Instruction Manual

P6051 PROBE and ACCESSORIES

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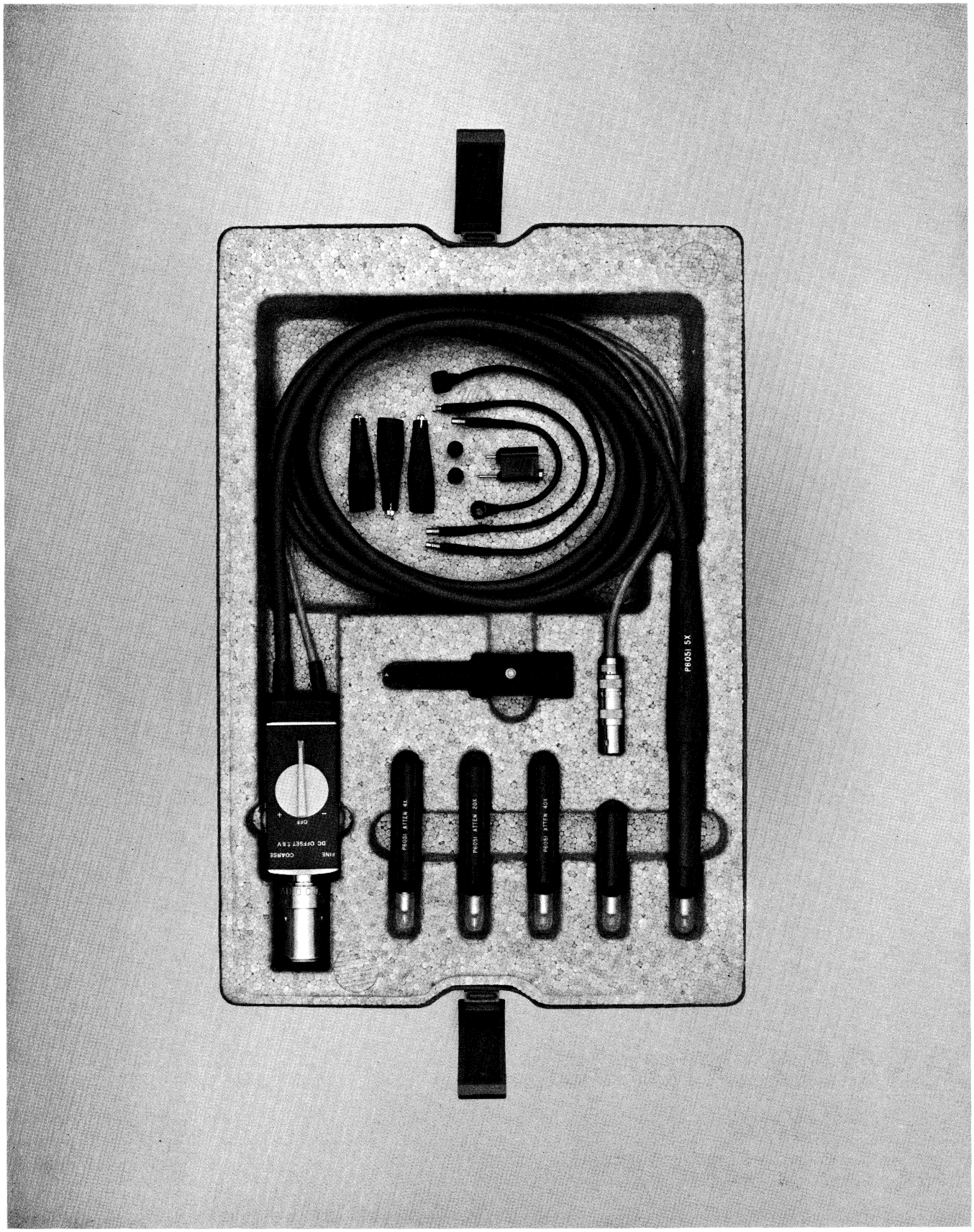


Fig. 1-1. P6051 Probe and accessories.

SECTION 1
P6051 SPECIFICATION

Introduction

The P6051 is a DC to one GHz active (FET) probe. It is designed for use with the 7000 series sampling and real-time oscilloscope systems; however, it can also be used with other oscilloscope systems if powered by an Accessory Power Supply.

The probe has 5X attenuation when terminated into 50 Ω and is supplied with three screw-on attenuator heads plus a coupling capacitor head. These attenuator heads when attached to the probe, provide additional attenuation up to 40X for a total of 200X. An offset feature permits offsetting AC signals with DC levels from 5 V up to 200 V, depending on the amount of attenuation used with the probe.

This section of the manual describes the P6051 electrical, physical and environmental characteristics.

Performance Conditions

The specified limits of the probe characteristics are valid under the following conditions:

The probe must have been calibrated within an ambient temperature range of 20°C to 30°C. (Section 5 provides a calibration and check procedure). The probe must be operated in an ambient temperature of −15°C to +55°C and it must be allowed to warm up for 20 minutes after power has been applied.

The probe outputs must be terminated into 50 Ω.

ELECTRICAL CHARACTERISTICS

Characteristic	Performance Requirement
Frequency Response	
Bandwidth (probe output terminated in 50 Ω)	DC to 1 GHz (calculated from rise-time)
Low-frequency (AC-coupled)	175 Hz or less
Step Response Rise-time (with or without attenuators or coupling capacitor)	0.35 ns or less
Probe Attenuation (alone)	5X within 4%
Signal Range (with 0 V Offset and probe output terminated in 50 Ω)	
Probe Input	At least + and −2.5 V
Probe Output	At least + and −0.5 V
Signal Compression or Expansion	Within 5% with 50 mV input signal over specified signal range.

Characteristic	Performance Requirement
Attenuator Accuracy (4X, 20X or 40X)	Within 1%
Input Impedance (Figs. 1-2 thru 1-5) Resistance (with or without attenuators)	1 MΩ ±1%
Capacitance	
Probe	2.8 pF within 10%
Probe with 4X attenuator	3.25 pF within 10%
Probe with 20X attenuator	2.0 pF within 10%
Probe with 40X attenuator	1.8 pF within 10%
AC Coupling Capacitor	At least 1000 pF

Electrical Characteristics (cont)

Characteristic	Performance Requirement
Noise (RMS)	70 μV or less at the probe output (equivalent to 350 μV or less at the probe tip). 70 μV RMS is equivalent to 140 μV noise tangentially measured.
Maximum Input Voltage (with or without Attenuators or Coupling Capacitor)	200 V (DC + peak AC) Derated with frequency; see Figs. 1-6 and 1-7
Signal Delay (probe tip to probe output)	10.5 ns ±0.5 ns
Offset Range (probe alone)	At least −5 V to +5 V
Offset Current (referred to probe tip)	1.72 μA for each volt of offset (calculated)
Drift with Temperature (probe output terminated into 50 Ω)	Less than 100 μV/°C at the probe output. (Equivalent to 500 μV/°C at the probe input.)

ENVIRONMENTAL CHARACTERISTICS

Characteristics	Performance Requirement
Temperature	
Non-operating Range	−55°C to +75°C
Operating Range	−15°C to +55°C

Environmental Characteristic (cont)

Characteristic	Performance Requirement
Altitude	
Non-operating Range	To 50,000 feet
Operating Range	To 15,000 feet
Humidity (Non-operating Range)	To 95% Relative Humidity
Shock (Non-operating)	400 g's, 1/2 sine at 1/2 ms, 1 ms and 2 ms duration.

PHYSICAL CHARACTERISTICS

Characteristic	Performance Requirement
Dimensions	
Probe Body	Approximately 5.4 inches X 0.5 inch outside diameter
Compensation Box	Approximately 4 inches X 1 inch X 1 inch
Attenuators	Approximately 2.4 inches X 0.5 inch outside diameter
Cables	
Signal	About 6 feet (measured between strain relief bases)
Power	About 4 feet (measured between strain relief base and connectors)
Weight	
Net (Complete with carrying case and accessories)	About 1 pound, 9 ounces
Shipping	About 2 pounds, 6 ounces

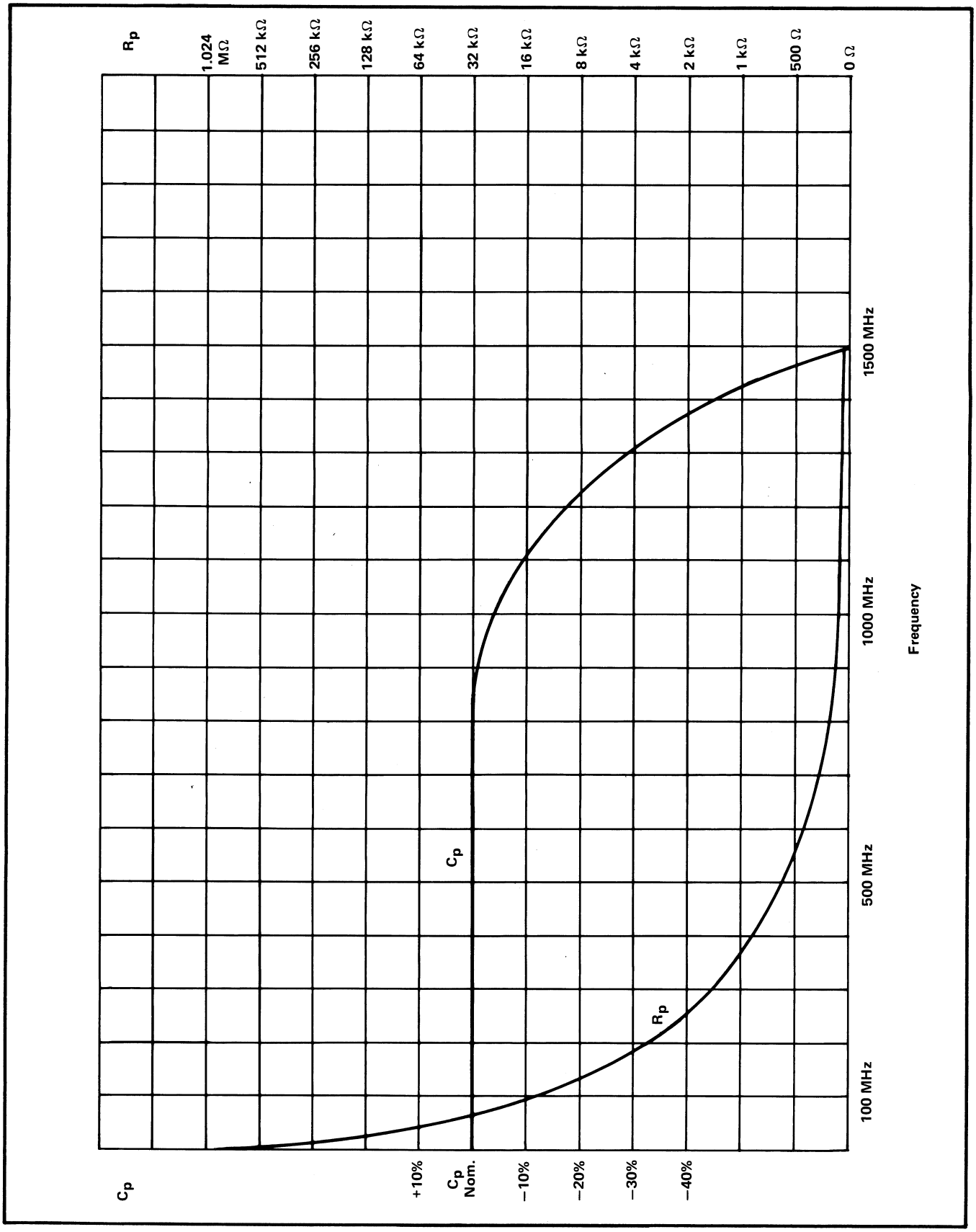


Fig. 1-2. P6051 Probe alone. Input C and R as a function of frequency at 25°C ambient.

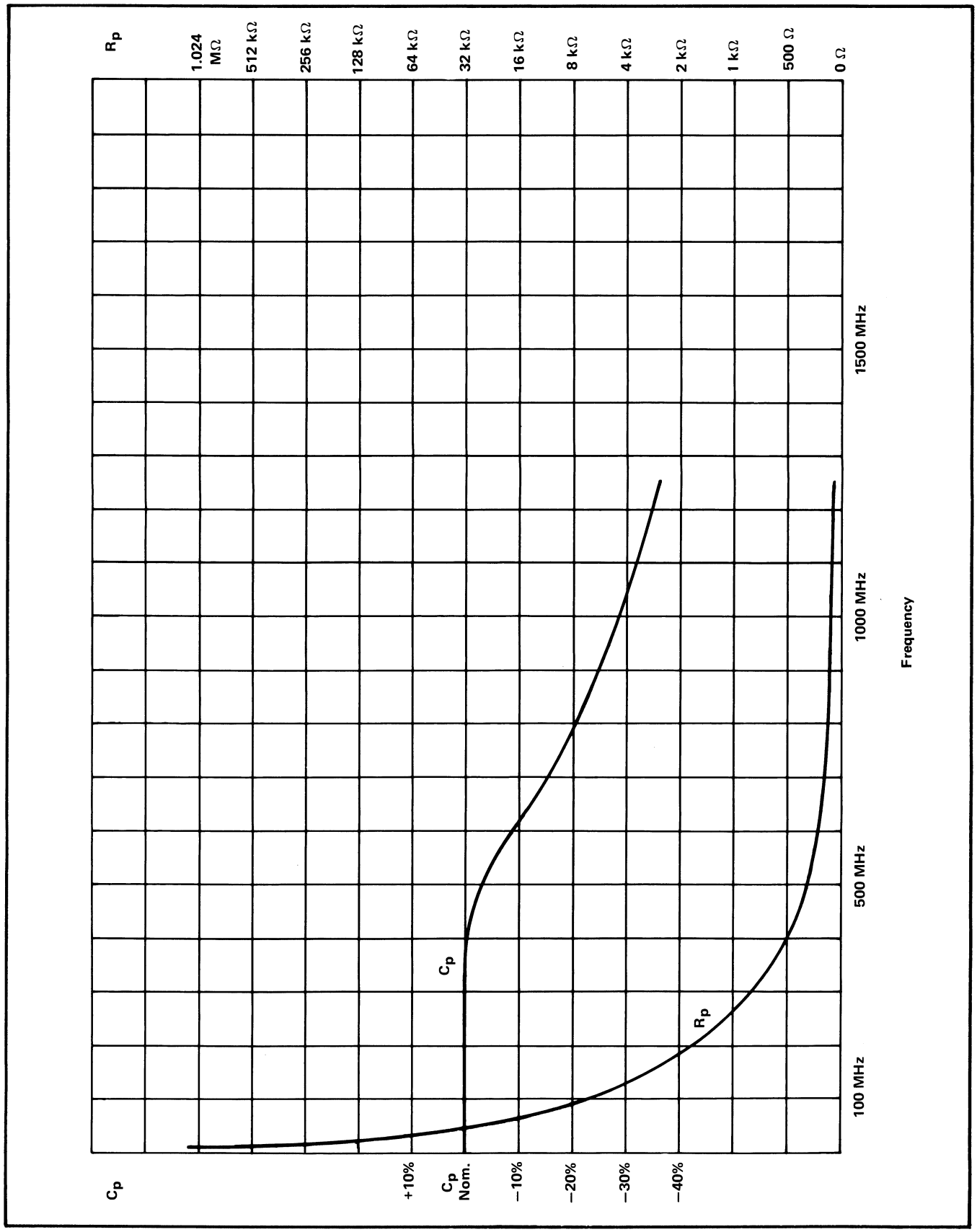


Fig. 1-3. P6051 Probe with 4X attenuator. Input C and R as a function of frequency at 25°C ambient.

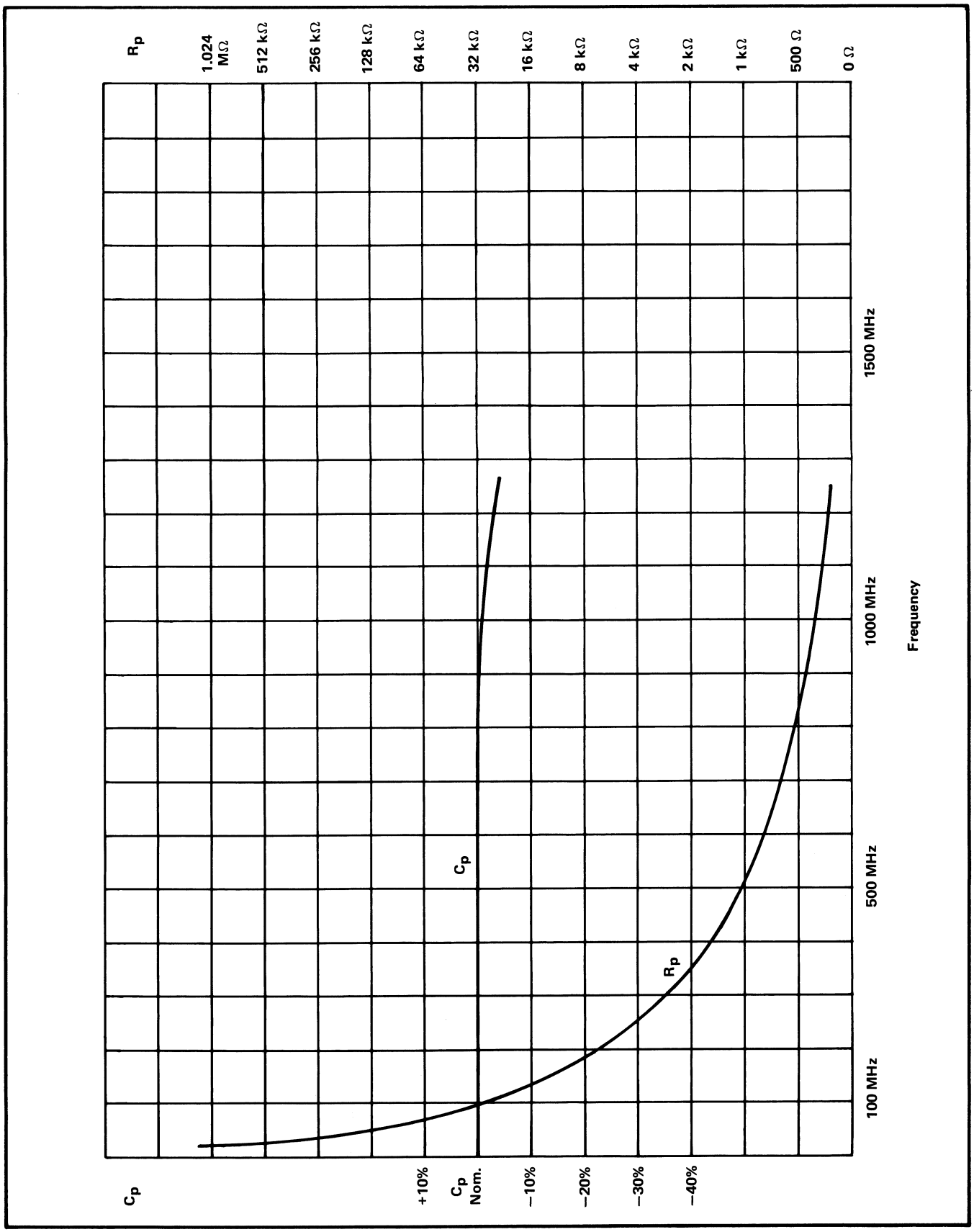


Fig. 1-4. P6051 Probe with 20X attenuator. Input C and R versus frequency at 25°C ambient.

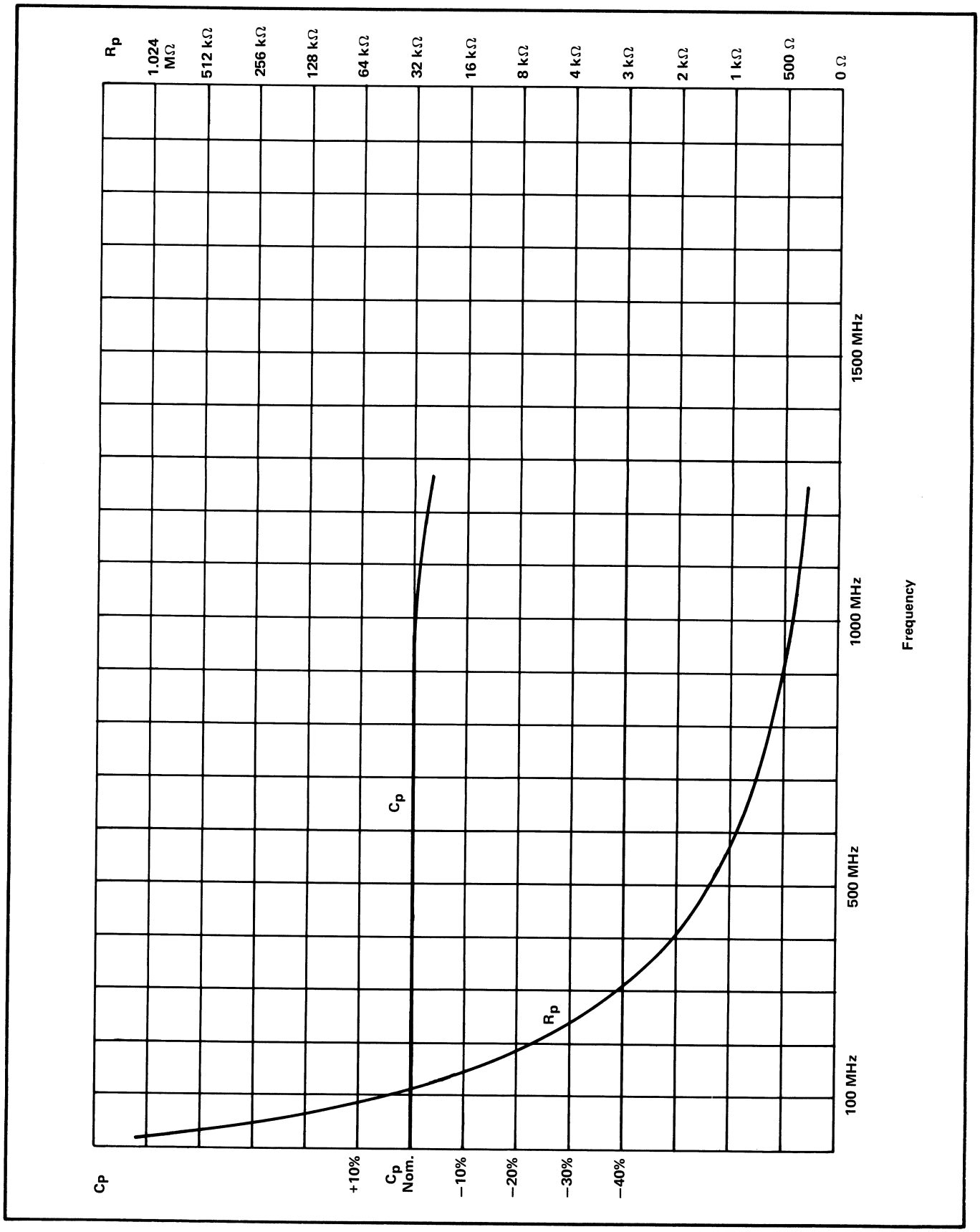


Fig. 1-5. P6051 Probe with 40X attenuator. Input C and R versus frequency at 25°C ambient.

