Tektronix®

EOS and ESD Prevention System for Tektronix Electrical and Optical Sampling Modules

Instructions

071-3763-00

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Instructions

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Contacting Tektronix

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USA

For product information, sales, service, and technical support:

- In North America, call 1-800-833-9200.
- Worldwide, visit www.tek.com to find contacts in your area.

Warranty

Tektronix warrants that this product will be free from defects in materials and workmanship for a period of one (1) year from the date of shipment. If any such product proves defective during this warranty period, Tektronix, at its option, either will repair the defective product without charge for parts and labor, or will provide a replacement in exchange for the defective product. Parts, modules and replacement products used by Tektronix for warranty work may be new or reconditioned to like new performance. All replaced parts, modules and products become the property of Tektronix.

In order to obtain service under this warranty, Customer must notify Tektronix of the defect before the expiration of the warranty period and make suitable arrangements for the performance of service. Customer shall be responsible for packaging and shipping the defective product to the service center designated by Tektronix, with shipping charges prepaid. Tektronix shall pay for the return of the product to Customer if the shipment is to a location within the country in which the Tektronix service center is located. Customer shall be responsible for paying all shipping charges, duties, taxes, and any other charges for products returned to any other locations.

This warranty shall not apply to any defect, failure or damage caused by improper use or improper or inadequate maintenance and care. Tektronix shall not be obligated to furnish service under this warranty a) to repair damage resulting from attempts by personnel other than Tektronix representatives to install, repair or service the product; b) to repair damage resulting from improper use or connection to incompatible equipment; c) to repair any damage or malfunction caused by the use of non-Tektronix supplies; or d) to service a product that has been modified or integrated with other products when the effect of such modification or integration increases the time or difficulty of servicing the product.

THIS WARRANTY IS GIVEN BY TEKTRONIX WITH RESPECT TO THE PRODUCT IN LIEU OF ANY OTHER WARRANTIES, EXPRESS OR IMPLIED. TEKTRONIX AND ITS VENDORS DISCLAIM ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. TEKTRONIX' RESPONSIBILITY TO REPAIR OR REPLACE DEFECTIVE PRODUCTS IS THE SOLE AND EXCLUSIVE REMEDY PROVIDED TO THE CUSTOMER FOR BREACH OF THIS WARRANTY. TEKTRONIX AND ITS VENDORS WILL NOT BE LIABLE FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES IRRESPECTIVE OF WHETHER TEKTRONIX OR THE VENDOR HAS ADVANCE NOTICE OF THE POSSIBILITY OF SUCH DAMAGES.

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Introduction to preventing Electrical Over Stress (EOS) and Electro-Static Discharge (ESD)

Tektronix wants you to get the best possible value from your Tektronix sampling module. Our research of customer test processes resulted in our design of the EOS/ESD Protection System. This system helps customers maximize uptime of their sampling modules. Customers who use the system have experienced up to an 80% reduction is EOS/ESD induced failures since implementing our protection system. The system removes the opportunity for operator error that may cause EOS/ESD damages to the sampling head.

The large percent of sampling heads returned for repair have EOS/ESD damage. Tektronix warranty and service agreement programs do not cover damages caused by EOS/ESD. We highly recommend use of the EOS/ESD Protection System to minimize EOS/ESD damage and to maximize your sampling module's uptime.

Protection system components

The Protection System consists of either an 80A02 protection module or an 80A09 protection device. Both can then be used with a P8018 (single ended) or P80318 (differential) probe. Each P80318 requires one module or device.

Table 1: EOS/ESD Protection System components

Item	Quantity	Description
80A02 	1 or more based on need.	Protection module (isolation module) Link to datasheet for detailed information: https://www.tek.com/datasheet/80a02-eos-esd-isolation-module-dsa8300
80A09 	1 or more based on need.	Protection device Link to datasheet for detailed information: https://www.tek.com/datasheet/80a09-26ghz-esd-protection-device-datasheet

Table 1: EOS/ESD Protection System components (cont.)

Item	Quantity	Description
P8018	1 or more based on need.	Single ended probe Link to datasheet for detailed information: https://www.tek.com/datasheet/p8018-tdr-probe-datasheet
P80318 P80318X 	Based on your needs. Note that the P80318X is a set of two P80318 probes. *(Each differential probe requires a separate protection module or protection device.)*	Differential probe Link to datasheet for detailed information: https://www.tek.com/datasheet/p80318-p80318x-differential-impedance-tdr-probes

Affected modules

This document applies to all Tektronix electrical and optical modules for sampling oscilloscopes.

