PSM2200

QuanteQ

user manual

IMPORTANT SAFETY INSTRUCTIONS

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

- 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.
- This appliance ***must*** be earthed. Ensure that the instrument is powered from a properly grounded supply outlet ***before*** connecting the inputs to hazardous voltages.
- The input connectors are High Voltage safety types for use up to 500V peak input from earth, overvoltage category II. Do not exceed 500V peak on any input connection. Only use test leads that are fitted with approved High Voltage safety connectors when working with hazardous voltages.
- Keep the ventilation holes on the underneath, rear, and sides free from obstruction.
- Do not operate or store under conditions where condensation may occur or where conducting debris may enter the case.
- 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

Manufacturer: Newtons4th Ltd.
Address: Ratcliffe House
30 Rothley Road
Mountsorrel
Loughborough
Leics.
LE12 7JU

We declare that the product:

Description: Integrated Test Equipment
Product name: QuanteQ
Model: Alpha

conforms to the requirements of Council Directives:

89/336/EEC relating to electromagnetic compatibility:
EN 61326:1997 Class A

73/23/EEC relating to safety of laboratory equipment:
EN 61010-1

January 2003

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 12 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 BACK).

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 QuanteQ 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 QuanteQ be re-calibrated annually.

ABOUT THIS MANUAL

QuanteQ has of number of separate measurement functions that share common resources such as the keyboard and display.

Accordingly, this manual first describes the general features and specification of the instrument as a whole; and then describes the individual functions in detail.

Each function is described in turn, in its own chapter, with details of the principles on which it is based, how to use it, the options available, display options, specifications etc.

Detailed descriptions of the RS232 command set is given in the separate manual “QuanteQ communications manual”.

3 August 2004

CONTENTS

APPENDICES

1 Introduction – general principles of operation

QuanteQ is a self-contained test instrument, with one output and two inputs, that incorporates a suite of test functions.

The QuanteQ has a versatile generator output that can be used as:

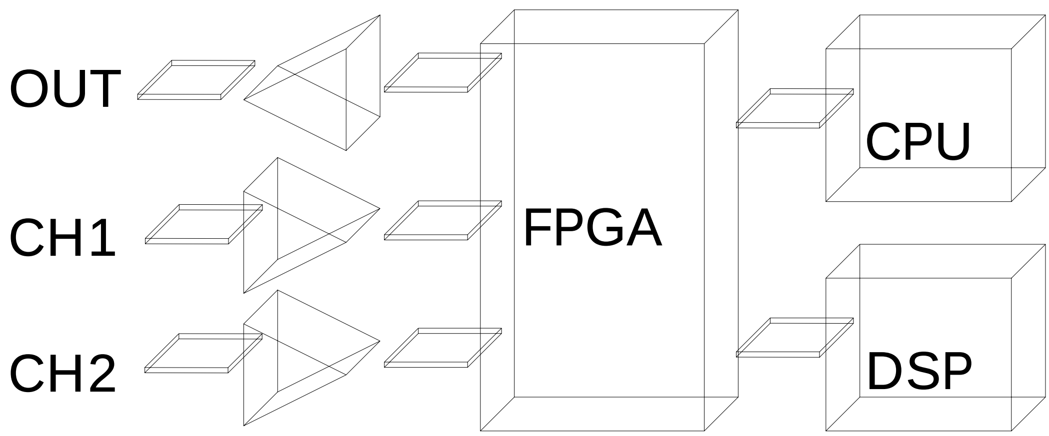
- signal generator (sine, triangle, square, sawtooth)
- dc generator
- pulse generator
- white noise generator
- dual frequency generator (FSK or harmonics)

The QuanteQ has two mutually isolated, wide range, high bandwidth, voltage inputs.

The QuanteQ has two processors:

- a DSP (digital signal processor) for data analysis
- a CPU (central processing unit) for control and display

At the heart of the system is an FPGA (field programmable gate array) that interfaces the various elements.



This general purpose structure provides a versatile hardware platform that can be configured by firmware to provide a variety of test functions, including:

signal generator
pulse generator
two channel true rms voltmeter
phase angle voltmeter (vector voltmeter)
two channel digital storage oscilloscope
frequency response analyser (gain/phase analyser)
phase meter
phase sensitive detector
dual frequency generator
harmonic analyser
two channel dual frequency selective level meter
transformer analyser

With additional external interface boxes, such as current shunts, other functions are possible:

true rms current meter
LCR meter
power meter
transformer analyser

QuanteQ is configured to perform the required test function by simple user menus, or can be controlled remotely via a serial interface.

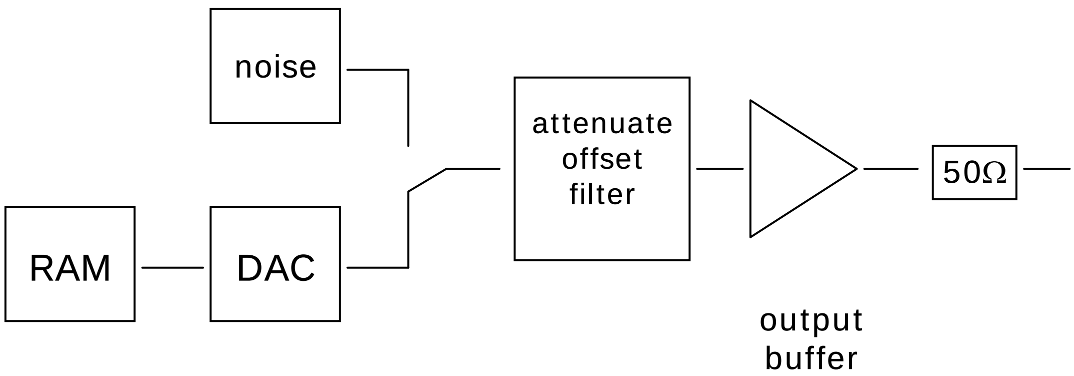
The programmable nature of the instrument means that new functions can be added as they become available, or existing functions can be enhanced, by simple firmware download.

1.1 Generator output

The generator consists of a DAC whose input is derived from a table held in RAM. The appropriate pattern is loaded into the RAM (sinewave, sawtooth, dual frequency etc.) by the DSP, then the RAM address is stepped at a rate given by the selected frequency. The output of the DAC is attenuated, has any offset added, is filtered and is buffered by a high speed, high current buffer.

The DAC is clocked at 23.04MHz.
The DAC resolution is 16 bit.
The RAM depth is 32k words x 16 bit.
The maximum output level is ±10V peak.
The maximum output current is ±200mA peak.
The 0V of the output is earthed.
There is a 50Ω output impedance.

There is a separate analogue white noise generator that can be selected instead of the DAC output. The rest of the attenuation, offset, filtering, and buffering circuitry is the same.



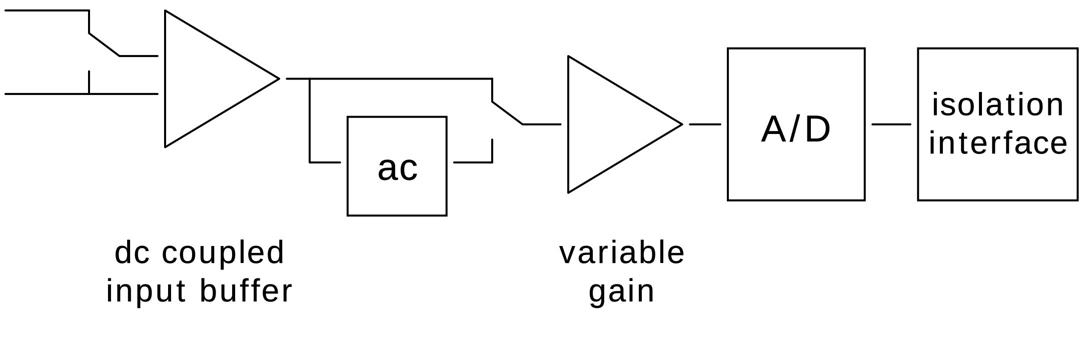
1.2 Voltage inputs

Each input consists of a high impedance buffer followed by switch to select ac or ac+dc coupling, 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 by communication across an isolation barrier. There is an autozero switch at the front end for dc accuracy.

Both input channels have their own isolated power supplies and are fully floating from earth and from each other. The isolation of the input channels with high CMRR allows measurements to be made relative to any potential within 500V from earth. For example, the small voltage across a current sense resistor can be measured, as the much higher supply voltage will be rejected.

One consequence of the isolation is that each input must have its signal 0V connected (unlike most oscilloscopes which force the inputs to be earth referenced).

The maximum input is ±500V peak.
The full scale of the lowest range is ±10mV peak.
The input frequency range is dc to 2.4MHz.
The A/D converter resolution is 14 bit.
The A/D sample rate is variable to 0.8M samples/s.



2 Getting started

The QuanteQ 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 QuanteQ unit
- one appropriate mains lead
- two high voltage safety probes
- one BNC output lead with clips
- one null modem cable to connect to a computer
- this manual

Having verified that the entire above list of contents is present, it would be wise to verify that your QuanteQ operates correctly and has not been damaged in transit.

First verify that the voltage rating on the rear of the QuanteQ is appropriate for the supply, then connect the mains cord to the inlet on the rear panel of the QuanteQ and the supply outlet.

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

Note that if there are no leads connected, the rms display should read zero. If any test leads are connected then because of the high impedance of the inputs, the rms display may read some random values due to noise pick up. If the unit does display any values with no leads connected, give the unit two minutes to warm up then press ZERO.

Connect the output lead to the output connector of the Veqtor and the input probes to the two input connectors. Connect the output to both of the inputs by connecting the black clip on the output lead to the 0V clip on each of the input probes, and the red clip of the output lead to the input probes. Note that this is easiest to do by connecting across a resistor (any value above 1k).

Press the OUT key to invoke the output menu, then press the UP key to select the output on/off control then the RIGHT key to turn on the output.

Exit the menu by pressing the HOME button *twice.*

The display should now indicate an rms value of ~1.4V on both channels, each of which should indicate the 3V range.

Press the FUNC key to select the gain phase analyser function and check that the gain reads 0dB ±0.05dB, and that the phase reads ≤ 0.01°.

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.

2.2 Keyboard and controls

The keyboard is divided into 3 blocks of keys:

- display control (6 top keys)
- menu control (middle 9 keys)
- setup keys (lower 12 keys)

In normal operation, the menu control (cursor) keys give one-touch adjustment of various parameters, such as generator amplitude, without having to access the menu system.

The display control and setup keys also have a secondary function for numeric entry in the menu system.

RMS	SCOPE	FUNC	DISP	ZOOM+	ZOOM-

BACK		UP		NEXT
	LEFT	HOME	RIGHT	
DELETE		DOWN		ENTER

SYSTEM	MODE	OUT	CH1	CH2	SETUP
PRINT	ALARM	PROG	START	ZERO	STEP

Primary key action (normal operation)

RMS	Selects RMS voltmeter function (or loads program).
SCOPE	Selects oscilloscope function (or loads program).
FUNC	Selects chosen test function (or loads program).
Note: the above keys allow one-touch switching between RMS, oscilloscope, or any other function, or stored programs.	
DISP	Selects display mode or long press initiates HOLD.
ZOOM+	Increase zoom level (where appropriate).
ZOOM-	Decrease zoom level (where appropriate).

BACK	Action depends on measurement function.
DELETE	Action depends on measurement function.
NEXT	Action depends on measurement function.
ENTER	Action depends on measurement function.
UP	Step up generator amplitude.
DOWN	Step down generator amplitude.
RIGHT	Step up generator frequency.
LEFT	Step down generator frequency.
Note: the step size for the above can be set via the menus.	
HOME	Retrigger

SYSTEM	System options menu.
MODE	Main operating mode menu.
OUT	Output control menu.
CH1	Input channel 1 control menu.
CH2	Input channel 2 control menu.
SETUP	Function setup menu.
PRINT	Printout control menu.
ALARM	Alarm control menu.
PROG	Program save and recall menu.
START	Start sweep or integration (depends function).
ZERO	Perform offset compensation.
STEP	Step control menu.

