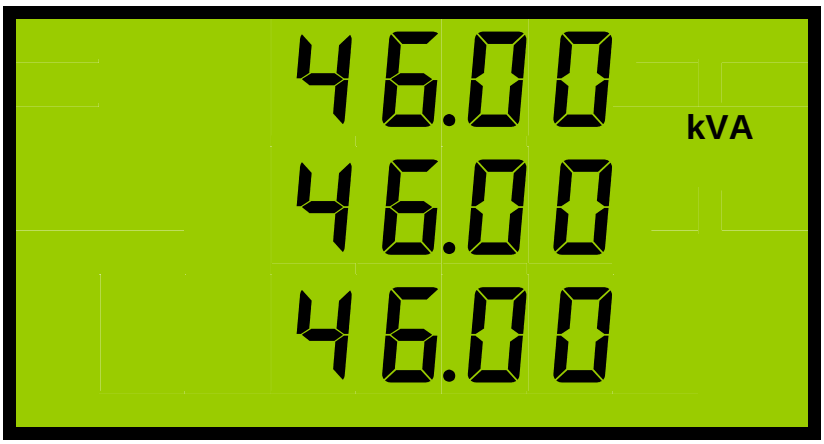
System, PF

A symbol after the PF and kvar values indicate a capacitive load.



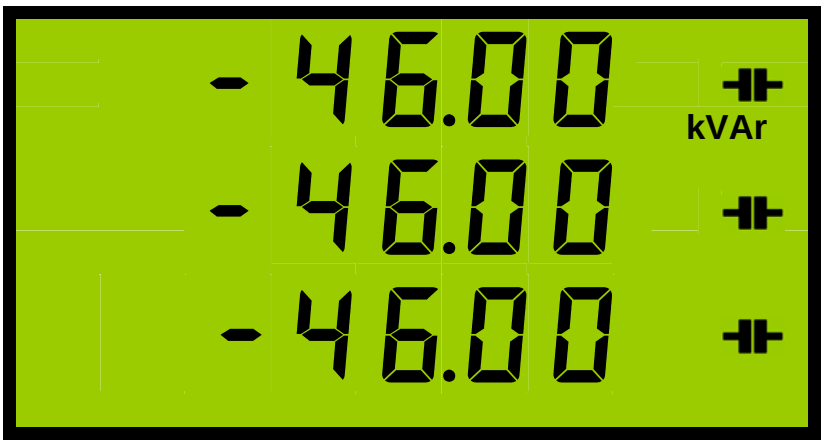
Phase Watts
Meter Types 1-4

Phase 1 true rms watts
Phase 2 true rms watts.
Phase 3 true rms watts



Phase VA
Meter Type 4 Only

Phase 1 true rms VA
Phase 2 true rms VA.
Phase 3 true rms VA

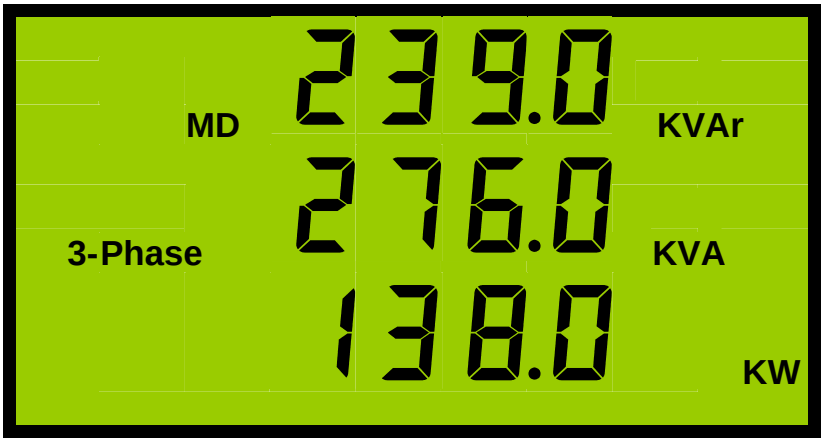


Phase var
Meter Types 3-4 Only

Phase 1 true rms Var
Phase 2 true rms Var.
Phase 3 true rms Var

A symbol after a var value indicates a capacitive load.

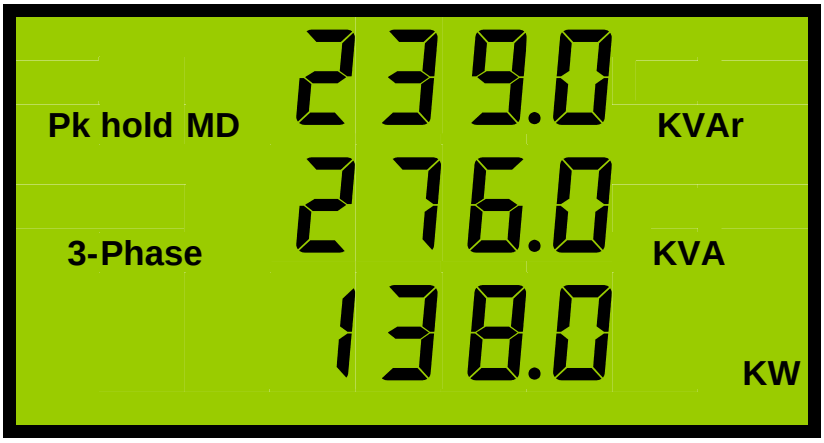
A negative sign before a var reading indicates export reactive power.