Terms

The following terms are used in this document:

ESD ESD (electrostatic discharge) is the momentary discharge of electricity between objects that are at different potentials. ESD can have amplitudes in hundreds or even thousands of volts. A single ESD event can cause the sampling head to fail.

EOS EOS (electrical overvoltage stress) occurs when an electronic device is subjected to a voltage level that is slightly higher than its designed limit. EOS damage can occur at low voltage levels. EOS damage has a cumulative effect, and over time causes the sampling head to fail. Standard methods for preventing ESD are not very effective against EOS damage.

Support

Contact your Account Manager or visit the Support link at www.tek.com for additional information.

Installation

Sampling modules fit into the front panel of TDS, CSA, DSA oscilloscopes. The following figure shows the front panel of an instrument and the locations of the sampling-module compartments.

If you have a TSO820 instrument with optical modules, see the module installation section in this document for information. (See page 5, *Module Installation*.)

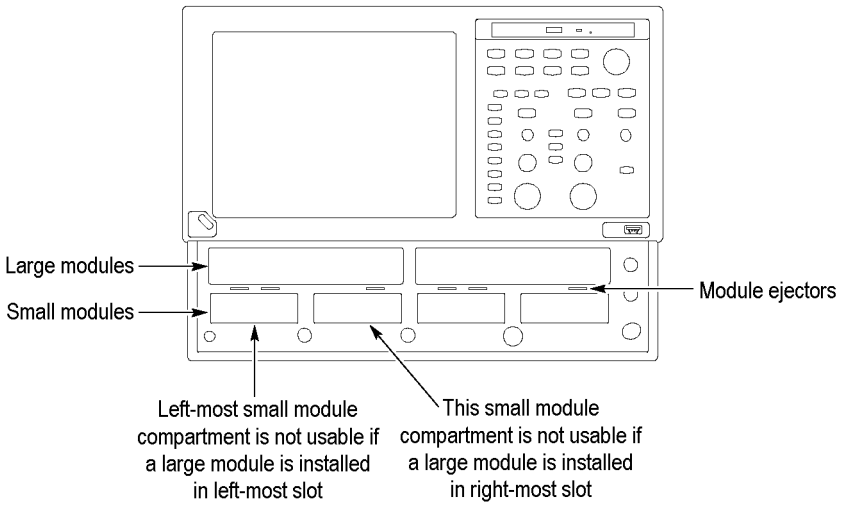


Figure 1: Sampling module compartments in 8000 Series

At least one sampling module must be installed in an instrument to sample signals.

NOTE. *Installing a large module in the left-most slot disables the left-most small module compartment. Installing a large module in the right-most slot disables the small module compartment that is second from the left.*

Each instrument supports four large-compartment channels, two per sampling module, and eight small-compartment channels, two per sampling module. Eight of the ten channels are usable at one time.

Electrostatic Discharge

To prevent electrostatic damage to the main instrument and sampling modules, follow the precautions described in this manual and the manuals that come with your instrument/modules.

Circuitry in the sampling module is very susceptible to damage from electrostatic discharge or from overdrive signals. Be sure to only operate the sampling module in a static-controlled environment. Be sure to discharge to ground any electrostatic charge that may be present on the center and outer connectors of cables before attaching the cable to the sampling module.

Know your signal source. If it is capable of delivering overvoltages, it is safer to not depend on the signal source settings for protection, but instead use an external attenuator that protects the input from the worst-case conditions. For example, for a 20 V maximum source connected to a 3 V maximum sampling module, use a 10X attenuator. Where possible, connect your cables to the signal source first, and to the sampling module second.

CAUTION. *To prevent damage from electrostatic discharge, install 50 Ω terminations on the sampling-module connectors before removing a sampling module from an instrument or when it is not in use. Store the sampling module in a static-free container, such as the shipping container. Whenever you move the sampling module from one instrument to another, use a static-free container to transport the sampling module.*

To prevent damage to the sampling module, discharge to ground any electrostatic charge that may be present on the center and outer conductors of cables before attaching the cable to the sampling module.

To prevent damage to the sampling module, do not create an ESD antenna by leaving cables attached to the sampling-module input with the other end of the cable open.

