

# TCPA300/400 Amplifiers & TCP300A/400 Series AC/DC Current Probes Service Manual



077-0323-01

**Tektronix**



# **TCPA300/400 Amplifiers & TCP300A/400 Series AC/DC Current Probes Service Manual**

This document applies for firmware version 1.0 and above.

## **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](http://www.tektronix.com)

077-0323-01

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- In North America, call 1-800-833-9200.
- Worldwide, visit [www.tektronix.com](http://www.tektronix.com) to find contacts in your area.

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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.*

While using this product, you may need to access other parts of a larger system. Read the safety sections of the other component manuals for warnings and cautions related to operating the system.

### To avoid fire or personal injury

**Use proper power cord.** Use only the power cord specified for this product and certified for the country of use.

**Use proper voltage setting.** Before applying power, ensure that the line selector is in the proper position for the source being used.

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

**Connect and disconnect properly.** De-energize the circuit under test before connecting or disconnecting the current probe.

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

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

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

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

The inputs are not rated for connection to mains or Category II, III, or IV circuits.

Connect the probe reference lead to earth ground only.

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

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

**Power disconnect.** The power switch disconnects the product from the power source. See instructions for the location. Do not block the power switch; it must remain accessible to the user at all times.

**Power disconnect.** The power cord disconnects the product from the power source. Do not block the power cord; it must remain accessible to the user at all times.

**Do not operate without covers.** Do not operate this product with covers or panels removed.

**Do not operate with suspected failures.** If you suspect that there is damage to this product, have it inspected by qualified service personnel.

**Avoid exposed circuitry.** Do not touch exposed connections and components when power is present.

**Use proper fuse.** Use only the fuse type and rating specified for this product.

**Wear eye protection.** Wear eye protection if exposure to high-intensity rays or laser radiation exists.

**Do not operate in wet/damp conditions.**

**Do not operate in an explosive atmosphere.**

**Keep product surfaces clean and dry.**

**Provide proper ventilation.** Refer to the manual's installation instructions for details on installing the product so it has proper ventilation.

**Terms in this manual** These terms may appear in this manual:



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



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

**Symbols and terms on the product**

These terms may appear on the product:

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

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



CAUTION  
Refer to Manual



Protective Ground  
(Earth) Terminal



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



WARNING  
Hot Surface

## Service safety summary

Only qualified personnel should perform service procedures. Read this *Service safety summary* and the *General safety summary* before performing any service procedures.

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

**Disconnect power.** To avoid electric shock, switch off the instrument power, then disconnect the power cord from the mains power.

**Use care when servicing with power on.** Dangerous voltages or currents may exist in this product. Disconnect power, remove battery (if applicable), and disconnect test leads before removing protective panels, soldering, or replacing components.

To avoid electric shock, do not touch exposed connections.

## Compliance Information

This section lists the EMC (electromagnetic compliance), safety, and environmental standards with which the instrument complies.

### EMC Compliance

#### EC Declaration of Conformity – EMC

Meets intent of Directive 2004/108/EC for Electromagnetic Compatibility. Compliance was demonstrated to the following specifications as listed in the Official Journal of the European Communities:

**EN 61326-1:2006, EN 61326-2-1:2006.** EMC requirements for electrical equipment for measurement, control, and laboratory use. <sup>1 2 3</sup>

- CISPR 11:2003. Radiated and conducted emissions, Group 1, Class A
- IEC 61000-4-2:2001. Electrostatic discharge immunity
- IEC 61000-4-3:2002. RF electromagnetic field immunity
- IEC 61000-4-4:2004. Electrical fast transient/burst immunity
- IEC 61000-4-5:2001. Power line surge immunity
- IEC 61000-4-6:2003. Conducted RF immunity
- IEC 61000-4-11:2004. Voltage dips and interruptions immunity <sup>4</sup>

**EN 61000-3-2:2006.** AC power line harmonic emissions

**EN 61000-3-3:1995.** Voltage changes, fluctuations, and flicker

#### European Contact.

Tektronix UK, Ltd.  
Western Peninsula  
Western Road  
Bracknell, RG12 1RF  
United Kingdom

<sup>1</sup> This product is intended for use in nonresidential areas only. Use in residential areas may cause electromagnetic interference.

<sup>2</sup> Emissions which exceed the levels required by this standard may occur when this equipment is connected to a test object.

<sup>3</sup> To ensure compliance with the EMC standards listed here, high quality shielded Interface Cables should be used.

<sup>4</sup> Performance Criterion C applied at the 70%/25 cycle Voltage-Dip and the 0%/250 cycle Voltage-Interruption test levels (IEC 61000-4-11).



**Australia / New Zealand  
Declaration of  
Conformity – EMC**

Complies with the EMC provision of the Radiocommunications Act per the following standard.

- CISPR 11:2003. Radiated and Conducted Emissions, Group 1, Class A, in accordance with EN 61326-1:2006 and EN 61326-2-1:2006.

**FCC – EMC**

Emissions are within the limits of FCC 47 CFR, Part 15, Subpart B for Class A equipment.

## Environmental Considerations

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

### Product End-of-Life Handling

Observe the following guidelines when recycling an instrument or component:

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



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

### Restriction of Hazardous Substances

This product is classified as an industrial monitoring and control instrument accessory, and is not required to comply with the substance restrictions of the recast RoHS Directive 2011/65/EU until July 22, 2017.

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# Preface

This Service Manual supports the basic maintenance of the TCPA300 and TCPA400 Current Probe Amplifiers, and the TCP300A/400 Series AC/DC current probes that mate with the amplifiers. The current probes covered in this manual are listed below:

- TCP312A (30 A, 100 MHz, compatible with TCPA300)
- TCP305A (50 A, 50 MHz, compatible with TCPA300)
- TCP303 (150 A, 15 MHz, compatible with TCPA300)
- TCP404XL (500 A\*, 2 MHz, compatible with TCPA400)  
\*750 A DC derated with duty cycle

If you are not familiar with these products, please refer to the *Getting Started* and *Operating Basics* chapters of the user manual (077-1183-xx) for basic operating information.

If you are an advanced user, the *Reference* section in the user manual contains information on advanced applications as well as user diagnostic and troubleshooting information.

The *Performance Verification* and *Adjustment Procedure* sections in this manual support the qualification and calibration of the probes when used with either amplifier.

The *Maintenance* in this manual section supports the routine maintenance and repair of mechanical parts associated with the amplifiers.

The *Glossary* and *Index* are provided as quick reference locators for important information.

## Manual Conventions

The term "amplifier" is used to refer to either the TCPA300 or TCPA400 when referring to common attributes. If a subject is unique to either amplifier, the amplifier will be referred to directly by model.

The terms "current probe" and "probe" are used to refer to any of the TCP300A/400 Series current probes when referring to common attributes. If a subject is unique to a particular probe, the probe will be referred to directly by model.



# Performance Verification Overview

The Performance Verification tests allow you to demonstrate that the Current Probe Amplifier and Current Probes meet their specified levels of performance. Since the TCPA300 and TCPA400 cannot operate without a current probe, a calibration adapter is used to verify the amplifier(s) separately. The TCPA Calibration Adapter is an optional accessory; see *Replaceable Parts* for part numbers. After you have verified the amplifier performance independent of the current probe(s), you can check the performance of current probes with confidence.

Tolerances that are specified in these procedures apply to the amplifiers and current probes and do not include test equipment error. The recommended calibration interval is one year.

## Performance Verification and Functional Checks

The warranted specifications for the amplifiers that are checked in the performance verification procedures are listed as shown. Warranted values are available. Functional checks are included for you to verify proper amplifier operation.

**Table 1: Amplifier checks**

Amplifier	Performance verification			Functional checks		
	DC gain accuracy	Bandwidth	Front-panel	AC coupling	Degauss	Overload <sup>1</sup>
TCPA300	✓	✓	✓	✓	✓	✓
TCPA400	✓	✓	✓	✓	✓	

<sup>1</sup> With probe attached

The warranted specifications for the probes that are checked in the performance verification procedures are listed as shown. (See Table 2.)

**Table 2: Probe performance verification checks**

Probe	DC gain accuracy	Bandwidth	Risetime
TCP312A	✓	✓	✓
TCP305A	✓	✓	✓
TCP303	✓	✓	✓
TCP404XL	✓		✓

## Test Procedure Conditions

These procedures are valid only under the following conditions:

- The system has been calibrated at an ambient temperature of  $23^{\circ} \pm 5^{\circ}\text{C}$ .
- The system is operating in an environment whose limits are described in the *Specifications* section.
- The system, including probe, has had a warm-up period of at least 20 minutes.
- The probe degauss/autobalance routine has been performed after the 20-minute warm-up period.

## Equipment Preparation

Before performing the verification tests, turn all equipment on and allow the entire system to warm up for a minimum of 20 minutes.

---

**NOTE.** *Before performing any verification procedure, properly degauss the probe. Remove the probe from any current-carrying conductor; lock the probe, and press the amplifier PROBE DEGAUSS AUTOBALANCE button. The degauss/autobalance routine is complete when the indicator light turns green.*

*The amplifier front panel will light the NOT TERMINATED INTO 50  $\Omega$  LED during the degauss/ autobalance routine if the amplifier is not properly terminated into 50  $\Omega$ . Verify that the oscilloscope input is 50  $\Omega$  and set to DC coupling. Use a 50  $\Omega$  feedthrough termination, attached at the oscilloscope input, if necessary.*

---

# TCPA300 and TCPA400 Performance Verification

This section covers the performance verification for the TCPA300 and TCPA400 Current Probe Amplifiers. All of the procedures cover both amplifiers, except the Current Overload test, which is for the TCPA300 only. Power on the amplifier and test equipment and let them warm up for 20 minutes.

Before starting these procedures, photocopy the appropriate test record to record the performance test results. The recommended calibration interval is one year. (See page 16, *TCPA300 Amplifier Test Record*.)

## Equipment Required

The performance verification procedures require the listed test equipment. The test equipment must meet or exceed the specifications listed. You may need to modify the test procedures if you do not use the recommended equipment.

**Table 3: Required test equipment**

Item	Description	Recommended
Oscilloscope	500 MHz bandwidth	Tektronix TDS5000
Leveled Sine Wave Generator	3 MHz to 100 MHz	Wavetek 9100 with >250 MHz Oscilloscope Calibration Option
Digital Multimeter	DCV: 0.1% Accuracy, 5½ digit resolution	Keithley 2700 or Tektronix DMM4050
Current Source	DCA: 0.1% Accuracy, 0 to ±100 mA, floating outputs	Fluke 5100 or HP 6612C
Current Source	DCA: 0.1% accuracy, 0 to ±15 A	Wavetek 9100
Square Wave Generator	ACV 1.5 Vp-p, 28 Hz square wave	Wavetek 9100
HF Current Loop	50 Ω, BNC Connector	Tektronix part number 015-0601-50
Precision Termination	50 Ω ±0.1%, 0.5 W	Tektronix part number 011-0129-00
BNC Cables (2)	50 Ω, 0.76 m (30 in) long	Tektronix part number 012-0117-00
Cable	TEKPROBE Interface Cable	Tektronix part number 012-1605-00
Adapter (2)	BNC-to-Dual Banana	Tektronix part number 103-0090-00
DC Current Loop	5 turns 18 AWG coated wire	(See page 4, <i>Making DC Current Loops</i> .)
DC Current Loop	50 turns 13 AWG coated wire	(See page 4, <i>Making DC Current Loops</i> .)
Calibration Adapter	TCPA Calibration Adapter	Tektronix part number 174-4765-00
Current Probe <sup>1</sup>	TCPA300/400-compatible probe	Tektronix TCP303, 305/305A, or 312/312A (TCPA300) or TCP404XL (TCPA400)

<sup>1</sup> Required for functional test only.

## Making DC Current Loops

You need to construct simple current loops to complete some tests for the amplifiers. The current loops are also used in the DC gain accuracy tests for the probes.

- 5-Turn DC Current Loop** Construct the loop using a cylindrical form approximately 3 inches in diameter:
1. Wind *exactly* 5 turns of #18 coated wire around the form.
  2. Scrape about a half-inch of coating off of the ends of the wire.

---

**NOTE.** *Ensure that the current loop has exactly 5 turns. A significant error will result for each turn variance from 5 turns.*

---

The 5-turn DC current loop is also used in the current probe performance verification and adjustment procedures.

- 50-Turn DC Current Loop** Construct the loop using a cylindrical form approximately 3 inches in diameter:
1. Wind *exactly* 50 turns of #13 coated wire around the form.
  2. Scrape about a half-inch of coating off of the ends of the wire.

---

**NOTE.** *Ensure that the current loop has exactly 50 turns. A significant error will result for each turn variance from 50 turns.*

---

The 50-turn DC current loop is also used in the current probe performance verification procedures.



## Front-Panel Display

The status and error LEDs on the front panel are illuminated briefly during the amplifier power-on sequence. Verify that all LEDs are functional by doing the following procedure:

1. Power-cycle the amplifier and check that the LEDs light briefly. Note that the PROBE DEGAUSS AUTOBALANCE and OVERLOAD LEDs are multi-color:
  - a. The PROBE DEGAUSS AUTOBALANCE LED lights in an orange →red →green sequence.
  - b. The OVERLOAD LED lights in an orange →red →green sequence.
  - c. The MANUAL BALANCE LED is orange, and lights briefly.
  - d. The RANGE and COUPLING LEDs are green, and light briefly.
2. Record the results (pass/fail) on the test record.

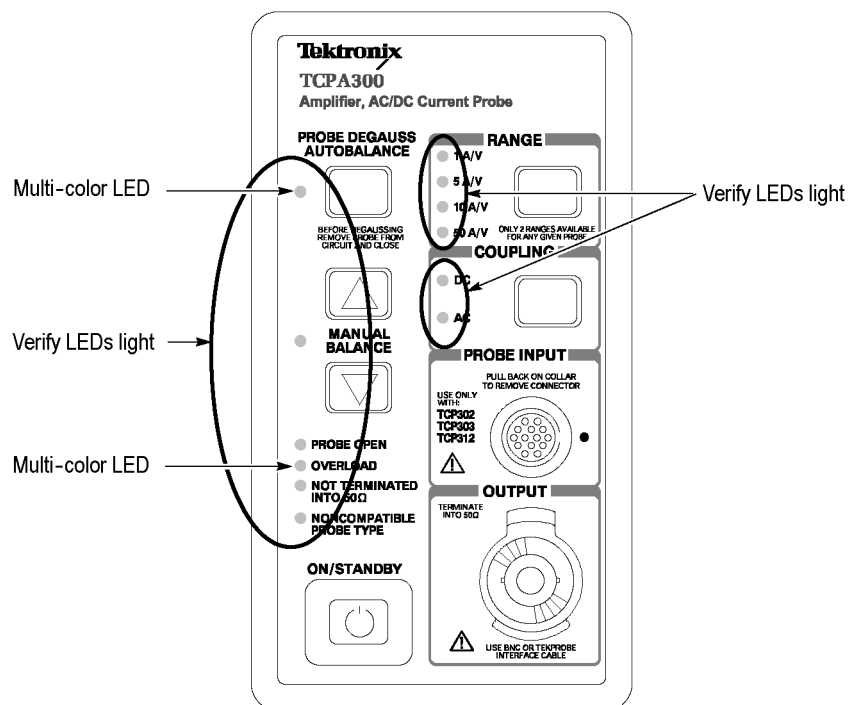


Figure 1: Check LED functionality

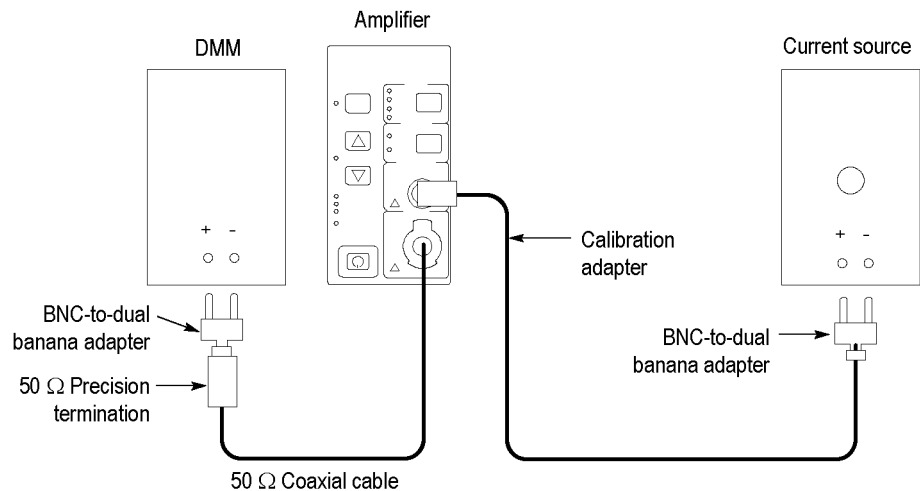
## DC Gain Accuracy

Use the following procedure to verify the DC gain accuracy of the amplifier.

### Test Equipment Setup

Set up the test equipment as follows:

1. Connect the output of the amplifier to the DMM:
  - a. Connect a BNC cable from the amplifier OUTPUT to the 50  $\Omega$  precision feedthrough termination.
  - b. Attach the termination to a BNC-to-dual banana adapter.
  - c. Observe polarity and insert the dual banana adapter into the digital multimeter DC voltage input.
2. Connect the probe input to the current source:
  - a. Connect the BNC end of the Calibration Adapter to a BNC-to-dual banana adapter.
  - b. Observe polarity and insert the dual banana adapter into the current source DC output. Do not connect the Calibration Adapter to the amplifier at this time.



**Figure 2: Equipment setup for DC gain accuracy test**

3. Make or verify the equipment settings as shown:

**Table 4: Equipment settings**

<b>Digital multimeter</b>	
Measurement Type	DC volts
Range	Autoranging
<b>Current source</b>	
Voltage	6 V
Current	100 mA
Output	Off
<b>TCPA300 and T CPA400 amplifier</b>	
Coupling	DC

**Procedure** After the equipment is set up, proceed as follows:

4. Connect the Calibration Adapter to the PROBE INPUT of the amplifier.
5. Perform the following steps for each of the Range settings: (See Table 5.)
  - a. If you are checking a T CPA300, set the amplifier to the desired Range setting. (See Table 5.)
  - b. Enable the output of the current source.
  - c. Record the exact measurement of the digital multimeter as  $M_1$ .

