*em***Power**®

Test Routine Reference Manual

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1. INTRODUCTION

This manual describes the use of the standard *em**Power*** ® test routines. Test routines for *em**Power*** ® are implemented using a technology known as Component Object Model (COM). COM technology is widely used in the software industry to make modular, component-based designs. Microsoft® Word and Excel are built upon COM. ActiveX® controls (like the ones found in Microsoft® Visual Basic®) are also based on COM.

By using COM a test routine can be developed independent of the program that will be using it. This allows for easy addition of new test routines. NH Research or anyone who follows the requirements for a test routine can develop the routines.

At first glance, the library of standard routines seems sparse; but a closer look reveals that the supplied routines are feature-packed. For example, the Voltage Regulation test combines the capabilities of an Absolute Voltage Regulation test, a Delta Regulation test, an Output Voltage Tolerance test and an Output Voltage Adjustment test. The Multi-Measurement test is actually a General Voltage State test, a Peak-to-Peak noise test, an RMS noise test, a Total Harmonic Distortion test, and even a Peak Inrush test.

2. BOOST/CUT TEST

2.1 Description

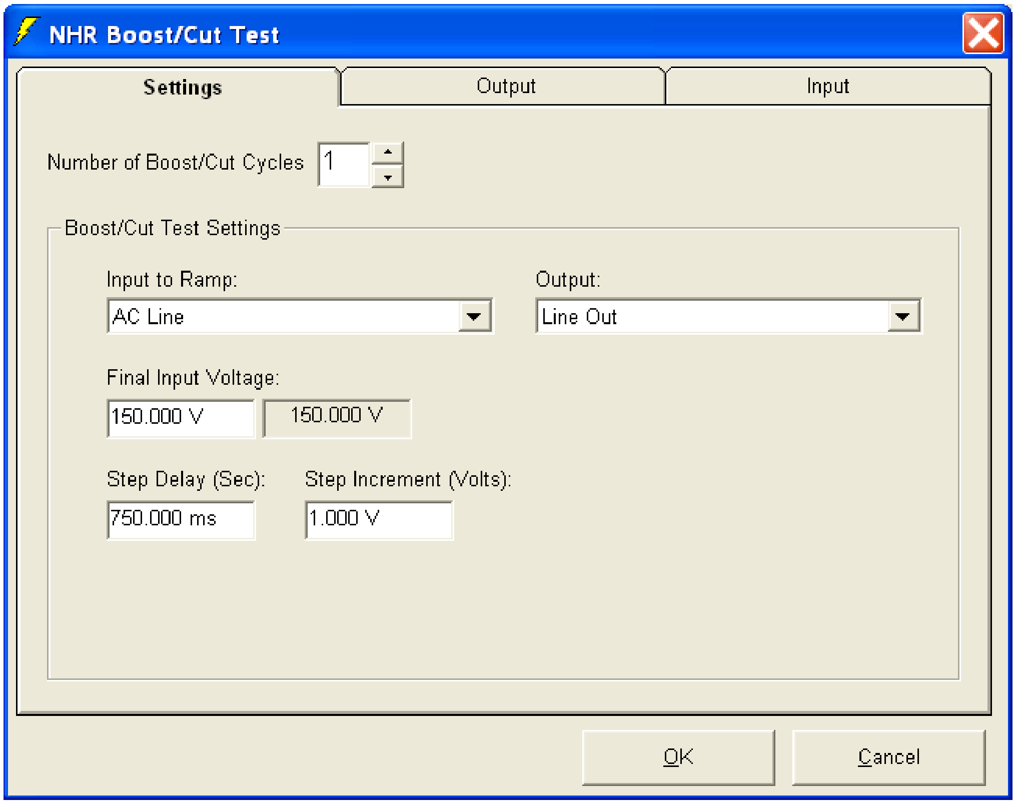
The Boost/Cut test routine ramps the UUT input voltage while monitoring the UUT output voltage for a change. Each change that exceeds the user-configured threshold is considered the transition point for that cycle. The test routine records and verifies each transition cycle.

2.2 Method

The source to ramp is stepped, in user specified increments, to the final input voltage. Measurements are made at each step after a programmable step delay. The change from the last measured value is calculated and compared to the user defined expected change in reading. The source will stop to ramping if there are no more cycles to detect or the final voltage has been reached.

2.3 Test Routine Properties

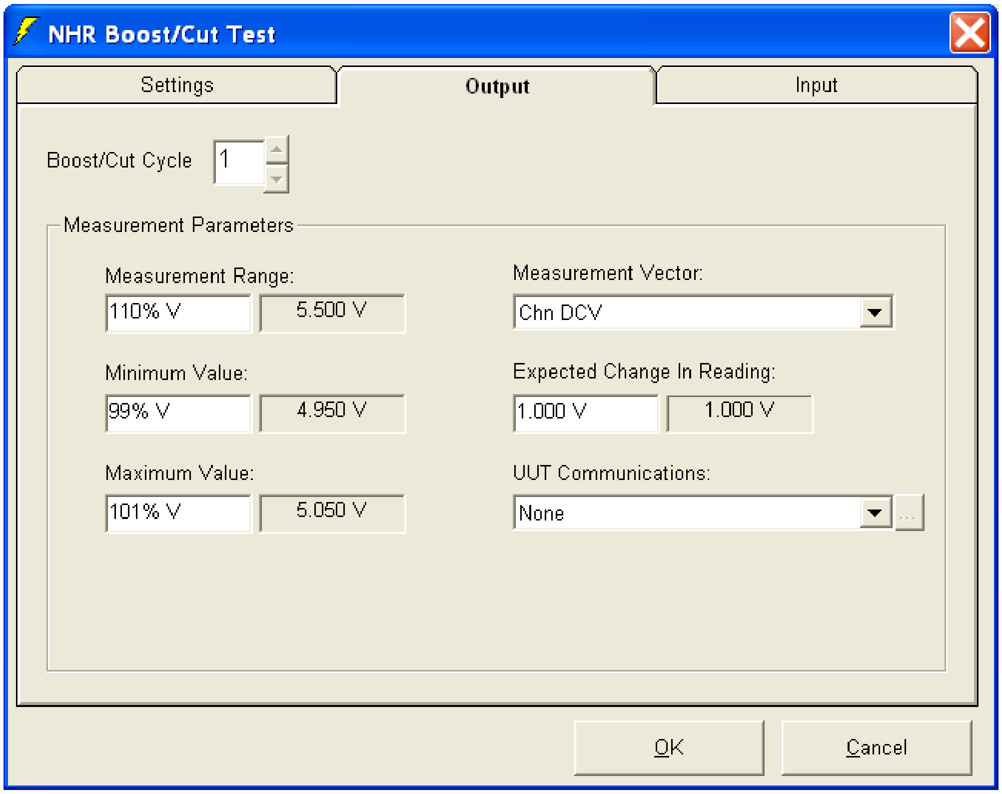
2.3.1 Settings



- Number of Boost/Cut Cycles - the number of expected tap transitions.
- Input to Ramp - this entry must be the logical name of an input/source. The input/source must have a power supply in its configuration (DC Source, AC Source, etc.).

- Final Input Voltage - the final voltage that the input/source will be set to.
- Step Increment - the number of increments that will take place for all phases.
- Step Delay - this delay will be applied between each of the voltage steps.
- Step Increment - the step size that will be applied to each step.
- Output - the output or load that is connected to the UUT.

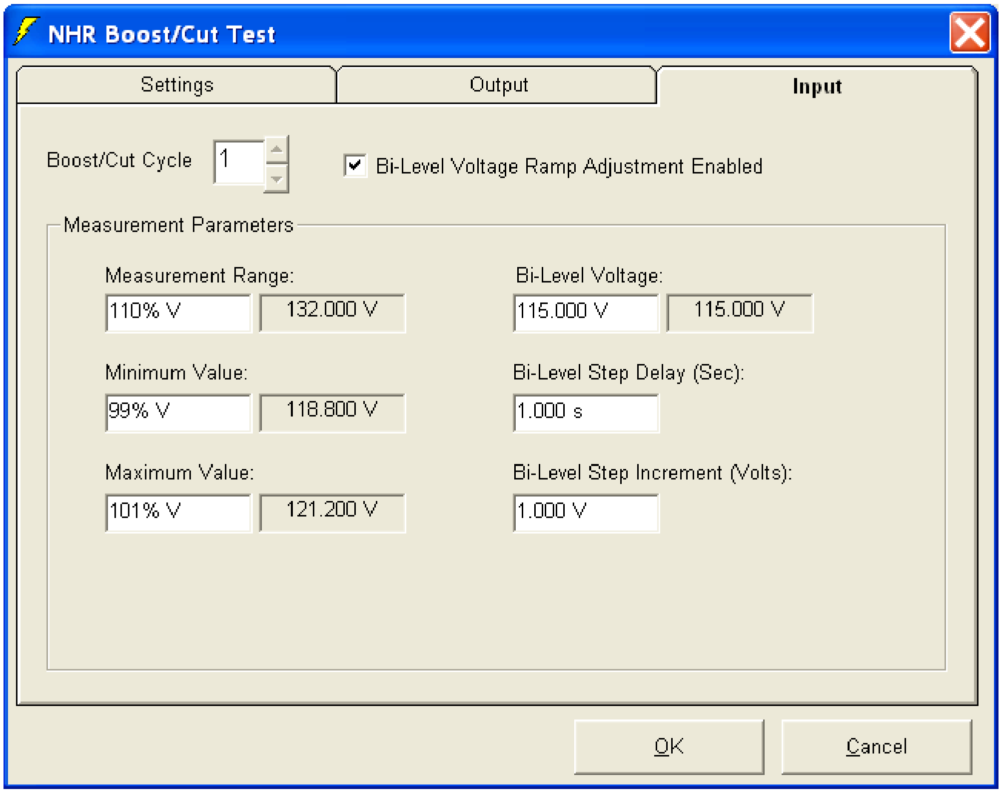
2.3.2 Output



- Boost/Cut Cycle - this designates which cycle is being configured.
- Measurement Range - this is the maximum expected measured value. This value will be sent to the measurement device that the measurement vector represents.
- Minimum Value - this is the allowable lower limit of the measured value. Measured values less than this will cause the test routine to fail.
- Maximum Value - this is the allowable upper limit of the measured value. Measured values greater than this will cause the test routine to fail.
- Measurement Vector - the vector that will be used to take measurements.
- Expected Change in Reading - this is the expected change that will take place in the output voltage during a transformer tap change.

- UUT Communications - select the desired UUT communication object from the drop-down list and press the ellipsis button for communications test parameters. Please refer to the appropriate UUT communications object reference manual for further details.

2.3.3 Input



- Boost/Cut Cycle - this designates which cycle is being configured.
- Measurement Range - this is the maximum expected measured value. This value will be sent to the measurement device that the measurement vector represents.
- Minimum Value - this is the allowable lower limit of the measured value. Measured values less than this will cause the test routine to fail.
- Maximum Value - this is the allowable upper limit of the measured value. Measured values greater than this will cause the test routine to fail.
- Bi-level Voltage Ramp Adjustment Enabled - this allows resetting of the step delay and incrementing at a particular voltage. Once the cycle is detected, the step size and increment are reset to the non bi-level settings that are defined on the settings tab.
- Bi-level Voltage - the voltage where the bi-level step delay and increment will be applied.
- Bi-level Step Delay – the delay applied between each of the voltage steps.
- Bi-level Step Increment - the step size that will be applied to each step.

2.4 Sequence

The load, source, digital and analog vectors defined by the program are applied to the tester hardware before the test routine sequence is initiated.

3. CONSTANT VOLTAGE OFFSET TEST

3.1 Description

The Constant Voltage Offset test routine differs from a simple CV vector set in that the actual CV value is based on an initial measurement instead of a hard-coded value. In addition, a measurement vector is used as feedback to adjust the actual set point to match the programmed value as close as possible.

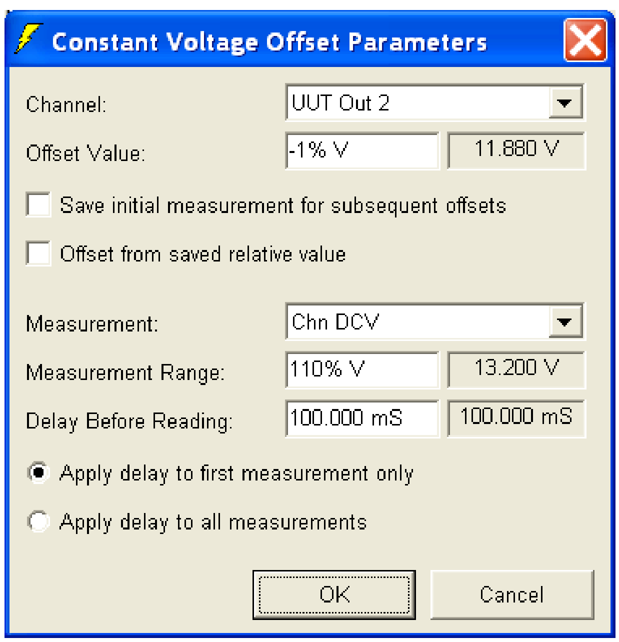
While the test parameters contain a measurement vector and range, no measurements are logged from this test. You would normally follow this test routine with one designed to make the desired measurement.

3.2 Method

Using either an initial measurement (or a previously saved measurement), the specified Constant Voltage offset value is calculated and sent to the selected channel. After performing the delay before reading another measurement is taken to verify the setting. If the amount of error (the difference between the set point and the measurement) is greater than 1mV, a new set value is calculated and sent to the selected channel. This iteration continues until the set point is reached or has been attempted 10 times.

Pass or fail status is determined by the success of the Constant Voltage "set" commands and is logged to the datalog devices.

3.3 Test Routine Properties



- Channel – the output to which you wish to apply the constant voltage setting.

- Offset Value – the amount of offset change from an initial measurement. The value may be entered either as a value or a percentage of channel reference voltage. Note: the equivalence value (shown in the gray area to the right of the offset field) is calculated from the reference voltage, while the actual runtime value will be calculated from an initial measurement.
- Save initial measurement for subsequent offsets –checking this selection will save the initial measurement for use in subsequent Constant Voltage Offset tests.
- Offset from saved relative value – check this box to offset from a previously saved initial measurement.
- Measurement – the measurement vector that will be used to take the measurement. Note that this must be a DMM-type voltage measurement vector.
- Measurement Range – this is the maximum expected measured value. The value may be entered either as a value or a percentage of a channel voltage reference.
- Delay before reading – the amount of time you allow the UUT to settle after setting the constant voltage value.
- Apply delay to first measurement only – check this box to perform the delay only after setting the first attempt at the desired constant voltage offset. Use this option if the UUT requires a settle time after the initial offset only. Subsequent correction settings will be made without delays.
- Apply delay to all measurements – check this box to perform the delay after setting any correction values in addition to delaying after the original offset.

3.4 Sequence

The load, source, digital and analog vectors defined by the program are applied to the tester hardware before the test routine sequence is initiated.

1) The initial CV offset set point is calculated by either the initial measurement, or by using a previously saved measurement value.
2) The offset value is programmed, changing the mode to Constant Voltage if necessary.
3) Wait the delay before reading time, if necessary
4) Take another measurement and calculate a new set value based on the error term.
5) Repeat steps 2-4 until the error term is < 1mV or 10 attempts have been made.
6) Check for faults and log them as necessary

4. DC IN-OUT RESISTANCE

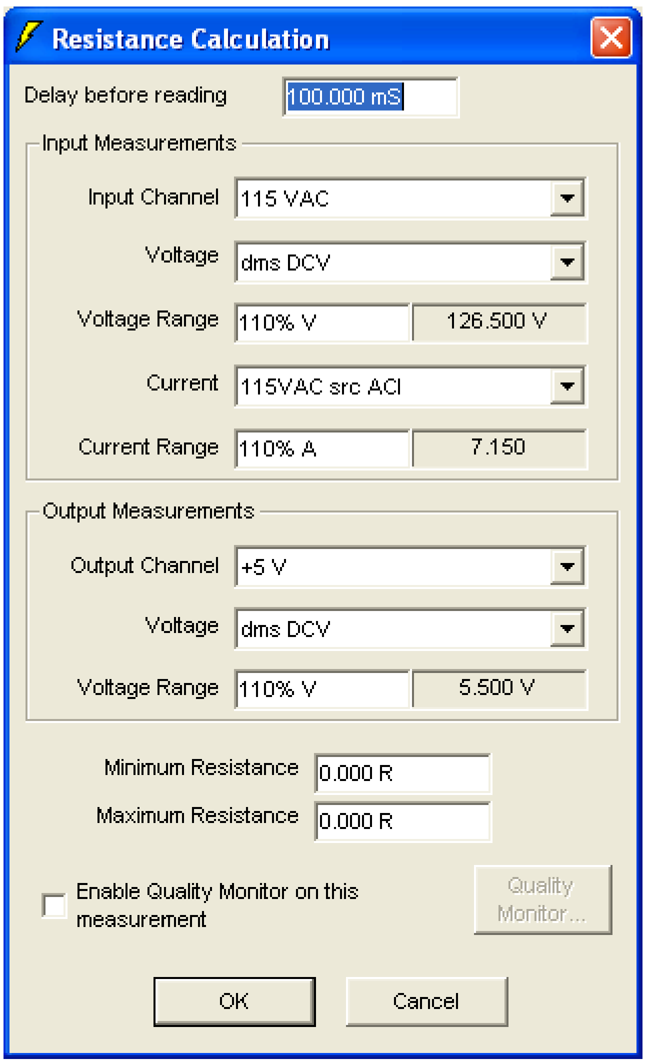
4.1 Description

This test routine calculates the DC Resistance through the UUT by measuring the input and output voltages, taking their difference, and dividing it by the input current. A failure occurs when the calculated resistance is either higher or lower then the configured threshold.

4.2 Method

The test routine first delays for the amount of time specified. The input voltage, input current, and output voltage measurements are then taken. The resistance is calculated as (input voltage – output voltage) / input current. This calculated value is then evaluated for pass/fail, and the result is logged to the datalog drivers.

4.3 Test Routine Properties



- Delay before reading – the amount of time you allow the UUT to settle before beginning the measurements.
- Input Channel – defines the channel to use when making the input measurements.
- Input Voltage – the measurement vector that will be used to take the Input Voltage measurement.
- Voltage Range – this is the maximum expected measured Input Voltage. The value may be entered either as a value or a percentage of the Input Channel voltage reference.
- Input Current – the measurement vector that will be used to take the Input Current measurement.
- Current Range – this is the maximum expected measured Input Current. The value may be entered either as a value or a percentage of the Input Channel current reference.
- Output Channel – defines the channel to use when making the output measurement.
- Output Voltage – the measurement vector that will be used to take the Output Voltage measurement.
- Voltage Range – this is the maximum expected measured Output Voltage. The value may be entered either as a value or a percentage of the Output Channel voltage reference.
- Minimum Resistance - this is the allowable lower limit of the calculated resistance. Calculated values less than this will cause the test routine to fail.
- Maximum Resistance - this is the allowable upper limit of the calculated resistance. Calculated values greater than this will cause the test routine to fail.
- Enable Quality Monitor on this measurement – check this box to enable Quality Monitor data collection.
- Quality Monitor… – press this button to display the Quality Monitor properties. Please refer to the Quality Monitor reference manual for further details.

4.4 Sequence

The load, source, digital and analog vectors defined by the program are applied to the tester hardware before the test routine sequence is initiated.

1) Get the Input Voltage, Input Current, and Output Voltage measurements
2) Calculate the DC Resistance
3) Evaluate and log the result.
4) Check for faults and log them as necessary

5. DESIGN VERIFICATION RAMP TEST

5.1 Description

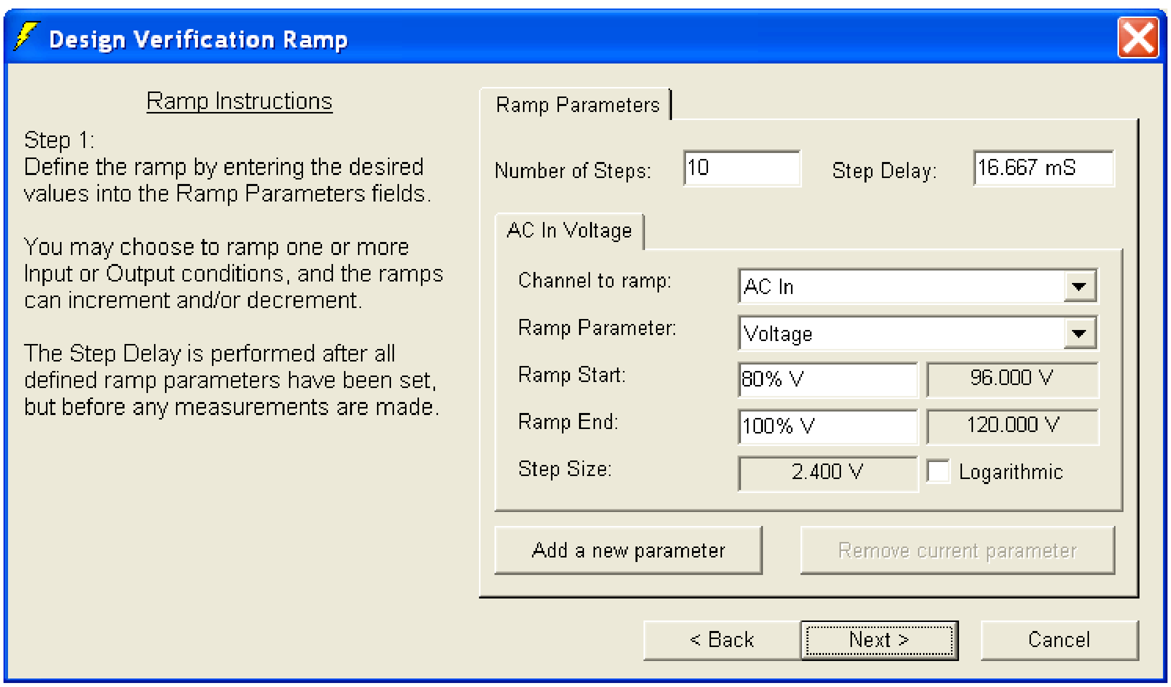
As an aid to design engineers, *em***Power** ® includes a ramping test routine that can be used to verify the integrity of their designs. With the Design Verification (DV) Ramp test routine, you can graph the regulation of your UUT output while ramping the current from minimum to maximum loading, or plot Efficiency curves from Low, Nominal and High Line conditions. Ramp parameters and measurement setups are easily entered via a step-by-step wizard, and a chart is automatically generated and logged. The individual data points can also be saved in a file for offline evaluation or data analysis.

5.2 Method

While one or more stimulus parameters are ramped, measurements are taken and logged. This procedure can be repeated for multiple vector baselines. Once the data has been collected a chart is created and logged, and the data points are optionally written to disk. The test routine returns a "Pass" if the data was collected successfully, or a "Fail" if any faults are encountered.

5.3 Test Routine Properties

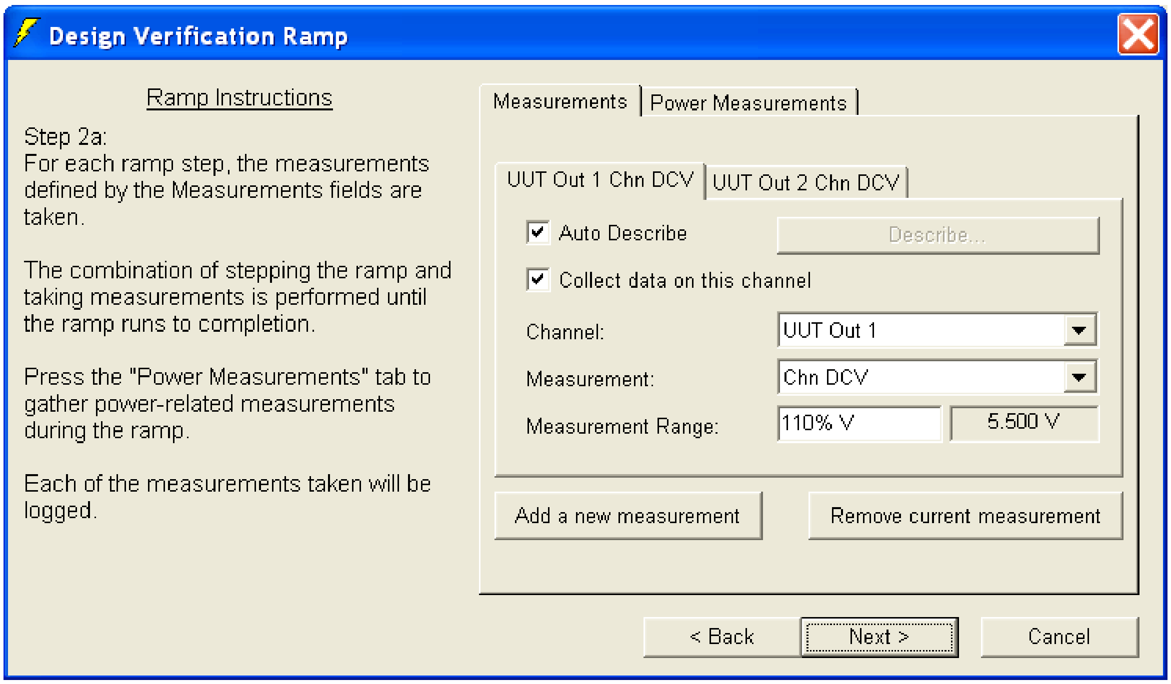
5.3.1 Ramp Parameters



- Number of Steps – the number of steps to take when ramping from the start value to the end value. This also indicates the number of measurements taken during the test.
- Step Delay – this delay will be applied between each of the ramp steps.

- Channel to ramp – the load or source channel to ramp
- Ramp Parameter – the parameter of the channel to ramp. Selections include voltage, current, frequency, etc.
- Ramp Start – the initial value of the ramp parameter.
- Ramp End – the final value of the ramp parameter.
- Logarithmic – check this box to perform step changes logarithmically instead of linearly. Notice that the “Step Size” field becomes “Step Multiplier”.
- Add a new parameter – press this button to create an additional ramp parameter. You may add as many ramp parameters as you wish.

5.3.2 Measurements

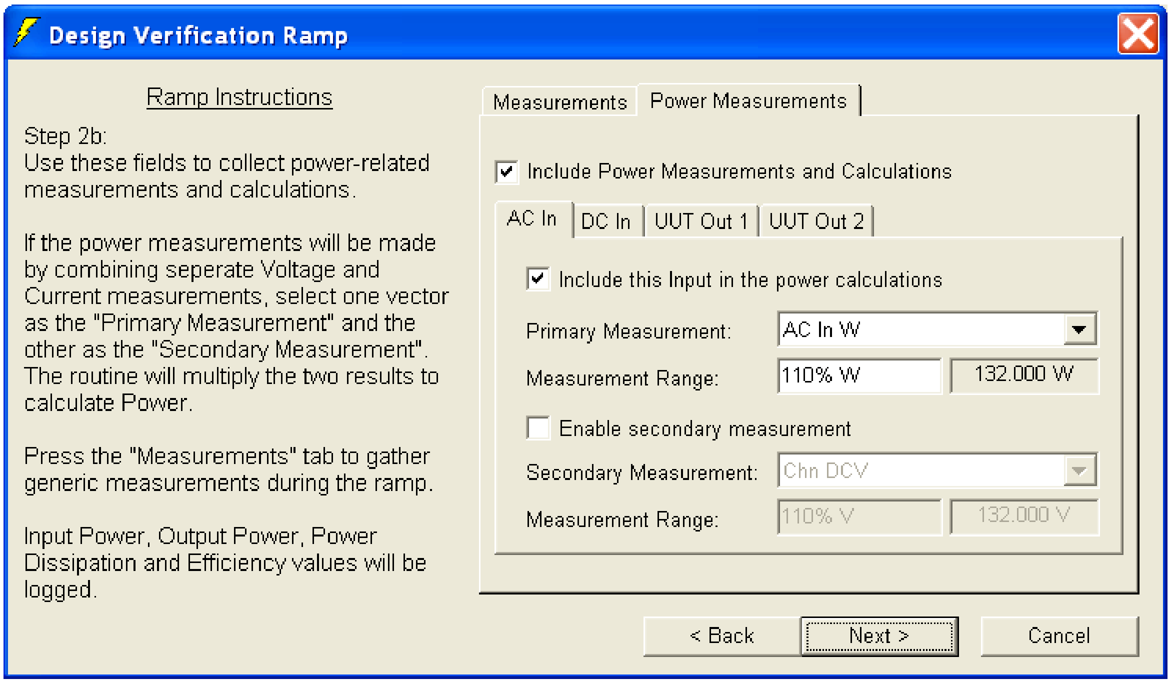


- Auto Describe – if checked, the measurement is described by combining the name of the channel to be measured with the measurement function. If unchecked, the user is prompted to provide a description of this measurement.
- Collect data on this channel – check this box to take a measurement of this channel and collect the corresponding data.
- Channel – defines the channel to use when making the measurement. Choose from any of the defined Inputs or Outputs.
- Measurement – the measurement vector that will be used to take the measurement. Note that this must be a DMM-type measurement vector.
- Measurement Range – this is the maximum expected measured value. The value may be entered either as a value or a percentage of a channel reference. The appropriate reference is

automatically selected based on the measurement vector entry. In the example above, the "UUT Out 1" Reference Voltage value will be used.

- Add a new measurement – press this button to add a new measurement and associated tab to the test routine.
- Remove current measurement – press this button to remove the currently selected measurement from the test routine. Once this button is pressed the measurement data is lost and cannot be recovered.

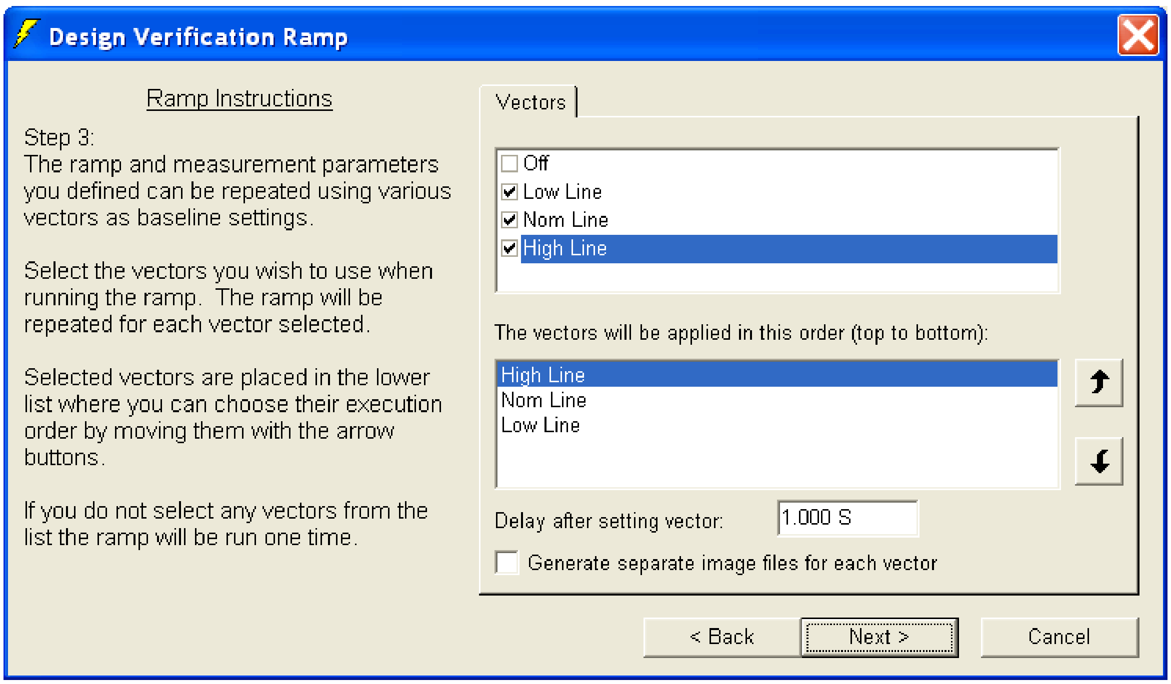
5.3.3 Power Measurements



- Include Power Measurements and Calculations – check this box to have Input Power, Output Power, Power Dissipation and Efficiency values collected and logged with any generic measurements defined on the "Measurements" tab.
- Include this Input/Output in the power calculations – check this box to enable the measurement(s) for this input or output and to have the power value included in the total Input/Output Power sum.
- Primary Measurement – the measurement vector that will be used to take the power measurement. A "True" power measurement vector is preferred, if available. If the input/output device is unable to make power measurements this entry may be used to take a measurement that will be multiplied with the value of the Secondary measurement to create a power value. For example, this entry could be a DC Voltage measurement while the Secondary vector makes a DC Current measurement.
- Measurement Range (Primary) – this is the maximum expected measured value. The value may be entered either as a value or a percentage of a channel reference. The appropriate reference is automatically selected based on the measurement vector entry. In the example above, the "AC In" Reference Wattage value will be used.

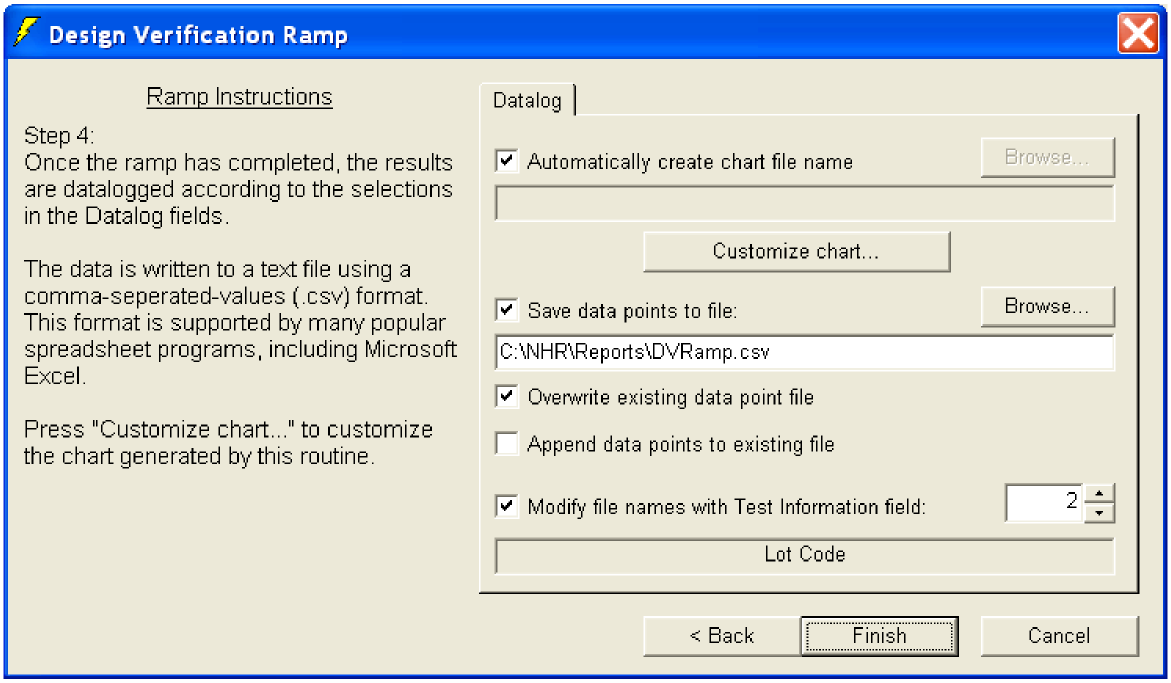
- Enable secondary measurement – check this box to instruct the test routine to take a secondary measurement and combine it with the primary measurement to calculate the true power of this input/output.
- Secondary Measurement – the measurement vector that will be used to take the secondary measurement. If the input/output device is unable to make True Power measurements this entry may be used to take a measurement that will be multiplied with the value of the Primary measurement to create a power value. For example, this entry could be a DC Current measurement while the Primary vector makes a DC Voltage measurement.
- Measurement Range (Secondary) – this is the maximum expected measured value. The value may be entered either as a value or a percentage of a channel reference.

5.3.4 Vectors



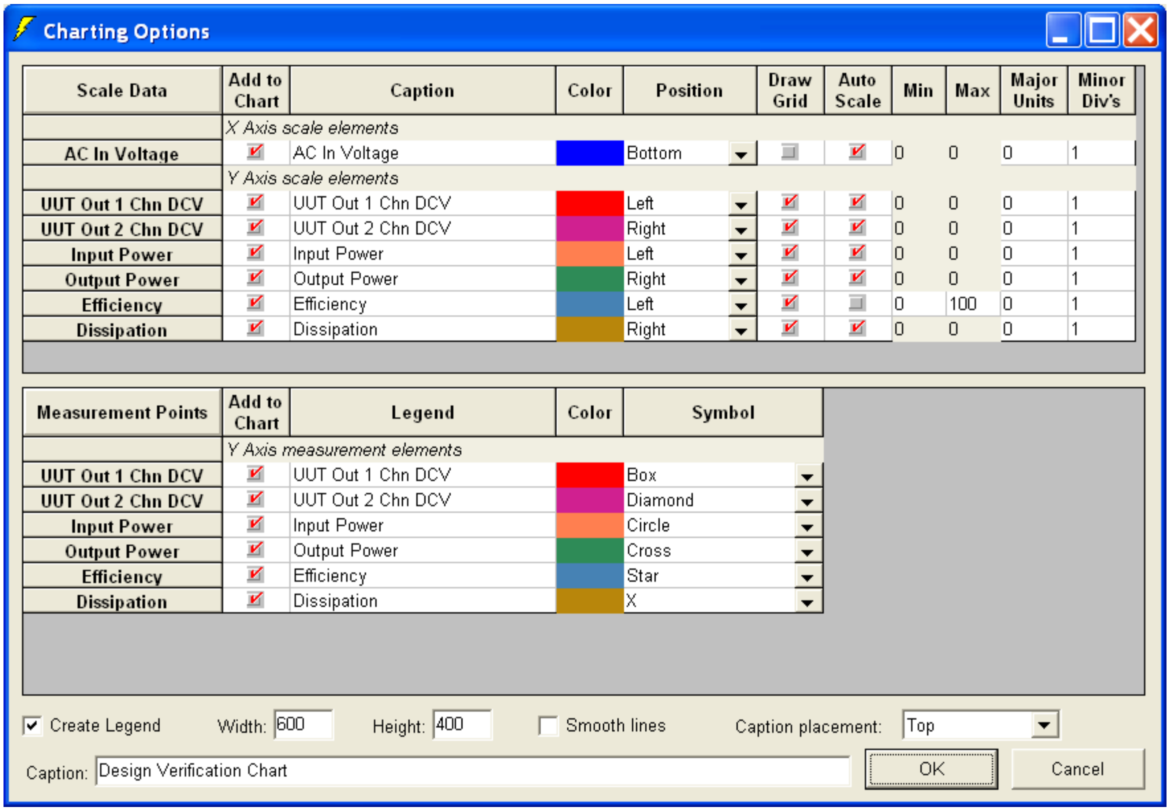
- (Check boxes) – place a check next to each vector that you would like to use when repeating the ramp (as defined in the previous pages). In this example, the ramp will be repeated three times.
- (Sorting list) – use the arrows to define the order you wish to run the vectors. In this example, the ramp will be run at "High Line" first, then repeated for "Nom Line", and finally executed once more with the "Low Line" vector applied. Data is collected for each vector.
- Delay after setting vector – the amount of time to delay between each vector setting before repeating the ramp definition.
- Generate separate image files for each vector – by default, a single image file containing all the collected data is created at the end of the test routine. By checking this box the test routine will generate separate images containing only the corresponding measurement data for each vector selected.

5.3.5 Datalog



- Automatically create chart file name – this selection determines whether chart image files generated during this test are managed automatically or if you will choose the file and path information.
- Customize chart… – the test routine will automatically generate a chart containing all the collected information. Press this button to customize the appearance of the chart to suit your needs. Refer to section 4.3.6, Charting Options, for detailed help on chart customization.
- Save data points to file – the collected data can be saved to a user specified file for use with offline data analysis tools. The file is saved in Comma Separated Variable format (CSV) for import to spreadsheet and data analysis programs.
- Overwrite existing data point file – if the test is rerun a naming conflict may exist. Check this box to overwrite any file with the same name as defined. If this box is cleared and a naming conflict exists, the new data will be saved with a unique number in parenthesis to indicate the order in which the data was collected. To avoid this problem, choose to modify the file name with a Test Information field as described below.
- Append data points to the existing file – use this option to store data collected in multiple runs of the test into a single file. The entries are separated by a timestamp, and include all the Test Information entered at the beginning of the test run.
- Modify file names with Test Information field – when enabled, a field from the Test Information Entry form will be appended to the user entered file names. The Test Information Entry form appears before running the test on each UUT, and is typically filled in by the test operator. Appending an information field provides a method of tracking specific chart and/or data point files to a particular UUT serial number or test pass. The number selection box determines which of the input fields from the Test Information Entry form will be appended to the file name.

5.3.6 Charting Options



- Scale Data – the ramp parameters are charted along the X-axis, while the measurement parameters are charted on the Y-axis. This section is used to configure the X and Y scales. Each scale entry can be customized as follows:
  - Add to Chart – check this box to include this scale data on the chart.
  - Caption – this text is used to describe the scale.
  - Color – defines the color of the text and gridlines. Click on the field to select a new color.
  - Position – the position on the chart. X-axis scale data can be placed on the top or bottom, while Y-axis scale data can be placed left or right of the chart data.
  - Draw Grid – check this box to include the gridlines in the chart image – vertical for X-axis data, and horizontal for Y-axis data.
  - Auto Scale – if this option is checked, the minimum and maximum scale values are generated from the collected data. If the checkbox is cleared the "Min" and "Max" fields are used.
  - Min – the minimum scale data. Only used if "Auto Scale" if false. Data points charted below this value will be clipped.
  - Max – the maximum scale data. Only used if "Auto Scale" is false. Data points charted above this value will be clipped.

  - Major Units – used to define the number of major divisions within the chart data. The divisions will be drawn from “Min” to “Max”, with this field used as an increment value. Use “0” to allow the software to automatically determine the optimal number of divisions. Gridlines are drawn at these positions if “Draw Grid” is enabled.
  - Minor Div’s – used to define the number of minor divisions within each major division. Gridlines are drawn at these positions if “Draw Grid” is enabled.
- Measurement Points – these are the data points collected during the test run. If more than one Vector was selected each Y-axis block will be repeated as necessary:
  - Add to Chart – check this box to plot the data on the chart.
  - Legend – if a legend is drawn, this text is used to describe the data.
  - Color – defines the color of the symbols and interconnecting lines. Click on the field to select a new color.
  - Symbol – selects the symbol that will be drawn at every plotted data point.
- Create Legend – check this box to include a legend area within the chart image.
- Width – specifies the recommended width of the image. If the software is unable to create the image as defined because of a lack of image space it will attempt to increase the width as necessary up to twice this value.
- Height – specifies the height of the image.
- Smooth lines – check this box to draw smooth data point interconnection lines instead of straight lines.
- Caption placement – specifies the placement of the chart caption.
- Caption – defines the title of the chart.

5.4 Sequence

The load, source, digital and analog vectors defined by the program are applied to the tester hardware before the test routine sequence is initiated.

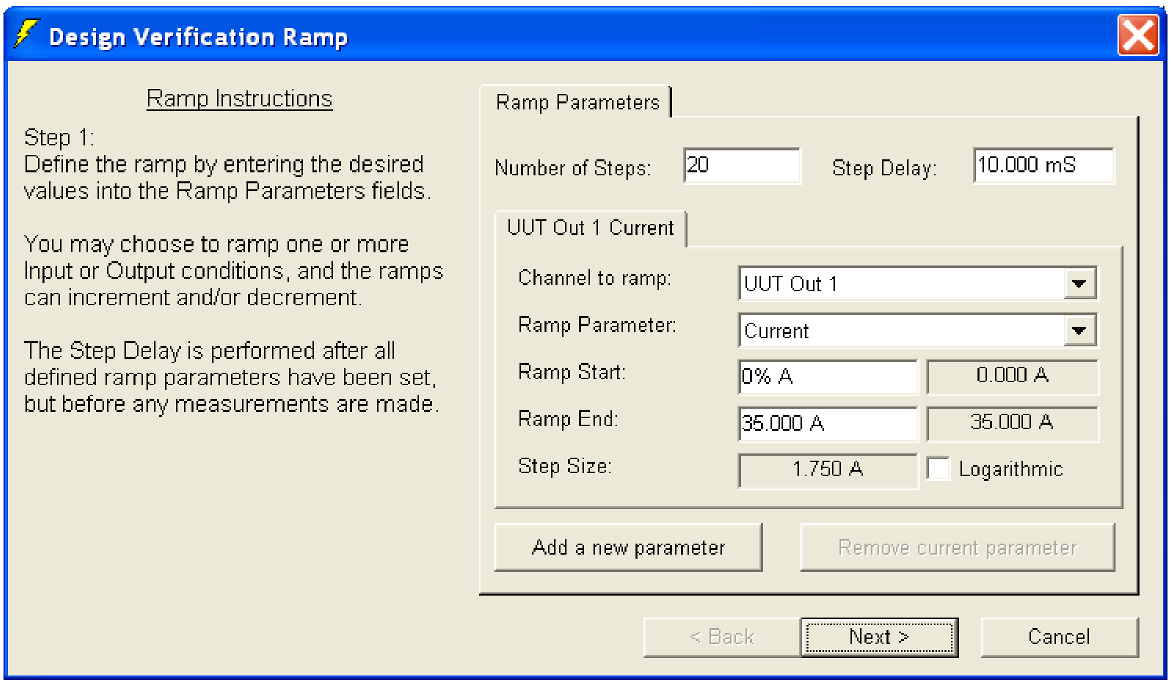
1) For each Vector defined on the “Vector” tab (performed once if no vectors are selected)
   a) Set the Ramp Parameters to the “Start” values
   b) Make the measurements defined on both the “Measurement” and “Power Measurement” tabs.
   c) Increment the Ramp Parameter values by the “Step Size” (or multiply by “Step Multiplier” if logarithmic) and make the measurements. Repeat this for the number of steps defined.
2) Create the chart(s) and write the data point file if necessary.
3) Check for faults and log them as necessary

5.5 Example

The following example will generate an Efficiency Curves report. The DV Ramp test will be used to ramp UUT Out 1 Current from 0A to 35A at Low Line, Nom Line and High Line input settings.

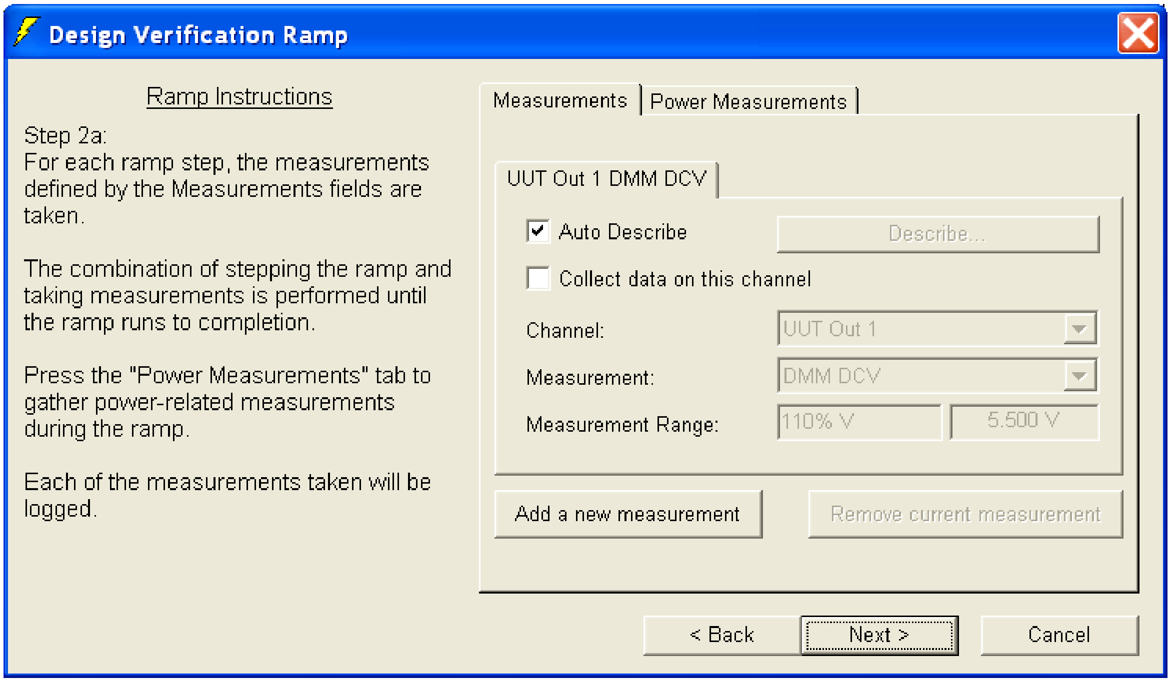
5.5.1 Ramp Parameters

The first step is to define the Output Current ramp. According to our example definition, we want to ramp UUT Out 1 Current from 0A to 35A. Review the figure below to be sure you understand the steps required to program the ramp. The choice of 20 ramp steps was arbitrary; increasing the step count will give you finer resolution in your graph, while decreasing the count will speed data collection. We set a step delay to allow the current change to settle before beginning the measurements.



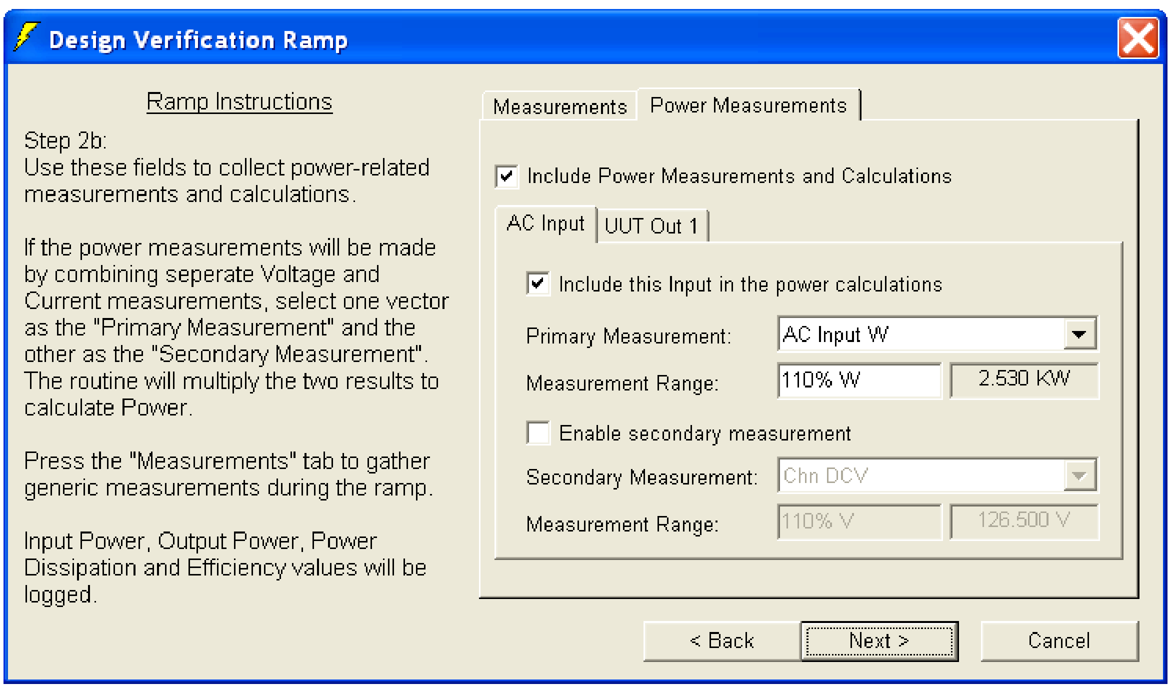
5.5.2 Measurements

To generate Efficiency Curves we do not need to collect any general measurements. We'll leave the "Collect data on this channel" check box cleared and proceed to the "Power Measurement" tab.

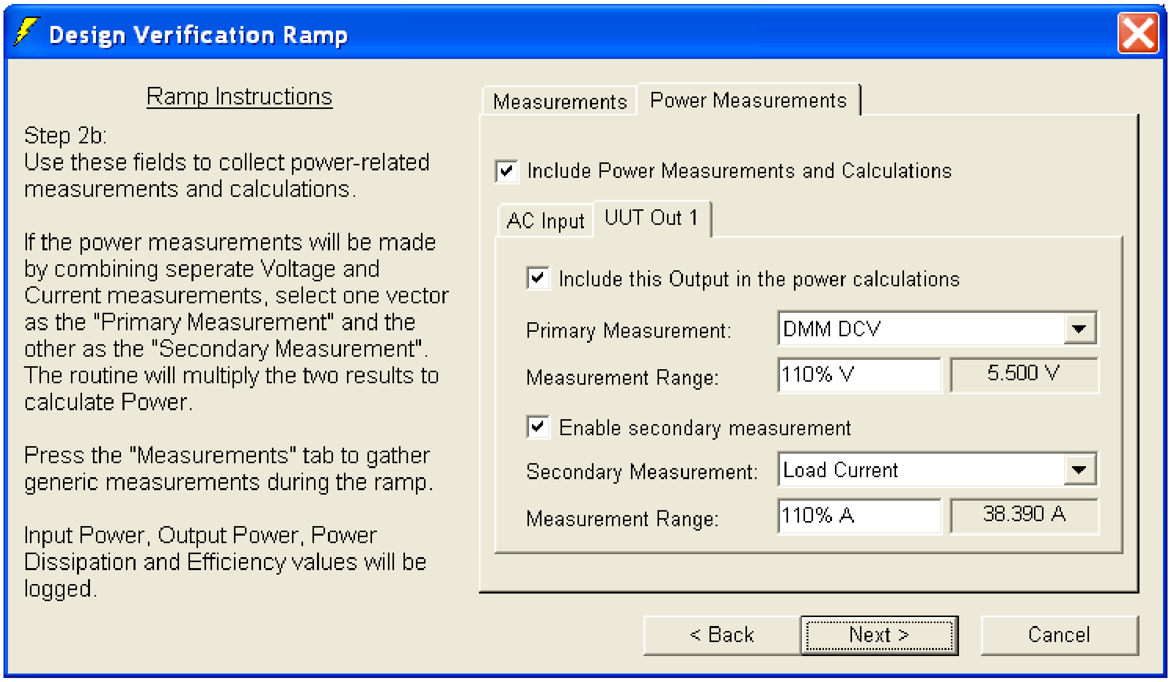


5.5.3 Power Measurements

On the Power Measurements tab we'll define our power measurements. We'll begin with Input Power:



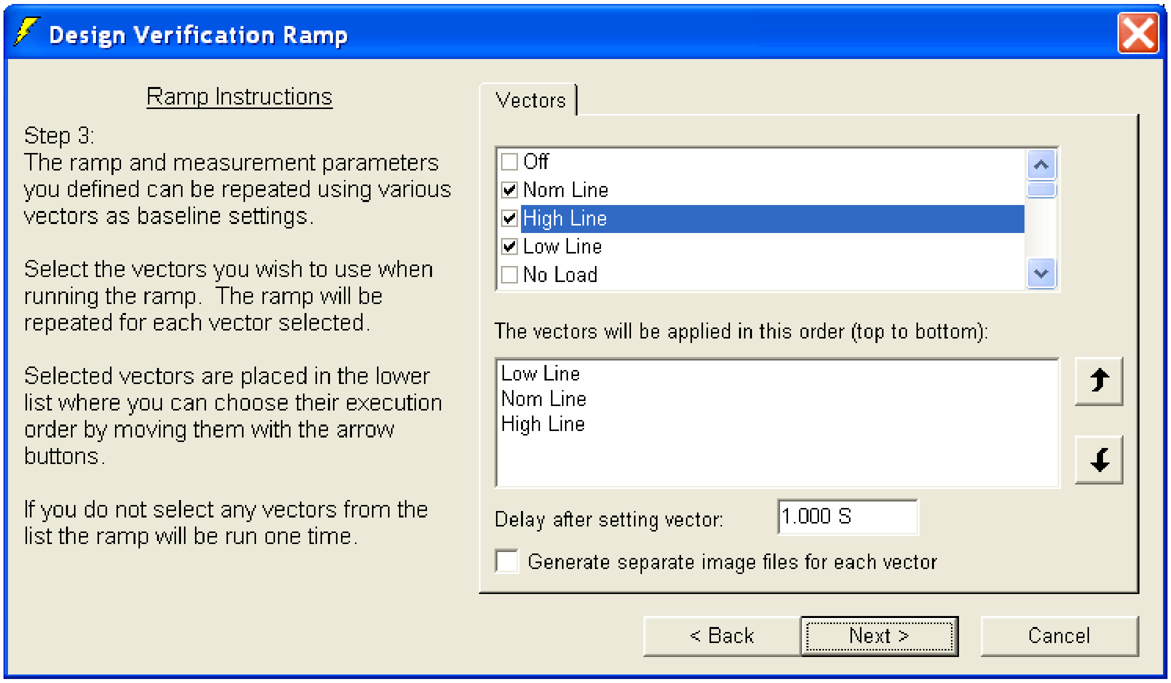
Next we'll define the Output Power. Notice that we're using the DMM to measure voltage and the Load device to measure current. Since the DMM can measure DC volts with a greater accuracy than the DC Source, this combination will provide us the most accurate power measurement.



5.5.4 Vectors

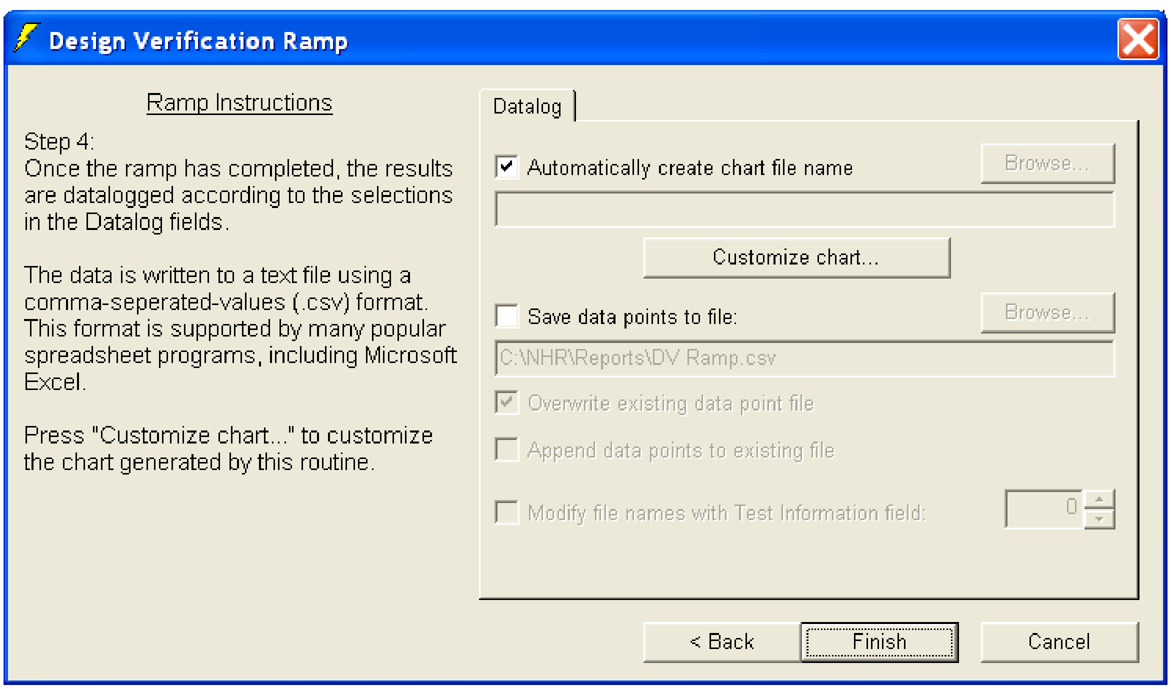
According to our example definition, we want to run the ramp at Low Line, Nom Line and High Line. We select the appropriate items in the Vector list. To ensure that the vectors will be executed in the correct order, use the arrows to move the entries as required. We'll set a delay to allow the UUT to settle after each vector is applied.

If you want separate charts for each vector check the "Generate separate image files" option. For our example we want to consolidate all three curves into one image so we leave the box unchecked.



5.5.5 Datalog

In this example we don't need to do anything special with the images so we'll let the test system control the chart naming. However, we'll want to customize the layout of the chart, so press the "Customize chart…" button.

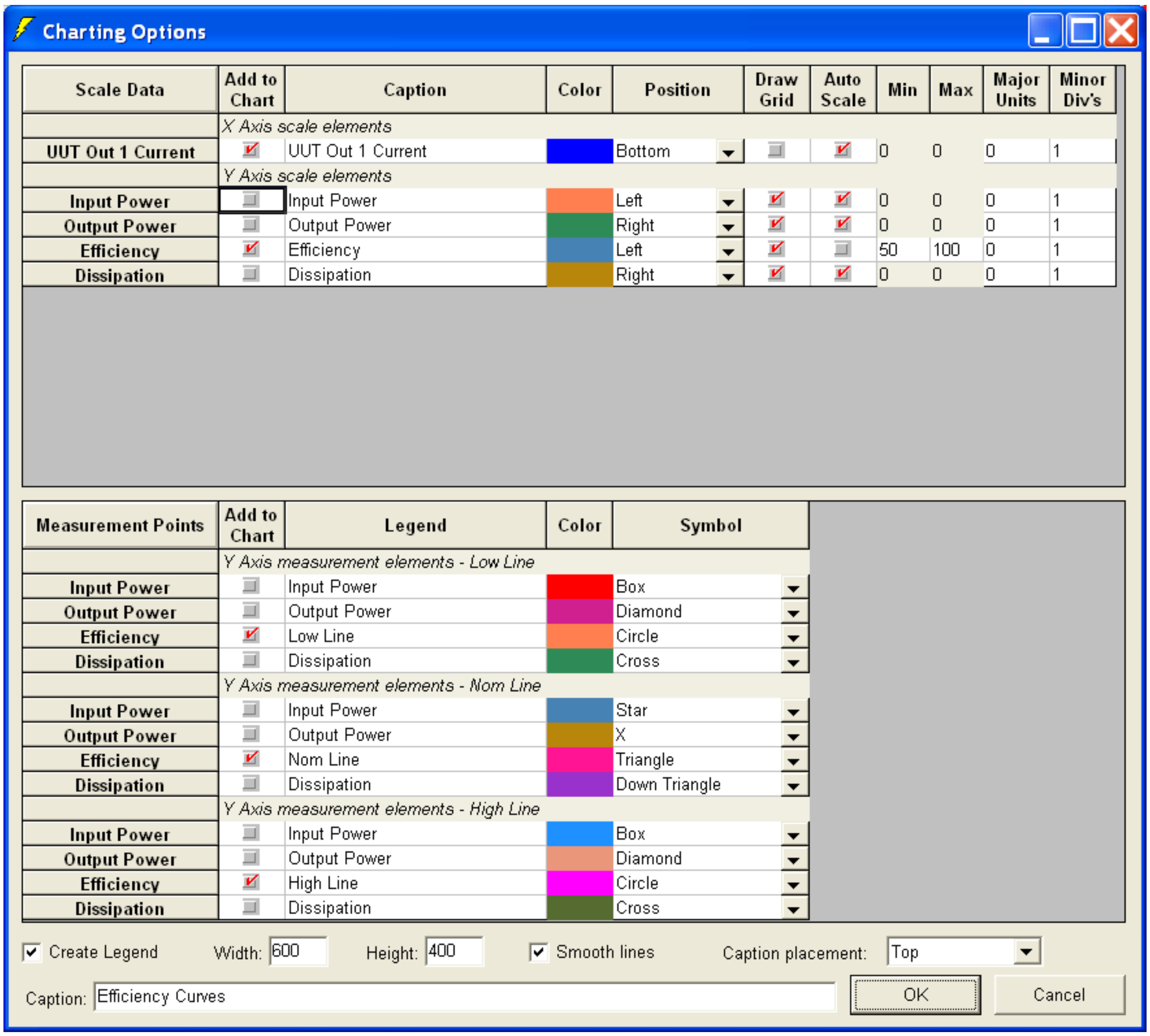


5.5.6 Charting Options

We'll make several changes to the chart layout in order to demonstrate the flexibility of the charting options. Let's begin by examining the "Y Axis scale elements" in the Scale Data (top) section.

By default, the test routine will graph all measurements defined by the ramp. When we choose to make Power measurements four values are gathered: Input Power, Output Power, Efficiency and Dissipation. In this example, we're only interested in the Efficiency values so we'll clear the "Add to Chart" checkboxes for the other measurements.

The only other modification we'll make to the Scale Data section is the "Min" field of the Efficiency entry. The default value is to include all possible values from 0% to 100%. In this example we want to magnify the deviations by setting the minimum value to 50.

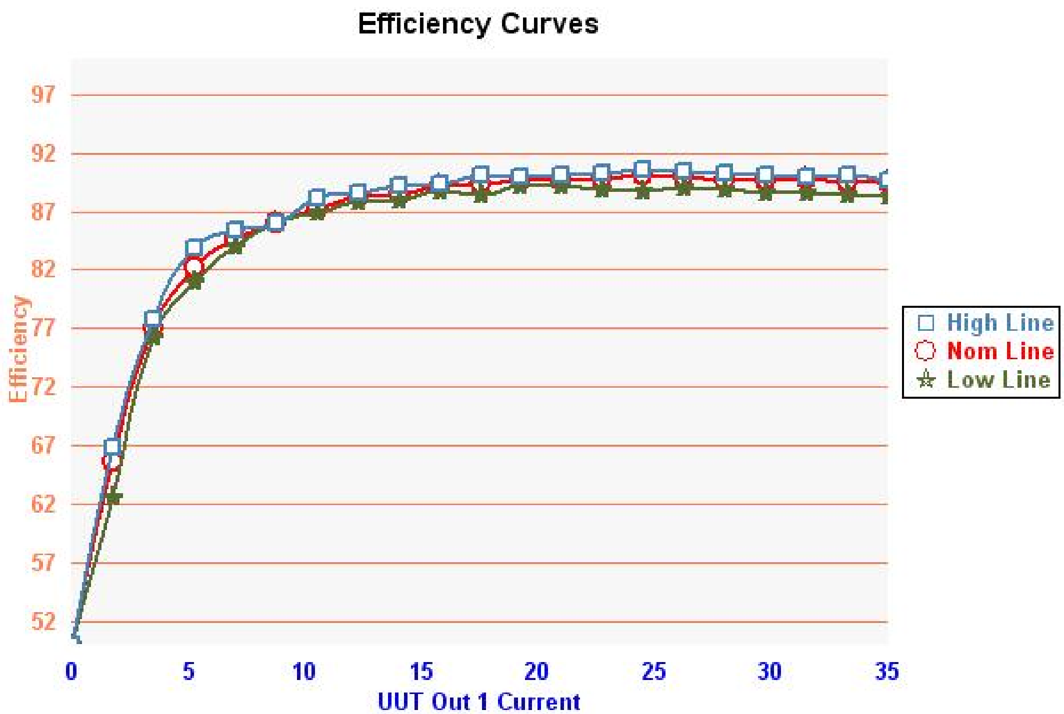


In the "Measurement Points" section (bottom), we have options for plotting the collected data. Since we defined the ramp to run under three vectors, we have three groups of data.

Like the Scale Data, we're only interested in Efficiency data, so clear the checkboxes for all the other data. Also, we'll want a name for the efficiency data that describes each collection better than the default name of “Efficiency”. We’ll name them “Low Line”, “Nom Line” and “High Line”. We know which vector is associated with each Measurement Point section by the corresponding title. Enable “Smooth lines” to remove the choppiness from the data and, finally, give the chart an appropriate caption of “Efficiency Curves”.

5.5.7 Sample Output

Using the setup defined in the previous steps, here’s a sample of a possible chart:



6. DEVICE CONTROL TEST

6.1 Description

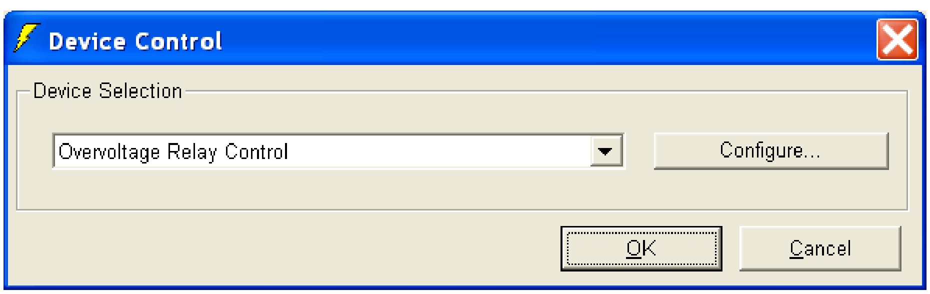
Configured *em***Power** ® devices can be accessed using the device control test routine. It enables the user to set up a device independently of other devices. Applying a vector using the program pane is the primary way to set up device states. This method has the drawback of setting states for all the devices that are contained in the vector. By using this test routine the user can set individual states for any device while leaving other devices untouched. Furthermore, devices can be accessed that are not contained in the program Input, Output, Digital or Analog configurations but exist in the system configuration.

This routine has the ability to control the state of the system Overvoltage Relays. The idea is to bracket the test sequence you wish to run with an Overvoltage Relay closed with two instances of this test routine. The first instance is used to close the desired relay, while the second instance is used to open the relay. Any test steps you perform in between will have the specified relay activated.

6.2 Method

The stored properties are loaded and applied to the selected device. The test routine returns a "Pass" if successful, or a "Fail" if any faults are encountered.

6.3 Test Routine Properties



- Device Selection - this drop-down menu enables selection of the desired device.
- Configure - this button provides access to the device properties.

6.4 Sequence

The load, source, digital and analog vectors defined by the program are applied to the tester hardware before the test routine sequence is initiated.

5) Get the device from the configuration manager
6) Load the stored device properties
7) Apply the properties
8) Check for faults and log them as necessary

7. DIGITAL STATE TEST

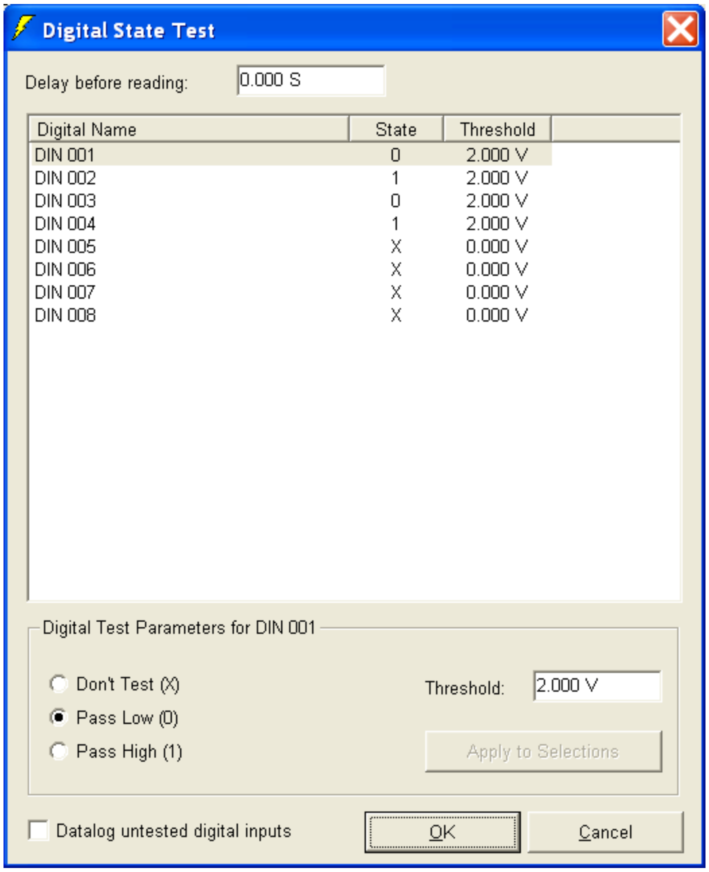
7.1 Description

The Digital State test performs a simple read of the state of the system digital input devices. It returns the state of each input as it relates to a specific threshold setting, either above the threshold value ("High") or below it ("Low"). This routine is useful for testing UUT outputs such as status signals and LED drive lines.

