



**TDP7700 Series  
TriMode™ Probes  
User Manual**



071-3559-01







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TriMode™ Probes  
User Manual**

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# 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.

[W2 – 15AUG04]

# 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.

## 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.

This product is not intended for detection of hazardous voltages.

<b>Observe all terminal ratings</b>	To avoid fire or shock hazard, observe all rating and markings on the product. Consult the product manual for further ratings information before making connections to the product.  Do not apply a potential to any terminal, including the common terminal, that exceeds the maximum rating of that terminal.
<b>Do not operate without covers</b>	Do not operate this product with covers or panels removed, or with the case open. Hazardous voltage exposure is possible.
<b>Avoid exposed circuitry</b>	Do not touch exposed connections and components when power is present.
<b>Do not operate in wet/damp conditions</b>	Be aware that condensation may occur if a unit is moved from a cold to a warm environment.
<b>Do not operate in an explosive atmosphere</b>	
<b>Keep product surfaces clean and dry</b>	Remove the input signals before you clean the product.

### Probes and test leads

Remove all probes, test leads and accessories that are not in use.

<b>Inspect the probe and accessories</b>	Before each use, inspect probe and accessories for damage (cuts, tears, or defects in the probe body, accessories, or cable jacket). Do not use if damaged.  Use only specified replacement parts.
--	--

## Terms in the 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.

## 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.

## Symbols on 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 symbols may appear on the product:



CAUTION  
Refer to Manual

# Compliance Information

This section lists the EMC (electromagnetic compliance), safety, and environmental standards with which the instrument complies. This product is intended for use by professionals and trained personnel only; it is not designed for use in households or by children.

## Environmental compliance

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

### Restriction of hazardous substances

Complies with RoHS2 Directive 2011/65/EU.

### Product end-of-life handling

Observe the following guidelines when recycling an instrument or component:

#### Equipment recycling

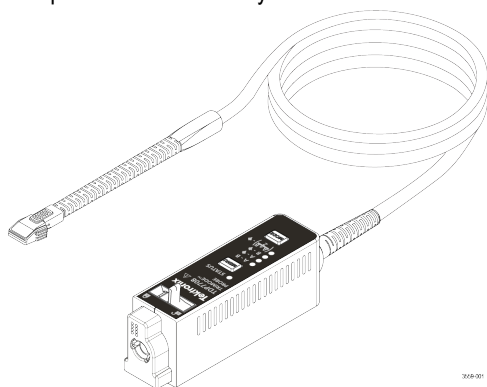
Production of this equipment required the extraction and use of natural resources. The equipment may contain substances that could be harmful to the environment or human health if improperly handled at the product's end of life. To avoid release of such substances into the environment and to reduce the 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)).

## Key features

The TDP7700 Series TriMode Probes allow you to take differential, single-ended, and common mode measurements with one probe connection. Key features include:



- Low loading for low power standards like MIPI D-PHY
- Thin flexible solder-in tips that can fit into tight spaces on a device under test
- Lightweight and Flexible probe cable and head
- TekFlex™ connector technology that makes the probe easy to connect to accessories
- Optional 2.92 mm adapter for connecting to 50  $\Omega$  RF test points
- Browser accessory with adjustable tip and auto corrected response to pin spacing
- Full AC calibration of the probe and accessory tips with unique S-parameters automatically downloaded to the scope at plug-in.
- Flexible solder-in tips and main probe cable
- Solder-in tips operate at extended temperature range

# Operating considerations

Table 1: TDP7700 Series TriMode probes

Characteristic	Description	Specification		
		TekFlex solder-in tips	P77BRWSR	P77C292MM adapter
Input Voltage	Dynamic range	2.5 Vpp (single-ended)	6.0 Vpp (single-ended)	1.2 Vpp (single-ended)
		5.0 Vpp (differential input)	12.0 Vpp (differential input)	2.0 Vpp (differential input)
	Operating voltage window	±5.25 V	±10.0 V	±4.0 V
	Offset voltage range	-4 V to +4 V	-10 V to +10 V	-4 V to +4 V
	Maximum non-destructive input voltage	-15 V to +15 V (tip attached or detached)		-5 V to +5 V
Temperature	Operating	Probe compensation box: 0 °C to 50 °C (32 °F to 122 °F)		
		Probe cable, solder tips, and P77C292MM adapter: -35 °C to 85 °C (-31 °F to 185 °F); Minimum Airflow required 46°C to 85°C (114.8 °F to 185 °F)		
	Non-operating	Probe compensation box: -20 °C to 60 °Cg (-4 °F to 140 °F)		
		Probe cable, solder tips, and P77C292MM adapter: -35 °C to 85 °C (-31 °F to 185 °F)		
Humidity	Operating	Probe compensation box: 5% to 90% Relative Humidity (%RH) at up to 40 °C non-condensing, 5% to 55% RH above 40°C up to 50°C non-condensing		
		Probe cable, solder tips, and P77C292MM adapter: 20% to 80% Relative Humidity (%RH) at up to 50 °C non-condensing		
	Non-operating	Probe compensation box: 5% to 90% Relative Humidity (%RH), at up to 40 °C non-condensing, 5% to 55% RH above 40 °C up to 60 °C non-condensing		
		Probe cable, solder tips, and P77C292MM adapter: 10% to 85% Relative Humidity (%RH), at up to 85 °C non-condensing		
Altitude	Non-operating	Probe Compensation Box, Cable, Tips, and SMA adapter: 12,000 meters (39,370 feet)		
Pollution Degree		2, Indoor use only		



**CAUTION:** To avoid ESD damage to the probe, always use an antistatic wrist strap (provided with your probe), and work at a static-approved workstation when you handle the probe.

## Installation overview



**CAUTION:** To avoid ESD damage to the probe, always use an antistatic wrist strap (provided with your probe), and work at a static-approved workstation when you handle the probe.

1. Connect the probe to the host instrument.

If it is the first time the probe has been connected to the oscilloscope, the oscilloscope will download the S-parameters stored in the probe and cycle through the LEDs. Once the oscilloscope has stored the S-parameters for the probe, it doesn't matter which channel the probe is plugged into. The stored S-parameters will be available for any channel the probe is moved to.

2. Connect the probe tip to the TekFlex connector on the probe.

When a tip is inserted into the probe for the first time, the oscilloscope will download the S-parameter data stored in the tip.

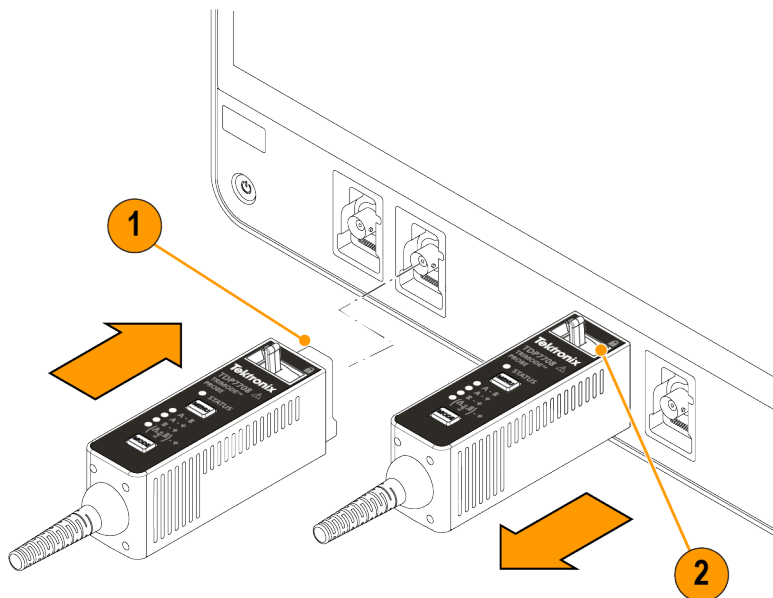
3. The probe performs a self test, and then one Input Mode LED remains on. The Status LED is also lit green.
4. Double-tap the channel badge to open the configuration menu.
5. Tap the Probe Setup panel to open the Probe Setup panel to confirm probe settings.
6. Use the Probe Setup panel to set the probe parameters as described in the *Basic operation* section.

## Connect to the host instrument



**Note:** Your FlexChannel instrument may require a firmware upgrade to support full functionality of the TDP7700 Series probes.

1. Slide the probe into the FlexChannel receptacle. The probe clicks into place when fully engaged.
2. Move the locking lever to the locked position.



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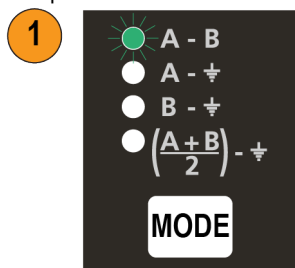
## Disconnect

To disconnect the probe, move and hold the locking lever at the unlocked position and pull out the probe.

## Probe and probe tip power-on

After the connection to the oscilloscope is made:

1. The probe cycles through all mode LEDs during a self-test and while S-Parameters are transferred to the instrument, and then the A – B Input Mode LED remains on. If a probe tip is attached, an LED on the tip also turns on when properly attached to the probe<sup>1</sup>.
2. The probe transfers data from the probe and tip to the host instrument.



