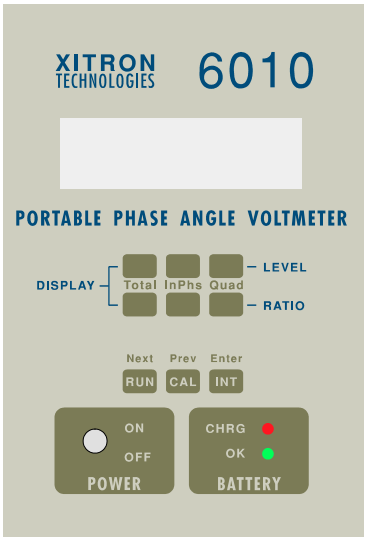
XITRON TECHNOLOGIES

6010

OPERATING INSTRUCTIONS



1. TABLE OF CONTENTS

1. TABLE OF CONTENTS 3

2. WARRANTY INFORMATION 6

3. SAFETY INFORMATION 7

4. CHANGE INFORMATION 8

5. INTRODUCTION 9

6. UNPACKING & INSTALLATION 10

6.1. Unpacking 10

6.2. Preparation For Use 10

6.3. Returning For Repair or Maintenance 10

7. SPECIFICATIONS 12

7.1. Input Specifications 12

7.1.1. General 12

7.1.2. Amplitude Accuracy 12

7.1.3. Phase Accuracy 12

7.2. General Specifications 12

7.2.1. Battery 12

7.2.2. Physical 13

7.2.3. Environmental 13

7.2.4. Digital Interface 13

7.2.5. Analog Interface 13

7.3. External Calibration 13

8. OPTIONS & ACCESSORIES 14

8.1. Main Unit 14

8.1.1. 6010 14

8.2. No Battery Option 14

8.2.1. NB 14

8.3. Interface Options 14

8.3.1. RS 14

8.3.2. IE 14

8.3.3. AN 14

8.4. Accessories 15

8.4.1. MO6010 15

8.4.2. MS6010 15

8.4.3. RC4000 15
9. REAR PANEL CONTROLS & CONNECTIONS 16
9.1. DC Power Connector 16
9.2. Input A & B Terminals 16
9.3. Interface Connectors 16
9.3.1. IE Connector 16
9.3.2. RS Connector 16
9.3.3. AN Connector 17
9.4. Interface Power Switch 17
10. GETTING STARTED 18
10.1. Preliminaries 18
11. FRONT PANEL CONTROLS 20
11.1. *POWER* Switch 20
11.2. *BATTERY* Status LEDs 20
11.2.1. CHRG 20
11.2.2. OK 20
11.3. *DISPLAY* Keys 20
11.3.1. *Total LEVEL* 20
11.3.2. *Total RATIO* 21
11.3.3. *InPhs LEVEL* 21
11.3.4. *InPhs RATIO* 21
11.3.5. *Quad LEVEL* 22
11.3.6. *Quad RATIO* 22
11.4. *RUN* Key 22
11.5. *CALIBRATE* Key 23
11.6. *INT* Key 23
12. CALIBRATION 24
12.1. External Calibration 24
12.1.1. When to Perform an External Calibration 24
12.1.2. Equipment Required for an External Calibration 24
12.1.3. Preparing for an External Calibration 24
12.1.4. Initiating an External Calibration 25
12.1.5. Calibration Against the External Standards 25
12.1.6. Completing the External Calibration 26
13. DIGITAL INTERFACING 27
13.1. RS232 Data Format Selection 27
13.2. IEEE488 Address Selection 27

13.3. Remote/Local Operation....28
13.4. Configuring the Instrument and Controller (IE only)....28
13.4.1. Configuring the Instrument....28
13.4.2. Configuring the Controller Card....29
13.4.3. Configuring the Controller Software....29
13.5. Reading Data From the 6010....31
13.6. Sending Data to the 6010....32
13.7. Special Considerations When Using Option RS....32
13.8. Special Considerations When Using Option IE....32
13.8.1. Bus Timing....32
13.8.2. Bus Commands....33
13.8.3. Other IEEE488 Specific Items....33
13.9. Command Set....33
13.9.1. DISP=*data*....33
13.9.2. EXTCAL, EXTSKIP and EXTUSE....34
13.9.3. HOLD....34
13.9.4. READ=*parameter*....34
13.9.5. RUN....35
13.10. Examples....35
13.10.1. Performing a Device Clear Operation....36
13.10.2. Reading the Value of a Parameter....36
14. ANALOG INTERFACING....39
14.1. Configuring Each Channel....39
14.1.1. Ranges for Each Parameter....39
14.2. Using the Analog Outputs....40
14.2.1. Driving Low Impedance Loads....40
15. 150 VOLT INPUT MODIFICATION....41
15.1. Input Specifications....41
15.1.1. General....41
15.1.2. Amplitude Accuracy....41
15.1.3. Phase Accuracy....41

2. WARRANTY INFORMATION

This Xitron Technologies instrument is warranteed against defects in material and workmanship for a period of two years after the date of manufacture. Xitron Technologies agrees to repair or replace any assembly or component (except batteries) found to be defective, under normal use, during this period. Xitron Technologies' obligation under this warranty is limited solely to repairing any such instrument which in Xitron Technologies' 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 Xitron Technologies.

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

Xitron Technologies assumes no responsibility for its product being used in a hazardous or dangerous manner, either alone or in conjunction with other equipment. Special disclaimers apply to this instrument, Xitron Technologies assumes no liability for secondary charges or consequential damages and, in any event, Xitron Technologies' 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 Xitron Technologies, or its' representatives, for use of its products are based upon tests believed to be reliable, but Xitron Technologies makes no warranty 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 Xitron Technologies any liability in connection with the sale of our products other than set forth herein.

INSTRUMENT SERIAL # : _____

Issue B - 2/97 MO6010

Xitron Technologies Inc., 6295 Ferris Square, Bldg. D, San Diego, CA 92121
Fax : (619) 458-9213 Voice : (619) 458-9852

3. SAFETY INFORMATION

The 6010 operates on, and measures, low voltages yielding very safe operation. When measuring signals having high voltage common mode signals (especially at high frequencies) it is highly desirable to ground the chassis of the instrument. This may be achieved by placing a direct ground connection between ground and one of the screws on the rear panel. Failure to correctly ground the chassis under these circumstances may result in capacitively coupled voltages appearing on exposed chassis components.