7.2 Method

The state of each enabled digital input is read and verified.

7.3 Test Routine Properties

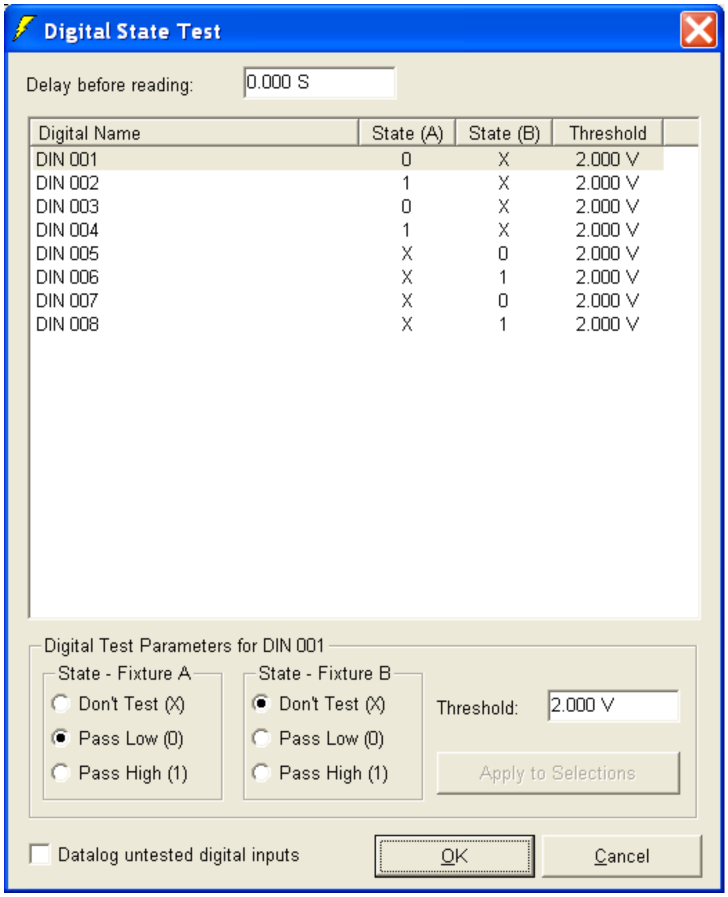


- Delay before reading – the amount of time you allow the UUT to settle before beginning the measurements.
- Digital Name – this column contains a list of all the digital inputs available in the system configuration.
- State – this column indicates the expected state of the input. Choose "1" if the digital is expected to be above the programmed threshold, "0" if the digital is expected to be below it,

or “X” if you do not wish to test this input. You change the value of this column by single clicking the appropriate DIN and checking the “Don’t Test”, “Pass Low” or “Pass High” buttons in the parameter area, or by double-clicking the value.

- Threshold – if the state of the corresponding digital input is to be verified (see the “State” column), this column defines the voltage value used to determine the state of the digital. The digital is considered “High” if its voltage value is greater than this threshold value, “Low” if its voltage value is less than this threshold. You change the value of this column by single clicking the appropriate DIN and entering the desired value in the “Threshold” edit field in the parameter area. This column can be ignored if the DIN is not being tested.
- Digital Test Parameters – it is in this area that you define the test parameters for each DIN. First select the desired DIN by single clicking the appropriate entry in the Digital Name column. Enable or disable the test by selecting the “Don’t Test”, “Pass Low” or “Pass High” option and set the test parameter by entering the desired threshold. You may also select more than one DIN from the list and apply the parameters to every selection.
- Apply To Selections – pressing this button causes all the selected digital inputs to take on the attributes currently defined in the “Digital Test Parameters” area.
- Datalog untested digital inputs – if this box is checked, all digital inputs with a “X” in the State column will be logged as “Untested” to the datalog devices. If the checkbox is cleared, no datalogging occurs for the untested digital inputs.

7.4 Test Routine Properties – Multi-fixture mode



When EDIT is set to multi-fixture mode, the DIN state test modifies itself to present choices for both the “A” and “B” fixtures. You select whether a DIN is tested while fixture “A”, “B” or both are active. Data entry is the same as single-fixture mode except double-clicking the DIN state value toggles both fixture values.

7.5 Sequence

The load, source, digital and analog vectors defined by the program are applied to the tester hardware before the test routine sequence is initiated.

1) For each digital input to be tested:
   a) Perform the measurement
   b) Evaluate and log the result
   c) Check for faults and log them as necessary

8. DIN FREQUENCY TEST

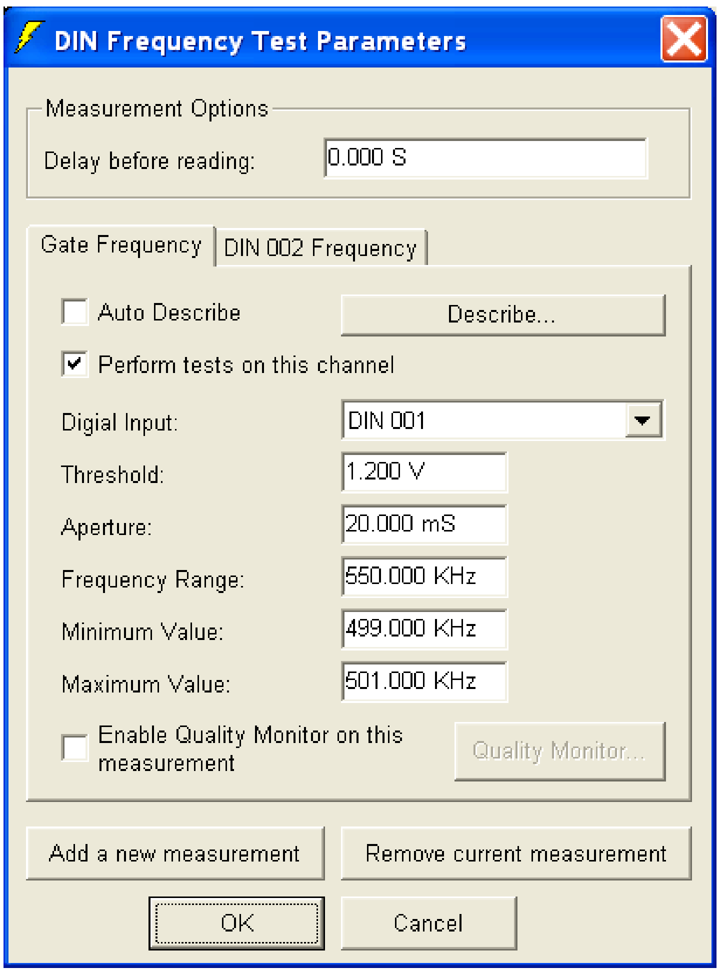
8.1 Description

The Digital Input (DIN) Frequency test is used to measure the frequency of a system digital input. It is useful for testing UUT outputs such as gate drive signals. Note: not all measurement units support this measurement.

8.2 Method

The frequency of each selected digital input is measured and verified.

8.3 Test Routine Properties



- Delay before reading – the amount of time you allow the UUT to settle before beginning the measurements.
- Auto Describe – if checked, the measurement is described by combining the name of the Digital Input to be measured with the measurement function (“frequency”). If unchecked, the user is prompted to provide a description of this measurement.

- Perform tests on this channel – check this box to take a DIN frequency measurement of the selected Digital Input.
- Digital Input – the digital input (DIN) to measure
- Threshold – the digital is considered “High” if its voltage value is greater than this threshold value, “Low” if its voltage value is less than this threshold. The measurement unit will measure the frequency at which the selected digital crosses this threshold value.
- Aperture – the measurement unit will take this long to make the measurement
- Frequency Range – this is the maximum expected measured value
- Minimum Value - this is the allowable lower limit of the measured value. Measured values less than this will cause the test routine to fail.
- Maximum Value - this is the allowable upper limit of the measured value. Measured values greater than this will cause the test routine to fail.

8.4 Sequence

The load, source, digital and analog vectors defined by the program are applied to the tester hardware before the test routine sequence is initiated.

1) For each digital input to be tested:
    a) Perform the measurement
    b) Evaluate and log the result
2) Check for faults and log them as necessary

9. EFFICIENCY TEST

9.1 Description

The efficiency test routine measures the UUT input power and output power and reports the percentage of output power/input power as the efficiency of the UUT. Secondary measurements enable verification of input and output power, power factor, and dissipated power.

This test routine also contains the ability to communicate to the UUT in order to verify its input and/or output power measurement circuitry.

9.2 Method

The routine begins by making the appropriate power measurement on each enabled input. If the secondary measurement box is enabled (see Properties), the results of the two measurements are multiplied together and the product is assumed to indicate true power[1].

The total input power is the sum of the power measurements for all the enabled inputs. The power factor measurements are also made if applicable. Power factor pass or fail status is determined and the result is logged to the datalog devices.

The power measurements for each enabled output are then acquired. If the secondary measurement box is enabled, the results of the two measurements are multiplied together and the product is assumed to indicate true power. The total output power is the sum of the power measurements for all the enabled outputs.

Efficiency is then calculated as follows: $\left(\dfrac{Total\ Output\ Power}{Total\ Input\ Power}\right)\times 100$

The test routine will log an invalid measurement if input or output power is negative, or if the output power measurement exceeds the input power measurement.

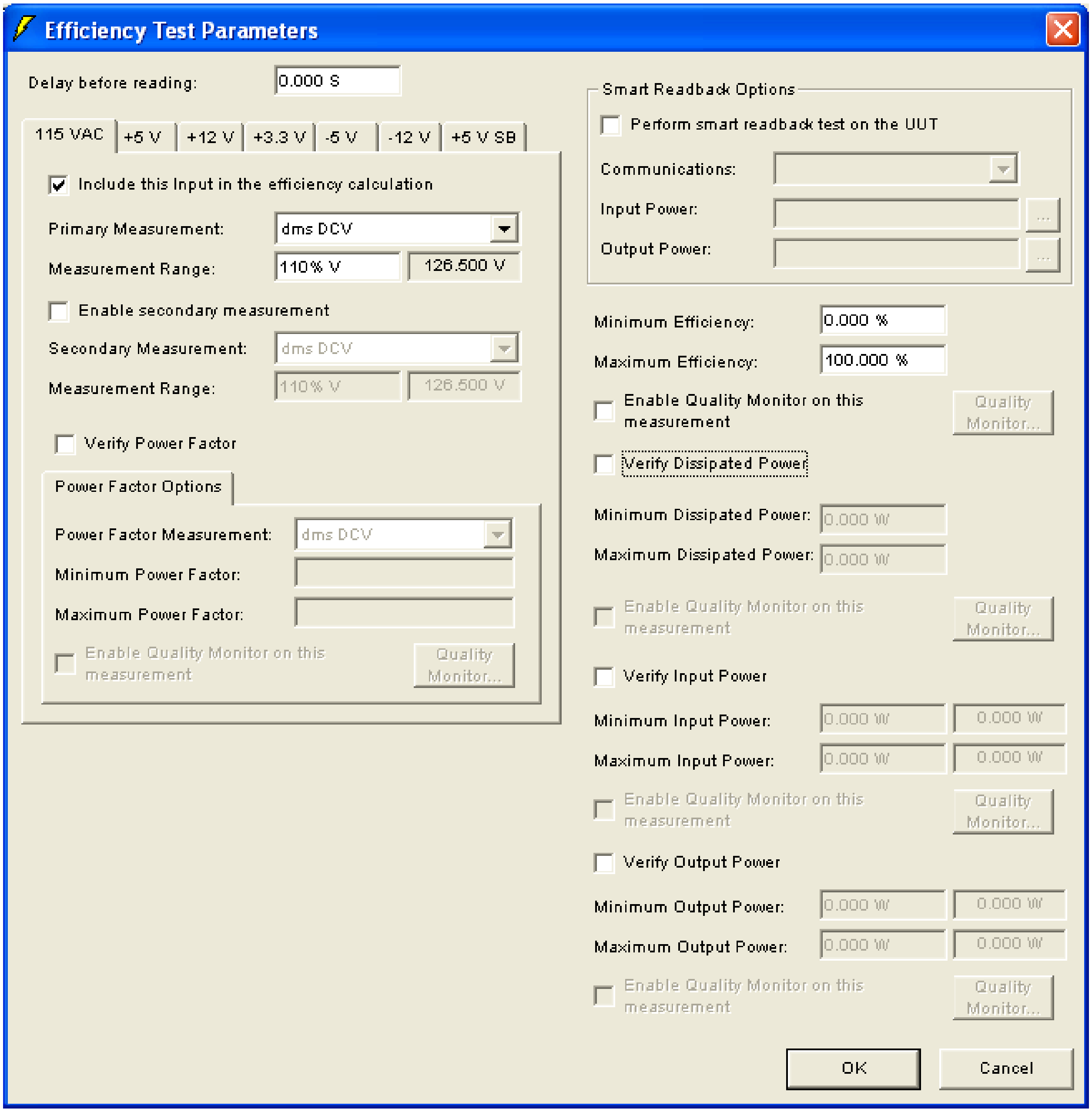
The routine continues by evaluating the total input and output power sums to determine their respective pass/fail status and logging the results to the datalog devices if applicable.

The power dissipation is calculated by subtracting the total output power from the total input power, and if applicable, a pass/fail status is determined and the result is logged to the datalog devices.

If the Smart Readback option is selected, the total input power value is passed to the UUT communications object as the reference value and the Input Power communication test is performed. Pass or fail status is determined and the result is logged to the datalog devices. The total output power value is then passed to the UUT communications object as the reference and the Output Power communications test is performed. Again, pass or fail status is determined and the result is logged to the datalog devices.

[1] Efficiency results calculated with a measurement other than a TRUE power measurement can give misleading results.

9.3 Test Routine Properties



- Include this Input/Output in the efficiency calculation – check this box to enable the measurement(s) for this input or output and to have the power value included in the total Input/Output Power sum.
- Primary Measurement – the measurement vector that will be used to take the measurement. A “True” power measurement vector is preferred, if available. If the input/output device is unable to make power measurements this entry may be used to take a measurement that will be multiplied with the value of the Secondary measurement to create a power value. For example, this entry could be a DC Voltage measurement while the Secondary vector makes a DC Current measurement.

- Measurement Range (Primary) – this is the maximum expected measured value. The value may be entered either as a value or a percentage of a channel reference. The appropriate reference is automatically selected based on the measurement vector entry. In the example above, the "UUT In 1" Reference Wattage value will be used.
- Enable secondary measurement – check this box to instruct the test routine to take a secondary measurement and combine it with the primary measurement to calculate the true power of this input/output.
- Secondary Measurement – the measurement vector that will be used to take the secondary measurement. If the input/output device is unable to make True Power measurements this entry may be used to take a measurement that will be multiplied with the value of the Primary measurement to create a power value. For example, this entry could be a DC Current measurement while the Primary vector makes a DC Voltage measurement.
- Measurement Range (Secondary) – this is the maximum expected measured value. The value may be entered either as a value or a percentage of a channel reference.
- Verify Power Factor – check this box to enable power factor measurement and reporting.
- Power Factor Measurement – the measurement vector that will be used to take the power factor measurement.
- Minimum Power Factor - this is the allowable lower limit of the measured value. Measured values less than this will cause the test routine to fail.
- Maximum Power Factor - this is the allowable upper limit of the measured value. Measured values greater than this will cause the test routine to fail.
- Collect Quality Monitor data on this measurement – check this box to enable Quality Monitor data collection.
- Quality Monitor… – press this button to display the Quality Monitor properties. Please refer to the Quality Monitor reference manual for further details.
- Perform smart Readback test on the UUT – check this box to perform the UUT communication section of the test routine.
- Communications – select the desired UUT communication object from the drop-down list and press the ellipsis buttons for communications test parameters. Please refer to the appropriate UUT communications object reference manual for further details.
- Input Power – the communications command used to query Input Power from the UUT. The data may be entered here, or in the appropriate field in the UUT communications object.
- Output Power – the communications command used to query Output Power from the UUT. The data may be entered here, or in the appropriate field in the UUT communications object.
- Minimum Efficiency - this is the allowable lower limit of the calculated value. Values less than this will cause the test routine to fail.
- Maximum Efficiency - this is the allowable upper limit of the calculated value. Values greater than this will cause the test routine to fail.

- Collect Quality Monitor data on this measurement – check this box to enable Quality Monitor data collection.
- Quality Monitor… – press this button to display the Quality Monitor properties. Please refer to the Quality Monitor reference manual for further details.
- Verify Dissipated Power – check this box to verify that the total dissipated power is within acceptable limits.
- Minimum Dissipated Power – this is the allowable lower limit of the total value. Values less than this will cause the test routine to fail.
- Maximum Dissipated Power – this is the allowable upper limit of the total value. Values greater that this will cause the test routine to fail.
- Verify Input Power – check this box to verify that the total input power is within acceptable limits.
- Minimum Input Power - this is the allowable lower limit of the total value. Values less than this will cause the test routine to fail.
- Maximum Input Power - this is the allowable upper limit of the total value. Values greater than this will cause the test routine to fail.
- Collect Quality Monitor data on this measurement – check this box to enable Quality Monitor data collection.
- Quality Monitor… – press this button to display the Quality Monitor properties. Please refer to the Quality Monitor reference manual for further details.
- Verify Output Power – check this box to verify that the total output power is within acceptable limits.
- Minimum Output Power - this is the allowable lower limit of the total value. Values less than this will cause the test routine to fail.
- Maximum Output Power - this is the allowable upper limit of the total value. Values greater than this will cause the test routine to fail.
- Collect Quality Monitor data on this measurement – check this box to enable Quality Monitor data collection.
- Quality Monitor… – press this button to display the Quality Monitor properties. Please refer to the Quality Monitor reference manual for further details.

9.4 Sequence

The load, source, digital and analog vectors defined by the program are applied to the tester hardware before the test routine sequence is initiated.

1) For each UUT input:
    a) Perform the primary measurement
    b) Perform the secondary measurement, if applicable, and multiply the result with that of the primary measurement

   c) Perform the power factor measurement, if applicable, and evaluate and log the result
2) Sum the input power measurements to create the Total Input Power
3) For each UUT output:
   a) Perform the primary measurement
   b) Perform the secondary measurement, if applicable, and multiply the result with that of the primary measurement
4) Sum the output power measurements to create the Total Output Power
5) Subtract the Total Output Power from the Total Input Power to get the Dissipated Power.
6) Calculate the efficiency: $\left(\dfrac{Total\ Output\ Power}{Total\ Input\ Power}\right)\times 100$
7) Evaluate and log the efficiency result
8) Evaluate and log the Total Input Power result, if applicable
9) Evaluate and log the Total Output Power result, if applicable
10) Evaluate and log the Dissipated Power result, if applicable
11) If performing the Smart Readback test:
   a) Set the ReferenceValue property equal to the total input power value
   b) Initiate the communication test
   c) Log the Input Power result
   d) Set the Reference Value property equal to the total output power value
   e) Initiate the communication test
   f) Log the Output Power result
12) Check for faults and log them as necessary

10. HARMONICS MEASUREMENT

10.1 Description

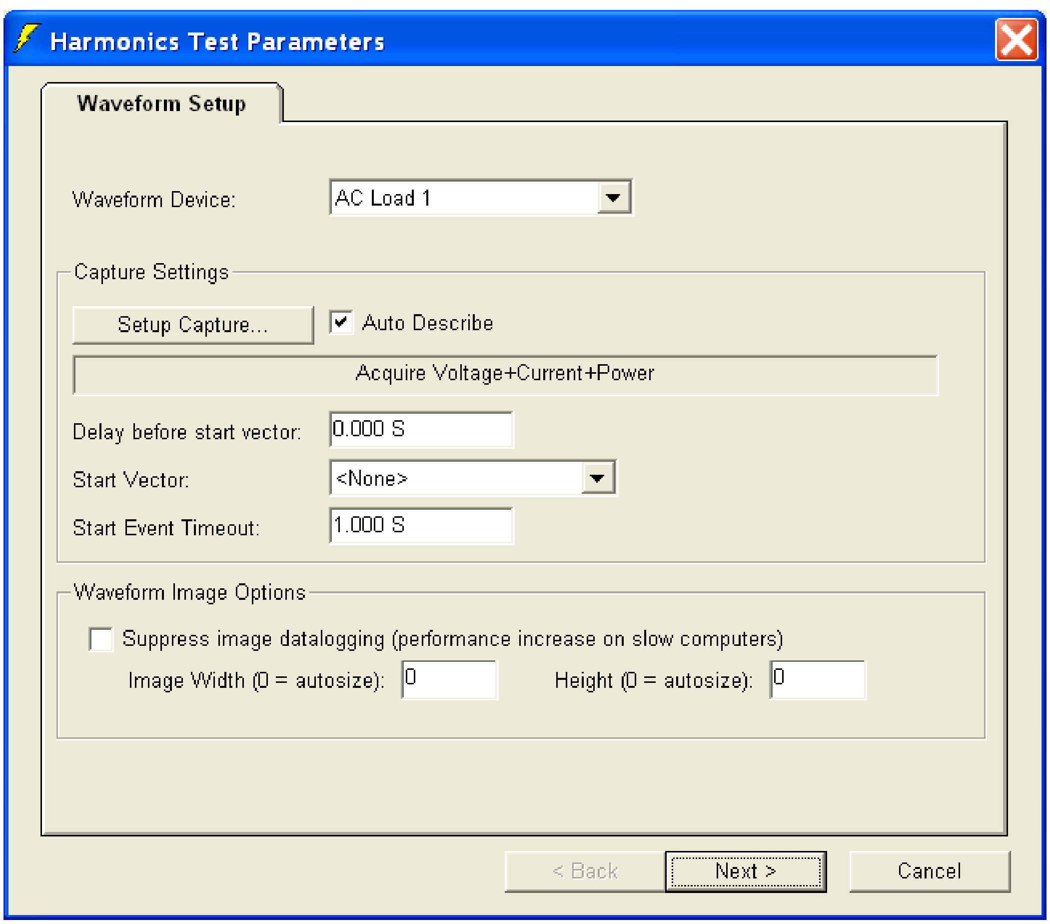
The Harmonics Measurement test routine is used to analyze a waveform to determine the constituent frequencies that make up the signal. It is most often applied to AC current waveforms to determine compliance with various international standards.

10.2 Method

After the acquisition of a waveform, this routine will determine the fundamental frequency and then perform an FFT (Fast-Fourier Transform) to determine the amplitude of the fundamental frequency and each harmonic (multiple) of the fundamental. The fundamental and each harmonic are then tested against user-specified maximums to determine if they pass or fail. In addition to testing the individual harmonics, the total harmonic distortion can be calculated and tested.

10.3 Test Routine Properties

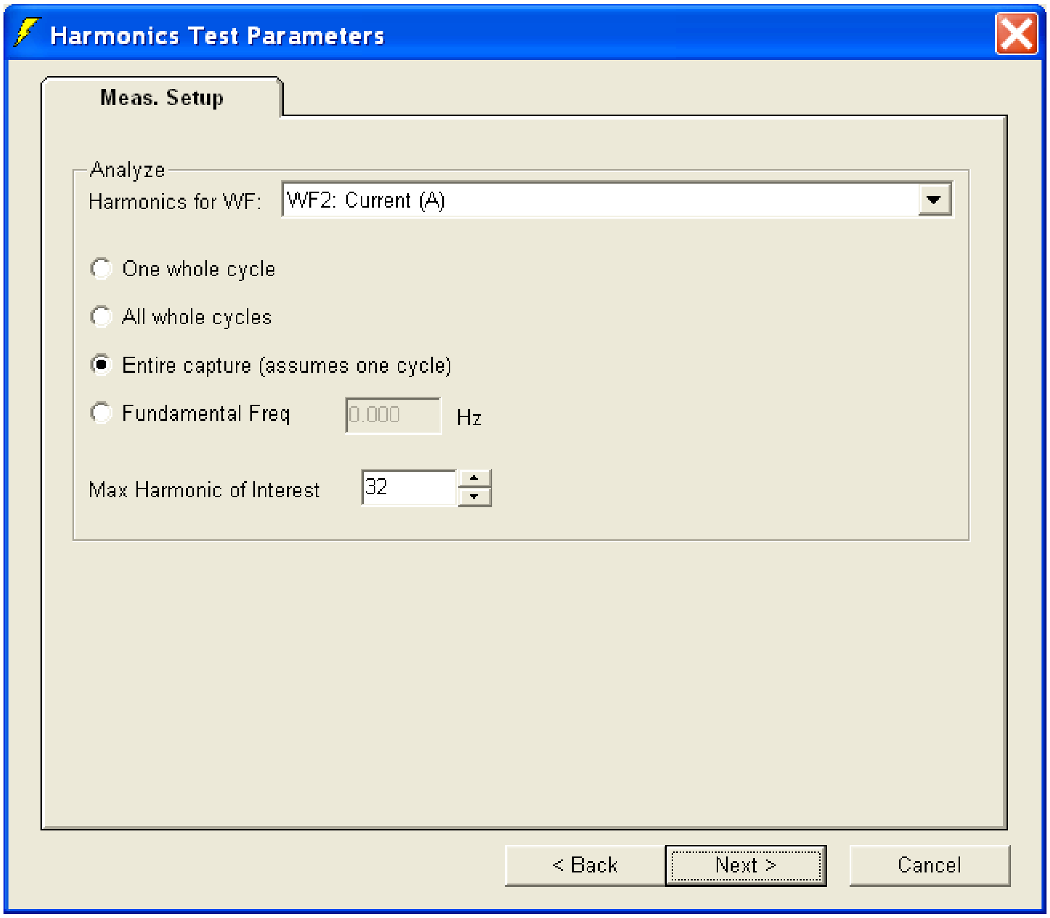
10.3.1 Waveform Setup



- Waveform Device – Select the device that will be used to capture the data. The list of available devices varies with the hardware installed. In the NHR default naming convention, waveform devices capable of accepting input external to the digitizer are named “External Waveform 1,” 2, etc. If the digitizer gets the input internally, the devices are listed by the logical hardware name like “AC Load 1,” “DC Load 1,” etc. These devices can be given customized names by the user in the Configuration utility (see NH Document 09-0269).
- Setup Capture – The “Setup Capture” button brings up the Digitizer Device virtual scope front panel control. This panel is used to select ranges, trigger options, input coupling and termination, which channels to enable, and which system elements to connect to the enabled channels.

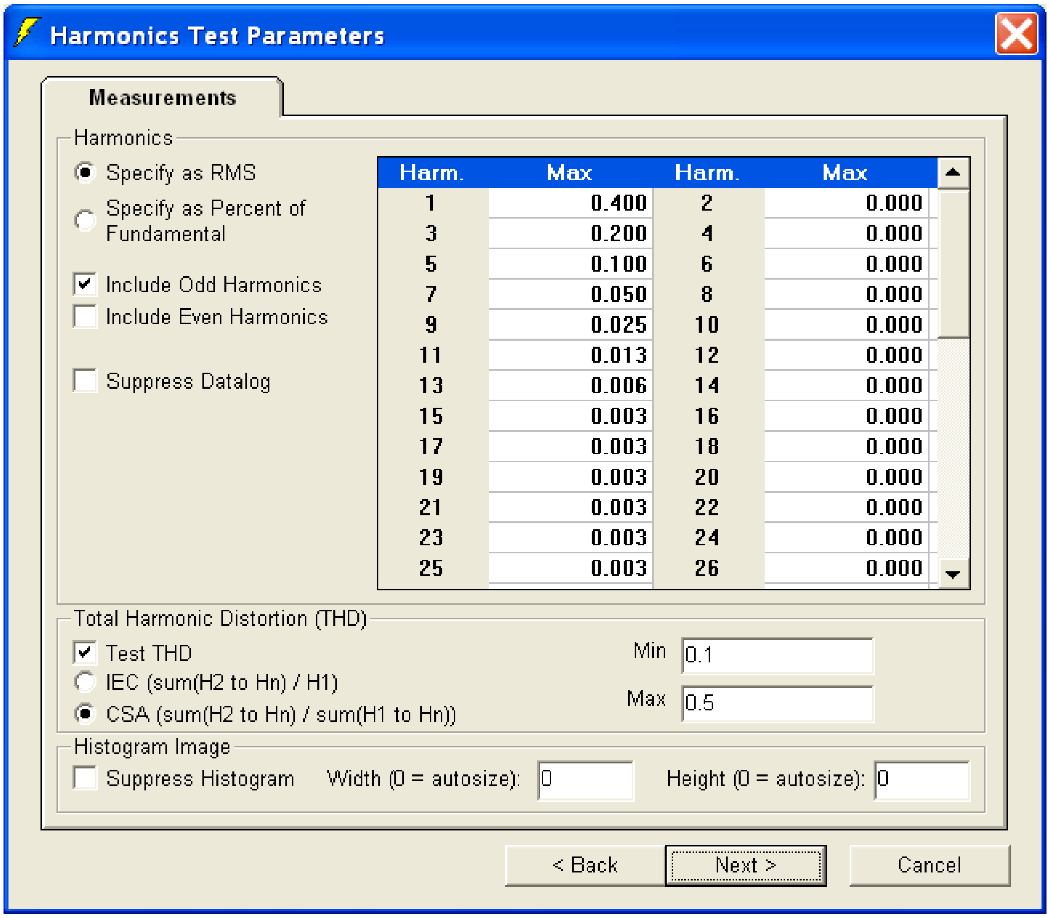
  The familiar DSO front panel interface (see 38.3.1 below for details) allows the multitude of possible set up options to be presented in an intuitive way, and the “live” graphical display allows checking the operation of the setup parameters. The Run and Force Trigger buttons allow samples to be captured for immediate verification of range and sample rate selections if other system signals are also “live” during test generation. A Measure button allows immediate verification of the possible measurement operations before they are used in the run time test program.
- Delay Before Start Vector – This time is used to delay the Start Vector from activation when the test program enters the Waveform Test step. This may be necessary to allow other system instruments, or the UUT, to be initialized or reach a nominal state as a result of previous program steps. Since the Start Vector will typically invoke a trigger condition required to capture data, the Delay Before Start Vector can be used to hold off this trigger for a fixed time if necessary. Pre-triggering memory fill delays are determined automatically depending on the Trigger Position selection (see below), the Delay Before Start Vector is not used for this purpose.
- Start Vector – the vector that will initiate the measurement. The dropdown contains an entry for every user defined Load, Source, Digital and Analog vector in the test program.
- Start Event Timeout – This time is used as a worst-case timeout value to keep the test program from waiting indefinitely for a trigger condition or other result of the Start Vector. As an example, if the Start Vector was UUT Power On, and the Waveform Test Trigger Source selection was a DIN input connected to a UUT Power Good output signal, the Start Event Timeout could be set to the greatest expected delay from UUT Turn On to Power Good. The timeout will keep the test from hanging indefinitely if a bad UUT never activates Power Good. If the Start Event Timeout expires, a test failure status is logged and the test program continues.
- Suppress Image Datalogging – If the suppress image option is selected, the test will still capture and process all measurements, but instead of displaying the measurement results AND the captured waveform image, only the measurement results will be displayed. If the image is not suppressed, it will be sized according to the width and height specified. Use 0 to have the routine choose the best size or specify your own. Width and height are specified in hundredths of inches; that is 5.50 inches would be specified as 550.

10.3.2 Measurement Setup



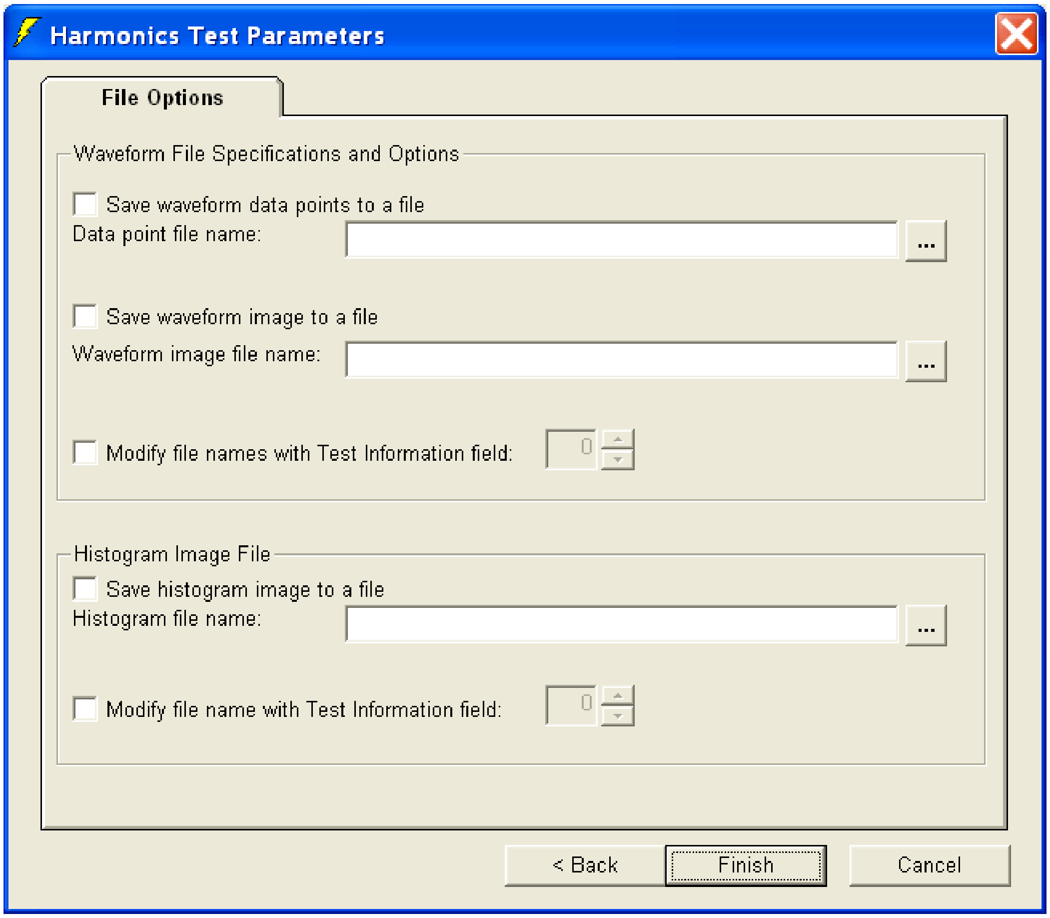
- Harmonics for WF – choose the waveform channel to analyze.
- Select how fundamental will be determined – The accuracy of determining the fundamental frequency is critical to the success of the harmonic analysis. In order for the test routine to determine the fundamental frequency automatically, at least 1.5 cycles are required in the capture. If that is the case, choose “One whole cycle” or “All whole cycles.” If the waveform device is known to return exactly one whole cycle (like the NHR AC Load), choose “Entire capture.” If the frequency is known, but cannot be determined automatically, choose “Fundamental Freq.” and enter the frequency.
- Max Harmonic of Interest – Determines the maximum harmonic that will be evaluated.

10.3.3 Measurements



- Harmonics – Determine the maximum value for each harmonic. The values entered will be in RMS or percent of fundamental as selected. If odd or even harmonics are excluded, they will not be tested but they will still show up on the histogram. If you only want the histogram, you can choose to suppress the datalog of the individual harmonic tests.
- Total Harmonic Distortion – If THD is to be tested in addition to the individual harmonics, specify the method and minimum and maximum.
- Histogram Image – The histogram will be displayed unless suppressed. If the image is not suppressed, it will be sized according to the width and height specified. Use 0 to have the routine choose the best size or specify your own. Width and height are specified in hundredths of inches; that is 5.50 inches would be specified as 550.

10.3.4 File Options



- Save waveform data points to a file – the collected data can be saved to a user specified file for use with offline data analysis tools. The file is saved in Comma Separated Variable format (CSV) for import to spreadsheet and data analysis programs.
- Save waveform image to a file – Save the waveform jpeg file in the specified location.
- Modify file names with Test Information field – when enabled, a field from the Test Information Entry form will be appended to the user entered file names. The Test Information Entry form appears before running the test on each UUT, and is typically filled in by the test operator. Appending an information field provides a method of tracking specific chart and/or data point files to a particular UUT serial number or test pass. The number selection box determines which of the input fields from the Test Information Entry form will be appended to the file name.
- Save waveform data points to a file – the collected data can be saved to a user specified file for use with offline data analysis tools. The file is saved in Comma Separated Variable format (CSV) for import to spreadsheet and data analysis programs.
- Save histogram image to a file – Save the histogram jpeg file in the specified location.
- Modify file name with Test Information field – when enabled, a field from the Test Information Entry form will be appended to the user entered file names.

10.3.5 Sequence

The load, source, digital and analog vectors defined by the program are applied to the tester hardware before the test routine sequence is initiated.

- Setup the waveform device and initiate capture. The waveform device will now be armed and waiting for the trigger.
- Delay "wait before start vector" time.
- Apply start vector with system trigger.
- Wait for waveform device to complete the capture. If the trigger has not been seen by the "start event timeout" then abort the capture.
- Determine fundamental frequency according to user choice.
- Perform FFT analysis.
- Analyze results.
- Datalog images and results as specified.

11. INPUT DETECTION TEST

11.1 Description

The Input Detection test routine is a specialized routine that requires the ability to communicate with the UUT. The routine is used to verify the internal measurement circuitry of the UUT by testing both input voltage and frequency. The measurements can be compared against user-entered values or values gathered from other test station measurement devices, and can be performed for every input connected to the UUT.

The test routine uses the properties of the selected UUT Communications object to control the flow of the test. As these communications objects differ in operation the flow of the test varies accordingly. Please refer to the appropriate UUT communications object reference manual for further details.

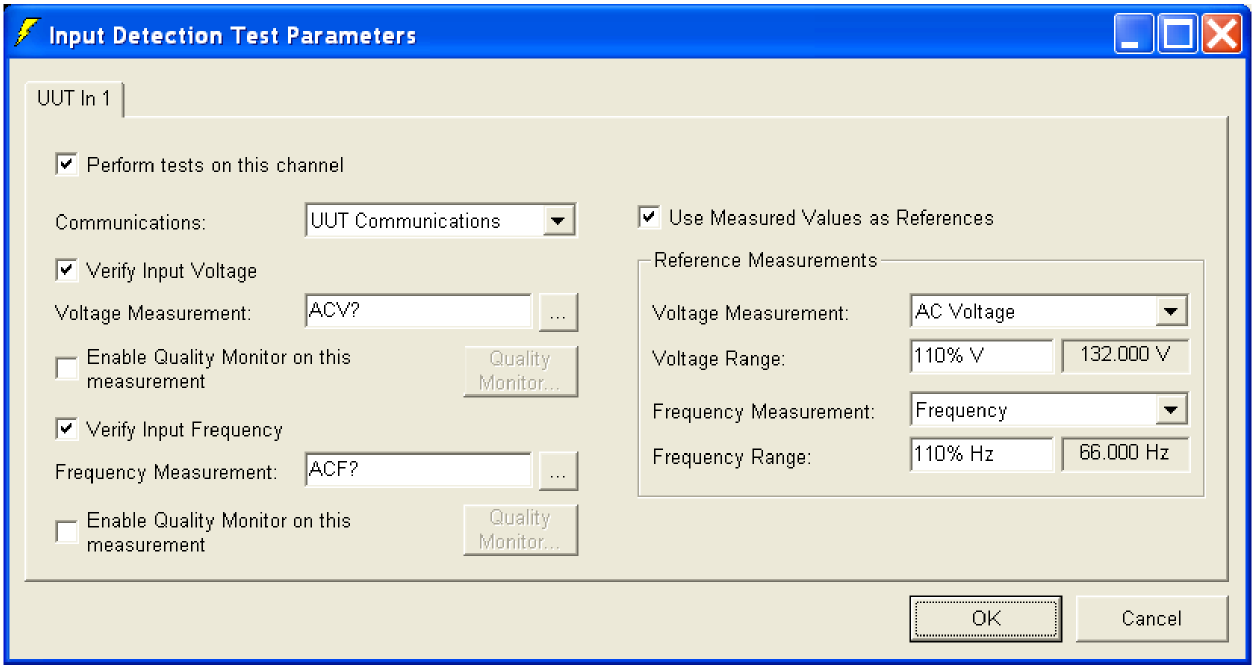
11.2 Method

The test begins by gathering the voltage measurement from the reference measurement device if that option is enabled. This measured value is passed to the UUT communications object as the reference value and the Input Voltage communication test is performed. Pass or fail status is determined and the result is logged to the datalog devices.

The reference frequency measurement is gathered from the reference measurement device, if that option is enabled. This measured value is passed to the UUT communications object as the reference value and the Input Frequency communication test is performed. Again, pass or fail status is determined and the result is logged to the datalog devices.

All communications control, data collection and validation of any return data is performed by the communications object. Please refer to the appropriate UUT communications object reference manual for further details.

11.3 Test Routine Properties



- Communications – select the desired UUT communication object from the drop-down list.
- Verify Input Voltage – check this box to verify the Voltage detection circuitry of the UUT.
- Voltage Measurement – press the ellipsis button for communications test parameters. Please refer to the appropriate UUT communications object reference manual for further details. The edit field to the left of the ellipsis button reflects the communications string to be sent to the UUT necessary to perform the voltage measurement. The data may be entered here, or in the appropriate field in the UUT communications object.
- Collect Quality Monitor data on this measurement – check this box to enable Quality Monitor data collection.
- Quality Monitor… – press this button to display the Quality Monitor properties. Please refer to the Quality Monitor reference manual for further details.
- Verify Input Frequency – check this box to verify the Frequency detection circuitry of the UUT.
- Frequency Measurement – press the ellipsis button for communications test parameters. Please refer to the appropriate UUT communications object reference manual for further details. The edit field to the left of the ellipsis button reflects the communications string to be sent to the UUT necessary to perform the frequency measurement. The data may be entered here, or in the appropriate field in the UUT communications object.
- Collect Quality Monitor data on this measurement – check this box to enable Quality Monitor data collection.
- Quality Monitor… – press this button to display the Quality Monitor properties. Please refer to the Quality Monitor reference manual for further details.

- Use Measured Values as References – check this box to gather voltage and/or frequency reference measurements from other test station measurement devices.
- Voltage Measurement – the measurement vector that will be used to take the voltage reference measurement. Note that this must be a DMM-type voltage measurement vector.
- Voltage Range – this is the maximum expected measured value. The value may be entered either as a value or a percentage of a channel voltage reference.
- Frequency Measurement – the measurement vector that will be used to take the frequency reference measurement. Note that this must be a DMM-type frequency measurement vector.
- Frequency Range – this is the maximum expected measured value. The value may be entered either as a value or a percentage of a channel frequency reference.

11.4 Sequence

The load, source, digital and analog vectors defined by the program are applied to the tester hardware before the test routine sequence is initiated.

1) If performing the Voltage test:
   a) Load the communication object test parameters
   b) If using a reference voltage measurement:
      i) Perform the measurement
      ii) Set the Reference Value property equal to the measurement
   c) Instruct the communication object to perform the test
   d) Retrieve the pass/fail status and returned value
   e) Log the result
   f) Check for faults and log them as necessary
2) If performing the Frequency test:
   a) Load the communication object test parameters
   b) If using a reference voltage measurement:
      i) Perform the measurement
      ii) Set the Reference Value property equal to the measurement
   c) Instruct the communication object to perform the test
   d) Retrieve the pass/fail status and returned value
   e) Log the result
   f) Check for faults and log them as necessary

12. MEASUREMENT MATH TEST

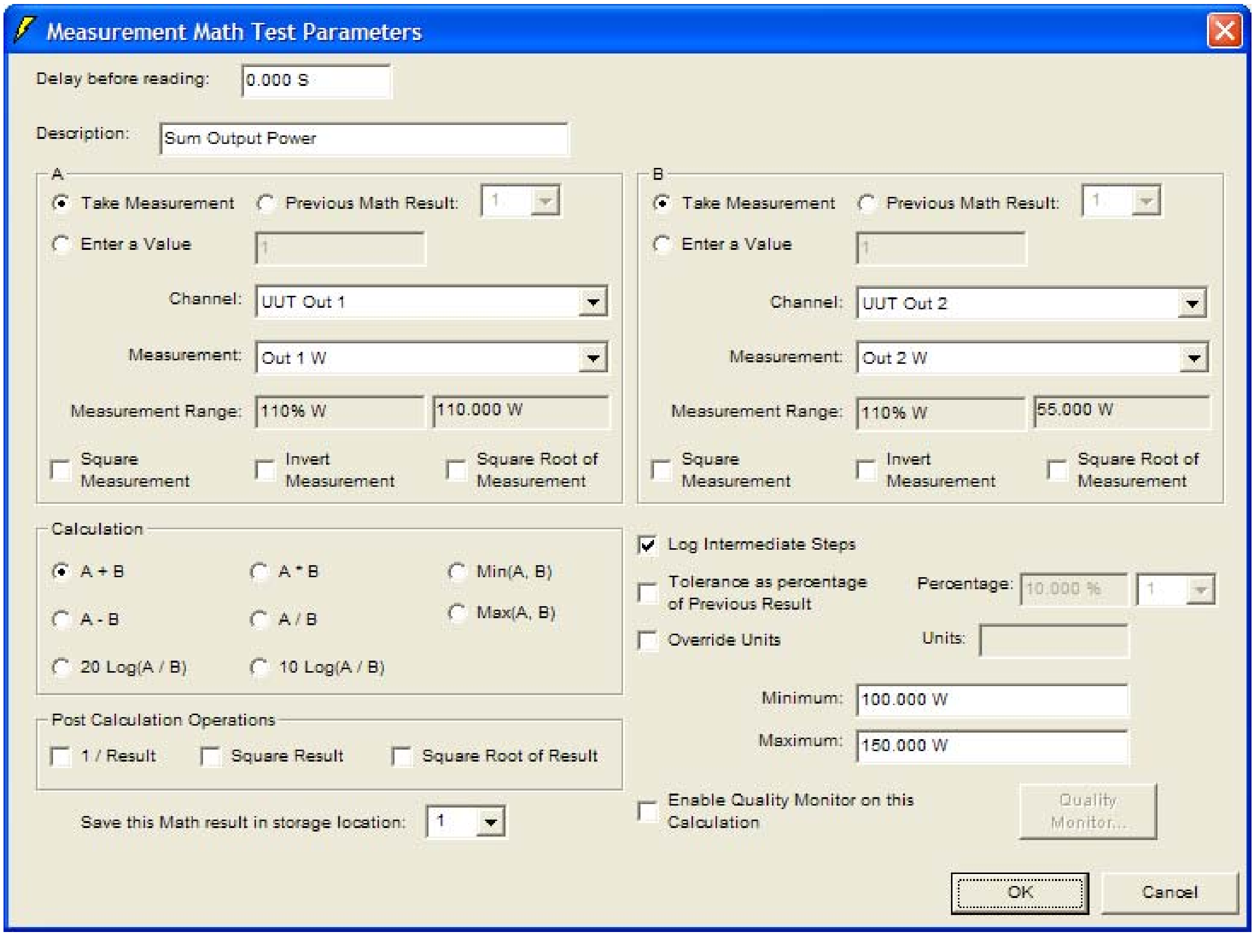
12.1 Description

The Measurement Math Test Routine is a general-purpose test routine that can be used to take two measurements, and then combine them using several mathematical equations. Additionally, after making the first calculation, the test routine offers the option of using previously calculated results in place of a new measurement. In this way, it is possible to combine many different combinations of measurements in a variety of ways.

12.2 Method

The test routine begins by gathering the measurement results for each required measurement. These measurements are then logged if the option to log intermediate steps was chosen. Once a result is recorded for both measurement A and B (either one of these may be defaulted to a user-defined value, or use a previous calculated result), the results are manipulated individually as specified. Each result can either be inverted, squared, or have the square root taken before combining it with the other result mathematically. The manipulated results are then combined using the specified mathematical equation. Once combined, the final result may be manipulated by either inverting, squaring, or taking the square root of it. The result is compared to a specified minimum and maximum value, and the result is evaluated and logged.

12.3 Test Routine Properties



- Delay before reading - the amount of time you allow the UUT to settle before beginning the measurements. Note that this delay happens once at the beginning of the routine.
- Description – a description of the calculation being performed
- A – the first measurement result
- B – the second measurement result
- Take Measurement/Enter a Value/Previous Math Result – this option will determine where result A comes from. Either take a new measurement, use a hard-coded value or use the result of a previous Measurement Math test result. If you are choosing a previous result, select the desired storage location from which to retrieve the previous value from the dropdown to the right.
- Channel - defines the channel to use when making the measurement. Choose from any of the defined Inputs or Outputs, or from the list of available multiplexer channels.
- Measurement – the measurement vector that will be used to take the measurement. Note that this must be a DMM-type measurement vector.

- Measurement Range - this is the maximum expected measured value. The value may be entered either as a value or a percentage of a channel reference. The appropriate reference is automatically selected based on the measurement vector entry.
- Square Measurement – check this option to square A or B after being measured.
- Invert Measurement – check this option to invert A or B after being measured.
- Square Root of Measurement – check this option to take the square root of A or B after being measured.
- Calculation – these are the available equations to be used to manipulate results A and B. They can be summed, subtracted, multiplied, divided, 20 Log(A/B) or 10 Log(A/B) can be calculated, or the minimum or maximum between the A and B can be returned.
- Post Calculation Operations – after the calculation is complete, the result can be squared, inverted, or have the square root taken. More than one of these options can be performed at one time.
- Log Intermediate Steps – checking this will cause all details of the calculation to be sent to the Datalog Server. This means that all measurements, manipulations of measurements, calculation results, and manipulation of calculation results will be displayed.
- Tolerance as percentage of Previous Result – if you enable this option, the Minimum and Maximum tolerances will be calculated as a percentage of a previous Measurement Math test result. Select the desired test result from the dropdown to the right.
- Override Units – the test routine will do its best to determine appropriate units for the calculation being performed. Select this option to ignore the units determined by the test routine, and supply your own.
- Units – units used to describe the end result of the calculation.
- Minimum - this is the allowable lower limit of the calculated result. Results less than this will cause the test routine to fail.
- Maximum - this is the allowable upper limit of the calculated result. Results higher than this will cause the test routine to fail.
- Save this Math result in storage location – the result of this calculation is stored so it can be used in subsequent Measurement Math calculations in this test program. The routine will store up to 100 values. Note: this storage is not persistent. When a new test program is loaded the storage locations are re-initialized to zero.
- Enable Quality Monitor on this Calculation - check this box to enable Quality Monitor data collection.
- Quality Monitor… – press this button to display the Quality Monitor properties. Please refer to the Quality Monitor reference manual for further details.

12.4 Sequence

The load, source, digital and analog vectors defined by the program are applied to the tester hardware before the test routine sequence is initiated.

1) Wait the delay before reading time
2) For both A and B:
   a) Perform the measurement, get a previously calculated Measurement Math result, or set the user-defined value.
   b) If a measurement was taken, apply any additional calculations specified (Square, Invert, Square Root)
3) With results of A and B:
   a) Perform the specified equation on the two results.
   b) Apply any additional calculations specified (Square, Invert, Square Root)
   c) Save the calculation in the appropriate storage location
   d) Check for faults and log them as necessary

13. MULTI-MEASUREMENT TEST

13.1 Description

The Multi-Measurement test routine is a very general-purpose test that will perform measurements on the UUT's inputs and/or outputs. Valid measurements include voltage, current, power, frequency, noise, distortion, etc. The measurement points of the UUT may be adjusted manually with a graphical display showing the measurement and its relationship to the upper and lower tolerances. This routine allows the setting of a single additional vector in order to perform tests like peak inrush current. The only constraint on this test is that the measurements must use DMM-type measurement vectors.

This test routine also contains the ability to communicate to the UUT in order to verify its status or internal measurement circuitry.

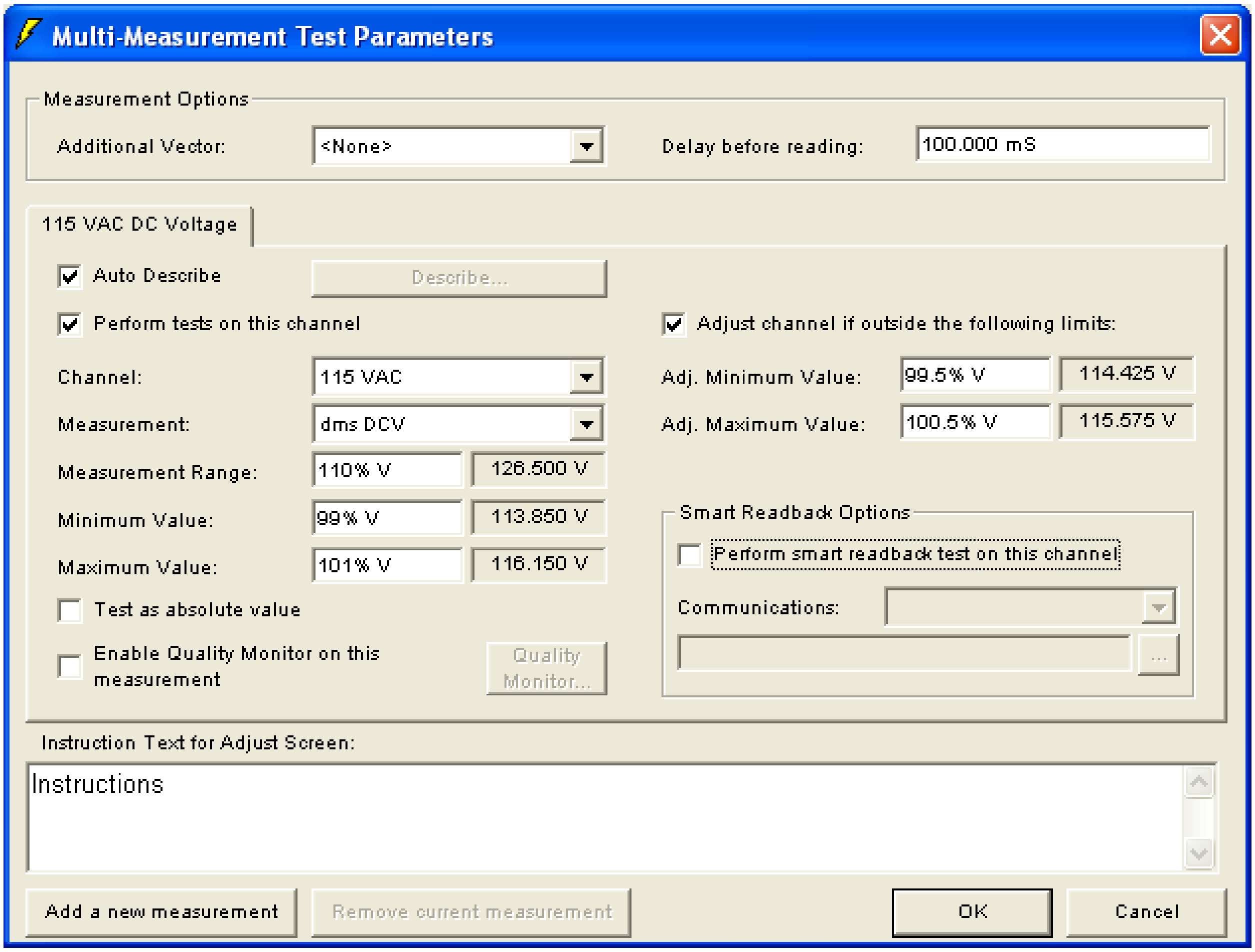
13.2 Method

If the "Additional Vector" is set to "None", after performing the "Delay before reading" the measurements are taken on each selected measurement. However, if an additional vector is selected, the algorithm is modified to setup the measurement(s), set the additional vector, wait the delay before reading time and then fetch the measured value(s). Note that the additional vector is applied *once* regardless of the number of measurements configured. The ability to "split" the measurement around the additional vector is hardware dependent; most measurement units can make one measurement while the vector is being applied. If the measurement unit is unable to span the vector with the requested measurements, the measurements will be taken *after* the vector completes. This case is likely if you define more than one measurement per measurement unit in the test routine.

Should any adjustable measurement fail, the operator is presented with an adjustment screen. After the adjustments (if any), pass or fail status is determined and the results are logged to the datalog devices.

If the Smart Readback option is selected, the measured value is passed to the UUT communications object as the reference value and the communication test is performed. Again, pass or fail status is determined and the result is logged to the datalog devices.

13.3 Test Routine Properties



- Additional Vector – this can be any load, source, digital or analog vector defined in the program. Note that this vector is applied once at the beginning of the test routine.
- Delay before reading – the amount of time you allow the UUT to settle before beginning the measurements. Note that this delay happens once at the beginning of the routine.
- Auto Describe – if checked, the measurement is described by combining the name of the channel to be measured with the measurement function. If unchecked, the user is prompted to provide a description of this measurement. This measurement is logged to the datalog devices as part of the results.
- Perform tests on this channel – check this box to take a measurement of this channel.
- Channel – defines the channel to use when making the measurement. Choose from any of the defined Inputs or Outputs, or from the list of available multiplexer channels.
- Measurement – the measurement vector that will be used to take the measurement. Note that this must be a DMM-type measurement vector.
- Measurement Range – this is the maximum expected measured value. The value may be entered either as a value or a percentage of a channel reference. The appropriate reference is

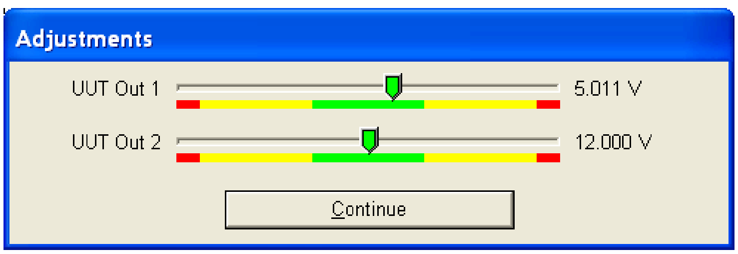
automatically selected based on the measurement vector entry. In the example above, the "UUT In 1" Reference Current value will be used.

- Minimum Value - this is the allowable lower limit of the measured value. Measured values less than this will cause the test routine to fail. The value may be entered either as a value or a percentage of a channel reference.
- Maximum Value - this is the allowable upper limit of the measured value. Measured values greater than this will cause the test routine to fail. The value may be entered either as a value or a percentage of a channel reference.
- Test as absolute value – check this box to use the absolute value of the measurement for pass/fail evaluation and UUT communication reference.
- Collect Quality Monitor data on this measurement – check this box to enable Quality Monitor data collection.
- Quality Monitor… – press this button to display the Quality Monitor properties. Please refer to the Quality Monitor reference manual for further details.
- Adjust channel if outside the following limits – check this box to indicate the channel may be adjusted if it is found to be outside the adjustment limits.
- Adj. Minimum Tolerance - this is the allowable lower limit of the adjustment range. Measured values less than this will cause this output to be added to the adjustment list. The value may be entered either as a value or a percentage of channel reference voltage.
- Adj. Maximum Tolerance - this is the allowable upper limit of the adjustment range. Measured values greater than this will cause this output to be added to the adjustment list. The value may be entered either as a value or a percentage of channel reference voltage.
- Perform smart readback test on this channel – check this box to perform the UUT communication section of the test routine.
- Communications – select the desired UUT communication object from the drop-down list and press the ellipsis button for communications test parameters. Please refer to the appropriate UUT communications object reference manual for further details. The edit field to the left of the ellipsis button reflects the communications string to be sent to the UUT. The data may be entered here, or in the appropriate field in the UUT communications object.
- Instruction Test for Adjust Screen – instructions entered in this field will be displayed on the adjustments screen during the test. If this field is left blank, the instructions area on the adjustments screen will not display.
- Add a new measurement – press this button to add a new measurement and associated tab to the test routine.
- Remove current measurement – press this button to remove the currently selected measurement from the test routine. Once this button is pressed the measurement data is lost and cannot be recovered.

13.4 Sequence

The load, source, digital and analog vectors defined by the program are applied to the tester hardware before the test routine sequence is initiated.

4) Set the additional vector, if applicable
5) Wait the delay before reading time
6) For each configured measurement:
   a) Perform the measurement
   b) Translate to absolute value if necessary
   c) Evaluate the result
   d) If passed, or the channel is not adjustable, log the result
   e) If adjustable and failed, add channel to the adjustment list
   f) Check for faults and log them as necessary
7) If there were any channels needing adjustment:



   a) Show the adjustment screen until the operator accepts the values. The test will pass as long as all measurements are in the yellow or green area of the adjustment scale. The green area is defined by the "Adj. Minimum/Maximum Tolerance" parameters, while the yellow area is defined by the "Minimum/Maximum Tolerance" parameters
   b) Evaluate and log the results
   c) Check for faults and log them as necessary
8) If performing the Smart Readback test:
   a) Set the Reference Value property equal to the measurement
   b) Initiate the communication test
   c) Log the result
   d) Check for faults and log them as necessary

14. MULTI-PASS REGULATION TEST

14.1 Description

The Multi-Pass Regulation test routine combines the capabilities of a Line Regulation, Load Regulation, Corner Regulation and a Cross Regulation test routine in one. This test checks the individual outputs of the UUT under various line and load conditions and compares the measurements to either the nominal channel voltage settings, a set of "initial" saved measurements or the channel voltage saved by a previous run of this routine or one of the Voltage Regulation test routines.

14.2 Method

If "Save initial measurements" is enabled and the "Compare against saved relative values" comparison option is selected, after performing the "Delay before reading" the measurements are taken on each selected output. The measured values are saved and are used for comparisons on the measurements that follow. These saved measurements are not validated or logged.

The test continues by applying the first selected Input and Output vector to the tester hardware, delaying the "Delay before reading" value and measuring the outputs using the selected measurement vectors. The measured values are validated and logged. This sequence is repeated for every combination of the selected Input and Output vectors. Note: you do not need to make selections from each vector column. You may perform a simple Line or Load Regulation test by selecting only Input or Output vectors.

The standard algorithm applies the vectors in a simple top to bottom order. The first Output vector is reloaded at the end of the Input sequence in order to prevent overloading of the channel. The standard pattern used by the figure below is:

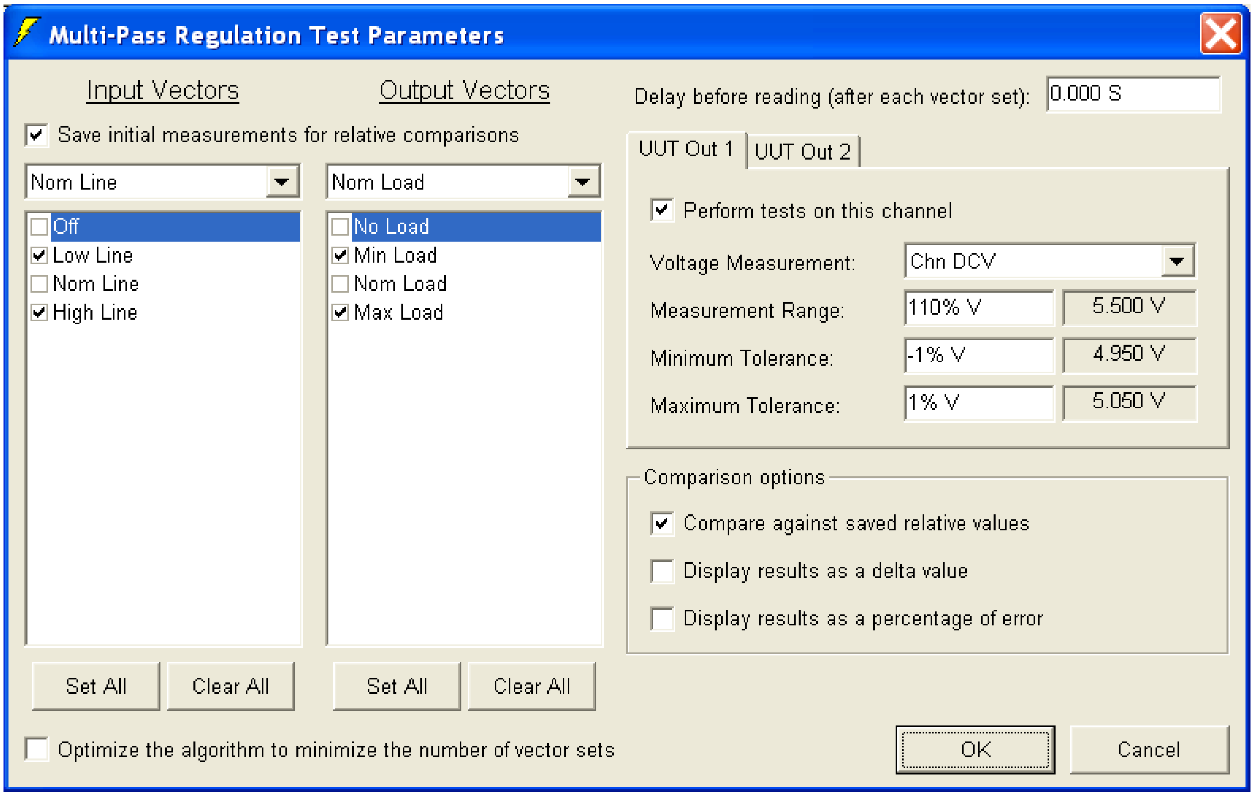
Low Line / Min Load
Low Line / Max Load
Low Line / Min Load ← This repeated setting is not logged the second time
High Line / Min Load
High Line / Max Load ← The test will end with these vectors active

The algorithm can be optimized to perform the least number of vector transitions. The pattern will sequence through each Input vector from top to bottom, while applying the Output vectors in an alternating top to bottom then bottom to top sequence. For example, the pattern used by the figure below is:

Low Line / Min Load
Low Line / Max Load
High Line / Max Load ← Note that only one vector is changed here (High Line)
High Line / Min Load ← The test will end with these vectors active

The results are not datalogged in this alternating pattern but in the more natural sequence of top to bottom of every combination regardless of the algorithm selection.

14.3 Test Routine Properties



- Save initial measurements for relative comparisons – check this box to apply the vectors selected in the drop down lists below and make a measurement for each output. The results of these measurements are saved, and used for relative comparisons if the “Compare against saved relative values” is selected.
- Input Vectors – place a check beside each Input vector you would like to use. Each selected Input vector is applied once with each selected Output vector during the test run.
- Output Vectors – place a check beside each Output vector you would like to use. Each selected Output vector is applied once with each selected Input vector during the test run.
- Optimize the algorithm to minimize the number of vector sets – sequence through each Input vector from top to bottom, while applying the Output vectors in an alternating top to bottom then bottom to top sequence. If this box is left unchecked, the Output vectors are applied top to bottom for each Input vector setting.
- Delay before reading (after each vector set) – the amount of time you allow the UUT to settle before beginning the measurements. Note that this delay happens at every vector change.
- Perform tests on this channel – check this box to take a measurement of this channel.
- Voltage Measurement – the measurement vector that will be used to take the measurement. Note that this must be a DMM-type voltage measurement vector.
- Measurement Range – this is the maximum expected measured value. The value may be entered either as a value or a percentage of a channel reference. The appropriate reference is

automatically selected based on the measurement vector entry. In the example above, the "UUT Out 1" Reference Voltage value will be used.

- Minimum Tolerance - this is the allowable lower limit of the measured value. Measured values less than this will cause the test routine to fail. The value may be entered either as a value or a percentage of a channel reference.
- Maximum Tolerance - this is the allowable upper limit of the measured value. Measured values greater than this will cause the test routine to fail. The value may be entered either as a value or a percentage of a channel reference.
- Compare against saved relative values – check this box to have the routine use a previously saved value instead of the reference value for measurement comparisons. Note that an error is logged if a measurement for this channel has not been previously saved. In that case, the test will continue using the reference value. The saved values can come from the "initial measurements" of this routine, or a previous run of this test routine or any of the Voltage Regulation test routines.
- Display results as a delta value – check this box to have the routine display the results as the difference of these measurements from the nominal voltage or the previously saved measured values, which ever is appropriate.
- Display results as a percentage of error – check this box to have the routine display the results as the percentage difference of these measurements from the nominal voltage or the previously saved measured values, which ever is appropriate.

14.4 Sequence

The load, source, digital and analog vectors defined by the program are applied to the tester hardware before the test routine sequence is initiated.

1) If "initial" values are being saved:
    a) Set the initial Input and Output vectors
    b) Wait the delay before reading time
    c) Perform the measurements
    d) Save the results for later use
2) For each selected Input Vector:
    a) Apply the Input vector
    b) For each selected Output Vector:
        i) Apply the Output Vector
        ii) Wait the delay before reading time
        iii) For each configured measurement:
            (1) Perform the measurement
            (2) Evaluate and log the result
            (3) Check for faults and log them as necessary

15. MULTI-TRANSIENT RESPONSE TEST

15.1 Description

This test routine will check the transient response of the UUT. The outputs will be subjected to a current change and voltage undershoot and overshoot will be measured. The output voltages may also be checked for proper settling after the transient has occurred.

A graphical image of the transients can be created and logged with the test results and Quality Monitor data can be collected on each measurement.

Unlike the standard Transient Response test routine, this routine uses the load devices connected to each UUT output to perform the measurements instead of a dedicated transient analyzer (TA). It is important to understand the differences:

- Each measurement is DC-coupled to the load, not AC-coupled like a TA.
- If the output voltage is near the limit of a range, it is possible to over-range the measurement circuitry when the Overshoot is performed. Ensure the selected Voltage Range is sufficient to handle the expected transient.
- As the Voltage Range increases, the measurement resolution decreases.
- The measurements are digitized. As the measurement aperture increases, the measurement Sample Rate decreases.

NOTE: This routine requires that a Model 4200 or 4700 Series DC Load be connected to each output under test.

