

P6022

Current Probe

Instruction Manual



070-0948-05

P6022 Current Probe Instruction Manual

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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070-0948-05

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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. De-energize the circuit under test before connecting or disconnecting the current probe.

Connect and Disconnect Properly. Connect the probe output to the measurement instrument before connecting the probe to the circuit under test. Connect the probe reference lead to the circuit under test before connecting the probe input. Disconnect the probe input and the probe reference lead from the circuit under test before disconnecting the probe from the measurement instrument.

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

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

Connect the probe reference lead to earth ground only.

Do not connect a current probe to any wire that carries voltages above the current probe voltage rating.

Do Not Operate Without Covers. Do not operate this product with covers or panels removed.

Do Not Operate With Suspected Failures. If you suspect that there is damage to this product, have it inspected by qualified service personnel.

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

Do Not Operate in Wet/Damp Conditions.

Do Not Operate in an Explosive Atmosphere.

Keep Product Surfaces Clean and Dry.

Terms in this Manual

These terms may appear in this manual:



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



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

Symbols and Terms on the Product

These terms may appear on the product:

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

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



CAUTION
Refer to Manual



Earth Terminal



Do not connect to or
remove from an
uninsulated conductor that
is HAZARDOUS LIVE.



Breakable.
Do not drop.



Use only on an
insulated wire.

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.

Compliance Information

This section lists the safety and environmental standards with which the instrument complies.

Safety Compliance

EC Declaration of Conformity – Low Voltage

Compliance was demonstrated to the following specification as listed in the Official Journal of the European Communities:

Low Voltage Directive 2006/95/EC.

- EN 61010-1: 2001. Safety requirements for electrical equipment for measurement control and laboratory use.
- EN 61010-2-032: 2002. Particular requirements for handheld current clamps for electrical measurement and test equipment.

Additional Compliances

- IEC 61010-1: 2001. Safety requirements for electrical equipment for measurement, control, and laboratory use.
- IEC 61010-2-032: 2002. Particular requirements for handheld current clamps for electrical measurement and test equipment.

Equipment Type

Test and measuring equipment.

Safety Class

Class 1 – grounded product.

Pollution Degree Description

A measure of the contaminants that could occur in the environment around and within a product. Typically the internal environment inside a product is considered to be the same as the external. Products should be used only in the environment for which they are rated.

- Pollution Degree 1. No pollution or only dry, nonconductive pollution occurs. Products in this category are generally encapsulated, hermetically sealed, or located in clean rooms.
- Pollution Degree 2. Normally only dry, nonconductive pollution occurs. Occasionally a temporary conductivity that is caused by condensation must be expected. This location is a typical office/home environment. Temporary condensation occurs only when the product is out of service.
- Pollution Degree 3. Conductive pollution, or dry, nonconductive pollution that becomes conductive due to condensation. These are sheltered locations where neither temperature nor humidity is controlled. The area is protected from direct sunshine, rain, or direct wind.

- Pollution Degree 4. Pollution that generates persistent conductivity through conductive dust, rain, or snow. Typical outdoor locations.

Pollution Degree Pollution Degree 2 (as defined in IEC 61010-1). Note: Rated for indoor use only.

Environmental Considerations

This section provides information about the environmental impact of the product.

Product End-of-Life Handling

Observe the following guidelines when recycling an instrument or component:

Equipment Recycling. Production of this equipment required the extraction and use of natural resources. The equipment may contain substances that could be harmful to the environment or human health if improperly handled at the product's end of life. In order to avoid release of such substances into the environment and to reduce the use of natural resources, we encourage you to recycle this product in an appropriate system that will ensure that most of the materials are reused or recycled appropriately.



This symbol indicates that this product complies with the applicable European Union requirements according to Directives 2002/96/EC and 2006/66/EC on waste electrical and electronic equipment (WEEE) and batteries. For information about recycling options, check the Support/Service section of the Tektronix Web site (www.tektronix.com).

Restriction of Hazardous Substances

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

Operator Information

This manual describes the P6022 current probe with passive termination, and provides information about making measurements with the probe.

Description

The P6022 current probe converts an alternating current waveform to a voltage that can be displayed and measured on an oscilloscope display. It provides accurate current measurements over a wide range of frequencies, and allows you to measure current without breaking the circuit.

The P6022 probe is compatible with general-purpose ground-referenced oscilloscopes having a 1 M Ω input impedance. The P6022 probe comes with a passive termination that matches oscilloscope and probe impedance, optimizes the probe performance, and provides two sensitivity settings.

The P6022 probe comes with a 5-foot cable, termination, and 6" ground lead.

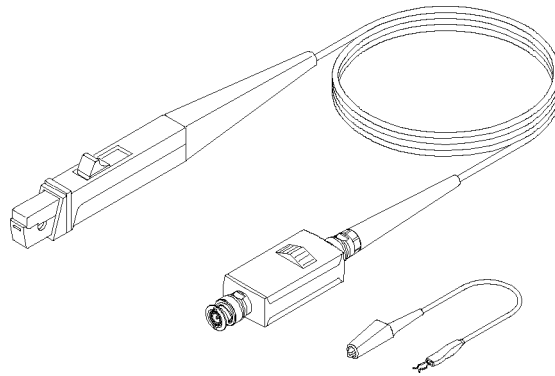


Figure 1: P6022 probe, termination, and ground lead

Installation

This section describes both attaching the probe to an oscilloscope and using the standard accessories with the probe.

To ensure the best performance from your probe/oscilloscope measurement system, check that the probe and oscilloscope are appropriately matched. The oscilloscope inputs should use BNC connectors, and have an impedance of 1 M Ω .

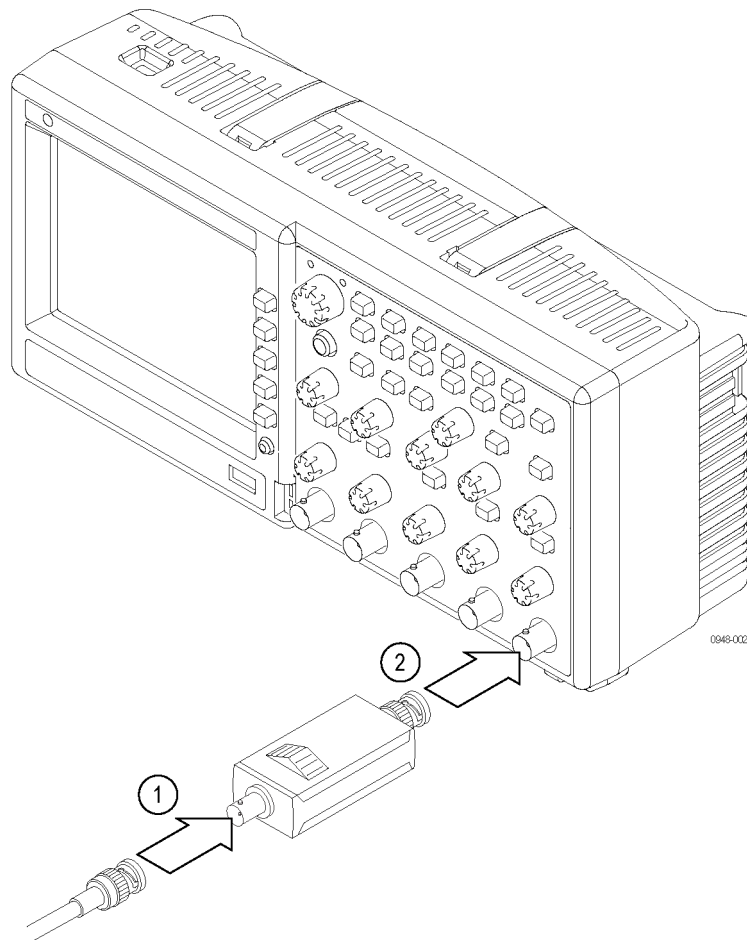


Figure 2: Connecting the probe and termination to the oscilloscope

Attaching the Probe and Termination to an Oscilloscope

1. Connect the termination box female BNC end to the P6022 probe output cable.
2. Connect the termination box male BNC end to a ground-referenced oscilloscope.