**Table 5: DC gain accuracy test for the T CPA300 and T CPA400**

Amplifier	Range, A/V	Current source output	Expected output, $V_E$ (VDC)	Measured output, $M_1$ (VDC)	% Error, calculated
TCPA300	1	100 mA	5.0000		
	5	100 mA	2.5000		
	10	100 mA	1.2375		
	50	100 mA	0.4835		
	50 (COMP) <sup>1</sup>	100 mA	0.4585		
TCPA400	1 A/mV	100 mA	2.5000		

<sup>1</sup> Both 10 A/V and 50 A/V RANGE LEDs light.

- d. Calculate the %Error between the measured output,  $M_1$ , and the expected output ( $V_E$ ) %Error as follows:

$$\%Error = \frac{M_1 - V_E}{V_E} \times 100$$

For example, using an expected output  $V_E$  of 2.5000 V and a measured output  $M_I$  of 2.510, the *%Error* would be:

$$\%Error = \frac{2.5100 - 2.5000}{2.5000} \times 100 = +0.4\%$$

---

**NOTE.** *It is important that the correct polarity be used to calculate the % Error.*

---

6. Verify that the measured DC gain accuracy is within the limits specified for all settings in the test record for the TCPA300. (See page 16, *TCPA300 Amplifier Test Record*.) The TCPA400 test record is available. (See page 17, *TCPA400 Amplifier Test Record*.) Record the *%Error* in the test record.

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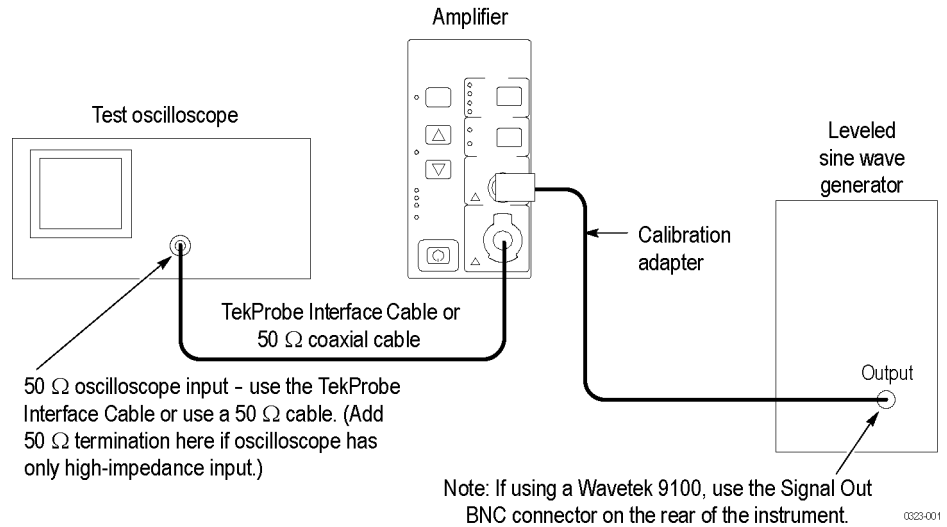
**NOTE.** *If the %Error on any of the settings is greater than the specified limit, you must perform the adjustment procedure. (See page 56, DC Gain Adjustment.)*

---

7. Disconnect the DMM cable from the amplifier and the calibration adapter from the current source.

## Bandwidth

This procedure tests the bandwidth of the T CPA300 and T CPA400 amplifiers. In this test you measure a signal at a relatively low frequency and again at the upper test frequency. The two measurements are compared to verify that the signal amplitude does not fall below a certain limit. Use the equipment connections shown.



**Figure 3: Bandwidth test setup**

1. If you are using a Tektronix oscilloscope that supports the TekProbe Level 2 Interface, use the TekProbe Interface Cable to connect the amplifier OUTPUT to the oscilloscope input. If you are not using a Tektronix oscilloscope that supports the TekProbe Level 2 Interface, use a 50 Ω BNC cable. If the input impedance of your oscilloscope is 1 M Ω, connect a 50 Ω feedthrough termination at the oscilloscope input. Do not connect the termination at the amplifier output.
2. Connect the Calibration Adapter to the amplifier PROBE INPUT.
3. Make or verify the equipment settings: (See Table 6.)

**Table 6: Equipment settings for bandwidth check**

Oscilloscope			
Vertical input impedance			50 Ω
Time base	T CPA300		40 ns/division
	T CPA400		80 ns/division
Record length			500
Coupling			DC
Offset			0 V (mid-scale)
Trigger type			Edge

**Table 6: Equipment settings for bandwidth check (cont.)**

Trigger mode	Auto	
Trigger position	50%	
Acquisition mode	Average	
Number of waveforms to average	16	
Measurement type	Peak-to-Peak	
<b>Leveled sine wave generator</b>		
Frequency	3 MHz	
Amplitude	TCPA300	~3.0 V <sub>p-p</sub>
	TCPA400	1.0 V <sub>p-p</sub>
<b>TCPA300 and T CPA400</b>		
	Coupling	DC

4. Connect the Calibration Adapter to the output of the leveled sine wave generator.
5. Enable the output of the leveled sinewave generator.
6. Verify the amplifier output is what is listed for the T CPA300 amplifier.  
(See Table 7 on page 11.) The T CPA400 amplifier output is also listed. (See Table 8 on page 11.)
7. Using the peak-peak measurement capability of the oscilloscope, measure and record the peak-peak reading as  $M_I$ . (See Table 7 on page 11.) (See Table 8 on page 11.)
8. If you are checking a T CPA300 perform the following steps. Each range setting and bandwidth filter is available. (See Table 8 on page 11.)  
The range setting and bandwidth filter is listed for the T CPA400. (See Table 7 on page 11.)
  - a. Set the oscilloscope time base to 4 or 5 ns/division. Increase the signal generator frequency to 50 or 100 MHz, depending on the range setting and bandwidth.
  - b. When you check the 100 MHz frequency, press either MANUAL BALANCE button until the orange MANUAL BALANCE LED lights. This engages a higher-frequency filter in the amplifier. After you check

the bandwidth at 100 MHz, press either MANUAL BALANCE button again to turn off the filter (the LED goes off.)

- c. Using the peak-peak measurement capability of the oscilloscope, measure and record the peak-peak reading as  $M_2$ . (See Table 7 on page 11.) (See Table 8 on page 11.)
9. The system meets the bandwidth specification if the ratio of the signal amplitude at the warranted bandwidth is at least 70% of the signal amplitude at 3 MHz. Using the following calculation, verify system bandwidth:

$$\text{Correction factor} = \frac{M_2}{M_1} > 0.707$$

10. Verify that the calculated system bandwidth is within the limits specified for all settings in the test record. (See page 16, *TCPA300 Amplifier Test Record*.) (See page 17, *TCPA400 Amplifier Test Record*.) Record the calculated system bandwidth in the test record.

**Table 7: TCPA300 bandwidth measurements**

Range	TEKPROBE Interface Cable		Coaxial cable		Bandwidth filter and generator frequency	Correction factor <sup>1</sup>	M1	M2
	Vertical gain setting	Amplifier output, p-p	Vertical gain setting	Amplifier output, p-p				
1 A/V	500 mA/div	~3 A	500 mV/div	~3 V	50 MHz	1.09		
	500 mA/div	~3 A	500 mV/div	~3 V	100 MHz	1.14		
5 A/V	1 A/div	~7.5 A	200 mV/div	~1.5 V	50 MHz	1.16		
10 A/V	1 A/div	~7.5 A	100 mV/div	~0.75 V	50 MHz	1.11		
50 A/V	2 A/div	~15 A	50 mV/div	~300 mV	50 MHz	1.14		
50 A/V COMP <sup>2</sup>	2 A/div	~15 A	50 mV/div	~300 mV	50 MHz	1.00		

<sup>1</sup> The correction factor accounts for impedance differences between the 50 Ω voltage source and the TCPA amplifier at higher frequencies.

<sup>2</sup> Both 10 A/V and 50 A/V RANGE LEDs light.

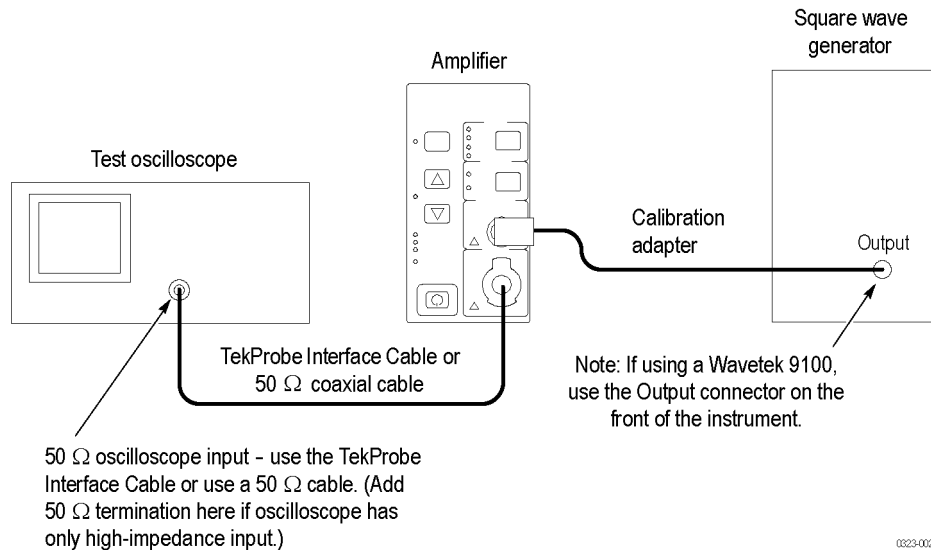
Use the table below to record the measurements for the TCPA400 Amplifier. (See Table 8.)

**Table 8: TCPA400 bandwidth measurements**

Range	TEKPROBE Interface Cable		Coaxial cable		Bandwidth filter and generator frequency	Correction factor	M1	M2
	Vertical gain setting	Amplifier output, p-p	Vertical gain setting	Amplifier output, p-p				
1 A/mV	100 A/div	~500 A	100 mV/div	~500 mV	50 MHz	1.09		

## AC Coupling

The following test checks that the AC coupling circuit of the amplifier functions properly. First, you measure a square-wave signal in DC coupling mode and record the value, and then switch to AC coupling and measure the signal amplitude.



**Figure 4: AC coupling test setup**

To perform the check, do the following:

1. Connect the circuit as shown.
2. Set the amplifier COUPLING to DC.
3. If you are checking a TCPA300, set the RANGE to 1 A/V.
4. Set the generator to output a 28 Hz square wave.
5. Set the oscilloscope horizontal scale to 4 or 5 ms/div.
6. More equipment settings are available. (See Table 9 on page 13.)
7. Measure the signal on the oscilloscope and verify that it is 1Vp-p. If necessary, adjust the generator output to achieve 1Vp-p.
8. Set the amplifier COUPLING to AC.
9. Measure the signal on the oscilloscope and verify that the signal is within the limits on the test record.



Table 9: TPCA300 and TPCA400 AC coupling measurements

Amplifier	TEKPROBE Interface Cable					BNC coaxial cable			
	Square wave generator amplitude	Vertical gain setting	DC coupled amplifier output	Minimum AC coupled amplifier output	Maximum AC coupled amplifier output	Vertical gain setting	DC coupled amplifier output	Minimum AC coupled amplifier output	Maximum AC coupled amplifier output
TCPA300	0.5 Vp	200 mA/div	1.00 Ap-p	1.05 Ap-p	1.50 Ap-p	200 mV/div	1.00 Vp-p	1.05 Vp-p	1.50 Vp-p
TCPA400	0.5 Vp	200 A/div	1000 Ap-p	1050 Ap-p	1500 Ap-p	200 mV/div	1.00 Vp-p	1.05 Vp-p	1.50 Vp-p

10. Disconnect the Calibration Adapter from the amplifier.

## Degauss

This is a functional test of the degauss operation. (See Figure 5.)

1. Connect a current probe to the output of the amplifier. Do not clamp the current probe around any conductor, but make sure the jaws are locked shut.
2. Press the amplifier PROBE DEGAUSS AUTOBALANCE button. When the indicator turns green, the degauss operation has successfully completed.
3. Verify that there are no error codes. Error codes display on the Probe Status LEDs when the AC and DC COUPLING LEDs alternately flash.
4. Record the results (pass/fail) on the test record.

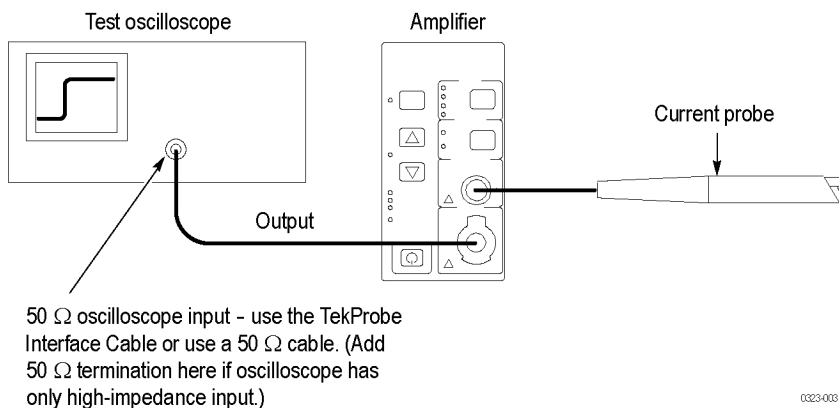
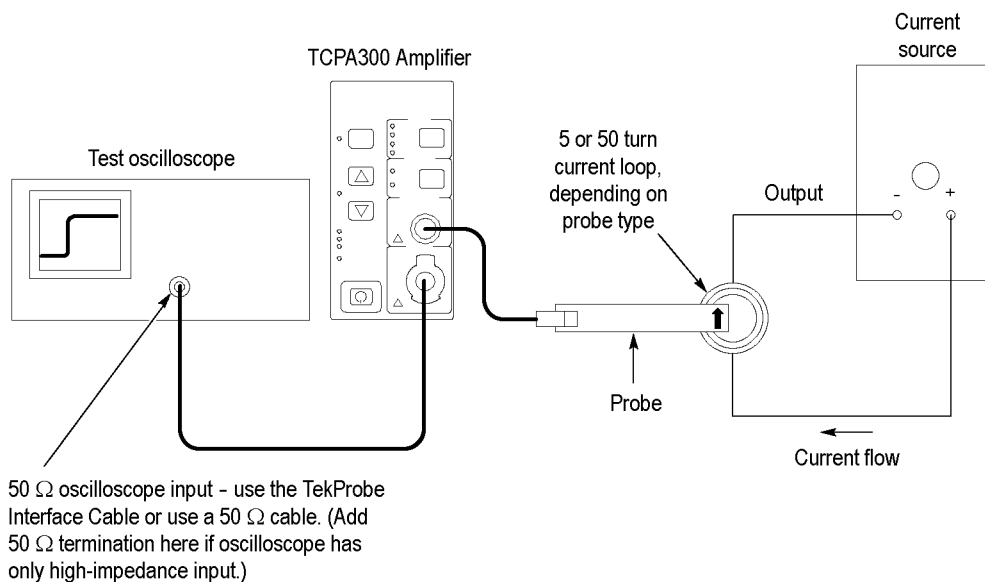


Figure 5: Setup for degaussing the current probe

## Current Overload Test (TCPA300 Only)

This test checks the functionality of the TCPA300 current overload detection circuit using the setup shown. You set the current source to output the maximum rated current for the probe/amplifier you are testing, and then increase the current source to a level that engages the overload circuit (the OVERLOAD LED is on). Then, you repeat the test at the opposite polarity.

This test uses current loops that you make using wire and 3-inch forms. Instructions on making current loops are available. (See page 4, *Making DC Current Loops*.)



**Figure 6: Overload test setup**

1. Connect the circuit as shown. (See Figure 6.) The correct current loop to use for the probe you are testing is available. (See Table 10 on page 15.)
2. Set the RANGE on the amplifier to the highest setting for the probe that is connected to the amplifier.
3. Adjust the current source output to the value for the probe you are testing. (See Table 10 on page 15.) For example, if you are testing a TCP305A, adjust the output to 10 A.
4. Check that the OVERLOAD LED is off.

**Table 10: Maximum current ratings for T CPA300-compatible probes**

Probe model	Range	Maximum current rating, Amps	Current loop used for test <sup>1</sup>	Current source output, Amps
TCP312/312A	10 A/V	±30	5 T	±6
TCP305/305A	10 A/V	±50	5 T	±10
TCP303	50 A/V	±212 <sup>2</sup>	50 T	±4.24

<sup>1</sup> (See page 4, *Making DC Current Loops*.)

<sup>2</sup> The TCP303 is a 150 A RMS probe with a peak current of 212 A. Apply current for only a short amount of time.

5. Slowly increase the output of the current source until the OVERLOAD LED on the amplifier is on.



**WARNING.** *Do not leave the current turned up longer than necessary - damage to the equipment or personal injury may result.*

6. Decrease the output of the current source to zero.
7. Record the results (pass/fail) on the test record.
8. Repeat steps 3 through 7 for the opposite polarity.

This completes the performance verification for the amplifiers.

If the T CPA300 or T CPA400 amplifier fails any of the verification tests, refer to the *Adjustments* section for servicing information.

## TCPA300 Amplifier Test Record

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

### TCPA300 test record

Instrument Serial Number:	Certificate Number:
Temperature:	Relative Humidity %:
Date of Calibration:	Technician:

Performance test		Range, A/V	Minimum	Measured/calculated	Maximum
Front-Panel Display			Pass/Fail		
DC Gain Accuracy (% Error)		1	-1%		+1%
		5	-1%		+1%
		10	-1%		+1%
		50	-1%		+1%
		50 (COMP)	-1%		+1%
Bandwidth		1	.707		—
		1 (100 MHz)	.707		—
		5	.707		—
		10	.707		—
		50	.707		—
		50 (COMP)	.707		—
AC Coupling <sup>1</sup>	TEKPROBE Cable	1	1.05 Ap-p		1.5 Ap-p
	BNC Coax Cable	1	1.05 Vp-p		1.5 Vp-p
Degauss			Pass/Fail		
Current Overload			Pass/Fail		

<sup>1</sup> The AC Coupling test can be performed with either cable, but the units of measure for the results differ between the two.

## TCPA400 Amplifier Test Record

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

### TCPA400 test record

Instrument Serial Number:	Certificate Number:
Temperature:	Relative Humidity %:
Date of Calibration:	Technician:

Performance test		Minimum	Measured/calculated	Maximum
Front-Panel Display		Pass/Fail		
DC Gain Accuracy (% Error)		-1%		+1%
Bandwidth		.707		—
AC Coupling <sup>1</sup>	TEKPROBE Cable	1050 Ap-p		1500 Ap-p
	BNC Coax Cable	1.05 Vp-p		1.5 Vp-p
Degauss		Pass/Fail		

<sup>1</sup> The AC Coupling test can be performed with either cable, but the units of measure for the results differ between the two.

