

AFG31000 Double Pulse Application

Introduction

This manual describes the Double Pulse application for use with your Tektronix AFG31000 Series Arbitrary Function Generator.

The Double Pulse application is a downloadable application. This application is used to measure switching parameters and evaluate dynamic behaviors of power devices. Function generators are typically unable to independently control pulse width, and it can be difficult to adjust pulse width while working. The Double Pulse application allows you to run double pulse tests using a function generator, combining the functionality of the function generator with a double-pulse tester.

The application allows you to measure the following switching parameters:

- **Turn-on parameters:** Turn-on delay ($t_{d(on)}$), rise time (t_r), turn-on time (t_{on}), E_{on} , dv/dt , and di/dt . Energy loss is then determined.
- **Turn-off parameters:** Turn-off delay ($t_{d(off)}$), fall time (t_f), turn-off time (t_{off}), E_{off} , dv/dt , and di/dt . Energy loss is then determined.
- **Reverse recovery parameters:** Reverse recovery time (t_{rr}), reverse recovery current (I_{rr}), reverse recovery charge (Q_{rr}), reverse recovery energy (E_{rr}), di/dt , and forward on voltage (V_{sd}).

By running a double-pulse test, you can:

- Guarantee the specifications of power device datasheets
- Confirm actual value or deviation of power devices or power modules
- Measure switching parameters with current value conditions and other devices.

Installing the application

Directions for installing applications onto your instrument using a USB flash drive are in the *AFG31000 User's Manual* (0771473XX).



Application specifications

Below are the specifications for the Double Pulse application:

Pulse number: 2 to 30 pulses. The number of pulses that the application generates.

High/low level:

- Minimum: -5 V
- Maximum: +5 V

Pulse width:

- Minimum: 20 ns
- Maximum: 150 μ s
- Resolution: 1 ns

Trigger: Manual, External, and Timer

Load impedance: 50 Ω and High Z

App navigation

The following topics explain how to open, navigate, and run tests using the Double Pulse application.

Opening the application

After installing the Double Pulse application, an icon for the application will show on your AFG31000 home screen directly below the Basic and Advanced buttons. After selecting the DoublePulse icon, the application opens.

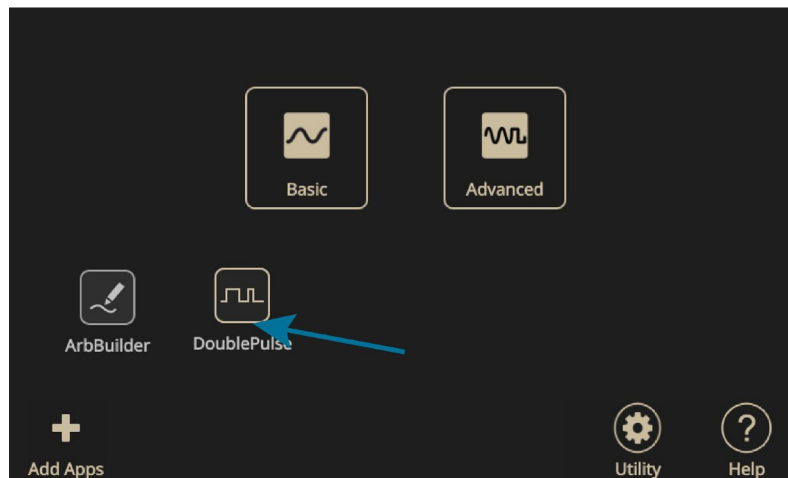


Figure 1: AFG31K homescreen

NOTE. If the application does not appear, see the *AFG31000 Users Manual* (0771473XX) for information.

