

Instruction Manual



P6022 Current Probe 070-0948-04

Warning

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

www.tektronix.com

www.valuetronics.com

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General Safety Summary

Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it.

Only qualified personnel should perform service procedures.

Injury Precautions

Avoid Electric Overload

To avoid injury or fire hazard, do not apply potential to any input, including the common inputs, that varies from ground by more than the maximum rating for that input.

Do Not Operate Without Covers

To avoid electric shock or fire hazard, do not operate this product with covers or panels removed.

Do Not Operate in Wet/Damp Conditions

To avoid electric shock, do not operate this product in wet or damp conditions.

Do Not Operate in an Explosive Atmosphere

To avoid injury or fire hazard, do not operate this product in an explosive atmosphere.

Product Damage Precautions

Do Not Operate with Suspected Failures

If you suspect there is damage to this product, have it inspected by qualified service personnel.

Do Not Immerse in Liquids

Clean the probe using only a damp cloth. Refer to cleaning instructions.

Safety Terms and Symbols

Terms in This Manual

These terms may appear in this manual:



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



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

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:



DANGER
High Voltage



Protective
Ground (Earth)
Terminal



ATTENTION
Refer to Manual



Double
Insulated

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.

Contacting Tektronix

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

* **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.

Operator Information

Thank you for choosing a Tektronix current probe. 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 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 and termination.

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 1 shows the probe and various parts referred to in this manual.

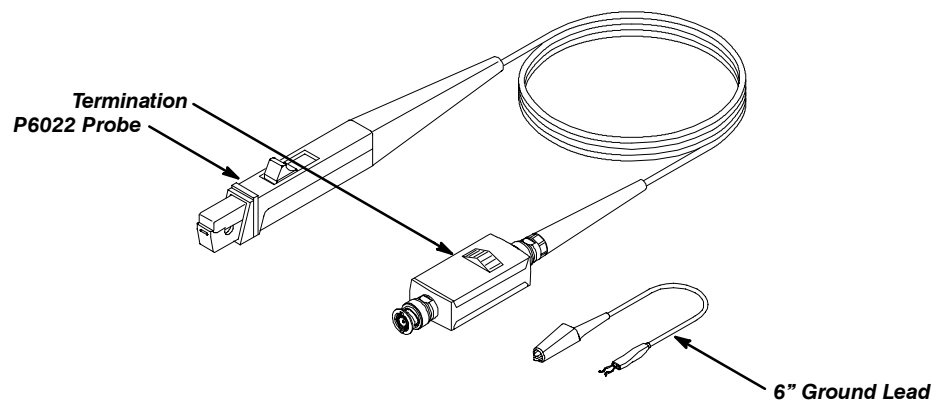


Figure 1: The P6022 Probe and Termination

Attaching the Probe and Termination to an Oscilloscope

Attach the probe to the termination as shown in Figure 1.

A 6-inch ground lead is supplied to improve EMI rejection at high frequencies (2 MHz and above). Snap the ground lead to the probe transformer post and attach the alligator clip directly to RF ground. This will reduce ringing and help bypass capacitively-coupled RF currents which can flow into the probe cable.



To avoid damaging 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 damage the current probe transformer.



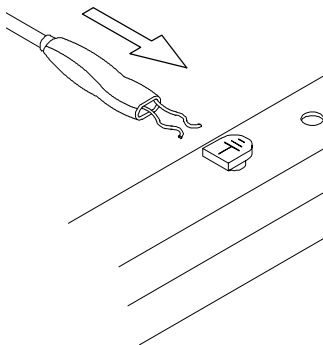
When the probe slides are open, the exposed ferrite core pieces are not insulated. To avoid injury or equipment damage, remove power from an uninsulated wire before clamping the current probe around it. Also, never disconnect the probe from the termination when the probe is connected to a live conductor.

Using the Standard Accessories

Your P6022 is shipped with the following accessories:

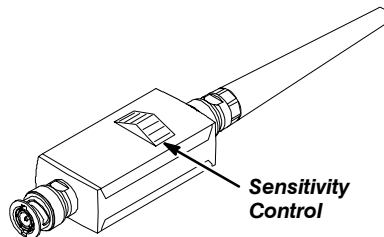
- **This instruction manual** — Read these instructions to familiarize yourself with the features, specifications, and operation of the P6022 current probe.
- **6-inch ground lead** — Use the 6-inch ground lead to ground the shield around the probe transformer at the probe end of the cable. This allows 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 in the section entitled *Replaceable Mechanical Parts* for part numbers.



Operating Considerations

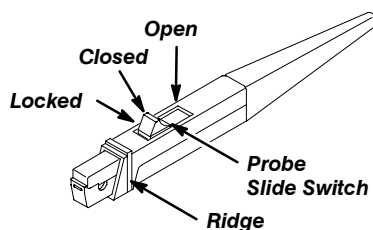
The information in this section will help you make the most effective use of your P6022 probe.



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 the closed positions.

To Use the Probe:

- Pull the slide switch toward you and hold the switch in position.
- 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.
- Release the switch, allowing the probe to close.
- 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.)

WARNING

To prevent shock when measuring uninsulated conductors, keep your hands and fingers behind the ridge on the probe head.

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. Figure 2 illustrates the equivalent circuit with additional impedance introduced by the P6022.

