Newtons4th Ltd

PPA500 Series

Precision Power Analyzer

User manual

Chapter 0 Table of Contents

Chapter 1 Safety

Important safety Information

This manual contains important information that must be followed to ensure the safety of all operatives and both this instrument and any accessories attached.

CAUTION.
Input Connections: It is critical that the 4mm inputs and BNC inputs on each PPA input channel are not connected to any external circuit at the same time.

You MUST only use EITHER the 4mm OR the BNC connection – NOT both, this applies to both Voltage and Current inputs.

General Safety Information

Use the product only as detailed in this manual. Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it. Carefully read all instructions. Retain these instructions for future reference.

For correct and safe operation of this instrument, it is essential that you follow generally accepted safety procedures in addition to the safety precautions specified in this manual.

The product is designed to be used by trained personnel only it is designed to comply with BSEN 61010-1 (Safety requirements for electrical equipment for measurement, control, and laboratory use)

Ensure that the supply voltage agrees with the rating of the instrument printed on the back panel before connecting the mains cord to the supply.

The cover(s) should not be removed to attempt repair, maintenance, or adjustment, as this instrument contains no user serviceable parts. All repairs, maintenance or adjustment should only be caried out by Newtons4th Ltd or our official distributor.

While using this product, you may need to access other parts of a larger system. Read the safety sections of the other component manuals for warnings and cautions related to operating the system.

When incorporating this equipment into a system, the safety of that system is the responsibility of the assembler of the system.

There are no user serviceable parts inside the instrument – do not attempt to open the instrument, refer service to the manufacturer or his appointed agent.

To avoid fire or personal injury

Use the correct mains lead. Use only the mains lead supplied with this product and certified for the country of use.

Ground the instrument. This instrument is grounded through the grounding conductor of the mains lead. To avoid electric shock, the grounding conductor **must** be connected to earth ground. Before making connections to the input or output terminals of the instrument, ensure that the instrument is properly grounded.

Power disconnect. Do not position the instrument so that it is difficult to disconnect the mains lead; it must always remain accessible to the user to allow for quick disconnection if needed in an emergency.

Connect and disconnect properly. Do not connect or disconnect probes or test leads while they are connected to a voltage source. Use only insulated voltage probes, test leads, and accessories supplied with the product, or indicated by Newtons4th Ltd. to be suitable for the product.

Observe all terminal ratings. To avoid fire or shock hazard, observe all rating and markings on the instrument. Consult the specifications in this user manual for further ratings information before making connections to the product. Do not exceed the Measurement Category (CAT) rating and voltage or current rating of the lowest rated individual component of a product, probe, or accessory. Use caution when using 1:1 test leads because the probe tip voltage is directly transmitted to the instrument.
Do not apply a potential to any terminal, including the common terminal, that exceeds the maximum rating of that terminal.

Avoid exposed circuitry. Do not touch exposed connections and components when power is present.

Do not operate with suspected failures. If you suspect that there is damage to this instrument, have it inspected by Newtons4th Ltd or our official distributor. Do not use the instrument if it is damaged or operates incorrectly. If in doubt about safety of the instrument, turn it off and disconnect the mains lead. Clearly mark the instrument to prevent its further operation. Before use, inspect voltage probes, test leads, and accessories for mechanical damage and replace when damaged. Do not use probes or test leads if they are damaged.

Use proper fuse. Use only the fuse type and rating specified for this product.

Do not operate in wet/damp conditions. Be aware that condensation may occur if a unit is moved from a cold to a warm environment.

Do not operate in an explosive atmosphere.

Keep product surfaces clean and dry. Remove the input signals before you clean the product, only use a dry cloth for cleaning. Do not use chemicals or cleaning products on this instrument.

Provide proper ventilation. Refer to the section on rack mounting in this manual's installation instructions for details on installing the instrument so it has proper ventilation. Slots and openings are provided for ventilation and should never be covered or otherwise obstructed. Do not push objects into any of the openings.

Provide a safe working environment. Always place the instrument in a location convenient for viewing the display and indicators. Use care when lifting and carrying the product. This product is provided with handles for lifting and carrying.

Terms in the manual

These terms may appear in this manual:

WARNING. Warning statements identify conditions or practices that could result in injury or loss of life.

CAUTION. Caution statements identify conditions or practices that could result in damage to this product or other property.

INFORMATION. Information statements identify instructions or commands that may save time or provide extra functionality.

Terms on the product

These terms may appear on the product:

- DANGER indicates an injury hazard immediately accessible as you read the marking.
- WARNING indicates an injury hazard not immediately accessible as you read the marking.
- CAUTION indicates a hazard to property including the product.

Symbols on the product

When this symbol is marked on the product, be sure to consult the manual to find out the nature of the potential hazards and any actions which must be taken to avoid them.

The following symbol(s) may appear on the instrument.

Instrument GND

Conventions used to signify control keys, screen menu options and remote control commands are differentiated as shown below.

control keys	*ACQU*	denoted by *italicised font*
menu options	***bandwidth***	denoted by ***bold italicised font***
script commands	****CLS***	denoted by ***grey, bold italicised font***

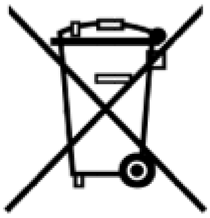
Environmental compliance

This section provides information about the environmental impact of the product.

Product end-of-life handling
Observe the following guidelines when recycling an instrument or component:

Equipment recycling. Production of this equipment required the extraction and use of natural resources.

The equipment may contain substances that could be harmful to the environment or human health if improperly handled at the product's end of life. To avoid release of such substances into the environment and to reduce the use of natural resources, we encourage you to recycle this product in an appropriate system that will ensure that most of the materials are reused or recycled appropriately.



This symbol indicates that this product complies with the applicable European Union requirements according to
Directives 2012/19/EU and 2006/66/EC on waste electrical and electronic equipment (WEEE) and batteries. For information about recycling options, check

Chapter 2 Declaration of Conformity

Manufacturer: Newtons4th Ltd.
Address: 1 Bede Island Road
Leicester
LE2 7EA

We declare that the product:

Description: Precision Power Analyzer
Model: PPA5xx Series

Conforms to the EEC Directives:

2014/30/EU relating to electromagnetic compatibility:
EN 61326-1:2013
EN 55022 class A
EN 61000-3-2:2014
EN 61000-3-3:2013

2014/35/EU relating to Low Voltage Directive:
EN 61010-2-030:2010
EN 61010-1:2010

January 2021

Jigar Patel
(Senior Engineer Newtons4th Ltd.)

Chapter 3 Preface

This manual covers the Newtons4th Ltd PPA15xx Series Precision Power Analyzers

Models covered

PPA510 PPA520 PPA530	Available in Standard and HC (High Current) versions

Key Features

Wide frequency range DC & 10mHz to 500kHz

0.05% Basic accuracy

10 millidegree phase accuracy for low power factor applications

Up to 30Arms(1000Apk) & 1000Vrms (2500Vpk) direct input

Standard, and high current versions 20Arms, 30Arms versions available

Remote control via RS232, LAN, USB or GPIB (IEEE 488) *

1 – 3 Phase versions available

Simple BNC connection of N4L shunts for high current applications

Real time Digital, & Tabular displays

Galvanically isolated voltage & current channels

Realtime no gap analysis

Planar shunt technology

Free Microsoft Windows Software for datalogging, graphs, Excel compatible output options, Microsoft, (Excel, Windows, Word, & C++) are trademarks of the Microsoft group of companies.

Pre-programmed application specific modes for -:

Lighting ballasts, Inrush current measurement, Standby power measurement

Warranty

This product is guaranteed to be free from defects in materials and workmanship for a period of 36 months from the date of purchase.

In the unlikely event of any problem within this guarantee period, first contact Newtons4th Ltd. or your local representative, to give a description of the problem. Please have as much relevant information to hand as possible – particularly the serial number and release numbers (press SYSTEM then LEFT).

If the problem cannot be resolved directly then you will need to request an RMA number from the support section of our website. https://resources.newtons4th.com/ and return the unit. The unit will be repaired or replaced at the sole discretion of Newtons4th Ltd.

This guarantee is limited to the cost of the PPA500 itself and does not extend to any consequential damage or losses whatsoever including, but not limited to, any loss of earnings arising from a failure of the product or software.

In the event of any problem with the instrument outside of the guarantee period, Newtons4th Ltd. offers a full repair and re-calibration service. It is recommended that PPA500 is re-calibrated annually.

Please contact your local Distributor or the N4L office for further details of N4L's instrument repair and re-calibration service.

Chapter 4 General Specifications

General Specifications

Frequency Range	
20Arms & 30Arms versions	DC & 10mHz to 500kHz
X10 mode	DC & 10mHz to 100kHz
Accuracy	0.02%

Voltage Input	
Ranges Normal	1Vpk to 2500Vpk(1000Vrms) in 8 ranges 20% over-range ability maintains 300Vpk range with 240Vrms
Accuracy	0.05% Rdg + 0.1% Rng + (0.005% x kHz Rdg) + 5mV *
Ranges x10	100mVpk to 300Vpk in 8 ranges
Accuracy	0.05% Rdg + 0.1% Rng + (0.01% x kHz Rdg) + 1mV *
External sensor input	0 to 3Vpk – BNC connector
Range	1mVpk to 3Vpk in 8 ranges
Accuracy	Accuracy – 0.05% Rdg + 0.1% Rng + (0.005% x kHz Rdg) + 5µV
40Hz-850Hz Voltage Accuracy	As per standard spec. with Rng error reduced from +0.1% VA Rng to 0.05%

Current Input	
The standard PPA is fitted with a 20Arms internal shunt, models with 30Arms internal shunts are available.	
20Arms Shunt	
Ranges Normal	100mApk to 300Apk (20Arms) in 8 ranges
Accuracy	0.05% Rdg + 0.1% Rng + (0.005% x kHz Rdg) + 500µA*
Ranges x10	10mApk to 30Apk in 8 ranges
Accuracy	0.05% Rdg + 0.1% Rng + (0.01% x kHz Rdg) + 100µA*
30Arms Shunt	
Ranges Normal	300mApk to 1000Apk (30Arms) in 8 ranges
Accuracy	0.05% Rdg + 0.1% Rng + (0.005% x kHz Rdg)+ 1mA*
Ranges x10	30mApk to 100Apk in 8 ranges
Accuracy	0.05% Rdg + 0.1% Rng + (0.01% x kHz Rdg)+ 300µA*
* Measured fundamental value	

Watts Accuracy	
Normal (20Arms), & -HC (30Arms) versions	[0.1% + 0.1%/pf +(0.01% x kHz)/pf] Rdg + 0.1%VA Rng
X10 (20Arms), & -HC (30Arms) versions	[0.1% + 0.1%/pf +(0.02% x kHz)/pf] Rdg + 0.1%VA Rng
40Hz-850Hz Watts Accuracy (Both Std and HC)	As per standard spec. with Rng error reduced from +0.1% VA Rng to 0.05%

DC Accuracy	
Voltage	
Internal	0.1% Rdg + 0.1% Rng + 10mV
X10 mode	0.1% Rdg + 0.1% Rng + 2mV
External	0.1% Rdg + 0.1% Rng + 10µV
Current	
Internal	
20Arms	0.1% Rdg + 0.1% Rng + 3mA
X10 mode	0.1% Rdg + 0.1% Rng + 200µA
30Arms	0.1% Rdg + 0.1% Rng + 5mA
X10 mode	0.1% Rdg + 0.1% Rng + 600µA
External	
	0.1% Rdg + 0.1% Rng + 10µV
Watts	
20Arms	0.20% Rdg + 0.20% VA Rng + 10µW
Voltage set to x10 mode	0.20% Rdg + 0.20% VA Rng + 2µW
Current set to x10 mode	0.20% Rdg + 0.20% VA Rng + 2µW
Both set to x10 mode	0.20% Rdg + 0.20% VA Rng + 0.4µW
30Arms	0.20% Rdg + 0.20% VA Rng + 30µW
Voltage set to x10 mode	0.20% Rdg + 0.20% VA Rng + 6µW
Current set to x10 mode	0.20% Rdg + 0.20% VA Rng + 6µW
Both set to x10 mode	0.20% Rdg + 0.20% VA Rng + 1.2µW

Common Mode Rejection	
Total Common Mode and Noise effect on current channels	
Applied 250V @ 50Hz	Typical 1mA (150dB)
Applied 100V @ 100kHz	Typical 3mA (130dB)

Total Harmonic Distortion (THD) Accuracy	
$$THD + THD\ Error = \left(\frac{1}{h1 + h1\ error}\right)\sqrt{\sum_{i=2}^{i=n}(hi + hi\ error)^2}$$	
Voltage:	
Hi error (Voltage)	= 0.05% hi Rdg + 0.1% Rng + 0.005% * KHz + 5mV
X10 mode	= 0.05% hi Rdg + 0.1% Rng + 0.01% * KHz + 1mV
Current:	
20A model Hi error (Current)	= 0.05% hi Rdg + 0.1% Rng + 0.005% * KHz + 500μA
X10 mode	= 0.05% hi Rdg + 0.1% Rng + 0.01% * KHz + 100μA
30A model Hi error (Current)	= 0.05% hi Rdg + 0.1% Rng + 0.01% * KHz + 1mA
X10 mode	= 0.05% hi Rdg + 0.1% Rng + 0.01% * KHz +300μA
External Sensor Input Hi error (Voltage)	= 0.05% hi Rdg + 0.1% Rng + 0.005% * KHz +5μA

Datalog	
Functions	Up to 4 measured functions user selectable (60 with free optional PPALog PC software)
Datalog window	From 10ms with no gap between each log
Memory	RAM, up to 16,000 records

General	
Crest factor	Voltage and Current - 20
Sample rate	Real time no gap - 1Ms/s on all channels
Low power accuracy	Compliant with IEC62301/EN50564 using internal shunt Refer to low power measurement application note
Remote operation	Full capability, control and data
Application modes	Ballast Inrush Standby Power

Ports	
RS232	Baud rate to 38400 – RTS/CTS flow control
LAN	10/100 base-T Ethernet auto sensing RJ45
GPIB (Option G)	IEEE488.2 compatible
USB	USB device – 2.0 and 1.1 compatible
Aux	N4L Auxiliary port
Extension	N4L accessory port

Physical	
Display	480 x 272 pixel Colour TFT Display
Size	92H x 215W x 312D mm – excluding feet
Weight	3.3kg – 1 phase - 4kg 3 phase
Safety isolation	1000V rms or DC – category II
Power supply	90-265 rms 50-60Hz 35VA max

Environmental	
Operational temperature range	0°C to +50°C
Storage temperature range	-10°C to +60°C
Relative Humidity range	20 to 95% non-Condensing
Maximum Altitude.	2,000 Metres

Chapter 5 Installing your PPA500

Checking the shipped contents

Carefully unpack your PPA500 and check the packing list that came with your instrument to verify that you have received all standard accessories and ordered items.


Newtons4th Ltd

PPA5510 BLACK SINGLE PHASE POWER ANALYZER PACKING LIST

If any items are missing or damaged, please contact either Newtons4th Head Office or your local Distributor.

Visit http://www.newtons4th.com to find contact details of your nearest distributor.

It is highly advised to retain all the original protective packaging for re-use when you require to return the instrument for calibration or repair purposes to avoid transit damage.

Operational Requirements

The PPA500 is designed to be used within the required operating environment, power, and signal input voltage ranges to provide the most accurate measurements and safe instrument operation.

Environmental and Power Requirements

Characteristic	Description
Storage Temperature	0 ° C to +50 ° C
Operational Temperature	-10 ° C to +60 ° C
Operating Humidity	20% to 95% relative humidity (% RH), Noncondensing.
Altitude	2,000 metres
Power source	voltage 90 V - 265 VAC rms, single phase 35VA

Input

Characteristic	Description
Voltage	
Voltage Internal Ranges	Normal : 1Vpk ~ 2500Vpk (8 ranges = 1V, 3V, 10V, 30V, 100V, 300V, 1KV, 3KV) X10 mode: 100mVpk ~ 300Vpk (8 ranges = 100mV, 300mV, 1V, 3V, 10V, 30V, 100V, 300V) (240Vrms within 300Vpk range, using 20% over range)
Internal Voltage Input Impedance	3Mohm in parallel with 5pF, 90pF common mode to chassis
Internal Voltage Connectors	4mm Safety connector
Voltage External Ranges	1mVpk ~ 3Vpk [BNC Connector 3Vpk Max Input] 8 Ranges = 1mV, 3mV, 10mV, 30mV, 100mV, 300mV, 1V, 3V
External Voltage Input Impedance	1Mohm in parallel with 40pF, 90pF common mode to chassis
External Voltage connectors	Single Safety BNC

Input

Characteristic	Description
Current	
PPA500 20Arms Shunt, 4mm Safety Connectors	Normal: 100mApk ~ 300Apk (8 ranges = 100mA, 300mA, 1A, 3A, 10A, 30A, 100A, 300A) X10 mode: 10mApk ~ 30Apk (8 ranges = 10mA, 30mA, 100mA, 300mA, 1A, 3A, 10A, 30A)
PPA500 30Arms Shunt, 4mm Safety Connectors	Normal: 300mApk ~ 1000Apk (8 ranges =, 300mA, 1A, 3A, 10A, 30A, 100A, 300A, 1000A) X10 mode: 30mApk ~ 100Apk 8 ranges = 30mA, 100mA, 300mA, 1A, 3A, 10A, 30A, 100A)
External Current BNC Input Ranges	1Vpk ~ 3Vpk [BNC Connector 3Vpk Max Input] 8 Ranges = 1mV, 3mV, 10mV, 30mV, 100mV, 300mV, 1V, 3V
External Current connectors	Single Safety BNC

Fitment of the PPA500 Series Carry/Tilt handle

The PPA500 Series Precision Power Analyzer is supplied with a Carry / Tilt Handle that is located within the accessory pack.

The handle allows a user to position the instrument upwards at one of two angles for easier viewing when the instrument is positioned below the line of sight.

The design also allows storage under the unit without obstruction of the rubber feet so that instruments can be stacked and is easily removed to allow the connection of rack mounting brackets without the need to remove instrument covers.

Correct installation of the handle is important to ensure the correct operation and long life the handle.

The following pictures illustrate correct and incorrect handle fitment:

Pic 1

Pic 2

Correct fitting is from the top of the unit as shown in pictures 1 & 2 above.

Pic 3

Pic 4

A correctly fitted handle will havetheN4LNewtons4th’ wording in the correct reading plane when the handle is to the front of the instrument (Pic. 3) Also, a correctly fitted handle will allow storage under the unit (Pic. 4)

Fitting the handle from the bottom of the unit as shown here is wrong, (Pic. 5)

Incorrect fitting can be seen because the handle does not fit correctly under the unit resulting in a gap under the rear feet, and handle sides do not fit flush with the registration washer (Pic. 6)

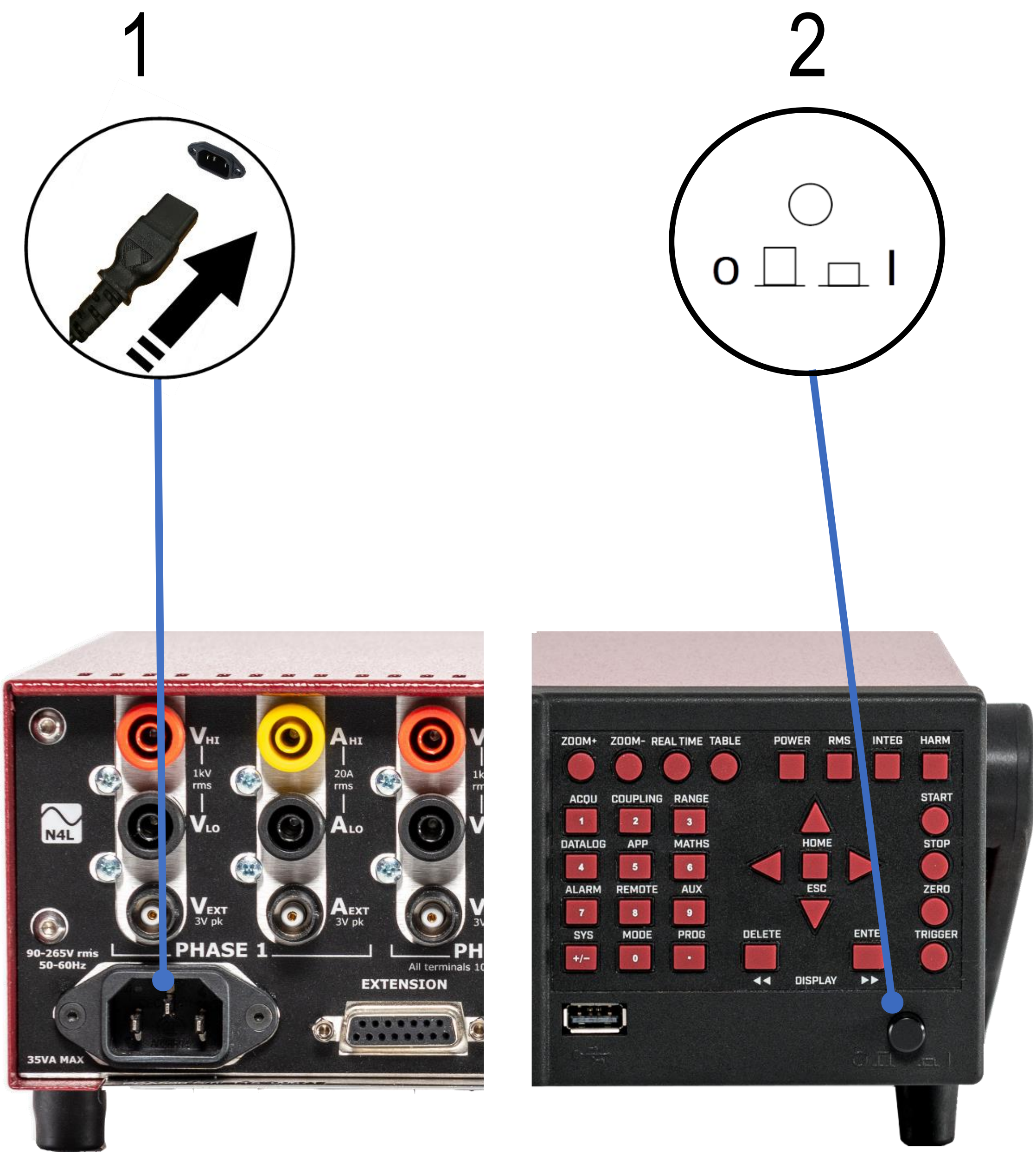
Pic 5

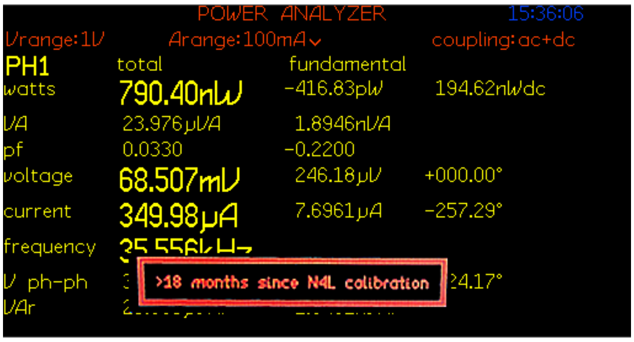
Pic 6

Powering On your PPA500

Step 1 Attach the supplied IEC power lead to the mains recepticle on the rear of the instrument

Step 2 Turn the instrument on using the On/Off switch on the front lower RH corner

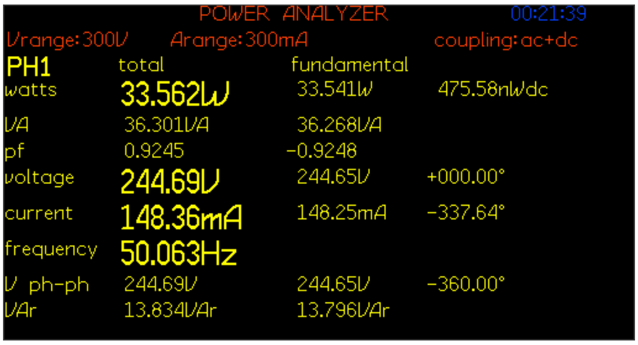




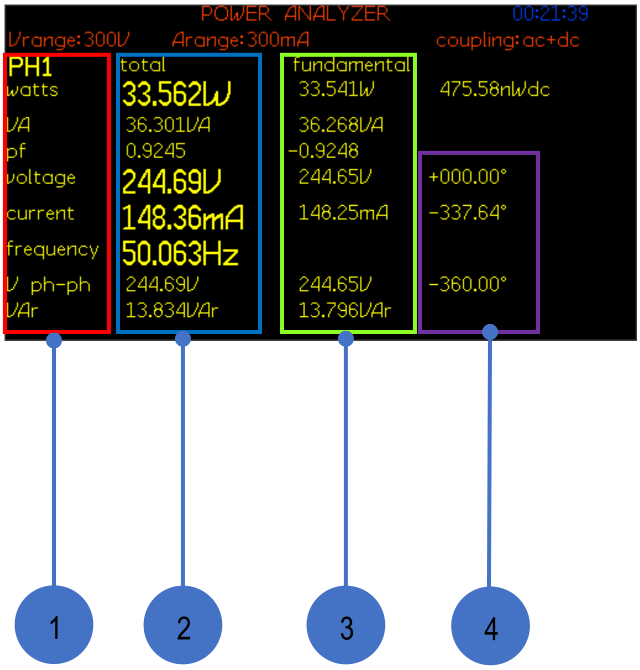
INFORMATION. The message displayed on boot up regarding N4L calibration due date is only accurate if the system clock and date is set correctly, this can be done using CommView2 software. V1.4

The PPA500 is supplied ready to use – it comes complete with an appropriate power lead and the requisite number of sets of test leads (dependent upon model). It is supplied fully calibrated and does not require anything to be done by the user before it can be put into service.

See Checking your PPA500 here



Once powered on, the analyser's factory default settings from memory location 0 will be displayed as shown, note these can be altered to your own desired settings here



Within the Power Analyzer screen you will notice several distinct areas: -

1.Unit of measure and phase being monitored
2.Total measurements
3.Fundamental measurements
4.Phase angle

Total Measurements = Fundamental + Harmonics + Noise

Fundamental = Fundamental Power Measurements (All Distortion Removed)

Each measurement mode is pre-configured to display relevant parameters. Up to 4 measurement functions can be selected and zoomed in so that they are displayed in a larger font size.

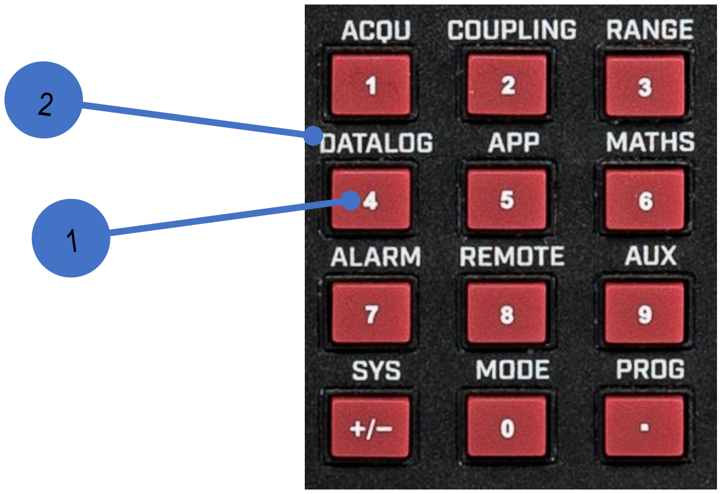
These can be viewed within 3 zoom screens; the Zoom function is described in detail here

Chapter 6 Instrument Layout

Front panel Controls

The front panel has keys for controlling the instrument, the colour LCD screen, a front USB connector and ON/OFF switch.

The display and controls are arranged into logical groupings, each item/group of controls is explained below.

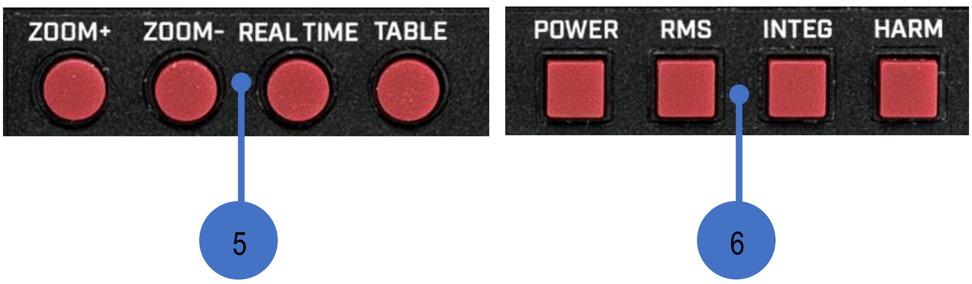


1. Primary numeric function, the key will display “4” or “G” when entering numerals and text in a menu option.
2. Secondary function, the key will open the DATALOG menu screen

Screen & other controls

3. Main results display, the contents of this area are context sensitive to the type of instrument MODE selected. In the screen shown above each column of results refers to the phase noted at the top of the column.
4. USB & Power switch. The USB port is used for storing or recalling results, programs, and screen shots to a USB drive. The main push key power switch is below the USB

Top row display & application control keys



5. Display control keys, this group of keys allows the user to select and highlight up to four parameters, return the screen to real time measurements, switch between tabular and graphical displays, & hold/release the real time readings.

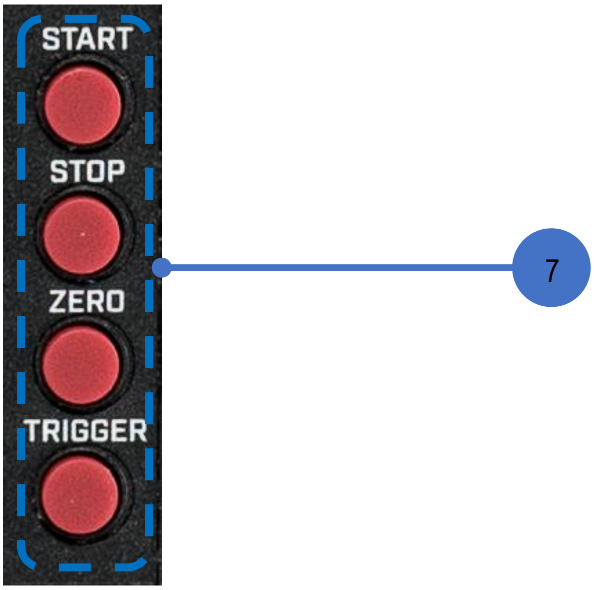
Data Hold

When in real time display mode, the data on the display can be held at any time by pressing the *REAL TIME* key. When *HOLD* is activated the word, ***HOLD*** flashes in the top right hand corner of the display as shown above in a magnified view of the top right corner of the screen.

Press the *REAL TIME* key again or the *HOME* or *START* key to release ***HOLD***; in this case, *HOME* and *START* keys do not have their normal functions. Changing mode also releases the hold function.

When *HOLD* has been activated, the DSP continues to sample, compute, and filter the results but the data is ignored by the CPU. When *HOLD* is released, the display is updated with the next available value from the DSP.

6. Application mode direct access keys, the POWER, HARM, RMS, & SCOPE keys allow direct one key access to the appropriate application menus for setting up the instrument. They also provide the SI unit prefix multipliers when entering numeric values.



7. Action keys, this group of keys are used to start and stop Dataloging, take screen shots to the USB stick, release the instrument from HOLD, & for Zero compensation.

Zero compensation

There are 2 levels of zero compensation:

Trim out the DC offset in the input amplifier chain.

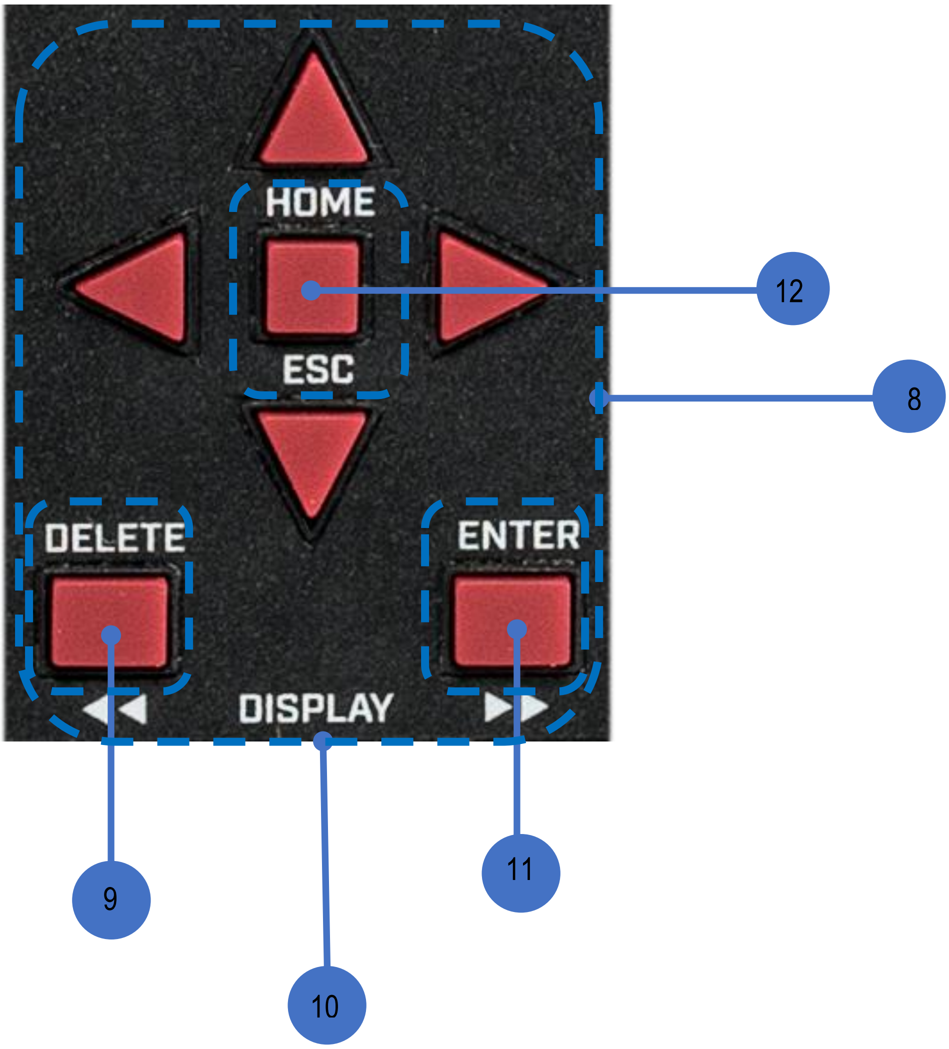
Measure any remaining offset and compensate.

The trim of the DC offset in the input amplifier chain can be manually invoked with the *ZERO* key, or over the RS232 with the ***REZERO*** command. This DC offset trim measures the DC present while the autozero switch is active and applies an equal and opposite offset via a D/A converter so that the input range to the A/D is optimised.

The measurement of the remaining offset also happens when the offset is trimmed but is also repeated at regular intervals. This is to compensate for any thermal drift in the amplifier chain. The remaining DC offset is precisely measured and stored so that the measurements can be compensated by an appropriate algorithm in the instrument firmware.

Real time measurement is not possible while the autozero measurement is in progress so this repeated autozero function can be disabled via the SYSTEM OPTIONS menu.

Navigation keys



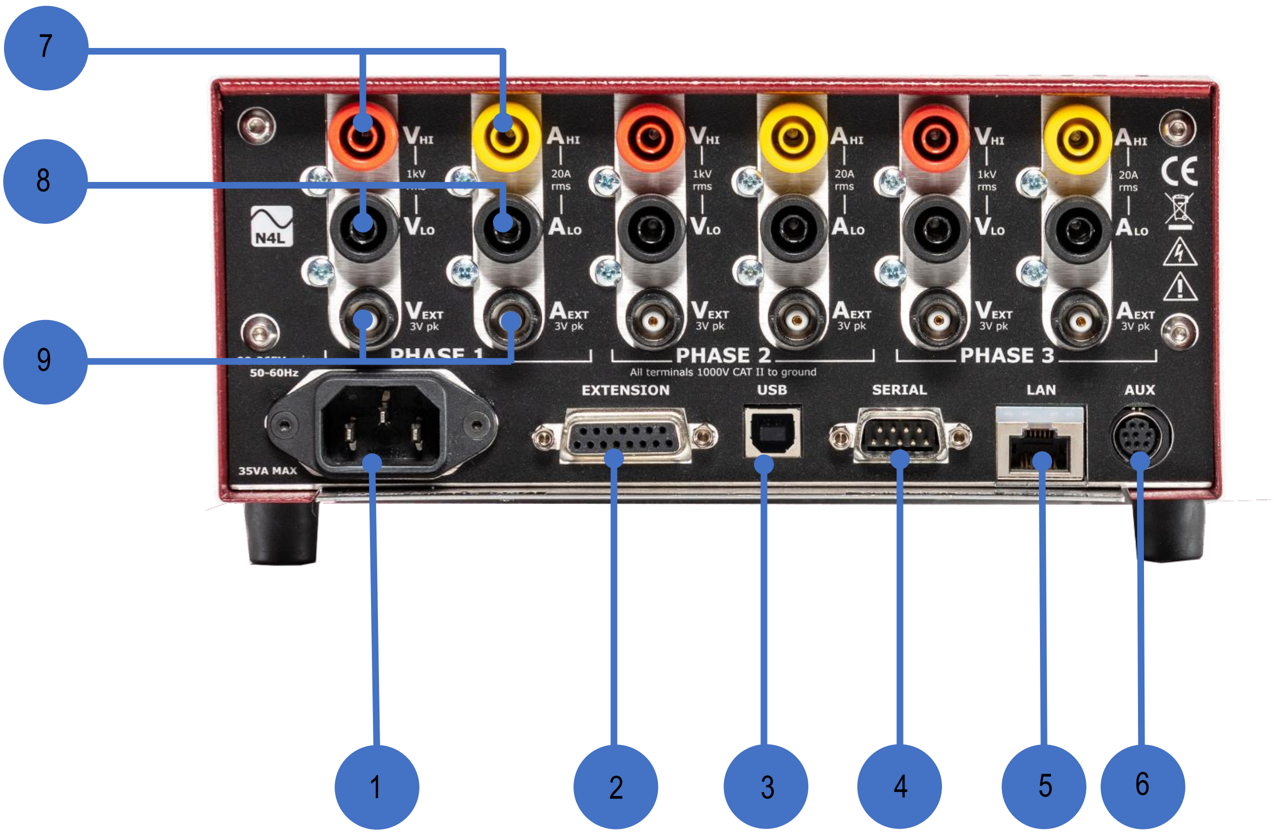
8. Menu navigation keys, the four directional arrow keys are multi-purpose, their main function is to navigate the menu options and drop down choices, in scope mode they are used to control cursors and time-base / measurement per division respectively.

9. Back/Delete key, this dual use key is used to edit alphanumeric entries and also to navigate between screens that have additional sub screens.

10. Home/ESC key, this dual use key will enable the user to return to the selected application start screen once it has been adjusted or will escape from any screen view and return to the selected application home screen.

11. Enter/Next key, this dual use key is used to confirm an entry or selection and to navigate between screens that have additional sub screens.

Rear panel connectors



1. IEC 60320 C13 mains inlet socket
2. Extension connection port via 15 way D-Sub connector.
3. Female USB 2.0 Type B socket for communication.
4. RS232 communication port, 9 pin D-Sub.
5. LAN / Ethernet port.
6. Auxiliary connection port.
7. Hi internal current & voltage input connections, 1, 2 or 3 channel dependent on model, connections are via 4mm safety plugs.
8. Lo internal current & voltage input connections, 1, 2 or 3 channel dependent on model, connections are via 4mm safety plugs. external connection via safety BNC connector.
9. External voltage and current connections, 1, 2, or 3 channel dependent on model, external connection via safety BNC connector.

