Instruction Manual

Tektronix

P6135A
Differential Probe Pair

070-7675-02

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

www.tektronix.com

Tektronix, Inc., P.O. Box 500, Beaverton, OR 97077

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General Safety Summary

Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it. To avoid potential hazards, use this product only as specified.

Only qualified personnel should perform service procedures.

To Avoid Fire or Personal Injury

Connect and Disconnect Properly. Do not connect or disconnect probes or test leads while they are connected to a voltage source.

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

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

Connect the ground lead of the probe to earth ground only.

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

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

Do Not Operate in Wet/Damp Conditions.

Do Not Operate in an Explosive Atmosphere.

Keep Product Surfaces Clean and Dry.

Safety Terms and Symbols

Terms in This Manual. These terms may appear in this manual:

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

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

Preface

This manual contains information on how to use and maintain the P6135A differential probe pair.

The manual is organized into the following sections:

- *Getting Started* provides a product overview and introduction to probe features and accessories.
- *Operating Basics* discusses techniques for improving measurement accuracy.
- *Specifications* lists the probe warranted characteristics.
- *Performance Verification and Calibration* contains procedures to verify performance and to calibrate the probe.
- *Maintenance* contains inspection and cleaning procedures and instructions for replacing probe tips.
- *Replaceable Parts* lists standard and optional probe parts and accessories and provides ordering information.

Contacting Tektronix

Product support	For questions about using Tektronix measurement products, call toll free in North America: 1-800-833–9200 6:00 a.m. – 5:00 p.m. Pacific time Or contact us by e-mail: support@tek.com For product support outside of North America, contact your local Tektronix distributor or sales office.
Service support	Tektronix offers extended warranty and calibration programs as options on many products. Contact your local Tektronix distributor or sales office. For a listing of worldwide service centers, visit our web site.
For other information	In North America: 1-800–833–9200 An operator can direct your call.
To write us	Tektronix, Inc. P.O. Box 500 Beaverton, OR 97077-1000 USA
Web site	www.Tektronix.com

Getting Started

Getting Started

The Tektronix P6135A probe is a 10X passive differential probe pair specifically designed for use with Tektronix differential plug-in units.

Product Description

Three sets of probe tips included with the package allow the probe pair to be used with plug-in units or oscilloscopes having input impedances of 1 MΩ at 13 to 17 pF (red tips), 1 MΩ at 18 to 22 pF (black tips), or 1 MΩ at 45 to 49 pF (blue tips). The attenuation ratio is adjustable to 10X, including the affect of amplifier input impedance.

The probes need not be used as a pair. When used individually, each will provide highly accurate signal transmission to any compatible oscilloscope input.

When the P6135A probe pair is used on a differential amplifier, the adjustable attenuation ratio compensates for differences in amplifier input resistance, thus improving the common-mode rejection ratio (CMRR) of the system.

The built-in compensation box adjusts for uniform frequency response characteristics, providing a high CMRR from DC to high frequencies, as well as adjustments to optimize transient response.

The special low-noise coaxial cable used on the P6135A helps to maintain high system CMRR, even when a probe is moved. Each probe has a 1.5 meter probe cable.

The P6135A probe pair meets the requirements of UL 1244 and is fully compatible with the Tektronix family of compact probe accessories.

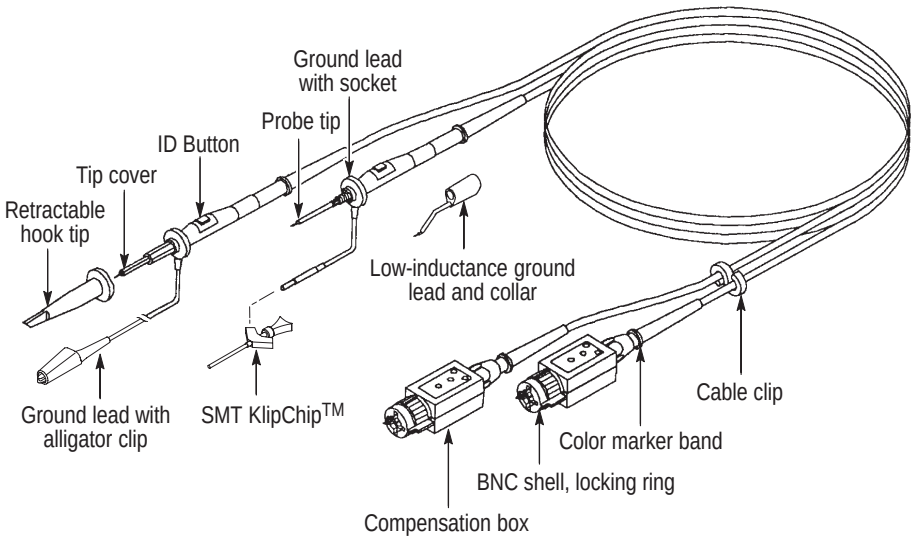


Figure 1–1: P6135A Differential Probe Pair with accessories

Standard Accessories

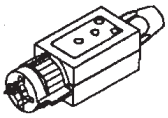
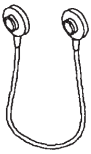
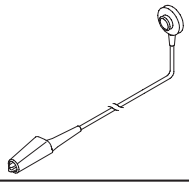
Standard accessories for the P6135A probe pair are listed below.

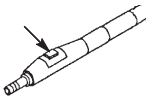
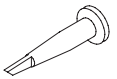
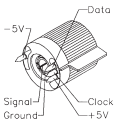
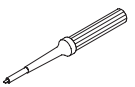
2	Retractable hook tips
2	Low-inductance ground lead and collars
2	Ground lead with sockets
2	Ground lead with alligator clips
1	Double ground lead
2	SMT KlipChips
1	Adjustment tool
1	Pkg., color marker bands
1	Cable clip
2	Tip holders
1	Accessory pouch
1	Instruction manual

Chapter six contains ordering information for all standard and optional accessories.

Probe Features

The following table discusses P6135A probe pair components, connectors, and standard accessories. Refer to Figure 1–1 to identify items within the probe pair.

	**BNC Shell, Locking Ring.** Locks the probe onto the instrument. To install, fully rotate the locking ring counter-clockwise as viewed from the cable end of the compensation box. Insert the probe onto the front-panel connector and rotate the locking ring clockwise until the probe is secured to the instrument.
	**Compensation Box.** Contains an adjustable network with four adjustment points that can be reached using the adjustment tool. These adjustments allow you to compensate the probe for uniform frequency-response characteristics, providing a high CMRR from DC to high frequencies.
	**Cable Clip.** Holds the probe cable in consistent relationship with each other. By minimizing movement and interaction, CMRR is optimized.
	**Color Marker Bands.** Identifies specific probes when using multi-channel oscilloscopes. Markers are provided in various different colors.
	**Double Ground Lead.** Provides a ground connection between the two probes.
	**Ground Lead with Alligator Clip.** Makes connections to ground pins.