## TCP305A and TCP312A Probes Performance Verification

The test procedures in this section verify warranted specifications and proper performance of the TCP305A and TCP312A current probes, using the TCPA300 Amplifier. Tolerances that are specified in these procedures apply to the amplifier and current probe and do not include test equipment error.

Before starting these procedures, photocopy the appropriate test record to record the performance test results. (See page 28, *TCP305A Current Probe Test Record*.) (See page 29, *TCP312A Current Probe Test Record*.) The recommended calibration interval is one year.

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**NOTE.** *If the amplifier is not properly terminated into 50  $\Omega$ , the NOT TERMINATED INTO 50  $\Omega$  status LED is on. Verify that the 50  $\Omega$  termination is connected at the DMM input when performing the following procedures.*

---

No probe or amplifier adjustments are required during these test procedures. If any tests fail, information is available. (See page 48, *TCP305A and TCP312A Probe DC Gain Adjustment*.)



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**WARNING.** *Magnetic fields are produced in these procedures that may cause a malfunction in heart pacemakers or damage to sensitive equipment.*

---

## Required Test Equipment

To perform the acceptance tests in this section, you will need the test equipment listed. The test equipment must meet or exceed the specifications listed. The test procedures may need to be modified if the recommended equipment is not used.

**Table 11: Required test equipment**

Item	Description	Recommended
Oscilloscope	500 MHz bandwidth	Tektronix TDS5000
Current Probe Amplifier		Tektronix TCPA300
Leveled Sine Wave Generator	3 MHz to 100 MHz	Fluke 9100 with Option 250
High Amplitude Pulse Generator	Rise time <1 ns, pulse width >100 ns amplitude >5 V <sub>p-p</sub> into 50 Ω	Picosecond Labs 2600
Digital Multimeter	DCV: 0.1% accuracy 5 <sup>1</sup> / <sub>2</sub> digit resolution	Keithley 2700 or Tektronix DMM4050
Current Source	DCA: 0.1% accuracy, 0 to ±10 A	Fluke 9100
HF Current Loop	50 Ω , BNC Connector	Tektronix part number 067-2396-00
DC Current Loop	5 turns 18 AWG coated wire	(See page 4, <i>Making DC Current Loops.</i> )
Precision Termination	50 Ω ±0.1%, 0.5 W	Tektronix part number 011-0129-00
BNC Cable	50 Ω, 0.76 m (30 in) long	Tektronix part number 012-0117-00
Cable	TEKPROBE Interface Cable	Tektronix part number 012-1605-00
Adapter	BNC-to-Dual Banana	Tektronix part number 103-0090-00
Adapter	BNC-female-to-BNC female barrel	Tektronix part number 103-0028-00

## DC Gain Accuracy

This procedure tests the DC gain accuracy of the TCP305A and TCP312A Current Probes. In this test you compare the voltage output of the amplifier to a reference input.

This test uses current loops that you make using wire and 3-inch forms. Instructions on making the current loops are available. (See page 4, *Making DC Current Loops*.)

### Equipment Connections

Using a BNC cable, connect the amplifier OUTPUT to the 50  $\Omega$  feedthrough termination. Attach the termination to a BNC-to-dual banana adapter. Insert the dual-banana adapter into the digital multimeter DC voltage input, taking care to maintain polarity.

1. Connect the current loop to the current source as shown.
2. Connect the current probe to the PROBE INPUT connector. Do not connect the probe to the current loop at this time.

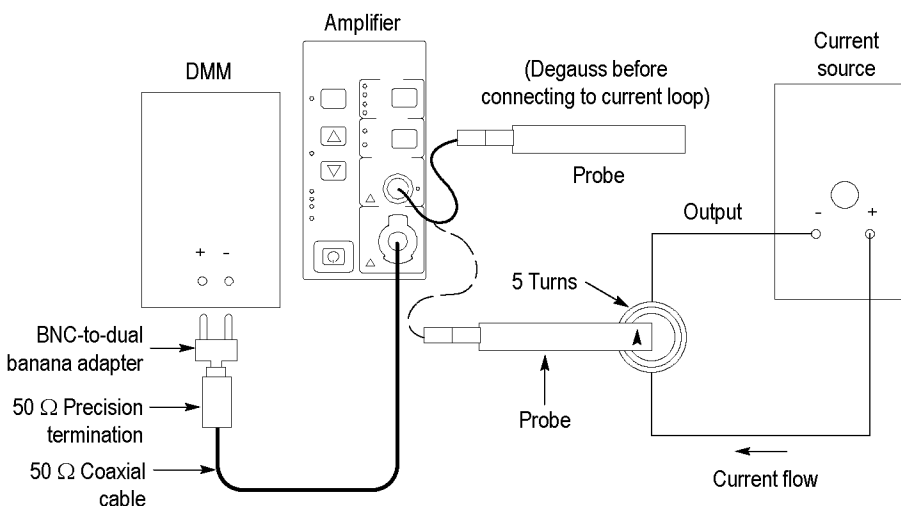


Figure 7: DC gain accuracy test setup for TCP305A and TCP312A



**Equipment Settings** Make or verify the equipment settings in the table below: (See Table 12.)

**Table 12: Equipment settings for DC gain accuracy**

<b>Digital multimeter</b>	
Measurement Type	DC volts
Range	Autoranging
<b>Current source</b>	
Amplitude	DC A
Output	Off
<b>TCPA300</b>	
Coupling	DC

- Procedure**
- Do not clamp the current probe around any conductor, but make sure the jaws are locked shut.
  - Press the amplifier PROBE DEGAUSS AUTOBALANCE button. Wait for the degauss/autobalance routine to complete before proceeding. The routine is complete when the indicator light turns green.
  - Clamp the current probe around the 5 turn current loop, as shown. (See Figure 7 on page 20.)  
Observe and maintain proper polarity; the arrow-shaped indicator on the probe points away from the (+) terminal of the current source.
  - Perform the following steps for each of the amplifier range settings. (See Table 13 on page 22.)
    - Set the amplifier range to the first setting for the probe you are testing. (See Table 13 on page 22.)  
For example, if you are testing a TCP305A, set the range to 5A/V.
    - Set the current source output to the first positive (+) setting for the probe you are testing. (See Table 13 on page 22.) For example, if you are testing a TCP305A, set the output to +1.00 A. (Each output level is tested at both polarities; later in the procedure, you will set the output to -1.00A.)
    - Enable the output of the current source.
    - Record the exact measurement of the digital multimeter as M1.
    - Set the current source output to the first negative (-) setting for the probe you are testing.  
(See Table 13 on page 22.) For example, if you are testing a TCP305A, set the output to -1.00 A.
    - Record the exact measurement of the digital multimeter as M2.

**Table 13: DC gain accuracy test for the TCP305A and TCP312A**

Probe	Range	Current source output (ADC)	Expected output, $V_E$ (VAC)	M1 (VDC)	M2 (VDC)	M1-M2 (VDC)	%Error, calculated
TCP305A	5 A/V	$\pm 1.00$ A	$\pm 1.00$ V				
		$\pm 3.00$ A	$\pm 3.00$ V				
		$\pm 5.00$ A	$\pm 5.00$ V				
	10 A/V	$\pm 2.00$ A	$\pm 1.00$ V				
		$\pm 6.00$ A	$\pm 3.00$ V				
		$\pm 10.00$ A	$\pm 5.00$ V				
TCP312A	1 A/V	$\pm 0.20$ A	$\pm 1.00$ V				
		$\pm 0.60$ A	$\pm 3.00$ V				
		$\pm 1.00$ A	$\pm 5.00$ V				
	10 A/V	$\pm 1.20$ A	$\pm 0.60$ V				
		$\pm 3.60$ A	$\pm 1.80$ V				
		$\pm 6.00$ A	$\pm 3.00$ V				

- g.** Verify that the measured output (M1-M2) is within the warranted specification listed, by computing %Error as follows:

$$\%Error = \frac{(M_1 - M_2) - 2 (V_E)}{2 (V_E)} \times 100$$

For example, you may measure values of 0.990 V for M1 and -0.998 V for M2. With an expected  $V_E$  of 1.0 V, you compute the %Error as follows:

$$\%Error = \frac{(0.990 V - (-0.998 V)) - 2 (1 V)}{2 (1 V)} \times 100$$

$$\frac{((1.988 V) - 2 V)}{2 V} \times 100 = -0.6\%$$

- 5.** Record the results on the test record.
- 6.** Disconnect the DMM cable from the amplifier and the probe from the 5T coil.

## Rise Time

This procedure measures the rise time of the TCP305A and TCP312A Current Probes. In this test you directly measure the rise time of a step input. Setup equipment connections.

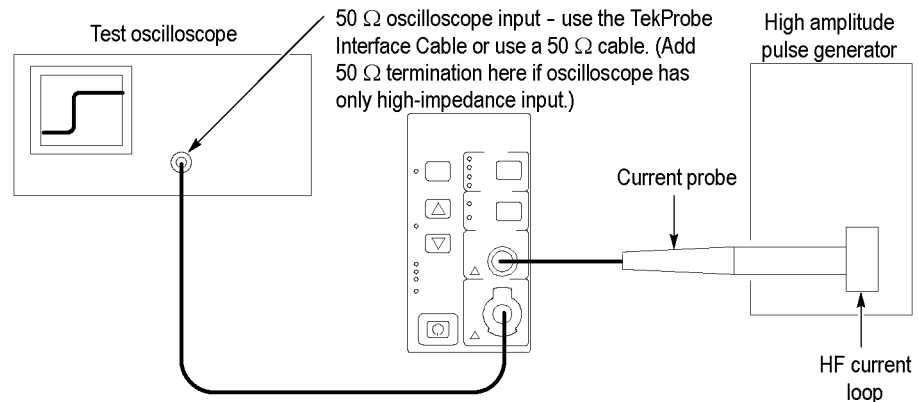


Figure 8: Rise time test setup for the TCP305A and TCP312A

### Equipment Connections

1. If you are using a Tektronix oscilloscope that supports the TekProbe Level 2 Interface, use the TekProbe Interface Cable to connect the amplifier OUTPUT to the oscilloscope input. If you are not using a Tektronix oscilloscope that supports the TekProbe Level 2 Interface, use a 50 Ω BNC cable. If the input impedance of your oscilloscope is 1 MΩ, connect a 50 Ω feedthrough termination at the oscilloscope input. Do not connect the termination at the amplifier output.
2. Connect the current probe to the amplifier PROBE INPUT.
3. Connect the HF current loop to the high amplitude pulse generator output.

**NOTE.** *If your oscilloscope cannot trigger on the pulse, use another BNC cable to connect the trigger output of the pulse generator to the trigger input of the oscilloscope. Configure the oscilloscope for an external trigger.*

### Equipment Settings

Make or verify the equipment settings: (See Table 13 on page 22.)

**Table 14: Equipment settings for rise time**

<b>Oscilloscope</b>		
Vertical input impedance		50 Ω
Vertical scale		200 mA/division
Time base		2 ns/division
Record length		500
Coupling		DC
Offset		0 V (mid-scale)
Trigger type		Edge
Trigger mode		Auto
Trigger position		50%
Acquisition mode		Average
Measurement type		32
Measurement type		Rise Time
<b>High amplitude pulse generator</b>		
Amplitude		Maximum
<b>TCPA300</b>		
Coupling		DC
Range	TCP305A	5 A/V
	TCP312A	1 A/V

- Procedure**
1. Do not clamp the current probe around any conductor, but make sure the jaws are locked shut.
  2. Press the amplifier PROBE DEGAUSS AUTOBALANCE button. Wait for the degauss/autobalance routine to complete before proceeding. The routine is complete when the indicator light turns off.
  3. Clamp the current probe around the HF current loop. Verify that the arrow-shaped indicator on the probe points away from the pulse generator.
  4. Adjust the vertical gain and vertical position of the oscilloscope so that 5 to 8 divisions are displayed. (You may have to adjust the pulse generator output to achieve this.)
  5. Using the measurement capability of the oscilloscope, measure the rise time of the displayed pulse from 10% to 90% amplitude.
  6. If the rise time of the pulse generator is greater than 1/4 of the rise time of the probe you are testing, calculate the rise time of the probe ( $t_r probe$ ) using the formula below:

$$t_r probe = \sqrt{t_r measured^2 - t_r system^2}$$

The measured rise time ( $t_r$ , *measured*) is the value calculated in step 5.

The system rise time ( $t_r$ , *system*) is the rise time of the displayed signal when output of the pulse generator is connected directly to the oscilloscope input. (The current probe and amplifier are excluded.)

7. Verify that the probe rise time is less than the warranted specification listed in the test record.
8. Record the results on the test record.
9. Disconnect the probe from the pulse generator.

## Bandwidth

This procedure tests the bandwidth of the TCP305A and TCP312A Current Probes. In this test you measure a signal at a relatively low frequency and again at the rated bandwidth of the probe. The two measurements are compared to verify that the signal amplitude does not fall below -3 dB at the probe bandwidth. The equipment connections are shown below. (See Figure 9.)

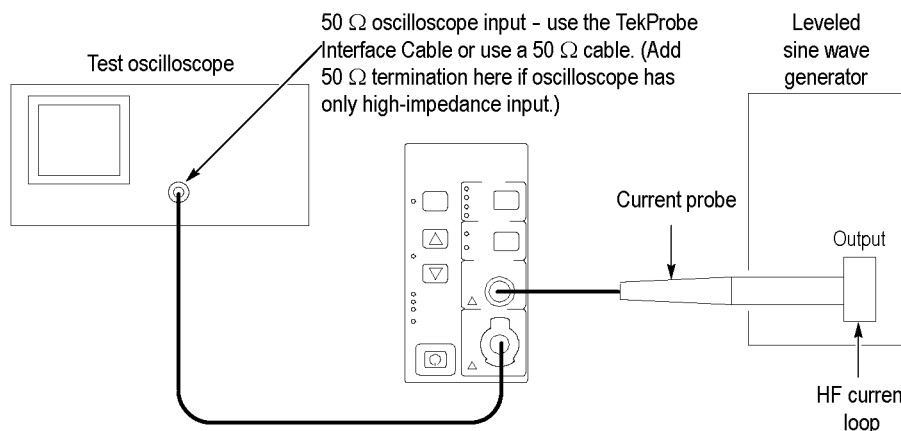


Figure 9: Bandwidth test setup for TCP305A and TCP312A

### Equipment Connections

1. If you are using a Tektronix oscilloscope that supports the TekProbe Level 2 Interface, use the TekProbe Interface Cable to connect the amplifier OUTPUT to the oscilloscope input. If you are not using a Tektronix oscilloscope that supports the TekProbe Level 2 Interface, use a 50 Ω BNC cable. If the input impedance of your oscilloscope is 1 MΩ, connect a 50 Ω feedthrough termination at the oscilloscope input. Do not connect the termination at the
2. Connect the current probe to the amplifier PROBE INPUT.
3. Connect the HF current loop to the output of the leveled sine wave generator.

**Equipment Settings** Make or verify the listed equipment settings.

**Table 15: Equipment settings for bandwidth**

<b>Oscilloscope</b>	
Vertical input impedance	50 $\Omega$
Time base	200 ns/division
Record length	500
Coupling	DC
Offset	0 V (mid-scale)
Trigger type	Edge
Trigger mode	Auto
Trigger position	50%
Acquisition mode	Average
Number of waveforms to average	8
Measurement type	Peak-to-Peak
<b>Leveled sine wave generator</b>	
Frequency	3 MHz
Amplitude	3 $V_{p-p}$
<b>TCPA300</b>	
Coupling	DC

- Procedure**
1. Do not clamp the current probe around any conductor, but make sure the jaws are locked shut.
  2. Press the amplifier PROBE DEGAUSS AUTOBALANCE button. Wait for the degauss/autobalance routine to complete before proceeding. The routine is complete when the indicator light turns green.
  3. Clamp the current probe around the HF current loop.
  4. Enable the output of the leveled sinewave generator.
  5. Verify the output level is what is listed for the probe. (See Table 16 on page 27.)
  6. Using the peak-peak measurement capability of the oscilloscope, measure the peak-peak reading and record it as  $M_I$ . (See Table 16 on page 27.)

Table 16: Bandwidth test for the TCP305A and TCP312A

Probe	Oscilloscope vertical gain		TCPA300 output		M1 @3 MHz ref freq	BW freq	M2 @warr. BW freq	Calculated <sup>1</sup>
	w/TEKPROBE Range cable	w/BNC cable	w/TEKPROBE cable	w/BNC cable				
TCP305A 5 A/V	10 mA/div	2 mV/div	~60 mA p-p	~12 mV p-p		50 MHz		
TCP312A 1 A/V	10 mA/div	10 mV/div	~60 mA p-p	~60 mV p-p		100 MHz		

<sup>1</sup> Use the formulas shown in step 9.

7. Set the oscilloscope time base to 4 or 5 ns/division. Increase the signal generator frequency to the warranted bandwidth.
8. Using the peak-peak measurement capability of the oscilloscope, measure and record the peak-peak reading as  $M_2$ .
9. The probe meets the bandwidth specification if the ratio of the signal amplitude at the warranted bandwidth is at least 70.7% of the signal amplitude at 3 MHz. Using the following calculation, verify probe bandwidth for the TCP305A:

$$\left(\frac{M_2}{M_1}\right) > 0.707$$

---

**NOTE.** The impedance of the HF current loop used in this test changes between 3 MHz and 100 MHz. Typically the impedance changes from 50  $\Omega$  at 3 MHz to 51.4  $\Omega$  at 100 MHz. Thus you can substitute the following equation to make this test more accurate for the TCP312A:

---

$$(1.03) \left(\frac{M_2}{M_1}\right) > 0.707$$

This completes the performance verification for the TCP305A and TCP312A probes.

If the TCP305A and TCP312A probes fail any of the verification tests, refer to the *Adjustments* section for servicing information.

