

**P7504 & P7506**  
**TriMode™ Probes**  
**Technical Reference**



077-0135-00



**P7504 & P7506  
TriMode™ Probes  
Technical Reference**

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# General Safety Summary

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

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

*Only qualified personnel should perform service procedures.*

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

## To Avoid Fire or Personal Injury

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

**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 apply a potential to any terminal, including the common terminal, that exceeds the maximum rating of that terminal.

**Do Not Operate Without Covers.** Do not operate this product with covers or panels removed.

**Do Not Operate With Suspected Failures.** If you suspect that there is damage to this product, have it inspected by qualified service personnel.

**Avoid Exposed Circuitry.** Do not touch exposed connections and components when power is present.

**Do Not Operate in Wet/Damp Conditions.**

**Do Not Operate in an Explosive Atmosphere.**

**Keep Product Surfaces Clean and Dry.**

**Terms in this Manual**      These terms may appear in this manual:



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

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

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**Symbols and Terms on the Product**

These terms may appear on the product:

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

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



CAUTION  
Refer to Manual

---

# Preface

This manual discusses topics that are not covered in depth in the *P7504 & P7506 TriMode Probes Quick Start User Manual*.

The main sections are:

- Theory of Operation — Contains probe details not covered in the user manual.
- Reference — Contains information about differential measurements and how to increase measurement accuracy.
- Specifications — Contains warranted, typical, and nominal characteristics for the probe and probe tip accessories.
- User Service — Describes troubleshooting and probe maintenance.

## Products Covered

The table below lists the TriMode probes covered by this manual.

**Table i: TriMode probes**

<b>Probe model</b>	<b>Serial number</b>
P7504	All
P7506	All



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# Theory of Operation

This section discusses operating considerations and probing techniques. For more detailed information about differential measurements and TriMode operation, refer to *Reference*. (See page 19.)

The P7500 Series TriMode probes are optimized for high bandwidth; they are not general-purpose probes. The probe tips are miniaturized for electrical characteristics and access to dense circuitry, and must be handled carefully.



**CAUTION.** *To prevent damage to the probe, use care when handling the probe. Rough or careless use can damage the probe.*

---

## Input Voltage Limits

The P7500 Series TriMode probes are designed to probe low-voltage circuits. Before probing a circuit, take into account the limits for maximum input voltage, the operating voltage window, and the differential-mode signal range. (See Table 4 on page 25.)

### Maximum Input Voltage

The maximum input voltage is the maximum voltage to ground that the inputs can withstand without damaging the probe input circuitry.



**CAUTION.** *To avoid damaging the inputs of the probes, do not apply more than  $\pm 15$  V (DC + peak AC) between each input or between either probe input and ground.*

---



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

---

### Operating Voltage Window

The operating voltage window defines the maximum voltage that you can apply to each input, with respect to earth ground, without saturating the probe input circuitry. A common-mode voltage that exceeds the operating voltage window may produce an erroneous output waveform even when the differential-mode specification is met.

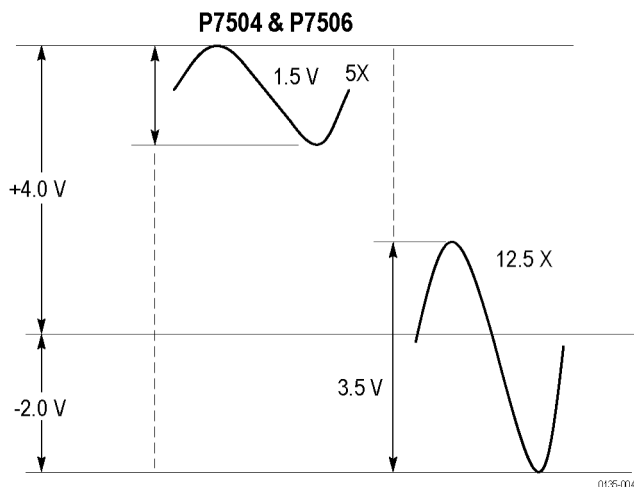


Figure 1: Operating voltage window

### Differential-Mode Signal Range

The differential-mode signal range is the maximum voltage difference between the A and B inputs that the probe can accept without distorting the signal. The distortion from a voltage that exceeds this maximum can result in a clipped or otherwise inaccurate measurement. The P7500 Series probes have two attenuation settings, 5X and 12.5X, that allow dynamic range to be traded off against signal noise. The 12.5X attenuator setting has the largest dynamic range; the 5X attenuator setting has the lowest noise. The graphs on the following pages illustrate the linearity error over the dynamic voltage range of the probes in both attenuation settings.

### Offset Voltage Range

The Offset Voltage Control, accessible from the attached oscilloscope user interface, allows the probe dynamic range to be effectively moved up and down within the limits of the offset voltage range and the operating voltage window. When the offset voltage is set to zero volts and the input signal is zero volts (inputs shorted to ground, not open), the displayed signal should be zero volts. If a noticeable zero volt offset is present under the above conditions, a Probe Cal operation should be performed. (See the *P7500 Series Probes Quick Start User Manual*).



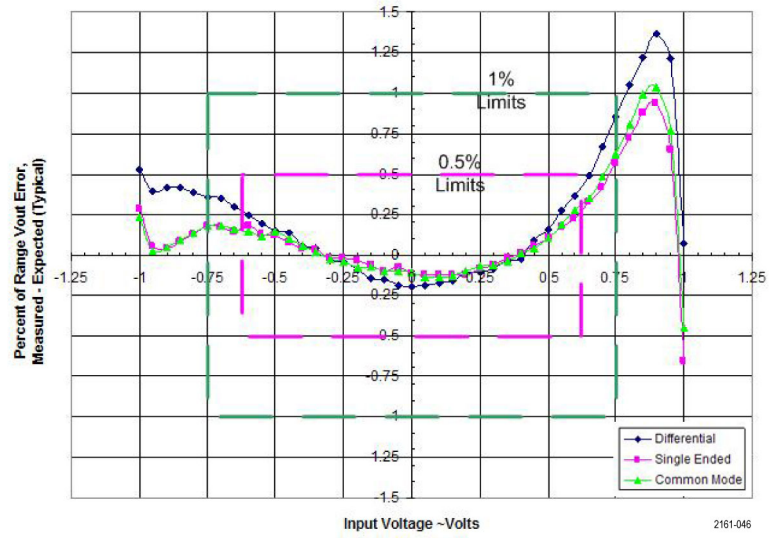


Figure 2: Dynamic range versus linearity, 5X range

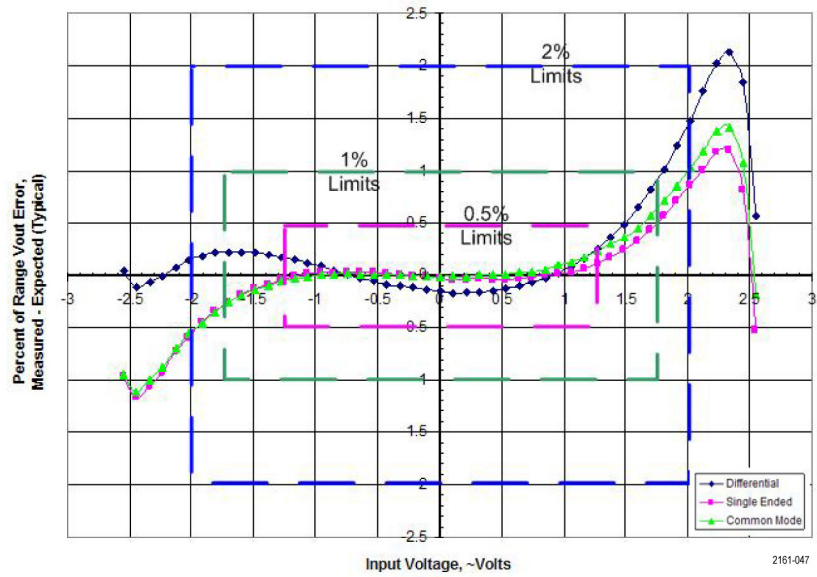


Figure 3: Dynamic range versus linearity, 12.5X range

## TriMode Operation

The TriMode feature of the new P7500 Series probe family is designed for improved convenience and enhanced capability in measuring differential signal quality. Since a differential signal is composed of two complementary single-ended signals, full characterization of differential signal quality requires more than a simple differential measurement. A TriMode probe features three Input Modes that allow a differential signal to be fully characterized with four measurements: differential, positive polarity and negative polarity single-ended, and common mode.

A TriMode probe provides improved efficiency and convenience by enabling full differential signal characterization from a single soldered connection. Using one of the solder tips available for the TriMode probes, (for example, the P75TLRST probe tip), probe connections are soldered to the two complementary signals (the A signal and the B signal) and a ground reference. From this single DUT (device under test) connection, the internal electronic switching control of the TriMode probe allows any one of the three probe Input Modes (four measurements) to be selected at a time. The TriMode probe inputs are routed on the probe ASIC (application-specific integrated circuit) to a set of four independent input amplifiers that perform the following signal calculations:

- $A - B$  (for differential signal measurement)
- $A - \text{GND}$  (for positive polarity single-ended measurement)
- $B - \text{GND}$  (for negative polarity single-ended measurement)
- $[A+B]/2 - \text{GND}$  (for common mode measurement)

---

**NOTE.** *In the B – GND Mode, the negative polarity B input is not inverted.*

---

The four input amplifiers are multiplexed together and only the selected Input Mode function is output to the connected oscilloscope. (See Figure 4 on page 5.) The figure shows a conceptual view of the TriMode probe input structure, where the C input provides the probe ground reference and is connected to the probe tip ground interconnect using the probe tip cable coaxial shields.

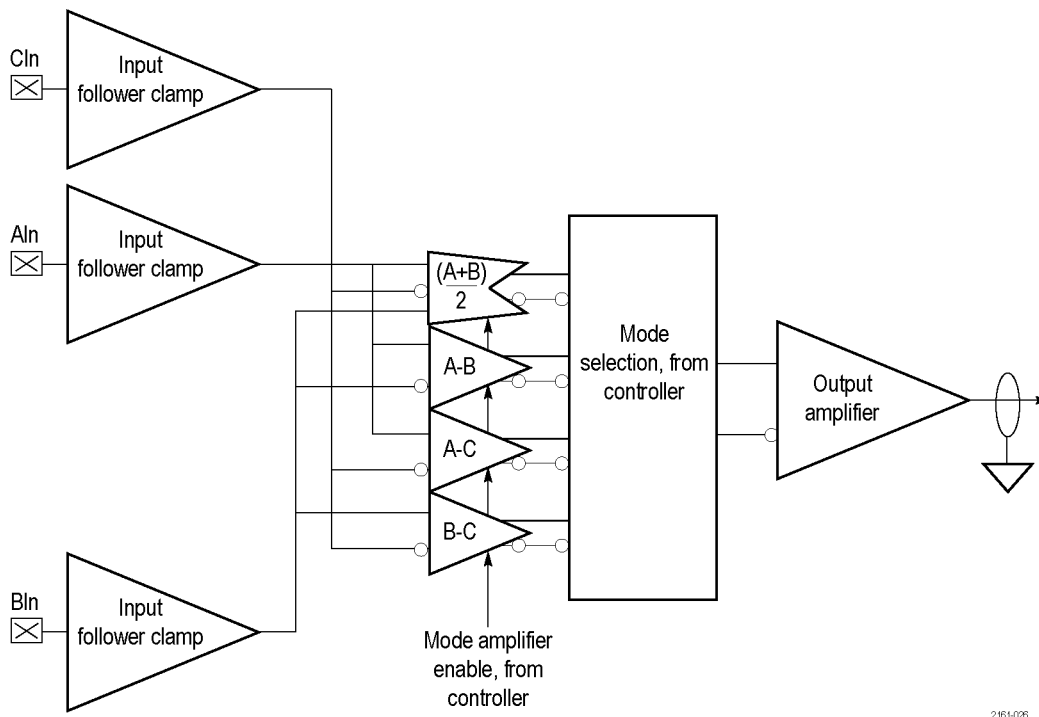


Figure 4: TriMode input structure

On oscilloscopes that do not provide full TriMode support, the TriMode features are controlled by the probe Control Box switches, which allow oscilloscope features like Probe Cal to be exercised only for the selected probe Input Mode.

On oscilloscopes that provide full TriMode support, the oscilloscope-controlled probe GUI (graphical-user interface) can perform a Probe Cal operation on all Input Modes and Attenuation Settings at once using the TriMode Probe Cal fixture that is supplied with P7500 Series probes. (See the *P7500 Series Quick Start User Manual* for instructions on running the Probe Cal routine.) Full TriMode support will also allow storage and automatic recall of relevant settings like Offset. (See Figure 5.)

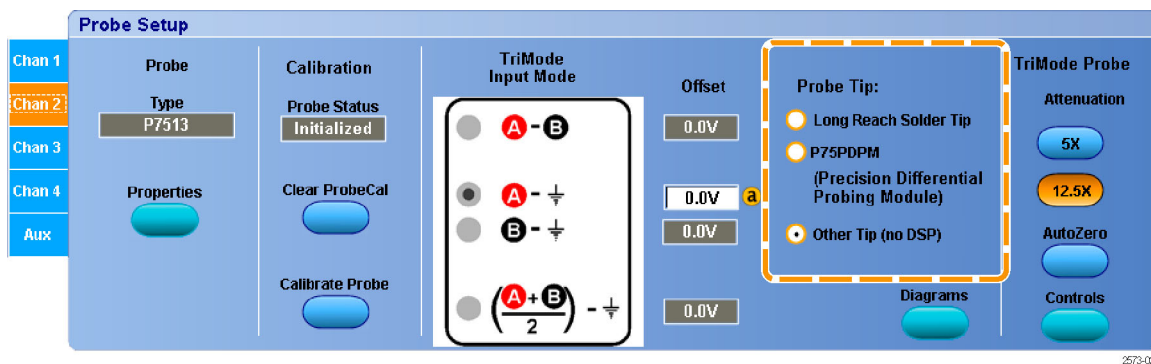


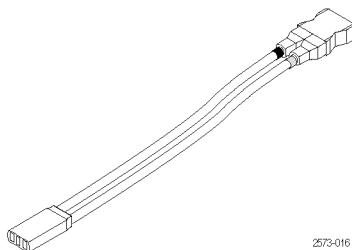
Figure 5: Typical TriMode Probe Setup screen

## Probing Techniques to Maximize Signal Fidelity

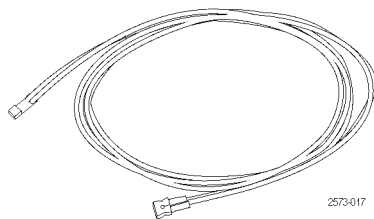
Signal fidelity is an indication of how accurately a probe represents the signal being measured. The signal fidelity of the probe is best when the probe is applied properly to the circuit with the P7500 probe tips. Recommendations for connecting the P7500 probe tips are given in the following section.

### Socket Cables

The Socket Cable assembly connects between the probe head and the two leave-behind probe tips that ship as standard accessories with the P7504 and P7506 probes. It is designed to preserve a 50  $\Omega$  signal path from the input to the probe, down the coaxial cable, and as well as possible through the square-pin connection to the solder tips.



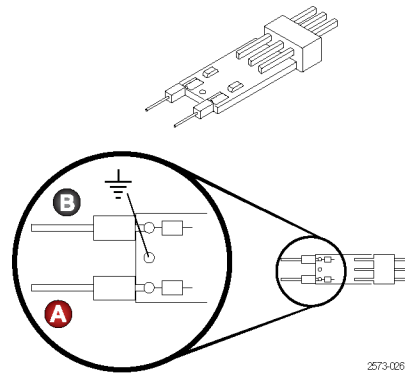
The Socket Cable XL is a similar but longer cable (5 ft.), and is available as an optional accessory. It is designed for use with the High Temp solder tip in environmental test chambers and similar applications.