WARNING. *To avoid electric shock and possible injury, do not apply any voltage above earth ground potential to the probe common lead (do not float the common). The exposed metal on the probe output cable and termination box is electrically connected to the probe common lead and therefore is at the same potential.*

This probe is intended for use with ground-referenced oscilloscopes only. Do not float the oscilloscope by removing or isolating the ground pin from the AC power cord.

Do not use this probe with any equipment with floating inputs, including the TPS2000 or THS700 series oscilloscope.

3. When you make high frequency measurements, snap the ground lead to the probe transformer post and attach the alligator clip directly to RF ground to improve EMI rejection at high frequencies (2 MHz and above). This reduces ringing and helps to bypass capacitively-coupled RF currents which can flow into the probe cable.



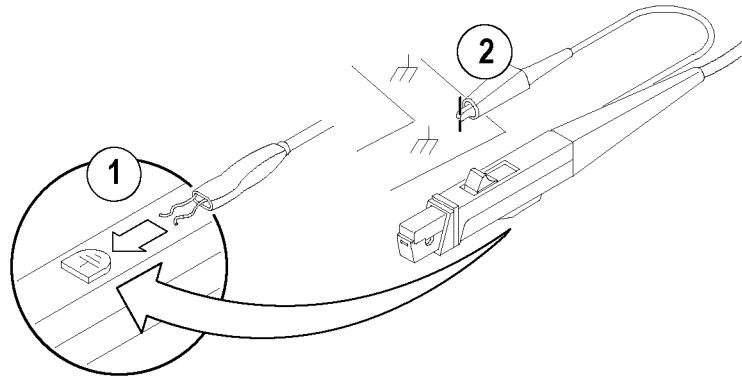
WARNING. *To avoid potential shock and damage to the probe, do not disconnect the probe termination and leave the P6022 clamped around the conductor when measuring high currents. Leaving the probe cable unterminated can cause a high voltage to develop in the secondary winding which may pose a shock hazard and damage the current probe transformer. Never disconnect the probe from the termination when the probe is connected to a live conductor.*

Never disconnect the probe from the termination when the probe is connected to a live conductor.

Using the Standard Accessories

Your P6022 probe is shipped with the following accessories:

- **This instruction manual** — Read these instructions to familiarize yourself with the features, specifications, and operation of the P6022 current probe.
- **6-inch ground lead** — Use the 6-inch ground lead to ground the shield around the probe transformer at the probe end of the cable. This allows you to move the ground connection closer to the circuit you are measuring, thereby improving high frequency response. The ground lead clips onto the ground connector on the bottom of the probe as shown.



Please refer to the parts list for part numbers. (See page 32, *Replaceable Mechanical Parts*.)

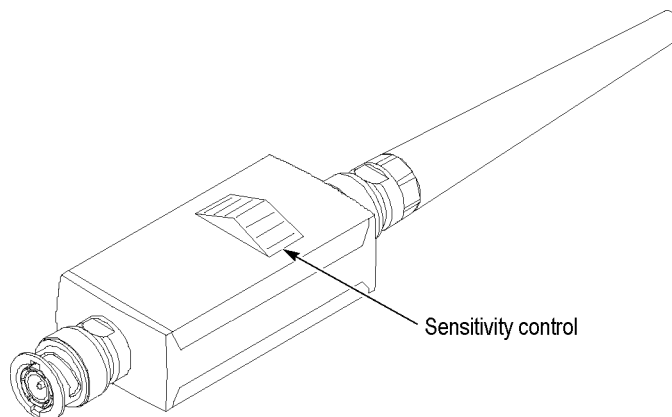
Operating Considerations

The information in this section will help you make the most effective use of your P6022 probe.

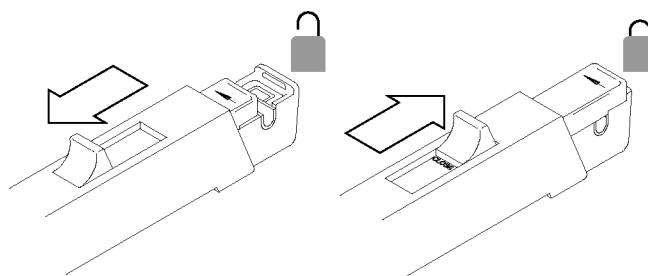
Features and Controls

- **Sensitivity Control** — The P6022 termination has a control that allows you to select probe sensitivity. The switch has two positions: 1 mA/mV and 10 mA/mV. When the control is in the 1 mA/mV position, the oscilloscope displays 1 mV for every 1 mA of current in the circuit under test. When the control is in the 10 mA/mV position, the oscilloscope displays 1 mV for every 10 mA of current in the circuit under test.

You can set vertical scale on the oscilloscope to any scale factor, as determined by the signal amplitude. To calculate the overall vertical scale factor for the oscilloscope, probe, and termination, multiply the termination sensitivity control setting by the vertical scale factor of the oscilloscope. For example, if the termination control is set to the 10 mA/mV position, and the oscilloscope to a vertical scale of 20 mV/division, the overall scale factor is 10 X 20, or 200 mA/division.



- **Probe Slide Switch** — The slide switch on the probe has three positions: open, closed, and locked. Use your thumb to move the probe slide switch. The switch is spring-loaded so that it automatically moves from the open to closed positions.



To Use the Probe.



WARNING. To reduce risk of electric shock, use only insulated conductors with these probes on circuits with voltages above 30 Vrms, 42 Vpk, or 60 VDC. These probes are not rated for bare wire voltages above 30 Vrms, 42 Vpk, or 60 VDC.



CAUTION. To reduce risk of fire, do not connect or disconnect the current probe to or from a live, uninsulated conductor. The core is not insulated. Always remove power before you connect or disconnect the probe to or from bare conductors.

NOTE. An insulated conductor is any conductor that is surrounded by an insulating material that is capable of isolating the voltage present on the conductor. Lacquer coatings like those typically found on transformer windings do not provide sufficient, reliable insulation for use with current probes. The lacquer coating can be easily nicked or damaged, which compromises the insulating capabilities of the lacquer coating.



CAUTION. To prevent damage to the probe, do not drop the probe, subject it to physical shock or rapid temperature changes, and do not insert insulated conductors larger than 2.6 mm into the probe jaw or damage may result. If the slider will not close around the conductors, do not force the slide closed, either reduce the number of conductors, or use a smaller conductor if possible without exceeded the amperage rating of the wire.

1. Pull the slide switch toward you and hold the switch in position.
2. Place the conductor-under-test inside the exposed transformer core. The arrow on the transformer end of the probe indicates conventional current flow. If you place the probe on the conductor so that the arrow on the probe matches conventional current flow through the conductor, orientation of the displayed waveform will be correct.
3. Release the switch, allowing the probe to close.
4. Lock the slide switch. To lock the switch, push it firmly toward the transformer (the switch will move only about 1/8th inch). Locking the switch assures maximum contact between the two halves of the transformer secondary. The conductor now becomes the primary of the transformer. (When measuring current, always check that the probe slide switch is moved completely forward into the locked position.)

Insertion Impedance

When you insert a conductor into the probe, you add impedance to the circuit you are measuring. This additional impedance affects signals; this is particularly important if you are measuring fast rise times. The equivalent circuit with additional impedance introduced by the P6022 is shown below.

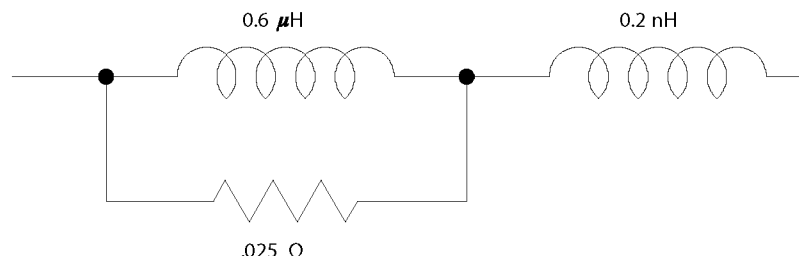


Figure 3: Insertion impedance of the probe

Minimizing Loading Effect

To minimize the loading effect of the probe, clamp it at the low or ground end of a component lead when possible. This method also minimizes noise or stray signal interference.

Increasing Probe Sensitivity

You can increase the current sensitivity of the probe by increasing the number of times a conductor passes through it. For example, if the conductor loops through the probe twice (a two-turn primary winding), the secondary current is doubled, because the ratio of current in a transformer is inversely proportional to the turns ratio.