4. CHANGE INFORMATION

This information provides a summary of changes to the **6010** instrument. The software version of the instrument is shown during the initial power on messages. The two digits to the left of the decimal point is the revision of the main processor software, and the two digits after the decimal point is the revision of the DSP software.

MAIN SOFTWARE REVISION	DSP SOFTWARE REVISION	INTRODUCTION DATE	DETAILS OF CHANGE
10	10	7/21/92	Initial Release

5. INTRODUCTION

The **6010** offers economical phase and amplitude measurements in the 10Hz to 10KHz frequency range. With full portability and optional IEEE488, RS232 interfaces or an 8-channel Analog Output, the **6010** will find many uses in engineering, production test and field service.

The implementation of simple and infrequent front panel (covers on) external calibration, enable the user to maintain the high accuracy of the instrument with ease, and with the minimum of costly calibration equipment.

The user should read this manual before attempting to use this equipment. In particular the user should read the UNPACKING & INSTALLATION, GETTING STARTED and FRONT PANEL CONTROLS chapters.

6. UNPACKING & INSTALLATION

6.1. Unpacking

If there is visible damage to the shipping carton, you should request that the carriers' agent is present when unpacking the instrument. If the instrument appears damaged when unpacked, then notify the carriers' agent, who should then authorize repairs before returning the instrument to Xitron Technologies or an authorized service center. Even if the instrument appears undamaged, it may have suffered internal damage in transit that may not be apparent until operating the instrument. If the instrument fails to achieve its' published specifications then notify the carriers' agent and Xitron Technologies or an authorized service center and retain the shipping carton for the carriers' inspection.

A label attached to the right hand side of the instrument shows the serial number and any attached options. This label should be checked against the original order and any discrepancy should be reported to Xitron Technologies or its' authorized agent.

6.2. Preparation For Use

The **6010** instrument requires no special preparation for normal use, other than ensuring that the internal battery has sufficient charge for use.

WARNING

The Charging Module MUST be suitable for the line voltage used.

The **Preliminaries** procedure described in the **GETTING STARTED - STANDARD APPLICATIONS** Chapter should be followed to ensure correct operation of the instrument. This also ensures that the correct instrument options are fitted.

6.3. Returning For Repair or Maintenance

The **6010** is warranted against defects for two years from the date of shipment. Prior to returning any equipment to Xitron Technologies or an authorized service center, for any reason, authorization must be obtained. When contacting Xitron Technologies, please have the following information available.

- ✓ The model number of the instrument (e.g., **6010**), and any installed options.
- ✓ The serial number of the instrument.
- ✓ The nature of the problem.

Attempted repair by unqualified personnel may void your warranty. Unless otherwise specified, returns should be made freight pre-paid, with the previously obtained authorization code clearly marked on the outer surface of the packing. The owner of the instrument, the name of a person to contact, and a description of the service required, should be identified on an external "tag" or on documentation within the packaging.

If the instrument is shipped by commercial transportation for any reason, then repackage it in the original shipping carton and packing material. If these are not available, or are unfit for use, then these should be replaced by equivalent materials.

7. SPECIFICATIONS

7.1. Input Specifications

All accuracy specifications given below are valid throughout the specified operating temperature range of the instrument, for one year, following a five minute warm up period.

7.1.1. General

Frequency Range :	10Hz to 10KHz (typical performance to 20KHz).
Isolation :	Inputs are isolated from each other for voltages of up to 30Vpk. Isolation from ground (chassis), interface (if fitted), and Charging Module for voltages up to 1500Vpk..
Input Voltage Range :	Specifications are valid for input signals with RMS values between 30mV and 15V.
Max. Input Slew Rate :	Specifications are valid for input voltage signals (either series or common mode) having <300V/μs slew rate.
Measurement Period :	Approximately 0.5s.
Settling Time :	8ms.

7.1.2. Amplitude Accuracy

Resolution :	1mV for inputs up to 7.5V RMS, 10mV up to 15V RMS.	
Accuracy :	0.03 to 3.75V :	8mV + 0.8mV/KHz
	3.75 to 7.5V :	15mV + 1.5mV/KHz
	7.5 to 15V :	30mV + 3mV/KHz
Crest Factor :	Better than 2:1 at 15V RMS, increasing linearly to 250:1 at 30mV. 30V peak max. input to maintain accuracy.	
Protection :	1000V peak continuously.	
Input Impedance :	100KΩ from any terminal to the Input A Low terminal. >1000MΩ || 5000pF from the Input A Low terminal to chassis.	

7.1.3. Phase Accuracy

Resolution :	0.1°.
Accuracy :	0.5° + 0.1°/KHz + 0.01°(15/Input A level) + 0.01°(15/Input B level)
Technique :	Proprietary correlation technique computing phase shift between correlating components in both input signals.

7.2. General Specifications

7.2.1. Battery

Discharge Time :	Greater than 2.5 hours following full charge.
Charge Time :	Less than 15 hours to full charge, may be operated continuously from the Charging Module if desired.

Charging Input :	Rear Panel mounted DC charging connector, 10-16V DC @ 900mA max.
Charging Module :	115VAC 50/60Hz US wall-socket type (others also available).
Battery Type :	Sealed Lead Acid.

7.2.2. Physical

Overall Size :	4.1" (104mm) wide by 6.3" (160mm) high by 9.7" (246mm) deep.
Weight :	3lbs. (1.4Kg) in use, 5lbs. (2.3Kg) shipping.

7.2.3. Environmental

Operating :	0°C to 45°C, less than 75% RH @ 40°C (non-condensing).
Storage :	-30°C to +65°C, less than 95% RH @ 40°C (non-condensing).

7.2.4. Digital Interface

With either IEEE488 or RS232 interface, multi-instrument systems may be controlled via a single interface. Each instrument also may be controlled by individual interfaces.

IEEE488 :	Full Talk/Listen capabilities. SH1AH1T6TE0L4LE0SR1RL1PP0DC1DT1C0.
RS232 :	Full Talk/Listen capabilities. Selectable baud rate of 1200, 2400, 4800, 9600 or 19200 baud.

7.2.5. Analog Interface

Number of Channels :	8.
Output Voltage :	-5V to +5V DC. Common ground.
Resolution :	5mV.
Accuracy :	0.1% of output + 5mV.
Usage :	Each output may be independently "connected" to any displayable parameter.
Settling Time :	Within accuracy specifications <0.5 seconds following measurement period changing parameter.
Output Drive :	2mA max. load on each output, 10mA max. total load.
Output Impedance :	Less than 0.2Ω.