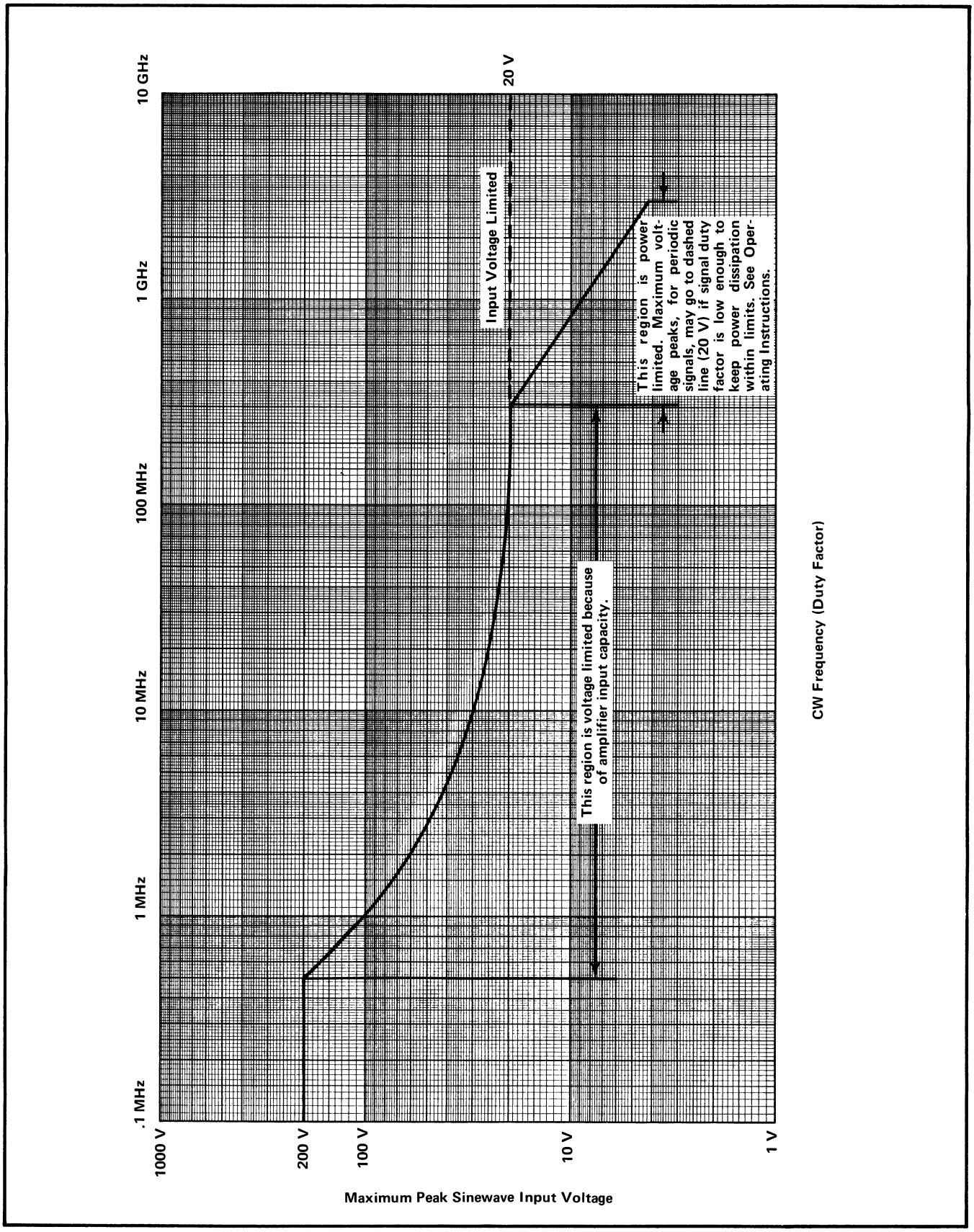


Fig. 1-6. Voltage derating as a function of frequency for the P6051 probe.

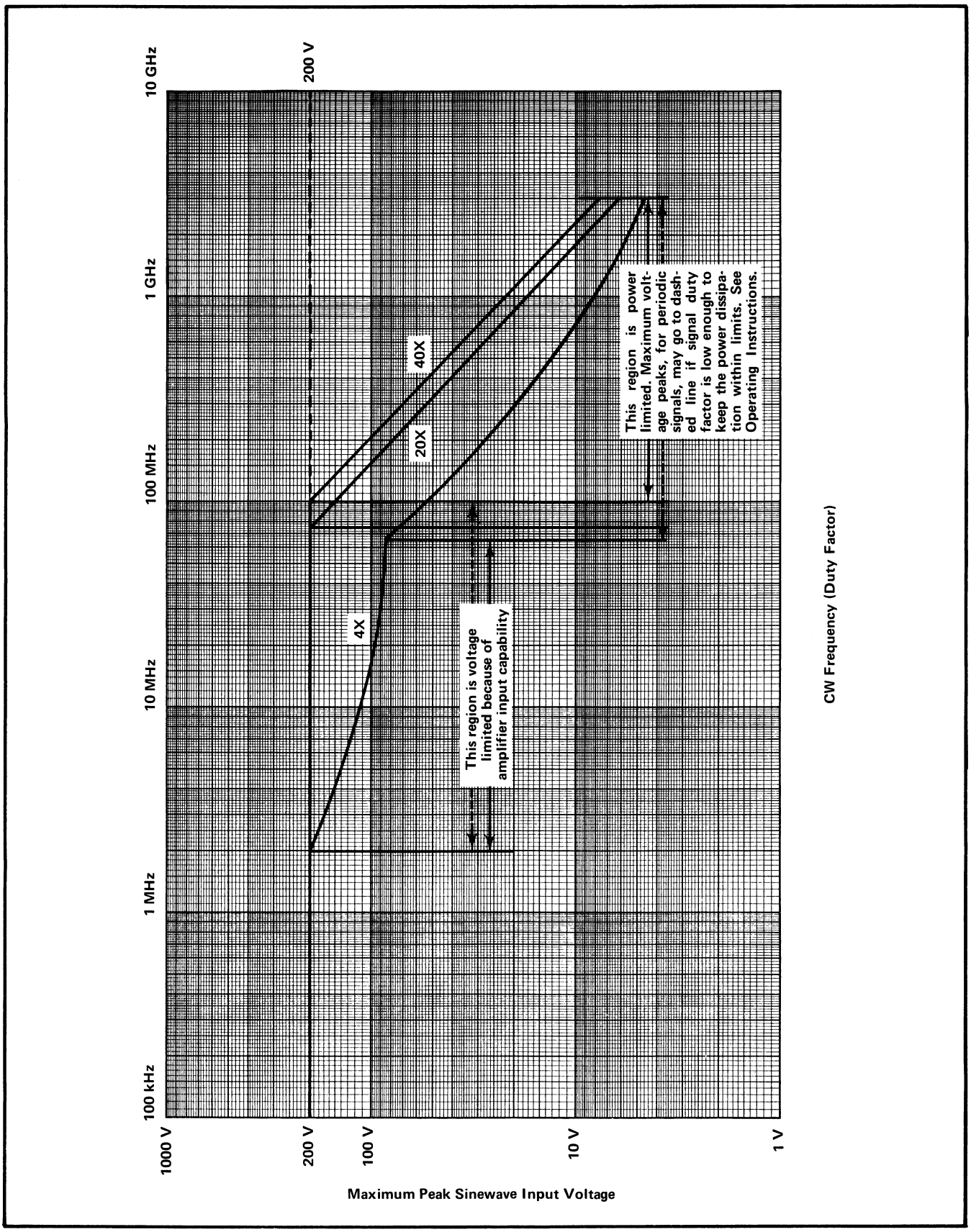


Fig. 1-7. Voltage derating curve as a function of frequency, for the P6051 Probe with attenuators.

SECTION 2
OPERATING INSTRUCTIONS

Introduction

This section of the manual describes operational procedures and precautions for the P6051 Probe. This includes probe installation, operation, use of accessories, probe loading effects on signal measurements, and probe signal limitations.

General

The P6051 Probe is an active probe, designed to use with instruments having a 50 Ω input impedance, such as sampling units. Terminate the probe into 50 Ω when it is used with instruments that have a high input impedance, such as real time units. The P6051 can be powered from the Probe Power output of a 7000-series indicator oscilloscope, or from a Type 1101 Accessory Power Supply. The probe can also be powered from the Type 454 Probe Power out or the 015-0073-00 accessory power supply, with the use of optional accessory (012-0187-00) adapter.

Probe attenuation is 5X within 4% when terminated into 50 Ω and approximately 2.5X unterminated. Additional attenuation is provided by three (4X, 20X and 40X) accessory attenuators that screw onto the probe head. These provide attenuation up to 200X (5X probe and 40X attenuator). Because of response degradation, the attenuators cannot be stacked. They are matched or compensated to the probe head but not to each other. When the probe is properly terminated into 50 Ω, its frequency response is DC to 1 GHz (equivalent to risetime of 350 ps or less). Connecting the probe into a 1 MΩ load impedance degrades the risetime response, and reduces the attenuation to about 2.5X.

Probe Handling

The P6051 Probe has been designed to be as rugged as possible consistent with good high-frequency response and miniature size. However, as with all precision devices, the probe and cable should be handled carefully to avoid damage. Special care should be taken that the cable is not crushed or pulled very hard. The probe tip should also be treated with special care. Use caution when inserting the probe tip into attenuators or other jacks to make sure that the tip is aligned with the receptacle. Avoid dropping the probe head. Some of the most sensitive circuitry of the probe is in the head. When not in use, protect the probe tip from damage by covering it with one of the small plastic probe-tip covers.

Power Source

The probe power connector is designed to connect to the probe power receptacle on the 7000 series oscilloscopes or the 1101 Accessory Power Supply. It can also be obtained by using a cable adapter (Part No. 012-0187-00) to adapt the P6051 power plug to the outlet receptacle on the 015-0073-00 Accessory Power Supply or the Type 454 oscilloscope. The probe requires +12 V to +15 V DC and −12 V to −15 V DC at 60 mA each to operate. See Maintenance section or circuit diagram for pin identification.

Probe Connector and Controls

The P6051 probe contains two offset adjustments and an offset polarity switch. Fig. 2-1 shows the location of these controls. The GR output connector is an integral part of the offset housing. The offset range of the two controls (coarse and fine) is at least 5 volts. The polarity (+ and −) is selected by the polarity switch. Adding any one of the

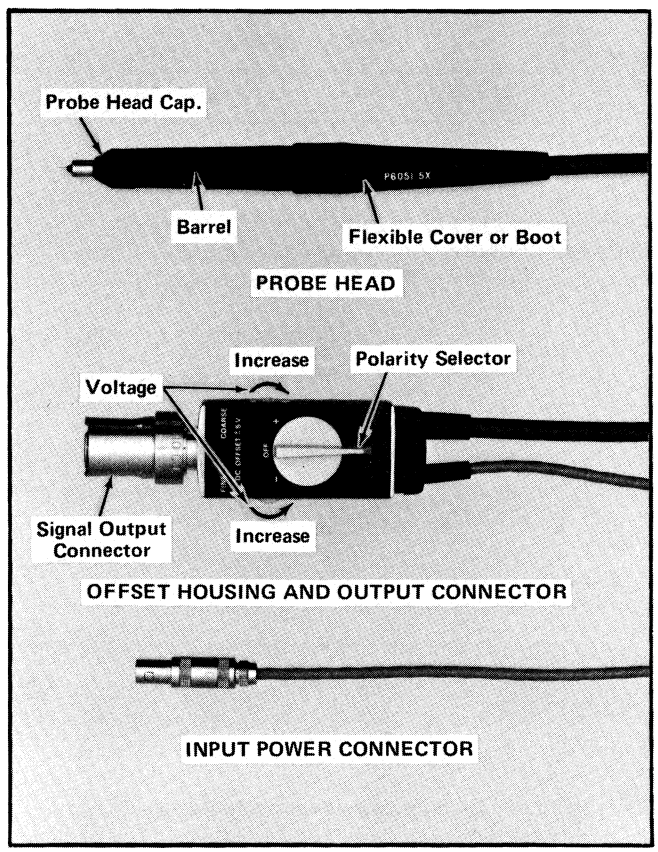


Fig. 2-1. P6051 Probe.

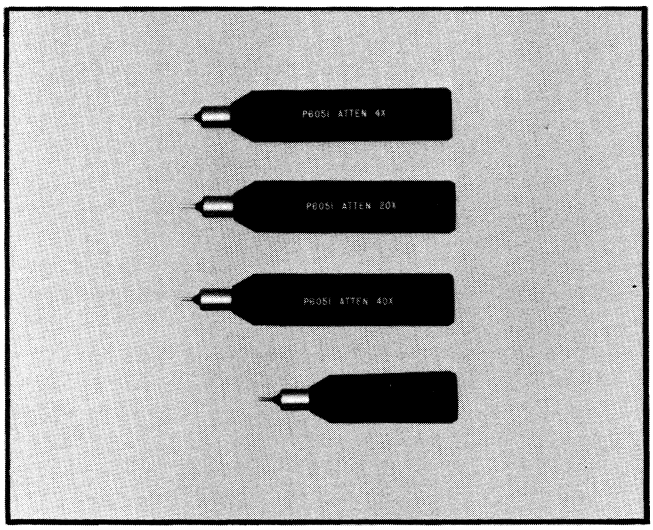


Fig. 2-2. P6051 Accessories.

three attenuators (4X, 20X and 40X) increases the offset range by the attenuation factor of the attenuator. Attenuators and Coupling Capacitor for the probe are shown in Fig. 2-2.

Dynamic Range

The dynamic (signal) range for the P6051 Probe and the probe with attenuators is illustrated in Fig. 2-3. The dynamic range or maximum input signal capability for the probe alone, when it is properly terminated into 50 Ω, is + and −2.5 V peak (5 V peak to peak). This 2.5 V signal can be offset + and −5 V, so the maximum dynamic window with DC offset is + and −7.5 V (AC + DC). If signals with amplitudes greater than 2.5 V peak are to be measured, or the DC offset exceeds 5 V, use the appropriate attenuator to reduce the signal voltage and DC offset down to the probe input limitation.

The voltage output of the probe, with + and −2.5 V peak input signal, is + and −0.5 V peak when it is properly terminated into 50 Ω and about one volt when the output is unterminated.

Maximum Voltage and Power Limitations

The power handling capability of the probe and attenuators is dependent on the series resistor inside the probe or attenuator body. The input voltage limitation depends on the input amplifier capabilities and the signal duty factor.

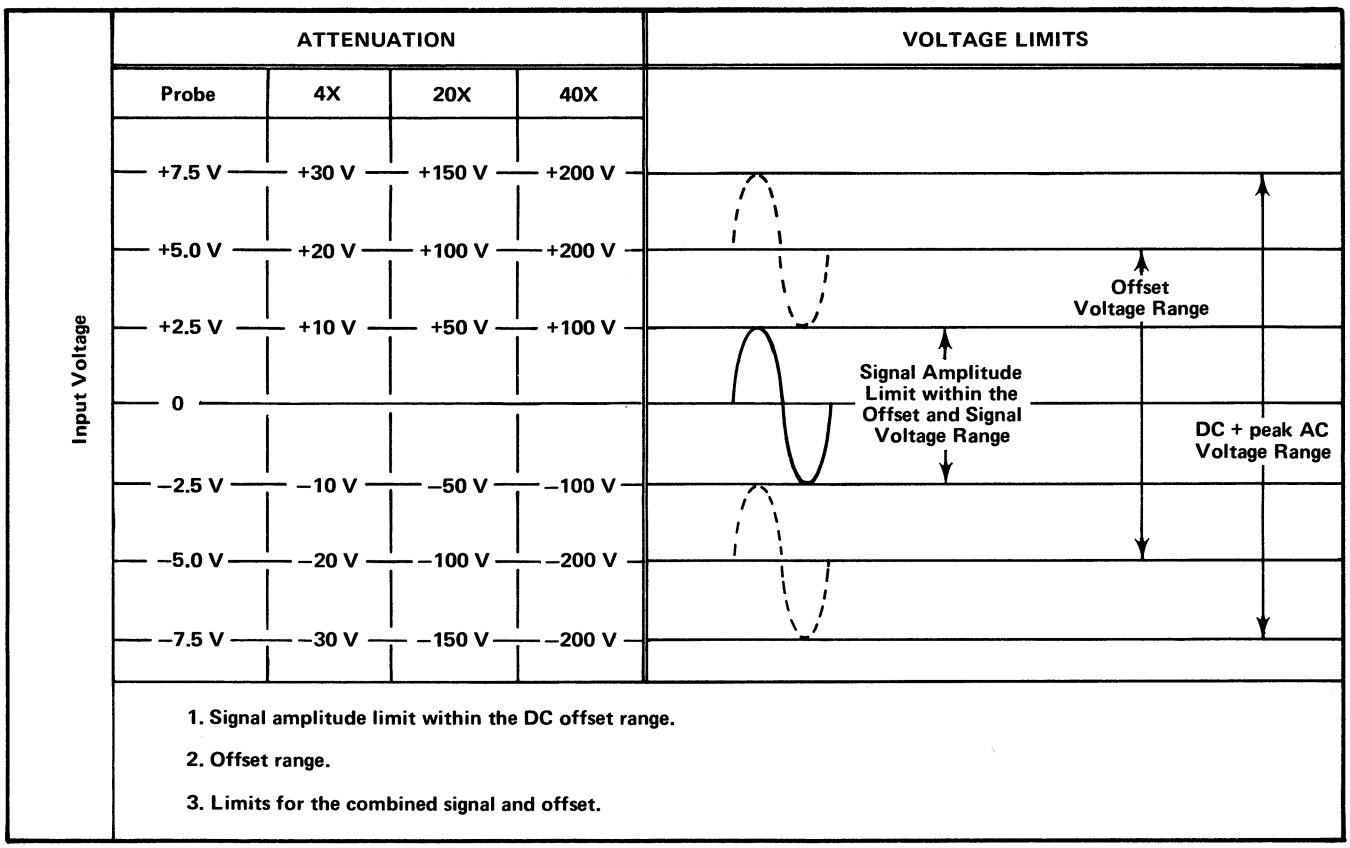


Fig. 2-3. Dynamic and offset limitations for the P6051 Probe and the probe with attenuators.

The P6051 Probe, with or without an attenuator, is designed to withstand up to 200 V (DC + peak AC) at the low frequencies. Voltages in excess of this may damage the probe or attenuator.

The 200 V limitation applies for frequencies up to about 5 MHz for the probe. Above this frequency, the power dissipation of the passive elements become significant and add to the voltage limitation of the probe. Fig. 1-6, in the Specification section, is a maximum voltage derating curve for the P6051 Probe. E_{max} is plotted as a function of frequency for a zero referenced sinewave. From approximately 5 MHz to 300 MHz, the probe is voltage-limited because of the input amplifier limitations. Above 300 MHz, the voltage limit remains at approximately 20 V peak, as indicated by the dashed line; however, the power handling capabilities of the probe becomes the dominant factor. The voltage must be reduced to offset the increased power dissipation if a signal with a duty factor of one is to be measured. Pulse peak voltages in excess of this portion of the curve can be measured if the average power of the signal is estimated. The following equation may be used to estimate the maximum input voltage for a periodic signal such as a pulsed waveform: (E_{max} is still limited to about 20 volts peak above 300 MHz)

$$E_{max} = \frac{\text{Voltage from the derating curve}}{\sqrt{\text{Duty factor}}} + \text{DC components}$$

$$\text{where duty factor} = \frac{\text{Pulse duration}}{\text{Pulse period}}$$

Fig. 1-7, in the Specification section, is a maximum voltage derating plot for the P6051 Probe with attenuators. Again the dashed line that extends out from the knee of the plot indicates voltage limitation for periodic signals with a low enough duty factor to keep the power dissipation below the solid derating line.

Attenuators and Coupling Capacitor

The P6051 Probe accessories include three attenuators and a coupling capacitor. The attenuators extend the input signal amplitude range of the probe in multiples of 4X, 20X and 40X, when they are attached to the probe head. To attach an attenuator to the probe head, unscrew the plastic cap at the head (see Fig. 2-4), then screw on the desired attenuator. Only one attenuator can be used with the probe. The attenuators are compensated to the probe head and not each other. Attenuator compensation is a calibration adjustment and is described in the Calibration procedure in Section 5.

The coupling capacitor accessory is used to block DC components that may be riding on the input signal. The low frequency cutoff (–3 dB) point is approximately 175 Hz.

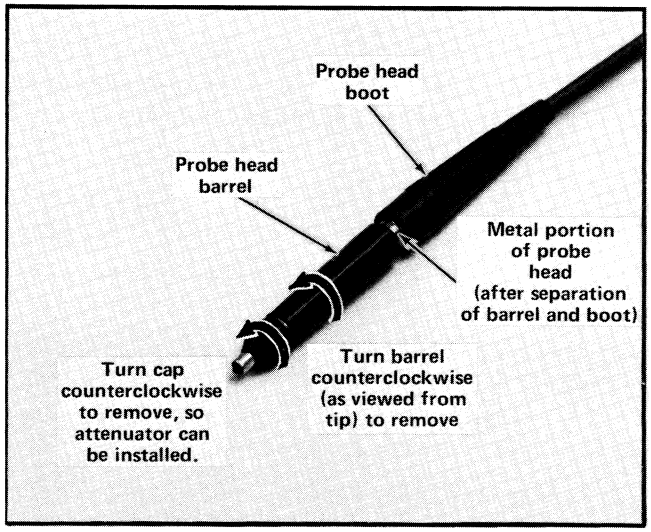


Fig. 2-4. Attaching the attenuators or coupling capacitor to the probe head.