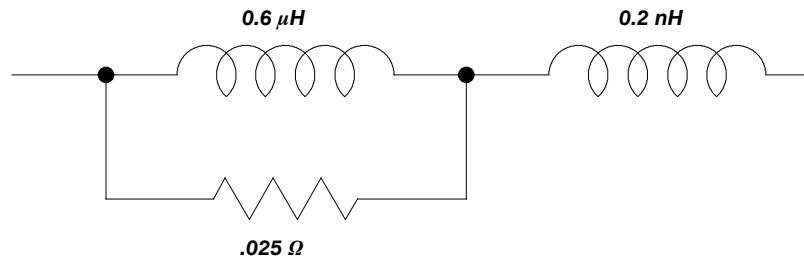


Figure 2: Insertion Impedance of the P6022

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 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=pulse duration

f=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 electrical characteristics listed in Table 1 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.
- The probe and instrument must be in an environment whose limits are described in 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 |
| Nonoperating | –40°C to +65°C |
| Altitude | |
| Operating | To 2,000 m (6,561 ft), <300 V CAT I To 4,572 m (15,000 ft), <150 V CAT II |

Table 2: Warranted Environmental Characteristics (Cont.)

| Characteristic | Information |
|----------------|-------------------------|
| Nonoperating | To 15,240 m (50,000 ft) |

Table 3: Maximum Ratings

| Characteristic | Information |
|---------------------------------|--|
| Maximum continuous (CW) current | Refer to Figure 3 for frequency derating curves |
| 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 |

Refer to Figure 3 for frequency derating curves

| | |
|--|--|
| Maximum pulse current | 100 A peak, not to exceed $9(A \cdot \mu s)$ or $2 A_{RMS}$. An $(A \cdot s)$ product greater than $9(A \cdot \mu s)$ reduces probe output to zero due to core saturation |
| Maximum working Input voltage (uninsulated conductors) | 300 VAC or VDC, CAT I, and 600 V _{pk} limited to <10 ms and <25% duty factor. |

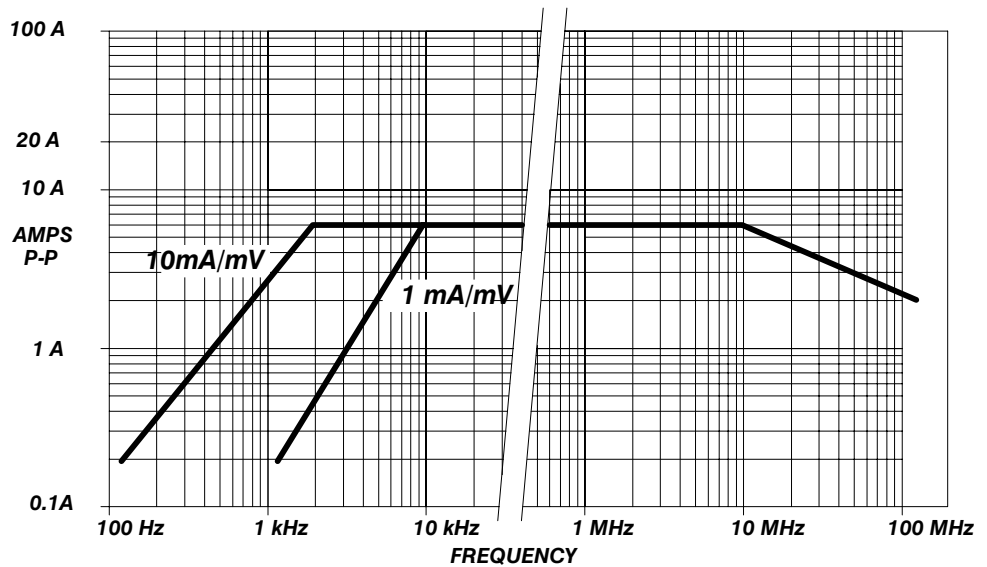


Figure 3: Probe and Termination Input Current vs. Frequency Derating

Table 4: Certifications and Compliances

EC Declaration of Conformity – Low Voltage

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

Low Voltage Directive 73/23/EEC, as amended by 93/68/EEC

| | |
|---------------|--|
| EN 61010-1/A2 | Part 1: General Requirements Safety requirements for electrical equipment for measurement, control, and laboratory test |
|---------------|--|

| | |
|---------------------|--|
| EN 61010-2-032:1995 | Part 2-032: Particular requirements for hand-held current clamps for electrical measurements and test |
|---------------------|--|

Installation Category Descriptions

Terminals on this product may have different installation category designations. The installation categories are:

| | |
|---------|---|
| CAT III | Distribution-level mains (usually permanently connected). Equipment at this level is typically in a fixed industrial location |
|---------|---|

| | |
|--------|--|
| CAT II | Local-level mains (wall sockets). Equipment at this level includes appliances, portable tools, and similar products. Equipment is usually cord-connected |
|--------|--|

| | |
|-------|---|
| CAT I | Secondary (signal level) or battery operated circuits of electronic equipment |
|-------|---|

| | |
|--------------------|--|
| Pollution Degree 2 | Do not operate in environments where conductive pollutants may be present. |
|--------------------|--|

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 5: Electrical Characteristics

| Characteristic | Information |
|---|---|
| Tilt | |
| 1 mA/mV | 4% or less within 1 μ s of step |
| 10 mA/mV | 4% or less within 10 μ s 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 | <i>Because the oscilloscope input capacitance becomes a part of the termination network, the step response will vary with different oscilloscopes</i> |
| 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 6: 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" W 1.10" H 0.86" | 88 mm 28 mm 22 mm |
| Probe body | L 6.0" W 0.4" H 0.6" | 152 mm 10 mm 15 mm |
| Maximum conductor diameter | 0.141" | 3.58 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, or to calibrate it. These procedures require the equipment listed in Table 7 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 as described in the section entitled *Maintenance* on page 23. 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 7: Equipment List

| Item | 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 | Risetime ≤ 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 μ A), 935 Hz to 120 MHz 1.5X, flatness | Wavetek 9100 with option 100:250, or Tektronix SG 5030, SG 503 |
| Digital multimeter (DMM) | 5 1/2 digits or better | Keithley 2000, or HP 3458A |
| RMS ACV | 50 kHz $\leq 0.5\%$ | |
| Adapter | BNC "T" | Tektronix Part No. 103-0030-XX |
| Coaxial cables (2) | 36-inch, 50 Ω precision | Tektronix Part No. 012-0482-XX |
| Adapter | BNC-to-dual banana | Tektronix Part No. 103-0090-XX |
| Fixture | Current probe, calibration | Tektronix Part No. 067-0559-XX |

Performance Verification

Check Midband Accuracy

Refer to Figure 4 when making equipment connections.

