

**DPO3PWR, MDO3PWR and DPO4PWR
Power Analysis Modules
User Manual**




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Tektronix

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Power Analysis Modules
User Manual**

www.tektronix.com
071-2631-01

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- Worldwide, visit www.tektronix.com to find contacts in your area.

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General safety summary

Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it.

To avoid potential hazards, use this product only as specified.

Only qualified personnel should perform service procedures.

While using this product, you may need to access other parts of a larger system. Read the safety sections of the other component manuals for warnings and cautions related to operating the system.

To avoid fire or personal injury

Use proper power cord. Use only the power cord specified for this product and certified for the country of use.

Connect and disconnect properly. Do not connect or disconnect probes or test leads while they are connected to a voltage source.

Connect and disconnect properly. De-energize the circuit under test before connecting or disconnecting the current probe.

Connect and disconnect properly. Connect the probe output to the measurement instrument before connecting the probe to the circuit under test. Connect the probe reference lead to the circuit under test before connecting the probe input. Disconnect the probe input and the probe reference lead from the circuit under test before disconnecting the probe from the measurement instrument.

Ground the product. This product is grounded through the grounding conductor of the power cord. To avoid electric shock, the grounding conductor must be connected to earth ground. Before making connections to the input or output terminals of the product, ensure that the product is properly grounded.

Observe all terminal ratings. To avoid fire or shock hazard, observe all ratings and markings on the product. Consult the product manual for further ratings information before making connections to the product.

Connect the probe reference lead to earth ground only.

Do not apply a potential to any terminal, including the common terminal, that exceeds the maximum rating of that terminal.

Do not connect a current probe to any wire that carries voltages above the current probe voltage rating.

Power disconnect. The power cord disconnects the product from the power source. Do not block the power cord; it must remain accessible to the user at all times.

Do not operate without covers. Do not operate this product with covers or panels removed.

Do not operate with suspected failures. If you suspect that there is damage to this product, have it inspected by qualified service personnel.

Avoid exposed circuitry. Do not touch exposed connections and components when power is present.

Use proper AC adapter. Use only the AC adapter specified for this product.

Use proper fuse. Use only the fuse type and rating specified for this product.

Wear eye protection. Wear eye protection if exposure to high-intensity rays or laser radiation exists.

Do not operate in wet/damp conditions.

Do not operate in an explosive atmosphere.

Keep product surfaces clean and dry.

Provide proper ventilation. Refer to the manual's installation instructions for details on installing the product so it has proper ventilation.

Terms in this manual

These terms may appear in this manual:



WARNING. *Warning statements identify conditions or practices that could result in injury or loss of life.*



CAUTION. *Caution statements identify conditions or practices that could result in damage to this product or other property.*

Symbols and terms on the product

These terms may appear on the product:

- DANGER indicates an injury hazard immediately accessible as you read the marking.
- WARNING indicates an injury hazard not immediately accessible as you read the marking.
- CAUTION indicates a hazard to property including the product.

The following symbol(s) may appear on the product:



Double
Insulated



Earth Terminal



Mains Disconnected
OFF (Power)



Mains Connected
ON (Power)

Preface

This manual describes operation of the DPO3PWR, MDO3PWR and DPO4PWR Power Analysis Modules, which enable automatic measurement of many common power measurements in the areas of power quality, harmonics, slew rate, switching loss, safe operating area, ripple, and modulation analysis.

The DPO4PWR module works in MDO4000, MSO4000 and DPO4000 Series oscilloscopes.

The MDO3PWR module works in MDO3000 Series oscilloscopes.

The DPO3PWR module works in MSO3000 and DPO3000 Series oscilloscopes.

Specific analysis types include:

- Power Quality
- Switching Loss
- Harmonics
- Ripple
- Modulation
- Safe Operating Area
- Slew rate

Installing the Application Module

Gathering Equipment

Use appropriate equipment, such as the following, to make your power measurements:

- MSO4000 or DPO4000 Series oscilloscopes with firmware version 2.17 or higher and the DPO4PWR application module installed.
- MDO4000 Series oscilloscopes with firmware version 2.08 or higher and the DPO4PWR application module installed.
- MDO3000 Series oscilloscopes with firmware version 1.10 or higher and the MDO3PWR application module installed.
- MSO3000 Series oscilloscopes with firmware version 2.06 or higher and the DPO3PWR application module installed.
- DPO3000 Series oscilloscopes with firmware version 1.10 or higher and the DPO3PWR application module installed.
- Differential probe, such as the TDP0500, TDP1000, THDP0200, TMDP0200, P5205A
- TPA-BNC Probe Adapter (when needed)
- Current probe, such as the TCP0020, TCP0030A, TCP0150 or TCP202A
- TEK-DPG Deskew Pulse Generator
- 067-1686-XX Power Measurement Deskew and Calibration Fixture

Ratings

MDO3000, MSO3000 and DPO3000 Series	Channels 1 - 4: 1 M Ω , 300 V _{RMS} maximum (CAT II), or 50 Ω , \pm 5 V _{RMS} maximum (CAT I), or 75 Ω , \pm 5 V _{RMS} maximum (CAT I) Aux Input: 300 V _{RMS} maximum (CAT II)
MDO4000, MSO4000B and DPO4000B Series	Channels 1 - 4: 1 M Ω , 300 V _{RMS} maximum (CAT II), or 50 Ω , \pm 5 V _{RMS} maximum (CAT I)
MSO4000 and DPO4000 Series	Channels 1 - 4: 1 M Ω , 250 VRMS maximum (CAT I), or 50 Ω , \pm 5 VRMS maximum (CAT I)
TDP0500 and TDP1000 probes	Voltage probe: Rated 30 V _{RMS} , 42 V _{DC} + Peak AC maximum
THDP0200 probe	Voltage probe: Rated \pm 1500 V maximum
TMDP0200 probe	Voltage probe: Rated \pm 750 V maximum
P5205A probe	Voltage probe: Rated \pm 1300 V, 1000 V _{RMS} maximum (CAT II)
TPA-BNC adapter	Probe adapter: Rated 30 V _{RMS} , 42 V _{Peak} , or 60 V _{DC} maximum
TCP0030A probe	Current probe: Rated 30 A _{RMS} maximum
TCP0020 probe	Current probe: Rated 20 A _{RMS} maximum
TCP202A probe	Current probe: Rated 20 A _{RMS} maximum
TCP0150 probe	Current probe: Rated 150 A maximum (CAT II)

