

# Service Manual



## P7240 4 GHz Active Probe

**071-1056-00**

### **Warning**

The servicing instructions are for use by qualified personnel only. To avoid personal injury, do not perform any servicing unless you are qualified to do so. Refer to all safety summaries prior to performing service.

**[www.tektronix.com](http://www.tektronix.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.*

**Do Not Service Alone.** Do not perform internal service or adjustments of this product unless another person capable of rendering first aid and resuscitation is present.

While using this product, you may need to access other parts of the system. Read the *General Safety Summary* in other system 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.

**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 there is damage to this product, have it inspected by qualified service personnel.

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

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

**Keep Product Surfaces Clean and Dry.**

**Provide Proper Ventilation.** Refer to the manual's installation instructions for details on installing the product so it has proper ventilation.

## Symbols and Terms

**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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**Terms on the Product.** These terms may appear on the product:

**DANGER** indicates an injury hazard immediately accessible as you read the marking.

**WARNING** indicates an injury hazard not immediately accessible as you read the marking.

**CAUTION** indicates a hazard to property including the product.

**Symbols on the Product.** The following symbols may appear on the product:



# Preface

This is the service manual for the P7240 4 GHz Active Probe. Read this preface to learn how this manual is structured and where you can find other information related to servicing this product.

## Manual Structure

This manual contains three sections – *Description*, *Performance Verification*, and *Adjustment Procedures*, and is intended to be used by qualified service personnel. Replaceable parts are limited to accessories and adapters, and are described in the Instruction Manual that is shipped with the probe.

Be sure to read the introductions to all procedures. These introductions provide important information needed to do the service correctly, safely, and efficiently.

## Related Documentation

The probe is shipped with the following manual:

- *P7240 4 GHz Active Probe Instruction Manual*. Tektronix part number 071-0759-XX.

## Contacting Tektronix

<b>Phone</b>	1-800-833-9200*
<b>Address</b>	Tektronix, Inc. Department or name (if known) 14200 SW Karl Braun Drive P.O. Box 500 Beaverton, OR 97077 USA
<b>Web site</b>	<a href="http://www.tektronix.com">www.tektronix.com</a>
<b>Sales support</b>	1-800-833-9200, select option 1*
<b>Service support</b>	1-800-833-9200, select option 2*
<b>Technical support</b>	Email: <a href="mailto:support@tektronix.com">support@tektronix.com</a> 1-800-833-9200, select option 3* 6:00 a.m. – 5:00 p.m. Pacific time

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\* This phone number is toll free in North America. After office hours, please leave a voice mail message.  
Outside North America, contact a Tektronix sales office or distributor; see the Tektronix web site for a list of offices.

# Description

This document describes the *Performance Verification and Adjustment Procedures* for the P7240 4 GHz Probe. There are no user-replaceable parts inside the probe. If the probe fails the performance verification procedure, and adjusting the probe cannot compensate for the failure, contact your Tektronix service center.

## Performance Verification

Use the performance verification procedures to verify the warranted specifications of the P7240 probe. The recommended calibration interval is one year. No software is required to complete a performance verification of the probe.

The performance verification procedures check the following specifications:

- Output zero
- DC attenuation accuracy
- Rise time

## Adjustments

The P7240 probe has two electronically-adjusted controls that rarely need adjusting unless a performance verification yields a specification that is out of tolerance, or the probe fails an oscilloscope probe calibration utility.

If you must make adjustments to the probe, you need the TekConnect Adjustment Software for the P7240 4 GHz Probe. Refer to *Equipment Setup* in the *Adjustment Procedures, step 7*, for instructions on finding and loading the adjustment software on your instrument.

The adjustment procedures describe the following adjustments for the probe:

- Offset zero
- Offset gain

## Equipment Required

Refer to Table 1 for the equipment required to perform the service procedures.

**Table 1: Equipment required for performance verification and adjustment procedures**

Item description	Performance requirement	Recommended example
TekConnect adjustment software <sup>1</sup>	P7240 Probe	Optional Applications for Windows-Based Oscilloscopes CD
Sampling Oscilloscope	≥12.5 GHz bandwidth	Tektronix TDS8000
Sampling head, with extension cable	≥12.5 GHz bandwidth	Tektronix 80E0X with 012-1568-00 cable
Oscilloscope	TekConnect Interface	Tektronix TDS7404
TekConnect calibration adapter	TekConnect Interface	067-0422-00
Calibration Step Generator	250 mV step, ≤30 ps rise time	067-1338-0X
Adapter	TekConnect-to-SMA	TCA-SMA
Adapter	Probe tip with 50 Ω terminator	015-0678-00
DC Power Supply	1 VDC at 1 mA	Tektronix PS280
DMM (2) with leads	0.05% accuracy, 0.1 mV resolution	Fluke 87 or equivalent
Feedthrough Termination	50 Ω ±0.05 Ω	011-0129-00
BNC-to-BNC coaxial cable (2)	50 Ω coaxial cable	012-0057-01
Coaxial cable	Male-to-Male SMA	012-0649-00
Adapter	SMA Male-to-Male	015-1011-00
Adapter	SMA Female-to-Female	015-1012-00
Adapter	SMA Male-to-BNC Female	015-0554-00
Adapter (2)	BNC Female-to-Dual Banana	103-0090-00
Adapter	Y-lead adapter	196-3456-00
Adapters (2)	KlipChip adapter	206-0364-00
SMA torque wrench	5/16-in, 7 in-lb.	
SMA adapter wrench	7/32-in	

<sup>1</sup> Required for adjustment procedures only

## Special Adapters Required

Some of the adapters listed in Table 1 are custom-made and available only from Tektronix. The adapters are described on the following pages.



**TekConnect-to-SMA Adapter**

The TekConnect-to-SMA Adapter, Tektronix part number TCA-SMA, allows signals from an SMA cable or probe to be connected to a TekConnect input. See Figure 1. Connect and disconnect the adapter the same way as you do the P7240 Probe.