15.2 Method

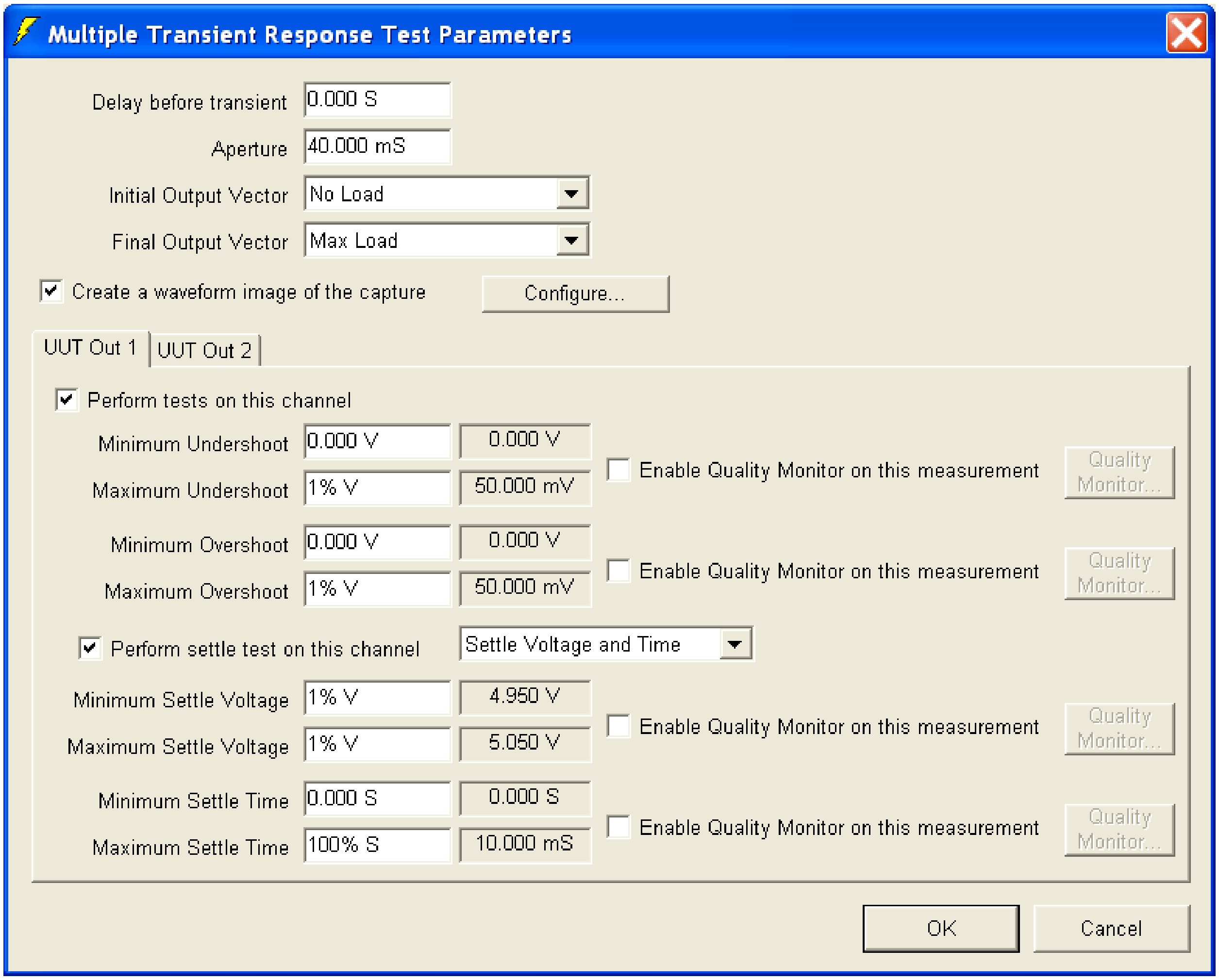
The test begins by setting the “Initial Output Vector”. The entire vector is applied, so you can use this vector to setup the tester prior to beginning the test sequence. This vector will program the voltage and current ranges of each output, as well as advanced properties such as slew rates, that will be active during the transient.

Utilizing the macro capability of the loads, a transient is programmed using the Current values from the “Final Output Vector” and “Initial Output Vector” selections. A macro is programmed for all outputs defined in the test program regardless of the state of the “Perform tests on this channel” selection. When the test is run the macro program of each output is executed synchronously and all channels are tested simultaneously.

Since all the outputs are programmed to transition regardless of the state of the “Perform tests on this channel” selection, you can suppress the transition of an output by programming the corresponding Current values of the “Initial” and “Final” vectors to the same value.

At the conclusion of this test, the outputs will be at the “Initial Output Vector” state.

15.3 Test Routine Properties

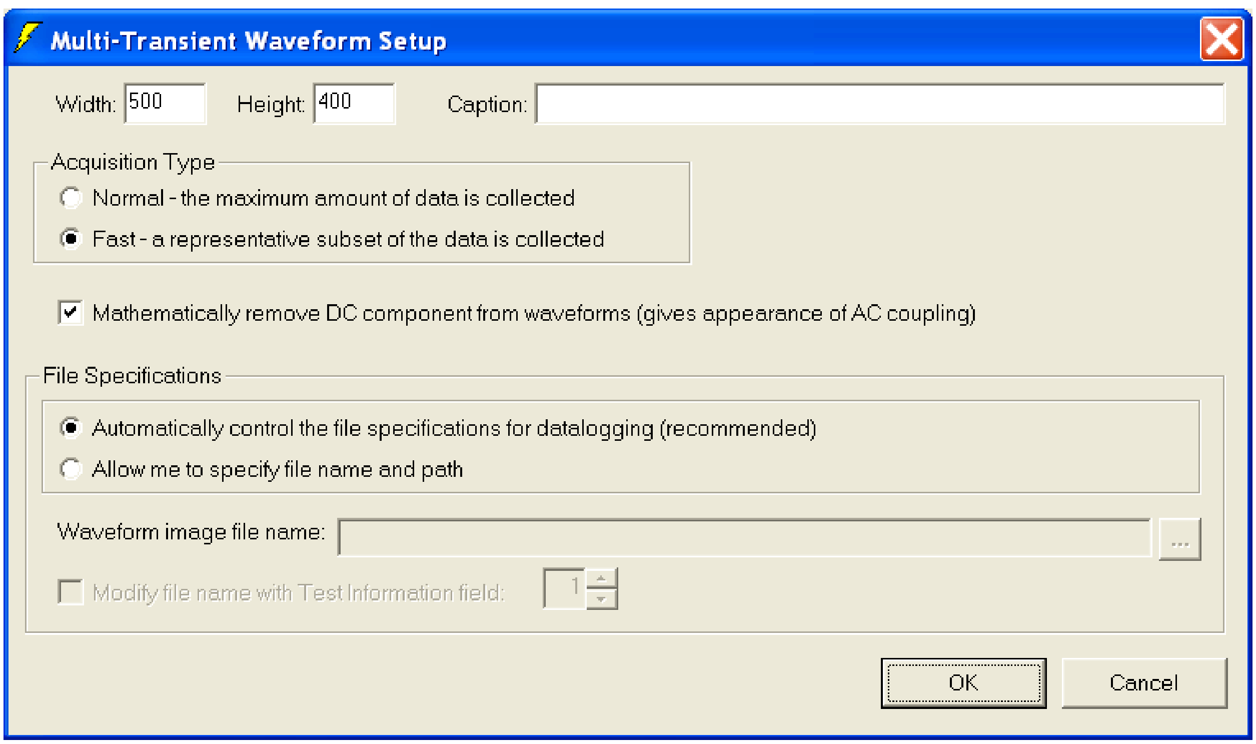


- Delay before transient – this delay occurs at the beginning of the test sequence before any other steps.
- Aperture – each output will capture data for this long beginning when the transient is applied. The undershoot occurs at the beginning of the aperture and the overshoot is programmed half way through this time. Make this time window large enough to capture the entire event, as required.
- Initial Output Vector – this output vector is applied before the transient is programmed. In addition, the Current settings from the vector are extracted and used to create the overshoot portion of the transient.
- Final Output Vector – the Current settings from this vector are extracted and used to create the undershoot portion of the transient. Note that the Final Output Vector currents must be greater than the Initial Output Vector currents.
- Create a waveform image of the capture – check this box to have the test generate an image of the transients and log it as part of the test data. Press the “Configure” button to customize the waveform image. If this box is cleared no image will be created.

- Configure – Press this button to customize the waveform image. See the following section.
- Perform tests on this channel – check this box to enable measurement collection on this channel.
- Minimum Undershoot – this is the allowable lower limit of the measured undershoot value. Measured values less than this will cause the test routine to fail. The value may be entered either as a value or a percentage of nominal channel voltage.
- Maximum Undershoot – this is the allowable upper limit of the measured undershoot value. Measured values greater than this will cause the test routine to fail. The value may be entered either as a value or a percentage of nominal channel voltage.
- Collect Quality Monitor data on this measurement – check this box to enable Quality Monitor data collection on the undershoot measurement.
- Quality Monitor… – press this button to display the Quality Monitor properties. Please refer to the Quality Monitor reference manual for further details.
- Minimum Overshoot – this is the allowable lower limit of the measured overshoot value. Measured values less than this will cause the test routine to fail. The value may be entered either as a value or a percentage of nominal channel voltage.
- Maximum Overshoot – this is the allowable upper limit of the measured overshoot value. Measured values greater than this will cause the test routine to fail. The value may be entered either as a value or a percentage of nominal channel voltage.
- Enable Quality Monitor on this measurement – check this box to enable Quality Monitor data collection on the overshoot measurement.
- Quality Monitor… – press this button to display the Quality Monitor properties. Please refer to the Quality Monitor reference manual for further details.
- Perform settle test on this channel – check this entry to enable settle testing on the output. Select the type of settle test to perform (Settle Voltage, Settle Time or both) from the list next to the check box.
    - “Settle Voltage” is defined as the average DCV sampled during the last 10% of the measurement aperture.
    - “Settle Time” is the amount of time it takes for the output voltage to return to the window defined by the Minimum and Maximum Overshoot values after the overshoot setting has been applied. If the overshoot never leaves this window, the settle time is reported as the amount of time it takes for the output voltage to return to the window defined by the Minimum and Maximum Undershoot values after the undershoot setting has been applied.
- Minimum Settle Voltage – this is the allowable lower limit of the measured settle value. Measured values less than this will cause the test routine to fail. The value may be entered either as a value or a percentage of nominal channel voltage.
- Maximum Settle Voltage – this is the allowable upper limit of the measured settle value. Measured values greater than this will cause the test routine to fail. The value may be entered either as a value or a percentage of nominal channel voltage.

- Collect Quality Monitor data on this measurement – check this box to enable Quality Monitor data collection on the settle voltage measurement.
- Quality Monitor… – press this button to display the Quality Monitor properties. Please refer to the Quality Monitor reference manual for further details.
- Minimum Settle Time – this is the allowable lower limit of the measured settle time. Measured values less than this will cause the test routine to fail. The value may be entered either as a value or a percentage of channel reference time.
- Maximum Settle Time – this is the allowable upper limit of the measured settle time. Measured values greater than this will cause the test routine to fail. The value may be entered either as a value or a percentage of channel reference time.
- Collect Quality Monitor data on this measurement – check this box to enable Quality Monitor data collection on the settle time measurement.
- Quality Monitor… – press this button to display the Quality Monitor properties. Please refer to the Quality Monitor reference manual for further details.

15.4 Waveform Properties



- Width – specifies the width of the image.
- Height – specifies the height of the image.
- Caption –this text is used to describe the image.
- Acquisition Type – when you select “Normal”, every data point gathered by the measurement hardware is downloaded and used to generate the image; “Fast” will download

128 data points, gathered evenly from throughout the aperture. Selecting “Fast” does not affect the quality of the measurements.

- Mathematically remove DC component from the waveform – since the measurements collected during this test are all DC coupled, you can select this option to have the waveform image offset the data to remove the DC voltage (as measured by the Settle Voltage). This gives the data the appearance of an AC coupled waveform, magnifying the transient portion of the image.
- File Specifications – These selection buttons determine whether the image file generated during this test is managed automatically or if you will choose the file and path.
  - Automatically control the file specifications for datalogging (recommended) – this selection determines whether the image file generated during this test is managed automatically.
  - Allow me to specify file name and path – choose this option if you want to manually select the filename and path for the image file.
  - Waveform image file name – if you chose to manually control the filename enter the specification here.
  - Modify file name with Test Information field – When enabled, a field from the Test Information Entry form will be appended to the user entered file name. The Test Information Entry form appears before running the test on each UUT and is typically filled in by the test operator. Appending an information field provides a method of tracking specific waveform images to a particular UUT serial number or test pass. The number selection box determines which of the input fields from the Test Information Entry form will be appended to the file name.

15.5 Sequence

The load, source, digital and analog vectors defined by the program are applied to the tester hardware before the test routine sequence is initiated.

1) Delay the “Delay before Transient” time
2) Apply the “Initial Output Vector”
3) Delay half the “Aperture” time to allow the vector to settle
4) For each UUT output:
   a) Create a transient macro using the Current values from the “Final” and “Initial” vectors
   b) If the test is being performed on the output, setup and arm the load measurement to capture the transient.
5) Issue a system trigger to cause each output to simultaneously begin both the transient macro and the measurement aperture.
6) Gather the measurements, evaluate and log the results
7) Create and log the waveform image, if required
8) Check for faults and log them as necessary

16. OVER CURRENT TEST

16.1 Description

The Over Current test routine provides the user with a method to ramp UUT Output loads while monitoring a group of DMM-type measurements. The test routine can be configured to ensure a UUT is functional at the extreme limits of specifications or to determine the overload point of any or all defined UUT outputs.

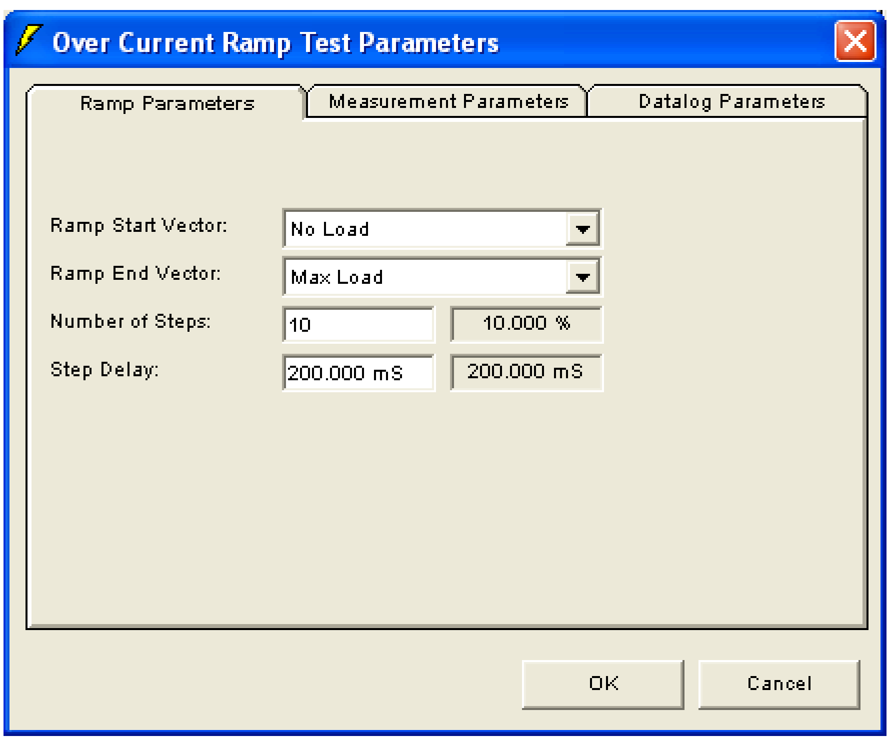
16.2 Method

The ramp is defined by entering the desired UUT Output vectors into the Ramp Parameters fields. For each ramp step, all the UUT Output containers defined in the test program are simultaneously stepped to a new ramp value. After a step delay the measurements defined by the Measurement Parameters fields are taken.

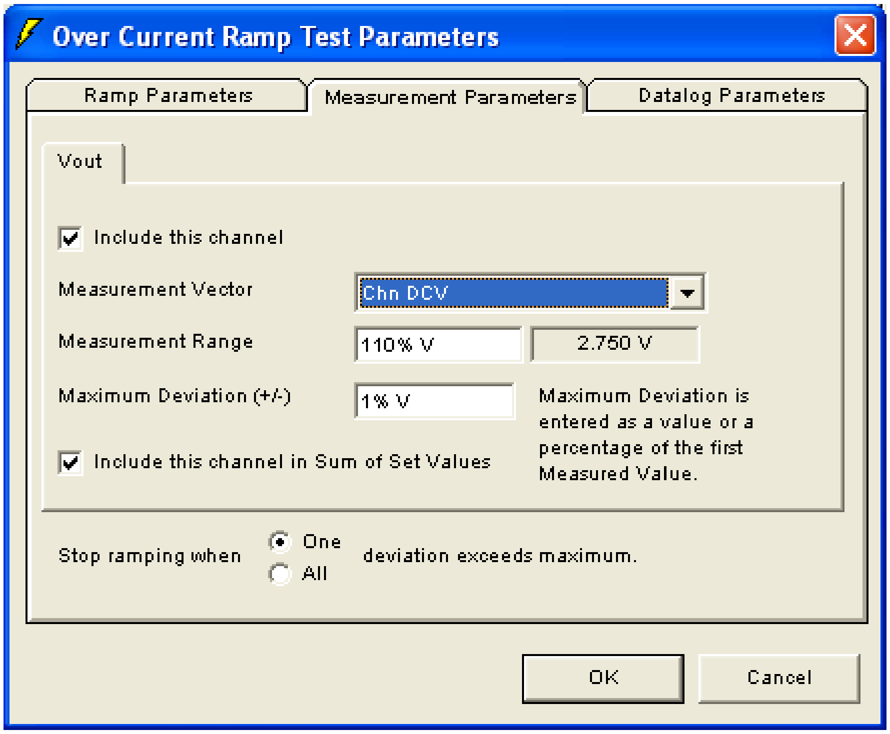
The combination of stepping the ramp and taking a measurement is performed until the ramp is stopped. You can choose to stop the ramp if one or all measurements exceed a deviation limit. If one or all of the measurements never exceed the deviation limits the ramp will run to completion. This occurrence can be flagged as an error if desired.

Once the ramp has been stopped or run to completion, the results are datalogged according to the selections in the Datalog Parameters fields. UUT outputs may to be ramped to a failure point but options are available to datalog the immediately preceding ramp set points and measurements.

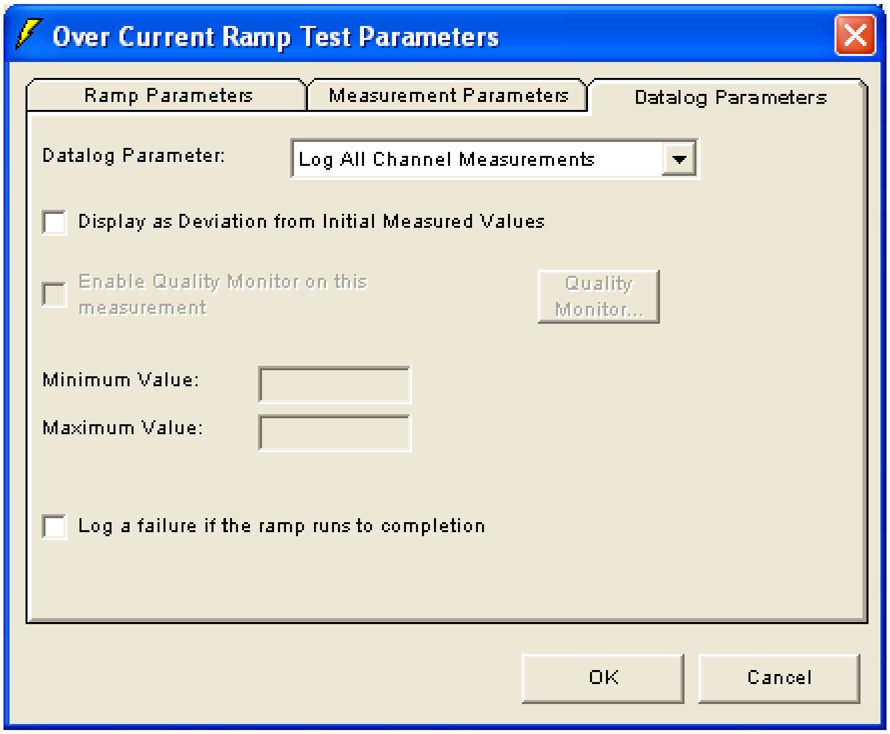
16.3 Test Routine Properties



- Ramp Start Vector– the initial value of the ramp parameter.
- Ramp End Vector– the final value of the ramp parameter.
- Number of Steps – the number of steps to take when ramping from the start value to the end value. This also indicates the number of measurements taken during the test.
- Step Delay – this delay will be applied between each of the ramp steps.



- Include this channel – check this box to take a measurement of this channel. These selections WILL NOT affect the ramp set values. All UUT Output Containers will be ramped synchronously at each step in this test routine.
- Measurement Vector – the measurement vector that will be used to take the measurement.
- Measurement Range – this is the maximum expected measured value. The value may be entered either as a value or a percentage of a channel reference.
- Maximum Deviation - this is the allowable limit of the measured value. Measured values exceeding this deviation may cause the test routine to stop ramping. The value may be entered either as a value or a percentage of the first measured value (measured at run-time).
- Include this channel in Sum of Set Values – check this box if using 'Sum of Set Values' Datalog Parameter and this channel is to be included in the set.
- Stop ramping when One or All deviation exceeds maximum – select One or All to control when the ramp is stopped.



- Datalog Parameter – select the measurements or ramp values you wish to datalog.

  Log All Channel Measurements – all enabled measurement channels are logged. The last measurements taken are logged.

  Log All Previous Channel Measurements– all enabled measurement channels are logged. The previous measurements (prior ramp step) are logged.

  Sum of Channel Measurements– all enabled measurement channels are summed and logged. The last measurements taken are included in the sum.

  Sum of Previous Channel Measurements– all enabled measurement channels are summed and logged. The previous measurements (prior ramp step) taken are included in the sum.

  Sum of Set Values– all enabled measurement channels selected for inclusion in the set are summed and logged. The last set values are included in the sum.

  Sum of Previous Set Values– all enabled measurement channels selected for inclusion in the set are summed and logged. The previous set values (prior ramp step) are included in the sum.

- Display as Deviation from Initial Measured Values – check this box to log the deviation from the initial measured value rather than the measured value.
- Collect Quality Monitor data on this measurement – check this box to enable Quality Monitor data collection.
- Quality Monitor… – press this button to display the Quality Monitor properties. Please refer to the Quality Monitor reference manual for further details.
- Minimum Value - this is the allowable lower limit of the measured value. Measured values less than this will cause the test routine to fail.

- Maximum Value - this is the allowable upper limit of the measured value. Measured values greater than this will cause the test routine to fail.
- Log a failure if the ramp runs to completion – check this box to log a failure if the ramp runs to completion.

16.4 Sequence

The load, source, digital and analog vectors defined by the program are applied to the tester hardware before the test routine sequence is initiated.

1) Initialize the ramp:
    a) Calculate ramp control parameters
2) Start the ramp:
    a) Take an initial measurement
3) For each ramp step:
    a) Calculate new set value
    b) Take the measurement
    c) Evaluate the results to determine whether to continue ramping
4) Datalog the results
5) Validate ramp and log results if necessary
6) Check for faults and log them as necessary

17. OVER CURRENT (HIGH PRECISION) TEST

17.1 Description

The High Precision Over Current test routine provides the user with a method to slew UUT Output loads at a controlled rate of change to determine the overload point of any or all defined UUT outputs. The resolution of the reported current is based on the sample rate of the load connected to the output channel, not a coarse step size as reported in a ramping routine. An optional waveform image can be datalogged.

NOTE: This routine requires that a Model 4200 or 4700 Series DC Load be connected to each output under test.

17.2 Method

A starting current value is set to each output being tested. Each output is then programmed to slew to the ending current value when the system trigger is issued. While the load is slewing, the output voltage is monitored for the overload point.

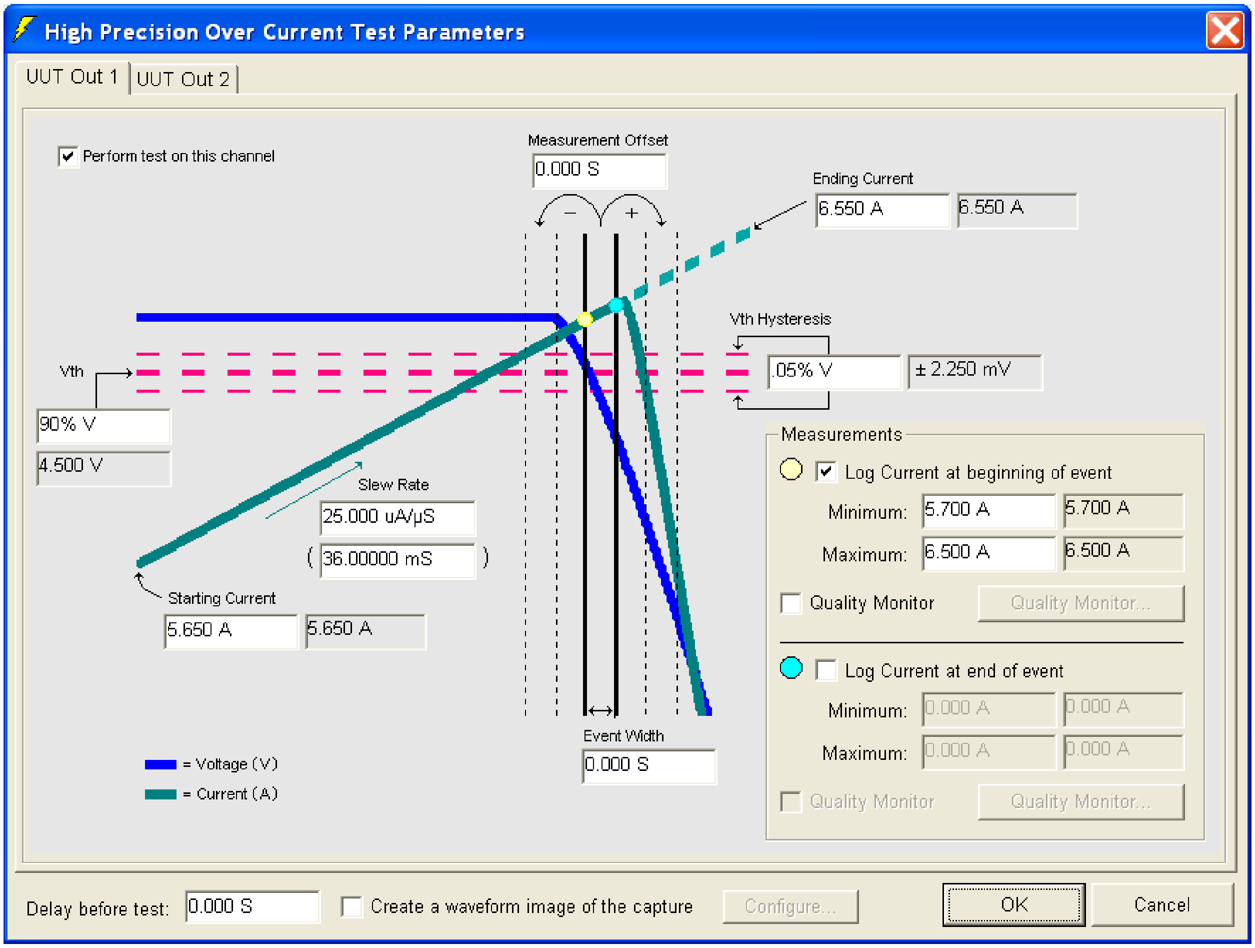
The overload point is defined as being the time when the output voltage drops below the voltage threshold level. You can define a hysteresis value around the voltage threshold and specify that the output must remain below this threshold window for a minimum amount of time (called the “event width”). Using the combination of hysteresis and event width you can account for any noise or “hiccup” in the output voltage and define the true overload point.

Once the slew has completed, the load is queried for the current that caused the overload point and that value is datalogged. If you defined an event width greater than zero you can also datalog the current that occurred at the end of the event window.

If desired, you can also have the load return overload values offset in time from when the load detected the event. For example, if your UUT shuts off 10mS after detecting the overload, you can enter a -10mS “measurement offset” and instruct the load to return the current values in effect 10mS before the detected event.

The test routine will slew each enabled load simultaneously. You'll get “invalid” measurements if the voltage doesn't drop below the threshold for the “event” time within the slew time for each enabled load. The waveform image, if logged, will contain both the current and voltage waveforms of each output. Threshold bars are drawn on the image in the same color as the corresponding waveform.

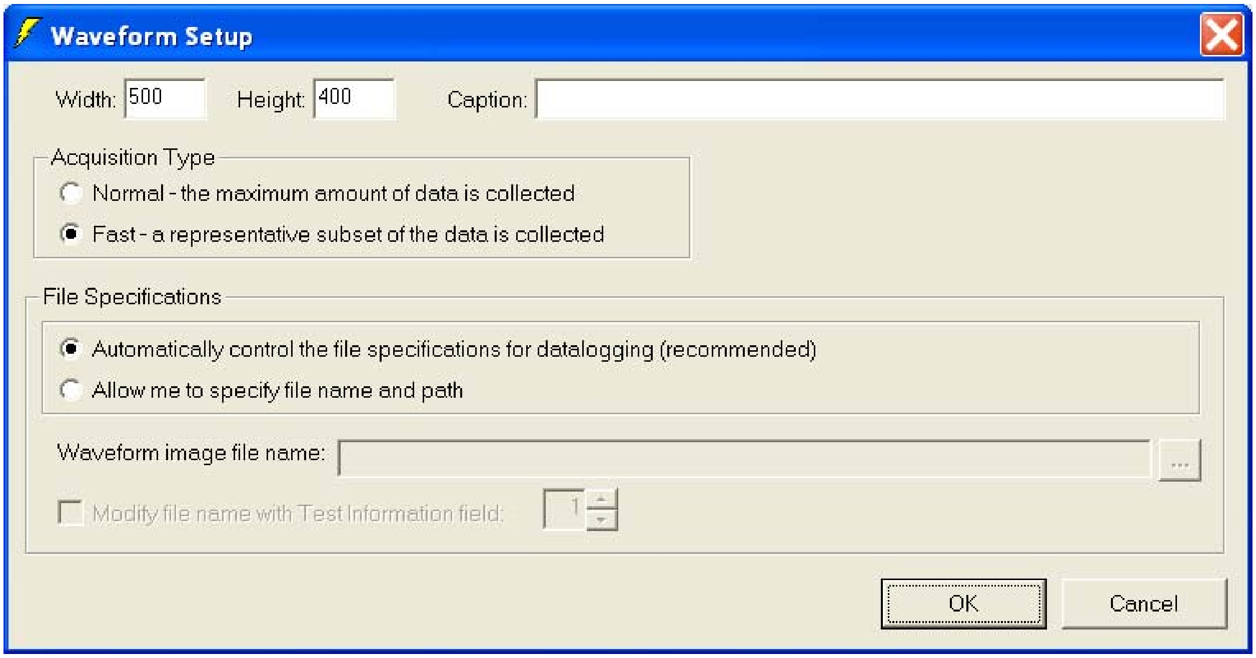
17.3 Test Routine Properties



- Perform test on this channel – check this box to perform the Over Current test on this channel. The channel must have a Model 42xx load connected to it. All enabled channels will be tested synchronously.
- Starting Current – the load will slew from this value to the Ending Current value. The value may be entered either as a value or a percentage of the channel reference Current.
- Ending Current – the load will slew from the Starting Current value to this value. The value may be entered either as a value or a percentage of the channel reference Current.
- Slew Rate – the rate at which the load will change from the Starting to the Ending value. The amount of time required to make this change is displayed within the parenthesis below. You can also control the slew rate by entering a value in the elapsed time field – the corresponding slew rate will be automatically calculated.
- Vth – the output channel must drop below this threshold value (including hysteresis, below) before it is considered overloaded. The value may be entered either as a value or a percentage of the channel reference Voltage.
- Vth Hysteresis – this value allows you to program a “window” around the threshold to account for any noise in the signal. If you program the hysteresis value using a percentage (e.g., “1.0 %”), the value is the percentage of the Vth value, not the channel reference.

- Event Width – when the output channel has stayed below the Vth and hysteresis for this amount of time the channel is overloaded. If the channel "bounces" above the hysteresis window before the event width has expired the channel is not overloaded. The measurements will be referenced to this time.
- Measurement Offset – use this value to have the routine report values offset from the event time. A negative value will go back through the aperture and report values before the Event window; a positive value will go forward through the aperture and report values after the Event window.
- Measurements – the test returns the current measured at the beginning of the event window and/or the end of the event window (offset as appropriate).
    - Log Current at beginning of event
        - Minimum – this is the allowable lower limit of the measured value. Measured values less than this will cause the measurement to fail. The value may be entered either as a value or a percentage of channel reference.
        - Maximum – this is the allowable upper limit of the measured value. Measured values greater than this will cause the measurement to fail. The value may be entered either as a value or a percentage of channel reference.
        - Quality Monitor – check this box to enable Quality Monitor data collection.
        - Quality Monitor… – press this button to display the Quality Monitor properties. Please refer to the Quality Monitor reference manual for further details.
    - Log Current at end of event
        - Minimum – this is the allowable lower limit of the measured value. Measured values less than this will cause the measurement to fail. The value may be entered either as a value or a percentage of channel reference.
        - Maximum – this is the allowable upper limit of the measured value. Measured values greater than this will cause the measurement to fail. The value may be entered either as a value or a percentage of channel reference.
        - Quality Monitor – check this box to enable Quality Monitor data collection.
        - Quality Monitor… – press this button to display the Quality Monitor properties. Please refer to the Quality Monitor reference manual for further details.
    - Delay before test – the amount of time you allow the UUT to settle before beginning the procedure. Note that this delay happens once at the beginning of the routine.
    - Create a waveform image of the capture – check this box to have the test generate an image of the over-current and log it as part of the test data. Press the "Configure" button to customize the waveform image. If this box is cleared no image will be created.
    - Configure – Press this button to customize the waveform image. See the following section.

17.4 Waveform Properties



- Width – specifies the width of the image.
- Height – specifies the height of the image.
- Caption –this text is used to describe the image.
- Acquisition Type – when you select “Normal”, every data point gathered by the measurement hardware is downloaded and used to generate the image; “Fast” will download 128 data points, gathered evenly from throughout the aperture. Selecting “Fast” does not affect the quality of the measurements.
- File Specifications – These selection buttons determine whether the image file generated during this test is managed automatically or if you will choose the file and path.
  - Automatically control the file specifications for datalogging (recommended) – this selection determines whether the image file generated during this test is managed automatically.
  - Allow me to specify file name and path – choose this option if you want to manually select the filename and path for the image file.
  - Waveform image file name – if you chose to manually control the filename enter the specification here.
  - Modify file name with Test Information field – When enabled, a field from the Test Information Entry form will be appended to the user entered file name. The Test Information Entry form appears before running the test on each UUT and is typically filled in by the test operator. Appending an information field provides a method of tracking specific waveform images to a particular UUT serial number or test pass. The number selection box determines which of the input fields from the Test Information Entry form will be appended to the file name.

17.5 Sequence

The load, source, digital and analog vectors defined by the program are applied to the tester hardware before the test routine sequence is initiated.

1) Delay before beginning the test
2) For each output in use:
    a) Set starting current. This value slews at the rate specified in the vector applied before the test program starts.
    b) Program the slew rate and measurement aperture
    c) Program the load to perform a triggered set to the ending current and a triggered measurement
3) Issue a system trigger and wait until the loads have finished capturing data
4) Fetch the measurements and waveform data, if applicable
5) Datalog the results
6) Check for faults and log them as necessary

18. OVER POWER (HIGH PRECISION) TEST

18.1 Description

The High Precision Over Power test routine provides the user with a method to slew UUT Output loads at a controlled rate of change to determine the overload point of any or all defined UUT outputs. The resolution of the reported power is based on the sample rate of the load connected to the output channel, not a coarse step size as reported in a ramping routine. An optional waveform image can be datalogged.

NOTE: This routine requires that a Model 4200 or 4700 Series DC Load be connected to each output under test.

18.2 Method

A starting current value is set to each output being tested. Each output is then programmed to slew to the ending current value when the system trigger is issued. While the load is slewing, the output voltage is monitored for the overload point.

The overload point is defined as being the time when the output voltage drops below the voltage threshold level. You can define a hysteresis value around the voltage threshold and specify that the output must remain below this threshold window for a minimum amount of time (called the “event width”). Using the combination of hysteresis and event width you can account for any noise or “hiccup” in the output voltage and define the true overload point.

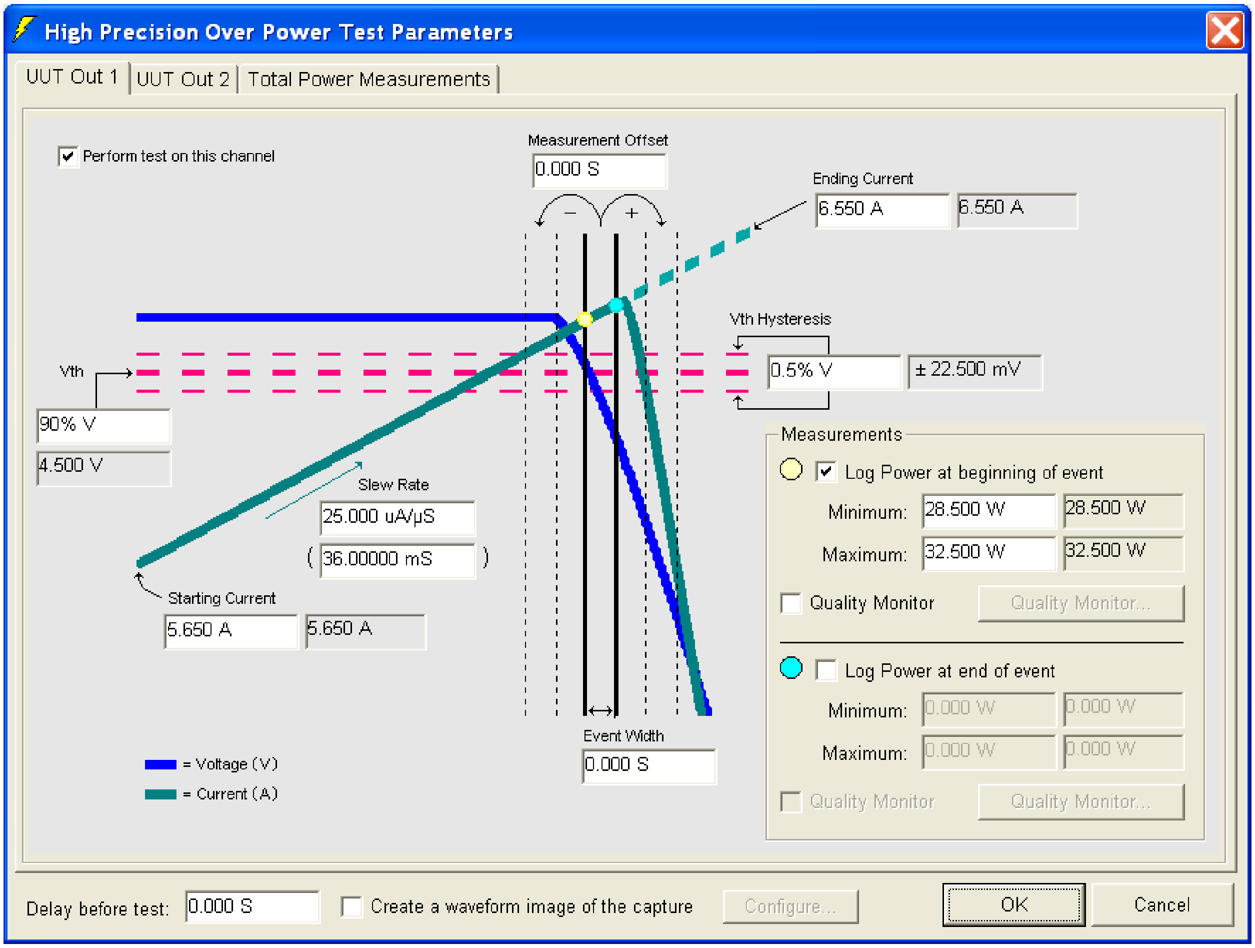
Once the slew has completed, the load is queried for the power that caused the overload point and that value is datalogged. If you defined an event width greater than zero you can also datalog the power that occurred at the end of the event window.

If desired, you can also have the load return overload values offset in time from when the load detected the event. For example, if your UUT shuts off 10mS after detecting the overload, you can enter a -10mS “measurement offset” and instruct the load to return the power values in effect 10mS before the detected event.

The test routine will slew each enabled load simultaneously. You can program a zero-change slew (where the start and end currents are the same) if the channel will collapse due to the change on the other channels. You'll get “invalid” measurements if the voltage doesn't drop below the threshold for the “event” time within the slew time for each enabled load.

The waveform image, if logged, will contain both the current and voltage waveforms of each output. Threshold bars are drawn on the image in the same color as the corresponding waveform.

18.3 Test Routine Properties

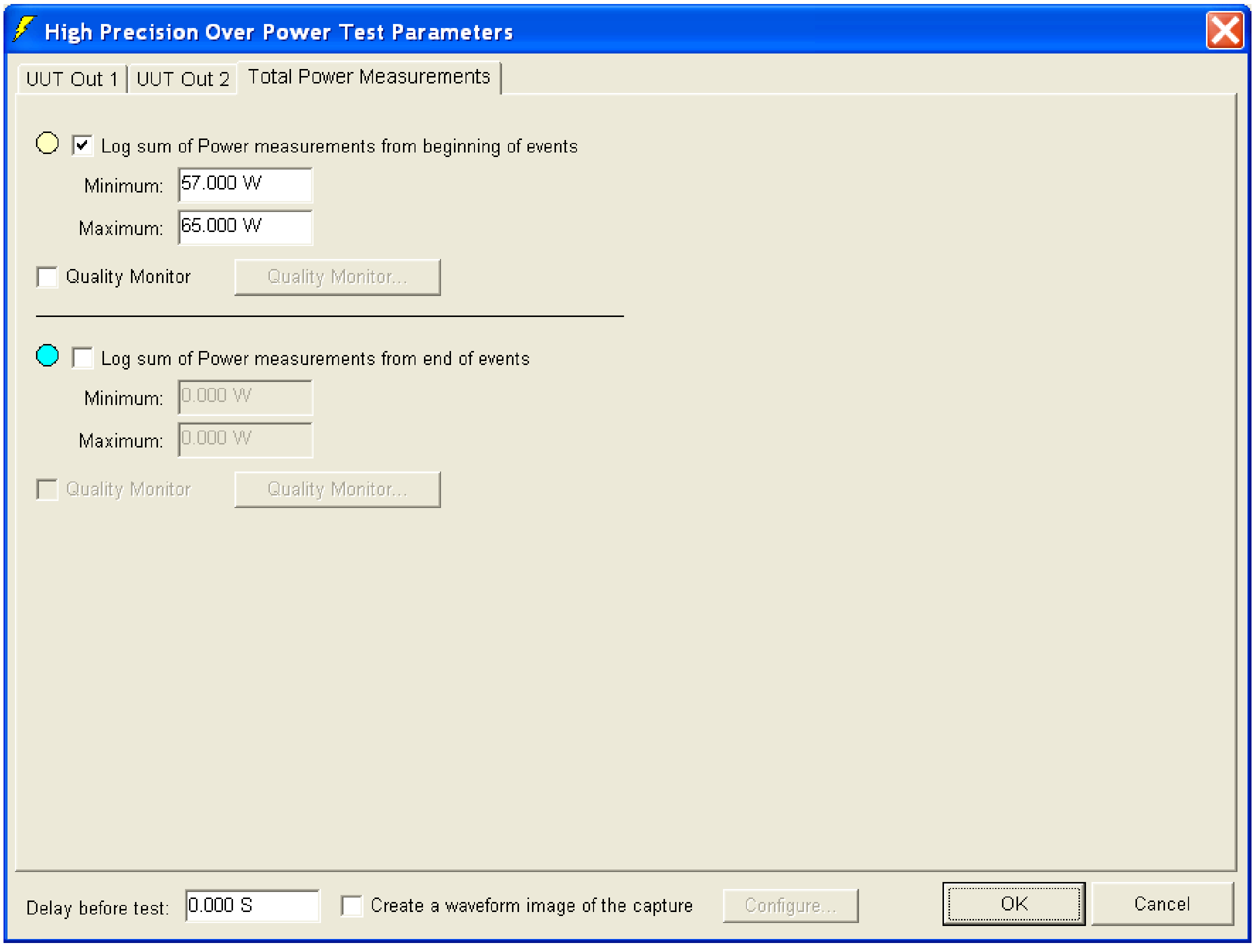


- Perform test on this channel – check this box to perform the Over Power test on this channel. The channel must have a Model 42xx load connected to it. All enabled channels will be tested synchronously.
- Starting Current – the load will slew from this value to the Ending Current value. The value may be entered either as a value or a percentage of the channel reference Current.
- Ending Current – the load will slew from the Starting Current value to this value. The value may be entered either as a value or a percentage of the channel reference Current.
- Slew Rate – the rate at which the load will change from the Starting to the Ending value. The amount of time required to make this change is displayed within the parenthesis below. You can also control the slew rate by entering a value in the elapsed time field – the corresponding slew rate will be automatically calculated.
- Vth – the output channel must drop below this threshold value (including hysteresis, below) before it is considered overloaded. The value may be entered either as a value or a percentage of the channel reference Voltage.
- Vth Hysteresis – this value allows you to program a “window” around the threshold to account for any noise in the signal. If you program the hysteresis value using a percentage (e.g., “1.0 %”), the value is the percentage of the Vth value, not the channel reference.

- Event Width – when the output channel has stayed below the Vth and hysteresis for this amount of time the channel is overloaded. If the channel "bounces" above the hysteresis window before the event width has expired the channel is not overloaded. The measurements will be referenced to this time.
- Measurement Offset – use this value to have the routine report values offset from the event time. A negative value will go back through the aperture and report values before the Event window; a positive value will go forward through the aperture and report values after the Event window.
- Measurements – the test returns the power measured at the beginning of the event window and/or the end of the event window (offset as appropriate).
    - Log Power at beginning of event
        - Minimum – this is the allowable lower limit of the measured value. Measured values less than this will cause the measurement to fail. The value may be entered either as a value or a percentage of channel reference.
        - Maximum – this is the allowable upper limit of the measured value. Measured values greater than this will cause the measurement to fail. The value may be entered either as a value or a percentage of channel reference.
        - Quality Monitor – check this box to enable Quality Monitor data collection.
        - Quality Monitor… – press this button to display the Quality Monitor properties. Please refer to the Quality Monitor reference manual for further details.
    - Log Power at end of event
        - Minimum – this is the allowable lower limit of the measured value. Measured values less than this will cause the measurement to fail. The value may be entered either as a value or a percentage of channel reference.
        - Maximum – this is the allowable upper limit of the measured value. Measured values greater than this will cause the measurement to fail. The value may be entered either as a value or a percentage of channel reference.
        - Quality Monitor – check this box to enable Quality Monitor data collection.
        - Quality Monitor… – press this button to display the Quality Monitor properties. Please refer to the Quality Monitor reference manual for further details.
    - Delay before test – the amount of time you allow the UUT to settle before beginning the procedure. Note that this delay happens once at the beginning of the routine.
    - Create a waveform image of the capture – check this box to have the test generate an image of the over-power and log it as part of the test data. Press the "Configure" button to customize the waveform image. If this box is cleared no image will be created.
    - Configure – Press this button to customize the waveform image. See the following section.

18.4 Total Power Measurements Properties

The final tab allows you to datalog the sum of all the individual power measurements as a “total” power. You can log the sum of the measurements collected at the beginning of the event windows, the sum of the measurements collected at the end of the event window, or both.

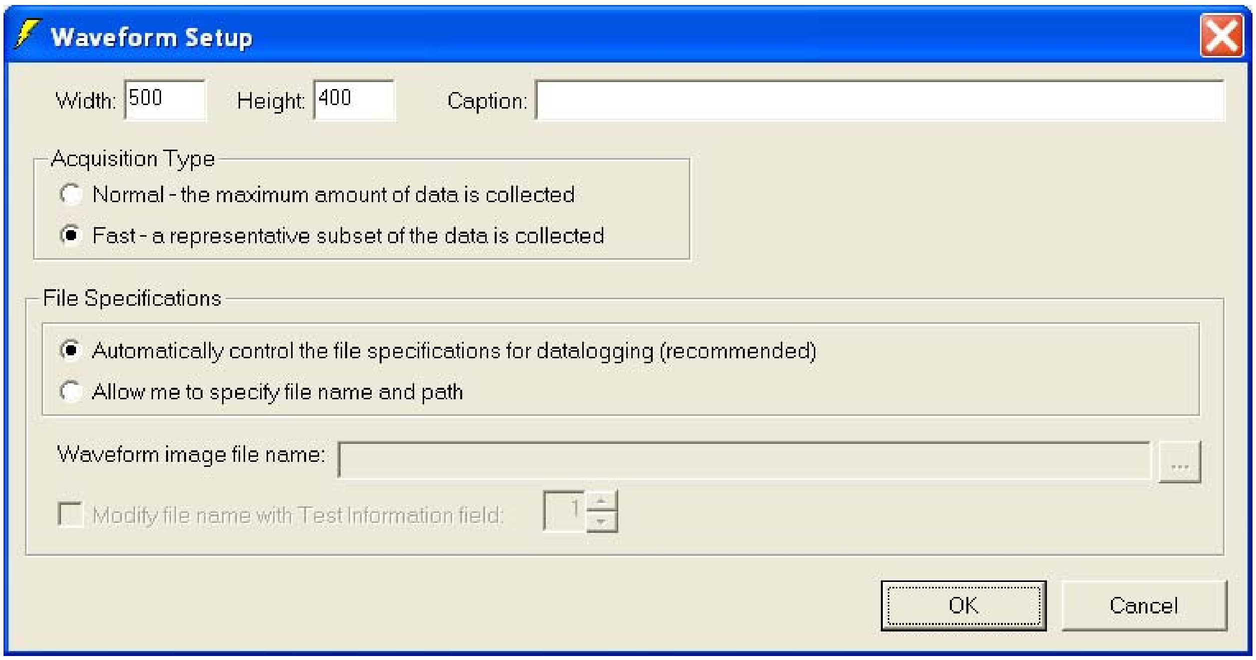


- Log sum of Power measurements from beginning of events
  - Minimum – this is the allowable lower limit of the measured value. Measured values less than this will cause the measurement to fail. The value may be entered either as a value or a percentage of channel reference.
  - Maximum – this is the allowable upper limit of the measured value. Measured values greater than this will cause the measurement to fail. The value may be entered either as a value or a percentage of channel reference.
  - Quality Monitor – check this box to enable Quality Monitor data collection.
  - Quality Monitor… – press this button to display the Quality Monitor properties. Please refer to the Quality Monitor reference manual for further details.
- Log sum of Power measurements from end of events

- Minimum – this is the allowable lower limit of the measured value. Measured values less than this will cause the measurement to fail. The value may be entered either as a value or a percentage of channel reference.
- Maximum – this is the allowable upper limit of the measured value. Measured values greater than this will cause the measurement to fail. The value may be entered either as a value or a percentage of channel reference.
- Quality Monitor – check this box to enable Quality Monitor data collection.
- Quality Monitor… – press this button to display the Quality Monitor properties. Please refer to the Quality Monitor reference manual for further details.

The “Delay before test” and “Create a waveform image of the capture” options are discussed in the previous section.

18.5 Waveform Properties



- Width – specifies the width of the image.
- Height – specifies the height of the image.
- Caption –this text is used to describe the image.
- Acquisition Type – when you select “Normal”, every data point gathered by the measurement hardware is downloaded and used to generate the image; “Fast” will download 128 data points, gathered evenly from throughout the aperture. Selecting “Fast” does not affect the quality of the measurements.
- File Specifications – These selection buttons determine whether the image file generated during this test is managed automatically or if you will choose the file and path.

- Automatically control the file specifications for datalogging (recommended) – this selection determines whether the image file generated during this test is managed automatically.
- Allow me to specify file name and path – choose this option if you want to manually select the filename and path for the image file.
- Waveform image file name – if you chose to manually control the filename enter the specification here.
- Modify file name with Test Information field – When enabled, a field from the Test Information Entry form will be appended to the user entered file name. The Test Information Entry form appears before running the test on each UUT and is typically filled in by the test operator. Appending an information field provides a method of tracking specific waveform images to a particular UUT serial number or test pass. The number selection box determines which of the input fields from the Test Information Entry form will be appended to the file name.

18.6 Sequence

The load, source, digital and analog vectors defined by the program are applied to the tester hardware before the test routine sequence is initiated.

1) Delay before beginning the test
2) For each output in use:
   a) Set starting current. This value slews at the rate specified in the vector applied before the test program starts.
   b) Program the slew rate and measurement aperture
   c) Program the load to perform a triggered set to the ending current and a triggered measurement
3) Issue a system trigger and wait until the loads have finished capturing data
4) Fetch the measurements and waveform data, if applicable
5) Datalog the results
6) Check for faults and log them as necessary

19. OVER VOLTAGE (HIGH PRECISION) TEST

19.1 Description

The High Precision Over Voltage test routine provides the user with a choice of four different methods to test the over-voltage protection circuitry of the UUT. The methods include a Crowbar test, a Latching test, an Input Current test and a Digital State test. Each method (except the Latching) slews an OVPS at a controlled rate of change to determine the over-voltage point of the selected UUT output. The resolution of the reported voltage is based on the sample rate of the load connected to the output channel, not a coarse step size as reported in a ramping routine. The Latching method emulates a ramping routine where the OVPS is returned to zero volts between each voltage step. An optional waveform image can be datalogged.

NOTE: This routine requires that a Model 4200 or 4700 Series DC Load be connected to each output under test, and that a Model 6100 Series DC Source be used as the OVPS.

19.2 Method

As the test differs slightly for each method, they will be discussed individually in the following sections.

19.2.1 Crowbar Method

Use this method if your UUT will crowbar the output when the over-voltage condition occurs, collapsing the OVPS voltage as well as the UUT output.

A starting voltage value is programmed to the OVPS and the OVPS relay of the selected output is closed. The OVPS is then programmed to slew to the ending voltage value when the system trigger is issued. While the source is slewing, the output voltage is monitored for the overload point.

The overload point is defined as being the time when the output voltage is pulled below the voltage threshold level. You can define a hysteresis value around the voltage threshold and specify that the output must remain below this threshold window for a minimum amount of time (called the “event width”). Using the combination of hysteresis and event width you can account for any noise or “hiccup” in the output voltage and discover the true overload point.

Once the slew has completed, the load is queried for the maximum voltage detected and that value is datalogged. You'll get an error message if the voltage doesn't drop below the threshold for the “event” time within the slew time.

19.2.2 Latching Method

Use this method if your UUT will latch off when the over-voltage condition occurs.

A starting voltage value is programmed to the OVPS and the OVPS relay of the selected output is closed. The OVPS is then programmed to step to the ending voltage value when the system trigger is issued. After each step, the voltage returns to zero volts to determine if the output latched off. The number of steps, and the amount of delay at each step is programmable.

The overload point is defined as being the last OVPS voltage programmed before the output voltage dropped below the Voltage threshold level. You can define a hysteresis value around the Voltage threshold and specify that the output voltage must remain below this threshold window for a minimum amount of time (called the “event width”). Using the combination of hysteresis and event width you can account for any noise or “hiccup” in the output voltage and discover the true overload point.

19.2.3 Input Current Drop Method

Use this method to measure the over-voltage condition by detecting a drop in the Input current draw of the UUT.

A starting voltage value is programmed to the OVPS and the OVPS relay of the selected output is closed. The OVPS is then programmed to slew to the ending voltage value when the system trigger is issued. While the source is slewing, the input current is monitored for the overload point.

The overload point is defined as being the OVPS voltage during the time when the input current drops below the Current threshold level. You can define a hysteresis value around the Current threshold and specify that the input current must remain below this threshold window for a minimum amount of time (called the “event width”). Using the combination of hysteresis and event width you can account for any noise or “hiccup” in the input current and discover the true overload point.

Once the slew has completed, the source is queried for the time that the Current drop occurred, the corresponding OVPS voltage determined and that value is datalogged. If you defined an event width greater than zero you can also datalog the voltage that occurred at the end of the event window.

If desired, you can also have the OVPS return overload values offset in time from when the event was detected. For example, if your UUT shuts off 10mS after detecting the overload, you can enter a -10mS “measurement offset” and instruct the OVPS to return the voltage values in effect 10mS before the detected event.

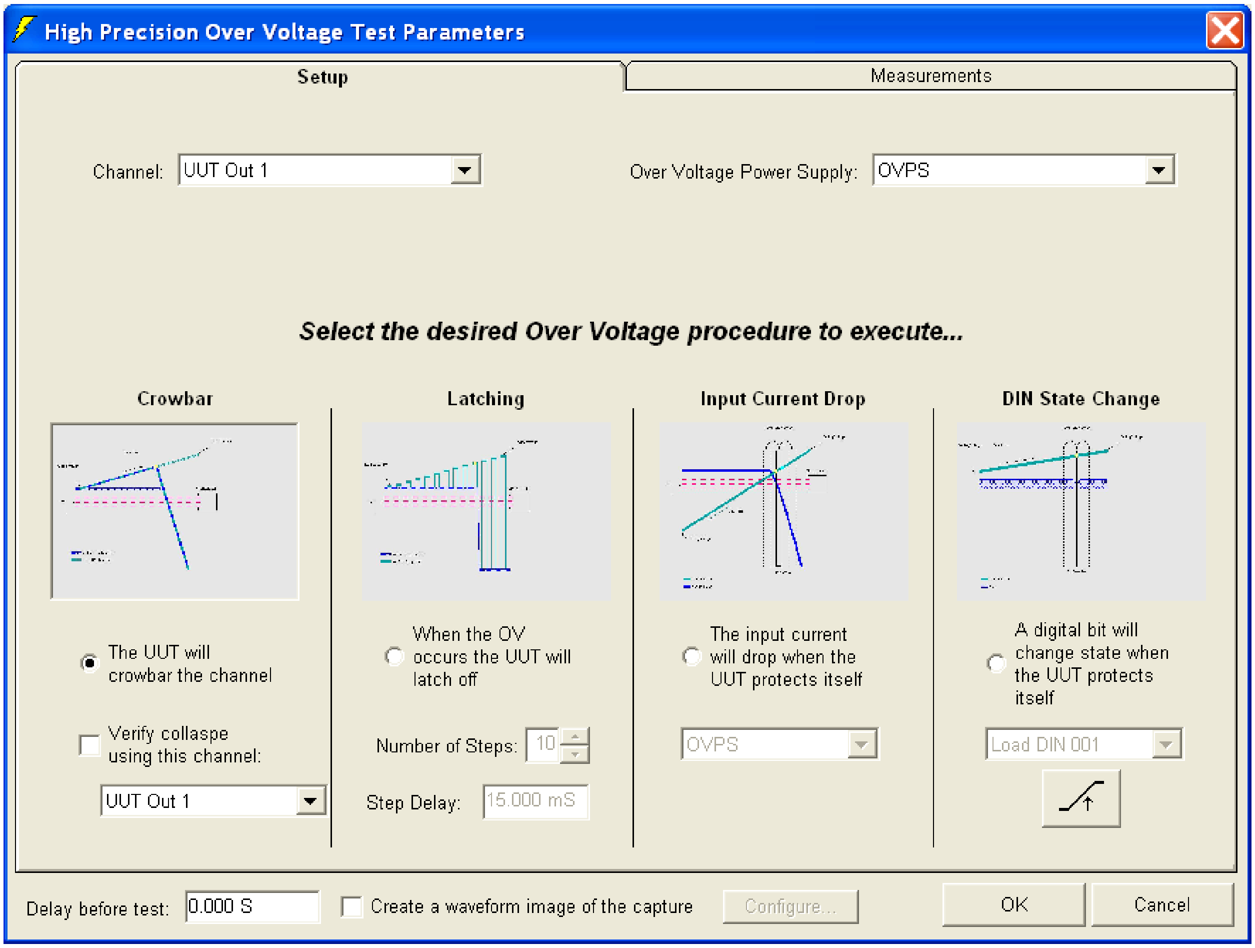
19.2.4 DIN State Change Method

Use this method to measure the over-voltage condition by detecting a change in state of a digital signal connected to the UUT. For example, if your UUT provides a “power good” signal, and this signal deactivates when the UUT is overloaded, you can use this method to detect the condition.

A starting voltage value is programmed to the OVPS and the OVPS relay of the selected output is closed. The OVPS is then programmed to slew to the ending voltage value when the system trigger is issued. While the source is slewing, the assigned Digital Input (DIN) is monitored for the overload point. The overload point is defined as the DIN changing state from low to high, or high to low, as desired. Once the slew has completed, the DIN is queried for the time that the state change occurred, the corresponding OVPS voltage determined and that value is datalogged.

If desired, you can also have the OVPS return overload values offset in time from when the event was detected. For example, if the DIN changes state 10mS after detecting the overload, you can enter a -10mS "measurement offset" and instruct the OVPS to return the voltage values in effect 10mS before the detected event.

19.3 Test Routine Properties

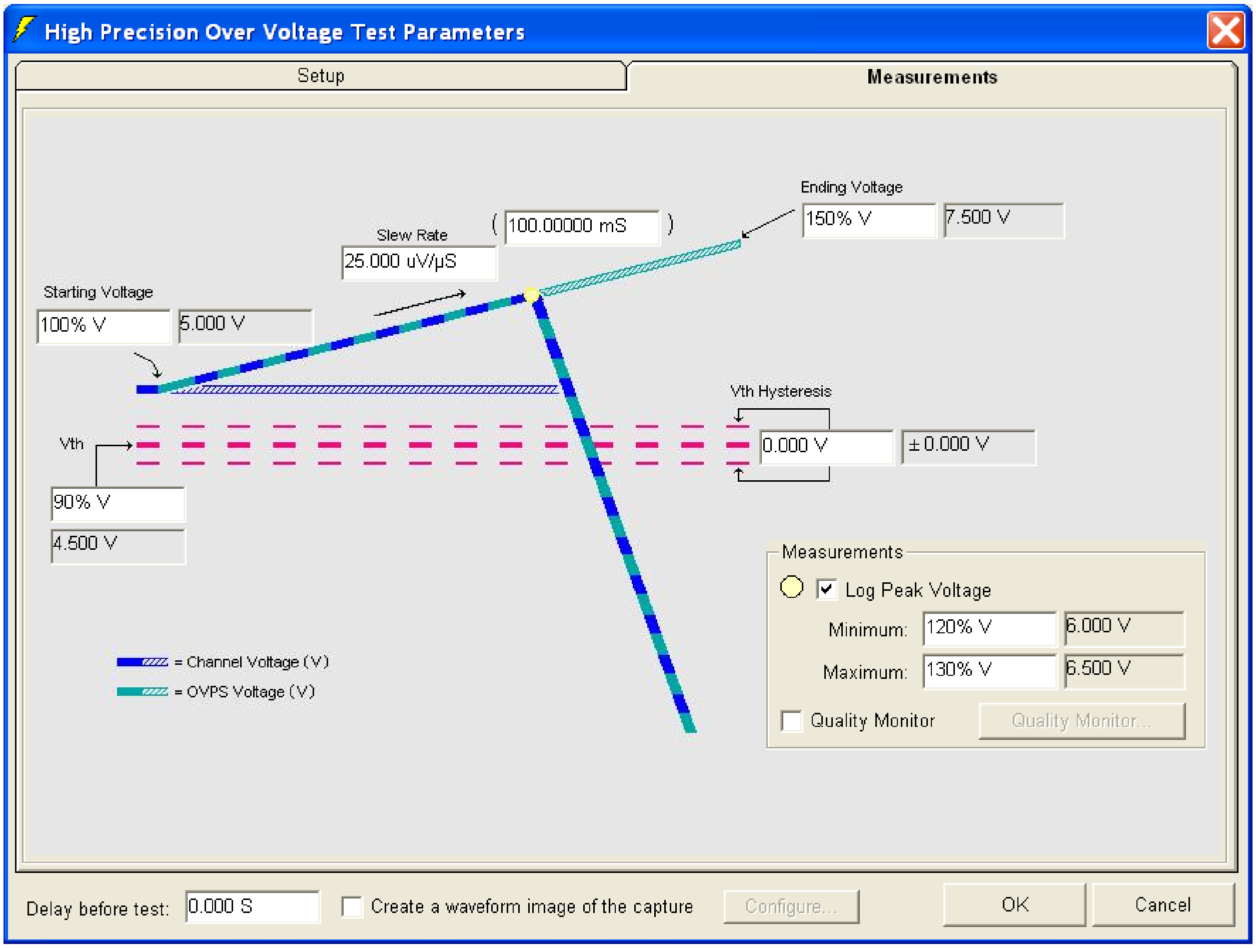


- Channel – the Over Voltage test will be performed on this channel. The channel must have a Model 42xx DC Load connected to it.
- Over Voltage Power Supply – the source that will be connected to the Channel during the test. The source must be a Model 61xx DC Source.
- Select the desired method. Each selection has special properties:
  - Crowbar
    - Verify collapse using this channel – check this box to redirect the measurements to the channel selected in the dropdown list. This is useful when you have a secondary output channel that will collapse in response to the over-voltage condition while the output you are physically testing does not (due to the fact that the OVPS is physically connected).
  - Latching

    - Number of Steps – the number of voltage steps between the Starting voltage and the Ending voltage. The OVPS will be set to zero volts between each of these steps.
    - Step Delay – the amount of time the OVPS will dwell at each programmed step, including the zero-volt steps.
  - Input Current Drop
    - Choose the Input source to monitor for the current drop from the dropdown list.
  - DIN State Change
    - Choose the DIN to monitor for the state change from the dropdown list.
    - Press the toggle button to choose either a rising or falling state change.
- Delay before test – the amount of time you allow the UUT to settle before beginning the procedure. Note that this delay happens once at the beginning of the routine.
- Create a waveform image of the capture – check this box to have the test generate an image of the over-voltage and log it as part of the test data. Press the "Configure" button to customize the waveform image. If this box is cleared no image will be created.
- Configure – Press this button to customize the waveform image. See "Waveform Properties" for more details.

19.4 Crowbar Properties

If you selected the “Crowbar” method, you will see the following screen when the “Measurements” tab is pressed:

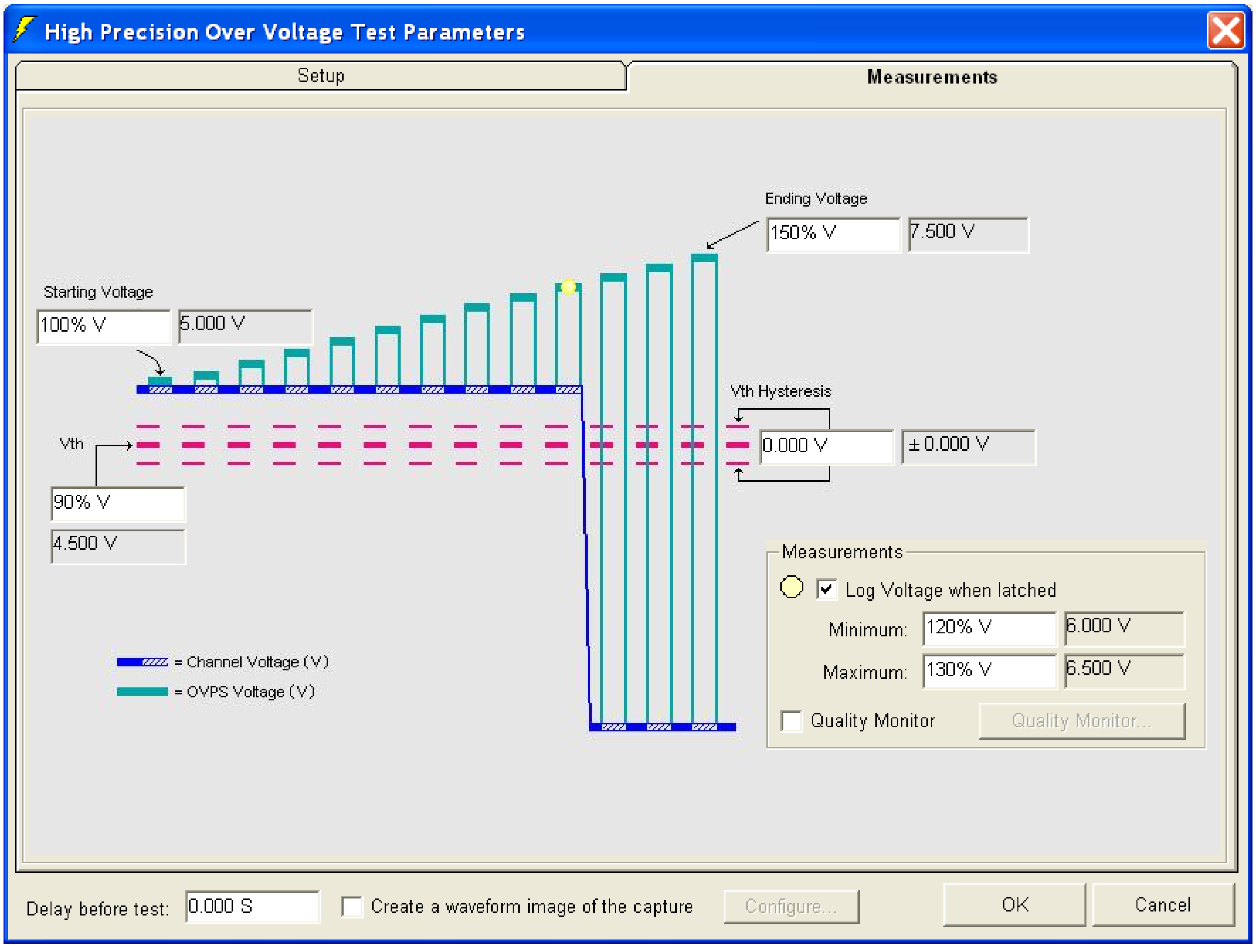


- Starting Voltage – the OVPS will slew from this value to the Ending Voltage value. The value may be entered either as a value or a percentage of the channel reference voltage.
- Ending Voltage – the OVPS will slew from the Starting Voltage value to this value. The value may be entered either as a value or a percentage of the channel reference voltage.
- Slew Rate – the rate at which the OVPS will change from the Starting to the Ending value. The amount of time required to make this change is displayed within the parenthesis below. You can also control the slew rate by entering a value in the elapsed time field – the corresponding slew rate will be automatically calculated.
- Vth – the output channel voltage must drop below this threshold value (including hysteresis, below) before it is considered overloaded. The value may be entered either as a value or a percentage of the channel reference Voltage.
- Vth Hysteresis – this value allows you to program a “window” around the threshold to account for any noise in the signal. If you program the hysteresis value using a percentage (e.g., “1.0 %”), the value is the percentage of the Vth value, not the channel reference.

- Log Peak Voltage – this test logs the peak voltage detected during the slew. Check this box to enable execution and logging of the test results.
  - Minimum – this is the allowable lower limit of the measured value. Measured values less than this will cause the measurement to fail. The value may be entered either as a value or a percentage of channel reference.
  - Maximum – this is the allowable upper limit of the measured value. Measured values greater than this will cause the measurement to fail. The value may be entered either as a value or a percentage of channel reference.
  - Quality Monitor – check this box to enable Quality Monitor data collection.
  - Quality Monitor… – press this button to display the Quality Monitor properties. Please refer to the Quality Monitor reference manual for further details.