Maximum Demand (MD)
Meter Types 3-4 Only

The calculated average of the system power values taken over a user definable time period T_p (1min to 60min).

A rolling time window is used and the display updated every $T_p/60$ with the averages of the most recent period displayed.



Peak Hold MD
Meter Types 3-4 Only

The maximum value of each power MD value. These are stored in non-volatile memory when the meter loses auxiliary power

Press ***I*** and ***V*** to reset all three maximums to zero [note 1].

Real Energy (Wh)
Meter Types 2-4 Only

This register accumulates when kW is positive (import).

This value returns to 0 when the value exceeds 99999999.

This register is stored in non-volatile memory when auxiliary power is not supplied to the meter.

Apparent Energy (VAh)
Meter Type 4 Only

VAh Accumulating register.

This value returns to 0 when the value exceeds 99999999.

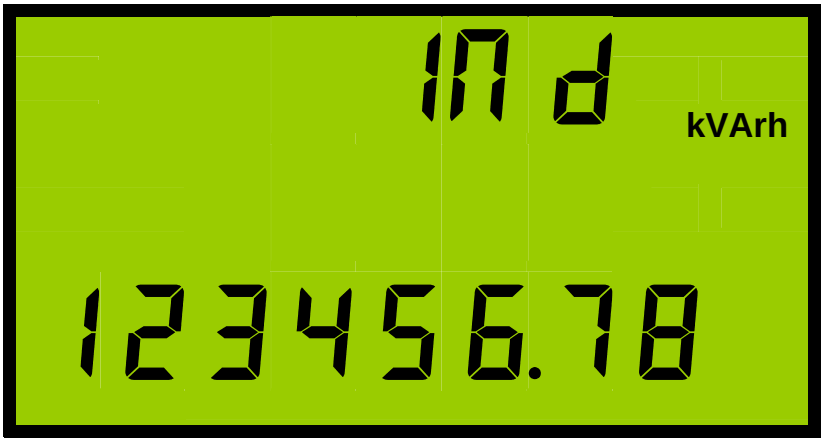
This register is stored in non-volatile memory when auxiliary power is not supplied to the meter.

Reactive Energy (varh)
Meter Types 3-4 Only

Import varh Accumulating register.

This value returns to 0 when the value exceeds 99999999.

This register is stored in non-volatile memory when auxiliary power is not supplied to the meter.



Reactive Energy Inductive
Meter Types 3-4 Only

This register is separate from the main import varh register and accumulates only when the measured load is inductive.

This register resets at 99999999 and is saved in non volatile memory.

Reactive Energy Capacitive
Meter Types 3-4 Only

This register is separate from the main import varh register and accumulates only when the load is capacitive.

This register resets at 99999999 and is saved in non volatile memory.

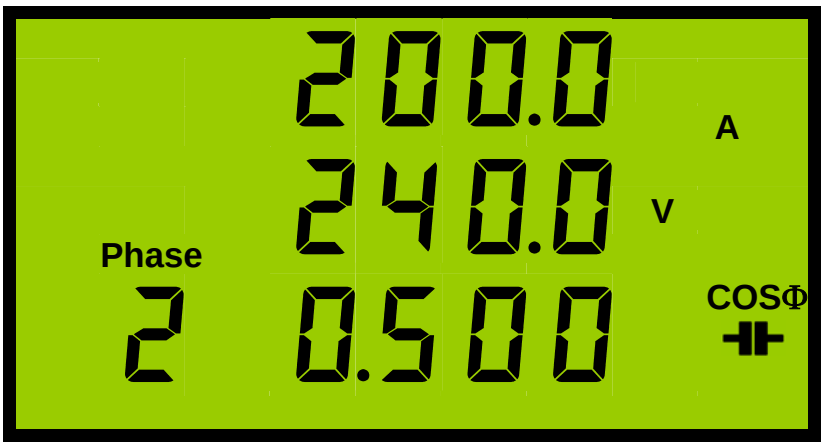
NOTE 1: Meters may be installed with all Peak Reset keypad functions disabled.

3.5 Reset of Energy Registers

Meters may be supplied with an option to reset energy registers to zero using the front keys. If the option is fitted, press ***I*** and ***V*** together while displaying any energy register and hold for approximately 3 seconds. All energy registers are simultaneously reset to zero. Once reset the registers may not be recovered.

3.6 Per-Phase Menu

Press the **>>** key to select the Auto Scrolling Per-Phase Menu.



Per-Phase Display Pages

Meter Types 1-4

Three pages show the Amps Volts and Power Factor of phases 1-3 consecutively.

The Phase automatically advances after approximately 5 seconds.

A symbol indicates a capacitive load.

Press the **>>** key to advance the scrolling pages more quickly.

