P5100A & P5150 High Voltage Probes
Performance Verification and Adjustments

Technical Reference

077-0530-02

Tektronix

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Technical Reference

Revision A

www.tektronix.com

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Contacting Tektronix

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For product information, sales, service, and technical support:

- In North America, call 1-800-833-9200.
- Worldwide, visit www.tektronix.com to find contacts in your area.

Warranty

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.

In order to obtain service under this warranty, Customer must notify Tektronix of the defect before the expiration of the warranty period and make suitable arrangements for the performance of service. Customer shall be responsible for packaging and shipping the defective product to the service center designated by Tektronix, with shipping charges prepaid. Tektronix shall pay for the return of the product to Customer if the shipment is to a location within the country in which the Tektronix service center is located. Customer shall be responsible for paying all shipping charges, duties, taxes, and any other charges for products returned to any other locations.

This warranty shall not apply to any defect, failure or damage caused by improper use or improper or inadequate maintenance and care. Tektronix shall not be obligated to furnish service under this warranty a) to repair damage resulting from attempts by personnel other than Tektronix representatives to install, repair or service the product; b) to repair damage resulting from improper use or connection to incompatible equipment; c) to repair any damage or malfunction caused by the use of non-Tektronix supplies; or d) to service a product that has been modified or integrated with other products when the effect of such modification or integration increases the time or difficulty of servicing the product.

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[W2 – 15AUG04]

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

Observe all terminal ratings. To avoid fire or shock hazard, observe all ratings and markings on the product. Consult the product manual for further ratings information before making connections to the product.

Connect the probe reference lead to earth ground only.

Do not apply a potential to any terminal, including the common terminal, that exceeds the maximum rating of that terminal.

Do not operate without covers. Do not operate this product with covers or panels removed.

Do not operate with suspected failures. If you suspect that there is damage to this product, have it inspected by qualified service personnel.

Avoid exposed circuitry. Do not touch exposed connections and components when power is present.

Do not operate in wet/damp conditions.

Do not operate in an explosive atmosphere.

Keep product surfaces clean and dry.

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

Terms in this manual

These terms may appear in this manual:

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

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

Symbols and terms on the product

These terms may appear on the product:

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

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

CAUTION
Refer to Manual

Protective Ground
(Earth) Terminal

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.

Disconnect power. To avoid electric shock, switch off the instrument power, then disconnect the power cord from the mains power.

Use care when servicing with power on. Dangerous voltages or currents may exist in this product. Disconnect power, remove battery (if applicable), and disconnect test leads before removing protective panels, soldering, or replacing components.

To avoid electric shock, do not touch exposed connections.

Preface

This manual contains procedures for checking the P5100A probe performance and for making adjustments to achieve the warranted specifications. The P5150 probe section describes adjustment procedures only.

WARNING. *The procedures included in this manual are for use by qualified service personnel only.*

P5100A Performance Verification

Use these performance verification procedures to verify that the probe meets the warranted specifications. These procedures should be performed in the order given using a DPO4104B oscilloscope with the equipment recommended in the following table. (See Table 1.)

WARNING. *The following instructions are for use by qualified service personnel only. To avoid electrical shock, do not disassemble or maintain the probe while it is connected to a signal source other than those specified in these procedures.*

NOTE. *The probe must be low-frequency compensated before performance can be verified.*

If your probe fails to qualify under these conditions, service-level adjustments (DC gain and high-frequency compensation) may be required. These adjustments must be done by a trained service person.

Test Equipment

Table 1: Recommended test equipment

Equipment	Minimum requirements	Recommended test equipment [1]
Oscilloscope	≥500 MHz BW, 1 MΩ ±1% input R	Tektronix DPO4104B
Calibration generator	≤0.5% accuracy, 10 Hz square wave, 5 V_{p-p} output	Fluke 9500B with 9530 active head
Adapter, BNC	Female-to-female barrel	103-0028-xx
Adapter, probe tip-to-BNC	Probe tip-to-male BNC	013-0291-xx
Pulse generator [2]	≤500 ps rise time, ≥100 ns pulse width, ≥3 V_{p-p} into 50 Ω	Picosecond Labs 2600C or Fluke 9500B with 9530 active head
Termination, 50 Ω feedthrough [2]	50 Ω male-to-female BNC	011-0049-xx
BNC cable, precision [2]	50 Ω, 36 in	012-0482-xx
Adjustment tool [2]	Insulated, straight edge	003-1433-xx
Screwdriver [2]	Flat blade	
Knife [2]	Razor edge	

