



**TIVM Series  
IsoVu™ Measurement System  
User Manual**



071-3495-00





**TIVM Series  
IsoVu™ Measurement System  
User Manual**

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- In North America, call 1-800-833-9200.
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# 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 page vii, *Service safety summary*.)

## 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

**Connect and disconnect properly.** Do not connect or disconnect sensor tip cables, test leads, or accessories while they are connected to a voltage source. Use only test leads and accessories 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 of a product or accessory.

Do not apply a potential that exceeds the maximum rating.

**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.

Before use, inspect accessories for mechanical damage and replace when damaged. Do not use them if they are damaged, or if there is exposed metal.

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

Use only specified replacement parts.

**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.**

**Keep product surfaces clean and dry.** Remove the input signals before you clean the product.

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

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

### Sensor tip cables

Maintain safe clearance from the sensor head and sensor tip cable while connected to the energized circuit as recommended in this manual.

Remove the sensor tip cable and adapters from the test circuit when not in use.

Leave the sensor tip cable connected to the sensor head when not in use.

Use only correct Measurement Category (CAT), voltage, temperature, altitude, and amperage rated sensor tip cables and accessories for any measurement.

**Beware of high voltages.** Understand the voltage ratings for the product you are using and do not exceed those ratings. It is important to know and understand the maximum measurement voltage rating of the product. The voltage rating depends

on the instrument and your application. Refer to the Specifications section of the manual for more information.



---

**WARNING.** *To prevent electrical shock, do not exceed the maximum measurement or maximum voltage category.*

---

**Connect and disconnect properly.**



---

**CAUTION.** *To avoid damage to the equipment, de-energize the test circuit before connecting or disconnecting the sensor tip cable.*

---

## Service safety summary

The *Service safety summary* 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.

## 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.*

---

**Isolated, electrically floating.** The terms *isolated*, *electrically floating*, and *galvanically isolated* are used in this document to indicate a measurement where there is no direct conduction path to earth ground.

## 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:



CAUTION  
Refer to Manual



WARNING  
High Voltage

# Preface

This document provides information for installing and using the Tektronix TIVM Series IsoVu Measurement System. The measurement system offers a galvanically isolated measurement solution for accurately resolving high bandwidth, low voltage differential signals up to  $\pm 50$  Vpk in the presence of large common mode voltages with the best in class common mode rejection performance across its bandwidth.

## Key features

- New IsoVu technology - galvanically isolated, floating, measurement system
  - Bandwidth from DC to 1 GHz
  - $> 120$  dB (1 million to 1 common mode rejection ratio) from DC to 100 MHz and 80 dB (10,000 to 1) at 1 GHz
- Differential voltages up to  $\pm 50$  Vpk (depending on sensor tip)
- Large common mode voltage range up to 2 kV

## Laser certification

CLASS 1 LASER PRODUCT

This product complies with 21 CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice No. 50, dated June 24, 2007.



**CAUTION.** *Use of controls or adjustments for performance of procedures other than those specified herein may result in hazardous radiation exposure.*

# Product description

The Tektronix TIVM Series IsoVu Measurement System offers a completely galvanically isolated (optical isolation) system. The system consists of a sensor tip cable, a sensor head, a controller, and a TekVPI interface as shown in the following figure. Hazardous voltages in the sensor head are completely isolated from the controller and oscilloscope by optical fiber cables.

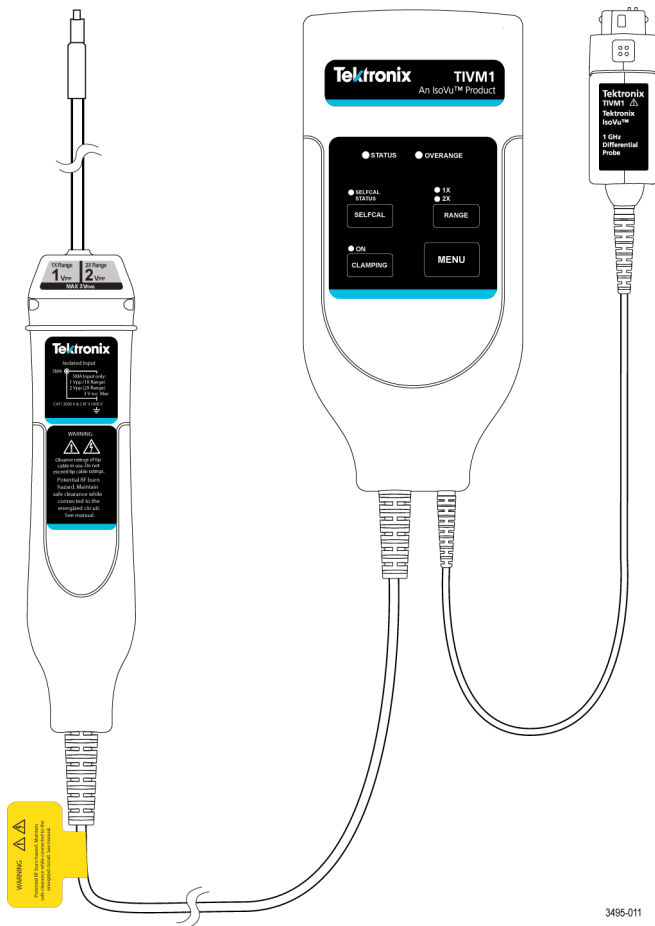


Figure i: TIVM Series IsoVu Measurement System

- Comp box** The TekVPI compensation box (Comp box) connects the measurement system to one of the input channels on the oscilloscope. Power is supplied to the measurement system through the TekVPI interface of the oscilloscope.
- Controller** The controller connects to the oscilloscope through a coaxial cable and the Comp box. Buttons and indicators on the controller provide a means for controlling the measurement system and indicating the overall status.



<b>Sensor head</b>	The sensor head provides an interface between the device-under-test (DUT) and the controller. It contains an electro-optic converter that converts the electrical signal from the sensor tip cables to an optical signal sent to the controller.
<b>Sensor tip cables</b>	Different sensor tip cables are available to connect the measurement system to the DUT. The sensor tip cable consists of an SMA connector that connects to the sensor head; two screws to secure the sensor tip cable to the sensor head; the other end of the sensor tip cable connects to the DUT through an MMCX connector and optional adapters.

## Models

The TIVM Series IsoVu Measurement System includes the following models:

- TIVM1. Tektronix IsoVu 1 GHz Medium Voltage with 3 m cable
- TIVM1L. Tektronix IsoVu 1 GHz Medium Voltage with 10 m cable
- TIVM05. Tektronix IsoVu 500 MHz Medium Voltage with 3 m cable
- TIVM05L. Tektronix IsoVu 500 MHz Medium Voltage with 10 m cable
- TIVM02. Tektronix IsoVu 200 MHz Medium Voltage with 3 m cable
- TIVM02L. Tektronix IsoVu 200 MHz Medium Voltage with 10 m cable

## Supported oscilloscopes

The measurement system can be used with the following Tektronix oscilloscopes. For oscilloscopes not included in this list, contact your local Tektronix representative.

- MDO3000 series
- MSO/DPO4000B series
- MDO4000B/C series
- MSO/DPO5000B series
- DPO7000C series

In addition to the above oscilloscopes, the measurement system can also be used with the following oscilloscopes with a TCA-VPI50 adapter.

- MSO/DPO70000C series
- MSO/DPO70000DX series
- DPO70000SX series



# Operating information

## Accessories

This section lists the standard and optional accessories available for the measurement system.

### Standard accessories

Table 1: Standard accessories

Accessory	Tektronix part number
IsoVu product carrying case, soft case	016-2108-xx
IsoVu accessories carrying case, soft case	016-2110-xx
Solder aid for 0.062-inch (1.57 mm) pitch square pins (0.016 - 0.018-inch (0.4 - 0.46 mm) square pin installation tool)	003-1946-xx
5X Sensor tip cable	IVTIP5X
25X Sensor tip cable	IVTIP25X
5/16-inch SMA wrench/driver tool	003-1947-xx
Probe tip adapter (blue), MMCX to 0.1-inch (2.54 mm) square pin (0.025-inch (0.635 mm) square pins)	131-9717-xx
Probe tip adapter (white), MMCX to 0.062-inch (1.57 mm) square pin (0.016 - 0.018-inch (0.4 - 0.46 mm) square pins)	131-9677-xx
DUT Interface pin kit with (qty. 20) 0.018-inch (0.46 mm) round solder-in pins	020-3169-xx
Flexible tripod with quick release	352-1171-xx
Flexible tripod feet, 3 each	344-0693-xx
Probe tip tripod support with living hinge, 2 each	352-1170-xx
Certificate of traceable calibration	—
Data calibration report	—

**Optional accessories** Additional accessories, such as other sensor tip cables are available. The following table lists the optional accessories.

**Table 2: Optional accessories**

<b>Accessory</b>	<b>Tektronix part number</b>
1X Sensor tip cable	IVTIP1X
10X Sensor tip cable	IVTIP10X
50X Sensor tip cable	IVTIP50X

## Operating considerations

Read this section before installing your measurement system to be aware of the operating requirements and clearance requirements including possible hazardous areas when the measurement system is connected to the DUT.

### **Measurement system handling best practices**

The measurement system consists of quality parts and should be treated with care to avoid damage or degrading the performance due to mishandling. Consider the following precautions when handling the fiber-optic cables and sensor tip cables:

- Do not crush, crimp, or sharply bend the fiber-optic cable. Avoid making loops in the fiber-optic cable smaller than 5 inches (12.7 cm).
- Do not twist the fiber-optic cable; twisting the cable will stress the optical fibers.
- Do not allow kinks or knots to develop in the fiber-optic cable.
- Avoid putting tension on the fiber-optic cable.
- Do not pull or jerk the fiber-optic cable, especially when kinks or knots are present.
- Do not drop the sensor head or controller assembly since damage and misalignment of the internal optical components can result.
- Avoid over-bending the sensor tip cables; do not exceed the minimum bend radius of 2.0 inches (5.1 cm).
- Avoid crushing the cables by accidentally running over the cable with a chair wheel or by dropping a heavy object onto the cable.
- Never support the weight of the sensor head or controller by the fiber-optic cable.
- Store the measurement system in the supplied carrying case when not in use.

**Environmental requirements**

The following tables describe specifications and maximum operating environmental ratings for the measurement system when connected to a DUT and a Tektronix oscilloscope.

**Table 3: Input specifications**

Feature	Description
Common mode	1000 V <sub>rms</sub> , CAT II
	2000 V peak, CAT I (expected transient voltage 2500 V peak)
Differential mode	Sensor tip cable dependent (See the Sensor tip cable voltage rating below.)

**Table 4: Environmental considerations**

Feature	Description
Temperature	
Controller	
Operating	0 °C to 40 °C (32 °F to 104 °F)
Non-operating	-40 °C to 70 °C (-40 °F to 158 °F)
Sensor head	
Operating	0 °C to 70 °C (32 °F to 158 °F)
Non-operating	-40 °C to 70 °C (-40 °F to 158 °F)
Sensor tip cables/adapters	
Operating and non-operating	-40 °C to 85 °C (-40 °F to 185 °F)
Humidity	
Controller	
Operating	5% to 85% RH (Relative Humidity), at up to 40 °C (104 °F), non-condensing
Non operating	5% to 85% RH (Relative Humidity), at up to 40 °C (104 °F) 5% to 45 % RH above 40 °C (104 °F) up to 70 °C (158 °F), non-condensing
Sensor head	
Operating	5% to 80% RH (Relative Humidity), at up to 40 °C (104 °F) 5% to 45 % RH above 40 °C (104 °F) up to 70 °C (158 °F), non-condensing
Non operating	5% to 85% RH (Relative Humidity), at up to 40 °C (104 °F) 5% to 45 % RH above 40 °C (104 °F) up to 70 °C (158 °F), non-condensing

**Table 4: Environmental considerations (cont.)**

Feature	Description
Sensor tip cables/adapters	
Operating	5% to 80% RH (Relative Humidity), at up to 40 °C (104 °F) 5% to 45 % RH above 40 °C (104 °F) up to 85°C (185 °F), non-condensing
Non operating	5% to 85% RH (Relative Humidity), at up to 40 °C (104 °F) 5% to 45 % RH above 40 °C (104 °F) up to 70 °C (158 °F), non-condensing
Altitude	
Operating	3000 m (9843 ft.)
Non operating	12,000 m (39370 ft.)

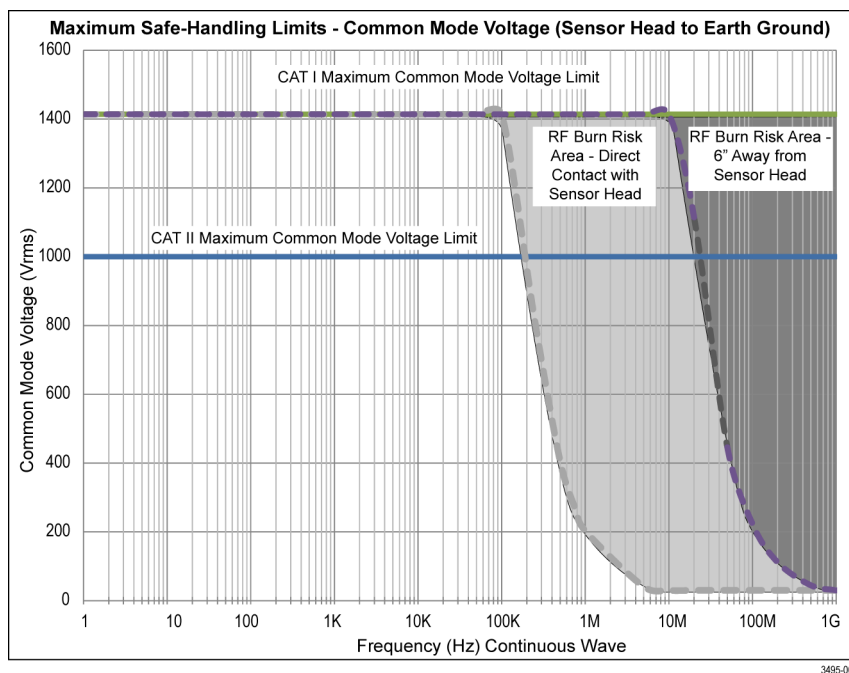
#### Clearance requirements

The unique common mode voltage range of the measurement system allows it to be used in the presence of high frequency/high voltage common mode signals. It is important to observe all precautions while using this product.



