Tektronix®

洛克儀器股份有限公司
Lock Instrument Co., Ltd.

TDP3500 and TDP4000
3.5 GHz and 4 GHz Differential Probes
Quick Start User Manual

071-2212-01

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www.tek.com

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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. Do not connect or disconnect probes or test leads while they are connected to a voltage source.

Ground the product. This product is indirectly grounded through the grounding conductor of the mainframe power cord. To avoid electric shock, the grounding conductor must be connected to earth ground. Before making connections to the input or output terminals of the product, ensure that the product is properly grounded.

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.

Connect the probe reference lead to earth ground only.

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:

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.*

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

Environmental Considerations

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).

Preface

This manual describes the installation and operation of the TDP3500 and TDP4000 Differential probes. Basic probe operations and concepts are presented in this manual. You can also check the Tektronix Web site for this document and other related information.

Documentation

To read about	Read these documents *
First Time Operation, Functional Check, Operating Basics	This manual.
Specifications, Performance Verification	The technical reference manual
In-depth oscilloscope operation, user interface, GPIB commands	The online help (from the Help menu on the host instrument)

* To access the documentation that is installed on your instrument, click **Start** in the taskbar and select **Programs > TekApplications**.

Conventions used in this manual

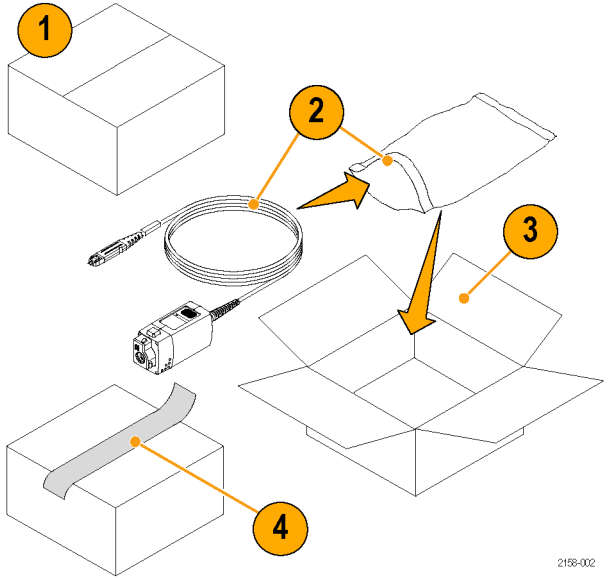
The following icon is used throughout this manual to indicate a step sequence.

Returning the probe for servicing

If your probe requires servicing, you must return the probe 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.



Key features

The TDP3500 and TDP4000 Differential probes enables you to make accurate differential measurements from DC to 3.5 GHz and 4 GHz using oscilloscopes featuring the Tektronix TekVPI oscilloscope interface. Key features include:

- DC to 3.5 Ghz bandwidth (TDP3500)
- DC to 4 Ghz bandwidth (TDP4000)
- 100 kΩ differential input resistance
- <0.3 pF differential input capacitance
- >25 dB CMRR @ 1 GHz
- Automatic unit scaling on the oscilloscope display

Operating considerations

Table 1: TDP3500 and TDP4000

Characteristic	Description
Input Voltage	Differential: ±2.0 V (DC + peak AC), 1.4 V RMS Operating Voltage Input Range: +5 V to –4 V (either input referenced to ground)
Temperature	Operating: 0 to +40 °C (+32 °F to +104 °F) Nonoperating: –40 °C to +71 °C (–40 °F to +160 °F)
Humidity	Operating: up to +40 °C (+104 °F) 5-90% RH Nonoperating: up to +60 °C (+140 °F) 5-90% RH
Altitude	Operating: Up to 3000 meters (10,000 feet) Nonoperating: Up to 15230 meters (50,000 feet)
Pollution Degree	2, Indoor use only

Installation

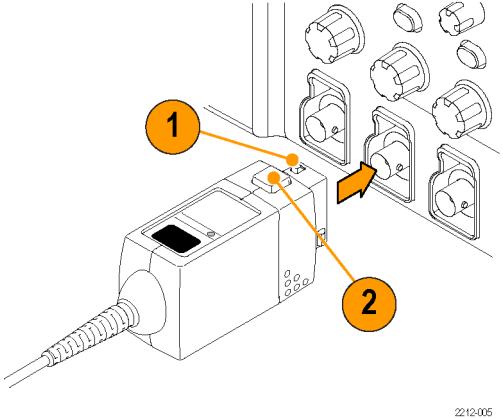
Connecting to the host instrument

NOTE. Your TekVPI instrument may require a firmware upgrade to support full functionality of the TDP3500 and TDP4000 probes. Before you connect the probe, check the version requirements. (See page 36, Host instrument firmware.)

1. Slide the probe into the TekVPI receptacle. The probe snaps when fully engaged.

   When you connect the probe, the host instrument reads information from the probe and identifies the probe type.

2. To disconnect, press the latch release button and pull away from the instrument.



Probe controls and indicators

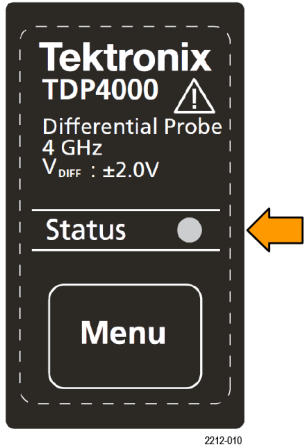
Status LED

When the probe is powered on, the Status LED glows green, then dark, and then remains lit green. This indicates that the probe is in normal operating mode.