19.5 Latching Properties

If you selected the "Latching" method, you will see the following screen when the "Measurements" tab is pressed (Note: the number of steps is representative of the capabilities of the routine and will not necessarily match the number you programmed):

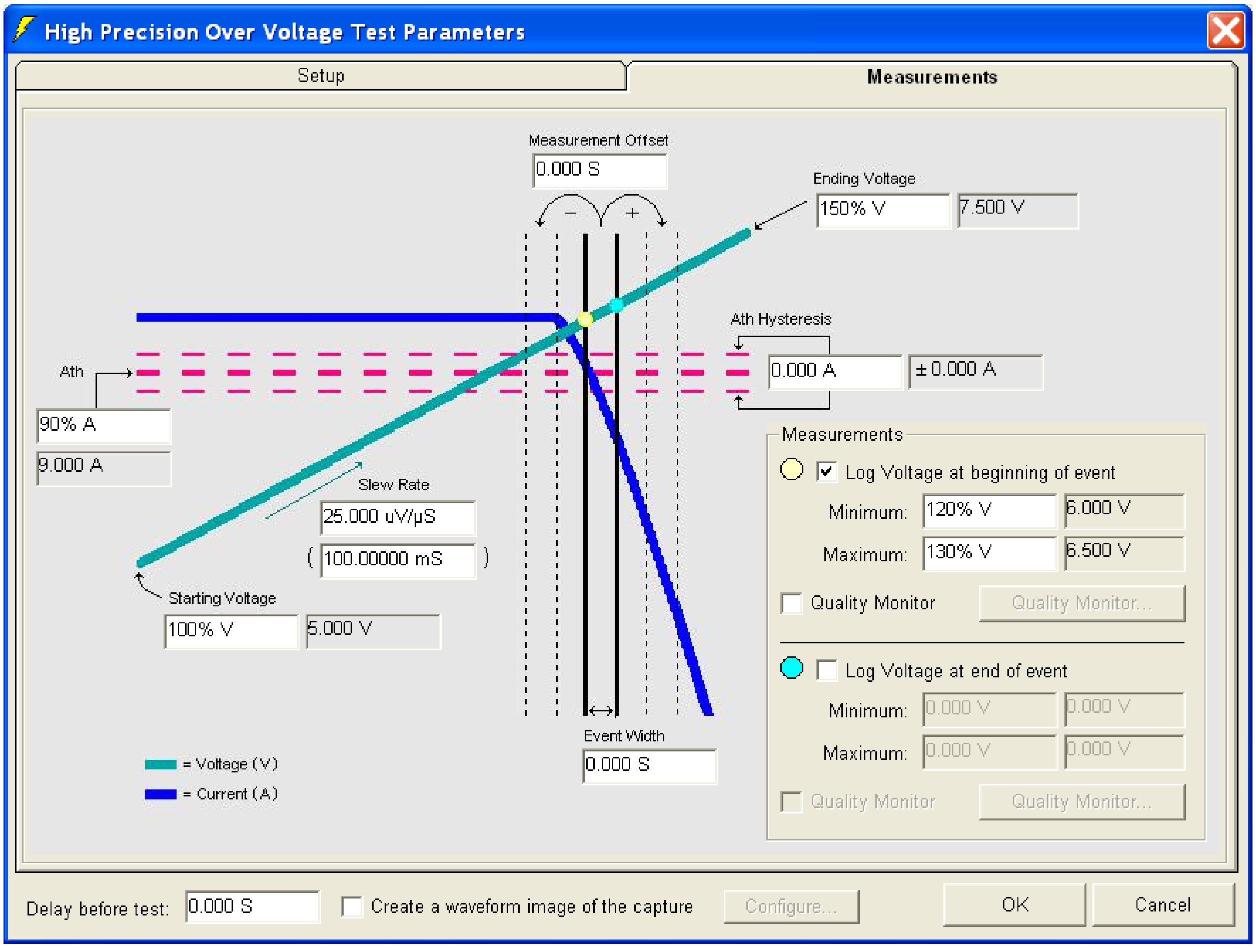


- Starting Voltage – the OVPS will slew from this value to the Ending Voltage value. The value may be entered either as a value or a percentage of the channel reference voltage.

- Ending Voltage – the OVPS will slew from the Starting Voltage value to this value. The value may be entered either as a value or a percentage of the channel reference voltage.
- Vth – the output channel voltage must drop below this threshold value (including hysteresis, below) before it is considered overloaded. The value may be entered either as a value or a percentage of the channel reference Voltage.
- Vth Hysteresis – this value allows you to program a “window” around the threshold to account for any noise in the signal. If you program the hysteresis value using a percentage (e.g., “1.0 %”), the value is the percentage of the Vth value, not the channel reference.
- Log Voltage when latched– this test logs the last voltage programmed before the output latched off. Check this box to enable execution and logging of the test results.
  - Minimum – this is the allowable lower limit of the measured value. Measured values less than this will cause the measurement to fail. The value may be entered either as a value or a percentage of channel reference.
  - Maximum – this is the allowable upper limit of the measured value. Measured values greater than this will cause the measurement to fail. The value may be entered either as a value or a percentage of channel reference.
  - Quality Monitor – check this box to enable Quality Monitor data collection.
  - Quality Monitor… – press this button to display the Quality Monitor properties. Please refer to the Quality Monitor reference manual for further details.

19.6 Input Current Drop Properties

If you selected the "Input Current Drop" method, you will see the following screen when the "Measurements" tab is pressed:

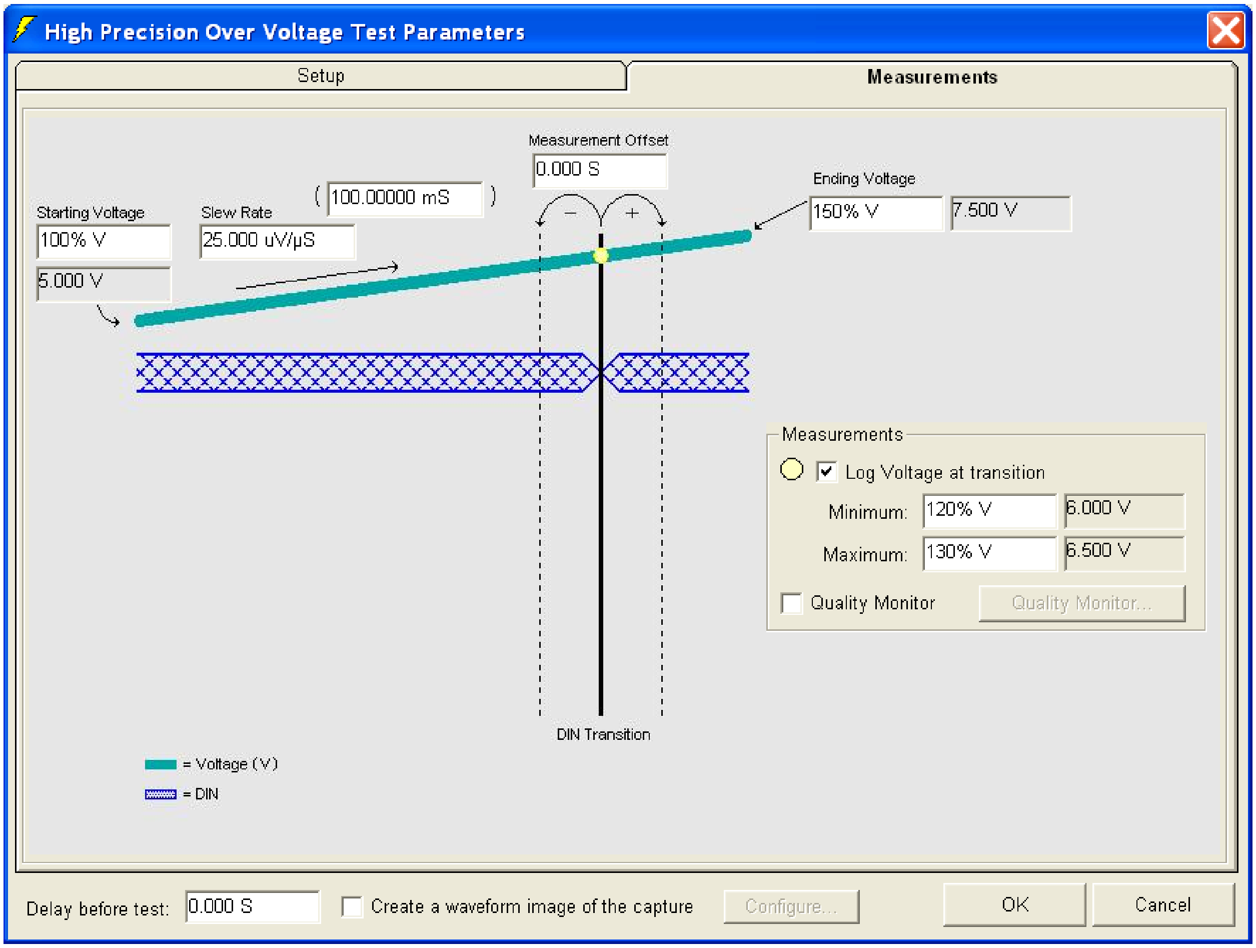


- Starting Voltage – the OVPS will slew from this value to the Ending Voltage value. The value may be entered either as a value or a percentage of the channel reference voltage.
- Ending Voltage – the OVPS will slew from the Starting Voltage value to this value. The value may be entered either as a value or a percentage of the channel reference voltage.
- Slew Rate – the rate at which the OVPS will change from the Starting to the Ending value. The amount of time required to make this change is displayed within the parenthesis below. You can also control the slew rate by entering a value in the elapsed time field – the corresponding slew rate will be automatically calculated.
- Ath – the input current must drop below this threshold value (including hysteresis, below) before it is considered overloaded. The value may be entered either as a value or a percentage of the input channel reference Current.
- Ath Hysteresis – this value allows you to program a "window" around the threshold to account for any noise in the signal. If you program the hysteresis value using a percentage (e.g., "1.0 %"), the value is the percentage of the Ath value, not the channel reference.

- Event Width – when the output channel has stayed below the Ath and hysteresis for this amount of time the channel is overloaded. If the channel “bounces” above the hysteresis window before the event width has expired the channel is not overloaded. The measurements will be referenced to this time.
- Measurement Offset – use this value to have the routine report values offset from the event time. A negative value will go back through the aperture and report values before the Event window; a positive value will go forward through the aperture and report values after the Event window.
- Measurements – the test returns the voltage measured at the beginning of the event window and/or the end of the event window (offset as appropriate).
    - Log Voltage at beginning of event
        - Minimum – this is the allowable lower limit of the measured value. Measured values less than this will cause the measurement to fail. The value may be entered either as a value or a percentage of channel reference.
        - Maximum – this is the allowable upper limit of the measured value. Measured values greater than this will cause the measurement to fail. The value may be entered either as a value or a percentage of channel reference.
        - Quality Monitor – check this box to enable Quality Monitor data collection.
        - Quality Monitor… – press this button to display the Quality Monitor properties. Please refer to the Quality Monitor reference manual for further details.
    - Log Voltage at end of event
        - Minimum – this is the allowable lower limit of the measured value. Measured values less than this will cause the measurement to fail. The value may be entered either as a value or a percentage of channel reference.
        - Maximum – this is the allowable upper limit of the measured value. Measured values greater than this will cause the measurement to fail. The value may be entered either as a value or a percentage of channel reference.
        - Quality Monitor – check this box to enable Quality Monitor data collection.
        - Quality Monitor… – press this button to display the Quality Monitor properties. Please refer to the Quality Monitor reference manual for further details.

19.7 DIN State Change Properties

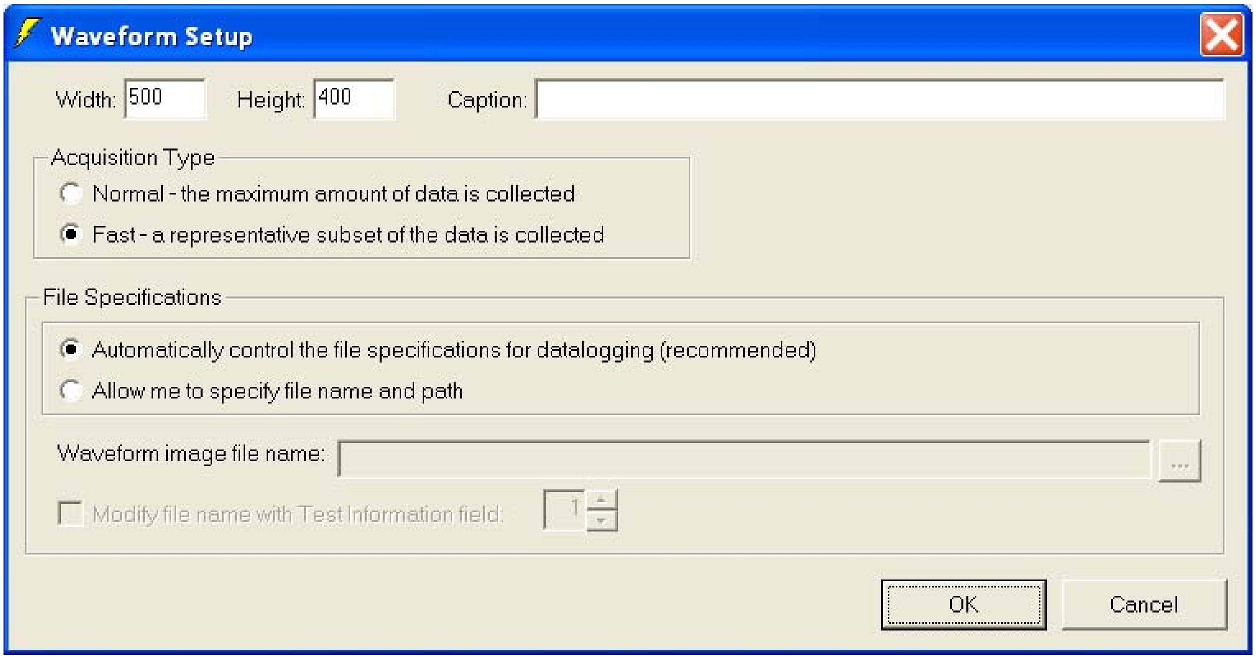
If you selected the "DIN State Change" method, you will see the following screen when the "Measurements" tab is pressed:



- Starting Voltage – the OVPS will slew from this value to the Ending Voltage value. The value may be entered either as a value or a percentage of the channel reference voltage.
- Ending Voltage – the OVPS will slew from the Starting Voltage value to this value. The value may be entered either as a value or a percentage of the channel reference voltage.
- Slew Rate – the rate at which the OVPS will change from the Starting to the Ending value. The amount of time required to make this change is displayed within the parenthesis below. You can also control the slew rate by entering a value in the elapsed time field – the corresponding slew rate will be automatically calculated.
- Measurement Offset – use this value to have the routine report values offset from the event time. A negative value will go back through the aperture and report values before the Event window; a positive value will go forward through the aperture and report values after the Event window.
- Log Voltage at transition– this test logs the voltage detected when the DIN state changes. Check this box to enable execution and logging of the test results.

- Minimum – this is the allowable lower limit of the measured value. Measured values less than this will cause the measurement to fail. The value may be entered either as a value or a percentage of channel reference.
- Maximum – this is the allowable upper limit of the measured value. Measured values greater than this will cause the measurement to fail. The value may be entered either as a value or a percentage of channel reference.
- Quality Monitor – check this box to enable Quality Monitor data collection.
- Quality Monitor… – press this button to display the Quality Monitor properties. Please refer to the Quality Monitor reference manual for further details.

19.8 Waveform Properties



- Width – specifies the width of the image.
- Height – specifies the height of the image.
- Caption –this text is used to describe the image.
- Acquisition Type – when you select “Normal”, every data point gathered by the measurement hardware is downloaded and used to generate the image; “Fast” will download 128 data points, gathered evenly from throughout the aperture. Selecting “Fast” does not affect the quality of the measurements.
- File Specifications – These selection buttons determine whether the image file generated during this test is managed automatically or if you will choose the file and path.
  - Automatically control the file specifications for datalogging (recommended) – this selection determines whether the image file generated during this test is managed automatically.

- Allow me to specify file name and path – choose this option if you want to manually select the filename and path for the image file.
- Waveform image file name – if you chose to manually control the filename enter the specification here.
- Modify file name with Test Information field – When enabled, a field from the Test Information Entry form will be appended to the user entered file name. The Test Information Entry form appears before running the test on each UUT and is typically filled in by the test operator. Appending an information field provides a method of tracking specific waveform images to a particular UUT serial number or test pass. The number selection box determines which of the input fields from the Test Information Entry form will be appended to the file name.

19.9 Sequence

The load, source, digital and analog vectors defined by the program are applied to the tester hardware before the test routine sequence is initiated.

1) Delay before beginning the test
2) Set starting current. This value slews at the rate specified in the vector applied before the test program starts. Close the OV relay on the selected channel.
3) For the latching method, program a macro to step the OVPS from the Starting to the Ending values, with a zero-volt stage after each step. For the other methods program the OVPS slew rate.
4) Issue a system trigger and wait until the devices have finished capturing data
5) Fetch the measurements and waveform data, if applicable
6) Open the OV relay and turn the OVPS off
7) Datalog the results
8) Check for faults and log them as necessary

20. PROMPT TEST

20.1 Description

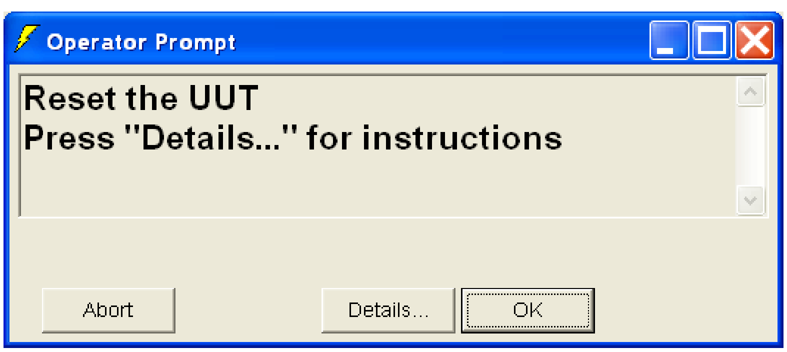
The prompt test is a multi-page user-interactive dialog that may be used to provide instructional information to and/or gather test result data from the operator. Each page may contain textual instructions and/or an image and up to four command buttons for user interaction. The entire dialog may be setup like a "wizard", allowing the user to step back and forth through the pages.

20.2 Method

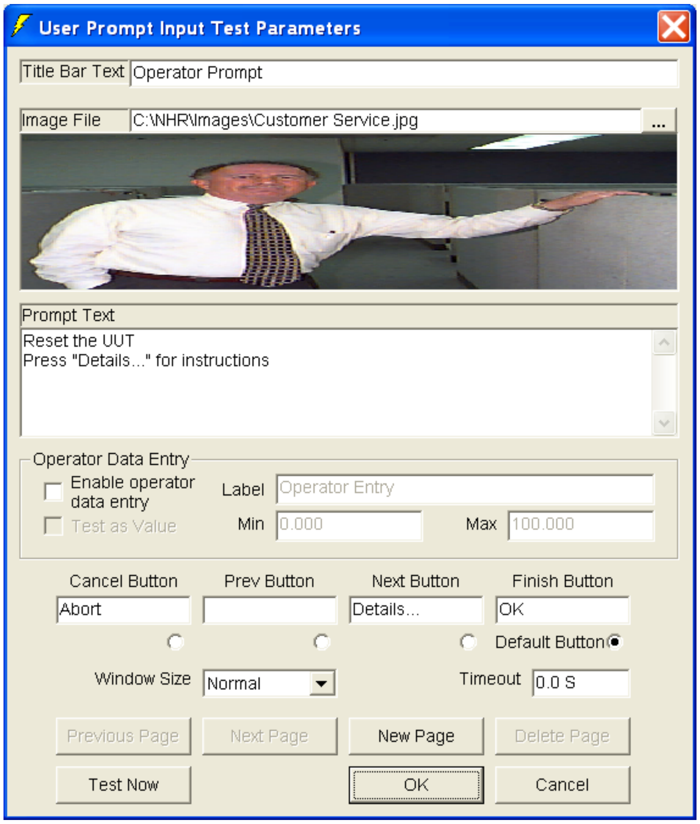
Each prompt page may contain from one to four command buttons. The action performed by the routine depends upon which button the user presses. A "cancel" and "finish" button are provided to close the dialog and return the corresponding status, allowing conditional branching to take place. "Next" and "previous" buttons allow the user to increment and decrement through the pages of the dialog. An optional timeout field allows the dialog to cycle through the pages automatically; the user may pause this action at any time by pressing the pause button.

20.3 Example

Let's say that at the midway point of our test program we require the operator to perform the manual procedure of resetting the UUT. Since the caption text of each of the four buttons is programmable, the "finish" button could be set to "OK", the "cancel" button to "Abort", the "next" button could read "Details…" and the "previous" button could be hidden. The first few times the operator performs the task step-by-step detailed instructions may be used to walk him/her through the procedure. However, once the operator has performed this action a few times, the detailed instructions may become burdensome. Providing the "OK" button allows the operator to perform the task from memory without having to cycle manually through the dialog pages.



20.4 Test Routine Properties



- Title Bar Text – this text string is displayed in the window title bar of all prompt pages.
- Image File – this is the path to the image file that will be included in the active prompt page. Press the ellipsis button ("…") to browse for the desired image. The Image Preview area displays the image if it can be located. The image file is optional; a smaller prompt dialog will be displayed at run time if no image is provided.
- Prompt Text – this is the text that will be included in the active prompt page. The dialog will add scroll bars automatically if necessary. The prompt text is optional; a smaller prompt dialog will be displayed at run time if no text is provided.
- Enable operator data entry – when this box is selected, and additional area of the prompt is displayed where the operator can enter a value. This is useful in situations where a measurement is performed by an instrument not controlled by the test system (such as a hand-held meter) but the measurement needs to be validated and datalogged.
- Label – additional text field for operator instructions concerning the data entry requirement
- Test as Value – select this box to test the value entered by the operator against the Min and Max fields. In this case, the data entered will be translated into a numeric form for datalogging. If the box remains unchecked, the data will be logged exactly as entered by the operator (no translation), however, no pass/fail determination will be made.
- Min – this is the allowable lower limit of the operator-entered value. Values less than this will cause the test routine to fail.

- Max – this is the allowable upper limit of the operator-entered value. Values greater than this will cause the test routine to fail.
- Cancel Button – the text entered here will be displayed on the face of the “cancel” button. If the user presses this button the prompt dialog is closed and a failure status is returned. Clear the text area to hide this button.
- Prev Button - the text entered here will be displayed on the face of the “previous” button. If the user presses this button the prompt routine displays the previous page in the dialog list. Clear the text area to hide this button.
- Next Button - the text entered here will be displayed on the face of the “next” button. If the user presses this button the prompt routine advances to the next page in the dialog list. Clear the text area to hide this button.
- Finish Button – the text entered here will be displayed on the face of the “finish” button. If the user presses this button the prompt dialog is closed and a passing status is returned. Clear the text area to hide this button.
- Default Button – set the default button by making the appropriate selection under the desired button field. This is the button that will be “pressed” when the user presses the Enter key. The action performed is that of the corresponding button.
- Window Size – this is the initial display size of the prompt.
- Timeout – the prompt dialog will automatically perform the Default Button action after the timeout period has elapsed. A setting of zero disables this feature.
- Previous Page – press this button to make the previous dialog page in the dialog list the active page for editing.
- Next Page – press this button to make the next dialog page in the dialog list the active page for editing.
- New Page – press this button to add a new page to your prompt dialog. There is no limit to the number of pages you may have in your prompt dialog.
- Delete Page – press this button to remove the active page from the prompt dialog page list.
- Test Now – pressing this button allows you to preview how the prompt dialog will perform at run time. You can resize the prompt here to control its runtime size. Note: Only one dialog size is stored regardless of the number of pages in the prompt.

20.5 Sequence

The load, source, digital and analog vectors defined by the program are applied to the tester hardware before the test routine sequence is initiated.

1) Set prompt dialog size
2) For each active page:
   a) Load the prompt text
   b) Load the image

c) Set button captions and show or hide as necessary

d) Start the page timer if necessary

21. RAMP (GENERAL PURPOSE) TEST

21.1 Description

The general purpose Ramp test routine provides the user with a very flexible method to ramp any load or source parameter while monitoring any DMM-type or DIN measurement. This test can be configured to perform a UUT ramp up test, over-current, over-voltage or over-power test, an output linearity test, etc.

21.2 Method

The ramp is defined by entering the desired values into the Ramp Parameters fields. For each ramp step, the measurement defined by the Measurement Parameters fields is taken.

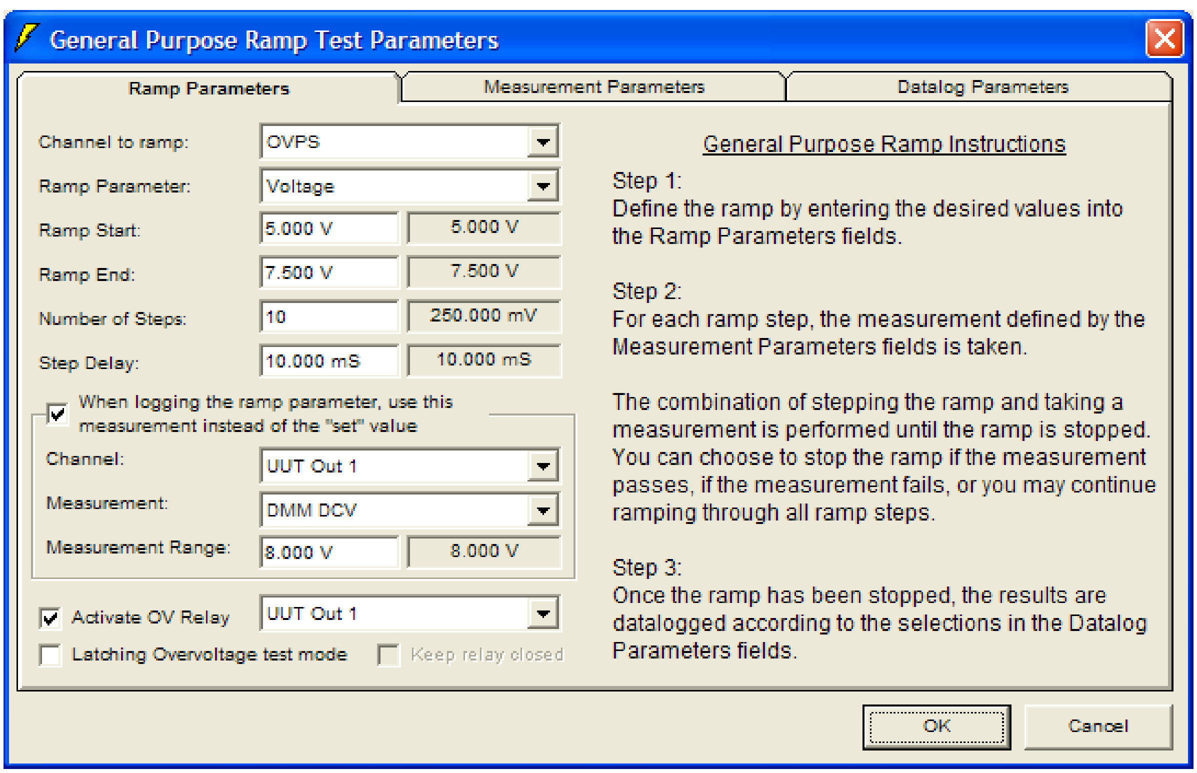
The combination of stepping the ramp and taking a measurement is performed until the ramp is stopped. You can choose to stop the ramp if the measurement passes, if the measurement fails, or you may continue ramping through all ramp steps.

Once the ramp has been stopped, the results are datalogged according to the selections in the Datalog Parameters fields.

21.3 Test Routine Properties

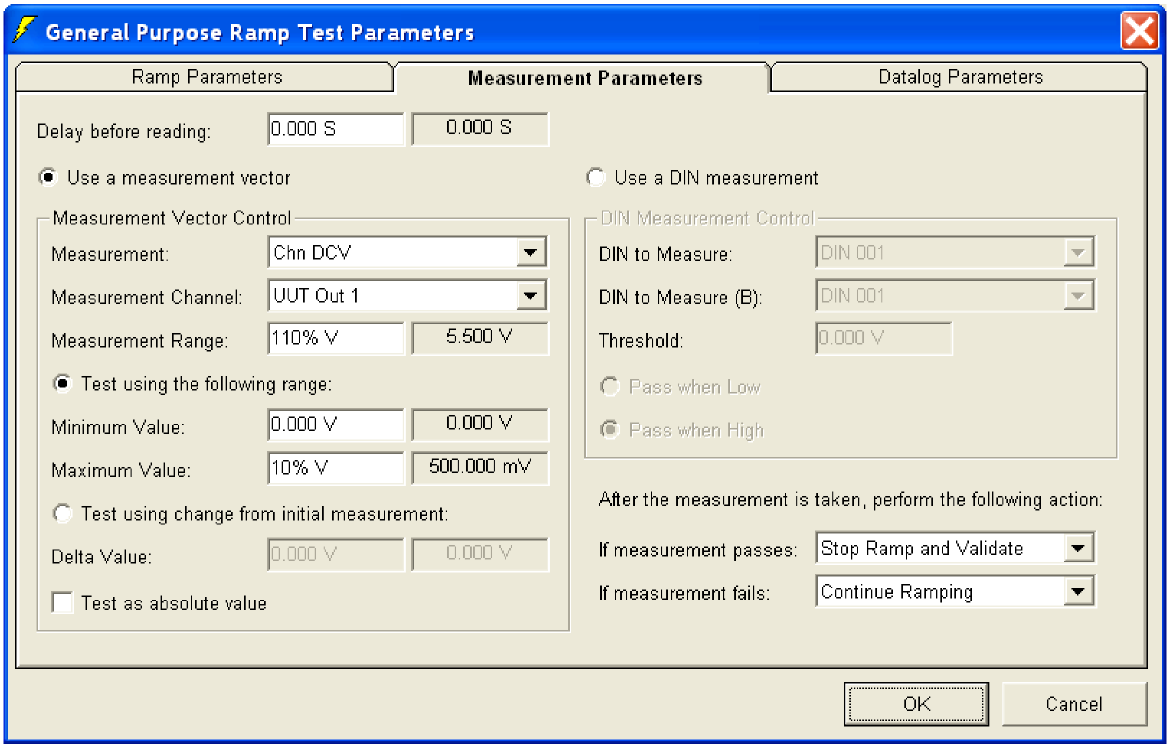
The test routine properties are split into three categories: Ramp, Measurement and Datalog parameters.

21.3.1 Ramp Parameters



- Channel to ramp – the load or source channel to ramp.
- Ramp Parameter – the parameter of the channel to ramp. Selections include voltage, current, frequency, etc.
- Ramp Start – the initial value of the ramp parameter.
- Ramp End – the final value of the ramp parameter.
- Number of Steps – the number of steps to take when ramping from the start value to the end value. This also indicates the number of measurements taken during the test.
- Step Delay – this delay will be applied between each of the voltage steps.
- When logging the ramp parameter, use this measurement instead of the “set” value – check this box to measure the “set” value and log this measurement instead of the programmed value when choosing the “Ramp Value” or “Previous Ramp Value” datalog options.
    - Channel – the load or source channel to measure.
    - Measurement – the measurement vector that will be used to take the measurement. Note that this must be a DMM-type measurement vector.
    - Measurement Range – this is the maximum expected measured value. The value may be entered either as a value or a percentage of channel reference. The appropriate reference is automatically selected based on the measurement vector entry. In the example above, the “UUT Out 1” Reference Voltage value will be used.
- Activate OV Relay – checking this box will instruct the load channel selected in the dropdown list to close its overvoltage relay during the ramp.
- Latching Overvoltage test mode – if checked, the algorithm will open the OV relay and take a measurement at each test step.
- Keep relay closed – when running a latching overvoltage test (above), the test system will simulate the relay opening by setting the ramp parameter to near zero before taking the measurement at each step. Restoring the ramp parameter to the next value in the sequence simulates closing the relay.

21.3.2 Measurement Parameters



- Use a measurement vector – select this option if the measurement you wish to take at each ramp step is a DMM-type measurement.
  - Measurement – the measurement vector that will be used to take the measurement. Note that this must be a DMM-type measurement vector.
  - Measurement Channel – the load or source channel to measure.
  - Measurement Range – this is the maximum expected measured value. The value may be entered either as a value or a percentage of channel reference. The appropriate reference is automatically selected based on the measurement vector entry. In the example above, the “UUT Out 1” Reference Voltage value will be used.
  - Test using the following range – check this box to enable the Minimum and Maximum Value entry fields. The measured value will be compared against the provided minimum and maximum values.
    - Minimum Value - this is the allowable lower limit of the measured value. Measured values less than this will cause the measurement to fail. The value may be entered either as a value or a percentage of channel reference.
    - Maximum Value - this is the allowable upper limit of the measured value. Measured values greater than this will cause the measurement to fail. The value may be entered either as a value or a percentage of channel reference.
  - Test using changes from initial value – check this box to enable the Delta Value field. The measured value will be compared against the provided delta value.

        - Delta Value – this value is subtracted from an initial measurement to determine the minimum value, and added to that initial measurement to determine the maximum value. Measured values outside this delta window will cause the measurement to fail. The value may be entered either as a value or a percentage of channel reference.
    - Test as absolute value – check this box to use the absolute value of the measurement for pass/fail evaluation and UUT communication reference.
- Use a DIN measurement – select this option if the measurement you wish to take at each ramp step is a DIN measurement.
    - DIN to Measure – select the DIN you wish to monitor from the provided dropdown list. If the program is running in multi-fixture mode, a second dropdown list is provided to select the desired DIN for fixture "B".
    - Threshold – the voltage value used to determine the state of the digital. The digital is considered "High" if its voltage value is greater than this threshold value, "Low" if its voltage value is less than this threshold.
    - Pass when Low – indicates that the measurement passes when the DIN is low.
    - Pass when High – indicates that the measurement passes when the DIN is high.

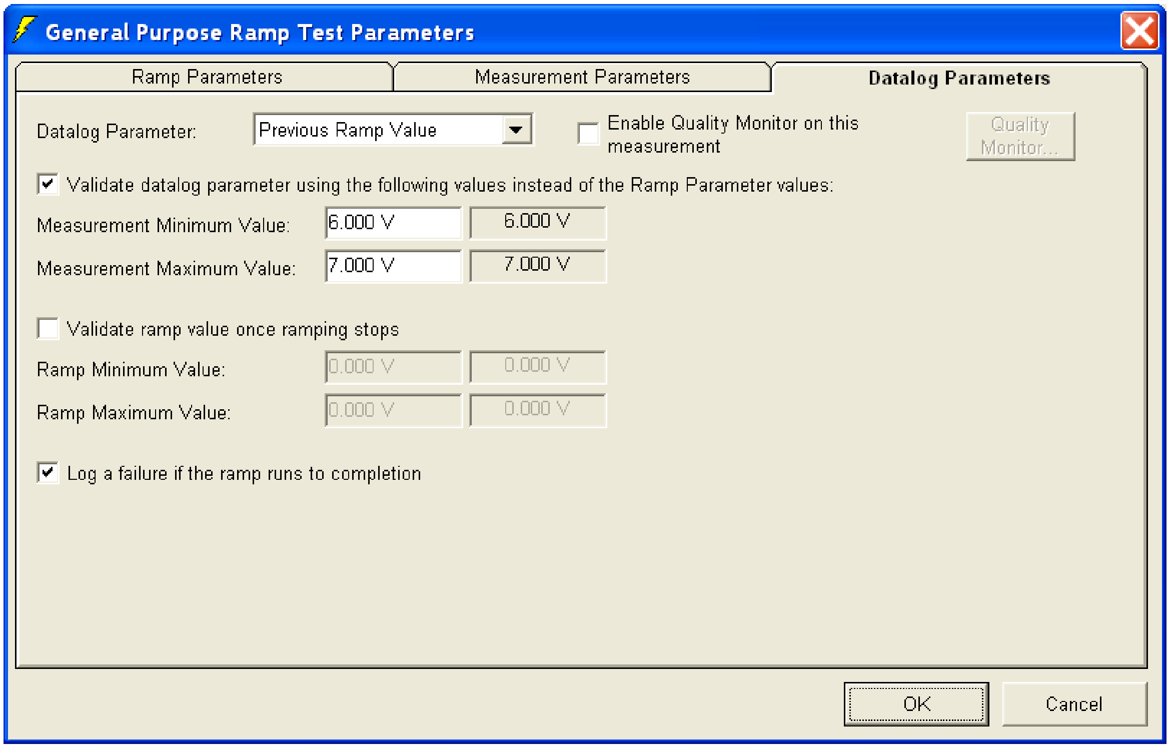
At each step in the ramp loop we evaluate the measurement, using the result to control the loop. There are four possible actions to take:

1. Continue ramping – this allows the ramp to continue running
2. Stop Ramp and Validate – this exits the ramp and allows the options on the Datalog Parameters tab to determine pass/fail results
3. Fail test (stop ramp) – this exits the ramp test, forcing the routine to fail
4. Abort test (stop ramp) – this exits the ramp test without determining a pass/fail result

After the measurement is taken, perform the following action:

- If measurement passes – the action to perform if the measurement passed.
- If measurement fails – the action to perform if the measurement failed.

21.3.3 Datalog Parameters



- Datalog Parameter – select the measurement or ramp value you wish to datalog.
  - All Measurements – the measurement from every ramp step will be validated and logged. This is useful when you expect every measurement to pass, as when you are performing a linearity test.
  - Maximum Measurement – the maximum measured value will be datalogged.
  - Measurement – the last measured value when the ramp stopped will be datalogged.
  - Minimum Measurement – the minimum measured value will be datalogged.
  - Previous Measurement – the next to the last measured value when the ramp stopped will be datalogged.
  - Previous Ramp Value – the next to the last programmed ramp value will be logged (unless the optional measurement is enabled on the “Ramp Parameters” tab).
  - Ramp Value – the last programmed ramp value will be logged (unless the optional measurement is enabled on the “Ramp Parameters” tab).
- Collect Quality Monitor data on this measurement – check this box to enable Quality Monitor data collection. Not available when logging “All Measurements”.
- Quality Monitor… – press this button to display the Quality Monitor properties. Please refer to the Quality Monitor reference manual for further details.
- Validate measurement using the following values instead of the Measurement Parameter values – if this box is checked, the datalog parameter is evaluated using the values entered in

the fields below; if the box is cleared, the datalog parameter is evaluated using the same minimum and maximum values used by the ramp loop control on the Measurement Parameter tab.

- Measurement Minimum Value – this is the allowable lower limit of the datalog parameter value. Values less than this will cause the test routine to fail. The value may be entered either as a value or a percentage of measurement channel reference.
- Measurement Maximum Value – this is the allowable upper limit of the datalog parameter value. Values greater than this will cause the test routine to fail. The value may be entered either as a value or a percentage of measurement channel reference.
- Validate ramp once ramping stops – check this box to test the last ramp set value to ensure it is within an acceptable range.
- Ramp Minimum Value – this is the allowable lower limit of the last ramp set value. Values less than this will cause the test routine to fail. The value may be entered either as a value or a percentage of the ramp channel reference.
- Ramp Maximum Value – this is the allowable upper limit of the last ramp set value. Values greater than this will cause the test routine to fail. The value may be entered either as a value or a percentage of the ramp channel reference.
- Log a failure if the ramp runs to completion – check this box to log an error if you expect the ramp to stop before reaching the Ramp End value and it doesn't.

21.4 Sequence

The load, source, digital and analog vectors defined by the program are applied to the tester hardware before the test routine sequence is initiated.

9) Initialize the ramp:
   a) Calculate ramp control parameters
   b) If using an OV relay:
      i) Activate the relay
      ii) Set an initial value one step size *below* the start value
      iii) Take and evaluate a measurement to make sure we haven't tripped yet
10) Start the ramp:
   a) Take an initial measurement
   b) Evaluate results to ensure we haven't satisfied the ramp before we've started
   c) Recalculate minimum and maximum parameters if using changes from an initial value (delta)
11) For each ramp step:
   a) Calculate new set value
   b) Take the measurement

c) If in latching Overvoltage test mode:
    i) Open the relay or remove the set value
    ii) Take another measurement
d) Evaluate the results to determine whether to continue ramping

12) Deactivate OV relay if necessary
13) Datalog the results
14) Validate ramp and log results if necessary
15) Check for faults and log them as necessary

22. REFERENCE CHANGE

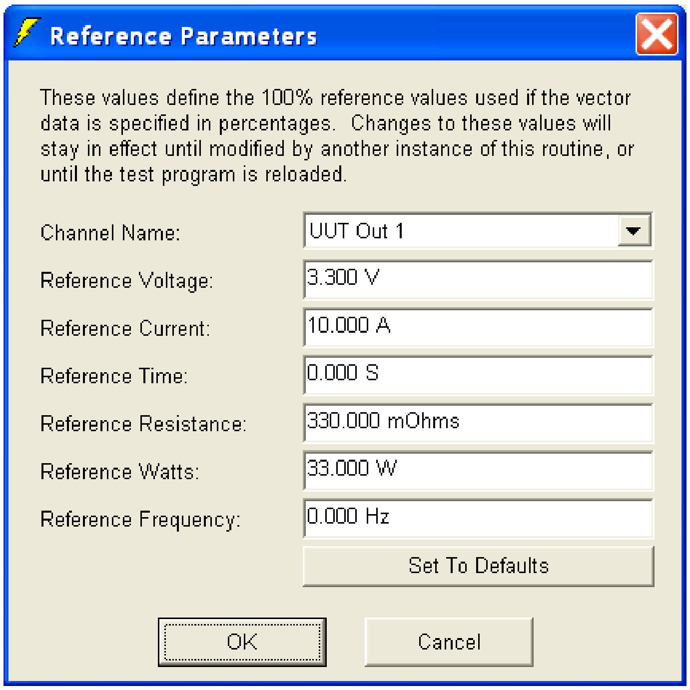
22.1 Description

The Reference Change test provides a convenient way to change reference voltages during the test at run-time. This would allow a particular test or sequence of tests to be combined into a subroutine and re-used. If test pass/fail parameters are expressed as percentages of reference voltages, then changing the reference changes those parameters to match a new nominal output. Thus, for programmable output supplies, changing the reference between program steps allows the same subroutine to test each new output value.

22.2 Method

Normally, reference voltages are set for a given UUT when Input or Output device Properties are defined. These reference values are used whenever test parameters are defined in terms of percentages instead of absolute numbers. To change the references within a test program, insert the Reference Change test in the program and define the new reference values. Inserting another Reference Change test and using the Set to Defaults button will return references to those in the device Properties control panel.

22.3 Test Routine Properties



- Channel Name – Input or Output Device named in the Input or Output Vector during program input.
- References – Values normally set in the Input or Output vector using the References tab of the device Properties panel. These are usually the nominal values for UUT inputs and

outputs. The values entered here will become the reference used in subsequent tests to compute pass or fail points based on specified percentage tolerances.

- Set to Defaults – Returns references to values specified in Input or Output device Properties control panel.

22.4 Sequence

The load, source, digital and analog vectors defined by the program are applied to the tester hardware before the test routine sequence is initiated.

1) Set the references to those specified in Reference Change test panel

23. RUN EXTERNAL

23.1 Description

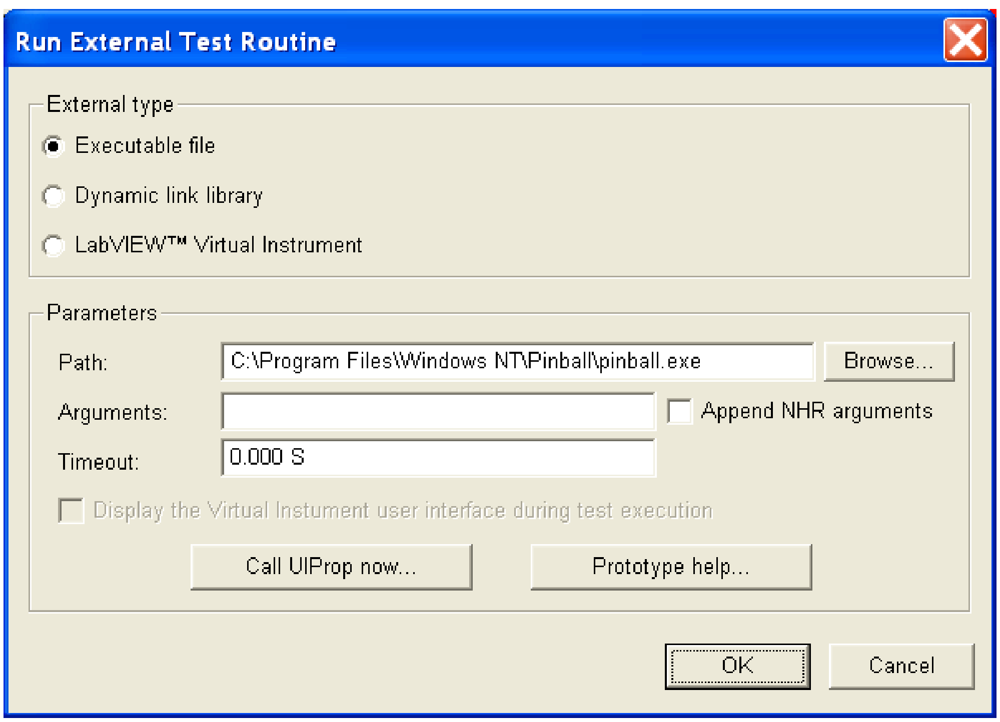
Allows the test program to suspend operation and transfer control to another executable program.

23.2 Method

Choose an external program to run during a test program. Enter a timeout value for the expected time to finish and return to *em***Power**®. Entering zero lets the program run indefinitely.

Important note: When you select an external program that is either a Dynamic Link Library (.dll) or a LabVIEW™ Virtual Instrument (.vi), certain calls in the "Action" list (below) will be made on the selected external program even while you are in the *em***Power** editor. This means that your external program must be ready to accept the calls before selection is made – at a minimum the calls must be "stubbed" out. Failure to do so usually results in programming exceptions that are caught and displayed by the *em***Power** Fault Manager. (Executable files are only launched from *em***Power** TEST.)

23.3 Test Routine Properties



- Executable file – Choose this option run an executable file (.exe)
- Dynamic link library – Choose this option to make a call into an external function library (.dll)
- LabVIEW Virtual Instrument – Choose this option to launch LabVIEW and run a virtual instrument panel (.vi)

- Path – a fully qualified path to the external file
- Arguments/Function – when the External type is an Executable file or Virtual Instrument this field is used to construct a string to send to the external file as arguments when launching. When the External type is a Dynamic link library this field contains a drop-down list of the functions exported by the library. Choose the desired function from the list. After entering the desired values try pressing the “Prototype help…” button to preview the constructed call.
- Append NHR arguments – check this box to pass arguments to the external file which will allow it to 1) modify its behavior based on where in we are in the test program flow, 2) gain access to the running *em**Power*** program components and tester hardware, and 3) store and retrieve data from the loaded test program (.NHRTPL file):

  Action (string): a variable defining the action to be performed at a particular step of the test routine procedure. The “actions” are:
    - UIProp – display the front panel user interface in order to collect the test routine properties
    - LoadBlobProp – load the test routine property blob
    - SaveBlobProp – save the test routine properties in a blob
    - Go – run the test routine algorithm
    - CopyBlobProp – copy the test routine properties into a new blob
    - DeleteBlobProp – delete the test routine properties from the Blob Manager
    - QualityMonitor – indicate whether any Quality Monitor data is being collected when running the algorithm

  ProcessID (unsigned integer): a unique value used to obtain access to the *em**Power*** components of the active process and, subsequently, the tester hardware.

  Blob Handle (unsigned integer): a unique value used to indicate the storage location of user-interface data for this routine instance in the active test program. The type of data stored depends on the purpose of the test routine. For example, if you’re going to make a single DMM-type measurement on a UUT output, you’ll need the following data:
    - Channel – the name of the Output that will be measured
    - Measurement – the name of the measurement vector used to define the measurement
    - Minimum – the minimum acceptable value of the measurement
    - Maximum – the maximum acceptable value of the measurement
    - QM Handle – the handle (storage location) of the Quality Monitor setup used for this measurement

  For detailed information on how to use these arguments, see the document “Sample LabVIEW Test Routine” located in C:\NHR\Custom\LabVIEW

- Timeout – if the external file has not finished by this amount of time a timeout error will be logged and the test program will continue

- Display the Virtual Instrument user interface during test execution – check this box to have LabVIEW display the user interface associated with the running VI during execution
- Call UIProp now… – this will call the library or virtual instrument with a call constructed like that described by the "Prototype help…" button with "UIProp" as the Action string. This allows you to collect any edit-time data required by the external file. Note: this action is not performed if the External type is "Executable file".
- Prototype help… – press this button to view a sample of how the call to the external file will be constructed
  - Executable Files: Executable files can be called with optional arguments. In addition, the standard *em**Power*** arguments may be appended to the argument list:
    - lProcessID: The ID of the calling process, passed as an unsigned 32-bit integer. This may be given to an NHR Object Depot server to obtain access to *em**Power*** objects (loads, sources, etc.) belonging to the process.
    - hBlob: A handle to an *em**Power*** data storage block, passed as an unsigned 32-bit integer.

    An exit code returned as an unsigned 32-bit integer is interpreted to indicate the number of failures encountered.
  - Dynamic Link Library: Calls to dynamic link libraries can be defined to accept either no arguments, or the standard *em**Power*** arguments. The prototype for a call accepting the standard *em**Power*** arguments is:
    `int32 ProcedureName(CStr sAction, uint32 lProcessID, uint32 hBlob);`
    - sAction: A string describing the type of action the test routine is to perform, such as "Go" or "UIProp" (display a user interface).
    - lProcessID: The ID of the calling process, passed as an unsigned 32-bit integer. This may be given to an NHR Object Depot server to obtain access to *em**Power*** objects (loads, sources, etc.) belonging to the process.
    - hBlob: A handle to an *em**Power*** data storage block, passed as an unsigned 32-bit integer.

    The calls return an unsigned 32-bit integer whose meaning varies depending on the value of "sAction". Note: calls are made using the standard Windows calling convention.
  - LabVIEW Virtual Instrument: The National Instruments LabVIEW development environment is launched prior to running the selected VI. Calls to VI's can be defined to accept either no arguments, or the standard *em**Power*** arguments. If using the arguments, parameters are passed through the VI connector as follows (3 inputs, 1 output):
    - Action: A string describing the type of action the test routine is to perform, such as "Go" or "UIProp" (display a user interface).

- ProcessID: The ID of the calling process, passed as an unsigned 32-bit integer. This may be given to an NHR Object Depot server to obtain access to *em**Power*** objects (loads, sources, etc.) belonging to the process.
- Blob Handle: A handle to an *em**Power*** data storage block, passed as an unsigned 32-bit integer.
- Return Value: The VI returns an unsigned 32-bit integer through this output connector. The meaning varies depending on the value of "Action".

Note: There are no values passed through the VI connector unless *em**Power*** arguments are enabled.

23.4 Sequence

The load, source, digital and analog vectors defined by the program are applied to the tester hardware before the test routine sequence is initiated.

1) Start Timeout counter
2) Start Executable program
3) If Timeout timer expires before program returns
    a. Log error

24. SHORT CIRCUIT TEST

24.1 Description

This test applies a short circuit to individual UUT outputs to verify that they go into current limit and that they recover properly after a short circuit condition.

This test routine also contains the ability to communicate to the UUT in order to verify its status or internal measurement circuitry.

24.2 Method

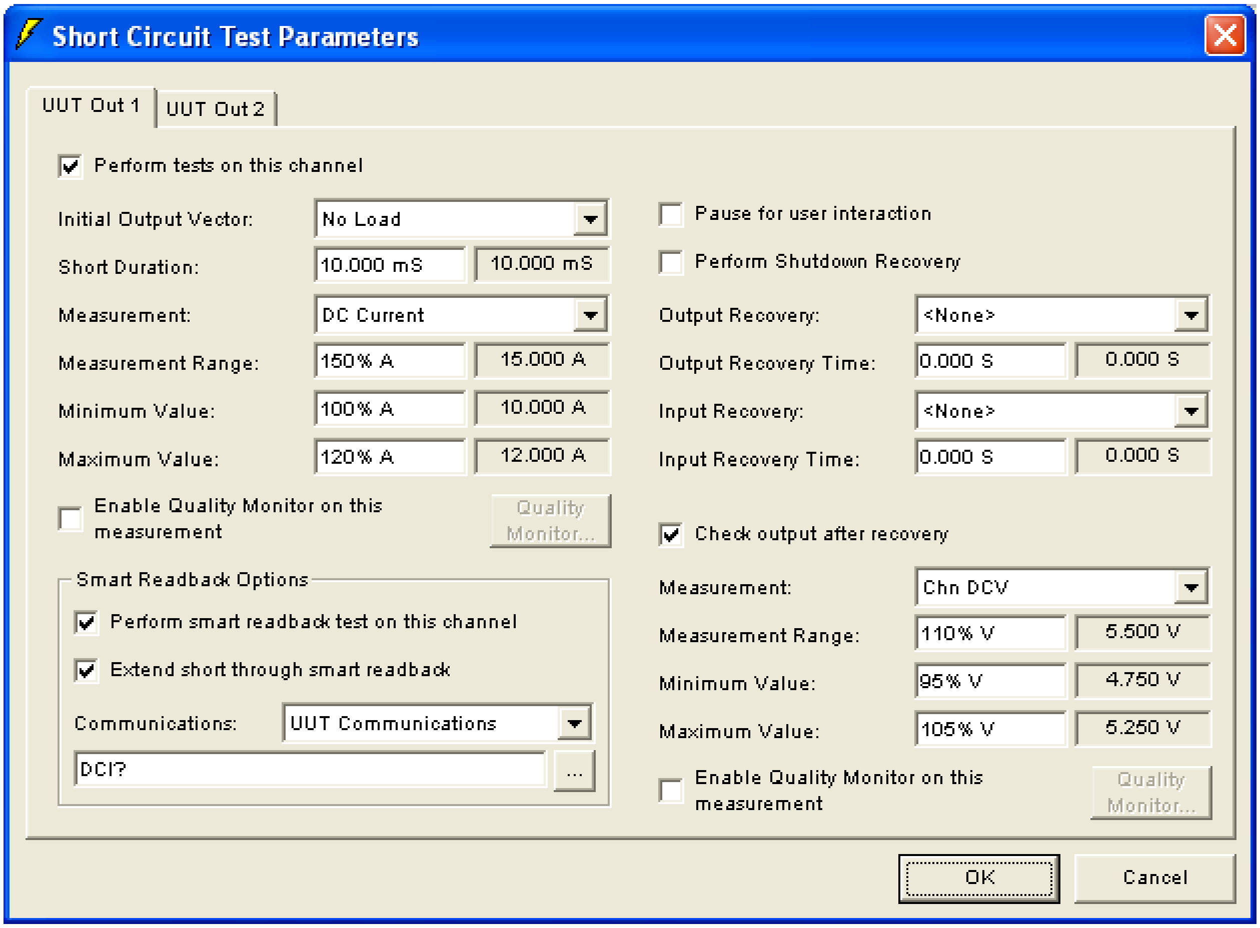
For each enabled output of the UUT, the test begins by setting an initial output vector, if specified, and applying the short circuit condition. After the specified short duration, the measurement is taken. The short is then removed by restoring the output to the operating mode active before the short was applied, unless instructed to extend through smart readback of the UUT. Pass or fail status is determined and the result is logged to the datalog devices.

If the Smart Readback option is selected, the measured value is passed to the UUT communications object as the reference value and the communication test is performed. Again, pass or fail status is determined and the result is logged to the datalog devices. The short is removed if it had not been previously removed.

If the UUT requires any user interaction in order to recover from the short circuit condition, such as manually pressing a reset button or closing a circuit breaker, a message box instructing the operator when to perform such action is presented. The test routine can also program all source devices attached to the UUT to zero volts to perform a shutdown recover sequence. An output recovery vector, recovery time and an input/digital recovery vector can all be programmed to aid the UUT recovery after the removal of the short.

To prove that the UUT has recovered, another measurement is taken. Again, pass or fail status is determined and the result is logged to the datalog devices.

24.3 Test Routine Properties



- Perform tests on this channel – check this box to perform the short circuit on this channel.
- Initial Output Vector – this output vector is applied before the output is shorted, allowing you to vary the loading when testing different outputs.
- Short Duration – the amount of time the short circuit should be active before taking the measurement. Note: the short is applied throughout the measurement cycle.
- Measurement – the measurement vector that will be used to take the measurement while the short is applied. Note that this must be a DMM-type measurement vector.
- Measurement Range – this is the maximum expected measured value. The value may be entered either as a value or a percentage of a channel reference. The appropriate reference is automatically selected based on the measurement vector entry. In the example above, the “UUT Out 1” Reference Current value will be used.
- Minimum Value - this is the allowable lower limit of the measured value. Measured values less than this will cause the test routine to fail. The value may be entered either as a value or a percentage of a channel reference.
- Maximum Value - this is the allowable upper limit of the measured value. Measured values greater than this will cause the test routine to fail. The value may be entered either as a value or a percentage of a channel reference.

- Collect Quality Monitor data on this measurement – check this box to enable Quality Monitor data collection.
- Quality Monitor… – press this button to display the Quality Monitor properties. Please refer to the Quality Monitor reference manual for further details.
- Perform smart readback test on this channel – check this box to perform the UUT communication section of the test routine.
- Extend short through smart readback – if this box is checked, the short will not be removed from the UUT until after the communication test has finished.
- Communications – select the desired UUT communication object from the drop-down list and press the ellipsis button for communications test parameters. Please refer to the appropriate UUT communications object reference manual for further details. The edit field to the left of the ellipsis button reflects the communications string to be sent to the UUT. The data may be entered here, or in the appropriate field in the UUT communications object.
- Pause for user interaction – checking this box will cause the test routine to display a message box informing the operator that the test has paused for user interaction.
- Perform Shutdown Recovery – check this box to set all inputs to zero volts to allow the UUT to recover from the short circuit.
- Output Recovery - this entry specifies the output vector used to allow the UUT to recover from the short circuit, if necessary.
- Output Recovery Time – this is the amount of time to delay after the short has been removed. This time is spent even if there was no output recovery performed.
- Input Recovery - this entry specifies the input vector or digital vector used to allow the UUT to recover from the short circuit, if necessary.
- Input Recovery Time – this is the amount of time to delay after the input recovery vector has been applied. This time is spent even if there was no input recovery performed.
- Check output after recovery – check this box to perform a measurement intended to prove that the output recovered once the short has been removed.
- Measurement – the measurement vector that will be used to take the recovery measurement.
- Measurement Range – this is the maximum expected measured value. The value may be entered either as a value or a percentage of a channel reference. The appropriate reference is automatically selected based on the measurement vector entry. In the example above, the "UUT Out 1" Reference Voltage value will be used.
- Minimum Value - this is the allowable lower limit of the measured value. Measured values less than this will cause the test routine to fail. The value may be entered either as a value or a percentage of a channel reference.
- Maximum Value - this is the allowable upper limit of the measured value. Measured values greater than this will cause the test routine to fail. The value may be entered either as a value or a percentage of a channel reference.

- Collect Quality Monitor data on this measurement – check this box to enable Quality Monitor data collection.
- Quality Monitor… – press this button to display the Quality Monitor properties. Please refer to the Quality Monitor reference manual for further details.

24.4 Sequence

The load, source, digital and analog vectors defined by the program are applied to the tester hardware before the test routine sequence is initiated.

1) For each UUT output:
   a) Set the Initial Output Vector, if applicable
   b) Apply the short circuit
   c) Delay the Short Duration
   d) Perform the measurement
   e) Restore the original output mode unless extending the short through the Smart Readback test
   f) Evaluate and log the result
   g) If performing the Smart Readback test:
      i) Set the ReferenceValue property equal to the measurement
      ii) Initiate the communication test
      iii) Log the result
   h) Restore the original output mode if the short was extended through the Smart Readback test
   i) Pause for user interaction, if necessary
   j) Send a RESET_VOLTAGE to all input containers if performing Shutdown Recovery
   k) Apply the Output Recovery vector, if necessary
   l) Delay the Output Recovery Time
   m) Apply the Input Recovery vector, if necessary
   n) Delay the Input Recovery Time
   o) If checking the output after recovery:
      i) Perform the measurement
      ii) Evaluate and log the result
   p) Check for faults and log them as necessary

25. SHORT CIRCUIT RECOVERY RAMP TEST

25.1 Description

This test applies a short circuit to a UUT output to verify that it will go into current limit and that it recovers properly after the short circuit has been removed. The short circuit is performed repeatedly, increasing or decreasing the value of the recovery condition for each pass through the loop.

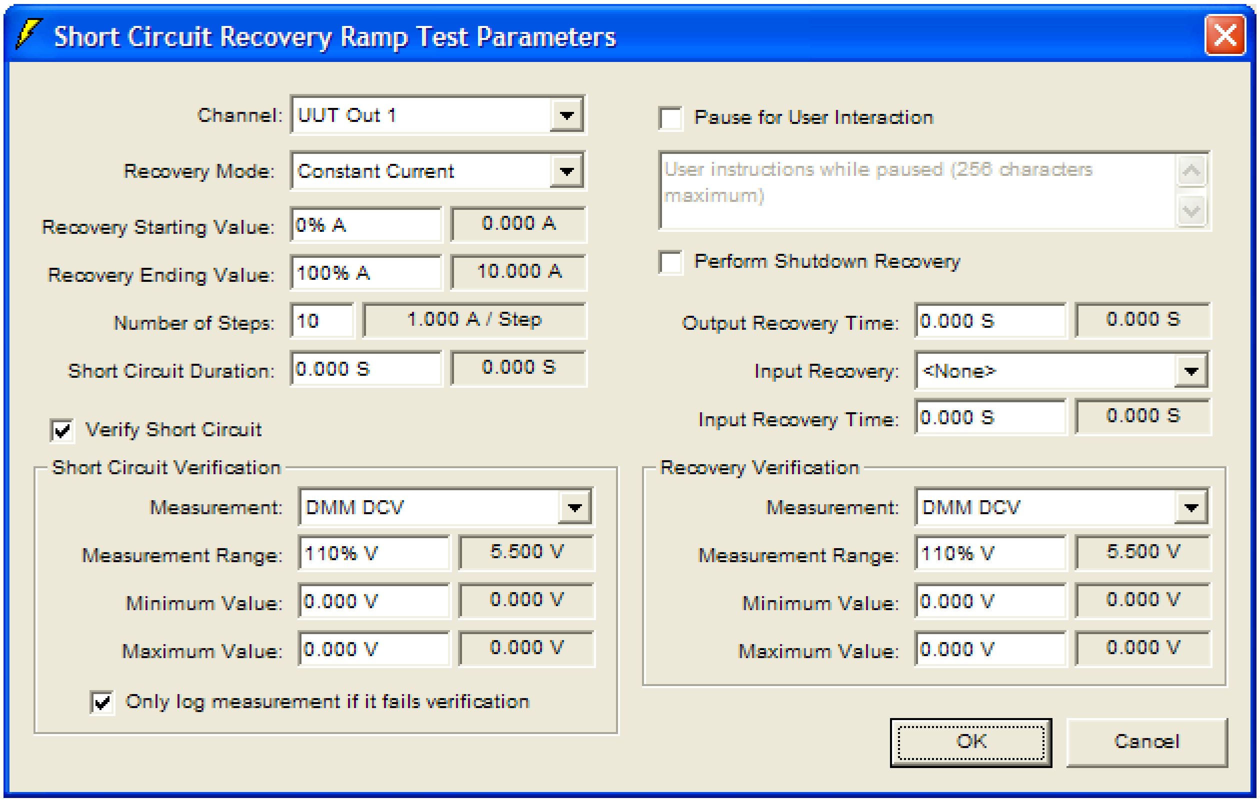
25.2 Method

The test begins by applying the short circuit condition. After the specified short duration, an optional verification measurement is taken to ensure that the unit collapsed sufficiently. This verification measurement may be logged to the datalog drivers. The short is then removed by placing the output in the specified recovery mode (Constant Current, Resistance, Voltage or Power) at the setting corresponding to the first ramp value.

If the UUT requires any user interaction in order to recover from the short circuit condition, such as manually pressing a reset button or closing a circuit breaker, a message box instructing the operator when to perform such action is presented. The test routine can also program all source devices attached to the UUT to zero volts to perform a shutdown recover sequence. An output recovery time and an input/digital recovery vector can be programmed to aid the UUT recovery after the removal of the short.

To prove that the UUT has recovered, another measurement is taken. Pass or fail status is determined and the result is logged to the datalog devices.

25.3 Test Routine Properties



- Channel – check this box to perform the short circuit on this channel.
- Recovery Mode – when the short is removed, the load will be set to this mode
- Recovery Starting Value – this is the value that will be combined with the selected Recovery Mode to determine the initial recovery state when the short circuit is removed.
- Recovery Ending Value – this is the last value that will be combined with the selected Recovery Mode.
- Number of Steps – determines the number of steps between the Starting and Ending values.
- Short Circuit Duration – the amount of time the short circuit will be active before setting the recovery mode and value. Note: the short is applied throughout the Short Circuit Verification measurement cycle if that option is enabled.
- Verify Short Circuit – select this option to perform a measurement to ensure the unit is shorted. If this option is selected, the following fields will be enabled:
  - Measurement – the measurement vector that will be used to take the measurement while the short is applied. Note that this must be a DMM-type measurement vector.
  - Measurement Range – this is the maximum expected measured value. The value may be entered either as a value or a percentage of a channel reference. The appropriate reference is automatically selected based on the measurement vector entry. In the example above, the “UUT Out 1” Reference Voltage value will be used.

   - Minimum Value - this is the allowable lower limit of the measured value. Measured values less than this will cause the test routine to fail. The value may be entered either as a value or a percentage of a channel reference.
   - Maximum Value - this is the allowable upper limit of the measured value. Measured values greater than this will cause the test routine to fail. The value may be entered either as a value or a percentage of a channel reference.
   - Only log measurement if it fails verification – if this option is selected, the Verification measurement will not be sent to the datalog unless the validation fails.
- Pause for user interaction – checking this box will cause the test routine to display a message box informing the operator that the test has paused for user interaction. Use the text box immediately below to enter instructions that will be displayed within the message box.
- Perform Shutdown Recovery – check this box to set all Inputs to zero volts to allow the UUT to recover from the short circuit.
- Output Recovery Time – this is the amount of time to delay after the short has been removed. This time delay occurs after the short circuit has been removed and the recovery state has been set.
- Input Recovery - this entry specifies the input vector or digital vector used to allow the UUT to recover from the short circuit, if necessary.
- Input Recovery Time – this is the amount of time to delay after the input recovery vector has been applied. This time is spent even if there was no Input Recovery performed.
- Recovery Verification – this section allows you to specify a measurement intended to prove that the output recovered once the short has been removed.
   - Measurement – the measurement vector that will be used to take the recovery measurement.
   - Measurement Range – this is the maximum expected measured value. The value may be entered either as a value or a percentage of a channel reference. The appropriate reference is automatically selected based on the measurement vector entry. In the example above, the "UUT Out 1" Reference Voltage value will be used.
   - Minimum Value - this is the allowable lower limit of the measured value. Measured values less than this will cause the test routine to fail. The value may be entered either as a value or a percentage of a channel reference.
   - Maximum Value - this is the allowable upper limit of the measured value. Measured values greater than this will cause the test routine to fail. The value may be entered either as a value or a percentage of a channel reference.

25.4 Sequence

The load, source, digital and analog vectors defined by the program are applied to the tester hardware before the test routine sequence is initiated.

1) For each step in the ramp:
   a) Apply the short circuit

b) Delay the Short Circuit Duration

c) Perform the Verification Measurement, if selected

d) Evaluate and log the Verification result, if selected

e) Remove the short by setting the Recovery mode and value (as defined by the loop)

f) Pause for user interaction, if necessary

g) Send a RESET_VOLTAGE to all input containers if performing Shutdown Recovery

h) Delay the Output Recovery Time

i) Apply the Input Recovery vector, if necessary

j) Delay the Input Recovery Time

k) Perform the Recovery Verification Measurement

l) Evaluate and log the Recovery Verification result

2) Check for faults and log them as necessary

26. SPLIT MEASUREMENT TEST

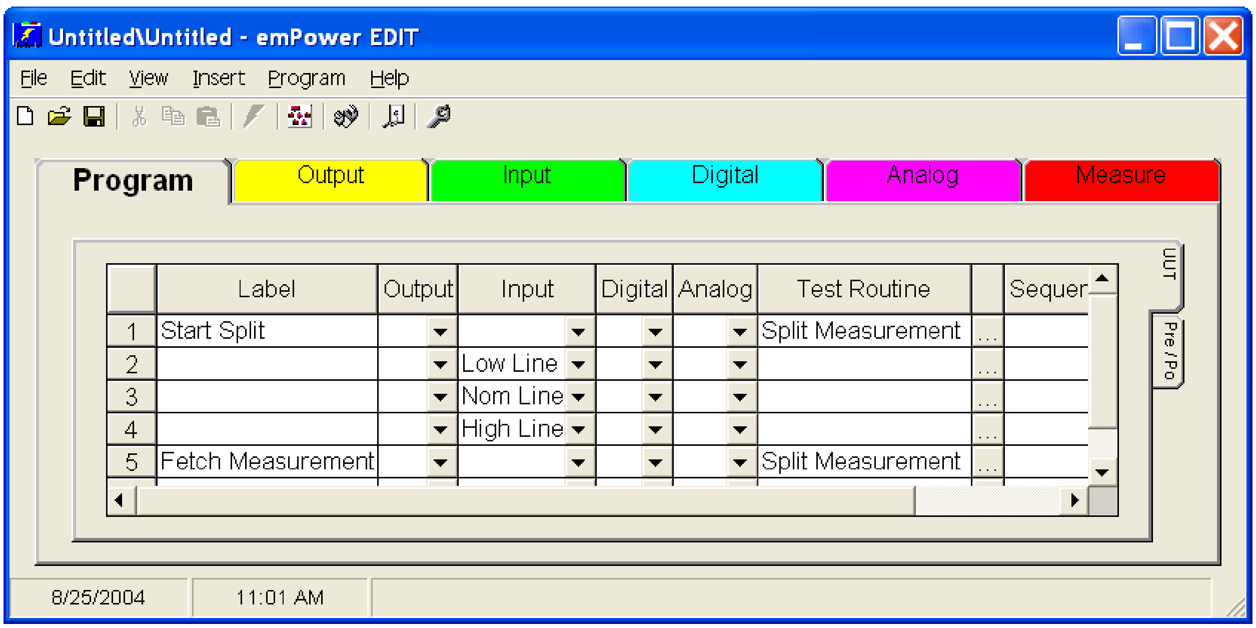
26.1 Description

This test routine provides the user with the ability to take a measurement that spans multiple *em***Power**® test steps.

The test is configured using two separate test steps. The first instance defines the measurement and begins the capture, and the second instance fetches the value and performs the datalog.

26.2 Method

The test begins by starting the measurement defined by the Setup Parameters. Control is then returned to *em***Power**® and test steps continue to run as defined by the test program. All test sequencing is performed as normal. Once the next instance of the Split Measurement test program is encountered where the "Fetch" option is selected the measured value will be evaluated and logged.