The coupling capacitor may be used with the attenuators as well as the probe head. The coupling capacitor is installed on the probe head or the probe and attenuator combination so that it is nearest to the signal source. Install the coupling capacitor by following the procedure described for the attenuator installation.

Initial Operation

1. Connect the P6051 Probe to the 50 Ω input connector of the test oscilloscope. If the oscilloscope input is not 50 Ω connect the probe through a 50 Ω termination and GR to BNC adapter. Oscilloscopes with BNC input connectors require the GR to BNC adapter (Tektronix Part No. 017-0083-00) which has an internal 50 Ω termination. If a standard GR to BNC adapter is used, a 50 Ω termination with BNC connectors must be used to terminate the probe signal cable.

2. Connect the probe power connector to the power receptacle on the back panel of the oscilloscope or the 1101 Accessory Power Supply.

3. Allow approximately 5 minutes for the probe circuits to warm up, unless the probe specifications are to be checked. The probe warmup time for a specification check is 20 minutes.

4. Install the required attenuator to reduce the signal source voltage to the voltage limits of the probe. See Dynamic Range. If the signal source contains some DC component, install the coupling capacitor or include this DC component when determining maximum voltage limits to the probe head.

5. Set the oscilloscope Volts/Div to the dynamic range of the probe or probe attenuator. Switch the oscilloscope Input Coupling to GND, center the oscilloscope sweep with the centering controls, then switch the oscilloscope amplifier Input Coupling to DC.

6. Connect the probe to the signal source (see Signal Connections) and note the oscilloscope display.

7. Adjust the DC Offset controls through their range with the polarity switch in either position and note their effects on the display. See Using DC Offset.

8. Measure the display amplitude in graticule divisions. Voltage amplitude of the signal source equals the display amplitude times the Volts/Div setting, multiplied by the attenuation factor of the probe and attenuator (if an attenuator is used).

Use of DC Offset

The probe offset capability allows the input signal to be positioned to the center of the dynamic window or operating range of the probe amplifier. This assures optimum probe transient response. To prepare the probe for this operation, switch the Input Coupling of the oscilloscope amplifier unit to GND position or disconnect the probe connector from the oscilloscope input. Center the trace in the graticule area with the oscilloscope Position controls. Reconnect the probe to the oscilloscope Input and switch the Input Coupling to DC position. Do not change the oscilloscope Position control setting, but use the P6051 Probe Offset controls to center the signal on the CRT graticule area. This assures that the observed signal is within the probe dynamic range.

Probe Connections to the Signal Source[1]

The input resistance of the probe is one MΩ with zero offset voltage. this input resistance decreases to approximately 580 kΩ when maximum offset is used. (1.72 μA/volt of offset is drawn from the source by the probe.) Adding an attenuator to the probe reduces this offset loading so the input resistance remains near one MΩ as DC offset is added. The AC or dynamic loading of the probe is not affected by DC Offset; however, it does depend on frequency. Figs. 1-2 through 1-5 illustrate the shunt input resistance and capacitive loading of the probe and attenuators as a function of frequency. Refer to these graphs when probe loading is a concern. When possible, the probe should be connected to a low impedance point in the circuit to minimize this circuit loading.

Signal connections should be made directly to the tip of the probe or its attenuators and coupling capacitor. Establish a good ground connection as directly as possible between the probe ground shield and the signal source ground. Long ground leads can induce ground loops between the probe amplifier and the signal source, generating considerable signal distortion.[1] Use one of the supplied clips or connectors to ground the probe outside terminal. If the ground plane is adjacent to the signal source, the bayonet tip is suggested as a grounding strap. If the signal source is a coaxial connector, use a probe tip adapter (Tektronix Part No. 013-0084-00 for probe tip to BNC, or 017-0076-00 for probe tip to GR connector) to connect the probe tip to the signal source. This coaxial environment improves performance and reduces interface problems with the signal source. It is good practice to always keep the ground lead as short as possible and to use a ground lead even for low frequency measurements.

The probe output cable contains a reverse termination of 50 Ω. For most applications the probe should be terminated into a 50 Ω load; however, this reverse termination permits the use of the probe in the unterminated mode without excessive degradation to the frequency response. When unterminated and connected into the high impedance (1 MΩ) of a real-time oscilloscope, the probe attenuation is approximately 2.5X. The thermal compensation for signal-generated thermal changes is no longer effective, so there will be a long term (about 80 ms) roll-off at the leading edge of a step function that equals 1 to 2% of the signal amplitude.

[1] **Tektronix Measurement Concept booklet on Probe Measurements (Part Number 062-1120-00) is a recommended treatise.**

SECTION 3
CIRCUIT DESCRIPTION

Introduction

The P6051 Probe circuits consist of an amplifier, a DC offset, and a regulated power supply. The amplifier is located in the probe head, permitting a short direct connection between the signal source and the input to the amplifier. The input impedance of the amplifier is one MΩ. Its output terminates into a 6 foot 50 Ω coaxial cable which transports the output signal to the associated oscilloscope. This 50 Ω coaxial cable is part of a 6 conductor cable which connects the amplifier in the probe head to the offset housing and output GR connector. The remaining 5 conductors of this cable carry DC voltages and ground from the offset and power regulator circuits to the probe amplifier.

A shielded 3-conductor cable supplies power, from the 7000 series oscilloscope or the 1101 Accessories Power supply, to the regulator circuit in the offset housing.

The objective of this section is to provide sufficient understanding of the circuit theory so the reader can efficiently troubleshoot, calibrate, and operate this probe. Refer to the schematic diagram at the rear of the manual when reading the circuit description.

Probe Amplifier

Signals at the probe tip are applied through a 2.4X attenuator to the gate of Q110A. The attenuator consists of the voltage-divider combination made up of R100, R101, R102, R105, R170, R171, R174 and R175. This attenuator plus the gate to source impedance of Q110A, provides an input resistance at the probe tip of one MΩ. The ratio of R102 to R105 plus R171 and half of R175 (582 kΩ to 417 kΩ) is essentially the voltage division for the incoming signal. Only about four-tenths of the input signal is coupled through to the gate of Q110A and the emitter of Q120.

Q120 and Q110A are connected in a cascode arrangement. High frequency components of the input signal are coupled through C120 to the emitter of ground-base amplifier Q120. This provides high frequency boost to compensate against high frequency roll-off.

Q110B provides compensation for ambient temperature changes and is also part of the feedback loop around the amplifier that compensates for signal-generated thermal changes in Q110A.

C120 is adjusted for optimum response to the first 5 ns of a step function. C102 (across R102) is then adjusted for flat top response to a rectangular waveform.

The output from Q110A and Q120 is coupled to emitter follower Q130, which drives output emitter follower Q140. Diode CR138 stabilizes the thermal drift of Q130 and Q140 by providing a negative temperature coefficient to compensate for the positive temperature coefficient of the two transistors. The two diodes (CR138) also correct for the DC offset produced by Q130 and Q140.

The output signal from Q140 terminates into R148-C148 and the 50 Ω coaxial cable. When the output cable is terminated into 50 Ω the output signal is attenuated another 2X, providing an overall attenuation of 5X from the probe tip to the terminated output cable. R148 and C148 reverse-terminate the output cable, so the output can be connected into a high impedance load, such as a real time oscilloscope, and still provide fair frequency response. When the output is unterminated, the attenuation is approximately 2.5X.

Thermal compensation for signal-generated temperature change is no longer effective, so there is a long-term (about 80 ms) roll-off at the leading edge of a step function. This roll-off equals approximately 1% to 2% of the signal amplitude.

The DC bias voltage on the gate of Q110B can be shifted about 150 mV by Output Level adjust R160. Adjusting R160 will shift the output DC level of the amplifier. It is adjusted for 0 V output.

Offset Circuit

The offset controls, located in the offset housing, provide offset voltage adjustment over a range of + and −5 volts. This voltage is applied through the six-conductor cable to the probe amplifier circuit board, then through R105 to the amplifier input (gate of Q110A). If the probe tip is connected to a signal source that contains any DC component, the gate of Q110A can be offset to 0 V by the offset controls. This returns the amplifier output to 0 volt.

The offset controls, (R175) COARSE and (R170) FINE, are switched across a plus and minus (2 mA) constant current source by POLARITY SWITCH S174. This

current source supplies + and −5 volts from power regulator U180. Switching the POLARITY SWITCH S174 to the OFF position grounds both ends of the offset controls. The ground return is through the six-conductor cable to the probe amplifier circuit board. Returning the ground to the amplifier board eliminates ground loop currents between the amplifier and power supply.

Power Regulator

Power regulator U180 requires a power source of +12 V to +15 V and −12 V to −15 V at 60 mA each to operate. This power is provided by the 7000 series oscilloscope or the 1101 Accessory Power Supply. A Type 454 oscilloscope or an accessory power supply (015-0073-00) with a special adapter (012-0187-00) can also act as the power source.

Power Supply

U180, an integrated power regulator, supplies positive and negative 2 mA constant current source to the offset circuit as well as the reference voltage for voltage regulator Q166 and Q162, and a regulated +7 V to the amplifier. A regulated −10 V is supplied by pass transistor Q162, which is in series with the −12 V to −15 V source. Q162 is controlled and temperature-compensated by Q166. C185 provides phase compensation between the −15 V source and power regulator U180. Output Level control R160, as previously described, sets the bias of Q110B in the amplifier. This bias sets the emitter of Q140 to 0 V when there is no offset applied to the input. The output of the probe is therefore 0 volts.

SECTION 4
MAINTENANCE

Introduction

This section recommends procedures for reducing or preventing probe malfunction, troubleshooting procedure, and corrective maintenance to repair the probe. Preventive maintenance improves the probe reliability. If the probe should fail to function properly, corrective measures should be taken immediately; otherwise, additional problems may develop within the probe circuits.

Access to Interior of Probe Head and DC Offset/ Voltage Regulator Box

CAUTION

Disconnect the probe power before removing the probe head barrel or the covers for the DC Offset and Voltage Regulator box. This will prevent accidental destruction of the solid state devices on the circuit boards. Do not apply power to the probe unless the barrel or calibration fixture 067-0624-00 is installed.

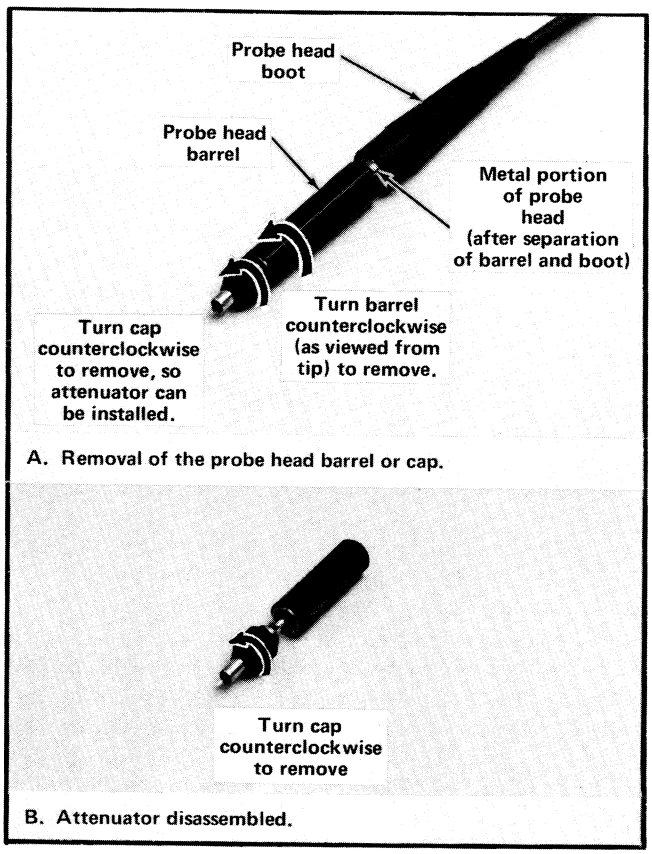


Fig. 4-1. Access to the probe head or attenuator circuit boards.

Access to the circuit board, inside the probe head, is accomplished by unscrewing the probe barrel. See Fig. 4-1. If the flexible cover (boot) behind the probe barrel should unscrew before the probe barrel, unscrew the boot to expose the metal bushing of the probe body then grasp the metal casing firmly and unscrew the probe-head barrel cover.

The barrel and boot should only be removed to calibrate or troubleshoot the circuitry. These covers protect the circuits from dust, provide the ground return, and shield the amplifier from stray electromagnetic fields. Do not apply power to the probe unless the probe barrel is installed. See CAUTION.

When replacing the barrel, insure that the probe tip is centered before screwing the barrel on tight, otherwise the tip may be damaged.

The Offset and Power Regulator housing consists of two plastic snap-fit covers that fit into a metal casing around the circuit boards. The polarity switch lever, on the top cover, is removed with the cover. Remove the top or bottom cover of the offset housing by pressing in on the cover edge and lifting up, one side at a time.

Install either cover by placing one side of the cover into the slot position on the housing and pressing the other side until it snaps into position. The polarity switch knob should be correctly aligned over the switch shaft so the shaft will slip into the slot on the knob before pressing the top cover in place.

PREVENTIVE MAINTENANCE

Preventive maintenance consists of a performance check and, if needed, a recalibration, visual inspection for damaged components, and cleaning. The schedule for this preventive maintenance depends on the environment in which the probe is operated and the house of use. With average conditions (laboratory situation) a preventive maintenance program should be conducted about every 1000 hours of probe operation or every six months if the probe is used only occasionally.

Cleaning

Normally the circuit boards in the interior of the probe will not require cleaning unless the cover has been left off

for an extended period. Any cleaning on the inside of the probe body should be done with extreme care. Use low pressure air to blow away accumulated dust. Do not use any cleaning agent on the circuit board.

Circuit boards in the offset housing are not as delicate as the amplifier board and may be cleaned with a cotton-tipped applicator dampened with a solution of mild detergent soap and water. After cleaning, the circuit boards or the interior of the housing, allow ample time for them to dry throughly before applying power to the circuits.

Visual Inspection

After cleaning, the probe circuit boards should be carefully checked for such defects as poor connections, damaged parts, and bent leads. The remedy for most defects is obvious; however, if heat damaged components are noticed it is an indication that other trouble is present in the circuit and measures should be taken to check this out.

When inspecting the probe head circuit board, a good magnifying glass or low power eye glass (approximately 4X) will aid in conducting a thorough visual check of the minute components used on this board. Examine the small black resistors for cracks near the end caps. Examine the resistor and capacitor in the probe tip and the connections to these components. Do not apply any pressure to these components, because many of them are very fragile.

Transistor and Integrated Circuit Checks

Periodic checks of transistors, FET's and IC's are not recommended. The best measure of semiconductor performance is operation in the circuit. This is checked during the performance check or recalibration of the probe. Any substandard components will usually be detected at this time.

If circuit malfunction occurs, the transistors on the regulator board may be removed from their sockets and checked by direct replacement or with a Transistor Curve Tracer such as Tektronix Type 576. Transistors and FET's for the input amplifier are soldered on the circuit board and should only be unsoldered and removed after circuit tests indicate the semiconductor device is probably defective. Observe soldering techniques suggested to remove or replace these transistors.

Performance Check and Recalibration

To insure accuracy, the probe should be checked after every 1000 hours of operation or every six months if used occasionally. The performance check and calibration procedure (in section 5) will usually indicate potential problems so that corrective measures can be taken before the probe fails to function properly.

TROUBLESHOOTING

The ability to recognize and locate trouble is acquired through experience and familiarity with the probe. The following describes a few aids that may assist in locating any trouble. After the defective component has been located, refer to Corrective Maintenance procedure for removal and replacement instructions.

Before looking for trouble in the probe, check to insure that the oscilloscope or associated equipment is operating properly.

Diagram. The circuit diagram of the P6051 Probe is given at the rear of the manual. Circuit numbers and electrical values of the components are shown on the diagram. Portions of the circuitry mounted on circuit boards are outlined in dashed lines.

Circuit Board Illustrations. All of the electrical components in the P6051 Probe are mounted on circuit boards. Fig. 4-5 shows the physical locations of all components mounted on the boards and the color code of the connecting wires. Test points may be located where the components are soldered to the boards.

Check Voltages and Waveforms

Turn off the power to the probe. Remove the probe barrel and install Calibration Fixture 067-0624-00. (The Calibration Fixture grounds the wiping contacts which are located on both edges of the probe circuit board, and exposes the circuit board for voltage and waveform measurements.)

Use a high resistance (20,000 ohms/volt or higher) meter for voltage measurements. Use a fine point probe to make the measurements to avoid accidentally shorting between adjacent components or circuits.

NOTE

The mounting bolts for the power regulator and offset circuit boards provide a ground return to the casting. If these bolts are removed, a ground return must be provided from the board to the casting.

Apply a signal, such as a square wave or sine wave, to the probe tip from a pulse or sine wave generator. (Fig. 4-2 illustrates a suggested method for mounting the probe head

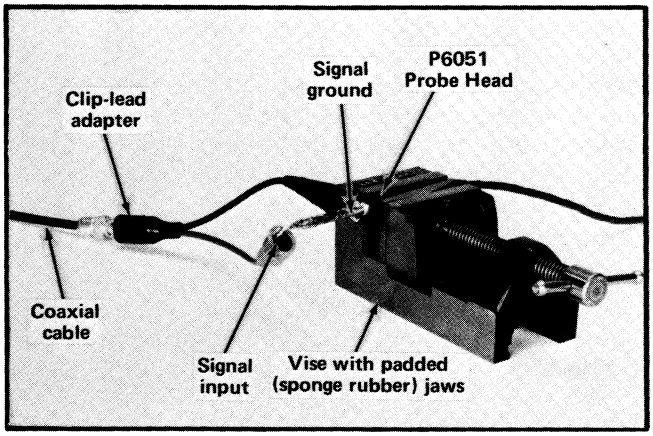


Fig. 4-2. Suggested method of mounting the probe head so components can be replaced, or a signal can be applied for troubleshooting.

and applying a test signal.) Use a test oscilloscope system, to signal-trace through the amplifier. The circuit schematic illustrates typical voltages at several test points and Fig. 4-5 (at the end of this section) shows the component location on each circuit board.

Probe Head Troubleshooting

CAUTION

Turn off the power to the probe before removing or installing the probe barrel or calibration fixture.

Visual Inspection. If the trouble has been isolated to the probe head, inspect the circuit components with a low-power binocular microscope (approximately 4 power to 10 power). Check for broken solder connections and broken components. In particular, examine the small black resistors for cracks near the end caps. Examine the resistor and capacitor in the probe tip and the connections to these components. Do not apply any pressure to the components on the probe input circuit board, as many of them are very fragile.

Check Semiconductors. Do not disconnect any semiconductors from the probe input circuit board to check them. The condition of transistors and diodes can be determined by checking voltages as given on the schematic and by checking resistance in the circuit with power disconnected.

Check Passive Components. Do not unsolder any components to check them. Continuity and approximate resistance values can be measured with the components in the circuit.

CORRECTIVE MAINTENANCE

Corrective maintenance generally consists of component replacement and instrument repair. The following paragraphs provide information that may be helpful if parts have to be replaced in the P6051 Probe.

Replacement Parts

Replacements for all electrical and mechanical parts used in the P6051 Probe can be obtained through your local Tektronix Field Office or representative. Some of the standard electronic components may be obtained more quickly by purchasing them locally. Before ordering or purchasing any replacement parts, refer to the Parts List in this manual for the required characteristics and correct description.

In addition to the standard electronic components, many special parts and components are used in the P6051 Probe. These parts are manufactured by or for Tektronix and are selected to meet specific requirements. Most of the mechanical parts used in the probe are manufactured by Tektronix and therefore are not available from other sources. Order all special parts directly from your Tektronix Field Office or representative. Include the following information: The instrument type (P6051 Probe); a complete description of the part as described in the Parts List; and, if it is an electrical component (such as Q162), give the circuit number.

Circuit Boards

Circuit boards in the P6051 Probe head and offset housing can be ordered with or without components. The replacement circuit board includes the metal tip and adapter bushing for the probe head. Refer to the Parts List for information on how to order. The following procedures describe the removal or replacement of these circuit boards.

Regulator and Offset Circuit Boards

To remove the circuit boards: Place the offset housing assembly on a flat surface. Remove the lock nuts and washers, then unscrew the two mounting bolts from the offset housing. (Do not lose the small standoff washers, washers and lock washers.) Unsolder the cable leads and remove the boards.

To replace the circuit boards: Solder the cable leads to their respective terminals on the circuit board. Install the mounting bolts through the offset board, add the standoff washer (the thickest of the two washers) and screw the bolt into and through the holes in the metal housing. Add the standoff washers for the power regulator board, then screw the mounting bolts through the two boards until the circuit

boards are secure. Install the flat washer, the lock washer and the locking nut then tighten with a 3/16 spin-tight socket wrench.

Probe Head Circuit Board Replacement

Remove the amplifier circuit board as follows: Unscrew the probe head barrel and flexible cover (boot). Use a 15 to 20 watt soldering iron to unsolder the cable wires and coaxial cable center conductor from the circuit board. Use a larger (40 watt) soldering iron to unsolder the coaxial braid from the brass bushing and pull the cable through the bushing.

Replace the circuit board as follows: Thread the cable wires through the brass bushing on the new board so the coaxial braid is on one side of the board and the wires and coaxial center conductor are on the other side. Pull the wires and center conductor up away from the board. Use the 40 watt soldering iron to solder the coaxial braid to the brass bushing. Use the smaller iron to solder the wires and coaxial center conductor to the circuit board terminals. Fig. 4-5 illustrates the location of the wires and board terminals.