## TCP305A Current Probe Test Record

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

### TCP305A test record

Instrument Serial Number:	Certificate Number:
Temperature:	Relative Humidity %:
Date of Calibration:	Technician:

Performance test	Range, A/V	Test	Minimum	Measured/calculated	Maximum
DC Gain Accuracy (% Error)	5 A/V	1.00 A	-3%		+3%
		3.00 A	-3%		+3%
		5.00 A	-3%		+3%
	10 A/V	2.00 A	-3%		+3%
		6.00 A	-3%		+3%
		10.00 A	-3%		+3%
Rise Time	5 A/V		—		≤7 ns
Bandwidth	5 A/V		0.707		—



## TCP312A Current Probe Test Record

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

### TCP312A test record

Instrument Serial Number:	Certificate Number:
Temperature:	Relative Humidity %:
Date of Calibration:	Technician:

Performance test	Range, A/V	Test	Minimum	Measured/calculated	Maximum
DC Gain Accuracy (% Error)	1 A/V	0.20 A	-3%		+3%
		0.60 A	-3%		+3%
		1.00 A	-3%		+3%
	10 A/V	1.20 A	-3%		+3%
		3.60 A	-3%		+3%
		6.00 A	-3%		+3%
Rise Time	1 A/V		—		≤3.5 ns
Bandwidth	1 A/V		.707		—

## TCP303 and TCP404XL Performance Verification

The test procedures in this section verify warranted specifications and proper performance of the TCP303 and TCP404XL Current Probes, using the appropriate amplifier. Tolerances that are specified in these procedures apply to the amplifier and current probe and do not include test equipment error.

Before starting these procedures, photocopy the appropriate test record to record the performance test results. The recommended calibration interval is one year. (See page 41, *TCP303 Current Probe Test Record*.)

---

**NOTE.** *If the amplifier is not properly terminated into 50  $\Omega$ , the NOT TERMINATED INTO 50  $\Omega$  status LED is on. Verify that the 50  $\Omega$  termination is connected at the DMM input when performing the following procedures.*

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No probe or amplifier adjustments are required during these test procedures. If any tests fail, information is available. (See page 50, *TCP303 and TCP404XL Adjustments*.)



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**WARNING.** *Magnetic fields are produced in these procedures that may cause a malfunction in heart pacemakers or damage to sensitive equipment.*

---

## Equipment Required

To perform the acceptance tests in this section, you will need the listed test equipment. The test equipment must meet or exceed the specifications listed. The test procedures may need to be modified if the recommended equipment is not used.

**Table 17: Required test equipment**

Qty	Item	Description	Recommended
1	Oscilloscope	100 MHz bandwidth	Tektronix TDS5000
1	High Amplitude Pulse Generator (TCP303 only)	Rise time <5 ns, pulse width >100 ns amplitude >20 V <sub>p-p</sub> into 50 Ω	Picosecond Labs 2600
1	High Amplitude Pulse Generator (TCP404XL only)	Square wave with a rise time <35 ns, ≥5 A into 50 Ω	AVTECH AVR-3-PW-C-P-TEK2
1	Leveled Sine Wave Generator (TCP303 only)	3 MHz to 20 MHz	Fluke 9100 with Option 250
1	Current Source	DCA: 0.1% accuracy, 0 to ±15 A	Fluke 9100
1	Digital Multimeter	DCV: 0.1% accuracy, 5 <sup>1/2</sup> digit resolution	Keithley 2700 or Tektronix DMM4050
1	Current Probe Amplifier	Use appropriate amplifier	Tektronix TCPA300 or TCPA400
1	BNC Cable	50 Ω, 0.76 m (30 in) long	Tektronix part number 012-0117-00
1	Cable	TEKPROBE Interface	Tektronix part number 012-1605-00
1	Adapter	BNC-to-Dual Banana	Tektronix part number 103-0090-00
1	HF Current Loop (TCP303 only)	50 Ω, BNC Connector	Tektronix part number 015-0601-50
1	DC Current Loop	50 turns 13 AWG coated wire	(See page 4, <i>Making DC Current Loops.</i> )
1	Precision Termination	50 Ω ±0.1%, 0.5 W	Tektronix part number 011-0129-00

## DC Gain Accuracy

This procedure tests the DC gain accuracy of the TCP303 and TCP404XL. In this test you compare the voltage output of the amplifier to a reference input.

This test uses a 50-turn current loop that you make using wire and a 3-inch form. Instructions on making a current loop is available. (See page 4, *Making DC Current Loops.*)

### Equipment Connections

Using a BNC cable, connect the amplifier OUTPUT to the 50 Ω feedthrough termination. Attach the termination to a BNC-to-dual banana adapter. Insert the dual-banana adapter into the digital multimeter DC voltage input, taking care to maintain polarity.

1. Connect the current loop to the current source as shown.
2. Connect the current probe to the PROBE INPUT connector. Do not connect the probe to the current loop at this time.

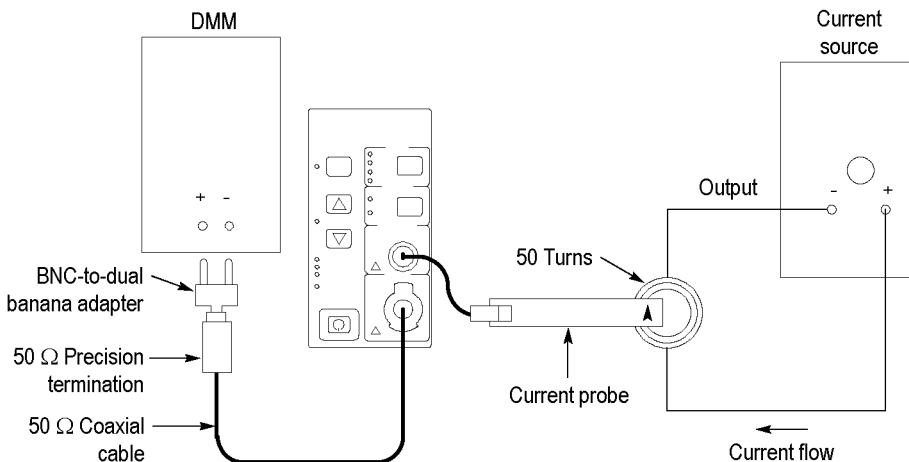


Figure 10: DC gain accuracy test setup for the TCP303 and TCP404XL

### Equipment Settings

Make or check the equipment settings in the table below: (See Table 18.)

Table 18: Equipment settings for DC gain accuracy

Digital multimeter	
Measurement	DC volts
Range	Autoranging
Current source	
Output	Off
TCPA300 and TCPA400	
Coupling	DC

- Procedure**
1. Do not clamp the current probe around any conductor, but make sure the jaws are locked shut.
  2. Press the amplifier PROBE DEGAUSS AUTOBALANCE button. Wait for the degauss/autobalance routine to complete before proceeding. The routine is complete when the indicator light turns green.
  3. Clamp the current probe around the 50 turn current loop, as shown. (See Figure 10 on page 32.) Maintain proper polarity; the arrow-shaped indicator on the probe points away from the (+) terminal of the current source.
  4. For each of the amplifier range settings, perform the following steps: (See Table 19 on page 34.)
    - a. If you are testing a TCP303, set the amplifier range to the first setting for that probe. (See Table 19 on page 34.) For example, set the range to 5A/V.
    - b. Set the current source output to the first positive (+) setting for the probe you are testing. (See Table 19 on page 34.) For example, if you are testing a TCP303, set the output to +0.100 A. (Each output level is tested at both polarities; later in the procedure, you will set the output to -0.100 A.)
    - c. Enable the output of the current source.
    - d. Record the exact measurement of the digital multimeter as M1.
    - e. Set the current source output to the first negative (-) setting for the probe you are testing. (See Table 19 on page 34.) For example, if you are testing a TCP303, set the output to -0.100 A.
    - f. Record the exact measurement of the digital multimeter as M2.
    - g. Verify that the measured output (M1-M2) is within the warranted specification by computing %Error as follows:

$$\%Error = \frac{(M_1 - M_2) - 2 (V_E)}{2 (V_E)} \times 100$$

For example, you may measure values of 0.990V for M1 and -0.998V for M2. With an expected  $V_E$  of 1.0 V, you compute the %Error as follows:

$$\begin{aligned} \%Error &= \frac{(0.990 V - (-0.998 V)) - 2 (1 V)}{2 (1 V)} \times 100 \\ &= \frac{(1.988 V - 2 V)}{2 V} \times 100 = -0.6\% \end{aligned}$$

5. Record the results on the test record.

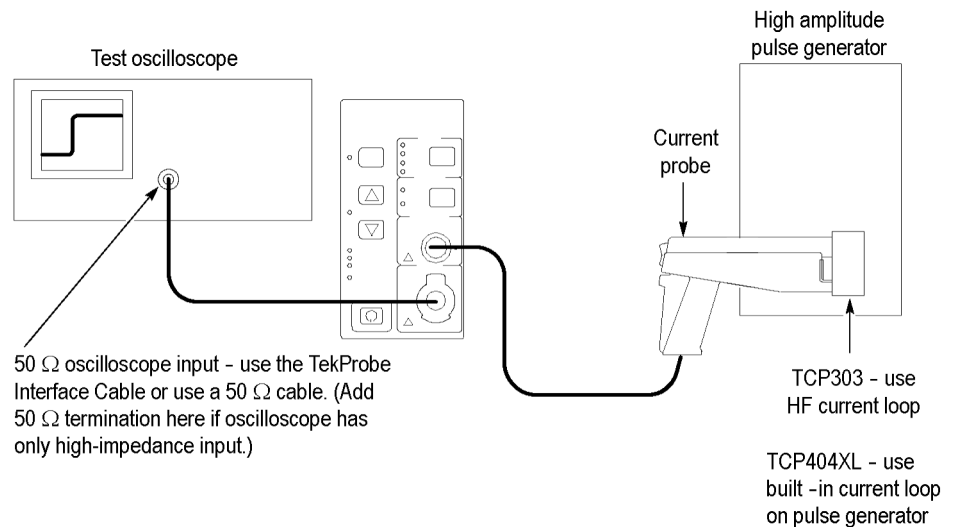
**Table 19: DC gain accuracy test worksheet for the TCP303 and TCP404XL**

Probe	Range	Current source output (ADC)	Expected output, $V_E$ (VAC)	M1 (VDC)	M2 (VDC)	M1-M2 (VDC)	% Error, calculated
TCP303	5 A/V	±0.100 A	±1.00 V				
		±0.300 A	±3.00 V				
		±0.500 A	±5.00 V				
	50 A/V	±0.600 A	±0.600 V				
		±1.80 A	±1.80 V				
		±3.00 A	±3.00 V				
TCP404XL	1 A/mV	±3.00 A	±0.150 V				
		±9.00 A	±0.450 V				
		±15.00 A	±0.750 V				

6. Disconnect the DMM cable from the amplifier and the probe from the 50T coil.

## Rise Time

This procedure measures the rise time of the TCP303 and TCP404XL Probes. In this test you directly measure the rise time of a step input. The equipment connections are shown below. (See Figure 11.)



**Figure 11: Rise time test setup for the TCP303 and TCP404XL**

### Equipment Connections

1. If you are using a Tektronix oscilloscope that supports the TekProbe Level 2 Interface, use the TekProbe Interface Cable to connect the amplifier OUTPUT to the oscilloscope input. If you are not using a Tektronix oscilloscope that supports the TekProbe Level 2 Interface, use a 50  $\Omega$  BNC cable. If the input impedance of your oscilloscope is 1 M $\Omega$ , connect a 50  $\Omega$  feedthrough termination at the oscilloscope input. Do not connect the termination at the amplifier output.
2. Connect the current probe to the amplifier PROBE INPUT connector.
3. If testing a TCP303, connect the HF current loop to the high amplitude pulse generator.

**NOTE.** *If your oscilloscope cannot trigger on the pulse, use another BNC cable to connect the trigger output of the pulse generator to the trigger input of the oscilloscope. Configure the oscilloscope for an external trigger.*

**Equipment Settings** Make or verify the equipment settings in the table below: (See Table 20.)

**Table 20: Equipment settings for rise time**

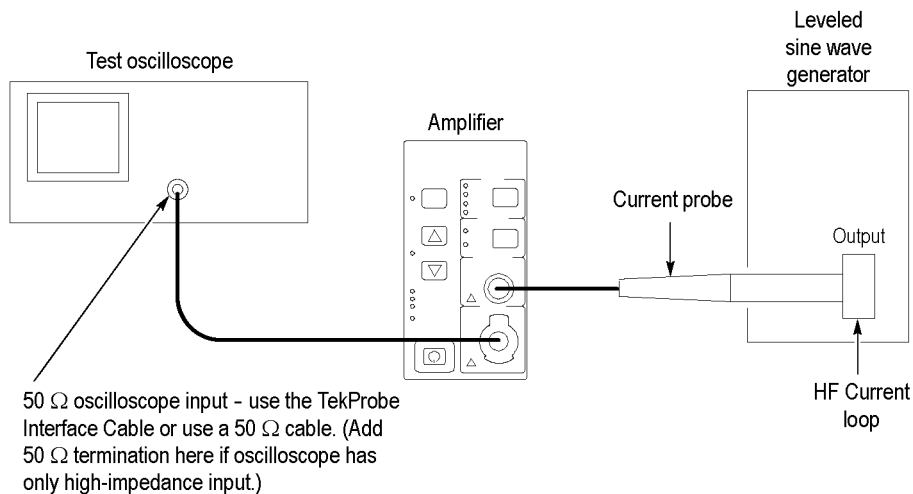
<b>Oscilloscope</b>		
Vertical scale:	TCP303	200 mA/division
	TCP404XL	1 A/division
Vertical input impedance		50 $\Omega$
Time base:	TCP303	10 ns/division
	TCP404XL	80 ns/division
Record length		500
Coupling		DC
20 MHz BW limit:	TCP303	Off
	TCP404XL	On
Offset		0 V (mid-scale)
Trigger type		Edge
Trigger mode		Auto
Trigger position		50%
Acquisition mode		Average
Number of waveforms to average		32
Measurement type		Rise Time
<b>High amplitude pulse generator (TCP303)</b>		
Amplitude		Maximum
<b>High amplitude pulse generator (TCP404XL)</b>		
Pulse width		250 ms
Pulse repetition frequency		10 Hz
Amplitude		5 A
<b>TCPA300 and TCPA400</b>		
Coupling		DC
Range		
	TCP303	5 A/V



- Procedure**
1. Do not clamp the current probe around any conductor, but make sure the jaws are locked shut.
  2. Press the amplifier PROBE DEGAUSS AUTOBALANCE button. Wait for the degauss/autobalance routine to complete before proceeding. The routine is complete when the indicator light turns green.
  3. Make the following connections:
    - a. If you are testing a TCP303, clamp the current probe around the HF current loop. Verify that the arrow-shaped indicator on the probe points away from the pulse generator.
    - b. If you are testing a TCP404XL, clamp the current probe around the built-in current loop on the pulse generator. Verify that the arrow-shaped indicator on the probe points away from the output terminal on the pulse generator.
  4. Adjust the vertical gain and set the vertical position of the oscilloscope so that the trace is at the bottom of the screen, and 5 to 8 divisions are displayed. Press LEVEL to trigger the oscilloscope. (You may have to adjust the pulse generator output to achieve this.)
  5. Using the measurement capability of the oscilloscope, measure the rise time of the displayed pulse from 10% to 90% amplitude.
  6. Check that the rise time is less than the warranted specification listed in the test record.
  7. Record the results on the test record.
  8. Disconnect the probe from the pulse generator.

## Bandwidth (TCP303)

This procedure tests the bandwidth of the TCP303 Current Probe. In this test you measure a signal at a relatively low frequency and again at the rated bandwidth of the probe. The two measurements are compared to verify that the signal amplitude does not fall below -3 dB at the probe bandwidth. The equipment connections are shown below. (See Figure 12.)



**Figure 12: Bandwidth test setup for TCP303**

### Equipment Connections

1. If you are using a Tektronix oscilloscope that supports the TekProbe Level 2 Interface, use the TekProbe Interface Cable to connect the amplifier OUTPUT to the oscilloscope input. If you are not using a Tektronix oscilloscope that supports the TekProbe Level 2 Interface, use a 50  $\Omega$  BNC cable. If the input impedance of your oscilloscope is 1 M $\Omega$ , connect a 50  $\Omega$  feedthrough termination at the oscilloscope input. Do not connect the termination at the amplifier output.
2. Connect the current probe to the amplifier PROBE INPUT.
3. Connect the HF current loop to the output of the leveled sine wave generator.

**Equipment Settings** Make or verify the equipment settings in the table below. (See Table 21.)

**Table 21: Equipment settings for bandwidth**

<b>Oscilloscope</b>	
Vertical input impedance	50 $\Omega$
Time base	200 ns/division
Record length	500
Coupling	DC
Offset	0 V (mid-scale)
Trigger type	Edge
Trigger mode	Auto
Trigger position	50%
Acquisition mode	Average
Number of waveforms to average	8
Measurement type	Peak-to-Peak
<b>Leveled sine wave generator</b>	
Frequency	3 MHz
Amplitude	3 V <sub>p-p</sub>
<b>TCPA300</b>	
Coupling	DC
Range	5 A/V

- Procedure**
1. Do not clamp the current probe around any conductor, but make sure the jaws are locked shut.
  2. Press the amplifier PROBE DEGAUSS AUTOBALANCE button. Wait for the degauss/autobalance routine to complete before proceeding. The routine is complete when the indicator light turns green.
  3. Clamp the current probe around the HF current loop.
  4. Enable the output of the leveled sinewave generator.
  5. Verify the output level is what is listed for the probe. (See Table 22 on page 40.)
  6. Using the peak-peak measurement capability of the oscilloscope, measure and record the peak-peak reading as  $M_1$ . (See Table 22 on page 40.)
  7. Set the oscilloscope time base to 40 or 50 ns/division. Increase the signal generator frequency to the warranted bandwidth. Refer to the test record for the warranted bandwidth.
  8. Using the peak-peak measurement capability of the oscilloscope, measure and record the peak-peak reading as  $M_2$ .

**Table 22: Bandwidth test for the TCP303**

TEKPROBE Interface Cable			BNC cable			M1 @3 MHz ref freq	M2 @ warranted BW freq (15 MHz)	Calculation <sup>1</sup>
Probe	Range	Oscilloscope vertical gain	TCPA300 output	Oscilloscope vertical gain	TCPA300 output			
TCP303	5 A/V	10 mA/div	~60 mA p-p	2 mV/div	~12 mV p-p			

<sup>1</sup> Use the formula in step 9 below.

- The probe meets the bandwidth specification if the ratio of the signal amplitude at the warranted bandwidth is at least 70.7% of the signal amplitude at 3 MHz. Using the following calculation, verify probe bandwidth:

$$\left(\frac{M_2}{M_1}\right) > 0.707$$

- Record the results on the test record.