	**Ground Lead with Socket.** Connects to the SMT KlipChip or directly onto the square-pin ground of a circuit board.
	**ID Button.** Activates the ID function in the host instrument. Pressing the ID button also executes a programmed test routine on some oscilloscopes.
	**Low-Inductance Ground Lead and Collar.** Provides low-inductance ground connections to ensure maximum performance.
	**Probe Tip.** Acquires the signal from the circuit under test. The P6135A probe pair comes standard with two tip holders for storage and three pairs of color-coded attenuator tips. Red: for oscilloscopes with 13 to 17 pF inputs. Black: for oscilloscopes with 18 to 22 pF inputs. Blue: for oscilloscopes with 45 to 49 pF inputs.
	**Retractable Hook Tip.** Provides a means of making a hands-free connection to a test point or component lead. To install, slide onto the probe tip. ***NOTE:*** *Retractable hook tips cannot be used with the low-inductance ground lead.*
	**SMT KlipChip.** Plugs into the ground leads to form connections in tight places.
	**TEKPROBE Interface (Level 1).** Provides communication with a similarly equipped host instrument (through the input connector) for signal, attenuation readout factor, and function triggering. Your oscilloscope may not implement all features of the TEKPROBE interface. Check your oscilloscope manual for details.
	**Adjustment Tool.** Use this tool to make compensation box adjustments.

Grounding the Probe

Connect the probe to the instrument and connect the ground lead to ground before making any measurements. Ensure that no part of the ground lead contacts voltage in the circuit under test. Except for the probe tip and BNC center conductor, all accessible metal (including the ground clip) is connected to the BNC shell.

WARNING. *To avoid electric shock when using the probe, keep your fingers behind the finger guard on the probe body. See Figure 1–2 below.*

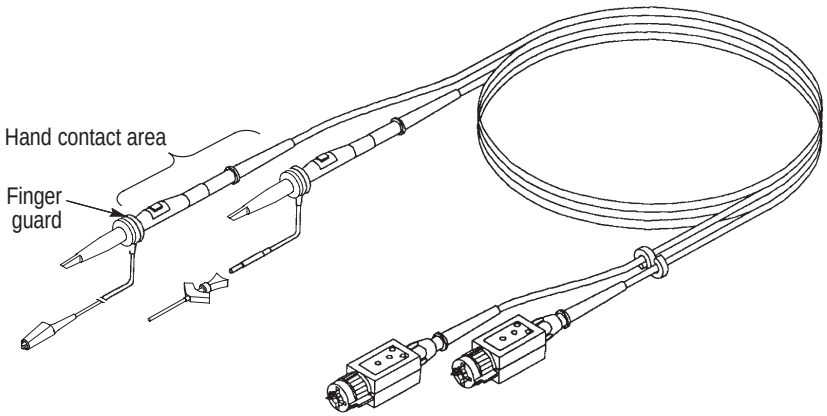


Figure 1–2: Probe finger guard and hand contact area

Choosing the Correct Probe Tip

The P6135A probe pair comes with three sets of matched probe tips. Each probe is shipped with the red tip installed.

Choose the correct set of tips for your instrument:

- Use the red tips for 11000 Series oscilloscopes that have 15 pF inputs.
- Use the black tips for 7000 Series oscilloscopes that have 20 pF inputs.
- Use the blue tips for 5000 Series and some 7000 Series oscilloscopes that have 47 pF inputs.

For instructions on how to change or replace a probe tip, refer to *Probe Tip Replacement* on page 5–2.

Operating Basics

Operating Basics

This section discusses technical issues you should consider when using the P6135A probe pair.

Probe Calibration

Accurate differential measurements require careful matching of both channels of the differential measurement system. In calibrating a probe pair to obtain optimum common-mode rejection ratio (CMRR), the adjustments compensate for imbalances in the differential amplifier and between the probes themselves.

***NOTE**. Probes will meet specification only when calibrated to the inputs on which they are used. If the probes are interchanged on the differential amplifier inputs or moved to another instrument, they must be recalibrated (this also applies when using the probes in nondifferential mode).*

Probe calibration is not difficult but must be accurately performed to achieve high CMRR characteristics. Refer to the *Performance Verification & Calibration Procedures* beginning on page 4–1 for calibration procedures.

CMRR Considerations

Common-mode signals are signals or parts of signals that are identical in amplitude, frequency, and phase. A differential amplifier rejects common-mode signals and amplifies the difference. The degree of rejection depends primarily on the symmetry of the amplifier and signal path. CMRR refers to the degree of rejection of common-mode signals and is expressed as a ratio. For instance, if 10 V of input common-mode signal resulted in 1 mV at the output, the CMRR would be 10,000:1.

The specified CMRR of a system assumes that the points being measured have identical source impedances. The measurement system input impedance has a loading effect on the source. It also affects the common-mode signal voltage as seen by the system. Measurement points having a significant difference in source impedance will present an unbalanced common-mode signal to the test system, thereby degrading CMRR performance.

A major advantage of using the P6135A probe pair with differential amplifiers is that loading is reduced at mid-to-high frequencies because of lower input capacitance. This reduced loading minimizes the effect of source impedance differences and makes it possible to have sufficient range for probe calibration balance adjustments, even in the presence of source impedance differences.

Balancing Probe Pair Impedance Differences

In order to optimize CMRR, you must balance the probe pair impedance differences using the following strategy.

1. Calibrate the probes with both probe tips connected to the same test point. See the *Performance Verification & Calibration Procedures* beginning on page 4–1 for calibration procedures.
2. Connect the probe tips to the desired test points and recalibrate them for the best CMRR. Ensure that the adjustments are attenuating only the common-mode signal. The best CMRR can be obtained by making final adjustments with the signal to be measured.
3. Recalibrate the probes if you change frequencies or move the probes to other test points. (Adjustment at one frequency can degrade CMRR performance for other frequencies.)

Dynamic Range Effects

The 10X attenuation of the P6135A probe pair effectively increases the dynamic range of the amplifier for CMRR measurements by a factor of 10. This increase in range applies at all frequencies and

settings of the Volts/Div switch and is limited only by the bandwidth and input voltage ratings of the system.

Probe Grounding

When using the P6135A probe pair for low-frequency CMRR measurements (less than 1 MHz), neither probe should be grounded to the equipment under test. Instead, the probe shields should be connected together at the probe bodies as shown in Figure 2–1. The probes will then be grounded through their BNC shells to the oscilloscope ground. Unfortunately, this degrades high-frequency performance but reduces the effect of ground-loop currents that can degrade low-frequency CMRR.

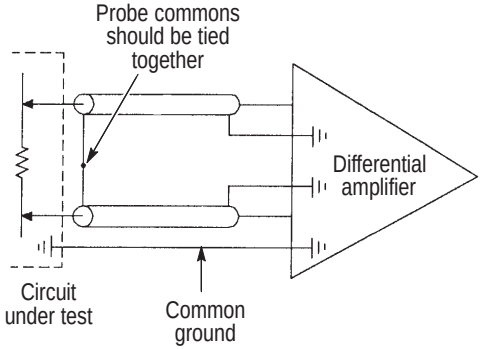


Figure 2–1: Optimizing low-frequency CMRR performance

For high-frequency measurements (greater than 1 MHz), the probes should be grounded to the equipment under test with short leads to minimize inductance (see Figure 2–2).