3.7 Meter Type Display Menus

MultiCube Type 1 Menus			
I	**V**	**P**	**>>**
Phase Amps	Phase Volts	System Power (kW), Hz, PF	Phase 1 PF, V, I
Time Averaged Amps	Line Volts	Phase Watts	Phase 2 PF, V, I
Peak Time Averaged Amps	Time Averaged Volts		Phase 3 PF, V, I
	Peak Time Averaged Volts		

MultiCube Type 2 Menus			
I	**V**	**P**	**>>**
Phase Amps	Phase Volts	System Power (kW), Hz, PF	Phase 1 PF, V, I
Time Averaged Amps	Line Volts	Phase Watts	Phase 2 PF, V, I
Peak Time Averaged Amps	Time Averaged Volts	Import Real Energy (Wh)	Phase 3 PF, V, I
	Peak Time Averaged Volts		

MultiCube Type 3 Menus			
I	**V**	**P**	**>>**
Phase Amps	Phase Volts	System Power (kW), Hz, PF	Phase 1 PF, V, I
Time Averaged Amps	Line Volts	System Power (kvar), Hz, PF	Phase 2 PF, V, I
Peak Time Averaged Amps	Time Averaged Volts	Phase Watts	Phase 3 PF, V, I
	Peak Time Averaged Volts	Phase Var	
		Maximum Demands (MD)	
		Peak Hold MDs	
		Import Real Energy (Wh)	
		Import Reactive Energy (varh)	
		Reactive Energy Inductive	
		Reactive Energy Capacitive	

MultiCube Type 4 Menus			
I	**V**	**P**	**>>**
Phase Amps	Phase Volts	System Power (kW), Hz, PF	Phase 1 PF, V, I
Peak Hold Phase Amps	Line Volts	System Power (kVA), Hz, PF	Phase 2 PF, V, I
System and Balance Amps	Peak Hold Phase Volts	System Power (kvar), Hz, PF	Phase 3 PF, V, I
Time Averaged Amps	Time Averaged Volts	Phase Watts	
Peak Time Averaged Amps	Peak Time Averaged Volts	Phase VA	
		Phase Var	
		Maximum Demands (MD)	
		Peak Hold MDs	
		Import Real Energy (Wh)	
		Apparent Energy (VAh)	
		Import Reactive Energy (varh)	
		Reactive Energy Inductive	
		Reactive Energy Capacitive	

3.8 Display Scaling

Measured values displayed on the LCD are scaled by the user settings of CT and/or PT primaries to provide optimum resolution.

3.8.1 Voltage Scaling)

PT Setting	Resolution
$10V_{L-L}$ - $80V_{L-L}$	0.01 V
$81V_{L-L}$ - 800V	0.1 V
$801V_{L-L}$ – $8,000V_{L-L}$	1 V
$8,001V_{L-L}$ - $50,000V_{L-L}$	0.01 kV

3.8.2 Current Scaling

CT Setting	Resolution
5A - 8A	0.001 A
9A - 80A	0.01 A
81A - 800A	0.1 A
801A – 8,000A	1 A
8,001A – 20,000A	0.01 kA

3.8.3 Power Scaling (W, VA, var)

PT Setting x CT Setting	Phase Parameters	System Parameters
100VA - 1,400VA	0.1 W	0.001 kW
1,401VA - 14,000VA	0.001 kW	0.01 kW
14,001VA - 140,000VA	0.01 kW	0.1 kW
140,001VA - 1,400,000VA	0.1 kW	1 kW
1,400,001VA - 14,000,000VA	1 kW	0.01 MW
14,000,001VA - 140,000,000VA	0.01 MW	0.1 MW
140,000,001VA – 1,000,000,000VA	0.1 MW	1 MW

3.8.4 Energy Registers (Wh, VAh, varh)

PT Setting x CT Setting	Resolution
100VA - 1,400VA	.001 kWh
1,401VA - 14,000VA	0.01 kWh
14,001VA - 140,000VA	0.1 kWh
140,001VA - 1,400,000VA	1 kWh
1,400,001VA - 14,000,000VA	0.01 MWh
14,000,001VA - 140,000,000VA	0.1 MWh
140,000,001VA – 1,000,000,000VA	1 MWh

3.8.5 Miscellaneous

All Settings	Resolution
System and Phase PF	0.001
Frequency	0.1 hz

3.9 Isolated Pulse Outputs

MultiCube meters which display kWh and/or kvarh incorporate isolated pulse output(s). These outputs provide a simple interface to external systems such as building management centres etc.

Each output takes the form of a normally open, volt free contact pair which provides a low resistance, for 100mS, at the end of a pre-set number of increments of the associated energy register ('pulse rate'). The pulse rate of each output may be programmed by the user to match the requirements of the external system. For further details on programming the MultiCube refer to Section 5.

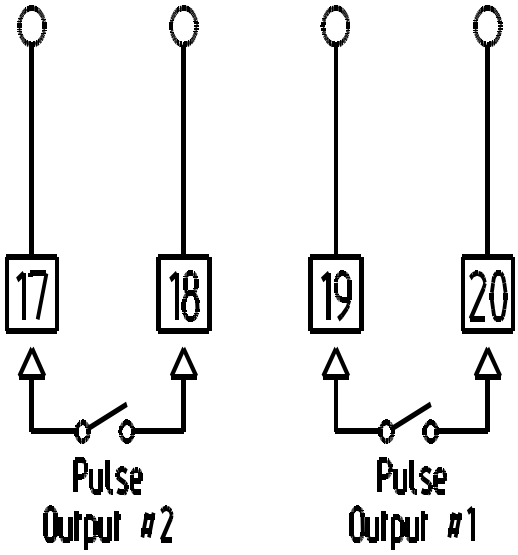


Figure 2.1 Pulse Output Connection

4. Installation

4.1 Panel Mounting

Panels should be of thickness 1mm to 4mm with a square cut-out of 92mm (+0.8 - 0.0). A minimum depth of 72mm should be allowed behind the panel for the meter. Remove the panel mounting clips and insert the meter into the cut-out from the front of the panel. Push the meter home. Ensure the screws in each panel mount clip are fully retracted and insert the clips as shown in the diagram below. Tighten the screws to secure the meter firmly in the panel.