For example, suppose you set the termination sensitivity to 1 mA/mV and the oscilloscope vertical scale to 10 mV/division. Ordinarily, this would result in the equivalent of 1×10 , or 10 mA/division. However, if the conductor is looped through the probe twice, the vertical scale is divided by two, resulting in the equivalent of 5 mA/division.

Looping the conductor twice effectively doubles vertical sensitivity; however, impedance from the probe winding is also reflected into the circuit being measured. This impedance varies as the square of the number of loops. This additional impedance affects signals; this effect is particularly important when you are measuring high-frequency current waveforms or waveforms with fast rise times.

Probe Shielding

The P6022 probe is shielded to minimize the effect of external magnetic fields. However, strong fields can interfere with the current signal being measured. If you suspect that an external field is interfering with your measurement, remove the probe from the conductor, but keep it in the same location as when you made the suspect measurement. If a signal still appears on the oscilloscope, try to measure the conductor current at a point farther from the location of the magnetic field.

If you must measure current in the presence of a strong magnetic field, you can minimize its interference by using two current probes and a differential-input oscilloscope. To do so, follow these steps.

1. Connect the probes (with termination) to the positive and negative inputs of the oscilloscope.
2. Clamp one probe around the conductor whose current you wish to measure.
3. Place the other probe as close as possible to the first. Ensure that its slide switch is completely closed, without a conductor inside it.
4. Set the oscilloscope to subtract the component of the signal that is common to both probes.
5. Adjust the positions of the probes for best results. It may be difficult to eliminate the undesirable signal completely, due to differences between the probes or their terminations.

Droop

The flat-top response of any AC current probe displays a certain amount of droop. This is caused by probe inductance loading the source impedance, causing an L/R exponential decay. For short pulse widths, the response looks nearly flat. The amount of droop can be calculated from the following relationship:

$$\% \text{ Droop} = 200 (\pi) T f$$

where:

$$T = \text{pulse duration}$$

$$f = \text{lower 3 dB frequency of probe}$$

Service Information

Warranted Characteristics

This section lists the various warranted characteristics that describe the P6022 Current Probe. Included are warranted electrical and environmental characteristics.

Warranted characteristics are described in terms of quantifiable performance limits that are warranted.

The warranted electrical characteristics listed apply under the following conditions:

- The probe and instrument with which it is used must have been calibrated at an ambient temperature of between +20 °C and +30 °C (68 °F to 86 °F).
- The probe and instrument must be in an environment whose limits are described in the environmental specifications table. (See Table 2.)

Table 1: Warranted electrical characteristics

Characteristic	Information
Sensitivity setting	1 mA or 10 mA for each mV at oscilloscope input, selected by termination sensitivity control
Midband accuracy	±3%
Bandwidth (-3 dB) (with BW >300 MHz oscilloscope)	
1 mA/mV	8.5 kHz to 100 MHz
10 mA/mV	935 Hz to 120 MHz

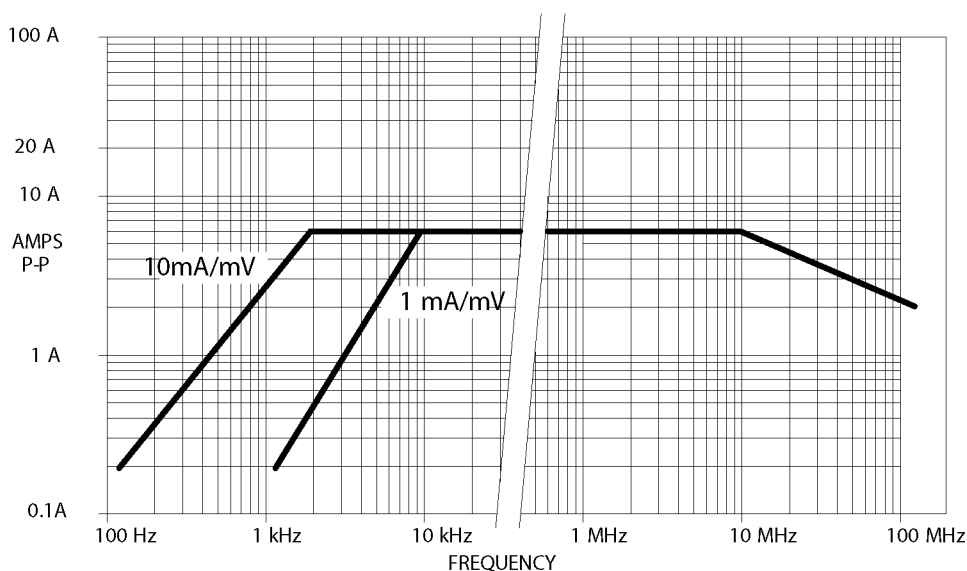
Table 2: Warranted environmental characteristics

Characteristic	Information
Temperature range:	
Operating	0 °C to +50 °C (32 °F to 122 °F)
Nonoperating	-40 °C to +65 °C (-40 °F to 149 °F)
Altitude	
Operating	To 2,000 m (6,561 ft)
Nonoperating	To 15,240 m (50,000 ft)

Table 3: Maximum ratings

Characteristic	Information
Maximum continuous (CW) current	Refer to figure for frequency derating curves (See Figure 4.)
1 mA/mV	6 A _{p-p} sine wave between 10 kHz and 10 MHz
10 mA/mV	6 A _{p-p} sine wave between 3 kHz and 10 MHz
Maximum pulse current	100 A peak, not to exceed 9(A · ms) or 2 A _{RMS} . An (A · s) product greater than 9 (A · ms) reduces probe output to zero due to core saturation
Maximum voltage on bare wire ¹	Insulated wire only for voltages above 30 VAC, 42 Vpk, 60 VDC.

¹ An insulated conductor is any conductor that is surrounded by an insulating material that is capable of isolating the voltage present on the conductor. Lacquer coatings like those typically found on transformer windings do not provide sufficient, reliable insulation for use with current probes. The lacquer coating can be easily nicked or damaged, which compromises the insulating capabilities of the lacquer coating.

**Figure 4: Probe and termination input current vs. frequency derating**

Typical Characteristics

This section lists the various typical characteristics that describe the P6022 Current Probe. Included are typical electrical and mechanical characteristics.

Typical characteristics are described in terms of typical or average performance. Typical characteristics are not warranted.

Table 4: Electrical characteristics

Characteristic	Information
Tilt	
1 mA/mV	4% or less within 1ms of step
10 mA/mV	4% or less within 10ms of step
Maximum DC without saturation	0.2 A
Signal delay, 5-foot probe with termination	Approximately 9 ns
Insertion impedance	0.03 Ω or less at 1 MHz, increasing to 0.2 Ω or less at 120 MHz
Rise time	
1 mA/mV	≤ 3.2 ns
10 mA/mV	≤ 2.9 ns
Step response	Because the oscilloscope input capacitance becomes a part of the termination network, the step response will vary with different oscilloscopes
Aberrations (probe and termination at either sensitivity setting.)	$\leq 15\%$ peak-to-peak within 25 ns of step; $\leq 2\%$ peak-to-peak thereafter

Table 5: Mechanical characteristics

Characteristic	Information
Probe cable length	5 ft, 1.5 m
Net weight:	
Probe and 5-foot cable	2.5 oz, ≈ 71 gm
Termination	1.7 oz, ≈ 48 gm
Termination	L 3.47", 88 mm W 1.10", 28 mm H 0.86", 22 mm
Probe body	L 6.0", 152 mm W 0.4", 10 mm H 0.6", 15 mm
Maximum conductor diameter	0.11", 2.79 mm

Circuit Description

This section describes the circuits in the P6022 current probe and termination.

Current Probe

The P6022 current probe consists of a current transformer mounted in the nose of the probe head case, an impedance-matching network, and an internal switch to disconnect the transformer shield from ground.

The transformer contains a two-section, U-shaped ferrite core. One section is stationary; the other is mechanically movable to permit closing the core around the conductor being measured. The conductor under test forms a one-turn primary winding for the transformer; the windings around the stationary portion of the core are the secondary windings. The circuitry between the transformer and the coaxial cable corrects any differences in level between the pulses induced in the windings of the secondary, and matches the balanced probe winding to the cable.