The data transfer takes a few minutes, and is only done when the host instrument discovers a new probe or new probe tip. The data transfer only occurs on instruments that are fully compatible with the probe.

3. After the data transfer is done, the probe is ready for a functional check. See [Functional check](#). If the probe's status LED is red, the power-on self-test likely failed. See [Error conditions](#) on page 40.

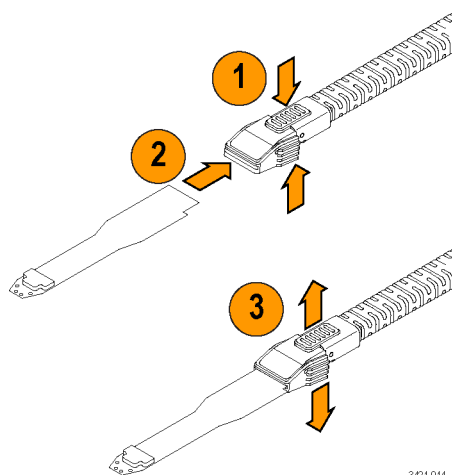
## Connect accessories to the TekFlex connector

All of the TDP7700 accessories mate with the new TekFlex (zero insertion force) connector. This connector provides an easy connection for attaching to the TDP7700 series accessories. The following procedures show the steps for connecting probe tips to the TekFlex connector; the procedures for connecting to other accessories are similar.

Connect the tip to the probe TekFlex connector as follows:

1. Pinch the TekFlex connector to open the jaws.
2. Orient the tip with the probe head (notch to the left) and slide the tip connector into the TekFlex connector.

A green LED will light up when the tip is inserted<sup>1</sup>. The LED is the first indication that the tip is powered and is inserted. You also need to confirm that the connector pins on the TekFlex connector fit through the alignment holes on the tip.



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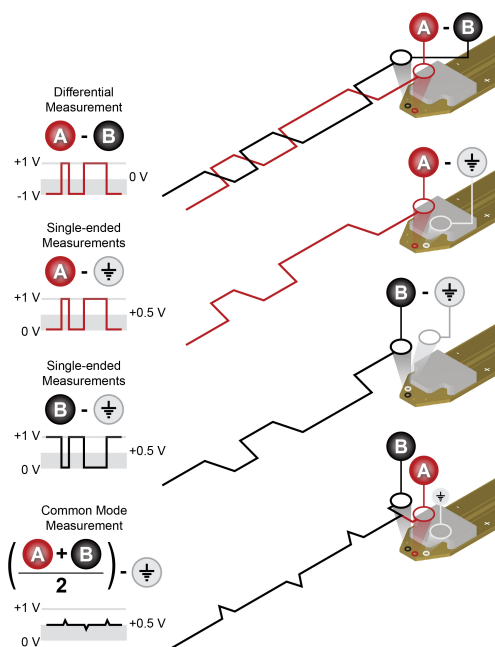
3. Once the tip is fully inserted, release the pinch and the TekFlex connector closes. When closed and properly seated, the top of connector will be flush with the probe tip housing.

<sup>1</sup> The P77C292MM does not contain an LED.

## TriMode probing

The TriMode feature allows you to view two single-ended signals and the resultant differential waveform and common-mode voltage without moving the probe connection. Press the Input Mode button to cycle through the waveform views.

This example shows a typical signal on the A and B inputs. The resultant differential waveform and common-mode voltage are shown.



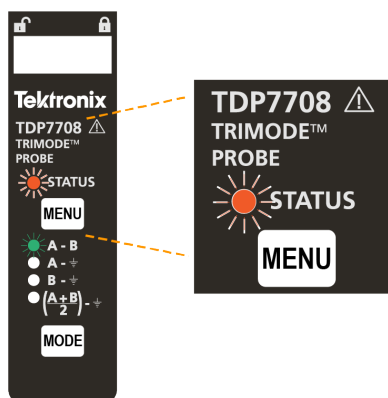
## Probe comp box controls and indicators

### Status LED

The Status LED glows red under the following conditions:

- Probe power-on self test failure
- Probe over-temperature detected
- The input voltage on either the A or B input exceeds the allowable limit or more than 50 mA is drawn by the inputs on the P77C292MM

The Status LED is green when the condition causing the warning is removed and under normal operation. A notifier message of a probe status condition can also be seen on the oscilloscope.



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**CAUTION:** Do not exceed the input voltage limits of the probe and probe tips. The probe or oscilloscope circuits may be damaged if the limits are exceeded. Make sure that you understand and work within the limits of the probe and probe tips.

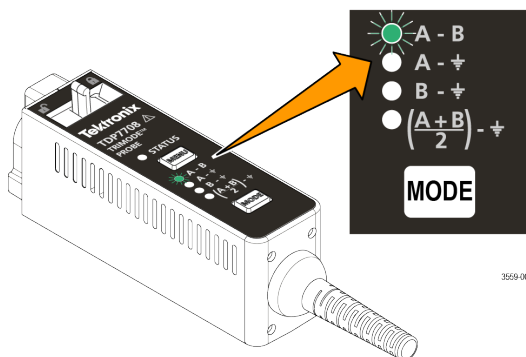
The TriMode feature allows you to view two single-ended signals and the resultant differential waveform and common-mode voltage without moving the probe connection. Press the Input Mode button to cycle through the waveform views.

### Input mode buttons and LEDs

The TDP7700 Series solder-in tips support TriMode operation. TriMode enables you to switch the probe between four different measurement types without changing the probe's connection.

Press the Input Mode button to select one of the four TriMode measurements. The modes cycle in the following sequence:

- A – B (for differential signal measurement)
- A – GND (for A input single-ended measurement)
- B – GND (for B input single-ended measurement)
- $(A + B)/2$  – GND (for common mode measurement)



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**Note:** You can also change the Input Mode in the oscilloscope Probe Setup panel.

# Functional check

After you connect the probe to the oscilloscope, you can perform a functional check using either the optional P77DESKEW deskew fixture designed for the probe or the optional P77C292MM Adapter.



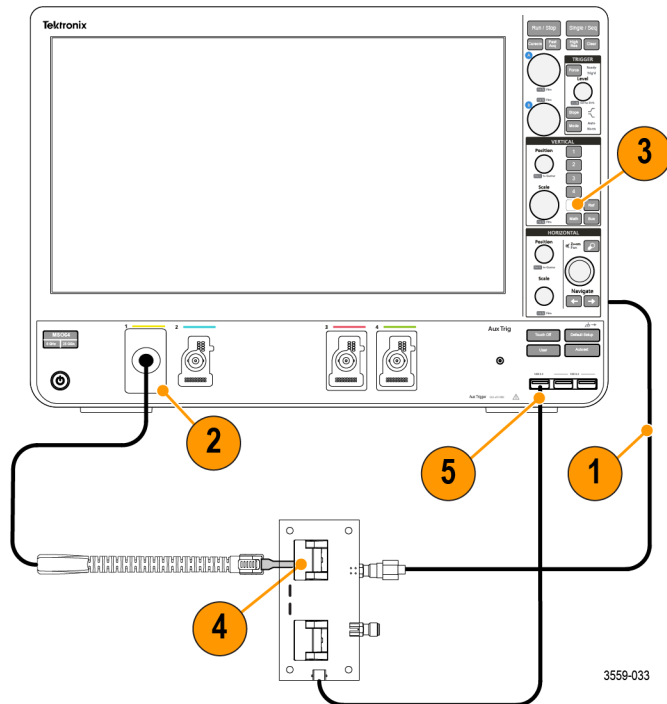
**CAUTION:** To avoid ESD damage to the probe, always use an antistatic wrist strap (provided with your probe), and work at a static-approved workstation when you handle the probe.

The following procedure checks the four TriMode settings on the probe. It verifies the signal path of both the probe A and B input signals and their combination in the four TriMode settings.

**Table 2: Required equipment, functional check with probe tip**

Item Description	Performance Requirement	Recommended Example
Oscilloscope	FlexChannel Interface	Tektronix MSO6 Series
Probe tip	Solder tip or Browser tip	P77STFLXA
Test board	Probe deskew fixture	P77DESKEW <sup>2</sup>
Signal generator	100 kHz square wave, 1 V <sub>pk-pk</sub> into 50 Ω	6 Series MSO AFG output <sup>2</sup>

## Test setup with the P77DESKEW deskew fixture



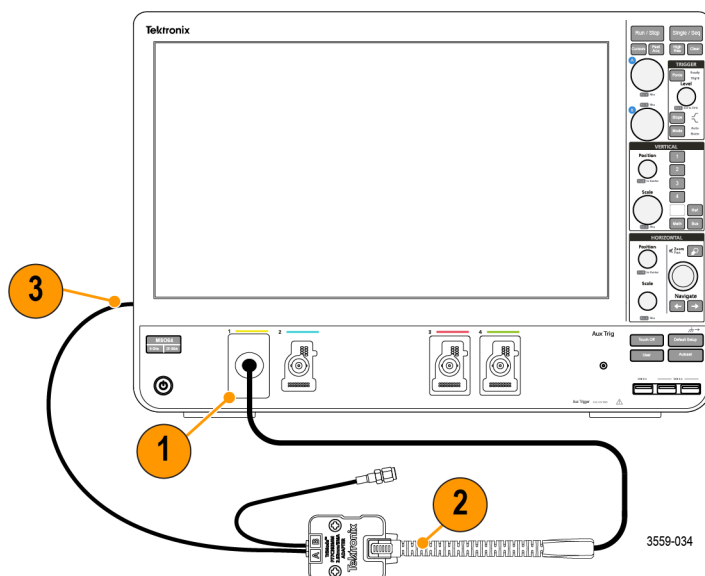
1. Connect an SMA cable from a signal source, such as the AFG output connector on the oscilloscope to the A input of the fixture.
2. Connect the probe to the desired channel of the oscilloscope.
3. Set the oscilloscope to display the connected channel.