### P7500 TriMode Solder Tips

The P7504 and P7506 probes include two different leave-behind solder tips (High Temp and Micro-Coax) to connect the probes to your circuit. Two High Temp and four Micro-Coax probe tips are shipped with the probes as standard accessories; other P7500 Series solder tips are available as optional accessories. All of the tips are described on the following pages.

**High Temp Solder Tip.** This leave-behind probe tip uses a 3-pin header with two connections for a differential signal and a third connection for a ground reference. The square pin header is mounted on a small circuit board which provides circuit connections for a pair of input signal pickoff resistors and a ground via for wiring to the DUT. As shown in the illustration, this probe tip design includes a ground via at the probe tip to provide a TriMode connection.

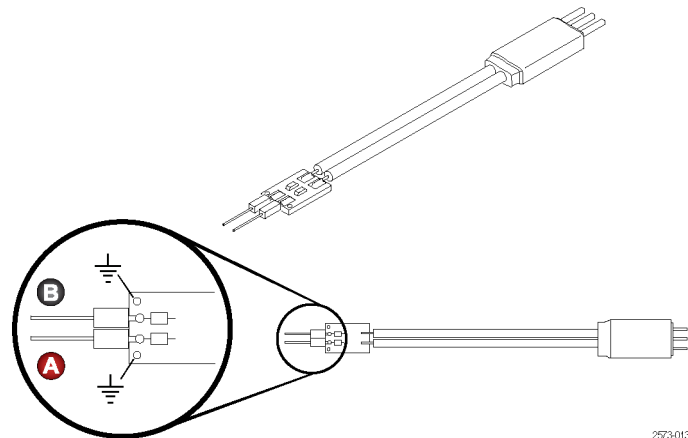


**Figure 6: High Temp solder tip**

This 3-pin interface topology is signal-ground-signal (S-G-S) with the ground connection between the signals for isolation. The DUT connection interface at the probe tip vias uses a split-resistor topology with axial-leaded resistors rather than wires for the DUT interconnect.

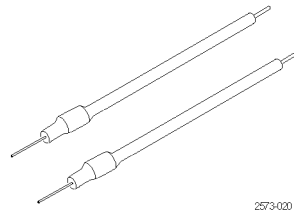
**Micro-Coax Solder Tip.** This leave-behind probe tip includes a mating cable assembly with a 3-pin header for connecting to one of the socket cables. The cable connection between the square-pin header and the probe tip signal pickoff resistors is a very flexible micro-coax cable. A TriMode connection can be made by adding a ground wire between a ground via on the probe tip circuit board and a local DUT ground, giving a single-ended return current path along the coaxial cable shield and through the center pin of the square-pin header.

The split-resistor topology used on the High Temp tip is also used on the Micro-Coax tip, as shown in the illustration. Replaceable axial-leaded resistors located at the probe tip are used for DUT connections, and surface-mount resistors are set back on the probe tip interface board. The square-pin header connector on the interface circuit board of the Micro-Coax solder tip is shielded with a ground shield similar to that used on the mating Socket Cable.



**Figure 7: Micro-Coax solder tip**

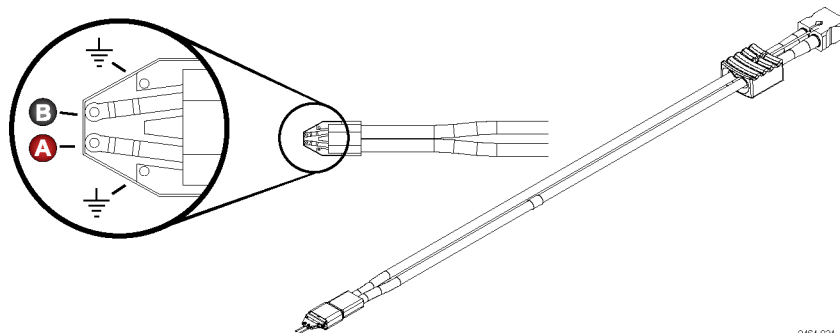
**Damped Wire Tip.** The Damped Wire Tip is a non-coaxial, extended-reach probe tip designed for DUT interconnect flexibility. The primary focus is for a single-ended probe tip solution with independent signal and ground connections. By separating the signal and ground connections, the user can provide a common ground connection for a group of different signal connections. This tip reduces the interconnect soldering task for applications with many single-ended signals and may have adequate performance for slower-speed signals. When routed closer together for a differential measurement, the damped wire tip provides remarkably good high frequency performance.



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The Damped Wire Tip has a 1.7 inch reach, which is designed for use in DDR memory module applications. The performance is optimized by splitting the input signal pickoff resistor as is done with the High Temp and Micro-Coax tips.

**P75TLRST TriMode Solder Tip.** The P75TLRST probe tip is composed of a small form factor interconnect circuit board with SMD0402 damping resistors and a set of vias for wire attachment to the DUT (Device Under Test). The circuit board vias are designed for both 4 mil and 8 mil wire and a special high tensile strength wire is supplied as part of the wire accessory kit. The expanded view of the probe tip shows the location of the A and B signal inputs as well as the two ground reference connections.



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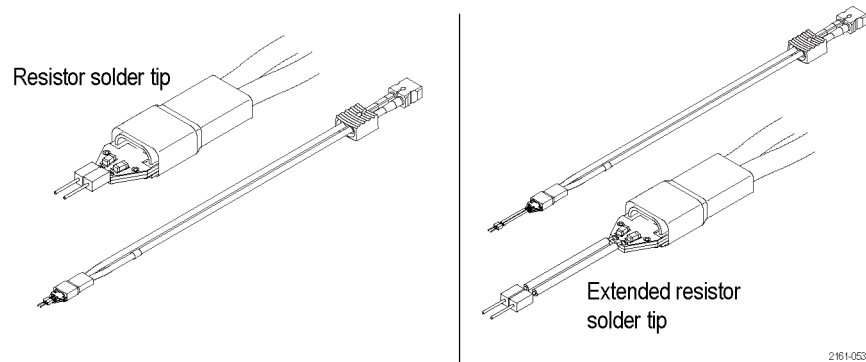
**Figure 8: P75TLRST TriMode Long Reach Solder Tip**

The recommended wire attachment method is to first solder the wires to the DUT, being careful to minimize the wire length of the signal and ground connections. This is followed by threading the wires through the probe tip board vias, being careful to achieve as symmetrical a wire pattern as possible between the two signal inputs and a very short ground connection. Finally, the attachment is completed by soldering the wires on top of the probe tip circuit board. Any excess

wire lead length extending through the probe tip board should be removed to minimize possible signal reflection problems.

Because of the limited mechanical strength of the wire interconnect and probe tip circuit board, the solder-down probe tip should be taped down at the DUT for strain relief. Although the accessory kit includes adhesive strips that can be used for the strain relief of the probe tip, the use of mylar tape will generally provide stronger attachment if room is available at the DUT.

**TriMode Resistor Solder Tips.** These solder tips separate the standard 175  $\Omega$  on-board damping resistors for each probe input (+ and -) into two components. A surface mount, 75  $\Omega$  resistor is board-mounted in series with a 100  $\Omega$  leaded resistor that extends off of the tip board. The other end of the resistor is soldered to your circuit. The TriMode Extended Resistor solder tips allow a longer tip reach to your circuit under test but reduce the measurement quality.



**Figure 9: TriMode Resistor solder tips**

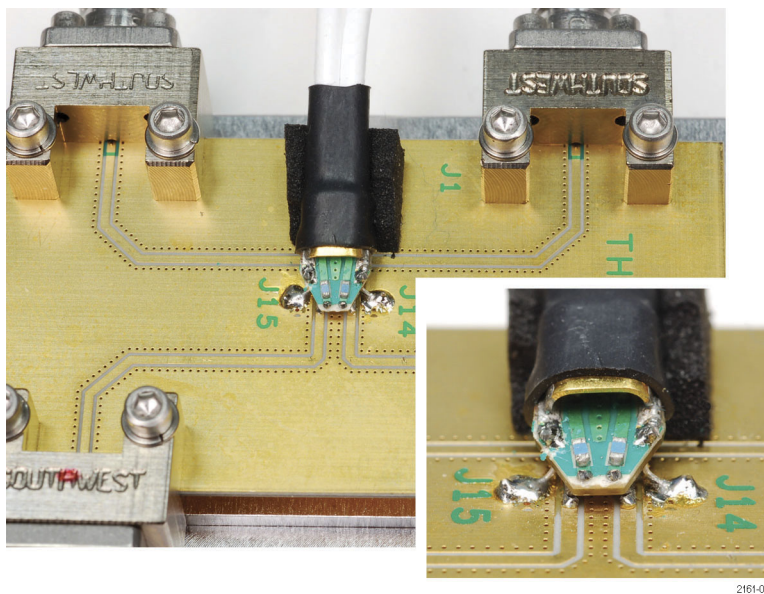
Since the leads of the 100  $\Omega$  resistors take the repeated soldering cycles required when reusing the tip, they limit the need to solder directly to the tip board, extending the life of the tip. The tip resistors are replaceable and are available as a kit. (See page 44, *Replaceable Parts*.)

**Probe Tip Cables and Connectors.** Attached to the probe tip circuit board of the P75TLRST and resistor solder tips are a pair of very low skew (<1ps) coaxial cables and a polarized G3PO dual connector block. The G3PO connectors use a miniature, high frequency design that enables quick and easy installation of the P7500 probe tips. The G3PO connector block of the probe tip is inserted into the input nose piece on the end of the probe body of the P7500 family probes. The probe body contains a mating, polarized G3PO connector block with attached G3PO connector bullets.

The connector bullets are a part of the G3PO connector design, providing a self-aligning interconnect mechanism between G3PO connectors. The G3PO connector in the probe body is designed to have higher detent force than the probe tip connectors, which is intended to ensure that the G3PO bullets remain in the probe body connector when disconnected. The probe body nose piece, with its integral spring mechanism, helps to provide a self-aligning mechanism for hand

insertion of the probe tip. The probe body nose springs also give a secure capture of the probe tip connector after insertion. Release of the probe tip is assisted by using the wire-connected cable release holder on the probe tip connector. This probe tip release holder should always be used rather than pulling on the probe tip cables, which may cause tip cable damage.

**DUT Connections.** The lead length of the resistor leads and connection wires between the probe tip board and the DUT must be kept as short as possible to preserve the integrity of the measured signal. Typical wire lengths range from 0.010 in. to 0.100 in. (See Figure 10.)



**Figure 10: Typical wire length from probe tip to circuit**

The following four figures illustrate the signal integrity effect on the P75TLRST solder tip when used with different lengths of tip wire. Signal fidelity is best when the wire length is kept as short as possible. The step generator that was used as a signal source for these screenshots has a 30 ps 10-90% rise time. The table in each figure contains data for two rise time measurements (10-90% and 20-80%) and were made using a P7516 probe. Comparable measurements made using a P7504 or P7506 probe would show much slower rise times. These screenshots can be used as a rough guide to gauge the effects of wire length, but actual results may vary depending on the other factors like characteristics of the device under test (for example, rise time and impedance), precision of the solder connection, and the model of probe and oscilloscope.



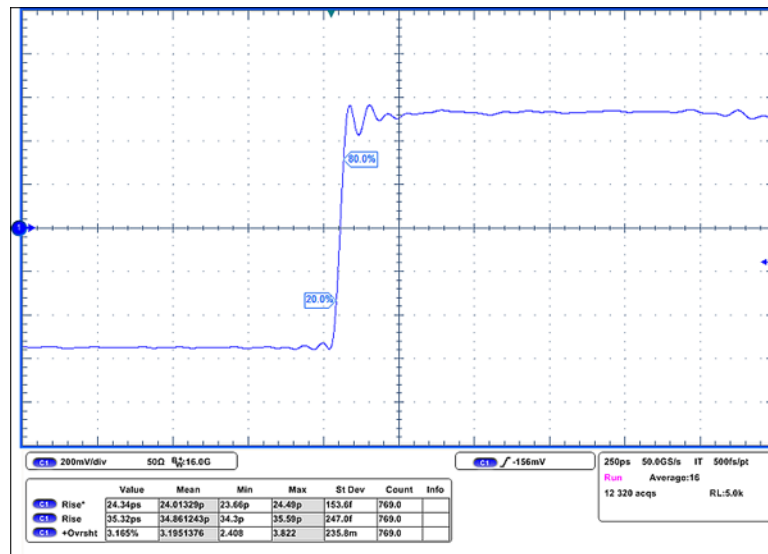


Figure 11: P75TLRST solder tip with 0.010 in. of tip wire

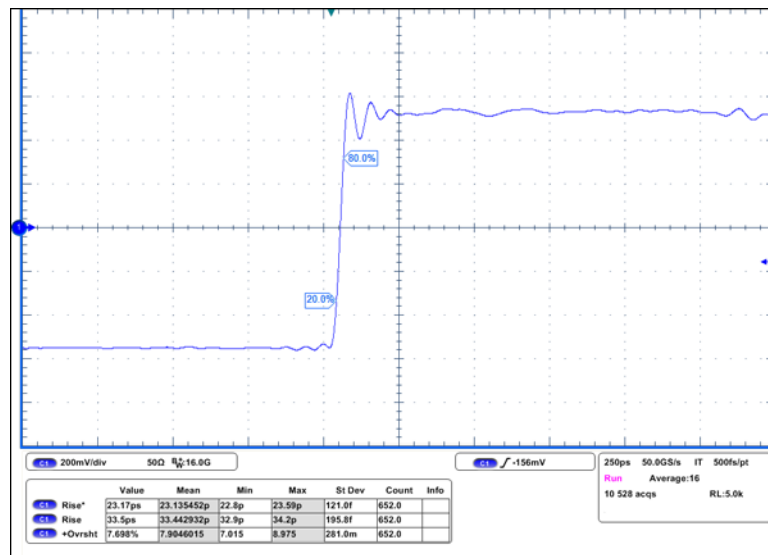


Figure 12: P75TLRST solder tip with 0.050 in. of tip wire

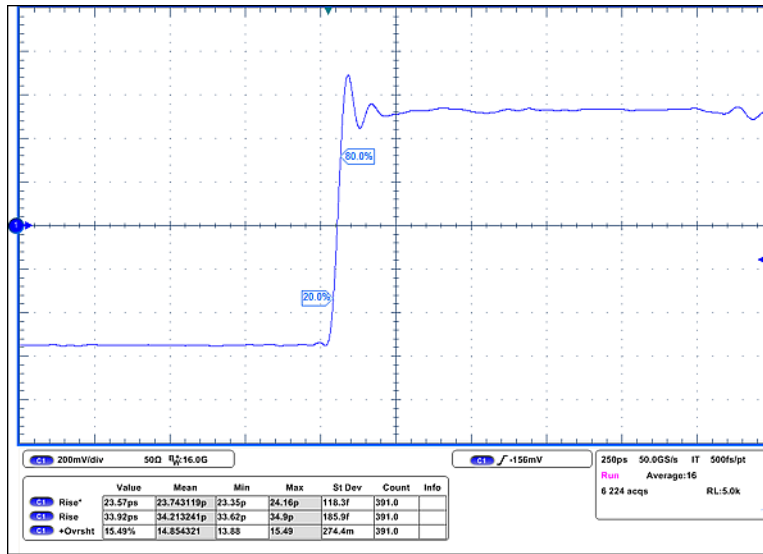


Figure 13: P75TLRST solder tip with 0.100 in. of tip wire

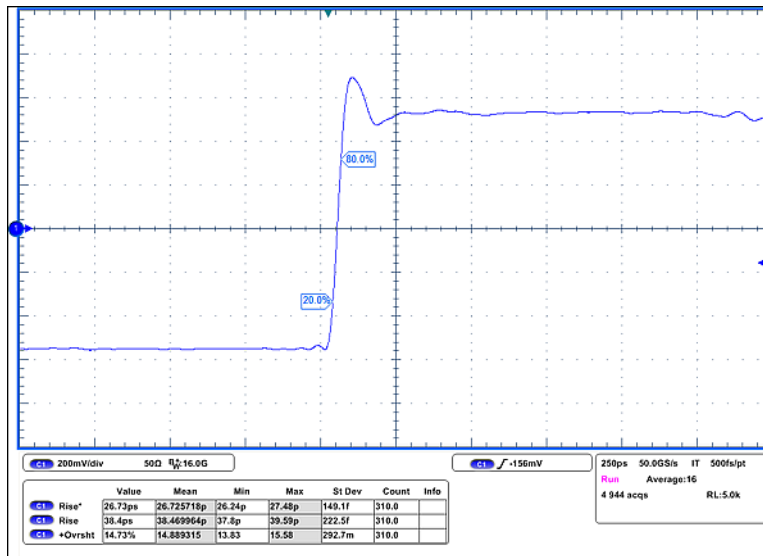
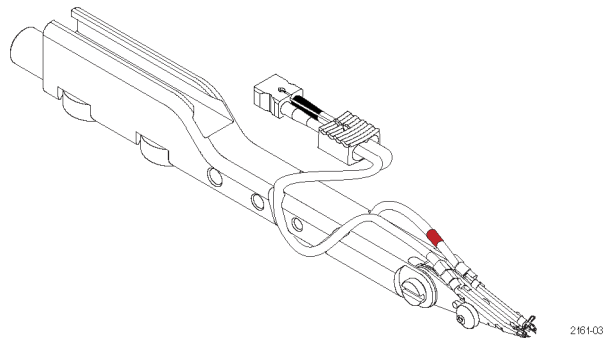