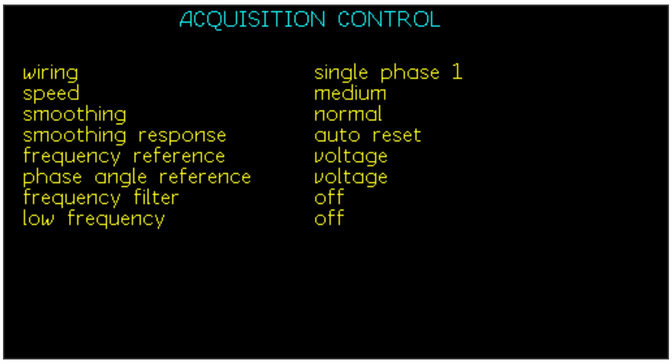
⚠ **WARNING.** The BNC safety connections (Item 9), A_{EXT} & V_{EXT} must be connected with touch proof safety BNC leads as these can carry dangerous levels of current.

Chapter 7 PPA500 Numeric key functions

Key & Sub Categories	Description
ACQU **Wiring:**	Acquisition Control: Used for configuring inputs appropriate to source and nature of signals being analyzed
Single Phase 1	In single phase 1 configuration, (phase 2 & phase 3) inputs are disabled and the selected phase acts as a completely independent single phase power analyzer
2 Phase 2 Wattmeter	In the 2 phase 2 wattmeter configuration, the voltages are measured relative to each individual phase input, with a single frequency reference selected within the frequency reference parameter
3 Phase 2 Wattmeter	In the 3 phase 2 wattmeter configurations, the voltages are measured relative to phase 3. Typically, the phase 1 voltage input is connected across phase 1 and phase 3, and phase 2 voltage input is connected across phase 2 and phase 3, thus measuring phase to phase voltage directly. Phase 1 and 2 current inputs are connected normally. There is no need to measure the current in phase 3 as phase 3 has no voltage relative to itself so the power contribution is zero. In this mode, the neutral channel displays the synthesized phase 3 current. The advantage of this connection method is that 3 phase power can be measured with only 2 wattmeters
3 Phase 3 Wattmeter	With the 3 phase 3 wattmeter configuration, each measurement phase is connected to a phase of the load with the voltage low inputs measuring to neutral. In this mode, phase to neutral voltages are measured directly and phase to phase voltages are also computed
Single Phase 2	In single phase 2 mode, (phase 1 & phase 3) inputs are disabled and the selected phase acts as a completely independent single phase power analyzer
Single Phase 3	In single phase 3 mode, (phase 1 & phase 2) inputs are disabled and the selected phase acts as a completely independent single phase power analyzer
3 Phase 2 Wattmeter + PH3	As above (3 phase, 2 wattmeter) but with the option to use PH3 as an independent meter i.e., use PH3 to measure a DC bus plus phase's 2 & 3 to measure a 3 phase inverter output. PH3 can be set as an additional connection for Torque & Speed to supplement the existing "EXT" BNC connections on the rear panel. This mode essentially facilitates independent frequency synchronisation of PH3
Single phase 1 + PH2	In this mode each phase can be selected as an individual analyzer enabling the ability to select its own frequency, coupling ranging etc.

Speed	In normal acquisition mode the window over which the measurements are computed is adjusted to give an integral number of cycles of the input waveform. The results from each window are passed through a smoothing filter. There are 5 pre-set speed options that adjust the nominal size of the window, and therefore the update rate and time constant of the filter. Greater stability is achieved at a slower speed at the expense of a slower update rate
Very Slow	Update rate = 10s. Results window size will update every 10 seconds
Slow	Update rate = 2.5s. Results window size will update every 2.5 seconds
Medium	Update rate = 1/3s. Results window size will update 3 times per second
Fast	Update rate = 1/20s. Results window size will update 20 times per second
Very Fast	Update rate = 1/80s. Results window size will update 80 times per second
Window	The window application will allow the user to input their own speed settings different to any of the 5 pre-set settings above
Smoothing	Smoothing filter will gather the data and average out over a sliding window time scale. This is very useful when gathering data which could be affected by noise. Each speed above has its own time constant for filtering and data updates
Normal	With Normal smoothing applied the following update windows will apply to the relevant speed selected. V.Fast =0.05s, Fast = 0.2s, Medium = 1.5s, Slow = 12s, V.Slow = 48s
Slow	With Slow smoothing selected all results are X4 greater than in normal smoothing mode
None	With no smoothing to computed results the data update will be dictated by the speed only
Smoothing Response	
Auto Reset	The smoothing response is by default set to “auto reset” where the filtering described in “smoothing” is reset in response to a significant change in data such as frequency, voltage, and current levels. This speeds up the response of the instrument to changing conditions
Fixed Time	Auto reset can be disabled so that the filtering has a fixed time constant, which would have an exponential response to a step change, this is useful for PWM inverter drive evaluation where variable frequency tracking is required

Speed and Smoothing



Within this section we look at how the speed and smoothing parameters are set within the Acquisition menu affect the measurement results

NOTE: All measurement windows must have an integral number of cycles within them to calculate correct RMS and Harmonics

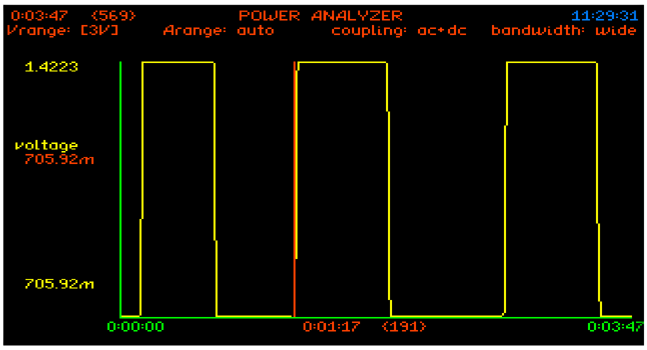
Input = 50Hz Sine Wave

Amplitude = 1Vpk & 2Vpk range

The first sets of results are from a Datalog conducted with NO smoothing selected, therefore the data update will be dictated by the speed parameter only.

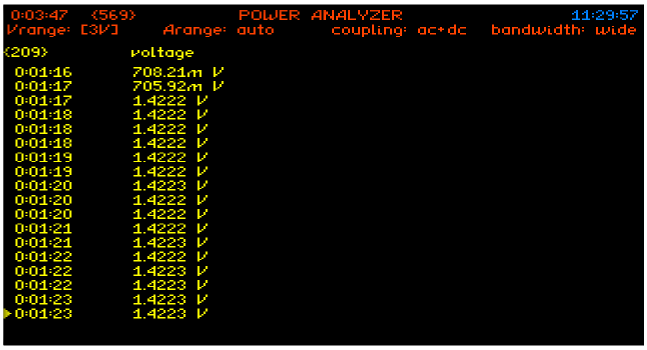
Speed set to medium = 3 updates per second

50Hz input signal = 50 cycles worth of data points per second recorded, analyzed, adjusted, and displayed within 3 update windows

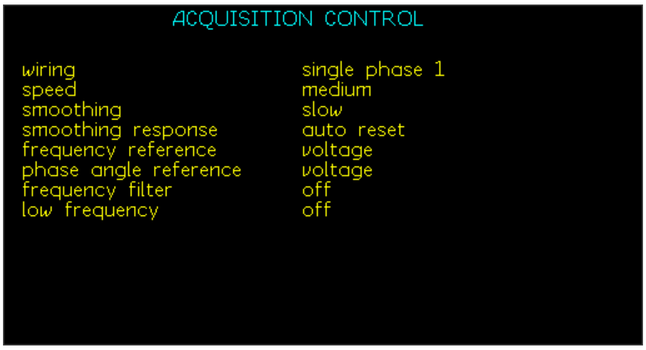


Displayed left is the graph showing the Datalog results with no smoothing present and the input amplitude switching between 1Vpk and 2Vpk from this graph as soon as the amplitude is increased or decreased then the next available update will show this change

The table of results displayed are in relation to the previous graph; and we can see that the voltage step is immediately recorded after 0:01:17


0:03:47 (569) POWER ANALYZER 11:29:57
Vrange: [3V] Arange: auto coupling: ac+dc bandwidth: wide

(209)	voltage
0:01:16	708.21m V
0:01:17	705.92m V
0:01:17	1.4222 V
0:01:18	1.4222 V
0:01:18	1.4222 V
0:01:18	1.4222 V
0:01:19	1.4222 V
0:01:19	1.4222 V
0:01:20	1.4223 V
0:01:20	1.4222 V
0:01:20	1.4222 V
0:01:21	1.4222 V
0:01:21	1.4223 V
0:01:22	1.4222 V
0:01:22	1.4223 V
0:01:22	1.4223 V
0:01:23	1.4223 V
0:01:23	1.4223 V



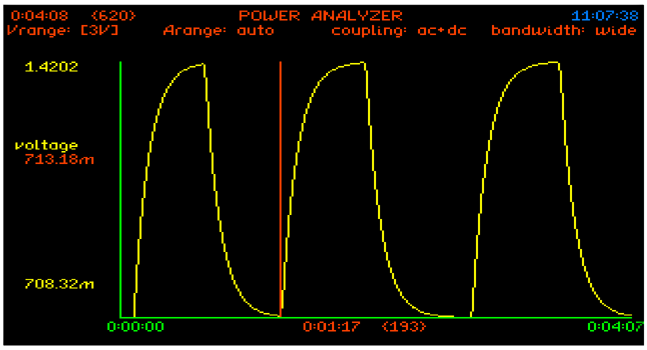
This next sets of screenshots are for the same set up, but with smoothing activated

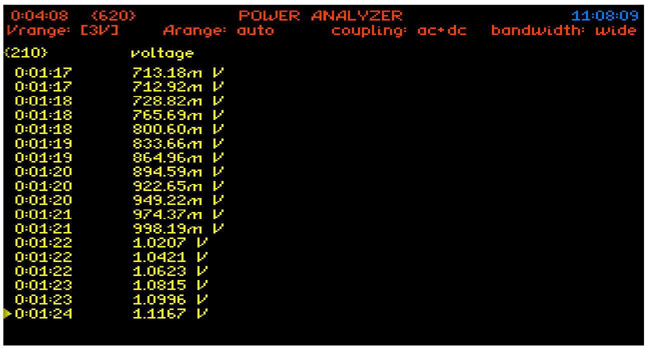
Selecting smoothing will take the data and apply the equivalent of a single pole low pass filter with an RC time constant relative to the selection mode dependent upon the speed selected

We have selected ***slow smoothing*** with a medium speed giving us a sliding window of 48 seconds

Smoothing response can be set to ***Auto Reset*** where the instrument will reset the filtering in response to any significant change in data

Fixed Time can be selected to correspond with the speed and smoothing parameters and will override ***auto-reset*** so that the smoothing is not reset when the frequency changes etc





The resulting graph and results table with smoothing applied are displayed above.

The displays above show how with smoothing applied, the data is smoothed out over the resultant timescale and displaying an intermediate value for every update window during the step between the two peak voltage values

Note: each speed parameter has its own time constant for smoothing and data updates as shown in the table below

Speed	**Update Rate: (speed only)**	**Normal Smoothing: applicable to relevant speed**	**Slow Smoothing: applicable to relevant speed**
Very Slow	10s	48s	196s
Slow	2.5s	12s	48s
Medium	0.333s	1.5s	6s
Fast	0.05s	0.2s	0.8s
Very Fast	0.0125s	0.05s	0.2s
Window	Manually Input speed setting different to 5 pre-selected one’s above		

Frequency Reference	The frequency may be measured from any of the following inputs:
Voltage	Select Voltage to detect frequency from the input voltage
Current	Select Current to detect frequency from the input current
Frequency Reference	On a multi-phase instrument, any Phase may be selected for the frequency measurement, the number of phases available will change dynamically dependant on the wiring option selected.
Phase 1	Select this option to detect frequency from phase 1
Phase 2	Select this option to detect frequency from phase 2
Phase 3	Select this option to detect frequency from phase 3
Phase Angle Reference	Phase angle measurements must be made with reference to a specific input
Voltage	Phase 1 voltage is by default set as the input reference
Current	The phase angle reference can be set to current which is useful if operating the instrument with only current inputs, or with low level voltage inputs

Frequency Filter	A parallel digital frequency filter of low-pass may be selected to filter out the HF carrier component of a PWM waveform ensuring measurements are carried out on the fundamental frequency.
Off	No frequency filter selected
Fundamental > 1kHz	Sets filter for fundamental frequencies above 1kHz
Fundamental < 1kHz	Sets filter for fundamental frequencies below 1kHz
Low Frequency	Normal frequency measurement is from 5Hz upwards so that there is not a very long delay if measuring DC. There is a low frequency option that extends the frequency measurement down to 20mHz. This low frequency option also applies a digital filter, which can be useful when measuring in a low frequency, noisy environment
Off	Select to switch this mode off
On	Select to switch this mode on

ADVANCED OPTIONS	
DFT Selectivity	Analysis of the fundamental component uses a DFT (Discrete Fourier Transform) algorithm. The selectivity of the DFT analysis is a compromise between noise rejection of frequencies close to the frequency of the fundamental component and the required stability of the frequency component
Normal	Default settings for the fundamental calculations
Narrow	Selecting "narrow" increases the selectivity of the DFT analysis (reducing the effective bandwidth at each component) which has the effect of improving the noise rejection. It does however require that the frequency of the fundamental component is more stable
Ignore Overload	In a noisy application any spikes present on the signal may push the instrument onto a higher range than is necessary for the signal being measured. If the nature of the spurious spikes is such that they do not contribute to the measurement and can safely be ignored, then the range can be manually set to the appropriate range for the signal to be measured and the instrument can be told to ignore any overload. If using this mode, it is wise to check the signal on the oscilloscope to be sure that the signal being measured is not genuinely over range
Off	Select to switch this mode off
On	Select to switch this mode on
Frequency Lock	In a very noisy application, where the frequency of the signal is known but the instrument is unable to measure the frequency even with filters or low frequency mode filters applied, it is possible to manually enter the frequency to be used for analysis
Normal	Utilises N4L unique signal processing techniques for fundamental frequency synchronisation including hysteresis to increase frequency noise immunity
Constant	Constant selection will allow the user to overwrite the present measured frequency with the known frequency. This entered frequency is then used for all the analysis and the frequency of the input signal is not measured
Dynamic	As per "Normal" without hysteresis. This option should not be used when DC only coupling is selected in the Coupling menu.
Watts	
Signed	Result assigned as +ve or -ve
Absolute	Magnitude of result only

Normalise Reference	Selecting the Normalise Reference function adjusts the scale factors on each current channel so that they read the same as phase 1. The reference can be either the current measured on phase 1 or if there is a reference CT it can be connected to the external input of phase 1 voltage and used as a reference.
Disabled	Normalise function is disabled
Voltage	Selecting the Normalise voltage reference function adjusts the scale factors on each voltage channel so that they read the same as phase 1.

Current	Selecting the Normalise current reference function adjusts the scale factors on each current channel so that they read the same as phase 1. The reference can be either the current measured on phase 1 or if there is a reference CT it can be connected to the external input of phase 1 voltage and used as a reference.

COUPLING

Coupling	There are three coupling options - AC only, AC+DC, or DC only. AC+DC coupling is the default option and should be used where possible. AC coupling should be used for measuring signals that are biased on a DC level (such as an amplifier operating on a single supply or the output of a DC PSU). DC coupling should be selected when making DC measurements as it prevents noise from resetting the frequency measurement algorithm. The coupling option does not affect the bandwidth of the instrument only the frequency detection.
ac + dc	Will allow both AC and DC signals to be calculated in all measurements
ac	AC Coupling only allows AC signals to be measured and will filter out all AC components
dc	DC coupling should be selected when making DC measurements as it prevents noise from resetting the frequency measurement algorithm, the bandwidth of the instrument is not affected. When DC coupling is selected “Dynamic” Frequency lock has no meaning and so should not be used.

Noise Filter	In signal processing, a “FILTER” is a device or process that removes from a signal some unwanted component or feature. The noise filter is a digitally selectable in line filter which will alter the bandwidth of the processed signal
Off	Select to switch this mode off
On	Select to switch this mode on

RANGE	Input channel options
Voltage Input	
Internal	The internal voltage attenuator selects the 4mm connections on the rear of the instrument and has a max input of 3000Vpk
External Attenuator (For connection to a HF shunt etc.)	An External Sensor / Shunt can be connected to the instrument which will give the operator more versatility in selecting the Input range required. Note: if this option is selected then the resulting data is scaled by the appropriate value within the attenuator and scale factor sub section. Max input of 3Vpk

CAUTION. This applies to both Voltage and Current connections
Input Connections: It is critical that the 4mm inputs and BNC inputs on each PPA input channel are not connected to any external circuit at the same time.

You **MUST** only use **EITHER** the 4mm **OR** the **BNC** connection – **NOT** both, this applies to both Voltage and Current inputs.

Autoranging	
Full Autorange	Default setting. Full autoranging will be selected and implemented within the instrument
Range up only	Selecting this option will allow the test being carried out to find the highest range via peak detection and hold on this range. Once this value has been found another test can be carried out by pressing the "Trigger" button which will restart from the minimum value for the set parameter used for "Low" Frequency measurements
Manual	Selecting this option will allow the user to set up the range from the configured measurements available, this is useful for inrush testing when a mid-analysis range change is not desirable
Minimum Range	Pre-set Input Voltage minimum range
1V	Minimum Input Voltage range will not be below 1v
3V	Minimum Input Voltage range will not be below 3v
10V	Minimum Input Voltage range will not be below 10v
30V	Minimum Input Voltage range will not be below 30v
100V	Minimum Input Voltage range will not be below 100v
300V	Minimum Input Voltage range will not be below 300v
1kV	Minimum Input Voltage range will not be below 1Kv
3kV	Minimum Input Voltage range will not be below 3Kv
Scale Factor	Manually set the scale factor required, normally used in conjunction with current transformers
Current Input	
Internal	The internal current shunt selects the 4mm connections on the rear of the instrument. Max Apk is dependent upon model type; LC (10A rms), Standard (30A rms) or HC (50Arms)
External Shunt	An External Shunt can be connected to the instrument which will give the operator more versatility in selecting the Input range required. Note: if this option is selected then the resulting data is scaled by the appropriate value within the scale factor and shunt value sub section

Autoranging	
Full Autorange	Default setting. Full autoranging will be selected and implemented within the instrument
Range up only	Selecting this option will allow the test being carried out to find the highest range via peak detection and hold on this range. Once this value has been found another test can be carried out by pressing the *TRIGGER* key which will restart from the minimum value set parameter
Manual	Selecting this option will allow the user to set up the minimum range from the configured measurements available
Minimum Range	Pre-set current input minimum range
100mA SC Version only	Minimum Input Current range will not be below 100mA
300mA SC, HC Versions	Minimum Input Current range will not be below 300mA
1A SC, HC Versions	Minimum Input Current range will not be below 1A
3A SC, HC Versions	Minimum Input Current range will not be below 3A
10A SC, HC Versions	Minimum Input Current range will not be below 10A
30A SC, HC Versions	Minimum Input Current range will not be below 30A
100A SC, HC Versions	Minimum Input Current range will not be below 100A
300A SC, HC Versions	Minimum Input Current range will not be below 300A
1000A HC Version only	Minimum Input Current range will not be below 1000A
Scale Factor	Manually set the scale factor required

DATALOG	
Datalog	Interrogation and extraction of information resulting from a test log in a specified time scale and at a set speed
Disabled	No memory selected
RAM	Instruments internal memory selected for data storage; this offers the fastest performance
USB memory stick	External USB memory stick selected for data storage

APP	
Mode	Application function to be selected
Normal	Using the Normal Application, the default settings within the instrument will be applied to all measurements, useful for general measurements
Default Settings	All default parameters will be selected when *ENTER* is pressed

Lighting Ballast	Electronic lighting ballast waveforms consist of a high frequency carrier signal modulated by the line frequency. The instrument measures the line frequency independently of the input waveform frequency and synchronises the measurement period to the line frequency. The carrier frequency measurement ignores any "dead band" around the zero crossing of the ac line to compute the actual switching frequency of the ballast. Both the frequency measured on the input waveform and the frequency of the line input are displayed, the output of the ballast should always be connected to Phase 1
Default Settings	All default parameters will be selected when *ENTER* is pressed
AC Line	Numerical field for line frequency setting
Frequency Tracking	Selectable tracking speed from drop down menu
Efficiency	Efficiency can be measured between selected channels from the drop down menu. disabled, phase/next phase, next phase/phase, phase 3/sum, & sum/phase 3
Inrush Current	Inrush current (surge) requires very fast sampling to catch the highest instantaneous value. Measurements must be made under conditions of manual ranging and with the voltage applied to the instrument. Then when the load is switched on the highest peak value can be detected. If the peak current is unknown then a minimum of two tests should be performed, one to set the range and a second test to capture the inrush current
Default Settings	All default parameters will be selected when *ENTER* is pressed
Minimum Range	Select the minimum current range applicable from the drop down menu
Auxiliary Device	Allows PCIS inrush switch to be used for measurement of Inrush Current. If selected phase offset and waveform cycle for results will require setting Swich phase offset is and the switch on cycle is selectable from continuous, half cycle & full cycle.
Switch Phase Offset	Selectable in 45º steps from 0º to 315º
Switch on Cycle	Continuous, half cycle, full cycle
Standby Power	To minimise standby power, some devices operate in a “dormant” mode whereby power is only drawn from the supply when needed. These devices draw very little current for most of the time and then draw a larger current for a single cycle to charge a reservoir capacitor. This pattern is repeated on an irregular basis. Most of the power consumed by devices in this mode is taken in the periodic higher current cycles so to accurately measure the power drawn by these devices, the instrument synchronises to the power frequency for the analysis but extends the measurement window to the irregular period of higher energy pulses. Because the instrument samples in true real time without any gaps, no data is missed, and every power cycle is captured. It is important that ranging is set to manual or up only autoranging so that the power cycles are not missed while ranging
Default Settings	All default parameters will be selected when “ENTER” is pressed
Low Frequency	Select “On” or “Off” if low frequency filter is required

Calibration	This mode is used when calibrating the instrument with N4L software
Default AC Settings	Select to calibrate AC
Default DC Settings	Select to calibrate DC
Frequency Filter	Frequency synchronisation for calibration gives more accuracy at low levels, applies to AC only
	Off
	Fundamental > 1kHz
	Fundamental < 1kHz

MATHS	
Formula	
Disabled	No maths formula is selected
(term1 + term2) / (term3 + term4)	Sum of (term1 + term2) divided by sum of (term3 + term4)
(term1 + term2) x (term3 / term4)	Sum of (term1 + term2) multiplied by sum of (term3 ÷ term4)
(term1 x term2) / (term3 + term4)	Sum of (term1 x term2) divided by sum of (term3 + term4)

Note: Selection of "TERMS" is via the zoom order selections here

ALARM	
Alarm 1 Data	Alarm on selected parameter and thresholds
Zoom 1	Zoom 1 parameter selected for alarm threshold
Zoom 2	Zoom 2 parameter selected for alarm threshold
Zoom 3	Zoom 3 parameter selected for alarm threshold
Zoom 4	Zoom 4 parameter selected for alarm threshold
Alarm Type (Alarm 1)	
Disabled	No alarm
Linear	Frequency of beep increases linearly as value reaches its limit
Alarm if high	Alarm will sound if values exceed a threshold
Alarm if low	Alarm will sound if values fall below a threshold
Outside window	Alarm will sound if values are outside a permitted window setting
Inside window	Alarm will sound if values are within a permitted window setting
High Threshold	Numerical value
Low Threshold	Numerical value
Alarm 2 Data	Alarm on selected parameter and thresholds
Zoom 1	Zoom 1 parameter selected for alarm threshold
Zoom 2	Zoom 2 parameter selected for alarm threshold
Zoom 3	Zoom 3 parameter selected for alarm threshold
Zoom 4	Zoom 4 parameter selected for alarm threshold
Alarm Type (Alarm 2)	
Disabled	No alarm
Alarm if high	Alarm will sound if values exceed a threshold
Alarm if low	Alarm will sound if values fall below a threshold
Outside window	Alarm will sound if values are outside a permitted window setting
Inside window	Alarm will sound if values are within a permitted window setting
High Threshold	Numerical value
Low Threshold	Numerical value

Alarm Function

The PPA500 has two independent alarms that can be read remotely or can generate an audible sound. Each of the alarms can be triggered by comparison to one or two thresholds:

sound the alarm if the value exceeds a threshold

sound the alarm if the value is below a threshold

sound the alarm if the value is outside a threshold window

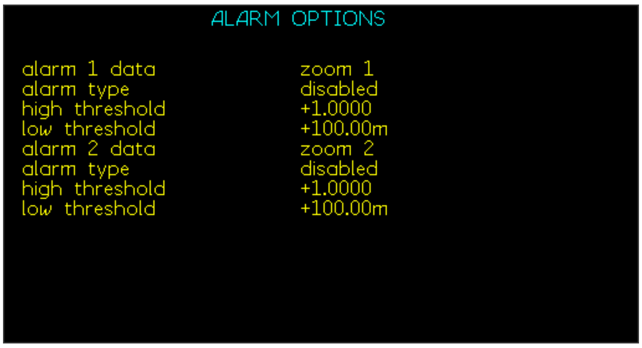
sound the alarm if the value is inside a threshold window

Additionally, one of the alarms (alarm 1) can be used to generate a sound which varies linearly between two user defined thresholds.

The value to which each alarm is applied can be any of the measurement parameters selected for zoom here

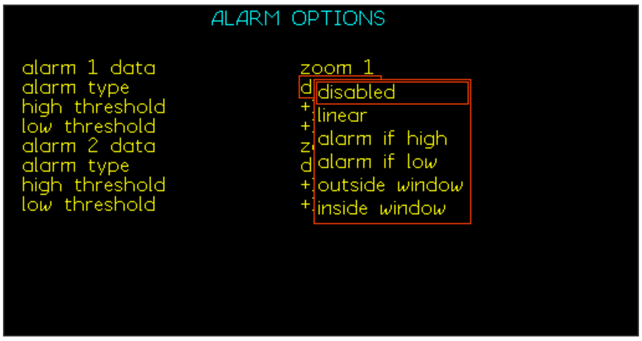
The *ALARM* menu screen shown below

alarm 1 data - is the first alarm, this can be linked to any of the measured parameters that have been defined by the zoom function, designated zoom 1 → zoom 4



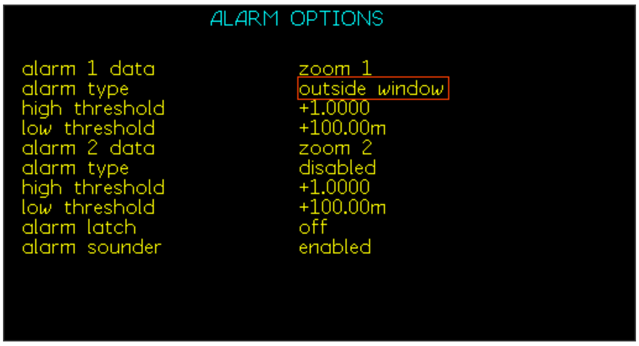
To program an alarm, first select the functions for the zoom; up to four measurements can be selected for the display, the alarm can be applied to any of them; then press *ALARM* to invoke the ***alarm options*** menu

Select which of the zoom functions is to be used, then select the type of alarm from the five choices displayed in the drop down list.



The **alarm type** sets up the way the thresholds are treated, enabling the user to set the upper and lower thresholds, both when set to one of the windows or to the linear option. Depending on the selection either one or two thresholds will be displayed for setting to the desired value.

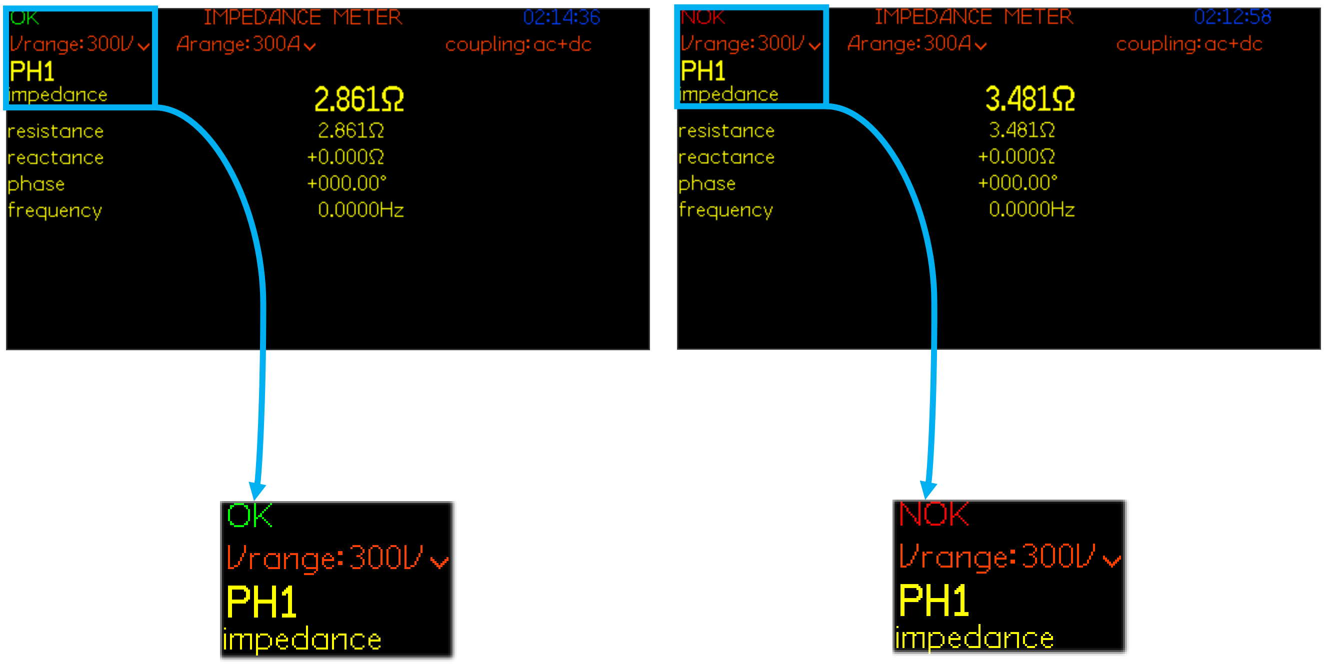
i.e., if ***alarm if high*** is chosen then the high threshold is displayed, conversely when ***alarm if low*** is chosen then the low threshold is displayed. If a ***linear, inside window*** or ***outside window*** option is chosen, then both the high and low thresholds will be displayed.



In this case ***outside window*** has been selected which then displays additional fields to be edited that are appropriate for the choice made. With both this and ***inside window*** the high and low threshold limits are displayed and editable rather than just the high or low threshold when ***alarm if high*** or ***alarm if low*** are chosen.

If ***alarm latch*** is set to ***ON*** the alarm will continue to sound even if the value being monitored returns to a value outside the set threshold(s).

If ***alarm sounder*** is ***enabled***, when triggered the alarm causes both an audible bleep and the OK in green at the top left of the screen changes to NOK in red, see below.
To clear the alarm, press *HOME*.
In the example shown below, Impedance is set as zoom1, with the value set to 3.000Ω



If the alarm latch is selected, then both alarms will continue to sound even if the value returns to within the normal boundaries. To clear the alarm, press *HOME*.

The alarm latch can also be set to *HOLD* the data so that an event can be captured. The data on the screen will be the measurement that first triggered the alarm condition.

The ***linear alarm*** option allows tests to be carried out even if it is not possible to see the display. Pressing *ZERO* in the alarm menu sets the upper and lower threshold to 4/3 and and 1/3 of the measured value respectively. The repetition rate of the sounder then varies linearly as the value changes between these thresholds.

REMOTE	
Resolution	Press to set the data resolution and change the format to which the instrument responds to future commands, via Comms interface
Normal	Data Resolution set to 5 decimal points
High	Data Resolution set to 6 decimal points
Binary	Data transmitted in Binary Format
Interface	Communications type between instrument and pc
RS232	RS232 Comms interface
USB	USB Comms interface
LAN	LAN Comms interface
GPIB	GPIB Comms interface
Recall with Program	When enabled recalls communication port settings from any stored memory location
Off	Turn OFF this option
On	Turn ON this option
Screen Print	
Disabled	No Screen print option selected
RS232	Print screen via RS232 Cable i.e., to printer
USB Memory Stick	Print screen directly onto USB memory stick

⚠ **INFORMATION.** It is advisable to only use USB sticks of 2Gb or smaller capacity.

AUX	
Auxiliary Device	
None	No Auxiliary device connected
PCIS Inrush Switch	Phase Controlled Inrush Switch – is an active device which is controlled over the extension port within the instrument
Switch Phase Offset	Selectable in 45º steps from 0º to 315º
Switch on Cycle	Continuous, half cycle, full cycle
Switch Input	Not currently used
External System Scaling	
Disabled	External System Scaling is not selected
Enabled	Enable External System Scaling and recall calibration Adjustment settings etc

SYS	
Set Clock	Clock is set with CommView2 software
Set Date	Date is set with CommView2 software
Brightness	
Low	Screen brightness set to Low
High	Screen brightness set to High
Phase Convention	Measurements of Phase can be expressed in one of three formats:
-180º to +180º	Commonly used in circuit analysis
0º to -360º	Commonly used in power applications
0º to +360º	Select as required
Phase Angle Reference	
Cosine	
Sine	

Keyboard Beep	Audible sound when keys are pressed
Disabled	Audible sound disabled
Enabled	Audible sound activated
Autozero	
Autozero	Periodically re-zero's input to prevent drift, useful for long periods of DC analysis
Manual	Unit will only zero inputs if "Zero" is pressed by user
Program 1-4 Direct Load	Program 1-4 may be recalled with a direct press of the function keys (POWER, HARM etc)
Disabled	Function will be disabled
Enabled	Function will be enabled
Zoom 2 High Resolution	The data displayed in zoom 2 may be displayed to one digit greater resolution than normal, this is particularly useful when measuring phase at power line frequencies
Disabled	Function will be disabled
Enabled	Function will be enabled
Independent Ranging	This allows the user to set different scale factors and select independently internal / external shunts separately on each phase
Disabled	Function will be disabled
Enabled	Function will be enabled
Low Value Blanking	Low value blanking will zero to display values under the following conditions Input Signal Peak < 45% of RNG 1 < 25% of RNG 2 < 15% of all other ranges
Disabled	Function will be disabled
Enabled	Function will be enabled

◄ System Information	The information given in this section cannot be changed by the user
Serial Number	Instruments unique serial number
Manufacturing Code	Code attributed to build date of instrument
Main Release	Current firmware release installed in instrument
DSP Release	Digital Signal Processing release version
FPGA Release	Field Programmable Gate Array release version
Boot Release	Release version of Instruments boot up firmware
Last N4L Calibration	Instruments last calibration date

► User Data	
Supervisor Access	Enable or Disable (not currently supported)
User Data	Manually enter company name
User Data	Manually enter individual or company
User Data	Manually enter unique ID for instrument
Save	Save all above settings

MODE	Each mode selection reveals a subset of settings appropriate to the selected mode
True RMS Voltmeter *	When selected, RMS voltmeter mode displays default secondary parameters, the same effect is achieved by pressing the RMS quick access key.
Phase meter	The phase meter mode is a secondary function which does not have a separate key. The phase meter uses the terminology of channel 1 for voltage and channel 2 for current as it is normal to use a phase meter to compare voltages directly. The phase meter measures the phase and gain of channel 2 relative to channel 1 using a Discrete Fourier Transform (DFT) algorithm at the fundamental frequency
Speed	The same options as in the ACQU menu
Smoothing	The same options as in the ACQU menu
Smoothing Response	The same options as in the ACQU menu
Computation	Ch1 / Ch2 or Ch2/Ch1
Power Analyzer *	In the POWER mode, the analyzer measures power values for each phase, this is the equivalent of the POWER quick access key.
Impedance Meter	The IMP mode on the PPA is a secondary function that can only be accessed via the MODE menu, it uses the real and imaginary components at the fundamental frequency using DFT analysis to compute the impedance of the load and associated parameters
Power Integrator	In the INTEG mode, the PPA will compute additional power values within a Datalog and display them relative to time (total power)
Harmonic Analyzer *	The HARM mode of the PPA computes multiple DFTs on the input waveforms in real time. There are two modes of operation: difference THD, and series harmonics. Series harmonic mode includes options for THD, TIF, THF, TRD, TDD and phase. There is also an option of a series harmonic bar graph display which shows both the voltage and current harmonics simultaneously. In difference THD mode, the THD (Total Harmonic Distortion) is computed from the rms and fundamental: In series THD mode, the THD is computed from a series of up to 125 harmonics (100 Harmonics for TDD, THF, TIF, TRD, Harmonic RMS and Harmonic Factor options).

The modes marked with a * are the equivalent of using the quick access keys

PROG	
Memory	Program Store / Recall Options
Internal Flash	Instruments internal memory utilised to store or recall data to/from
USB Memory Stick	External USB memory stick utilised to store or recall data to/from
Data	
Program	Upload or download a program
Results	Upload or download results
Datalog	Upload or download Datalog
Action	
Recall	Recall any Data selections from above
Store	Store any Data selections from above
Delete	Delete any Data selections from above
Location	999 selectable locations for data to be stored to, & recalled, or deleted from
Name	Allows user to name data within location
Execute	Using the ▲ & ▼ keys to highlight ***EXECUTE*** Press the *ENTER* key to execute any change(s) made to any parameter within "PROG" mode screen
Memory Status	Status of memory in either Internal or USB configuration

Program store and recall

There are 99 non-volatile program locations where the settings for the entire instrument can be saved for future recall later. An associated name of up to 24 characters can be entered by the user to aid identification, (see Text Entry)

Program number 1 (if not empty) is loaded when the instrument is powered on so that the PPA500 can be set to a user defined state whenever it is switched on. This is particularly useful to set system options such as phase convention, GPIB address etc. If no settings have been stored in program 1 then the factory default settings are loaded (program number 0).

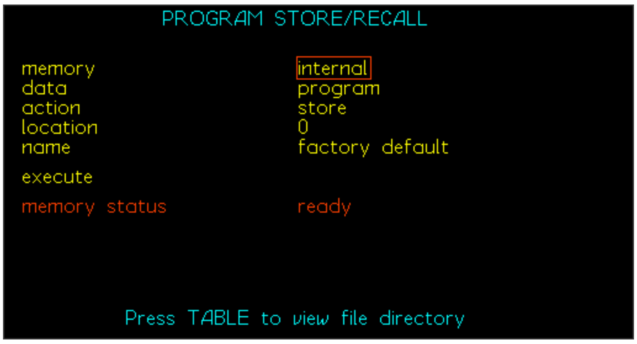
Program numbers 1-4 may be recalled with a single press of the Application Direct Access keys, (item 7) if the direct load option is selected in the system menu (see system options).

The instrument can be restored to the factory default settings at any time by recalling program number 0.

The program menu is accessed using the *PROG* key. The program location can be selected either by stepping through the program locations in turn using the ►&◄ keys to see the name or by entering the program number directly.

The default condition when in the Program Store/Recall menu is as shown below.

To store a configuration in any of the locations 2-99, press the ▼ key twice to highlight ***action***, then press the ► key once to select ***store***.



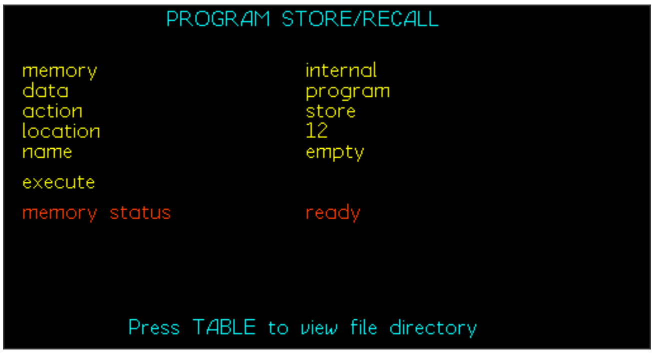
Now using the ▼ key highlight the program number and either step through the numbers with the ►&◄ keys or directly enter the number from the numeric keys, then press *HOME*.