If the Status LED glows red, a fault may exist. To clear the fault:

1. Disconnect the probe from the oscilloscope.
2. Reconnect the probe to the oscilloscope.

If the Status LED continues to glow red, return the probe to Tektronix.



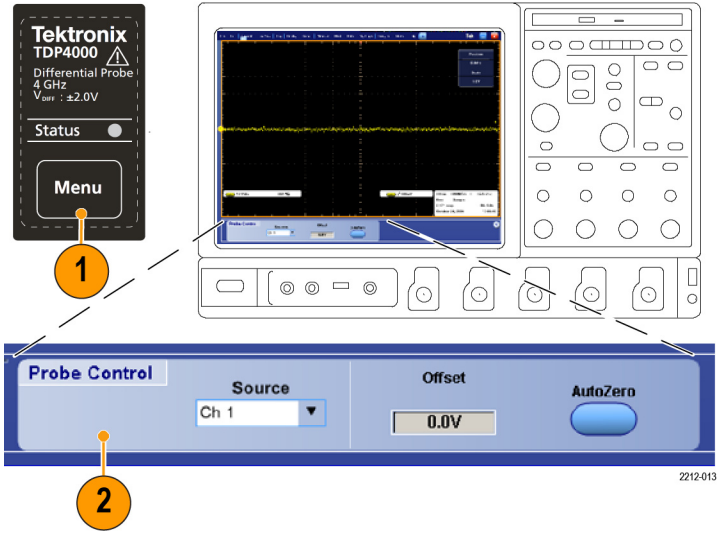
Menu button

1. Press the probe **Menu** button to display the Probe Control screen on the oscilloscope.

NOTE. Probe menu screens vary slightly between oscilloscope series; samples of DPO7000C Series screens are shown here.

This screen includes controls for probe functions that are not accessible on the probe, such as Offset.

2. Use the touch-screen buttons on the instrument to set the probe parameters.
3. Press the probe **Menu** button again to close the Probe Control screen.



Functional check

Use the following procedure to check that your probe is functioning properly. To verify that your probe meets the warranted specifications, refer to the *Performance Verification* procedures in the *TDP3500 Probe Technical Reference*.

NOTE. *The DPO7000C series oscilloscope is used in all illustrations in this manual, unless noted otherwise.*

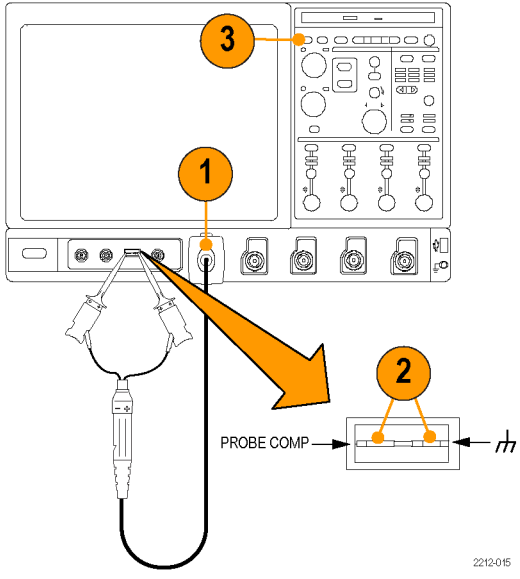
Required equipment

Description and quantity	Performance requirement	Recommended example
Oscilloscope	TekVPI Interface	Tektronix DPO7000C Series Tektronix 6 Series MSO
Square-pin adapter	Probe tip to 0.25-in square pins for external connections	Tektronix part number 016-1884-XX [1]
Y-lead adapter	0.25-in square pins for probe tip connections	Tektronix part number 196-3434-XX [1]
MicroCKT Test Tips (2)	0.25-in square pins-to-mini clips	Tektronix part number 206-0569-XX [1]

[1] Standard probe accessory

Signal

1. Connect the probe to any channel of the oscilloscope and set the oscilloscope to display that channel.
2. Use the Square-pin Adapter, Y-lead Adapter, and two MicroCKT Test Tips to connect the probe tip to the PROBE COMP terminals on the oscilloscope.
3. Press **AUTOSET** (or adjust the oscilloscope) to display the compensation waveform. A stable waveform indicates that your probe is functioning properly.



Calibration

The probe calibration routine minimizes your measurement errors by optimizing the gain and offset of the probe and oscilloscope combination. We recommend that you repeat the probe calibration on each channel that you use. Individual calibration constants are stored for each probe on each channel.

NOTE. *Probe calibration functions are not available on all oscilloscope models.*

Prerequisites

The equipment must be warmed up for 20 minutes, and the calibration status of the host instrument must be pass.

