

# Service Manual



## **P6248 1.7 GHz (Typical) Differential Probe**

**071-0573-03**

### **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.



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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.*

## 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. Disconnect the probe input and the probe ground 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.

Connect the ground lead of the probe to earth ground only.

**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:





# Service Safety Summary

Only qualified personnel should perform service procedures. Read this *Service Safety Summary* and the *General Safety Summary* before performing any 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.

**Use Care When Servicing With Power On.** To avoid electric shock, do not touch exposed connections.



# Preface

This manual contains specifications and service information for the P6248 differential probe.

## Related Manuals

For operating information, refer to the *P6248 Instructions* (071-0566-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:techsupport@tektronix.com">techsupport@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.**



# Specifications

The specifications in Tables 1 through 4 apply to a P6248 differential probe installed on a Tektronix TDS 694C oscilloscope. When the probe is used with another oscilloscope, the oscilloscope must have an input impedance of 50  $\Omega$ . The probe must have a warm-up period of at least 20 minutes and be in an environment that does not exceed the limits described in Table 1. Specifications for the P6248 differential probe fall into three categories: warranted, typical, and nominal characteristics.

## Warranted Characteristics

Warranted characteristics (Table 1) describe guaranteed performance within tolerance limits or certain type-tested requirements. Warranted characteristics that have checks in the *Performance Verification* section are marked with the ✓ symbol.

**Table 1: Warranted electrical characteristics**

Characteristic	Description
✓ DC attenuation accuracy	$\pm 2\%$ for input voltages $\pm 750$ mV ( $\div 1$ ) and $\pm 7.5$ V ( $\div 10$ ) $\pm 5\%$ for input voltages $\pm 850$ mV ( $\div 1$ ) and $\pm 8.5$ V ( $\div 10$ )
Maximum non destructive input voltage	$\pm 25$ V <sub>(DC + peak AC)</sub> between signal and common of the same channel
✓ Differential signal range (DC coupled)	$\pm 8.5$ V at attenuation setting of $\div 10$ $\pm 850$ mV at attenuation setting of $\div 1$
Common-mode signal range (DC coupled)	$\pm 7$ V
✓ Output offset voltage	$\pm 10$ mV (+20 to +30° C, +68 to +86° F) $\pm 50$ mV (0 to +50° C, +32 to +122° F)
✓ Rise time (probe only)	<265 ps
✓ Common-mode rejection ratio	45 dB at 1 MHz in $\div 10$ 25 dB at 100 MHz in $\div 10$ 20 dB at 500 MHz in $\div 10$ 18 dB at 1 GHz in $\div 10$ 60 dB at 1 MHz in $\div 1$ 38 dB at 100 MHz in $\div 1$ 35 dB at 500 MHz in $\div 1$ 30 dB at 1 GHz in $\div 1$
Bandwidth (probe only)	DC to $\geq 1.5$ GHz (-3dB)
Temperature	Operating: 0 to +50° C (+32 to +86° F), 0 to +60° C (+32 to +122° F) <sup>1</sup> (probe head) Nonoperating: -55 to +75° C (-131 to +167° F) <sup>1</sup>

**Table 1: Warranted electrical characteristics (cont.)**

Characteristic	Description
Humidity	Operating: 0-90% RH, tested at +30 to +50° C (+68 to +122° F) Nonoperating: 0-90% RH, tested at +30 to +60° C (+68 to +140° F)

<sup>1</sup> See warning that follows.



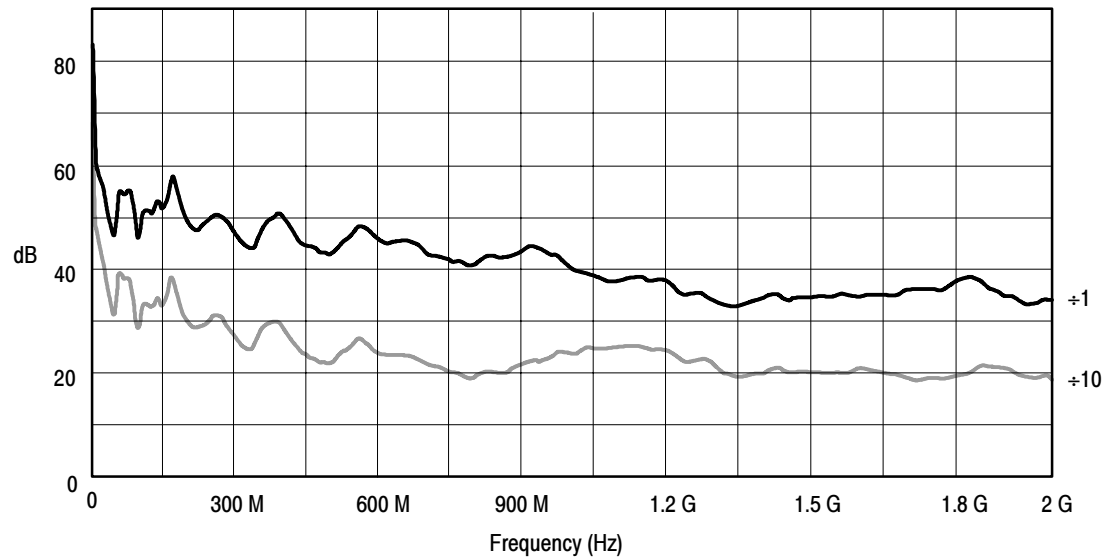
**WARNING.** To avoid a burn hazard at high ambient temperatures, do not touch the probe with bare hands at operating temperatures above +50° C (+122° F) or at nonoperating temperatures above +70° C (+158° F). Allow sufficient time for the probe to cool before handling.

## Typical Characteristics

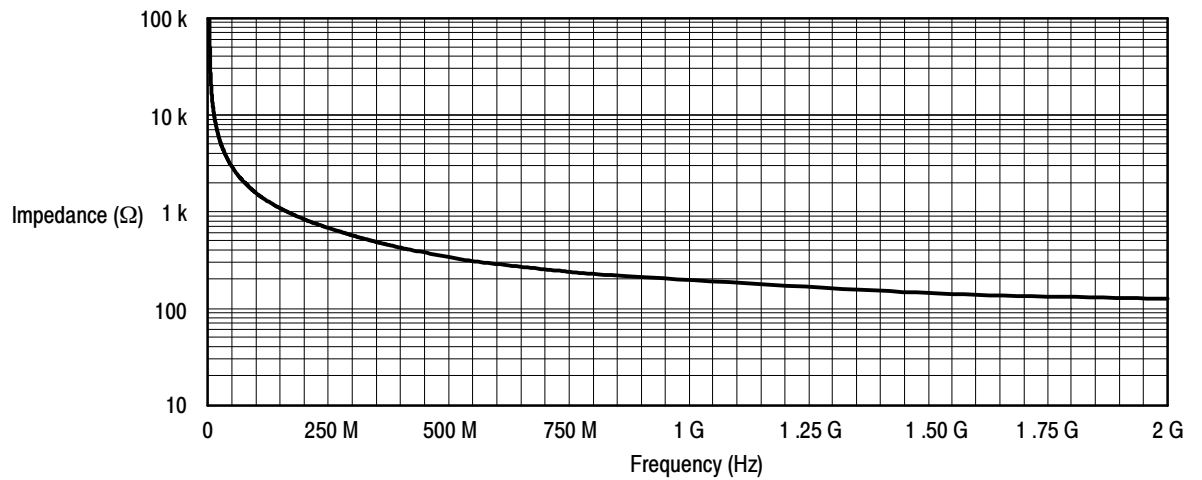
Typical characteristics (Tables 2 and 3) describe typical but not guaranteed performance.

**Table 2: Typical electrical characteristics**

Characteristic	Description
Differential input resistance, DC coupled	200 kΩ ±2%
Common-mode input resistance, DC coupled	100 kΩ ±2%
Differential input capacitance	<1 pF at 1 MHz
Common-mode input capacitance	<2 pF at 1 MHz
Harmonic distortion	≤1.5% measured using 354 mV <sub>RMS</sub> (or 1.0 V <sub>P-P</sub> ) output at 100 MHz
Differential offset range	±700 mV (÷ 1 range) ±7 V (÷ 10 range)
Common mode rejection ratio	See Figure 1
Random noise	< 50 nV/√Hz at 100 MHz
Input impedance	See Figure 2
Pass band ripple	≤ ±0.5 dB to 850 MHz (deviation from a nominal slope)
Bandwidth (probe only)	DC to ≥1.7 GHz (- 3dB) @ ≤27° C (÷ 1 range) DC to ≥1.85 GHz (- 3dB) @ ≤27° C (÷ 10 range)
Rise time (probe and oscilloscope)	<265 ps



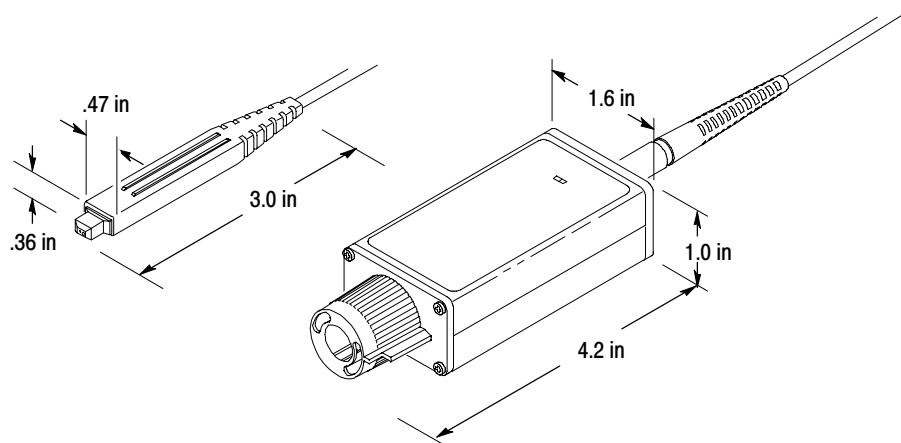
**Figure 1: Typical Common-Mode Rejection Ratio ( $\div 1$  and  $\div 10$  attenuation)**



**Figure 2: Typical differential input impedance versus frequency**

**Table 3: Typical mechanical characteristics**

Characteristic	Description
Dimensions, input connection	0.63 mm (0.025 in) square pin on 2.54 mm (0.100 in) centers
Dimensions, control box	107 mm × 41 mm × 26 mm (4.2 in × 1.6 in × 1.0 in)
Dimensions, probe head	78 mm × 12 mm × 9.3 mm (3.0 in × 0.47 in × 0.36 in)
Dimensions, output cable	1.2 m (47 in)
Unit weight (probe only)	160 g (5.4 oz)



**Figure 3: Dimensions of probe head and compensation box**

## Nominal Characteristics

Nominal characteristics (Table 4) describe guaranteed traits, but the traits do not have tolerance limits.

