OPERATOR MANUAL

Model 8100

Power and Energy Calibrator

Revision 2.3
Firmware Revision 1.65

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CERTIFICATION

Rotek Instrument Corp. certifies that prior to being shipped from the factory this instrument has been calibrated to meet or exceed all the specifications contained in this manual. The calibration has been performed with instruments, the accuracy of which is traceable to the National Institute of Standards and Technology (N.I.S.T.) formerly known as the National Bureau of Standards (N.B.S.).

WARRANTY

Rotek Instrument Corp. warrants each instrument manufactured by it to be free from defects in material and workmanship for a period of one year from date of delivery to the original purchaser, provided the instrument is used in accordance with the instructions in this manual. Rotek's obligation under this warranty is limited to servicing or adjusting an instrument returned to the factory, transportation charges prepaid, for that purpose. This is the only warranty offered in connection with the sale of this instrument, no other warranty is implied. Rotek is not liable for consequential damages.

If a fault in operation occurs, the following steps should be taken:

1. Immediately notify Rotek Instrument Corp. giving full details of the faulty operation, the model number and the serial number of the instrument. On receipt of this information, a Rotek Customer Service Representative will provide service data or shipping instructions.
2. On receipt of the shipping instructions, forward the instrument prepaid and all necessary repairs will be made at the factory.

If it becomes necessary to return this instrument to the factory, it should be shipped in the original packing carton. If that is not available, use any suitable rigid container with adequate packing to protect the unit during transit. Do not ship an unprotected instrument with peanuts (Pieces of foam or other material) as packing.

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Introduction

The Rotek Model 8100 is a precision source of AC voltage, current and phase angle used in the calibration and test of a wide range of electrical metering instrumentation. It has been designed to be nothing less than the ultimate electrical power calibration standard in both accuracy and flexibility. This single instrument replaces the complicated combinations of individual voltage sources, current sources and phase angle meters required to calibrate power, power quality, and energy meters. The Model 8100's wide range of outputs makes it the ideal instrument to meet many of your testing, measuring and calibration requirements relating to ISO 9000.

The Model 8100 makes use of sophisticated high-speed Digital Signal Processing (DSP) technology to generate extremely accurate outputs for a wide range of real world loads. The internal circuits of the Model 8100 use Rotek's patented digital feedback technology to monitor and verify the accuracy of the voltage and current outputs simultaneously at over 10,000 times per second. Its dual 50W high-power output amplifiers provide levels of burden and compliance required to drive even the most difficult loads.

The Model 8100 provides voltages from 1V to 700V and standard current outputs from 1mA to 55A. Optional internal current options can provide maximum currents of up to 80A. Optional external current extenders can provide maximum currents of 50, 100, 200 or 320A with compliance of up to 8V. Optional internal voltage options can provide maximum voltages of up to 1056V. The phase angle of the current output relative to the voltage output may be adjusted from +180º to -180º. Output frequency may be selected from 25 to 1000Hz.

The Model 8100 may be configured as a 2, 3 or 4 Phase System by simply connecting multiple Model 8100 Calibrators together using a standard Rotek synchronization and control cable. Front panel menus are used to set each unit as either Phase A, B, C or D. All voltage and current outputs are isolated providing complete flexibility in making connections to the UUT.

The deviation function of the Model 8100 may be set to indicate UUT errors in any of the output parameters including voltage, current, power, phase angle or frequency. The error units may be expressed as percent, parts per million or even in the units of the measurement itself.

The Model 8100 provides the functions required to fully test Power Quality meters. Harmonics, Fluctuating Harmonics, Notching and Inter-Harmonics may be added to both the voltage and the current outputs. In addition, all outputs may be configured to reproduce Sags, Swells and Interruptions. Other power quality related phenomena such as flicker may also be simulated.

The Model 8100 facilitates the testing of all types of energy meters by delivering precise user defined quantities of energy to the meter under test. The Model 8100 is also able to accept a pulse input for testing meters equipped with this type of output. The Option 8100-OPT optical rotation detector may be used to measure the rotation of an electro-mechanical energy standard. When used with the Rotek Model 8120 Counter-Comparator, up to six meters may be tested simultaneously. When used in the external energy reference mode, all UUT's may be simultaneously calibrated against a single external energy standard.

A menu-driven front panel and simple intuitive controls make the Model 8100 extremely easy to use. Output settings and menus are displayed on a large TFT Color LCD display. Power settings may be expressed in units of Volt-Amperes, Watts or

VARs. Similarly the phase angle may be expressed as either degrees or power factor. Such flexibility allows the Model 8100 to be configured to meet the specific requirements of any user. A compact rugged design makes the Model 8100 ideally suited to a wide range of operating environments from the laboratory to the factory floor.

The Model 8100 is entirely software calibrated and requires no internal adjustments during the adjustment process. All adjustments are made either via the front panel controls or through the IEEE-488 interface. The Model 8100 has been designed to require a minimum amount of test equipment further simplifying the adjustment process and making on site calibration possible.

Unequaled performance, simplicity of operation, and flexible system configuration make the Model 8100 today's standard for power and energy calibration.

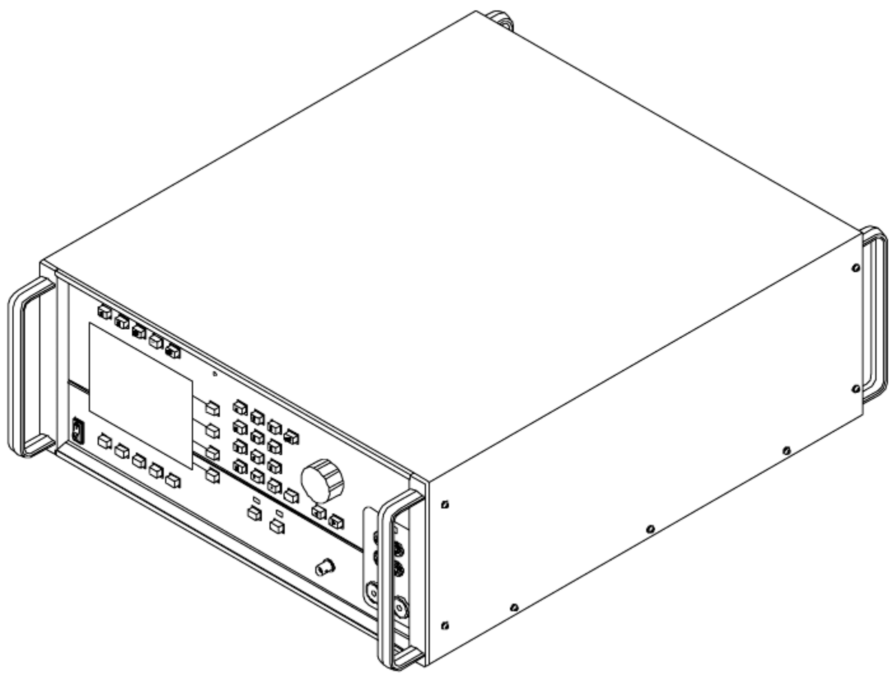

Figure 1-1
Rotek Model 8100

Operation and Control

All functions and features of the Model 8100 are available via the front panel controls, the standard RS-232 and IEEE-488 remote interfaces or the standard 8100FP PC based front panel program.

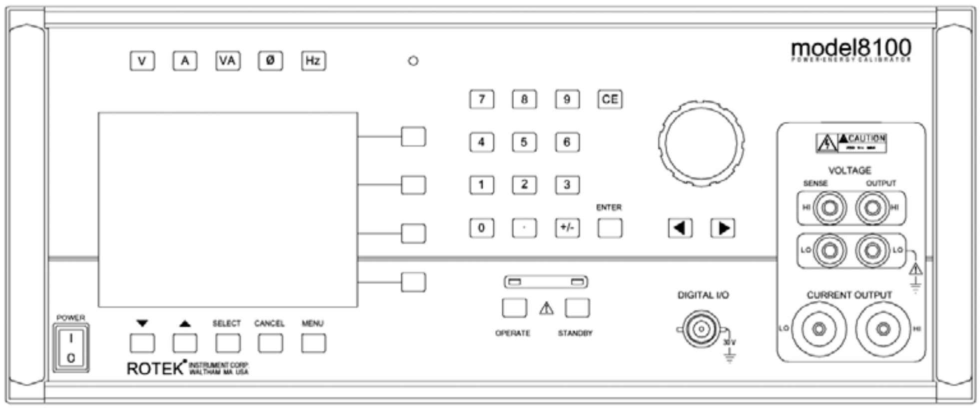

Figure 1-2
Front Panel Controls and Displays

The front panel output settings display is a color LCD display that provides information about the present setting of each of the Model 8100's output parameters, Voltage, Current, VA, Phase Angle, and Frequency. All system settings and configuration menus are displayed on this screen as well.

Dedicated output setting keys (V, A, VA, ϕ, Hz) allow immediate access to edit the primary output parameters, Voltage, Current, VA, Phase Angle, and Frequency. Numeric entries are made using the numeric keypad and settings may be changed using the entry control knob.

Dedicated menu controls and four variable function soft-keys are used to navigate the intuitive menu system. The various menus of the Model 8100 allow the control and configuration of all functions of the calibrator.

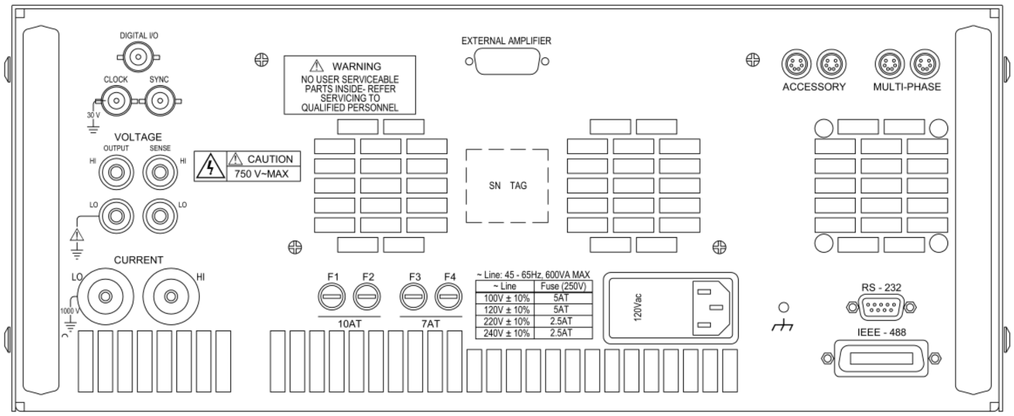

Figure 1-3
Rear Panel Connections

The rear panel of the Model 8100 contains duplicates of all input/output connectors found on the front panel.

Also included are connectors for the various 8100 accessories such as the Model 8120, Model 8145 and Model 8146. Multi-Phase connections are provided to connect multiple Model 8100's in a multiple phase configuration.

Standard RS-232 and IEEE-488 connectors provide access to the two standard remote interfaces. All functions and controls available via the front panel menu system are available via the remote interfaces.

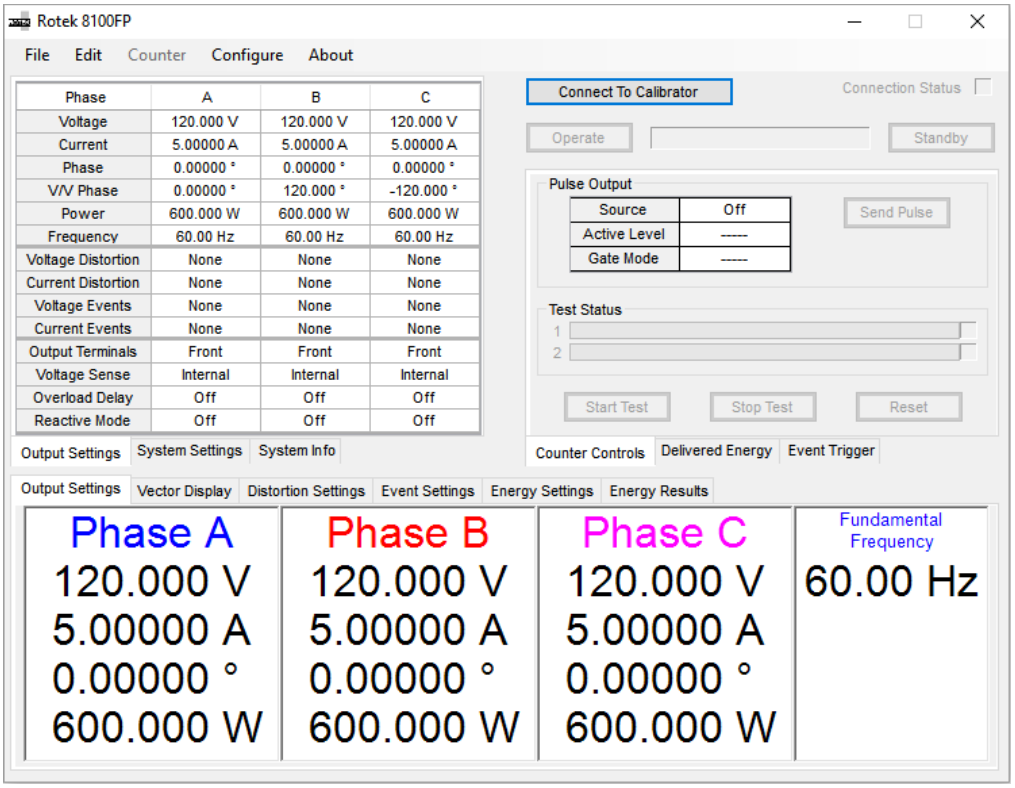

Figure 1-4
8100FP Main Screen

The Model 8100FP is a Windows based application that provides a virtual front panel allowing control of all Model 8100 functions via a PC equipped with an RS-232 or GPIB interface.

When the Model 8100 is connected to the PC via the serial connection operation of the calibrator is performed using the standard, familiar windows based controls of the Model 8100FP program.

The Model 8100FP is included as standard equipment with the Model 8100.

Multi-Phase Operation

The Model 8100 may be configured to operate in single or multi-phase configurations. Single, two, three and four phase configurations are possible. All Model 8100 calibrators may be used as part of a multi-phase system. Front panel menu controls are used to configure each Model 8100 as a Phase A, Phase B, Phase C or Phase D.

Figure 1-5 illustrates a Model 8100 three phase calibration system.

When a Model 8100 is setup in the default Phase A configuration it provides the synchronization signal required by the other phases of the multi-phase system. When a Model 8100 is setup in the Phase B, Phase C or Phase D configuration it suspends generation of the synchronization signal and begins using the signal provided by the Model 8100 configured as a Phase A.

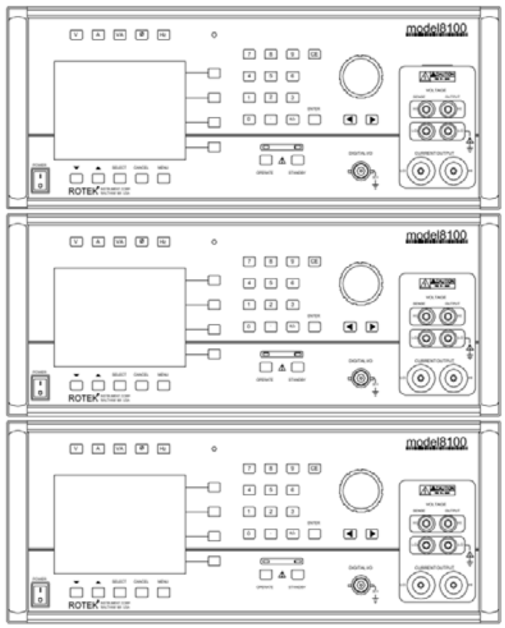

Figure 1-5
Three Phase Configuration (Front View)

When the Model 8100 is operated as a three phase system all controls and settings may be configured independently and the output settings for each phase are displayed on the front panel display for the phase. The two exceptions are frequency and the output control.

If the output frequency setting is changed on any of the components of a multi-phase system the output frequency will change on all phases. The system will maintain the same output frequency on all phases.

The output controls on any phase in a multi-phase system may be used to energize or de-energize the outputs. Pressing ‘Operate’ on any phase will cause all other phases to enter the operate mode as well. Similarly, pressing ‘Standby’ on any phase will cause all other phases to enter the standby mode as well.

Connection of each component of a three phase system is accomplished using a single synchronization cable between each phase of the multi-phase system. Each Model 8100 has two multi-phase connectors located on the rear panel. Either connector may be used to connect to any of the other phases in the system. Phase connections may be ‘Daisy-Chained’ as illustrated in Figure 1-6.

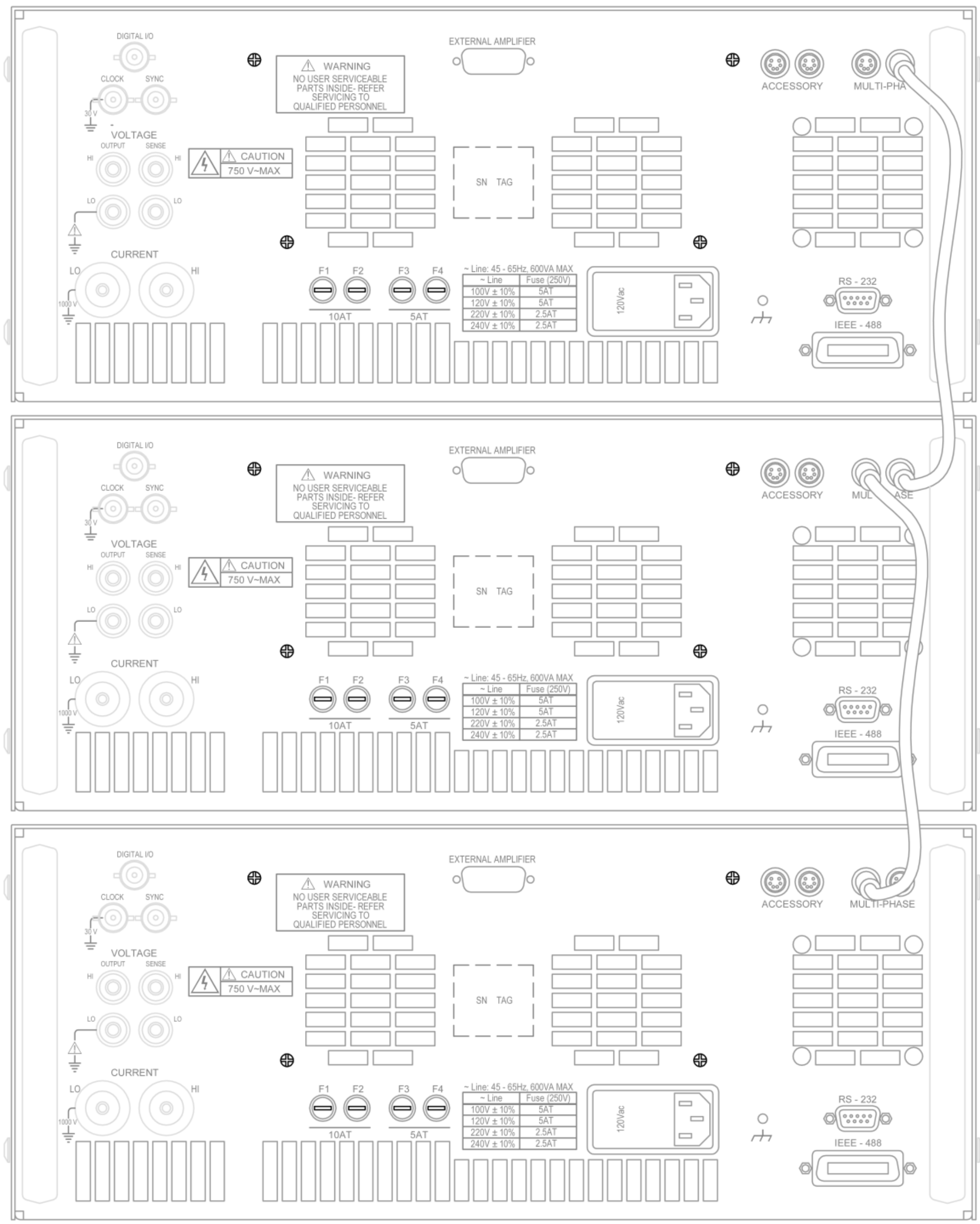

Figure 1-6
Three Phase Configuration (Rear View)

Options and Accessories

The options and accessories available for the Model 8100 are listed in the following paragraphs.

Model 8120 **Six Channel Energy Meter Pulse Counter Comparator.**
The Rotek Model 8120 Pulse Counter-Comparator is a six-channel counter designed to allow the simultaneous testing of up to six energy meters. The energy meters are energized with the voltage and current outputs of the Model 8100 and the pulse outputs of the meters under test are connected to the inputs of the Model 8120. All controls for energy meter testing are menu driven and are located on the Model 8100 main menu. Channel 1 may be configured to input a standard UUT signal or an external energy reference. The counter has a compact 1U (1 ¾”) high, 19” wide chassis. The Model 8120 can be used either as an accessory to the Model 8100 or as a stand-alone instrument.

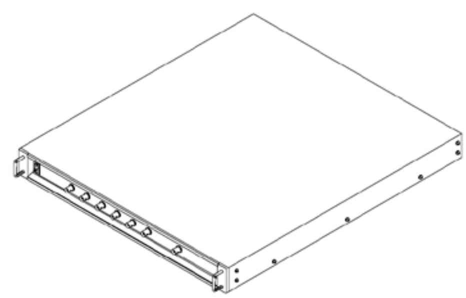

Figure 1-7
Rotek Model 8120

Model 8145 **200 Ampere, 400W Current Extender.**
The Rotek Model 8145 extends the maximum current output of the Model 8100 from 55A to 220A. The Model 8145 can deliver 50A at 8V compliance, 100A at 4V compliance and 200A at 2V compliance. The Model 8145 Current Extender is connected to the calibrator using two interconnection cables. All functions of the amplifier are controlled entirely by the Model 8100. All current outputs are obtained from the output terminals of the Model 8145 so it is not necessary to change lead connections when changing outputs from low to high currents.

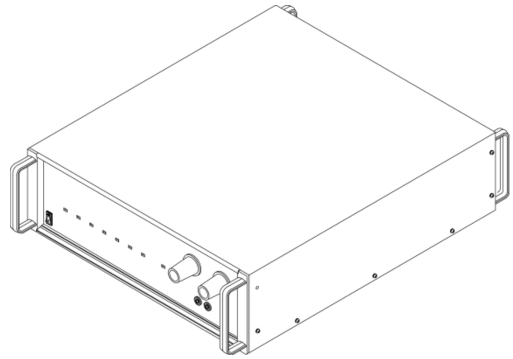

Figure 1-8
Rotek Model 8145

Model 8146 **200 Ampere, 400W Current Amplifier.**
The Rotek Model 8146 extends the maximum current output of the Model 8100 from 55A to 220A. The Model 8146 can deliver 50A at 8V compliance, 100A at 4V compliance and 200A at 2V compliance. The Model 8146 may be used with the Model 8100 or as a stand-alone current / transconductance amplifier. When used as an accessory to the Model 8100 the amplifier is connected to the calibrator using a single interconnection cable. All functions of the amplifier are controlled entirely by the Model 8100. When connected, all current outputs are obtained from the output terminals of the Model 8146 so it is not necessary to change lead connections when changing outputs from low to high currents.

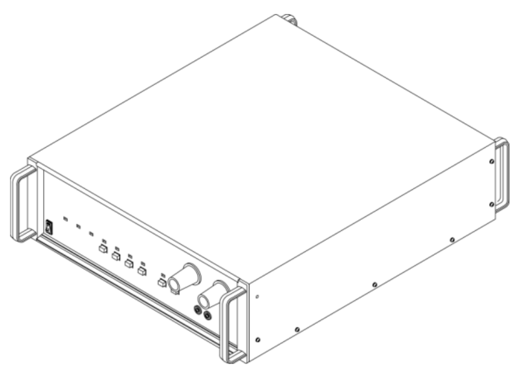

Figure 1-9
Rotek Model 8146

Model 8180 **DC Adapter.**

The Rotek Model 8180 DC Adapter is an accessory to the Model 8100. The Model 8180 provides the Model 8100 with DC voltage and current outputs. The Model 8180 provides DC outputs suitable for the calibration of 1 to 5% analog panel meters. In addition, the Model 8180 may be used to calibrate digital panel meters and DMMs. The Model 8180 converts the AC voltage and current outputs of the Model 8100 to DC voltage and current available at the Model 8180 output terminals.

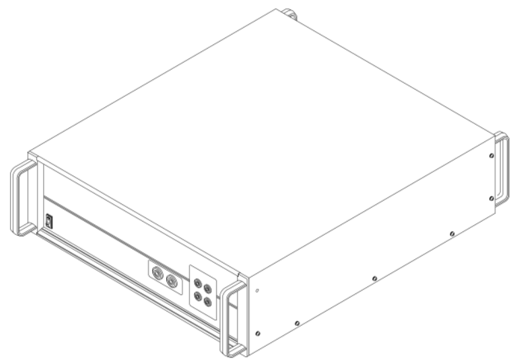

Figure 1-10
Rotek Model 8180

Model MSB100 **Primary Power/Energy Reference Standard.**
The Rotek Model MSB100 is a primary watt and watt-hour reference standard that performs at a new level of power and energy measurement accuracy. It provides reliable, accurate traceability to N.I.S.T. or other national standards worldwide. Versatile measurement ranges allow the MSB100 to be the single instrument necessary to calibrate a wide range of watt and watt-hour meters. The sophisticated power measurement technology used by the Model MSB100 allows measurement accuracies that are unsurpassed by any instrument in its class. This exceptional performance is maintained regardless of phase angle, greatly simplifying power measurements at near zero Power Factor.

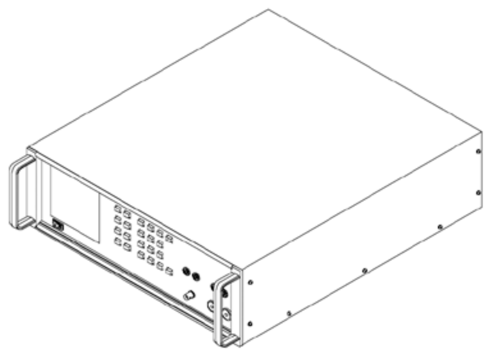

Figure 1-11
Rotek Model MSB100

8100-USIT **Automatic Meter Calibration Software.**
The 8100-USIT Energy Meter Test Software automates the testing and verification of energy meters using the Model 8100. Test results are recorded in a database and the software has the capability to generate a report of calibration that meets the requirements of ISO 9000. The 8100-USIT software controls the Model 8100 via the IEEE-488 interface or the RS-232 interface. All energy measurements are made using either the Model 8100's two built in pulse counters or the Model 8120's six pulse counters. All configuration and control of the Model 8100 is performed by the software and once a test is started there is no operator intervention required.

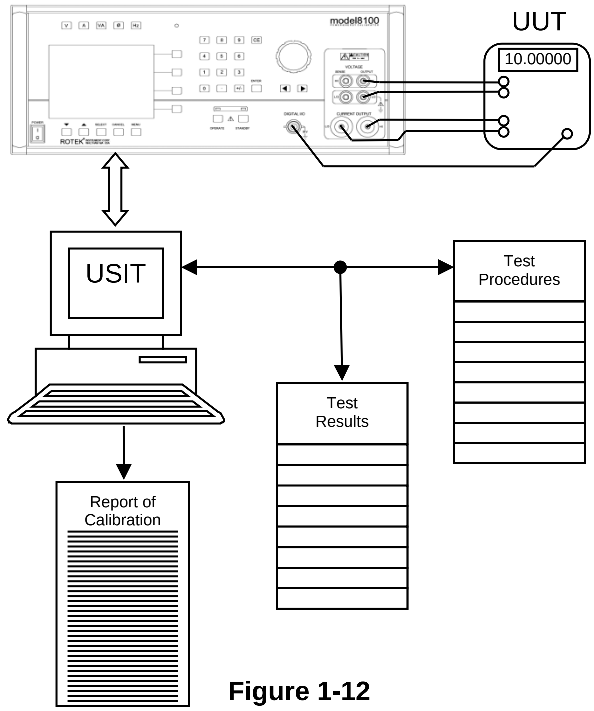

Figure 1-12
Rotek 8100-USIT

8100-CAL **Model 8100 Calibration/Adjustment Software.**

The Model 8100 Calibration and Adjustment software is designed to support and maintain the Model 8100 to factory specifications. The software works in conjunction with the Rotek Model MSB100 and the Agilent Model 3458A Multimeter to perform all calibrations and adjustments required by the Model 8100. Once a test is initiated all adjustments and measurements are performed with no operator intervention. Test results are stored in a database and the included report generator produces all required documentation of the test results.

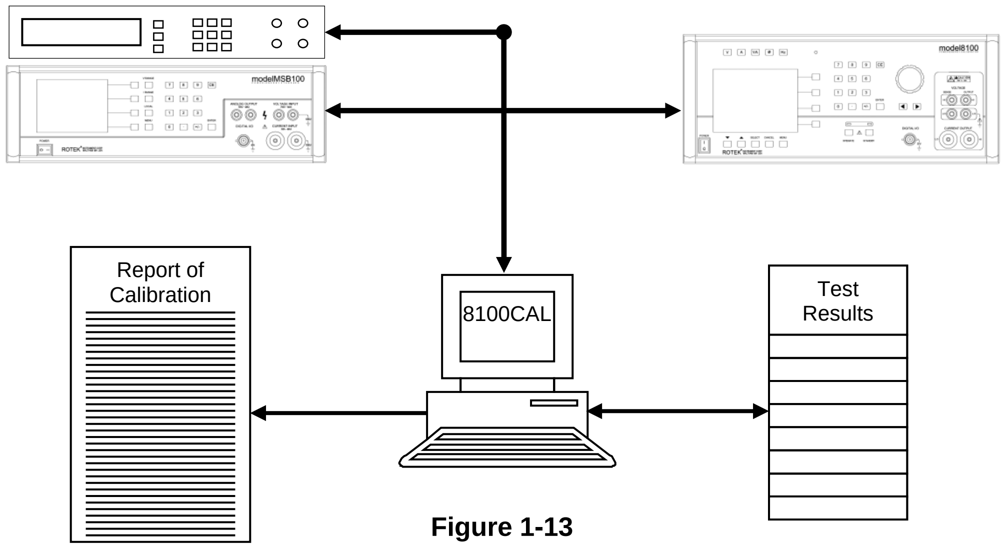

Figure 1-13
Rotek 8100-CAL

OPT-1 **Infrared LED Detector**
The Model OPT-1 detects the flashing of an infrared LED and converts it to pulses that may be counted by the Model 8100 or the Model 8120.

OPT-1V **Visible LED Detector**
The Model OPT-1 detects the flashing of an visible LED and converts it to pulses that may be counted by the Model 8100 or the Model 8120.

OPT-1S **Stand with Flexible Arm**
The Model OPT-1S is a stand with a flexible arm that is design to support both the Model OPT-1 and the OPT-1V and allow the detectors to be aimed at the LED source.

8100-80A **80A Current Extension**
The Option 8100-80A extends the maximum current output of the Model 8100 from 55A to 80A. This option is an internal option to the Model 8100 and does not change the exterior dimensions or weight of the calibrator.

8100-1KV **1000V Voltage Extension**
The Option 8100-1KV extends the maximum voltage output of the Model 8100 from 700V to 1056V. This option is an internal option to the Model 8100 and does not change the exterior dimensions or weight of the calibrator.

8100-RM **Rack Mount Ears.**
Rack mount ears for mounting the Model 8100 in a standard 19” rack.

8100-OPT **Optical Disk Rotation Detector.**
The Option 8100-OPT is an optical disk rotation detector to be used in the test of energy meters with a rotating disk but no pulse output. The detector is connected either directly to the Model 8100 via the standard pulse input connector or any of the 6 pulse input connectors of the Model 8120.

8100-OPA **Optical Port Adapter.**
The Option 8100-OPA is an optical port adapter used to read the test pulse generated by most electronic energy meters. The adapter is connected either directly to the Model 8100 via the standard pulse input connector or any of the 6 pulse input connectors of the Model 8120.

8100-ETH **Ethernet Interface Adapter.**
The Option 8100-ETH is an adapter that allows the standard RS-232 serial interface of the Model 8100 to be connected to an IP based Ethernet network. Using this adapter remote commands and queries may be sent to the calibrator using an Ethernet network instead of the Model 8100's standard serial or GPIB interfaces.

8100-CASE **Re-usable Shipping Container.**
The option 8100-CASE is a re-useable shipping container designed specifically for the Model 8100. This case provides a secure means to transport or store the Model 8100.

8100-LS50 **50 Ampere Current Lead Set**
The Option 8100-LS50 is a 50 Ampere current lead set for use with the Model 8100 consisting of 2 leads. The lead set has a length of 1 meter and is constructed of highly flexible 5 gauge reinforced insulated stranded wire. One end of each lead is terminated with Multicontact connector #15.0020-21, the high current mating connector for the Model 8100 current output terminals. The other end of each lead is terminated with a ½ inch ring terminal. One option 8100-LS50 is included with each new Model 8100 as the standard high current lead set.

8100- LSLC **Low Current.**
The Option 8100-LSLC is a 10 Ampere current lead set for use with the Model 8100 consisting of 2 leads, one red and one black. The lead set has a length of 1 meter and is constructed of highly flexible 18 gauge insulated stranded wire. Both ends of each lead are terminated with vertical stacking right angle banana plugs. Each lead is rated at 10 Amperes and 30VAC. One option 8100-LSLC lead set is included with each new Model 8100 as the standard low current lead set.

8100- LSV **Voltage Output Lead Set.**
The Option 8100-LSV is a voltage lead set for use with the Model 8100 consisting of 2 leads, one red and one black. The lead set has a length of 1 meter and is constructed of highly flexible 18 gauge insulated stranded wire. Both ends of each lead are terminated with vertical stacking retractable sheath

banana plugs. Each lead is rated at 5 Amperes and 1200VAC. One option 8100-LSV lead set is included with each new Model 8100 as the standard voltage lead set.

8100- LF	**Low frequency Output Option.** The Option 8100-LF extends the Voltage and Current fundamental output frequency below the standard minimum output frequency of 25Hz. With the option 8100-LF installed the Voltage and Current fundamental output frequency range is 16Hz – 1000Hz.

Accessory Connection

The Model 8100 may be configured to work with external accessories such as the Model 8120 Pulse Counter / Comparator and the Model 8145/8146 High Current Amplifier. While the Model 8146 and the Model 8120 may be operated as stand-alone devices they may also be connected to the Model 8100 to work as an integrated system.

Connection of each accessory to the Model 8100 is accomplished using a single accessory cable between the Model 8100 and the accessory. Each Model 8100 has two accessory connectors located on the rear panel. Either connector may be used to connect to any accessory. Accessory connections may be 'Daisy-Chained' as required.

Model 8120

When the Model 8120 is operated as an accessory to the Model 8100 it provides up to 6 channels of digital pulse counter inputs and one channel digital output. This supplements the two channels of digital inputs available on the Model 8100.

Figure 1-14 illustrates the Model 8100 and the Model 8120.

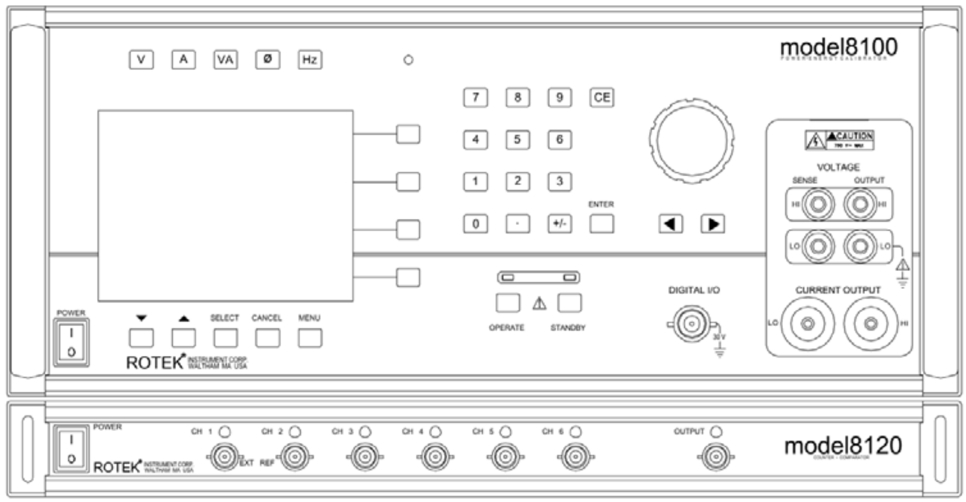

Figure 1-14
Model 8100 – Model 8120 (Front View)

The rear panel accessory connection of the Model 8120 to the Model 8100 is illustrated in Figure 1-15.

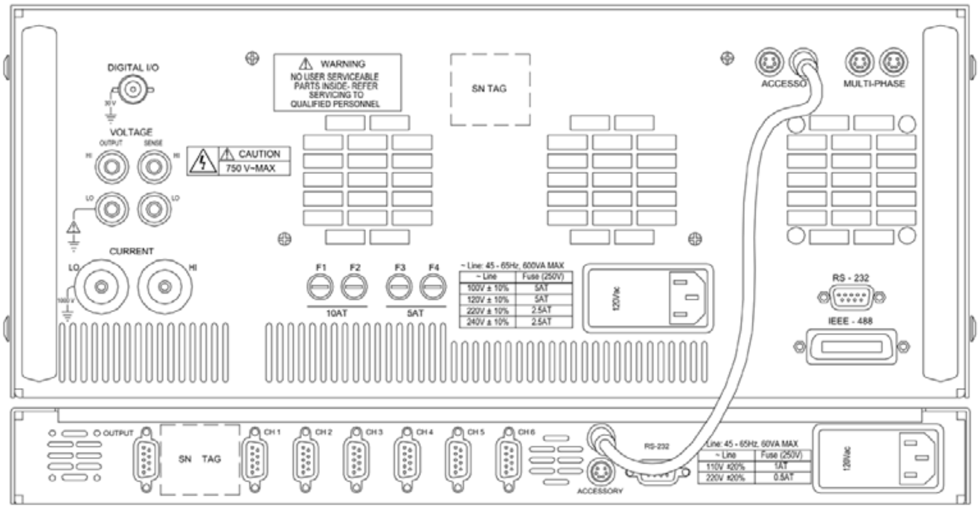

Figure 1-15
Model 8100 – Model 8120 (Rear View)

Model 8145

The Model 8145 is an accessory to the Model 8100 that extends the maximum current output of the Model 8100 from 55A to 220A. The Model 8145 can deliver 50A at 8V, 100A at 4V and 200A at 2V. All functions of the amplifier are controlled by the Model 8100 and all current outputs are obtained from the output terminals of the Model 8145. The Model 8145 output accuracy is controlled directly by the Model 8100 and cannot be used as a standalone amplifier.

Figure 1-16 illustrates the Model 8100 and Model 8145.

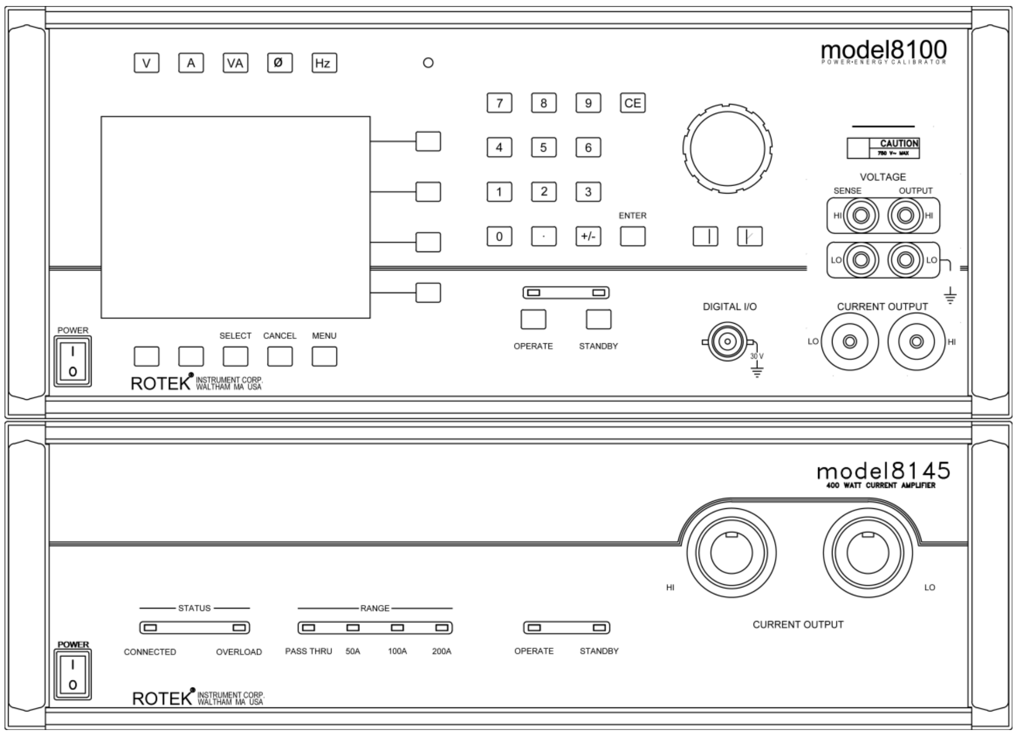

Figure 1-16
Model 8100 – Model 8145 (Front View)

The rear panel accessory connection of the Model 8145 to the Model 8100 is illustrated in Figure 1-17.

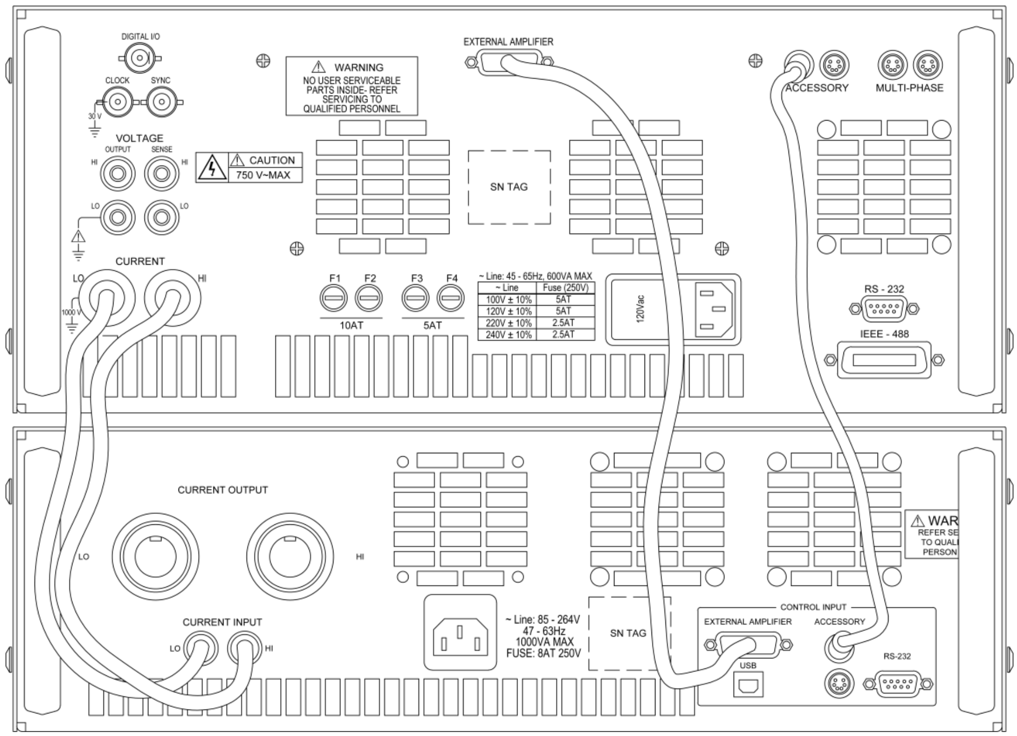

Figure 1-17
Model 8100 – Model 8145 (Rear View)

Model 8146

When the Model 8146 is operated as an accessory to the Model 8100 it extends the maximum current output of the Model 8100 from 55A to 220A. The Option 8146-300A is extends the maximum current output to 300A. The Model 8146 can deliver 50A at 8V, 100A at 4V and 200A at 2V. The Model 8146 can deliver 1.2V of voltage compliance at 300A with the Option 8146-300A. All functions of the amplifier are controlled by the Model 8100 and all current outputs are obtained from the output terminals of the Model 8146.

Performance specifications for the Model 8146 when operated as a stand-alone Transconductance amplifier or as an accessory to the Model 8100 are included in the Model 8146 Operating manual.

Figure 1-18 illustrates the Model 8100 and Model 8146.

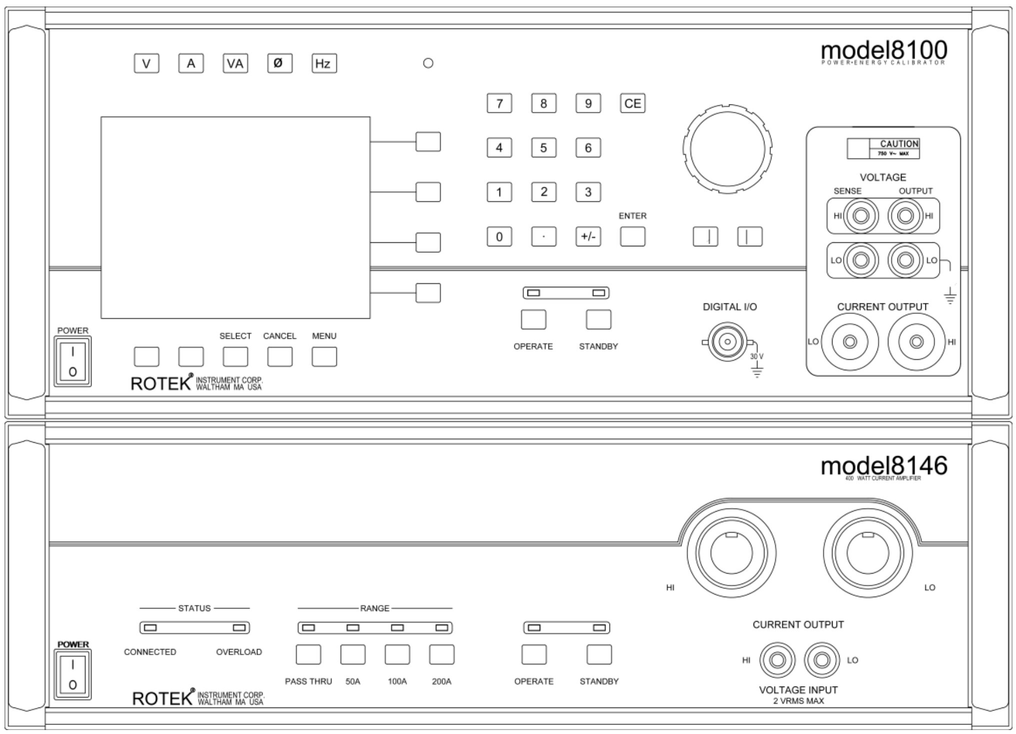

Figure 1-18
Model 8100 – Model 8146 (Front View)

The rear panel accessory connection of the Model 8146 to the Model 8100 is illustrated in Figure 1-19.

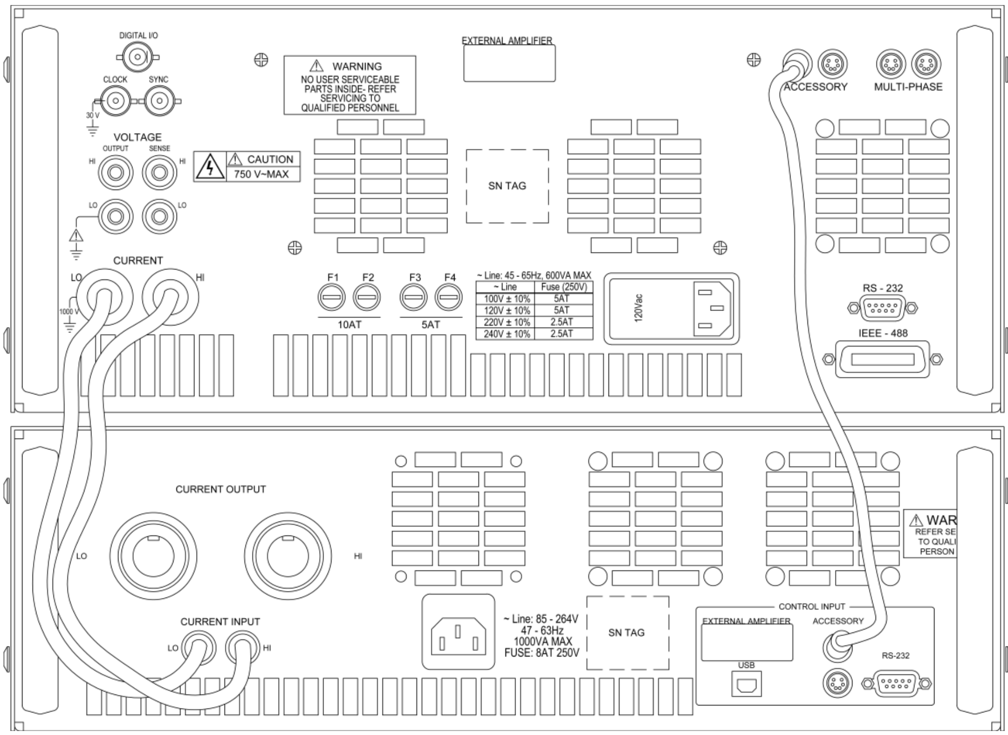

Figure 1-19
Model 8100 – Model 8146 (Rear View)

Model 8180 The Model 8180 is an accessory to the Model 8100 adding DC voltage and current output capability to the Model 8100.

Figure 1-20 illustrates the Model 8100 and Model 8180. Normal AC voltage and current outputs are available from the Model 8100 output terminals. DC voltage and current outputs are available from the output terminals of the Model 8180.

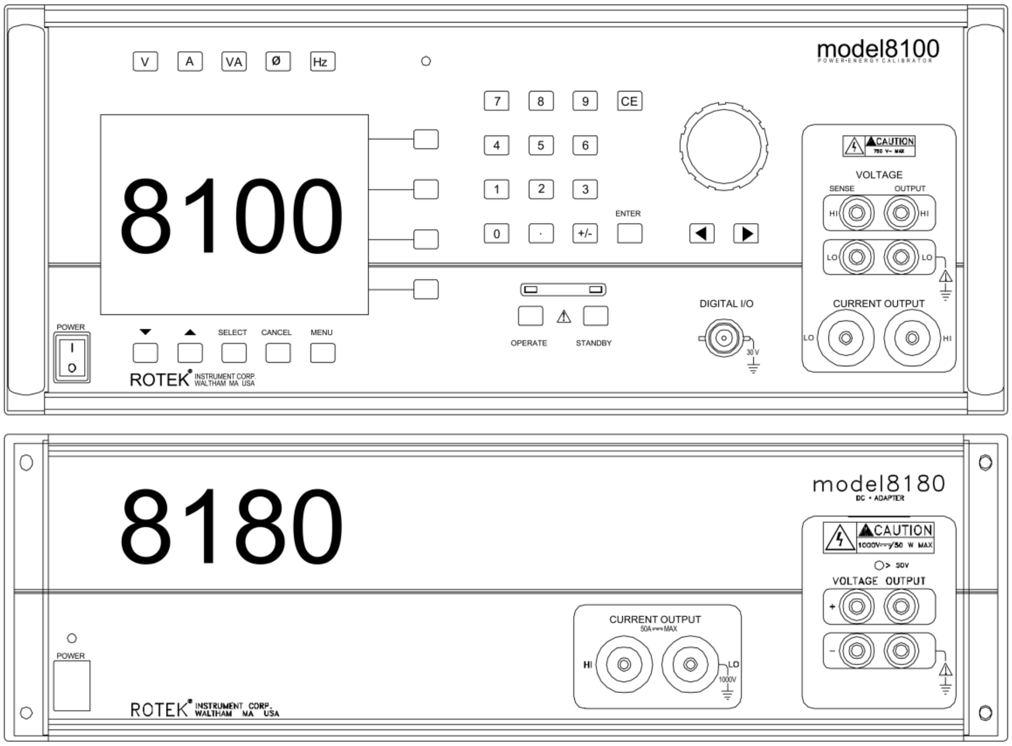

Figure 1-20
Model 8100 – Model 8180 (Front View)

The Model 8180 is connected to the Model 8100 using the supplied cable sets and the rear panel output terminals of the Model 8100. These connections are illustrated in Figure 1-21.

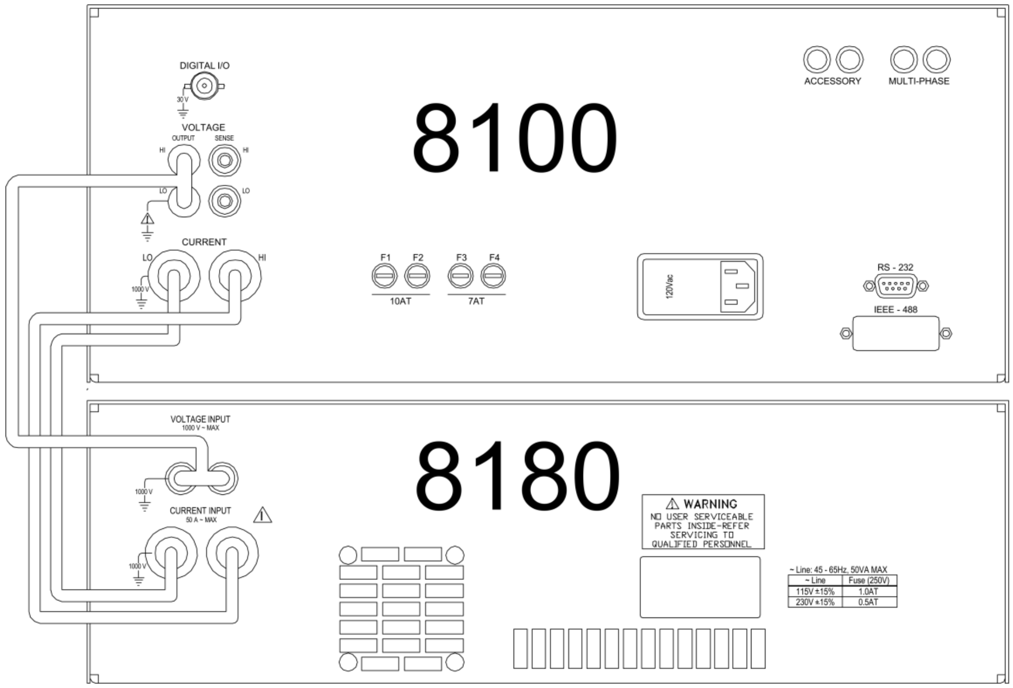

Figure 1-21
Model 8100 – Model 8180 (Rear View)

Model 8180 Specifications

Specifications apply after 60 minutes of warm-up at an ambient temperature of 23 ±5°C, a line frequency of 50 to 60Hz, at nominal line voltage ±10%, including loading and is maintained for a period of not less than 12 months. All specifications are described as maximum limits unless otherwise stated and are subject to change without notice.

Ranges of operation:

Voltage, 1V – 900VDC
Current, 1mA – 50ADC

Voltage Accuracy:

0.25% of setting, for voltage settings > 20V
0.25% of setting + 0.15V, for voltage settings <= 20V

Current Accuracy:

0.25% of setting

Loading:

Specified at 1mA (1k ohm/V) >= 100V and 100k < 100V
De-rate at 0.25% per k ohm

Current Compliance:

Current 1mA – 5A, 5V max
Current 10A – 50A, 1V max

Theory of Operation

The Model 8100 is a Power Calibration Source for periodic signals which consists of digitally synthesized voltage and current channels, the outputs of which are controlled by synchronous sampled feedback. This system results in accurate voltage and current waveform conformity and stability in amplitude and phase at high power levels, regardless of power factor or in-band frequency. The system compensates for errors in calibration normally caused by amplifier non-linearity and loading.

This system was introduced by Rotek with the Model 8000 in 1995 and is covered by United States Patent Number 5,642,300. Continued development of the synchronous sampled feedback system has resulted in the exceptional performance of the Model 8100.

The Model 8100 is designed to test power and energy meters in the frequency range 16Hz to 1000Hz over a wide range of voltages, currents and phase angle values. The calibrator provides sufficient power on both the voltage and current channels to activate the power or energy meters using the "phantom load" test method.

The Model 8100 uses synthesizers and wide band amplifiers to generate repetitive voltage and current waveforms. The amplified output waveforms (current and voltage) are controlled by synchronous, sampled feedback to be faithfully amplified reproductions of the reference waveforms. This is illustrated by reference to Figure 1-22 and Figure 1-23, which show, respectively, a block diagram of typical voltage and current channels and the timing for the sampling of the feedback error.

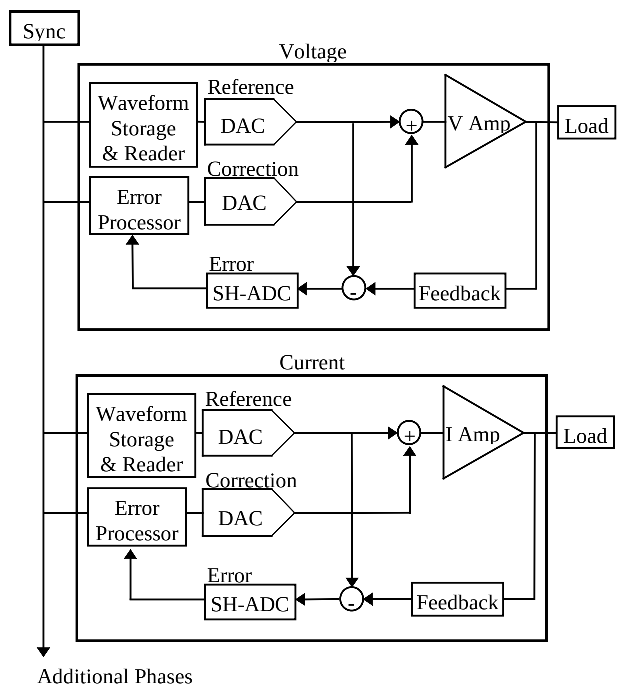

Figure 1-22
Synchronous Sampled Feedback Block Diagram

Figure 1-22 describes each channel as having in its forward path a digital waveform storage and reader, a reference DAC (digital to analog converter) and a power amplifier; and in its feedback and correction path, a feedback circuit, an analog subtractor, a sample-hold ADC (analog to digital converter), an error processor and a correction DAC. The circuits of the power amplifier include transformers to obtain a range of output values, 1-1056 volts, and 0.001 to 330 amperes.

Referring to Figure 1-23, the reference waveform (shown in bold) is composed of a number N of discrete intervals of duration τ, where $T = N\tau$. T is the period of the repetitive waveform. At each interval n, the feedback signal is subtracted from the discrete value of the reference to form an error for that interval in a particular cycle. The error value is digitized and stored in the error processor which, in its simplest form, is N integrators, one for each interval of the waveform. The typical n^{th} interval integrator sums the errors at the n^{th} interval of all the past cycles. This sum is used in the n^{th} interval by applying it to the Correction DAC at the beginning point of the interval. The error is sampled at the end of the interval, to give the reference DAC time to settle to its final value. Feedback and correction make the value of the scaled output equal to the reference at the sampling point in each of the N intervals.

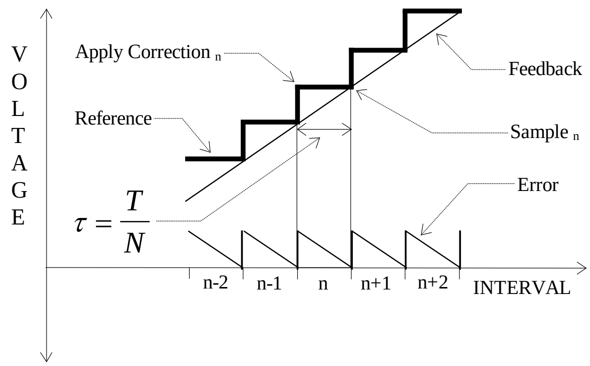

Figure 1-23
Timing for Sampling of Feedback

In the Model 8100 the normalized current and voltage reference waveforms are computed from an algorithm, creating at the N points the values to generate the correct phase between voltage and current. The outputs are adjusted to standard values on each range by applying corrections for amplitude and phase angle settings, using artifact commercial standards to provide the standard values. These corrections are then used in the waveform algorithm for phase, and in the computation of amplitude settings for the reference DACs mentioned previously.

It is not uncommon for modern power and energy meters to present a dynamic load to the output of the calibrator. A common dynamic load is a switching power supply connected to the voltage output. Such a load can cause severe distortion to the voltage output waveform. An example of this distortion is illustrated in Figure 1-24.

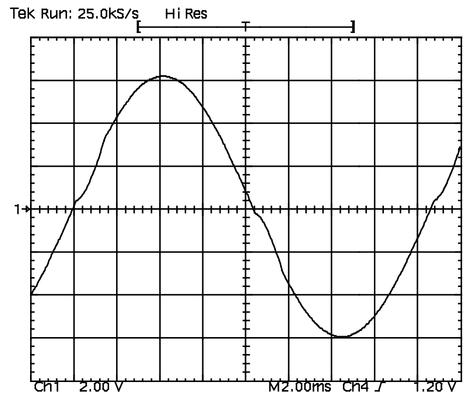

Figure 1-24
Voltage Output with Dynamic Load

Figure 1-25 shows that when a sampled feedback correction is applied to the voltage output, the distortion caused by the switching power supply is removed. Figure 1-25 shows both the corrected voltage output waveform and the correction signal required to compensate for the dynamic load.

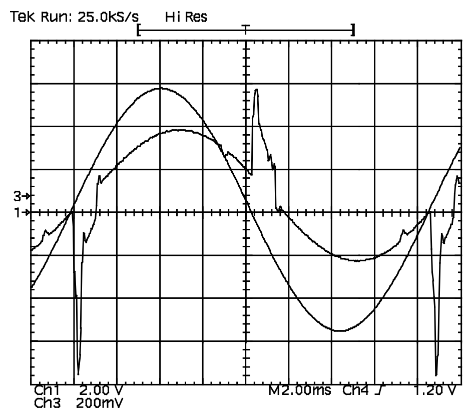

Figure 1-25
Voltage Output with Dynamic Load and Correction Signal

Specifications

Specifications apply after 60 minutes of warm-up at an ambient temperature of 23 ±5°C, a line frequency of 50 to 60Hz, at nominal line voltage ±10%, including loading and is maintained for a period of not less than 12 months. All specifications are described as maximum limits unless otherwise stated and are subject to change without notice.

Voltage

Setting Range: 1.00000V - 700.000V
1.00000V - 1056.00V With Option 8100-1KV

Setting Resolution: 6 digits via Front Panel Control (0.00001V)
7 digits via Remote Control (0.000001V)

Settling Time: < 2 seconds after setting change (Normal Mode, < 450Hz)
< 15 seconds after setting change (Normal Mode, > 450Hz)
< 15 seconds after setting change (Reactive Mode)

Maximum Overshoot: 10% of Setting at 'OPERATE'

DC Offset: Negligible - Transformer Coupled Output

Range Selection: Automatic

Sensing Modes: Internal (2 Wire)
External (4 Wire)

Ranges

Range (V)	Minimum Setting (RMS V)	Maximum Setting (RMS V)	Maximum Setting (Peak V)
20	1.00000	21.9999	31.1126
120	22.0000	131.999	186.675
240	132.000	263.999	373.351
480	264.000	527.999	746.703
640	528.000	700.000	989.949
1000*	528.000	1056.00	1493.409

* With Option 8100-1KV

Stability, 24hr

Range (V)	Setting (V)	±(% Setting+V)			
		40-70Hz	25-200, 400Hz	< 25‡, 200-600Hz	600-1000Hz
20	1.00000-21.9999	0.001+0.002	0.002+0.002	0.005+0.002	0.050+0.002
120	22.0000-131.999	0.001+0.004	0.002+0.004	0.005+0.004	0.050+0.004
240	132.000-263.999	0.001+0.008	0.002+0.008	0.005+0.008	0.050+0.008
480	264.000-527.999	0.001+0.016	0.002+0.016	0.005+0.016	0.050+0.016
640	528.000-700.000	0.001+0.020	0.002+0.020	0.005+0.020	0.050+0.020
1000*	528.000-1056.00	0.001+0.032	0.002+0.032	0.005+0.032	0.050+0.032

* With Option 8100-1KV
‡ With Option 8100-LF

Reactive Mode

Range (V)	Setting (V)	±(% Setting+V)			
		40-70Hz	25-200, 400Hz	< 25‡, 200-600Hz	600-1000Hz
20	1.00000-21.9999	0.015+0.002	0.025+0.002	0.025+0.002	0.050+0.002
120	22.0000-131.999	0.015+0.004	0.025+0.004	0.025+0.004	0.050+0.004
240	132.000-263.999	0.015+0.008	0.025+0.008	0.025+0.008	0.050+0.008
480	264.000-527.999	0.015+0.016	0.025+0.016	0.025+0.016	0.050+0.016
640	528.000-700.000	0.015+0.020	0.025+0.020	0.025+0.020	0.050+0.020
1000*	528.000-1056.00	0.015+0.032	0.025+0.032	0.025+0.032	0.050+0.032

* With Option 8100-1KV
‡ With Option 8100-LF

Accuracy

Range (V)	Setting (V)	±(% Setting+V) 40-70Hz	25-200,400Hz	< 25‡, 200-600Hz	600-1000Hz
20	1.00000-21.9999	0.011+0.002	0.017+0.002	0.050+0.002	0.100+0.002
120	22.0000-131.999	0.010+0.004	0.015+0.004	0.050+0.004	0.100+0.004
240	132.000-263.999	0.010+0.008	0.015+0.008	0.050+0.008	0.100+0.008
480	264.000-527.999	0.012+0.016	0.018+0.016	0.065+0.016	0.100+0.016
640	528.000-700.000	0.015+0.020	0.023+0.020	0.075+0.020	0.100+0.020
1000*	528.000-1056.00	0.015+0.032	0.023+0.032	0.075+0.032	0.100+0.032

* With Option 8100-1KV
‡ With Option 8100-LF

Reactive Mode

Range (V)	Setting (V)	±(% Setting+V) 40-70Hz	25-200,400Hz	< 25‡, 200-600Hz	600-1000Hz
20	1.00000-21.9999	0.033+0.002	0.051+0.002	0.050+0.002	0.100+0.002
120	22.0000-131.999	0.030+0.004	0.045+0.004	0.050+0.004	0.100+0.004
240	132.000-263.999	0.030+0.008	0.045+0.008	0.050+0.008	0.100+0.008
480	264.000-527.999	0.036+0.016	0.054+0.016	0.065+0.016	0.100+0.016
640	528.000-700.000	0.045+0.020	0.069+0.020	0.075+0.020	0.100+0.020
1000*	528.000-1056.00	0.045+0.032	0.069+0.032	0.075+0.032	0.100+0.032

* With Option 8100-1KV
‡ With Option 8100-LF

Capacitive Loading

Range (V)	Setting (V)	Max. Capacitance (nF) 16-75Hz	75-450Hz	450-600Hz	600-1000Hz
20	1.00000-21.9999	500	200	200	100
120	22.0000-131.999	300	20	150	100
240	132.000-263.999	100	5	100	50
480	264.000-527.999	33	5	10	5
640	528.000-700.000	20	2	10	5
1000*	528.000-1056.00	10	2	10	5

* With Option 8100-1KV

Reactive Mode

Range (V)	Setting (V)	Max. Capacitance (nF) 16-75Hz	75-450Hz	450-600Hz	600-1000Hz
20	1.00000-21.9999	1000	500	200	100
120	22.0000-131.999	1000	250	150	100
240	132.000-263.999	1000	150	100	50
480	264.000-527.999	100	60	10	5
640	528.000-700.000	100	60	10	5
1000*	528.000-1056.00	60	40	10	5

* With Option 8100-1KV

Burden

Range (V)	Setting (V)	Maximum Burden (mA RMS)	Maximum Burden (mA peak)
20	1.00000-21.9999	1000	1400
120	22.0000-131.999	440	620
240	132.000-263.999	220	310
480	264.000-527.999	110	155
640	528.000-700.000	80	110
1000*	528.000-1056.00	50	70

* With Option 8100-1KV

Harmonic Distortion

Range	Setting	THD (%)			
(V)	(V)	16-200Hz	200-400Hz	400-600Hz	600-1000Hz
20	1.00000-21.9999	0.100	0.100	0.100	0.200
120	22.0000-131.999	0.100	0.100	0.100	0.200
240	132.000-263.999	0.100	0.100	0.100	0.200
480	264.000-527.999	0.150	0.400	0.100	0.200
640	528.000-700.000	0.150	0.250	0.100	0.200
1000*	528.000-1056.00	0.150	0.250	0.100	0.200

* With Option 8100-1KV

Reactive Mode

Range	Setting	THD (%)			
(V)	(V)	16-200Hz	200-400Hz	400-600Hz	600-1000Hz
20	1.00000-21.9999	0.250	0.100	0.100	0.200
120	22.0000-131.999	0.250	0.100	0.100	0.200
240	132.000-263.999	0.250	0.100	0.100	0.200
480	264.000-527.999	0.250	0.100	0.100	0.200
640	528.000-700.000	0.250	0.100	0.100	0.200
1000*	528.000-1056.00	0.250	0.100	0.100	0.200

* With Option 8100-1KV

Current

Setting Range: 1.00000mA - 55.0000A
1.00000mA - 80.0000A With Option 8100-80A
1.00000mA - 330.000A With Model 8145 Current Amplifier
1.00000mA - 330.000A With Model 8146 Current Amplifier

Setting Resolution: 6 digits via Front Panel Control (0.00001mA)
7 digits via Remote Control (0.000001mA)

Settling Time: < 2 seconds after setting change (Normal Mode, < 450Hz)
< 15 seconds after setting change (Normal Mode, > 450Hz)
< 15 seconds after setting change (Reactive Mode)

Maximum Overshoot: 10% of Setting at ‘OPERATE’

DC Offset: Negligible - Transformer Coupled Output

Range Selection: Automatic

Ranges

Range (A)	Minimum Setting (RMS A)	Maximum Setting (RMS A)	Maximum Setting (Peak A)
0.015	0.00100	0.01829	0.02587
0.050	0.01830	0.05499	0.77768
0.150	0.05500	0.18299	0.25879
0.500	0.18300	0.54999	0.77780
1.500	0.55000	1.82999	2.58800
5.000	1.83000	5.49999	7.77816
10.00	5.50000	10.9999	15.5562
20.00	11.0000	21.9999	31.1126
50.00	22.0000	55.0000	77.7818
80.00†	22.0000	80.0000	113.137
50.00*	5.50000	55.0000	77.7818
100.0*	55.0000	110.000	155.563
200.0*	110.000	220.000	311.127
300.0§	110.000	330.000	466.690

† With Option 8100-80A
* With Optional Model 8145 Current Amplifier, § With Option 8145-300A

Stability, 24hr

Range (A)	Setting (A)	±(% Setting + mA) 40-70Hz	25-200,400Hz	< 25‡, 200-600Hz	600-1000Hz
0.015	0.00100-0.01829	0.003+0.002	0.005+0.002	0.020+0.002	0.100+0.002
0.050	0.01830-0.05499	0.003+0.002	0.005+0.002	0.020+0.002	0.100+0.002
0.150	0.05500-0.18299	0.003+0.003	0.005+0.003	0.020+0.003	0.100+0.003
0.500	0.18300-0.54999	0.003+0.006	0.005+0.006	0.020+0.006	0.100+0.006
1.500	0.55000-1.82999	0.003+0.020	0.005+0.020	0.020+0.020	0.100+0.020
5.000	1.83000-5.49999	0.003+0.060	0.005+0.060	0.020+0.060	0.100+0.060
10.00	5.50000-10.9999	0.004+0.100	0.005+0.100	0.020+0.100	0.100+0.100
20.00	11.0000-21.9999	0.005+0.200	0.005+0.200	0.020+0.200	0.100+0.200
50.00	22.0000-55.0000	0.006+0.400	0.007+0.400	0.025+0.400	0.150+0.400
80.00†	22.0000-80.0000	0.006+0.700	0.010+0.700	0.030+0.700	0.200+0.700
50.00*	5.50000-55.0000	0.006+1.200	0.010+1.200	-	-
100.0*	55.0000-110.000	0.006+1.600	0.010+1.600	-	-
200.0*	110.000-220.000	0.006+3.200	0.010+3.200	-	-
300.0§	110.000-330.000	0.008+6.400	0.012+6.400	-	-

† With Option 8100-80A
‡ With Option 8100-LF
* With Optional Model 8145 Current Amplifier, § With Option 8145-300A

Accuracy

Range (A)	Setting (A)	±(% Setting + mA) 40-70Hz	25-200,400Hz	< 25‡, 200-600Hz	600-1000Hz
0.015	0.00100-0.01829	0.016+0.005	0.024+0.005	0.200+0.005	1.000+0.005
0.050	0.01830-0.05499	0.014+0.005	0.021+0.005	0.200+0.005	1.000+0.005
0.150	0.05500-0.18299	0.012+0.006	0.018+0.006	0.200+0.006	1.000+0.006
0.500	0.18300-0.54999	0.012+0.012	0.018+0.012	0.200+0.012	1.000+0.012
1.500	0.55000-1.82999	0.012+0.040	0.018+0.040	0.200+0.040	1.000+0.040
5.000	1.83000-5.49999	0.012+0.120	0.018+0.120	0.200+0.120	1.000+0.120
10.00	5.50000-10.9999	0.016+0.200	0.024+0.200	0.200+0.200	1.000+0.200
20.00	11.0000-21.9999	0.020+0.600	0.050+0.600	0.200+0.600	1.000+0.600
50.00	22.0000-55.0000	0.030+1.000	0.060+1.000	0.200+1.000	1.000+1.000
80.00†	22.0000-80.0000	0.030+1.600	0.060+1.600	0.200+1.600	1.000+1.600
50.00*	5.50000-55.0000	0.050+8.000	0.200+8.000	-	-
100.0*	55.0000-110.000	0.050+16.00	0.200+16.00	-	-
200.0*	110.000-220.000	0.050+32.00	0.200+32.00	-	-
300.0§	110.000-330.000	0.075+64.00	0.200+64.00	-	-

† With Option 8100-80A
‡ With Option 8100-LF
* With Optional Model 8145 Current Amplifier, § With Option 8145-300A

Reactive Mode

Range (A)	Setting (A)	±(% Setting + mA) 40-70Hz	25-200,400Hz	< 25‡, 200-600Hz	600-1000Hz
0.015	0.00100-0.01829	0.048+0.005	0.072+0.005	0.200+0.005	1.000+0.005
0.050	0.01830-0.05499	0.042+0.005	0.054+0.005	0.200+0.005	1.000+0.005
0.150	0.05500-0.18299	0.036+0.006	0.054+0.006	0.200+0.006	1.000+0.006
0.500	0.18300-0.54999	0.036+0.012	0.054+0.012	0.200+0.012	1.000+0.012
1.500	0.55000-1.82999	0.030+0.040	0.054+0.040	0.200+0.040	1.000+0.040
5.000	1.83000-5.49999	0.036+0.120	0.054+0.120	0.200+0.120	1.000+0.120
10.00	5.50000-10.9999	0.048+0.200	0.072+0.200	0.200+0.200	1.000+0.200
20.00	11.0000-21.9999	0.060+0.600	0.150+0.600	0.200+0.600	1.000+0.600
50.00	22.0000-55.0000	0.090+1.000	0.180+1.000	0.200+1.000	1.000+1.000
80.00†	22.0000-80.0000	0.090+1.600	0.180+1.600	0.200+1.600	1.000+1.600
50.00*	5.50000-55.0000	0.050+8.000	0.200+8.000	-	-
100.0*	55.0000-110.000	0.050+16.00	0.200+16.00	-	-
200.0*	110.000-220.000	0.050+32.00	0.200+32.00	-	-
300.0§	110.000-330.000	0.075+64.00	0.200+64.00	-	-

† With Option 8100-80A
‡ With Option 8100-LF
* With Optional Model 8145 Current Amplifier, § With Option 8145-300A

Compliance

Range (A)	Setting (A)	Max. Compliance (V RMS)	Max. Compliance (V peak)
0.015	0.00100-0.01829	20.0	28.0
0.050	0.01830-0.05499	20.0	28.0
0.150	0.05500-0.18299	20.0	28.0
0.500	0.18300-0.54999	15.0	21.0
1.500	0.55000-1.82999	15.0	21.0
5.000	1.83000-5.49999	15.0	21.0
10.00	5.50000-10.9999	7.00	10.0
20.00	11.0000-21.9999	3.00	4.00
50.00	22.0000-55.0000	1.00	1.40
80.00†	22.0000-80.0000	0.70	1.00
50.00*	5.50000-55.0000	8.00	11.0
100.0*	5.50000-110.000	4.00	5.50
200.0*	5.50000-220.000	2.00	2.80
300.0§	5.50000-330.000	1.20	1.70

† With Option 8100-80A

* With Optional Model 8145 Current Amplifier, § With Option 8145-300A

Inductive Loading

Range (A)	Setting (A)	Max. Inductive Load (μH)			
		16-100Hz	100-400Hz	400-600Hz	600-1000Hz
0.015	0.00100-0.01829	3600	1800	900	900
0.050	0.01830-0.05499	3600	1800	900	900
0.150	0.05500-0.18299	1800	1800	900	600
0.500	0.18300-0.54999	900	600	600	300
1.500	0.55000-1.82999	250	250	200	50
5.000	1.83000-5.49999	250	25	10	5
10.00	5.50000-10.9999	100	10	2	1
20.00	11.0000-21.9999	75	5	2	1
50.00	22.0000-55.0000	10	2	2	1
80.00†	22.0000-80.0000	7	1	2	1
50.00*	5.50000-55.0000	15	5	-	-
100.0*	55.0000-110.000	15	5	-	-
200.0*	110.000-220.000	15	5	-	-
300.0§	110.000-330.000	10	3	-	-

† With Option 8100-80A
* With Optional Model 8145 Current Amplifier, § With Option 8145-300A

Reactive Mode

Range (A)	Setting (A)	Max. Inductive Load (μH)			
		16-100Hz	100-400Hz	400-600Hz	600-1000Hz
0.015	0.00100-0.01829	3600	1800	900	900
0.050	0.01830-0.05499	3600	1800	900	900
0.150	0.05500-0.18299	3600	1800	900	600
0.500	0.18300-0.54999	1800	1000	600	300
1.500	0.55000-1.82999	600	500	200	50
5.000	1.83000-5.49999	600	50	10	5
10.00	5.50000-10.9999	200	25	2	1
20.00	11.0000-21.9999	150	10	2	1
50.00	22.0000-55.0000	20	2	2	1
80.00†	22.0000-80.0000	12	2	2	1
50.00*	5.50000-55.0000	15	5	-	-
100.0*	55.0000-110.000	15	5	-	-
200.0*	110.000-220.000	15	5	-	-
300.0§	110.000-330.000	10	3	-	-

† With Option 8100-80A
* With Optional Model 8145 Current Amplifier, § With Option 8145-300A

Harmonic Distortion

Range (A)	Setting (A)	THD (%) 16-100Hz	100-400Hz	400-600Hz	600-1000Hz
0.015	0.00100-0.01829	0.100	0.300	0.200	0.300
0.050	0.01830-0.05499	0.100	0.300	0.200	0.300
0.150	0.05500-0.18299	0.100	0.600	0.200	0.300
0.500	0.18300-0.54999	0.100	0.250	0.200	0.300
1.500	0.55000-1.82999	0.100	0.400	0.200	0.300
5.000	1.83000-5.49999	0.100	0.500	0.200	0.300
10.00	5.50000-10.9999	0.100	0.800	0.300	0.400
20.00	11.0000-21.9999	0.100	0.900	0.400	0.500
50.00	22.0000-55.0000	0.100	1.000	0.400	0.500
80.00†	22.0000-80.0000	0.100	1.000	0.400	0.500
50.00*	5.50000-55.0000	0.250	0.500	-	-
100.0*	55.0000-110.000	0.250	0.500	-	-
200.0*	110.000-220.000	0.250	0.500	-	-
300.0§	110.000-330.000	0.250	0.500	-	-

† With Option 8100-80A
* With Optional Model 8145 Current Amplifier, § With Option 8145-300A

Reactive Mode

Range (A)	Setting (A)	THD (%) 16-100Hz	100-400Hz	400-600Hz	600-1000Hz
0.015	0.00100-0.01829	0.100	0.200	0.200	0.300
0.050	0.01830-0.05499	0.100	0.200	0.200	0.300
0.150	0.05500-0.18299	0.100	0.200	0.200	0.300
0.500	0.18300-0.54999	0.100	0.200	0.200	0.300
1.500	0.55000-1.82999	0.100	0.200	0.200	0.300
5.000	1.83000-5.49999	0.100	0.200	0.200	0.300
10.00	5.50000-10.9999	0.150	0.200	0.300	0.400
20.00	11.0000-21.9999	0.300	0.300	0.400	0.500
50.00	22.0000-55.0000	0.500	0.300	0.400	0.500
80.00†	22.0000-80.0000	0.500	0.300	0.400	0.500
50.00*	5.50000-55.0000	0.250	0.500	-	-
100.0*	55.0000-110.000	0.250	0.500	-	-
200.0*	110.000-220.000	0.250	0.500	-	-
300.0§	110.000-330.000	0.250	0.500	-	-

† With Option 8100-80A
* With Optional Model 8145 Current Amplifier, § With Option 8145-300A

Active Power (P)

Setting Range: 0.00000W - 58.080kW
0.00000W - 348.480kW With Optional Range Extensions

Setting Resolution: 6 digits via Front Panel Control (0.00001mW)
7 digits via Remote Control (0.000001mW)

Units: Watts

Settling Time: < 2 seconds after setting change (Normal Mode, < 450Hz)
< 15 seconds after setting change (Normal Mode, > 450Hz)
< 15 seconds after setting change (Reactive Mode)

Stability, 24hr

Voltage Setting (V)	Current Setting (A)	±(% VA Setting + W)			
		40-70Hz	25-200,400Hz	< 25[1], 200-600Hz	600-1000Hz
1.00000-21.9999	0.00100-0.01829	0.004+0.001	0.006+0.001	0.020+0.001	0.100+0.001
	0.01830-0.05499	0.003+0.001	0.006+0.001	0.020+0.001	0.100+0.001
	0.05500-0.18299	0.003+0.001	0.006+0.001	0.020+0.001	0.100+0.001
	0.18300-0.54999	0.003+0.001	0.006+0.001	0.020+0.001	0.100+0.001
	0.55000-1.82999	0.003+0.002	0.006+0.002	0.020+0.002	0.100+0.002
	1.83000-5.49999	0.003+0.005	0.006+0.005	0.020+0.005	0.100+0.005
	5.50000-10.9999	0.003+0.010	0.006+0.010	0.020+0.010	0.100+0.010
	11.0000-21.9999	0.003+0.020	0.007+0.020	0.020+0.020	0.100+0.020
	22.0000-55.0000	0.003+0.040	0.008+0.040	0.020+0.040	0.100+0.040
	22.0000-80.0000†	0.003+0.070	0.008+0.070	0.020+0.070	0.100+0.070
	5.50000-55.0000*	0.006+1.000	0.020+1.000	-	-
	5.50000-110.000*	0.006+2.000	0.020+2.000	-	-
	5.50000-220.000*	0.006+4.000	0.020+4.000	-	-
	5.50000-330.000§	0.008+8.000	0.020+8.000	-	-
22.0000-131.999	0.00100-0.01829	0.002+0.001	0.007+0.001	0.020+0.001	0.100+0.001
	0.01830-0.05499	0.001+0.001	0.005+0.001	0.020+0.001	0.100+0.001
	0.05500-0.18299	0.001+0.001	0.005+0.001	0.020+0.001	0.100+0.001
	0.18300-0.54999	0.001+0.002	0.005+0.002	0.020+0.002	0.100+0.002
	0.55000-1.82999	0.001+0.005	0.005+0.005	0.020+0.005	0.100+0.005
	1.83000-5.49999	0.001+0.015	0.005+0.015	0.020+0.015	0.100+0.015
	5.50000-10.9999	0.002+0.030	0.006+0.030	0.020+0.030	0.100+0.030
	11.0000-21.9999	0.002+0.060	0.007+0.060	0.020+0.060	0.100+0.060
	22.0000-55.0000	0.003+0.120	0.008+0.120	0.020+0.120	0.100+0.120
	22.0000-80.0000†	0.003+0.200	0.008+0.200	0.020+0.200	0.100+0.200
	5.50000-55.0000*	0.006+1.000	0.020+1.000	-	-
	5.50000-110.000*	0.006+2.000	0.020+2.000	-	-
	5.50000-220.000*	0.006+4.000	0.020+4.000	-	-
	5.50000-330.000§	0.008+8.000	0.020+8.000	-	-
132.000-263.999	0.00100-0.01829	0.002+0.002	0.007+0.002	0.020+0.002	0.100+0.002
	0.01830-0.05499	0.001+0.002	0.005+0.002	0.020+0.002	0.100+0.002
	0.05500-0.18299	0.001+0.002	0.005+0.002	0.020+0.002	0.100+0.002
	0.18300-0.54999	0.001+0.004	0.005+0.004	0.020+0.004	0.100+0.004
	0.55000-1.82999	0.001+0.010	0.005+0.010	0.020+0.010	0.100+0.010
	1.83000-5.49999	0.001+0.030	0.005+0.030	0.020+0.030	0.100+0.030
	5.50000-10.9999	0.002+0.060	0.006+0.060	0.020+0.060	0.100+0.060
	11.0000-21.9999	0.002+0.120	0.007+0.120	0.020+0.120	0.100+0.120
	22.0000-55.0000	0.003+0.240	0.008+0.240	0.020+0.240	0.100+0.240
	22.0000-80.0000†	0.003+0.400	0.008+0.400	0.020+0.400	0.100+0.400
	5.50000-55.0000*	0.006+1.000	0.020+1.000	-	-
	5.50000-110.000*	0.006+2.000	0.020+2.000	-	-
	5.50000-220.000*	0.006+4.000	0.020+4.000	-	-
	5.50000-330.000§	0.008+8.000	0.020+8.000	-	-

† With Option 8100-80A
[1] With Option 8100-LF
* With Optional Model 8145 Current Amplifier, § With Option 8145-300A

Stability, 24hr (Continued)

Voltage Setting (V)	Current Setting (A)	±(% VA Setting + W)			
		40-70Hz	25-200,400Hz	< 25[1], 200-600Hz	600-1000Hz
	0.00100-0.01829	0.003+0.002	0.008+0.002	0.030+0.002	0.100+0.002
	0.01830-0.05499	0.002+0.002	0.008+0.002	0.030+0.002	0.100+0.002
	0.05500-0.18299	0.002+0.004	0.008+0.004	0.030+0.004	0.100+0.004
	0.18300-0.54999	0.002+0.008	0.008+0.008	0.030+0.008	0.100+0.008
	0.55000-1.82999	0.002+0.020	0.008+0.020	0.030+0.020	0.100+0.020
	1.83000-5.49999	0.002+0.060	0.008+0.060	0.030+0.060	0.100+0.060
264.000-527.999	5.50000-10.9999	0.002+0.120	0.008+0.120	0.003+0.120	0.100+0.120
	11.0000-21.9999	0.002+0.240	0.008+0.240	0.003+0.240	0.100+0.240
	22.0000-55.0000	0.003+0.480	0.008+0.480	0.030+0.480	0.100+0.480
	22.0000-80.0000†	0.003+0.800	0.008+0.800	0.030+0.800	0.100+0.800
	5.50000-55.0000*	0.006+1.000	0.020+1.000	-	-
	5.50000-110.000*	0.006+2.000	0.020+2.000	-	-
	5.50000-220.000*	0.006+4.000	0.020+4.000	-	-
	5.50000-330.000§	0.006+8.000	0.020+8.000	-	-
	0.00100-0.01829	0.004+0.002	0.008+0.002	0.040+0.002	0.100+0.002
	0.01830-0.05499	0.003+0.004	0.008+0.004	0.040+0.004	0.100+0.004
	0.05500-0.18299	0.003+0.008	0.008+0.008	0.040+0.008	0.100+0.008
	0.18300-0.54999	0.003+0.020	0.008+0.020	0.040+0.020	0.100+0.020
	0.55000-1.82999	0.003+0.040	0.008+0.040	0.040+0.040	0.100+0.040
	1.83000-5.49999	0.003+0.120	0.008+0.120	0.040+0.120	0.100+0.120
528.000-700.000	5.50000-10.9999	0.003+0.240	0.008+0.240	0.040+0.240	0.100+0.240
	11.0000-21.9999	0.003+0.480	0.008+0.480	0.040+0.480	0.100+0.480
	22.0000-55.0000	0.004+0.960	0.008+0.960	0.040+0.960	0.100+0.960
	22.0000-80.0000†	0.004+1.600	0.008+1.600	0.040+1.600	0.100+1.600
	5.50000-55.0000*	0.006+2.000	0.020+2.000	-	-
	5.50000-110.000*	0.006+4.000	0.020+4.000	-	-
	5.50000-220.000*	0.006+8.000	0.020+8.000	-	-
	5.50000-330.000§	0.006+16.00	0.020+16.00	-	-
	0.00100-0.01829	0.004+0.002	0.008+0.002	0.040+0.002	0.100+0.002
	0.01830-0.05499	0.003+0.004	0.008+0.004	0.040+0.004	0.100+0.004
	0.05500-0.18299	0.003+0.008	0.008+0.008	0.040+0.008	0.100+0.008
	0.18300-0.54999	0.003+0.020	0.008+0.020	0.040+0.020	0.100+0.020
	0.55000-1.82999	0.003+0.040	0.008+0.040	0.040+0.040	0.100+0.040
	1.83000-5.49999	0.003+0.120	0.008+0.120	0.040+0.120	0.100+0.120
528.000-1056.00‡	5.50000-10.9999	0.003+0.240	0.008+0.240	0.040+0.240	0.100+0.240
	11.0000-21.9999	0.003+0.480	0.008+0.480	0.040+0.480	0.100+0.480
	22.0000-55.0000	0.004+0.960	0.008+0.960	0.040+0.960	0.100+0.960
	22.0000-80.0000†	0.004+1.600	0.008+1.600	0.040+1.600	0.100+1.600
	5.50000-55.0000*	0.005+2.000	0.020+2.000	-	-
	5.50000-110.000*	0.005+4.000	0.020+4.000	-	-
	5.50000-220.000*	0.006+8.000	0.020+8.000	-	-
	5.50000-330.000§	0.006+16.00	0.020+16.00	-	-

† With Option 8100-80A

* With Optional Model 8145 Current Amplifier, § With Option 8145-300A

[1] With Option 8100-LF

‡ With Option 8100-1KV

Accuracy

Voltage Setting (V)	Current Setting (A)	±(% VA Setting + W)			
		40-70Hz	25-200,400Hz	< 25Δ, 200-600Hz	600-1000Hz
1.00000-21.9999	0.00100-0.01829	0.040+0.001	0.060+0.001	0.200+0.001	1.000+0.001
	0.01830-0.05499	0.030+0.001	0.060+0.001	0.200+0.001	1.000+0.001
	0.05500-0.18299	0.030+0.001	0.060+0.001	0.200+0.001	1.000+0.001
	0.18300-0.54999	0.030+0.001	0.060+0.001	0.200+0.001	1.000+0.001
	0.55000-1.82999	0.030+0.002	0.060+0.002	0.200+0.002	1.000+0.002
	1.83000-5.49999	0.030+0.005	0.060+0.005	0.200+0.005	1.000+0.005
	5.50000-10.9999	0.030+0.010	0.060+0.010	0.200+0.010	1.000+0.010
	11.0000-21.9999	0.030+0.020	0.070+0.020	0.200+0.020	1.000+0.020
	22.0000-55.0000	0.030+0.040	0.080+0.040	0.200+0.040	1.000+0.040
	22.0000-80.0000†	0.030+0.070	0.080+0.070	0.200+0.070	1.000+0.070
	5.50000-55.0000*	0.050+1.000	0.200+1.000	-	-
	5.50000-110.000*	0.050+2.000	0.200+2.000	-	-
	5.50000-220.000*	0.050+4.000	0.200+4.000	-	-
	5.50000-330.000§	0.075+8.000	0.200+8.000	-	-
22.0000-131.999	0.00100-0.01829	0.020+0.001	0.070+0.001	0.200+0.001	1.000+0.001
	0.01830-0.05499	0.010+0.001	0.050+0.001	0.200+0.001	1.000+0.001
	0.05500-0.18299	0.010+0.001	0.050+0.001	0.200+0.001	1.000+0.001
	0.18300-0.54999	0.010+0.002	0.050+0.002	0.200+0.002	1.000+0.002
	0.55000-1.82999	0.010+0.005	0.050+0.005	0.200+0.005	1.000+0.005
	1.83000-5.49999	0.010+0.015	0.050+0.015	0.200+0.015	1.000+0.015
	5.50000-10.9999	0.020+0.030	0.060+0.030	0.200+0.030	1.000+0.030
	11.0000-21.9999	0.020+0.060	0.070+0.060	0.200+0.060	1.000+0.060
	22.0000-55.0000	0.030+0.120	0.080+0.120	0.200+0.120	1.000+0.120
	22.0000-80.0000†	0.030+0.200	0.080+0.200	0.200+0.200	1.000+0.200
	5.50000-55.0000*	0.050+1.000	0.200+1.000	-	-
	5.50000-110.000*	0.050+2.000	0.200+2.000	-	-
	5.50000-220.000*	0.050+4.000	0.200+4.000	-	-
	5.50000-330.000§	0.075+8.000	0.200+8.000	-	-
132.000-263.999	0.00100-0.01829	0.020+0.002	0.070+0.002	0.200+0.002	1.000+0.002
	0.01830-0.05499	0.010+0.002	0.050+0.002	0.200+0.002	1.000+0.002
	0.05500-0.18299	0.010+0.002	0.050+0.002	0.200+0.002	1.000+0.002
	0.18300-0.54999	0.010+0.004	0.050+0.004	0.200+0.004	1.000+0.004
	0.55000-1.82999	0.010+0.010	0.050+0.010	0.200+0.010	1.000+0.010
	1.83000-5.49999	0.010+0.030	0.050+0.030	0.200+0.030	1.000+0.030
	5.50000-10.9999	0.020+0.060	0.060+0.060	0.200+0.060	1.000+0.060
	11.0000-21.9999	0.020+0.120	0.070+0.120	0.200+0.120	1.000+0.120
	22.0000-55.0000	0.030+0.240	0.080+0.240	0.200+0.240	1.000+0.240
	22.0000-80.0000†	0.030+0.400	0.080+0.400	0.200+0.400	1.000+0.400
	5.50000-55.0000*	0.050+2.000	0.200+2.000	-	-
	5.50000-110.000*	0.050+4.000	0.200+4.000	-	-
	5.50000-220.000*	0.050+8.000	0.200+8.000	-	-
	5.50000-330.000§	0.075+16.00	0.200+16.00	-	-

† With Option 8100-80A

[1] With Option 8100-LF

* With Optional Model 8145 Current Amplifier, § With Option 8145-300A

Accuracy (Continued)

Voltage Setting (V)	Current Setting (A)	±(% VA Setting + W) 40-70Hz	25-200,400Hz	< 25[1], 200-600Hz	600-1000Hz
264.000-527.999	0.00100-0.01829	0.030+0.002	0.080+0.002	0.300+0.002	1.000+0.002
	0.01830-0.05499	0.020+0.002	0.080+0.002	0.300+0.002	1.000+0.002
	0.05500-0.18299	0.020+0.004	0.080+0.004	0.300+0.004	1.000+0.004
	0.18300-0.54999	0.020+0.008	0.080+0.008	0.300+0.008	1.000+0.008
	0.55000-1.82999	0.020+0.020	0.080+0.020	0.300+0.020	1.000+0.020
	1.83000-5.49999	0.020+0.060	0.080+0.060	0.300+0.060	1.000+0.060
	5.50000-10.9999	0.020+0.120	0.080+0.120	0.300+0.120	1.000+0.120
	11.0000-21.9999	0.020+0.240	0.080+0.240	0.300+0.240	1.000+0.240
	22.0000-55.0000	0.030+0.480	0.080+0.480	0.300+0.480	1.000+0.480
	22.0000-80.0000†	0.030+0.800	0.080+0.800	0.300+0.800	1.000+0.800
	5.50000-55.0000*	0.050+4.000	0.200+4.000	-	-
	5.50000-110.000*	0.050+8.000	0.200+8.000	-	-
	5.50000-220.000*	0.050+16.00	0.200+16.00	-	-
	5.50000-330.000§	0.075+32.00	0.200+32.00	-	-
528.000-700.000	0.00100-0.01829	0.040+0.002	0.080+0.002	0.400+0.002	1.000+0.002
	0.01830-0.05499	0.030+0.004	0.080+0.004	0.400+0.004	1.000+0.004
	0.05500-0.18299	0.030+0.008	0.080+0.008	0.400+0.008	1.000+0.008
	0.18300-0.54999	0.030+0.020	0.080+0.020	0.400+0.020	1.000+0.020
	0.55000-1.82999	0.030+0.040	0.080+0.040	0.400+0.040	1.000+0.040
	1.83000-5.49999	0.030+0.120	0.080+0.120	0.400+0.120	1.000+0.120
	5.50000-10.9999	0.030+0.240	0.080+0.240	0.400+0.240	1.000+0.240
	11.0000-21.9999	0.030+0.480	0.080+0.480	0.400+0.480	1.000+0.480
	22.0000-55.0000	0.040+0.960	0.080+0.960	0.400+0.960	1.000+0.960
	22.0000-80.0000†	0.040+1.600	0.080+1.600	0.400+1.600	1.000+1.600
	5.50000-55.0000*	0.050+8.000	0.200+8.000	-	-
	5.50000-110.000*	0.050+16.00	0.200+16.00	-	-
	5.50000-220.000*	0.050+32.00	0.200+32.00	-	-
	5.50000-330.000§	0.075+64.00	0.200+64.00	-	-
528.000-1056.00‡	0.00100-0.01829	0.040+0.002	0.080+0.002	0.400+0.002	1.000+0.002
	0.01830-0.05499	0.030+0.004	0.080+0.004	0.400+0.004	1.000+0.004
	0.05500-0.18299	0.030+0.008	0.080+0.008	0.400+0.008	1.000+0.008
	0.18300-0.54999	0.030+0.020	0.080+0.020	0.400+0.020	1.000+0.020
	0.55000-1.82999	0.030+0.040	0.080+0.040	0.400+0.040	1.000+0.040
	1.83000-5.49999	0.030+0.120	0.080+0.120	0.400+0.120	1.000+0.120
	5.50000-10.9999	0.030+0.240	0.080+0.240	0.400+0.240	1.000+0.240
	11.0000-21.9999	0.030+0.480	0.080+0.480	0.400+0.480	1.000+0.480
	22.0000-55.0000	0.040+0.960	0.080+0.960	0.400+0.960	1.000+0.960
	22.0000-80.0000†	0.040+1.600	0.080+1.600	0.400+1.600	1.000+1.600
	5.50000-55.0000*	0.050+8.000	0.200+8.000	-	-
	5.50000-110.000*	0.050+16.00	0.200+16.00	-	-
	5.50000-220.000*	0.050+32.00	0.200+32.00	-	-
	5.50000-330.000§	0.075+64.00	0.200+64.00	-	-