Figure 14: P75TLRST solder tip with 0.200 in. of tip wire

## P75PDPM Precision Differential Probing Module

The P75PDPM Probing Module is designed for handheld and fixtured probing applications. The P75PDPM probe tip is composed of two replaceable probe tip circuit boards with a pin on one end and a G3PO socket connector on the other. Damping resistors on the tip boards near the input pins and a 50  $\Omega$  transmission line on the board transmit the signal from the input pin to the G3PO socket connector. The probe tip boards are connected to the P7500 probe body with a very low skew (<1 ps) cable assembly (P75TC).

The left-side and right-side probe tip boards mount at an angle in the P75PDPM adjustment housing. The probe tip spacing is adjustable from 0.030 – 0.180 in. (0.76 – 4.57 mm) using the thumb-operated screw. Because of the variable spacing between the two probe tip boards, a gold-plated ground spring is connected between the probe tip boards to ensure a good common mode ground return near the probe tip pins.



**Figure 15: P75PDPM Precision Differential Probing Module**

The P75PDPM probe tip circuit boards mount in an articulating metal housing that also supports the variable spacing control. The angle of the probe tip housing can be adjusted and locked in place using an articulation screw in the probe holder bar. The probe holder bar contains mechanical details for retaining the probe tip cable assembly as well as a retaining clamp for the probe body. The probe holder bar can be held manually or can be mounted for fixtured probing on an articulating probe arm using mechanical features in the holder bar.

The P75PDPM design features improved mechanical compliance in probe tip attachment to the DUT. Mechanical compliance is a significant issue for differential probes because of the difficulty in making reliable contact with two DUT connections at the same time. The reliability in making this dual point connection can be improved by a tip structure with good mechanical compliance, in which there is sufficient give in the probe tips to absorb interconnect surface irregularity.

The P75PDPM does not have a local DUT ground connection because of the great difficulty in making a good three-point interconnect without soldering. As a result, the only low-noise TriMode Input Mode available with the P75PDPM is the A-B (DIFF) mode, since for differential signals, there is an inherent virtual ground present in the measurement circuit.

The following four figures illustrate the signal integrity effect of changing the spacing on the P75PDPM Probing Module. Signal fidelity is best with the tips at the smallest spacing. The step generator that was used as a signal source for these screenshots has a 30ps 10-90% rise time. The table in each figure contains data for two rise time measurements (10-90% and 20-80%). These screenshots can be used as a rough guide to gauge the effects of probe tip spacing, but actual results may vary depending on the other factors like characteristics of the device under test (for example, rise time and impedance) and the model of probe and oscilloscope.

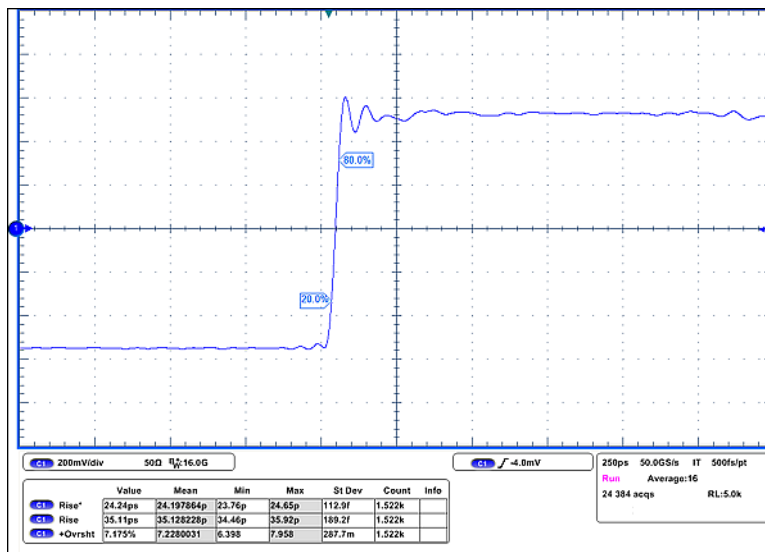


Figure 16: P75PDPM with short ground spring, 0.030 in. spacing

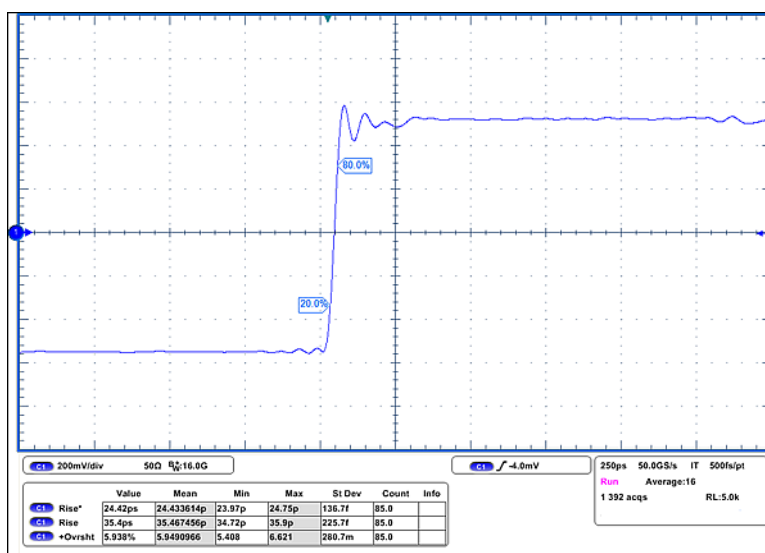


Figure 17: P75PDPM with short ground spring, 0.050 in. spacing

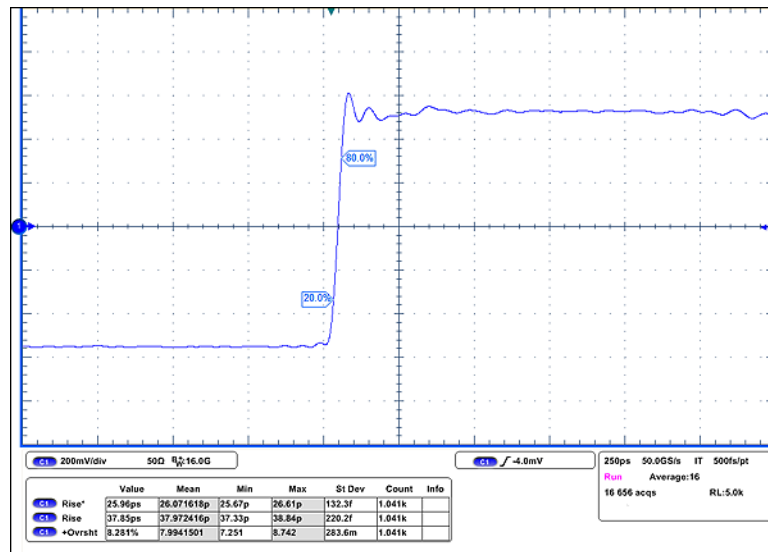


Figure 18: P75PDPM with short ground spring, 0.090 in. spacing

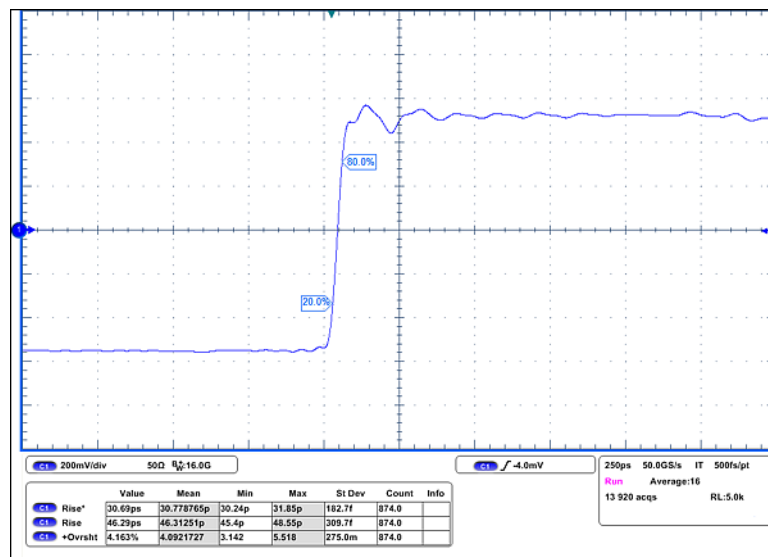
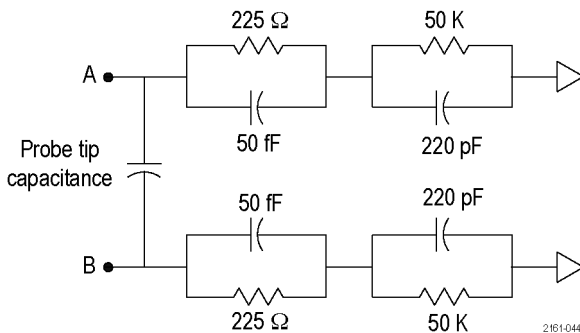


Figure 19: P75PDPM with short ground spring, 0.180 in. spacing

## Input Impedance and Probe Loading

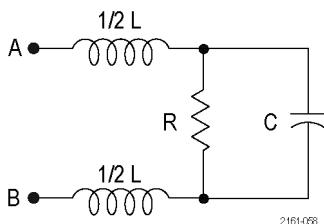
When you connect the probe inputs to a circuit, you are introducing a new resistance, capacitance, and inductance into the circuit. Each input of the differential probe has a DC input impedance of 50 kΩ to ground. (See Figure 20.)



**Figure 20: TriMode probe input model**

For signals with low source impedance and frequency, the 50 kΩ input impedance on each input is large enough to prevent the inputs from loading the signal sources. The more the signal source impedance on an input increases, the more the probe loads the source and reduces the signal amplitude. The greater the source impedances and the higher the signal frequencies, the more you must take these factors into account.

The frequency of the signal also affects signal measurement. As the frequency of the signal increases, the input impedance of the probe decreases. The lower the impedance of the probe relative to that of the source, the more the probe loads the circuit under test and reduces the signal amplitude. A high frequency input impedance model is shown below. (See Figure 21.)

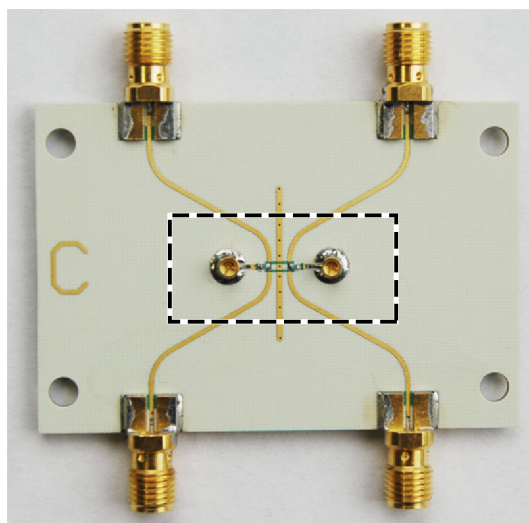


**Figure 21: TriMode probe high frequency input impedance model**

For impedance values of the individual TriMode solder tips, refer to the specifications. (See page 28, *Tip Specifications*.)

**Embedded Probe**

It is possible to acquire signals with the P7500 Series TriMode probes by including an embedded connection in your circuit. (See Figure 22.) Connectors that mate to the P75TC Tip Cable can be incorporated in the circuit board design and carefully placed to balance any reflections or other characteristics that may affect the circuit or measurement. An embedded probe connection will generally provide optimum probe performance because the signal interconnect lead length can be minimized if implemented correctly. For more information about embedded probe connections, contact Tektronix.



2161-043

Figure 22: Embedded probe fixture





# Reference

This section contains information about taking measurements with the TriMode probes and increasing measurement accuracy.

## Single-Ended Measurements Using A and B Modes

A differential probe such as the P7516 TriMode Probe can be used for single-ended measurements within the limits of its dynamic and offset voltage ranges. Single-ended probes such as the P7240 typically have a wider offset range than differential probes, but generally with lower bandwidth performance. (See Table 1.)

Table 1: Offset ranges

Probe	Frequency	DC Offset, 5X	Dynamic Range, 5X	DC Offset, 12.5X	Dynamic Range, 12.5X
P7240	4 GHz	+/- 5 V	4 V <sub>PP</sub>	–	–
P7504 & P7506 (differential mode)	4 GHz & 6 GHz	+2.5 V, -1.5 V	1.5 V <sub>PP</sub>	+2.5 V, -1.5 V	3.5 V <sub>PP</sub>
P7504 & P7506 (single-ended and common-mode)	4 GHz & 6 GHz	+3.4 V, -1.8 V	1.5 V <sub>PP</sub>	+3.4 V, -1.8 V	3.5 V <sub>PP</sub>

Differential probes are ideal for a class of single-ended measurements where the reference voltage is not ground:

- SSTL\_1,2:  $V_{TT}, V_{REF} = V_{DD}/2$
- PECL:  $V_{REF} = V_{CC}-1.3$

To measure single-ended signals in this class, connect the B input of the P7500 TriMode Probe to  $V_{REF}$ .

A differential probe in these applications displays the true signal despite any AC or DC variation in  $V_{REF}$  from its nominal value. A single-ended probe displays the signal plus the variation in  $V_{REF}$ .

Differential probes can also be used to make ground referenced single-ended measurements on either single-ended signals or differential signals like PCI Express or Serial ATA. To measure ground referenced single-ended signals with the handheld module, connect the B input of the P7500 TriMode Probe to ground.

Single-ended measurements on differential signals are used to measure common mode voltage and check for differential signal symmetry. By using the TriMode solder tip, you can easily take these measurements with one connection. Cycle the Input Mode switch to display the signal that you want to view.