DO NOT OVERTIGHTEN.

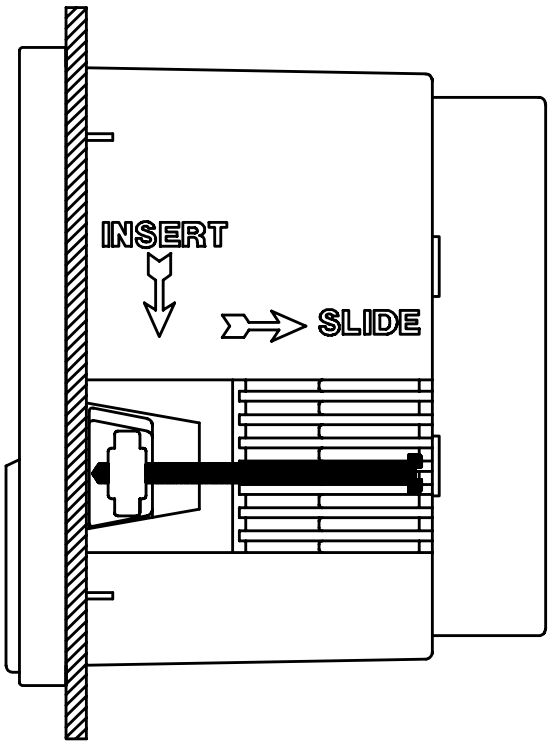


Figure 4-1 Fitting The Meter in a Panel

4.2 CT Connections

The MultiCube is designed for use with external current transformers (CTs). Recommended types should conform to Class 1 per IEC 60044-1. The secondary of the CT should be specified to suit the input rating defined on the meter label. Cables used for the current circuit should have a maximum conductor size of 4.0mm^2 and should be kept as short as possible to reduce cable losses loading the CT secondary.

CT Inputs to the meter are isolated from each other and all other parts of the circuit. This allows use on a wide variety of systems including those requiring common and/or earthed CT secondaries.

WARNING :
NEVER leave the secondary of a current transformer open circuit while a primary current flows. In this condition dangerous voltages may be produced at the secondary terminals.

4.3 Voltage Connections

Cables used for the voltage measurement circuit should be insulated to a minimum of 600V AC and have a minimum current rating of 250mA. The maximum conductor size is 4.0mm^2.

External protection fuses are recommended for the voltage measurement inputs. These should be rated at 160mA maximum, Type F, and should be able to withstand voltages greater than the maximum input to the meter.

4.4 Auxiliary Mains Supply (L & N)

The MultiCube uses an isolated auxiliary mains supply separate from the voltage measurement inputs. This may be connected separately or in parallel with the measurement inputs provided the ratings detailed on the instrument label are not exceeded.

Separate connection of the auxiliary mains is required, for example, when :

- A suitable supply voltage is not available locally.
- Measurement voltages are expected to vary over a wide range
- A backup supply is required to maintain meter display

The auxiliary mains supply is not internally fused. External fusing is required to protect the meter. External fuses should be rated at 250mA 250V Type T. The meter ratings are detailed on the instrument label.

WARNING :
CHECK the instrument **LABELS** for correct input ratings.
Incorrectly rated inputs may permanently damage the device