† With Option 8100-80A

* With Optional Model 8145 Current Amplifier, § With Option 8145-300A

[1] With Option 8100-LF

‡ With Option 8100-1KV

Accuracy (Continued)

Reactive Mode

Voltage Setting (V)	Current Setting (A)	±(% VA Setting + W)			
		40-70Hz	25-200,400Hz	< 25[1], 200-600Hz	600-1000Hz
1.00000-21.9999	0.00100-0.01829	0.120+0.001	0.180+0.001	0.200+0.001	1.000+0.001
	0.01830-0.05499	0.090+0.001	0.180+0.001	0.200+0.001	1.000+0.001
	0.05500-0.18299	0.090+0.001	0.180+0.001	0.200+0.001	1.000+0.001
	0.18300-0.54999	0.090+0.001	0.180+0.001	0.200+0.001	1.000+0.001
	0.55000-1.82999	0.090+0.002	0.180+0.002	0.200+0.002	1.000+0.002
	1.83000-5.49999	0.090+0.005	0.180+0.005	0.200+0.005	1.000+0.005
	5.50000-10.9999	0.090+0.010	0.180+0.010	0.200+0.010	1.000+0.010
	11.0000-21.9999	0.090+0.020	0.210+0.020	0.200+0.020	1.000+0.020
	22.0000-55.0000	0.090+0.040	0.240+0.040	0.200+0.040	1.000+0.040
	22.0000-80.0000†	0.090+0.070	0.240+0.070	0.200+0.070	1.000+0.070
	5.50000-55.0000*	0.150+1.000	0.300+1.000	-	-
	5.50000-110.000*	0.150+2.000	0.300+2.000	-	-
	5.50000-220.000*	0.150+4.000	0.300+4.000	-	-
	5.50000-330.000§	0.150+8.000	0.300+8.000	-	-
22.0000-131.999	0.00100-0.01829	0.060+0.001	0.210+0.001	0.200+0.001	1.000+0.001
	0.01830-0.05499	0.030+0.001	0.150+0.001	0.200+0.001	1.000+0.001
	0.05500-0.18299	0.030+0.001	0.150+0.001	0.200+0.001	1.000+0.001
	0.18300-0.54999	0.030+0.002	0.150+0.002	0.200+0.002	1.000+0.002
	0.55000-1.82999	0.030+0.005	0.150+0.005	0.200+0.005	1.000+0.005
	1.83000-5.49999	0.030+0.015	0.150+0.015	0.200+0.015	1.000+0.015
	5.50000-10.9999	0.060+0.030	0.180+0.030	0.200+0.030	1.000+0.030
	11.0000-21.9999	0.060+0.060	0.210+0.060	0.200+0.060	1.000+0.060
	22.0000-55.0000	0.090+0.120	0.240+0.120	0.200+0.120	1.000+0.120
	22.0000-80.0000†	0.090+0.200	0.240+0.200	0.200+0.200	1.000+0.200
	5.50000-55.0000*	0.150+1.000	0.300+1.000	-	-
	5.50000-110.000*	0.150+2.000	0.300+2.000	-	-
	5.50000-220.000*	0.150+4.000	0.300+4.000	-	-
	5.50000-330.000§	0.150+8.000	0.300+8.000	-	-
132.000-263.999	0.00100-0.01829	0.060+0.002	0.210+0.002	0.200+0.002	1.000+0.002
	0.01830-0.05499	0.030+0.002	0.150+0.002	0.200+0.002	1.000+0.002
	0.05500-0.18299	0.030+0.002	0.150+0.002	0.200+0.002	1.000+0.002
	0.18300-0.54999	0.030+0.004	0.150+0.004	0.200+0.004	1.000+0.004
	0.55000-1.82999	0.030+0.010	0.150+0.010	0.200+0.010	1.000+0.010
	1.83000-5.49999	0.030+0.030	0.150+0.030	0.200+0.030	1.000+0.030
	5.50000-10.9999	0.060+0.060	0.180+0.060	0.200+0.060	1.000+0.060
	11.0000-21.9999	0.060+0.120	0.210+0.120	0.200+0.120	1.000+0.120
	22.0000-55.0000	0.090+0.240	0.240+0.240	0.200+0.240	1.000+0.240
	22.0000-80.0000†	0.090+0.400	0.240+0.400	0.200+0.400	1.000+0.400
	5.50000-55.0000*	0.150+2.000	0.300+2.000	-	-
	5.50000-110.000*	0.150+4.000	0.300+4.000	-	-
	5.50000-220.000*	0.150+8.000	0.300+8.000	-	-
	5.50000-330.000§	0.150+16.00	0.300+16.00	-	-

† With Option 8100-80A

[1] With Option 8100-LF

* With Optional Model 8145 Current Amplifier, § With Option 8145-300A

Accuracy (Continued)

Reactive Mode

Voltage Setting (V)	Current Setting (A)	±(% VA Setting + W) 40-70Hz	25-200,400Hz	< 25[1], 200-600Hz	600-1000Hz
264.000-527.999	0.00100-0.01829	0.090+0.002	0.240+0.002	0.300+0.002	1.000+0.002
	0.01830-0.05499	0.060+0.002	0.240+0.002	0.300+0.002	1.000+0.002
	0.05500-0.18299	0.060+0.004	0.240+0.004	0.300+0.004	1.000+0.004
	0.18300-0.54999	0.060+0.008	0.240+0.008	0.300+0.008	1.000+0.008
	0.55000-1.82999	0.060+0.020	0.240+0.020	0.300+0.020	1.000+0.020
	1.83000-5.49999	0.060+0.060	0.240+0.060	0.300+0.060	1.000+0.060
	5.50000-10.9999	0.060+0.120	0.240+0.120	0.300+0.120	1.000+0.120
	11.0000-21.9999	0.060+0.240	0.240+0.240	0.300+0.240	1.000+0.240
	22.0000-55.0000	0.090+0.480	0.240+0.480	0.300+0.480	1.000+0.480
	22.0000-80.0000†	0.090+0.800	0.240+0.800	0.300+0.800	1.000+0.800
	5.50000-55.0000*	0.150+4.000	0.300+4.000	-	-
	5.50000-110.000*	0.150+8.000	0.300+8.000	-	-
	5.50000-220.000*	0.150+16.00	0.300+16.00	-	-
	5.50000-330.000§	0.150+3200	0.300+32.00	-	-
528.000-700.000	0.00100-0.01829	0.120+0.002	0.240+0.002	0.400+0.002	1.000+0.002
	0.01830-0.05499	0.090+0.004	0.240+0.004	0.400+0.004	1.000+0.004
	0.05500-0.18299	0.090+0.008	0.240+0.008	0.400+0.008	1.000+0.008
	0.18300-0.54999	0.090+0.020	0.240+0.020	0.400+0.020	1.000+0.020
	0.55000-1.82999	0.090+0.040	0.240+0.040	0.400+0.040	1.000+0.040
	1.83000-5.49999	0.090+0.120	0.240+0.120	0.400+0.120	1.000+0.120
	5.50000-10.9999	0.090+0.240	0.240+0.240	0.400+0.240	1.000+0.240
	11.0000-21.9999	0.090+0.480	0.240+0.480	0.400+0.480	1.000+0.480
	22.0000-55.0000	0.120+0.960	0.240+0.960	0.400+0.960	1.000+0.960
	22.0000-80.0000†	0.120+1.600	0.240+1.600	0.400+1.600	1.000+1.600
	5.50000-55.0000*	0.150+8.000	0.300+8.000	-	-
	5.50000-110.000*	0.150+16.00	0.300+16.00	-	-
	5.50000-220.000*	0.150+32.00	0.300+32.00	-	-
	5.50000-330.000§	0.150+64.00	0.300+64.00	-	-
528.000-1056.00‡	0.00100-0.01829	0.120+0.002	0.240+0.002	0.400+0.002	1.000+0.002
	0.01830-0.05499	0.090+0.004	0.240+0.004	0.400+0.004	1.000+0.004
	0.05500-0.18299	0.090+0.008	0.240+0.008	0.400+0.008	1.000+0.008
	0.18300-0.54999	0.090+0.020	0.240+0.020	0.400+0.020	1.000+0.020
	0.55000-1.82999	0.090+0.040	0.240+0.040	0.400+0.040	1.000+0.040
	1.83000-5.49999	0.090+0.120	0.240+0.120	0.400+0.120	1.000+0.120
	5.50000-10.9999	0.090+0.240	0.240+0.240	0.400+0.240	1.000+0.240
	11.0000-21.9999	0.090+0.480	0.240+0.480	0.400+0.480	1.000+0.480
	22.0000-55.0000	0.120+0.960	0.240+0.960	0.400+0.960	1.000+0.960
	22.0000-80.0000†	0.120+1.600	0.240+1.600	0.400+1.600	1.000+1.600
	5.50000-55.0000*	0.150+8.000	0.300+8.000	-	-
	5.50000-110.000*	0.150+16.00	0.300+16.00	-	-
	5.50000-220.000*	0.150+32.00	0.300+32.00	-	-
	5.50000-330.000§	0.150+64.00	0.300+64.00	-	-

† With Option 8100-80A

* With Optional Model 8145 Current Amplifier, § With Option 8145-300A

[1] With Option 8100-LF

‡ With Option 8100-1KV

Reactive Power (Q)

Setting Range: 0.00000W - 58.080kVAR
0.00000W - 348.480kVAR With Optional Range Extensions

Setting Resolution: 6 digits via Front Panel Control (0.00001mVAR)
7 digits via Remote Control (0.000001mVAR)

Units: VAR

Settling Time: < 2 seconds after setting change (Normal Mode, < 450Hz)
< 15 seconds after setting change (Normal Mode, > 450Hz)
< 15 seconds after setting change (Reactive Mode)

Stability, 24hr

Voltage Setting (V)	Current Setting (A)	±(% VA Setting + VAR)			
		40-70Hz	25-200,400Hz	< 25[1], 200-600Hz	600-1000Hz
1.00000-21.9999	0.00100-0.01829	0.004+0.001	0.006+0.001	0.020+0.001	0.100+0.001
	0.01830-0.05499	0.003+0.001	0.006+0.001	0.020+0.001	0.100+0.001
	0.05500-0.18299	0.003+0.001	0.006+0.001	0.020+0.001	0.100+0.001
	0.18300-0.54999	0.003+0.001	0.006+0.001	0.020+0.001	0.100+0.001
	0.55000-1.82999	0.003+0.002	0.006+0.002	0.020+0.002	0.100+0.002
	1.83000-5.49999	0.003+0.005	0.006+0.005	0.020+0.005	0.100+0.005
	5.50000-10.9999	0.003+0.010	0.006+0.010	0.020+0.010	0.100+0.010
	11.0000-21.9999	0.003+0.020	0.007+0.020	0.020+0.020	0.100+0.020
	22.0000-55.0000	0.003+0.040	0.008+0.040	0.020+0.040	0.100+0.040
	22.0000-80.0000†	0.003+0.070	0.008+0.070	0.020+0.070	0.100+0.070
	5.50000-55.0000*	0.006+1.000	0.020+1.000	-	-
	5.50000-110.000*	0.006+2.000	0.020+2.000	-	-
	5.50000-220.000*	0.006+4.000	0.020+4.000	-	-
	5.50000-330.000§	0.008+8.000	0.020+8.000	-	-
22.0000-131.999	0.00100-0.01829	0.002+0.001	0.007+0.001	0.020+0.001	0.100+0.001
	0.01830-0.05499	0.001+0.001	0.005+0.001	0.020+0.001	0.100+0.001
	0.05500-0.18299	0.001+0.001	0.005+0.001	0.020+0.001	0.100+0.001
	0.18300-0.54999	0.001+0.002	0.005+0.002	0.020+0.002	0.100+0.002
	0.55000-1.82999	0.001+0.005	0.005+0.005	0.020+0.005	0.100+0.005
	1.83000-5.49999	0.001+0.015	0.005+0.015	0.020+0.015	0.100+0.015
	5.50000-10.9999	0.002+0.030	0.006+0.030	0.020+0.030	0.100+0.030
	11.0000-21.9999	0.002+0.060	0.007+0.060	0.020+0.060	0.100+0.060
	22.0000-55.0000	0.003+0.120	0.008+0.120	0.020+0.120	0.100+0.120
	22.0000-80.0000†	0.003+0.200	0.008+0.200	0.020+0.200	0.100+0.200
	5.50000-55.0000*	0.006+1.000	0.020+1.000	-	-
	5.50000-110.000*	0.006+2.000	0.020+2.000	-	-
	5.50000-220.000*	0.006+4.000	0.020+4.000	-	-
	5.50000-330.000§	0.008+8.000	0.020+8.000	-	-
132.000-263.999	0.00100-0.01829	0.002+0.002	0.007+0.002	0.020+0.002	0.100+0.002
	0.01830-0.05499	0.001+0.002	0.005+0.002	0.020+0.002	0.100+0.002
	0.05500-0.18299	0.001+0.002	0.005+0.002	0.020+0.002	0.100+0.002
	0.18300-0.54999	0.001+0.004	0.005+0.004	0.020+0.004	0.100+0.004
	0.55000-1.82999	0.001+0.010	0.005+0.010	0.020+0.010	0.100+0.010
	1.83000-5.49999	0.001+0.030	0.005+0.030	0.020+0.030	0.100+0.030
	5.50000-10.9999	0.002+0.060	0.006+0.060	0.020+0.060	0.100+0.060
	11.0000-21.9999	0.002+0.120	0.007+0.120	0.020+0.120	0.100+0.120
	22.0000-55.0000	0.003+0.240	0.008+0.240	0.020+0.240	0.100+0.240
	22.0000-80.0000†	0.003+0.400	0.008+0.400	0.020+0.400	0.100+0.400
	5.50000-55.0000*	0.006+1.000	0.020+1.000	-	-
	5.50000-110.000*	0.006+2.000	0.020+2.000	-	-
	5.50000-220.000*	0.006+4.000	0.020+4.000	-	-
	5.50000-330.000§	0.008+8.000	0.020+8.000	-	-

† With Option 8100-80A
[1] With Option 8100-LF
* With Optional Model 8145 Current Amplifier, § With Option 8145-300A

Stability, 24hr (Continued)

Voltage Setting	Current Setting	±(% VA Setting + VAR)			
(V)	(A)	40-70Hz	25-200,400Hz	< 25[1], 200-600Hz	600-1000Hz
	0.00100-0.01829	0.003+0.002	0.008+0.002	0.030+0.002	0.100+0.002
	0.01830-0.05499	0.002+0.002	0.008+0.002	0.030+0.002	0.100+0.002
	0.05500-0.18299	0.002+0.004	0.008+0.004	0.030+0.004	0.100+0.004
	0.18300-0.54999	0.002+0.008	0.008+0.008	0.030+0.008	0.100+0.008
	0.55000-1.82999	0.002+0.020	0.008+0.020	0.030+0.020	0.100+0.020
	1.83000-5.49999	0.002+0.060	0.008+0.060	0.030+0.060	0.100+0.060
264.000-527.999	5.50000-10.9999	0.002+0.120	0.008+0.120	0.003+0.120	0.100+0.120
	11.0000-21.9999	0.002+0.240	0.008+0.240	0.003+0.240	0.100+0.240
	22.0000-55.0000	0.003+0.480	0.008+0.480	0.030+0.480	0.100+0.480
	22.0000-80.0000†	0.003+0.800	0.008+0.800	0.030+0.800	0.100+0.800
	5.50000-55.0000*	0.006+1.000	0.020+1.000	-	-
	5.50000-110.000*	0.006+2.000	0.020+2.000	-	-
	5.50000-220.000*	0.006+4.000	0.020+4.000	-	-
	5.50000-330.000§	0.006+8.000	0.020+8.000	-	-
	0.00100-0.01829	0.004+0.002	0.008+0.002	0.040+0.002	0.100+0.002
	0.01830-0.05499	0.003+0.004	0.008+0.004	0.040+0.004	0.100+0.004
	0.05500-0.18299	0.003+0.008	0.008+0.008	0.040+0.008	0.100+0.008
	0.18300-0.54999	0.003+0.020	0.008+0.020	0.040+0.020	0.100+0.020
	0.55000-1.82999	0.003+0.040	0.008+0.040	0.040+0.040	0.100+0.040
	1.83000-5.49999	0.003+0.120	0.008+0.120	0.040+0.120	0.100+0.120
528.000-700.000	5.50000-10.9999	0.003+0.240	0.008+0.240	0.040+0.240	0.100+0.240
	11.0000-21.9999	0.003+0.480	0.008+0.480	0.040+0.480	0.100+0.480
	22.0000-55.0000	0.004+0.960	0.008+0.960	0.040+0.960	0.100+0.960
	22.0000-80.0000†	0.004+1.600	0.008+1.600	0.040+1.600	0.100+1.600
	5.50000-55.0000*	0.006+2.000	0.020+2.000	-	-
	5.50000-110.000*	0.006+4.000	0.020+4.000	-	-
	5.50000-220.000*	0.006+8.000	0.020+8.000	-	-
	5.50000-330.000§	0.006+16.00	0.020+16.00	-	-
	0.00100-0.01829	0.004+0.002	0.008+0.002	0.040+0.002	0.100+0.002
	0.01830-0.05499	0.003+0.004	0.008+0.004	0.040+0.004	0.100+0.004
	0.05500-0.18299	0.003+0.008	0.008+0.008	0.040+0.008	0.100+0.008
	0.18300-0.54999	0.003+0.020	0.008+0.020	0.040+0.020	0.100+0.020
	0.55000-1.82999	0.003+0.040	0.008+0.040	0.040+0.040	0.100+0.040
	1.83000-5.49999	0.003+0.120	0.008+0.120	0.040+0.120	0.100+0.120
528.000-1056.00‡	5.50000-10.9999	0.003+0.240	0.008+0.240	0.040+0.240	0.100+0.240
	11.0000-21.9999	0.003+0.480	0.008+0.480	0.040+0.480	0.100+0.480
	22.0000-55.0000	0.004+0.960	0.008+0.960	0.040+0.960	0.100+0.960
	22.0000-80.0000†	0.004+1.600	0.008+1.600	0.040+1.600	0.100+1.600
	5.50000-55.0000*	0.005+2.000	0.020+2.000	-	-
	5.50000-110.000*	0.005+4.000	0.020+4.000	-	-
	5.50000-220.000*	0.006+8.000	0.020+8.000	-	-
	5.50000-330.000§	0.006+16.00	0.020+16.00	-	-

† With Option 8100-80A

* With Optional Model 8145 Current Amplifier, § With Option 8145-300A

[1] With Option 8100-LF

‡ With Option 8100-1KV

Accuracy

Voltage Setting (V)	Current Setting (A)	±(% VA Setting + VAR) 40-70Hz	25-200,400Hz	< 25Δ, 200-600Hz	600-1000Hz
1.00000-21.9999	0.00100-0.01829	0.040+0.001	0.060+0.001	0.200+0.001	1.000+0.001
	0.01830-0.05499	0.030+0.001	0.060+0.001	0.200+0.001	1.000+0.001
	0.05500-0.18299	0.030+0.001	0.060+0.001	0.200+0.001	1.000+0.001
	0.18300-0.54999	0.030+0.001	0.060+0.001	0.200+0.001	1.000+0.001
	0.55000-1.82999	0.030+0.002	0.060+0.002	0.200+0.002	1.000+0.002
	1.83000-5.49999	0.030+0.005	0.060+0.005	0.200+0.005	1.000+0.005
	5.50000-10.9999	0.030+0.010	0.060+0.010	0.200+0.010	1.000+0.010
	11.0000-21.9999	0.030+0.020	0.070+0.020	0.200+0.020	1.000+0.020
	22.0000-55.0000	0.030+0.040	0.080+0.040	0.200+0.040	1.000+0.040
	22.0000-80.0000†	0.030+0.070	0.080+0.070	0.200+0.070	1.000+0.070
	5.50000-55.0000*	0.050+1.000	0.200+1.000	-	-
	5.50000-110.000*	0.050+2.000	0.200+2.000	-	-
	5.50000-220.000*	0.050+4.000	0.200+4.000	-	-
	5.50000-330.000§	0.075+8.000	0.200+8.000	-	-
22.0000-131.999	0.00100-0.01829	0.020+0.001	0.070+0.001	0.200+0.001	1.000+0.001
	0.01830-0.05499	0.010+0.001	0.050+0.001	0.200+0.001	1.000+0.001
	0.05500-0.18299	0.010+0.001	0.050+0.001	0.200+0.001	1.000+0.001
	0.18300-0.54999	0.010+0.002	0.050+0.002	0.200+0.002	1.000+0.002
	0.55000-1.82999	0.010+0.005	0.050+0.005	0.200+0.005	1.000+0.005
	1.83000-5.49999	0.010+0.015	0.050+0.015	0.200+0.015	1.000+0.015
	5.50000-10.9999	0.020+0.030	0.060+0.030	0.200+0.030	1.000+0.030
	11.0000-21.9999	0.020+0.060	0.070+0.060	0.200+0.060	1.000+0.060
	22.0000-55.0000	0.030+0.120	0.080+0.120	0.200+0.120	1.000+0.120
	22.0000-80.0000†	0.030+0.200	0.080+0.200	0.200+0.200	1.000+0.200
	5.50000-55.0000*	0.050+1.000	0.200+1.000	-	-
	5.50000-110.000*	0.050+2.000	0.200+2.000	-	-
	5.50000-220.000*	0.050+4.000	0.200+4.000	-	-
	5.50000-330.000§	0.075+8.000	0.200+8.000	-	-
132.000-263.999	0.00100-0.01829	0.020+0.002	0.070+0.002	0.200+0.002	1.000+0.002
	0.01830-0.05499	0.010+0.002	0.050+0.002	0.200+0.002	1.000+0.002
	0.05500-0.18299	0.010+0.002	0.050+0.002	0.200+0.002	1.000+0.002
	0.18300-0.54999	0.010+0.004	0.050+0.004	0.200+0.004	1.000+0.004
	0.55000-1.82999	0.010+0.010	0.050+0.010	0.200+0.010	1.000+0.010
	1.83000-5.49999	0.010+0.030	0.050+0.030	0.200+0.030	1.000+0.030
	5.50000-10.9999	0.020+0.060	0.060+0.060	0.200+0.060	1.000+0.060
	11.0000-21.9999	0.020+0.120	0.070+0.120	0.200+0.120	1.000+0.120
	22.0000-55.0000	0.030+0.240	0.080+0.240	0.200+0.240	1.000+0.240
	22.0000-80.0000†	0.030+0.400	0.080+0.400	0.200+0.400	1.000+0.400
	5.50000-55.0000*	0.050+2.000	0.200+2.000	-	-
	5.50000-110.000*	0.050+4.000	0.200+4.000	-	-
	5.50000-220.000*	0.050+8.000	0.200+8.000	-	-
	5.50000-330.000§	0.075+16.00	0.200+16.00	-	-

† With Option 8100-80A

[1] With Option 8100-LF

* With Optional Model 8145 Current Amplifier, § With Option 8145-300A

Accuracy (Continued)

Voltage Setting (V)	Current Setting (A)	±(% VA Setting + VAR) 40-70Hz	25-200,400Hz	< 25[1], 200-600Hz	600-1000Hz
264.000-527.999	0.00100-0.01829	0.030+0.002	0.080+0.002	0.300+0.002	1.000+0.002
	0.01830-0.05499	0.020+0.002	0.080+0.002	0.300+0.002	1.000+0.002
	0.05500-0.18299	0.020+0.004	0.080+0.004	0.300+0.004	1.000+0.004
	0.18300-0.54999	0.020+0.008	0.080+0.008	0.300+0.008	1.000+0.008
	0.55000-1.82999	0.020+0.020	0.080+0.020	0.300+0.020	1.000+0.020
	1.83000-5.49999	0.020+0.060	0.080+0.060	0.300+0.060	1.000+0.060
	5.50000-10.9999	0.020+0.120	0.080+0.120	0.300+0.120	1.000+0.120
	11.0000-21.9999	0.020+0.240	0.080+0.240	0.300+0.240	1.000+0.240
	22.0000-55.0000	0.030+0.480	0.080+0.480	0.300+0.480	1.000+0.480
	22.0000-80.0000†	0.030+0.800	0.080+0.800	0.300+0.800	1.000+0.800
	5.50000-55.0000*	0.050+4.000	0.200+4.000	-	-
	5.50000-110.000*	0.050+8.000	0.200+8.000	-	-
	5.50000-220.000*	0.050+16.00	0.200+16.00	-	-
	5.50000-330.000§	0.075+32.00	0.200+32.00	-	-
528.000-700.000	0.00100-0.01829	0.040+0.002	0.080+0.002	0.400+0.002	1.000+0.002
	0.01830-0.05499	0.030+0.004	0.080+0.004	0.400+0.004	1.000+0.004
	0.05500-0.18299	0.030+0.008	0.080+0.008	0.400+0.008	1.000+0.008
	0.18300-0.54999	0.030+0.020	0.080+0.020	0.400+0.020	1.000+0.020
	0.55000-1.82999	0.030+0.040	0.080+0.040	0.400+0.040	1.000+0.040
	1.83000-5.49999	0.030+0.120	0.080+0.120	0.400+0.120	1.000+0.120
	5.50000-10.9999	0.030+0.240	0.080+0.240	0.400+0.240	1.000+0.240
	11.0000-21.9999	0.030+0.480	0.080+0.480	0.400+0.480	1.000+0.480
	22.0000-55.0000	0.040+0.960	0.080+0.960	0.400+0.960	1.000+0.960
	22.0000-80.0000†	0.040+1.600	0.080+1.600	0.400+1.600	1.000+1.600
	5.50000-55.0000*	0.050+8.000	0.200+8.000	-	-
	5.50000-110.000*	0.050+16.00	0.200+16.00	-	-
	5.50000-220.000*	0.050+32.00	0.200+32.00	-	-
	5.50000-330.000§	0.075+64.00	0.200+64.00	-	-
528.000-1056.00‡	0.00100-0.01829	0.040+0.002	0.080+0.002	0.400+0.002	1.000+0.002
	0.01830-0.05499	0.030+0.004	0.080+0.004	0.400+0.004	1.000+0.004
	0.05500-0.18299	0.030+0.008	0.080+0.008	0.400+0.008	1.000+0.008
	0.18300-0.54999	0.030+0.020	0.080+0.020	0.400+0.020	1.000+0.020
	0.55000-1.82999	0.030+0.040	0.080+0.040	0.400+0.040	1.000+0.040
	1.83000-5.49999	0.030+0.120	0.080+0.120	0.400+0.120	1.000+0.120
	5.50000-10.9999	0.030+0.240	0.080+0.240	0.400+0.240	1.000+0.240
	11.0000-21.9999	0.030+0.480	0.080+0.480	0.400+0.480	1.000+0.480
	22.0000-55.0000	0.040+0.960	0.080+0.960	0.400+0.960	1.000+0.960
	22.0000-80.0000†	0.040+1.600	0.080+1.600	0.400+1.600	1.000+1.600
	5.50000-55.0000*	0.050+8.000	0.200+8.000	-	-
	5.50000-110.000*	0.050+16.00	0.200+16.00	-	-
	5.50000-220.000*	0.050+32.00	0.200+32.00	-	-
	5.50000-330.000§	0.075+64.00	0.200+64.00	-	-

† With Option 8100-80A

* With Optional Model 8145 Current Amplifier, § With Option 8145-300A

[1] With Option 8100-LF

‡ With Option 8100-1KV

Accuracy (Continued)

Reactive Mode

Voltage Setting (V)	Current Setting (A)	±(% VA Setting + VAR) 40-70Hz	25-200,400Hz	< 25[1], 200-600Hz	600-1000Hz
1.00000-21.9999	0.00100-0.01829	0.120+0.001	0.180+0.001	0.200+0.001	1.000+0.001
	0.01830-0.05499	0.090+0.001	0.180+0.001	0.200+0.001	1.000+0.001
	0.05500-0.18299	0.090+0.001	0.180+0.001	0.200+0.001	1.000+0.001
	0.18300-0.54999	0.090+0.001	0.180+0.001	0.200+0.001	1.000+0.001
	0.55000-1.82999	0.090+0.002	0.180+0.002	0.200+0.002	1.000+0.002
	1.83000-5.49999	0.090+0.005	0.180+0.005	0.200+0.005	1.000+0.005
	5.50000-10.9999	0.090+0.010	0.180+0.010	0.200+0.010	1.000+0.010
	11.0000-21.9999	0.090+0.020	0.210+0.020	0.200+0.020	1.000+0.020
	22.0000-55.0000	0.090+0.040	0.240+0.040	0.200+0.040	1.000+0.040
	22.0000-80.0000†	0.090+0.070	0.240+0.070	0.200+0.070	1.000+0.070
	5.50000-55.0000*	0.150+1.000	0.300+1.000	-	-
	5.50000-110.000*	0.150+2.000	0.300+2.000	-	-
	5.50000-220.000*	0.150+4.000	0.300+4.000	-	-
	5.50000-330.000§	0.150+8.000	0.300+8.000	-	-
22.0000-131.999	0.00100-0.01829	0.060+0.001	0.210+0.001	0.200+0.001	1.000+0.001
	0.01830-0.05499	0.030+0.001	0.150+0.001	0.200+0.001	1.000+0.001
	0.05500-0.18299	0.030+0.001	0.150+0.001	0.200+0.001	1.000+0.001
	0.18300-0.54999	0.030+0.002	0.150+0.002	0.200+0.002	1.000+0.002
	0.55000-1.82999	0.030+0.005	0.150+0.005	0.200+0.005	1.000+0.005
	1.83000-5.49999	0.030+0.015	0.150+0.015	0.200+0.015	1.000+0.015
	5.50000-10.9999	0.060+0.030	0.180+0.030	0.200+0.030	1.000+0.030
	11.0000-21.9999	0.060+0.060	0.210+0.060	0.200+0.060	1.000+0.060
	22.0000-55.0000	0.090+0.120	0.240+0.120	0.200+0.120	1.000+0.120
	22.0000-80.0000†	0.090+0.200	0.240+0.200	0.200+0.200	1.000+0.200
	5.50000-55.0000*	0.150+1.000	0.300+1.000	-	-
	5.50000-110.000*	0.150+2.000	0.300+2.000	-	-
	5.50000-220.000*	0.150+4.000	0.300+4.000	-	-
	5.50000-330.000§	0.150+8.000	0.300+8.000	-	-
132.000-263.999	0.00100-0.01829	0.060+0.002	0.210+0.002	0.200+0.002	1.000+0.002
	0.01830-0.05499	0.030+0.002	0.150+0.002	0.200+0.002	1.000+0.002
	0.05500-0.18299	0.030+0.002	0.150+0.002	0.200+0.002	1.000+0.002
	0.18300-0.54999	0.030+0.004	0.150+0.004	0.200+0.004	1.000+0.004
	0.55000-1.82999	0.030+0.010	0.150+0.010	0.200+0.010	1.000+0.010
	1.83000-5.49999	0.030+0.030	0.150+0.030	0.200+0.030	1.000+0.030
	5.50000-10.9999	0.060+0.060	0.180+0.060	0.200+0.060	1.000+0.060
	11.0000-21.9999	0.060+0.120	0.210+0.120	0.200+0.120	1.000+0.120
	22.0000-55.0000	0.090+0.240	0.240+0.240	0.200+0.240	1.000+0.240
	22.0000-80.0000†	0.090+0.400	0.240+0.400	0.200+0.400	1.000+0.400
	5.50000-55.0000*	0.150+2.000	0.300+2.000	-	-
	5.50000-110.000*	0.150+4.000	0.300+4.000	-	-
	5.50000-220.000*	0.150+8.000	0.300+8.000	-	-
	5.50000-330.000§	0.150+16.00	0.300+16.00	-	-

† With Option 8100-80A

[1] With Option 8100-LF

* With Optional Model 8145 Current Amplifier, § With Option 8145-300A

Accuracy (Continued)

Reactive Mode

Voltage Setting (V)	Current Setting (A)	±(% VA Setting + VAR)			
		40-70Hz	25-200,400Hz	< 25[1], 200-600Hz	600-1000Hz
264.000-527.999	0.00100-0.01829	0.090+0.002	0.240+0.002	0.300+0.002	1.000+0.002
	0.01830-0.05499	0.060+0.002	0.240+0.002	0.300+0.002	1.000+0.002
	0.05500-0.18299	0.060+0.004	0.240+0.004	0.300+0.004	1.000+0.004
	0.18300-0.54999	0.060+0.008	0.240+0.008	0.300+0.008	1.000+0.008
	0.55000-1.82999	0.060+0.020	0.240+0.020	0.300+0.020	1.000+0.020
	1.83000-5.49999	0.060+0.060	0.240+0.060	0.300+0.060	1.000+0.060
	5.50000-10.9999	0.060+0.120	0.240+0.120	0.300+0.120	1.000+0.120
	11.0000-21.9999	0.060+0.240	0.240+0.240	0.300+0.240	1.000+0.240
	22.0000-55.0000	0.090+0.480	0.240+0.480	0.300+0.480	1.000+0.480
	22.0000-80.0000†	0.090+0.800	0.240+0.800	0.300+0.800	1.000+0.800
	5.50000-55.0000*	0.150+4.000	0.300+4.000	-	-
	5.50000-110.000*	0.150+8.000	0.300+8.000	-	-
	5.50000-220.000*	0.150+16.00	0.300+16.00	-	-
	5.50000-330.000§	0.150+3200	0.300+32.00	-	-
528.000-700.000	0.00100-0.01829	0.120+0.002	0.240+0.002	0.400+0.002	1.000+0.002
	0.01830-0.05499	0.090+0.004	0.240+0.004	0.400+0.004	1.000+0.004
	0.05500-0.18299	0.090+0.008	0.240+0.008	0.400+0.008	1.000+0.008
	0.18300-0.54999	0.090+0.020	0.240+0.020	0.400+0.020	1.000+0.020
	0.55000-1.82999	0.090+0.040	0.240+0.040	0.400+0.040	1.000+0.040
	1.83000-5.49999	0.090+0.120	0.240+0.120	0.400+0.120	1.000+0.120
	5.50000-10.9999	0.090+0.240	0.240+0.240	0.400+0.240	1.000+0.240
	11.0000-21.9999	0.090+0.480	0.240+0.480	0.400+0.480	1.000+0.480
	22.0000-55.0000	0.120+0.960	0.240+0.960	0.400+0.960	1.000+0.960
	22.0000-80.0000†	0.120+1.600	0.240+1.600	0.400+1.600	1.000+1.600
	5.50000-55.0000*	0.150+8.000	0.300+8.000	-	-
	5.50000-110.000*	0.150+16.00	0.300+16.00	-	-
	5.50000-220.000*	0.150+32.00	0.300+32.00	-	-
	5.50000-330.000§	0.150+64.00	0.300+64.00	-	-
528.000-1056.00‡	0.00100-0.01829	0.120+0.002	0.240+0.002	0.400+0.002	1.000+0.002
	0.01830-0.05499	0.090+0.004	0.240+0.004	0.400+0.004	1.000+0.004
	0.05500-0.18299	0.090+0.008	0.240+0.008	0.400+0.008	1.000+0.008
	0.18300-0.54999	0.090+0.020	0.240+0.020	0.400+0.020	1.000+0.020
	0.55000-1.82999	0.090+0.040	0.240+0.040	0.400+0.040	1.000+0.040
	1.83000-5.49999	0.090+0.120	0.240+0.120	0.400+0.120	1.000+0.120
	5.50000-10.9999	0.090+0.240	0.240+0.240	0.400+0.240	1.000+0.240
	11.0000-21.9999	0.090+0.480	0.240+0.480	0.400+0.480	1.000+0.480
	22.0000-55.0000	0.120+0.960	0.240+0.960	0.400+0.960	1.000+0.960
	22.0000-80.0000†	0.120+1.600	0.240+1.600	0.400+1.600	1.000+1.600
	5.50000-55.0000*	0.150+8.000	0.300+8.000	-	-
	5.50000-110.000*	0.150+16.00	0.300+16.00	-	-
	5.50000-220.000*	0.150+32.00	0.300+32.00	-	-
	5.50000-330.000§	0.150+64.00	0.300+64.00	-	-

† With Option 8100-80A

* With Optional Model 8145 Current Amplifier, § With Option 8145-300A

[1] With Option 8100-LF

‡ With Option 8100-1KV

Apparent Power (S)

Setting Range: 0.00000W - 58.080kVA
0.00000W - 348.480kVA With Optional Range Extensions

Setting Resolution: 6 digits via Front Panel Control (0.00001mVA)
7 digits via Remote Control (0.000001mVA)

Units: Volt-Ampere

Settling Time: < 2 seconds after setting change (Normal Mode, < 450Hz)
< 15 seconds after setting change (Normal Mode, > 450Hz)
< 15 seconds after setting change (Reactive Mode)

Stability, 24hr

Voltage Setting (V)	Current Setting (A)	±(% VA Setting + VA)			
		40-70Hz	25-200,400Hz	< 25[1], 200-600Hz	600-1000Hz
1.00000-21.9999	0.00100-0.01829	0.004+0.001	0.006+0.001	0.020+0.001	0.100+0.001
	0.01830-0.05499	0.003+0.001	0.006+0.001	0.020+0.001	0.100+0.001
	0.05500-0.18299	0.003+0.001	0.006+0.001	0.020+0.001	0.100+0.001
	0.18300-0.54999	0.003+0.001	0.006+0.001	0.020+0.001	0.100+0.001
	0.55000-1.82999	0.003+0.002	0.006+0.002	0.020+0.002	0.100+0.002
	1.83000-5.49999	0.003+0.005	0.006+0.005	0.020+0.005	0.100+0.005
	5.50000-10.9999	0.003+0.010	0.006+0.010	0.020+0.010	0.100+0.010
	11.0000-21.9999	0.003+0.020	0.007+0.020	0.020+0.020	0.100+0.020
	22.0000-55.0000	0.003+0.040	0.008+0.040	0.020+0.040	0.100+0.040
	22.0000-80.0000†	0.003+0.070	0.008+0.070	0.020+0.070	0.100+0.070
	5.50000-55.0000*	0.006+1.000	0.020+1.000	-	-
	5.50000-110.000*	0.006+2.000	0.020+2.000	-	-
	5.50000-220.000*	0.006+4.000	0.020+4.000	-	-
	5.50000-330.000§	0.008+8.000	0.020+8.000	-	-
22.0000-131.999	0.00100-0.01829	0.002+0.001	0.007+0.001	0.020+0.001	0.100+0.001
	0.01830-0.05499	0.001+0.001	0.005+0.001	0.020+0.001	0.100+0.001
	0.05500-0.18299	0.001+0.001	0.005+0.001	0.020+0.001	0.100+0.001
	0.18300-0.54999	0.001+0.002	0.005+0.002	0.020+0.002	0.100+0.002
	0.55000-1.82999	0.001+0.005	0.005+0.005	0.020+0.005	0.100+0.005
	1.83000-5.49999	0.001+0.015	0.005+0.015	0.020+0.015	0.100+0.015
	5.50000-10.9999	0.002+0.030	0.006+0.030	0.020+0.030	0.100+0.030
	11.0000-21.9999	0.002+0.060	0.007+0.060	0.020+0.060	0.100+0.060
	22.0000-55.0000	0.003+0.120	0.008+0.120	0.020+0.120	0.100+0.120
	22.0000-80.0000†	0.003+0.200	0.008+0.200	0.020+0.200	0.100+0.200
	5.50000-55.0000*	0.006+1.000	0.020+1.000	-	-
	5.50000-110.000*	0.006+2.000	0.020+2.000	-	-
	5.50000-220.000*	0.006+4.000	0.020+4.000	-	-
	5.50000-330.000§	0.008+8.000	0.020+8.000	-	-
132.000-263.999	0.00100-0.01829	0.002+0.002	0.007+0.002	0.020+0.002	0.100+0.002
	0.01830-0.05499	0.001+0.002	0.005+0.002	0.020+0.002	0.100+0.002
	0.05500-0.18299	0.001+0.002	0.005+0.002	0.020+0.002	0.100+0.002
	0.18300-0.54999	0.001+0.004	0.005+0.004	0.020+0.004	0.100+0.004
	0.55000-1.82999	0.001+0.010	0.005+0.010	0.020+0.010	0.100+0.010
	1.83000-5.49999	0.001+0.030	0.005+0.030	0.020+0.030	0.100+0.030
	5.50000-10.9999	0.002+0.060	0.006+0.060	0.020+0.060	0.100+0.060
	11.0000-21.9999	0.002+0.120	0.007+0.120	0.020+0.120	0.100+0.120
	22.0000-55.0000	0.003+0.240	0.008+0.240	0.020+0.240	0.100+0.240
	22.0000-80.0000†	0.003+0.400	0.008+0.400	0.020+0.400	0.100+0.400
	5.50000-55.0000*	0.006+1.000	0.020+1.000	-	-
	5.50000-110.000*	0.006+2.000	0.020+2.000	-	-
	5.50000-220.000*	0.006+4.000	0.020+4.000	-	-
	5.50000-330.000§	0.008+8.000	0.020+8.000	-	-

† With Option 8100-80A
[1] With Option 8100-LF
* With Optional Model 8145 Current Amplifier, § With Option 8145-300A

Stability, 24hr (Continued)

Voltage Setting (V)	Current Setting (A)	±(% VA Setting + VA)			
		40-70Hz	25-200,400Hz	< 25[1], 200-600Hz	600-1000Hz
	0.00100-0.01829	0.003+0.002	0.008+0.002	0.030+0.002	0.100+0.002
	0.01830-0.05499	0.002+0.002	0.008+0.002	0.030+0.002	0.100+0.002
	0.05500-0.18299	0.002+0.004	0.008+0.004	0.030+0.004	0.100+0.004
	0.18300-0.54999	0.002+0.008	0.008+0.008	0.030+0.008	0.100+0.008
	0.55000-1.82999	0.002+0.020	0.008+0.020	0.030+0.020	0.100+0.020
	1.83000-5.49999	0.002+0.060	0.008+0.060	0.030+0.060	0.100+0.060
264.000-527.999	5.50000-10.9999	0.002+0.120	0.008+0.120	0.003+0.120	0.100+0.120
	11.0000-21.9999	0.002+0.240	0.008+0.240	0.003+0.240	0.100+0.240
	22.0000-55.0000	0.003+0.480	0.008+0.480	0.030+0.480	0.100+0.480
	22.0000-80.0000†	0.003+0.800	0.008+0.800	0.030+0.800	0.100+0.800
	5.50000-55.0000*	0.006+1.000	0.020+1.000	-	-
	5.50000-110.000*	0.006+2.000	0.020+2.000	-	-
	5.50000-220.000*	0.006+4.000	0.020+4.000	-	-
	5.50000-330.000§	0.006+8.000	0.020+8.000	-	-
	0.00100-0.01829	0.004+0.002	0.008+0.002	0.040+0.002	0.100+0.002
	0.01830-0.05499	0.003+0.004	0.008+0.004	0.040+0.004	0.100+0.004
	0.05500-0.18299	0.003+0.008	0.008+0.008	0.040+0.008	0.100+0.008
	0.18300-0.54999	0.003+0.020	0.008+0.020	0.040+0.020	0.100+0.020
	0.55000-1.82999	0.003+0.040	0.008+0.040	0.040+0.040	0.100+0.040
	1.83000-5.49999	0.003+0.120	0.008+0.120	0.040+0.120	0.100+0.120
528.000-700.000	5.50000-10.9999	0.003+0.240	0.008+0.240	0.040+0.240	0.100+0.240
	11.0000-21.9999	0.003+0.480	0.008+0.480	0.040+0.480	0.100+0.480
	22.0000-55.0000	0.004+0.960	0.008+0.960	0.040+0.960	0.100+0.960
	22.0000-80.0000†	0.004+1.600	0.008+1.600	0.040+1.600	0.100+1.600
	5.50000-55.0000*	0.006+2.000	0.020+2.000	-	-
	5.50000-110.000*	0.006+4.000	0.020+4.000	-	-
	5.50000-220.000*	0.006+8.000	0.020+8.000	-	-
	5.50000-330.000§	0.006+16.00	0.020+16.00	-	-
	0.00100-0.01829	0.004+0.002	0.008+0.002	0.040+0.002	0.100+0.002
	0.01830-0.05499	0.003+0.004	0.008+0.004	0.040+0.004	0.100+0.004
	0.05500-0.18299	0.003+0.008	0.008+0.008	0.040+0.008	0.100+0.008
	0.18300-0.54999	0.003+0.020	0.008+0.020	0.040+0.020	0.100+0.020
	0.55000-1.82999	0.003+0.040	0.008+0.040	0.040+0.040	0.100+0.040
	1.83000-5.49999	0.003+0.120	0.008+0.120	0.040+0.120	0.100+0.120
528.000-1056.00‡	5.50000-10.9999	0.003+0.240	0.008+0.240	0.040+0.240	0.100+0.240
	11.0000-21.9999	0.003+0.480	0.008+0.480	0.040+0.480	0.100+0.480
	22.0000-55.0000	0.004+0.960	0.008+0.960	0.040+0.960	0.100+0.960
	22.0000-80.0000†	0.004+1.600	0.008+1.600	0.040+1.600	0.100+1.600
	5.50000-55.0000*	0.005+2.000	0.020+2.000	-	-
	5.50000-110.000*	0.005+4.000	0.020+4.000	-	-
	5.50000-220.000*	0.006+8.000	0.020+8.000	-	-
	5.50000-330.000§	0.006+16.00	0.020+16.00	-	-

† With Option 8100-80A

* With Optional Model 8145 Current Amplifier, § With Option 8145-300A

[1] With Option 8100-LF

‡ With Option 8100-1KV

Accuracy

Voltage Setting (V)	Current Setting (A)	±(% VA Setting + VA)			
		40-70Hz	25-200,400Hz	< 25∆, 200-600Hz	600-1000Hz
1.00000-21.9999	0.00100-0.01829	0.040+0.001	0.060+0.001	0.200+0.001	1.000+0.001
	0.01830-0.05499	0.030+0.001	0.060+0.001	0.200+0.001	1.000+0.001
	0.05500-0.18299	0.030+0.001	0.060+0.001	0.200+0.001	1.000+0.001
	0.18300-0.54999	0.030+0.001	0.060+0.001	0.200+0.001	1.000+0.001
	0.55000-1.82999	0.030+0.002	0.060+0.002	0.200+0.002	1.000+0.002
	1.83000-5.49999	0.030+0.005	0.060+0.005	0.200+0.005	1.000+0.005
	5.50000-10.9999	0.030+0.010	0.060+0.010	0.200+0.010	1.000+0.010
	11.0000-21.9999	0.030+0.020	0.070+0.020	0.200+0.020	1.000+0.020
	22.0000-55.0000	0.030+0.040	0.080+0.040	0.200+0.040	1.000+0.040
	22.0000-80.0000†	0.030+0.070	0.080+0.070	0.200+0.070	1.000+0.070
	5.50000-55.0000*	0.050+1.000	0.200+1.000	-	-
	5.50000-110.000*	0.050+2.000	0.200+2.000	-	-
	5.50000-220.000*	0.050+4.000	0.200+4.000	-	-
	5.50000-330.000§	0.075+8.000	0.200+8.000	-	-
22.0000-131.999	0.00100-0.01829	0.020+0.001	0.070+0.001	0.200+0.001	1.000+0.001
	0.01830-0.05499	0.010+0.001	0.050+0.001	0.200+0.001	1.000+0.001
	0.05500-0.18299	0.010+0.001	0.050+0.001	0.200+0.001	1.000+0.001
	0.18300-0.54999	0.010+0.002	0.050+0.002	0.200+0.002	1.000+0.002
	0.55000-1.82999	0.010+0.005	0.050+0.005	0.200+0.005	1.000+0.005
	1.83000-5.49999	0.010+0.015	0.050+0.015	0.200+0.015	1.000+0.015
	5.50000-10.9999	0.020+0.030	0.060+0.030	0.200+0.030	1.000+0.030
	11.0000-21.9999	0.020+0.060	0.070+0.060	0.200+0.060	1.000+0.060
	22.0000-55.0000	0.030+0.120	0.080+0.120	0.200+0.120	1.000+0.120
	22.0000-80.0000†	0.030+0.200	0.080+0.200	0.200+0.200	1.000+0.200
	5.50000-55.0000*	0.050+1.000	0.200+1.000	-	-
	5.50000-110.000*	0.050+2.000	0.200+2.000	-	-
	5.50000-220.000*	0.050+4.000	0.200+4.000	-	-
	5.50000-330.000§	0.075+8.000	0.200+8.000	-	-
132.000-263.999	0.00100-0.01829	0.020+0.002	0.070+0.002	0.200+0.002	1.000+0.002
	0.01830-0.05499	0.010+0.002	0.050+0.002	0.200+0.002	1.000+0.002
	0.05500-0.18299	0.010+0.002	0.050+0.002	0.200+0.002	1.000+0.002
	0.18300-0.54999	0.010+0.004	0.050+0.004	0.200+0.004	1.000+0.004
	0.55000-1.82999	0.010+0.010	0.050+0.010	0.200+0.010	1.000+0.010
	1.83000-5.49999	0.010+0.030	0.050+0.030	0.200+0.030	1.000+0.030
	5.50000-10.9999	0.020+0.060	0.060+0.060	0.200+0.060	1.000+0.060
	11.0000-21.9999	0.020+0.120	0.070+0.120	0.200+0.120	1.000+0.120
	22.0000-55.0000	0.030+0.240	0.080+0.240	0.200+0.240	1.000+0.240
	22.0000-80.0000†	0.030+0.400	0.080+0.400	0.200+0.400	1.000+0.400
	5.50000-55.0000*	0.050+2.000	0.200+2.000	-	-
	5.50000-110.000*	0.050+4.000	0.200+4.000	-	-
	5.50000-220.000*	0.050+8.000	0.200+8.000	-	-
	5.50000-330.000§	0.075+16.00	0.200+16.00	-	-

† With Option 8100-80A

[1] With Option 8100-LF

* With Optional Model 8145 Current Amplifier, § With Option 8145-300A

Accuracy (Continued)

Voltage Setting (V)	Current Setting (A)	±(% VA Setting + VA) 40-70Hz	25-200,400Hz	< 25[1], 200-600Hz	600-1000Hz
264.000-527.999	0.00100-0.01829	0.030+0.002	0.080+0.002	0.300+0.002	1.000+0.002
	0.01830-0.05499	0.020+0.002	0.080+0.002	0.300+0.002	1.000+0.002
	0.05500-0.18299	0.020+0.004	0.080+0.004	0.300+0.004	1.000+0.004
	0.18300-0.54999	0.020+0.008	0.080+0.008	0.300+0.008	1.000+0.008
	0.55000-1.82999	0.020+0.020	0.080+0.020	0.300+0.020	1.000+0.020
	1.83000-5.49999	0.020+0.060	0.080+0.060	0.300+0.060	1.000+0.060
	5.50000-10.9999	0.020+0.120	0.080+0.120	0.300+0.120	1.000+0.120
	11.0000-21.9999	0.020+0.240	0.080+0.240	0.300+0.240	1.000+0.240
	22.0000-55.0000	0.030+0.480	0.080+0.480	0.300+0.480	1.000+0.480
	22.0000-80.0000†	0.030+0.800	0.080+0.800	0.300+0.800	1.000+0.800
	5.50000-55.0000*	0.050+4.000	0.200+4.000	-	-
	5.50000-110.000*	0.050+8.000	0.200+8.000	-	-
	5.50000-220.000*	0.050+16.00	0.200+16.00	-	-
	5.50000-330.000§	0.075+32.00	0.200+32.00	-	-
528.000-700.000	0.00100-0.01829	0.040+0.002	0.080+0.002	0.400+0.002	1.000+0.002
	0.01830-0.05499	0.030+0.004	0.080+0.004	0.400+0.004	1.000+0.004
	0.05500-0.18299	0.030+0.008	0.080+0.008	0.400+0.008	1.000+0.008
	0.18300-0.54999	0.030+0.020	0.080+0.020	0.400+0.020	1.000+0.020
	0.55000-1.82999	0.030+0.040	0.080+0.040	0.400+0.040	1.000+0.040
	1.83000-5.49999	0.030+0.120	0.080+0.120	0.400+0.120	1.000+0.120
	5.50000-10.9999	0.030+0.240	0.080+0.240	0.400+0.240	1.000+0.240
	11.0000-21.9999	0.030+0.480	0.080+0.480	0.400+0.480	1.000+0.480
	22.0000-55.0000	0.040+0.960	0.080+0.960	0.400+0.960	1.000+0.960
	22.0000-80.0000†	0.040+1.600	0.080+1.600	0.400+1.600	1.000+1.600
	5.50000-55.0000*	0.050+8.000	0.200+8.000	-	-
	5.50000-110.000*	0.050+16.00	0.200+16.00	-	-
	5.50000-220.000*	0.050+32.00	0.200+32.00	-	-
	5.50000-330.000§	0.075+64.00	0.200+64.00	-	-
528.000-1056.00‡	0.00100-0.01829	0.040+0.002	0.080+0.002	0.400+0.002	1.000+0.002
	0.01830-0.05499	0.030+0.004	0.080+0.004	0.400+0.004	1.000+0.004
	0.05500-0.18299	0.030+0.008	0.080+0.008	0.400+0.008	1.000+0.008
	0.18300-0.54999	0.030+0.020	0.080+0.020	0.400+0.020	1.000+0.020
	0.55000-1.82999	0.030+0.040	0.080+0.040	0.400+0.040	1.000+0.040
	1.83000-5.49999	0.030+0.120	0.080+0.120	0.400+0.120	1.000+0.120
	5.50000-10.9999	0.030+0.240	0.080+0.240	0.400+0.240	1.000+0.240
	11.0000-21.9999	0.030+0.480	0.080+0.480	0.400+0.480	1.000+0.480
	22.0000-55.0000	0.040+0.960	0.080+0.960	0.400+0.960	1.000+0.960
	22.0000-80.0000†	0.040+1.600	0.080+1.600	0.400+1.600	1.000+1.600
	5.50000-55.0000*	0.050+8.000	0.200+8.000	-	-
	5.50000-110.000*	0.050+16.00	0.200+16.00	-	-
	5.50000-220.000*	0.050+32.00	0.200+32.00	-	-
	5.50000-330.000§	0.075+64.00	0.200+64.00	-	-

† With Option 8100-80A

* With Optional Model 8145 Current Amplifier, § With Option 8145-300A

[1] With Option 8100-LF

‡ With Option 8100-1KV

Accuracy (Continued)

Reactive Mode

Voltage Setting (V)	Current Setting (A)	±(% VA Setting + VA)			
		40-70Hz	25-200,400Hz	< 25[1], 200-600Hz	600-1000Hz
1.00000-21.9999	0.00100-0.01829	0.120+0.001	0.180+0.001	0.200+0.001	1.000+0.001
	0.01830-0.05499	0.090+0.001	0.180+0.001	0.200+0.001	1.000+0.001
	0.05500-0.18299	0.090+0.001	0.180+0.001	0.200+0.001	1.000+0.001
	0.18300-0.54999	0.090+0.001	0.180+0.001	0.200+0.001	1.000+0.001
	0.55000-1.82999	0.090+0.002	0.180+0.002	0.200+0.002	1.000+0.002
	1.83000-5.49999	0.090+0.005	0.180+0.005	0.200+0.005	1.000+0.005
	5.50000-10.9999	0.090+0.010	0.180+0.010	0.200+0.010	1.000+0.010
	11.0000-21.9999	0.090+0.020	0.210+0.020	0.200+0.020	1.000+0.020
	22.0000-55.0000	0.090+0.040	0.240+0.040	0.200+0.040	1.000+0.040
	22.0000-80.0000†	0.090+0.070	0.240+0.070	0.200+0.070	1.000+0.070
	5.50000-55.0000*	0.150+1.000	0.300+1.000	-	-
	5.50000-110.000*	0.150+2.000	0.300+2.000	-	-
	5.50000-220.000*	0.150+4.000	0.300+4.000	-	-
	5.50000-330.000§	0.150+8.000	0.300+8.000	-	-
22.0000-131.999	0.00100-0.01829	0.060+0.001	0.210+0.001	0.200+0.001	1.000+0.001
	0.01830-0.05499	0.030+0.001	0.150+0.001	0.200+0.001	1.000+0.001
	0.05500-0.18299	0.030+0.001	0.150+0.001	0.200+0.001	1.000+0.001
	0.18300-0.54999	0.030+0.002	0.150+0.002	0.200+0.002	1.000+0.002
	0.55000-1.82999	0.030+0.005	0.150+0.005	0.200+0.005	1.000+0.005
	1.83000-5.49999	0.030+0.015	0.150+0.015	0.200+0.015	1.000+0.015
	5.50000-10.9999	0.060+0.030	0.180+0.030	0.200+0.030	1.000+0.030
	11.0000-21.9999	0.060+0.060	0.210+0.060	0.200+0.060	1.000+0.060
	22.0000-55.0000	0.090+0.120	0.240+0.120	0.200+0.120	1.000+0.120
	22.0000-80.0000†	0.090+0.200	0.240+0.200	0.200+0.200	1.000+0.200
	5.50000-55.0000*	0.150+1.000	0.300+1.000	-	-
	5.50000-110.000*	0.150+2.000	0.300+2.000	-	-
	5.50000-220.000*	0.150+4.000	0.300+4.000	-	-
	5.50000-330.000§	0.150+8.000	0.300+8.000	-	-
132.000-263.999	0.00100-0.01829	0.060+0.002	0.210+0.002	0.200+0.002	1.000+0.002
	0.01830-0.05499	0.030+0.002	0.150+0.002	0.200+0.002	1.000+0.002
	0.05500-0.18299	0.030+0.002	0.150+0.002	0.200+0.002	1.000+0.002
	0.18300-0.54999	0.030+0.004	0.150+0.004	0.200+0.004	1.000+0.004
	0.55000-1.82999	0.030+0.010	0.150+0.010	0.200+0.010	1.000+0.010
	1.83000-5.49999	0.030+0.030	0.150+0.030	0.200+0.030	1.000+0.030
	5.50000-10.9999	0.060+0.060	0.180+0.060	0.200+0.060	1.000+0.060
	11.0000-21.9999	0.060+0.120	0.210+0.120	0.200+0.120	1.000+0.120
	22.0000-55.0000	0.090+0.240	0.240+0.240	0.200+0.240	1.000+0.240
	22.0000-80.0000†	0.090+0.400	0.240+0.400	0.200+0.400	1.000+0.400
	5.50000-55.0000*	0.150+2.000	0.300+2.000	-	-
	5.50000-110.000*	0.150+4.000	0.300+4.000	-	-
	5.50000-220.000*	0.150+8.000	0.300+8.000	-	-
	5.50000-330.000§	0.150+16.00	0.300+16.00	-	-

† With Option 8100-80A

[1] With Option 8100-LF

* With Optional Model 8145 Current Amplifier, § With Option 8145-300A

Accuracy (Continued)

Reactive Mode

Voltage Setting (V)	Current Setting (A)	±(% VA Setting + VA) 40-70Hz	25-200,400Hz	< 25[1], 200-600Hz	600-1000Hz
264.000-527.999	0.00100-0.01829	0.090+0.002	0.240+0.002	0.300+0.002	1.000+0.002
	0.01830-0.05499	0.060+0.002	0.240+0.002	0.300+0.002	1.000+0.002
	0.05500-0.18299	0.060+0.004	0.240+0.004	0.300+0.004	1.000+0.004
	0.18300-0.54999	0.060+0.008	0.240+0.008	0.300+0.008	1.000+0.008
	0.55000-1.82999	0.060+0.020	0.240+0.020	0.300+0.020	1.000+0.020
	1.83000-5.49999	0.060+0.060	0.240+0.060	0.300+0.060	1.000+0.060
	5.50000-10.9999	0.060+0.120	0.240+0.120	0.300+0.120	1.000+0.120
	11.0000-21.9999	0.060+0.240	0.240+0.240	0.300+0.240	1.000+0.240
	22.0000-55.0000	0.090+0.480	0.240+0.480	0.300+0.480	1.000+0.480
	22.0000-80.0000†	0.090+0.800	0.240+0.800	0.300+0.800	1.000+0.800
	5.50000-55.0000*	0.150+4.000	0.300+4.000	-	-
	5.50000-110.000*	0.150+8.000	0.300+8.000	-	-
	5.50000-220.000*	0.150+16.00	0.300+16.00	-	-
	5.50000-330.000§	0.150+3200	0.300+32.00	-	-
528.000-700.000	0.00100-0.01829	0.120+0.002	0.240+0.002	0.400+0.002	1.000+0.002
	0.01830-0.05499	0.090+0.004	0.240+0.004	0.400+0.004	1.000+0.004
	0.05500-0.18299	0.090+0.008	0.240+0.008	0.400+0.008	1.000+0.008
	0.18300-0.54999	0.090+0.020	0.240+0.020	0.400+0.020	1.000+0.020
	0.55000-1.82999	0.090+0.040	0.240+0.040	0.400+0.040	1.000+0.040
	1.83000-5.49999	0.090+0.120	0.240+0.120	0.400+0.120	1.000+0.120
	5.50000-10.9999	0.090+0.240	0.240+0.240	0.400+0.240	1.000+0.240
	11.0000-21.9999	0.090+0.480	0.240+0.480	0.400+0.480	1.000+0.480
	22.0000-55.0000	0.120+0.960	0.240+0.960	0.400+0.960	1.000+0.960
	22.0000-80.0000†	0.120+1.600	0.240+1.600	0.400+1.600	1.000+1.600
	5.50000-55.0000*	0.150+8.000	0.300+8.000	-	-
	5.50000-110.000*	0.150+16.00	0.300+16.00	-	-
	5.50000-220.000*	0.150+32.00	0.300+32.00	-	-
	5.50000-330.000§	0.150+64.00	0.300+64.00	-	-
528.000-1056.00‡	0.00100-0.01829	0.120+0.002	0.240+0.002	0.400+0.002	1.000+0.002
	0.01830-0.05499	0.090+0.004	0.240+0.004	0.400+0.004	1.000+0.004
	0.05500-0.18299	0.090+0.008	0.240+0.008	0.400+0.008	1.000+0.008
	0.18300-0.54999	0.090+0.020	0.240+0.020	0.400+0.020	1.000+0.020
	0.55000-1.82999	0.090+0.040	0.240+0.040	0.400+0.040	1.000+0.040
	1.83000-5.49999	0.090+0.120	0.240+0.120	0.400+0.120	1.000+0.120
	5.50000-10.9999	0.090+0.240	0.240+0.240	0.400+0.240	1.000+0.240
	11.0000-21.9999	0.090+0.480	0.240+0.480	0.400+0.480	1.000+0.480
	22.0000-55.0000	0.120+0.960	0.240+0.960	0.400+0.960	1.000+0.960
	22.0000-80.0000†	0.120+1.600	0.240+1.600	0.400+1.600	1.000+1.600
	5.50000-55.0000*	0.150+8.000	0.300+8.000	-	-
	5.50000-110.000*	0.150+16.00	0.300+16.00	-	-
	5.50000-220.000*	0.150+32.00	0.300+32.00	-	-
	5.50000-330.000§	0.150+64.00	0.300+64.00	-	-

† With Option 8100-80A

* With Optional Model 8145 Current Amplifier, § With Option 8145-300A

[1] With Option 8100-LF

‡ With Option 8100-1KV

Frequency (Fundamental)

Setting Range: 16.00Hz - 1.000kHz

Setting Resolution: 4 digits (0.001Hz)

Settling Time: < 2 seconds

Stability: 0.01%

Accuracy

Setting (Hz)	±(% Setting)
16.00-400.0*	0.04
25.00-1000	0.04
400.1-1000	0.10

*With option 8100-LF

Line Synchronization

The fundamental frequency setting may be synchronized to the power line frequency at any power line frequency from 16Hz to 1000Hz.

Phase Angle Voltage-Current

Setting Range:	-180.000º to +180.000º
Setting Resolution:	6 digits via Front Panel Control (0.00001°) 7 digits via Remote Control (0.000001°)
Units:	Degrees or Power Factor
Settling Time:	< 2 seconds after setting change (Normal Mode, < 450Hz) < 10 seconds after setting change (Normal Mode, > 450Hz) < 10 seconds after setting change (Reactive Mode)

Accuracy

The voltage –current phase angle accuracy is derived from the power accuracy specification for any particular voltage and current setting. The voltage –current phase angle accuracy is calculated using the following equation.

$$\text{Phase Angle Accuracy} = \pm 90^\circ - \cos^{-1}\left(\frac{\text{Power Accuracy}}{\text{VA Setting}}\right)$$

The calculation is illustrated in the following example for a setting of 120V, 5A, 0° at a frequency of 50Hz.

The power accuracy specification for this setting is 0.010% of VA setting ± 0.015W.

$$\begin{aligned}\text{Power Accuracy} &= 0.010\%(600) + 0.015\\ &= 0.06 + 0.015\\ &= 0.075W\end{aligned}$$

The phase angle accuracy equation may now be solved using a Power Accuracy of 0.075W and a VA setting of 600VA.

$$\begin{aligned}\text{Phase Angle Accuracy} &= \pm 90^\circ - \cos^{-1}\left(\frac{0.075}{600}\right)\\ &= \pm 90^\circ - \cos^{-1}(0.000125)\\ &= \pm 90^\circ - 89.9928^\circ\\ &= \pm 0.0072^\circ\end{aligned}$$

Phase Angle Line-Line

Setting Range: -180.0º to +180.0º

Setting Resolution: 4 digits via Front Panel Control (0.001°)
7 digits via Remote Control (0.000001°)

Settling Time: < 2 seconds after setting change (Normal Mode, < 450Hz)
< 10 seconds after setting change (Normal Mode, > 450Hz)
< 10 seconds after setting change (Reactive Mode)

Units: Degrees

Accuracy

Voltage Setting (V)	Current Setting (A)	Degrees 40-70Hz	25-200,400Hz	200-600Hz	600-1000Hz
1.00000-700.000	0.00100-55.0000	0.010	0.040	0.200	0.400
	0.00100-80.0000†	0.010	0.040	0.200	0.400
	55.0000-220.000*	0.010	-	-	-
1.00000-1056.00‡	0.00100-55.0000	0.010	0.040	0.200	0.400
	0.00100-80.0000†	0.010	0.040	0.200	0.400
	55.0000-220.000*	0.010	-	-	-

† With Option 8100-80A
* With Optional Model 8145 Current Amplifier
‡ With Option 8100-1KV

Energy

The Model 8100 provides several different methods that may be used to test energy meters. The Delivered Energy, Counter, and External Reference Modes are standard features of the Model 8100.

Delivered Energy Mode

Test Modes:	Voltage Startup Inhibit, Current Startup Inhibit
Max Test Duration:	1000 Hours
Max Energy Delivered	38,500 kWhr 232,320 kWhr With Optional Range Extensions
Accuracy:	$Error_{Time}+Error_{Power}+Error_{Startup}$

ErrorTime = (0.01% of Test Duration)Hr × (Applied Power)W
ErrorPower = (Test Duration)Hr × (Applied Power Error)W
ErrorStartup = 0.00005Hr × (Applied Power)W

Example:
Whr Setting = 60Whr
Power Setting = 600W
Test Duration = 0.1 Hr (6 min)
Applied Power Error = 0.075W (8100 Power Specifications)

ErrorTime = (0.0001 × 0.1)Hr × 600W = 0.006Whr
ErrorPower = 0.1Hr × 0.075W = 0.0075Whr
ErrorStartup = 0.00005Hr × 600W = 0.03Whr

ErrorTotal = ErrorTime+ErrorPower+ErrorStartup
ErrorTotal = 0.006Whr+0.0075Whr+0.03Whr
ErrorTotal = 0.0435Whr
ErrorTotal = 0.0435Whr ÷ 60Whr = 0.0725%

Note that the ErrorStartup term is a fixed value whose significance decreases as the test time increases. With a sufficiently long test duration this term will become insignificant.

Counter Mode

Input Channels:	2 6, With the Model 8120 Counter-Comparator
Max Counts/Channel:	4,294,967,295 Counts (32 Bit)
Pull-up Resistors:	150 Ohm, 1kOhm and 33kOhms Individually selectable per channel
Pulse Edge:	Rising or Falling Individually selectable per channel
Accuracy:	ErrorTime+ErrorPower

ErrorTime = (0.005% of Test Duration)Hr×(Applied Power)W
ErrorPower = (Test Duration)Hr×(Applied Power Error)W

Example:
Whr Setting = 60Whr
Power Setting = 600W
Test Duration = 0.1 Hr (6 min)
Applied Power Error = 0.075W (8100 Power Specifications)

ErrorTime = (0.00005 × 0.1)Hr × 600W = 0.003Whr
ErrorPower = 0.1Hr × 0.075W = 0.0075Whr

ErrorTotal = ErrorTime+ErrorPower
ErrorTotal = 0.003Whr+0.0075Whr
ErrorTotal = 0.0105Whr
ErrorTotal = 0.0105Whr ÷ 60Whr = 0.0175%

External Reference Mode

Reference Inputs:	1
UUT Inputs:	1 5, With the Model 8120 Counter-Comparator
Max Counts,Reference:	4,294,967,295 Counts (32 Bit)
Max Counts,UUT Input:	4,294,967,295 Counts (32 Bit)
Pull-up Resistors:	150 Ohm, 1kOhm and 33kOhms Individually selectable per channel
Pulse Edge:	Rising or Falling Individually selectable per channel
Accuracy:	Test accuracy depends entirely on the accuracy of the external energy reference used. When used with the optional Rotek Model MSB100 the energy accuracy is 0.005%.

Sag The Model 8100 Sag Event allows the simulation of short term reductions in the output amplitude typically referred to as Sags, Dips or Drops. The Model 8100 may apply a Sag to either the voltage or the current output channel.

Amplitude	Maximum:	100.00% of Nominal Setting
	Minimum:	1.0000% of Nominal Setting
	Nominal Accuracy:	0.0500% of Nominal Setting
	Sag Accuracy:	0.0500% of Nominal Setting
	Setting Resolution:	0.0001% of Nominal Setting
Duration	Maximum:	9999.0 Cycles or Seconds
	Minimum:	0.0000 Cycles or Seconds
	Setting Resolution:	0.5000 Cycles (0.0080 Seconds at 60Hz Output Frequency)
	Setting Units:	Cycles, Seconds
Start Ramp	Maximum:	9999.0 Cycles or Seconds
	Minimum:	0.0000 Cycles or Seconds
	Setting Resolution:	0.5000 Cycles (0.0080 Seconds at 60Hz Output Frequency)
	Setting Units:	Cycles, Seconds
Exit Ramp	Maximum:	9999.0 Cycles or Seconds
	Minimum:	0.0000 Cycles or Seconds
	Setting Resolution:	0.5000 Cycles (0.0080 Seconds at 60Hz Output Frequency)
	Setting Units:	Cycles, Seconds
Repeat	Mode:	Single or Continuous
	Maximum Delay:	9999.0 Cycles or Seconds
	Minimum Delay:	0.0000 Cycles or Seconds
	Delay Resolution:	0.5000 Cycles (0.0080 Seconds at 60Hz Output Frequency)
Trigger	Mode:	Normal or Auto-Start
	Source:	Internal, Front I/O Terminal, Rear I/O Terminal
	Maximum Delay:	9999.0 Cycles or Seconds
	Minimum Delay:	0.0000 Cycles or Seconds
	Delay Resolution:	0.5000 Cycles (0.0080 Seconds at 60Hz Output Frequency)

Output		
	Source:	Front I/O Terminal, Rear I/O Terminal
	Maximum Delay:	99.0 Seconds
	Minimum Delay:	0.00 Seconds
	Delay Resolution:	0.10 Seconds

Swell

The Model 8100 Swell Event allows the simulation of short-term increases in the output amplitude typically referred to as Swells or Rises. The Model 8100 may apply a Swell to either the voltage or the current output channel.

Amplitude	Maximum:	200.00% of Nominal Setting (< Maximum V/I Setting)
	Minimum:	100.00% of Nominal Setting
	Nominal Accuracy:	0.0500% of Nominal Setting
	Swell Accuracy:	0.0500% of Nominal Setting
	Setting Resolution:	0.0001% of Nominal Setting
Duration	Maximum:	9999.0 Cycles or Seconds
	Minimum:	0.0000 Cycles or Seconds
	Setting Resolution:	0.5000 Cycles (0.0080 Seconds at 60Hz Output Frequency)
	Setting Units:	Cycles, Seconds
Start Ramp	Maximum:	9999.0 Cycles or Seconds
	Minimum:	0.0000 Cycles or Seconds
	Setting Resolution:	0.5000 Cycles (0.0080 Seconds at 60Hz Output Frequency)
	Setting Units:	Cycles, Seconds
Exit Ramp	Maximum:	9999.0 Cycles or Seconds
	Minimum:	0.0000 Cycles or Seconds
	Setting Resolution:	0.5000 Cycles (0.0080 Seconds at 60Hz Output Frequency)
	Setting Units:	Cycles, Seconds
Repeat	Mode:	Single or Continuous
	Maximum Delay:	9999.0 Cycles or Seconds
	Minimum Delay:	0.0000 Cycles or Seconds
	Delay Resolution:	0.5000 Cycles (0.0080 Seconds at 60Hz Output Frequency)
Trigger	Mode:	Normal or Auto-Start
	Source:	Internal, Front I/O Terminal, Rear I/O Terminal
	Maximum Delay:	9999.0 Cycles or Seconds
	Minimum Delay:	0.0000 Cycles or Seconds
	Delay Resolution:	0.5000 Cycles (0.0080 Seconds at 60Hz Output Frequency)

Output	Source:	Front I/O Terminal, Rear I/O Terminal
	Maximum Delay:	99.0 Seconds
	Minimum Delay:	0.00 Seconds
	Delay Resolution:	0.10 Seconds

Interruption

The Model 8100 Interruption Event allows the simulation of short-term absence of the voltage or current output.

Amplitude	Maximum:	0.0000% of Nominal Setting
	Nominal Accuracy:	0.0500% of Nominal Setting
Duration	Maximum:	9999.0 Cycles or Seconds
	Minimum:	0.0000 Cycles or Seconds
	Setting Resolution:	0.5000 Cycles (0.0080 Seconds at 60Hz Output Frequency)
	Setting Units:	Cycles, Seconds
Repeat	Mode:	Single or Continuous
	Maximum Delay:	9999.0 Cycles or Seconds
	Minimum Delay:	0.0000 Cycles or Seconds
	Delay Resolution:	0.5000 Cycles (0.0080 Seconds at 60Hz Output Frequency)
Trigger	Mode:	Normal or Auto-Start
	Source:	Internal, Front I/O Terminal, Rear I/O Terminal
	Maximum Delay:	9999.0 Cycles or Seconds
	Minimum Delay:	0.0000 Cycles or Seconds
	Delay Resolution:	0.5000 Cycles (0.0080 Seconds at 60Hz Output Frequency)
Output	Source:	Front I/O Terminal, Rear I/O Terminal
	Maximum Delay:	99.0 Seconds
	Minimum Delay:	0.00 Seconds
	Delay Resolution:	0.10 Seconds

Flicker

The Model 8100 Flicker Event allows the simulation of fluctuations in the output amplitude typically referred to as Flicker. The Model 8100 may apply Flicker to either the voltage or the current output channel.

Amplitude

Maximum:	200.00% of Nominal Setting (< Maximum V/I Setting)
Minimum:	1.0000% of Nominal Setting
Nominal Accuracy:	0.0500% of Nominal Setting
Flicker Accuracy:	0.0500% of Nominal Setting
Setting Resolution:	0.0001% of Nominal Setting

Flicker Period

Maximum:	9999.0 Cycles
Minimum:	0.5000 Cycles
Setting Resolution:	0.5000 Cycles

Duration

Maximum:	9999.0 Cycles or Seconds
Minimum:	0.0000 Cycles or Seconds
Setting Resolution:	0.5000 Cycles (0.0080 Seconds at 60Hz Output Frequency)
Setting Units:	Cycles, Seconds

Start Ramp

Maximum:	9999.0 Cycles or Seconds
Minimum:	0.0000 Cycles or Seconds
Setting Resolution:	0.5000 Cycles (0.0080 Seconds at 60Hz Output Frequency)
Setting Units:	Cycles, Seconds

Exit Ramp

Maximum:	9999.0 Cycles or Seconds
Minimum:	0.0000 Cycles or Seconds
Setting Resolution:	0.5000 Cycles (0.0080 Seconds at 60Hz Output Frequency)
Setting Units:	Cycles, Seconds

Repeat

Mode:	Single or Continuous
Maximum Delay:	9999.0 Cycles or Seconds
Minimum Delay:	0.0000 Cycles or Seconds
Delay Resolution:	0.5000 Cycles (0.0080 Seconds at 60Hz Output Frequency)

Trigger	Mode:	Normal or Auto-Start
	Source:	Internal, Front I/O Terminal, Rear I/O Terminal
	Maximum Delay:	9999.0 Cycles or Seconds
	Minimum Delay:	0.0000 Cycles or Seconds
	Delay Resolution:	0.5000 Cycles (0.0080 Seconds at 60Hz Output Frequency)
Output	Source:	Front I/O Terminal, Rear I/O Terminal
	Maximum Delay:	99.0 Seconds
	Minimum Delay:	0.00 Seconds
	Delay Resolution:	0.10 Seconds

Harmonics

The Model 8100 Harmonics function allows the addition of harmonic distortion to either the voltage or the current output channel.

Harmonic

Maximum:	100^{th} (up to 6kHz)
Minimum:	2^{nd}
Multiple Harmonics:	100 (Via 8100 FP)

Amplitude

Maximum:	50.0% of Fundamental Setting
Setting Resolution:	0.0001% of Fundamental Setting
Accuracy:	(0.05% + Frequency Adder**) of Fundamental Setting

Phase Angle

Setting Range:	±180°
Setting Resolution:	1°

Maximum Peak Voltage Setting

Range (V)	Maximum Setting (Peak V)
20	43
120	260
240	520
480	1045
640	1385
1000‡	1500

‡ With Option 8100-1KV

Maximum Peak Current Setting

Range (A)	Maximum Setting (Peak A)
0.015	0.03621
0.050	0.10887
0.150	0.36230
0.500	1.08892
1.500	3.62319
5.000	10.8894
10.00	21.7786
20.00	43.5575
50.00	108.894
80.00†	158.392
50.00*	108.894
100.0*	217.788
200.0*	435.577

† With Option 8100-80A
* With Optional Model 8145 Current

** Frequency Adder = 0.50% × (Harmonic Frequency (kHz))^2

Inter-Harmonics

The Model 8100 Inter-Harmonics function allows the addition of non-harmonic distortion to either the voltage or the current output channel.

Frequency

Maximum:	9.000kHz
Minimum:	16.00Hz
Setting Resolution:	0.001Hz

Amplitude

Maximum:	50.000% of Fundamental Setting
Accuracy:	(1.0% + Frequency Adder**) of Fundamental Setting
Setting Resolution:	0.0001% of Fundamental Setting

Maximum Peak Voltage Setting

Range (V)	Maximum Setting (Peak V)
20	43
120	260
240	520
480	1045
640	1385
1000‡	1500

‡ With Option 8100-1KV

Maximum Peak Current Setting

Range (A)	Maximum Setting (Peak A)
0.015	0.03621
0.050	0.10887
0.150	0.36230
0.500	1.08892
1.500	3.62319
5.000	10.8894
10.00	21.7786
20.00	43.5575
50.00	108.894
80.00†	158.392
50.00*	108.894
100.0*	217.788
200.0*	435.577

† With Option 8100-80A
* With Optional Model 8145 Current Amplifier

** Frequency Adder = 0.50% × (Inter-Harmonic Frequency (kHz))^2

Fluctuating Harmonics

The Model 8100 Fluctuating function allows the addition of fluctuating amplitude of any harmonic distortion on either the voltage or the current output channel. The Fluctuating function has no effect until a harmonic has been added to the fundamental.

Amplitude

Range:	0-100% of Harmonic Amplitude
Accuracy:	0.0500% of Fundamental Setting

Fluctuate Period

Maximum:	9999.0 Cycles
Minimum:	0.5000 Cycles
Setting Resolution:	0.5000 Cycles

Notching

The Model 8100 Notching function allows the addition of periodic disturbances to either the voltage or the current output channel.

Notch

Maximum:	100 Notches per Cycle
Minimum:	2 Notches per Cycle

Amplitude

Maximum:	50.000% of Fundamental Setting
Accuracy:	0.0500% of Fundamental Setting
Setting Resolution:	0.0001% of Fundamental Setting

Phase Angle

Setting Range:	±180°
Setting Resolution:	1°

Maximum Peak Voltage Setting

Range (V)	Maximum Setting (Peak V)
20	43
120	260
240	520
480	1045
640	1385
1000‡	1500

‡ With Option 8100-1KV

Maximum Peak Current Setting

Range (A)	Maximum Setting (Peak A)
0.015	0.03621
0.050	0.10887
0.150	0.36230
0.500	1.08892
1.500	3.62319
5.000	10.8894
10.00	21.7786
20.00	43.5575
50.00	108.894
80.00†	158.392
50.00*	108.894
100.0*	217.788
200.0*	435.577

† With Option 8100-80A
* With Optional Model 8145 Current Amplifier

User Defined Distortion

The Model 8100 User Defined Distortion function allows the addition of user defined distortion to either the voltage or the current output channel. The numeric data describing the distortion waveform is entered via the Model 8100's remote interface.

Points

Number: 40,000 / Fundamental Frequency (Defining 1 Cycle)

Amplitude

Maximum: 50.000% of Fundamental Setting

Setting Resolution: 0.0001% of Fundamental Setting

Maximum Peak Voltage Setting

Range (V)	Maximum Setting (Peak V)
20	43
120	260
240	520
480	1045
640	1385
1000‡	1500

‡ With Option 8100-1KV

Maximum Peak Current Setting

Range (A)	Maximum Setting (Peak A)
0.015	0.03621
0.050	0.10887
0.150	0.36230
0.500	1.08892
1.500	3.62319
5.000	10.8894
10.00	21.7786
20.00	43.5575
50.00	108.894
80.00†	158.392
50.00*	108.894
100.0*	217.788
200.0*	435.577

† With Option 8100-80A

* With Optional Model 8145 Current Amplifier

External Synchronization Signals

The Model 8100 can provide optional, external signals that may be used to synchronize external, sampling measurement instruments to the output signal of the Model 8100. Two signals are provided, a high speed synchronization signal and a Cycle strobe signal.

Synchronization Signal

The external synchronization signal is a square wave with a selectable frequency of either 40kHz or 20MHz with a 5V, TTL, amplitude and a 50% duty cycle. The external synchronization signal has a frequency accuracy of 0.01%. A typical external synchronization signal is shown in Figure 1-26 with the frequency set to 40kHz.

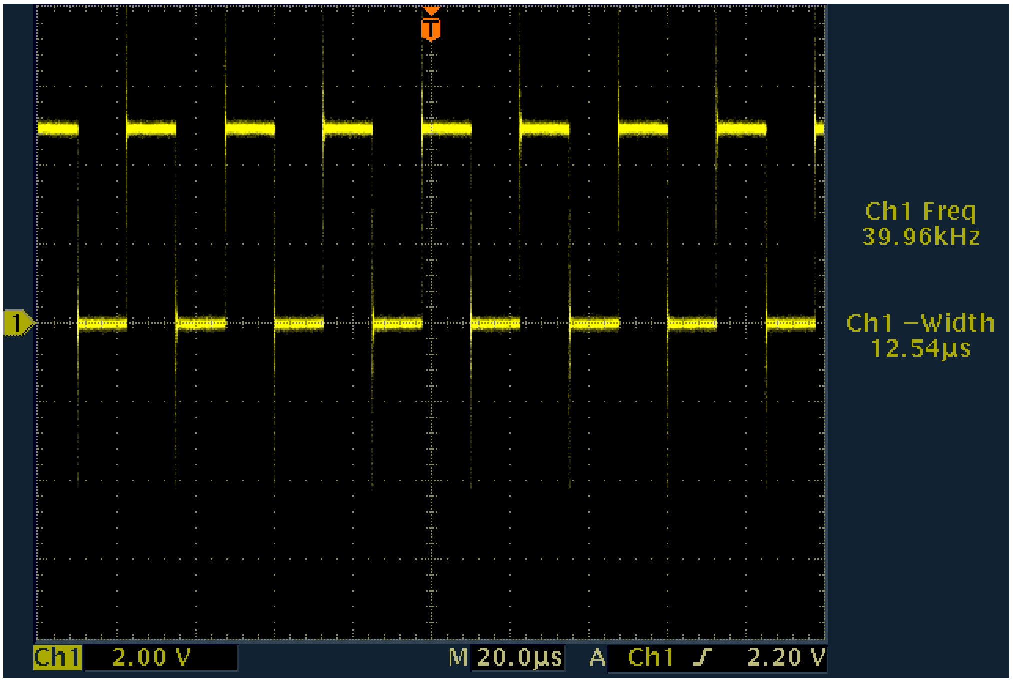

Figure 1-26
External Synchronization Signal

Cycle Strobe Signal

The cycle strobe signal is a 12µ second, negative going, 5V to 0V pulse occurring once every output cycle of the Model 8100. The strobe coincides with one zero crossing per cycle of the Model output voltage signal. A typical cycle strobe signal is shown in Figure 1-27. A more detailed view of the cycle strobe signal is shown in Figure 1-28.

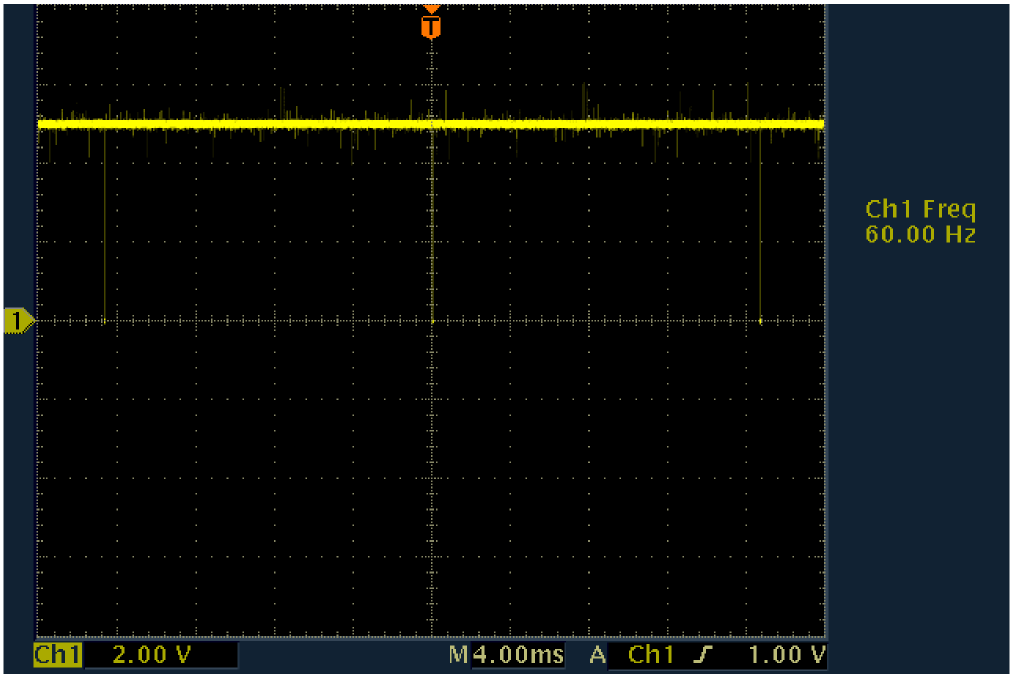

Figure 1-27
Cycle Strobe Signal

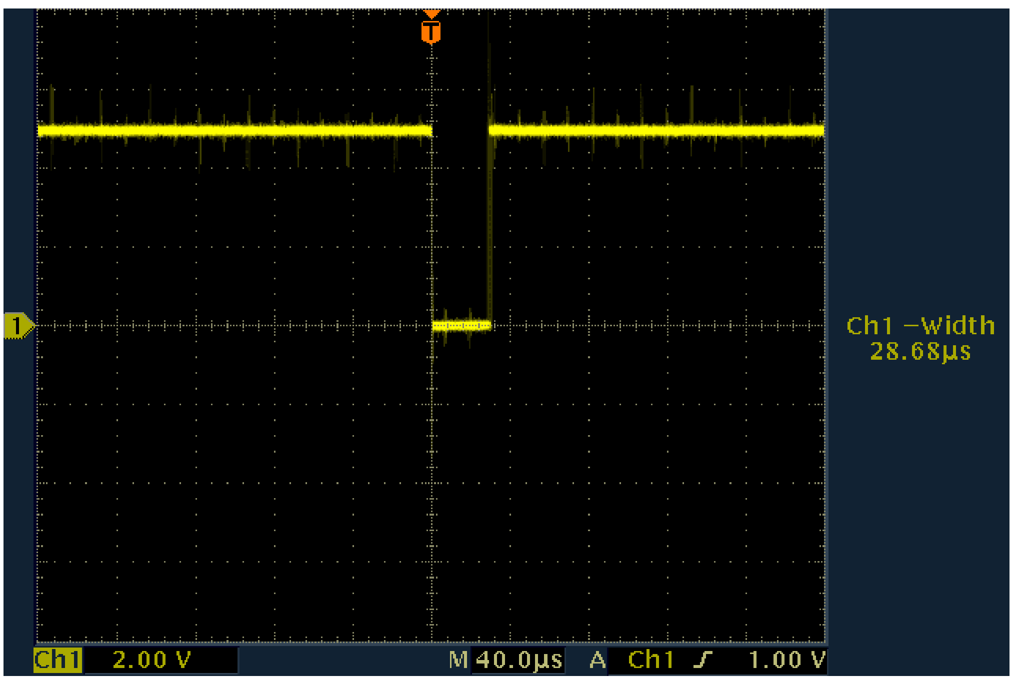

Figure 1-28
Cycle Strobe Signal Detail

General

Physical

Power:	500 Watts at nominal line voltage
Power Line Voltage:	90-132V, 175-264V
Power Line Frequency:	50-60Hz

Width:	432mm (17”)
Height:	178mm (7”)
Depth:	533mm (21”)
Weight:	25Kg (55lbs)

Fuse Rating

Line Fuse:

Power Line Voltage	Fuse Rating (250V)
100 ± 10%	5 A T
120 ± 10%	5 A T
220 ± 10%	2.5 A T
240 ± 10%	2.5 A T

F1, Current PA:	10A T (Slow Blow)
F2, Current PA:	10A T (Slow Blow)
F3, Voltage PA:	7A T (Slow Blow)
F4, Voltage PA:	7A T (Slow Blow)

Remote Interfaces

GPIB

Serial, RS-232

Chapter 2
OPERATING INSTRUCTIONS

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Model 8100

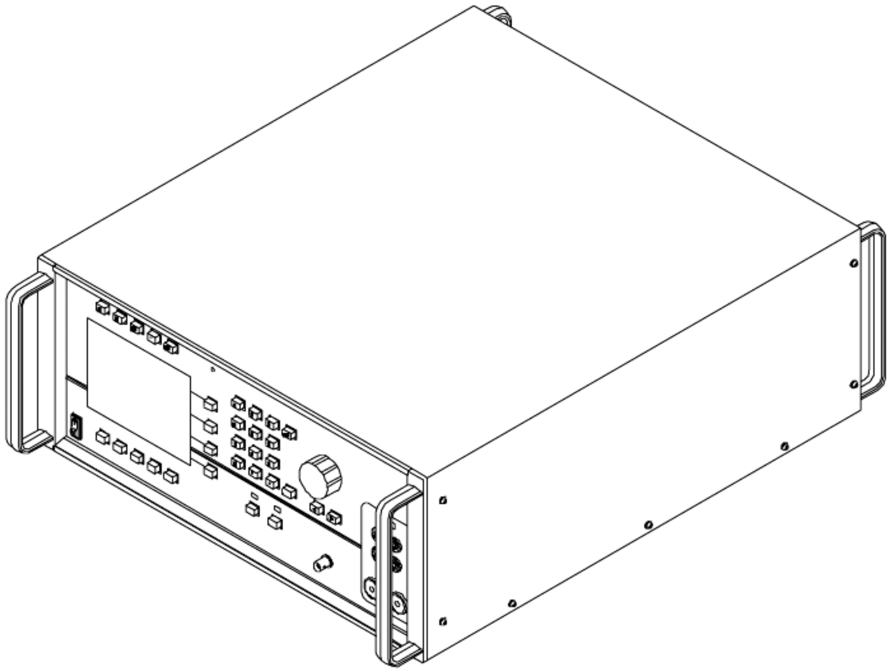


Figure 2-1
Model 8100

Installation

The standard configuration of the Model 8100 Calibrator is bench mounted. Rack-mounting ears are available as option 8100-RM and are easily installed in the field. Suitable support must be provided when mounting the Model 8100 in a rack.

When installing the Model 8100 in either a rack or on a bench care should be used to ensure that proper ventilation is provided at the rear of the instrument. The Model 8100 is equipped with 3 cooling exhaust fans and 1 large cooling air intake grill. The exhaust and intake grills must not be obstructed or the instrument may become unable to properly regulate its internal temperature. The speed of each cooling exhaust fan is independently variable and is controlled by the calibrator to maintain a constant internal temperature. At power-up or when the unit is idle the fans will be set to their lowest speed helping to reduce the noise generated by the calibrator. As the instrument is used the fan speed will vary. This variation is normal.

To meet all published specifications the instrument must be used in an environment with an ambient temperature within ±5°C of the last calibration temperature. The standard factory calibration temperature is 23°C. Factory calibration performed at temperatures other than 23°C is available as a special calibration option. The difference between the most recent calibration temperature and the present temperature is displayed on the front panel of the Model 8100.

Line Voltage Selection

The Model 8100 Calibrator can be operated from an AC power source of 90-132 Volts or 198-264 Volts, 45-65Hz. The Power Entry Module, located on the rear panel, provides a 4-position line voltage selector that is integrated with the fuse holder. The line fuse is rated at 5 Amps Slow Blow when the voltage selector is set to a line voltage setting of either 100VAC or 120VAC. The line fuse is rated at 2.5 Amps Slow Blow when the voltage selector is set to a line voltage setting of either 220VAC or 240VAC. The proper fuse ratings are listed in a table printed on the rear panel of the Model 8100. The selected line voltage setting is displayed in the voltage window of the fuse cover located on the rear panel adjacent to the line cord connector.

To change the selected power line voltage, first disconnect the power cord to the calibrator. Open the fuse cover using a small blade screwdriver or similar tool. Remove the voltage selector module and rotate it so that the desired line voltage setting is displayed in the window when the module is re-seated in the power entry module. Install a fuse of the appropriate rating into the fuse holder. Replace the fuse holder into the upper fuse position. Close the fuse cover and verify the desired line voltage is visible in the window.

⚠ WARNING ⚠

Replace fuse only with a 250V fuse of noted rating.

Always use fuses of type T (SB).

Use of incorrect fuses could result in damage to the calibrator and injury to personnel!

A three-conductor power cable is provided and when this cable is connected to a standard three-wire outlet the instrument chassis is connected to earth ground. This feature prevents the instrument case from assuming voltages that are potentially hazardous to personnel. In the event that an adapter is used to connect the three-wire cable to a two-wire outlet the green (ground) adapter terminal should always be connected to the earth ground.

Front Panel Controls & Displays

Figure 2-2 illustrates the location of the front panel controls, connections and indicators. Each element of control, display or connection is numbered and a description of the function of each appears below.

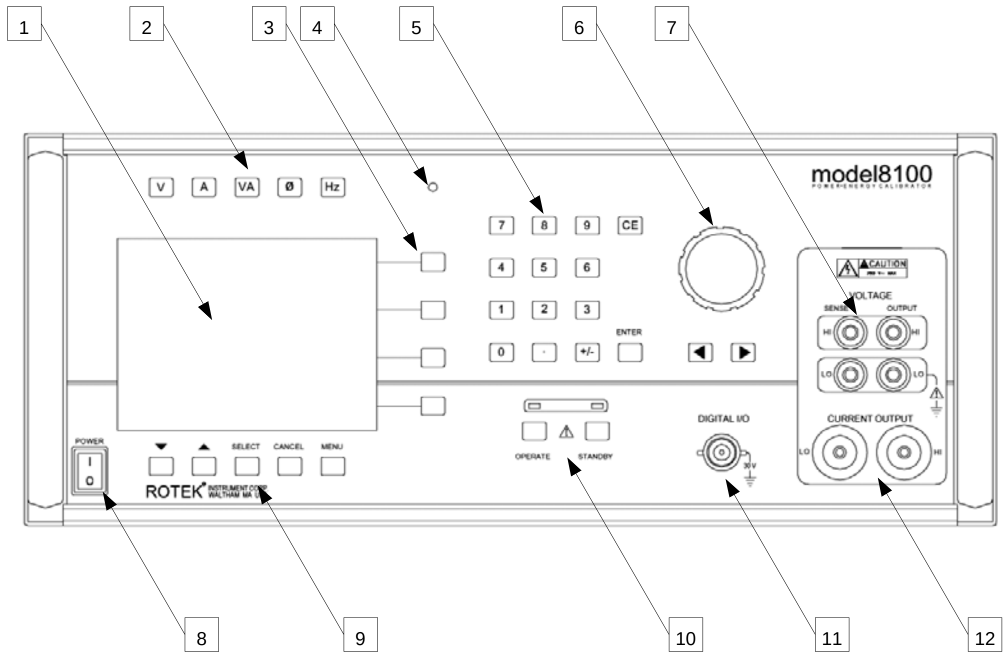


Figure 2-2
Front Panel Controls and Displays

1. Output Settings Display.
   The Output Settings Display is a color LCD display that provides information about the present setting of each of the output parameters, Voltage, Current, VA, Phase Angle, and Frequency. All system settings and configuration menus are displayed on this screen as well.

   The standard output setting display is shown in Figure 2-3 and the various features of the Main Display are described below.

   Output Voltage Setting.
   This field displays the present setting of the voltage output.

   Output Current Setting.
   This field displays the present setting of the current output.

   V/I Phase Angle Setting
   This field displays the present setting of the voltage to current phase angle.

   Output Power Setting.
   This field displays the present setting of the power output expressed in units of Watts, VARs or VA.

Configuration Status.
This field displays the present setting of various configuration parameters such as voltage sense and output terminals.

System Status.
This field displays system status information such as error messages. The standard message is ‘OK’.

Control Status
This field displays the control status of the calibrator. On power up, the calibrator will be in the LOCAL state and ‘Local’ will be displayed in this window. If the calibrator is addressed via either the GPIB or the Serial remote connection, ‘Remote’ will be displayed here. The ‘Talk’ and ‘Listen’ status indicators of the GPIB interface are also displayed here.

Output Frequency Setting.
This field displays the present setting of the output frequency.

V/V Phase Angle Setting.
This field displays the present setting of the voltage-to-voltage (line to line) phase angle. This setting applies when the Model 8100 is configured as a poly-phase system.

Phase Designator.
This field displays the present three phase configuration of the calibrator. The default setting is ‘Phase A’. Model 8100’s may be configured as ‘Phase A’, ‘Phase B’ or ‘Phase C’. This setting applies when the Model 8100 is configured as a poly-phase system.

Internal Temperature Δ.
This field displays the difference between the calibration temperature of the Model 8100 and the present internal temperature. The temperature is expressed in units of either °C or °F.

Voltage Phase Soft-Key.
This soft-key activates the Voltage-to-Voltage Setting edit mode. This key is applicable when the Model 8100 is configured as a poly-phase system.

Go To Local Soft Key.
This soft-key returns the calibrator to local control when it has been under remote control via the GPIB or RS-232 interface.