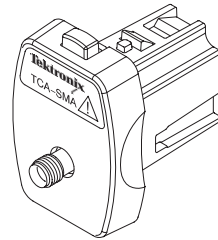


Figure 1: TekConnect-to-SMA adapter

**Probe Tip Adapter**

The probe tip adapter, Tektronix part number 015-0678-00, provides a low-noise method for connecting the P7240 to signals present on SMA cables. The adapter has a test point for the probe and two SMA connectors. A 50 ohm termination is included with the adapter, and is connected to the SMA connector nearest the probe test point to minimize reflections. Connect the cable from the test circuit to the other SMA connector. See Figure 2.

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**NOTE.** When taking measurements, do not touch the probe tip adapter. Measurement accuracy is degraded when the probe tip adapter is handled.

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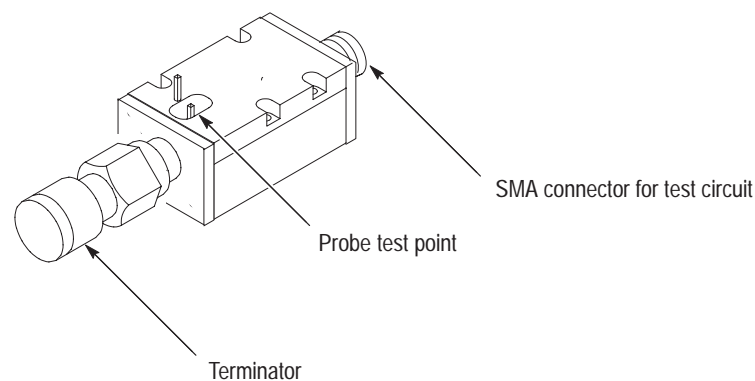
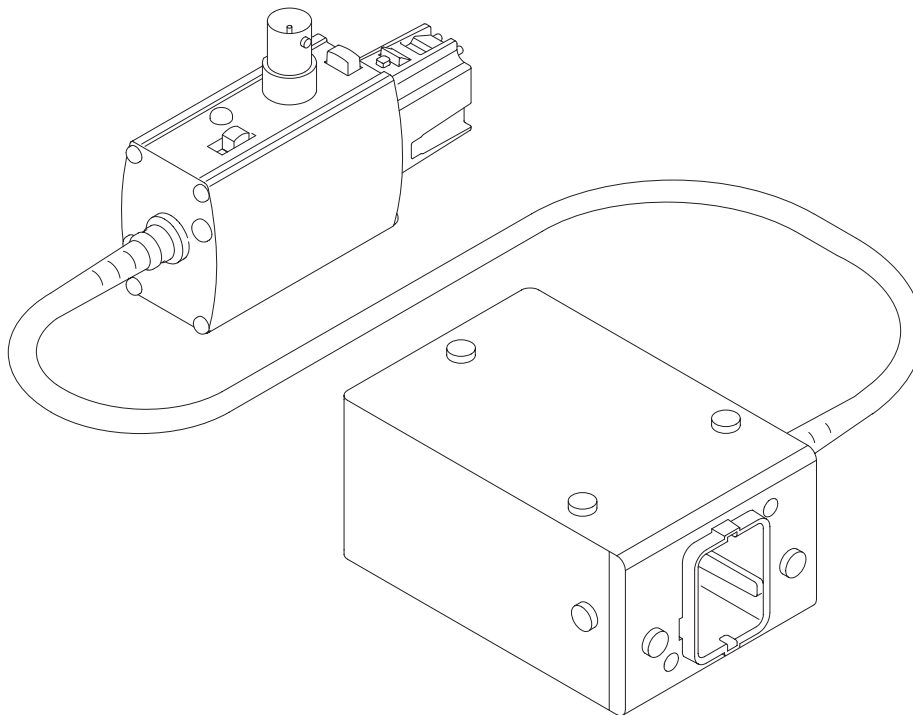


Figure 2: Probe tip adapter

**TekConnect Interface  
Calibration Adapter**

The TekConnect Interface Calibration Adapter, Tektronix part number 067-0422-00, connects between the host instrument and the probe under test, and provides connectors for probe signal and offset voltage measurements. See Figure 3.

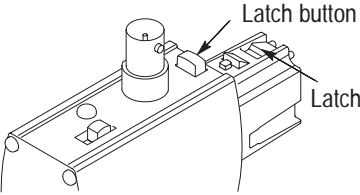
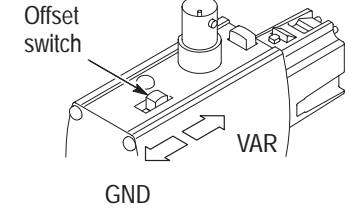
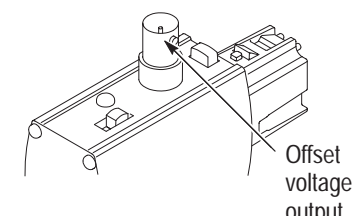
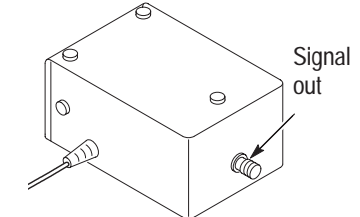


**Figure 3: TekConnect Interface Calibration Adapter**

When the adapter is connected to the oscilloscope, the adapter is identified as a valid calibration device. However, additional power supplies necessary to power the probe are not enabled until a TekConnect probe is connected to the adapter and identified by the oscilloscope. When a probe is detected through the adapter, the Volts/div readout on the oscilloscope displays ##.

Refer to Table 2 on page 5 for features of the calibration adapter.