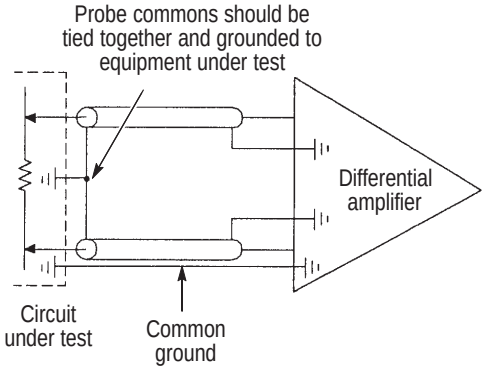


Figure 2–2: Optimizing high-frequency CMRR performance

Ground lead inductance can significantly reduce the performance of a probe. As shown in Figure 2–3, the ground lead inserts a series inductance into the signal path. This inductance forms a series-resonant circuit with

$$f_0 = \frac{1}{2\ \pi\ \sqrt{LC}}$$

between C_{in} of the probe and the ground lead L, with only R_{source} as damping.

A six-inch ground lead has approximately 150 nH of self-inductance producing an f_0 of approximately 127 MHz, which is within the frequency response of the instrument. This effect greatly degrades risetime, bandwidth, and transient accuracy as shown in Figure 2–4. To minimize ground lead inductance, use the low-inductance ground lead and collar.

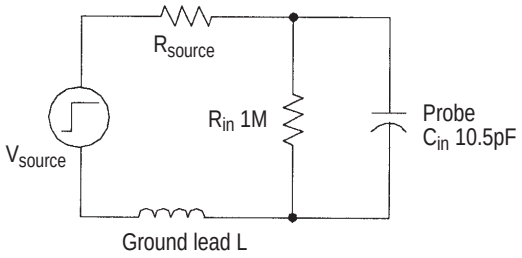
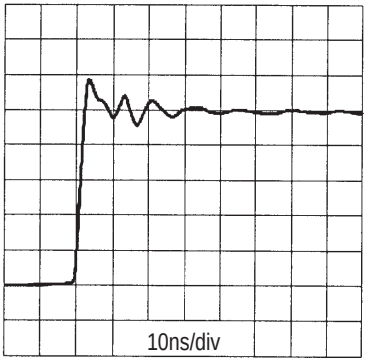


Figure 2–3: A series resonant circuit



Effects using a six inch ground lead

Figure 2–4: Effects of ground-lead inductance

Specifications

Specifications

This section lists the electrical, environmental, and physical specifications of the P6135A probe pair. All specifications are guaranteed unless labeled “typical”. Typical specifications are provided for your convenience and are not guaranteed. Specifications marked with the ✓ symbol are verified in in the *Performance Verification and Calibration Procedures* beginning on page 4–1.

The electrical characteristics listed in Table 3–1 apply to a probe pair calibrated between 20° C and 30° C. The instrument system must also be calibrated and operating within the environmental conditions listed in Table 3–2 on page 3–4.

Table 3–1: Electrical characteristics

Characteristic	Description
✓Attenuation[1]	Adjustable to 10X (Oscilloscope input resistance 1 MΩ ±1% at DC)
Input impedance (1 MΩ ±1%)[2]	Red Tip: 10.5 pF ±0.6 pF Black Tip: 11.0 pF ±0.6 pF Blue Tip: 13.7 pF ±0.6 pF
Compensation range	Red Tip: 13 pF 17 pF Black Tip: 18 pF 22 pF Blue Tip: 45 pF 49 pF
✓System bandwidth (–3 dB)[2]	Connected to 7A13/oscilloscope: DC to 90 MHz Connected to 11A33/oscilloscope: DC to 150 MHz
✓Rise time[1,2]	Connected to 7A13/oscilloscope: ≤3.89 ns Connected to 11A33/oscilloscope: ≤2.33 ns (Calculated from bandwidth, t_r = 0.35/BW)

Table 3–1: Electrical characteristics (Cont.)

Characteristic	Description
Maximum nondestructive input voltage, typical	500 V (DC + peak AC) to 1.3 MHz derated to 15 V (DC + peak AC) at 100 MHz. See Figure 3–2.
↙CMRR[1]	Connected to 11A33 oscilloscope: 10,000:1 from DC to 1 kHz, deceasing to 100:1 at 20 MHz. See Figures 3–3 and 3–4.