See the user manuals for these products to obtain more detailed specifications. You can find copies of Tektronix user manuals at: www.tektronix.com/manuals

NOTE. *When making mains (CAT II) measurements with the MSO4000 and DPO4000 Series oscilloscopes, use an attenuating probe properly rated for CAT II measurements.*

Over-voltage categories are defined as follows:

CAT II: Local level mains, appliances, portable equipment

CAT I: Signal level, special equipment or parts of equipment, telecommunications, electronics

Inserting the Application Module Key

To install a DPO3PWR, MDO3PWR or DPO4PWR application module in a compatible oscilloscope, follow these steps.

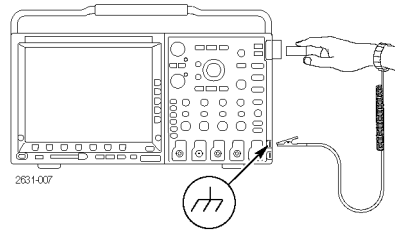
Basic Installation

Observe ESD precautions

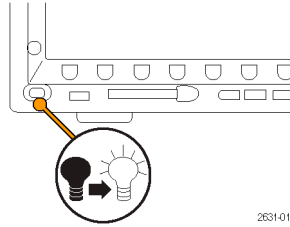
1. To avoid damage to the oscilloscope or the application module, observe proper electrostatic discharge (ESD) precautions. Use an ESD strap.

Insert the application key

2. While the oscilloscope is turned off, insert the power analysis application key in the indicated slot, to the right of the display.



- Power on the oscilloscope by pressing the on button.
Wait until the display appears.



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- Press the front-panel **Utility** button.
- Press the bottom-bezel **About** button. Verify that the oscilloscope detects a copy of the DPO3PWR, MDO3PWR or DPO4PWR Power Analysis application module and reports a firmware version shown in the table to the right.

Oscilloscope model	Firmware version
MSO4000 and DPO4000 Series	2.17 or higher
MDO4000 Series	2.08 or higher
MDO3000 Series	1.10 or higher
DPO3000 Series	1.10 or higher
MSO3000 Series	2.06 or higher

For further information on general set up of the oscilloscope, please refer to the appropriate *Series Oscilloscope User Manual*.

Checking and Troubleshooting the Module Installation

Use the following table to check that an application module is installed.

To check this module	Push this front-panel button	Check for
DPO3PWR, MDO3PWR or DPO4PWR	Test	A lower-bezel menu item appears labeled: Power Analysis If the lower-bezel menu button does not indicate Power Analysis , press the button and use the multipurpose knob A to select Power Analysis .

If the oscilloscope does not recognize the application module, perform these steps:

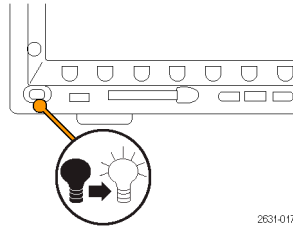
1. Turn off the oscilloscope.
2. Follow the ESD precautions shown previously.
3. Remove the application module.
4. Examine the application module contacts for damage.
5. Reinsert the application module into the oscilloscope.
6. Power on the oscilloscope. If the oscilloscope still does not show the application menu item, you have a problem with the application module or the module slot. Contact the nearest Tektronix service center to resolve the problem.

Getting Started



WARNING. To prevent electrical shock, do not exceed the measurement voltage ratings for the oscilloscope input BNC connectors, probe tip, or probe ground (reference) lead. Ground-referenced oscilloscopes and probes are not intended to be used for floating measurements.

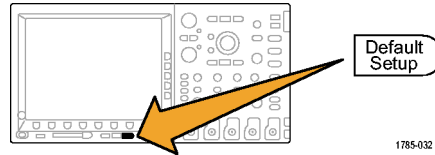
1. Power on the oscilloscope.
Wait until the display appears.



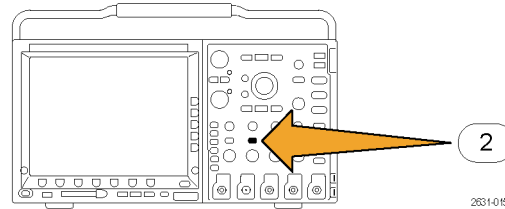
2631-017

2. Connect your probes to the oscilloscope, if not already done. For power measurements, typically insert the voltage probe into channel 1 and the current probe into channel 2.

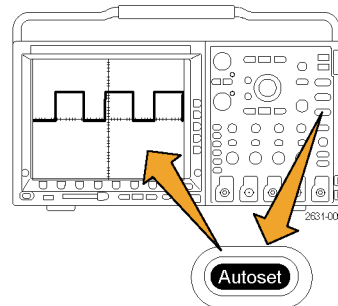
3. Push **Default Setup** to put the oscilloscope in a known state.



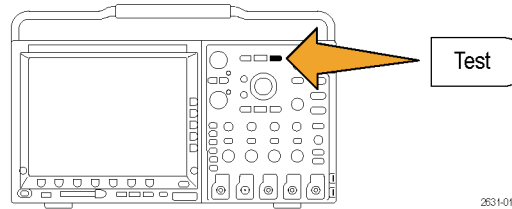
4. Push channel 2 to activate that channel.



