

**P7313SMA  
Differential Probe  
Quick Start User Manual**

[www.tektronix.com](http://www.tektronix.com)  
071-1965-01

**Tektronix**

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- In North America, call 1-800-833-9200.
- Worldwide, visit [www.tektronix.com](http://www.tektronix.com) to find contacts in your area.

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

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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.

**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.

**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.

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:



# Environmental Considerations

## 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. In order 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.

The symbol shown below indicates that this product complies with the European Union's requirements according to Directive 2002/96/EC on waste electrical and electronic equipment (WEEE). For information about recycling options, check the Support/Service section of the Tektronix Web site ([www.tektronix.com](http://www.tektronix.com)).



## Restriction of Hazardous Substances

This product has been classified as Monitoring and Control equipment, and is outside the scope of the 2002/95/EC RoHS Directive.

## Preface

This is the quick start user manual for the P7313SMA differential probe. This manual provides operating information, applications, and functional verification procedures for the probe.

## Documentation

### To read about

First Time Operation, Functional Check, Operating Basics

Specifications, Performance Verification

In-depth oscilloscope operation, user interface, GPIB commands

### Read these documents \*

This manual.

The technical reference manual.

The online help (from the Help menu on the host instrument).

\* To access the documentation that is installed on the host 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.

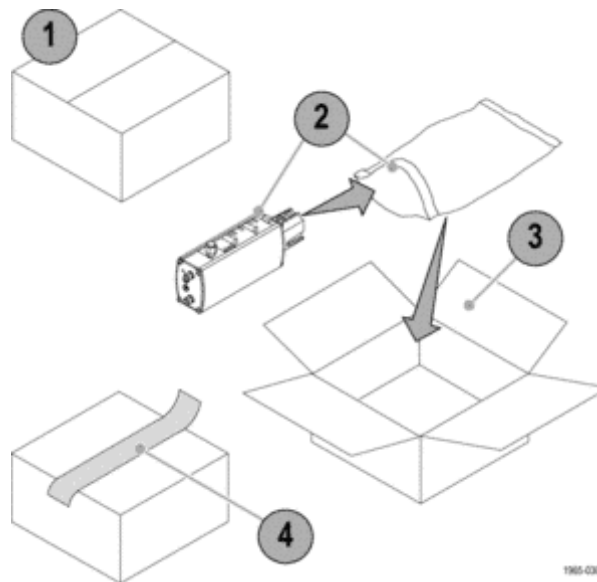


## Returning the Probe for Servicing

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

### Preparation for Shipment

1. Use a corrugated cardboard shipping carton having inside dimensions at least one inch greater than the probe dimensions. The box should have a carton test strength of at least 200 pounds.
2. Put the probe into an antistatic bag or wrap it to protect it from dampness.
3. Place the probe into the box and stabilize it with light packing material.
4. Seal the carton with shipping tape.
5. Refer to *Contacting Tektronix* at the beginning of this manual for the shipping address.

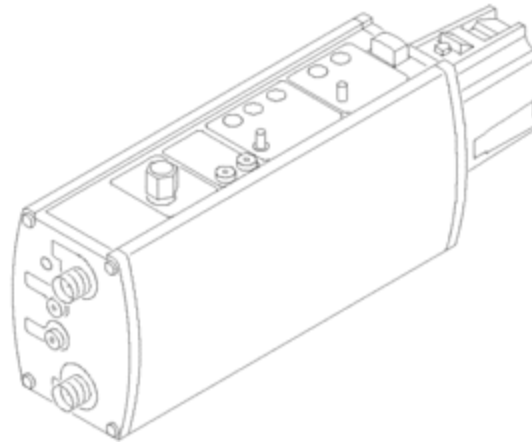




## Key Features

The P7313SMA is a 13 GHz, active differential probe designed for Serial Data Analysis (SDA) compliance testing and other applications that use differential serial busses in a 50  $\Omega$  signaling environment. The probe connects to oscilloscopes featuring the Tektronix TekConnect oscilloscope interface. Key features include:

- SMA inputs with 1 meter low skew cable pair
- DC to 13 GHz bandwidth
- Selectable 800 mV and 3.6 V p-p Differential Input Voltage ranges
- Selectable Termination Voltage Control modes with +3.6 V/-2.5 V range
- Auxiliary Output connector for triggering
- TekConnect interface
- Provides Automatic Units Scaling on the oscilloscope display



## Operating Considerations

**Table 1: P7313SMA**

<b>Characteristic</b>	<b>Description</b>
Input Voltage	Differential: +3.6 V/-2.5 V (DC + peak AC) Common Mode: ±2.5 V (DC + peak AC, both ranges; input referenced to ground)
Temperature	Operating: 0 to +40 °C (+32 °F to +104 °F) Nonoperating: -55 °C to +75 °C (-67 °F to +167 °F)
Humidity	Operating: +30 °C to +40 °C (+86 °F to +104 °F) 0-90% RH Nonoperating: +30 °C to +60 °C (+86 °F to +140 °F) 0-90% RH
Altitude	Operating: Up to 3000 meters (10,000 feet) Nonoperating: Up to 12192 meters (40,000 feet)
Pollution Degree	2, Indoor use only

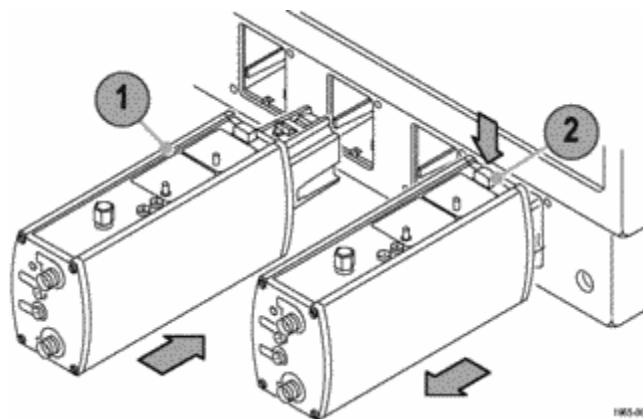


# Installation

## Connecting to the Host Instrument

The P7313SMA probe is powered through the TekConnect interface on the host instrument.

1. To install the probe, slide it into the TekConnect receptacle on the host instrument. The probe snaps into the receptacle when fully engaged.  
The host instrument performs a diagnostic check to verify basic probe functionality and to cycle the status LEDs.  
Before you use your probe, perform a functional check. (See page 11, *Signal and Termination Voltage Monitor Check*.)
2. To release the probe, grasp the probe, press the latch button, and pull the probe straight out.



## Connecting to the Probe

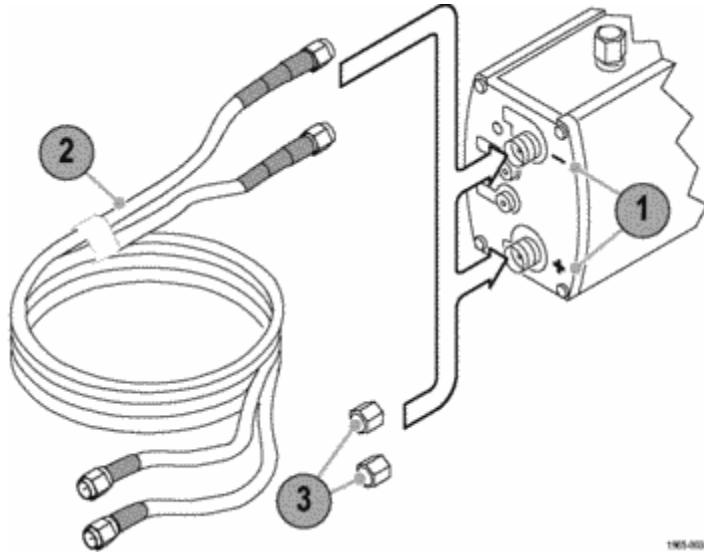
This overview of the probe connectors helps you perform a functional check. Find more details about the probe connectors and controls in *Basic Operation*. (See page 21, *Basic Operation*.)