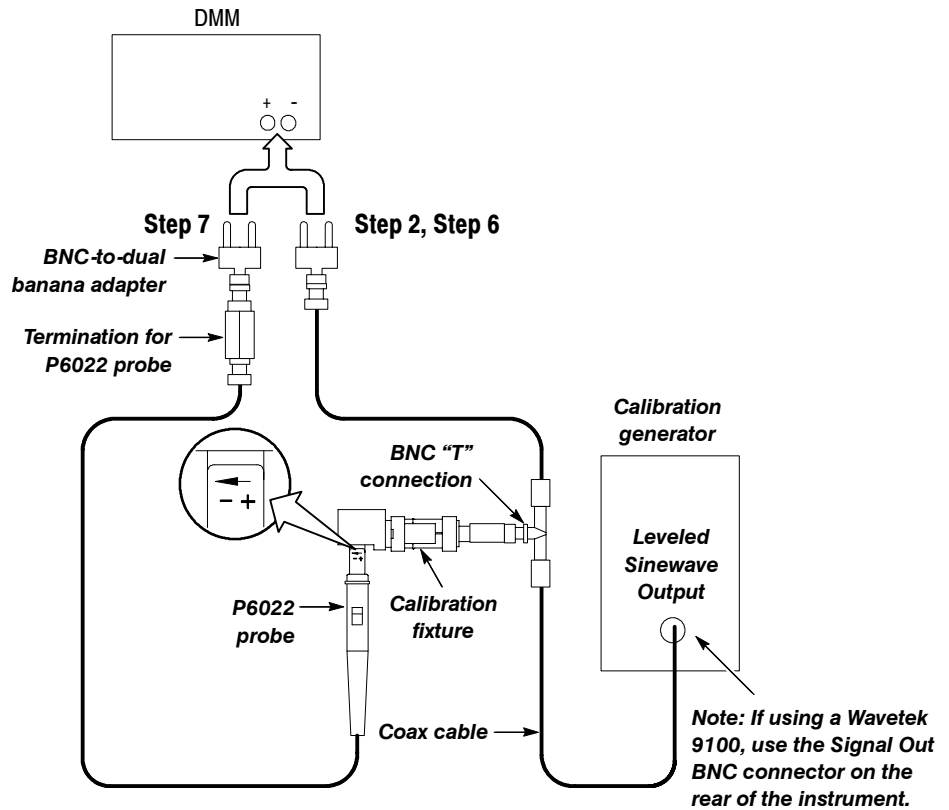


Figure 4: Midband accuracy test setup

- Step 1:** Set the P6022 termination sensitivity to 1 mA/mV.
- Step 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.
- Step 3:** Set the DMM to ACV (autorange).
- Step 4:** Set the Leveled Sinewave Output of the calibration generator to 50 kHz and an amplitude of 5 V_{pp}.
- Step 5:** Measure and record the DMM output as M1.
- Step 6:** Disconnect the coax cable from the BNC-to-dual banana adapter.

- Step 7:** Connect the P6022 termination and probe to the BNC-to-dual banana adapter.
- Step 8:** Connect the probe to the calibration fixture.
- Step 9:** Record the DMM output as M2.
- Step 10:** Calculate the % of error.

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

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

- Step 11:** Record the results in the test record on page 20 and compare the results against the midband accuracy specification on page 7.
- Step 12:** Set the P6022 termination sensitivity to 10 mA/mV.
- Step 13:** Record the DMM output as M3.
- Step 14:** Calculate the % of error:

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

- Step 15:** Record the results in the test record on page 20 and compare the results against the midband accuracy specification on page 7.

Check Low Frequency Response

Refer to Figure 4 on page 15 when making equipment connections.

- Step 1:** Connect the calibration fixture to the Leveled Sinewave Output of the calibration generator.
- Step 2:** Connect the BNC-to-dual banana adapter to the input of the DMM.
- Step 3:** Connect the P6022 termination and probe to the BNC-to-dual banana adapter that is connected to the DMM.
- Step 4:** Set the P6022 termination sensitivity to 1 mA/mV.
- Step 5:** Set the DMM to ACV (autorange).
- Step 6:** Set the Leveled Sinewave Output of the calibration generator to 50 kHz and an amplitude of 5 V_{pp}.
- Step 7:** Connect the probe to the calibration fixture.
- Step 8:** Enable the Leveled Sinewave Output of the calibration generator.

- Step 9:** Measure and record the DMM output as M1 in Table 1 – 1.
- Step 10:** Set the Leveled Sinewave Output of the calibration generator to 8.5 kHz.
- Step 11:** Measure and record the DMM output as M2 in Table 1 – 1.
- Step 12:** Calculate the low frequency bandwidth ratio:

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

- Step 13:** Record the results in the test record on page 20 and compare the results against the low frequency specification on page 20.
- Step 14:** Set the P6022 termination sensitivity to 10 mA/mV.
- Step 15:** Set the Leveled Sinewave Output of the calibration generator to 50 kHz and an amplitude of 5 V_{pp}.
- Step 16:** Measure and record the DMM output as M3 in Table 1 – 1.
- Step 17:** Set the Leveled Sinewave Output of the calibration generator to 935 Hz.
- Step 18:** Measure and record the DMM output as M4 in Table 1 – 1.
- Step 19:** Calculate the low frequency bandwidth ratio:

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

- Step 20:** Record the results in the test record on page 20 and compare the results against the low frequency specification on page 20.

NOTE

Dirty or worn mating surfaces between the transformer and the lid degrade the low-frequency response. Clean them if necessary. See page 23 for cleaning instructions.

Table 1-1: P6022 low frequency bandwidth measurements

| Probe sensitivity | Leveled Sinewave Output frequency (Calibration generator) | M1 | M2 | $\frac{M2}{M1}$ | M3 | M4 | $\frac{M4}{M3}$ |
|-------------------|---|----|----|-----------------|----|----|-----------------|
| 1 mA/mV | 50 kHz | | | | | | |
| | 8.5 kHz | | | | | | |
| 10 mA/mV | 50 kHz | | | | | | |
| | 935 Hz | | | | | | |

Check High Frequency Bandwidth

Refer to Figure 5 when making equipment connections.