To prevent damage to the sampling module or instrument, never install or remove a sampling module when the instrument is powered-on.

Always use a grounded wrist strap (provided with your instrument) when handling sampling modules or making signal connections. Wear anti-static clothing and work in a static-free workstation when using sampling modules.

Use a Tektronix 80A02 EOS/ESD Protection Module if doing TDR work.

To prevent damage to the sampling module or instrument, do not apply a voltage outside the Maximum Input Voltage for your sampling module.

Static Controlled Workstation

For information on creating a static-controlled workstation, consult the Electronic Industries Association document *EIA-625; Requirements for Handling Electrostatic-Discharge-Sensitive (ESDS) Devices.*

You can use a Tektronix 80A02/80A09 EOS/ESD Protection Module to protect the sampling module from damage due to static discharge from circuit boards and cables. Use the 80A02/80A09 in applications where large static charges can be stored on the device under test, such as when testing TDR circuit boards or cables.

Refer to the documentation supplied with the 80A02/80A09 modules for proper installation and use.

Module Installation

CAUTION. *To prevent damage to the sampling module or instrument, never install or remove a sampling module when the instrument is powered on or when either input connector is unprotected.*

To install a sampling module for the TDS, CSA, DSA series oscilloscopes, first turn off the instrument using the front-panel On/Standby switch. Then place the sampling module in a compartment and slowly push it in with firm pressure. Once the sampling module is seated, turn the hold-down screw on the sampling module to tighten the sampling module into place. (See Figure 2.)

NOTE. *When removing your sampling module, first loosen the hold-down screw, and then use the sampling module ejector on the main instrument to eject the sampling module.*

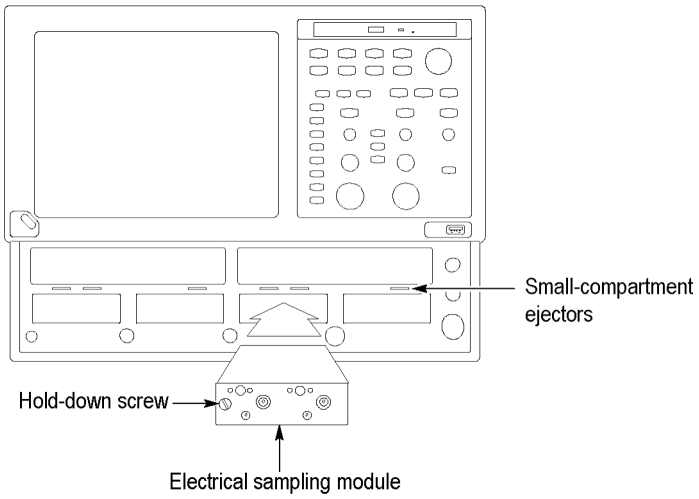


Figure 2: Installing a sampling module into a TDS, CSA, DSA oscilloscope

If you are installing a TSO8C17 or TSO8C18 optical module into a TSO820 oscilloscope, see the *8 Series Sampling Oscilloscope Installation and Safety Instructions* or the *8 Series Sampling Oscilloscope and TSOVu Application Help* at www.tek.com/manuals for detailed installation instructions.

CAUTION. *Do not hot swap TSO8C17 or TSO8C18 modules. Installing or removing these modules into/from the TSO820 mainframe with the power on will damage the modules. To avoid damage, turn off the power before installing or removing a module.*

Compensation

After installing a sampling module or after moving a sampling module from one compartment to another, you should run compensation from the Utilities menu to ensure the instrument meets it specifications. Also run a compensation (accessed from the Utilities menu) when doing the following:

- Installing an 80E00 sampling-module extender between the instrument and an 80E00 sampling module, where none was used before.
- Removing an 80E00 sampling-module extender between the instrument and an 80E00 sampling module, where one had been used before.
- Exchanging an extender for one of a different length.

For instructions on running a compensation, see *Optimizing Measurement Accuracy* in the Help for your main instrument.

Connecting optical signals

CAUTION. *To prevent loss of optical power or damage to the optical connectors, keep the connectors clean at all times. Check that all connectors, jumpers, and protective caps are clean before connecting them to the module.*

Do not drop an optical module, as doing so can cause damage and misalignment of the photodiode optical assembly.

Optical modules use a universal connector interface (UCI) that allows use of many standard fiber-optic female connector styles. Some of the standard UCI interfaces supported are FC, ST, SC, and DIN.