### SMA Input Connectors

1. The P7313SMA probe has SMA connectors for the (+) and (-) input signals.

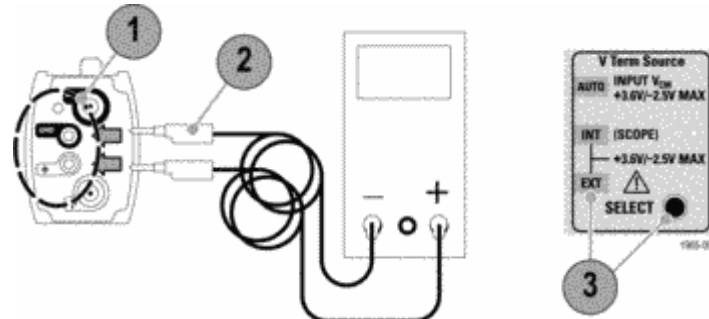
The SMA connectors provide a signal path through the internal 50  $\Omega$  termination network and differential probe buffer amplifier to the oscilloscope.

2. Use the matched-delay SMA cables that are supplied with the probe to connect the probe to your circuit.
3. Leave the 50  $\Omega$  terminations on the unused inputs.



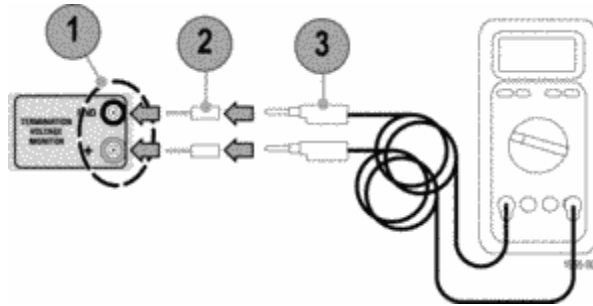
## DC Termination Voltage Input Jacks

1. Use these two 0.080 inch pin jacks to provide DC termination voltage control from an external power supply.
2. Connect the 0.080 inch pin-to-banana cables included with your probe to these jacks.
3. Press the **SELECT** button to set the Vterm Source to EXT mode.



## Termination Voltage Monitor Jacks

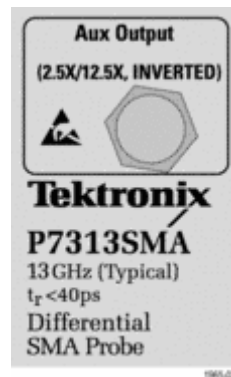
1. Use these two 0.040 inch jacks to monitor the termination voltage of the signal under test.
2. Connect the 0.040-to-0.080 inch pin-jack adapters included with your probe to the jacks.
3. Connect a digital multimeter (DMM) to the jack adapters with a pair of standard DMM test leads.



## Auxiliary Output SMA Connector

This SMA connector provides an attenuated, inverted sample of the signal under test.

The attenuation factor of the output signal matches the selected attenuation factor of the probe.



## Functional Check

Before using your probe, you should perform a functional check.

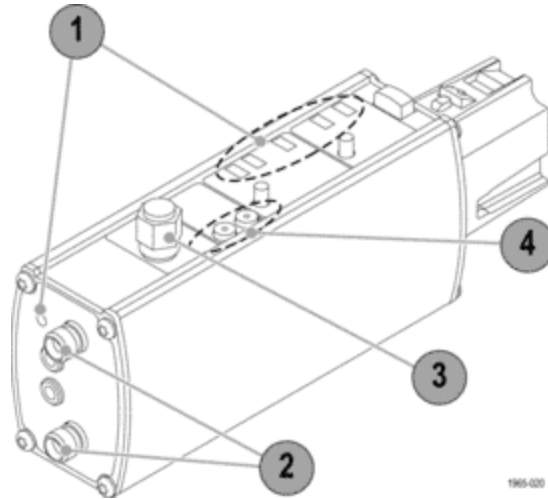
### Overview

A basic functional check consists of the following:

1. A power-on self test that verifies LED operation
2. An input signal amplitude and termination voltage monitor output test

To check the remaining probe functions, complete the following checks:

3. Auxiliary output amplitude and polarity
4. Termination voltage zero check



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## Required Equipment

Item description	Performance requirement	Recommended example <sup>1</sup>
Oscilloscope	TekConnect interface	Tektronix TDS6604, TDS6154C, or TDS7704
DMM	1.0 mV resolution	Fluke 87 or equivalent
Coaxial cable	Dual SMA, matched-delay	174-4944-00 <sup>2</sup>
Test leads	0.080 inch pin-to-Banana plug ends, one each color	012-1674-00 (red) <sup>2</sup> 012-1675-00 (black) <sup>2</sup>
Adapters (3)	SMA 50 $\Omega$ termination	015-1022-01 <sup>2</sup>
Adapter	SMA short-circuit	015-1020-00 <sup>2</sup>
Attenuator	SMA or BNC, 50 $\Omega$ , 5X	015-1002-01 (SMA) 011-0060-03 (BNC)
Adapter	TekConnect-to-SMA	Tektronix TCA-SMA
Adapter	BNC Male-to-SMA Female	015-0572-00 <sup>2</sup>
Adapters (2)	0.040 inch-to-0.080 inch Pin jack	012-1676-XX <sup>2</sup>

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

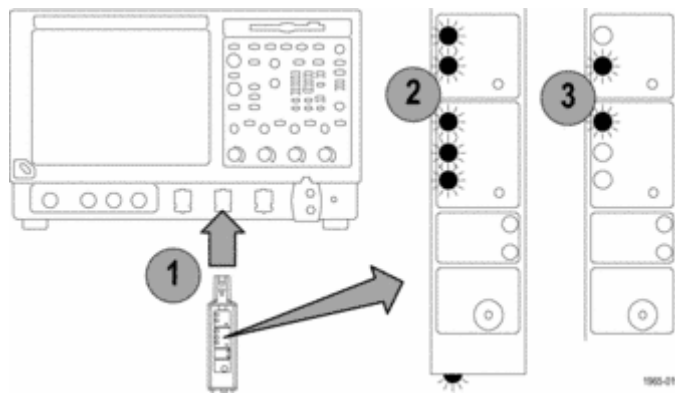
<sup>2</sup> Standard accessories included with the probe.

## Power-On Self Test

When the probe is powered on, an internal diagnostic check is performed to verify basic probe functionality. The probe checks communications with the host instrument, and cycles the probe status LEDs.

To check the probe LED functionality:

1. Connect the probe to any oscilloscope channel.
2. Check that all six LEDs light briefly: five on the top panel and the Overdrive Error LED on the front panel.
3. The 12.5X Attenuation and AUTO Voltage Termination Source LEDs light again and remain lit. The other LEDs remain unlit. The Auto Mode LED flashes when the probe inputs are open or AC-coupled.



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**NOTE.** If the Attenuation and Termination Source LEDs do not light as described, the oscilloscope may have stored different attenuation and termination source settings from a previous session. Use the SELECT buttons on the probe to toggle the LEDs to the 12.5X and AUTO settings. If both Range Select LEDs flash or otherwise appear to be malfunctioning after power-on, an error condition may exist. The User Service section includes instructions on clearing errors. (See page 49, User Service.)