5. Push **Autoset**.



6. Push **Test**.



7. Push **Analysis**.

Application	Analysis					
	None					

8. Use the side-bezel buttons to select the desired analysis function.

Choose among power quality, switching loss, harmonics, ripple, modulation, safe operating area, and deskew.

For further information on general set up of the oscilloscope, refer to the appropriate *Series Oscilloscopes User Manual*.

Deskewing Probes

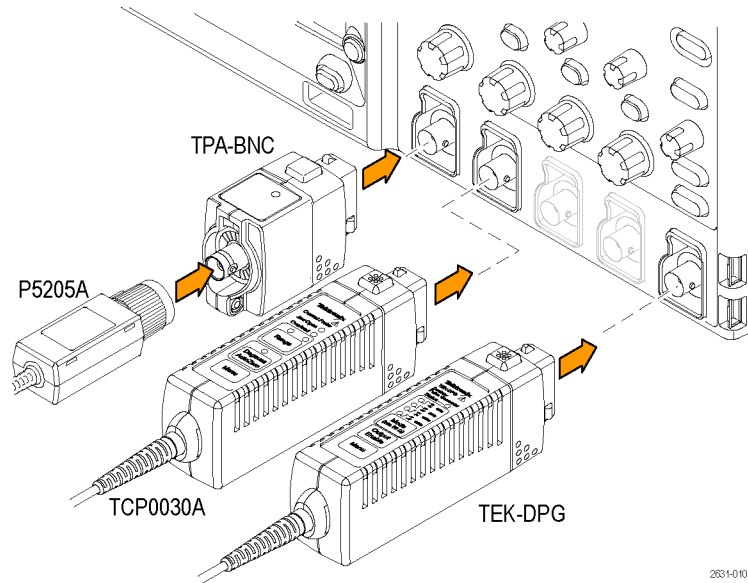
Run the deskew procedure to match the delays through the probes. Different probes introduce different delays between the probe tip and the oscilloscope. Many oscilloscope users do not have to worry about this because they use the same type of probe on all channels. Power measurement users, however, frequently use both a voltage probe and a current probe. A current probe typically has a larger delay than a voltage probe, so setting deskew values becomes important.

Using a Deskew Fixture

The following sample procedure assumes use of the deskew procedure built into the Power Analysis module, the Tektronix MDO4000, MSO4000, DPO4000, MDO3000, MSO3000 or DPO3000 Series Oscilloscope, the TCP0030A Current Probe, the P5205A Differential Probe, the TPA-BNC Adapter, the TEK-DPG Deskew Pulse Generator, and 067-1686-XX Power Measurement Deskew & Calibration Fixture. Adjust this procedure as needed if you use different equipment.

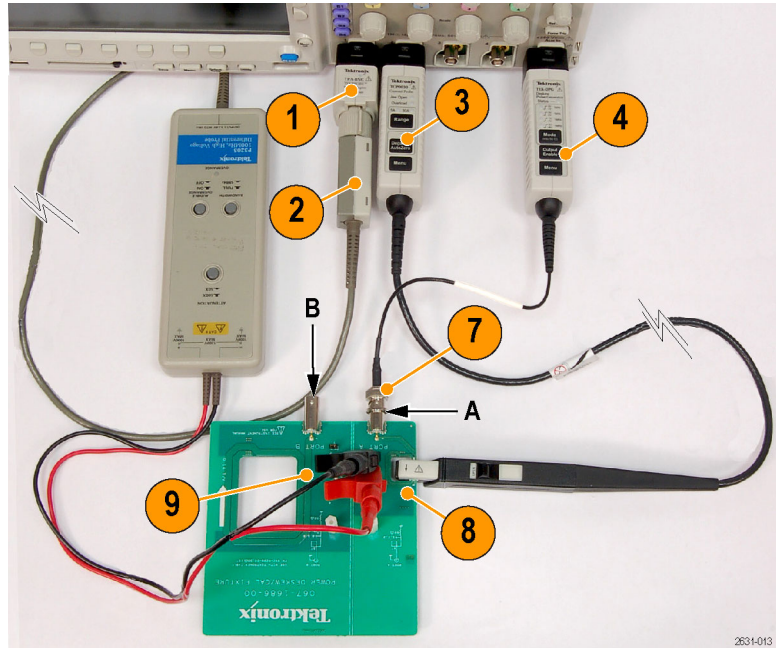
NOTE. For best results, warm up the equipment for 20 minutes before making critical adjustments.

1. Connect the TPA-BNC Adapter to channel 1.
2. Connect the voltage probe to the TPA-BNC Adapter.
3. Connect the current probe to channel 2.
4. Connect the TEK-DPG to AUX-IN. Push the button on the TEK-DPG marked **Output Enable** so that the light marked **Status LED** turns green. Push the button labeled **Mode** as many times as needed to select the desired signal.

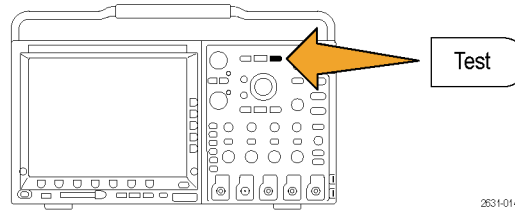


5. Push the oscilloscope front-panel **1** and **2** buttons, if needed, to be sure it displays the waveforms for both channels.
6. Push the range menu button on the current probe body to set the range values as desired.

7. Connect the TEK-DPG's BNC connector to Port A on the deskew fixture, as shown at the right.
8. Connect the TCP0030A probe to the deskew fixture as shown at the right. Make sure to align the polarity arrows on the current probe and the fixture. Make sure to close and lock the current probe slider.
9. Connect the P5205A probe tip and ground lead to the pins on the deskew fixture, as shown at the right.