7.3. External Calibration

The user may command an external calibration whenever desired. A one year external calibration interval is recommended for normal use. While calibration at 23°C ambient is recommended, this may be performed at any temperature from 10°C to 35°C without degradation of accuracy specifications.

8. OPTIONS & ACCESSORIES

8.1. Main Unit

8.1.1. 6010

This is presently the only model available.

8.2. No Battery Option

8.2.1. NB

The internal battery is not fitted in the instrument with this option. This is for applications where the instrument will be operated continuously within a system and the user wishes to power down the entire system by removing the line power.

8.3. Interface Options

Any one of the following interface options may be installed.

8.3.1. RS

This option enables the **6010** to be controlled or interrogated by any RS232 interfaced computer or terminal. This interface may be connected to a modem, enabling the **6010** to be controlled or interrogated remotely, via a telephone link. Baud rates of 1200, 2400, 4800, 9600 or 19200 baud may be selected.

8.3.2. IE

This option enables the **6010** to be controlled or interrogated by any IEEE488 interfaced computer.

8.3.3. AN

This option contains eight +/-5V DC analog outputs, each of which may independently "connected" to any available data within the instrument or controlled by the IEEE488 or RS232 interface.

8.4. Accessories

8.4.1. MO6010

This option is an additional copy of this manual. If not ordered at the time of placing the order for the basic unit, please have the serial number of the unit available when ordering.

8.4.2. MS6010

This option is a full service manual, incorporating schematics, assembly diagrams, fault diagnosis aids and full servicing information. If not ordered at the time of placing the order for the basic unit, please have the serial number of the unit available when ordering.

8.4.3. RC4000

A 10ft. long RS232 cable for connecting the **RS** option to an IBM® (or compatible) RS232 serial port (either 9-pin or 25-pin).

9. REAR PANEL CONTROLS & CONNECTIONS

9.1. DC Power Connector

This connector, located on the rear panel, is the receptacle for the DC power from the Charging Module or other DC power source.

9.2. Input A & B Terminals

These terminals are located on the rear panel, two terminals per input. For details as to application specific methods of connecting to these terminals the user should refer to later chapters of this manual. The RED terminal is the HI terminal and the BLACK terminal is the LO terminal.

9.3. Interface Connectors

These connectors are only present when either option **IE**, **RS** or option **AN** is fitted in the instrument.

9.3.1. IE Connector

This is a standard IEEE488 connector, and is present if option **IE** is fitted in the instrument. A description of the usage of this connector, and the method of using the IEEE488 interface is in the **DIGITAL INTERFACING** Chapter.

9.3.2. RS Connector

This is a female 9-pin sub-miniature "D" type connector, and contains the RS232 connections for the **RS** option of the instrument. The connections are as follows.

❶ Data Carrier Detect (Output from **6010**).

❷ Transmit Data (Output from **6010**).

❸ Receive Data (Input to **6010**).

❹ Data Terminal Ready (Input to **6010**).

❺ Ground (Common return for these signals).

❻ Data Set Ready (Output from **6010**).

❼ Request To Send (Input to **6010**).

❽ Clear To Send (Output from **6010**).

❾ Ring Indicate (Output from **6010**).

A description of the usage of this connector and the RS232 interface is in the **DIGITAL INTERFACING** Chapter.

9.3.3. AN Connector

This is a male 9-pin sub-miniature "D" type connector, and contains the analog output connections for the **AN** option of the instrument. Pins 1 through 8 are analog outputs 1 through 8 respectively, and pin 9 is the common ground for all 8 outputs.

A description of the usage of this connector and the **AN** interface is in the **ANALOG INTERFACING** Chapter.

9.4. Interface Power Switch

This is only fitted if options **IE** or **AN** are fitted in the instrument, and may be used to increase battery life when not using the interface and operating from battery. If the interface is powered then the battery life is reduced by approximately 0.5 hour.

10. GETTING STARTED

This chapter is intended to assist users in quickly getting started using their **6010** instrument.

10.1. Preliminaries

The user should follow these simple steps to verify that the instrument is of the correct type for the application and is correctly functioning.

- Ensure that all rear panel input connectors and interface connectors are disconnected from external circuitry.
- Ensure that the front panel ***POWER*** switch is in the ***OFF*** position.
- Ensuring that the charging module is suitable for the line supply voltage, plug the module into a power socket and plug the DC output from the module into the connector in the rear panel of the **6010**. If the **6010** has an internal battery (i.e., not option **NB**), the *CHARGING* LED on the front panel will illuminate. The period of time for which this LED will remain illuminated will depend on the condition of the battery.
- Change the front panel ***POWER*** switch to the ***ON*** position. The *BATT OK* LED on the front panel should illuminate continuously. Carefully watch and take note of the power-on messages.
- Check that there are no error messages displayed during the power-on sequence, and that the option fitted is consistent with the desired application.
- For each input, short each pair of terminals together. Any suitable gauge of wire may be used. The display will now show the RMS voltages for inputs A and B (top line), and the frequency of the signal on input A and the phase shift of the signal on input B with respect to input A (bottom line). The voltages displayed should be less than 0.02V and the frequency should be 0Hz.
- Connect a source of a sinewave signal having an amplitude of between 1 and 15V, and a frequency of 400Hz to both inputs in parallel. The correct voltages and frequency should be displayed. The phase displayed should be within 0.5° of zero. For non-15volt input range units, apply an amplitude between 10% and 100% of the maximum range.

☞ Momentarily press the ***Total RATIO*** key on the front panel. The display will now show the RMS level on input A and the ratio of the RMS level on B to that on A (top line), and the frequency of the signal on input A (bottom line). The displayed ratio should be between 0.996 and 1.004.

☞ Momentarily press the ***InPhs RATIO*** key on the front panel. The display will now show the RMS level on input A and the ratio of the RMS level of the in phase component on B to that on A (top line), and the frequency of the signal on input A (bottom line). The displayed ratio should be between 0.996 and 1.004.

☞ Momentarily press the ***Quad RATIO*** key on the front panel. The display will now show the RMS level on input A and the ratio of the RMS level of the quadrature (out of phase) component on B to that on A (top line), and the frequency of the signal on input A (bottom line). The displayed ratio should be within 0.009 of zero.

☞ Momentarily press the ***InPhs LEVEL*** key on the front panel. The display will now show the RMS level on input A and the RMS level of the in phase component on B (top line), and the frequency of the signal on input A (bottom line). The displayed levels should be within 0.4% of each other.