**Table 4: Nominal electrical characteristics**

Characteristic	Description
Input configuration	Differential (two inputs, + and -), with case ground
Output coupling	DC
Attenuation settings	÷ 1 and ÷ 10
Termination	Terminate output into 50 Ω



# Performance Verification

Use the following procedures to verify the warranted specifications of the P6248 Differential Probe. Before beginning these procedures, refer to page 18 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 offset voltage
- DC attenuation accuracy
- Differential signal range
- Rise time
- Common mode rejection ratio

## Equipment Required

Table 5 lists the equipment required to perform the performance verification procedure. The types and quantities of connectors may vary depending on the specific equipment you use.

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**NOTE.** *If you cannot obtain a network analyzer, refer to Appendix A: Alternate Verification Procedures on page 39 for procedures that do not require a network analyzer to perform the CMRR tests.*

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**Table 5: Test equipment**

Description	Minimum requirements	Example product
Calibrated DC voltage source (2 required)	Adjustable from 0 V to $\geq 17$ V. Outputs must be isolated from earth ground. DC bench supplies monitored with DMM are adequate.	Tektronix PS280
DMM (2 required)	DC Accuracy $\geq 0.5\%$ on range to measure 8.5 V, averaging mode.	Tektronix DMM916
Network analyzer	100 kHz to $\geq 2$ GHz, with cables and adapters to BNC male	Hewlett-Packard 8753D
Digitizing oscilloscope with TEKPROBE interface	Fully compatible with TEKPROBE interface (needed only for functional check of the TEKPROBE interface)	Tektronix TDS 500, 600, or 700 series oscilloscope

**Table 5: Test equipment (cont.)**

Description	Minimum requirements	Example product
Oscilloscope with sampling head		Tektronix 11800 series oscilloscope with SD-24
TEKPROBE Power Supply	Tektronix Type 1103	Tektronix Type 1103
BNC cables (2)	50 $\Omega$ , 42 inch	012-0057-01
SMA cables (2)	50 $\Omega$	015-0562-00
Banana-to-banana patch cords (3)	2 red 1 black	012-0031-00 012-0039-00
Adapter (3)	Dual-male-banana-to-female BNC	103-0090-00
Adapter (2)	BNC male to dual binding post	103-0035-00
0.025" square pins (3)	Approximately 0.75 inch long, smooth, gold plated.	131-1614-00
Precision inline BNC terminator	50 $\Omega \pm 0.1\%$	011-0129-00
Probe tip adapters Y-lead BNC to probe tip probe ground lead	(included in the standard probe tip accessory kit)	020-2328-XX
Adapter	SMA Male-to-male	015-1011-00
Adapter (2)	SMA Female-to-BNC male	015-0572-00

## Preparation

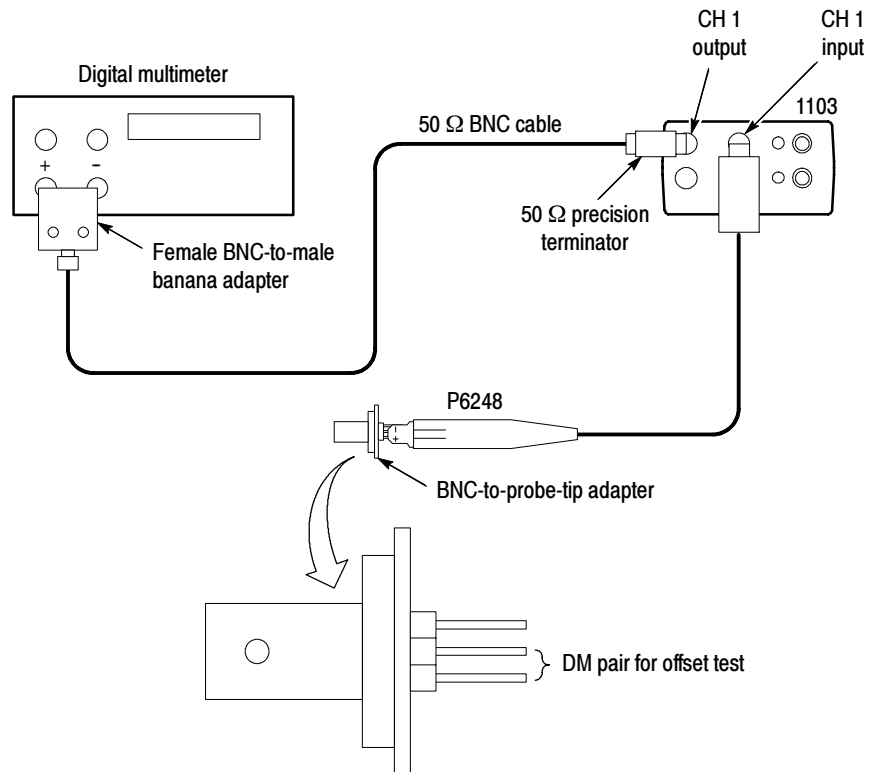
Prepare the equipment as follows:

1. Connect the Y-lead adapter to the inputs of the probe and the ground lead to the probe ground. (For a description of these accessories, refer to the list of standard accessories on pages 33 and 34.)
2. Attach the probe to the 1103 TekProbe power supply.
3. If necessary, set the line selector of the 1103 power supply to the correct voltage.
4. Turn on the 1103 power supply.
5. Set the 1103 offset to off (button not illuminated).
6. Allow the probe and test equipment to warm up for 20 minutes at an ambient temperature of 20° C to 30° C (68° F to 86° F).

Perform the verification procedures in order.

## Output Offset Voltage

1. Connect the probe as shown in Figure 4.



**Figure 4: Setup for the output offset voltage test**

2. Set the probe to  $\div 10$  attenuation.
3. Verify that the output voltage is  $\leq \pm 10$  mV.
4. Change the probe attenuation to  $\div 1$ .
5. Verify that the output voltage is  $\leq \pm 10$  mV.
6. Keep the output connections for the next procedure (DC attenuation accuracy).

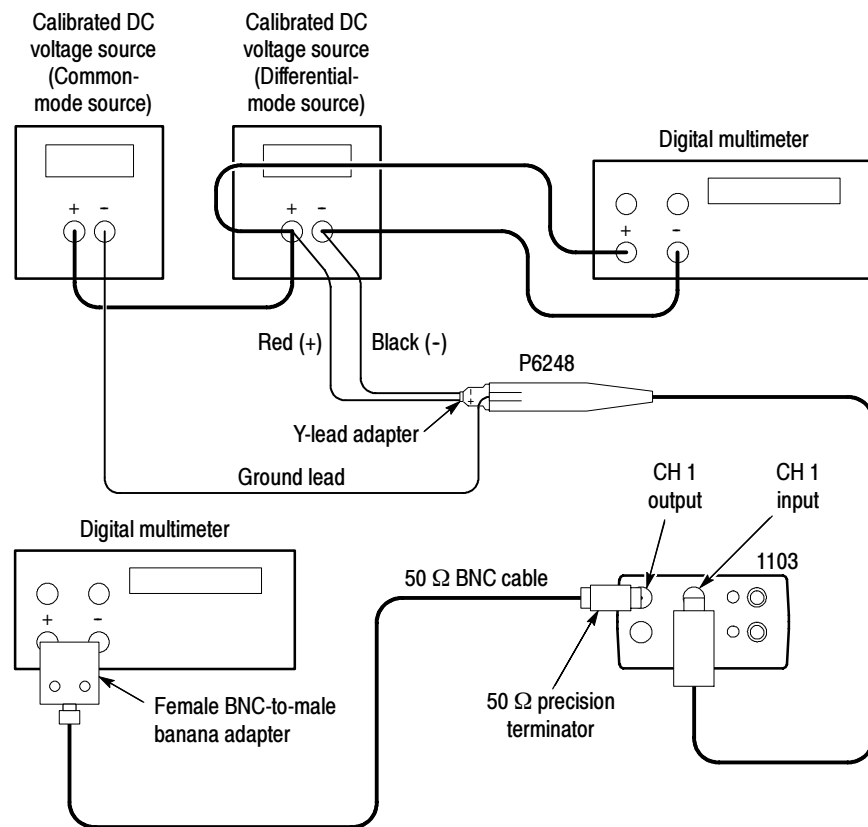
## DC Attenuation Accuracy

1. Connect the probe input to the Y-lead adapter and then to the DC source. Monitor the source voltage with the DMM.
2. Set the probe to  $\div 10$  attenuation.
3. Set the input voltage on the DC source to approximately 5 V. Record the actual voltage as  $V_{in1}$ .
4. Record the output voltage as  $V_{out1}$ .
5. Set the input voltage on the DC source to approximately 1 V. Record the actual voltage as  $V_{in2}$ .
6. Record the output voltage as  $V_{out2}$ .
7. Calculate the attenuation as follows:  $(V_{in1} - V_{in2}) \div (V_{out1} - V_{out2})$ .
8. Verify that the attenuation is in the range of 9.8 to 10.2.
9. Set input voltage on the DC source to approximately 0.5 V. Record the actual voltage as  $V_{in1}$ .
10. Change the attenuation to  $\div 1$ .
11. Record the output voltage as  $V_{out1}$ .
12. Set input voltage on DC source to approximately 0.1 V. Record the actual voltage as  $V_{in2}$ .
13. Record the output voltage as  $V_{out2}$ .
14. Calculate the attenuation as follows:  $(V_{in1} - V_{in2}) \div (V_{out1} - V_{out2})$ .
15. Verify that the attenuation is in the range of 0.98 to 1.02.
16. Keep the output connections for the next procedure.