10. Push **Default Setup**.
11. Push the **2** button to activate channel 2.
12. Push **Autoset**.
13. Push **Test**.



14. Push **Analysis**.

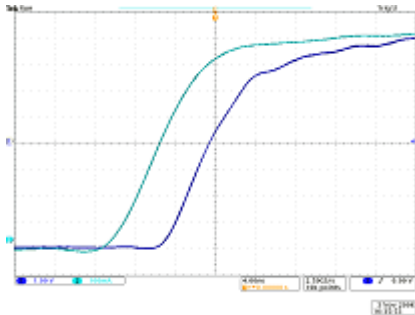
Application	Analysis					
	None					

15. Use the side-bezel buttons to select the function labeled **Deskew**.

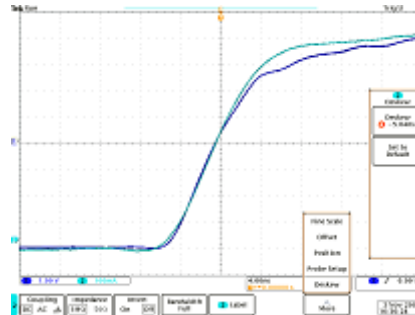
16. Push **Configure**.

Application Power	Analysis Deskew	Configure				
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17. Adjust the selected waveforms with the vertical and horizontal position and scale controls as needed. Then press the **Deskew** button on the side menu and rotate multipurpose knob **b**.



This shows a sample waveform prior to deskew.



This shows a sample waveform after deskew.

NOTE. For more information on use of the deskew and calibration fixture, refer to the 067-1686-XX Power Measurement Deskew & Calibration Fixture Instructions. It is available for download from www.tektronix.com/manuals.

Not Using a Deskew Fixture

If you do not have a deskew fixture, you can use the controls in the Deskew menu to set the oscilloscope's deskew parameters to recommended values, based on the normal propagation delay of each probe. Even if you are using a deskew fixture, the deskew menu controls can help you by getting the deskew values close to correct. You can then fine tune the values with the help of the deskew fixture.

The oscilloscope automatically loads the nominal propagation delay values of TekVPI and TekProbe II (requires use of a TPA-BNC adapter) probes. For other common probes, first push the side-bezel **Select** button, and select the channel to which the probe is attached. Then push the side-bezel **Probe Model** button, and select the probe model. If your probe is not in the list, set the probe model to **Other**, and push the side-bezel **Propagation Delay** button and dial in its propagation delay with multipurpose knob **a**.

To set the deskew value of each channel to the recommended value, push the side-bezel **Set all deskews to recommended value** button.

If you need to further adjust the selected waveforms on the screen, press the **Deskew** button on the side menu and rotate multipurpose knob **b**.

Press **Set all deskews to recommended values** from the side menu.

Observe the screen. The oscilloscope will calculate and set the proper deskew values automatically for known probes.

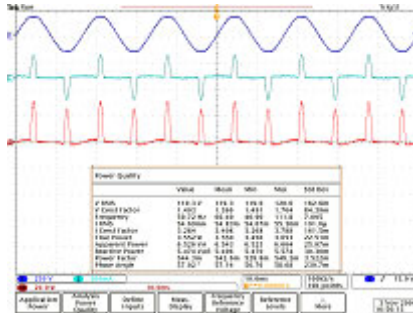
The oscilloscope will automatically recognize many Tektronix probes. If your probe is not on the list, select **Other** and manually input the propagation value, as shown below.

The oscilloscope will fill in the default values for recognized probes. You can manually input a value for an unrecognized probe by pressing this side button and turning multipurpose knob **a**.

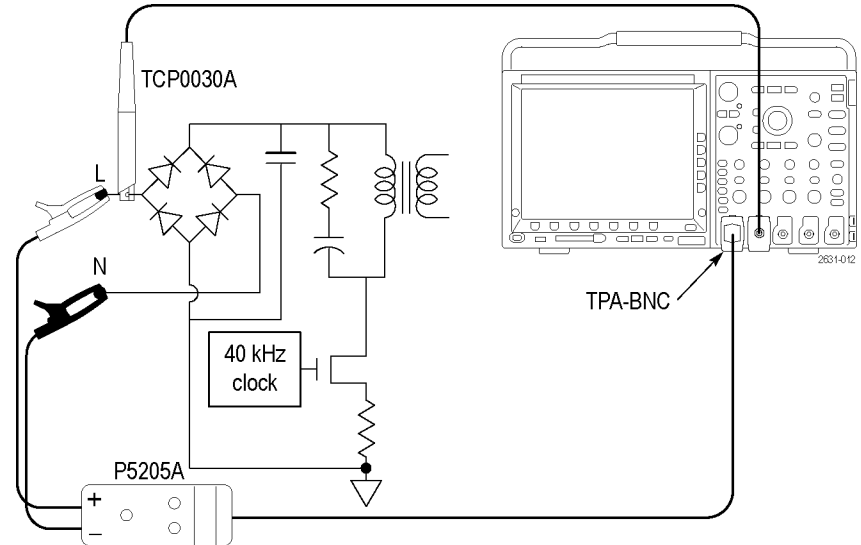
Deskew
Select (a) 1 Deskew (b) 0.00 S
Show rec. deskews Yes No
Set all deskews to recom- mended values
Probe Model Other
Propaga- tion Delay (a) 0.00 S

Measuring Power Quality

Use the power quality functions to view a table of measurement and statistics to check the general power quality in your test circuit.



Sample power quality screen shot



Sample power quality instrument setup



WARNING. To prevent electrical shock, always verify that the probe reference point is at ground potential before connecting the probe ground (reference) lead.