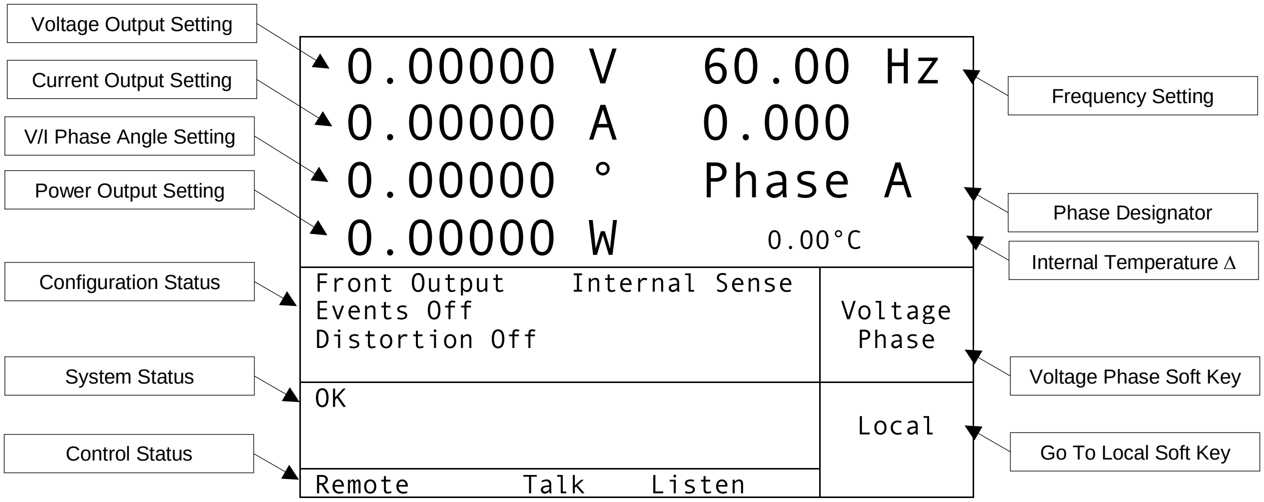


Figure 2-3
Main Display

2. Output Setting Edit Keys.
   The Output Setting Edit Keys are used to select which output parameter is to be modified. The keys labeled V, A, VA, ϕ, and Hz are used to modify Voltage, Current, Volt-Amperes, Phase Angle, and Frequency settings. Pressing one of these keys will cause the selected output-setting field to be highlighted, indicating that it is ready to be edited. The setting may be changed using the keys of the numeric keypad or the digit selection keys and the setting control knob. The VA (Volt-Amperes) key is used to edit the output power setting regardless of the power units selected by the user. The power may be entered as Active, Reactive or Apparent Power with units expressed as Watts, VARs or Volt-Amperes respectively.

   When the output setting of either the Voltage or Current output amplitudes are changed but no range change is required the Model 8100 waits for the next zero crossing and then immediately implements the amplitude change. Figure 2-4 illustrates the behavior of the voltage and current outputs when the amplitude setting is changed.

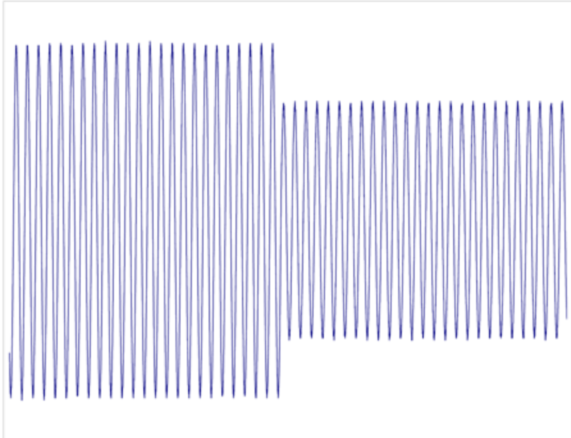


Figure 2-4
Amplitude Change (No Range Change)

When the output setting of either the Voltage or Current output amplitudes are changed and a range change is required the Model 8100 waits for the next zero crossing and shuts off the output for approximately 60mSec. While the output is off range relays are changed and at the next zero crossing the output is activated again in the new range. Figure 2-5 illustrates the initial changes to the output when changing ranges.

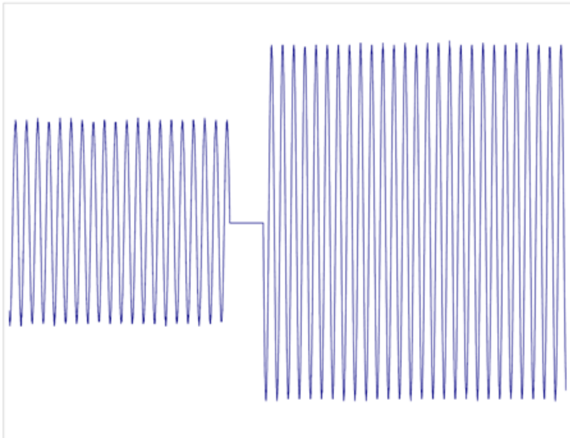


Figure 2-5
Initial Amplitude Change (Range Change)

The Model 8100 then calculates the new output waveform and applies the appropriate calibration adjustments to the output. This process is completed in approximately 1 second. When the new waveform is ready, the Model 8100 once again waits for the next zero crossing and shuts the output off for 0.5 Cycles. When the output is activated again, the output reflects the new, calibrated waveform. The behavior of the output during the final event of the amplitude change is illustrated in Figure 2-6.

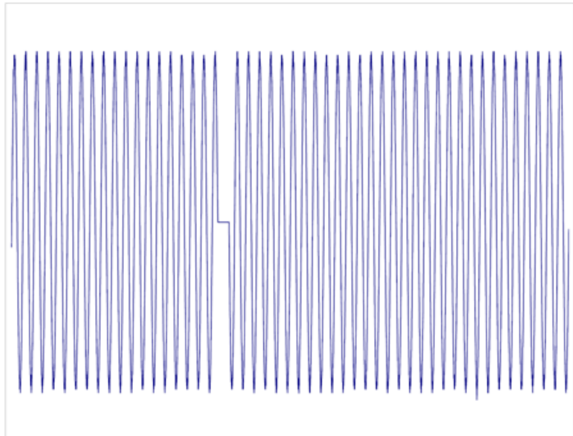


Figure 2-6
Final Amplitude Change (Range Change)

During the 1 second between the initial amplitude change event and the final amplitude change event both the Operate and Standby Front panel LED indicators are illuminated to indicate an unstable output.

When the output frequency is changed while the unit is in the 'Operate' state, the Model 8100 waits for the next zero crossing and shuts the output off for 0.5 Cycles. When the output is activated, the frequency will be changed. Figure 2-7 illustrates the behavior of the output when the frequency is changed.

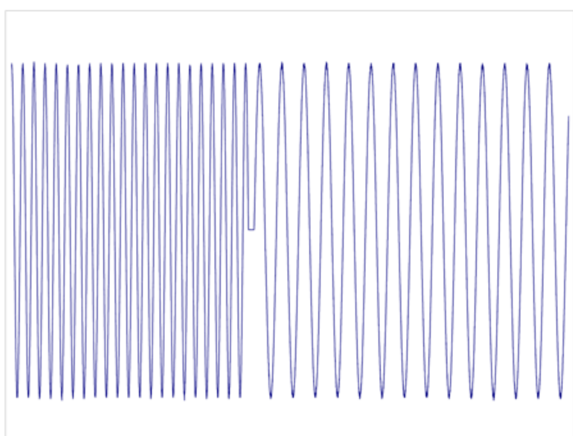


Figure 2-7
Frequency Setting Change

When the Voltage to current phase angle is changed while the unit is in the 'Operate' state, the Model 8100 waits for the next zero crossing and shuts the output off for 0.5 Cycles. When the output is activated, the phase angle will be changed. Figure 2-8 illustrates the behavior of the output when the phase angle is changed.

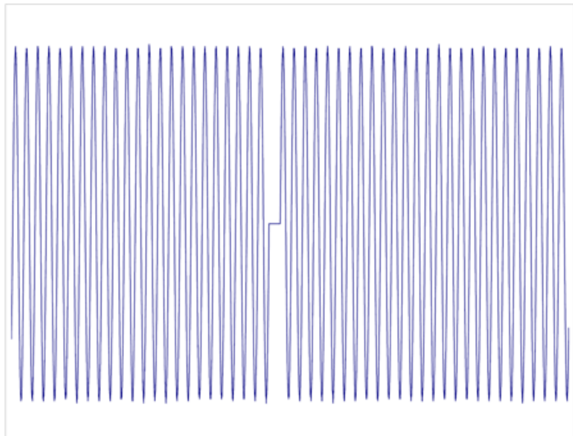


Figure 2-8
Phase Angle Setting Change

3. Soft Keys.
   The Soft Keys change function depending on the menu being viewed. The function of each key is indicated on the section of the display panel located to the left of the key.

4. Display Standby Indicator.
   The Display Standby Indicator is lit when the backlight timeout has expired and the backlight is turned off. The indicator is an amber LED that will be extinguished when any key is pressed and the backlight is turned on again.

5. Numeric Keypad.
   The Numeric Keypad is the means by which all numeric entries are made. Once a certain output parameter has been selected for modification, a new value may be keyed in using the keypad. The keypad provides the digits 0 to 9 and also includes a decimal point and ± symbol. The ± key is used to change the polarity of an entry, if the output parameter being edited supports negative values. Valid entries for each of the output parameters are described below.

   Voltage
   Values from between 1V and 1056V may be entered.

   Current
   Values from between 1.00000mA and 55.0000A may be entered. If the Model 8145 Current Amplifier is connected to the Model 8100 values from between 1.00000mA and 220.000A may be entered. Always enter the desired value in the units indicated in the output setting display. If the

indicated units were ‘A’ then 100mA would be entered as 0.1A. Whenever an entry is made which is less than 1A the display will automatically change the units to ‘mA’ to maintain resolution. Thus, when 0.1A is entered, the display will change to 100.000mA. To enter a setting of 5A, the value 5000mA would be entered and the display will change to 5.00000A.

Volt-Amperes
The maximum and minimum values for this field depend on the present settings for both voltage and current. This field is automatically updated when either the voltage or current settings are changed. When this setting is changed the value of the current setting is updated to maintain the appropriate Voltage × Current relationship. The units of this field may be expressed as VA, Watts or VARs.

Frequency
Values from between 16.00 and 1000Hz may be entered.

Phase Angle
Values from between +180.000° and -180.000° may be entered. The units of this field may be expressed as Degrees or Power Factor.

The ENTER key is used to complete any numeric entry such as changing the setting of one of the output parameters. Pressing the ENTER key causes the new setting to take effect and exits the setting edit mode.

The Cancel Entry (CE) Key causes the removal of the editing highlight from the currently selected output parameter. The display will revert to the setting that was active when the editing process was begun.

6. Setting Control Knob.
The Setting Control Knob may be used to change any individual digit of an output setting parameter. Rotating the knob clockwise will cause the selected digit to increment and rotating the knob counterclockwise will cause that digit to decrement, providing that the setting is valid. Changes to the output setting which are made with the setting control knob take effect at the output terminals immediately and there is no need to press the Enter key except to indicate the conclusion of the setting edit function.

   The Digit Selection Keys are used to select which digit is to be modified as the setting control knob is adjusted.

7. Voltage Output Terminal Array.
The Voltage Output Terminal Array consists of 4 voltage terminals, two output terminals and two sense terminals. The right two terminals are the voltage high and voltage low output terminals. All voltage outputs are derived from these terminals. The left two terminals are the Sense High and Sense Low terminals. These terminals are used to make the sense connections in a four-wire voltage connection. The current and voltage outputs terminals are completely isolated. The Voltage Output Terminal Array is duplicated on the rear panel and Front or Rear terminals are selected using a front panel menu item.

> ⚠ WARNING ⚠
>
> Caution should be used when making and removing connections to the voltage output terminal array. Always ensure that the calibrator is in the STANDBY state before changing connections.
>
> **Failure to use appropriate care could result in dangerous electric shock!**

8. Power Switch.

9. Menu Selection Keys.
   The Menu Selection Keys consist of 5 keys used to maneuver through the various configuration menus of the Model 8100. The MENU key must be pressed to activate the menu system. Pressing the MENU key when already in the menu system will exit the menu system. Once the menus have been activated, the ▲ or ▼ keys are used to move the cursor up or down through the menu choices. Once the desired choice is highlighted, pressing the SELECT key activates the selection. The CANCEL key closes the current menu and moves back one layer in the menu system. The Model 8100 remembers the last menus viewed and will automatically default to the most recent selection in any menu.

10. Output Control Keys
    There are two Output Control Keys, STANDBY and OPERATE. When in the standby state, the green LED located above the STANDBY key is illuminated. The voltage terminals are configured as an open circuit and the current terminals are shorted and the output amplifiers are removed from each. Once the desired settings have been established, pressing the OPERATE key will cause these settings to be present at the output terminals. At voltage settings of greater than 30V an audible warning can be sounded for one second before the output is activated. Whenever the calibrator is in the OPERATE state the red LED located over the OPERATE key is illuminated. To remove the output and restore the output terminals to a safe condition, simply press the STANDBY key. When the output signal is unstable both the Operate LED and the Standby LED will be illuminated. This can occur when changing settings or when operate is asserted. When the operate LED is lit alone the output is stable and ready for measurements.

    When operate is asserted both the voltage and current outputs are activated using a ramping up of amplitude from zero to the nominal amplitude setting. Figure 2-9 illustrates the operate output ramping function.

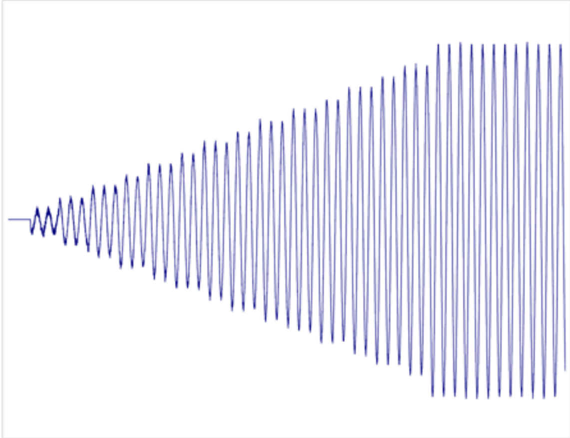


Figure 2-9
Operate Output Ramp

When Standby is asserted for the voltage or the current output the Model 8100 will set the amplitude to zero at the next zero crossing of the output. Figure 2-10 illustrates the behavior of the voltage and current outputs when standby is asserted.

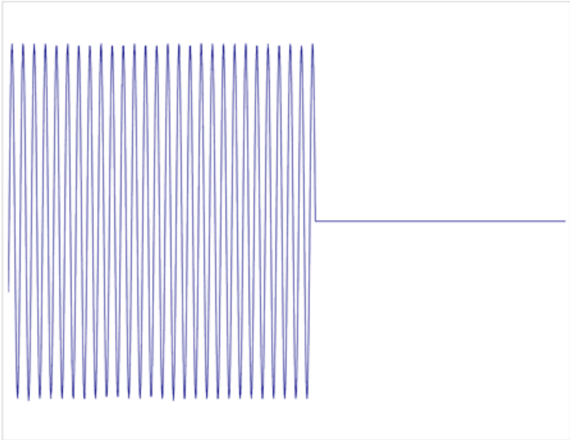


Figure 2-10
Standby Output Shut Down

11. Digital I/O.
    The Digital I/O terminal may be used to input pulse signals from energy meters and also to input or output various triggering and gating signals depending on the configuration of the calibrator. The Digital I/O connector is duplicated on the rear panel.

12. Current Output Terminals
    The Current Output Terminals consist of Current Output High and Current

Output Low terminals. The current and voltage outputs are completely isolated. The current connectors are designed to allow connection with both 4mm banana plugs for low currents and 6mm plugs for high currents. The current output terminals are duplicated on the rear panel.

Rear Panel Connections

Figure 2-11 illustrates the location of all rear panel connections. Each item is numbered and a description of the function of each appears below.

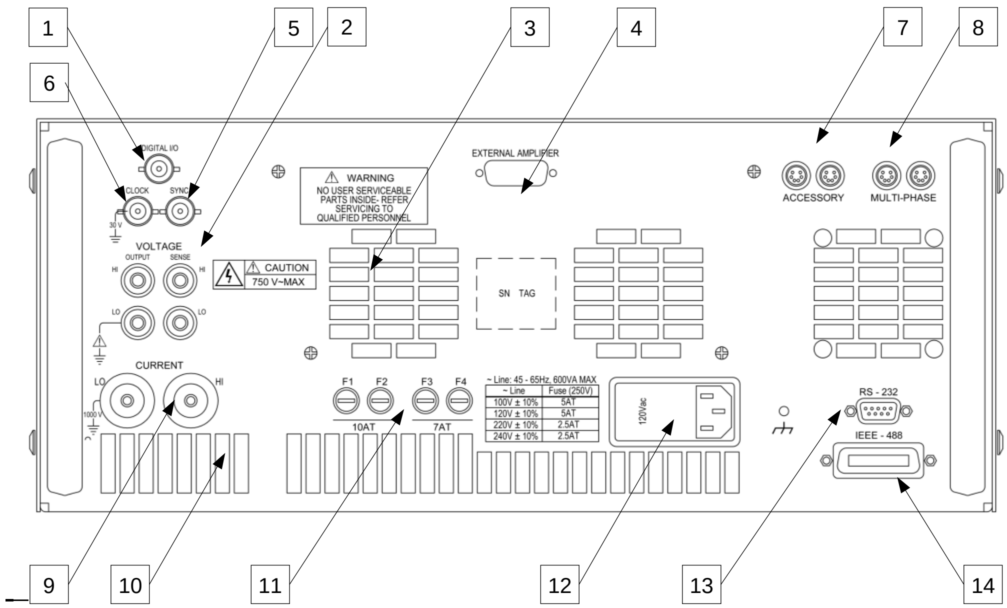


Figure 2-11
Rear Panel Connections

1. Digital I/O.
   The Digital I/O terminal may be used to input pulse signals from energy meters and also to input or output various triggering and gating signals depending on the configuration of the calibrator. The Digital I/O connector is duplicated on the front panel.

2. Voltage Output Terminal Array.
   The Voltage Output Terminal Array consists of 4 voltage terminals, two output terminals and two sense terminals. The right two terminals are the voltage high and voltage low output terminals. All voltage outputs are derived from these terminals. The left two terminals are the sense high and sense low terminals. These terminals are used to make the sense connections in a four-wire voltage connection. The current and voltage outputs terminals are completely isolated. The Voltage Output Terminal Array is duplicated on the front panel and front or rear terminals are selected using a front panel menu item.

⚠ WARNING ⚠

Caution should be used when making and removing connections to the voltage output terminal array. Always ensure that the calibrator is in the STANDBY state before changing connections.

Failure to use appropriate care could result in dangerous electric shock!

3. Cooling Fan Exhaust Vents.
   There are 3 cooling exhaust vents located on the rear panel. These vents must not be obstructed or the instrument may become unable to properly regulate its internal temperature. The speed of each cooling exhaust fan is independently variable and is controlled by the calibrator to maintain a constant internal temperature. At power-up or when the unit is idle the fans will be set to their lowest speed helping to reduce the noise generated by the calibrator. As the instrument is used the fan speed will vary. This variation is normal.
4. Serial Number Tag.
5. External Synchronization Connection (Optional)
   The external synchronization signal is a 40kHz square wave with a 5V amplitude and a 50% duty cycle. While the nominal output frequency is 40kHz the actual frequency will vary up to 1% depending on the selected frequency of the Model 8100 voltage and current output signals. This signal can be used to synchronize external, sampling measurement instruments to the output signal of the Model 8100.
6. Cycle Strobe Connection (Optional)
   The cycle strobe signal is a 12µ second, negative going, 5V to 0V pulse occurring once every output cycle of the Model 8100. The strobe coincides with one zero crossing per cycle of the Model output voltage signal. This signal can be used to synchronize external, sampling measurement instruments to the output signal of the Model 8100.
7. Accessory Connectors
   There are two accessory connectors located on the rear panel. These connectors are used to attach accessories such as the Model 8120 Counter / Comparator and Model 8140 High Current Amplifier. The connectors are 6 pin Mini DIN connectors and are wired internally in parallel. Either connector may be used for any accessory.
8. Multi-Phase Connector.
   There are two Multi-Phase connectors located on the rear panel. These connectors are used to attach multiple Model 8100s to form a multi-phase system. The connectors are 8 pin Mini DIN connectors and are wired internally in parallel. Either connector may be used for any additional Model 8100. Individual calibrators phase designation (A, B, C) are determined by the phase configuration of each unit.
9. Current Output Terminals.
   The Current Output Terminals consist of Current Output High and Current Output Low terminals. The current and voltage outputs are completely

isolated. The current connectors are designed to allow connection with both 4mm banana plugs for low currents and 6mm plugs for high currents. The current output terminals are duplicated on the front panel.

10. Cooling Air intake vents.
    The cooling air intake grills provide the opening for the intake of cooling air. The cooling air intake grills must not be obstructed or the instrument may become unable to properly regulate its internal temperature.

11. Power Amplifier Fuse Holders.
    Fuses that are accessible through the rear panel protect both the voltage and current power amplifiers. Fuses labeled F1 and F2 protect the Current Power Amplifier and are rated at 10A, 250V. Fuses labeled F3 and F4 protect the Voltage Power Amplifier and are rated at 5A, 250V. Inserting a small screwdriver into the slot in the fuse cover and rotating the cover ¼ turn counter-clockwise will allow removal of the fuses.

12. Power Entry Module.
    The Power Entry Module provides the line cord receptacle and a 4-position line voltage selector that is integrated with the fuse holder. The proper fuse ratings are listed in the table printed on the rear panel of the Model 8100 located to the left of the Power Entry Module. The selected line voltage setting is displayed in the voltage window of the fuse cover located on the rear panel adjacent to the line cord connector. A three-conductor power cable is provided and when this cable is connected to a standard three-wire outlet the instrument chassis is connected to earth ground. This feature prevents the instrument case from assuming voltages that are potentially hazardous to personnel. In the event that an adapter is used to connect the three-wire cable to a two-wire outlet the green (ground) adapter terminal should always be connected to the earth ground.

13. RS-232 Serial Interface Connector.

14. IEEE-488 Interface Connector.

Menu System

The Model 8100 provides an extensive menu system that provides the user with the ability to configure all aspects of the calibrator. To activate the menu system press the MENU key and the main menu will be displayed in the lower half of the display. To exit the menu system, press the MENU key again and the display will revert to the normal state.

Certain menu choices open 'Selection Boxes' which can offer a list of choices. Only four choices are ever displayed in the box even if more choices are available. A small arrow appears in the lower right corner of the selection box to indicate that there are more choices below the visible choices. Likewise, a small arrow appears in the upper right corner of the selection box to indicate that there are more choices above the visible choices. If the visible choices are in the middle of the list both arrows will be displayed to indicate that there are choices both above and below the visible choices. The ▲ or ▼ keys are used to scroll through the list of choices. Table 2-1 illustrates the Menu System.

Menu Item					Page
Main	Calibrator	Output Terminals	*Front*		2-30
			Rear		
		Voltage Sense	*Internal*		
			External		
		Overload Delay	*<value>*		
		Output Mode	*Normal*		
			Reactive		
			DC Option		
		Startup Ramp	*On*		
			Off		
		Voltage Phase	*<value>*		
		Power Line Sync			
		Phase Setup	*A*		
			B		
			C		
			D		
		External Clock	*Off*		
			Strobe		
			10 MHz		
			20 MHz		
		Minimum Range	Voltage Range	*20 V*	
				120 V	
				240 V	
				480 V	
				MAX V	
			Current Range	*15 mA*	
				50 mA	
				150 mA	
				500 mA	
				1.5 A	
				5 A	
				10 A	
				20 A	
				MAX A	
	Energy	Delivered Energy	Mode	*Off*	2-37
				Voltage Warm-up	
				Current Warm-up	
			Energy Setting	*<value>*	
			Time Setting	*<value>*	
			Warm-Up Time	*<value>*	
		Front Counter	Counter Mode	*Off*	
				Counter	
				Timer	
				Ext Ref	
				Jitter	
			Scale Factor	*<value>*	
			Energy Setting	*<value>*	
			Counts Setting	*<value>*	
			Time Setting	*<value>*	
			Measured Energy		
			Input Edge	*Positive*	
				Negative	
			Input Pull-up	*33K*	
				1000	
				150	

Table 2-1
Menu System

Menu Item					Page
Main	Energy	Rear Counter	Counter Mode	*Off* *Counter* *Timer* *Ext Ref* *Jitter*	2-37
			Scale Factor	*<value>*	
			Energy Setting	*<value>*	
			Counts Setting	*<value>*	
			Time Setting	*<value>*	
			Measured Energy		
			Input Edge	*Positive* *Negative*	
			Input Pull-up	*33K* *1000* *150*	
		Repeat Counts	*<value>*		
		Output Mode	Gate Source	*Off* *Front Counter* *Rear Counter* *Timer*	
			Pulse Mode	*Off* *On* *Once*	
			Active Level	*High* *Low*	
			Terminals	*Front* *Rear*	
		Applied Power	*<value>*		
	Power Quality	Voltage Distortion	Function	*Off* *Harmonics* *Inter-Harmonics* *Notching* *User Defined*	2-62
			Amplitude	*<value>*	
			Harmonic	*<value>*	
			Fluctuate Mode	*Off* *On*	
			Fluctuate Period	*<value>*	
			Frequency	*<value>*	
			Phase	*<value>*	
		Voltage Events	Event Type	*Off* *Sag* *Swell* *Interruption*	
			Amplitude	*<value>*	
			Duration	*<value>*	
			Flicker Mode	*Off* *On*	
			Flicker Period	*<value>*	
			Start Ramp Time	*<value>*	
			Exit Ramp Time	*<value>*	
			Repeat Mode	*Off* *On*	
			Repeat Delay	*<value>*	

Table 2-1
Menu System (Continued)

Menu Item					Page
Main	Power Quality	Current Distortion	Function	*Off* *Harmonics* *Inter-Harmonics* *Notching* *User Defined*	2-62
			Amplitude	*<value>*	
			Harmonic	*<value>*	
			Fluctuate Mode	*Off* *On*	
			Fluctuate Period	*<value>*	
			Frequency	*<value>*	
			Phase	*<value>*	
		Current Events	Event Type	*Off* *Sag* *Swell* *Interruption*	
			Amplitude Duration	*<value>* *<value>*	
			Flicker Mode	*Off* *On*	
			Flicker Period	*<value>*	
			Start Ramp Time	*<value>*	
			Exit Ramp Time	*<value>*	
			Repeat Mode	*Off* *On*	
			Repeat Delay	*<value>*	
	Trigger Setup	Auto Start	*On* *Off*		2-80
		Energy Delay	*<value>*		
		Voltage Event	*<value>*		
		Current Event	*<value>*		
		Trigger Immediate			
	Preferences	Power Units	*W* *VA* *VAR*		2-83
		Phase Units	*Degrees* *Power Factor* *VAR Factor*		
		Time Units	*Seconds* *Cycles*		
		Scale Factor Units	*Wh/Pulse* *Pulse/Wh*		
		Temperature Units	*C* *F*		
		Deviation Units	*Percent* *PPM* *Difference* *Ratio*		
		Keyboard Sound	*On* *Off*		
		Operate Warning	*On* *Off*		
		Beeper Volume	*High* *Low*		
		Energy Units	*Wh* *Percent*		

Table 2-1
Menu System (Continued)

Menu Item					Page
Main	Display	Backlight Timeout	*<value>*		2-86
		Error Timeout	*<value>*		
		Menu Timeout	*<value>*		
		Text Color	*Black*		
			White		
			Red		
			Yellow		
			Green		
			Blue		
			Swap		
		Background Color	*Black*		
			White		
			Red		
			Yellow		
			Green		
			Blue		
			Swap		
		Brightness	*<value>*		
		Deviation On/Zero	*Off*		
			Voltage		
			Current		
			Phase		
			Power		
	System Settings	Set Time 24h	*<time>*		2-89
		Set Date d/m/y	*<date>*		
		Set Password	*<value>*		
		GPIB Address	*<value>*		
		Power On Settings	*Defaults*		
			User 1		
			User 2		
			User 3		
			User 4		
		Save Settings	*User 1*		
			User 2		
			User 3		
			User 4		
		Recall Settings	*Defaults*		
			User 1		
			User 2		
			User 3		
			User 4		
		Calibration	Mode	*Off*	
				Voltage	
				Current	
				Voltage Phase	
				Current Phase	
			Voltage Setting	*Cal Point List*	
			Current Setting	*Cal Point List*	
			Frequency Setting	*Cal Point List*	
			Save Calibration		
			Energy Cal	*<value>*	
			Frequency Cal	*<value>*	
			Line Phase Cal	*<value>*	
			Cal Temp C	*<value>*	
			Cal Due d/m/y	*<date>*	
		About…			
	Reset				2-28

Table 2-1
Menu System (Continued)

Main Menu

```
                Main Menu

Calibrator          Display
Energy              System Settings
Power Quality       Reset
Trigger Setup
Preferences
```

The Main Menu consists of the 8 choices displayed above. Each of these calls a second tier menu with the exception of Reset. The 'Reset' choice causes the calibrator to reset, restoring the power on setting configuration.

Calibrator

Refer to page 2-30 for details of the Calibrator menu.

Energy

Refer to page 2-37 for details of the Energy menu.

Power Quality

Refer to page 2-62 for details of the Power Quality menu.

Trigger Setup

Refer to page 2-80 for details of the Trigger Setup menu.

Preferences

Refer to page 2-83 for details of the Preferences menu.

Display

Refer to page 2-86 for details of the Display menu.

System Settings

Refer to page 2-89 for details of the System Settings Menu.

Reset

The Reset menu choice causes the calibrator to reset the output settings to a known, safe state. The output settings the calibrator restores after a Reset are determined by the Power On Settings. If the Power On Settings are 'Default' then the output settings after Reset has been selected are as follows.

• Voltage	0.00000V
• Current	0.00000A
• Power	0.00000VA
• Phase	0.000°
• Frequency	60.00Hz
• Output	Standby (OFF)

If one of the four user-defined setting configurations has been set to the Power On Settings the calibrator will assume those settings after Reset. The Output state is always set to standby after a Reset. User selected preferences such as Power Units or Phase Angle Units are not affected by resetting the calibrator.

Calibrator

```
                Calibrator

Output Terminals       Voltage Phase
Voltage Sense          Power Line Sync
Overload Delay         Phase Setup
Output Mode            External Clock
Startup Ramp           Minimum Range
```

The Calibrator menu provides functions relating to the basic functionality of the calibrator. Most of the menu items of the Calibrator menu affect the hardware configuration of the Model 8100.

Output Terminals

Selecting this menu item opens a selection box with two choices, 'Front' and 'Rear'. The default setting of the Model 8100 is 'Front'.

The 'Front' choice directs the voltage and current output to the front panel output terminals. The 'Rear' choice directs the voltage and current output to the rear panel output terminals.

When the calibrator is in the Standby mode the active voltage output terminals are connected internally with a 100kΩ resistor and the current output terminals are connected internally with a short circuit. The inactive output terminals, both voltage and current, are connected internally as open circuits.

Also, when the calibrator is in the Standby mode the voltage applied to the active voltage output terminals is continuously monitored. If a voltage is present at these terminals when the OPERATE key is pressed, an error is generated indicating that a voltage is applied to the output terminals. To prevent damage to the internal circuits of the calibrator the calibrator will not be able to enter the Operate mode until the external voltage has been removed.

The Digital I/O connector is unaffected by the setting of the Output Terminals Selection because both I/O connectors are always active and may be configured as required by the active function of the calibrator.

Voltage Sense

Selecting this menu item opens a selection box with two choices, 'Internal' or 'External'. The default setting of the Model 8100 is 'Internal'.

When the voltage sense is set to 'Internal' the voltage output terminals are configured in 2-wire mode where the output is sensed at the output terminals of the calibrator. This is the default configuration of the Model 8100. In this mode the voltage connections to the calibrator are made only to the Voltage Output High and the Voltage Output Low terminals.

When the voltage sense is set to 'External' the voltage output terminals are configured in 4-wire mode where the output is sensed at some point external to the calibrator, typically at the input terminals of the UUT. In the external sense mode the internal sensing connections are broken and must be remade by the user at some point external to the Model 8100 as illustrated in Figure 2-12.

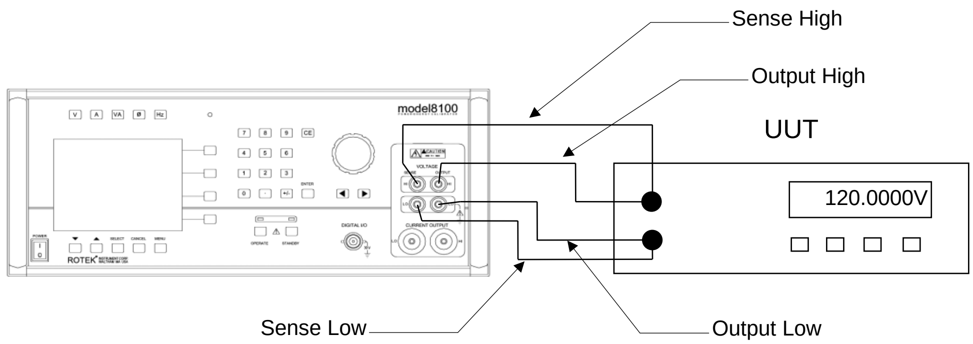


Figure 2-12
External Voltage Sense Connections

Overload Delay

Selecting this menu item opens a selection box that allows numeric input to define the period of time required before the overload detection function of the calibrator is enabled. The default setting is zero and during normal use this setting will probably never be changed.

This function can be useful if the UUT has a power supply that is powered from the voltage output circuit of the Model 8100. Under steady state operation this UUT may draw only an amount of current that the Model 8100 is able to deliver. When it is first energized, however, the UUT may draw large amounts of current for a short time as capacitors and other components charge. Even though this initial large rush of current may be complete in several seconds, the calibrator will have tripped to Standby indicating a voltage overload.

Entering an Overload delay setting of 2 seconds will cause the overload detection to be delayed for 2 seconds. By this time the overload situation should have passed and testing may continue normally. The overload delay may be set to any integer value between 0 and 8 seconds.

When the Overload Delay function is active the internal correction of errors in the voltage and current outputs is inhibited and the accuracy of the outputs will be greatly reduced. Errors in the voltage output could be as large as 15% and errors in the current output could be as large as 2%. When the overload delay period is complete the internal correction circuit is activated and the errors at both outputs are eliminated.

Output Mode

Selecting this menu item opens a selection box with three choices, ‘Normal’, ‘Reactive’ and ‘DC Option’. The default setting of the Model 8100 is ‘Normal’.

Selecting ‘Reactive’ will activate the Reactive Mode of the Model 8100 while ‘Normal’ will deactivate the Reactive Mode.

Many older power and energy meters present highly inductive or capacitive loads to the calibrator. If this load is sufficiently high it will cause the calibrator to shut down indicating either a voltage or a current overload.

Activating the Reactive Mode will greatly increase the calibrator's ability to drive these loads. When the Reactive Mode is activated the capacitive loading supported by the voltage output is typically 5 times greater than the standard mode. When the Reactive Mode is activated the inductive loading supported by the current output is typically 2 times greater than the standard mode. Refer to the detailed specifications included in Chapter 1 for more information on the improvements in capacitive and inductive loading of the voltage and current outputs.

The downside of the Reactive Mode is increased distortion of the voltage and current outputs. Typically the voltage and current distortion are double the distortion of the standard mode. Refer to the Voltage and Current Output specifications in Chapter 1 for information on how this mode affects the performance of the calibrator.

When the 'DC Option' menu item is selected the output of the Model 8100 will be available as DC voltage and current from the Model 8180 DC Adapter output terminals.

Startup Ramp

Selecting this menu item opens a selection box with two choices, 'On' and 'Off'. The default setting of the Model 8100 is 'On'.

Selecting 'On' will activate the Startup Ramp behavior of the Model 8100 voltage and current outputs described in Figure 2-9 while 'Off' will deactivate the Ramp feature.

With the Ramp feature disabled, the voltage and current outputs may exhibit some overshoot of the selected voltage and current setting.

Voltage Phase

Selecting this menu item sets the Voltage-Voltage Phase Angle Setting to the edit mode. This setting is edited in the same manner as the other primary output settings such as Voltage, Current, Phase, Power and Frequency.

The Voltage-Voltage Phase Angle Setting sets the Line-to-Line phase angle when the Model 8100 is configured as a three-phase system. Units configured as Phase A are always set to 0.000° while units set to Phase B, C or D may set the Line to Line phase angle to any setting ±180° with a setting resolution of 0.001°.

This menu item may be accessed via the 'Voltage Phase' soft key located on the standard screen of the front panel LCD Display.

The default setting for a unit configured as Phase B is +120.0° and the default setting for a unit configured as Phase C is –120.0°. The Model 8100 is configured as a specific component of a three-phase system using the 'Phase Setup' menu item of the 'Calibrator' menu.

Figure 2-13 illustrates the default phase angle relationship between the voltage outputs of a three phase Model 8100 system.

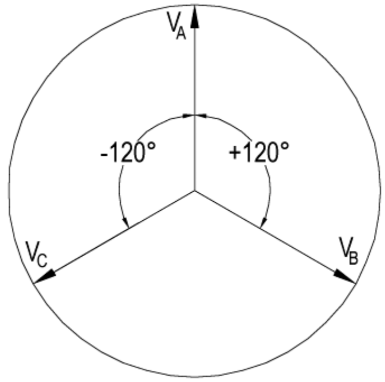


Figure 2-13
Default Line-Line Phase Angle Setting

Power Line Sync

Selecting this menu item causes the output frequency of the calibrator to be synchronized with the power line frequency.

When the Power Line Sync function is activated the calibrator measures the power line frequency and then applies the measured frequency to the calibrator's frequency output setting.

To re-synchronize the calibrator's frequency setting simply activate the Power Line Sync function again.

Phase Setup

Selecting this menu item opens a selection box with several choices. The choices are 'A', 'B', 'C' and 'D'. The default setting for the Phase Setup function of the Model 8100 is 'A'.

Selecting any one of these choices configures the calibrator to be either a phase A, B, C or D component of a multi-phase system. The selected configuration is displayed in large characters on the front panel display. Refer to Figure 2-3 for the location of the Phase Designator label.

When a Model 8100 is to be used as a single-phase system the Phase Configuration should set to 'A'.

Units configured as a Phase A operate as the 'Master' component of a three-phase system. Units configured as a Phase B, Phase C or Phase D component will operate as 'Slave' components of a three-phase system. Only one calibrator in a multi-phase system may be designated 'Phase A'.

Selecting a phase configuration will cause the default Line to Line Phase setting to be entered for the V/V phase setting on the front panel display. The default settings are +120.0° for Phase B and –120.0° for Phase C. Phase A is always set to 0.000°.

The Phase A calibrator generates the synchronization strobe and trigger signals that establish and control the phase relationship of all the calibrators in the multi-phase system. The Phase B and Phase C calibrators synchronize their outputs to the synchronization strobe and trigger signals generated by the Phase A calibrator.

When two or more Model 8100's are to be used as a multi-phase system they must be connected using the supplied Rotek Multi-Phase Synchronization cables. The cables are connected to the Multi-Phase connectors located on the rear panel of the Model 8100. Please refer to Figure 2-11 for the exact location of the Multi-Phase connectors.

External Clock

Selecting this menu item opens a selection box with four choices, 'Off', 'Strobe', '10 MHz' and '20 MHz'. The default setting of the Model 8100 is 'Off'. These options allow an external measurement device to be synchronized to the output signal of the Model 8100. The Sync connector located on the rear panel adjacent to the Clock connector always outputs a pulse at each zero crossing of the Model 8100 output signal.

Selecting 'Off' will deactivate the external clock signal available at the 'Clock' BNC connector located on the rear panel of the Model 8100.

Selecting 'Strobe' will activate the external clock signal available at the 'Clock' BNC connector located on the rear panel of the Model 8100. In the 'Strobe' mode, the signal will be a nominal 40 kHz square wave synchronized with the output frequency of the Model 8100. The exact frequency of the strobe signal is varied slightly depending on the actual output frequency setting to provide the most accurate output frequency possible.

Selecting '10 MHz' will activate the external clock signal available at the 'Clock' BNC connector located on the rear panel of the Model 8100. In the '10 MHz' mode, the signal will be a 10MHz square wave synchronized with the output frequency of the Model 8100.

Selecting '20 MHz' will activate the external clock signal available at the 'Clock' BNC connector located on the rear panel of the Model 8100. In the '20 MHz' mode, the signal will be a 20MHz square wave synchronized with the output frequency of the Model 8100.

Minimum Range

```
            Minimum Range

Voltage Range
Current Range
```

Selecting this menu choice opens a menu that includes all functions related to the setting of a minimum range for the voltage and current outputs of the calibrator.

The minimum range feature allows the user to select the minimum range selected by the calibrator regardless of the output setting selected. This feature can be selected for both the voltage and the current outputs independently.

This feature is useful when testing meters that require a large range of settings to be swept that would have spanned multiple output ranges of the calibrator and causing the output to be interrupted for several cycles while the range is changed. Some meters under test may react to this brief interruption in an undesirable manner. Typical meters under test would include analog panel meters whose pointers would fluctuate at each range change during a full scale sweep test of the meter.

Voltage Range

Selecting this menu choice opens a selection box that allows the user to select which voltage range will be the minimum range the calibrator will select, regardless of the voltage output setting. The choices are as follows.

- 20 V
- 120 V
- 240 V
- 480 V
- Max V

The 'Max V' choice selects the maximum voltage range installed in the calibrator which can vary depending on the voltage output option that is installed.

As an example, if the minimum range is set to '240 V', and an output setting of 100V is selected the calibrator will remain locked in the 240V range instead of changing automatically to the 120V range as it would if a minimum range were not set. If the same minimum range is set to '240 V', and an output setting of 480V is selected, the calibrator will automatically change to the 480 V range as normal.

If the 'Max V' minimum range is selected the calibrator will change to the maximum range and never change range regardless of the output voltage setting of the Model 8100.

Current Range

Selecting this menu choice opens a selection box that allows the user to select which current range will be the minimum range the calibrator will select, regardless of the current output setting. The choices are as follows.

- 15 mA
- 50 mA
- 150 mA
- 500 mA
- 1.5 A
- 5 A
- 10 A
- 20 A
- Max A

The 'Max A' choice selects the maximum current range installed in the calibrator which can vary depending on the current output option that is installed.

As an example, if the minimum range is set to '5 A', and an output setting of 500mA is selected the calibrator will remain locked in the 5A range instead of changing automatically to the 500mA range as it would if a minimum range were not set. If the same minimum range is set to '5 A', and an output setting of 20A is selected, the calibrator will automatically change to the 20A range as normal.

If the ‘Max A’ minimum range is selected the calibrator will change to the maximum range and never change range regardless of the output current setting of the Model 8100.

Energy

```
                  Energy

Delivered Energy     Applied Power
Front Counter
Rear Counter
Repeat Counts
Output Mode
```

The Energy menu provides the functions required for testing various types of energy meters.

The Model 8100 may be configured to deliver a precise amount of energy to the UUT or, using the built in two-channel pulse counter, measure the energy indicated by the UUT.

When the Model 8100 is configured to be a source of precise quantities of energy the delivered energy mode is used. This method of energy meter testing should be used with UUT's that have no other means than a display to indicate the energy measured.

UUT's equipped with pulse outputs may be tested using either the front or rear pulse counter inputs. Electro-Mechanical energy meters equipped with a rotating disc may be tested in this manner using the optional Optical Rotation Detector.

When the Model 8100 is testing energy meters equipped with pulse outputs, it is possible to compare one meter to an external energy reference such as the Rotek Model MSB100 Power and Energy Meter. When used in this way the Model 8100 acts only as a power source and measurement accuracy depends only on the external energy reference.

Delivered Energy

The Delivered Energy menu item opens the third tier, Delivered Energy menu. This menu provides the controls required to configure the Model 8100 to deliver precise amounts of energy to a UUT.

When used in this mode the Model 8100 will be configured to apply one output channel, either Voltage or Current, for a period of time to allow the UUT to warm-up while not registering any energy. Typically the Current is applied while the voltage is inhibited during the warm-up period though the Model 8100 may be configured to inhibit either the Voltage output or the Current output. During this period the display of the UUT should be reset to 0.

When the Warm-up period is complete, the inhibited channel is activated and the UUT begins to register energy. Simultaneously, the Model 8100 starts an internal timer measuring the time power has been applied to the UUT. The Model 8100 determines the duration of the test by dividing the requested energy by the power setting using the equation below.

$$Duration = \frac{Energy_{Setting}}{Power_{Applied}}$$

When the desired amount of energy has been delivered to the UUT the output of the calibrator will shut off and the calibrator will revert to the standby state. At this time the display of the UUT will indicate the amount of energy measured during the test.

The Trigger, as defined in the Trigger Setup menu, controls the initiation of a Delivered Energy test. When the Auto start option of the trigger is set to 'On', the Delivered Energy Test begins as soon as the OPERATE key is pressed. The timing diagram in Figure 2-14 illustrates the sequence of events that occur when a delivered mode energy test is initiated with Auto start set to 'On'. In this example the Current output is activated immediately while the Voltage channel is inhibited for the duration of the warm-up period. The current output and voltage output lines indicate the state of the voltage and current outputs. Low indicates no output and high indicates that the output is energized.

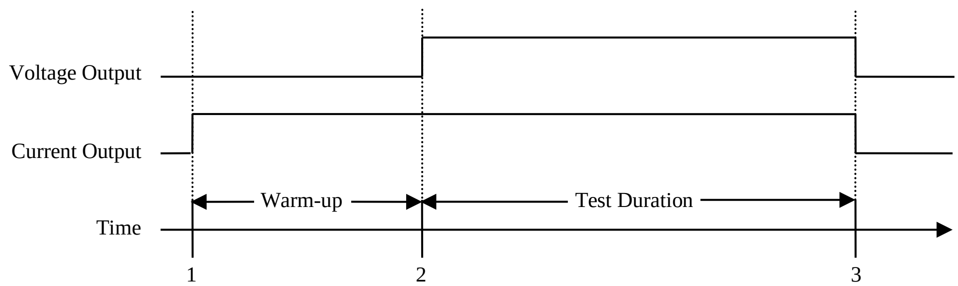


Figure 2-14
Delivered Energy Test Timing Diagram (Auto Start On)

Point 1 indicates when the OPERATE key is pressed and, since Auto Start is active, the trigger is also initiated. The current Channel is activated immediately while the Voltage Channel remains at 0. The outputs remain in this state until the warm-up period is complete. During this time the UUT is not registering any energy.

Point 2 indicates the conclusion of the warm-up period and the beginning of the portion of the test when energy is being delivered to the UUT. The Voltage Channel is activated and the internal timer starts counting down the time required for the test.

Point 3 indicates the conclusion of the test when both the voltage and the current outputs are shut off and the calibrator reverts to the Standby state. The UUT will indicate the energy measured.

When the Auto Start option of the trigger is set to 'Off', the Delivered Energy Test begins only after the trigger has been issued. If the trigger delay is set the delay occurs before the Delivered Energy test begins. With the Auto Start set to 'Off' the outputs both become active when the OPERATE key pressed. When the trigger is issued, one of the channels will be turned off for a period of time defined by the warm-up period.

The timing diagram in Figure 2-15 illustrates the sequence of events that occur when a Delivered Energy test is initiated with Auto start set to 'Off'. In this example the Current output is activated immediately while the Voltage channel is inhibited for the duration of the warm-up period.

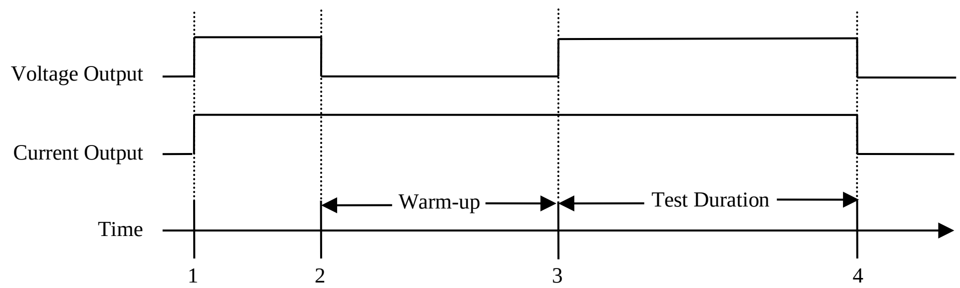


Figure 2-15
Delivered Energy Test Timing Diagram (Auto Start Off)

Point 1 indicates when the OPERATE key is pressed. Both the voltage and the current channels become active.

Point 2 indicates the time at which the trigger is initiated. The current Channel remains active while the Voltage Channel is set to 0. The outputs remain in this state until the warm-up period is complete. During this time the UUT is not registering any energy and the display should be reset.

Point 3 indicates the conclusion of the warm-up period and the beginning of the portion of the test when energy is being delivered to the UUT. The Voltage Channel is activated and the internal timer starts counting down the time required for the test.

Point 4 indicates the conclusion of the test when both the voltage and the current outputs are shut off and the calibrator reverts to the Standby State. The UUT will indicate the energy measured.

When a Delivered Energy test is run, there are fixed errors due to the activation of the inhibited output channel. When the inhibited channel becomes active, the Model 8100 first waits for a zero crossing of the output waveform. Then the calibrator increases the amplitude from 0 to the full setting value. The correction circuitry of the Model 8100 will then stabilize the output over a period of approximately 20 cycles. The period of time from when the output channel is requested to become active and when the output is actually stabilized at the correct setting will be a period of time when the amplitude of the activating channel may not be within the specified accuracy limits.

The error associated with this stabilization period is a fixed error whose significance will be reduced as the test duration is increased. This error will become negligible with a sufficiently long test.

The number of energy meters that may be tested simultaneously using the Delivered Energy Mode of testing is limited only by the voltage compliance and current burden presented to the Model 8100 by the UUT.

When testing a single energy meter using the Delivered Energy Mode of the Model 8100 the UUT should be connect to the calibrator as shown in Figure 2-16.

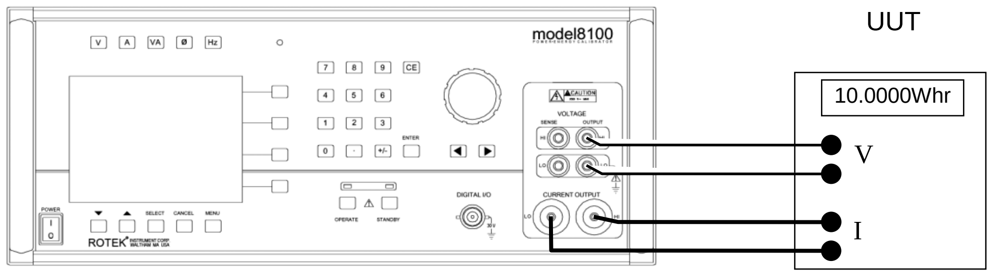


Figure 2-16
Delivered Energy UUT Connections (Single UUT Test)

When testing multiple energy meters using the pulse counters of the Model 8100 the UUT should be connect to the calibrator as shown in Figure 2-17. Note that the voltage inputs of the UUT are wired in parallel and the current inputs are wired in series so that both UUT's are energized by the same power.

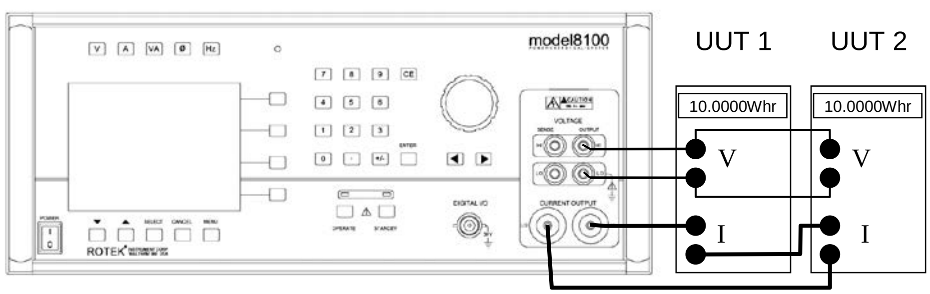


Figure 2-17
Delivered Energy UUT Connections (Multiple UUT Test)

The Delivered Energy menu is shown below.

```
              Delivered Energy

Mode
Energy Setting
Time Setting
Warmup Time
```

Mode

The Mode menu item allows the user to select one of 3 modes of operation for the Delivered Energy function. The choices are as follows:

- Off
- Voltage Warm-up
- Current Warm-up

Selecting 'Off' will disable the Delivered Energy function.

Selecting the 'Voltage Warm-up' choice activates the Delivered Energy function and configures the Voltage Output to remain active during the warm-up period while the current channel is inhibited.

Selecting the 'Current Warm-up' choice activates the Delivered Energy function and configures the current output to remain active during the warm-up period while the voltage channel is inhibited.

Energy Setting

Selecting this menu item opens a selection box that allows numeric input to define the amount of energy to be delivered to the UUT during the test. The energy setting is set to zero when there is no output power setting.

The energy setting is entered in units of Watthours.

The maximum energy delivered is defined by the maximum test time of 1000 hours. The maximum energy to be delivered can be calculated using the equation below.

$$Energy_{Max} = 1000 Hrs \times Power_{Applied}$$

For example, the maximum energy delivered with applied power of 600W would be 600kW.

The energy setting is dependent on the time setting. If the time setting is changed, the energy setting will be recalculated using the equation below.

$$Energy = Time \times Power_{Applied}$$

The time setting is also dependent on the energy setting. If the energy setting is changed, the time setting will be recalculated using the equation below.

$$Time = \frac{Energy}{Power_{Applied}}$$

It is important to note that the Delivered Energy Test will produce more accurate results when the test time is as long as possible.

Time Setting

Selecting this menu item opens a selection box that allows numeric input to define the duration of the test. The Default Time setting is 10 seconds.

The Time Setting is entered in units of Seconds.

The maximum time setting is 1000 Hours or 3,600,000 Seconds.

The time setting is dependent on the energy setting. If the energy setting is changed, the time setting will be recalculated using the equation below.

$$Time = \frac{Energy}{Power_{Applied}}$$

The energy setting is also dependant on the time setting. If the time setting is changed, the energy setting will be recalculated using the equation below.

$$Energy = Time \times Power_{Applied}$$

It is important to note that the Delivered Energy Test will produce more accurate results when the test time is as long as possible.

Warm-up Time

Selecting this menu item opens a selection box that allows numeric input to define the duration of the warm-up time. The Default warm-up time is 0 seconds.

The warm-up time is entered in units of Seconds.

The maximum warm-up time is 99999 Seconds or 27.8 Hours.

The warm-up time is the period of time when one of the output channels will be inhibited allowing the active channel to warm the input of the UUT to a stable temperature before the test begins. Typically the current channel remains on during the warm-up period and the voltage is inhibited though the Model 8100 supports both Voltage Warm-up and Current Warm-up.

During the warm-up time the UUT will not register any energy.

When the Trigger auto start mode is set to 'On' the warm-up time is initiated as soon as the OPERATE key is pressed. The inhibited channel will remain off until the warm-up time is complete.

When the Trigger auto start mode is set to 'Off' the warm-up time is initiated as soon as the trigger is issued. In this mode both channels are active until the trigger is issued at which time the inhibited channel will be set to off for the duration of the warm-up period.

Refer to Figure 2-14 and Figure 2-15 for detailed descriptions of the operation of these two modes.

Front Counter

The Model 8100 is equipped with a two-channel pulse counter/comparator that allows the testing of Watthour meters that are equipped with a pulse output. One input channel utilizes the Digital I/O connector located on the front panel and the second input channel utilizes the Digital I/O connector located on the rear panel. Refer to Figure 2-18 for an illustration detailing the locations of these connectors. Using the two standard counter input channels up to 2 meters may be tested simultaneously. If the Model 8120 Counter Comparator is connected to the accessory connector of the Model 8100, up to six meters under test may be connected simultaneously to channels 1 through 6 of the Model 8120.

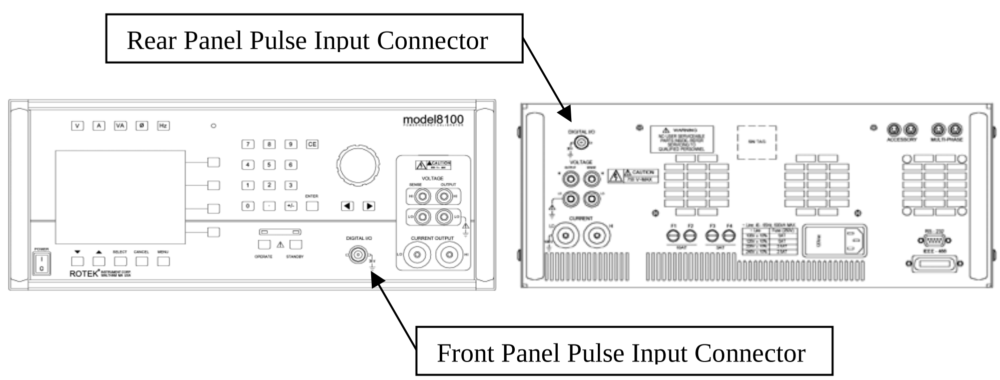


Figure 2-18
Pulse Input Connector Locations

When testing a single energy meter using the pulse counters of the Model 8100 the UUT should be connect to the calibrator as shown in Figure 2-19.

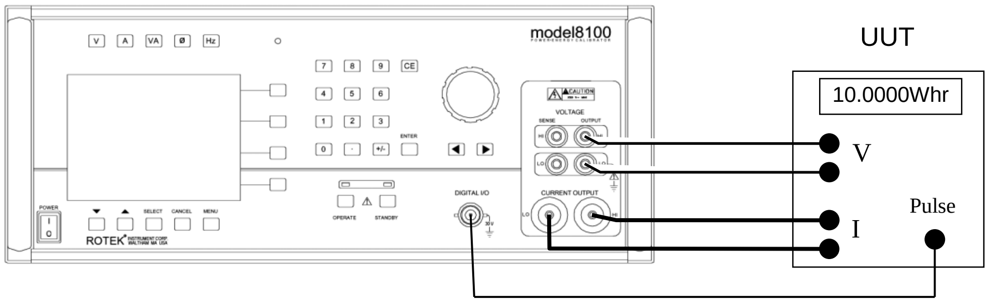


Figure 2-19
Pulse Counter UUT Connections (Single UUT Test)

When testing two energy meters using the pulse counters of the Model 8100 the UUT should be connect to the calibrator as shown in Figure 2-20. Note that the voltage inputs of the UUT are wired in parallel and the current inputs are wired in series so that both UUT's are energized by the same power.

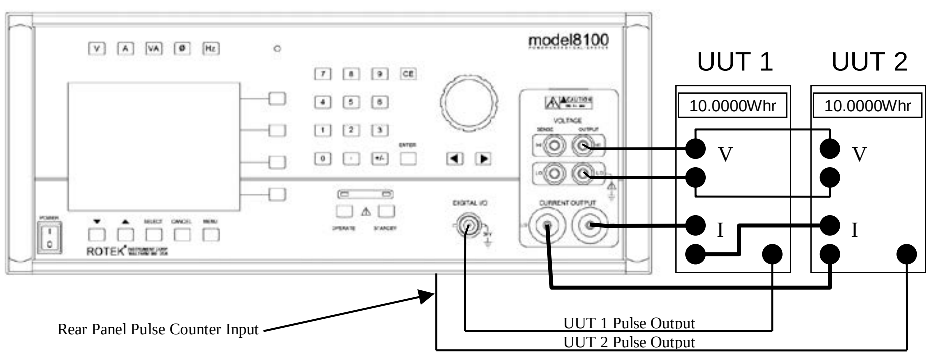


Figure 2-20
Pulse Counter UUT Connections (Two UUT Test)

The input circuit of the front counter is illustrated in Figure 2-21. A transient voltage suppressor, rated at 7V maximum, protects the pulse input. One of three resistors may be connected to the input as a pull-up to the +5V power supply. A 100Ω resistor limits the input current to a TTL compatible Schmitt Inverter that is used to transform slowly changing input signals into sharply defined, jitter-free signals. Finally, the input is optically isolated from the internal counter circuitry.

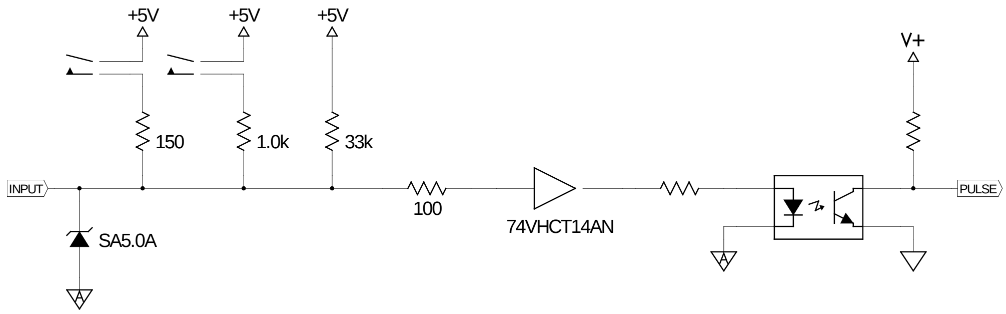


Figure 2-21
Counter Input Circuit

Each Model 8100 Counter Channel contains a 32 bit up-counter gated by a 32-bit down-counter. The counter may be configured to operate in one of the three modes listed below.

- Counter
- Timer
- External Reference

Counter Mode

When operating in the Counter Mode, the input of the down-counter is connected to the front Digital I/O connector and the input of the up-counter is connected to the internal 32kHz clock. This configuration is illustrated in Figure 2-22. During the test the up-counter is gated by the down-counter with the result being the final number of counts in the up-counter. Counter Mode tests may be run simultaneous on the front and rear counters.

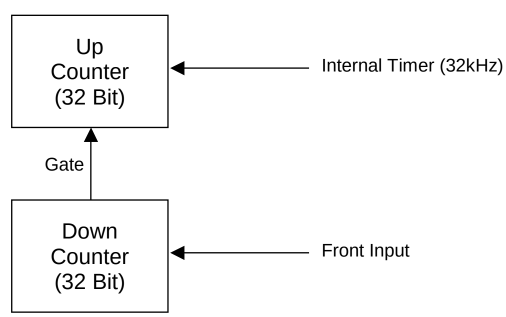


Figure 2-22
Counter Connections (Counter Mode)

When running a test using the counter mode, the initial value of the down-counter is set as a number of pulses from the UUT. The number of pulses may be entered directly or the Model 8100 will calculate this value from either the energy setting or the test time.

When a counter mode test is initiated the up-counter will accumulate counts from the internal clock at a rate of 32,768 counts per second while the value in the down-counter is reduced by 1 for each count received from the front input connector. When the down-counter reaches 0, the test is complete and the elapsed time measured in the up-counter represents the energy measured by the UUT. The Model 8100, using the equation below, calculates the measured energy and displays the test results in units of Whr.

$$Energy_{Measured} = Time_{Up-Counter} \times Power_{Applied}$$

The trigger, as defined in the Trigger Setup menu, controls the initiation of a Counter Mode Energy Test. The timing diagram in Figure 2-23 illustrates the sequence of events that occur when a counter mode energy test is initiated.

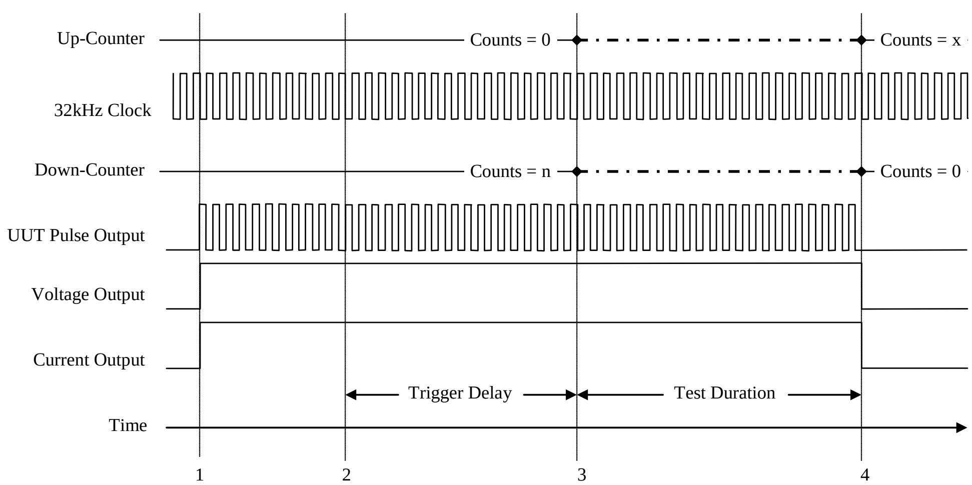


Figure 2-23
Counter Mode Energy Test Timing Diagram

1. The OPERATE key is pressed, activating both the voltage and the current outputs. The UUT will begin to output pulses as soon as power is applied.

   The pulses from the UUT are connected to the input of the down-counter according to the diagram in Figure 2-22. The down-counter value is set to *n* counts from the UUT and the down-counter is armed but not yet decrementing.

   The internal 32 kHz clock is available throughout the test and is connected to the input of the up-counter according to the diagram in Figure 2-22. The up-counter value is set to 0 counts from the 32 kHz Clock and the up-counter is armed but not yet incrementing.

2. The trigger is issued. If an Energy Test Trigger Delay has been set using the Trigger Menu, both the up-counter and down-counter remain armed until the Energy Test Trigger Delay period is complete.
3. The test begins. Every pulse received from the UUT reduces the down-counter value by 1. The up-counter value is increased by 1 for every pulse received from the 32 kHz timer.
4. The Test is Complete. When the value of the down-counter reaches 0, the incrementing of the up-counter is stopped. The value, x, of the up-counter is a representation of the time elapsed during the counting of n pulses from the UUT. The product of x times the applied power is the Energy measured by the UUT during the course of the test.

The maximum duration of a test in the counter mode is 36.4 hours using the internal 32,768 Hz clock. Since the up-counter is 32 bits wide, the maximum duration may be computed as follows:

$$Duration = \frac{2^{32}\,Pulses}{(32{,}768\,Pulses/Sec)\times(3600\,Sec/Hr)} = 36.41\,Hr$$

Timer Mode

When operating in the Timer Mode, the input of the down-counter is connected to the internal 32 kHz clock and the input of the up-counter is connected to either the Front or Rear Panel Digital I/O connector. This configuration is illustrated in Figure 2-24. During the test the up-counter is gated by the down-counter with the result being the final number of counts in the up-counter. Counter Mode tests may be run simultaneous on the front and rear counters.

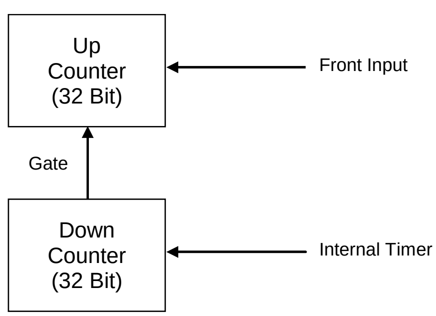


Figure 2-24
Counter Connections (Timer Mode)

When running a Timer mode test, the initial value of the down-counter is set as a number of pulses from the internal 32 kHz Clock. The number of pulses may be entered directly or the Model 8100 will calculate this value from either the energy setting or the test time.

The difference between the Timer Mode and the Counter Mode is that the final result stored in the up-counter is a value representing a quantity of energy measured by the UUT during the period of time defined by the clock connected to the down-counter. The Model 8100, using the equation below, calculates the Energy measured by the UUT. The Model 8100 displays the test results as Watthours.

$$Energy_{Measured} = Pulses_{Up-Counter} \times ScaleFactor_{UUT}$$

The Trigger, as defined in the Trigger Setup menu, controls the initiation of a Timer Mode Energy Test. The timing diagram in Figure 2-25 illustrates the sequence of events that occur when a Timer Mode Energy Test is initiated.

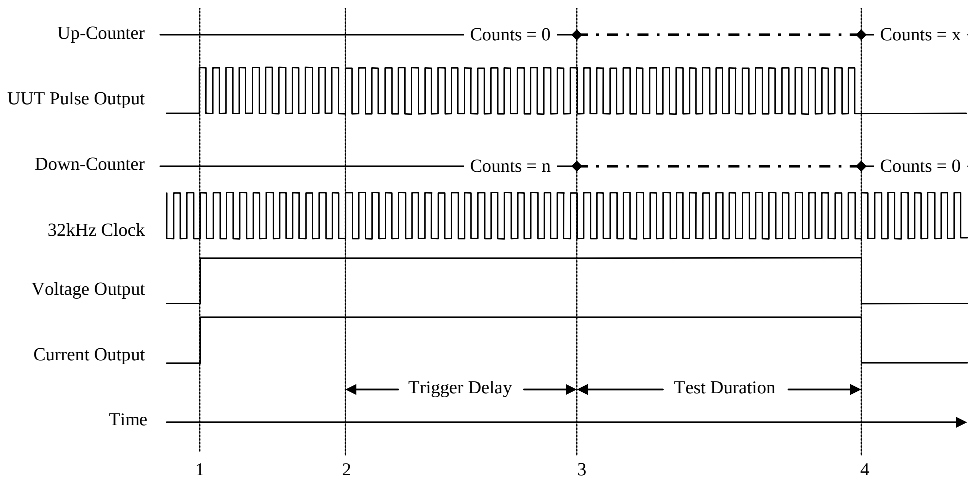


Figure 2-25
Timer Mode Energy Test Timing Diagram

5. The OPERATE key is pressed, activating both the voltage and the current outputs. The UUT will begin to output pulses as soon as power is applied.

   The internal 32 kHz clock is available throughout the test and is connected to the input of the down-counter according to the diagram in Figure 2-24. The down-counter value is set to n counts from the 32 kHz Clock and the down-counter is armed but not yet decrementing.

   The pulses from the UUT are connected to the input of the up-counter according to the diagram in Figure 2-24. The up-counter value is set to 0 counts from the UUT and the up-counter is armed but not yet incrementing.

15. The trigger is issued. If an Energy Test Trigger Delay has been set using the Trigger Menu, both the up-counter and down-counter remain armed until the Energy Test Trigger Delay period is complete.
16. The test begins. Every pulse received from the 32 kHz Clock reduces the down-counter value by 1. The up-counter value is increased by 1 for every pulse received from the UUT.
17. The Test is complete. When the value of the down-counter reaches 0, the incrementing of the up-counter is stopped. The value, x, of the up-counter is a representation of the energy measured during the counting of n pulses from the 32 kHz Clock. The product of x times the UUT Scale Factor is the Energy measured by the UUT during the course of the test.

The maximum duration of a test in the timer mode is 36.4 hours using the internal 32,768 Hz clock. Since the up-counter is 32 bits wide, the maximum duration may be computed as follows:

$$Duration = \frac{2^{32}\,Pulses}{(32{,}768\,Pulses/Sec)\times(3600\,Sec/Hr)} = 36.41\,Hr$$

Ext Ref Mode

When operating in the External Reference Mode, the input of the down-counter is connected to the pulse output of the UUT using either the Front or Rear Panel Digital I/O connector. The input of the up-counter is connected to the pulse output of the External reference using whichever Digital I/O connector is not in use for the UUT pulse connection. This configuration is illustrated in Figure 2-26. During the test the up-counter is gated by the down-counter with the result being the final number of counts in the up-counter.

The External Reference Mode allows a UUT to be compared directly to an external reference. When operating in this mode both the front and rear inputs will be used and either one may be configured as the UUT or Reference. Since the energy measured by the UUT is determined by the energy measured by the Reference the accuracy of the test is determined not by the accuracy of the Model 8100 but instead by the accuracy of the External Reference. To achieve optimal measurements using this mode an external reference equipped with a high-speed pulse output such as the Rotek Model MSB100 Power and Energy Standard is recommended.

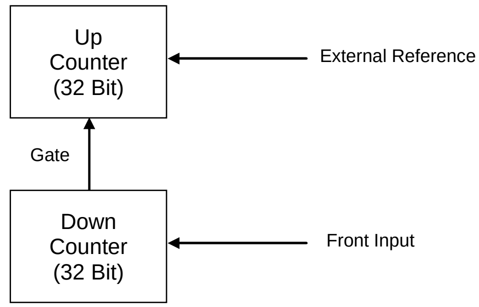


Figure 2-26
Counter Connections (External Reference Mode)

When running an External Reference mode test, the initial value of the down-counter is set as a number of pulses from the UUT. The number of pulses may be entered directly or the Model 8100 will calculate this value from either the energy setting or the test time.

When a test is initiated in the External Reference mode, the up-counter will accumulate counts from the External Energy Reference at a rate determined by the scale factor of the external reference and the applied power. Each count received from the UUT reduces the value in the down-counter by 1. When the down-counter reaches 0, the test is complete and the number of counts in the up-counter represents the energy measured by the UUT. The Model 8100, using the equation below, calculates the measured energy and displays the test results in units of Whr.

$$Energy_{Measured} = Counts_{Up-Counter} \times ScaleFactor_{External\ Reference}$$

The Trigger, as defined in the Trigger Setup menu, controls the initiation of an External Reference mode energy test. The timing diagram in Figure 2-27 illustrates the sequence of events that occur when an External Reference Mode Energy Test is initiated.

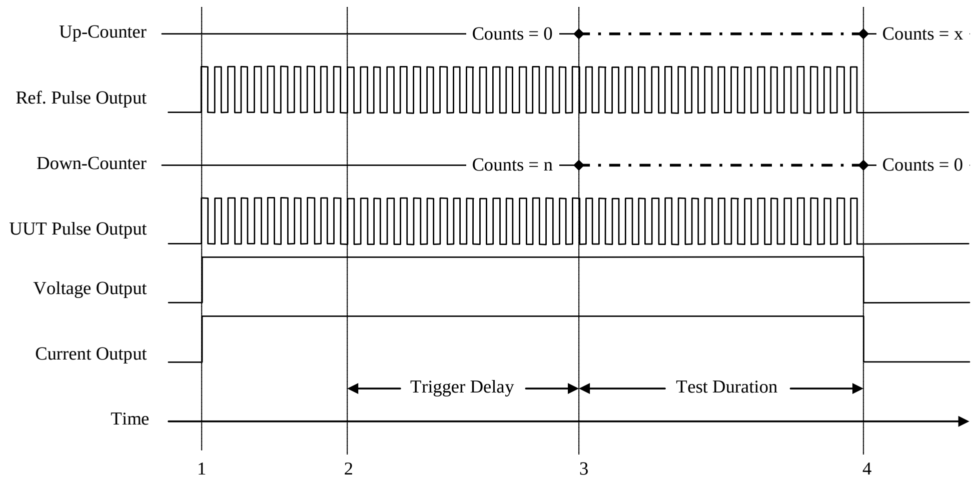


Figure 2-27
External Reference Mode Energy Test Timing Diagram

1. The OPERATE key is pressed, activating both the voltage and the current outputs. Both the UUT and the External Reference will begin to output pulses as soon as power is applied.

   The pulses from the UUT are connected to the input of the down-counter according to the diagram in Figure 2-26. The down-counter value is set to n counts from the UUT and the down-counter is armed but not yet decrementing.

   The pulses from the External Reference are connected to the input of the up-counter according to the diagram in Figure 2-26. The up-counter value is set to 0 counts from the external reference and the up-counter is armed but not yet incrementing.

18. The trigger is issued. If an Energy Test Trigger Delay has been set using the Trigger Menu, both the up-counter and down-counter remain armed until the Energy Test Trigger Delay period is complete.

19. The test begins. Every pulse received from the UUT reduces the down-counter value by 1. The up-counter value is increased by 1 for every pulse received from the External reference.

20. The Test is complete. When the value of the down-counter reaches 0, the incrementing of the up-counter is stopped. The value, x, of the up-counter is a representation of the energy measured by the External reference during the period of time defined by the counting of n pulses from the UUT. The product of x times the External reference Scale Factor is the Energy measured by the UUT during the course of the test.

The Front Counter Menu is shown below.

```
                 Front Counter

Counter Mode            Measured Energy
Scale Factor            Input Edge
Energy Setting          Input Pullup
Counts Setting
Time Setting
```

Counter Mode

The Counter Mode menu item allows the user to select one of 5 modes of operation for the Front Counter Input Channel. The choices are as follows:

- Off
- Counter
- Timer
- Ext Ref
- Jitter

Selecting 'Off' will disable the Front Counter Input Channel.

When any of the other Counter modes are selected the Status area of the Front Panel LCD display will indicate the present state of both the front and the rear counter input channels. Figure 2-28 shows the Energy mode display.

```
120.000 V    60.00 Hz
5.00000 A    0.000 °V/V
0.00000 °    Phase A
600.000 W        0.00°C

        Energy Mode                 Trigger
 Front: Reset      Rear: Off

OK                                  Local

Remote        Talk     Listen
```

Figure 2-28
Energy Mode Display

The Status display indicates the state of each Counter input Channel as follows.

Reset
When one of the Counter Input Channels is activated using any of the counter modes, a status of 'Reset' is reported.

Armed
When the trigger is issued the status of all active Counter Input Channels is changed to 'Armed'. If the Trigger Delay is 0 the 'Armed' state lasts only until the first pulse is counted. Otherwise, the 'Armed' Status is displayed for the duration of the Trigger Delay.

Counting
When pulses are being counted, the status of that Counter Input Channel is changed to 'Counting'.

Done
When one of the channels has completed the test the Status for that channel will be changed to indicate 'Done'. Since tests of differing duration may be setup for each Counter Input Channel one may finish before the other.

The functionality of the three counter modes of operation is described below. Detailed descriptions of each mode are included in the preceding section.

Counter
The Counter Mode allows a UUT to be calibrated directly against the Model 8100. The front and rear counter input channels may be configured to run two completely independent counter tests simultaneously.

When Operating in the Counter mode, the Model 8100 precisely measures the period of time required to count a number of pulses from the UUT. With this measured time and the applied power, the Model 8100 calculates the Energy measured by the UUT using the equation below.

$$Energy_{Measured} = Time \times Power_{Applied}$$

Timer
The Timer Mode allows a UUT to be calibrated directly against the Model 8100. The front and rear counter input channels may be configured to run two completely independent counter tests simultaneously.

The Timer Mode configures the Model 8100 to count the number of pulses generated by the UUT during a user-defined period of time. With these measured pulses and the Scale Factor (Whr/Pulse) for the UUT, the Model 8100 calculates the Energy measured by the UUT using the equation below.

$$Energy_{Measured} = Pulses_{UUT} \times ScaleFactor_{UUT}$$

Ext Ref
The External Reference Mode allows a UUT to be calibrated directly against an External Energy Reference. The front and rear counter input channels are both

required to run a test in this mode. The UUT is connected to one of the Counter Input Channels and the External Energy Reference is connected to the other.

When Operating in the External Reference Mode the Model 8100 precisely measures the number of pulses generated by the External Reference during the period of time required to count a user-defined number of pulses from the UUT. With these measured pulses and the Scale Factor (Whr/Pulse) for the External Reference, the Model 8100 calculates the Energy measured by the UUT using the equation below.

$$Energy_{Measured} = Pulses_{\text{Ext Ref}} \times ScaleFactor_{\text{Ext Ref}}$$

Jitter

The Jitter Mode uses the front and rear counters simultaneously to allow testing of the pulse output of a UUT with no delay between tests. This mode of operation allows a UUT to be tested multiple times and the result of the test is the average and standard deviation of the measurements made. These results can help determine the stability and repeatability of the energy meter under test.

When Operating in the Jitter Mode, the Model 8100 will measure energy for one pulse on the front counter, followed immediately by measuring one pulse on the rear counter. The test will continue for a user specified number of pulses and at the conclusion will report the average of the single pule energy tests and the standard deviation of these energy readings as well.

The 'Repeat Counts' menu item located on the Energy menu is used to determine the number of single pulse energy measurements to make before ending the test, calculating the Average Energy and standard Deviation of the energy readings.

When testing in the Jitter Mode, the pulse output of the UUT is connected to both the front counter input and the rear counter input simultaneously.

Scale Factor

The Scale Factor menu item allows the user to enter the scale factor for the energy meter connected to a specific Counter Input Channel.

The Scale Factor of an energy meter indicates how much energy the meter has measured before it outputs one pulse. The Scale Factor setting has units of Whr/Count. The Scale Factor setting window has an auto-ranging feature to allow 6 digits of setting resolution even when values become quite small. For example, if a scale factor setting of 0.1 Whr/ct is entered it will be re-formatted by the Model 8100 and displayed as 100.000mWhr/ct. Always enter values in the units indicated. Continuing the previous example, to change the setting back to 1 Whr/ct from 100.000mWhr/ct a setting of 1000mWhr/ct must be entered.

The Scale Factor allows the Model 8100 to calculate the amount of Watthours that corresponds to a specific number of pulses generated by an energy meter. The Model 8100 uses the equation below to make this calculation.

$$Energy_{Measured} = Counts \times ScaleFactor$$

The example below describes a typical calculation of Measured Energy using measured counts and the Scale factor. In this example 100,000 pulses are counted and the scale factor of the UUT is 10µWh/ct.

$$Energy_{Measured} = Counts \times ScaleFactor$$
$$Energy_{Measured} = 100{,}000(ct) \times 0.00001(Whr/ct)$$
$$Energy_{Measured} = 1.00000Whr$$

Energy Setting

Selecting this menu item opens a selection box that allows numeric input to define the amount of energy to be delivered to the UUT during the test. The energy setting is set to zero when there is no output power setting.

The Energy Setting is entered in units of Watthours. The Energy Setting window has an auto-ranging feature to allow 6 digits of setting resolution even when values become quite small. For example, if an Energy Setting of 0.1 Whr is entered it will be re-formatted by the Model 8100 and displayed as 100.000mWhr. Always enter values in the units indicated. Continuing the previous example, to change the setting back to 1 Whr from 100.000mWhr a setting of 1000mWhr must be entered.

The maximum number of pulses that may be counted, 2^{32}, and the Scale Factor Setting define the maximum Energy Setting. The maximum Energy Setting can be calculated using the equation below.

$$Energy_{Max} = 2^{32} \times ScaleFactor$$

For example, the maximum Energy Setting for a meter with a scale factor of 10µWhr/ct would be 42,949.7 Whrs.

The Energy Setting is dependant on the Counts Setting. If the Counts Setting is changed, the Energy Setting will be recalculated using the equation below.

$$Energy = ScaleFactor \times Counts$$

The Energy Setting must always be the result of an integral number of input counts. Therefore, the Scale Factor Setting determines the resolution of the Energy setting. Meters with fast pulse rates will allow greater resolution and permit more flexibility in energy setting. If an Energy Setting is requested that does not result in an integral number of counts, the Model 8100 automatically determines the nearest Energy Setting that does correspond to an integral number of counts.

The Energy Setting, Time Setting and Counts Setting are dependant on one another and are simply different ways to display the same setting.

Counts Setting

Selecting this menu item opens a selection box that allows numeric input to define the number of pulses to be counted from the UUT during the test.

The Counts Setting is entered in units of Counts. Counts are always entered as integers and the maximum number of counts is 2^{32}

The Energy Setting, Time Setting and Counts Setting are dependant on one another and are simply different ways to display the same setting. If the Time Setting or the Energy Setting is changed, the Counts Setting will be recalculated using the equation below.

$$Counts = \frac{Energy}{ScaleFactor}$$

Time Setting

Selecting this menu item opens a selection box that allows numeric input to define the period of time over which the test will occur. The Time Setting is set to zero when there is no output power setting.

The Time Setting is entered in units of Seconds. While it is possible to enter time settings of less than 1 second, typical Energy tests will occur over at least several seconds.

The maximum number of pulses that may be counted, 2^{32}, the Scale Factor Setting and the Applied Power define the maximum Time Setting. The maximum Time Setting can be calculated using the equation below.

$$Time_{Max} = \frac{2^{32} \times ScaleFactor}{Power_{Applied}}$$

For example, the maximum Time Setting for a meter with a scale factor of 10µWhr/ct and 600W Applied Power would be 71.6 Hrs or 257,698 Seconds.

The Energy Setting, Time Setting and Counts Setting are dependant on one another and are simply different ways to display the same setting. If the Counts Setting is changed, the Time Setting will be recalculated using the equation below.

$$Time_{Max} = \frac{Counts \times ScaleFactor}{Power_{Applied}}$$

The Time Setting must always be the result of an integral number of input counts. Therefore, the Scale Factor Setting determines the resolution of the Time setting. Meters with fast pulse rates will allow greater resolution and permit more flexibility in Time Setting. If a Time Setting is requested that does not result in an integral number of Counts, the Model 8100 automatically determines the nearest Time Setting that does correspond to an integral number of counts.

Measured Energy

Selecting this menu item opens a box that displays the amount of energy measured by the UUT during an Energy Test. The Measured Energy Displayed is always the result of the most recently completed energy test. If no tests have been completed, 0.00000Wh is displayed.

A Measured Energy value is available when the counter status display on the front panel indicates the status is ‘Done’.

The Measured Energy is display in units of Watthours.

Input Edge

Selecting this menu item opens a selection box with two choices. The choices are ‘Positive’ and ‘Negative’. The default setting for the Input Edge function of the Model 8100 is ‘Positive’.

The Input Edge function configures the pulse counter to count on either the rising or falling edge of the input pulse. If ‘Positive’ is selected pulses will be counted on the rising edge. If ‘Negative’ is selected pulses will be counted on the falling edge.

Input Pull-up

Selecting this menu item opens a selection box with three choices; ‘33k’, ‘1000’ and ‘150’. The default setting for the Input Pull-up function of the Model 8100 is ‘33k’.

The counter input of the Model 8100 includes a pull-up resistor to the internal 5V power supply. The value of this resistor may be changed to one of three values; 33kΩ, 1000Ω or 150Ω. Refer to Figure 2-21 for a detailed description of the counter input circuit of the Model 8100.

Rear Counter

The Model 8100 is equipped with a two-channel pulse counter. The input to one channel is located on the front panel while the second input is located on the rear panel. Refer to Figure 2-2 and Figure 2-11 for a detailed description of the location of each of these connectors.

Each input channel is a completely independent duplicate of the other. Please refer to the Front Counter input for a complete description of the functionality of the Rear Counter Input.

Repeat Counts

The ‘Repeat Counts’ menu item is used when the Pulse Counters are used in the ‘Jitter’ mode to set the number of single pulse readings that are included in the reported average and standard deviation of the energy measurements made.

Output Mode

The Model 8100 is capable of generating an output signal to mark the beginning and end of an energy test. This signal may be used to gate functions of the UUT or other external devices. The output signal is provide at either the front or rear panel Digital I/O connector. Refer to Figure 2-2 and Figure 2-11 for a detailed description of the location of each of these connectors. If a Digital I/O connector is already in use as a pulse input it may not be used as a pulse output.

The Output signal may be configured to function in one of two modes. In the ‘On’ mode the output is a single pulse that gates the entire test. This mode is illustrated in Figure 2-29.

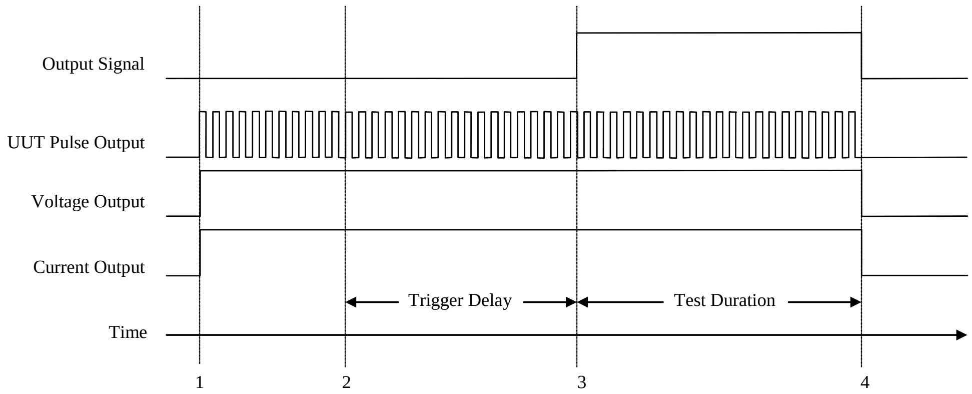


Figure 2-29
Output Signal Timing Diagram (Continuous Gate)

1. The OPERATE key is pressed, activating both the voltage and the current outputs. The UUT will begin to output pulses as soon as power is applied.
21. The Trigger is issued. If an Energy Test Trigger Delay has been set using the Trigger Menu, the Counter remains armed until the Energy Test Trigger Delay period is complete.
22. The test begins. The pulses from the UUT are being counted and the Output Gate Signal changes state. In this example the signal changes from the Normally Low State to the High State. The Output may be configured to be normally low or normally high.
23. The Test is Complete. The Output changes state again back to the normal state.

In the ‘On’ mode the output is a single pulse that gates the entire test. This mode is illustrated in Figure 2-30.

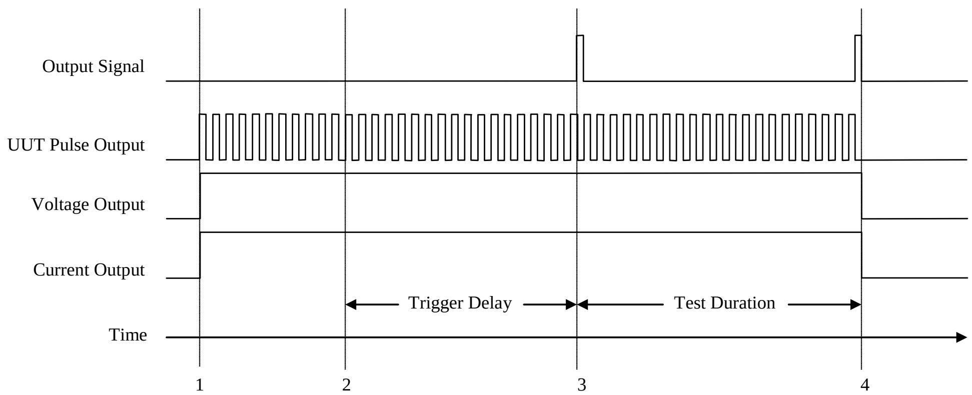


Figure 2-30
Output Signal Timing Diagram (Pulsed Gate)

1. The OPERATE key is pressed, activating both the voltage and the current outputs. The UUT will begin to output pulses as soon as power is applied.
24. The Trigger is issued. If an Energy Test Trigger Delay has been set using the Trigger Menu, the Counter remains armed until the Energy Test Trigger Delay period is complete.
25. The test begins. The pulses from the UUT are being counted and the Output Gate Signal generates a pulse. In this example the signal changes from the Normally Low State to the High State. The Output may be configured to be normally low or normally high.
26. The Test is Complete. The Output generates another pulse marking the end of the test.

A common use of the Output signal is to Gate the display of a UUT that supports this function. In this way the results of an energy test may be displayed on the front panel of the UUT as well as the Model 8100.

The Output Mode Menu is shown below.

```
              Output Mode

Gate Source
Pulse Mode
Active level
Terminals
```

Gate Source

Selecting this menu item opens a selection box with four choices. The choices are 'Off', 'Front Counter', 'Rear Counter' and 'Timer'. The default setting for the Gate Source function of the Model 8100 is 'Off'.

Selecting 'Off' will disable the Output function of the Model 8100.

When activated by selecting 'Front Counter', 'Rear Counter' or 'Timer' the output behave as described below.

- **Front Counter**
  If the Gate Source is set to 'Front Counter' the output signal will remain active for the period of time that the front counter is counting pulses.
- **Rear Counter**
  If the Gate Source is set to 'Rear Counter' the output signal will remain active for the period of time that the rear counter is counting pulses.
- **Timer**
  If the Gate Source is set to 'Timer' the output signal will be the internal 32 kHz clock (32,768Hz).

Pulse Mode

Selecting this menu item opens a selection box with three choices. The choices are 'Off', 'On', and 'Once'. The default setting for the Pulse Mode function of the Model 8100 is 'Off'.

Selecting 'Off' will disable the Pulse Mode function of the Model 8100. With the Pulse Mode 'Off' the Output Signal will behave as a single gate of the energy test. Refer to Figure 2-29 for a timing diagram describing this mode of operation.

When activated, the output will behave as described below.

- **On**
  The Pulse mode is activated and the normal behavior of the Output signal is modified so that the Output consists of two pulses gating the energy test. Refer to Figure 2-30 for a timing diagram describing this mode of operation.
- **Once**
  Selecting Once will send one discreet pulse to the output each time the mode is activated. This is useful when trying to synchronize external equipment that will be controlled by the Output Signal.

Active level

Selecting this menu item opens a selection box with two choices. The choices are 'High' and 'Low'. The default setting for the Active Level function of the Model 8100 is 'Low'.

When the Active Level is set to Low, the Output signal is normally low and becomes high when active.

When the Active Level is set to High, the Output signal is normally high and becomes Low when active.

The Active Level applies when the pulse mode is active as well.

Terminals

Selecting this menu item opens a selection box with two choices. The choices are 'Front' and 'Rear'. The default setting for the Terminals function of the Model 8100 is 'Front'.

Selecting 'Front' will direct the Output Signal to the Front Digital I/O Connector. Selecting 'Rear' will direct the Output Signal to the Rear Digital I/O Connector. Refer to Figure 2-2 and Figure 2-11 for a detailed description of the location of each of these connectors. If a Digital I/O connector is already in use as a pulse input it may not be used as a pulse output.

Applied Power

The ‘Applied Power’ menu item is used to set the actual power applied to a UUT when it differs from the power setting of the Model 8100. If ‘Applied Power’ is set to 0.00000W, the setting is ignored. The most common use of this setting is when energy testing is being done on a three phase UUT. In this application the applied power that the UUT measures is the sum of the power output of each phase. If ‘Applied Power’ is set to the actual power applied to the UUT this value will be used by the Model 8100 in calculating the energy measured by the UUT.

Power Quality

```
                Power Quality

Voltage Distortion
Voltage Events
Current Distortion
Current Events
```

The Power Quality menu provides functions relating to the configuration and control of the power quality test functions of the Model 8100. The power quality functions of the Model 8100 are divided into two groups, Distortion and Events. Any of the power quality functions may be applied to either the voltage or the current output of the Calibrator.

The Model 8100 Distortion functions each add some form of distortion to the output that exists continuously when the calibrator is generating voltage or current. Model 8100 Events are functions that occur over a fixed period of time. Events must be triggered by the user and will have a beginning and an end. Events may be configured to occur only once or to repeat continuously.

The Voltage and Current power quality functions are identical though completely independent.

Voltage Distortion

```
             Voltage Distortion

Function                 Frequency
Amplitude                Phase
Harmonic
Fluctuate Mode
Fluctuate Period
```

Selecting this menu choice will display the Voltage Distortion menu. This menu provides the controls to configure the type of distortion that will be applied to the Voltage output of the Model 8100.

The type of distortion to be added to the voltage output is controlled by the function menu. The remaining menu items of the Voltage Distortion Menu are used to configure the selected distortion function.

The available distortions include Harmonics, Fluctuating Harmonics, Inter-harmonics, Fluctuating Inter-harmonics, Notching and Fluctuating Notching. In addition the Model 8100 can accept user defined distortion waveforms.

Detailed descriptions of the various Distortion functions available for the Voltage output channel are described in the following paragraphs.

Function Selecting this menu item opens a selection box with the following choices.

- Off
- Harmonics
- Inter-Harmonic
- Notching
- User Defined

The default setting for the Voltage Distortion function of the Model 8100 is ‘Off’.

When any of the Distortion functions are activated the Distortion line in the Status area of the front panel display will change from ‘Distortion Off’ to a message that indicates the type of distortion applied to both the voltage and current outputs. Figure 2-31 shows the front panel display with Harmonics added to the voltage output and no distortion added to the current output.

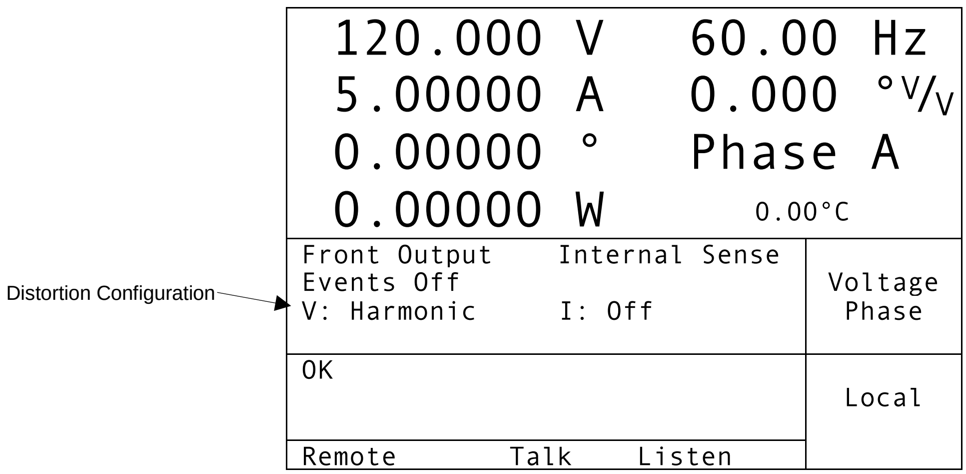


Figure 2-31
Distortion Configuration Display

Harmonics

When the Harmonics function is selected a secondary, distortion waveform is added to the fundamental voltage output. This waveform will be a sine wave with a frequency that is an integral multiple of the fundamental frequency. To configure a harmonic to be added to the voltage fundamental, the following parameters must be defined using the menu items of the Voltage Distortion menu.

- Harmonic
- Amplitude
- Phase

The Harmonic may also be configured to fluctuate in amplitude. To configure a harmonic to fluctuate the following two parameters must also be defined using the menu items of the Voltage Distortion menu.

- Fluctuate Mode
- Fluctuate Period

The frequency of the secondary, distortion sine wave is specified as a multiple of the fundamental frequency and is referred to here as the Harmonic. The Model 8100 supports harmonics up to the 100th for fundamental frequencies of 45-65Hz. The amplitude of the distortion can be as large as 50% of the fundamental output amplitude. The phase relationship of the distortion to the fundamental can be specified as an angular phase shift.

Figure 2-32 shows both the fundamental and the distortion waveform when 25% of the 5th harmonic is added to the output with no phase shift between the distortion and the fundamental.

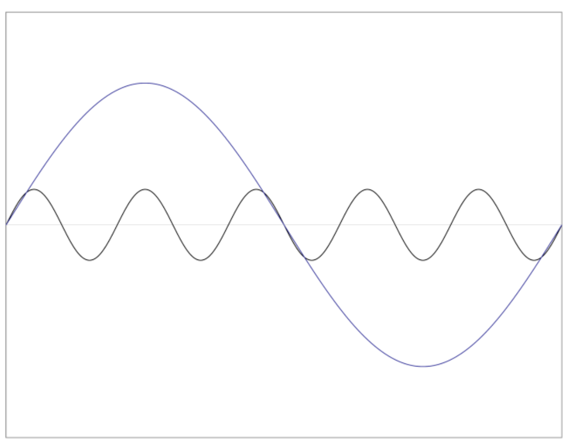


Figure 2-32
Fundamental and Harmonic Distortion Waveform (No Phase Shift)

Figure 2-33 shows the actual distorted output waveform when 25% of the 5th harmonic is added to the fundamental with no phase shift between the fundamental and the distortion waveform.

Figure 2-33
Harmonic Distorted Waveform (No Phase Shift)

Figure 2-34 shows both the fundamental and the distortion waveform when 25% of the 5th harmonic is added to the output with a 60° phase shift between the distortion and the fundamental.