4.5 Connection Schematics

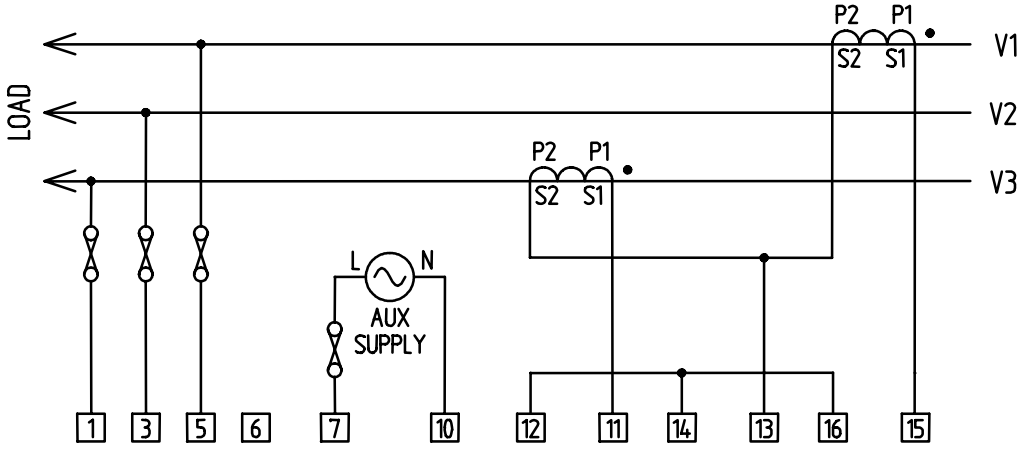


Figure 4-2 3-Phase 3-Wire 2CTs

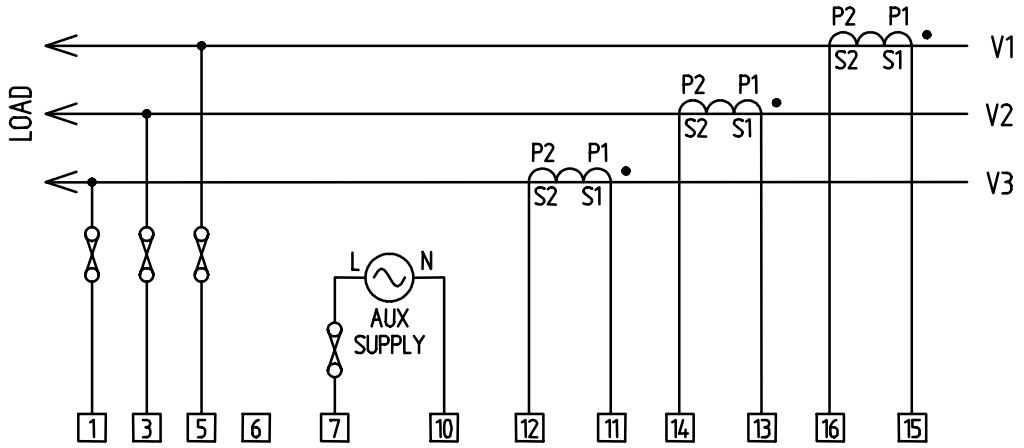


Figure 4-3 3-Phase 3-Wire 3CTs

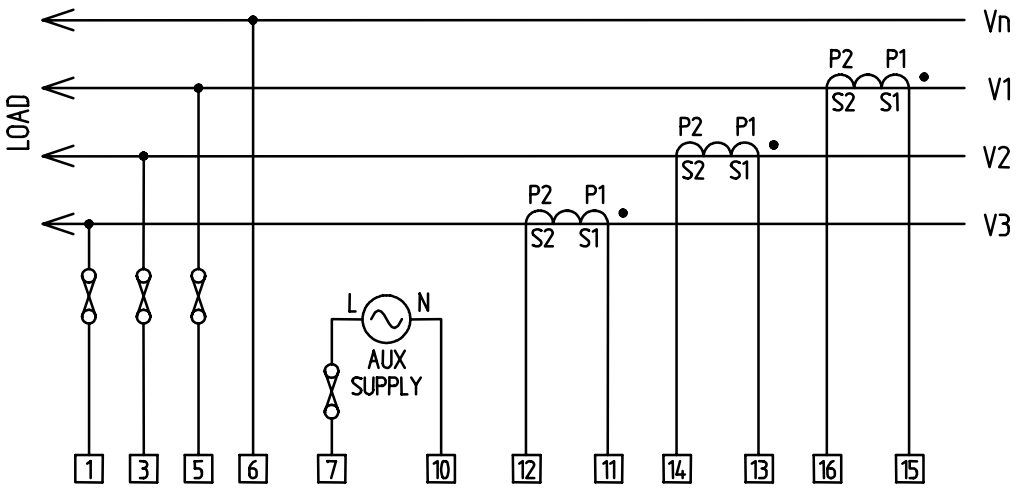


Figure 4-4 3-Phase 4-Wire

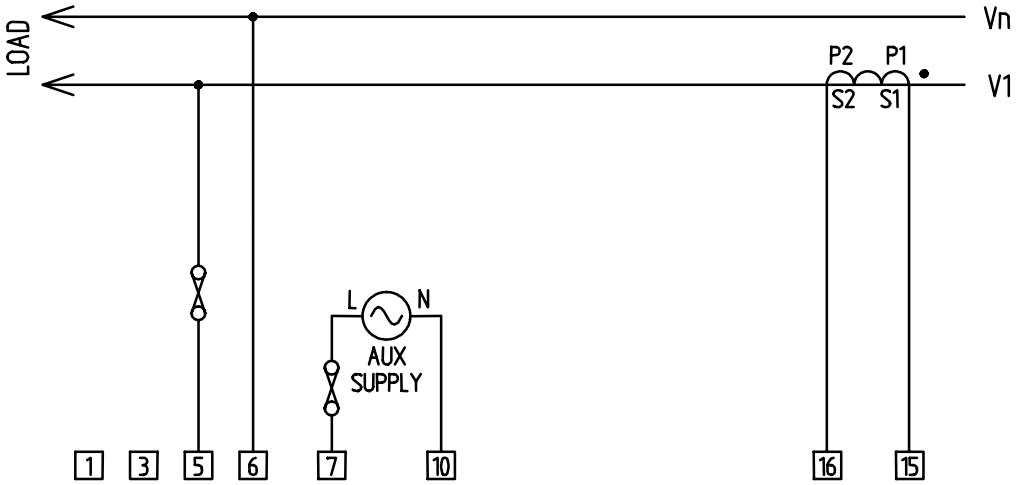


Figure 4-5 Single Phase

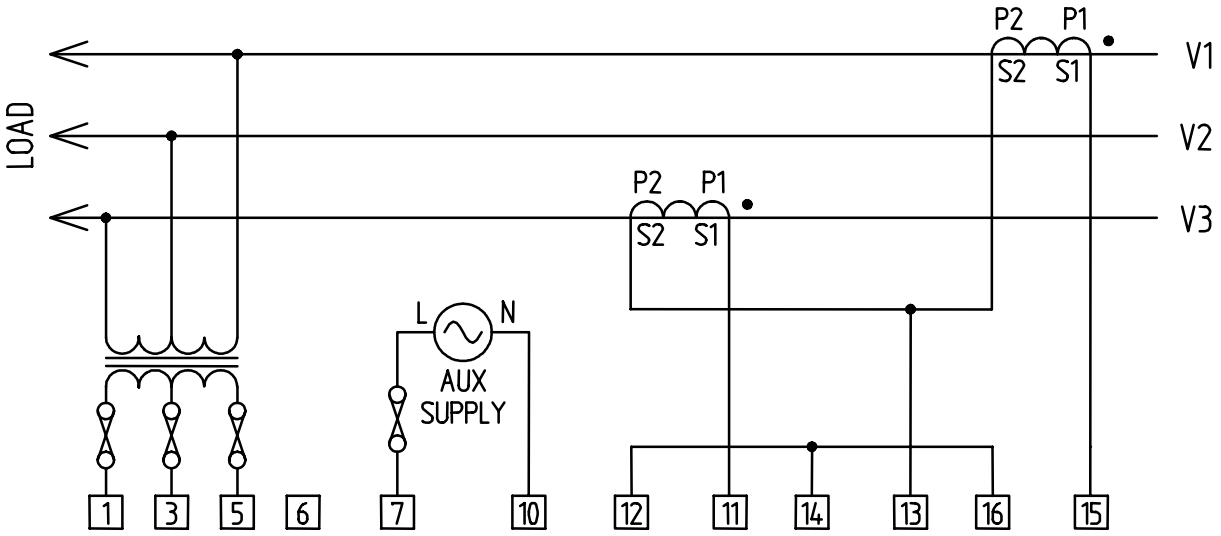


Figure 4-6 3 Phase 3 Wire Using Potential Transformers

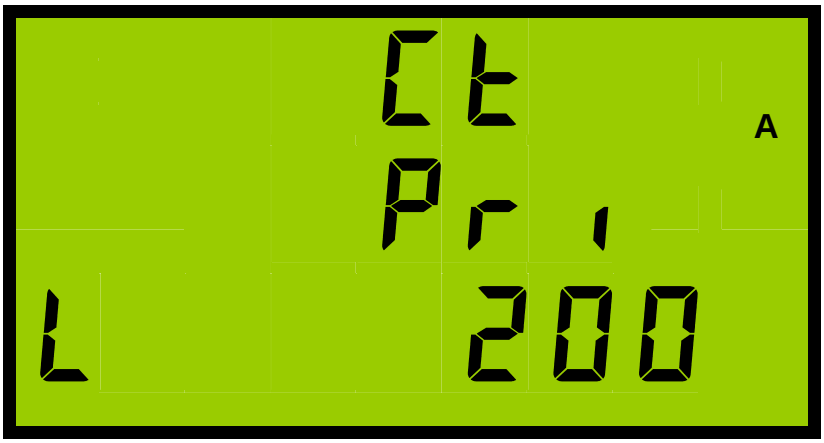
5. Meter Setup

5.1 Programming Menu

To enter programming mode:

Hold **I** and **>>** together for 5 Seconds.

Current Transformer Primary