## Bandwidth (TCP404XL)

The bandwidth of the probe is derived as a function of the probe rise time. The rise time ( $t_r$ ) is measured in nanoseconds between the 10% and 90% points of the leading edge of the pulse. (See page 23, *Rise Time*.) To calculate the probe bandwidth, use the following formula:

$$\left(\frac{0.35}{t_r}\right) = \text{Bandwidth}$$

For example, a rise time of 175 ns would result in the following solution:

$$\left(\frac{0.35}{175 \times 10^{-9} \text{seconds}}\right) = 2.0 \times 10^6 \text{ Hertz}$$

- Record the results on the test record.

This completes the performance verification for the TCP303 and TCP404XL probes.

If the TCP303 or TCP404XL probes fail any of the verification tests, servicing information is available. (See page 43, *Adjustment Procedures Overview*.)

## TCP303 Current Probe Test Record

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

### TCP303 test record

Instrument Serial Number:	Certificate Number:
Temperature:	Relative Humidity %:
Date of Calibration:	Technician:

Performance test	Range, A/V	Test	Minimum	Measured/calculated	Maximum
DC Gain Accuracy <sup>1</sup> (% Error)	5 A/V	1	-3%		+3%
		3	-3%		+3%
		5	-3%		+3%
	50 A/V	0.6	-3%		+3%
		1.8	-3%		+3%
		3.0	-3%		+3%
Rise Time	5 A/V	—	—		23 ns
Bandwidth	5 A/V	—	.707		—

<sup>1</sup> DC Gain Accuracy is tested at the 10 °C to 50 °C specification. If you need to test the probe at 0 °C to 10 °C, refer to the specification limits in the *TCPA300/400 Amplifiers & TCP300/400 Probes User Manual*.

## TCP404XL Current Probe Test Record

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

### TCP404XL test record

Instrument Serial Number:	Certificate Number:
Temperature:	Relative Humidity %:
Date of Calibration:	Technician:

Performance test	Range	Test	Minimum	Measured/calculated	Maximum
DC Gain Accuracy (% Error)	1 A/mV	3.0 A	-3%		+3%
		9.0 A	-3%		+3%
		15.0 A	-3%		+3%
Rise Time	1 A/mV	—	—		175 ns
Bandwidth	1 A/mV	—	2 MHz		—

# Adjustment Procedures Overview

The following procedures describe adjustments to the current probes and amplifiers. Before performing the adjustment procedures, do the following:

1. If you are adjusting an amplifier, remove the outer case to gain access to the adjustments. (See page 60, *Disassembly*.) Next, attach the Calibration Adapter to the amplifier.
2. If you are adjusting a probe, attach the current probe to the amplifier.
3. Turn the power on and allow the entire system to warm up for a minimum of 20 minutes. Warm up any test equipment that is listed at the beginning of the procedure used.

The recommended calibration interval is one year.

Adjustment information you can make to the amplifiers and probes is available. (See Table 23.)

**Table 23: Amplifier and probe adjustments**

Device	Adjustments		
	DC gain accuracy	Low frequency	High frequency
Amplifiers			
TCPA300	✓ (4 adjustments)		
TCPA400	✓		
Probes			
TCP312A	✓		
TCP305A	✓		
TCP303	✓	✓	✓
TCP404XL	✓	✓	✓

## TCPA300 and TCPA400 Amplifier Adjustments

This section covers the adjustments for the TCPA300 and TCPA400 Current Probe Amplifiers.

### Required Test Equipment

The adjustment procedures require the test equipment listed below. (See Table 24.) The test equipment must meet or exceed the specifications listed. You may need to modify the test procedures if you do not use the recommended equipment.

**Table 24: Required test equipment**

Qty	Item	Description	Recommended
1	Digital Multimeter	0.20%, 3 <sup>1</sup> / <sub>2</sub> digit resolution, range $\pm 50$ mV	Keithley 2700 or Tektronix DMM4050
1	Current Source	0.1%, 0 to $\pm 100$ mA	Fluke 5100 A or HP 6612C
1	Termination	50 $\Omega$ $\pm 0.1\%$ , 0.5 W	Tektronix part number 011-0129-00
2	BNC Cables	50 $\Omega$ , 1.05 m (42 in) long	Tektronix part number 012-0117-00
1	Cables	TEKPROBE Interface	Tektronix part number 012-1605-00
2	Adapters	BNC-to-Dual Banana Adapters	Tektronix part number 103-0090-00
1	Calibration Adapter	TCPA Calibration Adapter	Tektronix part number 174-4765-00
1	Adjustment tool	1/8-inch flat-blade	Tektronix part number 003-0675-01

### Accessing the Adjustments

To gain access to the amplifier adjustments, you must remove the outer case. There are access ports in the right-side internal cover, but you can also remove the internal cover to get a better view of the adjustments. (See page 60, *Disassembly*.) After completing the disassembly procedure, power on the amplifier and test equipment and let them warm up for at least 20 minutes.



## TCPA300 Amplifier

The TCPA300 has four internal adjustments that affect the gain of the amplifier. (The TCPA400 has one adjustment.) Each range has an individual control, except the 1 A/V range, which does not have an adjustment. To make adjustments to the amplifier, do the following:

1. Set up the circuit shown.

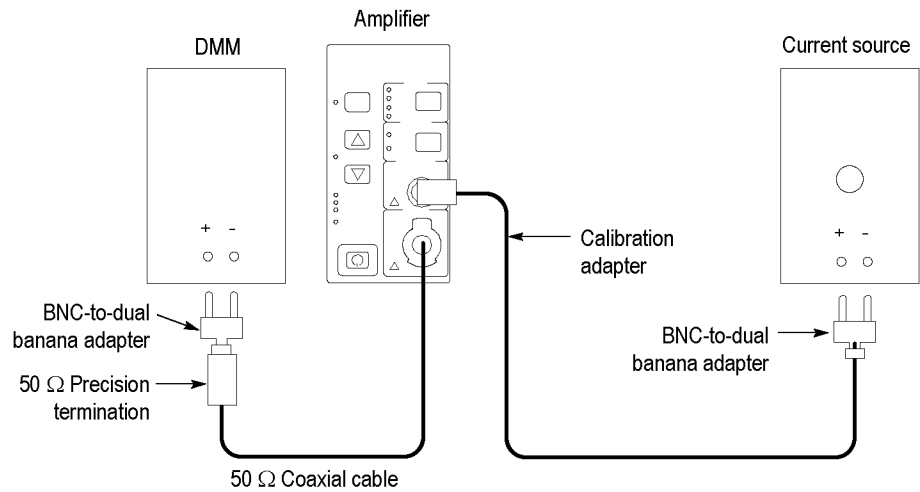


Figure 13: Amplifier adjustments

2. Set the current source to the values shown and adjust the corresponding adjustment pot to the target values shown. (See Table 25.) The adjustment locations on the amplifier board are shown. (See Figure 14 on page 46.)

Table 25: TCPA300 gain adjustments

Range, A/V	Current source value, ADC	Adjustment	Minimum output, VDC	Expected output, VDC	Maximum output, VDC
1	0.100	No adjustment	4.9900	5.0000	5.0100
5	0.100	25 Ω	2.4950	2.5000	2.5050
10	0.100	12.5 Ω	1.2350	1.2375	1.2400
50	0.100	5 Ω	0.4825	0.4835	0.4845
50 COMP <sup>1</sup>	0.100	5 Ω COMP	0.4576	0.4585	0.4594

<sup>1</sup> Both 10 A/V and 50 A/V LEDs light.

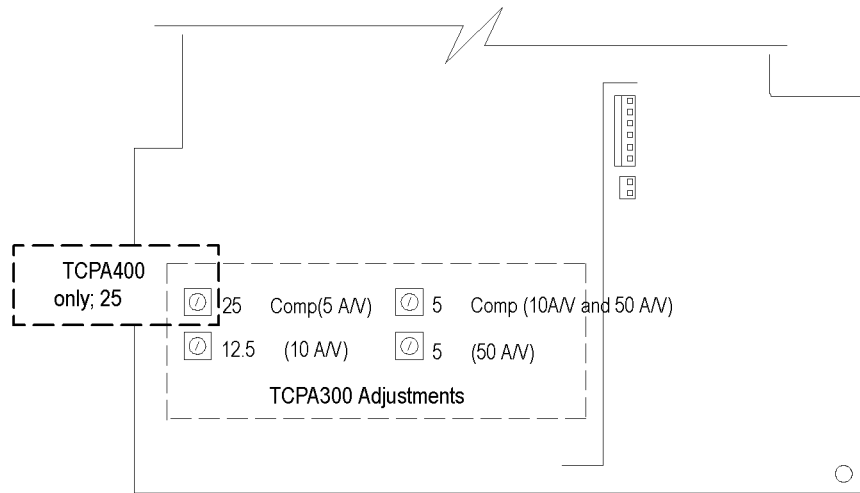


Figure 14: Amplifier gain adjustment locations

## TCPA400 Amplifier

The TCPA400 has one internal gain adjustment in the amplifier. To make adjustments to the amplifier, do the following:

1. Set up the circuit shown. (See Figure 13 on page 45.)
2. Set the current source to the value shown. (See Table 26.)
3. Locate the adjustment on the amplifier board. (See Figure 14.)
4. Adjust the corresponding adjustment pot to within the limits shown. (See Table 26.)

Table 26: TCPA400 gain adjustments

Range, A/mV	Current source value, DC A	Adjustment	Minimum output, VDC	Expected output, VDC	Maximum output, VDC
1	0.100	25 Ω	2.4938	2.5000	2.5063

This completes the adjustments for the amplifiers. Do the appropriate performance verification for the amplifier to verify that it meets the warranted specifications.

# TCP305A and TCP312A Probe Adjustments

The TCP305A and TCP312A Current Probes have one characteristic that is adjustable—DC gain. The following text describes the DC gain adjustment procedure. Tolerances that are specified in these procedures apply to the current probes and do not include test equipment error.

## Required Test Equipment

To perform the adjustment procedure in this section, you will need the test equipment listed. (See Table 27.) The test equipment must meet or exceed the specifications listed. The test procedure may need to be changed if the recommended equipment is not used.

**Table 27: Required test equipment**

Qty	Item	Description	Recommended
1	AC Current Source	ACA: 0.25% accuracy, 0 to $\pm 1.5$ A, square wave output	Fluke 9100
1	Digital Multimeter	ACV: <0.1% accuracy 5 $\frac{1}{2}$ digit resolution	Keithley 2700 or Tektronix DMM4050
1	Termination	50 $\Omega$ , 0.1% precision, BNC connector, feedthrough	Tektronix part number 011-0129-00
1	BNC Cable <sup>1</sup>	50 $\Omega$ , 0.76 m (30 in) long	Tektronix part number 012-0117-00
1	Adapter	BNC to Dual Banana	Tektronix part number 103-0090-00
1	DC Current Loop	5 turns 18 AWG coated wire	(See page 4, <i>Making DC Current Loops.</i> )

<sup>1</sup> Provided as a standard accessory with the TCPA300.

## Accessing the Adjustments

The location of the DC gain adjustment in the lower probe half is shown. (See Figure 15.)



**Figure 15: TCP305A and TCP312A DC gain adjustment location**

## TCP305A and TCP312A Probe DC Gain Adjustment

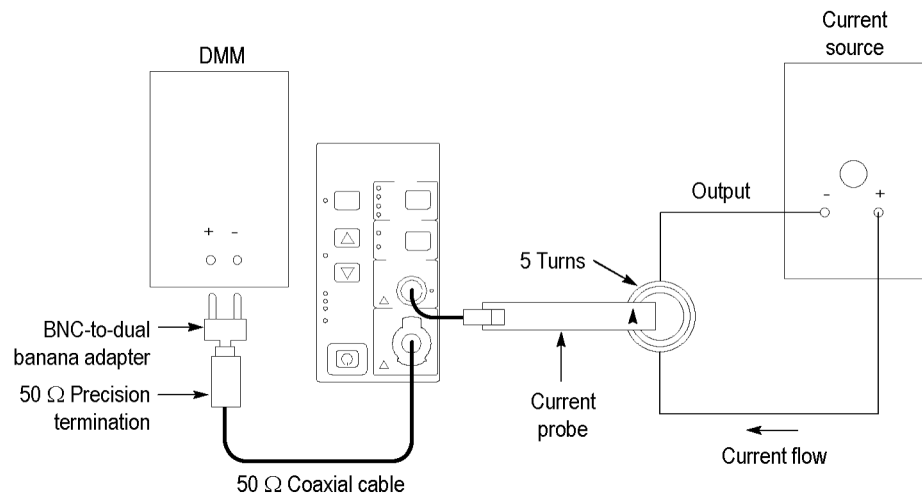
Use the following procedure to adjust the DC gain of the TCP305A and TCP312A Probes.

- Equipment Connections**
1. Connect the amplifier OUTPUT to the DMM input using a BNC-to-Dual Banana connector, 50  $\Omega$  BNC cable, and a 50  $\Omega$  precision feedthrough termination. Do not connect the termination at the amplifier output.
  2. Connect the current probe to the amplifier PROBE INPUT connector.
  3. Connect the 5-turn DC current loop to the current source as shown. (See page 4, *Making DC Current Loops*.)
  4. Do not clamp the current probe around any conductor, but make sure the slide is locked.

**Equipment Settings** Make or verify the equipment settings: (See Table 28.)

**Table 28: Settings for DC gain adjustment**

<b>Digital multimeter</b>	
Measurement Type	AC volts
Range	Autoranging
<b>Current source</b>	
Output waveshape/frequency	Square wave, 40 Hz
Output	Off
<b>TCPA300</b>	
Coupling	DC
Range	
TCP305A	5 A/V
TCP312A	1 A/V



**Figure 16: DC gain adjustment setup for TCP305A and TCP312A**

- Procedure**
1. Press the amplifier PROBE DEGAUSS AUTOBALANCE button. Wait for the degauss/autobalance routine to complete before proceeding. The routine is complete when the indicator light turns green.
  2. Connect the current probe to the 5-turn DC current loop.
  3. Perform the following steps: (See Table 29.)
    - a. Set the amplifier to the appropriate range setting for the probe you are testing.
    - b. Set the current source output to the correct current level.
    - c. Enable the output of the current source.
    - d. Adjust the DC gain control on the probe to the expected output value shown. (See Table 29.)

**Table 29: DC gain accuracy adjustments for the TCP305A and TCP312A**

Probe	Range	Current source output (mA $\mu$ k)	Expected output, $V_E$ (VAC)	Minimum output, VAC	Maximum output, VAC
TCP305A	5 A/V	300 mA	0.3000	0.2990	0.3011
TCP312A	1 A/V	60 mA	0.3008	0.2997	0.3018

This completes the adjustments for the TCP305A and TCP312A Current Probes. Do the appropriate performance verification procedure for the probe you adjusted, using these procedures. (See page 18, *TCP305A and TCP312A Probes Performance Verification*.)

## TCP303 and TCP404XL Adjustments

Each of the following adjustment procedures describes how to adjust specific performance characteristics of the TCP303 and TCP404XL. Tolerances that are specified in these procedures apply to the current probe and do not include test equipment error.

### Required Test Equipment

To perform the adjustment procedures in this section, you will need the test equipment listed. (See Table 30.) The test equipment must meet or exceed the specifications listed. You may need to modify the test procedures if you do not use the recommended equipment.

Perform these steps before starting these procedures. (See Table 23 on page 43.) To ensure proper completion, read each procedure before starting.

**Table 30: Required test equipment**

Qty	Item	Description	Recommended example
1	Oscilloscope	100 MHz bandwidth	Tektronix TDS5000
1	High Amplitude Pulse Generator (TCP404XL only)	Square wave with a rise time <35 ns, ≥5 A into 50 Ω	AVTECH AVR-3-PW-C-P-TEK2
1	Current Probe Amplifier		Tektronix TCPA300 (TCP303) or TCPA400 (TCP404XL)
1	AC Current Source	AC A: 0.25% accuracy, 0 to ±5 A, square wave output, 40 Hz-1 kHz, $t_r < 10$ ms	Fluke 9100
1	Digital Multimeter	AC V: ≤ 0.1% accuracy, 5½ digit resolution	Keithley 2700 or Tektronix DMM4050
1	Cable	TEKPROBE Interface	Tektronix part number 012-1605-00
1	BNC Cable (TCP303 only)	50 Ω, 0.76 m (30 in) long	Tektronix part number 012-0117-00
1	Cable	Banana plugs at ends, 18 inches	Tektronix part number 012-0031-00
1	Adapter	BNC to Dual Banana	Tektronix part number 103-0090-00
1	Termination	50 Ω ±0.1%, 0.5 W	Tektronix part number 011-0129-00
1	DC Current Loop (TCP404XL only)	5 turns 18 AWG coated wire	(See page 4, <i>Making DC Current Loops.</i> )

## Adjustment Locations

The location of the probe adjustments is shown below. (See Figure 17.)