1 Nine digit part numbers (xxx-xxxx-xx) are Tektronix part numbers

2 Required for adjustment procedures only

Test Setup

1. Turn on the oscilloscope.
2. Connect the probe to any channel (1–4) of the oscilloscope.
3. Turn on the generators and let the probe and test equipment warm up for 20 minutes.
4. Make a copy of the test record to tabulate the test results. (See Table 2 on page 4.)

System DC Attenuation Accuracy Check

1. Connect the test setup as shown.

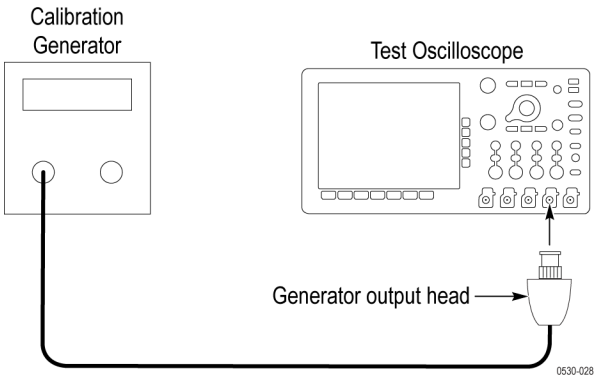


Figure 1: Setup for oscilloscope gain check

2. Set the oscilloscope to:
   - vertical to 10 mV/division
   - horizontal to 20 ms/division
   - averaging to 64
3. Set the calibration generator to:
   - output frequency = 10 Hz
   - 50 mV_{p-p} square wave output
   - output into 1 MΩ load
4. Enable the calibration generator output.
5. Trigger the oscilloscope and center the waveform on the screen.
6. Use the amplitude measurement selection on the oscilloscope to measure the generator output voltage.
7. Divide the measured output from the previous step into 50 mV to derive a correction factor, CF.

   For example, if you measured 50.13 mV, then the CF = 50/50.13 = 0.997.

   The correction factor will be used in step 14 of this procedure to calculate the corrected amplitude, V_{corr}.

8. Disconnect the calibration generator output from the oscilloscope and connect the probe to the same channel, as shown in the test setup below. You must use the same oscilloscope channel throughout this procedure for the test to be accurate and valid.

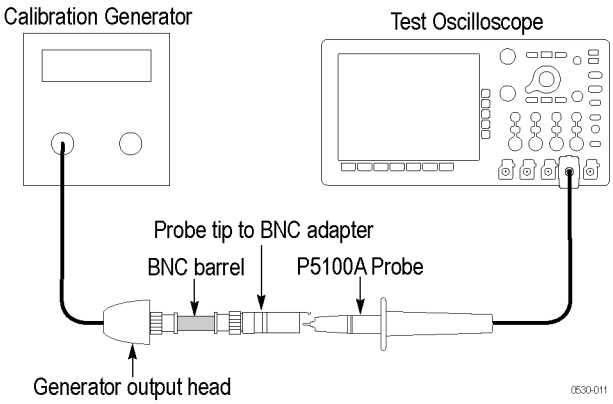


Figure 2: Setup for system accuracy check

9. Set the oscilloscope vertical to 1 V/division.
10. Set the calibration generator to 5 V_{p-p} square wave output.
11. Enable the calibration generator output.
12. Trigger the oscilloscope and center the waveform on the screen.
13. Use the amplitude measurement selection on the oscilloscope to measure the voltage amplitude.
14. Calculate the corrected amplitude, V_{corr} by multiplying the measured output from the previous step by the correction factor (CF) derived in step 7.

    For example, a measured output of 5.04 V multiplied by a correction factor of 0.997 yields a corrected amplitude of 5.025 V.
15. Verify that the corrected amplitude, V_{corr}, is 5 V, ±0.088 V. Record the results in the test record.

If your probe does not meet the specification, service-level adjustments (DC gain and high-frequency compensation) may be required. (See page 5, *P5100A Adjustments*.) The procedures to make adjustments and to optimize the bandwidth and high frequency response must be done by a qualified service technician.