Replacing the Probe Tip

The circuit board material is very durable; however, it will warp when heated; therefore, when replacing the probe tip, care must be exercised to prevent warping the circuit board and mis-aligning the probe tip. Mount the circuit board in the vertical position. Unsolder the tip, remove and wipe the board contact clean. Install the new tip. Solder in place using the minimum amount of heat and solder to make a good connection. Screw the probe head barrel in place to insure that the probe tip will go through the hole in the probe barrel. Probe tip should extend about 1.5 mm from the end of the barrel.

Attenuator Circuit Board Replacement

Access to the attenuator circuit board is accomplished by unscrewing the cap and barrel from the metal housing (see Fig. 4-1). Push down on the tip to free the circuit board, and slide the assembly out of the metal housing.

Assemble the attenuators as follows: Insert the circuit board and tip into the housing. Insure that the board is seated, then screw the barrel on the metal housing until the jack for the connector just touches or seats against the insulator spacer. Tighten the locking nut, then screw the cap in place. Do not overtighten, as temperature changes may bind the cap.

Coupling Capacitor

The coupling capacitor is a complete assembly. Refer to the Accessory List for Part Number.

SOLDERING TECHNIQUE

The components on the offset and regulator circuit board can be readily replaced. The components for the probe head amplifier circuit board, however, are small and delicate. The following suggestions may help when board components are replaced.

Regulator and Offset Boards

1. Use a pencil type soldering iron with a power rating of 15 to 25 watts.

2. Apply heat for minimum time to the junction between the component and the circuit board to melt the solder.

3. Heat-sink the lead of the component with a pair of longnosed pliers.

4. Use electronic grade 60-40 tin-lead solder (Tektronix Part No. 251-0738-00).

5. After the new component has been installed, clip off any excess lead extending beyond the circuit board and clean off any residual flux with a flux-removing solvent. Be careful that the solvent does not remove any printing from the circuit board.

Probe-Head Circuit Board Repair

All of the miniature components in the probe head are soldered onto the circuit board. We recommend returning the probe to one of the Tektronix Field Maintenance Centers for repair if a malfunction is known to exist in the probe head. Contact your local representative. Alternatives to returning the probe are replacement of the probe head circuit board, or replacing the probe head circuit board assembly as described previously.

If the components are replaced, use great care and minimum heat when unsoldering or soldering to the board. Use a pencil tip iron with a 15 watt power rating, a pair of tweezers, small diameter solder (such as Tektronix Part No. 251-0514-00) and a good magnifying glass or low power eye glass. Clamp the circuit board in a small vise, as shown in Fig. 4-2. After soldering, check carefully for solder drops or chips between conductors on the board.

Leadless Capacitors. Remove leadless capacitors by unsoldering connections to the top of the capacitor, then heat the circuit board base to remove the small chip. Use tweezers to lift the capacitor off the board.

Replace a leadless capacitor by heating the board base, then setting the capacitor in place. Next, solder the components to the top of the capacitor. Use the minimum amount of solder to make the connection. Inspect carefully with magnifying glass for loose solder shorting the capacitor or poor connections.

Variable Capacitors. The variable capacitors in the probe head and attenuator circuit boards consist of a flat rotor disk between a small metal spring and the circuit board contacts. The rotor is held in place by a pivot shaft and a small spring.

Remove the capacitor as follows: Grasp the rotor with one pair of tweezers and the spring with a second pair of tweezers. Lift up on the spring to relieve the tension, and lift the rotor out from under the spring. Replace the capacitor by using the same procedure.

The spring may be loosened when components are unsoldered or soldered to the board. To tighten the spring, remove the disc rotor from under this spring, reheat the solder connection and slide the spring into or out of the circuit board. When positioned correctly the spring should be resting on the board over the pivot hole for the rotor disk as illustrated in Fig. 4-3. Hold the spring perpendicular to the board surface as the solder hardens. Replace the disk rotor as described above.

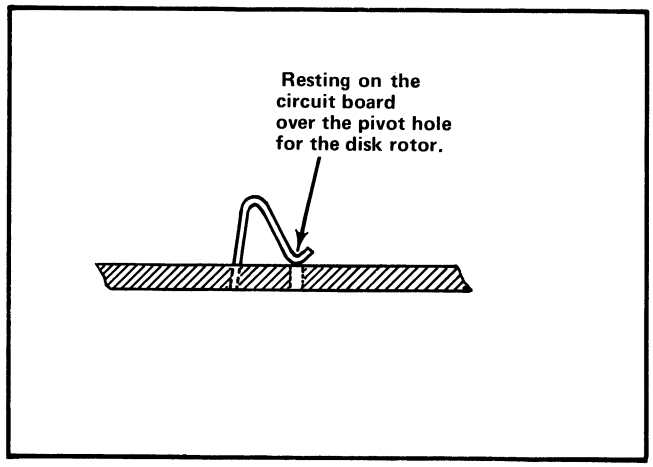


Fig. 4-3. Positioning the retainer spring for the variable capacitors on the circuit boards.

Probe Cable Replacement

The probe cable is specially designed for high frequency operation. If trouble occurs in the cable, we recommend that the probe be returned to your nearest Tektronix Field Center for repair. Contact your local representative. To replace the cable, the following is a suggested procedure:

1. Remove the offset housing covers and the offset and regulator circuit boards. See previous instructions for removing the circuit boards.

2. Remove the plastic cable holder on the back of the housing.

3. Clip the cable conductor leads at the circuit board terminals, leaving a small portion of the wire for color code identification when the new cable is installed. Remove the strain relief nipple, ferrule, and cable from the housing.

4. Disassemble the probe. Cut the cable about 3 inches from the probe head base. Slide the plastic ferrule off then strip the outer cover off the cable. Pull the cable wires and coaxial center conductor through the metal housing.

5. Install the new cable as follows: Thread the new cable through the plastic bushing, nipple, strain relief bushing and plastic support, as illustrated in the Mechanical drawing at the rear of the manual. Install the flexible boot and plastic ferrule for the probe-head end of the cable. Thread the cable wires through the brass bushing on the probe head as directed under circuit board replacement.

6. Install the cable holder and nipple on the offset housing then solder the cable wires to the offset and power regulator circuit boards. Connect the coaxial center conductor to the output GR connector. Inspect the boards for solder bits and poor connections then replace the circuit boards and offset housing covers.

7. Solder the coaxial braid and cable wires to the probe head bushing and circuit board as directed in circuit board replacement. Inspect the board for solder bits and poor connections with a good magnifying glass.

8. Install the protective boot and probe head barrel.

Transistor Replacement. Since each transistor has its own individual operating characteristics, a transistor should not be replaced unless it is actually defective. Any replacement transistor should be of the original or equivalent type and should be mounted in the same manner as the original transistor. Bend the leads to fit the socket correctly and cut the leads to the length of approximately 1/8 inch (3 mm). The transistor sockets in the P6051 power regulator board are wired for the standard emitter-base-collector configuration; see Fig. 4-4.

Transistors are soldered into place on the amplifier circuit board. Use tweezers to heat sink the transistor lead

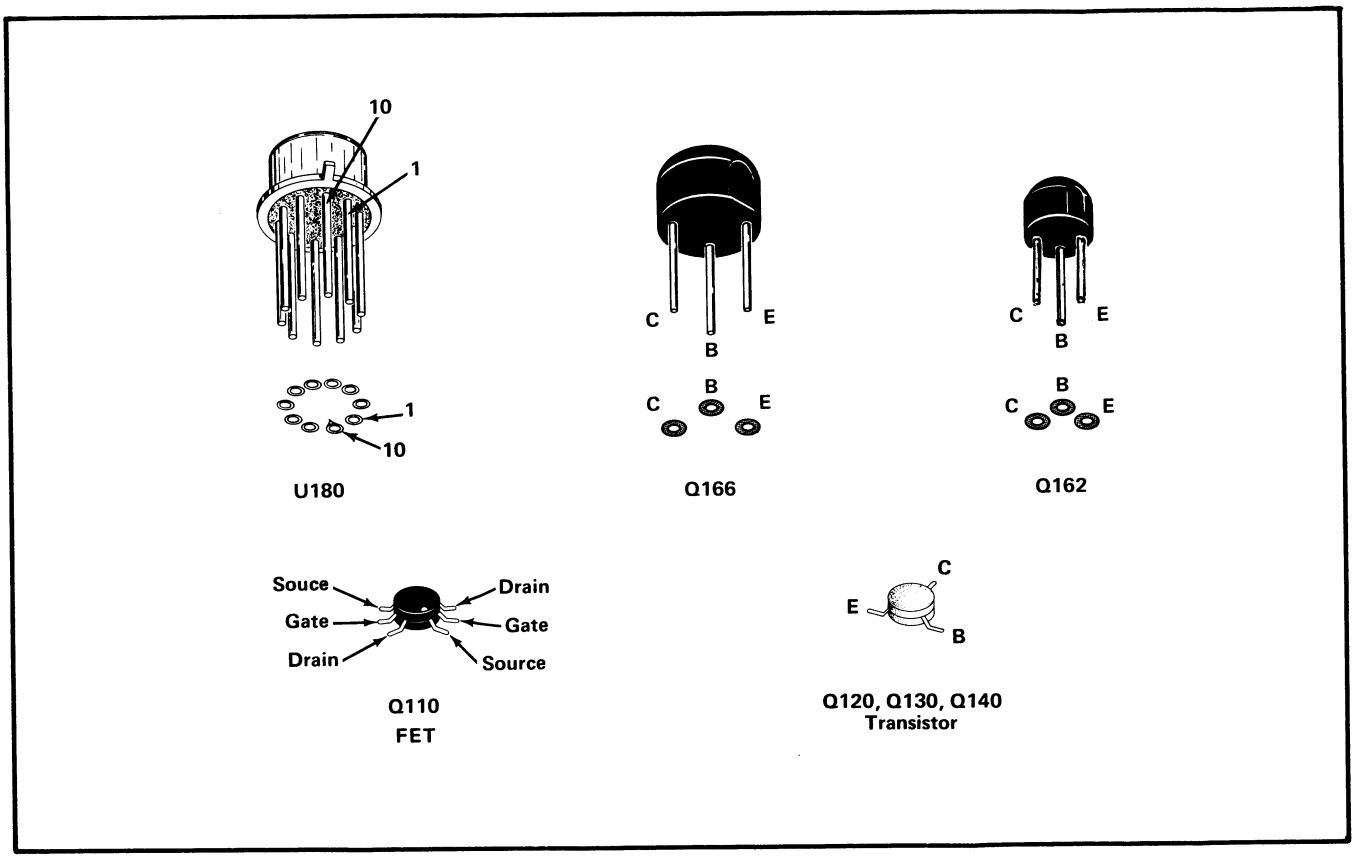


Fig. 4-4. Semiconductor electrode configuration.

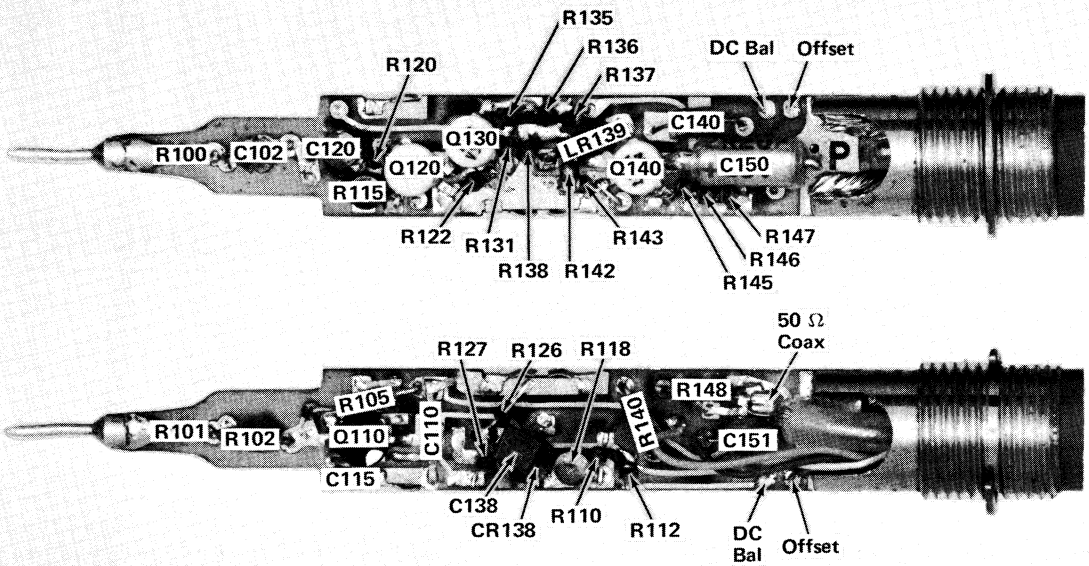
when the lead is unsoldered from or soldered to the circuit board or when components are soldered to the transistor leads.

Integrated Circuit Installation

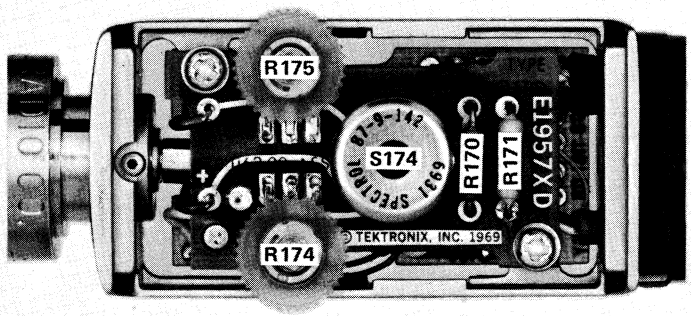
Be sure the IC is oriented correctly before it is inserted in its socket otherwise it may be destroyed when power is applied. One pin on the circuit board has an arrow tip which is the index marker. Align the index tab of the IC so that it coincides with the arrow tip on the circuit board, then insert the IC.

Switch Replacement

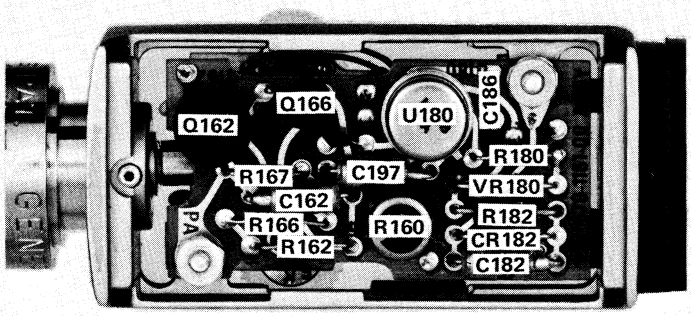
The DC Offset selector switch is plugged into the circuit board and may be easily replaced if it becomes faulty.



Amplifier circuit board.



Offset circuit board.



Power regulator circuit board.

Fig. 4-5. Component location and wiring color code for the P6051 circuit boards.

SECTION 5
PERFORMANCE CHECK/CALIBRATION

Introduction

This section contains a detailed performance check and calibration procedure, and a basic operational check and calibration procedure. The first procedure will check and calibrate the probe performance to the electrical characteristics specified in Section 1. The second will check and calibrate the main or essential parameters of measurement for the probe. The first procedure requires high tolerance and extensive test equipment to verify all specifications. The second procedure requires only the essential equipment necessary to verify that the probe is operating satisfactory for most applications.

Complete Performance Check and Calibration Procedure

The electrical characteristics in the Specification section are checked if you perform all steps in this procedure. The sequence of steps is arranged to reduce the required time to perform a complete check. By doing the steps in sequence, you will also find it easier to determine equipment hook-up for each step in the procedure. Checks on the probe's performance and calibration adjustments are integrated through this procedure. The calibration steps are identified with the ◐ symbol after the step title and the word "ADJUST" within the body of the procedure. Performance is checked in the "CHECK" part of the steps. Calibration adjustments follow the performance check, and should be made if the performance is not within specifications. Equipment setup pictures, control settings, and most waveform photographs apply to both performance checks and calibration objectives. Waveform pictures are intended as guides to illustrate calibration goals, and are not intended as tolerance specifications.

Some checks or adjustments within the procedure are not specifications, but relate to maintenance checks; for example, voltage limits for the probe voltage regulator, or aberrations to a pulse input. These checks are not preceded by CHECK and should only pertain to calibration procedure.

CAUTION

When the probe barrel is removed or the probe compensation calibration fixture is installed, removed or rotated, make sure the power is OFF. This will prevent possible short circuit damage to the probe.

Equipment and Test Fixtures Required

The following equipment and test fixture measurement capabilities are required to verify and calibrate all performance characteristics of this probe. If substitute equipment is used, it must meet or exceed the specifications listed. The calibration fixtures are recommended to facilitate the procedure and are available through your local Tektronix Field Office or representative.

1. Sampling oscilloscope system: Bandwidth DC to 4 GHz (risetime equal to or less than 75 ps), displayed noise less than 2 mV, and a delay line (75 ns) with trigger pickoff.

Real-time differential-unit oscilloscope system: Must have at least ±5 volt of offset capability available from the front panel or a ±5 V DC power supply.

a. Type 564B Storage Oscilloscope with Type 3S2 Sampling Amplifier plus S-1 and S-2 Sampling Heads/Type 3T2 Random Sampling Sweep unit and 7M11 Delay Line for the sampling system, plus a Type 3A7 Differential Amplifier/Type 2B67 Time Base unit for real-time differential measurement.

Trace storage is desirable; however, a non-storage 560 series can be used.

b. An alternate non-storage system that can be used is the 7000 Series oscilloscope with 7S11 Sampling Amplifier plus S-1 and S-2 Sampling Heads/7T11 Sampling Time Base and 7M11 Delay Line, and a 7A13 Differential Amplifier/7B50 or 7B70 Time Base unit for differential voltage measurement.

2. Probe power supply: Probe requires +12 V to +15 V and −12 V to −15 V at 60 mA each. Required voltages are available from the 7000 series oscilloscope, the Type 1101 Accessory Power Supply, or (by using adapter 012-0187-00) it can be powered from Accessory Power Supply 015-0073-00 or the Type 454 probe power outlet connector.

3. Pulse generator: Pulse risetime 70 ps or less, output pulse amplitude to 50 V, output impedance 50 MΩ. Tektronix Type 284 and Type 109 Pulse Generators. Type 284

required to check probe risetime, Type 109 required to check risetime of probe with attenuators.

4. Square wave generator: Frequency 10 kHz to 1 MHz, amplitude range 0.5 V to 12 V peak, risetime 1 ns or less. Tektronix Type 106 Square-Wave Generator. (Required to check the compensation of the probe and attenuators.)

5. Standard Amplitude Calibrator: 50 mV to 20 V in 1-2-5 sequence, with amplitude accuracy of 0.25%. Tektronix Calibration Fixture 067-0502-01.

6. Constant-amplitude signal generator: Frequency 100 Hz to 10 kHz, amplitude 10 mV to 1.25 V peak. General Radio Oscillator Type 1310-A.

7. Capacitance meter: Range 1 pF to 4 pF, accuracy within 3% of reading. Tektronix Type 130 Direct Reading LC Meter.

8. Resistance bridge: Measure 1 MΩ with an accuracy within 0.1%. Electro Scientific Industries Model 250 DA.

9. RMS voltmeter: Range to 10 mV or less, frequency 10 Hz to 10 MHz. Hewlett-Packard Model 3400A.

10. 50 Ω charge line: Cable length at least 20 ns. Tektronix Type 113 Delay Cable or 50 Ω coaxial 20 ns Type RG213/U cable (Tektronix Part No. 017-0504-00).

11. 50 Ω, 5 ns, coaxial cable: Type RG213/U with GR connectors. Tektronix Part No. 017-0502-00.

12. 50 Ω, 20 cm air line. Tektronix Part No. 017-0084-00.

13. Adapters:

a. Probe tip to GR with 50 Ω termination. (Tektronix Part No. 017-0088-00), or probe tip to BNC adapter (Tektronix Part No. 013-0084-01) with BNC feedthrough termination (Tektronix Part No. 011-0049-01).

b. Probe tip to BNC. Tektronix Part No. 013-0084-01.

c. UHF male to BNC female. Tektronix Part No. 103-0015-00.

d. GR to BNC male. Tektronix Part No. 017-0064-00.

14. Attenuators:

a. 50 Ω Termination, through-line, GR to BNC male (Tektronix Part No. 017-0083-00), or BNC feedthrough termination (Tektronix Part No. 011-0049-01) with BNC to GR adapter (Tektronix Part No. 017-0064-00).

b. Two (2) 50 Ω 2X with GR connectors. Tektronix Part No. 017-0080-00.

c. 50 Ω 5X with GR connectors. Tektronix Part No. 017-0079-00.

d. 50 Ω 10X with GR connectors. Tektronix Part No. 017-0078-00.

e. Two (2) 50 Ω 10X with BNC connectors. Tektronix Part No. 011-0059-01.

15. Calibration Fixtures:

a. Probe compensation. Tektronix Part No. 067-0624-00.

b. Attenuator compensation. Tektronix Part No. 067-0623-00.

Preliminary

The performance of the P6051 Probe should be checked within an ambient temperature of 0°C to +50°C. Allow a minimum warmup time of 20 minutes for the probe and test equipment to stabilize before checking or calibrating the probe. Calibrate the probe when the ambient temperature is within +20°C to +30°C for best performance.

a. Connect the P6051 Probe power connector to a power source such as the Type 1101, 7000 series oscilloscope, or (by means of adapter 012-0187-00) to accessory power supply 015-0073-00 or the Type 454 probe power connector.

b. Prepare the test oscilloscope sampling system for a DC to 4 GHz frequency measurement range by installing the S-1 sampling head into the 3S2 or 7S11 sampling amplifier. If the sampling amplifier is a 3S2, install a S-2 Sampling Head into CH B. Plug a 3T2 sweep unit into the horizontal compartment of the 564B oscilloscope, or the 7T11 into the horizontal compartment of the 7000 series oscilloscope.

c. Connect all test equipment to a power source, then turn the probe power supply and all equipment power on. Allow equipment to warm up before proceeding with the check.

When conducting a performance check only, do only the CHECK portions of each step.

CAUTION

When the probe barrel or calibration fixture is removed during calibration adjustments, or the calibration fixture is to be rotated, be sure to turn the probe power OFF. This will prevent possible damage to the probe due to short-circuiting.

