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TEK INSTRUCTION MANUAL

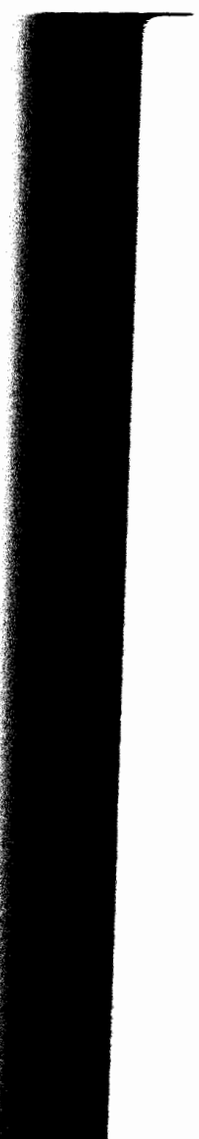
Part No. 070-6027-00
Product Group 60

P6231 PROBE

Please Check for
CHANGE INFORMATION
at the Rear of This Manual

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WARNING

The following servicing instructions are for use by qualified personnel only. To avoid personal injury, do not perform any servicing other than that contained in operating instructions unless you are qualified to do so.

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OPERATORS SAFETY SUMMARY

The general safety information in this part of the summary is for both operating and servicing personnel. Specific warnings and cautions will be found throughout the manual where they apply, but may not appear in this summary.

Terms In This Manual

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

CAUTION statements identify conditions or practices that could result in damage to the equipment or other property.

Do Not Operate In Explosive Atmospheres

To avoid explosion, do not operate this product in any explosive atmosphere unless it has been specifically certified for such operation.

Do Not Remove Covers

To avoid personal injury, do not remove the product covers. Do not operate the product without the covers properly installed.

SERVICE SAFETY SUMMARY

FOR QUALIFIED SERVICE PERSONNEL ONLY

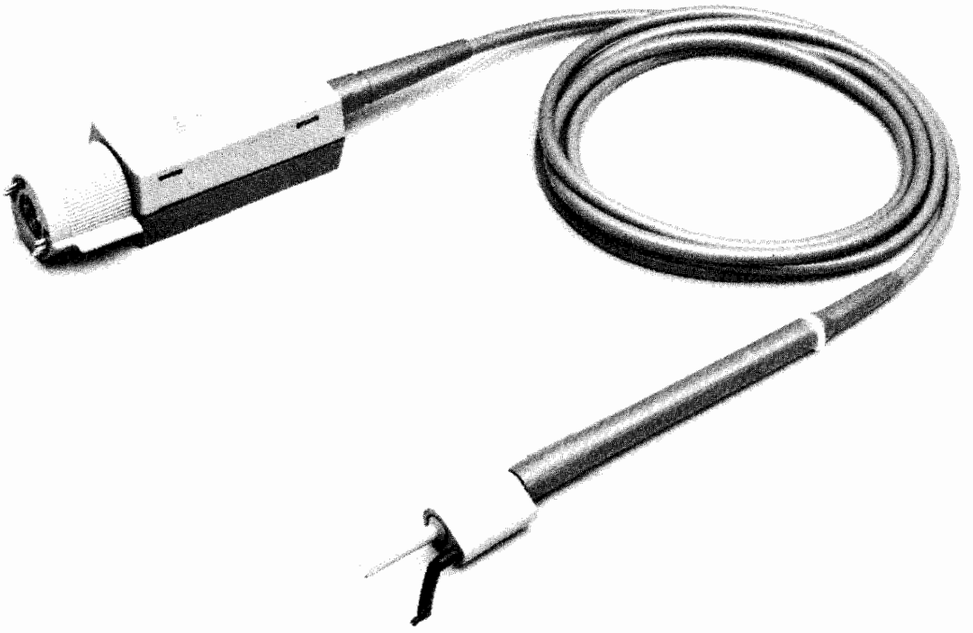
Refer also to the preceding Operators Safety Summary.

Do Not Service Alone

Do not perform internal service or adjustment of this product unless another person is present and capable of rendering first aid and resuscitation.

Use Care When Servicing With Power On

To avoid personal injury, do not touch exposed connections and components while power is on.



The P6231 probe. 6027-1

SPECIFICATION

DESCRIPTION

The TEKTRONIX P6231 is a low-impedance, subminiature, 10X active probe with identification capability. The probe is designed for use with 11000 Series oscilloscopes and is equipped with the new TEKPROBE™ interface which draws power from the host instrument and provides data communication between the oscilloscope and the probe. Data contained within the probe informs the instrument of the probe's attenuation, model number and identification number, and causes the input to automatically terminate with 50 ohms. The ID button on the probe head activates the ID function in the instrument. The ID signal can also set an SRQ (Service Request) flag on an IEEE-488 bus if the instrument is programmed to do so. The P6231 meets the requirements of UL 1244.

The P6231 offers a variable offset voltage at the probe tip to reduce loading effects. The offset is controlled through the TEKPROBE™ interface by the host instrument. The voltage available at the probe tip spans the range from −5V to +5V, allowing the probe to minimize loading effects on most logic families in use today.

The P6231 is available with a 1.5-meter signal cable. No power cable is necessary, as power is drawn from the host instrument plug-in through the TEKPROBE™ interface.

The subminiature probe head of the P6231 is fully compatible with the Tektronix family of subminiature probe accessories.

ACCESSORIES

The P6231 is shipped with the following standard accessories:

1 Instruction manual
1 Accessory Pouch
1 Hook tip
2 Circuit-board-to-probe-tip connectors
1 Ground lead with microhook/alligator clip
1 Low inductance ground-lead assembly
1 A packet of assorted cable-marker sets.

Use of these accessories is described in the "Operating Instructions" section of this manual. Part numbers and optional accessories are listed in the "Replaceable Parts List" (Section 7).

PERFORMANCE CONDITIONS

The electrical characteristics listed in Table 1-1 apply when a calibrated probe is used with a calibrated oscilloscope system operating within the environmental conditions stated in Table 1-2.

Items listed in the "Performance Requirement" column are verifiable qualitative or quantitative limits. Items listed in the "Supplemental Information" column are not verified in the "Performance Check Procedure" (Section 3); they are either explanatory notes, calibration setup descriptions, performance characteristics for which no absolute limits are specified, or characteristics that are impractical to check.

The probe's physical characteristics are listed in Table 1-3.

Table 1-1

Electrical Characteristics

Characteristic	Performance Requirement	Supplemental Information
Attenuation (system)	10X ±1% at dc.	Probe attached to 11000 series plug-in.
Input Resistance (system)	450Ω ±1% at dc.[a]	Probe attached to 11000 series plug-in.
Input Capacitance (1 kHz to 1.5 GHz)	Less than 1.6 pF.[a]	Typically 1.3 pF. See Figure 1-1 for a graph of input impedance versus frequency.

Table 1-1 (cont)

Characteristic	Performance Requirement	Supplemental Information
Bandwidth (−3 dB) (Probe only)	DC to at least 1.5 GHz.	Calculated from probe rise time. BW = 0.35/rise time.
Rise Time (Probe only)	Less than 230 ps.	Test system must have a rise time less than 100 ps.
Aberrations (Probe only)	< +4%, −6%, 6% p-p for 1st 1 ns (ref. from 1 ns); +4%, −6% for 1st 20 ns (ref. from 20 ns); ±3% thereafter.	In addition to system aberrations.
Signal Delay	8.70 ns ±100 ps.[a]	Probe tip to output BNC.
Input Dynamic Range	$-5\ V \leq (V_{signal} + V_{offset}) \leq +5\ V$	
Offset Null	Less than ± 10 mV.	
DC Offset Range	0 to at least +5 V, ±2% and −5 V, ±2%.	Measured from probe tip to ground with a high impedance (≥ 50 kΩ/V) voltmeter.
DC Thermal Drift	Less than 10 mV/°C.	Equivalent input offset

[a] **Performance requirement not checked in manual.**

Table 1-1 (cont)

Characteristic	Performance Requirement	Supplemental Information
Output Load Requirement	50Ω ±0.5%.	
Maximum Nondestructive Input Voltage	10 Vdc continuous.[a] 30 V (dc + peak ac) for 1 sec.	
Power Supply Requirements	Power is drawn from the[a] host instrument.	
ID Button Life	>50 Kcycles[a]	

[a] Performance Requirement not checked in manual.

Table 1-2

Environmental Characteristics

Characteristic	Information
Temperature Range (Operating)	0°C to +50°C (+32°F to +122°F).
Temperature Range (Nonoperating)	−55°C to +75°C (−67°F to +167°F).
Humidity	Five cycles (120 hr.) at 90% to 95% relative humidity at 30°C to 60°C.
Altitude (Operating)	To 4,600 m (15,000 ft).
Transportation	Qualifies under National Safe Transit Association's Pre-shipment Test Procedures; 1A-B-1.

Table 1-3

Physical Characteristics

Characteristic	Information
Net Weight (includes accessories)	354 g (12.5 oz).
Signal Cable Length	1.5 m (60 in).