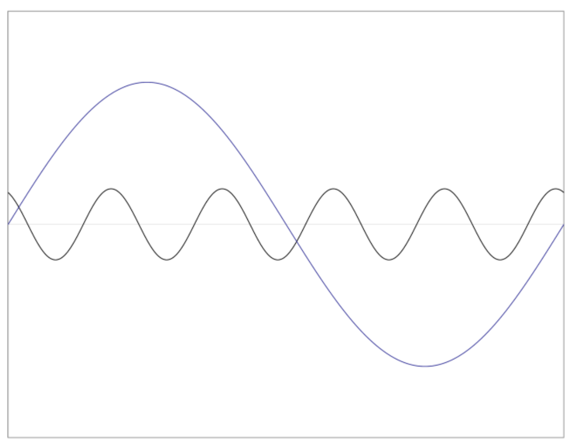


Figure 2-34
Fundamental and Harmonic Distortion Waveform (60° Phase Shift)

Figure 2-35 shows the actual distorted output waveform when 25% of the 5th harmonic is added to the fundamental with a 60° phase shift between the fundamental and the distortion waveform.

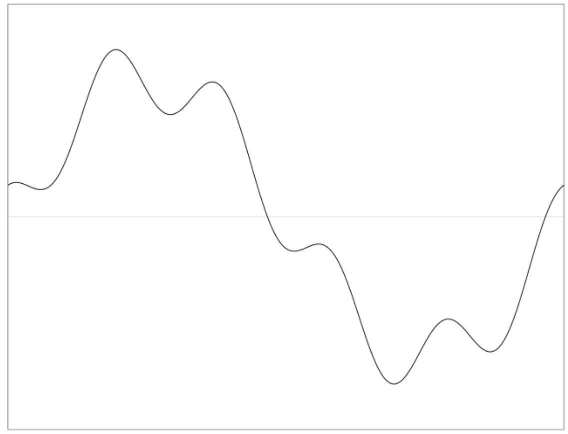


Figure 2-35
Harmonic Distorted Waveform (60° Phase Shift)

Inter-Harmonics

When the Inter-Harmonics function is selected a secondary waveform is added to the voltage output. This waveform will be a sine wave with a frequency that is independent of the fundamental frequency. To configure an Inter-Harmonic to be added to the output the following parameters must be defined using the menu items of the Voltage Distortion menu.

- Amplitude
- Phase

The frequency of the secondary sine wave is specified in Hz and is not related to the fundamental frequency. The amplitude of the distortion must be specified and can be as large as 50% of the fundamental output.

Notching

When the Notching function is selected periodic disturbance will be added to the voltage output. This disturbance will be a notch in the waveform with a fixed width of approximately 1/300th on a cycle. The notches will be placed at a regular interval throughout the cycle. To configure a notching disturbance to be added to the output the following parameters must be defined using the menu items of the Voltage Harmonics menu.

- Amplitude
- Frequency
- Phase

The frequency of the disturbance is specified in units of Notches/Cycle and is not related to the fundamental frequency. The amplitude of the disturbance must be specified and can be as large as 50% of the fundamental output. The phase relationship of notches to the start of the cycle must also be specified.

Figure 2-36 shows both the fundamental and the distortion waveform when a Notching distortion of 10 Notches per cycle is added to the output. The amplitude of the notches is 25% of the fundamental.

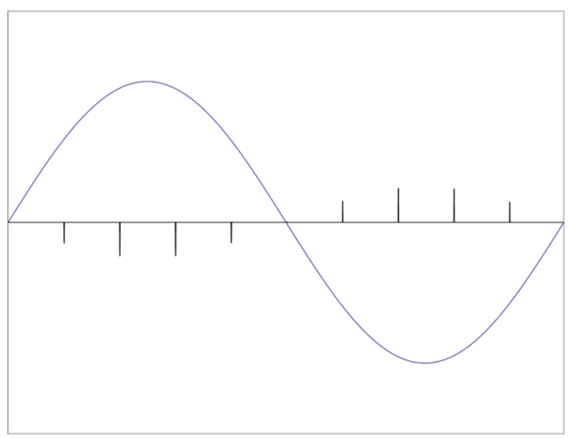


Figure 2-36
Fundamental and Notching Distortion Waveform

Figure 2-37 shows the actual distorted output waveform when a Notching distortion of 10 Notches per cycle is added to the output. The amplitude of the notches is 25% of the fundamental.

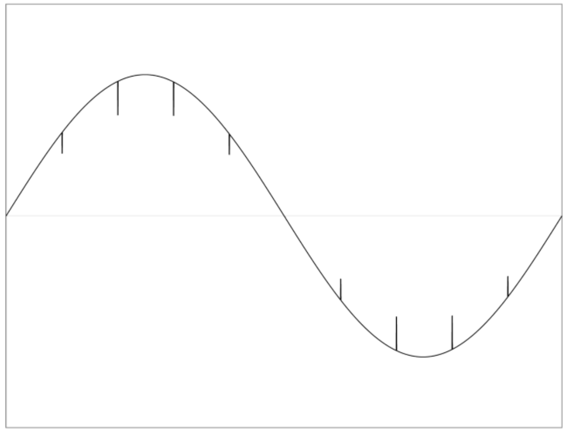


Figure 2-37
Notching Distorted Waveform

User Defined

When the User Defined function is selected a user-defined waveform will be added to the fundamental output waveform. The data points defining the waveform are entered via the remote interface, either the GPIB-488 or RS-232.

As with the previously described distortions, the distortion waveform is added to the output waveform to create an entirely customized distorted output waveform.

The maximum amplitude of the user-defined distortion is 50% of the fundamental.

Amplitude

The Amplitude menu item allows the user to enter the amplitude of the distortion to be added to the fundamental waveform. The amplitude setting applies to all distortion functions.

The amplitude value is entered as a percentage of the fundamental amplitude and the default setting is 0.000%.

The minimum setting resolution is 0.001%. The maximum setting is 50%.

Harmonic

The Harmonic menu item allows the user to enter the harmonic of the distortion to be added to the fundamental waveform. The harmonic setting only applies to the Harmonic distortion function.

The harmonic value is entered as an integer from 2 to 100.

The actual frequency of the distortion waveform depends on the frequency of the fundamental. The frequency of the distortion waveform is calculated as follows.

$$Frequency_{Distortion} = Harmonic \times Frequency_{Fundamental}$$

For example, if the fundamental frequency is 60Hz and the 5th harmonic is added to the waveform, the actual frequency of the distortion waveform will be 300Hz. Refer to Figure 2-32 for an illustration of this waveform.

Fluctuate Mode

Selecting this menu item opens a selection box with two choices. The choices are 'Off' and 'On'. The default setting for the Input Edge function of the Model 8100 is 'Off'.

The Fluctuate Mode function configures the applied distortion to be static or fluctuating. If the Fluctuate Mode is set to 'On', the amplitude of the applied distortion will fluctuate, modulated by a square wave. The period of the modulating square wave is selected using the Fluctuate Period Menu item.

The Fluctuate setting applies to all distortion functions.

Fluctuate Period

The Fluctuate Period menu item allows the user to enter the period of the square wave that will modulate the amplitude of the applied distortion. The Default Setting of the Fluctuate Period Setting is 2 cycles.

The maximum setting for the Fluctuate Period setting is 9999.0 cycles and the minimum setting is 0.5 cycles. The setting resolution is 0.5 cycles.

The Fluctuate Period setting applies to all distortion functions and is applied only when the Fluctuate mode is set to 'On'.

Frequency

The Frequency menu item allows the user to enter the frequency of the Inter-harmonic to be added to the fundamental waveform. The Frequency setting applies to only the Inter-harmonic function.

Phase

The Phase menu item allows the user to enter the Phase angle of harmonic distortion relative to the fundamental waveform. The Phase setting applies to only the Harmonic function.

The Phase setting has units of degrees and may be set to any angle from +180° to –180°. The minimum setting resolution is 1°.

Voltage Events

```
                Voltage Events

Event Type              Start Ramp Time
Amplitude               Exit Ramp Time
Duration                Repeat Mode
Flicker Mode            Repeat Delay
Flicker Period
```

Selecting this menu choice will display the Voltage Events menu. This menu provides the controls required to configure the type of event that will be applied to the voltage output of the Model 8100.

The type of event to be applied to the voltage output is controlled by the Event Type Menu. The remaining menu items of the Voltage Events Menu are used to configure the selected event function.

The available events include Sags, Swells, Interruptions and Flicker.

Events may be configured to occur once or to repeat continuously. If an event is configured to repeat, then the period of time that will elapse between events may be set.

Detailed descriptions of the various Event Types available for the Voltage output channel are described in the following paragraphs.

Event Type

Selecting this menu item opens a selection box with the following choices.

- Off
- Sag
- Swell
- Interruption

The default setting for the Voltage Event Type of the Model 8100 is ‘Off’.

When any of the Events are activated the Event line in the Status area of the front panel display will change from ‘Events Off’ to a message that indicates the type of event that is applied to both the voltage and current outputs. Figure 2-38 shows the front panel display with a sag event applied to the voltage output and no events applied to the current output.

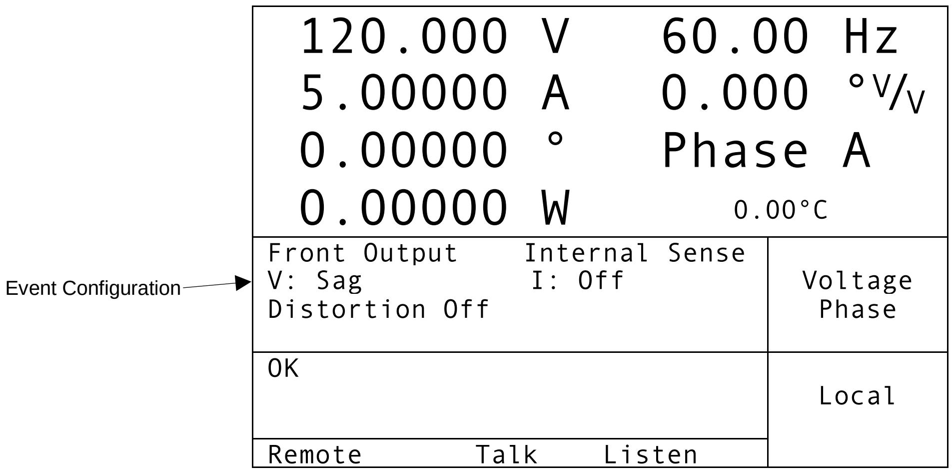


Figure 2-38
Event Configuration Display

The Flicker function is achieved by ‘Flickering’ either a sag event or a swell event. The Flicker Mode menu item is used to activate flicker when either sag or swell Event Type is selected.

The Trigger, as defined in the Trigger Setup menu, controls the initiation of events applied to the voltage output.

Sag

When the Sag Event Type is selected the voltage output will be configured to simulate a Sag Event. To configure a Sag event to be applied to the voltage output channel, the following parameters must be defined using the menu items of the Voltage Event menu.

- Start Ramp
- Duration
- Exit Ramp
- Amplitude

During a Sag event the voltage output will drop from the nominal amplitude to a pre-defined Sag amplitude. The reduced amplitude will be held for a period of time and then the amplitude will be return to the nominal setting.

The duration of a sag event may be set in units of either Seconds or Cycles, with a minimum setting of 0.5 Cycles. The amplitude is defined as a percentage of the nominal amplitude with maximum sag of 99% of the nominal.

Figure 2-39 illustrates a sag event with an amplitude setting of 20% and a duration of 10 Cycles.

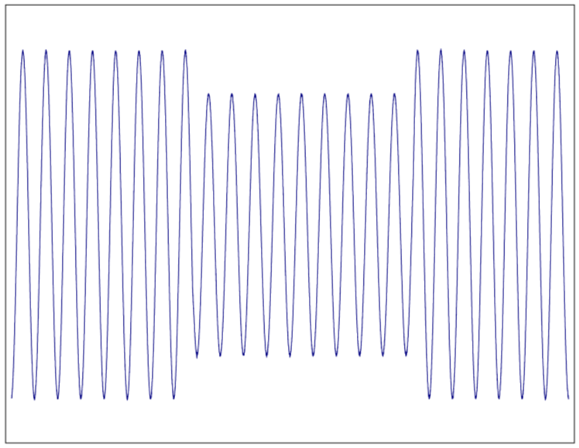


Figure 2-39
Sag Event with No Ramp

Sag events may include a start ramp, exit ramp or both. During the ramp time the amplitude will change in a linear manner from the amplitude at the beginning of the ramp to the amplitude at the end of the ramp.

The Start Ramp and Exit Ramp are defined in units of Seconds or Cycles and the minimum setting resolution is 0.5 Cycles.

Figure 2-40 illustrates a Sag Event with an amplitude setting of 20% of the nominal. The Start Ramp, Duration and Exit ramp are all set to 4 Cycles.

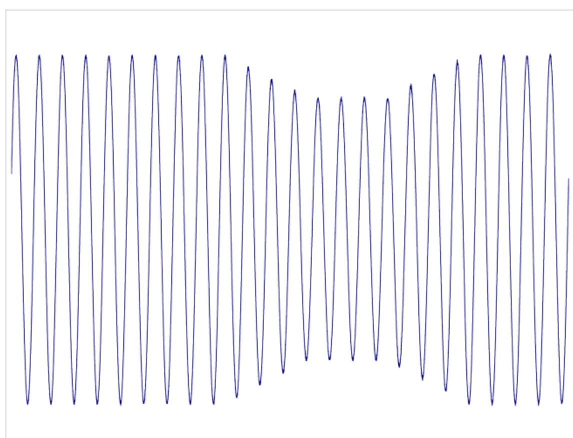


Figure 2-40
Sag Event with Ramping

Swell

When the Swell Event type is selected the voltage output will be configured to simulate a swell event. To configure a Swell Event to be applied to the voltage output channel, the following parameters must be defined using the menu items of the Voltage Event menu.

- Start Ramp
- Duration
- Exit Ramp
- Amplitude

During a swell event the voltage output will rise from the nominal amplitude to a pre-defined swell amplitude. The increased amplitude will be held for a period of time and then the amplitude will be return to the nominal setting.

The duration of a swell event may be set in units of either Seconds or Cycles, with a minimum setting of 0.5 Cycles. The amplitude is defined as a percentage of the nominal amplitude with maximum swell of 199% of the nominal.

Figure 2-41 illustrates a swell event with an amplitude setting of 20% and a duration of 10 Cycles.

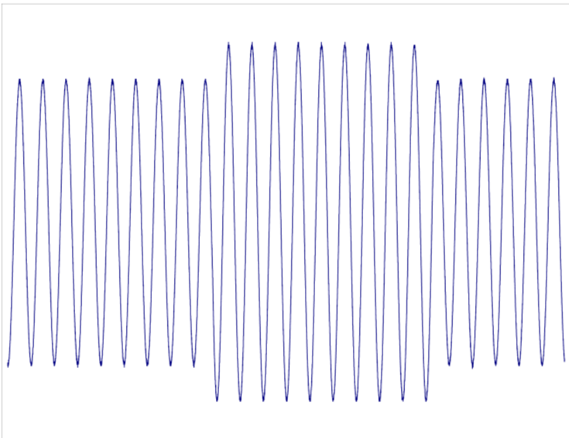


Figure 2-41
Swell Event Without Ramping

Swell events may include a start ramp, exit ramp or both. During the ramp time the amplitude will change in a linear manner from the amplitude at the beginning of the ramp to the amplitude at the end of the ramp.

The Start Ramp and Exit Ramp are defined in units of Seconds or Cycles and the minimum setting resolution is 0.5 Cycles.

Figure 2-42 illustrates a swell event with an amplitude setting of 20% of the nominal. The Start Ramp, Duration and Exit ramp are all set to 4 Cycles.

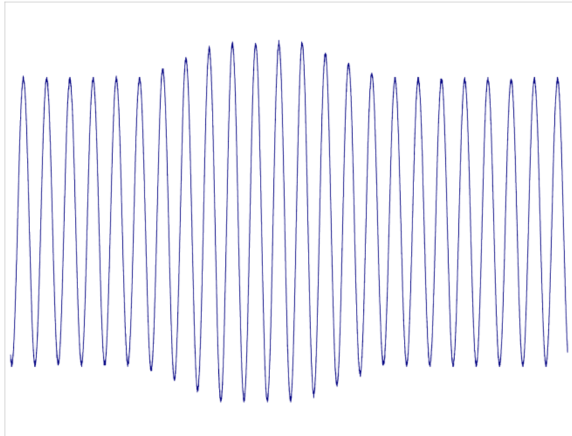


Figure 2-42
Swell Event With Ramping

Interruption

When the Interruption Event type is selected the voltage output will be configured to simulate an interruption event. To configure an interruption event to be applied to the voltage output channel, the following parameters must be defined using the menu items of the Voltage Event menu.

- Duration
- Amplitude

During a interruption event the voltage output will drop from the nominal amplitude to zero. The amplitude will be held at zero for a period of time and then the amplitude will be return to the nominal setting.

The duration of an interruption event may be set in units of either Seconds or Cycles, with a minimum setting of 0.5 Cycles.

Figure 2-43 illustrates an interruption event with a duration setting of 10 Cycles.

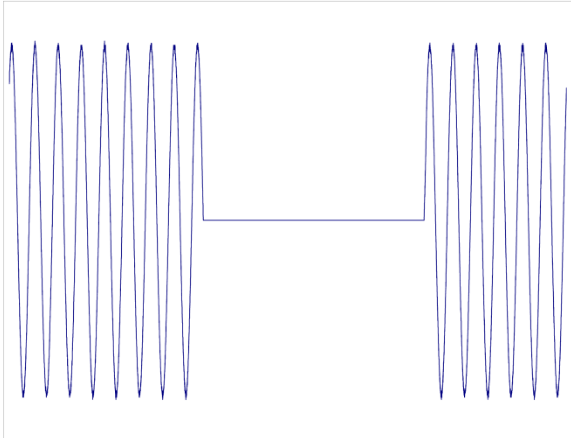


Figure 2-43
Interruption Event

Flicker

The voltage output may be configured to flicker by setting the Flicker Mode to 'On'. The Flicker Mode may affect either Sag or Swell events. When applying Flicker to a Sag Event the amplitude of the sag will be modulated at a frequency defined by the flicker period. When applying Flicker to a Swell Event the amplitude of the swell will be modulated at a frequency defined by the flicker period.

When applying Flicker a Sag or Swell Event type must be selected. To configure a Sag or Swell Event to flicker on the voltage output channel, the following parameters must be defined using the menu items of the Voltage Event menu.

- Start Ramp
- Duration
- Exit Ramp
- Flicker Mode
- Flicker Period
- Amplitude

When Flicker is applied to a swell event, the voltage output will behave as defined for a swell event but the output amplitude will be modulated at a rate defined by the flicker period setting. During the event the output will continuously rise to the swell amplitude and drop back to the nominal amplitude.

When Flicker is applied to a sag event, the voltage output will behave as defined for a sag event but the output amplitude will be modulated at a rate defined by the flicker period setting. During the event the output will continuously fall to the sag amplitude and rise back to the nominal amplitude.

The flicker period may be set in units of either Seconds or Cycles, with a minimum setting of 0.5 Cycles.

Figure 2-44 illustrates a flickering sag event with an amplitude setting of 20% and flicker period of 4 Cycles.

Figure 2-44
Flicker Event

Amplitude

The Amplitude menu item allows the user to enter the amplitude of the event to be applied to the voltage output. The amplitude setting only applies to Sag and Swell events. The amplitude of an interruption event is always zero.

The amplitude value is entered as a percentage of the fundamental amplitude and the default setting is 0.0000%.

The Amplitude setting resolution is 0.0001%. The maximum amplitude setting for a sag event is 100% for a sag amplitude setting that is 0% of the nominal setting. The maximum Amplitude setting for a swell event is 100% for a swell amplitude setting that is 200% of the nominal setting. The minimum amplitude setting for both sag and swell events is 0.0000%.

Figure 2-39 and Figure 2-41 illustrate both a sag and swell event with an event amplitude setting of 20%.

Duration

The Duration menu item allows the user to enter the period of time over which an event will occur. The Duration setting applies to all events.

The period of time defined by the duration setting does not include the times defined by the Start Ramp or Exit Ramp. If the Start Ramp and Exit Ramp settings are 0.0000 then the total time of the event will be the time defined by the duration setting. If the Start Ramp and Exit Ramp settings are non-zero, then the total time of the event will be the time defined by the sum of the duration setting, Start Ramp setting and the Exit ramp setting.

The Duration value is entered in units of either Seconds or Cycles and the default setting is 1.0000 Second.

The Duration setting resolution is 0.5 Cycles. The maximum Duration setting is 9999.0 Cycles or Seconds. The minimum Duration setting is 0.0000 Cycles or Seconds.

Figure 2-39 and Figure 2-41 illustrate both a sag and swell event with an event duration setting of 10 Cycles.

Start Ramp

The Start Ramp menu item allows the user to enter the period of time over which the amplitude setting will change from the nominal amplitude to the sag or swell amplitude.

If the Start Ramp value is set to zero, the nominal amplitude setting will change immediately to the Sag or Swell amplitude setting when the event is triggered. The Start Ramp setting only applies to Sag and Swell events.

The Start Ramp value is entered in units of either Seconds or Cycles and the default setting is 0.0000 Second.

The Start Ramp setting resolution is 0.5 Cycles. The maximum Start Ramp setting is 9999.0 Cycles or Seconds. The minimum Start Ramp setting is 0.0000 Cycles or Seconds.

Figure 2-40 and Figure 2-42 illustrate both sag and swell events with start ramp, duration and exit ramp settings of 4 Cycles.

Exit Ramp

The Exit Ramp menu item allows the user to enter the period of time over which the amplitude setting will change from the sag or swell amplitude back to the nominal amplitude setting.

If the Exit Ramp value is set to zero, the Sag or Swell amplitude setting will change immediately to the nominal setting when the event is triggered. The Exit Ramp setting only applies to Sag and Swell events.

The Exit Ramp value is entered in units of either Seconds or Cycles and the default setting is 0.0000 Second.

The Exit Ramp setting resolution is 0.5 Cycles. The maximum Exit Ramp setting is 9999.0 Cycles or Seconds. The minimum Exit Ramp setting is 0.0000 Cycles or Seconds.

Figure 2-40 and Figure 2-42 illustrate both sag and swell events with start ramp, duration and exit ramp settings of 4 Cycles.

Flicker Mode

Selecting this menu item opens a selection box with the following choices.

- Off
- On

The default setting for the 'Flicker Mode' is 'Off'.

When the Flicker Mode is set to 'On' the amplitude of the selected event will be modulated by a square wave with a frequency defined by the Flicker Period setting.

When the Event Type is set to 'Sag', activating the Flicker Mode will cause the output amplitude to move between the nominal amplitude setting and the Sag amplitude setting at a rate defined by the flicker period setting.

When the Event Type is set to 'Swell', activating the Flicker Mode will cause the output amplitude to move between the nominal amplitude setting and the Swell amplitude setting at a rate defined by the flicker period setting.

When the Event Type is set to 'Interruption', activating the Flicker Mode will cause the output amplitude to move between the nominal amplitude setting and the zero at a rate defined by the flicker period setting.

Figure 2-44 illustrates a Sag Event with the Flicker Mode set to 'On'. The Flicker period is set to 4 Cycles.

Flicker Period

The Flicker Period menu item allows the user to enter the period of the Square wave that will modulate the event amplitude setting causing the output to Flicker.

The Flicker Period value is entered in units of Cycles and the default setting is 2.0000 Cycles.

The Flicker Period setting resolution is 0.5 Cycles. The maximum Flicker Period setting is 9999.0 Cycles. The minimum Flicker Period setting is 2.0000 Cycles.

Figure 2-44 illustrates a Sag Event with the Flicker Mode set to 'On'. The Flicker period is set to 4 Cycles.

Repeat Mode

Selecting this menu item opens a selection box with the following choices.

- Off
- On

The default setting for the 'Repeat Mode' is 'Off'.

When the Repeat Mode is set to 'On' the selected event will be repeated indefinitely after it is triggered initially. The period of time between activation of the event is set using the Repeat Delay setting.

Repeat Delay

The Repeat Delay menu item allows the user to enter the period of time that will elapse between activation of the event. The Repeat Delay only has an effect when the Repeat Mode is set to 'On'.

The Repeat Delay value is entered in units of Seconds or Cycles and the default setting is 0.0000 Seconds.

The Repeat Delay setting resolution is 0.5 Cycles. The maximum Repeat Delay setting is 9999.0 Cycles. The minimum Repeat Delay setting is 2.0000 Cycles.

Current Distortion

```
             Current Distortion

Function                Frequency
Amplitude               Phase
Harmonic
Fluctuate Mode
Fluctuate Period
```

Selecting this menu choice will display the Current Distortion menu. This menu provides the controls to configure the type of distortion that will be applied to the Current output of the Model 8100.

The Current Distortion function of the Model 8100 is identical to the Voltage Distortion function. Refer to the preceding Voltage Distortion section for a detailed description of all aspects of this function.

Current Events

```
               Current Events

Event Type              Start Ramp Time
Amplitude               Exit Ramp Time
Duration                Repeat Mode
Flicker Mode            Repeat Delay
Flicker Period
```

Selecting this menu choice will display the Current Events Menu. This menu provides the controls required to configure the type of event that will be applied to the current output of the Model 8100.

The Current Event function of the Model 8100 is identical to the Voltage Event function. Refer to the preceding Voltage Event section for a detailed description of all aspects of this function.

Trigger Setup

```
                Trigger Setup

Auto Start
Energy Delay
Voltage Event
Current Event
Trigger Immediate
```

The Trigger Setup menu provides functions relating to the configuration of the Event trigger of the calibrator.

There are three types of events that may be initiated using the trigger. They are as follows.

- Energy Tests
- Voltage Events
- Current Events

The Model 8100 is equipped with a single trigger that will initiate all configured events simultaneously. Alternatively, each event may have a trigger delay associated with it. When a trigger delay is set for an event, the activation of the event will be delayed for a period of time after the global trigger is initiated. In this way multiple events may occur at different times though be synchronized with each other relative to the initial global trigger.

The global trigger may be initiated at any time after the operate state has been asserted. The trigger may also be automatically triggered when operate is asserted using the Auto Start function.

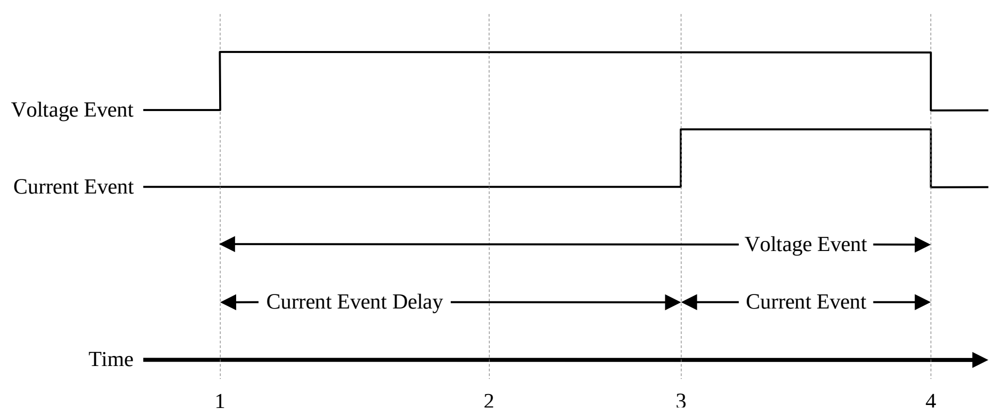


Figure 2-45
Event Trigger (Immediate)

Figure 2-45 illustrates both a voltage and a current event occurring simultaneously. The Current event has a trigger delay applied and the event durations are set so that they end at the same time. At point 1 the operate state is asserted. At point 2 the trigger is initiated. Since there is no trigger delay set for the voltage it starts immediately. The current event will wait for the duration of the Current Event Trigger Delay before being initiated at point 3. At point 4 both the voltage and current events are complete.

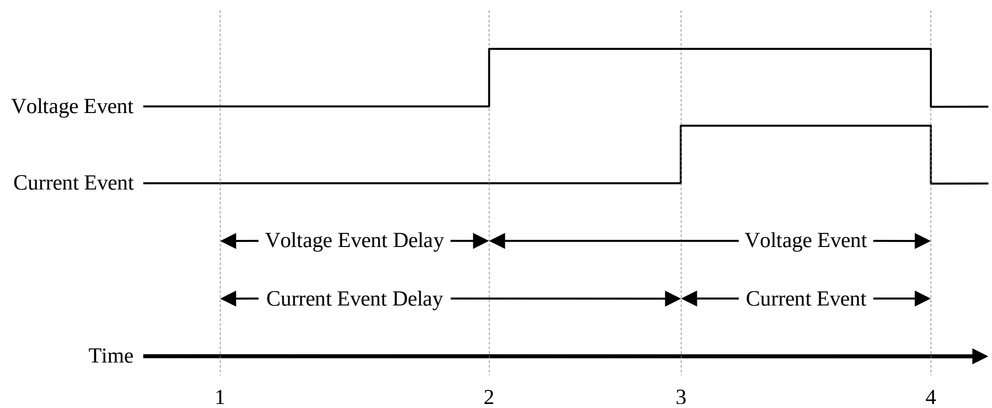


Figure 2-46
Event Trigger (Auto Start)

Figure 2-46 illustrates both a voltage and a current event occurring simultaneously. Each event has a trigger delay applied and the event durations are set so that they end at the same time. In this example the Auto Start function is active. At point 1 operate is asserted and, since the Auto Start Mode is set to ‘On’, the trigger is initiated as well. Both the voltage and current trigger delays begin. At point 2 the voltage trigger delay is complete and the voltage event begins. At point 3 the current trigger delay is complete and the current event begins. At point 4, both events are complete.

Auto Start

Selecting this menu item opens a selection box with the following choices.

- Off
- On

The default setting for the ‘Auto Start’ function is ‘Off’.

When the Auto Start is set to ‘On’ the trigger is initiated immediately as Operate is asserted. Figure 2-46 illustrates the use of the Auto Start function.

Energy Delay

The Energy Delay menu item allows the user to enter the period of time that will elapse between the global trigger and the activation of the Energy Event. Energy Events may occur at the same time as both voltage and current events. Trigger delays for all three events must be coordinated to ensure that the Voltage and Current events occur at the desired time during the energy test.

The Energy Delay value is entered in units of Seconds or Cycles and the default setting is 0.0000 Seconds.

The Energy Delay setting resolution is 0.5 Cycles. The maximum Energy Delay setting is 9999.0 Cycles. The minimum Energy Delay setting is 0.0000 Cycles.

Voltage Event

The Voltage Event menu item allows the user to enter the period of time that will elapse between the global trigger and the activation of the selected Voltage Event.

The Voltage Event Delay value is entered in units of Seconds or Cycles and the default setting is 0.0000 Seconds.

The Voltage Event Delay setting resolution is 0.5 Cycles. The maximum Voltage Event Delay setting is 9999.0 Cycles. The minimum Voltage Event Delay setting is 0.0000 Cycles.

Current Event

The Current Event menu item allows the user to enter the period of time that will elapse between the global trigger and the activation of the selected Current Event.

The Current Event Delay value is entered in units of Seconds or Cycles and the default setting is 0.0000 Seconds.

The Current Event Delay setting resolution is 0.5 Cycles. The maximum Current Event Delay setting is 9999.0 Cycles. The minimum Current Event Delay setting is 0.0000 Cycles.

Trigger Immediate

The Trigger Immediate menu item allows the user to issue the global trigger. All events are triggered using this function unless Auto Start is active. If the event trigger delays are set to zero then the events will occur as soon as the Trigger Immediate command is issued.

Preferences

```
                 Preferences

Power Units            Deviation Units
Phase Units            Keyboard Sound
Time Units             Operate Warning
Scale Factor Units     Beeper Volume
Temperature Units      Energy Units
```

The Preferences menu provides functions relating to the customization of the calibrator to meet the specific requirements of the user.

Power Units

There are 3 choices of units in which Power may be displayed. They are ‘Watt’, ‘VAR’, or ‘VA’. Changing the setting of power units will cause the power setting indicated in the Output Setting Display to change. For example, a setting of 120V and 5A will indicate 600VA. If the phase angle is set to 0°, changing the units from ‘Volt-Amperes’ to ‘Watts’ will indicate 600W. If the power the units are changed to ‘VARs’ the display will change to 0VAR. Changing any of these choices has no effect on the output but simply changes the format in which the power setting is displayed.

Phase Units

There are 3 choices of units in which Phase Angle may be displayed. They are ‘Degree’, ‘Power Factor, or ‘VAR Factor’. Changing the setting of phase units will cause the phase angle setting indicated in the Output Setting Display to change. If the phase angle is set to 0°, changing the units from ‘Degrees’ to ‘Power Factor’ will cause the Phase angle display to indicate 1.000PF. Changing any of these choices has no effect on the output but simply changes the way in which the phase angle setting is displayed.

When the Phase Units are set to either Power Factor or VAR Factor the + and – symbols indicate Leading and Lagging respectively.

Time Units

There are 2 choices of units in which time may be displayed. They are ‘Seconds’, or ‘Cycles’. Settings that rely on time settings include trigger settings and other event related functions. The conversion of a time setting from Seconds to Cycles depends on the fundamental output frequency. If the fundamental output frequency is set to 60Hz and the duration of an event is set to 50 Cycles the equivalent setting in units of seconds would be 833.333mSec.

The conversion from seconds to cycles is accomplished using the equation below.

$$Cycles = Seconds \times Frequency_{Fundamental}$$

The conversion from Cycles to Seconds is accomplished using the equation below.

$$Seconds = Cycles \times \left(\frac{1}{Frequency_{Fundamental}} \right)$$

Scale Factor Units

There are 2 choices of units in which the calibrator can indicate the scale factor of an energy meter.

- Watthours/Pulse
- Pulses/Watthour

The default setting for scale factor units is Watthours/Pulse.

Temperature Units

There are 2 choices of units in which the calibrator can indicate temperature.

- Degrees Celsius
- Degrees Fahrenheit.

Deviation Units

There are 4 choices of units in which the value indicated by the deviation meter may be displayed. They are ‘Percent’, ‘PPM’, ‘Difference’ or ‘Ratio’.

Percent
The deviation meter displays the percent difference between the present setting and the base setting.

PPM
The deviation meter displays the difference between the present setting and the base setting expressed as parts per million. This setting is useful when the deviation values are quite small.

Difference
The deviation meter displays the difference between the present setting and the base value using the units of the selected output parameter.

Ratio
The deviation meter displays the ratio of the present setting to the base setting.

Changing the deviation units has no effect on the output only changing the way in which the deviation meter result is displayed.

Keyboard Sound

Selecting this menu choice opens a selection box that allows the user to turn the keyboard sound ‘On’ or ‘Off’. When ‘On’ has been selected the calibrator keyboard will generate a chirp whenever a key is pressed. This feature provides audible feedback that a key has been pressed. Selecting ‘Off’ will disable this feature. The default setting is ‘On’

Operate Warning

Selecting this menu choice opens a selection box that allows the user to turn the Operate Warning ‘On’ or ‘Off’. When ‘On’ has been selected the calibrator keyboard will generate 5 loud beeps for one second after OPERATE has been pressed before the outputs are energized. This feature is only activated for voltage settings of greater than 30V. The overload warning does not occur when the operate command is issued over the IEEE-488 Interface. This feature provides an audible warning that potentially dangerous voltages are about to be present at the output terminals. Selecting ‘Off’ will disable this feature. The default setting is ‘On’

Beeper Volume

Selecting this menu choice opens a selection box that allows the user to set the volume of the internal beeper to ‘High’ or ‘Low’.

Energy Units

There are 2 choices of units in which the calibrator can report energy readings.

- Watt Hours
- Percent

Display

```
                 Display

Backlight Timeout     Brightness
Error Timeout         Deviation On/Zero
Menu Timeout
Text Color
Background Color
```

The Display menu provides functions relating to the configuration of the calibrator's front panel display.

Backlight Timeout

Selecting this menu choice opens a selection box that allows the user to select the time that display backlights remain lit.

The front panel display is an LCD Graphic Module that is lit from within by a CCFL backlight to provide excellent visibility in any ambient light. The CCFL light tube within the display has a specific life span and to maximize the MTBF of the tube the calibrator will turn it off after a period of inactivity.

When the backlight is off the display is not visible, the amber Display Standby Indicator will be lit to indicate that the calibrator is still powered up even though the display is off. Figure 2-2 illustrates the location of the Display Standby Indicator.

To activate the backlight again, press any key on the keyboard. The backlight time-out is entered in minutes. Entering 0 will disable the time-out and cause the backlights to be on continuously. The default setting is 240 minutes.

Error Timeout

If the calibrator detects an error condition an error message is indicated on the display panel. This error message will be displayed for a specific amount of time and will then be cleared. The Error Timeout is entered in seconds.

The Error Timeout may be set to 1-240 seconds and the default setting is 10 seconds.

Menu Timeout

Selecting this menu choice opens a selection box that allows the user to select the time period that inactive menus remain visible. If the menu system is entered, but no selections are made for some time, the calibrator will close the menus and revert to the standard status display. A value may be entered in the selection box that indicates the number of minutes that will pass before the display reverts to the standard display. If 0 minutes is selected the menus will remain displayed indefinitely. The default setting is 10 minutes.

Text Color

Selecting this menu choice opens a selection box that allows the user to select the color of the text printed on the front panel display. The colors Black, White, Red, Yellow, Green and Blue are listed. The last item in the list is 'Swap' The 'Swap' selection swaps the presently selected colors of the text and the background. The default setting is Black.

Background Color

Selecting this menu choice opens a selection box that allows the user to select the color of the background of the front panel display. The colors Black, White, Red, Yellow, Green and Blue are listed. The last item in the list is ‘Swap’. The ‘Swap’ selection swaps the presently selected colors of the text and the background. The default setting is White.

Brightness

Selecting this menu choice opens a selection box that allows the user to select the intensity of the front panel display backlight. Settings from 0% to 100% are allowed.

The default Brightness setting is 50%.

Deviation On/Zero

Selecting this menu item opens a selection box with several choices. The choices are ‘Off’, ‘Voltage’, ‘Current’, ‘Phase’ and ‘Power’. The default setting for the Deviation On/Zero function of the Model 8100 is ‘Off’.

Selecting any of these choices except ‘Off’ activates the deviation meter and configures it to measure the deviation of the selected output parameter from the initial setting. Selecting ‘Off’ deactivates the Deviation meter.

For example, if the voltage output is 100.000V and ‘Voltage’ is selected from the ‘Deviation On/Zero’ list, the deviation meter will be zeroed at 100.000V and will indicate a deviation of 0.00000%. If the voltage output setting is changed to 90.0000V the deviation meter will indicate -10.0%.

To reset the initial setting enter the new setting and select the ‘Deviation On/Zero’ menu item. When the Deviation meter is Active the function of the Soft-key to the right of the Deviation display is changed to ‘Dev Ref Set’. This key will set the deviation reference to the present setting of the selected output parameter.

The Deviation meter is displayed on the front panel LCD display when the menus are not active. The Meter replaces the Output status section of the display when it is activated. Refer to Figure 2-47 for an image of the LCD display with the Deviation meter displayed in the voltage mode with 100V set as the initial value.

The units of the deviation meter may be set to Percent, PPM, Ratio or in the units of the selected parameter. The deviation calculations for each Units setting are described in the following equations.

$$Percent = \left(\frac{Setting_{Initial} - Setting_{Present}}{Setting_{Initial}} \right) \times 100$$

$$PPM = \left(\frac{Setting_{Present} - Setting_{Initial}}{Setting_{Initial}} \right) \times 10^{6}$$

$$Ratio = \frac{Setting_{Present}}{Setting_{Initial}}$$

$$Difference = Setting_{Present} - Setting_{Initial}$$

The units of the Deviation Meter are selected using 'Deviation Units' Menu item of the Preferences menu.

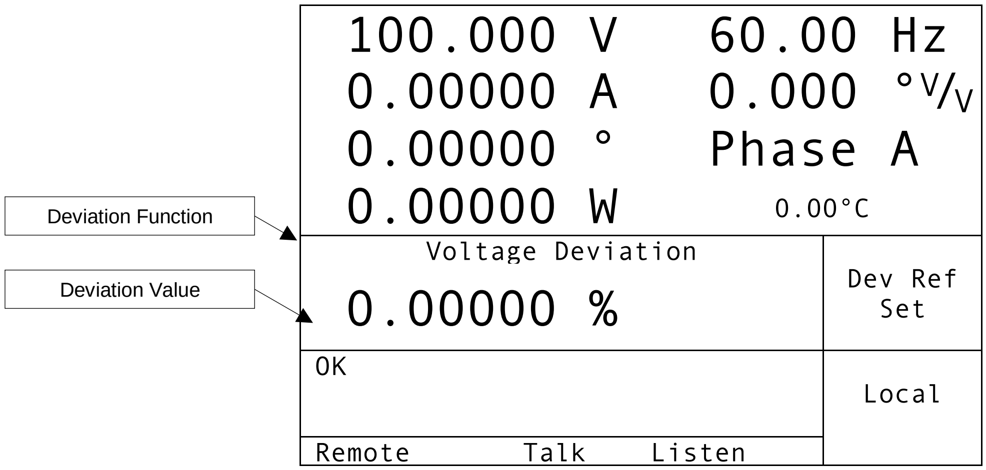


Figure 2-47
Deviation Meter Display

System Settings

```
               System Settings

Set Time 24h          Save Settings
Set date d/m/y        Recall Settings
Set Password          Calibration
GPIB Address          About
Power On Settings
```

The System Settings Menu provides functions relating to the basic setup of the calibrator.

Set Time 24h

Selecting this menu choice opens a selection box that allows the user to set the current system time of the calibrator. An internal real time clock controls the calibrator's system time. This clock maintains its settings regardless of whether or not the calibrator is connected to line power.

Set Date d/m/y

Selecting this menu choice opens a selection box that allows the user to set the current system Date of the calibrator. An internal real time clock controls the calibrator's system date. This clock maintains its settings regardless of whether or not the calibrator is connected to line power.

Set Password

Selecting this menu choice opens a selection box that allows the user to change the system password of the calibrator. The password is required to access any of the calibration functions of the calibrator. The password is numeric word up to 6 characters in length. If nothing is entered as the new password the password function will be disabled and no password will be required to enter the calibration mode. The default password is '8100'. If the password has been lost or forgotten, contact the factory for assistance.

GPIB Address

Selecting this menu choice opens a selection box that allows the user to change the GPIB Address of the calibrator. The address is a numeric entry with a value of between 0 and 30. The default address is 12.

Power On Settings

The Model 8100 can memorize up to four specific output setting configurations and store them in non-volatile memory. A configuration may be recalled at a later time to simplify setup time. The calibrator may be set to assume a user-defined configuration at power-up.

Selecting this menu choice opens a list box that allows the user to select which output setting configuration is applied on power up. The choices are Defaults, User 1, User 2, User 3 and User 4. The default setting is Defaults.

Save Settings

The Model 8100 can memorize up to four specific output-setting configurations and store them in non-volatile memory. A configuration may be recalled at a later time to simplify setup time. The calibrator may be set to assume a user-defined configuration at power-up.

Selecting this menu choice opens a list box that allows the user to select which of the four user defined memory positions will be used to save the present setting configuration. The choices are User 1, User 2, User 3 and User 4. The default setting is User 1.

All output-setting parameters are saved when Save Settings is selected. Table 2-2 summarizes the settings that are saved.

Output Settings	*Energy Output Mode*	*Current Events*
Voltage Setting	Gate Source	Event Type
Current Setting	Pulse Mode	Amplitude
Frequency Setting	Active Level	Duration
Voltage Phase	Terminals	Flicker Mode
Current Phase		Flicker Period
	Voltage Distortion	Start Ramp Time
Calibrator	Function	Exit Ramp Time
Output Terminals	Amplitude	Repeat Mode
Voltage Sense	Harmonic	Repeat Delay
Overload Delay	Fluctuate Mode	
Reactive Mode	Fluctuate Period	*Trigger Setup*
Deviation On/Zero	Frequency	Auto Start
Phase Setup	Phase	Energy Delay
		Voltage Event
Delivered Energy	*Voltage Events*	Current Event
Mode	Event Type	
Energy Setting	Amplitude	*Preferences*
Time Setting	Duration	Power Units
Warm-up Time	Flicker Mode	Phase Units
	Flicker Period	Time Units
Front Counter	Start Ramp Time	Scale Factor Units
Counter Mode	Exit Ramp Time	Temperature Units
Scale Factor	Repeat Mode	Deviation Units
Energy Setting	Repeat Delay	Keyboard Sound
Counts Setting		Operate Warning
Time Setting	*Current Distortion*	Beeper Volume
Input Edge	Function	
Input Pull-up	Amplitude	*Display*
	Harmonic	Backlight Timeout
Rear Counter	Fluctuate Mode	Error Timeout
Counter Mode	Fluctuate Period	Menu Timeout
Scale Factor	Frequency	Text Color
Energy Setting	Phase	Background Color
Counts Setting		Brightness
Time Setting		
Input Edge		
Input Pull-up		

Table 2-2
Save Setting Functions

The default setting for each of the output-setting parameters is listed in Table 2-3.

Function	Setting
Output Settings	
Voltage Setting	0.00000 V
Current Setting	0.00000 A
Frequency Setting	60.00 Hz
Voltage Phase	0.000 °
Current Phase	0.00000 °
Calibrator	
Output Terminals	Front
Voltage Sense	Internal
Overload Delay	0 Sec
Reactive Mode	Off
Deviation On/Zero	Off
Phase Setup	A
Delivered Energy	
Mode	Off
Energy Setting	0.00000 Whr
Time Setting	10.0000 Se
Warm-up Time	0.000 Sec
Front Counter	
Counter Mode	Off
Scale Factor	1.00000 Whr/ct
Energy Setting	1.00000 Whr
Counts Setting	1 ct
Time Setting	0.00000 Sec
Input Edge	Positive
Input Pull-up	33 k
Rear Counter	
Counter Mode	Off
Scale Factor	1.00000 Whr/ct
Energy Setting	1.00000 Whr
Counts Setting	1 ct
Time Setting	0.00000 Sec
Input Edge	Positive
Input Pull-up	33 k
Counter Mode	Off
Energy Output Mode	
Gate Source	Off
Pulse Mode	Off
Active Level	High
Terminals	Front
Voltage Distortion	
Function	Off
Amplitude	0.000 %
Harmonic	2
Fluctuate Mode	Off
Fluctuate Period	2.0000 Cycles
Frequency	120 Hz
Phase	0 °

Function	Setting
Voltage Events	
Event Type	Off
Amplitude	0.000 %
Duration	1.0000 Sec
Flicker Mode	Off
Flicker Period	2.0000 Cycles
Start Ramp Time	0.0000 Sec
Exit Ramp Time	0.0000 Sec
Repeat Mode	Off
Repeat Delay	0.0000 Sec
Current Distortion	
Function	Off
Amplitude	0.000 %
Harmonic	2
Fluctuate Mode	Off
Fluctuate Period	2.0000 Cycles
Frequency	120 Hz
Phase	0 °
Current Events	
Event Type	Off
Amplitude	0.000 %
Duration	1.0000 Sec
Flicker Mode	Off
Flicker Period	2.0000 Cycles
Start Ramp Time	0.0000 Sec
Exit Ramp Time	0.0000 Sec
Repeat Mode	Off
Repeat Delay	0.0000 Sec
Trigger Setup	
Auto Start	Off
Energy Delay	0.00 Sec
Voltage Event	0.00 Sec
Current Event	0.00 Sec
Preferences	
Power Units	W
Phase Units	Degrees
Time Units	Seconds
Scale Factor Units	Whr / pulse
Temperature Units	C
Deviation Units	Percent
Keyboard Sound	On
Operate Warning	On
Beeper Volume	Low
Display	
Backlight Timeout	240 Min
Error Timeout	10 Sec
Menu Timeout	10 Min
Text Color	Black
Background Color	White
Brightness	50 %

Table 2-3
Save Setting Function Default Values

Recall Settings

The Recall Settings function will allow the user to select any one of the four user defined setting configurations or the default settings. When the desired configuration is selected all settings stored for that configuration are applied immediately.

Calibration

```
                Calibration

Mode                     Energy Cal
Voltage Setting          Frequency Cal
Current Setting          Line Phase Cal
Frequency Setting        Cal Temp C
Save Calibration         Cal Due d/m/y
```

Selecting this menu choice opens a menu that includes all functions required to adjust the calibration of the calibrator.

Before allowing access to the calibration menu, the calibrator will prompt the user for the system password. The default password is '8100' and the 'Change Password' menu choice of the 'System Setup' menu should be used to change the password to something more secure. If a password of nothing has been selected the calibrator will not request a password entry when selecting this menu choice. It is highly recommended that a secure password be used to prevent accidental or unauthorized adjustment of the calibrator.

Mode

Selecting this menu choice opens a selection box that allows the user to select which function of the calibrator is to be adjusted. When a function has been selected, the function name is included in the title of the menu. The choices are as follows.

- Off
- Voltage
- Current
- Voltage Phase
- Current Phase

Off
Deactivates the calibration mode and is the standard mode.

Voltage
Configures the calibrator to be adjusted in voltage amplitude.

Current
Configures the calibrator to be adjusted in current amplitude.

Voltage Phase
Configures the calibrator voltage ranges to be adjusted in voltage phase.

Current Phase
Configures the calibrator current ranges to be adjusted in current phase.

To perform a complete calibration on the calibrator each of the functions Voltage, Current, Voltage Phase and Current Phase must be adjusted. When performing the adjustment, use the remaining menu choices of the calibration menu to move through the process. The calibration procedure is described in detail in Chapter 4.

Voltage Setting Selecting this menu choice opens a list of voltage amplitude adjustment points. Selecting a voltage amplitude adjustment point will change the voltage setting the adjusted value for that cal point. If the calibration has been erased the voltage setting will be exactly the same as the adjustment point selected from the list. If no changes are made to the voltage setting for a certain point, another voltage amplitude adjustment may be selected without affecting the calibration of the present point. Voltage amplitude adjustment points may be selected in any order.

Current Setting Selecting this menu choice opens a list of current amplitude adjustment points. Selecting a current amplitude adjustment point will change the current setting the adjusted value for that cal point. If the calibration has been erased the current setting will be exactly the same as the adjustment point selected from the list. If no changes are made to the current setting for a certain point, another current amplitude adjustment may be selected without affecting the calibration of the present point. Current amplitude adjustment points may be selected in any order.

Frequency Setting Selecting this menu choice opens a list of frequency adjustment points. Selecting a frequency adjustment point will change the frequency setting at which that voltage or current adjustment is being made. No adjustments are made to the frequency setting and all voltage and current adjustments may be performed at all frequency settings in any order.

Save Calibration Selecting this menu choice causes the calibrator to save all calibration adjustments that have been made since entering the calibration mode for a certain function. All adjustments may be made to a certain function before the Save Calibration menu choice is selected. If the calibration mode is exited before selecting Save Calibration, all new adjustments will be lost and the previous calibration will remain in effect.

Energy Cal Selecting this menu choice allows the user to adjust the internal time base used in all energy testing. The default calibration value for the energy time base is 32,768.0Hz. With a counter connected the digital IO connector the energy time base is measured and the measured value is entered in the place of the default time base. The entered value should be very near the default value.

Frequency Cal Selecting this menu choice allows the user to adjust the frequency of the voltage and current outputs. The default calibration value will be the frequency of the presently set output frequency. This single adjustment sets the frequency setting for all output frequencies. The measured actual frequency value is entered. The entered value should be very near the default value.

Line Phase Cal

Selecting this menu choice allows the user to adjust the Multiphase synchronization of the Model 8100. This adjustment is factory set it should not require further adjustment.

Cal Temp C

The Cal Temp C function stores the internal temperature of the calibrator at the time of calibration. The front panel temperature display indicates the difference of the present internal temperature from the stored calibration temperature.

Selecting the Cal Temp C menu item will open a numeric entry box where the user may enter the internal temperature of the Model 8100 at the time of Calibration. When this box opens, the previously stored calibration temperature is displayed. Entering 0 will cause the front panel temperature to display the present internal temperature of the meter. Select the Temperature menu item again and enter the temperature indicated on the front panel display. The front panel temperature display will now read ‘0.0°C’.

Cal Due d/m/y

The Calibration Due Date menu item allows the user to store the scheduled date of the next calibration of the calibrator. The Model 8100 uses this date to remind the user when the calibration interval has been exceeded by generating the ‘Calibration Recommended’ error message.

Selecting this menu item opens a numeric entry box that allows the user to change the calibration due date of the calibrator. The address is a date entry with a format of ‘dd/mm/yyyy’.

The default calibration due date is ‘00/00/0000’.

About

```
                About…

Serial Num: 0000     Cal Date: 01Jan00
Revision: 1.00.1     Cal Due : 01Jan01
DSP     : 1.00
Hours On: 1
Resets  : 1
```

Selecting this menu choice will display the ‘About…’ screen in the Main Display. The about screen provides specific information about this calibrator.

Each entry of the ‘About…’ screen is described below.

Serial Num.
This field indicates the serial number of the calibrator.

Revision.
This field indicates the firmware revision of the Controller Board installed in the calibrator.

DSP.
This field indicates the firmware revision of the DSP Board installed in the calibrator.

Hours On.
This field indicates the number of hours that the calibrator has been powered up.

Resets.
This field indicates the number of times the calibrator has been reset with a power cycle. The front panel reset menu command does not increment this counter.

Cal Date
This field indicates the date of the last calibration of the calibrator.

Cal Due
This field indicates the date of the next calibration of the calibrator.

U.S.I.T. Energy Meter Calibration Software

The U.S.I.T. Energy Meter Test Software automates the testing and verification of energy meters using the Model 8100. Test results are recorded in a database and the software has the capability to generate a report of calibration that meets the requirements of ISO 9000.

The U.S.I.T. software will control the Model 8100 via the IEEE-488 interface. All measurements are made using the Model 8100's built in pulse counters or the pulse counters of the Model 8120 counter comparator. All configuration and control of the Model 8100 is performed by the U.S.I.T. software and once a test is started there is no operator intervention required.

The U.S.I.T. software uses a single database file to store the test procedures and test results. A report generator will format and print reports of calibration to a preview window or to a printer.

Figure 2-48 illustrates how the different components of the U.S.I.T. program interact.

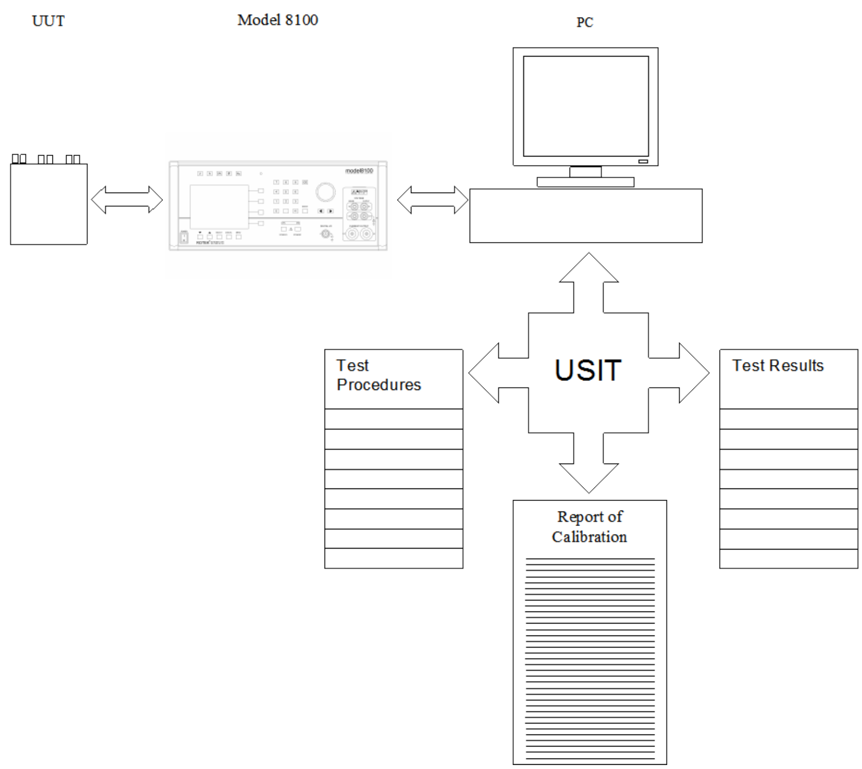


Figure 2-48
U.S.I.T. Block Diagram

Software Installation

The U.S.I.T. software has the following installation requirements.

- Microsoft Windows 95, Windows 98 or Windows ME.
- Minimum RAM: 32MB
- Recommended RAM: 128MB
- Minimum Hard Drive Space required: 50MB

If your computer system does not meet these requirements, the program may not run properly.

To install the U.S.I.T. program insert the CD or 3.5” Floppy disk 1 of the setup disks and follow the procedure below.

- Choose Run from the Start Menu.
- Enter n:\Setup in the Run Dialog box where n is the letter of the drive containing the U.S.I.T. setup disk.
- Click OK or press enter.

Follow the instructions of the setup program to complete the installation.

Hardware Installation

The U.S.I.T. software requires that a IEEE-488 interface be installed in the computer that will be controlling the Model 8100. U.S.I.T. may be installed on a computer that does not have an IEEE-488 controller installed and test procedures may be created and test reports generated. The IEEE-488 is required only to run a test procedure using the Model 8100.

The U.S.I.T. software works with IEEE-488 controllers manufactured by Capital Equipment Corporation or National Instruments. Consult the Factory to determine the most appropriate interface for a specific application.

Follow the installation and configuration instructions provided by the IEEE-488 controller manufacturer.

Starting U.S.I.T. For The First Time

When U.S.I.T. is started for the first time the U.S.I.T. Main Screen will open as shown in Figure 2-49. When U.S.I.T. normally starts it automatically opens the most recent database used. Since the first time the program is started there has been no previous database, one must be either opened or a new database created.

To create a new database select the 'New Database' menu item from the File Menu and a new U.S.I.T. database will be created. If a U.S.I.T. database has already been created but has been moved to another location select the 'Open Database' menu item from the File Menu and browse for the database. The program is now ready to create a test procedure. The status bar located at the bottom of the Main window has two panes. The left pane will display the path and file name of the database that is presently in use. The right pane will show the name of the test procedure presently in use.

Figure 2-49
U.S.I.T. Main Window

Options Window

There are a few items that must be configured before the program may be used. First select 'Options' from the 'File' menu. The Options Window will appear. This window has 4 tabs; Traceability, GPIB and Procedure Reports and Test Reports. When the window first opens, the Traceability tab is selected as is shown in Figure 2-50.

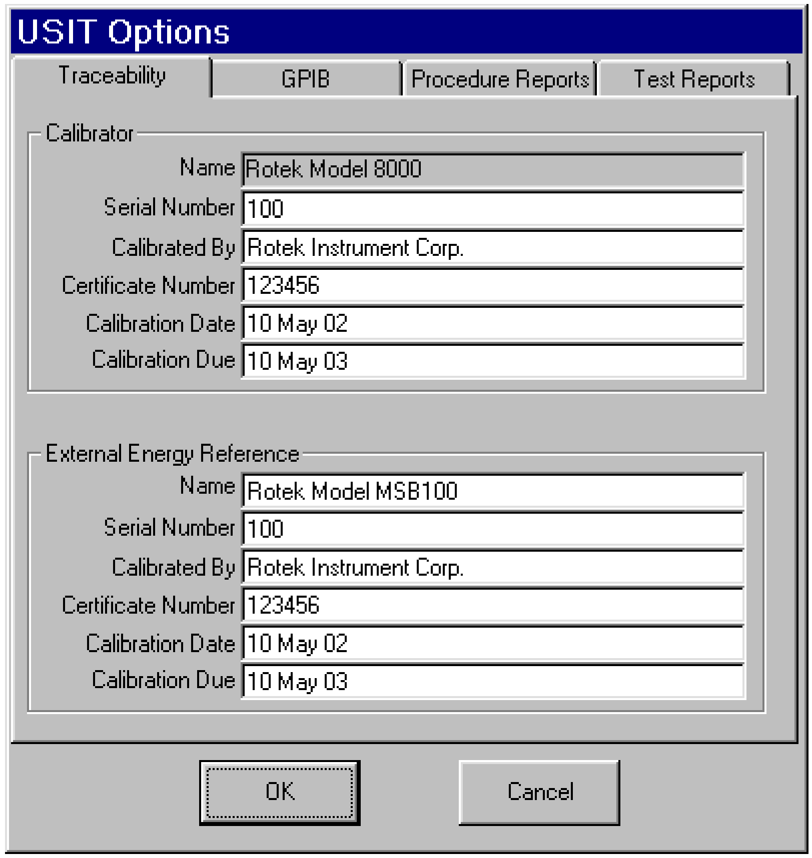


Figure 2-50
U.S.I.T. Options Window - Traceability

The screen allows the traceability information for the calibrator and the external energy reference to be entered. This information is required for the test report since it defines which equipment was used to perform the test, when it was calibrated and when the calibration is due. This information may be found on the Certificate of Calibration provided by Rotek with Model 8100.

When the program runs a test procedure it checks to see that the calibrator being used has the same serial number as the unit for which calibration traceability is available. If the Model 8100 is a different unit the program will stop and not allow the test to continue. This feature will prevent unapproved calibrators from being used in the calibration of units under test (UUT).

Also, when the program runs a test procedure it checks to see that the calibration due date of the Model 8100 being used is not overdue. If the calibration due date is past the program will stop and not allow the test to continue. This feature will prevent the calibration of UUTs with test equipment that is out of calibration.

The second tab provides information on the GPIB (IEEE-488) configuration of the U.S.I.T. program. Clicking on this tab changes the Options window to show the information in Figure 2-51.

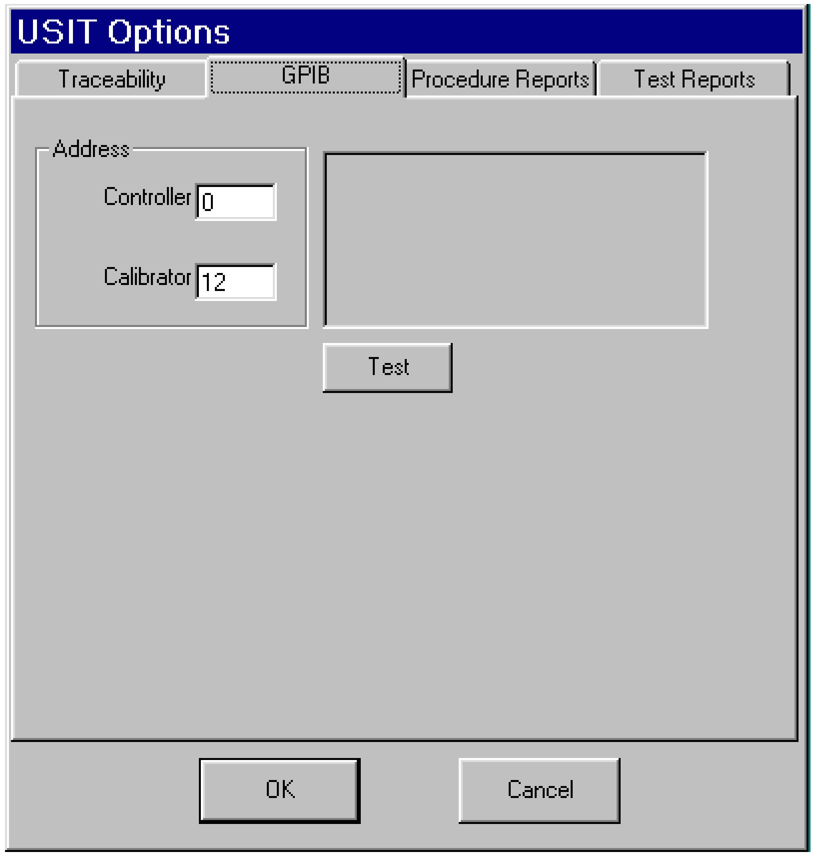


Figure 2-51
U.S.I.T. Options Window - GPIB

This screen allows the GPIB Address for the controller and the Model 8100 to be set. Typically the GPIB controller address will be set to 0. The default address for the Model 8100 is 12. This is the address that the unit is set to when it was shipped new. If the Model 8100's GPIB address has been changed, the correct address should be entered here.

GPIB addresses must be a number between 0 and 30. The Controller and the Model 8100 must be set to different addresses. The program will not allow invalid addresses.

Once the Controller and Calibrator addresses have been set, the communications with the Model 8100 may be tested. To perform the test the GPIB interface must be properly installed in the computer, the Calibrator must be connected to the computer via the GPIB interconnect cable, and the Model 8100 must be powered on.

The test is initiated by clicking the 'Test' button. The Model 8100 will reset and the results of the test will be displayed in the field above the test button. The most common reasons for a failed test are the following.

- GPIB interface not properly installed.
- Faulty GPIB interconnect cable.
- Model 8100 is not powered on.
- Model 8100 is set to the incorrect address.
- Another instrument is connected to the computer with the same address as the Controller or the Model 8100

If none of the above problems can be resolved, contact the factory for trouble shooting suggestions.

The third options tab is the Procedure Reports tab. When the tab is selected the Option window will change as in Figure 2-52. This tab allows the selection of the location of the Test Procedure report format files. The format files determine the style and layout of the test Procedure reports. These reports may me edited or replaced with user-defined reports. The location of the desired report is selected in this window. The test reports formats are defined in Crystal Reports version 8.0 format.

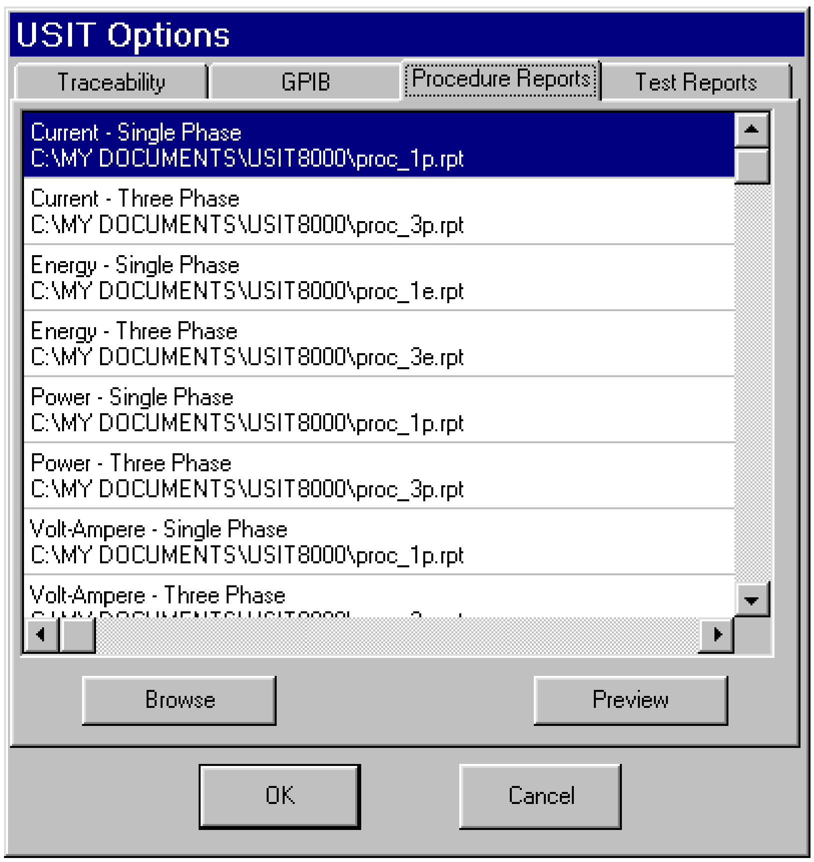


Figure 2-52
U.S.I.T. Options Window - Procedure Report Format Location

The fourth options tab is the Test Reports tab. When the tab is selected the Option window will change as in Figure 2-53. This tab allows the selection of the location of the Test Reports format files. The format files determine the style and layout of the Test Reports. These reports may be edited or replaced with user-defined reports. The location of the desired report is selected in this window. The test report format is defined using Crystal Reports version 8.0.

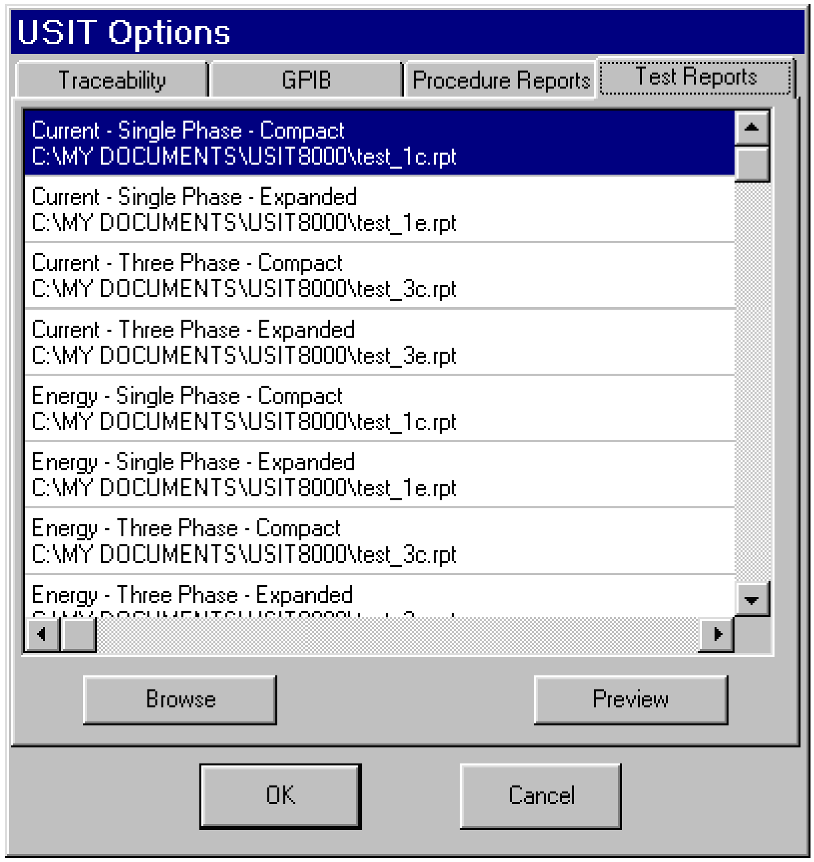


Figure 2-53
U.S.I.T. Options Window - Test Report Format Location

Creating a Test Procedure

To create a test procedure, select 'New Procedure' from the File menu. This will open the New Procedure window as shown in Figure 2-54.

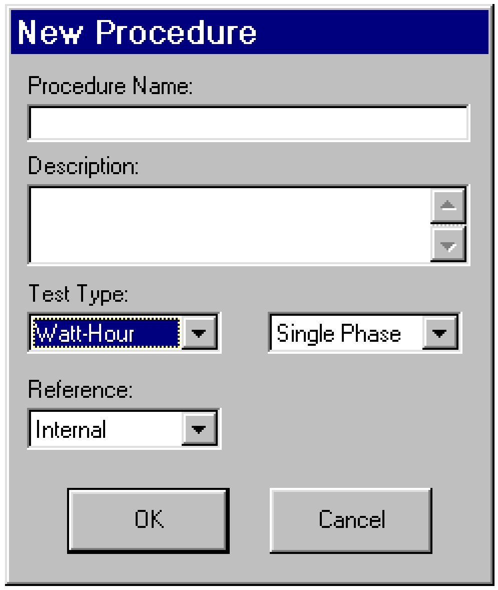


Figure 2-54
U.S.I.T. New Procedure Window

First, the procedure must be named. Enter the name in the Procedure name Text box. The name may included spaces but must not exceed 30 characters long. The program will automatically truncate any characters entered beyond 30.

If the selected name has already been used for another procedure the program will indicate that the procedure name is already in use.

The name should include some description of the function of this test to help identify it in the future. The description field may be used to include additional information about this test and it's intended use. The maximum number of characters for the description field is 256.

The test type should be selected as 'Watt-Hour' using the drop down list. This version of the program only supports energy meter testing.

Single phase or three phase testing must be selected. If the test is defined as a three-phase test the Model 8100 must have the option 8100-3P installed. Otherwise, the test should be defined as a single-phase test.

The reference for the test may be selected as either 'Internal' or 'External'. If internal is selected the UUT will be compared to the internal energy reference of the Model 8100. If 'External' is selected the UUT will be compared against an external energy reference standard. This standard must be connected to channel 1 of the Model 8100 pulse counter. The Rotek Model MSB100 is the recommended external energy standard though any energy standard may be used.

Once the test has been named and configured click ok to create the test.

The New Procedure window will close and the main window will become a procedure edit window as shown in Figure 2-55.

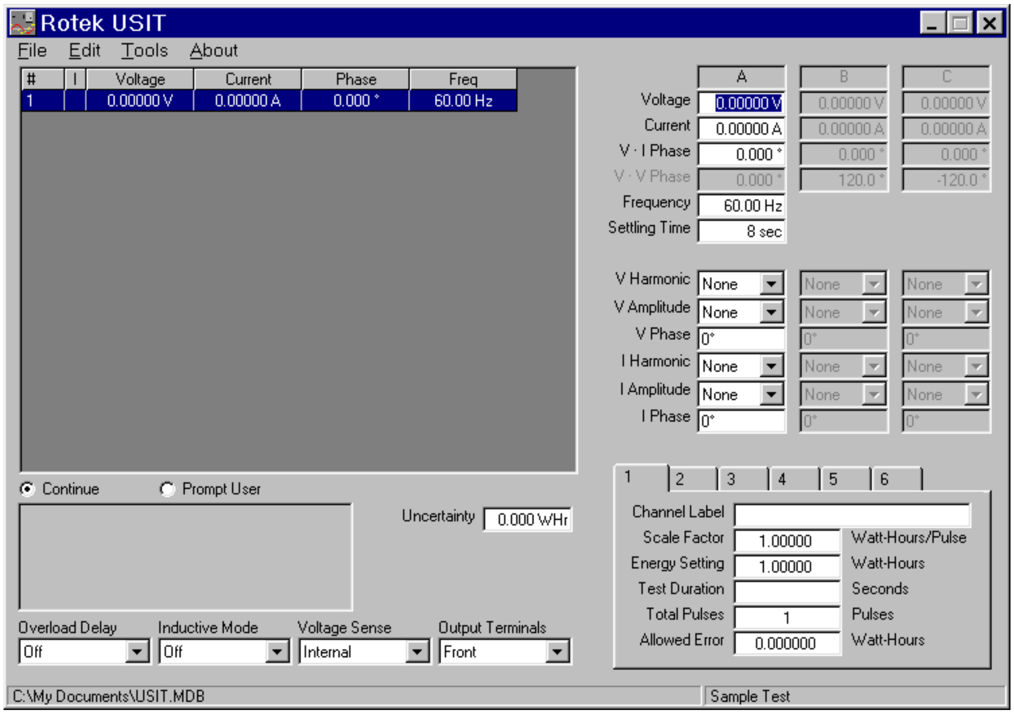


Figure 2-55
U.S.I.T. Procedure Edit Window

The Procedure Edit window is the central window defining a test procedure. When a new test is created a single test is included because all procedures must have at least one test. The settings for this default test are 0V, 0A, 0° and 60Hz.

The detailed test settings that define each test are edited and viewed using the other fields of the procedure edit window. These fields allow the user to modify settings for the output setting, energy settings, harmonic settings, output configuration and user prompts. Clicking on a test in the procedure list cause the detailed test settings for that test to be displayed in the Procedure Edit Window.

Test List

The central feature of the Procedure Edit window is the large list box on the left side. Figure 2-57 shows the Test List. This list box will list of all the tests to be performed by this procedure. If there are more tests than can fit in the list a scroll bar will appear on the right side of the list box.

The Test List gives a summary of the output settings of each test including Test Number, voltage setting, current setting, current to voltage phase angle setting and frequency. In addition, the column labeled ‘I’ indicates whether that test has an operator instruction associated with it. When the test is running execution will pause at this point while the operator configures the UUT.

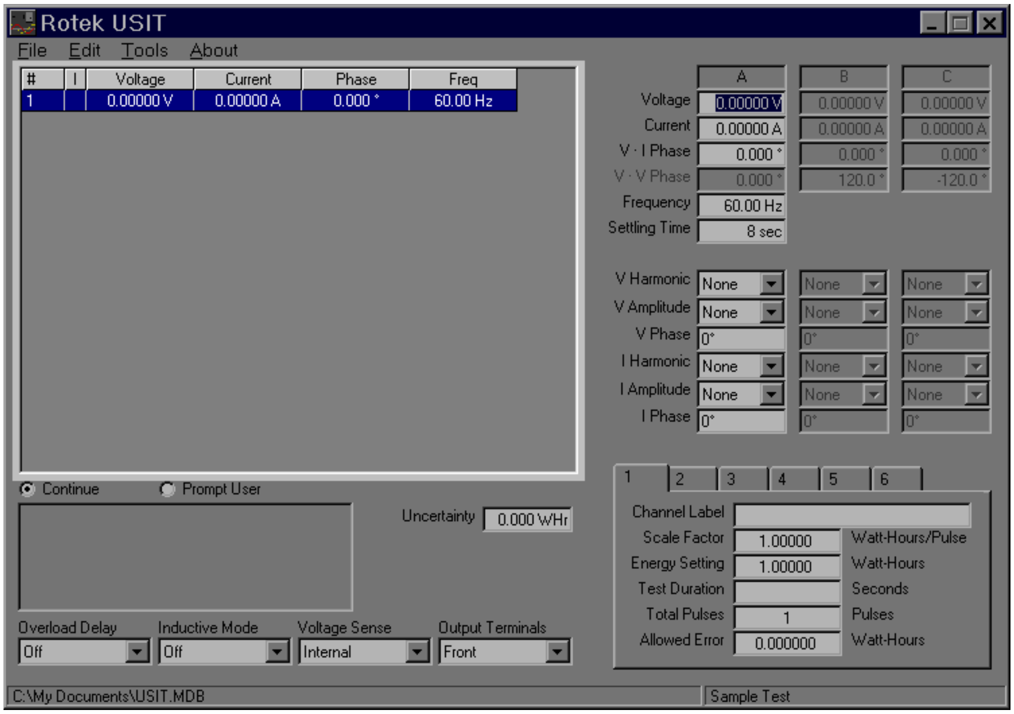


Figure 2-56
U.S.I.T. Test List

Output Setting

The Output Setting controls are shown in Figure 2-57.

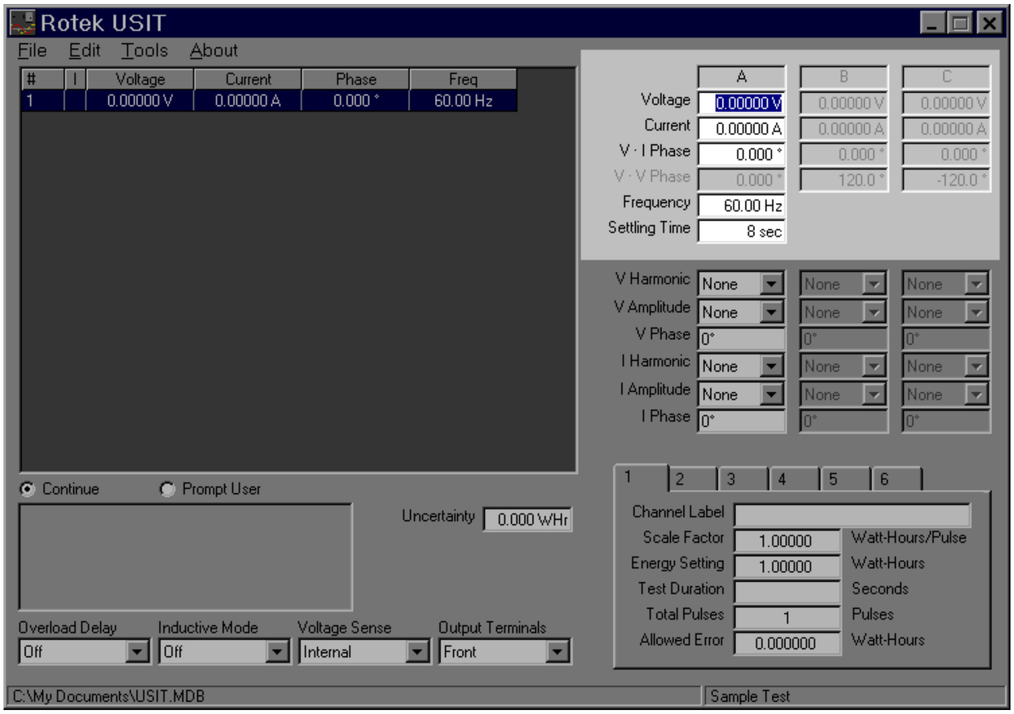


Figure 2-57
U.S.I.T. Output Setting Controls

The Output Setting controls allow the basic output setting for this test to be viewed or edited. All settings are dependant on the ranges of operation of the Model 8100. Voltage settings may be between 1 and 1056V. Current settings may be between 1mA and 355A depending on the current options installed in the Model 8100. The V·I Phase setting is the phase angle between the voltage and current outputs. It may be set to ±180°. The V·V Phase Setting is the Line-to-Line Phase angle between the Voltages of each phase of a three phase Model 8100. Phase A is always set to 0° while Phases B and C may be set to ±180°. The default settings are +120° for Phase B and –120° for Phase C. These fields are disabled for a single-phase test. Also, the Phase B and C output setting fields for Voltage, Current and V·I Phase are disabled for single-phase tests. The frequency may be set from 25Hz to 1kHz and this setting is applied to all phases globally.

When editing a single-phase test the controls for phase B and phase C are disabled. The frequency setting applies to all phases. Clicking on the ‘Balance Channels’ menu item of the Tools menu will cause the phase A settings to be copied into Phase B and C.

The Settling Time is entered in seconds and must be between 1 second and 30 seconds. When this test is run the calibrator will energize the outputs but the U.S.I.T. program will wait for the period defined in the settling time field before continuing with the test. This gives the UUT time to warm up and stabilize its output. The longer the settling time the more repeatable the results of the test will be. The default settling time is 8 seconds.

The allowed Error is enabled for all tests except energy tests. Energy tests have an allowed error setting for each channel of the pulse counter.

Harmonic Setting

The Harmonic Setting Controls are shown in Figure 2-58.

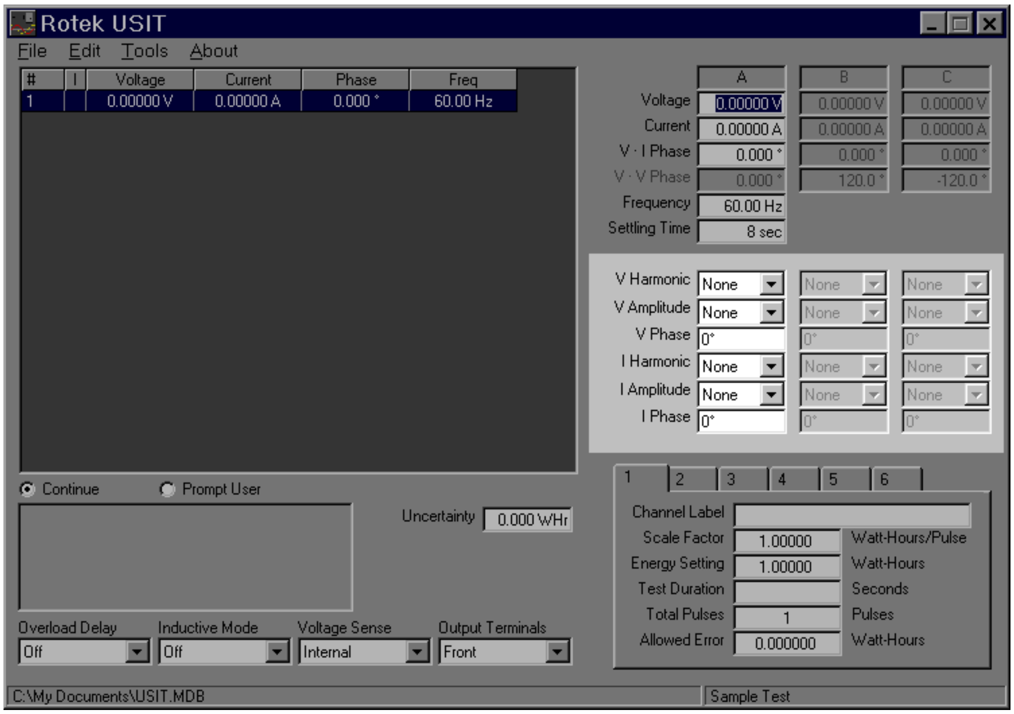


Figure 2-58
U.S.I.T. Harmonic Setting Controls

The harmonic content of the voltage and current outputs may be set independently. The default is none. Harmonics from the 1st to the 100th may be selected. The amplitude of each harmonic is set as a percentage of the fundamental, from 1% to a maximum of 25%. Also, the phase angle of the harmonic relative to the fundamental may be set to any angle between ±180°.

For single phase tests the Phase B and C Harmonic settings are disabled.

Waveform Window

An image of the resulting voltage and current waveforms may be viewed using the Waveform window. Selecting ‘View Waveform’ from the ‘Tools’ menu opens this window. The Waveform window is shown in Figure 2-59.

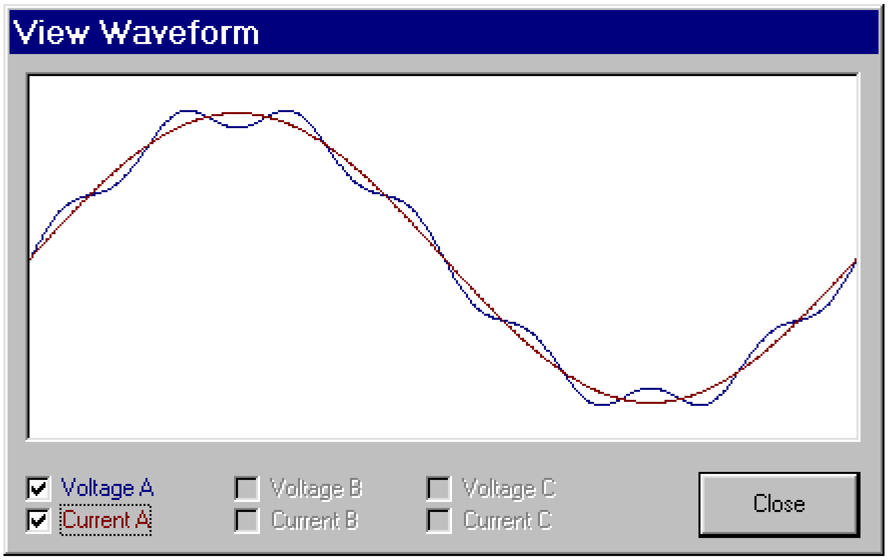


Figure 2-59
U.S.I.T. Waveform Window

The window shown above indicates a current output with no harmonic added but a voltage waveform with 10% of the 7th harmonic added with a phase angle of 0° to the fundamental. Check boxes allow the voltage and current waveforms to be viewed individually or simultaneously. In a three phase test the phase A, B and C check boxes are activated and may be used to view the waveform on each phase.

Energy Settings

The Energy Setting Controls are shown in Figure 2-60.

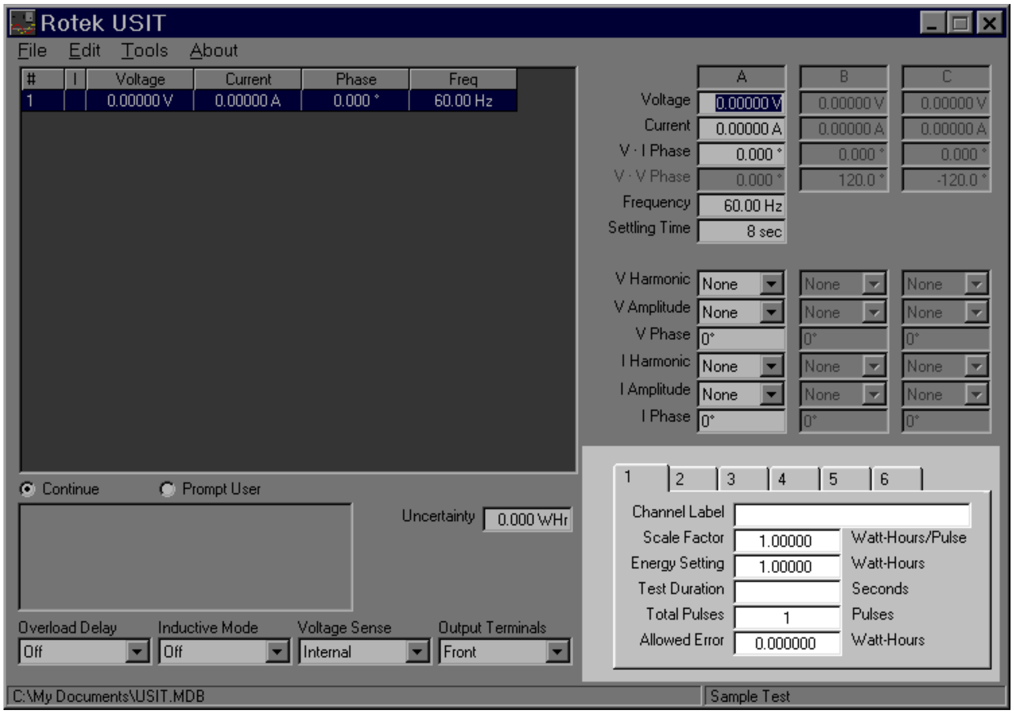


Figure 2-60
U.S.I.T. Energy Setting Controls

The energy setting controls allow energy settings to be entered for each channel of the Model 8100 pulse counter. There are 6 tabs one for each channel. The user has the ability to specify which channels are going to be active when the test is run.

Each channel represents an individual UUT and may be configured differently depending on the characteristics of each UUT.

The first field is the Channel label field. This allows the user to enter a unique description of the type of UUT connected to this channel. The maximum length of this label is 30 characters. This label is printed on the test report as well to help identify the UUT.

The second field is the Scale Factor field. This setting has units of Watt-Hours/Pulse and defines how many watt-hours are represented by one pulse output from the UUT. This setting is often referred to as the K_h of the meter. Some UUT's have a constant scale factor for any input setting and with these meters the scale factor will be the same value for every test. Other meters have different scale factors depending on the input range. With these meters, the scale factor may change depending on the specific voltage and current being applied. A typical modern energy standard will have a single scale factor for any voltage and current input and this scale factor will be typically 10µWHr/Pulse.

The third field is the Energy Setting field. The amount of energy to be delivered to the UUT is defined with this field. The units are watt-hours. This setting is dependant on the value entered in the scale factor field. The Model 8100 can only run an energy test over a period defined by an integral number of pulses. If the pulse rate of the UUT is relatively slow, then only energy settings that result in an integral number of pulses will be accepted. If an energy setting is entered that cannot be represented by an integral number of pulses the U.S.I.T. program will select the closest value for the energy setting that will.

The next 2 fields may not be edited directly and indicate the duration of the test in seconds and the number of pulses to be counted during the test. These values are computed based on the scale factor and energy setting defined for this test. If the duration of the test of the number of pulses counted during the test are more important parameters than the actual number of watt-hours measured, the Energy Setting Option window may be used to compute the energy setting required to give a specific test time or number of pulses.

Entering a value for Watt-Hours, Seconds or Pulses will cause the U.S.I.T. program to recalculate the corresponding values of the remaining 2 fields. If the test duration should be 10 seconds, then the program will calculate the energy setting that would be required to achieve this. The resulting number of pulses will also be computed.

Selecting the ‘Change All Energy Settings’ menu item from the Tools menu will cause the energy settings in all tests included in this procedure to have the same settings as this test. Select ‘Constant Watt-Hours’, ‘Constant Time’ or ‘Constant Pulses’ to indicate which parameter should be constant throughout the tests in this procedure. In this way all tests can easily be defined to have a duration of 10 seconds and the program will calculate the energy setting that is required for each test. All tests could also be set to test 10WHr and the test duration will vary with each test depending on the specific voltage and current applied to the UUT.

The final field of the Energy Settings window is the allowed error field. This field is used to define the Pass/Fail criteria for each test. Each channel may have a different allowed error because several different types of energy meter may be tested at the same time. Channel 1 may have a meter with an accuracy specification of 0.025% while channel 2 may have a meter with an accuracy specification of only 0.2%.

The allowed error is entered in units of watt-hours. The U.S.I.T. program includes an Error Calculator to help determine the allowed error in units of watt-hours when the unit is specified as a percentage of setting, range or some combination of the two.

Limit Calculator

Selecting 'Calculate Limits' from the 'Tools' menu opens the Limit Calculator window shown in Figure 2-61.

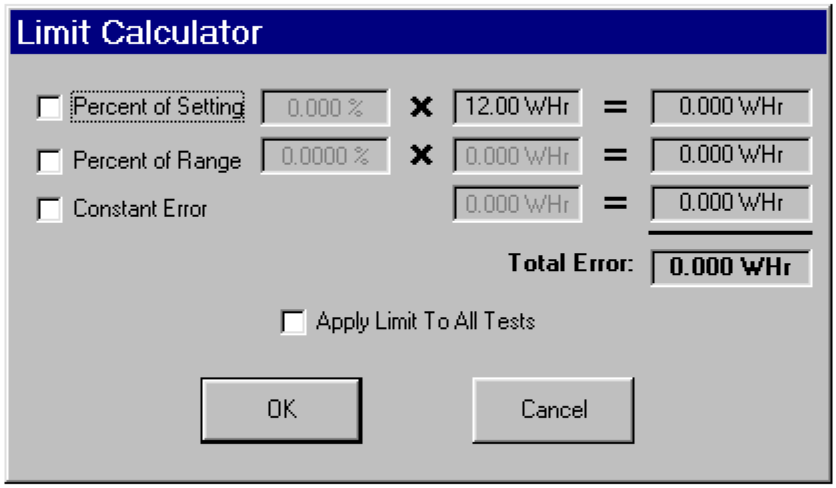


Figure 2-61
U.S.I.T. Limit Calculator Window

When this window is opened, the energy setting entered for this test is already entered in the appropriate field.

The total error is computed by selecting the specific terms used by the UUT's manufacturer to specify the accuracy of the meter. Often meters accuracy is specified in terms of percent of setting plus either a percent of range term or a constant error. If, for example, a UUT is specified as having an accuracy of 0.2% of setting plus 0.02% of range the Percent of setting line and the percent of range line would be checked. The percent of setting would be set to 0.2% and the percent of range would be set to 0.02%. The value of the range will also be required. When this information is entered the program will calculate the total allowed error for this test.

Click 'OK' to close this window and enter this allowed error in the allowed error field of the Energy Settings window.

These limits may be applied to all tests in the procedure globally by checking the 'Apply Limits to all tests' check box. When 'OK' is clicked, the allowed error is recalculated for every test in the procedure.

User Prompt

The User Prompt controls are shown in Figure 2-62.

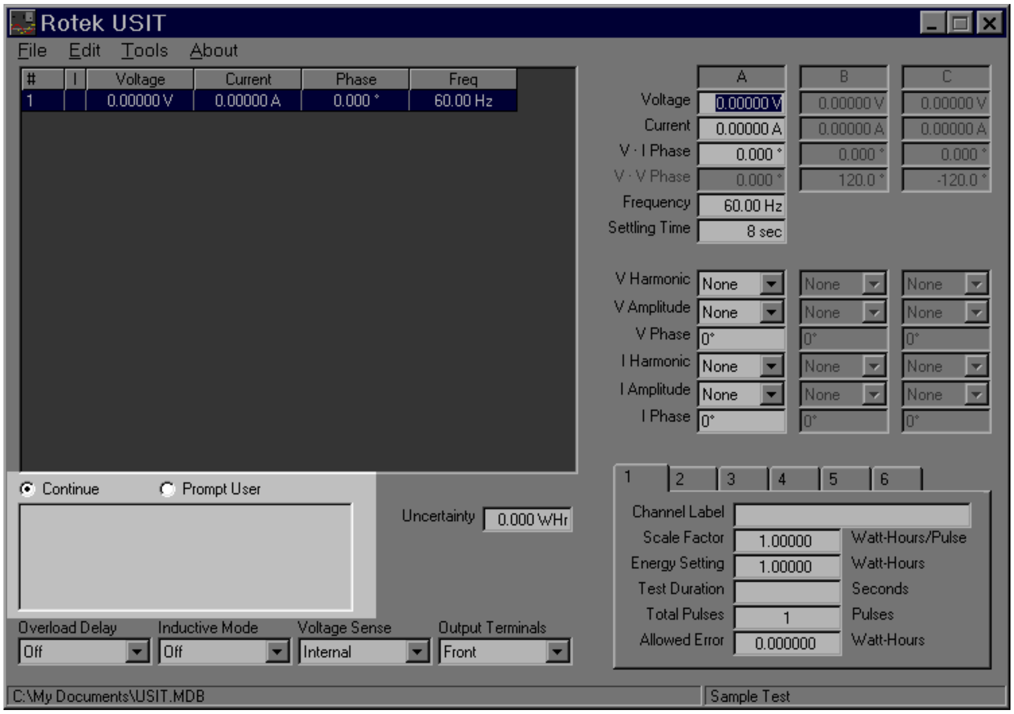


Figure 2-62
U.S.I.T. User Prompt Controls

When a test is run the operator may require specific instructions regarding the wiring of the UUT or other configuration changes. When the User Prompt controls indicates ‘Continue’ the program will not pause but instead will continue from one test to the next without stopping. It may be required that higher currents are connected to different current input terminals of the UUT. When the higher current is reach a user prompt may be generated to pause the execution of the test procedure while the operator follows the instructions indicated by the prompt. When the operator indicates that the changes have been made, the execution of the test procedure will continue.

Often a single prompt is provided at the beginning of a test to ensure that the test setup is correct and then the procedure may run uninterrupted for all the remaining tests.

When a test has a user prompt associated with it, a **|||** symbol will appear in the ‘I’ column of the test procedure list.

Configure Output

The Configure Output controls are shown in Figure 2-63.

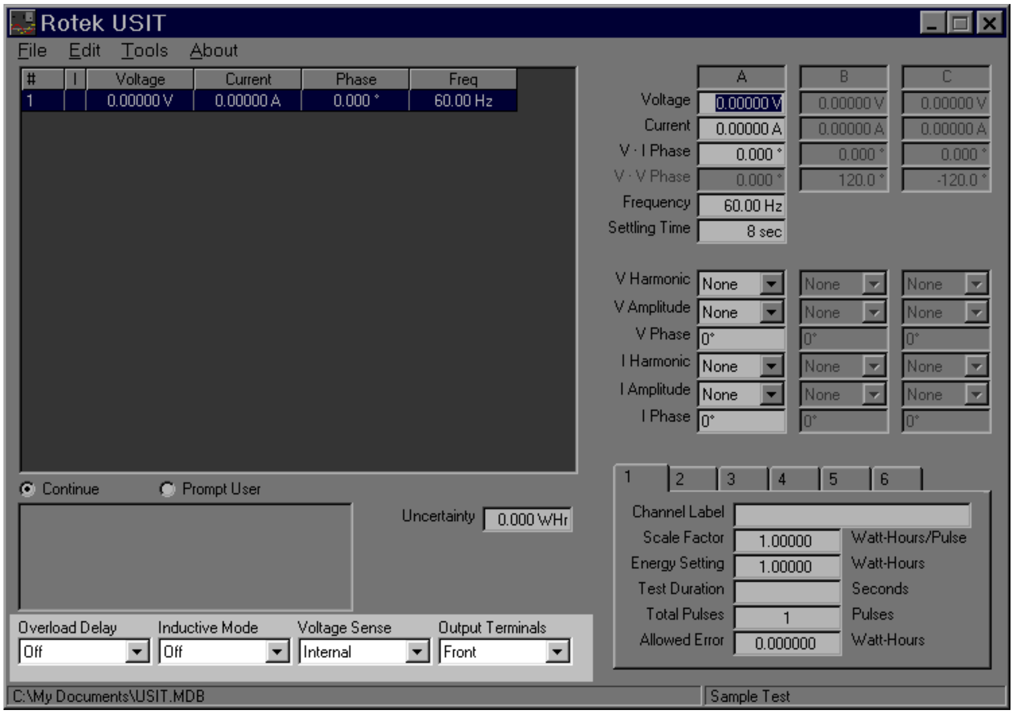


Figure 2-63
U.S.I.T. Configure Output Controls

The configure output controls provide the ability to configure the output of the Model 8100 on a per test basis. The user may select the front or rear output terminals. The user may also select voltage sense as either internal or external. The inductive mode may be turned on or off and the Overload Delay may be set to from 1 to 8 seconds. Each of these parameters is discussed in detail in previous sections of this manual.