Press ▲ or ▼ to select from the standard list of CT primaries while L is displayed. (***List Mode***)

Press ▲ or ▼ to increase or decrease the value by 10 while F is displayed. (***Fine Adjust Mode***)

Press ◀ and ▲ together to toggle between L and F.

Press ↵ to accept the set value.

Potential Transformer Primary

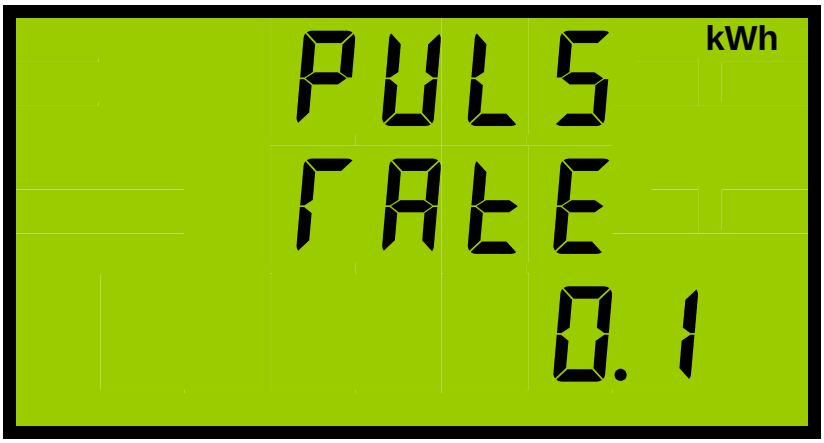
Press ▲ or ▼ to select from the standard list of PT primaries while L is displayed. (***List Mode***)

Press ▲ or ▼ to increase or decrease the value by 10 while F is displayed. (***Fine Adjust Mode***)

Press ↵ and ▲ together to toggle between L and F.