To Measure Power Quality, Follow These Steps:

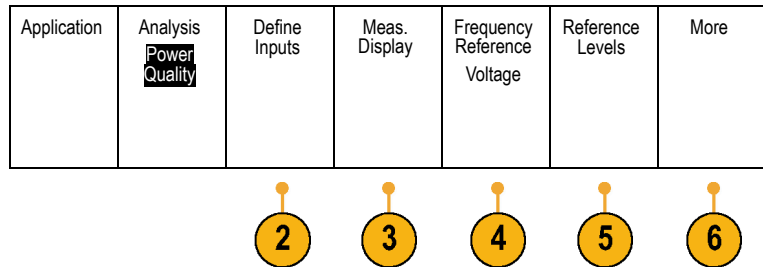
1. Select the **Power Quality** feature from the side menu. (See page 7, *Getting Started*.)

2. Push **Define Inputs** to select which channels to measure. Frequently, for these measurements, you will select a channel pair, where channel 1 is used as a voltage source and channel 2 as a current source.

 The Voltage and Current sources can be any analog waveforms, whether live channels or references.

3. Push **Meas. Display** to choose which of the 10 power quality measurements to display.

4. Push **Frequency Reference** to determine the source for the zero crossings for all Power Quality measurements and for frequency.



5. Push **Reference Levels** to choose how to make the power quality measurements.
6. Push **More** to select **Statistics**, **Gating**, or **Indicators**.

Indicators show where on the waveform the oscilloscope is taking the measurement.

Gating lets you define where on the waveform the oscilloscope is taking the measurement.

Measurements include:

Value	Description
Measurements on the voltage waveform	
V_{RMS}	The voltage root mean square. The V_{RMS} value is calculated across all complete cycles. The unit of measure is volts (V).
$V_{Crest\ Factor}$	The peak-to-RMS ratio for the voltage signal. The $V_{Crest\ Factor}$ indirectly specifies the purity of the AC supply. The $V_{Crest\ Factor} = (\text{voltage waveform max} / V_{RMS})$. It is expressed as a ratio. For example, the $V_{Crest\ Factor}$ is 1.414 for a pure sine wave and 1.0 for a 50% duty cycle square wave.
Frequency	The frequency is measured on the frequency source. The unit of measure is hertz (Hz).

Measurements on the current waveform

I_{RMS}	<p>The current root mean square.</p> <p>The I_{RMS} value is calculated across all complete cycles. The unit of measure is amps.</p>
$I_{Crest\ Factor}$	<p>The peak-to-RMS ratio for the current signal. It indirectly specifies the ability of the load to draw high AC peak currents.</p> <p>Current Crest Factor = (current waveform max / I_{RMS}).</p> <p>It is expressed as a ratio. For example, it is 1.414 for a pure sine wave and 1.0 for a 50% duty cycle square wave.</p>

Measurements on the power (math) waveform

True (Real) power	<p>This is the true power. It is the actual power delivered to the resistive part of the load, and it is measured in Watts. It is calculated by taking the mean value of the math ($V * A$) waveform.</p>
Apparent power	<p>The product of the RMS voltage and current (mathematically, the absolute value of the vector sum of the true and reactive power).</p> <p>Apparent power value = $V_{RMS} * I_{RMS}$.</p> <p>The unit of measure is Volt-Amperes or VA.</p>
Reactive power	<p>The reactive power in Volt-Amp Reactive.</p> <p>Reactive power = $V_{RMS} * I_{RMS} * \text{sine (phase angle)}$.</p> <p>The unit of measure is VAR.</p>

(True) Power factor	<p>The ratio (0 to 1) of real power to apparent power. If the signals are pure sine waves, the power factor is the cosine of the phase angle between the current and voltage waveforms.</p> <p>Apparent power = $V_{RMS} * I_{RMS}$.</p> <p>Typically, a higher power factor means more efficient use of energy. A purely resistive circuit would have a power factor of 1.0. A purely inductive circuit would have a power factor of 0.</p>
Phase angle	<p>The angle (0° to 180°) whose cosine is the true power factor.</p>

Operating Tips

- The power measurements in this menu are based on all the complete cycles found in the voltage waveform record.

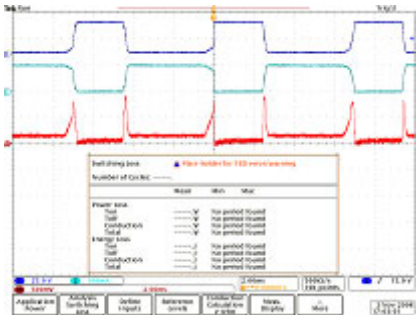
Measuring Switching Loss

Use the switching loss functions to view tables of power loss and energy loss across the acquired waveform, including turn-on, turn-off, conduction, and total loss.

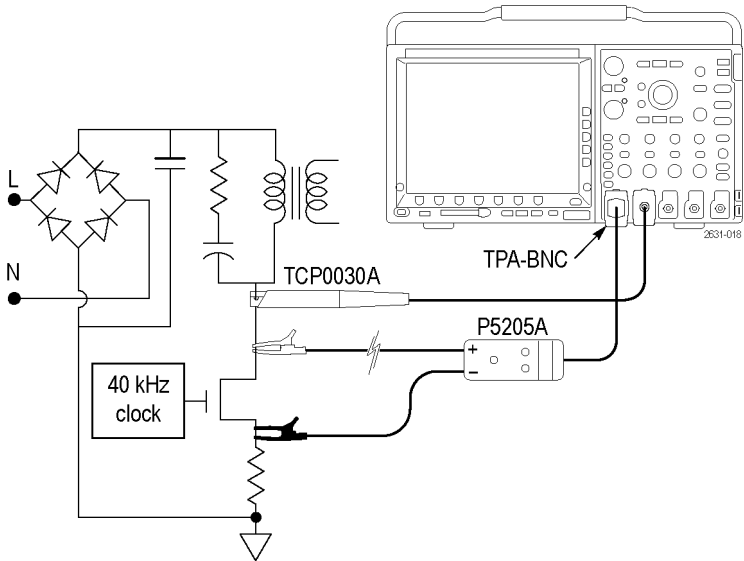
Typically, use these functions to characterize losses in power supply switching devices, as they switch on and off. Switching loss operations require the use of a voltage and a current probe.