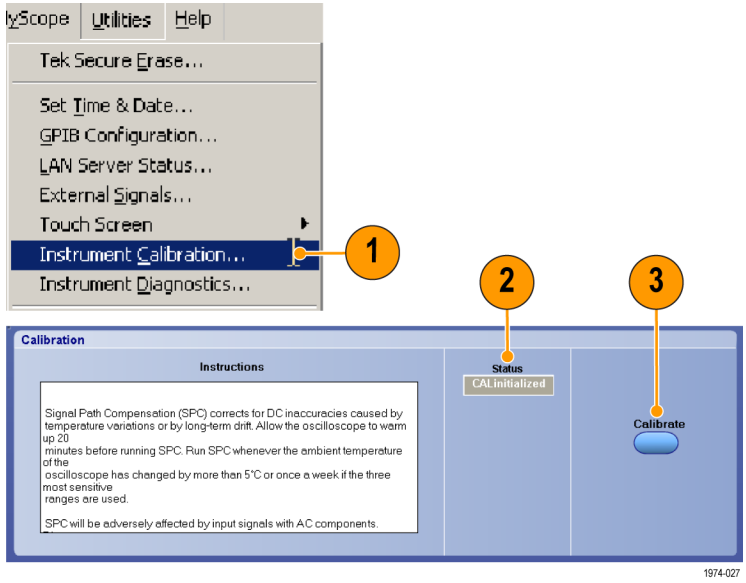
Required equipment

The required equipment for calibration is the same as for the functional check. (See page 6, *Required equipment*.)

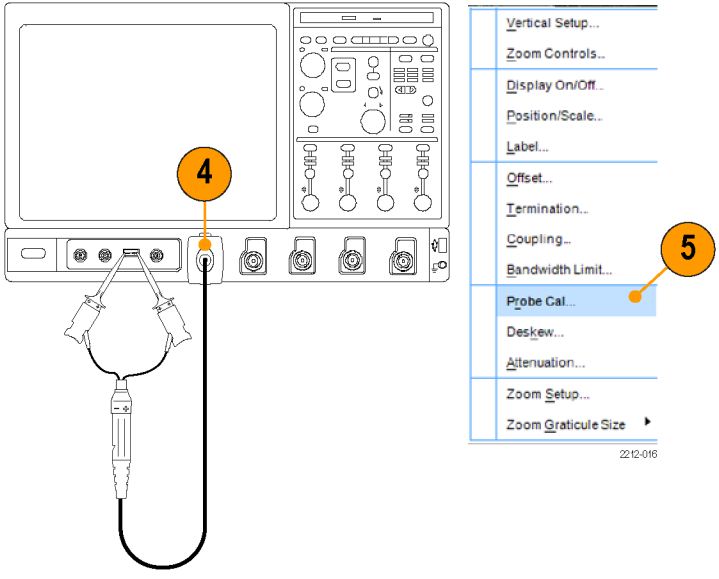
Test procedure

Check the Calibration Status of the instrument:

1. From the Utilities menu, select Instrument Calibration.
2. In the Status box, check that **Pass** is displayed.
3. If the Instrument Calibration Status is not pass, run the Signal Path Compensation routine: Disconnect all probes and signal sources from the oscilloscope, and select Calibrate. When **Pass** displays in the status box, proceed to the next step.

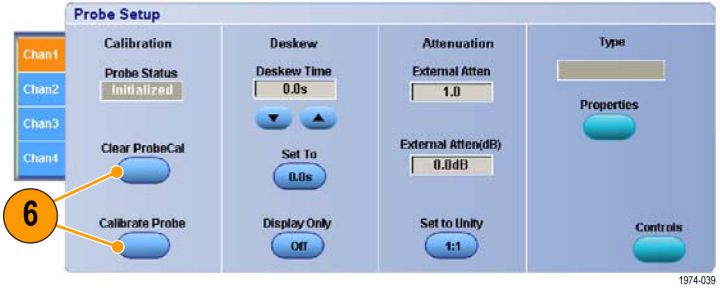


4. Connect the probe to the oscilloscope PROBE COMP connector.
5. From the Vertical menu, select **Probe Cal**.



6. When the Probe Setup screen appears, select **Clear ProbeCal**, and then select **Calibrate Probe**.

   The probe calibration routine begins. When the routine completes, the Probe Status changes from Running to Pass. Close the notifier and begin using your probe.



If the Probe Status changes to Fail:

- Check that the adapters are securely attached to the probe tips and to the PROBE COMP connectors on the oscilloscope
- Verify that the selected channel on the left side of the Probe Setup menu matches the channel that the probe is plugged into

Basic operation

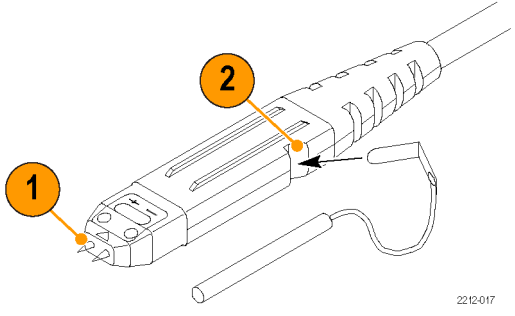
Follow these operating guidelines to get the best performance from your probe.

Probe head assembly

The probe head is designed for ease of use and high performance. Its small size makes it easy to handle in tight areas.

1. The probe tip pins are spaced 0.100 inch apart.
2. The ground connection on the side of the probe provides a short ground path for ground connections. Most differential measurements do not require a ground connection, however.