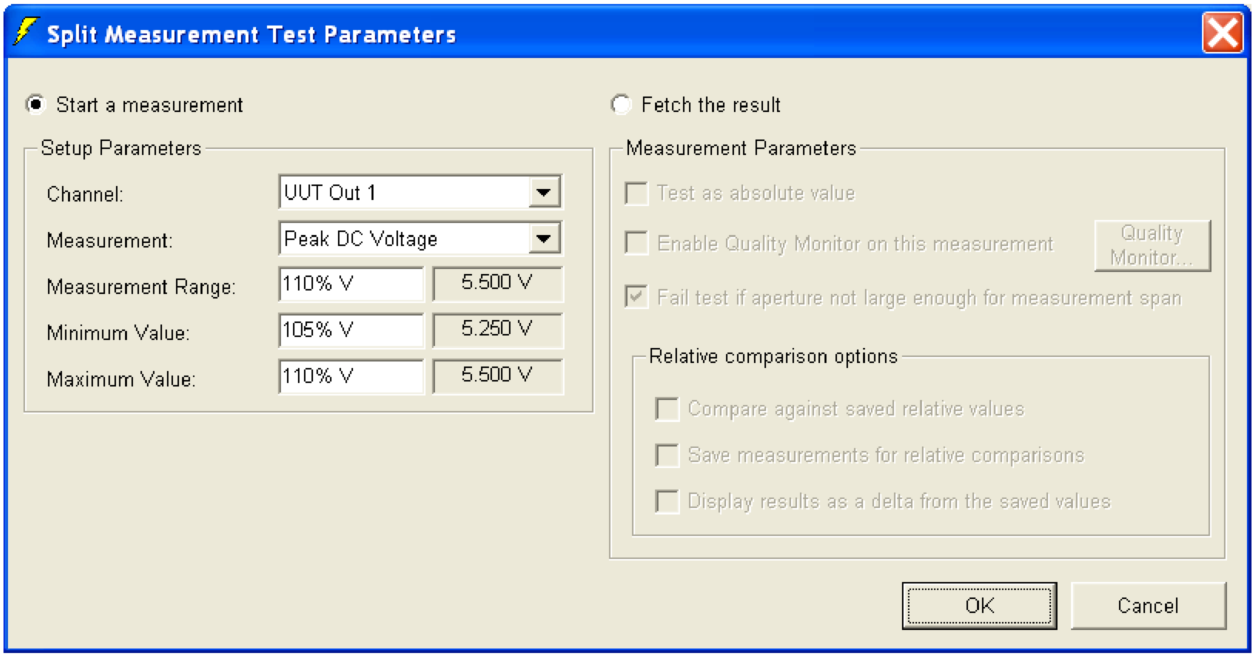
This test routine must be executed in pairs – a "Start" followed by a "Fetch". A failure will be logged if two sequential "Starts" are encountered, or a "Fetch" without a corresponding "Start".

WARNING: When you split a measurement between two or more steps, you CANNOT make any measurements using the same hardware that the split measurement is being captured on in between the start and fetch. An example would be to start a measurement on a mux input using the DMS measurement unit and then trying to capture a waveform using the PowerScope (also a DMS function).

26.3 Test Routine Properties

The Split Measurement routine has two sets of properties – one for defining the measurement and another for controlling the datalogging. Select the "Start a measurement" option to begin the split measurement, or "Fetch the result" to evaluate and log the result from a previous measurement.

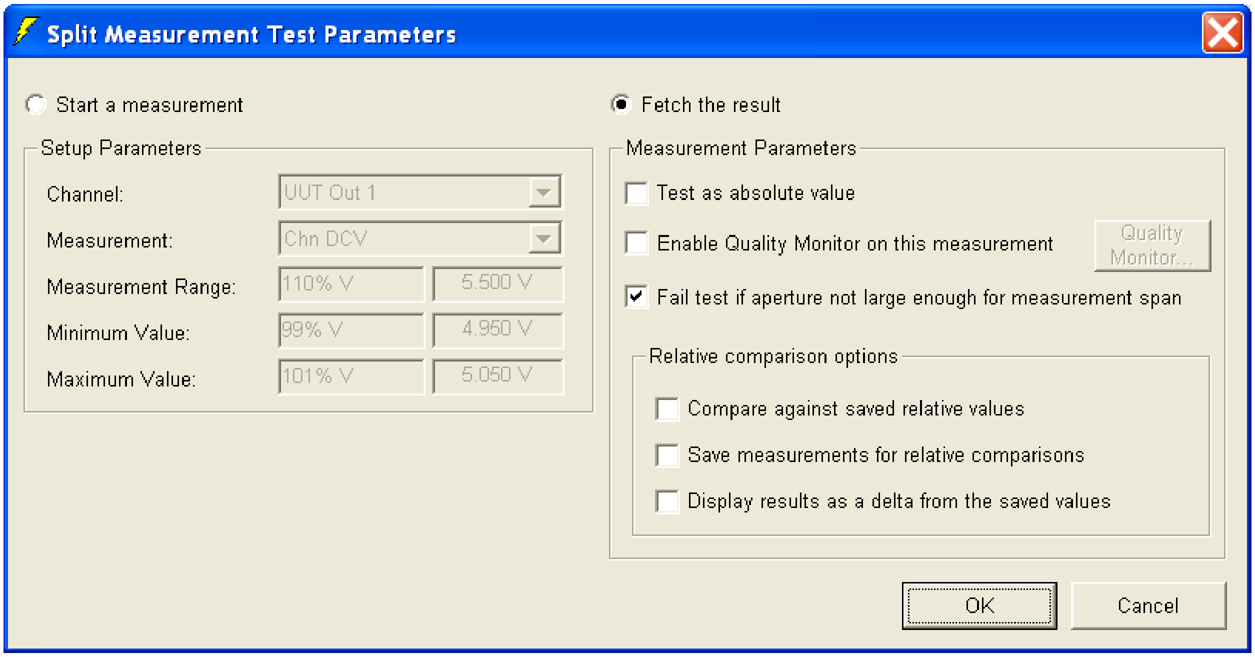
26.3.1 Start a Measurement



- Channel – the load or source channel to measure.
- Measurement – the measurement vector that will be used to take the measurement while the split is active. Be sure to specify a measurement aperture large enough to span the time between the start and fetch of the measurement. Note that this must be a DMM-type measurement vector.
- Measurement Range – this is the maximum expected measured value. The value may be entered either as a value or a percentage of channel reference. The appropriate reference is automatically selected based on the measurement vector entry. In the example above, the "UUT Out 1" Reference Voltage value will be used.
- Minimum Value - this is the allowable lower limit of the measured value. Measured values less than this will cause the test routine to fail. The value may be entered either as a value or a percentage of a channel reference.
- Maximum Value - this is the allowable upper limit of the measured value. Measured values greater than this will cause the test routine to fail. The value may be entered either as a value or a percentage of a channel reference.

Note: the Measurement Parameters fields are ignored during this phase of the test routine. It does not matter what data is contained in these fields.

26.3.2 Fetch the Result



- Test as absolute value – check this box to use the absolute value of the measurement for pass/fail evaluation.
- Enable Quality Monitor on this measurement – check this box to enable Quality Monitor data collection.
- Quality Monitor… – press this button to display the Quality Monitor properties. Please refer to the Quality Monitor reference manual for further details.
- Fail test if aperture not large enough for measurement span – check this box to ensure that the measurement is still in progress when the fetch request is made. With this option enabled you can be assured that the measurement device has captured your event. If the measurement is not active the aperture may have missed your event and a failure will be logged. Note: not all measurement hardware supports this feature.
- Compare against saved relative values – check this box to have the routine use a previously saved value instead of the reference value for measurement comparisons. Note that an error is logged if a measurement for this channel has not been previously saved. In that case, the test will continue using the reference value.
- Save measurements for relative comparisons – checking this selection will save the channel’s measurement for use in subsequent Split Measurement tests.
- Display results as a delta from the saved values – check this box to have the routine display the results as the difference of the measurement from the previously saved measured value.

Note: the Setup Parameters fields are ignored during this phase of the test routine. It does not matter what data is contained in these fields.

26.4 Sequence

The load, source, digital and analog vectors defined by the program are applied to the tester hardware before the test routine sequence is initiated.

1) If the test option is “Start a measurement”:
   a) Begin the measurement
   b) Check for faults and log them as necessary
2) If the test option is “Fetch the result”:
   a) If “Fail test if aperture not large enough for measurement span” is selected:
      i) If the measurement has already completed log a fault
   b) Fetch the measurement
   c) Evaluate and log the result
   d) Check for faults and log them as necessary

27. TIMESTAMP

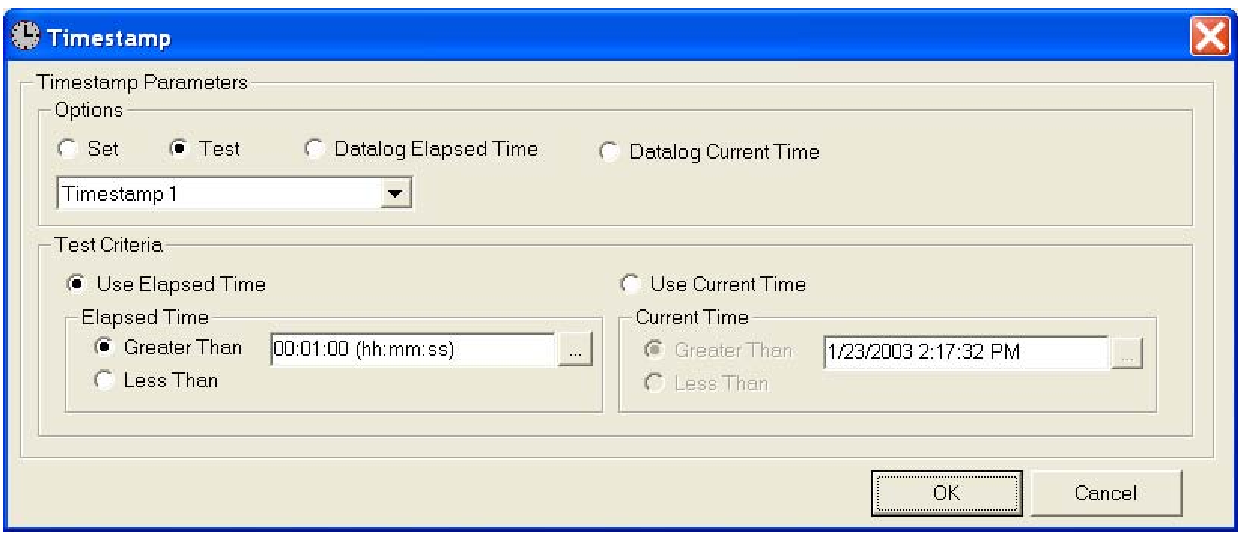
27.1 Description

The Timestamp test provides a way to time operations during the test run-time. Maximum and minimum times can be programmed to determine pass/fail status for UUT operations that must complete in a definite time period. Timing resolution is in seconds.

27.2 Method

Timestamps are normally used in pairs, bracketing other time-critical test steps. The first Timestamp is inserted before the operation to be timed with the Set option to clear the timer to zero. The second Timestamp is used after the operation to be timed with the Test option and the desired maximum or minimum times specified. If the elapsed time between timestamps was to long or short, and error is logged. Timestamps can also be used to stamp the current time and date in the test log, or test for test operation before or after a particular date.

27.3 Test Routine Properties



Set – Clears timer to zero

Test – Uses test criteria to determine pass or fail status

Datalog Elapsed Time – Places elapsed time from last Timestamp Set operation in test report

Datalog Current Time – Places current time and date in test report

Use Elapsed Time – Compare timer value from last Timestamp Set operation to limits to determine pass/fail test status.

Use Current Time – Compare host computer real time clock value to the specified time and date to determine pass/fail test status.

27.4 Sequence

The load, source, digital and analog vectors defined by the program are applied to the tester hardware before the test routine sequence is initiated.

1) If Set operation
   a) Clear Timestamp timer to 0
2) If Test Operation
   a) If Use Elapsed Time
      i) Capture Timestamp timer value
      ii) If Greater Than
         (1) Set error if timer value less than specified value
      iii) If Less Than
         (1) Set error if timer value greater than specified value
   b) If Use Current Time
      i) Capture Time and Date from host computer Real Time Clock
      ii) If Greater Than
         (1) Set error if Time and Date less than specified value
      iii) If Less Than
         (1) Set error if Time and Date greater than specified value
3) If Datalog Elapsed Time
   a) Capture Timestamp timer value
   b) Send captured Timestamp timer value to log file
4) If Datalog Current Time
   a) Capture Time and Date from host computer Real Time Clock
   b) Send captured Time and Date to log file

28. TIMING MEASUREMENT TEST

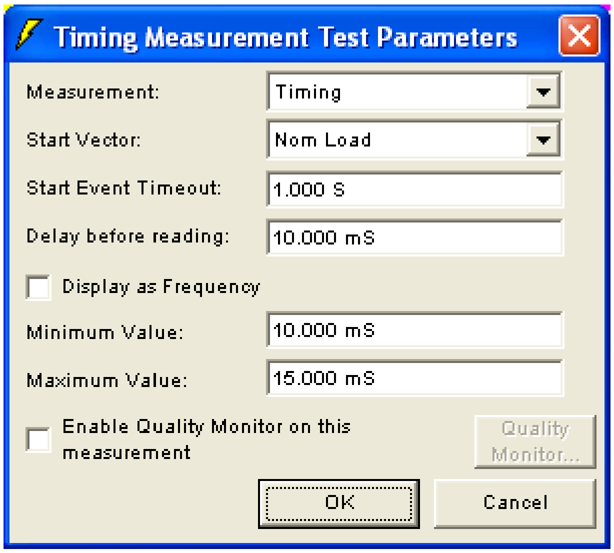
28.1 Description

This test is designed to perform a variety of general timing measurements including turn-on and hold-up times, rise and fall times, channel-to-channel timing, etc.

28.2 Method

The test begins by preparing the timing measurement device for the desired measurement as defined by the measurement vector. The Start Vector is applied, and after the Delay before reading, the timing value is obtained from the timing device. Pass or fail status is determined and the result is logged to the datalog devices.

28.3 Test Routine Properties



- Measurement – the measurement vector that will be used to take the measurement. Note that this must be a timing-type measurement vector.
- Start Vector – the vector that will initiate the measurement. The dropdown contains an entry for every Load, Source, Digital and Analog vector in the test program.
- Start Event Timeout – how long the timing device should wait for the start event to occur before generating a timeout error.
- Delay before reading – the amount of time you allow the timing device to acquire the measurement before fetching the value.
- Display as Frequency – show the measured value as a frequency instead of a timing
- Minimum Value - this is the allowable lower limit of the measured value. Measured values less than this will cause the test routine to fail.

- Maximum Value - this is the allowable upper limit of the measured value. Measured values greater than this will cause the test routine to fail.
- Collect Quality Monitor data on this measurement – check this box to enable Quality Monitor data collection.
- Quality Monitor… – press this button to display the Quality Monitor properties. Please refer to the Quality Monitor reference manual for further details.

28.4 Sequence

The load, source, digital and analog vectors defined by the program are applied to the tester hardware before the test routine sequence is initiated.

1) Initialize and arm the measurement device
2) Set the start vector
3) Delay before fetching the result
4) Evaluate and log the result
5) Check for faults and log them as necessary

29. TRANSIENT RESPONSE TEST

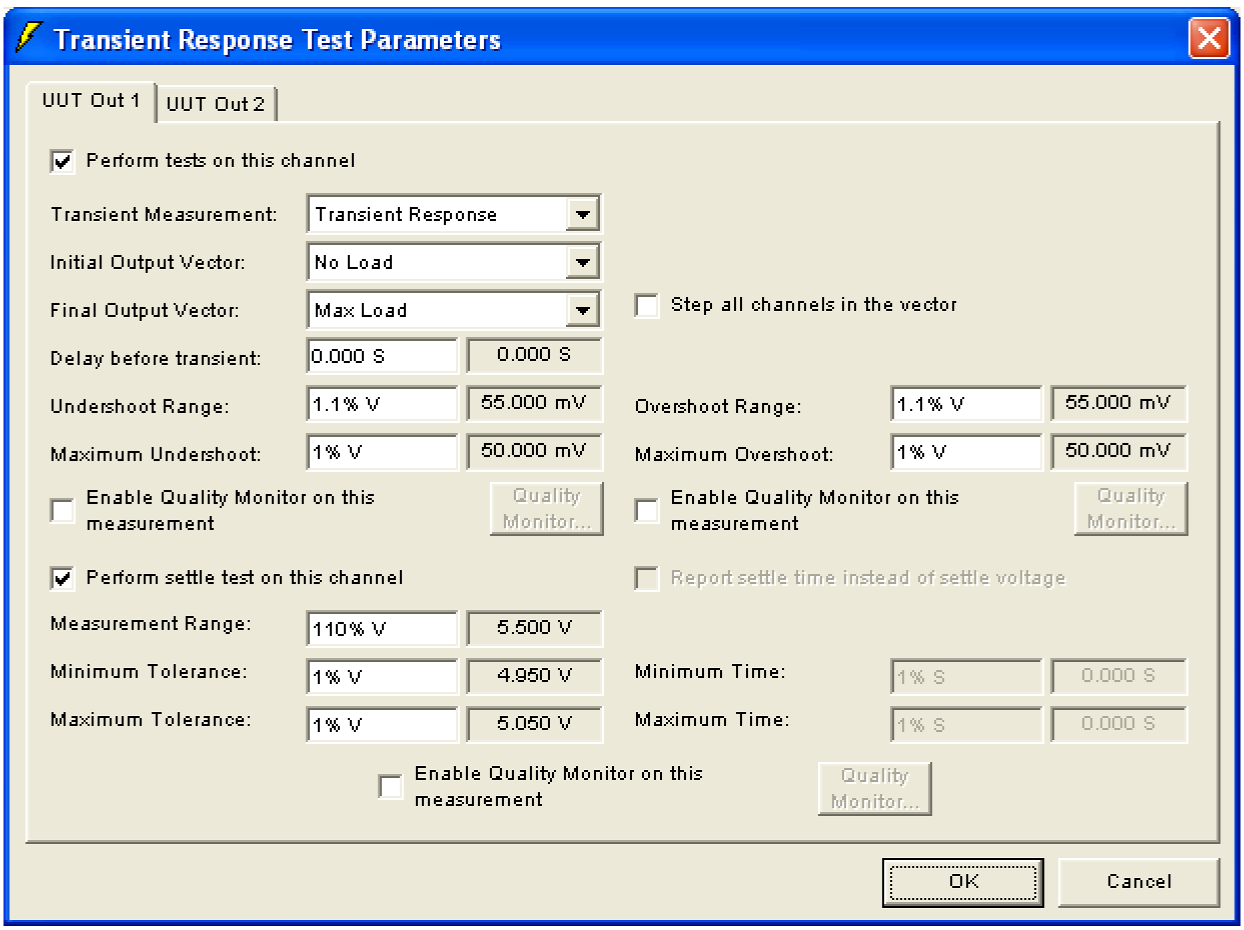
29.1 Description

This test routine will check the transient response of the UUT. The output will be subjected to a current change and voltage undershoot and overshoot will be measured. The output voltage may also be checked for proper settling after the transient has occurred.

29.2 Method

The undershoot transient is first performed by increasing the output current from the initial value to the final value. Returning the output current to its initial state performs the overshoot transient. If the settle test is performed, the output current is again set to the final value and the output voltage is sampled after the aperture time completes. Before continuing to the next output, the current is reset to its initial state.

29.3 Test Routine Properties



- Perform tests on this channel – check this box to perform the transient sequence on this channel.

- Transient Measurement – the measurement vector that will be used to perform the transient measurements. Note that this must be a transient-type measurement vector.
- Initial Output Vector – this output vector is applied before the transient. While under normal circumstances applying an output vector affects all outputs in the program, this test routine extracts the portion of the output vector specific to the active output and applies the properties to this output only.
- Final Output Vector – this output vector supplies the transient. Note that only the current setting for this specific output is used. Also, the Final Output Vector current must be greater than the Initial Output Vector current.
- Step all channels in the vector – check this box to synchronously apply the current settings for all UUT Outputs enabled for transient testing.
- Delay before transient – this delay occurs after the measurement device has been armed, but before the transient is applied.
- Undershoot Range – this is the maximum expected measured undershoot value. The value may be entered either as a value or a percentage of nominal channel voltage.
- Maximum Undershoot – this is the allowable upper limit of the measured undershoot value. Measured values greater than this will cause the test routine to fail. The value may be entered either as a value or a percentage of nominal channel voltage.
- Collect Quality Monitor data on this measurement – check this box to enable Quality Monitor data collection on the undershoot measurement.
- Quality Monitor… – press this button to display the Quality Monitor properties. Please refer to the Quality Monitor reference manual for further details.
- Overshoot Range – this is the maximum expected measured overshoot value. The value may be entered either as a value or a percentage of nominal channel voltage.
- Maximum Overshoot – this is the allowable upper limit of the measured overshoot value. Measured values greater than this will cause the test routine to fail. The value may be entered either as a value or a percentage of nominal channel voltage.
- Enable Quality Monitor on this measurement – check this box to enable Quality Monitor data collection on the overshoot measurement.
- Quality Monitor… – press this button to display the Quality Monitor properties. Please refer to the Quality Monitor reference manual for further details.
- Perform settle test on this channel – check this entry to sample the channel output voltage at the end of the transient window when going from initial to final current settings.
- Measurement Range – this is the maximum expected measured settle value. The value may be entered either as a value or a percentage of nominal channel voltage.
- Minimum Tolerance – this is the allowable lower limit of the measured settle value. Measured values less than this will cause the test routine to fail. The value may be entered either as a value or a percentage of nominal channel voltage.

- Maximum Tolerance – this is the allowable upper limit of the measured settle value. Measured values greater than this will cause the test routine to fail. The value may be entered either as a value or a percentage of nominal channel voltage.
- Report settle time instead of settle voltage – if the selected transient hardware supports measuring settle time this box will be enabled. Check the box to instruct the hardware to make the time measurement instead of the voltage measurement. When you make this choice, the Minimum and Maximum Tolerance values are interpreted as Minimum and Maximum threshold values. The UUT is deemed to have settled when the output stays within the window defined by these two values.
- Minimum Time – this is the allowable lower limit of the measured settle time. Measured values less than this will cause the test routine to fail. The value may be entered either as a value or a percentage of channel reference time.
- Maximum Time – this is the allowable upper limit of the measured settle time. Measured values greater than this will cause the test routine to fail. The value may be entered either as a value or a percentage of channel reference time.
- Collect Quality Monitor data on this measurement – check this box to enable Quality Monitor data collection on the settle measurement.
- Quality Monitor… – press this button to display the Quality Monitor properties. Please refer to the Quality Monitor reference manual for further details.

29.4 Sequence

The load, source, digital and analog vectors defined by the program are applied to the tester hardware before the test routine sequence is initiated.

1) For each UUT output:
   a) Calculate the required current for the transient by subtracting the initial input current from the final input current
   b) Apply the Initial Output Vector to the active output
   c) Get the load device that will perform the transient. The active output automatically finds the smallest device that can handle the required transient.
   d) Setup and arm the measurement device for the undershoot transient. If the transient hardware supports simultaneous undershoot and settle measurements, and the settle test is enabled, the settle measurement will also be gathered.
   e) Wait the delay time, then perform the transient by applying the Final Output Vector current
   f) Evaluate and log the undershoot result (and settle result, if applicable)
   g) Setup and arm the measurement device for the overshoot transient
   h) Wait the delay time, then perform the transient by restoring the Initial Output Vector current
   i) Evaluate and log the overshoot result

j) If performing the settle test and the hardware doesn't support simultaneous undershoot and settle tests:

    i) Setup and arm the measurement device for the settle transient

    ii) Wait the delay time, then perform the transient by applying the Final Output Vector current

    iii) Evaluate and log the settle result

    iv) Restore the output to the Initial Output Vector current setting

k) Check for faults and log them as necessary

30. TRANSIENT RESPONSE – MAXIMUM TOLERATED TEST

30.1 Description

This test routine will subject the UUT to a series of increasing transients in order to determine the maximum transient that the UUT can tolerate. Either the minimum voltage detected during the transient or the steady-state voltage measured after the transient has stopped can be used to determine if the UUT "tolerated" the transient. A waveform image of the maximum tolerated transient may be optionally logged. In addition to the minimum voltage, the maximum, peak-to-peak, low and high, and undershoot and overshoot values can also be logged.

30.2 Method

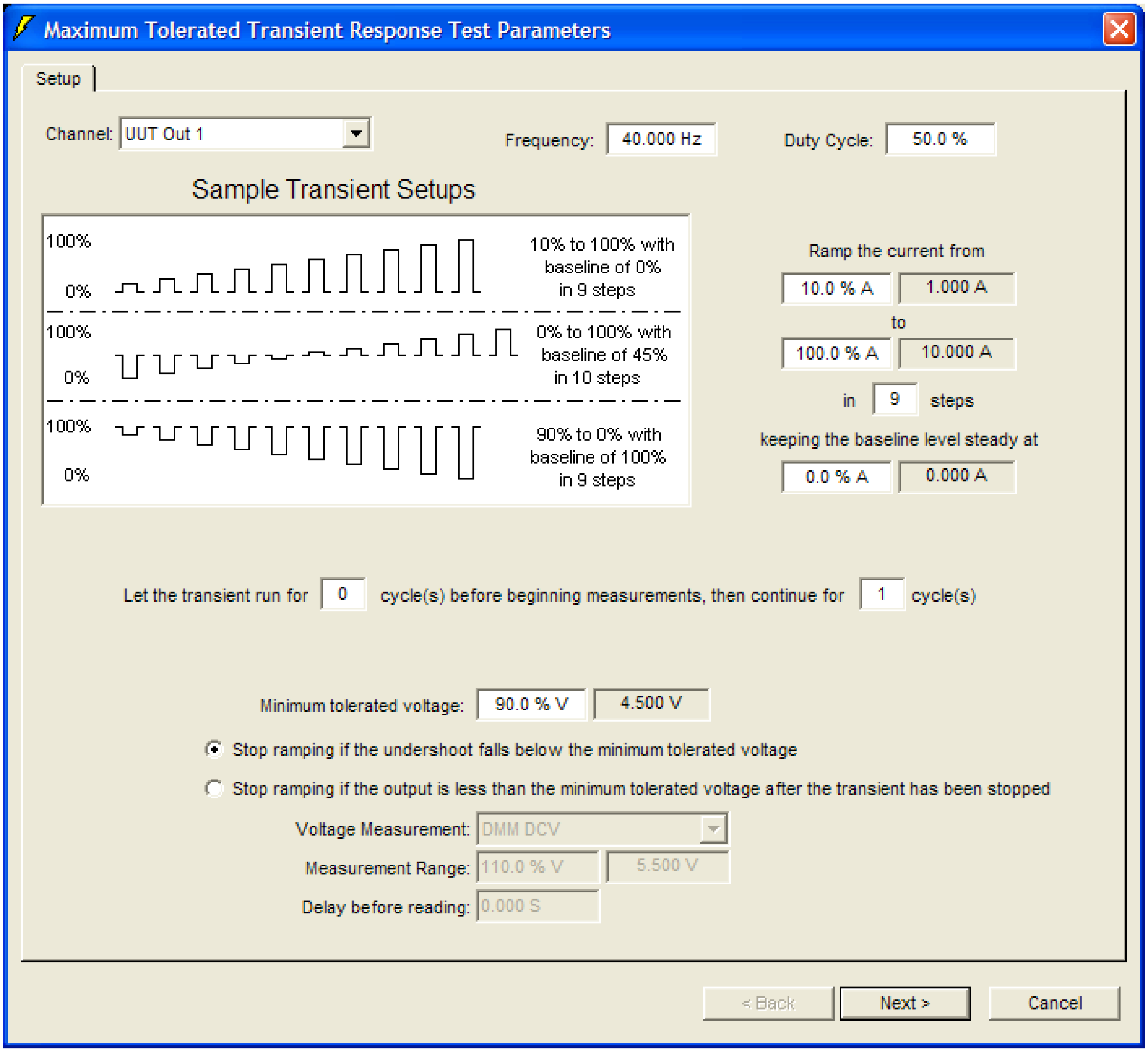
The test begins by programming the Output to pulse between a baseline current and the initial value specified by the ramp parameters, at a user-defined frequency and duty cycle. At each step, the measurements are collected. If the UUT tolerated the first pulse, the test continues by creating new transients between the baseline and each ramp step. If the UUT fails to tolerate a transient the ramp is stopped. At the end of the ramp, the test logs the values and image from the either the last step or the previous ramp step, as specified by the user. At the end of the test, the Output will be sitting at a steady-state value defined by the "baseline" parameter.

30.3 Test Routine Properties

The test routine is structured in a wizard-like format. Use the Next and Back buttons to navigate through the pages.

30.3.1 Setup

Use the Setup page to define the transient range. You can choose the Output to test, the current pulse amplitudes, and the frequency and duty cycle.

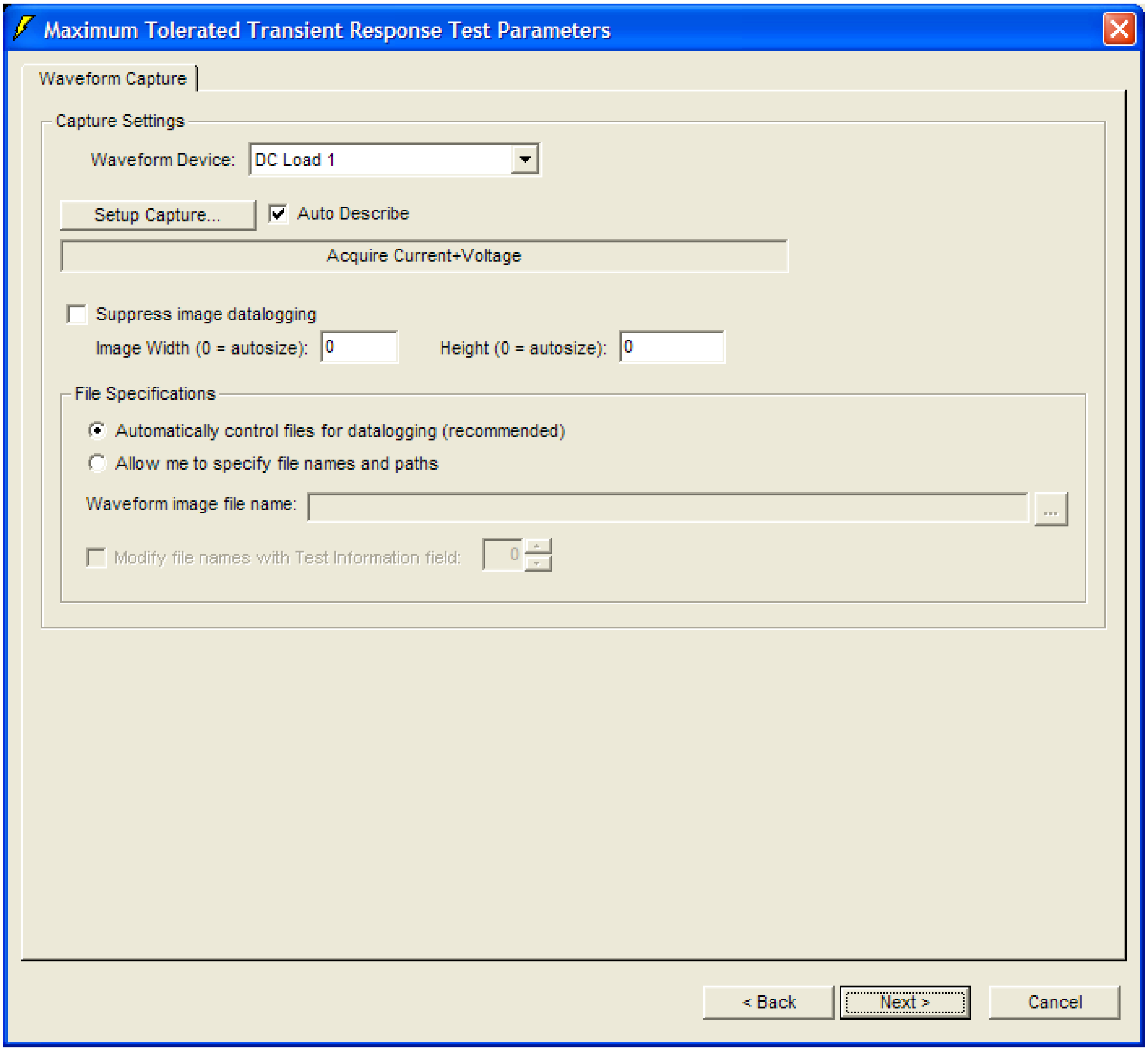


- Channel – defines the UUT output channel to test. Choose from any of the defined Outputs.
- Frequency – the frequency at which the transient pulse will operate.
- Duty Cycle – the duty cycle of the transient pulse.
- Ramp the current from X.X to X.X – defines the transient ramp limits. You can choose to ramp from low to high or high to low using these fields. Values can be entered as either direct values (in amps), or as percentages of the current reference of the selected channel.
- Steps – defines the number of steps the ramp will take between the current parameters.

- Keep the baseline level steady at – this parameter defines the beginning of the transient pulse levels. The test will create a transient that starts at this baseline and pulses to the values defined by the Ramp parameters.
- Let the transient run for X cycle(s) – the test will let the transient pulse execute for this specified number of cycles before beginning the measurements.
- Continue for X cycle(s) – this parameter defines the measurement aperture. The measurements will be taken while the transient executes for the specified number of cycles.
- Minimum tolerated voltage – the UUT output must remain at or above this value in order to "tolerate" the transient. If the output drops below this value the ramp will stop.
- Stop ramping if the undershoot exceeds the minimum tolerated voltage – select this option to check the output voltage while the transient is running. The measurement will use the minimum value reported during the transient. If the measurement is AC coupled, this value will probably be negative (as the undershoot value increases, it becomes more negative).
- Stop ramping if the output is less than the minimum tolerated voltage after the transient has been stopped – select this option to perform a DMM measurement on the output after the pulsing has been stopped. Choose this option if you expect the UUT to shutdown when the maximum tolerated transient has been exceeded.
    - Voltage Measurement – the measurement vector that will be used to take the measurement. Note that this must be a DMM-type voltage measurement vector.
    - Measurement Range – this is the maximum expected measured value. The value may be entered either as a value or a percentage of the voltage reference of the selected channel.
    - Delay before reading – the amount of time you allow the UUT to settle before beginning the measurement.

30.3.2 Waveform Capture

The test routine analyzes a captured waveform to determine the various measurements. This page allows you to specify the parameters that will control this waveform capture. In addition, you can choose to datalog an image of the capture.



- Waveform Device – allows you to select the device that will be used to capture the data. The list of available devices varies with the hardware installed. In the NHR default naming convention, waveform devices capable of accepting input external to the digitizer are named "External Waveform 1," 2, etc. If the digitizer gets the input internally, the devices are listed by the logical hardware name like "AC Load 1," "DC Load 1," etc. These devices can be given customized names by the user in the Configuration utility (see NH Document 09-0269).
- Setup Capture – this button brings up the Digitizer Device virtual scope front panel control. This panel is used to select ranges, trigger options, input coupling and termination, which channels to enable, and which system elements to connect to the enabled channels (see

section 38.3.1 for details.)

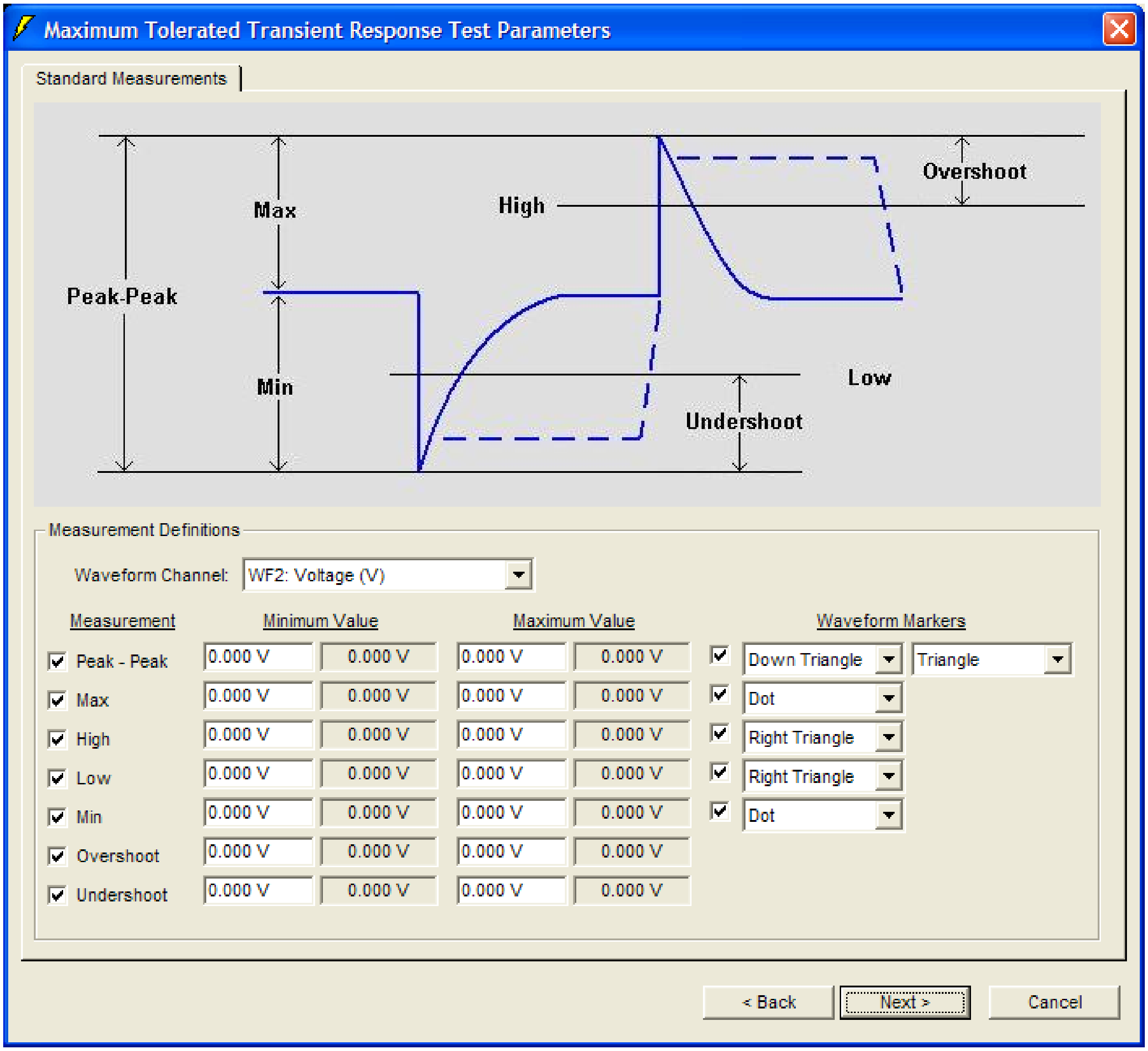
Typically you would set the channel coupling to AC, position the signal at 0.0, and set the vertical v/div to maximize the resolution, although you may DC couple and offset the signal to position it within the waveform area. The aperture value ("s/div") you select will be overridden by the test routine based on the frequency and number of cycles selected – you do not need to calculate an appropriate aperture. The trigger can be set to the falling edge of the selected waveform, or to System Trigger. Note: if you are using NHR Model 4100 loads to perform the current pulse, System Trigger can be used but it will result in a delayed start of the continuous pulse in relation to the trigger. Letting the transient run for at least one cycle before beginning the measurements will mitigate this offset.

You can enable the capture of additional signals (if supported by the Digitizer device).

- Auto Describe – this feature allows you to override the description of the waveform capture.
- Suppress image datalogging – if this option is selected, the test will still capture and process all measurements, but instead of displaying the measurement results AND the captured waveform image, only the measurement results will be displayed.
- Image Width and Height – these options allow you to specify the size of the image. Enter "0" to have the software calculate the optimal image size.
- File Specifications – These selection buttons determine whether files generated during this test are managed automatically or if you will choose the file and path. If the automatic method is chosen, the system will store waveform images in the most efficient way and insure that they can be viewed at a later time using the emPower Datalog capabilities.
- Waveform image file name – the .jpg image file showing the waveform image. Providing a file name than ends with a .bmp extension will generate a bitmap image (non-compressed).
- Modify file name with Test Information field – When enabled, a field from the Test Information Entry form will be appended to the user entered file name. The Test Information Entry form appears before running the test on each UUT, and is typically filled in by the test operator. Appending an information field provides a method of tracking specific digitizer samples to a particular UUT serial number or test pass. The number selection box determines which of the input fields from the Test Information Entry form will be appended to the file name.

30.3.3 Standard Measurements

There are seven measurements built-in to the routine. You control which measurements to make, what the acceptable minimum and maximum values are, and whether to display markers on the image to aid in discovering their location on the image.



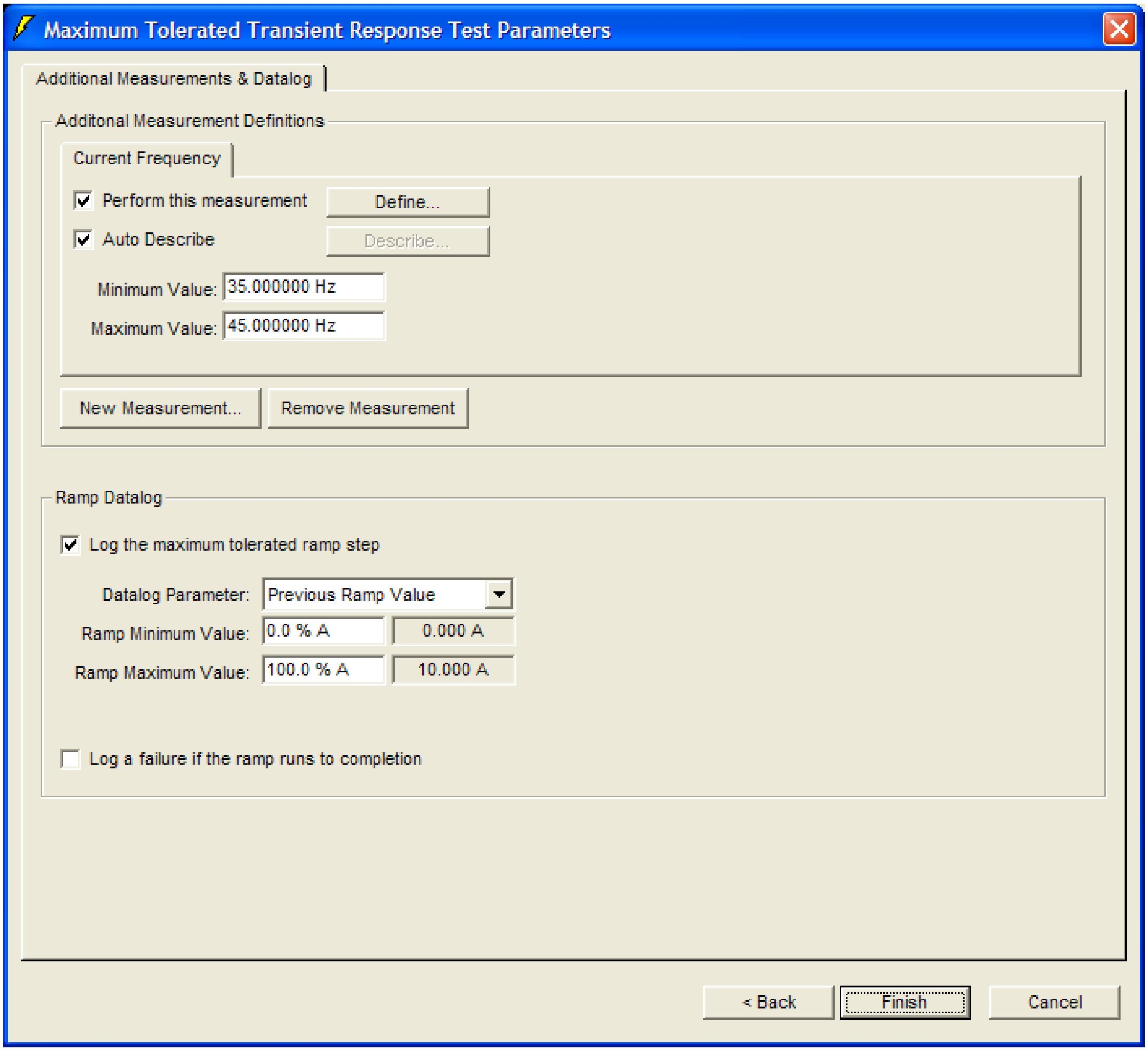
- Waveform Channel – allows you to select the waveform channel that will be used to capture the data. Many digitizers can capture data from multiple channels, while others cannot. With this option, you define which of the available digitizer channels contains the waveform data you wish to analyze.
- Measurement (check-box) – enables or disables the standard measurements.
  - *Peak-Peak* – the difference in amplitude between the highest and lowest sample points in the captured waveform. The number returned is positive regardless of whether the high and low sample points are both positive or negative.

- *Max* – the amplitude of the highest sample point in the captured waveform. This value may be positive or negative.
- *High* – the vertical amplitude at the top of the signal. The High value is the most common value above the midpoint of the acquired waveform. A histogram is used to derive the value. This statistical approach ignores short-term aberrations (such as overshoot and ringing), and is best used for examining pulse waveforms.
- *Low* – the vertical amplitude at the bottom of the signal. The Low value is the most common value below the midpoint of the acquired waveform. A histogram is used to derive the value. This statistical approach ignores short-term aberrations (such as undershoot and ringing), and is best used for examining pulse waveforms.
- *Min* – the amplitude of the lowest sample point in the captured waveform. This value may be positive or negative.
- *Overshoot* – the difference between the Max and High values. Note: you must select both Max and High in order to make the Overshoot measurement.
- *Undershoot* – the difference between the Low and Min values. Note: you must select both Low and Min in order to make the Undershoot measurement.

- Minimum Value - this is the allowable lower limit of the measured value. Measured values less than this will cause the test routine to fail. The value may be entered either as a value or a percentage of the Output nominal voltage.
- Maximum Value - this is the allowable upper limit of the measured value. Measured values greater than this will cause the test routine to fail. The value may be entered either as a value or a percentage of the Output nominal voltage.
- Waveform Markers (check-box) – enable these boxes to draw cursor lines and symbols on the captured image. Choose the desired symbols from the options to the right. For the peak-to-peak value, the left-most symbol controls the “minimum peak” value, and the right-most symbol is for the “maximum peak”.

30.3.4 Additional Measurements & Datalog

On this page, you are given the opportunity to augment the collection of measurements taken by this routine with any others provided by the Waveform analyzer, and specify how you would like to log the ramp parameters.



- New Measurement – initializes the data entry fields required for a new measurement. Any number of the available measurements can be added to a single Worst-case Transient test, and will be represented in a tabbed list for review or modification.
- Define… – opens a selection form for choosing among all available measurements that can be performed on captured data. The methods and properties for each measurement are described in the Waveform Test Routine section (see 38.3.5).
- Auto Describe – if checked, the measurement is described by combining the name of the Waveform Channel to be measured with the measurement function (e.g. "frequency"). If unchecked, the user is prompted to provide a description of this measurement.

- Minimum Value - this is the allowable lower limit of the measured value. Measured values less than this will cause the test routine to fail.
- Maximum Value - this is the allowable upper limit of the measured value. Measured values greater than this will cause the test routine to fail.
- Remove Measurement – removes the currently selected measurement.
- Log the maximum tolerated ramp step – select this to enable logging of the ramp step where the UUT failed to tolerate the transient.
  - Datalog Parameter – either “Ramp Value” or “Previous Ramp Value”, to log the step the UUT failed to tolerate, or the last value that the UUT tolerated, respectively. If you choose to log the previous value, and the ramp stops at the first value or the ramp runs to completion, the actual ramp value is logged instead.
  - Ramp Minimum Value – this is the allowable lower limit of the ramp parameter value. Values less than this will cause the test routine to fail.
  - Ramp Maximum Value – this is the allowable upper limit of the ramp parameter value. Values greater than this will cause the test routine to fail.
- Log a failure if the ramp runs to completion – check this box to log an error if you expect the ramp to stop before reaching the last ramp value and it doesn’t.

30.4 Sequence

The load, source, digital and analog vectors defined by the program are applied to the tester hardware before the test routine sequence is initiated.

1) Set the Output to the “baseline” value.
2) For each ramp step:
   a) Create a current pulse from the baseline to the ramp step with the specified duty cycle and specified frequency.
   b) Arm a waveform capture.
   c) Begin executing a continuous pulse on the Output.
   d) Make the measurements.
   e) Stop the current pulse and set the Output to the baseline value.
   f) If the minimum measurement exceeds the Minimum Tolerated Voltage, stop ramping.
   g) If an error is encountered, log the failure and abort the test.
3) Datalog the measurements and image.
4) Check for faults and log them as necessary.

31. TRANSIENT RESPONSE – WORST CASE TEST

31.1 Description

This test routine will report the worst-case transient response of the UUT. The output will be subjected to a series of current pulses, varying in both frequency and duty cycle. The peak-to-peak voltage is measured during each setup, and the maximum recorded value is reported. A waveform image of this worst-case transient may be optionally logged. In addition to the peak-to-peak value, the minimum and maximum, low and high, and undershoot and overshoot values can also be logged.

31.2 Method

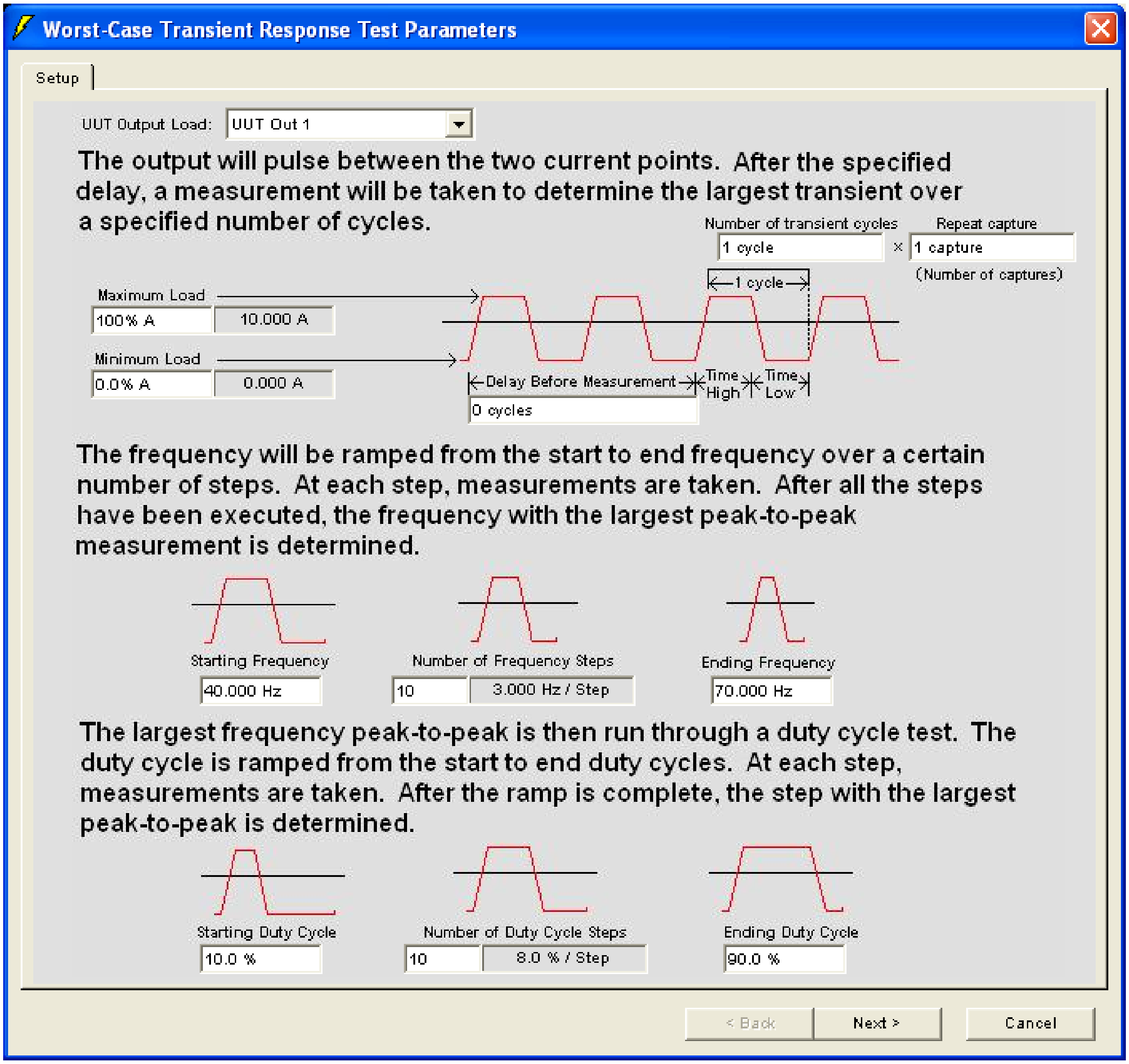
The test begins by programming the Output to pulse between two specified current points at a specified starting frequency with a fixed 50% duty cycle. This frequency is ramped to the specified ending frequency. At each step, the measurements are collected. Once the entire frequency range has been executed, the Output is programmed to pulse at the frequency that generated the greatest peak-to-peak value beginning at the specified starting duty cycle. This duty cycle is then ramped to the specified ending duty cycle, at that fixed frequency, with measurements collected at each step. Once the entire duty cycle range has been executed, the test logs the values and image from the combination that created the greatest (i.e. worst-case) transient response. At the end of the test, the Output will be sitting at a steady-state value defined by the Minimum Load parameter.

31.3 Test Routine Properties

The test routine is structured in a wizard-like format. Use the Next and Back buttons to navigate through the pages.

31.3.1 Setup

Use the Setup page to define the transient. You can choose the Output to test, the current pulse amplitudes, and the frequency and duty cycle ranges.

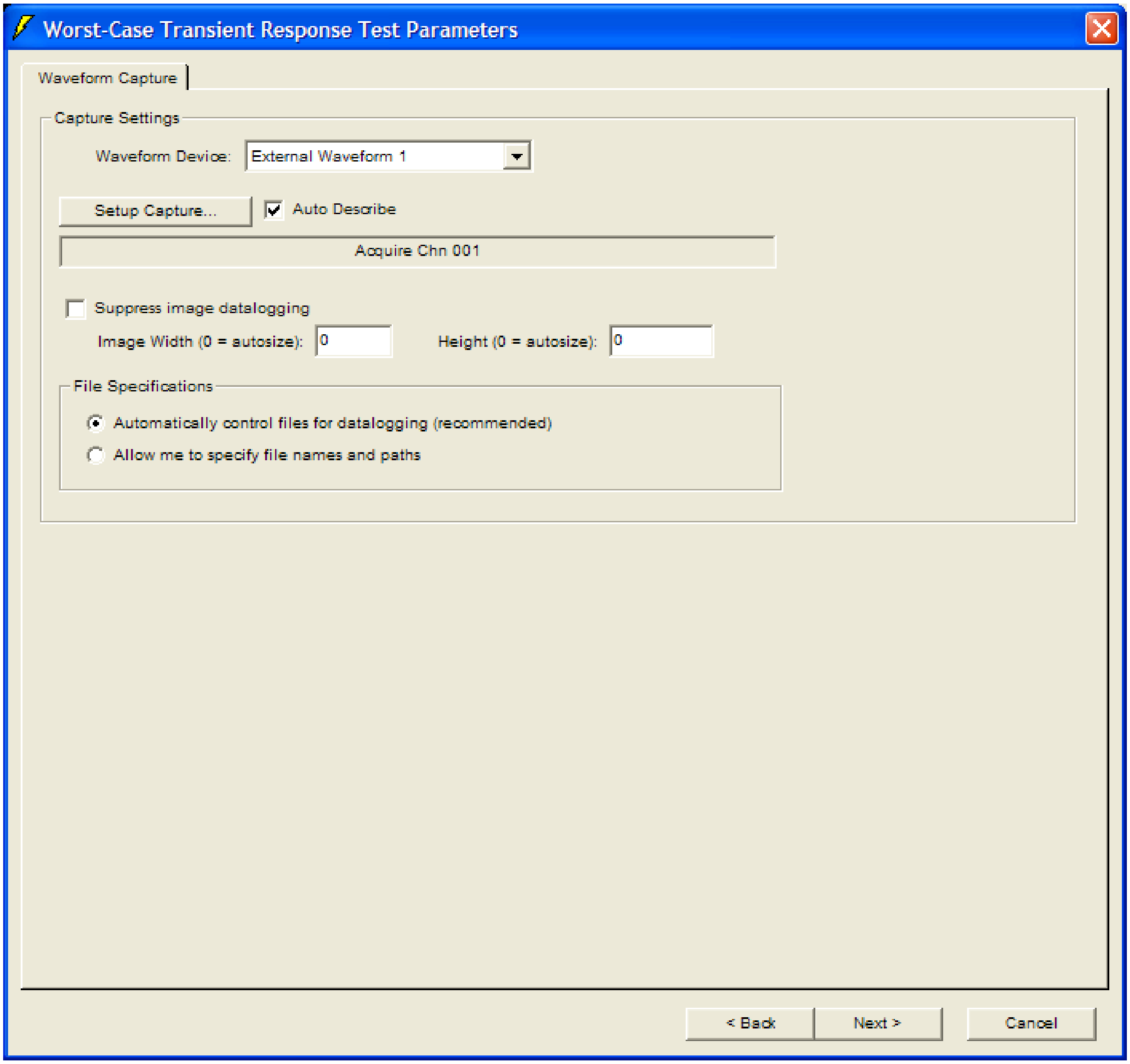


- UUT Output – defines the output channel to use when making the measurement. Choose from any of the defined Outputs.
- Maximum Load – the high value of the load used to create the transient pulse. This may be entered as a value or a percentage of the Output current reference. Note: the value must be greater than the Minimum Load value.
- Minimum Load – the low value of the load used to create the transient pulse. This may be entered as a value or a percentage of the Output current reference. Note: the value must be less than the Maximum Load value.
- Number of transient cycles – specifies the number of transient cycles to capture and measure.

- Number of captures – indicates the number of times you wish to repeat the capture. Only the measurement with the highest peak-to-peak value will be retained.
- Delay Before Measurement – indicates the number of cycles you wish the load to execute before the measurement capture is begun.
- Starting Frequency – for the frequency portion of the test, the transient pulse will begin with this frequency, and a 50% duty cycle.
- Number of Frequency Steps – the number of steps to take when ramping from the starting frequency value to the ending frequency value. If you wish to run the test at a single frequency, enter the same value for both Starting and Ending Frequency, and set the Number of Frequency Steps to 0.
- Ending Frequency – for the frequency portion of the test, the transient pulse will end with this frequency, and a 50% duty cycle.
- Starting Duty Cycle – for the duty cycle portion of the test, the transient pulse will begin with this value at the frequency that generated the maximum peak-to-peak values.
- Number of Duty Cycle Steps – the number of steps to take when ramping from the starting duty cycle value to the ending duty cycle value. If you wish to run the test at a single duty cycle, enter the same value for both Starting and Ending Duty Cycle, and set the Number of Duty Cycle Steps to 0. Note: a test is always performed at 50% regardless of the duty cycle values you enter.
- Ending Duty Cycle – for the duty cycle portion of the test, the transient pulse will end with this value at the frequency that generated the maximum peak-to-peak values.

31.3.2 Waveform Capture

The test routine analyzes a captured waveform to determine the various measurements. This page allows you to specify the parameters that will control this waveform capture. In addition, you can choose to datalog an image of the capture.



- Waveform Device – allows you to select the device that will be used to capture the data. The list of available devices varies with the hardware installed. In the NHR default naming convention, waveform devices capable of accepting input external to the digitizer are named "External Waveform 1," 2, etc. If the digitizer gets the input internally, the devices are listed by the logical hardware name like "AC Load 1," "DC Load 1," etc. These devices can be given customized names by the user in the Configuration utility (see NH Document 09-0269).
- Setup Capture – this button brings up the Digitizer Device virtual scope front panel control. This panel is used to select ranges, trigger options, input coupling and termination, which

channels to enable, and which system elements to connect to the enabled channels (see section 38.3.1 for details.)

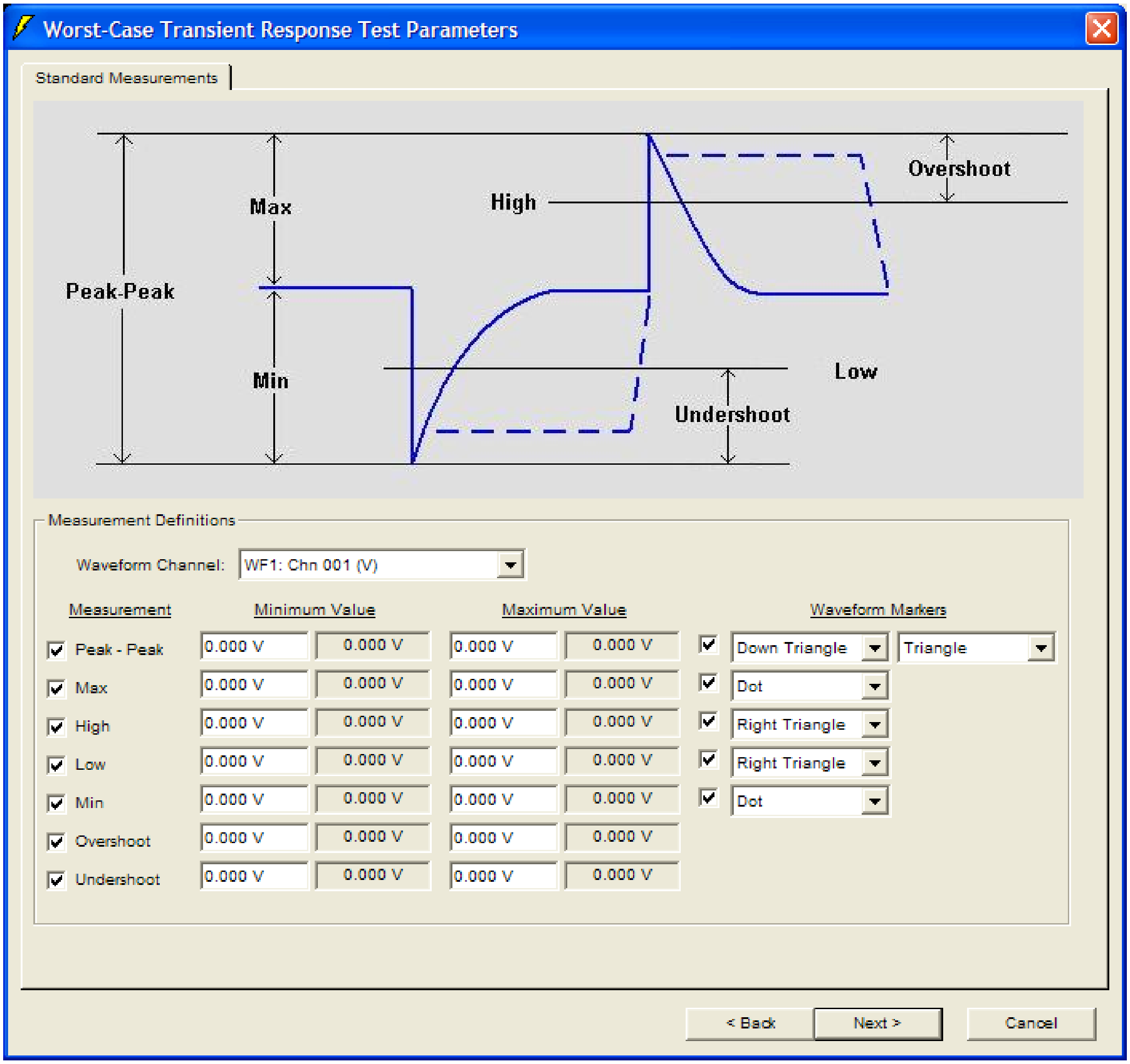
Typically you would set the channel coupling to AC, position the signal at 0.0, and set the vertical v/div to maximize the resolution, although you may DC couple and offset the signal to position it within the waveform area. The aperture value ("s/div") you select will be overridden by the test routine as it ramps through the frequency values. You do <u>not</u> need to calculate an aperture that will be sufficient for all. The trigger can be set to the falling edge of the selected waveform, or to System Trigger. Note: if you are using NHR Model 4100 loads to perform the current pulse, System Trigger can be used but it will result in a delayed start of the continuous pulse in relation to the trigger. Selecting a Delay Before Measurement of at least one cycle will mitigate this offset.

You can enable the capture of additional signals (if supported by the Digitizer device).

- Auto Describe – this feature allows you to override the description of the waveform capture.
- Suppress image datalogging – if this option is selected, the test will still capture and process all measurements, but instead of displaying the measurement results AND the captured waveform image, only the measurement results will be displayed.
- Image Width and Height – these options allow you to specify the size of the image. Enter "0" to have the software calculate the optimal image size.
- File Specifications – These selection buttons determine whether files generated during this test are managed automatically or if you will choose the file and path. If the automatic method is chosen, the system will store waveform images in the most efficient way and insure that they can be viewed at a later time using the emPower Datalog capabilities.

31.3.3 Standard Measurements

There are seven measurements built-in to the routine. You control which measurements to make, what the acceptable minimum and maximum values are, and whether to display markers on the image to aid in discovering their location on the image.

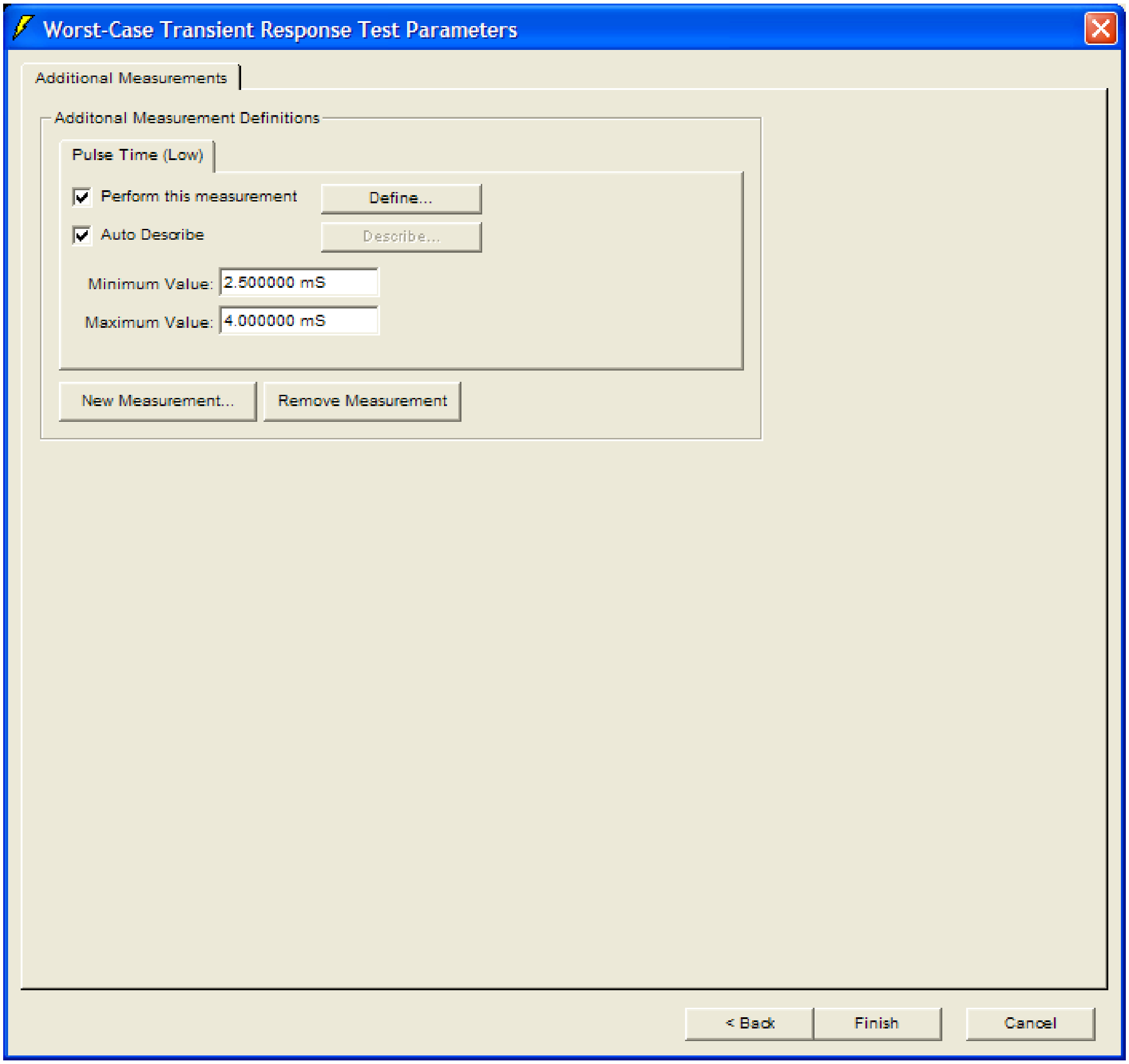


- Waveform Channel – allows you to select the waveform channel that will be used to capture the data. Many digitizers can capture data from multiple channels, while others cannot. With this option, you define which of the available digitizer channels contains the waveform data you wish to analyze.
- Measurement (check-box) – enables or disables the standard measurements.
  - *Peak-Peak* – the difference in amplitude between the highest and lowest sample points in the captured waveform. The number returned is positive regardless of whether the high and low sample points are both positive or negative.

  - *Max* – the amplitude of the highest sample point in the captured waveform. This value may be positive or negative.
  - *High* – the vertical amplitude at the top of the signal. The High value is the most common value above the midpoint of the acquired waveform. A histogram is used to derive the value. This statistical approach ignores short-term aberrations (such as overshoot and ringing), and is best used for examining pulse waveforms.
  - *Low* – the vertical amplitude at the bottom of the signal. The Low value is the most common value below the midpoint of the acquired waveform. A histogram is used to derive the value. This statistical approach ignores short-term aberrations (such as undershoot and ringing), and is best used for examining pulse waveforms.
  - *Min* – the amplitude of the lowest sample point in the captured waveform. This value may be positive or negative.
  - *Overshoot* – the difference between the Max and High values. Note: you must select both Max and High in order to make the Overshoot measurement.
  - *Undershoot* – the difference between the Low and Min values. Note: you must select both Low and Min in order to make the Undershoot measurement.
- Minimum Value - this is the allowable lower limit of the measured value. Measured values less than this will cause the test routine to fail. The value may be entered either as a value or a percentage of the Output nominal voltage.
- Maximum Value - this is the allowable upper limit of the measured value. Measured values greater than this will cause the test routine to fail. The value may be entered either as a value or a percentage of the Output nominal voltage.
- Waveform Markers (check-box) – enable these boxes to draw cursor lines and symbols on the captured image. Choose the desired symbols from the options to the right. For the peak-to-peak value, the left-most symbol controls the "minimum peak" value, and the right-most symbol is for the "maximum peak".

31.3.4 Additional Measurements

On this page, you are given the opportunity to augment the collection of measurements taken by this routine with any others provided by the Waveform analyzer.