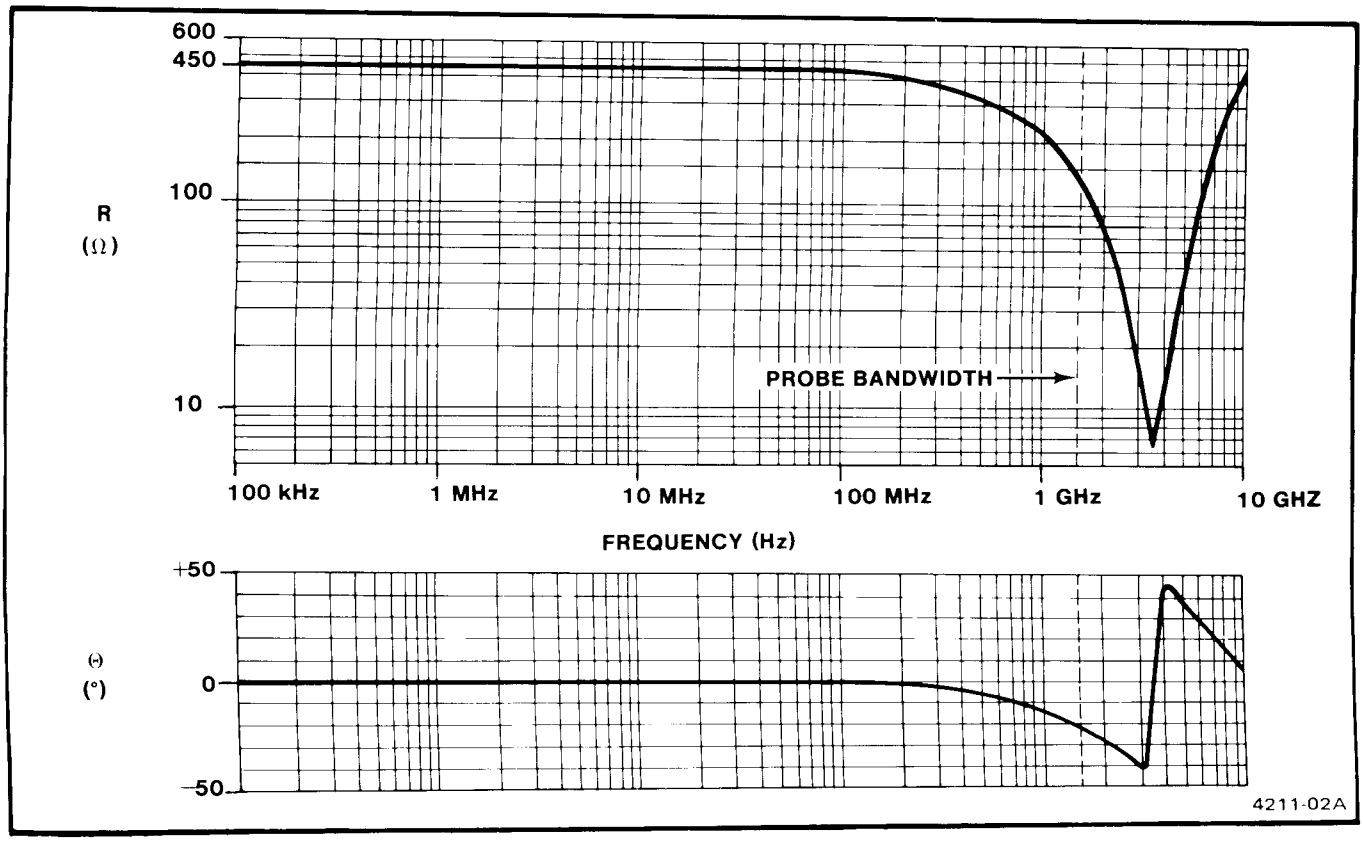


Figure 1-1. Typical input impedance versus frequency.

OPERATING INSTRUCTIONS

This section of the manual is intended to familiarize the operator with the use of the P6231 Probe. Included are operating considerations, descriptions of the controls and connectors, instructions for the use of the accessories, and a description of the use and operation of the probe.

NOTE

The P6231 is shipped along with its standard accessories. At installation, save the shipping and packaging materials for reuse should reshipment become necessary. Refer to "Maintenance" (Section 6) for further information.

OPERATING CONSIDERATIONS

Probe Handling

The P6231's subminiature body has been designed for ease of use when probing small circuitry. Both the probe itself and its accessories should be handled carefully at all times. Avoid dropping the probe body, since damage to its tip may result. Exercise care to prevent crushing the cable or placing excessive strain on it by pulling.

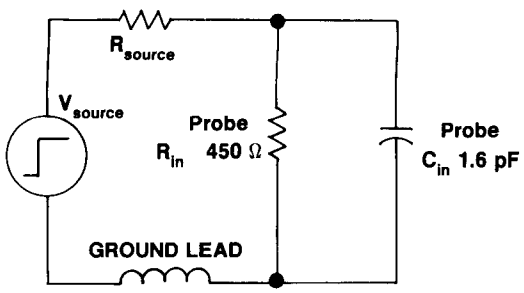
Input Dynamic Range

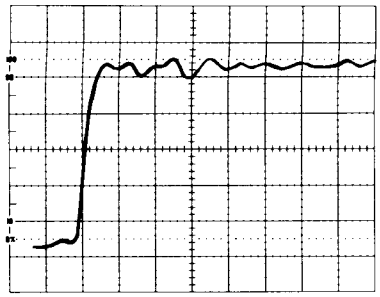
The input dynamic range of the P6231 is limited by the ability of the internal amplifier to drive the 50Ω termination. This limitation exists whether the input signal originates at the probe tip (test signal) or as internal offset voltage. Therefore, the limitation on the signal that can be applied to the probe tip is dependent on the amount of offset voltage being used. To maintain signal fidelity, the test signal should not exceed the limits imposed by the following formula:

$$-5.0\ V \leq (V_{signal} + V_{offset\ voltage}) \leq +5.0\ V$$

Probe Grounding

Inductance caused by either a long signal lead or ground lead will form a series-resonant circuit that can distort the true waveform or degrade the bandwidth. Ground lead and signal input connections should be kept as short as possible to maintain the best waveform fidelity. (Refer to Figures 2-1 and 2-2.)



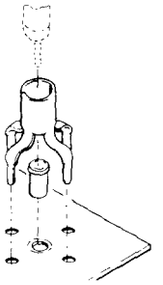


P6231 - Probe with 6" ground lead, Tr = 4 ns.

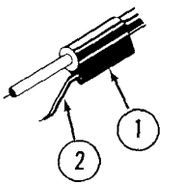
Ground lead inductance can significantly reduce the performance of a probe. As shown in the model above, the ground lead inserts a series inductance into the signal path forming a series-resonant circuit between C_{in} of the probe and ground lead L, with only R_{source} as damping. This forms a resonant circuit with an $f_O = 1 \div (2\pi \sqrt{LC})$. A six-inch ground lead has ~150 nH of self inductance causing an f_O of 325 MHz, which is within the frequency response of the instrument. This greatly degrades risetime, bandwidth, and transient accuracy (see illustration). For best results, make sure that ground lead inductance is minimized. Three methods for doing so are described on the following page.

6027-2

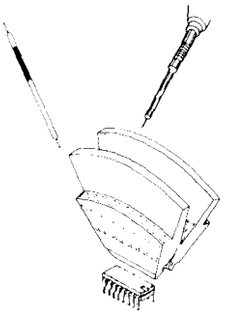
Figure 2-1. Damaging effects of ground-lead inductance.



ECB to Probe-Tip Adapters provide high-quality connection test points when installed on circuit boards. The ribbed-plastic tip cover on the probe must be removed. The probe will then plug into the test point directly. Adapters are available in bags of 100 (see "Replaceable Parts.")



The low-inductance lead provided with all Tek subminiature probes allows for a substantial reduction of ground-lead L (~32 nH instead of 150 nH). To use, unscrew the ribbed-tip cover and slide off the ground collar with ground lead. Slip on the low-inductance lead ground collar (1) and reinstall the ribbed-tip cover. Install the low-inductance lead (2) from the accessory pack.



The Tektronix Klipkit (optional, see "Replaceable Parts.") provides a hands-off connection of signal and ground to an IC (up to 16 pins). Klipkit ground is acquired by inserting a connecting pin (included) into the Klipkit at the proper pin. The probe body will then make ground connection when inserted into the other contact locations.

6027-3

Figure 2-2. Reducing the damaging effects of ground-lead inductance.

The following information will familiarize the operator with the location and function of the external controls and connections of the P6231. Please refer to Figure 2-3.

(1) **TEKPROBE™ Interface** - Provides connections for signal, power, and data communication between the probe and the host instrument.

(2) **BNC Locking Ring** - Locks the probe onto the host instrument. To install, first check that the locking ring is fully counter-clockwise as viewed from the rear of the compensation box. Insert the probe onto the instrument so that the flipper slips into the notch provided for it on the front panel. To lock the probe onto the instrument, rotate the locking ring clockwise until the probe is secured to the instrument.

(3) **ID Button** - Activates the ID function in the host instrument when pushed. Pressing the ID button can also execute a sequential step through a programmed test routine, or generate status flags on an IEEE-488 bus if the oscilloscope is programmed to do so.

(4) **Probe Tip** - Used to acquire the signal from the circuit under test.

(5) **Ground Collar with Lead** - Can be connected to the alligator clip, the micro-hook, or directly onto a square-pin ground on a circuit board.

(6) **Low Inductance Ground Lead Assembly** - Provides the lowest-inductance ground connection for best probe performance.

PROBE ACCESSORIES

Both standard and optional accessories for the P6231 are listed in the "Replaceable Parts List" near the back of this manual. Standard accessories are supplied to aid in connecting the probe to circuitry under test and to protect the probe against damage. These accessories are described in the following paragraphs and are illustrated in Figure 2-3.

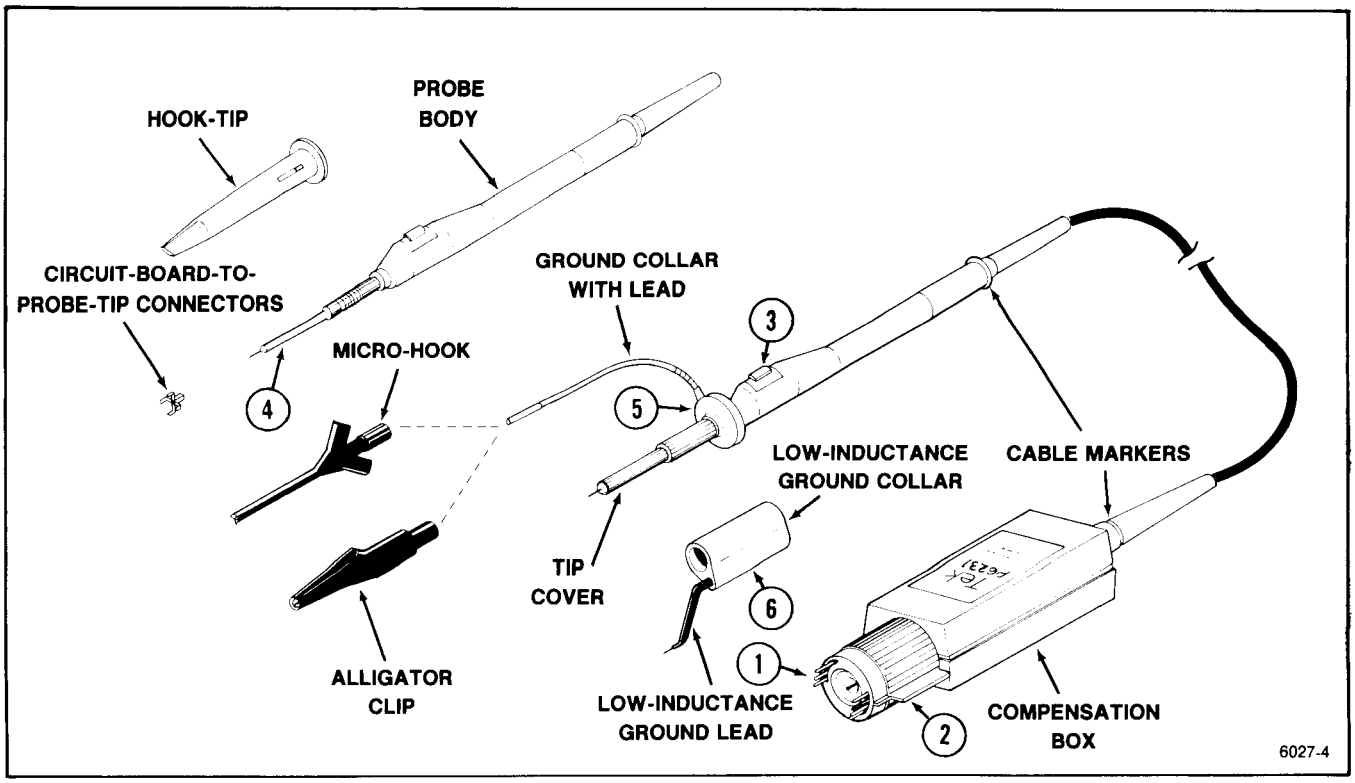


Figure 2-3. Controls, connectors, and probe accessories.

