Newtons4th Ltd

PPA5500

KinetiQ

USER MANUAL

Firmware v2.159

05th April 2017

DANGER OF ELECTRIC SHOCK
Only qualified personnel should install this equipment, after reading and understanding this user manual. If in doubt, consult your supplier.

RISQUE D'ELECTROCUTION
L'installation de cet équipement ne doit être confiée qu'à un personnel qualifié ayant lu et compris le présent manuel d'utilisation. Dans le doute, s'adresser au fournisseur.

GEFAHR VON ELEKTRISCHEM SCHOCK
Nur entsprechend ausgebildetes Personal ist berechtigt, diese Ausrüstung nach dem Lesen und Verständnis dieses Anwendungshandbuches zu installieren. Falls Sie Zweifel haben sollten, wenden Sie sich bitte an Ihren Lieferanten.

RISCHIO DI SCARICHE ELETTRICHE
Solo personale qualificato può installare questo strumento, dopo la lettura e la comprensione di questo manuale. Se esistono dubbiconsultate il vostro rivenditore.

PELIGRO DE DESCARGA ELÉCTRICA
Solo personal cualificado debe instalar este instrumento, después de la lectura y comprensión de este manual de usuario. En caso de duda, consultar con su suministrador.

IMPORTANT SAFETY INSTRUCTIONS

This equipment is designed to comply with BSEN 61010-1 (2001) (Safety requirements for electrical equipment for measurement, control, and laboratory use) – observe the following precautions:

- This instrument is to be connected and operated only by qualified personnel.

- This appliance ***must*** be earthed. Ensure that the instrument is powered from a properly grounded supply before connecting to any live inputs.

- 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 inputs are rated at 1kV rms or dc cat II; 600V rms or dc cat III. **Do not exceed the rated input**.

- Ensure that the voltage and current inputs are connected correctly ***before*** energising the load to be measured.

- Keep the ventilation slots in the top and sides of the cover free from obstruction.

- Do not operate or store under conditions where condensation may occur or where conducting debris may enter the case. Do not use in a wet environment.

- Ensure that the handle is correctly fitted before using it to lift or to carry the instrument.

- 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.

Note: Newtons4th Ltd. shall not be liable for any consequential damages, losses, costs or expenses arising from the use or misuse of this product however caused.

DECLARATION OF CONFORMITY

This declaration is issued under the sole responsibility of the manufacturer:

Newtons4th Ltd.
1 Bede Island Road
Leicester
LE2 7EA

We declare that the product:

Description: Power Analyser

Product name: KinetiQ

Model: PPA55xx Family

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 2017

Eur Ing Allan Winsor BSc CEng MIEE
(Director Newtons4th Ltd.)

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 be given an RMA number and asked to 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 instrument 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 – contact your local representative. It is recommended that the instrument be re-calibrated annually.

Calibration note:
- Performance test specification available from N4L upon request.
- If calibrating with Fluke 6105A, refer to brochure for test specification accuracy between 40~450Hz.

ABOUT THIS MANUAL

This manual describes the general features, usage and specifications of the PPA55xx range of power analysers "KinetiQ".

Detailed descriptions of the communications command set for RS232, USB, LAN and GPIB is given in the separate manual "PPA55xx" communications manual".

Firmware revision 2.159   (05th April 2017)

PPA55xx "KinetiQ" user manual

CONTENTS

APPENDICES

1   Introduction – general principles of operation

KinetiQ is a sophisticated and versatile power analyser, for accurate wide bandwidth power measurements.

The PPA55xx family of power analysers covers 1 to 3 phase applications in both a low current and high current models.

Each phase input has wide ranging voltage and current channels which are fully isolated from each other and from ground. The voltage input has a built in high voltage attenuator or may be used with an external attenuator. The current input has a built in current shunt or may be used with an external shunt.

The voltage and current inputs are simultaneously sampled and the data is analysed in real time by high speed DSPs (digital signal processors). A separate CPU (central processing unit) takes the DSP results for display and communications. At the heart of the system is an FPGA (field programmable gate array) that interfaces the various elements.

This powerful, versatile structure allows the measurement of a wide range of power related parameters including:

    W, VA, VAr, power factor, phase
    true rms, fundamental
    harmonics, TIF
    integrated values (W hours etc.)
    impedance
    inrush current, voltage surge
    oscilloscope

KinetiQ is particularly easy to use with a large clear colour display and single menu levels for all main parameters. Even difficult applications such as PWM motor drives and

lighting ballasts can be easily addressed with special modes application in the firmware of the instrument and dedicated hardware functions including torque/speed inputs and ac line sync.

The whole operation of the instrument may be controlled remotely via a serial interface (RS232/USB), LAN or GPIB interface.

The voltage and current channels are identical except for the voltage attenuator and current shunt at the very front end.

Each channel consists of a selection switch for external or internal attenuator/shunt followed by a high impedance buffer, bandwidth control then a series of gain stages leading to an A/D converter. Selection of the input gain and the sampling of the A/D converter are under the control of the DSP. There is an autozero switch at the front end for dc accuracy. The analogue circuitry is optimised for high linearity over a wide dynamic range and high frequency performance.

Both input channels are fully isolated with very good CMRR and noise rejection.

The current shunt is of a proprietary design which gives very wide bandwidth with minimum phase shift.

The voltage attenuator is of a proprietary design which has a wide bandwidth response matched to that of the current shunt.

Both the voltage and current channels are calibrated digitally so there are no physical adjustments to be made.

2   Getting started

KinetiQ is supplied ready to use – it comes complete with an appropriate power lead and a set of test leads. It is supplied calibrated and does not require anything to be done by the user before it can be put into service.

2.1 Unpacking

Inside the carton there should be the following items:
  one KinetiQ unit
  one appropriate mains lead
  one yellow, red and two black 4mm leads per phase
  one yellow, red and two black crocodile clips per phase
  one null modem cable
  one USB cable
  this manual

Before connecting the test leads to an active circuit first connect the mains cord from a properly grounded supply outlet to the inlet on the rear panel of the KinetiQ. KinetiQ has a universal mains input and accepts any supply voltage from 90-265Vrms at 50 or 60Hz.

Switch on the KinetiQ. The display should illuminate with the model name and the firmware version for a few seconds while it performs some initial tests. It should then default to the power measurement display. Note that the switch on message can be personalised – see the User Data section under System Options.

The screen is a 6" (150mm) LCD colour display. There are no manual adjustments as the display should be clear and visible in all lighting applications.

Allow 30 minutes warm up time before commencing any measurements in order to ensure accurate results.

The voltage and current leads may now be connected to a circuit under test. The high common mode rejection ratio (CMRR) of the instrument allows the current channel to be connected in the live path (high side shunt) instead of the neutral path (low side).

The test leads supplied meet the safety requirements of BSEN61010-1 to an operating voltage of up to 1000V rms cat II or 600V rms cat III.

The Quick Start guide, Section 3 below, gives an introduction to the operating modes of the KinetiQ, and the selection of options and parameters. The Quick Start guide may be followed with no inputs connected to the instrument.

In the event of any problem with this procedure, please contact customer services at Newtons4th Ltd. or your local authorised representative: contact addresses and telephone numbers are given in the appendix at the back of this manual.

3   Quick Start guide

3.1 Operating Mode Keys

POWER	INTEG	HARM	RMS	IMP	SCOPE
□	□	□	□	□	□
G	M	k	m	u	n
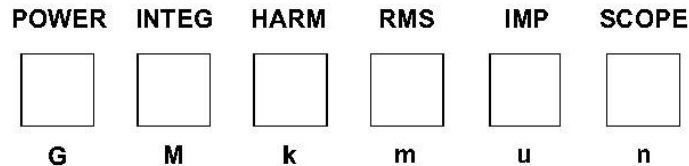
Operating Mode selection

(Power-on default is Power Analyzer – diagram below shows single-phase display.)
Note that with no inputs connected, display will be showing noise levels only.)

```
                    POWER ANALYZER
Vrange: 1V       Arange: 100mA    coupling: ac+dc   bandwidth: wide

PH1           total             fundamental
watts         3.2160µW          -24.646nW
VA            299.86µVA         24.891nVA
VAr           299.84µVAr        -3.4781nVAr
pf            0.011             +0.990
voltage       57.905mV          1.1420mV          +000.00°
current       5.1784mA          21.797µA          -171.97°

frequency     1.9835MHz
H3            -18.330nW         74.37%
dc watts      12.953µW
```
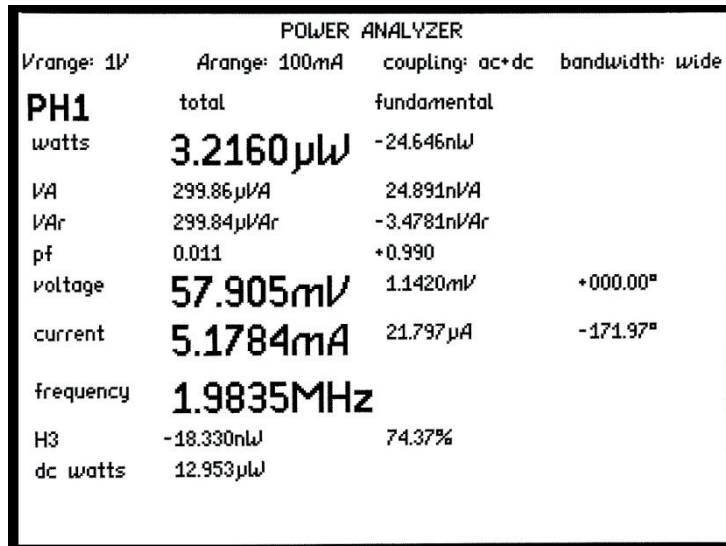
Press the POWER, INTEG, HARM, RMS, IMP, SCOPE key to access the operating mode directly, (except *Phase Meter* mode – see below).

Select Menu Options

> Press the operating mode key "Power" etc a second time, or press the "MODE" key, to access mode-specific options (diagram below shows *Power Analyzer* options).

```
┌─────────────────────────────────────────┐
│              POWER ANALYZER               │
│                                           │
│  operating mode          power analyzer   │
│  selected harmonic       3                │
│  sum current             total            │
│                                           │
│                                           │
│                                           │
│                                           │
│                                           │
│                                           │
│   Press < or > key to adjust the display contrast │
└─────────────────────────────────────────┘
```
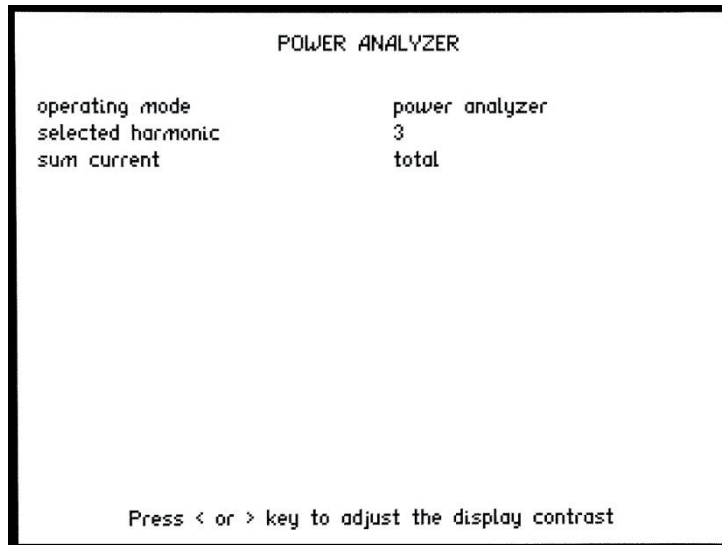
> Use Up and Down keys to highlight option, ENTER to confirm (see **MENU CONTROL KEYS**). Parameter values within the selected option may be adjusted using L or R keys or by entering a numeric value directly, as indicated. ENTER to confirm.

> With **Operating mode** highlighted, use L and R keys to cycle through operating modes and to access *Phase Meter* mode.

> With **adjust contrast** highlighted, L and R keys adjust display contrast.

> Use ENTER or HOME to return to readout display.