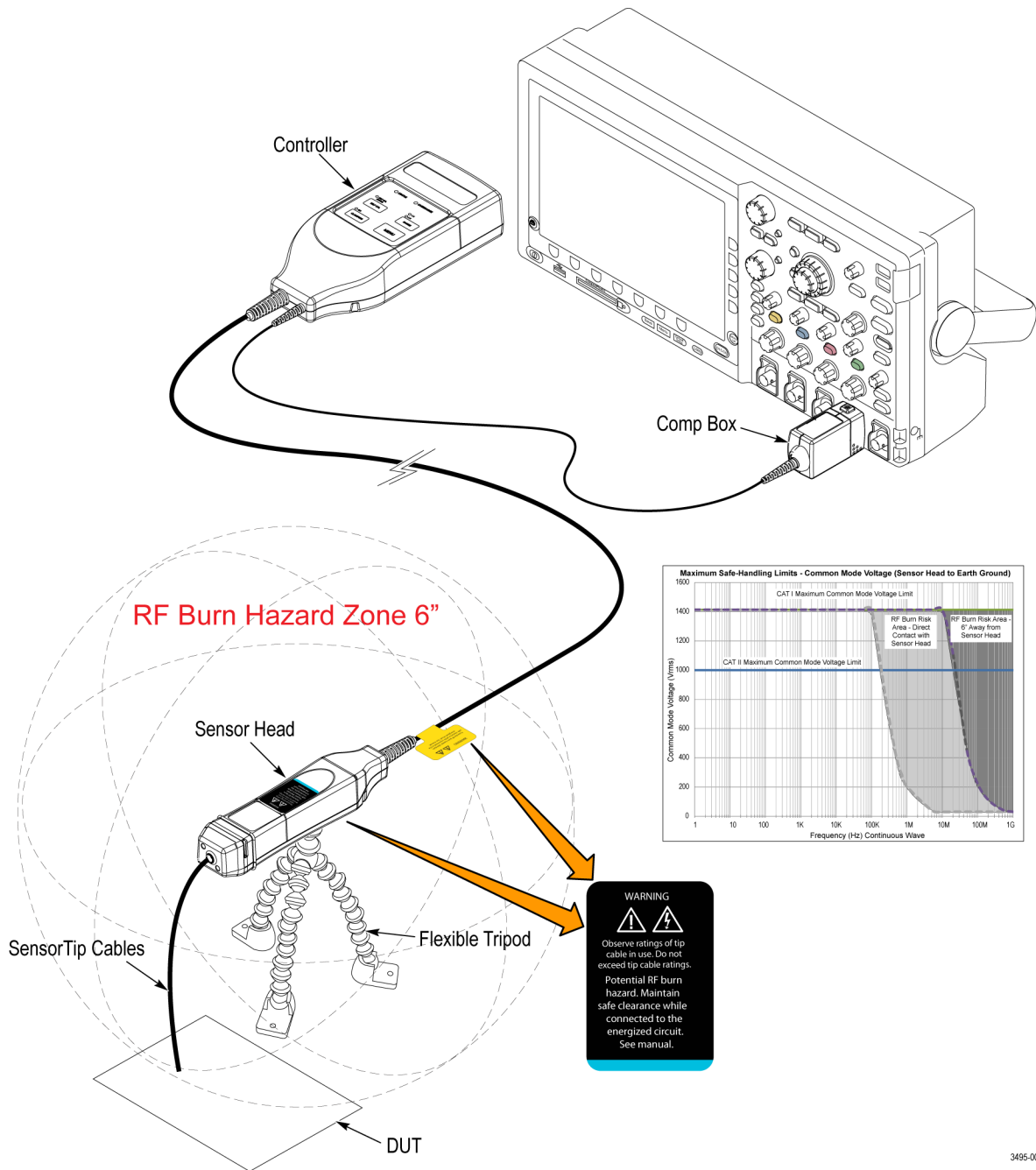
**WARNING.** *RF burns can occur while using this measurement system. Anyone making measurements that might come within the RF burn regions indicated in the following figure should be familiar with the hazards of working with signals in these regions and take appropriate action, such as RF shielding for the DUT.*

While measuring high frequency common mode signals, there is a risk of RF burns. Refer to the following derating curve to identify the danger areas. Measuring common mode signals within the light gray area can result in RF burns while directly contacting the sensor head. Measuring common mode signals within the dark gray shaded area can result in RF burns when within 6 inches (15.25 cm) of the sensor head.



**Figure 1: Maximum safe handling limits for common mode voltages between the sensor head and earth ground.**

The following figure shows the components of the measurement system and the potential RF burn area when working with hazardous voltages.



3495-002

Figure 2: RF burn hazard zone around the sensor head



## Controls and indicators

**Controller** The following figure shows the indicators and buttons on the controller; their functions are described in the following table.

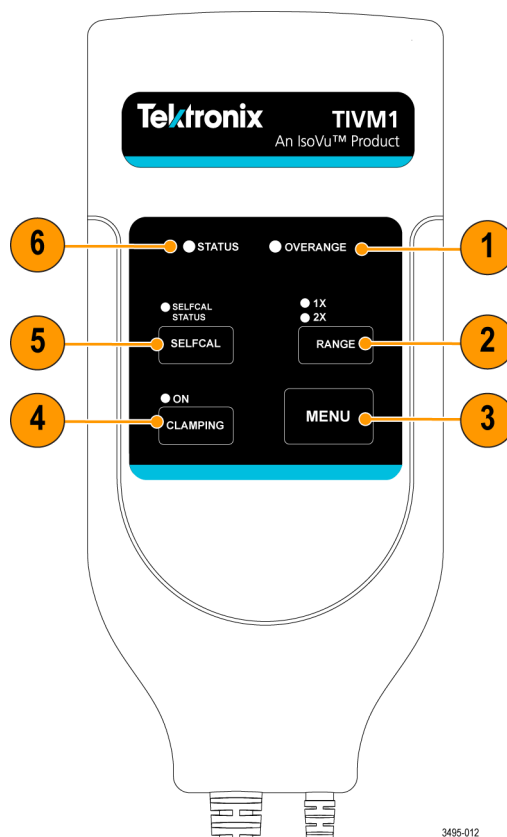


Figure 3: Controller indicators and buttons

Table 5: Controller indicators and buttons

Item	Description
1	OVERRANGE Indicator. This red LED indicates if the DC/low frequency differential voltage applied to the sensor head or attached sensor tip cable has exceeded the maximum specified input voltage levels.
2	RANGE indicator. The two LEDs indicate the differential input range setting. RANGE button. Push this button to toggle between one of two differential input voltage ranges.
3	MENU button. Push this button to view the Probe Control menu on the oscilloscope display.

**Table 5: Controller indicators and buttons (cont.)**

<b>Item</b>	<b>Description</b>
4	CLAMPING indicator. This LED indicates whether the output clamping is enabled.
	CLAMPING button. Push this button to enable or disable the output clamping feature.
5	SELF CAL indicator. This LED indicates the self calibration status.
	■ Solid green. The self calibration has passed.
	■ Flashing orange. The self calibration is in progress.
	■ Solid red. The self calibration has failed.
	■ Solid Orange. The self calibration has not been run or is questionable.
	SELF CAL button. Push this button to start the self calibration routine.
6	STATUS indicator. This LED indicates the status of the measurement system:
	■ Solid green. The unit has powered on and passed the power-on self tests and is in normal operation.
	■ Flashing green. The unit has not completed the power-up sequence. This is typically due to a communication fault between the host oscilloscope and the IsoVu unit. Disconnect the TekVPI comp box and then reattach the comp box.
	■ Solid or flashing red. Error condition that requires the unit to be sent to Tektronix for service.
	■ Flashing red/yellow. The unit has failed the power on self tests. Cycle the power; if the problem persists, the unit needs to be sent to Tektronix for service.

**Sensor head** Labels on the sensor head provide high-level specifications for connecting to the DUT. They also provide reminders of the potential RF burn hazards while connected to the DUT.



Figure 4: Labels on the sensor head

**Sensor tip cables** Each sensor tip cable has a set of labels on the top and bottom. The top labels provide reminders of the maximum differential input voltage range for each tip cable. The bottom labels include the name of the tip cable and the differential input resistance and capacitance for the tip cable (differential loading).

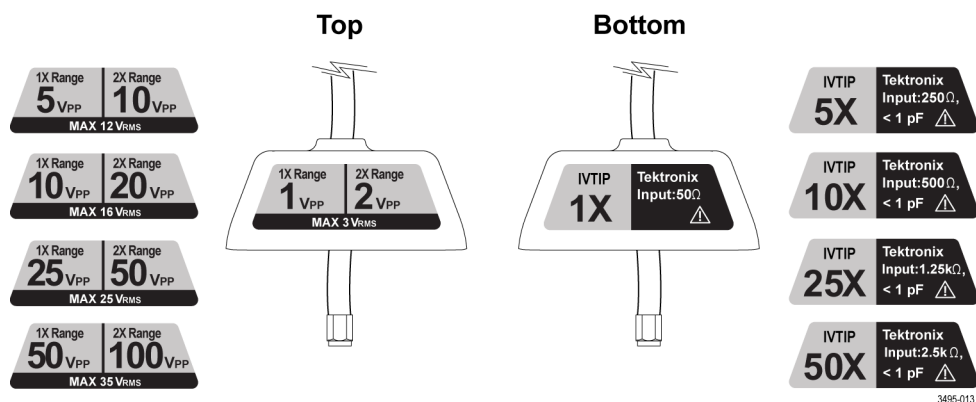


Figure 5: Sensor tip cable top and bottom labels

## Connecting to a circuit



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**WARNING.** *This measurement system contains laser sources; exposing these laser sources may cause laser exposure. Except for the sensor tip cables on the sensor head, do not remove any plastic or metallic covers from the sensor head or controller or attempt to disassemble the product.*

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**WARNING.** *Do not connect the measurement system to an energized circuit to avoid the risk of shock. Always de-energize the circuit-under-test before installing or removing the tip cable from the circuit-under-test.*

---



---

**WARNING.** *To avoid the risk of electrical shock or RF burns while the DUT is energized, do not touch the sensor head or sensor tip cable while taking measurements. Always keep a six (6) inch (15.25 cm) clearance from the sensor head during the measurement. (See Figure 2 on page 6.)*

*Be sure to check the maximum ratings and derating curve for more information on the RF burn hazard zone. (See Figure 1 on page 5.)*

---



---

**CAUTION.** *To avoid possible damage to the equipment, do not connect the coaxial (common) shield of the sensor tip cable or SMA input to the high impedance portion of a circuit. The additional capacitance can cause circuit damage. Connect the coaxial (common) shield to the low impedance section of the circuit.*

---

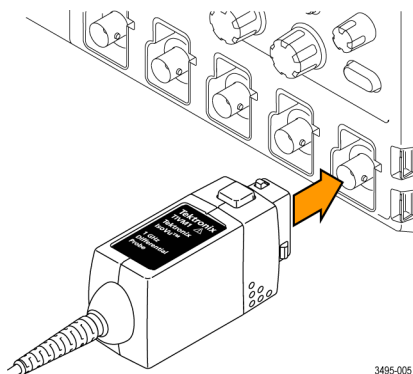
---

**NOTE.** *Touching the sensor head or sensor tip cable when measuring a high frequency, high voltage common mode signal increases the capacitive coupling and can degrade the common mode loading on the circuit-under-test.*

---

The following steps describe the process for connecting the measurement system between a Tektronix oscilloscope and the DUT.

1. Verify the DUT is not connected to an energized circuit.
2. Connect the Comp box to one of the channels on the oscilloscope.



**Figure 6: Connect the Comp box to the oscilloscope**

3. Refer to the following figure and install the sensor tip cable to the sensor head.
  - a. Line up the sensor tip cable with the sensor head.

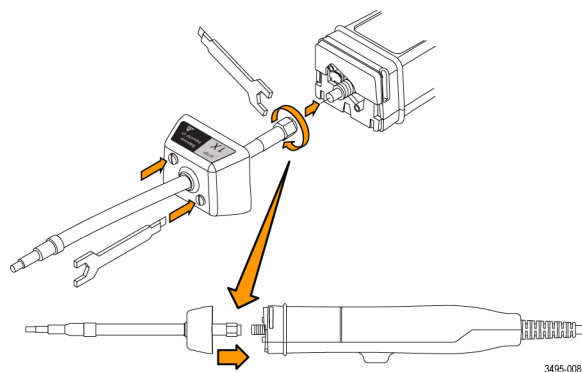
Take care to avoid bending or twisting the sensor tip cable assembly during this process.

- b. Connect the SMA connector of the sensor tip cable to the sensor head. Use the accessories wrench to tighten the SMA cable to 4 to 5-in lbs.

Use the adjustment tool that was shipped with your system.

- c. Press the sensor tip cable housing against the sensor head and then tighten the two screws to 3 to 5-in lbs.

Use the adjustment tool that was shipped with your system.



**Figure 7: Connecting the sensor tip cable to the sensor head**

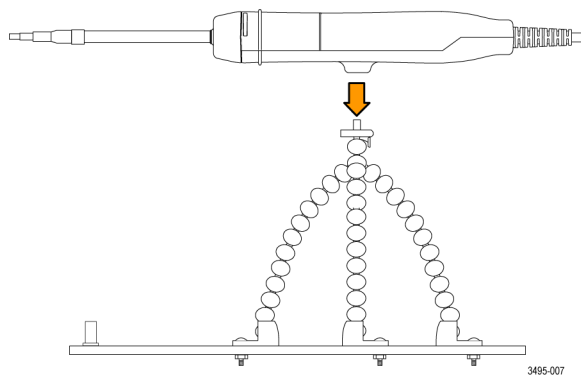
4. Connect the sensor head to the flexible tripod or a similar support.

This support keeps the sensor head steady reducing the potential mechanical stresses at the electrical connection point of the DUT. The support also keeps the sensor head away from surrounding circuits and conductive objects to minimize the parasitic capacitive coupling to these surroundings.

---

**NOTE.** The mating thread in the sensor head is UNC $\frac{1}{4}$ -20. If you use a different support, make sure that mating thread is UNC $\frac{1}{4}$ -20.

---



**Figure 8: Connect the sensor head to the flexible tripod**

---

**NOTE.** To obtain the most accurate measurement, allow the measurement system to warm up for 20 minutes. Then perform the self calibration before connecting the tip cable to the DUT and taking the measurement.

---

5. Connect the MMCX end, of the sensor tip cable to an MMCX connector on the DUT or to a square pin adapter on the DUT. The adapters connect to square pins with either 0.100-inch (2.54 mm) spacing or 0.062-inch (1.57 mm) spacing. (See Figure 28 on page 38.)
6. Set up the controls on the oscilloscope.
7. Apply power to the DUT to take the measurement.

## Self calibration

Press the SELF CAL button on the controller to adjust the operating point of the measurement system for the current range and clamp setting. (This function is not available in the Probe Setup menu of the oscilloscope.)

---

**NOTE.** Make sure there is no differential voltage present at the sensor tip cable when performing the self calibration.

---

When you power on the measurement system, the SELF CAL status indicator on the controller is orange, indicating that the operating point of the measurement system has not been optimized. As a result, the accuracy of the measurement system might be degraded. The SELF CAL sequence should always be run on the system after it is first powered on and has warmed up for 20 minutes. After pushing the SELF CAL button, the indicator blinks orange during the self calibration process; it turns solid green when the operation completes or solid red when the operation fails.

There are situations when further self calibration is required. The SELF CAL status indicator turns orange to indicate when this is necessary:

- The measurement system is first attached to the oscilloscope.
- Changes are made to the range (1X|2X) or clamp (ON|OFF) setting.
- The temperature in the sensor head changes more than 10 °C.
- The internal compensation adjustments have shifted outside their normal operating ranges.
- The sensor tip cable is changed.

## Programming

Users wanting to initiate the self calibration through the programmatic interface must configure the measurement system to perform a self calibration every time it receives the AutoZero command. To link these functions, hold the MENU button down and momentarily press the SELF CAL button. The OVERRANGE indicator should blink red twice. This mode is non-volatile, and it also changes the operation of the AutoZero button in the Probe Setup menu of the oscilloscope. Restore the original operation by repeating the MENU-SELF CAL button pushes. In this case the OVERRANGE indicator will blink once.

## AutoZero

When the displayed waveform is not centered correctly (for example, due to a small DC offset error), you might need to press the AutoZero button in the Probe Setup menu of the oscilloscope. This might be necessary for the first time after the self calibration operation has completed. Make sure there is no differential signal present at the sensor tip cable.

## Menu button

Press the MENU button on the controller to view the Probe Setup menu on the oscilloscope, similar to the following figure.

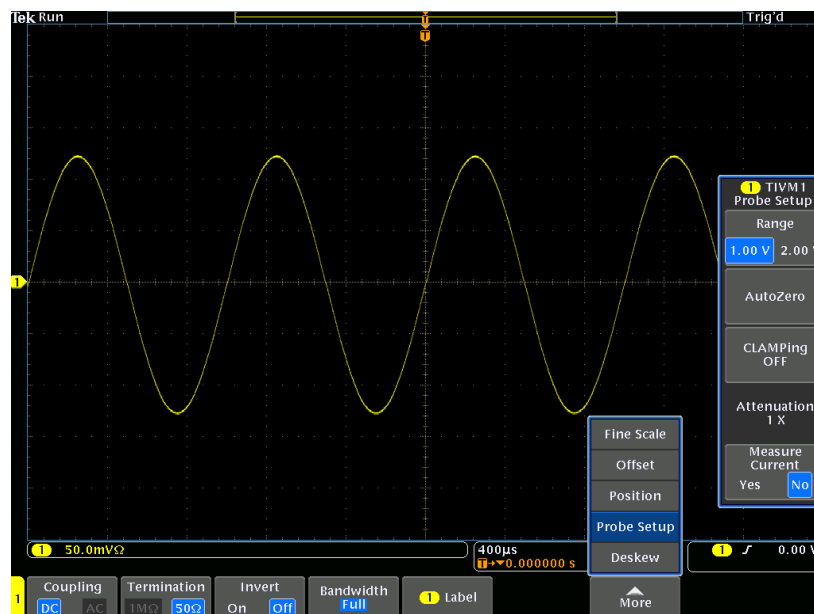


Figure 9: Probe Setup menu

Use the buttons on the oscilloscope to change the probe setups. Some of the functions are the same as pushing the buttons on the controller, such as turning clamping on or off, or setting the input ranges.