## Differential Signal Range

This procedure *directly* verifies the differential signal range and *indirectly* verifies the common-mode signal range.

1. Connect the probe as shown in Figure 5. Use the adapters and patch cords as necessary to make the connections. Use square pins to connect the ground lead and y-lead to the power supplies.



**Figure 5: Setup for differential-mode tests**

2. Set the probe to  $\div 10$  attenuation.
3. Set the common mode source to  $7.0\text{ V} \pm 50\text{ mV}$ .
4. Set the differential mode source to  $8.5\text{ V} \pm 100\text{ mV}$ . Record the actual voltage as  $V_{in}$ .
5. Measure and record the output voltage as  $V_{out}$ .
6. Calculate attenuation as  $V_{in} \div V_{out}$ .

7. Verify that the attenuation is in the range of 9.5 to 10.5.
8. Remove the Y-lead adapter from the probe and reverse the connection (black to +, red to -).
9. Measure and record the output voltage as  $V_{out}$ .
10. Calculate attenuation as  $V_{in} \div (-V_{out})$ .
11. Verify that the attenuation is in the range of 9.5 to 10.5.
12. Set the differential mode source to  $0.85\text{ V} \pm 10\text{ mV}$ . Record the actual voltage as  $V_{in}$ .
13. Make sure that the common mode source is still set to  $7.0\text{ V} \pm 50\text{ mV}$ .
14. Set the probe attenuation to  $\times 1$ .
15. Measure and record the output voltage as  $V_{out}$ .
16. Calculate attenuation as  $V_{in} \div (-V_{out})$ .
17. Verify that the attenuation is in the range of 0.95 to 1.05.
18. Remove the Y-lead adapter from the probe and reverse the connection again (red to +, black to -).
19. Measure and record the output voltage as  $V_{out}$ .
20. Calculate the attenuation as  $V_{in} \div V_{out}$ .
21. Verify that the attenuation is in the range of 0.95 to 1.05.
22. Remove all connections.

## Rise Time

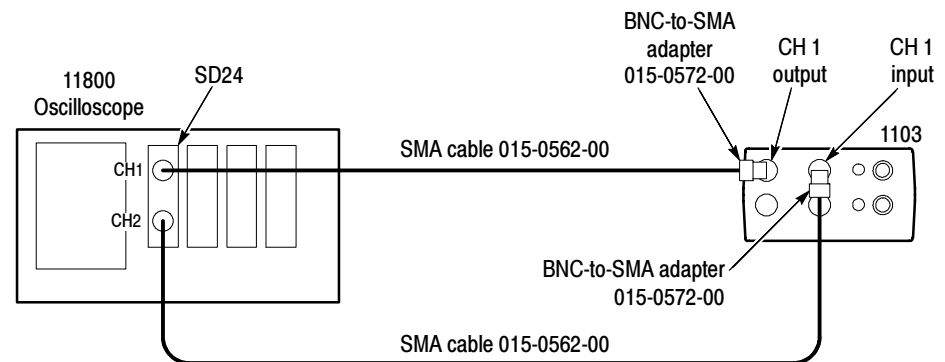
This procedure verifies the probe meets rise time specifications.

The probe rise time is calculated from rise times obtained by measuring the test system without the probe connected, and then the test system with the probe.

1. Connect the test equipment as shown in Figure 6.
2. Adjust the oscilloscope vertical sensitivity to 50 mV/div.
3. Adjust the oscilloscope vertical positioning to center the signal on screen.
4. Adjust the oscilloscope horizontal sensitivity to 500 ps/div.
5. Adjust the oscilloscope horizontal positioning to place the rising edge of the signal where it crosses the second vertical and center horizontal graticule lines.
6. Use the oscilloscope 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  $t_s$ .

If the measurement reading is not stable, use Average mode (16 Averages) to improve stability.

The system rise time ( $t_s$ ) that you measured in step 6 represents the rise time of the test system without the probe. The system rise time is used to calculate the probe rise time ( $t_p$ ) in steps 21 and 29.

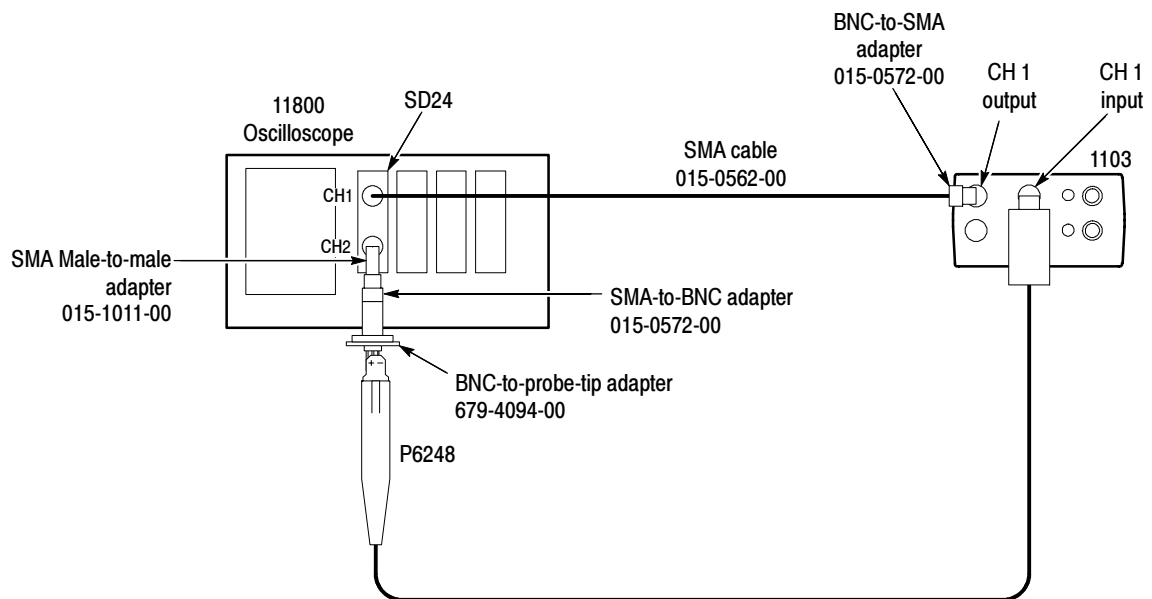


**Figure 6: Test system rise time setup**

The following steps instruct you to assemble the test setup that includes the probe, as shown in Figure 7. The system and probe rise time ( $t_{s+p}$ ) that you measure in steps 20 and 28 is used to calculate the probe rise time ( $t_p$ ) in steps 21 and 29.

7. Disconnect the BNC-SMA adapter from the CH 1 input of the 1103.
8. Disconnect the SMA cable from the CH 2 input of the SD-24.
9. Connect the probe to the 1103 power supply channel 1 input.
10. Set the offset control on channel 1 of the 1103 power supply to off.
11. Connect the SMA Male-to-male adapter to the CH 2 input of the SD-24.
12. Connect the BNC-SMA adapter to the SMA Male-to-male adapter.
13. Connect the BNC-probe tip adapter to the BNC-SMA adapter.
14. Connect the probe input to the DM pins on the BNC-probe tip adapter. Observe proper polarity; the + side of the probe should be on the center square pin of the probe tip adapter.

The test setup should now appear as shown in Figure 7.



**Figure 7: Rise time setup for test system with probe**

15. Set the probe attenuation to  $\pm 1$ .
16. Adjust the oscilloscope vertical sensitivity to 50 mV/div.
17. Adjust the oscilloscope vertical positioning to center the signal on screen.
18. Adjust the oscilloscope horizontal sensitivity to 500 ps/div.



19. Adjust the oscilloscope horizontal positioning to place the rising edge of the signal so that it crosses the second vertical and center horizontal graticule lines.
20. Use the oscilloscope measurement capability to display rise time. Rise time is determined from the 10% and 90% amplitude points on the waveform. Record the rise time for  $\div 1$  as  $t_{s+p}$ .
21. Calculate the probe rise time using the following formula:

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

22. Record the calculated probe rise time for  $\div 1$  on the test record.
23. Set the probe attenuation to  $\div 10$ .
24. Adjust the oscilloscope vertical sensitivity to 5 mV/div.
25. Adjust the oscilloscope vertical positioning to center the signal on screen.
26. Adjust the oscilloscope horizontal sensitivity to 500 ps/div.
27. Adjust the oscilloscope horizontal positioning to place the rising edge of the signal so that it crosses the second vertical and center horizontal graticule lines.
28. Use the oscilloscope measurement capability to display rise time. Rise time is determined from the 10% and 90% amplitude points on the waveform. Record the rise time for  $\div 10$  as  $t_{s+p}$ .
29. Calculate the probe rise time using the following formula:

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

30. Record the calculated probe rise time for  $\div 10$  on the test record.

## Common-Mode Rejection Ratio

The following steps prepare the network analyzer for measuring common-mode rejection ratio. The actual settings may vary with different models of network analyzer. Refer to the user documentation supplied with the network analyzer for details on performing these steps.

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**NOTE.** *The alternative procedure for testing CMRR without a network analyzer begins on page 39.*

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### Preparation

The 1103 power supply can operate two probes. To keep the probe warmed up, move it to channel 2 of the 1103 while normalizing channel 1.

1. Set the network analyzer to measure transmission loss,  $S_{21}$ . Attach cables to both ports.
2. Set the display format to log magnitude, 1 dB/div, reference value 0 dBm, and linear frequency.
3. Set the start frequency to  $\approx 1$  MHz and stop frequency to  $\approx 2$  GHz.
4. Set the test port power to 0 dBm.
5. Attach the cable from port 1 to the 1103 channel 1 input connector (Tek-Probe connector). Use a male BNC adapter, if necessary.
6. Attach the cable from port 2 to the 1103 channel 1 output connector (conventional BNC). Use a male BNC adapter, if necessary.
7. Normalize the network analyzer to remove the loss through channel 1 of the 1103 power supply.