> **FOR TEXT ENTRY see DATA ENTRY GUIDE**

3.2 Menu Control Keys

```
              △

           HOME
           ┌────┐
  ◁        │    │        ▷
           └────┘
           ESC

              ▽

  DELETE            ENTER
  ┌────┐            ┌────┐
  │    │            │    │
  └────┘            └────┘
  BACK              NEXT
```
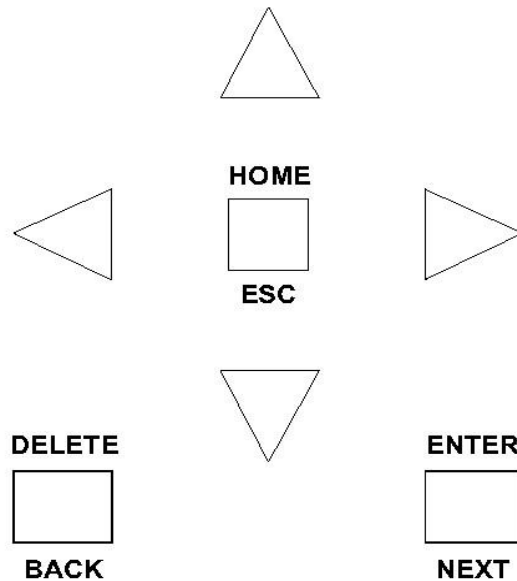
ENTER/NEXT confirms your selection or parameter value/data entry.

HOME/ESC returns to the original entry or to your previous action.

DELETE/BACK removes a previous selection or value, or returns to your previous action.

ARROW KEYS (Up, Down, L, R) to move around menu options, make incremental/decremental changes etc. Also to position cursors in *SCOPE* mode.

3.3 Display Control Keys

ZOOM +   ZOOM -   REALTIME   TABLE   GRAPH

◯   ◯   ◯   ◯   ◯

└─── HOLD ───┘

Display Zoom

Up to 4 displayed values may be emphasized.

a. Return to no zoom by pressing ZOOM−
   (*press twice from top zoom level*).
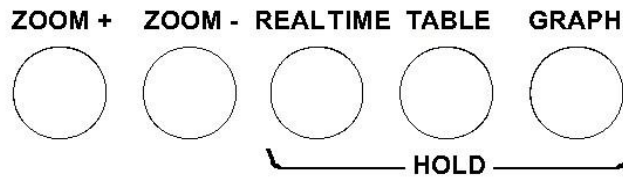
b. Press ZOOM+ to view presently selected data.
   (Diagram below shows *Power Analyzer* default
   selection, this time with a load connected.)

```
                    POWER ANALYZER
Vrange: 300V     Arange: 3A        coupling: ac+dc   bandwidth: wide

PH1          total            fundamental
watts        40.453W          41.355W

VA           72.430VA         42.994VA
VAr          60.080VAr        11.759VAr
pf           0.559            +0.962
voltage      241.34V          241.21V         +000.00°

current      300.12mA         178.24mA        -344.13°

frequency    50.004Hz

H3           -286.29mW        -0.692%
dc watts     195.17µW
```

c. Press DELETE to clear that selection.

d. Move the flashing box to the desired data to be
   emphasized using the Up, Down, L and R menu
   control keys.

e. Press ENTER to confirm (*flashing stops).*

f. Continue to select up to a total of 4 values.

g. Press ZOOM+ once or twice to display emphasized values as desired. (Diagram below shows top zoom level for *Power Analyzer.*)

```
                    POWER ANALYZER
Vrange: 300V    Arange: 3A      coupling: ac+dc   bandwidth: wide

PH1
 total
 watts        40.453        W

 rms
 voltage      241.34        V

 rms
 current      300.12m       A

 frequency    50.004        Hz
```
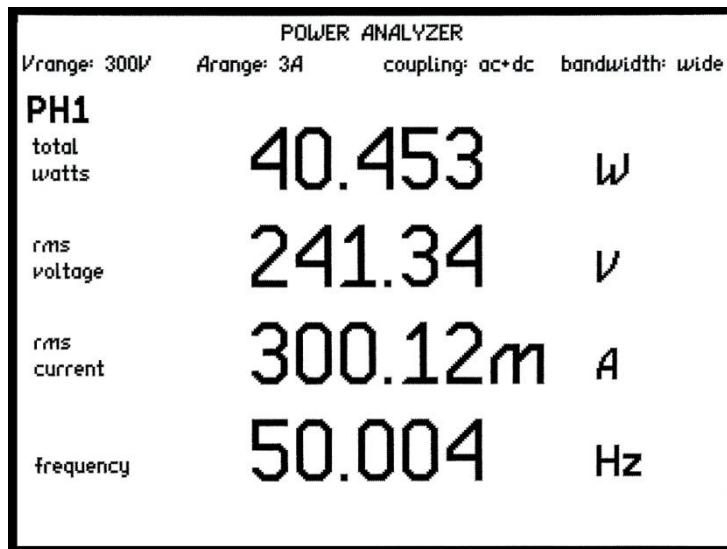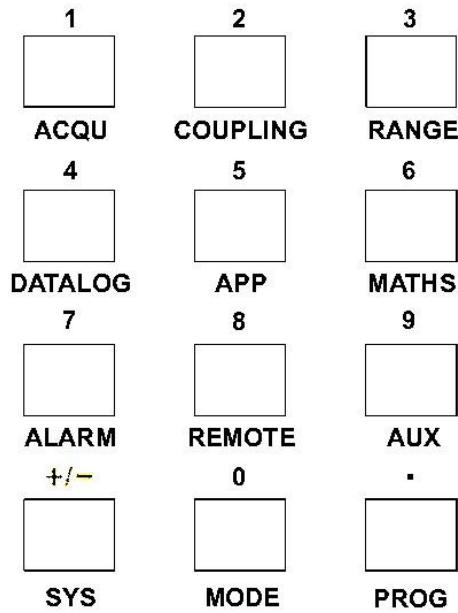
Realtime/Hold

Toggles between continuous display readings and holding an instantaneous reading on screen. Note: measurements continue to be taken even when display is in Hold.

Table, Graph

Select tabular or graphical presentation of data as collected in Datalog (see **SETUP KEYS**), or in **HARMONIC ANALYZER** mode.

3.4 Setup Keys/Keypad

1	**2**	**3**
ACQU	COUPLING	RANGE
4	**5**	**6**
DATALOG	APP	MATHS
7	**8**	**9**
ALARM	REMOTE	AUX
+/−	**0**	**.**
SYS	MODE	PROG

SELECT MENUS for non mode-specific configuration. Also use as numeric keypad when entering parameter values or data.

ACQU – use for configuring inputs appropriate to source and nature of signals being analyzed. (Diagram below shows *Power Analyzer* default setup.)

```
              ACQUISITION CONTROL

    wiring                  3 phase 3 wattmeter
    speed                   medium
    smoothing               normal
    smoothing response      auto reset
    frequency reference     voltage
    phase reference         voltage
    frequency filter        off
    low frequency           off




                   advanced options >
```
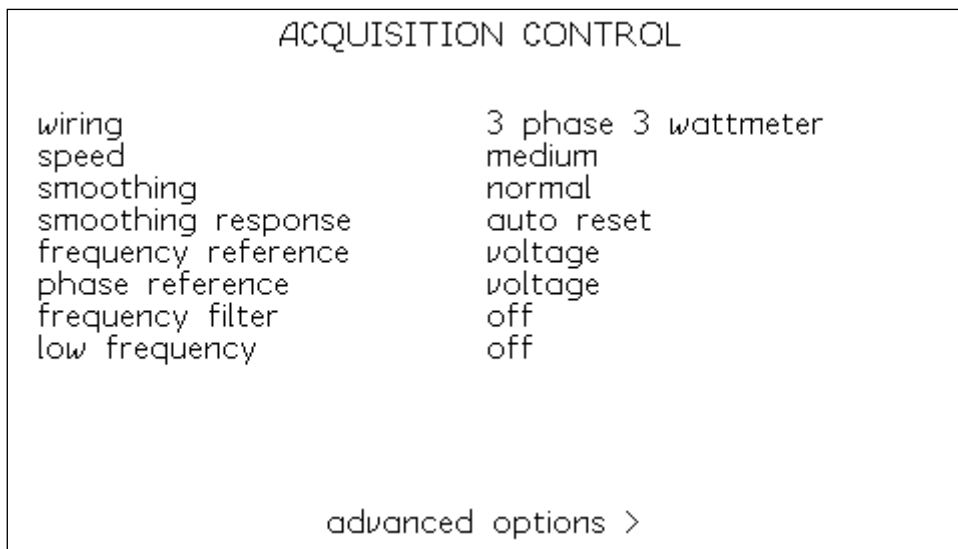
COUPLING – appropriate to input signals.

RANGE – configure according to magnitude (voltage and current) of input signals.

DATALOG – only available for *Power Analyzer*: sampling interval; data retained or not at power-down. Default is disabled. (See also Table, Graph in **DISPLAY CONTROL KEYS**.)

APP – application-specific measurements, e.g. PWM motor drive.

MATHS – no options available at present.

ALARM – audible/visual indication of thresholds crossed set by ZOOM values (see **DISPLAY CONTROL KEYS**). Default is disabled.

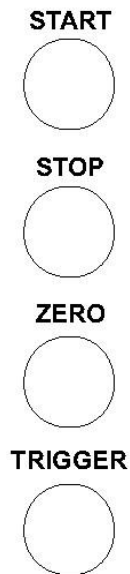REMOTE – configure external comms.

AUX – configure auxiliary devices.

SYS – configure general system features.

MODE – see **OPERATING MODE KEYS**.

PROG – save, recall or delete Mode, Display and Setup configurations for user-defined applications. Recall data saved in Datalog (see **DATALOG** key above).

 FOR NUMERIC ENTRY see DATA ENTRY GUIDE

3.5 Control Keys

START

STOP

ZERO

TRIGGER

START & STOP datalog function (when enabled) or integration (***INTEG*** mode). Either key also triggers single-shot in ***SCOPE*** mode.

Use **ZERO** key for:

a. Zero compensation of input amplifier chain, and test-lead compensation (*USER MANUAL*)*.*

b. Reset integrator to zero (***INTEG*** mode).

TRIGGER (or **START)** returns display to Real Time from Hold. Also triggers single-shot in ***SCOPE*** mode.

3.6 Scope Mode

Selecting **SCOPE** mode from the **OPERATING MODE KEYS**, or by cycling through the operating modes in any of the Operating Mode Select Options, displays voltage and current waveforms as a conventional oscilloscope – diagram below shows the default display with no inputs connected.
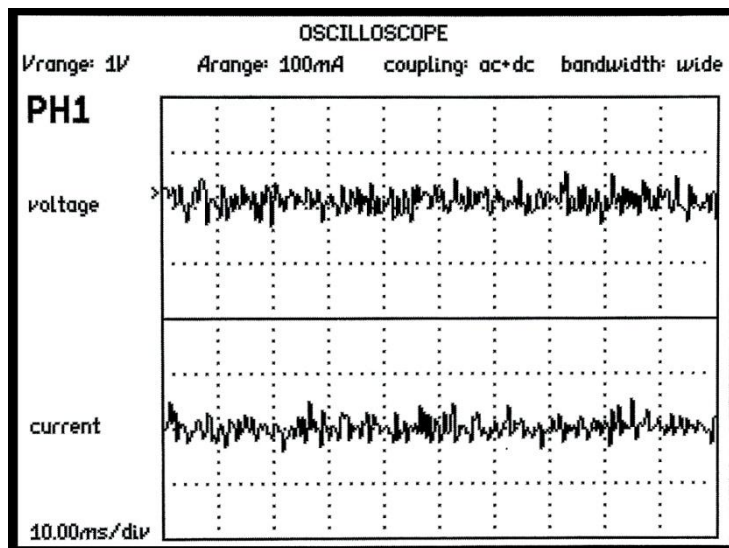
The following diagram shows the options available in **SCOPE** mode:
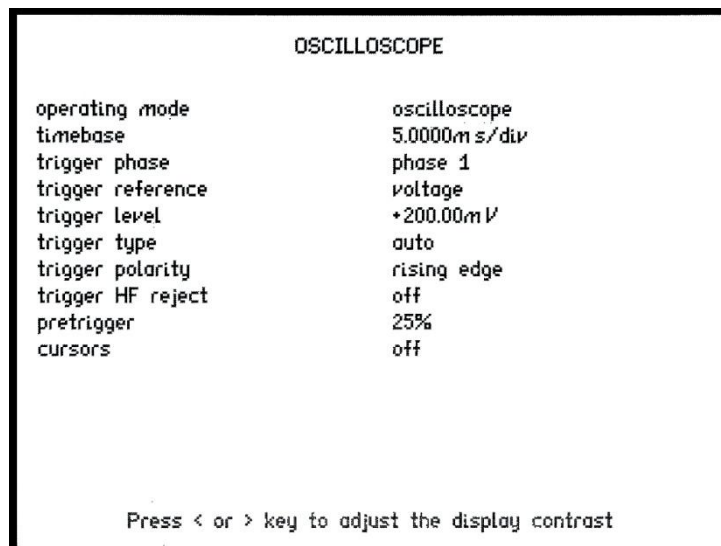
A typical display of voltage and current waveforms for a switched mode power supply is shown below:

```
                         OSCILLOSCOPE
Vrange: 300V     Arange: 1A        coupling: ac+dc   bandwidth: wide

PH1


voltage


current


5.000ms/div
```
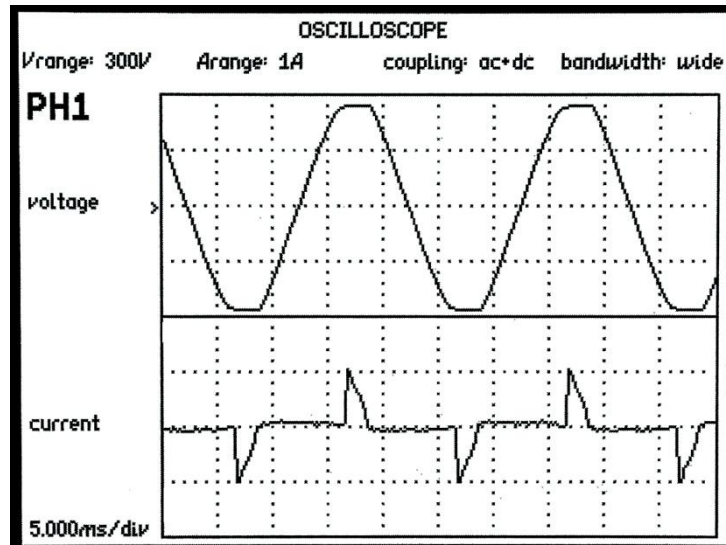
When operating in the oscilloscope mode, the left and right control keys operate in one of two modes:

