ViTREK

4700

OPERATING & MAINTENANCE MANUAL

ABOUT THIS MANUAL

This applies to all 4700 instruments having a main firmware revision of 1.10; there may be minor differences if the 4700 being operated has a different main firmware version.

Due to continuing product refinement and possible manufacturer changes to components used in this product, ViTREK reserves the right to change any or all specifications without notice.

This manual has been created with “clickable” links. Where a reference is made to another section of the manual, the user may click on the section name reference and the document will automatically go to that section.

The table of contents is “clickable”. The user may click on any of the entries to go to that section.

The table of contents is also made available as Bookmarks for Adobe Reader or Acrobat, allowing the user to permanently display the table of contents alongside the document and navigate by clicking on each section needed.

WARRANTY INFORMATION

This ViTREK instrument is warranted against defects in material and workmanship for a period of 1 year after the date of purchase (extended up to a total of 3 years with registration and annual calibrations at ViTREK). ViTREK agrees to repair or replace any assembly or component (except batteries) found to be defective, under normal use, during the warranty period. ViTREKs obligation under this warranty is limited solely to repairing any such instrument, which in ViTREKs sole opinion proves to be defective within the scope of the warranty, when returned to the factory or to an authorized service center. Transportation to the factory or service center is to be prepaid by the purchaser. Shipment should not be made without prior authorization by ViTREK.

This warranty does not apply to any products repaired or altered by persons not authorized by ViTREK or not in accordance with instructions provided by ViTREK. If the instrument is defective as a result of misuse, improper repair, improper shipment, or abnormal conditions or operations, repairs will be billed at cost.

ViTREK assumes no responsibility for its products being used in a hazardous or dangerous manner, either alone or in conjunction with other equipment. Special disclaimers apply to this instrument. ViTREK assumes no liability for secondary charges or consequential damages, and, in any event, ViTREKs liability for breach of warranty under any contract or otherwise, shall not exceed the original purchase price of the specific instrument shipped and against which a claim is made.

Any recommendations made by ViTREK or its representatives, for uses of its products are based on tests believed to be reliable, but ViTREK makes no warranties of the results to be obtained. This warranty is in lieu of all other warranties, expressed or implied and no representative or person is authorized to represent or assume for ViTREK any liability in connection with the sale of our products other than set forth herein.

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SECTION 1 – PRODUCT INFORMATION

FEATURES

The 4700 is an advanced Precision High Voltage Meter with many standard features which make it unique in this field.

- The 4700 can measure from 0.01V to 140KV (10KV without optional accessory probe). Accuracies down to 300ppm and resolutions down to 10ppm can be achieved.
- There's no worry about selecting the incorrect operating range or mode, the 4700 always automatically measures both the DC and AC signal contents and displays them both, along with the frequency and crest factor of applied AC voltages. The 4700 is effectively a single range instrument, using non-linear DSP technology to achieve a very wide dynamic range. For most applications the user never has to use any of the 4700 controls.
- The 4700 is capable of measuring very low frequency AC signals down to 0.009Hz. You can now test the accuracy of your VLF type dielectric tester with confidence.
- The 4700 has a ripple measurement mode, allowing it to accurately reject the DC signal content and only measure the AC ripple. You can now test the ripple on high voltage DC power supplies.
- The 4700 makes differential measurements. Common mode offsets up to 800Vpk are accommodated using the COMMON terminal; this can be extended up to 100KV by using external available accessory probes.
- The 4700 has a selectable high-speed mode allowing dielectric tester ramp and dwell times and ramp conformance to be plotted and printed as a graphics chart.
- The 4700 can be used as a data logger, graphically charting the measurements over periods from a second to several days. The chart can be printed at any time.
- The present measurements can be printed on a suitable USB printer, allowing the user to make a paper record of the measurements.
- If the user wishes to use the 4700 with a computer, then RS232 or Ethernet or available GPIB interfacing can be chosen as the interfacing medium between them.

AVAILABLE OPTIONS AND ACCESORIES

INTERFACING OPTIONS

Option **GP-47** adds a GPIB interface to the standard RS232, LAN and USB printer interfaces.

TERMINAL OPTIONS

Option **RPO-47** changes the terminals to be on the rear panel instead of on the front panel as in a standard 4700.

POWER OPTIONS

Option **BP-47** adds an internal Lithium-Ion battery pack to the 4700.

PROBE ACCESSORIES

Any of the following probes can be used with the 4700. All probes are calibrated for use with any 4700. Two probes can be used for differential measurements.

- **HVP-35**. This is a hand held probe allowing measurements up to 35KV.
- **HVL-35**. This is a laboratory bench top probe allowing precise measurements up to 35KV.
- **HVL-70**. This is a laboratory bench top probe allowing precise measurements up to 70KV.
- **HVL-100**. This is a laboratory bench top probe allowing precise measurements up to 100KV.
- **HVL-150.** This is a laboratory bench top probe allowing precise measurements up to 140KV
- **HVL-35G**. This is a laboratory bench top probe with high impedance allowing precise DC measurements up to 35KV.
- **HVL-70G**. This is a laboratory bench top probe with high impedance allowing precise DC measurements up to 70KV.
- **HVL-100G**. This is a laboratory bench top probe with high impedance allowing precise DC measurements up to 100KV.
- Contact Vitrek with your specific requirements if you do not see the probe you are looking for.

SECTION 2 – SAFETY

The user must be aware of these safety warnings at all times while using the 4700.

WARNING - THE 4700 MEASURES VOLTAGES WHICH MAY BE LETHAL; UNSAFE OPERATION MAY RESULT IN SEVERE INJURY OR DEATH.

WARNING - IF THE 4700 IS USED IN A MANNER NOT SPECIFIED BY VITREK, THE PROTECTION PROVIDED BY THE EQUIPMENT MAY BE IMPAIRED AND SAFETY MAY BE COMPROMISED.

GROUNDING

WARNING - THE USER MUST SECURELY GROUND THE PROTECTIVE GROUND TERMINAL LOCATED ON THE 4700 REAR PANEL WHEN IN USE OR WHENEVER HIGH VOLTAGES MAY BE PRESENT.

NEVER – ATTEMPT TO USE THE 4700 WITHOUT THE PROTECTIVE GROUND TERMINAL BEING GROUNDED IN AN ATTEMPT TO INCREASE THE COMMON MODE VOLTAGE CAPABILITY OF THE 4700. THIS IS EXTREMELY DANGEROUS AND CAN DAMAGE THE 4700.

TERMINALS AND WIRING

WARNING - THE 4700 MEASURES VOLTAGES OF UP TO 10kVrms ON THE DIRECT TERMINAL, AND VOLTAGES UP TO 140KVrms ON A PROBE TIP TERMINAL, THESE VOLTAGES CAN CAUSE SEVERE INJURIES OR DEATH. THE USER MUST ENSURE THAT CONNECTIONS TO THESE HAVE SUFFICIENT INSULATION FOR THESE VOLTAGES. EVEN WHEN SUFFICIENT INSULATION IS PRESENT, THE USER SHOULD NOT PUT ANY PART OF THEIR BODY IN PROXIMITY TO THE CONNECTIONS WHILE HIGH VOLTAGES ARE PRESENT (AT LEAST ½ INCH PER KV IS RECOMMENDED). THE USER SHOULD NOT INSERT OR REMOVE ANY CONNECTIONS TO THE 4700 WHEN HIGH VOLTAGES ARE PRESENT.

WARNING – DO NOT APPLY HIGH VOLTAGES TO A PROBE WITHOUT IT BEING PROPERLY PLUGGED INTO A 4700.

WARNING - WHEN USING AN EXTERNAL PROBE OR PROBES WITH THE 4700, NO PART OF THE USERS' BODY MUST BE WITHIN 4" (HVP-35 OR HVL-35), 8" (HVL-70) OR 12" (HVL-100) OF THE PROBE BODY (OTHER THAN THE HANDLE OF THE HVP SERIES PROBES) WHEN VOLTAGES MAY BE PRESENT.

WARNING – WHEN AC VOLTAGES ARE PRESENT, EVEN IF THERE IS SUFFICIENT INSULATION ON THE CONNECTIONS, THERE MAY BE SIGNIFICANT CAPACITIVE COUPLING WHICH CAN CAUSE AN UNSAFE CURRENT TO FLOW INTO NEARBY OBJECTS AND ALSO CORONA MAY OCCUR EVEN OUTSIDE OF THE INSULATION. THESE EFFECTS ARE MADE WORSE BY SHARP CORNERS. IN SEVERE CASES CORONA CAN CAUSE INTERFERENCE WITH THE MEASUREMENTS OF THE 4700 AND WILL REDUCE THE CAPABILITIES OF THE WIRING INSULATION OVER TIME, EVENTUALLY RESULTING IN INSULATION FAILURE.

SECTION 3 –INSTALLATION, STORAGE AND SHIPPING

GENERAL SPECIFICATIONS

Nominal Dimensions	4700 : 133mmH x 215mmW x 251mmD (5.25” x 8.5” x 10”) HVP-35 : 470mmL x 68mmDia (18.5” x 2¾”), 1.75m cord length HVL-35 or HVL-70 : 600mmH x 220mmL x 120mmD (24” x 8.75” x 4.75”), 1.75m cord length HVL-100 : 680mmH x 220mmL x 120mmD (27” x 8.75”x 4.75”), 1.75m cord length
Nominal Weight	4700 (Std) : 2.25kg (5lb) net, 3.25kg (7lb) shipping 4700 (with BP-47) : 2.5kg (5.5lb) net, 3.5kg (7.5lb) shipping HVP-35 : 0.5kg (1lb) net, 1kg (2lb) shipping HVL-35, HVL-70 or HVL-100 : 1.25kg (2.5lb) net, 1.75kg (3.5lb) shipping
Storage Environment	-20 to 75C (non-condensing)
Operating Environment	0 to 50C, <85% RH (non-condensing), Pollution Degree 2 Reduced maximum voltage capability above 35C
Operating Altitude	0 to 10000ft ASL Reduced maximum voltage capability above 5000ft
Power	DC Input Power : 11-16.5Vdc, 1.25A maximum, 2.1mm pin, center positive. Supplied Power Supply : 105-265Vrms, 45 to 450Hz, 25VA maximum
Mains Measurement	Measurement Category I

THE 4700 SHOULD NOT BE USED IN AN ENVIRONMENT WHERE CONDUCTIVE POLLUTION CAN OCCUR, E.G. IN AN OUTDOOR ENVIRONMENT.

IF FLUIDS OR OTHER CONDUCTIVE MATERIALS ARE ALLOWED TO ENTER THE UNIT ENCLOSURE, EVEN IF NOT POWERED, THEN THE UNIT SHOULD BE IMMEDIATELY TAKEN OUT OF OPERATION AND SERVICED AS SAFETY MAY HAVE BEEN COMPROMISED.

IF THE UNIT IS TRANSPORTED BETWEEN DIFFERING ENVIRONMENTS AND CONDENSATION IS SUSPECTED, THE UNIT SHOULD REMAIN UNPOWERED FOR SUFFICIENT TIME FOR CONDENSATION TO HAVE DISSIPATED.

INTERNAL BATTERY (OPTION BP-47)

Operating Time	>8hr continuous operation from fully charged at 20C (backlight continuously powered) >11hr continuous operation from fully charged at 20C (backlight infrequently powered)
Self-Discharge	>10 days to 50% charge from fully charged at 20C >45 days to 50% charge from fully charged at 20C (rear panel switch in SHIP position)
Charging Time	<5hr from fully discharged, automatically terminated charge Charging disabled if battery temperature is outside of 10-40C range
Battery Type	2 x Lithium-Ion 18650 size cells
Battery Life	>200 full charge/discharge cycles
Battery Type	Lithium-Ion batteries (user replaceable as purchased internal module)

SHIPPING AND STORAGE

The 4700 has a rear panel accessible switch (labeled SHIP) which totally disables the 4700 during shipment if this switch is placed in the down position. If a 4700 with option BP-47 is to be shipped or is to be stored for periods of longer than several days then placing this switch in the down position will prevent the 4700 from being accidently turned on in transit and will also reduce the self-discharge rate of the battery.

INITIAL INSPECTION

After the 4700 has been shipped or otherwise handled in an unknown manner, the user should visually inspect the 4700 for damage before attempting to operate it. Particular attention should be taken to ensure that there are no significant dents or cracks in any outer surfaces, there are no scratches on the front panel LCD touchscreen and that all terminals are securely mounted to the unit. If any significant dents or any loosely mounted terminals are noted then it is recommended that the 4700 be serviced prior to being placed into use, as safety may have been compromised.

SECTION 4 – INPUT SPECIFICATIONS

Throughout this section, a voltage on a single terminal or probe input refers to the voltage between the specified terminal or probe input and the 4700 chassis ground.

The accuracy specifications are valid for a period of 1 year at ambient temperatures within ±5C of calibration temperature (add 0.004% of reading per C outside of this). The accuracy specifications include the measurement uncertainties in the standards and methods employed by Vitrek during calibration of the 4700 and probes; to obtain the accuracy relative to the standards and methods used in the actual calibration of the 4700 or probes reduce all DC accuracy specifications by 0.0075% of reading and all AC accuracy specifications by 0.025% of reading.

The accuracy specifications for probes assume the use of the probe with the specific 4700 used for its' calibration. When this is not the case, add 0.01% of reading to all probe accuracy specifications.

MAXIMUM INPUT VOLTAGES

HVL-150 Probe	140KVdc, 100KVrms (<65Hz), 150KVpk continuous, fully specified 6500KV.Hz max above 65Hz. 30KV per millisecond max signal slew rate above 50KV. 10% overload for <1 second without damage.
HVL-100 Probe	100KVdc, 75KVrms, 110KVpk continuous, fully specified 15% overload for <1s, no permanent damage
HVL-100G Probe	100KVdc, 110KVpk continuous, fully specified 15% overload for <1s, no permanent damage 100KV/ms max rate of change
HVL-70 Probe	70KVdc, 50KVrms, 75KVpk continuous, fully specified 15% overload for <1s, no permanent damage
HVL-70G Probe	70KVdc, 75KVpk continuous, fully specified 15% overload for <1s, no permanent damage 65KV/ms max rate of change
HVP-35/HVL-35 Probe	35KVdc, 30KVrms, 45KVpk continuous, fully specified 15% overload for <1s, no permanent damage
HVL-35G Probe	35KVdc, 45KVpk continuous, fully specified 15% overload for <1s, no permanent damage 50KV/ms max rate of change
DIRECT Terminal	DC & ≥15Hz : 10KVdc, 10KVrms, 15KVpk continuous, fully specified <15Hz : 7KVrms continuous, fully specified 20% overload for <1s, no permanent damage
COMMON Terminal	600Vdc, 600Vrms, 800Vpk continuous, fully specified 2KVdc, 2KVrms, 3KVpk for <1s, no permanent damage

Decrease maximum voltages by 1%/C above 35C ambient temperature and by 5%/1000ft above 5000ft ASL altitude.