Secondary key action (menu mode)

RMS	'G' multiplier (x 10^{9}), or 'A' for text.
SCOPE	'M' multiplier (x 10^{6}), or 'E' for text.
FUNC	'k' multiplier (x 10^{3}), or 'I' for text.
DISP	'm' multiplier (x 10^{-3}), or 'O' for text.
ZOOM+	'μ' multiplier (x 10^{-6}), or 'U' for text.
ZOOM-	'n' multiplier (x 10^{-9}), or 'space' for text.

NEXT	Step to next menu, or next character for text.
BACK	Back to previous menu or character for text.
UP	Cursor up, or upper case for text.
DOWN	Cursor down, or lower case for text.
RIGHT	Step forward in a list or in data entry.
LEFT	Step backward in a list or in data entry.
DELETE	Delete previous character in data entry.
ENTER	Enter numerical value or text.
HOME	Return to start of menu, or exit if at the start.
Note: to exit any menu press HOME twice.	

SYSTEM	0 in a data entry, or jump to item 0 in a list.
MODE	1 in a data entry, or jump to item 1 in a list.
OUT	2 in a data entry, or jump to item 2 in a list.
CH1	3 in a data entry, or jump to item 3 in a list.
CH2	4 in a data entry, or jump to item 4 in a list.
SETUP	Insert minus sign in a data entry (if valid).
PRINT	5 in a data entry, or jump to item 5 in a list.
ALARM	6 in a data entry, or jump to item 6 in a list.
PROG	7 in a data entry, or jump to item 7 in a list.
START	8 in a data entry, or jump to item 8 in a list.
ZERO	9 in a data entry, or jump to item 9 in a list.
STEP	Insert decimal point in a data entry (if valid). Toggle autoranging in channel menu. Set alarm limits in alarm menu.

2.3 Basic operation

Once the unit has powered on and is displaying the default RMS voltmeter screen, the simplest way to configure the instrument is to start at the ‘operating mode’ screen and step through the menus using the NEXT key. The instrument will present a sequence of menus then exit to the normal operating screen.

Press MODE	select the main function required.
Press NEXT	select the output conditions required.
Press NEXT	change the channel 1 setup if needed.
Press NEXT	change the channel 2 setup if needed.
Press NEXT	select the options for the main function.
Press NEXT	further options for the main function if any.
Press NEXT	exit menu sequence.

For more detail about the menu system refer to the next chapter.

For example, to use the gain/phase analyser on a circuit under test, connect the output of the QuanteQ to the input of the circuitry, connect channel 1 also to the input of the circuitry, and connect channel 2 to the output of the circuitry.

Press MODE and select gain phase analyser.
Press NEXT, select the amplitude and turn the output on.
Press NEXT, NEXT, NEXT, select the number of steps, the start frequency and stop frequency.
Press NEXT, NEXT.

The instrument will now display the gain and phase of the transfer function of the circuit under test at the spot frequency specified by the output control menu.

Press LEFT or RIGHT to adjust the frequency, Press UP or DOWN to adjust the amplitude. (In order to change the size of the steps when using the cursor keys in normal operation, use the STEP menu).

Press START and QuanteQ will start a frequency sweep over the specified range.

Pressing DISP selects the display option:
spot frequency result
table (step through with NEXT and BACK)
gain graph
phase graph
gain + phase graph simultaneously

Pressing PRINT allows two lines of print title to be entered and prints the selected display plus the table of results and the setup information.

Press HOME to revert to the real time display at a spot frequency.

There are three ways to change the measurement function:
MODE menu
RMS, SCOPE, FUNC keys
FUNC key + one of the setup keys within 1.5s

3 Using the menus

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

Each of the main menus may be accessed directly from a specific key (e.g. output menu using OUT key, function setup menu using SETUP key) or may be invoked in a logical sequence using the NEXT key.

The main menu sequence is:

MODE menu
OUTPUT menu
CH1 menu
CH2 menu
SETUP menu(s)

In order to configure QuanteQ, start at the MODE menu to select the main function then keep pressing the NEXT key checking each menu and modifying any parameters as required. When all relevant menus have been displayed, QuanteQ reverts back to normal operation in the selected mode.

Note that the BACK key steps through the menus in the reverse sequence.

Additionally there are some other menus that are not linked by the NEXT key:

SYSTEM menu (use dedicated SYSTEM key)
STEP menu (use dedicated STEP key)
ALARM menu (use dedicated ALARM key)
PROGRAM menu (use dedicated PROG key)

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

3.1 Selection from a list

This data type is used where there are only specific options available such as the output may be ‘on’ or ‘off’, 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 waveform selection list comprises the options:

sinewave	(item 0)
triangle wave	(item 1)
square wave	(item 2)
leading sawtooth	(item 3)
trailing sawtooth	(item 4)

and the presently selected option is sinewave, there are 3 ways to select leading sawtooth:

press RIGHT three times
press LEFT twice
press number 3

3.2 Numeric data entry

Parameters such as frequency and offset are entered as real numbers; frequency is an example of an unsigned parameter, offset 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 maximum amplitude of the QuanteQ generator is 10V peak; if a value of 15V is entered, a warning will be given and the amplitude set to the maximum of 10V.

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 5 digits (1.0000-999.99 and a multiplier).

3.3 Text entry

There are occasions where it is useful to enter a text string; for example, any printout may have two lines of text as a title.

Text is entered by selecting one of 6 starting characters using the display control keys on the top row of the keyboard, then stepping forwards or backwards through the alphabet with the NEXT and BACK 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 NEXT and BACK 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 UP and DOWN 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.

4 Special functions

4.1 Display zoom

QuanteQ normally displays many results on the screen in a small font size. Where only one or two results are of interest, the zoom function allows those results to be displayed in a larger font size.

There are two zoom levels:

Up to four results each approx. double normal size
A single result approx. four times normal size

To invoke the zoom function from any screen with numeric results, press the ZOOM+ key.

If no zoom parameters have already been selected, a flashing box will surround the first 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.

Next time that ZOOM+ is pressed from the normal screen, the screen shows the previously selected parameters. These can be accepted by pressing the ZOOM+ key again, or may be cleared using the DELETE key.

4.2 Program store and recall

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 QuanteQ 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 or printer type. If no settings have been stored in program 1 then the factory default settings are loaded (program number 0).

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. To print out a directory of stored programs, press PRINT while in the program menu.

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

Each of the 'one-touch' keys – RMS, SCOPE, and FUNC – may optionally be set to load a specified program instead.

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

4.3 Zero compensation

There are 3 levels of zero compensation:

Trim out the dc offset in the input amplifier chain.
Measure any remaining offset and compensate.
Measure parasitic external values and compensate.

The trim of the dc offset in the input amplifier chain is re-applied every time that the measurement function is changed, or can be manually invoked with the ZERO key, or over the RS232 with the REZERO command.

The measurement of the remaining offset also happens when the offset is trimmed but is also repeated at regular intervals when using a measurement function that requires dc accuracy (such as the rms voltmeter). This is to compensate for any thermal drift in the amplifier chain. This repeated autozero function can be disabled via the SYSTEM OPTIONS menu.

The compensation for parasitic external values (for example to compensate for the capacitance of the test leads when measuring capacitance) is invoked manually by the ZERO key. Refer to each function section for the function specific operations.

Any compensation values are stored along with the instrument configuration when a program is stored.

To restore operation without function specific compensation press ZERO then DELETE.

4.4 Alarm function

QuanteQ has an audible alarm that can be used in a variety of ways:

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
vary the alarm linearly between thresholds

The value to which the alarm is applied can be any of the measurements selected for zoom.

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

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

The linear alarm option allows tests to be carried out even if it is not possible to see the display. Pressing STEP 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.

4.5 Data hold

The data on the display can be held at any time by pressing and holding down the DISP key for ½ second. When HOLD is activated a warning message is briefly displayed and the word HOLD appears in the top right hand corner of the display. The held data is that present when the DISP key was first recognised.

While HOLD is active, the DISP key operates as normal so that other values may be viewed while the data is not changing (eg. rms and watts in power meter mode).

Press 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.

5 Using remote control

QuanteQ is fitted with an RS232 serial communications port as standard, and may have an IEEE488 (GPIB) interface fitted as an option. The two interfaces use the same ASCII protocol with the exception of the end of line terminators:

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

All the functions of the QuanteQ can be programmed via either interface, 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 QuanteQ 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 timebase for the oscilloscope function is TIMEBA but the full word TIMEBASE may be sent as the redundant SE 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.

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.

QuanteQ 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).

QuanteQ 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 IEEE (see section 5.2).

The IEEE address defaults to 23 and can be changed via the SYSTEM 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 SYSTEM menu.

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

5.1 Standard event status register

PON		CME	EXE	DDE	QYE		OPC

bit 0 OPC (operation complete)
cleared by most commands
set when data available or sweep complete
bit 2 QYE (unterminated query error)
set if no message ready when data read
bit 3 DDE (device dependent error)
set when the instrument has an error
bit 4 EXE (execution error)
set when the command cannot be executed
bit 5 CME (command interpretation error)
set when a command has not been recognised
bit 7 PON (power on event)
set when power first applied or unit has reset

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

5.2 Serial Poll status byte

		ESB	MAV		FDV	SDV	RDV

bit 0 RDV (result data available)
set when results are available to be read as enabled by DAVER

bit 1 SDV (sweep data available)
set when sweep 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 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).

5.3 RS232 connections

The RS232 port on QuanteQ 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

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

5.4 Data streaming

The phase meter, phase angle voltmeter and power meter modes have the option of high speed data streaming. In this operation, the window width for the measurement may be specified from 660us to 100ms and the data for each measurement window is transmitted over the communications in a continuous stream. The window is adjusted to synchronise to the measured frequency.

QuanteQ buffers the data and transmits at the fastest rate that is possible. The buffer depth is over 8000 data values so more than 5 seconds of data can be captured at the fastest rate of 1500 readings per second even if the data is not read at all. If the window size is such that the data can be read out in real time then data streaming can continue indefinitely.

Once the data streaming window has been setup, the display periodically shows the measured value. Once streaming has been started, the display is blanked to minimise processing overheads. Streaming can be stopped either immediately (ABORT) or may be stopped but remaining data continues to be transmitted until the buffer is empty (STOP).

STREAM,ENABLE,0.01
START
read data
STOP
continue to read stored data

6 Using the printer

The QuanteQ has a parallel output port for directly driving an external printer.

The printout consists of:
- Optional 1 or 2 line title
- Header with the user data and serial number
- Setup information
- Table of data if available (such as frequency sweep)
- Graph if available

Where a sweep has been performed (such as when using the gain/phase analyser) or when a waveform is on the display then one or more graphs can be printed with a table of results; otherwise the available data from the real-time analysis is printed. The sweep printout may be selected as:
- table and graph
- table only
- graph only

A sequential number can be printed out as part of the title line by entering the code ## (start with space and press NEXT). This helps to keep a series of printouts in the correct sequence.

The data to be printed and the associated instrument settings are captured internally to a printer buffer when the print key is pressed so that the instrument settings can be changed once printing has started.

The printer output may be in the format for an HP inkjet such as Deskjet 600 (also some laser printers), an Epson inkjet that accepts the ESC /P2 command set (such as the Stylus range), or Canon bubblejet such as the portable BJC-80. As printers often have selectable emulation modes, it may be necessary to check that the printer has the correct setting (the BJC-80 often defaults to an incompatible Epson format).

The timeout on each printed character can be adjusted via the SYSTEM menu. This may be necessary if using a very slow printer.

If no printer is connected to the printer port then the 8 data output lines and the 5 control input lines may be used as general purpose logic level I/O lines for controlling or monitoring external equipment.

Input lines:

7	6	5	4	3	2	1	0
			ACK	BUSY	END	SLI	ERR

6.1 Printer port connection

The QuanteQ printer port uses the same pinout and connector (25-pin female ‘D’ type) as is used on a PC. A standard PC to Centronics printer cable is required.

7 System options

Press SYSTEM to access the system options.