   A. With the cursor option 'off' (default); the left and right control keys change the timebase
   B. With the cursor option 'on'; the left and right control keys change the cursor position and the up or down keys toggle between cursor 1 control or cursor 2 control.

3.7 Data Entry Guide

TEXT ENTRY

Enter text via the six function keys in the upper right of the panel. Each function key jumps to a different letter of the alphabet:

(*POWER*) **A**, (*INTEG*) **E**, (*HARM*) **I**,
(*RMS*) **O**, (*IMP*) **U**, (*SCOPE*) **space**

Choose other characters by stepping forward or backward using the UP and DOWN keys. Select upper/lower case with the ZOOM+, ZOOM– keys.

(Values may be overwritten, or edited by use of the RIGHT, LEFT and DELETE keys)

Alternatively text entry can be made via the numerical keypad resembling a telephone keypad. Key 1 is symbols, key 2 ABC, key 3 DEF etc.

NUMERIC ENTRY

Use **MODE/ENTRY KEYS** for number, multiplier, decimal point, or +/– to enter parameter value.

Press ENTER (**MENU CONTROL KEYS)** to set value.

Press HOME (**MENU CONTROL KEYS)** to abort data entry, restore original.

(Values may be overwritten, or edited by use of the R, L and DELETE keys)

4   Using the menus

KinetiQ is a very versatile instrument with many configurable parameters. These parameters are accessed from the front panel via a number of menus.

Each of the main menus may be accessed directly from a specific key.

ACQU	data acquisition parameters such as speed and filtering
COUPLING	select ac/dc coupling and bandwidth
RANGE	select input ranges, and scaling
DATALOG	specify datalog parameters
APP	Application specific functions
MATHS	User defined computations
ALARM	control of audible alarm and analogue output
REMOTE	communications options (RS232 etc)
AUX	control of auxiliary devices connected to the rear EXTENSION port
SYSTEM	general system options such as phase convention, keyboard beep etc.
MODE	function control
PROG	recall/store/ delete of non-volatile programs and datalog

Each menu starts with the currently set parameters visible but no cursor. In this condition, pressing the menu key again or the HOME key aborts the menu operation and reverts back to normal operation.

To select any parameter, press the UP or DOWN key and a flashing box will move around the menu selecting each parameter. In this condition the keys take on their secondary function such as numbers 0-9, multipliers n-G etc.

Pressing the HOME key first time reverts to the opening state where the parameters are displayed but the cursor is hidden. Pressing the HOME key at this point exits the menu sequence and reverts back to normal operation.

To abort the menu sequence, press the HOME key twice.

There are three types of data entry:
      selection from a list
      numeric
      text

4.1 Selection from a list

This data type is used where there are only specific options available such as the smoothing may be 'normal', 'slow', or 'none', the graph drawing algorithm may use 'dots' or 'lines'.

When the flashing cursor is highlighting the parameter, the RIGHT key steps forward through the list, and the LEFT key steps backwards through the list. The number keys 0-9 step directly to that point in the list, which provides a quick way to jump through long lists. There is no need to press the ENTER key with this data type

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

    normal   (item 0)
    slow   (item 1)
    none   (item 2)
and the presently selected option is normal, there are 3 ways to select non:

    press RIGHT twice times
    press LEFT once
    press number 2

4.2 Numeric data entry

Parameters such as external shunt impedance and scale factor are entered as real numbers; shunt impedance is an example of an unsigned parameter, scale factor is an example of a signed parameter.

Real numbers are entered using the number keys, multiplier keys, decimal point key, or +/- key (if signed value is permitted). When the character string has been entered, pressing the ENTER key sets the parameter to the new value. Until the ENTER key is pressed, pressing the HOME key aborts the data entry and restores the original number.

If a data value is entered that is beyond the valid limits for that parameter then a warning is issued and the parameter set as close to the requested value as possible. For example, the minimum user defined measurement window 10ms; if a value of 5ms is entered, a warning will be given and the amplitude set to the maximum of 10ms.

When the parameter is first selected there is no character cursor visible – in this condition, a new number may be entered directly and will overwrite the existing number.

To edit a data value rather than overwrite it, press the RIGHT key and a cursor will appear. New characters are inserted at the cursor position as the keys are pressed, or the character before the cursor position can be deleted with the DELETE key.

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

4.3 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 6 starting characters using the function keys on the top right hand row of the keyboard, then stepping forwards or backwards through the alphabet with the UP and DOWN keys.

The starting letters from left to right are A, E, I, O, U, or space.

Numbers can also be inserted using the number keys.

The UP and DOWN keys step forward and backward 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.

When entering alphabetic characters, the ZOOM+ and ZOOM- keys select upper and lower case respectively for the character preceding the cursor and the next characters to be entered.

The editing keys, RIGHT, LEFT, DELETE and ENTER operate in the same way as for numeric entry.

5   Special functions

5.1 Display zoom

KinetiQ 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 is also an even larger font for up to 4 selected values (second zoom level).

The second zoom level with the largest font has the option of increasing the displayed data resolution via the SYSTEM OPTIONS menu.

To set the data values for the larger font size, first return to no zoom by pressing ZOOM-, twice if necessary. Press 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, UP, DOWN, LEFT and RIGHT. Pressing the ENTER key selects the result for zoom and the box ceases to flash. Further results (up to four in total) can then be selected using the cursor keys in the same way – a solid box remains around the already selected item, and a new flashing box appears.

Having selected the desired results, pressing the ZOOM+ key invokes the first zoom level, pressing it again selects the higher level. Pressing ZOOM-, steps back down one level each time.

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

5.2 PROG – non volatile memory store and recall

There are 3 types of data which can be saved in non-volatile locations:
    Programs
    Data log
    Measurement results

There are 100 non-volatile program locations where the settings for the entire instrument can be saved for recall at a later date. Each of the 100 locations has an associated name of up to 20 characters that can be entered by the user to aid identification.

Program number 1 (if not empty) is loaded when the instrument is powered on, so that KinetiQ 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. If no settings have been stored in program 1 then the factory default settings are loaded (program number 0).

Program numbers 1-6 may be recalled with a single press of the function keys 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 to see the name, or by entering the program number directly.

When storing a configuration in a program, there will be a short pause of about 1 second if the program location had 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.

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 or USB etc). 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 the "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" button. This will allow all the information to be displayed as a table and show what the internal file directory contains. (By pressing the "Table" button again exits the directory).

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.

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 the 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.

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.

5.3 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.

5.4 ALARM - alarm function

KinetiQ has 2 independent alarms that can be used to generate an audible warning:

 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 window
 sound the alarm if the value is inside a window

The values to which the alarms are applied can be any of the measurements selected for zoom. The alarm status is also available as a logic output via the communications.

The first alarm also has option to generate a variable sound changing linearly as the value changes between two thresholds.

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

 select which of the zoom functions is to be used
 select the type of alarm
 set the upper limit (if appropriate)
 set the lower limit (if appropriate)
 select whether the alarm is to be latched
 select whether the alarm sounder is enabled

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 SYNC output can be used to trigger a PLC or ATE system on alarm. The SYNC output will be logic high when the instrument is in an alarm condition and logic low if not. There is also an Analogue Output (max ±10v) for a voltage representative of Zoom 1-4 measurements or a manual level.

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 1/3 of the measured value respectively. The repetition rate of the sounder then varies linearly as the value changes between these thresholds.

When using GPIB communications (IEEE488) the instrument can be configured to generate an SRQ on alarm (see section on remote control).

5.5 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.

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

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.

HOLD can also be triggered by a an alarm condition (see section 5.4 alarm function)

5.6 Master/slave operation

Two instruments can be connected together to make synchronised measurements with up to 6 phases. The unit assigned as 'master' controls the measurements so both instruments are taking data in the same time.

When in POWER or INTG modes, the SUM power from the slave instrument is read by the master instrument to compute the overall efficiency.

To operate in master/slave mode, connect together the extension ports on the back of the instrument with the 15 way ribbon cable and the 15 pin D type port inverter. Also connect together the SYNC BNC connectors on the back of the instruments with a BNC cable. Press the AUX key on each instrument to set master/slave to master and slave respectively. The master/slave selection is shown in the top left hand corner of the display.

Because the measurement window is set by the master instrument, if the slave instrument is measuring a different frequency (for example when measuring efficiency of a 3 phase inverter) then the measurements on the slave will not be exactly synchronised to its frequency and may take a little longer to settle than usual.

In the event that either instrument changes range or detects a significant change in frequency then both instruments will resynchronise and "waiting for data" will be shown on the display.

To synchronise data read over the communications ports, first send 'HOLD,ON' to the master (which puts both instruments in hold mode) read the data from the master and slave, then release HOLD on the master 'HOLD,OFF'.

6   Using remote control

KinetiQ is fitted as standard, with RS232 serial communications port, USB port, IEEE488 (GPIB) and LAN interface. All the interfaces use the same ASCII protocol with the exception of the end of line terminators:

	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 KinetiQ can be programmed via any of the interfaces, and 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 KinetiQ are always upper case, delimited by commas, without spaces.

Only the first six characters of any command are important – any further characters will be ignored. For example, the command to set the bandwidth is BANDWI but BANDWIDTH may be sent as the redundant DTH at the end will be ignored.

Fields within a command are delimited by comma, multiple commands can be sent on one line delimited with a semi-colon. Eg.
        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 KinetiQ are in scientific notation, with a 5 digit mantissa by default. For extra resolution, this can be increased to 6 digit by setting 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:

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

KinetiQ 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? (see section 5.1).

KinetiQ 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 (see section 5.2).

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. 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. Press HOME to return to "local" operation.

RS232 data format is: start bit, 8 data bits (no parity), 1 stop bit. Flow control is RTS/CTS (see section 5.2), 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 communications 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

6.1 Standard event status register

PON		CME	EXE	DDE	QYE		OPC

bit 0 OPC   (operation complete)
               cleared by most commands
               set when data available
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).

6.2 Serial Poll status byte

		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).

6.3 RS232 connections

The RS232 port on KinetiQ 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

KinetiQ will only transmit when CTS (pin 8) is asserted, and can only receive if DCD (pin 1) is asserted. KinetiQ constantly asserts (+12V) DTR (pin 4) so this pin can be connected to any unwanted modem control inputs to force operation without handshaking. KinetiQ 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 KinetiQ to a PC, use a 9 pin female to 9 pin female null modem cable:

|		
1 & 6	-	4
2	-	3
3	-	2
4	-	1 & 6
5	-	5
7	-	8
8	-	7

6.4 RS232 printer

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.