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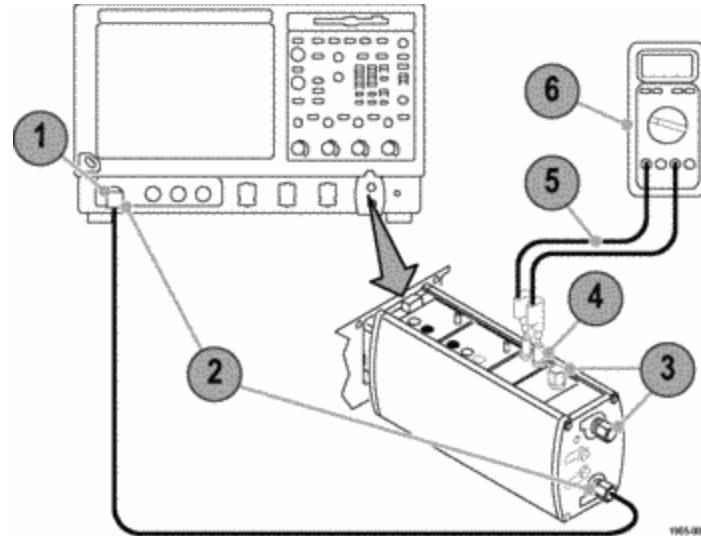


## Signal and Termination Voltage Monitor Check

The following tests use the PROBE COMPENSATION or FAST EDGE output on the front panel of the oscilloscope to verify that the probe input circuits are functioning. The termination voltage monitor output is also checked, using a DMM.

### Setup for the 12.5X Range Test

1. Connect the BNC-SMA adapter to the PROBE COMPENSATION or FAST EDGE connector on the oscilloscope.
2. Connect an SMA cable between the adapter and the (+) SMA probe input. (You can use one cable of the matched-delay cable set included with your probe.)
3. Connect 50  $\Omega$  SMA terminations to the (-) SMA probe input and the Aux output connectors.
4. Connect the 0.040 inch-to-0.080 inch adapters to the Vterm monitor jacks.
5. Connect the 0.080 inch pin-to-banana plug test leads from the DMM to the adapters.
6. Set the DMM to measure DC voltage.



## Test Procedure for the 12.5X Range

1. Press the probe **SELECT** buttons to set the probe attenuation to **12.5X**, and the Vterm source to **Auto**.
2. Press the **Autoset** button on the oscilloscope. A stable square wave indicates that the probe is functional on the 12.5X attenuation setting.
3. The probe compensation signal amplitude and common mode voltage is dependent on the oscilloscope model. Check that the signal amplitude on the oscilloscope and the common mode voltage (displayed on the DMM) approximate those in the table:

<b>P7313SMA Probe</b>	<b>TDS6604</b>	<b>TDS7704</b>	<b>TDS6154C</b>
Signal amplitude	200 mV p-p	500 mV p-p	440 mV p-p
$V_{CM}$	900 mV	-250 mV	220 mV

Refer to *Single-Ended Measurements* in the *Technical Reference Manual* for more information on the measured common mode input voltage.

This completes the 12.5X attenuation signal check. If you want to check the 2.5X attenuation setting of the probe, perform steps 4 through 7. (See page 13.)

## Test Procedure for the 2.5X Range

4. Begin with the setup for the 12.5X Range test, and insert a 50  $\Omega$ , 5X attenuator in-line with the probe compensation output connector. The attenuator is necessary to bring the probe compensation signal within the dynamic range of the probe at the lower attenuation setting. Without this attenuator, the probe amplifier in the 2.5X attenuator setting will be overdriven and the display will show a limited DC level instead of the probe compensation square wave.

You can use a BNC-style 5X attenuator, Tektronix part number 011-0060-XX, or SMA-style 5X attenuator, Tektronix part number 015-1002-XX.

5. Set the attenuation on the probe to 2.5X.
6. Press **Autoset**. A stable square wave indicates that the probe is functional on the 2.5X attenuation setting.
7. Check that the signal amplitude on the oscilloscope and the common mode voltage (displayed on the DMM) approximate those in the table below.

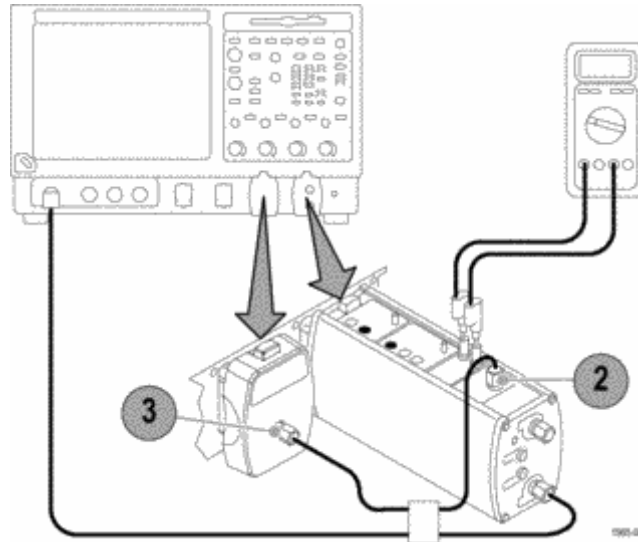
P7313SMA Probe	TDS6604	TDS7704	TDS6154C
Signal amplitude	40 mV p-p	100 mV p-p	88 mV p-p
$V_{CM}$	180 mV	-50 mV	44 mV

## Aux Output Check

The following tests verify that the Aux output signal is functional. The Aux output is an inverted, attenuated sample of the signal that is displayed on the main output of the probe.

### Setup

1. Begin with the setup for the 12.5X Range test.
2. Remove the 50  $\Omega$  termination from the Aux output connector.
3. Connect an SMA cable from the probe Aux output to another channel on the oscilloscope, using a Tektronix TCA-SMA adapter. (You can use the other cable of the matched-delay cable set included with your probe.)



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## Test Procedure for the 12.5X Attenuation Aux Output

1. Set the attenuation on the probe to 12.5X.
2. Display the channel to which you connected the Aux Output signal, and check that the Aux Output signal is an inverted sample of the probe compensation signal that is displayed on the P7313SMA main output.

The Aux Output amplitude is attenuated by a factor of 12.5X from that displayed on the P7313SMA main output. This is a result of the intelligent probe interface that adjusts for the selected attenuation factor on the main probe output.

## Test Procedure for the 2.5X Attenuation Aux Output

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**NOTE.** *The 2.5X attenuation Aux Output check requires the in-line 5X external attenuator on the probe compensation output. Due to the combination of the 5X attenuator and the 5X increase in the probe gain (from 12.5X to 2.5X), the amplitude of the measured signal in step 3 below will match that of the 12.5X attenuation check in step 2.*

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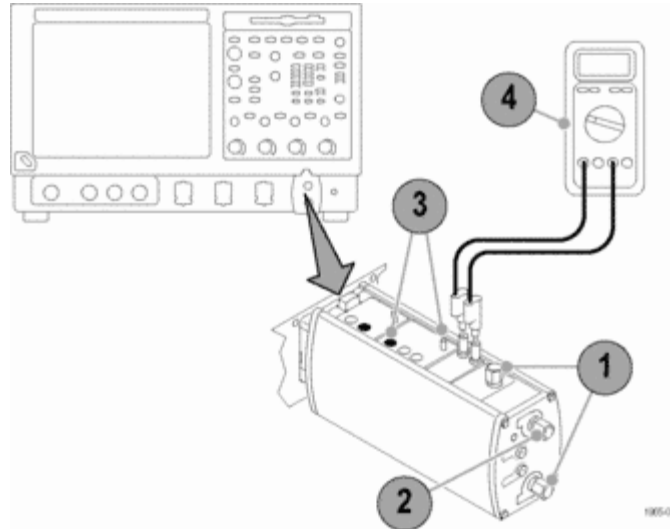
1. Insert a 50  $\Omega$ , 5X attenuator in line with the probe compensation output connector.
2. Set the probe attenuation to 2.5X.
3. Check that the signal amplitude is the same as that measured in step 2 of the 12.5X Attenuation Aux Output test.

## DC Termination Voltage Zero Check

This test checks that the termination voltage defaults to 0 volts under the conditions shown below for the three different termination voltage selection modes.