1. Check Probe Power Regulator Output (Maintenance check only)

a. Terminate the output of the probe into a 50 Ω termination.

b. Remove the bottom cover of the DC offset housing and locate the +7 V and −10 V test points (see Fig. 5-1).

c. Measure the regulator output voltage with an accurate voltmeter. Voltages should check within 0.5 V of +7 V and −10 V.

d. Remove the 50 Ω termination and connect the probe output to the input of the sampling amplifier.

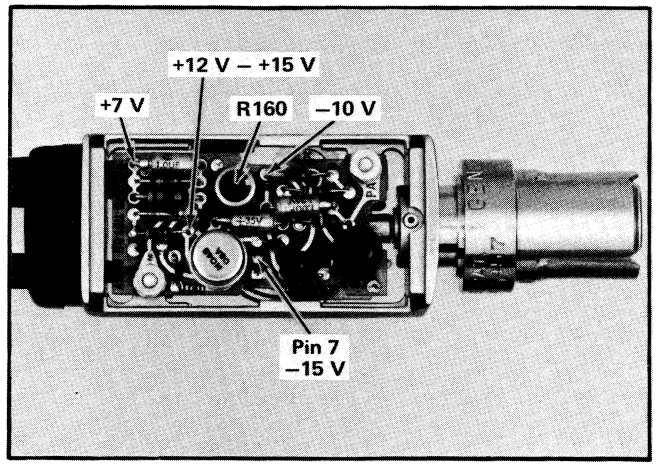


Fig. 5-1. Power regulator test points and output level adjustment.

2. Check/Adjust Probe Output Level ◐

Requirement—The probe output level is adjustable to 0 volt.

a. With the probe power off, position the CRT trace to graticule center.

b. Switch the probe power on and allow the probe to stabilize.

c. CHECK—Probe trace should not offset from the reference more than + or −5 mV.

d. ADJUST—Remove the cover to the offset housing and adjust R160 (Fig. 5-1) to eliminate any trace offset.

e. Replace the cover on the offset housing.

NOTES

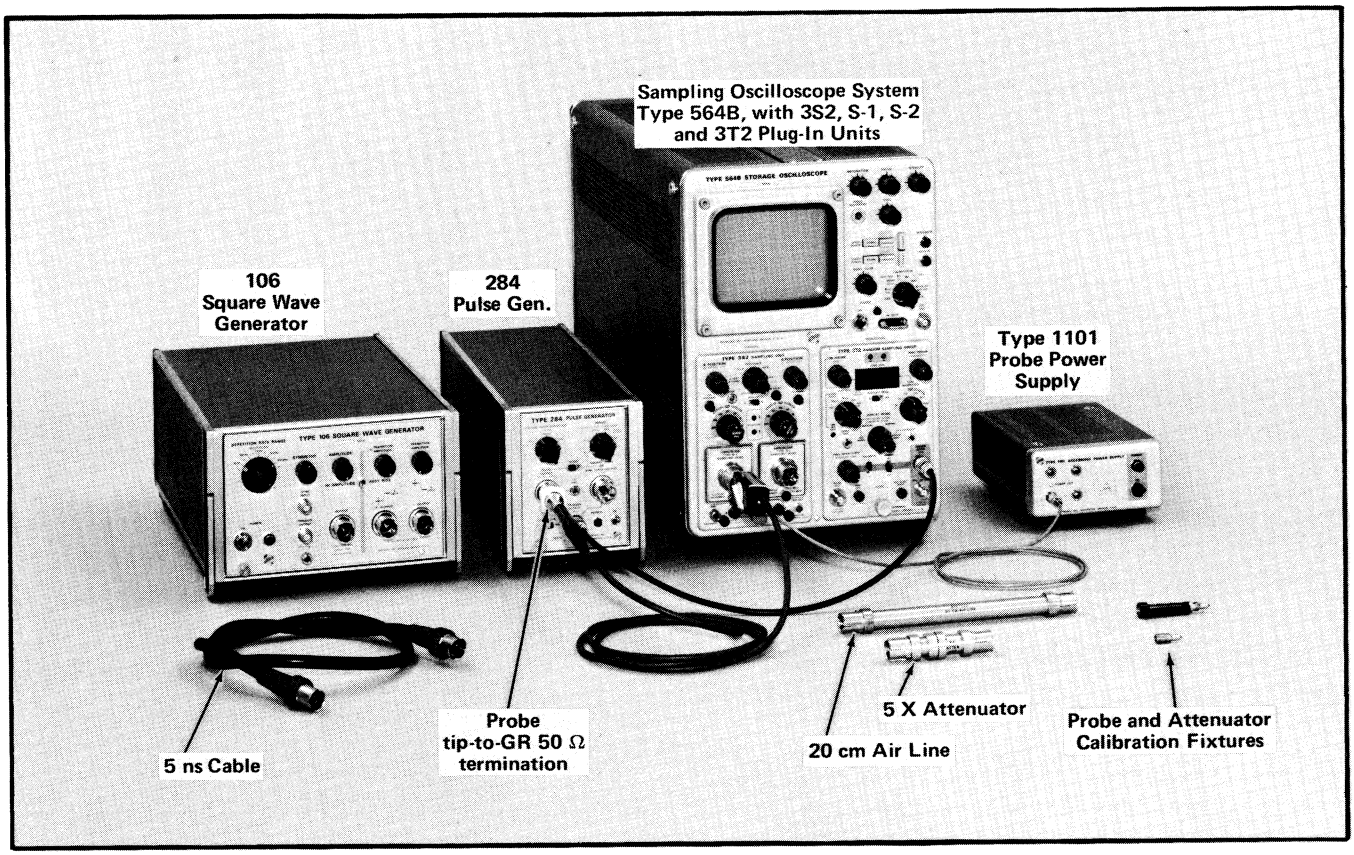


Fig. 5-2. Equipment setup to check/adjust probe compensation, risetime, delay (step 3 through 5).

3. Check/Adjust Probe Compensation (Maintenance or calibration only) ◐

a. Test equipment setup is shown in Fig. 5-2.

b. Connect the P6051 Probe to the input of a DC to 4 GHz sampling system (3S2 amplifier with S-2 Sampling Head in the 560 series oscilloscope or the 7S11 amplifier with S-2 Sampling Head in the 7000 series oscilloscope).

c. Apply the Output of a fast rise (less than 100 ps) pulse generator (Type 284) to the probe and sampling system as follows:

1) Connect the probe through a pulse tip-to-GR 50 Ω termination to the Output of the pulse generator.

2) Trigger the sampling sweep unit (Type 3T2 or 7T11) from the pulse generator by connecting a coaxial cable between the Trigger Output of the pulse generator and the Trigger Input of the sweep unit. Set the Trigger Source to Ext position, sweep mode to Normal or Sequential, sweep rate to 1 ns/Div and adjust the Trigger Sensitivity for a triggered display.

d. Set and adjust the sampling amplifier mVolts/Div selectors for a 5 division display.

e. Check—The first 5 ns of the step function for aberrations (overshoot, ringing or rounding). Waveform aberrations should not exceed +5%, −5% or a total of 7% of the pulse amplitude. If aberrations are within these limits, proceed to step (g).

f. Adjust—If aberrations in step (e) are excessive, compensate the probe amplifier as follows:

1) Turn the probe power supply OFF or disconnect the probe power connector from the power source.

2) Unscrew the probe barrel and install the Probe Calibration Fixture (Part No. 067-0624-00) as shown in Fig. 5-3. After the calibration fixture has been installed and the locking screws tightened, turn the probe power supply ON.

3) Insert the probe tip, through the probe tip-to-GR 50 Ω-feedthrough adapter, to the Output of the Type 284 pulse generator.

4) ADJUST—Using a small non-metallic probe (such as a toothpick) adjust C120 (Fig. 5-3) for minimum aberrations at the front corner of the pulse. The capacitor has small indentations along its edge so that it can be rotated with the small non-metallic probe.

NOTE

Excessive aberrations can be caused by an open ground lead or decoupling capacitor. Check ground spring contacts on the probe circuit board to the Calibration Fixture.

g. Disconnect the probe tip and probe-tip-to-GR feedthrough adapter from the fast-rise pulse generator output, and connect the probe tip through the adapter to the + Output of the square wave generator (Type 106). Remove the trigger cable from the Type 284 pulse generator and reconnect it to the Trigger Output connector on the square wave generator. Adjust the trigger sensitivity, if necessary, for a triggered display.

h. Set the square wave generator pulse repetition rate to 100 kHz, the pulse mode for Fast Rise pulse, and adjust the amplitude control for a 5 division display.

i. Change the time-base sweep rate to 1 μs/Div.

j. Check—The front corner and pulse top for aberrations. Must not exceed +5%, −5%, or a total of 7%. If aberrations are within these limits, proceed to step 4.

k. ADJUST—If aberrations in step (j) are excessive, compensate the probe amplifier as follows:

1) Turn the probe power OFF and install the Probe Calibration Fixture as directed in step (f) above.

2) Insert the probe tip, through the probe tip-to-GR 50 Ω feedthrough adapter to the Output of the square wave generator, and turn the probe power supply ON.

3) ADJUST—C102 (Fig. 5-3A) for best square wave corner and flat top response to the square wave generator pulse output.

NOTE

If aberrations are excessive, check ground contacts on the probe amplifier circuit board to the Calibration Fixture.

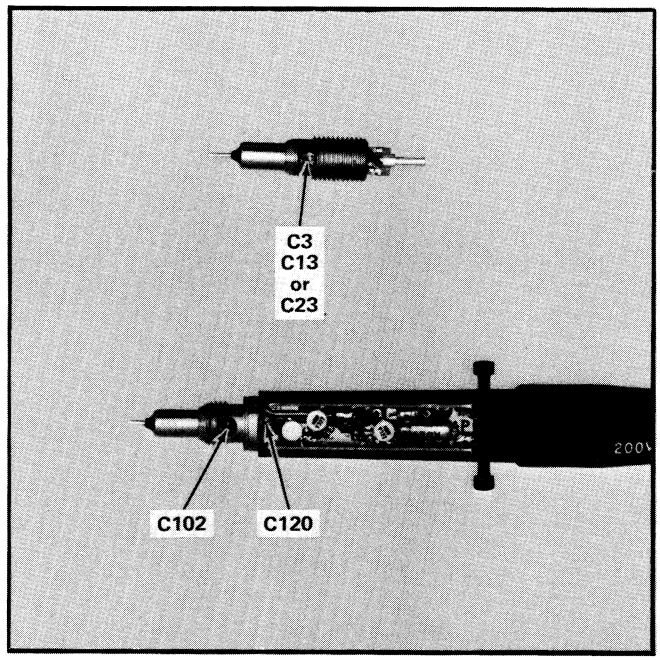


Fig. 5-3. Location of compensation adjustments in the probe amplifier and the attenuators.

4) Turn the probe power supply OFF. Remove the Calibration Fixture and replace the probe barrel.

4. Check Probe Step Response

Requirement—Probe risetime equals 0.35 ns or less.

a. Equipment setup is given in Fig. 5-2 and step 3.

b. Apply the pulse output from the fast-rise pulse generator (Type 284) through a 20 cm 50 Ω air line and a 5X attenuator with GR connector to the input of the S-2 Sampling Head. Trigger the sequential sweep with the Type 284 Trigger output by connecting a coaxial cable between the Trigger Output and the Trigger Input connector for the sweep unit (3T2 or 7T11).

c. Adjust the sweep unit trigger sensitivity controls for a triggered display, using 2 ns/Div sweep rate and sequential or normal sweep mode.

d. Set and adjust the sampling amplifier mVolts/Div selectors for a 5 division display, then change the sweep rate to .1 ns/Div.

e. Measure and record the oscilloscope system (pulse source, amplifier, and mainframe) risetime to the input step function. Use a large number of samples per division to

insure an accurate display. The display can be readily observed by storing the trace.

f. Remove the 20 cm air line and 5X attenuator, then connect the P6051 Probe between the input of the S-2 sampling head and the pulse output of the Type 284 pulse generator. Use a probe tip-to-GR 50 Ω-feedthrough adapter to connect the probe tip to the output of the pulse generator.

g. Re-set and adjust the sampling amplifier mVolts/Div selectors for a 5 division display amplitude and set the Time/Div to 0.1 ns.

h. CHECK—The probe step response to the generator pulse output as follows:

1) Check the risetime of the displayed pulse for the probe, sampling amplifier and oscilloscope mainframe. Fig. 5-4 illustrates typical display orientation for measuring risetime.

2) Compute the probe risetime as follows:

$$\text{Probe } T_r = \sqrt{(T_r \text{ of display})^2 - (T_r \text{ of system})^2}$$

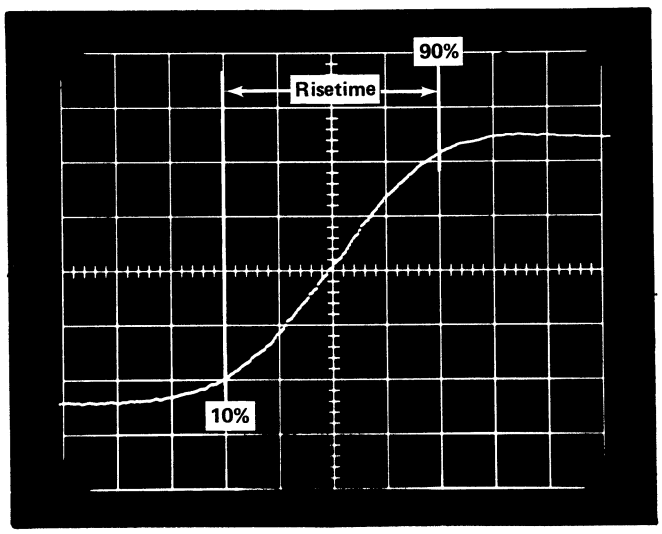


Fig. 5-4. Pulse oriented in the graticule window for risetime measurement.

where; T_r of display is probe and oscilloscope system, and T_r of system is oscilloscope system only, as noted in step (e).

i. If probe risetime is more than 0.35 ns, repeat probe compensation adjustments (step 3).

5. Check Probe Delay Time

Requirement—The signal delay through the P6051 Probe is 10.5 ns ±0.5 ns.

a. The equipment setup for this measurement is shown in Fig. 5-2.

b. Apply the pulse output from the fast-rise pulse generator (Type 284) through a 5 ns coaxial cable and 5X attenuator to the Input of the sampling amplifier (S-2). The attenuator is connected at the input to the sampling amplifier.

c. Trigger the sampling sweep with the Trigger Output from the pulse generator.

d. Set the sweep rate to 2 ns/Div. Set and adjust the amplifier mVolts/Div selectors for a display amplitude of 5 divisions.

e. To establish a reference point, position the leading edge of the pulse to the second vertical graticule division line with the Time Position control. Do not alter Trigger, Time or any control position for the remainder of this check.

f. Remove the 5X attenuator and connect the P6051 Probe between the amplifier input and the 5 ns coaxial cable. Use a probe tip to GR 50 Ω termination adapter to connect the probe tip to the 5 ns cable.

g. CHECK—The delay in the leading edge of the pulse from the previous reference. Delay should equal 10.5 ns ±0.5 ns.

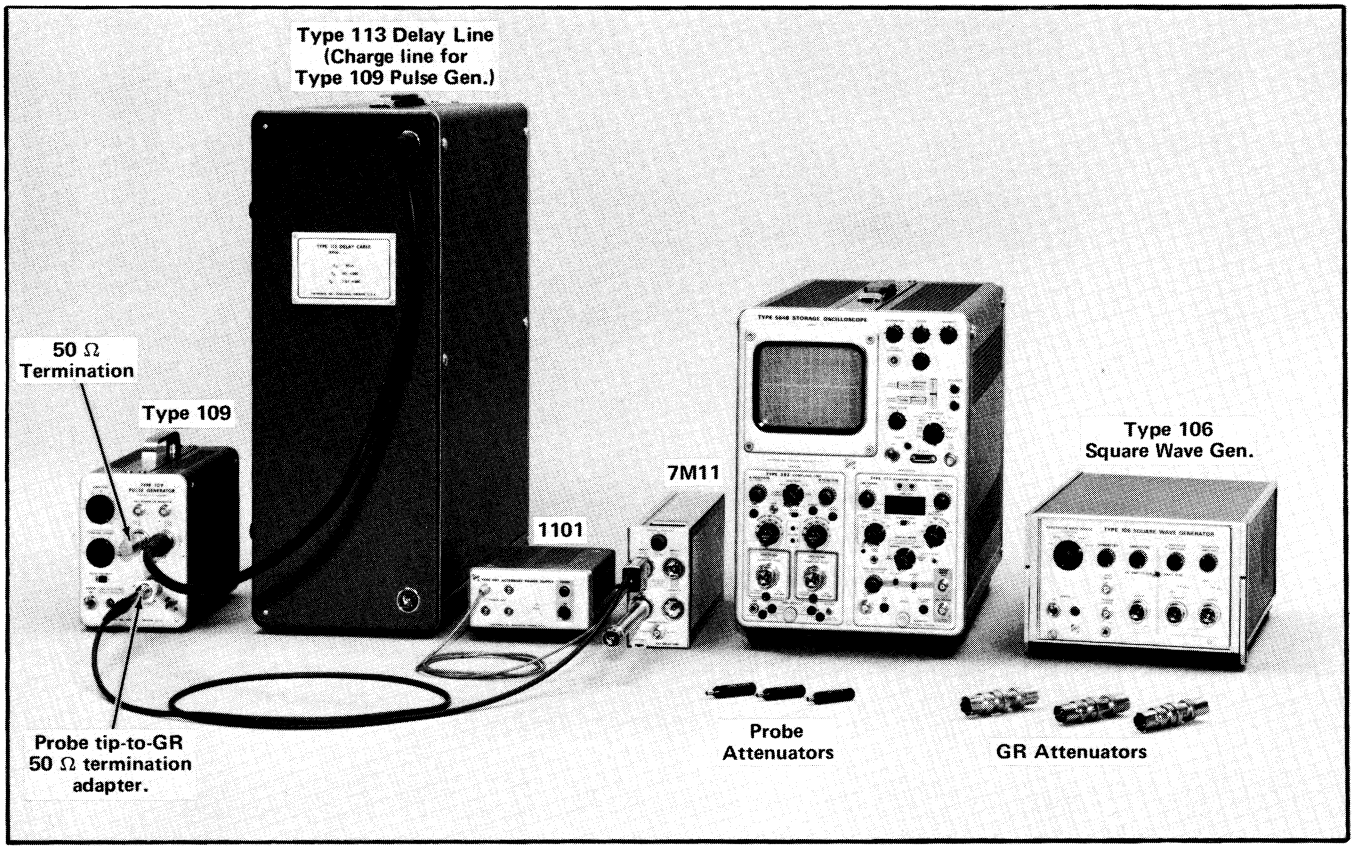


Fig. 5-5. Equipment setup to check and adjust attenuator compensation and check step response of the probe with attenuators (steps 6 and 7).

6. Check/Adjust Attenuator Compensation (Maintenance check or calibration adjustment only)

NOTE

Probe must be properly compensated (see Step 3) before performing this check or adjustment.

a. Equipment setup is shown in Fig. 5-5.

b. Connect the P6051 Probe, with any one of the three attenuators installed, to the Input of the sampling amplifier.

c. Apply the Hi Amplitude Output of the square wave generator (Type 106) to the probe tip by using the probe tip-to-GR 50 Ω termination adapter.

d. Trigger the sweep externally from the trigger output of the square wave generator by connecting a coaxial cable between the sampling sweep unit Trigger Input and the Trigger Output connector on the square wave generator (Type 106).

e. Set the sampling sweep rate to 1 μs/Div and the square wave generator pulse repetition rate to 100 kHz.

f. Set and adjust the sampling amplifier mVolts/Div selectors and the square wave generator output amplitude control for a 5 division display.

g. Check—The pulse front corner and pulse top for aberrations. Aberrations should not exceed +5%, −5% or a total of 7% of the pulse amplitude. If aberrations are within this limit, proceed to step (i).

h. Adjust—If aberrations in step (g) are excessive, compensate the attenuator as follows:

1) Unscrew the attenuator cap, then unscrew the brass housing with the attenuator circuit board and tip, from the attenuator barrel.

2) Remove the circuit board and tip from the metal housing and insert the attenuator circuit board with tip

into the Attenuator Compensation Calibration Fixture (Part No. 067-0623-00) so the compensating capacitor is visible through the adjustment hole (see Fig. 5-3).

3) Screw the calibration fixture with the attenuator circuit board into the attenuator barrel until the connector jack on the board just touches the insulator spacer.

4) Insert the tip through a probe tip-to-GR 50 Ω termination adapter to the Hi Amplitude Output connector on the square wave generator.

5) Adjust—Compensating capacitor for the best square corner and pulse top flatness.

6) Remove the calibration fixture. Replace the metal housing and screw it and the circuit board back into the attenuator body housing until the connector jack just touches. Tighten the lock nut then replate the cap.

i. Repeat this procedure to check the compensation or adjustment for each of the remaining two attenuators.

7. Check Step Response of Probe with Attenuator

Requirement—Risetime for P6051 probe with attenuator equals 0.35 ns or less.

a. Equipment setup is shown in Fig. 5-5.

b. Apply a fast-rise 50 V pulse from the pulse generator (Type 109) to the P6051 Probe with the 40X attenuator as follows:

1) Use a delay line with trigger output (7M11) between the probe output and the input to the sampling amplifier (S-2 Sampling Head). Connect Output 1 of the 7M11 through a 20 cm air line or 5 ns coaxial cable to the Input of the S-2 Sampling Head. Connect a cable between the delay line Trigger Output and the Trigger Input for the sampling sweep unit. Switch the delay line Trigger Selector (7M11) to the respective delay channel (1).

2) Connect the P6051 Probe output to Input 1 of the delay line.

3) Connect a charge line (such as the Type 113 Delay Line or 20 ns RG213/U Cable, Part No. 017-0504-00) to one charge line connector on the Type 109 and a 50 Ω end line termination to the other.