INPUT IMPEDANCE

HVL-100G Probe	30GΩ ± 2% in parallel with <5pF to the 4700 chassis ground
HVL-70G Probe	20GΩ ± 2% in parallel with <5pF to the 4700 chassis ground
HVL-35G Probe	10GΩ ± 2% in parallel with <5pF to the 4700 chassis ground
HVL-150 Probe	1000MΩ ± 2% in parallel with <5pF to the 4700 chassis ground
HVL-100 Probe	600MΩ ± 2% in parallel with <5pF to the 4700 chassis ground
HVL-70 Probe	400MΩ ± 2% in parallel with <5pF to the 4700 chassis ground
HVP-35/HVL-35 Probe	200MΩ ± 2% in parallel with <5pF to the 4700 chassis ground
DIRECT Terminal	110MΩ ± 2% in parallel with <5pF to the 4700 chassis ground
COMMON Terminal	3.025MΩ ± 2% in parallel with <10pF to the 4700 chassis ground

DIRECT:COMMON MEASUREMENT SPECIFICATIONS

This section contains the specifications for the 4700 when not using an external probe (i.e. the 4700 is measuring the voltage between the DIRECT and COMMON terminals of the 4700).

Total DC measurement uncertainty is the addition of all relevant DC Measurement Accuracy specifications and the High Voltage Self-Heating uncertainty.

Total AC measurement uncertainty is the addition of all relevant AC Measurement Accuracy specifications and the High Voltage Self-Heating uncertainty.

MEASUREMENT RESOLUTION

Measurement resolution is dependent on the DIRECT terminal voltage (AC content only in RIPPLE mode).

DC & AC	0.01V (<1400Vpk±10%), 0.1V (<14KVpk±10%), 1V (otherwise) Limited to a maximum of 6 digits (4 digits in RIPPLE and FAST modes)
Pk-Pk	0.1V (<1400Vpk±10%), 1V (<14KVpk±10%), 10V (otherwise) Limited to a maximum of 4 digits
Crest Factor	4 digits (automatically reduced at very low signal levels)
Frequency	4 digits

DC MEASUREMENT ACCURACY

PRECISE Mode	<0.03% of reading + 0.03V + ½ digit
FAST Modes	<0.04% of reading + 0.05V + ½ digit
AC Rejection	AC signal >(3.5Vrms + 2% of DC signal) : >78dB (PRECISE Mode) or >60dB (FAST Modes)
Common Mode Error	<0.05% of the COMMON terminal DC voltage

AC MEASUREMENT ACCURACIES

PRECISE Mode (30-600Hz Band Selection)

30 to 200Hz : <0.12% of reading + 0.1V + ½ digit
200 to 450Hz : <0.4% of reading + 0.1V + ½ digit
450 to 600Hz : <0.75% of reading + 0.1V + ½ digit

PRECISE Mode (10-150Hz Band Selection)

10 to 65Hz : <0.12% of reading + 0.1V + ½ digit
65 to 150Hz : <0.4% of reading + 0.1V + ½ digit

PRECISE Mode (1-75Hz Band Selection)

1 to 35Hz : <0.12% of reading + 0.1V + ½ digit
35 to 75Hz : <0.4% of reading + 0.1V + ½ digit

PRECISE Mode (0.1-35Hz Band Selection)

0.1 to 15Hz : <0.12% of reading + 0.1V + ½ digit
15 to 35Hz : <0.4% of reading + 0.1V + ½ digit

PRECISE Mode (0.01-2Hz Band Selection)

0.01 to 1Hz : <0.12% of reading + 0.1V + ½ digit
1 to 2Hz : <0.4% of reading + 0.1V + ½ digit

RIPPLE Mode	30 to 600Hz : <2% of reading + 0.15V + ½ digit
FAST Modes	45 to 200Hz : <0.2% of reading + 0.15V + ½ digit (55Hz minimum in FAST 16ms mode) 200 to 450Hz : <0.5% of reading + 0.15V + ½ digit 450 to 600Hz : <1% of reading + 0.15V + ½ digit
DC Rejection	>65dB, except RIPPLE mode which is >100dB
Common Mode Error	<0.05% + (0.008% times frequency in Hz) of the COMMON terminal AC voltage
Pk-Pk	1V + 2*AC accuracy + ½ digit
Crest Factor	0.001 + ((0.5V + AC Accuracy) / AC Signal Level) + ½ digit
Frequency	AC signal >(3.5Vrms + 2% of DC signal) : <0.02% (<0.05% in FAST Modes) + ½ digit

HIGH VOLTAGE SELF-HEATING

This is the effect of self-heating induced as a result of voltage on the DIRECT terminal. This effect is additional to the accuracy specifications above and may take several minutes to dissipate after removal of the high voltage.

DC & ≥20Hz	<1.5ppm of reading per KV^2
<20Hz	<5ppm of reading per KV^2

KV = total RMS (DC+AC) voltage expressed in KV

HVP-35 OR HVL-35 HI PROBE:COMMON MEASUREMENT SPECIFICATIONS

This section contains the specifications for the 4700 when using a single HVP-35 or HVL-35 probe (i.e. the 4700 is measuring the voltage between the HI PROBE tip and COMMON terminal of the 4700). These specifications assume that no signal is present on the DIRECT terminal.

Total DC measurement uncertainty is the addition of all relevant DC Measurement Accuracy specifications and the High Voltage Self-Heating uncertainty.

Total AC measurement uncertainty is the addition of all relevant AC Measurement Accuracy specifications and the High Voltage Self-Heating uncertainty.

PROBE LOCATION

Full accuracy specifications are valid assuming that there are no objects within a cylinder of radius 18" centered on the probe body extending from the handle (or base) to a point 6" beyond the probe tip. The connection to the probe tip is assumed to extend from the probe tip in line with the probe for at least 6".

Typically the effect of a hand-sized grounded object is <0.01% at 60Hz when placed 4" from the probe and <0.1% at 400Hz when placed 18" from the probe. As long as objects do not move relative to the probe, there is negligible effect on DC measurements caused by nearby objects. Objects generating fields may need to be placed further away from the probe than these figures.

MEASUREMENT RESOLUTION

Measurement resolution is dependent on the HI PROBE tip voltage (AC content only in RIPPLE mode).

DC & AC	0.01V (<800Vpk±10%), 0.1V (<8KVpk±10%), 1V (otherwise) Limited to a maximum of 6 digits (5 digits in RIPPLE and FAST modes)
Pk-Pk	0.1V (<800Vpk±10%), 1V (<8KVpk±10%), 10V (otherwise) Limited to a maximum of 4 digits
Crest Factor	4 digits (automatically reduced at low signal levels)
Frequency	4 digits

DC MEASUREMENT ACCURACY

PRECISE Mode	HVP-35 : <0.035% of reading + 0.07V + ½ digit HVL-35 : <0.025% of reading + 0.07V + ½ digit
FAST Modes	<0.045% of reading + 0.1V + ½ digit
AC Rejection	AC signal >(7.5Vrms + 2% of DC signal) : >78dB (PRECISE Mode) or >60dB (FAST Modes)
Common Mode Error	<0.05% of the COMMON terminal DC voltage

AC MEASUREMENT ACCURACIES

PRECISE Mode (30-600Hz Band Selection)

HVP-35, 30 to 200Hz : <0.1% of reading + 0.2V + ½ digit
HVL-35, 30 to 200Hz : <0.08% of reading + 0.2V + ½ digit
HVL-35, within ±10Hz of calibration frequency : <0.05% of reading + 0.2V + ½ digit
200 to 450Hz : <0.6% of reading + 0.2V + ½ digit
450 to 600Hz : <1.25% of reading + 0.2V + ½ digit

PRECISE Mode (10-150Hz Band Selection)

10 to 65Hz : <0.1% of reading + 0.2V + ½ digit
65 to 150Hz : <0.5% of reading + 0.2V + ½ digit

PRECISE Mode (1-75Hz Band Selection)

1 to 35Hz : <0.15% of reading + 0.2V + ½ digit
35 to 75Hz : <0.5% of reading + 0.2V + ½ digit

PRECISE Mode (0.1-35Hz Band Selection)

0.1 to 15Hz : <0.15% of reading + 0.2V + ½ digit
15 to 35Hz : <0.5% of reading + 0.2V + ½ digit

PRECISE Mode (0.01-2Hz Band Selection)

	0.01 to 1Hz : <0.15% of reading + 0.2V + ½ digit 1 to 2Hz : <0.5% of reading + 0.2V + ½ digit
RIPPLE Mode	30 to 600Hz : <2% of reading + 0.3V + ½ digit
FAST Modes	45 to 200Hz : <0.15% of reading + 0.3V + ½ digit (55Hz minimum in FAST 16ms mode) 200 to 450Hz : <0.6% of reading + 0.3V + ½ digit 450 to 600Hz : <1.25% of reading + 0.3V + ½ digit
DC Rejection	>65dB, except RIPPLE mode which is >100dB
Common Mode Error	<0.05% + (0.01% times frequency in Hz) of the COMMON terminal AC voltage
Pk-Pk	2V + 2*AC accuracy + ½ digit
Crest Factor	0.001 + ((1V + AC Accuracy) / AC Signal Level) + ½ digit
Frequency	AC signal >(7.5Vrms + 2% of DC signal) : <0.02% (<0.05% in FAST Modes) + ½ digit

HIGH VOLTAGE SELF-HEATING

This is the effect of self-heating induced as a result of voltage on the probe input. This effect is additional to the accuracy specifications above and may take several minutes to dissipate after removal of the high voltage.

HVP-35, DC & ≥20Hz	<0.75ppm of reading per KV^2
HVP-35, <20Hz	<1.25ppm of reading per KV^2
HVL-35, DC & ≥20Hz	<0.4ppm of reading per KV^2
HVL-35, <20Hz	<0.6ppm of reading per KV^2

KV = total RMS (DC+AC) voltage expressed in KV

HVL-35G HI PROBE:COMMON MEASUREMENT SPECIFICATIONS

This section contains the specifications for the 4700 when using a single HVL-35G probe (i.e. the 4700 is measuring the voltage between the HI PROBE tip and COMMON terminal of the 4700). These specifications assume that no signal is present on the DIRECT terminal.

Total DC measurement uncertainty is the addition of all relevant DC Measurement Accuracy specifications and the High Voltage Self-Heating uncertainty.

PROBE LOCATION

Full accuracy specifications are valid assuming that there are no objects within a cylinder of radius 18” centered on the probe body extending from the handle (or base) to a point 6” beyond the probe tip. The connection to the probe tip is assumed to extend from the probe tip in line with the probe for at least 6”.

As long as objects do not move relative to the probe, there is negligible effect on DC measurements caused by nearby objects. Objects generating fields may need to be placed further away from the probe than these figures.

MEASUREMENT RESOLUTION

Measurement resolution is dependent on the HI PROBE tip voltage.

DC	1V

DC MEASUREMENT ACCURACY

PRECISE Mode	<0.25% of reading + 1.5V
FAST Modes	<0.25% of reading + 2V
Common Mode Error	<0.5% of the COMMON terminal DC voltage

HVL-70 HI PROBE:COMMON MEASUREMENT SPECIFICATIONS

This section contains the specifications for the 4700 when using a single HVP-70 or HVL-70 probe (i.e. the 4700 is measuring the voltage between the HI PROBE tip and COMMON terminal of the 4700). These specifications assume that no signal is present on the DIRECT terminal.

Total DC measurement uncertainty is the addition of all relevant DC Measurement Accuracy specifications and the High Voltage Self-Heating uncertainty.

Total AC measurement uncertainty is the addition of all relevant AC Measurement Accuracy specifications and the High Voltage Self-Heating uncertainty.

PROBE LOCATION

Full accuracy specifications are valid assuming that there are no objects within a cylinder of radius 24” centered on the probe body extending from the handle (or base) to a point 9” beyond the probe tip. The connection to the probe tip is assumed to extend from the probe tip in line with the probe for at least 9”.

Typically the effect of a hand-sized grounded object is <0.01% at 60Hz when placed 8” from the probe and <0.1% at 400Hz when placed 24” from the probe. As long as objects do not move relative to the probe, there is negligible effect on DC measurements caused by nearby objects. Objects generating fields may need to be placed further away from the probe than these figures.

MEASUREMENT RESOLUTION

Measurement resolution is dependent on the HI PROBE tip voltage (AC content only in RIPPLE mode).