There are two levels of brightness for the display: bright or dim. Dim can be selected for low ambient light conditions where the very high contrast of the display may be uncomfortable; or may be automatically selected if there has been no key presses for 20 minutes.

The graphs on the display and printout 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

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.

Regular autozero measurements can be suppressed.

Press NEXT to access the second system menu.

'Program step' allows a sequence of user configurations to be stepped through using NEXT and BACK keys. Store the desired configurations in the program locations and when 'program step' is enabled, the configurations may be selected by pressing NEXT and BACK. Any empty program stores are ignored.

Low value blanking can be disabled.

Some functions, such as LCR meter and transformer analyser, can automatically change the test conditions (frequency and amplitude) to suit the component under test. Manually changing the conditions disables the automatic function.

The shunt value is usually selected automatically when changing function to one that needs a current input such as power meter or LCR meter. If the ‘automatic shunt’ option is disabled then the shunt value will not be changed.

Any measurements that are expressed in length (eg. LVDT) can be displayed in metres or inches.

Press NEXT to access the third system menu.

The printer timeout can be adjusted for slower printers.

The RS232 Baud rate can be selected from 1200 to 19200.

Emulation can be enabled or disabled.

If the IEEE card is fitted, the address can be set from 1-30.

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

Pressing NEXT from the third SYSTEM OPTIONS menu selects the USER DATA screen.

Pressing BACK from the first SYSTEM OPTIONS menu displays the serial number and release versions.

7.1 User data

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

The first line is displayed every time that the instrument is switched on, the other two lines, if entered, are also printed out in the header to identify the instrument.

Typical arrangement of the user data would 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 QuanteQ at all.

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

The entered text may also be read over the RS232 to identify the instrument (see USER?).

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

8 Mode options

The main measurement function for the instrument may be manually selected in one of three ways:

- ‘one-touch’ keys, RMS, SCOPE or FUNC,
- FUNC key + a setup key within 1.5s,
- the MODE menu.

The setup keys have the following effect when pressed within 1.5s of the FUNC key:

SYSTEM	power meter
OUT	gain/phase analyser
CH1	harmonic analyser
CH2	phase meter
PRINT	LCR meter
ALARM	vector voltmeter
PROG	transformer analyser
START	selective level meter

Once the mode is set, the FUNC key will restore the previously selected mode. For example, if the frequency meter is selected it is possible to switch to rms voltmeter, scope, and back to frequency meter using the ‘one-touch’ keys without going back to the MODE menu.

The output mode may be one of the available generators:

- disabled
- sin/squ/tri
- dc only
- pulse
- white noise
- dual frequency

Each input channel may be selected to be:

- disabled
- voltage
- external shunt

If the external shunt option is selected, the data is scaled by the shunt value (entered under the relevant channel menu) and the units are displayed in Amps. Any resistor can be used as a shunt, or precision low inductance current shunts are available as accessories. Current transformers can be used if fitted with an appropriate burden resistor.

Note that the external shunt input polarity is reversed compared to that of the voltage input: ie the outer screen of the input connector is positive and the inner contact is negative. This is so that the capacitance to ground of the input channel 0V is driven with the lower source impedance in order to minimise errors at high frequency.

Note that some modes force the input channels to be voltage or current automatically, eg. the power meter defaults to channel 1 as voltage and channel 2 as current. This automatic selection can be overridden if required.

Some control parameters that relate to the operation of the instrument as a whole rather than a specific measurement are common across all the relevant measurement functions. For example, when synchronising to the input frequency, there is a low frequency option that extends the frequency measurement down to 20mHz. If this parameter is set in any measurement function (eg. vector voltmeter) it applies also to any other function that uses it (eg. power meter).

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 three speed options - slow, medium and fast - 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.

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 filter, normal or slow, or the filter can be deselected. The filter applies an auto reset function to give a fast dynamic response to a change of measurement – this function can be deselected and the filter forced to operate with a fixed time constant for use with noisy signals.

The nominal values are:

speed	update rate	normal time constant	slow time constant
fast	1/20s	0.2s	0.8s
medium	1/3s	1.5s	6s
slow	2.5s	12s	48s

These common parameters can be set as part of the function SETUP menu where appropriate.

9 Output control

The output for the signal generator, pulse generator, and dual frequency generator are digitally synthesised at an update rate of 23.04Msamples/s. This gives very good sinewave waveform, even at 2.4MHz, while preserving very accurate frequency control. Output filtering removes the stepped effect of the sampling.

The white noise generator, however, is a separate analog circuit to give true, non-repetitive noise.

The output for the signal generator, noise generator, and dual frequency generator pass through a logarithmic attenuator equivalent to 17 bits so that very fine amplitude increments are possible at low signal levels.

The pulse generator bypasses this attenuator to improve the rising and falling edges that are limited only by the output filtering. The amplitude of the pulse is set directly by the output DAC. The rising and falling edges can be set to be slower.

An offset may be added to any output to bias the signal or to null out any dc present.

The output parameters of each generator are stored separately so that changing the output amplitude of the pulse generator does not change the output amplitude configured for the signal generator when that is next selected.

The LEFT and RIGHT keys adjust the frequency of the generator by a fixed increment stored via the STEP menu; the UP and DOWN keys adjust the amplitude.

The RS232 commands are common for each generator and are applied to whichever generator has been selected.

The signal generator has a trim function that controls the measured level to a specified accuracy. This is particularly useful to maintain a consistent excitation level during a frequency sweep (amplitude compression). At each measurement point, the measured level is checked against the specified level and tolerance; if an adjustment is needed the data is discarded and a new measurement made at the new output level. The user is alerted to the adjustment by an audible beep.

Both dc and ac components can use independent control values.

Note that as the trim functions compute a new generator level by scaling:

new level = present x specified / measured

the trim function can be used even if there are amplifiers or attenuators between the generator output and the input channel but cannot be used to trim out dc offsets to zero.

The dual frequency generator can be used in two modes, FSK or harmonics. In FSK mode, the waveform consists of half one frequency then half the second frequency; in harmonic mode, both frequency components are present all the time.

Note that the frequency specified for the dual frequency generator is the repetition frequency of the composite waveform. It is only the same as the fundamental frequency in harmonic mode if one of the components is specified as 1 cycle.

Generator specifications

General	
accuracy	frequency ±0.1% amplitude ±2.5% (to 100kHz)
output impedance	50Ω ±10%
output voltage	±10V to ±10mV peak
offset	±10V peak maximum

Signal generator	
waveforms	sine, triangle, square, sawtooth, dc only
frequency	100uHz to 2.4MHz (sine) 20mHz to 1MHz (other)

Pulse generator	
frequency	100uHz to 1MHz
pulse width	200ns to 10s
resolution	50ns
rise and fall time	50ns (5V) to 1s

Noise generator	
output voltage	~10mV to ~0.5V rms

Dual frequency generator	
repetition frequency	100uHz to 2.4MHz / n
components	2
number of cycles	1 to 50
type	FSK or harmonics

10 Input channels

The two input channels consist are electrically isolated from each other and from earth, and are controlled independently but sampled synchronously.

The input ranges have nominal full scale values set with a ratio of 1:√10 from 10mV to 1000V (although the input is rated at 500V maximum.). This gives the following ranges:

range	reference	nominal full scale	attenuator
1	10mV	10mV	low
2	30mV	31.6mV	low
3	100mV	100mV	low
4	300mV	316mV	low
5	1V	1V	low
6	3V	3.16V	low
7	10V	10V	low
8	30V	31.6V	high
9	100V	100V	high
10	300V	316V	high
11	500V	1000V (500V max)	high

Additionally, there are some special ranges, marked with an asterisk that use different attenuator settings

range	reference	nominal full scale	attenuator
12	300mV*	316mV	high
13	1V*	1V	high
14	3V*	3.16V	high
15	10V*	10V	high
16	30V*	31.6V	low

The ranges may be selected manually, or by autoranging (default). 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 HOME key (or sending *TRG) restarts the autoranging from the selected minimum range.

When in an input channel menu, the STEP 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 STEP 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 STEP 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 viewing slow events on the oscilloscope, are more reliable with manual ranging. Manual ranging (or up-only autoranging) is essential for low frequency measurements.

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), ac coupling can be used. This is particularly useful for the oscilloscope option. AC+DC coupling is the normal option and should be used where possible. There are two ac coupling options that are selected according to the size of the dc bias present:

< 10V dc
< 500V dc

Using the <10V option allows the instrument to autorange from the 10mV range; the <500V option allows the instrument to autorange from the 300mV range. When the dc bias is greater than 10V it is essential that the <500Vdc option is used for correct operation.

A scaling factor can be entered for each channel for use with attenuators such as x10 oscilloscope probes. A nominal value can be entered or the attenuation factor of the probe can be measured and the precise value entered. The measured voltage will be displayed after multiplication by the scale factor.

Note that low voltage oscilloscope probes must not be used where there are hazardous voltages – use high voltage safety leads such as those supplied with the instrument.

If the channel has been set for use with an external shunt then the value of the shunt can be entered.

11 True RMS Voltmeter

The RMS voltmeter measures the total rms of the signal present at the input terminals to the bandwidth of the instrument (>2.4MHz). Care must be taken when measuring low signal levels to minimise noise pick on the input leads.

The RMS voltmeter measures the elementary values:

- rms
- dc
- peak
- surge

and derives the values: ac, dBm and crest factor.

The rms value of a periodic waveform, v(ϕ), is given by:

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

For a sampled signal, the formula becomes:

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

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

These are fundamental definitions that are valid for all waveshapes. For a pure sinewave, the formulae evaluate to peak/√2, but this cannot be applied to other waveshapes. QuanteQ computes the true rms value from the fundamental definition for sampled data.

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.

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

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

The ac component is also expressed in dB referred to 1mW into 600Ω (dBm):

$$dBm = 20 \log (Vac/Vref)$$
where $Vref = \sqrt{(1mW \times 600\Omega)}$

or $$20 \log (Iac/Iref)$$
where $Iref = \sqrt{(1mW / 600\Omega)}$

The peak measurement is simply the value with the largest magnitude. Positive and negative peaks are independently filtered then the result with the largest magnitude is taken as the peak value.

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

Crest factor is derived from the peak and rms:

cf = peak / rms

The measurements are computed over rectangular windows with no gaps. The processing power of the DSP allows the measurements to be made in real time without missing any samples. In this way, the measured rms 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 SYTEM OPTIONS menu.

The ZOOM function can be used to select any combination of up to four parameters from the display.

DISP selects the measurement screen:

rms, dc, ac, dBm

rms, peak, crest factor, surge

RMS voltmeter specification

DVM	
channels	2 isolated
display	5 digits
measurement	true rms, ac, dc, dBm, peak, cf, surge
coupling	ac or ac+dc
frequency	dc to >2.4MHz (ac+dc coupling)
ac coupling cut off	~1.5Hz (–3dB)
max input	±500V peak ±500V peak from earth
input ranges	500V, 300V, 100V, 30V, 10V, 3V, 1V, 300mV, 100mV, 30mV, 10mV
ranging	full auto, up only, or manual
input impedance	1M // 30pF (exc. leads)
accuracy (ac)	0.05% range + 0.05% reading + 0.3mV <1kHz 0.15% range + 0.15% reading + 0.3mV < 10kHz 0.5% range + 0.5% reading + 0.0025%/kHz + 0.3mV > 10kHz
accuracy (dc)	0.1% range + 0.1% reading + 0.5mV
CMRR (typical)	140dB @ 240V 50Hz 120dB @ 100V 1kHz 60dB @ 10V 1MHz
time constant	0.2s, 1.5s or 12s

Conditions:

23ºC +/- 5ºC ambient temperature
instrument allowed to warm up for ≥30 minutes
sinewave
slow speed, normal filtering
ac+dc coupling
autoranging or manual ranging ≥ 1/3 range

12 Low frequency storage oscilloscope

The QuanteQ provides a 2 channel storage oscilloscope function with isolated inputs. The isolation of the inputs makes it possible to view signals that are not earth referenced (all normal oscilloscopes have their inputs tied to earth). One consequence of the isolation, however, is that it is essential to connect the 0V of both inputs. If both inputs are connected to the same circuitry, it is not sufficient to connect one 0V line and leave the other floating.