Setting up a double pulse

After opening the Double Pulse application, you can set up your double-pulse test. The following figure shows the Double Pulse test screen. Here you can set the:

- Number of Pulses (N): 2 to 30 pulses
- High and Low voltage
- Trigger Delay
- Trigger Source: Manual, External, or Timer
- Load: 50 Ω or High Z

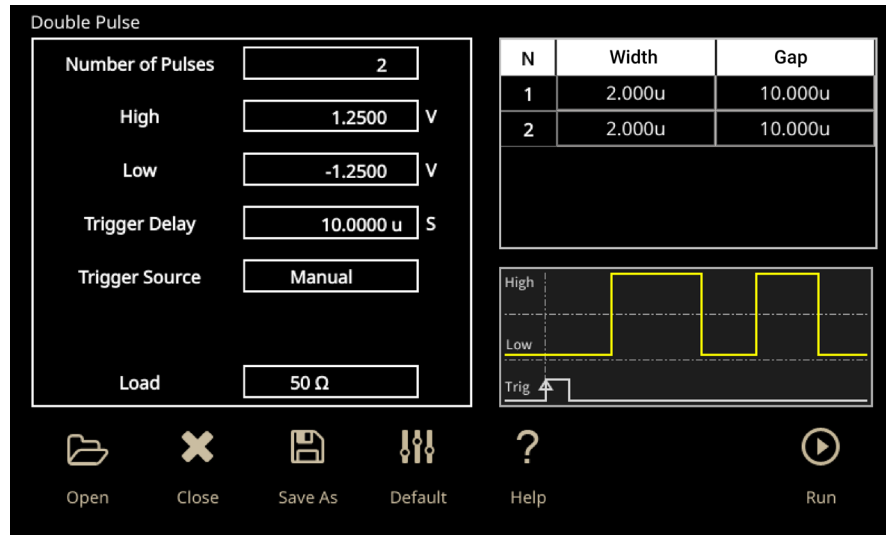


Figure 2: Double Pulse application screen

When you are finished with your setup, select **Run** to start your test. Select **Stop** to end the test.

NOTE. Selecting **Close** does not reset your application settings. Selecting **Default** restores the default settings.

Saving and retrieving your data

The Double Pulse application allows you to save and open tests on both the internal memory of the AFG31000 and with a USB flash drive.

To save your completed test information:

Select Save As on the Double Pulse application window.

1. Select either Memory, for internal memory, or USB as the save location.
2. Navigate to, or create, your folder on the right pane and select the folder.

Select OK.

NOTE. The Double Pulse application saves test files as .json and .tfwx files.

The following figure shows the save window.

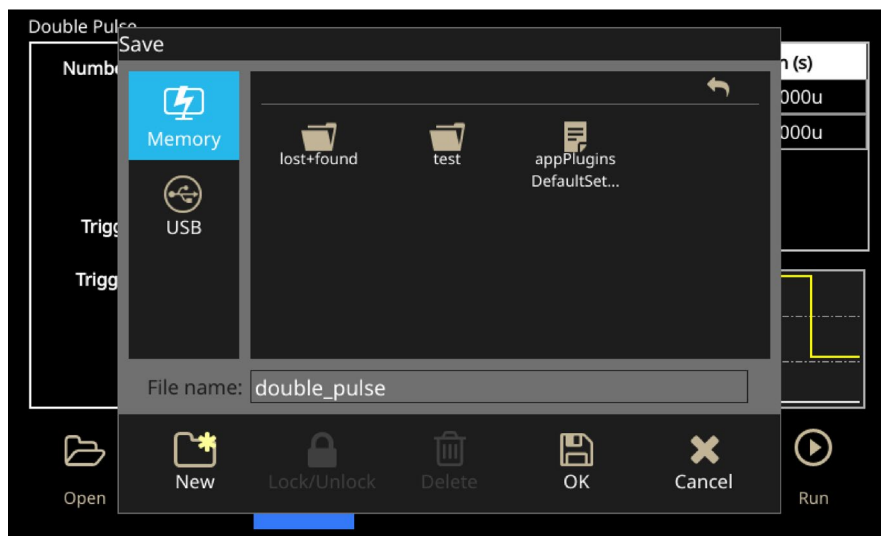


Figure 3: Save window

To retrieve your previously saved data:

Select Open on the Double Pulse application window.

1. Select the location of your saved data on the left pane.
2. Navigate to the folder on the right pane and select the file.
3. Select OK.

The following figure shows the Load window.