Typically these configuration settings are left to the default settings as follows.

- Terminals set to ‘Front’.
- Voltage Sense set to ‘Internal’
- Inductive Model set to ‘Off’.
- Overload Delay set to ‘Off’.

Be certain to read about these settings carefully before changing from the default settings.

Adding or Deleting Tests in a Procedure

A test may be added to a procedure by selecting ‘Insert Test’ from the ‘Edit’ menu. This will insert a duplicate of the highlighted test. This new test may then be edited as required. The U.S.I.T. program will allow a maximum of 300 tests per procedure.

Tests may also be copied and cut from one place in the procedure and pasted in another location. Tests will be run in the order they appear in the test procedure list.

Tests may also be deleted from a procedure by selecting 'Delete' from the 'Edit' Menu.

Managing Procedures

Once a procedure has been created it must be saved. Selecting 'Save' from the 'File' menu will save all changes made to a procedure in the database. If the U.S.I.T. program is shut down and changes to a procedure have not been saved, all changes will be lost. The program will prompt the user to save the procedure before any data is lost.

To save the present procedure using a different file name, select 'Save As' from the 'File'. This is a good way to create a second procedure that will be very similar to another procedure already in the database.

Selecting 'Delete' from the 'File' menu will delete the present procedure from the database. Once a procedure has been deleted it may never be recovered again.

Opening Procedures

Selecting 'Open Procedure' from the 'File' menu will open an existing procedure. The Open Procedure window will appear as shown in Figure 2-64.

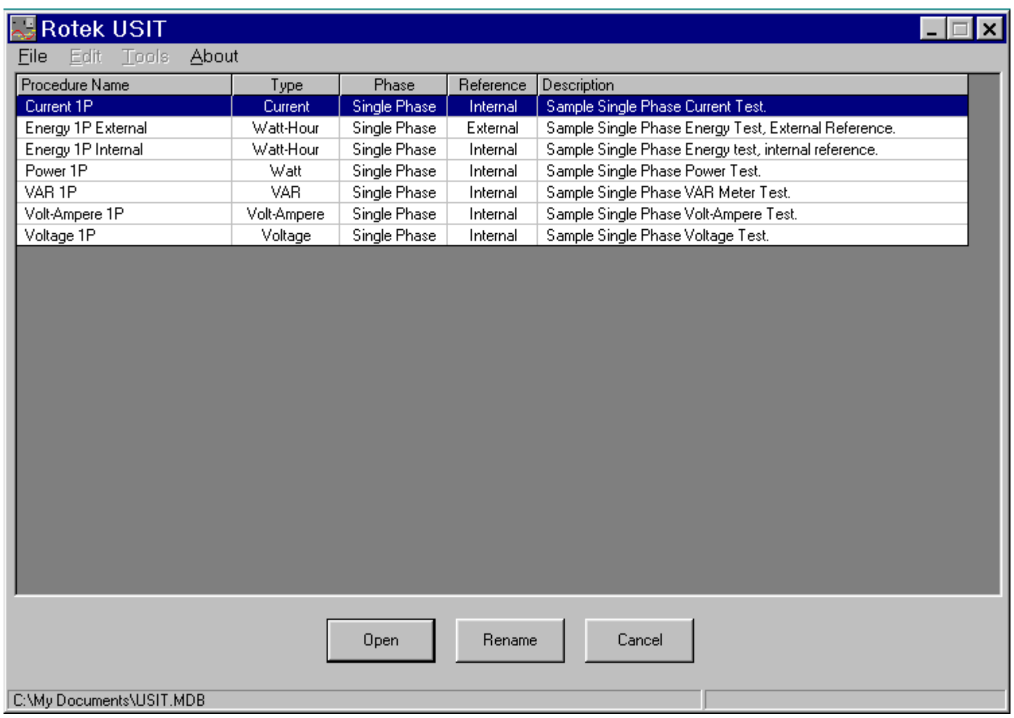


Figure 2-64
U.S.I.T. Open Procedure Window

Select the desired test from the list of procedures. All procedures in the database will be included. Click ‘Open’ to open this procedure.

Clicking on the ‘Rename’ button will permit changes to the name or description of a procedure. This will open the rename window as shown in Figure 2-65. Simply enter the new name or description and click ‘OK’.

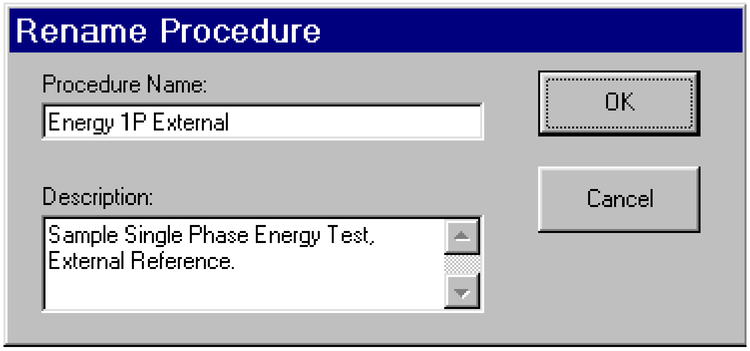


Figure 2-65
U.S.I.T. Rename Procedure Window

Printing Procedures

Selecting ‘Print Procedure’ from the ‘File’ menu can generate a hard copy of a procedure. This will open a print preview window allowing review of the procedure before it is sent to the printer.

The procedure report format file defines the format of the report. Standard formats are installed with the U.S.I.T. program. Custom formats may be created or supplied by the factory. The desired format file is selected by clicking on ‘Options’ from the file menu.

A sample of the preview window is shown in Figure 2-66. The window may be sized by dragging the edges of the window. The buttons at the top left corner of the window allow navigation through the pages of the procedure.

Click on the printer icon to send the document to the printer for a hard copy. Clicking on the envelope icon will export the report in various formats.

The zoom of the window may be adjusted using the drop down list of zoom settings or select page width of whole page.

Clicking on the close window button in the windows control box closes the preview window.

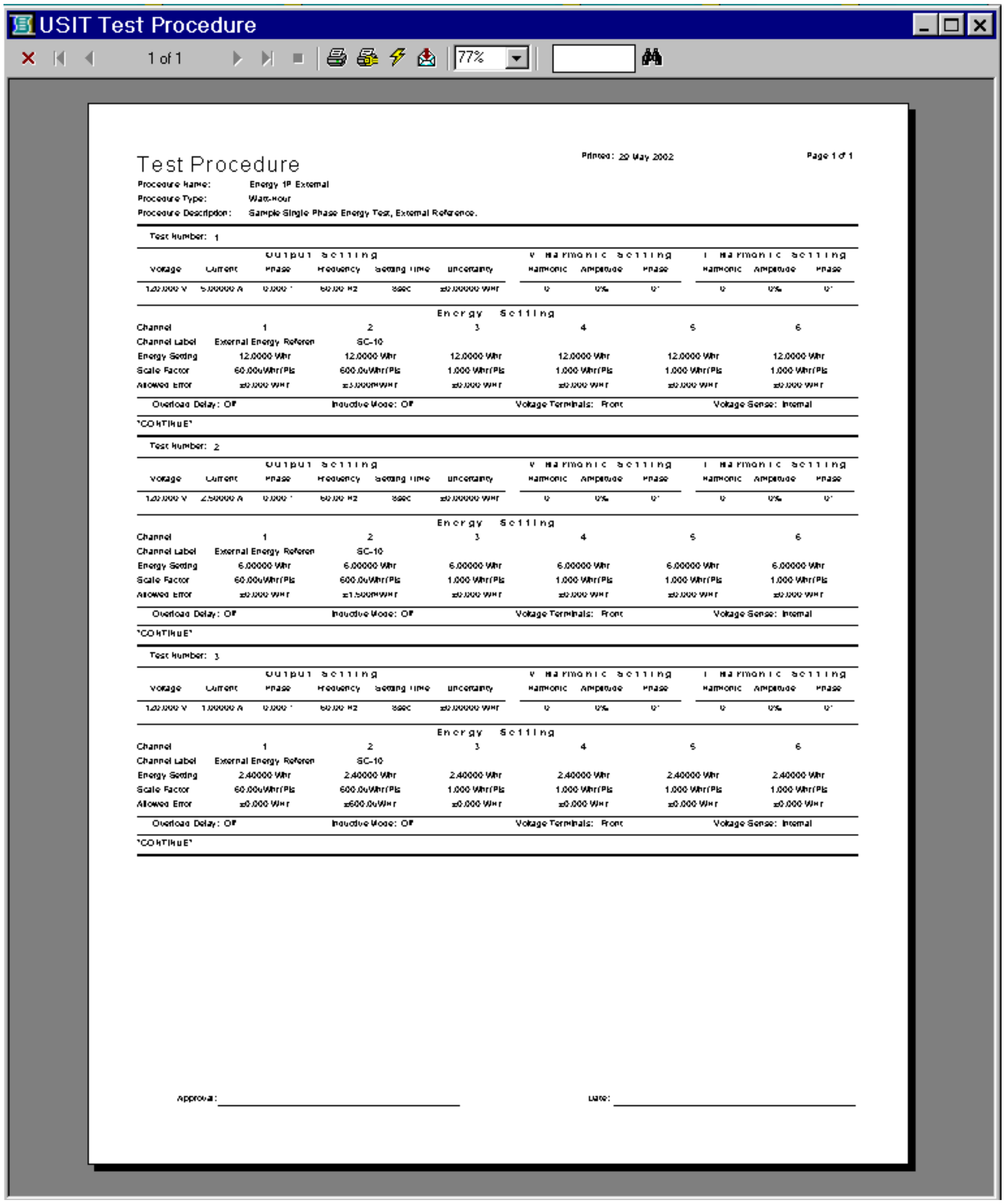


Figure 2-66
U.S.I.T. Print Procedure Preview Window

Running a Test Procedure

Once a procedure has been created and saved in the U.S.I.T. database it may be opened again at any time for editing or to execute. When running a test procedure the U.S.I.T. program must be connected to the Model 8100 via the GPIB interface on the computer. All settings required for each test of the procedure are sent to the Model 8100 via the GPIB interface. The pulse counter is configured and all results are reported back to the U.S.I.T. program via the GPIB interface.

When multiple UUT's are to be tested simultaneously the voltage output of the Model 8100 should be connected in parallel to the voltage inputs of each UUT. In this situation all current inputs of the UUT's should be connected in series. Figure 2-67 illustrates this connection for two UUTs. The same connections should be used for up to six UUTs.

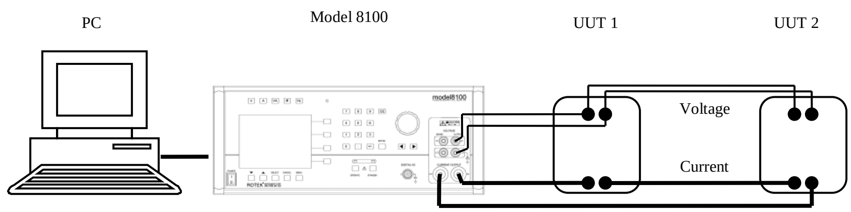


Figure 2-67
U.S.I.T. Multiple UUT Connection Diagram

The pulse output of each UUT should be connected to the pulse inputs located on the rear panel of the Model 8100.

Selecting 'Run Procedure' from the 'File' menu runs a test procedure. If changes have been made to the procedure, the U.S.I.T. program will prompt the user to save them before proceeding. The other procedure windows will then be closed and if this is an Energy test, the U.S.I.T. program will open a window that will allow the user to select which channels of the pulse counter are to be used in this test. This window is shown in Figure 2-68.

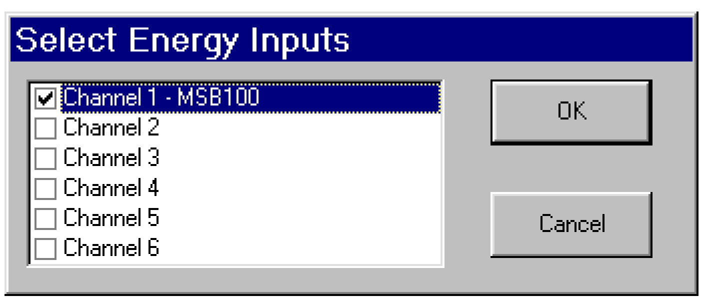


Figure 2-68
U.S.I.T. Select Energy Inputs Window

Each available channel will be listed with the channel number and the channel label both included to help identify which UUT will be connected to each. The user must check which channels are to be used during this test. It is important to check only those channels that are to be used at this time.

Clicking on 'OK' will cause the Run window to open. If this is not an Energy test the select channels window will not appear.

The U.S.I.T. program will then initialize the GPIB controller and then the Model 8100. The program will query the Model 8100 for its serial number and option configuration after the calibrator has been reset and initialized. When the initialization is successfully completed the Run window will look like Figure 2-69.

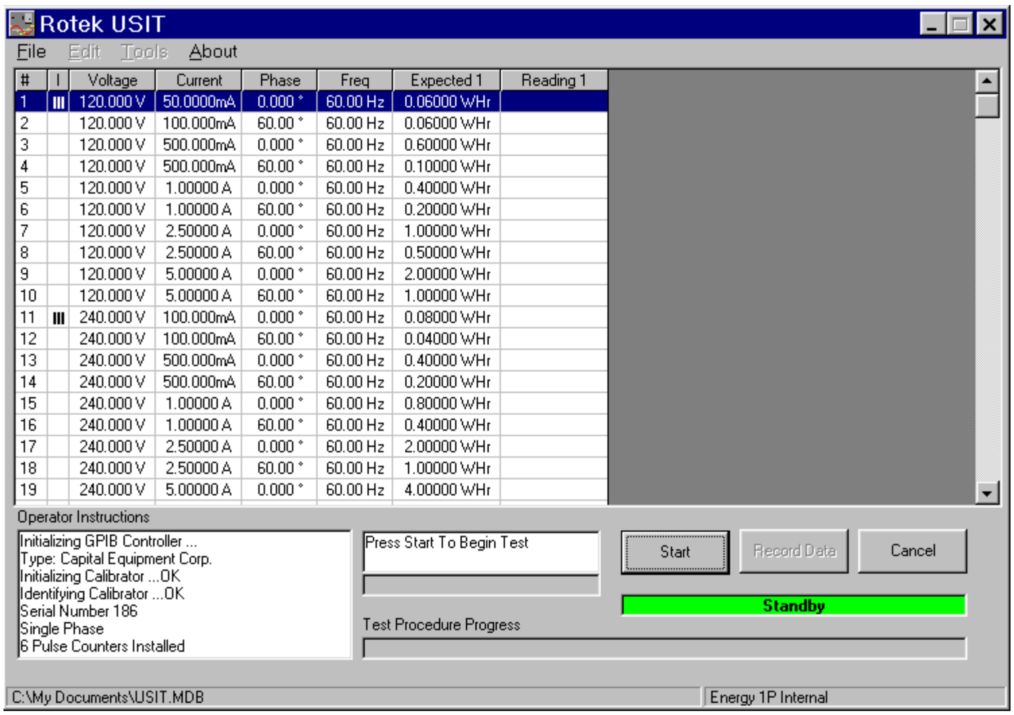


Figure 2-69
U.S.I.T. Run Test Window - Initialize

The test procedure list will show the basic output setting for each test in the procedure. In addition there is a column indicating the expected reading for this test and also a column that will display the measured value. These two columns are repeated for each of the channels to be included in this test. In this example, only one UUT is connected.

Clicking on 'Start' will cause the program to configure the Model 8100 for the first test. All settings will be configured automatically. If there is a user prompt set the program will pause and the instructions will appear in the Operator instructions box in the Run window. Clicking 'Start' again will cause the program to energize the calibrator and begin the test. When the test is running the Run window will display status information about the test in progress. A typical Run window for an Energy test will look like Figure 2-70.

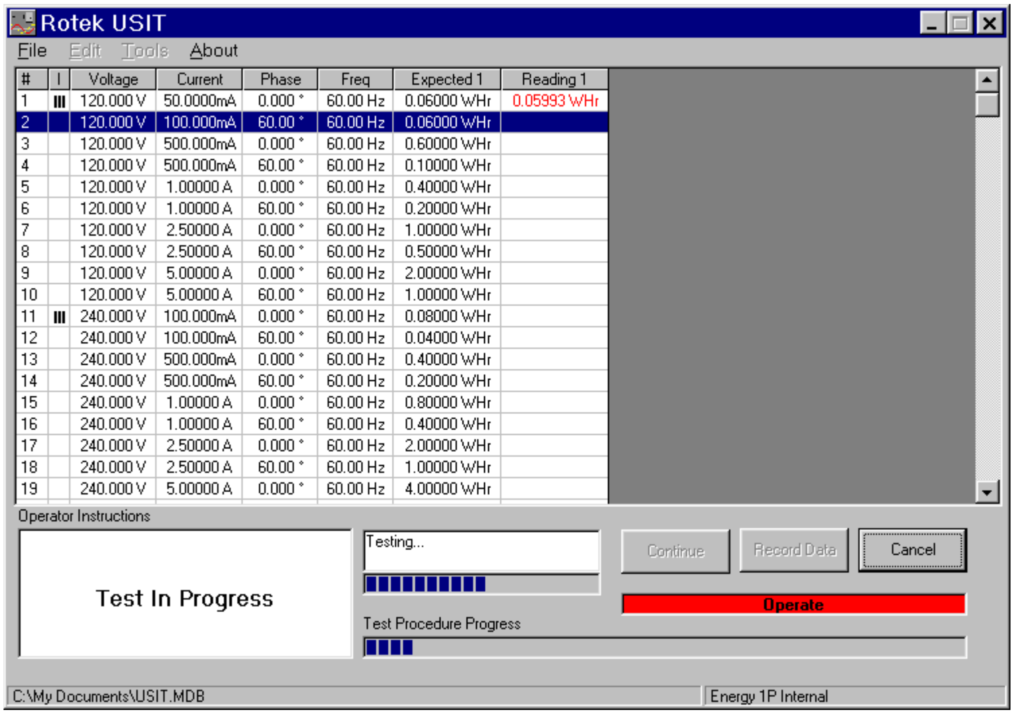


Figure 2-70
U.S.I.T. Run Test Window – Energy Testing

There are two status bars in the Run window. The shorter one indicates the progress of the current test while the larger one indicates overall progress in this procedure. The Model 8100 output status is indicated with the words 'Operate' if the output is energized and 'Standby' if the output is off.

If this is an Energy test, the test will now run without user intervention unless a user prompt has been selected for one of the tests in this procedure. If this is not an Energy test the Run window will be configured somewhat differently and provide a text box to enter the reading of the UUT. This text box will be disabled during the stabilizing period defined for this test.

A typical Run window for a non-energy test will look like Figure 2-71.

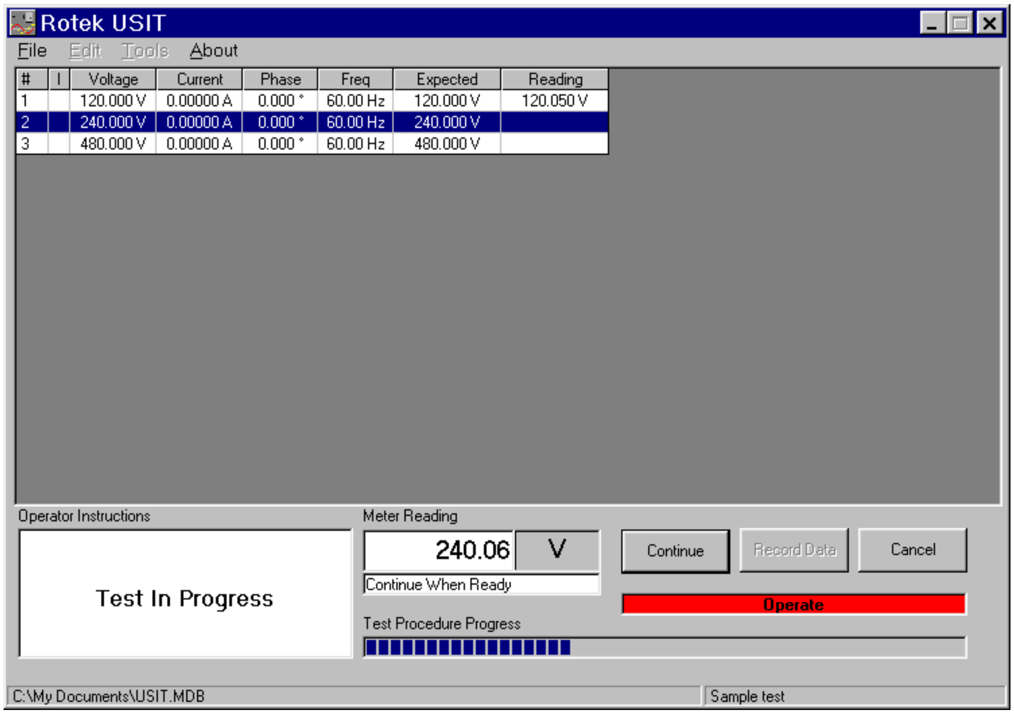


Figure 2-71
U.S.I.T. Run Test Window – Non Energy Testing

The results of each reading are displayed in the column labeled ‘Reading’. Readings that fall within the allowed limits for this test are displayed in black while failed tests are displayed in red.

If the test must be stopped for any reason, click on the ‘Cancel’ button and the test will be halted and the Model 8100 set to the safe ‘Standby’ mode.

When the test is complete the Run window will indicate this and instruct the user to click on the ‘Record Data’ button to save the measurements made during this test. Clicking on the ‘Record Data’ button closes the Run window and opens the Record Test Data window shown in Figure 2-72.

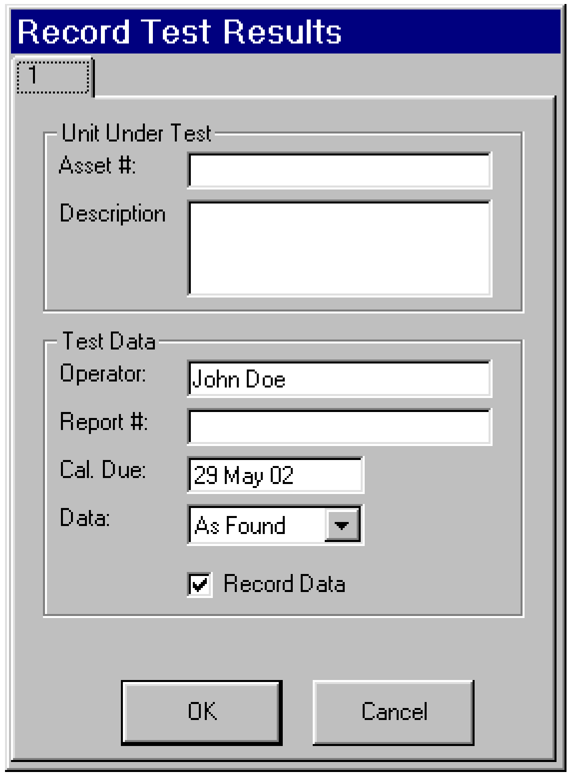


Figure 2-72
U.S.I.T. Record Test Data Window

Each channel that was active during the test will have a tab on the Record Test Data window. The fields in this window save information with the measurements made when the test was running. For each UUT information may be entered such as the Asset Number of the UUT and a Description. The Asset Number field has a maximum length of 20 characters. The Description field has a maximum length of 255 characters.

The name of the operator may be entered to be included in the test report. Also, a unique test report number may be entered to identify this test data when the report is recorded. The calibration Due date for the UUT must also be entered so that it may also be included with the test report. Finally, the data type must be selected as either 'As Found' or 'As Left'.

The record data check box must be checked for the test data to be recorded in the U.S.I.T. database. If, for some reason, one of the UUTs generated unusable data this check box could be cleared and the data will be abandoned.

Clicking on 'OK' will cause the data for each UUT to be recorded in the U.S.I.T. database. Once it has been saved, this data can be used to create test reports at any time in the future.

Printing a Test Report

Once test results have been saved in the U.S.I.T. database the test data will be available for test reports. To generate a test report of a particular set of test data, select ‘Print Test Report’ from the ‘File’ menu. The Report Window will open as is illustrated in Figure 2-73.

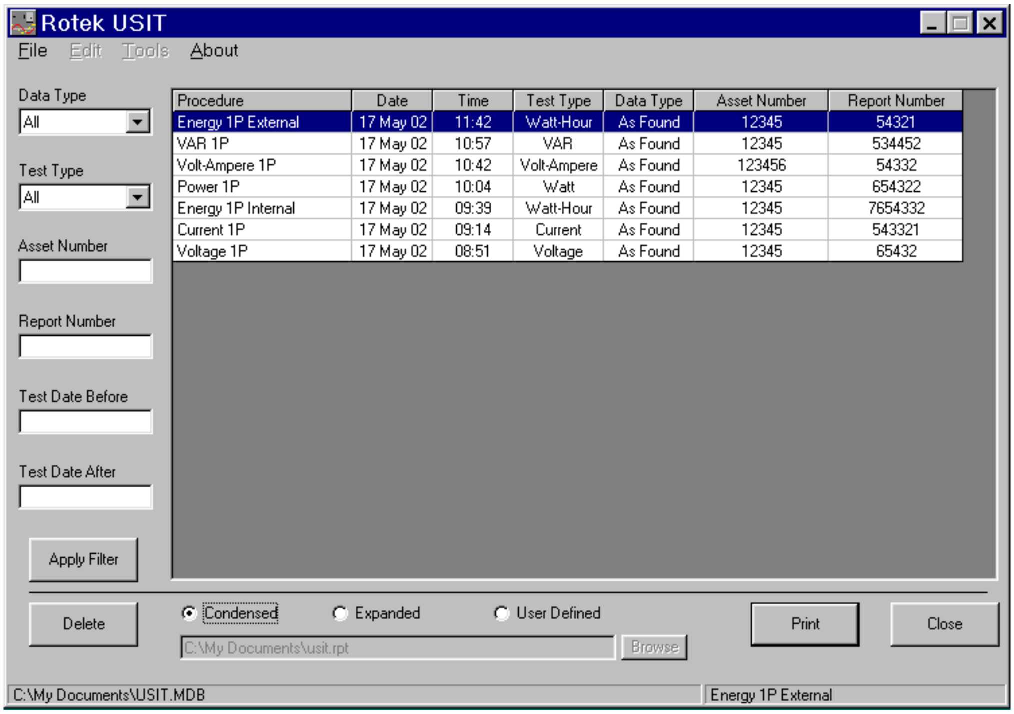


Figure 2-73
U.S.I.T. Print Test Report Window

All test data stored in the U.S.I.T. database is displayed in the test report window. This list can be filtered in the following ways.

- Data Type
- Test Type
- Asset Number
- Report Number
- Test Date Before
- Test Date After

If the list is filtered by data Type the list can display only ‘As Found’ test data or only ‘As Left’ test data.

If the Test Type filter is set to Watt-Hour then only Watt-Hour tests will be displayed.

If an asset number is entered as a filter the list will show only test data relating to a UUT with a specific Asset Number.

If a report number is entered as a filter the list will show only test data relating to a UUT with a specific Report Number.

The 'Test Date Before' and 'Test Date After' fields allow the list to be filtered to include only test data recorded in a specific period of time.

The U.S.I.T. program can generate either a condensed or an expanded test report. The condensed versions include the most critical setting data and the test results in a compact test report. The expended report includes additional information about the output setting such as harmonic settings. The report formats of each of these reports may changed. Custom report formats may be substituted for the standard reports installed with the U.S.I.T. program. Custom report formats may be created using Crystal Reports or supplied by the factory. To use a custom report format click on 'User Defined' and enter the path and file name in the list box. If a custom format is to be used all the time then the both the condensed and expanded report formats may be changed by clicking 'Options' on the file menu and selecting the 'Test Report Format' tab.

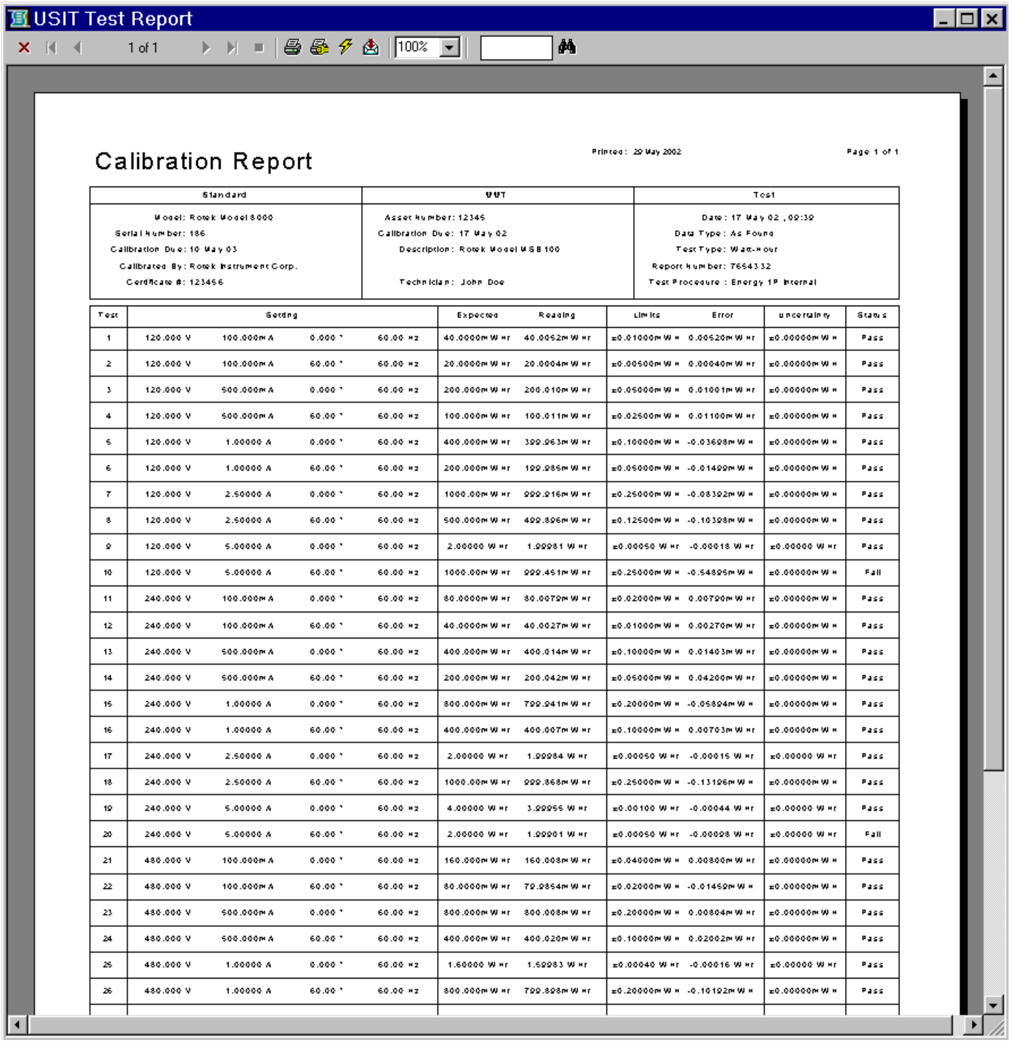
Clicking on 'Print' will send the test report directly to the printer. Clicking on 'Preview' will open the Test Report Preview Window, allowing review of the test report before it is sent to the printer.

A sample of the preview window is shown in Figure 2-74. The window may be sized by dragging the edges of the window. The buttons at the top left corner of the window allow navigation through the pages of the procedure.

Click on the printer icon to send the document to the printer for a hard copy. Clicking on the envelope icon will export the report in various formats.

The zoom of the window may be adjusted using the drop down list of zoom settings or select page width of whole page.

Clicking on the close window button in the windows control box closes the preview window.



Calibration Report

Printed: 20 May 2002 Page 1 of 1

Standard	UUT	Test
Model: Rotek Model 8000	Asset Number: 12345	Date: 17 May 02 ,09:39
Serial Number: 186	Calibration Due: 17 May 02	Data Type: As Found
Calibration Due: 10 May 03	Description: Rotek Model MSB 100	Test Type: Watt-Hour
Calibrated By: Rotek Instrument Corp.		Report Number: 7654332
Certificate #: 123456	Technician: John Doe	Test Procedure : Energy 1P Internal

Test	Setting				Expected	Reading	Limits	Error	Uncertainty	Status
1	120.000 V	100.000mA	0.000 °	60.00 Hz	40.0000mWHr	40.0052mWHr	±0.01000mWH	0.00520mWHr	±0.00000mWH	Pass
2	120.000 V	100.000mA	60.00 °	60.00 Hz	20.0000mWHr	20.0004mWHr	±0.00500mWH	0.00040mWHr	±0.00000mWH	Pass
3	120.000 V	500.000mA	0.000 °	60.00 Hz	200.000mWHr	200.010mWHr	±0.05000mWH	0.01001mWHr	±0.00000mWH	Pass
4	120.000 V	500.000mA	60.00 °	60.00 Hz	100.000mWHr	100.011mWHr	±0.02500mWH	0.01100mWHr	±0.00000mWH	Pass
5	120.000 V	1.00000 A	0.000 °	60.00 Hz	400.000mWHr	399.963mWHr	±0.10000mWH	-0.03698mWH	±0.00000mWH	Pass
6	120.000 V	1.00000 A	60.00 °	60.00 Hz	200.000mWHr	199.985mWHr	±0.05000mWH	-0.01499mWH	±0.00000mWH	Pass
7	120.000 V	2.50000 A	0.000 °	60.00 Hz	1000.00mWHr	999.916mWHr	±0.25000mWH	-0.08392mWH	±0.00000mWH	Pass
8	120.000 V	2.50000 A	60.00 °	60.00 Hz	500.000mWHr	499.896mWHr	±0.12500mWH	-0.10398mWH	±0.00000mWH	Pass
9	120.000 V	5.00000 A	0.000 °	60.00 Hz	2.00000 WHr	1.99981 WHr	±0.00050 WHr	-0.00018 WHr	±0.00000 WHr	Pass
10	120.000 V	5.00000 A	60.00 °	60.00 Hz	1000.00mWHr	999.451mWHr	±0.25000mWH	-0.54895mWH	±0.00000mWH	Fail
11	240.000 V	100.000mA	0.000 °	60.00 Hz	80.0000mWHr	80.0079mWHr	±0.02000mWH	0.00790mWHr	±0.00000mWH	Pass
12	240.000 V	100.000mA	60.00 °	60.00 Hz	40.0000mWHr	40.0027mWHr	±0.01000mWH	0.00270mWHr	±0.00000mWH	Pass
13	240.000 V	500.000mA	0.000 °	60.00 Hz	400.000mWHr	400.014mWHr	±0.10000mWH	0.01403mWHr	±0.00000mWH	Pass
14	240.000 V	500.000mA	60.00 °	60.00 Hz	200.000mWHr	200.042mWHr	±0.05000mWH	0.04200mWHr	±0.00000mWH	Pass
15	240.000 V	1.00000 A	0.000 °	60.00 Hz	800.000mWHr	799.941mWHr	±0.20000mWH	-0.05894mWH	±0.00000mWH	Pass
16	240.000 V	1.00000 A	60.00 °	60.00 Hz	400.000mWHr	400.007mWHr	±0.10000mWH	0.00703mWHr	±0.00000mWH	Pass
17	240.000 V	2.50000 A	0.000 °	60.00 Hz	2.00000 WHr	1.99984 WHr	±0.00050 WHr	-0.00015 WHr	±0.00000 WHr	Pass
18	240.000 V	2.50000 A	60.00 °	60.00 Hz	1000.00mWHr	999.868mWHr	±0.25000mWH	-0.13196mWH	±0.00000mWH	Pass
19	240.000 V	5.00000 A	0.000 °	60.00 Hz	4.00000 WHr	3.99956 WHr	±0.00100 WHr	-0.00044 WHr	±0.00000 WHr	Pass
20	240.000 V	5.00000 A	60.00 °	60.00 Hz	2.00000 WHr	1.99901 WHr	±0.00050 WHr	-0.00098 WHr	±0.00000 WHr	Fail
21	480.000 V	100.000mA	0.000 °	60.00 Hz	160.000mWHr	160.008mWHr	±0.04000mWH	0.00800mWHr	±0.00000mWH	Pass
22	480.000 V	100.000mA	60.00 °	60.00 Hz	80.0000mWHr	79.9854mWHr	±0.02000mWH	-0.01459mWH	±0.00000mWH	Pass
23	480.000 V	500.000mA	0.000 °	60.00 Hz	800.000mWHr	800.008mWHr	±0.20000mWH	0.00804mWHr	±0.00000mWH	Pass
24	480.000 V	500.000mA	60.00 °	60.00 Hz	400.000mWHr	400.020mWHr	±0.10000mWH	0.02002mWHr	±0.00000mWH	Pass
25	480.000 V	1.00000 A	0.000 °	60.00 Hz	1.60000 WHr	1.59983 WHr	±0.00040 WHr	-0.00016 WHr	±0.00000 WHr	Pass
26	480.000 V	1.00000 A	60.00 °	60.00 Hz	800.000mWHr	799.898mWHr	±0.20000mWH	-0.10192mWH	±0.00000mWH	Pass

Figure 2-74
U.S.I.T. Preview Test Report Window

Clicking on the ‘Close’ Button closes the Test Report window.

Database and Report Formats

The U.S.I.T. program creates a single database in which to store all Test Procedures and Test Results. The database format used is standard Microsoft Access 97 format. Reports may be generated directly from the database using a variety of report generation programs including the reporting feature of Microsoft Access.

The report definition files used by the U.S.I.T. program are created using Crystal Reports. The Crystal Reports editor may be used to create new report definitions or to simply modify those provided with the program. In this way the format of the test reports may be customized.

Custom report formats are also available from the factory.

Model 8145

The Model 8145 is an accessory to the Model 8100 that extends the maximum current output of the Model 8100 from 55A to 220A. The Model 8145 can deliver 50A at 8V, 100A at 4V and 200A at 2V. All functions of the amplifier are controlled by the Model 8100 and all current outputs are obtained from the output terminals of the Model 8145. The Model 8145 output accuracy is controlled directly by the Model 8100 and cannot be used as a standalone amplifier.

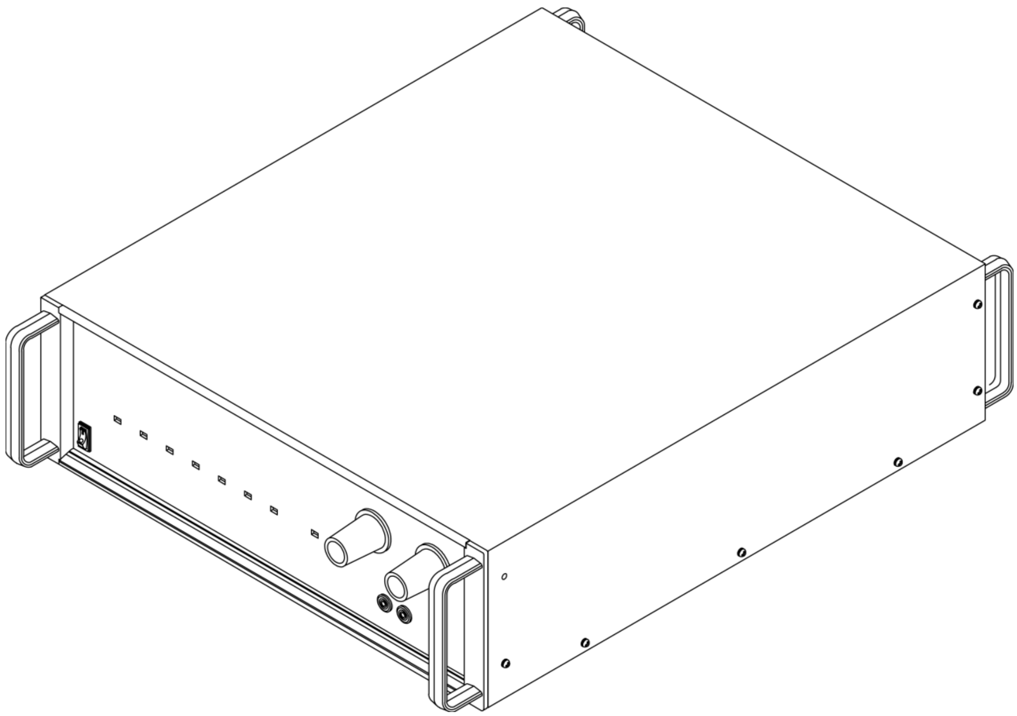


Figure 2-75
Model 8145 Current Extender

Front Panel Controls & Displays

Figure 2-76 illustrates the location of the front panel controls, connections and indicators. Each element of control, display or connection is numbered and a description of the function of each appears below.

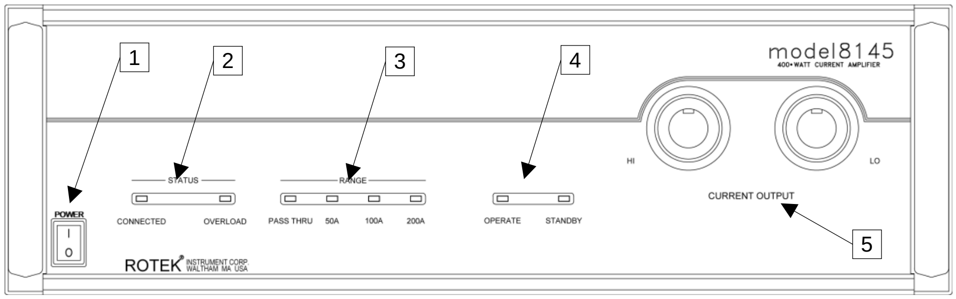


Figure 2-76
Model 8145 - Front Panel Controls

1. Power Switch.
2. Status Indicators.
   There are two Status indicators that provide information about the present state of the amplifier. The Connected indicator is illuminated when the amplifier is connected as an accessory to the Model 8100.
3. Range indicators.
4. Output Indicators
   The two Output Control Indicators show the state of the output of the Model 8100 and the Model 8145, either STANDBY or OPERATE. When in the standby state, the green LED is illuminated. The voltage terminals of the Model 8100 are configured as an open circuit, the current terminals are shorted and the output amplifiers are disconnected. When the calibrator is in the OPERATE state the red LED is illuminated. To restore the output terminals to a safe condition, press the STANDBY key on the Model 8100. When the output signal is unstable both the Operate LED and the Standby LED will be illuminated. This can occur when changing settings or when operate is initially asserted. When the operate LED is lit alone the output is stable and ready for measurements.
5. Current Output Terminals
   The current output of the amplifier is available at the current output terminals. These terminals are connected internally in parallel with the rear panel current output terminals. It is important to have no connections made to the rear panel current output terminals when the current output is to be supplied by the front panel terminals. When the pass through range is selected the current applied to the rear panel current input terminals is available at the current output terminals. In all other ranges the amplified current output is available to a maximum of 220A, or 320A if the 300A option is installed.

Rear Panel Connections

Figure 2-77 illustrates the location of the front panel connections. Each connection is numbered and a description of the function of each appears below.

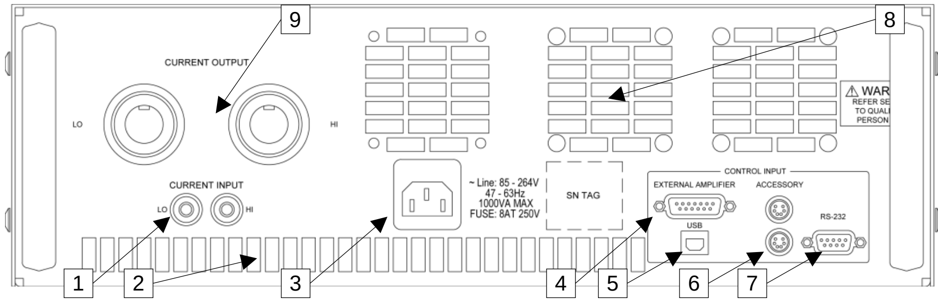


Figure 2-77
Model 8145 - Rear Panel Connections

1. Current Input Terminals
   Current settings of the Model 8100 are passed through the Model 8145, bypassing the amplifier allowing all current outputs of the Model 8100 to appear at the output terminals of the Model 8145.
2. Cooling Air Intake Vents.
   The cooling air intake grills provide the opening for the intake of cooling air. The cooling air intake grills must not be obstructed or the instrument may become unable to properly regulate its internal temperature.
3. Power Entry Module.
   The Power Entry Module provides the line cord receptacle and fuse holder. The Model 8145 has a universal input accepting line voltages of 90 - 260VAC. The single fuse is rated at 8A.
4. External Amplifier Connection
   This connector provides the analog control of the output current of the Model 8145 by the Model 8100.
5. USB Connector
   The functionality of this connector is not active in the Model 8145.
6. Accessory Connectors
   There are two accessory connectors located on the rear panel. These connectors are used to attach the Model 8145 to the Model 8100. The connectors are 6 pin Mini DIN connectors and are wired internally in parallel. Either connector may be used to connect to the Model 8100 or any other accessory.
7. RS-232 Serial Interface Connector.
   The functionality of this connector is not active in the Model 8145.
8. Cooling Fan Exhaust Vents.
   There are 3 cooling exhaust vents located on the rear panel. These vents must not be obstructed or the instrument may become unable to properly regulate its internal temperature. The speed of each cooling exhaust fan is

independently variable and is controlled by the amplifier to maintain a constant internal temperature. At power-up or when the unit is idle the fans will be set to their lowest speed helping to reduce the noise generated by the amplifier. As the instrument is used the fan speed will vary. This variation is normal.

9. Current Output Terminals
   The current output of the amplifier is available at the current output terminals. These terminals are connected internally in parallel with the front panel current output terminals. It is important to have no connections made to the front panel current output terminals when the current output is to be supplied by the rear panel terminals. When the pass through range is selected the current applied to the rear panel current input terminals is available at the current output terminals. In all other ranges the amplified current output is available to a maximum of 220A, or 330A with the 300A option installed.

Connecting to the Model 8100

The Model 8145 extends the maximum current output of the Model 8100 from 55A to 330A depending on the option installed. All functions of the amplifier are controlled by the Model 8100 and all current outputs are obtained from the output terminals of the Model 8145.

Figure 2-78 illustrates the front panel of the Model 8100 and Model 8145. There are no front panel connections required for the control of the Model 8145. Voltage output connections are made as usual to the voltage output terminals of the Model 8100. Current output connections are made to the current output terminals of the Model 8145. When the necessary rear panel connections are made, all currents from 1mA to 330A will be supplied at the current output terminals of the Model 8145.

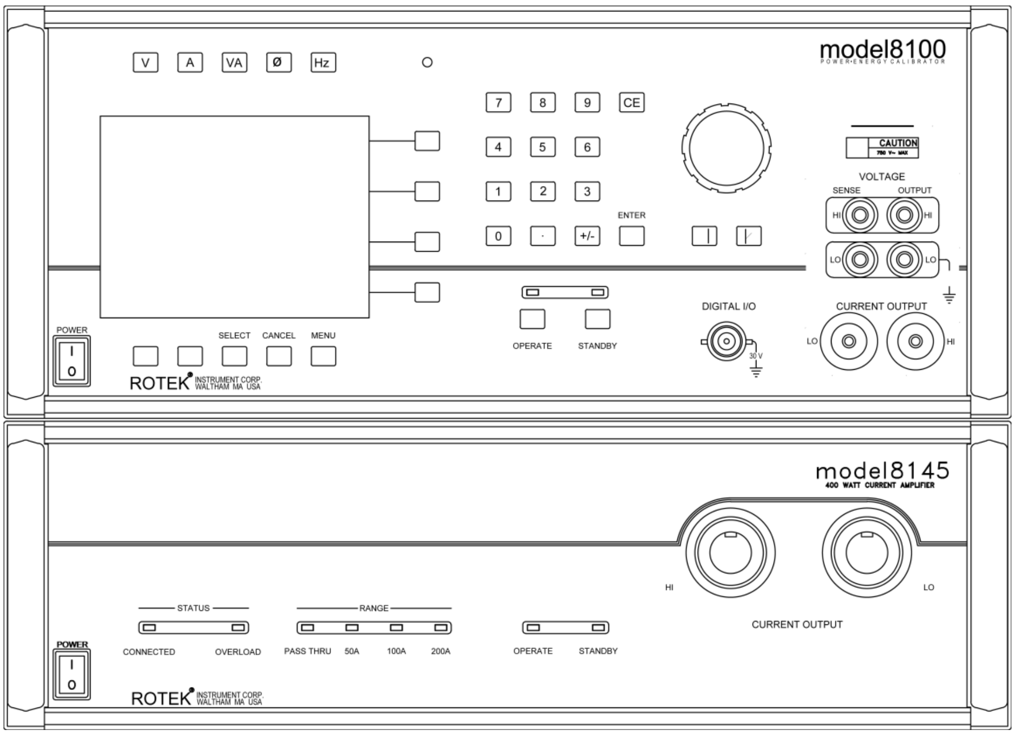


Figure 2-78
Model 8145 – Model 8100 (Front View)

The rear panel connections of the Model 8145 to the Model 8100 are illustrated in Figure 2-79.

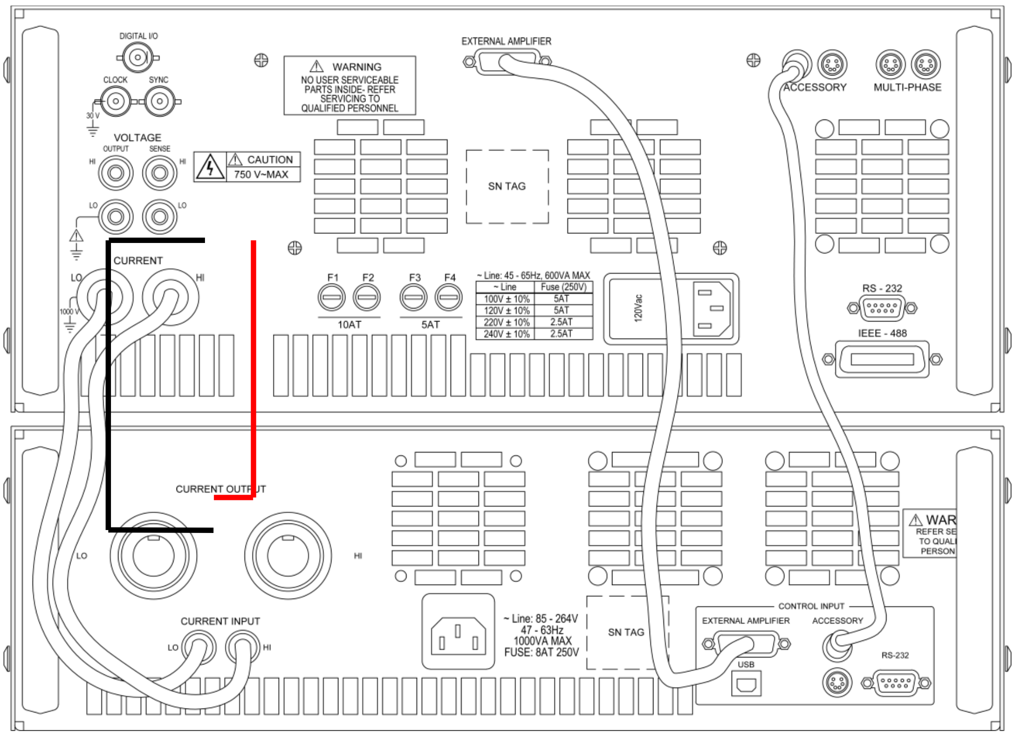


Figure 2-79
Model 8145 – Model 8100 (Rear View)

For the Model 8145 to be used as an accessory to the Model 8100 two connections must be made between the calibrator and the amplifier.

Using a Rotek accessory interconnect cable, supplied with the Model 8145, connect the Model 8100 to the Model 8145 using the accessory ports located on the rear panel of each instrument. This connection is illustrated in Figure 2-79. After this connection is made, the power must be cycled on each instrument. When applying power it is important to energize the Model 8145 first followed by the Model 8100. On power up the Model 8100 will recognize that the Model 8145 is present and will configure itself to use the accessory.

The success of the connection may be verified by entering a setting of 200A as the current output of the Model 8100. If the amplifier has been properly connected, the setting will be accepted. If the Model 8145 has not been properly recognized the setting will generate a 'Data Out of Range' error.

When the Model 8100 powers up, it will set the Model 8145 to the connected state.

In addition to the accessory interconnect cable, the current pass through connections must also be made between the Model 8100 and the Model 8145. This connection is made using the supplied current pass through cable between the current output terminals of the Model 8100 and the current input terminals of the Model 8145. This connection is illustrated in Figure 2-79.

When the Model 8100 is outputting currents of 20A or less, the current is output from the Model 8100 to the Model 8145 and directed to the Model 8145 current output terminals.

Since the current interconnect cable could carry up to 20A it is important to use the supplied cable set or some other cable set that is rated to carry at least 20A.

When the Model 8100 detects the presence of the Model 8145 the current output will automatically be redirected to the rear current output terminals of the Model 8100. The voltage output will still be available at the front panel voltage terminals and the front panel will indicate that the terminals are set to 'Front'. If the Model 8100 rear terminals are selected then both the voltage and current outputs will be directed to the rear panel terminals.

The final connection that must be made between the Model 8100 and the Model 8145 is the External Amplifier cable. This connection carries the analog signals required for the Model 8100 to control the current outputs of the Model 8145.

Operating with the Model 8100

When the Model 8145 is used with the Model 8100 and current settings are less than 11A the Model 8145 will be in the pass through mode. The range indicator located on the front panel of the Model 8145 will indicate that the 'Pass Through' range is selected. When in this mode the output currents from the Model 8100 will be passed through to the output terminals of the Model 8145. The Model 8145 power amplifier is disconnected from the current path.

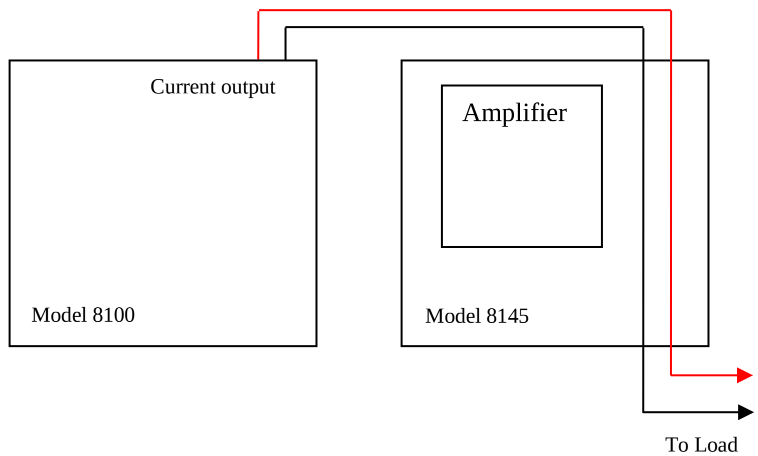


Figure 2-80
Model 8145 Pass Through Mode

Figure 2-80 illustrates the current path from the Model 8100 to the load when outputting currents less than 11A. The output current will leave the rear terminals of the Model 8100 and be carried to the Model 8145 via the current interconnect cable. The internal connections of the Model 8145 will direct this current to the Model 8145 output terminals and from there to the load.

When the Model 8145 is used and current settings are greater than 11A the Model 8145 will operate as a current amplifier. The range indicator located on the front panel of the Model 8145 will indicate the range that is selected. This selection is made automatically by the Model 8100.

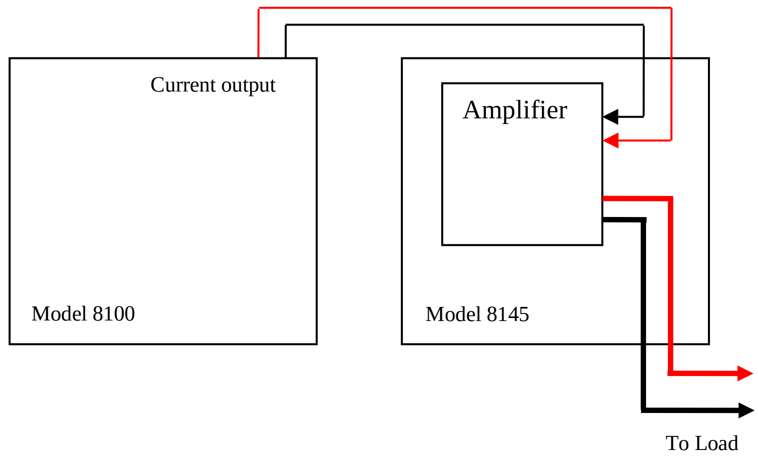


Figure 2-81
Model 8145 Amplifier Mode

Figure 2-81 illustrates the current path from the Model 8100 to the load when outputting currents greater than 11A. The control of the Model 8145 amplifier will be made through the External Amplifier connector. The current output of the power amplifier is then directed to the Model 8145 output terminals and from there to the load.

Model 8180

The Rotek Model 8180 DC Adapter is an accessory to the Model 8100. The Model 8180 provides the Model 8100 with DC voltage and current outputs. The Model 8180 provides DC outputs suitable for the calibration of 1 to 5% analog panel meters. In addition, the Model 8180 may be used to calibrate digital panel meters and DMMs.

The Model 8180 converts the AC voltage and current outputs of the Model 8100 to DC voltage and current available at the Model 8180 output terminals.

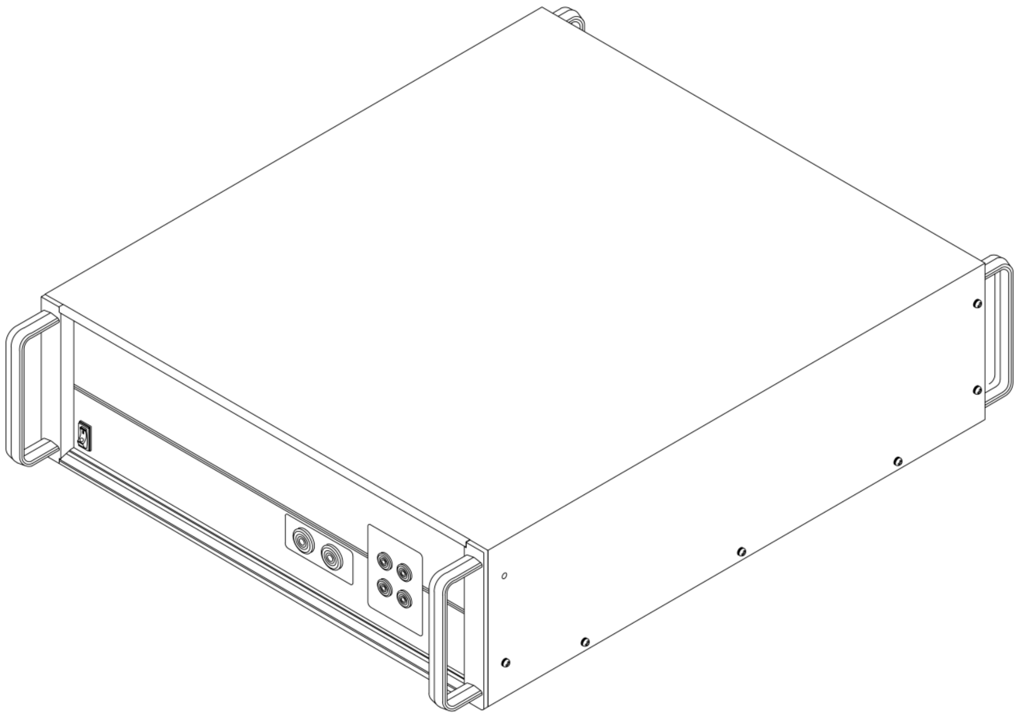


Figure 2-82
Model 8180, DC Adapter

Installation

The standard configuration of the Model 8180 DC Adapter is bench mounted. Rack-mounting ears are available as option 8180-RM and are easily installed in the field. Suitable support must be provided when mounting the Model 8180 in a rack.

When installing the Model 8180 in either a rack or on a bench care should be used to ensure that proper ventilation is provided at the rear of the instrument. The Model 8180 is equipped with a cooling exhaust fan and a cooling air intake grill. The exhaust and intake grills must not be obstructed or the instrument may become unable to properly regulate its internal temperature.

To meet all published specifications the instrument must be used in an environment with an ambient temperature within ±5°C of the last calibration temperature. The standard factory calibration temperature is 23°C. Factory calibration performed at temperatures other than 23°C is available as a special calibration option.

Line Voltage Selection

The Model 8180 DC Adapter may be operated from an AC power source of 104-253 Volts, 45-65Hz. The Power Entry Module, located on the rear panel, houses the fuse holder. The line fuse is rated at 1 Amps Slow Blow when the line voltage is 115VAC. The line fuse is rated at 0.5 Amps Slow Blow when the voltage is 230VAC. The proper fuse ratings are listed in a table printed on the rear panel of the Model 8180.

To change the fuse, first disconnect the power cord to the calibrator. Open the fuse cover using a small blade screwdriver or similar tool. Remove the fuse holder and install a fuse of the appropriate rating. Replace the fuse holder into the upper fuse position. Close the fuse cover.

⚠ WARNING ⚠

Replace fuse only with a 250V fuse of noted rating.

Always use fuses of type T (SB).

Use of incorrect fuses could result in damage to the calibrator and injury to personnel!

A three-conductor power cable is provided and when this cable is connected to a standard three-wire outlet the instrument chassis is connected to earth ground. This feature prevents the instrument case from assuming voltages that are potentially hazardous to personnel. In the event that an adapter is used to connect the three-wire cable to a two-wire outlet the green (ground) adapter terminal should always be connected to the earth ground.

Front Panel Controls & Displays

Figure 2-83 illustrates the location of the front panel controls, connections and indicators. Each element of control, display or connection is numbered and a description of the function of each appears below.

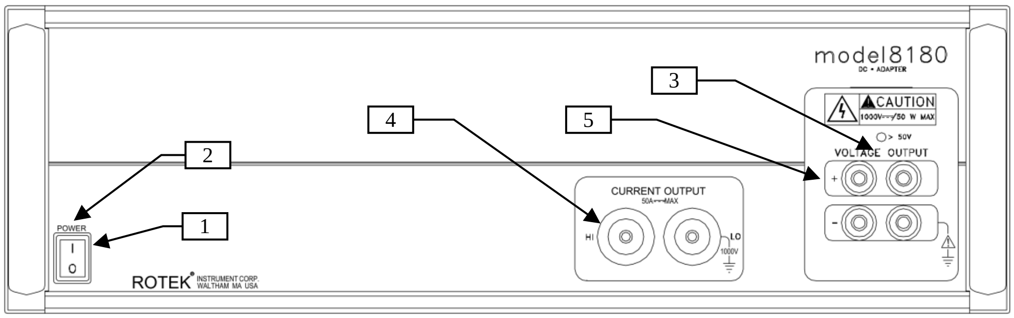


Figure 2-83
Model 8180 - Front Panel Controls

1. Power Switch.
2. Power Status Indicator.
   The power switch indicator is illuminated when the DC Adapter is powered on.
3. High Voltage Output Indicator.
   The high voltage output indicator located above the DC voltage output terminals. It is illuminated when the output voltage exceeds 50 volts DC.
4. Current Output Terminals
   DC Current outputs are available at these terminals.
5. Voltage Output Terminals
   DC Voltage outputs are available at these terminals.

Rear Panel Connections

Figure 2-84 illustrates the location of the front panel connections. Each connection is numbered and a description of the function of each appears below.

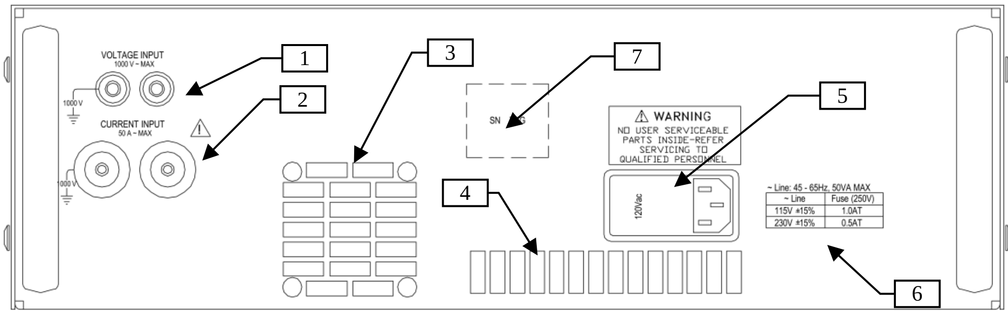


Figure 2-84
Model 8180 - Rear Panel Connections

1. AC Voltage Input Terminals
   The AC Voltage Input Terminals connect to the Model 8100 voltage output terminals using the supplied voltage lead set.
2. AC Current Input Terminals
   The AC Current Lead Set connect to the Model 8100 current output terminals using the supplied current lead set.
3. Cooling Fan Exhaust Vent.
   The cooling fan exhaust vent is located on the rear panel. This vent must not be obstructed or the instrument may become unable to properly regulate its internal temperature.
4. Cooling Air Intake Vent.
   The cooling air intake grill provides the opening for the intake of cooling air. The cooling air intake grill must not be obstructed or the instrument may become unable to properly regulate its internal temperature.
5. Power Entry Module.
   The Power Entry Module provides the line cord receptacle and a 4-position line voltage selector that is integrated with the fuse holder. The proper fuse ratings are listed in the table printed on the rear panel of the Model 8180 located to the right of the Power Entry Module. The selected line voltage setting is displayed in the voltage window of the fuse cover located on the rear panel adjacent to the line cord connector. A three-conductor power cable is provided and when this cable is connected to a standard three-wire outlet, the instrument chassis is connected to earth ground. This feature prevents the instrument case from assuming voltages that are potentially hazardous to personnel. In the event that an adapter is used to connect the three-wire cable to a two-wire outlet the green (ground) adapter terminal should always be connected to the earth ground.

6. Fuse Rating Table
   The proper fuse ratings at all acceptable line voltage settings are listed in this table. Always use a power line fuse of the value corresponding to the line voltage selected in the power entry module.

7. Serial Number Tag

Connecting to the Model 8100

The Model 8180 is an accessory to the Model 8100 adding DC voltage and current output capability to the Model 8100.

Figure 2-85 illustrates the Model 8100 and Model 8180. Normal AC voltage and current outputs are available from the Model 8100 output terminals. DC voltage and current outputs are available from the output terminals of the Model 8180.

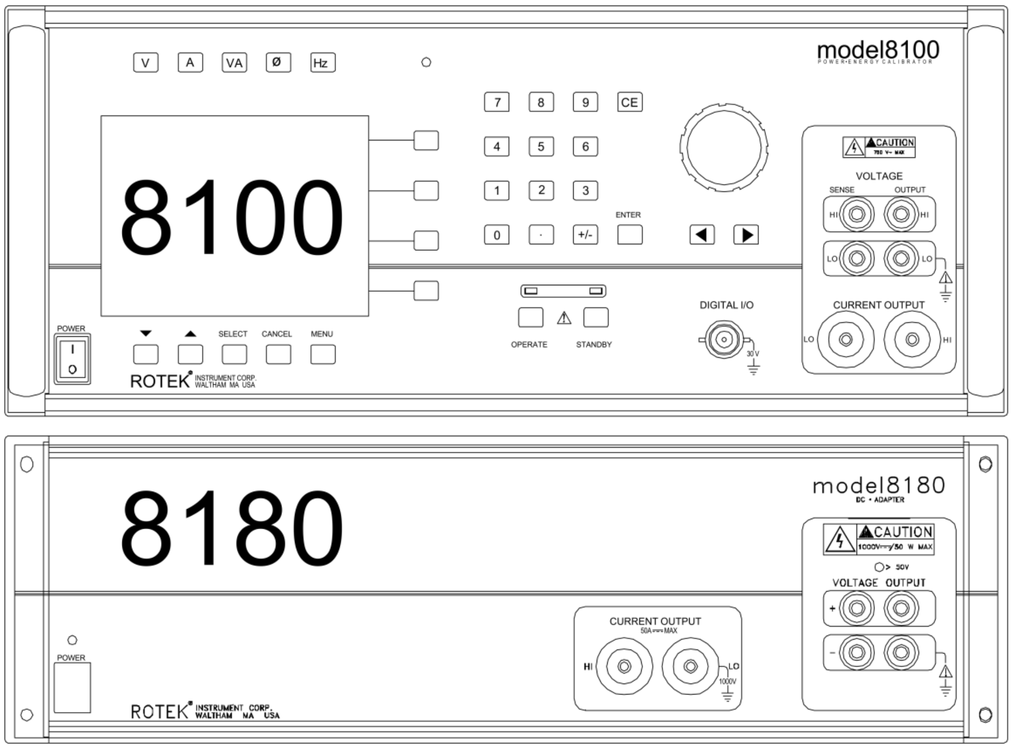


Figure 2-85
Model 8180 – Model 8100 (Front View)

The Model 8180 is connected to the Model 8100 using the supplied cable sets and the rear panel output terminals of the Model 8100. These connections are illustrated in Figure 2-86.

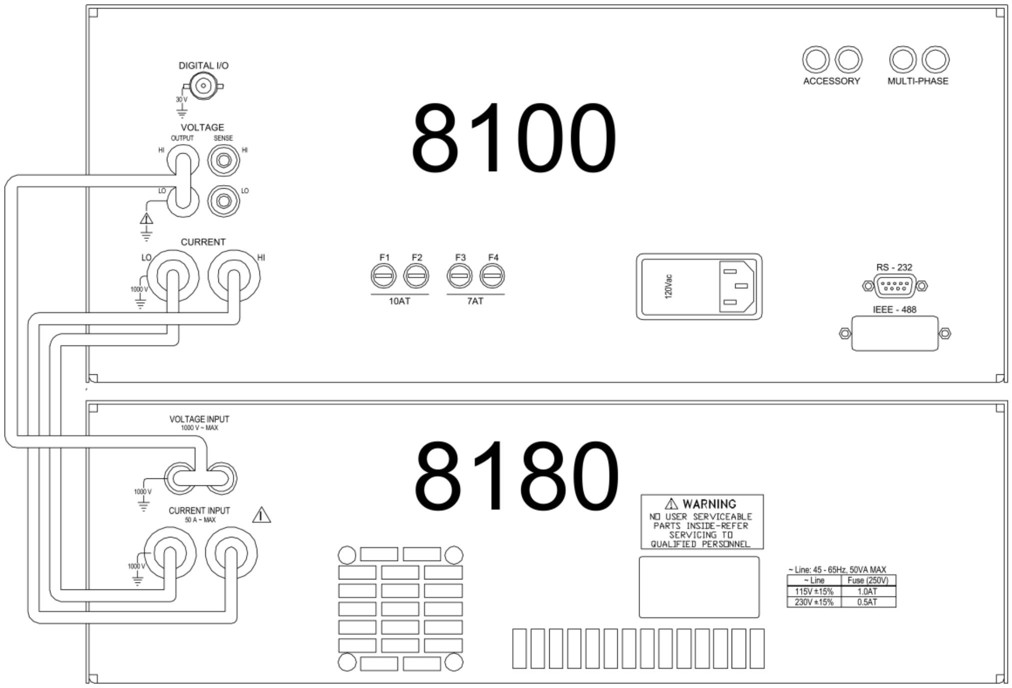


Figure 2-86
Model 8180 – Model 8100 (Rear View)

Operating with the Model 8100

The output setting of the Model 8100 controls the Model 8180 DC voltage and current output. The default output terminal selection setting of the Model 8100 is 'front' output terminals. This choice directs the voltage and the current outputs to the front panel output terminals of the Model 8100. The 'rear' output terminal selection setting directs the voltage and the current outputs to the Model 8100 rear panel output terminals. When operating the Model 8180 with the Model 8100 all controls of the Model 8100 behave in the same manner as when the Model 8100 is operated without the Model 8180 with the exception of the following two Model 8100 configuration settings.

1. Select Rear Output Terminals:
   From the front panel of the Model 8100 press the 'MENU' button to open the Model 8100 main menu. From the 'Main' menu select the 'Calibrator' menu item to open the 'Calibrator' menu. From the 'Calibrator' menu select the 'Output Terminals' menu item and select 'REAR'. Press the front panel menu button to close the menu window.
2. From the front panel of the Model 8100 press the 'MENU' button to open the Model 8100 main menu. From the 'Main' menu select the 'Calibrator' menu item to open the 'Calibrator' menu. From the 'Calibrator' menu select the 'Output Mode' menu item and select 'DC Option'. Press the front panel menu button to close the menu window.

Chapter 3
REMOTE OPERATION

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Remote Interface

The Model 8100 is equipped with a remote interface that may be accessed using either the IEEE-488 or RS-232 communications ports. Both communications ports are standard equipment and may be used interchangeably.

The IEEE-488 interface is compliant with IEEE standards 488.1-1987 and 488.2-1987.

The RS-232 communication port uses the following settings.

19200 Bits per second
8 Data Bits
No Parity
1 Stop Bit
No Flow Control

All functions of the Model 8100, whether keyboard entry or menu choice, are available via remote commands issued through either the IEEE-488 or RS-232 interfaces.

The locations of the remote interface connectors are shown in Figure 3-1.

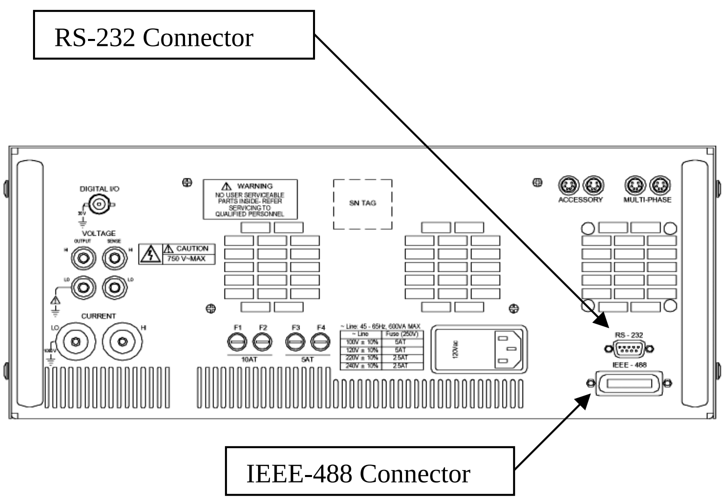

Figure 3-1
Remote Interface Connector Locations

Command Syntax

Commands sent to the calibrator are not case sensitive. As an example, the reset function ‘*RST’ could be sent in any of the following forms.

‘*RST’

‘*rst’

‘*Rst’

It is not necessary to send the entire command word to the calibrator. It will respond to the first 4 characters unless the 4th character is a vowel and in that chase will respond to the first 3 characters. In the event that the command is 4 characters long the 4^{th} character must be included even if it is a vowel. Commands are written in this section with the essential letters of a command in capital letters and the non-essential letters in lower case. The command to set the calibrator to the OPERATE state is ‘Output OFF’. This command could be sent as ‘Outp off’ and have the same effect as sending the entire command word.

Some items in a command word may be optional and these words will be printed between brackets, [ ]. In the example above, the complete command to set the calibrator to the OPERATE state would be written ‘OUTPUT:STATE OFF’. The word ‘STATE’ is optional and as such the command could be written as ‘OUTPUT OFF’ and have the same effect.

The following sections detail all the commands to which the calibrator will respond. The section title will list the command including all optional components, enclosed in [ ], followed by any input parameters. The function of each parameter will be discussed and several examples will follow illustrating the various forms the command can take.

Command				Page
CALIBRATION<3>	:CURRENT	*<Cal Point List>*		3-11
	:DUE	*yyyy,mm,dd*		
	:FREQUENCY	*<Cal Point List>*		
	:SAVE			
	[:STATE]	*OFF* *VOLTage* *CURRent* *VPHASe* *CPHASe*		
	:TABLE	:VOLTAGE	:AMPLITUDE	
			:PHASE	
		CURRENT	:AMPLITUDE	
			:PHASE	
	:TEMPERATURE	*<Value>*		
	:VOLTAGE	*<Cal Point List>*		
COMM<3>	:AMPLIFIER	*<String>*		3-22
	:COUNTER	*<String>*		
	:DSP	*<String>*		
DISPLAY<3>	:BRIGHTNESS	*ON* *OFF* *<value>*		3-23
	:COLOR	*<Fore>,<Back>*		
	:ENABLE	*ON* *OFF* *<value>*		
ENERGY<3>	:DELIVERED	:AMPLITUDE	*<value>*	3-28
		:MODE	*Off* *Voltage* *Current*	
		:TIME	*<value>*	
		:WARMUP	*<value>*	
	:INPUT<2>	:AMPLITUDE	*<value>*	
		:COUNTS	*<value>*	
		:EDGE	*Positive* *Negative*	
		:MODE	*Off* *Counter* *Timer* *External*	
		:PULLUP	*0* *1* *2*	
		:SCALE	*<value>*	
		:STATE?		
		:TIME	*<value>*	
	:MEASURE<2>	:AMPLITUDE?		
	:OUTPUT	:LEVEL	*High* *Low*	
		:MODE	*Off* *Front* *Rear* *Timer*	
		:PULSE	*Off* *On* *Once*	
		:TERMINALS	*Front* *Rear*	

Table 3-1
Remote Command Summary

Command					Page
MEASURE<3>	:TEMPERATURE?				3-65
	:LFREQUENCY?				
OUTPUT<3>	:PROTECTION	:DELAY?	*<value>*		3-68
	:REACTIVE	*ON* *OFF*			
	[:STATE]	*ON* *OFF* *<Value>*			
ROUTE<3>	[:TERMINALS]	*FRONT* *REAR*			3-72
SENSE<3>	[:VOLTAGE]	*INTERNAL* *EXTERNAL*			3-73
[SOURCE]	:CURRENT<3>	[:AMPLITUDE]	*<value>*		3-74
		:DISTORTION	:AMPLITUDE	*<value>*	
			:FLUCTUATE	*<value>*	
			:FREQUENCY	*<value>*	
			:MODE	*Off* *Harmonics* *Interharmonic* *Notching* *User*	
			:NUMBER	*<value>*	
			:PERIOD	*<value>*	
			:PHASE	*<value>*	
			:POINTS?		
		:EVENT	:AMPLITUDE	*<value>*	
			:DELAY	*<value>*	
			:DURATION	*<value>*	
			:EXIT	*<value>*	
			:FLICKER	*<value>*	
			:MODE	*Off* *Sag* *Swell* *Interruption*	
			:PERIOD	*<value>*	
			:REPEAT	*<value>*	
			:START	*<value>*	
		:PHASE	*<value>*		
	:FREQUENCY	*<value>*			
	:POWER<3>	*<value>*			
	:VOLTAGE<3>	[:AMPLITUDE]	*<value>*		
		:DISTORTION	:AMPLITUDE	*<value>*	
			:FLUCTUATE	*<value>*	
			:FREQUENCY	*<value>*	
			:MODE	*Off* *Harmonics* *Interharmonic* *Notching* *User*	
			:NUMBER	*<value>*	
			:PERIOD	*<value>*	
			:PHASE	*<value>*	
			:POINTS?		

Table 3-1
Remote Command Summary (Continued)

Command					Page
[SOURCE]	:VOLTAGE<3>	:EVENT	:AMPLITUDE	*<value>*	3-109
			:DELAY	*<value>*	
			:DURATION	*<value>*	
			:EXIT	*<value>*	
			:FLICKER	*<value>*	
			:MODE	*Off* *Sag* *Swell* *Interruption*	
			:PERIOD	*<value>*	
			:REPEAT	*<value>*	
			:START	*<value>*	
		:PHASE	*<value>*		
SYSTEM<3>	:BEEPER	[:IMMEDIATE]	*<freq>, <time>*		3-110
		:VOLUME	*<value>*		
	:DATE	<date>			
	:ERROR?				
	:LOCAL				
	:PASSWORD	:CDISABLE			
		[:CENABLE]	*<value>*		
		:NEW	*<value>*		
		:STATE?			
	:STATISTICS?				
	:TIME	<time>			
TRIGGER<3>	:AUTOSTART	*On* *Off*			3-121
	:DELAY	:CURRENT	*<value>*		
		:ENERGY	*<value>*		
		:VOLTAGE	*<value>*		
	:INITIATE				
UNIT<3>	:ANGLE	*DEG* *PF* *VF*			3-126
	:POWER	*VA* *WATT* *VAR*			
	:TEMPERATURE?	*C* *F*			

Table 3-1
Remote Command Summary (Continued)

Calibration Subsystem

The calibration subsystem includes the commands required to adjust and calibrate the Model 8100. Possible setting parameters are indicated in italics.

CALIBRATION<3>	:CURRENT	*<Cal Point List>*	
	:DUE	*yyyy,mm,dd*	
	:FREQUENCY	*<Cal Point List>*	
	:SAVE		
	[:STATE]	*OFF* *VOLTage* *CURRent* *VPHASe* *CPHASe*	
	:TABLE	:VOLTAGE	:AMPLITUDE
			:PHASE
		CURRENT	:AMPLITUDE
			:PHASE
	:TEMPERATURE	*<Value>*	
	:VOLTAGE	*<Cal Point List>*	

Current

CALIBRATION<3>	:CURRENT	*<Cal Point List>*

The Calibration Current command is used to select the current setting to be adjusted in either amplitude or phase.

The data to be supplied for the <Cal Point List> argument must be a value indicating the position of the desired Calibration Setting in the calibration point list.

0. 0.00600A
1. 0.01500A
2. 0.02000A
3. 0.05000A
4. 0.06000A
5. 0.15000A
6. 0.20000A
7. 0.50000A
8. 0.60000A
9. 1.50000A
10. 2.00000A
11. 5.00000A
12. 6.00000A
13. 10.0000A
14. 12.0000A
15. 20.0000A
16. 25.0000A
17. 50.0000A

This command is only active when the calibrator is in the calibration mode.

This command has the front panel equivalent of ‘Menu-System Settings-Calibration-Current Setting’.

Example To select the 5A calibration setting any of the following commands could be used.

```
CALIBRATION:CURRENT 11
CAL:CURR 11
Cal:Curr 11
```

Due

CALIBRATION<3>	:DUE	*yyyy,mm,dd*

The Calibration:Due command is used to set or return the calibration due date of the Model 8100. This date is determined by the user and is typically 1 year from the most recent calibration. The Model 8100 will generate a warning when this calibration date has passed.

The Calibration Due Date is entered in the format ‘yyyy,mm,dd’.

This command is only active when the calibrator is in the calibration mode.

This command has the front panel equivalent of ‘Menu-System Settings-Calibration-Cal Due’.

Example To set the calibration due date to 1 January 2003 any of the following commands could be used.

```
CALIBRATION:DUE 2003,01,01
CAL:DUE 2003,01,01
Cal:Due 2003,01,01
```

Frequency

CALIBRATION<3>	:FREQUENCY	*<Cal Point List>*

The Calibration Frequency command is used to select the frequency setting to be adjusted in either amplitude or phase.

The data to be supplied for the <Cal Point List> argument must be a value indicating the position of the desired Calibration Setting in the calibration point list.

18. 50.00 Hz
19. 60.00 Hz
20. 100.0 Hz
21. 400.0 Hz

This command is only active when the calibrator is in the calibration mode.

This command has the front panel equivalent of ‘Menu-System Settings-Calibration-Frequency Setting’.

Example To select the 50 Hz calibration setting any of the following commands could be used.

```
CALIBRATION:FREQUENCY 0
CAL:FREQ 0
Cal:Freq 0
```

Save

CALIBRATION<3>	:SAVE

The Calibration Save command is used to save any adjustments made to the calibrator and has no additional arguments.

This command is only active when the calibrator is in the calibration mode.

This command has the front panel equivalent of ‘Menu-System Settings-Calibration-Save’.

Example To save adjustments made to the Model 8100 any of the following commands could be used.

```
CALIBRATION:SAVE
CAL:SAVE
Cal:Save
```

State

CALIBRATION<3>	[:STATE]	*OFF* *VOLTage* *CURRent* *VPHASe* *CPHASe*

The Calibration State command is used activate the calibration mode of the Model 8100. This command must be issued before any of the other commands of the calibration subsystem will be activated. The System Password command must be issued before the Calibration State can be changed to any setting other than OFF. The Calibration State command has the following arguments.

- Off
- Voltage
- Current
- VPhase
- CPhase

Each of the calibration states is described in the following paragraphs.

Off The Calibration Off command disables the calibration mode and has the front panel menu equivalent of 'Off' on the 'Function' list of the 'Calibration' menu.

Voltage The Calibration Voltage command enables the calibration for the voltage amplitude function of the calibrator. When the command is issued the calibrator will change the voltage output setting to the calibration point closest in value to the present setting. The output frequency will also be set to the calibration frequency that is nearest to the present frequency setting. The Calibration Lowest and Calibration Next commands may then be used to move from one calibration point to the next. The calibrator will automatically set all other output parameters to the following settings.

Current	0.00000 A
Power	0.00000 VA
Phase	0.00000 °

Current

The Calibration Current command enables the calibration for the current amplitude function of the calibrator. When the command is issued the calibrator will change the current output setting to the calibration point closest in value to the present setting. The output frequency will also be set to the calibration frequency that is nearest to the present frequency setting. The Calibration Lowest and Calibration Next commands may then be used to move from one calibration point to the next. The calibrator will automatically set all other output parameters to the following settings.

Voltage	0.00000 V
Power	0.00000 VA
Phase	0.00000 °

Vphase

The Calibration Vphase command enables the calibration for the voltage phase function of the calibrator. When the command is issued the calibrator will change the voltage output setting to the calibration point closest in value to the present setting. The voltage phase setting is not usually displayed on single phase systems but this display becomes active in the voltage phase calibration mode. Refer to Chapter 2 for a description of the output setting display. The output frequency will also be set to the calibration frequency that is nearest to the present frequency setting. The Calibration Lowest and Calibration Next commands may then be used to move from one calibration point to the next. The calibrator will automatically set all other output parameters to the following settings.

Current	0.50000 A
Power	0.00000 VA
Phase	-90.0000 °

Cphase

The Calibration Cphase command enables the calibration for the current phase function of the calibrator. When the command is issued the calibrator will change the current output setting to the calibration point closest in value to the present setting. The output frequency will also be set to the calibration frequency that is nearest to the present frequency setting. The Calibration Lowest and Calibration Next commands may then be used to move from one calibration point to the next. The calibrator will automatically set all other output parameters to the following settings.

Voltage	120.000 V
Power	0.00000 VA
Phase	-90.0000 °

This command is only active when the calibrator is in the calibration mode.

This command has the front panel equivalent of ‘Menu-System Settings-Calibration-Mode’.

Example To set the Model 8100 to the Voltage Amplitude Calibration State any of the following commands could be used.

```
CALIBRATION:STATE VOLTAGE
CAL:STAT VOLT
Cal:Stat Volt
```

Table

CALIBRATION<3>	:TABLE	:VOLTAGE	:AMPLITUDE
			:PHASE
		CURRENT	:AMPLITUDE
			:PHASE

The Calibration Table command is used to extract or restore calibration constants from the Model 8100. Constants are extracted or restored in four blocks of constants for each calibration frequency. The blocks represent the functions of the calibration state command; Voltage Amplitude, Current Amplitude, Voltage Phase and Current Phase. A typical block of voltage amplitude calibration constants is shown below.

9.996779e+00,1.999403e+01,5.998056e+01,1.199605e+02,1.399492e+02,2.399116e+02,2.799099e+02,4.798535e+02,5.398823e+02,6.398588e+02

This command is only active when the calibrator is in the calibration mode.

This command has no front panel equivalent.

Example To extract the voltage amplitude calibration constants from the Model 8100 any of the following commands could be used.

```
CALIBRATION:TABLE:VOLTAGE:AMPLITUDE?
CAL:TABL:VOLT:AMPL?
Cal:Tabl:Volt:Ampl?
```

Temperature

CALIBRATION<3>	:TEMPERATURE	*<value>*

The calibration temperature function stores the internal temperature of the Model 8100 at the time of calibration. The front panel temperature display indicates the difference of the present internal temperature from the calibration temperature.

This command is only active when the calibrator is in the calibration mode.

This command has the front panel equivalent of 'Menu-System Settings-Calibration-Cal Temp C'.

Example To set the calibration temperature of the Model 8100 to 40 °C any of the following commands could be used.

```
CALIBRATION:TEMPERATURE 40
CAL:TEMP 40
Cal:Temp 40
```

Voltage

CALIBRATION<3>	:VOLTAGE	*<Cal Point List>*

The Calibration Voltage command is used to select the voltage setting to be adjusted in either amplitude or phase.

The data to be supplied for the <Cal Point List> argument must be a value indicating the position of the desired Calibration Setting in the calibration point list.

22. 10.0000 V
23. 20.0000 V
24. 60.0000 V
25. 120.000 V
26. 140.000 V
27. 240.000 V
28. 280.000 V
29. 480.000 V
30. 540.000 V
31. 640.000 V

This command is only active when the calibrator is in the calibration mode.

This command has the front panel equivalent of ‘Menu-System Settings-Calibration-Voltage Setting’.

Example To select the 120 V calibration setting any of the following commands could be used.

```
CALIBRATION:VOLTAGE 3
CAL:VOLT 3
Cal:Volt 3
```

Comm Subsystem

The Comm subsystem includes the commands required to pass commands directly to other devices connected the internal communications network of the model 8100. These devices include the DSP board, the Model 8140 Current Amplifier and the Model 8120 Counter Comparator. The commands of the Comm Subsystem are summarized below. Possible setting parameters are indicated in italics.

COMM<3>	:AMPLIFIER	*<String>*
	:COUNTER	*<String>*
	:DSP	*<String>*

Possible command strings for the Model 8120 and the Model 8140 are found in the operations manuals for each device. Low level commands for the internal DSP board of the Model 8100 are reserved for special applications and will be provided by the factory if needed.

These commands have no front panel equivalents.

Display Subsystem

The display subsystem includes the commands required to control the LCD display located on the front panel of the Model 8100. The commands of the Display Subsystem are summarized below. Possible setting parameters are indicated in italics.

DISPLAY<3>	:BRIGHTNESS	*ON* *OFF* *<value>*
	:COLOR	*<Fore>,<Back>*
	:ENABLE	*ON* *OFF* *<value>*

Brightness

DISPLAY<3>	:BRIGHTNESS	*ON* *OFF* *<value>*

The Display Brightness command controls the intensity of the backlight for the LCD display located on the front panel of the Model 8100. The command has the following arguments.

On

The Display Brightness ON command is used to activate the backlight illumination for the LCD display module located on the front panel of the Model 8100. This command is equivalent to the Display:Enable ON command and is included for compatibility with the Rotek Model 8000 Calibrator.

This command has no front panel equivalent.

Off

The Display Brightness OFF command is used to deactivate the backlight illumination for the LCD display module located on the front panel of the Model 8100. Display backlight life can be prolonged if the backlights are shut off when not required. This command is equivalent to the Display:Enable OFF command and is included for compatibility with the Rotek Model 8000 Calibrator.

This command has no front panel equivalent.

<value>

The Display Brightness command is used to control the intensity of the backlight illumination for the LCD display module located on the front panel of the Model 8100. The intensity is set as a percentage from 0% to 100%. A setting of 0% will cause the backlight to be quite dim, though not off. A setting of 100% will set the backlight to the maximum intensity. The default setting is 50%.

This command has the front panel keyboard equivalent of Menu-Display-Brightness.

Example 1

To activate the backlight for the front panel display any of the following commands may be sent.

```
DISP:BRIG ON
Display:Brightness On
```

Example 2

To deactivate the backlight for the front panel display any of the following commands may be sent.

```
DISP:BRIG OFF
Display:Brightness Off
```

Example 3 To set the backlight intensity of the front panel display to the default setting of 50% any of the following commands may be sent.

```
DISP:BRIG 50
Display:Brightness 50
```

Color

DISPLAY<3>	:COLOR	*Fore,Back*

The Display Color command controls the color of the backlight for the LCD display located on the front panel of the Model 8100. The command has an argument that provides the text color (Fore) and the Background Color (Back).

Possible color choices for both the Text and Background are listed below.

- Black
- White
- Red
- Yellow
- Green
- Blue

This command has the front panel keyboard equivalents of Menu-Display-Text Color and Menu-Display-Background Color.

Example To set the colors of the front panel display to Blue Text on a White Background any of the following commands may be sent.

```
DISPLAY:COLOR BLUE,WHITE
Disp:Color Blue,White
```

Enable

DISPLAY<3>	:ENABLE	*ON* *OFF* *<value>*

The Display Enable command controls the intensity of the backlight for the LCD display located on the front panel of the Model 8100. The command has the following arguments.

On

The ON setting is used to activate the backlight illumination for the LCD display module located on the front panel of the Model 8100.

This command has no front panel equivalent.

Off

The OFF setting is used to deactivate the backlight illumination for the LCD display module located on the front panel of the Model 8100. Display backlight life can be prolonged if the backlights are shut off when not required.

This command has no front panel equivalent.

<value>

The <value> setting is used as On and Off though values of 0 and 1 may be used to activate and deactivate the LCD backlight.

This command has no front panel equivalent.

Example 1

To activate the backlight for the front panel display any of the following commands may be sent.

```
DISP:ENABLE ON
Display:Enable On
```

Example 2

To deactivate the backlight for the front panel display any of the following commands may be sent.

```
DISP:Enable OFF
Display:Enable Off
```

Example 3

To deactivate the backlight for the front panel display any of the following commands may be sent.

```
DISPLAY:ENABLE 0
Display:Enable 0
```

Energy Subsystem

The Energy subsystem includes the commands required to control the energy meter testing functions of the Model 8100. The commands of the Energy Subsystem are summarized below. Possible setting parameters are indicated in italics.

ENERGY<3>	:DELIVERED	:AMPLITUDE	*<value>*
		:MODE	*Off* *Voltage* *Current*
		:TIME	*<value>*
		:WARMUP	*<value>*
	:INPUT<2>	:AMPLITUDE	*<value>*
		:COUNTS	*<value>*
		:EDGE	*Positive* *Negative*
		:MODE	*Off* *Counter* *Timer* *External*
		:PULLUP	*0* *1* *2*
		:SCALE	*<value>*
		:STATE?	
		:TIME	*<value>*
	:MEASURE<2>	:AMPLITUDE?	
	:OUTPUT	:LEVEL	*High* *Low*
		:MODE	*Off* *Front* *Rear* *Timer*
		:PULSE	*Off* *On* *Once*
		:TERMINALS	*Front* *Rear*

The Energy Subsystem provides the commands required for testing various types of energy meters.

The Model 8100 may be configured to deliver a precise amount of energy to the UUT or, using the built in two-channel pulse counter, measure the energy indicated by the UUT.

When the Model 8100 is configured to be a source of precise quantities of energy the delivered energy mode is used. This method of energy meter testing should be used with UUT's that have no other means than a display to indicate the energy measured.

UUT's equipped with pulse outputs may be tested using either the front or rear pulse counter inputs. Electro-Mechanical energy meters equipped with a rotating disc may be tested in this manner using the optional Optical Rotation Detector.

When the Model 8100 is testing energy meters equipped with pulse outputs, it is possible to compare one meter to an external energy reference such as the Rotek Model MSB100 Power and Energy Meter. When used in this way the Model 8100 acts only as a power source and measurement accuracy depends only on the external energy reference.

Delivered

ENERGY<3>	:DELIVERED	:AMPLITUDE	*<value>*
		:MODE	*Off* *Voltage* *Current*
		:TIME	*<value>*
		:WARMUP	*<value>*

When used in the delivered energy mode the Model 8100 will be configured to apply one output channel, either Voltage or Current, for a period of time to allow the UUT to warm-up while not registering any energy. Typically the Current is applied while the voltage is inhibited during the warm-up period though the Model 8100 may be configured to inhibit either the Voltage output or the Current output. During this period the display of the UUT should be reset to 0.

When the Warm-up period is complete, the inhibited channel is activated and the UUT begins to register energy. Simultaneously, the Model 8100 starts an internal timer measuring the time power has been applied to the UUT. The Model 8100 determines the duration of the test by dividing the requested energy by the power setting using the equation below.

$$Duration = \frac{Energy_{Setting}}{Power_{Applied}}$$

When the desired amount of energy has been delivered to the UUT the output of the calibrator will shut off and the calibrator will revert to the standby state. At this time the display of the UUT will indicate the amount of energy measured during the test.

The Trigger, as defined in the Trigger Setup menu, controls the initiation of a Delivered Energy test. When the Auto start option of the trigger is set to ‘On’, the Delivered Energy Test begins as soon as the Output State is set to ‘On’. The timing diagram in Figure 3-2 illustrates the sequence of events that occur when a delivered mode energy test is initiated with Auto start set to ‘On’. In this example the Current output is activated immediately while the Voltage channel is inhibited for the duration of the warm-up period. The current output and voltage output lines indicate the state of the voltage and current outputs. Low indicates no output and high indicates that the output is energized.

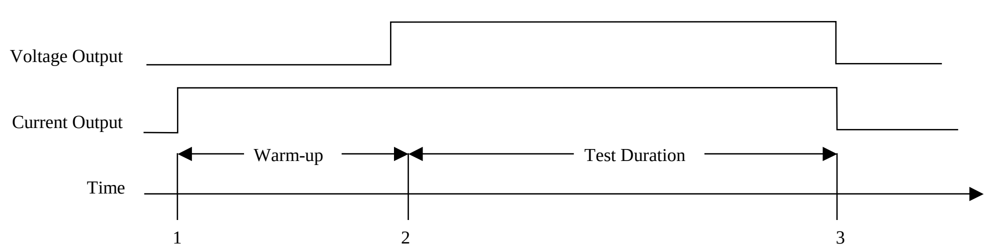

Figure 3-2
Delivered Energy Test Timing Diagram (Auto Start On)

Point 1 indicates when the output is set to ‘On’ and, since Auto Start is active, the trigger is also initiated. The current Channel is activated immediately while the Voltage Channel remains at 0. The outputs remain in this state until the warm-up period is complete. During this time the UUT is not registering any energy.

Point 2 indicates the conclusion of the warm-up period and the beginning of the portion of the test when energy is being delivered to the UUT. The Voltage Channel is activated and the internal timer starts counting down the time required for the test.

Point 3 indicates the conclusion of the test when both the voltage and the current outputs are shut off and the calibrator reverts to the Standby state. The UUT will indicate the energy measured.

When the Auto Start option of the trigger is set to ‘Off’, the Delivered Energy Test begins only after the trigger has been issued. If the trigger delay is set the delay occurs before the Delivered Energy test begins. With the Auto Start set to ‘Off’ the outputs both become active when the output is set to ‘On’. When the trigger is issued, one of the channels will be turned off for a period of time defined by the warm-up period.