### Verification

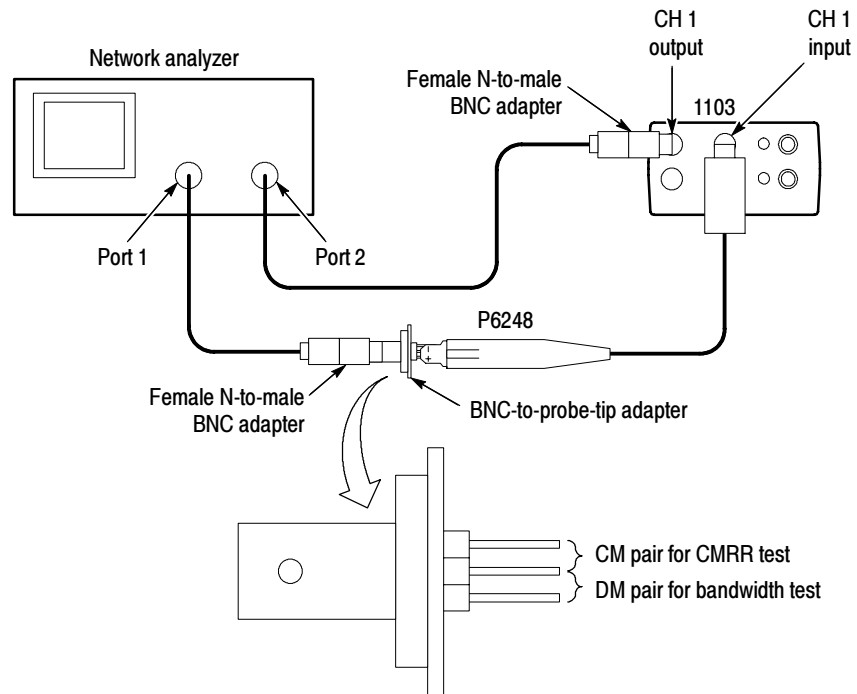
1. Disconnect the port 1 cable from the 1103 channel 1 input connector.

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**NOTE.** *Do not remove the end connected to the network analyzer. Connect the cable to the BNC-to-Probe Tip adapter.*

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2. Move the probe from the 1103 channel 2 to channel 1 input connector.
3. The setup should now appear as shown in Figure 8.



**Figure 8: Setup for CMRR test**

**NOTE.** CMRR performance is influenced by cable dress. When making CMRR measurements, keep the probe cable away from ground planes and objects. Do not allow kinks, loops or other deformities in the probe cable, and maintain a maximum distance between the probe head and the probe control box.

4. Set the reference value of the network analyzer to 0 dBm.
5. Connect the probe input to the CM pins on the BNC-to-probe-tip adapter. Polarity is unimportant.
6. Set the probe for  $\pm 1$  attenuation.
7. Position the 0 dBm reference near the top of the screen.
8. The network analyzer plot is common-mode feedthrough, the reciprocal of common-mode rejection ratio. CMRR can be read by inverting the sign of the magnitude, (that is, - 46 dBm common-mode feedthrough equals + 46 dBm CMRR).
9. Measure the feedthrough magnitude at 1 MHz, 100 MHz, 500 MHz, and 1 GHz. Analyzers with marker capability can do this directly by setting the marker intercepts at 1, 100, 500, and 1 GHz. If necessary, turn on the network analyzer Average mode with 16 averages to stabilize the reading.

10. Verify that the feedthrough is less than the values in  $\pm 1$  Measured Feedthrough column of Table 6.

**Table 6: CMRR and Measured Feedthrough limits 6**

Frequency	$\pm 1$ CMRR	$\pm 10$ CMRR	$\pm 1$ Measured feedthrough	$\pm 10$ Measured feedthrough
1 MHz	$\geq 60$ dB	$\geq 45$ dB	$\leq -60$ dBm	$\leq -65$ dBm
100 MHz	$\geq 38$ dB	$\geq 25$ dB	$\leq -38$ dBm	$\leq -45$ dBm
500 MHz	$\geq 35$ dB	$\geq 20$ dB	$\leq -35$ dBm	$\leq -40$ dBm
1 GHz	$\geq 30$ dB	$\geq 18$ dB	$\leq -30$ dBm	$\leq -38$ dBm

11. Change the probe attenuation to  $\pm 10$ .
12. Measure the feedthrough magnitude at 1 MHz, 100 MHz, 500 MHz, and 1 GHz. Analyzers with marker capability can do this directly by setting the marker intercepts at 1 MHz, 100 MHz, 500 MHz, and 1 GHz.
13. Actual CMRR can be calculated by subtracting 20 dB from the absolute magnitudes to compensate for the attenuation. (that is,  $|-68 \text{ dB}| - 20 \text{ dB} = 48 \text{ dB}$ ). The calculation has been performed in the  $\pm 10$  Measured Feedthrough column.
14. Verify that the feedthrough is less than the values in  $\pm 10$  Measured Feedthrough column of Table 6.

## TEKPROBE Communication (operational check)

This step verifies correct operation of the TEKPROBE interface communication with compatible oscilloscopes. It requires a TDS 500, 600, or 700 series oscilloscope.

1. Turn on the oscilloscope. Wait for the power on self test to complete.
2. Disconnect all cables or probes from the inputs.
3. Press the Autoset button.
4. Press the CH 1 button.
5. Use the Vertical Scale knob to set the vertical scale factor to 100 mV/div.
6. Press the Vertical Menu button.
7. Select the Coupling menu (left button along lower bezel).

- 8.** If necessary, set the input impedance to  $1\text{ M}\Omega$  (bottom button along right side of bezel).
- 9.** Watch the input impedance setting while attaching the probe to the CH 1.
- 10.** Verify that the input impedance changed to  $50\ \Omega$ .
- 11.** Set the probe attenuation to  $\div 10$ .
- 12.** Verify that the channel 1 scale factor is  $1\text{ V/div}$ .
- 13.** Set the probe attenuation to  $\div 1$ .
- 14.** Verify that the channel 1 scale factor is  $100\text{ mV/div}$ .

This completes the functional check and the performance verification.

**Test record**

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

Performance test	Minimum	Incoming	Outgoing	Maximum
Output offset voltage (÷ 10 setting) ± 10 mV (20° C to 30° C)	- 10 mV	_____	_____	+ 10 mV
Output offset voltage (÷ 1 setting) ± 10 mV (20° C to 30° C)	- 10 mV	_____	_____	+ 10 mV
DC attenuation accuracy (÷ 10 setting)	9.8	_____	_____	10.2
DC attenuation accuracy (÷ 1 setting)	0.98	_____	_____	1.02
Differential signal range (÷ 10 setting) Attenuation	9.5	_____	_____	10.5
Attenuation with connections reversed	9.5	_____	_____	10.5
Differential signal range (÷ 1 setting) Attenuation	0.95	_____	_____	1.05
Attenuation with connections reversed	0.95	_____	_____	1.05
Rise time (÷ 1 setting)	< 265 ps	_____	_____	N/A
Rise time (÷ 10 setting)	< 265 ps	_____	_____	N/A
Measured feedthrough (verifies CMRR specifications)				
÷ 1 setting				
1 MHz	-60 dB	_____	_____	N/A
100 MHz	-38 dB	_____	_____	N/A
500 MHz	-35 dB	_____	_____	N/A
1 GHz	-30 dB	_____	_____	N/A
÷ 10 setting				
1 MHz	-65 dB	_____	_____	N/A
100 MHz	-45 dB	_____	_____	N/A
500 MHz	-40 dB	_____	_____	N/A
1 GHz	-38 dB	_____	_____	N/A

# Adjustment Procedures

These procedures are for use by qualified service personnel only.

Prepare the probe for adjustment as follows:

1. Remove the four screws attaching the top cover from the control box.
2. Remove the top cover.
3. Attach the probe to the 1103 TEKPROBE Power Supply.
4. If necessary, set the line selector to the correct voltage.
5. Turn on the 1103 power supply.
6. Set the 1103 power supply offset to off (button not illuminated).
7. Allow at least 20 minutes for the equipment to warm up.

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**NOTE.** Ambient temperature must be within 20° C to 30° C (68° F to 86° F) when you adjust the probe.

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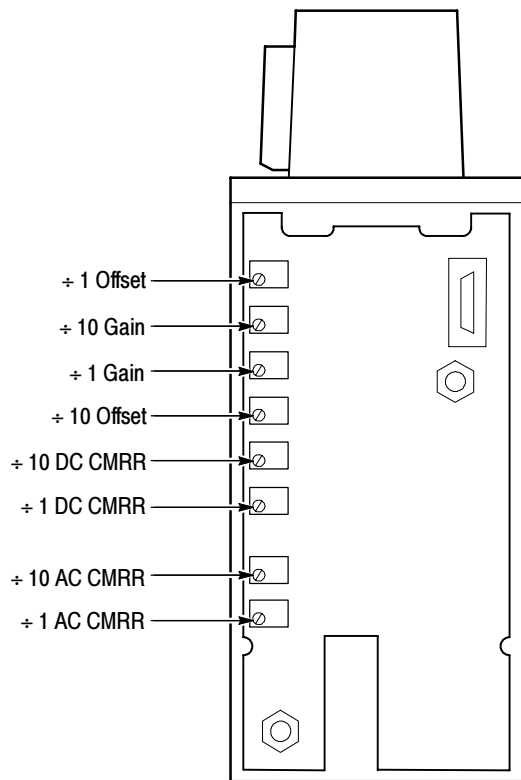
## Equipment Required

In addition to the equipment required to perform the performance verification, the adjustment procedures require the equipment listed in Table 7.

**Table 7: Test equipment**

Description	Minimum requirements	Example product
Digitizing oscilloscope (Required for adjustment procedure only)	Bandwidth $\geq 100$ MHz, average acquisition mode, vertical sensitivity 2 mV/div	Tektronix TDS 300 series
Function generator (Square and sine wave output)	Output level adjustable to 10 V <sub>pk-pk</sub> , Separate Trigger or Sync output	Tektronix CFG 280
50 $\Omega$ terminator (needed only if oscilloscope does not support 50 $\Omega$ termination)	50 $\Omega \pm 1 \Omega$	011-0049-01

Figure 9 shows the location of the adjustments inside the control box.