Table 2-1

Typical Performance Effects of Grounding Configurations

Grounding Method	Risetime	Bandwidth (calculated)
Probe tip-to-GR adapter.	230 ps.	1.5 GHz.
Low-inductance lead.	440 ps.	800 MHz.
6.5-inch lead.	1.0 ns.	350 MHz.
No ground lead.	16 ns.	22 MHz.

Ground Leads

The P6231 Probe is supplied with two ground-lead systems: a ground collar with integral lead and a low-inductance ground collar/lead. The collar with integral lead features a 6.5-inch lead length which is attachable to an alligator clip, a micro-hook, or directly to a square-pin connector on the circuit board. Refer to the information on ground-lead inductance in Figures 2-1 and 2-2 to assist you in making the best selection of a ground-lead system.

Cable Markers

Cable markers are provided in several different colors to help identify specific probes when using multichannel oscilloscopes.

Circuit-Board-to-Probe-Tip Connectors

Two circuit-board-to-probe-tip connectors are provided for making permanent probe test points on circuit boards. These connectors provide extremely short signal and ground paths to minimize ringing. Before inserting the probe tip into a connector, remove both the light-grey probe-body shell and the grounding collar from the tip.

Hook Tip

The hook tip provides the means for making a hands-free connection to a test point or component lead. To install the hook tip, just slide the hook tip onto the probe.

Carrying Pouch

The carrying pouch (not shown) provides a convenient means to store and protect the P6231, its accessories, and this manual when they are not in use.

OPERATION

The P6231 is a passive, 500-ohm divider probe with the additional feature of a variable offset available at the probe tip.

What is the value of this offset? Imagine a source which consists of an AC signal riding on a DC level. Imagine also that the source impedance is high enough that its operation (specifically, its bias), is disrupted by the addition of a 500 ohm shunt to ground (similar to a traditional 500-ohm probe).

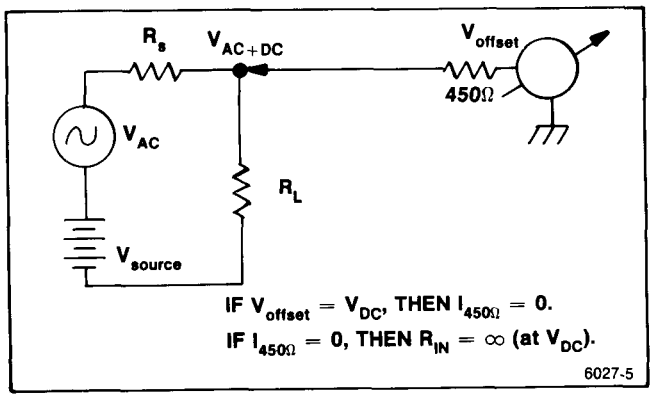


Figure 2-4. Example of reduced loading.

Now, add the feature of offset bias, with the P6231 attached to the circuit and with its offset adjusted to equal the DC component of the signal being measured. The DC component of probe loading is now eliminated, and circuit bias is restored.

In Figure 2-4, there is a source having both DC and AC components. From the voltage divider of R_S and R_L, there will be a DC voltage at that test point. If the P6231 offset is adjusted so that it is equal to that DC voltage, then there is effectively no DC voltage across the 450-ohm probe resistor (and no current flow), which implies an infinite impedance (for that voltage only).

To use the offset feature, first measure or calculate the offset potential present at the test point. Call up the menu controlling probe functions on the 11000 Series oscilloscope, Select Probe Offset Voltage, then rotate the front-panel-control knob until the correct voltage is displayed on screen. Select that voltage, then exit the menu. That voltage is now output to the probe tip. Confirmation of this voltage can be made by checking the voltage to ground at the probe tip with a voltmeter or other high-impedance measurement device.

PERFORMANCE CHECK PROCEDURE

PURPOSE

The "Performance Check Procedure" is used to verify the probe's Performance Requirements as listed in "Specification" (Section 1) and to determine the need for readjustment. This procedure may also be used both as an acceptance check and as a test of the probe after repair.

This section contains only the procedures for checking the P6231's dc offset range and high-frequency characteristics. The check procedure for the probe's attenuation accuracy has been combined with the probe's adjustment procedures due to the similarity of their setups. This check/adjustment may be found in "Adjustment Procedures" (Section 4).

TEST EQUIPMENT REQUIRED

The test equipment listed in Table 3-1 is a complete list of equipment required to accomplish the "Performance Check Procedure." Test equipment specifications described in Table 3-1 are the minimum necessary to provide accurate results; therefore, equipment used must meet or exceed the listed specifications. Detailed operating instructions for test equipment are not contained in this procedure. Should additional operating information be needed, refer to the appropriate test-equipment instruction manual.

LIMITS AND TOLERANCES

The limits and tolerances given in this procedure are for the P6231 under test only. Test-equipment error is not included except as noted.

PREPARATION

Before proceeding with the check, allow sufficient warm-up time for test equipment to stabilize (typically 20 minutes).

Table 3-1

Test Equipment Required

Item Number and Description	Minimum Specification	Purpose	Example of Suitable Test Equipment
1. Oscilloscope	Bandwidth: dc to about 15 MHz. Vertical deflection factor: 5 mV to 1 V.	Offset range check.	TEKTRONIX 11000 Series with 11A32 plug-in.
2. Digital Multimeter	DC volts accuracy: 0.1%	Offset range check.	TEKTRONIX DM 502A.
3. DC Voltage Source	Output: + and − 5 V.	Offset range check.	TEKTRONIX PS 503A.
4. Sampling Oscilloscope	Bandwidth: dc to 4.6 GHz.	HF checks.	TEKTRONIX 7704A with 7S12 plug-in.
5. Sampling Head	Bandwidth: dc to 4.6 GHz.	HF checks.	TEKTRONIX S-6.
6. Pulse Generator	Rise time: less than 25 ps.	HF checks.	TEKTRONIX S-52.
7. Termination Adapter	Impedance: 50Ω. Connectors: subminiature probe tip-to-GR.	HF checks.	Tektronix Part Number 017-0520-00.

Table 3-1 (cont)

Test Equipment Required

Item Number and Description	Minimum Specification	Purpose	Example of Suitable Test Equipment
8. Adapter	Connectors: GR-to-BNC female.	HF checks.	Tektronix Part Number 017-0063-00.
9. Adapter	Connectors: SMA male-to-GR.	HF checks.	Tektronix Part Number 015-1007-00.

PROCEDURE STEPS

1. DC Offset Check

Equipment Required (see Table 3-1):

Oscilloscope (Item 1)
Digital Multimeter (Item 2)
DC Voltage Source (Item 3)

a. Connect the probe to an 11A32 plug-in in an 11000 Series oscilloscope mainframe.

b. Set the oscilloscope controls as follows:

Volts/Division	2 V
Input Coupling	GND
Time/Division	1 ms
Trigger Source	Internal
Trigger Mode	Auto

c. Vertically position the trace to the center horizontal graticule line.

d. Set the oscilloscope input coupling to DC.

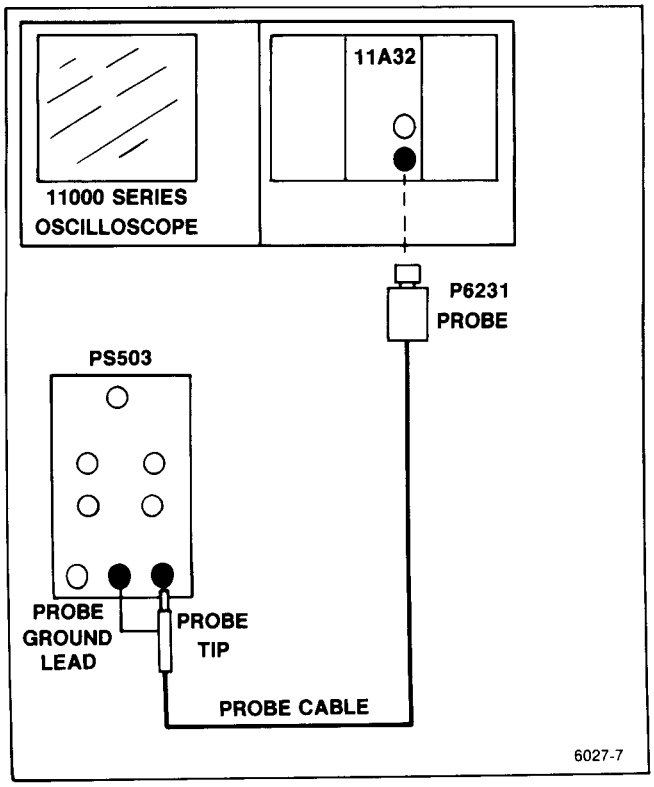


Figure 3-1. Offset check setup.