As indicated on the probe body, the turns ratio of the P6022 is 50:1. This refers to the number of windings in the secondary of the probe transformer.

The probe transformer is shielded to eliminate interference from outside signals. To eliminate the possibility of creating a short circuit from this shield to the conductor being measured, the slide switch disconnects the ground from the shield when you open the sliding portion of the probe to connect or remove it from a conductor.

Termination

The P6022 termination consists of an impedance-matching network to terminate the coaxial cable, and a voltage divider that is switched in by a sensitivity control to change the sensitivity by a factor of five. When the control is in the 1 mA/mV position, a 10 mA current signal in the conductor under test induces a 10 mV signal at the output of the termination. (This assumes that the termination is connected to a 1 M Ω input oscilloscope.)

When the sensitivity control is in the 10 mA/mV position, a 10 mA current signal is attenuated to induce a 1 mV signal at the output of the termination.

Probe Performance



WARNING. *This probe should be serviced only by qualified service personnel.*

To avoid personal injury and damage to the probe, remove the probe from any signal source before attempting to adjust or service the probe.

Do not service electrical equipment alone. If you must service or adjust equipment that is attached to a signal or power source, do so only when another person capable of rendering first aid and resuscitation is present.

This section provides procedures to check the performance of the P6022 probe, or to calibrate it. These procedures require the equipment listed. (See Table 6 on page 14.) Specifications given are the minimum necessary for accuracy. If equipment is substituted, it must meet or exceed the specifications of the recommended equipment. Test equipment is assumed to be correctly calibrated and operating within the given specifications.

Also, if equipment is substituted, control settings or equipment setup may need to be altered. For detailed operating instructions for the test equipment, refer to the instruction manual for each unit.

To ensure measurement accuracy, check the performance of the probe and termination whenever you begin using them with a different oscilloscope input, especially when you have changed input capacitance. Recalibrate the probe if necessary. Also check the calibration of the probe and termination every 1000 hours of operation, or every six months if they have been used infrequently.

Before calibrating the probe, inspect and clean it thoroughly. (See page 24, *Maintenance*.) Dirty or worn mating surfaces between the transformer and the lid can degrade low-frequency response. Clean these surfaces if necessary.

Calibration procedures can also be used as performance checks by completing all steps except those that adjust the probe. This checks the probe and termination to the original performance standards without requiring you to remove the termination cover or make internal adjustments.

Table 6: Equipment list

Item	Characteristic	Description	Recommended equipment
Oscilloscope	Bandwidth	DC to ≥ 300 MHz	TDS 303X, or TDS 305X
	Vertical sensitivity	1 mV/div	
	Measurement functions	Amplitude averaging	
Calibration generator	Fast rise time	Rise time ≤ 1 ns 1 V _{P-P} into 50 Ω	Wavetek 9100 with option 100:250 or Tektronix PG 506A
	Sinewave voltage	5 V _{P-P} into 50 Ω (100 mA), 935 Hz to 120 MHz 1.5X, flatness	
Digital multimeter (DMM)	RMS ACV	5 1/2 digits or better 50 kHz $\leq 0.5\%$	Keithley 2000, or HP 3458A
Adapter		BNC "T"	Tektronix part number 103-0030-XX
Coaxial cables (2)		36-inch, 50 Ω precision	Tektronix part number 012-0482-XX
Adapter		BNC-to-dual banana	Tektronix part number 103-0090-XX
Fixture		Current probe, calibration	Tektronix part number 067-0559-XX

Photocopy the Test Record and use it to record the performance test results. (See Table 9 on page 21.)

Performance Verification

Check Midband Accuracy Refer to the illustration below when making equipment connections.

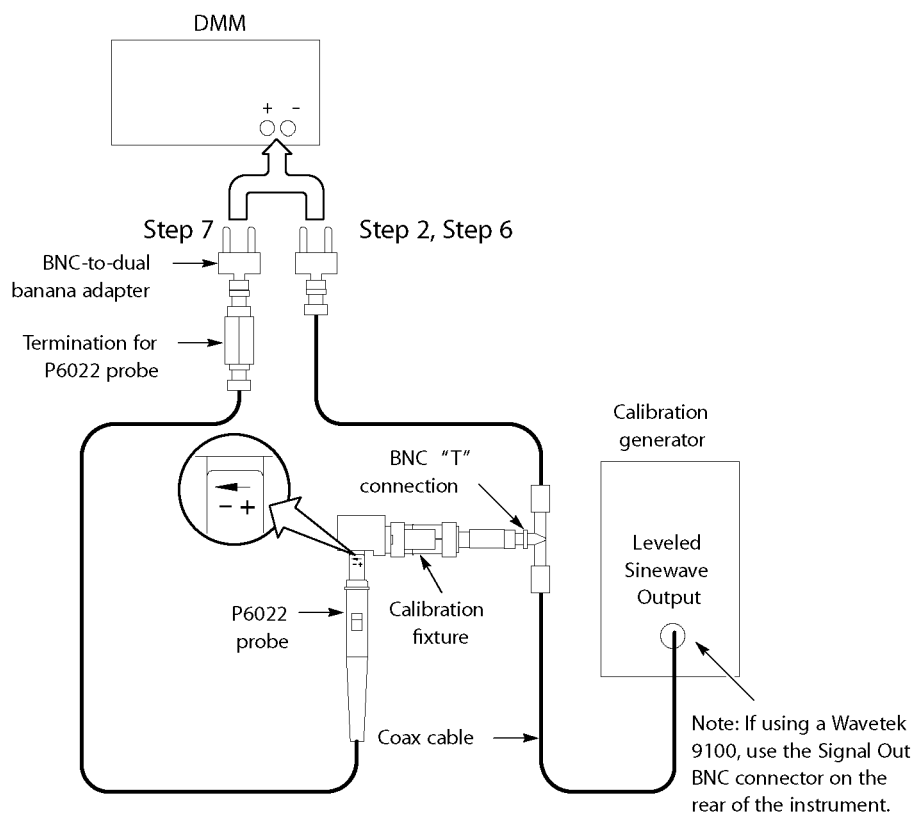


Figure 5: Midband accuracy test setup

1. Set the P6022 termination sensitivity to 1 mA/mV.
2. Connect the Leveled Sinewave Output of the calibration generator to a BNC "T". Connect one branch of the BNC "T" to the calibration fixture. Connect the other branch of the BNC "T" to the DMM input using a BNC-to-dual banana adapter.
3. Set the DMM to ACV (autorange).
4. Set the Leveled Sinewave Output of the calibration generator to 50 kHz and an amplitude of 5 V_{pp}.
5. Measure and record the DMM output as M1.
6. Disconnect the coax cable from the BNC-to-dual banana adapter.
7. Connect the P6022 termination and probe to the BNC-to-dual banana adapter.
8. Connect the probe to the calibration fixture.
9. Record the DMM output as M2.
10. Calculate the % of error.

$$I_{test} = \frac{M1}{50 \Omega}$$

$$\%Error = \frac{M2 - I_{test}}{I_{test}} \times 100$$

11. Record the results in the test record and compare the results against the midband accuracy specification. (See Table 1 on page 9.)
12. Set the P6022 termination sensitivity to 10 mA/mV.
13. Record the DMM output as M3.
14. Calculate the % of error:

$$\%Error = \frac{10 \times M3 - I_{test}}{I_{test}} \times 100$$

15. Record the results in the test record and compare the results against the midband accuracy specification.

Check Low Frequency Response

Refer to the setup diagram when making equipment connections. (See Figure 5 on page 15.)