More information on the ground connection is available. (See page 34, *Probe grounding*.)



Probe input

The probe is electrically protected against static voltage. However, if you apply voltages above its design limits you may damage the probe tip amplifier. The limits are shown in the graph on the following page. (See Figure 1 on page 14.)

Operating voltage input range

The operating voltage input range is the maximum voltage that you can apply to either of the input pins, with respect to earth ground, without exceeding the linear input range of the amplifier. A signal that is outside this range, if applied to either probe input, can lead to an wrong output waveform even if the differential input range is met.

Differential-Mode signal range

The differential-mode signal range is the maximum voltage difference between the (+) and (-) input pins that the probe can accept without distorting the signal. The distortion from an input signal that is too large can result in a wrong measurement.

Common-Mode signal range

The common-mode input voltage is the average of the voltage on the (+) and (-) input pins with respect to ground. The common-mode voltage input range is determined by both the operating voltage input range and the amplitude of the applied differential signal. The peak signal applied to either input pin should not exceed the operating voltage input range, so the common-mode voltage input range is equal to the operating voltage input range reduced by one-half the amplitude of the differential input signal. With low amplitude differential input signals, the common-mode input range is almost equal to the operating voltage input range. Higher amplitude differential voltages cause the common-mode input range to be reduced.

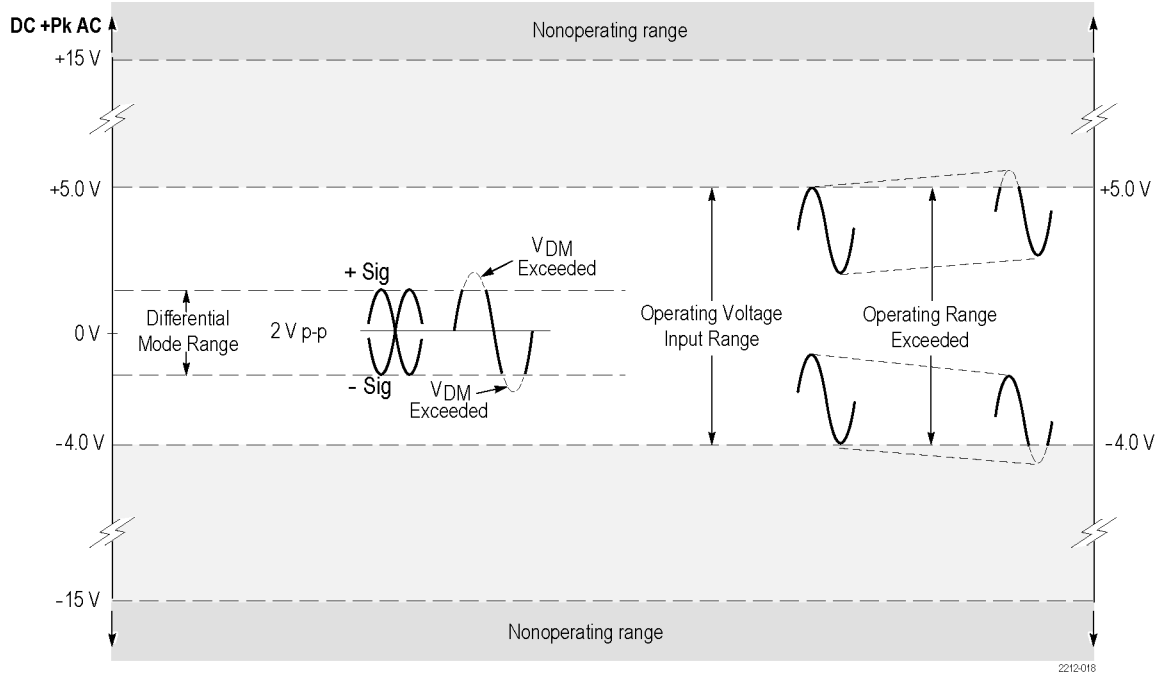


Figure 1: Input voltage limits with no DC offset

Probe offset

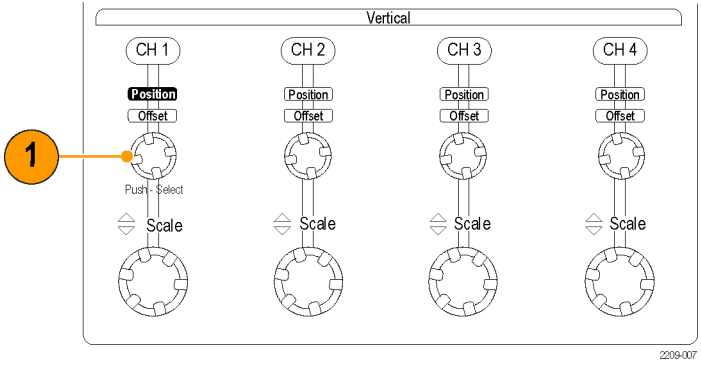
The probe offset is adjustable for operation within the linear range of the probe. To increase the sensitivity of the probe at higher DC measurement voltages, you should adjust the offset for optimal probe performance.