4) Connect the probe with a 40X attenuator to the Output connector of the pulse generator (Type 109) by using a probe tip-to-GR 50 Ω termination adapter.

c. Set the pulse generator output amplitude to 50 V and turn the power On.

d. Set the sampling sweep rate to .1 ns/Div and the amplifier mVolts/Div to 20.

e. Adjust the sampling sweep triggering for a triggered display, and the mVolts/Div selectors for a 5 division pulse amplitude. The display can be readily observed by storing the trace. Position the leading edge of the pulse to a graticule area so that risetime can be measured.

f. CHECK—The probe with attenuator risetime, must not exceed 0.35 ns. To ensure that the attenuator does not degrade the pulse response, remove the 40X probe attenuator and connect the probe alone to the pulse source through two GR 2X attenuators and one GR 10X attenuator (total of 40X attenuation). The probe must be connected to the attenuators through a probe tip-to-GR 50 Ω termination adapter. Compare this response with the response obtained in step (e). There must not be any noticeable change in pulse response.

g. Repeat the above procedure to check the probe with its 20X attenuator by substituting one 2X attenuator and one 10X attenuator (20X) in place of the probe 20X attenuator.

h. Repeat the above procedure to check the probe with its 4X attenuator by substituting two 2X attenuators (4X) in place of the probe 4X attenuator.

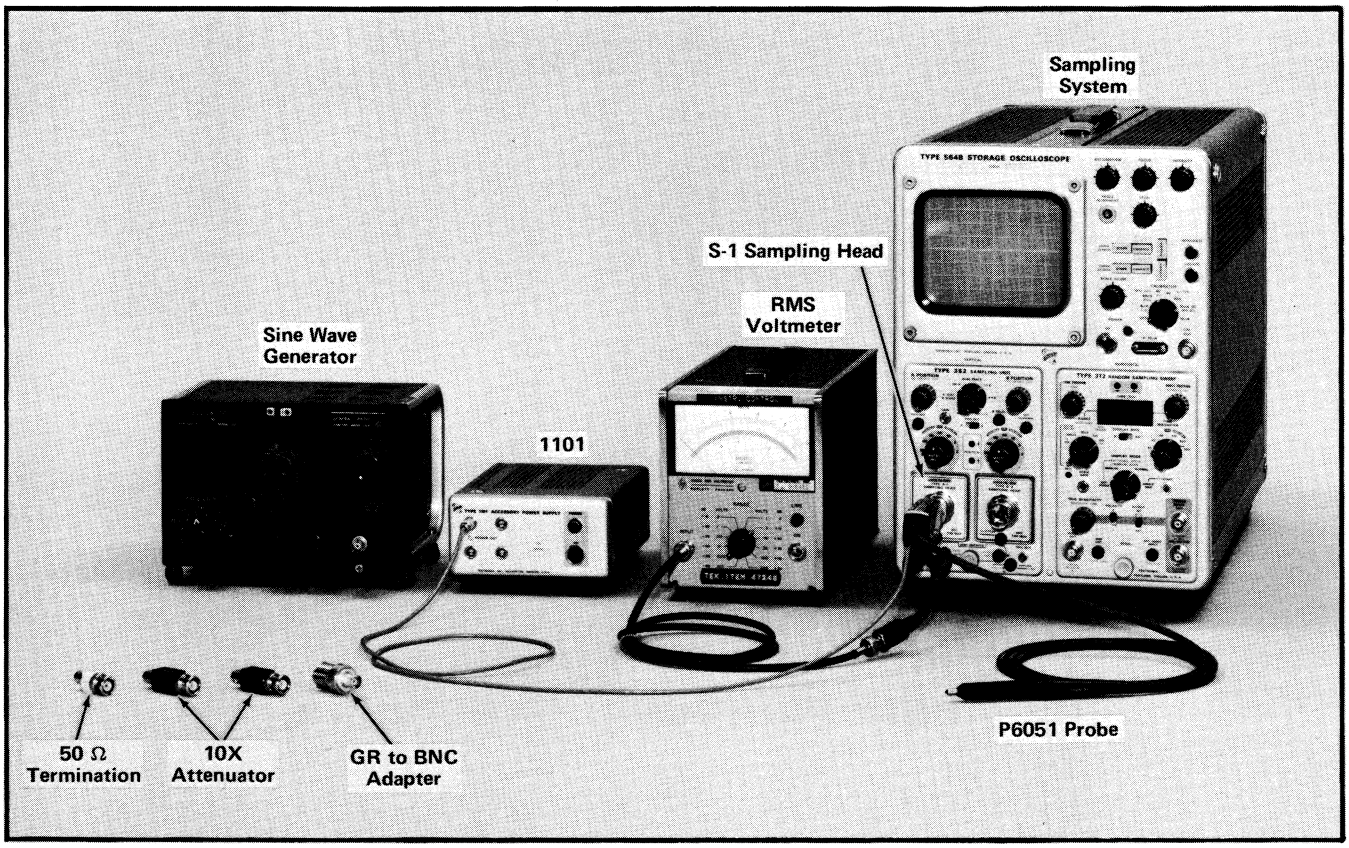


Fig. 5-6. Equipment setup to check probe noise (step 8).

8. Check Probe Amplifier Noise

Requirement—The output RMS noise from the probe must not exceed 70 μV.

a. Equipment setup is shown in Fig. 5-6.

NOTE

The sampling amplifier must have less than 2 mV displayed noise (S-1 Sampling Head with 3S2 or 7S11 amplifiers).

b. Connect the P6051 Probe output into the Input of the S-1 Sampling Head.

c. Set the amplifier mVolts/Div selector to 2 (calibrated). Set the sampling sweep rate to 10 ns/Div and adjust the sweep triggering for a free-running trace with the sweep start point at Before Trigger.

d. Connect a RMS reading voltmeter between the sampling amplifier vertical signal output (for the S-1 head) and the ground jack.

e. Adjust the sampling unit dot response for unity loop gain, as described in the sampling amplifier instruction manual.

f. Install the probe tip bayonet ground adapter on the probe and short across the probe tip and its ground. Note the RMS voltmeter reading (about 2 mV).

g. Remove the P6051 Probe output connector from the INput to the S-1 Sampling Head and apply a 1 kHz oscillator signal to the sampling amplifier input. Use two (2) 10X attenuators and a 50 Ω coaxial cable to connect the oscillator output into the Input of the sampling amplifier.

h. Adjust the output of the oscillator so the 1 kHz signal produces the same RMS voltmeter reading that was obtained in step (f).

i. Remove the two 10X attenuators and the RMS reading voltmeter from the sampling amplifier. Connect the output of the oscillator to the RMS voltmeter using a coaxial cable and a 50 Ω termination at the meter input. Note the RMS voltmeter reading.

j. CHECK—The RMS voltmeter reading must not exceed 7 mV. (7 mV divided by 100X attenuation equals 70 μV.)

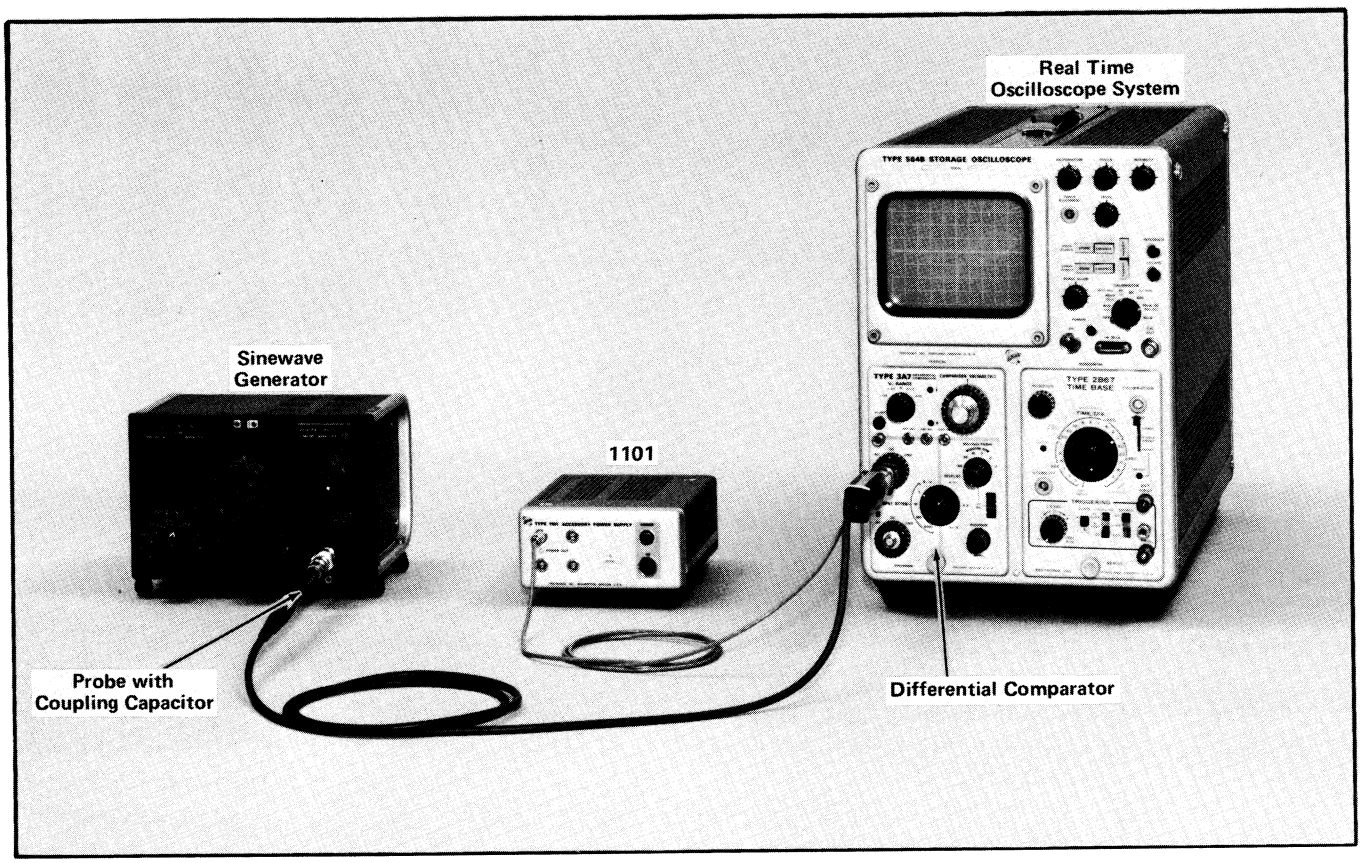


Fig. 5-7. Equipment setup for AC coupled low frequency response (step 9).

9. Check Low Frequency Response of AC-Coupled Probe

Requirement—Low frequency cutoff at −3 dB is 175 Hz or less.

a. Equipment setup is shown in Fig. 5-7.

b. Replace the sampling plug-in units with a differential comparator (Type 3A7) and a real-time time-base (Type 2B67) plug-in units.

c. Use a GR to BNC 50 Ω termination adapter to connect the P6051 Probe output to one channel (CH A) of the differential comparator.

d. Set the front panel controls as follows:

Differential Comparator

V_C Range	0
Comparison Voltage	0
A Input	DC
B Input	GND
Input Atten	1
Millivolts/Div	50
Display	A-V_C
Position	mid-position
DC Bal	balanced

Time Base

Time/Div	0.1 ms
Variable	Calibrated
Mode	Norm
Triggering	
Level	Auto
Slope	+
Coupling	DC
Source	Int
Position	mid-position

Ⓐ

e. Connect the P6051 Probe, with coupling capacitor head, through a probe tip to BNC adapter, a 50 Ω termination, and a BNC to plug jack adapter, to the output of a 100 Hz to 10 kHz constant-amplitude sine wave generator.

f. Set the signal generator frequency to about 5 kHz and adjust its output for a reference display amplitude of 5 divisions.

g. Change the sine wave generator frequency to 175 Hz and the time-base unit sweep rate to 10 ms/Div.

h. CHECK—Signal amplitude of the display must equal 3.5 divisions or more (70% of 5 divisions).

i. Remove the coupling capacitor from the probe head.

NOTES

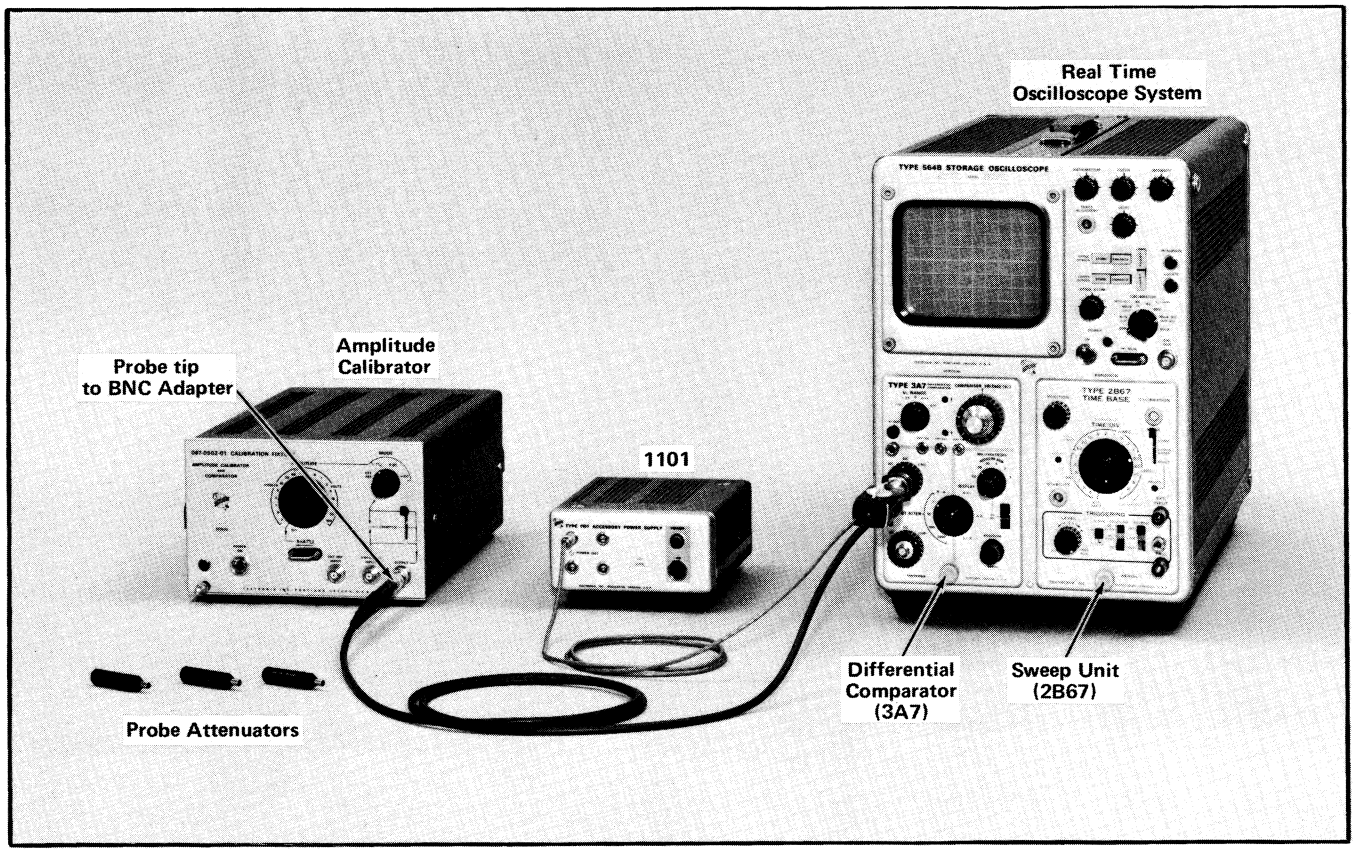


Fig. 5-8. Equipment setup to check attenuation accuracy, probe signal range and DC offset range (step 10 through 12).

10. Check Attenuation Accuracy of Probe and Attenuators

Requirement—Probe attenuation is 5X ±4%. The accuracy of the 4X, 20X and 40X attenuators is within 1%.

a. The equipment setup is shown in Fig. 5-8.

b. Apply a 100 mV signal from the amplitude calibrator (Tektronix Part No. 067-0502-01) through a coaxial cable to the Input of the differential comparator.

c. Set the differential comparator mVolts/Div to 20. Set the sweep rate of the time base unit to 50 μs/Div and the sweep trigger to Free Run.

d. Adjust the mVolts/Div Variable control or the amplifier calibrate for a display amplitude of 5 divisions. This step calibrates the display and must be as accurate as you can determine.

e. Remove the cable from the differential comparator and the amplitude calibrator output and by means of a BNC-to-probe-tip adapter connect the probe from the differential comparator Input to the Output of the amplitude calibrator. Probe output must be connected to the Input of the differential comparator.

f. Change the amplitude calibrator Amplitude selector to 500 mVolts.

g. CHECK—The display amplitude must equal 5 divisions ±4% (1 minor division).

h. Re-adjust the differential comparator Variable control for a display amplitude of 5 divisions.

i. Install the 4X attenuator on the probe. Reconnect the probe with attenuator to the Output of the amplitude calibrator.

j. Change the Amplitude selector on the calibrator to 2 volts.

k. CHECK—The display amplitude must equal 5 divisions ±1% (0.25 minor divisions).

l. Replace the 4X attenuator with the 20X attenuator and switch the Amplitude selector on the calibrator to 10 volts.

m. CHECK—The display amplitude must equal 5 divisions ±1%.

n. Replace the 20X attenuator with the 40X attenuator and switch the Amplitude selector on the calibrator to 20 V.

o. CHECK—The display amplitude must equal 5 divisions ±1%.

p. Return the mVolts/Div Variable control on the differential comparator to the calibrate position. Remove the 40X attenuator and replace the collar on the probe head.

11. Check Signal Range of Probe

Requirement—The compression or expansion of a 50 mV AC signal, over a + and −2.5 V DC range at the probe tip is no greater than 5%.

a. Equipment setup is shown in Fig. 5-8.

b. Apply a 50 mV square wave signal from the amplitude calibrator to the P6051 Probe tip.

c. Set the sweep rate to 50 μs/Div and the sweep triggering for free running sweep.

d. Set the differential comparator Input Attenuator selector to 1, the mVolts/Div to 2, and adjust the Variable control for a display amplitude of 5 divisions.

e. Set the comparison voltage of the differential comparator to +0.5 V (Comparison Voltage dial to 500 and the V_C Range selector to +1.1).

f. Switch the probe DC OFFSET selector to − position and adjust the probe DC OFFSET controls to shift the 5 division display within the graticule window.

g. CHECK—The display amplitude must equal 5 divisions ±5% (0.25 div).

h. Switch the comparison voltage of the differential comparator to −0.5 V (V_C Range to −1.1).

i. Switch the probe DC OFFSET selector to + and adjust the probe DC OFFSET controls to shift the display within the graticule window.

j. CHECK—The display amplitude must equal 5 divisions ±5%.

12. Check Probe DC Offset Control Range

Requirement—Offset control range must equal or exceed + and −5 volts.

a. Equipment setup is shown in Fig. 5-8 and given in steps 10 and 11.

b. Set the comparison voltage of the differential comparator to +5 V (V_C Range +11, Comparison Voltage dial 500). Set the Input Attenuator to 1, the mVolts/Div to 10, and the Input Display switch to A-B.

c. Switch the input coupling selector to GND position and center the free running trace.

d. Switch the input coupling to DC and switch the probe DC OFFSET selector to the + position.

e. Connect the probe tip to the comparison voltage output jack (V_C Out).

f. CHECK—The probe DC OFFSET controls must position the trace on or below the graticule center.

g. Change the comparison voltage of the differential comparator to −5 V (V_C Range −11, Comparison Voltage dial at 500). Switch the probe DC OFFSET selector to the − position.

h. CHECK—The probe DC OFFSET controls must position the trace on or above the graticule center.

13. Check Probe Input Resistance

Requirement—Input resistance with or without attenuators must equal 1 MΩ ±1%.

a. Equipment for this check consists of an accurate resistance measuring device such as a resistance bridge.

b. Connect a ground lead to the probe (next to the tip) then connect the probe tip and ground lead across the terminals of the resistance bridge.

c. Measure the input resistance of the probe.

d. CHECK—Input resistance of the probe must equal 1 MΩ ±10 kΩ.

e. Install the attenuators, one at a time, and measure the input resistance of the probe with attenuators.

f. CHECK—Input resistance of the probe with attenuators must equal 1 MΩ ±10 kΩ.

NOTES

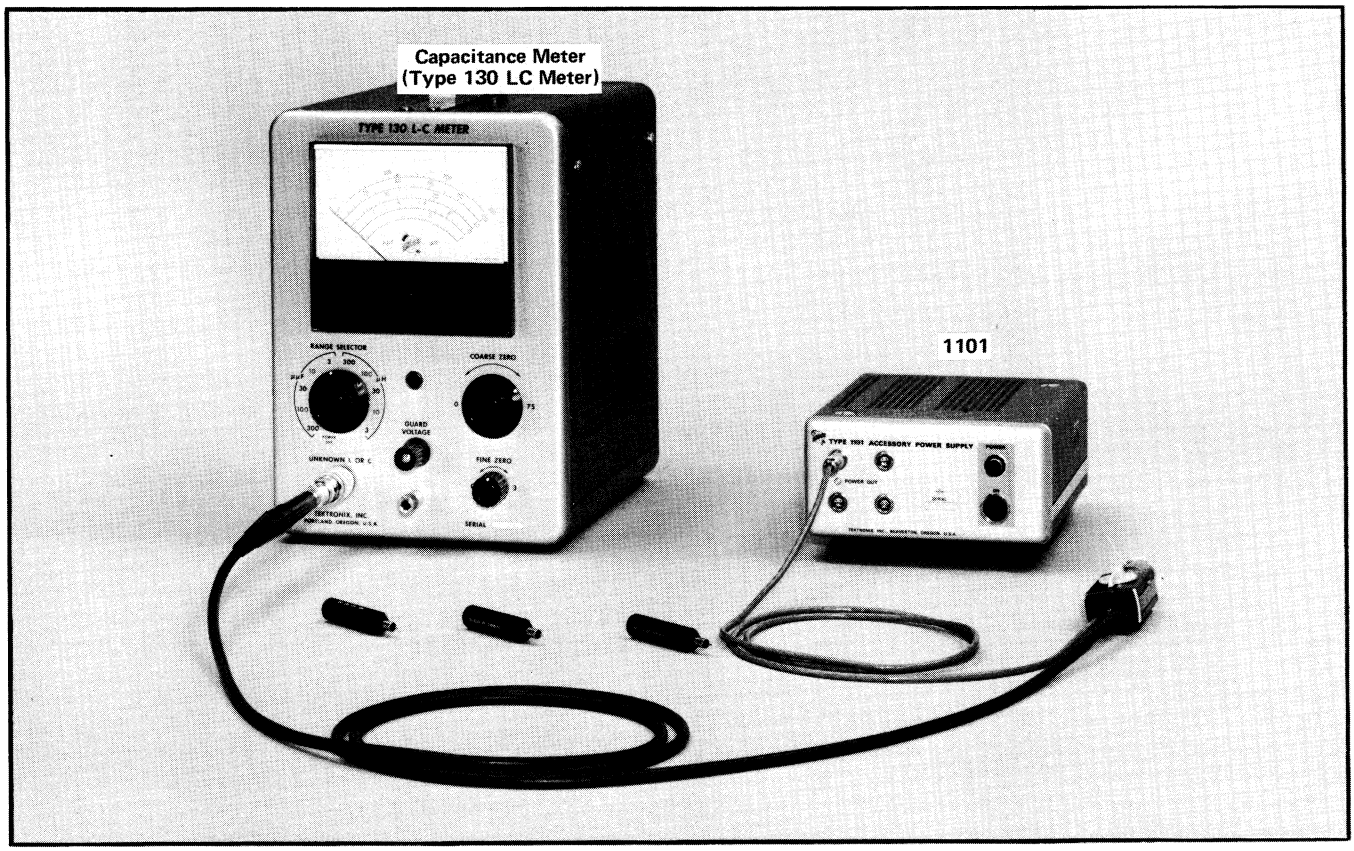


Fig. 5-9. Equipment setup to check input C (step 14).