DC & AC	0.01V (<1.6KVpk±10%), 0.1V (<16KVpk±10%), 1V (otherwise) Limited to a maximum of 6 digits (5 digits in RIPPLE and FAST modes)
Pk-Pk	0.1V (<1.6KVpk±10%), 1V (<16KVpk±10%), 10V (otherwise) Limited to a maximum of 4 digits
Crest Factor	4 digits (automatically reduced at low signal levels)
Frequency	4 digits

DC MEASUREMENT ACCURACY

PRECISE Mode	HVP-70 : <0.04% of reading + 0.2V + ½ digit HVL-70 : <0.03% of reading + 0.2V + ½ digit
FAST Modes	<0.05% of reading + 0.3V + ½ digit
AC Rejection	AC signal >(15Vrms + 2% of DC signal) : >78dB (PRECISE Mode) or >60dB (FAST Modes)
Common Mode Error	<0.05% of the COMMON terminal DC voltage

AC MEASUREMENT ACCURACIES

PRECISE Mode (30-600Hz Band Selection)

HVP-70, 30 to 100Hz : <0.12% of reading + 0.4V + ½ digit
HVL-70, 30 to 100Hz : <0.1% of reading + 0.4V + ½ digit
HVL-70, within ±10Hz of calibration frequency : <0.075% of reading + 0.4V + ½ digit
100 to 200Hz : <0.6% of reading + 0.4V + ½ digit
200 to 450Hz : <2.5% of reading + 0.4V + ½ digit

PRECISE Mode (10-150Hz Band Selection)

10 to 65Hz : <0.15% of reading + 0.4V + ½ digit
65 to 150Hz : <0.5% of reading + 0.4V + ½ digit

PRECISE Mode (1-75Hz Band Selection)

1 to 35Hz : <0.2% of reading + 0.4V + ½ digit
35 to 75Hz : <0.5% of reading + 0.4V + ½ digit

PRECISE Mode (0.1-35Hz Band Selection)

0.1 to 15Hz : <0.2% of reading + 0.4V + ½ digit
15 to 35Hz : <0.5% of reading + 0.4V + ½ digit

PRECISE Mode (0.01-2Hz Band Selection)

0.01 to 1Hz : <0.2% of reading + 0.4V + ½ digit
1 to 2Hz : <0.5% of reading + 0.4V + ½ digit

RIPPLE Mode	30 to 600Hz : <2% of reading + 0.6V + ½ digit
FAST Modes	45 to 100Hz : <0.15% of reading + 0.6V + ½ digit (55Hz minimum in FAST 16ms mode) 100 to 200Hz : <0.6% of reading + 0.6V + ½ digit 200 to 450Hz : <2.5% of reading + 0.6V + ½ digit
DC Rejection	>65dB, except RIPPLE mode which is >100dB
Common Mode Error	<0.05% + (0.025% times frequency in Hz) of the COMMON terminal AC voltage
Pk-Pk	4V + 2*AC accuracy + ½ digit
Crest Factor	0.001 + ((2V + AC Accuracy) / AC Signal Level) + ½ digit
Frequency	AC signal >(15Vrms + 2% of DC signal) : <0.02% (<0.05% in FAST Modes) + ½ digit

HIGH VOLTAGE SELF-HEATING

This is the effect of self-heating induced as a result of voltage on the probe input. This effect is additional to the accuracy specifications above and may take several minutes to dissipate after removal of the high voltage.

HVP-70, DC & ≥20Hz	<0.25ppm of reading per KV^2
HVP-70, <20Hz	<0.4ppm of reading per KV^2
HVL-70, DC & ≥20Hz	<0.14ppm of reading per KV^2
HVL-70, <20Hz	<0.2ppm of reading per KV^2

KV = total RMS (DC+AC) voltage expressed in KV

HVL-70G HI PROBE:COMMON MEASUREMENT SPECIFICATIONS

This section contains the specifications for the 4700 when using a single HVL-70G probe (i.e. the 4700 is measuring the voltage between the HI PROBE tip and COMMON terminal of the 4700). These specifications assume that no signal is present on the DIRECT terminal.

Total DC measurement uncertainty is the addition of all relevant DC Measurement Accuracy specifications and the High Voltage Self-Heating uncertainty.

PROBE LOCATION

Full accuracy specifications are valid assuming that there are no objects within a cylinder of radius 24” centered on the probe body extending from the handle (or base) to a point 9” beyond the probe tip. The connection to the probe tip is assumed to extend from the probe tip in line with the probe for at least 9”.

As long as objects do not move relative to the probe, there is negligible effect on DC measurements caused by nearby objects. Objects generating fields may need to be placed further away from the probe than these figures.

MEASUREMENT RESOLUTION

Measurement resolution is dependent on the HI PROBE tip voltage.

DC	1V

DC MEASUREMENT ACCURACY

PRECISE Mode	<0.35% of reading + 3.5V
FAST Modes	<0.35% of reading + 5.5V
Common Mode Error	<0.5% of the COMMON terminal DC voltage

HVL-100 HI PROBE:COMMON MEASUREMENT SPECIFICATIONS

This section contains the specifications for the 4700 when using a single HVL-100 probe (i.e. the 4700 is measuring the voltage between the HI PROBE tip and COMMON terminal of the 4700). These specifications assume that no signal is present on the DIRECT terminal.

Total DC measurement uncertainty is the addition of all relevant DC Measurement Accuracy specifications and the High Voltage Self-Heating uncertainty.

Total AC measurement uncertainty is the addition of all relevant AC Measurement Accuracy specifications and the High Voltage Self-Heating uncertainty.

PROBE LOCATION

Full accuracy specifications are valid assuming that there are no objects within a cylinder of radius 30” centered on the probe body extending from the handle (or base) to a point 12” beyond the probe tip. The connection to the probe tip is assumed to extend from the probe tip in line with the probe for at least 12”.

Typically the effect of a hand-sized grounded object is <0.01% at 60Hz when placed 15” from the probe. As long as objects do not move relative to the probe, there is negligible effect on DC measurements caused by nearby objects. Objects generating fields may need to be placed further away from the probe than these figures.

MEASUREMENT RESOLUTION

Measurement resolution is dependent on the HI PROBE tip voltage (AC content only in RIPPLE mode).

DC & AC	0.01V (<2.4KVpk±10%), 0.1V (<24KVpk±10%), 1V (otherwise) Limited to a maximum of 6 digits (5 digits in RIPPLE and FAST modes)
Pk-Pk	0.1V (<2.4KVpk±10%), 1V (<24KVpk±10%), 10V (otherwise) Limited to a maximum of 4 digits
Crest Factor	4 digits (automatically reduced at low signal levels)
Frequency	4 digits

DC MEASUREMENT ACCURACY

PRECISE Mode	<0.05% of reading + 0.3V + ½ digit
FAST Modes	<0.07% of reading + 0.5V + ½ digit
AC Rejection	AC signal >(25Vrms + 2% of DC signal) : >78dB (PRECISE Mode) or >60dB (FAST Modes)
Common Mode Error	<0.05% of the COMMON terminal DC voltage

AC MEASUREMENT ACCURACIES

PRECISE Mode (30-600Hz Band Selection)
30 to 70Hz : <0.12% of reading + 0.6V + ½ digit
70 to 200Hz : <1% of reading + 0.6V + ½ digit
200 to 450Hz : <15% of reading + 0.6V + ½ digit

PRECISE Mode (10-150Hz Band Selection)
10 to 65Hz : <0.2% of reading + 0.6V + ½ digit
65 to 150Hz : <1% of reading + 0.6V + ½ digit

PRECISE Mode (1-75Hz Band Selection)
1 to 35Hz : <0.3% of reading + 0.6V + ½ digit
35 to 75Hz : <0.75% of reading + 0.6V + ½ digit

PRECISE Mode (0.1-35Hz Band Selection)
0.1 to 15Hz : <0.3% of reading + 0.6V + ½ digit
15 to 35Hz : <0.5% of reading + 0.6V + ½ digit

PRECISE Mode (0.01-2Hz Band Selection)
0.01 to 1Hz : <0.3% of reading + 0.6V + ½ digit
1 to 2Hz : <0.5% of reading + 0.6V + ½ digit

RIPPLE Mode	30 to 600Hz : <2% of reading + 0.6V + ½ digit
FAST Modes	45 to 70Hz : <0.15% of reading + 0.9V + ½ digit (55Hz minimum in FAST 16ms mode) 70 to 200Hz : <1% of reading + 0.9V + ½ digit 200 to 450Hz : <15% of reading + 0.9V + ½ digit
DC Rejection	>65dB, except RIPPLE mode which is >100dB
Common Mode Error	<0.05% + (0.025% times frequency in Hz) of the COMMON terminal AC voltage
Pk-Pk	6V + 2*AC accuracy + ½ digit

Crest Factor	0.001 + ((3V + AC Accuracy) / AC Signal Level) + ½ digit
Frequency	AC signal >(25Vrms + 2% of DC signal) : <0.02% (<0.05% in FAST Modes) + ½ digit

HIGH VOLTAGE SELF-HEATING

This is the effect of self-heating induced as a result of voltage on the probe input. This effect is additional to the accuracy specifications above and may take several minutes to dissipate after removal of the high voltage.

DC & ≥20Hz	<0.14ppm of reading per KV^2
<20Hz	<0.2ppm of reading per KV^2

KV = total RMS (DC+AC) voltage expressed in KV

HVL-100G HI PROBE:COMMON MEASUREMENT SPECIFICATIONS

This section contains the specifications for the 4700 when using a single HVL-100G probe (i.e. the 4700 is measuring the voltage between the HI PROBE tip and COMMON terminal of the 4700). These specifications assume that no signal is present on the DIRECT terminal.

Total DC measurement uncertainty is the addition of all relevant DC Measurement Accuracy specifications and the High Voltage Self-Heating uncertainty.

PROBE LOCATION

Full accuracy specifications are valid assuming that there are no objects within a cylinder of radius 30” centered on the probe body extending from the handle (or base) to a point 12” beyond the probe tip. The connection to the probe tip is assumed to extend from the probe tip in line with the probe for at least 12”.

As long as objects do not move relative to the probe, there is negligible effect on DC measurements caused by nearby objects. Objects generating fields may need to be placed further away from the probe than these figures.

MEASUREMENT RESOLUTION

Measurement resolution is dependent on the HI PROBE tip voltage (AC content only in RIPPLE mode).

DC	1V (<38KVpk±10%), 10V (otherwise)

DC MEASUREMENT ACCURACY

PRECISE Mode	<0.5% of reading + 15V
FAST Modes	<0.5% of reading + 30V
Common Mode Error	<0.5% of the COMMON terminal DC voltage

HVL-150 HI PROBE:COMMON MEASUREMENT SPECIFICATIONS

This section contains the specifications for the 4700 when using a single HVL-150 probe (i.e. the 4700 is measuring the voltage between the HI PROBE tip and COMMON terminal of the 4700). These specifications assume that no signal is present on the DIRECT terminal.

Total DC measurement uncertainty is the addition of all relevant DC Measurement Accuracy specifications and the High Voltage Self-Heating uncertainty.

Total AC measurement uncertainty is the addition of all relevant AC Measurement Accuracy specifications and the High Voltage Self-Heating uncertainty.

PROBE LOCATION

Full accuracy specifications are valid assuming that there are no objects within a cylinder of radius 48" centred on the probe body extending from the base to a point 18" beyond the probe tip. The connection to the probe tip is assumed to extend from the probe tip in line with the probe for at least 18".

At 60Hz, the effect of a hand-sized object is about 0.05% at 30 inches. As long as objects do not move relative to the probe, there is negligible effect on DC measurements caused by nearby objects. Objects generating fields may need to be placed further away from the probe than these figures.

MEASUREMENT RESOLUTION

Measurement resolution is dependent on the HI PROBE tip voltage (AC content only in RIPPLE mode).

DC & AC	0.1V (<13KVpk±10%), 1V (<130KVpk±10%), 10V (otherwise) Limited to a maximum of 6 digits (5 digits in RIPPLE and FAST modes)

DC MEASUREMENT ACCURACY

PRECISE Mode	<0.08% of reading + 0.7V + ½ digit
FAST Modes	<0.1% of reading + 1V + ½ digit

AC MEASUREMENT ACCURACIES

PRECISE Mode (30-600Hz Band Selection)
<65Hz: <0.5% of reading + 1V + ½ digit
65-100Hz: <3% of reading + 1V + ½ digit

PRECISE Mode (10-150Hz Band Selection)
<65Hz: <0.5% of reading + 1V + ½ digit
65-100Hz: <3% of reading + 1V + ½ digit

PRECISE Mode (1-75Hz Band Selection)
1 to 75Hz : <2% of reading + 1V + ½ digit

PRECISE Mode (0.1-35Hz Band Selection)
0.1 to 35Hz : <2% of reading + 1V + ½ digit

PRECISE Mode (0.01-2Hz Band Selection)
0.01 to 2Hz : <2% of reading + 1V + ½ digit

HIGH VOLTAGE SELF-HEATING

This is the effect of self-heating induced as a result of voltage on the probe input. This effect is additional to the accuracy specifications above and may take several minutes to dissipate after removal of the high voltage.

Self-Heating: <0.2ppm of reading per KV^2

KV = total RMS (DC+AC) voltage expressed in KV

HI PROBE:LO PROBE MEASUREMENTS

These specifications assume that no signal is present on the DIRECT or COMMON terminals.

Add the relevant HI PROBE : COMMON accuracy specifications for each probe (each in volts using the voltage on each probe in the computation), for AC measurements also add the AC Common Mode Error from the table below as a percentage of the LO PROBE AC voltage. This additional AC common mode error is worst case assuming that the HI PROBE and LO PROBE voltages are in phase, for other cases multiply the figure by cos(phase). The measurement resolution is the largest of the resolution specifications for each probe (using the voltage on each probe).

Probes	AC Common Mode Error
Both HVP-35/HVL-35	0.005% per Hz
Both HVP-70/HVL-70	0.01% per Hz
Both HVL-100	0.03% per Hz
Dissimilar Probes	0.03% per Hz

MEASUREMENT TIME

All results are measured over independent consecutive measurement times shown in the following table, dependent on the selected Mode and Band selections. The measurement time is automatically adjusted to be an integer number of cycles of the input waveform if possible. Results are fully valid following a change in applied signal within a worst case maximum of 2 measurement times plus 0.1s plus 4 cycles of the input waveform (for AC signals) plus 1s following a change in the DC level (RIPPLE Mode only).

Mode Selection	Band Selection	Measurement Time
PRECISE	30-600Hz	0.2s ± 10%
	10-150Hz	0.4s ± 15%
	1-75Hz	2s ± 30%
	0.1-35Hz	10s ± 50%
	0.01-2Hz	100s ± 50%
FAST (20ms)	N/A	0.02s ± 50%
FAST (16ms)	N/A	0.0167s ± 50%
RIPPLE	N/A	0.2s ± 10%

SECTION 5 – USING THE 4700

4700 REAR PANEL SWITCHES

There are two rear panel accessible switches, labeled SHIP and AUTO ON.

SHIP SWITCH

This switch totally disables the 4700 during shipment if it is in the down position. If a 4700 with option BP-47 is to be shipped or is to be stored for periods of longer than several days then placing it in the down position will prevent the 4700 from being accidently turned on in transit and will also reduce the self-discharge rate of the battery. This switch must be in the UP position to operate the 4700.

AUTO ON SWITCH

If this switch is in the down position then the 4700 will automatically power on whenever external power becomes available at the rear panel DC power input. In this manner a 4700 without option BP-47 will function as if it had a "hard" power switch which has been left in the ON position and the mains supply is turned on and off.