6.5 Screen Shot

If required you are able to 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' button for roughly 2 seconds. This will capture what is currently on the screen and save it as a bitmap image on the memory stick.
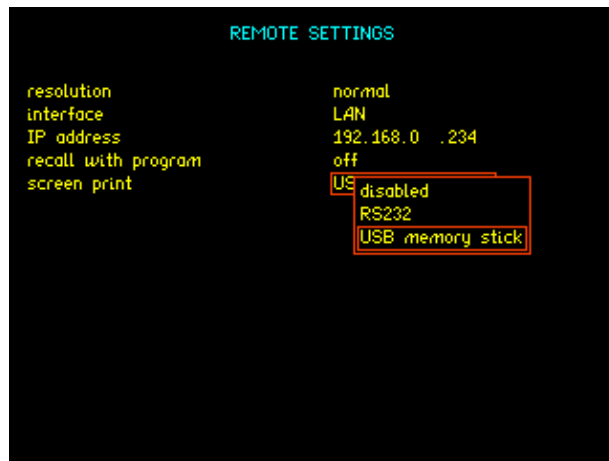
By default the save location for the screen shot will be the USB memory stick; this can be changed in the 'Remote' menu. You can change it to print to the RS232 port, that is used to print to an attached printer to print a physical copy of what is shown on the screen described in 6.4.

7   System options

Press SYS to access the system options.

Measurements of phase can be expressed in one of three conventional formats:
    -180° to +180° (commonly used in circuit analysis)
    0° to -360° (commonly used in power applications)
    0° to +360°
The measurement is exactly the same it is only the way that it is expressed that changes.

Blanking can be applied to a number of measurements so that zero is shown when the measurement is below a certain level. This blanking can be disabled if desired.

The oscilloscope display and datalog graph may be made up of single points or lines.

Each key press is normally accompanied by an audible 'beep' as well as the tactile 'click'. The 'beep' can be disabled for quiet environments if the feel of the key is sufficient feedback

Regular autozero measurements can be suppressed.

The 6 main function keys, POWER, INTEG, HARM, RMS, IMP, SCOPE, can be used to load stored configurations as a "one-touch" way of configuring the instrument for specific applications. This is particularly useful in a production environment where an operator has a small number of specific tests to perform.

The data displayed in zoom level 2 may be shown to one digit greater resolution than normal. This is particularly useful when measuring phase at power line frequencies where the normal resolution of 0.01° is not sufficient.

To save these system settings as default, store the setup in program 1 so that they are reloaded on power on.

Pressing RIGHT from the SYSTEM OPTIONS menu selects the USER DATA screen where up to three lines of user specified text may be entered. The first line is displayed on power up; all three lines may be read remotely by the command USER? to identify the instrument.

Pressing LEFT from first SYSTEM OPTIONS menu displays the serial number, manufacture code, release versions, and calibration date. These cannot be changed by the user.

7.1 User data

KinetiQ can be personalised by entering up to 3 lines of user data as text (see section on text entry).

User data is displayed every time that the instrument is switched on to identify the instrument. The entered text may also be read over the communications to identify the instrument (see USER?).

Typical arrangement of the user data might be:
    line 1 company name
    line 2 department or individual name
    line 3 unique identifying number (eg. asset number)

Any user data may be entered as required, as the lines are treated purely as text and are not interpreted by KinetiQ at all.

After changing the user data, execute 'store' to save the data in non-volatile memory.

For use in a production environment, KinetiQ supports two modes of operation, supervisor and user. When supervisor mode is disabled, the stored programs can only be recalled, not changed. KinetiQ saves the mode of operation with the user data so that it may be configured to power up in either mode as required.

8   Measurement options

8.1 Wiring configuration

The three phase version of KinetiQ, the PPA5530, can be used in a variety of wiring configurations. Other versions, PPA5520 and PPA5510, accept a subset of these configurations:

configuration	5530	5520	5510
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). This allows direct measurement of efficiency in a 3 phase motor drive or 3 phase inverter application. The frequency reference for the independent phase 3 may be selected to be voltage, current, the mains line frequency, or the same as phase 1 & 2. In this mode, frequencies up to 1kHz can be measured with phase 3.

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.
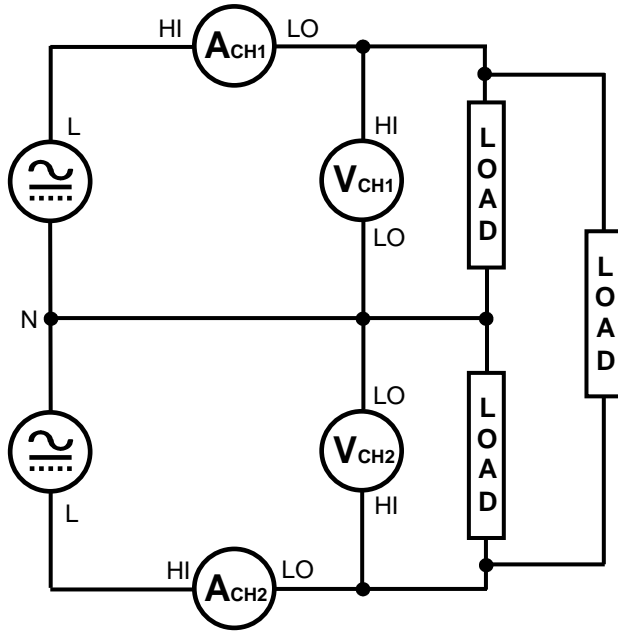
The wiring configuration is the first item to be selected under the ACQU menu.

8.1.1 Wiring diagrams

Single Phase
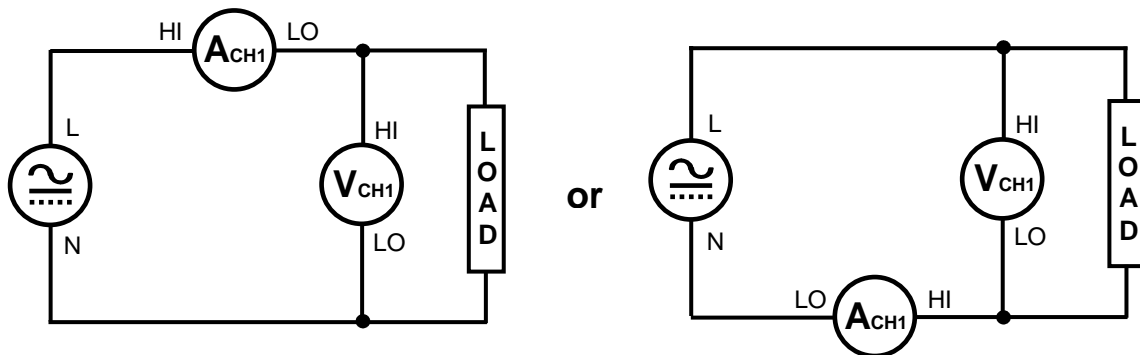
Two Phase Two Wattmeter

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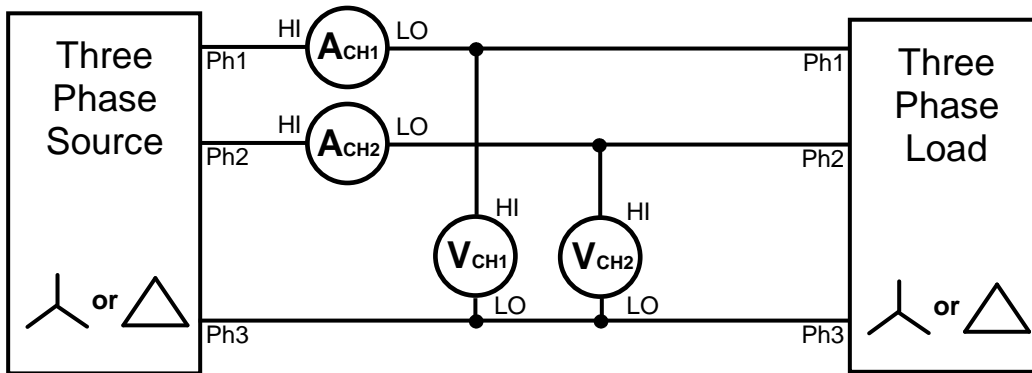
Three Phase Three Wattmeter - simulated neutral
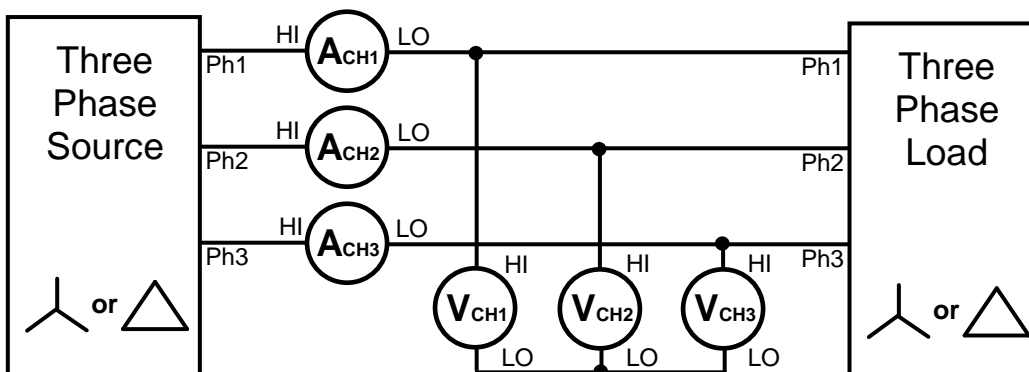
Three Phase Three Wattmeter – Star Connections
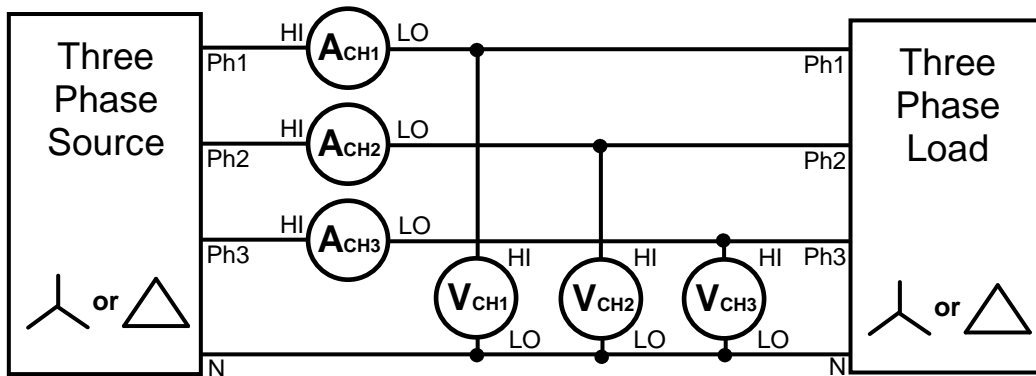
Three Phase Three Wattmeter– Delta Connections
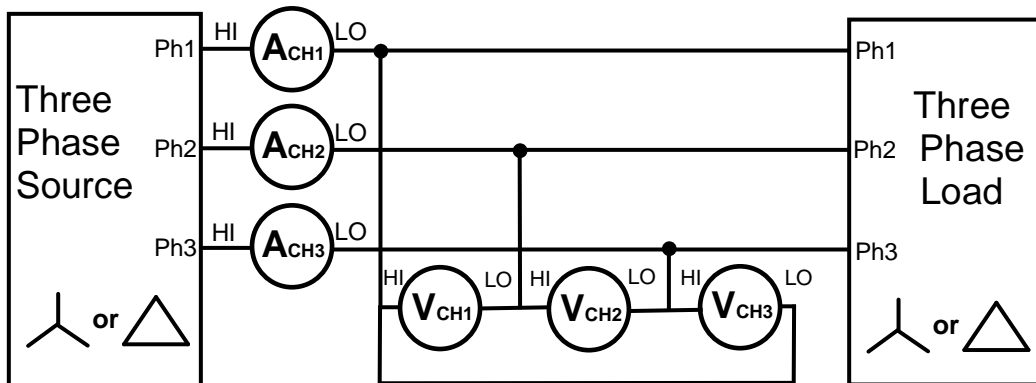
On a multi phase instrument all the phases usually use the same input control data – internal/external, scaling factor etc. It is possible to select "independent" so that the phases can be set up differently. This is useful if different scaling factors are required for external shunts or if one phase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

8.2 ACQU - Acquisition options

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 digital filter equivalent to a first order RC low pass filter.