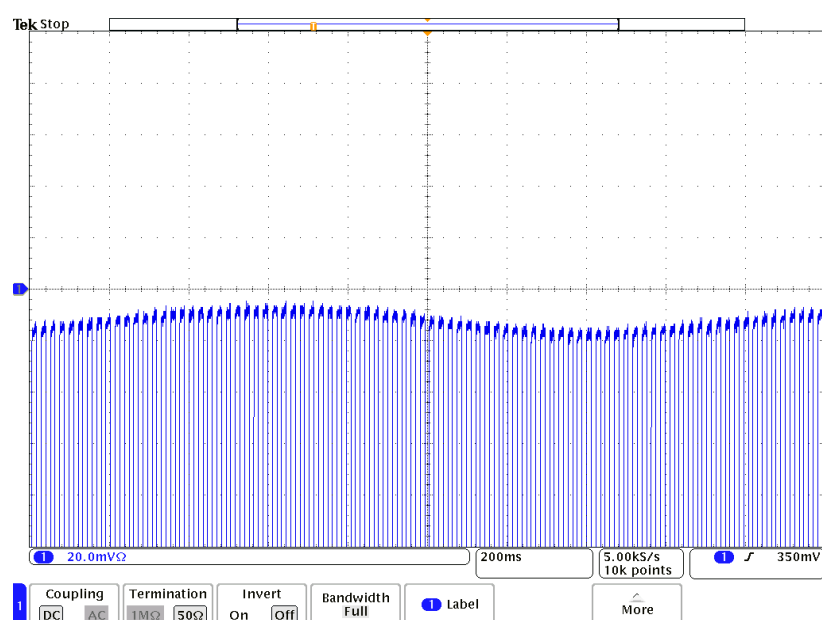
## Offset correction

The measurement system uses state-of-the-art technology that allows the DUT to be totally isolated from the oscilloscope. This results in a very large common mode rejection ratio (CMRR) and lets you see small signals that would otherwise be obscured by the high common mode interference.

The TIVM Series products implement an offset correction algorithm to minimize any drift in the system due to changes in temperature or fiber movement. The offset correction algorithm maintains a constant DC level for the displayed on-screen signal.

One of the components used for offset correction is a digital low-pass filter. Normally, the frequency of the signal is high enough that the operation of the filter is transparent. However, at low frequencies special care must be taken to prevent aberrations from being introduced.

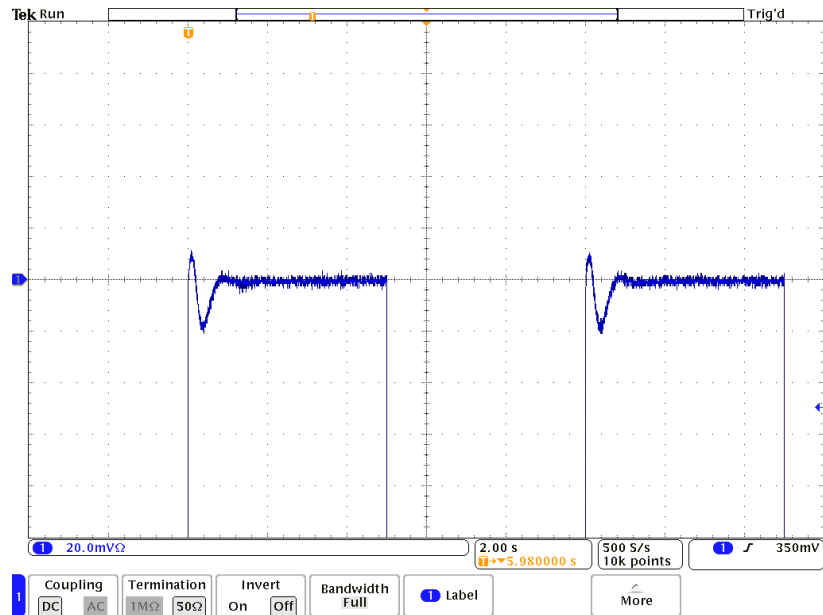
When attempting to capture a signal that has a frequency near 43.5 Hz, 87.0 Hz, or 130.5 Hz, the display might show aliasing. If you cannot avoid these frequencies, the offset correction should be disabled. The sample rate of the digital filter was selected to not alias at 50 Hz or 60 Hz.



**Figure 10: Digital filter aliasing**

To disable the offset correction algorithm, hold down the MENU button on the controller and momentarily press the CLAMPING button. The OVERRANGE indicator on the controller should blink two times. To re-enable the correction, repeat the operation; the OVERRANGE indicator should blink once. Turning off the correction is temporary; when the measurement system is removed/re-attached, the offset correction is re-enabled.

Another source of aberrations is introduced when the signal is below the cutoff frequency of the digital filter (5.0 Hz). The following figure shows a close-up view of the front edge of a 0.1 Hz 800 mV<sub>p-p</sub> square wave. These aberrations are also created by the digital filter.



**Figure 11: Digital filter aberrations (about 2.5% of V<sub>p-p</sub>)**

The following figure shows the aberrations after the offset correction has been disabled. When the offset correction is disabled, the system no longer corrects for long-term drift due to temperature change and fiber movement.

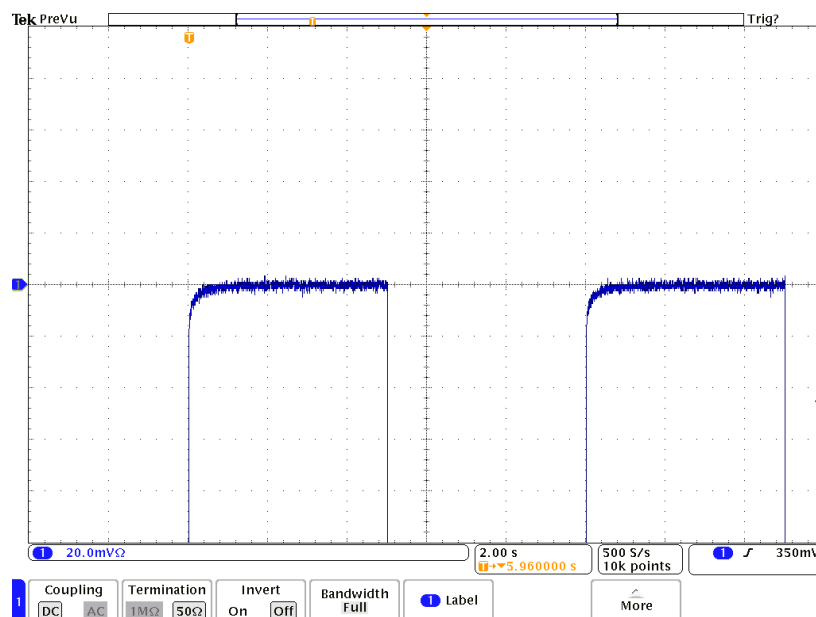


Figure 12: Digital filter aberrations after disabling offset correction

## 1X/2X Range

The top label of each sensor tip cable (IVTIP1X, IVTIP5X, IVTIP10X, IVTIP25X, IVTIP50X) shows the dynamic range in peak-to-peak volts as shown in the following figure.

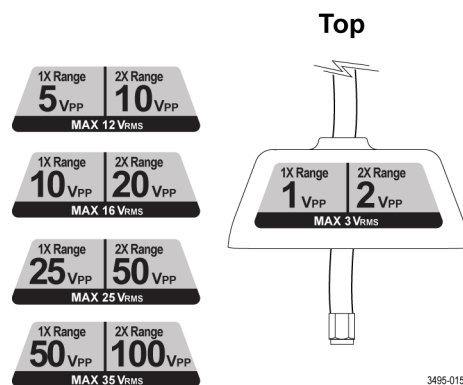


Figure 13: Top sensor tip labels

For example, the IVTIP5X tip has a dynamic range of  $5 V_{p-p}$  when the 1X Range is selected. This means that you can display a signal with a  $\pm 2.5 V$  differential voltage. When the 2X Range is selected, the dynamic range increases from  $5 V_{p-p}$  to  $10 V_{p-p}$  ( $\pm 5.0 V$ ). Refer to the *Linear differential input voltage range* in the specifications table for more information.



---

**CAUTION.** *To avoid damaging the probe, do NOT exceed either the RMS OR Peak Voltage ratings. The Maximum Non-Destruct Voltage limits (RMS and Peak Voltage) do not increase when the 2X Range is selected. For the IVTIP5X, the  $12 V_{rms}$  and  $\pm 21.5 V_{pk}$  limits are the same for the 1X or 2X Range.*

---

## Auto Range

By default, the MSO/DPO5000, DPO7000, and MSO/DPO70000 Series Oscilloscopes select the 1X or 2X Range automatically when you change the V/div setting. This hides the complexity of selecting the range from casual users. However, there are combinations of Range and V/div settings that cannot be reached when Auto Range is selected. For these situations, select Manual Range when full flexibility is desired.

## Selecting a sensor tip cable



**CAUTION.** Avoid over-voltage conditions that can damage or degrade the sensor head input termination by selecting the wrong sensor tip cable. The sensor head SMA input is a 50  $\Omega$  terminated input. Selecting the correct sensor tip cable attenuation factor is crucial to ensure that the sensor head input termination is not degraded or damaged by an over-voltage condition. Select the sensor tip cable that will provide the highest attenuation possible for the signal being measured. This also provides the highest differential impedance to the circuit-under-test.

When selecting a sensor tip cable for a particular application, consider the following questions:

- What is the maximum RMS/Peak Voltage at the test point being measured (for example, under a fault condition)?
- What is the minimum differential loading (input resistance) that my circuit can tolerate?
- How large of a signal do I want to display at one time on the oscilloscope?
- What sensitivity do I need (for example, the minimum V/div setting)?

The following table will help you select the correct sensor tip. Start at the top of the table and work down. Choose the first tip that meets all of your criteria.

**Table 6: Sensor tip selection table**

Sensor tip	Differential input specifications				
	Most sensitive V/div setting <sup>1</sup>	Linear voltage range <sup>2</sup>	Maximum non-destruct voltage (RMS)	Maximum non-destruct voltage (Peak)	Differential input resistance
IVTIP50X	50 mV/div	$\pm 50$ V (100 V <sub>p-p</sub> )	35 V <sub>rms</sub>	200 Vpk	2.5 k $\Omega$
IVTIP25X	25 mV/div	$\pm 25$ V (50 V <sub>p-p</sub> )	25 V <sub>rms</sub>	107.5 Vpk	1.25 k $\Omega$
IVTIP10X	10 mV/div	$\pm 10$ V (20 V <sub>p-p</sub> )	16 V <sub>rms</sub>	43 Vpk	500 $\Omega$
IVTIP5X	5 mV/div	$\pm 5$ V (10 V <sub>p-p</sub> )	12 V <sub>rms</sub>	21.5 Vpk	250 $\Omega$
IVTIP1X	1 mV/div	$\pm 1$ V (2 V <sub>p-p</sub> )	3 V <sub>rms</sub>	4.3 Vpk	50 $\Omega$

<sup>1</sup> On 1X range

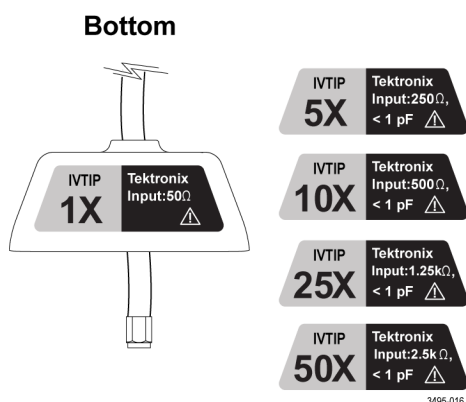
<sup>2</sup> On 2X range

## Output clamping

The measurement system has a selectable output clamping feature. Push the button on the controller to enable or disable the output clamping feature. When enabled (indicator is on), the output clamping limits the output voltage swing of the measurement system into the oscilloscope input. It allows you to increase the vertical sensitivity without over-driving or saturating the oscilloscope input.

## Sensor tip loading

Each of the sensor tip cables (IVTIP1X, IVTIP5X, IVTIP10X, IVTIP25X, IVTIP50X) has a differential input resistance listed on the bottom labels as shown in the following figure.



**Figure 14: Bottom sensor tip labels**

It is important to understand the impact of the tip loading on the DUT. For example, the IVTIP5X tip has a differential input resistance of 250 Ω. If you choose the IVTIP25X tip, the differential input resistance increases to 1.25 kΩ. Refer to the *Input resistance/capacitance* section in the specifications table for more information. The sensor tip cables are specially designed to act as a common mode choke that helps reduce the common mode loading.

---

**NOTE.** The coaxial (common) shield of the sensor tip cable should always be connected to the lowest impedance point (usually a circuit common or power supply rail) in the circuit-under-test (relative to the sensor tip cable/center conductor) to obtain the most accurate waveform.

---

## Probe compensation

The DPO7000 and MSO/DPO70000 Series oscilloscopes have a Compensate Probe feature accessible from the Probe Setup window. Pressing this button always results in a failure because the input resistance of the TIVM sensor tips is too low and cannot be driven by the calibrator output of the oscilloscope. The accuracy of the TIVM system is still guaranteed on these oscilloscopes even though the Compensate Probe feature fails.

## Deskew

Each oscilloscope family has a unique way of allowing you to adjust the timing relationship between signals acquired between different probes. Consult the user manual or online help of the oscilloscope for specific directions needed to deskew the probe. The 3 m and 10 m measurement systems have a propagation delay of approximately 35 ns and 68 ns respectively. The actual propagation delay is measured on each measurement system and is stored within each unit.

## Input offset

The measurement system provides a user-adjustable, input referred offset voltage. This allows you to view a portion of the signal that is off-screen. One of the controls on the oscilloscope can be assigned this function.

The minimum/maximum offset is different for each sensor tip cable. It is the same when the 1X or 2X Range is selected; it is also the same for all V/div settings. Refer the following input offset table.

**Table 7: Input offset**

Sensor tip cable	Input offset voltage
IVTIP1X	±2 V
IVTIP5X	±10 V
IVTIP10X	±20 V
IVTIP25X	±50 V
IVTIP50X	±100 V



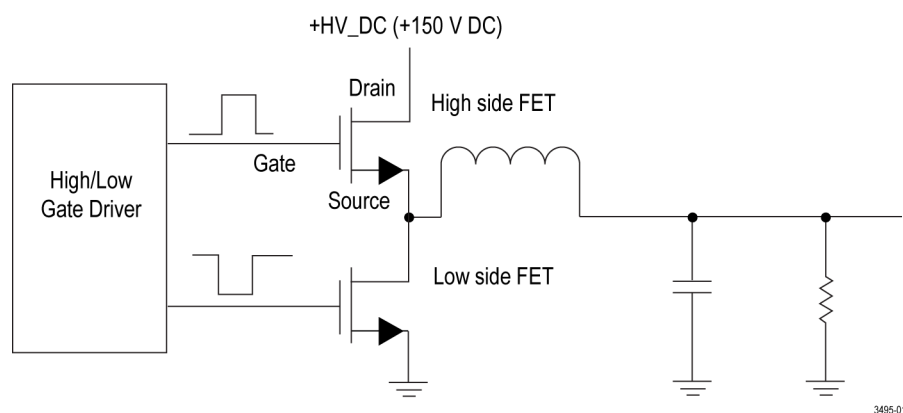


# Application examples

The following examples are provided to help you become familiar with the TIVM Series IsoVu measurement system and to achieve the best performance for your application.