14. Check Input Capacitance of Probe and Probe with Attenuators

Requirement:

Probe alone	2.8 pF ±10%
Probe with 4X attenuator	3.25 pF ±10%
Probe with 20X attenuator	2.0 pF ±10%
Probe with 40X attenuator	1.8 pF ±10%

a. Equipment setup is shown in Fig. 5-9.

b. Turn the capacitance measuring device power on and allow ample time for the instrument to stabilize. Calibrate the meter then switch the Range Selector to 10 μμF position.

c. Connect the probe tip through a probe tip to BNC adapter and a BNC to UHF adapter to the capacitance meter (Type 130 LC Meter).

d. CHECK—Measure the probe input capacitance. Must equal 2.8 pF ±0.28 pF.

e. Install the 4X attenuator on the probe and measure the input capacitance.

f. CHECK—Input capacitance of the probe with 4X attenuator must equal 3.25 pF ±0.325 pF.

g. Install the 20X attenuator on the probe and measure the input capacitance.

h. CHECK—Input capacitance of the probe with 20X attenuator must equal 2.0 pF ±0.2 pF.

i. Install the 40X attenuator on the probe and measure the input capacitance.

j. CHECK—Input capacitance of the probe with 40X attenuator must equal 1.8 pF ±0.18 pF.

This completes the performance check and calibration procedure for the P6051 Probe and its attenuators.

BASIC OPERATIONAL CHECK AND CALIBRATION

This procedure provides a concise check and calibration which checks the probe operation to insure that it is satisfactory for most applications. The procedure does not check all the electrical characteristics, nor the high-tolerance requirements of some. The intent of this procedure is to provide a less extensive and less costly method of checking and calibrating the main parameters of the probe. For example, the probe risetime is checked and calibrated with a DC to 1 GHz sampling system in this procedure. This is satisfactory for most applications.

Inherent characteristics that depend on high-tolerance components do not change unless the components are damaged. When this happens, the change is usually extensive and easily observed as an operational defect. Examples of this are the probe noise specification, the input capacitance and resistance, AC coupled low frequency cutoff point, etc.

Equipment and Test Fixtures Required for Basic Operational Check

The equipment required for this procedure is not as extensive or costly as that required for the complete performance check. The procedure following this list will check and calibrate the essential parameters.

The test oscilloscope system and the pulse generators listed here do not cover the frequency range or risetime required to check the probe risetime specification; however, they will provide an adequate check for a DC to 1 GHz system. If the probe is used with a DC to 4 GHz system use it to check and calibrate the probe.

1. Sampling oscilloscope system: Bandwidth DC to 1 GHz (risetime equal to or less than 350 ps), delay line (75 ns or more) with trigger pickoff.

a. Type 564B Storage Oscilloscope with Type 3S1 Sampling Amplifier or 3S2 plus the S-1 Sampling Head, 3T2 Random Sampling Sweep unit or 3T77A Sampling Sweep unit, and 7M11 Delay Line.

Trace storage is desirable; however, a non-storage 560 series can be used.

b. An alternate non-storage system that can be used is a 7000 series oscilloscope with 7S11 Sampling Amplifier plus S-1 Sampling Head, 7T11 Sampling Time Base, and 7M11 Delay Line.

2. Probe power supply: Probe requires +12 V to +15 V and −12 V to −15 V at 60 mA each. This is available from the 7000 series mainframe or the Type 1101 Accessory Power Supply; or, by using adapter (012-0187-00) it can be powered from Accessory Power Supply 015-0073-00 or the Type 454 probe power outlet connector.

3. Pulse generator: Pulse risetime 250 ps or less, output pulse amplitude to 50 V, output impedance 50 Ω. Tektronix Type 109 Pulse Generator.

4. Square wave generator: Frequency 10 kHz to 1 MHz, amplitude 0.5 V to 12 V peak, risetime 1 ns or less. Tektronix Type 106 Square Wave Generator.

5. 50 Ω charge line: Cable length at least 20 ns. 20 ns of Type RG213/U coaxial cable (Tektronix Part No. 017-0504-00) or Tektronix Type 113 Delay Cable.

6. 50 Ω, 5 ns coaxial cable, Type RG213/U with GR connectors. Tektronix Part No. 017-0502-00.

7. 50 Ω coaxial cable with BNC connectors. Tektronix Part No. 012-0057-01.

8. Adapters:

a. Probe tip to GR with 50 Ω termination. (Tektronix Part No. 017-0088-00), or probe tip to BNC adapter (Tektronix Part No. 013-0084-01) with BNC feedthrough termination (Tektronix Part No. 011-0049-01) plus a GR to Female BNC adapter (Part No. 017-0063-00).

b. Probe tip to BNC. Tektronix Part No. 013-0084-01.

c. GR to BNC male. Tektronix Part No. 017-0064-00.

9. Attenuators:

a. Two (2) 50 Ω 2X with GR connectors. Tektronix Part No. 017-0080-00.

b. 50 Ω 5X with GR connectors. Tektronix Part No. 017-0079-00.

c. 50 Ω 10X with GR connectors. Tektronix Part No. 017-0078-00.

d. 50 Ω termination, end line. Tektronix Part No. 017-0081-00.

10. Calibration Fixtures

a. Probe compensation. Tektronix Part No. 067-0624-00.

b. Attenuator compensation. Tektronix Part No. 067-0623-00.

Preliminary

The performance of the P6051 Probe should be checked within an ambient temperature of 0°C to 50°C. Allow a minimum warmup time of 20 minutes for the probe and test equipment to stabilize before checking or calibrating the probe. Calibrate the probe when the ambient temperature is within +20°C to +30°C for best performance.

a. Connect the P6051 Probe power connector to a power source such as the Type 1101, 7000 series mainframe, or (by means of adapter 012-0187-00) to accessory power supply 015-0073-00 or the Type 454 probe power connector. See Fig. 5-11.

b. Prepare the sampling oscilloscope system for a DC to 1 GHz bandwidth by installing either the 3S1 or 3S2 with S-1 Sampling Head into the 560 series oscilloscope. Install a 3T2 or 3T77A sweep unit into the horizontal compartment. If the 7000 series oscilloscope is used, install a 7S11 with S-1 Sampling Head and a 7T11 sweep unit into the mainframe.

c. Connect all test equipment to a power source, then turn the probe power supply and all equipment power on. Allow equipment to warm up before proceeding with the check.

When conducting a performance check only, do only the check portions of each step.

CAUTION

When the probe barrel or calibration fixture is removed or replaced during calibration adjustments, or the calibration fixture is to be rotated, be sure to turn the probe power OFF. This will prevent possible damage to the probe due to short circuiting.

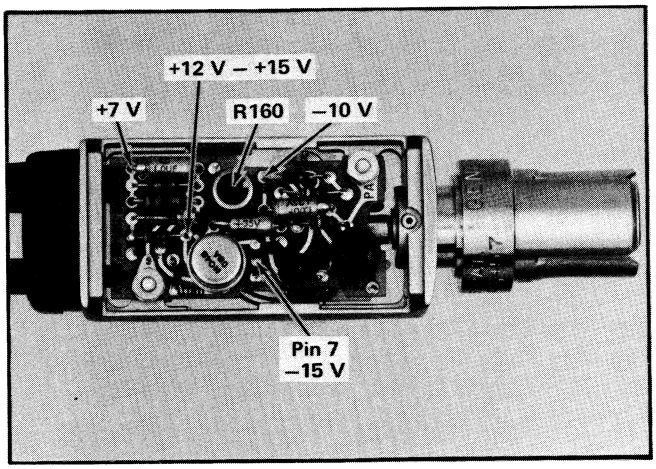


Fig. 5-10. Power regulator test points and output level adjustment.

1. Check Probe Power Regulator Output (Maintenance check only)

a. Terminate the output of the probe into a 50 Ω termination.

b. Remove the bottom cover for the DC offset housing and locate the +7 V and –10 V test points (see Fig. 5-10).

c. Measure the regulator output voltage with an accurate voltmeter. Voltages should check within 0.5 V of +7 V and –10 V.

d. Remove the 50 Ω termination and connect the probe output to the input of the sampling amplifier.

2. Check/Adjust Probe Output Level ❶

Requirement—The probe output level is adjustable to 0 volt.

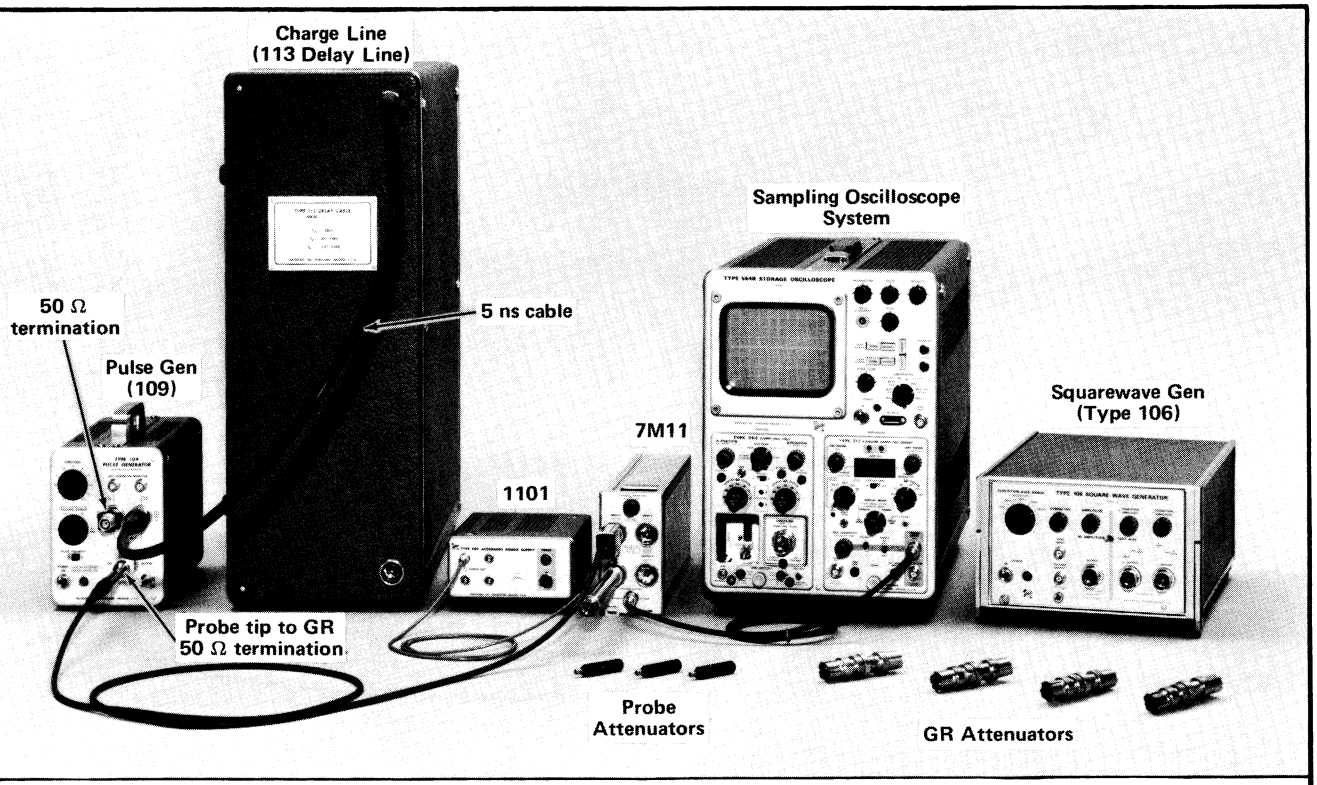
a. With the probe power off, position the CRT trace to the graticule center with the Sampling Unit mVolts/Div selector at 2.

b. Switch the probe power on and allow the probe to stabilize.

c. CHECK—Probe trace should not offset from the reference more than + or –5 mV.

d. ADJUST—Remove the cover to the offset housing and adjust R160 (Fig. 5-10) to eliminate any trace offset.

e. Replace the cover on the offset housing.



Type 113 Delay Line (charge line for 109)
Type 109, Pulse Generator (risetime ⩽350 ps)
Type 1101 Probe Power Supply
7M11 Delay Line with trigger pickoff.
20 cm airline (optional)
Sampling Oscilloscope system.
(Type 564B with S-1 Sampling Head, and 3T2)

Type 106 Squarewave Generator
Probe tip to GR 50 Ω termination adapter
Trigger cable
5X, 2X, 2X, 10X Attenuators.
Probe attenuators
5 ns coax cable

Fig. 5-11. Equipment required for basic operational check and calibration.

3. Check/Adjust Probe Compensation (Maintenance check or calibration only)

a. Equipment setup is shown in Fig. 5-11.

b. Apply the + Output of a fast rise square wave generator (Type 106) through a 5 ns coaxial cable and a GR 5X attenuator to the Input of the DC to 1 GHz sampling system. Externally trigger the sweep unit with the trigger output from the square wave generator by connecting a cable between the Trigger Out connector of the generator and the Trigger Input connector of the sweep unit (Type 3T2 or 7T11). Set the sweep rate to 2 ns/Div.

c. Switch the square wave generator pulse mode to Fast Rise position and its Repetition Rate to 1 MHz.

d. Adjust the sweep unit triggering sensitivity controls for a triggered display using 2 ns/Div sweep rate and sequential or normal sweep mode.

e. Set and adjust the sampling amplifier mVolts/Div selectors for a calibrated 10 mV/Div. Adjust the square wave generator output for a display amplitude of 5 divisions.

f. Note the step response. This response is to be used as a reference with which to compare the probe response.

g. Remove the 5X attenuator and the 5 ns cable and connect the P6051 Probe output to the input of the sampling amplifier. Connect the probe through a probe tip-to-GR 50 Ω-feedthrough termination to the Output of the square wave generator.

h. CHECK–The probe response to the step function. Waveform aberrations such as overshoot, ringing, or rounding should not exceed +5%, –5% or a total of 7% of the pulse amplitude. If aberrations are within these limits, proceed to step (j).

i. If aberrations in step (h) are excessive, compensate the probe amplifier as follows:

1) Turn the probe power OFF or disconnect the probe power connector from the power source.

2) Unscrew the probe barrel and install the Probe Compensation Fixture (Part No. 067-0624-00) as shown in Fig. 5-12. After the calibration fixture is installed and the locking screws tightened, turn the probe power supply ON.

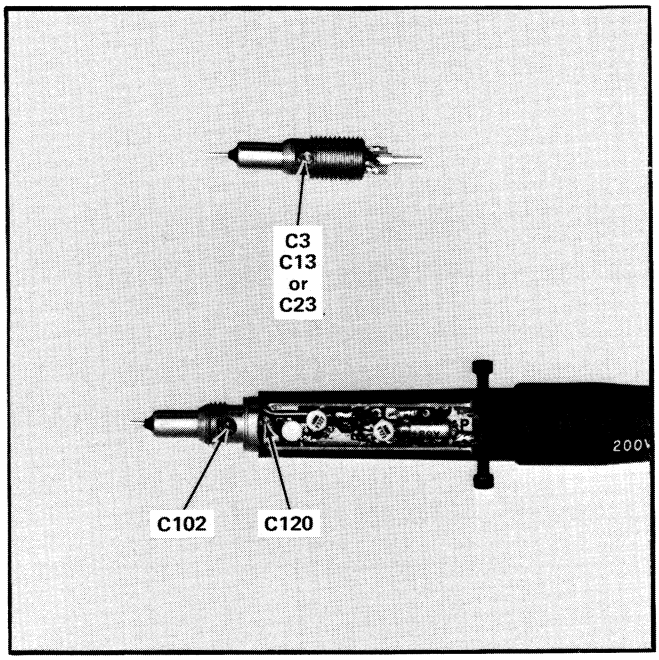


Fig. 5-12.

3) Insert the probe tip, through the probe tip-to-GR 50 Ω termination adapter, to the + Output of the square wave generator.

4) ADJUST—Using a small non-metallic probe such as a tooth pick, adjust C120 (Fig. 5-12) for minimum aberrations at the front corner of the square wave. The capacitor has small indentations along its edge so that it can be rotated with the small non-metallic probe.

NOTE

Excessive aberrations can be caused by an open ground lead or decoupling capacitor. Check ground spring contacts on the probe circuit board to the Calibration Fixture. Be sure the probe power is OFF before rotating or removing the calibration fixture.

j. Change the square wave generator repetition rate to 100 kHz and the sampling sweep unit sweep rate to 1 μs/Div.

k. CHECK—The step response front corner and pulse top for aberrations, must not exceed +5%, −5% or a total of 7% of the pulse amplitude. If aberrations are within these limits, proceed to step 4.

l. If aberrations are excessive, compensate the probe as follows:

1) Turn the probe power supply OFF and install the Probe Calibration fixture as directed in step (i) above.

2) Insert the probe tip, through the probe tip-to-GR 50 Ω termination adapter, to the + Output of the square wave generator and turn the probe power supply ON.

3) Adjust—C102 (Fig. 5-12) for best square corner and flat top of the square wave generator pulse output.

4) Turn the probe power supply OFF. Remove the Calibration Fixture and replace the probe barrel.

4. Check Probe Step Response

a. Equipment setup is described in step 3.

b. Apply the fast rise 50 V pulse from the pulse generator (Type 109) to the Input of the Input of the sampling amplifier as follows:

1) Use a delay line with trigger output (7M11) between the pulse source and the input to the sampling amplifier.

2) Connect Output 1 of the 7M11 through a 5 ns coaxial cable to the Input of the sampling amplifier.

3) Connect Input 1 of the 7M11 through a second 5 ns cable, GR 5X, 2X, 2X and 10X attenuators (total of 200X) to the Output of the pulse generator.

4) Connect a trigger cable from the delay line (7M11) Trigger Output to the Trigger Input on the sampling sweep unit. Set the delay line selector (7M11) Trigger Selector to Input 1.

5) Connect a GR 50 Ω end-line termination on Chg Line 1 connector and a 20 ns cable on Chg Line 2 con-

nector of the Type 109. The charge line can also be the Type 113 Delay Line.

6) Set the sampling sweep rate to .2 ns/Div and the Start Point at With Trigger.

7) Set the sampling amplifier mV/Div to 20 and the Smooth/Normal switch to Smooth position.

8) Turn the pulse generator On and, if necessary, adjust the pulse amplitude of the pulse generator for a 5 division display.

c. Measure and note the system risetime response.

d. Turn the pulse generator off and replace the 5 ns cable and 5X attenuator, between the Output of the pulse generator and the delay line, with the P6051 Probe. Use a probe tip-to-GR 50 Ω termination adapter to connect the probe into the GR attenuator on the Output connector of the pulse generator.

e. CHECK—Measure the risetime of the display and compute the probe risetime as follows:

$$T_r = \sqrt{(T_r \text{ display})^2 - (T_r \text{ system})^2}$$

The probe risetime must not exceed 0.35 ns.

5. Check/Adjust Attenuator Compensation (Maintenance check or calibration adjustment only)

NOTE

The probe must be properly compensated, as described in step 3, before performing this check or adjustment.

a. Apply the Hi Amplitude Output of the square wave generator (Type 106) through a 5 ns coaxial cable 2X, 2X, 5X and 10X GR attenuators (total attenuation of 200X) to the Input of the sampling amplifier. Connect the Trigger Out signal of the generator to the generator to the Trigger Input of the Sampling sweep unit.

b. Set the sampling amplifier mVolts/Div selector to 10. Set the sampling sweep Time/Div selector to 1 μs and adjust the triggering controls for a triggered display.

c. Set the square wave generator Repetition Rate to 100 kHz and adjust its Amplitude control for a 5 division display. Note the step response at the top front corner of the display.

d. Replace the 5 ns cable and the GR attenuators with the P6051 Probe with its 40X attenuator. Use a probe tip-to-GR 50 Ω termination adapter to connect the probe head to the Output of the square wave generator.

e. Check—The pulse front corner and pulse top for aberrations. Aberrations must not exceed +5%, −5% or a total of 7% of the pulse amplitude. If aberrations are within this limit, proceed with step (g).

f. ADJUST—If aberrations in step (e) are excessive, compensate the attenuator as follows:

1) Unscrew the attenuator cap, then unscrew the brass housing with the attenuator circuit board and tip, from the attenuator barrel.

2) Remove the circuit board and tip from the metal housing and insert the attenuator circuit board with tip into the Attenuator Compensation Calibration Fixture (Part No. 067-0623-00) so the compensating capacitor is visible through the adjustment hole (see Fig. 5-12).

3) Screw the calibration fixture with the attenuator circuit board into the attenuator barrel until the connector jack on the board just touches the insulator spacer.

4) Insert the tip through a probe tip-to-GR 50 Ω termination adapter to the Hi Amplitude Output connector on the square wave generator.