Offset

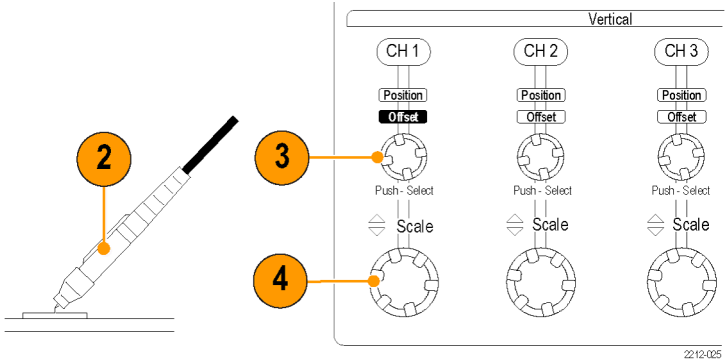
To set the probe offset, follow these steps:

NOTE. *See your oscilloscope manual for specific instructions on using the offset control.*

1. Use the vertical position control to set a zero reference level on the oscilloscope display.



2. Attach the probe to the circuit.
3. Adjust the offset to bring the trace to the oscilloscope zero reference.
4. If you change the volts/division setting, adjust the offset to keep the trace on the zero reference level.



NOTE. *The differential input range of the probe is 2.0 Vp-p, over an operating input voltage range of +5 V to –4 V. The offset range is +1 V to –1 V.*

Applications

The following example shows a simplified AC/DC circuit diagram that uses the TDP4000 probe and a DPO7000C oscilloscope. The oscilloscope is loaded with the DPOPWR power measurement software application to solve a typical test problem.

Measure switching loss

Measure the power loss at the switching device. Minimizing the power loss will improve the power supply efficiency.

1. Connect the differential probe across the switching device and attach a current probe in series with the device. (See Figure 2.)

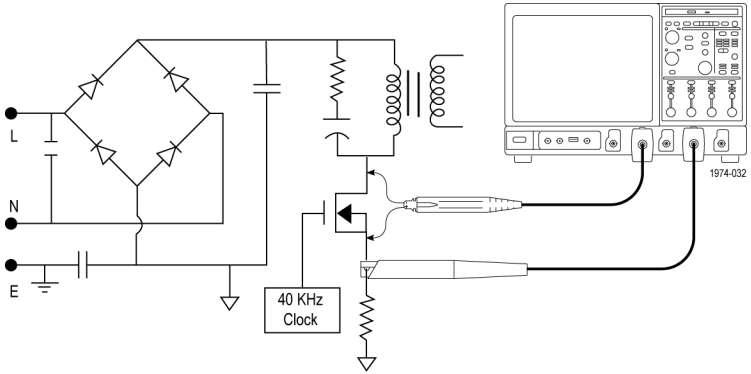


Figure 2: Power supply test points

2. Run the DPOPWR application.
3. Select the Power Device tab.
4. Select Switching Loss option and press the Configure button.
5. In the Source Configuration Panel, set the appropriate I-Probe Settings.
6. Select the Deskew button to deskew probes and channels.

7. Select Switching Loss measurement.
8. Select Run to acquire data and display the results. (See Figure 3 on page 19.)

Figure 3: Switching loss results display

Accessories and options

This section lists the standard accessories and provides information on how to use the accessories. Specifications are provided where appropriate so that you can choose the accessory that best fits your needs. (Refer to the *TDP3500 Technical Reference* for full specifications.) In some cases, reorder kit quantities differ from the actual number of accessories included with the probe.

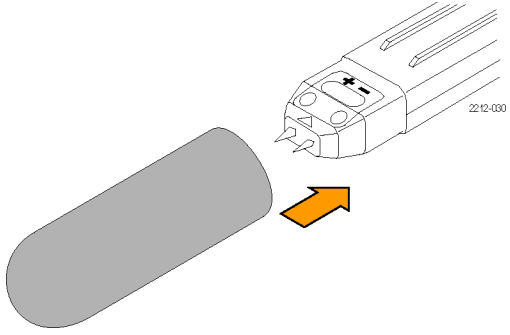
Using standard accessories

Probe tip cover

The probe tip cover is shipped on the probe. The probe tips are extremely sharp to ensure good contact and measurement integrity. When you are not using the probe, slide the probe tip cover over the probe head to prevent damage to the probe tips and to protect yourself from injury.

Reorder Tektronix part number:

- 200-4236-XX



Square pin adapter

Use the square pin adapter to connect the probe to other accessories, such as the Y-lead adapter. The inputs on the adapter are spaced 0.100 inches apart.

1. Push the square pin adapter onto the probe tip until it seats against the probe head.

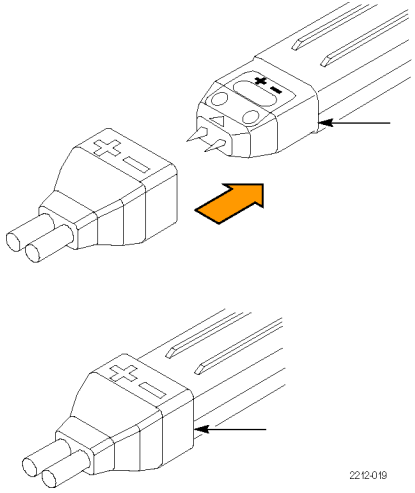
CAUTION. *To avoid damaging the square pin connectors, do not insert anything larger than a 0.025-inch square pin into the inputs.*

The elastomeric contacts inside the adapter are rated for 50 to 75 insertion cycles with the probe tip. Replace the adapter after exceeding these limits to avoid unreliable operation.