## Channel Isolation

Under ideal conditions when taking single-ended measurements with a differential probe, no part of a signal applied to one input of the probe would appear on the other input. In reality some portion of the signal on one input does “bleed” over to the other input, and this effect increases with frequency. Channel isolation is a measure of how much crosstalk occurs between the two probe inputs. The channel isolation is defined with S-parameter measurements below, where:

A input = S1, B input = S2, Output = S3

A ISOLATION =  $20 \log (S32 / S31) | \text{A Mode}$

B ISOLATION =  $20 \log (S31 / S32) | \text{B Mode}$

A typical isolation plot for the P7500 series TriMode probes using an embedded probe with zero-ground lead length is shown. Channel isolation performance is highly dependent on probe tip attachment lead length. Good channel isolation requires keeping the interconnect lead length for both signal and ground connections very short. (See Figure 23.)

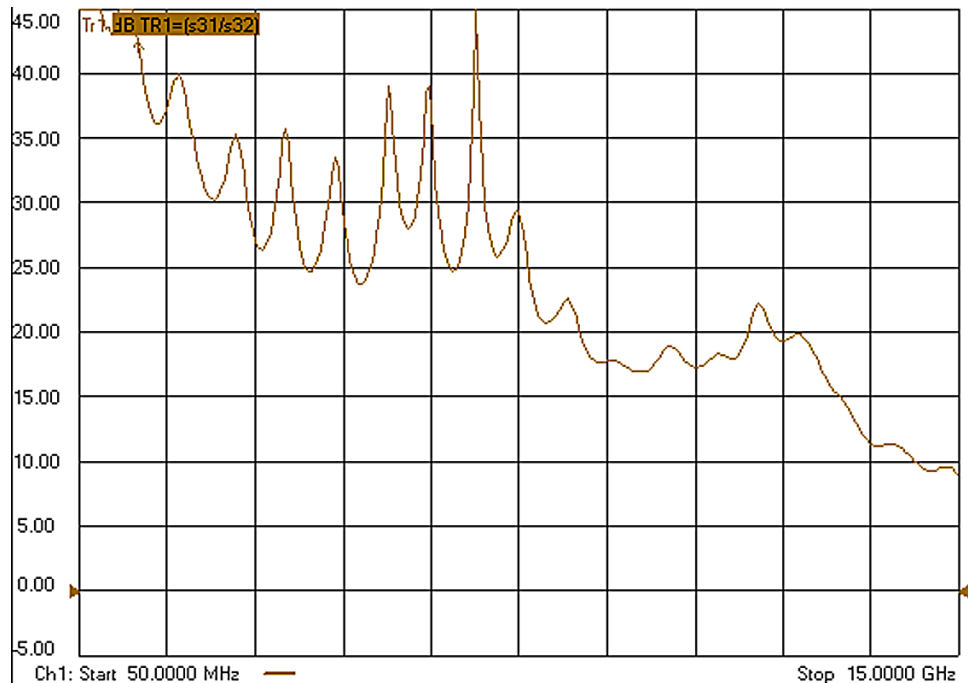


Figure 23: Typical channel isolation for P7500 Series TriMode probes

## Differential Measurements

A differential probe is optimized to measure high speed differential signals. Differential signals are formed from two complementary signals with a common reference voltage. (See Figure 24.)

Devices designed for differential measurements avoid problems presented by single-ended systems. These devices include a variety of differential probes, differential amplifiers, and isolators.

A differential probe is basically a differential amplifier, which is used to make differential measurements that reject any voltage that is common to the inputs and amplifies any difference between the inputs. Voltage that is common to both inputs is often referred to as the Common-Mode Voltage ( $V_{CM}$ ) and voltage that is different as the Differential-Mode Voltage ( $V_{DM}$ ).

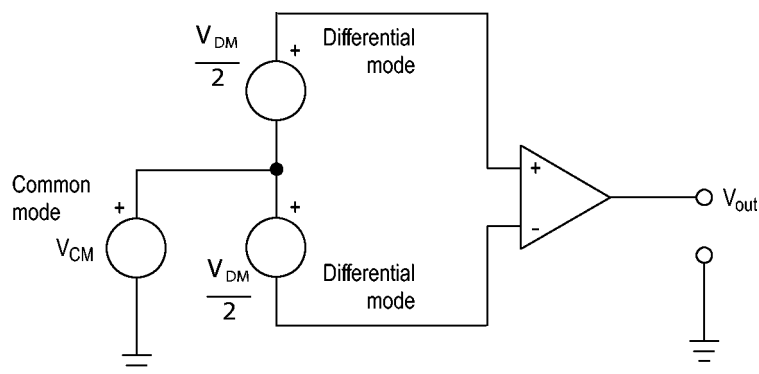


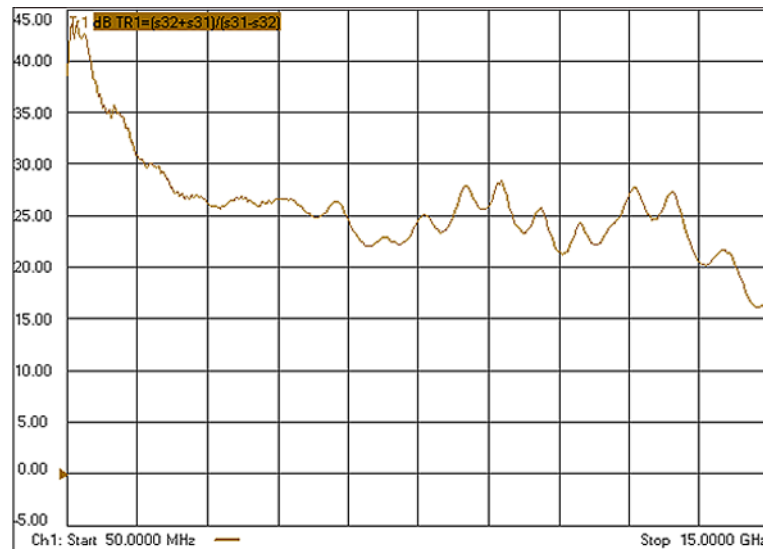
Figure 24: Simplified model of a differential amplifier

### Common-Mode Rejection Ratio

Differential amplifiers cannot reject all of the common-mode signal. The ability of a differential amplifier to reject the common-mode signal is expressed as the Common-Mode Rejection Ratio (CMRR). The CMRR is the differential-mode gain ( $A_{DM}$ ) divided by the common-mode gain ( $A_{CM}$ ). It is expressed either as a ratio or in dB.

$$CMRR = \frac{A_{DM}}{A_{CM}} \quad dB = 20 \log \frac{A_{DM}}{A_{CM}}$$

CMRR generally is highest (best) at DC and degrades with increasing frequency. A typical CMRR plot for the P7500 Series TriMode probes is shown. (See Figure 25 on page 22.)



**Figure 25: Typical CMRR for P7500 Series TriMode probes**

### Assessing CMRR Error

The CMRR of the P7500 Series TriMode Probes is shown in graphs assuming a sinusoidal common-mode signal.

A quick way to assess the magnitude of CMRR error when the common-mode signal is not sinusoidal is to connect both leads to the same point in the circuit. The oscilloscope displays only the common-mode component that is not fully rejected by the probe. While this technique may not give you accurate measurements, it does allow you to determine if the magnitude of the common-mode error signal is significant. Make the probe tip wires the same length to maximize the probe CMRR.

### Input Impedance Effects on CMRR

The lower the input impedance of the probe relative to the source impedance, the lower the CMRR for a given source impedance imbalance. Differences in the source impedance driving the two inputs lowers the CMRR. Note that single-ended measurements generally result in asymmetric source impedances which tend to reduce the differential mode CMRR.

### Differential-Mode Rejection

When making common-mode signal measurements ( $A+B/2 -GND$ ) with the TriMode probe, it is desirable to reject the differential-mode signal present between the two inputs. This rejection is expressed as the Differential-Mode Rejection Ratio (DMRR), and is defined as the common-mode gain ( $A_{CM}$ ) divided by the differential-mode gain ( $A_{DM}$ ). It is expressed either as a ratio or in dB, and degrades at higher frequencies.

$$DMRR = \frac{A_{CM}}{A_{DM}} \quad dB = 20 \log \frac{A_{CM}}{A_{DM}}$$

## Serial Bus Standards

The table below lists some popular high-speed data communication standards that can be measured with the P7500 Series TriMode Probes.

**Table 2: Serial bus standards with dynamic range requirements**

Standard Data Rate	Vdm_max	Vdm_min	Vcm_max	Vcm_min
HDMI/DVI 1.65 Gb/s	800 mV	150 mV	3.3 V	2.8 V
InfiniBand TX 2.5 Gb/s	1.6 V	1.0 V	1.0 V	0.5 V
InfiniBand RX 2.5 Gb/s	1.6 V	0.175 V	1.0 V	0.5 V
PCI Express TX 2.5 Gb/s	1.2 V	0.8 V	AC	AC
PCI Express RX 2.5 Gb/s	1.2 V	0.175 V	AC	AC
Serial ATA TX 1.5 Gb/s	0.6 V	0.4 V	0.3 V	0.2 V
Serial ATA RX 1.5 Gb/s	0.6 V	0.325 V	0.3 V	0.2 V
XAUI TX 3.125 Gb/s		0.4 V		
XAUI RX 3.125 Gb/s		0.1 V		
OIF-SxI-5 TX 3.125 Gb/s	1.0 V	0.5 V	1.23 V	0.72 V
OIF-SxI-5 RX 3.125 Gb/s	1.0 V	0.175 V	1.30 V	1.10 V
LV PECL (std ECL) >12 GHz	1.66 V (typ)	1.48 V	1.3 V (vt)	0.5 V (vt)
LV PECL (RSECL) >12 GHz	1.05 V	0.70 V	1.3 V (vt)	0.5 V (vt)

## Specifications

These specifications apply to the P7500 Series TriMode Probes installed on an oscilloscope with a TekConnect interface. When the probe is used with another oscilloscope, the oscilloscope must have an input impedance of 50  $\Omega$ . The probe must have a warm-up period of at least 20 minutes and be in an environment that does not exceed the allowed limits. (See Table 3.)

Specifications for the P7500 Series TriMode Probes fall into three categories: warranted, typical, and nominal characteristics.

### Warranted Characteristics

Warranted characteristics describe guaranteed performance within tolerance limits or certain type-tested requirements.

**Table 3: Warranted electrical characteristics**

Characteristic	Specification (applies to all models unless specified otherwise.)		
		P7504	P7506
Rise time <sup>1</sup>	10–90%	<105 ps	<75 ps
	20–80%	<70 ps	<50 ps
DC attenuation accuracy	5X	0.200 $\pm$ 2%	
	12.5X	0.0800 $\pm$ 2%	
Output Offset Zero	5X	$\pm$ 3 mV (+20 to +30 °C, +68 to +86 °F) $\pm$ 15 mV on oscilloscope	
	12.5X	$\pm$ 3 mV (+20 to +30 °C, +68 to +86 °F) $\pm$ 37.5 mV on oscilloscope	
Temperature	Operating	0 to +40 °C (+32 to +104 °F)	
	Nonoperating	–20 to +71 °C (–4 to +160 °F)	
Humidity	Operating	20–80% RH, at up to +40 °C (+104 °F)	
	Nonoperating	5–90% RH	
Altitude	Operating	3000 meters (10,000 feet)	
	Nonoperating	12,000 meters (40,000 feet)	

<sup>1</sup> Measurements taken using an embedded probe fixture and a 250 mV step (18 to 28 °C +64 to +82 °F)

## Typical Characteristics

Typical characteristics describe typical but not guaranteed performance.

**Table 4: Typical electrical characteristics**

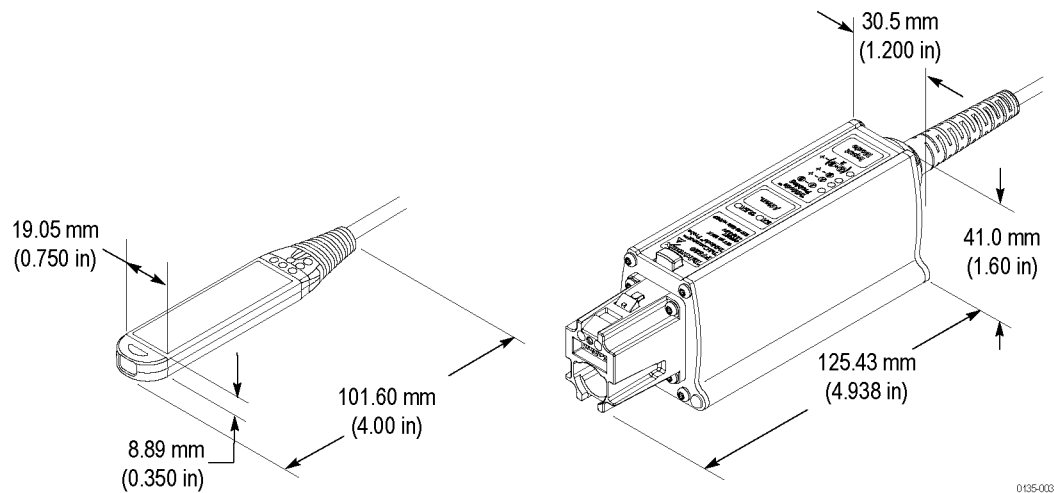
Characteristic	Specification (applies to all models unless specified otherwise).	
	P7504	P7506
Bandwidth <sup>1</sup>	>4 GHz	>6 GHz
Operating Voltage Window	-2.0 V to +4.0 V	
Differential signal range (DC coupled)	5X	±0.750 V
	12.5X	±1.75 V
Linearity	5X	±1% over a dynamic range of -0.75 V to +0.75 V
	12.5X	±1% over a dynamic range of -1.75 V to +1.75 V
Offset voltage range	Differential	-1.5 V to +2.5 V
	Single-ended and common-mode	-1.8 V to +3.4 V
Offset scale accuracy	Differential	0.093 ±2%, referred to input
	Single-ended and common-mode	0.186 ±2%, referred to input
DC offset drift	Differential	-100 µV/ °C (5X, at probe output)
		-60 µV/ °C (12.5X, at probe output)
DC voltage measurement accuracy	Single-ended and common-mode	+100 µV/ °C (5X, at probe output)
		+30 µV/ °C (12.5X, at probe output)
DC voltage measurement accuracy	5X	±(2% of input + 2% of offset + 15 mV + 7.5 mV)
	12.5X	±(2% of input + 2% of offset + 37.5 mV + 17.5 mV)
Maximum nondestructive input voltage	±15 V <sub>(DC + peak AC)</sub> between each input or between either probe inputs and ground	
Input impedance <sup>1</sup>	Differential	430 Ω at 1 GHz
		400 Ω at 4 GHz
	Single-ended	215 Ω at 1 GHz
		200 Ω at 4 GHz
	Common-mode	215 Ω at 1 GHz
		200 Ω at 4 GHz
Differential input resistance, DC coupled	100 kΩ ±6 kΩ	
Input resistance matching	±250 Ω side-to-side with respect to ground	
Common-mode input resistance, DC coupled	50 kΩ ±3 kΩ	
Common-mode rejection ratio, differential-mode <sup>1</sup>	>60 dB at DC	>60 dB at DC
	>40 dB to 50 MHz	>40 dB to 50 MHz
	>30 dB to 1 GHz	>30 dB to 1 GHz
	>28 dB to 2 GHz	>25 dB to 3 GHz
	>25 dB to 4 GHz	>20 dB to 6 GHz

Characteristic	Specification (applies to all models unless specified otherwise).	
	P7504	P7506
Differential-mode rejection ratio, common-mode <sup>1</sup>	>40 dB to 50 MHz >30 dB to 1 GHz >28 dB to 2 GHz >25 dB to 4 GHz	>40 dB to 50 MHz >30 dB to 1 GHz >25 dB to 3 GHz >20 dB to 6 GHz
Channel isolation, single-ended mode <sup>1</sup>	>40 dB to 50 MHz >30 dB to 1 GHz >25 dB to 2 GHz >20 dB to 4 GHz	>40 dB to 50 MHz >30 dB to 1 GHz >24 dB to 3 GHz >18 dB to 6 GHz
Noise	5X	$<33 \text{ nV}/\sqrt{\text{Hz}}$
	12.5X	$<48 \text{ nV}/\sqrt{\text{Hz}}$
Delay time <sup>1</sup>	5.76 ns ±0.1 ns	

<sup>1</sup> Embedded probe only. Refer to *Tip Specifications* for specifications when using TriMode accessory tips. (See page 28, *Tip Specifications*.)