☞ Momentarily press the ***Quad LEVEL*** key on the front panel. The display will now show the RMS level on input A and the RMS level of the quadrature (out of phase) component on B (top line), and the frequency of the signal on input A (bottom line). The displayed level for input B (right hand level) should be less than 0.009 times the input A level.

☞ Momentarily press the ***RUN*** key on the front panel. The display will momentarily display "Measurements Frozen". Remove the connections to the input terminals. The displayed levels should remain unchanged.

☞ Momentarily press the ***RUN*** key on the front panel a second time. The display will momentarily display "Measurements Released". The displayed levels should now change to close to zero.

✍ If there were no error messages, and the correct instrument number was shown, then the instrument is correctly functioning and the user may configure it for the desired use. If there was an error, then take any actions suggested within the error message and retest the instrument.

11. FRONT PANEL CONTROLS

11.1. *POWER* Switch

This switch is used to apply (***ON***) or disconnect (***OFF***) power to the internal measurement circuitry in the 6010. The internal battery (if fitted) is always being charged from the rear panel charging connector.

It is highly recommended that this switch be maintained in the ***OFF*** position when the instrument is not in use. Applying signals to the ***INPUT*** terminals when this switch is in the ***OFF*** position does not damage the instrument.

11.2. *BATTERY* Status LEDs

These indicate the present status of the internal battery (if fitted).

11.2.1. CHRG

This is illuminated whenever the internal battery is accepting charge from the rear panel charging connector. This may pulsate during normal operation, this indicates that the battery is being maintained at full charge. This should NEVER illuminate when no external power source is present.

11.2.2. OK

This is illuminated whenever the ***POWER*** switch is in the ***ON*** position and the battery is sufficiently charged to power the instrument.

11.3. *DISPLAY* Keys

These six keys control the information which is displayed by the instrument. The user should note that all data is computed at all times. These keys will change the displayed information while measurements are held following usage of the ***RUN*** key, the data being that present prior to holding measurements.

The information selected by the ***Total LEVEL*** key is automatically selected following application of power to the instrument.

11.3.1. *Total LEVEL*

This key selects the following data to be displayed :

Top Line

Leftmost data : The RMS level on input A

Rightmost data : The RMS level on input B

Bottom Line

Leftmost data : The frequency of the signal on input A

Rightmost data : The phase shift between the signal on input B from the signal on input A. This is formatted to be in the range of -180.0° to +180.0°.

11.3.2. *Total RATIO*

This key selects the following data to be displayed :

Top Line

Leftmost data : The RMS level on input A

Rightmost data : The RMS level on input B as a ratio of the RMS level on input A

Bottom Line

Leftmost data : The frequency of the signal on input A

Rightmost data : The phase shift between the signal on input B from the signal on input A. This is formatted to be in the range of -180.0° to +180.0°.

11.3.3. *InPhs LEVEL*

This key selects the following data to be displayed :

Top Line

Leftmost data : The RMS level on input A

Rightmost data : The RMS level of the component of the signal on input B which is in phase with the signal on input A

Bottom Line

Leftmost data : The frequency of the signal on input A

Rightmost data : "InPhase".

11.3.4. *InPhs RATIO*

This key selects the following data to be displayed :

Top Line

Leftmost data : The RMS level on input A

Rightmost data : The ratio of the RMS level of the component of the signal on input B which is in phase with the signal on input A, to the RMS level on input A

Bottom Line

Leftmost data : The frequency of the signal on input A

Rightmost data : "InPhase".

11.3.5. *Quad LEVEL*

This key selects the following data to be displayed :

Top Line

Leftmost data : The RMS level on input A

Rightmost data : The RMS level of the component of the signal on input B which is out of phase (in quadrature) with the signal on input A

Bottom Line

Leftmost data : The frequency of the signal on input A

Rightmost data : "Quad".

11.3.6. *Quad RATIO*

This key selects the following data to be displayed :

Top Line

Leftmost data : The RMS level on input A

Rightmost data : The ratio of the RMS level of the component of the signal on input B which is out of phase (in quadrature) with the signal on input A, to the RMS level on input A

Bottom Line

Leftmost data : The frequency of the signal on input A

Rightmost data : "Quad".

11.4. *RUN* Key

Repeated operation of this key alternately selects between the following states :

Measurements Frozen — In this condition, the instrument ceases to update its internal database to the measured data. Actual measurements are still performed (allowing autoranging and protection to continue) but no data is updated. All data is still obtainable, both from the front panel and from the interface (if fitted). The data displayed (or read from the interface) is that present when the measurements were frozen.

Measurements Released — This is the normal condition of the instrument, allowing it to update the displayed data (or data read from the interface) from measurement results.

11.5. CALIBRATE Key

This key enables the user to perform an External Calibration of the instrument. The user is referred to the **CALIBRATION** Chapter for details regarding performing this function.

11.6. INT Key

This key is only operational when an interface (options **IE**, **RS** or **AN**) is fitted. This enables the user to :

1. Select the IEEE488 interface address (option **IE**).

2. Select the RS232 data communications baud rate (option **RS**).

3. Select the output parameters for each of the analog outputs (option **AN**).

The operation of this key is described in later chapters.

12. CALIBRATION

This chapter specifically describes the front panel method of performing an External Calibration of the instrument. The IEEE488 and RS232 commanded methods follow essentially the same methods, using the commands described in the **DIGITAL INTERFACING** Chapter.

12.1. External Calibration

12.1.1. When to Perform an External Calibration

The user may command an External Calibration whenever desired, however a one year External Calibration interval is recommended for normal use. While calibration at 23°C ambient is recommended, this may be performed at any temperature from 10°C to 35°C without degradation of accuracy specifications.

12.1.2. Equipment Required for an External Calibration

The instrument may be calibrated at any frequency within the measurement range of the instrument below 1KHz. The factory recommended frequency is 400Hz.

The calibration procedure requires sinewave signal inputs at the following RMS voltage levels to both inputs :

2.5V, 5V and 10V.

Note: These voltage levels may change for units fitted with non-standard ranges. Please provide the sinewave signal at the 1evel requested on the display.

The external calibration standards should be certified to within an accuracy of 0.1% (0.05% is recommended for a 4:1 uncertainty ratio) at the calibration levels shown above, and at the frequency selected by the user. The usage of a Fluke 5700A is highly suitable for this task.