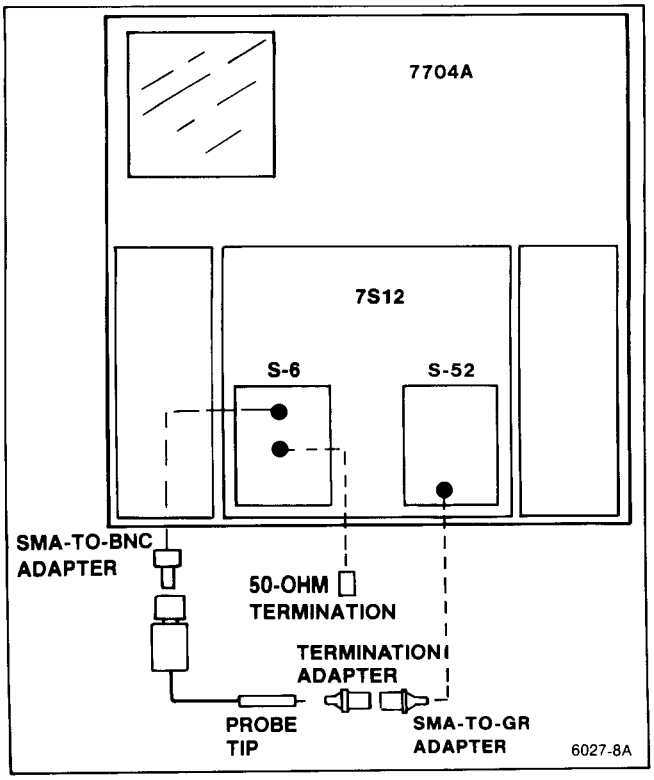


Figure 3-2. High-frequency check setup.

e. Touch the probe input to a convenient ground point on the test oscilloscope.

f. CHECK — That the OFFSET VOLTAGE control on the oscilloscope is able to vertically position the trace over a +5.0 V to −5.0 V range.

g. Remove the probe input from the ground point. Connect the probe ground, via a probe ground lead, to the common input of the multimeter. Touch the probe input to the + input of the multimeter.

h. Set multimeter controls for DC volts, 20 V scale.

i. CHECK — That the OFFSET VOLTAGE control on the oscilloscope is able to vary the voltage at the probe tip over a +5.0 V and −5.0 V range.

j. Remove the probe from the multimeter.

k. Using the multimeter to confirm, adjust the variable dc voltage source (PS503) to +5.0 V.

l. Connect the probe ground, via a probe ground lead, to the voltage source (PS503) common output. Touch the the probe input to the + output (refer to Figure 3-1).

m. CHECK — That the OFFSET VOLTAGE control on the oscilloscope is able to set the oscilloscope trace to 0.0 V.

n. Repeat steps l and m with the voltage source set to −5.0 V and the probe connected to the − output.

o. Disconnect the test setup.

2. Bandwidth/Risetime/High-Frequency Aberrations Check

Equipment Required (see Table 3-1):

Oscilloscope (Item 4)
Sampling Head (Item 5)
Pulse Generator Head (Item 6)
Termination Adapter (Item 7)
Adapter (Item 8)
Adapter (Item 9)

NOTE

The risetime and aberrations specifications of the pulse generator/sampling oscilloscope system are required to complete this check (see step g). These may be found in the "Specifications" section of the appropriate instrument manual or measured by performing the procedure given below while substituting a 50-Ω cable for the P6231 and increasing the Volts/Division setting by a factor of 10.

a. Connect the test setup as shown in Figure 3-2.

b. Set the oscilloscope/sampling plug-in controls as follows:

Volts/Division	5 mV
Time/Division	50 ps

c. Adjust the sampling plug-in's DC Offset and Time-Distance controls to center the leading edge of the pulse on the screen.

d. Adjust the Volts/Division Variable control for a 5-division display.

e. Measure the risetime of the displayed waveform.

f. Calculate the probe risetime using the following formula:

$$\text{Probe Risetime} = \sqrt{(\text{Measured risetime})^2 - (\text{Sampling system risetime})^2}$$

g. CHECK — The probe rise time calculated in part f should be less than 230 ps. This indicates a bandwidth of at least 1.5 GHz as calculated from the formula:

$$\text{Bandwidth} = 0.35/\text{Rise Time}$$

h. Set the oscilloscope/sampler Time/Division control to 500 ps.

i. CHECK — The high-frequency aberrations do not exceed +4%, −6%, 6% p-p for the first 1 ns, (referenced from 1 ns), +4% −6% for first 20 ns (referenced from 20 ns), ±3% thereafter (in addition to system aberrations).

j. Disconnect the test setup.

ADJUSTMENT PROCEDURE

PURPOSE

This section contains the information necessary to perform the attenuation, offset null, and mid-frequency adjustments for the P6231 Probe. The adjustment procedures are not intended to be troubleshooting guides. However, any deficiency found during performance of each adjustment step should be corrected before continuing. Tektronix Field Service Centers and the Factory Service Center provide instrument repair and adjustment service. Refer to "Maintenance" in Section 6 for further repair information.

TEST EQUIPMENT REQUIRED

The test equipment listed in Table 4-1 is a complete list of equipment required to accomplish the "Adjustment Procedures." Test equipment specifications described in Table 4-1 are the minimum necessary to provide accurate results; therefore, equipment used must meet or exceed the listed specifications. Detailed operating instructions for test equipment are not contained in this procedure. Should additional operating information be needed, refer to the appropriate test equipment instruction manual.

ADJUSTMENT SEQUENCE

Because of adjustment interaction, the adjustment steps must be performed in the order given.

ADJUSTMENT LOCATIONS

Adjustment locations are shown in Figure 4-1. Only the adjustable components are illustrated in this figure.

PREPARATION

Before proceeding with each adjustment step, allow sufficient warm-up time for test equipment to stabilize (typically 20 minutes).

It is necessary to remove the top half of the Control Box cover to perform the Adjustment Procedure. Refer to the removal instructions in "Maintenance" (Section 6).

Table 4-1

Test Equipment Required

Item Number and Description	Minimum Specification	Purpose	Example of Suitable Test Equipment
1. Real Time Oscilloscope	Bandwidth: dc to at least 100 MHz. Vertical deflection factor: 5 mV to 1 V. Two vertical channels.	Offset null, attenuation, and mid-frequency adjustments	TEKTRONIX 11000 Series with 11A32 plug-in.
2. Calibration Generator	Pulse rise time: 1 ns or less. Amplitude: 0.5 V or more into 50Ω. Repetition rate: 1 kHz to 100 kHz, Accuracy: ±0.25%.	Attenuation and mid-frequency adjustments.	TEKTRONIX PG 506.[a]
3. Precision Coaxial Cable	Impedance: 50Ω. Length: 36 in. Connectors: BNC.	Attenuation and mid-frequency adjustments.	Tektronix Part Number 012-0482-00.

[a]Requires a TM 500-Series power-module mainframe.

Table 4-1 (cont)

Test Equipment Required

Item Number and Description	Minimum Specification	Purpose	Example of Suitable Test Equipment
4. Adapter	Connectors: subminiature-probe-tip-to-BNC male.	Attenuation and mid-frequency adjustments.	Tektronix Part Number 013-0195-00.
5. Termination	Impedance: 50Ω. Connectors: BNC.	Attenuation and mid-frequency adjustments.	Tektronix Part Number 011-0049-01.
6. BNC T	Connectors: BNC.	Attenuation and mid-frequency adjustments.	Tektronix Part Number 103-0030-00.
7. Low-Reactance Alignment Tool	Length: 2-in shaft. Bit size: .050 in.	Offset null, attenuation, and mid-frequency adjustments.	Tektronix Part Number 003-1364-00.

PROCEDURE STEPS

1. Check/Adjust Offset Null

Equipment Required (see Table 4-1):

Oscilloscope (Item 1)
Alignment Tool (Item 7)

a. Connect the probe output to the test oscilloscope vertical input. Leave the probe tip free of all connections.

b. Set test oscilloscope controls as follows:

Volts/Division	100 mV
Time/Division	1 ms
Input Coupling	DC
Bandwidth	Full Bandwidth

c. Center the trace on the screen.

d. CHECK — That the oscilloscope trace does not shift more than 1/2 of a minor division (10 mV referenced to the probe tip), while rotating the OFFSET VOLTAGE control on the oscilloscope from one extreme to the other.

If the trace shift is within tolerance, proceed with the next adjustment. If the trace shift is excessive, proceed with part e.

e. ADJUST — R38 (see Figure 4-1) for minimum trace shift while rotating the OFFSET VOLTAGE on the oscilloscope control back and forth.

2. Check/Adjust Attenuation Accuracy and Mid-Frequency Response

Equipment Required (see Table 4-1):

Oscilloscope (Item 1)
Calibration Generator (Item 2)
Coaxial Cable (Item 3)
Adapter (Item 4)
Termination (Item 5)
BNC T (Item 6)
Alignment Tool (Item 7)

a. Set test oscilloscope controls as follows:

Ch 1 Volts/Division	100 mV
Ch 2 Volts/Division	10 mV
Display Mode	Alternate
Trigger Source	Mode
Time/Division	1 ms
Input Coupling	DC
Bandwidth	Full Bandwidth

b. Set the calibration generator controls as follows:

Amplitude	0.5 V
Period	1 ms
Mode	Standard Amplitude

c. Connect the Amplitude Output of the calibration generator to the channel 1 vertical input via the 50-Ω cable. (Do not use the 50-Ω termination).

d. Set the oscilloscope triggering controls for a stable display and center the display on the screen.

e. Adjust the channel 1 gain control for an exact 5-division display.

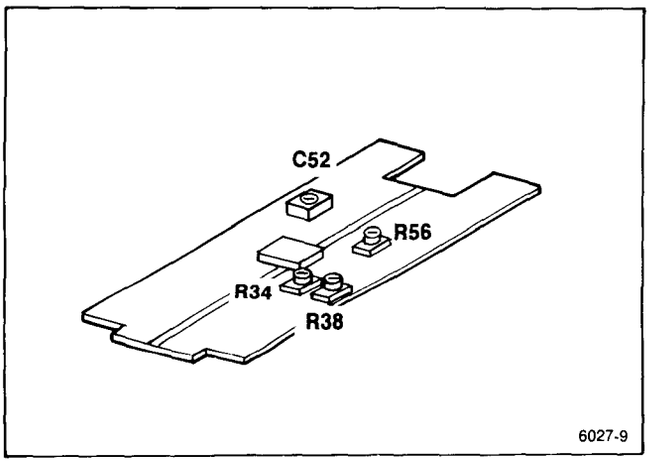


Figure 4-1. P6231 adjustment locations.

f. Move the 50-Ω cable from the channel 1 vertical input to the channel 2 vertical input. (Do not use the 50-Ω termination).

g. Change the amplitude of the calibration generator to 50 mV.

h. Adjust the channel 2 gain control for an exact 5-division display.

i. Remove the 50-Ω cable from the test setup. Install the P6231 on the channel 2 vertical input and set the Channel 2 input to 50-Ω terminated.

j. Connect one end of the 50-Ω cable to the positive-going fast-rise output of the calibration generator. Connect the other end of the cable to one branch of the BNC T connector. Install the subminiature probe tip-to-BNC adapter on the other branch of the BNC T. Install the center leg of the BNC T on the channel 1 vertical input.

k. Change the calibrator mode to Fast Rise.

l. Adjust the calibrator pulse amplitude for a 5-division display.

m. Center the two traces on the screen.

n. CHECK — The amplitude of the channel 2 trace should be within 3% (0.15 division) of the amplitude of the channel 1 trace. The front corner aberrations of the channel 2 trace should also match those of the channel 1 trace within 3%.