4700 FRONT PANEL CHG AND PWR INDICATORS

These indicate the present power supply status of the 4700 as follows –

BP-47 not fitted –

- PWR is continuously illuminated with a red color whenever suitable power is applied via the rear panel DC power input.
- CHG is never illuminated.

BP-47 fitted –

- PWR is as follows –
    - Flashing green every 2 seconds. This indicates that the battery voltage is suitable to power the 4700 and no external power is applied via the rear panel DC power input and the 4700 is turned OFF.
    - Continuously illuminated with a green color. This indicates that the battery voltage is suitable to power the 4700 and no external power is applied via the rear panel DC power input and the 4700 is turned ON.
    - Continuously illuminated with an orange color. This indicates that the battery voltage is suitable to power the 4700 and suitable power is applied via the rear panel DC power input.
    - Continuously illuminated with a red color. This indicates that the battery voltage is very low but suitable power is applied via the rear panel DC power input.
    - Not flashing nor illuminated. This indicates that the battery voltage is very low and no external power is applied via the rear panel DC power input.
- CHG is as follows –
    - Not illuminated. This indicates that the battery is not being changed and has not been charged. This indicates that either there is no external power being applied via the rear panel DC power input, or the battery is faulty, or the operating temperature is beyond the allowable range for battery charging.

- Continuously illuminated with a red color. This indicates that the battery is being charged from the power applied via the rear panel DC power input.
- Continuously illuminated with a green color. This indicates that the battery has been fully charged from the power applied via the rear panel DC power input.

USING THE 4700 TOUCHSCREEN

The 4700 LCD panel touchscreen is used for all manual user interaction with the 4700, including turning the 4700 on and off.

- Do not use a pen or pencil, or a sharp object, or a fingernail on the touchscreen, this may damage the screen.
- Do not apply excessive pressure to the touchscreen otherwise it may be damaged.
- It is not recommended to use gloves when using the touchscreen.
- The touchscreen has been designed to not require the use of a stylus; however one can be used if desired. If a stylus is used then ensure that it has a smooth surface where it touches the screen and do not apply excessive force, otherwise it may damage the screen.
- In normal operation, the display shows the areas which may be used as buttons or controls with the touchscreen.

TURNING ON THE 4700

After ensuring that power is applied to the 4700 either via the rear panel DC power input or via the internal batteries if option BP-47 is fitted, the unit may be turned on by pressing and holding the front panel touchscreen (typically it must be continuously held for at least 250ms to turn the 4700 power on).

After turning on, the 4700 shows an introductory screen for at least 2 seconds. This screen is maintained until the touchscreen is released. After the introductory period has elapsed and the touchscreen has been released the unit shows the primary measurement results screen and is ready for use.

There are three primary screens on the 4700 –

- Primary Measurement Results Screen.
- Chart Measurement Results Screen.
- Configuration Screen.

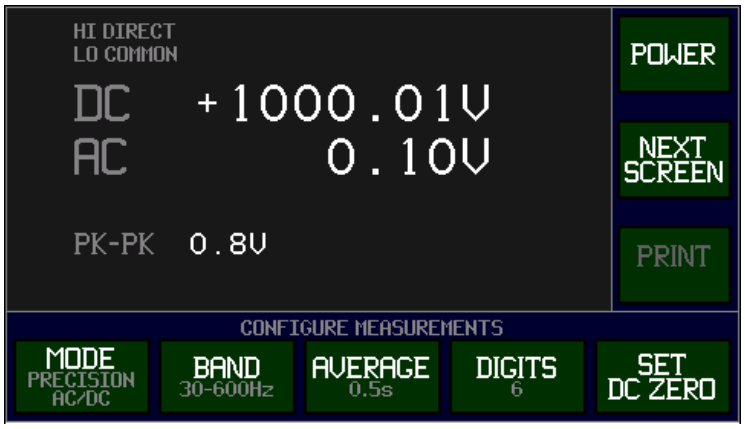
Pressing the NEXT SCREEN button on each of these screens successively selects each in the order shown above, returning to the first listed from the last screen.

TURNING OFF THE 4700

All screens of the 4700 with a few exceptions contain a POWER button in the upper right hand corner of the touchscreen. Pressing this will automatically save any settings which have changed but have not been saved (a message is displayed during this time, which may take one or two seconds) and then the 4700 will turn off. If power is physically removed from the 4700 (if BP-47 is not installed) rather than using the POWER button then the 4700 will immediately power off and might not have saved any settings which have been recently changed.

MAKING MEASUREMENTS WITH THE 4700

After the 4700 is turned on and the introductory screen is shown, the 4700 shows the Primary Measurement Results Screen. From any other screen successively press the NEXT SCREEN button until it is shown.



The main section of this screen shows the selected input terminals to the 4700 and the measurement results. If an input is in overload then the overloaded input terminal name is shown in red, and also the measurement results are shown in red.

The buttons down the right side of the screen provide auxiliary functions.

The buttons across the bottom of the screen allow you to configure the measurements. These settings are non-volatile, so they are retained during a power cycle of the 4700. The measurement configurations selected on this screen affects all measurements made, regardless of the screen being shown. The presently selected configuration is shown within each configuration button; note that these are the only configuration settings which affect measurement results.

INPUT TERMINAL OR PROBE SELECTION

The input terminals or probes are automatically selected depending on the presence or absence of probes in the HI PROBE and LO PROBE connectors. Whenever an input selection change occurs a temporary message is shown on the 4700 screen. There are three valid combinations of inputs to the 4700 –

- If neither the HI PROBE nor LO PROBE connectors have a probe connected. The 4700 uses the HI DIRECT and LO COMMON terminals on the front panel of the 4700. The measurement results are for the voltage between the two terminals, a positive DC result indicates that the HI DIRECT terminal is more positive than the LO COMMON terminal.
- If both the HI PROBE and LO PROBE connectors have probes connected. The 4700 uses the HI PROBE and LO PROBE inputs. The measurement results are for the voltage between the two probes, a positive DC result indicates that the HI PROBE input is more positive than the LO PROBE input.
- If only the HI PROBE connector has a probe attached. The 4700 uses the HI PROBE input and LO COMMON terminal on the front panel of the 4700. The measurement results are for the voltage between the HI PROBE input and the COMMON terminal, a positive DC result indicates that the HI PROBE input is more positive than the LO COMMON terminal.

If a probe is in use as either the HI or LO terminal then the type of probe is shown at the top of the screen. If the probe is being used with the 4700 which was the calibration host for this probe, then HOST is displayed along with the type of probe.

Note, if a probe is connected to the LO PROBE connector without a probe in the HI PROBE connector then this has no affect as this is not a valid terminal configuration.

When using probes with the 4700 the user should always note the following –

- The safety spacing requirements in the SAFETY section of this manual must be followed at all times.
- The spacing requirements shown in the relevant SPECIFICATIONS section of this manual should be observed to maintain the accuracy of the probe(s).
- When operating a probe at near its' maximum voltage rating the probe body and tip may be at an elevated temperature. Do not handle the probe body immediately after high voltage has been applied.
- The user should not attempt to extend the cord between the 4700 and the probe. Probes with longer cords may be available from ViTREK on request, contact ViTREK for details.
- The cable(s) between the probe(s) and the 4700 are shielded, but for best results the user should not route them in very close proximity to power cords, interface cables, or other equipment.
- The 4700 probes are high impedance probes, as with any such probe they will pick up fields present in the area of the probe yielding a non-zero AC indication when no apparent input is applied. Such fields are always present unless the 4700 is being used in a very sparsely populated area with no local mains supply, or in a shielded environment. Unless the pick-up is large and/or the signal being measured is small this is typically of little consequence, however the user may wish to consider the following regarding the effects of pick-up on AC RMS measurements –
    - The accuracies stated in the SPECIFICATIONS section for probes assume that externally generated fields are negligible. The specifications include the effects of the 4700 and the probe itself, but externally generated fields are part of the users' environment and as such cannot be estimated by ViTREK.
    - High impedances will pick up both electric and magnetic fields.
    - The higher the impedance the more that fields affect the AC zeroes. Always try to use the lowest impedance probe possible (a 35KV max. input probe is half the impedance of a 70KV probe so will be less sensitive to fields).
    - You can measure the AC zero in your environment but, unlike DC offsets, you cannot subtract AC zero measurements from the displayed measurements to improve accuracy. If you short the HI PROBE input to the LO COMMON terminal (if using a single probe) or the two probe inputs to each other (if using two probes) then you can see the AC zero on the Primary Measurement Results screen of the 4700.
    - Moving the probes (or nearby equipment) will indicate where the optimum position is for the probe(s) for minimum AC zero – ensure that the minimum spacing requirements are met however.
    - For unrelated signals (i.e. where the field frequency, typically local mains, is more than a few Hz away from the frequency of the signal being measured) the effect is diminished by the square of the relative amplitudes, e.g. if the signal being measured is 100Vrms at 50Hz, the local mains frequency is 60Hz and the AC zero is 1V, then the effect is (1V/100V) squared = 0.01% of the reading.
    - When the signal being measured has exactly the same frequency as that causing the AC zero then the effect is dependent on the relative phase and harmonic contents, both of which are

typically unknown. The error cannot be estimated, but will almost always be a maximum of ± the AC zero measurement.

- When the signal being measured is close in frequency to that causing the AC zero (e.g. measuring an exact 60Hz signal in a 60Hz power environment) then a beat may be noticed as slowly changing measurement results (this may have a period of several minutes or more so might not be easily noticed). The error will typically be a maximum of ± the AC zero measurement, but may be higher, depending on the harmonic content of the field causing the AC zero. Although commonly done, assuming a measurement half way between the extents of the "beat" does not necessarily produce an accurate estimate of the actual measurement.

MEASUREMENT RESULTS

- All measurement results are of the voltage difference between the selected HI and LO terminals and are computed digitally in real time from high speed sampling (nominally 40KSPS) of the input voltage waveforms. Proprietary techniques are used to obtain an effective sampling resolution of 25 bits with no sub-sampling frequency artifacts.
- All results, except frequency, are obtained in each measurement time from the same set of samples, obtained with the same circuitry. Computational precision is sufficient to ensure less than 1ppm of reading computational error in each final measurement result.
- The DC measurement result is the true average signal voltage over each measurement time. The DC result is not shown when RIPPLE mode is selected.
- The HVL-xxG series of probes do not measure AC voltages; only the DC measurement result is shown when a HVL-xxG series probe is attached.
- The AC measurement result is the true RMS voltage of the DC subtracted signal. There is no low-pass filter used in AC measurements (except for RIPPLE mode) so there is no loss in accuracy at low frequencies as long as the frequency is at or above the minimum allowed for by the MODE and BAND selected.
- The PK-PK measurement result is the difference between the mathematically highest and lowest instantaneous signal voltages within each measurement time.
- The FREQ (frequency) measurement result is computed from the time difference and number of zero crossings between two zero crossings of the DC subtracted signal. The starting and ending zero crossings are automatically selected in the 4700 to be approximately one measurement time apart, independently of the amplitude results measurement time. The frequency measurement is used to "lock" the measurement time to an integer number of cycles of the applied signal, so fully synchronous DC and AC measurements are made.
- The CF measurement result uses the (0.5*PK-PK/RMS) definition of AC crest factor.
- The FREQ and CF results are only displayed when sufficient AC signal content is detected for these to be meaningful.

MODE BUTTON

This shows the presently selected measurement mode. Pressing this button changes the bottom set of buttons to the mode selection set of buttons, returning when a mode selection button is pressed. The following mode selections are available –

- **PRECISION**. This is the recommended normal operating mode, providing the best accuracy and resolution of measurements of both DC and AC signals and is the only mode which allows making very low frequency measurements.
- **FAST(20ms)** or **FAST(16ms)**. These allow the user to configure the 4700 to make fast DC and AC measurements with a measurement period of either 20ms or 16.667ms to provide moderate rejection of small line frequency related AC components. For 50Hz/400Hz local mains select FAST(20ms) otherwise select FAST(16ms). This selection only affects the rejection of small AC signals as larger amplitude AC components are automatically synchronized to. These modes should be selected if it is wished to chart the output of a dielectric tester with ramp and/or dwell times of a few seconds or shorter.
- **RIPPLE**. This allows the user to configure the 4700 to only measure the AC signal content, having the maximal rejection of the DC signal content. This is recommended if the signal has a large DC offset but a small AC signal is required to be measured (e.g. measurement of power supply ripple). NOTE – the accuracy of the AC results is reduced in this mode, the user should carefully consider whether to use this mode or the PRECISION mode (see SPECIFICATIONS for details). This selection is not available when a HVL-xxG series probe is attached.

BAND BUTTON

This is only present if the PRECISION mode is selected. This shows the presently selected AC measurement bandwidth. Pressing this button changes the bottom set of buttons to the bandwidth selection set of buttons, returning when a bandwidth selection button is pressed.

For best results always select the BAND setting having the highest maximum frequency possible but which still covers the expected frequency. For measurements of DC and mains frequencies (or higher) the 30-600Hz setting is recommended.

The BAND selection has a large effect on the measurement time and on the amount of time the 4700 takes to "lock-on" to a signal when initially applied or changed; see MEASUREMENT TIME in SPECIFICATIONS for details.

AVERAGE BUTTON

This is only present if either the PRECISION or RIPPLE mode is selected. This shows the presently selected averaging interval for the displayed measurements. Pressing this button changes the bottom set of buttons to the average selection set of buttons, returning when an average selection button is pressed.

This does not affect the actual measurement time (see the specifications section); the displayed results are updated each measurement time, but each displayed result is the average over the preceding average time. If the input signal has instability then increasing this can help reduce the instability in the displayed measurement results. A setting of 0.5sec (with a 30-600Hz bandwidth) is recommended for most purposes, the available selections are dependent on the selected bandwidth setting.

DIGITS BUTTON

This is only present if the PRECISION mode is selected. This shows the presently selected maximum number of digits for the displayed measurements. Pressing this button changes the bottom set of buttons to the digits selection set of buttons, returning when a digits selection button is pressed.

This does not affect the actual measurements; only the displayed format is affected. A setting of 6 is normally recommended; the user may wish to reduce this if the input signal is unstable and the user wishes to reduce the display resolution to mask the instability. Independent of this setting, the display resolution is also limited by the specified minimum resolution shown in the SPECIFICATIONS sections for the specific input and signal level present. The display resolution is limited using the round-to-nearest method.