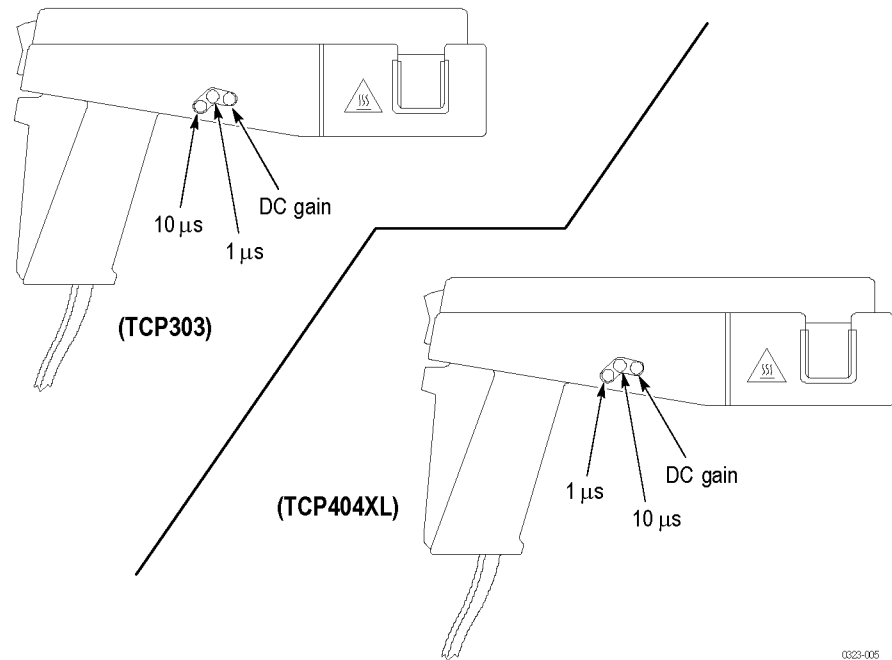


Figure 17: TCP303 and TCP404XL adjustment locations

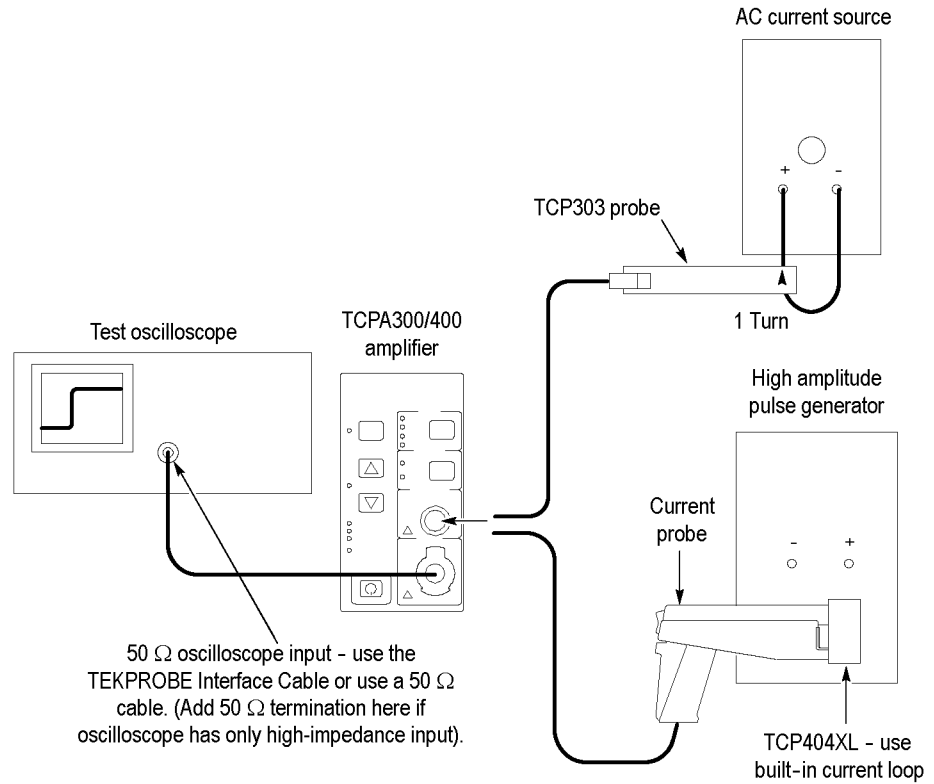
## TCP303 and TCP404XL Transient Response and Coarse Gain Adjustment

These procedures describe how to adjust and optimize the transient response and coarse gain adjustment of the TCP303 and TCP404XL probes, using the 1 ms, 10 ms, and DC gain adjustments. The current source and current loop setups are different between the two probes, but the connections are similar. The equipment connections are shown. (See Figure 18 on page 52.)

### Equipment Connections

1. If you are using a Tektronix oscilloscope that supports the TEKPROBE Level 2 Interface, use the TEKPROBE Interface Cable to connect the amplifier OUTPUT to the oscilloscope input. If you are not using a Tektronix oscilloscope that supports the TEKPROBE Level 2 Interface, use a 50  $\Omega$  BNC cable. If the input impedance of your oscilloscope is 1 M $\Omega$ , connect a 50  $\Omega$  feedthrough termination at the oscilloscope input. Do not connect the termination at the amplifier output.
2. Connect the current probe to the amplifier PROBE INPUT connector.

3. If you are adjusting a TCP303, form a 1-turn current loop by connecting the banana lead to the output connectors of the AC current source.
4. Do not clamp the current probe around any conductor, but make sure the jaws are locked shut.



**Figure 18: TCP303 and TCP404XL transient response and coarse gain adjustment setup**



**Equipment Settings** Make or verify the listed equipment settings.

**Table 31: Settings for transient response and preliminary gain adjustments**

**TCPA300 and TCPA400**

Coupling	DC
Range: TCPA300	5 A/V

**Oscilloscope**

Vertical Gain:	
TCP303	Using TEKPROBE Cable: 100 mA/division
	Using BNC Cable: 20 mV/division
TCP404XL	Using TEKPROBE Cable: 1 A/division
	Using BNC Cable: 1 mV/division
Time Base	100 ms/division, Auto triggered
Vertical Input	50 $\Omega$
Record Length	500
Coupling	DC
Offset	0 V
Trigger	
Type	Edge
Mode	Auto
Position	10%
Acquisition Mode	Average
Number of Waveforms	8
Measurement Type	Rise time, Amplitude

**AC current source (TCP303 only)**

Frequency	1 kHz square wave
Amplitude	0.3 A pk

**High amplitude pulse generator (TCP404XL only)**

Pulse Width	250 ms
Pulse Repetition Frequency	20 Hz
Amplitude	5 A p-p

- TCP303 Procedure**
1. Remove the access plugs that cover the DC gain, 10  $\mu$ s, and 1 ms adjustments on the probe.
  2. Preset the probe adjustments: The adjustment locations are shown. (See Figure 17 on page 51.) Do this only at the beginning of the probe adjustment process.
    - a. Set the 1 ms adjustment fully clockwise.
    - b. Set the 10 ms adjustment fully counter-clockwise.
  3. Do not clamp the current probe around any conductor, but make sure the jaws are locked shut.
  4. Press the amplifier PROBE DEGAUSS AUTOBALANCE button. Wait for the degauss/autobalance routine to complete before proceeding. The routine is complete when the indicator light turns green.
  5. Connect the probe to the 1-turn current loop.
  6. Enable the output of the generator.

---

**NOTE.** *The DC gain, 10  $\mu$ s, and 1  $\mu$ s adjustments on the TCP303 interact. Adjusting them can be a repetitive process. You may need to balance between transient response and gain to meet both specifications at once.*

---

7. Repeat steps 7 and 8 as necessary to achieve optimum response:
  - a. Adjust the DC gain and 10 ms adjustments to achieve an amplitude of six divisions and a flat waveform (optimum response).
  - b. Adjust the 1 ms adjustment to achieve a flat waveform (optimum response).
  - c. Repeat step a.
8. Verify the DC gain accuracy of the probe using this procedure. (See page 30, *TCP303 and TCP404XL Performance Verification*.) You may need to make some minor adjustments to the DC gain adjustment to achieve the highest accuracy possible.

**TCP404XL Procedure**

1. Move the oscilloscope trace to one graticule line from the bottom of the screen.
2. Do not clamp the current probe around any conductor, but make sure the jaws are locked shut.
3. Remove the probe access plugs for 1 ms, 10 ms, and DC Gain.
4. Preset the probe adjustments: The adjustment locations are shown. (See Figure 17 on page 51.) Do this only at the beginning of the probe adjustment process.
  - a. Set the 1  $\mu$ s adjustment fully clockwise
  - b. Set the 10 ms adjustment fully counterclockwise
5. Press the amplifier PROBE DEGAUSS AUTOBALANCE button. Wait for the degauss/autobalance routine to complete before proceeding. The routine is complete when the PROBE DEGAUSS AUTOBALANCE LED returns to green.
6. Lock the jaws of the probe around the built-in current loop on the high amplitude pulse generator. Observe proper polarity; the arrow-shaped indicator on the probe points away from the (+) terminal of the current source.
7. Repeat steps a through d to achieve optimum response:
  - a. Adjust the DC gain adjustment to produce an amplitude of five graticule divisions (5 A) at the 100 ms portion of the pulse.
  - b. Adjust the 10 ms control for a flat waveform to match the level at the 100 ms point.
  - c. Adjust the oscilloscope sweep to 1 ms/div.
  - d. Adjust the 1 ms control to flatten the front end of the pulse.

---

**NOTE.** *The 10  $\mu$ s and 1  $\mu$ s adjustments on the TCP404XL interact. Adjusting them can be a repetitive process. You may need to balance between short and long term response to meet both specifications at once.*

---

8. Verify the DC gain accuracy using this procedure. (See page 56, *DC Gain Adjustment*.) You may need to make some minor adjustments to the DC gain adjustment to achieve the highest accuracy possible.

## DC Gain Adjustment

This procedure adjusts the DC gain accuracy of the TCP303 and TCP404XL probes.

### Equipment Connections

1. Connect the amplifier OUTPUT to the DMM input using a BNC-to-Dual Banana connector, 50  $\Omega$  BNC cable, and a 50  $\Omega$  precision feedthrough termination. Do not connect the termination at the amplifier output.
2. Connect the current probe to the amplifier PROBE INPUT connector.
3. If you are adjusting a TCP303, connect the banana lead cable to the output connectors of the AC current source. If you are adjusting a TCP404XL, connect the 5-turn DC current loop to the current source as shown.
4. Do not clamp the current probe around any conductor, but make sure the slide is locked.

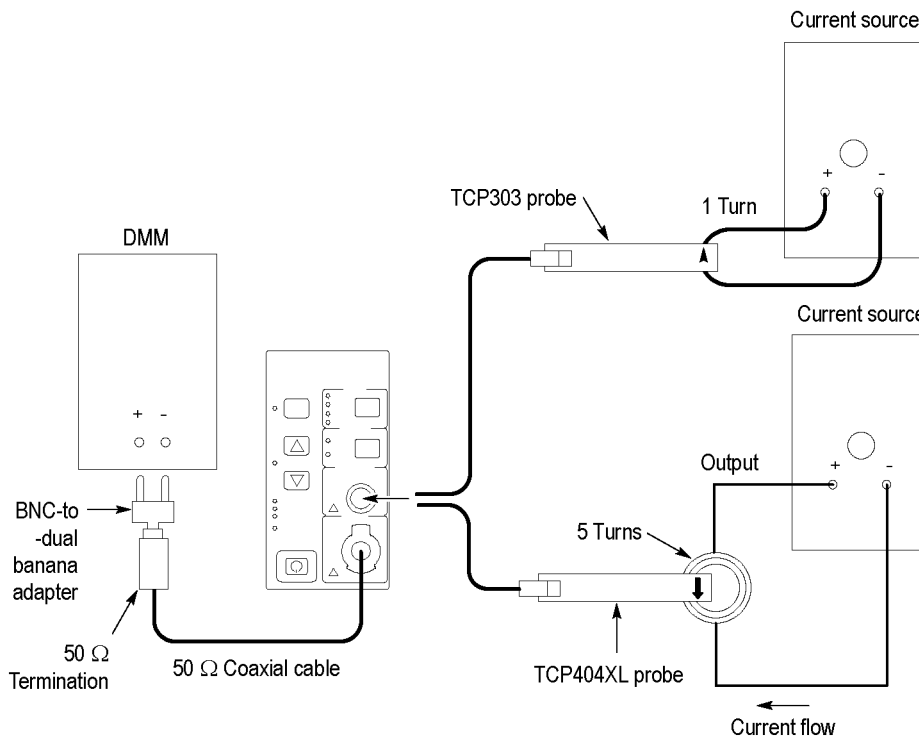


Figure 19: DC gain accuracy adjustment setup

**Equipment Settings** Make or check the equipment settings below. (See Table 32.)

**Table 32: Equipment settings for DC gain accuracy**

<b>Digital multimeter</b>	
Measurement Type	AC volts, autorange
<b>Current source</b>	
Output wave shape/frequency	Square wave, 40 Hz
Output	Off
<b>TCPA300 and TCPA400</b>	
Coupling	DC
Range: TCP303	5 A/V

- Procedure**
1. Do not clamp the current probe around any conductor, but make sure the jaws are locked shut.
  2. Press the amplifier PROBE DEGAUSS AUTOBALANCE button. Wait for the degauss/autobalance routine to complete before proceeding. The routine is complete when the indicator light turns green.
  3. Connect the current probe to the appropriate current loop. (One-turn for the TCP303 and 5-turn for the TCP404XL.)
  4. Perform the following steps with this information: (See Table 33.)
    - a. Set the current source output to the correct current level.
    - b. Enable the output of the current source.
    - c. Adjust the DC gain adjustment on the probe to the expected output value shown. (See Table 33.)

**Table 33: DC gain accuracy adjustments for the TCP303 and TCP404XL**

Probe	Range	Current source output (A pk)	Expected output, $V_E$ (mVAC)	Minimum output, mVAC	Maximum output, mVAC
TCP303	5 A/V	1.5 A	300.00	299.00	301.10
TCP404XL	1A/mV	5 A	25.00	24.91	25.09

5. Remove the probe from the current loop.
6. If the DC gain adjustment was adjusted, verify the pulse response by repeating this procedure. (See page 51, *TCP303 and TCP404XL Transient Response and Coarse Gain Adjustment*.)
7. When the probe adjustments are done, reinstall the probe access plugs for the 1  $\mu$ s, 10  $\mu$ s, and DC Gain adjustments.



---

# Maintenance

This section describes the preventive maintenance and repair procedures for the amplifiers and probes.

## Service Strategy

The amplifiers have some mechanical and electrical parts that may be replaced by the user. The TCP303 and TCP404XL probes can also be repaired to component level. The TCP305A and TCP312A probes use a slender form factor that do not contain any user-serviceable parts.

## Preventive Maintenance

The TCPA300 and TCPA400 Current Probe Amplifiers and current probes require little maintenance during normal use. The primary maintenance involves cleaning accumulated dirt from the probe body and, if necessary, cleaning the exposed core surfaces in the probe jaw.

**General Care** Protect the instrument from adverse weather conditions. The instrument is not waterproof.



**CAUTION.** *To avoid damage to the instrument, do not expose it to sprays, liquids, or solvents. Do not use chemical cleaning agents; they may damage the instrument. Avoid chemicals that contain benzene, toluene, xylene, acetone, or similar solvents.*

---

### Cleaning the Exterior

Clean the exterior surfaces of the instrument with a dry, lint-free cloth or a soft-bristle brush. If dirt remains, use a cloth or swab dampened with a 75% isopropyl alcohol solution. A swab is useful for cleaning in narrow spaces around the controls and connectors. Do not use abrasive compounds on any part of the instrument.



**CAUTION.** *Avoid getting moisture inside the instrument during exterior cleaning and use only enough solution to dampen the cloth or swab. Use a 75% isopropyl alcohol solution as a cleanser, and rinse with deionized water.*

---

## Disassembly

To access the internal adjustments or to replace internal components of the amplifiers, you need to remove the instrument case and internal covers. This section covers the disassembly of the amplifiers. Current probe procedures are described later in this section.

### Amplifiers

Use these procedures when making adjustments or replacing components in the amplifiers.



**WARNING.** *Amplifier disassembly must be performed by qualified service personnel at an antistatic workstation to avoid personal injury or loss of life.*

The following components are replaceable:

- Outer Case
- Front Panel Assembly
- Amplifier Board
- Power Supply
- Fan

### Equipment Required

Use the listed equipment to replace the internal components.

**Table 34: Equipment required**

Qty	Description
1	#2 Phillips screwdriver
1	T-15 screwdriver
1	Long-nose pliers
1	3/8-inch nutdriver or wrench
1	Torque wrench
1	Antistatic wrist strap



## Removing the Outer Case and Internal Covers

To replace internal components, you need to remove the outer case and internal covers. You may also want to remove the case and covers to access the internal adjustments. The following procedures describe the removal process:

1. Disconnect the AC cord and any probes or cables from the amplifier.
2. Remove the 3 screws from the rear of the amplifier and slide the case off the rear side of the amplifier as shown.

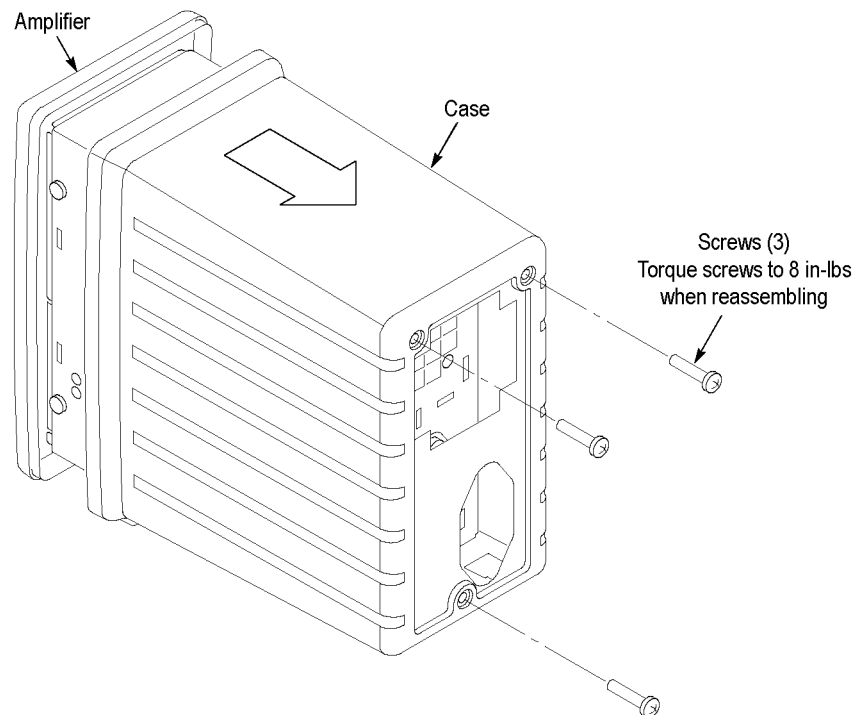
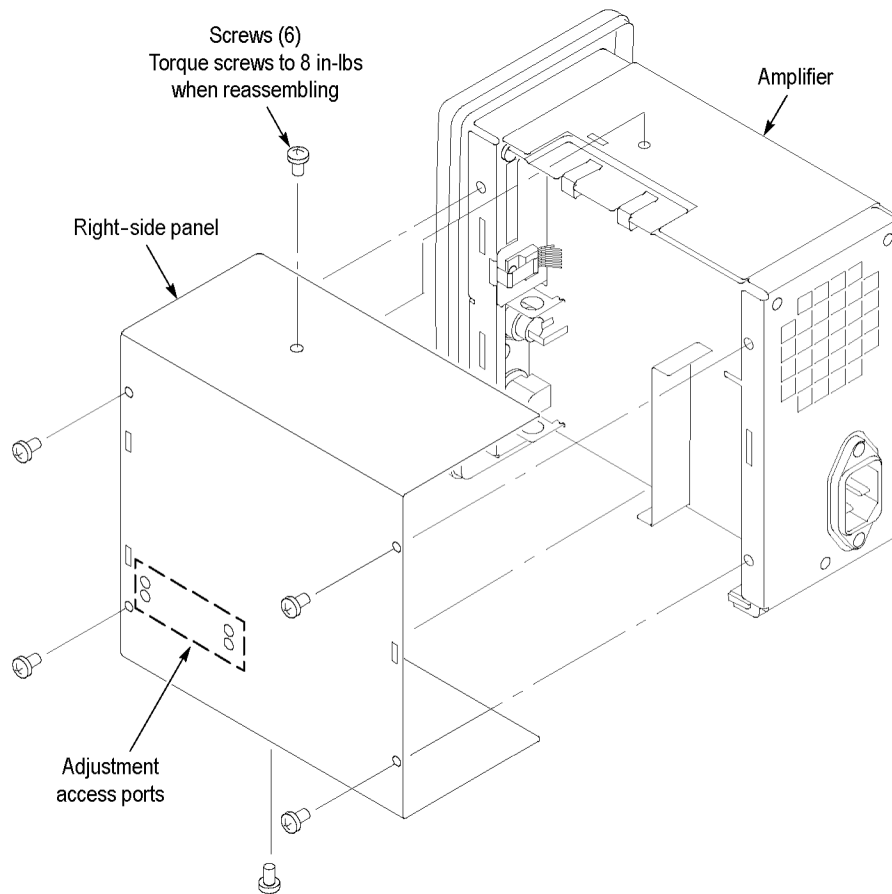