1. Connect the calibration fixture to the Leveled Sinewave Output of the calibration generator.
2. Connect the BNC-to-dual banana adapter to the input of the DMM.
3. Connect the P6022 termination and probe to the BNC-to-dual banana adapter that is connected to the DMM.
4. Set the P6022 termination sensitivity to 1 mA/mV.
5. Set the DMM to ACV (autorange).
6. Set the Leveled Sinewave Output of the calibration generator to 50 kHz and an amplitude of 5 V_{pp}.
7. Connect the probe to the calibration fixture.
8. Enable the Leveled Sinewave Output of the calibration generator.
9. Measure and record the DMM output as M1 in the table below. (See Table 7 on page 18.)
10. Set the Leveled Sinewave Output of the calibration generator to 8.5 kHz.
11. Measure and record the DMM output as M2 in the table below. (See Table 7.)
12. Calculate the low frequency bandwidth ratio:

$$\text{low frequency bandwidth ratio} = \frac{M2}{M1}$$
13. Record the results in the test record and compare the results against the low frequency specification. (See Table 1 on page 9.)
14. Set the P6022 termination sensitivity to 10 mA/mV.
15. Set the Leveled Sinewave Output of the calibration generator to 50 kHz and an amplitude of 5 V_{pp}.
16. Measure and record the DMM output as M3 in the table below. (See Table 7.)
17. Set the Leveled Sinewave Output of the calibration generator to 935 Hz.
18. Measure and record the DMM output as M4 in the table below. (See Table 7.)
19. Calculate the low frequency bandwidth ratio:

$$\text{low frequency bandwidth ratio} = \frac{M4}{M3}$$
20. Record the results in the test record and compare the results against the low frequency specification.

NOTE. *Dirty or worn mating surfaces between the transformer and the lid degrade the low-frequency response. Clean them if necessary. (See page 24, Maintenance.)*

Table 7: P6022 low frequency bandwidth measurements

Probe sensitivity	Probe sensitivity	M1	M2	M2/M1	M3	M4	M4/M3
1 mA/mV	50 kHz						
	8.5 kHz						
10 mA/mV	50 kHz						
	935 Hz						

Check High Frequency Bandwidth

Refer to the figure below when making equipment connections.

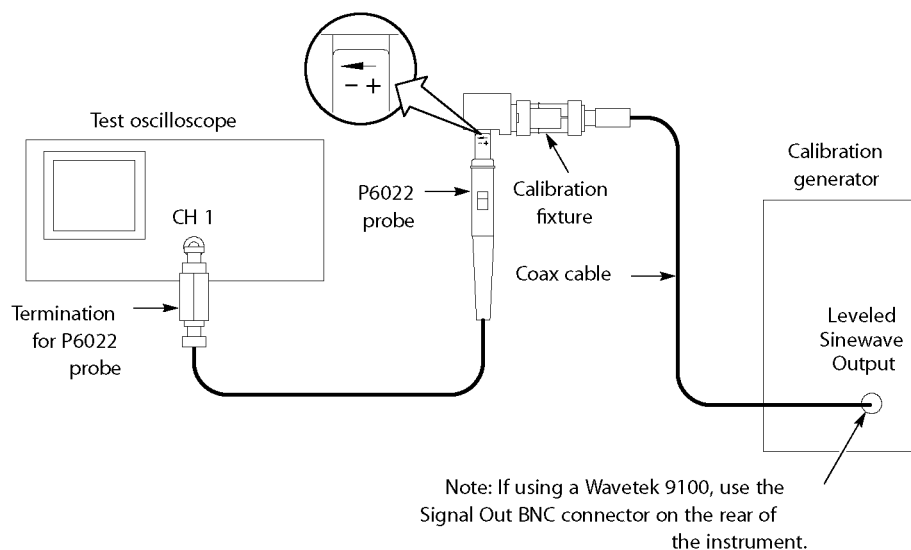


Figure 6: High frequency bandwidth test setup

1. Set the P6022 termination sensitivity to 1 mA/mV.
2. Connect the calibration fixture to the Leveled Sinewave Output of the calibration generator.
3. Connect the P6022 termination and probe to CH1 of the oscilloscope.
4. Set the oscilloscope Vertical Deflection to 20 mV/div.
5. Set the oscilloscope Horizontal Scale to 10 μ s/div.
6. Set the oscilloscope Auto Measurement to display "Amplitude".
7. Set the Leveled Sinewave Output of the calibration generator to 50 kHz and an amplitude of 5 V_{pp}.
8. Connect the probe to the calibration fixture.
9. Enable the Leveled Sinewave Output of the calibration generator.
10. Measure and record the oscilloscope "amplitude" Auto Measurement as M1 in the table. (See Table 8 on page 20.)
11. Set the oscilloscope Horizontal Scale to 4 ns/div or 5 ns/div.
12. Set the Leveled Sinewave Output of the calibration generator to 100 MHz.
13. Measure and record the oscilloscope amplitude Auto Measurement as M2 in the table.
14. Calculate the high frequency bandwidth ratio:

$$\text{high frequency bandwidth ratio} = \frac{M2}{M1}$$

15. Record the results in the test record and compare the results against the high frequency specification. (See Table 1 on page 9.)
16. Set the P6022 termination sensitivity to 10 mA/mV.
17. Set the oscilloscope Vertical Deflection to 2 mV/div.
18. Set the oscilloscope Horizontal Scale to 10 μ s/div.
19. Set the Leveled Sinewave Output of the calibration generator to 50 kHz and an amplitude of 5 V_{pp}.
20. Measure and record the oscilloscope amplitude Auto Measurement as M3 in the table.
21. Set the oscilloscope Horizontal Scale to 4 ns/div or 5 ns/div.
22. Set the Leveled Sinewave Output of the calibration generator to 120 MHz.
23. Measure and record the oscilloscope amplitude Auto Measurement as M4 in the table.
24. Calculate the high frequency bandwidth ratio:

$$\text{high frequency bandwidth ratio} = \frac{M4}{M3}$$

25. Record the results in the test record and compare the results against the high frequency specification.

When you are done, disconnect all test equipment and replace the termination cover.

Table 8: High frequency bandwidth measurements

Probe sensitivity	Vertical Deflection	Horizontal Scale	Leveled Sinewave Output frequency (calibration generator)	M1	M2	M2/M1	M3	M4	M4/M3
1 mA/mV	20 mV/div	10 μ s/div	50 kHz						
		4 or 5 ns/div	100 MHz						
10 mA/mV	2 mV/div	10 μ s/div	50 kHz						
		4 or 5 ns/div	120 MHz						

P6022 Test Record

Photocopy this form and use it to record the performance test results.

Table 9: P6022 test record

Instrument Serial Number:

Certificate Number:

Temperature:

Relative Humidity %:

Date of Calibration:

Technician:

Performance test	Range, mA/mV	Minimum	Measured/calculated	Maximum
Midband Accuracy (% Error)	1	-3%		+3%
	10	-3%		+3%
Bandwidth, Low Frequency Response	1	0.707		—
	10	0.707		—
Bandwidth, High Frequency Response	1	0.707		—
	10	0.707		—

Adjustment Procedure

Preparation

If the probe does not pass the performance verification procedure or you want to optimize the performance of the probe, perform the following adjustment procedure:

1. Insert a small screwdriver between the cover and the termination near the part number, and gently pry up only the top cover from the P6022 termination by twisting the screwdriver. Leave the bottom cover on, as it must remain in place whenever the termination is in use.
2. Set up the oscilloscope as described below:

Control	Setting
Vertical mode	CH 1
Horizontal mode	Main
Trigger source	CH 1
Trigger coupling	AC
Trigger mode	Peak-to-peak, auto
Trigger slope	Positive
Trigger level	As required
Ch 1 coupling	DC
Volts/division	2 mV
Time/division	4 ns or 5 ns (depending on oscilloscope type)
Averages	5 to 10

NOTE. When using a Wavetek 9100 calibrator with the scopecal option, no other calibrators are required. The following setups are generic with nominal settings indicated for the major adjustment steps.

Adjust Aberrations



CAUTION. To avoid damaging the probe, do not disconnect the probe termination when measuring high currents. Leaving the probe cable unterminated can cause a high voltage to develop in the secondary winding which may damage the current probe transformer.

1. Connect the current probe calibration fixture to the fast rise output of the calibration generator.
2. Set the fast rise output to maximum ($1 V_{pp}$)
3. Connect the P6022 cable BNC connector to the termination.
4. Connect the P6022 termination to the oscilloscope Ch 1 input.
5. Set the P6022 termination sensitivity to 1 mA/mV.
6. Connect the probe to the current probe calibration fixture. The figure below shows the proper probe orientation to the current probe calibration fixture.