## Example 1: High-side $V_{GS}$ measurement

Advancements in the components used in switching power supplies have made characterizing the performance of these power supplies increasingly difficult and challenging. A particularly challenging measurement is measuring the high-side  $V_{GS}$  in a half bridge. To accurately make this measurement, an exceptionally good CMRR is required from the test system. The following figure shows an example of this circuit.



**Figure 15: Half-bridge circuit showing the gate, source, and drain of the high-side FET**

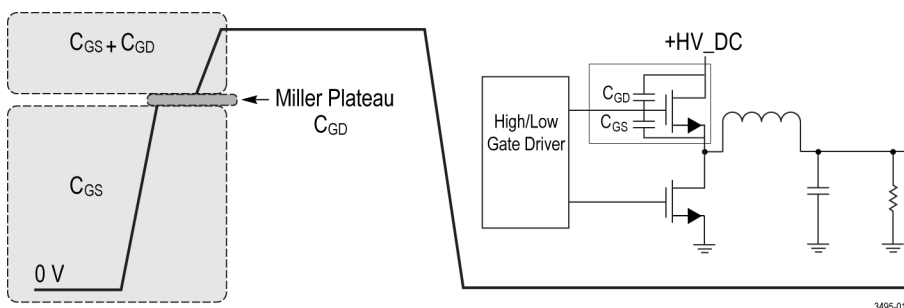
In this type of circuit, the gate-source voltage is of interest because the rate at which the device switches is determined by the gate drive characteristics. The reference node for this measurement is the high-side source node, which switches between the input supply voltage and the local PCB ground during operation. In a measurement system without sufficient CMRR, this rapidly changing common mode voltage results in interference which obscures the measurement. It is important to note that the CMRR for all measurement systems is frequency dependent; however, the frequency that is critical for this measurement is not the switching frequency, but the frequency corresponding to the edge rate. For example, to accurately characterize a power supply with a switching frequency of 100 kHz and an edge rate of 1 ns, a system with good CMRR at 350 Mhz is necessary because of the edge speed.

In this example, the gate drive voltage could be about 5 V but usually has some ringing and overshoot which are important to characterize. For this measurement, it is appropriate to use a 10X tip with a 10 V<sub>p-p</sub> input (on the 1X range) so that the signal is fully resolved and is within the dynamic range of the measurement system.

To get the best CMRR from your TIVM Series IsoVu measurement system, pay careful attention when connecting the measurement system to the DUT. This connection should preserve the signal fidelity and shield the signal from unwanted interference. To achieve the best performance from the measurement system, use an MMCX connector as close to the test point as possible. The MMCX connectors are available from a number of vendors and are relatively inexpensive. The key attributes of these connectors, which make them excel for this application, are their compact footprint and solid metal body. The solid metal body and gold contacts provide a well-shielded signal path.

The IsoVu input provides a floating differential measurement with *differential input resistance* from 50  $\Omega$  to 2.5 k $\Omega$ , depending on the tip attenuation. In the VGS measurement example the 10X tip with a 500  $\Omega$  input impedance is used. The *common mode resistance* is extremely high, greater than G  $\Omega$ , in parallel with a small capacitance from the tip cable shield to ground, typically 2 pF or less. Keep these impedances in mind when determining how to connect the measurement system to the DUT. The source node in the half bridge circuit is a very low impedance point, and is the point that should be used to drive the tip cable shield capacitance. The gate driver output, which is also a low impedance node (but not as low impedance as the source), should be used to drive the center contact of the sensor tip cable. The input impedance of the sensor tip cable for the 10X tip is 500  $\Omega$  relative to the shield – not to ground.

An example of a measurement that is possible with IsoVu is measuring the high-side turn-on characteristics shown in the following figure.



### Figure 16: High-side turn-on characteristics

In general there are three characteristic regions of interest of the turn-on waveform (See Figure 16.):

- The first region is the  $C_{GS}$  charge time.
- The second region is the Miller Plateau (the time required to charge the gate-drain Miller capacitance ( $C_{GD}$ ), and is  $V_{DS}$  dependent. The charge time increases as  $V_{DS}$  increases.
- The third region occurs when the channel is in conduction and the gate charges up to its final value.

Due to the rapid rise of the voltage on the switch node during the high side turn-on, there can be very high frequency and high amplitude common mode voltage changes during the transition. If this common mode voltage transient is not rejected, then the measurement of the high-side  $V_{GS}$  during the transition is not possible.

## Example 2: High-side drain current measurement

Current sensing is a critical measurement in many applications. Using the half bridge circuit again as an example, measuring the high-side drain current,  $I_D$ , can be very challenging particularly during startup. At startup, there can be common mode voltage transients due to parasitic inductance in the supply leads in addition to large current swings. Inserting a conventional current probe into the circuit at this point would require adding excessive inductance, which might limit circuit performance. Using a small value resistor as a current shunt makes it possible to take very high frequency current measurements with minimal additional impedance in the drain connection. (See Figure 17.)

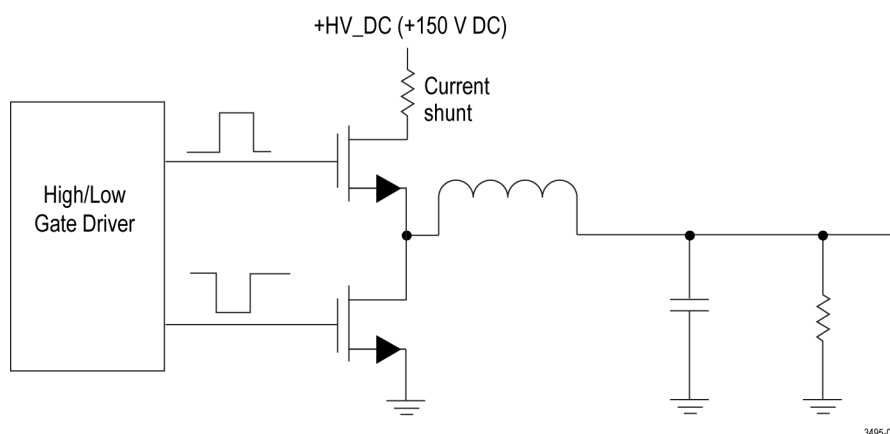
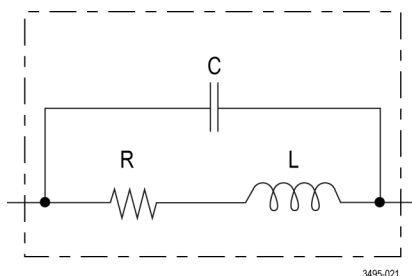


Figure 17: High side current shunt

In a typical application, a  $0.25\ \Omega$  resistor might be used to measure a transient current of 1 A, resulting in a voltage swing of 0.25 V, which can be measured with the measurement system using a 1X or 5X tip. A typical surface mount resistor can have a series inductance of less than 0.2 nH and series capacitance of less than 0.04 pF, resulting in much lower impedance at high frequency than could be obtained with a conventional current probe.



**Figure 18: SMT resistor model**

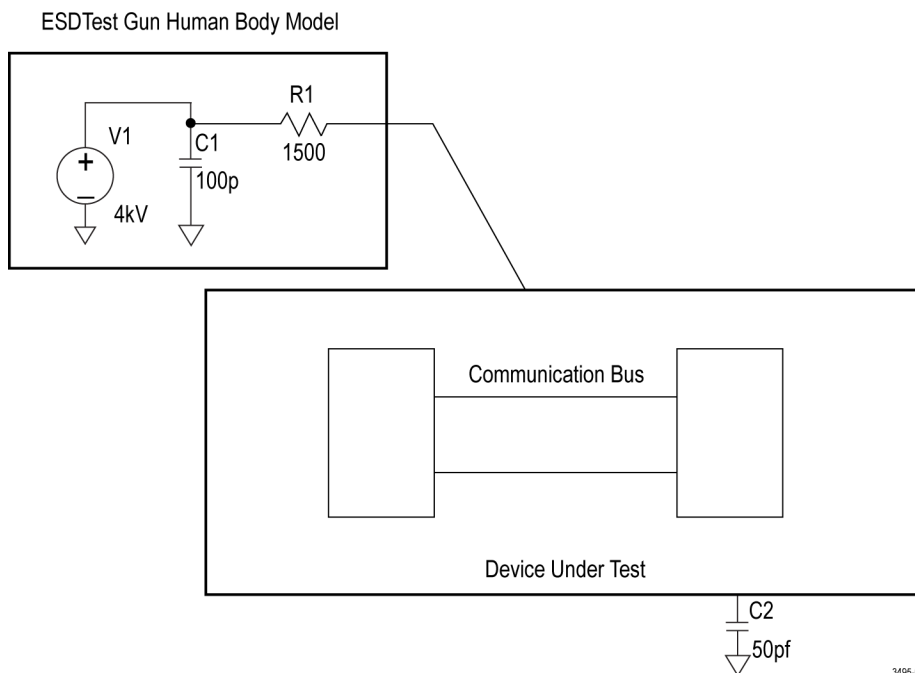
Go to <http://www.vishay.com/docs/60107/freqresp.pdf> for models of different types of surface mount resistors.

In general, surface mount resistors have fairly low power ratings; care must be taken not to exceed these ratings when using them as current shunts. Several vendors make very high power parts that can be used when high power dissipation is required. For example, the RP0402CB-R500FN-2Q from Barry Industries (<http://www.barryind.com/>) is a 1.0 W,  $0.5\ \Omega$  0402 resistor on an AlN substrate, or the RP0402CB-R500FN-2Q from US Microwaves (<http://www.usmicrowaves.com/>) is a 1.5 W,  $1\ \Omega$  resistor on a BeO substrate.

### Example 3: ESD troubleshooting

Many devices and systems can be negatively affected by ESD discharges. Troubleshooting problems that occur during an ESD discharge can be very difficult. A piece of test equipment connected to a device undergoing ESD testing has to not only withstand the ESD discharge, but it also has to reject interference caused by the rapid changes in potential on the DUT during an ESD discharge test.

For example, consider using the standard human body model of 100 pF and  $1500\ \Omega$ . If the DUT is being tested to 4 kV and has a capacitance of 50 pF, the test equipment will be exposed to a voltage change of more than 1 kV in tens of nanoseconds.



**Figure 19: ESD discharge test example**

In this example, if it is suspected that there is a glitch on the communication bus between two devices during the ESD discharge, then it is helpful to connect to the signals on the bus and to inspect them during the discharge. Because the measurement system uses Galvanic isolation, it rejects any interference from the ESD transient and tolerates the high common mode voltage during the discharge; the communication bus can be monitored throughout the ESD discharge and any irregularities can be investigated without interference from the ESD discharge.



# Reference information

## Specifications

The following tables list the specifications for the measurement system. The specifications are guaranteed unless otherwise indicated.

The performance limits in this specification are valid with these conditions:

- The instrument must be in an environment with temperature, altitude, and humidity within the operating limits described in these specifications.
- The instrument must have had a warm-up period of at least 20 minutes.
- The measurement system is powered from a TekVPI compatible oscilloscope.

Warranted specifications describe guaranteed performance with tolerance limits or certain type-tested requirements.

The performance verification procedures for the Propagation delay are listed later in this document. (See page 47, *Propagation delay*.)

**Table 8: Warranted specifications**

Characteristic	Description
Propagation delay (Warranted)	3 m fiber length: 35 ns $\pm$ 5 ns (actual propagation delay is measured and stored within each unit) 10 m fiber length: 68 ns $\pm$ 7 ns (actual propagation delay is measured and stored within each unit)

**Table 9: Electrical specifications**

Characteristic	Description
Controller output termination	Terminate the controller output into 50 $\Omega$
Controller output coupling	DC coupled
Range attenuation	<i>Sensor tip cable/adapter</i> 1X range                      2X range
	Sensor head input SMA                      1X ( $\div$ 1)                      2X ( $\div$ 2)
	IVTIP1X, 1X Sensor tip cable                      1X ( $\div$ 1)                      2X ( $\div$ 2)
	IVTIP5X, 5X Sensor tip cable                      5X ( $\div$ 5)                      10X ( $\div$ 10)
	IVTIP10X, 10X Sensor tip cable                      10X ( $\div$ 10)                      20X ( $\div$ 20)
	IVTIP25X, 25X Sensor tip cable                      25X ( $\div$ 25)                      50X ( $\div$ 50)
	IVTIP50X, 50X Sensor tip cable                      50X ( $\div$ 50)                      100X ( $\div$ 100)

Table 9: Electrical specifications (cont.)

Characteristic	Description		
Input resistance/capacitance (attached to sensor head, 50 $\Omega$ termination), (Typical)	Sensor tip cable/adaptor	Resistance	Capacitance
	Sensor head input SMA	50 $\Omega \pm 2\%$	NA
	IVTIP1X, 1X Sensor tip cable	50 $\Omega$	NA
	IVTIP5X, 5X Sensor tip cable	250 $\Omega$	< 1pF
	IVTIP10X, 10X Sensor tip cable	500 $\Omega$	< 1pF
	IVTIP25X, 25X Sensor tip cable	1.25 k $\Omega$	< 1pF
	IVTIP50X, 50X Sensor tip cable	2.5 k $\Omega$	< 1pF
Maximum non-destructive differential input voltage range, (Typical)	Sensor tip cable/adaptor	$V_{rms}$	$V_{peak}$
	Sensor head input SMA	3 V	4.3 Vpk
	IVTIP1X, 1X Sensor tip cable	3 V	4.3 Vpk
	IVTIP5X, 5X Sensor tip cable	12 V	21.5 Vpk
	IVTIP10X, 10X Sensor tip cable	16 V	43 Vpk
	IVTIP25X, 25X Sensor tip cable	25 V	107.5 Vpk
	IVTIP50X, 50X Sensor tip cable	35 V	200 Vpk
Linear differential input voltage range, (Typical)		Clamping Off, 1X Range	Clamping Off, 2X Range
	Sensor tip cable/adaptor	$\pm V_{peak}$ (DC + peak AC)	$\pm V_{peak}$ (DC + peak AC)
	Sensor head input SMA	$\pm 0.5$ V	$\pm 1$ V
	IVTIP1X, 1X Sensor tip cable	$\pm 0.5$ V	$\pm 1$ V
	IVTIP5X, 5X Sensor tip cable	$\pm 2.5$ V	$\pm 5$ V
	IVTIP10X, 10X Sensor tip cable	$\pm 5$ V	$\pm 10$ V
	IVTIP25X, 25X Sensor tip cable	$\pm 12.5$ V	$\pm 25$ V
	IVTIP50X, 50X Sensor tip cable	$\pm 25$ V	$\pm 50$ V
Output clamping range (Input referred) (Typical)	Sensor tip cable/adaptor	Clamping on, 1X Range	Clamping on, 2X Range
	Sensor head input SMA	$\pm 100$ mV	$\pm 200$ mV
	IVTIP1X, 1X Sensor tip cable	$\pm 100$ mV	$\pm 200$ mV
	IVTIP5X, 5X Sensor tip cable	$\pm 500$ mV	$\pm 1$ V
	IVTIP10X, 10X Sensor tip cable	$\pm 1$ V	$\pm 2$ V
	IVTIP25X, 25X Sensor tip cable	$\pm 2.5$ V	$\pm 5$ V
	IVTIP50X, 50X Sensor tip cable	$\pm 5$ V	$\pm 10$ V
Output clamping overdrive recovery (Typical)	< 20 ns		



**CAUTION.** To avoid damaging the measurement system, be aware of the input voltage limits; this specification applies to both the 1X Range and 2X Range.



Table 9: Electrical specifications (cont.)