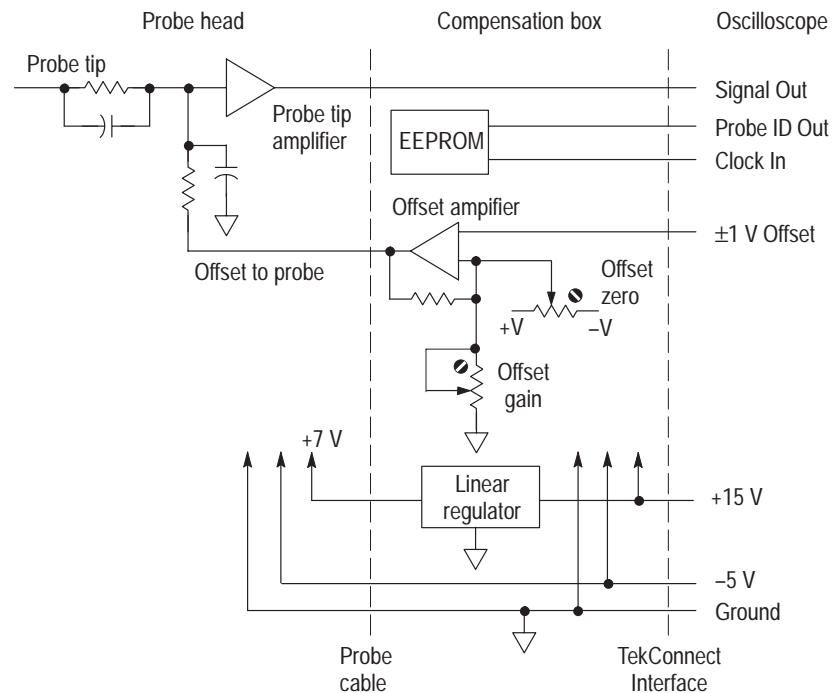
Table 2: TekConnect Interface Calibration Adapter features

Feature	Description
 <p>Latch button</p> <p>Latch</p>	<p><b>Latch button.</b> The spring-loaded latch mechanically retains the adapter to the oscilloscope. To release the adapter, grasp the adapter housing, depress the latch button, and pull the adapter straight out of the oscilloscope.</p>
 <p>Offset switch</p> <p>GND</p> <p>VAR</p>	<p><b>Offset output select switch.</b> The offset output switch selects between ground and the offset voltage level from the oscilloscope.</p> <p>Leave the switch in the ground position for the performance verification procedures.</p> <p>Move the switch to the variable position for the adjustment procedures.</p>
 <p>Offset voltage output</p>	<p><b>Offset voltage.</b> The offset voltage of the probe is accessed through the BNC connector.</p> <p>Measure the offset voltage using a DVM, BNC coaxial cable, and BNC-to-dual-banana jack.</p>
 <p>Signal out</p>	<p><b>Signal out.</b> The SMA connector on the rear of the box allows for direct monitoring of the probe signal.</p>

## Theory of Operation

Refer to Figure 4 as you read the following information.

There are two adjustments in the P7240 adjustment procedure: Offset Zero and Offset Gain. These adjustments are made using digitally controlled potentiometers that are controlled by a two-wire serial interface from the host oscilloscope. Because the adjustments are digitally controlled, the probe does not need to be disassembled as part of the adjustment procedure. The software application provides the control needed to make the adjustments to the probe.



**Figure 4: P7240 simplified schematic diagram**

The offset signal from the oscilloscope extends the dynamic range of the P7240 probe by compensating for some of the DC voltage that may be part of the signal applied to the probe. Compensation is accomplished by summing the offset signal with the probe input signal at the probe input attenuator, as shown in Figure 4. The host oscilloscope supplies the offset signal (with a range of  $\pm 1$  volt) to the offset amplifier in the probe. Since the offset scale factor of the P7240 probe is 5X, the effective offset signal range is increased to  $\pm 5$  V.

The Offset Zero adjustment is used to null out any amplifier voltage offsets in the offset signal path. With no input signal at the probe input and no offset signal from the host oscilloscope, the Offset Zero is adjusted to produce 0.0000 V at the probe output. Since the P7240 probe is designed to operate into a host oscilloscope with a 50  $\Omega$  load, a precision 50  $\Omega$  feed thru terminator is used in the adjustment procedure.

The Offset Gain adjustment is used to adjust the offset amplifier gain for a precise 1X scale factor. Since the P7240 input signal scale factor has been designed with a 5X scale factor, the Offset Gain is adjusted to null out the difference between a DC input signal and a 5X-scaled offset signal from the host oscilloscope.

# Performance Verification

Use the following procedures to verify the warranted specifications of the P7240 probe. Before beginning these procedures, refer to page 14 and photocopy the test record and use it to record the performance test results. The recommended calibration interval is one year. These procedures test the following specifications:

- Output zero
- DC attenuation accuracy
- Rise time

## Equipment Setup

Use this procedure to set up the equipment to test the probe.

1. Connect the probe calibration adapter to the oscilloscope.
2. Connect the probe to the probe calibration adapter.
3. Turn on the oscilloscope, and enable the channel.
4. Verify that the Volts/div readout on the oscilloscope channel displays ## (the oscilloscope recognizes the probe through the adapter).
5. Set the multimeters to read DC volts.
6. Allow 30 minutes for the equipment to warm up.

## Output Zero

Use this procedure to verify the probe output zero.

1. Connect the test equipment as shown in Figure 5.
2. Set the offset switch on the calibration adapter to **GND**.

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**NOTE.** Leave the offset switch in the ground position for all of the performance verification checks.

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3. Ground the probe tip by connecting the probe tip to the probe ground socket. (Connecting two KlipChip adapters together is recommended.)
4. Observe the multimeter display, and record the results on the test record.

The displayed DC level should be 0.000 V  $\pm$ 10 mV.