Attach the fiber optic cable with a suitable connector or a UCI Interface adapter to the optical input receptacle as follows:

1. Line up the key with the slot in the UCI adapter before inserting.
2. Firmly press the cable connector or adapter into the UIC interface ferrule until it reaches the stop.

CAUTION. *Do not insert the connector into the UCI adapter at an angle. Do not insert the connector and then rotate to line up the key with the slot. Either action may damage the UCI adapter.*

4. Firmly tighten the cable connector or the adapter shell. Tighten with finger pressure only.
5. To remove, loosen the cable connector or adapter shell.

CAUTION. *To avoid damaging the module optical input, maintain signal levels within optimal performance range, and avoid clipping, attenuate the input optical signal to the Absolute Maximum Nondestructive Optical Input (peak) specifications.*

Optical sampling modules may have dynamic ranges exceeded without obvious visual indication on the display because the overloaded photodetector signal output may still be within the dynamic range of the internal electrical sampler.

Cleaning optical connectors

1. Obtain the following equipment:
   - One compressed air can (Tektronix part number 118-1068-01).
   - A cleaning tool such as a FIS cassette cleaner (FI-6270), a FIS tape dispenser cleaner (FI-7111), or an Optipop pipe cleaner (F1-6364). Cleaning kits for optical connectors (such as the Tektronix Optical Connector Cleaner part number 020-2494-xx) are available from several suppliers.
2. Loosen the UCI adapter and remove it. This exposes the male fiber end-face behind the UCI connector.
3. Pull the pipe cleaner through the hollow female-to-female ferrule alignment tube inside the UCI adapter. Then use the compressed air to clean the tube of the UCI adapter.

CAUTION. *Do not blow compressed air into the female input of the UCI adapter when it is installed on the module.*

4. Advance the fiber cleaning cassette or tape-dispenser cleaner to expose an unused clean section of the lint-free, dry, cleaning surface.
5. Lightly drag the clean, dry, surface of the cleaning tool cloth against the male end-face of the fiber input for a short distance (a centimeter or two).
6. Place the UCI adapter back on the cleaned fiber end-face on the module.
7. When the module does not have a fiber cable attached to its input(s), attach the black dust-cap to prevent airborne contaminates from lodging in the female optical input.
8. Clean any male fiber end-face input fiber cable or device that you attach to the UCI input.

Failures, detection, and prevention

In order to achieve very high bandwidth performance in electronic circuits, parasitic capacitance, inductance, as well as series resistances, need to be kept to a minimum. Tektronix's high bandwidth sampling modules adopted the same philosophy with attention in every detail during design to ensure state of the art bandwidth performances. To achieve low parasitics, it is essential to minimize device dimensions and semiconductor junctions. Along with those miniaturizations came an increased vulnerability to accidental out of specification electrical stresses, such as EOS (electrical overvoltage stress) and ESD (electrostatic discharge).

Dominant failure mechanisms (EOS and ESD)

Historical experience in the ESD process has led to well established preventative measures to control ESD damage to devices. These include, but are not limited to:

- electrostatic safe workbench
- antistatic garment
- grounding wristband
- grounded footwear
- ionized air shower

Device damage due to EOS, however, is seldom discussed and often overlooked. Ignorance of this damage mechanism resulted in many sampling module failures seen in production line test areas where ESD preventative measures were rigorously followed.

EOS occurs where an electronic device is subjected to a voltage level higher than its designed maximum limit. Unlike ESD, where hundreds or often thousands of volts are involved, EOS damage can start at very low voltages. It is therefore important to recognize where the EOS sources are and then find a way to interrupt its damaging course.

EOS/ESD prevention

EOS and ESD failure mechanisms can be involved at times. However, the principle for prevention is relatively straightforward: electrically ground the device under test (DUT) immediately prior to engaging a sensitive measuring instrument, such as a sampling module, to the DUT.