Characteristic	Description		
System noise (Typical)	1 GHz system noise (input referred)		
	Sensor tip cable/adaptor	1X Range	2X Range
	Sensor head input SMA	< 0.8 mV <sub>rms</sub>	< 1.6 mV <sub>rms</sub>
	IVTIP1X, 1X Sensor tip cable	< 0.8 mV <sub>rms</sub>	< 1.6 mV <sub>rms</sub>
	IVTIP5X, 5X Sensor tip cable	< 4 mV <sub>rms</sub>	< 8 mV <sub>rms</sub>
	IVTIP10X, 10X Sensor tip cable	< 8 mV <sub>rms</sub>	< 16 mV <sub>rms</sub>
	IVTIP25X, 25X Sensor tip cable	< 20 mV <sub>rms</sub>	< 40 mV <sub>rms</sub>
	IVTIP50X, 50X Sensor tip cable	< 40 mV <sub>rms</sub>	< 80 mV <sub>rms</sub>
DC gain accuracy <sup>1</sup> , (Input referred) (Typical)			
Differential DC gain accuracy	±3% ±DC offset error voltage ± input offset accuracy error		
80% to 100% of full scale in 2X Range:	±5% ±DC offset error voltage ± input offset accuracy error		
DC offset error voltage <sup>2</sup> (Input referred) (Typical)	Sensor tip cable/adaptor	1X Range	2X Range
	Sensor head input SMA	±2 mV	±4 mV
	IVTIP1X, 1X Sensor tip cable	±2 mV	±4 mV
	IVTIP5X, 5X Sensor tip cable	±10 mV	±20 mV
	IVTIP10X, 10X Sensor tip cable	±20 mV	±40 mV
	IVTIP25X, 25X Sensor tip cable	±50 mV	±100 mV
	IVTIP50X, 50X Sensor tip cable	±100 mV	±200 mV
Input offset voltage range (Typical)	Sensor tip cable/adaptor	Input offset voltage range	
	Sensor head input SMA	±2 V	
	IVTIP1X, 1X Sensor tip cable	±2 V	
	IVTIP5X, 5X Sensor tip cable	±10 V	
	IVTIP10X, 10X Sensor tip cable	±20 V	
	IVTIP25X, 25X Sensor tip cable	±50 V	
	IVTIP50X, 50X Sensor tip cable	±100 V	
Input offset voltage accuracy (Typical)	±5%		
Small signal rise time (10% to 90%) (Typical) (SMA input and with sensor tip cables)		Rise time	
	TIVM1/TIVM1L	≤ 350 ps	
	TIVM05/TIVM05L	≤ 700 ps	
	TIVM02/TIVM02L	≤ 1.8 ns	
Small signal frequency response (Typical) (SMA input and with sensor tip cables)		-3 dB bandwidth	
	TIVM1/TIVM1L	DC to ≥ 1 GHz	
	TIVM05/TIVM05L	DC to ≥ 500 MHz	
	TIVM02/TIVM02L	DC to ≥ 200 MHz	

Table 9: Electrical specifications (cont.)

Characteristic	Description				
Common mode rejection ratio ( <i>Typical</i> )					
<i>Sensor tip cable/adapter</i>	<i>DC</i>	<i>100 MHz</i>	<i>200 MHz</i>	<i>500 MHz</i>	<i>1 GHz</i>
IVTIP1X, 1X Sensor tip cable	> 120 dB	120 dB	110 dB	100 dB	90 dB
IVTIP5X, 5X Sensor tip cable	> 120 dB	120 dB	110 dB	100 dB	90 dB
IVTIP10X, 10X Sensor tip cable	> 120 dB	120 dB	110 dB	100 dB	90 dB
IVTIP25X, 25X Sensor tip cable	> 120 dB	110 dB	100 dB	100 dB	90 dB
IVTIP50X, 50X Sensor tip cable	> 120 dB	100 dB	90 dB	90 dB	80 dB
MMCX-to 0.1 in (2.54 mm) square pin adapter with sensor tip cable.	> 120 dB	70 dB	60 dB	40 dB	30 dB
MMCX-to 0.062 in (1.57 mm) square pin adapter with sensor tip cable.	> 120 dB	70 dB	60 dB	40 dB	30 dB
Common mode voltage range	2 kVpk (2 kV CAT I, 1000 V CAT II)				
Common mode resistance ( <i>Typical</i> )	N.A. due to Galvanically isolation (fiber optic connection)				
Common mode capacitance <sup>3</sup> ( <i>Typical</i> )	~2 pF				
Overload indicator range ( <i>Typical</i> )	<i>Sensor tip cable/adapter</i>		<i>Overload indicator On</i>		
	Sensor head input SMA		V <sub>in</sub> < -3 V or V <sub>in</sub> > +3 V		
	IVTIP1X, 1X Sensor tip cable		V <sub>in</sub> < -3 V or V <sub>in</sub> > +3 V		
	IVTIP5X, 5X Sensor tip cable		V <sub>in</sub> < -12 V or V <sub>in</sub> > +12 V		
	IVTIP10X, 10X Sensor tip cable		V <sub>in</sub> < -16 V or V <sub>in</sub> > +16 V		
	IVTIP25X, 25X Sensor tip cable		V <sub>in</sub> < -25 V or V <sub>in</sub> > +25 V		
	IVTIP50X, 50X Sensor tip cable		V <sub>in</sub> < -35 V or V <sub>in</sub> > +35 V		

<sup>1</sup> The difference between the measured DC gain and the nominal DC gain, divided by the nominal DC gain and expressed as a percent.

<sup>2</sup> The input referred offset error voltage when the input is shorted and the probe input offset is set to 0 volts

<sup>3</sup> The capacitance between the sensor head and a reference plane. The sensor head is placed six inches (15.25 cm) above the reference plane.

Table 10: Physical specifications

Characteristic	Description
Net weight	(Weight does not include accessories and packaging.)
Sensor tip cables	0.025 kg (0.055 lb)
Sensor head	0.363 kg (0.8 lb)
Controller box	0.816 kg (1.8 lb)
TekVPI Comp box	0.57 kg (0.125 lb)
Sensor tip cable length	15.24 cm (6.0 in)
Fiber cable length	
TIVM1, TIVM02, TIVM05	3 m (9.84 ft)
TIVM1L, TIVM02L, TIVM05L	10 m (32.81 ft)
TekVPI cable length	55.88 cm (22 in)
Overall length and tolerances	
Comp box to controller	0.5588 m $\pm$ 3.81 cm (22 in $\pm$ 1.5 in) shoulder-to-shoulder, Boot area included in the overall length.
Controller to sensor head (TIVM1, TIVM02, TIVM05)	2.9718 m $\pm$ 10.2 cm (117 in $\pm$ 4 in)
Controller to sensor head (TIVM1L, TIVM02L, TIVM05L)	9.982 m $\pm$ 10.2 cm (393 in $\pm$ 4 in)

## Dimensional drawings

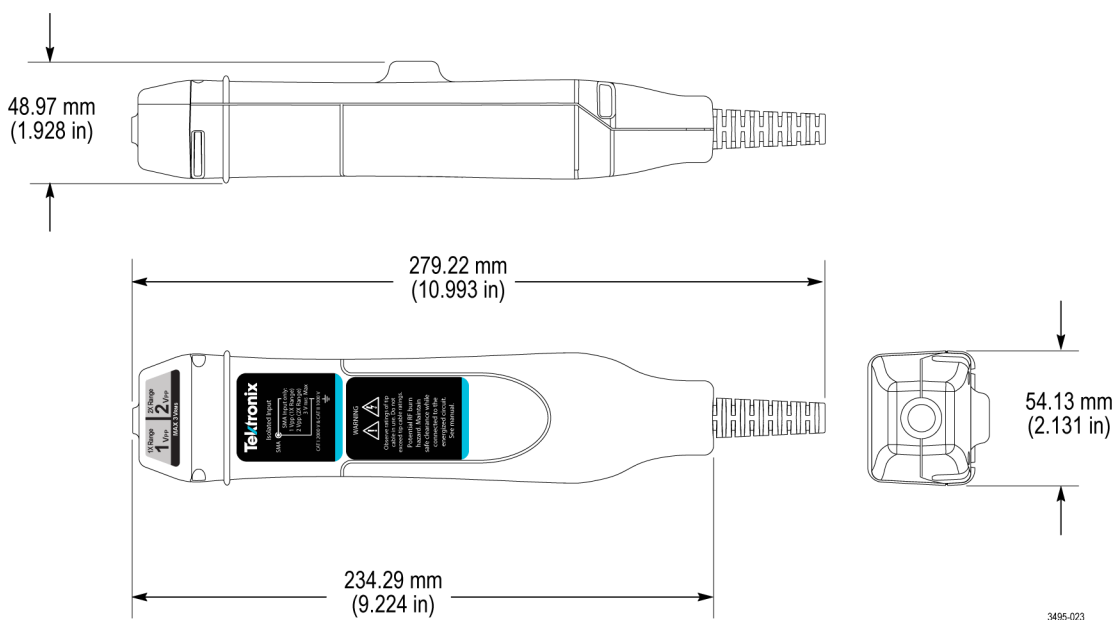


Figure 20: Sensor head dimensions with probe tip cover

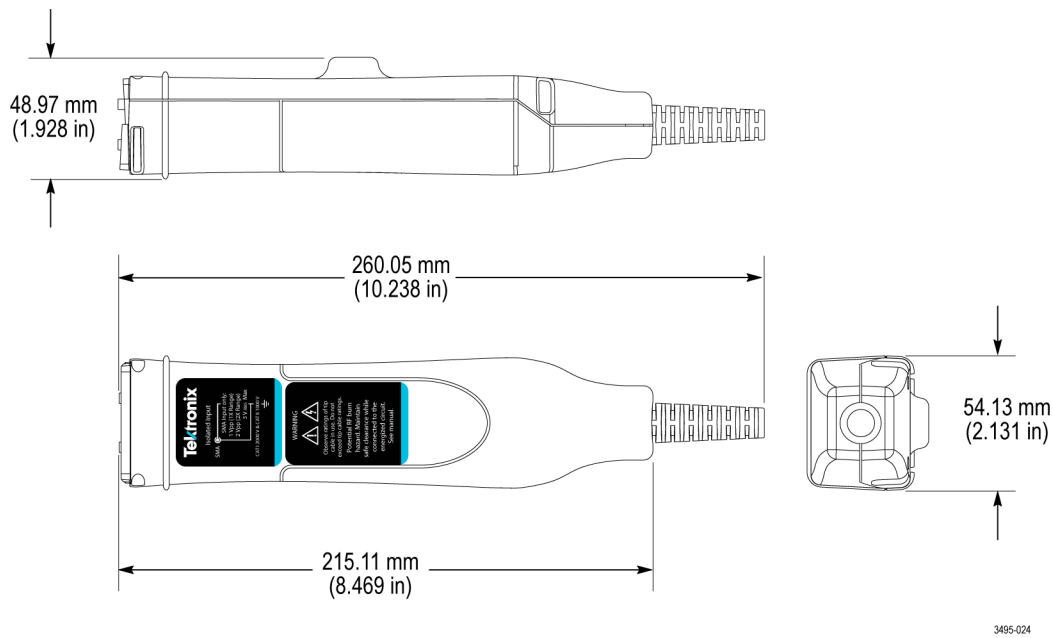


Figure 21: Sensor head dimensions without probe tip cover

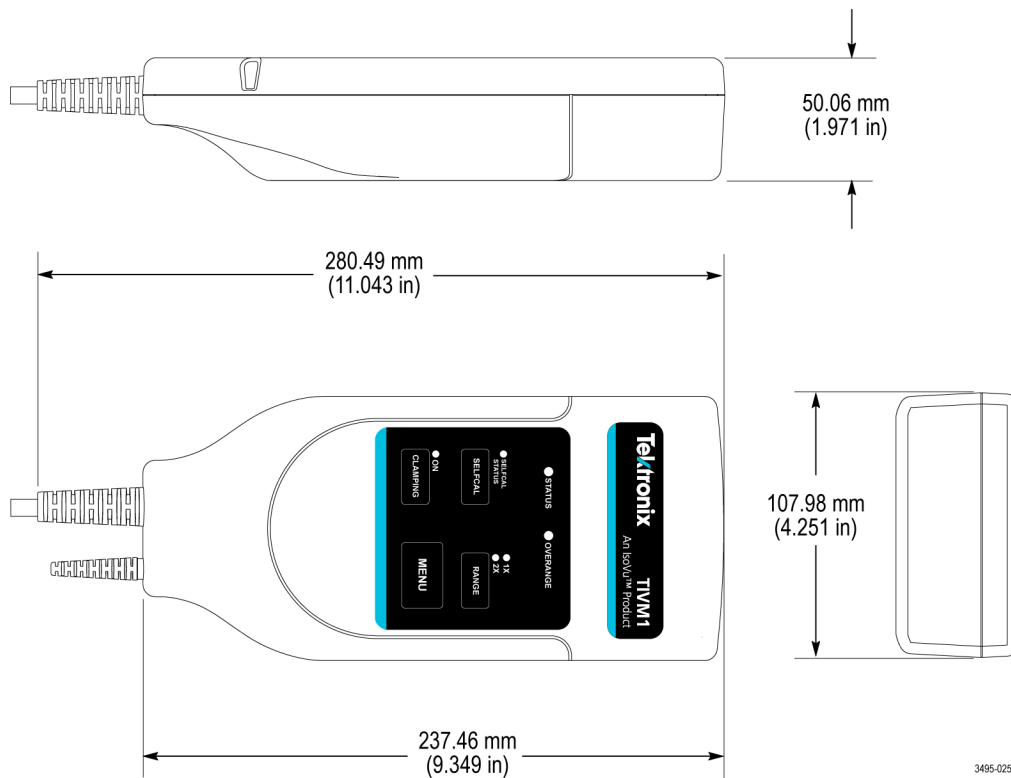


Figure 22: Controller dimensions

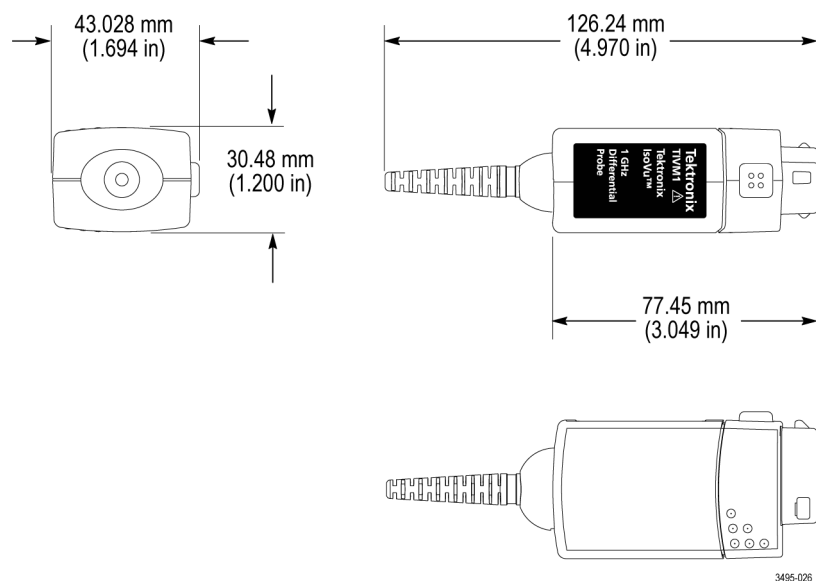


Figure 23: Comp box dimensions

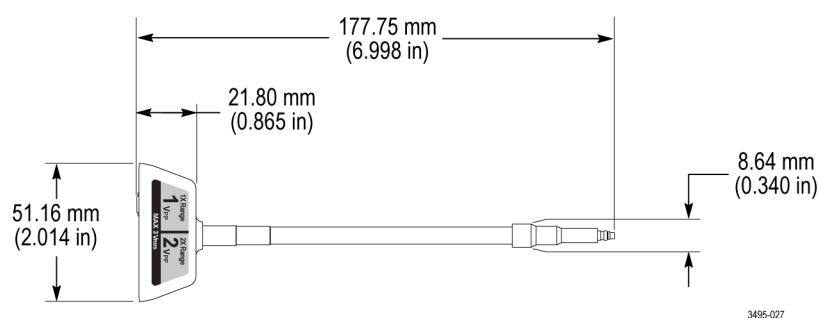
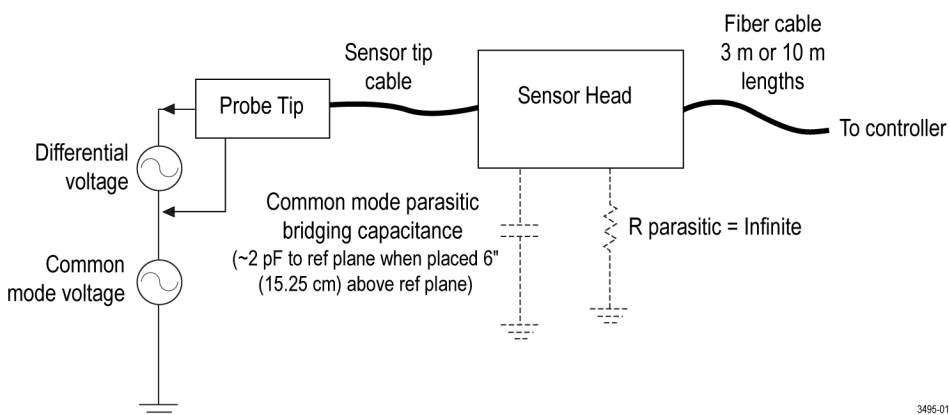


Figure 24: Probe tip adapter dimensions

## IsoVu measurement system block diagram

The following figure shows a block diagram of the IsoVu measurement system.