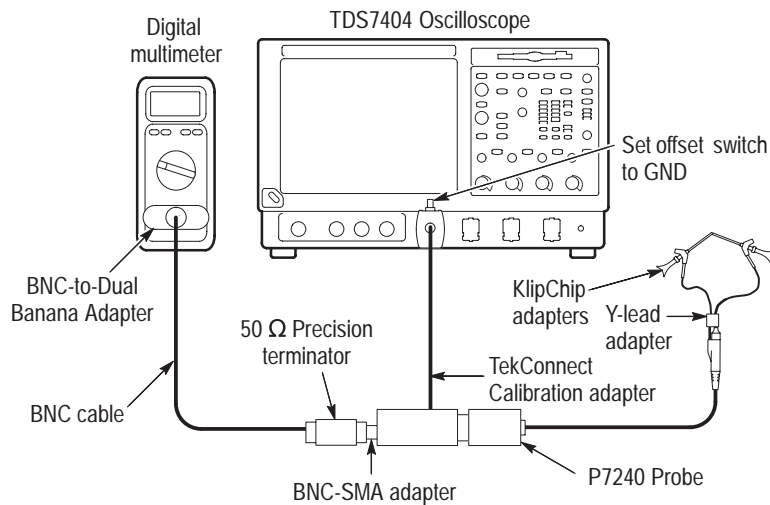
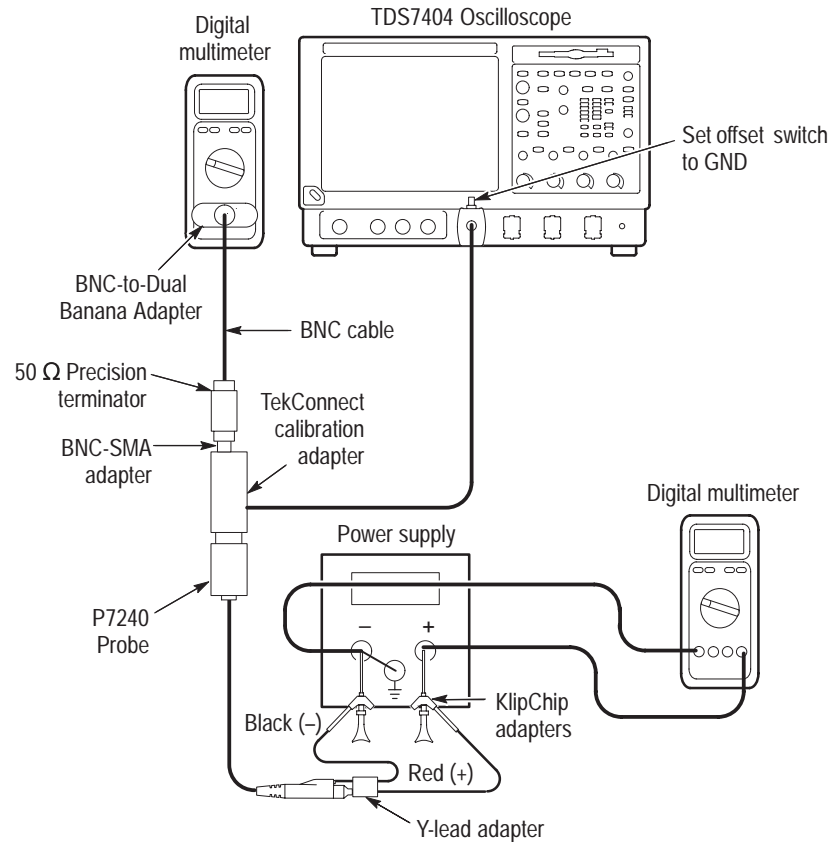


Figure 5: Setup for output zero

## DC Attenuation Accuracy

1. Disconnect the KlipChip adapters, and connect the setup as shown in Figure 6.



**Figure 6: Setup for DC attenuation accuracy**

Record the results of steps 2 through 5 separately. Use the results to calculate the DC accuracy of the probe in step 6.

2. Set the power supply to +1.000 V. Use the multimeter connected to the power supply to verify that the DC voltage is as close to +1.000 V as possible. Record this measurement as  $V_{max}$ .
3. Measure and record the reading of the other multimeter as  $M1$ .
4. Set the power supply to -1.000 V. Use the multimeter connected to the power supply to verify that the DC voltage is as close to -1.000 V as possible. Record this measurement as  $V_{min}$ .
5. Measure and record the reading of the other multimeter as  $M2$ .

- Determine the percent error by using the formula below:

$$\%Error = \left[ \frac{M1-M2}{(Vmax-Vmin) \times .2} - 1 \right] \times 100\%$$

Example:

$$\begin{aligned} \%Error &= \left[ \frac{0.2028 - (-0.2021)}{[1.007 - (-0.998)] \times .2} - 1 \right] \times 100\% \\ &= \frac{0.4049}{0.4010} - 1 \times 100\% \\ &= 1.0097 - 1 \times 100\% \\ &= + 0.97\% \end{aligned}$$

The calculated error should be  $\leq 2\%$ .

- Record the results on the test record.

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**NOTE.** An unacceptable error value may result if a low tolerance termination is substituted for the recommended termination.

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## Rise Time

This procedure verifies that the probe meets rise time specifications.

The probe rise time is calculated using rise times measured from the test system separately, and the test system including the probe.

- Connect the test equipment as shown in Figure 7 on page 11.




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**CAUTION.** To prevent damage, use care when working with SMA connectors: support equipment to avoid mechanical strain on the connectors, and use a torque wrench when tightening connections.

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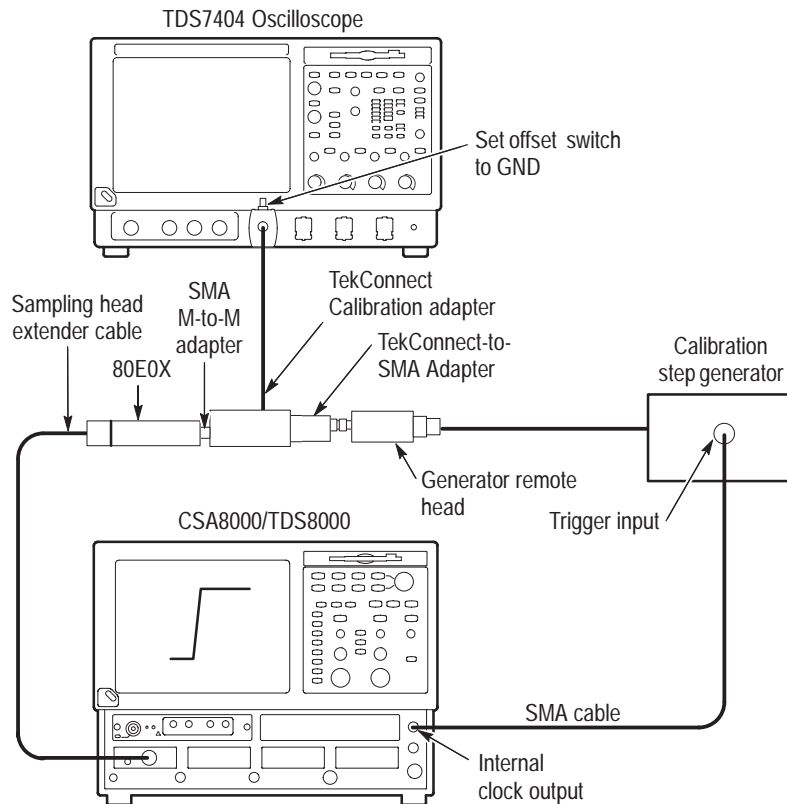


Figure 7: Test system rise time setup

2. Set the oscilloscope trigger to internal clock.
3. Select the channel you have connected to on the 80E0X sampling head, and then set the oscilloscope vertical scale to 50 mV/div.