SET DC ZERO BUTTON

This is not available if RIPPLE mode is selected. This enables the user to store an offset which will be applied to all future DC measurement results. When pressed, the present input signal is measured over a period of about 3 seconds (a message is displayed while this is being performed), and the resulting DC measurement result is saved and used to offset all future DC measurement results.

- If a true DC zero is desired, then this can be performed with either shorted or open circuited input terminals. If probe(s) are being used then it is recommended to short the inputs together (HI PROBE to LO COMMON or HI PROBE to LO PROBE as applicable) to reduce the effects of nearby movement.
- Even if this feature is not required, it is useful to use this to reduce the effects of DC offsets in the input wiring and can be used to offset internal DC zero offsets in changing environments.
- It is possible that another user has used this feature to offset DC measurements; it is recommended that this button be used whenever the present user is uncertain about previous usage, or whenever probes are initially attached, detached or changed, to ensure that a true DC zero is being used.
- There is no limit on the amount of DC zero which can be accommodated, but the accuracy is always dependent on the actual voltages applied and the maximum voltage input on each input must be observed at all times.
- The DC zero offset is stored and applied separately for the three possible input terminal configurations.
- The DC measurement used to determine the DC offset does not reject AC signal content below 30Hz. Do not perform this if very low frequency signals are present.

POWER BUTTON

Pressing this button will turn off the 4700. The 4700 will save any unsaved changes to the measurement configuration prior to actually turning off; this may take one or two seconds if needed.

NEXT SCREEN BUTTON

Pressing this button changes the screen to the Chart Measurement Results Screen.

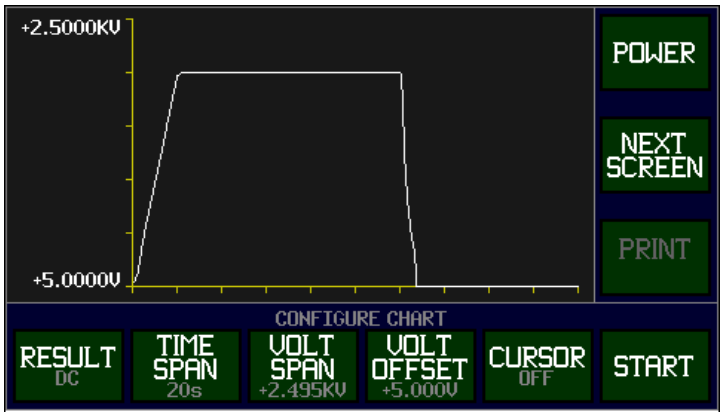
PRINT BUTTON

The text contained in this button is one of the following –

- **PRINT** (grey color). This indicates that there is no printer attached to the 4700 USB printer port. Pressing this button has no affect.
- **PRINT – ERROR** (red color). This indicates that the printer connected to the 4700 USB printer port is incompatible or is indicating that an error has occurred. Pressing this button has no affect.
- **PRINT – READY**. This indicates that a suitable printer is properly attached to the 4700 USB printer port and that it is ready to print. Pressing this button causes the 4700 to print a short page containing the present measurement results and a listing of the measurement configuration.
- **PRINT – PRINTING**. This indicates that the attached printer is presently printing. Pressing this button will abort the print activity and return to the PRINT – READY status as soon as possible. Note – do not press the NEXT PAGE while this screen is being printed.

CHARTING MEASUREMENT RESULTS WITH THE 4700

The Chart Measurement Results Screen is accessed by pressing the NEXT SCREEN button on the Primary Measurement Results Screen.



The 4700 can collect DC and AC measurement results over a user configurable time span. Starting data collection can be performed either manually or automatically. The measurement results are configured on the Primary Measurement Results Screen.

During chart data collection, both DC and AC measurement results are collected with full resolution, as they become available. The data is collected as the average measurement results within 300 equal time increments spanning the requested time span of the chart. If no measurement results were available in any given time increment but surrounding increments have valid results then interpolation is automatically performed. The selections for the DC or AC result and the chart vertical scale and offset settings only affect the displayed chart, not the underlying data, allowing the user to change the vertical scaling and offset of the chart for close inspection of the charted data as needed.

The displayed chart is updated on the screen as data is collected.

It is not necessary to remain on this screen to collect data, once started the data collection will continue until any of the following occurs –

- The 4700 is turned off.
- Data is collected beyond the selected time span.
- The chart Time Span is changed (this also clears any collected data).
- The user presses the STOP button.

The main section of this screen shows the charted results. Note, after charted data has been collected then it is always available, even if the screen is changed, until any of the following occurs –

- The 4700 is turned off.
- The chart Time Span is changed.
- Another chart data collection is initiated.

The buttons down the right side of the screen provide auxiliary functions.

The buttons across the bottom of the screen allow you to configure the chart. These settings are non-volatile, so they are retained during a power cycle of the 4700.

RESULT BUTTON

This shows whether the DC or AC amplitude result is shown in the chart. Once a chart has been started, this has no effect on the collected data as both are always collected. It does affect how a chart is automatically started however (see **START – AUTO** below for details on this). Pressing this button changes the bottom set of buttons to the data selection set of buttons (DC or AC), returning when a selection button is pressed.

TIME SPAN BUTTON

This shows the presently set overall time span for the chart. Pressing this starts a new screen which allows the user to enter the desired overall time span in integer seconds, minutes, hours or days as needed. After entering the chart time span the screen is automatically returned to the chart screen and the chart data is cleared. Note – there are always 10 equally spaced markers on the chart X axis (the time axis), it may be desirable to ensure that the entered time span is divisible by 10. The maximum possible chart time span is approximately 4000000seconds (almost 50 days).

VOLT SPAN AND OFFSET BUTTONS

These show the overall voltage span and the voltage for the bottom of the Y (voltage) axis of the chart. These can be changed without effecting the collected data, they do affect how a chart is automatically started however (see **START – AUTO** below for details on this). There is no limit placed on the entries for span and offset, the actual voltages for the top and bottom of the voltage axis are displayed on the chart. The user may enter negative quantities for either or both the offset and span if desired. Note – there are always 5 equally spaced markers on the chart Y axis (the voltage axis), it may be desirable to ensure that the entered voltage span is divisible by 5. Note – the voltage span and offset used are the actually entered data, the displayed data within the buttons and next to the vertical axis have limited resolution but this does not affect the actual chart.

CURSOR BUTTON

If the chart area itself is pressed by the user then a vertical cursor is shown at the position pressed and will stay in place until moved by pressing elsewhere on the chart or the cursor is turned off by pressing the CURSOR button. The CURSOR button text shows the present time position and voltage recorded at the selected point in the chart. For the most accurate placement of the cursor the user may wish to use a stylus.

START OR STOP BUTTON

This starts or stops data collection for the chart. The 4700 automatically changes the button text depending on whether chart data is presently being collected. Data collection is automatically stopped when the selected chart time span has been exceeded. When the START button is pressed the user is given a choice regarding the method used to initiate data collection –

START – MANUAL

The 4700 immediately starts collecting data for the chart. The chart is updated as data is collected and the user may stop data collection using the STOP button while data is being collected.

START – AUTO

The 4700 is armed to start but does not immediately start collecting data. Using the present RESULT, VOLT SPAN and VOLT OFFSET settings the 4700 waits until the selected measurement result is within the voltage span of the chart before starting. Once the chart has started, the user may change these settings, but after selecting for START-AUTO and before data collection has actually started these may not be changed. The STOP button can be used to disarm the automatic start. The following recommendations are made regarding START-AUTO:

- Generally this is used to chart ramp and dwell times in dielectric testers. It is recommended to use either of the FAST modes (see the Measurement Results Screen for details) for ramp or dwell times shorter than 10 seconds.
- Typically a dielectric tester will ramp its' output voltage (either DC or AC) from zero to a preset level either at a preset rate or in a preset time (the ramp). It is recommended to set the chart

VOLT OFFSET to just above zero (perhaps 5V) to produce a start condition as soon as the ramp actually starts.

POWER BUTTON

Pressing this button will turn off the 4700. The 4700 will save any unsaved changes to the measurement configuration prior to actually turning off; this may take one or two seconds if needed.

NEXT SCREEN BUTTON

Pressing this button changes the screen to the Configuration Screen.

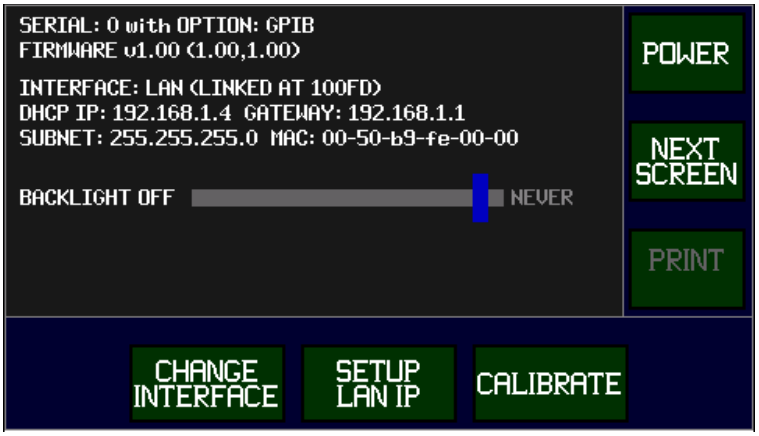
PRINT BUTTON

The text contained in this button is one of the following –

- **PRINT** (grey color). This indicates that there is no printer attached to the 4700 USB printer port. Pressing this button has no affect.
- **PRINT – ERROR** (red color). This indicates that the printer connected to the 4700 USB printer port is incompatible or is indicating that an error has occurred. Pressing this button has no affect.
- **PRINT – READY**. This indicates that a suitable printer is properly attached to the 4700 USB printer port and that it is ready to print. Pressing this button causes the 4700 to print a single page containing the present chart (in monochrome) and a listing of the measurement and chart configuration.
- **PRINT – PRINTING**. This indicates that the attached printer is presently printing. Pressing this button will abort the print activity and return to the PRINT – READY status as soon as possible. Note – do not press the NEXT PAGE while this screen is being printed.

CONFIGURING THE INTERFACES AND POWER CONSUMPTION OF THE 4700

The Configuration Screen is accessed by pressing the NEXT SCREEN button on the Chart Measurement Results Screen.



The example shown above is for a 4700 without option BP-47 installed.

The information shown on the main portion of the screen is as follows –

- The 4700 serial number and a listing of the installed options.
- The 4700 firmware versions numbers (the primary firmware is the first version shown).
- The presently active interface and the configuration for that interface (if any).

- A slider control which shows and allows the user to change the presently configured time of inactivity before the screen backlight is turned off.
- (If option BP-47 if installed) A slider control which shows and allows the user to change the presently configured time of inactivity before the 4700 is automatically turned off when running on battery power.

CHANGE INTERFACE BUTTON

This button allows the user to change the selected interface. Any of the installed interfaces can be selected to be able to control the 4700 or all interfaces can be disabled entirely (this can save power when running from batteries).

SETUP LAN BUTTON

This button is only shown if the LAN interface is selected to be able to control the 4700. Pressing this button changes the bottom row of buttons to those allowing configuration of the LAN. You may need to consult your IT department before configuring the 4700 to connect to your LAN, you will need to know if DHCP can be used (typically this is fine, but some LANs do not allow it) and if not then an IP address for the 4700, a gateway IP address and the local subnet mask for the LAN. You might need to know the MAC address of the 4700, this can be obtained from information on the Configuration screen after the 4700 is configured for LAN interfacing.

USE DHCP BUTTON

If presently configured to use DHCP to configure the LAN then this button has a highlighted surround, otherwise it does not. Pressing this button selects that DHCP will be used for LAN configuration and no further configuration is required.

SET FIXED IP BUTTON

Pressing this button disables DHCP configuration of the LAN and provides a new screen which allows the user to enter a fixed IP address for the 4700. Note, if not using DHCP then the IP and Gateway addresses and the subnet mask must be manually set.

SET GATEWAY BUTTON

Pressing this button disables DHCP configuration of the LAN and provides a new screen which allows the user to enter the gateway IP address for the 4700 LAN interface. Note, if not using DHCP then the IP and Gateway addresses and the subnet mask must be manually set.

SET SUBNET BUTTON

Pressing this button disables DHCP configuration of the LAN and provides a new screen which allows the user to enter the subnet mask for the 4700 LAN interface. Note, if not using DHCP then the IP and Gateway addresses and the subnet mask must be manually set.

DONE BUTTON

Pressing this button completes entry of the desired LAN interface details and returns to the standard set of bottom buttons. Changes made are not employed until this button is pressed.

SELECT BAUD RATE BUTTON

This button is only shown if the RS232 interface is selected to be able to control the 4700. Pressing this button changes the bottom row of buttons to those allowing selection of the RS232 Baud Rate. Pressing one of the baud rate buttons selects that baud rate and returns to the normal set of bottom buttons.

SET GPIB ADDR BUTTON

This button is only shown if the (optional) GPIB interface is selected to be able to control the 4700. Pressing this button starts a new screen allowing entry of the desired GPIB address for the 4700. Note that the GPIB address of the 4700 may be any integer between 1 and 29 inclusive.

CALIBRATE BUTTON

This release of the 4700 manual does not contain information regarding external calibration of the 4700 and probes.

BACKLIGHT OFF SLIDER CONTROL

This slider control shows and allows the user to change the presently configured time of inactivity before the screen backlight is turned off. The screen backlight has a typical life of several thousand hours; this can be extended by turning off the backlight when the 4700 screen is left inactive for a period of time. Also, if option BP-47 is fitted this can save power during periods of inactivity. The 4700 continues making measurements and continues to collect chart data (if running) while the screen backlight is off. The backlight will automatically turn off after there has been no touchscreen activity for the configured time. Touching anywhere on the screen will turn the backlight back on again if it has turned off. The control setting can be changed by pressing anywhere along the controls' length or by dragging the slider button to the desired point. The time selected is shown to the right side of the control (NEVER indicates that the backlight will not turn off automatically).

BATTERY OFF SLIDER CONTROL

This is only shown if option BP-47 is installed. This slider control shows and allows the user to change the presently configured time of inactivity before the 4700 is automatically turned off when running on battery power. This does not affect operation when running from external power. The 4700 will automatically turn off after there has been no touchscreen or interfacing activity for the configured time. The control setting can be changed by pressing anywhere along the controls' length or by dragging the slider button to the desired point. The time selected is shown to the right side of the control (NEVER indicates that the 4700 will not turn off automatically).