Test Record

Photocopy this test record for recording the results of the performance verification procedures.

Table 2: P5100A probe test record

Probe Model Number: P5100A

Certificate Number:

Probe Serial Number:

RH %:

Temperature:

Technician:

Date of Calibration:

Probe test	Minimum	Incoming	Outgoing	Maximum
System DC Attenuation Accuracy	4.912 V			5.088 V

P5100A Adjustments

To gain access to the adjustments, you must disassemble the probe compensation box as described below.

1. Using a razor knife, cut in half the two labels on the sides of the compensation box, along the top and bottom cover seams. Be careful to not damage the labels; they must remain intact and on the probe due to regulatory requirements.

Figure 3: Cut the two side labels in half

2. Separate the covers by inserting a thin flat-blade screwdriver into the one of the slots on the side of the compensation box. The slots are hidden beneath the labels.

Figure 4: Separate the covers

3. Lift the cable end of the top cover away from the compensation box and then pull the cover out of the connector housing.

Figure 5: Remove the top cover from the probe

The five adjustments that you will likely need to access are available through the openings in the metal shield. If you need to access the sixth adjustment (fine LF comp), you must slide the metal shield away from the connector end of the probe.

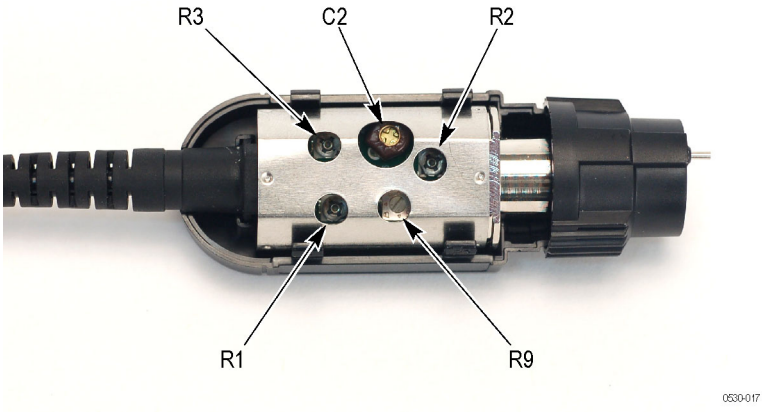


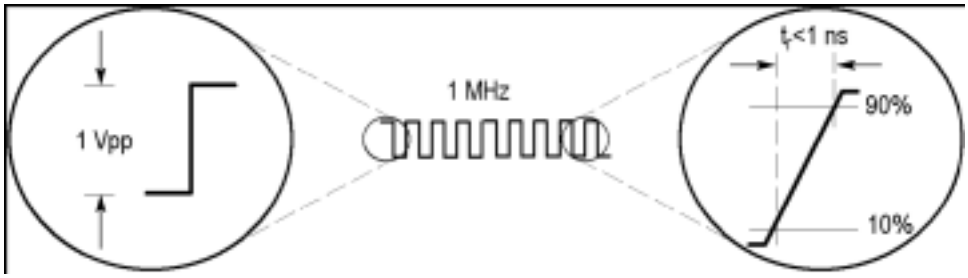
Figure 6: P5100A probe adjustment locations

DC Gain and High Frequency (HF) Compensation

Precision or high-frequency compensation is not a common user adjustment. However, precision compensation should be checked if the probe was repaired or if any of the following conditions are true:

- The probe has excessive high-frequency aberrations.
- You have installed the probe on an oscilloscope having an input capacitance near the limits of the probe compensation range.

To perform the high-frequency compensation adjustment you will need a signal source that has all of the following characteristics:



- Fast rise output with rise time ≤500 ps
- Output properly terminated

The Picosecond Labs 2600C Pulse Generator output meets these requirements when properly terminated.

Gain Adjustment (DC Accuracy)

1. Connect the probe as shown in the *System DC Attenuation Accuracy Check* setup. (See Figure 2 on page 3.)
2. Set the oscilloscope to:
   - vertical to 1 V/division
   - horizontal to 20 ms/division
   - averaging to 64
3. Set the calibration generator to:
   - output frequency = 10 Hz
   - 5 V_{p-p} square wave output
   - output into 1 MΩ load
4. Locate R9 (the DC gain adjustment).