<sup>2</sup> Optional accessory

4. Connect the included P77STFLXA TekFlex solder in tip to the TDP7700 probe using the pinch to open TekFlex connector at the end of the main cable. Insert the P77STFLXA in to the plastic clamp on port 1 or 2 of the deskew fixture. This is done by compressing the spring-loaded clamp, inserting the probe tip input into the clamp, and then releasing the clamp so that it locks the connection.
5. Connect the deskew fixture to a USB power source, such as the front panel USB connector on the oscilloscope. The LEDs on the fixture will turn on.
6. If a P77BRWSR tip is used instead of a solder-down tip to make connection to the Deskew Fixture, the TekFlex connector of the probe should first be connected to the P77BRWSR tip. The P77BRWSR tip inputs must then be pressed into place against the A and B signal trace on the deskew fixture. Either of two sets of A and B signal trace connection points may be used

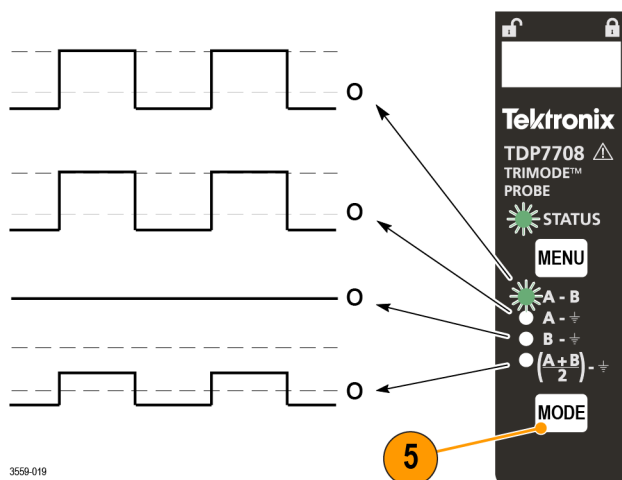
### Test setup with the P77C292MM adapter

1. Connect the probe to the desired channel of the oscilloscope. Connect the probe to the P77C292MM adapter. Set the oscilloscope to display the connected channel.
2. Connect the A cable from the P77C292MM adapter to the AFG Out connector.

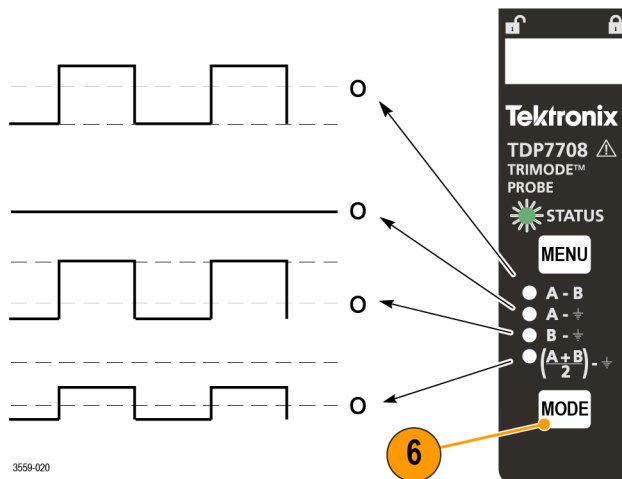


### Test procedure

1. Set the signal generator so that it produces a  $1 V_{pk-pk}$  100 kHz square wave.
2. Set the probe Input Mode to A-B.
3. Adjust the oscilloscope to display a stable waveform (or press the Autoset button). The test signal is a 100 KHz square wave. The amplitude of the signal is attenuated by 4X, compared to a single path termination, due to the power splitter built into the deskew fixture.
4. When you see a stable square waveform, check the amplitude. The attenuated amplitude displayed for the test signal should be about  $250 mV_{pp}$ .
5. Cycle the Input Mode button through the remaining selections and compare the displayed waveforms to the waveform measured in the setup steps.
  - A-B
  - A-GND (same amplitude and polarity as previously measured)
  - B-GND (the B input is grounded; no signal is measured)
  - (A+B)/2- GND (half-amplitude, but the same polarity as previously measured)



6. Change the SMA cable connection from the Deskew Fixture A input to the B input. Repeat the displayed waveform checks. The measurements should be different as follows:



- A-B (the polarity of the signal will be inverted due to the B signal inversion, although the p-p amplitude should be the same)
- A-GND (the A input is grounded; no signal is measured)
- B-GND (same amplitude but non-inverted polarity compared to the A-B mode)
- (A+B)/2- GND (half-amplitude, but the same polarity as measured in the B-GND mode)

## Basic operation

This section includes information about the probe input limits, using the probe controls, and procedures for connecting the probe to your circuit.

A simplified input model of the probe is shown below to illustrate the probe offset voltage controls. The probe has two symmetrical signal inputs, the A input and the B input, which you can display independently or in combination by selecting the appropriate probe input mode. The probe also has independent offset voltage controls for the probe A and B input signals.

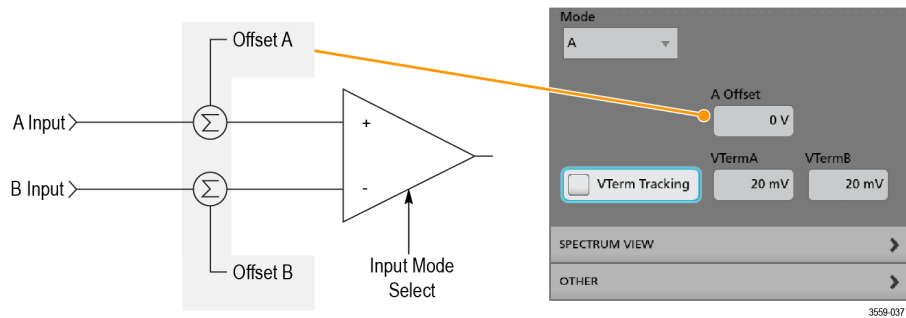


Figure 1: Simplified probe input model

## Offset voltage

The offset voltage adjusts the probe input dynamic range within the larger probe input operating range. The probe input dynamic range is the region where an input signal is within the linear operating region of the probe. The probe A and B offset voltages are set and stored as common settings for all four input modes.

## Using the offset voltages

The offset voltage shifts the center of the dynamic range, allowing more resolution for inputs not around ground. The size of the probe input dynamic range depends on the probe tip that you are using and can also depend on the input mode selected.

To set the offset voltages on the probe, you can use the controls in the Probe Setup panel. See [Probe setup panel](#) on page 22.

To display the Probe Setup panel, double tap the channel badge to open the configuration menu. Tap Probe Setup to open the Probe Setup panel. Make changes to the offset.

## Probe setup panel

Use the Probe Setup panel to adjust the probe input settings for the measurement you are taking. To display the Probe Setup panel, double-tap the channel badge and then tap Probe Setup. The Probe Setup panel can be used to select the TriMode Input Mode setting and is also used to adjust the offset voltage controls for the probe tip A and B inputs.

The following pages describe the controls and status fields in the Probe Setup panel.

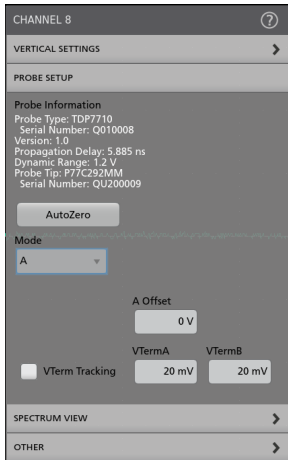


Figure 2: Probe setup panel

## Selecting the TriMode input mode

The input Mode button on the probe toggles the internal probe input selector switches among the four input mode selections. The mode can also be selected from the Mode list in the Probe Setup panel. This TriMode feature allows full characterization of a differential signal from a single connection.



**A-B mode** The A-B Mode is used for making differential signal measurements and represents the traditional differential probe functionality. Since the A-B Mode measures the difference between the A and B input signals, it eliminates any common mode voltage, such as a DC bias common to both inputs, within the CMRR performance capability of the probe.

**A-GND mode** The A-GND mode is used for making single-ended measurements with the probe A input. The probe ground input connects the probe tip and main cable shield. The A-GND Mode is designed for minimal coupling from any signal present on the B input within the A input isolation performance of the probe.

**B-GND mode.** The B-GND mode is used for making single-ended measurements with the probe B input. The probe ground input connects the probe tip and main cable shield. The B-GND Mode is designed for minimal coupling from any signal present on the A input within the B input isolation performance of the probe.

