PSM2201

Veqtor

user manual

“Do not be hasty when making measurements.”

Veqtor is a precision instrument that provides you with the tools to make a wide variety of measurements accurately, reliably, and efficiently - but good metrology practice must be observed. Take time to read this manual and familiarise yourself with the features of the instrument in order to use it most effectively.

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.
- The inputs are rated at 10V peak maximum with common mode up to 600V rms (1000V peak) overvoltage category II. Do not exceed 15V peak on any input or 600V rms (1000V peak) to earth. Input connectors are high voltage safety types; only use test leads that are fitted with approved high voltage safety connectors if 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: 30 Loughborough Road
Mountsorrel
Loughborough
Leics. UK
LE12 7AT

We declare that the product:

Description: Phase Sensitive Multimeter
Product name: Veqtor
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 61010-1:1993

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 Veqtor 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 Veqtor be re-calibrated annually.

ABOUT THIS MANUAL

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

Accordingly, this manual first describes the general details 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 "communications manual".

10 March 2005

CONTENTS

APPENDICES

1 Introduction – general principles of operation

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

Veqtor has a versatile generator output that can be used as:

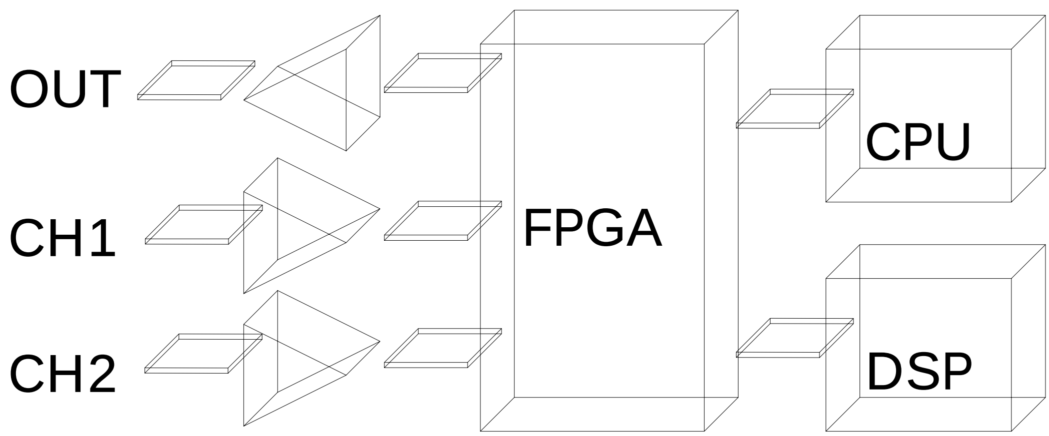
- signal generator (sine, triangle, square, sawtooth)
- dc generator
- white noise generator

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

Veqtor 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
two channel true rms voltmeter
phase angle voltmeter (vector voltmeter)
two channel digital storage oscilloscope
frequency response analyser (gain/phase analyser)
phase meter
harmonic analyser

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

true rms current meter
LCR meter

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

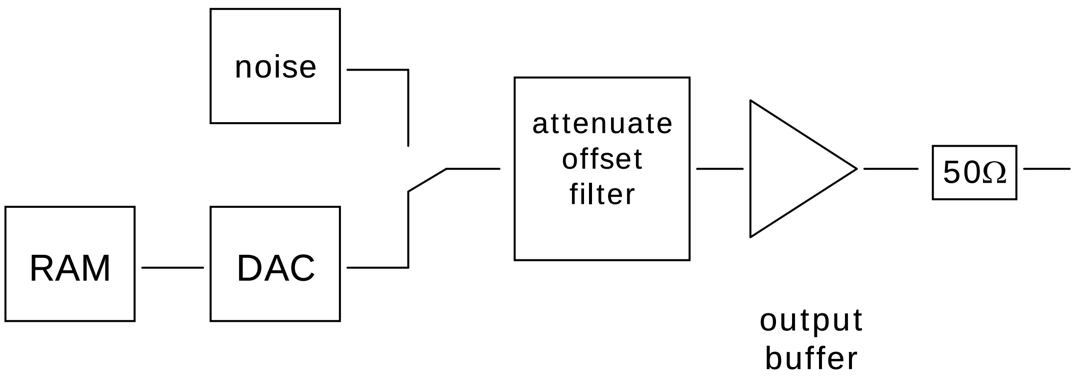
The programmable nature of the instrument means that new functions can be added, or existing functions can be enhanced, by simple firmware download.