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 20μs/div to 5s/div. Pressing BACK and DELETE adjust the timebase by the factor stored via the STEP menu (default 2). Thus the timebase may be adjusted in fixed increments by a single key press, or may be entered directly using the menu. For slow timebase operation, (> 0.8s/div) the display operates in 'roll' mode where the waveform scrolls across from left to right until triggered.

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.

The trigger level is set directly in Volts 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 fixed increment stored via the STEP menu (default 200mV).

The trigger may be set to rising edge or falling edge on either channel 1 or channel 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 mode may be set to:

- auto (trigger if possible but do not wait for long)
- normal (wait indefinitely for trigger)
- single shot (wait for trigger then hold)

The single shot option is reset using the HOME key.

Pretrigger may be set to:

- none
- 25%
- 50%
- 75%

Pretrigger is useful to see the conditions leading up to the trigger event.

The display may be set to

- Both channel 1 and channel 2
- Channel 1 only
- Channel 2 only

using the DISP key. When printing, the screen will be printed with whichever channel(s) have been selected.

There are no ZOOM options with the oscilloscope mode.

Autoranging can be used with the oscilloscope functions but it is more customary to fix the range manually. Manual ranging is essential for rare events with a low mark space ratio.

LF Oscilloscope specification

	Low frequency DSO
channels	2 isolated
timebase	20us to 5s per division
roll mode	timebase > 0.8s/div
pretrigger	none, 25%, 50%, or 75%
trigger	auto, normal, or single shot
coupling	ac or ac+dc
max input	±500V peak
	±500V peak from earth
input ranges	500V, 300V, 100V, 30V, 10V, 3V, 1V, 300mV, 100mV, 30mV, 10mV
input impedance	1M // 30pF (exc. leads)
ranging	full auto, up only, or manual

13 Frequency response analyser

QuanteQ measures the gain and phase of channel 2 relative to channel 1 using a discrete Fourier transform (DFT) algorithm at the fundamental frequency.

The DFT technique can measure phase as well as magnitude and is inherently good at rejecting noise – it is much more reliable than measuring the rms at one point relative to another point.

The circuit can be characterised by computing the gain and phase at a number of points over a frequency range. This gives results that show the transfer function of the circuit as a graph on the display.

The DFT analysis yields two components – in-phase and quadrature, or ‘a’ and ‘b’ values – from which the magnitude and phase can be derived.

Considering the components at the fundamental frequency:

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

$$a_1 = 1/2\pi \int_0^{2\pi} v(\phi).\cos(\phi)\, d\phi$$

$$b_1 = 1/2\pi \int_0^{2\pi} v(\phi).\sin(\phi)\, d\phi$$

For a sampled signal, the formulae become:

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

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

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.

Having computed the real and quadrature components, the magnitude and phase of each channel can be derived:

$$mag = \sqrt{(a_1^2 + b_1^2)}$$

$$\theta = \tan^{-1}(b_1/a_1)$$

The relative gain and phase of the circuitry under test at that particular frequency is derived from the real and quadrature components by vector division:

vector gain = (a + jb) {ch2} / (a + jb) {ch1}

gain = magnitude (vector gain)

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

The gain is usually quoted in dB:

$$dB = 20 \log_{10}(gain)$$

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

offset gain = measured dB – offset dB

The filtering is applied to the real and quadrature components individually, rather than the derived magnitude and phase values. This gives superior results as any noise contribution to the components would have random phase and therefore would be reduced by filtering.

QuanteQ can operate either in real time mode at a single frequency where the gain and phase are filtered and updated on the display; or it can sweep a range of frequencies and present the results as a table or graphs of gain and phase.

The frequency points to be measured are specified with three parameters:

number of steps
start frequency
end frequency

QuanteQ computes a multiplying factor that it applies to the start frequency for the specified number of steps. Note that due to compound multiplication it is unlikely that the end frequency will be exactly that programmed. The frequency sweep is initiated by the START key, and when completed the data can be viewed as a table or graphs or printed out.

The window over which the measurements are computed is adjusted to give an integral number of cycles of the input waveform. In real time mode the results from each window are passed through a digital filter equivalent to a first order RC low pass filter; in sweep mode each result comprises a single window without any filtering.

Very good results can be obtained in a reasonable time using the medium speed setting (e.g. 50 points x ~1/3s ≅ 17s); for the very best results, use the slow setting (50 points x ~2.5s ≅ 125s or 2 minutes, 5 seconds).

The top of the vertical axis for the graph is normally set to be the highest measured value during the sweep. The bottom of the vertical axis is normally either set to the lowest measured value or the result of the highest value less 20dB/decade of frequency. The vertical axis can be fixed to a manual scale using the menus.

As the DFT algorithm is very good at measuring even very low signals, the QuanteQ does not have any blanking of the results.

The ZOOM function can be used to select up to four parameters from the display when in real time mode. It has no function following a sweep.

Following a sweep the DISP key selects between:

real time display
table of sweep results (use BACK and NEXT to view)
graph of gain v frequency
graph of phase v frequency
graph of gain and phase v frequency.

Pressing HOME restarts the real time measurement at the selected frequency.

Although it is most usual to use the QuanteQ generator when performing gain/phase analysis, there may be circumstances where this is impractical, for example measuring across a transformer under load. In this case, turn off the QuanteQ generator (OUT menu) and the frequency reference for the analysis is measured from channel 1. Provided that the signal is clean enough for an accurate frequency measurement (and for DFT analysis the frequency does need to be accurately known), then the gain and phase can be measured reliably.

When using an external frequency reference there can be no sweep function.

Frequency response analyser specification

Frequency response (gain/phase) analyser	
frequency	100uHz to 2.4MHz (own generator) 20mHz to 1MHz (external source)
max input	±500V peak ±500V peak from earth
input ranges	500V, 300V, 100V, 30V, 10V, 3V, 1V, 300mV, 100mV, 30mV, 10mV
ranging	full auto, up only, or manual
input impedance	1M // 30pF (exc. leads)
gain accuracy	0.02 dB < 1kHz 0.05 dB < 10kHz 0.2 dB < 50kHz 0.2 dB + 0.001 dB/kHz > 50kHz
phase accuracy	0.02° < 100Hz 0.05° < 1kHz 0.2° + 0.005°/kHz > 1kHz
sweep step rate	1/20s, 1/3s or 2.5s (approx.)

Conditions:

23ºC +/- 5ºC ambient temperature
instrument allowed to warm up for ≥30 minutes
ac+dc coupling
autoranging or manual ranging ≥ 1/3 range

14 Phase angle voltmeter (vector voltmeter)

A phase angle voltmeter (or vector voltmeter, or phase sensitive voltmeter) measures the signal at one input compared to the phase of the signal at a reference input. The results may be expressed as magnitude and phase, or as separate in-phase and quadrature components.

QuanteQ measures the in-phase and quadrature components at the fundamental frequency using DFT analysis as described in the section on frequency response analysis. CH2, the measurement input, is phase referred to CH1, the reference input. The individual components are filtered separately to minimise the effects of noise, which would have random phase and would therefore be filtered out. The true rms of the input signals is also computed.

CH1 and CH2 may be voltage inputs or may use external shunts.

From the phase referred fundamental components, (a + jb), the following results can be derived:

magnitude	$= \sqrt{(a^2 + b^2)}$
phase	$= \tan^{-1}(b/a)$
B/A	= b/a
A2/A1	= a2 / a1
LVDT (diff)	= scale * a2 / a1
LVDT (ratio)	= scale * (m1-m2) / (m1+m2)

where a1 and a2 are the in-phase components, and m1 and m2 are the magnitudes, of the signals present at ch1 and ch2 respectively.

The parameter of interest is selected via the SETUP menu. The frequency and phase are always displayed.

A null meter display may be selected by pressing DISP to allow adjustment of a circuit for minimum phase or component. The parameter on the display depends on the selected component:

parameter	display	null meter
A		A
B		B
B/A	B/A (= tanϕ)	B/A
magnitude	magnitude	magnitude
phase	phase	
rms	rms	rms2
rms2/1	rms2/rms1	rms2/rms1
A2/A1	A2/A1	A2/A1
LVDT diff	LVDT	LVDT
LVDT ratio	LVDT	LVDT

There is a phase offset option that applies a vector rotation of +/- 45 degrees to the CH2 input data.

QuanteQ can operate either in real time mode at a single frequency where the measurements are filtered and updated on the display; or it can sweep a range of frequencies and present the results as a table or graphs. Before performing a sweep, the desired parameter must be selected.

The frequency points to be measured are specified with three parameters:

number of steps
start frequency
end frequency

QuanteQ computes a multiplying factor that it applies to the start frequency for the specified number of steps. Note that due to compound multiplication it is unlikely that the end frequency will be exactly that programmed. The frequency sweep is initiated by the START key, and when completed the data can be viewed as a table or graphs or printed out.

The window over which the measurements are computed is adjusted to give an integral number of cycles of the input waveform. In real time mode the results from each window are passed through a digital filter equivalent to a first order RC low pass filter; in sweep mode each result comprises a single window without any filtering.

Very good results can be obtained in a reasonable time using the medium speed setting (e.g. 50 points x ~1/3s ≅ 17s); for the very best results, use the slow setting (50 points x ~2.5s ≅ 125s or 2 minutes, 5 seconds).

The ZOOM function can be used to select up to four parameters from the display when in real time mode. It has no function following a sweep.

Following a sweep press, the DISP key to select between the real time display, the table of results and the graphs. Pressing HOME restarts the real time measurement at the selected frequency.

Although it is most usual to use the QuanteQ generator when making Phase Angle Voltmeter measurements, there may be circumstances where this is impractical, for example measuring LVDT displacement under actual circuit conditions. In this case, turn off the QuanteQ generator (OUT menu) and the frequency reference for the analysis is measured from channel 1. Provided that the signal is clean enough for an accurate frequency measurement (and for DFT analysis the frequency does need to be accurately known), then the measurements can be made reliably.

When using an external frequency reference there can be no sweep function.

Phase angle voltmeter specification

Phase angle voltmeter (vector voltmeter)	
frequency	100uHz to 2.4MHz (own generator) 20mHz to 1MHz (external source)
measurement type	DFT analysis, and true rms
measurements	magnitude, phase, A & B components, B/A, A2/A1, LVDT (diff), LVDT (ratio), rms, rms2/1
max input	±500V peak, ±500V peak from earth
input ranges	500V, 300V, 100V, 30V, 10V, 3V, 1V, 300mV, 100mV, 30mV, 10mV
ranging	full auto, up only, or manual
input impedance	1M // 30pF (exc. leads)
magnitude accuracy	0.05% range + 0.05% reading + 0.1mV <1kHz 0.15% range + 0.15% reading + 0.1mV < 10kHz 0.5% range + 0.5% reading + 0.0025%/kHz + 0.1mV > 10kHz
phase accuracy	0.02° < 100Hz 0.05° < 1kHz 0.2° + 0.005°/kHz > 1kHz
resolution	0.01°
A/B resolution	0.001
CMRR (typical)	140dB @ 240V 50Hz 120dB @ 100V 1kHz 60dB @ 10V 1MHz
sweep step rate	1/20s, 1/3s or 2.5s (approx.)

Conditions:

23ºC +/- 5ºC ambient temperature
instrument allowed to warm up for ≥30 minutes
ac+dc coupling
autoranging or manual ranging ≥ 1/3 range

15 Phase meter

QuanteQ measures the phase of channel 2 relative to channel 1 using a discrete Fourier transform (DFT) algorithm at the fundamental frequency.

The DFT technique is inherently good at rejecting noise and QuanteQ improves the noise rejection by phase referring channel 2 to channel 1, then filtering the in-phase and quadrature components independently. As noise has a random phase, the effect is to filter out the noise but leave the fundamental signal.

In the event that CH1 has a much noisier signal than that on CH2 a more stable reading may be obtained more quickly by changing the phase reference CH2.

The frequency for the DFT algorithm can be taken either from the QuanteQ generator (if used) or can be measured from the input on channel 1.