If the amplitude and front corner aberrations are within tolerance, disconnect the test setup. If they are not, proceed with step o.

o. Set — The calibration generator to 100 kHz rep rate. Adjust C52 for the fastest response.

p. SET — The calibration generator to 1 kHz rep rate and adjust R56 and R34. The responses of the two channels should match within ±3%.

q. Disconnect the test setup.

THEORY OF OPERATION

INTRODUCTION

This section contains a functional description of the circuitry used in the P6231 Probe. The schematic diagram in "Replaceable Parts" (Section 7 of this manual) may be useful when reading the detailed circuit description. A functional block diagram is also provided (Figure 5-1).

GENERAL CIRCUIT DESCRIPTION

Figure 5-1 is a functional block diagram of the P6231. The P6231 divides the signal into two separate signal paths. The high-frequency path consists of the tip assembly, the cable assembly, R62, C32, and the 50-Ω termination. The probe tip assembly and the termination resistor form a voltage divider as in a conventional 50-Ω passive probe. The dc-to-mid-frequency path consists of the tip assembly, the cable assembly, R62, R54, R56, inverting amplifier U30, differential amplifier U18, R34, and R24. The dc-to-mid-frequency path provides the input bias/offset voltage function.

DETAILED CIRCUIT DESCRIPTION

Operational amplifier U30, R1, R62, R54 and R56, and R78 and R64 form an inverting amplifier with an adjustable bias provided at the amplifier + input by U10. In the dc and low-frequency range, the node at the junction of R56, R76, and R64 is the virtual ground or null point for the inverting amplifier. At dc, the op amp will force the voltage at the null point to equal the adjustable bias voltage applied to the + input (pin 3 of U30). In the mid-frequency-to-high-frequency range, the node at the − input (pin 2 of U30) is an ac ground point.

One half of U10 is low-pass filter/gain stage which removes any noise present on the offset line and applies a gain of 5X to the ± 1V available from the instrument to develop ± 5V of offset at the probe tip. The other half of U10 is unused.

R78, R64, and C66 form a phase-lead network which forces op amp U30 to compensate for the phase lag of op amp U18. CR76 is a clamping diode which protects op amp U30 from excessive probe input voltages (such as electrostatic discharges).

U18, R68, R58, R28 and R38, and R26 form a differential amplifier. The differential amplifier subtracts the input bias voltage at pin 3 of U18 from the output of U18 (pin 6), and re-inverts the dc-to-mid-frequency signal. R24 and R34 and the 50-Ω termination form a voltage divider for the output of U18.

U1010 on the flexible circuit board is a factory programmed ROM that stores such data as probe model, identification number, and special conditions required for the probe such as termination, units displayed on screen, or attenuation factor. This data is relayed to the scope on power-up or in response to a query by the host instrument.

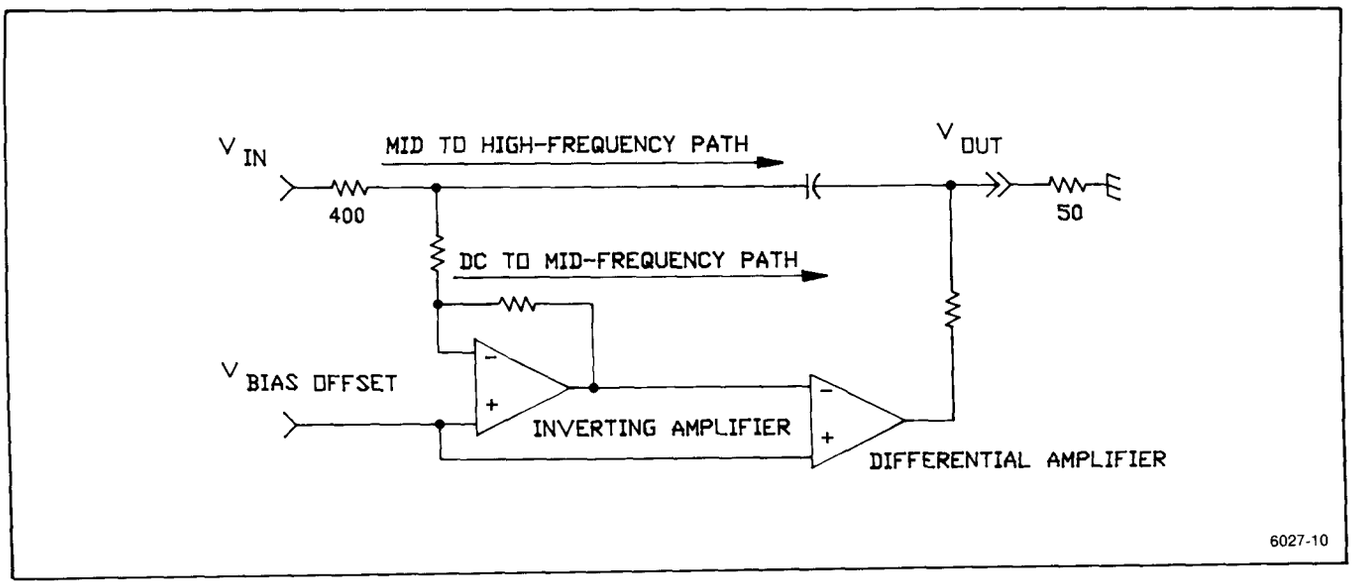


Figure 5-1. Functional block diagram.

MAINTENANCE

INTRODUCTION

This section contains information for performing preventive maintenance, troubleshooting, and corrective maintenance on the P6231 Probe.

WARNING

The following service instructions are for use by qualified personnel only. To avoid electrical shock, do not perform any probe maintenance while the probe is connected to a signal source.

STATIC-SENSITIVE COMPONENTS

CAUTION

Static discharge can damage any semiconductor component in this probe.

This probe contains electrical components that are susceptible to damage from static discharge. See Table 6-1 for relative susceptibility of various classes of semiconductors. Static voltages of 1 kV to 30 kV are common in unprotected environments.

Observe the following standard precautions to avoid damage:

1. Minimize handling of static-sensitive components.

2. Transport and store static-sensitive components or assemblies in their original containers, on a metal rail, or on conductive foam. Label any package that contains static-sensitive assemblies or components.

3. Discharge the static electricity from your body by wearing a wrist strap while handling these components. Servicing static-sensitive assemblies or components should be performed only at a static-free work station by qualified service personnel.

Table 6-1

Relative Susceptability to Static Discharge Damage

Semiconductor Classes	Approximate Susceptibility Level[a]
MOS or CMOS (most sensitive)	100-500 V.
ECL	200-500 V.
Schottky signal diodes	250 V.
Schottky TTL	500 V.
High-frequency bipolar transistors	400-600 V.
JFET	600-800 V.
Linear microcircuits	400-1000 V.
Low-power Schottky TTL	900 V.
TTL (least sensitive)	1200 V.

[a]Voltage discharged from a 100 pF capacitor through a 100-Ω resistor.

4. Nothing capable of generating or holding a static charge should be allowed on the work station surface.

5. Keep the component leads shorted together, whenever possible, with a shorting wire or conductive foam.

6. Pick up components by the body, never by the leads.

7. Do not slide the components over any surface.

8. Avoid handling components in areas that have a floor or work-surface covering capable of generating a static charge.

9. Use a soldering iron that is connected to earth ground.

10. Use only special antistatic suction-type or antistatic wick-type desoldering tools.

PREVENTIVE MAINTENANCE

Preventive maintenance consists primarily of cleaning and visual inspection. When performed on a regular basis, preventive maintenance can prevent instrument breakdown and may improve instrument reliability. The frequency of maintenance depends on the severity of the environment to which the probe is subjected. A convenient time to perform preventive maintenance is just before performing an Adjustment Procedure.

CLEANING

CAUTION

Avoid the use of chemical cleaning agents which may damage the plastics and circuit board used in the probe. In particular, avoid chemicals which contain benzene, toluene, xylene, acetone, MEK, or similar solvents. For additional information on recommended cleaning agents, consult your Tektronix Service Center or representative.

Exterior

Loose dust accumulated on the outside of the probe can be removed with a soft cloth or a small brush. Dirt which remains can be removed with a soft cloth dampened in a mild detergent and water solution. Do not use abrasive cleaners.

Interior

Cleaning the interior of the probe should not be necessary. Normally, the probe compensation box circuit board will not require cleaning unless a cover has been removed for an extended period of time. The best way to clean the interior is to blow off the accumulated dust with dry, low-velocity air (about 9 lb/sq. in). Remove any dirt which remains with a soft brush or a cloth dampened with a nonresidue-type cleaner, preferably isopropyl alcohol. A cotton-tipped applicator is useful for cleaning in narrow spaces or for cleaning more delicate circuit components.

VISUAL INSPECTION

Occasionally inspect the P6231 for such defects as broken connections, damaged parts, bent leads, and heat-damaged components. Overheating usually indicates other trouble in the probe, therefore, the cause of overheating must be corrected to prevent recurrence of the damage.

SEMICONDUCTOR CHECKS

Periodic checking of semiconductors is not recommended. The best check of semiconductor performance is proper operation of the probe.

TROUBLESHOOTING

The following information is provided to facilitate troubleshooting the P6231. An understanding of circuit operation is often helpful in locating troubles. Refer to "Theory of Operation" (Section 5) for this information.

Table 6-2 lists the equipment useful for troubleshooting the P6231. If the particular items listed are not available, substitutions may be made with similar test equipment which meet or exceed the listed specifications.

Table 6-3 is a listing of possible fault indications and their probable causes.