POWER BUTTON

Pressing this button will turn off the 4700. The 4700 will save any unsaved changes to the measurement configuration prior to actually turning off; this may take one or two seconds if needed.

NEXT SCREEN BUTTON

Pressing this button changes the screen to the Primary Measurement Results Screen.

PRINT BUTTON

The text contained in this button is one of the following –

- **PRINT** (grey color). This indicates that there is no printer attached to the 4700 USB printer port. Pressing this button has no affect.
- **PRINT – ERROR** (red color). This indicates that the printer connected to the 4700 USB printer port is incompatible or is indicating that an error has occurred. Pressing this button has no affect.
- **PRINT – READY**. This indicates that a suitable printer is properly attached to the 4700 USB printer port and that it is ready to print. Pressing this button causes the 4700 to print a single page containing the present configuration settings.

- **PRINT – PRINTING**. This indicates that the attached printer is presently printing. Pressing this button will abort the print activity and return to the PRINT – READY status as soon as possible. Note – do not press the NEXT PAGE while this screen is being printed.

MAINTAINING THE 4700 BATTERIES (OPTION BP-47)

The batteries in the 4700 BP-47 option can be charged from an external supply at any time as long as the ambient temperature allows the batteries to be in the range of 10 to 40C during charging. Battery charging takes place independently of the power on/off state of the 4700. The 4700 uses normal Lithium-Ion battery charging techniques to ensure the best possible battery cycle lifetime.

- Battery charging is completely automatic, the batteries will not be damaged or degraded by leaving the 4700 connected to an external supply.
- The batteries can be degraded if the 4700 is left in storage for long periods of time. If it is planned to take the 4700 out of service for periods of more than a few days, or if the 4700 is to be shipped, then it is recommended to place the rear panel accessible SHIP switch in the DOWN position to prevent degradation of the batteries and also prevent the possibility of the 4700 being accidently turned on.
- The battery is charged using a tapered rate over time, this means that a fully discharged battery is typically charged to 75% of its' capacity in the first 2 hours of the charging time.
- The charging cycle is automatically terminated by the 4700 when nominally 95% completed. The user can "top up" the battery to more than 95% capacity by removing the external supply and reconnecting it after a >2 second delay. This will add an extra charge of about 1 or 2% to the battery. Repeatedly "topping-up" the batteries will not cause damage to the batteries as the 4700 contains safeguards against this.
- It is not recommended to fully discharge the batteries. The 4700 includes circuitry to protect the batteries from full discharge and to rebalance their charge afterwards. If the batteries become fully discharged then the user is recommended to maintain an external supply to the 4700 for at least 24 hours to ensure that the batteries are charged and rebalanced properly, otherwise the user may not be able to charge the batteries to their full capacity. During this time you may notice the CHG indicator showing more than one charge cycle being performed (i.e. the indicator returns to the charging state sometime after being in the completed state), this is normal as more charge is automatically put into the batteries as they become balanced.
- The battery indicator in the POWER button of the 4700 (when powered on) should only be used as an approximate guide for the charge state of the batteries.
- The user must take appropriate precautions when replacing the batteries in the battery pack as this can cause the batteries to become unsafe. If the batteries no longer operate properly (i.e. fail to retain charge or fail to receive charge) then the entire battery pack should only be replaced by one purchased from ViTREK or both batteries should be replaced using off the shelf tabbed 18650 Li-Ion batteries.
- If a battery pack is removed from the 4700 then it must be stored or shipped in a fully enclosing NON-CONDUCTIVE wrapping (e.g. a non-conductive plastic bag).

SECTION 6 – CONNECTING INTERFACES

This section describes how to connect to each interface.

For programming information using an interface to control the 4700 see SECTION 7 – PROGRAMMING VIA AN INTERFACE.

CONTROLLING THE 4700 BY THE RS232 INTERFACE

SPECIFICATIONS

Baud Rate	9600, 19200, 57600 or 115200
Handshake	Bi-directional, hardware (RTS/CTS)
Data Bits	8
Parity	None
Start/Stop Bits	1
Connector	9-pin Male Dsub
Interface Pinout	DTE (same as PC computer)
Cable required	9-wire female-female null modem cable, fully wired
Cable Length	<50ft (per standard)

CONNECTIONS

Using a RS232 cable supplied by ViTREK, connect the RS232 port on the 4700 rear panel to the RS232 (Serial) port of a computer. The user may supply their own cable, in which case it should be a 9-wire female-female null modem cable capable of full handshake 115200baud operation.

CONTROLLING THE 4700 BY THE GPIB INTERFACE

CONNECTIONS

Using a standard GPIB cable connect the GPIB port on the 4700 rear panel to the GPIB port of a computer. It is recommended to use a high quality, shielded GPIB cable. Cables may be purchased from ViTREK.

CONTROLLING THE 4700 BY THE LAN INTERFACE

SPECIFICATIONS

Interface	Ethernet 10baseT or 100baseTX, auto-selected
Duplex	Half or full-duplex, auto-selected
MDI/MDIX	Auto-selected
Protocols	ICMP, ARP, DHCP, TCP/IP (IPv4 only)
TCP Port	10733
Remote Connections	Only one remote connection is allowed at any given time
Connector	RJ45
Cable required	CAT5 or CAT5e, UTP or STP
Cable Length	<100m (per standard)

CONNECTIONS

The 4700 connects to the local network using a standard CAT5 or CAT5e Ethernet cable and RJ45 connector.

PRINTING FROM THE 4700 USING THE USB INTERFACE

SPECIFICATIONS

Printer Class	Printer must be a “Printer” USB Class device
Printer Language	PJL/PCL (HP)
USB Speed	Full Speed
Hub	Not supported

Many printers meet the requirements above; ViTREK has tested the 4700 with the HP OfficeJet Pro 8000 Series and the HP LaserJet 2420. The 4700 is generally not compatible with multi-purpose printers (e.g. “All-in-One” types).

CONNECTING

The printer should be connected to the 4700 USB Printer port using a standard USB cable of any suitable length. The printer must be directly connected to the 4700; a hub must not be used.

SECTION 7 – PROGRAMMING VIA AN INTERFACE

The 4700 may be programmed via the RS232, GPIB or LAN interface. All use the same general format for commands and query responses. All data uses the standard 7-bit ASCII character set. In general all activities are independent for each interface.

There are two types of command –

- Commands which do not have a response. These always cause the 4700 to take an action.
- Commands which have a response (these are named Query commands in this document). These generally do not cause the 4700 to take an action other than sending back the response. These all have a keyword which ends with the ? character.

Throughout this section reference is made to several special ASCII characters –

<CR> the carriage return character

<LF> the line feed character

<FF> the form feed character

<TAB> the tab character

<SPACE> the space character

Throughout this section reference is made to whitespace characters, the **<SPACE>** and **<TAB>** characters are considered whitespace characters.

Throughout this section reference is made to data field formats, these are described in more detail later in this section –

<EMPTY> is an empty field, containing nothing other than optional whitespace characters

<STRING> is a general string of ASCII characters

<NR1> is an integer numeric

<NR3> is a floating point numeric

<BOOL> is a boolean, indicating true or false

LOCAL AND REMOTE OPERATION

When the 4700 receives a command from the enabled interface the screen disallows many of the configuration buttons and replaces them with a single button which allows the user to return the 4700 to LOCAL operation. If the 4700 has been enabled to return to the local state by the controlling interface then the standard set of buttons will return if this is pressed.

GENERAL COMMAND SYNTAX

Every command takes the form of a set of one or more fields; each field is separated from the next by a field separator. The first field is always the command keyword, the remaining fields and their syntax depends on the command keyword.

Multiple commands can be transferred as a single set of commands; each command is separated from the next by a command separator. If there are multiple query commands in a single set then each response is given as separate fields in the overall response, which is not transmitted until all commands in the set have been successfully actioned. Commands are always actioned in the same order as they are received.

The end of a set of commands is denoted by the inclusion of a command terminator. Sets of commands are always actioned in the same order as they are received.

Received characters on each interface are buffered from the actual communications stream, the contents of the buffer being decoded and actioned when a command terminator is found in the stream. The maximum length of a set of commands is 1023 characters.

The 4700 does not raise an error if an empty set of commands is received, i.e. if there are two or more consecutive command terminators. This is effectively a "do nothing" set of commands.

The 4700 does not raise an error if an empty command is received within a set of commands, i.e. there are two or more consecutive command separators, or a command separator is immediately followed by a command terminator. This is effectively a "do nothing" command.

If an error is found in a set of commands, then processing of the set of commands is terminated and the remainder of the set of commands is not decoded or actioned. There is never any response from a set of commands which contains an error, even if the erroneous command was after a query command in the set.

FIELD SYNTAX

Except for the **<STRING>** format data field (see below), any field may optionally start and/or end with one or more whitespace characters.

Fields within a command are position dependent, i.e. the exact order is defined for each command. There are two types of fields in a command -

1. COMMAND KEYWORD. Although all command keywords are shown using uppercase characters in this document, lowercase characters may be used if desired. Command keywords must exactly match the defined set for the 4700. The first field in a command is always the command keyword.
2. DATA. There are several types of data, the type used is dependent on the field -
    a. **<EMPTY>.** This is a field containing no, or only whitespace, characters between the enclosing separators. In many commands the user may give an empty field where another format is expected, this generally has a specific effect defined in the description for each command.
    b. **<BOOL>**. This can be the single character "Y" or '1' denoting a true state, or the single character 'N' or '0' denoting the false state (the Y or N may be upper- or lower-case).
    c. **<NR1>**. One of three methods may be used to define a **<NR1>** field-
        i. Decimal value. A string of numeric (0 through 9) characters defining a decimal number without polarity or decimal point (e.g. "123" defines the decimal number one hundred and twenty three). A value greater than 4294967295 is a syntax error.
        ii. Hexadecimal value. The user can optionally start this field with the characters "0X" or the single character "X" (in both cases the "X" character can also be lowercase), in which case the following data defines the number in hexadecimal format using the numeric characters and the letters A through F (either upper- or lowercase), as an example 0x12 defines the decimal numeric value 18. A value greater than 0xffffffff is a syntax error.
        iii. Binary value. The user can optionally start this field with the characters "0B" or the single character "B" (in both cases the "B" character can also be lowercase), in which case the following data defines the number in binary format using the "0" and "1" characters only with the most-significant bit being defined first, as an example 0b00010010 defines the decimal numeric value 18 or hexadecimal value 0x12. In all cases, leading digits or bits which are not defined are assumed to be zero (e.g. 0b00010010 is the same as 0b10010). A value greater than 32 bits is a syntax error.

d. **<NR3>**. This is a string of characters defining a floating point numeric value, optionally having a polarity, and/or a decimal point, and/or an exponent. Within the limitations of the 4700 command input buffer, there is no limitation on the number of numeric characters before the decimal, after the decimal or in the exponent. There may be none or one polarity character and, if present, it must be the first character in the field. If an exponent is required then it may be defined immediately following the mantissa in one of two ways, either a) an upper- or lowercase 'E' character followed by an optional exponent polarity character (+ or -) followed by the integer exponent (in **<NR1>** format), or b) a single character (case sensitive) explicitly defining the exponent which may be one of the characters T (+12), G (+9), M (+6), K (+3), k (+3), m (-3), u (-6), n (-9) or p (-12). Examples include –
    i. "12". Defines the floating point value +12.0. A **<NR1>** syntax numeric can always be used to define a **<NR3>** value.
    ii. "-12". Defines the floating point value -12.0.
    iii. "1.2345". Defines the floating point value +1.2345.
    iv. "12.45e+1". Defines the floating point value +124.5.
    v. "12.45e+01". Defines the floating point value +124.5.
    vi. "12.45e1". Defines the floating point value +124.5.
    vii. "12.345K". Defines the floating point value +12345.0.

e. **<STRING>**. This can be any combination of printable ASCII characters (including whitespace characters). To include a separator character in a **<STRING>** the user must immediately precede the character with the / character. Any character immediately following a / character is taken "literally" and included in the **<STRING>** and the / character is discarded.

FIELD SEPARATOR

Fields are separated by the comma character.

COMMAND SEPARATOR

Commands are separated by the semi-colon character.

COMMAND TERMINATOR

A command (or set of commands) is terminated by any of the following-

- A line-feed character (shown in this document as <LF>).
- A carriage return character (shown in this document as <CR>).
- A form feed character (shown in this document as <FF>).
- (GPIB only) Any data byte with EOI asserted.
- (GPIB only) Reception of the GET bus command.

GENERAL RESPONSE SYNTAX

Multiple query commands may be included in the same set of commands, in which case the overall response will include each requested response, separated by the comma character, in the order defined in the set of commands. A response is always terminated with a <CR> character followed by a <LF> character (with EOI asserted for the GPIB interface). If the response is over 4095 characters in total length then an error is raised and no response is given. For the GPIB interface only, a space character is appended to the start of each set of responses (including a blank response).

On the RS232 and Ethernet interfaces any response is transmitted as soon as the set of commands containing one or more query commands is completely decoded.

On the GPIB interface the user must take some action to receive the response from the 4700 (i.e. a READ bus operation). If a read operation is performed when there is no data to be transmitted then a blank data is transmitted (i.e. a single space character followed by <CR><LF>).

If another set of commands is decoded containing a query command prior to the 4700 fully transmitting a prior response then the new response is not provided and an error is raised.

The following types of responses are given-

- **<BOOL>.** This is a single character '0' indicating the false condition or '1' indicating the true condition. This is always 1 character in length.
- **<STRING>**. This is one or more printable ASCII characters. This has a variable number of characters in length, and may be of no length.
- **<NR1>.** This is one or more decimal characters defining a decimal numeric value. If the polarity is positive then no polarity character is included, otherwise the data starts with the minus character. This has a variable number of characters in length.
- **<NR3>.** This is always 12 characters in length, and is of the following format (in the order shown)-
    - A single polarity character (either + or -).
    - Six decimal characters with a decimal point character contained within them (i.e. a total of seven characters) indicating the mantissa value.
    - The single 'E' (always uppercase) character.
    - A single polarity character (either + or -) indicating the polarity of the exponent.
    - Two decimal digit characters indicating the value of the exponent. For clarity in engineering use the exponent is always divisible by 3.