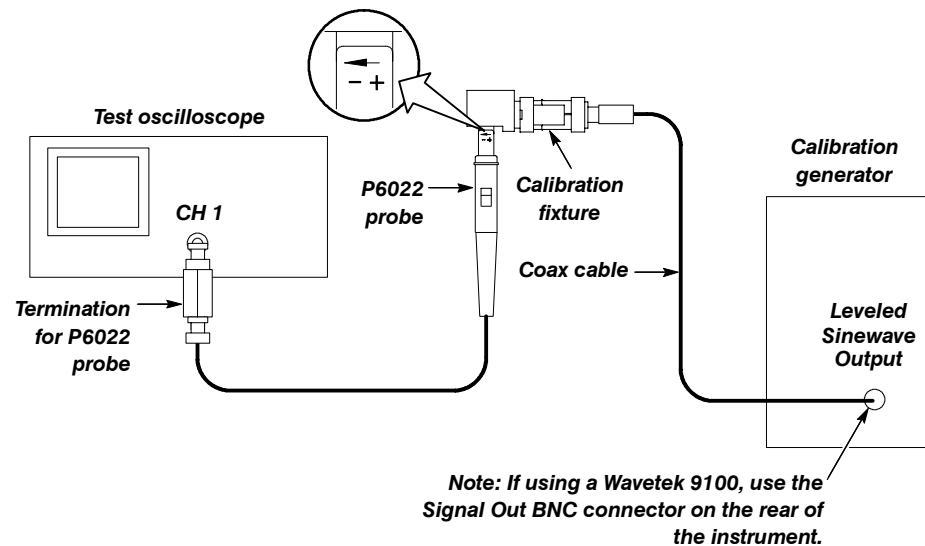


Figure 5: High frequency bandwidth test setup

- Step 1:** Set the P6022 termination sensitivity to 1 mA/mV.
- Step 2:** Connect the calibration fixture to the Leveled Sinewave Output of the calibration generator.
- Step 3:** Connect the P6022 termination and probe to CH1 of the oscilloscope.
- Step 4:** Set the oscilloscope Vertical Deflection to 20 mV/div.
- Step 5:** Set the oscilloscope Horizontal Scale to 10 μ s/div.
- Step 6:** Set the oscilloscope Auto Measurement to display "Amplitude".
- Step 7:** Set the Leveled Sinewave Output of the calibration generator to 50 kHz and an amplitude of 5 V_{pp} .
- Step 8:** Connect the probe to the calibration fixture.
- Step 9:** Enable the Leveled Sinewave Output of the calibration generator.
- Step 10:** Measure and record the oscilloscope "amplitude" Auto Measurement as M1 in Table 1–2 on page 19.
- Step 11:** Set the oscilloscope Horizontal Scale to 4 ns/div or 5 ns/div.
- Step 12:** Set the Leveled Sinewave Output of the calibration generator to 100 MHz.

Step 13: Measure and record the oscilloscope amplitude Auto Measurement as M2 in Table 1–2 on page 19.

Step 14: Calculate the high frequency bandwidth ratio:

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

Step 15: Record the results in the test record on page 20 and compare the results against the high frequency specification on page 20.

Step 16: Set the P6022 termination sensitivity to 10 mA/mV.

Step 17: Set the oscilloscope Vertical Deflection to 2 mV/div.

Step 18: Set the oscilloscope Horizontal Scale to 10 μs/div.

Step 19: Set the Leveled Sinewave Output of the calibration generator to 50 kHz and an amplitude of 5 V_{pp}.

Step 20: Measure and record the oscilloscope amplitude Auto Measurement as M3 in Table 1–2.

Step 21: Set the oscilloscope Horizontal Scale to 4 ns/div or 5 ns/div.

Step 22: Set the Leveled Sinewave Output of the calibration generator to 120 MHz.

Step 23: Measure and record the oscilloscope amplitude Auto Measurement as M4 in Table 1–2.

Step 24: Calculate the high frequency bandwidth ratio:

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

Step 25: Record the results in the test record on page 20 and compare the results against the high frequency specification on page 20.

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

Table 1-2: High frequency bandwidth measurements

| Probe sensitivity | Vertical Deflection | Horizontal Scale | Leveled Sinewave Output frequency (calibration generator) | M1 | M2 | $\frac{M2}{M1}$ | M3 | M4 | $\frac{M4}{M3}$ |
|-------------------|---------------------|------------------|---|----|----|-----------------|----|----|-----------------|
| 1 mA/mV | 20 mV/div | 10 μs/div | 50 kHz | | | | | | |
| | | 4 or 5 ns/div | 100 MHz | | | | | | |
| 10 mA/mV | 2 mV/div | 10 μs/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.

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 | | — |
| 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:

Step 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.

Step 2: Set up the oscilloscope as described below:

| | |
|------------------|---|
| 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



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.

- Step 1:** Connect the current probe calibration fixture to the fast rise output of the calibration generator.
- Step 2:** Set the fast rise output to maximum (1 V_{pp})
- Step 3:** Connect the P6022 cable BNC connector to the termination.
- Step 4:** Connect the P6022 termination to the oscilloscope Ch 1 input.
- Step 5:** Set the P6022 termination sensitivity to 1 mA/mV.

- **Step 6:** Connect the probe to the current probe calibration fixture. Figure 6 shows the proper probe orientation to the current probe calibration fixture.