12.1.3. Preparing for an External Calibration

Prior to initiating an External Calibration sequence the user should perform the following steps :

① The instrument being calibrated should have been operated continuously in the calibration environment for at least one hour prior to initiating the External Calibration sequence.

② The external calibration standards against which the instrument is to be calibrated should be fully stabilized (see the manufacturers recommended warm up interval) and should be within its certified calibration period. If necessary, any calibration offsets should be obtained and applied as required during the procedure.

12.1.4. Initiating an External Calibration

After performing the preparation steps outlined above, the user may initiate an External Calibration procedure. This is achieved by pressing the ***CAL*** key.

12.1.5. Calibration Against the External Standards

After successfully completing the steps outlined above, the instrument will initiate the prompted External Calibration sequence. Each calibration step follows the same procedure, which is outlined below :

① The instrument prompts the user to input the desired voltage into both of the inputs, in parallel.

② The user should provide the requested input and then press the ***Enter or INT*** Key. Pressing the ***Next or RUN*** key at this time will skip to the next calibration step without affecting the stored calibration data for this step. Pressing the ***CAL*** key aborts the entire External Calibration sequence, discarding all adjustments made.

③ The instrument now continuously displays the measured input levels, input A on the top line, input B on the bottom line.

④ When the user is satisfied that the correct input level has been established, the user should press the ***Enter or INT*** key to command the instrument to accept the input as the correct input level.

Note that no adjustment of the input level is required during an External Calibration procedure, other than that required to produce the actual requested output level from the external calibration standard.

Pressing the ***Next or RUN*** key at this time will skip to the next calibration step without affecting the stored calibration data for this step. Pressing the ***CAL*** key aborts the entire External Calibration sequence, discarding all adjustments made.

If the calibration constant obtained from the measured input level is outside the range allowed by the instrument (either due to an internal malfunction, or misapplication of the requested input level) the instrument will abort the calibration without affecting the previously stored calibration constants, and display a relevant message for two seconds.

12.1.6. Completing the External Calibration

After completing (or skipping over) the last step of the External Calibration procedure, the instrument updates the calibration constants and returns to normal operation, using the previously saved default operating parameters..

13. DIGITAL INTERFACING

The **6010** has an optional IEEE488 or RS232 interface, allowing the instrument to be both controlled and interrogated by a computer.

Both interfaces operate in similar manners, using basically the same command set. The major difference between the operation of these interfaces is in the ability of the IEEE488 interface to switch between remote and local command states (which the RS232 interface does not offer), and the ability of the controller to continuously read the same data from the IEEE488 interface (the controller must always prompt the instrument to transmit the desired data from the RS232 interface).

Throughout this chapter it is assumed that the user is conversant with manual operation of the instrument, and with the methods of operating the controller for the particular interface being used.

13.1. RS232 Data Format Selection

When the **RS** interface is fitted in the instrument, the baud rate may be set as described below :

① Press the ***INT*** key.

② Repeatedly select the (Next or RUN) or (Prev or CAL) keys, until the desired baud rate is shown.

③ Press the ***Enter*** key.

The user should ensure that the computer connected to the RS232 port is set to the same baud rate, 8 bit data with no parity, 1 stop bit and 1 start bit. In normal operation the user should select the highest baud rate (19200 baud), however it should be noted that some IBM PC compatible computers do not operate correctly at this speed, particularly when operating in a multi-tasking environment (such as *Microsoft Windows*® or when connected to a network such as *Lantastic*®). When operating in environments having severe interference, when using very long cable lengths, or when the user is unsure whether the computer is capable of the highest baud rate, the user may wish to decrease the selected baud rate to reduce data transfer error rates.

13.2. IEEE488 Address Selection

When the **IE** option is fitted, the interface address may be set as described below :

① Press the ***INT*** key.

② Repeatedly select the (Next or RUN) or (Prev or CAL) keys, until the desired address is shown.

③ Press the ***Enter*** key.

13.3. Remote/Local Operation

With the **RS** option there are no defined REMOTE or LOCAL states, thus the instrument will respond to commands from either the front panel or the interface as applicable. The IEEE488 interface defines separate REMOTE and LOCAL states for the instrument thus this paragraph is only applicable to this interface.

While in the LOCAL state (e.g., following the initial application of power) the instrument will only respond to commands from the front panel of the instrument. After placing the instrument in the REMOTE state (via the defined interface command) the instrument will only respond to commands received via the interface (until released into the LOCAL state by the defined interface command). In either state, the instrument may have its present status read by the interface. If the instrument is in the REMOTE state (and LOCAL LOCKOUT has not been commanded) then pressing the ***INT*** key will return the instrument to the LOCAL state.

The REMOTE state is entered in the manner defined by the IEEE488 interface bus, normally this is achieved automatically when the instrument is correctly addressed to "listen" to a command string.

13.4. Configuring the Instrument and Controller (IE only)

Throughout this section of the manual, the use of a National Instruments AT-GPIB® IEEE488 controller board in an IBM AT (or compatible) is assumed. If the user is using a different controller or a controller card from another vendor, then the exact methods used will differ from those shown. If the user is using a computer with a built-in interface (such as the Hewlett-Packard series 300 and similar computers) then no configuration is usually required.

13.4.1. Configuring the Instrument

Other than setting the desired address and connecting the IEEE488 cable, the user need not perform any specific configurations on the instrument. As with all IEEE488 instruments and devices, the user must ensure that the selected address does not conflict with any other devices in the system. When using the instrument with the National Instruments controller card (and with many other cards for the IBM AT) the user should not select an instrument address of 0, as this will conflict with the address of the card.

13.4.2. Configuring the Controller Card

The user should follow the manufacturers recommended installation procedure when installing the card in the computer. Where an IBM PC (i.e., 8-bit) card is to be installed into an IBM AT type machine (i.e. 16-bit or higher), the user should take particular note of the hardware interrupt and DMA channel selected for the card.

Most manufacturers of these cards set these parameters to those compatible with the IBM PC, unfortunately these usually conflict with other cards normally found in the IBM AT class computers. In particular the user should beware that the first parallel port in an IBM AT class computer uses interrupt IRQ7.

When a conflict occurs between interrupts and DMA channels, the problems may not appear for some time, or may only cause intermittent operation. When any doubt occurs the user is recommended to first deselect the DMA channel, and then (if the problem persists) deselect the IRQ. Although this will perform slightly slower than the published specifications for the card, this will ensure that no conflicts occur.