WARNING. *To reduce risk of electric shock, use only the provided insulated adjustment tool when making adjustments. Hazardous voltages may be present inside the compensation box.*

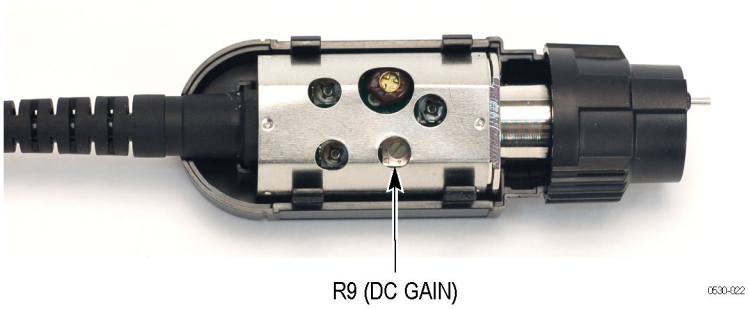


Figure 7: R9 (DC gain) adjustment location

5. Adjust the DC gain (R9) to a probe output level of 5 V, ±0.088 V, as displayed on the oscilloscope.
6. Record the output level in the outgoing column of the *System DC Attenuation Accuracy* check in the test record.

Low-Frequency Compensation (LF) Adjustment

1. Connect the probe to the Probe Compensation output of the oscilloscope and check the LF comp of the probe. If it needs adjustment, do the following:

   - Adjust LF compensation with C2, and if necessary, do a minor adjustment to C116 for best LF flatness.

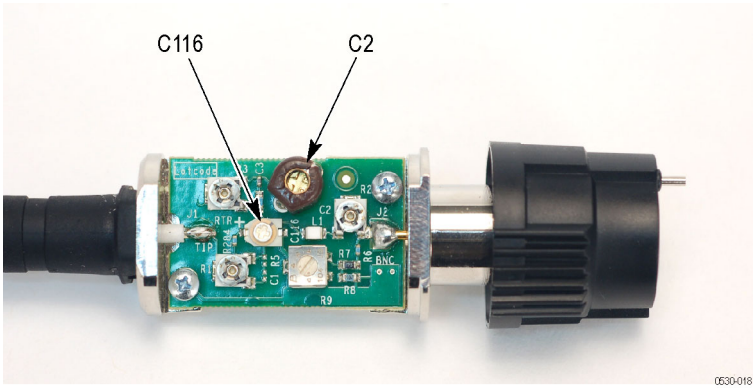


Figure 8: C2 (LF) and C116 (fine LF) adjustment locations

   - Use C2 to check LF compensation range over and under compensation range.
   - Use C2 for a coarse LF adjust and use C116 to get a consistent roll up or roll off.
   - Finally, go back and use C2 one last time to flatten the overall response.

2. Proceed to the *High Frequency (HF) Adjustment*. (See page 10.)

High Frequency (HF) Adjustment

1. Connect the test setup as shown.

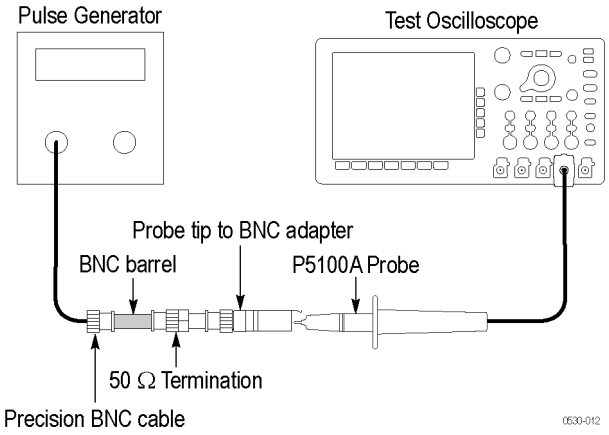


Figure 9: Setup to adjust HF response

2. Set the output level of the pulse generator to 5 volts (20 dB) and the pulse width to 100 ns.
3. Set the oscilloscope to:
   - vertical to 1 V/division
   - horizontal to 4 ns/division
   - averaging to 64
   - input impedance to 1 MΩ
4. Adjust the HF response as follows:

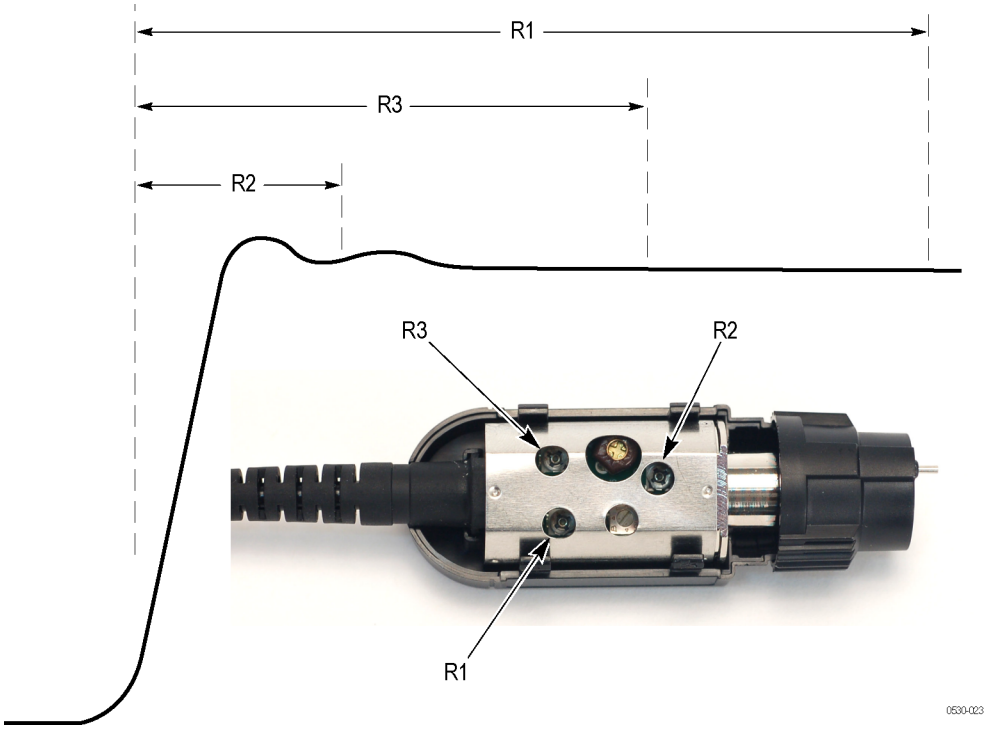


Figure 10: Areas of the waveform affected by adjustments R1, R2, and R3

- First adjust R1 to flatten out to 20-30 ns.
- Next, adjust R3 for the 10-20 ns area.
- Adjust R2 for the last ~5 ns. If the overshoot is too great, then adjust R2 to roll off the front corner and readjust R3 followed by R1. The procedure is done when the 3 adjustments have been optimized for the best overall response.

5. Reassemble the probe. (See page 12, *Reassemble the Probe*.)

Reassemble the Probe

If you removed the metal shield to access the fine LF adjustment, it is easier to reinstall the shield with the bottom cover removed, so begin with step 1. Otherwise, skip to step 3.

1. Remove the bottom cover.
2. Install the shield over the circuit board so that the shield covers the metal ends of the board housing. (See Figure 11.)
3. Using your thumb or finger to hold the shield in place, align and seat the probe into the bottom cover, beginning at the cable end. As you seat the probe into the connector end of the cover, pull out the spring-loaded connector to allow it to clear the front edge of the cover and fully seat into the bottom cover.