1 **System characteristic.**

2 **See oscilloscope manual to verify system specifications.**

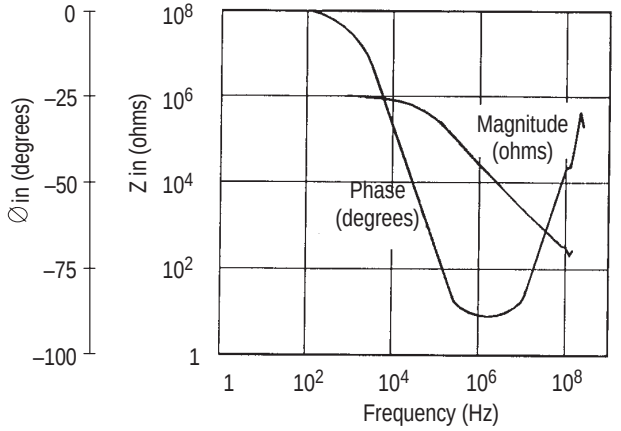


Figure 3–1: Typical input impedance

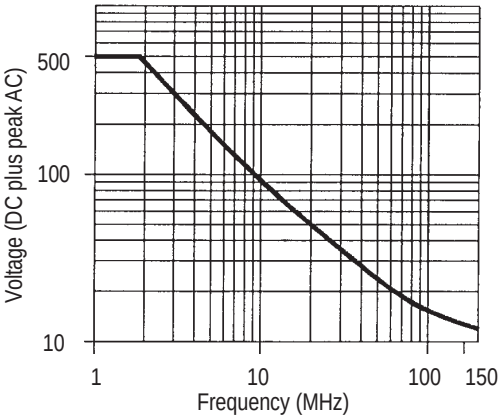


Figure 3–2: Typical voltage derating vs. frequency

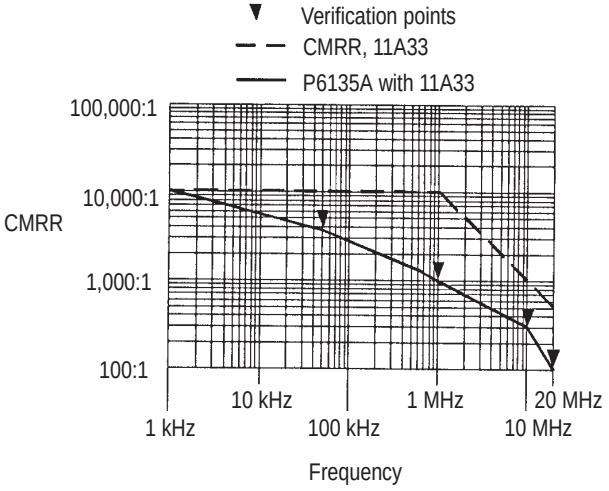


Figure 3–3: Typical CMRR vs frequency with 11A33 oscilloscope

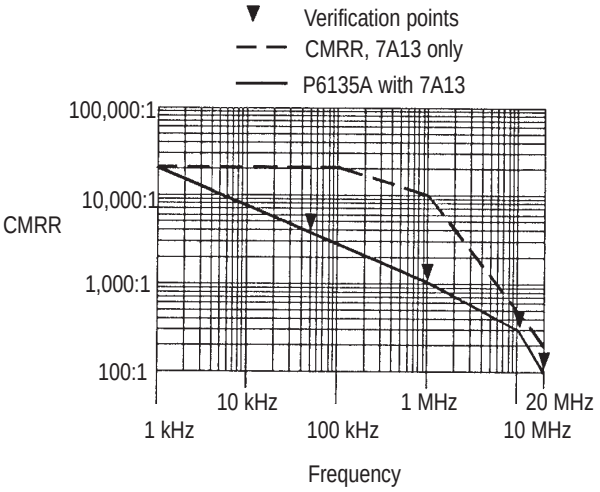


Figure 3–4: Typical CMRR vs frequency with 7A13 oscilloscope

Table 3–2: Environmental characteristics

Characteristic	Information
Temperature range	
Operating	0° C to 50° C (32° F to 122° F)
Nonoperating	–55° C to 75° C (–67° F to +167° F)
Altitude	
Operating	To 4,500 m (15,000 ft)
Nonoperating	To 15,000 m (50,000 ft)
Packaged product[1]	Qualified under National Safe Transit Association's Preshipment Test Procedures: 1A-B-1

[1] **Transportation vibration and shock.**

Table 3–3: Physical characteristics

Characteristic	Information
Net weight[1]	397 g (14 oz)
Probe length	1.5 m (59 inch)

1 **Includes accessories, excludes packaging.**

Table 3–4: Certifications and compliances

EC declaration of conformity – low voltage	Compliance was demonstrated to the following specification as listed in the Official Journal of the European Communities: Low Voltage Directive 73/23/EEC, as amended by 93/68/EEC. HD401 S1:1980 Safety Requirements for Electronic Apparatus
Pollution degree	Degree 2
Safety class	Class 1 (ground reference)

Performance Verification and Calibration Procedures

Performance Verification and Calibration Procedures

In this section you will find the following verification and adjustment procedures:

- Performance verification: procedures to verify that the P6135A probe pair meets the performance requirements listed in the *Specifications* section. These procedures may also be used as an acceptance check.
- Calibration: adjustment procedures to return the probes to factory calibration.

You must be familiar with the basic operation of the oscilloscope being used with the P6135A probe pair prior to performing any procedure.

***NOTE**. The procedures in this section are for 11000 and 7000 Series oscilloscopes but also apply to 5000 Series oscilloscopes with the exception of the HF compensation procedure.*

Procedures that differ for 11000 and 7000 Series oscilloscopes are clearly marked.

Test Equipment

Table 4–1 describes the test equipment used to perform the performance verification and calibration procedures. The equipment recommended is the minimum necessary to provide accurate results. Substitute equipment must meet or exceed the specifications listed.

The limits and tolerances given in the following procedures are for the P6135A probe pair under test. Except as noted, test equipment error is not included.

Table 4–1: Test equipment

Description	Minimum requirements	Example product
Oscilloscope system		Tektronix 11000 Series oscilloscope with 11A33 differential amplifier. Tektronix 7000 Series oscilloscope with 7A13 differential comparator-amplifier and 7B92A time base.
Calibration generator	Amplitude range adjustable to 10 V_{p-p}. Frequency range adjustable to 150 MHz.	Wavetek 9500 Universal Calibration System with option 250 or Fuke 5500A with option SC.
Leveled sine wave generator		
Probe tip adapter (2)	Probe tip-to-BNC	Tektronix 013-0226-00
Precision coaxial cable	50 Ω BNC, 36 inch length	Tektronix 012-0482-00
T-adapter	BNC male-to-dual-female	Tektronix 103-0030-00
Elbow adapter (2)	BNC	Tektronix 103-0031-00
Termination	50 Ω BNC	Tektronix 011-0049-01
Low-reactance adjustment tool	Insulated, low reactance type. (Supplied with probe.)	Tektronix 003-1433-00

NOTE. *Before beginning any performance verification or calibration procedure, warm up all test equipment for at least 20 minutes.*

Single-ended Applications

Use the following checks to verify and adjust probe performance for single-ended applications. Check each probe separately (one on the positive input, one on the negative input). Input coupling on the unused probe should be set to ground or off.

Checks for dual-probe applications begin on page 4–12.

***NOTE**. Oscilloscope displays of negative probe inputs will be inverted.*

Check and Adjust DC Attenuation

1. Set the test equipment controls as indicated in the tables below. Use the second column of values for 11000 Series oscilloscopes and the third column of values for 7000 Series oscilloscopes.

Differential comparator

Setting	11A33	7A13
Menu	WAVEFORM	—
+ Input	OFF	GND
– Input	OFF	GND
Offset	0 V	—
Volts/Div	10 mV	10 mV
Bandwidth	20 MHz	5 MHz
Position	Centered	Centered

Time base

Setting	11000 Series	7000 Series
Menu	TRIGGER	—
Coupling	AC	AC
Mode	AUTO LEVEL	P-P AUTO
Level	50%	—
Source	—	INT
Time/Div	500 ms	500 ms

Calibration generator

Function	Setting
Mode	STANDARD AMPLITUDE
Amplitude	5 V

2. Position the trace to the center graticule line.
3. Change the positive input to DC and the negative input to V_C.
4. Set the oscilloscope controls as indicated below.

Setting	11000 Series	7000 Series
Vertical offset	+5 V	—
V_C	—	+5 V

5. Use the coaxial cable to connect the calibration generator standard amplitude output directly to the oscilloscope positive input connector.
6. Adjust the offset or V_C voltage to position the top of the calibrator waveform to the center graticule line. Note and record the offset or V_C reading.

7. Remove the coaxial cable from the positive input connector.
8. Connect a probe to the positive input of the differential comparator. Connect the probe tip to the calibration generator output with a probe tip-to-BNC adapter.
9. Set the oscilloscope Volts/Div to 10 mV.
10. If you are using an 11000 Series oscilloscope, go directly to Step 13.
11. Set the oscilloscope positive and negative inputs to GND and position the trace to the center graticule.
12. Change the positive input to DC and the negative input to V_C. Set V_C to the same voltage as noted in Step 6.
13. Verify that the top of the calibrator waveform is on the center graticule line.
14. If necessary, adjust DC ATTEN on the positive probe compensation box to position the top of the calibrator waveform to the center graticule line. Use the low-reactance adjustment tool.
15. Disconnect the positive probe tip from the calibration generator and connect the negative probe tip.
16. Set the positive input to V_C and the negative input to DC. Adjust the negative probe DC ATTEN control so the waveform bottom lines up on the center graticule line.

NOTE. *You will have to remove the positive probe compensation box from the oscilloscope to adjust the negative probe.*

Check and adjust low-frequency (LF) compensation

1. Set the test equipment controls as indicated in the tables below. Use the second column of values for 11000 Series oscilloscopes and the third column of values for 7000 Series oscilloscopes.