The phase measurement may be made with voltage inputs or using an external shunt for current. If using an external shunt, then use a low inductance current sensing shunt to minimise any phase shift due to the shunt. A range of low inductance shunts is available as accessories.

For making phase measurements where there is a fixed time delay (eg. audio tests on a loudspeaker), the delay may be compensated for by entering an offset. The offset is entered as a time value and the effect on phase at a given frequency is computed.

The formulae for DFT analysis are given in the chapter on frequency response analysis.

The low frequency option is only relevant when not using the QuanteQ generator. Low frequency mode extends the maximum window to allow for very low frequencies (~20mHz), otherwise the lowest frequency depends on the selected speed.

The phase meter has a special ‘data streaming’ mode for high speed data capture over RS232 or IEEE488 (GPIB). In this mode, the capture window is specified between 650us and 100ms, and data is computed over a window given by the nearest integral number of cycles of the input waveform to the specified window size. When START is pressed, all the results are buffered and streamed out of the RS232 port without filtering. Press HOME to stop. While data is being streamed, the display is blanked.

Data streaming can also be started by sending START command, and can be stopped either by STOP or ABORT. The effect of STOP is to stop any further data acquisition but to continue transmitting stored data. The effect of ABORT is to stop acquisition and discard any stored values.

When using data streaming mode, filtering can be applied as normal.

The ZOOM function can be used to select up to four parameters from the display.

Phase meter specification

Phase meter	
frequency	100uHz to 2.4MHz (own generator) 20mHz to 1MHz (external source)
max input	±500V peak ±500V peak from earth
input ranges	500V, 300V, 100V, 30V, 10V, 3V, 1V, 300mV, 100mV, 30mV, 10mV
ranging	full auto, up only, or manual
input impedance	1M // 30pF (exc. leads)
phase accuracy	0.02° < 100Hz 0.05° < 1kHz 0.2° + 0.005°/kHz > 1kHz
resolution	0.01°
measurement	DFT analysis
data streaming window	660us – 100ms
maximum data rate	1500 readings per second

Conditions:

23°C +/- 5°C ambient temperature
instrument allowed to warm up for ≥30 minutes
ac+dc coupling
autoranging or manual ranging ≥ 1/3 range

16 Phase sensitive detector

A phase sensitive detector measures a signal buried in noise by multiplication of the input signal by the known frequency of the signal of interest.

QuanteQ uses a discrete Fourier transform (DFT) algorithm with independent filtering of the in-phase and quadrature components. As any non-synchronous signal (such as noise) would have a varying phase relative to the frequency reference, the effect is to filter out the noise but leave the fundamental signal.

The frequency reference may be either the QuanteQ generator (if used) for dual channel operation, or can be measured on channel 1 from a reference source. Channel 2 is always a measurement channel.

The formulae for DFT analysis are given in the chapter on gain/phase analysis.

The low frequency option is only relevant when not using the QuanteQ generator. Low frequency mode extends the maximum window to allow for very low frequencies (~20mHz), otherwise the lowest frequency depends on the selected speed.

For very poor signal to noise ratios (80dB or worse) the result can be integrated with linear weighting over an indefinite period. Optimum noise rejection is obtained by integrating the in-phase and quadrature components separately (coherent integration) providing that the signal of interest does not drift in phase relative to the reference. If the phase does drift then the magnitude can be averaged but this will not be as effective because noise always increases the magnitude. Integration is started or reset with the START key.

Phase sensitive detector specification

Phase sensitive detector	
frequency	100uHz to 2.4MHz (own generator) 20mHz to 1MHz (external source)
max input	±500V peak ±500V peak from earth
input ranges	500V, 300V, 100V, 30V, 10V, 3V, 1V, 300mV, 100mV, 30mV, 10mV
ranging	full auto, up only, or manual
input impedance	1M // 30pF (exc. leads)
noise rejection (1V white noise)	~60dB (no integration) ~70dB (integration for 10 minutes) ~80dB (integration for 2 hours)
measurement	DFT analysis

Conditions:

23ºC +/- 5ºC ambient temperature
instrument allowed to warm up for ≥30 minutes
ac+dc coupling
autoranging or manual ranging ≥ 1/3 range

17 Power meter

The power meter measures the total power and fundamental power of the signal present at the input terminals to the bandwidth of the instrument (>2MHz).

One of the inputs must be configured as an external shunt input. The external shunt may be a simple resistor or dedicated high frequency precision shunts are available as accessories. Current transformers and clamps may be used if fitted with a suitable burden resistor.

The power meter will operate either from its own generator or will use the frequency measured on channel 1 (usually voltage).

The power meter measures the elementary values:

- W
- Vrms
- Arms
- V fundamental (in-phase and quadrature)
- A fundamental (in-phase and quadrature)
- Vdc
- Adc
- frequency

and derives the following values:

- VA (true and fundamental)
- power factor (true and fundamental)
- fundamental W
- phase shift

When the integrator function is activated, the following values are available:

- Elapsed time (in hours, minutes and seconds)
- Watt-hours (true and fundamental)
- VA hours (true and fundamental)
- average power factor (true and fundamental)
- Ampere hours (true and fundamental)

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.

These are elementary definitions that are valid for all waveshapes. QuanteQ computes the true watts value from the elementary definition for sampled data. Formulae for the components at the fundamental frequency are given in the section on frequency response analysis.

The formulae for the derived results are:

VA	$= V_{rms} \times A_{rms}$
power factor	= Watts/VA
fundamental Watts	$= V_{fund} \times A_{fund} \times \cos(angle)$
	$= V_{real} \times A_{real} + V_{quad} \times A_{quad}$
fundamental VA	$= V_{fund} \times A_{fund}$
fund power factor	$= W_{fund} / VA_{fund}$

The measurements are computed over rectangular windows with no gaps. The processing power of the DSP allows the measurements to be made in 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 SYTEM OPTIONS menu.

QuanteQ blanks the results when either of the measured rms signals are low compared to the full scale range. This function can be disabled if desired in the SETUP menu.

The ZOOM function can be used to select any combination of up to four parameters from the display.

DISP selects the data to be displayed:

Watts/VA/power factor
channel data: rms/magnitude/phase/dc
integrated data

When printing, all the available data is printed out whichever display is selected at the time.

The integrator is started, or reset, by pressing the START key. 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.

Power meter specification

Power meter	
current input	external shunt
display	5 digits
measurement	W, VA, PF, fundamental, rms, phase
coupling	ac or ac+dc
frequency	dc to > 2.4MHz 20mHz to 1MHz (fundamentals)
ac coupling cut off	~1.5Hz (–3dB)
max input	±500V peak ±500V peak from earth
input ranges	500V, 300V, 100V, 30V, 10V, 3V, 1V, 300mV, 100mV, 30mV, 10mV
ranging	full auto, up only, or manual
input impedance	1M // 30pF (exc. leads)
accuracy (ac)	0.15% range + 0.15% reading < 1kHz 1.5% range + 1.5% reading < 50kHz 2% range + 8% reading < 1MHz
accuracy (dc)	0.2% range + 0.3% reading
CMRR (typical)	140dB @ 240V 50Hz 120dB @ 100V 1kHz 60dB @ 10V 1MHz
time constant	0.2s, 1.5s or 12s

Conditions:

23ºC +/- 5ºC ambient temperature
instrument allowed to warm up for ≥30 minutes
sinewave, power factor > 0.7
slow speed, normal filtering
ac+dc coupling
autoranging or manual ranging ≥ 1/3 range
0.1% current shunt selected to give > 100mV rms

18 Selective level meter

QuanteQ measures the magnitude of one or two specific frequencies on channel 1 and channel 2 using a discrete Fourier transform (DFT) algorithm.

Variable selectivity (bandwidth) is achieved by adjusting the sampling and analysis conditions of the DFT. The formulae for DFT analysis are given in the chapter on gain/phase analysis.

Simultaneous analysis of two frequencies is particularly useful for evaluating an active FSK (Frequency Shift Keying) signal where the magnitudes of the two components vary with the encoded data stream.

The magnitudes of the signals are given in volts (or amps) and also in dB relative to 1mW into 600Ω (dBm).

dBm = 20 log (Vac/Vref)
where Vref = √ (1mW x 600Ω)

or 20 log (Iac/Iref)
where Iref = √ (1mW / 600Ω)

The selective level meter operates in one of three modes:
- single frequency scan
- dual frequency scan
- frequency sweep

With single frequency scan, the data from both channels can be seen together; with dual frequency scan the data from both frequencies can be seen from either channel. The channel on the display can be selected using the DISP key.

Frequency sweep plots the measurements over a range of frequencies and displays a graph of dBm against frequency. QuanteQ then selects the two largest peaks (indicated by cursors) and takes their frequencies as the nominal frequencies for analysis. Pressing HOME then restarts the real time measurement at the selected frequencies.

The selectivity of the measurement may be chosen as:

coarse	(~100Hz +0-3dB)
medium	(~24Hz +0-3dB)
fine	(~3Hz +0-3dB)
very fine	(~0.4Hz +0-3dB)

When sweeping a frequency range it is usual to set coarse selectivity to minimise the possibility of missing peaks that lie between spot frequencies. Once the approximate frequency is known, medium or fine selectivity can be used. At low frequencies however, (below ~1kHz) it is better to use medium selectivity for the sweep.

Coarse selectivity is also useful where the frequency of the signal to be measured is not closely stabilised.

The centre frequency of the pass band may be adjusted manually or automatically:

For manual adjustment, the ‘one-touch’ keys BACK and DELETE increase and decrease the search frequency respectively, as do NEXT and ENTER using a finer step:

Selectivity	BACK/DELETE	NEXT/ENTER
coarse	50Hz	10Hz
medium	10Hz	1Hz
fine	1Hz	0.1Hz
very fine	0.2Hz	0.02Hz

For automatic adjustment, enter the frequencies of interest to within ±10% (or perform the frequency sweep) and press START. QuanteQ searches for the one or two frequencies with the largest magnitudes by performing three successive sweeps with increasingly fine resolution, then reverts back to normal operation at the detected frequencies. Having found the frequencies, pressing the START key again repeats the final sweep at finest resolution in case the signals have drifted slightly. The search can be operated over the communications with the START command – monitor OPC with *ESR? to see when the search is complete.

This automatic tuning procedure will find the frequency of one or two largest signal components and can be used to measure the frequency of a tone even in the presence of another tone, or when buried in noise, where time domain frequency measurement would fail.

The window over which the measurements are computed is adjusted to give an integral number of cycles of the input waveform. In real time mode the results from each window are passed through a digital filter equivalent to a first order RC low pass filter; in sweep mode each result comprises a single window without any filtering.

In order to make it easier to see the frequencies of interest, blanking at a preset threshold can be applied. The threshold is entered in dBm and is the same for all ranges.

The ZOOM function can be used to select up to four parameters from the display when in real time mode. It has no function following a sweep.

18.1 FSK measurement procedure

1. Choose ‘selective level meter mode’ (via MODE menu or FUNC & SETUP within 1.5s).
2. If the frequencies of the FSK tones are known to within 10%, press SETUP, select scan = ‘dual’, enter the two nominal frequencies and proceed from step 9.
3. Press SETUP and select scan = ‘sweep’
4. Enter a start and end frequency that will include the two tones of the FSK signal.
5. Set the number of steps to around 100.
6. Press NEXT and set the selectivity to coarse, or medium if below ~1kHz.
7. Press NEXT again to exit the menu.
8. Press START and observe the graph on the display. When the graph is complete, QuanteQ will mark the two largest components with cursors. If these do not look correct, try changing the sweep parameters and press START again.
9. Once two tones have been identified, press NEXT to initiate the automatic tuning procedure.
10. When the tuning is complete, QuanteQ reverts back to real time operation displaying the selected frequencies and their magnitudes.