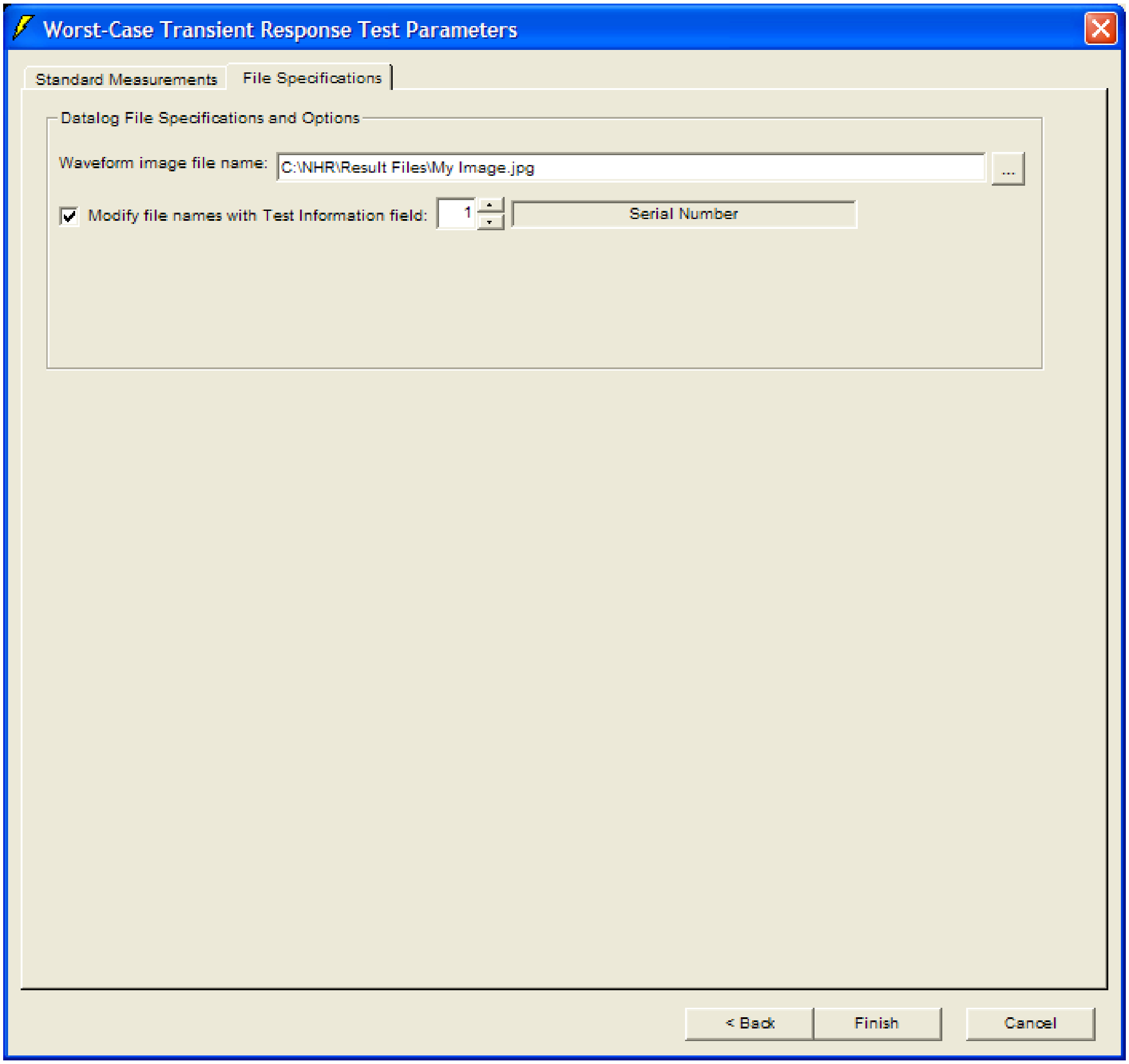


- New Measurement – initializes the data entry fields required for a new measurement. Any number of the available measurements can be added to a single Worst-case Transient test, and will be represented in a tabbed list for review or modification.
- Define… – opens a selection form for choosing among all available measurements that can be performed on captured data. The methods and properties for each measurement are described in the Waveform Test Routine section (see 38.3.5).
- Auto Describe – if checked, the measurement is described by combining the name of the Waveform Channel to be measured with the measurement function (e.g. "frequency"). If unchecked, the user is prompted to provide a description of this measurement.

- Minimum Value - this is the allowable lower limit of the measured value. Measured values less than this will cause the test routine to fail.
- Maximum Value - this is the allowable upper limit of the measured value. Measured values greater than this will cause the test routine to fail.
- Remove Measurement – removes the currently selected measurement.

31.3.5 File Specifications

If you chose to manually specify file names and paths for the image, you need to define those parameters here. This may require significant disk storage and slow test times.



- Waveform image file name – the .jpg image file showing the waveform image. Providing a file name than ends with a .bmp extension will generate a bitmap image (non-compressed).

- Modify file name with Test Information field – When enabled, a field from the Test Information Entry form will be appended to the user entered file name. The Test Information Entry form appears before running the test on each UUT, and is typically filled in by the test operator. Appending an information field provides a method of tracking specific digitizer samples to a particular UUT serial number or test pass. The number selection box determines which of the input fields from the Test Information Entry form will be appended to the file name.

31.4 Sequence

The load, source, digital and analog vectors defined by the program are applied to the tester hardware before the test routine sequence is initiated.

1) Set the Output to the Minimum Load value.
2) For each Frequency step:
    a) Create a current pulse from Minimum Load to Maximum Load with a 50% duty cycle at the specified frequency.
    b) Arm a waveform capture.
    c) Begin executing a continuous pulse on the Output.
    d) Make a peak-to-peak measurement. If the peak-to-peak measurement is the largest collect so far:
        i) Make all the other measurements as required.
        ii) Save the waveform image.
        iii) Save the frequency value.
    e) Stop the current pulse and set the Output to the Minimum Load value.
    f) If an error is encountered, log the failure and abort the test.
3) For each Duty Cycle step:
    a) Create a current pulse from Minimum Load to Maximum Load with the specified duty cycle at the saved frequency.
    b) Arm a waveform capture.
    c) Begin executing a continuous pulse on the Output.
    d) Make a peak-to-peak measurement. If the peak-to-peak measurement is the largest collect so far:
        i) Make all the other measurements as required.
        ii) Save the waveform image.
        iii) Save the duty cycle value.
    e) Stop the current pulse and set the Output to the Minimum Load value.
    f) If an error is encountered, log the failure and abort the test.
4) Datalog the measurements and image corresponding to the maximum peak-to-peak value.

5) Check for faults and log them as necessary.

32. TURN-ON / TURN-OFF MEASUREMENT TEST

32.1 Description

The Turn-On / Turn-Off test routine is used to perform timing and other dynamic measurements of the UUT during power up or down cycles. The standard measurements collected for each UUT input or output during a power-up cycle include turn-on time, rise time, settle time, settle value, peak value and overshoot of both voltage and current. During a power-off cycle the measurements include hold-up time, fall time, settle time, settle value, minimum value and undershoot. When the UUT has more than one output the measurements can be compared to each other to test turn-on and turn-off sequencing. In addition, input measurements can be compared to output measurements.

A graphical image of the power cycle can be created and logged with the test results and Quality Monitor data can be collected on each measurement.

NOTE: This routine requires that a Model 4200 or 4700 Series DC Load be connected to each output under test and a Model 6100 Series DC Source connected to each input. Inputs and Outputs that do not have the appropriate hardware connections will be disabled.

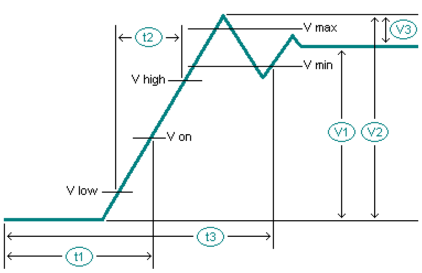
32.2 Method

The test begins by applying a Start Event. The start event can be any Output, Input, Digital or Analog vector. When the vector is applied, each of the configured inputs and outputs of the UUT begins capturing data during the aperture window. At the end of the aperture the measurements are collected and datalogged, and an optional image is created.

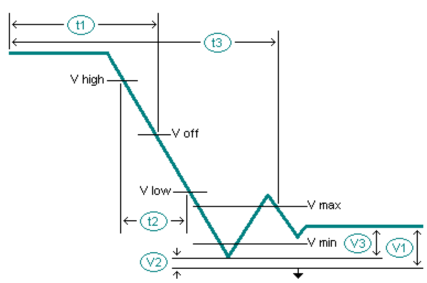
32.3 Test Routine Properties

32.3.1 Start a Capture

In this portion of the test you define the type of power cycle you will perform – either a Turn-on test or a Turn-off test. Based on your selection, a timing diagram will be drawn as an aid to help understand the definition of the standard measurements. We'll discuss the diagrams further in the next section.

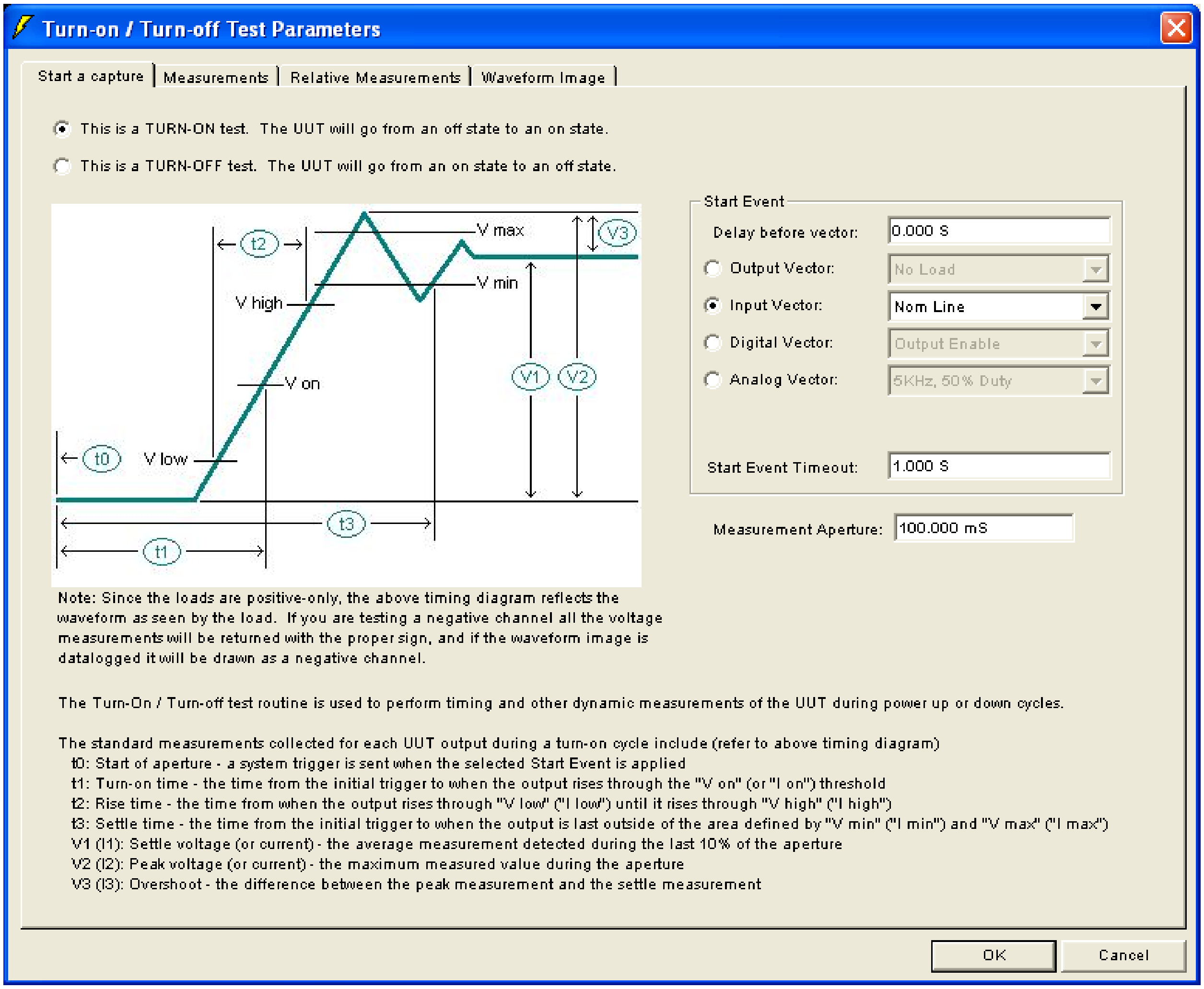


Turn-on image



Turn-off image

You also select the Start Event and aperture time from this initial screen.

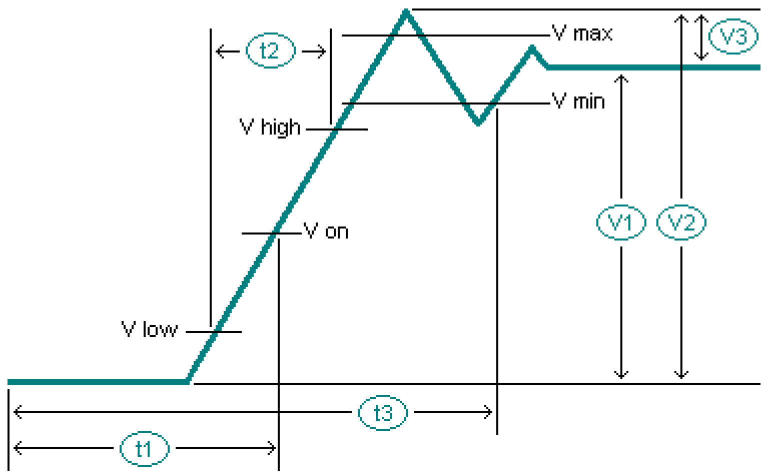


- This is a TURN-ON test – select this option if you wish to capture a turn-on cycle.
- This is a TURN-OFF test – select this option if you wish to capture a turn-off cycle.
- Delay before vector – this delay occurs before the selected start event is applied.
- Output Vector – select this option if the event you wish to capture is triggered by a change in the output state of the UUT, and then select the desired vector from the list.
- Input Vector – select this option if the event you wish to capture is triggered by a change in the input state to the UUT, and then select the desired vector from the list.
- Digital Vector – select this option if the event you wish to capture is triggered by a change in a digital output, and then select the desired vector from the list.
- Analog Vector – select this option if the event you wish to capture is triggered by a change in an analog stimulus to the UUT, and then select the desired vector from the list.
- Start Event Timeout– This time is used as a worst-case timeout value to keep the test program from waiting indefinitely for a trigger condition or other result of the Start Event. If the Start Event Timeout expires, a test failure status is logged and the test program ends.

- Measurement Aperture – the measurement unit will capture data for this long after receiving the Start Event trigger. Make this time window large enough to capture the entire event, as desired.

32.3.2 Measurements

Each of the diagrams defines three timing measurements (t1 – t3) and either three voltage measurements (V1 – V3) or three current measurements (I1 – I3). These are the twelve standard measurements collected on every input or output. You can choose which measurements to collect. Here is the Voltage view of the Turn-on diagram:



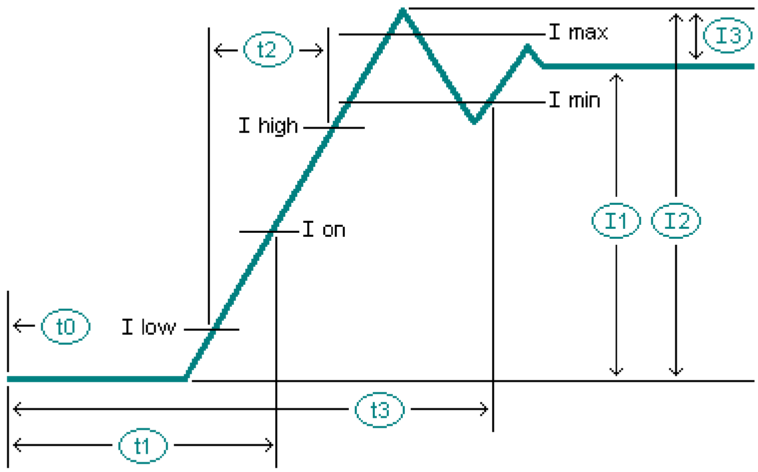
The three timing measurements:

- "t1" is the turn-on time. It is defined as the time from the initial trigger to when the voltage rises through the "V on" threshold. You define the "V on" threshold.
- "t2" is the rise time. It is defined as the time from when the voltage rises through "V low" until it rises through "V high". You define both the "V low" and "V high" thresholds.
- "t3" is the settle time. It is defined as the time from the initial trigger to when the voltage is last outside of the area defined by the "V min" and "V max" thresholds. You define both the "V min" and "V max" thresholds.

The three voltage measurements:

- "V1" is the settle voltage. This is the average voltage measurement detected during the last 10% of the aperture.
- "V2" is the peak voltage. This is the maximum voltage measured during the aperture.
- "V3" is the overshoot. It is defined as the difference between the peak voltage and the settle voltage.

Here is the Current view of the Turn-on diagram:



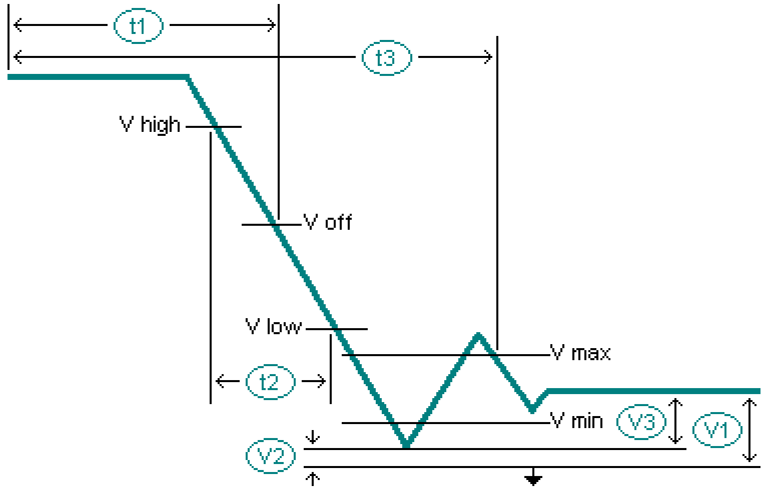
The three timing measurements:

- “t1” is the turn-on time. It is defined as the time from the initial trigger to when the current rises through the “I on” threshold. You define the “I on” threshold.
- “t2” is the rise time. It is defined as the time from when the current rises through “I low” until it rises through “I high”. You define both the “I low” and “I high” thresholds.
- “t3” is the settle time. It is defined as the time from the initial trigger to when the current is last outside of the area defined by the “I min” and “I max” thresholds. You define both the “I min” and “I max” thresholds.

The three current measurements:

- “I1” is the settle current. This is the average current measurement detected during the last 10% of the aperture.
- “I2” is the peak current. This is the maximum current measured during the aperture.
- “I3” is the overshoot. It is defined as the difference between the peak current and the settle current.

The Turn-off images are similar. Here is the Voltage view of the Turn-off diagram:



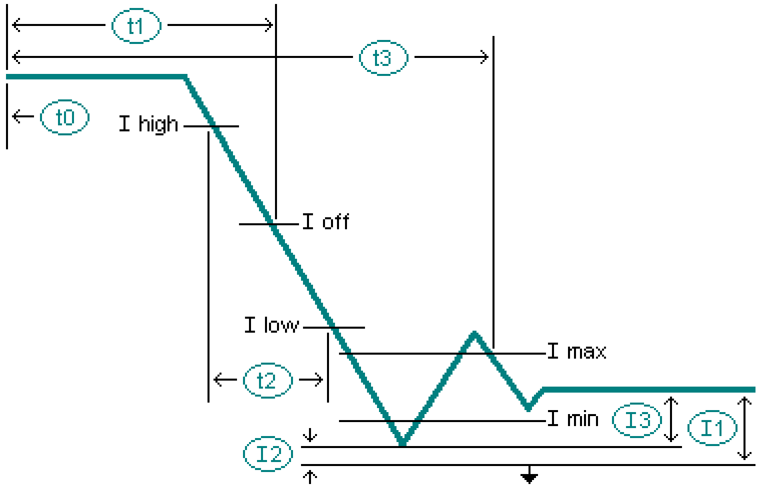
The three timing measurements:

- "t1" is the hold-up time. It is defined as the time from the initial trigger to when the voltage falls through the "V off" threshold. You define the "V off" threshold.
- "t2" is the fall time. It is defined as the time from when the voltage falls through "V high" until it falls through "V low". You define both the "V low" and "V high" thresholds.
- "t3" is the settle time. It is defined as the time from the initial trigger to when the voltage is last outside of the area defined by the "V min" and "V max" thresholds. You define both the "V min" and "V max" thresholds.

The three voltage measurements:

- "V1" is the settle voltage. This is the average voltage measurement detected during the last 10% of the aperture.
- "V2" is the minimum voltage. This is the minimum voltage measured during the aperture.
- "V3" is the undershoot. It is defined as the difference between the minimum voltage and the settle voltage.

Here is the Current view of the Turn-off diagram:

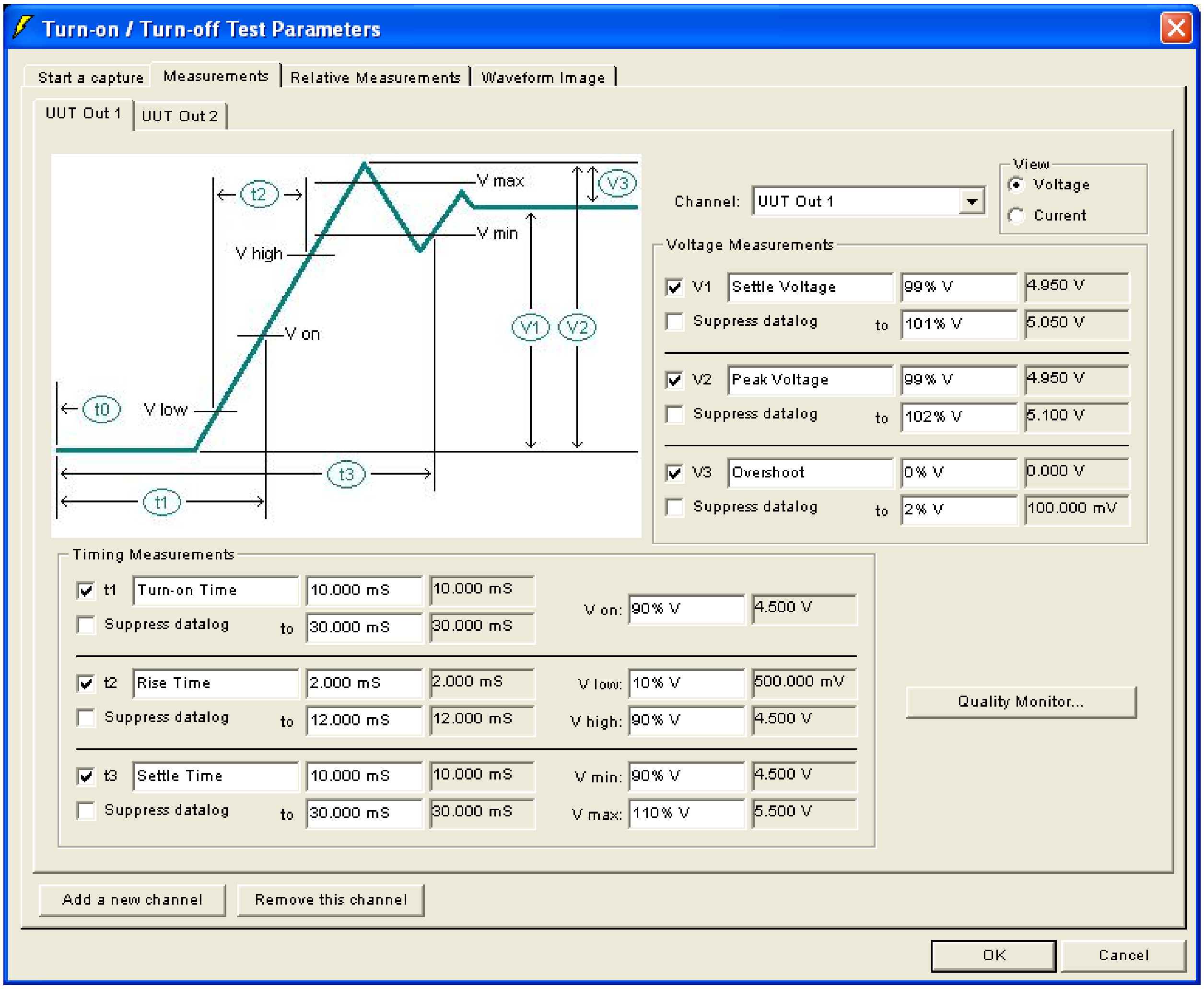


The three timing measurements:

- "t1" is the hold-up time. It is defined as the time from the initial trigger to when the current falls through the "I off" threshold. You define the "I off" threshold.
- "t2" is the fall time. It is defined as the time from when the current falls through "I high" until it falls through "I low". You define both the "I low" and "I high" thresholds.
- "t3" is the settle time. It is defined as the time from the initial trigger to when the current is last outside of the area defined by the "I min" and "I max" thresholds. You define both the "I min" and "I max" thresholds.

The three current measurements:

- "I1" is the settle current. This is the average current measurement detected during the last 10% of the aperture.
- "I2" is the minimum current. This is the minimum current measured during the aperture.
- "I3" is the undershoot. It is defined as the difference between the minimum current and the settle current.



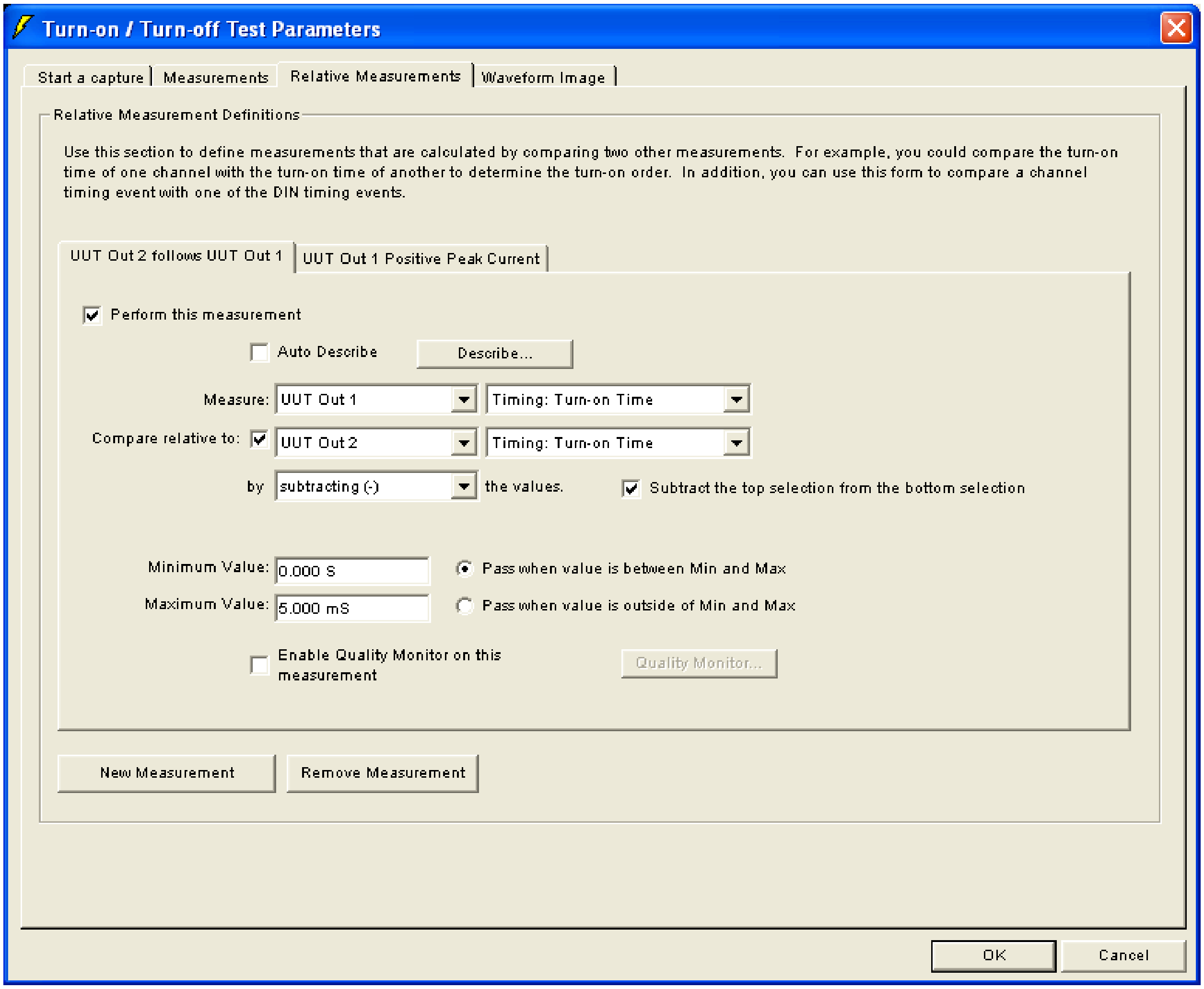
- Add a new channel – press this button to define the measurement setup for a new channel. The next available UUT channel is automatically chosen; select the desired channel using the "Channel" dropdown list.
- Remove this channel – press this button to remove the currently displayed channel from the measurement page.
- Channel – when you add a new channel the next available UUT channel is automatically selected. Use this dropdown to select another UUT channel.
- View – this controls the data entry of the form. When "Voltage" is selected, the Voltage image is shown and the fields are used to setup the Voltage measurements; when "Current" is selected, the Current image is shown and the fields are used to setup the Current measurements. Use this to toggle between the two views.
- Voltage/Current Measurements – for each of the three standard Voltage or Current measurements you can define the following:
  - V1/2/3 (or I1/2/3) check box – select this box to enable the corresponding standard measurement.

  - Suppress datalog – when you check this box, you are instructing the test program to gather the corresponding measurement, but not to datalog it. This is useful when you wish to make a relative measurement using this value as part of a calculation and prefer not to datalog the result independently.
  - Measurement description – you can override the datalog description by changing this field.
  - Minimum Tolerance – this is the allowable lower limit of the measurement. Measured values less than this will cause the test routine to fail. The value may be entered either as a value or a percentage of nominal channel voltage.
  - Maximum Tolerance – this is the allowable upper limit of the measurement. Measured values greater than this will cause the test routine to fail. The value may be entered either as a value or a percentage of nominal channel voltage.
- Timing Measurements – for each of the three standard timing measurements you can define the following:
  - t1/2/3 check box – select this box to enable the corresponding standard timing measurement.
  - Measurement description – you can override the datalog description by changing this field.
  - Minimum Tolerance – this is the allowable lower limit of the measurement. Measured values less than this will cause the test routine to fail. The value may be entered either as a value or a percentage of the channel timing reference.
  - Maximum Tolerance – this is the allowable upper limit of the measurement. Measured values greater than this will cause the test routine to fail. The value may be entered either as a value or a percentage of the channel timing reference.
  - V on/off (or I on/off) – this is the threshold value the channel must pass through to determine the turn-on or turn-off time. The value may be entered either as a value or a percentage of nominal channel voltage
  - V low and V high (or I low and I high) – these are the threshold values the channel must pass through to determine rise or fall time. The values may be entered either as values or percentages of nominal channel voltage.
  - V min and V max (or I min and I max) – these are the threshold values used to determine when the channel has settled. The channel is considered settled when it no longer exceeds both values. The values may be entered either as values or percentages of nominal channel voltage.
- Quality Monitor… – press this button to display the Quality Monitor properties. Please refer to the Quality Monitor reference manual for further details.

32.3.3 Relative Measurements

Use this section to define measurements that are calculated by comparing two other measurements. For example, you could compare the turn-on time of one channel with the turn-on time of another to determine the turn-on order. In addition, you can use this form to compare a channel timing event with one of the DIN timing events.

Also, other various voltage, current and power measurements are available from this page.

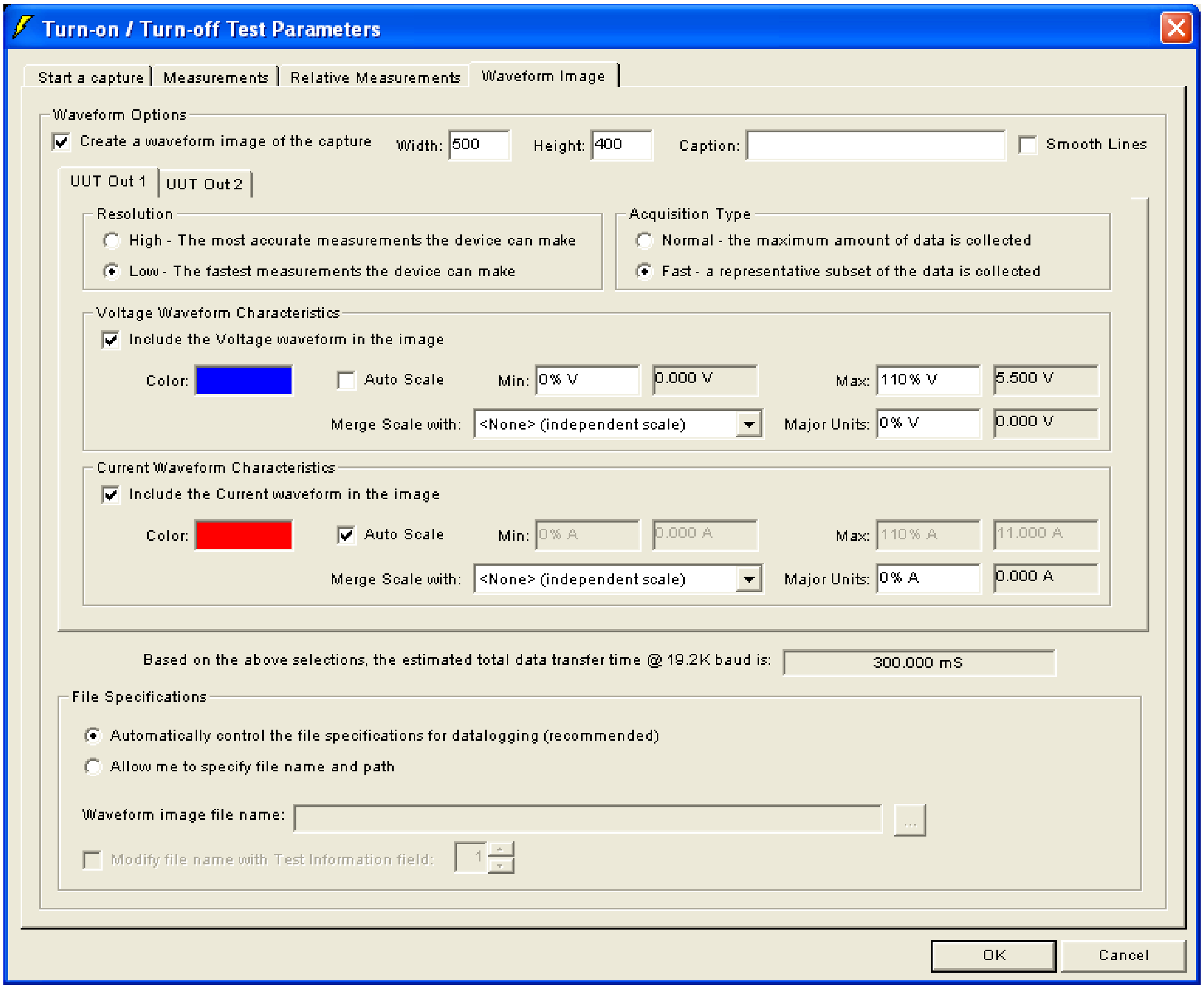


- New Measurement – press this button to add another measurement to the relative measurement group.
- Remove Measurement – press this button to remove the currently displayed measurement from the relative group.
- Perform this measurement – check this box to perform the specified measurement on this channel.
- Auto Describe – if checked, the measurement is described by combining the name of the channel to be measured with the measurement function. If unchecked, the user provides a description of this measurement
- Describe – press this button to enter the description of the measurement.
- Measure – select the channel to be measured from this dropdown list.

- Measurement – select the desired measurement from this dropdown list.
- Compare relative to – check this box to define a relative measurement. If checked, select the relative channel and measurement from the dropdown lists and choose a comparison method (add, subtract, multiply or divide). The value resulting from the calculation will be the new “measured” value. When subtracting or dividing, you are given the choice of the calculation direction.
- Minimum Value - this is the allowable lower limit of the measured value. Measured values less than this will cause the test routine to fail.
- Maximum Value - this is the allowable upper limit of the measured value. Measured values greater than this will cause the test routine to fail.
- Pass when value is between Min and Max – select this box to use the standard comparison technique to determine pass or fail.
- Pass when value is outside of Min and Max – select this box to use the alternate comparison method where the value must not be in between the range defined by Min and Max.
- Enable Quality Monitor on this measurement – check this box to enable Quality Monitor data collection on the measurement.
- Quality Monitor… – press this button to display the Quality Monitor properties. Please refer to the Quality Monitor reference manual for further details.

32.3.4 Waveform Image

The test routine includes the ability to create and log a waveform image of the turn-on or turn-off cycle. There are numerous options available for defining the image, ranging from the amount of data collected to the color of the lines. Use the following dialog to customize the image.



- Create a waveform image of the capture – check this box to enable the waveform options. If this box is cleared no image will be created.
- Width – specifies the width of the image.
- Height – specifies the height of the image.
- Caption –this text is used to describe the image.
- Smooth lines – check this box to draw smooth data point interconnection lines instead of straight lines.
- For each channel defined in the test:

- Resolution – select “High” to download the highest resolution possible from the hardware; choose “Low” to decrease download time. Note: all measurements are made using the highest resolution possible regardless of the image “resolution” parameter.
- Acquisition Type – when you select “Normal”, every data point gathered by the measurement hardware is downloaded and used to generate the image; “Fast” will download 128 data points, gathered evenly from throughout the aperture. Selecting “Fast” does not affect the quality of the measurements.

  The combination of “resolution” and “acquisition type” determines how long it takes to download the data from the measurement hardware. Low resolution and fast acquisition combine to create the quickest download time; using the highest resolution with a normal acquisition type will result in a substantially longer test execution time.
- Voltage Waveform Characteristics
  - Include the Voltage waveform in the image – check this box if you wish to add the voltage waveform from this channel to the image.
  - Color – this is the color of the voltage waveform and scales. Click on the color field to change the selected color.
  - Auto Scale – if selected, the scale minimum and maximums will be determined from the actual data collected at run time. If unchecked, you must enter the “Min” and “Max” data.
  - Min – the minimum value of the scale. Data points that are below this value will be clipped from the image. The value may be entered either as a direct value or a percentage of nominal channel voltage.
  - Max – the maximum value of the scale. Data points that are above this value will be clipped from the image. The value may be entered either as a direct value or a percentage of nominal channel voltage.
  - Merge Scale with – this entry determines if the waveform scale is added as an independent scale (multiple overlapping scales) or if the scale data is merged with another voltage channel to create a single scale that spans the extremes of both channels.
  - Major Units - used to define the number of major divisions within the scale data. The divisions will be drawn from “Min” to “Max”, with this field used as an increment value. Use “0” to allow the software to automatically determine the optimal number of divisions.
- Current Waveform Characteristics
  - Include the Current waveform in the image – check this box if you wish to add the current waveform from this channel to the image.
  - Color – this is the color of the current waveform and scales. Click on the color field to change the selected color.

  - Auto Scale – if selected, the scale minimum and maximums will be determined from the actual data collected at run time. If unchecked, you must enter the “Min” and “Max” data.
  - Min – the minimum value of the scale. Data points that are below this value will be clipped from the image. The value may be entered either as a direct value or a percentage of channel reference current.
  - Max – the maximum value of the scale. Data points that are above this value will be clipped from the image. The value may be entered either as a direct value or a percentage of channel reference current.
  - Merge Scale with – this entry determines if the waveform scale is added as an independent scale (multiple overlapping scales) or if the scale data is merged with another current channel to create a single scale that spans the extremes of both channels.
  - Major Units - used to define the number of major divisions within the scale data. The divisions will be drawn from “Min” to “Max”, with this field used as an increment value. Use “0” to allow the software to automatically determine the optimal number of divisions.

- File Specifications – These selection buttons determine whether the image file generated during this test is managed automatically or if you will choose the file and path.
  - Automatically control the file specifications for datalogging (recommended) – this selection determines whether the image file generated during this test is managed automatically.
  - Allow me to specify file name and path – choose this option if you want to manually select the filename and path for the image file.
  - Waveform image file name – if you chose to manually control the filename enter the specification here.
  - Modify file name with Test Information field – When enabled, a field from the Test Information Entry form will be appended to the user entered file name. The Test Information Entry form appears before running the test on each UUT, and is typically filled in by the test operator. Appending an information field provides a method of tracking specific waveform images to a particular UUT serial number or test pass. The number selection box determines which of the input fields from the Test Information Entry form will be appended to the file name.

32.4 Sequence

The load, source, digital and analog vectors defined by the program are applied to the tester hardware before the test routine sequence is initiated.

1) The routine waits the “Delay before vector” time.
2) Each of the selected channels is synchronized and armed for measurements.
3) The selected Output, Input, Digital or Analog vector is applied. When the test ends, the tester remains in the state specified by this vector.

4) At the end of the measurement aperture each of the enabled measurements are compared and datalogged for every selected channel.
5) The relative measurements are calculated and datalogged.
6) If an image is being created, the data points are downloaded and the image file is constructed and datalogged.

33. UNDERVOLTAGE LOCKOUT TEST

33.1 Description

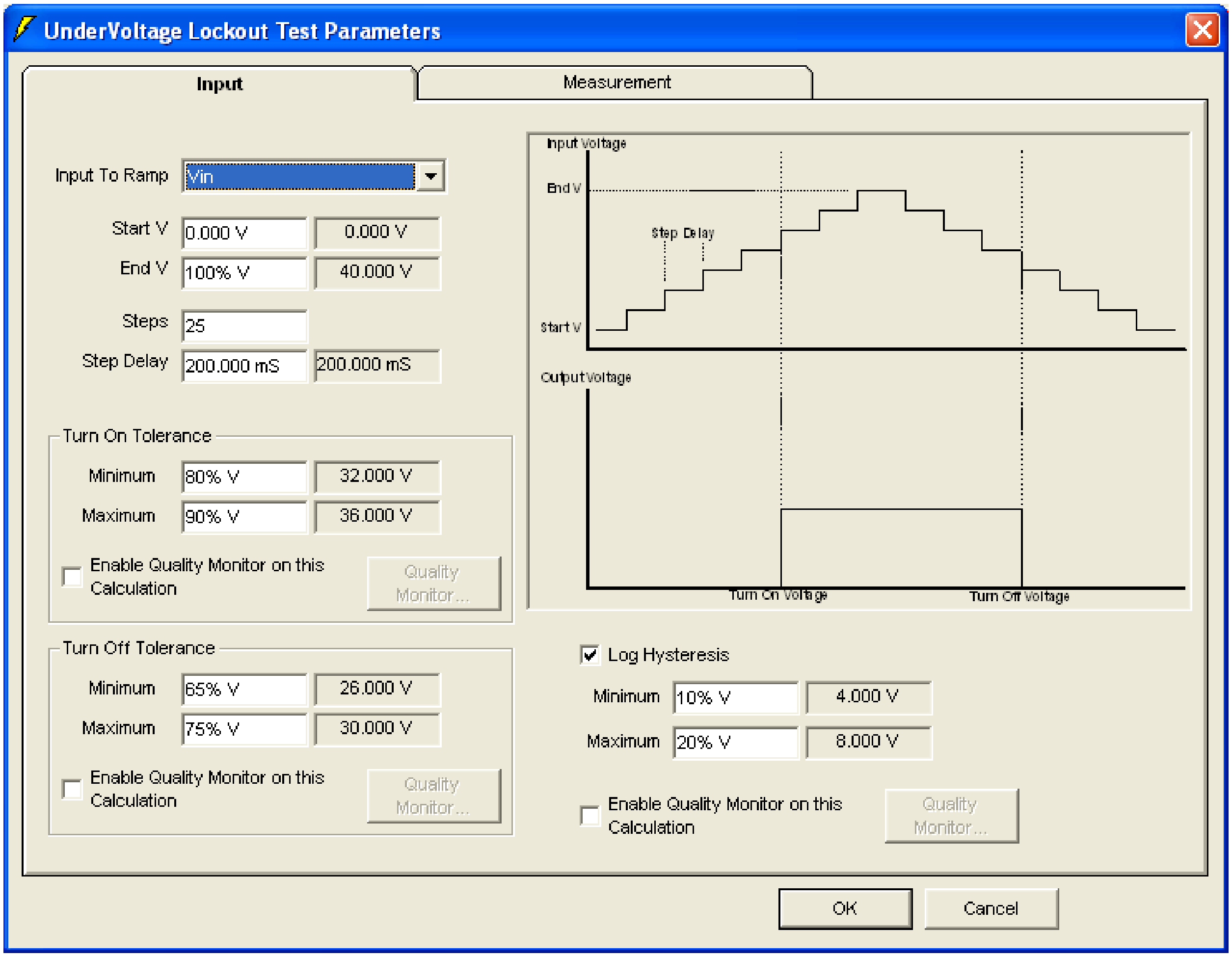
This test ramps the input voltage to a UUT up and then down (or down and then up) to determine the input voltage at which a specific output channel will turn on and the input voltage at which the output channel turns off. The difference between the input turn-on and input turn-off voltage may be reported as Hysteresis. Either the UUT channel output voltage or a DIN is monitored to determine when the device switched between on/off states.

This test is capable of performing the test input voltage ramp as either a positive (start low [off], ramp to on, then ramp back low) or negative (start on, ramp to low [off], then ramp back on) type depending on the start and end ramp voltages.

33.2 Method

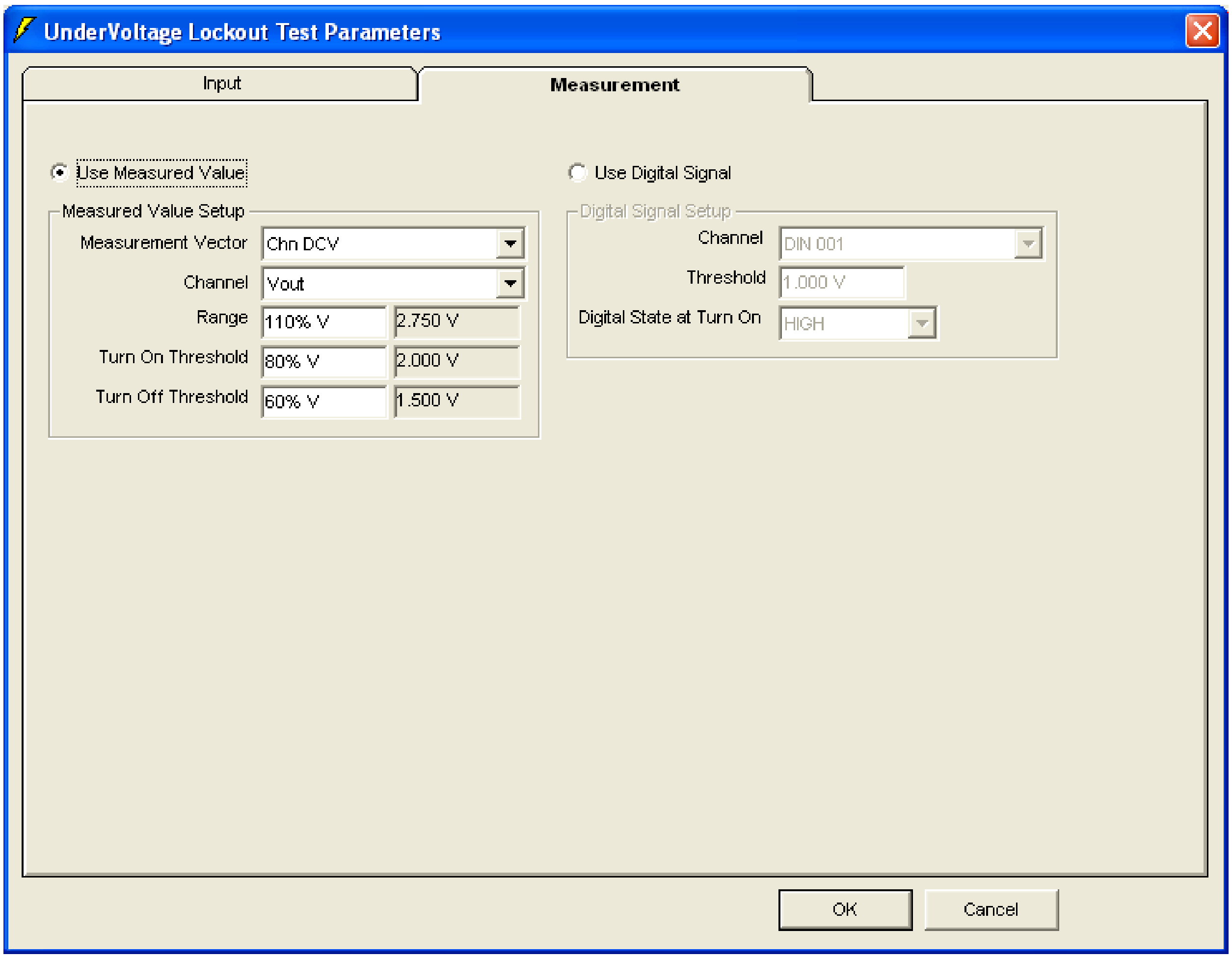
The test begins by determining whether we are ramping up or down first (depending on whether the Start Voltage is greater or less than the End Voltage). This also determined whether we are looking for a Turn On or Turn Off state. The input voltage ramps from Start Voltage to End Voltage, with a delay between each step equal to the Step Delay. The UUT measurement (Digital or Measured) is taken after each ramp step. This measurement is compared to the Threshold (Turn On, Turn Off, or Digital). When the state of the UUT changes (Turns On/Off), the input voltage of that ramp step is recorded and logged. The input voltage is then ramped the opposite direction, and looks for the opposite state. At the end of the test, the Hysteresis (delta between Turn On/Turn Off ramp value) can be recorded and logged.

33.3 Test Routine Properties



- Input To Ramp – The input channel to ramp
- Start V – Voltage to start ramping from (if this value is higher than End V, the voltage will be ramped down, and then back up).
- End V – Voltage to stop ramping.
- Steps – The number of ramp steps. The size of each ramp step will be (Start V – End V) / Steps.
- Step Delay – The amount of time to wait between each ramp and when the UUT Measurement is taken.
- Turn On Tolerance Minimum – The minimum value the input voltage can be when the UUT turns on in order to pass.
- Turn On Tolerance Maximum – The maximum value the input voltage can be when the UUT turns on in order to pass.

- Turn Off Tolerance Minimum – The minimum value the input voltage can be when the UUT turns off in order to pass.
- Turn Off Tolerance Maximum - The maximum value the input voltage can be when the UUT turns off in order to pass.
- Hysteresis Minimum – The minimum value the difference between the actual turn on and turn off input voltage can be in order to pass.
- Hysteresis Maximum - The maximum value the difference between the actual turn on and turn off input voltage can be in order to pass.
- Enable Quality Monitor on this measurement – check this box to enable Quality Monitor data collection on the measurement.
- Quality Monitor… – press this button to display the Quality Monitor properties. Please refer to the Quality Monitor reference manual for further details.



- Use Measured Value – If this radio button is selected, the UUT Turn On/Turn Off will be based on a voltage measurement taken from the designated output channel.
- Use Digital Signal – If this radio button is selected, the UUT Turn On/Turn Off will be based on the state of a Digital Signal.

- Measurement Vector – The measurement vector that will be used to take the measurement.
- Measurement Channel – The output channel that will be measured in order to determine whether the UUT is on or off.
- Range – The measurement range.
- Turn On Threshold – The voltage at which the UUT is considered to be on.
- Turn Off Threshold – The voltage at which the UUT is considered to be off.
- Digital Channel – The digital channel that will be measured in order to determine whether the UUT is on or off.
- Digital Threshold – The voltage at which the digital signal is considered to be High or Low.
- Digital State at Turn On – This determines whether the UUT is considered to be on at a High or Low digital signal. The State at Turn Off will be the opposite.

33.4 Sequence

The load, source, digital and analog vectors defined by the program are applied to the tester hardware before the test routine sequence is initiated.

1) Determine whether we are ramping up or down (looking for Turn On or Turn Off).
2) Set the input voltage for each ramp step (starting with Start V).
3) Delay.
4) Take a measurement from the UUT using either a voltage measurement or a digital signal.
5) Use the measurement to determine if the UUT has turn on/turned off. If so, log the input voltage at this ramp step, and stop ramping.
6) Ramp the opposite way we just ramped, and look for the opposite state.
7) Repeat steps 2 – 5.
8) Log the Turn On Voltage.
9) Log the Turn Off Voltage.
10) Calculate and log the Hysteresis if requested.
11) Check for faults and log them as necessary

34. UUT COMMUNICATIONS TEST

34.1 Description

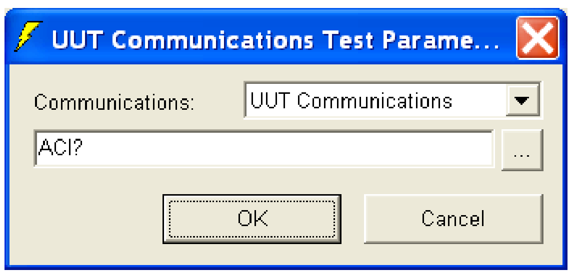
The UUT Communications test routine provides the ability to communicate with the UUT during the test program execution. The routine can be used to verify the UUT status, internal measurement circuitry, serial number / configuration information, etc.

The test routine uses the properties of the selected UUT Communications object to control the flow of the test. As these communications objects differ in operation the flow of the test varies accordingly. Please refer to the appropriate UUT communications object reference manual for further details.

34.2 Method

The test begins by initializing the communications object with the test parameters and instructing the object to perform the desired communication. All control, data collection and validation of any return data is performed by the communications object. Again, please refer to the appropriate UUT communications object reference manual for further details. Pass or fail status is retrieved from the object and the result is logged to the datalog devices.

34.3 Test Routine Properties



- Communications – select the desired UUT communication object from the drop-down list and press the ellipsis button for communications test parameters. Please refer to the appropriate UUT communications object reference manual for further details. The edit field to the left of the ellipsis button reflects the communications string to be sent to the UUT. The data may be entered here, or in the appropriate field in the UUT communications object.

34.4 Sequence

The load, source, digital and analog vectors defined by the program are applied to the tester hardware before the test routine sequence is initiated.

12) Load the communication object test parameters

13) Instruct the communication object to perform the test

14) Retrieve the pass/fail status and returned value (if applicable)

15) Log the result

16) Check for faults and log them as necessary

35. VI CHART TEST

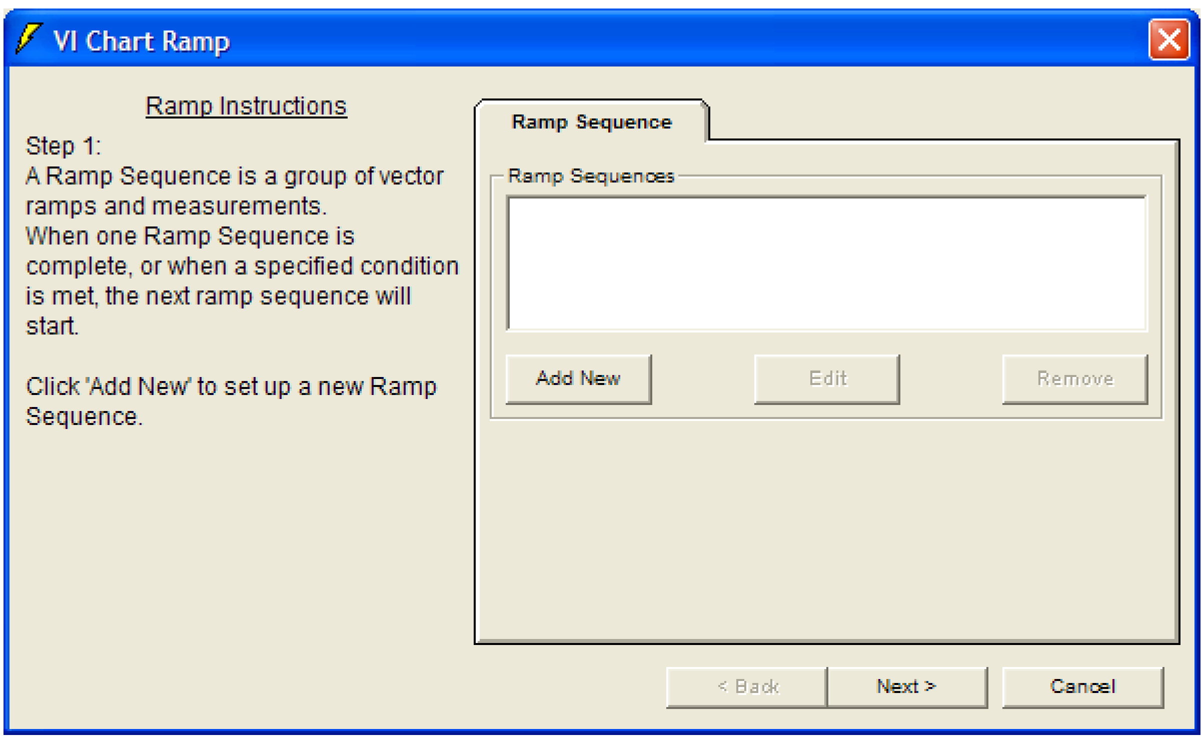
35.1 Description

As an aid to design engineers, *em**Power*** ® includes a Voltage-Current (VI) charting test routine that can be used to verify the integrity of their designs. With the VI Chart test routine, you can graph the regulation of your UUT output while ramping the current (in Constant Current mode) from minimum to maximum loading, and then switch to ramp the voltage (in Constant Voltage mode) down to zero. Ramp parameters and measurement setups are easily entered via a step-by-step wizard, and a chart is automatically generated and logged. A tolerance array can be defined to ensure that the UUT remains in regulation during the entire test.

35.2 Method

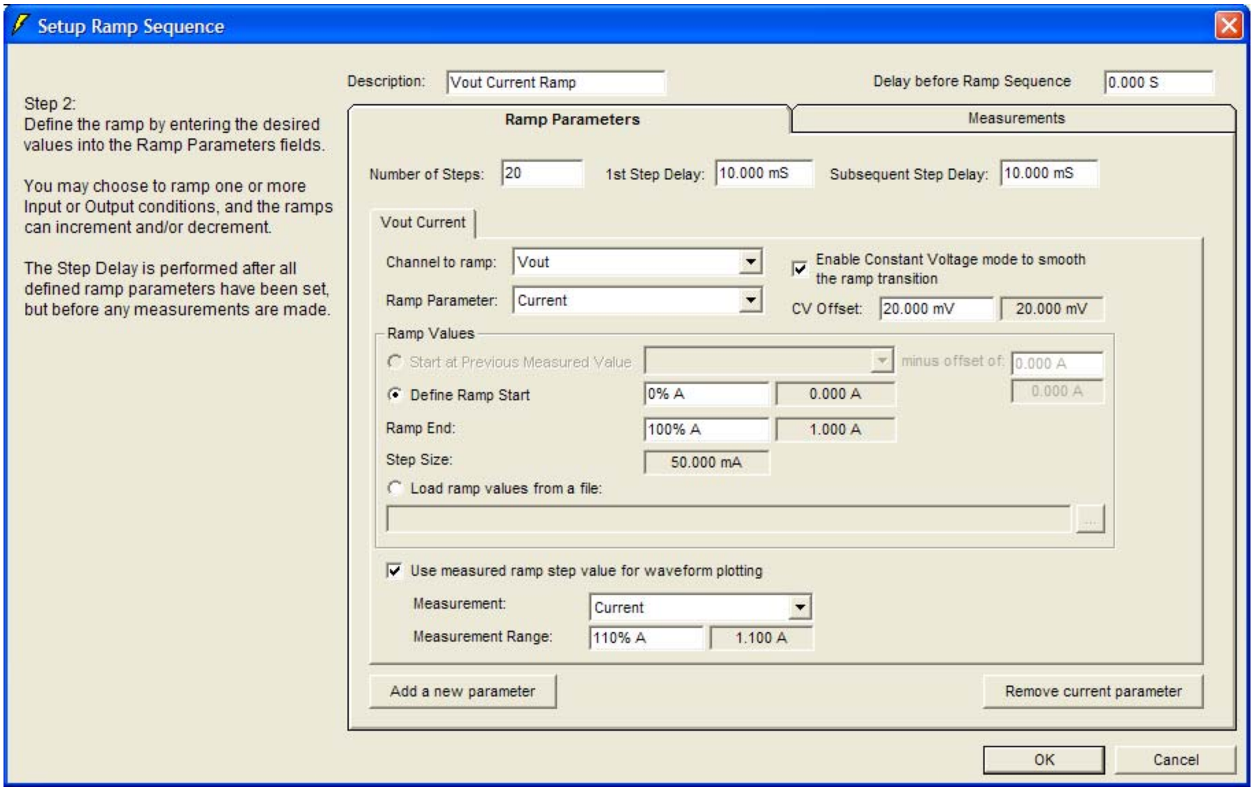
While one or more stimulus parameters are ramped, measurements are taken and logged. This procedure can be repeated for multiple vector baselines. Once the data has been collected a chart is created and logged. The test routine returns a “Pass” if the data was collected successfully and every measurement is within the values defined by the tolerance array.

35.3 Test Routine Properties



- Add New – add a new ramp sequence. Each sequence provides for multiple ramp and measurement parameters. Up to two sequences can be defined.
- Edit – modify the currently selected ramp sequence.
- Remove – delete the currently selected ramp sequence from the list of sequences.

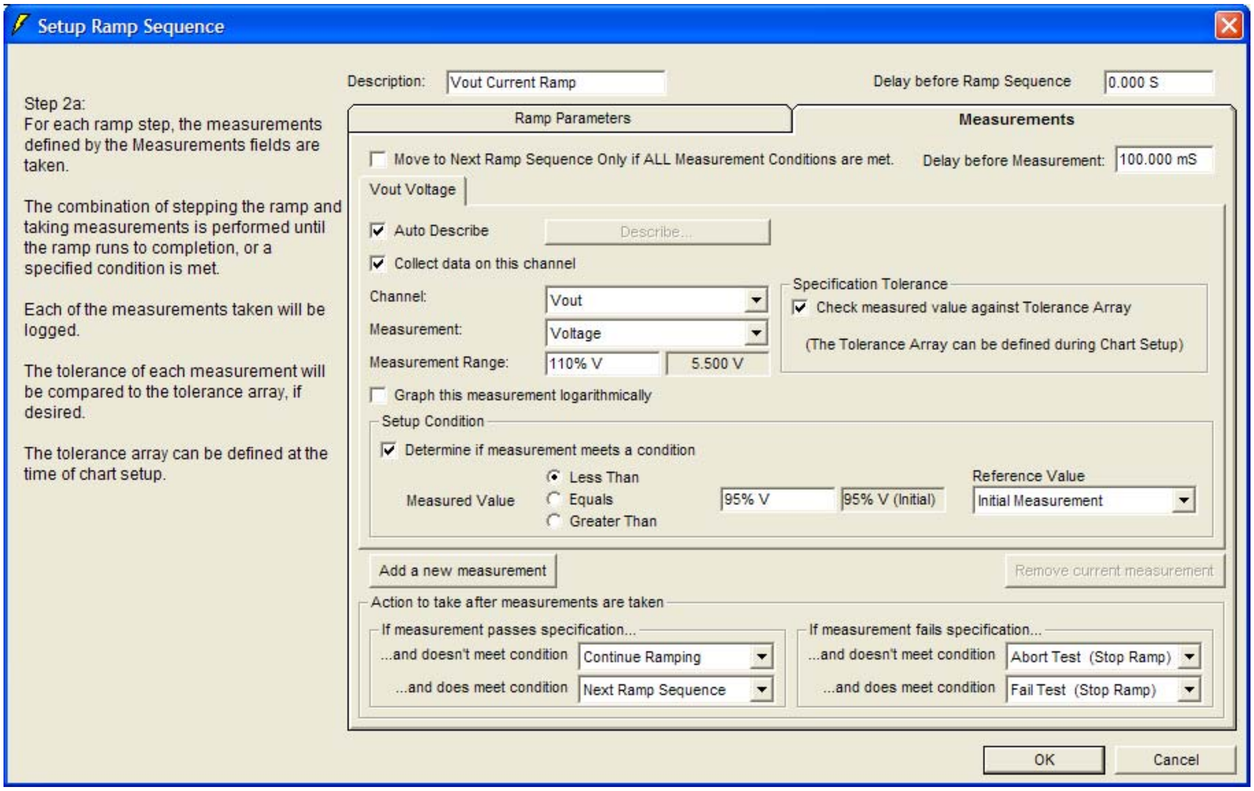
35.3.1 Ramp Parameters



- Description – the text in this field is used to describe the ramp sequence, and is placed in the list of ramp definitions on the previous screen.
- Delay before Ramp Sequence – this delay occurs before the ramp sequence is begun. Use this value to program a delay between two ramp sequences.
- Number of Steps – the number of steps to take when ramping from the start value to the end value. This also indicates the number of measurements taken during the test.
- 1st Step Delay – this delay will be applied after the first ramp value has been set.
- Subsequent Step Delay – this delay will be applied between each of the ramp steps beginning with the second step.
- Channel to ramp – the load or source channel to ramp
- Ramp Parameter – the parameter of the channel to ramp. Selections include voltage, current, frequency, etc.
- Enable Constant Voltage mode to smooth the ramp transition – when the load hardware supports it, this feature will allow you to program a Constant Voltage value in addition to the selected ramp parameter. The load measures the voltage, and the CV value is set to this measured value minus the stated CV Offset. Use this feature to smooth the transition into CV mode when the next ramp sequence will ramp voltage.

- CV Offset – a voltage value that will be subtracted from the measured voltage when Constant Voltage smoothing is enabled. The voltage is measured at each ramp step and readjusted accordingly.
- Start at Previously Measured Value – when selected, the initial value of the ramp will be the value of last measurement specified in the dropdown list. You can alter this initial value by subtracting an offset, so the initial ramp value is less than the previous measurement.
- Define Ramp Start – the initial value of the ramp parameter.
- Ramp End – the final value of the ramp parameter.
- Load ramp values from a file – when this option is selected, the ramp values are read from a comma-separated or white-space delimited text file. This allows a non-algorithmic ramp to be defined. The text file simply contains values (0.000, 1.500, 2.250 etc.) – the units correspond to the selected “Ramp Parameter”. Note: any unrecognized values will be set to zero at run-time.
- Use measured ramp step value for waveform plotting – when selected, the ramp value will be measured using the specified measurement vector and used to create the chart waveform. Normally, the programmed ramp value is plotted.
- Measurement – the measurement vector used to measure the ramp step. It should correspond to the Ramp Parameter type.
- Measurement Range – this is the maximum expected measured value for the ramp step. The value may be entered either as a value or a percentage of a channel reference. The appropriate reference is automatically selected based on the measurement vector entry. In the example above, the “Vout” Reference Current value will be used.
- Add a new parameter – press this button to create an additional ramp parameter. You may add as many ramp parameters as you wish.
- Remove current parameter – press this button to delete the currently displayed ramp parameter.

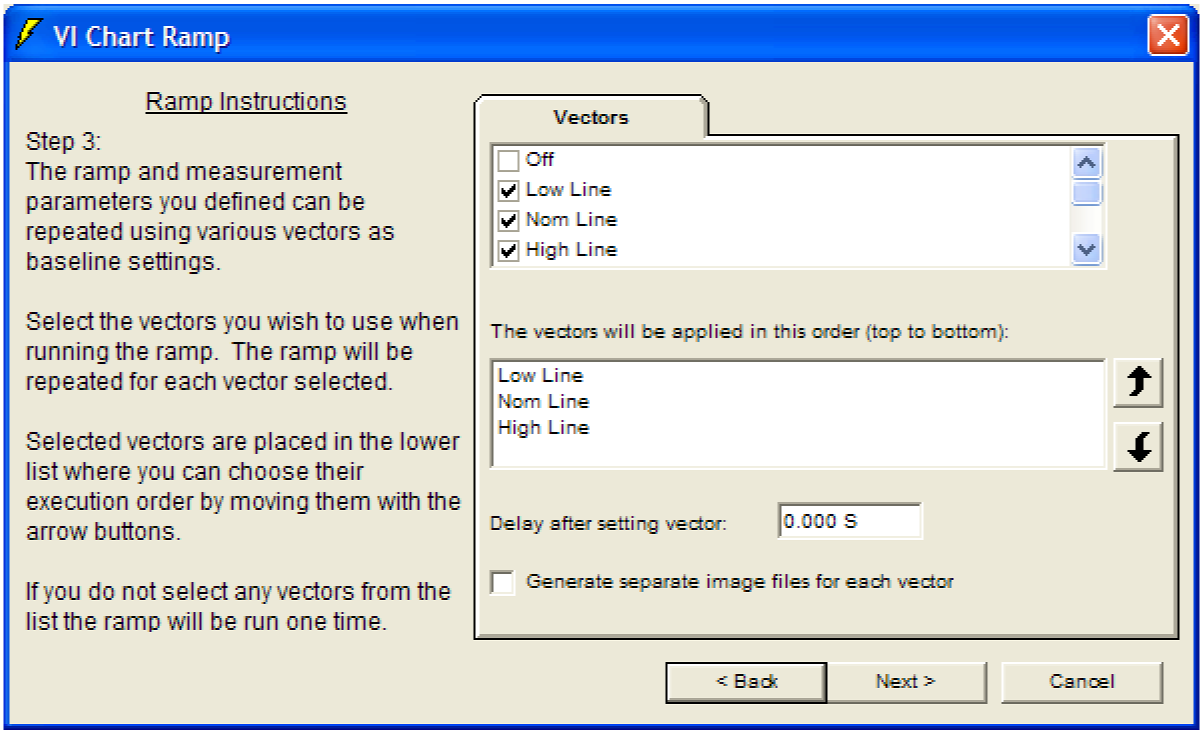
35.3.2 Measurements



- Move to Next Ramp Sequence Only if ALL Measurement Conditions are met – measurements are taken during each step of the ramp, and continue until the ramp ends or a measurement is above, below or equal to a specified value (i.e., a “condition”). Select this box to continue ramping until conditions are met on all specified measurements.
- Delay before Measurement – this delay occurs before any of the measurements are taken, but after the Constant Voltage transition smoothing value has been set.
- Auto Describe – if checked, the measurement is described by combining the name of the channel to be measured with the measurement function. If unchecked, the user is prompted to provide a description of this measurement.
- Collect data on this channel – check this box to take a measurement of this channel and collect the corresponding data.
- Channel – defines the channel to use when making the measurement. Choose from any of the defined Inputs or Outputs.
- Measurement – the measurement vector that will be used to take the measurement. Note that this must be a DMM-type measurement vector.
- Measurement Range – this is the maximum expected measured value. The value may be entered either as a value or a percentage of a channel reference. The appropriate reference is automatically selected based on the measurement vector entry. In the example above, the “Vout” Reference Voltage value will be used.