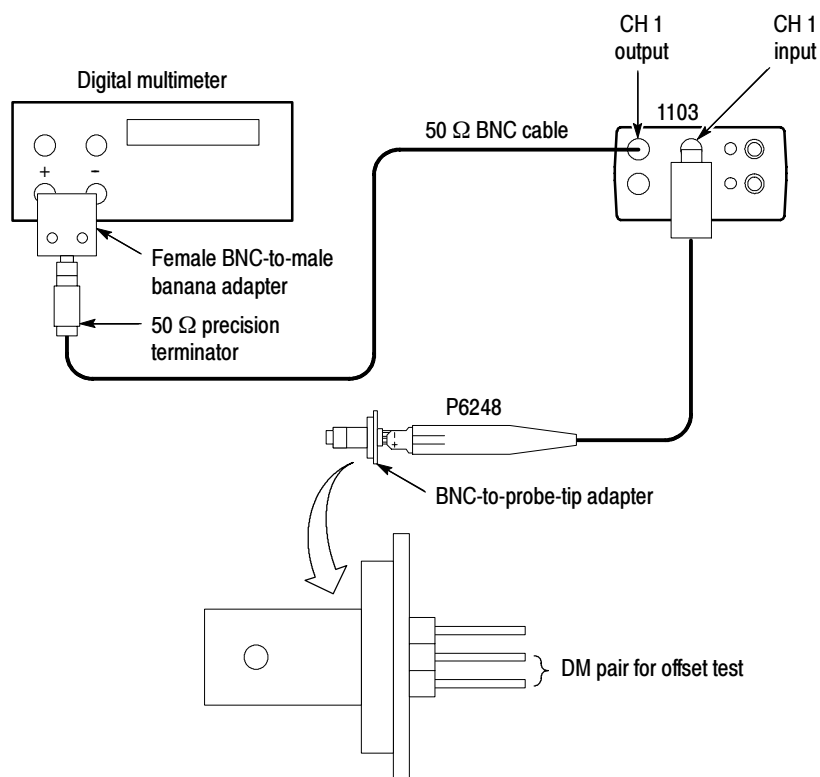
**Figure 9: Adjustment locations**



## Offset (preliminary)

**NOTE.** Do not attempt to adjust offset directly on an oscilloscope equipped with TekProbe Interface. These oscilloscopes utilize a closed loop compensation system for gain and offset, which will interfere with the manual adjustment of the probe.

1. Connect the probe as shown in Figure 10.

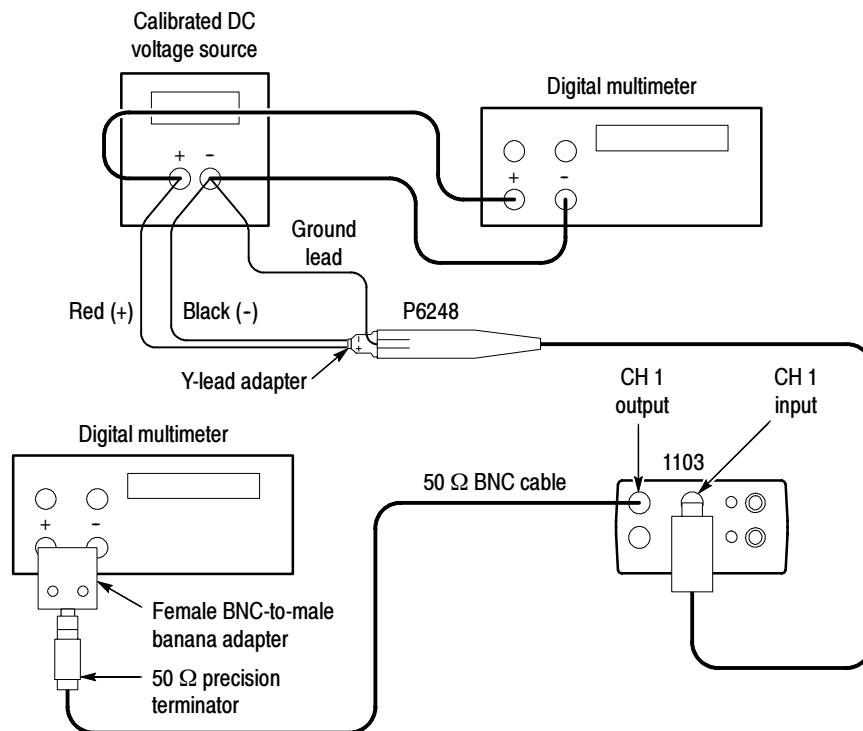


**Figure 10: Setup for the offset adjustment**

2. Set the DMM to DC volts, 200 mV or 300 mV range, average on, average 10 readings.
3. Set the probe to  $\div 1$  attenuation.
4. Adjust the  $\div 1$  offset adjustment for  $0 \text{ mV} \pm 1 \text{ mV}$ .
5. Change the probe attenuation to  $\div 10$ .
6. Adjust the  $\div 10$  offset adjustment for  $0 \text{ mV} \pm 1 \text{ mV}$ .
7. Keep the output cable set up for the next step.

## Gain

1. Set up the equipment as shown in Figure 11:
  - a. Remove the BNC to probe tip adapter from the probe input. Insert the Y-lead adapter into the probe tip.
  - b. With square pins, connect the red lead to the power supply positive terminal, and the black lead to the power supply negative terminal.
  - c. Connect a ground lead from the probe case ground to the negative terminal of the power supply.
  - d. Connect a second DMM to a pair of banana leads from the power supply outputs.



**Figure 11: Setup for gain adjustment**

2. Set the DMM monitoring the output to DC Volts, 2 or 3 volt range.
3. Set the DMM monitoring the input to the 2 or 3 volt range. Keep averaging turned on.
4. Set the probe to  $\div 1$  attenuation.

5. Adjust the power supply to output about 700 mV.
6. Adjust the  $\div 1$  gain adjustment until the output voltage measures the same as the input within  $\pm 5$  mV.
7. Change the probe attenuation to  $\div 10$ .
8. Change the DMM monitoring the input to the 20 or 30 volt range.
9. Adjust the power supply to output approximately 7 V.
10. Adjust the  $\div 10$  gain adjustment until the DMM measuring the output reads 1/10 of the same voltage as the DMM monitoring the input within  $\pm 5$  mV.
11. Keep the probe output connections for the next step.

## Offset (Final)

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**NOTE.** *The offset and gain adjustments interact.*

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1. Repeat steps 1 through 6 of the *Offset (preliminary)* procedure.
2. Remove the output cable termination and input for the next procedure.

## DC CMRR

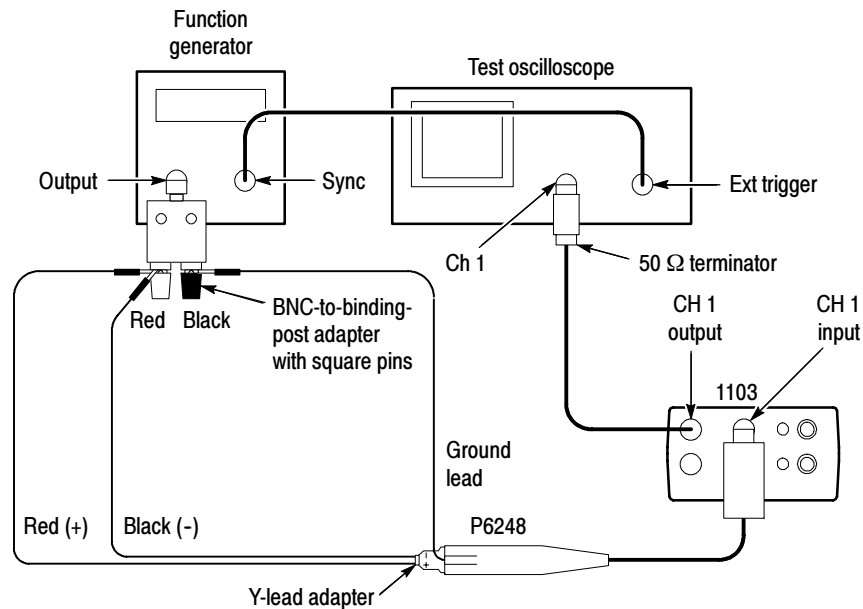
1. Set up the equipment as shown in Figure 12:
  - a. Connect a BNC cable from the output of the 1103 to the Channel 1 input of the oscilloscope. If the oscilloscope does not have 50  $\Omega$  input setting, add a 50  $\Omega$  inline BNC terminator at the oscilloscope input.
  - b. Connect the Y lead adapter to the probe input. Using square pins, connect both leads to the red binding post of a binding post to BNC adapter. Connect the BNC adapter to the function generator output. (If necessary, use a BNC cable and a female-to-female BNC connector between the BNC adapter and the generator.) If the function generator reference (shield of the BNC connector) is isolated from ground, connect the ground lead from the probe case to the black binding post.

---

**NOTE.** *Do not use the BNC to probe tip adapter for this connection. The power level of the generator will exceed the terminator rating.*

---

- c. Connect a second BNC cable from the function generator Trigger or Sync Output to the External Trigger or Channel 2 Input of the oscilloscope.



**Figure 12: Setup for DC CMRR and AC CMRR adjustments**

2. Set the probe to  $\pm 1$  attenuation.
3. Set the function generator to square wave, 1 ms period (1 kHz frequency), approximately  $10 V_{pk-pk}$ , ( $5 V_{pk}$ ).
4. Set the oscilloscope to display channel 1. Set channel 1 to DC and  $50 \Omega$  input impedance (or use external terminator), 2 mV/div. Set the time/division to 200  $\mu s$ /div. Set the trigger source to external (or Channel 2). Set the acquisition mode to average 8 to 10 acquisitions. Apply vertical bandwidth limiting, if available, to reduce noise.
5. Adjust the trigger level for a stable trigger. (If the trigger is obtained through channel 2, it may be necessary to change the volts/div setting.)
6. The displayed square wave is the common mode feedthrough. If the probe is severely misadjusted the waveform may be off-screen. If necessary, increase the channel 1 volts/div to keep the waveform on screen.
7. Adjust the  $\pm 1$  DC CMRR for minimum amplitude in the flat portions of the displayed waveform. This adjustment does not affect the leading edge transitions. Increase the vertical sensitivity as the amplitude decreases.