Selective level meter specification

Selective level meter	
frequency	10Hz to 2.4MHz
max input	±500V peak ±500V peak from earth
input ranges	500V, 300V, 100V, 30V, 10V, 3V, 1V, 300mV, 100mV, 30mV, 10mV
ranging	full auto, up only, or manual
input impedance	1M // 30pF (exc. leads)
input channels	2
scan	single, dual or sweep
selectivity (+0/-3dB)	~100Hz, ~24Hz, ~3Hz, ~0.4Hz (user selectable)
accuracy	±0.02 dBm <1kHz ±0.05 dBm < 10kHz ±0.2 dBm < 100kHz ±0.5 dBm < 1MHz ±1 dBm < 2MHz
frequency homing	manual or automatic
sweep step rate	~1/6s (coarse or medium) ~1/3s (fine) ~3s (very fine)

Conditions:

23°C +/- 5°C ambient temperature
instrument allowed to warm up for ≥30 minutes
ac+dc coupling
autoranging or manual ranging ≥ 1/3 range
stable frequency source

19 LCR meter

In LCR meter mode, channel 1 measures the voltage across the component under test, and channel 2 measures the current through it. To measure the current, channel 2 must be connected across an appropriate external shunt.

The easiest way to use the LCR meter is with the 'LCR active head' (see accessories) that fits onto the front of QuanteQ and provides Kelvin clip connections to the component under test. The active head provides a choice of shunts, selectable from the front panel, and buffers the signals to minimise the effects of stray capacitance and inductance.

Measurements can be made without the active head by simply connecting a series shunt (set the LCR head option in the SETUP menu to 'none'). This allows measurements to be made at the full operating voltage range of QuanteQ (eg. the primary of a mains transformers energised at mains voltage). The shunt chosen must be appropriate for the voltage, the current and the frequency of operation.

QuanteQ measures the real and imaginary components at the fundamental frequency using DFT analysis as described in the section on gain/phase analysis. The frequency may be taken from its own generator or from the circuitry under test.

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

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

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

The magnitude of the voltage and current are also computed.

From the complex impedance the following parameters can be derived:

ac resistance
inductance,
capacitance
impedance
phase
tanδ (= real/imaginary)
Q factor (= imaginary/real)

Values are displayed for both series and parallel configurations.

If the parameter option in SETUP menu is set to ‘auto’, QuanteQ 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.

The operating conditions for the component under test may be selected manually or QuanteQ will automatically try to find appropriate conditions.

When measuring large electrolytic capacitors, it is necessary to add an appropriate bias voltage to polarise the electrodes. In this case it may be necessary to select ac coupling in the CH1 menu in order to reliably measure the small ac voltage present.

When measuring small inductance or low resistance, it may be necessary to zero out the stray inductance from the test connections, even if using Kelvin leads. Connect together the test leads to a good short and press ZERO – the message 'ZERO SET' will be displayed. To remove the zero, press ZERO then press DELETE within 1.5s – the message 'ZERO CLEARED' will be displayed.

QuanteQ can operate either in real time mode at a single frequency where the measurements are filtered and updated on the display; or it can sweep a range of frequencies and present the results as a table or graphs. Before performing a sweep, either series circuit or parallel circuit must be selected.

The frequency points to be measured are specified with three parameters:

number of steps
start frequency
end frequency

QuanteQ computes a multiplying factor that it applies to the start frequency for the specified number of steps. Note that due to compound multiplication it is unlikely that the end frequency will be exactly that programmed. The frequency sweep is initiated by the START key, and when completed the data can be viewed as a table or graphs or printed out.

The window over which the measurements are computed is adjusted to give an integral number of cycles of the input waveform. In real time mode the results from each window are passed through a digital filter equivalent to a first order RC low pass filter; in sweep mode each result comprises a single window without any filtering.

Very good results can be obtained in a reasonable time using the medium speed setting (e.g. 50 points x ~1/3s ≅ 17s); for the very best results, use the slow setting (50 points x ~2.5s ≅ 125s or 2 minutes, 5 seconds).

The ZOOM function can be used to select up to four parameters from the display when in real time mode. It has no function following a sweep.

Following a sweep press the DISP key to select between the real time display, the table of results and the graphs. Pressing HOME restarts the real time measurement at the selected frequency.

Although it is most usual to use the QuanteQ generator when performing LCR measurements, there may be circumstances where this is impractical, for example measuring the inductance of a transformer primary winding under load. In this case, turn off the QuanteQ generator (OUT menu) and the frequency reference for the analysis is measured from channel 1. Provided that the signal is clean enough for an accurate frequency measurement (and for DFT analysis the frequency does need to be accurately known), then the measurements can be made reliably.

When using an external frequency reference there can be no sweep function.

LCR meter specification

LCR meter	
frequency	100uHz to 2.4MHz (own generator) 20mHz to 1MHz (external source)
measurement type	DFT analysis
measurements	L, C, R (ac), Q, tanδ, impedance, phase series or parallel circuit
conditions	auto, or manual
display	numeric values table of sweep results graph of any measurement
ranges (with external shunt)	100pF to 100uF 1μH to 100H 1Ω to 1MΩ
ranges (with active head)	10pF to 1000uF 100nH to 1kH 10mΩ to 100MΩ
basic accuracy	0.25% < 1kHz 0.75% < 10kHz 2.5% < 100kHz 12.5% < 1MHz 20% < 2MHz
sweep step rate	1/20s, 1/3s or 2.5s (approx.)

Conditions:

- 23°C +/- 5°C ambient temperature
- instrument allowed to warm up for ≥30 minutes
- ac+dc coupling
- autoranging or manual ranging ≥ 1/3 range
- both signals < 10V peak

20 Harmonic analyser

The QuanteQ harmonic analyser computes multiple DFTs on the input waveforms in real time (refer to the chapter on frequency response analysis for the formulae for DFT analysis).

There are three modes of operation: single harmonic, difference thd, and series thd. In single harmonic mode, the specified harmonic is displayed both in Volts and as a ratio to the fundamental; in thd mode, the computed thd and a specified harmonic are displayed as a ratio to the fundamental.

In difference thd mode, the thd is computed from the rms and fundamental:

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

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

$$thd = 1/h_1 \sqrt{\sum_{i=2}^{i=n} h_i^2}$$

where h_i is the i^{th} harmonic

In all cases the harmonics are phase referred to CH1 fundamental so that their in-phase and quadrature components may be separately filtered to minimise noise.

The single harmonic and the thd are expressed relative to the fundamental either as a percentage or in dB, as selected via the SETUP menu.

The harmonic that is displayed can be selected either from the SETUP menu or may be stepped using NEXT and BACK keys.

QuanteQ can operate either in real time mode at a single frequency where the measurements are filtered and updated on the display; or it can sweep a range of frequencies and present the results as a table or graphs.

The frequency points to be measured are specified with three parameters:

number of steps
start frequency
end frequency

QuanteQ computes a multiplying factor that it applies to the start frequency for the specified number of steps. Note that due to compound multiplication it is unlikely that the end frequency will be exactly that programmed. The frequency sweep is initiated by the START key, and when completed the data can be viewed as a table or graphs or printed out.

The window over which the measurements are computed is adjusted to give an integral number of cycles of the input waveform. In real time mode the results from each window are passed through a digital filter equivalent to a first order RC low pass filter; in sweep mode each result comprises a single window without any filtering.

Very good results can be obtained in a reasonable time using the medium speed setting (e.g. 50 points x ~1/3s ≅ 17s); for the very best results, use the slow setting (50 points x ~2.5s ≅ 125s or 2 minutes, 5 seconds).

The ZOOM function can be used to select up to four parameters from the display when in real time mode. It has no function following a sweep.

Following a sweep press the DISP key to select between the real time display, the table of results and the graphs.

Pressing HOME restarts the real time measurement at the selected frequency.

Although it is most usual to use the QuanteQ generator when making harmonic measurements, there may be circumstances where this is impractical, for example measuring harmonic currents drawn from the mains. In this case, turn off the QuanteQ generator (OUT menu) and the frequency reference for the analysis is measured from channel 1. Provided that the signal is clean enough for an accurate frequency measurement (and for DFT analysis the frequency does need to be accurately known), then the measurements can be made reliably.

When using an external frequency reference there can be no sweep function.

Harmonic analyser specification

Harmonic analyser	
fundamental frequency	100uHz to 1.2MHz (own generator) 20mHz to 1MHz (external source)
harmonic frequency	200uHz to 2.4MHz
measurement type	multiple DFT analysis
measurements	single harmonic or thd
max harmonic	50
max input	±500V peak, ±500V peak from earth
input ranges	500V, 300V, 100V, 30V, 10V, 3V, 1V, 300mV, 100mV, 30mV, 10mV
ranging	full auto, up only, or manual
input impedance	1M // 30pF (exc. leads)
magnitude accuracy	0.1% of fundamental + 0.01mV
sweep step rate	1/20s, 1/3s or 2.5s (approx.)

Conditions:

- 23ºC +/- 5ºC ambient temperature
- instrument allowed to warm up for ≥30 minutes
- ac+dc coupling
- autoranging or manual ranging ≥ 1/3 range

21 Transformer analyser

The transformer analyser mode allows a comprehensive set of measurements to be performed on a transformer at a single frequency or automatically swept over a range of frequencies.

The tests available are:

- turns ratio
- inductance
- leakage inductance
- ac resistance and Q factor
- dc resistance
- interwinding capacitance
- magnetising current
- insertion loss
- return loss
- single harmonic distortion
- total harmonic distortion
- longitudinal balance

The easiest way to connect to the transformer in the various configurations for the different test is to use the transformer analyser fixture (see accessories) that connects to the QuanteQ BNC connectors and also to the QuanteQ extension port. Using the fixture, with appropriate source and load resistors, the test configuration and winding selection is selectable from the front panel. Active buffers within the fixture minimise the effects of stray capacitance and inductance.

Measurements can be made without the automatic fixture by manually making the appropriate connections to the transformer and resistors (set the fixture option in the SETUP menu to 'none'). This allows measurements to be made at the full operating voltage range of QuanteQ (eg. the turns ratio of a mains transformers under load). Ensure that all connections and resistors used are appropriate for the voltage, the current and the frequency of operation.

Each of the tests are discussed separately in their own section. The NEXT and BACK can be used to step through the tests; this is particularly useful when using the transformer analyser fixture that will reconfigure the relays automatically for each test.

The operating conditions for the component under test may be selected manually or for some tests (such as turns ratio) QuanteQ will automatically try to find appropriate conditions.

QuanteQ can operate either in real time mode at a single frequency where the measurements are filtered and updated on the display; or it can sweep a range of frequencies and present the results as a table or graphs. Before performing a sweep, the required test must be selected.

The frequency points to be measured are specified with three parameters:

- number of steps
- start frequency
- end frequency

QuanteQ computes a multiplying factor that it applies to the start frequency for the specified number of steps. Note that due to compound multiplication it is unlikely that the end frequency will be exactly that programmed. The frequency sweep is initiated by the START key, and when completed the data can be viewed as a table or graphs or printed out.

The window over which the measurements are computed is adjusted to give an integral number of cycles of the input waveform. In real time mode the results from each window are passed through a digital filter equivalent to a first order RC low pass filter; in sweep mode each result comprises a single window without any filtering.

Very good results can be obtained in a reasonable time using the medium speed setting (e.g. 50 points x ~1/3s ≅ 17s); for the very best results, use the slow setting (50 points x ~2.5s ≅ 125s or 2 minutes, 5 seconds).

The ZOOM function can be used to select up to four parameters from the display when in real time mode. It has no function following a sweep.

Following a sweep press the DISP key to select between the real time display, the table of results and the graphs. Pressing HOME restarts the real time measurement at the selected frequency.

Although it is most usual to use the QuanteQ generator when performing transformer analysis, there may be circumstances where this is impractical, for example measuring the turns ratio of a transformer under load. In this case, turn off the QuanteQ generator (OUT menu) and the frequency reference for the analysis is measured from channel 1. Provided that the signal is clean enough for an accurate frequency measurement (and for DFT analysis the frequency does need to be accurately known), then the measurements can be made reliably.

When using an external frequency reference there can be no sweep function.

21.1 Turns ratio

Turns ratio is computed from the real part of the complex ratio of CH2 divided by CH1 using DFT analysis at the fundamental frequency (refer to the chapter on gain/phase analysis for the formulae for DFT analysis). This technique gives good results even on ‘lossy’ transformers.