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.



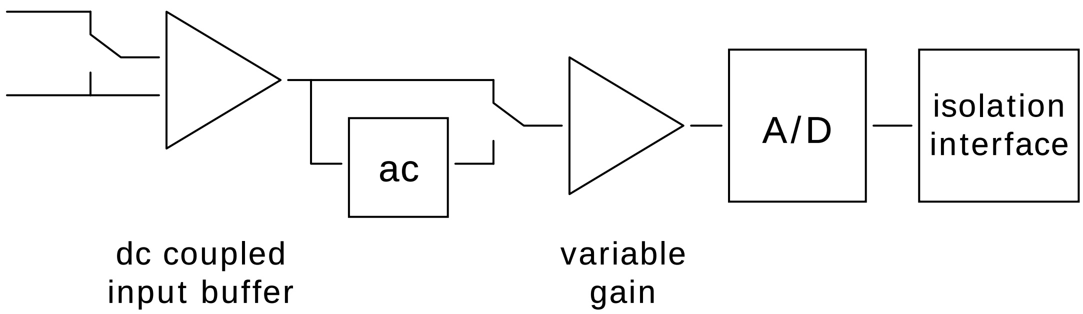
1.2 Voltage inputs

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 600V rms (1000V peak) 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 it’s signal 0V connected (unlike most oscilloscopes which force the inputs to be earth referenced).

The maximum input is ±10V peak.
The full scale of the lowest range is ±1mV 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 Veqtor 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 Veqtor unit
- one appropriate mains lead
- two oscilloscope 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 Veqtor operates correctly and has not been damaged in transit.

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

Switch on the Veqtor. 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 ~0.65V on both channels, each of which should indicate the 1V 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.

PAV	FRA	LCR	PAGE	ZOOM+	ZOOM-

BACK		UP		NEXT
	LEFT	HOME	RIGHT	
DELETE		DOWN		ENTER

SYSTEM	MODE	OUT	CH1	CH2	SETUP
PRINT	MONITOR	PROGRAM	START	ZERO	STEP

Primary key action (normal operation)

PAV	Selects phase angle voltmeter function.
FRA	Selects frequency response analyser function.
LCR	Selects LCR analyser function.
Note: the above keys allow one-touch switching between PAV, FRA, or LCR functions, or stored programs.	
PAGE	Selects display page 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.
MONITOR	Alarm control menu.
PROGRAM	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)

PAV	'G' multiplier (x 10^9), or 'A' for text.
FRA	'M' multiplier (x 10^6), or 'E' for text.
LCR	'k' multiplier (x 10^3), or 'I' for text.
PAGE	'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.
MONITOR	6 in a data entry, or jump to item 6 in a list.
PROGRAM	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 Veqtor 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 Veqtor will start a frequency sweep over the specified range.

Pressing PAGE 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.

3 Using the menus

Veqtor 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 Veqtor, 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, Veqtor 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)
MONITOR menu (use dedicated MONITOR key)
PROGRAM menu (use dedicated PROGRAM 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

These are covered in the following 3 sections.

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 Veqtor 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

Veqtor 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 Veqtor 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 PROGRAM 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 – PAV, FRA, LCR – 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

Veqtor 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 MONITOR 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 is 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 PAGE 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 PAGE key was first recognised.