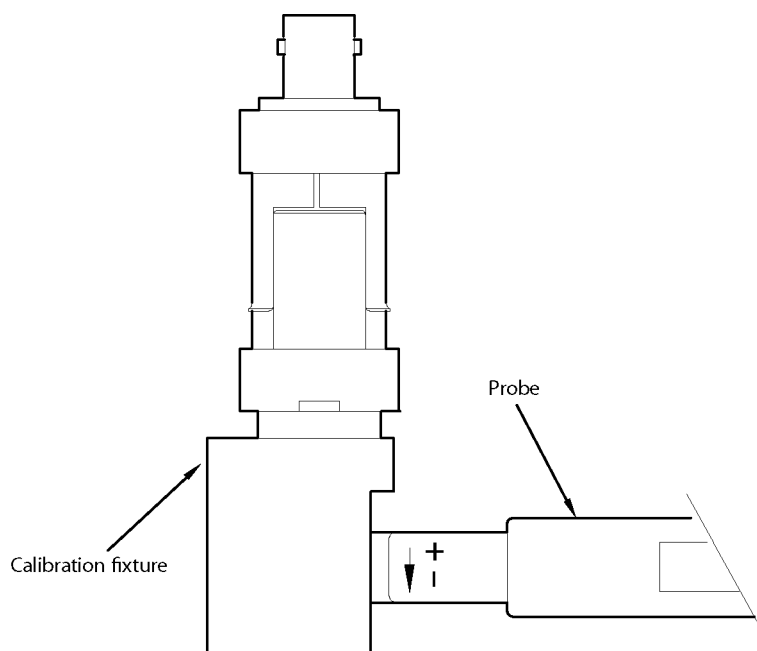


Figure 7: Connecting the probe to the calibration fixture

7. Adjust C28 and C29 (in the termination), and then R10 (through the hole in the probe body) to minimize aberrations and achieve the best flat-top response. The adjustment locations are shown in the illustration. (See Figure 8 on page 24.)

NOTE. The R10 adjustment affects the aberrations of both the 1mA/mV and 10 mA/mV termination setting along with the high frequency response. Readjust the high frequency response if it fails.

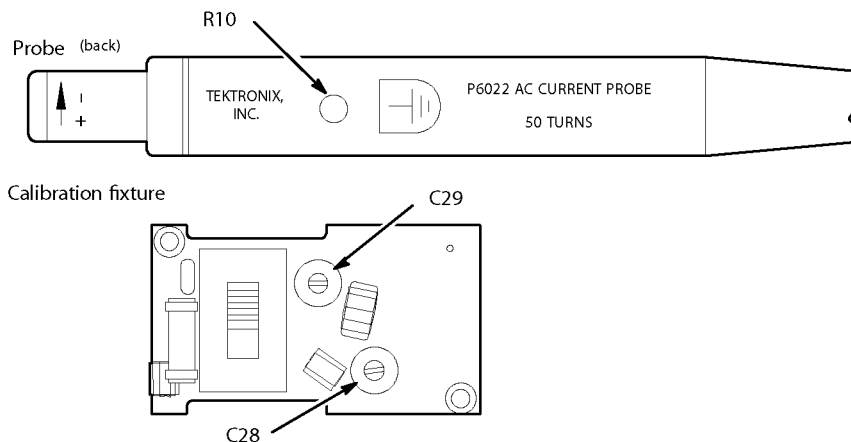


Figure 8: Location of probe and termination adjustments

Maintenance

The information in this section will help you maintain your probe for a long service life.

Cleaning

To clean the probe body, use a soft cloth dampened with water. To clean the core, open the jaw and clean the exposed core surfaces with a cotton swab dampened with isopropyl alcohol.



CAUTION. To prevent damage to probe materials, avoid using chemicals that contain benzene, benzine, toluene, xylene, acetone, or similar solvents.

Do not immerse the probe in liquids or use abrasive cleaners.

Do not lubricate the jaws mating surfaces. Any lubricant between the core pieces should be removed with a recommended solvent.

Do not use a petroleum based lubricant on the plastic. If the plastic slide assembly requires lubrication, use a silicone-based grease sparingly.

When cleaning the probe, look for any excessive wear of the slide parts that might cause the probe to operate improperly. Dirty or worn mating surfaces between the transformer and the lid can degrade low-frequency response. Clean these surfaces if necessary.

Disassembling the Probe

Use the following procedure to disassemble the probe for cleaning or repair. You will need a low power soldering iron with a fine point. Work over a smooth, clean surface so that you can easily find any small pieces that may drop. (See Figure 9.)



CAUTION. To avoid degrading the performance of the probe, do not touch the polished mating surfaces of the transformer after cleaning.

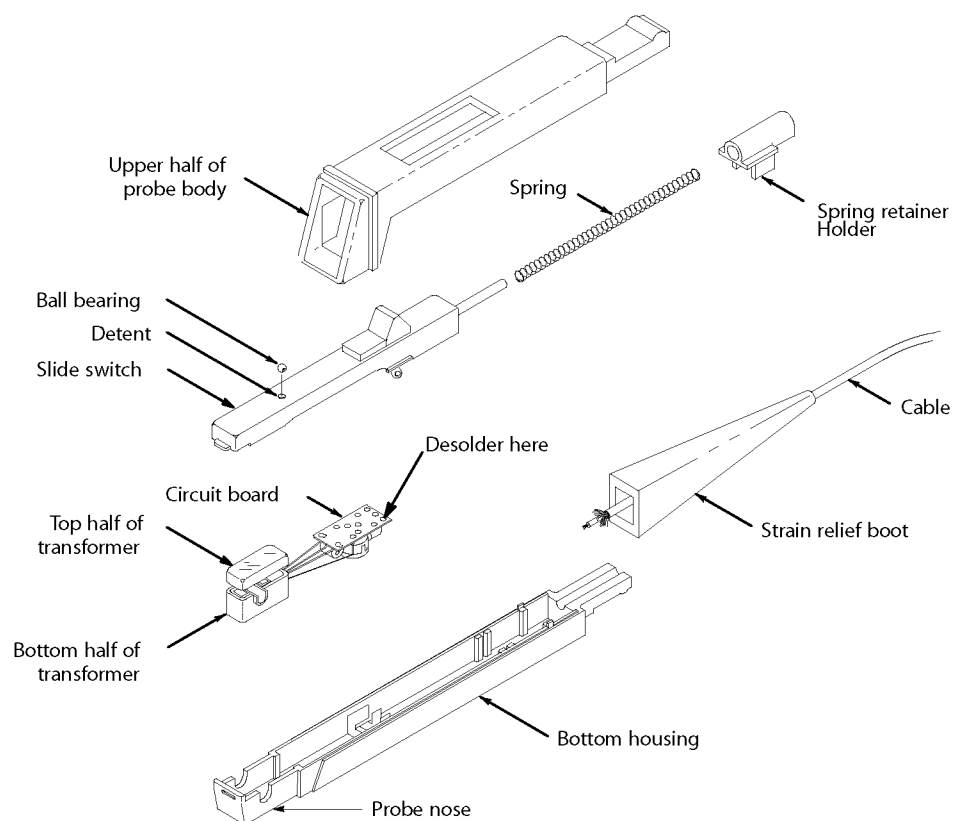


Figure 9: Disassembling the probe

1. Hold the probe horizontally with the slide switch up.
2. Pull the strain relief boot back over the cable. Lightly rock the strain relief boot from side to side as you pull back on it.
3. Be careful, there is a spring-loaded retainer and a small ball bearing you are about to expose.
4. Slowly lift the upper half of the probe body slightly at the cable end and push the assembly forward over the nose and off.
5. Remove the small ball bearing from the detent in the slide switch.
6. Lift the back of the return spring retainer out of the holder.
7. Remove the slide switch, spring retainer, and the top of the transformer as a unit. Notice the orientation of the movable portion of the transformer in the slide.



CAUTION. *To prevent damage to the circuit board when desoldering, use only enough heat to separate or attach connections. Excess heat may cause irreparable damage to the circuit board.*

8. Desolder the ground connection on the circuit board. (See Figure 9 on page 25.)
9. Lift the circuit board, transformer, and cable out of the probe body as a unit. Be careful, the cable connection to the board is fragile and may break if not handled gently.
10. To reassemble the probe, reverse the procedure above.

When replacing the slide switch, spring retainer, and transformer top as a unit, push the slide switch contacts gently inside the sides of the bottom housing.