Four adapters are included with the probe.

Reorder Tektronix part number:

- 016-1884-XX quantity 4

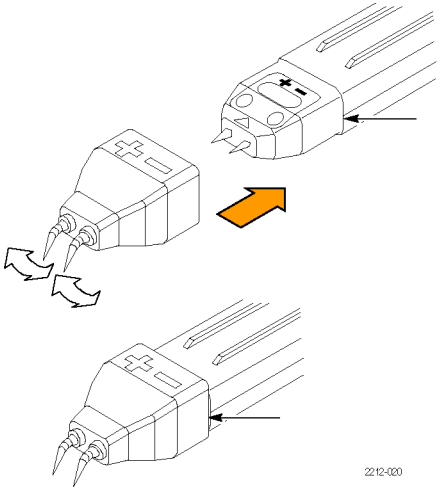


Variable spacing adapter

Use the variable spacing adapter to probe any two adjacent leads or test points spaced between 0.020 and 0.180 inches apart. The variable spacing adapter fits over the probe tip.

1. Push the adapter onto the probe tip until it seats against the probe head.
2. Adjust the articulated pins by gently rotating them using a pair of tweezers.

NOTE. *The articulated pins can be bent, but they are fragile. Use extreme care when bending the pins.*



The elastomeric contacts inside the adapter are rated for 50 to 75 insertion cycles with the probe tip. Replace the adapter after exceeding these limits to avoid unreliable operation.

Four adapters are included with the probe.

Reorder Tektronix part number:

- 016-1885-XX quantity 4

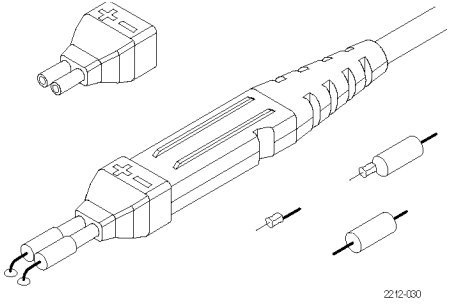
Solder-in adapter kit

Use the solder-in adapter with the resistors and wires in the kit to create soldered test points to your circuit.

The kit instructions include installation procedures and specifications for the adapter, resistors, and wires.

Reorder Tektronix part number:

- 020-2505-XX



Y-Lead adapter

Use the Y-lead adapter to extend the reach of the probe and to connect to 0.025 inch square pins spaced as far as 1.5 inches apart.

NOTE. *This adapter performance is best below 100 MHz.*

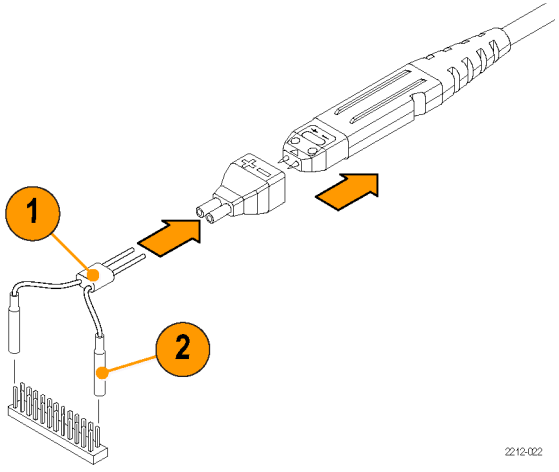
The Y-lead adapter accepts any of the probe tips or adapters.

1. Push the adapter into the probe until it is seated.
2. Connect the adapter to your circuit or to another adapter, such as the MicroCKT test tip.

Two adapters are included with the probe.

Reorder Tektronix part number:

- 196-3434-XX quantity 1
- 196-3468-XX quantity 2



MicroCKT test tip

Use the MicroCKT test tips to access dense circuitry and IC leads spaced down to 10 mil-centers.

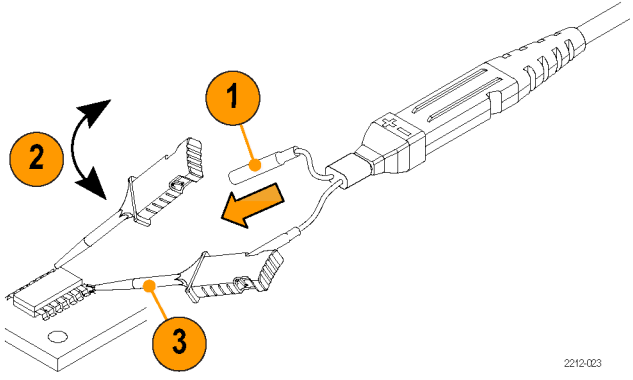
NOTE. *This adapter performance is best below 100 MHz.*

1. Press the Y-lead into the handle of the MicroCKT test tip.
2. Turn the tip body to allow better probe orientation.
3. If necessary, slightly bend the sleeve of the tip to reduce stress on the connection.

Three adapters are included with the probe.

Reorder Tektronix part number:

- 206-0569-XX quantity 1



3” ground lead

Use the ground lead for general, lower-frequency probing.