There are five pre-set speed options – Very fast, fast, medium, slow, and very slow – that adjust the nominal size of the window, and therefore the update rate and the time constant of the filter. Greater stability is obtained at the slower speed at the expense of a slower update rate.

There is also an option to set a specific size of the window to a value other than the preset options. In order to synchronise to an integral number of cycles, the window size is either reduced by up to 25% or increased as necessary.

Note that at low frequencies, the window is extended to cover a complete cycle of the input waveform even if this is a longer period than the nominal update rate.

There are two time constants for the smoothing filter, normal or slow, or the filter can be deselected. The nominal values are:

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

The smoothing response is usually set to "auto reset" where the filtering is reset in response to a significant change in data. This speeds up the response of the instrument to changing conditions. This function can be disabled so that the filtering has a fixed time constant, which would have an exponential response to a step change.

The frequency may be measured from the voltage, current, speed input or ac line. On a multi-phase instrument, any channel may be selected for the frequency measurement.

Phase angle measurements have to be made with reference to a specific input – normally phase 1 voltage. 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. In multi-wattmeter wiring modes, phase 1 is always used for the phase angle reference; phase 2 or phase 3 is used when in single phase 2 wiring or single phase 3 wiring.

A frequency filter, 4kHz 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.

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.

8.2.1   Advanced options

Pressing ACQU to access the acquisition control menu then the right arrow key gives access to some advanced options which would not be needed for normal measurement applications.

The analysis for 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. Selecting "narrow" increases the selectivity of the DFT analysis (reducing the effective bandwidth) which has the effect of improving the noise rejection. It does however require that the frequency of the fundamental component is more stable.

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 are 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 overrange.

In a very noisy application, where the frequency of the signal is known but KinetiQ is unable to measure the frequency even with PWM filters or low frequency mode filters applied, it is possible to enter the frequency to be used for analysis. When "frequency lock" is selected to be "on" the present measured frequency is displayed but this can be overwritten with the known frequency. This entered frequency is then used for all the analysis and the frequency of the input signal is not measured.

8.3 COUPLING - coupling & bandwidth options

There are three coupling options - AC only, AC+DC, or DC only. AC+DC coupling is the normal 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.

There are three bandwidth options - wide, low, and DC only. Low bandwidth may be useful in noisy applications for example where there are switching spikes superimposed on the waveform of interest. The switching spikes may push the input channels onto a higher range than is necessary for the measurement. Selecting low bandwidth puts a hardware filter in the analogue input path to eliminate unwanted high frequency components.

The DC only bandwidth option applies a dc-accurate low pass filter of around 10Hz to reduce the ac signal. This is particularly useful when accurately measuring the dc content of an ac waveform such as the output of a UPS (uninterruptible Power Supply). A 50Hz or 60Hz ac signal would not be removed entirely so that the measurement may still be synchronised to the waveform, but the amplitude would be greatly reduced so that the instrument would be on a more appropriate range for the dc component

In multi-phase applications, if independent input control has been set (see system options) then the coupling and bandwidth options are independently set on each phase.

Coupling option	Bandwidth option	Measurement bandwidth	Notes
ac+dc	wide	dc - 2MHz	default
ac+dc	low	dc - 200kHz	
ac+dc	dc	dc - 5Hz	
ac	wide	5Hz – 2MHz	
ac	low	5Hz –200kHz	
ac	dc	dc – 5Hz	dc bandwidth overrides ac coupling
dc	wide	dc - 2MHz	* dc coupling disables auto frequency search and no compensation is applied.
dc	low	dc - 200kHz	*
dc	dc	dc - 5Hz	*

8.4 RANGE - input channel options

All the input channels are fully isolated from each other and from earth with very high CMRR (common mode rejection ratio). They are controlled independently but sampled synchronously.

Each input channel has an external input as well as an internal shunt or high voltage attenuator. The external input gives versatility in the input ranging by using external shunts or attenuators. If the external shunt or external attenuator option is selected, the data is scaled by the appropriate value (entered under the relevant channel menu).

Precision low inductance current shunts or current transformers may be used with the current channels; high voltage attenuators or oscilloscope probe may be used with the voltage channels. **Note that when using external shunts or attenuators on high voltage signals, the inputs must not exceed 1000V rms cat II, or 600V cat III, to ground.**

There are 9 input ranges with nominal full scale values set with a 1:3:1 ratio. For convenience, the peak range system has been converted to the equivalent rms ranges on the next page of this manual, this gives the following range system:

10Arms Model

Peak Ranges				RMS Ranges – Sinusoid	
Range	internal current	internal voltage	external input	Internal current	Internal voltage
1	3mA	300mV	300µV	2.54mArms	254mVrms
2	10mA	1V	1mV	8.48mArms	848mVrms
3	30mA	3V	3mV	25.4mArms	2.54Vrms
4	100mA	10V	10mV	84.8mArms	8.48Vrms
5	300mA	30V	30mV	254mArms	25.4Vrms
6	1A	100V	100mV	848mArms	84.8Vrms
7	3A	300V	300mV	2.54Arms	254Vrms
8	10A	1kV	1V	8.48Arms	848Vrms
9	30A	3kV	3V	10.0Arms	1000Vrms

30Arms Model

Peak Ranges				RMS Ranges – Sinusoid	
Range	internal current	internal voltage	external input	Internal current	Internal voltage
1	30mA	300mV	300µV	25.4mArms	254mVrms
2	100mA	1V	1mV	84.8mArms	848mVrms
3	300mA	3V	3mV	254mArms	2.54Vrms
4	1A	10V	10mV	848mArms	8.48Vrms
5	3A	30V	30mV	2.54Arms	25.4Vrms
6	10A	100V	100mV	8.48Arms	84.8Vrms
7	30A	300V	300mV	25.4Arms	254Vrms
8	100A	1kV	1V	30Arms	848Vrms
9	300A	3kV	3V	30Arms	1000Vrms

50Arms Model

Peak Ranges				RMS Ranges – Sinusoid	
Range	internal current	internal voltage	external input	Internal current	Internal voltage
1	100mA	300mV	300µV	84.8mArms	254mVrms
2	300mA	1V	1mV	254mArms	848mVrms
3	1A	3V	3mV	848mArms	2.54Vrms
4	3A	10V	10mV	2.54Arms	8.48Vrms
5	10A	30V	30mV	8.48Arms	25.4Vrms
6	30A	100V	100mV	25.4Arms	84.8Vrms
7	100A	300V	300mV	50Arms	254Vrms
8	300A	1kV	1V	50Arms	848Vrms
9	1000A	3kV	3V	50Arms	1000Vrms

The actual ranges have approximately 20% overload (subject to noise) headroom so, for example, the 300Vpk range has an actual peak input value of 360Vpk allowing for the 20% headroom.

All N4L analyzers auto-range to the waveform peak, this is vitally important as it ensures that the waveform is not clipped unlike within traditional rms ranging power analyzers.

The ranges may be selected manually, or by autoranging (default). To speed up the autoranging, the start range for autoranging may be selected if it is known that the signal will not be below a certain level.

There is also an option to autorange 'up only' so that a test may be carried out to find the highest range. Once the highest range has been determined, the range can be set to manual and the test carried out without losing any data due to range changing. Pressing the TRIGGER key (or sending *TRG) restarts the autoranging from the selected minimum range.

In multi-phase applications it is usual to allow the phases to independently range but there is an option to lock the ranges across the phases. When enabled, this means that all the voltage channels will be on the same range, and all the current channels will be on the same range.

When in an input channel menu, the ZERO key provides a quick way to lock and unlock the range. When no flashing box is visible in the input channel menu and autoranging is selected, pressing the ZERO key selects the range that the instrument is currently using and sets the autoranging to manual, thus locking the range and preventing further autoranging. Pressing the ZERO key again returns to full autoranging from the bottom range.

For most measurement functions full autoranging is the most suitable option but some applications, such as where transient events are occurring, are more reliable with manual ranging. Manual ranging (or up-only autoranging) is essential for low frequency measurements.

Separately from the current shunt and attenuator value, a scaling factor can be entered for each channel.

In multi-phase applications, if independent input control has been set (see system options) then the ranging options may be independently set on each phase. Press the RIGHT and LEFT keys to step between the phases.

8.5 DATALOG – datalog options

KinetiQ can store and display measurements recorded at regular intervals over a time period. Each data record consists of the elapsed time and up to four data values selected by ZOOM. The instrument can graph and display all four sets of measurements simultaneously. The 1Gb memory enables the storage of a very large quantity of records, whether they are just one value or four values.

The actual interval between data points is governed by the measurement speed and the datalog interval. KinetiQ stores the next available measurement after the datalog interval has elapsed: the actual elapsed time is attached to each datalog record, is displayed with the data on the table or each graph, and returned with each record over the communications (RS232, USB, LAN or GPIB).

The data values may be stored to an external memory device (Memory Stick) or directly into non-volatile memory as each value becomes available. The non-volatile option is useful for acquiring data over long periods, to prevent the loss of data in the event of a power failure. Data that has been stored into external memory may be subsequently transferred to non-volatile memory using the PROG menu. In this mode the data may be viewed in real time, as it is being acquired.

For high speed data acquisition, the datalog interval may be set to zero so that each measurement is stored. The measurement interval is controlled with the "speed" option in the ACQU menu. Using the "window" option for speed allows greater control of the measurement interval. In this mode, the display flashes "DATALOG RUNNING" and only shows the acquisition time. The minimum datalog interval depends on the function but is typically 10ms.

Note that in all cases the measurement interval is necessarily adjusted to be an integral number of cycles of the measured waveform.

Press DATALOG to set up the datalog options. The datalog is started with the START key, and stopped with the STOP key unless the store becomes full first. The zero reference for the elapsed time is taken as the first data measurement after START.

The data can be viewed as a table or as individual graphs. Pressing GRAPH steps the graph through the stored parameters. If more than 250 records have been stored, the graph can show the data for the whole period or pressing ZOOM redraws the graph to show 250 records about the cursor. The cursor can be moved in single steps (LEFT or RIGHT) or large steps (UP or DOWN). Pressing UNZOOM shows the whole data gain. Movements of the cursor are synchronised in both the TABLE and GRAPH views.

8.6 MATHS – custom result computation

Non-standard results may be computed from a combination of voltage and current parameters, signals on the torque and speed inputs, and constants.

There are 3 formulae, each combining up to 4 terms:

1: (term1 + term2) / (term3+term4)
2: (term1 + term2) x term3 / term4
3: term1 x term2 / (term3+term4)

Each term comprises a result, scaled by a signed factor, or a signed constant.

For example, consider the formula:

maths = Vpk.Apk / $\sqrt{2}$

Select formula 2 with:
    term1 = voltage peak x 1.0
    term2 = disabled
    term3 = current peak x 1.0
    term4 = constant x 1.414
or
    term1 = voltage peak x 1.0
    term2 = disabled
    term3 = current peak x 0.7071
    term4 = disabled

The selected formula is applied to the data from each phase.

The result is displayed with a user definable label of up to 12 characters and units up to 8 characters.

9   Application specific modes

Select the application specific options form the APP menu.

9.1 PWM motor drive

The nature of the waveforms in a PWM motor drive application makes measurement of the fundamental frequency difficult. Within the application mode for PWM motor drive it is possible to select one of seven pre determined frequency filter ranges, 64Hz, 250Hz, 1KHz, 4KHz, 16KHz, 64KHz or 250KHz. As a general guide it is advisable to select the range closest to the highest fundamental frequency, for example if a PWM motor is running at 500Hz the best filter to select would be the 1KHz. However experimentation is sometimes the best way to select the optimum filter.

Note: The filter does **NOT** change the measured data at all it is only applied to the data for the frequency measurement

PWM application mode also allows torque and speed to be simultaneously measured so that efficiency can be computed.

To select PWM motor drive mode, press the APP key, select the mode with the cursor keys, move down to the "default settings" option and press ENTER. The filter and torque/speed settings can now be selected.

When low frequency mode is enabled this allows frequency measurements down to 10mHz and is good to 30Hz for 100 harmonics and 60Hz for 50 harmonics.

The calculation for efficiency may be selected as the ratio of:

    Phase 1 and phase 2
    Slave sum and master sum
    Mechanical and sum
    Phase 3 and sum

9.2 Lighting ballast

Electronic lighting ballast waveforms consist of a high frequency carrier signal modulated by the line frequency. KinetiQ 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 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

To select lighting ballast mode, press the APP key, select the mode with the cursor keys, move down to the "default settings" option and press ENTER. The defaults are loaded and the particularly important parameters can then be changed.