The polarity of the windings is indicated by a positive turns ratio for in phase windings and negative ratio for inverted windings.

A nominal number of turns may be entered using the SETUP menu if known and QuanteQ will then also display the computed number of turns.

As the inputs are independent of the output it is possible to energise a third winding when measuring turns ratio, or only two windings may be used.

To manually connect a transformer for turns ratio, connect the QuanteQ output to the winding to be energised, and the inputs to the two windings for the ratio.

Note that when using the transformer analyser fixture, the transformer is always energised through the source resistance.

Pressing ZERO makes the turns ratio read 1:1, and the computed number of turns equal to the value entered via SETUP. This allows accurate testing of transformers or chokes against a known good reference. Press ZERO followed by DELETE to restore true turns ratio measurement.

21.2 Inductance & leakage inductance

The inductance of a winding is computed from the complex ratio of CH1 (voltage across the winding) divided by CH2 (current through the winding) using DFT analysis at the fundamental frequency (refer to the chapter on gain/phase analysis for the formulae for DFT analysis).

CH2 is forced to be external shunt input – enter the value of the external shunt as the source resistance via the SETUP menu.

To manually connect a transformer for inductance measurement, connect an appropriate source resistance in series with the winding and connect the QuanteQ output across the series combination of the source resistance and winding. Connect the CH1 input across the winding to measure the voltage, and CH2 across the series resistance (note that the polarity of external shunt input is the opposite of that for voltage). Leave all other windings open.

To manually measure leakage inductance, use the same set up as for inductance but short the other windings.

When using the transformer analyser fixture, the connections for inductance or leakage inductance are made automatically by relays.

When measuring small inductance it may be necessary to zero out stray effects by replacing the winding with a good short and pressing ZERO. The message ‘ZERO SET’ will be displayed. To remove the effect of the zero press ‘ZERO’ followed ‘DELETE’ within 1.5s and the message ‘ZERO CLEARED’ will be displayed.

21.3 AC resistance and Q factor

AC resistance is measured the same way as inductance with CH1 monitoring the voltage across the winding, and CH2 monitoring the current through it via the external shunt (source resistance).

The Q factor measurement is an effective way of detecting a shorted turn – either on a transformer, or on a choke when using the transformer analyser fixture TAF02. When using suitable conditions (often very different from the normal operating conditions of the device under test) the Q factor changes dramatically when a shorted turn is present.

21.4 DC resistance

DC resistance is measured with the same circuit arrangement as inductance and ac resistance, but dc signals are used (refer to the chapter on the rms voltmeter for the formulae for dc analysis).

21.5 Interwinding capacitance

The interwinding capacitance of a transformer is computed from the complex ratio of CH1 (voltage across the transformer) divided by CH2 (current through the transformer) using DFT analysis at the fundamental frequency (refer to the chapter on gain/phase analysis for the formulae for DFT analysis).

CH2 is forced to be external shunt input – enter the value of the external shunt as the source resistance via the SETUP menu.

To manually connect a transformer for interwinding capacitance measurement, connect an appropriate source resistance in series with one winding and connect the QuanteQ output across the transformer from the series resistance to another winding. Connect the CH1 input across the transformer from one winding to the other to measure the voltage across the windings, and CH2 across the series resistance (note that the polarity of external shunt input is the opposite of that for voltage).

When using the transformer analyser fixture, the connections for interwinding capacitance are made automatically by relays.

When measuring small capacitance it may be necessary to zero out stray effects by disconnecting the transformer and pressing ZERO – the message ‘ZERO SET’ will be displayed. The transformer analyser fixture TAF01, has a stray capacitance of around 60pF that can be zeroed out this way. To remove the effect of the zero press ‘ZERO’ followed ‘DELETE’ within 1.5s and the message ‘ZERO CLEARED’ will be displayed.

21.6 Magnetising current

The magnetising current is the current drawn by the primary, energised under normal operating conditions but without any secondary load. It is typically measured on power transformers rather than signal transformers so although the transformer analyser fixture, TAF01, will select appropriate relays to make the measurement it is more common that a manual connection or a custom fixture would be used.

The magnetising current is measured as the true rms value (refer to the chapter on the rms voltmeter for the formulae for rms analysis) so it will include all distortion components.

To manually connect a transformer for magnetising current measurement, connect an appropriate shunt in series with the primary. When selecting the shunt, bear in mind the current that it must pass, the resulting voltage drop across it, and the power that will be dissipated in it. Connect CH1 directly across the primary winding, and CH2 across the series resistance (note that the polarity of external shunt input is the opposite of that for voltage). Ensure that all connections and the series resistance are appropriate for the voltage, the current and the frequency of operation.

Energise the primary so that the voltage seen at the primary after the series resistance, is the normal operating voltage.

21.7 Return loss

Return loss is a measure of impedance mismatch in signal transformers that are terminated with the design load resistance.

The secondary winding is terminated with the appropriate load resistance and the primary is energised via a source resistance that is equal to the resistance that should be reflected back from the secondary (load resistance * $(\text{turns ratio})^2$). The impedance looking into the primary is measured.

If **z** is the complex impedance measured at the primary, and R is the source resistance then the return loss is given by:

$$\text{return loss} = |\mathbf{z} + R| \,/\, |\mathbf{z} - R|$$

Return loss is usually expressed in dB:

$$= 20 \log (|\mathbf{z} + R| \,/\, |\mathbf{z} - R|) \text{ dB}$$

As a figure of merit, a higher value of return loss indicates a better transformer.

The circuit arrangement for return loss is the same as that for inductance measurement except that the secondary is terminated with the appropriate load resistance.

21.8 Insertion loss

Insertion loss is a measure of power loss due to impedance mismatch in signal transformers that are terminated with the design load resistance.

The secondary winding is terminated with the appropriate load resistance and the primary is energised via a source resistance that is equal to the resistance that should be reflected back from the secondary (load resistance * (turns ratio)^2). The voltage energising the series resistance and primary winding is measured and the voltage on the secondary is measured.

If Rs is the source resistance, the power into the transformer is computed as:

$$Win = Vin^2 / 4\ Rs$$

If Rl is the load resistance, the power out is computed as:

$$Wout = Vout^2 / Rl$$

Insertion loss then is given by:

$$\text{Insertion loss} = Win / Wout$$
$$= (Vin / Vout)^2 \,.\, Rl / 4\ Rs$$

Insertion loss is usually expressed in dB:

$$= 10 \log ((Vin / Vout)^2 \,.\, Rl / 4\ Rs)\ \text{dB}$$

As a figure of merit, a lower value of insertion loss indicates a better transformer.

To manually connect a transformer for insertion loss measurement, fit the appropriate source resistance in series with the primary winding then connect the QuanteQ output and CH1 input across the series combination of the source resistance and the primary winding. Connect the appropriate load resistance and Ch2 input across the secondary.

When using the transformer analyser fixture, the connections for insertion loss are made automatically by relays.

As the values of the load resistance, Rl, and the source resistance, Rs, are used in the computation, it is important that both values are entered via the SETUP menu.

21.9 Harmonics and distortion

Harmonic distortion introduced by a signal transformer may be measured either at a single spot harmonic or as the thd computed from a series of harmonics.

The primary of the transformer is energised either by the output of QuanteQ or by external means and CH2 is connected across the secondary. It is usual to measure harmonic distortion with the secondary loaded.

Specify the single harmonic, or the maximum series harmonic via the SETUP menu.

QuanteQ analyses for up to 50 harmonics in real time, using multiple DFTs (refer to the chapter on gain/phase analysis for the formulae for DFT analysis). Each harmonic is individually phase referenced to the fundamental so that the in-phase and quadrature components can be separately filtered. As the harmonics are usually very small, this technique is important to give adequate noise rejection.

The series harmonic data is combined to give the thd (refer to the chapter on harmonic analysis for the thd formula).

The single harmonic and the thd are expressed as dB relative to the fundamental.

21.10 Longitudinal balance

Longitudinal balance is a measure of the common mode rejection ratio, CMRR, of the transformer.

Longitudinal balance requires external circuitry to give the required accuracy – a plug in module is available for the transformer analyser fixture, TAF01, with precision resistors and active buffers adjacent to the transformer pins to minimise stray effects.

As a figure of merit, a higher value of longitudinal balance indicates a better transformer.

When stepping through the tests using the BACK and NEXT keys, longitudinal balance is skipped because of the need to fit the specialist jig. All the other tests can be performed using the normal plug in module.

Transformer analyser specification

Transformer analyser	
frequency	100uHz to 2.4MHz (own generator) 20mHz to 1MHz (external source)
measurement type	DFT analysis, true rms as appropriate
measurements	turns ratio turns inductance leakage inductance ac resistance dc resistance interwinding capacitance insertion loss return loss longitudinal balance harmonics thd
conditions	auto, or manual
display	numeric values table of sweep results graph of any measurement
accuracy	refer to other functions
sweep capability	all ac functions
sweep step rate	1/20s, 1/3s or 2.5s (approx.)

ACCESSORIES

Power meter adaptors

The power meter adaptors allow easy and safe connection of the QuanteQ to a mains appliance under test to measure the power or harmonics.

The appliance under test plugs into a standard mains outlet on the adaptor, which contains a precision low resistance shunt for monitoring the current. The adaptor connects to the QuanteQ inputs using safety BNC connectors approved for use up to 500V cat II.

The adaptor is fitted with a standard mains plug.

When the adaptor is plugged into the mains and the mains switched on, the appliance is energised and QuanteQ can be used to measure the power or harmonics.

Leave the QuanteQ generator off (OUT menu) so that it will synchronise to the mains frequency.

Various versions with different current ratings are available. It is best to use the version with the lowest rating possible for the appliance to give the best accuracy for the current.

Part numbers

500-006	UK 13A power meter adaptor
512-010	UK 5A power meter adaptor
500-011	UK 1A power meter adaptor

Car Power Conversion Kit

The car power conversion kit allows QuanteQ to be used at a remote location where a normal mains supply is not available. Power for the QuanteQ is derived from a vehicle cigarette lighter socket.

Warning. Only use the car power adapter kit where there is a safety earth connection available. QuanteQ must be securely earthed before power is applied and before the inputs are connected to any hazardous voltages.

Kit contents

12V input 230V 50Hz inverter with safety earth lead.
Safety earth lead for QuanteQ.

Instructions

Connect the ring on the QuanteQ earth lead to the earth post on the front of the instrument.
Securely clip the QuanteQ earth lead to a safety earth point.
Securely clip the inverter earth lead to a safety earth point.
Warning: Do not proceed if no suitable safety earth points are available.
Connect the normal mains lead from the QuanteQ into the outlet socket on the inverter.
Connect the cigarette lighter adapter from the inverter into the socket in the vehicle. ***Note that the adapter is only suitable for negative earth +12V vehicles (center pin is +12V, outer contacts are 0V).***
Switch on the inverter and observe that the red light illuminates.

Switch on QuanteQ and operate as normal.

QuanteQ draws approximately 3A from the lighter connection so it is advisable to keep the engine running while using the inverter to avoid discharging the vehicle battery.

Inverter specification

Input voltage range	10-15V dc
Low battery shutdown	10V dc
Output	230V 50Hz
Output waveform	Quasi-sinewave
Output power	Maximum 75W continuous
Efficiency	>80%

Part numbers

500-014 car power conversion kit
512-007 safety earth lead

75Ω / 600Ω output adapter

The generator output from the QuanteQ has a series impedance of 50Ω. The output adapter fits directly onto the front of the instrument and provides 2 outputs:

75Ω via a BNC connector
600Ω via 4mm sockets.

There are two versions of the adapter that have different spacing between the 4mm sockets:

½" (12.5mm) as commonly used for communications.
¾" (19mm) as standard on instruments.

In both cases, the red connector carries the output signal, the green or black connector is 0V (connected to earth via the QuanteQ chassis).

The impedance conversion is resistive and does not limit the frequencies available from the generator (dc coupled). When driving into the characteristic impedance (75Ω or 600Ω as appropriate) the voltage delivered to the load will be half that delivered into open circuit.