For example, implementation of the following safeguards and procedure could be done in a PCB impedance testing area to prevent static damages to the TDR modules:

1. Place the TDR instrument and the PCB under test on only a properly grounded antistatic workbench (please contact a Tektronix Field Office if you need help to properly install an antistatic work environment).
2. Wear a grounded wrist strap and foot straps.
3. Wear only antistatic gloves or none at all.
4. Keep a ground cap on the TDR module input terminal whenever it is not in use.
5. Never hot plug/unplug a sampling module.
6. Momentarily ground the center conductor of the SMA cable before connecting it to a TDR input.
7. Momentarily ground the center conductor of the TDR probe before connecting it to the SMA cable attached to the TDR module.
8. Ground the probe tip or place the probe tip inside a grounded Faraday cage when not probing any DUT, but the probe is still connected to a TDR module.
9. Avoid personnel movement in the vicinity of a TDR test station to minimize the chance of induction charge transients.
10. Establish a momentary ground path to the DUT to fully discharge any accumulated static charges immediately before connecting a live TDR probe to it.
11. Do not swipe a live TDR probe across any isolated conductor unless that surface has been properly discharged.

The above simple procedure, when rigorously followed, can ensure an EOS/ESD damage free operation of the TDR modules for a long time.

Experience in customer production lines told us that due to human errors, EOS/ESD damages to sampling modules in the areas where the above procedures are “followed” can still happen and often at an alarmingly high level. This is because the EOS damages are cumulative and any accidental out of process mistakes are faithfully “experienced and recorded” by the TDR module’s sensitive input circuit. As those incremental damages accumulate, increased measurement errors result.

EOS/ESD protection for the system

To assist our production line customers in resolving these hard-to-avoid human errors causing EOS/ESD failures, Tektronix designed and marketed this integrated, intuitive EOS/ESD prevention system. The combination of the protection module and TDR probe seamlessly blends in a DUT discharging cycle just prior to the TDR module engagement to the DUT, without operator conscious intervention; like the foot switch systems (such as SIU800) do. The system also included a reference impedance line section along with a much improved net bandwidth (better impedance variation resolving power). Initial test of the prevention system on the production floor of a major PCB manufacturer has demonstrated excellent results. TDR failures due to static damages are essentially eliminated. Before the deployment of the prevention system, that customer had recorded over 100 failure incidences over the prior 12 months. After system deployment, reduced impedance testing down time and tremendous cost savings resulted for both the customer and Tektronix.

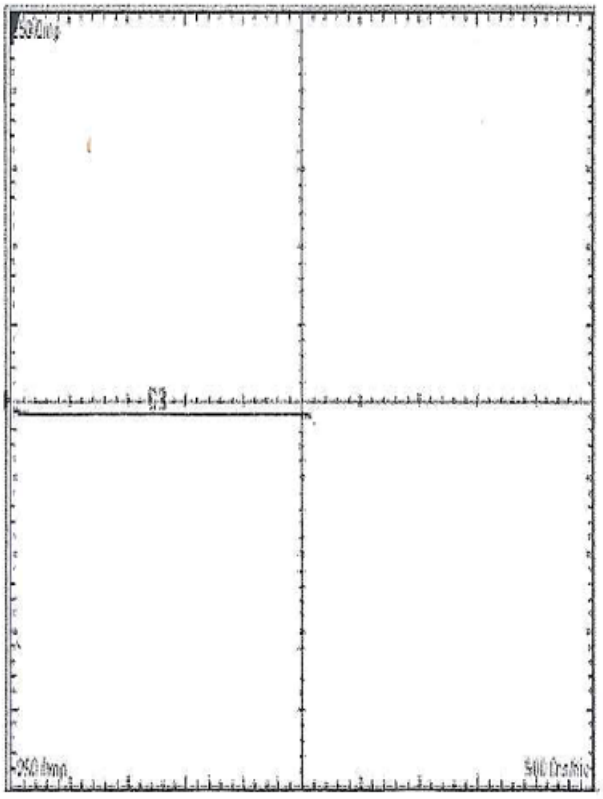
To assist production line customers who need high bandwidth differential TBS hand probes, Tektronix has introduced the P80318 18 GHz adjustable pitch, 100 Ω differential TDR hand probes that work with the protection module/device.

Detecting blown inputs

High bandwidth sampling modules are vulnerable to damage through ESD and EOS to the input due to their technology. Damage can occur instantaneously. Under most conditions, when EOS damage occurs the trace will be flat. It typically involves short period, high current discharge. Large offset or no response to input indicates a blown diode.

To check for damage of an 80E00 series sampling module if your instrument has TDR capability, use the following procedure. If checking a non-TDR sampling module, use a similar procedure as shown below, but use an external step source. The Tektronix part number 067-1338-00 is recommended.