**Table 5: Typical mechanical characteristics**

Characteristic	Description
Dimensions, control box	125.4 mm × 41 mm × 35 mm (4.9 in × 1.6 in × 1.4 in)
Dimensions, probe body	101.6 mm × 8.89 mm × 19 mm (4.0 in × 0.350 in × 0.750 in)
Dimensions, probe length	1.3 m (51.6 in) (end-to-end with no accessories attached)
Unit weight	1.86 kg (4.1 lbs) (probe, accessories and packaging)



**Figure 26: Probe body and control box dimensions**



## Nominal Characteristics

Nominal characteristics describe guaranteed traits, but the traits do not have tolerance limits.

**Table 6: Nominal electrical characteristics**

Characteristic	Description
Input configuration	
Micro-Coax & High Temp solder tips	Differential (two signal inputs, A and B; shared with single-ended) Single-ended (one each A and B signal input and at least one ground input)
P75TLRST solder tip	Differential (two signal inputs, A and B; shared with single-ended) Single-ended (one each A and B signal input and two ground inputs)
TriMode Resistor & Extended Resistor solder tips	Differential (two signal inputs, A and B; shared with single-ended) Single-ended (one each A and B signal input and two ground inputs)
P75PDPM handheld module	Differential (two inputs, A and B)
Damped wire pair	Differential (two inputs, A and B)
Output coupling	DC
Output termination	50 $\Omega$
Probe attenuation settings	5X and 12.5X

## Tip Specifications

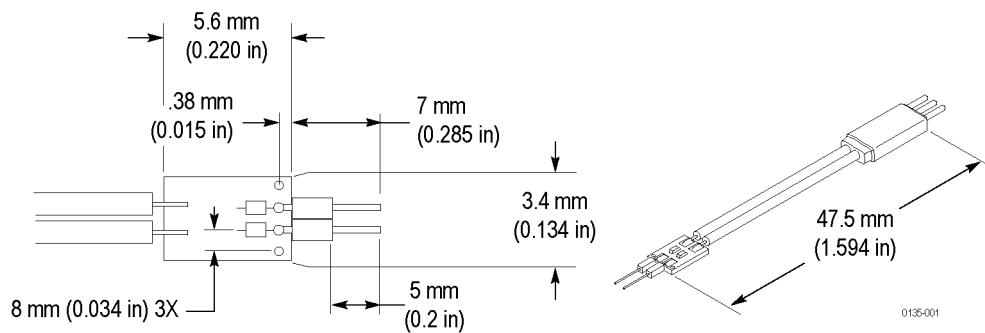
This section lists specifications that are applicable to the probe when used with the accessory tips available for the TriMode probes.

**Micro-Coax Solder Tip** Specifications are typical and apply to all ranges and input modes unless specified otherwise.

**Table 7: Micro-Coax solder tip specifications**

		Measurement mode		
		Differential (A – B)	Single-ended (A – Gnd, B – Gnd)	Common (A + B/2) – Gnd
Input impedance		430 $\Omega$ at 1 GHz 300 $\Omega$ at 2 GHz 250 $\Omega$ at 4 GHz	215 $\Omega$ at 1 GHz 160 $\Omega$ at 2 GHz 125 $\Omega$ at 4 GHz	215 $\Omega$ at 1 GHz 160 $\Omega$ at 2 GHz 125 $\Omega$ at 4 GHz
<b>P7504</b>				
Bandwidth		>3.5 GHz	>2.0 GHz	>1.5 GHz
Rise time	10%–90%	<120 ps	<180 ps	<220 ps
	20%–80%	<80 ps	<120 ps	<150 ps
Input mode crosstalk		CMRR >60 dB at DC >40 dB at 50 MHz >30 dB at 1 GHz >25 dB at 2 GHz >20 dB at 4 GHz	Channel isolation >40 dB at 50 MHz >15 dB at 1 GHz >10 dB at 2.5 GHz <sup>1</sup>	DMRR >40 dB at 50 MHz >30 dB at 1 GHz >25 dB at 1.5 GHz <sup>1</sup>
<b>P7506</b>				
Bandwidth		>4.0 GHz	>2.0 GHz	>1.5 GHz
Rise time	10%–90%	<120 ps	<180 ps	<200 ps
	20%–80%	<80 ps	<120 ps	<150 ps
Input mode crosstalk		CMRR >60 dB at DC >40 dB at 50 MHz >30 dB at 1 GHz >25 dB at 2 GHz >20 dB at 4 GHz <sup>1</sup>	Channel isolation >40 dB at 50 MHz >15 dB at 1 GHz >10 dB at 2.5 GHz <sup>1</sup>	DMRR >40 dB at 50 MHz >30 dB at 1 GHz >25 dB at 1.5 GHz <sup>1</sup>

<sup>1</sup> Probe tip BW limited



**Figure 27: Micro-Coax solder tip dimensions**

The following figures show the typical step response of the TriMode probes with the Micro-Coax solder tip. A 50 ps filter was used on the pulse source for these measurements.



**Figure 28: P7504 probe with the Micro-Coax solder tip**

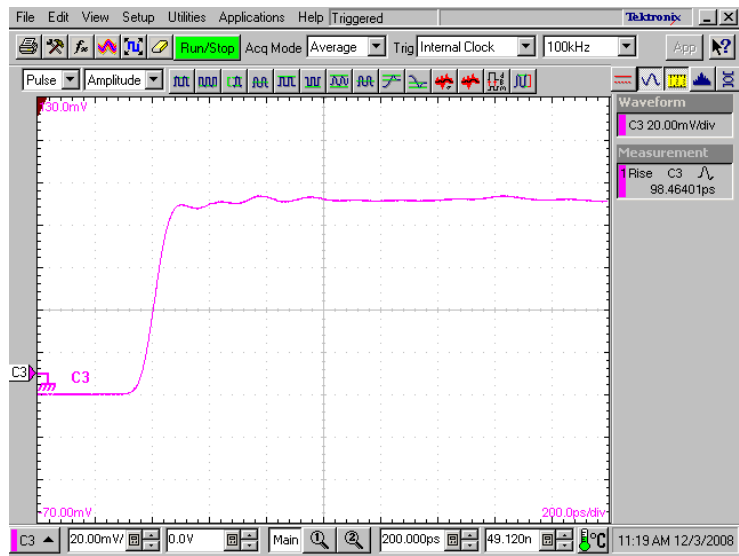


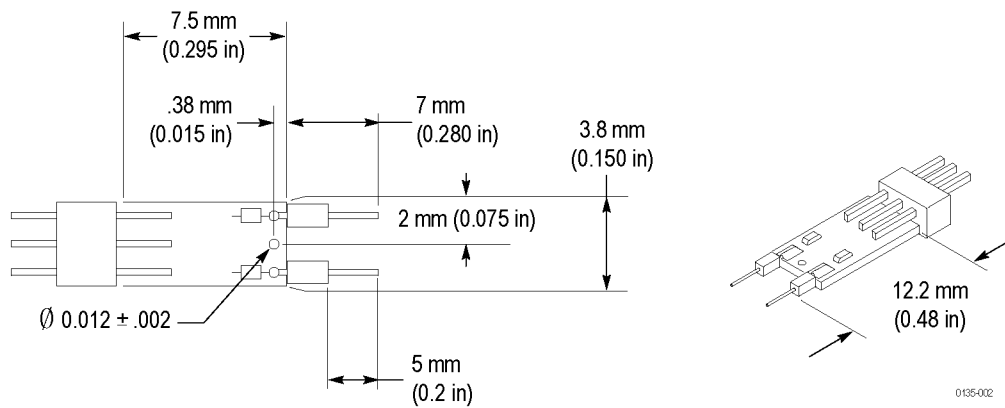
Figure 29: P7506 probe with the Micro-Coax solder tip

**High Temp Solder Tip** Specifications are typical and apply to all ranges and input modes unless specified otherwise.

**Table 8: High Temp solder tip specifications**

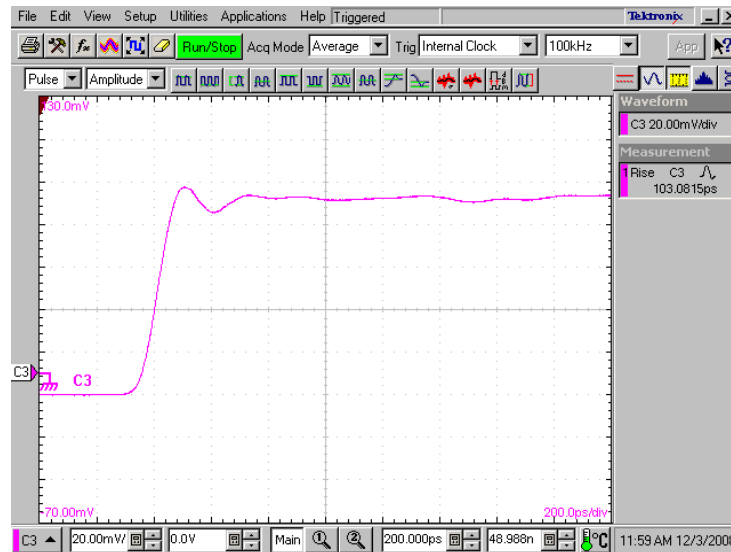
		Measurement mode		
		Differential (A – B)	Single-ended (A – Gnd, B – Gnd)	Common (A + B/2) – Gnd
Input impedance		430 $\Omega$ at 1 GHz 360 $\Omega$ at 3 GHz 280 $\Omega$ at 6 GHz	215 $\Omega$ at 1 GHz 160 $\Omega$ at 3 GHz 125 $\Omega$ at 6 GHz	215 $\Omega$ at 1 GHz 160 $\Omega$ at 3 GHz 125 $\Omega$ at 6 GHz
<b>P7504</b>				
Bandwidth		>4.0 GHz	>3.0 GHz	>2.5 GHz
Rise time	10%–90%	<110 ps	<125 ps	<150 ps
	20%–80%	<75 ps	<85 ps	<100 ps
Input mode crosstalk		CMRR >60 dB at DC >40 dB at 50 MHz >30 dB at 1 GHz >25 dB at 2 GHz >20 dB at 4 GHz	Channel isolation >40 dB at 50 MHz >15 dB at 1 GHz >10 dB at 3 GHz <sup>1</sup>	DMRR >40 dB at 50 MHz >30 dB at 1 GHz >20 dB at 2.5 GHz <sup>1</sup>
<b>P7506</b>				
Bandwidth		>5.5 GHz	>3.0 GHz	>2.5 GHz
Rise time	10%–90%	<80 ps	<120 ps	<150 ps
	20%–80%	<55 ps	<80 ps	<100 ps
Input mode crosstalk		CMRR >60 dB at DC >40 dB at 50 MHz >35 dB at 1 GHz >25 dB at 3 GHz >15 dB at 6 GHz	Channel isolation >40 dB at 50 MHz >25 dB at 1 GHz >10 dB at 3 GHz <sup>1</sup>	DMRR >40 dB at 50 MHz >30 dB at 1 GHz >20 dB at 2.5 GHz <sup>1</sup>

<sup>1</sup> Probe tip BW limited



**Figure 30: High Temp solder tip dimensions**

The following figures show the typical step response of the TriMode probes with the High Temp solder tip. A 50 ps filter was used on the pulse source for these measurements.



**Figure 31: P7504 probe with the High Temp solder tip**

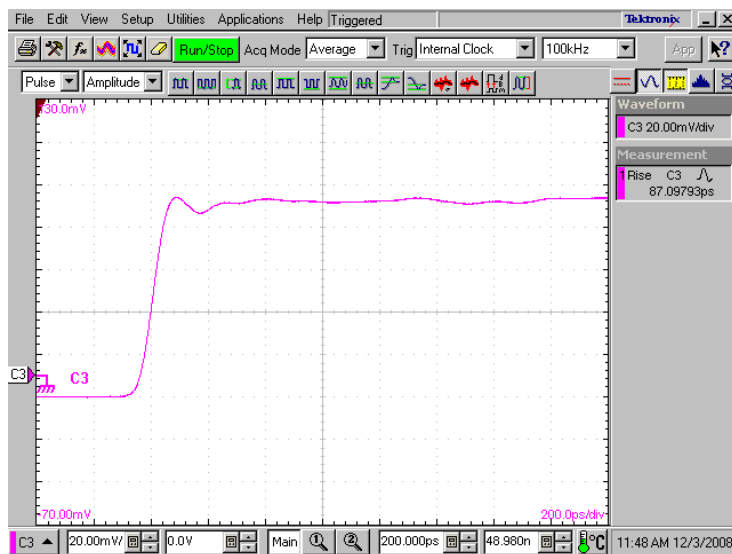


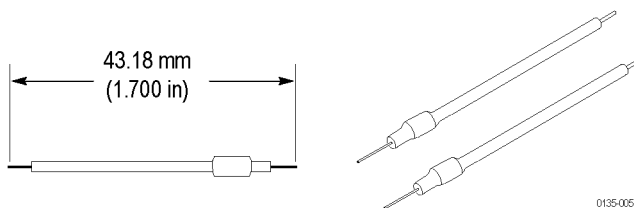
Figure 32: P7506 probe with the High Temp solder tip

**Damped Wire Pair**

Specifications are typical and apply to all ranges and input modes unless specified otherwise. The damped wires are intended for differential mode measurements only.

**Table 9: Damped Wire Pair specifications**

		Differential mode (A – B)
Input impedance	430 Ω at 1 GHz	
	350 Ω at 4 GHz	
	250 Ω at 8 GHz	
<b>P7504</b>		
Bandwidth	>4.0 GHz	
Rise time	10%–90%	<105 ps
	20%–80%	<70 ps
CMRR	>60 dB at DC	
	>40 dB at 50 MHz	
	>30 dB at 1 GHz	
	>25 dB at 4 GHz	
<b>P7506</b>		
Bandwidth	>6.0 GHz	
Rise time	10%–90%	<75 ps
	20%–80%	<50 ps
CMRR	>60 dB at DC	
	>40 dB at 50 MHz	
	>30 dB at 1 GHz	
	>25 dB at 3 GHz	
	>20 dB at 6 GHz	



**Figure 33: Damped Wire Pair dimensions**



The following figures show the typical step response of the TriMode probes with the Damped Wire Pair. A 50 ps filter was used on the pulse source for these measurements.