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**NOTE.** The output of the step generator rises from a  $-250$  mV level to ground.

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4. Adjust the oscilloscope horizontal and vertical position controls to display a signal similar to that shown in Figure 7.
5. Set the oscilloscope horizontal scale to 50 ps/div and center the waveform.
6. Use the oscilloscope measurement capability to display rise time. Increase the stability of the pulse edge measurement by using averaging, if available. Rise time is determined from the 10% and 90% amplitude points on the waveform. Record the rise time as  $t_s$ .

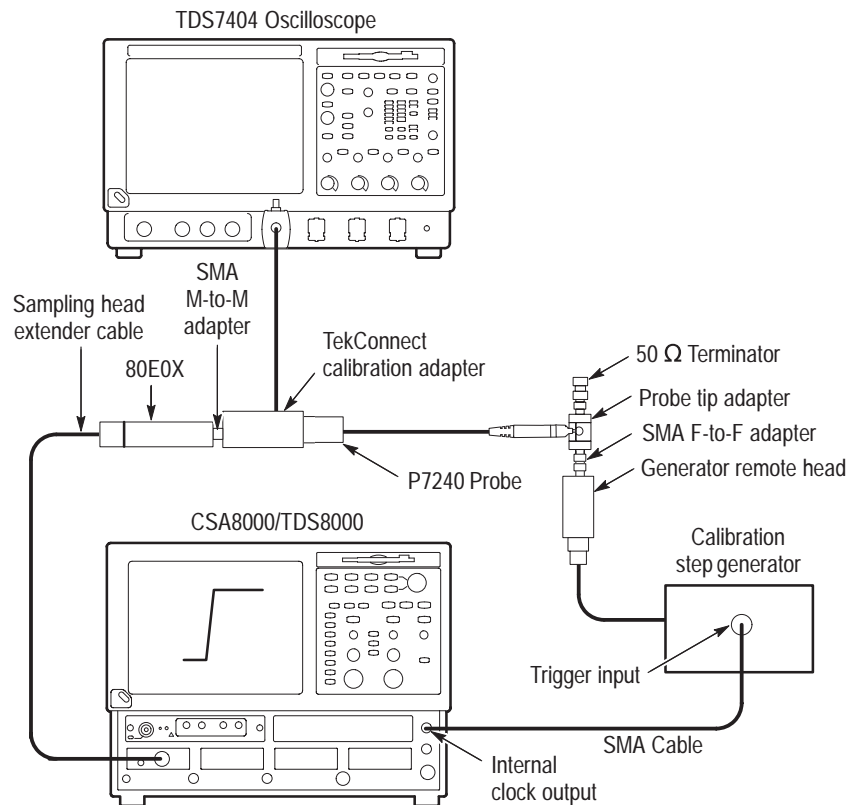
The system rise time ( $t_s$ ) that you measured in step 6 represents the rise time of the test system without the probe.

After you assemble the test setup that includes the probe, as shown in Figure 8, you will measure the system and probe rise time ( $t_{s+p}$ ) in step 13. This is used to calculate the probe rise time ( $t_p$ ) in step 14.

7. Set the step generator control switch to standby.
8. Remove the TekConnect-SMA adapter from the test setup.
9. Connect the test setup as shown in Figure 8 on page 12.



**CAUTION.** To prevent damaging the SMA connectors, use a 7/32-inch wrench when connecting and disconnecting the female-to-female SMA adapter.



**Figure 8: Test system and probe rise time setup**

10. Set the step generator control switch to on.
11. On the TDS8000, expand the horizontal scale to locate the step edge. Set the vertical scale to 10 mV/div, and adjust horizontal range to 100 ps/div while maintaining the edge view. For a more stable measurement display, turn averaging on.

12. Adjust the TDS8000 horizontal and vertical position controls to display a signal similar to that shown in Figure 8.

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**NOTE.** Do not touch the probe tip adapter when making calibration measurements. Measurement accuracy is degraded when the probe tip adapter is handled.

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13. Use the TDS8000 measurement capability to display rise time. Rise time is determined from the 10% and 90% amplitude points on the waveform. Record the rise time as  $t_{s+p}$ .
14. Calculate the probe-only rise time using the following formula:

$$t_p = \sqrt{t_{(s+p)}^2 - t_s^2}$$

15. Check that the calculated rise time meets the probe specification. The rise time ( $t_p$ ) must be  $\leq 120$  ps.
16. Record the results on the test record.

**Test record**

Probe Model: \_\_\_\_\_  
 Serial Number: \_\_\_\_\_  
 Certificate Number: \_\_\_\_\_  
 Temperature: \_\_\_\_\_  
 RH %: \_\_\_\_\_  
 Date of Calibration: \_\_\_\_\_  
 Technician: \_\_\_\_\_

Performance test	Minimum	Incoming	Outgoing	Maximum
Output zero voltage (at probe output) ± 10 mV (20° C to 30° C)	- 10 mV	_____	_____	+ 10 mV
DC attenuation accuracy (% error)	N/A	_____	_____	≤2 %
Rise time	N/A	_____	_____	≤120 ps

# Adjustment Procedures

These instructions are for personnel who are familiar with servicing the product. If you need further details for disassembling or reassembling the product, refer to the appropriate product manual. Contact your nearest Tektronix, Inc., Service Center or Tektronix Factory Service for installation assistance.