### Auto Mode

1. Disconnect the cables from the (+) input of the probe and the Aux output connector, and replace them with two 50  $\Omega$  SMA terminations.
2. Ensure that a 50  $\Omega$  SMA termination is connected to the (-) input.
3. Use the Vterm SELECT button on the probe to set the Vterm mode to AUTO.
4. Check that the DMM displays the termination voltage of approximately 0 V.



## Internal (Int) Mode

1. Use the Vterm Source SELECT button on the probe to set the Vterm mode to INT.
2. Check that the DMM displays the termination voltage of approximately 0 V. If not, check that the oscilloscope has an internal Vterm control set to a voltage other than zero. See your oscilloscope manual for details on using the internal Vterm controls.

## External (Ext) Mode

1. Verify that the external termination voltage inputs on the probe are open.
2. Use the Vterm Source SELECT button on the probe to set the Vterm mode to EXT.
3. Check that the DMM displays the termination voltage of approximately 0 V.

This completes the functional check of the probe. If your instrument supports probe calibration routines, now is a good time to perform them. (See page 18, *Probe Calibration*.)

## Probe Calibration

After you perform a functional check of the probe, use the following instructions to run a probe calibration routine, which optimizes the gain and offset of the probe and oscilloscope combination to minimize measurement errors.

### Check the Signal Path Compensation Status

1. From the Utilities menu, select Instrument Calibration.
2. In the Calibration box, check the Status. If it is not **pass**, which is required for the probe calibration routine, disconnect all probes and signal sources from the oscilloscope, and run the Signal Path Compensation routine.

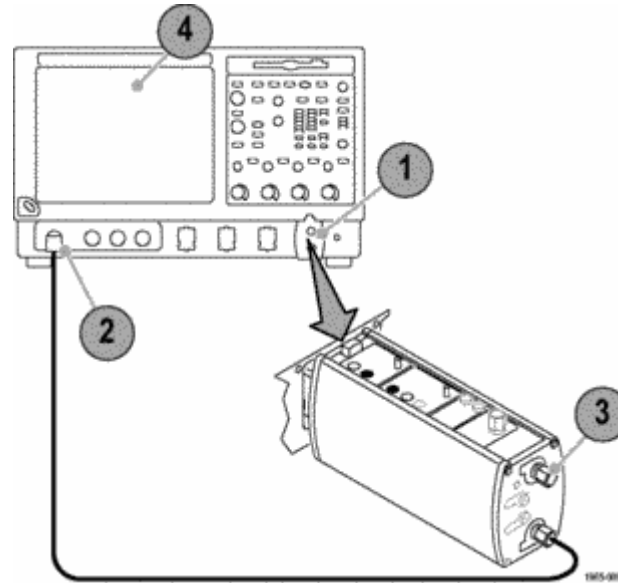


## Run the Probe Calibration

1. When the Signal Path Compensation test status is **pass**, connect the probe to one of the oscilloscope channels, and set the oscilloscope to display the channel. Allow the probe to warm up for 20 minutes.

**NOTE.** Do not use a 50 ohm SMA termination; an invalid Probe Cal will result.

2. Connect the SMA cable from the oscilloscope PROBE COMPENSATION connector (Probe Cal on some models) to the (+) SMA probe input. You may need an adapter.
3. Connect a short-circuit SMA termination to the (-) input of the probe.
4. Disconnect any cables attached to the External Vterm inputs.



5. From the Vertical menu, select **Probe Cal**.
6. Click **Calibrate probe**. The probe calibration routine optimizes the probe to the oscilloscope for both probe attenuation settings.

If your probe fails the functional checks or probe calibration routine, refer to the service information. (See page 49, *User Service*.)

# Basic Operation

## Probe Controls and Connections

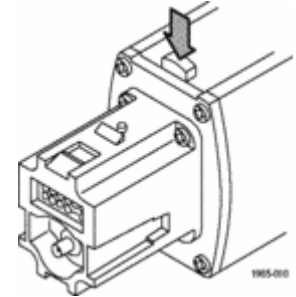
The controls and connections of the P7313SMA differential probe are described on the following pages.

### Description

**TekConnect interface.** The TekConnect interface provides a communication path between the probe and the oscilloscope. Contact pins provide power, signal, and a data communication interface for probe identification and internal termination voltage control (if supported by the oscilloscope).

The probe snaps into the oscilloscope when fully engaged. To remove, grasp the compensation box, press the latch button, and pull the probe out.

### Control



### Description

**Input signal connections.** The SMA terminals provide shielded, low-noise connections to your circuit. Differential or single-ended signals are buffered by the internal probe amplifier and are sent through the TekConnect interface to the oscilloscope.

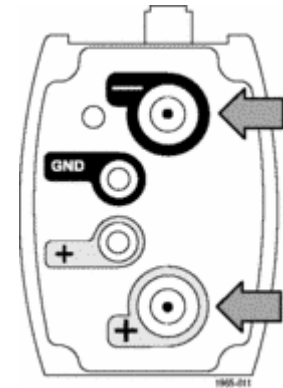
Although the allowable input DC common mode ( $V_{CM}$ ) range and the termination voltage ( $V_T$ ) range are both +3.6 V/-2.5 V, there are additional limitations on the voltage difference between  $V_{CM}$  and  $V_T$  that you must consider, to avoid non-linear operation.

Because of the low resistance 50  $\Omega$  termination network, relatively large currents can flow, depending on the input signal source impedance and the  $V_{CM}$  and  $V_T$  voltage difference. Since the amplifier that drives the  $V_T$  voltage node between the two 50  $\Omega$  termination resistors has a current limit of about  $\pm 82$  mA for linear operation, this limits the allowable voltage difference between  $V_{CM}$  and  $V_T$ .

As a general guideline, the voltage difference between  $V_{CM}$  and  $V_T$  should be limited to about 2 V for 0  $\Omega$  source impedances and about 3 V for 50  $\Omega$  source impedances. More exact calculations of the termination network and input load currents can be made using the equations in the *Technical Reference Manual*.

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### Control



## Description

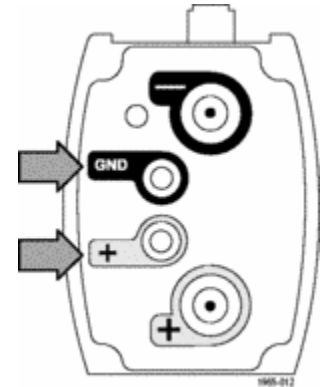
**External DC termination control voltage connections.** The red and black 0.080 inch jacks on the end of the probe provide a means for controlling the DC termination voltage with an external DC power supply.

Use the banana-to-0.080 inch plug adapter cables included with the probe when you connect external control voltages to these terminals.

The red terminal is the DC control voltage input to a buffer amplifier that drives the center-tap (common-mode node) of the internal  $50\ \Omega$  termination network. The  $100\ \text{k}\Omega$  resistance to ground at the buffer amplifier input gives a  $0.00\ \text{V}$  termination voltage in EXT mode with the inputs open. The black terminal is connected to system ground.

- The normal termination voltage range is  $+3.6\ \text{V}/-2.5\ \text{V}$ .
- The buffer amplifier input is diode-protected to  $\pm 15\ \text{volts}$ , but the Overdrive Error LED will flash when the EXT termination voltage is driven about 10% beyond the specified  $+3.6\ \text{V}/-2.5\ \text{V}$  range.