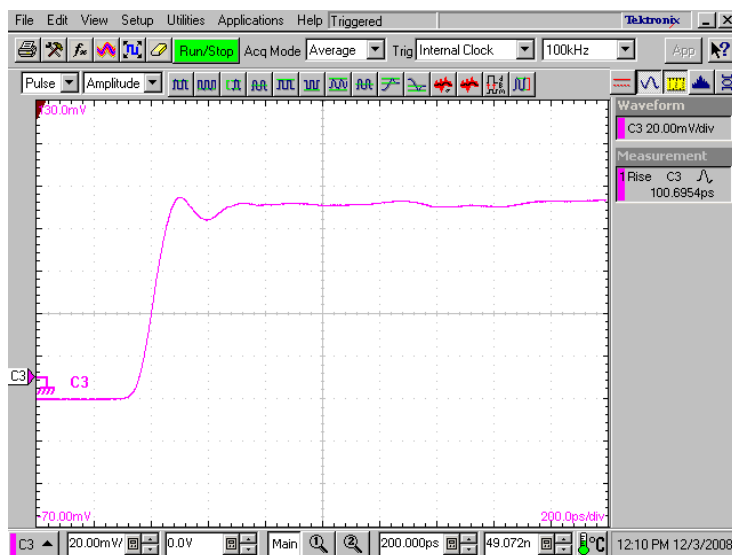


Figure 34: P7504 probe with the Damped Wire Pair

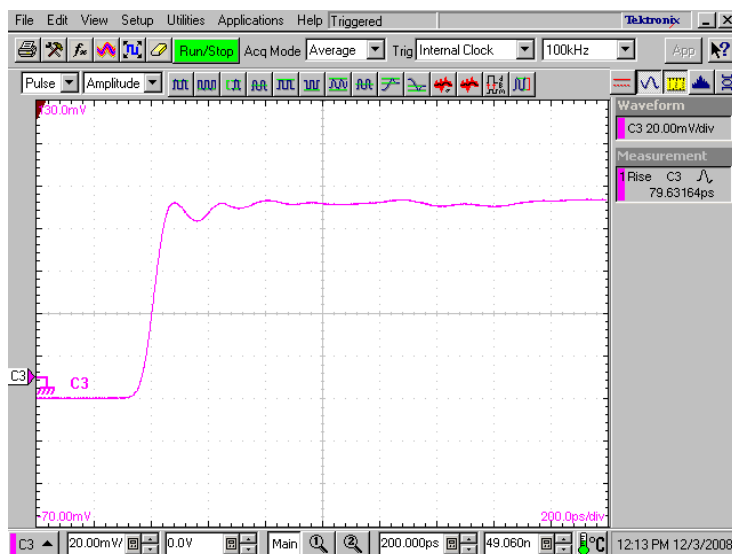


Figure 35: P7506 probe with the Damped Wire Pair

**P75TLRST TriMode Long Reach Solder Tip**

Specifications are typical and apply to all ranges and input modes unless specified otherwise.

**Table 10: P75TLRST TriMode Long Reach Solder Tip specifications**

	Measurement mode		
	Differential (A – B)	Single-ended (A – Gnd, B – Gnd)	Common (A + B/2) – Gnd
Input impedance	430 $\Omega$ at 1 GHz	215 $\Omega$ at 1 GHz	215 $\Omega$ at 1 GHz
	350 $\Omega$ at 3 GHz	175 $\Omega$ at 3 GHz	175 $\Omega$ at 3 GHz
	220 $\Omega$ at 6 GHz	110 $\Omega$ at 6 GHz	110 $\Omega$ at 6 GHz
<b>P7504</b>			
Bandwidth	>4.0 GHz		
Rise time	10%–90%	<105 ps	
	20%–80%	<70 ps	
Input mode crosstalk	CMRR	Channel isolation	DMRR
	>60 dB at DC	>40 dB at 50 MHz	>40 dB at 50 MHz
	>40 dB at 50 MHz	>25 dB at 1 GHz	>30 dB at 1 GHz
	>30 dB at 1 GHz	>20 dB at 2 GHz	>25 dB at 2 GHz
	>28 dB at 2 GHz	>15 dB at 4 GHz	>20 dB at 4 GHz
	>25 dB at 4 GHz		
<b>P7506</b>			
Bandwidth	>6.0 GHz		
Rise time	10%–90%	<75 ps	
	20%–80%	<50 ps	
Input mode crosstalk	CMRR	Channel isolation	DMRR
	>60 dB at DC	>40 dB at 50 MHz	>40 dB at 50 MHz
	>40 dB at 50 MHz	>25 dB at 1 GHz	>30 dB at 1 GHz
	>30 dB at 1 GHz	>20 dB at 3 GHz	>25 dB at 3 GHz
	>25 dB at 3 GHz	>15 dB at 6 GHz	>20 dB at 6 GHz
	>20 dB at 6 GHz		

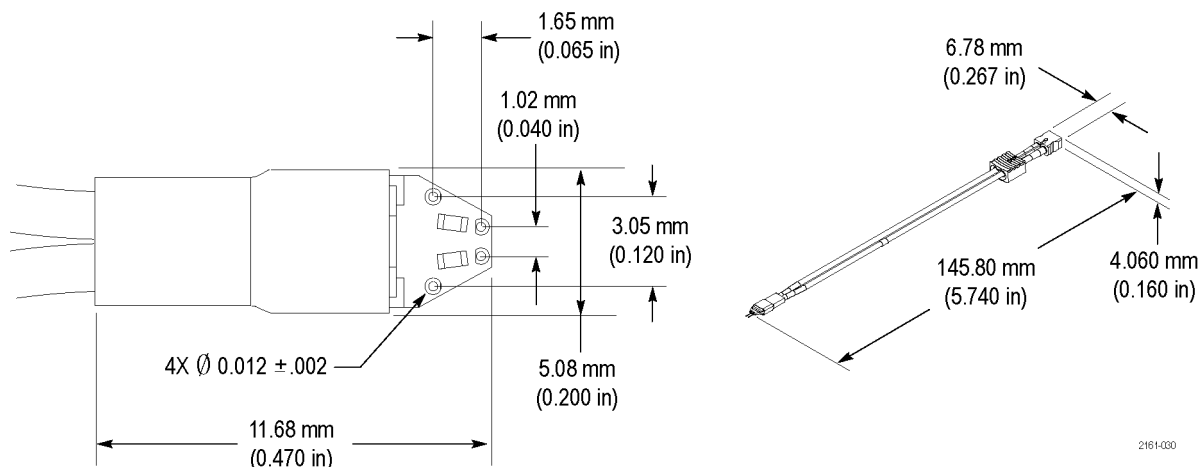


Figure 36: P75TLRST TriMode Long Reach Solder Tip dimensions

The following figures show the typical step response of the TriMode probes with the P75TLRST solder tip. A 50 ps filter was used on the pulse source for these measurements.

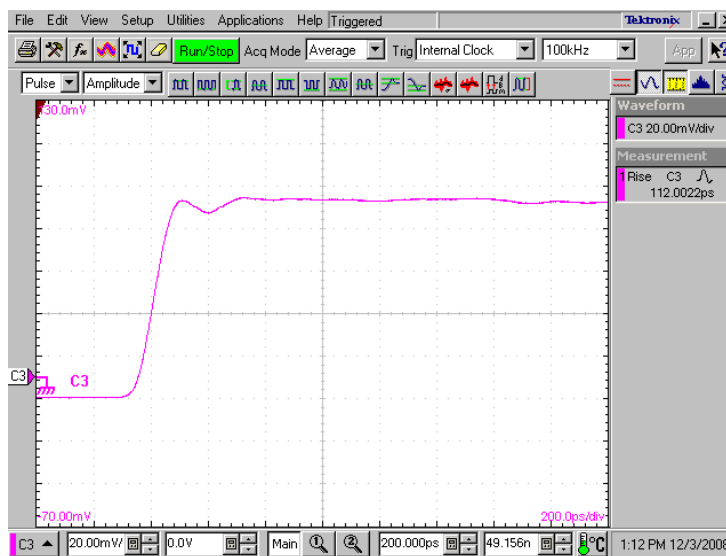


Figure 37: P7504 probe with the P75TLRST solder tip

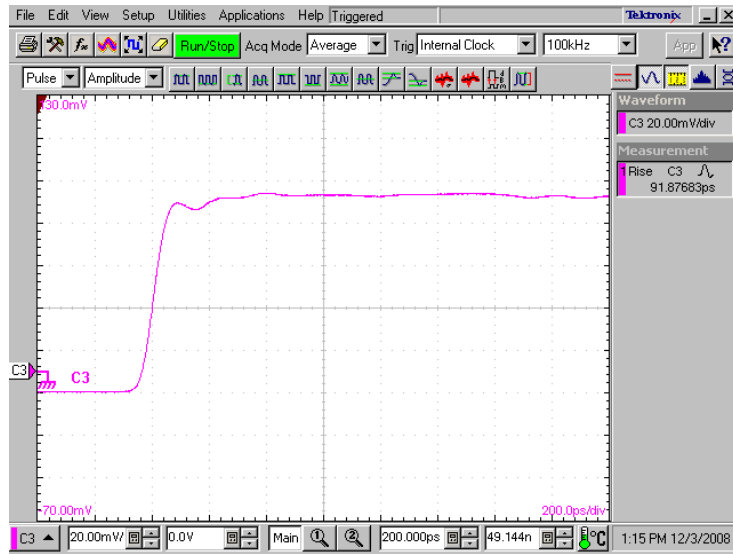


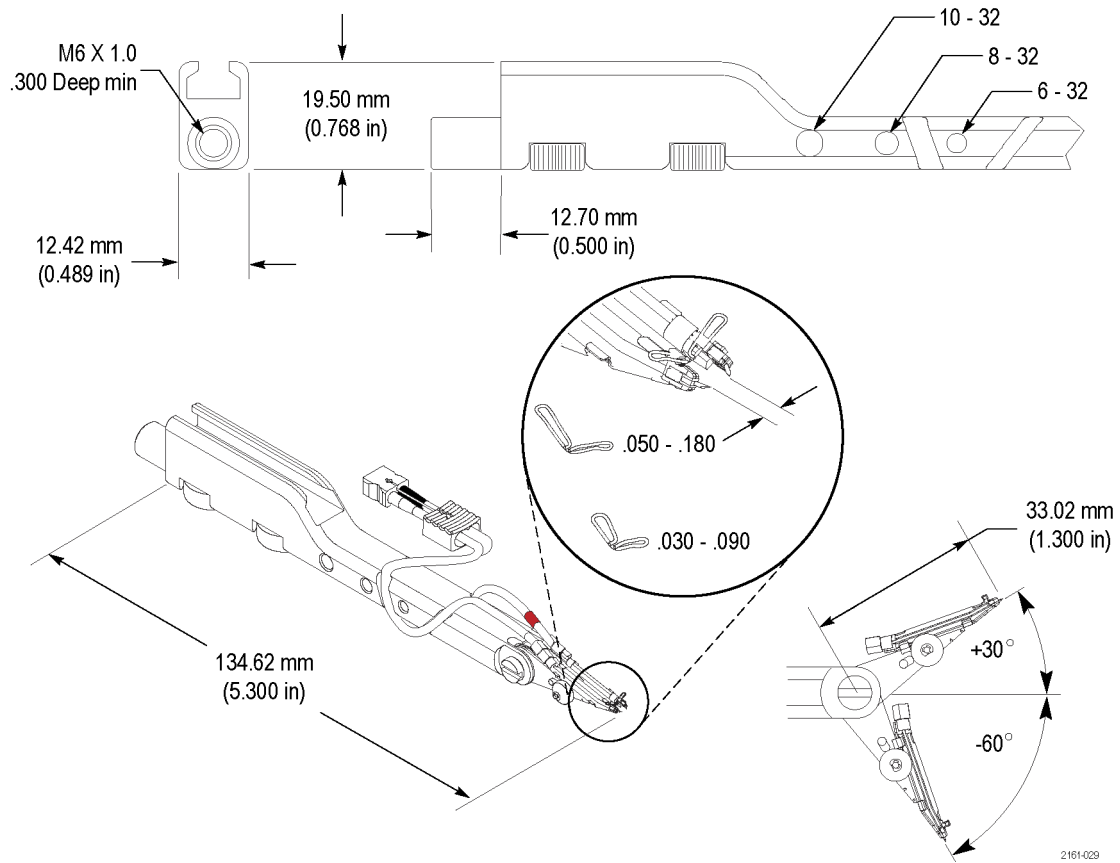
Figure 38: P7506 probe with the P75TLRST solder tip

### P75PDPM Precision Differential Probing Module

Specifications are typical and apply to all ranges and input modes unless specified otherwise. The probing module is intended for differential mode measurements only.

**Table 11: P75PDPM Precision Differential Probing Module specifications**

		Differential mode (A – B)
Input impedance		430 $\Omega$ at 1 GHz 400 $\Omega$ at 2 GHz 320 $\Omega$ at 4 GHz
<b>P7504</b>		
Bandwidth		>4.0 GHz
Rise time	10%–90%	<105 ps
	20%–80%	<70 ps
CMRR		>60 dB at DC >40 dB at 50 MHz >30 dB at 1 GHz >28 dB at 2 GHz >25 dB at 4 GHz
<b>P7506</b>		
Bandwidth		>6.0 GHz
Rise time	10%–90%	<75 ps
	20%–80%	<50 ps
CMRR		>60 dB at DC >40 dB at 50 MHz >30 dB at 1 GHz >25 dB at 3 GHz >20 dB at 6 GHz



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**Figure 39: P75PDPM Precision Differential Probing Module dimensions**

The following figures show the typical step response of the TriMode probes with the P75PDPM probing module. A 50 ps filter was used on the pulse source for these measurements.

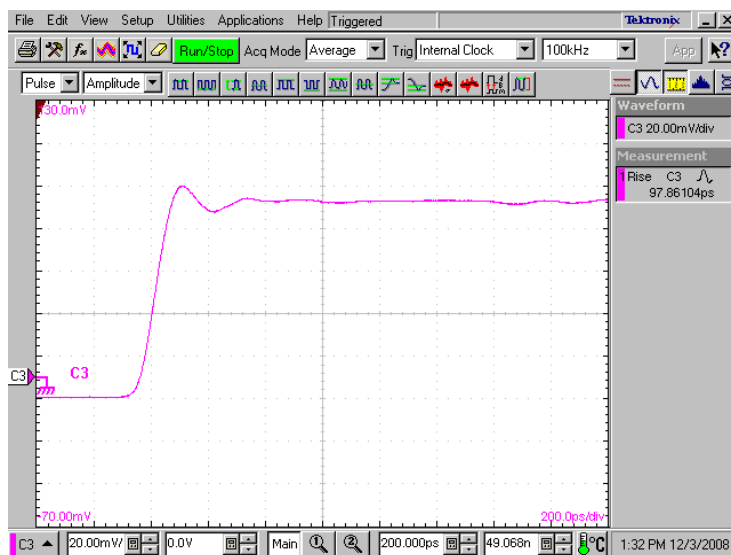


Figure 40: P7504 probe with the P75PDPM probing module

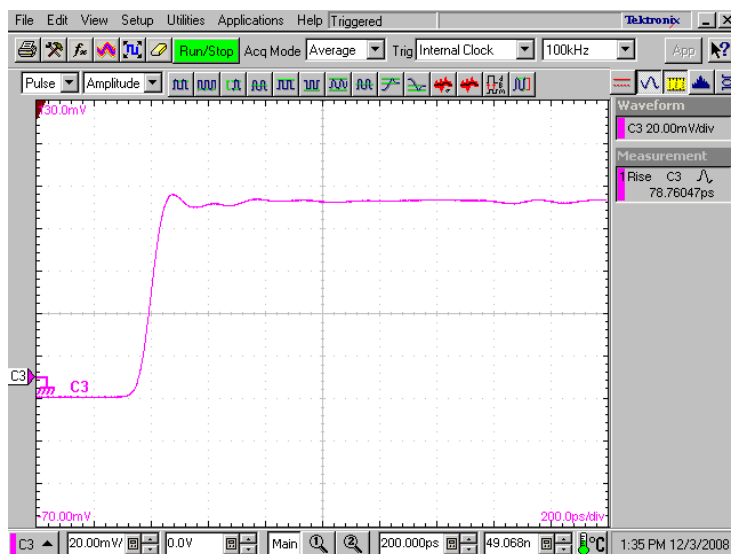


Figure 41: P7506 probe with the P75PDPM probing module





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# User Service

This section covers troubleshooting and probe maintenance.