**(A+B)/2 mode.** The (A+B)/2 Mode is used for making common mode measurements on a differential signal and represents a capability that previously could only be made using oscilloscope math on multiple channels. For a differential signal, the common mode measurement indicates the DC bias level and also shows the degree of asymmetry between the A and B inputs. Since the (A+B)/2 Mode measures the average between the A and B input signals, it eliminates any complementary

differential signal voltage, within the DMRR performance capability of the probe. This measurement also requires a ground connection to the probe.

## Selecting the offset voltage

You can set both the A and B offset voltages to levels that are common for all input modes.

You can enter specific offset values directly in the Offset fields.

There are manual offset voltage value entry fields which also display the current offset voltage settings. An offset voltage entry field is activated for adjustment by tapping the setting window. A single tap activates both the setting window and the general purpose knobs on the oscilloscope front panel. A second tap in the setting window when activated also brings up a keypad entry window.

The oscilloscope vertical channel offset control also adjusts the selected Input mode offset voltage field.

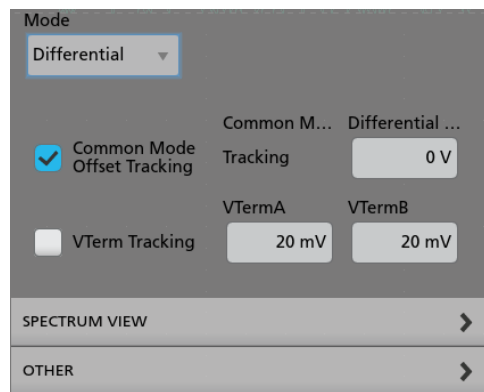
## Offset tracking set up

The probe A and B signal inputs are sensed, monitored, and averaged by probe internal circuitry and the sensed values are used by the offset tracking control buttons.

### Common Mode Offset Tracking

When this mode is selected Common Mode Offset is set to tracking.

Common Mode Tracking automatically sets the common mode offset to the average of the inputs  $(A+B)/2$ .



### Differential Mode Offset Tracking

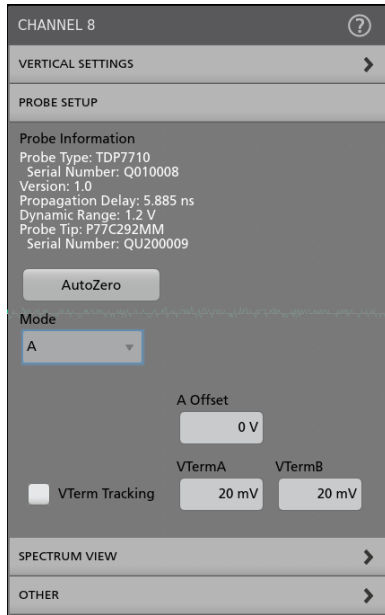
When this mode is selected Differential Mode Offset is set to tracking.

Differential Mode Tracking automatically sets the differential mode offset to the difference of the inputs  $(A-B)$ .

## Termination voltage

For the P77C292MM adapter, the termination voltage adjusts the effective probe DC loading of the 50  $\Omega$  input termination. Use the voltage to minimize the DC loading of the probe input signals. By setting the voltage equal to the DC bias voltage of the input signal, the probe DC loading is nulled out, as if a DC block was inserted. However, unlike a DC block, the signal DC voltage is still present at the probe input and might require you to adjust the Offset voltage to move the signal into the probe input dynamic range. There are some signal measurement applications that benefit from the availability of an adjustable termination voltage and avoid the need for a pair of bias tees.

The probe A and B termination voltages are common for each of the four input modes. When using the P77C292MM adapter, the voltage can be adjusted over a limited operating range before reaching an overload condition. If **VTerm Tracking** is checked, the termination voltages are set automatically.



## Probe tip information



**Note:** Probe tip ID is fully automatic. Manual selection is not required.

When the probe is first connected to the oscilloscope channel, the oscilloscope queries the probe for status information, including the probe type, serial number, and the model number of the tip that is connected to the probe. The first time a probe or probe tip is connected to a host oscilloscope, the probe and probe tip serial numbers are logged and the stored S-parameters are downloaded. If the probe or probe tip are moved to another channel on the same oscilloscope, the logged information is automatically processed without repeating the download process.

## Improving measurement accuracy

This section covers some of the features and characteristics of the probe that can affect the accuracy of your measurements, and some steps that you can take to improve the performance of the probe.

### Probe architecture

The probe measurement setup, as shown in the simplified drawing below, requires a host FlexChannel oscilloscope, a TDP7700 Series probe, and probe tips. An active probe tip includes a dual input buffer capable of driving the 50 ohm signal path of the probe TekFlex connector and probe main cable. The dual input buffer is designed for good matching of the A and B probe tip inputs to support differential measurements.

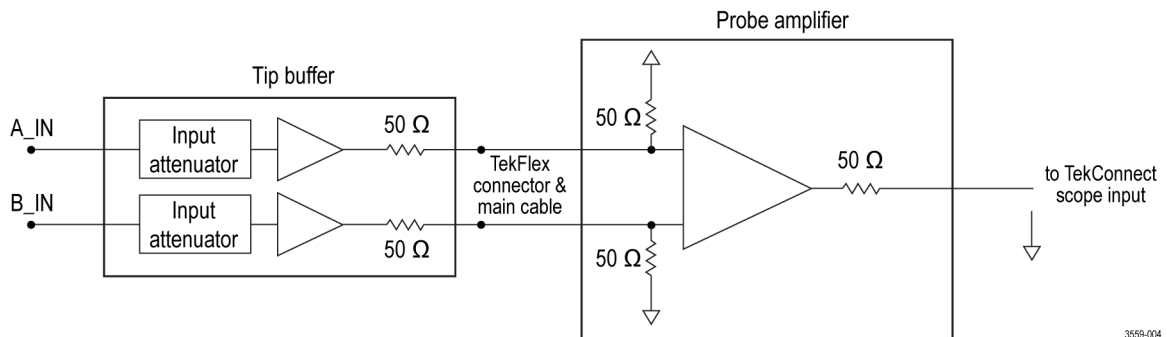


Figure 3: Simplified probe architecture diagram

3559-004

The probe tip dual input buffer also provides high DC resistance input attenuators, which are carefully designed to minimize high frequency loading on the input signals. The attenuation factor of the buffer input attenuators depends on the probe tip type. Using a different attenuation factor allows you to trade-off dynamic range for noise performance.

The probe comp box contains the main probe amplifier, as shown above. This main probe amplifier has a differential input termination network that receives the buffered A and B input signals from the active probe tip. The main probe amplifier has a TriMode input configuration for switching between differential, single-ended, and common-mode measurements. The probe main amplifier has a wide gain range with variable gain control for calibrated gain performance and to optimize noise performance. The probe main amplifier is also capable of driving the 50 ohm signal path of the probe FlexChannel interface with the host oscilloscope.

## Solder-in tip connection wire length

There are four via locations for soldering wire connections between the probe tip and the measurement DUT.

The via connections include the probe tip A and B inputs for a differential signal and two ground connections for best performance and flexibility in connecting to a close DUT ground. In general, the probe tip soldered wire connection length should be kept as short as possible. In addition, the probe tip A and B input wires should be matched in length for best Differential mode measurement performance.

The Differential input mode does not require a ground reference wire connection, since the differential measurement process provides its own virtual ground. The single-ended input modes, which include A-GND mode, B-GND mode, and Common mode, all require at least one ground wire connection. However, if there is room for another connection and a circuit ground near the probe tip, hooking up a ground connection is recommended. This might help avoid a situation where a large potential on the ground plane of the DUT causes the test signal to drift outside of the linear range of the input amplifier of the probe. Ideally, it is a good idea to hook up the differential inputs and the ground to avoid clipping of the signal in the probe amplifier.

The measurement performance of the single-ended input modes is affected by the length of the ground wire connection, with high frequency performance degradation increasing with increased ground wire length. The solder-in probe tip performance is specified using a test fixture built with a probe tip having a signal wire length of 10 mils (.25 mm) and a ground wire length of 66 mils (1.7 mm).

Please see the *Probing tips for high performance design and measurement* application note available for download at the Tektronix website for more detailed specifications on wire length as it affects tip performance. (See [Probing Tips for High Performance Design and Measurement](#).)

## Using offset voltage to extend TDP7700 series solder-in tip input voltage range

The single-ended linear dynamic range of the TekFlex solder-in tip inputs is specified to be  $2.5 V_{p-p}$ , which is a range from -1.25 V to +1.25 V with zero volt offset. The dynamic range of TDP7700 Series buffers is limited by the input attenuation factor, which is 2X for the solder-in probe tips as shown in the simplified drawing. A 4X attenuation factor was selected for the probe tips as a compromise between dynamic range and noise, since a higher attenuation factor would have increased probe noise.