Differential comparator

Setting	11A33	7A13
Menu	WAVEFORM	—
+ Input	DC	DC
– Input	OFF	GND
Offset	0 V	—
Volts/Div	10 mV	200 mV
Bandwidth	20 MHz	5 MHz
Position	Centered	Centered

Time base

Setting	11000 Series	7000 Series
Menu	TRIGGER	—
Coupling	AC	AC
Mode	AUTO LEVEL	P-P AUTO
Level	50%	—
Source	—	INT
Time/Div	20 µs	20 µs

Calibration generator

Function	Setting
Mode	FAST RISE
Period (Frequency)	0.1 ms (10 kHz)
Amplitude	MAX ($\approx$1 V_{p-p})

2. Using a 50 Ω termination and a probe tip-to-BNC adapter, connect the positive probe tip to the +FAST RISE output of the calibration generator.
3. Center the waveform on the oscilloscope display and check the top of the waveform for flatness.
4. If necessary, adjust LF COMP on the positive probe compensation box for waveform flatness. Use the low-reactance adjustment tool.
5. Disconnect the positive probe tip and connect the negative probe tip to the calibration generator.
6. Set the oscilloscope positive input to GND (OFF) and the negative input to DC.
7. Repeat Steps 3 through 5 above for the negative probe compensation box and adjust the bottom of the waveform for flatness.

***NOTE**. You will have to remove the positive probe compensation box from the oscilloscope to adjust the negative probe.*

Check and adjust high-frequency (HF) compensation

1. Set the test equipment controls as indicated in the tables below. Use the second column of values for 11000 Series oscilloscopes and the third column of values for 7000 Series oscilloscopes.

Differential comparator

Setting	11A33	7A13
Menu	WAVEFORM	—
+ Input	DC	DC
– Input	OFF	GND
Offset	0 V	—
Volts/Div	200 mV	200 mV
Bandwidth	150 MHz	FULL
Position	Centered	Centered

Time base

Setting	11000 Series	7000 Series
Menu	TRIGGER	—
Coupling	AC	AC
Mode	AUTO LEVEL	P-P AUTO
Level	50%	—
Source	—	INT
Time/Div	20 ns	20 ns

Calibration generator

Function	Setting
Mode	FAST RISE
Period (Frequency)	0.1 µs (1 MHz)
Amplitude	Adjust for 5 division display

2. Using a 50 Ω termination and probe tip-to-BNC adapter, connect the probe tip to the +FAST RISE of the calibration generator.
3. Adjust the oscilloscope display for five vertical divisions with the top of the waveform visible.
4. If necessary, adjust HF ADJUST 1 for best overall flat response.
5. If necessary, adjust HF ADJUST 2 for a square front corner.

***NOTE**. You will have to remove the positive probe compensation box from the oscilloscope to adjust the negative probe.*

Check bandwidth and system rise time

Perform the following procedure to verify the bandwidth specification.

Set the test equipment controls as indicated in the tables below. Substitute the sine wave generator output for the calibration generator output. Use the second column of values for 11000 Series oscilloscopes and the third column of values for 7000 Series oscilloscopes.

Differential comparator

Setting	11A33	7A13
Menu	WAVEFORM	—
+ Input	DC	DC

Differential comparator (Cont.)

Setting	11A33	7A13
– Input	OFF	GND
Offset	0 V	—
Volts/Div	1 V	1 V
Bandwidth	150 MHz	FULL
Position	Centered	Centered

Time base

Setting	11000 Series	7000 Series
Menu	TRIGGER	—
Coupling	AC	AC
Mode	AUTO LEVEL	P-P AUTO
Level	50%	—
Source	—	INT
Time/Div	50 µs	50 µs

Sine wave generator

Function	Setting
Mode	50 kHz
Voltage (peak to peak)	5 V

NOTE. *To prevent excessive capacitive loading, connect only one probe at a time to the sine wave generator output.*

1. Connect the positive probe tip to the sine wave generator output using a 50 Ω termination and probe tip-to-BNC adapter.
2. Adjust the sine wave generator output to display a waveform five divisions in amplitude.
3. Change the oscilloscope time base to 10 ns/div.
4. Set the sine wave generator frequency as listed below.

Setting	11A33 Plug-in	7A13 Plug-in
Sine wave frequency	150 MHz	90 MHz

5. Verify that the displayed waveform is at least 3.5 divisions in amplitude.

   To calculate the exact bandwidth and rise time of your system, increase the frequency of the sine wave generator until the displayed waveform is exactly 3.5 divisions in amplitude. This is the system bandwidth.

   To determine the system rise time, use the following equation:

   $t_r = 0.35 \div$ bandwidth frequency.

6. To check the bandwidth and rise time with the negative probe, disconnect the positive probe tip from the sine wave generator and connect the negative probe tip. Set the positive input to GND (OFF) and the negative input to DC. Set the sine wave generator frequency to 50 kHz and repeat steps 2 through 5 above.

Common Mode Applications

Use the following checks to verify and adjust dual-probe performance for common-mode applications.

Before proceeding with the common mode performance checks, do the following:

- Check the CMRR of the differential amplifier to ensure it meets specifications.
- Perform the *Single-ended Applications* checks beginning page 4–3.
- Install the cable clips to minimize cable interaction during CMRR measurements.

Check and Adjust DC Attenuation

1. Connect the test setup as shown in Figure 4–1.

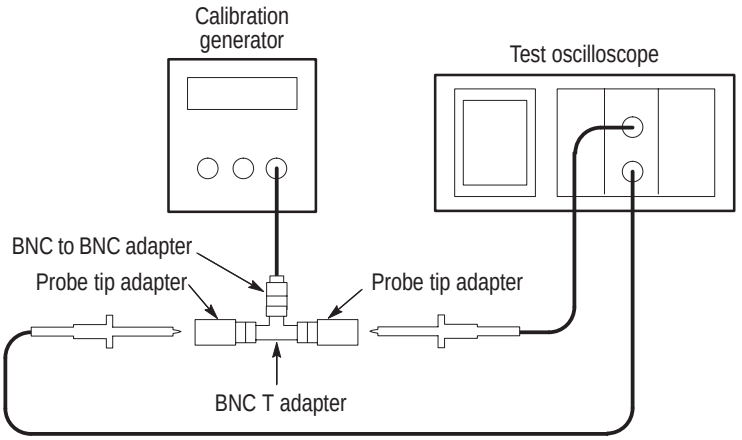


Figure 4–1: Setup for adjustment of DC attenuation

2. Set the test equipment controls as indicated in the tables below. Use the second column of values for 11000 Series oscilloscopes and the third column of values for 7000 Series oscilloscopes.

Differential comparator

Setting	11A33	7A13
Menu	WAVEFORM	—
+ Input	DC	DC
– Input	DC	DC
Offset	0 V	—
Volts/Div	10 mV	10 mV
Bandwidth	20 MHz	5 MHz
Position	Centered	Centered

Time base

Setting	11000 Series	7000 Series
Menu	TRIGGER	—
Coupling	AC	AC
Mode	AUTO LEVEL	P-P AUTO
Level	50%	—
Source	—	INT
Time/Div	500 µs	500 µs

Sine wave generator

Function	Setting
Mode	STANDARD AMPLITUDE
Amplitude	10 V

3. Center the waveform on the display.
4. Adjust DC ATTEN of the positive probe to balance out the square wave component. Disregard any remaining spikes at this time.