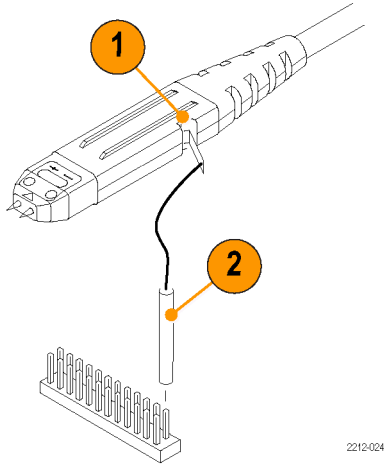
1. Connect the male end of the lead to the ground socket on the probe.
2. Connect the socketed end of the lead to any of the probe tips or adapters. You can also connect to 0.025 inch square pins in your circuit.

When selecting the grounding connection, maintain as short a ground path as possible. (See page 34, *Probe grounding*.)

Two ground leads are included with the probe.

Reorder Tektronix part number:

- 196-3465-XX quantity 2



Color band kit

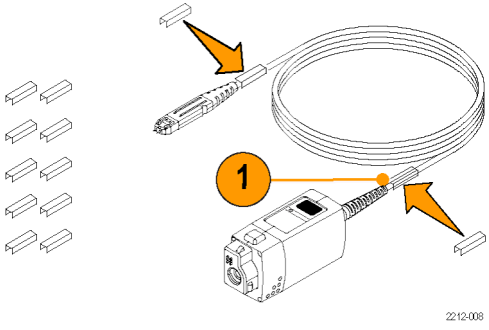
Use the color bands to help identify probes in a multi-probe application.

1. Attach one band to the probe cable and another one of the same color near the probe compensation box.
2. Connect the probe to the channel that matches the color of the band.

Five colored pairs are included with the probe.

Reorder Tektronix part number:

- 016-1315-XX quantity 5 colored pairs

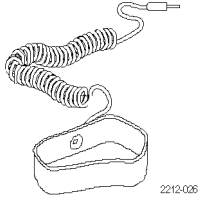


Antistatic wrist strap

When using the probe, always work at an antistatic work station and wear the antistatic wrist strap.

Reorder Tektronix part number:

- 006-3415-XX

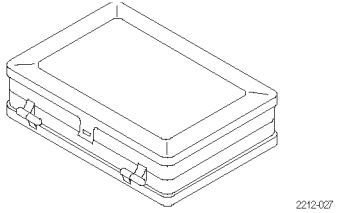


Plastic accessory box

Use the plastic box to store the probe accessories when not in use.

Reorder Tektronix part number:

- 006-7164-XX



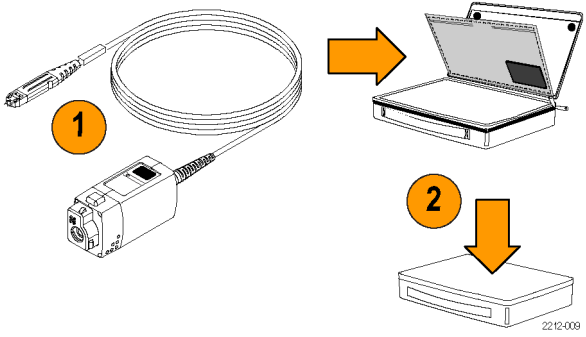
Nylon carrying case with inserts

Use the carrying case to hold the probe, the accessories, and the manual.

1. Place the probe, accessory box, and manual in the carrying case.
2. Close the carrying case to transport the accessories to another location or for storage.

Reorder Tektronix part number:

- 016-1952-XX



Quick Start User Manual

The Quick Start User Manual provides instructions for operating the TDP3500 and TDP4000 probes. Printed copies are available in the languages listed below.

Tektronix part numbers:

- 071-2212-XX (English)
- 071-2213-XX (Japanese)
- 071-2214-XX (Simplified Chinese)
- 077-0295-XX (Russian)

Calibration certificate

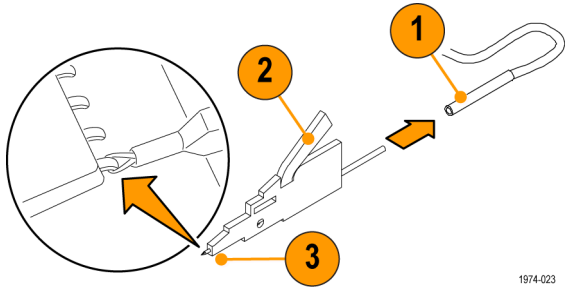
A certificate of traceable calibration is provided with every instrument shipped.

Optional accessories

This section lists the optional accessories that you can purchase to help you with your probing tasks.

IC Micro-Grabber

Use the IC Micro-Grabber to probe the leads on integrated circuits that are surface-mounted. The IC Micro-Grabbers are easiest to use with the Y-Lead Adapter or Ground wires.



1. Push the IC Micro-Grabber onto the wire lead.
2. Press the lever to open the contacts.
3. Attach the IC Micro-Grabber to your circuit.

Two adapters are included with the probe.