Although the dynamic range of the probe tip buffer cannot be extended, it is possible to extend the range over which the tip dynamic range window can be moved by adjusting the probe offset voltage. The offset voltage range of the TekFlex solder-in tips is -4 V to +4 V, which is adjusted using the Probe Setup screen of the oscilloscope or the offset knobs on the oscilloscope front panel. Using the offset voltage controls, it is possible to make measurements within any  $2.5 V_{p-p}$  window between -5.25 V and +5.25 V. For example, by setting the offset voltage to +3.0 V, it is possible to measure an HDMI signal, which has a signal swing between about +2.8 V and +3.3 V.

## Making single ended measurements using the P77BRWSR differential probe tip

A TriMode tip provides solder connections for a DUT ground reference for both the A and B probe inputs making single-ended measurements with a TriMode probe tip straightforward. Although the differential input mode of the probe is normally used to make a differential signal measurement, single-ended measurements can be made using Differential Input mode

when the probe input connections and offset voltage controls are configured properly. This single-ended configuration process is particularly important to understand when using the tip, since this variable-spacing Browser tip operates only in Differential Input mode. Differential Input mode provides a measurement of the difference ( $A - B$ ) between the A and B input signals. If the probe tip B input is connected to a DUT ground, the resulting Differential Input mode measurement ( $A - 0\text{ V}$ ) results in a display of the single-ended A input signal response.

When making differential signal measurements, the P77BRWSR Offset Voltage control is normally set to the Common-mode (CM) Tracking mode. With CM tracking mode active, the A and B input signals are monitored and the Offset A and Offset B settings are both adjusted to match the DC common-mode voltage of the A and B input signals  $[(A + B)/2]$ . The differential Offset voltage should be set manually to the center of the signal voltage swing. The common mode offset should be set to 1/4 of the signal swing. For a +5 V CMOS logic signal; for example, the differential offset voltage should be set to +2.5 V and the common mode offset should be set +1.25V. The A signal input voltage should then range from +5 V to 0 V, which is within the 6 Vp-p dynamic range of the Browser tip as long as the offset voltage is set near the center of its expected voltage swing. These offset settings maximize the dynamic range of single ended measurements for the differential browser.

## Temperature compensation

These probes employ temperature compensation to optimize measurement accuracy.

To maximize measurement accuracy when the probe is first powered on from a cold start condition, you must allow the probe and oscilloscope a 20 minute warm-up period. A fan is used to stabilize temperature and may come on from time to time.

## DSP correction

This series of probes contain S-parameter characterization data for the probe, which is downloaded to the attached oscilloscope when the probe is first connected. The probe tips also contain S-parameter characterization data for the tip, which is also downloaded to the attached oscilloscope when the probe tip is attached to the probe. This probe and tip characterization data is used to generate DSP correction filters that improves high frequency measurement accuracy.

## Solder tip measurement configuration

In many of the high-frequency signaling standards that the TDP7700 Series probes are designed for, a 50  $\Omega$  termination at the transmitter is in parallel with another 50  $\Omega$  termination at the end of the transmission line path, effectively making a 25  $\Omega$  signal source impedance. In this application, the solder tip adapter measurement configuration is designed to pick off the transmitted signal at a location in the signal transmission path.

The input impedance for a solder tip, Z probe, varies with frequency. For a P77STFLXA tip the DC input resistance is about 50 k $\Omega$  and decreases with frequency above about 10 MHz to about 100  $\Omega$  above 10 GHz.

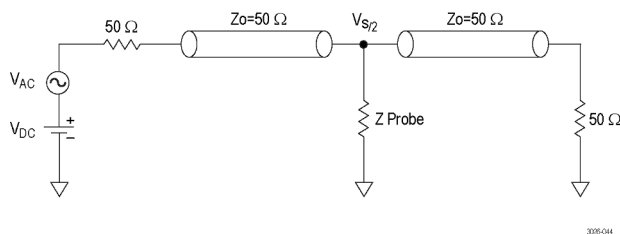


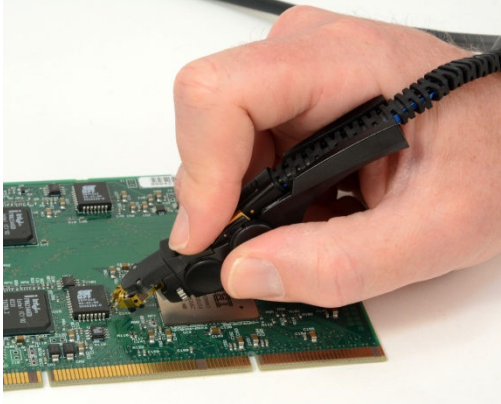
Figure 4: Solder tip measurement configuration

## Connecting to a circuit board

TriMode tips are necessary to complete the connection between the TDP7700 Series probes and your circuit. The tips are available as both standard and optional accessories and provide several connection options.

## P77BRWSR browser and accessories (Pen wand and hands free Tri-Pod)

The browser connects to the circuit using two tips with very fine point tips. These tips have built-in compliance (0.02", 0.5 mm) and adjustable spacing (.008-.210" (0.2-5.3 mm)). The browser can be held in place with a hand or can be used with the hands free Tri-Pod accessory or a probe positioner such as the Tektronix PPM203B. See [Making single ended measurements using the P77BRWSR differential probe tip](#) on page 26.



The browser is a differential only probe accessory, but can be used to measure ground referenced, single-ended circuits as well. When measuring a ground referenced signal, connect the A side (positive) input to the signal to be measured and the B side (negative) input to the ground connection.



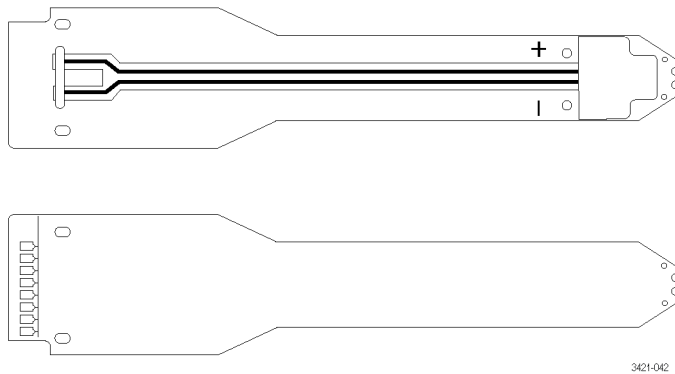
**Note:** The pins on the browser are small and delicate, so use caution when pressing them to make a connection.

If a probe tip breaks, it can be easily replaced. See [Browser tip replacement](#) on page 40.

## Flex circuit based solder tips

The flex circuit based solder tips are connected to the circuit using thin (38 AWG) wire connected to the vias on the tip. The steps to follow when soldering the tip to the circuit are shown in the soldering procedure section below.

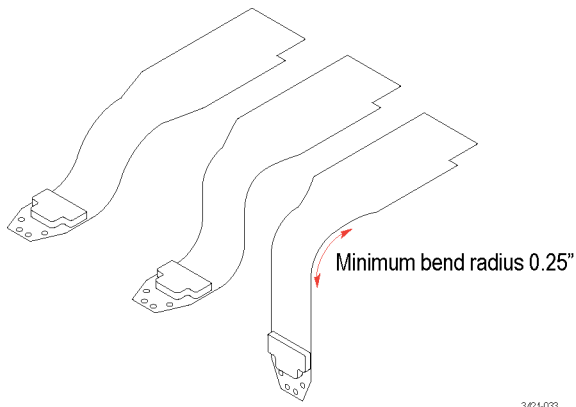
The flex circuit based solder tips support TriMode operation. To use TriMode, a minimum of three connections are needed, the A and B side inputs and one of the ground connections.



The flex circuit based solder tips are made with flex circuit material and can be bent and shaped to fit around or into spaces where it is difficult to reach a test point.

The minimum bend radius for the flex tips is 0.25 in (6.35 mm). There is no impact on the performance of the tip when it is bent into a curved shape that conforms to bend radius limits.

Typical life for tips are 30 - 50 bending cycles before replacement is needed.

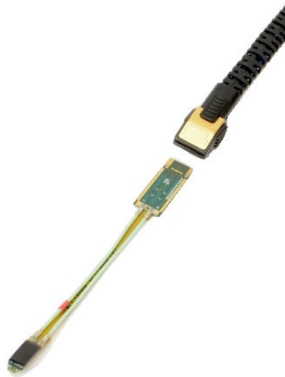


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### P77STCABL Solder-in Tip

The P77STCABL solder-in tips have similar input via connections for thin (38 AWG) wire. The steps to follow when soldering this tip to the circuit are identical to the flex circuit based solder tips and are shown in the soldering procedure section below. These tips are longer than the flex circuit based solder tips and are more flexible.

These tips support TriMode operation. To use TriMode, a minimum of three connections are needed, the A and B side inputs and one of the ground connections.



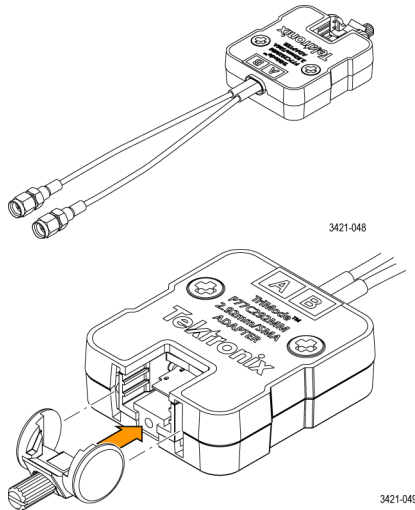
**Note:** There is no exposed metal surface on the P77STCABL tip except for the TriMode inputs and the TekFlex contacts.