The user also should note that some 8-bit cards will not reliably operate in high speed computers (such as 80386 based machines), the user should consult the manufacturer of the card regarding this issue.

When operating using hardware interrupts and DMA channels, and the computer is operating under the control of multi-tasking software (such as *Microsoft Windows*), then there are many other issues that require attention. In these circumstances the user should consult with the vendor of the controller card for specific configuration details.

13.4.3. Configuring the Controller Software

With the National Instruments AT-GPIB controller card, and with many other cards, there is a configured *device driver* installed in the computer. This driver must be correctly configured to ensure reliable operation with the **6010**. This section describes the settings that have been tested with the National Instrument AT-GPIB driver revision 1.5 accessed with the *ibconf* program supplied with the controller card, other drivers and revisions may be similar to those shown below :

Controller Card Configuration (***GPIB0***) : Note that these settings may be varied dependent on other instrumentation using the IEEE488 bus.

Primary Address	*0.*[1]
Secondary Address	*NONE.*[1]
Timeout Setting	*T10s.*[1]
EOS	*00H.*[1]
Terminate on EOS	*no.*[1]

Set EOI with EOS on Write	*no.*[1]
Type of Compare on EOS	*7-bit.*[1]
Set EOI w/last byte of Write	*yes.*[1]
System Controller	*yes.*[2]
Assert REN when SC	*no.*[1,2]
Enable Auto Serial Polling	*yes.*[3]
Timing	*500ns.*[4]
Enable 488.2 Protocols	*yes.*[5]
CIC protocol	*no.*[2]
Interrupt Setting	*11.*[6]
Base I/O Address	*02C0H.*[6]
DMA Channel	*5.*[6]

NOTES :

1 These selections are only for data transfers regarding the controller card itself. Thus other settings may be used, but have not been fully tested by Xitron Technologies Inc..

2 These selections assume the use of a single controller. In configurations where a second controller exists these may be altered, other settings have not been fully tested by Xitron Technologies Inc..

3 The Xitron Technologies **6010** does not currently use the SRQ and Serial Poll capabilities of the IEEE488 bus. This setting will be dependent on other instruments, thus does not affect the **6010** instrument.

4 Timings of longer than this are also valid. The 350ns selection has been tested on shorter cable lengths by Xitron Technologies Inc. and may be used, however in normal operation there is little overall performance gain by using it with the **6010** instrument. If other, very high speed, devices exist in the system then this shorter time may be selected.

5 The **6010** does not use the IEEE488.2 specifications, thus this setting has no affect on these instruments if the user has otherwise ensured that no IEEE488.2 type transfers take place with the **6010**. If all other devices also do not use the IEEE488.2 type transfers, then this setting should be set to *no* to ensure compatibility.

6 Although these settings have no affect on the **6010**, the user should ensure that no hardware conflicts exist with other installed devices in the computer. The settings shown above are highly recommended, as the probability of conflict is lowest with these settings.

Settings for the **6010**. The user should note that, as documented in the National Instruments manual, the name given for the device should not exist as a file, directory, or subdirectory within the computer system. If this occurs then unreliable operation of both the bus and the computer may result. Especially when operating in a network environment, it is recommended that the name given is cryptic to reduce the probability of this occurring.

Primary Address	*2.*[1]
Secondary Address	*NONE.*[1]
Timeout Setting	*T1s.*[2]
EOS Byte	*0AH.*[3]
Terminate read on EOS	*yes.*[4]

Set EOI with EOS on Write	*no.*[5]
Type of Compare on EOS	*7-bit.*[4]
Set EOI w/last byte of Write	*yes.*[5]
Repeat Addressing	*no.*[6]

NOTES :

1 The address should be that configured in the instrument. The **6010** does not use secondary addressing.

2 The only command that may hold the bus handshake for longer than 20ms. is the device clear command. If this command is not used then even shorter timeout periods can be used to detect a failure. The device clear command may hold the bus handshake for up to three seconds.

3 The **6010** always sends a carriage return (0DH) and a line feed (0AH) with EOI asserted at the end of each data transfer from the **6010**.

4 Terminating a data read with the defined EOS byte ensures that data transfers are correctly terminated. This ensures that the user does not have to specify the exact number of characters for each transfer. Data transfers from the **6010** are all 7-bit ASCII data with no parity.

5 The **6010** will terminate a data receive operation with either a line feed character (0AH), or any character with EOI asserted, or with a device trigger. Selecting the EOI w/last byte of Write option ensures the shortest possible data transfer.

6 The **6010** does not "unaddress" at the completion of a transfer. Thus, assuming no other device has been subsequently addressed, there is no requirement to re-address the instrument.

13.5. Reading Data From the 6010

With either interface the user may interrogate the various data held by the instrument. This is achieved by sending a "data read" command string (see the next section), which defines which data is to be interrogated, and then reading the data from the instrument.

In the **RS**, this data is automatically transmitted from the instrument to the controller, the instrument will then wait for a further "data read" command before sending further data.

In the **IE** interface, the controller may immediately attempt to read the requested data, the controller will then be held for a short delay (typically less than 1ms) until the requested data is available, then the requested data will be read by the controller. This data may be read by the **IE** interface any number of times, the data transmitted will always be the latest available data (unless the instrument is in the Measurements Frozen state).

In either interface, the instrument responds by sending a single "space" character, followed by a numeric string (with a preceding polarity symbol), followed by the respective "engineering format" exponent data in the form "*e+3*", and terminated by the "carriage return" and "line feed" characters (with the **IE** interface this last character is sent with the EOI line asserted).

13.6. Sending Data to the 6010

Both the **RS** and **IE** interface operate similarly with regards to sending data to the instrument. The only difference being the previously mentioned requirement to place the instrument in the REMOTE state with the **IE** interface. ASCII characters transmitted to the interface are stored in a "buffer" until either a "line feed" or "carriage return" character is received (or a character with the EOI line asserted, or a "Group Execute Trigger" command is received, in the **IE** interface), the received characters then are decoded and actioned. If both a "line feed" and a "carriage return" character are transmitted to the instrument, then the preceding command string will be actioned when the first of these characters is received, the remaining character is simply discarded when received, there being no command strings between them.

Up to 100 characters may be stored in the "receive buffer," which may contain more than one complete command string type if desired. If the user sends conflicting commands within the same command string, then the last effective command will be used.

It should be noted that the **6010** operates with the received ASCII characters, the command used to send these characters via the designated interface is dependent on the computer system and peripheral used.