1. Attach a 50 Ω termination to the channel input and perform a TDR measurement of the attached fitting.
2. Adjust the HORIZONTAL SCALE to 500 ns per division. This should display the TDR step from edge to edge. Display the step top at 40 mρ per division and check for flatness. If the top is bowed, sagged, hooked, or tilted, assume static has damaged the module and service is required. See following image.



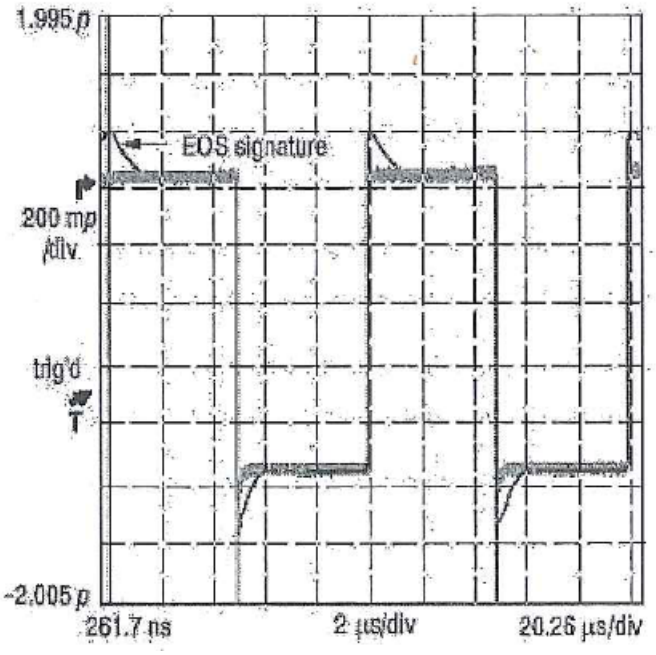
Verifying EOS damage

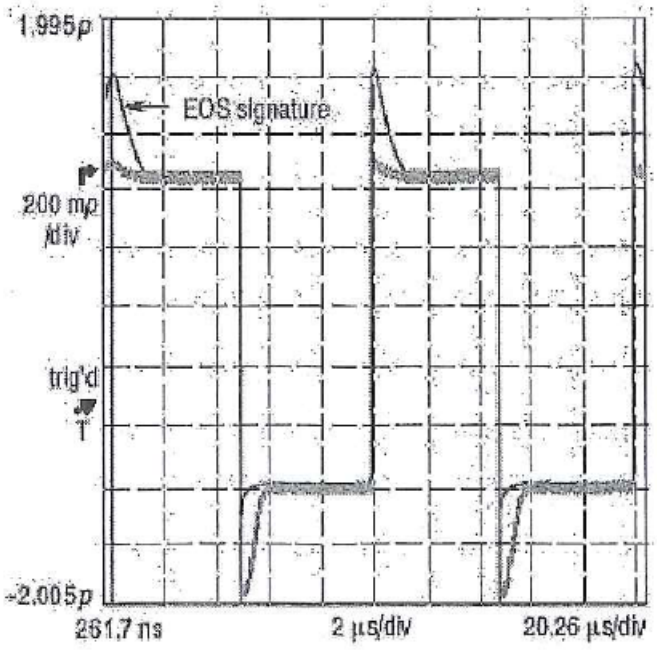
The following procedure can be used to identify heads that have EOS damage.

If the waveform top is bowed, sagged, hooked, or tilted, assume static has damaged the module and service is required. Figure 1 shows a typical waveform signature indicating EOS damage. Also be aware that EOS can be cumulative; that is, every time an EOS event occurs during testing, EOS damage can accumulate until there is even greater damage, as shown in the following figures. In this example, the percentage of overshoot is increased.

If checking for damage of an 80E04 sampling module and your instrument has TDR capability, us the following procedure. If checking a non-TDR sampling module, use a similar procedure as shown below, but use an external step source. The Tektronix part number 067-1338-00 is recommended.

1. Attach a 50 Ω termination to the channel input.
2. Select the TDR channel to turn it on.
3. Press the TDR preset.
4. Perform a TDR measurement.
5. Adjust the HORIZONTAL SCALE to 2 µs per division. The vertical setting should be 200 mρ, as shown in the illustrations. This should display the entire TDR step from edge to edge. Display the step top at 40 mρ per division and check for flatness. The top of the waveform should be flat.





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