### P77C292MM, 2.92 mm Adapter

Use this adapter to connect a TDP7700 series probe to a DUT with 50  $\Omega$  test point connectors. Also use the adapter to connect to SMA connections.

After connecting the adapter to the flex cable, use the retainer to provide a secure connection to the flex cable to minimize movement or to attach the adapter to the hand's free tripod.

An accessory kit is available with linkage adapters for stacking the adapters.



## Tip soldering



**CAUTION:** This procedure uses equipment at high temperature. Avoid touching hot surfaces.

### Recommended equipment

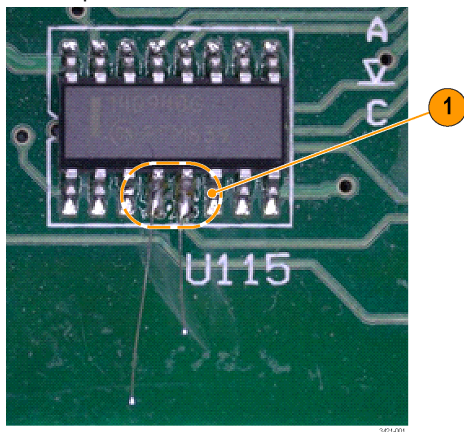
- Lead-free solder
- 4 mil diameter (38 AWG) wire
- MetCal Soldering Station + UFTC-7CN04 (Conical UltraFine Soldering Cartridge, max tip temp 775 °F (412 °C)) or equivalent

- Solder-Wick Rosin SD Size #1 (80-1-10) or equivalent
- Tweezers and sharp wire cutters

### Tip soldering procedure

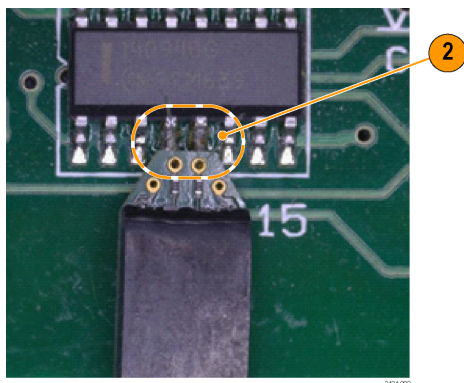
Keep the wires short as possible for best signal fidelity. Soldering wires first to the test points and then attaching the TDP7700 Solder tips is the best way to keep wire lengths short.

1. Solder wires to the test points. Cut wires with different lengths. This will make it easier to thread the wires onto the solder tips.



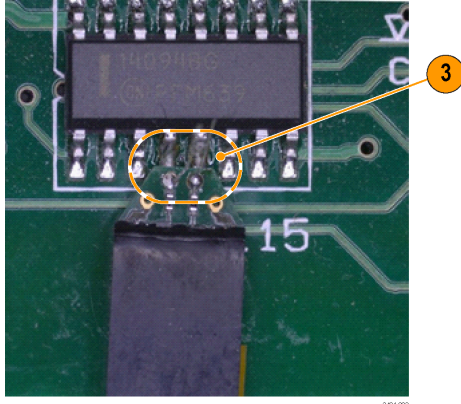
2. Thread tip onto wires. The two middle vias are the A(+) and B(-) inputs of the tip.

You may find it useful to use the double-sided foam tape that was shipped with your probe to hold the probe tip in place.

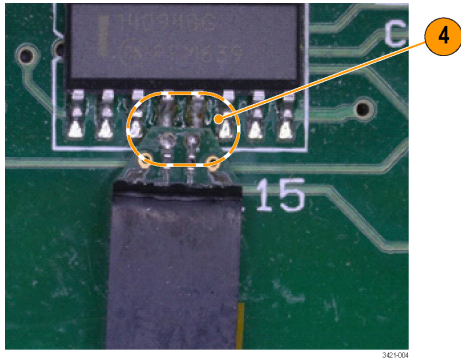


**Note:** The double-sided foam tape is only good for one use. For maximum strain relief, always use a fresh piece of tape each time you attach a tip.

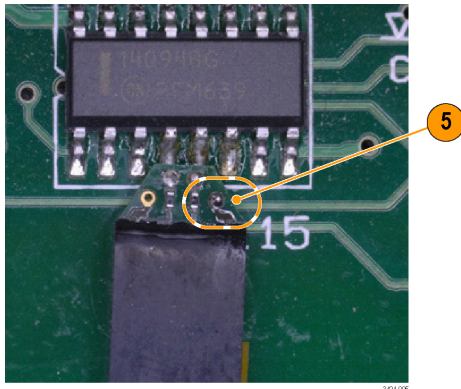
3. With the tip in position, quickly solder the wires to the vias. If the soldering iron is left too long on the tip, it may cause the 0201 input resistors to reflow and move.



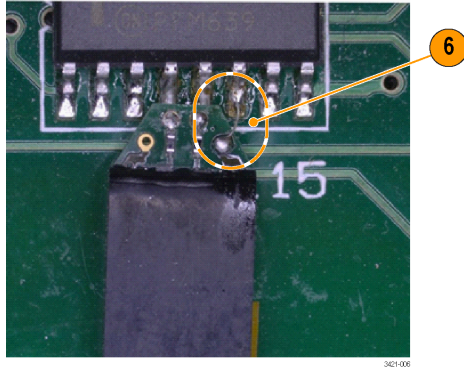
4. Trim wires flush with the board on the probe tip.



5. Attach the ground wire for TriMode input to the probe tip. First add solder to the test point and the nearest ground via on the solder tip.

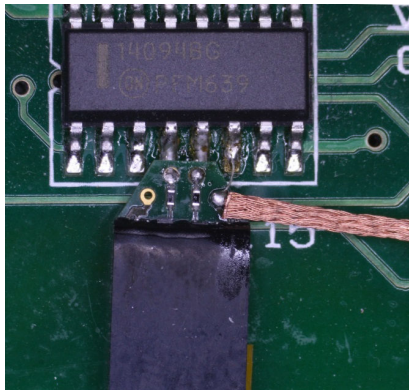


6. Second, solder a short piece of wire between the ground via on the tip and the ground test point. This configuration optimizes the performance of the probe for differential measurements. Longer wires on the ground path will have an impact on Single-Ended Mode and Common Mode performance. If there is a ground test point conveniently placed, it would be best to use the same solder technique shown on the A and B inputs of the tip to ensure the shortest ground path. Once the tip is fully soldered in place, it is recommended to firmly secure the tip to the board using additional foam tape or hot melt glue.

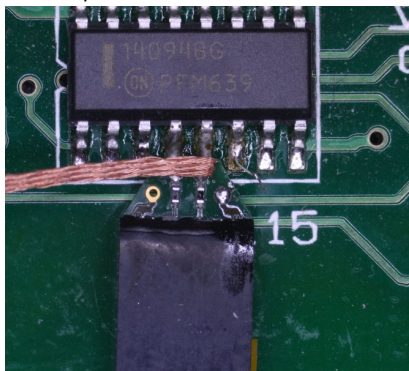


### Tip unsoldering procedure

1. Use small solder-wick to remove the solder and wire from the tip ground via. Size #1 Solder-Wick is recommended due to the small size of the tip and vias. Do not place the solder wick over the 0201 input resistors and these parts may accidentally be unsoldered from the board.

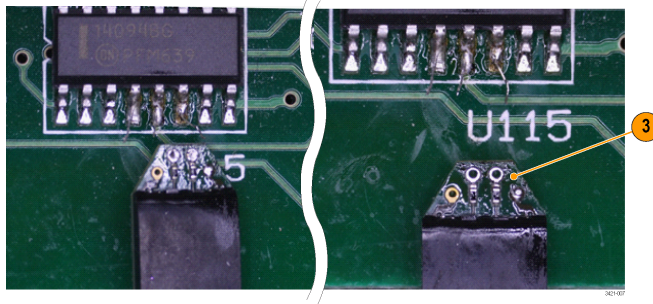


2. Use the solder-wick to remove excess solder from the input vias. Again, be careful not to place the solder-wick too close to the input resistors.



3. If the solder cannot be fully removed from the input via while attached to the test points, it is possible rock the tip side to side while reflowing the solder in the vias. Since the wires are cut flush to the board, the tip can be slowly removed from the wires using this method. Once the tip has been removed from the board, use the solderwick to clean out the vias so the tip can be reused.

If you used double-sided foam tape for strain relief rocking and moving the tip from side to side will loosen the tape's adhesion to the tip. Do not try to pull the tip directly off of the tape. Pulling the tip up without first breaking the tape's adhesion can damage the tip.