DELAYS AND TIMEOUTS

The user does not need to perform any delays between sets of commands, or between a set of commands containing query commands and reading the response. The 4700 automatically handshakes the commands as needed. The only exception to this is following application of power to the 4700 in which case a minimum delay of 3 seconds is required prior to operation of the interfaces.

The maximum length of time for which the 4700 will "hold-off" a set of commands (e.g. waiting for a previous set of commands to be decoded) is 100ms.

For all interfaces, responses to query commands are generally transmitted within a very short period of time, however in some circumstances there may be some delay enforced by the 4700. The user should use a timeout of no less than 100ms for responses.

GPIB BUS COMMANDS

Most standard GPIB bus commands are implemented in the normal fashion, however some cause a special activity in the 4700-

DEVICE CLEAR (SDC AND DCL)

Either of these cause the 4700 to clear all interface buffers and all interface status registers.

INTERFACE CLEAR (IFC)

This causes the 4700 to clear all interface buffers and clear all interface status registers.

GROUP EXECUTE TRIGGER (GET)

This can be used as a GPIB interface command terminator.

ETHERNET SESSIONS

The Ethernet interface uses TCP/IP as its' transport protocol which is a session based protocol. The computer is the session client and the 4700 is the session server, so each session is managed by the computer.

The 4700 is only allowed to have one session active at a time. The active session is established between the 4700 and the opening combination of the client IP address and TCP port (this combination is often called a "socket").

With most operating systems (e.g. Windows) the management of sessions is transparent to the user, being entirely handled by the OS. The user only needs to program –

- Initiating a session (opening the connection).
- Sending and receiving ASCII data to and from the respective streams.
- Closing the session.

If the 4700 is power cycled then it will power up with no active session. The user should employ timeouts to detect that the 4700 has become off-line and restart the session.

If a session is inactive for more than 1 minute then the 4700 will allow a session to be initiated from a different source, automatically closing the inactive session if a new session is started. This prevents a potential lockup if the user does not close an active session properly.

STATUS REGISTERS

There are several status registers associated with the 4700 interfaces.

STB AND SRE REGISTERS

The value of the STB register is logically ORed with the value of the SRE register; if the result is non-zero then the GPIB SRQ line is asserted if the GPIB interface is enabled. The STB register is read by the GPIB interface when a serial poll bus command is performed.

The SRE register may be read or written by commands; the STB register is read-only except that it is cleared whenever it is read and by the *CLS and *RST commands.

Although primarily intended for the GPIB interface, the STB register is also useful in all interfaces to determine when new measurement results become available.

They are 8-bit registers (i.e. has values from 0 to 255). Each bit is defined as follows –

- Bit 0, decimal value 1, binary value 00000001 – set when new measurement data becomes available, in the STB register it is cleared when the register is read (either by command or GPIB serial poll).
- Bit 1, decimal value 2, binary value 00000010 – not used, always 0.
- Bit 2, decimal value 4, binary value 00000100 – not used, always 0.
- Bit 3, decimal value 8, binary value 00001000 – not used, always 0.
- Bit 4, decimal value 16, binary value 00010000 – not used, always 0.
- Bit 5, decimal value 32, binary value 00100000 – not used, always 0.

- Bit 6, decimal value 64, binary value 01000000 – as defined by IEEE488.1, set if the 4700 is asserting the SRQ line, otherwise it is cleared. Always zero for the SRE register.
- Bit 7, decimal value 128, binary value 10000000 – not used, always 0.

OPC REGISTER

This is an 8-bit register (i.e. has values from 0 to 255). All of the bits in this register are cleared when read by the user. Each bit is defined as follows –

- Bit 0, decimal value 1, binary value 00000001 – set when a command set is decoded without error.
- Bit 1, decimal value 2, binary value 00000010 – set when a command is decoded with a field count error.
- Bit 2, decimal value 4, binary value 00000100 – set when a command is decoded with an internal memory error.
- Bit 3, decimal value 8, binary value 00001000 – set when a command is decoded with a field syntax or data range error.
- Bit 4, decimal value 16, binary value 00010000 – set when a command is decoded with a compatibility error.
- Bit 5, decimal value 32, binary value 00100000 – set when a query command is decoded but there is insufficient room in the output buffer for the response.
- Bit 6, decimal value 64, binary value 01000000 – set when the command buffer is overflowed.
- Bit 7, decimal value 128, binary value 10000000 – set when a command is received with a command word that is not known to the 4700, or the command cannot be processed at this time.

ESR REGISTER

This is an 8-bit register (i.e. has values from 0 to 255). All of the bits in this register are cleared when read by the user. Each bit is defined as follows –

- Bit 0, decimal value 1, binary value 00000001 – set when a command is decoded and an error occurred during decode.
- Bit 1, decimal value 2, binary value 00000010 – set when a query command is decoded but the response is too long for the response buffer.
- Bit 2, decimal value 4, binary value 00000100 – not used, always 0.
- Bit 3, decimal value 8, binary value 00001000 – not used, always 0.
- Bit 4, decimal value 16, binary value 00010000 – set when an internal fault is detected.
- Bit 5, decimal value 32, binary value 00100000 – not used, always 0.
- Bit 6, decimal value 64, binary value 01000000 – not used, always 0.
- Bit 7, decimal value 128, binary value 10000000 – not used, always 0.

ERR REGISTER

This is a numeric value register. The value is cleared to zero when read by the user. The value is set according to the success or failure of the last decoded command on this interface. The possible values of this register are defined as follows –

0. The command was decoded without error.
1. The command could not be decoded at this time.
2. The command is not compatible with this specific instruments' capability.

3. The command contained a numeric value field which was outside of the allowable range.
4. The command contained a field which did not have the correct syntax.
5. The command did not contain an expected field.
6. The command contained additional fields than expected.
7. The command keyword was not recognized.
8. The 4700 had an internal memory error while executing the command.
9. The previous response had not yet been transmitted when this query command was executed.
10. The set of commands was too long, over 1023 characters.

COMMANDS

Command	Description
Register Commands	
*CLS	Clears the STB, SRE, OPC, ESR and ERR registers. Resets the front panel to the LOCAL state.
*ESR?	Responds with a <NR1> field value of the ESR register then clears the ESR register
*ERR?	Responds with a <NR1> field value of the ERR register then clears the ERR register
*OPC?	Responds with a <NR1> field value of the OPC register then clears the OPC register
*STB?	Responds with a <NR1> field value of the STB register then clears the STB register
*SRE?	Responds with a <NR1> field value of the SRE register
*SRE,<NR1>	Sets the SRE register
Measurement Query Commands	
DCV?	Responds with the latest <NR3> DC voltage measurement result (in Volts)
ACV?	Responds with the latest <NR3> AC voltage measurement result (in Volts)
FREQ?	Responds with the latest <NR3> frequency measurement result (in Hz)
PKPK?	Responds with the latest <NR3> peak-to-peak voltage measurement result (in Volts)
CF?	Responds with the latest <NR3> AC Crest Factor measurement result
Charted Measurement Query Commands	
CHARTDC?,<NR3>	Responds with the status and value of the charted DC measurement at the requested percentage of the chart time span – 1st field : <BOOL> indicating if any valid measurements where at this percentage or not. 2nd field : <NR3> the DC measurement result
CHARTAC?,<NR3>	Responds with the status and value of the charted AC measurement at the requested percentage of the chart time span – 1st field : <BOOL> indicating if any valid measurements were at this percentage or not. 2nd field : <NR3> the AC measurement result
Probe Attachment Query Commands	
HIPROBE?	Responds with a <STRING> representing the type of probe attached to the HI PROBE connector (NONE if none).
LOPROBE?	Responds with a <STRING> representing the type of probe attached to the LO PROBE connector (NONE if none).
DC Zero Command	
DCZERO	Commands a DC ZERO Offset operation

Command	Description
Configuration Settings Query Commands	
MODE?	Responds with a <STRING> corresponding to the present MODE setting (PRECISE, FAST20, FAST16 or RIPPLE)
DIGITS?	Responds with a <NR1> corresponding to the present display resolution limit setting (4 through 6)
BAND?	Responds with a <NR1> corresponding to the present BAND setting 0 : 30-600Hz 1 : 10-150Hz 2 : 1-75Hz 3 : 0.1-35Hz 4 : 0.01-2Hz
AVERAGE?	Responds with a <NR1> corresponding to the present AVERAGE setting (0 is the fastest for the specific mode and bandwidth, 3 is the longest averaging period)
Chart Control Commands and Queries	
CHARTMEAS,<STRING>	Sets the displayed chart to either the DC or AC measurements. Also sets the automatic start measurement.
CHARTTSPAN,<NR1>,<STRING>	Sets the chart time span value (<NR1>) and units (STRING>, SECS, MINS, HOURS, or DAYS)
CHARTTSPAN?	Responds with the chart time span value and units 1st field : <NR1> time span value 2nd field : <STRING> time span units (SECS, MINS, HOURS or DAYS)
CHARTVSPAN,<NR3>	Sets the chart voltage span to the passed value (in Volts)
CHARTVOFFSET,<NR3>	Sets the chart voltage offset to the passed value (in Volts)
CHARTCURSOR,<NR3>	Sets the chart cursor position to the passed percentage of the time span (negative value turns off the cursor)
CHART,<STRING>	CHART,CLEAR : clears the chart data CHART,START : Starts a chart data collection immediately CHART,AUTO : Starts chart data collection using the AUTO mode CHART,STOP : Stops chart data collection
CHART?	Responds with a <NR1> indicating the present state of chart data collection : 0 : Empty 1 : Arming 2 : Armed 3 : Running 4 : Stopped
Configuration Settings Commands	
MODE,<STRING>	Sets the measurement mode to PRECISE, FAST20, FAST16 or RIPPLE.
DIGITS,<NR1>	Sets the maximum displayed digits in the main screen (4 through 6). This does not affect the resolution of results obtained via the interface; those are always at maximum resolution.
BAND,<NR1>	Sets the present BAND setting to the <NR1> value 0 : 30-600Hz 1 : 10-150Hz 2 : 1-75Hz 3 : 0.1-35Hz 4 : 0.01-2Hz
AVERAGE,<NR1>	Sets the AVERAGE setting to the <NR1> value code (0 is the fastest for the specific mode and bandwidth, 3 is the longest averaging period)
Identification Commands	

Command	Description
*IDN?	Responds with a set of <STRING> fields describing the product 1st field : VITREK 2nd field : 4700 3rd field : Main firmware revision 4th field : 2nd firmware revision 5th field : 3rd firmware revision
Misc. Commands	
*RST	Resets the interface
LOCAL	Sets the front panel into the LOCAL state
LOCKOUT	Sets the front panel into the REMOTE LOCK-OUT state

SECTION 8 - PERFORMANCE VERIFICATION AND ADJUSTMENT

The 4700 has been designed to give many years of service without needing calibration and is fully specified for 1 year between calibrations.

There are three strategies recommended for periodic performance verification/adjustment of the 4700. Which one is selected by the user depends on the users specific requirements regarding quality level and the availability of equipment.

- Periodic Adjustment Calibration Only. This is the simplest of the strategies, while it gives the typical user a reasonable degree of certainty that the 4700 is performing to its specifications, it does not cross-check that the calibration technique was performed correctly and does not account for some (rare) possible malfunctions in the 4700.
- Periodic Adjustment followed by Verification. With this strategy the user ensures that the 4700 was within specification as received by performing the adjustment calibration and checking that the adjustments are within the product specification, then checking that the calibration was correctly performed and checking for the rare possible 4700 malfunctions by means of the post-adjustment verification. This completely ensures that the outgoing 4700 meets its' specifications but leaves the possibility of an error made during the adjustment calibration leading to the incorrect indication that the incoming 4700 did not meet specifications.
- Periodic Verification – Adjustment – Verification. This is the most complete strategy, but is also the most costly in time. The time cost can be reduced by performing the initial verification and then only performing the Adjustment – Verification components if the initial verification indicates that it is necessary (as an example, only perform if beyond some percentage of specification in the initial verification).

CALIBRATION OF A 4700 AND PROBE(S)

As specified in the Specifications section of this manual, there is a slight difference in the overall accuracy between using any probe with any 4700, and using a probe with the 4700 which was used for calibrating the probe.

If both a 4700 and probe(s) are to be calibrated together then the 4700 must be calibrated first, and then the probe should be calibrated with that 4700.

ADJUSTMENT CALIBRATION (4700)

The 4700 employs internal software calibration adjustments, there are no physical adjustments required. The adjustment calibration procedure for the 4700 is an internally prompted sequence.

Please take note of the following–

- The 4700 should be externally powered and turned on for at least 10 minutes (1 hour is recommended) prior to being calibrated. Initially there should be no connections to any of the 4700 terminals and it is recommended to not have any connections to the interface ports during the procedure.
- Ensure that the chassis of the 4700 is grounded at all times during calibration.
- In many cases the same accuracy determining circuitry is used in several different modes of operation. As an example, there is no difference between the DC and AC voltage modes of operation in the accuracy determining circuitry of the 4700. Because of this the entire product can be calibrated with complete certainty by only a few fairly simple calibrations.

EQUIPMENT REQUIRED

The applied voltages and currents do not need to be exactly the requested value; the user only needs to know the actual value. Generally the actual level only needs to be within ±10% of the requested value.

1. A source of +200V, +500V and +1000V DC. This must have an accuracy of better than 0.008% (80ppm) for a 4:1 accuracy ratio.
2. (Optional) A source of +3000V DC. This must have an accuracy of better than 0.008% (80ppm) for a 4:1 accuracy ratio. If this voltage cannot be provided, or insufficient accuracy is available at this voltage level, then optionally a 1000V DC source may be used, which must have an accuracy of better than 0.004% (40ppm) for a 4:1 accuracy ratio.
3. A source of DC current at levels of 2uA, 20uA, 100uA and 200uA. This must have an accuracy of better than 0.005% (50ppm) + 0.1nA for a 4:1 accuracy ratio. Please note the following-
    a. Although each current must be with 50ppm + 0.1nA, the ratio between any two currents must also be within 50ppm + 0.1nA. If this is not observed then the 4700 may be mis-calibrated.
    b. Most readily available calibration equipment does not meet the accuracies required.
    c. Using a voltage source, resistor and a current meter generally will not achieve these accuracies as the common-mode leakage current of most DC current meters is not specified.
    d. The easiest and most accurate method to generate these currents is to use a 5MΩ resistor with a well-known value capable of withstanding 1000V with minimal voltage coefficient and self-heating errors and an accurate DC voltage source of between 10V and 1000V. The combination of the errors of the DC voltage source, the known value of the 5MΩ resistor, and any self-heating and voltage coefficient errors in the resistor must be <50ppm (which can be readily attained). If used in this manner then the actual current must be calculated from the applied voltage and the known 5MΩ value plus 24.99KΩ.
4. An 8-pin Mini-DIN connector suitable for plugging into the PROBE 1 and 2 inputs to the 4700 front panel. These are available from ViTREK.