Matching the source to the load impedance minimises reflections at higher frequencies and improves transient response, especially when driving long lengths of cable or transformers.

Part numbers

500-005	75/600Ω adaptor with ½" spacing
500-026	75/600Ω adaptor with ¾" spacing

LCR active head

The QuanteQ LCR active head fits onto the front of the instrument, making connection to the output and the two inputs, to provide four BNC connections for use with Kelvin leads to connect to the component under test.

A cable from the active head connects to the extension port on the rear of the QuanteQ to allow selection of one of the four internal shunts:

shunt	value	purpose
low	5Ω	test current > 70mA rms
normal	50Ω	general purpose, all frequencies
high	2kΩ	higher impedance, low to medium frequency
very high	100kΩ	impedance > 100kΩ, low frequency only

The active head contains high impedance buffer amplifiers that help to reduce the effect of stray capacitance and inductance.

The active head is usually supplied with Kelvin clip leads but Kelvin test probes are also available for in-circuit testing.

Part numbers

500-013	LCR active head
510-013	Kelvin clip lead set
510-014	Kelvin test probe set

Transformer analyser fixture, TAF01

The transformer analyser fixture TAF01 consists of a relay switching base unit that accepts plug in module to interface to transformers.

It connects to the BNC connectors on the front of QuanteQ and is controlled by QuanteQ via the extension port.

It supports transformers with 2 single windings, or with 1 single winding and one split winding. The winding(s) to be used for a measurement may be controlled by the front panel or by communications.

The connections to the transformer may be made either by a plug in pcb with suitable ZIF socket and resistors, or by flying leads with cable clips. To use the latter, plug in a resistance carrier board with appropriate source and load resistors.

NB it is essential that a source resistor be fitted for all tests.

The fixture contains high impedance buffer amplifiers that help to reduce the effect of stray capacitance and inductance.

Part numbers

500-017	TAF01 transformer analyser fixture
500-019	plug in module for modem transformers
500-020	plug in module for longitudinal balance
500-021	plug in resistance carrier
500-044	plug-in terminal block module
510-015	TAF01 Kelvin lead set
509-004	UK mains PSU

Transformer analyser fixture, TAF02

The transformer analyser fixture TAF02 consists of a relay switching unit with two vertical probes for testing coils. The small probe (3mm diameter) is W3, the large probe (10mm diameter) is W4.

It connects to the BNC connectors on the front of QuanteQ and is controlled by QuanteQ via the extension port.

Coils are placed over one of the probes and connected via flying leads with Kelvin clips or grabbers for small transformers. The probe and winding(s) to be used for a measurement may be controlled by the front panel or by communications.

The probe can be energised and the turns ratio measured against the known number of turns energising the probe. Two windings from the device under test may be simultaneously connected and a turns ratio measurement made.

Inductance may be measured and Q factor measurement can be used to reliably detect a shorted turn.

The fixture contains high impedance buffer amplifiers that help to reduce the effect of stray capacitance and inductance.

Part numbers

500-022	TAF02 transformer analyser fixture
510-025	TAF02 Kelvin lead set
510-027	TAF02 grabber lead set
510-028	TAF02 BNC lead set
509-004	UK mains PSU

Isolation transformer

When testing the stability of control loops it is necessary to inject a small disturbance signal into the loop. QuanteQ output is ground referenced so it is necessary to isolate the output before it can be connected to the loop.

The isolation transformer provides an isolated output at a reduced signal level of about 1/6 of the direct output level over a frequency range of about 10Hz to 200kHz.

Connections are via BNC connectors – one is grounded to the case the other is isolated. The grounded connector should be connected to the OUTPUT connector of QuanteQ – the isolated connector should be wired to the circuit under test.

Part numbers

500-042 isolation transformer

CommVIEW PC software

CommVIEW is a self contained software program for a PC, which facilitates communication with QuanteQ over RS232.

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

Strings to be sent to QuanteQ 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 a quote character are sent to QuanteQ
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*

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	
ACTRIM,channel,level,tol	
AMPLIT,amplitude	
AMPLI2,amplitude	
BLANKI,on/off,threshold	
CONFIG,parameter,data	
CONFIG,parameter?	single integer or real data value
COUPLI,channel,coupling	
COUPLI,channel?	single integer data value
DAV?	single integer data value
DAVER,value	
DAVER?	single integer data value
DCTRIM,channel,level,tol	
DUALFR,type,cyc1,cyc2	
FALLTI,falltime	
FILTER,type,dynamics	
FRA	
FRA?	freq,mag1,mag2,dB,phase
FRA,SWEEP?	n lines of GAINPH? data
FREQUE,frequency	
FSWEEP,steps,start,end	
GAINPH	
GAINPH?	freq,mag1,mag2,dB,phase
GAINPH,SWEEP?	n lines of GAINPH? data
HARMON,scan,para,h,hmax	
HARMON?	freq,mag1,mag2,hmag1,hmag2,h1,h2
or	freq,mag1,mag2,thd1,thd2,h1,h2

HARMON,SWEEP?	n lines of HARMON? data
INPUT,channel,type	
INPUT,channel?	single integer data value
LCR,conditions,param,head	
LCR?	freq,mag1,mag2,impedance,phase,R, L,C (series),R,L,C (parallel),tanδ,Q
LCR,SWEEP?	n lines of data: freq,QF,tanδ,impedance,phase,L,C,R
LOWFRE,on/off	
MODE,type	
OFFSET,offset	
OUTPUT,type	
PAV,parameter,scaling	
PAV?	freq,mag1,mag2,parameter,phase,a,b
PAV,SWEEP?	n lines of VECTOR? data
PHASE	
PHASE?	freq,phase
PHASE,STREAM,window	phase,phase,phase,phase,phase,.......
PHCONV,convention	
PHREF,channel	
POWER,integration type	
POWER,WATTS?	W,W.f,VA,VA.f,pf,pf.f,Wdc,freq
POWER,RMS?	rms1,rms2,dc1,dc2,fnd1,fnd2,φ1,φ2
POWER,INTEGR?	Wh,Wh.f,VAh,VAh.f,pf,pf.f,Ah,Ah.f,t
PPORT,value	
PPORT?	single integer data value
PRETRI,data	
PRINT	
PROGRAM,function,number	
PSD,integration type	
PSD?	freq,magnitude,integration
RANGE,ch,ranging,range	
RESOLU,resolution	
REZERO	
RISETI,risetime	
SCALE,channel,factor	
SCALE,channel?	single real data value
SHUNT,channel,resistance	
SHUNT,channel?	single real data value
SLM,select,scan,freq1,freq2	
SLM?	freq,mag1,mag2,dbm1,dbm2
SLM,SWEEP?	n lines of SLM? data
SPEED,speed	
START	

STATUS,channel?	range number,range text,over/low/ok
STOP	
STREAM,enable,window	
STREAM,disable	
STREAM?	data, data, data, data, data, …..
TIMEBA,timebase	
TFA	
TFA?	freq,mag1,mag2,dB,phase
TFA,SWEEP?	n lines of GAINPH? data
TRIGGE,level,ch,edge,type	
TXA,test,fixture,load,source	
TXA?	freq,mag1,mag2,parameter
TXA,SWEEP?	n lines of TXA? data
TXTEST,test,wind1,wind2	
USER?	3 CR terminated strings
VECTOR,parameter,scaling	
VECTOR?	freq,mag1,mag2,parameter,phase,a,b
VECTOR,SWEEP?	n lines of VECTOR? data
VERSIO?	model,mark,cpu,fpga,dsp,boot
VRMS	
VRMS?	RMS? data followed by SURGE?
VRMS,RMS?	rms1,rms2,dc1,dc2,ac1,ac2,db1,db2
VRMS,SURGE?	pk1,pk2,cf1,cf2,surge1,surge2
WAVEFO,type	
WIDTH,width	
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
CALNOI,value	
CALPHA,index	
CALRES	
CALSAV,password	
CALSHU,index,value	
CALSHU?	single real data value
CALSNO,serial number	
CALSTR,string	
CALSTR?	string

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
1	operating mode
2	alternate operating mode
3	output mode
4	autozero manual or auto
5	blanking disable
6	phase convention
7	main output on/off
8	line drawing on/off
9	keyboard beep on/off
10	auto dim timer
11	low frequency mode
12	printer type
13	measurement speed
14	filter type
15	filter dynamics
16	baud rate
17	program step enable
18	sweep steps
19	sweep start frequency
20	sweep stop frequency
21	single sweep / continuous sweep
22	auto conditions
23	auto shunt
	Input parameters
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	filter channel 1
31	filter channel 2
32	scale factor channel 1
33	scale factor channel 2
34	external shunt channel 1
35	external shunt channel 2
	General parameters
38	5/6 digit resolution
39	phase reference
40	output scaling
41	output resolution
	Display parameters
42	zoom level
43	function zoomed on 1
44	function zoomed on 2
45	function zoomed on 3
46	function zoomed on 4
	Signal generator parameters
48	generator frequency
49	generator amplitude
50	generator offset
51	generator waveform
52	delta frequency
53	delta amplitude
	DC generator parameters
56	generator amplitude
57	delta amplitude
	Pulse generator parameters
60	pulse repetition frequency
61	pulse width
62	pulse amplitude
63	pulse offset
64	delta frequency

65	delta amplitude
66	rise time
67	fall time
	Dual frequency generator parameters
68	waveform repetition frequency
69	generator amplitude 1
70	generator amplitude 2
71	number of cycles 1
72	number of cycles 2
73	type
58	delta frequency
59	delta amplitude
	White noise generator parameters
74	white noise generator amplitude
75	white noise on/off
76	delta amplitude
	Voltmeter parameters
78	display option
	Power meter parameters
82	display option
83	integration type
	Phase meter parameters
94	display option
95	data streaming
96	data streaming window size
97	phase offset time delay
	Harmonic analyser parameters
98	display option
99	mode
100	selected harmonic
101	maximum harmonic
102	computation
	Oscilloscope parameters

106 timebase
109 trigger level
110 pretrigger samples
111 trigger polarity
112 trigger mode
113 delta timebase
114 delta trigger
115 channel to display

Transformer analyser parameters

120 display option
121 test
122 fixture
123 winding 1
124 winding 2
125 source impedance
126 load impedance
127 nominal number of turns

LCR meter parameters

136 display option
137 computation
138 series/parallel sweep
139 graph option
140 active head control
141 impedance lin/log

gain/phase analyser parameters

144 dB maximum
145 dB minimum
146 auto scaling
147 display option
148 dB offset

System parameters

153 IEEE address
154 printer timeout

Alarm functions

156 alarm data

157	type
158	high threshold
159	low threshold
160	latching type
	Phase sensitive detector parameters
164	display option
165	integration type
	Selective level meter parameters
168	display option
169	scan type
170	selectivity
171	frequency 1
172	frequency 2
173	minimum dB level for blanking
174	frequency to adjust using ‘one-touch’ keys
	Vector voltmeter parameters
130	LVDT head
131	LVDT computation
176	display option
177	computation
178	LVDT scaling
179	manual null meter ranging
180	null maximum
181	phase offset
	One touch program recall
182	key 1
183	key 2
184	key 3
	Amplitude compression parameters
186	ac trim enable
187	dc trim enable
188	ac trim level
189	dc trim level

190	trim tolerance
	Other parameters
119	length units
191	sampling control
192	graph/table printout
193	graph scaling manual/auto
194	manual graph scaling maximum
195	manual graph scaling minimum
196	emulation mode

Appendix E – Contact details

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

Newtons4th Ltd.
30 Loughborough Road
Mountsorrel
LOUGHBOROUGH
LE12 7AT
United Kingdom

Tel: (0116) 230 1066 international +44 116 230 1066
Fax: (0116) 230 1061 international +44 116 230 1061

E-mail address: sales@newtons4th.com
support@newtons4th.com

web site: www.newtons4th.com

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.

QUANTEQ comments

serial number:	main release: dsp release: fpga release: boot release: (press SYSTEM then BACK)	date:

your contact details:

comments:

detailed description of relevant application or circumstances:

Please post or fax to Newtons4th Ltd.