## Control



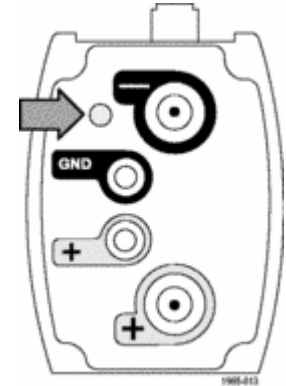
## Description

### The Overdrive Error LED:

- Glows when the termination voltage driver current exceeds its linear range. To prevent internal damage, the probe automatically reduces the termination voltage, overriding the user-set value. In general, this will occur when the user-set termination voltage differs from the common-mode voltage by as little as 2.0 volts for 0  $\Omega$  source impedances and about 3.0 volts for 50  $\Omega$  source impedances.
- Flashes when the termination voltage in Auto Mode or EXT Mode exceeds the specified +3.6 V/-2.5 V range by enough to exceed the linear operating voltage range of the termination voltage driver.
- Clears when the range violation signal is removed.

*Error Conditions* includes more information. (See page 50.)

## Control



## Description

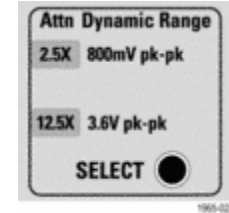
**Attenuation/Dynamic Range Select and indicators.** The Attn Dynamic Range Select button allows you to select 2.5X or 12.5X probe attenuation. The maximum linear dynamic range for each attenuator setting is specified as a differential peak-to-peak value.

- The two indicator LEDs light briefly when the probe is powered on, and then the 12.5X LED lights to indicate that the 12.5X attenuation is selected.

**NOTE.** *If the Attenuation LEDs do not light as described, the host oscilloscope may have stored different attenuation and termination source settings from a previous session. Use the SELECT buttons on the probe to change the settings if necessary.*

- If both LEDs flash, an internal probe diagnostic fault exists. Disconnect and reconnect the probe to restart the power-on diagnostic sequence. If the LEDs continue to flash, the probe is defective, and must be returned to Tektronix for repair.

## Control



## Description

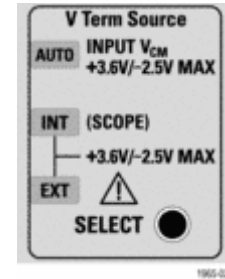
**Termination Voltage Control Mode Select and indicators.** The V Term Source SELECT button allows you to select between three termination voltage control modes: Auto, Internal, and External. The three indicator LEDs light briefly when the probe is powered on, and then the AUTO LED lights.

**NOTE.** *If the Termination Source LEDs do not light as described, the host oscilloscope may have stored different attenuation and termination source settings from a previous session. Use the SELECT buttons on the probe to change the settings if necessary.*

The probe is initially set to Auto mode; press the SELECT button to choose another mode. The Auto Mode LED also flashes when the probe signal inputs are AC-coupled or open-circuit. When this happens, the termination voltage is set to 0.0 V.

- In Auto mode, the input signal DC common mode voltage is measured and the DC termination voltage is automatically set to equal that voltage (default mode setting when the probe is powered on).
- In Internal mode, set the DC termination voltage with TekConnect user interface controls. If your oscilloscope does not support this mode, the termination voltage defaults to 0 volts.
- In External mode, the DC termination voltage is controlled indirectly by an external DC power supply connected to the 0.080 inch pin jacks on the probe face plate. If these control voltage inputs are left open, the termination voltage defaults to 0 volts.

## Control





## Description

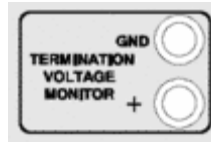
**Termination Voltage Monitor jacks.** Connect a DMM to these red and black jacks to monitor the DC termination voltage. For example, use these jacks in Auto mode to indirectly measure the DC common-mode input voltage.

Use a DMM and a pair of standard DMM test leads. The output impedance of the termination voltage monitor (+) output is about 1 k $\Omega$ . The other output of the termination voltage monitor is connected to signal ground.

**Auxiliary Output connector.** This SMA connector provides a full-bandwidth, attenuated, inverted sample of the input signal. Use this auxiliary signal to trigger your TDS/CSA8000 series sampling oscilloscope, or as an input to a spectrum analyzer or network analyzer to measure the frequency domain response of the input signal.

When you are not using this connector, leave the termination cap connected to protect the SMA output connector from damage and to ensure maximum signal fidelity of the main probe output signal to the oscilloscope.

## Control



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# Applications

The following applications give examples of how the P7313SMA probe can be used to make common measurements.

## HDMI

HDMI (High Definition Multimedia Interface) is an interface between audio/video components that transfers all-digital, non-compressed content over multiple channels within a single, multi-wire cable. The block diagram shows the three differential channel pairs that make up the HDMI video signal. They carry the three primary colors (RGB) that make up the video image. Audio is embedded in the data signal protocol. The fourth channel carries the clock, which runs at 1/10th the bit rate of the video data. The display data channel carries the synchronizing information. (See Figure 1 on page 30.)

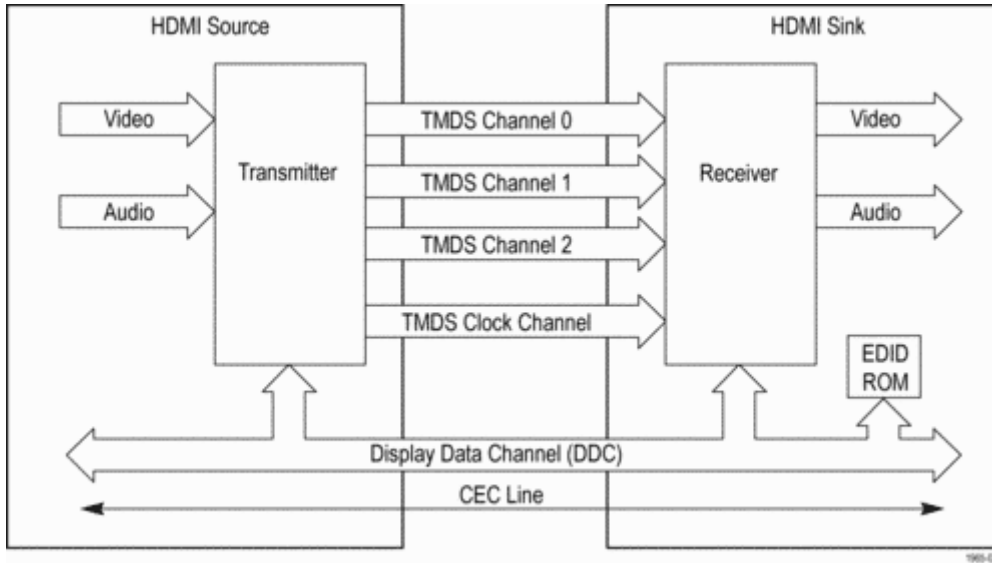


Figure 1: HDMI Block Diagram

Each channel pair at the source (transmitter) uses a current source on the (+ and -) line to drive the signal down the transmission path through the cable. Termination resistors at the receiver pull up the complementary single-ended signals before the internal amplifier processes them to the differential signal. You can see the differential signal of any output channel pair by connecting the probe + and - inputs to the SMA output connector pairs on the breakout board. (See Figure 2.)

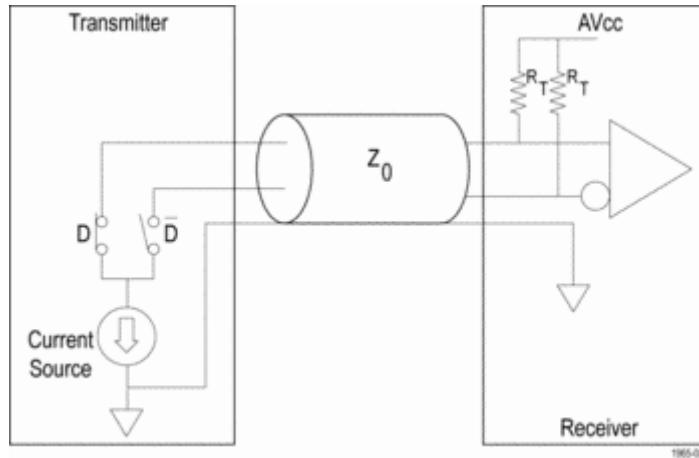


Figure 2: HDMI Transmit/Receive Circuitry

Using an oscilloscope loaded with the TDSHT3 HDMI Compliance Software application, a signal break-out board, and the P7313SMA probe, you can make single-ended and differential measurements of HDMI signals. (See Figure 3.) The software and break-out boards provide a means for testing both source and sink signals to and from your HDMI components.