Repairing the Probe

To make repairs inside the probe body, disassemble the probe as described in the previous section. If you need to solder on the circuit board, use a minimum of heat and observe normal circuit board procedures.

If you need to replace the current transformer, replace the entire assembly including the other half of the transformer core mounted in the slide switch. The transformer halves are matched at the factory before shipment.

Repairing the Termination

Repairing the termination can consist of replacing either the connectors or the circuit board. These tasks are described below.

Replacing the Connectors. To replace the connectors, follow these steps:

1. Insert a small screwdriver between the cover and the termination near the part number, and gently pry up the plastic snap-on cover from the termination.
2. Using a heat sink, unsolder the leads from the defective connector.
3. Unscrew and remove the defective connector.
4. Replace the defective connector with the new one.
5. Screw and solder the new connector back in place.
6. Align the switch with the slider in the front cover and replace the front cover.

Replacing the Circuit Board. To replace the circuit board, follow these steps:

1. Remove the plastic snap-on covers from the front and back of the termination.
2. Using a heat sink, unsolder the leads from the connectors.
3. Unscrew the two screws from the back of the circuit board.
4. Remove the circuit board from the termination and repair it as you require, being careful to use a minimum of heat and observe normal circuit board procedures.
5. Replace the circuit board by reversing the above procedure.
6. Align the switch with the slider in the front cover and replace the front cover.

Replaceable Electrical Parts

Parts Ordering Information

Replacement parts are available from or through your local Tektronix, Inc. service center or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available and to give you the benefit of the latest circuit improvements. Therefore, when ordering parts, it is important to include the following information in your order:

- Part number
- Instrument type or model number
- Instrument serial number
- Instrument modification number, if applicable

If a part you order has been replaced with a different or improved part, your local Tektronix service center or representative will contact you concerning any change in the part number.

Change information, if any, is located at the rear of this manual.

Using the Replaceable Parts List

The tabular information in the Replaceable Parts List is arranged for quick retrieval. Understanding the structure and features of the list will help you find the all the information you need for ordering replacement parts.

Item Names

In the Replaceable Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, U.S. Federal Cataloging Handbook H6-1 can be used where possible.

Abbreviations

Abbreviations conform to American National Standards Institute (ANSI) standard Y1.1

List of Assemblies

A list of assemblies can be found at the beginning of the electrical parts list. The assemblies are listed in numerical order. When the complete component number of a part is known, this list will identify the assembly in which the part is located.

**Component Number
(column 1 of the parts list)**

The circuit component number appears on the diagrams and circuit board illustrations. Each diagram and circuit board illustration is clearly marked with the assembly number. Assembly numbers are also marked on the mechanical exploded views located in the mechanical parts list. The component number is obtained by adding the assembly number prefix to the circuit number.

The electrical parts list is divided and arranged by assemblies in numerical sequence (e.g., assembly A1 with its subassemblies and parts, precedes assembly A2 with its subassemblies and parts).

Chassis-mounted parts have no assembly number prefix and are located at the end of the electrical parts list.

**Tektronix Part Number
(column 2 of the parts list)**

Indicates part number to be used when ordering replacement part from Tektronix.

**Serial Number (columns 3
& 4 of the parts list)**

Column three (3) indicates the serial number at which the part was first used. Column four (4) indicates the serial number at which the part was removed. No serial number entered indicates part is good for all serial numbers.

**Name & Description
(column five of the parts
list)**

In the parts list, an item name is separated from the description by a colon (:). Because of space limitations, an item name may sometimes appear as incomplete. For further item name identification, the U.S. Federal Catalog handbook H6-1 can be utilized where possible.

Table 10: Replaceable electrical parts

Component number	Tektronix part number	Serial number effective/dscont	Name & description
A1	670-1112-00		CIRCUIT BD ASSY:PROBE
A2	011-0106-00		TERMN,COAXIAL:P6022
A1	670-1112-00		CIRCUIT BD ASSY:PROBE
A1C10	283-0157-00		CAP,FXD,CER DI:7PF,5%,50V
A1L10	120-0285-00		XFMR,TOROID:4 TURNS,SINGLE
A1R10	311-0605-00		RES,VAR,NONWW:TRMR,200 OHM,0.5W
A1T1	120-0603-00		TRANSFORMER,CUR:
A1T14	120-0286-00		XFMR,TOROID:2 TURNS,BIFILAR,3S76
A2	011-0106-00		TERMN,COAXIAL:P6022
A2C21	283-0066-00		CAP,FXD,CER DI:2.5PF,+/-0.5PF,200V
A2C26	281-0629-00		CAP,FXD,CER DI:33PF,5%,600V
A2C28	281-0123-00		CAP,VAR,CER DI:5-25PF,100V
A2C29	281-0123-00		CAP,VAR,CER DI:5-25PF,100V
A2C37	283-1162-00		CAP,FXD,CERAMIC; MLC;39PF,5%,50V,C0G/NPO;RADIAL SQUARE
A2L26	108-0409-01		COIL,RF:FIXED,17.5UH
A2L28	108-0523-00		XFMR,TOROID:FIXED,160NH
A2L33	108-0395-00		COIL,RF:FIXED,64UH
A2R26	321-0014-00		RES,FXD,FILM:13.7 OHM,1%,0.125W,TC=T0
A2R28	317-0201-00		RES,FXD,CMPSN:200 OHM,5%,0.125W
A2R29	321-0751-06		RES,FXD,FILM:50 OHM,0.25%,0.125W,TC=T9
A2R31	321-0210-00		RES,FXD,FILM:1.50K OHM,1%,0.125W,TC=T0
A2R33	321-0078-00		RES,FXD,FILM:63.4 OHM,1%,125W,TC=T0
A2R34	321-0002-00		RES,FXD,FILM:10.2 OHM,1%,0.125W,TC=T0
A2R35	321-0003-00		RES,FXD,FILM:10.5 OHM,1%,0.125W
A2R36	317-0270-00		RES,FXD,CMPSN:27 OHM,5%,0.125W
A2R37	317-0300-00		RES,FXD,CMPSN:30 OHM,5%,0.125W
A2R39	317-0240-00		RES,FXD,CMPSN:24 OHM,5%,0.125W
A2SW30	260-0723-00		SWITCH,SLIDE:DPDT,0.5A,125VAC

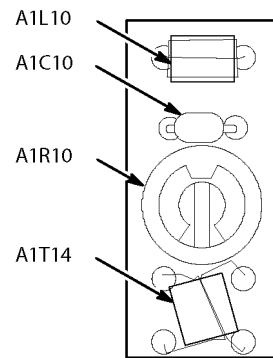


Figure 10: P6022 probe component location

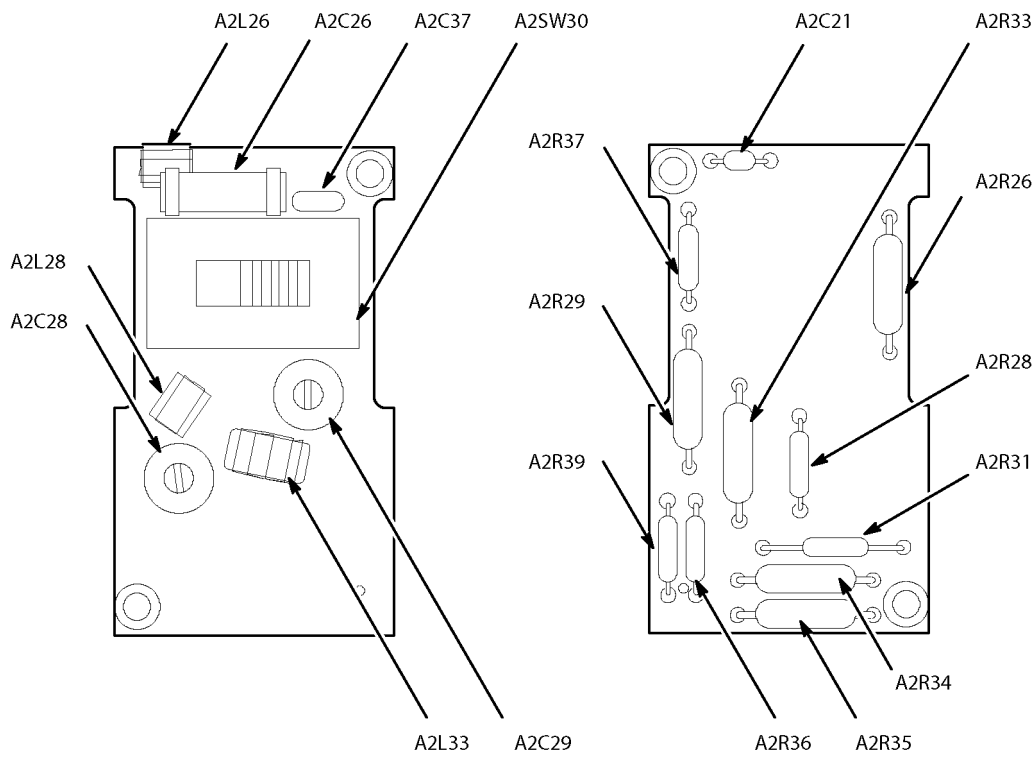


Figure 11: P6022 termination component Location

Replaceable Mechanical Parts

This section contains a list of the mechanical parts that are replaceable for the P6022. Use this list to identify and order replacement parts.