## Precautions when connecting to the circuit

To achieve the best performance and service life of the probe and tips, observe the best practices below when you make connections:

- Wear the antistatic wrist strap that is supplied with the probe and work at an antistatic-approved workstation.
- The flex circuit based solder tips are built with flexible circuit board material and are susceptible to mechanical overstress and harsh handling particularly at the ends of the probe tip where the components are mounted. Always support the probe tips by taping or gluing them to your circuit or by providing a means to prevent strain on the tips and circuit connections.
- The flex circuit based solder tips contain active circuitry. The majority of the tips, including the cover on the buffer amplifier, are non-conductive surfaces. However, the back end of the tips includes some small surface mount devices and pads on the top that present a small risk of shorting with the DUT circuitry. This was necessary to minimize the size and weight of the probe tips. If you need to use the flex circuit based solder tips where their topside components might contact the DUT, take care to avoid shorting the exposed circuitry of the tips to the DUT circuitry. Covering these areas with non-conductive tape is one method to avoid shorting.
- The P77STCABL tip is designed to be more flexible than the flex circuit based solder tips; care should be taken to avoid bending the connecting cables at too sharp an angle, since overstress can cause damage or reduce signal performance.
- To preserve the cables and maintain the highest signal fidelity, never kink the wires or put undue stress on them. Support the probe head by taping it to your circuit or providing a means to prevent strain on the circuit connection.

## Care of TekFlex solder-in tips

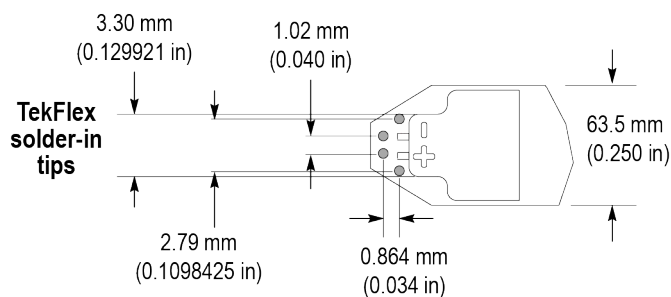


**CAUTION:** The top of the tips contain active components and can cause shorting if the tips are mounted top-down and the discrete components on the back end of the tips come into contact with an active circuit. Ensure that metal components do not touch anything else.

If the tips are mounted with the top up or if the TekFlex connector is attached, it is unlikely that the components on the board will contact the active circuit. The covers on the buffer amplifier of the tips are non-conductive. There are no conductive surfaces on the bottom of the tips except for the TriMode inputs and the TekFlex contacts.

### Tip dimensions

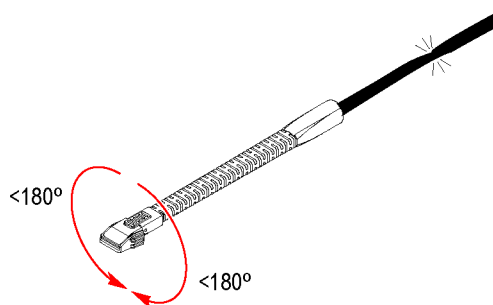
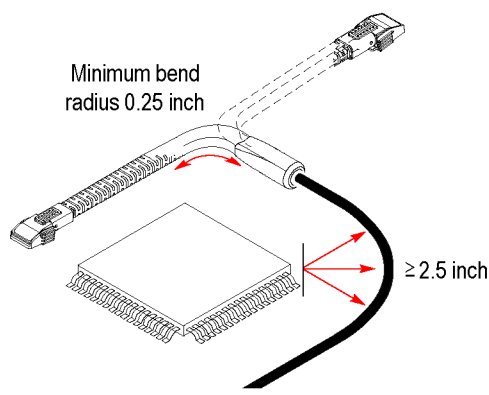
The dimensions of the solder tip connections are provided here for reference. You can also design the tip footprint into your circuit board layout for easier test connections.



## Probe handling best practices

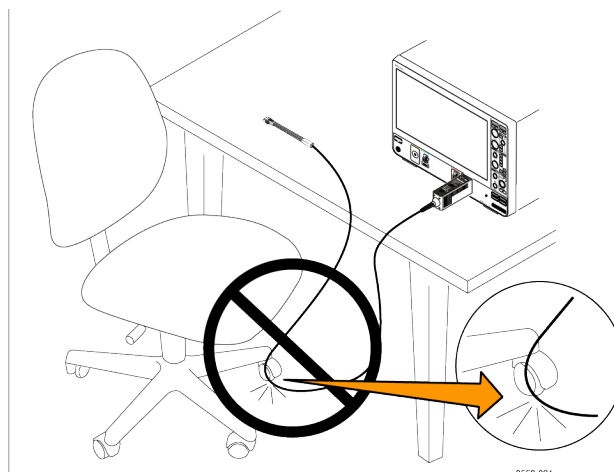
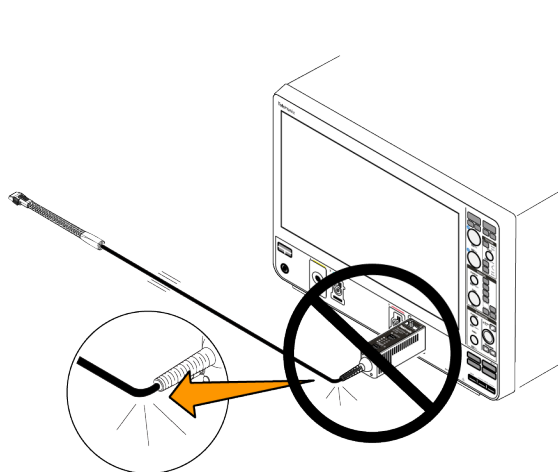
Tektronix TriMode probes are quality measurement tools and should be treated with care to avoid damage or performance degradation due to mishandling. Take the following precautions when handling the probe cables:

- Never over-bend the probe main or tip cables, which can put a permanent kink into the cable. When storing the probe do not coil it too tightly. It is best to use the protective foam carrying case which is designed to not exceed the minimum bend radius for the cable of 2.5 inches. The minimum bend radius for the flex cable is 0.25 inches (6.35 mm).
- To maximize probe life, limit the amount of cable twist relative to the probe comp box to  $\pm 180$  degrees. Always uncoil a probe cable gently before applying the twisting forces needed to orient the probe head for connection to the probe tip.



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- Do not excessively pull or twist the probe cables when positioning the probe for measurements.
- Never crush the cable, as will occur when you run over the probe with a chair wheel or drop something heavy on the cable.



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## Accessories and options

You can reorder the following replacement parts and accessories. Note that in some cases, the reorder quantities may differ from those that ship with the probe.

### Standard accessories

The following accessories are shipped with the TDP7700 Series probes. If no quantity is listed, only one of that item is shipped.

Reorder part number and quantity	Description
024-0021-xx	This carrying case has several cut-outs to hold the probe and accessories.
P77STFLXA	Active tips (2 solder tips)
020-3167-xx	Adhesive tape
016-2111-xx	Color bands
006-3415-xx	<b>Antistatic wrist strap.</b> When you use the probe, always work at an antistatic work station and wear the antistatic wrist strap.
–	<b>Calibration certificate.</b> A certificate of traceable calibration is provided with every probe.
–	<b>Data calibration report.</b> The Data Calibration Report lists the manufacturing test results of your probe at the time of shipment and is included with every probe.
071-3559-xx	<b>User manual.</b> The manual provides instructions for using the TDP7700 Series TriMode Probes. Other documents, such as the technical reference and other probe literature are located on the Tektronix web site ( <a href="http://www.tek.com/manuals">www.tek.com/manuals</a> ).

### Optional accessories




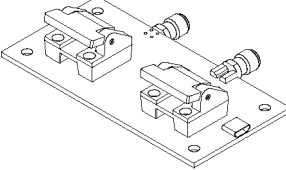
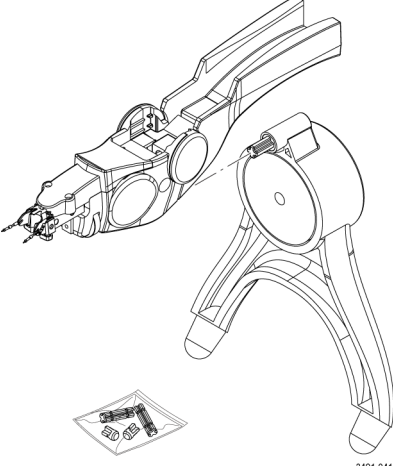
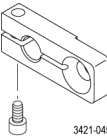
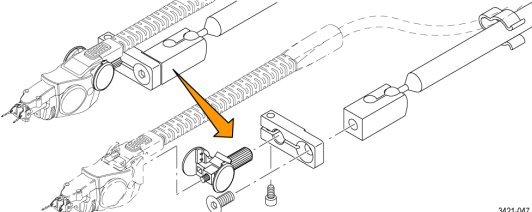
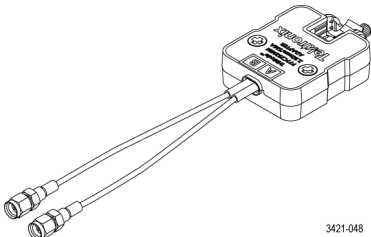
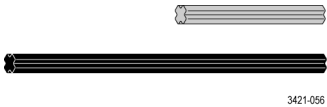
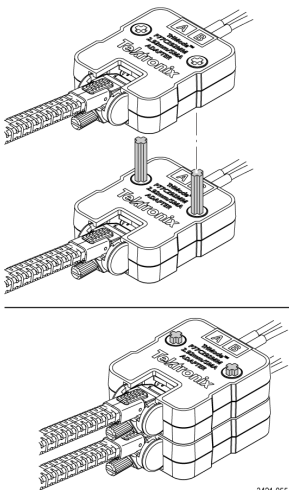
Optional accessory	Part and description
	P77STCABL, Solder-in active tip This tip provides a soldered, multi-point connection that supports full TriMode measurement capabilities at full probe bandwidth.
	P77STFLXA Flex circuit based solder tips These tips use flex circuit material and provide soldered, multi-point connections. Designed for the lowest loading across the full bandwidth of the probe. <sup>3</sup>

Table continued...