8. Change the probe to  $\div 10$  attenuation.
9. Adjust the  $\div 10$  DC CMRR for minimum amplitude in the flat portions of the displayed waveform. This adjustment does not affect the leading edge transitions.
10. Keep the connections for the next procedure.

## AC CMRR

1. Change the function generator to sine wave.
2. Set the frequency of the function generator to 5 MHz and the output amplitude to approximately 10 V pk-pk, (5 V peak).
3. Set the probe to  $\div 1$  attenuation.
4. Change the oscilloscope horizontal 100ns/div. If necessary, adjust the channel 2 volts/div and trigger level for a stable trigger.
5. The displayed sine wave is the common mode feedthrough. If the probe is severely misadjusted, the waveform may be off screen.
6. Adjust the  $\div 1$  AC CMRR for minimum amplitude. Usually it is not possible to completely eliminate the high frequency feedthrough.
7. Change the probe to  $\div 10$  attenuation.
8. Adjust the  $\div 10$  AC CMRR for minimum amplitude.
9. There is some interaction between the DC and AC CMRR adjustments. Repeat the DC CMRR adjustment steps 5 through 12.
10. Remove all connections from the probe. Carefully replace the top cover of the control box and the four retaining screws.

This completes the adjustment procedures.



# Maintenance

The procedures in this section describe how to maintain and repair the P6248 differential probe.

## Cleaning

Remove dirt with a soft cloth dampened in a mild detergent and water solution or isopropyl alcohol.



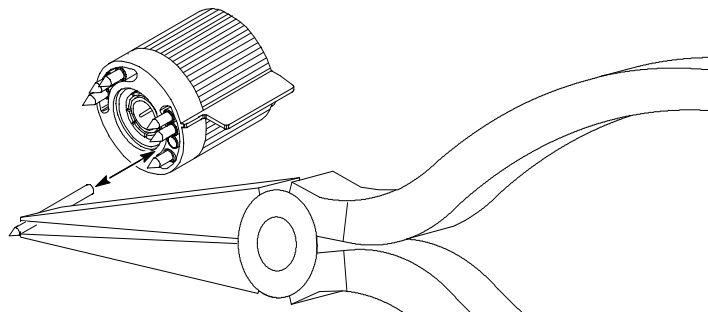
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**CAUTION.** To avoid damaging the probe, use only a mild detergent and water solution or isopropyl alcohol; do not use any other solvents or abrasive cleaners. Do not immerse the probe.

---

## Replacing TEKPROBE Interface Pins

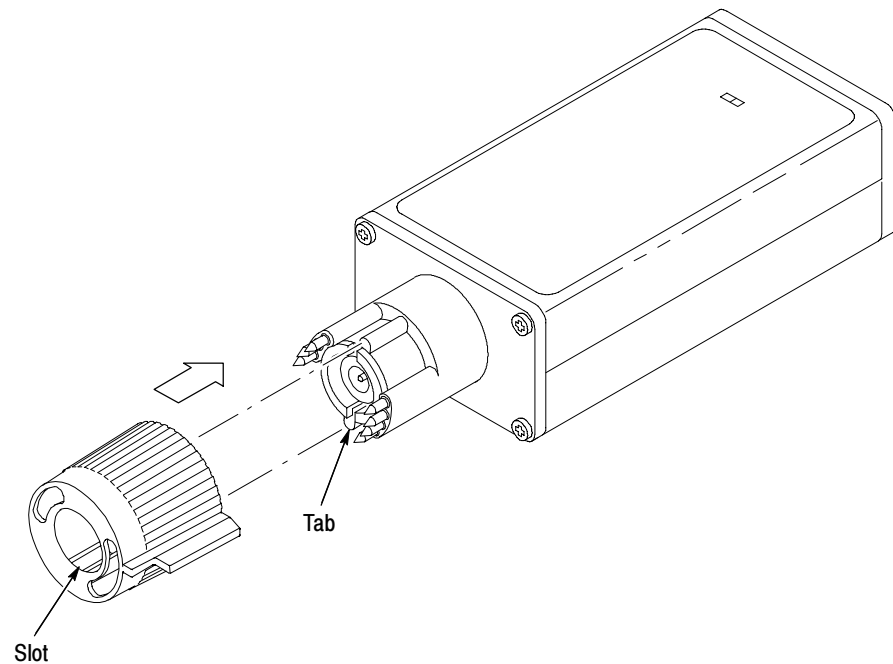
1. To remove the interface pin, grasp the pin with a pair of needle-nose pliers and gently pull the pin out. See Figure 13.
2. To replace the pin, insert the new pin into the socket and press it in against a hard surface.



**Figure 13: Replacing TEKPROBE interface pins**

## Removing and Replacing the TEKPROBE Interface Collar

1. To remove the collar, firmly pull the collar off by hand.
2. To replace the collar, align the smaller group of pins with the smaller of the two holes in the interface collar and align the tabs with the slots. Gently press the two pieces together. See Figure 14.



**Figure 14: Replacing the TEKPROBE collar**



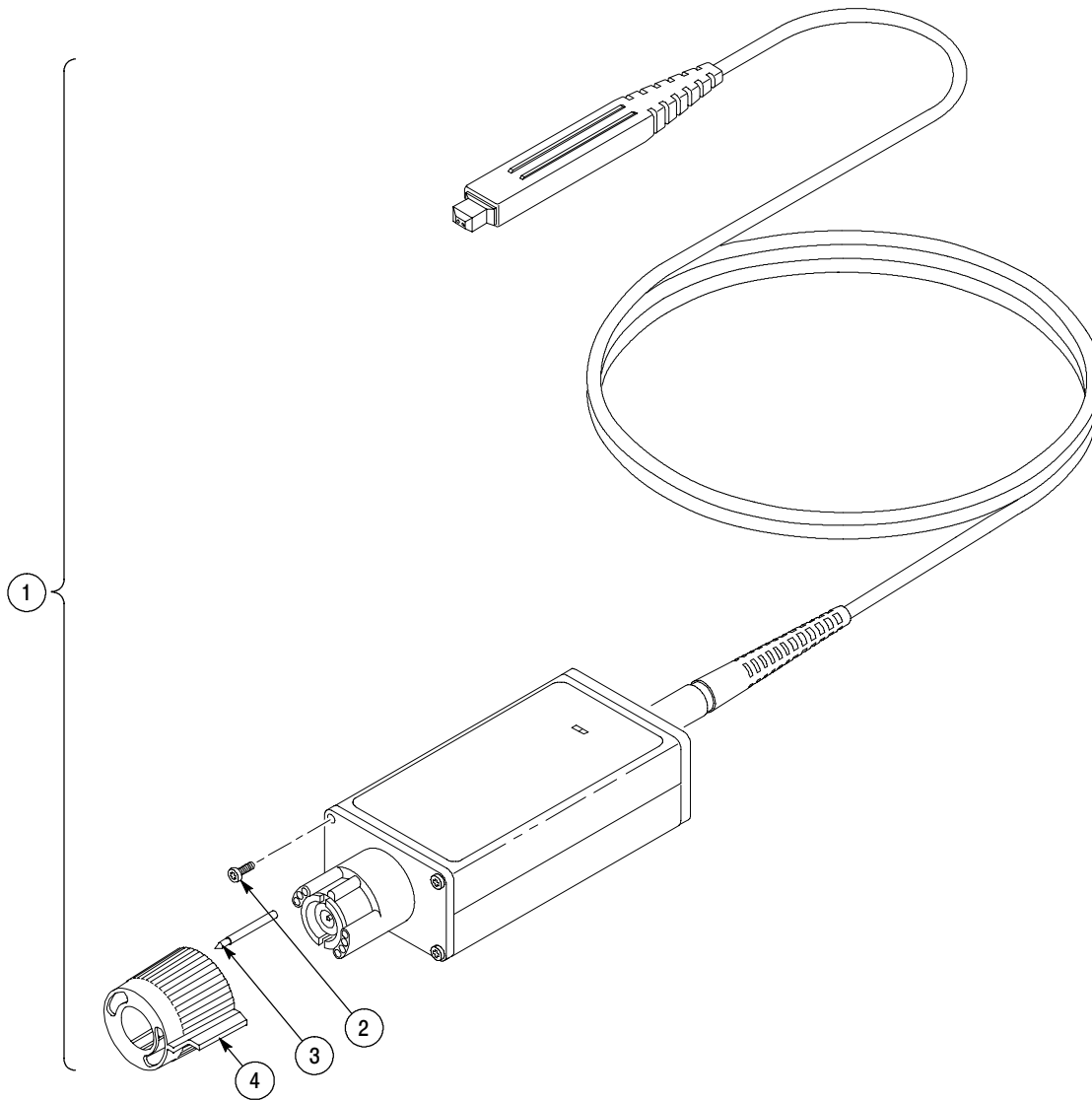


## Options

Option 95 is a report of the calibration data. This option must be ordered at the time of purchase.