3495-017

**Figure 25: Block diagram**

The common mode resistance and capacitance to earth ground is shown in the figure. (See Figure 25.) The common mode resistance is shown as  $R_{parasitic}$  and is essentially infinite with the IsoVu measurement system since it is galvanically isolated and can be ignored. The common mode coupling capacitance to earth ground and the surrounding circuit is shown as the Parasitic Bridging Capacitance ( $C_{parasitic}$ ). This parasitic capacitance will be approximately 2 pF when the sensor head is placed six (6) inches (15.25 cm) above a ground plane.

To minimize the effects of common mode capacitive loading consider the following items:

- Whenever possible, choose a reference point in the circuit-under-test that is static potential with respect to earth ground.
- Connect the coaxial (common) shield of the sensor tip cable to the lowest impedance point of the circuit.
- Increasing the physical distance between the sensor head and any conductive surface will reduce the parasitic capacitance.
- When using multiple IsoVu systems to measure different points in the circuit that do not have the same common mode voltages, keep the sensor heads separated to minimize the capacitive coupling.

## Tripods

Tektronix provides two tripods as accessories with the measurement system. The Flexible tripod holds the sensor head while connected to the DUT. The Probe tip tripod supports the sensor tip cables while they are connected to adapters on the circuit board.

### Flexible tripod

The tripod can be connected to the DUT in different ways. You can secure the tripod to the DUT using optional feet. The feet can be clamped or attached to the DUT using common screws. This allows you to install the tripod upside down or right side up as shown in the following figures.

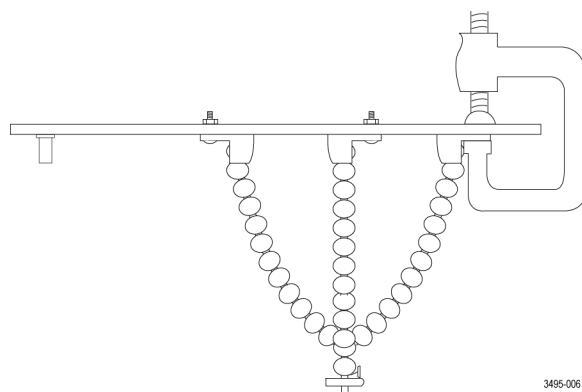


Figure 26: Installing the flexible tripod under the DUT.

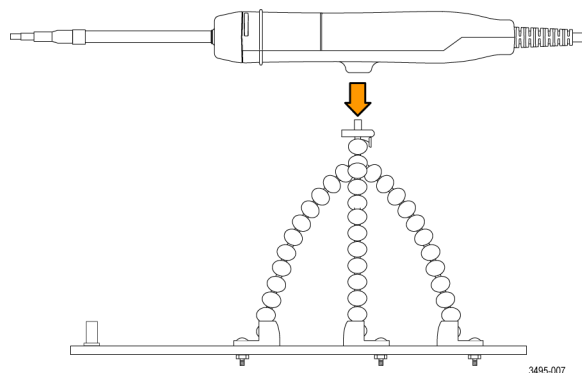


Figure 27: Connecting the sensor head to the top of the DUT with the flexible tripod.

### Probe tip tripod

Use the probe tip tripod to connect the sensor tip cables to adapters on the circuit board. This tripod has flexible hinges to easily position the probe tip cable above the adapter on the circuit board. Tektronix recommends gluing the tripod in place on the circuit board to provide additional support for the sensor tip cables. The following figure shows an example of connecting to an adapter on the circuit board with the tripod; it reduces stresses on the test point.

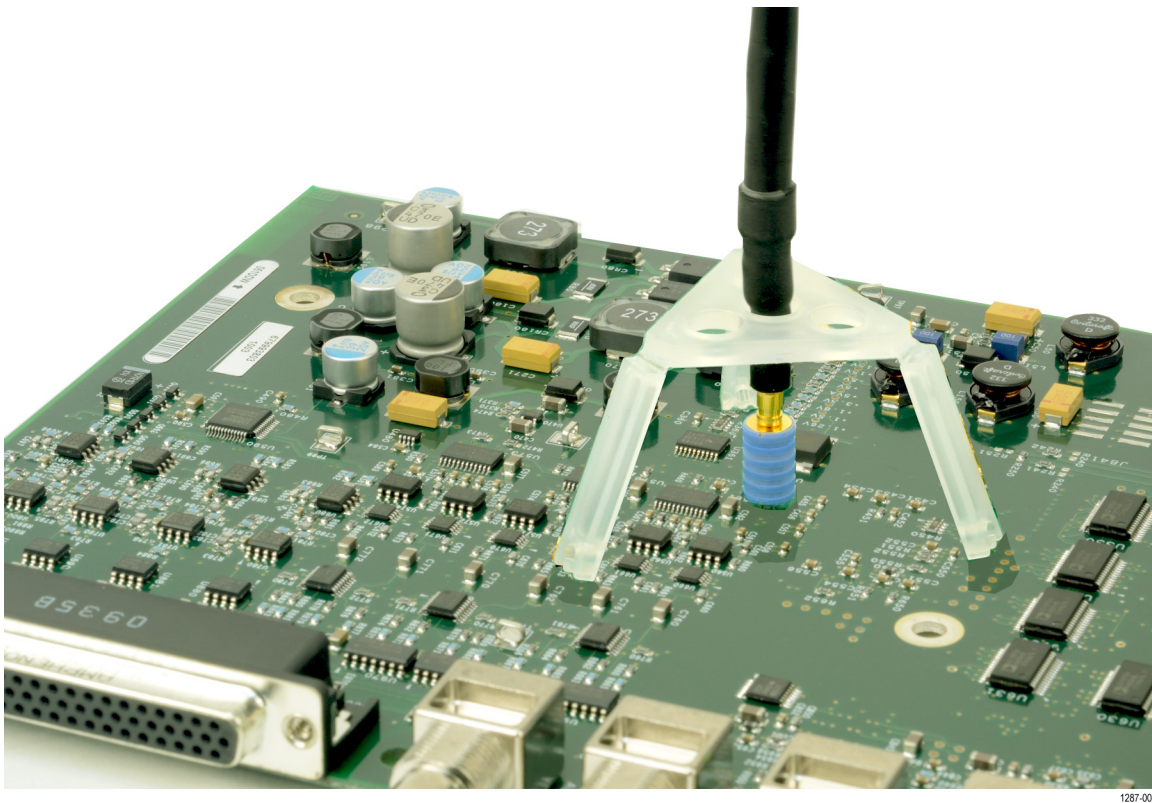


Figure 28: Connecting to an adapter on the circuit board with the probe tip tripod



## Installing the probe tip adapters

Tektronix provides two probe tip adapters to connect the sensor tip cables to pins on the circuit board. The MMCX-to-0.1-inch (2.54 mm) pitch adapter and the MMCX-to-0.062-inch (1.57 mm) pitch adapter.

One end of each adapter has an MMCX socket for connection to an IsoVu tip cable. The other end of the adapter has a center pin socket and four common (shield) sockets around the outside of the adapter. Notches on the adapters can be used to locate the shield sockets. The procedure for installing these adapters are the same, the main difference is the spacing of the pins on the circuit board.

To install the adapters onto the square pins, line up the center of the adapter with the signal source pin on the circuit board. Use the notch on the adapter to align one of the shield sockets to the common pin on the circuit board. The following figures show examples of lining up the adapters on the circuit board.

To achieve the best electrical performance, especially the CMRR performance and EMI susceptibility, place the probe tip adapter as close as possible to the circuit board.

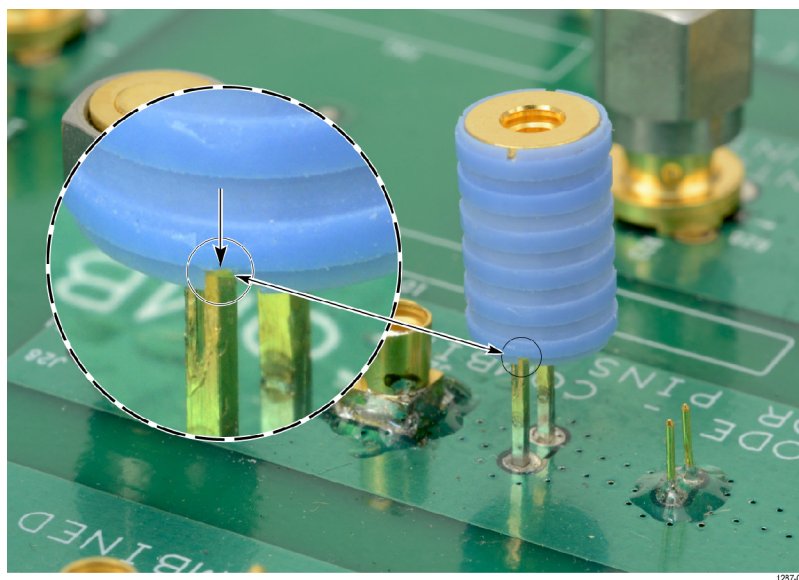
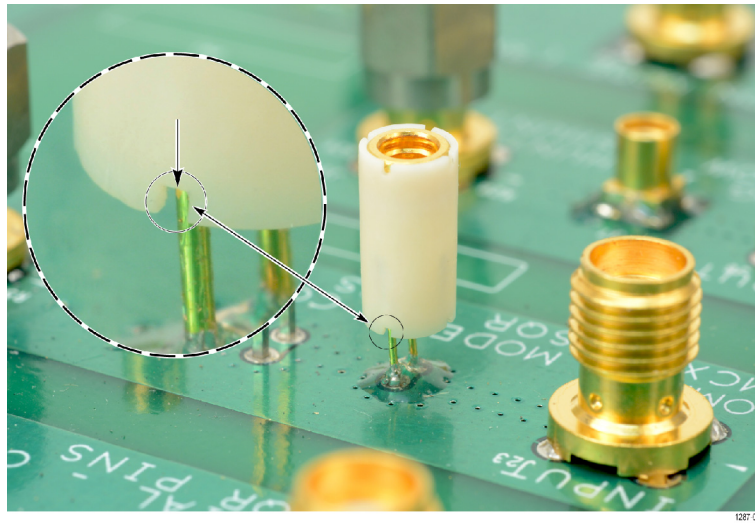
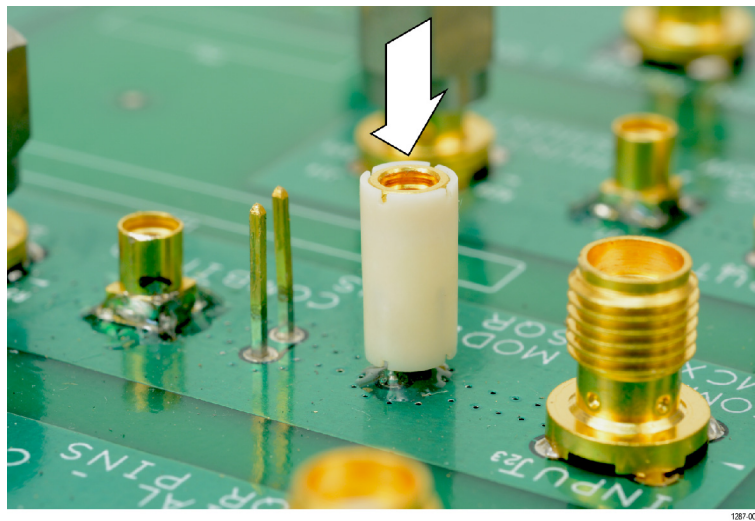


Figure 29: Lining up the MMCX-to-0.1-inch (2.54 mm) adapter on the circuit board

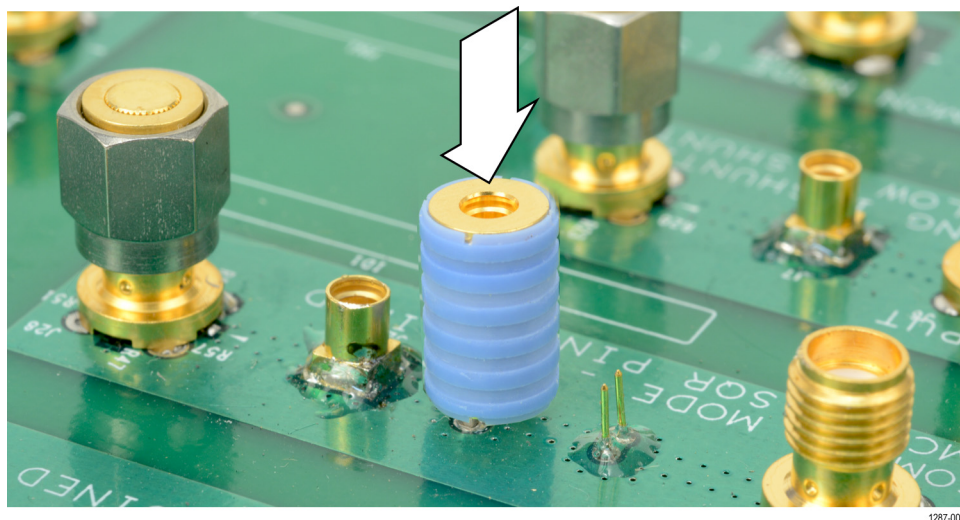


**Figure 30: Lining up the MMCX-to-0.062-inch (1.57 mm) adapter on the circuit board**

After lining up the adapters gently push down on the adapter to seat it in place on the circuit board.



**Figure 31: Pushing the MMCX-to-0.062-inch (1.57 mm) adapter in place**



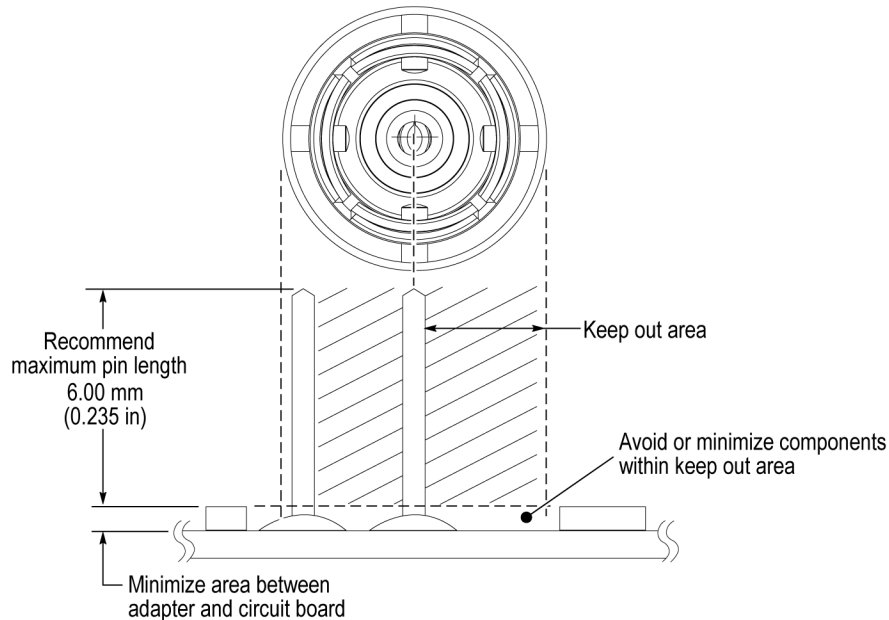
**Figure 32: Pushing the MMCX-to-0.1-inch (2.54 mm) adapter in place**

When the adapters are firmly in place on the circuit board connect the sensor tip cable to the top of the adapter while using the probe tip tripod to ease the tension off the probe tip cable and adapter. (See Figure 28 on page 38.)