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**CAUTION.** To prevent static discharge damage, service the product only in a static-free environment. Observe standard handling precautions for static-sensitive devices when servicing the probe. Always wear a grounded wrist strap, grounded foot strap, and static resistant apparel when servicing the probe.

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## Equipment Setup

Use this procedure to set up the equipment to adjust the probe.

1. Turn on the oscilloscope and enable the channel you intend to use.
2. Connect the probe calibration adapter to the oscilloscope.
3. Connect the probe to the probe calibration adapter.
4. Verify that the Volts/div readout on the oscilloscope channel displays ## (the oscilloscope recognizes the probe through the adapter).
5. Set the multimeters to read DC volts.
6. Allow 30 minutes for the equipment to warm up.
7. While the equipment is warming, verify that the application has been loaded onto the oscilloscope:
  - a. Minimize the scope application window by going to File→Minimize.
  - b. Go to: Start→Programs→Tektronix→TekConnect Adjust
  - c. If the application is not loaded on the oscilloscope, get the application:  
Retreive the application CD that came with the oscilloscope, insert the CD in the drive, select Start→Run, and then enter **D:\setup.exe**  
  
Or, download the application from the Tektronix website at:  
  
[www.tektronix.com/Software and Drivers/Accessories](http://www.tektronix.com/Software and Drivers/Accessories)
8. When the application starts, the display appears as shown in Figure 9.

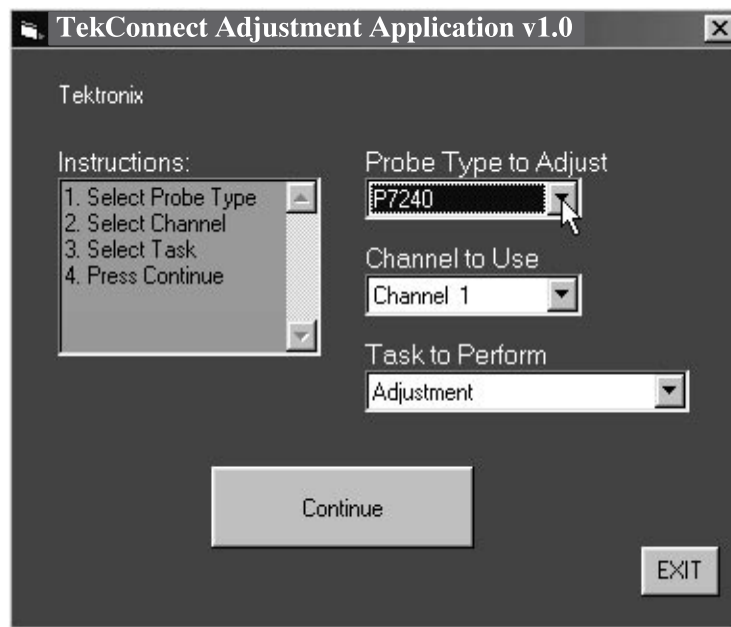


Figure 9: TekConnect probe adjustment application

## Application Setup

1. Make the following selections in the application dialog box:
  - a. Select **P7240** in the Probe Type to Adjust list.
  - b. Select the oscilloscope channel that the adapter is connected to in the Channel to Use list.
  - c. Select **Adjustment** in the Task to Perform list.
2. Click Continue.
3. The P7240 Probe Adjustments Dialog Box appears. See Figure 11 on page 18.

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**NOTE.** An error message appears if one of the following conditions exists:

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- A probe is not connected to the adapter.
- A probe model other than a P7240 is connected to the adapter.
- The P7240 connected to the adapter is defective (unable to properly communicate with the adapter).

If an error message appears, click OK, correct the condition that caused the error message, and then click Continue.

4. Proceed to the *Offset Zero* procedure.

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**NOTE.** To avoid corrupted test results, do not disconnect the probe under test or the probe calibration adapter until you have completed the service procedures. If the probe or adapter are disconnected before completing the procedures, you must reconnect the probe and adapter, and exit and restart the application.

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## Offset Zero

Use this procedure to adjust the probe offset zero.

1. Connect the test equipment as shown in Figure 10.

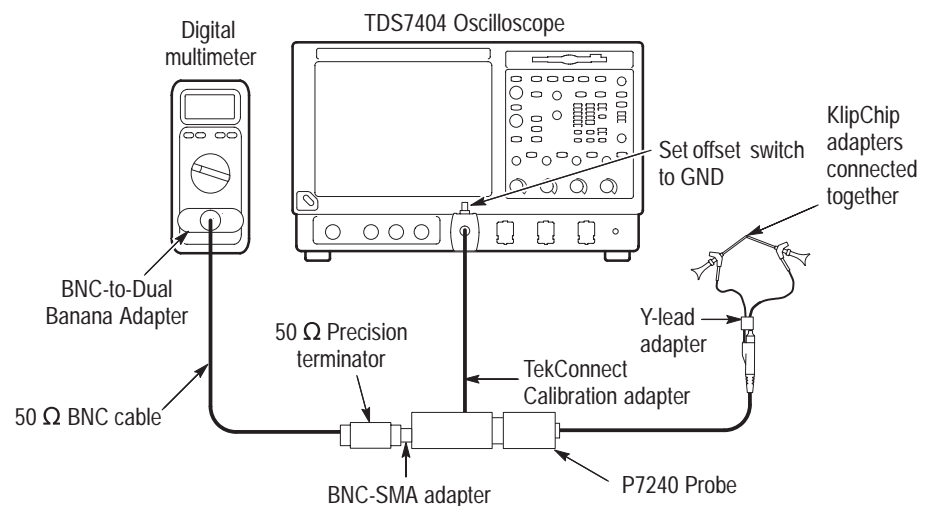


Figure 10: Setup for offset zero

2. Set the offset switch on the calibration adapter to **GND**.
3. Click Offset Zero in the application window. See Figure 11 on page 18.