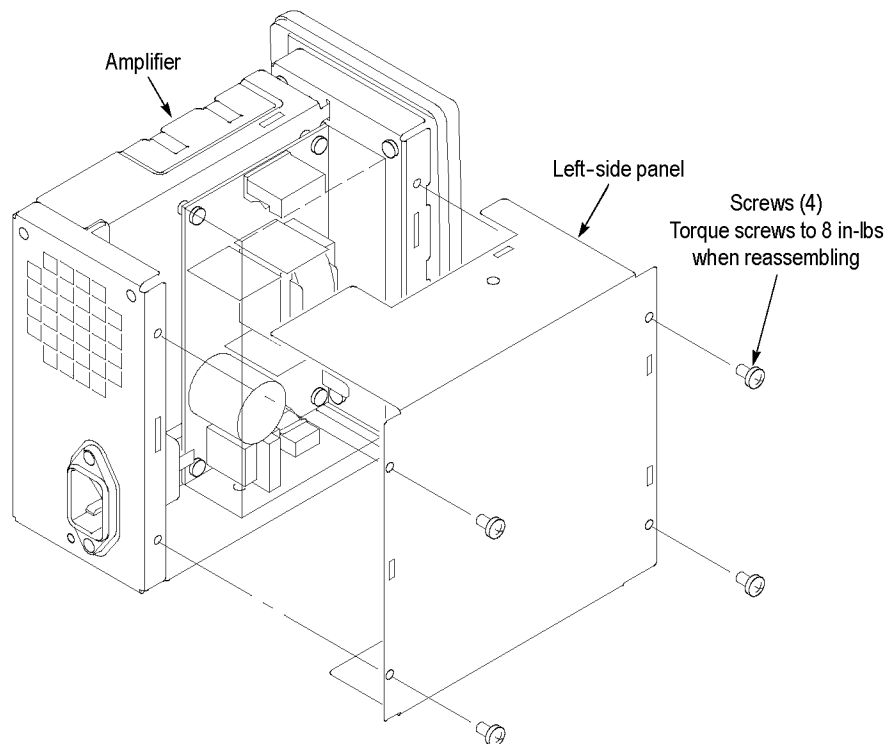
Figure 20: Removing the case from the amplifier

3. Remove the 6 screws that secure the right-side inner panel to the chassis.



**Figure 21: Removing the right-side inner panel**

4. Remove the 4 screws that secure the left-side inner panel to the chassis.



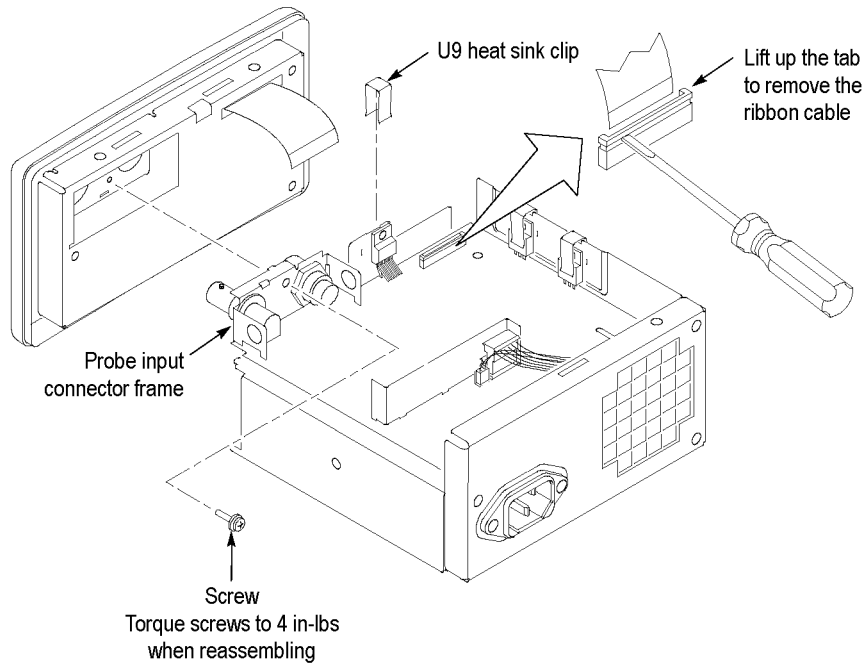
**Figure 22: Removing the left-side inner panel**

You now have exposed access to the amplifier adjustments. If you need to replace any of the internal components, refer to the following instructions.

## Replacing the Front Panel Assembly

If you need to replace the Front Panel Assembly, do the following:

1. Wear an antistatic wriststrap when handling the circuit assemblies.
2. Using pliers, remove the heat sink clip from U9 as shown.



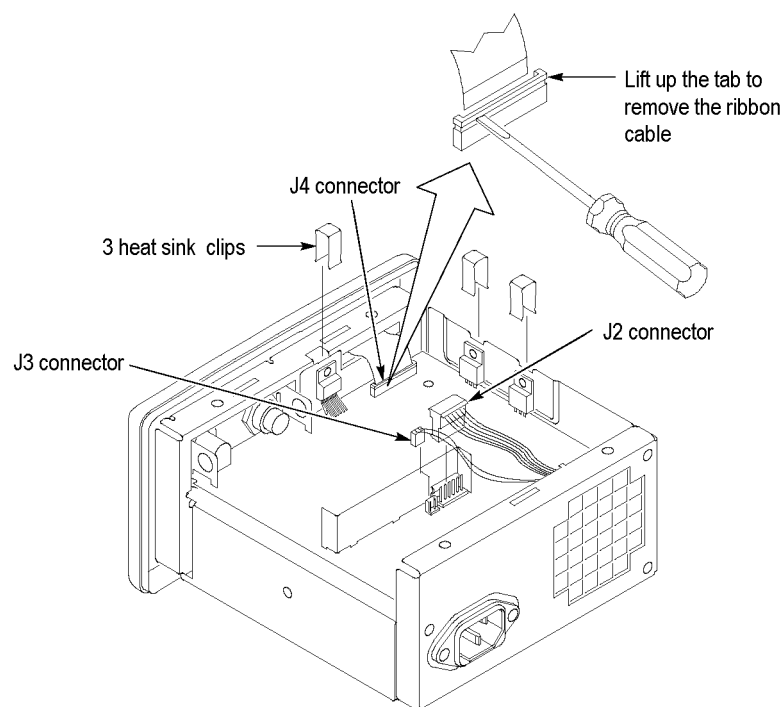
**Figure 23: Disconnecting the front-panel assembly**

3. Disconnect the front-panel ribbon connector from J4 on the amplifier board. Release the tab on the connector by carefully lifting the ends of the tab before removing the ribbon cable from the connector as shown.
4. Remove the screw that attaches the probe input connector frame to the front-panel assembly. Pull the front-panel assembly away from the amplifier.
5. Do in reverse steps 4 through 1 to install a new front-panel assembly.

## Replacing the Amplifier Board

If you need to replace the amplifier board, you must detach the rear- and front-panel assemblies of the amplifier from the chassis.

1. Wear an antistatic wriststrap when handling the circuit assemblies.
2. Remove the 2 Phillips screws that attach the AC power connector to the rear panel.
3. Gently pull back the rear panel enough to allow clearance for the amplifier board.
4. Disconnect the DC power supply connector from J3 on the amplifier board.
5. Disconnect the fan connector from J2 on the amplifier board.
6. Using pliers, remove the three heat sink clips from U9, Q18, and Q21 as shown.



**Figure 24: Removing the three heat sink clips**

7. Disconnect the front-panel ribbon connector from J4 on the amplifier board. Be sure to carefully release the tab on the connector before removing the ribbon cable from the connector. Only lift the ends of the tab to release it from the connector. (See Figure 24.)

8. Remove the screw that attaches the probe input connector to the front panel amplifier board to the chassis. Pull the front panel assembly away from the amplifier and set it aside as shown.
9. Remove the three screws that attach the amplifier board to the chassis.
10. Do in reverse steps 9 through 2 to install a new amplifier board.

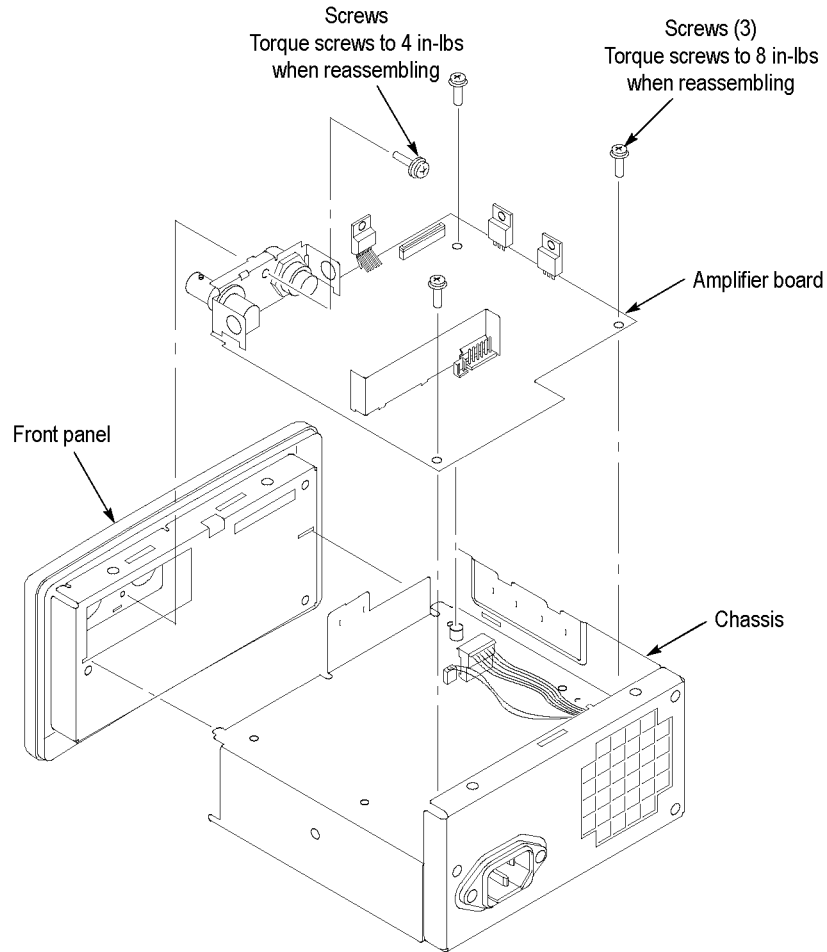
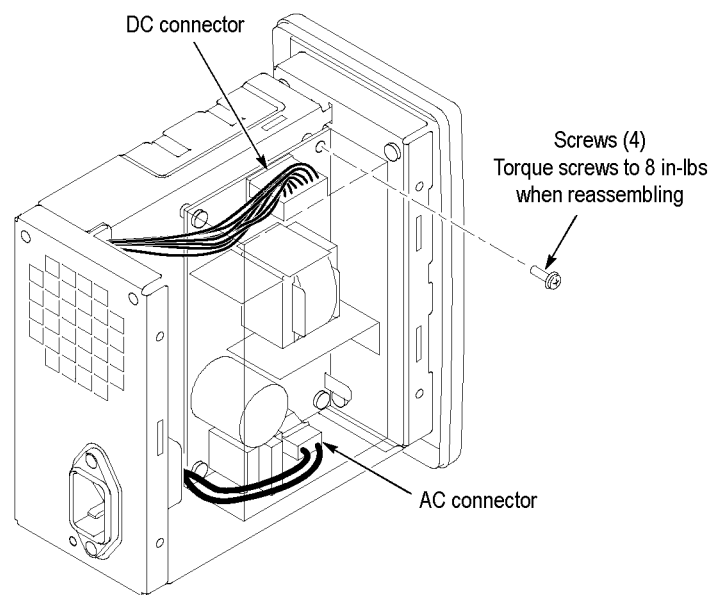


Figure 25: Removing the amplifier board

## Replacing the Power Supply

To replace the power supply, do the following:

1. Disconnect the AC and DC power connectors from the power supply.
2. Remove the four screws from the power supply.
3. Remove the power supply from the chassis.
4. Do in reverse steps 3 through 1 to install a new power supply.

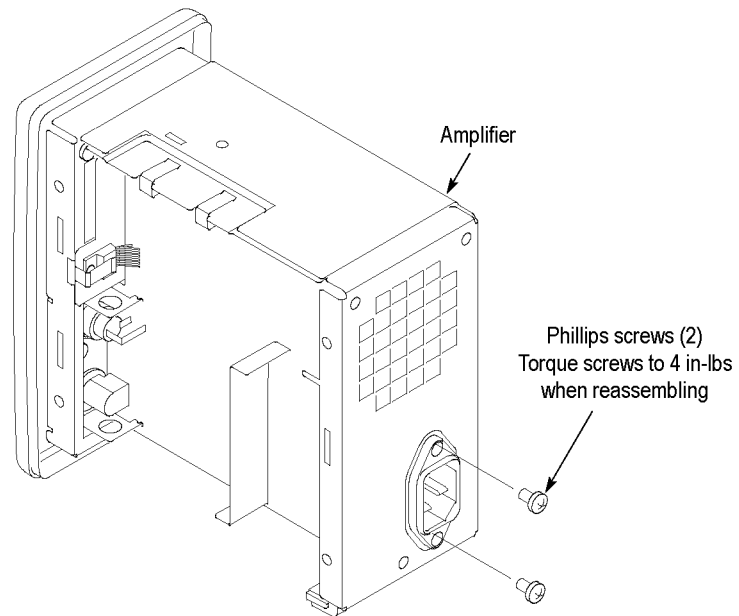


**Figure 26: Replacing the power supply**

## Replacing the Fan

If you need to replace the fan, you must first detach the rear panel of the amplifier from the chassis to gain access to the fan:

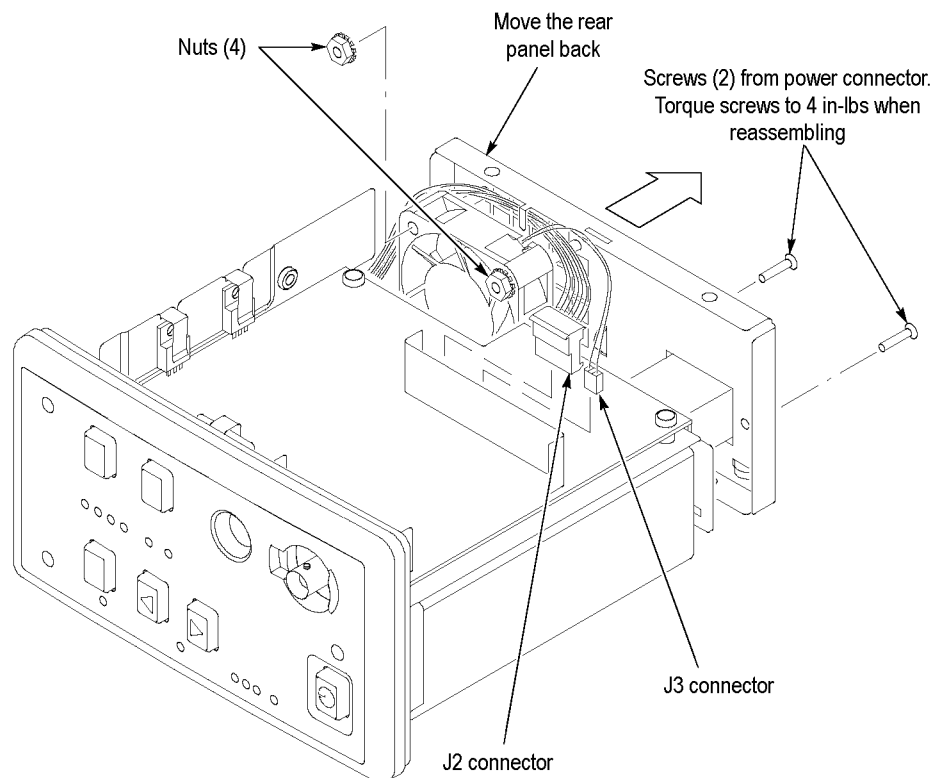
1. Remove the 2 Phillips screws that attach the AC power connector to the rear panel as shown. (See Figure 27.)



**Figure 27: Removing the AC power connector**



2. Disconnect the DC power supply connector from J2 on the amplifier board as shown. (See Figure 28.)
3. Disconnect the fan connector from J3 on the amplifier board.
4. Gently pull back the rear panel enough to allow access to the four nuts that secure the fan to the rear panel.



**Figure 28: Removing the fan**

5. Remove the four 3/8-inch nuts that secure the fan to the rear panel.
6. Lift the fan off of the four studs on the rear panel.
7. Do in reverse steps 6 through 2 to install a new fan. Be careful not to pinch the power supply cable wires under the fan.

## Probes

Use these procedures when repairing or replacing defective components in the current probes.



**WARNING.** *Probe disassembly must be performed by qualified service personnel to avoid personal injury or loss of life.*

The probes that mate with the TCPA300 and TCPA400 Current Probe Amplifiers have two physical styles. The TCP305A and TCP312A probes use a slender form factor that do not contain any user-serviceable parts.