PROCEDURE

Follow the prompts in the display of the 4700 for the actual procedure as changes may be made in future releases of the 4700 firmware to enhance accuracy.

1. On the Configuration Screen, press the CALIBRATE key.
2. The 4700 screen now prompts the user for entry of the Calibration Password. The standard password is 12169, but this may be changed by the user (contact ViTREK for details regarding how to do this).
3. Press the ADJUST 4700 key on the screen.
4. As requested on the screen of the 4700, provide the requested voltage or current to the designated terminals and perform the requested adjustments, note the following-
    a. The applied voltage or current does not need to be exactly the requested value, the user only needs to know the actual value and then adjust the reading to match as closely as possible the actual value. Generally the actual level only needs to be within ±10% of the requested value.
    b. If the displayed measurement is shown in ORANGE or RED this indicates that the result is near to, or outside (respectively) the expected values. If the value is shown in RED then the 4700 cannot be calibrated at this level.
    c. The user may change the amount by which the adjustment is stepped. Except in rare cases, only the finest adjustment increment should be needed.

d. If the ABORT CAL button is pressed during calibration then the calibration is aborted and any adjustments made are discarded. Adjustments are not actually saved until the entire procedure is successfully accomplished.

e. The source of the applied voltages must have its' LO terminal either grounded or within a few volts of ground.

f. The source of the applied currents should be floating with respect to ground (the 4700 will ground the source LO terminal).

ADJUSTMENT CALIBRATION (PROBE)

The 4700 probes employ internal software calibration adjustments, there are no physical adjustments required. The adjustment calibration procedure for the 4700 probe is an internally prompted sequence.

Calibration of a probe requires the use of a 4700 which has very recently been calibrated.

Please take note of the following–

- The 4700 should be externally powered and turned on for at least 10 minutes (1 hour is recommended) prior to being calibrated. Initially there should be no connections to any of the 4700 terminals and it is recommended to not have any connections to the interface ports during the procedure.
- Ensure that the chassis of the 4700 is grounded at all times during calibration.
- Ensure that there is sufficient open space around the probe and that the High Voltage Lead is routed as recommended. See the relevant SPECIFICATIONS section for details for the specific probe model being calibrated.

EQUIPMENT REQUIRED

The applied voltages and currents do not need to be exactly the requested value; the user only needs to know the actual value. Generally the actual level only needs to be within ±10% of the requested value.

1. (All except HVL-xxG series probes). A source of +1000V DC. This must have an accuracy of better than 0.01% (100ppm) for a 4:1 accuracy ratio. Optimally this should be the same 1000V DC source used for calibration of the 4700.
2. (HVL-xxG probes). A source of +10000V DC. This must have an accuracy of better than 0.05% (500ppm) for a 4:1 accuracy ratio.
3. (All except HVL-xxG series probes). A source of 1000Vrms at a frequency between 40 and 80Hz. This must have an amplitude accuracy of better than 0.025% (250ppm) for a 4:1 accuracy ratio. Best results are obtained if the frequency is chosen to be other than the local line frequency (e.g. use 50Hz in 60Hz environments and vice versa). The same frequency as local line power can be used but the user should ensure they watch the displayed reading for at least 1 minute at each calibration point to ensure that the source or wiring does not have significant line related interference which will beat with the applied frequency, and may need to average this beat – which may lead to errors in calibration.
4. (All except HVL-xxG series probes). A source of 1000Vrms at a frequency between 100 and 400Hz. This must have an amplitude accuracy of better than 0.025% (250ppm) at 100Hz or 0.15% (1500ppm) at 400Hz for a 4:1 accuracy ratio. For all except the HVL-100, a frequency of 400Hz is strongly recommended, for the HVL-100 a frequency of 100Hz should be used.

PROCEDURE

Follow the prompts in the display of the 4700 for the actual procedure as changes may be made in future releases of the 4700 firmware to enhance accuracy.

1. Do not attach the probe to the 4700 until prompted to do so.
2. On the Configuration Screen, press the CALIBRATE key.
3. The 4700 screen now prompts the user for entry of the Calibration Password. The standard password is 12169, but this may be changed by the user (contact ViTREK for details regarding how to do this).
4. Press the ADJUST PROBE key on the screen.
5. As requested on the screen of the 4700, provide the requested voltage to the tip of the probe and perform the requested adjustments, note the following-
    a. Avoid excessive movement around the calibration area, particularly when calibrating HVL-100 or any HVL-xxG series probes. This is of particular importance immediately after the probe has been requested to be connected as the 4700 performs zero checks during that time. It is best to observe anti-static procedures (e.g. wear a grounding strap) as this significantly reduces the effects of movement on the readings.
    b. At all times the probe must have sufficient free space around it and the high voltage wiring must be routed as described in the relevant specifications section of this manual. Probes which have an anti-corona toroid MUST be calibrated with the toroid in place. It is recommended that there be at least 2ft of free space all around the probe. For a HVP-35 probe the probe MUST be stood in a probe stand, under no circumstances should the probe be resting on or against anything.
    c. The applied voltage does not need to be exactly the requested value, the user only needs to know the actual value and then adjust the reading to match as closely as possible the actual value. Generally the actual level only needs to be within ±10% of the requested value.
    d. The source of the applied voltages must have its' LO terminal either grounded or within a few volts of ground.
    e. If the displayed measurement is shown in ORANGE or RED this indicates that the result is near to, or outside (respectively) the expected values. If the value is shown in RED then the 4700 cannot be calibrated at this level.
    f. The user may change the amount by which the adjustment is stepped. Except in rare cases, only the finest adjustment increment should be needed.
    g. If the ABORT CAL button is pressed during calibration then the calibration is aborted and any adjustments made are discarded. Adjustments are not actually saved until the entire procedure is successfully accomplished.
    h. Take careful note that there should be very little (if any) adjustment needed for the 1000V (40-80Hz) adjustment. This adjustment is to allow for the slight AC/DC difference error caused by the mechanical construction of the probe, which should never significantly change. If a significant difference is noted then it is more likely that there is a mis-adjustment in the calibration voltage sources being used or that there is insufficient free space around the probe.

VERIFYING CALIBRATION (4700)

The 4700 has a built-in prompted verification procedure which may be followed by the user. In some circumstances the user may wish to not use this built-in procedure, but use their own. If the user uses their verification procedure then the accuracy of the probe inputs cannot be verified. This document describes how to use the built-in prompted verification procedure.

Please take note of the following–

- The 4700 should be externally powered and turned on for at least 10 minutes (1 hour is recommended) prior to being calibrated. Initially there should be no connections to any of the 4700 terminals and it is recommended to not have any connections to the interface ports during the procedure.
- Ensure that the chassis of the 4700 is grounded at all times during calibration.
- In many cases the same accuracy determining circuitry is used in several different modes of operation. As an example, there is no difference between the DC and AC voltage modes of operation in the accuracy determining circuitry of the 4700. Because of this the entire product can be calibrated with complete certainty by fewer calibrations.

EQUIPMENT REQUIRED

The applied voltages and currents do not need to be exactly the requested value; the user only needs to know the actual value. Generally the actual level only needs to be within ±10% of the requested value.

1. A source of +100V, +200V, +500V, +1000V, and -1000V DC. This must have an accuracy of better than 0.0075% (75ppm) + 8mV for a 4:1 accuracy ratio.
2. A source of +4000V and +9000V DC. These must have an accuracy of better than 0.0087% (87ppm) and 0.0107% (107ppm) respectively for a 4:1 accuracy ratio.
3. A source of 500Vrms and 1000Vrms at a frequency between 40 and 80Hz and at 400Hz (1000Vrms only). These must have an amplitude accuracy of better than 0.025% (250ppm) at 40-80Hz and 0.15% (1500ppm) at 400Hz for a 4:1 accuracy ratio. Best results are obtained if the frequency is chosen to be other than the local line frequency (e.g. use 50Hz in 60Hz environments and vice versa). The same frequency as local line power can be used but the user should ensure they watch the displayed reading for at least 1 minute at each calibration point to ensure that the source or wiring does not have significant line related interference which will beat with the applied frequency, and may need to average this beat – which may lead to errors in calibration.
4. A source of 9000Vrms at a frequency between 40 and 80Hz. This must have an amplitude accuracy of better than 0.028% (280ppm) for a 4:1 accuracy ratio. Best results are obtained if the frequency is chosen to be other than the local line frequency (e.g. use 50Hz in 60Hz environments and vice versa). The same frequency as local line power can be used but the user should ensure they watch the displayed reading for at least 1 minute at each calibration point to ensure that the source or wiring does not have significant line related interference which will beat with the applied frequency, and may need to average this beat – which may lead to errors in calibration.
5. A source of DC current at levels of 1uA, 2uA, 10uA, 20uA, 100uA and 200uA. This must have an accuracy of better than 0.005% (50ppm) + 0.1nA for a 4:1 accuracy ratio. Please note the following-
    a. Most readily available calibration equipment does not meet the accuracies required.
    b. Using a voltage source, resistor and a current meter generally will not achieve these accuracies as the common-mode leakage current of most DC current meters is not specified.
    c. The easiest and most accurate method to generate these currents is to use a 5MΩ resistor with a well-known value capable of withstanding 1000V with minimal voltage coefficient and self-heating errors and an accurate DC voltage source of between 5V and 1000V. The combination of the errors of the DC voltage source, the known value of the 5MΩ resistor, and any self-heating and voltage coefficient errors in the resistor must be <50ppm (which can be readily attained). If used in this manner then the actual current must be calculated from the applied voltage and the known 5MΩ value plus 24.99KΩ.
6. An 8-pin Mini-DIN connector suitable for plugging into the PROBE 1 and 2 inputs to the 4700 front panel. These are available from ViTREK.

PROCEDURE

Follow the prompts in the display of the 4700 for the actual procedure as changes may be made in future releases of the 4700 firmware to enhance accuracy.

1. On the Configuration Screen, press the CALIBRATE key.
2. The 4700 screen now prompts the user for entry of the Calibration Password. The standard password is 12169, but this may be changed by the user (contact ViTREK for details regarding how to do this).
3. Press the VERIFY 4700 key on the screen.
4. As requested on the screen of the 4700, provide the requested voltage or current to the designated terminals and note the readings on the 4700 display, note the following-
    a. The applied voltage or current does not need to be exactly the requested value, the user only needs to know the actual value.
    b. If the displayed measurement is shown in ORANGE or RED this indicates that the result is near to, or outside (respectively) the expected values. If the value is shown in RED then the 4700 should not be calibrated at this level.
    c. The source of the applied voltages must have its' LO terminal either grounded or within a few volts of ground.
    d. The source of the applied currents should be floating with respect to ground (the 4700 will ground the source LO terminal).
    e. For the CMRR steps, the voltage shown represents the residual error, so should not be compared to the actual applied voltage directly.

VERIFYING CALIBRATION (PROBE)

The user should verify the calibration of a probe by using the 4700 and probe together in a normal, single probe manner. The 4700 should be configured for PRECISION mode, 30-600Hz BAND, 1 second (or more) AVERAGE and 6 DIGITS maximum display resolution.

Calibration of a probe requires the use of a 4700 which has very recently been calibrated.

Please take note of the following–

- The 4700 should be externally powered and turned on for at least 10 minutes (1 hour is recommended) prior to being calibrated.
- Ensure that the chassis of the 4700 is grounded at all times during calibration.
- Ensure that there is sufficient open space around the probe and that the High Voltage Lead is routed as recommended. See the relevant SPECIFICATIONS section for details for the specific probe model being calibrated.
- Ensure the probe is connected to the PROBE 1 input of the 4700 and that there are no connections to the DIRECT or PROBE 2 connections of the 4700. Connect the common terminal of the voltage source (s) to the COMMON terminal of the 4700.
- The user must decide on the voltages to be used during probe verification. ViTREK recommends verifying at 1000V and at 10000V intervals up to the maximum allowed voltage for the probe at DC and AC at a frequency of choice. For example-
    - For a HVx-35 probe: 1000V (DC & AC), 10000V (DC & AC), 20000V (DC & AC) and 30000V (DC & AC).

  - For a HVx-70 probe: 1000V (DC & AC), 10000V (DC & AC), 20000V (DC & AC), 30000V (DC & AC), 40000V (DC & AC), 50000V (DC & AC), 60000V (DC only) and 70000V (DC only).
  - For a HVx-100 probe: 1000V (DC & AC), 10000V (DC & AC), 20000V (DC & AC), 30000V (DC & AC), 40000V (DC & AC), 50000V (DC & AC), 60000V (DC & AC), 70000V (DC & AC), 80000V (DC only), 90000V (DC only) and 100000V (DC only).
- The frequency response of the probe may also be verified. It is recommended to perform this at 1000V since the availability of higher voltage higher frequency sources is extremely limited. This should be performed at 1000Vrms at 400Hz. The frequency response of a probe is determined by mechanical constraints, so it needs only be tested at a single voltage since it has no voltage dependency.
- The frequency chosen for AC voltage verification should be carefully considered. Verifying at a frequency other than the local line frequency is recommended (e.g. using 50Hz in a 60Hz environment or vice versa) but if the same frequency as the local line frequency is chosen then consider the following-
  - If the frequency is synchronous with local line then there will be an offset in the measurement results shown by the 4700 caused by interference pickup in the probe. This offset cannot easily be estimated, but noting the AC reading when the probe input is shorted to the COMMON terminal of the 4700 may be used as an indication. As previously described in this manual, the AC zero cannot be subtracted from the displayed results. The user will need to take corrective action if the zero indication is too high.
  - If the frequency is nominally the same as the local line frequency then there will be a beat between the applied voltage and the local line frequency. The user should employ the same method as above to ensure that interference from local line is minimized and watch the displayed measurement result for at least 1 minute to ensure that the beat has little significance when making each verification reading. Averaging the readings over this time can reduce the error, but it should not be relied upon.