Using the ▼ key, highlight ***execute***, and press *ENTER*.

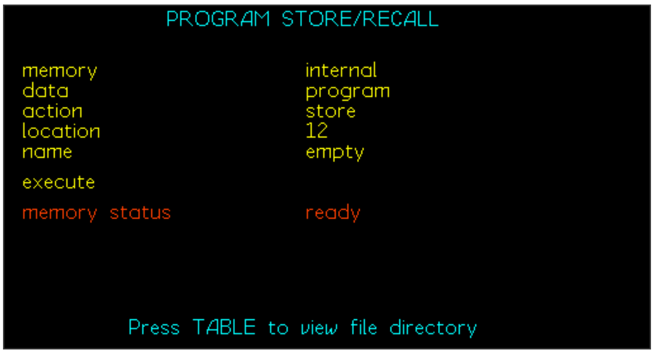
When storing a configuration in a program, there will be a slight pause (of about 1 second) if the program has previously been written or deleted. The process will be very quick if the location has not been used.

When supervisor mode is disabled (see system options), programs can only be recalled, not stored nor deleted, to avoid accidental modification.

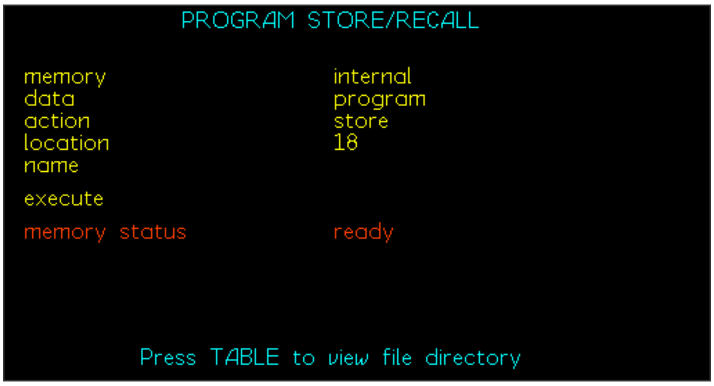
Scrolling through the numerical memory locations using the ► & ◄ keys it will be observed that against the field called ***name*** there can be 3 options., either ***empty*** which means that there is nothing stored in that location , or a name such as ***MOTOR TEST*** which shows that the location has a program stored at that location number which has been named MOTOR TEST, lastly it can be completely blank, this does not mean the memory slot is empty, but rather settings were stored without saving their name to identify them. This is poor practice and should be avoided if possible as it is bad housekeeping.



In this screenshot location 12 is shown as empty and can be used to store program settings.



In this case location 5 has a program stored called TEST this location can be used for storage, but it will be overwritten by the new saved program.

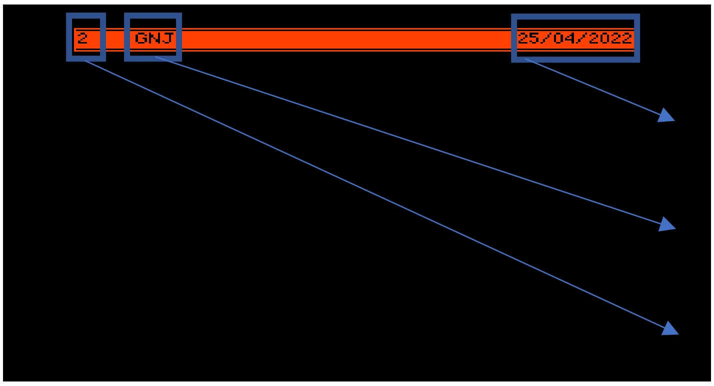


In this last instance, location 18 is not showing either the word empty or a program name. This infers that there is a program stored in this location, but it was saved without a name. As previously it can be overwritten with a new program.

CAUTION. Of the 3 cases shown above the memory slot in the first one is empty, however in the second and third cases they both have something stored in them and to use these slots will overwrite the contents already there without any warning.

When recalling a program, it may be desirable for the program to recall the selected communications interface that was in use when the program was stored (RS232, LAN, or USB). Alternatively, it is more common for the communications interface to be associated with the instrument rather than a stored program. There is a selectable option in the *REMOTE* menu to enable "***recall with program***". If this is "***off***" then recalling the program will not change the communications interface.

All file directory information can be displayed by pressing the "*PROG*" key and then the "TABLE" key. This will allow all the information to be displayed as a table and show what the internal file directory contains. (Pressing the "*TABLE*" key again exits the directory screen).



This screen shot shows the file table, there is only one entry in this instance.

The date the program or results were saved.

The program or results name (up to 24 characters)

The memory position or "slot" number 2-999

Results store and recall

Each of the 99 locations can store either real-time results, datalogs or instrument settings / programs, as described in the previous paragraphs.

Measurement results can be stored in one of 20 locations. Press *HOLD* to hold the results, press *PROG* and select ***memory*** = ***results***. Each location holds the entire set of computed results for all the phases no matter what phase is on the display. Oscilloscope and harmonic series data can also be stored but these take 3 contiguous locations each because of a large amount of data. In each case, the full instrument set up is stored with the data and recalled so that measurements may easily be repeated and verified.

Datalog store and recall

Datalog can be stored directly into non-volatile memory or can be logged to RAM and stored subsequently. The data then can be recalled for viewing or to download to a PC for further analysis. There is a single non-volatile location for holding the datalog.

Saving data & files to USB Memory Stick

Data and files can also be stored and downloaded via a USB memory device. When using a large capacity or slow device all the data may not be transferred within the transfer time window. If this happens it will be recognised, and a display caption appears to prompt the user to press “any Key” to terminate the transfer when completed.

You can use larger USB sticks such as a 4GB or 8GB if they are not full of files, if they are, the time taken reading the file directory will cause a time out error.

The best way to ensure that a 4GB or 8GB USB stick will function correctly is as follows: -

1. Format a 4GB or 8GB USB drive. Both FAT16 and FAT 32 formats will work.

2. When you put the stick in, it will start flashing and there will be a message saying “press any key” – ignore this and any further error messages, typically “Error 4”

3. After a period of time, you will see that the USB stick stops flashing the activity LED, once this has gone out the stick is ready to use for screen shots, program saving etc.

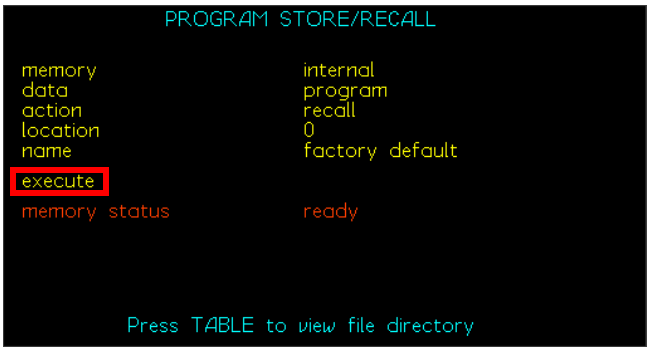
ZOOM +	Increase font size on selected parameters on display screen
ZOOM -	Decrease font size on selected parameters on display screen
REAL TIME	Press *REAL TIME* to return to the display screen and see all data in real time. Pressing the *REAL TIME* key will toggle between HOLD and REAL TIME modes
TABLE	Press *TABLE* to view results either during or at the completion of a Datalog in tabular format, this is also the default screen whilst Datalog is running
POWER	Direct key to Power Analyzer mode functions
RMS	Direct key to True RMS Voltmeter mode functions
INTEG	Direct key to Power Integrator mode functions
HARM	Direct key to Harmonic Analyzer mode functions
START	*START* key will start any Datalog. Is also the key used to initialise a screen dump of any data displayed onto a USB memory stick
STOP	*STOP* key will stop any Datalog
ZERO	*ZERO* key will reset the inputs to zero
TRIGGER	*TRIGGER* returns display screen back to real time from a hold command. Also triggers a single shot in SCOPE mode, all trigger settings can be found by pressing the *SCOPE* key whilst in SCOPE mode
ENTER / ►► (Dual use key)	*ENTER* / ►► will enable the user to confirm any configurations they have set within the menus and will scroll through the display screen to view all individual phase screens or all phases together
DELETE / ◄◄ (Dual use key)	*DELETE* / ◄◄ will enable the user to delete any inputted data or scroll back through any results screens
HOME / ESC (Dual use key)	*HOME / ESC* will enable the user to return to the home page once data within parameters has been adjusted and entered, or will escape from any screen view and return to the selected mode's home screen

Chapter 8 Guide for testing the basic functionality of the instrument.

This section of the manual provides instructions on how to test the basic functionality of your Precision Power Analyzer to ensure it has a basic level of functionality; this should be used as a pre cursor to any further fault investigations. Details are provided of the instrument setup, the required connections between the PPA and other basic test equipment commonly available in a laboratory. Furthermore, screen shots of the expected results are displayed on the PPA.

Testing of the external inputs of the PPA is performed by monitoring the output of a signal generator. To test the internal inputs of the PPA a breakout box with a load connected is used, the PPA monitoring the AC mains supply with the current shunts in series with the load and the voltage attenuators in parallel.

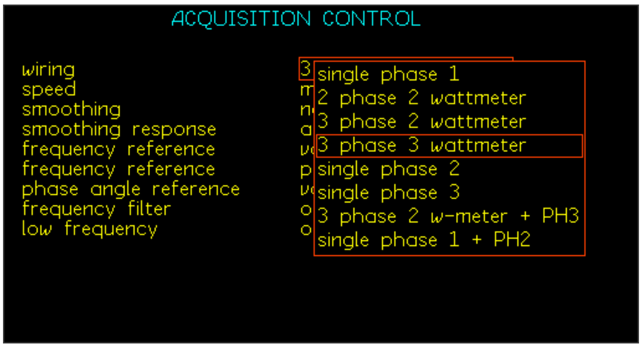
RESETTING THE PPA TO FACTORY DEFAULT MODE.
This will clear any user defined programs that might be stored in the PPA and recalled when the instrument is switched on. Program 1 is recalled when the PPA is restarted.



To access Program Store / Recall mode:

Press the *PROG* key, then press the ▼ Key until the Red Box surrounds the number adjacent to ***Location.***
Press “0” & then press the ▼ Key until the Red Box surrounds ***Execute,*** press *ENTER* - This will now reset the instrument to factory default mode.

Setting up PPA500 for external BNC functionality Check.



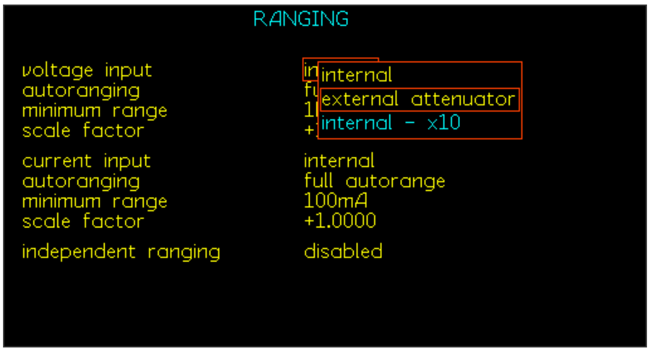
Acquisition control.

Press *ACQU* key, then press the ▼ key until the Red Box surrounds the ***wiring*** options. Use the ▼&▲ keys to select ***3 phase 3 wattmeter*** from the list, then press *Enter*.

Coupling

Press COUPLING key

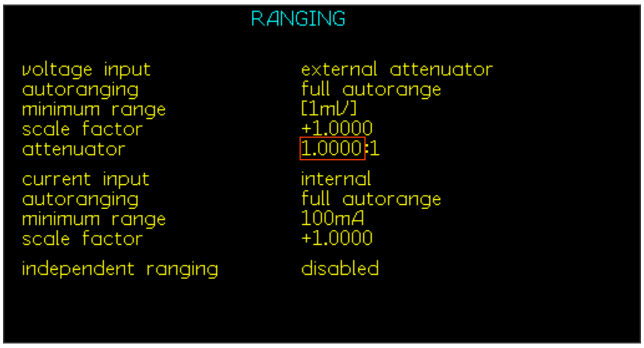
Press the▼ key until the Red Box surrounds the “Coupling” options. Use the ▼&▲ keys to select ***ac+dc*** from the drop down list.



Ranging.

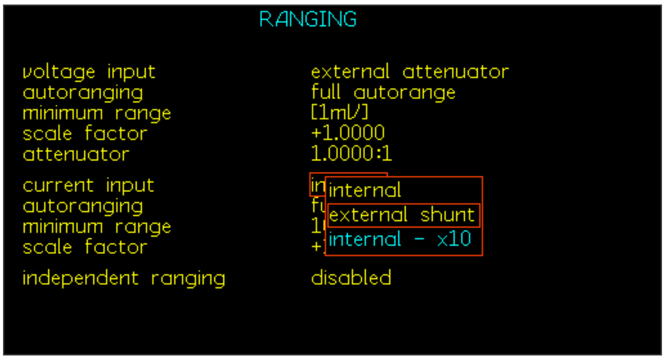
Press *RANGE* key press the ▼key until
the Red Box surrounds the ***Voltage input*** options.

Use the ▼&▲ keys to select ***external attenuator*** from the list.



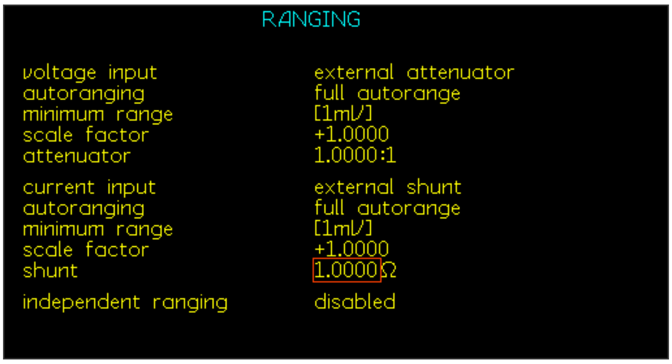
Press the ▼key until the Red Box surrounds the ***attenuator*** options

Type in an attenuator setting of ***1.0000:1***



Press the ▼key until the Red Box surrounds the ***current input*** options

Use the ▼&▲ keys to select ***external shunt*** from the list.



Press the ▼key until the Red Box surrounds the ***shunt*** options

Type in an attenuator setting of ***1.0000Ω***

Connecting the PPA to a signal Generator
A signal generator is required to provide a 1.41V PK (1.00Vrms) 50Hz sine wave, if the signal generator expects a 50Ohm load impedance then an output voltage of 0.707V (0.5Vrms) should be used. This signal is used for checking the integrity of the external voltage and external current inputs; these are 3Vpk Max Isolated Differential Voltage inputs.

The PPA is connected to the signal as shown in the drawing. The various modes on the instrument can then be selected. The following section provides screenshots of the PPA display for each of these modes.

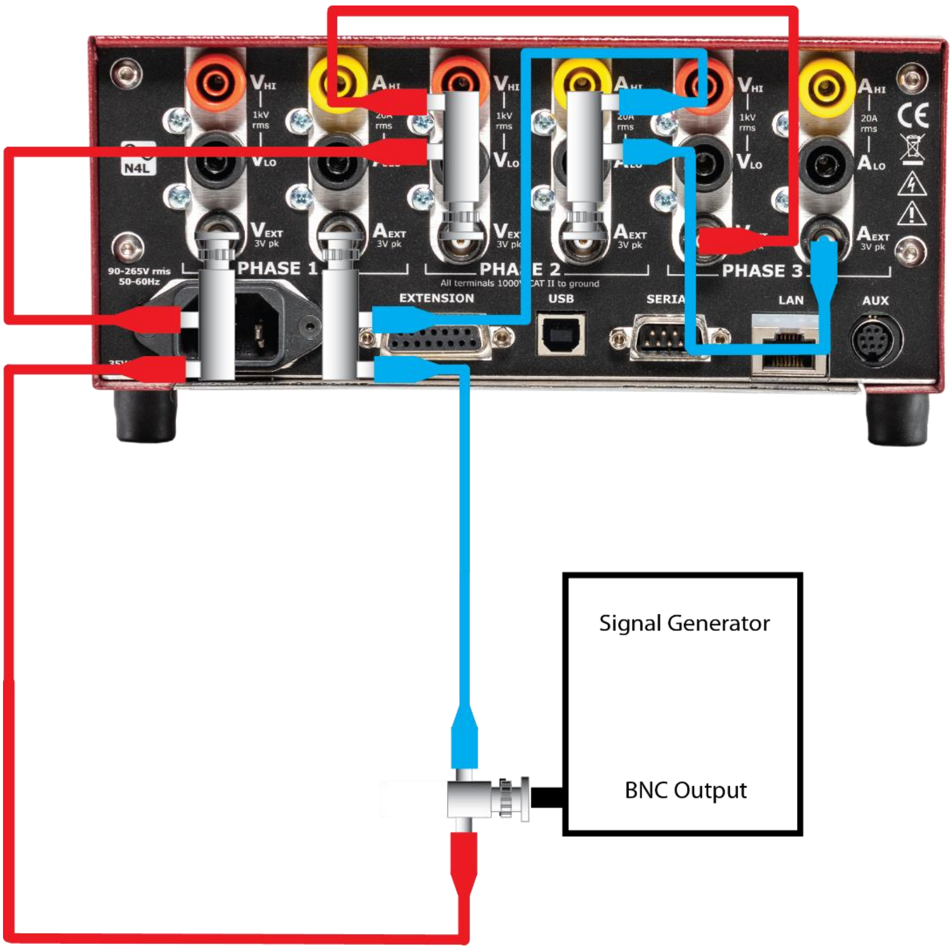
To make the connections shown in the diagram you will need the following accessories that are not supplied with the PPA.

4 x BNC cables for connections on the rear of the PPA.

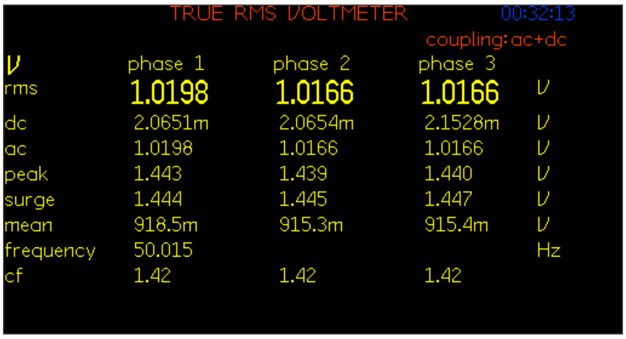
2 x BNC cables to connect between the PPA and the signal generator.

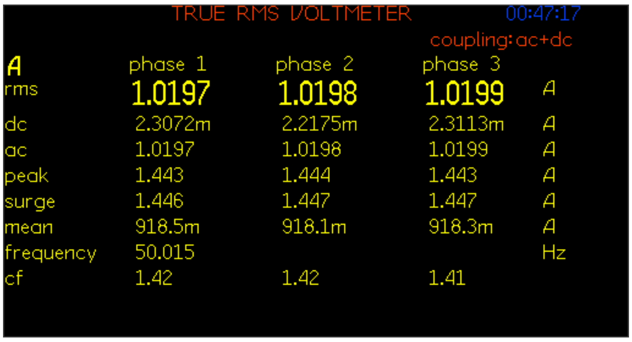
5 x BNC "T" piece connectors.

Connection diagram for the functionality checks of the External BNC inputs

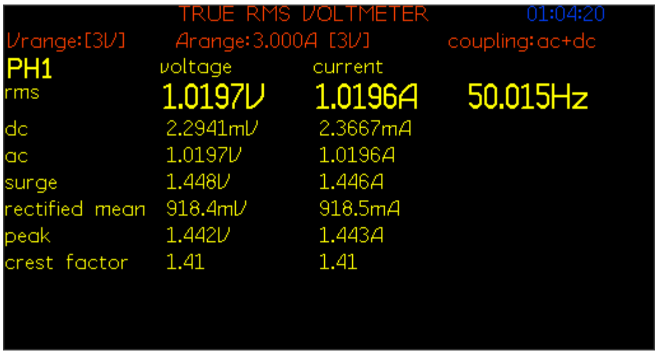


True RMS Voltmeter Mode



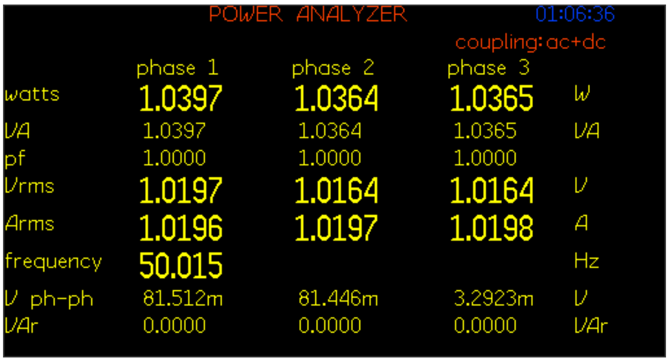


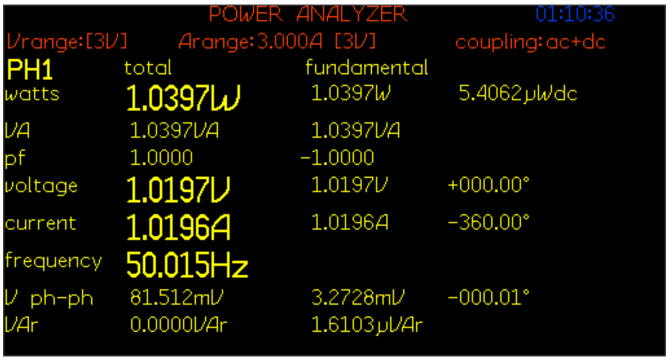
These screenshots are of the instrument in True RMS Voltmeter mode. The one on the left is displaying the voltage results for all 3 phases whilst the one on the right is displaying current for all 3 phase inputs. These allow comparisons of current and voltage readings between the 3 phases. It is also possible to check that the instrument has detected the correct frequency.



In this screenshot we are looking at just one phase, in this example phase 1. The instrument is displaying both the voltage and current readings for the one phase only. It is also possible to scroll through the various true RMS voltmeter displays to view similar results for phases 2 or 3.

Power Analyzer Mode

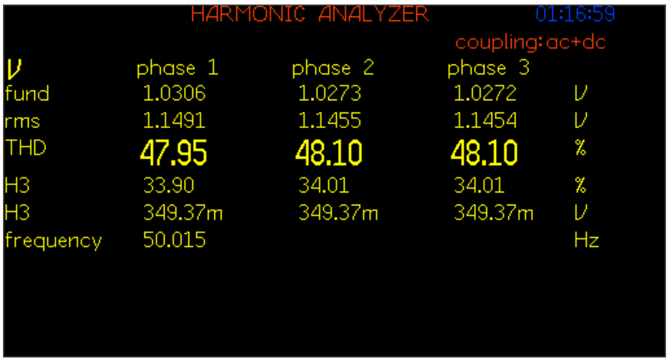


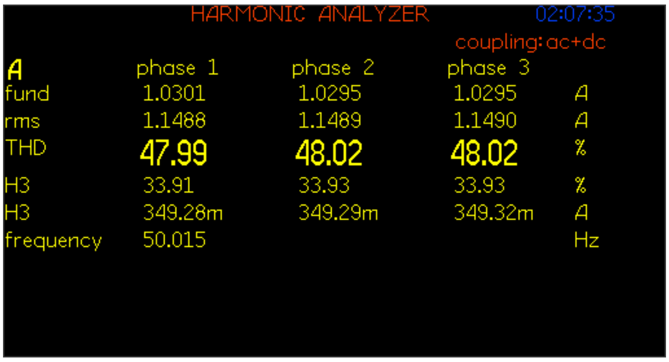


The above screenshots are of the instrument in Power Analyzer mode. The screenshot on the left is displaying the results for all 3 phase inputs. The screenshot on the right is the results for phase 1 only. Comparison of current, power and voltage can be made on all 3 phases, and it is also possible to check that the instrument has detected the correct frequency.

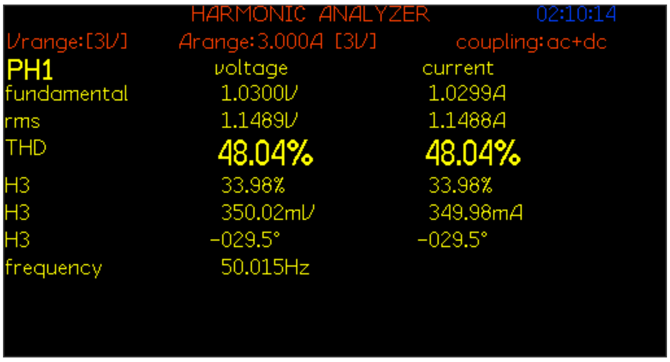
Harmonic Analyzer Mode

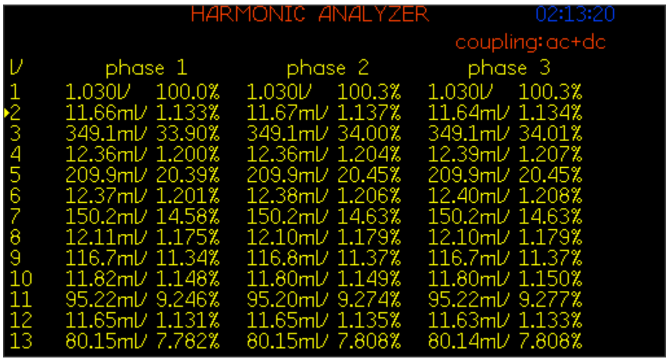
The signal generator is adjusted to provide a 1.00V PK, 50Hz square wave to check the frequency detection function of the PPA. Harmonic Analyzer mode is utilised, and correct harmonic magnitudes are displayed providing the fundamental frequency of the waveform is correctly detected.





The screenshots above show the instrument in Harmonic Analyzer mode with a square wave input. Comparisons can be made of Current, Power, Voltage and Total Harmonic Distortion on all 3 phases. When looking at a single channel it is also possible to check the frequency of the signal. The final screenshot shows that it is also possible to look at the harmonics in table form so that it is possible to look at all the individual harmonics at once. This example was for the voltage harmonics, but it is also possible to get the same table format for current harmonics.





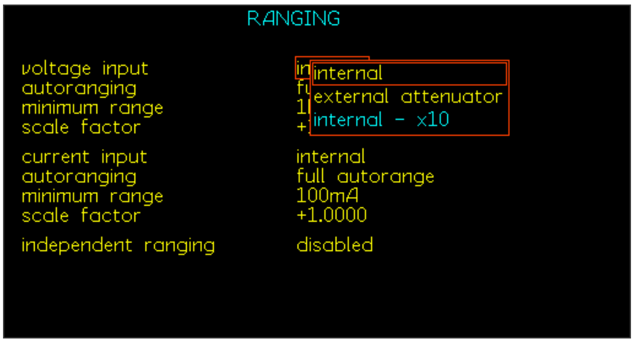
We have used a square wave as the harmonics of this waveform are well known, it is advisable to compare the harmonic values in the displayed table and ensure they are nominally the same as the table below.

Harmonic Content of a Square Wave

Harmonic Number	Frequency	Relative Magnitude
Fundamental	50 Hz	100 %
3rd harmonic	150 Hz	33 %
5th harmonic	250 Hz	20 %
7th harmonic	350 Hz	14 %
9th harmonic	450 Hz	11 %

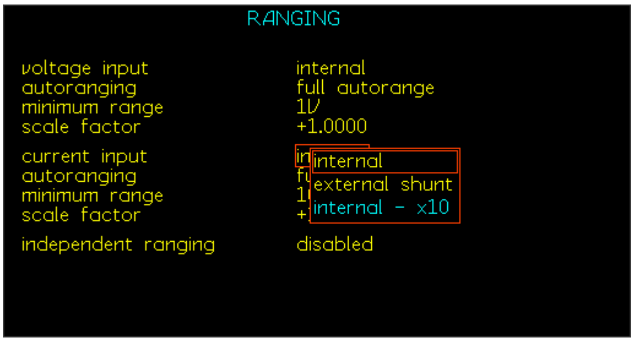
Setting up PPA for "internal" measurements.

The set up procedure for internal measurements is very similar to that above for external measurements. The only difference is in the configuration of the Ranging settings.



Ranging should be set up as follows:

Press the *RANGE* key
Press the ▼ key until the Red Box surrounds the ***Voltage input*** options
Use the ▼&▲ keys to select ***internal*** from the list.



Press the ▼ key until the Red Box surrounds the ***current input*** options Use the ▼&▲keys to select ***internal*** from the list.

Connecting the PPA for "internal" measurements.

The breakout box is connected to a mains supply. A load is connected to the breakout box to produce a current for the PPA to monitor. The PPA is used to monitor the voltage and current on the connections of the breakout box. The same voltage and current levels are applied to the 3 phase inputs of the PPA. Therefore, the display should indicate the nominally same values for all 3 phases. For the tests illustrated in this manual a 230V 50Hz mains supply was used, the load used was sinking a current of 3.00A.

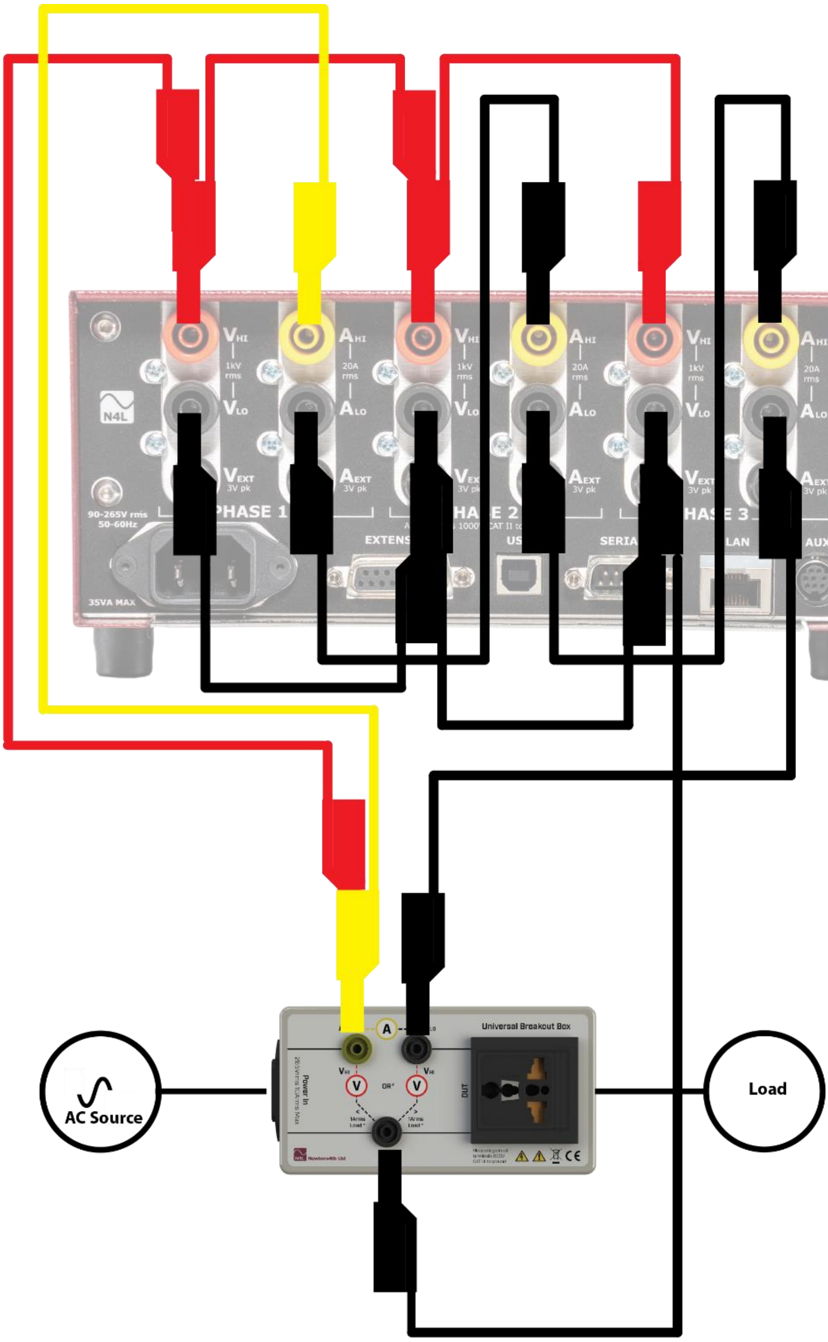
To make the connections shown in the diagram you will need the following accessories that are not supplied with the PPA.

1 x breakout box.

1 x Load that will be connected to the breakout box.

All other connections can be made using the 4mm safety leads supplied with the PPA.

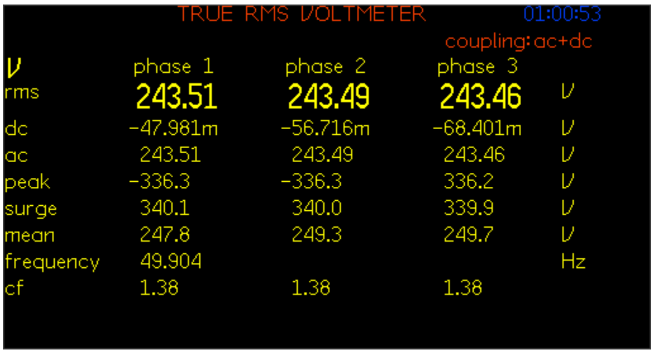
Connection diagram for the functionality checks of the Internal 4mm sockets inputs.

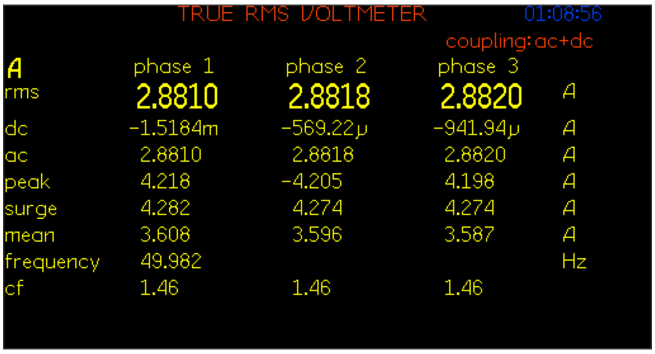


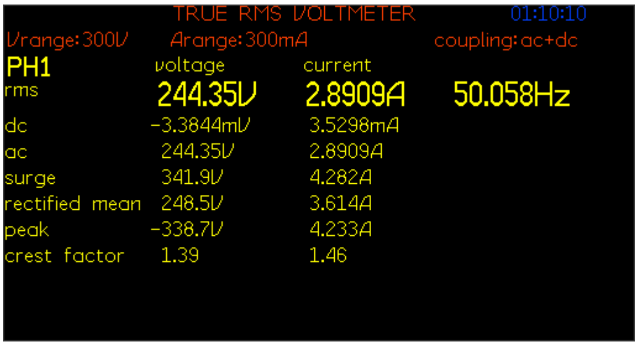
Screenshots of PPA Display when making “internal” measurements.

The following screenshot examples were taken with the PPA set up for internal measurements. For full descriptions for each of the PPA modes please refer to the “external” measurements

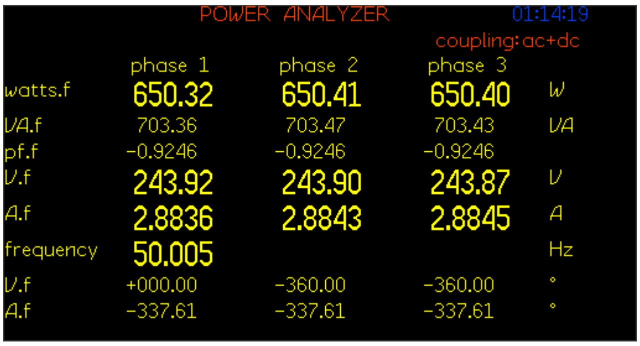
True RMS Voltmeter Mode

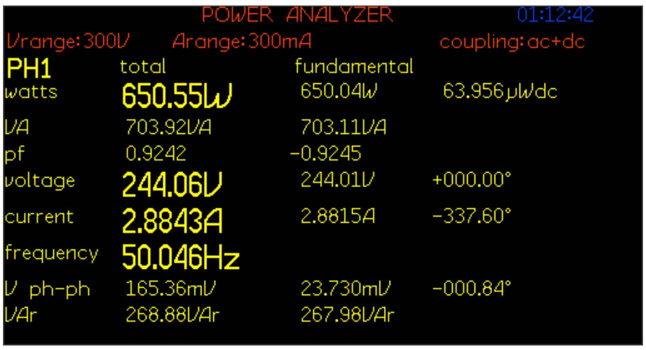




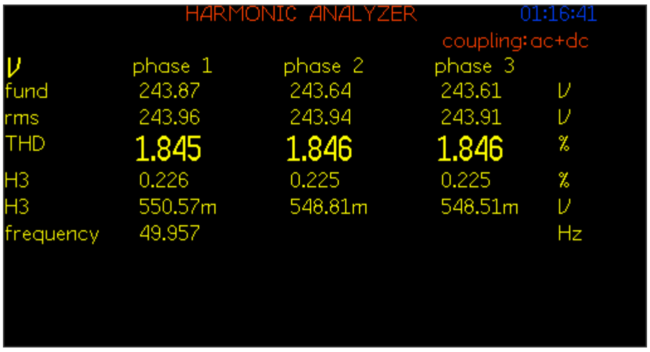


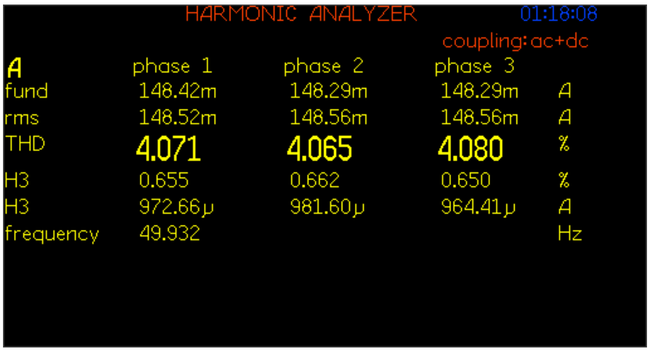
Power Analyzer Mode

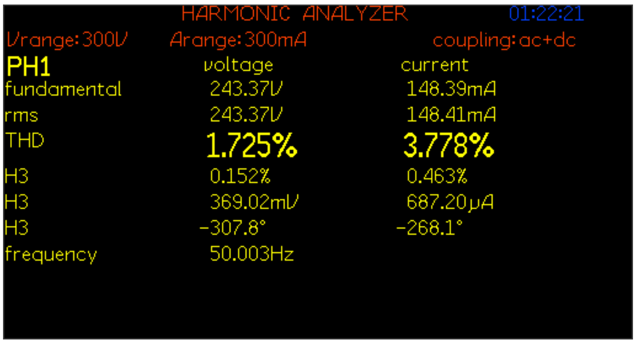




Harmonic Analyzer Mode







Harmonic verification

Verify that Vthd is nominally the same across all phases inputs, as a reference signal (such as a square wave) is not being used we cannot verify individual harmonic magnitudes. This is not a problem as we have already verified this with the external inputs.