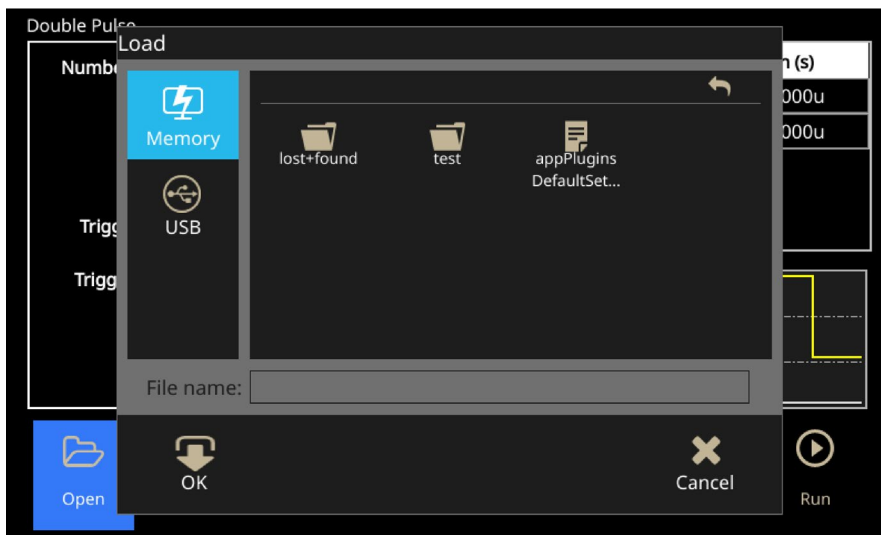


Figure 4: Load window

Using the Double Pulse application

You can use the Double Pulse application with an inductive load and a power supply. Using the Tektronix AFG31000 Arbitrary Function Generation, the output pulses trigger the MOSFET gate and turn it on to start current conduction. The following figure shows a typical setup to measure switching parameters of a power device. The following setup uses two devices to measure all parameters of the switch.

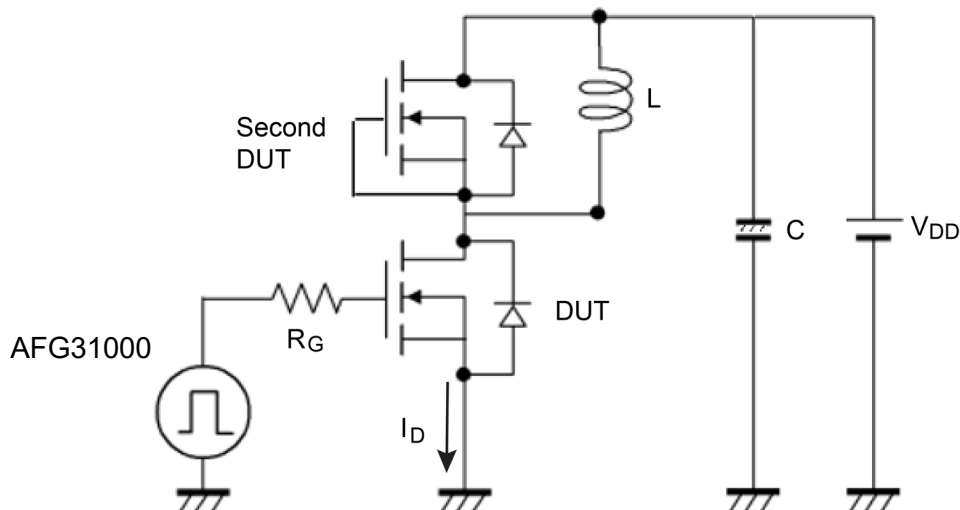


Figure 5: Double pulse measurement setup

NOTE. You must adjust the first pulse width to get an accurate switching current value. The longer the DUT is switched ON, the more the current level will increase during that time.

You can create pulses with varying pulse widths using the Double Pulse application. After adjusting the first pulse width to get an expected switching current value, the second pulse width can be adjusted independently. The second pulse width is typically shorter than the first pulse to prevent damage to the power device. You can also adjust the time gaps between each pulse.

Double Pulse test

The following figure is the double-pulse test schematic of the behavior for a high-side diode test. The first, second, and third callouts are steps in a sequence of operation.