***NOTE**. When making CMRR adjustments, use the negative probe as the reference. Perform all adjustments to the positive probe; do not adjust the negative probe.*

Check and Adjust LF and HF Compensation

1. Connect both probe tips as shown in Figure 4–1. Substitute the leveled sine wave generator output for the calibration generator.
2. Set the test equipment controls as indicated in the tables below. Use the second column of values for 11000 Series oscilloscopes and the third column of values for 7000 Series oscilloscopes.

Differential comparator

Setting	11A33	7A13
Menu	WAVEFORM	—
+ Input	DC	DC
– Input	OFF	GND
Offset	0 V	—
Volts/Div	2 V	2 V

Differential comparator (Cont.)

Setting	11A33	7A13
Bandwidth	20 MHz	5 MHz
Position	Centered	Centered

Time base

Setting	11000 Series	7000 Series
Menu	TRIGGER	—
Coupling	AC	AC
Mode	AUTO LEVEL	P-P AUTO
Level	50%	—
Source	—	INT
Time/Div	20 µs	20 µs

Sine wave generator

Function	Setting
Frequency	50 kHz
Voltage (peak to peak)	5 V

3. Adjust the sine wave generator output to display a waveform five divisions in amplitude.

NOTE. *Since the sine wave generator is not terminated into 50 Ω, the output amplitude will be twice the front panel reading of the sine wave generator.*

4. Change the negative input to DC and the Volts/Div to 10 mV/div.
5. Center the waveform on the display.
6. Adjust the positive probe LF COMP to obtain a minimum display amplitude.
7. Change the sine wave generator frequency to 10 MHz and the oscilloscope Time/Div to 100 ns.
8. Change the oscilloscope settings as listed below.

Oscilloscope	11000 Series	7000 Series
Bandwidth	150 MHz	FULL bandwidth

9. Adjust HF ADJ 1 on the positive probe to obtain minimum display amplitude.
10. Change the sine wave generator frequency to 20 MHz and increase the oscilloscope Volts/Div setting as necessary to bring the waveform on screen.
11. Adjust HF ADJ 2 on the positive probe to obtain minimum display amplitude. See Table 4–2 for 11A33 and 7A13 CMRR verification points.
12. Repeat Steps 7 through 11 above two or three times to achieve optimum probe performance.

NOTE. *Some interaction exists between the LF, HF, and DC adjustments. Repeat the adjustment sequence (steps 6 through 12) two or three times to achieve optimum results. Use Table 4–2 for verification.*

Table 4–2: Verification points for CMRR (with 11A33 and 7A13)

Sine Wave Generator				
Frequency	50 kHz	1 MHz	10 MHz	20 MHz
Amplitude	10 V	10 V	10 V	10 V
Volts/Div (At Probe Tips)	10 mV	10 mV	10 mV	20 mV
Time/Div (Oscilloscope)	20 µs	1 µs	0.1 µs	0.05 µs
Amplitude (Display)	≤0.27 div	≤1 div	≤3.3 div	≤5 div
CMRR	3700:1	1000:1	300:1	100:1

System Calibration and Time Delay Error Compensation (11A33 only)

1. Connect a probe tip-to-BNC adapter to the calibrator output of the oscilloscope.
2. Connect either probe tip to the probe tip-to-BNC adapter.
3. Touch **PROBES** in the oscilloscope UTILITY menu.
4. Touch the menu that describes the channel to be calibrated and deskewed (compensated for time delay between channels, e.g., R1 for right, channel 1).
5. Touch **EXIT COMP** to complete the procedure.

The input channel is now vertically calibrated and deskewed (propagation delay balanced) against an internal reference signal. The P6135A probe is calibrated and ready for use in common-mode signal application measurements. See Figure 4–2 for an example CMRR display following calibration.

NOTE. *If the probes are interchanged on the inputs, moved to a different amplifier, or used with a different attenuator range than the one on which they were calibrated, they must be recalibrated for optimum CMRR.*

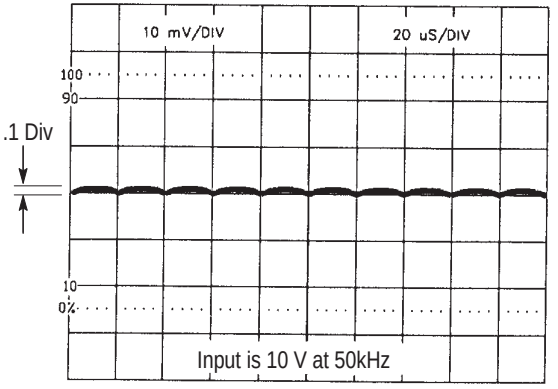


Figure 4–2: Typical CMRR display after calibration

Maintenance

Maintenance

This section contains information on preventive and corrective maintenance.

Preventive Maintenance

Preventive maintenance includes visually inspecting and cleaning the probes. Perform preventive maintenance on a regular basis to prevent instrument breakdown and improve reliability. The frequency of maintenance depends on environmental operating conditions. A good time to perform maintenance is just before a performance verification check or calibration.

CAUTION. *To prevent electric shock or component shorting, do not perform any maintenance with the probe connected to a signal or voltage source.*

Visual Inspection

Occasionally inspect the P6135A probe pair for broken connections, damaged parts, bent leads, or heat-damaged components.

Cleaning

To remove accumulated dirt from the probe exterior, use a soft cloth dampened with a mild detergent and water solution or isopropyl alcohol. Do not use abrasive cleaners.

CAUTION. *Avoid chemical cleaning agents that may damage the probe's circuit board or plastic components. In particular, avoid chemicals containing benzene, toluene, xylene, acetone, MEK, or similar solvents.*

Probe Tip Replacement

NOTE. *Both tips must be replaced at the same time.*

Use the following procedure to change the probe tips (refer to Figure 5–1).

1. Pull off the retractable hook tip.
2. Unscrew the tip cover.
3. Unscrew the installed tip.
4. Screw in the replacement tip.
5. If desired, screw on the tip cover and slide the retractable-hook tip back into place.

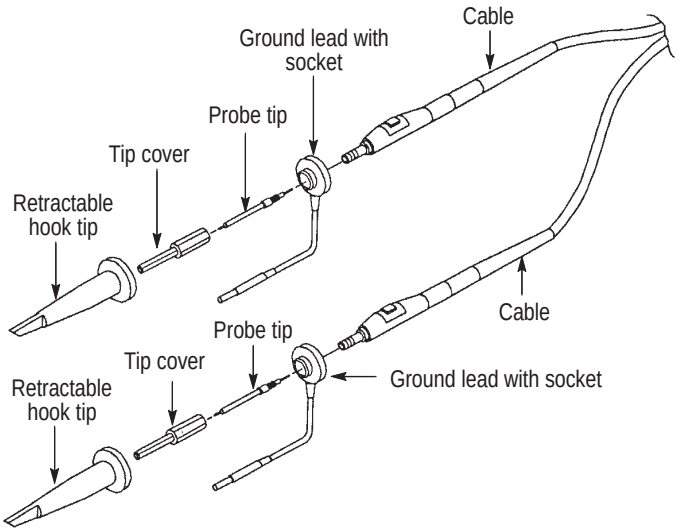


Figure 5–1: P6135A probe tip assembly

Readjustment After Repair

Following any repair or parts replacement, complete the performance verification procedure (beginning on page 4−1) to verify that the probe is within specification. If adjustment is necessary, follow the appropriate procedure.