The timing diagram in Figure 3-3 illustrates the sequence of events that occur when a Delivered Energy test is initiated with Auto start set to ‘Off’. In this example the Current output is activated immediately while the Voltage channel is inhibited for the duration of the warm-up period.

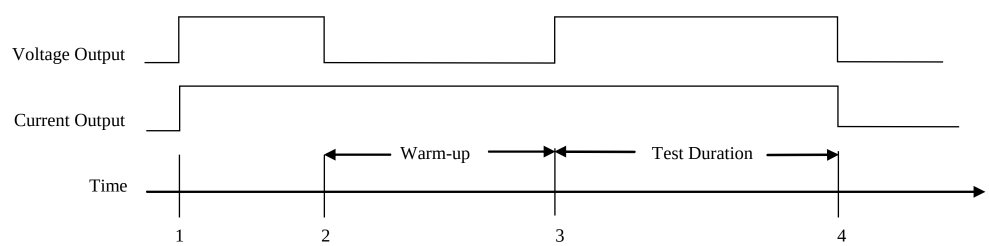

Figure 3-3
Delivered Energy Test Timing Diagram (Auto Start Off)

Point 1 indicates when the output is set to ‘On’. Both the voltage and the current channels become active.

Point 2 indicates the time at which the trigger is initiated. The current Channel remains active while the Voltage Channel is set to 0. The outputs remain in this state until the warm-up period is complete. During this time the UUT is not registering any energy and the display should be reset.

Point 3 indicates the conclusion of the warm-up period and the beginning of the portion of the test when energy is being delivered to the UUT. The Voltage Channel is activated and the internal timer starts counting down the time required for the test.

Point 4 indicates the conclusion of the test when both the voltage and the current outputs are shut off and the calibrator reverts to the Standby State. The UUT will indicate the energy measured.

When a Delivered Energy test is run, there are fixed errors due to the activation of the inhibited output channel. When the inhibited channel becomes active, the Model 8100 first waits for a zero crossing of the output waveform. Then the calibrator increases the amplitude from 0 to the full setting value. The correction circuitry of the Model 8100 will then stabilize the output over a period of approximately 20 cycles. The period of time from when the output channel is requested to become active and when the output is actually stabilized at the correct setting will be a period of time when the amplitude of the activating channel may not be within the specified accuracy limits.

The error associated with this stabilization period is a fixed error whose significance will be reduced as the test duration is increased. This error will become negligible with a sufficiently long test.

The number of energy meters that may be tested simultaneously using the Delivered Energy Mode of testing is limited only by the voltage compliance and current burden presented to the Model 8100 by the UUT.

When testing a single energy meter using the Delivered Energy Mode of the Model 8100 the UUT should be connect to the calibrator as shown in Figure 3-4.

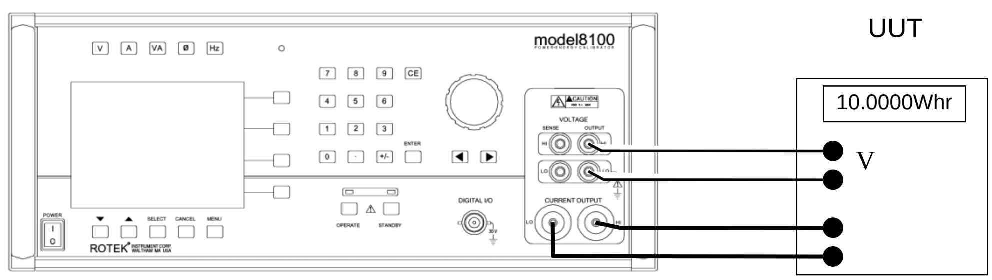

Figure 3-4
Delivered Energy UUT Connections (Single UUT Test)

When testing multiple energy meters using the pulse counters of the Model 8100 the UUT should be connect to the calibrator as shown in Figure 3-5. Note that the voltage inputs of the UUT are wired in parallel and the current inputs are wired in series so that both UUT's are energized by the same power.

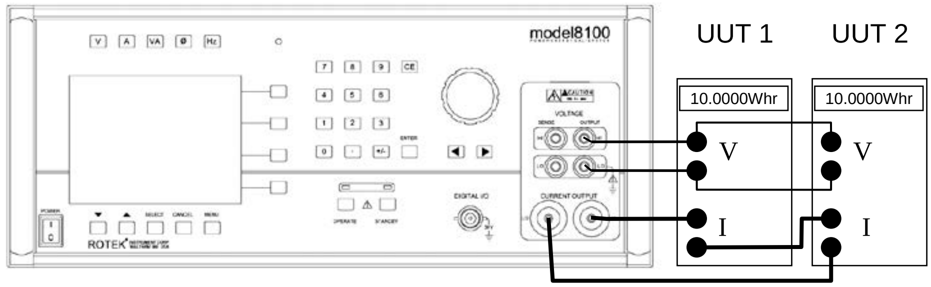

Figure 3-5
Delivered Energy UUT Connections (Multiple UUT Test)

Each of the commands required to perform a delivered energy test are discussed below.

Amplitude

ENERGY<3>	:DELIVERED	:AMPLITUDE	<*value*>

The amplitude command allows a numeric input defining the amount of energy to be delivered to the UUT during the test. The Amplitude setting is set to zero when there is no output power setting.

The Amplitude Setting is entered in units of Watthours.

The maximum energy delivered is defined by the maximum test time of 1000 hours. The maximum energy to be delivered can be calculated using the equation below.

$$Energy_{Max} = 1000 Hrs \times Power_{Applied}$$

For example, the maximum energy delivered with applied power of 600W would be 600kW.

The energy setting is dependant on the time setting. If the time setting is changed, the energy setting will be recalculated using the equation below.

$$Energy = Time \times Power_{Applied}$$

The time setting is also dependant on the energy setting. If the energy setting is changed, the time setting will be recalculated using the equation below.

$$Time = \frac{Energy}{Power_{Applied}}$$

It is important to note that the Delivered Energy Test will produce more accurate results when the test time is as long as possible.

Example To set the Model 8100 to deliver 10 Whr of energy to the UUT any of the following commands may be sent.

```
ENERGY:DELIVERED:AMPLITUDE 10
ENER:DEL:AMPL 10
```

Mode

ENERGY<3>	:DELIVERED	:MODE	*Off* *Voltage* *Current*

The Mode Command allows the user to select one of 3 modes of operation for the Delivered Energy function. The choices are as follows:

- Off
- Voltage
- Current

Setting the Mode to 'Off' will disable the Delivered Energy function.

Setting the Mode to 'Voltage' activates the Delivered Energy function and configures the Voltage Output to remain active during the warm-up period while the current channel is inhibited.

Setting the Mode to 'Current' activates the Delivered Energy function and configures the current output to remain active during the warm-up period while the voltage channel is inhibited.

Example To activate the delivered energy mode using the voltage warm-up mode any of the following commands may be sent.

```
ENERGY:DELIVERED:MODE VOLTAGE
ENER:DEL:MODE VOLTAGE
```

Time

ENERGY<3>	:DELIVERED	:TIME	<*value*>

The Time command allows a numeric input defining the duration of the delivered energy test. The default Time setting is 10 seconds.

The Time Setting is entered in units of Seconds.

The maximum time setting is 1000 Hours or 3,600,000 Seconds.

The time setting is dependant on the energy setting. If the energy setting is changed, the time setting will be recalculated using the equation below.

$$Time = \frac{Energy}{Power_{Applied}}$$

The energy setting is also dependant on the time setting. If the time setting is changed, the energy setting will be recalculated using the equation below.

$$Energy = Time \times Power_{Applied}$$

It is important to note that the Delivered Energy Test will produce more accurate results when the test time is as long as possible.

Example To set the duration of a delivered energy test to 60 seconds any of the following commands may be sent.

```
ENERGY:DELIVERED:TIME 60
ENER:DEL:TIME 60
```

Warmup

ENERGY<3>	:DELIVERED	:WARMUP	*<value>*

The Warmup command allows a numeric input defining the duration of the warm-up period for a delivered energy test. The Default warm-up time is 0 seconds.

The warm-up time is entered in units of Seconds.

The maximum warm-up time is 99999 Seconds or 27.8 Hours.

The warm-up time is the period of time when one of the output channels will be inhibited allowing the active channel to warm the input of the UUT to a stable temperature before the test begins. Typically the current channel remains on during the warm-up period and the voltage is inhibited though the Model 8100 supports both Voltage Warm-up and Current Warm-up.

During the warm-up time the UUT will not register any energy.

When the Trigger auto start mode is set to 'On' the warm-up time is initiated as soon as the output state is set to 'On'. The inhibited channel will remain off until the warm-up time is complete.

When the Trigger auto start mode is set to 'Off' the warm-up time is initiated as soon as the trigger is issued. In this mode both channels are active until the trigger is issued at which time the inhibited channel will be set to off for the duration of the warm-up period.

Refer to Figure 3-2 and Figure 3-3 for detailed descriptions of the operation of these two modes.

Example To set the warm-up period of a delivered energy test to 20 seconds any of the following commands may be sent.

```
ENERGY:DELIVERED:WARMUP 20
ENER:DEL:WARM 20
```

Input

ENERGY<3>	:INPUT<2>	:AMPLITUDE	*<value>*
		:COUNTS	*<value>*
		:EDGE	*Positive* *Negative*
		:MODE	*Off* *Counter* *Timer* *External*
		:PULLUP	*0* *1* *2*
		:SCALE	*<value>*
		:STATE?	
		:TIME	*<value>*

The Input Commands are used to configure the Model 8100 to test energy meters that generate pulse outputs.

The Model 8100 is equipped with a two-channel pulse counter/comparator that allows the testing of Watthour meters that are equipped with a pulse output. One input channel utilizes the Digital I/O connector located on the front panel and the second input channel utilizes the Digital I/O connector located on the rear panel. Refer to Figure 3-6 for an illustration detailing the locations of these connectors. Using the two standard counter input channels up to 2 meters may be tested simultaneously. If the Model 8120 Counter Comparator is connected to the accessory connector of the Model 8100, up to six meters under test may be connected simultaneously to channels 1 through 6 of the Model 8120.

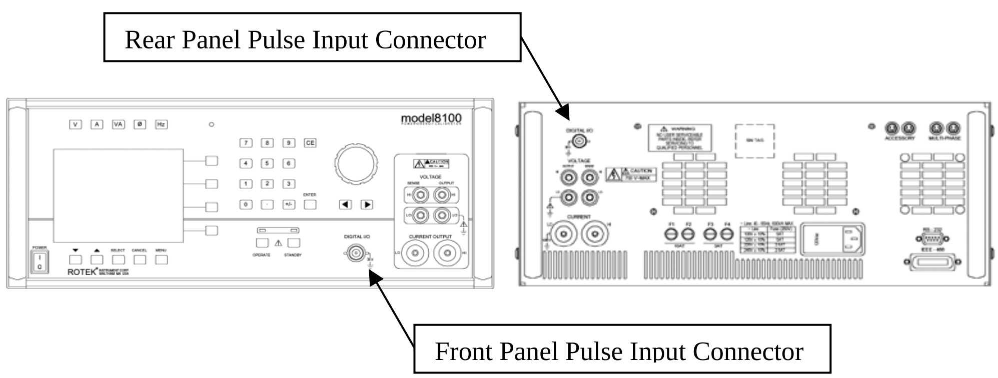

Figure 3-6
Pulse Input Connector Locations

When testing a single energy meter using the pulse counters of the Model 8100 the UUT should be connect to the calibrator as shown in Figure 3-7.

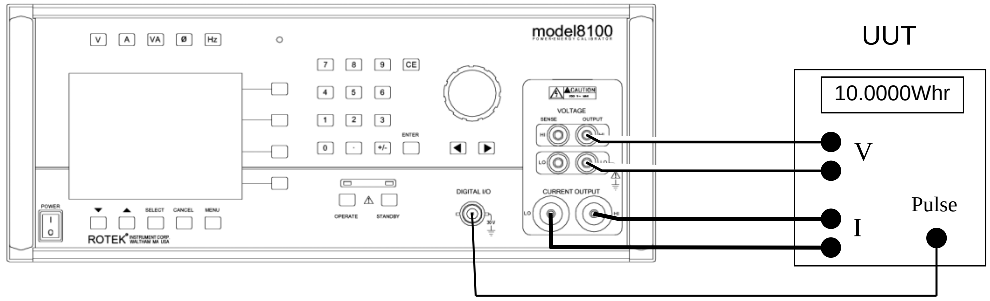

Figure 3-7
Pulse Counter UUT Connections (Single UUT Test)

When testing two energy meters using the pulse counters of the Model 8100 the UUT should be connect to the calibrator as shown in Figure 3-8. Note that the voltage inputs of the UUT are wired in parallel and the current inputs are wired in series so that both UUT's are energized by the same power.

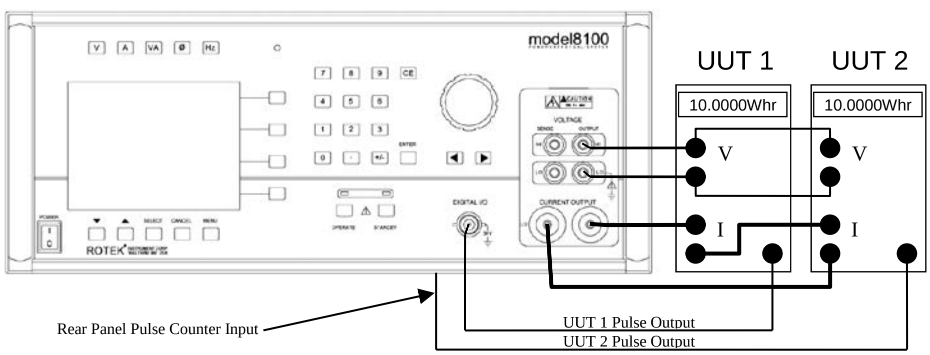

Figure 3-8
Pulse Counter UUT Connections (Two UUT Test)

The input circuit of the front counter is illustrated in Figure 3-9. A transient voltage suppressor, rated at 7V maximum, protects the pulse input. One of three resistors may be connected to the input as a pull-up to the +5V power supply. A 100Ω resistor limits the input current to a TTL compatible Schmitt Inverter that is used to transform slowly changing input signals into sharply defined, jitter-free signals. Finally, the input is optically isolated from the internal counter circuitry.

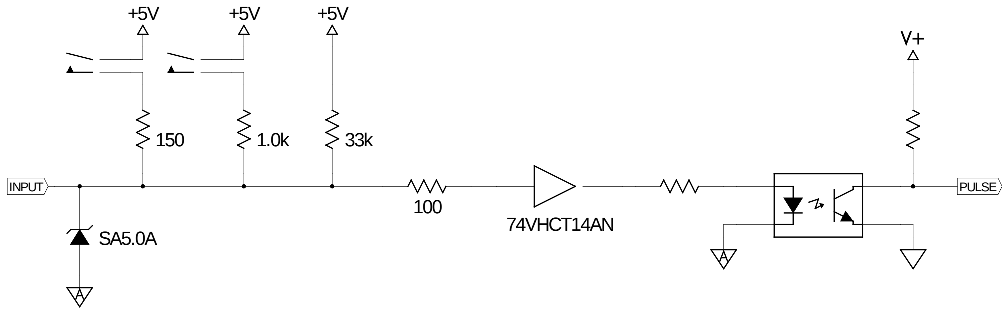

Figure 3-9
Counter Input Circuit

Each Model 8100 Counter Channel contains a 32 bit up-counter gated by a 32-bit down-counter. The counter may be configured to operate in one of the three modes listed below.

- Counter
- Timer
- External Reference

Counter Mode

When operating in the Counter Mode, the input of the down-counter is connected to the front Digital I/O connector and the input of the up-counter is connected to the internal 32 kHz clock. This configuration is illustrated in Figure 3-10. During the test the up-counter is gated by the down-counter with the result being the final number of counts in the up-counter. Counter Mode tests may be run simultaneous on the front and rear counters.

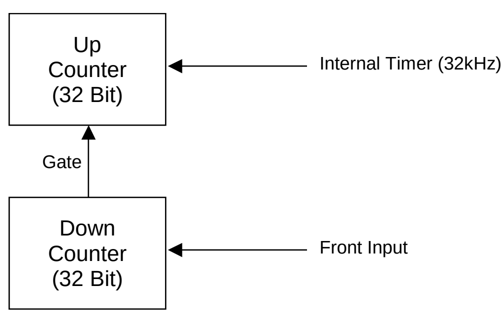

Figure 3-10
Counter Connections (Counter Mode)

When running a test using the counter mode, the initial value of the down-counter is set as a number of pulses from the UUT. The number of pulses may be entered directly or the Model 8100 will calculate this value from either the energy setting or the test time.

When a counter mode test is initiated the up-counter will accumulate counts from the internal clock at a rate of 32,768 counts per second while the value in the down-counter is reduced by 1 for each count received from the front input connector. When the down-counter reaches 0, the test is complete and the elapsed time measured in the up-counter represents the energy measured by the UUT. The Model 8100, using the equation below, calculates the measured energy and displays the test results in units of Whr.

$$Energy_{Measured} = Time_{Up-Counter} \times Power_{Applied}$$

The trigger, as defined in the Trigger Setup menu, controls the initiation of a Counter Mode Energy Test. The timing diagram in Figure 3-11 illustrates the sequence of events that occur when a counter mode energy test is initiated.

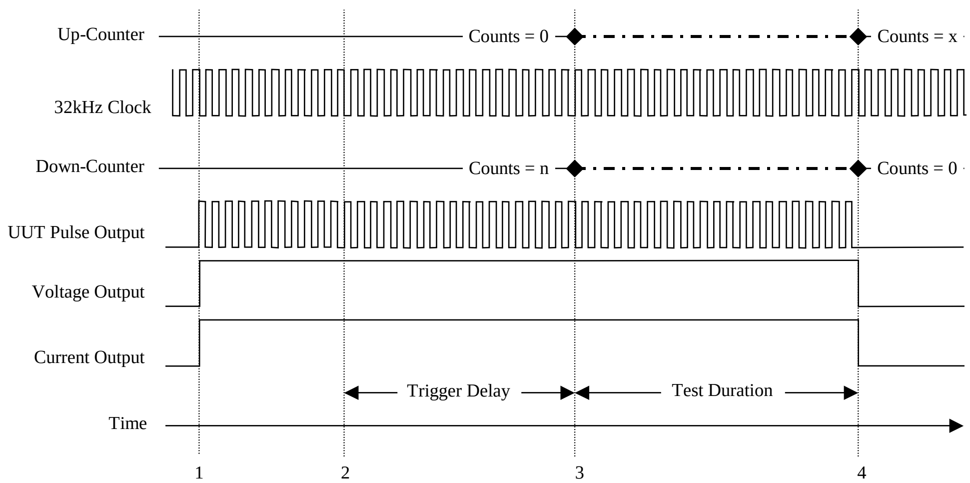

Figure 3-11
Counter Mode Energy Test Timing Diagram

1. The output state is set to ‘On’, activating both the voltage and the current outputs. The UUT will begin to output pulses as soon as power is applied.

   The pulses from the UUT are connected to the input of the down-counter according to the diagram in Figure 3-10. The down-counter value is set to *n* counts from the UUT and the down-counter is armed but not yet decrementing.

   The internal 32 kHz clock is available throughout the test and is connected to the input of the up-counter according to the diagram in Figure 3-10. The up-counter value is set to 0 counts from the 32 kHz Clock and the up-counter is armed but not yet incrementing.

2. The trigger is issued. If an Energy Test Trigger Delay has been set using the Trigger Menu, both the up-counter and down-counter remain armed until the Energy Test Trigger Delay period is complete.
3. The test begins. Every pulse received from the UUT reduces the down-counter value by 1. The up-counter value is increased by 1 for every pulse received from the 32 kHz timer.
4. The test is complete. When the value of the down-counter reaches 0, the incrementing of the up-counter is stopped. The value, x, of the up-counter is a representation of the time elapsed during the counting of n pulses from the UUT. The product of x times the applied power is the Energy measured by the UUT during the course of the test.

The maximum duration of a test in the counter mode is 36.4 hours using the internal 32,768 Hz clock. Since the up-counter is 32 bits wide, the maximum duration may be computed as follows:

$$Duration = \frac{2^{32}\,Pulses}{(32{,}768\,Pulses/Sec) \times (3600\,Sec/Hr)} = 36.41\,Hr$$

Timer Mode

When operating in the Timer Mode, the input of the down-counter is connected to the internal 32 kHz clock and the input of the up-counter is connected to either the Front or Rear Panel Digital I/O connector. This configuration is illustrated in Figure 3-12. During the test the up-counter is gated by the down-counter with the result being the final number of counts in the up-counter. Counter Mode tests may be run simultaneous on the front and rear counters.

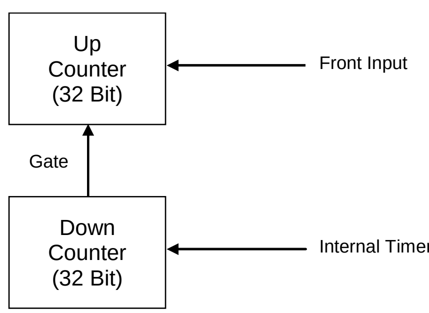

Figure 3-12
Counter Connections (Timer Mode)

When running a Timer mode test, the initial value of the down-counter is set as a number of pulses from the internal 32 kHz Clock. The number of pulses may be entered directly or the Model 8100 will calculate this value from either the energy setting or the test time.

The difference between the Timer Mode and the Counter Mode is that the final result stored in the up-counter is a value representing a quantity of energy measured by the

UUT during the period of time defined by the clock connected to the down-counter. The Model 8100, using the equation below, calculates the Energy measured by the UUT. The Model 8100 displays the test results as Watthours.

$$Energy_{Measured} = Pulses_{Up-Counter} \times ScaleFactor_{UUT}$$

The Trigger, as defined in the Trigger Setup menu, controls the initiation of a Timer Mode Energy Test. The timing diagram in Figure 3-13 illustrates the sequence of events that occur when a Timer Mode Energy Test is initiated.

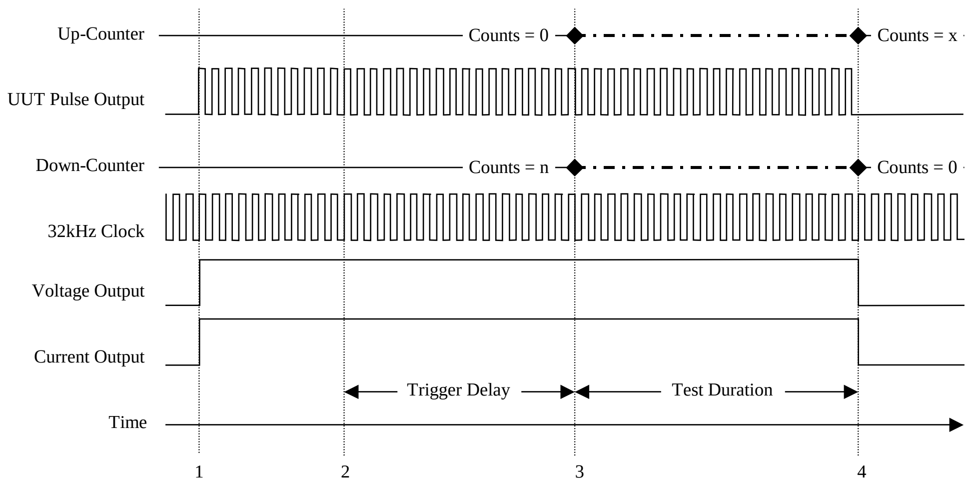

Figure 3-13
Timer Mode Energy Test Timing Diagram

1. The output state is set to 'On', activating both the voltage and the current outputs. The UUT will begin to output pulses as soon as power is applied.

   The internal 32 kHz clock is available throughout the test and is connected to the input of the down-counter according to the diagram in Figure 3-12. The down-counter value is set to *n* counts from the 32 kHz Clock and the down-counter is armed but not yet decrementing.

   The pulses from the UUT are connected to the input of the up-counter according to the diagram in Figure 3-12. The up-counter value is set to 0 counts from the UUT and the up-counter is armed but not yet incrementing.

2. The trigger is issued. If an Energy Test Trigger Delay has been set using the Trigger Menu, both the up-counter and down-counter remain armed until the Energy Test Trigger Delay period is complete.

3. The test begins. Every pulse received from the 32 kHz Clock reduces the down-counter value by 1. The up-counter value is increased by 1 for every pulse received from the UUT.

4. The Test is complete. When the value of the down-counter reaches 0, the incrementing of the up-counter is stopped. The value, x, of the up-counter is a representation of the energy measured during the counting of n pulses from the 32 kHz Clock. The product of x times the UUT Scale Factor is the Energy measured by the UUT during the course of the test.

The maximum duration of a test in the timer mode is 36.4 hours using the internal 32,768 Hz clock. Since the up-counter is 32 bits wide, the maximum duration may be computed as follows:

$$Duration = \frac{2^{32}\,Pulses}{(32{,}768\,Pulses/Sec)\times(3600\,Sec/Hr)} = 36.41\,Hr$$

External

When operating in the External Reference Mode, the input of the down-counter is connected to the pulse output of the UUT using either the Front or Rear Panel Digital I/O connector. The input of the up-counter is connected to the pulse output of the External reference using whichever Digital I/O connector is not in use for the UUT pulse connection. This configuration is illustrated in Figure 3-14. During the test the up-counter is gated by the down-counter with the result being the final number of counts in the up-counter.

The External Reference Mode allows a UUT to be compared directly to an external reference. When operating in this mode both the front and rear inputs will be used and either one may be configured as the UUT or Reference. Since the energy measured by the UUT is determined by the energy measured by the Reference the accuracy of the test is determined not by the accuracy of the Model 8100 but instead by the accuracy of the External Reference. To achieve optimal measurements using this mode an external reference equipped with a high-speed pulse output such as the Rotek Model MSB100 Power and Energy Standard is recommended.

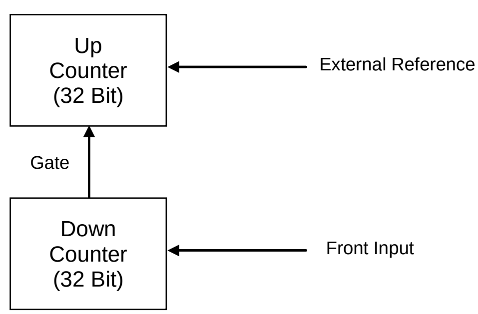

Figure 3-14
Counter Connections (External Reference Mode)

When running an External Reference mode test, the initial value of the down-counter is set as a number of pulses from the UUT. The number of pulses may be entered directly or the Model 8100 will calculate this value from either the energy setting or the test time.

When a test is initiated in the External Reference mode, the up-counter will accumulate counts from the External Energy Reference at a rate determined by the scale factor of the external reference and the applied power. Each count received from the UUT reduces the value in the down-counter by 1. When the down-counter reaches 0, the test is complete and the number of counts in the up-counter represents the energy measured by the UUT. The Model 8100, using the equation below, calculates the measured energy and displays the test results in units of Whr.

$$Energy_{Measured} = Counts_{Up-Counter} \times ScaleFactor_{External\ Reference}$$

The Trigger, as defined in the Trigger Setup menu, controls the initiation of an External Reference mode energy test. The timing diagram in Figure 3-15 illustrates the sequence of events that occur when an External Reference Mode Energy Test is initiated.

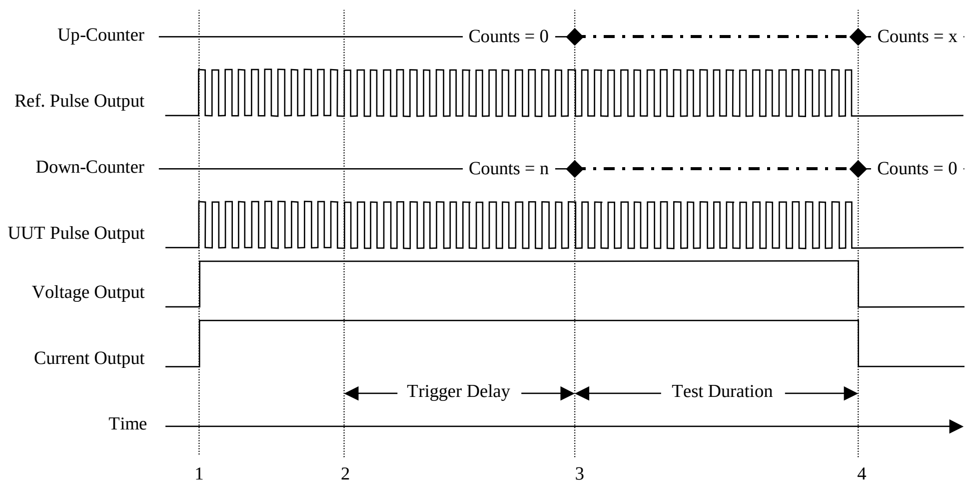

Figure 3-15
External Reference Mode Energy Test Timing Diagram

1. The output state is set to 'On', activating both the voltage and the current outputs. Both the UUT and the External Reference will begin to output pulses as soon as power is applied.

   The pulses from the UUT are connected to the input of the down-counter according to the diagram in Figure 3-14. The down-counter value is set to *n* counts from the UUT and the down-counter is armed but not yet decrementing.

   The pulses from the External Reference are connected to the input of the up-counter according to the diagram in Figure 3-14. The up-counter value is set to 0 counts from the external reference and the up-counter is armed but not yet incrementing.

2. The trigger is issued. If an Energy Test Trigger Delay has been set using the Trigger Menu, both the up-counter and down-counter remain armed until the Energy Test Trigger Delay period is complete.
3. The test begins. Every pulse received from the UUT reduces the down-counter value by 1. The up-counter value is increased by 1 for every pulse received from the External reference.
4. The Test is complete. When the value of the down-counter reaches 0, the incrementing of the up-counter is stopped. The value, *x*, of the up-counter is a representation of the energy measured by the External reference during the period of time defined by the counting of *n* pulses from the UUT. The product of *x* times the External reference Scale Factor is the Energy measured by the UUT during the course of the test.

Amplitude

ENERGY<3>	:INPUT<2>	:AMPLITUDE	*<value>*

The amplitude command allows a numeric input defining the amount of energy to be delivered to the UUT during the pulse counter energy test. The amplitude setting is set to zero when there is no output power setting.

The Energy Setting is entered in units of Watthours. The Energy Setting window has an auto-ranging feature to allow 6 digits of setting resolution even when values become quite small. For example, if an Energy Setting of 0.1 Whr is entered it will be re-formatted by the Model 8100 and displayed as 100.000mWhr. Always enter values in the units indicated. Continuing the previous example, to change the setting back to 1 Whr from 100.000mWhr a setting of 1000mWhr must be entered.

The maximum number of pulses that may be counted, 2^{32}, and the Scale Factor Setting define the maximum Energy Setting. The maximum Energy Setting can be calculated using the equation below.

$$Energy_{Max} = 2^{32} \times ScaleFactor$$

For example, the maximum Energy Setting for a meter with a scale factor of 10µWhr/ct would be 42,949.7 Whrs.

The Energy Setting is dependant on the Counts Setting. If the Counts Setting is changed, the Energy Setting will be recalculated using the equation below.

$$Energy = ScaleFactor \times Counts$$

The Energy Setting must always be the result of an integral number of input counts. Therefore, the Scale Factor Setting determines the resolution of the Energy setting. Meters with fast pulse rates will allow greater resolution and permit more flexibility in energy setting. If an Energy Setting is requested that does not result in an integral number of counts, the Model 8100 automatically determines the nearest Energy Setting that does correspond to an integral number of counts.

The Energy Setting, Time Setting and Counts Setting are dependant on one another and are simply different ways to display the same setting.

Example To set the amount of energy to be measured on the front counter to 10 Whr any of the following commands may be sent.

```
ENERGY:INPUT1:AMPLITUDE 10
ENER:INPUT:AMPL 10
```

Counts

ENERGY<3>	:INPUT<2>	:COUNTS	*<value>*

The Counts command allows a numeric input defining the number of pulses to be counted from the UUT during the test.

The Counts Setting is entered in units of Counts. Counts are always entered as integers and the maximum number of counts is 2^{32}

The Energy Setting, Time Setting and Counts Setting are dependant on one another and are simply different ways to display the same setting. If the Time Setting or the Energy Setting is changed, the Counts Setting will be recalculated using the equation below.

$$Counts = \frac{Energy}{ScaleFactor}$$

Example To set the number of pulses to be counted on the front counter to 50,000 any of the following commands may be sent.

```
ENERGY:INPUT1:COUNTS 50000
ENER:INPUT:COUN 50000
```

Edge

ENERGY<3>	:INPUT<2>	:EDGE	*Positive* *Negative*

The Input Edge command configures the pulse counter to count on either the rising or falling edge of the input pulse. If ‘Positive’ is selected pulses will be counted on the rising edge. If ‘Negative’ is selected pulses will be counted on the falling edge.

Example To configure the Model 8100 front counter to count on the rising edge of a pulse any of the following commands may be sent.

```
ENERGY:INPUT1:EDGE POSITIVE
ENER:INPUT:EDGE Positive
```

Mode

ENERGY<3>	:INPUT<2>	:MODE	*Off* *Counter* *Timer* *External*

The Mode command allows the user to select one of 4 modes of operation for the front or rear counter input channel. The choices are as follows:

- Off
- Counter
- Timer
- External

Setting the Mode to 'Off' will disable the Front Counter Input Channel.

When any of the other Counter modes are selected the Status area of the Front Panel LCD display will indicate the present state of both the front and the rear counter input channels. Figure 3-16 shows the Energy mode display.

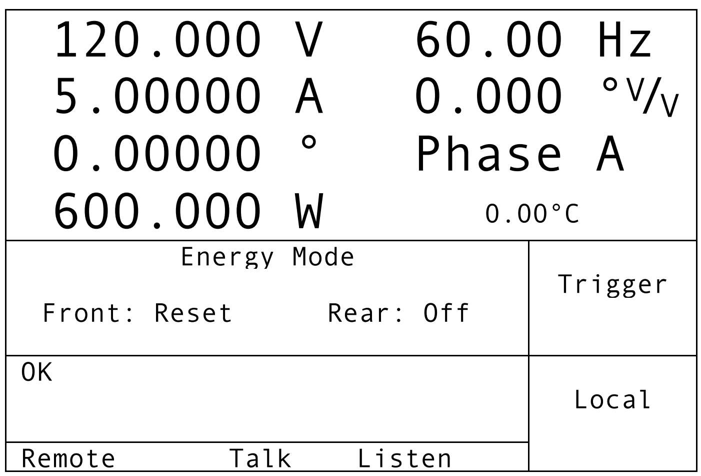

Figure 3-16
Energy Mode Display

The Status display indicates the state of each Counter input Channel as follows.

Reset
When one of the Counter Input Channels is activated using any of the counter modes, a status of 'Reset' is reported.

Armed
When the trigger is issued the status of all active Counter Input Channels is changed to 'Armed'. If the Trigger Delay is 0 the 'Armed' state lasts only until the first pulse

is counted. Otherwise, the 'Armed' Status is displayed for the duration of the Trigger Delay.

Counting
When pulses are being counted, the status of that Counter Input Channel is changed to 'Counting'.

Done
When one of the channels has completed the test the Status for that channel will be changed to indicate 'Done'. Since tests of differing duration may be setup for each Counter Input Channel one may finish before the other.

The functionality of the three counter modes of operation is described below. Detailed descriptions of each mode are included in the preceding section.

Counter
The Counter Mode allows a UUT to be calibrated directly against the Model 8100. The front and rear counter input channels may be configured to run two completely independent counter tests simultaneously.

When Operating in the Counter mode, the Model 8100 precisely measures the period of time required to count a number of pulses from the UUT. With this measured time and the applied power, the Model 8100 calculates the Energy measured by the UUT using the equation below.

$$Energy_{Measured} = Time \times Power_{Applied}$$

Timer
The Timer Mode allows a UUT to be calibrated directly against the Model 8100. The front and rear counter input channels may be configured to run two completely independent counter tests simultaneously.

The Timer Mode configures the Model 8100 to count the number of pulses generated by the UUT during a user-defined period of time. With these measured pulses and the Scale Factor (Whr/Pulse) for the UUT, the Model 8100 calculates the Energy measured by the UUT using the equation below.

$$Energy_{Measured} = Pulses_{UUT} \times ScaleFactor_{UUT}$$

Ext Ref
The External Reference Mode allows a UUT to be calibrated directly against an External Energy Reference. The front and rear counter input channels are both required to run a test in this mode. The UUT is connected to one of the Counter Input Channels and the External Energy Reference is connected to the other.

When Operating in the External Reference Mode the Model 8100 precisely measures the number of pulses generated by the External Reference during the period of time required to count a user-defined number of pulses from the UUT. With these measured pulses and the Scale Factor (Whr/Pulse) for the External Reference, the Model 8100 calculates the Energy measured by the UUT using the equation below.

$$Energy_{Measured} = Pulses_{\text{Ext Ref}} \times ScaleFactor_{\text{Ext Ref}}$$

Example To configure the Model 8100 front counter to operate in the counter mode any of the following commands may be sent.

```
ENERGY:INPUT1:MODE COUNTER
ENER:INPUT:MODE Counter
```

Pullup

ENERGY<3>	:INPUT<2>	:PULLUP	*0* *1* *2*

The counter input of the Model 8100 includes a pull-up resistor to the internal 5V power supply. The value of this resistor may be changed to one of three values; 33kΩ, 1000Ω or 150Ω. Refer to Figure 3-9 for a detailed description of the counter input circuit of the Model 8100. The pull-up value is selected using a value 0,1 or 2 corresponding to the values of 33kΩ, 1000Ω or 150Ω.

Example To configure the Model 8100 front counter to use a 1000Ω pull-up resistor any of the following commands may be sent.

```
ENERGY:INPUT1:PULLUP 1
ENER:INPUT:PULL 1
```

Scale

ENERGY<3>	:INPUT<2>	:SCALE	*<value>*

The Scale command allows the user to enter the scale factor for the energy meter connected to a specific Counter Input Channel.

The Scale Factor of an energy meter indicates how much energy the meter has measured before it outputs one pulse. The Scale Factor setting has units of Whr/Count. The Scale Factor setting window has an auto-ranging feature to allow 6 digits of setting resolution even when values become quite small. For example, if a scale factor setting of 0.1 Whr/ct is entered it will be re-formatted by the Model 8100 and displayed as 100.000mWhr/ct. Always enter values in the units indicated. Continuing the previous example, to change the setting back to 1 Whr/ct from 100.000mWhr/ct a setting of 1000mWhr/ct must be entered.

The Scale Factor allows the Model 8100 to calculate the amount of Watthours that corresponds to a specific number of pulses generated by an energy meter. The Model 8100 uses the equation below to make this calculation.

$$Energy_{Measured} = Counts \times ScaleFactor$$

The example below describes a typical calculation of Measured Energy using measured counts and the Scale factor.

$$\begin{aligned}
Counts_{Total} &= 100{,}000 \\
ScaleFactor &= 10\mu Whr/ct \\
Energy_{Measured} &= Counts \times ScaleFactor \\
Energy_{Measured} &= 100{,}000(ct) \times 0.00001(Whr/ct) \\
Energy_{Measured} &= 1.00000Whr
\end{aligned}$$

Example To set the scale factor of the energy meter connected to the front counter to 10µWhr/Pulse any of the following commands may be sent.

```
ENERGY:INPUT1:SCALE 0.00001
ENER:INPUT:SCAL 0.00001
```

State?

ENERGY<3>	:INPUT<2>	:STATE?

The State command is a query only command that returns the present state of the counter. The strings returned reflect the energy status labels located on the front panel display. The State query can return 'Off', 'Reset', 'Armed', 'Counting' and 'Done'. Each state is described below.

Off
The Counter is not active.

Reset
The Counter has been initialized but the test has not been triggered.

Armed
The Test has been triggered and the counter is waiting for the first pulse.

Counting
The Test is running and the counter is counting pulses.

Done
The test is complete and the results are available.

Example To query the Model 8100 to determine the state of the front pulse counter any of the following commands may be sent.

```
ENERGY:INPUT1:STATE?
ENER:INPUT:Stat?
```

Time

ENERGY<3>	:INPUT<2>	:TIME	*<value>*

The Time command allows a numeric input defining the period of time over which the test will occur. The Time Setting is set to zero when there is no output power setting.

The Time Setting is entered in units of Seconds. While it is possible to enter time settings of less than 1 second, typical Energy tests will occur over at least several seconds.

The maximum number of pulses that may be counted, 2^{32}, the Scale Factor Setting and the Applied Power define the maximum Time Setting. The maximum Time Setting can be calculated using the equation below.

$$Time_{Max} = \frac{2^{32} \times ScaleFactor}{Power_{Applied}}$$

For example, the maximum Time Setting for a meter with a scale factor of 10µWhr/ct and 600W Applied Power would be 71.6 Hrs or 257,698 Seconds.

The Energy Setting, Time Setting and Counts Setting are dependant on one another and are simply different ways to display the same setting. If the Counts Setting is changed, the Time Setting will be recalculated using the equation below.

$$Time_{Max} = \frac{Counts \times ScaleFactor}{Power_{Applied}}$$

The Time Setting must always be the result of an integral number of input counts. Therefore, the Scale Factor Setting determines the resolution of the Time setting. Meters with fast pulse rates will allow greater resolution and permit more flexibility in Time Setting. If a Time Setting is requested that does not result in an integral number of Counts, the Model 8100 automatically determines the nearest Time Setting that does correspond to an integral number of counts.

Example To set the duration of an energy test to 60 seconds any of the following commands may be sent.

```
ENERGY:INPUT1:TIME 60
ENER:INPUT:TIM 60
```

Measure

ENERGY<3>	:MEASURE<2>	:AMPLITUDE?

The Measure Amplitude Command is used to return the results of a counter energy meter test. This command is a query only command that returns the measured energy in the following format.

0.00000e+00 Wh

Example To query the Model 8100 for the results of a completed energy test on the front counter any of the following commands may be sent.

```
ENERGY:MEASURE1:AMPLITUDE?
ENER: MEASURE:AMPL?
```

Output

ENERGY<3>	:OUTPUT	:LEVEL	*High* *Low*
		:MODE	*Off* *Front* *Rear* *Timer*
		:PULSE	*Off* *On* *Once*
		:TERMINALS	*Front* *Rear*

The Model 8100 is capable of generating an output signal to mark the beginning and end of an energy test. This signal may be used to gate functions of the UUT or other external devices. The output signal is provide at either the front or rear panel Digital I/O connector. Refer to Figure 3-6 for a detailed description of the location of each of these connectors. If a Digital I/O connector is already in use as a pulse input it may not be used as a pulse output.

The Output signal may be configured to function in one of two modes. In the 'On' mode the output is a single pulse that gates the entire test. This mode is illustrated in Figure 3-17.

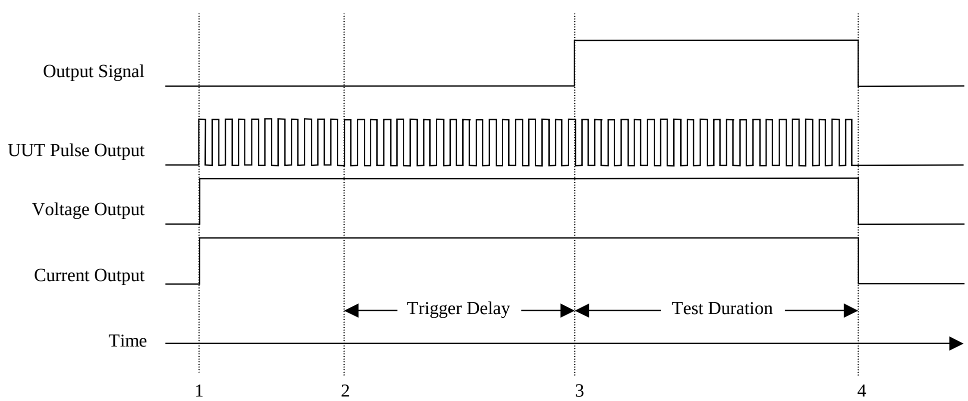

Figure 3-17
Output Signal Timing Diagram (Continuous Gate)

1. The Output State is set to ON, activating both the voltage and the current outputs. The UUT will begin to output pulses as soon as power is applied.
2. The Trigger is issued. If an Energy Test Trigger Delay has been set using the Trigger Menu, the Counter remains armed until the Energy Test Trigger Delay period is complete.
3. The test begins. The pulses from the UUT are being counted and the Output Gate Signal changes state. In this example the signal changes from the Normally Low State to the High State. The Output may be configured to be normally low or normally high.
4. The test is complete. The Output changes state again back to the normal state.

In the 'On' mode the output is a single pulse that gates the entire test. This mode is illustrated in Figure 3-18.

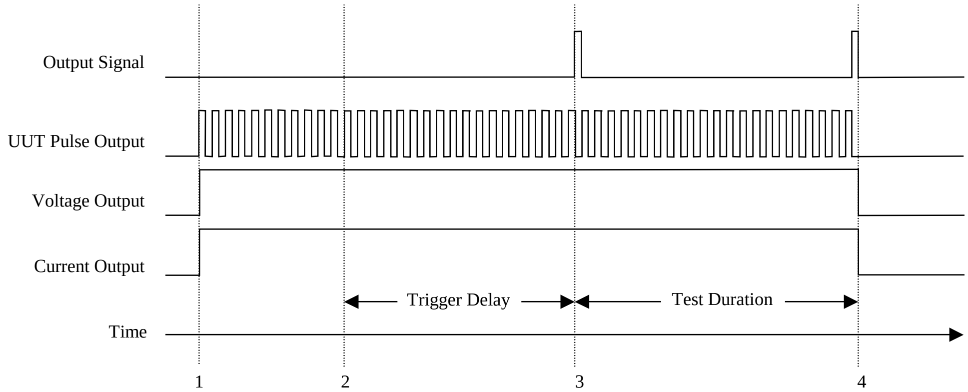

Figure 3-18
Output Signal Timing Diagram (Pulsed Gate)

1. The output is set to on, activating both the voltage and the current outputs. The UUT will begin to output pulses as soon as power is applied.
2. The Trigger is issued. If an Energy Test Trigger Delay has been set using the Trigger Menu, the Counter remains armed until the Energy Test Trigger Delay period is complete.
3. The test begins. The pulses from the UUT are being counted and the Output Gate Signal generates a pulse. In this example the signal changes from the Normally Low State to the High State. The Output may be configured to be normally low or normally high.
4. The Test is Complete. The Output generates another pulse marking the end of the test.

A common use of the Output signal is to Gate the display of a UUT that supports this function. In this way the results of an energy test may be displayed on the front panel of the UUT as well as the Model 8100.

Level

ENERGY<3>	:OUTPUT	:LEVEL	*High* *Low*

The active level of the output signal may be set using the output level command. The default setting is 'Low'.

When the Level is set to Low, the Output signal is normally low and becomes high when active.

When the Level is set to High, the Output signal is normally high and becomes Low when active.

The Level applies when the pulse mode is active as well.

Example To set the active level of the energy output to High any of the following commands may be sent.

```
ENERGY:OUTPUT:LEVEL HIGH
ENER:OUTP:LEV High
```

Mode

ENERGY<3>	:OUTPUT	:MODE	*Off* *Front* *Rear* *Timer*

There are four modes of operation for the Energy Output function; ‘Off’, ‘Front Counter’, ‘Rear Counter’ and ‘Timer’. The default setting for the Output Mode function of the Model 8100 is ‘Off’.

Setting the Output Mode to ‘Off’ will disable the Output function of the Model 8100.

When activated by selecting ‘Front’, ‘Rear’ or ‘Timer’ the output behave as described below.

Front
If the Gate Source is set to ‘Front Counter’ the output signal will remain active for the period of time that the front counter is counting pulses.

Rear
If the Gate Source is set to ‘Rear Counter’ the output signal will remain active for the period of time that the rear counter is counting pulses.

Timer
If the Gate Source is set to ‘Timer’ the output signal will be the internal 32 kHz clock (32,768Hz).

Example To set the Energy Output Mode to generate the output signal when the front channel is counting any of the following commands may be sent.

```
ENERGY:OUTPUT:MODE FRONT
ENER:OUTP:MODE Front
```

Pulse

ENERGY<3>	:OUTPUT	:PULSE	*Off* *On* *Once*

The output function of the Model 8100 may operate in three pulse modes; 'Off', 'On', and 'Once'. The default setting for the pulse function of the Model 8100 is 'Off'.

Setting the output pulse mode to 'Off' will disable the pulse function of the Model 8100. With pulse set to 'Off' the Output Signal will behave as a single gate of the energy test. Refer to Figure 3-17 for a timing diagram describing this mode of operation.

When activated by setting the pulse mode to 'On' or 'Once' the output will behave as described below.

On
The Pulse mode is activated and the normal behavior of the Output signal is modified so that the Output consists of two pulses gating the energy test. Refer to Figure 3-18 for a timing diagram describing this mode of operation.

Once
Selecting Once will send one discreet pulse to the output each time the mode is activated. This is useful when trying to synchronize external equipment that will be controlled by the Output Signal.

Example To deactivate the pulse mode any of the following commands may be sent.

```
ENERGY:OUTPUT:PULSE OFF
ENER:OUTP:PULS Off
```

Terminals

ENERGY<3>	:OUTPUT	:TERMINALS	*Front* *Rear*

The Output signal can be made available at either the 'Front' or 'Rear' Digital I/O terminals. The default setting for the Terminals function of the Model 8100 is 'Front'.

Selecting 'Front' will direct the Output Signal to the Front Digital I/O Connector. Selecting 'Rear' will direct the Output Signal to the Rear Digital I/O Connector. Refer to Figure 3-6 for a detailed description of the location of each of these connectors. If a Digital I/O connector is already in use as a pulse input it may not be used as a pulse output.

Example To set the energy output signal to be available at the rear Digital I/O terminals any of the following commands may be sent.

```
ENERGY:OUTPUT:TERMINALS REAR
ENER:OUTP:TERM REAR
```

Measure Subsystem

The measure subsystem includes the queries required to read various measured values from the Model 8100.

MEASURE<3>	:TEMPERATURE?
	:LFREQUENCY?

Temperature

MEASURE<3>	:TEMPERATURE?

The Measure Temperature query will return the internal temperature of the calibrator.

The Measure Temperature Query has no front panel menu equivalent.

Example To query the calibrator and return the internal temperature any of the following queries may be used.

```
MEAS:TEMP?
Measure:Temperature?
```

Lfrequency

MEASURE<3>	:LFREQUENCY?

The Measure Lfrequency query will return the frequency of the power line connected to the Model 8100.

The Measure Lfrequency Query has the front panel menu equivalent of Menu-Calibrator-Power Line Sync.

Example To query the calibrator and return the power line frequency any of the following queries may be used.

```
MEAS:LFREQUENCY?
Measure:Lfrequency?
```

Output Subsystem

The Output subsystem includes the commands and queries required to control the output of the Model 8100. Possible setting parameters are indicated in italics.

OUTPUT<3>	:PROTECTION	:DELAY?	*<value>*
	:REACTIVE	*ON* *OFF*	
	[:STATE]	*ON* *OFF* *<Value>*	

Protection Delay

OUTPUT<3>	:PROTECTION	:DELAY?	<*value*>

The Output Protection Delay is used to define the period of time that will elapse before the overload detection function of the calibrator is enabled. The overload detection function of the calibrator may be delayed for up to 8 seconds. The default setting is zero.

The Output Protection Delay has the front panel menu equivalent of 'Overload Delay' under the 'Calibrator' menu.

Example To delay the overload protection function of the calibrator for 4 seconds any of the following queries may be used.

```
OUTP:PROT:DEL 4
Output:Protection:Delay 4
```

Reactive

OUTPUT<3>	:REACTIVE	*ON* *OFF*

The Reactive command has two states; ‘On’ and ‘Off’. The default setting of the Model 8100 is ‘Off’.

Selecting ‘On’ will activate the Reactive Mode of the Model 8100 while ‘Off’ will deactivate the Reactive Mode.

Many older power and energy meters present highly inductive or capacitive loads to the calibrator. If this load is sufficiently high it will cause the calibrator to shut down indicating either a voltage or a current overload.

Example To set the reactive mode to ‘On’ any of the following queries may be used.

```
OUTP:REACTIVE ON
Output:Reactive On
```

State

OUTPUT<3>	[:STATE]	*ON* *OFF* *<Value>*

Output State is used to control the state of the calibrators output. Issuing the Output On command will cause the calibrator to go into the OPERATE mode. Issuing the Output OFF command will cause the calibrator to go into the STANDBY mode.

The values 0 and 1 may be used in the place of the text command arguments 'On' and 'Off'.

The Output State has the front panel front panel keyboard equivalent pressing the standby or operate keys.

Example 1 To turn on the calibrator output any of the following queries may be used.

```
OUTP ON
Output ON
Output:State ON
```

Example 2 To turn off the calibrator output any of the following queries may be used.

```
OUTP OFF
Output OFF
Output:State OFF
```

Route Subsystem

The Route Subsystem consists of only one command and is used to determine at which terminals the output is present. Setting the output to the front will cause the voltage and current outputs to be present at the front panel terminals. Setting the output to the rear will cause the voltage and current outputs to be present at the rear panel terminals.

ROUTE<3>	[:TERMINALS]	*FRONT* *REAR*

The Route Terminals command has the front panel menu equivalent of 'Output Terminals' under the 'Calibrator' menu.

Example 1

To direct the output to the front panel terminals any of the following command could be used.

```
ROUT FRONT
Route Front
Route:Terminals FRONT
```

Example 2

To direct the output to the rear panel terminals any of the following command could be used.

```
ROUT REAR
Route Rear
Route:Terminals Rear
```

Sense Subsystem

The Sense Subsystem consists of only one command and is used to determine whether the voltage output is sensed internally or externally.

SENSE<3>	[:VOLTAGE]	*INTERNAL* *EXTERNAL*

The Sense Terminals command has the front panel menu equivalent of ‘Voltage Sense’ under the ‘Calibrator’ menu.

Example 1

To set the voltage sensing to internal any of the following command could be used.

```
SENSE INTERNAL
Sense Internal
Sense:Voltage Internal
```

Example 2

To set the voltage sensing to external any of the following command could be used.

```
SENSE EXTERNAL
Sense External
Sense:Voltage External
```

Source Subsystem

The Source subsystem includes the commands required to control the output setting of each of the output parameters of the Model 8100. Possible setting parameters are indicated in italics.

[SOURCE]	:CURRENT<3>	[:AMPLITUDE]	*<value>*	
		:DISTORTION	:AMPLITUDE	*<value>*
			:FLUCTUATE	*<value>*
			:FREQUENCY	*<value>*
			:MODE	*Off* *Harmonics* *Interharmonic* *Notching* *User*
			:NUMBER	*<value>*
			:PERIOD	*<value>*
			:PHASE	*<value>*
			:POINTS?	
		:EVENT	:AMPLITUDE	*<value>*
			:DELAY	*<value>*
			:DURATION	*<value>*
			:EXIT	*<value>*
			:FLICKER	*<value>*
			:MODE	*Off* *Sag* *Swell* *Interruption*
			:PERIOD	*<value>*
			:REPEAT	*<value>*
			:START	*<value>*
		:PHASE	*<value>*	
	:FREQUENCY	*<value>*		
	:POWer<3>	[:AMPLitude]	*<value>*	
	:VOLTage<3>	[:AMPLitude]	*<value>*	
		:DISTORTION	:AMPLITUDE	*<value>*
			:FLUCTUATE	*<value>*
			:FREQUENCY	*<value>*
			:MODE	*Off* *Harmonics* *Interharmonic* *Notching* *User*
			:NUMBER	*<value>*
			:PERIOD	*<value>*
			:PHASE	*<value>*
			:POINTS?	
		:EVENT	:AMPLITUDE	<value>
			:DELAY	<value>
			:DURATION	<value>
			:EXIT	<value>
			:FLICKER	<value>
			:MODE	Off Sag Swell Interruption
			:PERIOD	<value>
			:REPEAT	<value>
			:START	<value>
		:PHASE	<value>	

Current

The Current command is used to control all aspects of the current output of the calibrator.

[SOURCE]	:CURRENT<3>	[:AMPLITUDE]	*<value>*	
		:DISTORTION	:AMPLITUDE	*<value>*
			:FLUCTUATE	*<value>*
			:FREQUENCY	*<value>*
			:MODE	*Off* *Harmonics* *Interharmonic* *Notching* *User*
			:NUMBER	*<value>*
			:PERIOD	*<value>*
			:PHASE	*<value>*
			:POINTS?	
		:EVENT	:AMPLITUDE	*<value>*
			:DELAY	*<value>*
			:DURATION	*<value>*
			:EXIT	*<value>*
			:FLICKER	*<value>*
			:MODE	*Off* *Sag* *Swell* *Interruption*
			:PERIOD	*<value>*
			:REPEAT	*<value>*
			:START	*<value>*
		:PHASE	*<value>*	

Amplitude

[SOURCE]	:CURRENT<3>	[:AMPLITUDE]	*<value>*

Current Amplitude controls the current output setting of the calibrator. The setting value must be a valid current output for the calibrator in units of A. A setting of 0A will disable the current output.

The Current Amplitude command has the front panel equivalent of entering the current setting in the output setting display.

Example 1 To set the current output setting to 5A any of the following commands could be used.

```
CURR 5
Current 5
Source:Current:Amplitude 5A
```

Example 2 To set the current output setting to 50mA any of the following commands could be used.

```
CURR 0.00005
Current 50mA
Source:Current:Amplitude .00005A
```

Phase

[SOURCE]	:CURRENT<3>	:PHASE	<*value*>

Current Phase controls the voltage to current phase relationship on any particular phase of the calibrator. The current phase setting may be any valid phase angle setting of the calibrator. The default units are whichever units have been selected in for Phase Angle Units in the 'User Preferences' Menu.

The Current Phase command has the front panel equivalent of entering the phase angle setting in the output setting display.

Example 1 To set the current to voltage phase to 0° any of the following commands could be used.

```
CURR:PHAS 0
Current:Phase 0Deg
Current:Phase 1.0PF
```

Example 2 To set the current to voltage phase to -90° any of the following commands could be used.

```
CURR:PHAS -90
Current:Phase -90Deg
Current:Phase -0PF
```

Distortion

[SOURCE]	:CURRENT<3>	:DISTORTION	:AMPLITUDE	*<value>*
			:FLUCTUATE	*<value>*
			:FREQUENCY	*<value>*
			:MODE	*Off* *Harmonics* *Interharmonic* *Notching* *User*
			:NUMBER	*<value>*
			:PERIOD	*<value>*
			:PHASE	*<value>*
			:POINTS?	

This function provides the controls to configure the type of distortion that will be applied to the current output of the Model 8100.

The type of distortion to be added to the voltage output is controlled by the Mode Command. The remaining Distortion Commands are used to configure the selected distortion function.

The available distortions include Harmonics, Fluctuating Harmonics, Inter-harmonics, Fluctuating Inter-harmonics, Notching and Fluctuating Notching. In addition the Model 8100 can accept user defined distortion waveforms.

Detailed descriptions of the various Distortion Modes available are described in the following paragraphs.

Mode

[SOURCE]	:CURRENT<3>	:DISTORTION	:MODE	*Off* *Harmonics* *Interharmonic* *Notching* *User*

The Mode Command determines which type of distortion will be added to the output and has the following choices.

- Off
- Harmonics
- Inter-Harmonic
- Notching
- User Defined

The default setting for the Mode Command of the Model 8100 is ‘Off’.

When any of the Distortion functions are activated the Distortion line in the Status area of the front panel display will change from ‘Distortion Off’ to a message that indicates the type of distortion applied to both the voltage and current outputs.

Figure 3-19 shows the front panel display with Harmonics added to the voltage output and no distortion added to the current output.

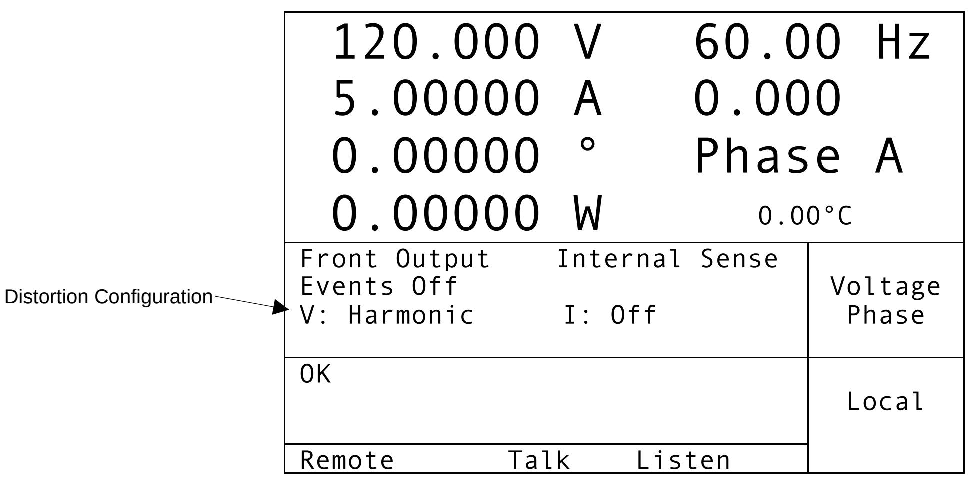

Figure **3-19**
Distortion Configuration Display

Harmonics

When the Harmonics Mode is selected a secondary, distortion waveform is added to the fundamental voltage output. This waveform will be a sine wave with a frequency that is an integral multiple of the fundamental frequency. To configure a harmonic to be added to the voltage fundamental, the following parameters must be defined using the menu items of the Voltage Distortion menu.

- Harmonic
- Amplitude
- Phase

The Harmonic may also be configured to fluctuate in amplitude. To configure a harmonic to fluctuate the Fluctuate command must be set to a non zero value.

The frequency of the secondary, distortion sine wave is specified as a multiple of the fundamental frequency and is referred to here as the Harmonic. The Model 8100 supports harmonics up to the 100th for fundamental frequencies of 45-65Hz. The amplitude of the distortion can be as large as 50% of the fundamental output amplitude. The phase relationship of the distortion to the fundamental can be specified as an angular phase shift.

Figure 3-20 shows both the fundamental and the distortion waveform when 25% of the 5th harmonic is added to the output with no phase shift between the distortion and the fundamental.

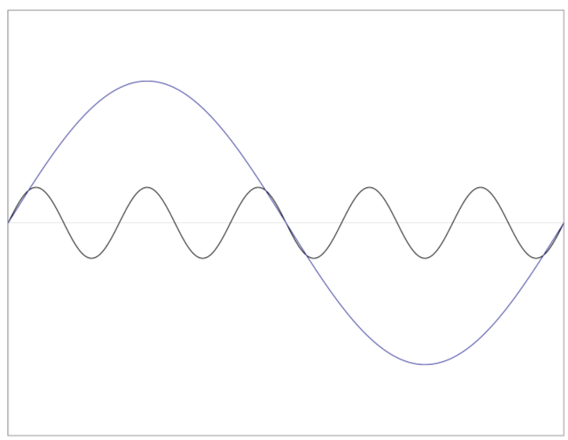

Figure 3-20
Fundamental and Harmonic Distortion Waveform (No Phase Shift)

Figure 3-21 shows the actual distorted output waveform when 25% of the 5th harmonic is added to the fundamental with no phase shift between the fundamental and the distortion waveform.

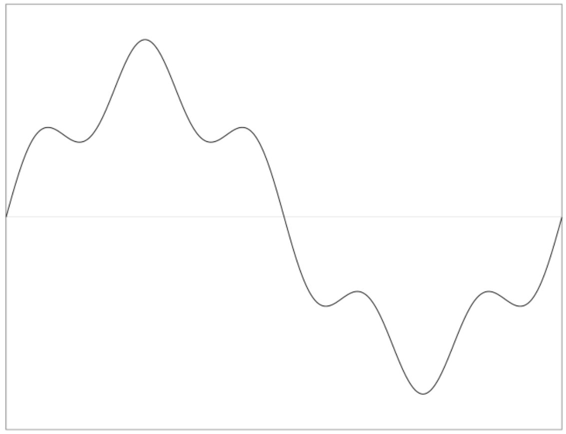

Figure 3-21
Harmonic Distorted Waveform (No Phase Shift)

Figure 3-22 shows both the fundamental and the distortion waveform when 25% of the 5^{th} harmonic is added to the output with a 60° phase shift between the distortion and the fundamental.

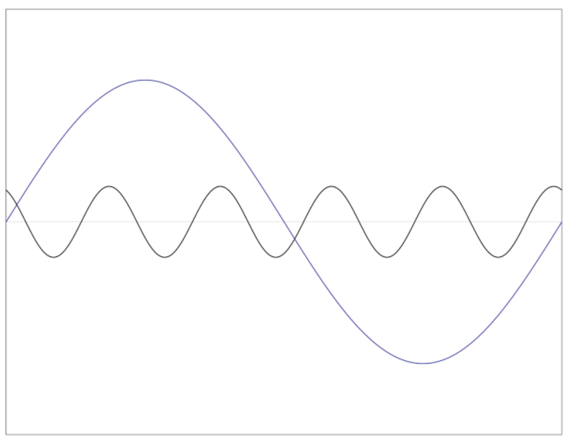

Figure 3-22
Fundamental and Harmonic Distortion Waveform (60° Phase Shift)

Figure 3-23 shows the actual distorted output waveform when 25% of the 5^{th} harmonic is added to the fundamental with a 60° phase shift between the fundamental and the distortion waveform.

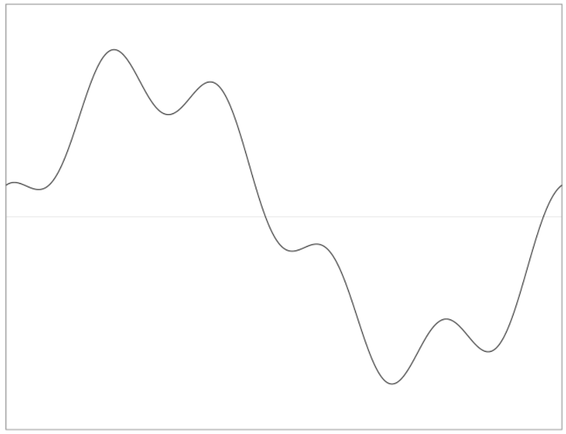

Figure 3-23
Harmonic Distorted Waveform (60° Phase Shift)

Inter-Harmonics

When the Inter-Harmonics function is selected a secondary waveform is added to the voltage output. This waveform will be a sine wave with a frequency that is independent of the fundamental frequency. To configure an Inter-Harmonic to be added to the output the following parameters must be defined using the menu items of the Voltage Distortion menu.

- Amplitude
- Phase

The frequency of the secondary sine wave is specified in Hz and is not related to the fundamental frequency. The amplitude of the distortion must be specified and can be as large as 50% of the fundamental output.

Notching

When the Notching function is selected periodic disturbance will be added to the voltage output. This disturbance will be a notch in the waveform with a fixed width of approximately 1/300th on a cycle. The notches will be placed at a regular interval throughout the cycle. To configure a notching disturbance to be added to the output the following parameters must be defined using the menu items of the Voltage Harmonics menu.

- Amplitude
- Frequency
- Phase

The frequency of the disturbance is specified in units of Notches/Cycle and is not related to the fundamental frequency. The amplitude of the disturbance must be specified and can be as large as 50% of the fundamental output. The phase relationship of notches to the start of the cycle must also be specified.

Figure 3-24 shows both the fundamental and the distortion waveform when a Notching distortion of 10 Notches per cycle is added to the output. The amplitude of the notches is 25% of the fundamental.

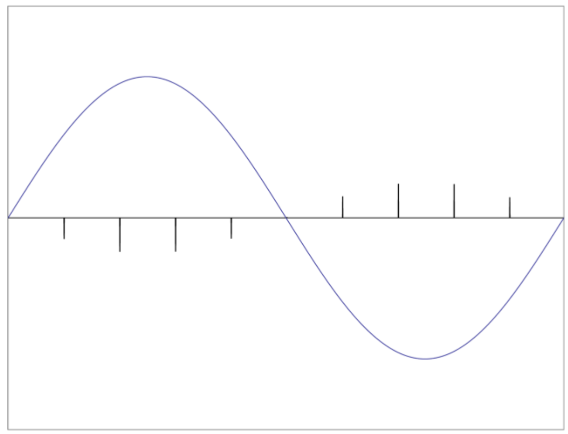

Figure 3-24
Fundamental and Notching Distortion Waveform

Figure 3-25 shows the actual distorted output waveform when a Notching distortion of 10 Notches per cycle is added to the output. The amplitude of the notches is 25% of the fundamental.

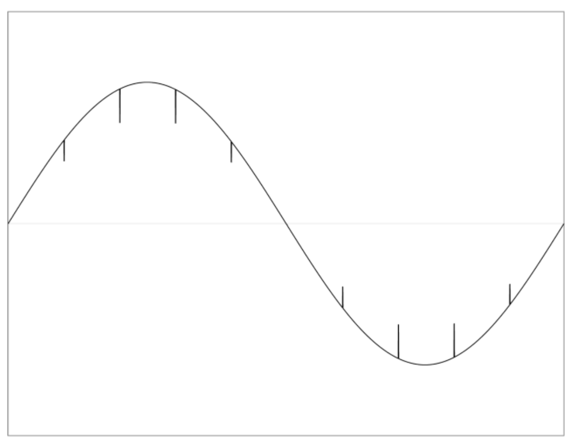

Figure 3-25
Notching Distorted Waveform

User Defined

When the User Defined function is selected a user-defined waveform will be added to the fundamental output waveform. The data points defining the waveform are entered via the remote interface, either the GPIB-488 or RS-232.

As with the previously described distortions, the distortion waveform is added to the output waveform to create an entirely customized distorted output waveform.

The maximum amplitude of the user-defined distortion is 50% of the fundamental.

Amplitude

[SOURCE]	:CURRENT<3>	:DISTORTION	:AMPLITUDE	<*value*>

The Amplitude Command allows the user to enter the amplitude of the distortion to be added to the fundamental waveform. The amplitude setting applies to all distortion functions.

The amplitude value is entered as a percentage of the fundamental amplitude and the default setting is 0.000%.

The minimum setting resolution is 0.001%. The maximum setting is 50%.

Example To set the amplitude of the applied distortion to be 20% of the fundamental any of the following commands could be used.

```
CURRENT:DISTORTION:AMPLITUDE 20
Current:DIST:AMPL 20
Current:Dist:Ampl 20
```

Fluctuate

[SOURCE]	:CURRENT<3>	:DISTORTION	:FLUCTUATE	*<value>*

The Fluctuate Command is used to activate and de-activate the Fluctuating function of the Model8100. If the Fluctuate Command has values of 0 or 1 corresponding to 'Off' and 'On'. The default setting for the Input Edge function of the Model 8100 is 0.

The Fluctuate function configures the applied distortion to be static or fluctuating. If the Fluctuate Mode is set to 'On', the amplitude of the applied distortion will fluctuate, modulated by a square wave. The period of the modulating square wave is selected using the Fluctuate Period Menu item.

The Fluctuate setting applies to all distortion functions.

Example

To activate the fluctuate mode causing the amplitude of the applied distortion to flutuatel any of the following commands could be used.

```
CURRENT:DISTORTION:FLUCTUATE 1
Current:DIST:FLUC 1
Current:Dist:Fluc 1
```

Frequency

[SOURCE]	:CURRENT<3>	:DISTORTION	:FREQUENCY	<*value*>

The Frequency Command allows the user to enter the frequency of the Inter-harmonic to be added to the fundamental waveform. The Frequency setting applies to only the Inter-harmonic function.

Example To set the frequency of an inter-harmonic to 220Hz any of the following commands could be used.

```
CURRENT:DISTORTION:FREQUENCY 220
Current:DIST:FREQ 220
Current:Dist:Freq 220
```

Number

[SOURCE]	:CURRENT<3>	:DISTORTION	:NUMBER	*<value>*

The Number Command allows the user to enter the number of the harmonic to be added to the fundamental waveform. The harmonic setting only applies to the Harmonic distortion function.

The harmonic value is entered as an integer from 2 to 100.

The actual frequency of the distortion waveform depends on the frequency of the fundamental. The frequency of the distortion waveform is calculated as follows.

$$Frequency_{Distortion} = Harmonic \times Frequency_{Fundamental}$$

For example, if the fundamental frequency is 60Hz and the 5^{th} harmonic is added to the waveform, the actual frequency of the distortion waveform will be 300Hz. Refer to Figure 3-20 for an illustration of this waveform.

Example To set the number of the harmonic to be added to the fundamental to the 5^{th} harmonic any of the following commands could be used.

```
CURRENT:DISTORTION:NUMBER 5
Current:DIST:NUMB 5
Current:Dist:Numb 5
```

Period

[SOURCE]	:CURRENT<3>	:DISTORTION	:PERIOD	<*value*>

The Period Command allows the user to enter the period of the square wave that will modulate the amplitude of the applied distortion when the Fluctuate Mode is Active. The Default Setting of the Fluctuate Period Setting is 2 cycles.

The maximum setting for the Fluctuate Period setting is 9999.0 cycles and the minimum setting is 0.5 cycles. The setting resolution is 0.5 cycles.

The Fluctuate Period setting applies to all distortion functions and is applied only when the Fluctuate mode is set to 'On'.

Example To set the set the period of the modulating square wave to 2 cycles any of the following commands could be used.

```
CURRENT:DISTORTION:PERIOD 2
Current:DIST:PER 2
Current:Dist:Per 2
```

Phase

[SOURCE]	:CURRENT<3>	:DISTORTION	:PHASE	*<value>*

The Phase Command allows the user to enter the Phase angle of harmonic distortion relative to the fundamental waveform. The Phase setting applies to only the Harmonic Distortion function.

The Phase setting has units of degrees and may be set to any angle from +180° to –180°. The minimum setting resolution is 1°.

Example To set the phase angle of the harmonic waveform to the fundamental to 60° any of the following commands could be used.

```
CURRENT:DISTORTION:PHASE 60
Current:DIST:PHAS 60
Current:Dist:Phas 60
```

Points?

[SOURCE]	:CURRENT<3>	:DISTORTION	:POINTS?

The Points Command is a query only command that returns the number of points output in one cycle of the reference waveform. The number points in the reference waveform depend on the fundamental frequency setting.

Example To query the Model 8100 for the number of points in one cycle of the output waveform any of the following commands could be used.

```
CURRENT:DISTORTION:POINTS?
Current:DIST:POIN?
Current:Dist:Poin?
```

Event

[SOURCE]	:CURRENT<3>	:EVENT	:AMPLITUDE	*<value>*
			:DELAY	*<value>*
			:DURATION	*<value>*
			:EXIT	*<value>*
			:FLICKER	*<value>*
			:MODE	*Off* *Sag* *Swell* *Interruption*
			:PERIOD	*<value>*
			:REPEAT	*<value>*
			:START	*<value>*

The Event Commands provide the functions required to configure the type of event that will be applied to the output of the Model 8100.

The type of event to be applied to the output is controlled by the Event Mode Command. The remaining Event commands are used to configure the selected event function.

The available events include Sags, Swells, interruptions and Flicker.

Events may be configured to occur once or to repeat continuously. If an event is configured to repeat, then the period of time that will elapse between events may be set.

Detailed descriptions of the various Event Types available for the Voltage output channel are described in the following paragraphs.

Mode

[SOURCE]	:CURRENT<3>	:EVENT	:MODE	*Off* *Sag* *Swell* *Interruption*

The Mode Command is used to select one of the Follow Events to apply to the Output of the Model 8100.

- Off
- Sag
- Swell
- Interruption

The default setting for the Event Mode of the Model 8100 is 'Off'.

When any of the Events are activated the Event line in the Status area of the front panel display will change from 'Events Off' to a message that indicates the type of event that is applied to both the voltage and current outputs. Figure 3-26 shows the front panel display with a sag event applied to the voltage output and no events applied to the current output.

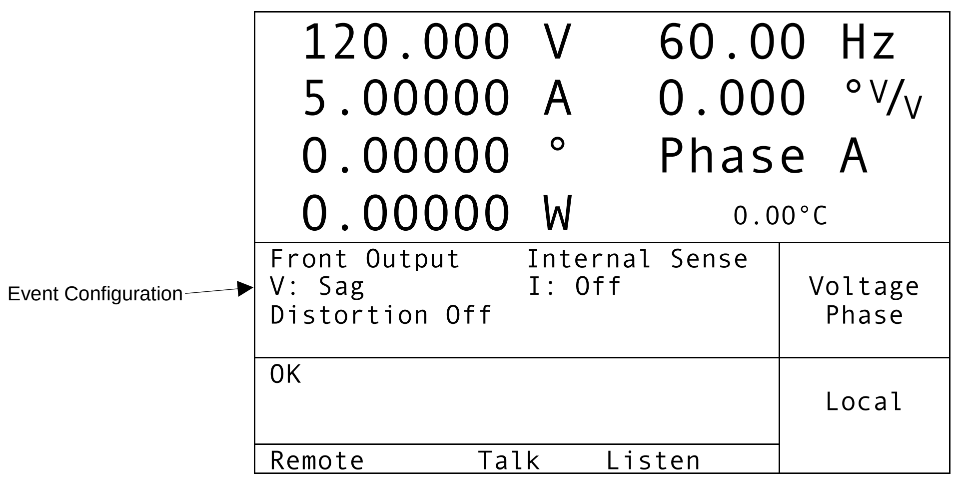

Figure 3-26
Event Configuration Display

The Flicker function is achieved by 'Flickering' either a sag event or a swell event. The Flicker Mode menu item is used to activate flicker when either sag or swell Event Type is selected.

The Trigger, as defined in the Trigger Setup menu, controls the initiation of events applied to the voltage output.

Sag When the Sag Mode is selected the voltage output will be configured to simulate a Sag Event. To configure a Sag event to be applied to the voltage output channel, the following parameters must be defined using the following commands from the Event command.

- Event:Start
- Event:Duration
- Event:Exit
- Event:Amplitude

During a Sag event the voltage output will drop from the nominal amplitude to a pre-defined Sag amplitude. The reduced amplitude will be held for a period of time and then the amplitude will be return to the nominal setting.

The duration of a sag event may be set in units of either Seconds or Cycles, with a minimum setting of 0.5 Cycles. The amplitude is defined as a percentage of the nominal amplitude with maximum sag of 99% of the nominal.

Figure 3-27 illustrates a sag event with an amplitude setting of 20% and a duration of 10 Cycles.

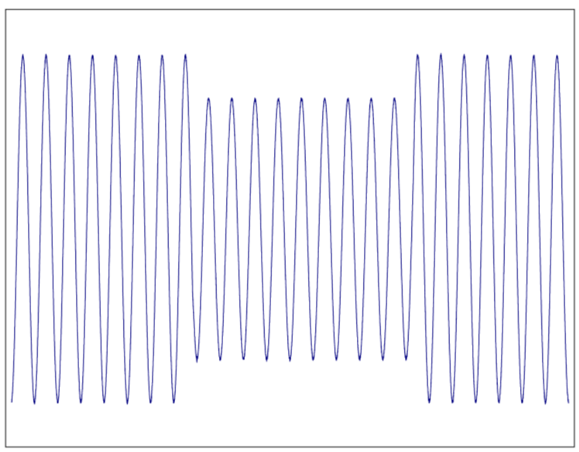

Figure 3-27
Sag Event with No Ramp

Sag events may include a start ramp, exit ramp or both. During the ramp time the amplitude will change in a linear manner from the amplitude at the beginning of the ramp to the amplitude at the end of the ramp.

The Start Ramp and Exit Ramp are defined in units of Seconds or Cycles and the minimum setting resolution is 0.5 Cycles.

Figure 3-28 illustrates a Sag Event with an amplitude setting of 20% of the nominal. The Start Ramp, Duration and Exit ramp are all set to 4 Cycles.

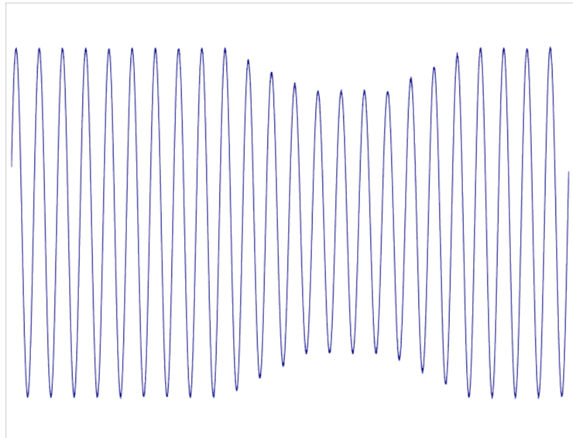

Figure 3-28
Sag Event with Ramping

Swell When the Swell Mode is selected the voltage output will be configured to simulate a swell event. To configure a Swell Event to be applied to the voltage output channel, the following parameters must be defined using the following commands from the Event command.

- Event:Start
- Event:Duration
- Event:Exit
- Event:Amplitude

During a swell event the voltage output will rise from the nominal amplitude to a pre-defined swell amplitude. The increased amplitude will be held for a period of time and then the amplitude will be return to the nominal setting.

The duration of a swell event may be set in units of either Seconds or Cycles, with a minimum setting of 0.5 Cycles. The amplitude is defined as a percentage of the nominal amplitude with maximum swell of 199% of the nominal.

Figure 3-29 illustrates a swell event with an amplitude setting of 20% and a duration of 10 Cycles.

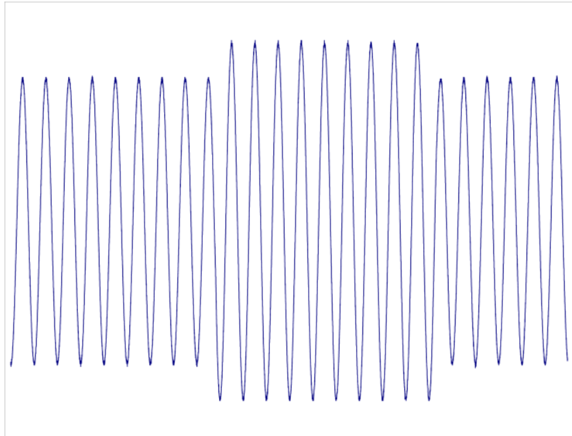

Figure 3-29
Swell Event Without Ramping

Swell events may include a start ramp, exit ramp or both. During the ramp time the amplitude will change in a linear manner from the amplitude at the beginning of the ramp to the amplitude at the end of the ramp.

The Start Ramp and Exit Ramp are defined in units of Seconds or Cycles and the minimum setting resolution is 0.5 Cycles.

Figure 3-30 illustrates a swell event with an amplitude setting of 20% of the nominal. The Start Ramp, Duration and Exit ramp are all set to 4 Cycles.

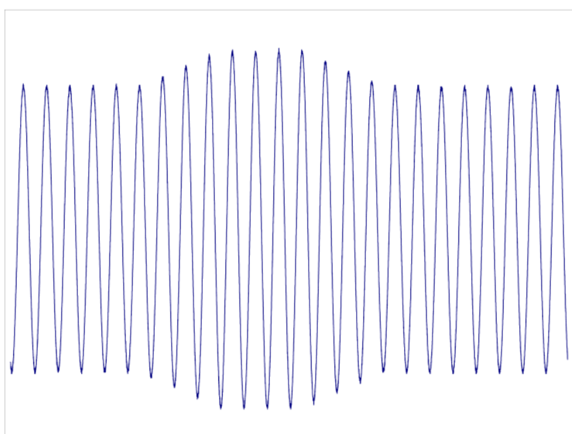

Figure 3-30
Swell Event With Ramping

Interruption

When the Interruption Mode is selected the voltage output will be configured to simulate an interruption event. To configure an interruption event to be applied to the voltage output channel, the following parameters must be defined using the following commands from the Event command.

- Event:Duration
- Event:Amplitude

During an interruption event the voltage output will drop from the nominal amplitude to zero. The amplitude will be held at zero for a period of time and then the amplitude will be return to the nominal setting.

The duration of an interruption event may be set in units of either Seconds or Cycles, with a minimum setting of 0.5 Cycles.

Figure 3-31 illustrates an interruption event with a duration setting of 10 Cycles.

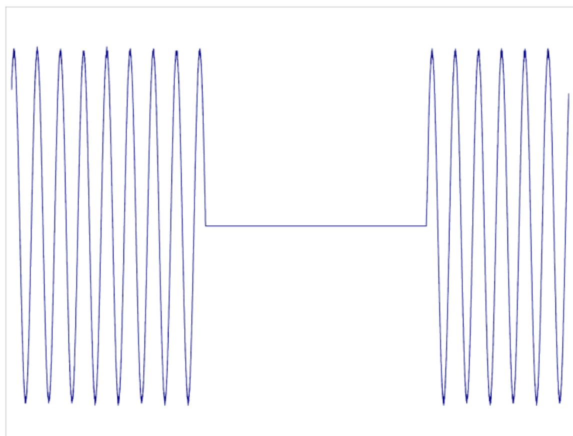

Figure 3-31
Interruption Event

Flicker

The voltage output may be configured to flicker by setting the Flicker Mode to ‘On’. The Flicker Mode may affect either Sag or Swell events. When applying Flicker to a Sag Event the amplitude of the sag will be modulated at a frequency defined by the flicker period. When applying Flicker to a Swell Event the amplitude of the swell will be modulated at a frequency defined by the flicker period.

When applying Flicker a Sag or Swell Event type must be selected. To configure a Sag or Swell Event to flicker on the voltage output channel, the following parameters must be defined using the following commands from the Event command.

- Event:Start
- Event:Duration
- Event:Exit
- Event:Flicker
- Event:Period
- Event:Amplitude

When Flicker is applied to a swell event, the voltage output will behave as defined for a swell event but the output amplitude will be modulated at a rate defined by the flicker period setting. During the event the output will continuously rise to the swell amplitude and drop back to the nominal amplitude.

When Flicker is applied to a sag event, the voltage output will behave as defined for a sag event but the output amplitude will be modulated at a rate defined by the flicker period setting. During the event the output will continuously fall to the sag amplitude and rise back to the nominal amplitude.

The flicker period may be set in units of either Seconds or Cycles, with a minimum setting of 0.5 Cycles.

Figure 3-32 illustrates a flickering sag event with an amplitude setting of 20% and flicker period of 4 Cycles.

Figure 3-32
Flicker Event

Amplitude

[SOURCE]	:CURRENT<3>	:EVENT	:AMPLITUDE	*<value>*

The Amplitude command allows the user to enter the amplitude of the event to be applied to the voltage output. The amplitude setting only applies to Sag and Swell events. The amplitude of an interruption event is always zero.

The amplitude value is entered as a percentage of the fundamental amplitude and the default setting is 0.0000%.

The Amplitude setting resolution is 0.0001%. The maximum amplitude setting for a sag event is 100% for a sag amplitude setting that is 0% of the nominal setting. The maximum Amplitude setting for a swell event is 100% for a swell amplitude setting that is 200% of the nominal setting. The minimum amplitude setting for both sag and swell events is 0.0000%.

Figure 3-27 and Figure 3-29 illustrate both a sag and swell event with an event amplitude setting of 20%.

Example To set the amplitude of the event applied to the current output to 20% of the nominal output setting any of the following commands could be used.

```
CURRENT:EVENT:AMPLITUDE 20
Current:EVEN:AMPL 20
Current:Even:Ampl 20
```

Delay

[SOURCE]	:CURRENT<3>	:EVENT	:DELAY	*<value>*

The Delay command allows the user to enter the period of time that will elapse between activation of the event. The Repeat Delay only has an effect when the Repeat Mode is set to 'On'.

The Repeat Delay value is entered in units of Seconds or Cycles and the default setting is 0.0000 Seconds.

The Repeat Delay setting resolution is 0.5 Cycles. The maximum Repeat Delay setting is 9999.0 Cycles. The minimum Repeat Delay setting is 2.0000 Cycles.

Example To set the period of time the event will be delayed after the global trigger is initiated to 5 seconds any of the following commands could be used.

```
CURRENT:EVENT:DELAY 5
CURR:EVEN:DEL 5
Curr:Even:Del 5
```

Duration

[SOURCE]	:CURRENT<3>	:EVENT	:DURATION	<*value*>

The Duration Command allows the user to enter the period of time over which an event will occur. The Duration setting applies to all events.

The period of time defined by the duration setting does not include the times defined by the Start Ramp or Exit Ramp. If the Start Ramp and Exit Ramp settings are 0.0000 then the total time of the event will be the time defined by the duration setting. If the Start Ramp and Exit Ramp settings are non-zero, then the total time of the event will be the time defined by the sum of the duration setting, Start Ramp setting and the Exit ramp setting.

The Duration value is entered in units of either Seconds or Cycles and the default setting is 1.0000 Second.

The Duration setting resolution is 0.5 Cycles. The maximum Duration setting is 9999.0 Cycles or Seconds. The minimum Duration setting is 0.0000 Cycles or Seconds.

Figure 3-27 and Figure 3-29 illustrate both a sag and swell event with an event duration setting of 10 Cycles.

Example To set the duration the event to 10 seconds any of the following commands could be used.

```
CURRENT:EVENT:DURRATION 10
CURR:EVEN:DURR 10
Curr:Even:Durr 10
```

Exit

[SOURCE]	:CURRENT<3>	:EVENT	:EXIT	*<value>*

The Exit Command allows the user to enter the period of time over which the amplitude setting will change from the sag or swell amplitude back to the nominal amplitude setting.

If the Exit Ramp value is set to zero, the Sag or Swell amplitude setting will change immediately to the nominal setting when the event is triggered. The Exit Ramp setting only applies to Sag and Swell events.

The Exit Ramp value is entered in units of either Seconds or Cycles and the default setting is 0.0000 Second.

The Exit Ramp setting resolution is 0.5 Cycles. The maximum Exit Ramp setting is 9999.0 Cycles or Seconds. The minimum Exit Ramp setting is 0.0000 Cycles or Seconds.

Figure 3-28 and Figure 3-30 illustrate both sag and swell events with start ramp, duration and exit ramp settings of 4 Cycles.

Example To set the period of time over which the amplitude setting will change from the sag or swell amplitude back to the nominal amplitude setting to 5 seconds any of the following commands could be used.

```
CURRENT:EVENT:EXIT 5
CURR:EVEN:EXIT 5
Curr:Even:Exit 5
```

Flicker

[SOURCE]	:CURRENT<3>	:EVENT	:FLICKER	*<value>*

The Flicker Command is used to active the Flicker Mode. The Flicker values of 0 and 1 correspond to Flicker Modes of ‘Off’ and ‘On’.

The default setting for the ‘Flicker Mode’ is 0.

When the Flicker Mode is set to ‘On’ the amplitude of the selected event will be modulated by a square wave with a frequency defined by the Flicker Period setting.

When the Event Type is set to ‘Sag’, activating the Flicker Mode will cause the output amplitude to move between the nominal amplitude setting and the Sag amplitude setting at a rate defined by the flicker period setting.

When the Event Type is set to ‘Swell’, activating the Flicker Mode will cause the output amplitude to move between the nominal amplitude setting and the Swell amplitude setting at a rate defined by the flicker period setting.

When the Event Type is set to ‘Interruption’, activating the Flicker Mode will cause the output amplitude to move between the nominal amplitude setting and the zero at a rate defined by the flicker period setting.

Figure 3-32 illustrates a Sag Event with the Flicker Mode set to ‘On’. The Flicker period is set to 4 Cycles.

Example To activate the flicker mode any of the following commands could be used.

```
CURRENT:EVENT:FLICKER 1
CURR:EVEN:FLIC 1
Curr:Even:Flic 1
```

Period

[SOURCE]	:CURRENT<3>	:EVENT	:PERIOD	*<value>*

The Period Command allows the user to enter the period of the square wave that will modulate the event amplitude setting causing the output to Flicker.

The Flicker Period value is entered in units of Cycles and the default setting is 2.0000 Cycles.

The Flicker Period setting resolution is 0.5 Cycles. The maximum Flicker Period setting is 9999.0 Cycles. The minimum Flicker Period setting is 2.0000 Cycles.

Figure 3-32 illustrates a Sag Event with the Flicker Mode set to ‘On’. The Flicker period is set to 4 Cycles.

Example To set the period of the square wave that will modulate the event amplitude to 4 cycles any of the following commands could be used.

```
CURRENT:EVENT:PERIOD 4
CURR:EVEN:PER 4
Curr:Even:Per 4
```

Repeat

[SOURCE]	:CURRENT<3>	:EVENT	:REPEAT	*<value>*

The Repeat Command is used to activate the repeat mode of the event. The values 0 and 1 correspond to the settings of ‘On’ and ‘Off’.

The default setting for the ‘Repeat Mode’ is ‘Off’.

When the Repeat Mode is set to ‘On’ the selected event will be repeated indefinitely after it is triggered initially. The period of time between activation of the event is set using the Repeat Delay setting.

Example To activate the repeat mode any of the following commands could be used.

```
CURRENT:EVENT:REPEAT 1
CURR:EVEN:REP 1
Curr:Even:Rep 1
```

Start

[SOURCE]	:CURRENT<3>	:EVENT	:START	*<value>*

The Start Command allows the user to enter the period of time over which the amplitude setting will change from the nominal amplitude to the sag or swell amplitude.

If the Start Ramp value is set to zero, the nominal amplitude setting will change immediately to the Sag or Swell amplitude setting when the event is triggered. The Start Ramp setting only applies to Sag and Swell events.

The Start Ramp value is entered in units of either Seconds or Cycles and the default setting is 0.0000 Second.

The Start Ramp setting resolution is 0.5 Cycles. The maximum Start Ramp setting is 9999.0 Cycles or Seconds. The minimum Start Ramp setting is 0.0000 Cycles or Seconds.

Figure 3-28 and Figure 3-30 illustrate both sag and swell events with start ramp, duration and exit ramp settings of 4 Cycles.

Example To set the period of time over which the amplitude setting will change from the nominal amplitude to the sag or swell amplitude to 5 seconds any of the following commands could be used.

```
CURRENT:EVENT:START 5
CURR:EVEN:STAR 5
Curr:Even:Start 5
```

Frequency

[Source]	:FREQUENCY	<*value*>

The Frequency command is used to set the fundamental frequency of the calibrator. The valid frequency settings are between 16Hz and 1kHz.

The Frequency command has the front panel equivalent of entering the frequency setting in the output setting display.

Example 1 To set the output frequency of the calibrator to 50Hz any of the following commands could be used.

```
FREQ 50
Frequency 50
Frequency 50.00
```

Example 2 To set the output frequency of the calibrator to 60.05 Hz any of the following commands could be used.

```
FREQ 60.05
Frequency 60.05
```

Power

[Source]	:POWer<3>	*<value>*

The Power command is used to set the output power of the calibrator. When a new power setting is set the calibrator will compute the current setting which is required to by the new power setting with no change to the voltage setting. If the units are not included the setting units are those set using the UNIT:POWER command. Units of W, VA and VAR are acceptable.

The Power Amplitude command has the front panel equivalent of entering the power setting in the output setting display.

Example 1 To set the phase A output power of the calibrator to 600W with the power units already set to Watts any of the following commands could be used.

```
POW 600
Power 600
Power 600W
```

Example 2 To set the phase C output power of the calibrator to 300VA with the power units already set to Watts any of the following commands could be used.

```
POW3 300VA
Power3 300VA
```

Voltage

[SOURCE]	:VOLTage<3>	[:AMPLitude]	*<value>*	
		:DISTORTION	:AMPLITUDE	*<value>*
			:FLUCTUATE	*<value>*
			:FREQUENCY	*<value>*
			:MODE	*Off* *Harmonics* *Interharmonic* *Notching* *User*
			:NUMBER	*<value>*
			:PERIOD	*<value>*
			:PHASE	*<value>*
			:POINTS?	
		:EVENT	:AMPLITUDE	<value>
			:DELAY	<value>
			:DURATION	<value>
			:EXIT	<value>
			:FLICKER	<value>
			:MODE	Off Sag Swell Interruption
			:PERIOD	<value>
			:REPEAT	<value>
			:START	<value>

The Voltage commands are identical to the current commands described in the preceding section.

System Subsystem

The System subsystem includes the commands required to control miscellaneous functions of the Model 8100. Possible setting parameters are indicated in italics.

SYSTEM<3>	:BEEPER	[:IMMEDIATE]	*<freq>, <time>*
		:VOLUME	*<value>*
	:DATE	<date>	
	:ERROR?		
	:LOCAL		
	:PASSWORD	:CDISABLE	
		[:CENABLE]	*<value>*
		:NEW	*<value>*
		:STATE?	
	:STATISTICS?		
	:TIME	<time>	

Beeper

SYSTEM<3>	:BEEPER	[:IMMEDIATE]	*<freq>, <time>*
		:VOLUME	*<value>*

The Beeper command is used to control the internal beeper of the calibrator. The time parameter determines the amount of time the beeper will be on and is specified in seconds. The maximum time is 5 seconds. The Freq parameter determines the frequency of the beeper. The Beeper Volume command is used to set the volume between two states; Low and High. Values of 0 and 1 correspond to beeper volumes of Low and High.

There is no front panel menu equivalent for the Beeper command.

Example 1 To sound the beeper for 0.1 seconds at 2kHz any of the following commands could be used.

```
SYST:BEEP 2000,100
System:Beeper 2000,100
```

Example 2 To sound the beeper for 2 seconds at 3kHz any of the following commands could be used.

```
SYST:BEEP 3000,2000
System:Beeper 3000,2000
```

Date

SYSTEM<3>	:DATE	<date>

The Date command is used to set or return the system date of the calibrator. The date must be entered in the following format: *year, month, day*.

The System Date command has the front panel menu equivalent of ‘Set Date’ item on the ‘System Settings’ menu.

Example 1 To set the system date of the calibrator to 1 January 2003 any of the following commands could be used.

```
SYST:DAT 2004,1,1
System:Date 2004,1,1
```

Error?

SYSTEM<3>	:ERROR?

The Error query returns the first system error message stored in the error queue. If the system error queue is empty ‘’No Error’ is returned. Please refer to Table 3-3 for a list of all system errors.

System errors are reported on the front panel in the system settings display.

Example To return the first error in the system error queue any of the following commands could be used.

```
SYST:ERR?
System:Error?
```

Password

SYSTEM<3>	:PASSWORD	:CDISABLE	
		[:CENABLE]	<*value*>
		:NEW	<*value*>
		:STATE?	

The Password command provides for the enabling, disabling and changing of passwords to control access to commands which are under the control of System:Password. The only protected commands are the Calibration commands for the Model 8100. The default password for the Model 8100 is ‘8100’. If the password is changed and forgotten consult the factory.

Cdisable

SYSTEM<3>	:PASSWORD	:CDISABLE

Sending the Cdisable (command disable) command disables the protected commands.

Example To disable the password protected commands any of the following commands could be used.

```
SYST:PASSWORD:CDISABLE
System:Pass:Cdis
```

Cenable

SYSTEM<3>	:PASSWORD	[:CENABLE]	<*value*>

Sending the Cenable (command enable) command enables the protected commands to function. The present system password must be entered for the value parameter.

Example To enable the password protected commands when the password is set to ‘8100’ any of the following commands could be used.

```
SYST:PASSWORD:CENABLE “8100”
System:Pass:Cen “8100”
```

New

SYSTEM<3>	:PASSWORD	:NEW	*<value>*

The password new command changes the password from the default, ‘8100’, or current value to a new value. Passwords are strings and are case sensitive. Using the password new command a password containing non-numeric characters may be set. The front panel does not have provision for entering non-numeric characters so passwords containing non-numeric characters may only be issued over the IEEE interface.