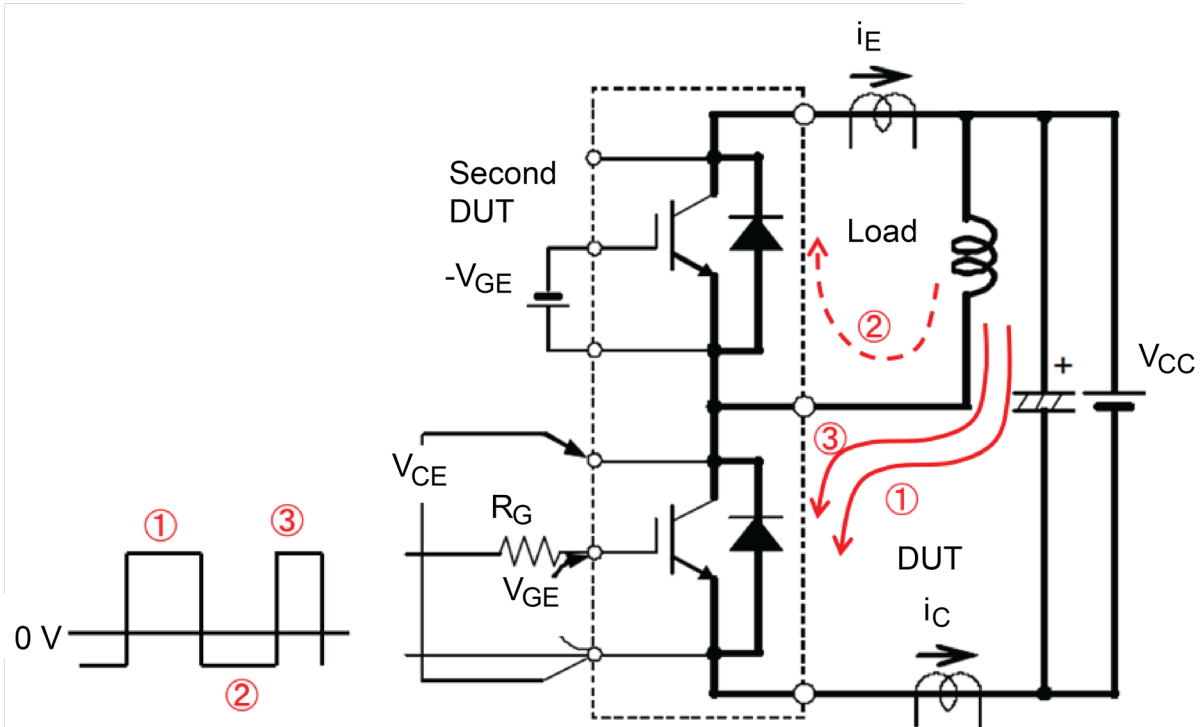


Figure 6: Double Pulse test setup

The sequence of operation of a double pulse is shown in the following two figures. The first figure shows the pulse as a sequence of operation where the gate voltage is measured on the DUT.

- The first step in the sequence is the initial adjusted pulse width. This establishes the current value in the inductive test load.
- The second step is the off phase between pulses. The current load is constant during this step.
- The third step is the second pulse under pre-charged conditions.