Basic Fault Symptoms and Causes

Symptom	Cause
Noisy trace on external voltage input	Possible damage to analogue front end circuitry caused by excessive voltage
Noisy trace on external current input	Possible damage to analogue front end circuitry caused by excessive current
Flat trace on external voltage input	Possible damage to digital circuitry in voltage card
Flat trace on external current input	Possible damage to digital circuitry in voltage card
Incorrect Voltage reading on External Input	Possible damage to input attenuator caused by excessive voltage
Incorrect Current reading on External Input	Possible damage to input attenuator caused by excessive voltage.
Incorrect Voltage reading on Internal Input	Possible damage to input attenuator caused by excessive voltage
Incorrect Current reading on Internal Input	Possible damage to current shunt caused by excessive current
Incorrect Harmonic magnitude on external input	Possible damage to analogue input circuitry / Incorrect frequency detection
Incorrect Harmonic magnitude on internal input	Possible damage to analogue input circuitry / Incorrect frequency detection

Chapter 9 Menus-how to use and navigate them

Main menus

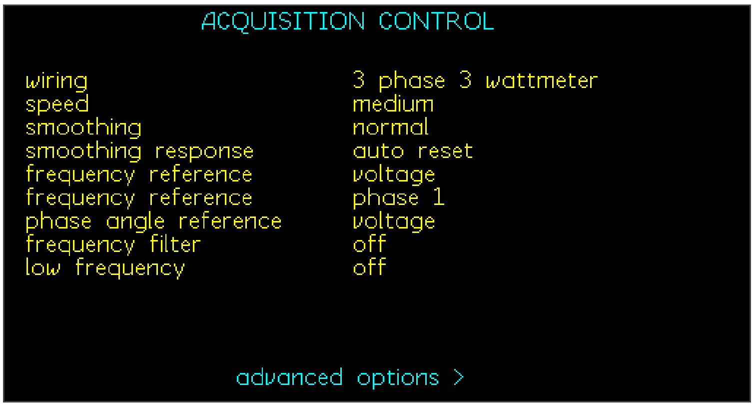
There are twelve main menu options available, these are labelled under each of the twelve numeric keys and are accessed by a single keypress.

The PPA500 Series can be configured for a wide range of application disciplines. Keys 1-9 on the alphanumeric keyboard, +/- and decimal point are used to access the menus to set up the PPA500 Series to suit the intended measurement application.

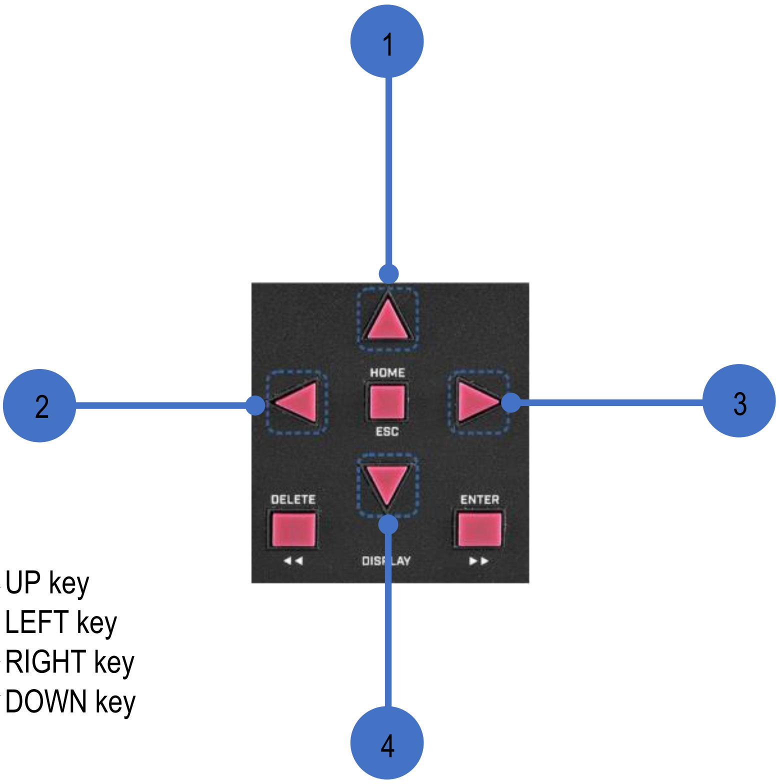
ACQC	Press key 1
Acquisition Control: Used for configuring inputs appropriate to source and nature of signals being analysed	
COUPLING	Press key 2
There are three coupling options - AC only, AC+DC, or DC only. AC+DC coupling is the default option and should be used where possible. The coupling option does not affect the bandwidth of the instrument only the frequency detection	
RANGE	Press key 3
Input channel options	
DATALOG	Press key 4
Interrogation and extraction of information resulting from a test log in a specified time scale and at a set speed	
APP	Press key 5
Application function to be selected	
MATHS	Press key 6
Used to select appropriate formulae for derived units not directly measured	
ALARM	Press key 7
Used to select the alarm types and options	
REMOTE	Press key 8
Press to set the data resolution and change the format to which the instrument responds to future commands, via Comms interface	
AUX	Press key 9
Used to select and setup specific parameters for any optional accessories connected to the PPA	
SYS	Press key ±
Used to set general system wide controls	
MODE	Press key 0
Used to select pre-programmed instrument functions	
PROG	Press the decimal point **.** key
Recall/Store/Delete of non-volatile programs	

Selection from a list
This data type is used where there are only predefined options available such as the output may be ‘on’ or ‘off’, or the bandwidth may be low, wide, or auto.

Upon entry to any of the twelve main menus, no options are highlighted (ACQU menu screen shown below)

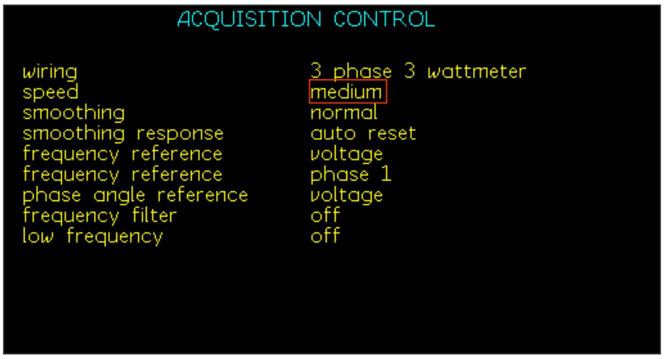


If the ▼ key is then pressed the first option, ***wiring*** will be highlighted by a flashing box



1 ▲UP key
2 ◀LEFT key
3 ▶RIGHT key
4 ▼DOWN key

4 way navigation keys for the menus and data entry



Press the ▼ a second time then the flashing cursor will highlight the second parameter, ***speed***. The ► key steps forward through the list, & the ◄ key steps backwards through the list. When the correct option has been highlighted by use of the ►&◄ keys, then *Enter* must be selected to choose that parameter.

The number keys, 0-9, depending on the number of options available, jump directly to the appropriate position in the list, this provides a quick way to jump through long lists. Again, *Enter* will need to be pressed to select the desired choice.

For example, if the speed selection list comprises the options:

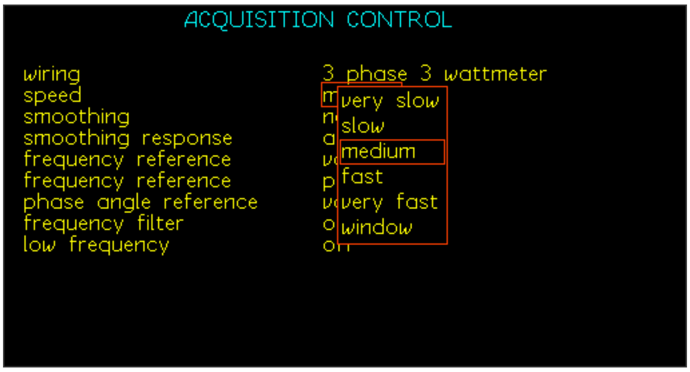
very slow	(item 0)
slow	(item 1)
medium	(item 2)
fast	(item 3)
very fast	(item 4)
window	(item 5)

and the presently selected option is ***medium***, there are 3 ways to select ***window***:

press ► twice followed by *Enter*

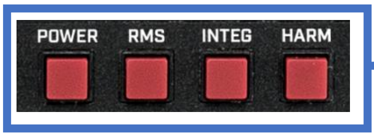
press ◄ three times followed by *Enter*

or press number *5* key followed by *Enter*



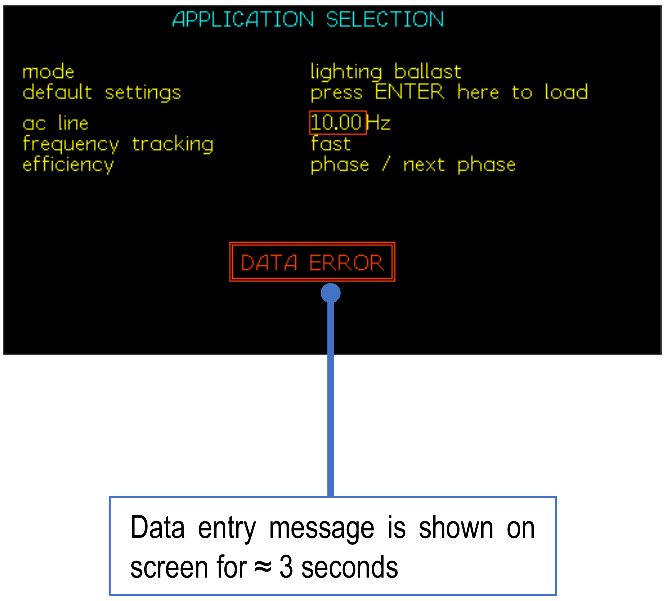
Direct numeric entry
Parameters such as frequency and phase offset are entered as numeric characters; frequency is an example of an unsigned parameter; phase offset is an example of a signed parameter.

Numbers are entered using the number keys, decimal point key, and +/- key (if a signed value is permitted), & if required, the SI unit prefix multiplier keys (M, k, m, & μ,) will add the associated prefix.



When the numeric character string has been entered, pressing the *ENTER* key (item 12) sets the parameter to the new value. Until the *ENTER* key is pressed, pressing the *HOME* key (item 11) aborts the data entry and restores the original number.

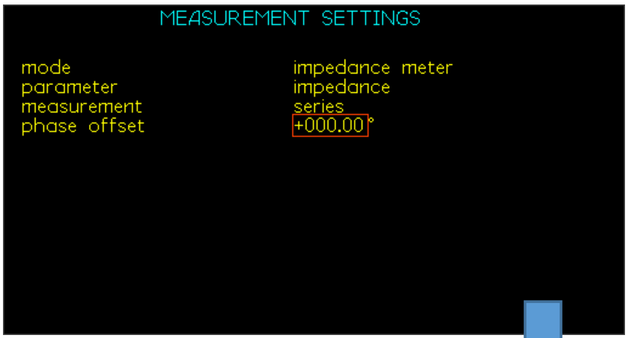
If the numeric data value is entered that is outside the valid limits for that parameter, then a warning beep is heard, a message is displayed on the screen showing ***DATA ERROR*** and the parameter is re-set as close to the requested value as possible. For example, the ***ac line*** frequency; if a value under 10.00Hz is entered, a warning beep together with a message will be given, and the value set to the minimum of 10.00Hz as shown below.



When any menu is first displayed the numeric parameters will have no cursor “▯” visible.

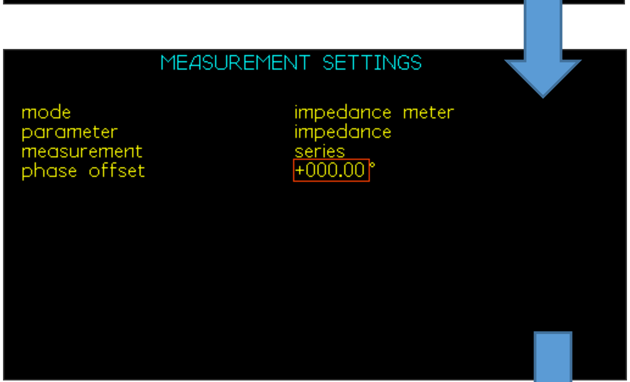
There are two types of numeric variables, those showing an integer value and those showing a decimal value.

To edit a decimal numeric value such as ***phase offset*** in the screen shot below, use the ▼key to highlight the numeric value, in this case you would need to press the ▼key four times to highlight the ***phase offset*** numeric value. Once highlighted a new number will overwrite the existing value if any numeric key(s) are pressed.



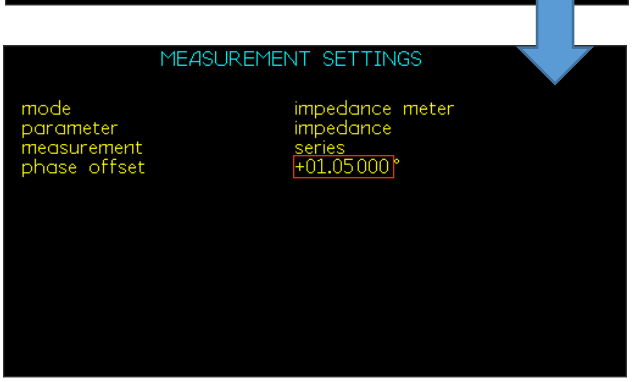
If you wanted to edit the value to be 1.05˚ for example.

Press ► x1 to display the cursor | as shown in the second screen shot



Press ► x1 to insert & move the cursor 2 places to the right

Press 1 once, to insert a 1 to the left of the cursor |



Press► x2 to move the cursor 2 further places to the right.

Now press 5

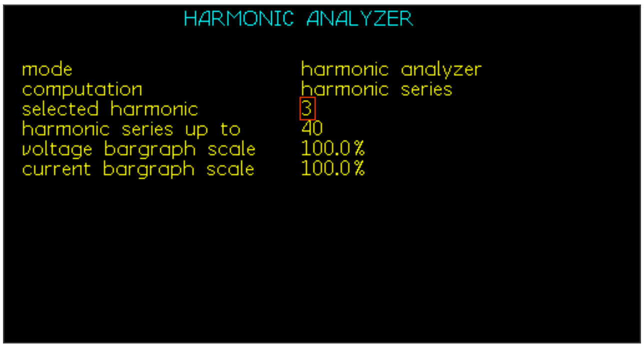
Press *ENTER* and now the value is saved for that parameter.

If you want to correct a mistake, then pressing *DELETE* will delete the character to the left of the current cursor position.

If you need to change a value after pressing *ENTER,* then use the ▼ key to position the cursor against the correct parameter and use the ► key to move the cursor to the right of the character you want to delete.

REMEMBER the numeric keys and the *DETETE* key always affect the character to the **left** of the cursor

To edit an integer numeric value such as ***selected harmonic*** in the *POWER ANALYZER* menu shown below.



Using the ▲ & ▼ keys move the highlight to the desired line.

Use of the ◄ & ► keys to increase or decrease the selected value.

Alternatively use the numeric keys to enter the value directly. If a multiple digit value is entered, then the ◄ & ► keys can be used to position the cursor for editing as above.

INFORMATION. Data values are always shown in engineering notation to at least 5 digits (1.0000-999.99 and a multiplier).

Text Entry

There are occasions where it is useful to enter a text string; for example, a non-volatile program may have some text as a title.

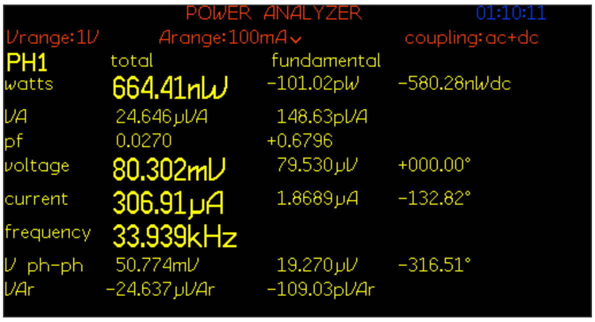
Text is entered by selecting one of 4 starting characters using the main function keys on the top right hand side of the keyboard (item 6), then stepping forwards or backwards through the alphabet with the ▲and ▼ keys.

The starting letters are A (*POWER*), I (*RMS*), O (*INTEG*), or space (*HARM*). You can continue from any one of the starting letters backwards and forwards using the ▲and ▼ keys step forward and backwards using the ASCII character definitions – other printable characters such as # or ! can be obtained by stepping on from the space. The available character set is given in the Appendix. Numbers can also be inserted using the number keys.

The editing keys, ►◄, *DELETE* and *ENTER* operate in the same way as for numeric entry.

User Data

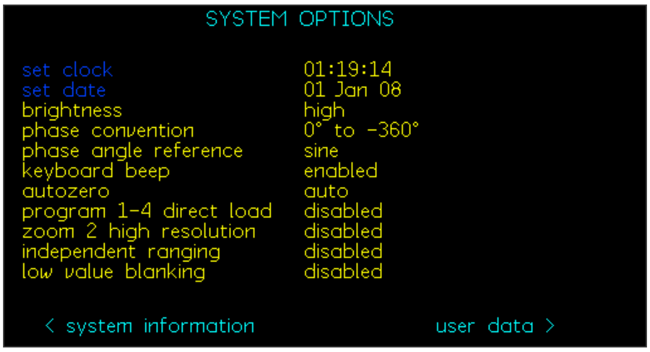
When the PPA500 is first powered on, for approx. 4 seconds a splash screen is shown, by default, the instrument model, firmware version and Newtons4th Ltd. will be displayed. This splash screen can be edited and personalised to your company details.



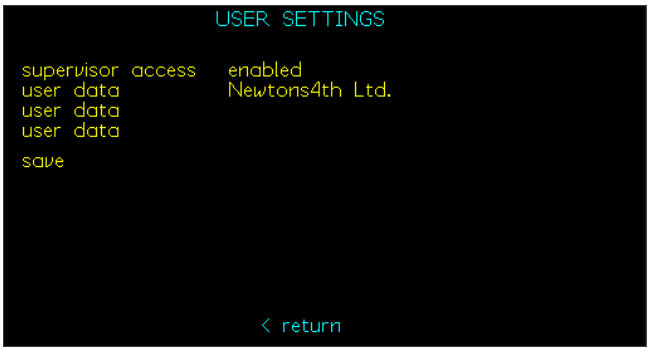
The splash screen then changes to the default real time Power Analyzer screen

Editing the User Data

To do so, press the *SYS* key followed by the ► key which will then display the following screens: -

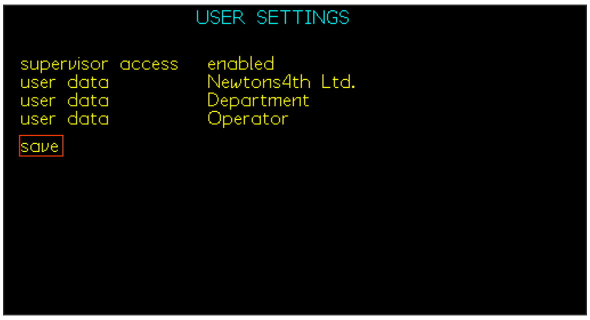


then



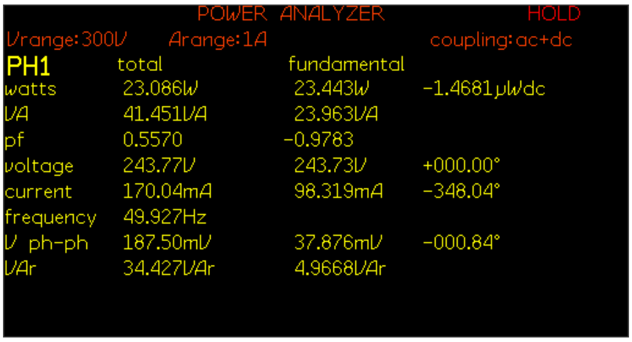
There are 3 lines of ***user data*** that can be edited to suit the user, (see section preceding section, Text Entry)

A sample of edited ***user data*** is shown below. The 3 lines of user data have been set to "Company name", "Department", and "Operator", however these can be edited by the user to read appropriately to your usage, i.e., "operator could be "Asset No." or similar.

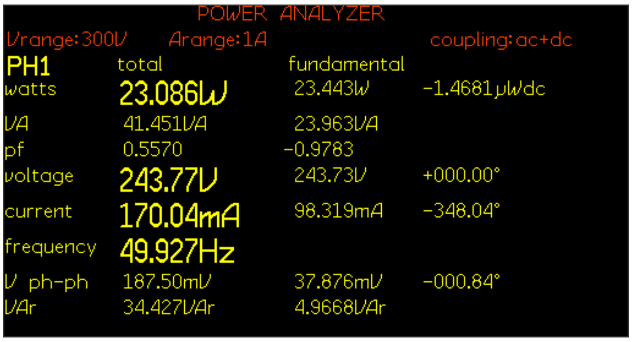


Display Zoom

The PPA500 normally displays many results on the screen in a combination of small font size (no zoom) and up to 4 values in a larger font size (first zoom level). There are two further zoom levels which can display up to four and up to three selected values respectively at larger font sizes (second and third zoom levels).

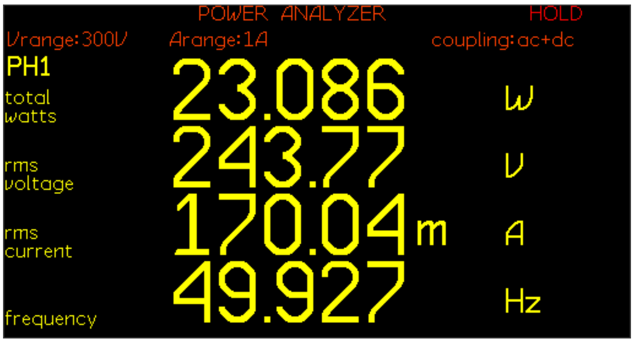


No Zoom

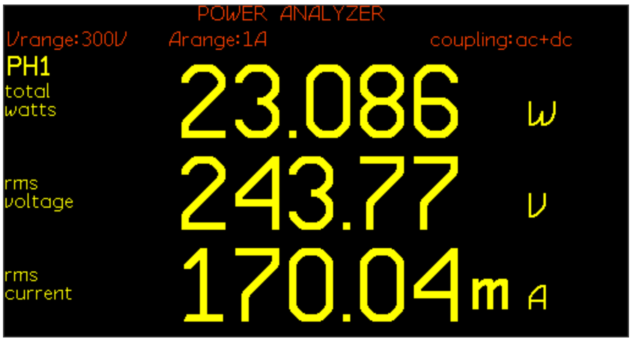


1st level Zoom

(Default level and parameters shown)

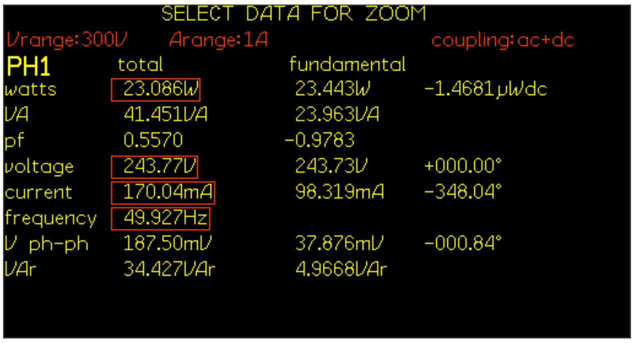


2nd level Zoom

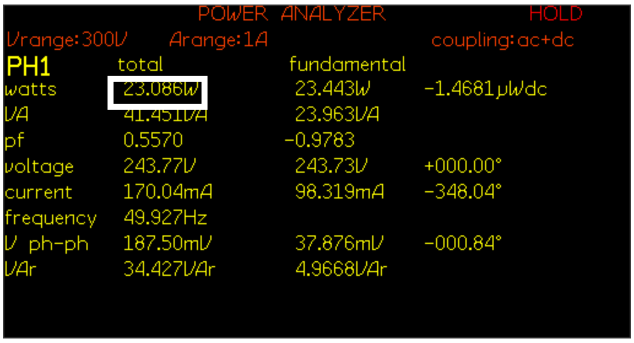


3rd level Zoom

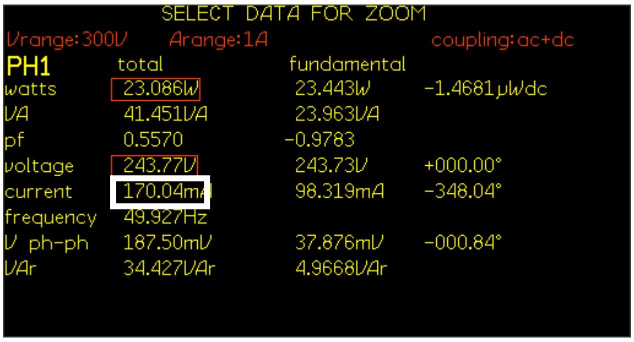
To set the data values for a larger font size, first, return to no zoom by pressing *ZOOM* as many times as necessary.



Press the *ZOOM* key to view the presently selected data, and press *DELETE* to clear the selection



A flashing box surrounds the first available result. The flashing box is moved around the available results using the cursor keys, ▲,▼,◄,& ►. Pressing the *ENTER* key selects the result for zoom and the box now flashes alternately red and white. Further results (up to four in total) can then be selected using the cursor keys in the same way – a solid red box remains around the already selected item. Having selected the desired results, pressing the *ZOOM* key steps through the zoom levels until the highest is reached, at which point a further press returns to no zoom.



This screen shot, shows two parameters selected (Watts and rms voltage) with the selection cursor currently on rms current.

INFORMATION. Note that any of the parameters selected for the zoom function can be used as the input for the alarm monitoring, and datalog

Having selected the chosen parameters for zooming, each press of the *ZOOM* +key will display the next level of zoom.

No Zoom→ Zoom Selection→First Zoom→Second Zoom→Third Zoom

Likewise, the ZOOM – key reduces the level of zoom each time it is pressed.

Third Zoom→ Second Zoom→ First Zoom→ Zoom Selection→No Zoom

The PPA500 supports 1-4 parameters in both zoom modes, it is not necessary to have to select four parameters. Each solid highlight signifies that the parameter will be zoomed when the *ZOOM*+ key is pressed. If a fifth parameter is selected, the first parameter will be deselected.

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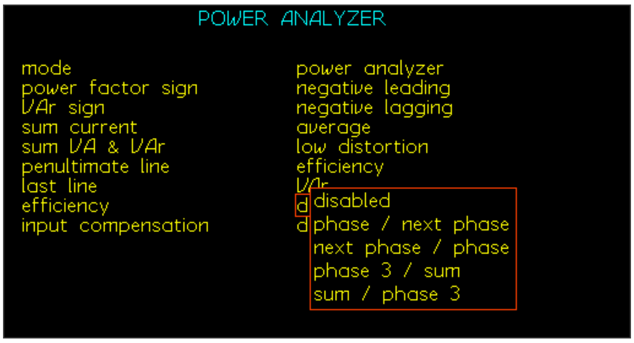
EFFICIENCY

The "Efficiency" mode will compute and compare the data resuls from any of the configurations shown within the screenshot below



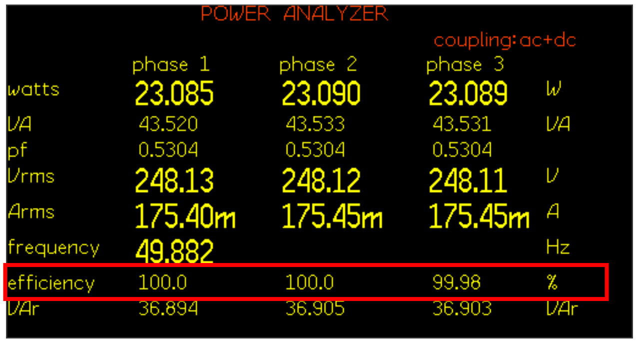
To select the "Efficiency" parameter from any application mode.

Access the Power Analyzer home screen and press *POWER* this will take you into a sub menu. Scroll down to the ***efficiency*** parameter and press ▶ key, this will open the dropdown menu with all available configurations as shown

Use the ▲ & ▼ keys to move through the configurations and press *ENTER* to select and confirm

Press *HOME* to return to the Power Analyzer display screen

The results will then be displayed at the end of the Power Analyzer home screen as shown



Chapter 10 Instrument modes

The PPA500 Series has seven different modes, these are selected via the Mode menu, four of them are also accessible from the direct selection keys (see item 7)

In this section each mode will be described with examples and help on the best configurations to select for different DUT's.

The modes are:-

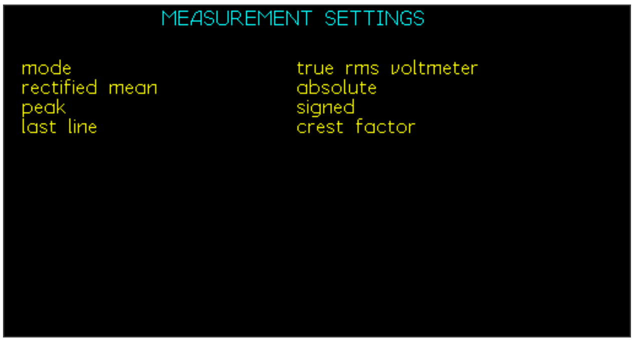
True RMS Voltmeter *
Phase Meter
Power Analyzer *
Impedance Meter
Power Integrator *
Harmonic Analyzer *

The entries above designated with an asterisk are also available directly from the keys at the top right side of the keyboard, labelled POWER, RMS, INTEG, and. HARM, (See item 6)

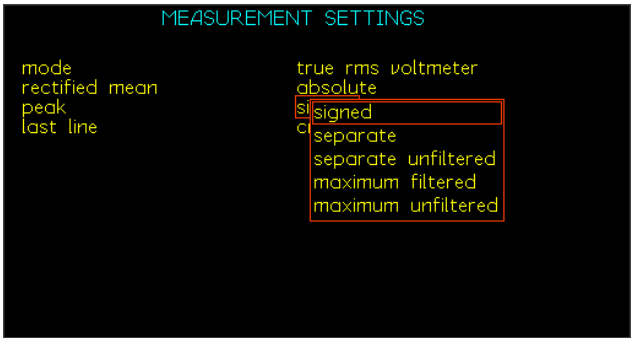
True RMS Voltmeter

Atypical application that would utilise True RMS Voltmeter would be for measuring the inrush current of a DUT with the aid of our PCIS accessory (see our website for details)

When selecting True RMS Voltmeter from the Mode menu, the default measurement settings screen is displayed as shown below.

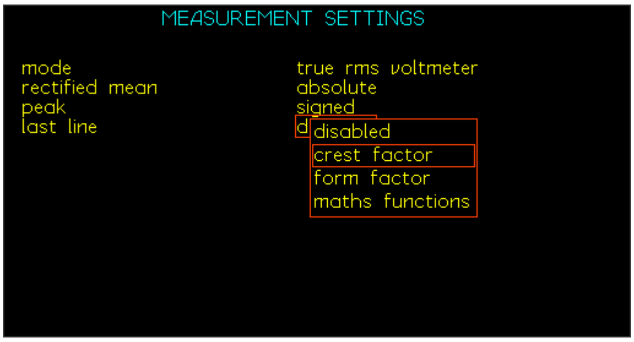


Rectified mean can be set to either ***normalised*** or ***absolute***



The ***Peak*** parameter can be set to the options shown below.

Signed, separate & ***separate unfiltered*** are updated on a per window bases. Whereas ***maximum filtered*** and ***maximum unfiltered*** are parameters that are updated when the value is higher than the existing displayed value, and not refreshed for each window. In all cases unfiltered ignores the effect of the smoothing filter if that has been selected.



The last line parameter of the RMS mode setting enables the user to choose between Disabled, Crest factor, Form Factor, & Maths Functions.

While both crest factor and form factor are set up completely from this menu selection, when maths functions is selected, unless formula in the Maths menu is changed from disabled, the maths parameter in True RMS will display in blue indicating that it is currently unavailable.

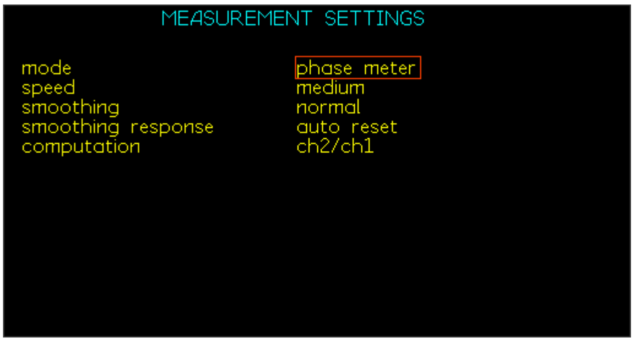
Phase Meter

The phase meter mode is a secondary function which does not have a separate direct access key. It is only selected by stepping through the operating mode via the *MODE* menu. The phase meter uses the terminology of channel 1 for voltage and channel 2 for current as it is normal to use a phase meter to compare voltages directly. In this case, the current input is set to external attenuator in the *RANGE* menu, and a voltage probe (oscilloscope probe) can be used. For optimum phase accuracy, the same type of voltage probe should be used for the voltage input which can also be set to external attenuator in the *RANGE* menu.
Remember to trim the oscilloscope probes, if necessary, by connecting them to a 1kHz square wave and adjusting them for 33.3% 3rd harmonic in the ***harmonic analyser*** mode.

The phase meter measures the phase and gain of channel 2 relative to channel 1 using a discrete Fourier transform (DFT) algorithm at the fundamental frequency. Relative gain is given as an absolute value and in dB. The ratio can be inverted to give the gain of channel 1 relative to channel 2.

To look at differences in gain from a nominal value, an offset gain can be applied either manually or by pressing ZERO.
offset gain = measured dB – offset dB

The screen below is displayed on first selecting ***phase meter*** in the *mode* menu.



Speed – This is the same control parameter as is accessed in the *ACQU* menu see here for full details.

Smoothing and ***smoothing response*** are also the same parameters that are available in the *ACQU* menu.

Computation- The default is ch2/ch1, however ch1/ch2 can be set if required.

Speed	Update Rate	Normal Time Constant	Slow Time Constant
Very Fast	1/80s	0.05s	0.2s
Fast	1/20s	0.2s	0.8s
Medium	1/3s	1.5s	6s
Slow	2.5s	12s	48s
Very Slow	10s	48s	192s

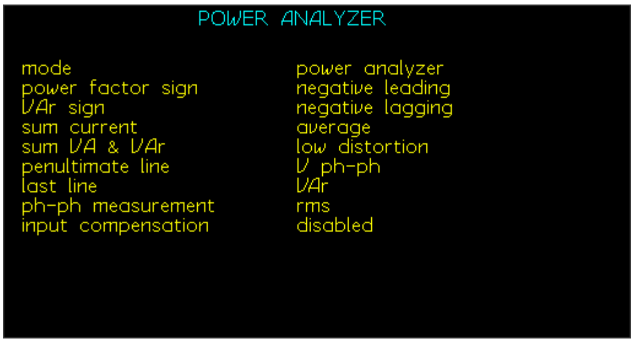
Power Analyzer

In the POWER Analyzer mode, the PPA500 series measures the following values for each phase:

Parameter	Type	Units
Frequency	elementary	Hz
True power	elementary	W
Apparent power	secondary	VA
Reactive power	secondary	VAr
Power factor	secondary	Unitless
RMS voltage	elementary	V
RMS current	elementary	A
Fundamental power	secondary	W
Fundamental VA	secondary	VA
Fundamental VAr	secondary	VAr
Fundamental power factor	secondary	Unitless
Voltage fundamental	elementary	V
Current fundamental	elementary	A
Voltage magnitude	secondary	V
Current magnitude	secondary	A
phase	secondary	degrees
Voltage harmonic	elementary	V
Current harmonic	elementary	A
Voltage harmonic magnitude	secondary	V
Current harmonic magnitude	secondary	A
DC voltage	elementary	V
DC current	elementary	A
DC power	secondary	W
Peak voltage	elementary	V
Peak current	elementary	A
Rectified mean voltage	elementary	V
Rectified mean current	elementary	A

All elementary parameters (e.g., Watts) are computed from their true definitions in real time so the measurements are valid for all waveshapes. Secondary parameters are computed from one or more of the elementary parameters (e.g., VA = Vrms x Arms).

Not all the parameters listed are displayed in POWER mode, but they are all computed, these can be accessed via the remote control commands. (See Appendix B)



On entering the Power Analyzer mode either by 2 presses of the direct access key labelled *POWER*, or via the drop down menu found on the *MODE* key, the first settings screen is displayed.

Both ***VAr*** and ***power factor*** can be switched between negative leading or lagging.

Sum current can be set to ***total*** or ***average***

Sum VA & VAr can be set to ***low*** or ***high distortion***

Ph-ph measurement can be set to ***rms*** or ***average***

Input compensation can be ***enabled*** or ***disabled***

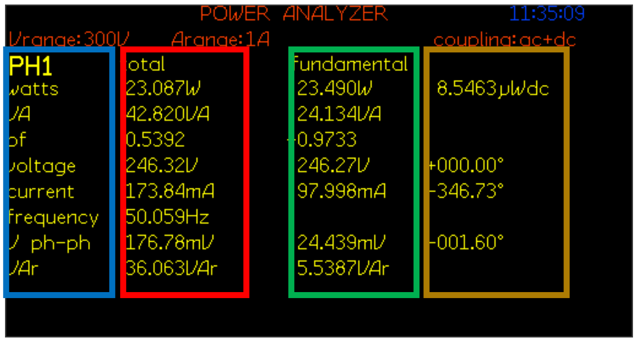
Selective harmonic can be set between 2 and 50

Parameter	**Setting**
Power Factor sign	Negative leading
	Negative lagging
VAr sign	Negative leading
	Negative lagging
Sum Current	Total
	average
Sum VA & VAr	Low distortion
	High distortion
Ph-Ph measurement	rms
	average
Input compensation	enabled
	disabled
Penultimate line	Disabled or 1 of 9 options
Last line	Disabled or 1 of 9 options

Penultimate and Last line can be set to 1 of 9 options, or disabled which will remove the line from the display. (See the table on the following page.)

Penultimate & Last line parameter options	
Disabled	Removes line from the Power Analyzer display
V ph-ph	Voltage phase to phase
VAr	Reactive power
Efficiency **	Set efficiency numerator and denominator terms
Maths Functions	Set maths terms and formulae
V thd	Voltage Total harmonic distortion
A thd	Current Total harmonic distortion
Selected harmonic	Specify harmonic to measure 2-50
δW	Delta Watts
VA x PF.f	Fundamental Watts

A multi phase instrument also computes the equivalent values for total power (SUM channel) and the values for the NEUTRAL current. Neutral currents are synthesised from the phase measurements and are accurate for low distortion waveform. Step through the phase values with the *DELETE/*◄◄ & *ENTER/*►► keys, as shown below. Ph1→ Ph2→ Ph3→ SUM→ Ph1,2, & 3 total values→ Ph1,2, & 3 fundamental values→ Neu "*then back to the beginning of the cycle"*



Each press of the ENTER/►► key will progress through the phases.

The number of phases that can be displayed, will depend on the settings chosen in the *ACQU* menu for the ***wiring*** parameter.

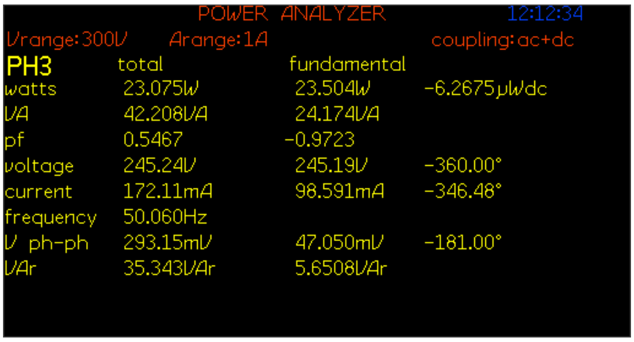
It is quite possible to have a 3 phase PPA1530 but if wiring is set to single phase 1 or 2 etc, then only that phase will be shown when using the keys to step back and forth.

In the single phase screen, there are four columns.