Example To set the password to ‘1234’ any of the following commands could be used.

```
SYST:PASSWORD:NEW “1234”
System:Pass:New “1234”
```

State?

SYSTEM<3>	:PASSWORD	:STATE?

The password state query returns a 0 if the password protected commands are disabled and returns a 1 if the protected commands are enabled.

Example To query the Model 8100 to determine the present state of the password protected commands any of the following commands could be used.

```
SYST:PASS:STATE?
System:Password:Stat?
```

Statistics?

SYSTEM<3>	:STATISTICS?

The Statistics query returns the number of times the calibrator has been through a hard reset. The query also includes the number of hours and minutes that the calibrator has been powered up. The string returned by the query is in the format 'Resets', 'hours on':'minutes on'.

This information is available in the 'About' screen under the 'system settings' menu.

Example To return the system statistics any of the following commands could be used.

```
SYST:STAT?
System:Statistics?
```

Time

SYSTEM<3>	:TIME	<time>

The System Time command is used to set or return the system time of the calibrator. The time must be entered in the following format: *hour, minute, second.*

The System Time command has the front panel menu equivalent of ‘Set Time item on the ‘System Settings’ menu.

Example To set the system time of the calibrator to 8:25AM any of the following commands could be used.

```
SYST:TIM 8,25,0
System:Time 8,25,0
```

Trigger Subsystem

The Trigger subsystem allows the user to configure all aspects of the Trigger function of the Model 8100.

TRIGGER<3>	:AUTOSTART	*On* *Off*	
	:DELAY	:CURRENT	*<value>*
		:ENERGY	*<value>*
		:VOLTAGE	*<value>*
	:INITIATE		

There are three types of events that may be initiated using the trigger. They are as follows.

- Energy Tests
- Voltage Events
- Current Events

The Model 8100 is equipped with a single trigger that will initiate all configured events simultaneously. Alternatively, each event may have a trigger delay associated with it. When a trigger delay is set for an event, the activation of the event will be delayed for a period of time after the global trigger is initiated. In this way multiple events may occur at different times though be synchronized with each other relative to the initial global trigger.

The global trigger may be initiated at any time after the operate state has been asserted. The trigger may also be automatically triggered when operate is asserted using the Auto Start function.

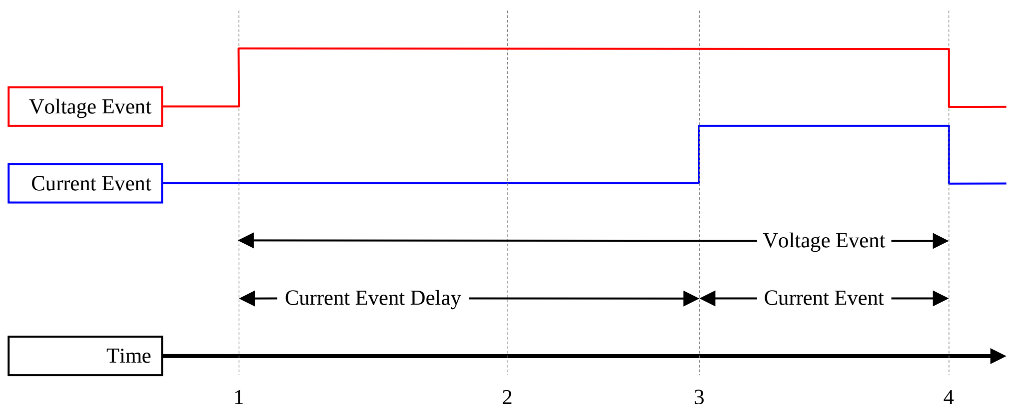

Figure 3-33
Event Trigger (Immediate)

Figure 3-33 illustrates both a voltage and a current event occurring simultaneously. The Current event has a trigger delay applied and the event durations are set so that they end at the same time. At point 1 the operate state is asserted. At point 2 the trigger is initiated. Since there is no trigger delay set for the voltage it starts immediately. The current event will wait for the duration of the Current Event Trigger Delay before being initiated at point 3. At point 4 both the voltage and current events are complete.

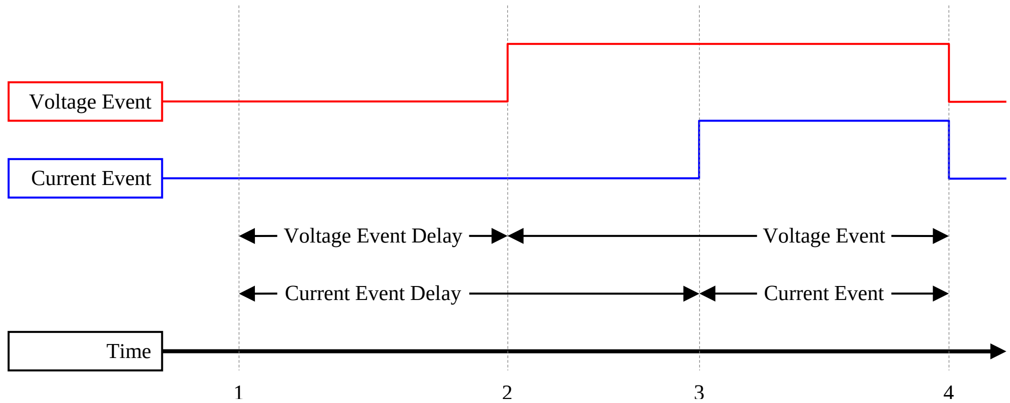

Figure 3-34
Event Trigger (Auto Start)

Figure 3-34 illustrates both a voltage and a current event occurring simultaneously. Each event has a trigger delay applied and the event durations are set so that they end at the same time. In this example the Auto Start function is active. At point 1 operate is asserted and, since the Auto Start Mode is set to 'On', the trigger is initiated as well. Both the voltage and current trigger delays begin. At point 2 the voltage trigger delay is complete and the voltage event begins. At point 3 the current trigger delay is complete and the current event begins. At point 4, both events are complete.

Autostart

TRIGGER<3>	:AUTOSTART	*On* *Off*

The Autostart command is used to activate the auto-start mode. Values of 0 and 1 correspond to the actions of 'Off' and 'On'.

The default setting for the 'Auto Start' function is 'Off'.

When the Auto Start is set to 'On' the trigger is initiated immediately as Operate is asserted. Figure 3-34 illustrates the use of the Auto Start function.

Example To activate the auto-start mode any of the following commands could be used.

```
TRIGGER:AUTOSTART 1
TRIG:AUT 1
```

Delay

TRIGGER<3>	:DELAY	:CURRENT	*<value>*
		:ENERGY	*<value>*
		:VOLTAGE	*<value>*

Energy

The Delay Energy Command allows the user to enter the period of time that will elapse between the global trigger and the activation of the Energy Event. Energy Events may occur at the same time as both voltage and current events. Trigger delays for all three events must be coordinated to ensure that the Voltage and current events occur at the desired time during the energy test.

The Energy Delay value is entered in units of Seconds or Cycles and the default setting is 0.0000 Seconds.

The Energy Delay setting resolution is 0.5 Cycles. The maximum Energy Delay setting is 9999.0 Cycles. The minimum Energy Delay setting is 0.0000 Cycles.

Voltage

The Delay Voltage Command allows the user to enter the period of time that will elapse between the global trigger and the activation of the selected Voltage Event.

The Voltage Event Delay value is entered in units of Seconds or Cycles and the default setting is 0.0000 Seconds.

The Voltage Event Delay setting resolution is 0.5 Cycles. The maximum Voltage Event Delay setting is 9999.0 Cycles. The minimum Voltage Event Delay setting is 0.0000 Cycles.

Current

The Delay Current Event Command allows the user to enter the period of time that will elapse between the global trigger and the activation of the selected Current Event.

The Current Event Delay value is entered in units of Seconds or Cycles and the default setting is 0.0000 Seconds.

The Current Event Delay setting resolution is 0.5 Cycles. The maximum Current Event Delay setting is 9999.0 Cycles. The minimum Current Event Delay setting is 0.0000 Cycles.

Example

To delay the voltage event by 5 seconds after the global trigger is initiated any of the following commands could be used.

```
TRIGGER:DELAY:VOLTAGE 5
TRIG:DEL:VOLT 5
```

Initiate

TRIGGER<3>	:INITIATE

The Trigger Initiate command initiates the global trigger. All configured events will be triggered and will become active after any delays that have been set.

Example To initiate the global trigger any of the following commands could be used.

```
TRIGGER:INITIATE
TRIG:INIT
```

Unit Subsystem

The unit subsystem allows the user to specify the default units of various output parameters of the calibrator. When the default unit has been set the front panel displays will reflect the selection.

UNIT<3>	:ANGLE	*DEG* *PF*
	:POWER	*VA* *WATT* *VAR*
	:TEMPERATURE?	*C* *F*

Angle

UNIT<3>	:ANGLE	*DEG* *PF* *VF*

The Unit Angle command allows the user to set the default units of the phase angle setting. Phase angle units may be expressed as degrees, Power Factor or Var Factor.

The Unit Angle command has the front panel menu equivalent of ‘Phase Units’ item on the ‘User Preferences’ menu.

Example 1 To set the default phase angle unit to degrees any of the following commands could be used.

```
UNIT:ANGL DEG
Unit:Angle Deg
```

Example 2 To set the default phase angle unit to Power Factor any of the following commands could be used.

```
UNIT:ANGL PF
Unit:Angle PF
```

Power

UNIT<3>	:POWER	*VA* *WATT* *VAR*

The Unit Power command allows the user to set the default units of the power setting. Power units may be expressed as Volt-Amperes, Watts or VARs.

The Unit Power command has the front panel menu equivalent of ‘Power Units’ item on the ‘User Preferences’ menu.

Example 1 To set the default power unit to Volt-Amperes any of the following commands could be used.

```
UNIT:POW VA
Unit:Power VA
```

Example 2 To set the default power unit to Watts any of the following commands could be used.

```
UNIT:POW W
Unit:Power W
```

Temperature

UNIT<3>	:TEMPERATURE?	*C* *F*

The Unit Temperature command allows the user to set the default units of the temperature setting. Temperature units may be expressed as degrees Fahrenheit or Celsius.

The Unit Temperature command has the front panel menu equivalent of ‘Temp Units’ item on the ‘User Preferences’ menu.

Example 1 To set the default temperature unit to degrees Fahrenheit any of the following commands could be used.

```
UNIT:TEMP F
Unit:Temperature F
```

Example 2 To set the default temperature unit to degrees Celsius any of the following commands could be used.

```
UNIT:TEMP C
Unit:Temperature C
```

IEEE-488.2 Common Commands

The table below lists the IEEE-488.2 common commands to which the Model 8100 will respond. Each command is discussed in detail in the following sections.

Mnemonic	Name	Group
*IDN?	Identification Query	System Data
*RST	Reset	System Data
*TST?	Self-Test Query	Internal Operations
*CLS	Clear Status	Internal Operations
*ESE	Standard Event Status Enable	Status & Event
*ESR?	Standard Event Status Register Query	Status & Event
*SRE	Service Request Enable	Status & Event
*SRE?	Service Request Enable Query	Status & Event
*STB?	Read Status Byte	Status & Event

Table 3-2
IEEE-488.2 Common Commands

*IDN

The identification query may be used to identify the Model 8100 over the IEEE-488 interface. The syntax of the command is “*IDN”. When this command is sent to the Model 8100 it will respond with a string which contains the following information.

Manufacturer

Model

Serial Number

Firmware Revision

DSP Firmware Revision

*RST

The reset command causes the Model 8100 to perform a reset of all internal circuits and output settings. The reset values of the output parameters are as listed below.

Voltage	0.00000V
Current	0.00000A
Phase	0.000°
Frequency	60.00Hz
Output State	STANDBY
Deviation Mode	OFF

The reset command will not affect any of the following items.

The state of the IEEE interface

IEEE-488 Address

The output queue

Standard Event Status register

*TST? The self test query causes the Model 8100 to initiate a self test. At the conclusion of the test the Model 8100 will respond by placing a 0 (Fail) or 1 (Pass) in the output queue. At the conclusion of the self test all settings are returned their state just prior to the test.

*CLS The clear status command clears all status registers including the standard event, operation and questionable status registers.

*ESE The standard event status enable command sets a mask such that specific standard event register bits are reflected in the summary message bit of the Status Byte.

*ESE? The standard event status enable query returns the current contents of the standard event status enable register.

*ESR? The standard event status register query returns the current contents of the standard event status register. Reading the contents of the register causes it to be cleared.

*SRE The service request enable command sets the service request enable register which is an 8 bit register that allows corresponding summary messages in the status byte register. Setting this register can instruct the Model 8100 to generate a service request for specific reasons.

*SRE? The service request enable query causes the Model 8100 to return the current status of the service request enable register.

*STB? The read status byte query causes the Model 8100 to return the value of the status byte.

Status Byte Figure 3-35 describes the various components of the Status Byte.

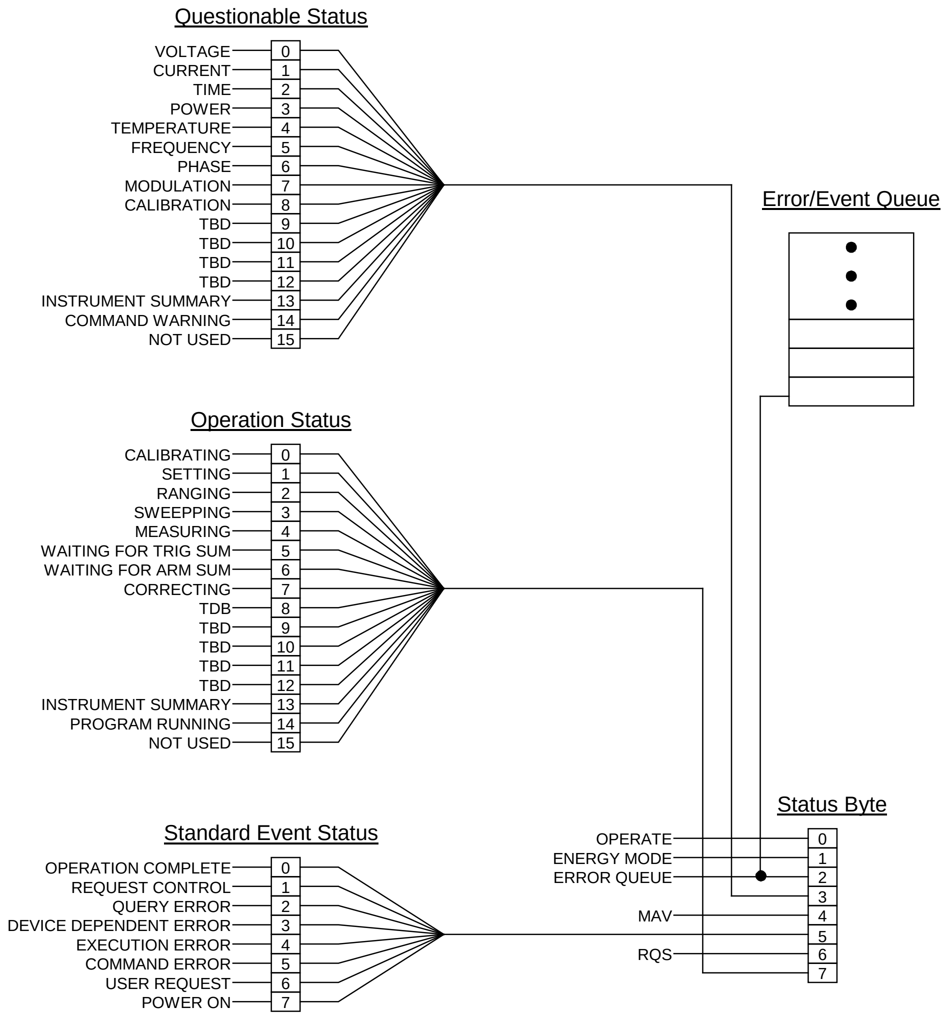

Figure 3-35
Status Byte

Querying the Calibrator

The calibrator may be queried at any time and it will provide information regarding its present configuration. Most of the commands to which the calibrator will respond have a query form as well. The query form is simply the command itself followed by a '?'. The calibrator will then return a string which contains the requested information.

For example, if the calibrator has been set to 120V and the operator would like to verify that this is in fact the actual setting before energizing the output, the voltage setting could be queried. This query could take one of the following forms.

Voltage?

Source:Voltage?

Source:Voltage:Level?

The calibrator would then respond with "120V", confirming the actual setting.

Error Codes

The Model 8100 can return the error codes and messages listed in Table 3-3 Error Codes in response to error conditions. If an error condition occurs, the error is message is displayed on the front panel System Settings display. If the calibrator is being controlled remotely using the GPIB interface the same error message is placed in the Error/Event Queue.

Code	Message	Code	Message
-102	"Syntax error"	-224	"Illegal parameter value"
-104	"Data type error"	-230	"Data corrupt or stale"
-108	"Parameter not allowed"	-231	"Data questionable"
-109	"Missing parameter"	-240	"Hardware error"
-110	"Command Header Error"	-241	"Hardware missing"
-111	"Header Separator Error"	-260	"Expression Error"
-113	"Undefined header"	-261	"Math error in expression"
-114	"Header suffix out of range"	-300	"Device-specific error"
-120	"Numeric data error"	-310	"System error"
-121	"Invalid character in number"	-311	"Memory error"
-123	"Exponent too large"	-312	"PUD memory lost"
-124	"Too many digits"	-313	"Calibration memory lost"
-128	"Numeric data not allowed"	-314	"Save/recall memory lost"
-130	"Suffix error"	-315	"Configuration memory lost"
-131	"Invalid suffix"	-330	"Self-test failed"
-134	"Suffix too long"	-350	"Queue overflow"
-138	"Suffix not allowed"	-400	"Query error"
-140	"Character data error"	201	"Query only"
-141	"Invalid character data"	202	"No query allowed"
-144	"Character data too long"	203	"Parameter(s) not expected"
-148	"Character data not allowed"	204	"Constant not allowed"
-150	"String data error"	207	"Enumeric value not in union"
-151	"Invalid string data"	208	"Illegal number of parameters"
-158	"String data not allowed"	210	"Run out of memory handles"
-160	"Block data error"	211	"Unit not matched"
-161	"Invalid block data"	212	"Unit not valid"
-168	"Block data not allowed	220	"Calibration Mode not set"
-170	"Expression error"	221	"Setting invalid in Cal Mode"
-171	"Invalid expression"	222	"Energy Mode not set"
-178	"Expression data not allowed"	223	"Setting Invalid in Calibration Mode"
-200	"Execution error"	224	"Password invalid"
-201	"Invalid while in local"	300	"Output Overload"
-202	"Settings lost due to rtl"	301	"Output Unstable"
-220	"Parameter error"	302	"Signal on output"
-221	"Settings conflict"	303	"Unexpected Standby"
-222	"Data out of range"	304	"No Power Setting"
-223	"Too much data"	310	"Calibration Recommended"

Table 3-3
Error Codes

If the error condition is the result of a setting error, the error is cleared when the next valid setting is entered. For example if the user enters 1000V the calibrator will respond with an error message of "Data out of range". This message will be displayed until a valid setting such as 100V is entered. If the error condition is the result of a system error, such as an overload, the error message will be cleared the next time operate is achieved.

Programming Examples

This section provides programming examples which illustrate the implementation of the commands described in the previous examples. The code has been created for Microsoft Visual Basic Version 6.0.

Some of the examples make use of each other so it is important to review each of the examples completely.

Reset The following code illustrates the process of resetting the calibrator. It is important to note that in addition to the '*RST' command several other commands are also sent.

While '*RST' does reset the settings of the calibrator it has no effect on the GPIB interface or any of the Status registers. The '*CLS' may be used to clear the status registers as well as the error queue.

Sending a '*SRE 0' disables service request enable register.

The '*ESE' command is used to apply a mask to the Standard Event Status 'Byte. This will enable the Operation Complete bit of the 'Standard Event Status Byte to be reported on bit 5 of the 'Status Byte. Operation Complete is useful when trying to determine whether or not the calibrator is busy. The Send routine included in this section makes use of this bit and does not send a new command until the calibrator is finished processing the previous command. The calibrator will accept commands when still processing other commands but it is good practice not to rush it.

The Display Enable is sent to set the output settings display to indicate the desired phase's settings. The Display Brightness command is sent to turn on the front panel display backlights.

```
Sub Calibrator_RESET()
DIM CalibratorAddress as integer

CalibratorAddress=12

'Reset Calibrator
If SEND(CalibratorAddress, "*rst") Then Stop
'Clear Status Byte
If SEND(CalibratorAddress, "*cls") Then Stop
'Disable service request enable register
If SEND(CalibratorAddress, "*sre 0") Then Stop
'Set mask for event status register
If SEND(CalibratorAddress, "*ese 1") Then Stop
'Activate the front panel display
If SEND(CalibratorAddress, "Display:Enable ON") Then Stop
'Set the front panel display backlights to 50%
If SEND(CalibratorAddress, "Display:Brightness 50") Then Stop

End Sub
```

Send

The following code illustrates the procedure to be followed when sending commands to the calibrator. This routine first sends the *cls command to clear the status registers and then sends the command.

The routine then checks to see if the calibrator has completed the operation by serial polling for operation complete, bit 5 in the status byte if the mask, '*ESE 1', has been applied to the Standard Event Register. It is not required to wait but it is good practice to not rush the calibrator.

Once the command has been sent the routine verifies that bit 3 of the status byte is not set indicating an error condition. If an error is reported the error is identified by reading the error event queue using the System Error query.

```
Sub Calibrator_SEND(s As String)
Dim CalibratorAddress as Integer
Dim InputString As String * 80
Dim poll As Long
Dim status As Long
Dim EndTime As Long
Dim Response As String

CalibratorAddress=12

'Clear status registers
If SEND(CalibratorAddress, "*ese 1;*CLS") Then Stop

Sleep 50

'Send String
If SEND(CalibratorAddress, s) Then Stop

Sleep 100

'Check for calibrator Operation Complete
EndTime = GetTickCount() + 5000
Do
Sleep 10
SPOLL CalibratorAddress, poll, status
If status Then Stop
Loop Until (poll And SP_STD) Or (GetTickCount() > EndTime)
If (poll And SP_STD) = 0 Then Stop

Sleep 20

'Check for errors
SPOLL CalibratorAddress, poll, status
If status Then Stop

'If error then enter error string
If (poll And SP_ERR) Then
If SEND(CalibratorAddress, "System:Error?") Then Stop

'Enter Response
EndTime = GetTickCount() + 5000
Do
Sleep 50
SPOLL CalibratorAddress, poll, status
If status Then Stop
Loop Until (poll And SP_MAV) Or (GetTickCount() > EndTime)
If (poll And SP_MAV) = 0 Then Stop

Sleep 10

If Enter(InputString, CalibratorAddress) Then Stop
End if

MsgBox InputString

End Sub
```

Enter The following code illustrates the procedure which should be used to enter data from the calibrator. This routine begins to attempt to enter data from the calibrator and will continue to do so until it is successful or there has been a time out.

```
Sub ENTER_Calibrator (s As String)
Dim CalibratorAddress as integer
Dim POLL As Long
Dim Status As Long
Dim InputString As String * 80
Dim EndTime As Long
dim SP_MAV As Integer

CalibratorAddress = 12
SP_MAV = &H10

EndTime = GetTickCount() + 5000
Do
Sleep 10
SPOLL CalibratorAddress, poll, status
If status Then Stop
Loop Until (POLL And SP_MAV) Or (GetTickCount() > EndTime)
If (POLL And SP_MAV) = 0 Then Stop

If Enter(InputString, CalibratorAddress) Then Stop

s = Trim(InputString)
If s = "" Then MsgBox "Model 8100 - No Message Received."

End Sub
```

Query The following code illustrates the procedure to be followed when querying the calibrator. This routine sends the query and then waits until the calibrator sets the Message Available (MAV) bit of the Status Byte indicating that the response is ready. The data is then retrieved using the Enter routine described elsewhere in this section.

```
Sub Calibrator_Query(s As String, Response As String)
Dim CalibratorAddress As Integer
Dim poll As Long
Dim status As Long
Dim EndTime As Long

CalibratorAddress = 12

If SEND(CalibratorAddress, s) Then Stop

'Wait for MAV
EndTime = GetTickCount() + 5000
Do
Sleep 10
SPOLL CalibratorAddress, poll, status
If status Then Stop
Loop Until ((poll And SP_MAV) = SP_MAV) Or (GetTickCount() >
EndTime)

If (poll And SP_MAV) = 0 Then Stop

Sleep 50

'Enter Response
If Enter(Response, CalibratorAddress) Then Stop

Response = Trim(Response)

End Sub
```

Chapter 4
MAINTENANCE

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General

The following sections provide the instructions required to support the Model 8100 in normal use. Any required repair or service to the internal components should always be referred to qualified service personnel. Contact the factory before removal of the cover.

⚠ WARNING ⚠

Dangerous Voltages Present Inside the Model 8100.

Removal of the cover could result in damage to the calibrator and injury to personnel!

To maintain optimum performance it is recommended that the calibrator be maintained in the manner described in this manual. The factory recommended calibration interval is 12 months and while the equipment may not require adjustment on this cycle, the performance specifications included with this manual are only valid for this period of time.

The calibrator maintains an internal record of the most recent calibration date. This information is stored in non-volatile RAM and is maintained whether or not power is applied to the instrument. When 12 months have passed since the last calibration the calibrator notifies the user by generating an error message, ‘Cal Recommended’. This message is displayed in the system status area of the front panel LCD display. The error is also made available via the GPIB interface. The ‘Cal Recommended’ error message is generated whenever power is applied to the calibrator or when the calibrator is reset. If power is applied to the calibrator 24 hours a day the error message is generated each day at 12:00AM.

The most recent calibration date is set using the ‘Cal Due’ menu item of the calibration menu.

Since routine service and adjustment of the Model 8100 requires no access to the internal components of the calibrator, the calibration and adjustment procedures should be performed with the cover in place.

Required Test Equipment

The Model 8100 has been designed to require a minimum amount of test equipment to maintain optimum performance. The equipment recommended in Table 4-1may be used and substitutions may be made based upon equivalence of performance specifications.

Instrument Nomenclature	Performance Specifications	Use	Manufacturer & Model Number
AC Voltage Standard	AC Voltage 0.0030%	Verify and Adjust AC Voltage	Various
AC Current Standard	AC Current 0.0035%	Verify and Adjust AC Current	Various
Power Meter	AC Power 0.0050%	Verify AC Power	Rotek Model MSB100
Phase Angle/ Power Factor Meter	Power Factor 0.0001PF @ 90° Phase Angle	Verify and Adjust Phase Angle	Rotek Model MSB100

Table 4-1
Recommended test Equipment

Performance Verification

Performance tests may be used to verify adherence to specification. The performance tests are conducted with a nominal line voltage ±5%, 50-60 Hertz at a temperature of 23 ± 5°C, at a relative humidity less than 50%.

Performance checklists are provided in Table 4-2, Table 4-3, Table 4-5, Table 4-6, Table 4-7 and Table 4-8.

These checklists may be copied and completed to maintain a record of periodic verification. The performance checklists designate a minimum number of test points which are required to verify specifications.

Calibration measurements should be made for Voltage, Current and Power. The Model 8100 is certified at the factory for all three parameters independently. It is important to verify power accuracy independent of voltage and current as the power inaccuracy is not simply the sum of the Voltage and Current contributions.

The test configurations in Figure 4-1, Figure 4-2, and Figure 4-3 show the basic connections for measuring each function.

When making high accuracy measurements at frequencies near the power line frequency, it is possible that the measurements will appear to ‘wander’ somewhat. The apparent wandering of the measurements is the result of a heterodyning effect between voltages within the Model 8100, at the test frequency, and line (mains) voltage, at the line frequency. The heterodyne, or ‘beat’, frequency will be at the difference between the oscillator and line frequencies. The influence of the ‘wander’ can be reduced by using a meter with filtering to average the readings. Most full featured DMM’s provide this capability, and it is recommended that readings be averaged over 20 seconds.

Voltage Accuracy Verification

The Voltage Accuracy of the Model 8100 is verified using the test configuration shown in Figure 4-1. The specific AC Voltage standard used is not important as long as the performance specifications of the standard are adequate to make the required measurement. Refer to Chapter 1 for AC Voltage specifications of the Model 8100. A 4:1 ratio between the measurement standard and UUT is recommended wherever possible.

Apply power to the Model 8100 and allow it to warm-up for 1 hour. Enter the voltage and frequency setting to be measured. The Current and Phase settings should be 0.00000A and 0.000°, respectively. Press the Operate key to energize the output of the calibrator. Allow the voltage output ten seconds to stabilize. Use this procedure to complete the voltage accuracy tests listed in Table 4-2.

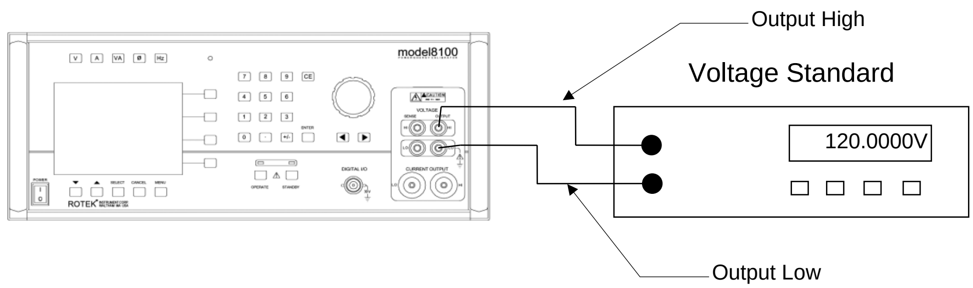

Figure 4-1
Voltage Test Configuration

Frequency	Setting	Reading	Nominal	Minimum	Maximum
50.00Hz	10.0000 V		10.0000 V	9.99690 V	10.0031 V
	20.0000 V		20.0000 V	19.9958 V	20.0042 V
	60.0000 V		60.0000 V	59.9900 V	60.0100 V
	120.000 V		120.000 V	119.984 V	120.016 V
	140.000 V		140.000 V	139.978 V	140.022 V
	240.000 V		240.000 V	239.968 V	240.032 V
	280.000 V		280.000 V	279.950 V	280.050 V
	480.000 V		480.000 V	479.926 V	480.074 V
	540.000 V		540.000 V	539.899 V	540.101 V
	640.000 V		640.000 V	639.884 V	640.116 V
60.00Hz	10.0000 V		10.0000 V	9.99690 V	10.0031 V
	20.0000 V		20.0000 V	19.9958 V	20.0042 V
	60.0000 V		60.0000 V	59.9900 V	60.0100 V
	120.000 V		120.000 V	119.984 V	120.016 V
	140.000 V		140.000 V	139.978 V	140.022 V
	240.000 V		240.000 V	239.968 V	240.032 V
	280.000 V		280.000 V	279.950 V	280.050 V
	480.000 V		480.000 V	479.926 V	480.074 V
	540.000 V		540.000 V	539.899 V	540.101 V
	640.000 V		640.000 V	639.884 V	640.116 V
100.0Hz	10.0000 V		10.0000 V	9.99660 V	10.0034 V
	20.0000 V		20.0000 V	19.9952 V	20.0048 V
	60.0000 V		60.0000 V	59.9876 V	60.0124 V
	120.000 V		120.000 V	119.979 V	120.021 V
	140.000 V		140.000 V	139.972 V	140.028 V
	240.000 V		240.000 V	239.958 V	240.042 V
	280.000 V		280.000 V	279.939 V	280.061 V
	480.000 V		480.000 V	479.907 V	480.093 V
	540.000 V		540.000 V	539.883 V	540.117 V
	640.000 V		640.000 V	639.865 V	640.135 V
400.0Hz	10.0000 V		10.0000 V	9.99660 V	10.0034 V
	20.0000 V		20.0000 V	19.9952 V	20.0048 V
	60.0000 V		60.0000 V	59.9876 V	60.0124 V
	120.000 V		120.000 V	119.979 V	120.021 V
	140.000 V		140.000 V	139.972 V	140.028 V
	240.000 V		240.000 V	239.958 V	240.042 V
	280.000 V		280.000 V	279.939 V	280.061 V
	480.000 V		480.000 V	479.907 V	480.093 V
	540.000 V		540.000 V	539.883 V	540.117 V
	640.000 V		640.000 V	639.865 V	640.135 V

Table 4-2
Voltage Accuracy Tests

Current Accuracy Verification

The Current Accuracy of the Model 8100 is measured using the test configuration shown in Figure 4-2. The specific AC Current standard used is not important as long as the performance specifications of the standard are adequate to make the required measurement. Refer to Chapter 1 for the AC Current specifications of the Model 8100. A 4:1 ratio between the measurement standard and UUT is recommended wherever possible.

Apply power to the Model 8100 and allow it to warm-up for 1 hour. Enter the current and frequency setting to be measured. The Voltage and Phase settings should be 0.00000V and 0.000°, respectively. Press the Operate key to energize the output of the calibrator. Allow the current output ten seconds to stabilize. Use this procedure to complete the current accuracy tests listed in Table 4-3 and Table 4-4.

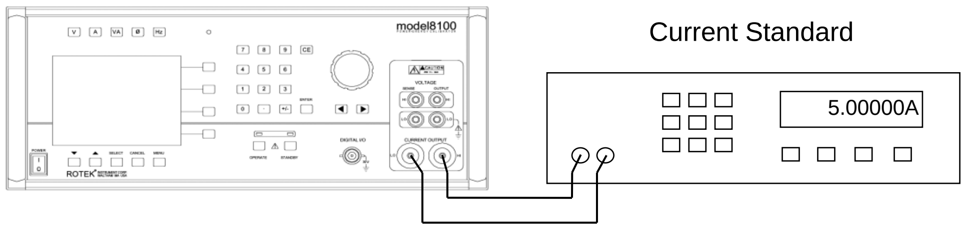

Figure 4-2
Current Test Configuration

Frequency	Setting	Reading	Nominal	Minimum	Maximum
50.00Hz	6.00000mA		6.00000mA	5.99404mA	6.00596mA
	15.0000mA		15.0000mA	14.9926mA	15.0074mA
	20.0000mA		20.0000mA	19.9922mA	20.0078mA
	50.0000mA		50.0000mA	49.9880mA	50.0120mA
	60.0000mA		60.0000mA	59.9868mA	60.0132mA
	150.000mA		150.000mA	149.976mA	150.024mA
	200.000mA		200.000mA	199.964mA	200.036mA
	500.000mA		500.000mA	499.928mA	500.072mA
	600.000mA		600.000mA	599.900mA	600.100mA
	1.50000 A		1.50000 A	1.49981 A	1.50019 A
	2.00000 A		2.00000 A	1.99964 A	2.00036 A
	5.00000 A		5.00000 A	4.99928 A	5.00072 A
	6.00000 A		6.00000 A	5.99884 A	6.00116 A
	10.0000 A		10.0000 A	9.99820 A	10.0018 A
	12.0000 A		12.0000 A	11.9970 A	12.0030 A
	20.0000 A		20.0000 A	19.9954 A	20.0046 A
	25.0000 A		25.0000 A	24.9915 A	25.0085 A
	50.0000 A		50.0000 A	49.9840 A	50.0160 A
60.00Hz	6.00000mA		6.00000mA	5.99404mA	6.00596mA
	15.0000mA		15.0000mA	14.9926mA	15.0074mA
	20.0000mA		20.0000mA	19.9922mA	20.0078mA
	50.0000mA		50.0000mA	49.9880mA	50.0120mA
	60.0000mA		60.0000mA	59.9868mA	60.0132mA
	150.000mA		150.000mA	149.976mA	150.024mA
	200.000mA		200.000mA	199.964mA	200.036mA
	500.000mA		500.000mA	499.928mA	500.072mA
	600.000mA		600.000mA	599.900mA	600.100mA
	1.50000 A		1.50000 A	1.49981 A	1.50019 A
	2.00000 A		2.00000 A	1.99964 A	2.00036 A
	5.00000 A		5.00000 A	4.99928 A	5.00072 A
	6.00000 A		6.00000 A	5.99884 A	6.00116 A
	10.0000 A		10.0000 A	9.99820 A	10.0018 A
	12.0000 A		12.0000 A	11.9970 A	12.0030 A
	20.0000 A		20.0000 A	19.9954 A	20.0046 A
	25.0000 A		25.0000 A	24.9915 A	25.0085 A
	50.0000 A		50.0000 A	49.9840 A	50.0160 A

Table 4-3
Current Accuracy Tests (50 and 60Hz)

Frequency	Setting	Reading	Nominal	Minimum	Maximum
100.0Hz	6.00000mA		6.00000mA	5.99356mA	6.00644mA
	15.0000mA		15.0000mA	14.9914mA	15.0086mA
	20.0000mA		20.0000mA	19.9908mA	20.0092mA
	50.0000mA		50.0000mA	49.9845mA	50.0155mA
	60.0000mA		60.0000mA	59.9832mA	60.0168mA
	150.000mA		150.000mA	149.967mA	150.033mA
	200.000mA		200.000mA	199.952mA	200.048mA
	500.000mA		500.000mA	499.898mA	500.102mA
	600.000mA		600.000mA	599.852mA	600.148mA
	1.50000 A		1.50000 A	1.49969 A	1.50031 A
	2.00000 A		2.00000 A	1.99952 A	2.00048 A
	5.00000 A		5.00000 A	4.99898 A	5.00102 A
	6.00000 A		6.00000 A	5.99836 A	6.00164 A
	10.0000 A		10.0000 A	9.99740 A	10.0026 A
	12.0000 A		12.0000 A	11.9934 A	12.0066 A
	20.0000 A		20.0000 A	19.9894 A	20.0106 A
	25.0000 A		25.0000 A	24.9840 A	25.0160 A
	50.0000 A		50.0000 A	49.9690 A	50.0310 A
400.Hz	6.00000mA		6.00000mA	5.99356mA	6.00644mA
	15.0000mA		15.0000mA	14.9914mA	15.0086mA
	20.0000mA		20.0000mA	19.9908mA	20.0092mA
	50.0000mA		50.0000mA	49.9845mA	50.0155mA
	60.0000mA		60.0000mA	59.9832mA	60.0168mA
	150.000mA		150.000mA	149.967mA	150.033mA
	200.000mA		200.000mA	199.952mA	200.048mA
	500.000mA		500.000mA	499.898mA	500.102mA
	600.000mA		600.000mA	599.852mA	600.148mA
	1.50000 A		1.50000 A	1.49969 A	1.50031 A
	2.00000 A		2.00000 A	1.99952 A	2.00048 A
	5.00000 A		5.00000 A	4.99898 A	5.00102 A
	6.00000 A		6.00000 A	5.99836 A	6.00164 A
	10.0000 A		10.0000 A	9.99740 A	10.0026 A
	12.0000 A		12.0000 A	11.9934 A	12.0066 A
	20.0000 A		20.0000 A	19.9894 A	20.0106 A
	25.0000 A		25.0000 A	24.9840 A	25.0160 A
	50.0000 A		50.0000 A	49.9690 A	50.0310 A

Table 4-4
Current Accuracy Tests (100 and 400Hz)

Power Accuracy Verification

The Power Accuracy of the Model 8100 is measured using the test configuration shown in Figure 4-3. The specific AC Power standard used is not important as long as the performance specifications of the standard are adequate to make the required measurement. Refer to Chapter 1 for AC Power specifications of the Model 8100. The Rotek Model MSB100 Power and Energy Standard is recommended and is shown in the test setup in Figure 4-3.

Apply power to the Model 8100 and allow it to warm-up for 1 hour. Enter the voltage, current, phase angle and frequency setting to be measured. Press the Operate key to energize the output of the calibrator. Allow the voltage and current outputs ten seconds to stabilize. Use this procedure to complete the voltage accuracy tests listed in Table 4-5, Table 4-6, Table 4-7 and Table 4-8.

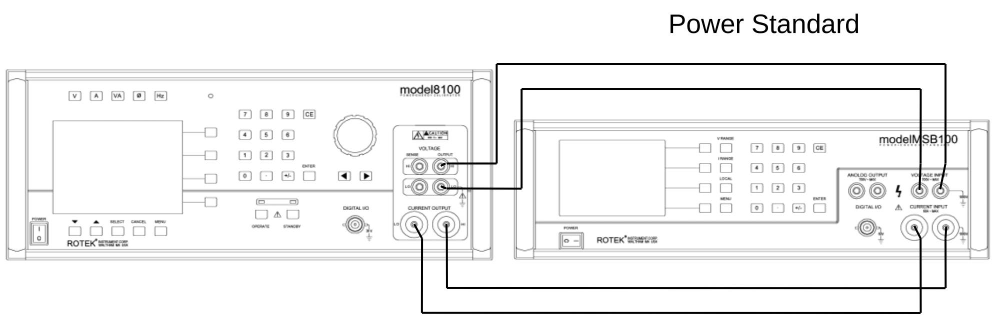

Figure 4-3
Power Test Configuration

Voltage	Current	Phase	Reading	Nominal	Minimum	Maximum
10.0000 V	500.000mA	-90.0000 °		0.00000 W	-2.50000mW	2.50000mW
10.0000 V	500.000mA	0.00000 °		5.00000 W	4.99750 W	5.00250 W
20.0000 V	500.000mA	-90.0000 °		0.00000 W	-4.00000mW	4.00000mW
20.0000 V	500.000mA	0.00000 °		10.0000 W	9.99600 W	10.0040 W
60.0000 V	500.000mA	-90.0000 °		0.00000 W	-5.00000mW	5.00000mW
60.0000 V	500.000mA	0.00000 °		30.0000 W	29.9950 W	30.0050 W
120.000 V	6.00000mA	-90.0000 °		0.00000 W	-1.14400mW	1.14400mW
120.000 V	6.00000mA	0.00000 °		720.000mW	719.999mW	720.001mW
120.000 V	15.0000mA	-90.0000 °		0.00000 W	-1.36000mW	1.36000mW
120.000 V	15.0000mA	0.00000 °		1.80000 W	1.79864 W	1.80136 W
120.000 V	20.0000mA	-90.0000 °		0.00000 W	-1.24000mW	1.24000mW
120.000 V	20.0000mA	0.00000 °		2.40000 W	2.39876 W	2.40124 W
120.000 V	50.0000mA	-90.0000 °		0.00000 W	-1.60000mW	1.60000mW
120.000 V	50.0000mA	0.00000 °		6.00000 W	5.99840 W	6.00160 W
120.000 V	60.0000mA	-90.0000 °		0.00000 W	-1.72000mW	1.72000mW
120.000 V	60.0000mA	0.00000 °		7.20000 W	7.19828 W	7.20172 W
120.000 V	150.000mA	-90.0000 °		0.00000 W	-2.80000mW	2.80000mW
120.000 V	150.000mA	0.00000 °		18.0000 W	17.9972 W	18.0028 W
120.000 V	200.000mA	-90.0000 °		0.00000 W	-4.40000mW	4.40000mW
120.000 V	200.000mA	0.00000 °		24.0000 W	23.9956 W	24.0044 W
120.000 V	500.000mA	-90.0000 °		0.00000 W	-8.00000mW	8.00000mW
120.000 V	500.000mA	0.00000 °		60.0000 W	59.9920 W	60.0080 W
120.000 V	600.000mA	-90.0000 °		0.00000 W	-12.2000mW	12.2000mW
120.000 V	600.000mA	0.00000 °		72.0000 W	71.9878 W	72.0122 W
120.000 V	1.50000 A	-90.0000 °		0.00000 W	-23.0000mW	23.0000mW
120.000 V	1.50000 A	0.00000 °		180.000 W	179.977 W	180.023 W
120.000 V	2.00000 A	-90.0000 °		0.00000 W	-39.0000mW	39.0000mW
120.000 V	2.00000 A	0.00000 °		240.000 W	239.961 W	240.039 W
120.000 V	5.00000 A	-90.0000 °		0.00000 W	-75.0000mW	75.0000mW
120.000 V	5.00000 A	0.00000 °		600.000 W	599.925 W	600.075 W
120.000 V	6.00000 A	-90.0000 °		0.00000 W	-174.000mW	174.000mW
120.000 V	6.00000 A	0.00000 °		720.000 W	719.826 W	720.174 W
120.000 V	10.0000 A	-90.0000 °		0.00000 W	-270.000mW	270.000mW
120.000 V	10.0000 A	0.00000 °		1200.00 W	1199.73 W	1200.27 W
120.000 V	12.0000 A	-90.0000 °		0.00000 W	-348.000mW	348.000mW
120.000 V	12.0000 A	0.00000 °		1440.00 W	1439.65 W	1440.35 W
120.000 V	20.0000 A	-90.0000 °		0.00000 W	-540.000mW	540.000mW
120.000 V	20.0000 A	0.00000 °		2400.00 W	2399.46 W	2400.54 W
120.000 V	25.0000 A	-90.0000 °		0.00000 W	-1.02000mW	1.02000mW
120.000 V	25.0000 A	0.00000 °		3000.00 W	2998.98 W	3001.02 W
120.000 V	50.0000 A	-90.0000 °		0.00000 W	-1.92000mW	1.92000mW
120.000 V	50.0000 A	0.00000 °		6000.00 W	5998.08 W	6001.92 W
140.000 V	500.000mA	-90.0000 °		0.00000 W	-11.0000mW	11.0000mW
140.000 V	500.000mA	0.00000 °		70.0000 W	69.9890 W	70.0110 W
240.000 V	500.000mA	-90.0000 °		0.00000 W	-16.0000mW	16.0000mW
240.000 V	500.000mA	0.00000 °		120.000 W	119.984 W	120.016 W
280.000 V	500.000mA	-90.0000 °		0.00000 W	-36.0000mW	36.0000mW
280.000 V	500.000mA	0.00000 °		140.000 W	139.964 W	140.036 W
480.000 V	500.000mA	-90.0000 °		0.00000 W	-56.0000mW	56.0000mW
480.000 V	500.000mA	0.00000 °		240.000 W	239.944 W	240.056 W
540.000 V	500.000mA	-90.0000 °		0.00000 W	-101.000mW	101.000mW
540.000 V	500.000mA	0.00000 °		270.000 W	269.899 W	270.101 W
640.000 V	500.000mA	-90.0000 °		0.00000 W	-116.000mW	116.000mW
640.000 V	500.000mA	0.00000 °		320.000 W	319.884 W	320.116 W

Table 4-5
Power Accuracy Tests (50Hz)

Voltage	Current	Phase	Reading	Nominal	Minimum	Maximum
10.0000 V	500.000mA	-90.0000 °		0.00000 W	-2.50000mW	2.50000mW
10.0000 V	500.000mA	0.00000 °		5.00000 W	4.99750 W	5.00250 W
20.0000 V	500.000mA	-90.0000 °		0.00000 W	-4.00000mW	4.00000mW
20.0000 V	500.000mA	0.00000 °		10.0000 W	9.99600 W	10.0040 W
60.0000 V	500.000mA	-90.0000 °		0.00000 W	-5.00000mW	5.00000mW
60.0000 V	500.000mA	0.00000 °		30.0000 W	29.9950 W	30.0050 W
120.000 V	6.00000mA	-90.0000 °		0.00000 W	-1.14400mW	1.14400mW
120.000 V	6.00000mA	0.00000 °		720.000mW	719.999mW	720.001mW
120.000 V	15.0000mA	-90.0000 °		0.00000 W	-1.36000mW	1.36000mW
120.000 V	15.0000mA	0.00000 °		1.80000 W	1.79864 W	1.80136 W
120.000 V	20.0000mA	-90.0000 °		0.00000 W	-1.24000mW	1.24000mW
120.000 V	20.0000mA	0.00000 °		2.40000 W	2.39876 W	2.40124 W
120.000 V	50.0000mA	-90.0000 °		0.00000 W	-1.60000mW	1.60000mW
120.000 V	50.0000mA	0.00000 °		6.00000 W	5.99840 W	6.00160 W
120.000 V	60.0000mA	-90.0000 °		0.00000 W	-1.72000mW	1.72000mW
120.000 V	60.0000mA	0.00000 °		7.20000 W	7.19828 W	7.20172 W
120.000 V	150.000mA	-90.0000 °		0.00000 W	-2.80000mW	2.80000mW
120.000 V	150.000mA	0.00000 °		18.0000 W	17.9972 W	18.0028 W
120.000 V	200.000mA	-90.0000 °		0.00000 W	-4.40000mW	4.40000mW
120.000 V	200.000mA	0.00000 °		24.0000 W	23.9956 W	24.0044 W
120.000 V	500.000mA	-90.0000 °		0.00000 W	-8.00000mW	8.00000mW
120.000 V	500.000mA	0.00000 °		60.0000 W	59.9920 W	60.0080 W
120.000 V	600.000mA	-90.0000 °		0.00000 W	-12.2000mW	12.2000mW
120.000 V	600.000mA	0.00000 °		72.0000 W	71.9878 W	72.0122 W
120.000 V	1.50000 A	-90.0000 °		0.00000 W	-23.0000mW	23.0000mW
120.000 V	1.50000 A	0.00000 °		180.000 W	179.977 W	180.023 W
120.000 V	2.00000 A	-90.0000 °		0.00000 W	-39.0000mW	39.0000mW
120.000 V	2.00000 A	0.00000 °		240.000 W	239.961 W	240.039 W
120.000 V	5.00000 A	-90.0000 °		0.00000 W	-75.0000mW	75.0000mW
120.000 V	5.00000 A	0.00000 °		600.000 W	599.925 W	600.075 W
120.000 V	6.00000 A	-90.0000 °		0.00000 W	-174.000mW	174.000mW
120.000 V	6.00000 A	0.00000 °		720.000 W	719.826 W	720.174 W
120.000 V	10.0000 A	-90.0000 °		0.00000 W	-270.000mW	270.000mW
120.000 V	10.0000 A	0.00000 °		1200.00 W	1199.73 W	1200.27 W
120.000 V	12.0000 A	-90.0000 °		0.00000 W	-348.000mW	348.000mW
120.000 V	12.0000 A	0.00000 °		1440.00 W	1439.65 W	1440.35 W
120.000 V	20.0000 A	-90.0000 °		0.00000 W	-540.000mW	540.000mW
120.000 V	20.0000 A	0.00000 °		2400.00 W	2399.46 W	2400.54 W
120.000 V	25.0000 A	-90.0000 °		0.00000 W	-1.02000mW	1.02000mW
120.000 V	25.0000 A	0.00000 °		3000.00 W	2998.98 W	3001.02 W
120.000 V	50.0000 A	-90.0000 °		0.00000 W	-1.92000mW	1.92000mW
120.000 V	50.0000 A	0.00000 °		6000.00 W	5998.08 W	6001.92 W
140.000 V	500.000mA	-90.0000 °		0.00000 W	-11.0000mW	11.0000mW
140.000 V	500.000mA	0.00000 °		70.0000 W	69.9890 W	70.0110 W
240.000 V	500.000mA	-90.0000 °		0.00000 W	-16.0000mW	16.0000mW
240.000 V	500.000mA	0.00000 °		120.000 W	119.984 W	120.016 W
280.000 V	500.000mA	-90.0000 °		0.00000 W	-36.0000mW	36.0000mW
280.000 V	500.000mA	0.00000 °		140.000 W	139.964 W	140.036 W
480.000 V	500.000mA	-90.0000 °		0.00000 W	-56.0000mW	56.0000mW
480.000 V	500.000mA	0.00000 °		240.000 W	239.944 W	240.056 W
540.000 V	500.000mA	-90.0000 °		0.00000 W	-101.000mW	101.000mW
540.000 V	500.000mA	0.00000 °		270.000 W	269.899 W	270.101 W
640.000 V	500.000mA	-90.0000 °		0.00000 W	-116.000mW	116.000mW
640.000 V	500.000mA	0.00000 °		320.000 W	319.884 W	320.116 W

Table 4-6
Power Accuracy Tests (60Hz)

Voltage	Current	Phase	Reading	Nominal	Minimum	Maximum
10.0000 V	500.000mA	-90.0000 °		0.00000 W	-4.00000mW	4.00000mW
10.0000 V	500.000mA	0.00000 °		5.00000 W	4.99600 W	5.00400 W
20.0000 V	500.000mA	-90.0000 °		0.00000 W	-7.00000mW	7.00000mW
20.0000 V	500.000mA	0.00000 °		10.0000 W	9.99300 W	10.0070 W
60.0000 V	500.000mA	-90.0000 °		0.00000 W	-17.0000mW	17.0000mW
60.0000 V	500.000mA	0.00000 °		30.0000 W	29.9830 W	30.0170 W
120.000 V	6.00000mA	-90.0000 °		0.00000 W	-1.50400mW	1.50400mW
120.000 V	6.00000mA	0.00000 °		720.000mW	718.496 W	721.504 W
120.000 V	15.0000mA	-90.0000 °		0.00000 W	-2.26000mW	2.26000mW
120.000 V	15.0000mA	0.00000 °		1.80000 W	1.79774 W	1.80226 W
120.000 V	20.0000mA	-90.0000 °		0.00000 W	-2.20000mW	2.20000mW
120.000 V	20.0000mA	0.00000 °		2.40000 W	2.39780 W	2.40220 W
120.000 V	50.0000mA	-90.0000 °		0.00000 W	-4.00000mW	4.00000mW
120.000 V	50.0000mA	0.00000 °		6.00000 W	5.99600 W	6.00400 W
120.000 V	60.0000mA	-90.0000 °		0.00000 W	-4.60000mW	4.60000mW
120.000 V	60.0000mA	0.00000 °		7.20000 W	7.19540 W	7.20460 W
120.000 V	150.000mA	-90.0000 °		0.00000 W	-10.0000mW	10.0000mW
120.000 V	150.000mA	0.00000 °		18.0000 W	17.9900 W	18.0100 W
120.000 V	200.000mA	-90.0000 °		0.00000 W	-14.0000mW	14.0000mW
120.000 V	200.000mA	0.00000 °		24.0000 W	23.9860 W	24.0140 W
120.000 V	500.000mA	-90.0000 °		0.00000 W	-32.0000mW	32.0000mW
120.000 V	500.000mA	0.00000 °		60.0000 W	59.9680 W	60.0320 W
120.000 V	600.000mA	-90.0000 °		0.00000 W	-41.0000mW	41.0000mW
120.000 V	600.000mA	0.00000 °		72.0000 W	71.9590 W	72.0410 W
120.000 V	1.50000 A	-90.0000 °		0.00000 W	-95.0000mW	95.0000mW
120.000 V	1.50000 A	0.00000 °		180.000 W	179.905 W	180.095 W
120.000 V	2.00000 A	-90.0000 °		0.00000 W	-135.000mW	135.000mW
120.000 V	2.00000 A	0.00000 °		240.000 W	239.865 W	240.135 W
120.000 V	5.00000 A	-90.0000 °		0.00000 W	-315.000mW	315.000mW
120.000 V	5.00000 A	0.00000 °		600.000 W	599.685 W	600.315 W
120.000 V	6.00000 A	-90.0000 °		0.00000 W	-462.000mW	462.000mW
120.000 V	6.00000 A	0.00000 °		720.000 W	719.538 W	720.462 W
120.000 V	10.0000 A	-90.0000 °		0.00000 W	-750.000mW	750.000mW
120.000 V	10.0000 A	0.00000 °		1200.00 W	1199.25 W	1200.75 W
120.000 V	12.0000 A	-90.0000 °		0.00000 W	-1.06800 W	1.06800 W
120.000 V	12.0000 A	0.00000 °		1440.00 W	1438.93 W	1441.07 W
120.000 V	20.0000 A	-90.0000 °		0.00000 W	-1.74000 W	1.74000 W
120.000 V	20.0000 A	0.00000 °		2400.00 W	2398.26 W	2401.74 W
120.000 V	25.0000 A	-90.0000 °		0.00000 W	-2.52000 W	2.52000 W
120.000 V	25.0000 A	0.00000 °		3000.00 W	2997.48 W	3002.52 W
120.000 V	50.0000 A	-90.0000 °		0.00000 W	-4.92000 W	4.92000 W
120.000 V	50.0000 A	0.00000 °		6000.00 W	5995.08 W	6004.92 W
140.000 V	500.000mA	-90.0000 °		0.00000 W	-39.0000mW	39.0000mW
140.000 V	500.000mA	0.00000 °		70.0000 W	69.9610 W	70.0390 W
240.000 V	500.000mA	-90.0000 °		0.00000 W	-64.0000mW	64.0000mW
240.000 V	500.000mA	0.00000 °		120.000 W	119.936 W	120.064 W
280.000 V	500.000mA	-90.0000 °		0.00000 W	-120.000mW	120.000mW
280.000 V	500.000mA	0.00000 °		140.000 W	139.880 W	140.120 W
480.000 V	500.000mA	-90.0000 °		0.00000 W	-200.000mW	200.000mW
480.000 V	500.000mA	0.00000 °		240.000 W	239.800 W	240.200 W
540.000 V	500.000mA	-90.0000 °		0.00000 W	-236.000mW	236.000mW
540.000 V	500.000mA	0.00000 °		270.000 W	269.764 W	270.236 W
640.000 V	500.000mA	-90.0000 °		0.00000 W	-276.000mW	276.000mW
640.000 V	500.000mA	0.00000 °		320.000 W	319.724 W	320.276 W

Table 4-7
Power Accuracy Tests (100Hz)

Voltage	Current	Phase	Reading	Nominal	Minimum	Maximum
10.0000 V	500.000mA	-90.0000 °		0.00000 W	-4.00000mW	4.00000mW
10.0000 V	500.000mA	0.00000 °		5.00000 W	4.99600 W	5.00400 W
20.0000 V	500.000mA	-90.0000 °		0.00000 W	-7.00000mW	7.00000mW
20.0000 V	500.000mA	0.00000 °		10.0000 W	9.99300 W	10.0070 W
60.0000 V	500.000mA	-90.0000 °		0.00000 W	-17.0000mW	17.0000mW
60.0000 V	500.000mA	0.00000 °		30.0000 W	29.9830 W	30.0170 W
120.000 V	6.00000mA	-90.0000 °		0.00000 W	-1.50400mW	1.50400mW
120.000 V	6.00000mA	0.00000 °		720.000mW	718.496 W	721.504 W
120.000 V	15.0000mA	-90.0000 °		0.00000 W	-2.26000mW	2.26000mW
120.000 V	15.0000mA	0.00000 °		1.80000 W	1.79774 W	1.80226 W
120.000 V	20.0000mA	-90.0000 °		0.00000 W	-2.20000mW	2.20000mW
120.000 V	20.0000mA	0.00000 °		2.40000 W	2.39780 W	2.40220 W
120.000 V	50.0000mA	-90.0000 °		0.00000 W	-4.00000mW	4.00000mW
120.000 V	50.0000mA	0.00000 °		6.00000 W	5.99600 W	6.00400 W
120.000 V	60.0000mA	-90.0000 °		0.00000 W	-4.60000mW	4.60000mW
120.000 V	60.0000mA	0.00000 °		7.20000 W	7.19540 W	7.20460 W
120.000 V	150.000mA	-90.0000 °		0.00000 W	-10.0000mW	10.0000mW
120.000 V	150.000mA	0.00000 °		18.0000 W	17.9900 W	18.0100 W
120.000 V	200.000mA	-90.0000 °		0.00000 W	-14.0000mW	14.0000mW
120.000 V	200.000mA	0.00000 °		24.0000 W	23.9860 W	24.0140 W
120.000 V	500.000mA	-90.0000 °		0.00000 W	-32.0000mW	32.0000mW
120.000 V	500.000mA	0.00000 °		60.0000 W	59.9680 W	60.0320 W
120.000 V	600.000mA	-90.0000 °		0.00000 W	-41.0000mW	41.0000mW
120.000 V	600.000mA	0.00000 °		72.0000 W	71.9590 W	72.0410 W
120.000 V	1.50000 A	-90.0000 °		0.00000 W	-95.0000mW	95.0000mW
120.000 V	1.50000 A	0.00000 °		180.000 W	179.905 W	180.095 W
120.000 V	2.00000 A	-90.0000 °		0.00000 W	-135.000mW	135.000mW
120.000 V	2.00000 A	0.00000 °		240.000 W	239.865 W	240.135 W
120.000 V	5.00000 A	-90.0000 °		0.00000 W	-315.000mW	315.000mW
120.000 V	5.00000 A	0.00000 °		600.000 W	599.685 W	600.315 W
120.000 V	6.00000 A	-90.0000 °		0.00000 W	-462.000mW	462.000mW
120.000 V	6.00000 A	0.00000 °		720.000 W	719.538 W	720.462 W
120.000 V	10.0000 A	-90.0000 °		0.00000 W	-750.000mW	750.000mW
120.000 V	10.0000 A	0.00000 °		1200.00 W	1199.25 W	1200.75 W
120.000 V	12.0000 A	-90.0000 °		0.00000 W	-1.06800 W	1.06800 W
120.000 V	12.0000 A	0.00000 °		1440.00 W	1438.93 W	1441.07 W
120.000 V	20.0000 A	-90.0000 °		0.00000 W	-1.74000 W	1.74000 W
120.000 V	20.0000 A	0.00000 °		2400.00 W	2398.26 W	2401.74 W
120.000 V	25.0000 A	-90.0000 °		0.00000 W	-2.52000 W	2.52000 W
120.000 V	25.0000 A	0.00000 °		3000.00 W	2997.48 W	3002.52 W
120.000 V	50.0000 A	-90.0000 °		0.00000 W	-4.92000 W	4.92000 W
120.000 V	50.0000 A	0.00000 °		6000.00 W	5995.08 W	6004.92 W
140.000 V	500.000mA	-90.0000 °		0.00000 W	-39.0000mW	39.0000mW
140.000 V	500.000mA	0.00000 °		70.0000 W	69.9610 W	70.0390 W
240.000 V	500.000mA	-90.0000 °		0.00000 W	-64.0000mW	64.0000mW
240.000 V	500.000mA	0.00000 °		120.000 W	119.936 W	120.064 W
280.000 V	500.000mA	-90.0000 °		0.00000 W	-120.000mW	120.000mW
280.000 V	500.000mA	0.00000 °		140.000 W	139.880 W	140.120 W
480.000 V	500.000mA	-90.0000 °		0.00000 W	-200.000mW	200.000mW
480.000 V	500.000mA	0.00000 °		240.000 W	239.800 W	240.200 W
540.000 V	500.000mA	-90.0000 °		0.00000 W	-236.000mW	236.000mW
540.000 V	500.000mA	0.00000 °		270.000 W	269.764 W	270.236 W
640.000 V	500.000mA	-90.0000 °		0.00000 W	-276.000mW	276.000mW
640.000 V	500.000mA	0.00000 °		320.000 W	319.724 W	320.276 W

Table 4-8
Power Accuracy Tests (400Hz)

Adjustment Procedure

The adjustment of the Model 8100 is accomplished entirely through the front panel or remotely via the IEEE-488 or RS-232 interface. There are no internal components to adjust. A complete adjustment requires that the voltage and current outputs of the calibrator be adjusted in both amplitude and phase. The calibrator has all adjustment settings stored internally and will only allow adjustments at the required points. Amplitude adjustments are made at several points in each voltage and current range. All ranges have at least 2 adjustment points though some may have more. The amplitude adjustment points for the voltage and current outputs are listed in Table 4-9 and Table 4-10. Phase adjustments are made at -90.00° for each voltage and current adjustment point. The phase adjustment points are listed in Table 4-11 and Table 4-12.

Amplitude adjustments are made as required for the voltage and current outputs to meet the voltage and current accuracy specifications described in Chapter 1. Figure 4-4 illustrates the amplitude adjustment of either voltage or current. Amplitude measurements are made using voltage and current standards configured as illustrated in Figure 4-1 and Figure 4-2. When making amplitude adjustments each output is measured independently and thus the phase angle setting is not relevant.

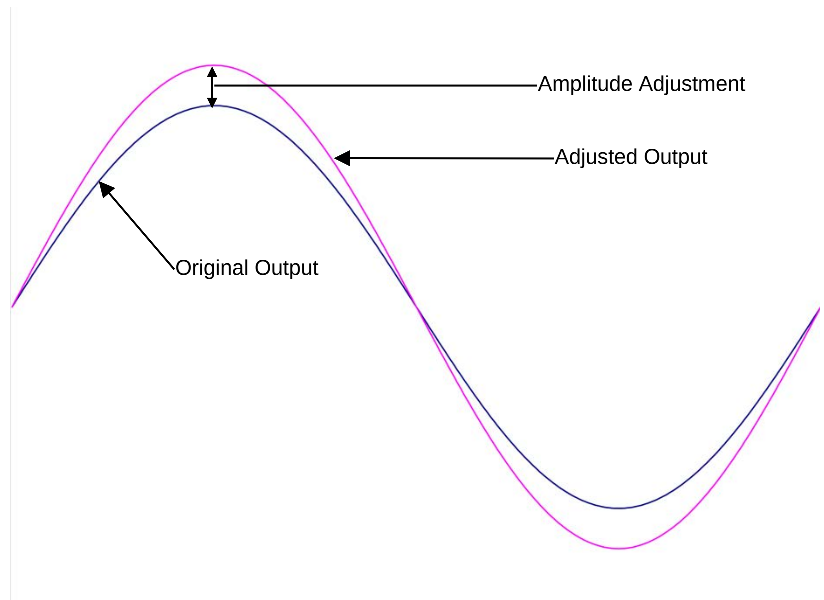

Figure 4-4
Amplitude Adjustment

Phase adjustments are made to both the voltage and current outputs as required for the calibrator to meet the power and phase angle accuracy specifications described in Chapter 1. Figure 4-5 illustrates the phase adjustment of either voltage or current. Phase measurements are made using any suitable phase angle standard though the Rotek MSB100 power standard is recommended. The phase angle measurement configuration is illustrated in Figure 4-3. It is possible to use a power standard such as the MSB100 to make highly accurate phase measurements. When making phase adjustments to the calibrator the phase angle setting is automatically set to -90.00°.

At this phase angle setting small amplitude errors in the voltage and current outputs have a negligible effect on power measurements and any power errors can be attributed entirely to phase.

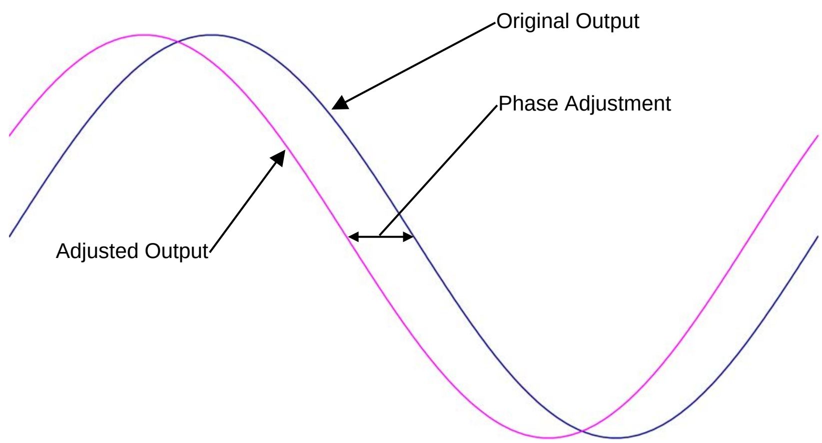

Figure 4-5
Phase Adjustments

Before any adjustments can be made the calibration mode of the calibrator must be activated. Select the 'Calibration' menu item from the 'System Settings' menu. The password prompt will appear. The default password is '8100'. The password may be changed using the 'Change Password' menu item from the 'System Setup' menu. Once the correct password has been entered the Calibration Menu will appear.

```
                Calibration

Mode                     Energy Cal
Voltage Setting          Frequency Cal
Current Setting          Line Phase Cal
Frequency Setting        Cal Temp C
Save Calibration         Cal Due d/m/y
```

When the Calibration Menu is first activated, the Calibration Mode is set to 'Off'. Until a calibration mode has been selected, the calibrator is not in the calibration mode, and the output may be controlled normally.

To activate the calibration mode, select the Mode menu item and choose either Voltage, Current, Voltage Phase or Current Phase. If the calibrator is being controlled via the GPIB or RS-232 interface, the 'CALIBRATION:STATE *function*' command should be issued where *function* is either ‘VOLTAGE’, ‘CURRENT’, ‘VPHASE’ or ‘IPHASE’. This will cause the calibrator to enter the calibration mode. The temperature indication on the front panel LCD display is replaced by the message ‘CalMode’ as shown in Figure 4-6.

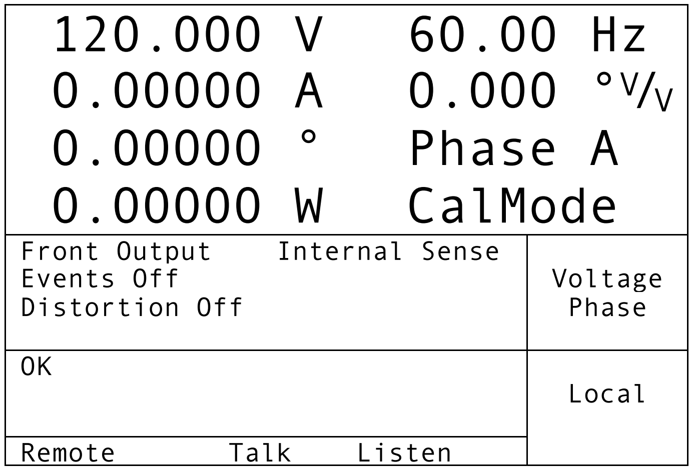

Figure 4-6
Calibration Mode Display

When the Calibration Mode is activated the output settings of the calibrator are controlled by the controls of the Calibration Menu.

If the calibration mode is Voltage or Voltage Phase the voltage setting is specified using Voltage Setting menu item. Select the desired voltage calibration setting from the list and the output will change to match the selection.

If the calibration mode is Current or Current Phase the current setting is specified using Current Setting menu item. Select the desired current calibration setting from the list and the output will change to match the selection.

A frequency is required for all calibration modes and the frequency setting is specified using Frequency Setting menu item. Select the desired frequency calibration setting from the list and the output will change to match the selection.

The calibrator output should then be energized by pressing the OPERATE key or sending the command ‘Output ON’ via the remote interface.

The output should be allowed to stabilize for several seconds before continuing. The exact stabilization time required will depend on the requirements of the measurement standard being used.

If the measurement standard indicates an error, the output setting of the calibrator should be changed by whatever amount is required to eliminate the error.

Once the measurement standard indicates that the output of the calibrator is set as closely as possible to the target setting, the calibration value should be saved by selecting the ‘Save Calibration’ menu choice of the Calibration Menu or sending the command ‘Calibration Save’ via the remote Interface.

The flow chart in Figure 4-7 illustrates this procedure.

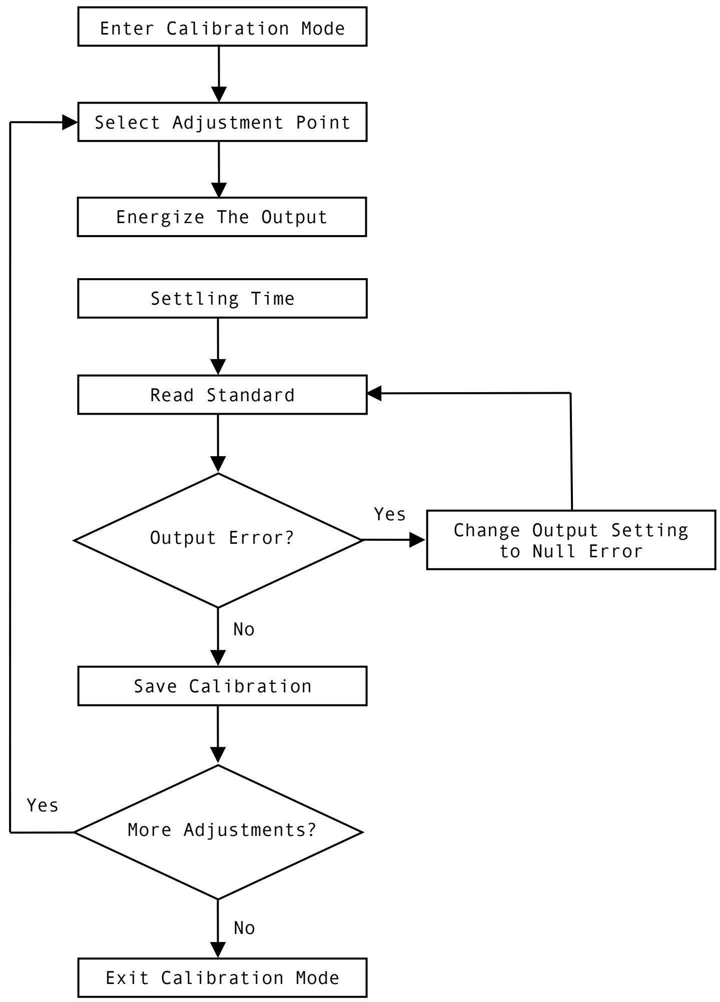

Figure 4-7
Adjustment Flow Chart

Once the required adjustments have been completed, the calibration mode should be exited by setting the calibration mode to ‘Off’ using the Mode menu item of the Calibration Menu or by sending the command ‘Calibration OFF’ via the remote interface.

Adjustment Settings

The Adjustment Settings for each function, Voltage, Current, Voltage Phase and Current Phase are listed in the following tables.

Voltage Range	Setting	Adjustment Settings
20V	1.00000–21.9999	10V, 20V
120V	22.0000–131.999	60V, 120V
240V	132.000–263.999	140V, 240V
480V	264.000–527.999	280V, 480V
640V	528.000–700.000	540V, 640V

Table 4-9
Voltage Adjustment Settings

Current Range	Setting	Adjustment Settings
15mA	0.00100-0.01829	6mA, 15mA
50mA	0.01830-0.05499	20mA, 50mA
150mA	0.05500-0.18299	60mA, 150mA
500A	0.18300-0.54999	200mA, 500mA
1.5A	0.55000-1.82999	600mA, 1.5A
5A	1.83000-5.49999	2A, 5A
10A	5.50000-10.9999	6A, 10A
20A	11.0000-21.9999	12A, 20A
50A	22.0000-55.0000	25A, 50A

Table 4-10
Current Adjustment Settings

Voltage Range	Setting	Adjustment Settings
20V	1.00000–21.9999	10V, 20V
120V	22.0000–131.999	60V, 120V
240V	132.000–263.999	140V, 240V
480V	264.000–527.999	280V, 480V
640V	528.000–700.000	540V, 640V

Table 4-11
Voltage Phase Adjustment Settings

Current Range	Setting	Adjustment Settings
15mA	0.00100-0.01829	6mA, 15mA
50mA	0.01830-0.05499	20mA, 50mA
150mA	0.05500-0.18299	60mA, 150mA
500A	0.18300-0.54999	200mA, 500mA
1.5A	0.55000-1.82999	600mA, 1.5A
5A	1.83000-5.49999	2A, 5A
10A	5.50000-10.9999	6A, 10A
20A	11.0000-21.9999	12A, 20A
50A	22.0000-55.0000	25A, 50A

Table 4-12
Current Phase Adjustment Settings

AdminData Test Equipment Calibration Database Software

The AdminData test equipment calibration database software is an application that allows the user to create and maintain a database of calibration test equipment. The program tracks the calibration history of any type of test equipment, maintains a list of qualified technicians, and maintains a list of current firmware revisions of Rotek products.

The AdminData program creates a database that is used by the 8100CAL program to provide lists of available test equipment, associated calibration data, qualified technicians and current firmware revisions. This database must be created using the AdminData program before the 8100CAL program can be run.

Software Installation

The AdminData software has the following installation requirements.

- Microsoft Windows 98, Windows ME or Windows XP.
- Minimum RAM: 128MB
- Recommended RAM: 512MB
- Minimum Hard Drive Space required: 50MB

If your computer system does not meet these requirements, the program may not run properly.

To install the AdminData program insert the setup CD and follow the procedure below.

- Choose Run from the Start Menu.
- Enter n:\Setup in the Run Dialog box where n is the letter of the drive containing the 8100CAL setup disk.
- Click OK or press enter.

Follow the instructions of the setup program to complete the installation.

If upgrading a previous installation of 8100CAL it is recommended that the earlier installation be removed from the system before installing the most recent version.

8100CAL Calibration Software

8100Cal, the Model 8100 Calibration and Adjustment software, is designed to support and maintain the Model 8100 to factory specifications. The software works in conjunction with the Rotek Model MSB100 and the Agilent Model 3458A Multimeter to perform all calibrations and adjustments required by the Model 8100. Once a test is initiated all adjustments and measurements are performed with no operator intervention. Test results are stored in a database and the included report generator produces all required documentation of the test results.

The 8100CAL software will control the Model 8100 and test equipment via the IEEE-488 interface. All configuration and control of the Model 8100, MSB100 and 3458A is performed by the 8100CAL software and once a test is started there is no operator intervention required.

The 8100CAL software uses a single database file to store the test results. A report generator will format and print reports of calibration data to a preview window or to a printer.

Figure 4-8 illustrates how the different components of the 8100CAL program interact.

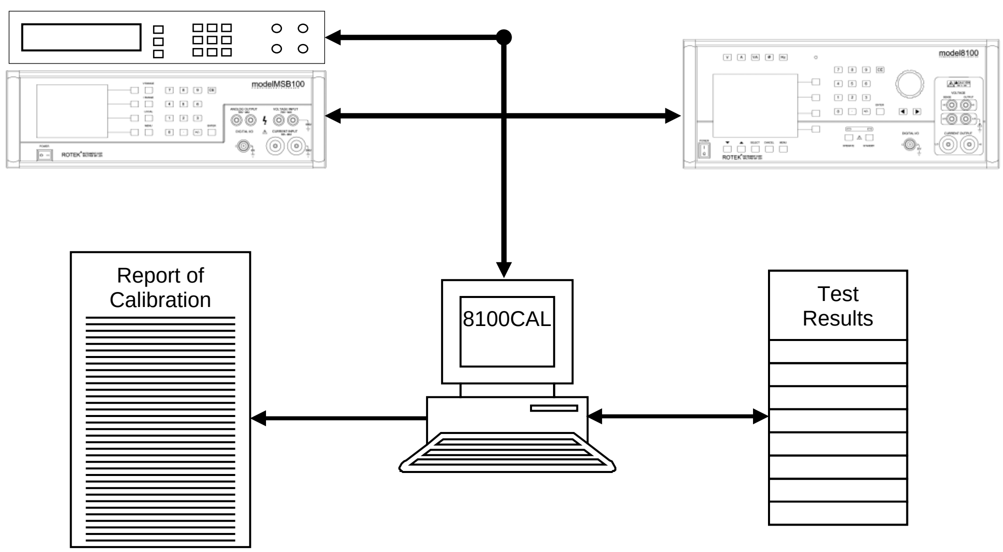

Figure 4-8
8100CAL Block Diagram

8100CAL works with data stored in two databases. The first is the main 8100CAL database. All test results are stored in the main database. A Second database is used to store administration information including test equipment calibration information and operator qualifications. The Rotek AdminData program is used to create and maintain the administration database.

The 8100CAL software performs all measurement and adjustment functions and records the test results in the main database. The Rotek CalReport program is used to view test results and generate test reports.

The 8100CAL program can operate as a server for the Rotek Client Program to allow real time monitoring of tests across a TCP/IP network. The Client Program will show exactly the same display as the 8100CAL program allowing test progress to be monitored remotely across an internal network or the internet.

Figure 4-9 illustrates how these four programs interact with each other via the Main Database and the Admin Database.

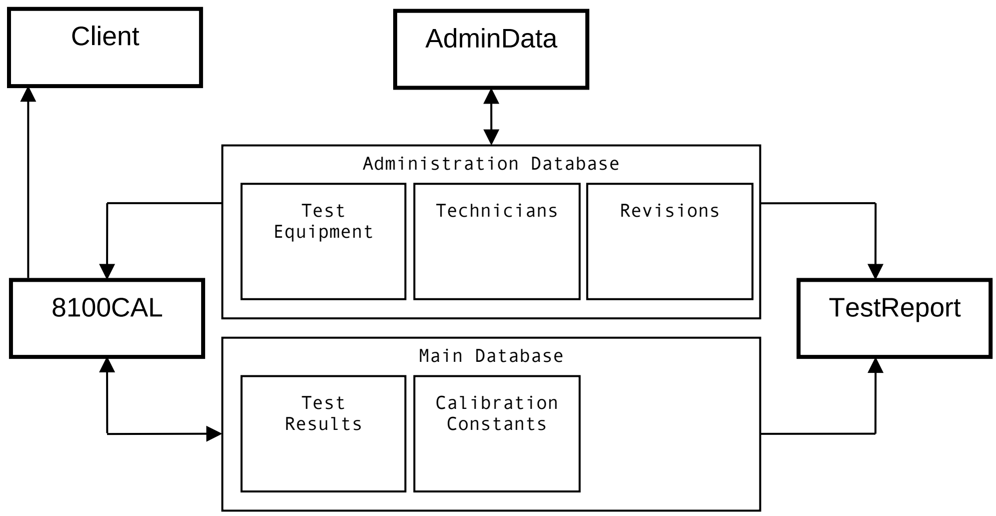

Figure 4-9
8100CAL Application and Database Diagram

Software Installation

The 8100CAL software has the following installation requirements.

- Microsoft Windows 95, Windows 98 or Windows ME.
- Minimum RAM: 64MB
- Recommended RAM: 128MB
- Minimum Hard Drive Space required: 50MB

If your computer system does not meet these requirements, the program may not run properly.

To install the 8100CAL program insert the setup CD and follow the procedure below.

- Choose Run from the Start Menu.
- Enter n:\Setup in the Run Dialog box where n is the letter of the drive containing the 8100CAL setup disk.
- Click OK or press enter.

Follow the instructions of the setup program to complete the installation.

If upgrading a previous installation of 8100CAL it is recommended that the earlier installation be removed from the system before installing the most recent version.

Hardware Installation

The 8100CAL software requires that a IEEE-488 interface be installed in the computer that will be controlling the Model 8100 and test equipment.

The 8100CAL software works with IEEE-488 controllers manufactured by Capital Equipment Corporation or National Instruments. Consult the Factory to determine the most appropriate interface for a specific application.

Follow the installation and configuration instructions provided by the IEEE-488 controller manufacturer.

Starting 8100CAL For The First Time

When 8100CAL is started for the first time the 8100CAL Main Screen will open as shown in Figure 4-10. When 8100CAL normally starts it automatically opens the Admin Database and Main Database specified on the options form.

The location of both the Main and the Admin databases are set using the options window. The location of these databases must be set before and calibration or adjustments may be performed.

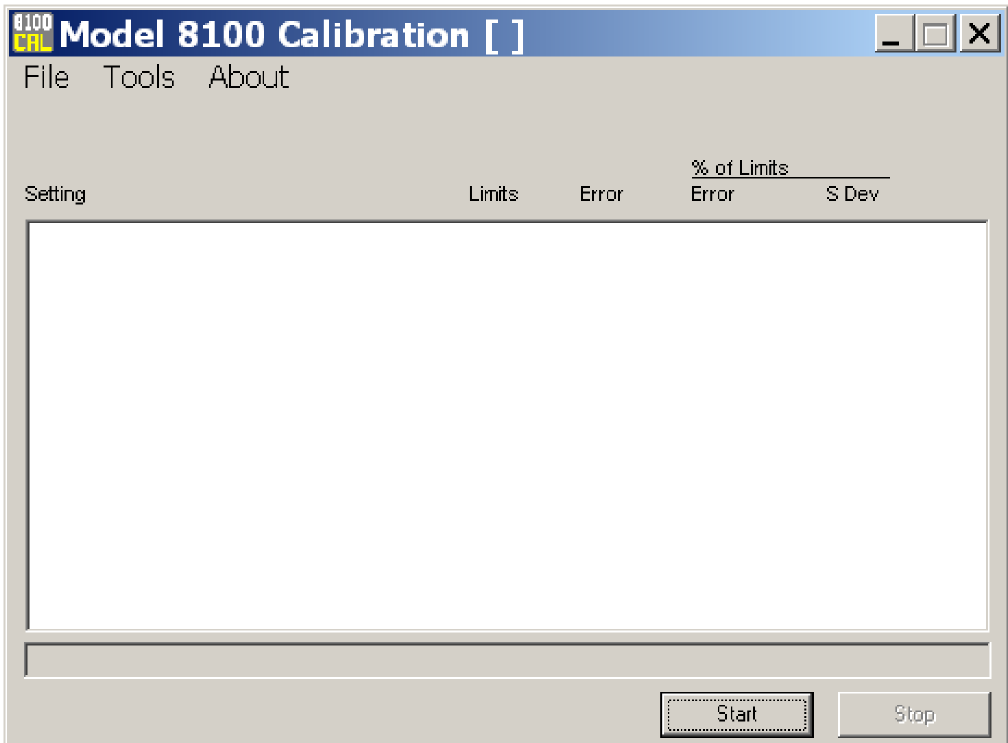

Figure 4-10
8100CAL Main Window

Options Window

There are a few items that must be configured before the program may be used. First select 'Options' from the 'Tools' menu. The Options Window will appear. This window has 6 tabs; File Locations, GPIB, Security, TH Logger, Power Standard and General.

When the window first opens, the File Locations tab is selected as is shown in Figure 4-11.

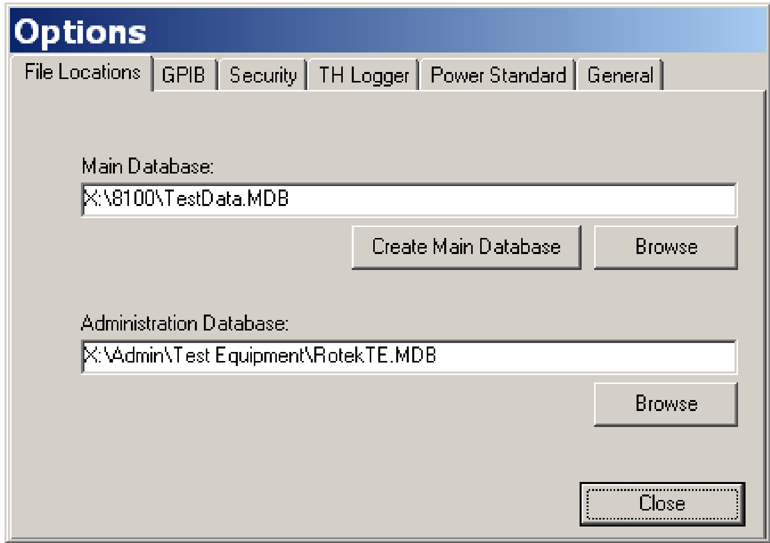

Figure 4-11
8100CAL Options Window – File Locations

Use the Browse buttons to locate the main database and the administration database. If the main database does not exist a new database may be created by clicking on the 'Create Main Database' button. The Administration database must be created using the AdminData program.

The GPIB tab provides the controls to configure the communications with the Model 8100, Model MSB100 and Model 3458A. The GPIB tab is shown in Figure 4-12.

Communication with the Model 8100 may be via either the GPIB or the RS-232. Use the drop down list next to the Model 8100 address to select GPIB or Comm 1, Comm 2, or Comm 3.

Communications with both the Model MSB100 and the Model 3458A are via GPIB alone.

In the text boxes provided enter the address for the controller and each instrument.

Clicking on the Test button will verify proper communication between the program and each device. The results of the test are reported in the text box located above the test button.

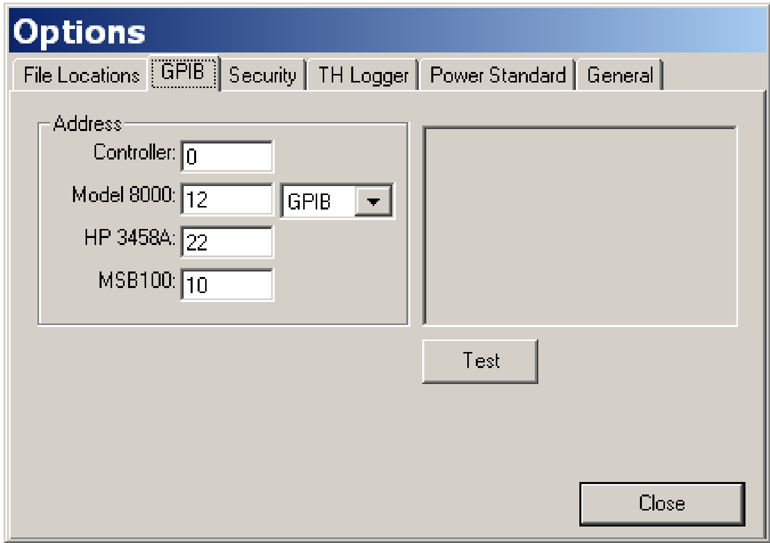

Figure 4-12
8100CAL Options Window – GPIB

The security tab is illustrated in Figure 4-13. The check boxes on this tab allow the program to be configured to require a password before starting the program, changing any options or when adjusting the Model 8100.

Click on the 'Change Password' button the change the password. The Default password is 'ROTEK' The password may contain alpha numeric characters and is case sensitive .

Checking the option 'Start 8100CAL Program' will require that the password be entered every time the program is started.

Checking the option 'Change Options' will require that the password be entered every time the options window is opened.

Checking the option 'Adjust Model 8100' will require that the password be entered every time the Model 8100 is adjusted.

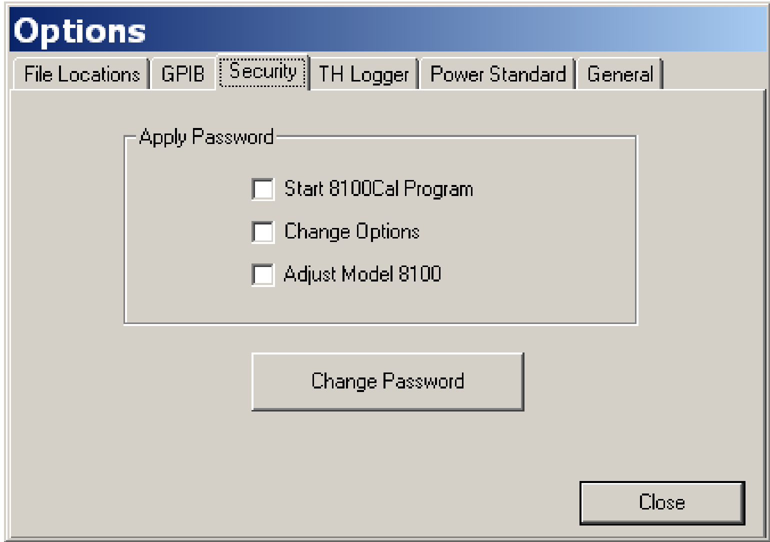

Figure 4-13
8100CAL Options Window – Security

The TH Logger tab is illustrated in Figure 4-14. The controls on this tab allow the 8100CAL program to be configured to communicate with a Rotek Temperature/Humidity Logger. If a remote TH Logger is connected to the 8100CAL program the ambient Temperature and humidity is recorded automatically at the beginning of each test. Otherwise this information must be provided manually.

The TH Logger may be connected to the PC running 8100CAL using a RS-232 or winsock connection. Select the address for the logger and specify either the comm. Port or the winsock as the interface type.

If using the winsock, the IP address of the remote host and the remote port must be provided.

A text box is provided to enter the communications timeout value.

Once the connection data is entered the connection may be tested by clicking on the 'Test' button. The label above the 'Test' button will display the temperature and humidity measured by the TH Logger.

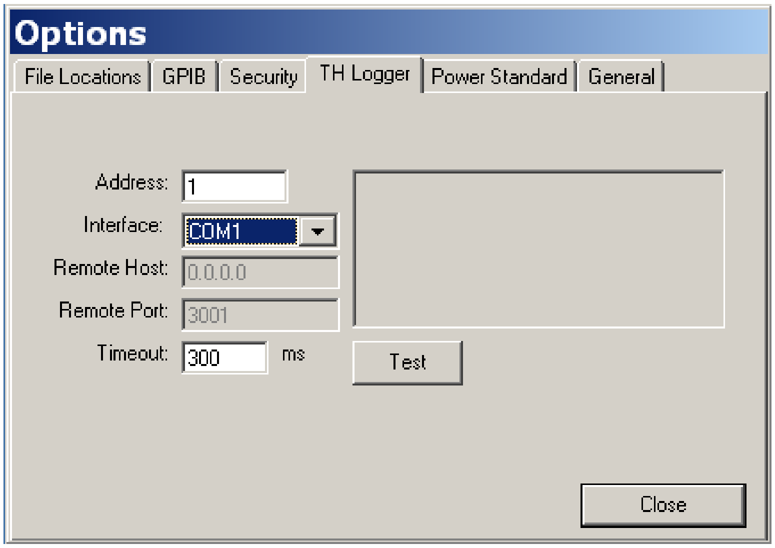

Figure 4-14
8100CAL Options Window – TH Logger

The Power Standard tab is illustrated in Figure 4-15. This tab provides the controls required to select which power standard is to be used. In addition the power line frequency of the power standard may be entered here as well.

The 8100CAL program can be used with either the Rotek Model MSB100 or MSB-001A power standard. When the Model MSB100 is used the 8100Cal program will run in a completely automatic mode requiring no operator intervention after a test is started. The MSB-001A requires that the operator manually change ranges on the power standard as the output settings change.

Power measurement 'beat' may be reduced by increasing the period of time over which each power reading is made. If the line frequency is set to 60Hz then the period of time over the power readings are made is doubled. If a line frequency other than 50 or 60Hz is used there is no need for additional measurement averaging.

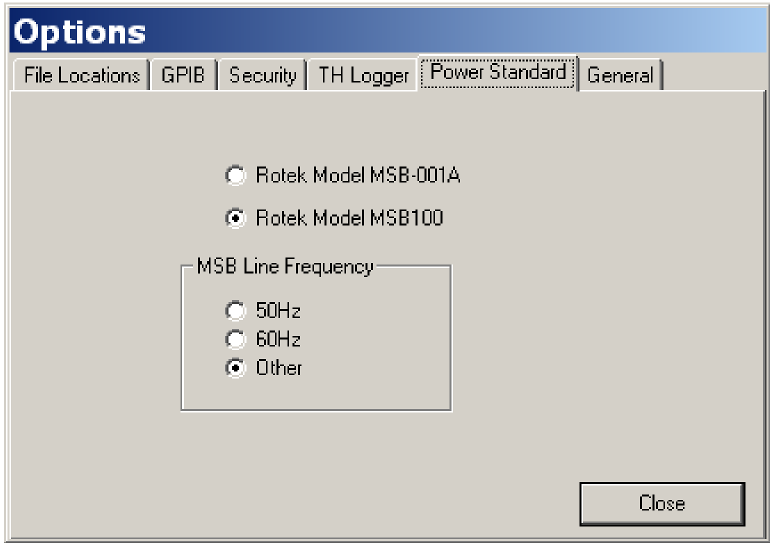

Figure 4-15
8100CAL Options Window – Power Standard

The General options tab is illustrated in Figure 4-16.

The Retry limits function allows the program to automatically repeat a measurement that exceeds certain limitations.

Checking limits will allow the test to be repeated if the reading exceeds a certain percentage of the limits for this test. If the retry limit is set to 100%, the test will be repeated whenever a reading exceeds the limits.

Checking SDev will allow the test to be repeated if the standard deviation of the reading exceeds a certain percentage of the limits for this test. If the retry limit is set to 33%, the test will be repeated whenever a reading's standard deviation exceeds 33% of the limits.

The 8100CAL program can operate as a server for the Rotek Client Program to allow real time monitoring of tests across a TCP/IP network. The server port is specified on this tab. The default server port is 2000.

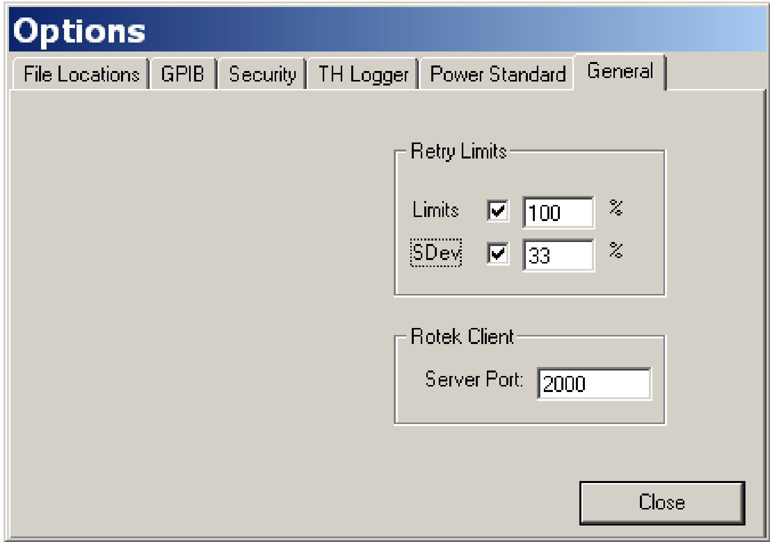

Figure 4-16
8100CAL Options Window – General

File Menu The File menu has only 2 entries and is illustrated in Figure 4-17.

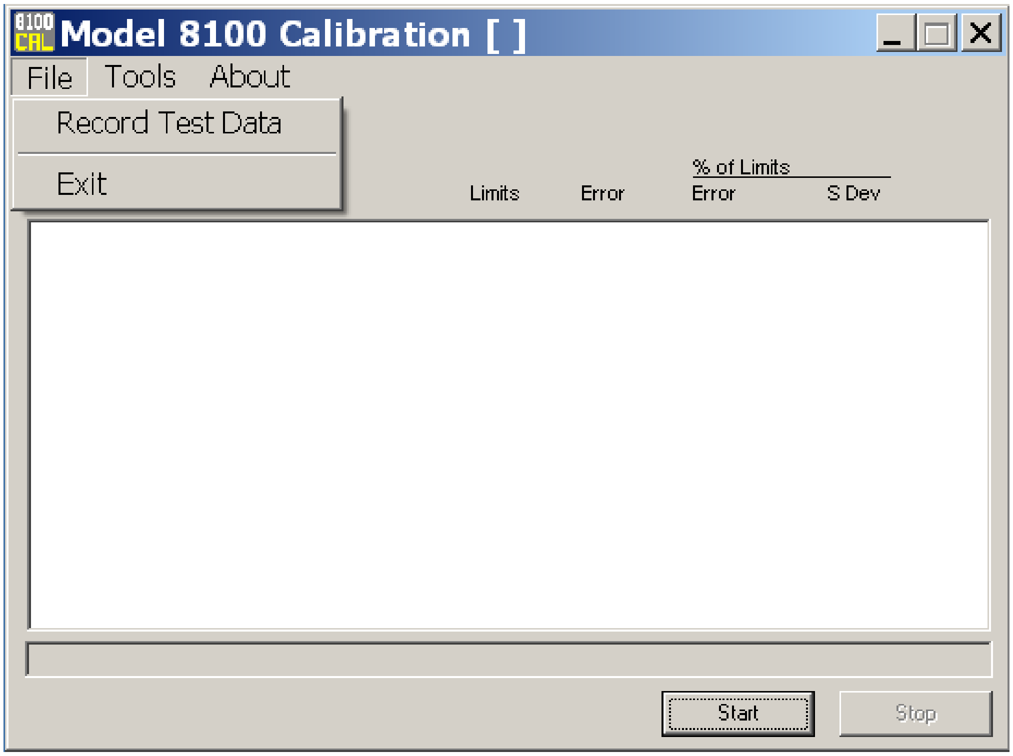

Figure 4-17
8100CAL File Menu

- The 'Record Test Data' menu item is used to record the measurement data from a completed test to the main database. When a test is run the data is stored in a temporary database on the local PC. Since it is possible to have the main database physically located on a computer other than the one running the 8100CAL program it is possible that network changes could occur during a long test. To ensure that data is not lost due to any network problems all measurements are stored on the local machine.