13.7. Special Considerations When Using Option RS

The **RS** interface is configured to use the RS232 hardware "handshake" lines RTS and CTS to handshake data. The usage of these hardware "handshake" lines ensures that data will not be lost due to different speeds in the **6010** and the computer. Sometimes the particular computer used is not able to use these handshake lines properly (e.g., some computer systems continue to transmit a few characters after being "held off" from transmitting). The user should place delays between sending individual command strings in these cases to prevent "data overrun."

13.8. Special Considerations When Using Option IE

There are several differences between the **IE** and **RS** interface operation, these are all due to the extended capabilities of the hardware interface of the IEEE488 standard.

13.8.1. Bus Timing

Almost all of the timing requirements of the bus interface are handled by the hardware handshake system used by the IEEE488 interface. During decode of a command all further received data are "held-off" by this hardware handshake until the decode has been completed. Typically data transfer rates of up to 50,000 characters per second are attainable with the **6010**.

13.8.2. Bus Commands

As previously mentioned, the IEEE488 interface can perform many tasks that the RS232 does not, those used by the **6010** are as follows -

Remote/Local. This has been previously described.

Device Clear. The IEEE488 defined Device Clear functions (both selective and global) force the **6010** to perform a power-on reset function.

Interface Clear. The IEEE488 standard defines this command, which causes the interface portion of the **6010** to be reset to the power on conditions, aborting any bus activity in progress.

13.8.3. Other IEEE488 Specific Items

Should a handshake sequence be improperly completed during a transfer of data to or from the **IE** interface, then the **6010** will automatically perform a power on reset sequence. This facility prevents the interface becoming "locked out" should the interface cable be removed or become faulty during a data transfer.

13.9. Command Set

The various features of the **6010** may be controlled by the controller sending certain command "strings" to the **6010**. The user may freely distribute "space" and non-printing characters throughout the command string (including within the actual command itself), and may send more than one command before sending the termination character.

Commands are terminated by the reception of a "line feed" or "carriage return" character, the reception of a character with the EOI line asserted (**IE** only), or by the reception of the "Group Execute Trigger" command (**IE** only).

Command strings may be separated by any "non-command" character, e.g. a "comma" character or "semi-colon" character. The user may freely use either lower or upper case characters, as desired.

The commands listed below are shown in alpha-numeric order.

13.9.1. DISP=*data*

This command selects which data will be displayed on the front panel of the **6010**. The ***data*** portion of the command may be one of the following characters :

0 Same as pressing the ***Total LEVEL*** key.

1 Same as pressing the ***InPhs LEVEL*** key.

2 Same as pressing the ***Quad LEVEL*** key.

3 Same as pressing the ***Total RATIO*** key.

4 Same as pressing the ***InPhs RATIO*** key.

5 Same as pressing the ***Quad RATIO*** key.

13.9.2. EXTCAL, EXTSKIP and EXTUSE

These commands allow the user to perform an automated external calibration of the instrument. The ***EXTCAL*** command initiates an external calibration sequence, the ***EXTSKIP*** command selects the next external calibration point without affecting the data for the point being measured (if any) and the ***EXTUSE*** command shows that the instrument should compute the calibration data using the actual input level present and then select the next calibration point.

13.9.3. HOLD

This command specifies that the instrument is to enter the Measurements Frozen state. All database parameters are maintained at the values present at the time this command is received. These parameters may be subsequently released by the ***RUN*** command.

13.9.4. READ=*parameter*

This command determines which parameter the instrument will next transmit to the controller. For the **RS** interface the requested data will be transmitted automatically following decode of this command, whereas the **IE** will simply store this request until the instrument is next interrogated by the controller (i.e. addressed as a talker).

The available data is denoted by the characters used in the ***parameter*** portion of the command as follows :

LEVELA	The RMS level on input A
LEVELB	The RMS level on input B
FREQ	The frequency of the signal on input A
PHASE	The phase shift of the signal on input B from that on input A
INPHSB	The RMS level of the in phase component of input B
QUADB	The RMS level of the out of phase (quadrature) component of input B
RATIO	The ratio of the RMS level on input B to the RMS level on input A

RINPHSB The ratio of the RMS level of the in phase component of input B to the RMS level on input A

RQUADB The ratio of the RMS level of the out of phase (quadrature) component of input B to the RMS level on input A

13.9.5. RUN

This command releases a previously received ***HOLD*** command. If the instrument is not presently in the HOLD state then this command has no effect.

13.10. Examples

In the examples shown below, the use of the National Instruments AT-GPIB (or similar) controller card for an IBM AT (or compatible) computer is assumed. Other controller cards and computers may have similar commands, in these cases the user is referred to the specific operating methods for the controller card and computer being used.

It is assumed that the user has already configured the device driver in the controller, and the instrument, as described at the beginning of this chapter.

NOTE

In the examples that follow, the commands and operations specific to the National Instruments software are printed in *italics*. This manual is not intended as a complete reference to the National Instruments software package, and should not be used as such.

The instrument specific portion of each command shown below is typed in BOLD HELVETICA typeface for clarity, and as an aid to those users who are not using the National Instruments software and controller.

The National Instruments software normally requires that the user perform an *ibfind* operation to ascertain the handle for both the controller card and the instrument prior to performing any bus task. In all of the examples shown below it is assumed that the user has performed these *ibfind* operations and that either the target has been set to the instrument (for users using the *ibic* utility) or the int type variables phasemeter and gpib_board have been set for the instrument and controller card (for users writing software). Software examples are generally shown using the 'C' language.

13.10.1. Performing a Device Clear Operation

As defined in the IEEE488 standard, the user may perform a device clear operation either on a single instrument, or on all instruments on the bus. In the **6010** this function performs essentially the same operation as cycling the power supply to the instrument.

Performing this operation requires no instrument specific operations, thus users who are not using the National Instruments software and controller card should refer to their specific information regarding performing a device clear operation.

This operation is typically used at the start of a software program to ensure that the instrument is in a known state. It is not recommended that this is performed regularly (e.g. at the start of every test sequence) as this is time consuming and unnecessary.

If the user is manually typing the command using the *ibic* utility, then typing *ibclr* performs this operation. This is a useful basic check of operation of the IEEE488 interface, as the effect is directly noticeable on the instrument (the display will show the power-on messages).