Instrument Repackaging for Shipment

If available, use the original packaging carton to ship your probe. If the carton is unfit for use or not available, repackage the probe as follows:

1. Use a carton with a test strength of no less than 175 pounds.
2. Surround the probe with protective polyethylene sheeting.
3. Cushion the probe on all sides with at least two inches of tightly packed urethane foam or other packing material.
4. Seal the carton with shipping tape or an industrial stapler.

Replaceable Parts

Replaceable Parts

This section contains a list of the replaceable modules for the P6135A differential probe pair. Use this list to identify and order replacement parts.

Parts Ordering Information

Replacement parts are available through your local Tektronix field office or representative.

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

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

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

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

Module Servicing

Modules can be serviced by selecting one of the following three options. Contact your local Tektronix service center or representative for repair assistance.

Module Exchange. In some cases you may exchange your module for a remanufactured module. These modules cost significantly less than new modules and meet the same factory specifications. For more information about the module exchange program, call 1-800-TEK-WIDE, extension 6630.

Module Repair and Return. You may ship your module to us for repair, after which we will return it to you.

New Modules. You may purchase replacement modules in the same way as other replacement parts.

Using the Replaceable Parts List

This section contains a list of the mechanical and/or electrical components that are replaceable for the P6135A probe pair. Use this list to identify and order replacement parts. The following table describes each column in the parts list.

Parts list column descriptions

Column	Column name	Description
1	Figure & index number	Items in this section are referenced by figure and index numbers to the exploded view illustrations that follow.
2	Tektronix part number	Use this part number when ordering replacement parts from Tektronix.
3 and 4	Serial number	Column three indicates the serial number at which the part was first effective. Column four indicates the serial number at which the part was discontinued. No entry indicates the part is good for all serial numbers.
5	Qty	This indicates the quantity of parts used.
6	Name & description	An item name is separated from the description by a colon (:). Because of space limitations, an item name may sometimes appear as incomplete. Use the U.S. Federal Catalog handbook H6-1 for further item name identification.
7	Mfr. code	This indicates the code of the actual manufacturer of the part.
8	Mfr. part number	This indicates the actual manufacturer's or vendor's part number.

Abbreviations

Abbreviations conform to American National Standard ANSI Y1.1–1972.

Mfr. Code to Manufacturer Cross Index

The table titled Manufacturers Cross Index shows codes, names, and addresses of manufacturers or vendors of components listed in the parts list.

Manufacturers cross index

Mfr. code	Manufacturer	Address	City, state, zip code
24931	BERG ELECTRONICS INC	BERG ELECTRONICS RF/COAXIAL DIV 2100 EARLYWOOD DR PO BOX 547	FRANKLIN, IN 46131
7X318	KASO PLASTICS INC	11013 A NE 39TH	VANCOUVER, WA 98662
05006	20TH CENTURY BOK	3628 CRENSHAW BOULEVARD ATTN: CUSTOM DEPARTMENT	LOS ANGELES, CA 90016
80009	TEKTRONIX INC	14150 SW KARL BRAUN DR PO BOX 500	BEAVERTON, OR 97077–0001
TK2469	UNITREK CORPORATION	3000 LEWIS & CLARK HWY SUITE 2	VANCOUVER, WA 98661
TK2548	XEROX CORPORATION	14181 SW MILLIKAN WAY	BEAVERTON, OR 97005
TK2565	VISION PLASTICS INC	26000 SW PARKWAY CENTER DRIVE	WILSONVILLE, OR 97070