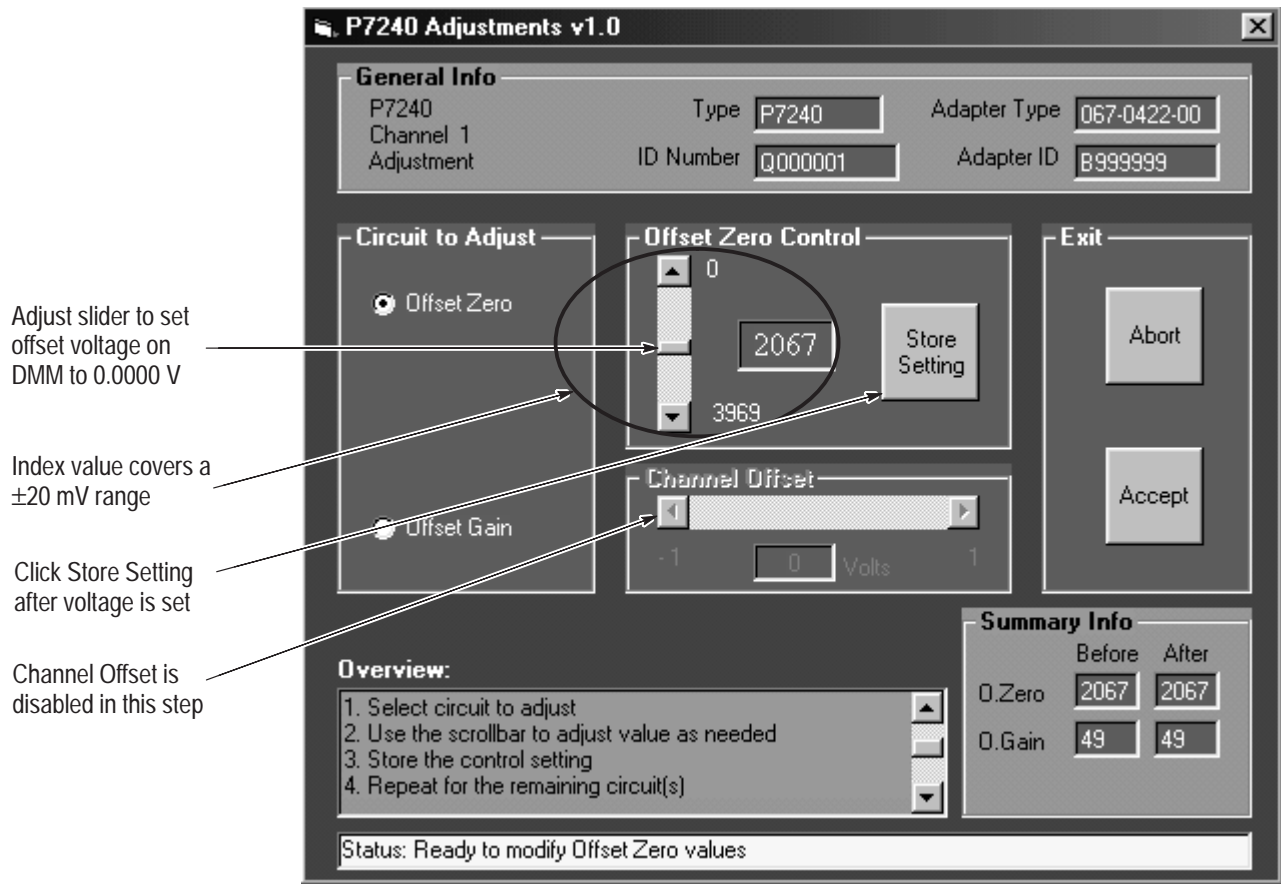


Figure 11: Offset Zero window

- Set the offset zero voltage on the DMM to 0.0000 V by adjusting the Offset Zero Control. The index value in the Offset Zero Control varies from 0 to 3969, and corresponds to approximately  $\pm 20$  mV of offset voltage range.

Use one of the following methods to make the adjustment:

- Use your finger or the mouse to drag the on-screen slider up or down.
- Click or touch the up/down arrow keys above and below the slider. Each click adjusts the offset voltage by about  $10 \mu\text{V}$ .
- To increment by ten clicks or about  $100 \mu\text{V}$ , click in the bar above or below the slider.



- When the offset zero voltage displayed on the voltmeter is 0.0000 V  $\pm$ 0.0001 V, click Store Setting to save the offset zero voltage level.

**NOTE.** In the Summary Info box, the After field updates with the control value from step 5. This is a temporary value until Accept is selected later, after all adjustments have been made.

If you select Accept now, the application requests confirmation: If you click Yes, the application exits; if you click No, you are able to make further adjustments. You must complete all adjustments before selecting Accept.

- Proceed to the *Offset Gain* procedure.

## Offset Gain

Use this procedure to adjust the probe offset gain.

- Set the DC power supply to  $-2.5$  volts. Use a DMM to measure the voltage. Record this voltage as M1.
- Connect the test equipment as shown in Figure 12.

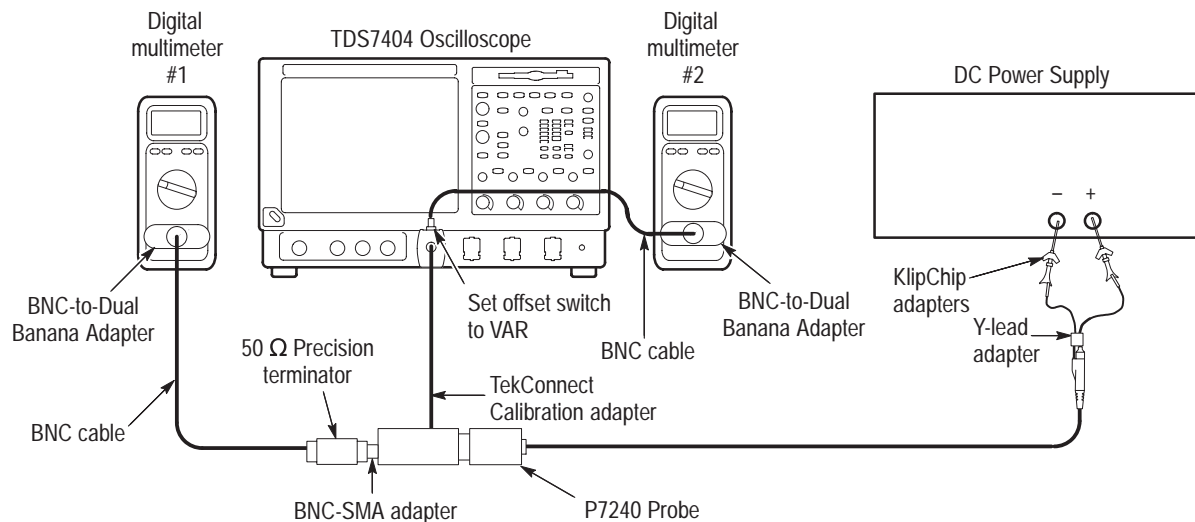


Figure 12: Setup for offset gain

- Set the offset switch on the calibration adapter to **VAR**.
- Click **OFFSET GAIN** in the application window. See Figure 13 on page 20.