While HOLD is active, the PAGE 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

Veqtor 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	line feed or EOI	line feed with EOI

All the functions of the Veqtor 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 Veqtor 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.

Veqtor 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).

Veqtor 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 communication command section of the manual.

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

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

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 Veqtor 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

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

Veqtor 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 Veqtor 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 Veqtor 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

Veqtor 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 Veqtor 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, Veqtor supports two modes of operation, supervisor and user. When supervisor mode is disabled, the stored programs can only be recalled, not changed. Veqtor 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 either by the ‘one-touch’ keys, PAV, RMS and LCR, or via the MODE menu.

The measurement mode may be set to:

rms voltmeter
oscilloscope
gain phase analyser (frequency response analyser)
phase meter
LCR meter
phase angle voltmeter (vector voltmeter)
harmonic analyser
signal generator only

The output mode may be one of the available generators:

disabled
sin/squ/tri
dc only
white noise

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 LCR 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 set in any measurement function (eg. vector voltmeter) it applies also to any other function that uses it.

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.

Some functions have a data streaming option where the window may be specified to be between 660us and 100ms. This allows data to be read at up to 1500 readings per second.

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 is 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. There is also a dc only generator.

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 dc only generator pass through a logarithmic attenuator equivalent to 17 bits so that very fine amplitude increments are possible at low signal levels.

An offset may be added to the signal generator or white noise generator 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.

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)

Noise generator	
type	analogue, non-repetitive
output voltage	~10mV to ~0.5V rms

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 1mV to 10V. This gives the following ranges:

range	reference	nominal full scale
1	1mV	1mV
2	3mV	3.16mV
3	10mV	10mV
4	30mV	31.6mV
5	100mV	100mV
6	300mV	316mV
7	1V	1V
8	3V	3.16V
9	10V	10V

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 send *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.

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:

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

For a sampled signal, the formula becomes:

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

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

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. Veqtor 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 Veqtor 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.

PAGE 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	~0.7Hz (–3dB)
max input	±10V peak ±600V rms (1000V peak) cat II from earth
input ranges	10V, 3V, 1V, 300mV, 100mV, 30mV, 10mV, 3mV, 1mV
ranging	full auto, up only, or manual
input impedance	1M // 30pF (exc. leads)
accuracy (ac)	0.05% range + 0.05% reading + 0.1mV <1kHz 0.15% range + 0.15% reading + 0.1mV < 10kHz 0.5% range + 0.5% reading + 0.001%/kHz + 0.1mV > 10kHz
accuracy (dc)	0.15% range + 0.15% reading + 0.1mV
CMRR	>140dB @ 240V 50Hz >120dB @ 100V 1kHz >55dB @ 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 Veqtor 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 as 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 PAGE 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	±10V peak ±600V rms (1000V peak) cat II from earth
input ranges	10V, 3V, 1V, 300mV, 100mV, 30mV, 10mV, 3mV, 1mV
input impedance	1M // 30pF (exc. leads)
ranging	full auto, up only, or manual

13 Frequency response analyser

Veqtor 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, $v(\phi)$, 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.

Veqtor 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

Veqtor 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 Veqtor 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 PAGE 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 Veqtor 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 Veqtor 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	±10V peak ±600V rms (1000V peak) cat II from earth
input ranges	10V, 3V, 1V, 300mV, 100mV, 30mV, 10mV, 3mV, 1mV
ranging	full auto, up only, or manual
input impedance	1M // 30pF (exc. leads)
gain accuracy	0.01 dB < 1kHz 0.03 dB < 10kHz 0.1 dB < 50kHz 0.1 dB + 0.001 dB/kHz > 50kHz
phase accuracy	0.01° < 1kHz 0.02° < 20kHz 0.001°/kHz > 20kHz
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.

Veqtor 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 by filtered out.

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 PAGE 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.