5) Adjust—Compensating capacitor for the best square corner and pulse top flatness.

6) Remove the calibration fixture. Replace the circuit board in the metal housing and screw the brass housing with the circuit board into the body shell of the attenuator until the connector jack just touches. Tighten the lock nut, then replace the cap.

g. Remove the probe 40X attenuator and install the 20X attenuator.

h. Insert a GR 2X attenuator between the probe tip-to-GR 50 Ω termination adapter and the Output connector of the square wave generator.

i. Check—The pulse corner and top for aberrations. Aberrations must not exceed +5%, −5% or a total of 7%. If aberrations are within limits, proceed to step (k).

j. Adjust—If aberrations are excessive, repeat the procedure described in step (f) to compensate the 20X attenuator.

k. Remove the 20X attenuator and install the probe 4X attenuator.

l. Insert a GR 10X attenuator in place of the 2X attenuator, between the probe tip-to-GR 50 Ω termination adapter.

m. Check—The pulse corner and top for aberrations. Aberrations must not exceed +5%, −5% or 7% total. If aberrations are excessive, repeat the calibration procedure to compensate the 4X attenuator.

6. Check Attenuation Accuracy of Probe and Attenuators

Requirement—Probe accuracy is 4%, attenuators 1%. This check compares the probe and attenuators with 2% attenuators.

a. Equipment setup is given in step 5.

b. Apply the Hi Amplitude Output of the Square wave generator (Type 106) through a 5 ns coaxial coable and 200X attenuation (consisting of GR 5X, 2X, 2X and 10X attenuators) to the Input of the sampling amplifier.

c. Set the sampling sweep rate to 2 μs/Div and the square wave generator repetition rate to 100 kHz.

d. Set the sampling amplifier mVolts/Div to 10 and carefully adjust the square wave generator output Amplitude or the sampling amplifier mVolts/Div Variable control for a display amplitude as near 5 divisions as possible.

e. Remove the 5 ns coaxial cable, plus the GR 5X attenuator, and substitute the P6051 Probe in their place. Use the probe-tip-to-GR termination adapter to connect the probe head into the remaining three GR attenuators.

f. CHECK—The display amplitude must equal 5 divisions ±6% or 0.3 div (6% is the probe attenuation accuracy of 4% plus the 2% of the GR attenuator).

g. Adjust the sampling amplifier mVolts/Div Variable control for an accurate 5 division display amplitude.

h. Attach the probe 4X attenuator to the probe head. Remove the two 2X GR attenuators and connect the probe tip through the probe tip-to-GR 50 Ω termination adapter to the 10X attenuator.

i. CHECK—The amplitude of the display must equal 5 divisions ±3% or 0.15 division (3% is equal to the 1% tolerance of the Probe attenuator plus the GR attenuator tolerance of 2%).

j. Remove the probe 4X attenuator and install the 20X attenuator. Connect the probe tip through the probe tip-to-GR 50 Ω termination adapter and a GR 2X attenuator to the Output of the square wave generator.

k. CHECK—The amplitude of the display must equal 5 divisions ±3%.

l. Remove the 20X probe attenuator and install the 40X attenuator. Connect the probe through the probe tip-to-GR 50 Ω termination adapter directly to the Output of the generator (all GR attenuators removed).

m. CHECK—The amplitude of the display must equal 5 divisions ±3%.

n. Remove the probe 40X attenuator.

7. Check Signal Compression and Expansion

Requirement—The compression or expansion of a 50 mV AC signal at the probe tip is within 5% for an equivalent DC offset range of + and −2.5 volts at the probe tip.

a. Apply the Fast Rise + Output of the square wave generator (Type 106) through a probe tip-to-GR 50 Ω termination adapter to the probe tip. Connect the probe output to the Input of the sampling amplifier. Insure that the probe DC OFFSET selector is at the OFF position.

b. Set the sampling amplifier mVolts/Div selector at 2 and the Variable control at Calibrate position.

c. Set the sampling sweep rate to 2 μs/Div and the square wave generator repetition rate at 100 kHz.

d. Adjust the square wave generator Amplitude control for a display amplitude of 5 divisions.

e. Switch the sampling amplifier mVolts/Div selector to 200 and center the trace vertically.

f. Switch the probe DC OFFSET to + position and adjust the DC OFFSET controls to position the trace 2.5 divisions below the graticule center.

g. Switch the sampling amplifier mVolts/Div selector to 2.

h. Adjust the sampling amplifier Offset control to bring the display within the graticule area, and measure the display amplitude.

i. Check—The display amplitude must equal 5 divisions ±5% (±0.25 div).

j. Change the mVolts/Div selector back to 200 mVolts/Div, switch the probe DC OFFSET to OFF, and again center the trace in the graticule area.

k. Switch the probe DC OFFSET switch to − position and adjust the probe DC OFFSET controls to position the trace 2.5 divisions above the graticule center.

l. Switch the mVolts/Div selector to 2 and adjust the sampling amplifier Offset control to display the waveform. Measure its amplitude.

m. CHECK—The display amplitude must equal 5 divisions ±5% (±0.25 div).

n. Switch the probe DC OFFSET selector to OFF position.

8. Check DC OFFSET Control Range

Requirement—DC OFFSET control range must equal or exceed + and −5 volts.

a. The following equipment is required for this check:

Pulse generator that has both + and − polarity outputs and amplitude of at least 10 V (Type 109). Delay line or charge line for the pulse generator (Type 113 Delay Line or 20 ns cable with GR connectors, Part No. 017-0504-00). Delay line with trigger take off (7M11).

b. Connect the charge line to Chg Line 1 and a 50 Ω end line termination to Chg Line 2 of the Type 109.

c. Apply the Output of the pulse generator (Type 109) through a 5 ns cable to the Input 1 of the 7M11 delay line.

d. Trigger the sampling sweep unit externally by connecting a BNC cable between the 7M11 Trigger Output connector and the sampling sweep unit Trigger Input. Switch the 7M11 Trigger Selector to 1.

e. Attach the 4X attenuator to the probe head. Connect the probe output to the Input of the sampling amplifier and connect the probe with attenuator through a probe tip-to-GR 50 Ω termination adapter to Output 1 of the 7M11 delay line.

f. Set the sampling sweep rate to 1 ns/Div and the sampling amplifier mVolts/Div to 50, Variable in Calibrate position.

g. Switch the pulse generator polarity to + position and adjust its Amplitude control for a display amplitude of 5 divisions.

h. Remove the probe 4X attenuator, reconnect the probe through the probe tip-to-GR 50 Ω adapter to the Output of the 7M11 delay line, and position the bottom of the pulse display at the graticule center line. The probe DC OFFSET selector must be OFF.

i. Switch the probe DC OFFSET selector to + and adjust the probe DC OFFSET controls to offset the display by the maximum amount.

j. CHECK—The top of the pulse must be on or below the graticule center line. DC OFFSET range of +5 volts.

k. Turn the probe DC OFFSET selector to OFF position and the pulse generator (Type 109) polarity switch to − position.

l. Position the top of the display to the graticule center line.

m. Switch the probe DC OFFSET selector to the − position and adjust the DC OFFSET controls to offset the display by the maximum amount.

n. CHECK—The bottom of the display must be on or above the graticule center line. DC OFFSET range of −5 volts.

o. Turn the DC OFFSET switch to OFF and disconnect the probe tip from the 7M11 delay line Output.

9. Check Probe Output Noise

Requirement—No discernible noise.

a. Insert the probe tip into a probe tip-to-GR 50 Ω termination adapter with the adapter removed from any input.

b. Switch the sampling amplifier mVolts/Div selector to 2 and the Normal-Smooth switch at Normal.

c. CHECK—There should not be any noticeable increase in the trace width.

This completes the operational check and calibration for the P6051 Probe.

SECTION 6
ELECTRICAL PARTS LIST

Values are fixed, unless marked Variable.

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
			Capacitors			
Tolerance ±20% unless otherwise indicated.						
C3	*214-1376-01			Var w/pin		
C6	283-0216-00		1.5 pF	Cer	50 V	10%
C13	*214-1374-01			Var w/pin		
C16	283-0137-00		7 pF	Cer		
C23	*214-1375-01			Var w/pin		
C26	283-0132-00		10 pF	Cer	50 V	5%
			Connector			
P199	131-0778-00			Plug, electrical, 4 contact		
			Resistors			
Resistors are fixed, composition, ±10% unless otherwise indicated.						
R1	307-0228-00		50 Ω	1/10 W		
R3	325-0060-00		750 kΩ	1/20 W	Prec	1/2%
R6	325-0062-00		333.3 kΩ	1/20 W	Prec	1/2%
R8	317-0430-00		43 Ω	1/8 W		5%
R11	307-0228-00		50 Ω	1/10 W		
R13	325-0068-00		950 kΩ	1/20 W	Prec	1/2%
R16	325-0069-00		52.63 kΩ	1/20 W	Prec	1/2%
R18	317-0510-00		51 Ω	1/8 W		5%
R21	307-0228-00		50 Ω	1/10 W		
R23	325-0063-00		975 kΩ	1/20 W	Prec	1/2%
R26	325-0061-00		25.63 kΩ	1/20 W	Prec	1/2%
R28	317-0430-00		43 Ω	1/8 W		5%

OFFSET BOX Circuit Board Assembly (Lower)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
	*670-1161-00			Complete Board (Lower)		
				Capacitors		
Tolerance ±20% unless otherwise indicated.						
C162	290-0267-00			1 μF	Elect. 35 V	
C182	290-0267-00			1 μF	Elect. 35 V	
C185	283-0139-00			150 pF	Cer 50 V	
C186	283-0201-00			27 pF	Cer 200 V	10%
C197	290-0267-00			1 μF	Elect. 35 V	
				Semiconductor Device, Diodes		
VR180	152-0278-00			Zener	1N4372A 400 mW, 3 V, 5%	
CR182	152-0141-02			Silicon	1N4152	
				Transistors		
Q162	*151-0228-00			Silicon PNP	TO-5 Tek Spec	
Q166	151-0223-00			Silicon NPN	TO-18 2N4275	
				Resistors		
Resistors are fixed, composition, ±10% unless otherwise indicated.						
R160	311-0644-01			20 kΩ, Var		
R162	317-0271-00			270 Ω	1/8 W	5%
R166	317-0391-00			390 Ω	1/8 W	5%
R167	317-0392-00			3.9 kΩ	1/8 W	5%
R180	317-0047-00			4.7 Ω	1/8 W	5%
R182	315-0331-00			330 Ω	1/4 W	5%
				Integrated Circuit		
U180	*155-0033-00			Probe power supply, 16 pin DIP		

OFFSET BOX Circuit Board Assembly (Upper)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
	*670-1162-00			Complete Board (Upper)			
				Resistors			
Resistors are fixed, composition, ±10% unless otherwise indicated.							
R170	321-0326-00			24.3 kΩ	1/8 W	Prec	1%
R171	321-0230-00			2.43 kΩ	1/8 W	Prec	1%
R174	311-1003-00			5 kΩ, Var			
R175	311-1003-00			5 kΩ, Var			
				Switch			
	Wired or Unwired						
S174	*260-1119-00			Rotary			

INPUT Circuit Board Assembly

	*670-1164-00			Complete Board			
				Capacitors			
Tolerance ±20% unless otherwise indicated.							
C102	*214-1376-01				Var	w/pin	
C105	283-0207-00			500 pF	Cer	50 V	
C110	283-0207-00			500 pF	Cer	50 V	
C114	283-0207-00			500 pF	Cer	50 V	
C115	283-0207-00			500 pF	Cer	50 V	
C120	*214-1376-01				Var	w/pin	
C122	283-0137-00			7 pF	Cer		
C126	283-0207-00			500 pF	Cer	50 V	
C131	283-0207-00			500 pF	Cer	50 V	
C138	283-0219-00			1500 pF	Cer	50 V	
C140	290-0448-00			0.47 μF	Elect.	20 V	10%
C142	283-0207-00			500 pF	Cer	50 V	
C143	283-0133-00			5 pF	Cer	50 V	5%
C148	283-0248-00			2.7 pF	Cer		±0.1pF
C150	290-0136-00			2.2 μF	Elect.	20 V	
C151	290-0448-00			0.47 μF	Elect.	20 V	10%

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INPUT Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
		Semiconductor Device, Diode		
CR138	*155-0034-00			Dual diode, 3 pin micro pak
		Inductor		
LR139	*108-0595-00			58 nH (wound on a 56 Ω resistor)
		Transistors		
Q110A, B	151-1034-00			Silicon Dual, N channel FET CC6 package
Q120	151-0295-00			Silicon NPN V327
Q130	151-0295-00			Silicon NPN V327
Q140	151-0295-00			Silicon NPN V327
		Resistors		
Resistors are fixed, composition, ±10% unless otherwise indicated.				
R100	307-0227-00		150 Ω	1/10 W 5%
R101	307-0240-00		50 Ω	1/10 W
R102	325-0067-00		582.4 kΩ	1/20 W Prec 1/2%
R105	325-0066-00		415.5 kΩ	1/20 W Prec 1/2%
R110	307-0247-00		3.3 kΩ	1/10 W
R112	307-0248-00		100 kΩ	1/10 W
R115	307-0236-00		27 Ω	1/10 W
R118	307-0236-00		27 Ω	1/10 W
R120	307-0243-00		200 Ω	1/10 W
R122	307-0241-00		100 Ω	1/10 W
R126	307-0234-00		500 Ω	1/10 W
R127	307-0235-00		1.3 kΩ	1/10 W
R131	307-0240-00		50 Ω	1/10 W
R135	307-0242-00		180 Ω	1/10 W
R136	307-0242-00		180 Ω	1/10 W
R137	307-0242-00		180 Ω	1/10 W
R138	307-0246-00		2 kΩ	1/10 W
R140	317-0184-00		180 kΩ	1/8 W 5%
R142	307-0150-00		75 Ω	1/10 W 5%
R143	307-0240-00		50 Ω	1/10 W
R145	307-0243-00		200 Ω	1/10 W
R146	307-0243-00		200 Ω	1/10 W
R147	307-0243-00		200 Ω	1/10 W
R148	325-0045-00		46.4 Ω	1/20 W Prec 1/2%

SECTION 7
MECHANICAL PARTS LIST

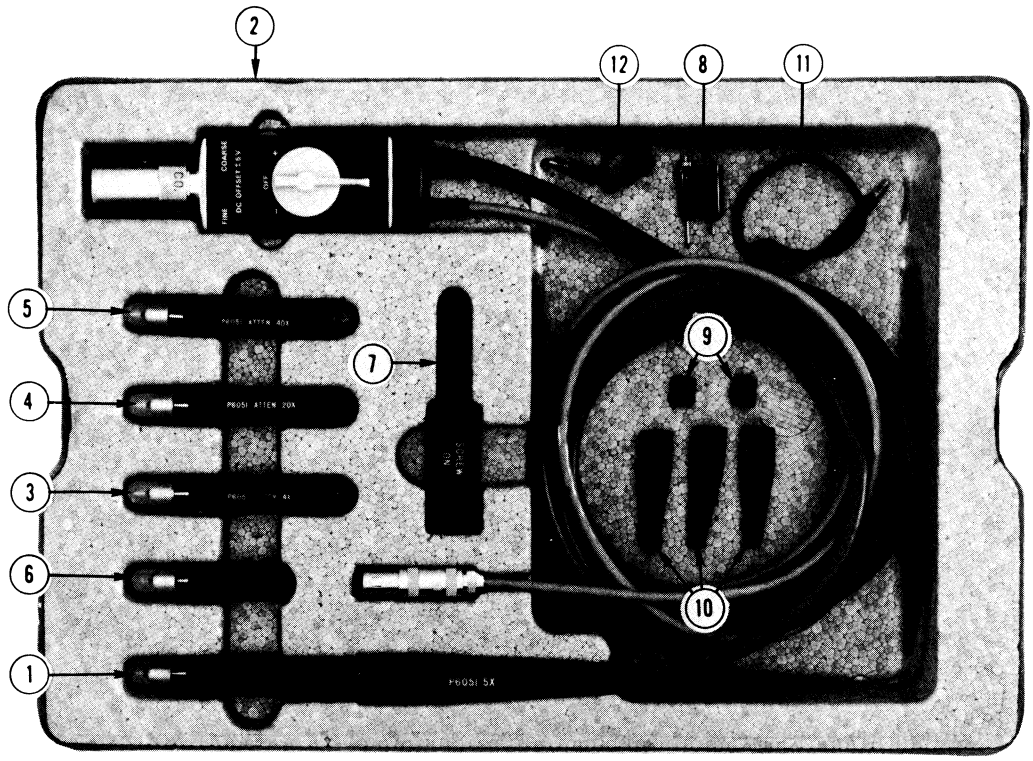
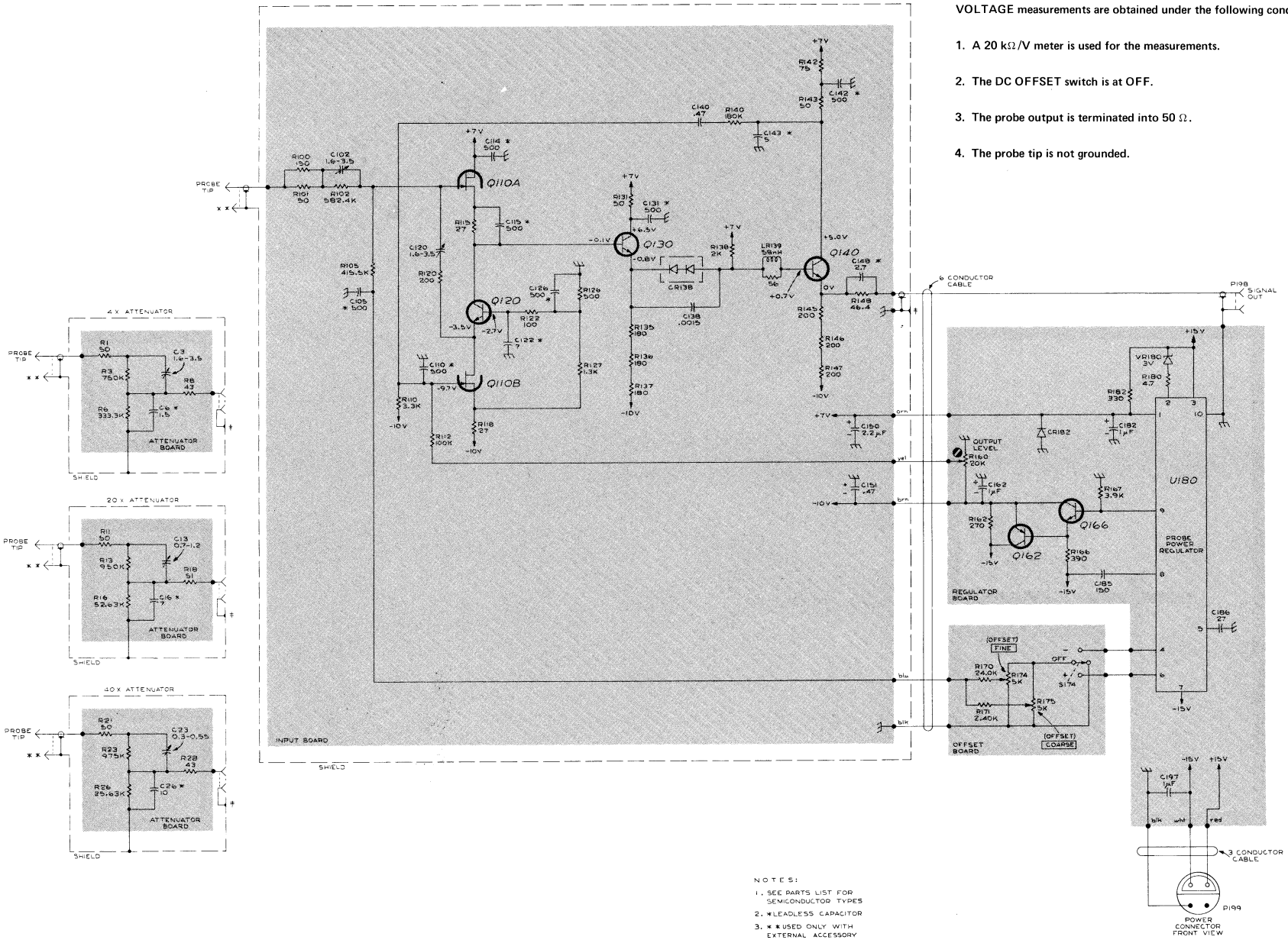


Fig. 7-1. P6051 Probe and Standard Accessories.

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty 1 2 3 4 5	Description
					PROBE PACKAGE
1 thru 12	010-0227-00 - - - - - -			1 -	PROBE PACKAGE, P6051, 6 foot package includes:
					PROBE ONLY
1-1	010-0226-00			1	PROBE, P6051, 6 foot
					STANDARD ACCESSORIES
-2	016-0156-00			1	CASE, carrying
-3	010-0370-00			1	ATTENUATION HEAD, 4X
-4	010-0371-00			1	ATTENUATION HEAD, 20X
-5	010-0372-00			1	ATTENUATION HEAD, 40X
-6	010-0373-00			1	CAPACITOR-COUPLER HEAD
-7	013-0109-00			1	HOOKTIP, retractable
-8	013-0085-00			1	ADAPTER, bayonet ground
-9	166-0404-01			2	SLEEVE, insulating
-10	344-0046-00			3	CLIP, alligator (w/cover)
-11	175-0849-01			1	LEAD, 6 inches long (w/probe nose adapter)
-12	175-0849-00			1	LEAD, 3 inches long (w/probe nose adapter)
	175-0848-01			1	LEAD, 5 inches long (not shown)
	070-1009-00			1	MANUAL, instruction (not shown)

VOLTAGE measurements are obtained under the following conditions:

1. A 20 kΩ/V meter is used for the measurements.
2. The DC OFFSET switch is at OFF.
3. The probe output is terminated into 50 Ω.
4. The probe tip is not grounded.



NOTES:

1. SEE PARTS LIST FOR SEMICONDUCTOR TYPES
2. *LEADLESS CAPACITOR
3. * * USED ONLY WITH EXTERNAL ACCESSORY ATTACHED
4. ‡SPRING CONTACT