# Replaceable Parts



**Figure 15: P6248 replaceable parts**

**Replaceable parts list**

Fig. & index number	Tektronix part number	Serial no. effective	Serial no. discont'd	Qty	Name & description	Mfr. code	Mfr. part number
					<b>Probe</b>		
15-1	010-6248-00			1	PROBE,DIFF,ACT:1.7GHZ DIFFERENTIAL,CERTIFICATE OF TRACEABLE CALIBRATION STANDARD,P6248	80009	010-6248-00
-2	211-0001-00			8	SCREW,MACHINE:2-56 X 0.25,PNH,STL CD PL,POZ	80009	ORDER BY DESCRIPTION
-3	131-3627-02			1	CONTACT,ELEC:GOLD PLATED TIP	80009	131-3627-02
-4	205-0191-01			1	SHELL,ELEC CONN:BNC,ABS,DOVE GRAY	80009	205-0191-01

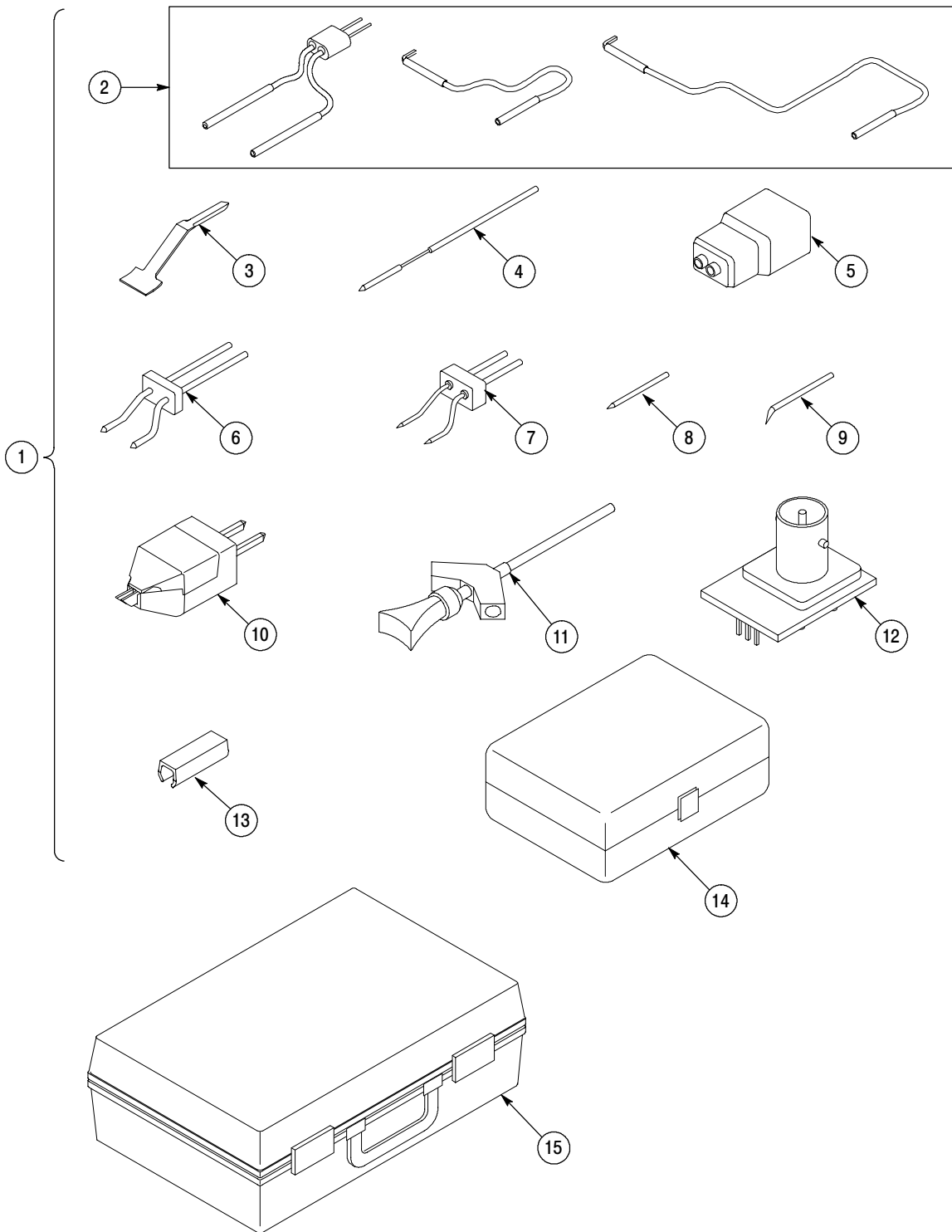
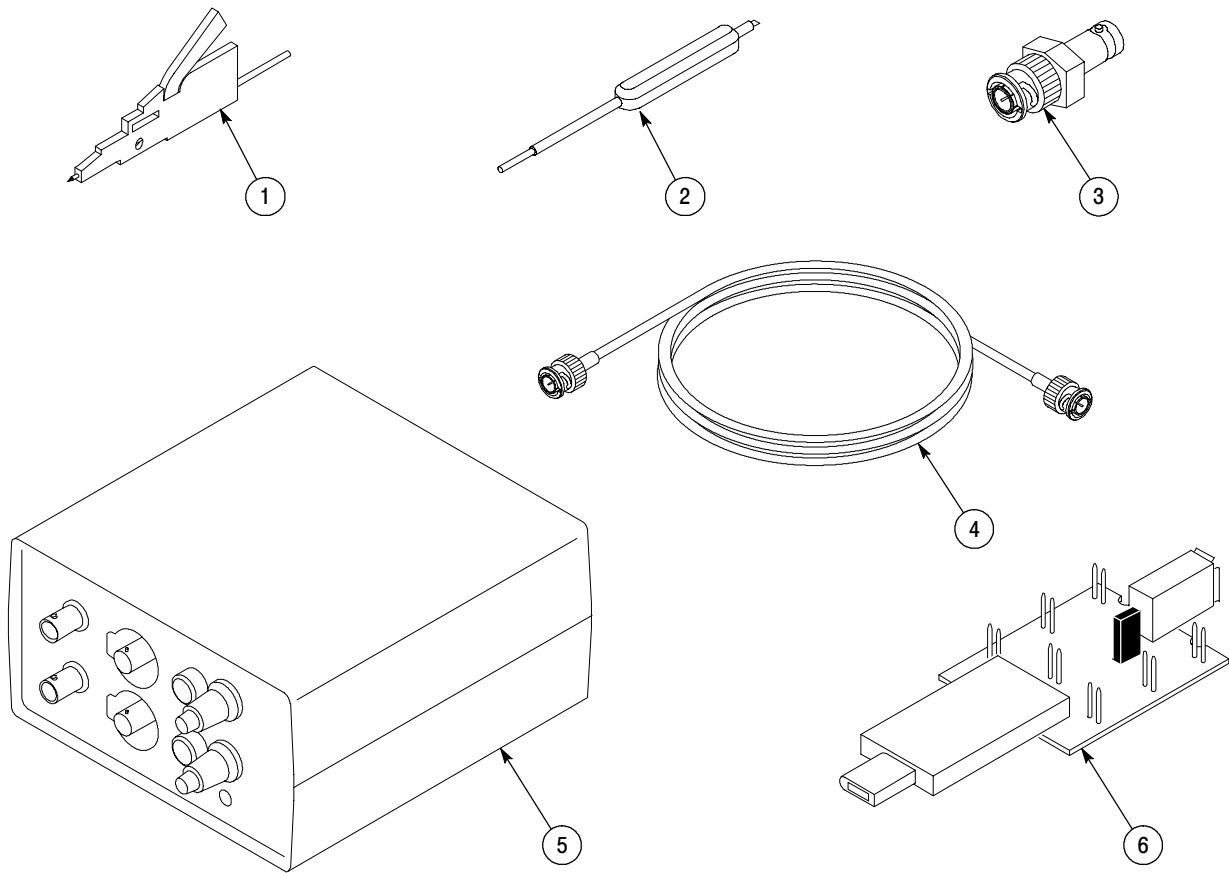


Figure 16: P6248 standard accessories

**Replaceable parts list**

Fig. & index number	Tektronix part number	Serial no. effective	Serial no. discont'd	Qty	Name & description	Mfr. code	Mfr. part number
<b>Standard Accessories</b>							
16-1	020-2328-02			1	ACCESSORY PKG,P6248 (Includes items 2 through 14)	80009	020-2328-02
-2	196-3462-00			1	ACCESSORY KIT:LEAD SET,GROUND AND Y LEAD	80009	196-3462-00
-3	016-1783-00			1	ACCESSORY KIT:GROUND CONTACTS,PKG OF 10 131-6247-00	80009	016-1783-00
-4	016-1782-00			1	ACCESSORY KIT:SPRING LOADED GROUND PINS,PKG OF 6 131-6271-00	80009	016-1782-00
-5	016-1781-00			1	ACCESSORY KIT:TIP SAVER,PKG OF 2 206-0489-00	80009	016-1781-00
-6	016-1786-00			1	TIP,PROBE:PKG OF FOUR 013-0305-00	80009	016-1786-00
-7	016-1780-00			1	ADAPTER:LONGHORN VIA,PKG OF 5 206-0490-00	80009	016-1780-00
-8	016-1891-00			1	ACCESSORY KIT:PROBE TIP ADAPTER,STRAIGHT, 8 EACH 131-7143-00	060D9	016-1891-00
-9	016-1890-00			1	ACCESSORY KIT:PROBE TIP ADAPTER,VARITIP, 8 EACH 131-7142-00	060D9	016-1890-00
-10	016-1785-00			1	ADAPTER:DIFFERENTIAL PROBE,PKG OF FOUR 013-0306-00	80009	016-1785-00
-11	206-0364-XX			4	TIP,PROBE:MICROCKT TEST,0.05 CTR	80009	206-0364-XX
-12	679-4094-00			1	CKT BD SUBASSY:PROBE TIP TO BNC ADAPTER	80009	679-4094-00
-13	016-1315-00			1	MARKER KIT,ID:CABLE MARKER BAND,2 EACH, VARIOUS COLORS	80009	016-1315-00
-14	006-7164-00			1	BOX,PLASTIC:4.625 X 2.875 X 1.0	80009	006-7164-00
-15	016-1879-00			1	CASE,CARRYING:PROBE CARRYING CASE,P6248	80009	016-1879-00
	071-0566-XX			1	MANUAL,TECH:INSTRUCTION,P6248	80009	071-0566-XX
	071-0573-XX			1	MANUAL, TECH:SERVICE,P6248	80009	071-0573-XX



**Figure 17: P6248 optional accessories**

**Replaceable parts list**

Fig. & index number	Tektronix part number	Serial no. effective	Serial no. discont'd	Qty	Name & description	Mfr. code	Mfr. part number
<b>Optional Accessories</b>							
17 -1	SMK4			1	TIP,PROBE:MICROCKT TEST,PKG OF 4	80009	SMK4
-2	003-0675-00			1	SCREWDRIVER:5 INCH TOTAL,PLASTIC,W/PLASTIC TIP ONE END METAL TIP OPPOSITE END P6055 PROBE AD	80009	003-0675-00
-3	011-0049-01			1	TERMN,COAXIAL:50 OHM,2W,BNC	24931	011-0049-01
-4	012-0076-00			1	CA ASSY,RF:COAXIAL,RFD,50 OHM,20 L,BNC, MALE,STR,BOTH ENDS,W/STRAIN RELIEF BOOT BOTH ENDS	80009	012-0076-00
-5	1103			1	TEKTRONIX 1103 TEKPROBE POWER SUPPLY	80009	ORDER BY DESCRIPTION
-6	679-5027-00			1	CKT BD SUBASSY:1394 ADAPTER	80009	679-5027-00



**Manufacturers cross index**

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<b>Mfr. code</b>	<b>Manufacturer</b>	<b>Address</b>	<b>City, state, zip code</b>
060D9	UNITREK CORPORATION	3000 COLUMBIA HOUSE BLVD, SUITE 120	VANCOUVER, WA 98661
24931	BERG ELECTRONICS INC	BERG ELECTRONICS RF/COAXIAL DIV 2100 EARLYWOOD DR PO BOX 547	FRANKLIN, IN 46131
80009	TEKTRONIX INC	14150 SW KARL BRAUN DR PO BOX 500	BEAVERTON, OR 97077-0001



# Appendix A: Alternate Verification Procedures

This appendix contains alternate procedures for verifying the common mode rejection ratio specifications.