Veqtor 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

Veqtor 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 PAGE 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 Veqtor 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 Veqtor 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	±10V peak
input ranges	10V, 3V, 1V, 300mV, 100mV, 30mV, 10mV, 3mV, 1mV
ranging	full auto, up only, or manual
input impedance	1M // 30pF (exc. leads)
magnitude accuracy	0.05% range + 0.05% reading + 0.02mV <1kHz 0.15% range + 0.15% reading + 0.02mV < 10kHz 0.3% range + 0.3% reading + 0.02mV < 50kHz 0.5% range + 0.5% reading + 0.001%/kHz + 0.02mV > 50kHz
phase accuracy	0.01° < 1kHz 0.02° < 20kHz 0.001°/kHz > 20kHz
resolution	0.01°
A/B resolution	0.0001
CMRR	>140dB @ 240V 50Hz >120dB @ 100V 1kHz >55dB @ 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

Veqtor 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 Veqtor 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 Veqtor 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 Veqtor 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	±10V peak ±600V rms (1000V peak) cat II from earth
input ranges	10V, 3V, 1V, 300mV, 100mV, 30mV, 10mV, 3mV, 1mV
ranging	full auto, up only, or manual
input impedance	1M // 30pF (exc. leads)
phase accuracy	0.01° < 1kHz 0.02° < 20kHz 0.001°/kHz > 20kHz
resolution	0.01°
measurement	DFT analysis
offset	fixed time
data streaming window	660us – 100ms
maximum data rate	1500 readings per second

Conditions:

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

16 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 Veqtor 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’). The shunt chosen must be appropriate for the voltage, the current and the frequency of operation.

Veqtor 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), Veqtor 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 by 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’, Veqtor 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 Veqtor 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.

Veqtor 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

Veqtor 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 PAGE 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 Veqtor 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 Veqtor 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 0.5% < 10kHz 1.5% < 50kHz 5% < 1MHz 10% < 2.4MHz
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
both signals < 10V peak

17 Harmonic analyser

The Veqtor 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.

Veqtor 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

Veqtor 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 PAGE 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 Veqtor 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 Veqtor 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	±10V peak ±600V rms (1000V peak) cat II from earth
input ranges	10V, 3V, 1V, 300mV, 100mV, 30mV, 10mV, 3mV, 1mV
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

ACCESSORIES

Car Power Conversion Kit

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

Warning. Only use the car power adapter kit where there is a safety earth connection available. Veqtor 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 Veqtor.

Instructions

Connect the ring on the Veqtor earth lead to the earth post on the front of the instrument.
Securely clip the Veqtor 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 Veqtor 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 Veqtor and operate as normal.

Veqtor 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 Veqtor 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 Veqtor 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 Veqtor 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 Veqtor 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

Isolation transformer

When testing the stability of control loops it is necessary to inject a small disturbance signal into the loop. Veqtor 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 Veqtor – 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 Veqtor over RS232.

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

Strings to be sent to Veqtor 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 Veqtor
- 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	
*WAI	
ABORT	
ACTRIM,channel,level,tol	
AMPLIT,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	
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,parameter,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	
PPORT,value	
PPORT?	single integer data value
PRETRI,data	
PRINT	
PROGRAM,function,number	
RANGE,ch,ranging, range	
REZERO	
RESOLU,resolution	
SCALE,channel,factor	
SCALE,channel?	single real data value
SHUNT,channel,resistance	
SHUNT,channel?	single real data value
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	
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	
ZERO	
ZERO,DELETE	
ZOOM,level,d1,d2,d3,d4	
ZOOM?	level,d1,d2,d3,d4

calibration commands

CALAPP	
CALCOMP,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	
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

Although some parameters do not have a specific communication command, all parameters can be accessed using the CONFIG command:

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

where the parameter number is given in the list below

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
	White noise generator parameters
74	white noise generator amplitude
75	white noise on/off

76	delta amplitude
	Voltmeter parameters
78	display option
	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
	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
	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 Veqtor 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 here 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 use 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.

VEQTOR 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.