Ballast mode quick start guide

After selecting "Ballast mode" in the APP menu the next step is to connect the ballast input and output (if required) to the Power Analyzer.

1. 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.
2. 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

Carrier Frequency

AC Line Frequency
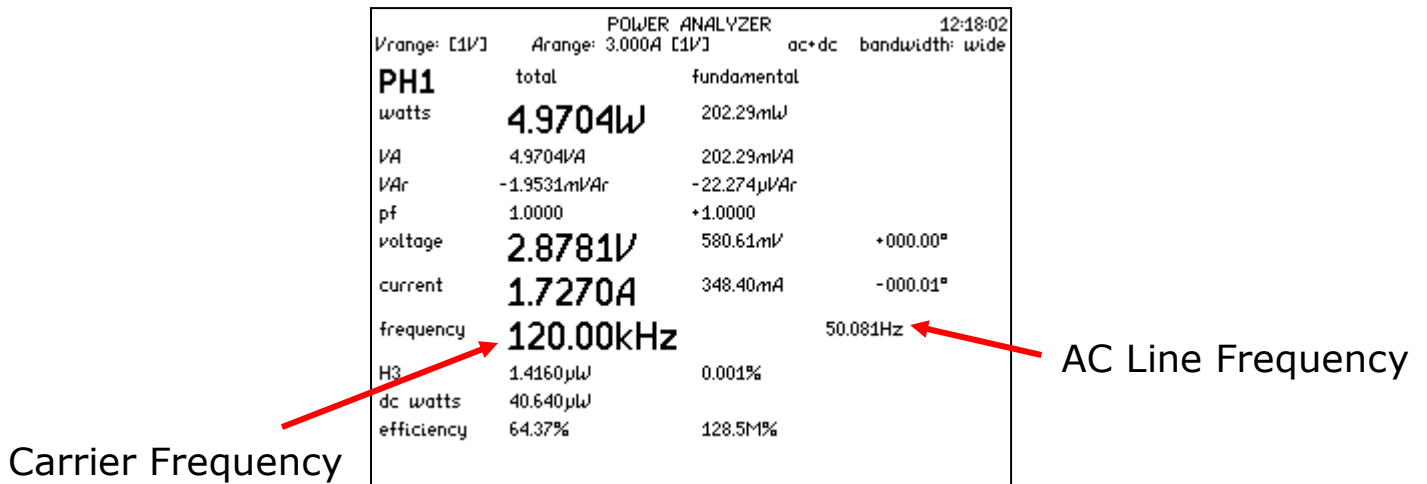
Phase 2 will also display the same two frequency components for the user's reference.

Note: The default setting for efficiency measurements is Phase 1/Phase 2, as displayed on the bottom line of the display.

9.3 Inrush current

Measurement of 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. In inrush mode, KinetiQ samples and analyses every sample at the full sample rate in excess of 2Msamples/s to catch even very fast peaks.

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 KinetiQ, controls the switch on of the power to the DUT from 0° to 315° in steps of 45° from the KinetiQ front panel.

ENTERing the default settings in inrush mode in the application menu selects the PCIS and sets KinetiQ 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.

Note:
- Short term inrush current specification available from N4L upon request.

9.4 Power transformers

Large power transformers operate at very low power factor (<0.01) and the phase accuracy is critical to measure the losses. Power transformer application mode sets the configuration options to the optimum for phase accuracy eg. AC+DC coupling, range lock across phases.

The multiple phase display is also changed to show imbalance across the phases. Phase 1 appears with the normal measurements but the voltage and current measurements for phase 2 and phase 3 are expressed as a percentage of the corresponding values from phase 1. The phase angle measurements are expressed as deviation from the expected values of -120° and -240°.

The temperature can be monitored at the same time by connecting a suitable temperature sensor to the "torque" BNC input. The input accepts an analogue voltage from -10V to +10V which can be scaled by an offset and a factor in degrees per Volt. The offset is entered as the zero degree voltage so for a sensor with an output range of 5° / Volt and 0V = 10 degrees, the offset to be entered would be -2V.

In power transformer mode the Corrected Power (labelled Pcorr on the PPA display) and K-factor are calculated and displayed in the individual phase and SUM displays.

The equations use to calculate the Corrected power and K-factor are:

IEC76-1(1976), ANSI/IEEE C57.12.90-1993	IEC76-1(1993)
$$P = \frac{P_m}{P_1 + k \cdot P_2}$$ $$k = \left(\frac{U}{U'}\right)^2$$	$$P_0 = P_m(1+d)$$ $$d = \frac{U' - U}{U'}$$

Where

K = K factor

P or P_0 = corrected power

P_m = measured power

P_1 = ratio of hysteresis loss to total iron losses

P_2 = ratio of eddy current losses to total iron losses.

U' = Normalised mean value of voltage

U = rms value of voltage

9.5 Standby power measurement

In order 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, so 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.

10 Power measurements

In the POWER mode, KinetiQ 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	
RMS voltage	elementary	V
RMS current	elementary	A
Fundamental power	secondary	W
Fundamental VA	secondary	VA
Fundamental VAr	secondary	VAr
Fundamental power factor	secondary	
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 (eg 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 (eg. VA = Vrms x Arms).

Not all of the parameters listed are displayed in POWER mode but they are all computed.

A multi phase instrument also computes the equivalent values for total power (SUM channel) and the values for the NEUTRAL current. Step through the phase values with NEXT and BACK.

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.

10.1   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.

10.2   Sum computations

When in 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 respectively then may optionally be divided by the number of phases to give the average.

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:

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

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

10.3   Neutral synthesis

In 3 phase 3 wattmeter configuration, the values for the neutral current are synthesised from the calibrated values of the three phases. By Kirchoff'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.

10.4   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:

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

$$V_{12} = \sin(\omega t) [V - V \cos(120°)] + V \cos(\omega t).\sin(120°)$$
$$= 1.5 \, V \sin(\omega t) - \sqrt{3}/2 \, V \cos(\omega t)$$
$$= \sqrt{3} \, V \sin(\omega t - 30°)$$

So the phase to phase voltage would have a magnitude $\sqrt{3}$ times larger than the phase to neutral voltage at a phase displacement of -30°.

KinetiQ applies the computations in the 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.

10.5 Mechanical power

KinetiQ has 2 extra inputs to measure the mechanical power of motors or generators. Torque is measured in Nm with a +/-10V analogue input scaled in Nm/V or as a pulse count input scaled in pulses/Nm. Speed is measured in rpm either with a +/-10V analogue input scaled in rpm/V, or as a pulse input which can be scaled with pulses/revolution.

An offset can be entered to allow for dc offset within the torque and speed sensors. The scaled value is derived as:

Torque or speed = (measured value – offset) x scale

The speed offset only applies to analogue speed, not pulsed. The offset values can be entered directly in the APP menu or by pressing ZERO when 'home' in the APP menu ie no menu items are highlighted. To use the ZERO function press APP, move down to enable the torque and speed, press HOME to return the cursor to the 'home' position then press ZERO. The presently measured values will be entered automatically as the offsets.

The mechanical power is given by:

Wmech = torque x angular velocity (rad/s)
= torque x speed (rpm) x 60 x 2π

The mechanical power can then be used to compute efficiency as:

efficiency = mechanical power / sum power (motor)
or
efficiency = sum / mechanical power (generator)

The measurement of mechanical power is made simultaneously with the electrical measurements over the same window.

Frequency offset can be set in pulsed mode for both speed & torque within the APP menu as shown below

10.6 Efficiency

Efficiency may be computed as a ratio of:

    phase 1 and phase 2 power
    master and slave power
    mechanical and sum power
    phase 3 and sum power

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.

10.7   Torque & Speed

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

11 Integrated power measurements

In the INTEG mode, KinetiQ 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

The integrator is started by pressing the START key; the elapsed time is displayed in the upper left corner of the display. 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.

To make an integrated measurement over a specific interval, an integration run time can be entered in hours and minutes. The integration will automatically stop when the integration timer reaches the value entered, as if the

STOP button had been pressed. Setting the integration time to zero, disables the timer.

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 integrated results may be displayed as the total accumulated values or as the average over the integration period.

12 True RMS Voltmeter

The RMS voltmeter displays the additional secondary parameters of ac, crest factor, surge, mean and form factor:

Having computed the true rms and the dc component, the ac component can be derived from:

$$rms^2 = ac^2 + dc^2 \quad => \quad ac^2 = rms^2 - dc^2$$

Crest factor is derived from the peak and rms:

$$cf = peak / rms$$

In order to measure surge conditions, the maximum instantaneous peak value (unfiltered) is also recorded. It is important that KinetiQ does not autorange while measuring surge – either set the range to manual or repeat the test several times with ranging set to up only. To reset the maximum, press TRIGGER.

The mean value, also known as rectified mean, is computed by the arithmetic mean of the absolute value of the samples:

$$mean = 1/2\pi \int_0^{2\pi} |v(\phi)| \, d\phi$$

For a sampled signal, the formula becomes:

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

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

Note that the mean value will not give the same measurement as rms. The form factor indicates the ratio of mean to rms:

form factor = rms / mean

For an undistorted sinewave, the form factor is given by:

sine wave form factor = $\pi / 2\sqrt{2}$
= 1.11072

There is also an option to normalise the rectified mean measurement (factor = pi / 2root2 = 1.11072) as form factor is always computed from the absolute value (before normalisation).

13 Harmonic analyser

The HARM mode of KinetiQ 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 bargraph 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:

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

In series THD mode, the THD is computed from a series of up to 100 harmonics.

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

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 ith harmonic
and t_i is the ith 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 ith harmonic
and t_i is the ith 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 scale 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 ith 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 ith 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 is selectable in the same way as for THD.

Harmonics can be measured from Phase to Neutral or Phase to Phase, this option is selected in the HARM menu

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.

Harmonic phase angle reference

As phase angle is a measurement of the relative difference between the computed harmonic and the zero phase angle reference, it is important to understand to what the harmonic is being referred.

Single phase

The default phase angle reference is voltage fundamental but can be set by menu option to current fundamental.

As all harmonics are referred to the same measurement, the harmonics can be combined to recreate the original waveform by adding the components:

$$V(t) \approx \sum_{i=1}^{i=n} A_i \cos(i\ \omega t + \varphi_i)$$

where:
  ω = angular frequency
  i = harmonic number
  n = maximum harmonic
  A_i = amplitude of harmonic i
  φ_i = phase angle of harmonic i

Note that computed phase angles are quoted according to the cosine formula above not a sine formula.

Multi phase

In a multi-phase measurement, the fundamental phase angle of each phase is expressed relative to a common reference, normally phase 1 voltage; while the harmonic phase angles of each phase are expressed relative to their own phase, normally voltage as with single phase. So on a three phase system with the same waveform on each phase displaced by 120 degrees at the fundamental, the harmonic measurements would show the same phase angle on each phase (because they are referred to their own phase) while the fundamentals would show the 120 degree phase displacement.

So to recreate the original waveform, apply the same formula as for single phase but first refer the phase angle of the fundamentals to the same reference as that of the harmonics. If the reference is voltage, subtract the voltage phase angle from the current angle and set the voltage to zero; if the reference is current, subtract the current phase angle from the voltage phase angle and set the current phase angle to zero.

Phase to phase harmonics

When the instrument is wired phase to neutral but the option is selected to display phase to phase harmonics, the phase angle reference for all the harmonics, including the fundamentals, is the same. The common phase angle reference is the original phase to neutral signal on phase 1 so the formula for single phase can be applied without changing the phase reference for the fundamentals.

Interharmonic Sweeps

Interharmonic Sweep Mode measures the Interharmonic voltage and Interharmonic current on each phase over a range of harmonics.

The results are displayed on the PPA and can be exported to an Excel document using PPA Datalogger software.

The following parameters can be selected:

Frequency step size: selectable from 500mHz to 100Hz.
(Frequency step between each harmonic)

Selected Harmonic: selectable from 2 to 1000.
(Individual harmonic)

Harmonic Series up to: selectable from 2 to 9999.
(Number of harmonics included in the sweep)

Harmonic Factor

The Harmonic Voltage Factor and Harmonic Current Factor are defined in section 7.2.1.1 of EN60034-1:2010.

Harmonic Voltage Factor.

HVF is the square root of the sum of the squared voltage harmonics divided by their harmonic number, for harmonics 2 to 13 excluding those divisible by 3.

Note: we do not limit the upper harmonic to 13 to allow the user to enter the upper harmonic of their choice. However, this should be set to 13 for the test to be compliant to the standard.