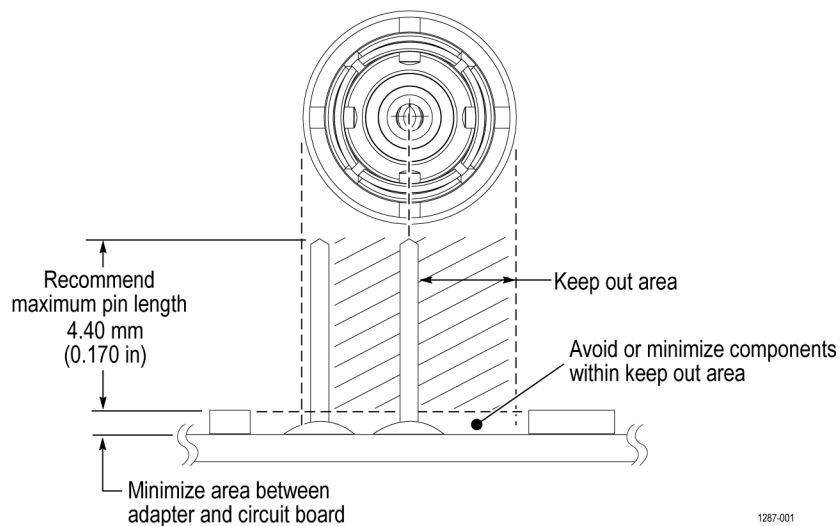
## Installing the square pins on the circuit board

The following figure shows the recommended clearance requirements for connecting the adapters to the square pins on the circuit board. The bottoms of the adapters are shown at the top.

*Probe Tip Adapter, MMCX to 0.1" pitch sq pin 0.635 mm (0.025 in) sq. pins*



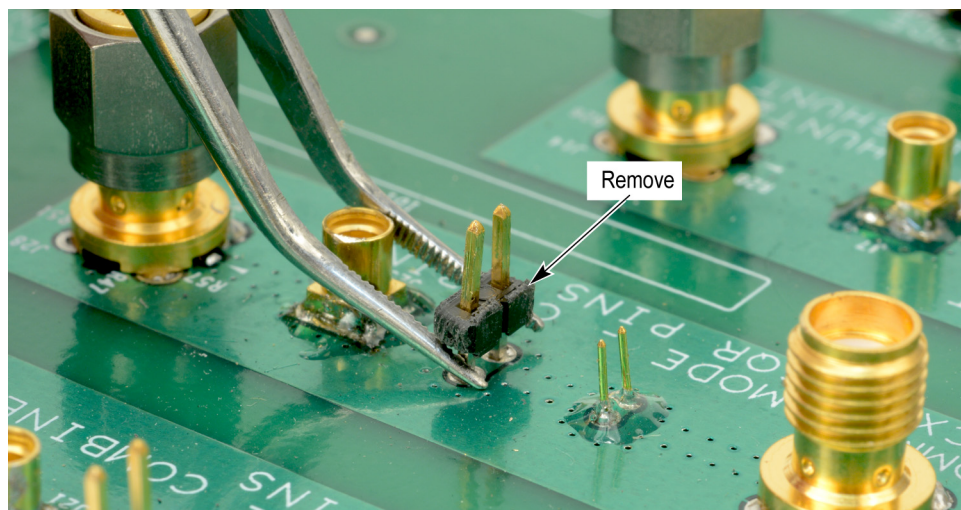
*Probe Tip Adapter, MMCX to 0.062 in pitch sq pin 0.406 mm (0.016 in) sq. pins*



1287-001

**Figure 33: Adapter clearance requirements**

The 0.025-inch (0.635 mm) square pins should already be located on the circuit board. Some square pins might have headers installed on the circuit board. Tektronix recommends removing the plastic spacer from the square pins to gain closer access to the circuit board as shown in the following figure to achieve the best electrical performance, especially the CMRR. You might need to use a pair of tweezers to remove the spacer as shown in the figure.



1287-002

**Figure 34: Removing the header from square pins on the circuit board**

Tektronix provides a set of solder pins (0.018-inch (0.46 mm) diameter) to install on the circuit board for use with the MMCX to 0.062-inch (1.57 mm) adapter. Use the soldering aide tool accessory (Tektronix part number, 003-1946-xx) to install these pins on the circuit board.

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**NOTE.** The solder pins are extremely small and can be challenging to handle. Tektronix recommends using tweezers and a magnifying tool when installing the pins on the circuit board.

The solder pins can be installed around a surface mounted component on the circuit board, but adequate clearance should be maintained for a good electrical connection for the adapter. (See Figure 33 on page 42.)

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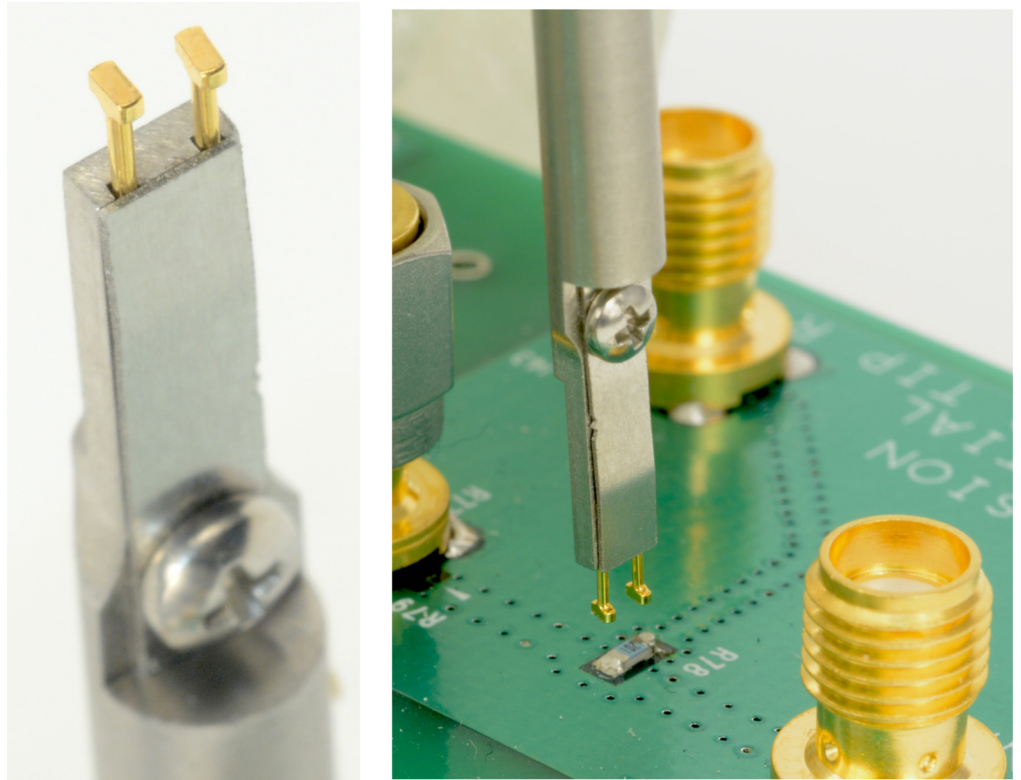
**NOTE.** The coaxial (common) shield of the sensor tip cable and tip adapters should always be connected to the lowest impedance point (usually a circuit common or power supply rail) in the circuit-under-test (relative to the sensor tip cable/center conductor) to obtain the most accurate waveform.

---



Use the following steps to install the solder pins using the soldering aid on the circuit board:

1. Carefully insert the solder pins into the soldering aid as shown in the following illustration.



**Figure 35: Using the soldering aid to install the square pins on the circuit board**

2. Use the soldering aid to hold the square pins in place while soldering the square pins to the circuit board.
3. If necessary apply a small amount of adhesive to further strengthen the connection to the circuit board. However, keep the height of the adhesive to a minimum to provide good electrical contact for the adapter. (See Figure 33.)

---

# User service

## Service offerings

Tektronix provides service to cover repair under warranty and other services that are designed to meet your specific service needs.

Whether providing warranty repair service or any of the other services listed below, Tektronix service technicians are well equipped to service the IsoVu measurement system. Services are provided at Tektronix Service Centers and on-site at your facility, depending on your location.

### Warranty repair service

Tektronix warrants this product as described in the warranty statements at the front of this manual. Tektronix technicians provide warranty service at most Tektronix service locations worldwide. The Tektronix Web site provides information on all service locations worldwide.

### Calibration and repair service

In addition to warranty repair, Tektronix Service offers calibration and other services that provide cost-effective solutions to your service needs and quality standards compliance requirements. Tektronix instruments are supported worldwide by the leading-edge design, manufacturing, and service resources of Tektronix to provide the best possible service.

## Preventive maintenance



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**CAUTION.** *To prevent damage to the measurement system, do not expose it to sprays, liquids, or solvents. Avoid getting moisture inside the controller or sensor head when cleaning the exterior.*

---

Clean the exterior surfaces with a dry, lint-free cloth or a soft-bristle brush. If dirt remains, use a soft cloth or swab dampened with a 75% isopropyl alcohol solution. Use only enough solution to dampen the cloth or swab. Do not use abrasive compounds on any part of the instrument.

## Performance verification procedures

Use the following procedures to verify the performance of the IsoVu measurement system. Before beginning the procedures, photocopy the test record and use it to record the performance results. (See page 53, *Test record*.)

**Required equipment** The equipment required to perform the performance verification procedures are shown in the following table.

**Table 11: Required equipment for performance verification**

Description	Minimum requirements	Example product
Oscilloscope with TekVPI interface	$\geq 1$ GHz, 50 $\Omega$ input support, fully compatible with TekVPI interface	Tektronix MDO4104C
Pulse generator	1 V <sub>p-p</sub> , <1ns risetime	Tektronix Tek-DPG
TIVM series 1X sensor tip cable	As per description	Tektronix IVTIP1X
MMCX Jack (female) to BNC female adapter	As per description	Fairview Microwave Product SKU: SM3610

**Preparation** Prepare the equipment as follows:

1. Turn on the TekVPI oscilloscope.
2. Connect the Tek-DPG Deskew pulse generator into Channel 2 of the TekVPI oscilloscope.
3. Allow the test equipment to warm up for 20 minutes at an ambient temperature of 20 °C to 30 °C.



## Propagation delay

This procedure verifies that the TIVM Series IsoVu measurement system is functioning and meets the warranted propagation delay specification. The propagation delay will be measured by first applying the output of the pulse generator to the input of the oscilloscope and storing the captured waveform as a reference waveform. Next, the measurement system is connected to the oscilloscope and the output of the pulse generator is connected to the input of the measurement system. The delay is then measured between the saved reference waveform and the acquired waveform of the measurement system.

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**NOTE.** *This procedure is valid for all versions of the TIVM Series IsoVu measurement systems.*

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### Create the reference waveform

Complete the following steps to create the reference waveform:

1. Connect the Tek-DPG Deskew Pulse Generator output BNC cable directly to Channel 1 input of the TekVPI oscilloscope.
2. Enable Channel 2 and use the following setups:
  - Vertical Scale: **500 mV/div.**
  - Vertical Position: **-3 divisions**
  - Set Termination: **1 M $\Omega$ ,**
  - Coupling: **DC**
  - Bandwidth: **FULL**
  - Deskew: **0 seconds**
3. Set the Trigger menu using the following setups:
  - Type: **Edge**
  - Source: **CH2**
  - Slope: **Negative**
  - Level: **+1.50 V**
  - Coupling: **DC**
4. Use the following setups for Channel 1.
  - Vertical Scale: **200 mV/div**
  - Coupling: **DC**
  - Termination: **50  $\Omega$**
  - Bandwidth: **FULL**

- Position: **0** (centered)
  - Offset: **-500 mV**
  - Deskew: **0** seconds
5. Set the Horizontal menu to the following setups:
    - Horizontal Scale to **10 ns/div.**
    - Horizontal Position: **40 ns**
    - Acquire: **Average 128**
  6. Set the Tek-DPG to the following setups:
    - **0 to -1 kHz mode** (Mode 1)
    - Output Enable: **ON**
  7. The Channel 1 waveform should appear approximately on the center of the oscilloscope display. If the waveform is not vertically centered in the display, adjust the display as necessary to vertically center the waveform.
  8. Use the following steps to save the Channel 1 waveform as the reference waveform (R1).
    - Press **MENU** on the oscilloscope.
    - Select **Save Waveform.**
    - Source: **CH1.**
    - Destination: **R1.**
    - Select **OK Save** to save the Channel 1 waveform as reference waveform R1. The new reference waveform should now be displayed on the oscilloscope.
  9. Disable the output of the Tek-DPG.
  10. Disconnect the Tek-DPG Deskew Pulse Generator output BNC cable from the Channel 1 input of the TekVPI oscilloscope.

### Create the TIVM series waveform

Complete the following steps to set up the TIVM series waveform:

1. Connect the Comp box of the TIVM series measurement system to Channel 1 of the TekVPI oscilloscope.
2. Connect a IVTIP1X sensor tip cable to the TIVM series input (tighten the SMA connector from the cable to the sensor head and attach the nose cone.)
3. Allow the measurement system to warm up for 20 minutes at an ambient temperature of 20 ° to 30 °C.
4. Connect an MMCX Jack (female) to BNC female adapter to the output BNC cable of the Tek-DPG.

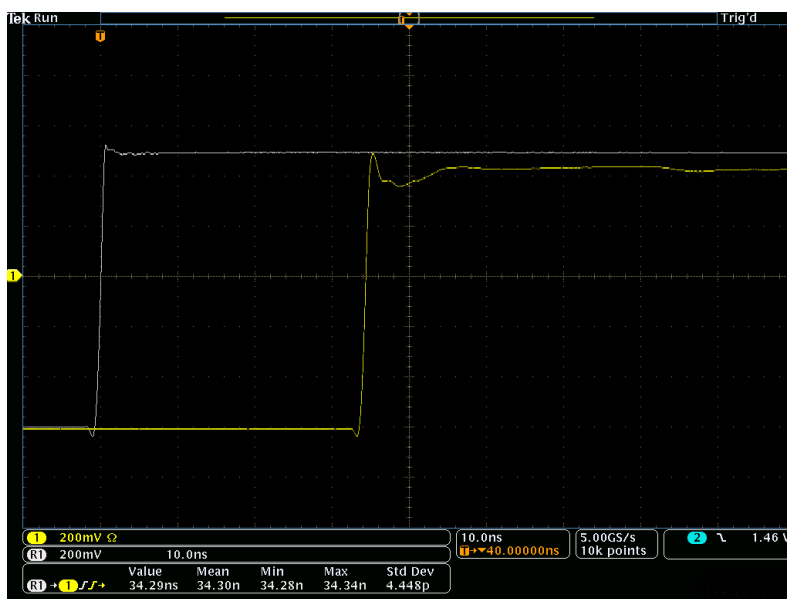
5. Set the TIVM series to the following:
  - Range: **2X**
  - CLAMPING: **Off**
  - Push the SELF CAL button to perform the self calibration (wait for the SELF CAL Status indicator to turn solid green).
6. On Channel 1 of the oscilloscope set the Vertical Scale to 200 mv/div.
7. Connect the IVTIP1X sensor tip cable to the MMCX Jack (female) to BNC female adapter.
8. Enable the output of the Tek-DPG.
9. The Channel 1 waveform should appear on the oscilloscope display and be approximately vertically centered on the display. If not, **ONLY** adjust the vertical settings as necessary to center the waveform on the display.

### Measure the propagation delay

Complete the following steps to measure and record the propagation delay.

1. Set up the delay measurement on the oscilloscope as follows:
  - a. Select **Measure**.
  - b. Select **Add Measurement**.
  - c. Select Measurement Type: **Delay**.
  - d. Select Configure: **Delay**.
  - e. Set the Source to **R1**.
  - f. Set Delay To to **CH1**.
  - g. Select **OK Add Measurement**.