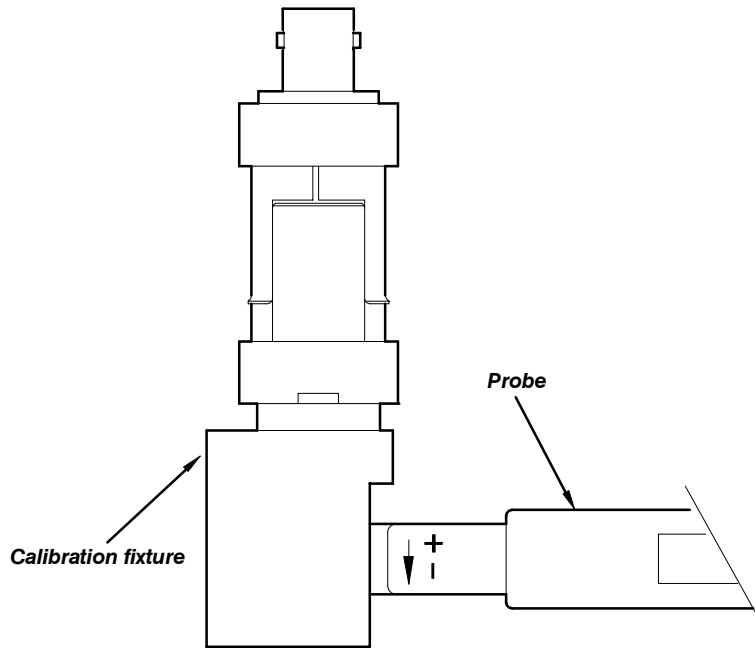


Figure 6: Connecting the Probe to the calibration fixture

- **Step 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. See Figures 7 for the adjustment locations.

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.

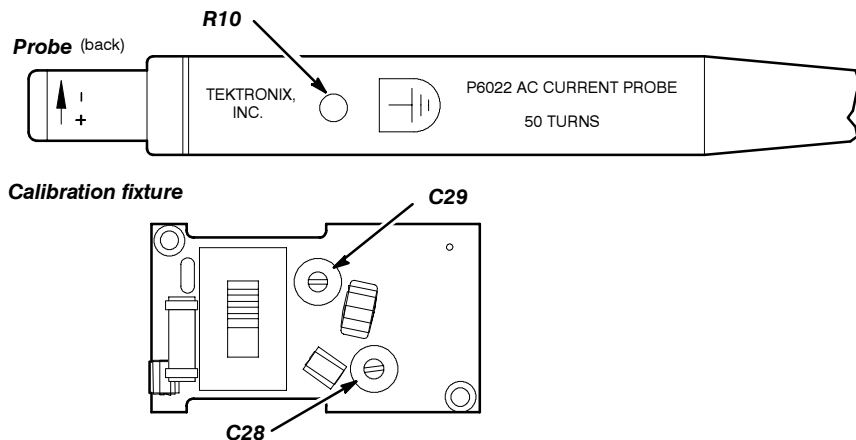


Figure 7: Location of Probe and Termination Adjustments

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 in a solution of mild detergent and water. To clean the core, open the jaw and clean the exposed core surfaces with a cotton swab dampened with isopropyl alcohol (isopropanol) or ethyl alcohol (fotocol or ethanol).



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. Refer to Figure 8 on page 24.



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

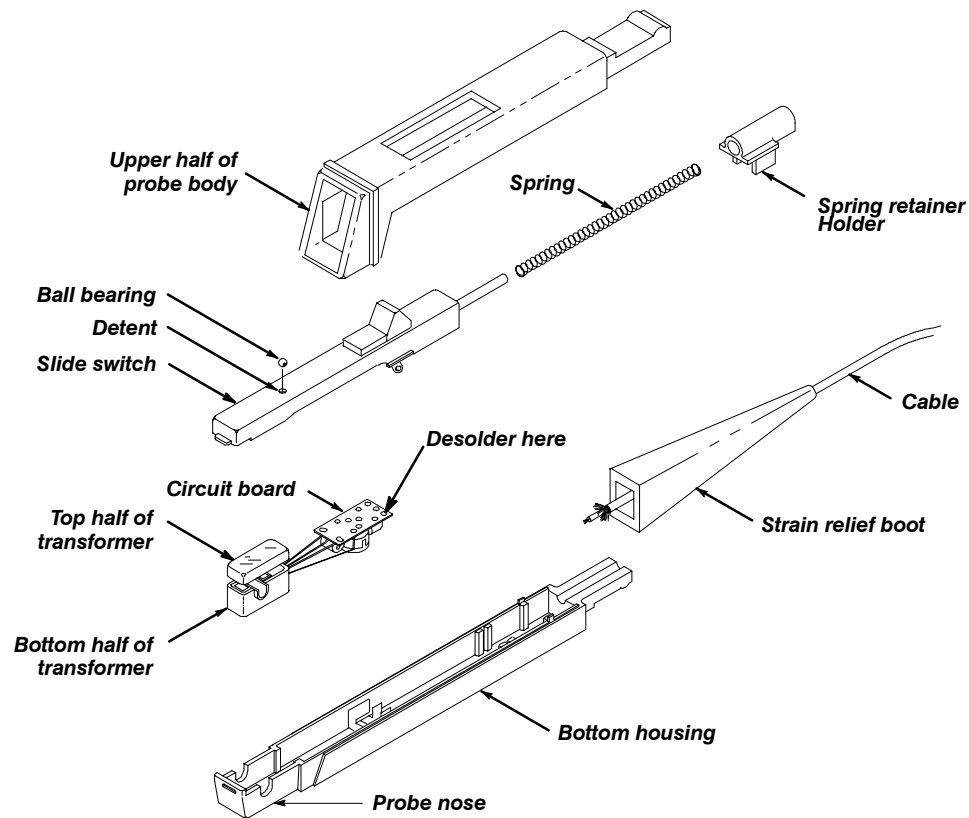


Figure 8: Disassembling the Probe

- Step 1:** Hold the probe horizontally with the slide switch up.
- Step 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.
- Step 3:** Be careful, there is a spring-loaded retainer and a small ball bearing you are about to expose.
- Step 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.
- Step 5:** Remove the small ball bearing from the detent in the slide switch.
- Step 6:** Lift the back of the return spring retainer out of the holder.
- Step 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.



When applying heat to the soldered connection, use only enough heat for as long as necessary. Excess heat may cause irreparable damage to the circuit board.

- Step 8:** Desolder the ground connection on the circuit board. See Figure 8 on the page 24.
- Step 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.
- Step 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.