Use these alternate procedures only if it is not feasible to obtain a network analyzer.

For the complete set of performance verification procedures, refer to the *Performance Verification* section on page 5 and refer to this section when directed to do so.

## Equipment Required

Table 8 lists the equipment required to perform the procedures in this section. The types and quantities of connectors may vary depending on the specific equipment you use.

**Table 8: Test equipment**

Description	Minimum requirements	Example product
Sine wave generator (preferably a synthesizer)	0 dBm to 20 dBm from 1 MHz to 1.5 GHz.	Fluke 6066
Spectrum analyzer	1 MHz to 1.8 GHz (dynamic range $\geq 100$ dBm at 1 MHz)	Advantest R3365A
TEKPROBE Power Supply	Tektronix Type 1103	Tektronix Type 1103
BNC-to-Type-N coax adapters (2)	Type N-male-to-BNC female	103-0045-00
BNC cables (2)	50 $\Omega$ , 18 inch	012-0076-00
Probe tip adapters BNC-to-probe tip	(included in the standard probe tip accessory kit)	020-2203-00

## Preparation

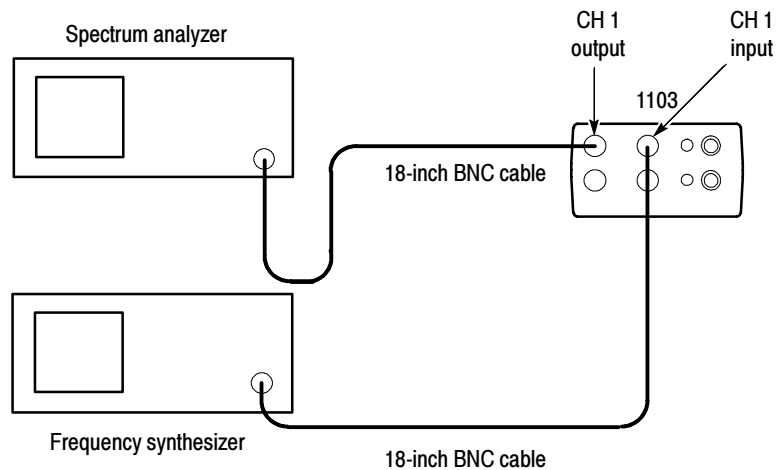
Allow all test equipment to warm up for 20 minutes in an environment that is within the environmental conditions specified in Table 1 on page 1. Prepare the equipment as follows:

1. Connect the probe tip adapter to the inputs of the probe. (For a description of these accessories, refer to the list of standard accessories on pages 33 and 34).
2. Attach the probe to the 1103 TEKPROBE power supply.
3. If necessary, set the line selector of the 1103 power supply to the correct voltage.
4. Turn on the 1103 power supply.
5. Set the 1103 offset to off (button not illuminated).
6. Allow at least 20 minutes for the probe and equipment to warm up.

Perform the verification procedures in order.

## CMRR (Common-Mode Rejection Ratio)

1. Normalize the setup as follows:
  - a. Connect the equipment as shown in Figure 18.



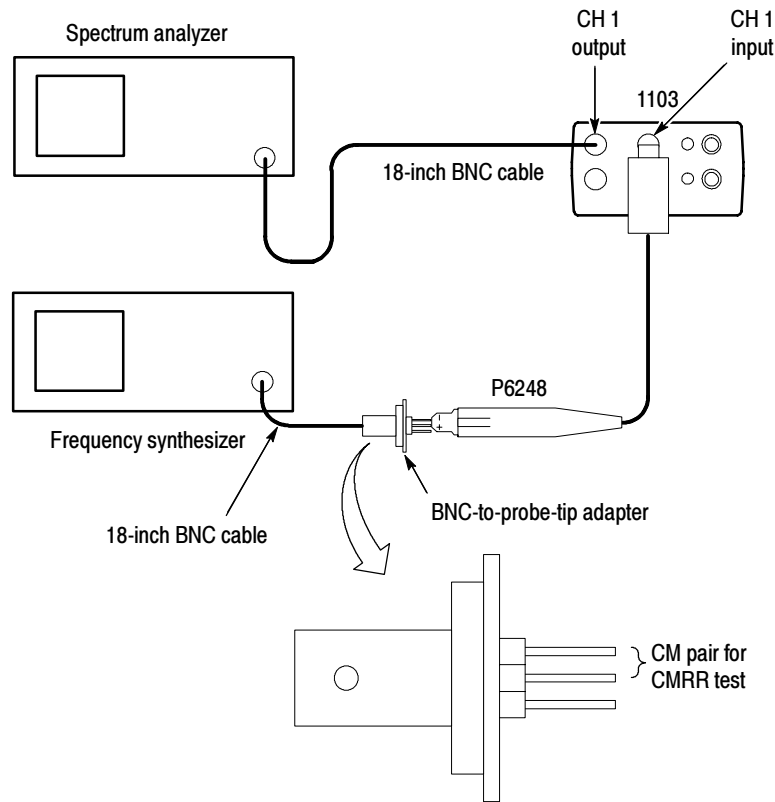
**Figure 18: Normalizing the setup**

- b. Set the synthesizer to 1 MHz and 10 dBm.
  - c. Adjust the spectrum analyzer input attenuator to accept the high level of 10 dBm.
  - d. Set the reference level to 10 dBm, the center frequency to 1 MHz, and the vertical scale to 10 dB/div.
  - e. Adjust the span to 10 kHz and the resolution bandwidth to auto.
  - f. Record the level displayed on the spectrum analyzer.
2. Remove the BNC cable from the 1103 input, and insert the adapter and probe as shown in Figure 19. Use the CM pins of the BNC to probe tip adapter.

---

**NOTE.** *CMRR performance is influenced by cable dress. When making CMRR measurements, keep the probe cable away from ground planes and objects. Do not allow kinks, loops or other deformities in the probe cable, and maintain a maximum distance between the probe head and the probe control box.*

---



**Figure 19: Setup for the CMRR tests**

3. Set the probe to  $\div 1$  attenuation.
4. Change the spectrum analyzer reference level to  $-20$  dBm.
5. Record the level displayed on the spectrum analyzer (be sure to factor in the change in reference level,  $30$  dBm). It may be necessary to use the video filter to lower the noise floor. Verify that the change in the level (relative to the level recorded in step 1f above) is less than or equal to the  $\div 1$  measured feed through column of Table 9 on page 43.
6. Set the probe to  $\div 10$  attenuation.
7. Record the level displayed on the spectrum analyzer. Verify that the change in the level (relative to the level recorded in step 1f above) is less than or equal to the  $\div 10$  measured feed through column of Table 9 on page 43. (These values are  $20$  dB lower than the specification to account for the  $\div 10$  attenuation.)
8. Set the synthesizer to  $100$  MHz and  $0$  dBm.

9. Set the reference level to 0 dBm, the center frequency to 100 MHz and the vertical scale to 10 dB/div. Adjust the span to 200 kHz and the resolution bandwidth to auto.
10. Connect the BNC cable from the synthesizer output to the 1103 input as shown in Figure 18.
11. Record the level displayed on the spectrum analyzer.
12. Remove the BNC cable from the 1103 input and insert the adapter and probe as shown in Figure 19. Use the CM pins of the BNC to probe tip adapter.
13. Set the probe to  $\div 1$  attenuation.
14. Record the level displayed on the spectrum analyzer. Verify that the change in the level (relative to the level recorded in step 11 on page 43) is less than or equal to the  $\div 1$  measured feedthrough column of Table 9 on page 43.
15. Set the probe to  $\div 10$  attenuation.
16. Record the level displayed on the spectrum analyzer. Verify that the change in the level (relative to the level recorded in step 11 on page 43) is less than or equal to the  $\div 10$  measured feedthrough column of Table 9 on page 43.
17. Set the synthesizer to 500 MHz and 0 dBm.
18. Set the spectrum analyzer center frequency to 500 MHz.
19. Repeat steps 10 through 16.
20. Set the synthesizer to 1 GHz and 0 dBm.
21. Set the spectrum analyzer center frequency to 1 GHz.

---

**NOTE.** Carefully dress the probe cable so that it does not cross itself or pass near the BNC to probe tip adapter. Improperly dressing the probe cable can affect the measurements at 1 GHz and above.

---

22. Repeat steps 10 through 16.

**Table 9: CMRR and measured feedthrough limits**

Frequency	$\div 1$ CMRR	$\div 10$ CMRR	$\div 1$ measured feed-through	$\div 10$ measured feed-through
1 MHz	$\geq 60$ dB	$\geq 45$ dB	$\leq - 60$ dBm	$\leq - 65$ dBm
100 MHz	$\geq 38$ dB	$\geq 25$ dB	$\leq - 38$ dBm	$\leq - 45$ dBm
500 MHz	$\geq 35$ dB	$\geq 20$ dB	$\leq - 35$ dBm	$\leq - 40$ dBm
1 GHz	$\geq 30$ dB	$\geq 18$ dB	$\leq - 30$ dBm	$\leq - 38$ dBm