- The oscilloscope display should be similar to the following figure.



**Figure 36: Propagation delay measurement**

Record the resulting delay measurement on the test record.

- Disable the output of the Tek-DPG.

## Troubleshooting and error conditions

The following table lists possible problems that you might encounter when taking measurements with TIVM Series IsoVu measurement system. Use the table as a quick troubleshooting reference before contacting Tektronix for service.

**Table 12: Problems and possible solutions**

Problem	Remedy
The measurement system will not power on; no indicators are on.	Verify the TekVPI comp box is securely attached to the oscilloscope. Detach and then reattach the comp box (using a different oscilloscope channel if necessary). If the condition persists, return the system to Tektronix for service.
Controller STATUS indicator is flashing green.	Detach and then reattach the comp box (using a different oscilloscope channel if necessary). Do not force the comp box into the oscilloscope connector at an angle; connect it to the oscilloscope with a firm, horizontal force. If the condition persists, return the system to Tektronix for service.
Controller STATUS indicator is flashing red and yellow	This condition indicates a failure in the measurement system. Most often, a failure is detected when the measurement system is first connected to the oscilloscope (while executing power-on self tests). Detach and then reattach the comp box to the scope. If the condition persists, return the system to Tektronix for service.

Table 12: Problems and possible solutions (cont.)

Problem	Remedy
Controller SELF CAL STATUS indicator turns solid red after pressing SELF CAL button (or never completes).	<ul style="list-style-type: none"> <li>■ Remove input signal (differential must be 0.0V).</li> <li>■ Allow system to warm up 20 minutes.</li> <li>■ Make sure the fiber cable is not subjected to dynamic mechanical or thermal stresses.</li> <li>■ If the self calibration does not complete in a minute, detach and reattach the comp box to the oscilloscope – then try again.</li> </ul>
Waveform distortion when the signal from the DUT is less than 5 Hz or a multiple of 43.5 Hz	Disable the Offset Correction. Refer to the <i>Offset correction</i> section earlier in this document. (See page 15.)
Output waveform is clipped or distorted	<ul style="list-style-type: none"> <li>■ Verify that the Output Clamp is disabled.</li> <li>■ Check that the proper sensor tip cable is being used for the measurement. Refer to <i>Selecting a sensor tip cable</i> section earlier in this document. (See page 19.)</li> <li>■ Change the Input Offset to center the signal on-screen.</li> <li>■ Make sure the correct Range is selected (1X or 2X).</li> </ul>
Frequency response is rolled off	<ul style="list-style-type: none"> <li>■ Check the bandwidth limit on the oscilloscope.</li> <li>■ Check the sensor tip cable continuity and sensor head input resistance (see below).</li> </ul>
Output waveform is unstable (low frequency noise and/or DC offset keep changing)	<ul style="list-style-type: none"> <li>■ Make sure the fiber cable is not subjected to dynamic mechanical and thermal stresses.</li> <li>■ Verify that Offset Correction is enabled (detach and then reattach the comp box to make sure it has been re-enabled).</li> </ul>
Measurements are inaccurate	<ul style="list-style-type: none"> <li>■ Run SELF CAL.</li> <li>■ Check that the proper sensor tip cable is being used for the measurement. Refer to <i>Selecting a sensor tip cable</i> section earlier in this document. (See page 19.)</li> <li>■ Make sure the correct Range is selected (1X or 2X).</li> <li>■ Make sure the signal is on-screen.</li> </ul>
Cannot achieve high CMRR	Try a different sensor tip cable.
Too much noise and cannot accurately resolve signal	<ul style="list-style-type: none"> <li>■ Switch to the 1X Range.</li> <li>■ Choose a sensor tip cable with less attenuation.</li> </ul>

Table 12: Problems and possible solutions (cont.)

Problem	Remedy												
No signal detected; waveform is a flat line	■ Check the sensor tip cable continuity:												
	<table><tr><th><i>Sensor tip cable</i></th><th><i>Resistance</i></th></tr><tr><td>IVTIP1X - 1X sensor tip cable</td><td>≤0.2 Ω</td></tr><tr><td>IVTIP5X - 5X sensor tip cable</td><td>200 Ω ± 2%</td></tr><tr><td>IVTIP10X - 10X sensor tip cable</td><td>453 Ω ± 2%</td></tr><tr><td>IVTIP25X - 25X sensor tip cable</td><td>1.21 kΩ ± 2%</td></tr><tr><td>IVTIP50X - 50X sensor tip cable</td><td>2.49 kΩ ± 2%</td></tr></table>	<i>Sensor tip cable</i>	<i>Resistance</i>	IVTIP1X - 1X sensor tip cable	≤0.2 Ω	IVTIP5X - 5X sensor tip cable	200 Ω ± 2%	IVTIP10X - 10X sensor tip cable	453 Ω ± 2%	IVTIP25X - 25X sensor tip cable	1.21 kΩ ± 2%	IVTIP50X - 50X sensor tip cable	2.49 kΩ ± 2%
	<i>Sensor tip cable</i>	<i>Resistance</i>											
	IVTIP1X - 1X sensor tip cable	≤0.2 Ω											
	IVTIP5X - 5X sensor tip cable	200 Ω ± 2%											
	IVTIP10X - 10X sensor tip cable	453 Ω ± 2%											
	IVTIP25X - 25X sensor tip cable	1.21 kΩ ± 2%											
IVTIP50X - 50X sensor tip cable	2.49 kΩ ± 2%												
■ Measure the SMA input resistance of the Sensor Head using a 4-wire measurement; it should be between 47.5 Ω and 52.5 Ω. If not, then the Sensor Head has been damaged and needs to be returned to Tektronix for service.													
■ Check the controller STATUS indicator for possible error conditions.													
■ Apply a test signal directly to the SMA input of sensor head to determine if the problem is the sensor tip cable or the sensor head.													
Large DC offset in waveform	■ Run SELF CAL.												
	■ Run AutoZero.												
	■ Set Input Offset to 0.0 V.												
Cannot select between 1X and 2X range (5000/7000/70000 Series oscilloscopes)	When Auto Range is turned ON, the Range is selected automatically when the V/div setting is changed. You cannot change the Range directly (the button will appear to not function).												
Probe compensation fails (7000/70000 Series oscilloscopes)	This is a normal condition. You can ignore the failure.												

## Repack the measurement system for shipment

If you need to return the measurement system to Tektronix for repair, use the original packaging. If this is unavailable or not fit for use, contact your Tektronix representative to obtain new packaging.

When you return the measurement system to Tektronix, attach a tag showing the following information:

- Name of the product owner
- Address of the owner
- Instrument serial number
- A description of problems encountered and/or service required

## Test record

Photocopy this test record for recording the results of the performance verification procedures.

**Table 13: Test record**

Model number:

Certificate number:

Serial number:

RH %:

Temperature:

Technician:

Date of calibration:

<b>Propagation delay</b>	<b>Minimum</b>	<b>Incoming</b>	<b>Outgoing</b>	<b>Maximum</b>
TIVM1 (3 m fiber length)	30 ns			40 ns
TIVM1L (10 m fiber length)	61 ns			75 ns
TIVM02 (3 m fiber length)	30 ns			40 ns
TIVM02L (10 m fiber length)	61 ns			75 ns
TIVM05 (3 m fiber length)	30 ns			40 ns
TIVM05L (10 m fiber length)	61 ns			75 ns





---

## Appendix A: Remote programming

This appendix describes commands and queries that can be sent to the sensor head when attached to a Tektronix oscilloscope. Long-form and short-form keywords are indicated with upper/lower case letters. The commands and queries are supported by most oscilloscopes; differences in supporting oscilloscopes, if any, are described with the commands.

For details on the command syntax, refer to the programmer documentation for your oscilloscope.

### CH<n>:PRObe?

Returns probe information for channel <n>. Query only.

### CH<n>:PRObe:AUTOZero EXECute

This command executes the AutoZero function. The operation is first performed by the measurement system and then by the oscilloscope. Command only.

The system can be configured (with special keystrokes) to perform a full self calibration before the oscilloscope does its AutoZero.

Refer to the self calibration procedure for information on performing the self calibration. (See page 12, *Self calibration*.)

### CH<n>:PRObe:COMMAND “CLAMP”, {“ON” | “OFF”}

Only supported by 3000/4000 Series oscilloscopes.

The command enables or disables the clamp circuitry. The parameters enclosed in quotes are case sensitive and must be sent as capital letters.

CH<n>:PRObe:COMMAND? “CLAMP”. The query returns either “ON” or “OFF” enclosed in quotes.

### CH<n>:PRObe:SET {“CLAMP ON” | “CLAMP OFF”}

Only supported by 5000/7000/70000 Series oscilloscopes.

The command enables or disables the clamp circuitry. The parameters enclosed in quotes are case insensitive.

CH<n>:PRObe:SET?. The query returns either “CLAMP ON” or “CLAMP OFF” enclosed in quotes. The case is the same as the last command received.

## CH<n>:PRObe:FORCEDRange <NR3>

The command selects the dynamic range of the sensor tip in  $V_{p-p}$  and is dependent the attached sensor tip cable.

The following table lists the sensor tip cables and the dynamic range.

**Table 14: Sensor tip cables and dynamic ranges**

Sensor tip cable	Range $V_{p-p}$
1X	1.0 or 2.0
5X	5.0 or 10.0
10X	10.0 or 20.0
25X	25.0 or 50.0
50X	50.0 or 100.0

CH<n>:PRObe:FORCEDRange? The query returns the dynamic range of the sensor tip in  $V_{p-p}$ .

## CH<n>:PRObe:GAIN?

Returns the gain factor of the sensor tip (inverse of attenuation). Dependent on the attached sensor tip cable. Query only.

## CH<n>:PRObe:ID {:SERnumber | :TYPE}?

Query only. When sending only PRObe:ID?, the query returns the sensor tip type string followed by the serial number string.

When sending PRObe:SERnumber?, the query returns the serial number string.

When sending PRObe:TYPE?, the query returns one of the following sensor tip type strings (note the trailing spaces within the return strings):

- "TIVM1 " (1GHz, 3m)
- "TIVM1L " (1GHz, 10m)
- "TIVM05 " (500MHz, 3m)
- "TIVM05L" (500MHz, 10m)
- "TIVM02 " (200MHz, 3m)
- "TIVM02L" (200MHz, 10m)

## **CH<n>:PRObe:PROPDElay?**

Only supported by 3000/4000 Series oscilloscopes.

Returns the propagation delay value (in seconds). Query only.

## **CH<n>:PRObe:RECDESkew?**

Only supported by 3000/4000 Series oscilloscopes.

Returns the recommended deskew value (in seconds). Query only.

## **CH<n>:PRObe:RESistance?**

Returns the input resistance (in ohms). It depends on the attached sensor tip cable. Query only.

## **CH<n>:PRObe:UNIts?**

Returns the units of the sensor tip (always “V”). Query only.

## **CH<n>:PROBEControl {AUTO | MAN}**

Only supported by 5000/7000/70000 Series oscilloscopes.

The command sets the Auto or Manual sensor tip range control.

CH<n>:PROBE:PROBEControl?. The query returns the keyword AUTO or MANUAL.

## **CH<n>:PROBEFunc:EXTAtten <NR3>**

Only supported by 5000/7000/70000 Series oscilloscopes.

The command sets user-defined external attenuation factor.

CH<n>:PROBEFunc:EXTAtten?. The query returns the external attenuation factor.

## **CH<n>:PROBEFunc:EXTDBatten?**

Only supported by 5000/7000/70000 Series oscilloscopes.

Returns the external attenuation factor expressed in dB. Query only.

## **CH<n>:PROBEFunc:EXTUnits {"UU" | "None"}**

Only supported by 5000/7000/70000 Series oscilloscopes.

The command set the user-defined units. Only two characters are displayed by the oscilloscope. Entering "None" resets the units to default.

CH<n>:PROBEFunc:EXTUnits?. The query returns "V" unless a user-defined value has been entered.

---

## Appendix B: Compliance information

This section lists the Safety and Environmental standards with which the instrument complies.

### Safety compliance

This section lists the safety standards with which the product complies and other safety compliance information.

#### EU low voltage directive

Compliance was demonstrated to the following specification as listed in the Official Journal of the European Union:

Low Voltage Directive 2014/35/EU.

- EN 61010-1. Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use – Part 1: General Requirements.
- EN 61010-031. Particular requirements for handheld probe assemblies for electrical measurement and test equipment (partially applicable).

#### U.S. nationally recognized testing laboratory listing

- UL 61010-1. Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use – Part 1: General Requirements.
- UL 61010-031. Particular requirements for handheld probe assemblies for electrical measurement and test equipment (partially applicable).

#### Canadian certification

- CAN/CSA-C22.2 No. 61010-1. Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use – Part 1: General Requirements.
- CAN/CSA-C22.2 No. 61010-031. Particular requirements for handheld probe assemblies for electrical measurement and test equipment (partially applicable).

#### Additional compliances

- IEC 61010-1. Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use – Part 1: General Requirements.
- UL 61010-031. Particular requirements for handheld probe assemblies for electrical measurement and test equipment (partially applicable).
- EN 60825-1. Safety of Laser Products-Part 1: Equipment Classification and Requirements - Edition 2 2007
- US 21CFR PT1010 Performance Standard for Electronic Parts 2015.
- US 21CFR PT1040 Performance Standards for Light Emitting Products 2015.

<b>Equipment type</b>	Test and measuring equipment.
<b>Pollution degree descriptions</b>	<p>A measure of the contaminants that could occur in the environment around and within a product. Typically the internal environment inside a product is considered to be the same as the external. Products should be used only in the environment for which they are rated.</p> <ul style="list-style-type: none"> <li>■ Pollution degree 1. No pollution or only dry, nonconductive pollution occurs. Products in this category are generally encapsulated, hermetically sealed, or located in clean rooms.</li> <li>■ Pollution degree 2. Normally only dry, nonconductive pollution occurs. Occasionally a temporary conductivity that is caused by condensation must be expected. This location is a typical office/home environment. Temporary condensation occurs only when the product is out of service.</li> <li>■ Pollution degree 3. Conductive pollution, or dry, nonconductive pollution that becomes conductive due to condensation. These are sheltered locations where neither temperature nor humidity is controlled. The area is protected from direct sunshine, rain, or direct wind.</li> <li>■ Pollution degree 4. Pollution that generates persistent conductivity through conductive dust, rain, or snow. Typical outdoor locations.</li> </ul>
<b>Pollution degree rating</b>	Pollution degree 2 (as defined in IEC 61010-1). Rated for indoor, dry location use only.
<b>IP rating</b>	IP20 (as defined in IEC 60529).
<b>Measurement and overvoltage category descriptions</b>	<p>Measurement terminals on this product may be rated for measuring mains voltages from one or more of the following categories (see specific ratings marked on the product and in the manual).</p> <ul style="list-style-type: none"> <li>■ Category I. Circuits not directly connected to a mains supply.</li> <li>■ Category II. Circuits directly connected to the building wiring at utilization points (socket outlets and similar points).</li> <li>■ Category III. In the building wiring and distribution system.</li> <li>■ Category IV. At the source of the electrical supply to the building.</li> </ul> <hr/> <p><b>NOTE.</b> Only measurement circuits have a measurement category rating. Other circuits within the product do not have either rating.</p> <hr/>

## Environmental considerations

This section provides information about the environmental impact of the product.

### Product end-of-life handling

Observe the following guidelines when recycling an instrument or component:

**Equipment recycling.** Production of this equipment required the extraction and use of natural resources. The equipment may contain substances that could be harmful to the environment or human health if improperly handled at the product's end of life. To avoid release of such substances into the environment and to reduce the use of natural resources, we encourage you to recycle this product in an appropriate system that will ensure that most of the materials are reused or recycled appropriately.



This symbol indicates that this product complies with the applicable European Union requirements according to Directives 2012/19/EU and 2006/66/EC on waste electrical and electronic equipment (WEEE) and batteries. For information about recycling options, check the Tektronix Web site ([www.tek.com/productrecycling](http://www.tek.com/productrecycling)).





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