Press ↵ to accept the set value

Pulse Rate



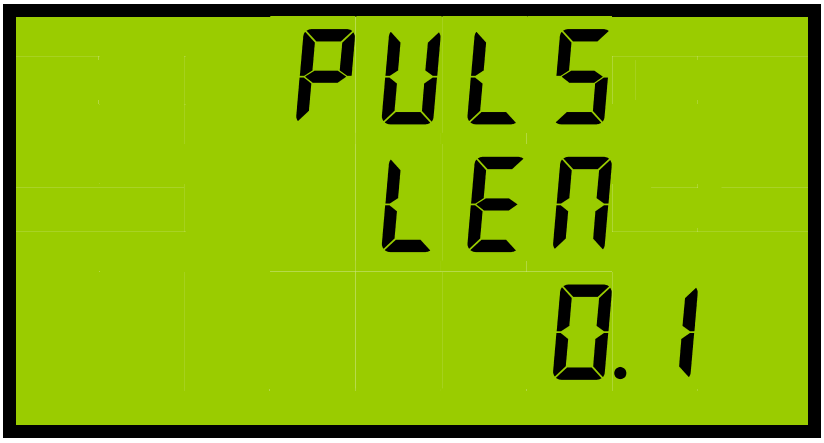
This sets the amount of energy (kWh) required to trigger each Pulse 1 output.

Pulse 2 is set at the same rate but linked to a different register (eg kvarh).

Press ▲ or ▼ to select the next/previous Pulse Rate from a standard list.

Press ↵ to accept the set value.

Pulse Length



This sets the contact closure time for both pulse outputs.

Press ▲ or ▼ to select the next/previous Pulse Length from a standard list.

Press ↵ to accept the set value.

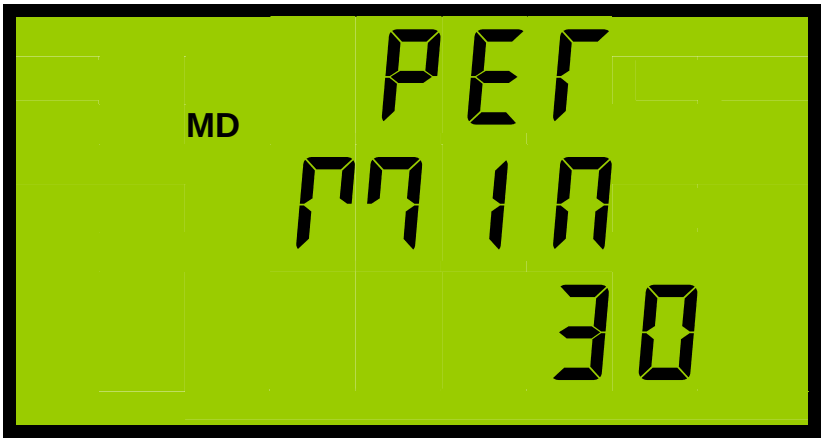
Current/Voltage Time Average Period

This sets the integration period in seconds used for the sliding time window average calculation for current and voltage.

Press ▲ or ▼ to increment or decrement the value.

Press ↵ to accept the set value.

Power MD Integration Period

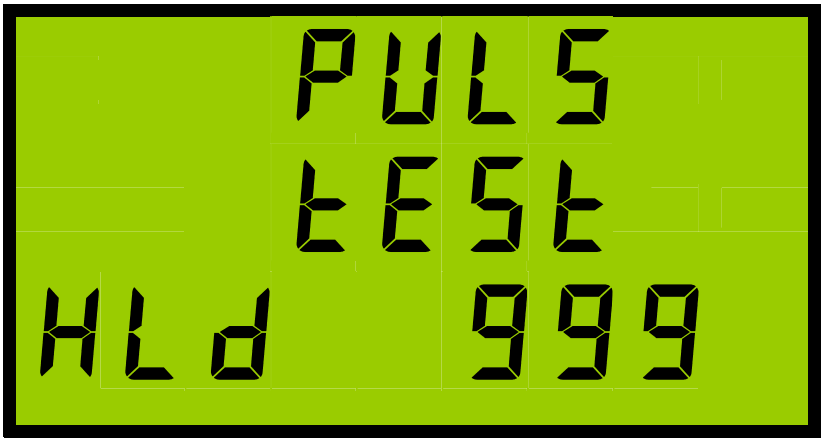


This sets the integration period in minutes used for the sliding time window MD calculation for power.

Press ▲ or ▼ to increment or decrement the value.

Press ↵ to accept the set value.

Pulse Test



This allows the commissioning engineer to test both pulse outputs and associated circuits without the need of a test load.

Press ▲ or ▼ to start/stop a test pulse stream. The display shows HLd (Hold) or rUn respectively.

The counter shows the total number of pulses during the test.

Press ***I*** and ***V*** to reset the test counter to zero.

Press ↵ to accept the set value.

6. Options

6.1 Retro-Fit Modules

A range of retro-fit options modules are available for the MultiCube. These provide additional features to the meter such as Modbus serial communications, analogue outputs, alarms etc. A single options module may be mounted to the rear of the MultiCube as shown.

For detailed information on individual options modules refer to the separate Instruction manual.