If the user is writing software to accomplish this operation then the command is similar to :

ibclr (*phasemeter*) ;

Due to internal timing constraints within the instrument, if the user wishes to access the instrument via the IEEE488 bus immediately following this command, then a delay of at least 0.1s should be enforced prior to doing so (often this is accomplished by rewriting the computer display, or another similar operation).

13.10.2. Reading the Value of a Parameter

The transmitted character string contains the numeric value of the requested parameter. The format of the numeric string (after the initial space character) is as follows -

1st character	The polarity symbol. This is always present, and is either the **+** or the **-** character.
2nd thru 8th characters	The numeric (mantissa) portion. This data always contains a decimal point, thus contains 6 digits and a decimal point character.
9th character	The ***e*** character. This shows the start of the exponent portion of the data, and is always present.

10th & 11th characters — The exponent, containing the exponent polarity (either the **+** or **-** character) and a single digit. The position of the decimal point in the mantissa portion of the string is such that the exponent is always divisible by 3. This allows the user to easily convert the returned data to include a multiplier character if desired.

The user should note that the format described above is directly compatible with most compilers for data conversion into the native numeric format (e.g. *float* or *double* in 'C', using the *atof* function).

If the user is using the interactive National Instrument software (*ibic*) then reading (for example) the RMS voltage for input A is achieved as follows :

❶ Enter *ibwrt ("***READ=LEVELA***")*

❷ Enter *ibrd 20*

❸ The *ibic* software prints the received data, in both hexadecimal and ASCII formats, at this time.

If the user is writing software, then the following 'C' example demonstrates reading the input A RMS voltage, converting the value into *float* format, and checking the value against limits.

```
char string[25] ;
float rms_voltage ;

ibwrt (power_analyser, "READ=LEVELA", 13L) ;
ibrd (phasemeter, string, 20) ;
rms_voltage = atof (string) ;
if (rms_voltage < 1.0)
        printf ("Voltage is below limits\n") ;
else if (rms_voltage > 1.2)
        printf ("Voltage is above limits\n") ;
```

In the example above, the data is read immediately following sending the "READ=" command to the **6010**. In general, this will yield the desired result (i.e., the desired data will be read), however this may not be the case in all circumstances. The following notes should be observed :

1. New data will not be made available to the controller until any data presently being read has been completely transmitted from the **6010**. This includes the terminating CR and LF characters. If the controller ceases to read data following the reception of the CR character, then this leaves the LF character still to be transmitted from the **6010**. In this case the data read from the **6010** will be "held" until this character is read. The user should carefully ensure that the controller terminates receiving characters using the EOI hardware line rather than a specific character.

2. Certain compilers may "appear" to give the opportunity to read the data as a numeric rather than a string. This often fails to correctly operate, mainly due to the space character transmitted from the **6010** as the first character, and due to the terminating CR and LF characters. The data from the **6010** should be read as a character string and then converted separately.

14. ANALOG INTERFACING

Option **AN** provides up to 8 channels of analog output to a strip chart recorder, data logging system, or similar system.

14.1. Configuring Each Channel

Each channel of analog output may be independently set to output any of the listed parameters.

Each output may be configured by pressing the ***INT*** key. Each channel may then be configured as described below -

The display shows the present parameter for the first channel of the analog output. Pressing the ***Enter*** key changes the channel being displayed.

The user may change the selected parameter by pressing the (***Next or RUN)*** and (***Prev or CAL)*** keys.

This sequence may be repeated for each of the eight output channels.

14.1.1. Ranges for Each Parameter

Each parameter uses a default offset and range for the output from the interface. The table below lists the values for each parameter which will cause an output of -5V, 0V and +5V.

Parameter	-5V	0V	+5V
Input A RMS Level	-	0V	15V
Input B RMS Level	-	0V	15V
Input A Frequency	-	0Hz	10KHz
Input B Phase Shift from Input A	-180.0°	0.0°	+180.0°
In Phase component of Input B	-15V	0V	+15V
Quadrature component of Input B	-15V	0V	+15V
Ratio of Input B RMS Level to the Input A RMS Level	-1.0	0	+1.0
Ratio of Input B In Phase RMS Level to the Input A RMS Level	-1.0	0	+1.0
Ratio of Input B Quadrature RMS Level to the Input A RMS Level	-1.0	0	+1.0

14.2. Using the Analog Outputs

Each output channel produces DC voltage output levels between -5V and +5V, unless the channel is disabled (in which case the output level is indeterminate). These outputs may be used to drive the inputs of a chart recorder, process control system or data logger (or any other system requiring a DC voltage input).

14.2.1. Driving Low Impedance Loads

When driving low impedance loads the user should ensure that the total loading on all of the outputs does not exceed the 10mA maximum limit. If the user is using several channels then care should be taken with the wire size used for the common return, otherwise significant errors will be introduced due to the voltage drop caused by the current from each channel. If possible, the user should separately wire the common return for low impedance loads.

15. 150 VOLT INPUT MODIFICATION

15.1. Input Specifications

All accuracy specifications given below are valid throughout the specified operating temperature range of the instrument, for one year, following a five minute warm up period.

15.1.1. General

Frequency Range :	10Hz to 10KHz (typical performance to 20KHz).
Isolation :	Inputs are isolated from each other for voltages of up to 300Vpk. Isolation from ground (chassis), interface (if fitted), and Charging Module for voltages up to 1500Vpk..
Input Voltage Range :	Specifications are valid for input signals with RMS values between 300mV and 150V.
Max. Input Slew Rate :	Specifications are valid for input voltage signals (either series or common mode) having <300V/µs slew rate.
Measurement Period :	Approximately 0.5s.
Settling Time :	8ms.

15.1.2. Amplitude Accuracy

Resolution :	10mV for inputs up to 75.0V RMS, 100mV up to 150V RMS.	
Accuracy :	0.3 to 37.5V :	80mV + 8mV/KHz
	37.5 to 75V :	150mV + 15mV/KHz
	75 to 150V :	300mV + 30mV/KHz
Crest Factor :	Better than 2:1 at 150V RMS, increasing linearly to 250:1 at 300mV. 300V peak max. input to maintain accuracy.	
Protection :	1000V peak continuously.	
Input Impedance :	300KΩ from any terminal to the Input A Low terminal. >1000MΩ || 5000pF from the Input A Low terminal to chassis.	

15.1.3. Phase Accuracy

Resolution :	0.1°.
Accuracy :	0.5° + 0.1°/KHz + 0.01°(150/Input A level) + 0.01°(150/Input B level)

Technique : Proprietary correlation technique computing phase shift between correlating components in both input signals.