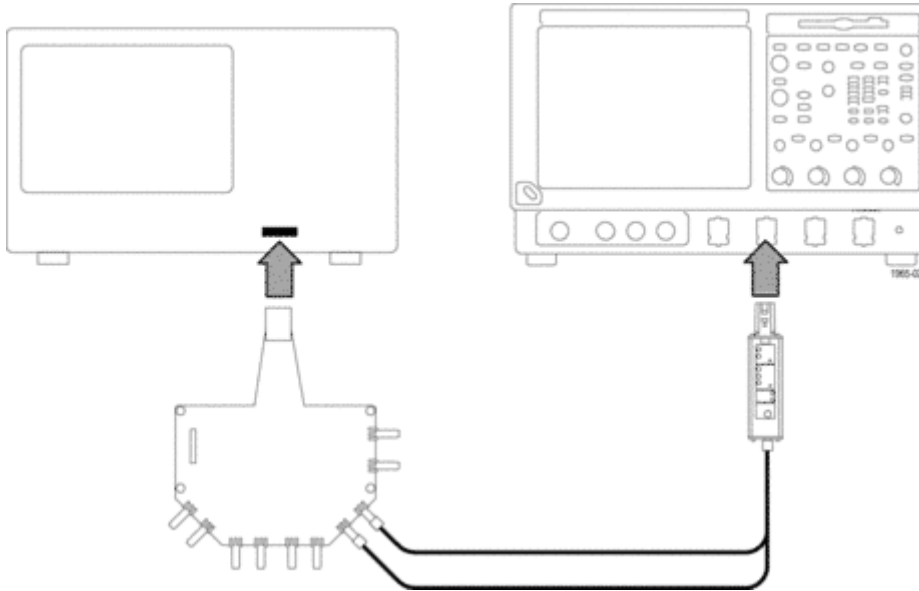


Figure 3: HDMI Source Test Setup

To perform an HDMI source test, connect an HDMI signal breakout board in place of the transmission line cable to allow you access to the transmitter signal. The P7313SMA probe terminates the HDMI signal like a receiver and allows you to measure the signal. The termination voltage range of the P7313SMA probe is sufficient to meet the +3.3 V specification for the HDMI AVcc termination voltage.

With the TDSHT3 HDMI Compliance Software, you can run an eye diagram test to automatically make differential measurements of the HDMI signal such as signal amplitude, clock jitter, clock duty cycle, rise and fall time, and overshoot/undershoot. (See Figure 4 on page 34.)

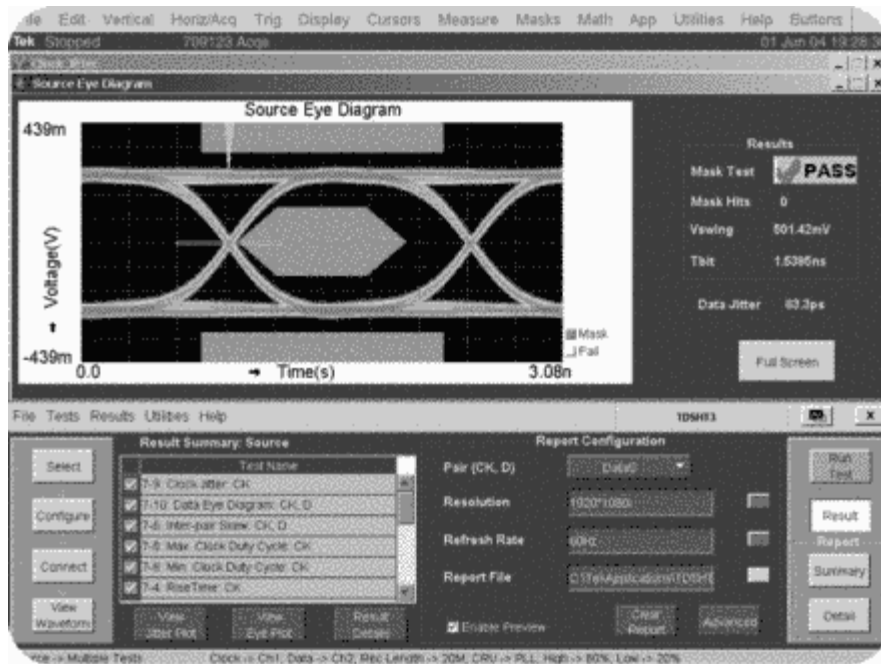


Figure 4: TDSHT3 Application Software Test Results



## Termination Voltage Control Modes

The termination voltage control modes allow you to monitor and control the termination voltage using three different methods. If you are using a second measurement instrument, such as a spectrum analyzer, the auxiliary output provides an attenuated, inverted sample of the input signal for additional processing. The following examples illustrate some typical probe configurations and applications.

## Auto Mode

If you test 50  $\Omega$  serial data lines such as InfiniBand or DC-Coupled PCI Express, you can use Auto mode to automatically set the termination voltage. Auto mode minimizes the DC loading on the differential input source by matching the termination voltage to the input signal common mode voltage.

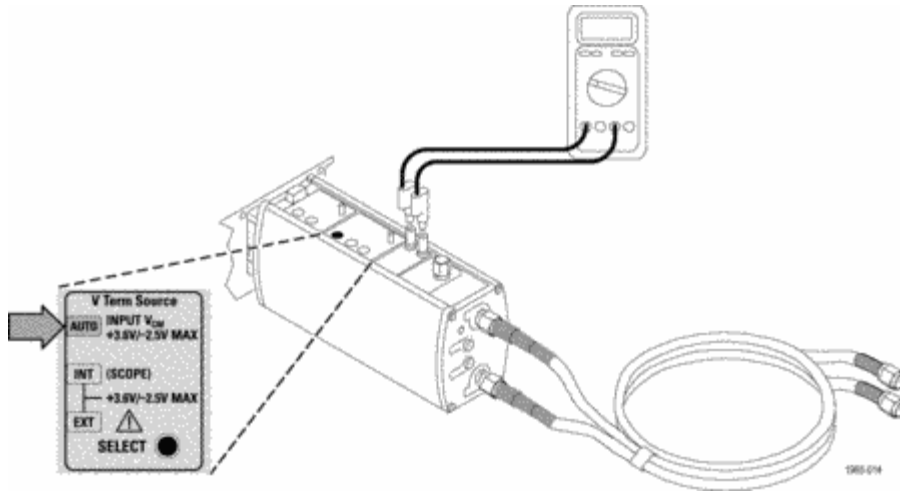


Figure 5: Using Auto Termination Voltage Control Mode

## External Mode

When you want to control the termination voltage, set the  $V_{term}$  source to Ext mode and connect the termination voltage control inputs to an external power supply. You can use a DMM to verify that the termination voltage matches the externally-supplied DC control voltage.