Order Tektronix part number:

- SMK4 quantity 4

TwinFoot adapter

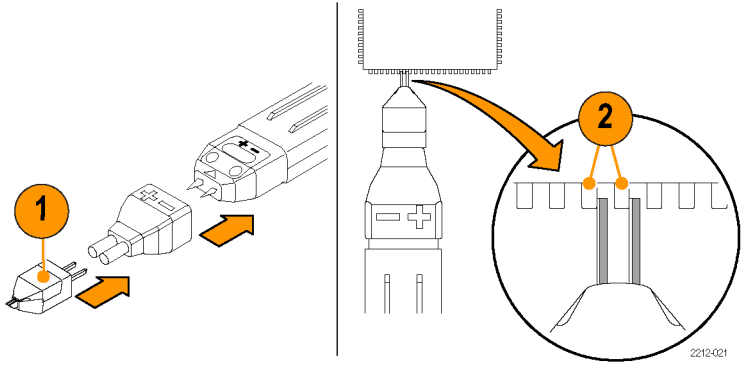
Use the TwinFoot adapter to probe two adjacent leads on a surface-mount integrated circuit. The flexible fingers adapt to a range of lead spacings.

1. Push the adapter into the probe tips until it is seated.
2. Touch the adapter to your integrated circuit leads. One side of each adapter pin is insulated to prevent short-circuiting to adjacent pins.

Four adapters are included with the probe.

Reorder Tektronix part number:

- 016-1785-XX quantity 4

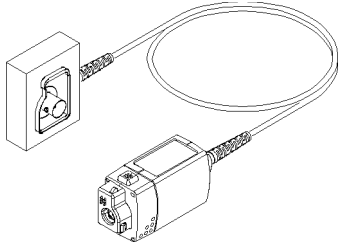


TekVPI calibration fixture

The calibration fixture is required to do a performance verification on the probe. It provides an SMA connector in the probe signal path for internal probe measurements. Instructions for use are included in the performance verification procedures.

Order Tektronix part number:

- 067-1701-XX



Options

Service Options

- **Option CA1.** Provides coverage for a single calibration event
- **Option C3.** Calibration service 3 years
- **Option C5.** Calibration service 5 years
- **Option D1.** Calibration data report
- **Option D3.** Calibration data report, 3 years (with Option C3)
- **Option D5.** Calibration data report, 5 years (with Option C5)
- **Option R3.** Repair service 3 years
- **Option R5.** Repair service 5 years

Manual Options

- **Option L0.** English language instruction manual
- **Option L5.** Japanese language instruction manual
- **Option L7.** Simplified Chinese language instruction manual

Probing principles

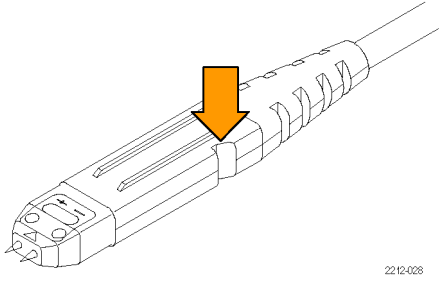
Read the helpful hints on the following pages to make probing easier and noise free.

Probe grounding

In addition to the (+) and (-) inputs on the probe head, there is also a ground (common) input. You can use the probe to take a differential measurement regardless of whether the ground is connected.

CAUTION. *To avoid damaging the circuitry under test, connect the probe ground (common) to a ground-reference point only.*

See the technical reference manual on the CD for more information.



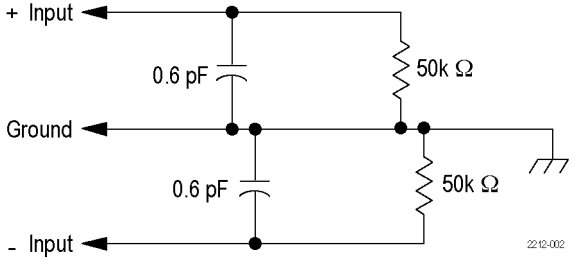
Input impedance and probe loading

When you connect the probe inputs to a circuit, you are introducing new resistance, capacitance, and inductance into the circuit. Each input of the differential probe has a characteristic input impedance of 50 kΩ to ground in parallel with less than 0.6 pF.

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 greater the source impedances and the higher the signal frequencies, the more you should take these factors into account.

The more the impedance of the signal source on an input increases, the more the probe loads the source and reduces the signal amplitude.

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.



Maintenance

This section contains maintenance and support information for your probe.

Host instrument firmware

If some of the LEDs or features do not appear to function correctly, go to www.tektronix.com/probe-support to check for probe/oscilloscope compatibility. Read the release notes and other information associated with the firmware upgrades to learn about any anomalies that may exist with your probe/oscilloscope combination when using that version of firmware. If you need to upgrade your instrument firmware, go to www.tektronix.com/software to download the latest firmware.

To check the firmware version on Windows-based instruments, from the menu bar, click Help/About TekScope. On Linux-based instruments, press the Utilities button on the front panel. It is good practice to periodically check the Web site for new firmware versions that enhance the performance and capabilities of your Tektronix instruments.

Error condition

If the Status LED lights red after you connect the probe, an internal probe diagnostic fault may exist. 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.

Replacement parts

There are no user-replaceable parts within the probe. Refer to the accessory list for replaceable accessories for your probe.

Cleaning

Protect the probe from adverse weather conditions. The probe is not waterproof.

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 benzine, 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. A swab is useful for cleaning 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.

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