Table 6-2

Troubleshooting Equipment

Description	Minimum Specification	Example
1. Real time oscilloscope	Bandwidth: dc to about 15 MHz. Vertical deflection factor: 5 mV to 1 V.	TEKTRONIX 7704A with 7A26 and 7B80 plug-ins.
2. Digital Multimeter	Voltmeter; 0 to 20 V dc range, 0.15% accuracy. Ohmmeter; 0 to 2 MΩ range.	TEKTRONIX DM 502A.

Table 6-3

Fault Indication and Probable Cause

Fault Indication	Probable Cause	Corrective Action
Wrong Attenuation Ratio	1. Defective probe tip assembly.	Replace probe tip assembly.
	2. Input signal exceeds probe dynamic range.	Reduce signal amplitude.

Table 6-3 (cont)

Fault Indication and Probable Cause

Fault Indication	Probable Cause	Corrective Action
DC and mid-frequency attenuation wrong. HF attenuation correct.	Attenuation and mid-frequency adjustments incorrect.	See "Adjustment Procedure."
DC and mid-frequency portion of signal missing or severely attenuated.	1. Defective power supply.	Check power-supply fuses in plug-in.
	2. U30 or U18 defective.	Return to service center.
	3. R56 or R34 defective.	Return to service center.
HF portion of signal missing or severely attenuated. DC and mid-frequency response correct.	C32 defective.	Return to service center.
Mid-frequency gain out specification.	C52 misadjusted or defective.	See "Adjustment Procedure." Return to service center if adj. does not correct problem.

Table 6-3 (cont)

Fault Indication and Probable Cause

Fault Indication	Probable Cause	Corrective Action
Rise time out of specification or excessive hf aberrations.	1. Defective probe tip assembly.	Replace probe tip assembly.
	2. R62 defective.	Return to service center.
	3. C32 defective.	Return to service center.
No signal or intermittent signal.	1. Broken or unsoldered wire, connection, or component.	Visually check for damage and repair any found.
	2. Defective cable assembly.	Check for shorts or opens and replace if necessary.
	3. Signal path shorted to ground.	Visually check all probe cable connectors and circuit board connectors. Repair or replace if necessary.
	4. R62 defective.	Return to service center.
	5. Defective probe-tip assembly.	Replace probe tip assembly.

Table 6-3 (cont)

Fault Indication and Probable Cause

Fault Indication	Probable Cause	Corrective Action
Instrument does not respond to ID switch	1. Defective ID switch. 2. Open Cable. 3. Broken pin on TPI conn.	Return to service center. Replace cable. Replace pin.
Input bias/offset voltage feature does not work or is out of specification.	1. U30 defective.	Return to service center.
	2. U10, R20, R48, R46 defective.	Return to service center.
	3. Power supply is defective or out of specification.	Check power-supply fuses in plugin.
	4. C22 defective.	Return to service center.
Oscilloscope does not respond to installed probe.	1. Broken pin on TPI connector.	Replace pin.
	2. ROM damaged.	Return to service center.

TROUBLESHOOTING TECHNIQUES

The following techniques are arranged in an order that checks the simple possibilities before proceeding with extensive troubleshooting. The first few checks ensure proper connection, operation, and calibration. If the trouble is not located by these checks, the remaining steps should aid in isolating a defective component. Replace defective components using the "Corrective Maintenance" procedures in this section.

1. Check Control Settings

Incorrect control settings can indicate a trouble that does not exist. If there is any question about the correct funtion or operation of any control, refer to Section 2, "Operating Instructions."

2. Check Associated Equipment

Associated equipment at either input or output of the probe may be defective. A signal you expect to see might not exist or might be distorted at the point you are testing. If you are using the probe with an oscilloscope, the vertical amplifier may be defective or the vertical controls may be misadjusted.

3. Check Calibration

An out-of-calibration condition of either oscilloscope or probe can cause an apparent error in a measurement.

4. Make Visual Checks

Many problems can be located visually. Check for broken wires, damaged connections, or damaged circuit boards. If you discover a heat-damaged component, find the cause of overheating to prevent recurrence of the problem.

5. Refer to Troubleshooting Chart

Table 6-3 lists possible malfuntions and their probable causes.

6. Check Waveforms and Voltages.

Schematic and component layout diagrams are provided in Section 7.

CORRECTIVE MAINTENANCE

Corrective maintenance consists of replacing a defective component or assembly. Special techniques required to replace components are given here.

MAINTENANCE PRECAUTIONS

To reduce the possibility of personal injury or probe damage, observe the following precautions:

WARNING

To prevent electric shock or shorting of components, do not perform probe maintenance while the probe is connected to a power source.

NOTE

Because the P6231 is constructed with surface-mounted components which are not easily removed or resoldered, repair of components on the circuit boards should be referred to a Tektronix service center.

OBTAINING REPLACEMENT PARTS

Special Parts

Most of the parts and assemblies in this probe are specifically made or selected by Tektronix, Inc. to meet specific performance requirements. Order all parts directly from your local Tektronix Field Office or representative.

Ordering Parts

When ordering and to insure recieving the proper parts or assemblies, include all of the the following information with your order:

1. Instrument type (including modification or option numbers).

2. Description of the part (if electrical, include the circuit number).

3. The Tektronix part number.

PROBE DISASSEMBLY

Control Box Disassembly

WARNING

To prevent electric shock or shorting of components, do not perform probe maintenance while the probe is connected to a power source.

The following procedure should be used when replacing assemblies in the Control Box.

Insert tool (Tekronix Part Number 003-1383-00, optional), into the slots near the top of the control box, pressing firmly on both tabs while prying upwards on the box-half parting line to separate the halves.

Hold the halves apart while repeating the procedure on the other side. Gently work the top half off the control box while holding the cable-boot assembly and the BNC assembly firmly in the bottom box half.

CAUTION

Failure to hold the cable boot and BNC assemblies in the bottom box half while disassembling may result in damage to the flexible circuit board which resides below the main board and connects it to the BNC assembly. It is suggested that adhesive tape be used to hold the BNC and cable boot assemblies to the bottom box-half while performing inspections.

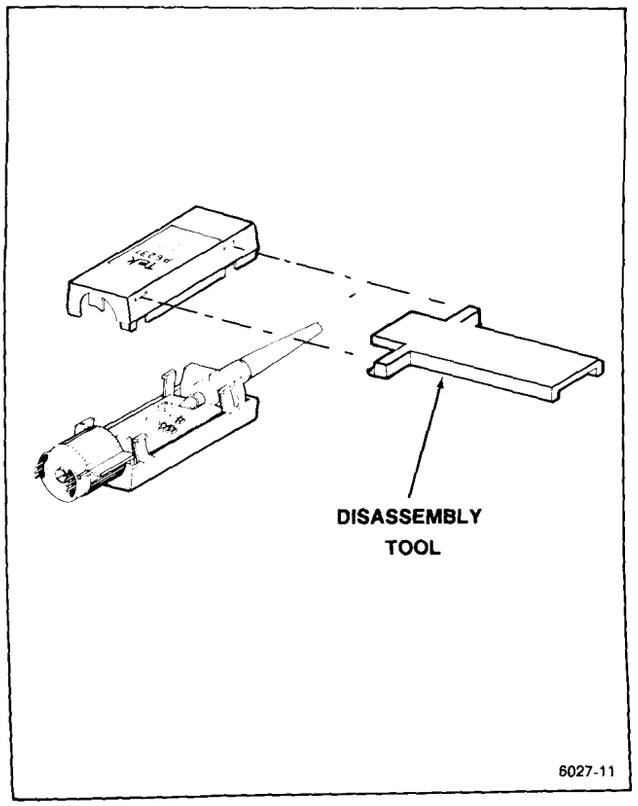


Figure 6-1. Disassembly of control box.

Cable Assembly Replacement

The probe head and cable is replaceable as a complete assembly. To remove the cable assembly, first follow the steps given above to gain access to the circuit board. Then proceed as follows.

Note the position of the circuit-board aligning spring at the rear of the circuit board. Unsolder the blue wire coming from the cable into the main board. Note that its solder pad is labelled ID. Unsolder the cable center conductor from the circuit board. Remove the tape holding the cable assembly. Gently tilt the back of the main board upwards by lifting the gray plastic cable retainers.

CAUTION

Do not tilt the main board further than necessary or attempt to remove it entirely as damage to the flexible board will result.

Carefully unplug the cable assembly from the main board and remove the retainer halves.

Plug the new cable into the main board. Resolder the cable center conductor to the circuit board. Reattach the retainer halves to the cable. Lower this assembly into the lower box half while holding the circuit board alignment spring out of the way with tweezers (one corner at a time). Press the circuit board/cable assembly firmly into the bottom box half. Insert the blue wire into the solder pad marked ID. Resolder. Reinstall the box top half noting that the semicircular cutout with the tab must mate with the BNC end.

Probe Tip Replacement

To remove the probe tip, first unscrew the light gray probe body shell and slide off the grounding collar (refer to Figure 2-2). Then unscrew the probe tip from the cable assembly. The probe tip for the P6231 has small plastic end pieces that are color coded yellow at the tip end and blue at the cable end to aid in distinguishing the P6231 tip from other subminiature probe tips. To install a replacement probe tip, simply reverse the procedure.

READJUSTMENT AFTER REPAIR

After any electrical component has been replaced, complete the "Performance Check Procedure" (Section 3) to verify that the probe is within specification limits. If adjustment is necessary, perform the appropriate "Adjustment Procedure" (Section 4).

INSTRUMENT REPACKING

Required Reshipment Information

If the probe is to be shipped to a Tektronix Service Center for service or repair, attach a tag (before packaging) that contains the following information.

1. Owner's name and address, with the name of an individual at your firm that can be contacted.

2. Description of the service required.

To repackage the probe:

1. Obtain a corrugated cardboard carton having inside dimensions of no less than 2 inches more than probe dimensions to allow cushioning. Use a carton having a test strength of at least 175 pounds.

2. Surround the probe with protective polyethylene sheeting.

3. Cushion the probe on all sides by tightly packing dunnage or urethane foam between carton and probe, allowing 2 inches on all sides.

4. Seal carton with shipping tape or industrial stapler.

DIAGRAMS AND CIRCUIT BOARD ILLUSTRATIONS

Symbols and Reference Designators

Electrical components shown on the diagrams are in the following units unless noted otherwise:

Capacitors = Values one or greater are in picofarads (pF).
Values less than one are in microfarads (μF).
Resistors = Ohms (Ω).