- Step 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.
- Step 2:** Using a heat sink, unsolder the leads from the defective connector.
- Step 3:** Unscrew and remove the defective connector.
- Step 4:** Replace the defective connector with the new one.
- Step 5:** Screw and solder the new connector back in place.

- Step 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.

- Step 1:** Remove the plastic snap-on covers from the front and back of the termination.
- Step 2:** Using a heat sink, unsolder the leads from the connectors.
- Step 3:** Unscrew the two screws from the back of the circuit board.
- Step 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.
- Step 5:** Replace the circuit board by reversing the above procedure.
- Step 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

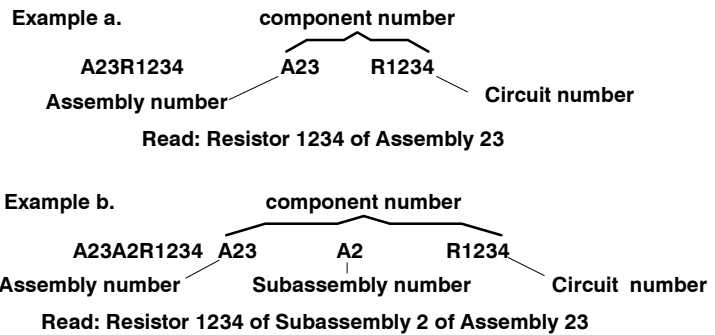
List of Assemblies

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.

Cross Index-Mfr. Code Number to Manufacturer

The Mfg. Code Number to Manufacturer Cross Index for the electrical parts list is located immediately after this page. The cross index provides codes, names, and addresses of manufacturers of components listed in the electrical parts list.

Component Number (column 1 of the parts list)



The circuit component's 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 No. (column 2 of the parts list)

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

Serial No. (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.

Mfr. Code (column 6 of the parts list)

Indicates the code number of the actual manufacturer of the part. (Code to name and address cross reference can be found immediately after this page.)

Mfr. Part No. (column 7 of the parts list)

Indicates actual manufacturer's part number.

| Component Number | Tektronix Part No. | Serial No. | | Name & Description | Mfr. Code | Mfr. Part No. |
|------------------|--------------------|------------|--------|---|-----------|-----------------|
| | | Effective | Dscont | | | |
| A1 | 670-1112-00 | | | CIRCUIT BD ASSY:PROBE | 80009 | 670111200 |
| A2 | 011-0106-00 | | | TERMN,COAXIAL:P6022 | 80009 | 011010600 |
| A1 | 670-1112-00 | | | CIRCUIT BD ASSY:PROBE | 80009 | 670111200 |
| A1C10 | 283-0157-00 | | | CAP,FXD,CER DI:7PF,5%,50V | 04222 | SR155A7R0DAA |
| A1L10 | 120-0285-00 | | | XFMR,TOROID:4 TURNS,SINGLE | 0JR03 | 120-0285-00 |
| A1R10 | 311-0605-00 | | | RES,VAR,NONWW:TRMR,200 OHM,0.5W | 32997 | 3329H-G48-201 |
| A1T1 | 120-0603-00 | | | TRANSFORMER,CUR: | 80009 | 120060300 |
| A1T14 | 120-0286-00 | | | XFMR,TOROID:2 TURNS,BIFILAR,3S76 | 0JR03 | 120-0286-00 |
| A2 | 011-0106-00 | | | TERMN,COAXIAL:P6022 | 80009 | 011010600 |
| A2C21 | 283-0066-00 | | | CAP,FXD,CER DI:2.5PF,+/-0.5PF,200V | 80009 | 283006600 |
| A2C26 | 281-0629-00 | | | CAP,FXD,CER DI:33PF,5%,600V | 52763 | 2RDPZZ007 33POJ |
| A2C28 | 281-0123-00 | | | CAP,VAR,CER DI:5-25PF,100V | 59660 | 518-000A5-25 |
| A2C29 | 281-0123-00 | | | CAP,VAR,CER DI:5-25PF,100V | 59660 | 518-000A5-25 |
| A2C37 | 283-1162-00 | | | CAP,FXD,CERAMIC; MLC;39PF,5%,50V,C0G/NPO;RADIAL SQUARE | 04222 | 283-1162-00 |
| A2L26 | 108-0409-01 | | | COIL,RF:FIXED,17.5UH | 0JR03 | 108-0409-01 |
| A2L28 | 108-0523-00 | | | XFMR,TOROID:FIXED,160NH | 0JR03 | 108-0523-00 |
| A2L33 | 108-0395-00 | | | COIL,RF:FIXED,64UH | 0JR03 | 108-0395-00 |
| A2R26 | 321-0014-00 | | | RES,FXD,FILM:13.7 OHM,1%,0.125W,TC=T0 | 91637 | CMF55116G13R70F |
| A2R28 | 317-0201-00 | | | RES,FXD,CMPSN:200 OHM,5%,0.125W | TK1727 | SFR16 2322-180- |
| A2R29 | 321-0751-06 | | | RES,FXD,FILM:50 OHM,0.25%,0.125W,TC=T9 | 57668 | CRB14 CZE 50.0 |
| A2R31 | 321-0210-00 | | | RES,FXD,FILM:1.50K OHM,1%,0.125W,TC=T0 | 91637 | CMF55116G15000F |
| A2R33 | 321-0078-00 | | | RES,FXD,FILM:63.4 OHM,1%,125W,TC=T0 | 91637 | CMF55116G63R40F |
| A2R34 | 321-0002-00 | | | RES,FXD,FILM:10.2 OHM,1%,0.125W,TC=T0 | 91637 | CMF55116G10R20F |
| A2R35 | 321-0003-00 | | | RES,FXD,FILM:10.5 OHM,1%,0.125W | 91637 | CMF55116G10R50F |
| A2R36 | 317-0270-00 | | | RES,FXD,CMPSN:27 OHM,5%,0.125W | TK1727 | SFR16 2322-180- |
| A2R37 | 317-0300-00 | | | RES,FXD,CMPSN:30 OHM,5%,0.125W | TK1727 | SFR16 2322-180- |
| A2R39 | 317-0240-00 | | | RES,FXD,CMPSN:24 OHM,5%,0.125W | TK1727 | SFR16 2322-180- |
| A2SW30 | 260-0723-00 | | | SWITCH,SLIDE:DPDT,0.5A,125VAC | 79727 | GF126-0028 |