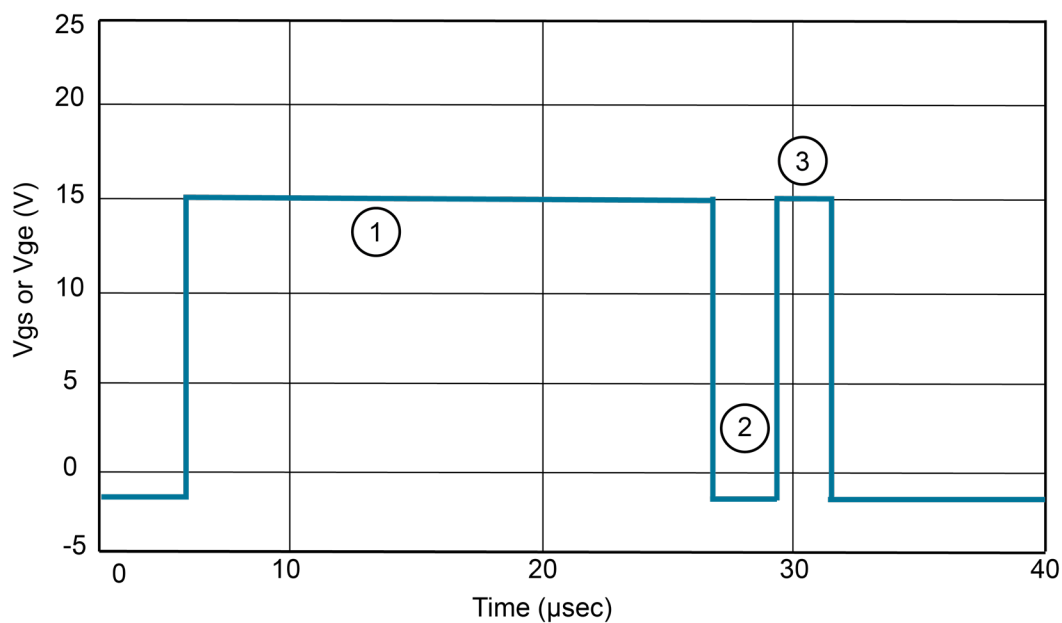


Figure 7: Double Pulse test graph

The second graph shows a test with resultant drain current waveform and drain voltage. The same sequence that was used in the first graph is used in this graph. The difference is that both pulses with insulated-gate bipolar transistor (IGBT) and MOSFET are represented on the graph. The blue line represents the drain voltage. The red line represents the drain current. The overshoots are due to ringing in the current.

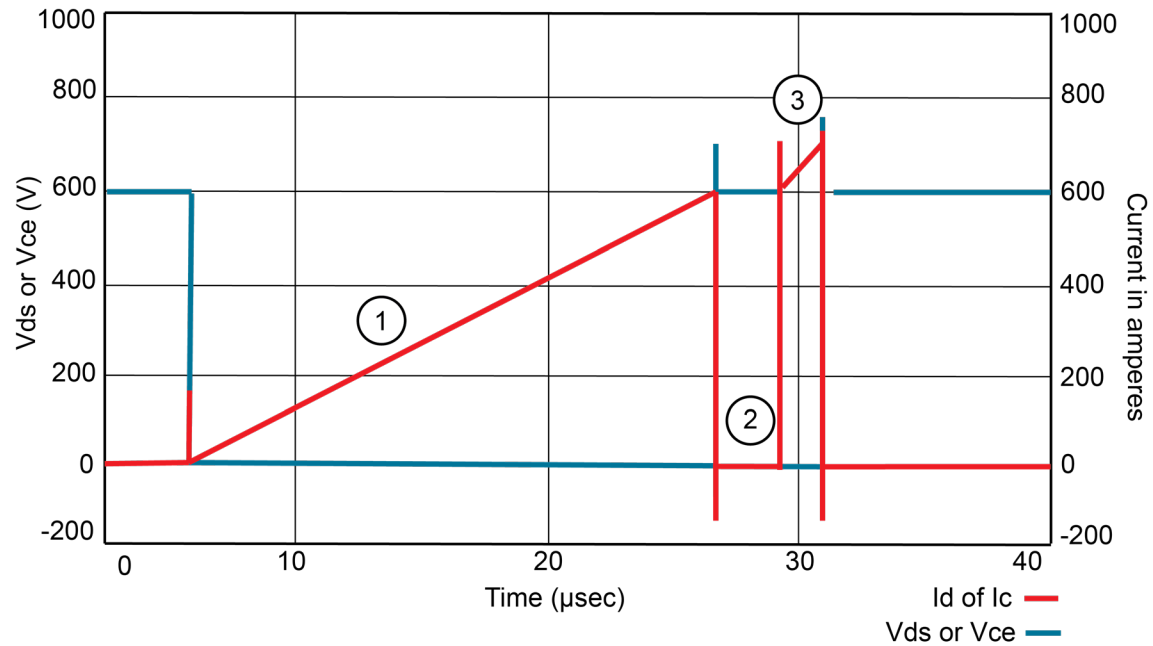


Figure 8: Double Pulse test MOSFET and IGBT

NOTE. IGBT is used in the schematic symbols and the waveforms for MOSFET or IGBT are equivalent. Current through the secondary DUT is not measured during step two.