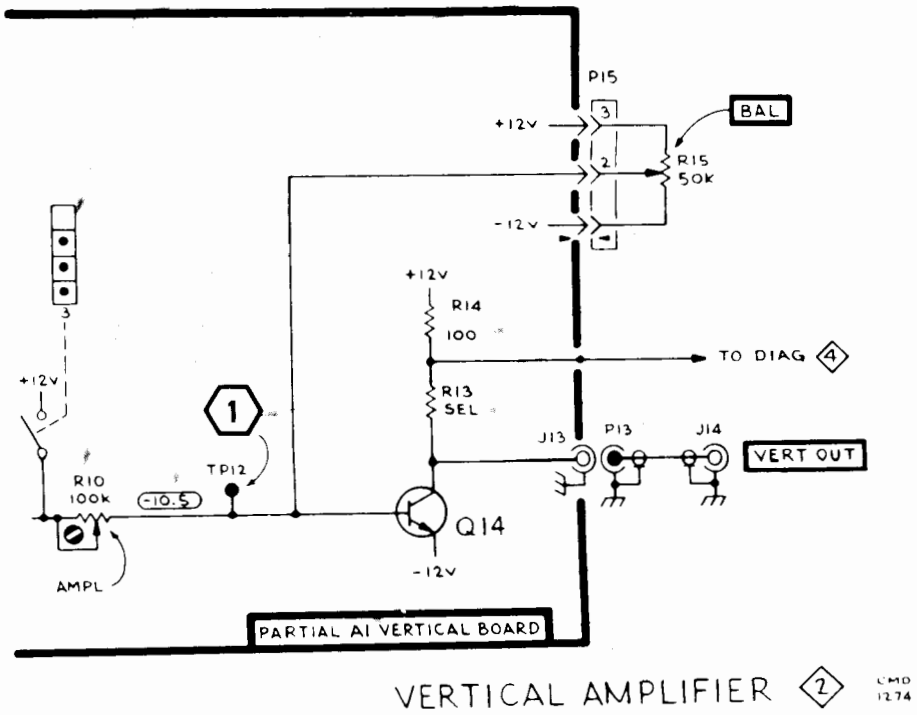
Symbols used on the diagrams are based on USA Standard Y32.2-1967.

Logic symbology is based on MIL-STD-806B in terms of positive logic. Logic symbols depict the logic function performed and may differ from the manufacturer's data.

The following prefix letters are used as reference designators to identify components or assemblies on the diagrams.

A	Assembly, separable or repairable (circuit board, etc.)	H	Heat dissipating device (heat sink, heat radiator, etc.)	RT	Thermistor
AT	Attenuator, fixed or variable	HR	Heater	S	Switch
B	Motor	HY	Hybrid circuit	T	Transformer
BT	Battery	J	Connector, stationary portion	TC	Thermocouple
C	Capacitor, fixed or variable	K	Relay	TP	Test point
CB	Circuit breaker	L	Inductor, fixed or variable	U	Assembly, inseparable or non-repairable (integrated circuit, etc.)
CR	Diode, signal or rectifier	LR	Inductor/resistor combination	V	Electron tube
DL	Delay line	M	Meter	VR	Voltage regulator (zener diode, etc.)
DS	Indicating device (lamp)	P	Connector, movable portion	Y	Crystal
E	Spark Gap	Q	Transistor or silicon-controlled rectifier	Z	Phase shifter
F	Fuse	R	Resistor, fixed or variable		
FL	Filter				

The following special symbols are used on the diagrams:



VERTICAL AMPLIFIER 2

CMD 1274

Cam Switch Closure Chart

Internal Screwdriver Adjustment
Test Voltage

Plug to E.C. Board

Panel Adjustment

Plug Index

Modified Component—See Parts List
Refer to Waveform

Refer to Diagram Number

SEL Value Selected at Factory

Coaxial Connector

Panel Connector

Assembly Number

Board Name

Etched Circuit Board Outlined in Black
Schematic Name and Number

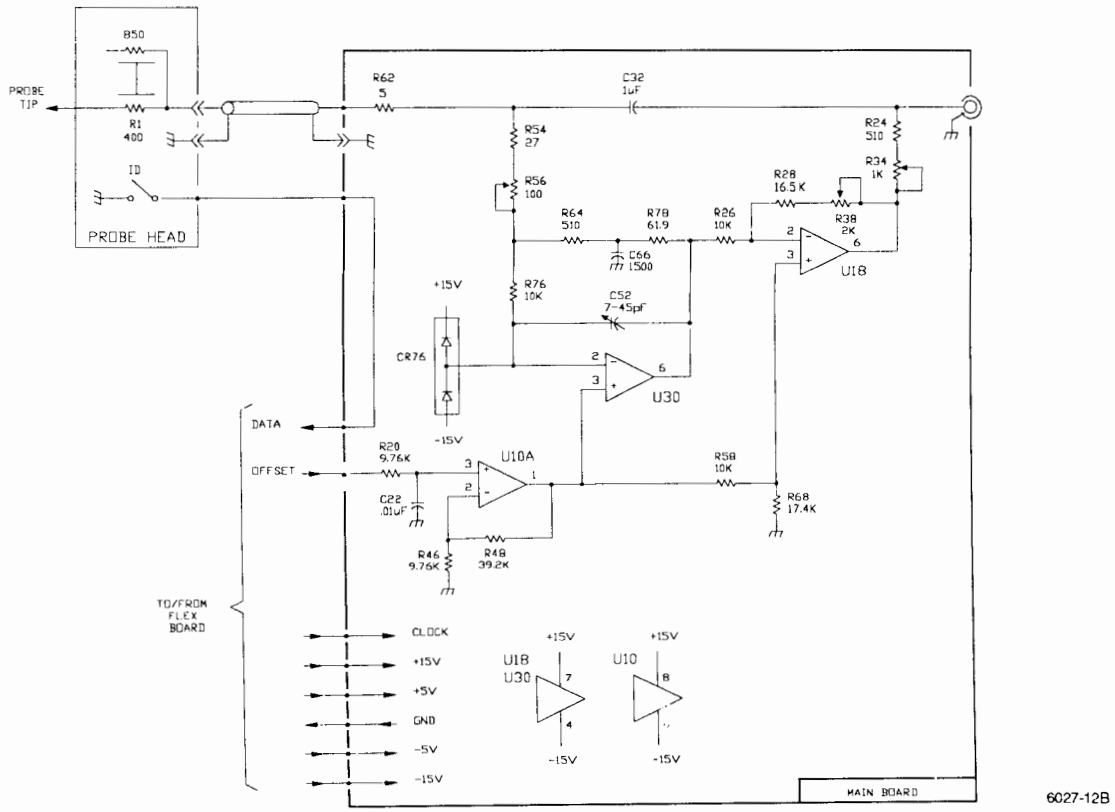


Figure 7-1. Main circuit board schematic.

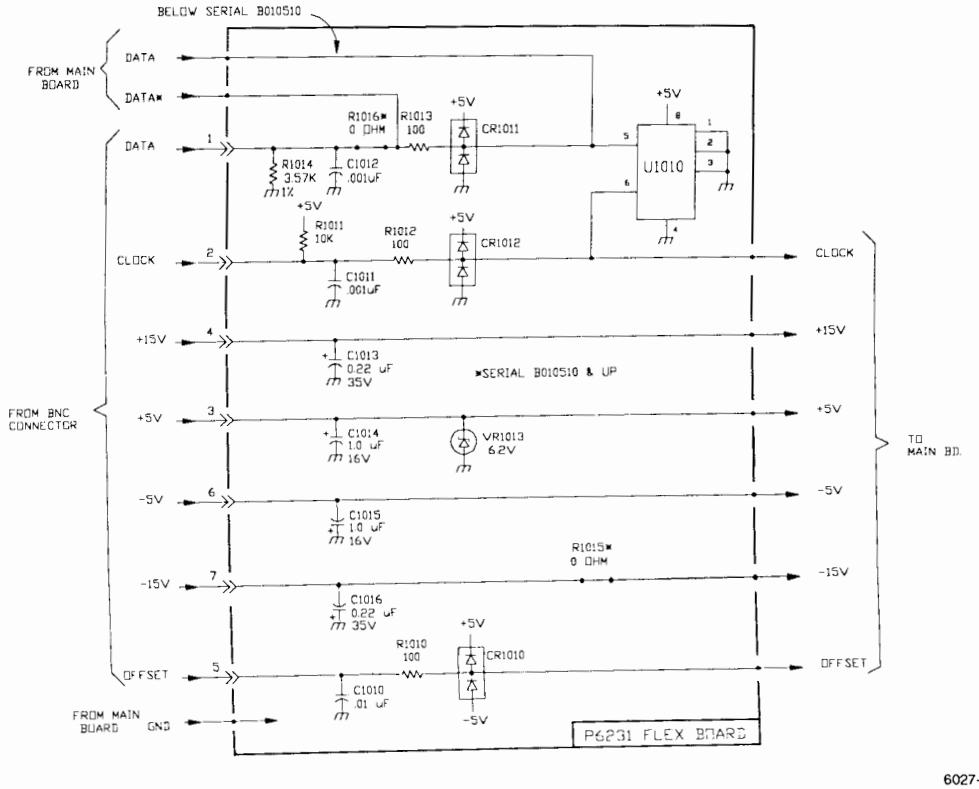


Figure 7-2. Flexible circuit board schematic.