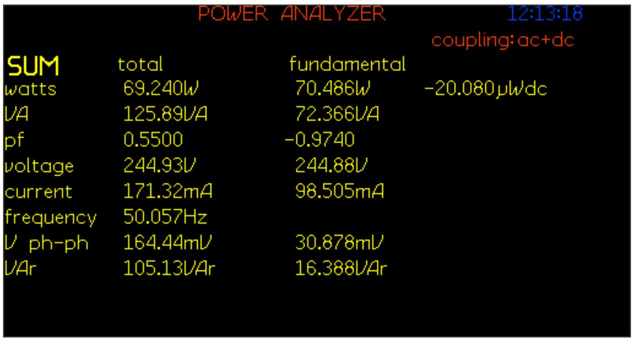
The first column shown in blue is headed by the phase being displayed, in this case phase 1, and then lists the parameters that are being displayed, voltage, current, frequency etc.

Column 2, in Red displays the total values, column 3, in green displays the same parameters as column 2 but for the fundamental frequency.

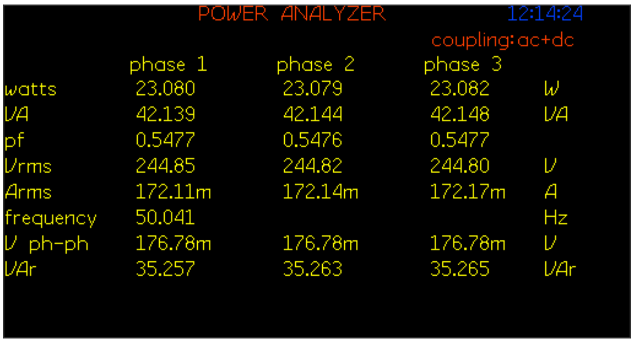
Lastly the fourth column displays the phase angle of the voltage and the current with respect to the reference set in the *ACQU* menu.



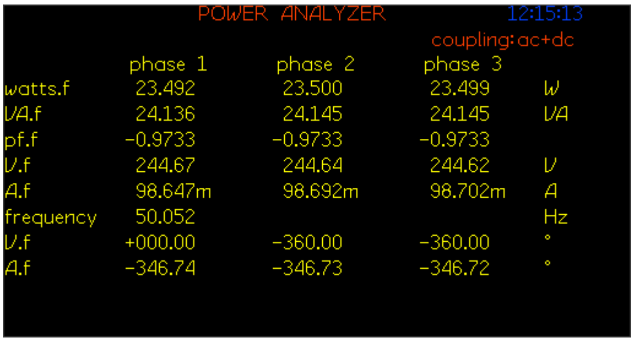
Phase 3 is shown here for clarity of the totals shown on the Sum screen below.



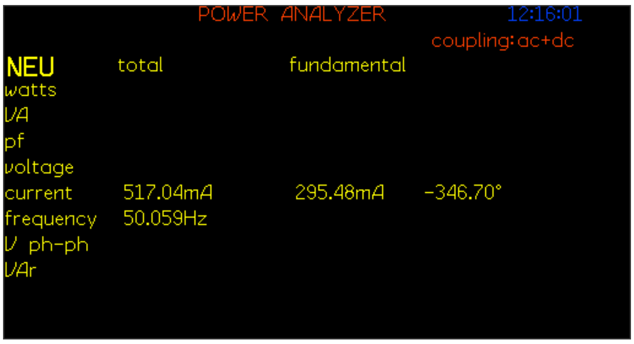
The SUM results screen displays the arithmetic sum of the three phases for Watts, VA, VAr, H3 & DC Watts, while Voltage, Current, V ph-ph & pf are the average value of the phases.



This view shows each of the phases results for Total values of each parameter.



The next view shows the same multi-phase view as previously but in this case, it is for the fundamental values rather than the total.



The final display available shows the neutral current values the derivation of these is via Kirchhoff's Law and explained in more detail along with the other derivations of the secondary values on the following pages.

The measurements are computed over rectangular windows with no gaps. The processing power of the DSPs allows the measurements to be made in true real time without missing any samples. In this way, the measured power is a true value even if the signal is fluctuating. The only occasion when data is missed is when an autozero measurement is requested – this can be disabled in the *SYSTEM OPTIONS* menu.

The elementary values are individually filtered before being used for secondary computations.

Individual phase computations

The power dissipated in a load subjected to a periodic voltage, $v(\phi)$, with a current flowing $a(\phi)$, is given by:

$$w = 1/2\pi \int_{0}^{2\pi} v(\phi).a(\phi)\, d\phi$$

For a sampled signal, the formula becomes:

$$w = 1/n \sum_{i=0}^{i=n-1} v[i].a[i]$$

Where n is the number of samples for an integral number of complete cycles of the input waveform.

The rms value of a periodic waveform, $v(\phi)$, is given by:

$$rms = \sqrt{\left[\, 1/2\pi \int_{0}^{2\pi} v^2(\phi)\, d\phi \,\right]}$$

For a sampled signal, the formula becomes:

$$rms = \sqrt{\left[\, 1/n \sum_{i=0}^{i=n-1} v^2[i] \,\right]}$$

Where n is the number of samples for an integral number of complete cycles of the input waveform.

The DC present is given by:

$$DC = 1/2\pi \int_{0}^{2\pi} v(\phi)\, d\phi$$

For a sampled signal, the formula becomes:

$$DC = 1/n \sum_{i=0}^{i=n-1} v[i]$$

Where n is the number of samples for an integral number of complete cycles of the input waveform.

From these elementary values of W, rms and DC, the following secondary values can be derived:

VA	$= V_{rms} \times A_{rms}$
VAr	$= \sqrt{(VA^2 - W^2)}$
power factor	= W/VA
W_{DC}	$= V_{DC} \times A_{DC}$

The fundamental in-phase and quadrature values of a periodic waveform, $v(\phi)$, are given by:

$$a_1 = \sqrt{2}/2\pi \int_{0}^{2\pi} v(\phi).\cos(\phi)\, d\phi$$

$$b_1 = \sqrt{2}/2\pi \int_{0}^{2\pi} v(\phi).\sin(\phi)\, d\phi$$

For a sampled signal, the formulae become:

$$a_1 = 1/n \sum_{i=0}^{i=n-1} v[i].\cos(2\pi ci/n)$$

$$b_1 = 1/n \sum_{i=0}^{i=n-1} v[i].\sin(2\pi ci/n)$$

Where n is the number of samples for an integral number of complete cycles of the input waveform, and c is the number of cycles.

These ‘a’ and ‘b’ values yield the further elementary parameters:

magnitude $= \sqrt{(a^2 + b^2)}$

phase angle $= \tan^{-1}(b/a)$

From these elementary ‘a’ and ‘b’ values of voltage and current, the following secondary values can be derived:

fundamental Watts	$= V_a \times A_a + V_b \times A_b$
fundamental VA	$= V_{mag} \times A_{mag}$
fund power factor	$= W_{fund} / VA_{fund}$
fundamental VAr	$= V_a \times A_b - V_b \times A_a$

The signs of Watts and VAr are a direct result of the computation (watts has the sign of cos (phase angle), VAr has the sign of sin(phase angle)). The sign of fundamental power factor is determined by convention such that a lagging current (inductive load) is shown as a positive power factor and a leading current (capacitive load) is shown as a negative power factor; this is effectively the sign of sin (-phase angle). Optionally the signs of fundamental VAr and power factor can be independently inverted.

Sum computations
When the PPA500 is set in either of the 3 phase wiring modes, (2 Wattmeter or 3 Wattmeter), the values for the total load are computed from the data for each individual channel.

W, VA, VAr, W.f, VA.f , VAr.f, W.DC, and W.h are computed as the sum of the individual phase data.

V.rms, V.mag, V.pprms and V.ppmag are computed as the average of the individual phase data.

A.rms and A.mag are computed from sum VA / sum V and sum VA.f / sum V.f

Sum power factor is computed as sum W / sum VA and the fundamental power factor is computed as fundamental sum W / fundamental sum VA with the sign derived from the sign of sum VAr.

When calculating 3 phase 2 wattmeter Sum:VA and VAr, options are as follows:

For low distortion signals:

$$sum.VAr = ph1.VAr + ph2.VAr$$

$$sum.VA = \sqrt{(sum.W^2 + sum.VAr^2)}$$

For High distortion signals:

$$sum.VAr = \sqrt{(sum.VA^2 - sum.W^2)}$$

$$sum.VA = \frac{\sqrt{3}}{2}(ph1.VA + ph2.VA)$$

Negative Reading?

In 3ph 2w mode, Phase 3 is used as the reference point.

In certain conditions, the combination of power factor values below 0.5 and Phase Angle can result in leading and lagging Power vectors. These can cause negative watts values to be displayed particularly for Phase 2.

Application Note **APP014** describes 3 Phase 2 Wattmeter Power Measurements in more detail. Vector diagrams and example calculations are used to explain how the measurements are computed.

Neutral synthesis

In 3 phase 3 wattmeter configuration, the values for the neutral current are synthesised from the measured values of the three phases. By Kirchhoff's law, the sum of the instantaneous currents flowing into a node must be zero. By convention neutral current is regarded as flowing out of the load so the neutral current can be derived from the sum of the three phase currents.

In 3 phase 2 wattmeter configuration, the "neutral current" values are synthesised from the 2 phase currents and represent the third phase current.

Values available are rms, fundamental magnitude and phase. Additional values for DC, AC, peak and crest factor are displayed in RMS mode.

Phase to phase computations

In 3 phase 3 wattmeter configuration, the voltmeters are connected across each individual phase and neutral. The phase to phase voltages are synthesised from the individual phase data:

display phase	computation
phase 1	phase 1 – phase 2
phase 2	phase 2 – phase 3
phase 3	phase 3 – phase 1

Phase to phase values are computed for rms, fundamental magnitude and phase.

Consider the fundamental component:

$$V_{12}(t) = V_1(t) - V_2(t)$$

$$= V_1 \sin(\omega t) - V_2 \sin(\omega t + \varphi_{12})$$

$$= V_1 \sin(\omega t) - V_2 [\sin(\omega t).\cos(\varphi_{12}) + \cos(\omega t).\sin(\varphi_{12})]$$

$$= \sin(\omega t) [V_1 - V_2 \cos(\varphi_{12})] - V_2 \cos(\omega t).\sin(\varphi_{12})$$

In a balanced system:

$$V_1 = V, V_2 = V \text{ and } \varphi_{12} = 120^\circ$$

$$V_{12} = \sin(\omega t) [V - V \cos(120^\circ)] + V \cos(\omega t).\sin(120^\circ)$$

$$= 1.5 V \sin(\omega t) - \sqrt{3}/2 V \cos(\omega t)$$

$$= \sqrt{3} V \sin(\omega t - 30^\circ)$$

Therefore the phase to phase voltage would have a magnitude √3 times larger than the phase to neutral voltage at a phase displacement of -30˚.

The PPA500 series applies the computations in a general way without any assumptions about the system. It, therefore, computes the correct values whatever the waveform.

The phase to phase values may also be displayed as a rectified mean measurement.

Efficiency
Efficiency may be computed as a ratio of any of the following:

phase / next phase,
next phase / phase,
sum / phase 3, or
phase 3 / sum

In all cases, either term may be input power or output power.

Total efficiency is computed from the total power, fundamental efficiency is computed from the fundamental power. In the case of mechanical power, there is only the one measured power which is used both for total and fundamental.

Torque & Speed
Should an input for mechanical power measurements is required, the phase 3 external inputs for voltage and current can be utilised.

Torque & Speed can be set for power measurement mode by independently using Phase 3 within the 3 Phase 2 Wattmeter + Phase 3 wiring configuration.

Channel 3 Voltage Input BNC = Torque
Channel 3 Current Input BNC = Speed

If using Multilog software:
PH3 Watts = Power
PH3 voltage DC = Torque
PH3 current DC = Speed

Input compensation
This compensation option subtracts the power absorbed by the voltage input.

When measuring low power with the voltage input wired after the current input the Power measurement would include the power absorbed by the voltage attenuator.

For example, at 230V a 1MΩ voltage attenuator would absorb a power of 0.0529W ($230V^2/1M\Omega$). Enabling Input compensation subtracts this power and the corresponding currents from the measured values.

Wiring configurations

Unlike the single phase PPA510, the three phase version PPA530 can be used in a variety of wiring configurations.

Instrument configuration	530	520	510
single phase 1	✓	✓	✓
2 phase	✓	✓	
3 phase 2 wattmeter	✓	✓	
3 phase 3 wattmeter	✓		
single phase 2	✓	✓	
single phase 3	✓		
3 phase 2 wattmeter + phase 3	✓		

In the single phase modes (phase 1, phase 2, phase 3) the other phase inputs are completely ignored and the selected phase acts as a completely independent single phase power analyser.

In the 3 phase 2 wattmeter configuration, the voltages are measured relative to phase 3. The phase 1 voltage input is connected across phase 1 and phase 3, and phase 2 voltage input is connected across phase 2 and phase 3, thus measuring phase to phase voltage directly. Phase 1 and 2 current inputs are connected normally. There is no need to measure the current in phase 3, as phase 3 has no voltage relative to itself so the power contribution is zero. In this mode, the neutral channel displays the synthesised phase 3 current.

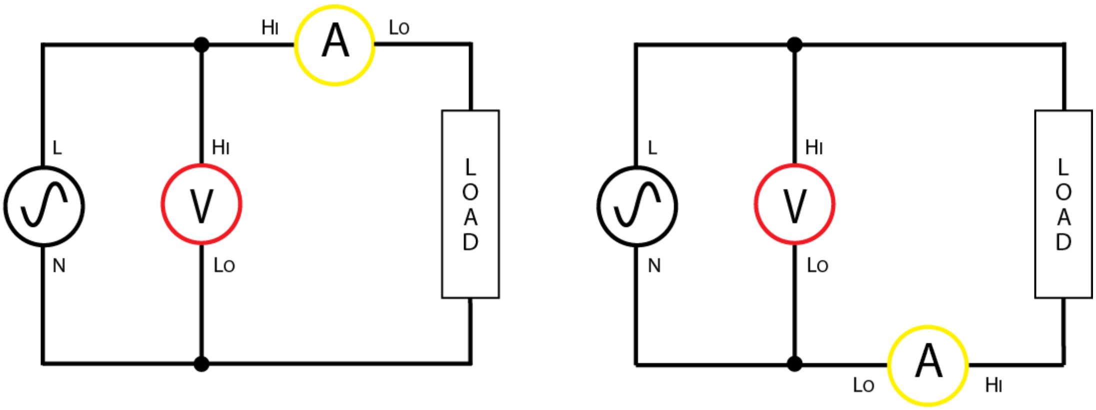
The advantage of this connection method is that 3 phase power can be measured with only 2 wattmeters. This frees up phase 3 of a 3 phase instrument to simultaneously measure the power of a single phase input (3 phase 2 wattmeter + phase 3 configuration). The frequency reference for the independent phase 3 may be selected to be voltage or current. In this mode, frequencies up to 1kHz can be measured with phase 3.

The 3 phase 2 wattmeter + phase 3 configuration can be used as an additional Torque & Speed application to supplement the existing “EXT” BNC connections on the rear panel.

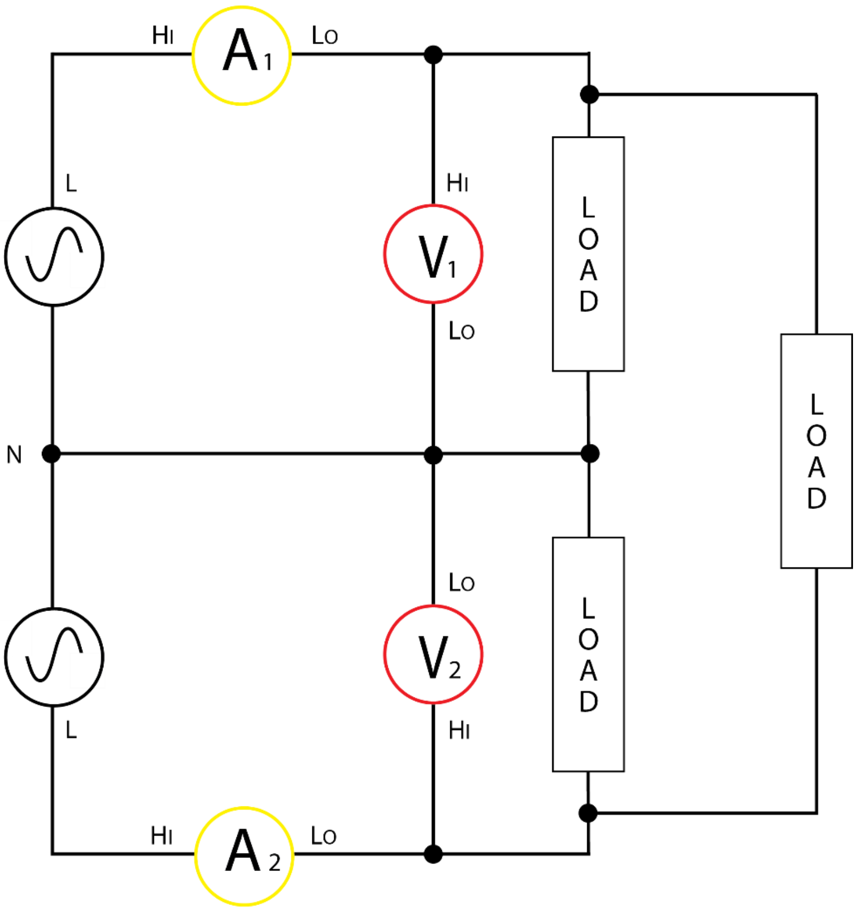
With the 3 phase 3 wattmeter configuration, each measurement phase is connected to a phase of the load with the voltage inputs measuring to neutral. In this mode, phase to neutral voltages are measured directly and phase to phase voltages are also computed.

Wiring diagrams

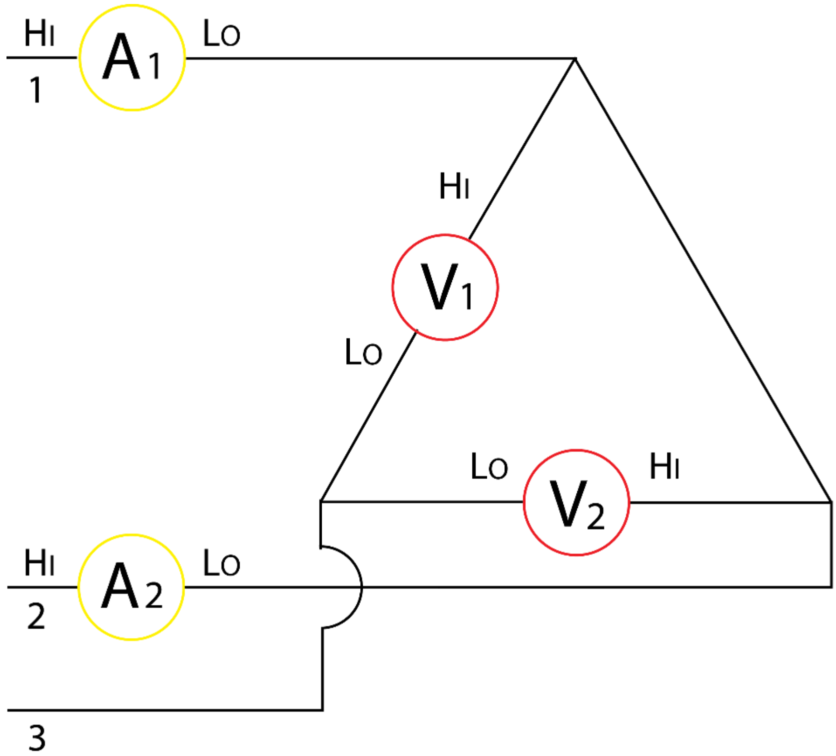
Single Phase



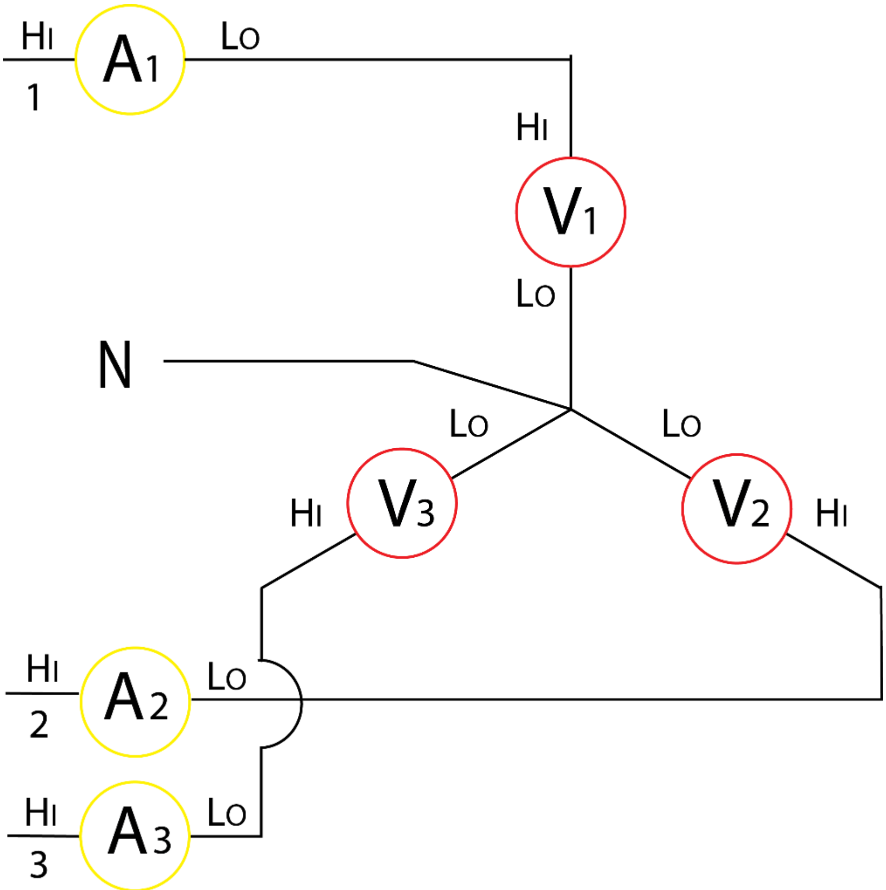
Two Phase Two Wattmeter



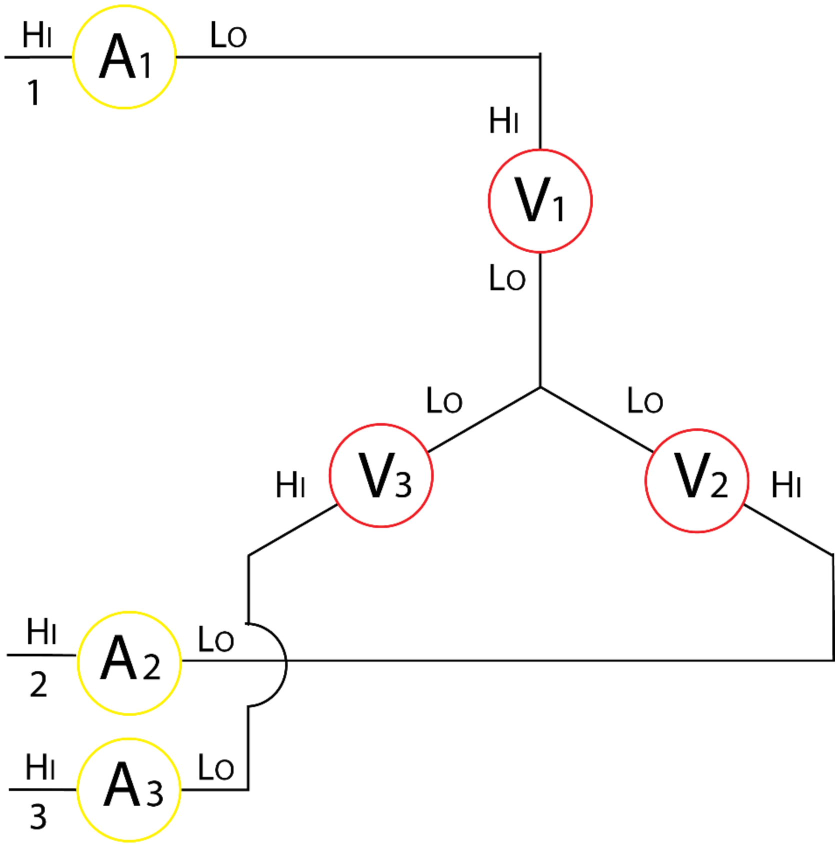
Three Phase Two Wattmeter Delta connection



Three Phase Three Wattmeter - Star connection



Three Phase Three Wattmeter – Simulated neutral – Star connection



On a multi phase instrument, all the phases usually use the same input control data – internal/external, scaling factor etc. It is possible to select 'independent' so that the phases can be set up differently. This is useful if different scaling factors are required for external shunts or if one phase is using internal shunt when others are external.

Instrument wiring

Please refer to Appendix F for physical PPA connection diagrams.

Impedance meter

The ***Impedance*** mode on the PPA500, which is selectable from the *Mode* menu uses the real and imaginary components at the fundamental frequency together with DFT analysis as described previously to compute the impedance of the load and associated parameters.

From the fundamental components of voltage, (a + jb), and those of the current, (c + jd), the PPA500 computes the complex impedance given by:

$$\mathbf{z} = v / \mathbf{i}$$

$$= (a + jb) / (c + jd)$$

The components of the complex impedance are filtered independently to minimise the effects of noise, which would have random phase and would therefore be filtered out.

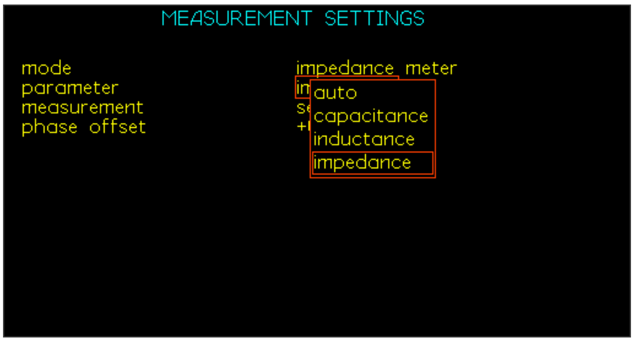
The magnitude of the voltage and current are also computed.

From the complex impedance the following parameters can be derived:

Resistance
inductance
capacitance
impedance
phase
tanδ (= real/imaginary)
Q factor (= imaginary/real)

Values can be displayed for either series or parallel models.

If the parameter option in LCR menu is set to ***auto***, the PPA500 will display capacitance or inductance according to the phase of the measurement. Alternatively, the display can be forced to capacitance, inductance, or impedance as shown here.



Capacitance is displayed with tanδ, inductance is displayed with Q factor, and impedance is displayed in its resistive + reactive form and as magnitude. The phase of the impedance is displayed with all options.

For phase critical impedance measurements, is it possible to offset the phase measurement to allow for phase shift within the connection leads

Note that the phase of the impedance is the opposite to the phase of the current in POWER mode. This is because the impedance is defined as voltage/current which, considering the magnitude and phase of Z (impedance), V (voltage) and A (current), gives:

Zmagnitude = Vmagnitude / Amagnitude

Zphase = Vphase – Aphase

As the phase is referred to the voltage:

Zphase = - Aphase

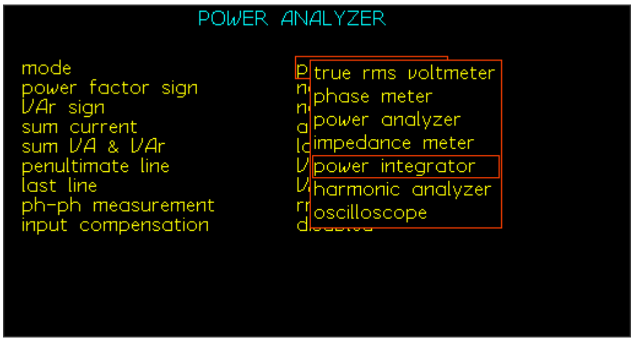
Therefore, using the phase convention from -180° to +180°, an inductive load which has an impedance with positive phase would cause a current with negative phase.

Power Integrator

In the INTEG mode, the PPA500 computes the following additional values:

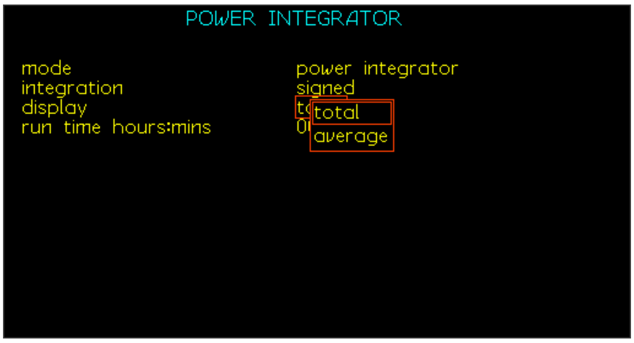
Parameter	Units
Watt hours	Wh
VA hours	VAh
VAr hours	VArh
Average power factor	
Average rms voltage	V
Ampere hours	Ah
Fundamental watt hours	Wh
Fundamental VA hours	VAh
Fundamental VAr hours	VArh
Average fundamental power factor	
Average fundamental voltage	V
Fundamental ampere hours	Ah

Setting up and running the Integrator function

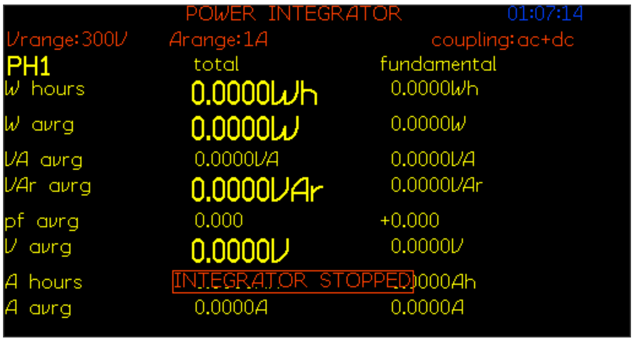


The setup menu options can be accessed by means of *MODE* key and using the ▼, ►, ▼, ▼ combination of direction keys to highlight ***power integrator*** then press *ENTER*.

The Watt hour integration and the Ampere hour integration can be selected to be signed or magnitude. To integrate the total power in terms of heating effect, choose magnitude. If signed integration is selected, then the rms current is given the sign of the power before integration. The Ampere hours and Watt hours then reflect the power taken by the load, less any power generated by the load, such as during regenerative braking in battery systems.



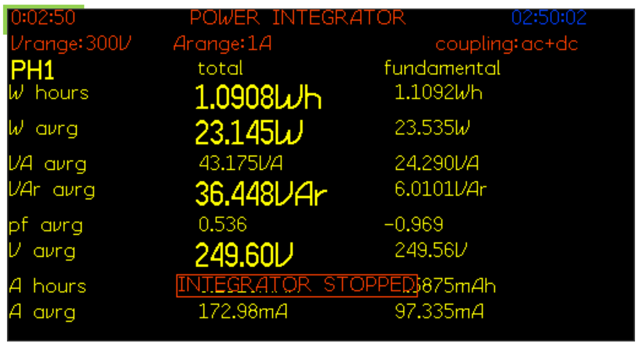
The integration results can be set to be ***Total*** accumulated values or as the ***average*** over the integration period, depending on the ***display*** parameter settings, as shown left. Lastly a countdown ***run time*** timer can be set for the desired length of time that the integration needs, up to a maximum of 99 hours and 59 minutes. Setting the timer to zero, disables the timer. Alternatively, if a longer integration time is required, the time can be controlled manually via the *START* and *STOP* keys or remotely via the command set.



Once all the parameters have been set, press the *HOME* key twice and the integrator will display the starting zeroed integration screen. the elapsed time is displayed in the upper left corner of the display as soon as the integration starts.

The integration can be stopped by pressing the *STOP* key then restarted by pressing the *START* key again. To reset the accumulated values and time press the *ZERO* key. While the integration is running, pressing the *REAL TIME* key holds the displayed values but accumulation continues in the background.

Once started, the integration continues to accumulate in the background even if the *MODE* is changed to *POWER* or *RMS*. This allows the real time values to be displayed without disturbing the integration.



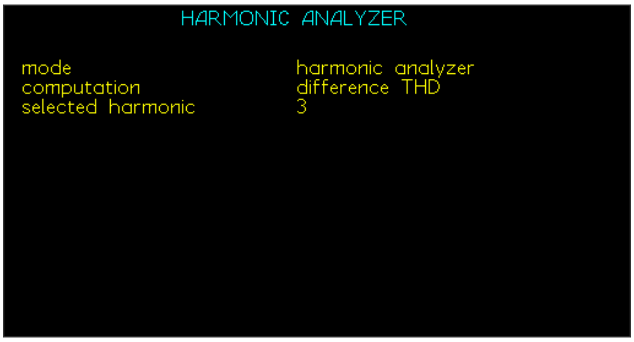
The running integration shows the timer in the top right hand corner, highlighted in green.

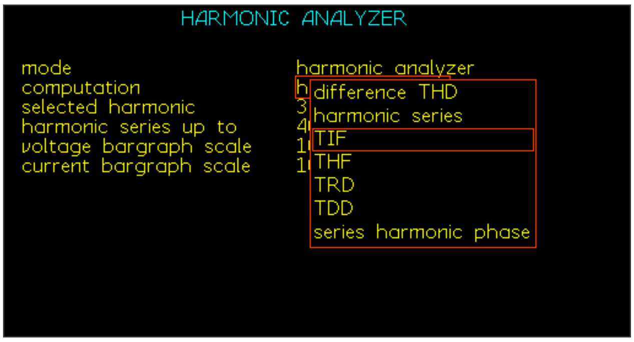
When either the timer reaches zero or the *STOP* key is pressed then the screen displays INTEGRATOR STOPPED at the bottom of the screen.

Harmonic analyser

The *HARM* mode of the PPA500 computes multiple DFTs on the input waveforms in real time.

Each mode of operation displays a context sensitive option settings screen relevant to the type of harmonics analysis being performed.





There are two modes of operation: difference THD, and series harmonics.

Series harmonic mode includes options for THD, TIF, THF, TRD, TDD and phase.

The results are available in real time, tabular or bar graph format.

Not all analyses are displayed in all formats.

Analysis Type	Real Time	Tabular	Bar graph
THD	✓	✗	✗
Series THD	✓	✓	✓
Series TIF	✓	✓	✓
Series THF	✓	✓	✓
Series TRD	✓	✓	✓
Series TDD	✓	✓	✓
Series Harmonics phase	✓	✓	✓

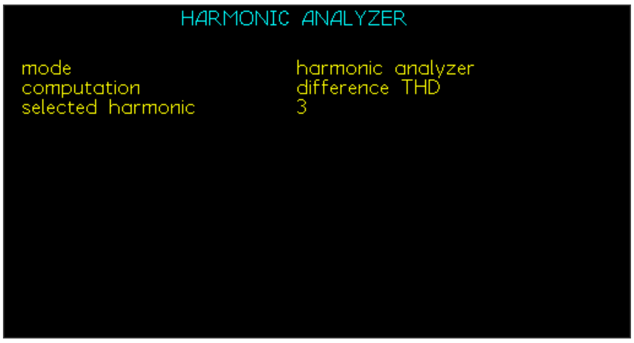
Analyses Formulae

In difference THD mode, the THD (Total Harmonic Distortion) is computed from the rms and fundamental:

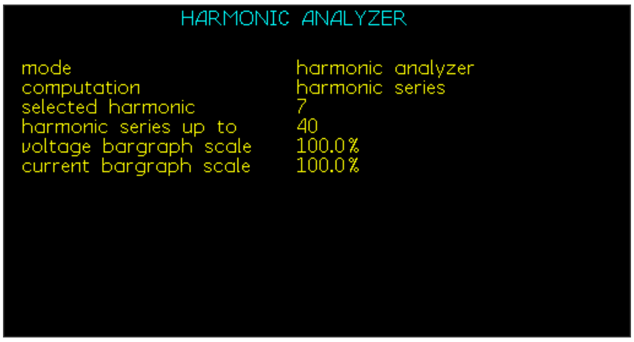
$$THD = 1/h_1 \sqrt{(rms^2 - h_1^2)}$$

In series THD mode, the THD is computed from a series of up to 50 harmonics.

$$THD = 1/h_1 \sqrt{\sum_{i=2}^{i=n} h_i^2}$$ where h_i is the i^{th} harmonic



Difference THD parameter settings default screen



Series harmonic THD, TIF, & THF all share the same setup parameter options.

TIF (Telephone Influence Factor) is similar to THD, but each harmonic has a weighting factor applied to reflect the severity of the potential interference of that harmonic on telephone communication.

$$TIF = 1/rms \sqrt{\sum_{i=1}^{i=n} (h_i \times t_i)^2}$$

where h_i is the i^{th} harmonic

and t_i is the i^{th} weighting factor

TIF is defined by IEEE standard 115 and the weighting factors are given in ANSI standard C50-13. The harmonic factors for TIF are specified for harmonics of 60Hz.

THF (Telephone Harmonic Factor) is a similar computation to TIF but uses different weighting factors and is expressed as a percentage.

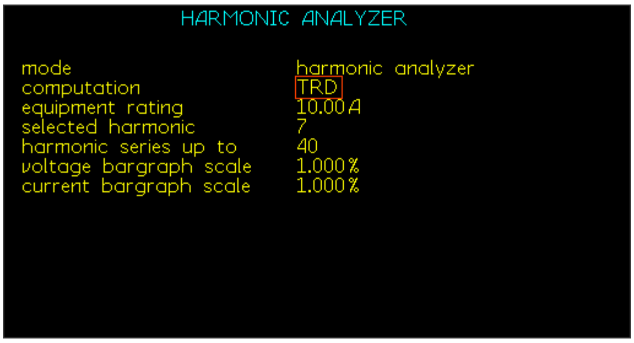
$$THF = 1/rms \sqrt{\sum_{i=1}^{i=n} (h_i \times t_i)^2}$$

where h_i is the i^{th} harmonic

and t_i is the i^{th} weighting factor

The THF computation and weighting factors have been implemented according to IEC standard 60034 part 1 (1996) with amendments A1 (1997) and A2 (1999). The harmonic factors are specified for harmonics of 50Hz.

TRD (Total Rated Distortion) uses a different reference to scale the harmonic percentages instead of the fundamental. The voltage harmonics are scaled by the rms voltage, and the current harmonics are scaled by the larger of the rms current or the rated current entered by the HARM menu. The rms is computed from the series of harmonics.



$$TRD = 1/ref \sqrt{\sum_{i=2}^{i=n} h_i^2}$$

where h_i is the i^{th} harmonic

and ref is rms or rated current.

Similarly, TDD (Total Demand Distortion) scales the computed harmonic distortion by the measured rms. For voltage, TDD is the same as TRD; for current, TRD is less than TDD unless the measured rms current is greater than the entered rated current.

The value for TRD and TDD will always be lower than the computed THD as rms is always greater than the fundamental.

$$TDD = 1/rms \sqrt{\sum_{i=2}^{i=n} h_i^2}$$

where h_i is the i^{th} harmonic

Harmonic phase can be selected instead of a thd computation and each harmonic in the series is computed as a magnitude and phase angle.

The number of harmonics used for THF, TIF, TRD, TDD and series harmonic phase computation (max 50) is selectable in the same way as for THD.

In all cases, the harmonics are phase referred to Phase 1 voltage fundamental so that their in-phase and quadrature components may be separately filtered to minimise noise.

Accurate frequency synchronisation is essential for reliable harmonic measurement. Good results can be obtained in a reasonable time using the medium speed setting (which runs a little slower than other modes) but for the best results, use the slow speed setting.

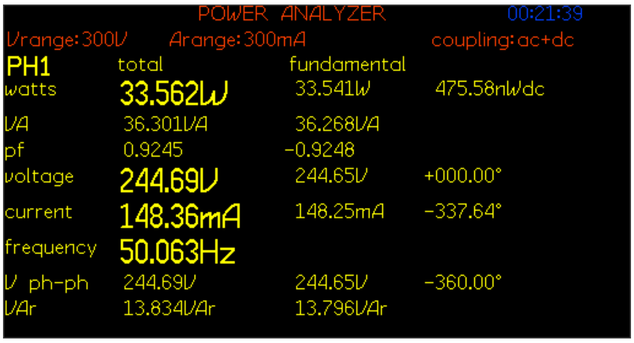
Chapter 11 Application Modes

Within this section we will look at all the different application modes selectable from within the PPA500 Series *APP* menu, with the aid of screenshots and instructions.