WARNING. *To prevent electrical shock, always verify that the probe reference point is at ground potential before connecting the probe ground (reference) lead.*



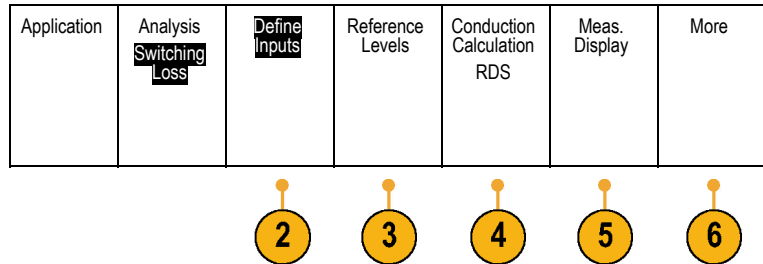
Sample switching loss screen shot



Sample switching loss instrument setup

To Measure Switching Loss, Follow These Steps:

1. Select the **Switching Loss** feature from the side menu. (See page 7, *Getting Started*.)
2. Push **Define Inputs** to select which channels to measure. For these measurements, you need to select a channel pair. Typically, channel 1 is used as a voltage source and channel 2 as a current source.
3. Press **Reference Levels** to choose how to make the switching loss measurements.
4. Press **Conduction Calculation** to set the method for calculating the conduction loss.



The **Voltage Waveform** method measures the voltage drop across the switching device during conduction. Because this voltage is typically very small compared with the voltage across the switching device when it is not conducting, you generally cannot measure both voltages accurately at the same vertical setting of the oscilloscope. In that case, consider using one of the following approaches for more accurate results.

The **RDS(on)** approach is the best model for MOSFETs and is based on information from the device data sheet. This value is the expected on-resistance between the drain and the source of the device when it is conducting.

The **VCE(sat)** approach is the best model for BJTs and IGBTs and is based on information from the device data sheet. It is the expected saturation voltage from the collector to the emitter of the device when it is saturated.

5. Press **Meas. Display** to set which of the available switching loss measurements to display. The choices are **Power Loss**, **Energy Loss**, or **All** (both Power and Energy Loss).

6. Press **More** to define **Statistics**, **Gating**, and **Indicators**.

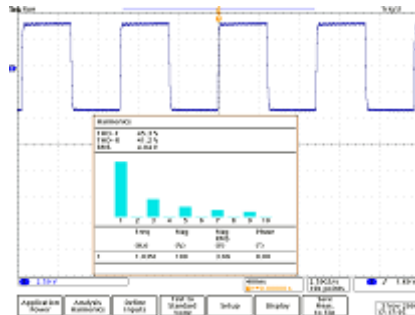
Indicators graphically show where on the waveform the oscilloscope is taking the measurement. Gating lets you define where on the waveform the oscilloscope is taking the measurement.

NOTE. *Switching loss measurements are made on each individual complete cycle within the selected region of the acquisition (the entire waveform, by default) and the statistics of those measurements are accumulated across the acquisition, but not between acquisitions.*

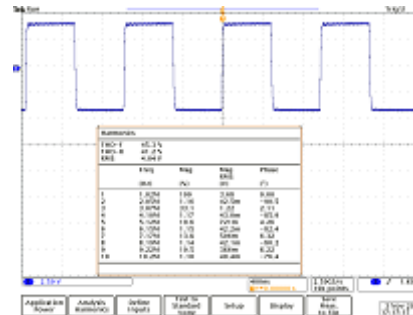
Measuring Harmonics

Use the Harmonics menu functions to display the frequency spectrum of the source waveform and the associated measurement values and perform in-depth troubleshooting of power quality problems.

Select **Harmonics** to bring up the Harmonics menu. The oscilloscope will display the frequency spectrum of the source waveform and the associated measurement values.

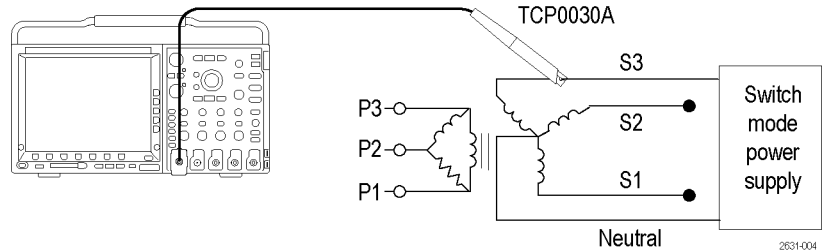


First 10 harmonics shown graphically



First 10 harmonics shown textually

The figure to the right shows a sample instrument setup for measuring harmonics.



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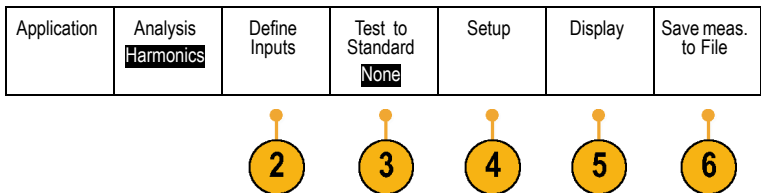


WARNING. To prevent electrical shock, always verify that the probe reference point is at ground potential before connecting the probe ground (reference) lead.