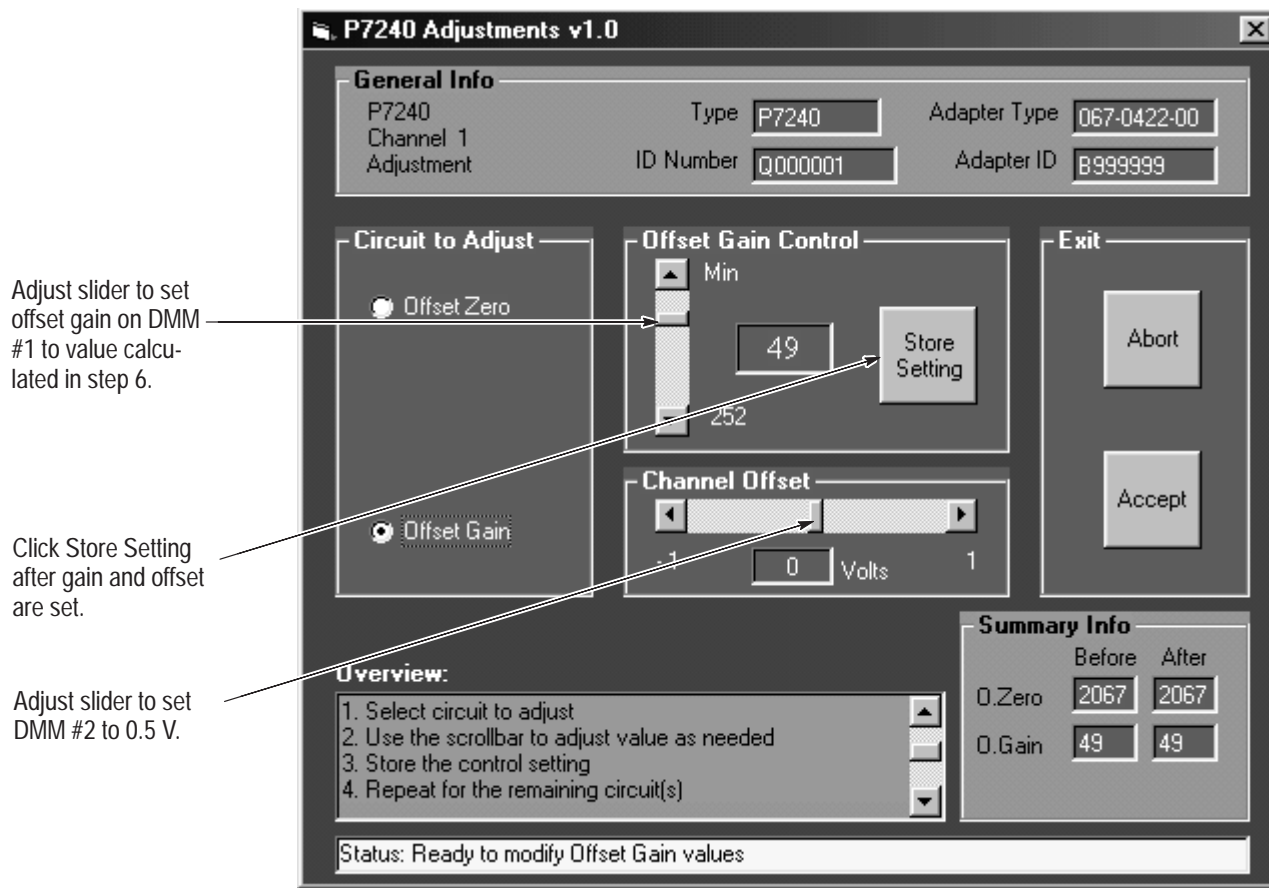


Figure 13: Offset Gain window

**NOTE.** Channel offset is multiplied by the 5X attenuator in the probe. The offset voltage (+ 0.5 V) measured at the BNC connector on the Calibration Adapter nulls out the -2.5 V applied to the probe input.

5. Set the Channel Offset control to display 0.5 V on DMM #2.  
Use one of the following methods:
  - Use your finger or the mouse to drag the on-screen slider up or down.
  - Click or touch the up/down arrow keys above and below the slider. Each click adjusts the offset voltage by about 1 mV.
  - To increment by ten clicks or 10 mV, click in the bar above or below the slider.

Record this voltage as M2.

- Determine the offset gain target value by using the formula below:

$$\text{Offset gain target value} = \frac{M1}{5} + M2$$

- The Offset Gain voltage is displayed on DMM #1. Adjust the Offset Gain Control to the offset gain target value,  $\pm 1$  mV, using one of the following methods:
  - Use your finger or the mouse to drag the on-screen slider up or down.
  - Click or touch the up/down arrow keys above and below the slider. Each click adjusts the offset voltage by about 1 mV.
  - To increment by ten clicks or 10 mV, click in the bar above or below the slider.
- When the offset gain displayed on DMM #1 is within  $\pm 1$  mV of the offset gain target value, click Store Setting to save the offset gain level.

In the Summary Info box, the **AFTER** field updates with the control value from step 8. This is a temporary value until Accept is selected.

- Click Accept to save all the values that you set in these procedures.
- Click Yes to update the contents.

This completes the adjustments to the probe.

## Verify Operation

Do the *Performance Verification* procedures to verify that the probe meets specifications.

■ End of document ■