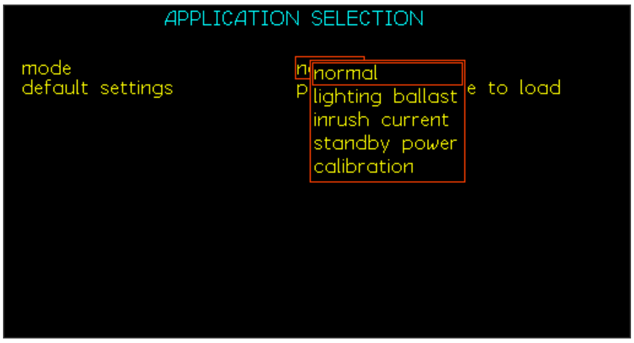
Each of the *APP* selections will load and adjust settings as a suitable starting point for the application appropriate to the DUT or system that is to be analysed.

While the top of the display screen will still show for example, ***Power Analyzer*** when the ***Lighting Ballast*** *APP* has been selected, the instruments settings will not be the same as when it is set to ***Power Analyzer*** in ***normal*** mode. In fact, some of the settings are only available in a particular *APP* selection compared to the standard Power Analyzer mode.

Normal default screen

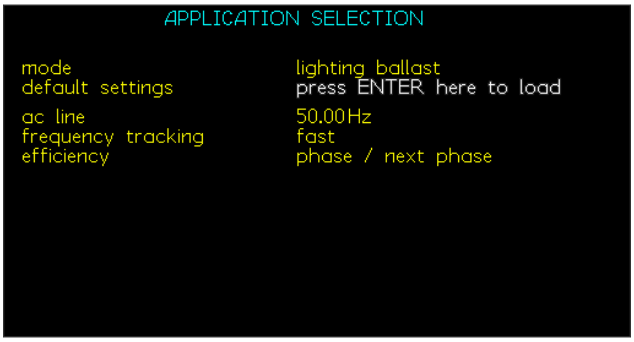


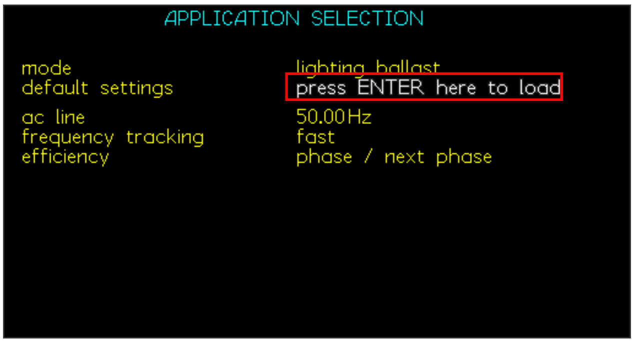
APP Menu screen



To select lighting Ballast or any of the other applications, use the ◄ ► ▲ ▼keys to select the application mode required and then press enter.

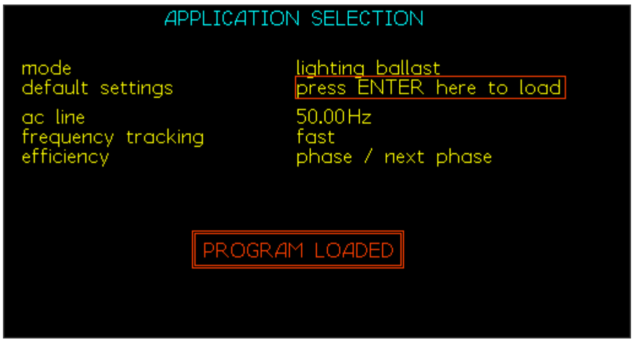
The screen will now look as shown below left.



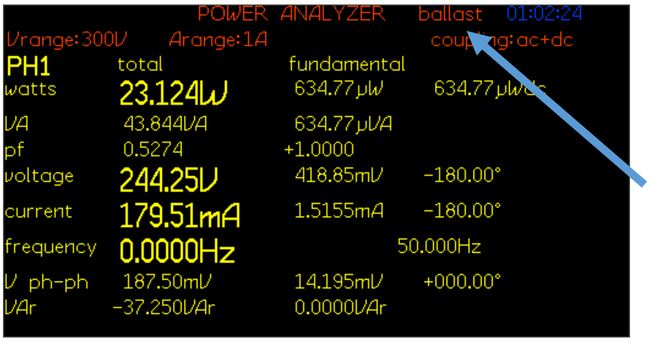


Use the ▼key to highlight the flashing white text and then press ***Enter***

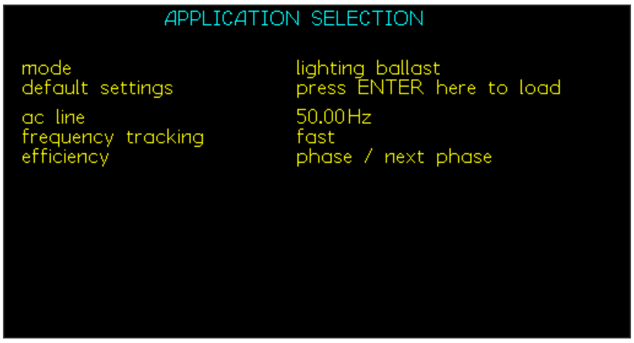
A message showing that the application has loaded will show on the screen for approx 3 seconds



Press the home key twice and the screen will now show the default power analyzer screen for the selected application, this is confirmed by the addition of the application name to the right of POWER ANALYZER



Ballast is displayed between the mode and the time.



If the ***APP*** key is pressed, the settings loaded by the App are shown. In this case efficiency has been set to ***phase/next phase*** additionally their may be other hidden settings that are only normally accesable via the command set that have been adjusted for the particular application.

To reset to the normal Power Analyzer mode, chose ***Normal*** in the *APP* selection screen and load the default settings by highlighting Press ENTER here to load Followed by *ENTER*

To select your chosen measurement application, you will need to activate the *APP* key. Use the ▼ key to select mode / function then press the ► key to open the drop down menu.

In the following sections, each App mode setup and configuration will be illustrated to enable the maximum use and benefit from the PPA500 Series instruments.

Lighting Ballast

Electronic lighting ballast waveforms consist of a high frequency carrier signal modulated by the line frequency. The PPA500 measures the line frequency independently of the input waveform frequency and synchronises the measurement period to the line frequency.

The carrier frequency measurement ignores any “dead band” around the zero crossing of the AC line to compute the actual switching frequency of the ballast.

Both the frequency measured on the input waveform and the frequency of the line input are displayed.

As the switching frequency can vary over the cycle, the analysis frequency of the DFT measurement is continually adjusted to give an optimum measurement of the fundamental and harmonics. The response of the tracking algorithm can be adjusted to suit the ballast being measured:

Fixed time (no adjustment)
Fast
Medium
Slow

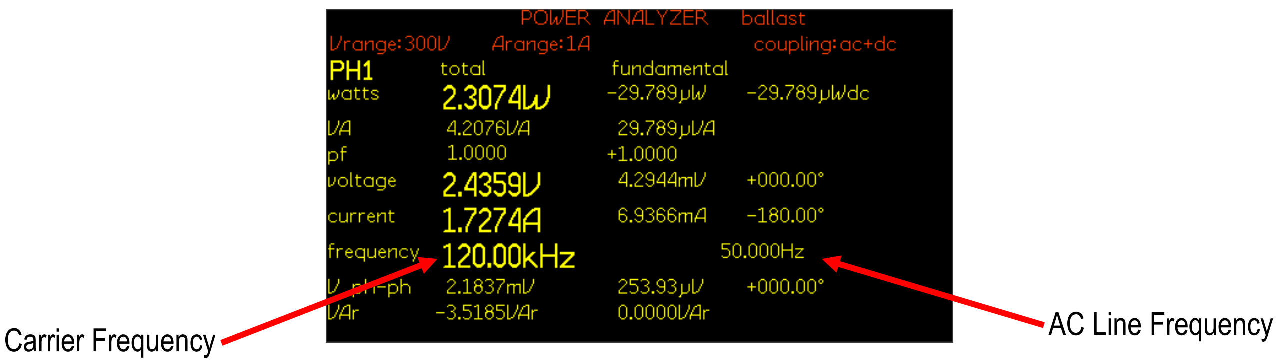
Ballast mode quick start guide

After selecting ***lighting ballast*** in the APP menu (see above), the next step is to connect the ballast input and output (if required) to the Power Analyzer.

Connect the OUTPUT of the ballast to PHASE 1 of the PPA, this is important as detection of the modulation signal is on PHASE 1.
Connect the input (50/60Hz line etc) of the ballast to PHASE 2 of the PPA.

With connections to the PPA made, we are ready to commence measurements.

Example measurements



Phase 2 will also display the same two frequency components for the user’s reference.

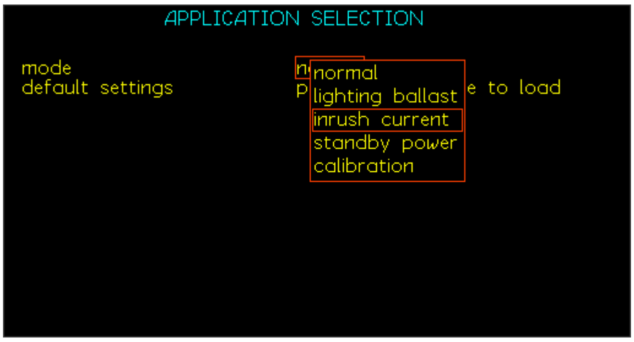
INFORMATION. The default setting for efficiency measurements is Phase 1/Phase 2

Inrush Current

Measurement of inrush current (surge) requires very fast gapless sampling to catch the highest instantaneous transient typical of this type of behaviour. By default, the PPA500 series will be set to auto ranging, while in most cases this is a positive advantage, for determining inrush current measurements, it can work against the PPA500.

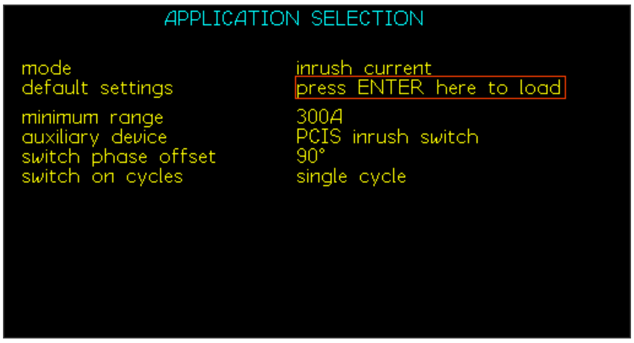
The PPA500 series can be used in two ways to measure the inrush current, firstly as a standalone instrument, and secondly with the use of the PCIS accessory (See Appendix A)

Inrush measurement without a PCIS accessory.



In the *APP* menu, select ***inrush current*** and then press *ENTER* to load the default settings

The default settings are shown in the screen shot below



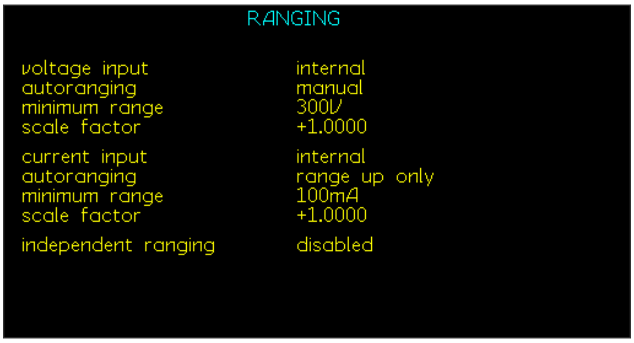
The default settings expect the PCIS to be used, by pressing the ▼ twice, the auxiliary device parameter is highlighted, use the ▶ and ▲ key to highlight ***none*** followed by *ENTER*

The last two parameters, ***switch phase offset*** and ***switch on cycles*** will be removed from the screen and measurements can commence.

The measurements must be made under conditions of manual ranging and with the voltage applied to the instrument. Then when the load is switched on the highest peak value can be detected. In inrush mode, the PPA500 samples and analyses every sample at the full sample rate of 1Msamples/s to catch even very fast peaks.

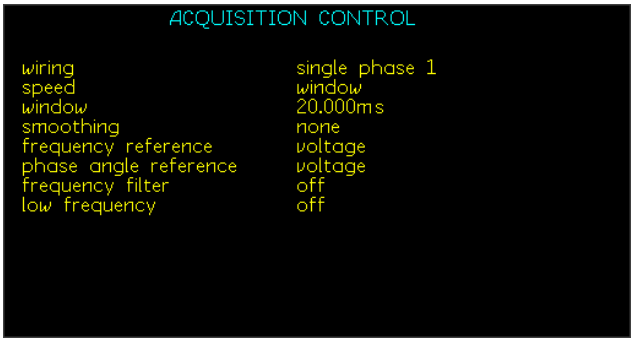
Setting the range parameter

This is best configured if the user has prior knowledge of the peak current measurement expected from the DUT. If this is not available, then the user should set the current settings as follows.

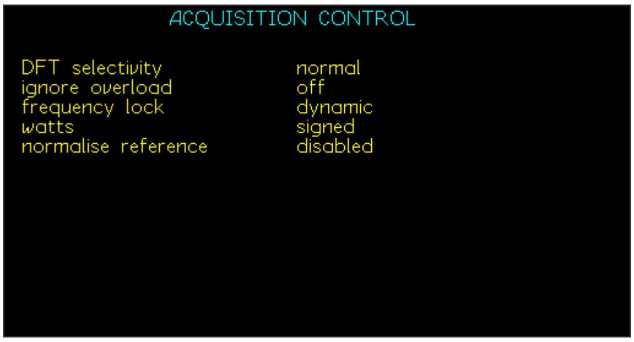


Set the ***autoranging*** parameter to ***range up only*** and the minimum range to the 100mA range this will allow the test being carried out to find the highest range via peak detection and hold on this range

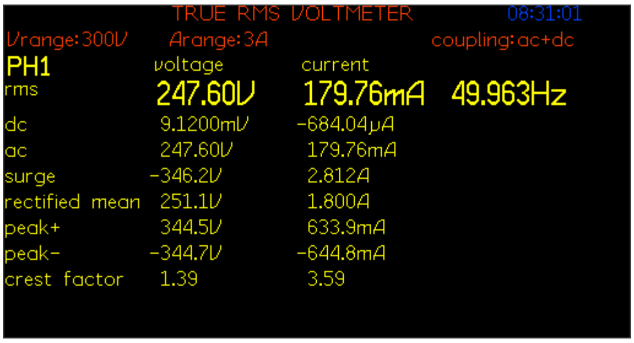
Setting the Speed and Smoothing



For this application a mains input signal of 50Hz was used, therefore we can set the ***speed*** to ***window*** and ***20.00ms*** this will enable us to capture cycle by cycle data over the whole waveform, to get the instantaneous cycle by cycle power the ***smoothing*** parameter is best set to ***none*** as shown



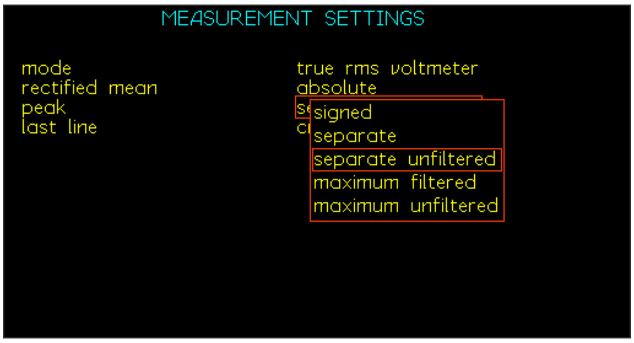
Upon completion of the speed and smoothing settings press the ► key to take you to the advanced settings screen. If undertaking cycle by cycle measurements on the input signal, then set the ***frequency lock*** to ***Dynamic***



Setting Peak Measurement Parameters, if required, you can display the ***Peak+*** and ***Peak-*** measurements within the RMS Voltmeter mode screen

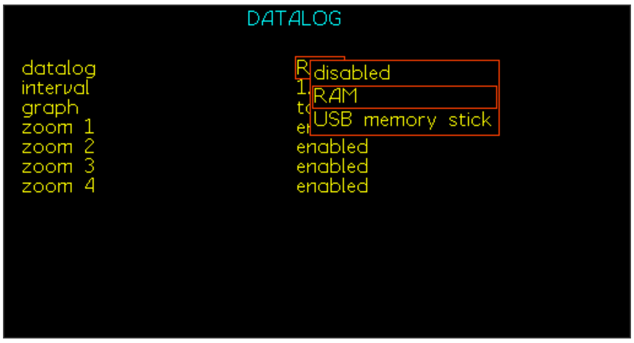
These parameters can be configured within the True RMS Voltmeter mode key

Press the *RMS* mode key until the measurement settings screen is displayed



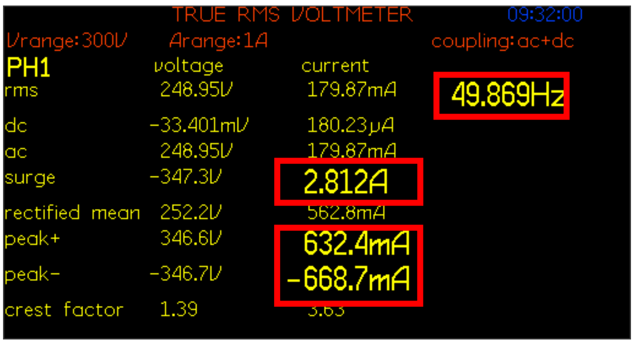
For this demonstration we selected ***separate unfiltered*** this then gave us the unfiltered ***Peak +*** and ***Peak –*** measurement parameters as displayed earlier for both Voltage and Current

Data logging to Internal Memory



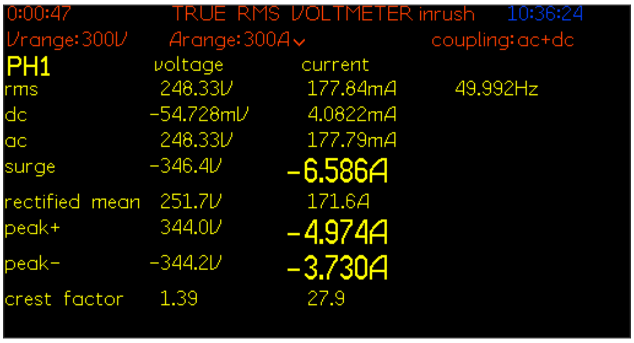
Set the ***Datalog*** parameter to the internal ***RAM*** memory this will offer the user the fastest performance

Set the ***interval*** time to ***0.00s*** to enable the Datalog to capture every cycle of the fundamental frequency

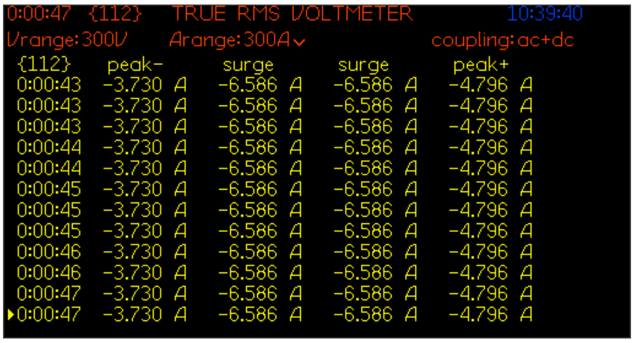


Reconfigure zoom parameters within real time display as described here

Zoomed parameters can now be used to capture the Inrush Current (Surge) data within a Datalog

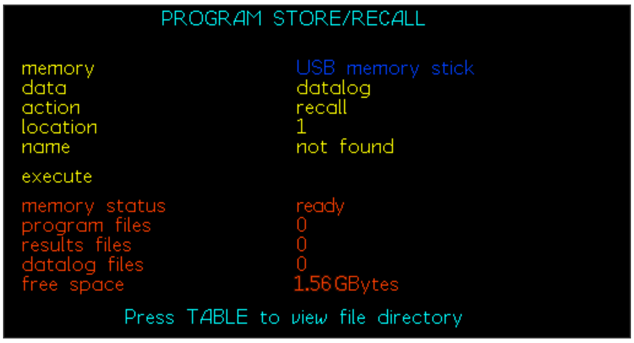


DataLog Results
From the Real Time display the surge measurement at the moment the DUT was switched on is recorded as 6.586A

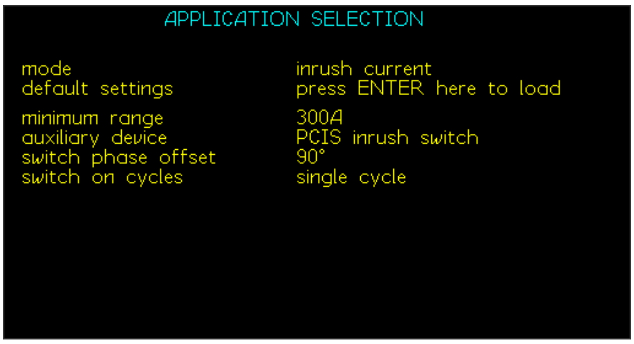


Pressing the *TABLE* key will now display all the data points taken from the associated DataLog and you will notice that the Inrush Current (Surge) is displayed as being 6.586 A

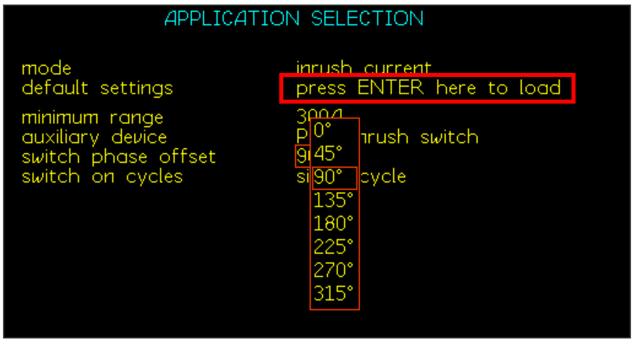
Upon completion you are now able to save / recall or delete your test results taken from your DataLog within the *PROG* mode key



Transferring the Datalog from the RAM memory onto a USB memory stick will allow the user to export the .txt file which can be imported into an Excel file if desired, more details can be found relating to the transfer of data here

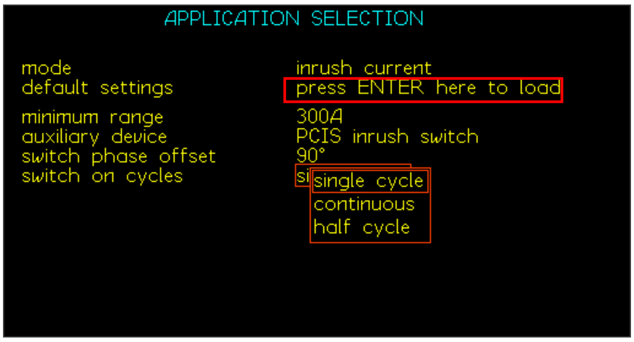


Inrush Current Mode using the N4L PCIS Switch.
For the worst case inrush current the input to the device under test must be switched on at the worst point in the cycle (90˚ or 270˚ for a capacitive load, 0˚ or 180˚ for an inductive load). The Phase Controlled Inrush Switch, or PCIS, available as an accessory for the



PPA500, controls the switch on of the power to the DUT from 0˚to 315˚ in steps of 45˚ from the Instruments front panel.

Switch Phase Offset:
Press the ▼ Key followed by the ▶ key to reveal the drop down menu to select switch on phase angle. Select the desired angle by use of the ▲ & ▼ keys, followed by *ENTER* to confirm the selection.



Switch on Cycles:
Press the ▼ Key, the ***Switch on Cycles*** parameter will be selected. Press the ▶ key, the drop down box will open with all available waveform cycle ranges.

Select the desired waveform cycles value by use of the ▲ & ▼ keys, followed by *ENTER* to confirm the selection

The testing, datalogging etc can now be performed in the same manner as in the previous section without the PCIS

When performing analysis of inrush current of a product such as a transformer or the input stage of a switched mode power supply, "range up only" (found in the *RANGE* menu) can provide a useful method for determining an appropriate range for the inrush tests if the current consumption of the product during an inrush event is unknown.

However, precautions should be taken regarding the range-up only function as this functionality is generally intended for use when monitoring gradual load current changes, such as when a motor load is gradually increased over time.

Ideally, before performing an inrush test the range setting in the PPA would be manually selected and fixed using the ***manual*** setting in the *RANGE* menu. This setting will reflect the maximum peak current you expect the device under test to draw from the voltage supply.

INFORMATION. It is important that the voltage supply signal is always present at the voltage input terminals of the PPA, do not turn the source on and off to perform inrush current tests. The voltage source should be disconnected and reconnected to the device under test using safe working practices.

To utilise “range up only” to determine an appropriate range, it is advisable to make the following settings

1. ***Speed, medium***
2. ***Smoothing response, fixed time***
3. ***Low frequency mode, ON***
4. ***RANGE, current, range up only***

After these settings are made, the device under test should be connected to the voltage source repeatedly until the range up only function no longer “ranges up”.

If at any time you observe the range briefly ranging up and then ranging back down, you should revert to manual ranging and perform the tests manually until a suitable range is found.

After these tests are made, the appropriate range should be set to ***manual*** and ***smoothing*** and ***low frequency*** mode ***disabled***

If you wish to analyse the peak current (this is the highest single sample point detected) within any cycle, then a slower speed can be selected and the ***surge*** parameter in ***RMS*** mode will provide this value***.***

INFORMATION. Entering the default settings in inrush mode in the application menu selects the PCIS and sets the PPA15xx to manual ranging. If PCIS is not being used, then it can be deselected in the AUX menu. Having selected the default settings, the current range should be set to an appropriate range for the DUT. The oscilloscope mode is also useful for qualitatively evaluating the inrush current.

Standby Power

Standby power, also sometimes referred to as vampire power, vampire draw, phantom load or ghost load refers to the way electric power is consumed by electronic and electrical appliances while they are seemingly “switched off” or in a dormant or “standby state. This occurs when devices claimed to be "switched off" on their control interface are in fact drawing small amounts of power to enable rapid switch on, or to maintain timer functions and the like. Some devices, such as power adapters for disconnected electronic devices, consume power without offering any features (sometimes called no-load power). All the above examples, such as the remote control, digital clock functions and—in the case of adapters, no-load power—are completely switched off just by switching off at the power point. However, for some devices with built-in internal battery, such as a phone, the standby functions can be stopped by removing the battery instead where this is feasible.

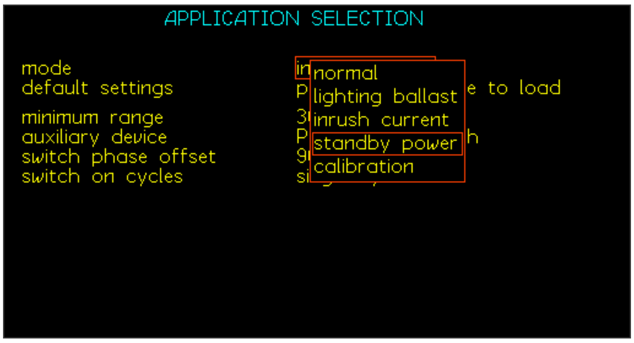
In the past, standby power was largely a non-issue for users, electricity providers, manufacturers, and government regulators. However, as climate change awareness has grown it has become an important consideration for all parties. Up to the middle of the 2000’s, standby power was often several watts or even tens of watts per appliance. By 2010, regulations were in place in most developed countries restricting standby power of devices sold to one watt (and half that from 2013).

IEC 62301:2011 - Household electrical appliances - Measurement of standby power is the standard used to measure against. The unrivalled dynamic range of the PPA500 series enables the user to comply with IEC62301 and Energy Star testing standards. Utilising "Standby Power Mode" the PPA employs proprietary standby power signal processing algorithms to provide accurate no gap analysis of high crest factor (CF) signals.

Most of the power consumed by devices in standby mode is taken in the periodic higher current cycles, so to accurately measure the power drawn by these devices, the PPA500 synchronises to the power frequency for the analysis but extends the measurement window to the irregular period of higher energy pulses. Because the PPA500 samples in true real time without any gaps, no data is missed, and every power cycle is captured.

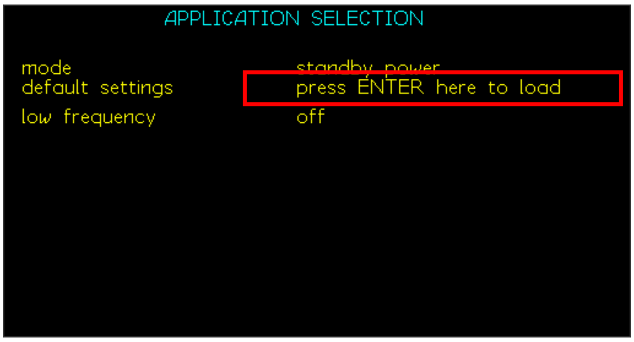
The Standby Power settings are accessed in the same way as the other application modes, i.e., via the *APP* menu key, and the default settings are enabled via the use of the *ENTER* key as previously.

To access standby mode:



Press the *APP* key
Press the ▼ key and then the ► key. This will open the drop down menu selections.
Press the ▼ key 5 times until the red box surrounds standby power.
Press *ENTER*, this will now set the mode

Press the ▼ key to move to default settings and press *ENTER*. The instrument will now set the voltage and current measurement parameters



Press the ▼ key to move the cursor to low frequency mode

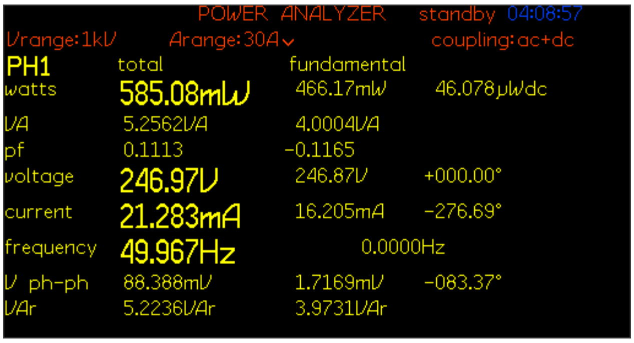
Pressing *ENTER* to load the applications default settings will automatically set the ***low frequency*** parameter to ***OFF.***

You can now return to the Power Analyzer screen

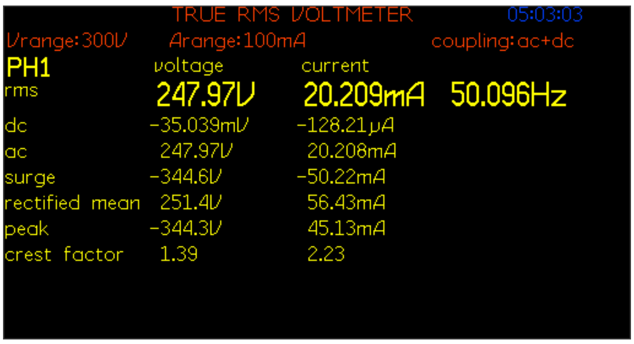
Test device: 1 x Stand-alone Heater

Accessories: 1 x Break Out Box

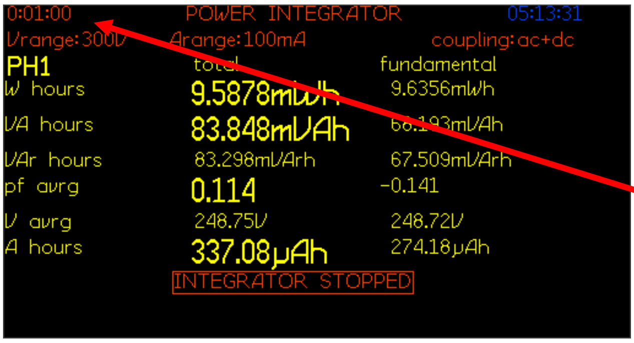
It is important that ranging is set to manual or up only auto ranging so that the power cycles are not missed while ranging.



The real time display shows a screenshot from the Power Analyzer home screen with the test device in standby mode



Reverting to the “RMS” screen you can see all the subsequent voltage measurements from each phase associated with the test unit in Standby Mode



Left is a display taken from the power integrator screen *INTEG*, displaying a 1 minute integration of the power being consumed

(The timer is in the top left hand corner)

Calibration

Calibration Mode is to be used in combination with N4LCal (N4L Calibration software) which facilitates performing manual calibration with an external source. This software is supplied with a detailed manual describing the calibration process, for more information contact N4L on the following email.

support@newtons4th.com

Chapter 12 Setting up and using remote control

The PPA5500 SERIES is fitted with an RS232 serial communications port, USB port, and LAN interface fitted as standard, (Port No 10001, IEEE488 (GPIB) is available as an additional module (Port No 10001). All the interfaces use the same ASCII protocol except for the end of line terminators:

Interface	Rx expects	Tx sends
RS232 USB LAN	Carriage return (line feed ignored)	carriage return and line feed
IEEE488	Carriage return or line feed or EOI	carriage return with EOI

All the functions of the PPA500 SERIES can be programmed via any of the interfaces, and the results read back. When the IEEE488 interface is set to ***remote*** the RS232 port is ignored.

The commands are not case sensitive and white space characters are ignored (e.g., tabs and spaces). Replies from PPA500 SERIES are always upper case, delimited by commas, without spaces.

Only the first six characters only of any command are significant – any further characters will be ignored. For example, the command to set the generator frequency is ***FREQUE*** but the full word ***FREQUENCY*** may be sent as the redundant ***NCY*** at the end will be ignored.

Fields within a command are delimited by a comma, multiple commands can be sent on one line delimited with a semi-colon e.g.

BANDWI,LOW;SPEED,SLOW

Mandatory commands specified in the IEEE488.2 protocol have been implemented, (e.g. ****IDN?, *RST***) and all commands that expect a reply are terminated with a question mark.

Data values returned by the PPA500 SERIES are in scientific notation, with a 5 digit mantissa by default. For extra resolution, this can be increased to 6 digits by setting the resolution to ***high*** in the *REMOTE* menu.

There is also an option for higher speed data transfer by selecting ***resolution*** = ***binary*** where each value is returned in 4 bytes, each of which has the msb set so that it will not be interpreted as an ASCII character.

byte 1	2's complement signed exponent
byte 2	Bit 6 = mantissa sign bit 5:0 = mantissa bits 19:14
byte 3	mantissa bits 13:7
byte 4	mantissa bits 6:0

When the msbs are stripped off and the bytes put together, there is 6 bit signed exponent, a mantissa sign bit and a 20 bit mantissa magnitude. The value then is given by:

$$\text{Value} = +/- 2^{\text{exponent}} \times \text{mantissa} / 2^{20}$$

The PPA500 SERIES maintains an error status byte consistent with the requirements of the IEEE488.2 protocol (called the standard event status register) that can be read by the mandatory command ***ESR?**

The PPA500 SERIES also maintains a status byte consistent with the requirements of the IEEE488.2 protocol, that can be read either with the IEEE488 serial poll function or by the mandatory command ***STB?** over RS232 or USB or IEEE or LAN.

The IEEE address defaults to 23 and can be changed via the *REMOTE* menu. Setting the LAN IP address to 0.0.0.0 will enable the DHCP and the unit will obtain its IP-Address from the DHCP server. The DHCP server must be present on the network for this to work. The LAN will not start normal operation until it receives an IP address from the server.

Setting the LAN IP manually will disable the DHCP and the unit will use a fixed IP address, defined by the IP Address setting in the *REMOTE* menu.

The keyboard is disabled when the instrument is set to “remote” using the IEEE interface or if the command ***KEYBOA,DISABL*** is sent via RS232 or LAN. Press *HOME* to return to Local operation.

RS232 data format

The RS232 format is: start bit, 8 data bits (no parity), 1 stop bit. Flow control is ***RTS/CTS***, baud rate is selectable via the *REMOTE* menu.

A summary of the available commands is given in the Appendix. Details of each command are given in the communication command section of the manual.

Commands are executed in sequence except for two special characters that are immediately obeyed:

Control T (20) – reset interface (device clear)
Control U (21) – warm restart

To maintain compatibility with some communication systems, there is an optional “protocol 2” which requires a space between the command and any arguments.

Standard event status register

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
PON		CME	EXE	DDE	QYE		OPC

Bit 0 OPC (operation complete)
cleared by most commands
set when data available or sweep complete

Bit 2 QYE (unterminated query error)
set if no message ready when data read

Bit 3 DDE (device dependent error)
set when the instrument has an error

Bit 4 EXE (execution error)
set when the command cannot be executed

Bit 5 CME (command interpretation error)
set when a command has not been recognised

Bit 7 PON (power on event)
set when power first applied, or unit has reset

The bits in the standard event status register except for OPC are set by the relevant event and cleared by specific command (***ESR?, *CLS, *RST***). OPC is also cleared by most commands that change any part of the configuration of the instrument (such as ***MODE*** or ***START***).

Serial Poll status byte

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
		ESB	MAV	ALA	FDV		RDV

Bit 0 RDV	(result data available) set when results are available to be read as enabled by ***DAVER***
Bit 2 FDV	(fast data available (streaming)) set when data streaming results are available to be read as enabled by ***DAVER***
Bit 3 ALA	(alarm active) set when an alarm becomes active as enabled by ***ALARMER***
Bit 4 MAV	(message available) set when a message reply is waiting to be read
Bit 5 ESB	(standard event summary bit) set if any bit in the standard event status register is set as well as the corresponding bit in the standard event status enable register (set by ****ESE***).

RS232 connections

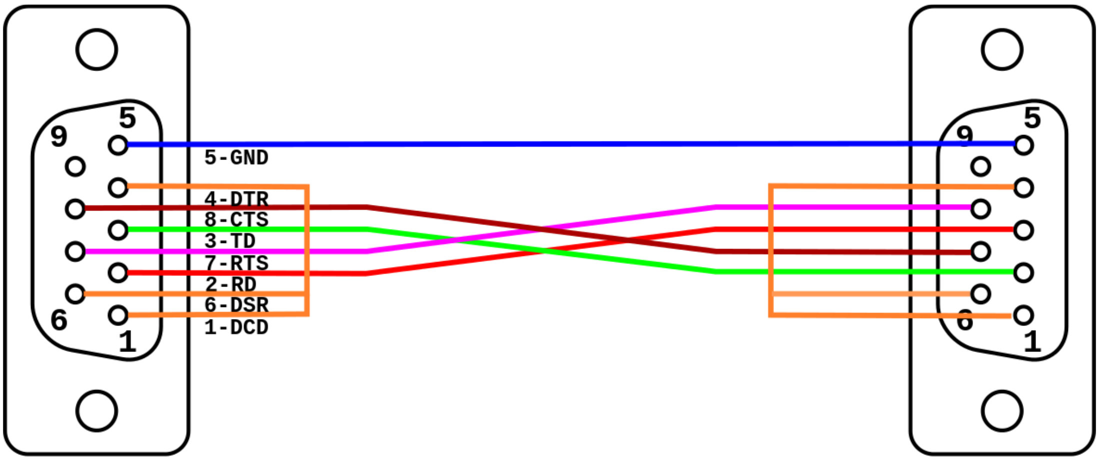
The RS232 port on the PPA500 SERIES uses the same pinout as a standard 9 pin serial port on a PC or laptop (9-pin male ‘D’ type).

Pin	Function	Direction
1	DCD	in (+ weak pull up)
2	RX data	in
3	TX data	out
4	DTR	out
5	GND	
6	DSR	not used
7	RTS	out
8	CTS	in
9	RI	Not used

The PPA500 SERIES will only transmit when CTS (pin 8) is asserted and can only receive if DCD (pin 1) is asserted. The PPA500 SERIES constantly asserts (+12V) DTR (pin 4) so this pin can be connected to any unwanted modem control inputs to force operation without handshaking. The PPA500 SERIES has a weak pull up on pin 1 as many null modem cables leave it open circuit. In electrically noisy environments, this pin should be driven or connected to pin 4.