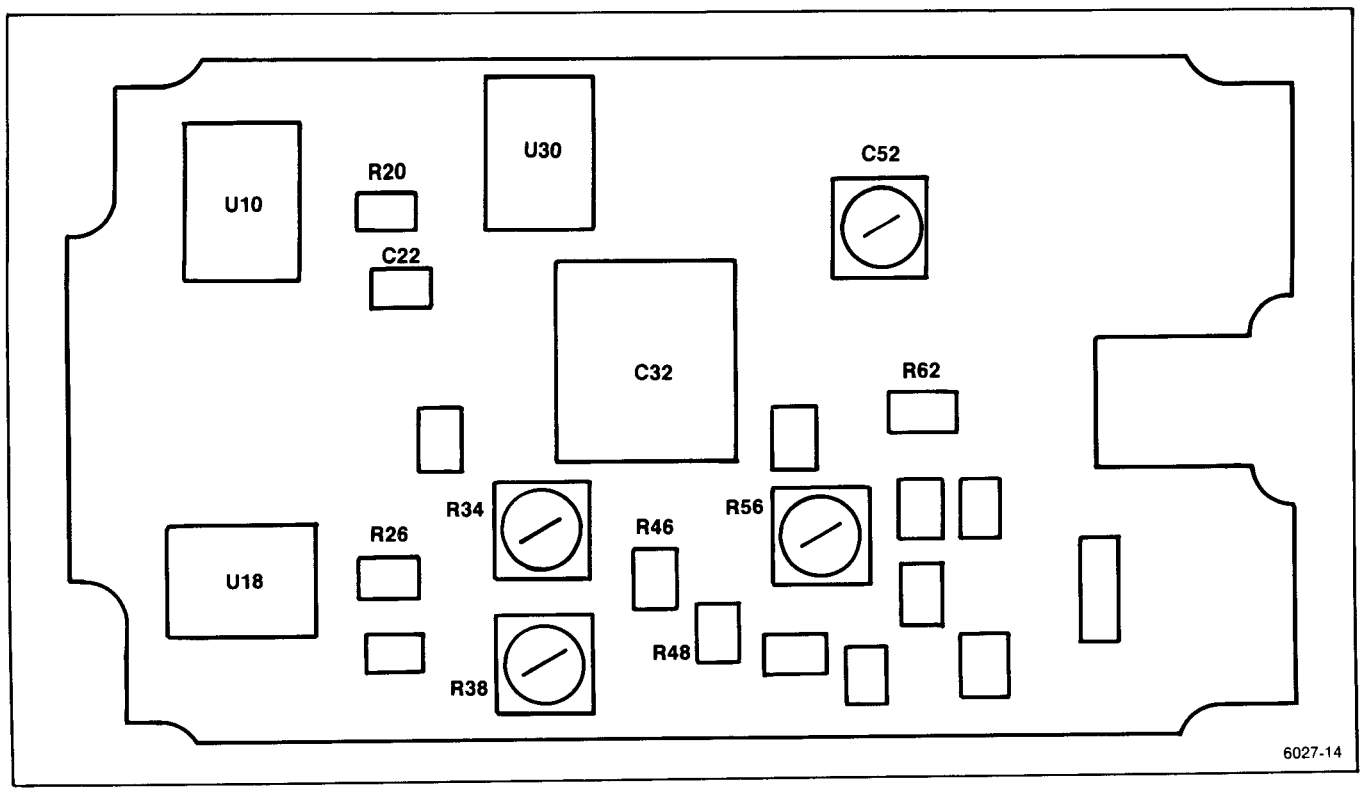


Figure 7-3. Main circuit board component layout for trouble shooting.

REPLACEABLE PARTS

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office 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 developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations.

ITEM NAME

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 Cataloging Handbook H6-1 can be utilized where possible.

INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the description column.

```
1 2 3 4 5                    Name & Description
Assembly and/or Component
Attaching parts for Assembly and/or Component
                - - - * - - -
  Detail Part of Assembly and/or Component
  Attaching parts for Detail Part
                - - - * - - -
    Parts of Detail Part
    Attaching parts for Parts of Detail Part
                - - - * - - -
```

Attaching Parts always appear in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation. The separation symbol - - - * - - - indicates the end of attaching parts.

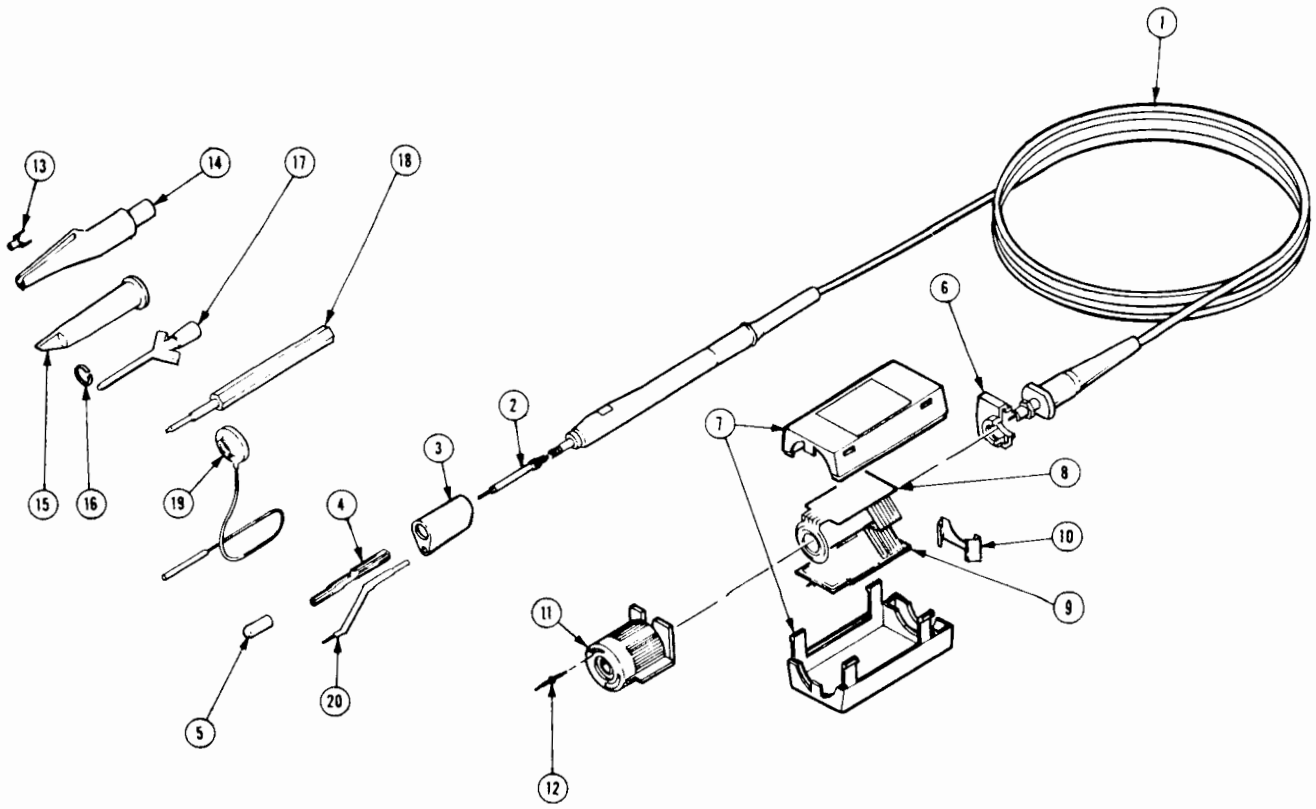
Attaching parts must be purchased separately, unless otherwise specified.

CROSS INDEX - MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
80009	TEKTRONIX INC	4900 S W GRIFFITH DR P O BOX 500	BEAVERTON OR 97077
TK1473	RICHARD HIRSCMANN OF AMERICA	PO BOX 229/INDUSTRIAL ROW	RIVERDALE NJ 07457
TK1556	CONSOLIDATED VINYL SALES	1237 S SAN GABRIEL BLVD	SAN GABRIEL CA 91776

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
1-1	174-0246-00			1	CABLE ASSY,RF:50 OHM COAX,1.5M	80009	174-0246-00
-2	206-0279-00		8627	1	TIP ASSY,PROBE:10X,YELLOW/BLUE	80009	206-0279-00
	206-0279-10	8628		1	TIP ASSY,PROBE:10X,YELLOW/BLUE	80009	206-0279-10
-3	343-1003-01			1	COLLAR,GND:	80009	343-1003-01
-4	204-0925-01			1	BODY SHL,PROBE:	80009	204-0925-01
-5	200-2747-00			1	COVER,PROBE TIP:	80009	200-2747-00
-6	343-1279-00			2	CLAMP,CABLE:SLATE GRAY,ABS	80009	343-1279-00
-7	200-3317-00			1	COVER,COMP BOX:TOP & BOTTOM W/LABEL & REMOVAL TO OL	80009	200-3317-00
-8	670-9726-01	B010100	B010509	1	CIRCUIT BD ASSY:FLEX,TESTED W/ID	80009	670-9726-01
	670-9726-03	B010510		1	CIRCUIT BD ASSY:FLEX,TESTED	80009	670-9726-03
-9	670-9596-00			1	CIRCUIT BD ASSY:MAIN	80009	670-9596-00
-10	344-0397-00			1	CLIP,SPR TNSN:0.80 L X 0.406 X 0.2,BE CU	80009	344-0397-00
-11	131-3733-00			1	CONNECTOR ASSY:BNC,7 PIN ID	80009	131-3733-00
-12	131-3627-00			7	.CONTACT,ELEC:GOLD PLATED TIP	80009	131-3627-00

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345	Name & Description	Mfr. Code	Mfr. Part No.
						STANDARD ACCESSORIES		
-13	131-2766-03			1		CONNECTOR,PROBE:W/SOCKET,DATA SHEET	80009	131-2766-03
-14	344-0398-00			1		CLIP,ELECTRICAL:ALLIGATOR,0.155 L,STL CS PL	80009	344-0398-00
-15	013-0208-00		8627	1		TIP,PROBE:RETRACTABLE HOOK	80009	013-0208-00
	013-0208-01	8628		1		*TIP,PROBE:RETRACTABLE HOOK*	*80009*	*013-0208-01*
-16	016-0633-00			1		MARKER SET,CA:2 EA,9 COLORS	80009	016-0633-00
-17	013-0217-00			1		GRABBER,IC LEAD:BLACK,2.047 L X 0.137 DIA	TK1473	973 592 500
1-18	003-1364-00			1		SCREWDRIVER:ADJUSTMENT TOOL,METAL TIP	80009	003-1364-00
-19	196-3113-00			1		LEAD,ELECTRICAL:STRD,26 AWG,6.0 L,0-N W/CLR	80009	196-3113-00
-20	195-4240-00			1		LEAD,ELECTRICAL:0.025 DIA,COPPER,2.3 L	80009	195-4240-00
	016-0708-00			1		POUCH,ACCESSORY:	TK1556	ZIP-6.25X9.25ID
	070-6027-00			1		MANUAL,TECH:INSTR,P6231	80009	070-6027-00
						OPTIONAL ACCESSORIES		
	003-1383-00			1		RLSE TOOL,COVER:COMP BOX,POLYCARBONATE	80009	003-1383-00
	013-0195-00			1		ADAPTER,CONN:BNC TO PROBE	80009	013-0195-00
	013-0197-00			1		KLIPKIT:(2)16 PIN CLIP W/(4)CONTACT GROUND	80009	013-0197-00
	017-0520-00			1		CONN,PLUG,ELEC:50 OHM COAX	80009	017-0520-00
	131-2766-01			1		CONNECTOR,PROBE:PACKAGE OF 100	80009	131-2766-01


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