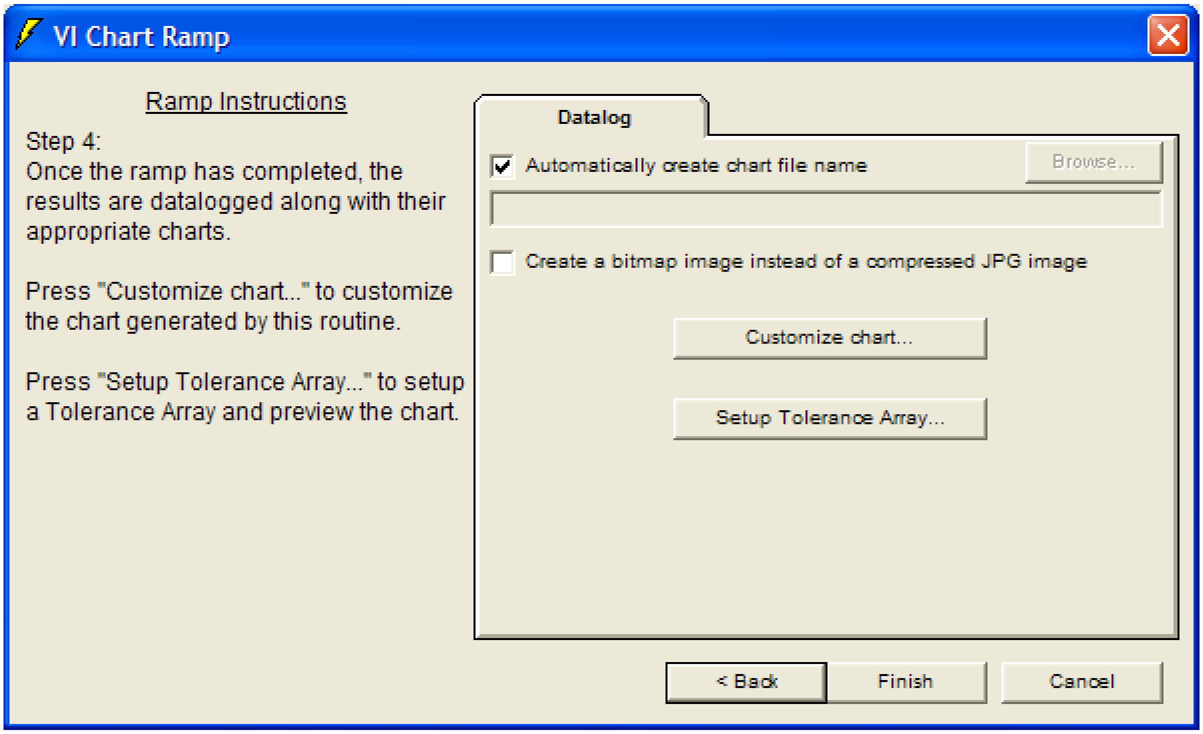
- Graph this measurement logarithmically – selecting this option causes the measurement to be plotted on a logarithmic scale instead of a linear scale.
- Check measured value against Tolerance Array – the tolerance array allows you to specify a bounding shape for the measurements. If any measurement is outside of this boundary the test will fail. See 35.3.6 Setup Tolerance Array.
- Determine if measurement meets a condition – each measurement can be tested to see that it is less than, equal or greater than a specified value. When this test is "true", the condition is deemed to be met. You can alter control of the ramp based on the "condition" of each measurement.
- Reference Value – if the "condition" value is entered as a percentage, you can choose the method used to translate the percentage into a numeric value. Select from the channel reference, the first measurement, or none. If "none" is selected, be sure to enter a numeric value into the "condition" field. Note: it does not matter which translation method is selected when a numeric value is entered into the "condition" field because it is not used.
- Add a new measurement – press this button to add a new measurement and associated tab to the test routine.
- Remove current measurement – press this button to remove the currently selected measurement from the test routine. Once this button is pressed the measurement data is lost and cannot be recovered.
- Action to take after measurements are taken – use these fields to control how the ramp is executed based on the measurement results. The measurement passes or fails "specification" based on how it compares to the Tolerance Array. The measurement meets or does not meet "condition" based on how it compares to the Setup Condition value.

35.3.3 Vectors



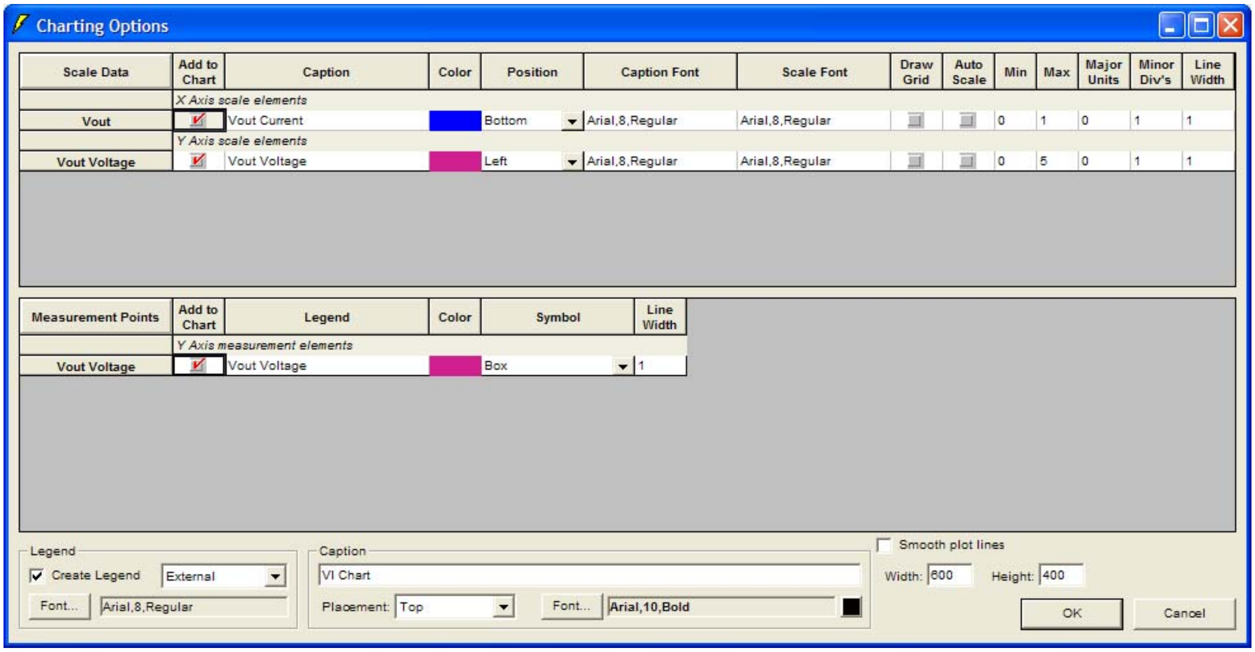
- (Check boxes) – place a check next to each vector that you would like to use when repeating the ramp (as defined in the previous pages). In this example, the ramp will be repeated three times.
- (Sorting list) – use the arrows to define the order you wish to run the vectors. In this example, the ramp will be run at “Low Line” first, then repeated for “Nom Line”, and finally executed once more with the “High Line” vector applied. Data is collected for each vector.
- Delay after setting vector – the amount of time to delay between each vector setting before repeating the ramp definition.
- Generate separate image files for each vector – by default, a single image file containing all the collected data is created at the end of the test routine. By checking this box the test routine will generate separate images containing only the corresponding measurement data for each vector selected.

35.3.4 Datalog



- Automatically create chart file name – this selection determines whether chart image files generated during this test are managed automatically or if you will choose the file and path information. If you choose to manage the file naming, you must enter a file name in the text field provided.
- Create a bitmap image instead of a compressed JPG image – choose the desired image format. Bitmaps create clear images, but require a larger amount of disc space; JPG files are smaller, but can suffer from image blurring due to the compression algorithm.
- Customize chart… – the test routine will automatically generate a chart containing all the collected information. Press this button to customize the appearance of the chart to suit your needs. Refer to section 35.3.5 Charting Options, for detailed help on chart customization.
- Setup Tolerance Array… - use this option to define the tolerance boundary shape and values. Refer to section 35.3.6 Setup Tolerance Array, for detailed help.

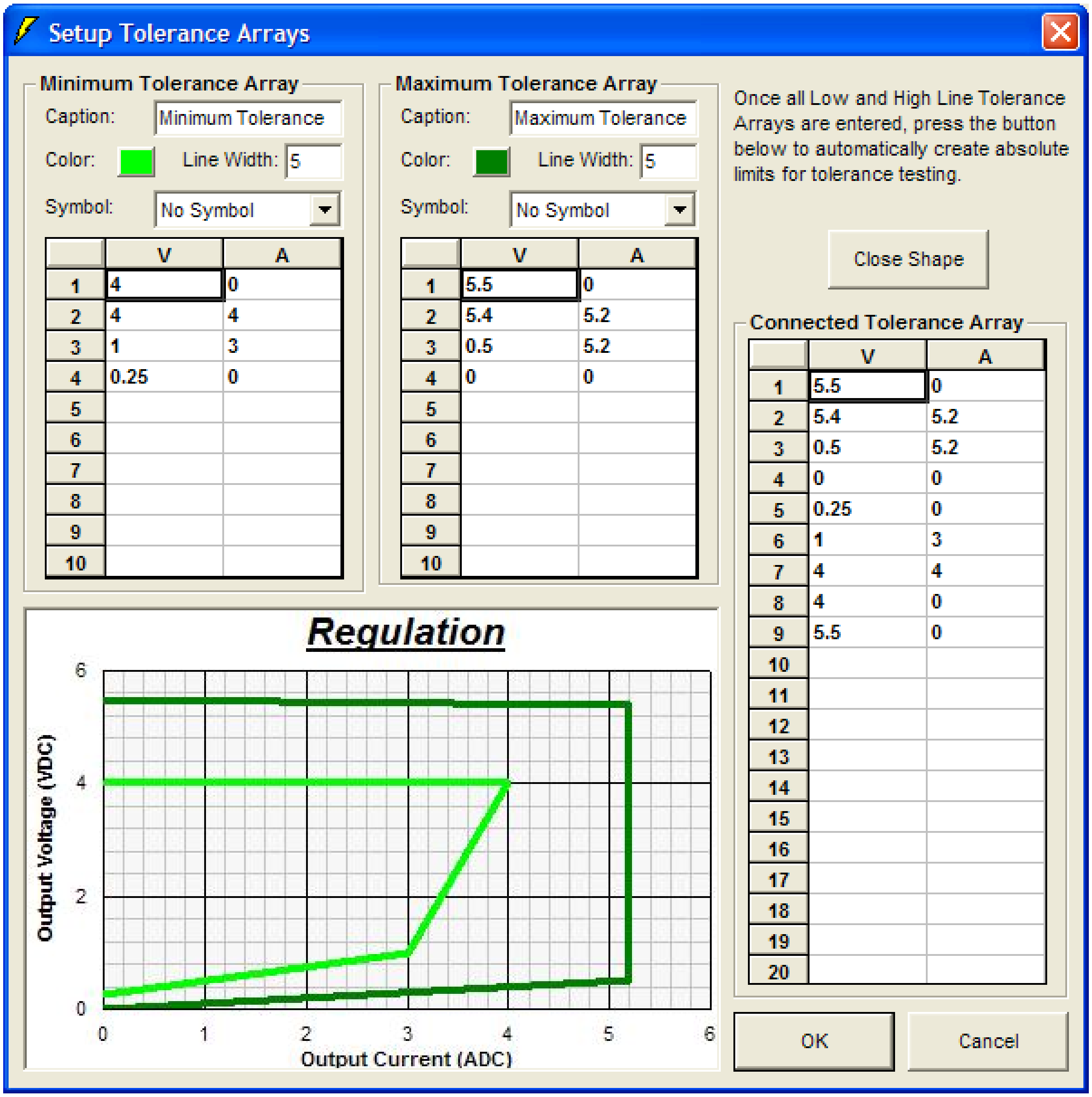
35.3.5 Charting Options



- Scale Data – the ramp parameters are charted along the X-axis, while the measurement parameters are charted on the Y-axis. This section is used to configure the X and Y scales. Each scale entry can be customized as follows:
  - Add to Chart – check this box to include this scale data on the chart.
  - Caption – this text is used to describe the scale.
  - Color – defines the color of the text and gridlines. Click on the field to select a new color.
  - Position – the position on the chart. X-axis scale data can be placed on the top or bottom, while Y-axis scale data can be placed left or right of the chart data.
  - Caption Font – the font face, size and effects used for the caption text. Click on the field to select a new font. Note: font color is controlled by the corresponding scale color field.
  - Scale Font – the font face, size and effects used for the scale numeric data. Click on the field to select a new font. Note: font color is controlled by the corresponding scale color field.
  - Draw Grid – check this box to include the gridlines in the chart image – vertical for X-axis data, and horizontal for Y-axis data.
  - Auto Scale – if this option is checked, the minimum and maximum scale values are generated from the collected data. If the checkbox is cleared the “Min” and “Max” fields are used.
  - Min – the minimum scale data. Only used if “Auto Scale” if false. Data points charted below this value will be clipped.
  - Max – the maximum scale data. Only used if “Auto Scale” is false. Data points charted above this value will be clipped.

  - Major Units – used to define the number of major divisions within the chart data. The divisions will be drawn from “Min” to “Max”, with this field used as an increment value. Use “0” to allow the software to automatically determine the optimal number of divisions. Gridlines are drawn at these positions if “Draw Grid” is enabled.
  - Minor Div’s – used to define the number of minor divisions within each major division. Gridlines are drawn at these positions if “Draw Grid” is enabled.
  - Line Width – the width of the grid lines in hundredths of an inch. “100” will draw a line 1 inch thick; “25” will draw a line ¼ inch thick.
- Measurement Points – these are the data points collected during the test run. If more than one Vector was selected each Y-axis block will be repeated as necessary:
  - Add to Chart – check this box to plot the data on the chart.
  - Legend – if a legend is drawn, this text is used to describe the data.
  - Color – defines the color of the symbols and interconnecting lines. Click on the field to select a new color.
  - Symbol – selects the symbol that will be drawn at every plotted data point.
  - Line Width – the width of the plot line in hundredths of an inch. “100” will draw a line 1 inch thick; “25” will draw a line ¼ inch thick.
- Create Legend – check this box to include a legend area within the chart image. Use the dropdown list to select the position of the legend. All positions are within the graph area and will obscure the plot and grid lines. Select “External” to have the legend drawn outside (and to the right) of the chart.
- Legend Font – the font face, size and effects used for the legend. The color of the font will correspond to the scale and plot data colors.
- Caption – defines the title of the chart.
- Caption placement – specifies the placement of the chart caption.
- Caption Font – the font face, size and effects used for the caption.
- Caption Font Color – press the colored box next to the caption font to select the desired font color.
- Smooth plot lines – check this box to draw smooth data point interconnection lines instead of straight lines.
- Width – specifies the recommended width of the image. If the software is unable to create the image as defined because of a lack of image space it will attempt to increase the width as necessary up to twice this value.
- Height – specifies the height of the image.

35.3.6 Setup Tolerance Array



- Minimum and Maximum Tolerance Array – these fields specify limit lines that define the shape of the tolerance array. Each tolerance array entry can be customized as follows:
  - Caption – text that describes the tolerance array line. This text will be placed in the legend.
  - Color – press the colored box to select the desired line color.
  - Line Width – the width of the tolerance line in hundredths of an inch. “100” will draw a line 1 inch thick; “25” will draw a line ¼ inch thick.
  - Symbol – selects the symbol that will be drawn at every line segment point.
  - V and A – the V and A fields specify limit line segments that define the shape of the tolerance array. Each entry defines an X-Y point within the graph, and lines are drawn to

connect the points. The minimum and maximum limit lines can each contain up to 10 points (9 line segments).

- Close Shape – press this button once you have defined both the minimum and maximum line limits or any time you adjust either of the tolerance line segments. This will close the "gaps" in the tolerance array, creating a closed shape. Measurements that land outside this shape will fail the "specification" test. Additionally, if consecutive measurements land inside the shape, but the line between them ventures outside the borders (i.e., "cuts the corner"), the specification test will fail.

35.4 Sequence

The load, source, digital and analog vectors defined by the program are applied to the tester hardware before the test routine sequence is initiated.

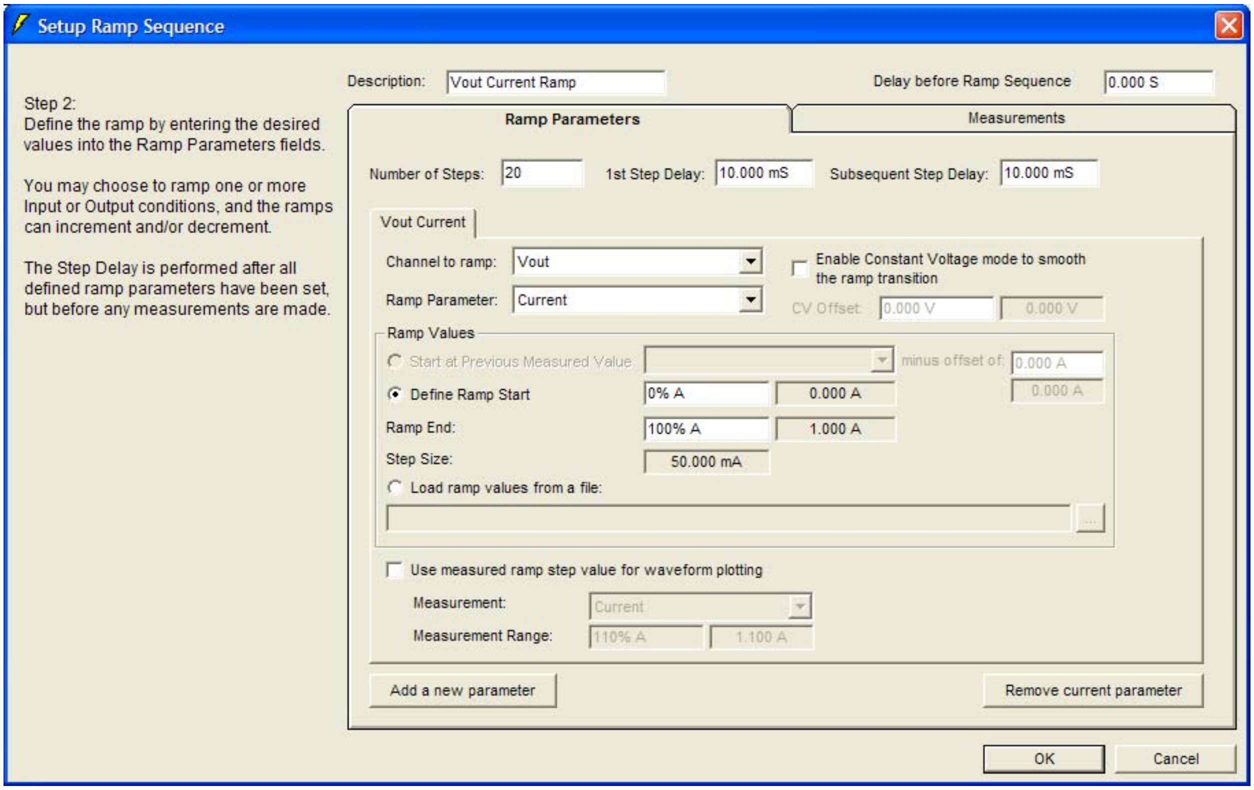
1) For each Vector defined on the "Vector" tab (performed once if no vectors are selected)
    a) For each Ramp Sequence
        i) Set the Ramp Parameters to the "Start" values
        ii) Make the measurements defined on the "Measurement" tab.
        iii) Increment the Ramp Parameter values by the "Step Size" and make the measurements. Repeat this for the number of steps defined.
2) Create the chart(s).
3) Check for faults and log them as necessary

35.5 Example

The following example will generate a Regulation report. The VI Chart test will be used to ramp Vout current from 0A to 1.0A in Constant Current mode, and then switch to Constant Voltage mode to force the output down to 0.5V. The unit will be tested at Low Line, Nom Line and High Line input settings.

35.5.1 Ramp Parameters – Current Ramp Sequence

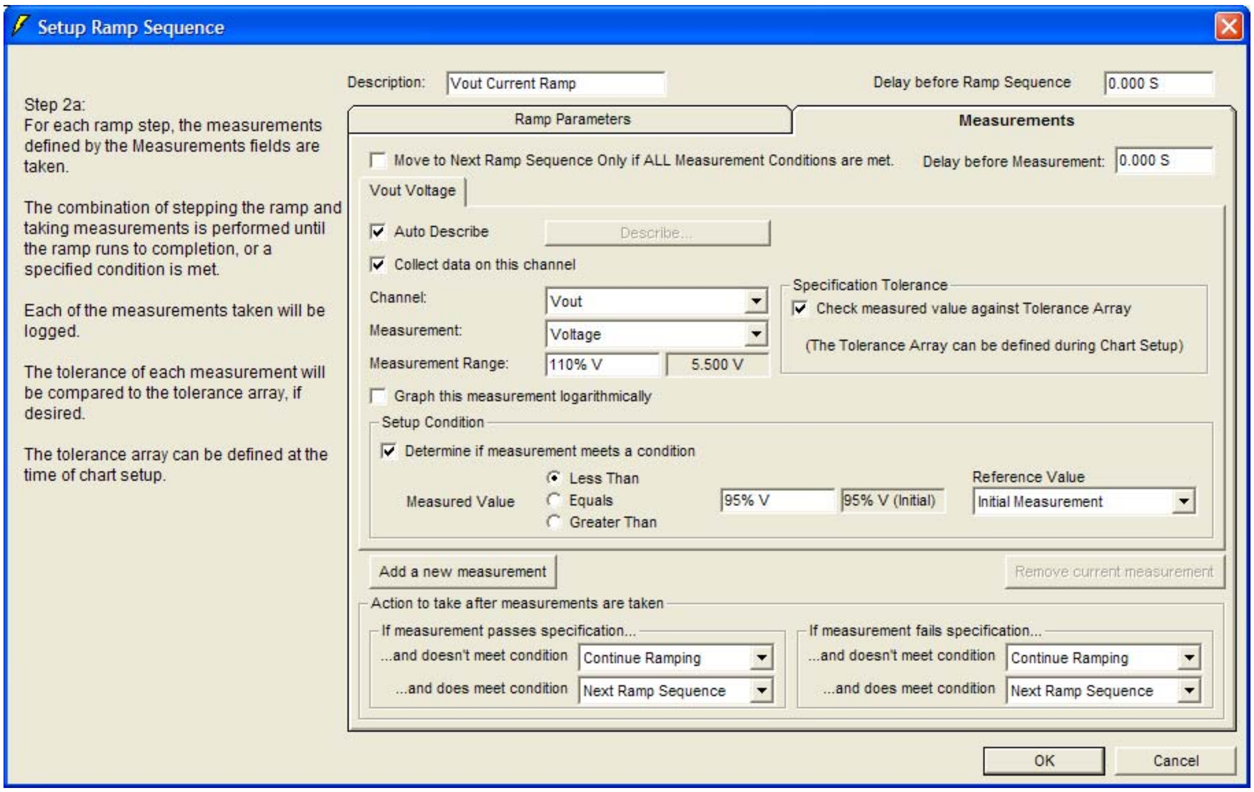
The first step is to define the Current ramp. According to our example definition, we want to ramp Vout current from 0A to 1.0A. Review the figure below to be sure you understand the steps required to program the ramp. The choice of 20 ramp steps was arbitrary; increasing the step count will give you finer resolution in your graph, while decreasing the count will speed data collection. We set a step delay to allow the current change to settle before beginning the measurements.



35.5.2 Measurements – Current Ramp Sequence

Since we're ramping current, we need to verify the output voltage at each step. We'll want to ensure our output stays within tolerance, so select the "Check measured value against Tolerance Array" option.

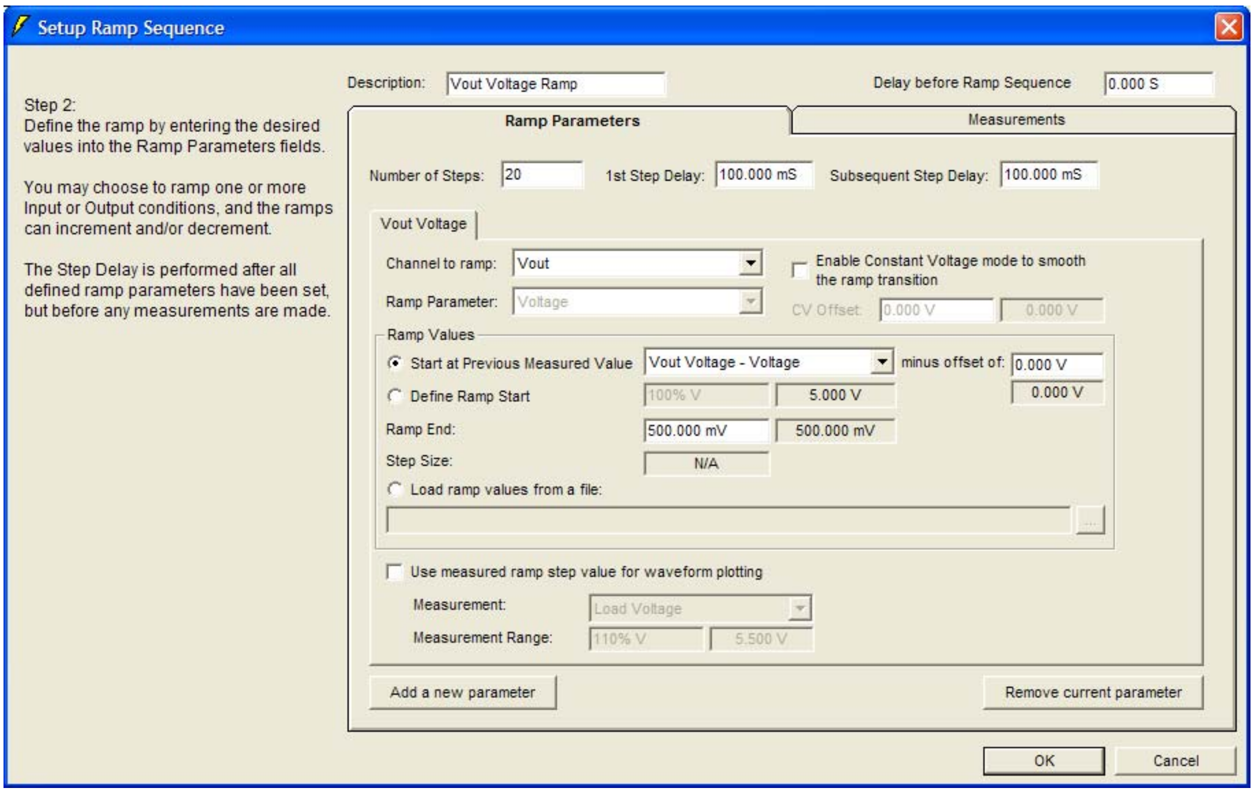
Additionally, we'll want to end our Constant Current ramp once the output voltage drops below our regulation specification. This will be our "condition" to determine whether to continue the current ramp or jump to the next ramp sequence. In this example, if the UUT drops below 5% of the initial measurement we want to begin the Constant Voltage sequence. Review the figure below to be sure you understand the steps required to program the ramp measurements.



35.5.3 Ramp Parameters – Voltage Ramp Sequence

The next step is to define the Voltage ramp. According to our example definition, we want to ramp Vout voltage down to 0.5V. Since the output voltage has been dropping due to the increased current demand of the Current ramp sequence, we'll want the Voltage ramp to begin where the Current ramp left off – select the "Start at Previous Measured Value" option and choose the Vout Voltage measurement.

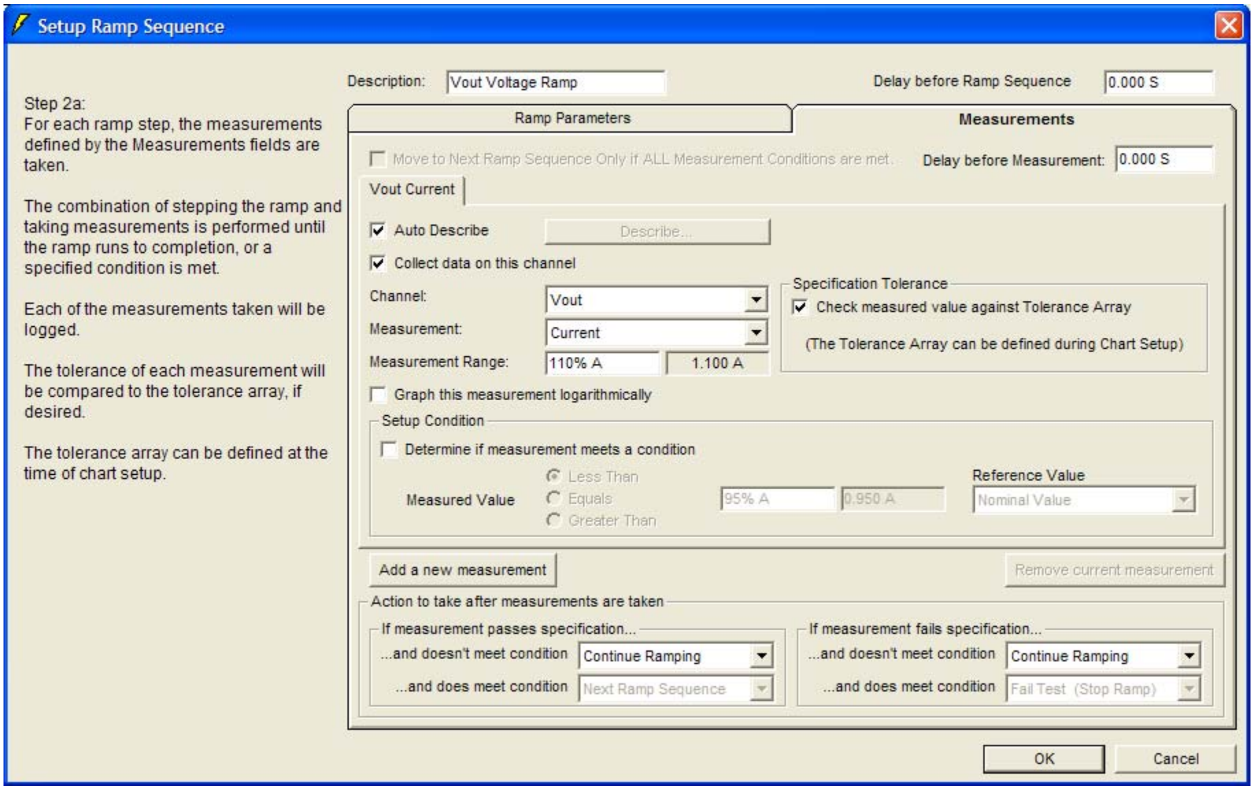
Review the figure below to be sure you understand the steps required to program the ramp. Again, the choice of 20 ramp steps was arbitrary; increasing the step count will give you finer resolution in your graph, while decreasing the count will speed data collection. We set a step delay to allow the voltage change to settle before beginning the measurements.



35.5.4 Measurements – Voltage Ramp Sequence

Since we're ramping voltage, we need to measure the output current at each step. We'll want to ensure our output stays within tolerance, so select the "Check measured value against Tolerance Array" option.

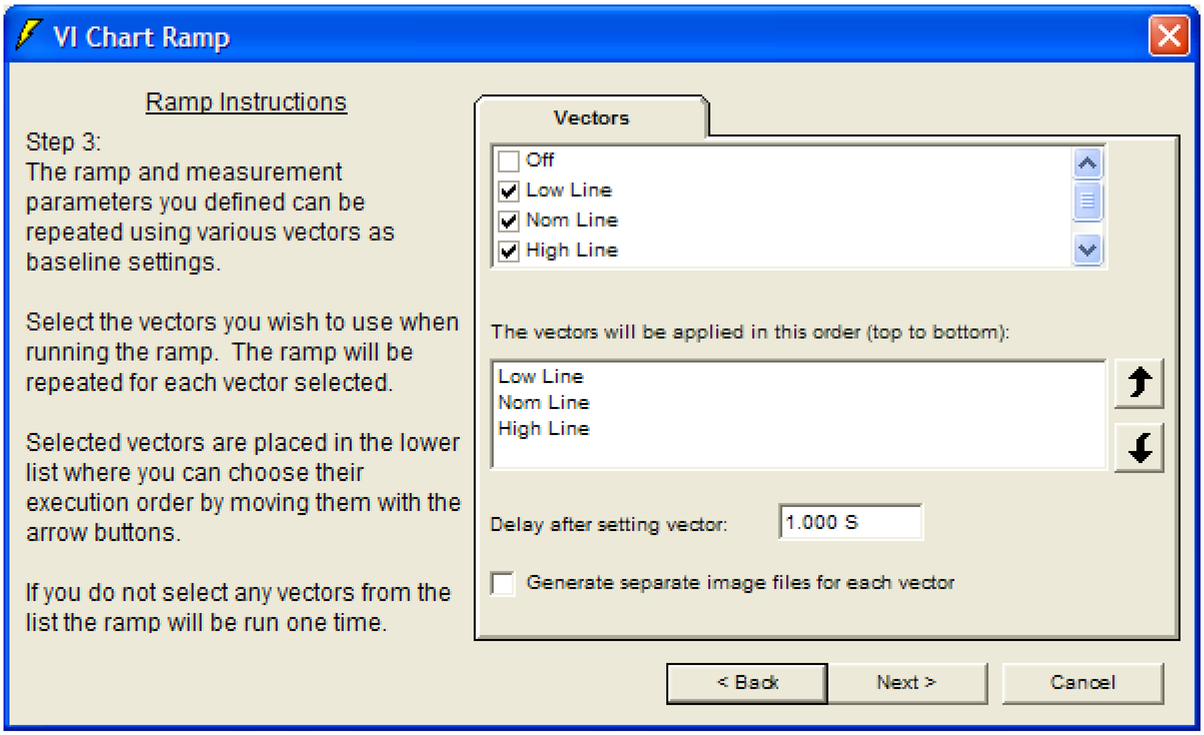
In this case, we'll want to continue the Voltage ramp down to our desired 0.5V regardless of what the output does, therefore we do not need to provide a "condition" value. Review the figure below to be sure you understand the steps required to program the ramp measurements.



35.5.5 Vectors

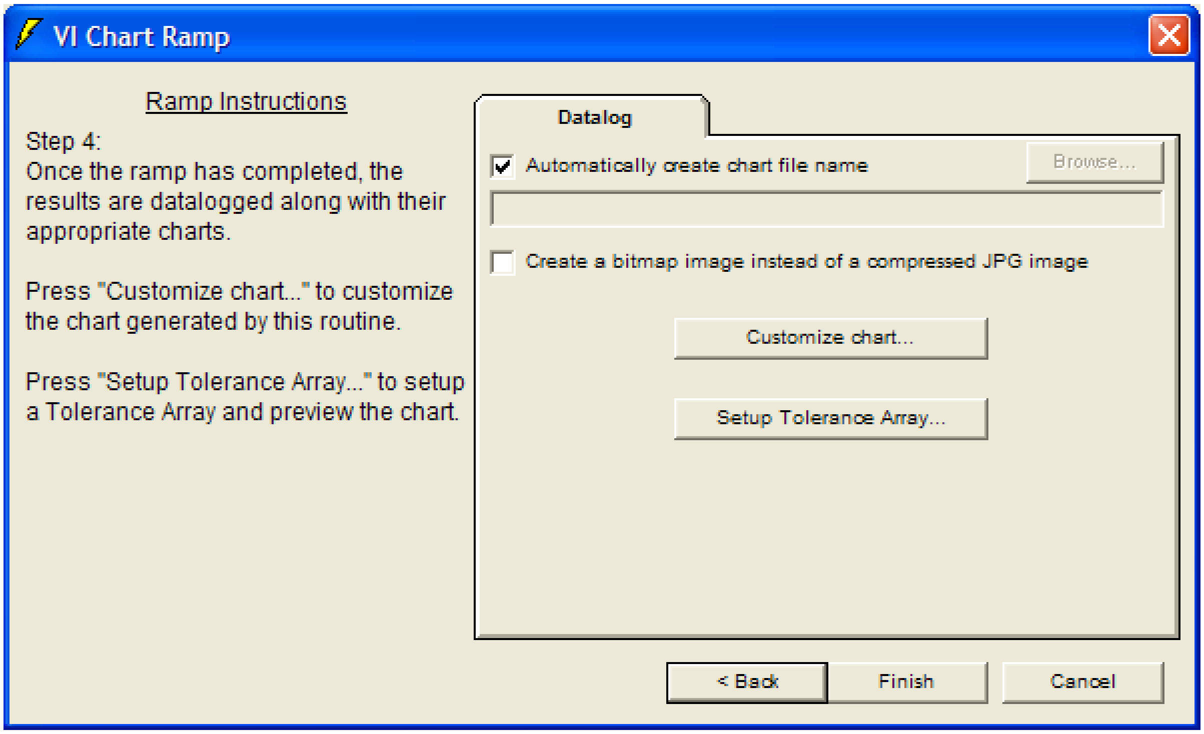
According to our example definition, we want to run the ramp at Low Line, Nom Line and High Line. We select the appropriate items in the Vector list. To ensure that the vectors will be executed in the correct order, use the arrows to move the entries as required. We'll set a delay to allow the UUT to settle after each vector is applied.

If you want separate charts for each vector check the "Generate separate image files" option. For our example we want to consolidate all three curves into one image so we leave the box unchecked.



35.5.6 Datalog

In this example we don't need to do anything special with the images so we'll let the test system control the chart naming. However, we'll want to customize the layout of the chart as well as define our Tolerance Array. Begin by pressing the "Customize chart…" button.



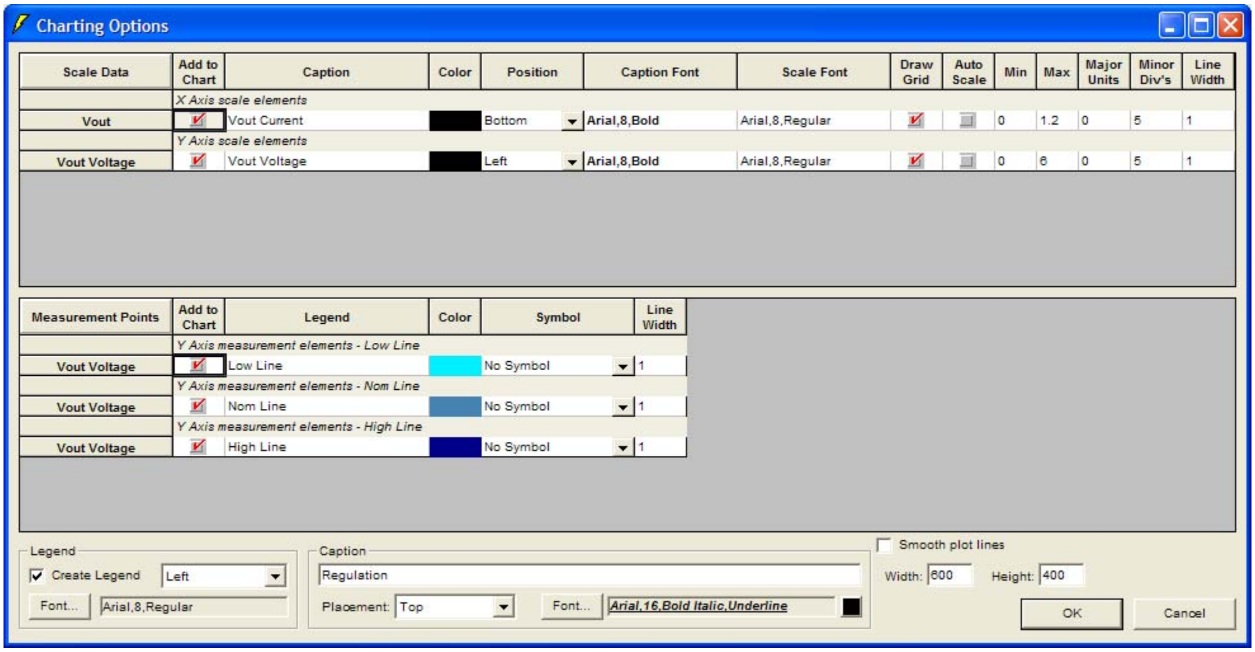
35.5.7 Charting Options

We'll make several changes to the chart layout in order to demonstrate the flexibility of the charting options. Let's begin by examining the "Y Axis scale elements" in the Scale Data (top) section.

To make the chart look more like an oscilloscope image, we'll select "Draw Grid" for both axes, and split each cell into 5 sub-units by setting the "Minor Div's" to 5.

To allow the graphing to account for possible out-of-tolerance values, we've extended the graph range for both current and voltage by increasing the "Max" values. We could have selected auto-scale to ensure that the graph always displays the values, but we wanted consistent charts from every UUT.

We've also made some modifications to colors and font selections to suit our preferences.

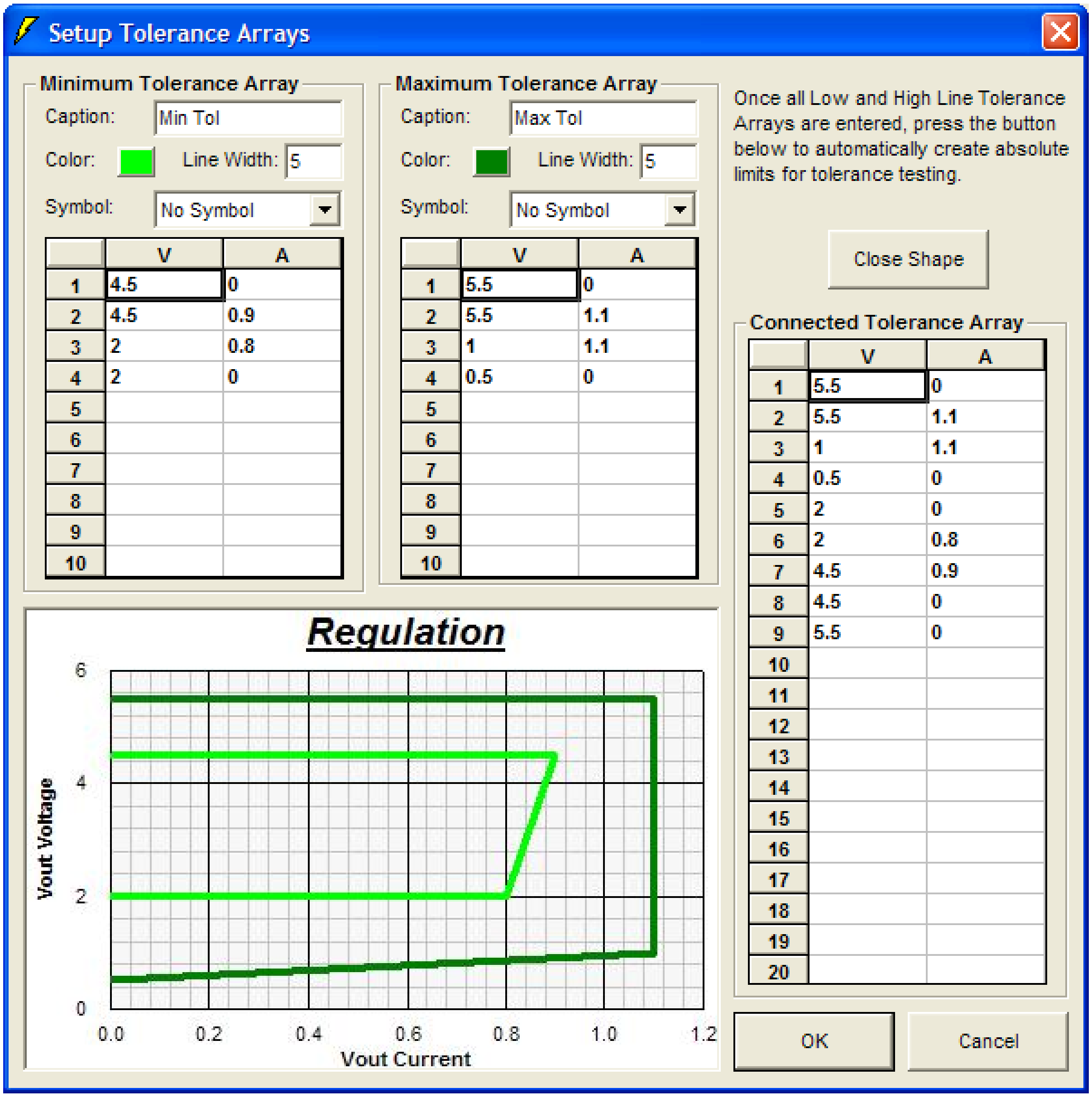


In the "Measurement Points" section (bottom), we have options for plotting the collected data. Since we defined the ramp to run under three vectors, we have three groups of data.

We've shortened the legend text, adjusted the colors and removed the symbols from the plot lines. By placing the legend inside the graph (at the left edge), we are maximizing the graph to fit the image width. Finally, we gave the chart an appropriate caption of "Regulation" and adjusted the font to make it more noticeable.

35.5.8 Setup Tolerance Arrays

We will need to create a tolerance shape that allows the UUT voltage to foldback towards 0.0V without failing. Each tolerance limit line consists of 3 line segments, or 4 X-Y points.



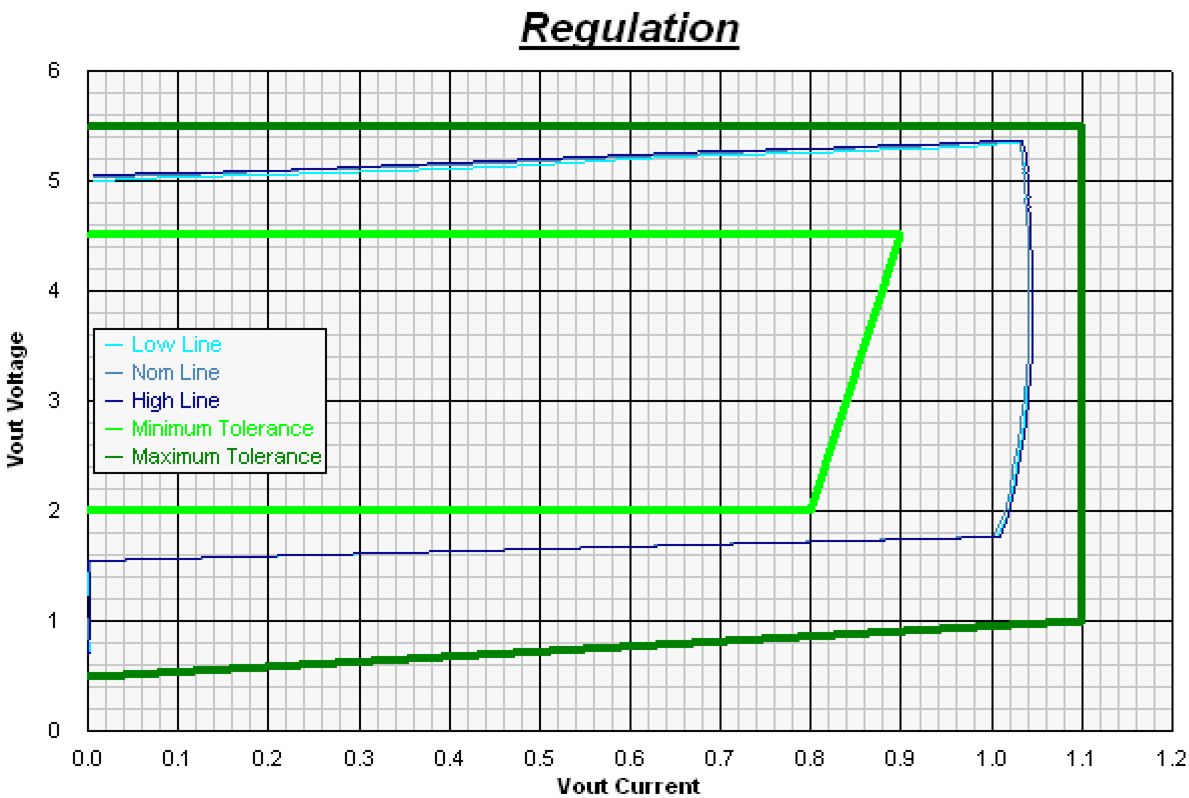
The first point of the Minimum Tolerance line will allow the unit to provide at least 4.5V with no current draw. The second point declares that the UUT should remain at least 4.5V from 0A to 900mA. Beyond 900mA, it's OK if the UUT voltage begins to collapse, so our final two points extend our tolerance array back towards 0.0V.

The first point of the Maximum Tolerance line specifies that the unit should not exceed 5.5V with no current draw. The second point declares that the UUT should never exceed 5.5V from 0A to 1.1A. The third point indicates that the output current is never expected to exceed 1.1A even as the unit is folding back. The final point defines the expected behavior as the UUT approaches 0.0V.

Be sure to press the "Close Shape" button once the tolerance line segments are entered. Again, you are free to choose fonts, colors and line widths according to your preferences.

35.5.9 Sample Output

Using the setup defined in the previous steps, here's a sample of a possible chart:



36. VOLTAGE REGULATION TEST

36.1 Description

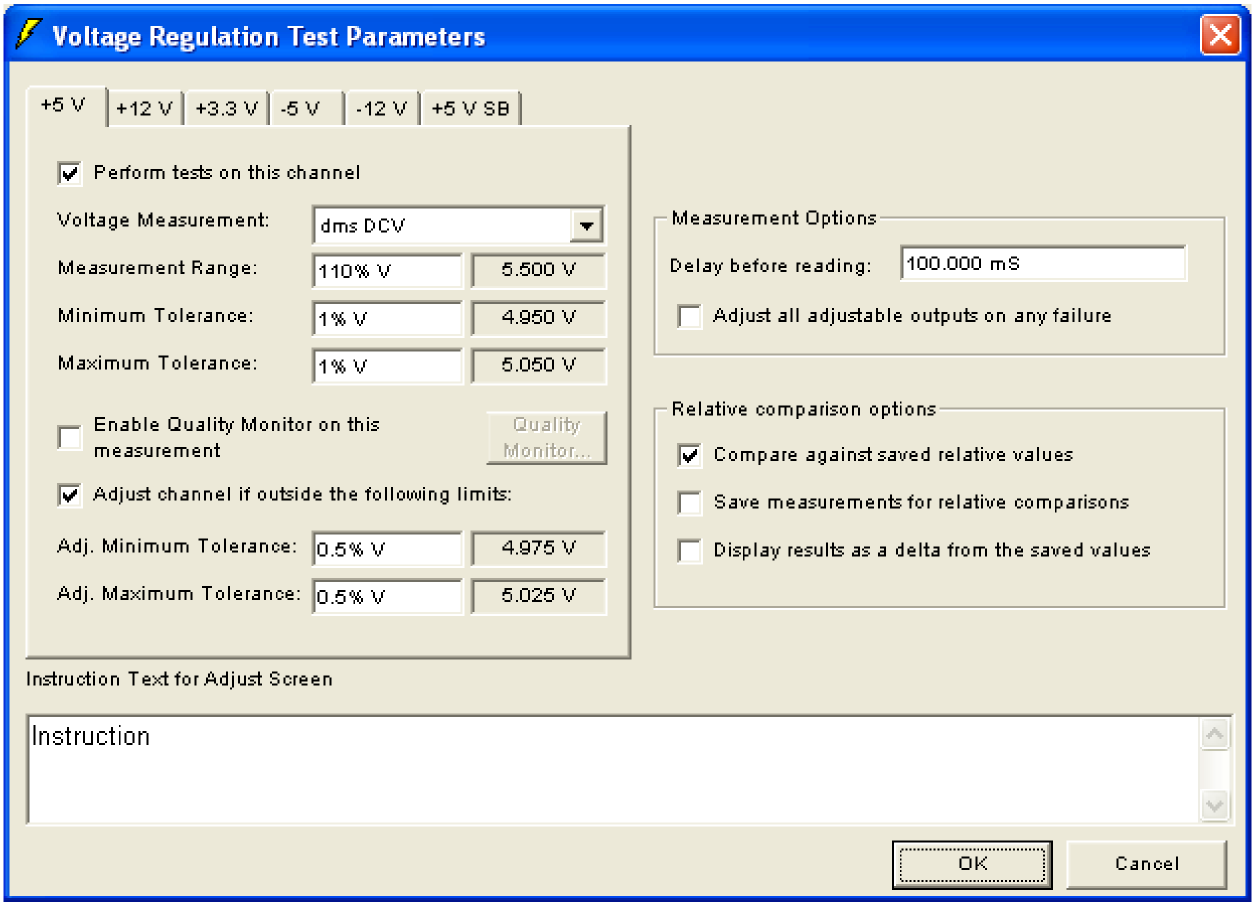
The Voltage Regulation test routine combines the capabilities of an Absolute Voltage Regulation, a Relative Voltage Regulation and an Output Voltage Adjustment test routine in one. This test checks the individual outputs of the UUT and compares the measurements to either the nominal channel voltage settings, or the actual channel voltage saved by a previous run of this routine. This test is used for line/load regulation tests that want an absolute measurement displayed.

In addition, the individual outputs of the UUT may be adjusted manually with a graphical display showing the measurement and its relationship to the upper and lower tolerances.

36.2 Method

After performing the delay before reading, the measurement is taken on each enabled UUT output. Should any adjustable output fail, the operator is presented with an adjustment screen. After the adjustments (if any), pass or fail status is determined and the results are logged to the datalog devices.

36.3 Test Routine Properties



- Perform tests on this channel – check this box to take a measurement of this channel.
- Voltage Measurement – the measurement vector that will be used to take the measurement. Note that this must be a DMM-type voltage measurement vector
- Measurement Range – this is the maximum expected measured value. The value may be entered either as a value or a percentage of a channel reference.
- Minimum Tolerance - this is the allowable lower limit of the measured value. Measured values less than this will cause the test routine to fail. The value may be entered either as a value or a percentage of nominal channel voltage.
- Maximum Tolerance - this is the allowable upper limit of the measured value. Measured values greater than this will cause the test routine to fail. The value may be entered either as a value or a percentage of nominal channel voltage.
- Enable Quality Monitor on this measurement – check this box to enable Quality Monitor data collection.
- Quality Monitor… – press this button to display the Quality Monitor properties. Please refer to the Quality Monitor reference manual for further details.
- Adjust channel if outside the following limits – check this box to indicate the channel may be adjusted if it is found to be outside the adjustment limits.

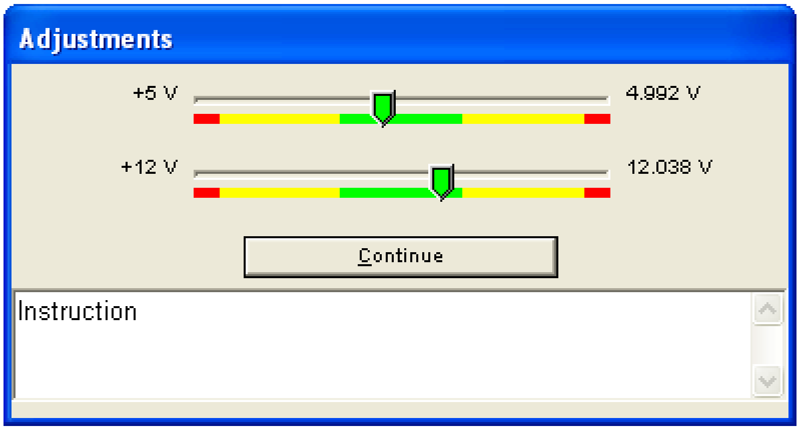
- Adj. Minimum Tolerance - this is the allowable lower limit of the adjustment range. Measured values less than this will cause this output to be added to the adjustment list. The value may be entered either as a value or a percentage of nominal channel voltage.
- Adj. Maximum Tolerance - this is the allowable upper limit of the adjustment range. Measured values greater than this will cause this output to be added to the adjustment list. The value may be entered either as a value or a percentage of nominal channel voltage.
- Delay before reading – the amount of time you allow the UUT to settle before beginning the measurements. Note that this delay happens once at the beginning of the routine.
- Adjust all outputs on any failure – check this box to have all the outputs included in the graphical adjustment screen should *any* output need adjustment.
- Compare against saved relative values – check this box to have the routine use previously saved values instead of the nominal channel voltage for measurement comparisons. Note that an error is logged if the output voltage for this channel has not been previously saved. In that case, the test will continue using the nominal channel voltage instead of the true voltage.
- Save measurements for relative comparisons – checking this selection will save the channel's measurement (true output voltage) for use in subsequent Relative Voltage Regulation tests.
- Display results as a delta from the saved values – check this box to have the routine display the results as the difference of these measurements from previously saved measured values.
- Instruction Test for Adjust Screen – instructions entered in this field will be displayed on the adjustments screen during the test. If this field is left blank, the instructions area on the adjustments screen will not display.

36.4 Sequence

The load, source, digital and analog vectors defined by the program are applied to the tester hardware before the test routine sequence is initiated.

1) Wait the delay before reading time
2) For each UUT output:
    a) Perform the measurement
    b) Evaluate the result
    c) If passed, or the output is not adjustable, log the result
    d) If adjustable and failed, add output to the adjustment list
    e) Check for faults and log them as necessary

3) If there were any outputs needing adjustment:



a) Show the adjustment screen until the operator accepts the values. The test will pass as long as all measurements are in the yellow or green area of the adjustment scale. The green area is defined by the “Adj. Minimum/Maximum Tolerance” parameters, while the yellow area is defined by the “Minimum/Maximum Tolerance” parameters

b) Evaluate and log the results

c) Check for faults and log them as necessary

37. VOLTAGE REGULATION (ENHANCED) TEST

37.1 Description

The Voltage Regulation (Enhanced) test routine is just what is says – an enhanced version of the original Voltage Regulation test. The major difference between the two routines lies in the handling of the Tolerance fields. In the original test, the Minimum Tolerance value is always subtracted from the nominal value, while the Maximum Tolerance value is always added, keeping the minimum and maximum tolerance values surrounding the expected nominal. This can cause difficulties when the expected value rises above or below nominal, and the programmer wants to enter values that both fall on the same side as nominal.

This enhanced version relies on the sign of the entered value to determine whether the tolerance should be subtracted or added from the nominal. With this change you enter negative minimum tolerance values and positive maximum values to surround the nominal value.

Let's say you apply a trim input to your supply, causing it to rise above nominal. You can now enter positive minimum and maximum tolerances to surround the new expected value. If the unit is trimmed low, you can enter negative minimum and maximum values.

The other change is that a new Relative Comparison option is introduced with this test – you can now display the results of the comparison as a percentage of error from the saved values.

In all other respects the routines remain the same.

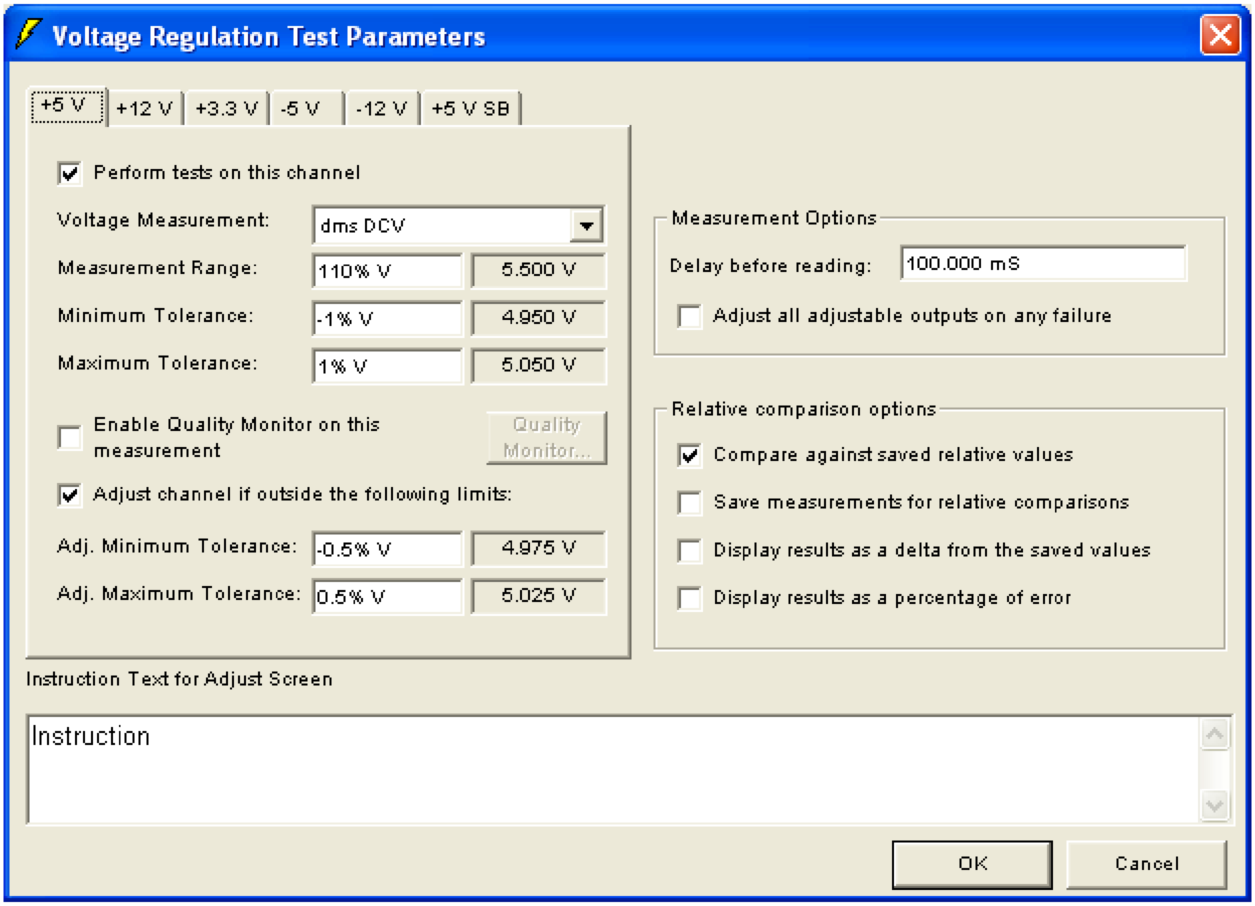
This test combines the capabilities of an Absolute Voltage Regulation, a Relative Voltage Regulation and an Output Voltage Adjustment test routine in one. This test checks the individual outputs of the UUT and compares the measurements to either the nominal channel voltage settings, or the actual channel voltage saved by a previous run of this routine. This test is used for line/load regulation tests that want an absolute measurement displayed.

In addition, the individual outputs of the UUT may be adjusted manually with a graphical display showing the measurement and its relationship to the upper and lower tolerances.

37.2 Method

After performing the delay before reading, the measurement is taken on each enabled UUT output. Should any adjustable output fail, the operator is presented with an adjustment screen. After the adjustments (if any), pass or fail status is determined and the results are logged to the datalog devices.

37.3 Test Routine Properties



- Perform tests on this channel – check this box to take a measurement of this channel.
- Voltage Measurement – the measurement vector that will be used to take the measurement. Note that this must be a DMM-type voltage measurement vector
- Measurement Range – this is the maximum expected measured value. The value may be entered either as a value or a percentage of a channel reference.
- Minimum Tolerance - this is the allowable lower limit of the measured value. Measured values less than this will cause the test routine to fail. The value may be entered either as a value or a percentage of nominal channel voltage.
- Maximum Tolerance - this is the allowable upper limit of the measured value. Measured values greater than this will cause the test routine to fail. The value may be entered either as a value or a percentage of nominal channel voltage.
- Enable Quality Monitor on this measurement – check this box to enable Quality Monitor data collection.
- Quality Monitor… – press this button to display the Quality Monitor properties. Please refer to the Quality Monitor reference manual for further details.
- Adjust channel if outside the following limits – check this box to indicate the channel may be adjusted if it is found to be outside the adjustment limits.

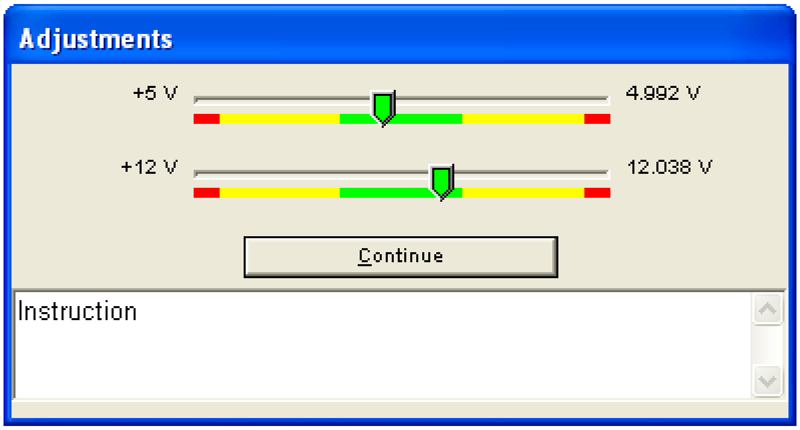
- Adj. Minimum Tolerance - this is the allowable lower limit of the adjustment range. Measured values less than this will cause this output to be added to the adjustment list. The value may be entered either as a value or a percentage of nominal channel voltage.
- Adj. Maximum Tolerance - this is the allowable upper limit of the adjustment range. Measured values greater than this will cause this output to be added to the adjustment list. The value may be entered either as a value or a percentage of nominal channel voltage.
- Delay before reading – the amount of time you allow the UUT to settle before beginning the measurements. Note that this delay happens once at the beginning of the routine.
- Adjust all outputs on any failure – check this box to have all the outputs included in the graphical adjustment screen should *any* output need adjustment.
- Compare against saved relative values – check this box to have the routine use previously saved values instead of the nominal channel voltage for measurement comparisons. Note that an error is logged if the output voltage for this channel has not been previously saved. In that case, the test will continue using the nominal channel voltage instead of the true voltage.
- Save measurements for relative comparisons – checking this selection will save the channel’s measurement (true output voltage) for use in subsequent Relative Voltage Regulation tests.
- Display results as a delta from the saved values – check this box to have the routine display the results as the difference of these measurements from previously saved measured values.
- Display results as a percentage of error – check this box to have the routine display the results as the percentage difference of these measurements from the previously saved values.
- Instruction Test for Adjust Screen – instructions entered in this field will be displayed on the adjustments screen during the test. If this field is left blank, the instructions area on the adjustments screen will not display.

37.4 Sequence

The load, source, digital and analog vectors defined by the program are applied to the tester hardware before the test routine sequence is initiated.

4) Wait the delay before reading time
5) For each UUT output:
    a) Perform the measurement
    b) Evaluate the result
    c) If passed, or the output is not adjustable, log the result
    d) If adjustable and failed, add output to the adjustment list
    e) Check for faults and log them as necessary

6) If there were any outputs needing adjustment:



a) Show the adjustment screen until the operator accepts the values. The test will pass as long as all measurements are in the yellow or green area of the adjustment scale. The green area is defined by the "Adj. Minimum/Maximum Tolerance" parameters, while the yellow area is defined by the "Minimum/Maximum Tolerance" parameters

b) Evaluate and log the results

c) Check for faults and log them as necessary

38. WAVEFORM TEST ROUTINE

38.1 Description

The Waveform Test Routine provides the capability to display a digitized waveform from the selected instrument, and compute various magnitude and timing values from the captured data. Controls and functions are very similar to those found on a multi-channel Digital Sampling Oscilloscope (DSO). Any of the NHR hardware that supports digitizing can be used with this test routine. Some devices are very general purpose and provide capabilities that exceed many DSO's (like the DMS PowerScope), others are more limited (like the AC Load).

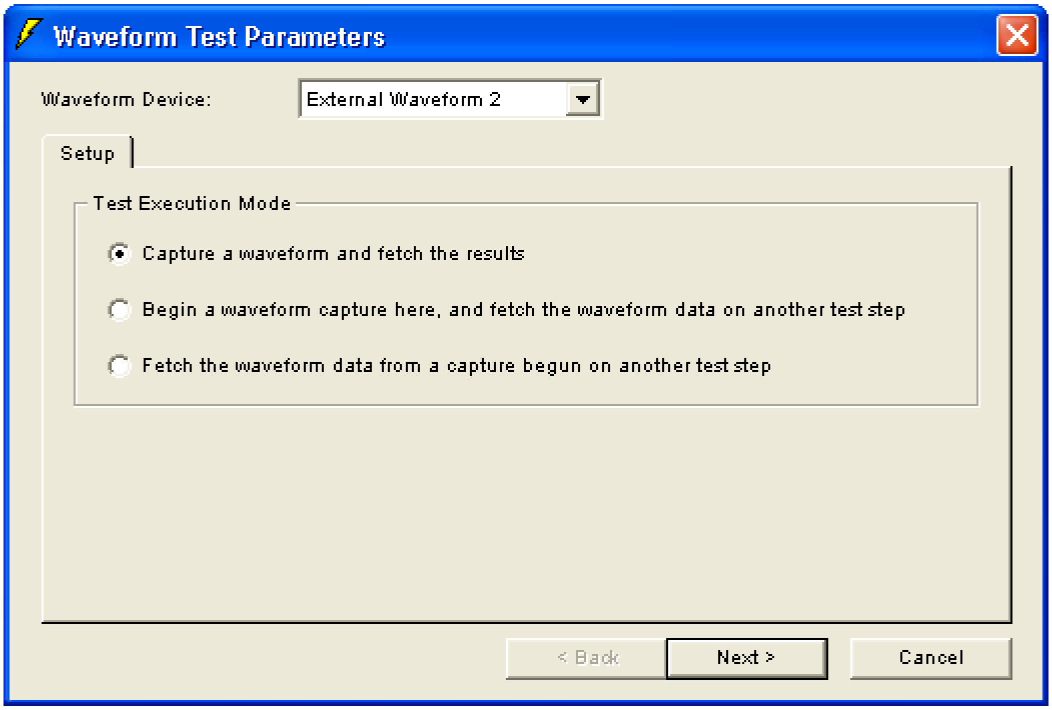
The Waveform Test Routine is intended to be a general-purpose measurement tool much like a DSO would be used in an engineering laboratory. The user is free to set up capture parameters without any specific test routine constraints. Any number of the available waveform measurements can be specified for a given data capture, as well as visual operator inspection and verification of on-screen waveform display.

38.2 Method

At test run time, the waveform device is set up and the capture is begun. The Start Vector is applied after the Delay Before Start Vector expires. If the Start Event Timeout expires before the waveform trigger condition occurs, the test posts a failed status. If the trigger occurs in the allotted time, the captured waveform is transferred to the PC for processing. Any measurement operations are performed on captured data, pass or fail status is determined, and the result is logged to the datalog devices.

38.3 Test Routine Properties

From the Program entry screen, the Waveform Measurement is selected from the Test Routine field.