  At the conclusion of a test the operator can choose to record the test data or discard it. If data is not immediately recorded it remains on the local PC until another test is started.
- The 'Exit' menu item closes the program.

Tools Menu

The Tools menu has only 2 entries and is illustrated in Figure 4-18.

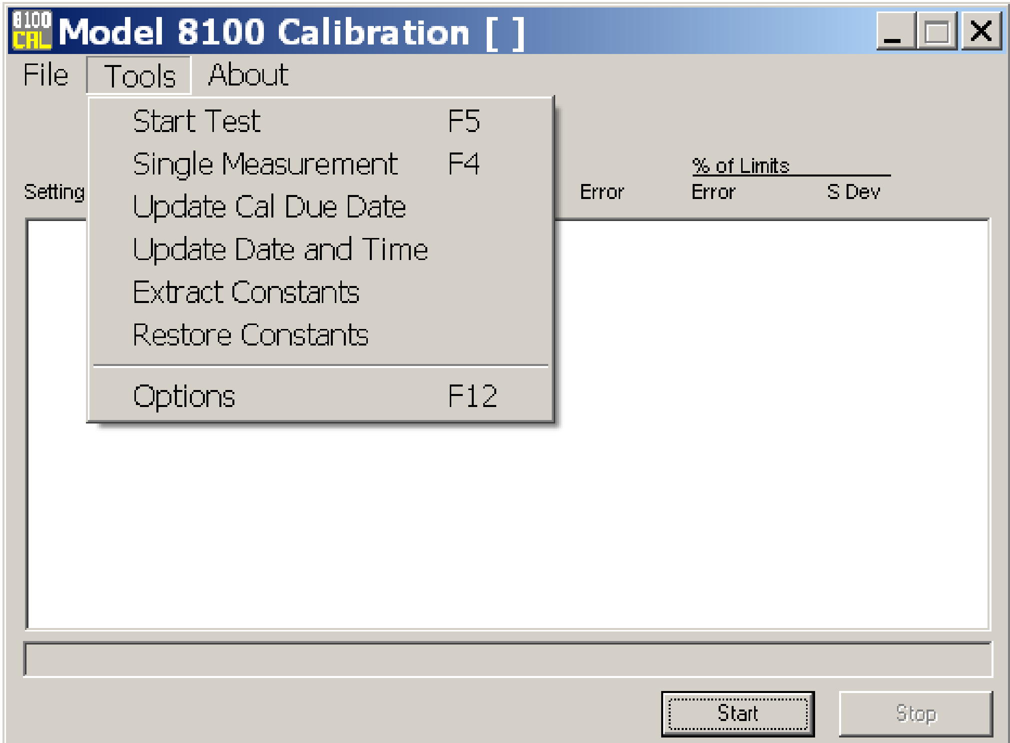

Figure 4-18
8100CAL Tools Menu

- The 'Start Test' menu item is used to begin a test and has the same function as pressing the 'Start' button on the main screen. The 'Start' menu item may also be accessed using the shortcut key F5. A detailed description is included in the 'Starting a Test' section.
- The 'Single Measurement' menu item is used to open the single measurement diagnostic tool. The 'Single Measurement' menu item may also be accessed using the shortcut key F4. A detailed description is included in the 'Making Single Measurements' section.
- The 'Update Cal Due Date' menu item is used to set the Calibration Due Date stored within the Model 8100. This date is used to generate the 'Cal Recommended' warning when the calibration interval has been exceeded. Figure 4-19 illustrates the Update Cal Due window that opens when the 'Update Cal Due Date' menu item is selected.
- The 'Update Date and Time' menu item is used to set the date and time of the Model 8100's real time clock. When this function is selected the Date and time setting of the calibrator is set to match the date and time of the computer running 8100CAL.

- The ‘Extract Cal Constants’ menu item is used to extract the present calibration constants stored within the Model 8100. These constants are stored in the Main Database and for a record of the adjustments of the Model 8100 at a specific time. The constants may also be restored to the calibrator in the event that the calibration constants are lost or corrupted.
- The ‘Restore Cal Constants’ menu item is used to restore a set of saved calibration constants to the Model 8100. These constants are stored in the Main Database and the specific set of constants to be restored is selected from the Select Calibration Constants window that is opened with this menu item. The Constant sets are listed chronologically in the window. Clicking on one set and pressing ‘OK’ will overwrite all calibration constants within the calibrator with those from the database.
- The ‘Options’ menu item opens the option form discussed in the ‘Starting 8100CAL For The First Time’.

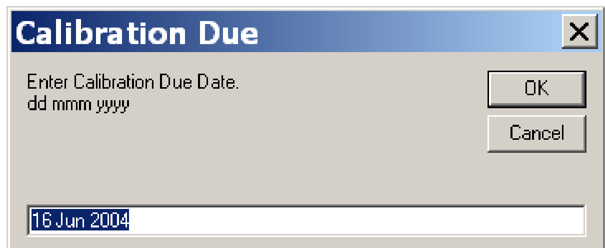

Figure 4-19
8100CAL Update Cal Due

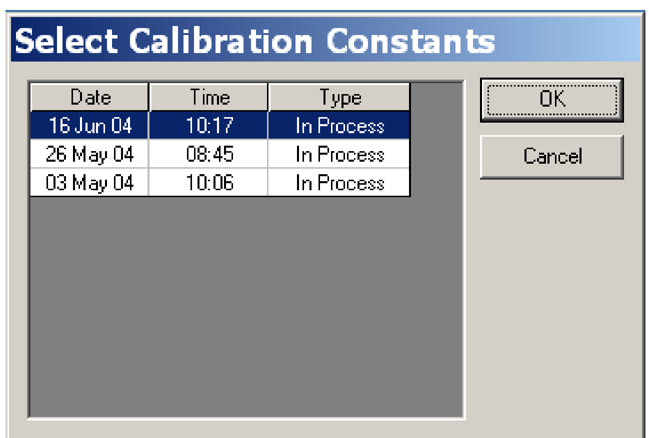

Figure 4-20
8100CAL Select Calibration Constants

About Menu

The About menu opens the 'About' Window that is illustrated in Figure 4-21. The About Window provides the version number of 8100CAL.

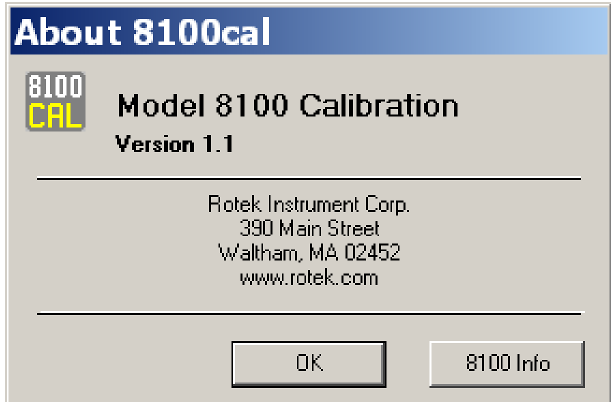

Figure 4-21
8100CAL About

Clicking on the '8100 Info' button queries the calibrator for the serial number and installed firmware revisions. This information is displayed in the Information window illustrated in Figure 4-22.

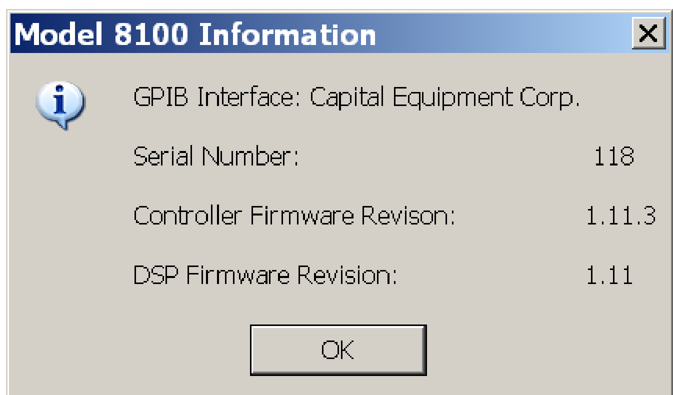

Figure 4-22
8100CAL 8100 Information

Starting a Test

Tests are started using by clicking on the 'Start' button in the lower left corner of the main window. Test may also be started by selecting the Start Test menu item from the tools menu or by pressing the F5 function key.

Tests are defined using a series of data entry screens using the sequence described in the flow chart shown in Figure 4-23.

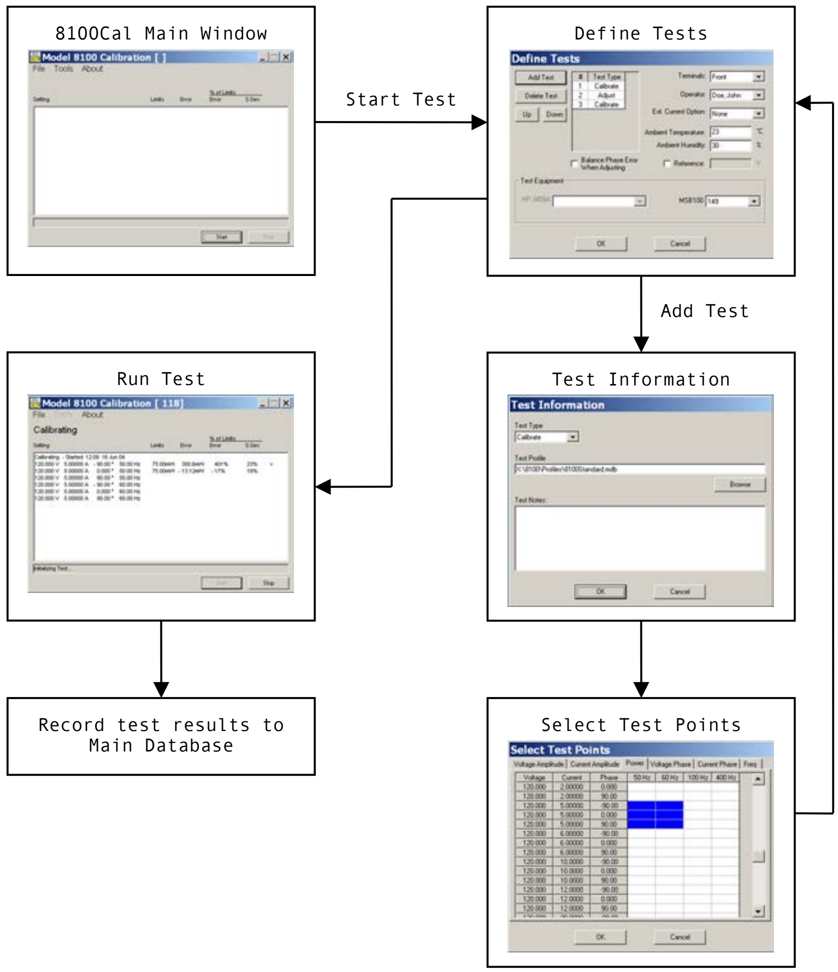

Figure 4-23
8100CAL Test Sequence Flow Chart

When a test is started the 'Define Tests' window appears. This screen provides the controls to define the tests to be performed. The Define tests screen is shown in Figure 4-24.

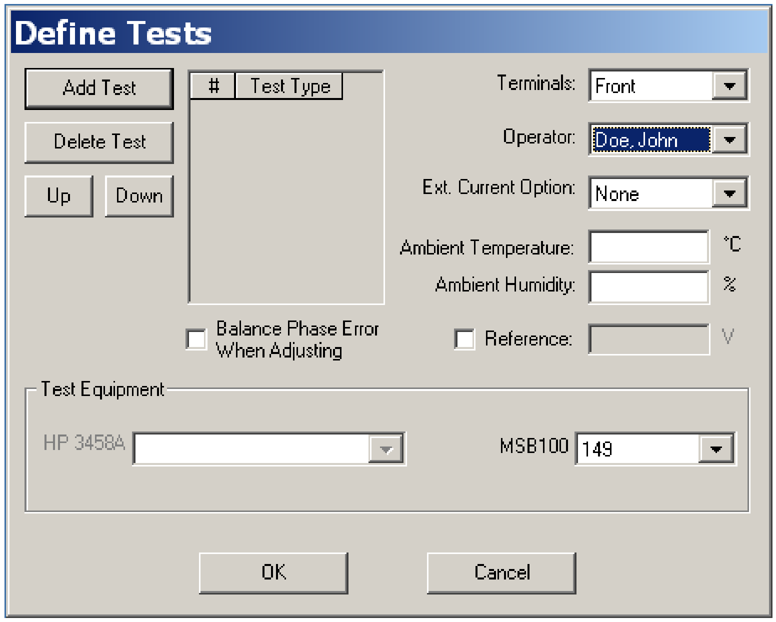

Figure 4-24
8100CAL Define Tests

The 8100CAL program can perform multiple tests automatically in the sequence defined on this screen. The test list is initially empty and is filled by pressing the 'Add Test' button.

When adding a test the 'Test Information' screen becomes visible. This screen allows the type of test to be selected, the specific test profile to use and a Notes field. The 'Test Information' screen is shown in Figure 4-25.

There are 3 types of tests that may be added.

- Calibrate
- Adjust
- Stability

<u>Calibrate.</u>
The Calibrate test will make a series of measurements at specific settings. The results of the measurements are recorded in the main database.

<u>Adjust.</u>
The Adjust test will enter the Calibration Mode and adjust the output of Model 8100 to remove errors. After an adjustment is made, the program will measure the same setting with the Calibration Mode disabled. This measurement will verify that a proper adjustment was made. The results of the as adjusted measurements are recorded in the main database.

<u>Stability.</u>
The Stability test will make a series of measurements at specific settings and repeat

these measurements every 10 minutes. The duration of a stability test is user definable and is typically 12 to 24 hours. The results of the measurements are recorded in the main database.

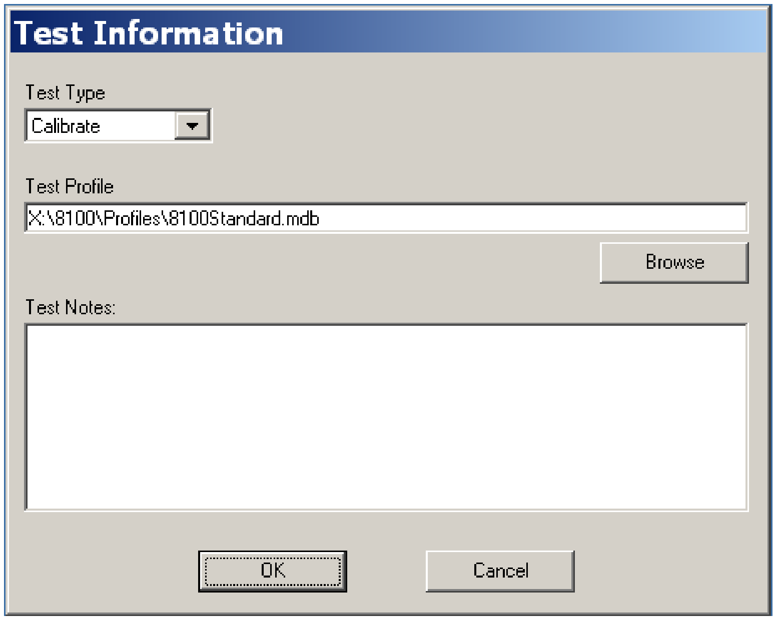

Figure 4-25
8100CAL Test Information

The test profile is a file that stores a list of test points that may be performed during a test. When the 8100CAL program is installed a profile named 8100Standard.mdb is installed as well. This profile includes all tests required to verify the performance of the Model 8100. Profiles have a file format that is a standard Microsoft Access database format. The standard profile may be copied and edited to meet specific testing requirements.

Profiles are only used to select test points for the Calibrate and Stability Test types. When performing an adjustment the list of tests settings available include only the adjustment points of the Model 8100.

The Notes field allows a note or description of the test to be entered. This text is stored with the test in the main database and will be included on the printed test report.

When the Test Information screen is complete, click ‘OK’ to proceed to the ‘Select Test Points’ screen shown in Figure 4-26.

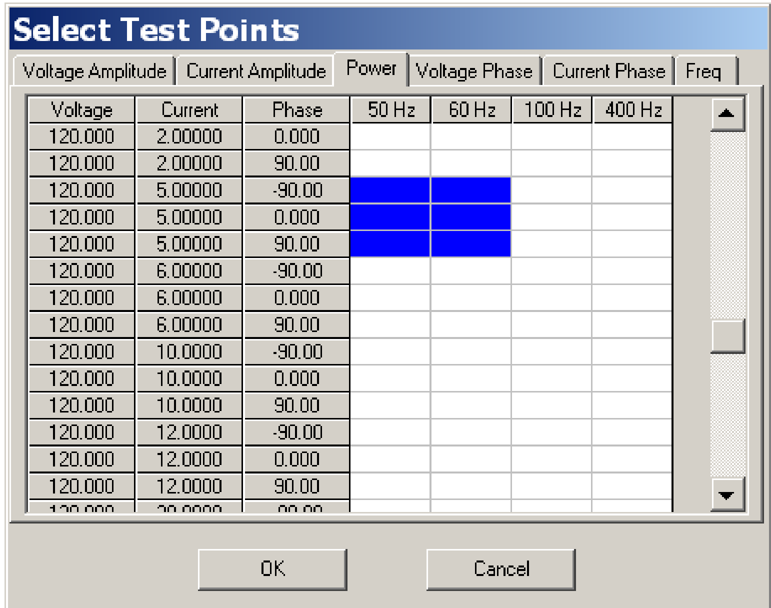

Figure 4-26
8100CAL Select Test Points

The ‘Select Test Points’ screen consists of a set of Tabs each containing a large grid displaying all tests included in the test profile. The tabs group the available tests under the functions Voltage Amplitude, Current Amplitude, Power, Voltage Phase and Current Phase. Select a function tab to make the settings grid for that function visible.

Clicking on a cell in the grid will change the color from white to blue indicating that the test point will be included in the test.

The mouse pointer may also be dragged across the grid to select multiple cells.

Clicking on a frequency column label will cause the entire column to be selected. Clicking on a setting row label will cause the entire row to be selected.

Clicking on a cell that has previously been selected will change the color of the cell from blue to white indicating that that setting is not to be included in the test.

When all the test points have been selected clicking on ‘OK’ will return to the ‘Test Definition’ Screen and the test has been added to the Test Definition list. Clicking on ‘Add Test’ again will start the process to add another test to the test list.

In this way a sequence of tests may be added. One common sequence would include a calibration of the instrument to gather the ‘As Found’ test data followed by an adjustment to remove any errors in the Model 8100. The last test could be another Calibrate to record the ‘As Left’ or Final Data.

When all the required test have been created the test definition screen will appear as shown in Figure 4-27.

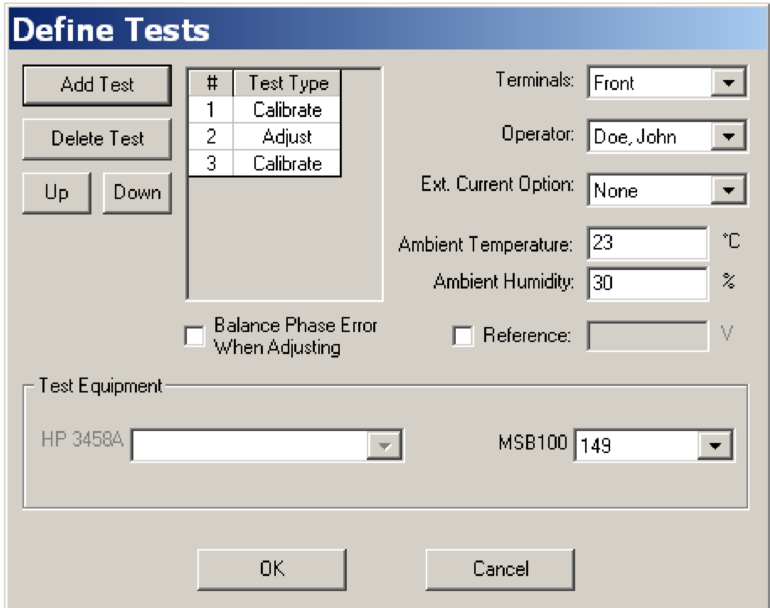

Figure 4-27
8100CAL Define Tests (Complete)

Highlighting a test in the test list will select that test. It may then be moved up or down in the list using the ‘Up’ and ‘Down’ buttons located to the left of the list. Once selected the test may also be deleted from the list using the ‘Delete’ button.

Once the tests are defined the other information on the ‘Test Definition’ Screen must be completed.

The Terminals selection allows the test to be performed using the front or rear terminals of the Model 8100.

The Operator drop down list will include the names of technicians who are qualified to test the Model 8100. The qualifications are defined in the Administration Database. The Operator name is included on the printed test report.

The External Current option indicates whether a Rotek Model 8140 Current Extender is connected with this Model 8100 and is to be used during this test.

Ambient Temperature and Ambient Humidity must be entered. This information is stored with the test in the main database and is included on the printed test report. If the Rotek TH Logger is being used these fields are disabled and the readings are automatically entered.

The internal 5V reference of the Model 8100 may be entered. This field is optional and is typically only recorded during factory calibrations. If a value is to be entered the field must be enabled by checking the reference check box located to the left of the reference text box.

The ‘Balance Phase Errors When Adjusting’ is used to make phase adjustments when there is a large phase imbalance at a particular setting. This option is typically for factory use only and should not be used in normal calibration and adjustments.

The test equipment in use during the test must be selected from the drop down lists. The equipment included in these lists is stored in the administration database which is maintained using the AdminData program. If the power standard is the Model MSB100, it will be automatically identified by the 8100CAL program. The MSB100 list will contain only one entry for the instrument that is connected. The Model 3458A must be manually selected from the list. If there is no 3458A connected the program will prompt the user and allow testing of power and phase points only.

When all information is complete then the ‘OK’ button is clicked to initiate the test.

The title bar of the main window is updated to indicate the serial number of the Model 8100 under test.

The 8100Cal main window is also updated the list the test points to be included in the first test. The type of test and the starting date and time is printed at the beginning of the list. The test type is also printed in bold characters at the top of the window.

The status bar located at the bottom of the Main Window will indicate the status of the current test point.

As each test is completed the test results are added to the list. The results are expressed in terms of an error in the units of the measurement. Also included are the limits and the percentage of the measured error to the limits. Any test with a percentage of limits greater than 100% is a failed test.

Each measurement is actually an average of several measurements made over a 7 to 10 second period. The standard deviation of this set of readings is also recorded to give an indication of the short term stability of the reading. This value is displayed in the main window as a percentage of the limits for the test.

Failed tests are indicated with a × in the status column. If the status column is blank the measured error is within the limits for that test.

Figure 4-28 shows the main window with a test in progress. The test is a Calibration including 6 test points. The first measurement has exceeded the limits for the test and an × appears in the status column. The second measurement is within the limits for this test point and the status column remains blank for the test point. The third test is in progress and the status bar located at the bottom of the window indicates ‘Initializing Test…”.

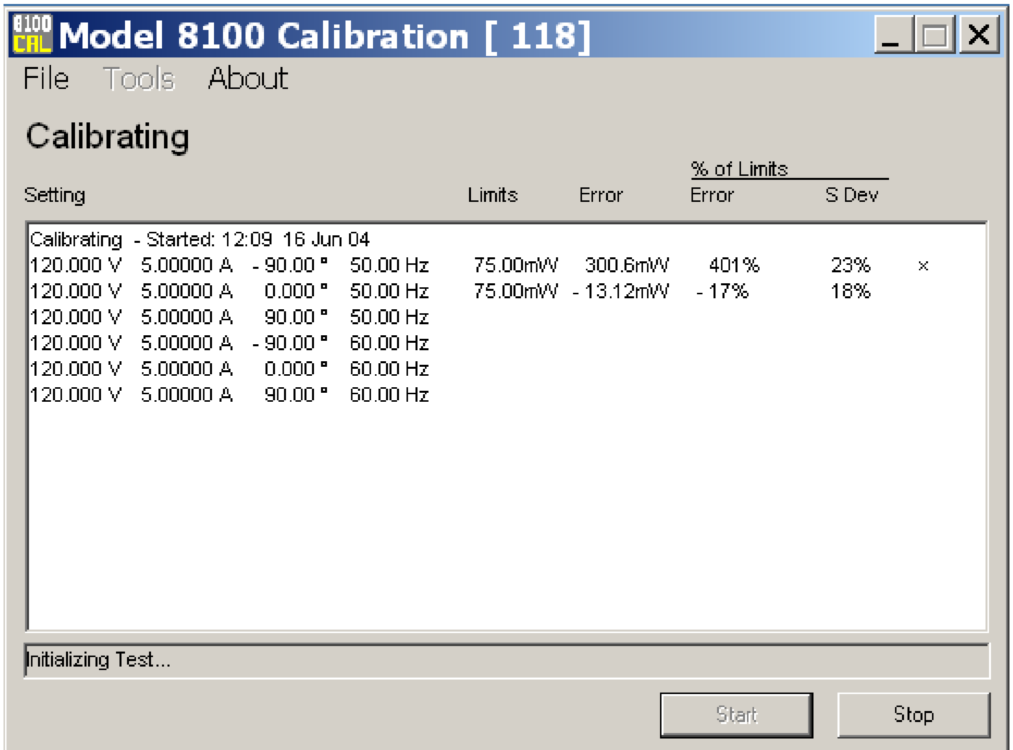

Figure 4-28
8100CAL Main Screen (Testing)

The testing is in progress, the start button is inactive and the Stop Button is active. If the test is to be cancelled the stop button should be clicked.

When the test is complete a message box appears to indicate the conclusion if the test and to ask if the data should be recorded to the main database. Answering yes records the data as is the ‘Record Test Data’ item of the File Menu has been selected. Answering no does not delete the data and it could be manually updated later using the ‘Record Test Data’ item of the File Menu. Test data is not deleted until another test is started.

Single Measurement Mode

The 8100CAL program has the ability to make single and multiple measurements of a single output setting. The single measurement mode is a diagnostic tool designed to help troubleshoot the Model 8100.

The single measurement window provides all the controls required to configure the calibrator and test equipment to make measurements of voltage amplitude, current amplitude and power. Figure 4-29 shows the single measurement window as it appears when first opened.

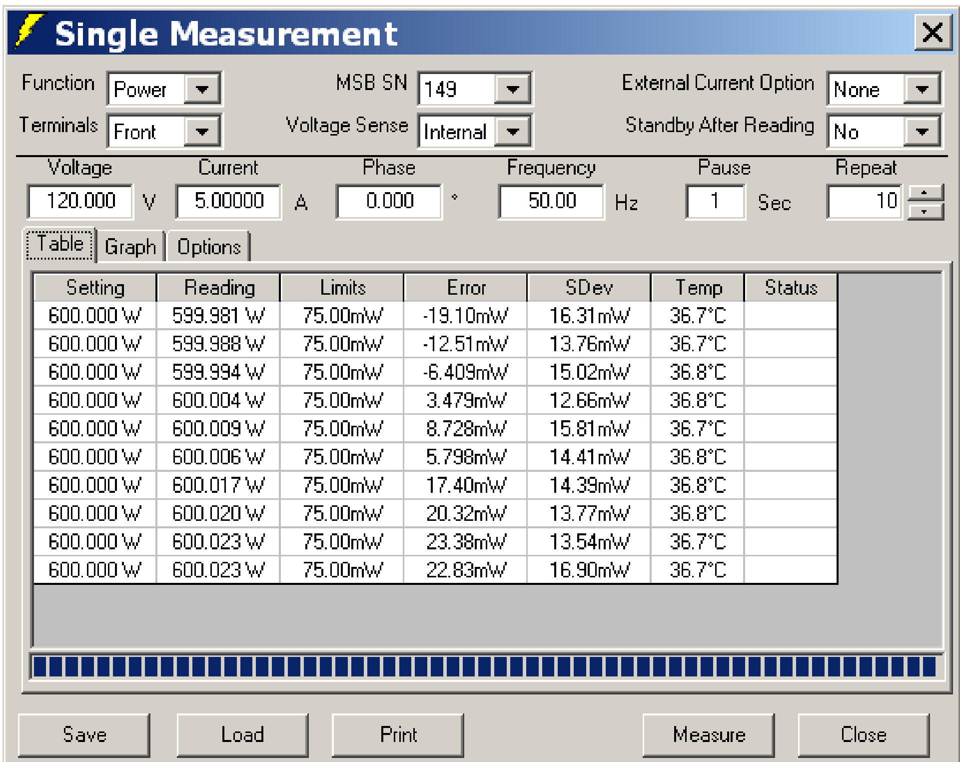

Figure 4-29
8100CAL Single Measurement (Table View)

The top portion of the window provides the controls to configure the test.

Function provides a drop down list with the choices Voltage, Current or Power.

Terminals provides a drop down list with the choices Front and Rear.

MSB SN provides a means of identifying the MSB being used in the test. If the MSB is an MSB100 then the serial number is automatically retrieved from the unit and is the only item in the list. If the Power standard is set to MSB-001A then the list contains all MSB-001A instruments available in the administration database. The correct instrument must be selected to ensure the proper calibration corrections are applied to measurements made using the power standard.

Voltage Sense provides a drop down list with the choices Internal and External.

External Current Option provides a drop down list with the choices ‘None’ and ‘Model 8140’.

Standby After Reading provides a drop down list with the choices Yes, No and Yes Rst. When No is selected the Model 8100 will have its output energized and then will remain in the Operate state for the duration of the test even if multiple readings are made. When Yes is selected the Model 8100 will change the output state to Standby after each measurement and the unit will return to Operate before each reading when multiple measurements are made. When ‘Yes RST’ is selected the Model 8100 will behave as if ‘Yes’ has been selected with the addition of a Reset of the calibrator every time the unit returns to the standby state.

The next section allows the setting of the Voltage, Current, Phase and Frequency values. In addition, the duration of the delay between multiple readings is set here and, finally, the number of times the measurement is to be repeated. The maximum number of times a measurement may be repeated is 500.

The test is initiated by clicking on the ‘Measure’ button located in the lower right corner of the window.

The default view of the test results is the table view as shown in Figure 4-29. The results may also be viewed in graphical form by selecting the Graph tab in the results area of the window.

The graphical view will shows a graph with the readings plotted on the Y axis and time along the x axis. An example of the graphical view is shown in Figure 4-30.

The values plotted on the y axis can be expressed in the units of the measurement or as ppm of setting.

The display of the graphical view can be customized using the controls of the Options tab.

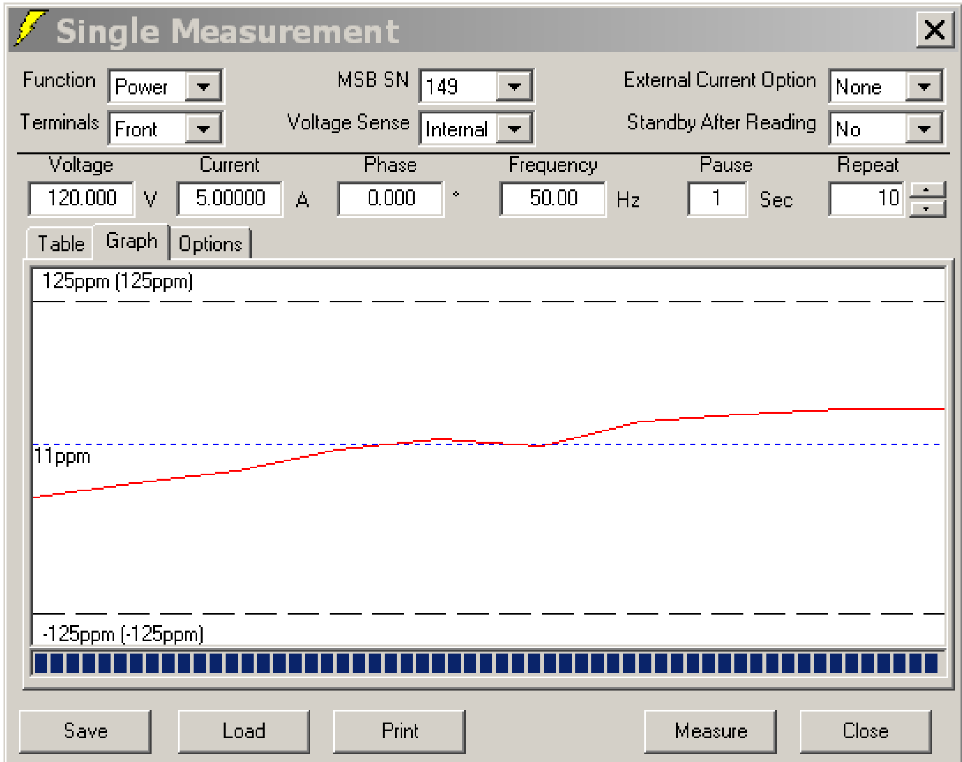

Figure 4-30
8100CAL Single Measurement (Graph View)

Figure 4-31 shows the graph options tab. Features can be displayed on the graph by checking the items listed on this tab. The possible graph features are listed below.

Limits
When the limits option is checked the accuracy limits for the present test settings are printed as dashed lines. Limits of ±125ppm are illustrated in Figure 4-30.

Mean
When the Mean option is checked the mean of the measurements is printed as a blue dotted line. A Mean of 11ppm is shown in Figure 4-30.

Temperature
When the Temperature option is checked the internal temperature of the Model 8100 is plotted in green. The scale for the temperature readings is printed on the right side of the graph. Figure 4-32 illustrates the graph view with the internal temperature of the Model 8100 plotted in addition to the measurements.

Readings
When the Readings option is checked the measurements of the Model 8100 output are plotted on the graph in red. Readings are plotted in both Figure 4-30 and Figure 4-32.

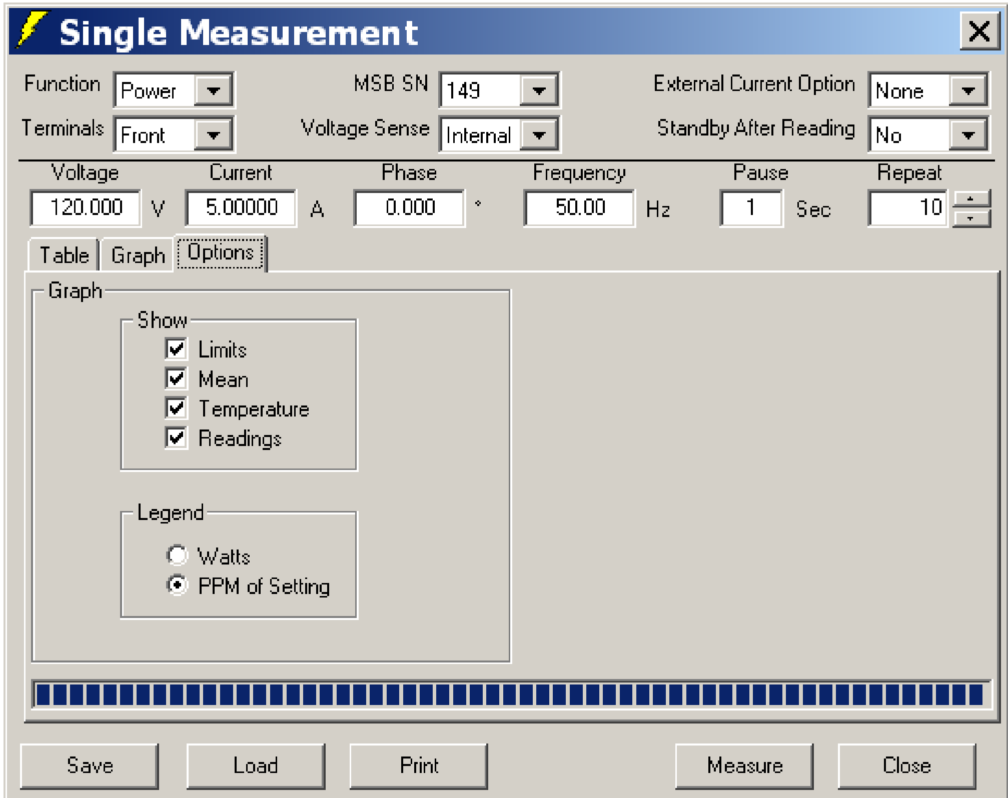

Figure 4-31
8100CAL Single Measurement (Graph Options)

While measurements are being made the progress bar at the bottom of the window indicates the portion of the test that is complete.

When the test is complete the results may be saved to a file or printed to the default printer. Saved files may be loaded at a later date and viewed in the single measurement window. The saved files are formatted as comma separated values (CSV) and may be viewed in any text viewer or spreadsheet application.

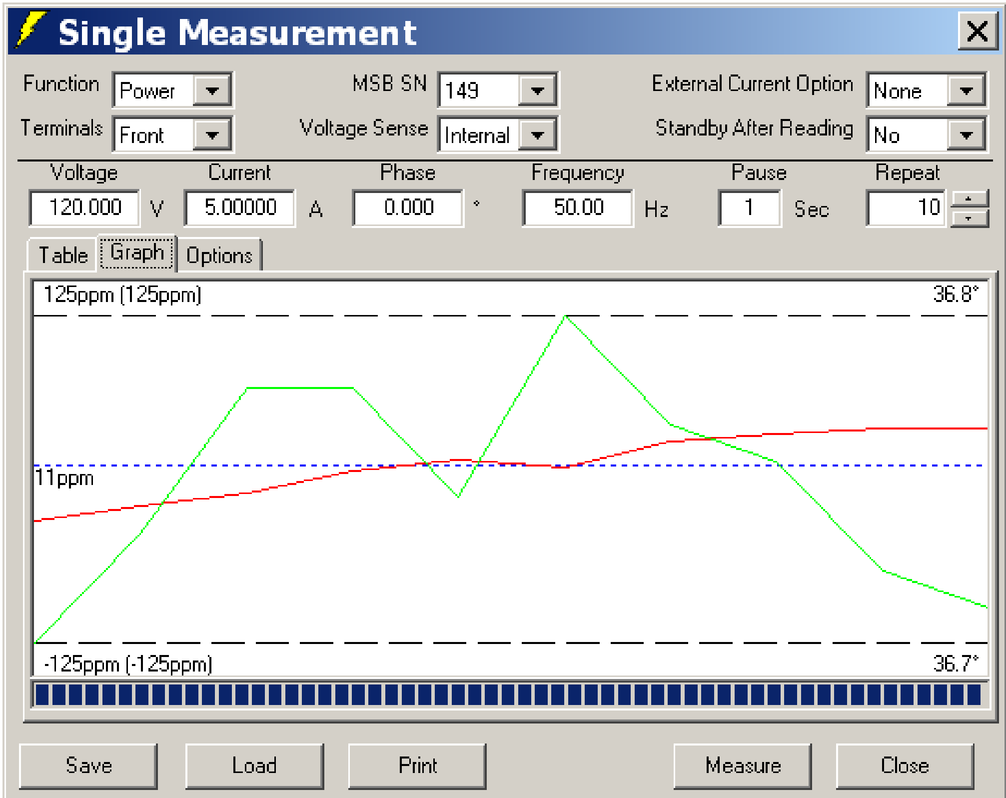

Figure 4-32
8100CAL Single Measurement (Graph View With Temperature)

CalReport Reporting Software

CalReport, the 8100CAL Test Report generation software, will create test reports based on the measurements recorded by the 8100CAL program.

CalReport creates test reports based on data stored in two databases. The first is the main 8100CAL database. All test results are stored in the Main Database. A second database is used to store administration information including test equipment calibration information and operator qualifications. The Rotek AdminData program is used to create and maintain the administration database.

Figure 4-9 illustrates how these programs interact with each other via the Main Database and the Admin Database.

Software Installation

The CalReport software has the following installation requirements.

- Microsoft Windows 95, Windows 98 or Windows ME.
- Minimum RAM: 64MB
- Recommended RAM: 128MB
- Minimum Hard Drive Space required: 50MB

If your computer system does not meet these requirements, the program may not run properly.

To install the CalReport program insert the setup CD and follow the procedure below.

- Choose Run from the Start Menu.
- Enter n:\Setup in the Run Dialog box where n is the letter of the drive containing the 8100CAL setup disk.
- Click OK or press enter.

Follow the instructions of the setup program to complete the installation.

If upgrading a previous installation of CalReport it is recommended that the earlier installation be removed from the system before installing the most recent version.

Starting CalReport For The First Time

When CalReport is started for the first time the CalReport Main Screen will open as shown in Figure 4-34. When CalReport normally starts it automatically opens the Admin Database and Main Database specified on the Locate Databases Window.

The Locate Databases window is opened by selecting 'Database Location' from the File menu. Figure 4-33 shows the Locate Databases window.

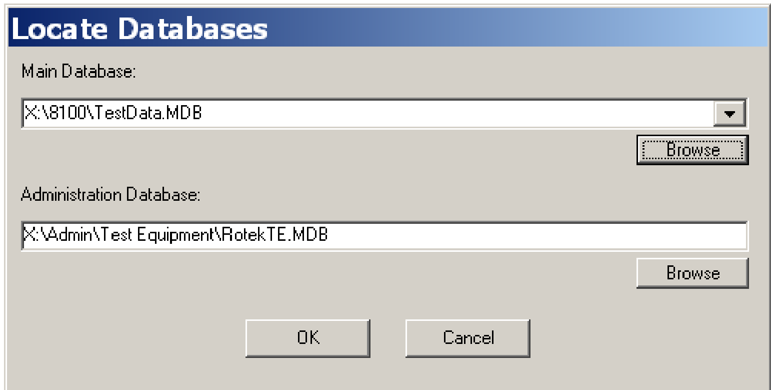

Figure 4-33
CalReport Locate Databases Window

The Main Database field identifies the path and file name of the 8100CAL Main Database. Clicking on the Browse button located adjacent to the Main Database text box will open a file dialog box to locate the Main Database. The Main database text box is also a drop down list whose entries will include the past five databases opened. Recently used databases may be selected by picking them off the drop down list. The Main Database stores test results of calibrations and adjustments performed with 8100CAL. The CalReport Software will format and print these test results as test reports.

The Administration Database field identifies the path and file name of the 8100CAL Administration Database. Clicking on the Browse button located adjacent to the Administration Database text box will open a file dialog box to locate the Administration Database. The Administration Database stores information regarding the test equipment used in 8100CAL calibrations and adjustments to establish calibration status and traceability of the standards used to gather the test results stored in the Main Database. The CalReport Software will format and print these test results as test reports.

Click OK when both the Main Database and Administration Database have been located. The Cal report program main window will open each of these databases and then display a list of tests stored in the main database. Figure 4-34 shows the main window displaying a list of test reports that may be viewed or printed.

The test results stored in the Main Database are filtered to simplify locating a specific test report. In the top left corner of the window are three drop down list boxes used to define the filter criteria.

The first list includes the serial number of all Model 8100's for which test results have been stored in the Main Database. When a serial number is selected the main list will be updated to show only test results for the Model 8100 with that serial number.

The second list includes phase designators. All data for Model 8100's is stored as Phase A data even if the unit will be configured as a component of a multi-phase system later. Other Rotek products that use the CalReport program to print test reports do make use of the Phase designator list. If data for Phase B or C is selected when viewing test results from a Model 8100 Main Database the main list will display 'No Data'.

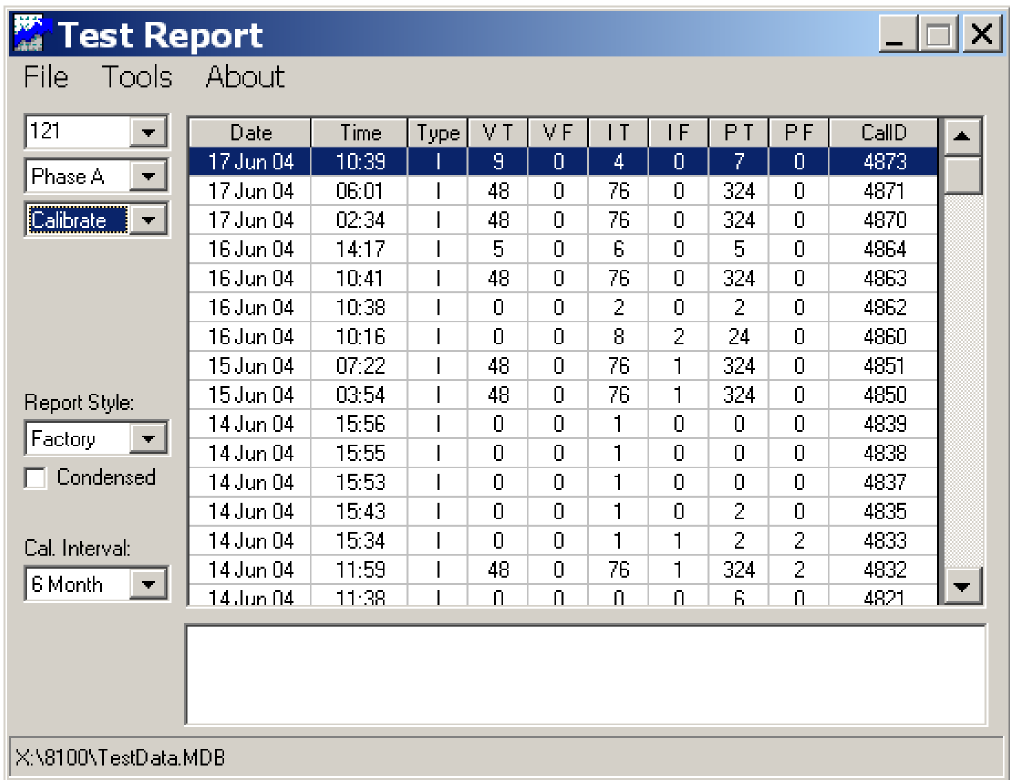

Figure 4-34
CalReport Main Window

The third list includes the three different types of reports that may be viewed and printed; Calibrate, Adjust and Stability. Selecting 'Calibrate' will force the main list to update and display all the calibration reports for the specified serial number.

After the filters have been applied a list of available test reports will appear in the main list. The data included in the list changes depending which type of report is being viewed. Descriptions of the headings are included in Table 4-13, Table 4-14 and Table 4-15.

Heading	Description
Date	Date the test was started
Time	Time the test was started
Type	Type of test I – ‘In process’ F – ‘Final’ or ‘As Left’ Data B – ‘Before’ or ‘As Found’ Data
VT	Number of Voltage tests
VF	Number of Failed Voltage Tests
IT	Number of Current tests
IF	Number of Failed Current Tests
PT	Number of Power tests
PF	Number of Failed Power Tests
CalID	Unique Test Report Identification number.

Table 4-13
CalReport – Calibration List Heading Definitions

Heading	Description
Date	Date the test was started
Time	Time the test was started
VT	Number of Voltage Amplitude tests
VF	Number of Failed Voltage Amplitude Tests
IT	Number of Current Amplitude tests
IF	Number of Failed Current Amplitude Tests
VP T	Number of Voltage Phase tests
VP F	Number of Failed Voltage Phase Tests
IP T	Number of Current Phase tests
IP F	Number of Failed Current Phase Tests
CalID	Unique Test Report Identification number.

Table 4-14
CalReport – Adjustment List Heading Definitions

Heading	Description
Date	Date the test was started
Time	Time the test was started
Type	Type of test I – ‘In process’ F – ‘Final’ or ‘As Left’ Data B – ‘Before’ or ‘As Found’ Data
Voltage	Number of Voltage tests
Current	Number of Current tests
Power	Number of Power tests
Hrs	Number of Failed Current Tests
CalID	Unique Test Report Identification number.

Table 4-15
CalReport – Stability List Heading Definitions

Select a report to print by clicking on that test with the mouse pointer. A test report may be generated by double clicking on the selected test or by selecting the ‘Print Report’ menu item from the File Menu. Reports are always generated to a preview window as shown in Figure 4-35. The controls located at the top of the preview window are used to send the report to the printer, export the report to a disk file, control the zoom and navigate through the report page by page.

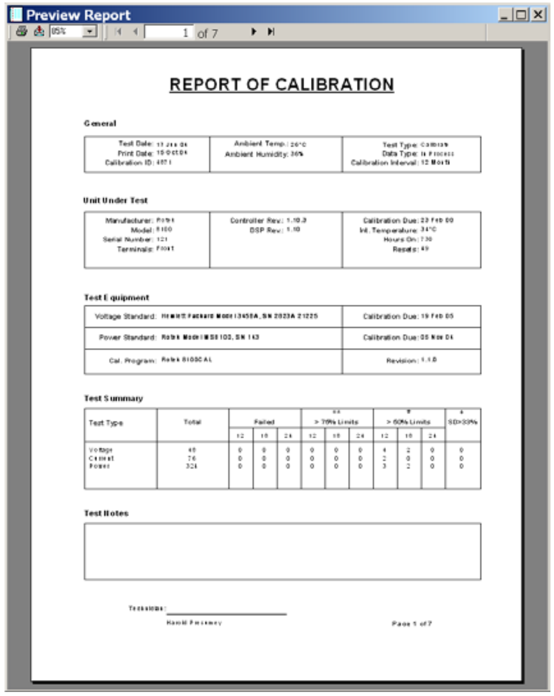

Figure 4-35
CalReport Preview Window

File Menu

The File menu is illustrated in Figure 4-36. It provides the menus used to print all reports and locate the databases that contain the test report data.

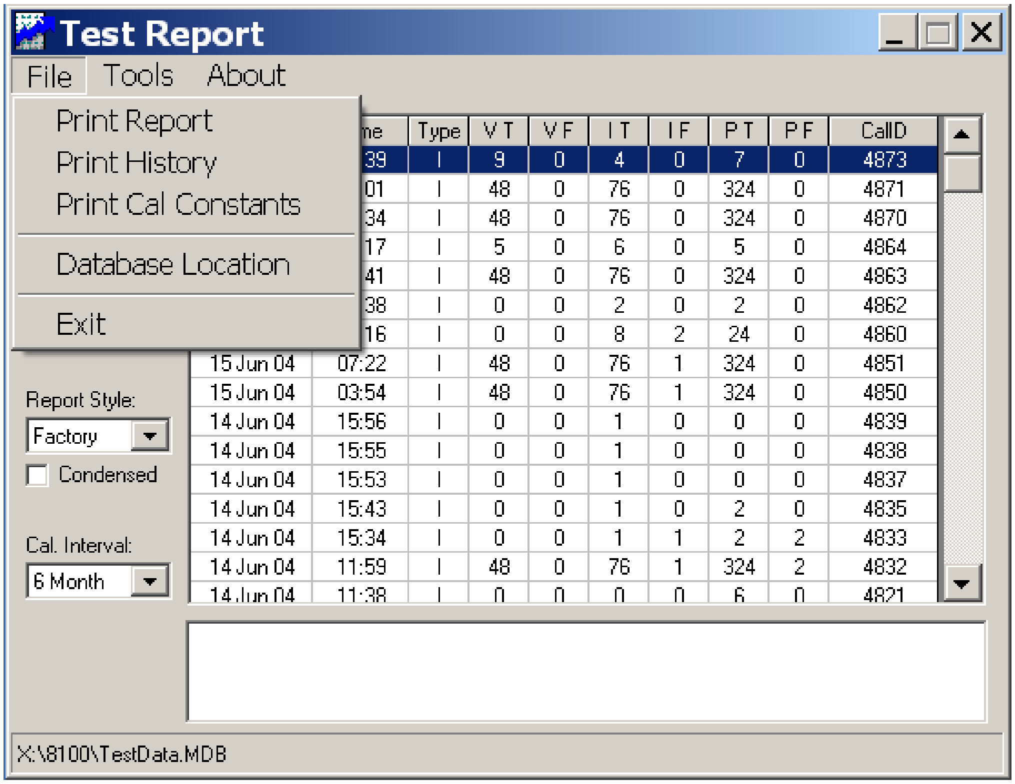

Figure 4-36
CALReport File Menu

Print Report

Selecting the 'Print Report' menu item from the file menu opens the preview window and displays the test report for the data highlighted in the main list. This function is also activated by double clicking on the data in the list.

The cover page of a typical calibration test report is shown in Figure 4-37. A sample of a data page from a typical factory format calibration report is shown in Figure 4-38. A sample of a data page from a typical customer format calibration report is shown in Figure 4-39. A sample of a data page from a typical evaluation format calibration report is shown in Figure 4-40.

The cover page of a typical stability test report is shown in Figure 4-41. A sample of a data page from a typical stability report is shown in Figure 4-42.

REPORT OF CALIBRATION

General

Test Date: 17 Jun 04 **Print Date:** 18 Jun 04 **Calibration ID:** 4871	**Ambient Temp.:** 26°C **Ambient Humidity:** 36%	**Test Type:** Calibrate **Data Type:** In Process **Calibration Interval:** 6 Month

Unit Under Test

Manufacturer: Rotek **Model:** 8100 **Serial Number:** 121 **Terminals:** Front	**Controller Rev.:** 1.10.3 **DSP Rev.:** 1.10	**Calibration Due:** 23 Feb 00 **Int. Temperature:** 34°C **Hours On:** 730 **Resets:** 49

Test Equipment

Voltage Standard: Hewlett Packard Model 3458A, SN 2823A 21225	**Calibration Due:** 19 Feb 05
Power Standard: Rotek Model MSB100, SN 143	**Calibration Due:** 05 Nov 04
Cal. Program: Rotek 8CAL	**Revision:** 1.1.0

Test Summary

Test Type	Total	Failed			** > 75% Limits			* > 50% Limits			+ SD>33%
		6	12	24	6	12	24	6	12	24	
Voltage	48	0	0	0	0	0	0	4	2	0	0
Current	76	0	0	0	0	0	0	2	0	0	0
Power	324	0	0	0	0	0	0	3	2	0	0

Test Notes

Technician: ______________________

Harold Presumey

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Figure 4-37
CALReport – Sample Calibration Report Cover Page

Model 8100, SN 121, Phase A

Voltage

Test Type: Calibrate
Data Type: In Process

Test Date: 17 Jun 04
Calibration ID: 4871

Frequency	Voltage	Reading	Limits	Error	% Limits	S Dev	% Limits	Status
50.00 Hz	1.00000 V	1.00006 V	0.00211 V	0.00006 V	3%	0.00004 V	2%	
50.00 Hz	10.0000 V	10.0003 V	0.00310 V	0.00028 V	9%	0.00016 V	5%	
50.00 Hz	20.0000 V	20.0007 V	0.00420 V	0.00065 V	15%	0.00037 V	9%	
50.00 Hz	60.0000 V	60.0041 V	0.01000 V	0.00411 V	41%	0.00117 V	12%	
50.00 Hz	120.000 V	120.003 V	0.01600 V	0.00329 V	21%	0.00218 V	14%	
50.00 Hz	140.000 V	140.004 V	0.02200 V	0.00349 V	16%	0.00289 V	13%	
50.00 Hz	240.000 V	239.997 V	0.03200 V	-0.00276 V	-9%	0.00504 V	16%	
50.00 Hz	280.000 V	280.009 V	0.04960 V	0.00849 V	17%	0.00113 V	2%	
50.00 Hz	347.000 V	347.009 V	0.05764 V	0.00867 V	15%	0.00268 V	5%	
50.00 Hz	480.000 V	480.003 V	0.07360 V	0.00272 V	4%	0.00758 V	10%	
50.00 Hz	540.000 V	540.009 V	0.10100 V	0.00856 V	8%	0.00574 V	6%	
50.00 Hz	640.000 V	640.002 V	0.11600 V	0.00202 V	2%	0.00811 V	7%	
60.00 Hz	1.00000 V	1.00032 V	0.00211 V	0.00032 V	15%	0.00016 V	8%	
60.00 Hz	10.0000 V	10.0007 V	0.00310 V	0.00067 V	22%	0.00004 V	1%	
60.00 Hz	20.0000 V	20.0005 V	0.00420 V	0.00048 V	11%	0.00017 V	4%	
60.00 Hz	60.0000 V	60.0064 V	0.01000 V	0.00641 V	64%	0.00084 V	8%	*
60.00 Hz	120.000 V	120.000 V	0.01600 V	-0.00033 V	-2%	0.00171 V	11%	
60.00 Hz	140.000 V	140.007 V	0.02200 V	0.00672 V	31%	0.00286 V	13%	
60.00 Hz	240.000 V	240.007 V	0.03200 V	0.00701 V	22%	0.00361 V	11%	
60.00 Hz	280.000 V	280.017 V	0.04960 V	0.01721 V	35%	0.00307 V	6%	
60.00 Hz	347.000 V	347.015 V	0.05764 V	0.01509 V	26%	0.00624 V	11%	
60.00 Hz	480.000 V	480.022 V	0.07360 V	0.02175 V	30%	0.00399 V	5%	
60.00 Hz	540.000 V	540.015 V	0.10100 V	0.01527 V	15%	0.01290 V	13%	
60.00 Hz	640.000 V	640.012 V	0.11600 V	0.01182 V	10%	0.01150 V	10%	
100.0 Hz	1.00000 V	1.00019 V	0.00214 V	0.00019 V	9%	0.00006 V	3%	
100.0 Hz	10.0000 V	10.0003 V	0.00340 V	0.00025 V	7%	0.00026 V	8%	
100.0 Hz	20.0000 V	20.0007 V	0.00480 V	0.00066 V	14%	0.00059 V	12%	
100.0 Hz	60.0000 V	60.0036 V	0.01240 V	0.00361 V	29%	0.00191 V	15%	
100.0 Hz	120.000 V	120.004 V	0.02080 V	0.00409 V	20%	0.00315 V	15%	
100.0 Hz	140.000 V	140.011 V	0.02760 V	0.01069 V	39%	0.00289 V	10%	
100.0 Hz	240.000 V	240.012 V	0.04160 V	0.01240 V	30%	0.00311 V	7%	
100.0 Hz	280.000 V	280.022 V	0.06080 V	0.02214 V	36%	0.00547 V	9%	
100.0 Hz	347.000 V	347.022 V	0.07152 V	0.02236 V	31%	0.00653 V	9%	
100.0 Hz	480.000 V	480.018 V	0.09280 V	0.01769 V	19%	0.00901 V	10%	
100.0 Hz	540.000 V	540.025 V	0.11720 V	0.02473 V	21%	0.01341 V	11%	
100.0 Hz	640.000 V	640.027 V	0.13520 V	0.02661 V	20%	0.01705 V	13%	
400.0 Hz	1.00000 V	1.00043 V	0.00214 V	0.00043 V	20%	0.00026 V	12%	
400.0 Hz	10.0000 V	10.0003 V	0.00340 V	0.00030 V	9%	0.00070 V	21%	
400.0 Hz	20.0000 V	20.0003 V	0.00480 V	0.00033 V	7%	0.00100 V	21%	
400.0 Hz	60.0000 V	60.0011 V	0.01240 V	0.00109 V	9%	0.00393 V	32%	
400.0 Hz	120.000 V	120.002 V	0.02080 V	0.00210 V	10%	0.00623 V	30%	
400.0 Hz	140.000 V	140.007 V	0.02760 V	0.00692 V	25%	0.00663 V	24%	
400.0 Hz	240.000 V	240.008 V	0.04160 V	0.00836 V	20%	0.01260 V	30%	
400.0 Hz	280.000 V	280.032 V	0.06080 V	0.03242 V	53%	0.01445 V	24%	*
400.0 Hz	347.000 V	347.051 V	0.07152 V	0.05140 V	72%	0.01680 V	23%	*
400.0 Hz	480.000 V	480.055 V	0.09280 V	0.05520 V	59%	0.02295 V	25%	*
400.0 Hz	540.000 V	540.044 V	0.11720 V	0.04350 V	37%	0.02469 V	21%	
400.0 Hz	640.000 V	640.048 V	0.13520 V	0.04823 V	36%	0.03223 V	24%	

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Figure 4-38
CALReport – Sample Calibration Report Data Page (Factory)

Model 8100, SN 121, Phase A

Test Type: Calibrate
Data Type: In Process

Test Date: 17 Jun 04
Calibration ID: 4871

Voltage

Frequency	Voltage	Reading	Limits	Error	ppm Nom	S Dev	ppm Nom	Status
50.00 Hz	1.00000 V	1.00006 V	0.00211 V	0.00006 V	62	0.00004 V	36	
50.00 Hz	10.0000 V	10.0003 V	0.00310 V	0.00028 V	28	0.00016 V	16	
50.00 Hz	20.0000 V	20.0007 V	0.00420 V	0.00065 V	32	0.00037 V	18	
50.00 Hz	60.0000 V	60.0041 V	0.01000 V	0.00411 V	68	0.00117 V	20	
50.00 Hz	120.000 V	120.003 V	0.01600 V	0.00329 V	27	0.00218 V	18	
50.00 Hz	140.000 V	140.004 V	0.02200 V	0.00349 V	25	0.00289 V	21	
50.00 Hz	240.000 V	239.997 V	0.03200 V	-0.00276 V	-11	0.00504 V	21	
50.00 Hz	280.000 V	280.009 V	0.04960 V	0.00849 V	30	0.00113 V	4	
50.00 Hz	347.000 V	347.009 V	0.05764 V	0.00867 V	25	0.00268 V	8	
50.00 Hz	480.000 V	480.003 V	0.07360 V	0.00272 V	6	0.00758 V	16	
50.00 Hz	540.000 V	540.009 V	0.10100 V	0.00856 V	16	0.00574 V	11	
50.00 Hz	640.000 V	640.002 V	0.11600 V	0.00202 V	3	0.00811 V	13	
60.00 Hz	1.00000 V	1.00032 V	0.00211 V	0.00032 V	322	0.00016 V	159	
60.00 Hz	10.0000 V	10.0007 V	0.00310 V	0.00067 V	67	0.00004 V	4	
60.00 Hz	20.0000 V	20.0005 V	0.00420 V	0.00048 V	24	0.00017 V	9	
60.00 Hz	60.0000 V	60.0064 V	0.01000 V	0.00641 V	107	0.00084 V	14	
60.00 Hz	120.000 V	120.000 V	0.01600 V	-0.00033 V	-3	0.00171 V	14	
60.00 Hz	140.000 V	140.007 V	0.02200 V	0.00672 V	48	0.00286 V	20	
60.00 Hz	240.000 V	240.007 V	0.03200 V	0.00701 V	29	0.00361 V	15	
60.00 Hz	280.000 V	280.017 V	0.04960 V	0.01721 V	61	0.00307 V	11	
60.00 Hz	347.000 V	347.015 V	0.05764 V	0.01509 V	43	0.00624 V	18	
60.00 Hz	480.000 V	480.022 V	0.07360 V	0.02175 V	45	0.00399 V	8	
60.00 Hz	540.000 V	540.015 V	0.10100 V	0.01527 V	28	0.01290 V	24	
60.00 Hz	640.000 V	640.012 V	0.11600 V	0.01182 V	18	0.01150 V	18	
100.0 Hz	1.00000 V	1.00019 V	0.00214 V	0.00019 V	186	0.00006 V	60	
100.0 Hz	10.0000 V	10.0003 V	0.00340 V	0.00025 V	25	0.00026 V	26	
100.0 Hz	20.0000 V	20.0007 V	0.00480 V	0.00066 V	33	0.00059 V	30	
100.0 Hz	60.0000 V	60.0036 V	0.01240 V	0.00361 V	60	0.00191 V	32	
100.0 Hz	120.000 V	120.004 V	0.02080 V	0.00409 V	34	0.00315 V	26	
100.0 Hz	140.000 V	140.011 V	0.02760 V	0.01069 V	76	0.00289 V	21	
100.0 Hz	240.000 V	240.012 V	0.04160 V	0.01240 V	52	0.00311 V	13	
100.0 Hz	280.000 V	280.022 V	0.06080 V	0.02214 V	79	0.00547 V	20	
100.0 Hz	347.000 V	347.022 V	0.07152 V	0.02236 V	64	0.00653 V	19	
100.0 Hz	480.000 V	480.018 V	0.09280 V	0.01769 V	37	0.00901 V	19	
100.0 Hz	540.000 V	540.025 V	0.11720 V	0.02473 V	46	0.01341 V	25	
100.0 Hz	640.000 V	640.027 V	0.13520 V	0.02661 V	42	0.01705 V	27	
400.0 Hz	1.00000 V	1.00043 V	0.00214 V	0.00043 V	427	0.00026 V	256	
400.0 Hz	10.0000 V	10.0003 V	0.00340 V	0.00030 V	30	0.00070 V	70	
400.0 Hz	20.0000 V	20.0003 V	0.00480 V	0.00033 V	16	0.00100 V	50	
400.0 Hz	60.0000 V	60.0011 V	0.01240 V	0.00109 V	18	0.00393 V	66	
400.0 Hz	120.000 V	120.002 V	0.02080 V	0.00210 V	18	0.00623 V	52	
400.0 Hz	140.000 V	140.007 V	0.02760 V	0.00692 V	49	0.00663 V	47	
400.0 Hz	240.000 V	240.008 V	0.04160 V	0.00836 V	35	0.01260 V	52	
400.0 Hz	280.000 V	280.032 V	0.06080 V	0.03242 V	116	0.01445 V	52	
400.0 Hz	347.000 V	347.051 V	0.07152 V	0.05140 V	148	0.01680 V	48	
400.0 Hz	480.000 V	480.055 V	0.09280 V	0.05520 V	115	0.02295 V	48	
400.0 Hz	540.000 V	540.044 V	0.11720 V	0.04350 V	81	0.02469 V	46	
400.0 Hz	640.000 V	640.048 V	0.13520 V	0.04823 V	75	0.03223 V	50	

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Figure 4-39
CALReport – Sample Calibration Report Data Page (Evaluation)

Model 8100, SN 121, Phase A

Test Type: Calibrate
Data Type: In Process

Test Date: 17 Jun 04
Calibration ID: 4871

Voltage

Frequency	Voltage	Reading	Error	% of Limits	Limits	Uncertainty	T. U. R.	Status
50.00 Hz	1.00000 V	1.00006 V	0.00006 V	3%	0.00211 V	0.00002 V		
50.00 Hz	10.0000 V	10.0003 V	0.00028 V	9%	0.00310 V	0.00020 V		
50.00 Hz	20.0000 V	20.0007 V	0.00065 V	15%	0.00420 V	0.00040 V		
50.00 Hz	60.0000 V	60.0041 V	0.00411 V	41%	0.01000 V	0.00120 V		
50.00 Hz	120.000 V	120.003 V	0.00329 V	21%	0.01600 V	0.00300 V		
50.00 Hz	140.000 V	140.004 V	0.00349 V	16%	0.02200 V	0.00350 V		
50.00 Hz	240.000 V	239.997 V	-0.00276 V	-9%	0.03200 V	0.00600 V		
50.00 Hz	280.000 V	280.009 V	0.00849 V	17%	0.04960 V	0.00700 V		
50.00 Hz	347.000 V	347.009 V	0.00867 V	15%	0.05764 V	0.00868 V		
50.00 Hz	480.000 V	480.003 V	0.00272 V	4%	0.07360 V	0.01200 V		
50.00 Hz	540.000 V	540.009 V	0.00856 V	8%	0.10100 V	0.01350 V		
50.00 Hz	640.000 V	640.002 V	0.00202 V	2%	0.11600 V	0.01600 V		
60.00 Hz	1.00000 V	1.00032 V	0.00032 V	15%	0.00211 V	0.00002 V		
60.00 Hz	10.0000 V	10.0007 V	0.00067 V	22%	0.00310 V	0.00020 V		
60.00 Hz	20.0000 V	20.0005 V	0.00048 V	11%	0.00420 V	0.00040 V		
60.00 Hz	60.0000 V	60.0064 V	0.00641 V	64%	0.01000 V	0.00120 V		
60.00 Hz	120.000 V	120.000 V	-0.00033 V	-2%	0.01600 V	0.00300 V		
60.00 Hz	140.000 V	140.007 V	0.00672 V	31%	0.02200 V	0.00350 V		
60.00 Hz	240.000 V	240.007 V	0.00701 V	22%	0.03200 V	0.00600 V		
60.00 Hz	280.000 V	280.017 V	0.01721 V	35%	0.04960 V	0.00700 V		
60.00 Hz	347.000 V	347.015 V	0.01509 V	26%	0.05764 V	0.00868 V		
60.00 Hz	480.000 V	480.022 V	0.02175 V	30%	0.07360 V	0.01200 V		
60.00 Hz	540.000 V	540.015 V	0.01527 V	15%	0.10100 V	0.01350 V		
60.00 Hz	640.000 V	640.012 V	0.01182 V	10%	0.11600 V	0.01600 V		
100.0 Hz	1.00000 V	1.00019 V	0.00019 V	9%	0.00214 V	0.00003 V		
100.0 Hz	10.0000 V	10.0003 V	0.00025 V	7%	0.00340 V	0.00025 V		
100.0 Hz	20.0000 V	20.0007 V	0.00066 V	14%	0.00480 V	0.00050 V		
100.0 Hz	60.0000 V	60.0036 V	0.00361 V	29%	0.01240 V	0.00150 V		
100.0 Hz	120.000 V	120.004 V	0.00409 V	20%	0.02080 V	0.00360 V		
100.0 Hz	140.000 V	140.011 V	0.01069 V	39%	0.02760 V	0.00420 V		
100.0 Hz	240.000 V	240.012 V	0.01240 V	30%	0.04160 V	0.00720 V		
100.0 Hz	280.000 V	280.022 V	0.02214 V	36%	0.06080 V	0.00840 V		
100.0 Hz	347.000 V	347.022 V	0.02236 V	31%	0.07152 V	0.01041 V		
100.0 Hz	480.000 V	480.018 V	0.01769 V	19%	0.09280 V	0.01440 V		
100.0 Hz	540.000 V	540.025 V	0.02473 V	21%	0.11720 V	0.01620 V		
100.0 Hz	640.000 V	640.027 V	0.02661 V	20%	0.13520 V	0.01920 V		
400.0 Hz	1.00000 V	1.00043 V	0.00043 V	20%	0.00214 V	0.00009 V		
400.0 Hz	10.0000 V	10.0003 V	0.00030 V	9%	0.00340 V	0.00092 V	3.7	
400.0 Hz	20.0000 V	20.0003 V	0.00033 V	7%	0.00480 V	0.00184 V	2.6	
400.0 Hz	60.0000 V	60.0011 V	0.00109 V	9%	0.01240 V	0.00552 V	2.2	
400.0 Hz	120.000 V	120.002 V	0.00210 V	10%	0.02080 V	0.01128 V	1.8	
400.0 Hz	140.000 V	140.007 V	0.00692 V	25%	0.02760 V	0.01316 V	2.1	
400.0 Hz	240.000 V	240.008 V	0.00836 V	20%	0.04160 V	0.02256 V	1.8	
400.0 Hz	280.000 V	280.032 V	0.03242 V	53%	0.06080 V	0.02632 V	2.3	
400.0 Hz	347.000 V	347.051 V	0.05140 V	72%	0.07152 V	0.03262 V	2.2	
400.0 Hz	480.000 V	480.055 V	0.05520 V	59%	0.09280 V	0.04512 V	2.1	
400.0 Hz	540.000 V	540.044 V	0.04350 V	37%	0.11720 V	0.05076 V	2.3	
400.0 Hz	640.000 V	640.048 V	0.04823 V	36%	0.13520 V	0.06016 V	2.2	

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Figure 4-40
CALReport – Sample Calibration Report Data Page (Customer)

STABILITY REPORT

General

Test Date: 10 Jun 04 **Print Date:** 18 Jun 04 **Calibration ID:** 4790	**Ambient Temp.:** 23°C **Ambient Humidity:** 44%	**Test Type:** Stability **Data Type:** In Process **Test Duration** 11 Hrs, 51 Min

Unit Under Test

Manufacturer: Rotek **Model:** 8100 **Serial Number:** 121 **Terminals:** Front	**Controller Rev.:** 1.10.3 **DSP Rev.:** 1.10	**Calibration Due:** 15 Feb 00 **Int. Temperature:** 35°C **Hours On:** 620 **Resets:** 38

Test Equipment

Voltage Standard: Hewlett Packard Model 3458A, SN 2823A 21225	**Calibration Due:** 19 Feb 05
Power Standard: Rotek Model MSB100, SN 143	**Calibration Due:** 05 Nov 04
Cal. Program: Rotek 8CAL	**Revision:** 1.1.0

Test Notes

Technician: ______________________

Harold Presumey

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Figure 4-41
CALReport – Sample Stability Report Cover Page

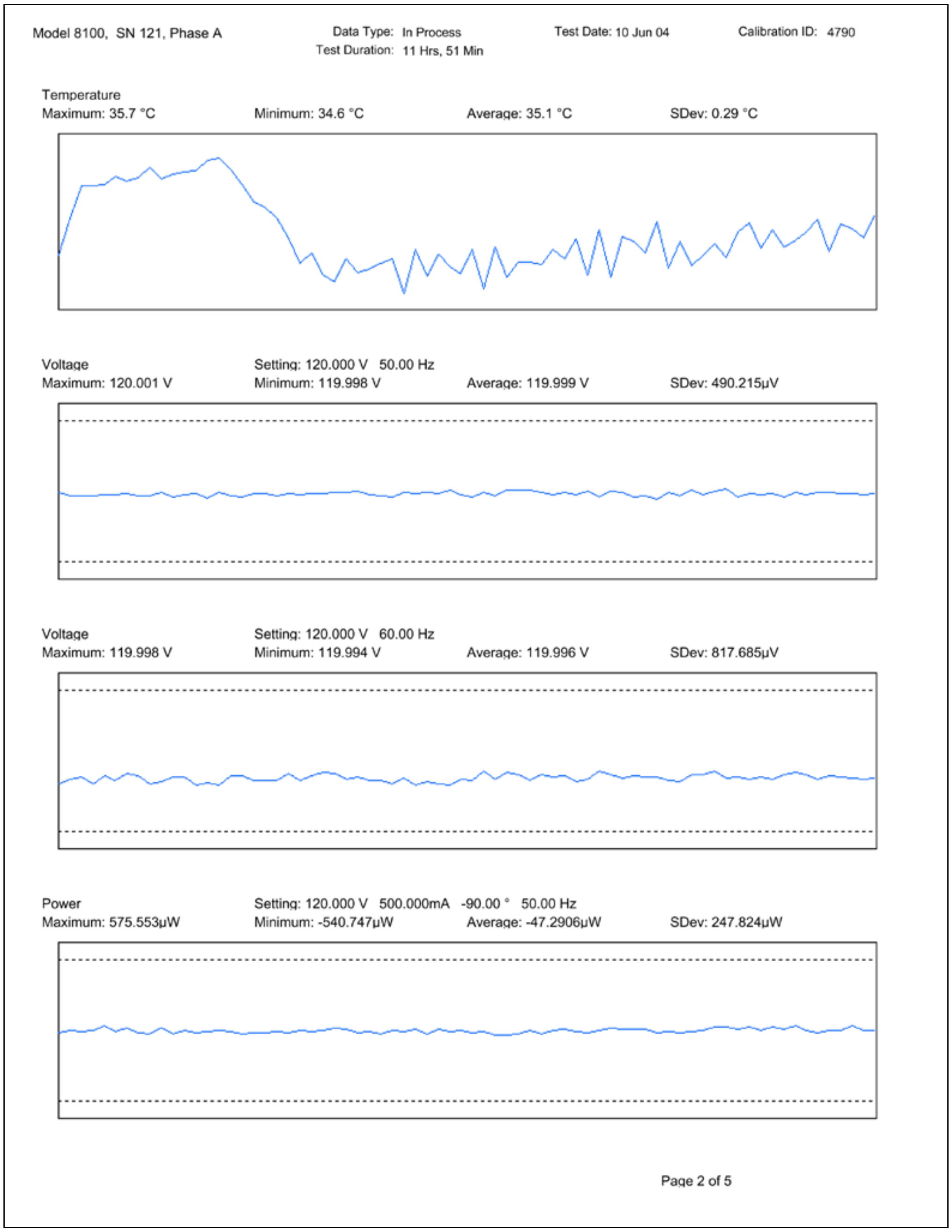

Figure 4-42
CALReport – Sample Stability Report Data Page

Print History

Selecting the ‘Print History’ menu item from the file menu opens the preview window and displays the Test History Report for the Model 8100 with the currently selected serial number. This report lists all tests performed on the instrument with the currently selected serial number.

A typical page from a Test History report is shown in Figure 4-43.

Calibration History

18 October 2004

Rotek Model 8000, SN 124, Phase A
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Test Date	CalID	Test Type	3458A SN	MSB SN	Function	Total Tests	Failed Tests	Error>75% of Limits	Error >50% of Limits	SD>33% of Limits
15 Jul 04	5033	Adjusted	2823A 11603	102	Voltage	40	0	0	0	0
15 Jul 04	5039	In Process	2823A 11603	102	Voltage	48	0	0	0	0
16 Jul 04	5042	Adjusted	2823A 11603	109	Current	72	0	0	0	0
				109	Voltage Phase	40	0	0	0	4
				109	Current Phase	68	0	0	0	23
16 Jul 04	5044	In Process	2823A 11603	109	Voltage	48	2	2	0	1
				109	Current	76	0	0	5	2
				109	Power	324	1	1	6	4
16 Jul 04	5045	In Process	2823A 11603	109	Voltage	48	2	2	0	0
				109	Current	76	0	0	2	3
				109	Power	324	1	1	6	13
16 Jul 04	5046	In Process	2823A 11603	109	Voltage	44	2	2	0	1
				109	Current	76	0	0	1	3
				109	Power	324	1	1	9	2
17 Jul 04	5047	In Process	2823A 11603	109	Voltage	44	2	2	0	0
				109	Current	76	0	0	9	4
				109	Power	324	2	12	19	4
17 Jul 04	5048	Stability	2823A 11603	109	Voltage	144	0	0	0	4
				109	Power	720	0	0	0	38
19 Jul 04	5049	Adjusted	2823A 11603	109	Voltage	4	0	0	0	0
				109	Current	18	0	0	0	1
19 Jul 04	5050	In Process	2823A 11603	109	Voltage	4	0	0	0	0
				109	Current	21	0	0	1	2
				109	Power	17	0	1	1	1
19 Jul 04	5051	Adjusted	2823A 11603	109	Current	2	0	0	0	0
19 Jul 04	5052	In Process	2823A 11603	109	Current	3	0	0	0	0
				109	Power	3	0	0	0	0
19 Jul 04	5055	In Process	2823A 11603	109	Voltage	44	0	0	0	1
				109	Current	76	0	0	2	0
				109	Power	324	0	1	18	8
19 Jul 04	5073	Stability	2823A 11603	109	Current	864	0	0	51	162
20 Jul 04	5074	In Process	2823A 11603	109	Voltage	44	0	0	1	0
				109	Current	76	0	0	1	4
				109	Power	324	0	0	22	10
20 Jul 04	5075	In Process	2823A 11603	109	Voltage	44	0	0	1	1
				109	Current	76	0	0	1	2
				109	Power	324	0	0	9	8
20 Jul 04	5080	Adjusted	2823A 11603	109	Voltage	40	0	0	0	0
				109	Current	1	0	0	0	0
20 Jul 04	5081	In Process	2823A 11603	109	Voltage	4	0	0	0	0
				109	Current	2	0	0	0	0
23 Jul 04	5158	In Process	2823A 12429	109	Voltage	44	0	0	0	1
				109	Power	196	0	0	9	0
23 Jul 04	5159	As Left	2823A 12429	109	Voltage	44	0	0	0	0
				109	Current	76	0	0	1	1
				109	Power	324	0	0	11	4
23 Jul 04	5160	Stability	2823A 12429	109	Power	864	0	0	1	1
24 Jul 04	5161	Stability	2823A 12429	109	Power	864	0	0	0	1
24 Jul 04	5162	In Process	2823A 12429	109	Voltage	44	0	0	0	0
				109	Current	76	0	1	0	2
				109	Power	324	0	0	5	3
26 Jul 04	5163	In Process	2823A 12429	109	Current	2	0	0	1	0
26 Jul 04	5198	In Process	2823A 12429	109	Voltage	44	0	0	0	0
				109	Current	76	0	0	6	2
				109	Power	324	0	3	24	6
27 Jul 04	5199	In Process	2823A 12429	109	Power	3	0	0	2	0
27 Jul 04	5200	In Process	2823A 12429	109	Power	3	0	0	1	0
27 Jul 04	5206	In Process	2823A 12429	109	Voltage	11	0	0	7	0
				109	Current	4	0	0	0	0
240volt test										
27 Jul 04	5221	In Process	2823A 12429	109	Voltage	5	0	0	0	0
				109	Current	5	0	0	2	0

Figure 4-43
CALReport – Sample History Report

Print Cal Constants

Selecting the ‘Print Cal Constants’ menu item from the file menu opens the Select Cal Constants window. The Select Calibration Constants window is shown in Figure

4-44. This window provides a list of all calibration constants stored in the Main Database for the current serial number. The list is sorted by date and time. Checking items in the list will include that set of calibration constants in the Calibration Constant Report. Up to 6 sets of constants may be included in a report.

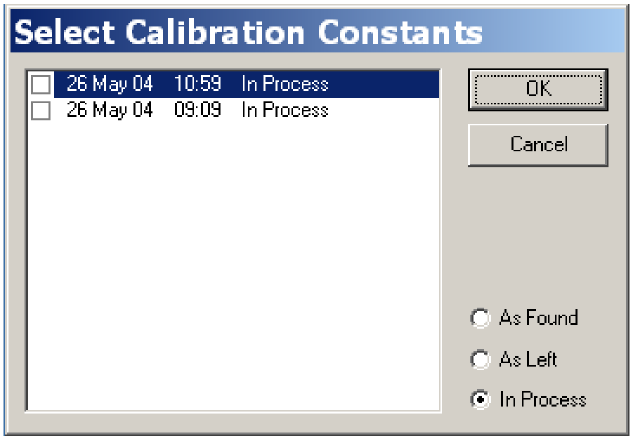

Figure 4-44
CALReport – Select Calibration Constants Window

The Calibration Constant Report includes the calibration constants extracted from a Model 8100 at different times and allows direct comparison of the constants for every calibration point. Figure 4-45 shows a sample Calibration Constant Report. This page of the report provides the calibration constants for voltage amplitude on two dates.

Calibration Constants Model 8000 Serial Number 121 Phase: A

Voltage

	Save Date:	26 May 04	26 May 04
	Save Time:	10:59	09:09
	Hours On:	395	393
	Resets:	30	29
	Firmware Rev:	1.10.3	1.10.3
	V DSP Rev:	1.10	1.10
	I DSP Rev:		
Setting		In Process	In Process
50.00 Hz	10.0000 V	9.996461 V	9.996461 V
60.00 Hz	10.0000 V	9.996799 V	9.996799 V
100.0 Hz	10.0000 V	9.995827 V	9.995827 V
400.0 Hz	10.0000 V	9.995778 V	9.995778 V
50.00 Hz	20.0000 V	19.99305 V	19.99305 V
60.00 Hz	20.0000 V	19.99359 V	19.99359 V
100.0 Hz	20.0000 V	19.99176 V	19.99176 V
400.0 Hz	20.0000 V	19.99138 V	19.99138 V
50.00 Hz	60.0000 V	59.97968 V	59.97968 V
60.00 Hz	60.0000 V	59.98203 V	59.98203 V
100.0 Hz	60.0000 V	59.97595 V	59.97595 V
400.0 Hz	60.0000 V	59.97423 V	59.97423 V
50.00 Hz	120.000 V	119.9555 V	119.9555 V
60.00 Hz	120.000 V	119.9564 V	119.9564 V
100.0 Hz	120.000 V	119.9473 V	119.9473 V
400.0 Hz	120.000 V	119.9461 V	119.9461 V
50.00 Hz	140.000 V	139.9530 V	139.9530 V
60.00 Hz	140.000 V	139.9612 V	139.9612 V
100.0 Hz	140.000 V	139.9474 V	139.9474 V
400.0 Hz	140.000 V	139.9445 V	139.9445 V
50.00 Hz	240.000 V	239.9142 V	239.9142 V
60.00 Hz	240.000 V	239.9289 V	239.9289 V
100.0 Hz	240.000 V	239.9066 V	239.9066 V
400.0 Hz	240.000 V	239.8977 V	239.8977 V
50.00 Hz	280.000 V	279.9159 V	279.9159 V
60.00 Hz	280.000 V	279.9396 V	279.9396 V
100.0 Hz	280.000 V	279.8601 V	279.8601 V
400.0 Hz	280.000 V	279.2754 V	279.2754 V
50.00 Hz	480.000 V	479.8501 V	479.8501 V
60.00 Hz	480.000 V	479.8948 V	479.8948 V
100.0 Hz	480.000 V	479.7501 V	479.7501 V
400.0 Hz	480.000 V	478.7690 V	478.7690 V
50.00 Hz	540.000 V	539.8603 V	539.8603 V
60.00 Hz	540.000 V	539.9180 V	539.9180 V
100.0 Hz	540.000 V	539.7551 V	539.7551 V
400.0 Hz	540.000 V	539.2144 V	539.2144 V
50.00 Hz	640.000 V	639.8249 V	639.8249 V
60.00 Hz	640.000 V	639.8904 V	639.8904 V
100.0 Hz	640.000 V	639.7158 V	639.7158 V
400.0 Hz	640.000 V	639.0834 V	639.0834 V

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Figure 4-45
CALReport – Sample Calibration Constant Report

Database Location

Selecting the 'Database Location' menu item from the file menu opens the database location window. This window is discussed in the previous section describing 'Using CalReport for the First Time'.

Tools Menu

The Tools menu is illustrated in Figure 4-46. It provides the menus used to manipulate, modify or delete test data.

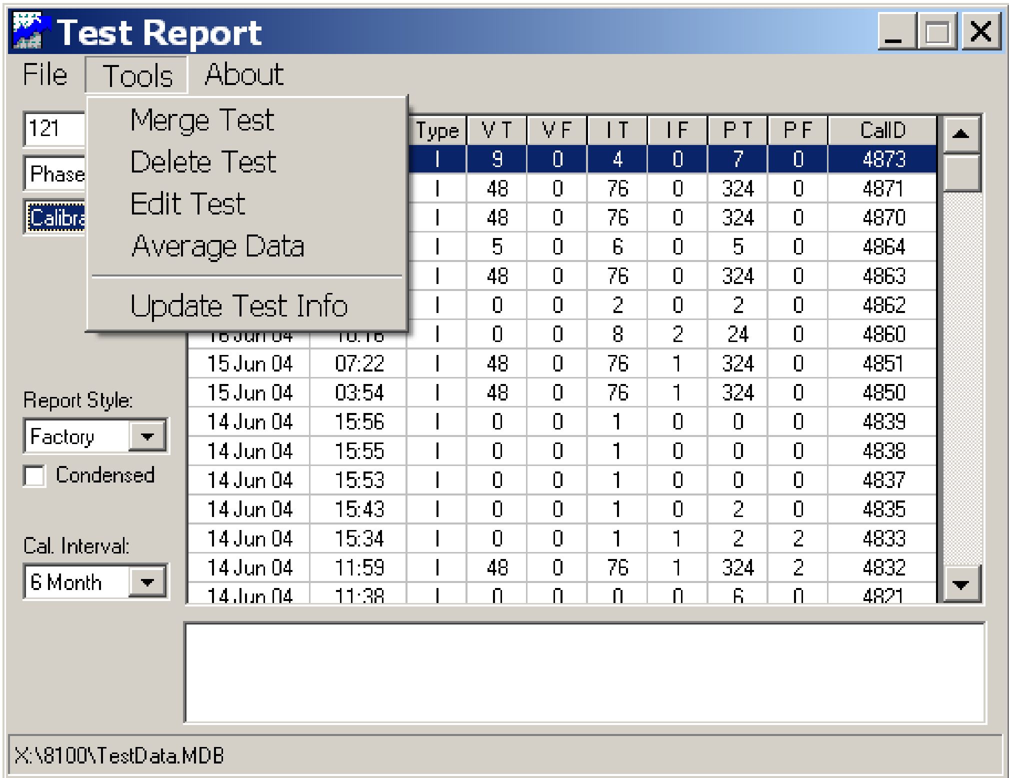

Figure 4-46
CALReport Tools Menu

Merge Test

Selecting the ‘Merge Test’ menu item from the Tools menu opens the Merge code dialog box. The code ‘MERGE’ must be entered before proceeding. When the code is accepted the Merge Test window will appear. The Merge Tests window is shown in Figure 4-47.

The Merge Tests window is a tool that allows two test reports to be merged with each other. Data from one report is merged with another. If the data being merged is not duplicated in the target report then the new tests are simply added to the target report. If the source report contains tests that exist in the target report the original tests in the target are overwritten with the data from the source report.

The original two reports are not affected by the merge operation. A new report is created that is the result of the merge process. The Test notes are appended to indicate which the two reports are the source for the resulting merged report.

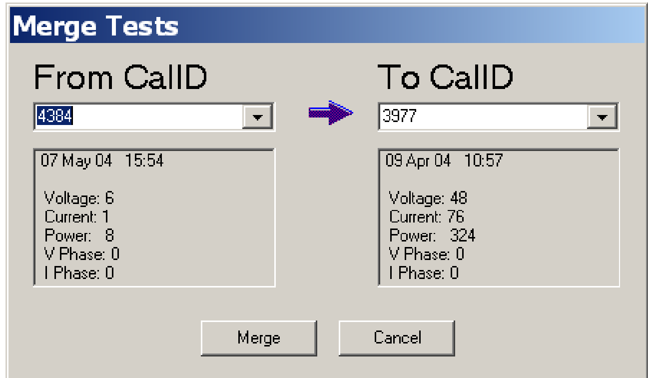

Figure 4-47
CALReport Merge Tests Window

Delete Test

Selecting the 'Delete Test' menu item from the Tools menu allows the user to delete a report from the Main Database. This function must be used with care as it is not reversible. When the menu item is selected a prompt will appear confirming the action. After responding 'Yes" the presently selected report will be removed from the database.

Edit Test

Selecting the 'Edit Test' menu item from the Tools menu opens the Edit Test Code dialog box. The code 'EDIT' must be entered before proceeding. When the code is accepted the Edit Measurements window will appear. The Edit Measurements window is shown in Figure 4-48.

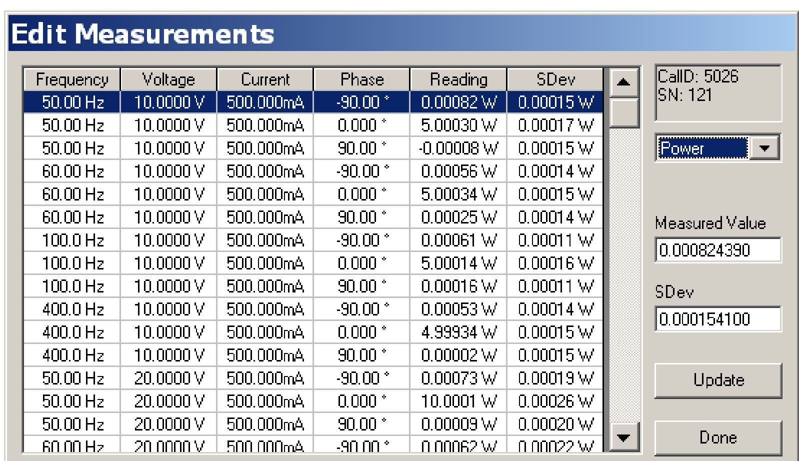

Figure 4-48
CALReport Merge Tests Window

The large table in the Edit Measurements window displays a list of tests that is filtered by test type. The drop down list in the right side of the window is used to select the test type as either Voltage, Current or Power. Selecting a test in the list will cause the measured value or SDev (Standard Deviation) for test are display in the corresponding text boxes on the right side of the display. The values may be edited

Rotek Download Program

The Rotek Download Program is a software application that allows the internal programs of the Model 8100 to be updated via the serial port of a PC. New versions of firmware may be distributed on floppy disk, CD or made available on the World Wide Web. When the Model 8100 is connected to a PC the Rotek Download Program will transfer a new program to the Model 8100 and store it on the internal flash ROM.

A standard 9 pin RS-232 interface cable is used to connect the Model 8100 to the serial port connector on the PC. There is only one 9-pin connector on the rear panel of the Model 8100.

Figure 4-49 illustrates the hardware connections for the Rotek Download Program.

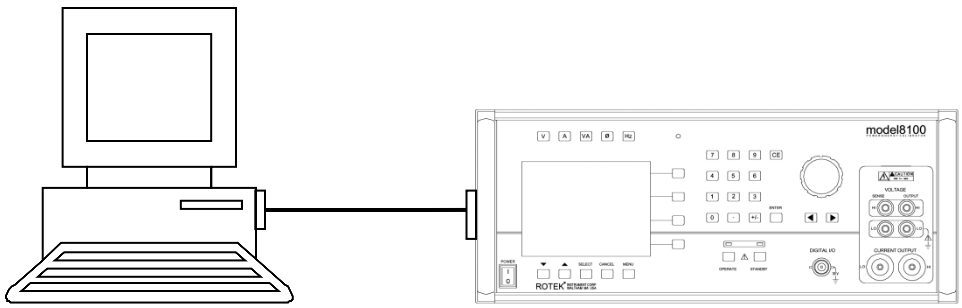

Figure 4-49
Download Program Connections

Software Installation

The Rotek Download Program is distributed on one CD ROM or two, 3 ½ inch floppy disks. It requires a PC with at least one available serial port and Windows 95, 98, ME or XP operating system and 4-MB free hard disk space.

To install the program insert the CD ROM or the floppy disk labeled disk 1 and select RUN from the Windows START button. When using the CD-ROM browse to locate the CD-ROM drive and run the program named SETUP.EXE. When using floppy disks type ‘A: Setup’ and press enter. The setup program will proceed automatically through the installation process.

Software Operation

The setup program will install the Rotek Download Program icon in the Windows Taskbar. To start the Download Program, click on the icon in the taskbar.

Figure 4-50 shows the program window for the Download Program.

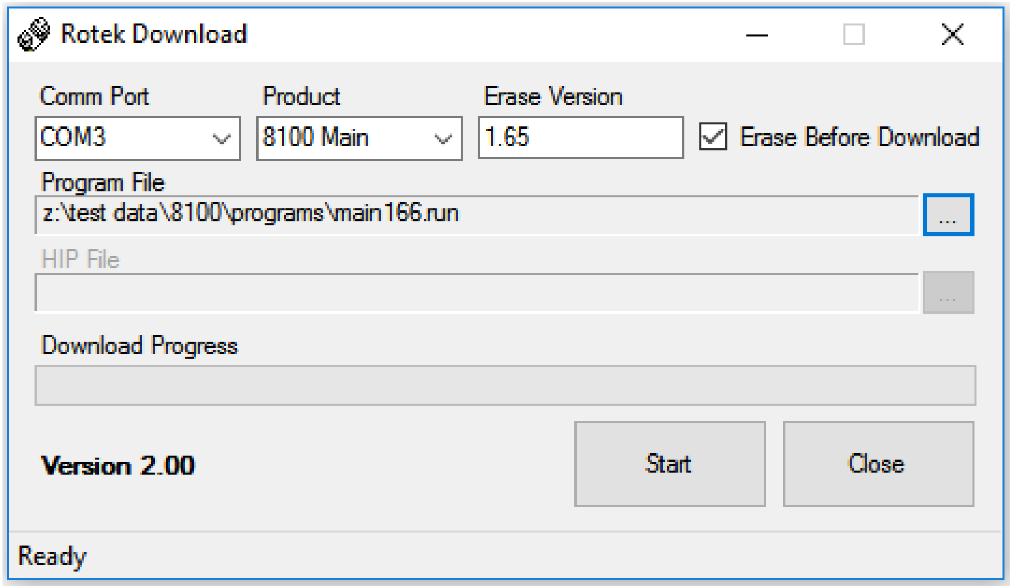

Figure 4-50
Rotek Download Program

The Comm Port selection allows the user to select which Com port to use. Be certain that this selection is the same as the hardware connection to the Model 8100. If a port is not available its selection will not be allowed.

The Product selection allows the user to indicate which program within the Model 8100 is to be updated. The Main program is stored on the controller board of the Model 8100 and is responsible for the overall operation of the calibrator including all I/O functions. The DSP program resides on the DSP board of the Model 8100. This program provides the low level control of the voltage and current outputs. Since this version of the Download Program also supports the Model 8000 and the Model MSB100, they also appear in this list.

The ‘Erase Version’ text box allows the user to enter the version number of the program presently installed in the Model 8100. To avoid downloading an incorrect program the user is required to enter this version number before the download will proceed. The version number of the existing program may be found on the ‘About’ menu of the System Settings menu. Refer to Chapter 2 for a description of the ‘About’ screen.

The ‘Erase Before Download’ check box allows the user to select one of two modes of operation. If *‘Erase Before Download’* is checked the Download program will erase the old program in the Model 8100 and then download the new program. This mode is the default mode and is the recommended selection for normal use of the program. If *‘Erase Before Download’* is not checked the download program will only download the new program to the Model 8100. The operation will fail if the existing program in the Model 8100 has not previously been erased. This mode should only be used on the recommendation of the factory.

The ‘Program File’ text box is used to select the location of the file that contains the new program to be downloaded to the Model 8100. Clicking on the button located to the right of the file test box will open an ‘Open File’ dialog box to allow selection of the file location.

The ‘HIP File’ text box is only used by the Model 8000 and is disabled when downloading firmware into the Model 8100.

The ‘Download Progress’ shows the percent complete status of the download while it is in process.

The Start button begins the download process.

The Close button exits the Rotek Download program. While the download is in process the Close button changes to a Cancel button. If pressed the Cancel button will abort the download operation.

Updating the Main Program

To update the main program of the Model 8100 use the following instructions.

- Connect the Model 8100 to the PC as per Figure 4-49.
- Start the Rotek Download Software on the PC.
- Select the appropriate Com port.
- Select the ‘Erase Before Download’ Mode.
- Select the ‘8100 Main’ mode.
- Find the existing revision of the Main program presently installed in the Model 8100. Press the Menu button on the front panel of the Model 8100. Select the ‘System Settings’ menu item. Select the ‘About…’ menu item to display the About Screen. The Main board program revision is listed next to the ‘Revision’ item. Enter the numeric portion of the revision in the ‘Old Version’ text box of the Download Program.
- Click on the button located next to the file location text box text box to open the file location dialog box. Select the location of the file that contains the new Main Program for the Model 8100. The Rotek factory must provide this file and the name will typically be ‘main.run’. Click Open to select the file.
- Press the Start button and the download process will begin. The records sent indicator will begin changing and the status bar will begin to move across the screen. The download will be complete when the status indicator reaches the right side of the screen.

When the download process is complete the Model 8100 will automatically reset and the new program will be installed.

Updating the DSP Program

To update the DSP program of the Model 8100 use the following instructions.

- Connect the Model 8100 to the PC as per Figure 4-49.
- Start the Rotek Download Software on the PC.
- Select the appropriate Com port.
- Select the ‘Erase Before Download’ Mode.
- Select the ‘8100 DSP mode.
- Find the existing revision of the DSP program presently installed in the Model 8100. Press the Menu button on the front panel of the Model 8100. Select the ‘System Settings’ menu item. Select the ‘About…’ menu item to display the About Screen. The DSP board program revision is listed next to the ‘DSP’ item. Enter the numeric portion of the revision in the ‘Old Version’ text box of the Download program.
- Click on the button located next to the file location text box text box to open the file location dialog box. Select the location of the file that contains the new DSP program for the Model 8100. The Rotek factory must provide this file and the name will typically be ‘DSP.run’. Click Open to select the file.
- Press the Start button and the download process will begin. The records sent indicator will begin changing and the status bar will begin to move across the screen. The download will be complete when the status indicator reaches the right side of the screen.