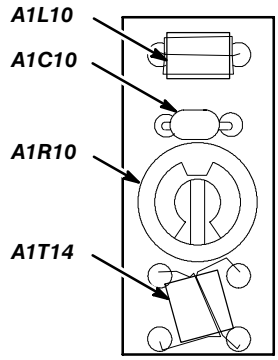


Figure 9: P6022 Probe Component Location

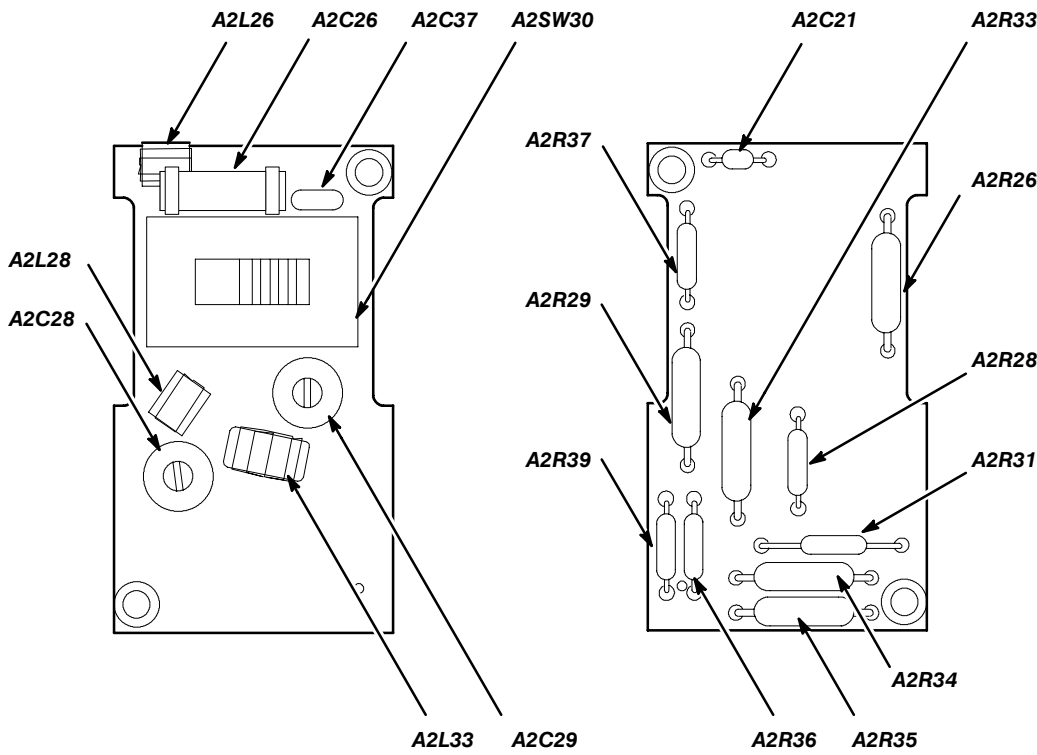


Figure 10: P6022 Termination Component Location

CROSS INDEX – MFR. CODE NUMBER TO MANUFACTURER

| Mfr. Code | Manufacturer | Address | City, State, Zip Code |
|--------------|------------------------------------|---|--------------------------------------|
| TK1727 | PHILIPS NEDERLAND BV AFD ELONCO | POSTBUS 90050 | 5600 PB EINDHOVEN THE NETHERLANDS |
| 0JR03 | ZMAN MAGNETICS INC | 7633 S 180th | KENT WA 98032 |
| 04222 | AVX CERAMICS DIV OF AVX CORP | 19TH AVE SOUTH P O BOX 867 | MYRTLE BEACH SC 29577 |
| 32997 | BOURNS INC TRIMPOT DIV | 1200 COLUMBIA AVE | RIVERSIDE CA 92507–2114 |
| 52763 | STETCO INC | 3344 SCHIERHORN | FRANKLIN PARK IL 60131 |
| 57668 | ROHM CORP | 8 WHATNEY PO BOX 19515 | IRVINE CA 92713 |
| 59660 | TUSONIX INC | 7741 N BUSINESS PARK DR PO BOX 37144 | TUCSON AZ 85740–7144 |
| 79727 | C–W INDUSTRIES | 130 JAMES WAY | SOUTHAMPTON PA 18966–3818 |
| 80009 | TEKTRONIX INC | 14150 SW KARL BRAUN DR PO BOX 500 | BEAVERTON OR 97077–0001 |
| 91637 | DALE ELECTRONICS INC | 2064 12TH AVE PO BOX 609 | COLUMBUS NE 68601–3632 |

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.

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Using the Replaceable Parts List