The HVF is computed using the following formula:

$$HVF = \sqrt{\sum_{n=2}^{k} \frac{u_n^2}{n}}$$

Where:
$k = 13$
n = the order of harmonic (not divisible by three)
un = is the ratio of the harmonic voltage Un to the rated voltage UN.

Harmonic Current Factor.

The HCF is the square root of the sum of the squared current harmonics for Harmonics 2 to 13.

Note: the harmonics are not divided by the harmonic number, nor are those divisible by 3 excluded. It is effectively the same as THD with the maximum harmonic set to 13.

The HCF is computed using the following formula:

$$HCF = \sqrt{\sum_{n=2}^{k} i_n^2}$$

Where:
$k = 13$
n = the order of harmonic
in = is the ratio of harmonic current In to the rated current IN.

14 Impedance meter

The IMP mode on KinetiQ uses the real and imaginary components at the fundamental frequency using 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), KinetiQ computes the complex impedance given by:

$$\mathbf{z} \quad = \quad \mathbf{v} / \mathbf{i}$$
$$= \quad (a + jb) / (c + jd)$$

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 displayed for either series or parallel models.

If the parameter option in LCR menu is set to 'auto', KinetiQ will display capacitance or inductance according to

the phase of the measurement. Alternatively, the display can be forced to capacitance, inductance or impedance.

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.

15 Oscilloscope mode

KinetiQ provides a storage oscilloscope function in order to view the waveforms being measured.

The display for the oscilloscope is divided into 10 divisions along the time axis with the selected timebase displayed in units of time/division. The timebase may be set to any real value between 15μs/div to 5s/div using the SCOPE menu. Pressing LEFT and RIGHT adjust the timebase by a factor of 2. For slow timebase operation, (> 0.8s/div) the display operates in 'roll' mode where the waveform scrolls across from left to right until triggered.

Two cursors can be enabled on the display. If cursors are "on" in the menu (press SCOPE or MODE) then the LEFT and RIGHT key mode the selected cursor, UP and DOWN toggle which cursor is selected. The time difference between the 2 cursors, 'delta t', is displayed on the lower left of the display. When the cursors are enabled, LEFT and RIGHT no longer adjust the timebase.

The vertical scaling is shown as a full scale value, rather than as a V/cm. This indicates the range that the instrument is using for each channel.

Triggering is very important to obtain a stable trace and there are various options to control the trigger:
     source
     level
     type
     polarity
     HF reject
     pretrigger

The data source for the trigger can be selected to be either voltage or current. On a mutiphase instrument, any of the phases may be selected for the trigger source.

The trigger level is set directly in Volts or Amps and does not change if the range is changed, i.e. it is an absolute trigger level and not relative to the range full scale. Pressing NEXT and ENTER adjust the trigger level by a factor of 2.

The trigger level is shown as a small horizontal bar on the extreme left-hand edge of the display against the appropriate channel. If the trigger is set to a value above or below the range of the input channel then a small carat ^ is shown at the top or inverted at the bottom of the display as appropriate.

The trigger type may be set to:
      auto   (trigger if possible but do not wait)
      normal   (wait indefinitely for trigger)
      single shot   (wait for trigger then hold)
The single shot option is reset using the TRIGGER key.

The trigger polarity may be set to rising edge or falling edge.

When 'trigger HF reject' is on, a low pass filter is applied to the trigger data to stabilise the trace with noisy signals. The filter only influences the trigger detection and does not change the data displayed.

Pretrigger may be set to:
      none
      25%
      50%
      75%

Autoranging can be used with the oscilloscope functions but it is more customary to fix the range manually particularly when looking for a single event in 'single shot' mode. Manual ranging is essential for rare events with a low mark space ratio.

15-1   PPA Capture Mode

To perform capture mode tests it is necessary to use a PPA5510 or a PPA5530 and upgrade the Firmware within the instrument to either PPA5512 (Single Phase) or PPA5532 (Three Phase)

Capture mode operates as a sub function of the normal oscilloscope mode – enable "capture mode" in the application menu. Data is then stored in a 50000 byte circular buffer per channel. Set the trigger mode to single shot and trigger as normal. Extracting the sample data is performed using the CAPTUR? command. Data is returned in 200 lines per channel of 250 values.

The sample capture data reply is consistent with multiple lines of IEEE488.2 "definite length arbitrary block response data". So each line of data should return as follows:

[#3503] [h1][h2] [d1.1][d1.2][d2.1][2.2]……[d250.1][d250.2] [error] [CR] [LF]

 Each line consists of:

5 bytes that represent #3503 (ASCII)
2 bytes that represent the Header bits including channel number [h1][h2]
500 bytes that represent the actual data. 250 pieces of data each made up of 2 bytes. d1.1 is data 1 bit 1, d1.2 is data 1 bit 2, d2.1 is data 2 bit 1, d2.2 is data 2 bit 2 etc
1 byte that represents the error checking bit [error]
1 byte that represents Carriage return [CR]
1 byte that represents Line Feed [LF]

Each 8 bit byte has the msb set in order to prevent any misinterpretation of data within drivers and software which otherwise could mistake data for carriage return etc. so 14 bit data values are returned.

The meaning of the 2 header bytes is as follows:

      (header h1)   (header h2)
        [1][c2][c1][c0][0][0][0][a7]
[1][a6][a5][a4][a3][a2][a1[a0]
      ^ first bit   ^ first bit
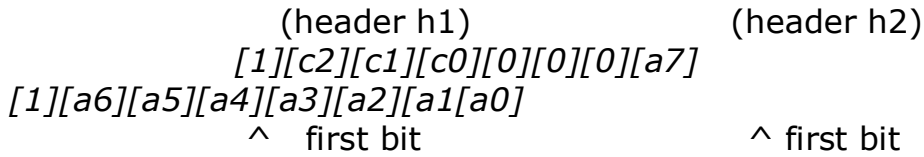
And as for the meaning of each of the bits:

[0][0][0] these 3 bits are not used and can be ignored.

[c2][c1][c0] are the channel number
 4   2   1   so the channel number can be a number between 0 and 7

[a7][a6][a5][a4][a3][a2][a1][a0] are the line number.
128 64 32 16   8   4   2   1   so the line number can be a number between 0 and 255.

The meaning of each pair of data bytes is as follows:

       (data d1.1)   (data 1.2)
[1][d13][d12][d11][d10][d9][d8][d7]
[1][d6][d5][d4][d3][d2][d1][d0]
^ first bit   ^ first bit
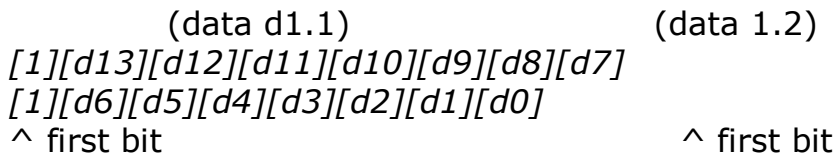
[d13] [d12] [d11] [d10] [d9] [d8] [d7] [d6] [d5] [d4] [d3] [d2] [d1] [d0] contain the data [a number]
8192 4096 2048 1024 512 256 128 64 32 16   8   4   2   1
So the data can be a number between 8191 and -8192.

RETURNED DATA (BINARY FORMAT)

The returned data starts by indicating the date / time and setup mode.

The first line of data is then displayed. The format is as stated above. The first 5 bytes with an MSB of "0" represent #3503 (ASCII). The first 2 bytes with an MSB of "1" represent the header followed by the 500 bytes of data. The final byte with an MSB of "1" is the error check. The line is completed with 2 bytes starting with an MSB of "0", these are [CR] and [LF].

This is then repeated for each of the remaining lines.

RETURNED DATA EXAMPLE

	#	3	5	0	3	h1
03/06/2014 13:57:24 [RX]	00100011	00110011	00110101	00110000	00110011	10010000

h2	d1.1	d1.2	d2.1	d2.2	d3.1	d3.2	d4.1	d4.2
10000000	10010001	11000101	10011110	11000101	10011010	11000101	11110101	
11000110
etc until

d248.1	d248.2	d249.1	d249.2	d250.1	d250.2	[ERROR]	[CR]	[LF]
10111011	11001111	10111101	11001010	11000101	11000110	11101101	00001101	
00001010

This example is from the start of the returned data. The date, time and mode etc are displayed first. The data for the first line starts from the byte of data labelled # and finishes with the data byte labelled [LF]. Only the early and later pairs of data bytes are shown in this example.

15-5

PPA Settings for Capture Mode

To run capture mode it is necessary to set the PPA up as follows:

Press the APP button and select capture mode on the drop down menu. Press enter.
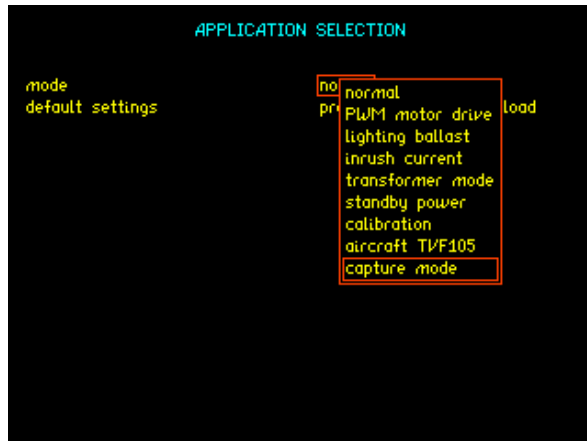
The Capture mode settings are then displayed. Select the Default settings and press enter
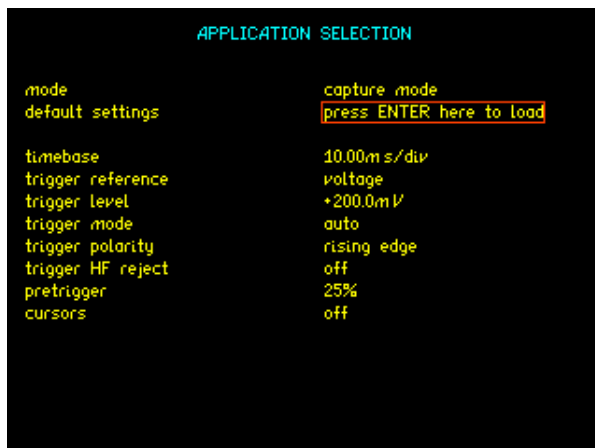
Press the mode button and confirm that the settings are as shown in the screenshot below.
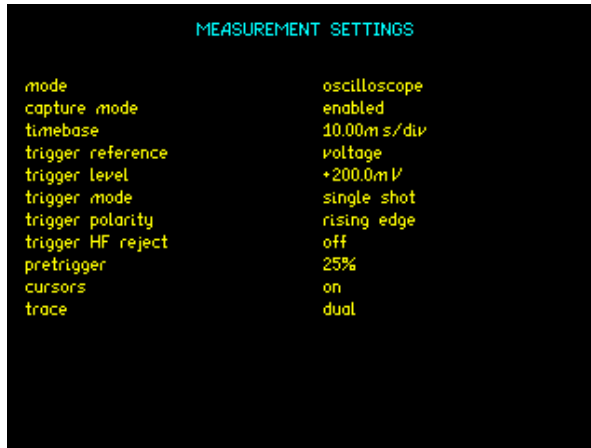
Press the enter button, the PPA display shown will now be in Oscilloscope mode.

CommView2 Software

Open the N4L CommView2 software.

Enter the *idn? command and press send, check the reply to confirm that the software is connected to the correct instrument model (either PPA5512 or PPA5532), serial number and Firmware Level.
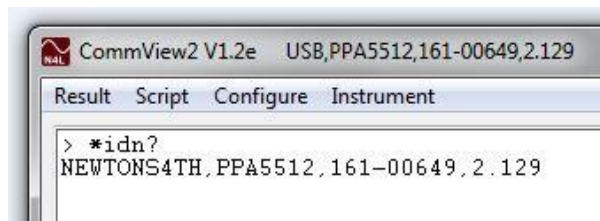
Enter the Captur? Command and press send.

The capture data should now start to be displayed in the CommView2 window. The data download should take around 25 seconds to complete.

The above screenshot shows the CommView2 window with the capture data being downloaded.

If there is a problem getting the CAPTUR? Command to start returning data it may be necessary to adjust the trigger level on the PPA in the mode menu.