Double Pulse test equipment setup

The following figure shows the equipment setup for running a Double Pulse test. The following equipment is required:

- AFG31000: Generates the control signal.
- Oscilloscope (this setup uses a MSO5 or MSO6): Measures the control signal (drain or collector voltage) and drain current or collector current, depending on the device.
- IsoVu Prober: A high common-mode rejection probe. Connects the scope to the gate.

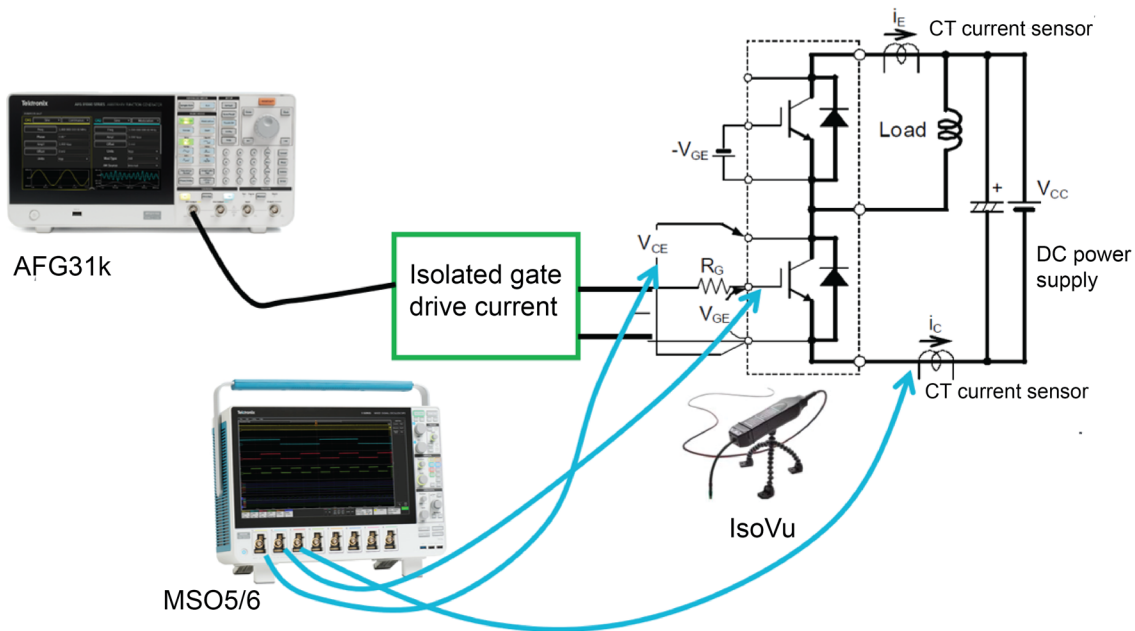


Figure 9: Double Pulse equipment setup

In the above figure, the oscilloscope is measuring the DUT on channel 3. The second DUT, in the previous setup, would be measured on channel 4.

NOTE. The Double Pulse application is a single-channel application and outputs to channel 1.

The above double-pulse test setup allows you to:

- Analyze switching transients and switching power losses of the power switching stage.
- Investigate switching characteristics in real experiments and compare them with a simulation tool.
- Estimate fast switching transients that can cause high-switching stresses on the transistor, such as current and voltage overshoot and ringing.
- Verify a short-circuit protection system implemented in the gate driver (short-circuit currents).

Important safety information

This manual contains information and warnings that must be followed by the user for safe operation and to keep the product in a safe condition.

To safely perform service on this product, additional information is provided at the end of this section. See [Service safety summary](#) (on page 13).

General safety summary

Use the product only as specified. Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it. Carefully read all instructions. Retain these instructions for future reference.

Comply with local and national safety codes.