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Item Names

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Abbreviations

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

| Fig. & Index No. | Tektronix Part No. | Serial No. | | Qty | 12345 Name & Description | Mfr. Code | Mfr. Part No. |
|-----------------------------|-----------------------|------------|--------|-----|--|--------------|---------------|
| | | Effective | Dscont | | | | |
| 11 - | ----- | | | 1 | P6022,PROBE,CURRENT:120 MHZ,100A,5FT W/TERM | | |
| -1 | 204-0360-01 | | | 1 | .BODY,PROBE:UPPER | 80009 | 204036001 |
| -2 | 214-0581-00 | | | 1 | .BALL,DETENT:0.062 DIA STEEL | 80009 | 214058100 |
| -3 | 351-0174-00 | | | 1 | .SLIDE,TEST PROD:ACETAL | 80009 | 351017400 |
| -4 | 214-0735-00 | | | 1 | .SPRING,HLCPS:0.12 OD X 1.5 L,OPEN ENDS,MUW | 8X345 | ORDER BY DESC |
| -5 | 214-1110-00 | | | 1 | .RETAINER,SPRING:CURRENT PROBE | 80009 | 214111000 |
| -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 | 80009 | 204036202 |
| -9 | 175-1027-00 | | | 1 | .CABLE ASSY,RF:62.5 OHM COAX,60.0 L | 80009 | 175102700 |
| -10 | 200-0852-06 | | | 1 | .COV,COAX TERMN:W/SHLD & KNOB | 80009 | 200085206 |
| -11 | 426-0423-03 | | | 1 | .FRAME,COAX TERM: | 80009 | 426042303 |
| -12 | 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 | 24931 | 28JR178-1 |
| -13 | 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 | 24931 | 28PR104-1 |
| -14 | 361-0219-00 | | | 2 | .SPACER,SLEEVE:0.06 L X 0.093 ID,BRS | 80009 | 361021900 |
| -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 | TK0435 | ORDER BY DESC |
| -17 | 200-0851-03 | | | 1 | .COV,COAX TERMN: | 80009 | 200085103 |
| STANDARD ACCESSORIES | | | | | | | |
| -18 | 196-3120-01 | | | 1 | LEAD,ELEC,PROBE GROUND;SDI,23 AWG,6.0 L | 80009 | 196312001 |
| | 070-0948-xx | | | 1 | MANUAL,TECH:INSTRUCTION,P6022 | 80009 | 070094803 |

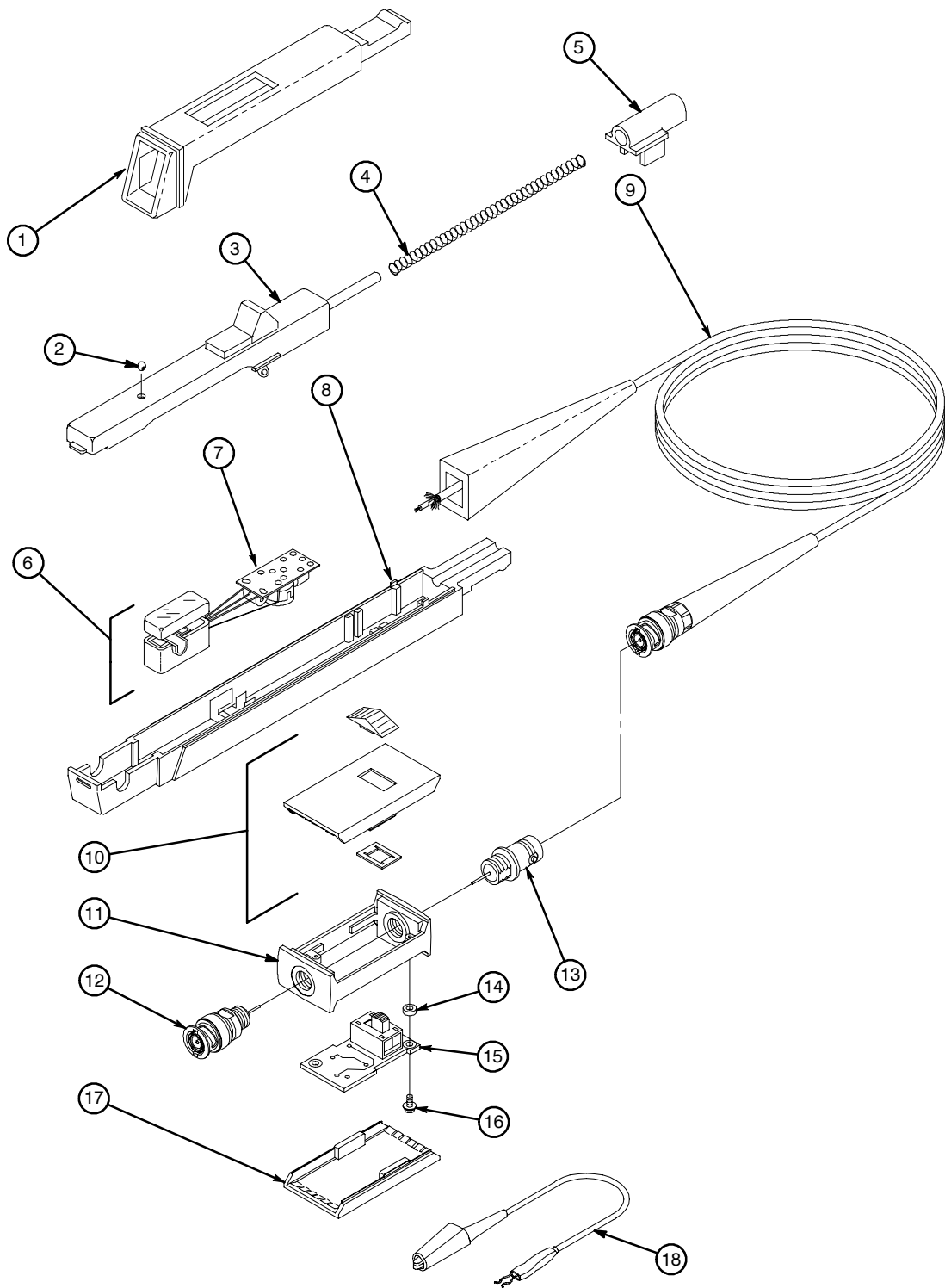


Figure 11: P6022 Exploded View

CROSS INDEX – MFR. CODE NUMBER TO MANUFACTURER

| Mfr. Code | Manufacturer | Address | City, State, Zip Code |
|----------------------|----------------------------|--------------------------------------|------------------------------|
| TK0435 | LEWIS SCREW CO | 4300 S RACINE AVE | CHICAGO IL 60609-3320 |
| 24931 | SPECIALTY CONNECTOR CO INC | 2100 EARLYWOOD DR PO BOX 547 | FRANKLIN IN 46131 |
| 8X345 | NORTHWEST SPRING & MFG CO | 5858 WILLOW LANE | LAKE OSWEGO OR 97034-5343 |
| 80009 | TEKTRONIX INC | 14150 SW KARL BRAUN DR PO BOX 500 | BEAVERTON OR 97077-0001 |

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