If your probe does not meet the specifications listed in the *Specifications*, you can send the probe to Tektronix for repair. (See page 56, *Preparation for Shipment*.)

## Error Conditions

The LEDs on the probe alert you to error or status conditions affecting the probe. When the probe is functioning correctly, there is a quick flash of the LEDs on the probe just after connecting to the oscilloscope. If the probe LEDs flash or otherwise appear to be malfunctioning, an error condition may exist.

### LEDs Do Not Remain Lit

If none of the Range or TriMode LEDs remain lit after you connect the probe, a probe/oscilloscope interface fault exists. Perform the following steps until you clear the fault or isolate the problem:

- Disconnect and reconnect the probe to restart the power-on diagnostic sequence.
- Connect the probe to a different channel on the oscilloscope.
- Disconnect the probe from the oscilloscope, power-cycle the oscilloscope, and then reconnect the probe.
- Connect the probe to a different oscilloscope.

If the symptoms remain (they follow the probe), then the probe is defective and must be returned to Tektronix for repair.

### LEDs Flash On and Off

If all of the Range or TriMode LEDs flash on and off repeatedly after you connect the probe, an internal probe diagnostic fault exists. Disconnect and reconnect the probe to restart the power-on diagnostic sequence. If the symptoms continue, the probe is defective, and must be returned to Tektronix for repair.

If the LEDs repeatedly flash on and off for a selected mode or range setting, an internal probe diagnostic fault exists. Disconnect and reconnect the probe to restart the power-on diagnostic sequence. If the symptoms continue, the indicated setting is defective and the probe should be returned to Tektronix for repair. Although the probe can be used under these conditions, it may not pass the probe calibration procedure.

### Signal Display

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

- Check the probe tip connection on your circuit.
- Check the probe tip connection at the probe body.
- Perform a functional check using the TriMode calibration board included with the probe. Refer to the *P7504 & P7506 Quick Start User Manual* for specific instructions.

## Replaceable Parts

The following parts may need to be replaced due to normal wear and damage. When you replace these components, secure the probe in a small vise or positioner to simplify the procedure.

**Table 12: TriMode probes replaceable parts**

Description	Replacement part number
Probe body bullet contacts	013-0359-xx, kit of 4
P75TLRST solder tip wires	020-2754-xx, Wire Replacement Kit, includes one bobbin each: 4 mil wire, 8 mil wire, and SAC305 solder
TriMode Resistor (020-2936-xx) & TriMode Extended Resistor (020-2944-xx) solder tip resistors	020-2937-xx Replacement Resistor Kit, includes 50 each: 100 $\Omega$ leaded resistors, 75 $\Omega$ surface mount resistors, nonconductive tubing
P75PDPM Probing Module springs	016-1998-xx, kit of 4 (large springs) 016-1999-xx, kit of 4 (small springs)
P75PMT Probing Module tips (left and right)	P75PMT, one pair
P75TC Probing Module Tip Cable	P75TC, qty. 1

Refer to the user manual for a list of the accessories that are available for your probe.

**Table 13: Required equipment**

Description	Minimum requirement	Recommended example <sup>1</sup>
Bullet removal tool	Custom tool	003-1896-xx
Connector separator tool	Custom tool	003-1897-xx
Ground spring tool	Custom tool	003-1900-xx
Tweezers	General purpose	
Magnifying glass or microscope	Free standing to allow hands-free use	
Probe positioner or bench vise	Able to hold probe	PPM203B or PPM100

<sup>1</sup> Nine-digit part numbers (xxx-xxxx-xx) are Tektronix part numbers.

## Replacing probe body bullet contacts

The bullet contacts in the probe body should be replaced every 200 insertion cycles. Follow these steps to replace the bullets by using the removal tool:

### Remove.

1. Squeeze the tool plunger to extend the holder tangs.
2. Insert the tool into the probe body so that the holder tangs surround one of the bullets.
3. Release the plunger to secure the holder tangs on the bullet.
4. Gently pull the tool outward to remove the bullet.
5. Repeat for the other bullet.



**CAUTION.** *If you cannot extract the bullets with the bullet removal tool, use fine needle-nosed pliers and a magnifying glass or microscope. Be careful not to damage the probe body with the pliers.*

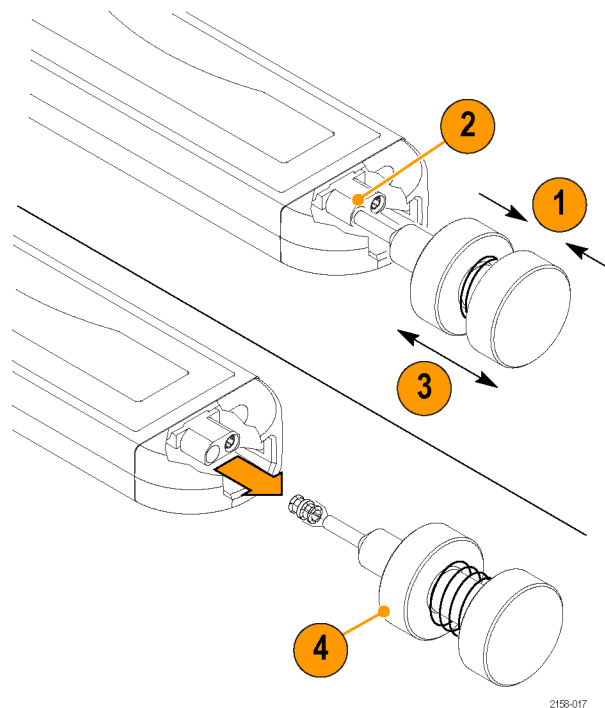
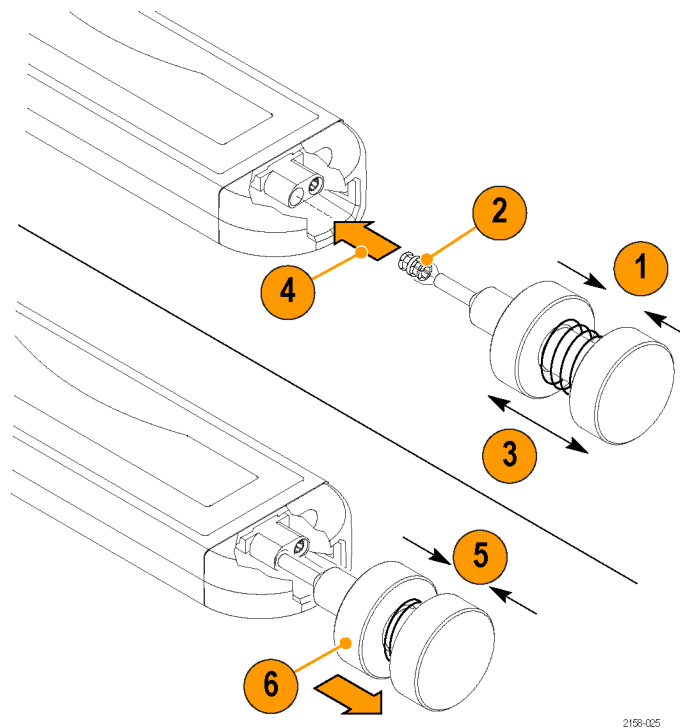


Figure 42: Removing the bullets

**Install.** When both bullets have been removed, install new bullets by doing the following:

1. Squeeze the tool plunger to extend the holder tangs.
2. Insert a new bullet into the tool so that the holder tangs surround the bullet.
3. Release the plunger to secure the holder tangs on the bullet.
4. Insert the tool into the probe body and seat the bullet in the recess.
5. Squeeze the tool plunger to release the bullet.
6. Gently pull the tool out of the probe body.
7. Repeat for the other bullet.
8. Test that the bullets are installed correctly by connecting and then removing an accessory solder tip to the probe head. Inspect the probe head and verify that the bullets remain seated in the probe head.



**Figure 43: Installing the bullets**

## P75TLRST Solder Tip Wires

The solder vias on the circuit board at the end of the P75TLRST Solder Tip are small (0.012 in.), and require small wires to attach to your circuit. (Use the 4-mil and 8-mil wires included with the Wire Replacement kit to make the connections.) Because of the small dimensions, the solder tips have a limited number of solder cycles that the vias can withstand before the Solder Tips become unusable. If you expect to make frequent soldering changes, consider using the optional TriMode Resistor solder tips. The resistors that extend off of these tips can accept a higher number of solder cycles and can be replaced when necessary.

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**NOTE.** *Axial-leaded tip resistors (included in the TriMode resistor replacement kit, Tektronix part number 020-2937-XX), should not be used in place of wires with the P75TLRST probe tip unless the surface-mount, SMD0402 resistors are also changed. The total probe tip resistance for the P7500 Series probes is designed to be 175  $\Omega$ .*

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**CAUTION.** *To prevent damage to the circuit board or circuit board connections due to accidental movement of the probe and soldered leads, we recommend that you secure the tip to the circuit board using the adhesive tip tape provided in your accessory kit. You can also use other materials such as Kapton tape or hot glue.*

*To avoid damage to the tip or the circuit under test, avoid applying excessive heat from the soldering iron. Use a low wattage, temperature-controlled soldering iron and appropriately sized soldering iron tip.*

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To prolong the life of your solder tips, consider the following points before you use the solder tips.

Consider the types of measurements that you plan to take. If you are going to take a few measurements at one location and then move to another, you may be able to use longer wires. Longer wires may degrade your measurement slightly (which may not matter), but the wires can then be cut or desoldered at your circuit and reused, rather than subjecting the solder tip to a desolder/solder cycle.

Perhaps the optional P75PDPM Precision Differential Probing Module is a better choice for the test points that you do not measure as often. The probing module can take both single-ended and differential measurements, and when used with a probe positioner, can provide hands-free access to tight spaces. Depending on your measurement requirements and circuit geometries, the probing module might be a preferable alternative.

At critical test points such as circuit outputs, you might need to keep the wires as short as possible. If possible, use the solder tip dimensions shown in the *Specifications* section to lay out a matching footprint on your circuit board.

Use the following precautions when you solder the tips:

- For best soldering results, use a microscope to examine the quality of the solder joints.
- Use a low-wattage, temperature-controlled soldering iron and a small mass soldering iron tip. The soldering iron temperature should be set as low as possible, while still providing a reliable solder joint.
- Use SAC305 solder (included with the wire replacement kit) to attach the tip wires to the circuit under test.
- When replacing tip wires or axial-lead resistors, solder wick can be used to remove the excess solder from the probe tip circuit board via holes. Be careful not to overheat the via and damage the board.
- The attachment wires should be bent symmetrically to vary the interconnect spacing. Use care when you solder a tip to a circuit under test to avoid inadvertently desoldering either the attachment wires or the damping resistor.
- For optimum performance and signal integrity, keep the lead length between the DUT (Device Under Test) and the tip as short as possible, and the lead lengths the same length.

### P75PDPM Probing Module Springs

Equipment Required: ground spring tool, magnifying glass or microscope, tweezers, probe holder

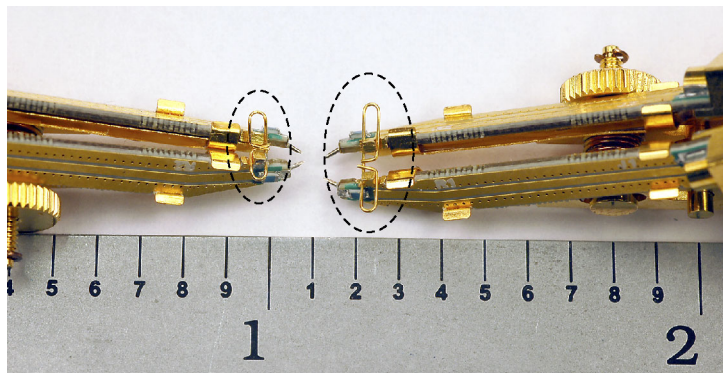
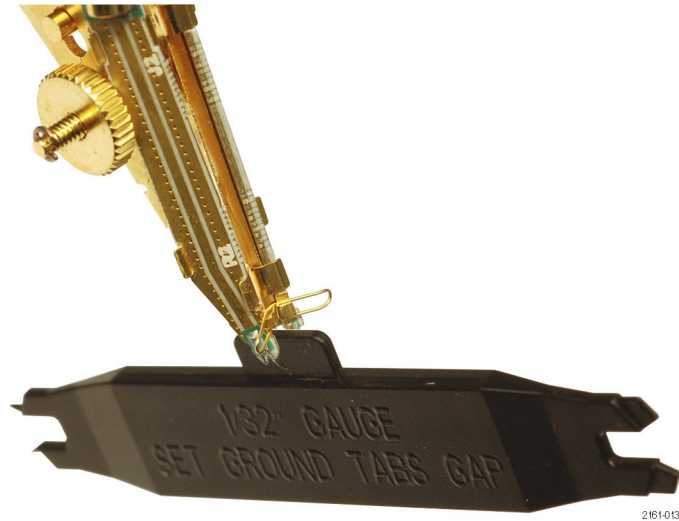


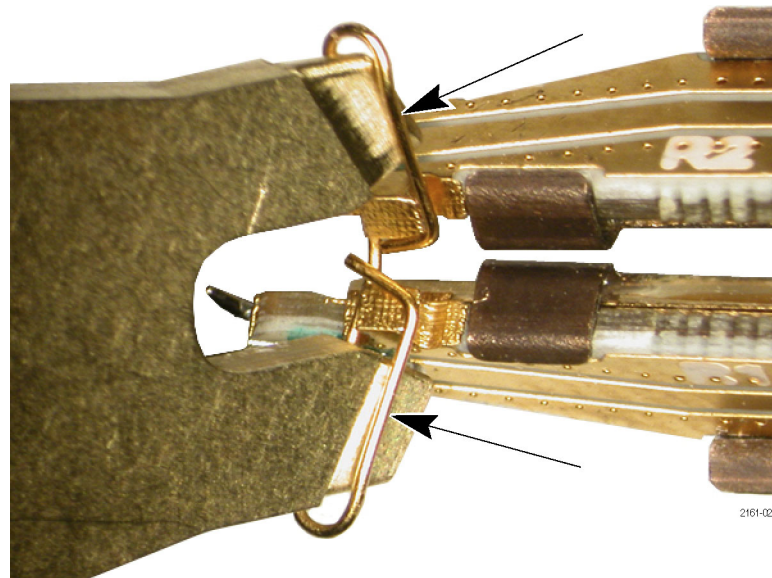
Figure 44: Large and small springs installed

**Remove.**

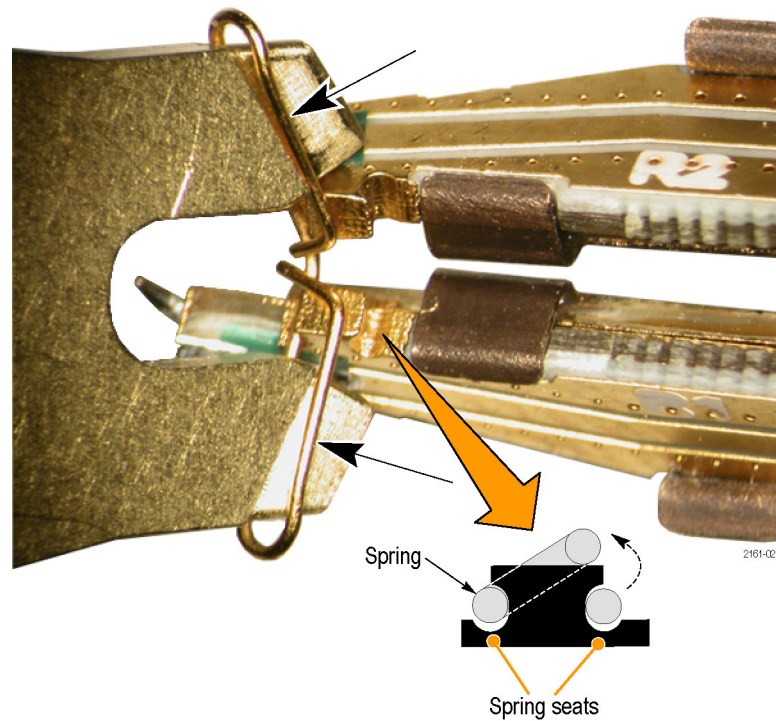
1. Adjust the tip gap using the gap measurement tab on the spring tool. Set the tool between the tip circuit boards, not the tips.