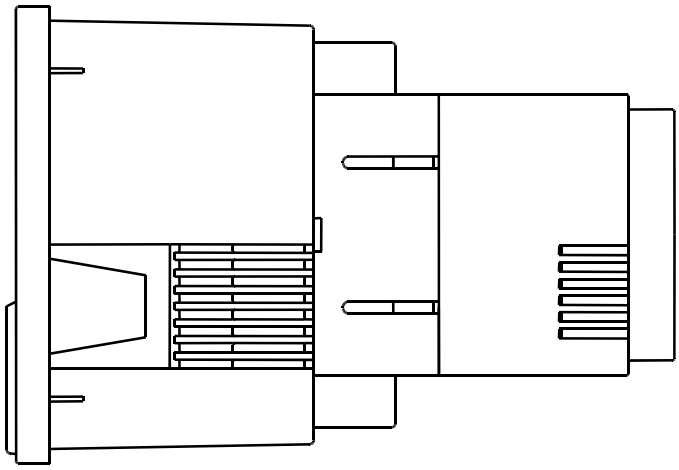


Figure 6-1 Options Module Attached to MultiCube

6.2 Internal Modbus Communications

The MultiCube may be supplied with RS485 Modbus communications. This is available as a factory fitted internal option. This option precludes the use of additional retro-fit options.

7. Specification

Inputs	
System	3-Phase 3 or 4 Wire Unbalanced Load
Voltage	Vb. 230 / 400 Volt. 3-Phase 3 or 4 Wire Vb. 63 / 110 Volt optional Vb. 120 / 208 Volt optional
Current	Ib 5 Amp from external current transformers (CTs) Ib 1 Amp optional Fully Isolated (2.5kV each phase)
Measurement Range **Voltage** **Current**	 20% to 120% 0.5% to 120%
Frequency Range **Fundamental** **Harmonics**	 45 to 65Hz Up to 30th harmonic
Input Loading **Voltage** **Current**	 Less than 0.1 VA per phase Less than 0.1 VA per phase
Overloads **Voltage** **Current**	 x2 for 2 seconds maximum x40 for 0.5 seconds maximum

Auxiliary Supply	
Standard	230 Volt 50/60Hz ±15%
Options	110 Volt 50/60Hz ±15%. (Others to order)
Load	3 VA Maximum
Isolation	2.5kV (1 minute)

Display	
Display Type	Custom, supertwist, LCD with LED backlight
Data Retention	10 years minimum Stores energy registers, user settings, and peaks
Display Format	2 Rows x 4 Digits, 1 Row x 8 Digits + Legends
Display Update	1 second

Digital (Pulse) Outputs	
Function	1 pulse / energy unit (Output #1=N Wh, Output #2=N varh)
Scaling	Programmable
Pulse Period	Programmable 100ms minimum. (2ms Rise, 2ms Fall)
Type	N/O Volt free contact. Optically isolated BiFET
Contacts	100mA AC/DC max, 100V AC/DC max
Isolation	2.5kV (50V #1 to #2)

Accuracy	
Phase Current	0.2% Ib (1.0% Rdg. 0.05 Ib ≤ I_{ph} ≤ 1.2 Ib) ±1 digit.
Neutral Current	0.6% Ib (2.0% Rdg. 0.05 Ib ≤ I_n ≤ 1.2 Ib) ±1 digit.
Phase Voltage	0.2% Vb (1.0% Rdg. 0.2 Vb ≤ V_{ph} ≤ 1.2 Vb) ±1 digit.
Line-Line Voltage	0.3% Vb (1.0% Rdg. 0.2 Vb ≤ V_{LL} ≤ 1.2 Vb) ±1 digit.
Phase Watts	0.4% FS (1.0% Rdg. 0.05FS ≤ P ≤ 1.2FS) ±1 digit.
Phase VA	0.6% FS (1.5% Rdg. 0.05FS ≤ Q ≤ 1.2FS) ±1 digit.
Phase var	0.8% FS (2.0% Rdg. 0.05FS ≤ S ≤ 1.2FS) ±1 digit.
Phase PF	± 0.2 Degrees
System Watts	0.6% FS (1.0% Rdg. 0.05FS ≤ P ≤ 1.2FS) ±1 digit.
System VA	1.0% FS (1.5% Rdg. 0.05FS ≤ Q ≤ 1.2FS) ±1 digit.
System var	1.5% FS (2.0% Rdg. 0.05FS ≤ S ≤ 1.2FS) ±1 digit.
System PF	± 0.2 Degrees
Frequency	±0.05Hz. 45Hz ≤ F ≤ 65Hz
Wh Register	Class 1.0 EN 61036
VAh Register	Class 2.0
varh Registers	Class 2.0 IEC 1268
% THD Amps	± 0.5% THD 0.05 Ib ≤ I_{ph} ≤ 1.2 Ib
% THD Volts	± 0.5% THD 0.2 Vb ≤ V_{ph} ≤ 1.2 Vb
Timebase	Better than 100ppm

General	
Temperature **Operating** **Storage**	 -10 deg C to +65 deg C -25 deg C to +70 deg C
Environment	IP54
Humidity	<75% non-condensing

Mechanical	
Enclosure	DIN 96mm x 96mm Mablex ULV94-V-O
Dimensions	96mm x 96mm x 80mm (72mm behind panel) 130mm behind panel with options unit fitted
Weight	Approx. 400g
Terminals	Rising Cage. 4.0mm^2 cable max