To Measure Harmonics, Follow These Steps:

1. Select the **Harmonics** feature from the side menu. (See page 7, *Getting Started*.)

2. Push **Define Inputs** to identify which channels the voltage and current waveforms are on.
3. Push **Test to Standard** to choose between general harmonics analysis or testing to a specific standard, such as IEC 61000-3-2 Class A or MIL-STD-1399 Section 300A.
4. If you selected **None** in the previous menu item, this item will read **Setup**. Push this to specify the number of harmonics to calculate, whether to calculate harmonics on the voltage or the current waveform, and how to determine the frequency of the primary waveform.



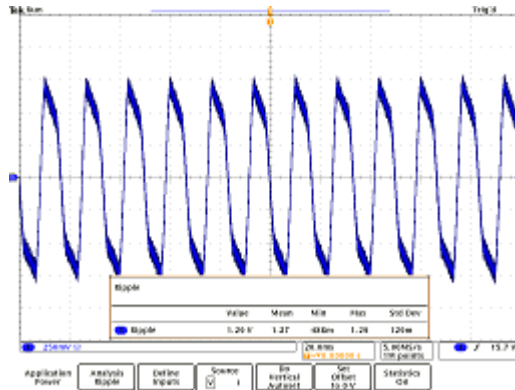
By default, the frequency reference is set to the harmonics source, however, you can set it to the voltage waveform, the current waveform, or a fixed value if the voltage and current waveforms are noisy and the primary harmonic is not easy to determine.

If you selected **IEC 61000-3-2** or **MIL-STD-1399** in a previous menu item, use this item to further define what configuration of these standards you wish to measure.

5. Push **Display** to choose whether to show harmonics information as a table or a bar chart.
You can also use this item to choose to display information for all, just odd, or just even harmonics if you did not previously choose to test to one of the supported standards.
6. Push **Save Meas. to File** to save the results to a .csv file.

Measuring Ripple

Use ripple to view a table of measurements and statistics for the AC components of the acquired waveform. Ripple is often found on top of a large DC signal.



To Measure Ripple, Follow These Steps:

1. Select the **Ripple** feature from the side menu.
(See page 7, *Getting Started*.)

2. Push **Define Inputs** to identify which channels the voltage and current waveforms are on.

Application Power	Analysis Ripple	Define Inputs	Source V I	Do Vertical Autoset	Set Offset to 0 V	Statistics On
----------------------	---------------------------	------------------	---------------	------------------------	----------------------	-------------------------

3. Push **Source** to choose whether to measure the ripple on the voltage or the current waveform.



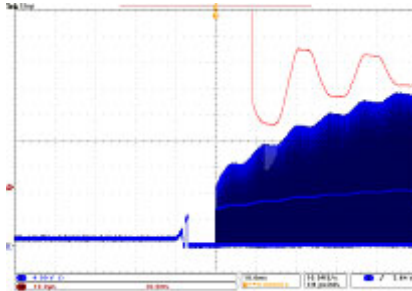
4. Push **Do Vertical Autoset** to remove the DC component from the signal by adding vertical offset and then auto-scaling the AC component for optimal measurement accuracy.

Typically, a ripple measurement involves looking at a very small voltage riding on a large voltage. You want to use the internal resolution of the oscilloscope as effectively as possible to measure that small voltage. With **Do Vertical Autoset**, you can devote much more of the oscilloscope's ADC range to measurement of the desired ripple.

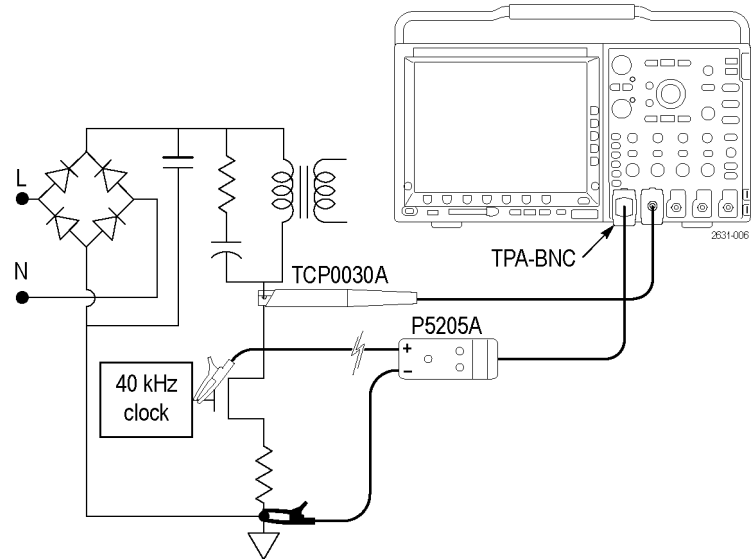
5. Push **Set Offset to 0** to remove all vertical offset.

Measuring Modulation

Use the modulation function to view a trend plot of a measurement value across the acquired waveform. This is useful for showing the variations in the modulated switching signal.



Sample modulation screen shot



Sample modulation instrument set up.



WARNING. To prevent electrical shock, always verify that the probe reference point is at ground potential before connecting the probe ground (reference) lead.

To Measure Modulation, Follow These Steps:

1. Select the **Modulation** feature from the side menu. (See page 7, *Getting Started*.)

2. Push **Define Inputs** to identify which channels the voltage and current waveforms are on.

Application	Analysis Modulation	Define Inputs	Source V I	Modulation Type +Width	Reference Levels	
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3. Push **Source** to choose which waveform to measure modulation on.