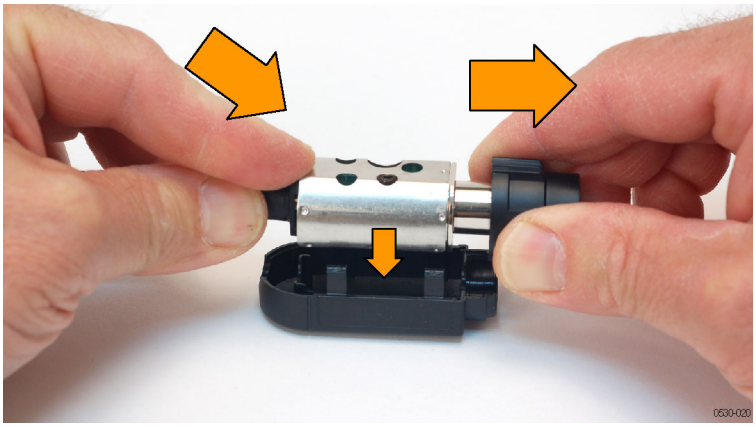


Figure 11: Align and seat the probe into the bottom cover

4. Verify that the metal shield is properly located. (See Figure 11.) Align the top cover onto the probe, beginning at the cable end. As you seat the cover onto the connector end of the probe, pull out the connector to allow the cover to clear the connector and to engage with the bottom cover.

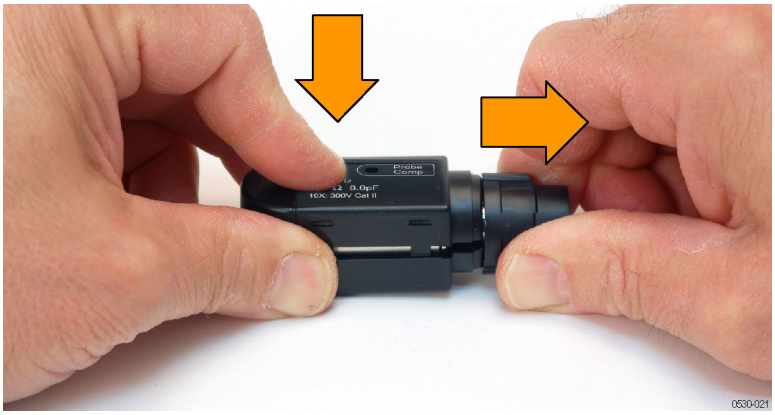


Figure 12: Install the top cover

5. Recheck that the probe functions properly.

End of procedure.

P5150 Adjustments

These procedures describe how to make low- and high-frequency compensation adjustments to the P5150 probe. Use the equipment listed below for the test setup.

Table 3: Recommended test equipment

Equipment	Minimum requirements	Recommended test equipment [1]
Oscilloscope [2]	≥200 MHz bandwidth (floating input) ≥500 MHz bandwidth (ground-referenced input)	Tektronix TPS2024B or THS3024 Tektronix TDS3054C
Pulse generator	≤500 ps rise time, ≥100 ns pulse width, ≥3 V_{p-p} into 50 Ω	Picosecond Labs 2600C or Fluke 9500B with 9530 active head
Termination, 50 Ω feedthrough	50 Ω male-to-female BNC	011-0049-xx
Adapter, BNC	Female-to-female barrel	103-0028-xx
Adapter, probe tip-to-BNC	Probe tip-to-male BNC	013-0291-xx
BNC cable, precision	50 Ω, 36 in	012-0482-xx
Adjustment tool	Insulated, straight edge	003-1433-xx
Screwdriver	Flat blade	

1 Nine digit part numbers (xxx-xxxx-xx) are Tektronix part numbers

2 P5150 probes are intended for use with oscilloscopes that have isolated (floating) inputs. The Tektronix TPS2024B and THS3024 oscilloscopes are the highest bandwidth floating-input oscilloscopes currently available. If you do not have access to one of these oscilloscopes, use the recommended ground-referenced model.

Access the Adjustments

To gain access to the adjustments, you must slide the cover off of the probe body. Insert a thin flat-blade screwdriver into the slot on the top of the compensation box and slide back the cover. (See Figure 13.)

Figure 13: Depress the tab and slide back the cover

Low-Frequency Compensation (LF) Adjustment

1. Connect the probe to the compensation output of the oscilloscope and check the LF comp of the probe. If it needs adjustment, do the following:
   - Use C2 to check that the LF compensation range spans above and below the optimized response.
   - Adjust LF compensation with C2, and if necessary, do a minor adjustment to C116 for best LF flatness.