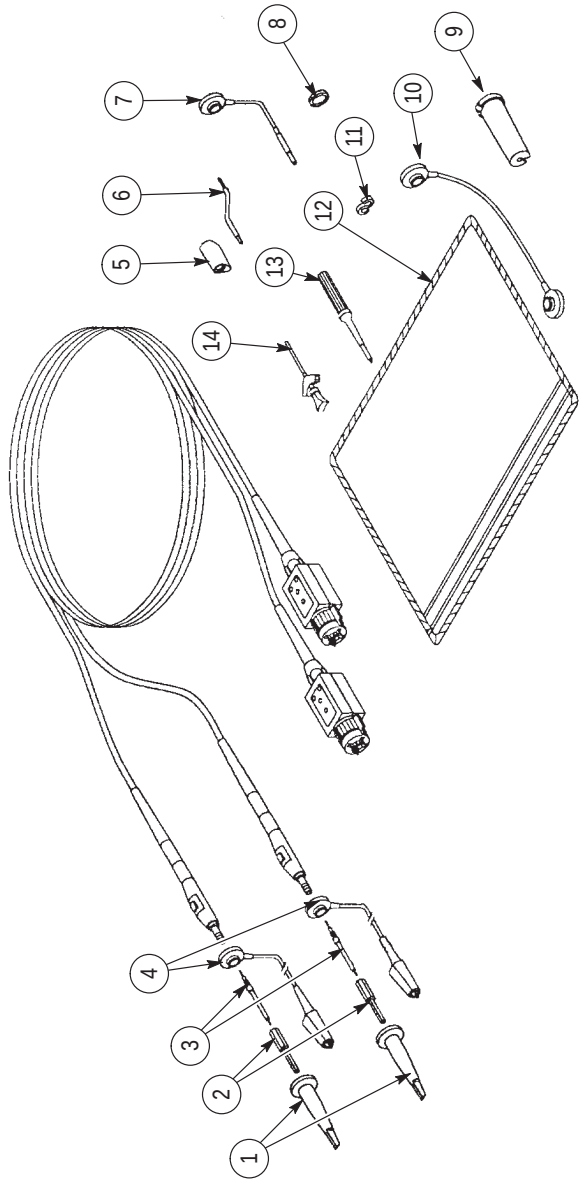


Figure 6–1: P6135A probe with standard accessories

Replaceable parts: P6135A probe and standard accessories

Fig. & index number	Tektronix part number	Serial no. effective	Serial no. discont'd	Qty	Name & description	Mfr. code	Mfr. part number
					P6135A		
6–1 –1	013–0107–06		9139	2	TIP,PROBE:MINIATURE/COMPACT SIZE,RETRACTABLE HOOK ASSY	80009	013–0107–06
	013–0107–07	9140		2	TIP,PROBE:MINIATURE/COMPACT SIZE	TK2565	013–0107–07
–2	204–1049–00			2	BODY SHELL:TIP COVER	TK2565	204–1049–00
–3	206–0415–00			1	TIP,PROBE:45–49PF,SET OF 2,BLUE/NATURAL	80009	206–0415–00
	206–0416–00			1	TIP,PROBE:13–17 PF,SET OF 2,RED/NATURAL	80009	206–0416–00
	206–0419–00			1	TIP,PROBE:18–22 PF,SET OF 2,BLACK/YELLOW	80009	206–0419–00
–4	196–3305–00			2	LEAD,ELECTRICAL:22 AWG,6.0 L,W/CLIP	TK2469	196–3305–00
					STANDARD ACCESSORIES		
–5	343–1003–00			2	COLLAR,GND:P6130	80009	343–1003–00
–6	195–4240–00			2	LEAD,ELECTRICAL:0.025 DIA,COPPER,2.3 L	TK2469	195–4240–00
–7	196–3113–02			2	LEAD,ELECTRICAL:STRD,22 AWG,6.0 L,8–N	TK2469	196–3113–02
–8	016–0633–00			1	MARKER SET,CA:2 EA VARIOUS COLORS	80009	016–0633–00
–9	352–0670–00			2	HOLDER,PROBE:ATTENUATOR TIPS (3)	TK2565	352–0670–00
–10	196–3295–00			1	LEAD,ELECTRICAL:22 AWG,6.0 L,8–N,W/DBL GRD COLLAR	TK2469	196–3295–00
–11	344–0408–02			1	CLIP,RING,CABLE:S CLIP,TENITE 4230A,POLYPROPYLENE BLACK,PKG OF 12	TK2565	344–0408–02

Replaceable parts: P6135A probe and standard accessories (Cont.)

Fig. & index number	Tektronix part number	Serial no. effective	Serial no. discont'd	Qty	Name & description	Mfr. code	Mfr. part number
6–1 –12	016–0708–00			1	POUCH,ACCESSORY:6.25 X 9.25	05006	501494
–13	003–1433–02			1	TOOL:SCREWDRIVER,ADJUSTMENT TOOL,PLASTIC,BLACK	TK1163	003–1433–02
–14	206–0364–00			2	TIP,PROBE:MICROCKT TEST,0.05 CTR	80009	206–0364–00
	070–7675–02			1	MANUAL,TECH:INSTR,P6135A,DP	TK2548	070–7675–02

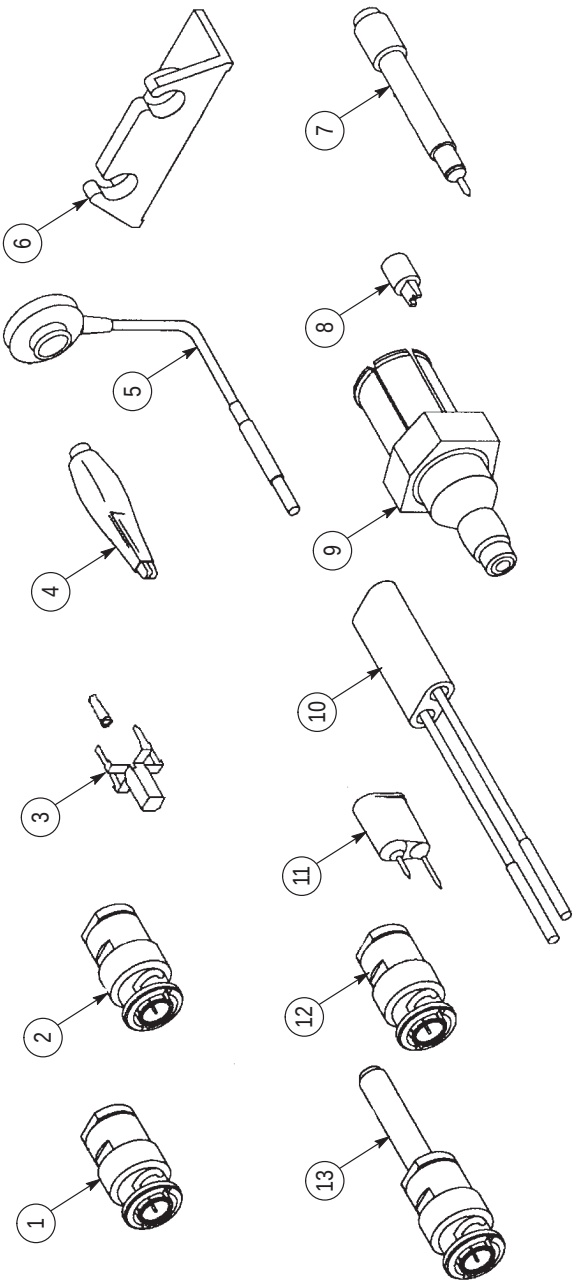


Figure 6–2: P6135A probe optional accessories

Replaceable parts: P6135A probe optional accessories

Fig. & index number	Tektronix part number	Serial no. effective	Serial no. discont'd	Qty	Name & description	Mfr. code	Mfr. part number
					OPTIONAL ACCESSORIES		
6–2 –1	013–0226–00			1	CONNECTOR,BNC:BNC TO PROBE TIP ADAPTER STRAIGHT THRU	24931	28P264–2
–2	013–0227–00			1	CONNECTOR,BNC:50 OHM,BNC TO PROBE TIP ADAPTER	24931	28P312–1
–3	131–5031–00			1	CONNECTOR,PROBE:PKG OF 25, COMPACT	80009	131–5031–00
–4	344–0398–00			1	CLIP,ELECTRICAL:ALLIGATOR,0.155 L,STL CS PL	80009	344–0398–00
–5	196–3113–03			1	LEAD,ELECTRICAL:STRD,22 AWG,3.0 L,8–N	TK2469	196–3113–03
–6	352–0351–00			1	HOLDER,PROBE:BLACK ABS P6000 SERIES	7X318	1127
	– – – – – – –			1	SMT KLIPCHIP:20 ADAPTERS (SEE FIGURE 6–1–14)		

Replaceable parts: P6135A probe optional accessories (Cont.)

Fig. & index number	Tektronix part number	Serial no. effective	Serial no. discont'd	Qty	Name & description	Mfr. code	Mfr. part number
6–2 –7	013–0202–02			1	ADAPTER,PROBE:SUBMINIATURE/COMPACT TO MINI	TK2565	013–0202–02
					NOTE: ITEMS 8 THROUGH 12 ARE USABLE WHEN THE SUBMINIATURE/COMPACT TO MINIATURE PROBE TIP ADAPTER (FIGURE 6–2–7) IS USED.		
–8	015–0201–07			1	TIP,PROBE:IC TEST,PKG OF 10	80009	015–0201–07
	015–0201–08			1	TIP,PROBE:IC TEST,PKG OF 100	80009	015–0201–08
–9	017–0088–00			1	CONN,PLUG,ELEC:50 OHM,GR	80009	017–0088–00
–10	015–0325–00			1	ADAPTER,PROBE:PROBE TO CONNECTOR PINS	TK2565	015–0325–00
–11	013–0085–00			1	TIP,PROBE:GROUNDING	80009	013–0085–00
–12	013–0084–01			1	ADAPTER,CONN:BNC TO PROBE	24931	28P156–1
–13	013–0254–00			1	ADAPTER,CONN:BNC TO PROBE TIP,MALE,STR,PROBE,2.14 L,INT 4.5 X 0.077 MM THD,COMPACT	24931	28P–302–2