To connect the PPA500 SERIES to a PC, use a 9 pin female to 9 pin female null modem cable:

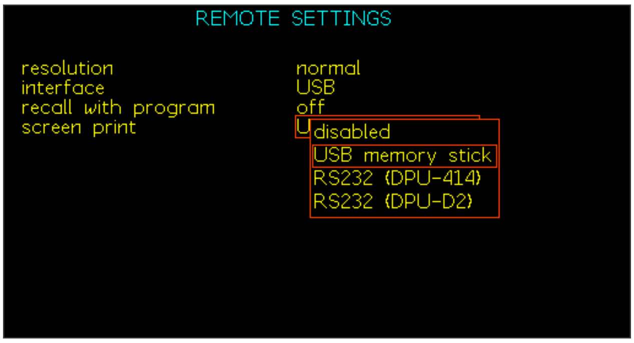
Pin(s)	Conect to	Pin(s)
1 & 6	⇆	4
2	⇆	3
3	⇆	2
4	⇆	1 & 6
5	⇆	5
7	⇆	8
8	⇆	7



Null modem serial cable pin-out

Screen Shot

If required, you can take a screenshot of what is currently displayed on the screen. To do this, insert a USB memory stick into the USB slot on the front of the device and then hold the 'START' key for roughly 2 seconds. This will capture what is currently on the screen and save it as a bitmap image on the memory stick.



By default, the save location for the screen shot will be the USB memory stick; this can be changed in the *REMOTE* menu. You can change it to print to the RS232 port, that is used to print to an attached printer to print a physical copy of what is shown on the screen.

RS232 printer

Alternatively, the RS232 port can also be connected to a serial printer for making a hard copy of any screen. When printing is enabled in the REMOTE menu, then pressing START will commence a screen dump to the printer. The graphic protocol used is the ESC/P so any printer which supports this protocol should work such as the Seiko DPU-414.

The other communication options, USB, LAN or GPIB, can still be used while the RS232 printer is enabled.

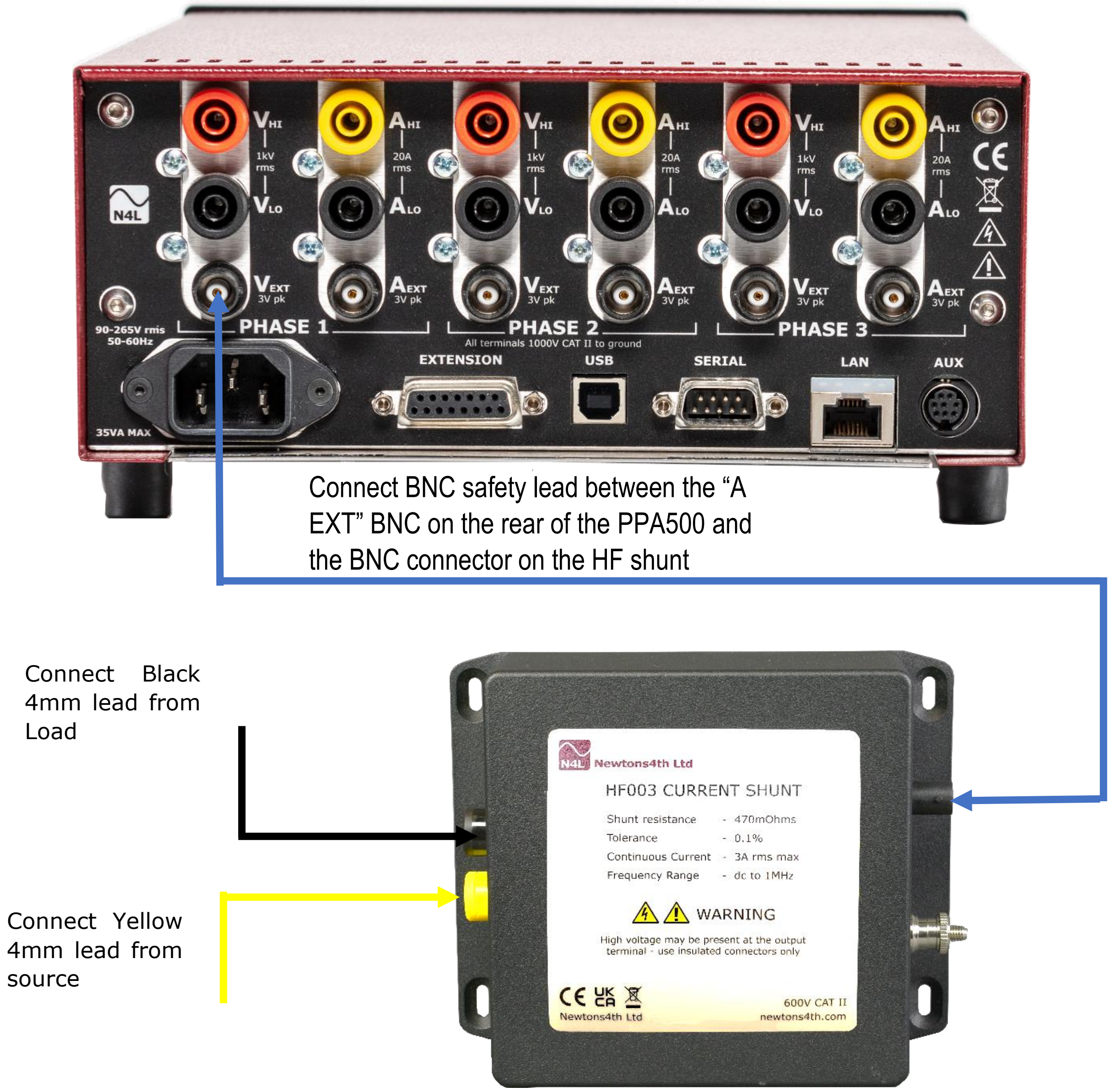
Chapter 13 External shunts and transducers

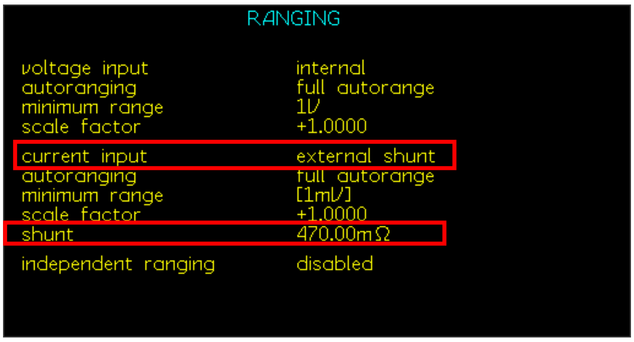
A variety of peripherals can be connected to the PPA500 range of instruments, to enhance and adapt the measuring capability to suit most scenarios.

Refer to website for full range of accessories and transducers. This section explains how to connect and set up the most often used types of transducers

External current shunts can be used as an alternative to the instruments internal shunt as a fixed value Impedance circuit. Note do not use both shunts together

Test equipment for demonstration:
1 x Inverter/Motor test unit (single phase)
1 x HF 003 Current Shunt (shunt resistance = 470mΩ)
Wiring Configuration:





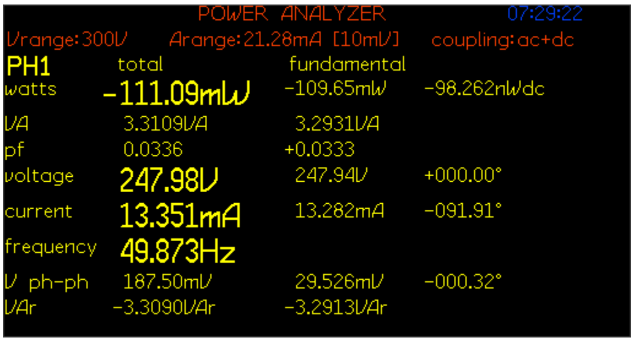
Set up PPA to read the external current shunt:

Press the *RANGE* button
Press the ▼ key until the flashing red highlight surrounds the ***current*** input parameter
Press the ► key and select ***external shunt***

Press *ENTER*, to select the external shunt

Press the ▼ key until the flashing red highlight surrounds the ***shunt*** parameter. Manually input the shunt resistance value
Press *ENTER*, external shunt value will now be selected

If connecting the external shunt to a different channel, then use the ► key to select the correct channel configurations screen as prompted at the bottom of the *RANGE* home screen, this is only available if ***independent ranging*** has been set to ***enabled*** in the System Options menu (*SYS*)



Now going back to the real time display screen, the range selected by the analyzer is the (10mV) range. This range is a peak range, and the analyzer will convert this voltage to the equivalent current range, dependent upon the shunt value entered in the *RANGE* menu.

In this case the shunt value is 470mΩ; therefore, the analyzer will display 21.28mA for the 10mV range $I = \frac{10mV}{470m\Omega}$

As the instrument ranges up and down the ***Arange*** value will change accordingly

CAUTION.
Input Connections: It is critical that the 4mm inputs and BNC inputs on each PPA input channel are not connected to any external circuit at the same time.

You MUST only use EITHER the 4mm OR the BNC connection – NOT both, this applies to both Voltage and Current inputs.

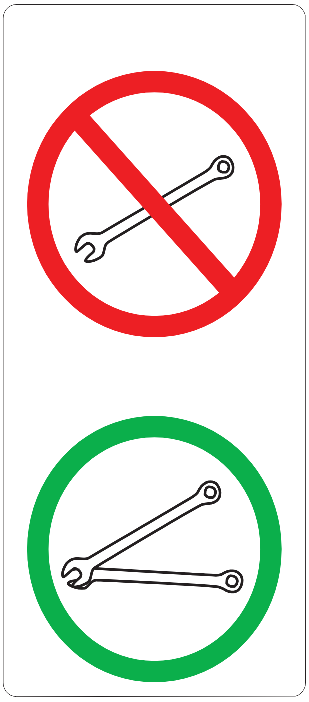
Remember to disconnect all leads to appropriate channels internal current shunts

CAUTION. Connection to some of the shunts is made via a stud and bolt, great care must be taken when connecting heavy duty ring terminals to the appropriately sized stud or alternatively, to an "L" bracket on the HF500 shunt.

It is essential that 2 correctly sized spanners are **ALWAYS** used (see table below) so that adequate torque can be applied to the bolt without transferring any excessive turning force to the stud

Any damage caused to the fixing stud **WILL** be irreparable

Damage to the shunt will occur when using only 1 spanner



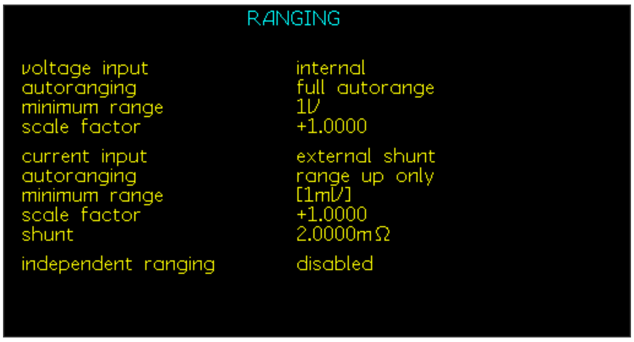
Always use 2 spanners to limit torque stress on the shunt stud

Current Shunt Model	Spanner Size
HF100 + HF200	17mm
HF500	24mm

Rogowski Coil

The Rogowski coil offers an alternative means of measuring high current DUT's with the advantage that they can be used in situations where it is not possible to break the current path or that the conductor in question is of such a size that the more widely used zero flux current transformers are unable to accommodate.

A Rogowski coil consists of the measuring coil itself, attached to an integrator box.



Input the correct shunt value corresponding to the switch value on the Rogowski Transducer

The shunt value is set to 2mΩ to reflect the switch position being set to 1KA (2mV per A) and a scale factor of 1:1

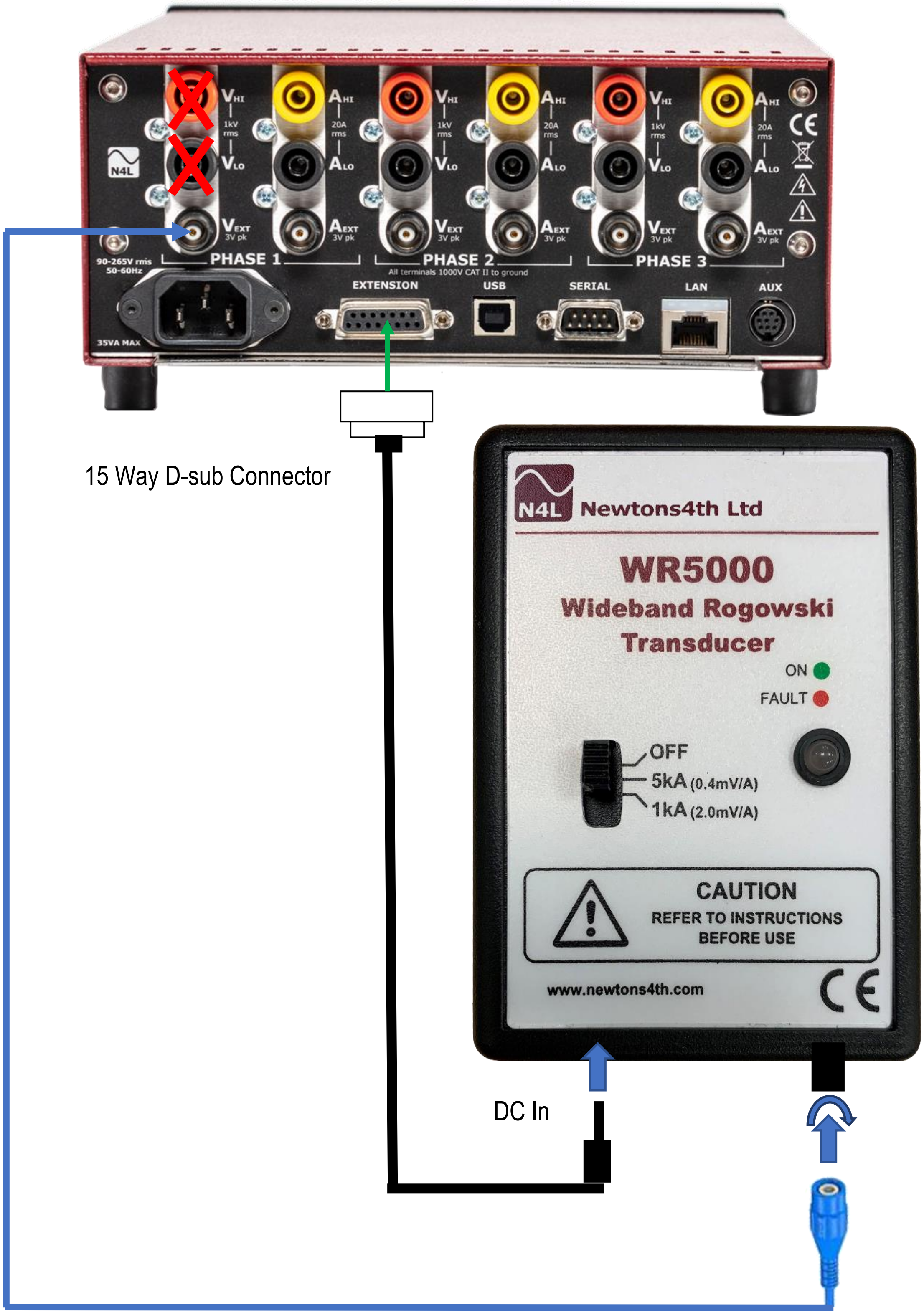
The shunt is set to 2mΩ as a 2mΩ shunt would also produce the same 2mV/A output as the coil

Multiple turns around the conductor:

If the coil is wrapped twice around the conductor set the shunt value to 4mΩ

If the coil is wrapped 3 times around the conductor set the shunt value to 6mΩ etc.

Connection should be made as per the following diagrams:

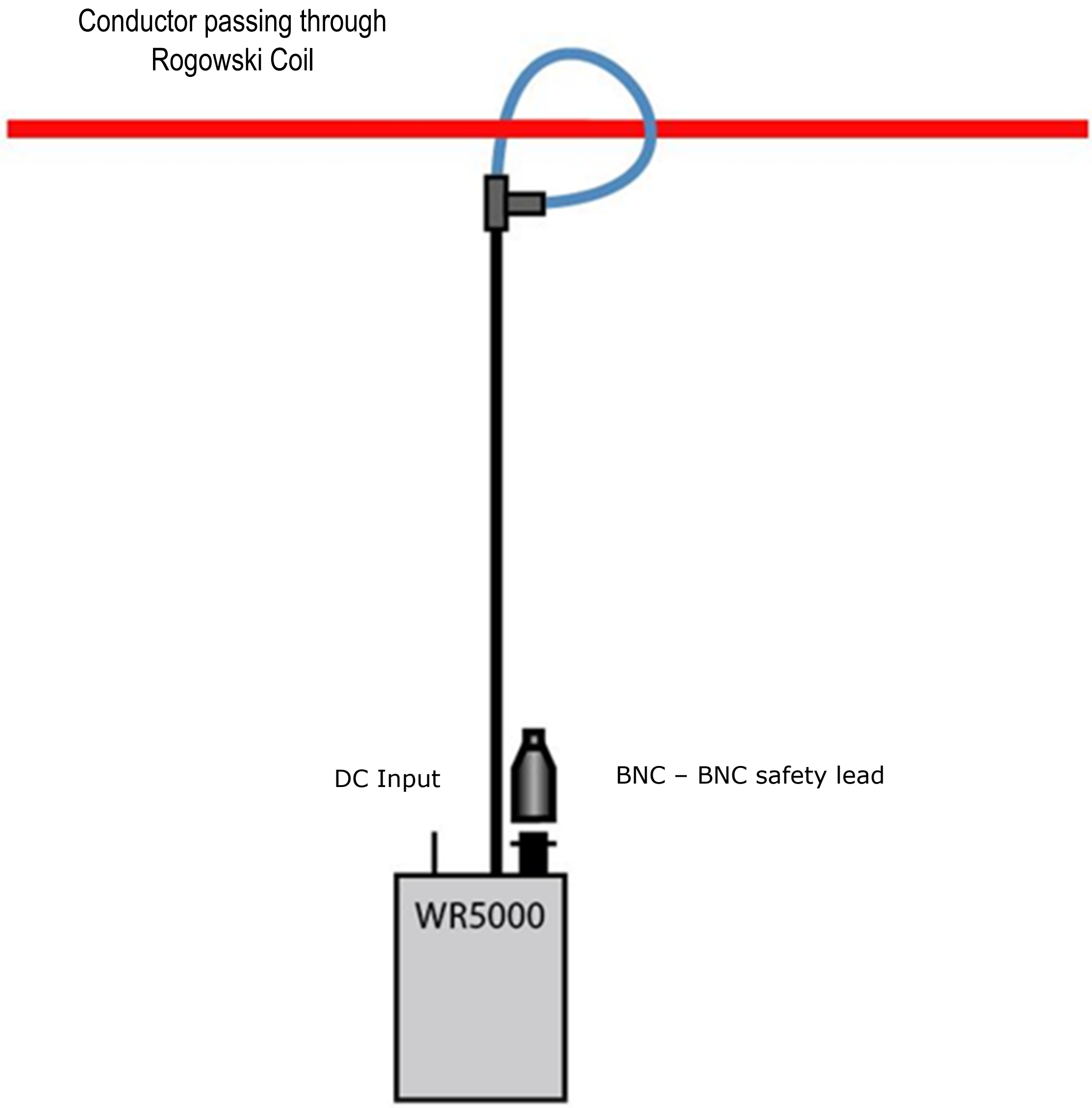


CAUTION. Remember to connect either to the Internal or External shunt only

Connect up the Rogowski Coil as shown, wrap the clear plastic tube around the conductor and slot into the “T”piece connector, tighten the connector nut to secure the lead into position

A single coil wrapped around the conductor will result in voltage measurement equal to the 2mV/A detail on the WR5000 as set on previous page

If the coil is double wrapped around the conductor, then the voltage value will double accordingly



Zero Flux Current Transformers (CT)

For measuring currents exceeding the internal current shunts fitted to the PPA500 series

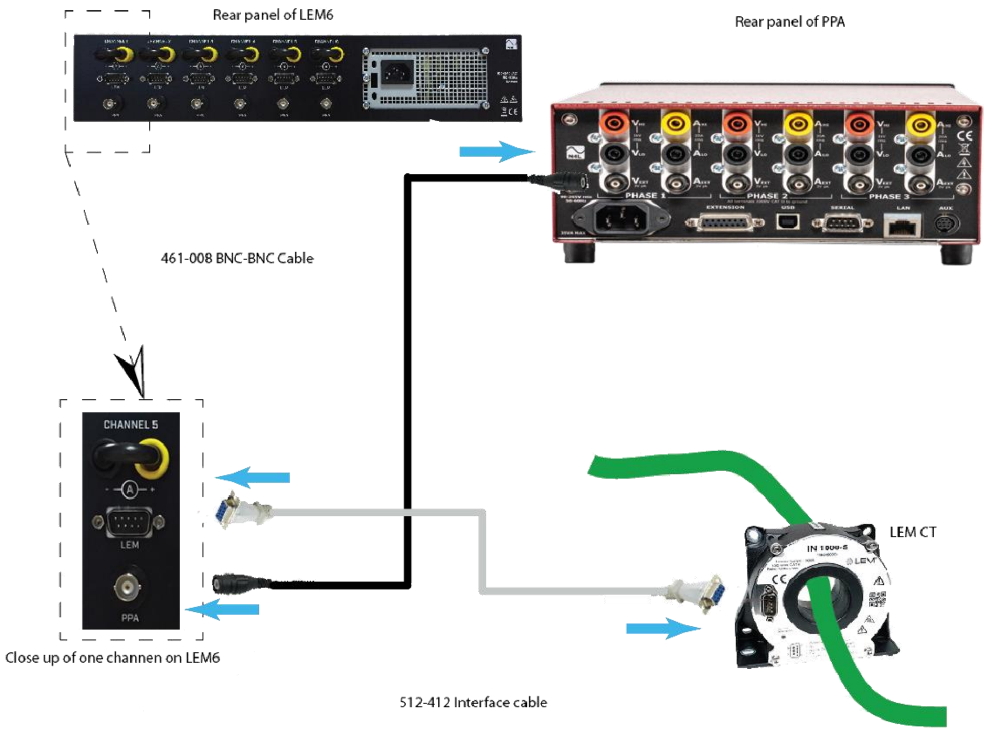
PPA500 20Arms
PPA500-HC 30Arms

Zero Flux Current Transducers are often utilised, combined with N4L interfaces a flexible multiphase system is achievable.

Dependent on the exact model of CT used, there are two ranges of interface available.

Here we examine the LEM 6-X series of interface which are available in 3 - 6 phase configurations.

LEM 6-6 A 6 phase 19" rack mountable interface for CT's



Connection diagram

The N4L LEM-6 Interface serves as a high accuracy, highly stable interfacing unit allowing simple "plug and play" connection of the PPA500 series to the LEM or Danisense current transducers listed in table 1.

The LEM-6 supplies the LEM or Danisense transducer with a highly stable isolated supply voltage; each channel is isolated from the next providing excellent cross channel coupling immunity. There are 4x current shunts per channel, 1Ω, 2.5Ω, 5Ω & 10Ω; this ensures the transducer can be utilized accurately throughout its dynamic range without the introduction of noise into the measurement.

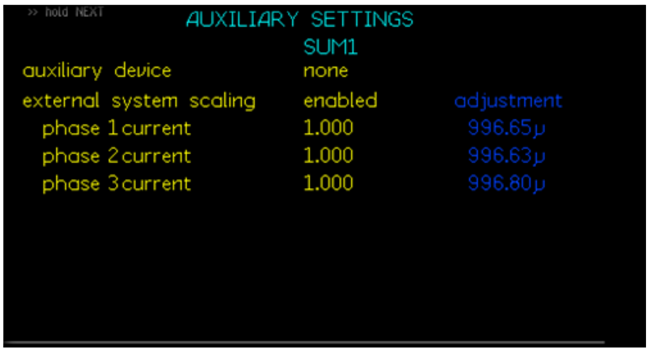
Model Number	Current Rating		Conversion Factor
IT60-S	60Apk	42Arms	600
IN100-S	150Apk	100Arms	500
IT200-S	200Apk	141Arms	1000
IN200-S	200Apk	300Arms	1000
IT400-S	400Apk	282Arms	2000
IN400-S	400Apk	600Arms	1500
IT700-S	700Apk	495Arms	1750
ITN600-S	600Apk	424Arms	1500
IN500-S	500Apk	800Arms	750
DS50ID	150Apk	50Arms	500
DS200ID	370Apk	200Arms	500
DS300ID	500Apk	300Arms	1000
DS400ID	600Apk	300Arms	1000
DS600ID	1000Apk	600Arms	1500
DM1200ID	1800Apk	1200Arms	1500

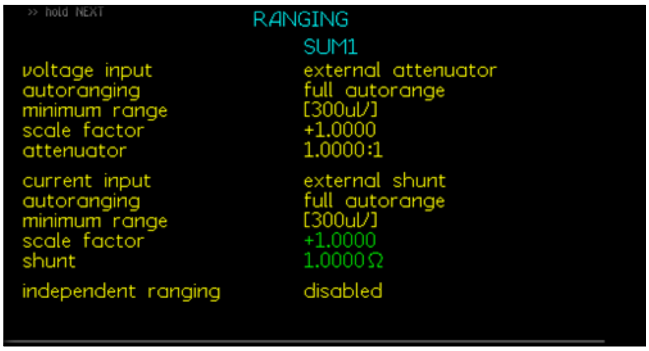
INFORMATION. N4L supply a wider range of current transformers than listed above, however the other models are not suitable to be used with the LEM 6-X interface as the power requirements exceed that of the LEM 6 PSU. In this case then we offer a LEM-1 interface

If the LEM-6 is purchased with an N4L power analyzer and LEM transducers, the LEM-6 Interface can be "system calibrated" within N4L's ISO17025 UKAS laboratory. This provides the operator with a single uncertainty figure and improved accuracy performance.

Following System Calibration, the Calibration Adjustment figures for the 4 current shunts on the LEM6 are stored in program location 1 on the instrument. They are then automatically recalled each the instrument is switched on.

These values can be viewed by pressing the *AUX* button and referring to the ***External system Scaling*** option. The screenshot below shows the adjustment figures for the 1Ω current shunt shown in blue.





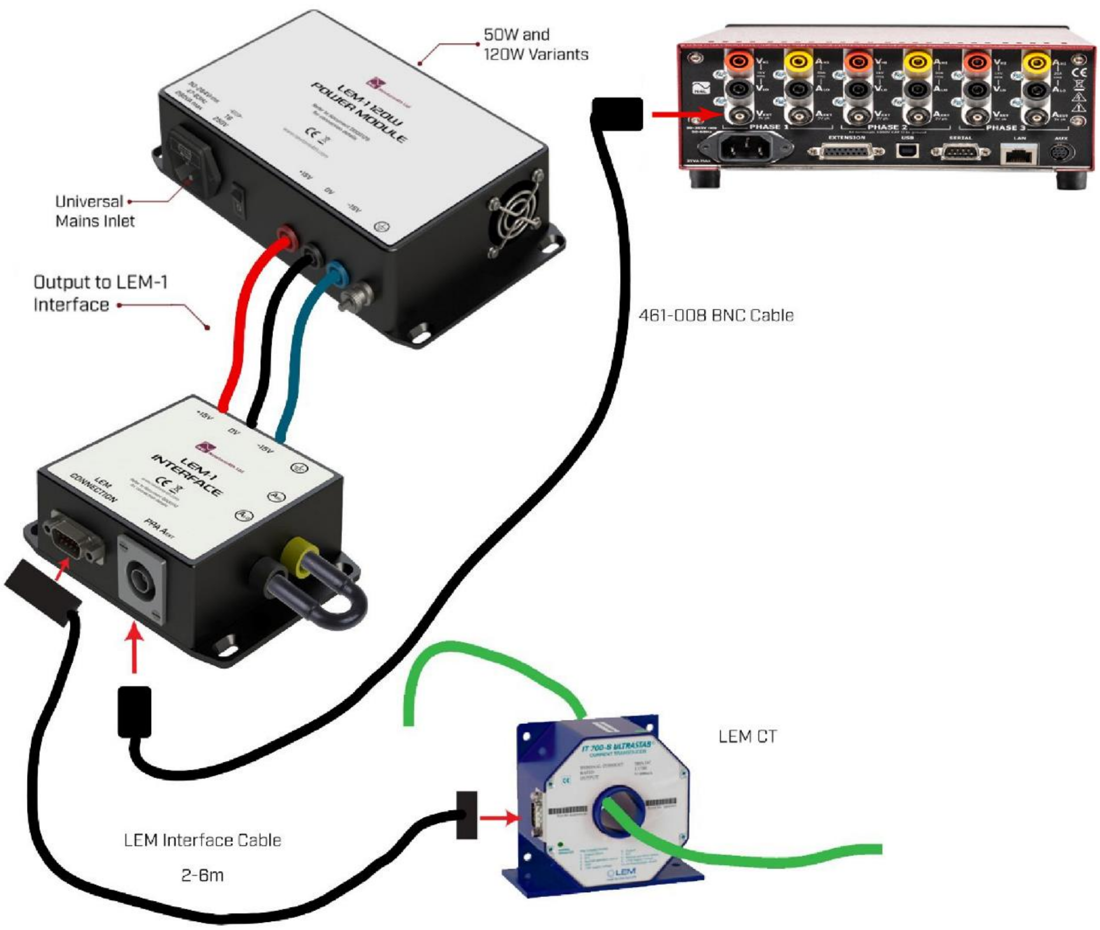
Pressing the *RANGE* key to display the ***RANGING*** menu will confirm that the external system scaling has been selected in the *AUX* menu, as the Scale factor and the nominal shunt value will be displayed in green text. The screenshot left shows the settings for Phase 1.

Only the settings stored in program location 1 are automatically recalled each time the instrument is switched on. Should it be preferred to not have them automatically recalled they can instead by saved to an alternative memory location and then deleted from location 1. The User can then recall the System Calibration data when required. The Program Store/Recall/Delete menu should be used to make the changes:

The LEM6 can also be used with non-system calibrated CT's.

Full details of the LEM6 features, Specification, and setup procedure for use with System Calibrated and Non-System Calibrated CT's can be found in the LEM6 User Manual which can be downloaded from our website resources page https://resources.newtons4th.com

The LEM 1 interface system is suitable with the complete range of LEM and Danisense CT models that N4L supply.

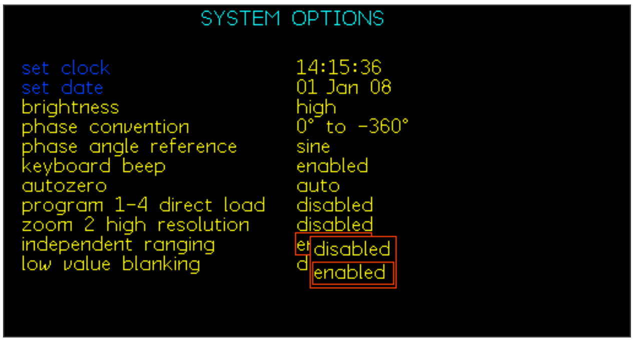


For multi-phase systems, each phase requires a separate LEM 1 interface, the number and wattage of the LEM 1 PSU's is dependent on which CT model and the number of phases required.

There is a guide to compatibility and supply requirements that can be downloaded from our website.

As with the LEM6 interface, the LEM 1 interface can be set up with system calibrated CT's or non-system calibrated CT's

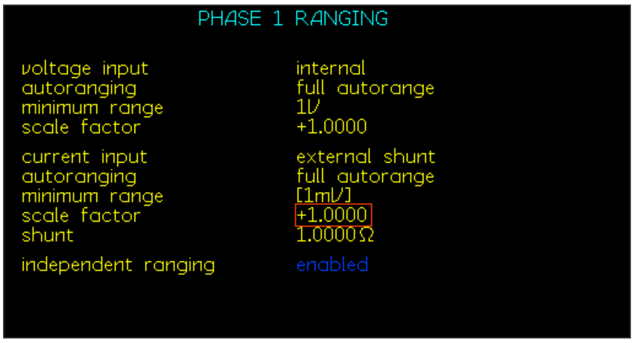
Use with non-system calibrated CT's



Press the *SYS* key

Press the ▼ key until ***independent ranging*** is highlighted red
Press the ▶ key, select ***Enabled*** with the ▼key.

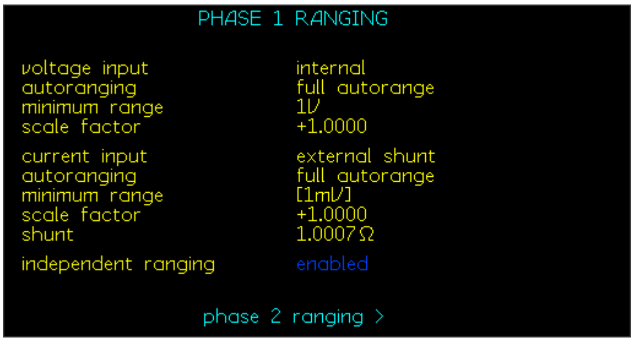
Press the ENTER key twice to return to the power analyser screen.



Press the *RANGE* key followed by the ▼ key five times until Current Input is highlighted.

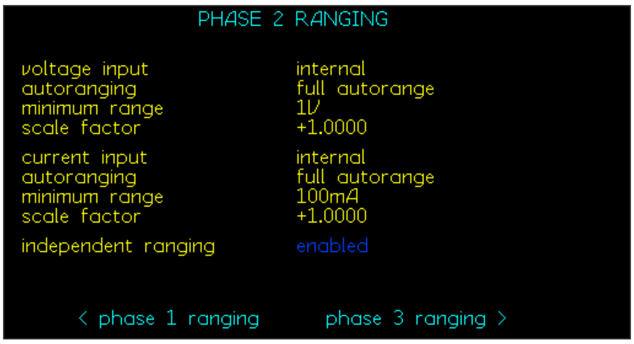
Press the ▶ key, then the ▼ key to select ***External shunt***.

Press the ENTER key followed by the ▼key 3 times and set the ***Scale factor*** to suit the CT in use.



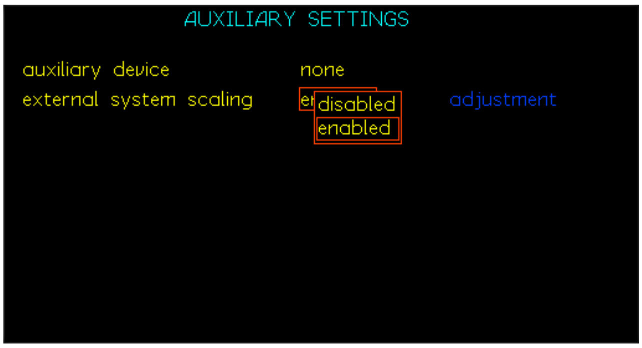
Press the ▼ key and set the ***shunt*** value to the actual value from calibration certificate. 1.0007Ω in this instance.

Press *HOME* key then using ▶ key go to the next phase connected to the PPA.



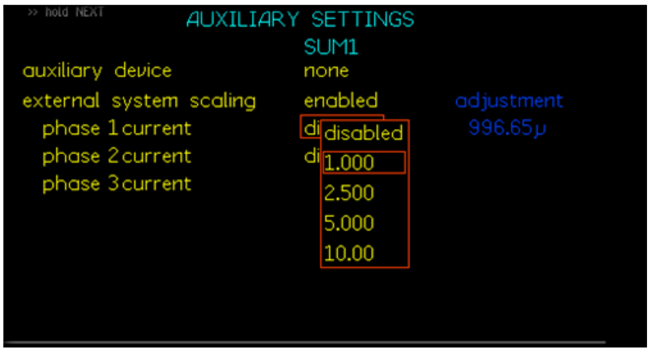
Repeat the steps followed for phase 1 to set the shunt value for phases 2 & 3

Use with system calibrated CT's

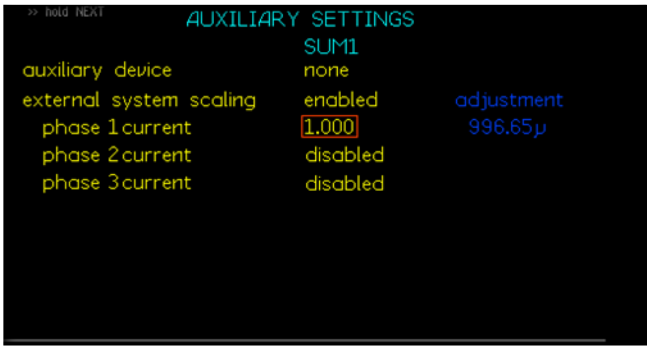


Press the *AUX* key
Press the ▼ 3 times to highlight ***External system scaling***.

Press the ► key followed by the ▼key to select ***enabled***.



Press the *ENTER* key
Press the ▼ key to highlight ***Phase 1 current***
Press the ► key, this now displays menu showing shunts.



Using the ▼ key to select the 1Ω shunt value, press the *ENTER* key, then to the right the adjustment value is shown in blue, then press *ENTER*.

Repeat for each connected LEM-1

Chapter 14 Trouble shooting – FAQ

Q. The PPA will not connect to the Datalogger software.

A. There are several points to check depending on the connection method used.
Firstly whether RS232, USB or LAN is being used to make the connection, the method chosen in the software must match that selected via the *REMOTE* menu on the PPA itself, additionally if using RS232, the connection cable must be a Null modem cable, and the Baud rate must be set to 19200 in both the software and the PPA.

Q. Error messages pop up when trying to connect.

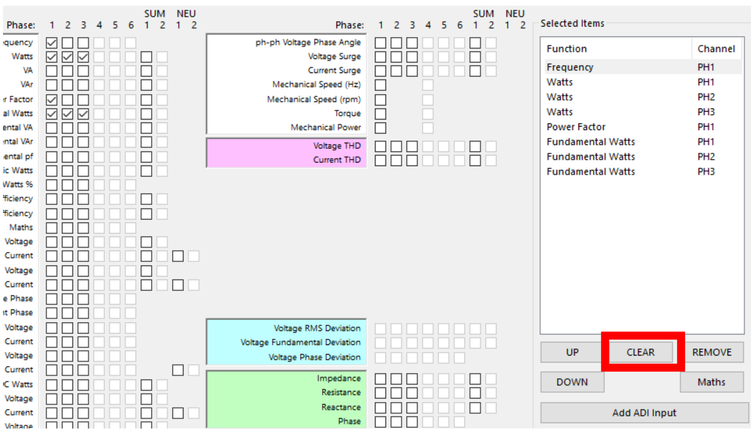
A. If an error message other than failed to connect appears, then the most likely cause is that there is an incompatibility between the software and firmware versions. We always advise that the latest versions of software and firmware are used. These are available as free downloads from https://resources.newtons4th.com/

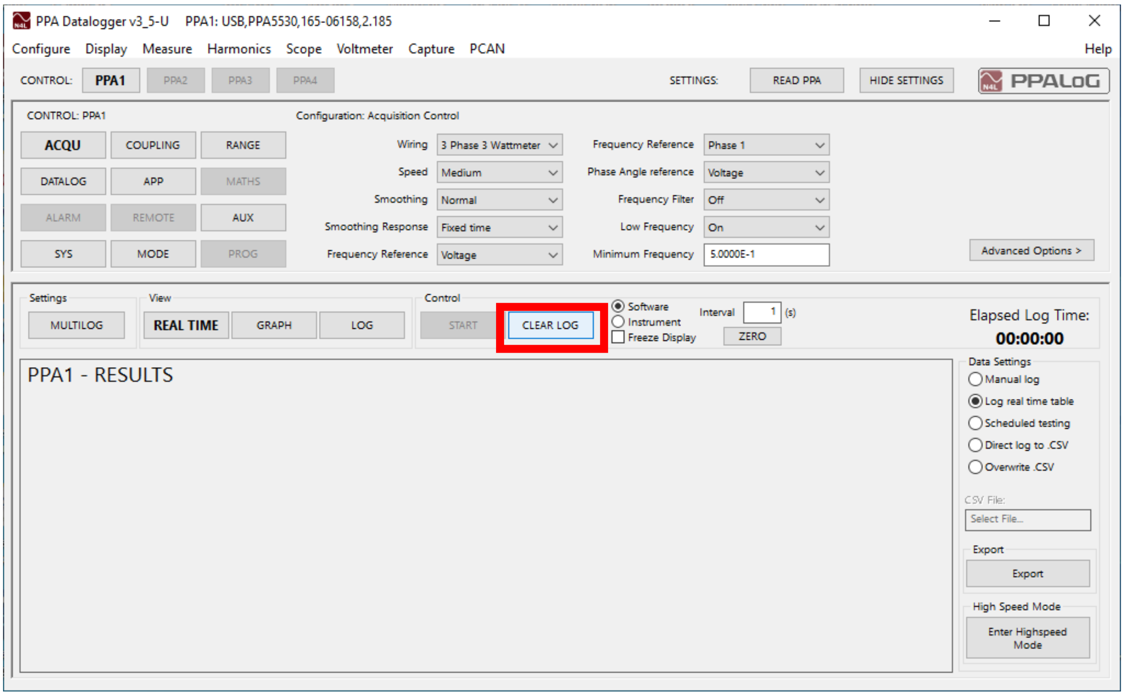
Q. Can't lock on to the fundamental frequency

A. Normally in most cases voltage on phase 1 should be used as the frequency reference, however, should current or a different phase be required, these parameters can be set from the *ACQU* menu.