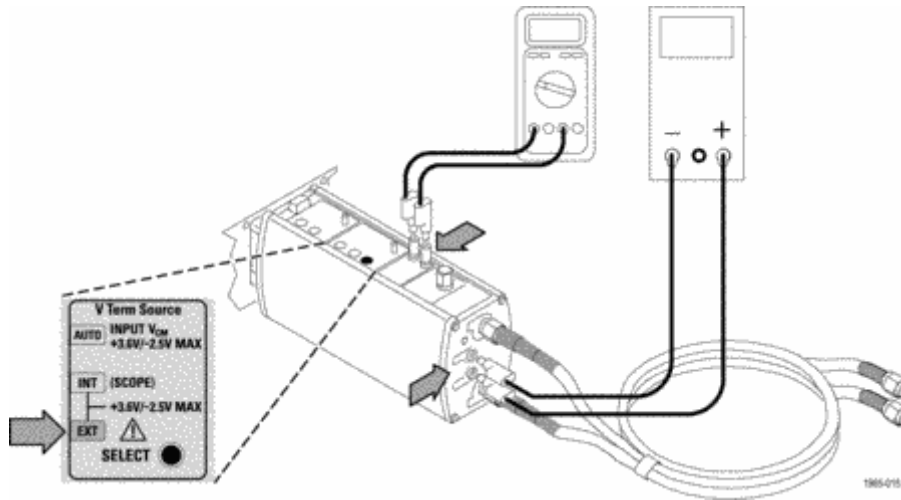


Figure 6: Using External Termination Voltage Control Mode

## Internal Mode

For TekConnect-interface oscilloscopes that support Int mode, you can use the oscilloscope to generate termination voltages, eliminating the need for an external power supply.

Refer to your oscilloscope manual for details on using the graphical user interface.

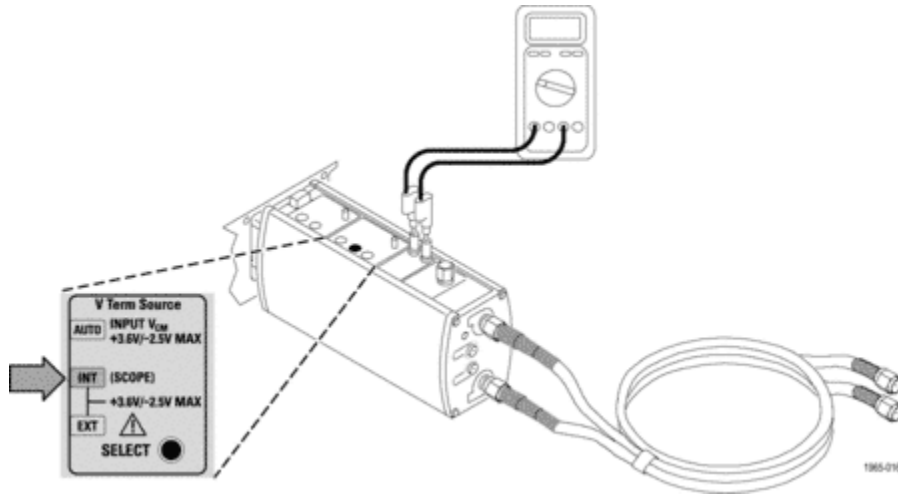


Figure 7: Using Internal Termination Voltage Control Mode

## Auxiliary Output

You can use the Aux Out connection to connect to a spectrum or network analyzer, or to generate clock recovery signals for other instrumentation.

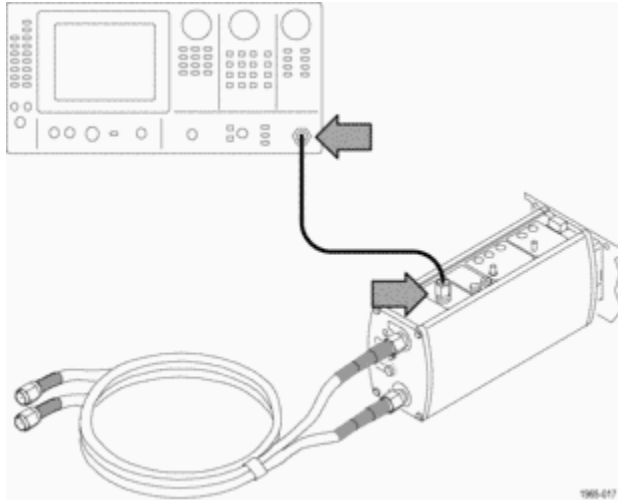


Figure 8: Viewing the Aux Out signal on a spectrum analyzer

You can connect the P7313SMA probe to Tektronix TDS8000 and CSA8000 Series sampling oscilloscopes by using the Tektronix 80A03 TekConnect Probe Interface. The 80A03 interface is an optional accessory for the probe that adapts TekConnect probes to Tektronix TDS8000 and CSA8000 Series oscilloscopes.

The 80A03 interface uses 80E0X Series electrical modules that are part of the Tektronix TDS8000 and CSA8000 Series oscilloscopes.

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**NOTE.** *The firmware of your 80A03 interface must be version 2.2 or higher to be compatible with your P7313SMA probe.*

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**80A05 Clock Recovery Module.** Add an 80A05 Clock Recovery Module to your sampling oscilloscope, and use the Aux output of your P7313SMA probe to trigger the module on the input signal and view eye diagrams. The 80A05 module generates a recovered clock from an acquired data stream when the data rate is known. (See Figure 9 on page 41.)

If a clock signal rather than a data signal is acquired by the probe, then the Aux output can be connected to one of the oscilloscope external trigger inputs.

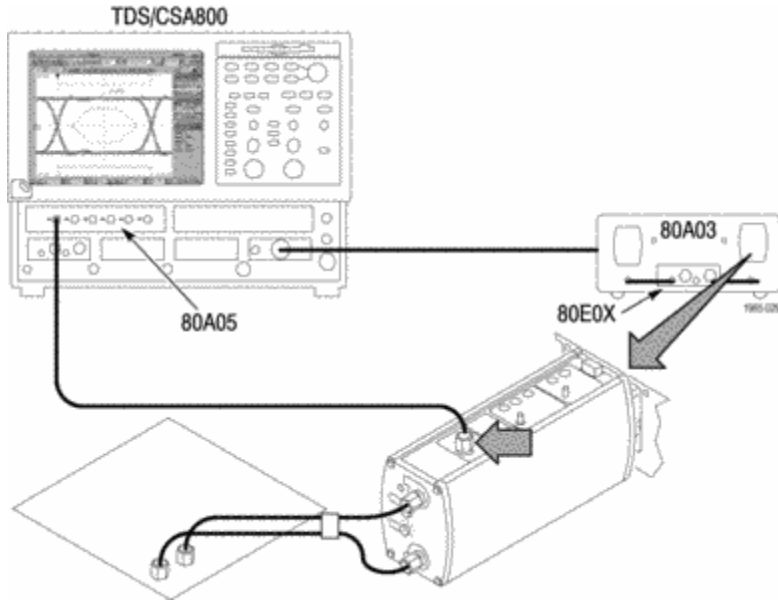


Figure 9: Using the probe with an 80A03 Interface and an 80A05 Module to view eye diagrams on a TDS8000 Series sampling oscilloscope







## Standard Accessories

The standard accessories included with the P7313SMA differential probe are listed below. The probe ships with one of each accessory unless noted otherwise. (See Table 2.) To order replacements, use the Tektronix part number listed with each accessory.

**Table 2: P7313SMA standard accessories**

Description	Accessory
<p><b>Male SMA 50 <math>\Omega</math> termination (3 ea).</b> The probe is shipped with these terminations connected to the probe SMA inputs and the Auxiliary Output connector. Protect the probe circuitry by connecting the terminations to these connectors when the probe is not in use.</p> <p>When making single-ended measurements in a 50 <math>\Omega</math> environment, one of these terminations should be installed on the unused input.</p> <p>Remove the 50 <math>\Omega</math> termination from the Auxiliary Output connector only when you connect the Auxiliary Output to another measurement instrument, such as a network analyzer. Otherwise, leave the termination connected to the probe.</p> <p>Tektronix part number: 015-1022-XX (package of 1)</p>	
<p><b>Male SMA short-circuit.</b> Use this adapter when performing a functional check on the probe.</p> <p>The SMA short-circuit can also be used to terminate an unused input for 0 <math>\Omega</math> source signals in a single-ended measurement topology.</p> <p>Tektronix part number: 015-1020-XX</p>	

**Table 2: P7313SMA standard accessories (cont.)****Description**

**SMA Female-to-BNC Male adapter.** Use the adapter to connect the probe SMA inputs to BNC connections, such as the BNC calibration output connector on your oscilloscope.