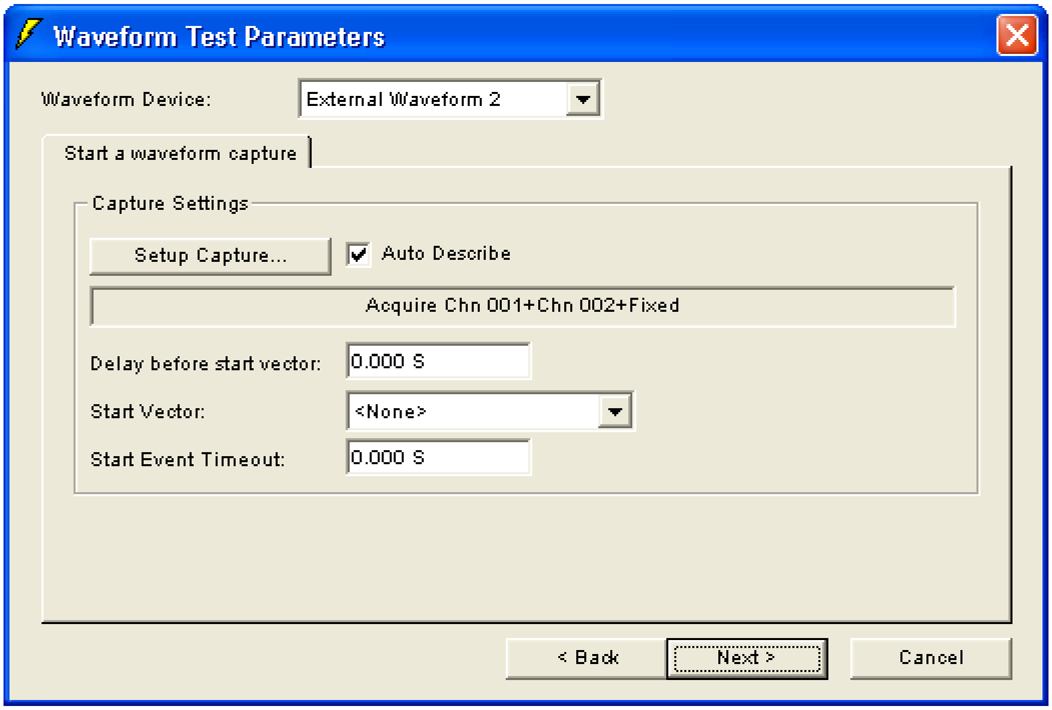


The first page of the test routine parameters allows you to select the device that will be used to capture the data. The list of available devices varies with the hardware installed. In the NHR default naming convention, waveform devices capable of accepting input external to the digitizer are named “External Waveform 1,” 2, etc. If the digitizer gets the input internally, the devices are listed by the logical hardware name like “AC Load 1,” “DC Load 1,” etc. These devices can be given customized names by the user in the Configuration utility (see NH Document 09-0269).

The Test Execution Mode is selected here as well. In most cases, you will be capturing and fetching the results in this one step. Examples of this are a noise measurement, a turn-on or turn-off capture, and any other that requires only one system vector to achieve the condition to capture. In those cases where you want to capture a waveform while a series of vectors are applied, you will need to use this test routine in two steps in the test program. The first will choose the “Begin a waveform capture here” option and the second the “Fetch the waveform data” option.

WARNING: If you split the waveform between two steps, you CANNOT make any measurements using the same hardware that the waveform is being captured on in between the capture and fetch. An example would be to start a capture on the PowerScope (a DMS digitizer) and while capturing, trying to measure a mux input (also DMS hardware).

The next page is where you setup the capture parameters and what vector, if any, you want to apply after the capture has begun.



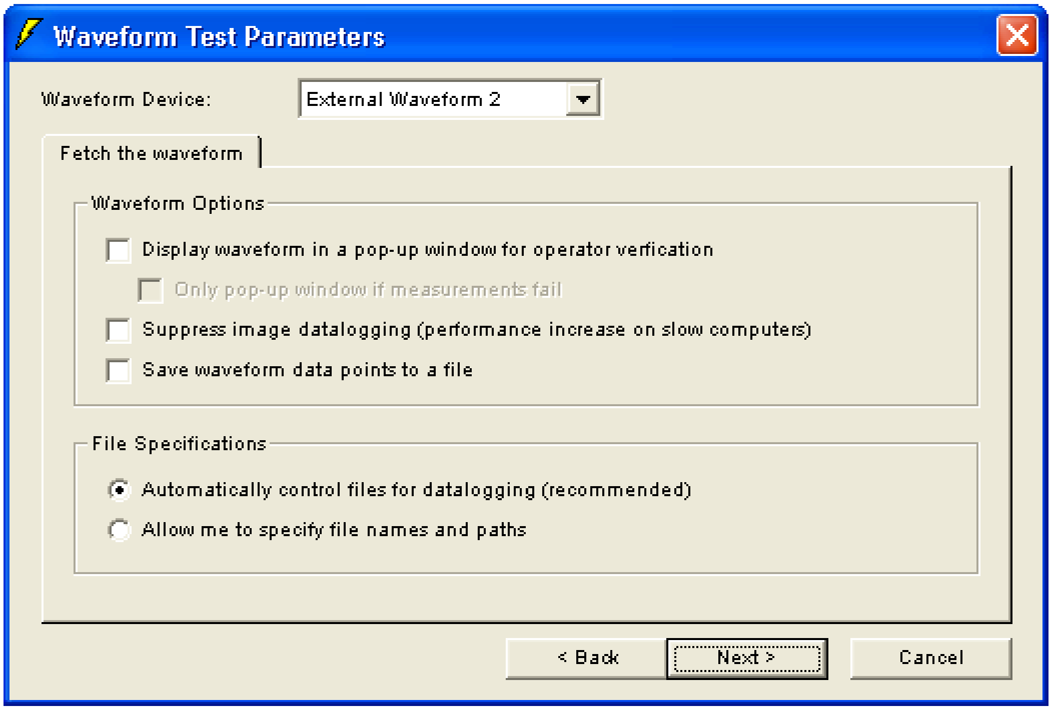
The "Setup Capture" button brings up the Digitizer Device virtual scope front panel control. This panel is used to select ranges, trigger options, input coupling and termination, which channels to enable, and which system elements to connect to the enabled channels.

The familiar DSO front panel interface (see 38.3.1 below for details) allows the multitude of possible set up options to be presented in an intuitive way, and the "live" graphical display allows checking the operation of the setup parameters. The Run and Force Trigger buttons allow samples to be captured for immediate verification of range and sample rate selections if other system signals are also "live" during test generation. A Measure button allows immediate verification of the possible measurement operations before they are used in the run time test program.

- Delay Before Start Vector – This time is used to delay the Start Vector from activation when the test program enters the Waveform Test step. This may be necessary to allow other system instruments, or the UUT, to be initialized or reach a nominal state as a result of previous program steps. Since the Start Vector will typically invoke a trigger condition required to capture data, the Delay Before Start Vector can be used to hold off this trigger for a fixed time if necessary. Pre-triggering memory fill delays are determined automatically depending on the Trigger Position selection (see below), the Delay Before Start Vector is not used for this purpose.
- Start Vector – the vector that will initiate the measurement. The dropdown contains an entry for every user defined Load, Source, Digital and Analog vector in the test program.
- Start Event Timeout – This time is used as a worst-case timeout value to keep the test program from waiting indefinitely for a trigger condition or other result of the Start Vector. As an example, if the Start Vector was UUT Power On, and the Waveform Test Trigger Source selection was a DIN input connected to a UUT Power Good output signal, the Start Event Timeout could be set to the greatest expected delay from UUT Turn On to Power

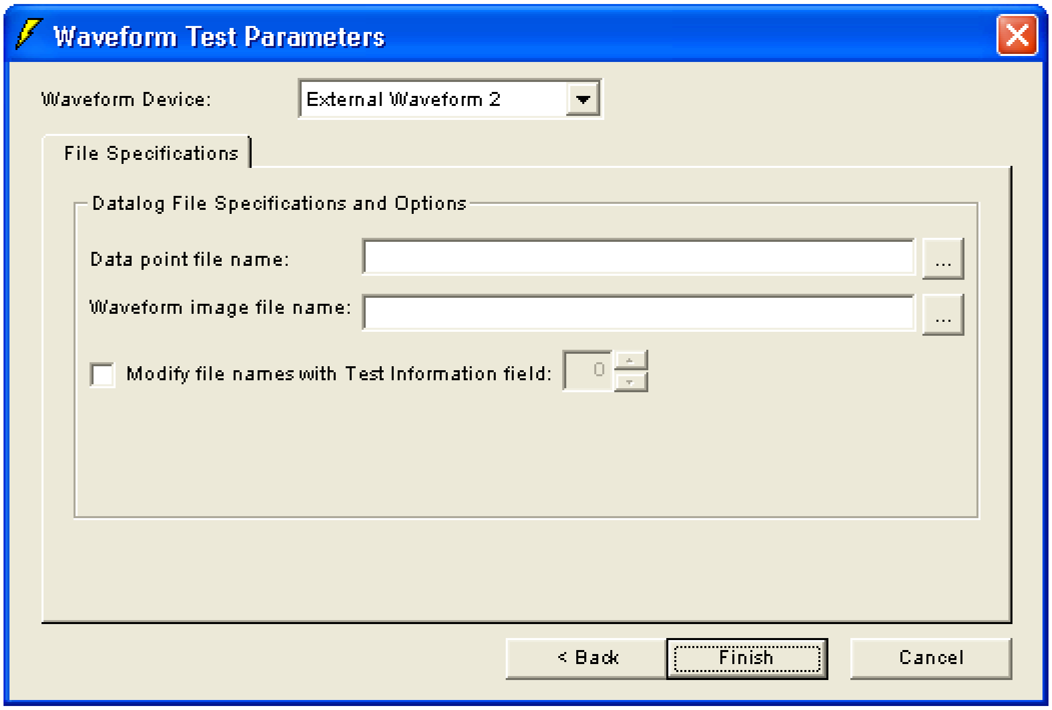
Good. The timeout will keep the test from hanging indefinitely if a bad UUT never activates Power Good. If the Start Event Timeout expires, a test failure status is logged and the test program continues.

The following page is used to decide how to display and log test results.



- Waveform Options – These selection buttons determine whether the Scope Panel visual waveform display appears on the operator monitor at test run time.
  - If the Display waveform in a pop-up window is selected, the operator is required to select a Pass or Fail button at run time to complete the test step.
  - If the suppress image option is selected, the test will still capture and process all measurements, but instead of displaying the measurement results AND the captured waveform image, only the measurement results will be displayed.
  - If the save waveform data points to a file is selected, the waveform sample data can be saved to a user specified file for use with offline data analysis tools. The file is saved in Comma Separated Variable format (CSV) for import to spreadsheet and data analysis programs. Values of time and waveform magnitude are in floating point format with descriptive column titles. The number of sample values and file size are determined by the Seconds/Division setting and Acquisition Setup parameters set in the Scope Panel (see below).
- File Specifications – These selection buttons determine whether files generated during this test are managed automatically or if you will choose the file and path.
  - If the automatic method is chosen, the system will store waveform images and data files in the most efficient way and insure that they can be viewed at a later time using the emPower Datalog capabilities.

- If you choose to specify file names and paths for data files and images, they will be saved in unique files for each test in addition to the version saved by the Datalog functions. This may require significant disk storage and slow test times.



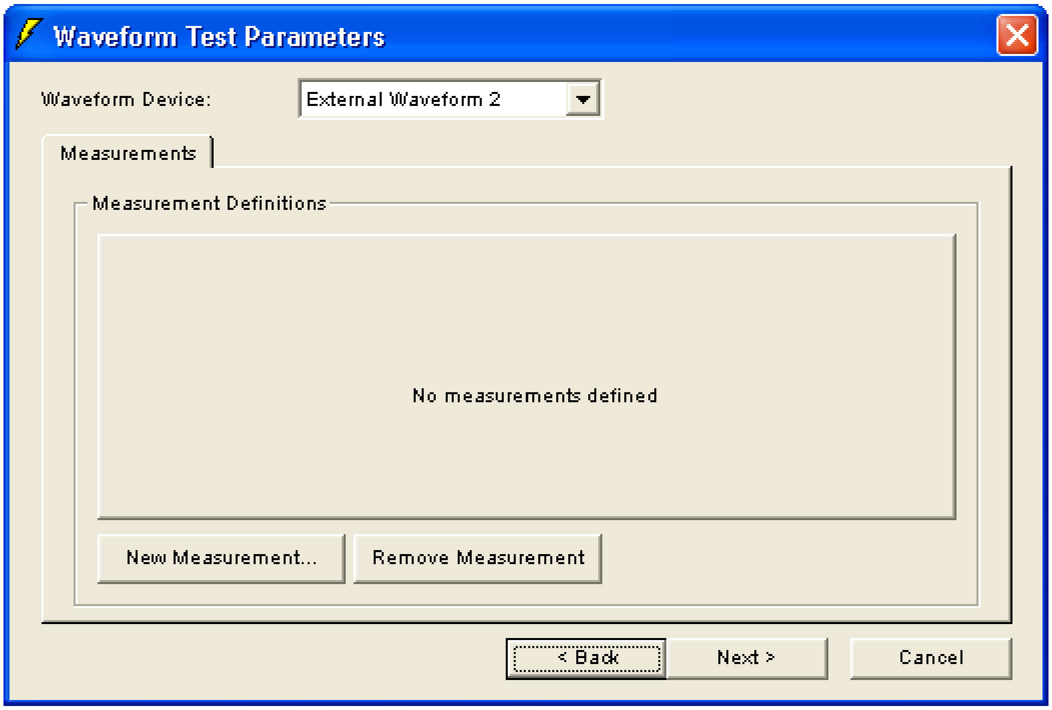
- Data point file name will store the .csv file with the raw waveform data.
- Waveform image file name will be the .jpg image file showing the waveform image.
- Modify file name with Test Information field – When enabled, a field from the Test Information Entry form will be appended to the user entered file name. The Test Information Entry form appears before running the test on each UUT, and is typically filled in by the test operator. Appending an information field provides a method of tracking specific digitizer samples to a particular UUT serial number or test pass. The number selection box determines which of the input fields from the Test Information Entry form will be appended to the file name.

The final page of the setup is the waveform measurement page.

- New Measurement – Opens a selection form for choosing among all available measurements that can be performed on captured data. The methods and properties for each measurement are described below (see 38.3.5). Any number of the available measurements can be added to a single Waveform Test, and will be represented in a tabbed list for review or modification.

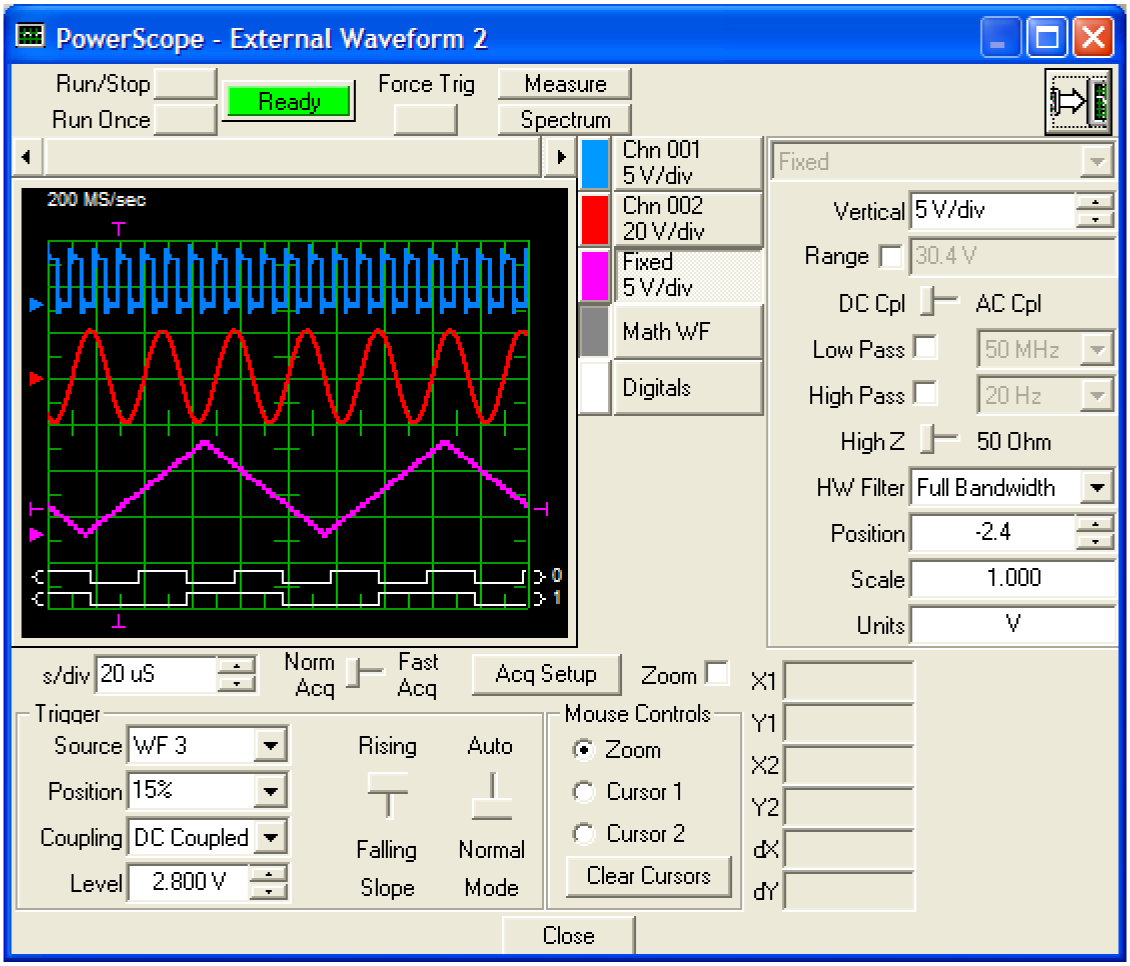
Some controls are common to all waveform tests. These are seen after a New Measurement has been added:

- Auto Describe – if checked, the measurement is described by combining the name of the Waveform Channel to be measured with the measurement function (e.g. “frequency”). If unchecked, the user is prompted to provide a description of this measurement.
- Enable Quality Monitor on this measurement – check this box to enable Quality Monitor data collection.
- Quality Monitor… – press this button to display the Quality Monitor properties. Please refer to the Quality Monitor Reference Manual for further details.



38.3.1 NHR Scope Virtual Front Panel

The NHR Scope panel appearance varies slightly depending on the digitizing device selected when the Waveform Test was created. The number of channels available and their capabilities may vary for loads, sources, or multiplexed measurement devices, but the controls for capturing waveform data are consistent across devices.



The scope panel can be logically divided into the same functional areas found on most Digital Sampling Oscilloscope instruments; Display Features, Vertical Control, Horizontal Control, Trigger Control, Acquisition Control, and Measurement Control.

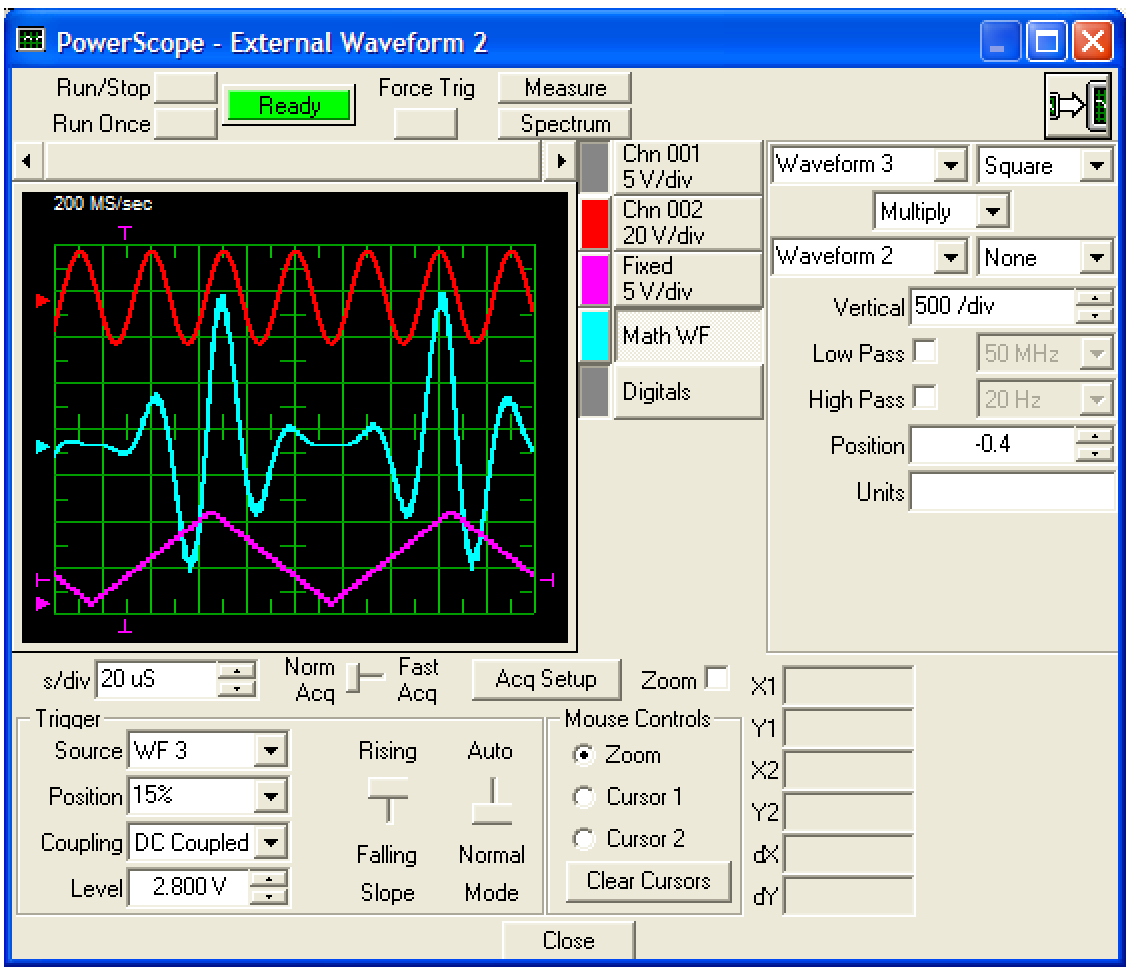
38.3.1.1 Display Features

- Display Window – The virtual scope display window has ten major divisions vertically and ten horizontally. Only eight vertical divisions are displayed in the window while the other two are off the screen. This allows captured signals to be shifted up or down one major division without clipping their display. Each of the ten major divisions is divided into five minor divisions.
- Mouse Controls – Select various drag and drop operations on the display panel. When the selector is in the default Zoom position, dragging the cursor across a part of the waveform display will enlarge that selection to fill the entire display window (see below). The Cursor 1

and Cursor 2 selections provide visual measurement guides, which are dragged and dropped at waveform points on the screen. The vertical and horizontal values corresponding to the position of the visual cursors are displayed in real time.

- Zoom Mode – When the Mouse Control selector is in the Zoom position, dragging the mouse cursor can enlarge a portion of the waveform. This operation can be repeated multiple times for very fine resolution within a deep memory buffer. The Zoom Mode indicator turns green to indicate data has been magnified. The Seconds/Division control can be used for fine resolution control in Zoom mode, and clicking on the Zoom mode indicator button will reset the display to original resolution.
- Scope Panel Detail Control – The detail button in the upper right corner allows the Scope Panel to be reduced to save display space.

38.3.1.2 Vertical Controls



- Math WF – A channel that takes two existing waveforms and combines them into a new waveform, such as a voltage and a current waveform multiplied together making a power waveform.
- Channel Enables - A colored button is provided for each channel to enable or disable data capture on that channel. The color of the channel enable is keyed to the same color trace in

the display window. The Channel Selection button (below) must also be selected to enable the control functions for a channel.

- Channel Selection – A button displaying the channel name and selected vertical scale factor is used to determine which of the available channels will be modified by the other vertical control settings. The control settings affect <u>only</u> the channel with the Channel Selection button currently active.
- Input Selection – The channel selection drop-down list chooses which of many possible inputs will be connected to the selected channel. For waveform instruments connected through measurement multiplexers, all channels in the current hardware configuration should be available. For instruments connected to dedicated or fixed inputs, no channel selection is available.
- Vertical Selection – Sets the vertical scaling factor for the selected channel. This setting will determine the appropriate range setting to be used on the measurement instrument hardware i.e.: The minimum range that can accommodate ten vertical divisions. The increment and decrement buttons will select standard vertical scale factors, but any whole or fractional number can be entered.
- Range – Allows locking the hardware range for the selected channel. The hardware will use the closest range setting lower than the displayed value. Any number can be entered in the range window that will cover the maximum expected peak value of the signal. This can be useful when using the Position control (see below) to shift a signal on the “scope” window without causing a corresponding automatic hardware shift to a higher range. Note that clipping of signals can occur in this mode that may not be obvious on the display.
- Coupling – Selects between AC and DC coupling the input to the selected channel. This is available only when the measurement instrument has this capability.
- Low Pass and High Pass – These can be used to perform mathematical filtering operations on the displayed data. If both Low and High Pass frequencies are selected, the result is a bandpass filter operation. These filter selections affect only the displayed waveform and have no effect on waveform measurement values. See section 38.3.5.1 Common Measurement Function Operators for more details.
- Input Termination - Selects a high impedance or 50 ohm input termination for the selected channel. Available only on measurement instruments with selectable termination capability. NH Research instruments generally use AC coupled 50 termination only, check applicable instrument hardware reference manual for details. Power supply outputs and other low impedance sources should use 50-Ohm termination and matched coaxial cable for high frequency signal measurements.
- Hardware Filter – This control is available on instruments that have a hardware filter circuit. It selects a low pass filter to remove high frequency signal components before digital sampling. The filters available vary on different instrument types, check the Hardware Reference manual for the device being used. If the signal to be sampled contains components higher than twice the frequency of the available sampling rate, the hardware low pass filter should be used to avoid aliasing.

- Position – Allows offsetting the position of the selected waveform up or down the display panel. The increment or decrement arrows can be used, or the desired number of positive or negative Vertical Divisions entered directly. Shifting the position by more than one major division will cause the hardware to change to a higher range to insure the signal will not be clipped. This automatic up ranging can be defeated with the Range selection (see above).
- Scale Multiplier – Provides a convenient way of accommodating non-direct inputs on the selected channel. The Scale Multiplier value entered will affect visual cursor readings and any Measurement operations and the effective vertical scaling. If an input signal were externally attenuated by a factor of 10 before input to the waveform instrument, changing the scale multiplier to 10.0 would provide a direct correlation between the Vertical scale controls, visual display, and measurements and the actual value present on the UUT.
- Units – Allows the user to specify appropriate unit characters for specially scaled inputs on a selected channel. This new unit descriptor will replace the standard volt descriptor in on-screen displays and Measurement outputs. If a current shunt amplifier with a gain sufficient to provide 250 mV/Amp were connected to a channel, changing the Scale Multiplier (see above) to 4.0 and the units from V to A would give visual and Measurement readings directly in Amps.

38.3.2 Horizontal Controls

- Seconds/Division – Sets horizontal scaling for all channels. The increment and decrement buttons can be used to select standard values. This setting can be used in conjunction with the Zoom mode (see Display Features above) to adjust the display to fit any portion of a captured waveform. As the Seconds/Division setting is increased to large values, waveform instruments with limited memory loose resolution due to saving only a subset of available samples at intervals greater than the minimum sample period. The Acquisition Controls (see description below) can be used to change memory sample size, or use peak detection modes to counteract loss of resolution.
- Normal/Fast Acquisition – Allows waveform instrument capture and data transfer time to be minimized when full resolution isn’t required. One some instruments it may reduce each sample resolution to fewer bits than the hardware provides. It also reduces the sample buffer to a minimum memory size (typically 128 samples) regardless of the Seconds/Division or any specified sample count. May introducing aliasing due to reduced effective sample rate and likely to reduce accuracy.

38.3.3 Trigger Controls

- Source – Selects among the waveform instrument trigger sources and other system trigger sources. Waveform instruments with multiplexed inputs may have descriptors for waveform numbers corresponding to digitizer channels. Devices with fixed inputs may list trigger sources by functional name. Available Trigger Sources will vary by system configuration and Waveform instrument type.
- Position – Determines where the trigger point is positioned in the display window. The drop down selector list provides convenient positions for most waveforms, but numbers can be entered directly in either percent of display window, or time. Negative position values are permitted to display waveform segments occurring long after the trigger without having to

increase the Seconds/Division setting. Some instruments offer only a fixed trigger position, refer to Hardware Reference Manual for details.

- Coupling – Sets the input coupling options for the selected trigger source. Selecting AC coupling will block DC offset from a trigger input and pass only transients. Other DC coupled trigger input options are High Frequency Reject, Noise Reject, and High Frequency Reject and Noise Reject combined. These options allow more control of trigger operations on noisy or modulated signals. Some waveform instruments do not have independent coupling for input signals and trigger sources, and trigger control function bandwidths may vary. Check with applicable waveform instrument Hardware Reference Manuals for full specifications.
- Level – Sets threshold level for trigger source signal. Selecting trigger sources that are digital signals or internal to the test system will disable the level selection.
- Rising/Falling Edge – Selects desired trigger signal edge for selected trigger source. Edge selection may not apply to some trigger sources, such as Digital Pattern.
- Auto/Normal Mode – Allows the system to generate a periodic trigger if the selected trigger input does not occur regularly. In the Auto mode, the system trigger will cause the Display Panel to be updated periodically, even if the selected Trigger Source is not transitioning. In Normal mode, no waveform data will be displayed until the selected Trigger Source has an edge transition across the specified Level value.
- Force Trigger - The Force Trigger button on the Scope Panel can force a display update when no Trigger condition is present.

38.3.4 Acquisition Controls

- Desired Number of Samples – Allows the user to increase or decrease how many sample data points to capture. Any number can be entered, but waveform instrument hardware limitations may reduce the entered value if memory size is limited. Selecting large memory buffers may slow the Display Panel update rate. Deep memory buffer waveforms are displayed in a condensed format on the Display Panel in that multiple sample points are plotted in a single vertical interval. Zooming into any area of the waveform will continue to restore resolution up to the point where each individual sample can be plotted on the screen.
- Acquisition Mode – Determines method of collecting and presenting sample data.

  Normal Mode - Allows the hardware to sample at maximum frequency, saving all values until the specified memory size is filled. If the time required to span the Display Panel window (determined by Seconds/Division) exceeds the product of sample count specified times the instrument’s minimum sampling period, the effective sample rate must be reduced. This is accomplished by taking multiple samples during a memory buffer time slot, but only saving a single sample (the last one taken in that time slot).

  High Resolution – Provides increased accuracy per waveform point by averaging multiple samples. This mode can be useful when viewing a low frequency signal with random noise interference at a higher frequency. The Desired Number of Samples setting is ignored in this mode, as the hardware will use all available memory. The samples are captured at the maximum possible rate, and groups of samples are averaged to provide the necessary number of points to fill the displayed aperture time. Since multiple samples can be averaged to make up each point of the displayed waveform, resolution IS effectively increased. Note that this mode can significantly increase test time since all available memory may be transferred for a given aperture setting.

Peak Detect Mode – This mode is helpful when checking for aliasing on high frequency sampled signals and for short duration pulses occurring infrequently over a long time period (small memory, large aperture). If the Desired Number of Samples specified is less than required to span the Display Panel window at the instrument's minimum sample period, the measurement instrument will perform multiple samples per memory time slot. Sampling at the instrument's maximum rate and using real-time hardware comparison of these multiple samples, the upper and lower peak values will be retained and saved for each memory time slot. The waveform display will plot both of these values in order of their occurrence. Since this mode saves two samples per memory time slot, the minimum waveform time display resolution is effectively increased by two.

Fixed Average Mode – This mode is similar to High Resolution (see above) except that the number of points averaged is fixed. The number of points averaged depends on the instrument, consult the Hardware Reference Manual for details.

Envelope Mode – Collects multiple waveforms that are combined to make one waveform with a higher sample rate. The waveforms are displayed on top of each other. If a waveform capture is initiated by a trigger, insure the trigger is an event that will repeat.

- Run Once – Captures a single waveform when the Trigger condition is met.
- Run\Stop – This button toggles continuous waveform captures on and off. The repetition rate between Display Panel updates varies according to waveform instrument, number of samples taken, and the repetition rate of the Trigger condition. If no Trigger condition is present, the Trigger Auto Mode must be selected for continuous waveform capture.

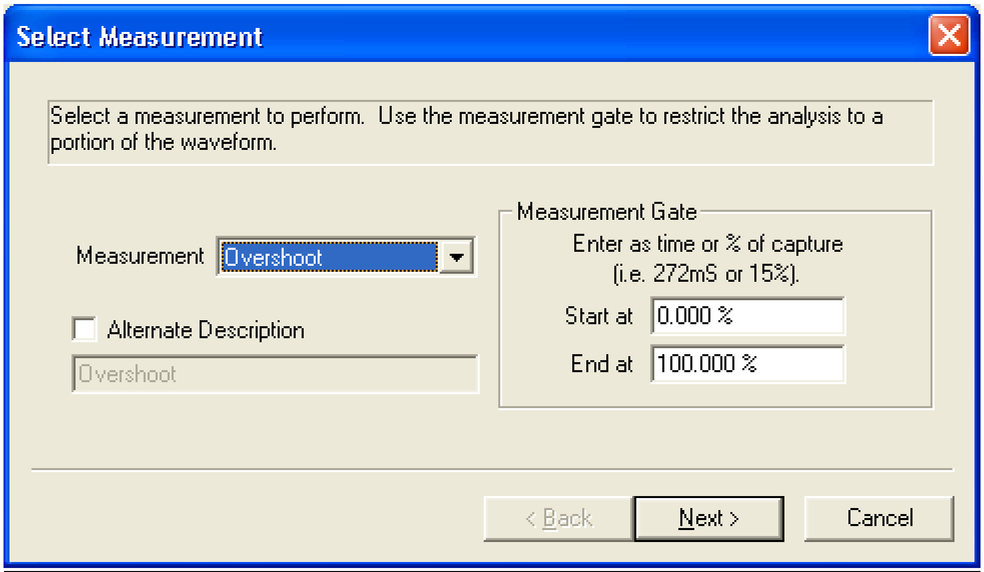
38.3.5 Measurement Control

The Measure Control button on the Scope Panel is intended for use during program development to provide immediate access to the waveform data calculations. The Measurement window provided allows direct selection of the test functions available and their setup controls and parameters. Capturing data will cause measurement values to be updated in the display window for live testing of system settings and UUT performance. Any Measurement setup performed using the Scope Panel Measure button is not saved when the Scope Panel is closed.

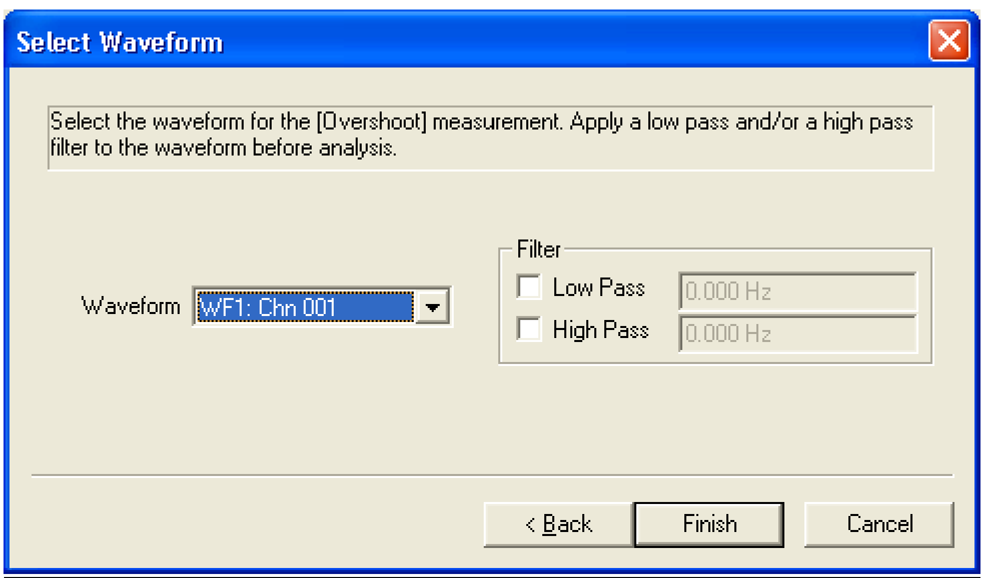
The Measurement functions and setup parameters are entered into the test program using another method, a New Measurement entry option in the Waveform Test form. The test functions listed below are available using this entry option, and all test and setup parameters entered become part of the Waveform Test program step.

38.3.5.1 Common Measurement Function Operators

Many measurement functions use common control parameters and methods. These are described here for reference.



Measurement Gate – Provides a method of selecting only a portion of the total waveform data to be used for a specific measurement calculation. The beginning and end points of the gate settings can be specified as a time value, based on the Seconds/Division horizontal control setting, or as a percentage of the total displayed waveform. Selecting gate conditions that exclude waveform areas with transitions necessary for a specific measurement function will give "Invalid" measurement results.



Filtering – Provides low pass and high pass bandwidth boundaries that can be used separately or in combination. Note that if hardware filtering is applied before sampling, digital filters are subject to sampling theory limitations (see Notes on Filtering and Sample Rate below). A single pole Butterworth digital filtering algorithm is applied. These boundaries allow a variety of filter types:

- Low Pass - If only the low pass bandwidth is specified, signals above the specified frequency will be attenuated. The reading will be approximately 3 dB attenuated from nominal at the specified low pass boundary, and will decrease at 20 dB per decade as frequency increases.

- High Pass - If only the high pass bandwidth is specified, signals below the specified frequency will be attenuated. The reading will be approximately 3 dB attenuated from nominal at the specified low pass boundary, and will decrease at 20 dB per decade as frequency decreases.
- Bandpass – If high pass and low pass frequency boundaries are specified, and the high pass boundary is below the low pass boundary, a bandpass filter is formed. This filter will pass frequencies between the two boundaries.
- Notch Filter – If high pass and low pass frequency boundaries are specified, and the low pass boundary is below the high pass boundary, a notch filter is formed. This filter will attenuate frequencies between the two boundaries.

38.3.5.2 Notes on Filtering and Sample Rate

Depending on the digitizing hardware available, the user must take care to use a suitable sample rate to reliably process captured data using the filter functions. The High Speed Digitizer option of the Digital Measurement System has a specified 3db input bandwidth of 100 MHz and a maximum sample rate of 200M samples per second. The standard DMS digitizer hardware has an available input bandwidth of 1 MHz and a maximum sample rate of 100K samples per second. The upper bandwidth limit of the digitizing hardware is not set by a roll-off filter, only by characteristics of the circuit design and input multiplexing, and may possibly be higher.

If any frequency–dependent signal processing algorithms are to be performed on digitized samples, the frequency content of the input signal must be well known. To satisfy sampling theory, either the sampling rate must be maintained at twice the rate of the highest frequency harmonic contained in the signal, or the input signal must be low-pass filtered to remove frequencies above half the sample rate. The digital filtering algorithms can only give correct and reliable results on data that was captured without aliasing.

The sampling rate will be reduced from the maximums listed above when the aperture time (screen display time in seconds) is greater than the amount of memory requested times the minimum sample period. In this case, the input will still be sampled at the maximum rate, but some fraction of samples will be discarded and only a subset is saved in memory. While this lowers the effective sample rate, the full bandwidth is still provided to the digitizer so that high frequency components can give aliased results in the waveform.

To avoid aliased data for longer aperture times, increase the amount of memory (Desired Number of Samples under Acquisition Control) so that the maximum sample rate can be used. For very long aperture times requiring more memory than is available on the digitizer device (and reducing the sample rate), a hardware low-pass filter may be needed to remove high frequency components in the signal. Some instruments may have this function built in, and others may require use of an external in-line filter. Hardware low pass filtering can also reduce data processing time for post-capture filter operations on low-frequency components of broadband signals.

38.3.5.3 Notes on Filtering and Gating

Measurement At Event and *Measurement Between Events* are not measurements but gating methods used to define the section of the waveform used for the actual measurement that is select later. The waveforms used to define the start and stop events can be filtered independently from each other, the waveform of the measurement and even independently of the displayed waveform. Filtering changes both the amplitude and the timing of the waveform. If the start/stop events use different filtering than is used on the measurement waveform, the events may not be in the right place.

If, for example, an inrush current is captured by the High Speed Digitizer option of the Digital Measurement System at 200M samples per second for 2 milliseconds. The actual inrush is a small part of the total captured waveform. After selecting *Measurement Between Events*, Rising Edge at 0.1 amps for a start event and Falling edge at 0.1 amps for an end event, and selecting *Integral over Time* with markers, the test is executed. Upon examination of the waveform image, the start marker is at the correct location, but the stop marker is on top of the start marker. The marker information below the waveform image says the stop event was 5 nanoseconds after the start event. Both gates were triggered by noise that rose above 0.1 amp and then came back down. To compensate for this, a low pass filter is applied to the stop event waveform of sufficient magnitude to insure no false triggering due to noise and the test is executed. Upon examination of the new waveform image, the start marker is still at the correct location but the stop marker is near 0.0 amps and well past the expected location. This is because the waveform used to determine the end of the measurement was not the waveform measured. The waveform used to determine the end event was phase shifted by the low pass filter.

To avoid this confusion, if any waveform of a measurement is filtered, then all the waveforms of that measurement should be filtered by the same amount including the displayed waveform.

Area – Computes product of time and amplitude for the sampled waveform. This can be used as a tool to quantify non-symmetric or irregularly shaped signals. The Gate control can be used to restrict the part of the waveform used for the Area calculation.

Cursor Delta – Computes the difference of Cursor 2 minus Cursor 1. The selected waveform data is not used however the scale of the selected waveform does determine the values of the cursors. Cursor Delta is a way for the operator to manually select the positions of the waveform to measure.

Cursor Time – Retrieves the time Cursor 1. The selected waveform data is not used at all and all the waveforms have the same time base. Cursor Time is a way for the operator to manually select the positions of the waveform to retrieve its time.

Cursor Value – Retrieves the value Cursor 1. The selected waveform data is not used however the scale of the selected waveform does determine the values of the cursors. Cursor Value is a way for the operator to manually select the positions of the waveform to retrieve its value.

Frequency – Gives the frequency computed by finding the time period between two consecutive rising or falling edges. A built in hysteresis function is used to determine thresholds for valid edge detection. The filter function may be required if excessive noise on the signal causes false readings.

Frequency Content – Sums the RMS amplitudes of the discrete frequency components in a specified range of frequencies. The upper and lower limits can be set to exclude unwanted frequencies that may be present due to noise or sampling artifacts.

Harmonic Analysis – Provides a measurement of the waveform in terms of the amplitudes of the harmonics of the sampled signal. Several standard harmonic distortion measurement types can be selected, as well as a user specified version. Measurements can be on single or multiple cycles. Accuracy is increased by having multiple cycles in the waveform data and adjusting the Second/Division to capture whole cycles as closely as possible without partial cycles.

High – A measurement indicating the vertical amplitude at the top of the signal. The High value is the most common value above the midpoint of the acquired waveform. A histogram is used to derive the value. This statistical approach ignores short-term aberrations (such as overshoot and ringing), and is best used for examining pulse waveforms.

I2T Peak / 2 – Stands for current squared time. The measurement returns the square of the peak value of the captured waveform, times the aperture time, divided by two. When this measurement is used on an inrush current waveform, the result is proportional to the energy of the inrush. Gate control can be used to restrict the part of the waveform used for the calculation. Note: Gating defines the aperture.

I2T Peak / 3 (Replaces I2T Peak) – Stands for current squared time. The measurement returns the square of the peak value of the captured waveform, times the aperture time, divided by three. When this measurement is used on an inrush current waveform, the result is proportional to the energy of the inrush. Gate control can be used to restrict the part of the waveform used for the calculation. Note: Gating defines the aperture.

I2T RMS – Stands for current squared time. The measurement returns the square of the RMS value of the captured waveform, times the aperture time. When this measurement is used on an inrush current waveform, the result is proportional to the energy of the inrush. Gate control can be used to restrict the part of the waveform used for the calculation. Note: Gating defines the aperture.

Integral over Time – Returns the integral of the waveform over the aperture. Gate control can be used to restrict the part of the waveform used for the calculation. The integral of current is the total charge transfer over the aperture. The integral of power is total energy.

Low – A measurement indicating the vertical amplitude at the bottom of the signal. The Low value is the most common value below the midpoint of the acquired waveform. A histogram is used to derive the value. This statistical approach ignores short-term aberrations (such as undershoot and ringing), and is best used for examining pulse waveforms.

Mean – Returns the average of all waveform data points. All data samples are summed, and the result is divided by the number of samples. The Gate function can be used to restrict the calculation to a subset of data samples. This function might be useful for finding a DC value in a noisy signal modulated by AC components.

Measurement At Event – Allows a measurement on one selected channel to be synchronized to an event on another channel. The first channel specified will be used to trigger the measurement, and a number of criteria can be used to generate the trigger event. After selecting a trigger Event and the number of occurrences, the channel to be measured is specified. The measurement to be performed is selected, as well as start and stop times to provide an aperture for the measurement. The measurements available are a subset of those described in this section.

The event can be found starting at the first captured data and moving toward the last (left to right on the waveform display), or starting from the last and moving toward the first (right to left). The First Occurrence or Last Occurrence buttons select this search direction. A count value can be entered to determine which of multiple captured Events should initiate the measurement.

For waveform channels, the Rising Edge and Falling Edge Selections require the waveform data to transition back and forth across the programmed level setting to initiate Amplitude measurement. The Above, Below, Level Between, and Level Outside settings use only the levels of the Event selection without any state logic. The Amplitude will be captured as soon as the Event signal crosses the programmed threshold, or enters (or leaves) the band defined by both thresholds.

For Digital Pattern Event recognition, the pattern recognition operates in edge-detect rather than a level mode. The pattern must toggle between Matching and Not Matching states – an Event is not generated if the pattern matches throughout the entire capture. Selections are available to choose Leading Edge (capture Magnitude the first time pattern transitions from Not Matching to Matching), or Trailing Edge (capture Magnitude when pattern transitions Matching to Not Matching. The First and Last Occurrence selection buttons and counter are available to select among multiple Event conditions in a single capture window.

Measurement Between Events – Allows a measurement on one selected channel to be synchronized to events on another channel. The first channel specified will be used to trigger the start of the measurement aperture. The second channel specified will be used to trigger the end of the measurement aperture. A number of criteria can be used to generate the trigger events. After selecting the trigger Events and the number of occurrences, the channel to be measured is specified. The measurement to be performed is selected, as well as start and stop times to provide the aperture for the measurement. The measurements available are a subset of those described in this section.

The events can be found starting at the first captured data and moving toward the last (left to right on the waveform display), or starting from the last and moving toward the first (right to left). The First Occurrence or Last Occurrence buttons select this search direction. A count value can be entered to determine which of multiple captured Events should initiate and terminate the measurement.

For waveform channels, the Rising Edge and Falling Edge Selections require the waveform data to transition back and forth across the programmed level setting to initiate Amplitude measurement. The Above, Below, Level Between, and Level Outside settings use only the levels of the Event selection without any state logic. The Amplitude will be captured as soon as the Event signal crosses the programmed threshold, or enters (or leaves) the band defined by both thresholds.

For Digital Pattern Event recognition, the pattern recognition operates in edge-detect rather than a level mode. The pattern must toggle between Matching and Not Matching states – an Event is not generated if the pattern matches throughout the entire capture. Selections are available to choose Leading Edge (capture Magnitude the first time pattern transitions from Not Matching to Matching), or Trailing Edge (capture Magnitude when pattern transitions Matching to Not

Matching. The First and Last Occurrence selection buttons and counter are available to select among multiple Event conditions in a single capture window.

Median – Returns the value that falls in the center of all sampled data values. If all samples are ordered from low to high, the Median value will have an equal number of samples before and after it in the ordered list. This measurement might be useful for finding an approximate nominal DC value for a signal modulated with short, high amplitude spikes which do not affect circuit operation. This reading may take a significant amount of time to compute unless the number of memory samples can be reduced (see Section 38.3.4 Acquisition Controls).

Monotonicity – Returns the time of the first non-monotonic value occurs in the waveform. For an increasing waveform (a positive slope), a non-monotonic value is one that is less than the previous. The returned value from a waveform that is monotonic is zero.

Overshoot – The Overshoot value is computed by taking the highest peak magnitude in the waveform and subtracting a mean value. The mean value is calculated by assuming the signal has settled to its final value before 90% of the waveform buffer is filled. The samples in the last 10% of the waveform buffer (rightmost division of the display panel) are used to calculate the mean value. This is typically used for a turn on transient. The Gating function can be used to select a single event if the displayed waveform contains more than one.

Peak-to-Peak – Measures the difference in amplitude between the highest and lowest sample points in the captured waveform. The number returned is positive regardless of whether the high and low sample points are both positive or negative.

Peak, Absolute – Measures the amplitude of the highest sample point excursion from zero in the captured waveform. This value may be positive or negative.

Peak, Max – Measures the amplitude of the highest sample point in the captured waveform. This value may be positive or negative.

Peak, Min – Measures the amplitude of the lowest sample point in the captured waveform. This value may be positive or negative.

Phase – Measures the difference in phase between one channel specified as a reference, and a second channel to be measured. The measurement is intended for signals with the same, or very similar, frequencies. It is useful for determining phase relationships between outputs of multi-phase AC sources, or output to input phasing of inverter devices. The measurement is taken between the trigger point of the reference signal and the closest rising edge transition of the measured signal. The captured waveform must include at least one complete cycle of both signals.

RMS, AC Coupled – Performs an RMS calculation on all sampled points and removes the mean value (DC). All samples are squared and summed. The result is divided by the number of samples, then the square root of the result is taken. The Mean value (calculated as described above) is subtracted from the RMS value for the final value. All sample points are used regardless of any repetitive cycle start and end points. To perform exact cycle calculations, the gating function can be used to eliminate fractional cycles.

RMS, DC Coupled – Performs an RMS calculation on all sampled points. The same algorithm is performed as AC Coupled RMS except the mean value is not subtracted.

Slope (of best fit line) – Performs a least squares fit of the waveform to a straight line and returns the slope of that line.

Square Integral over Time – Returns the integral of the square of the waveform over the aperture. Gate control can be used to restrict the part of the waveform used for the calculation. This function was added to compliment the *I2T* measurements. The integral of squared current is proportional to total energy.

Time between Cursors – Computes the time difference of Cursor 2 minus Cursor 1. The selected waveform data is not used at all and all waveforms have the same time. Time between Cursors is a way for the operator to manually select the positions of the waveform to measure the time.

Timing as Frequency - Returns a measurement value for the frequency between specified Start and Stop Events. Similar to the Timing General measurement but result is presented and evaluated as a frequency.

Timing General - Returns a measurement value for time between specified Start and Stop Events. The Events specified must be present in the captured waveform as displayed. While trigger-positioning settings can be used to frame the desired Events in the waveform window, the trigger position itself has no effect on the Event defined for the measurement.

Events can be found starting at the first captured data and moving toward the last (left to right on the waveform display), or starting from the last and moving toward the first (right to left). The First Occurrence or Last Occurrence buttons select this search direction. A count value can be entered to determine which of multiple captured Events should be used to Start or Stop the measurement.

The Event source can be any of three analog channels or a pattern from the sixteen Digital Inputs.

For waveform channels, the Rising Edge and Falling Edge Selections require the waveform data to transition back and forth across the programmed level setting to initiate a Timing measurement. The Above, Below, Level Between, and Level Outside settings use only the levels of the Event selection without any state logic. The Event occurs as the signal crosses the programmed threshold, or enters (or leaves) the band defined by both thresholds.

For Digital Pattern Event recognition, the pattern recognition operates in edge-detect rather than a level mode. The pattern must toggle between Matching and Not Matching states – an Event is not generated if the pattern matches throughout the entire capture. Selections are available to choose Leading Edge (Event occurs the first time pattern transitions from Not Matching to Matching), or Trailing Edge (Event occurs when pattern transitions Matching to Not Matching. The First and Last Occurrence selection buttons and counter are available to select among multiple Event conditions in a single capture window.

Transfer Time – Measures the transition time between the halting of one continuous waveform and the beginning of another continuous waveform (either the same or a different one) on a selected waveform channel. Useful for measuring dead cycle times in AC source outputs, or switch-over time for the transition from line output to inverter output in battery back-up devices.

Undershoot – The Undershoot value is computed by subtracting a mean value from the lowest peak magnitude in the waveform – resulting in a positive value. The mean value is calculated by assuming the signal has settled to its final value before 90% of the waveform buffer is filled.

The samples in the last 10% of the waveform buffer (rightmost division of the display panel) are used to calculate the mean value. This would typically used for a turn off transient from a nominal value to a lower, or “off” value. This measurement assumes a single turn off event settling to a final value within the waveform window. The Gating function can be used to select a single event if the displayed waveform contains more than one.

WF Delta between Cursors – Computes the difference of the waveform at Cursor 2 minus the waveform at Cursor 1. The vertical position of the cursors is not used. The data is the values of the waveform at the intersections of the waveforms and the cursors. WF Delta between Cursors is a way for the operator to manually select the positions of the waveform to measure.

WF Value at Cursor – Retrieves the value of the waveform at Cursor 1. The vertical position of the cursor is not used. The retrieved value is the value of the waveform at the intersections of the waveform and the cursor. WF Value at Cursor is a way for the operator to manually select the positions of the waveform to measure.

38.3.6 Spectrum Measurement

The Spectrum Measurement function can provide a snapshot look at the frequency components in a captured waveform. The display plots the Fast Fourier Transform of the captured waveform in either Log or Linear frequency scales. Waveform test functions Frequency Content and Harmonic Analysis can be used for program analysis in the frequency domain.

The accuracy of the harmonic amplitudes is maximized with the following waveform capture guidelines;

- Set the Second/Division control to provide a long enough aperture to contain at least two periods of the lowest frequency of interest for broadband signals.
- The FFT algorithm works best with multiple cycles in the captured waveform.
- The Seconds/Division setting should be adjusted to keep the number of cycles displayed near a whole integer, minimizing partial cycles whenever possible.

The Enhanced Method selection will perform harmonic analysis with an attempt to restore some of the amplitude to the most significant harmonics that may be lost due to the FFT windowing function. It may be desirable to use this mode to insure that the highest peak value of a given harmonic is displayed.

The amplitude of the highest frequency harmonic is displayed in a box at the bottom of the spectrum display window.

39. OBSOLETE TESTS

39.1 Single Measurement Test

Note: This routine is now obsolete. It has been replaced with "Multi-Measurement Test", which provides the same capability within a more flexible framework.

39.1.1 Description

The Single Measurement test routine is a very general-purpose test that will perform a single measurement on each of the UUT's inputs and/or outputs. Valid measurements include voltage, current, power, frequency, noise, distortion, etc. The only constraint on this test is that the measurements must not be triggered or transient in nature.

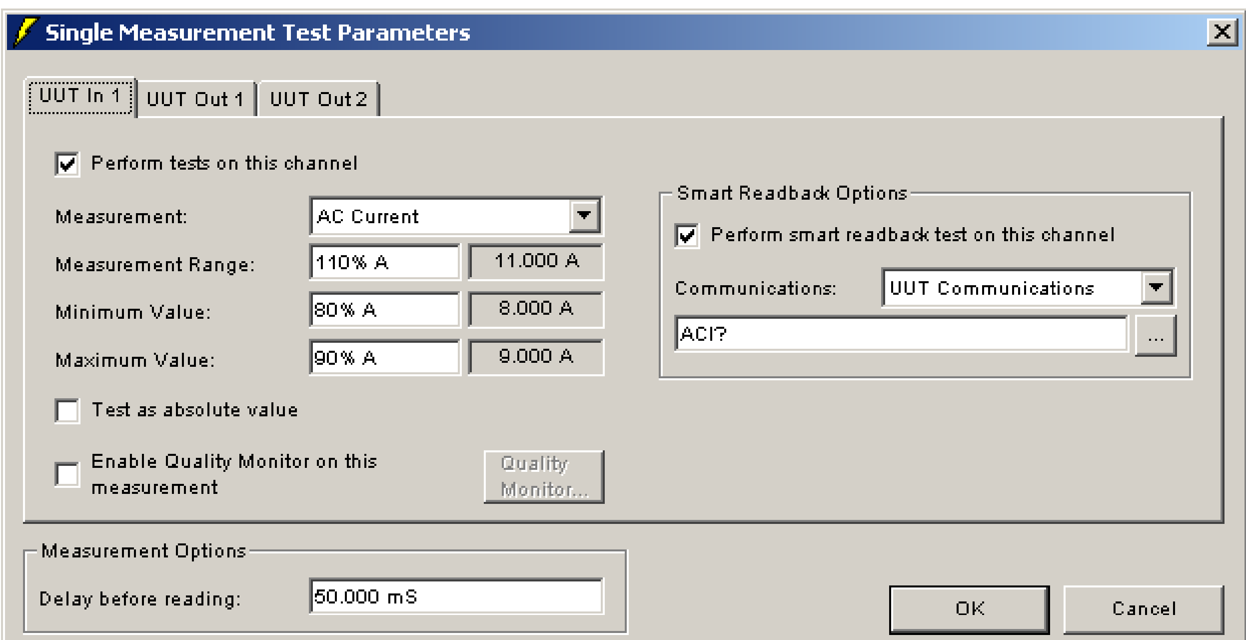
This test routine also contains the ability to communicate to the UUT in order to verify its status or internal measurement circuitry.

39.1.2 Method

After performing the delay before reading, the measurement is taken on each enabled input and output. Pass or fail status is determined and the result is logged to the datalog devices.

If the Smart Readback option is selected, the measured value is passed to the UUT communications object as the reference value and the communication test is performed. Again, pass or fail status is determined and the result is logged to the datalog devices.

39.1.3 Test Routine Properties



- Perform tests on this channel – check this box to take a measurement of this channel.

- Measurement – the measurement vector that will be used to take the measurement. Note that this must be a DMM-type measurement vector.
- Measurement Range – this is the maximum expected measured value. The value may be entered either as a value or a percentage of a channel reference. The appropriate reference is automatically selected based on the measurement vector entry. In the example above, the "UUT In 1" Reference Current value will be used.
- Minimum Value - this is the allowable lower limit of the measured value. Measured values less than this will cause the test routine to fail. The value may be entered either as a value or a percentage of a channel reference.
- Maximum Value - this is the allowable upper limit of the measured value. Measured values greater than this will cause the test routine to fail. The value may be entered either as a value or a percentage of a channel reference.
- Test as absolute value – check this box to use the absolute value of the measurement for pass/fail evaluation and UUT communication reference.
- Collect Quality Monitor data on this measurement – check this box to enable Quality Monitor data collection.
- Quality Monitor… – press this button to display the Quality Monitor properties. Please refer to the Quality Monitor reference manual for further details.
- Perform smart readback test on this channel – check this box to perform the UUT communication section of the test routine.
- Communications – select the desired UUT communication object from the drop-down list and press the ellipsis button for communications test parameters. Please refer to the appropriate UUT communications object reference manual for further details. The edit field to the left of the ellipsis button reflects the communications string to be sent to the UUT. The data may be entered here, or in the appropriate field in the UUT communications object.
- Delay before reading – the amount of time you allow the UUT to settle before beginning the measurements. Note that this delay happens once at the beginning of the routine.

39.1.4 Sequence

The load, source, digital and analog vectors defined by the program are applied to the tester hardware before the test routine sequence is initiated.

1) Wait the delay before reading time
2) For each UUT input and/or output:
    a) Perform the measurement
    b) Translate to absolute value if necessary
    c) Evaluate and log the result
    d) If performing the Smart Readback test:
        i) Set the Reference Value property equal to the measurement

   ii) Initiate the communication test

   iii) Log the result

e) Check for faults and log them as necessary

39.2 Ramp-Up Test

Note: This routine is now obsolete. It has been replaced with "Ramp (General Purpose) Test", which provides the same capability within a more flexible framework.

39.2.1 Description

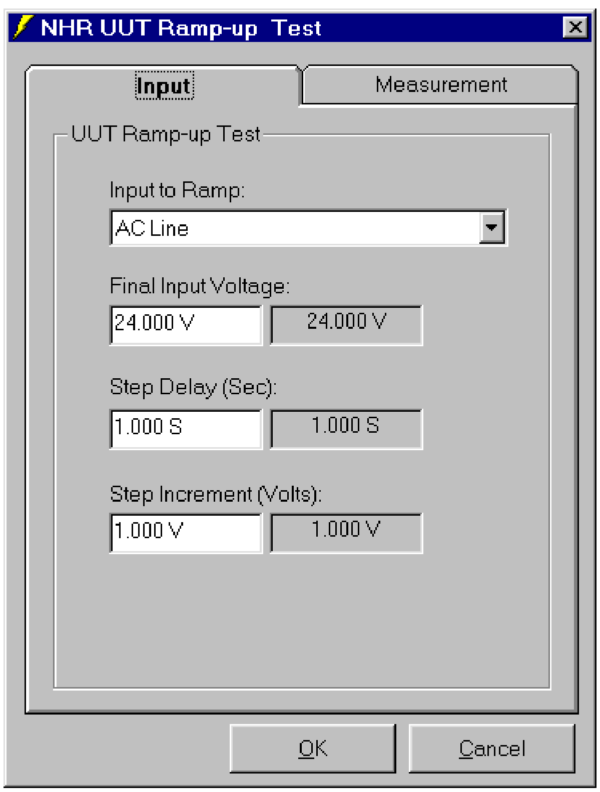
The Ramp-up test routine ramps up the input voltage to the UUT while watching the input current for a maximum value. Each step of the source voltage is verified by checking the input current against the user-specified range. This test can be employed to check that there are no catastrophic errors on the UUT.

39.2.2 Method

The source to ramp is stepped in user specified increments to the final voltage. Measurements are made at each step after a programmable step delay.

39.2.3 Test Routine Properties

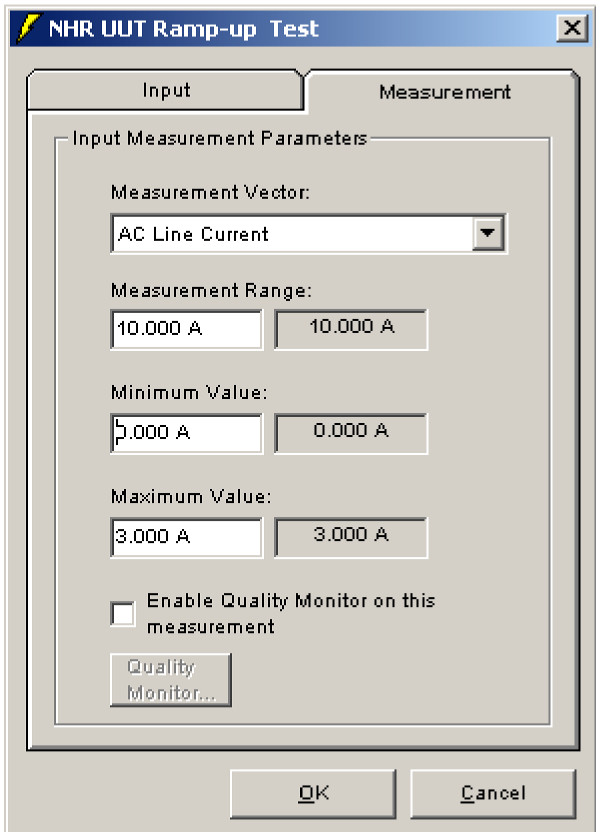
39.2.3.1 Input Parameters



- Input to Ramp - this entry must be the logical name of an input/source. The input/source must have a power supply in its configuration (DC Source, AC Source, etc.).

- Final Input Voltage - the final voltage that the input/source will be set to.
- Step Delay - this delay will be applied between each of the voltage steps.
- Step Increment - the step size that will be applied to each step.

39.2.3.2 Measurement Parameters



- Measurement Vector - the vector that will be used to take measurements.
- Measurement Range - this is the maximum expected measured value. This value will be sent to the measurement device that the measurement vector represents.
- Minimum Value - this is the allowable lower limit of the measured value. Measured values less than this will cause the test routine to fail.
- Maximum Value - this is the allowable upper limit of the measured value. Measured values greater than this will cause the test routine to fail.

39.2.4 Sequence

The load, source, digital and analog vectors defined by the program are applied to the tester hardware before the test routine sequence is initiated.

- Initiate test routine

39.3 Three-Phase UUT Ramp Power-up Test

39.3.1 Description

The ramp power-up test routine ramps up the input voltage to the UUT while watching the input current for a maximum value. Each step of the source voltage is verified by checking the input current against the user-specified range. This test can be employed to check that there are no catastrophic errors on the UUT.

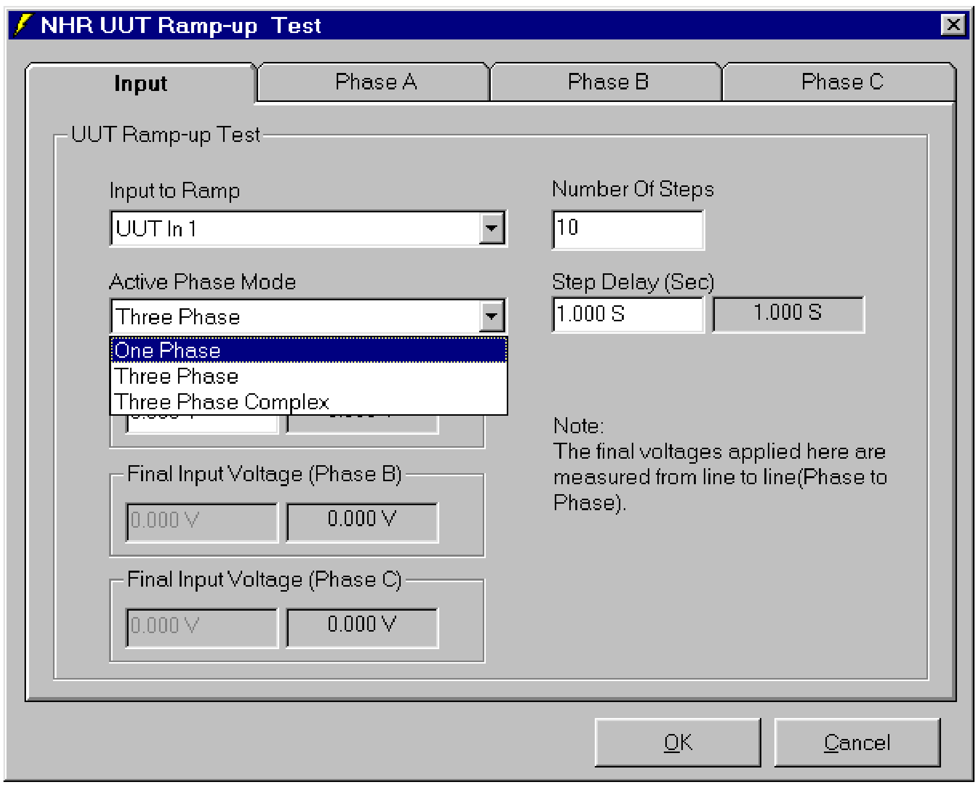
39.3.2 Method

The source to ramp is stepped, using user-specified increments, to the final input vector voltage. Measurements are made at each step after a programmable step delay.

39.3.3 Test Routine Properties

39.3.3.1 Input Parameters

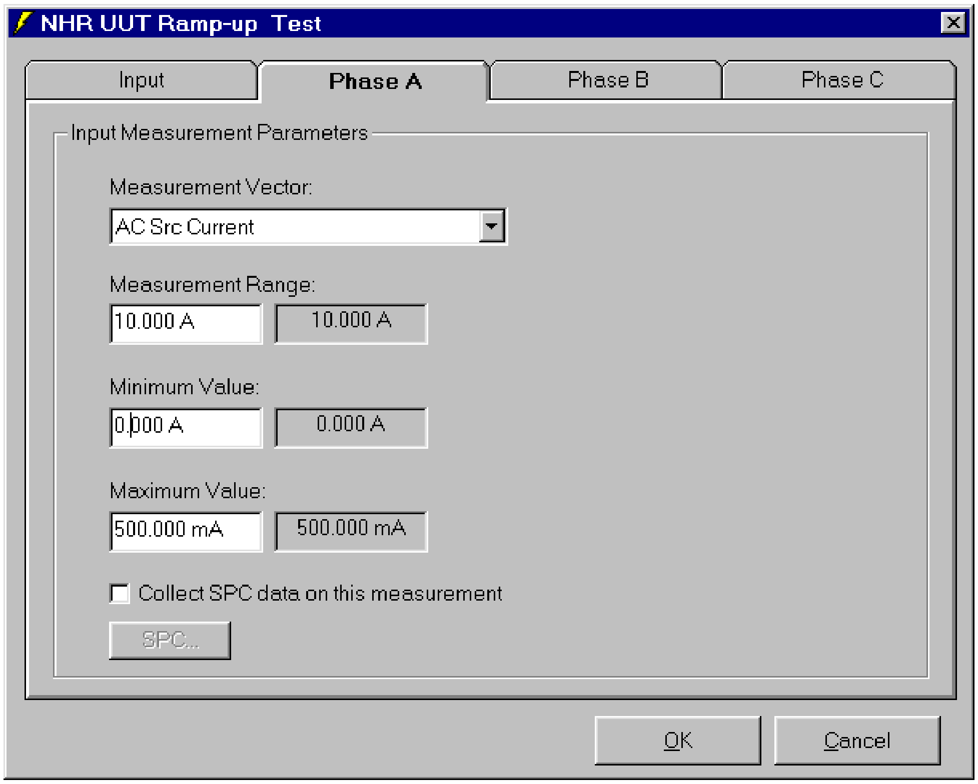
There are seven fields in the Input tab that are described below.



- Input to Ramp - this entry must be the logical name of an input/source. The input/source must have a power supply in its configuration (DC Source, AC Source, etc.).
- Active Phase Mode - the configured mode for the source. For a complete description of these modes please refer to the source documentation.
- Final Input Voltage - the final voltage to which the input/source is set. Three-phase mode uses this setting for all three phases. Three-phase complex uses this setting for phase A only.

- Final Input Voltage - the final voltage to which phase B is set.
- Final Input Voltage - the final voltage to which phase C is set.
- Number of Steps - the number of increments that will take place for all phases.
- Step Delay - the delay that will be applied to each step before taking measurements.

39.3.3.2 Measurement Parameters Phase A



- Measurement Vector - the vector that will be used to take measurements.
- Measurement Range - this is the maximum expected measured value. This value will be sent to the measurement device that the measurement vector represents.
- Minimum Value - this is the allowable lower limit of the measured value. Measured values less than this will cause the test routine to fail.
- Maximum Value - this is the allowable upper limit of the measured value. Measured values greater than this will cause the test routine to fail.

Note: Phase A settings are applied for one- and three-phase settings, but only to Phase A settings for Three-phase Complex.

- Collect Quality Monitor data on this measurement – check this box to enable Quality Monitor data collection.
- Quality Monitor… – press this button to display the Quality Monitor properties. Please refer to the Quality Monitor reference manual for further details.

39.3.3.3 Measurement Parameters Phase B and C

- Measurement Vector - the vector that will be used to take measurements.
- Measurement Range - this is the maximum expected measured value. This value will be sent to the measurement device that the measurement vector represents.
- Minimum Value - this is the allowable lower limit of the measured value. Measured values less than this will cause the test routine to fail.
- Maximum Value - this is the allowable upper limit of the measured value. Measured values greater than this will cause the test routine to fail.
- Collect Quality Monitor data on this measurement – check this box to enable Quality Monitor data collection.
- Quality Monitor… – press this button to display the Quality Monitor properties. Please refer to the Quality Monitor reference manual for further details.

39.3.4 Sequence

The load, source, digital and analog vectors defined by the program are applied to the tester hardware before the test routine sequence is initiated.

- Initiate test routine