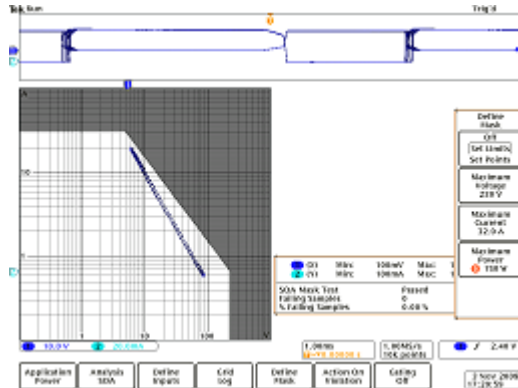
4. Push **Modulation Type** to define what exactly to measure. Choices include: positive pulse width, negative pulse width, period, frequency, positive duty cycle, and negative duty cycle.

5. Push **Reference Levels** to define where to make the measurement.

Measuring Safe Operating Area

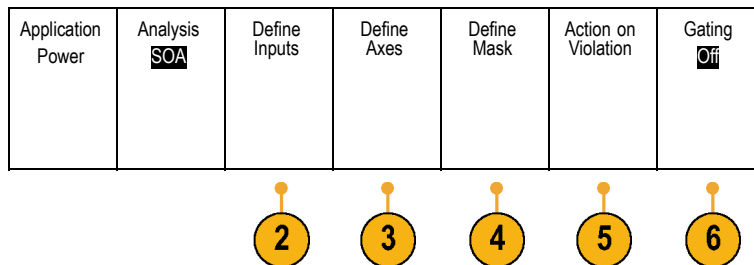
Use the safe operating area functions to view a graphical X-Y display of the switching device-under-test's voltage and current. Also, use them to perform a mask test of the X-Y signal relative to the graphical X-Y description of the device specification limits.

The safe operating area is typically the voltage and current values that a semiconductor device can operate without damaging itself. The safe operating display shown in these functions is a simple graphical method for monitoring the interactions between voltage and current and determining whether the device exceeds the limits specified in the manufacturer's data sheet for the device.

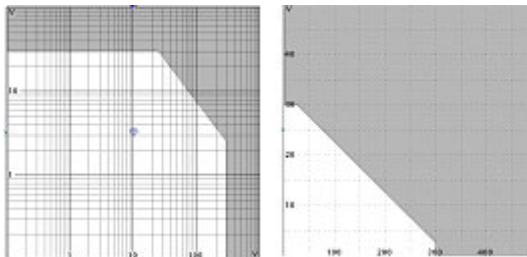


To Measure Safe Operating Area, Follow These Steps:

1. Select the **Safe Operating Area** feature from the side menu. (See page 7, *Getting Started*.)
2. Push **Define Inputs** to select which channels to measure. For this measurement, there are four valid voltage/current input pairs. These are Ch1/Ch2, Ch3/Ch4, Reference 1/Reference 2, and Reference 3/Reference 4.



3. Push **Define Axes** to select either a log or linear graticule. You can use the side menu items and multipurpose knob **a** to set the size of the graticule.
The x axis typically displays voltage and the y axis displays current.



4. Push **Define Mask** to define the safe operating area within the grid.

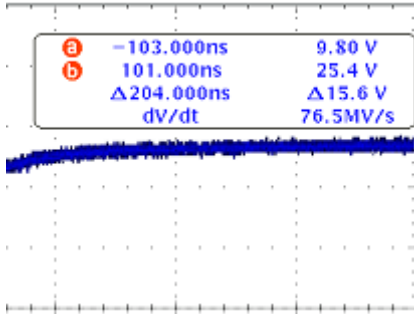
Use the side-menu **Set Limits** choice for simpler four-point masks. You need to input the maximum voltage, maximum current, and maximum power to set a mask with this method.

Use the side-menu **Set Points** to define a more complex mask with up to 10 points, each of which you can define.

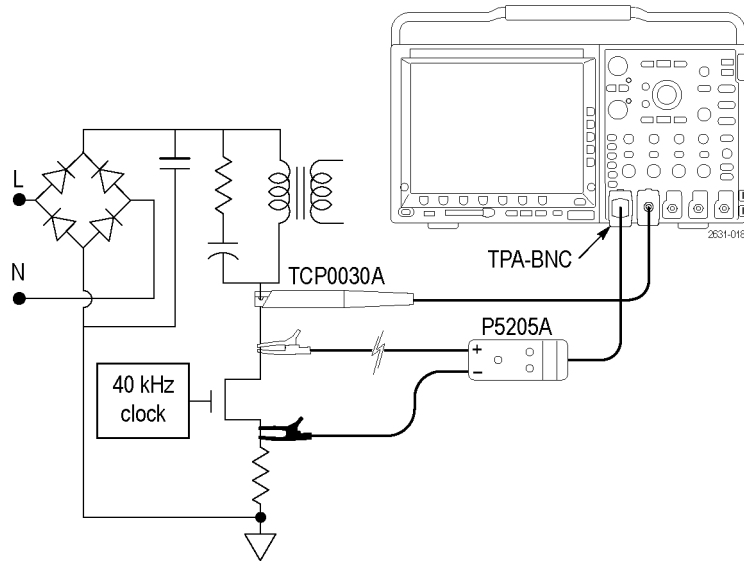
5. Push **Action on Violation** to select whether or not to stop acquisitions on the detection of an error.
6. Push **Gating** to define where in time to measure the safe operating area.

Making di/dt and dV/dt Measurements

Use the cursor readouts to measure the slope (rate of change) of signals.



Sample dV/dt readout



Sample d/dt instrument set up



WARNING. *To prevent electrical shock, always verify that the probe reference point is at ground potential before connecting the probe ground (reference) lead.*

The d/dt measurement appears in the bottom of the cursor readout. It appears automatically when the power application key is installed.

Adjust the cursors to vary the portion of the waveform over which to measure. The measurement works with both waveform and screen cursors.

If you have selected a voltage waveform, the oscilloscope will display the dV/dt measurement. If you have selected a current waveform, the oscilloscope will display the dI/dt measurement.

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