Tektronix part number: 015-0572-XX

**Accessory**

**Dual SMA cables.** These 38 inch cables are bound together and have factory-calibrated integral phase adjusters to limit cable-to-cable skew to less than 1 ps. The cables are color-coded at each end for easy identification, and provide matched signal paths from your circuit to the probe to ensure accurate differential signal measurements. The P7313SMA differential probe includes built-in cable loss compensation when used with the cable assembly.


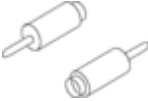

**NOTE.** To make DUT connections easier, connect the phase-adjuster ends of the cables to the probe inputs.

If you need to probe two points that are farther apart than the matched SMA cable set will allow, only use matched, high-quality, low loss SMA cables, and deskew them before you connect them to your circuit. Note that using cables other than those supplied with the probe may degrade probe performance. See *Checking Cable Skew* and *Adjusting Cable Skew* in the *Technical Reference Manual* for instructions.

Tektronix part number: 174-4944-XX



Table 2: P7313SMA standard accessories (cont.)

Description	Accessory
<p><b>0.080 inch Pin-to-Banana plug adapter cables (1 ea red and black).</b> Use these cables in external mode to control the DC termination voltage, using an external power supply to set the value.</p> <p>Tektronix part numbers:</p> <ul style="list-style-type: none"><li>■ 012-1674-XX (red)</li><li>■ 012-1675-XX (black)</li></ul>	
<p><b>0.040-to-0.080 inch Pin jack adapters (2 ea).</b> Use two pin jack adapters to connect the 0.040 inch Termination Voltage Monitor jacks to the 0.080 inch pin-to-banana plug adapter cables. Connect the banana plug ends of the cables to a DMM to measure the termination voltage.</p> <p>Tektronix part number: 012-1676-XX (package of 1)</p>	
<p><b>Antistatic wrist strap.</b> When using the probe, always work at an antistatic work station and wear the antistatic wrist strap.</p> <p>Tektronix part number: 006-3415-XX</p>	

**Table 2: P7313SMA standard accessories (cont.)**

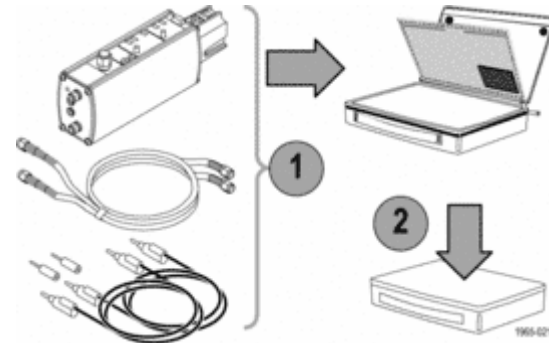
**Description**

**Accessory**

**Nylon Carrying Case with Inserts.**

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

Tektronix part number: 016-1952-XX



**Quick Start User Manual and CD-ROM** The Quick Start User Manual provides instructions for operating the P7313SMA differential probe.

The CD includes PDFs of the Quick Start User Manual, Technical Reference Manual, primers, and related information.

Tektronix part numbers:

- 020-2720-XX (English)
- 020-2737-XX (Japanese)
- 020-2738-XX (Simplified Chinese)

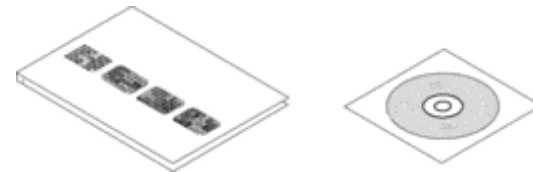
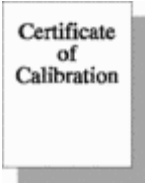


Table 2: P7313SMA standard accessories (cont.)

Description	Accessory
<p><b>Calibration certificate.</b> A certificate of traceable calibration is provided with every instrument shipped.</p>	

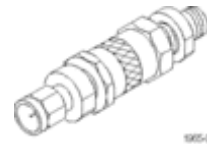
## Optional Accessories

The following accessories can be ordered for your probe:

**Phase adjuster.** Use two phase adjusters if you need to bring the skew between inputs to 1 ps or less because of skew in the device under test differential signal path. See *Adjusting Cable Skew* in the Technical Reference Manual for instructions.

The phase adjuster has a 25 ps adjustment range. The matched-delay SMA cables that come with your probe have a 31 ps skew at the cable ends.

Tektronix part number: 015-0708-XX (package of 1)

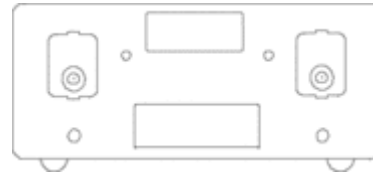


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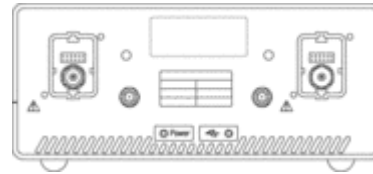
**80A03 TekConnect Probe Interface Module.** This adapter allows you to use TekConnect probes with CSA8000 and TDS8000 Series sampling oscilloscopes and 80E0X sampling modules.

The interface is made up of an enclosure that houses a compartment for one 80E0X electrical sampling module and two TekConnect probe inputs. The interface routes the probe signal outputs through SMA connectors on the front panel. Semi-rigid SMA cables link the probe outputs to the 80E0X module inputs.

The 80A03 Interface Module is required to complete a performance verification of the probe.



**RTPA2A TekConnect Probe Adapter.** This adapter allows you to connect a TekConnect probe to a Real-Time Spectrum Analyzer.



## User Service

This section covers troubleshooting and maintenance for the P7313SMA differential probe.

### Probe/Adapter/Oscilloscope Compatibility

The P7313SMA differential probe is designed to work with all TekConnect-interface oscilloscopes and adapters. However, there may be some cases where all of the probe features may not work properly.

Before suspecting a problem with your probe, compare the symptoms of your probe with the following:

Symptom	Likely cause
Int mode for Vterm does not display a control window on the oscilloscope	<p>The oscilloscope does not support this mode. (Instead, the termination voltage defaults to 0 volts.)</p> <p>If you need to manually set the termination voltage, use Ext mode with an external power supply.</p>
P7313SMA probe does not work with an 80A03 TekConnect Probe Interface Adapter	<p>Incompatible probe (indicated by the LED on the 80A03 Adapter glowing red).</p> <p>The 80A03 Adapter requires firmware version V:2.2 or above. Contact Tektronix for information on updating the adapter firmware.</p>

## Error Conditions

The LEDs on the probe alert you to the following error or status conditions. If the remedy does not clear the error condition, the probe is defective and must be returned to Tektronix for repair.

Symptom	Cause	Remedy
Auto mode LED flashing	Probe signal inputs are open or AC-coupled	This is not an error; it is a status indicator. The probe is functioning normally.
Both Attn/Dynamic Range LEDs flash after power-on	Internal probe fault	Disconnect the probe from the oscilloscope and reconnect.
Overdrive LED on	Termination Voltage Driver exceeds maximum current limit - difference too large between $V_{term}$ and $V_{cm}$	Remove all signal sources from probe, verify the signal amplitudes do not exceed probe limits, then reconnect.
Overdrive LED flashing	Termination voltage in Auto or EXT mode exceeds maximum voltage range limit	Remove termination voltage source from probe, verify that the voltage does not exceed probe limits, and then reconnect.



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