<sup>3</sup> 2 tips included with probe.

Optional accessory	Part and description
	<p>P77STFLXB Flex circuit based solder in tips for memory interposer probing. These tips use flex circuit material and provide soldered, multi-point connections. Designed to be used with Nexus Technology memory interposers.</p>
<p>017-0103-xx</p>	<p>Wire kit (38 AWG, 4 mil)</p>
 <p>3421-029</p>	<p>P77DESKEW, Deskew fixture</p> <p>Use this fixture to compensate a probe, deskew up to 2 probes at once, or to perform a probe functional check.</p>
 <p>3421-041</p>	<p>P77BRWSR, Browser accessory includes these items:</p> <p><b>Browser wand.</b> Extends the length of the browser for a more comfortable grip. (Part number 020-3160-xx.)</p> <p><b>Browser hands-free tripod.</b> Holds the browser on a test point without the need to use your hands. (Part number 020-3161-xx.)</p> <p><b>Browser replacement tips.</b> Use to repair any browser tips that are broken with use. (Part number 020-3162-xx.)</p> <p><b>Adapter attachment.</b> Attaches the browser to the hands-free tri-pod or other holders.</p> <p><b>Ground lead.</b> Attaches the browser to a circuit ground if necessary.</p> <p>The browser accessories can be stored in the TekFlex accessories box that comes standard with the probe.</p>
 <p>3421-045</p>	<p>407-6019-xx, Probe adapter</p> <p>Use this accessory to attach the browser to the PPM203B. probe arm/positioner</p>
 <p>3421-047</p>	
Table continued...	

Optional accessory	Part and description
 <p>3421-048</p>	<p>P77C292MM, 2.92 mm adapter</p> <p>Use this adapter to connect a TDP7700 series probe to a DUT with 50 <math>\Omega</math> test point connectors.</p>
 <p>3421-056</p>	<p>020-3179-xx, Linkage adapter kit</p> <p>Use the adapters for stacking two or more P77C292MM 2.92 mm adapters.</p>
 <p>3421-055</p>	<p>Use two gray adapters to stack two P77C292MM adapters; use two black adapters to stack three or four P77C292MM adapters.</p> <p>Insert the linkage adapters into the P77C292MM adapters as shown (gray linkage adapters shown).</p>

# Maintenance

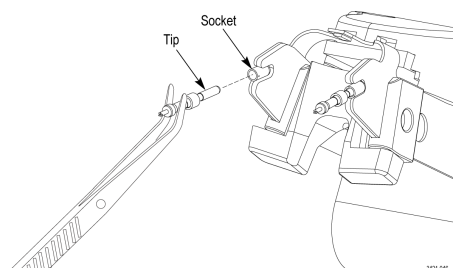
This section contains maintenance and support information for your probe.

## Browser tip replacement



**Note:** Note: It may be helpful to have a magnifying device or glasses when performing this operation.

The tips of the P77BRWSR can break during use. If one of the tips on your browser breaks, it is easy to replace the tip with a new one and be ready to make measurements again in a few seconds. To replace the tip, you will need a pair of tweezers. Using the tweezers, grip the shaft of the tip and pull downward to remove it. Dispose of the broken tip.



Once the old tip has been removed, retrieve a new, replacement tip from its storage vial in the accessory kit. Grip the replacement tip with the tweezers, gently push the tip into the socket on the browser's front end.

## Error conditions

### LED indicators

There is a Status indicator LED located on the top plate of the probe comp box. This LED is normally green, but turns red when any of the following conditions exist and remains red until the problem condition is cleared:

- Probe power-on self-test failure (clear by disconnecting and reconnecting the probe)
- Probe over-temperature detected (clear by disconnecting and reconnecting the probe, allowing time for probe to cool)
- Probe input over-voltage detected (reduce input over-voltage to clear)
- Probe over current detected (adjust  $V_{term}$  or remove input signal to clear)

If the LED is red, disconnect and reconnect the probe to restart the power-on diagnostic sequence. If the symptoms continue, connect the probe to another oscilloscope channel or oscilloscope. If the symptoms remain, return the probe to Tektronix for repair.

### Signal display

If the probe is connected to an active signal source and you do not see the signal displayed on the oscilloscope:

- Perform an Autoset operation on the host oscilloscope. This will automatically adjust the oscilloscope settings to try to display a useable waveform.
- Check the probe tip connection at the probe TekFlex connector. The LED on top of the accessory tip should be on if the tip is connected properly.
- Check that the input signal is within the allowable input voltage range. The Auto Offset control in the Probe Setup menu can be used to set the offset of the probe voltages to maximize the probe tip input dynamic range.
- Perform a functional check procedure. See [Functional check](#). This procedure will check that the probe is operating properly.

## Measurement errors

- If you suspect that your measurement may not be accurate, and you are using a solder in connection, check that the solder tip signal and ground connections are correct and intact.
- Checking the signal measurement in some of the other TriMode Input modes may provide some clue if there is a measurement problem. For example, operating the probe in DIFF mode does not require a ground connection. Switching the input mode between DIFF and SE might point out a grounding problem.
- If the signal being measured is a differential signal, temporarily switch the TriMode input on the probe to A only and B only and verify that each component of the differential signal looks correct. Switch the probe's input to the common mode setting and see if there is a large and unexpected common mode signal present on the probe input.
- Perform a Functional Check operation on the probe. This should verify that a fast rise time signal can be measured by the probe with a comparable probe tip attached. See [Functional check](#).

## Handling the probe

This probe is a precision high-frequency device; exercise care when you use and store the probe. The probe and cable are susceptible to damage caused by careless use. Always handle the probe at the comp box and probe body to avoid undue physical strain to the probe cable, such as kinking, excessive bending, or pulling. Visible dents in the cable will increase signal aberrations.



**CAUTION:** To prevent damage to the probe, always use an antistatic wrist strap connected to a static-controlled workstation when you handle the probe. The probe input contains electronic components that can be damaged by contact with high voltages, including static discharge.

Observe the following precautions when using the probe. Do not do any of the following:

- Drop the probe or subject it to physical shock
- Subject the probe to adverse weather conditions
- Kink or fold the probe main cable tighter than a 2.5 inch radius; minimum bend radius for the solder tips is 0.25 inch (6.35 mm)
- Solder the tips with excessive heat or duration
- Injure yourself with the sharp tips

See [Probe handling best practices](#) on page 36.

## Cleaning the probe



**CAUTION:** To prevent damage to the probe, do not expose it to sprays, liquids, or solvents. Avoid getting moisture inside the probe during exterior cleaning.

Do not use chemical cleaning agents; they may damage the probe. Avoid using chemicals that contain benzene, benzene, toluene, xylene, acetone, or similar solvents.

Clean the exterior surfaces of the probe 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 and rinse with deionized water. A swab is useful to clean narrow spaces on the probe; use only enough solution to dampen the swab or cloth. Do not use abrasive compounds on any part of the probe.

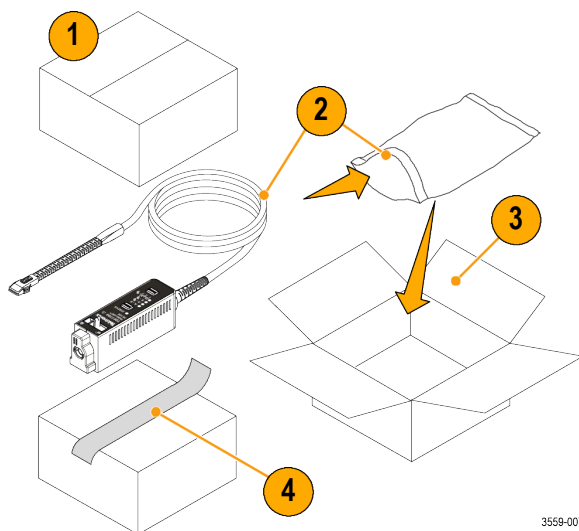
## Returning the probe for servicing

If your probe requires servicing, you must return it to Tektronix. If the original packaging is unfit for use or not available, use the following packaging guidelines:

### Preparation for Shipment

1. Use a corrugated cardboard shipping carton having inside dimensions at least one inch greater than the probe dimensions. The box should have a carton test strength of at least 200 pounds.

2. Put the probe into an antistatic bag or wrap it to protect it from dampness.
3. Place the probe into the box and stabilize it with light packing material.
4. Seal the carton with shipping tape.
5. Refer to [Contacting Tektronix](#) at the beginning of this manual for the shipping address.



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