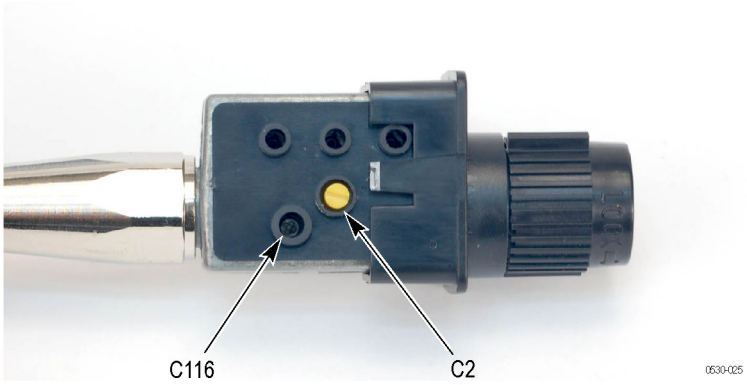


Figure 14: LF and fine LF adjustment locations

   - Use C2 for a coarse LF adjust and use C116 to get a consistent roll up or roll off.
   - Finally, go back and use C2 one last time to flatten the overall response.
2. Proceed to the *High Frequency (HF) Adjustment*. (See page 15, *High Frequency (HF) Adjustment*.)

High Frequency (HF) Adjustment

1. Connect the probe and equipment as shown in the *High Frequency (HF) Adjustment* setup for the P5100A probe. (See Figure 9 on page 10.)
2. Set the oscilloscope horizontal to 4 ns/div. (Adjust the oscilloscope as necessary to view the leading edge of the waveform.)
3. Adjust the HF response as follows:

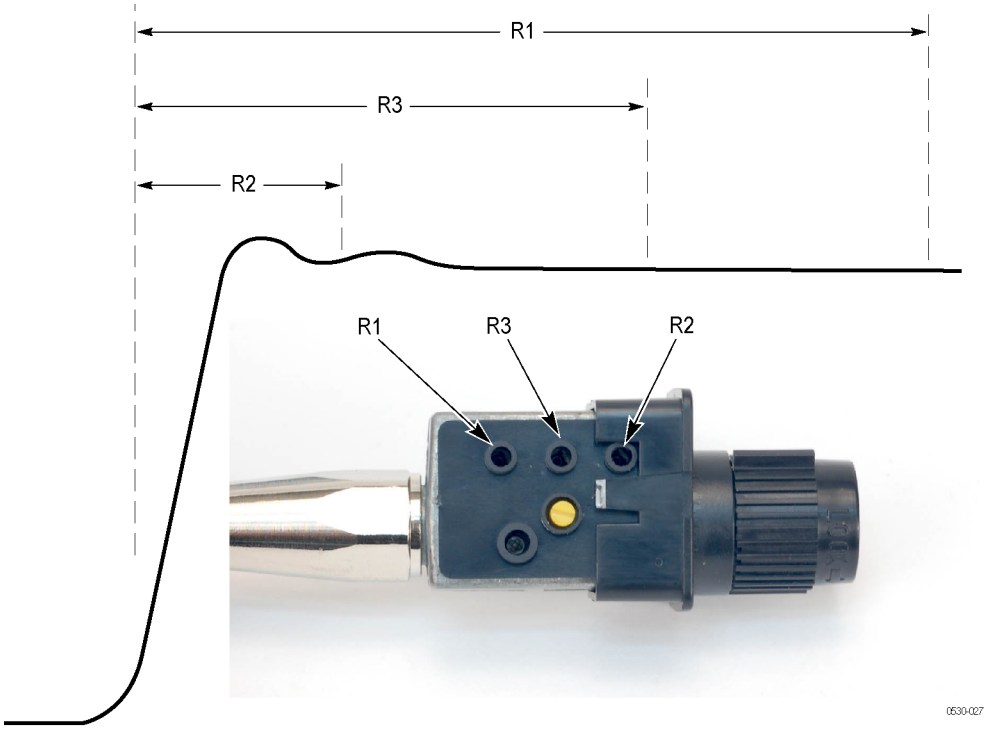


Figure 15: Areas of the waveform affected by adjustments R1, R2, and R3

- First adjust R1 to flatten out to 20-30 ns.
- Next, adjust R3 for the 10-20 ns area.
- Adjust R2 for the last ~5 ns. If the overshoot is too great, then adjust R2 to roll off the front corner and readjust R3 followed by R1. The adjustments are complete when you have optimized the waveform.

4. Slide the probe cover back over the probe body until the body tab engages with the cover slot.

End of procedure.