**Figure 45: Set the gap**

2. Insert the ground spring tool under the top of the spring.

**Figure 46: Insert tool beneath spring**

3. Rock the tool away from the tips so that the spring clears the seat edge.



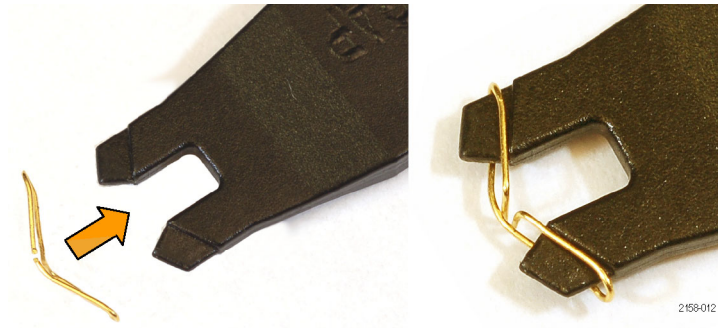
**Figure 47: Transfer spring from tip to tool**

4. Gently pull the tool away; the spring should come away with the tool.
5. Put the spring in the accessory container or a safe place to avoid losing the spring.

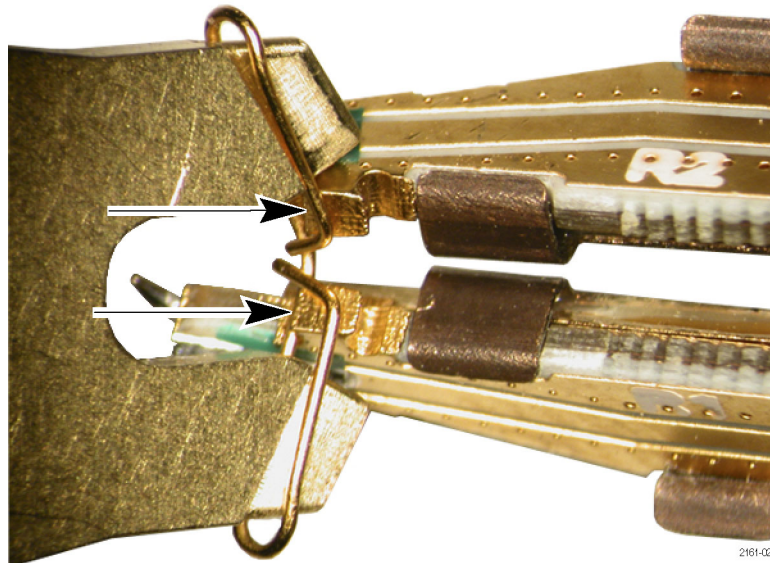


**Install.**

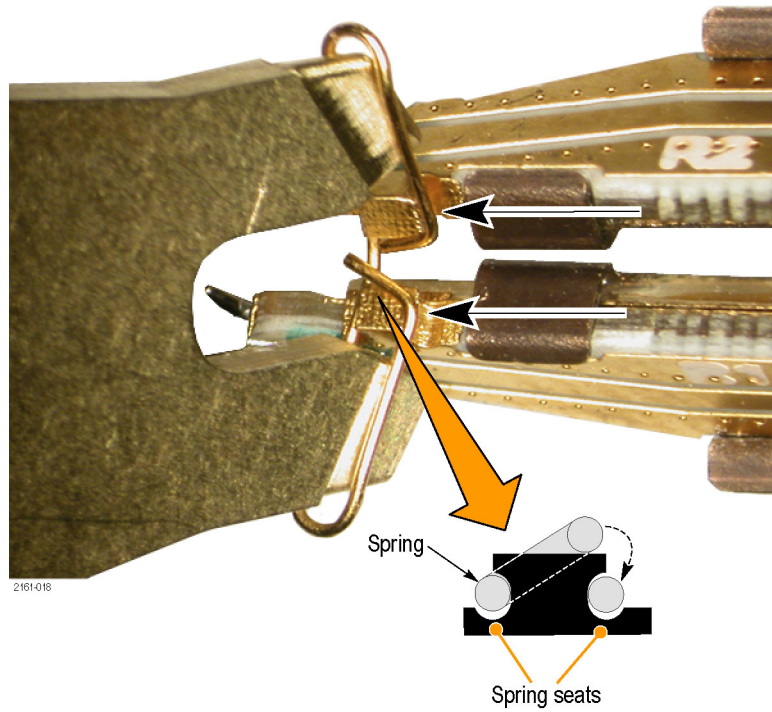
1. Two spring sizes are available: the small spring allows 0.030 – 0.090 in. (0.76 – 2.28 mm) tip span, the large spring allows 0.050 – 0.180 in. (1.27 – 4.57 mm) tip span.
2. Check that the tip gap is .032 in. using the gap measurement tab on the spring tool. Adjust if necessary.
3. Using tweezers, install the spring on the tool. The tool has a large and small side, one for each size spring. Make sure the gap in the spring is on the top of the tool as shown.

**Figure 48: Place spring on tool**

4. Set the bottom of the spring in the front seats (those closest to the tip ends). Maintain a slight pressure on the spring to keep it in the front seats.

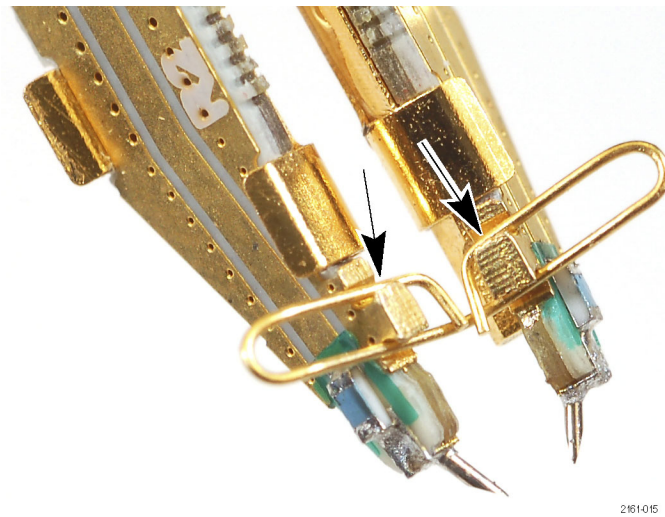
**Figure 49: Set spring in front seat**

5. Set the top of the spring in the rear seats by lifting the tool to clear the edge of the rear seat with the top of the spring.



**Figure 50: Set the spring in the rear seats**

6. Gently retract the tool from the spring. Verify that the spring is seated as shown.



**Figure 51: Properly seated spring**

### P75TC Probing Module Tip Cable

Equipment Required: connector separator tool

1. Disconnect the Cable Tip by the inserting the tool between the connectors. The tapered edges of the tool gently separate the cable connector from the tip connector.

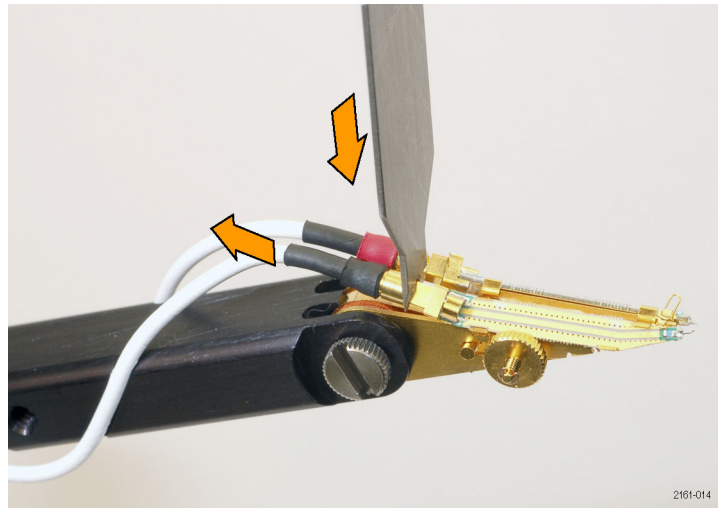


Figure 52: Disconnecting the tip cable

2. Repeat for the other cable and then pull both cables away from the tip connectors.

### P75PMT Probing Module Tips (Left and Right)

Equipment Required: connector separator tool, magnifying glass or microscope (preferred), tweezers, and probe holder.

**NOTE.** *The probing module tips are electrically matched pairs and should be replaced together. Failure to do so may degrade the performance of your probe.*

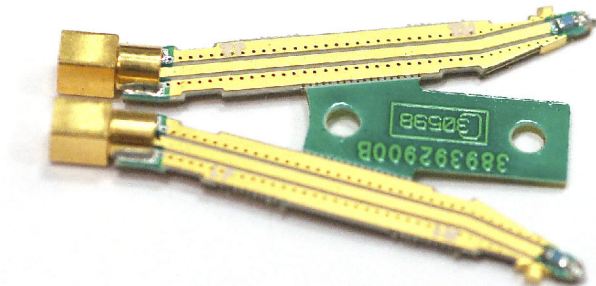
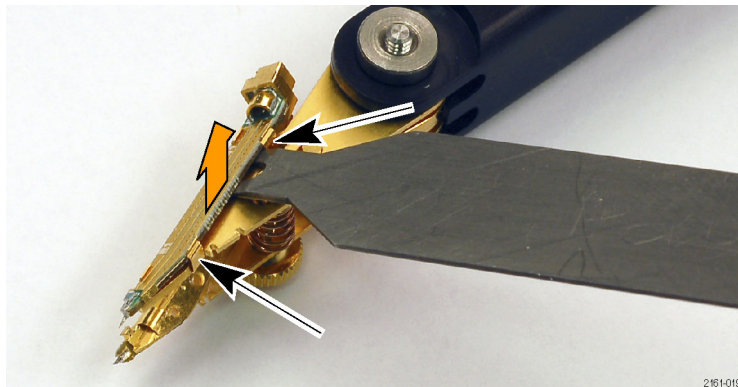


Figure 53: Probing module tips

**Remove.**

1. Disconnect the Cable Tips. (See page 53, *P75TC Probing Module Tip Cable*.)
2. Remove the spring. (See page 48, *P75PDPM Probing Module Springs*.)
3. Adjust the tip gap to maximum width.
4. Use the connector separator tool or a small screwdriver to pry the board up from the bottom. The bottom tabs are designed to flex; the top tabs are not.

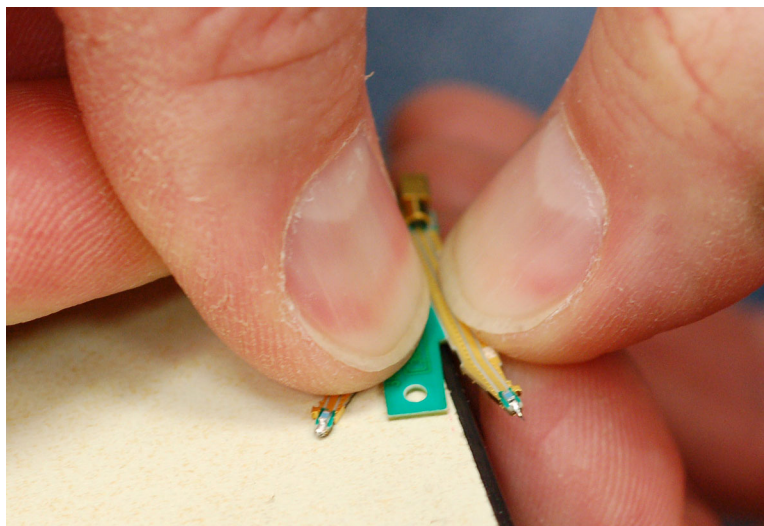


**Figure 54: Removing the tip**

5. Repeat for the other tip.

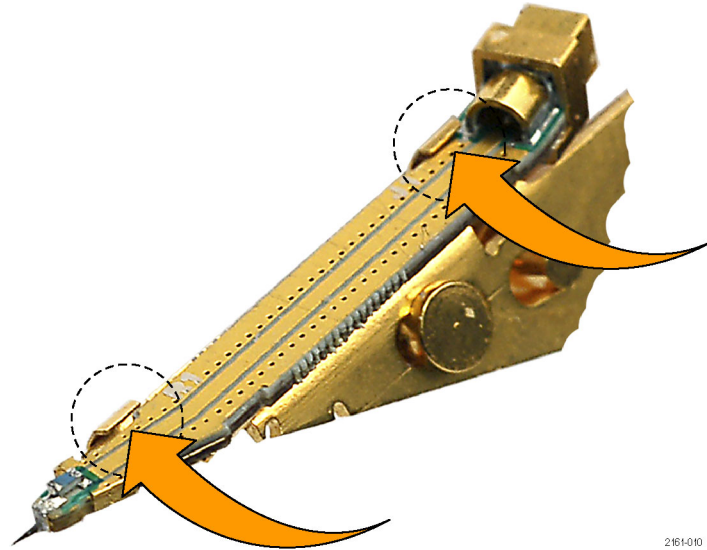
**Install.**

6. Separate the new tip board pair by snapping the board against a sharp edge.



**Figure 55: Separating the tip board pair**

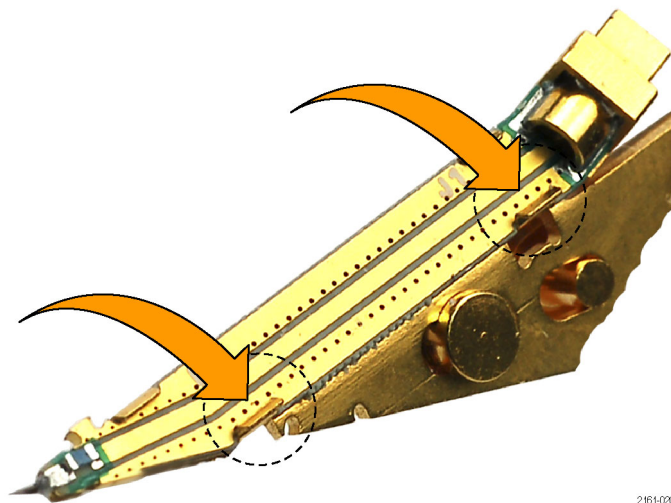
7. Select the correct board (left or right), and seat the board in the top tabs. The board is notched to align it to the tip body.



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**Figure 56: Seating the tip in the top tabs**

8. Press the bottom of the board to snap it past the bottom tabs.



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**Figure 57: Snapping the tip into the bottom tabs**

9. Repeat steps 7 and 8 for the other tip.
10. Attach the spring. (See page 48, *P75PDPM Probing Module Springs*.)
11. Reattach the cable pair.

## Preparation for Shipment

If the original packaging is unfit for use or not available, use the following packaging guidelines:

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 to protect it from dampness.
3. Place the probe into the box and stabilize it with light-weight packing material.
4. Seal the carton with shipping tape.
5. Refer to *Contacting Tektronix* on the copyright page of this manual for the shipping address.