Q. When in Datalogger the modes cannot be changed.

A. If data has already been recorded, it is important to clear the log before trying to change the mode. The Clear Log button is shown highlighted in red below. Additionally, it is important to clear the selections made in the multilog window. This is accomplished by clicking the CLEAR button





Q. How do you set up the PPA for different current capacity Current Transformers.

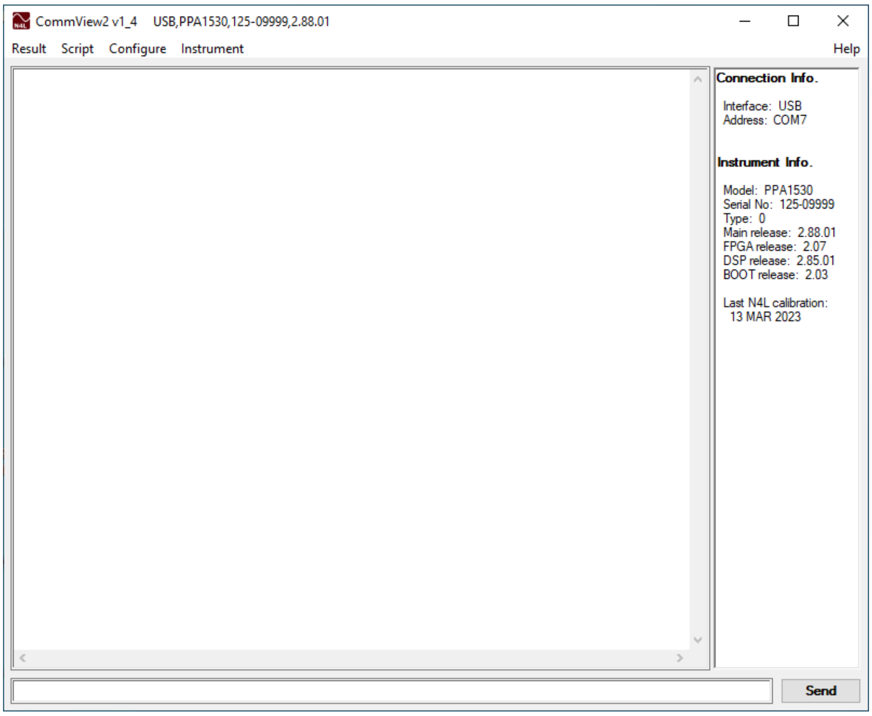
A. To take best advantage of each CT, it is necessary to enable ***independent ranging*** from the *SYS* menu. After this has been enabled within the *RANGE* menu there will be the opportunity to switch between each phase by use of the ► & ◄ keys

Chapter 15 Appendix A- Accessories and software

Supplied Standard Accessories

Leads	Power, RS232, USB
Connection cables	30Arms rated 1.5 meter long leads with 4mm – stackable terminals 1x Yellow, 1 x Red and 2x Black per phase
Connection clips	4mm terminated alligator clips – 1x Yellow, 1 x Red and 2x Black per phase
Documentation	Calibration Certificate, Both the User manual (this manual) & Communications manual are free downloads from www.newtons4th.com

Firmware Upgrade & CommView2 PC software



N4L CommView2 is a self-contained executable software program written in C++ using the Microsoft win32 graphics set.

CommView2 can connect to the PSMPPA500 via Serial/RS232, USB, or LAN.

INFORMATION. Dependant on the version of Windows loaded on the connected PC, the USB drivers may need updating. These are available from our website. https://resources.newtons4th.com/

CommView2 allows strings to be sent and received between a PC and the PPA500. The strings can be viewed in a window and optionally stored in a file. Data received from the instrument may be displayed in normal scientific notation with an identifying label.

CommView2 may be used interactively or may execute a series of commands automatically from a prepared text tile.

CommView2 may be used to upgrade the firmware in the instrument when new firmware is released.

The script file is created with any text editor and includes three types of lines (interpreted by the first character on each line):

lines beginning with " are sent to the PPA500

lines beginning with # are commands for CommView2

any other line is a comment.

The # commands that are recognised:

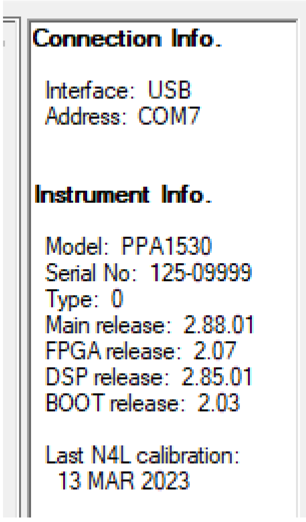
format	arguments	effect
"text	string	send text to instrument
#label,i,name	i = result index name = string	overwrites label associated with results value [n]
#pause,t	t = delay in s	delay by real number seconds
#wait,text		display text string and wait for a key press (discard key press)
#beep		sound beeper on PC
#reply,t	t = timeout in s	wait for a reply using a specified timeout
#flush		discard any received characters.
;text		comment

Other functions in CommView2:	Found within
save results	***results menu***
set COM port parameters	***configure menu***
firmware upgrade	***instrument menu***
read/store user programs	***instrument menu***

As with all N4L Software, it is available for free download along with a full User manual from our website. See https://resources.newtons4th.com/ for more details.

Once registered and your account has been activated you will have access to the software and manuals download sections.

When connecting to the instrument the panel to the right hand side of the software window will display details about the instrument.



This includes:

Connection Information: Details of the interface used to connect the instrument to the PC.

Instrument Information: Instrument Model, Serial number along with firmware details.

Calibration information: Details of when the instrument was last calibrated*

*From firmware version v2.185 onwards details of the last N4L Calibration procedure are displayed along with details of any later calibration performed by a locally based Calibration Laboratory.

At boot up an advisory message is displayed if the N4L Calibration & Adjustment was last performed more than 18 months ago.

PPA Datalogger/PPALoG PC software

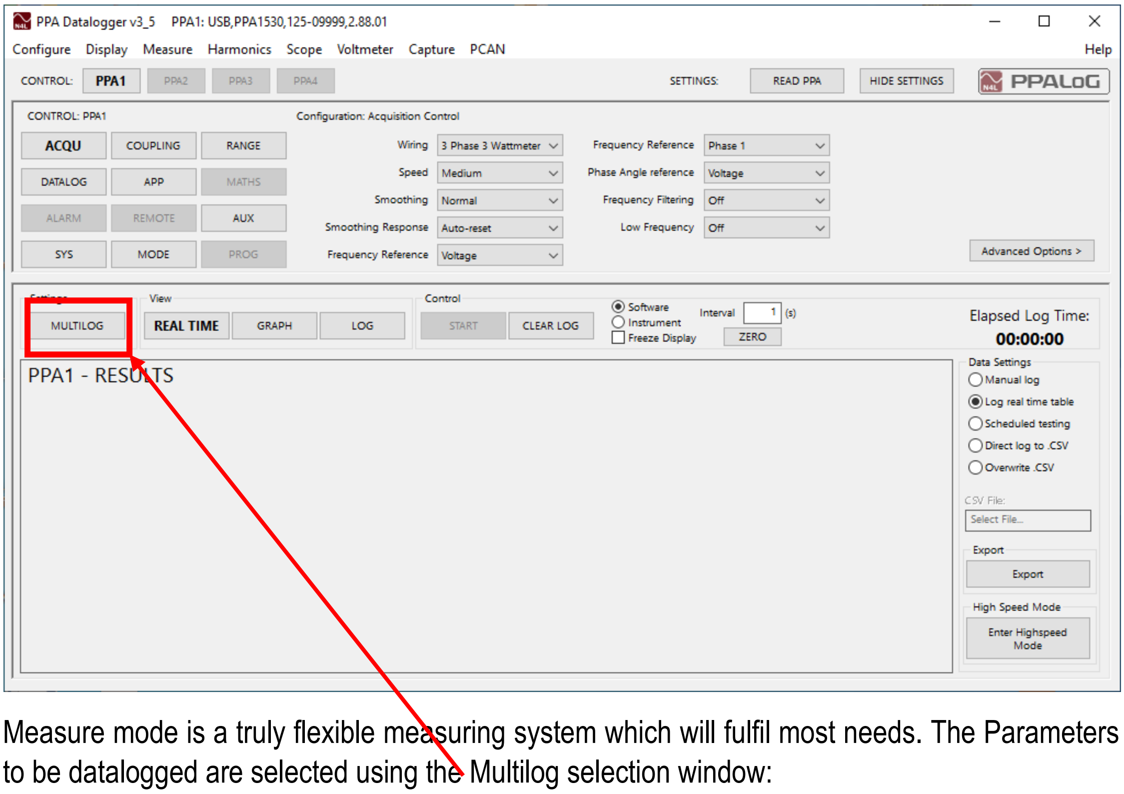
PPA Datalogger is a self-contained executable software program written in C++ using the Microsoft win32 graphics set.

PPA Datalogger has the ability to connect to the PPA series of instruments via RS232, USB and LAN. The software includes all measurement modes to reflect instrument operation.

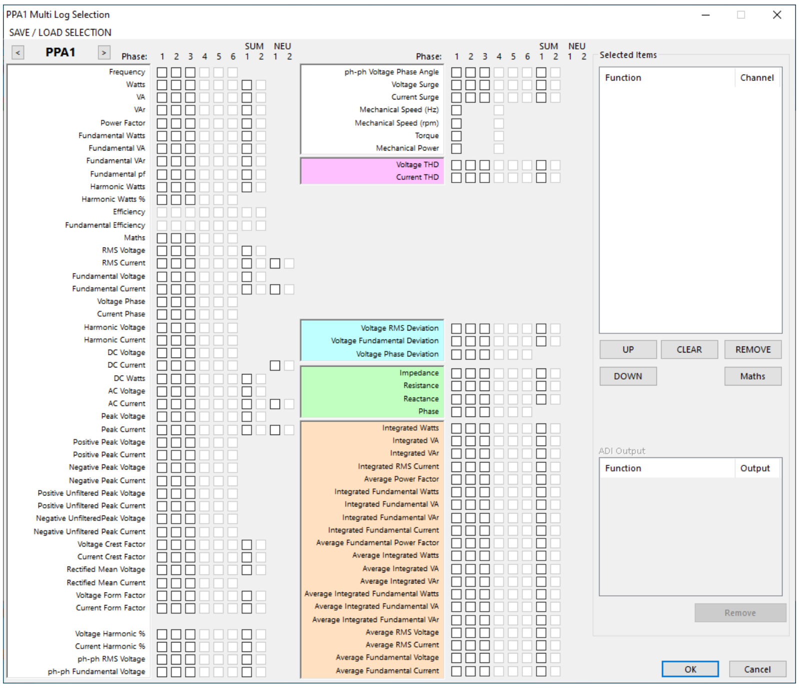
PPA Datalogger has the capability to communicate with up to 4 different PPA Instruments at the same time.

PPA Datalogger supports the ability to export text files in CSV format as well as export directly to Microsoft Excel ™

Measure Mode is PPA Datalogger's all-purpose measurement mode. Measure mode is an intuitive way to log a wide range of parameters using Real Time, Graph and Log datalogging methods. A few simple steps will see PPA Datalogger ready to record up to 60 of the PPAs wide range of multilog parameters, on up to 4 PPAs synchronised by PPA Datalogger, with speeds up to 200 results a second.



Measure mode is a truly flexible measuring system which will fulfil most needs. The Parameters to be datalogged are selected using the Multilog selection window:



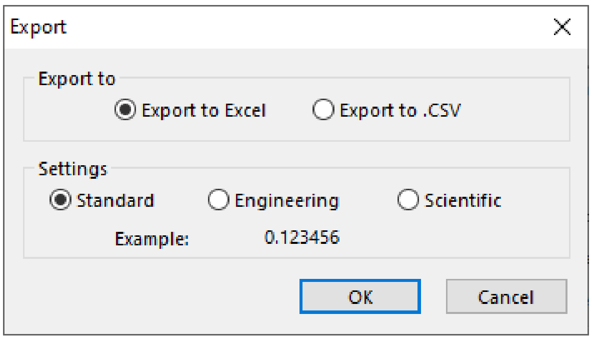
There are several measuring modes including:

Real Time: the default mode which records each result read from the connected Instrument to the Data Log.

Scheduled Testing Mode: The Start Time and Date and End Time and Date for the test are pre-selected.

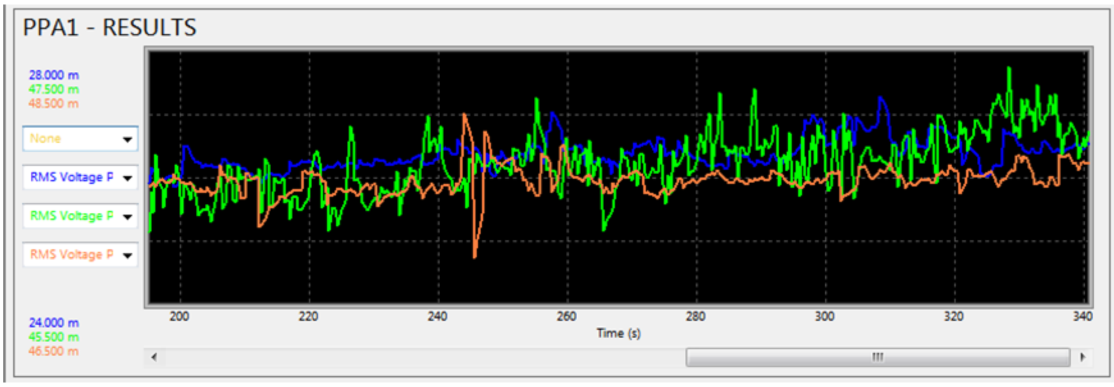
Direct Log to CSV Mode: The data is recorded from the instruments straight to a CSV file.

On completion of the test the results can be exported to Excel™ of CSV in several formats using the Export function:



Other PPA Datalogger Features:

Customisable Graph mode allowing up to 4 parameters to be selected:



Harmonics Mode: Harmonic data can be displayed in graph or table format.

Scope Mode: Allows up to 4 parameters to be displayed in Scope format, either in single step or continuous mode.

Capture Mode: Allows screenshots to be taken of the PPA display.

Display mode: Allows the displayed software screen to be saved to the clipboard, a Bitmap file or a Word document.

Equations Mode: Measure Mode's Multilog Parameters can be used to create custom equations. The equations can be added to Multilog Setups and logged alongside other Multilog Parameters, as well as exported.

The PPA Datalogger User Manual provides a full description of the various datalogging modes and functionality. There are full setup instructions for the software and connecting to the instruments.

Chapter 16 Appendix B-Serial Command Summary

command format	reply format
*CLS	
*ESE,value	
*ESE?	single integer data value
*ESR?	single integer data value
*IDN?	company,product,serial no,version
*OPC?	0 or 1
*RST	
*SRE,value	single integer data value
*SRE?	
*STB?	single integer data value
*TRG	
*TST?	single integer data value
*WAI	
ABORT	
ADIMAP	
ALARM,latch,sounder	
ALARM?	single integer data value
ALARME,value	
ALARME?	decimal equivalent of alarm bits
ALARM1,type,data,hi,lo	
ALARM2,type,data,hi,lo	
APPLIC,type,setting	
BANDWI,phase,type	
BEEP	
BLANKI,on/off,threshold	

CALVER,string	
CALVER? CAPTUR?	string
CONFIG,parameter,data	
CONFIG,parameter?	single integer or real data value
COUPLI,phase,coupling	
DATALO,function,interval	
DATALO,LINES?	single integer data value
DATALO,0?	index,time,data… one record per line
DATALO,start,records?	index,time,data… one record per line
DAV?	single integer data value
DAVER,value	
DAVER?	single integer data value
DISPLAY,phase	
DISPLAY?	multiple real data values
EFFICI,type	
EFFICI?	total efficiency, fundamental efficiency
FAST on/off	
FQLOCK,on/off	
FQREF,phase,channel	
FREQUE,frequency	
HARMON,para,h,hmax	
HARMON,phase? or	freq,mag1,mag2,hmag1,hmag2,h1,h2, thd1,thd2,hphase1,hphase2
HARMON,phase,SERIES? or	mag,%, x n harmonics mag,phase, x n harmonics
HOLD,on/off	
INPUT,channel,type	
INTEGR,type,display INTEGR,RUNTIM,hours,mins	

INTEGR,phase?	time,Wh,Wh.f, VArh,VArh.f,VAh,VAh.f, pf,pf.f,Vav,Vav.fAh,Ah.f
KEYBOA,value	
LCR,conditions,param,head	
LCR,phase?	freq,Vmag,Amag,impedance,phase,R, L,C,tanδ,Qf,reactance
LOWFRE,on/off	
MODE,type	
MSLAVE,type	
MULTILOG,index,phase,func	
MULTILOG? NORMALISE,current NORMALISE,voltage	1-30 floats as selected
PFCONV,convention PHANGREF,reference	 Current or Voltage
PHASEM,ratio	
PHASEM,phase?	Freq,mag1,mag2,dB,phase
PHCONV,convention	
POWER,sum A	
POWER,PHASE,WATTS?	Freq,W,W.f, VA,VA.f,Var,Var.f,pf,pf.f, Wdc,W.h
POWER,PHASE,VOLTAGE?	Freq,rms,mag,dc,ϕ,peak,cf,mean,ff, harmonic
POWER,PHASE,CURRENT?	Freq,rms,mag,dc,ϕ,peak,cf,mean,ff, harmonic
POWER,PH-PH?	Freq,rms1,mag1,ϕ1,rms2,mag2,ϕ2, rms3,mag3,ϕ3
POWER,RMS?	Freq,vrms1,vdc1,arms1,adc1,vrms2, vdc2,arms2,adc2,vrms3,vdc3, arms3, adc3
POWER,VECTORS?	Freq,mag1,ϕ1,mag2,ϕ2,mag3,ϕ3, mag4,ϕ4,mag5,ϕ5,mag6,ϕ6
POWER,WVA?	Freq,w1,vrms1,arms1,w2,vrms2, arms2,w3,vrms3,arms3
PROGRAM,function,number	
PROGRAM,files? PROGRAM,name?	Lists all program files Name of selected program

RANGE,ch,ranging,range	
RESOLU.format	
RESULT,function,number	
RESULT	multiple integers
REZERO	
SCALE,channel,factor	
SCALE,channel?	Single real data value
SCOPE,phase,v/a?	range, trigger, 250 signed integer data values
SHUNT,channel,resistance	
SHUNT,channel?	Single real data value
SMOOTH,type,dynamics	
SPEED,value,window	
START	
STATUS,channel?	Range number,range text,over/low/ok
STOP	
STREAM,enable,window	
STREAM,disable	
STREAM?	Data, data, data, data, data, …..
SUSPEN,on/off	
TEMPER,type,scale,offset	
TEMPER?	single real data value
TORQSP,type,tscale,sscale	
TORQSP,OFFSET,toff,soff	
TORQSP?	Mechanical power, torque, speed
USER?	3 CR terminated text strings
VARCON,convention	
VERSION?	Datecode,cpu,dsp,fpga,boot
VRMS	

VRMS,PHASE,RMS?	Rms1,rms2,dc1,dc2,ac1,ac2
VRMS,PHASE,MEAN?	Rms1,rms2,mean1,mean2,ff1,ff2
VRMS,PHASE,SURGE?	Pk1,pk2,cf1,cf2,surge1,surge2
WIRING,configuration	
ZERO	
ZERO,DELETE	
ZOOM,level,d1,d2,d3,d4	
ZOOM?	Level,d1,d2,d3,d4

Chapter 17 Appendix C- Available character set

The following characters can be selected in text entry mode.

The table is to be read across then down (e.g. starting at space and repeatedly pressing NEXT gives ! “ # $ % & ‘ ( ) * etc.)

	!	“	#	$	%	&	‘
(	)	*	+	,	-	.	/
0	1	2	3	4	5	6	7
8	9	:	;	<	=	>	?
@	A	B	C	D	E	F	G
H	I	J	K	L	M	N	O
P	Q	R	S	T	U	V	W
X	Y	Z	[	\	]	^	_
‘	a	b	c	d	e	f	g
h	i	j	k	l	m	n	o
p	q	r	s	t	u	v	w
x	y	z	{	|	}		

Chapter 18 Appendix D- Configurable parameters

All parameters can be accessed using the CONFIG command:

CONFIG,*parameter*?

CONFIG,*parameter,data*

Number	Function
	System parameters
1	operating mode
2	digital resolution
3	master/slave
4	autozero manual or auto
6	phase convention
7	Frequency lock constant / dynamic / normal
8	graph
9	keyboard beep on/off
10	ignore overload
11	low frequency mode
12	window size
13	speed
14	Smoothing
15	Smoothing response
16	baud rate
18	LAN IP address nibble 3
19	LAN IP address nibble 2
20	LAN IP address nibble 1
21	LAN IP address nibble 0
22	Independent ranging

	Input parameters (phase 1)
24	enable channel 1
25	enable channel 2
26	input range channel 1
27	input range channel 2
28	input ranging channel 1
29	input ranging channel 2
30	coupling
31	bandwidth
32	scale factor channel 1 voltage
33	scale factor channel 2 current
34	external shunt channel 1
35	external shunt channel 2
	General parameters
38	Remote resolution
40	voltage or current frequency reference
	Display parameters
41	display page
42	zoom level
43	function zoomed on 1
44	function zoomed on 2
45	function zoomed on 3
46	function zoomed on 4
47	datalog display type

	Advance parameters
48	manual frequency
49	DFT selectivity
50	program 1-6 direct load
51	language (if installed)
52	frequency filter
53	phase reference current / voltage
	Datalog parameters
54	datalog zoom 1
55	datalog zoom 2
56	datalog zoom 3
57 58 59	datalog zoom 4 datalog memory type datalog interval
60	datalog graph
	Maths parameters
61	formula
62	argument 1
63	sub argument 1
64	coefficient 1
65	argument 2
66	sub argument 2
67	coefficient 2
 69	**Application mode parameters** minimum frequency (dynamic)
70	application mode
71	Not used
72	ballast frequency tracking speed
73	Not used

	More maths parameters
74	argument 3
75	sub argument 3
76	coefficient 3
77	argument 4
78	sub argument 4
79	coefficient 4
	Power meter parameters
80	temperature
81	sum watts
82	wiring configuration
83	integration type
84	torque and speed enable
85	torque scaling Nm/V
86	speed scaling Hz/V
87	pulses per revolution
88	integration display
89	sum current average
90	phase 3 frequency reference
91	power factor sign convention
92	VAr sign convention
93	efficiency computation
94	range lock
95	mechanical torque offset
96	mechanical speed offset
	Harmonic analyser parameters
99	computation mode
100	selected harmonic
101	maximum harmonic
	More maths parameters
102	harmonic bargraph voltage

103	rated current for TRD
104	harmonic bargraph current
105	Extended harmonic frequency range
	Oscilloscope parameters
106	time-based
107	trigger level
108	Pre-trigger
109	trigger polarity
110	trigger mode
111	trigger reference
112	trigger phase
113	cursors enable
114	trigger HF reject
115	traces
	System parameters
119	zoom 2 high resolution
120	brightness
121	display
	Auxiliary parameters
122	Auxiliary drive
128	PICS phase offset
129	PICS cycles
	Other power parameters
130 131	speed input gear ratio 2 wattmeter sum computation
132	integrator run time
133 134	phase to phase mean phase to phase measurement
135	Difference THD

	LCR meter parameters
137	parameter
138	measurement
139	offset
	Phase meter parameters
140	rms voltage peak
143	sampling rate/compensation
144	rectified mean
148	dB offset
150	computation
	System parameters
152	RS232 printer enable
153	IEEE address
154	interface
155	recall with program
	Alarm functions
156	alarm 1 data
157	alarm 1 type
158	alarm 1 high threshold
159	alarm 1 low threshold
160	alarm latch
161	alarm sounder
162	analogue output
164	analogue zero
165	analogue full scale
167	alarm 2 data

168	alarm 2 type
169	alarm 2 high threshold
170	alarm 2 low threshold
171	sync on alarm
	Input parameters (phase 2)
176	enable channel 3
177	enable channel 4
178	input range channel 3
179	input range channel 4
180	input ranging channel 3
181	input ranging channel 4
182	acdc coupling phase 2
183	bandwidth phase 2
184	scale factor channel 3 voltage
185	scale factor channel 4 current
186	external attenuator channel 3
187	external shunt channel 4
	Input parameters (phase 3)
200	enable channel 5
201	enable channel 6
202	input range channel 5
203	input range channel 6
204	input ranging channel 5
205	input ranging channel 6
206	coupling phase 3
207	bandwidth phase 3
208	scale factor channel 5 voltage
209	scale factor channel 6 current
210	external attenuator channel 5
211	external shunt channel 6

	Program storage
217	memory
218	data
219	action
220	location
	System clock
240	set clock (hrs)
241	set clock (mins)
242	set clock (secs)
243	set date (day)
244	set date (month)
245	set clock (year)

Chapter 19 Appendix E- Default Menu settings

The tables show the default menu settings at bootup from Prog 0 (factory default reset)

The table header shows both the short name below the key along with the title displayed on the LCD for each menu. Below the header the parameters and their values are listed.

Menu name below key	Title displayed on LCD
parameter	value

ACQU	ACQUISITION CONTROL
wiring	3 phase 3 wattmeter
speed	medium
smoothing	normal
Smoothing response	Auto reset
frequency reference	voltage
frequency reference	Phase 1
phase angle reference	voltage
frequency filter	off
low frequency	off
advanced options >	
DFT selectivity	normal
ignore overload	off
frequency lock	normal
watts	signed
normalise reference	disabled
<return	

COUPLING	COUPLING
coupling	ac+dc
noise filter	off

RANGE	RANGING
voltage input	internal
autoranging	full autorange
minimum range	1v
scale factor	+1.0000
current input	internal
autoranging	full autorange
minimum range	100mA
scale factor	+1.0000
Independent ranging	disabled

DATALOG	DATALOG
datalog	disabled

APP	APPLICATION SELECTION
mode	normal
default settings	press ENTER here to load

APP	APPLICATION SELECTION
mode	Inrush current
default settings	press ENTER here to load
Minimum range	100mA
Auxiliary device	none

APP	APPLICATION SELECTION
mode	Lighting ballast
default settings	press ENTER here to load
AC line	50.00Hz
frequency tracking	fast
efficiency	disabled

APP	APPLICATION SELECTION
mode	standby power
default settings	press ENTER here to load
low frequency	off

APP	APPLICATION SELECTION
mode	calibration
default ac settings	press ENTER here to load
default dc settings	press ENTER here to load
Frequency filter	off

MATHS	MATHS FUNCTIONS
formula	disabled

ALARM	ALARM OPTIONS
alarm 1 data	zoom 1
alarm type	disabled
High threshold	+1.0000
Low threshold	+100.00m
alarm 2 data	zoom 2
alarm type	disabled
High threshold	+1.0000
Low threshold	+100.00m

REMOTE	REMOTE SETTINGS
resolution	normal
interface	USB
recall with program	off
screen print	USB memory stick

AUX	AUXILARY SETTINGS
formula	disabled

SYS	SYSTEM OPTIONS
Set clock	10:32:59
Set date	28 Jun 22
brightness	high
phase convention	0° to -360°
Phase angle reference	sine
Keyboard beep	enabled
autozero	auto
program 1-4 direct load	disabled
Zoom 2 high resolution	disabled
Independent ranging	enabled
Low value blanking	disabled
< system information	User data>

SYS	SYSTEM INFORMATION
serial number	xxx-xxxxx
manufacturing code	xxxxxx
main release	x.xxx.xx
DSP release	x.xxx.xx
FPGA release	x.xx.xx
boot release	x.xx
last N4L calibration	Day Month Year Time Initials
return >	

SYS	USER SETTINGS
Supervisor access	enabled
User data	Newtons4th Ltd.
User data	
User data	
save	
< return	

The MODE menu is context dependent, and selection of the *MODE* key will display the relevant menu for the currently selected mode from the Function Keys, and allow the mode to be changed.

MODE	rue rms voltmeter
rectified mean	absolute
peak	signed
Last line	Crest factor

MODE	Phase meter
speed	medium
smoothing	normal
smoothing response	auto reset
computation	ch2/ch1

MODE	Power analyzer
power factor sign	negative leading
VAr sign	negative lagging
sum current	average
selected harmonic	3
sum VA & VAr computation	low distortion
Penultimate line	V ph-ph
Last line	VAr
Ph-ph measurement	rms
input compensation	disabled

MODE	Impedance meter
parameter	impedance
measurement	series
Phase offset	+000.00˚

MODE	Power integrator
integration	signed
display	total
run time hours:mins	00:00

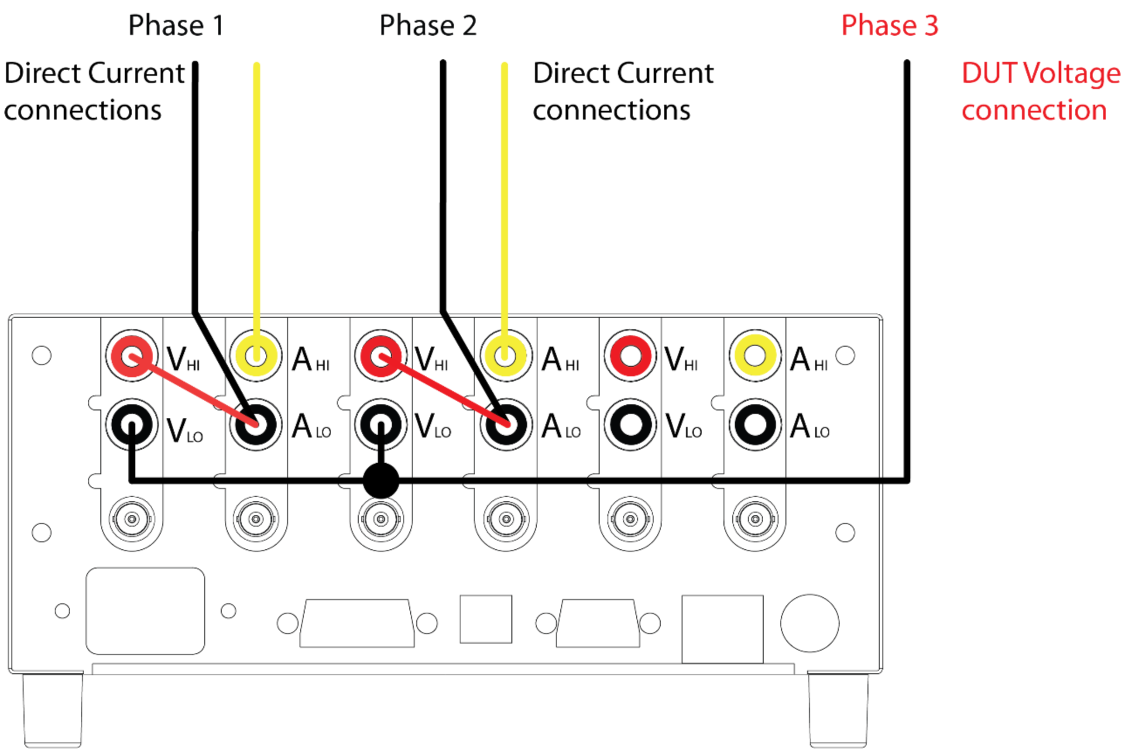
MODE	harmonic analyzer
computation	harmonic series
selected harmonic	3
harmonic series up to	40
voltage bargraph scale	100.0%
current bargraph scale	100.0%

PROG	Program Store/Recall
memory	Internal
data	program
action	recall
location	0
name	factory default
execute	

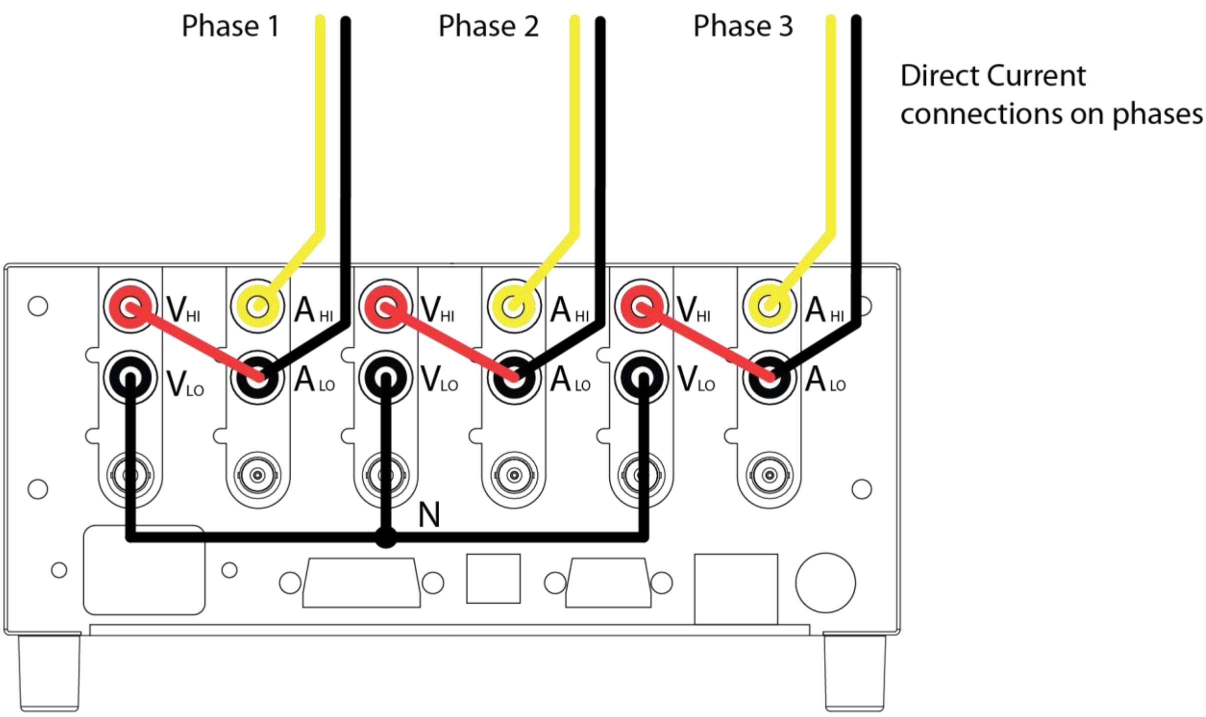
Chapter 20 Physical connection diagrams

Internal Inputs only

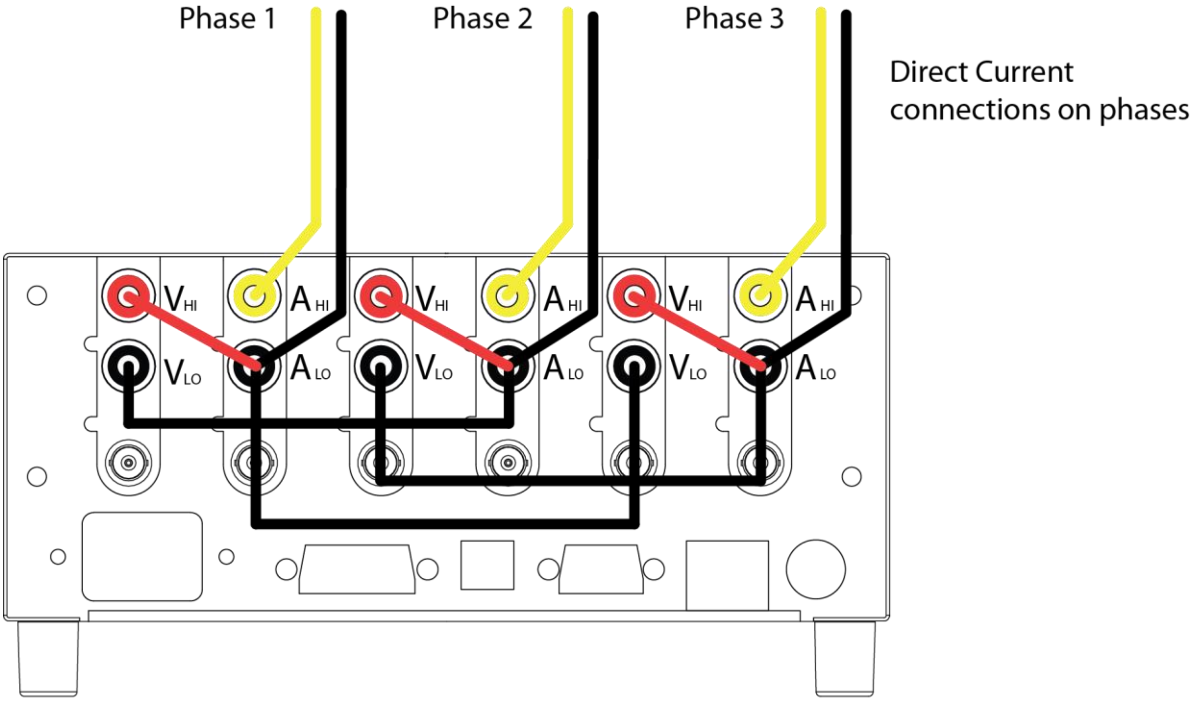
3P2W Delta



3P3W Star



3P3W Delta


Phase 1
Phase 2
Phase 3
Direct Current
connections on phases
VHI
AHI
VLO
ALO
VHI
AHI
VLO
ALO
VHI
AHI
VLO
ALO

Chapter 21 Appendix G- Contact Details

Please direct all queries or comments regarding the PPA500 instrument or manual to:

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United Kingdom

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At Newtons4th Ltd. we have a policy of continuous product improvement and are always keen to hear comments, whether favourable or unfavourable, from users of our products.

An example comment form can be found at the end of this manual – if you have any comments or observations on the product, please fill a copy of this form with as much detail as possible then fax or post it to us.

Alternatively send an e-mail with your comments.

PPA500 comments

serial number:	main release: dsp release: fpga release: boot release: (press SYS then LEFT)	date:

your contact details:

comments:

detailed description of application or circumstances:

Please post or fax to Newtons4th Ltd.