16 Phase meter

The phase meter mode is a secondary function which does not have a separate button. It is 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

17 Specifications & Comparisons

Frequency Range

DC and 10mHz to 2MHz (10Arms or 30Arms versions)
DC and 10mHz to 1MHz (50Arms version)
Accuracy − 0.001%

Voltage Input

Ranges − 300mVpk to 3000Vpk (1000Vrms) in 9 ranges
20% over-range ability maintains 300Vpk range with 240Vrms
Accuracy − 0.01% Rdg + 0.038% Rng + (0.004% x kHz) + 5mV *
External sensor input to 3Vpk − BNC connector
Range - 300µVpk to 3Vpk in 9 ranges
Accuracy − 0.01% Rdg + 0.038% Rng + (0.004% x kHz) + 3µV

Current Input

The standard PPA is fitted with a 30Arms internal shunt.
10Arms or 50Arms internal shunts are available as an option
30A rms Shunt:
Ranges − 30mApk to 300Apk (30Arms) in 9 ranges
Accuracy − 0.01% Rdg + 0.038% Rng + (0.004% x kHz) + 300uA*
10A rms Shunt:
Ranges − 3mApk to 30Apk (10Arms) in 9 ranges
Accuracy − 0.01% Rdg + 0.038% Rng + (0.004% x kHz) + 30uA*
50A rms Shunt:
Ranges − 100mApk to 1000Apk (50Arms) in 9 ranges
Accuracy − 0.01% Rdg + 0.038% Rng + (0.004% x kHz) + 900uA*
External shunt input to 3Vpk − BNC connector
Ranges - 300µVpk to 3Vpk in 9 ranges
Accuracy − 0.01% Rdg + 0.038% Rng + (0.004 x kHz) + 3µV

Phase Accuracy

5 millidegrees + (10 millidegrees x kHz) (10Arms + 30Arms shunts)
10 millidegrees + (20 millidegrees x kHz) (50Arms shunt)

Watts Accuracy

[0.03% + 0.03%/pf +(0.01% x kHz)/pf] Rdg + 0.03%VA Rng

40Hz-850Hz Watts Accuracy

[0.02% + 0.03%/pf +(0.01% x kHz)/pf] Rdg + 0.01%VA Rng

DC Accuracy
Voltage – Internal
0.02% Rdg + 0.076% Rng + 10mV
Voltage – External
0.02% Rdg + 0.076% Rng + 6μv

Current – Internal
(30Arms) 0.02% Rdg + 0.076% Rng + 600uA
(10Arms) 0.02% Rdg + 0.076% Rng + 60uA
(50Arms) 0.02% Rdg + 0.076% Rng + 1.8mA
Current – External
0.02% Rdg + 0.076% Rng + 6uV

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

Torque and Speed Analogue Accuracy

Range: +/- 10V Analogue Bipolar
Accuracy: 0.05% Rdg + 0.05% Rng

Torque and Speed Pulse Count Accuracy

Range: +/- 1Hz to 1MHz
Accuracy: 0.01% Rdg

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) = 0.01% hi rdg + 0.038% rng + 0.004% * KHz + 5mV

Current:
10A models:
hi error (Current) = 0.01% hi rdg + 0.038% rng + 0.004% * KHz + 30uA

30A models:
hi error (Current) = 0.01% hi rdg + 0.038% rng + 0.004% * KHz + 300uA

50A models:
hi error (Current) = 0.01% hi rdg + 0.038% rng + 0.004% * KHz + 900uA

Datalog

Functions	Up to 4 measured functions user selectable (30 with optional PC software)
Datalog window	From 10ms with no gap between each log
Memory	RAM or non-volatile, up to 10,000,000 records

General

Crest factor	Voltage and Current - 20
Sample rate	Real time no gap - 2.2Ms/s on all channels
Low power accuracy	Compliant with IEC62301 using internal shunt Refer to low power measurement application note
Remote operation	Full capability, control and data
Application modes	PWM Motor Drive Ballast Inrush Power transformer

Ports

RS232	Baud rate to 38400 – RTS/CTS flow control
LAN (option L)	10/100 base-T Ethernet auto sensing RJ45
GPIB (option G)	IEEE488.2 compatible
USB	USB device – 2.0 and 1.1 compatible
Analogue	Bipolar +/- 10V
Speed	Analog bipolar +/- 10V or pulse count
Torque	Analog bipolar +/- 10V or pulse count
Sync	Measurement synchronization for 6 phase mode
Extension	Master slave control and N4L accessory port

Physical

Display	320 x 240mm Colour TFT Display
Size	PPA55xx - 132H x 400W x 280D mm – excl feet
Weight	5.5kg – 1 phase – 7.8kg 3 phase
Safety isolation	1000V rms or dc – category II
Power supply	90-265 rms 50-60Hz 35VA max

* measured fundamental value

PPA Comparison Table	PPA2500	PPA2600	PPA5500
Accuracy			
Basic reading + range	0.04% + 0.04%	0.04% + 0.04%	**0.01% + 0.038%**
Direct current input options			
10Arms (30Apk)	✔	✔	✔
30Arms (300Apk)	✔	✔	✔
50Arms (1000Apk)		✔	✔
Ranges	8	8	**9**
Bandwidth			
10Arms and 30Arms options	DC to 2MHz	DC to 2MHz	DC to 2MHz
50A current option		DC to 1MHz	DC to 1MHz
General features			
Display	BW Graphic	BW Graphic	**High contrast Colour Graphic**
Processing power - Harmonic computations per second	300	300	**1,800**
Non volatile internal Memory	192kB	192kB	**1GB**
USB port for memory drive			✔
Plug in USB memory drive - supplied standard			**2GB**
Non volatile real time clock			✔
Analogue output			✔
Internal datalog functions	4	4	**16 (4 x 4)**
Datalog record storage capacity	8,000	8,000	**10,000,000**
Frequency measurement accuracy	0.02%	0.02%	**0.001%**
Mechanical			
Handle	Fixed	Fixed	**Adjustable**
Tilt	Single position	Single position	**Multiple position**
19" Rack mounting option		✔	✔
Shared features			
Phases - Internal	1 - 3	1 - 3	1 – 3
Master Slave mode	4 - 6	4 - 6	4 - 6
Direct voltage input up to 3000Vpk	✔	✔	✔
No gap analysis	✔	✔	✔
RS232, USB, LAN* and GPIB* (* option)	✔	✔	**All fitted as standard**
Direct Torque and speed inputs	✔	✔	✔
Harmonic mode with THD, TIF, THF, TRD and TDD	✔	✔	✔
RMS mode with dc, ac, pk, mean, cf, surge	✔	✔	✔
Impedance mode with resistance, reactance, phase	✔	✔	✔
Scope mode with high update speed	✔	✔	✔

Appendix A – Accessories

Supplied Standard Accessories

Leads	Power, RS232, USB
Connection cables	36Arms rated 1.5 meter long leads with 4mm – stackable terminals 1x Yellow, 1 x Red and 2x Black per phase Note 1: LC version instruments (rated at 10Arms) are supplied with 20Arms connection cables Note 2: HC version instruments (rated at 50Arms) are not supplied with connection cables or connection clips.
Connection clips	4mm terminated alligator clips – 1x Yellow, 1 x Red and 2x Black per phase
Documentation	Calibration Certificate, User manual with quick start guide, Communications manual

External shunts

A range of high bandwidth external shunts are available to extend the operating range of the current measurements.

The external shunts are built using N4L proprietary shunt design to give high accuracy from DC to 1MHz. They are designed to comply with the safety standards of BSEN61010-1 to 1000V rms cat II. The sense output is via safety BNC connection to connect to the instrument, the current connections depend on the device.

Part numbers

HF003	470mΩ 3A rms	4mm safety
HF006	100mΩ 6A rms	4mm safety
HF020	10mΩ 20A rms	4mm safety
HF100	1mΩ 100A rms	safety terminals
HF200	500uΩ 200A rms	M10 bolt
HF500	200uΩ 500A rms	M16 bolt

PCIS - Phase controlled inrush switch

To measure the maximum inrush current of a load it is important to switch on the supply to it at the worst point in the cycle – usually 90˚ or 270˚ for a capacitive load, 0˚ or 180˚ for an inductive load.

The PCIS is an active device which is controlled by KinetiQ over the extension port. It accurately synchronises to the line input, measures the frequency, and switches on the output at a precise phase angle selectable from the KinetiQ front panel in steps of 45˚.

Part numbers

PCIS   Phase Controlled Inrush Switch

Ultra low capacitance high voltage probes

The KinetiQ voltage inputs have a capacitance to ground of around 50pF but even this low value can cause problems with high frequency high voltage waveforms. The ultra low capacitance high voltage probes use a differential input arrangement optimised for minimum capacitance to achieve an input capacitance to ground less than 1pF with an input range up to ±3kV pk and a bandwidth from dc to 2MHz ±1dB.

The probes connect to the external voltage input using the touchproof BNC cable supplied. They are powered either by an ac/ac mains adaptor or a dedicated ±12V dc supply.

Part numbers

ULCP   Ultra Low Capacitance Probe

External input attenuator

The KinetiQ voltage inputs have a +/-3V peak external input for use with probes or attenuators.

A divide by 10 or divide by 20 passive attenuator with a bandwidth of dc-30MHz (+/-1dB) is available to extend the +/-3V peak input to +/-30V and +/-60V respectively.

The low frequency accuracy is +/-0.3% max

The attenuators have a short flying lead to connect to the external BNC of the instrument.

Part numbers

     ATT10   divide by 10 attenuator
     ATT20   divide by 20 attenuator

CommVIEW PC software

CommVIEW is a self contained software program for a PC, which facilitates communication with KinetiQ over RS232, USB or LAN.

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

Strings to be sent to KinetiQ can be stored in a "script file" and executed automatically. 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 KientiQ
> lines beginning with # are commands for CommVIEW
> any other line is a comment.

The # commands that are recognised:

#beep	*sound the beeper on the PC*
#label,i,string	*apply a label to data value[i]*
#pause,t	*wait for time t*
#reply,t	*wait time t for a reply*

For an example script file, look at example.scr on the CommVIEW release disc.

Other functions in CommVIEW:

save results	*results menu*
set COM port parameters	*configure menu*
firmware upgrade	*instrument menu*
read/store user programs	*instrument menu*

All N4L software applications are available to download free of charge from our website. To find out more please visit us at www.newtons4th.com

A-6

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	
ALARM,latch,sounder	
ALARM?	single integer data value
ALARME,value	
ALARM1,type,data,hi,lo	
ALARM2,type,data,hi,lo	
APPLIC,type,setting	
BANDWI,phase,type	
BEEP	
BLANKI,on/off,threshold	
CALVER,string	
CALVER?	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?	freq,mag1,mag2,hmag1,hmag2,h1,h2,
or	thd1,thd2,hphase1,hphase2
HARMON,phase,SERIES?	mag,%, x n harmonics
or	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?	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?	CR terminated text string
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

calibration commands

CALAPP	
CALCOM,freq	
CALFIL,index,value	
CALFIL?	Six real data values
CALFRQ,index,freq	
CALFRQ?	Seven real data values
CALIBR,index,value	
CALIBR?	Single integer data value
CALIDS,string	
CALIDS?	String
CALPHA,index	
CALRES	
CALSAV,password	
CALSNO,serial number	
CALSTR,string	
CALSTR?	String
CALTQS,index,value	
CALTQS?	Four real data values

Appendix C – Available character set

The following characters can be selected in text entry mode.
The table is to be read across then down (eg, 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	{			}	

Appendix D – Configurable parameters

All parameters can be accessed using the CONFIG command:

    CONFIG,*parameter*?
    CONFIG,*parameter,data*

Number   Function

System parameters

Number	Function
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)

Number	Function
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

63	sub argument 1
64	coefficient 1
65	argument 2
66	sub argument 2
67	coefficient 2

Application mode parameters

69	minimum frequency (dynamic)
70	application mode
71	PWM frequency filter
72	ballast frequency tracking speed
73	PWM low frequency mode

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
102   harmonic bargraph voltage
103   rated current for TRD
104   harmonic bargraph current
105   Extended harmonic frequency range

Oscilloscope parameters

106   timebase
107   trigger level
108   pretrigger
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   speed input gear ratio
131   2 wattmeter sum computation
132   integrator run time
133   phase to phase mean
134   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

226	set clock (hrs)
227	set clock (mins)
228	set clock (secs)
229	set date (day)
230	set date (month)
231	set clock (year)

Appendix E – Contact details

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

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1 Bede Island Road
Leicester
LE2 7EA
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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.

PPA55xx KINETIQ 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.