Parts Ordering Information

Replacement parts are available from or through your local Tektronix, Inc. service center or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available and to give you the benefit of the latest circuit improvements. Therefore, when ordering parts, it is important to include the following information in your order:

- Part number
- Instrument type or model number
- Instrument serial number
- Instrument modification number, if applicable

If a part you order has been replaced with a different or improved part, your local Tektronix service center or representative will contact you concerning any change in the part number.

Change information, if any, is located at the rear of this manual.

Using the Replaceable Parts List

The tabular information in the Replaceable Parts List is arranged for quick retrieval. Understanding the structure and features of the list will help you find the all the information you need for ordering replacement parts.

Item Names In the Replaceable Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, U.S. Federal Cataloging Handbook H6-1 can be used where possible.

Abbreviations Abbreviations conform to American National Standards Institute (ANSI) standard Y1.1

Table 11: Replaceable mechanical parts

Fig. & index no.	Tektronix part no.	Serial number effective dscont	Qty	Name & description
12 -	—		1	P6022,PROBE,CURRENT:120 MHZ,100A,5FT W/TERM
-1	204-0360-01		1	BODY,PROBE:UPPER
-2	214-0581-00		1	BALL,DETENT:0.062 DIA STEEL
-3	351-0174-00		1	SLIDE,TEST PROD:ACETAL
-4	214-0735-00		1	SPRING,HLCPS:0.12 OD X 1.5 L,OPEN ENDS,MUW
-5	214-1110-00		1	RETAINER,SPRING:CURRENT PROBE
-6	—		1	TRANSFORMER,CUR:(SEE A1T1 REPL)
-7	—		1	CIRCUIT BD ASSY:PROBE(SEE A1 REPL)
-8	204-0362-02		1	BODY ASSY,PROBE:LOWER
-9	175-1027-00		1	CABLE ASSY,RF:62.5 OHM COAX,60.0 L
-10	200-0852-06		1	COV,COAX TERMN:W/SHLD & KNOB
-11	426-0423-03		1	FRAME,COAX TERM:
-12	131-0602-00		1	CONN,RF PLUG::BNC,;50 OHM,MALE,STR, .FEEDTHRU./FRONT PNL,1.555 L,0.285 L .0.375-32 THD,0.5. L 22 AWG TAB,0.384 DIA MTG
-13	131-0106-02		1	CONN,RF JACK:BNC,;50 OHM,FEMALE,SLDR .CUP/FRONT PNL,0.520 MLG X 0.403 TAIL,0.04 L .SLDR CUP,0.380,D/1 FLAT
-14	361-0219-00		2	SPACER,SLEEVE:0.06 L X 0.093 ID,BRS
-15	—		1	TERMN,COAXIAL:(SEE A2 REPL) ATTACHING PARTS
-16	211-0001-00		2	SCREW,MACHINE:2-56 X 0.25,PNH,STL END ATTACHING PARTS
-17	200-0851-03		1	COV,COAX TERMN:
STANDARD ACCESSORIES				
-18	196-3120-01		1	LEAD,ELEC,PROBE GROUND;SDI,23 AWG,6.0 L
	070-0948-xx		1	MANUAL,TECH:INSTRUCTION,P6022

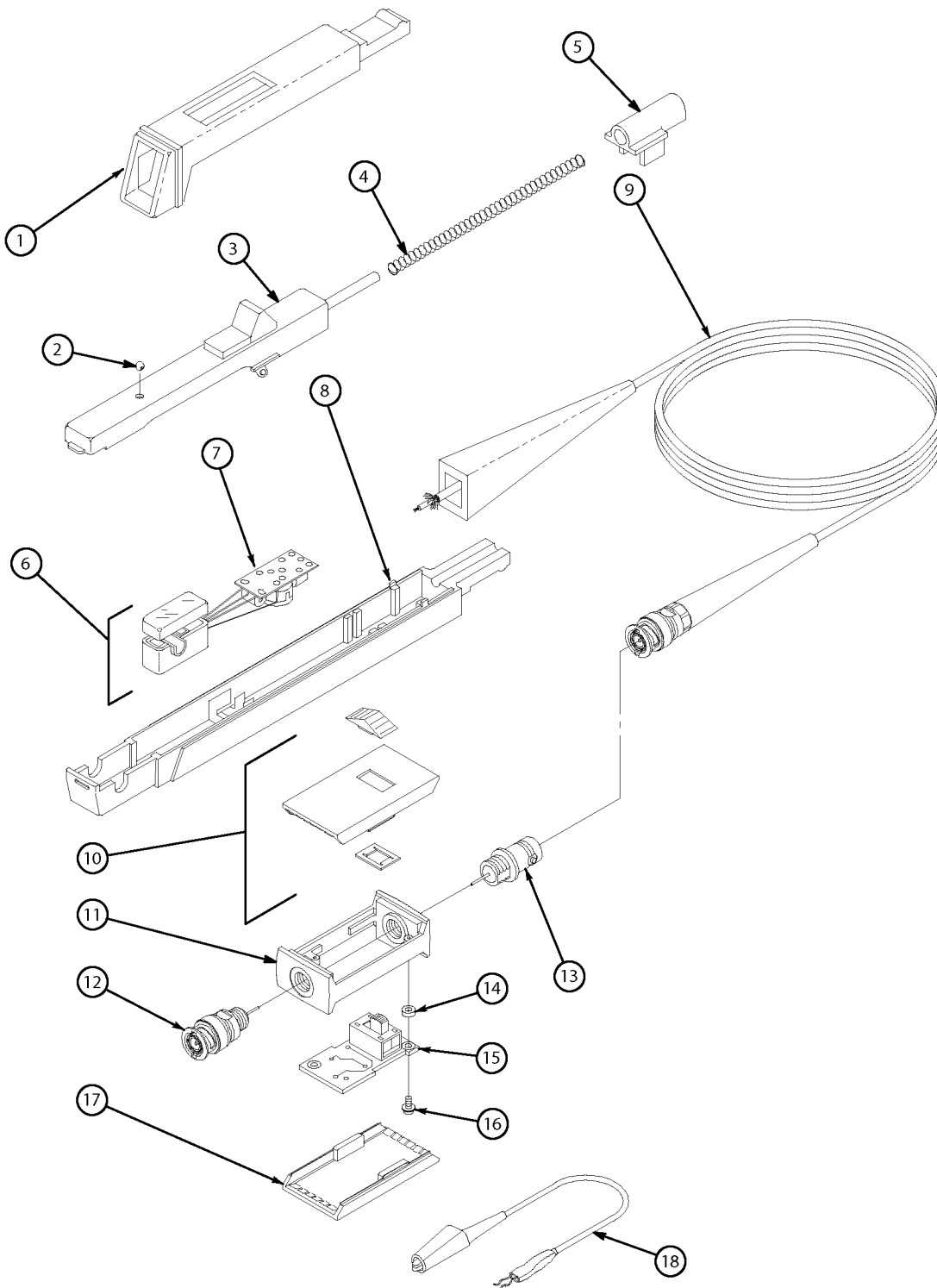


Figure 12: P6022 exploded view

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