For correct and safe operation of the product, it is essential that you follow generally accepted safety procedures in addition to the safety precautions specified in this manual.

The product is designed to be used by trained personnel only.

Only qualified personnel who are aware of the hazards involved should remove the cover for repair, maintenance, or adjustment.

Before use, always check the product with a known source to be sure it is operating correctly.

This product is not intended for detection of hazardous voltages.

Use personal protective equipment to prevent shock and arc blast injury where hazardous live conductors are exposed.

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.

When incorporating this equipment into a system, the safety of that system is the responsibility of the assembler of 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.

Do not use the provided power cord for other products.

Use proper voltage setting. Before applying power, make sure that the line selector is in the proper position for the source being used or make sure the line voltage is corrected based on the published specifications.

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, make sure that the product is properly grounded.

Do not disable the power cord grounding connection.

Power disconnect. The power cord disconnects the product from the power source. See instructions for the location. Do not position the equipment so that it is difficult to operate the power cord; it must remain accessible to the user at all times to allow for quick disconnection if needed.

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

Use only connectors and adapters supplied with the product, or indicated by Tektronix to be suitable for the product.

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. Do not exceed the Measurement Category (CAT) rating and voltage or current rating of the lowest rated individual component.

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

Do not float the common terminal above the rated voltage for that terminal.

Do not operate without covers. Do not operate this product with covers or panels removed, or with the case open. Hazardous voltage exposure is possible.

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

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

Disable the product if it is damaged. Do not use the product if it is damaged or operates incorrectly. If in doubt about safety of the product, turn it off and disconnect the power cord. Clearly mark the product to prevent its further operation.

Examine the exterior of the product before you use it. Look for cracks or missing pieces.

Use only specified replacement parts.

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

Do not operate in wet/damp conditions. Be aware that condensation may occur if a unit is moved from a cold to a warm environment.

Do not operate in an explosive atmosphere.

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

Slots and openings are provided for ventilation and should never be covered or otherwise obstructed. Do not push objects into any of the openings.

Provide a safe working environment. Always place the product in a location convenient for viewing the display and indicators.

Avoid improper or prolonged use of keyboards, pointers, and button pads. Improper or prolonged keyboard or pointer use may result in serious injury.

Be sure your work area meets applicable ergonomic standards. Consult with an ergonomics professional to avoid stress injuries.

Use care when lifting and carrying the product. This product is provided with handles for lifting and carrying.

Use only the Tektronix rack-mount hardware specified for this product.

Keep product surfaces clean and dry. Remove the input signals before you clean the product. Inspect the instrument as often as operating conditions require. To clean the exterior surface, perform the following steps:

1. Remove loose dust on the outside of the instrument with a lint-free cloth. Use care to avoid scratching the clear glass display filter.
2. Use a soft cloth dampened with water to clean the instrument. Use an aqueous solution of 75% isopropyl alcohol for more efficient cleaning.



CAUTION. Avoid getting moisture inside the unit during external cleaning. Use only enough cleaning solution to dampen the cloth or swab. To avoid damage to the instrument, do not expose it to sprays, liquids, or solvents, and do not use any abrasive or chemical cleaning agents.

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.

Service safety summary

This section contains additional information required to safely perform service on the product. Only qualified personnel should perform service procedures. Read this *Service safety summary* and the General safety summary before performing any service procedures.

To avoid electric shock. Do not touch exposed connections.

Do not service alone. Do not perform internal service or adjustments of this product unless another person capable of rendering first aid and resuscitation is present.

Disconnect power. To avoid electric shock, switch off the product power and disconnect the power cord from the mains power before removing any covers or panels, or opening the case for servicing.

Use care when servicing with power on. Dangerous voltages or currents may exist in this product. Disconnect power, remove battery (if applicable), and disconnect test leads before removing protective panels, soldering, or replacing components.

Verify safety after repair. Always recheck ground continuity and mains dielectric strength after performing a repair.

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.



When this symbol is marked on the product, be sure to consult the manual to find out the nature of the potential hazards and any actions which have to be taken to avoid them. (This symbol may also be used to refer the user to ratings in the manual.)

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