The TCP303 and TCP404XL use a pistol-style case with an integral hand grip. These probes contain three replaceable assemblies: the connector/cable, the circuit board, and the current transformer. Both probes use a few mechanical components that are replaceable, such as springs and plastic parts.

## Equipment Required

Listed is the required equipment to service the probes.

**Table 35: Equipment required**

Qty	Description
1	#2 Phillips screwdriver
1	Isopropyl alcohol
1	Silicone-based grease
1	25 W soldering iron

## TCP303 and TCP404XL

The following procedures explain how to disassemble the probe body and replace the current transformer, the circuit board, and the cable assembly.



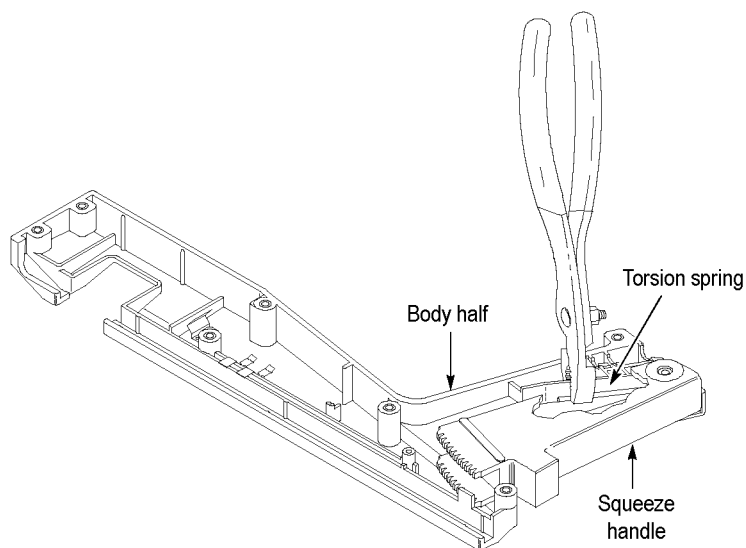
**WARNING.** Probe disassembly must be performed by qualified service personnel to avoid personal injury or loss of life.

1. Unlock the probe slide.
2. Place the probe on a flat surface with the screw heads facing up.
3. Using a  $\frac{3}{32}$  inch Allen wrench, remove the eight retaining screws from the case.
4. While holding the squeeze handle and slide, lift the top part of the probe body off.
5. Remove the slide.



**WARNING.** There is a spring in the squeeze handle that can pop out and cause personal injury unless care is exercised when disassembling the probe.

6. Lift the cable out of the probe handle and insert a pair of pliers in the handle as shown.



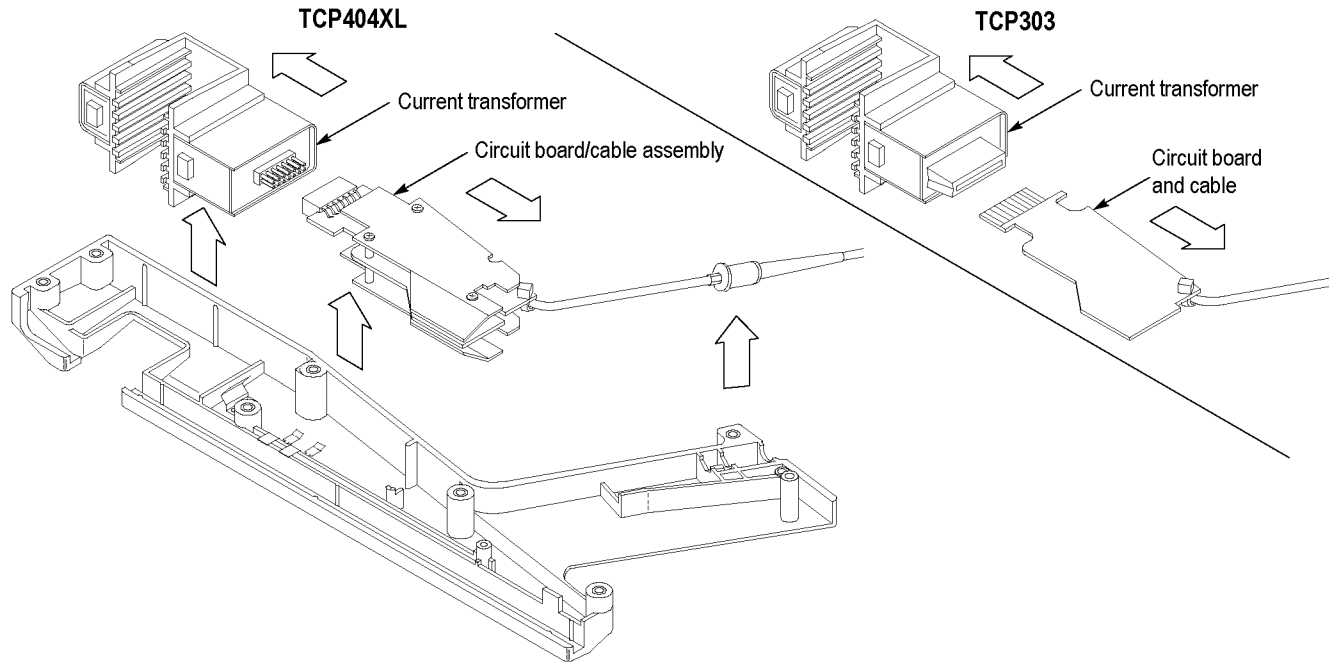
**Figure 29: Removing the handle**

7. While maintaining a firm grip on the pliers, carefully lift the squeeze handle and gear out of the probe. (See Figure 29.) (See Figure 30 on page 72.)

**Removing the Current Transformer**

Remove the current transformer of the probe as follows:

8. To remove the current transformer, lift the assembly out of the probe as shown and unplug it from the circuit board.



**Figure 30: Removing the current transformer**

**Removing the Circuit Board or Cable (TCP303)**

The circuit board and cable are replaceable separately on TCP303 probes (see note).

---

**NOTE.** The circuit board and cable on TCP303 probes are replaceable separately on probes with serial number B020000 and above.

For TCP303 probes with a serial number below B020000, the original transformer and cable/circuit board subassemblies must be replaced as a set. (Order Replacement Kit Number 050-3663-XX.) This kit updates the probe to the equivalent of a serial number B020000 and above, allowing the separate components to be replaced in the future.

---

9. To remove the circuit board, cut the cable tie that secures the cable to the board, and then disconnect the cable from the board. (See Figure 31 on page 73.) When reassembling the probe, do not tighten the new cable tie until you seat the board and cable in the probe case, to allow enough cable length for a proper fit.

10. To remove the cable, do step 9 and then unsolder the two switch wires.

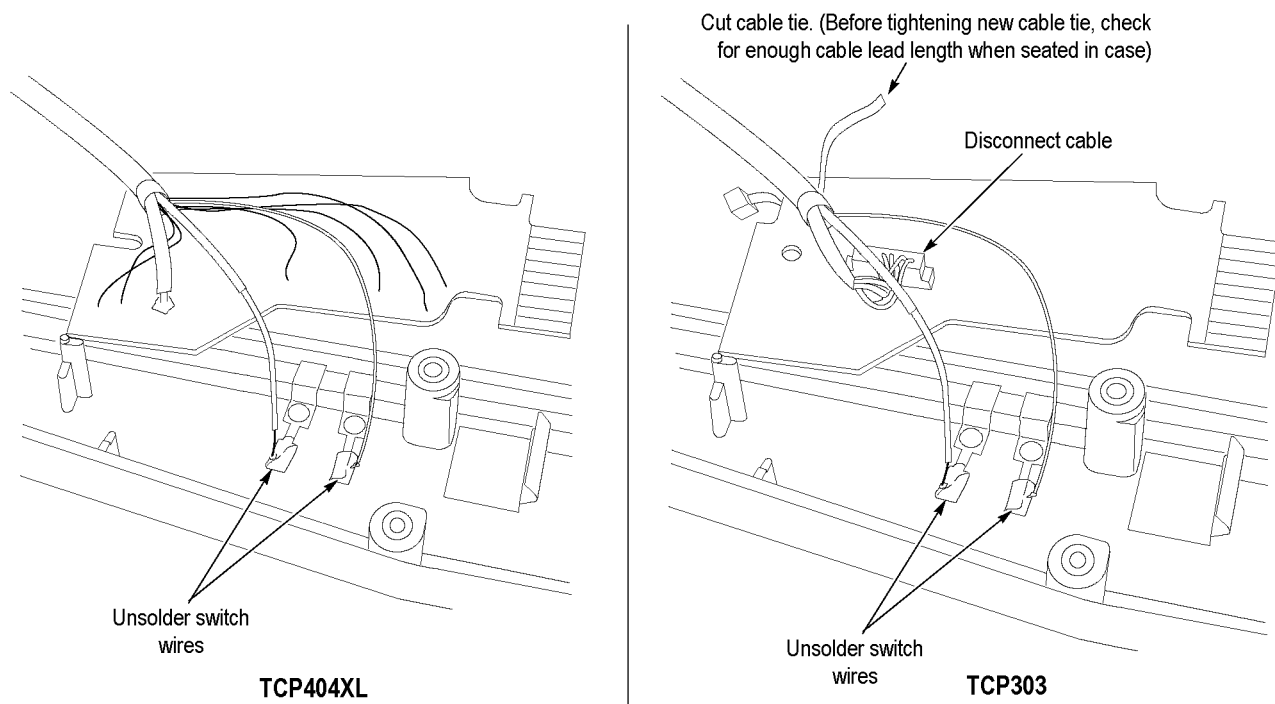


Figure 31: Removing the circuit board and cable

### Removing the Circuit Board and Cable Assembly (TCP404XL)

The circuit board and cable are replaced as an assembly on TCP404XL probes.

11. Observe the routing of the switch leads through the circuit board shield. It is important that you route the leads in the same way when you replace the assembly. Desolder the two leads from the slide switch as shown and lift the circuit board and cable clear.

### Reassembling the Probe

Reassemble the probe by doing the following:

1. Before reassembling the probe, be sure to clean the gap between the stationary and moveable core pieces. If necessary, clean the core pieces using a lint-free cloth and water or isopropyl alcohol (IPA). Also, clean the contacts of the slide switch, if necessary.
2. Should the plastic slide assembly require lubrication, sparingly apply silicone-based grease to the parts.
3. Probe reassembly is the reverse of steps 1 through 10 or 11, depending on the probe model and what you are replacing. You may need to squeeze the handle slightly to align the gear teeth with the slide rack.

## Isolating Hardware Faults

Use the following procedures to help locate a hardware malfunction.

You can isolate the symptoms to the amplifier or probe by substituting a known good probe or amplifier. If you suspect that you have a defective probe and you don't have another compatible probe, you can use the calibration adapter in place of the probe to verify some of the amplifier functions.

Information about some of the failures that can occur with the amplifiers and probes is listed. (See Table 36.) (See Table 37.)

**Table 36: Amplifier hardware faults**

Symptom	Possible cause	Repair action
Amplifier does not power on. LEDs do not turn on and fan does not work.	Internal power supply problem Connector loose between main board and front panel Front panel is defective	Check for +15 V on power supply connector J2, pin 1 at main board. If OK, replace amplifier board. If not, replace power supply. Secure ribbon cable from front-panel assembly to main board Replace front-panel assembly
LEDs do not turn on and fan works.	Internal power supply problem Connector loose between main board and front panel Front panel is defective	Check for +15 V on power supply connector J2, pin 1 at main board. If OK, check power supply test points on main board: +5VD, +5VA, -5VA, +10V, -10V. If these voltages check OK, replace the front-panel assembly. If not, replace the main board. Secure ribbon cable from front-panel assembly to main board Replace front-panel assembly
LEDs turn on and fan does not work.	Defective fan or defective power supply	Check for greater than +7V at fan connector J3, pin 1 at main board. If present, replace fan. If not, check for +15 V input from power supply. If +15 V is present, replace the amplifier board. If not, replace the power supply.
LEDs turn on in a random pattern (different than is documented in this manual)	Front panel is defective	Replace front-panel assembly
One amplifier range does not work, other range is OK. (TCPA300 only)	Defective amplifier circuit	Replace main board assembly

**Table 37: Probe hardware faults**

Symptom	Possible Cause	Repair Action
Probe Open LED stays continuously lit, even with the probe slider closed.	Open coil in probe.	Substitute probe with another probe or the Calibration Adapter - if the Probe Open LED goes out, coil is open - repair bad connection or replace coil (TCP303 and TCP404XL probes only).

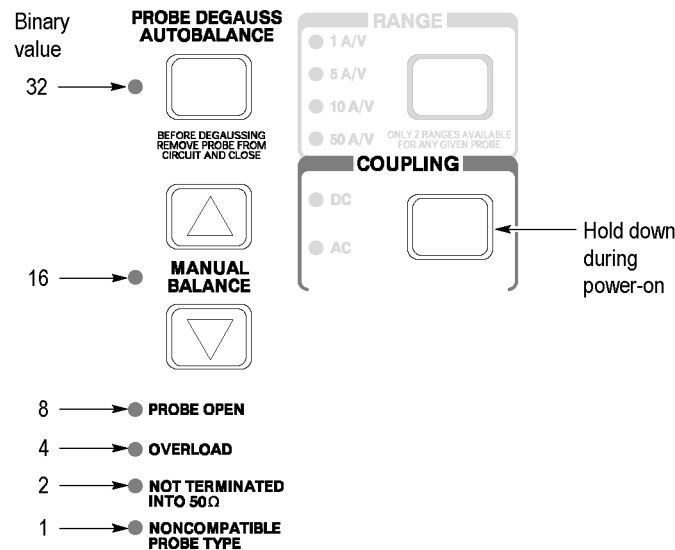
## Determining the Amplifier Firmware Version Number

If you are having a problem with your amplifier, it may be helpful to know the version of firmware that is in the amplifier. The firmware version may help the Technical Support Center to isolate the amplifier symptoms to a specific cause.

To determine the amplifier firmware version number, do the following:

1. Turn the amplifier power off.
2. Press and hold the COUPLING button.
3. Turn the amplifier power on.

After the power-on LED sequence, the LEDs on the far-left side of the front panel show a binary representation of the firmware version number. The firmware version number is the sum of the values for the lit LEDs. Shown are the values each LED represent.



**Figure 32: Displaying the amplifier firmware version number**

For example, if the NONCOMPATIBLE PROBE TYPE LED is lit, the firmware version number is 1.





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# Replaceable Parts

This section contains a list of the components that are replaceable for the TCPA300 and TCPA400. As described below, use these lists to identify and order replacement parts.

## Parts Ordering Information

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

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

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

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

## Using the Replaceable Parts List

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

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

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

# Amplifier Replaceable Parts

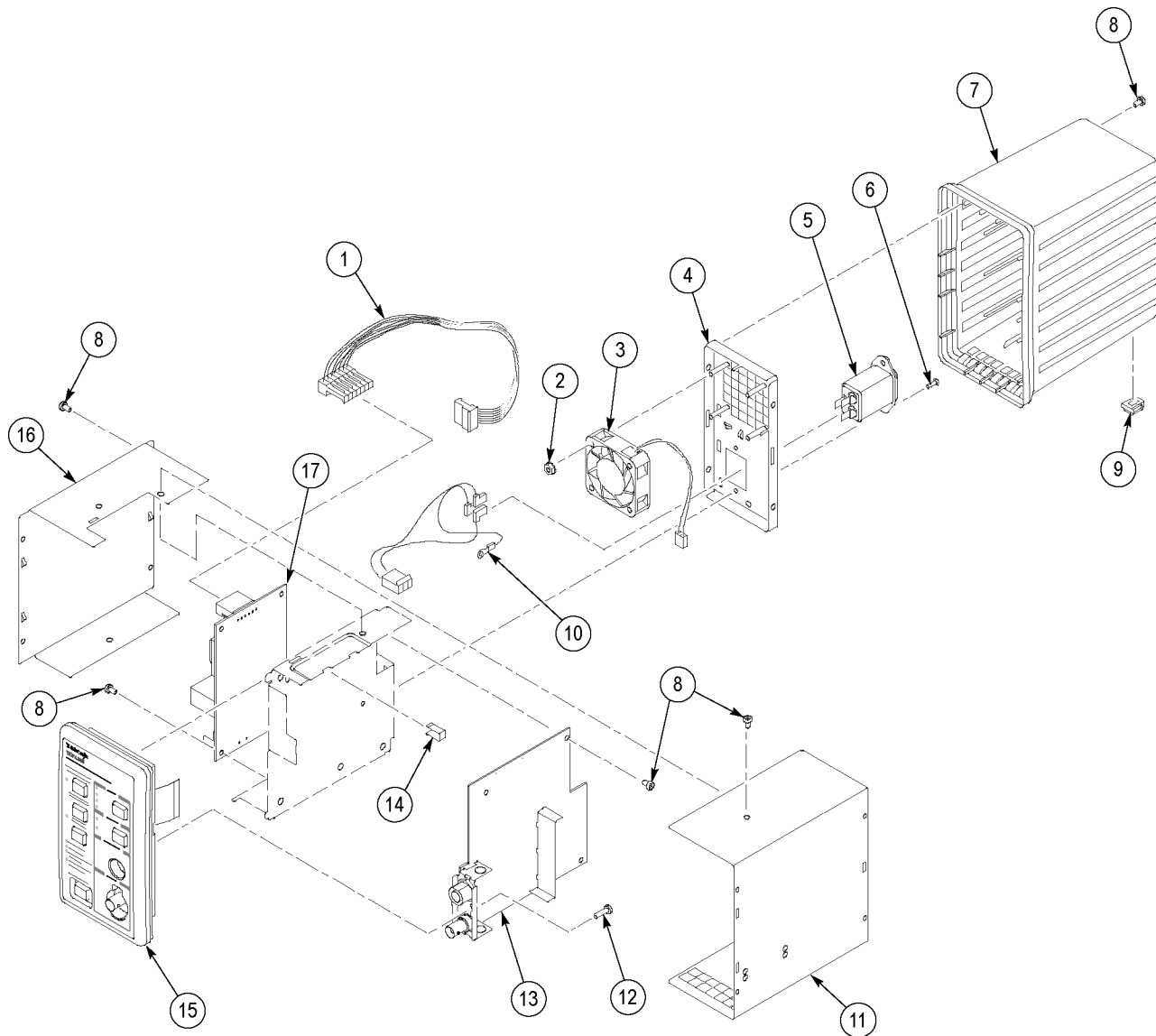
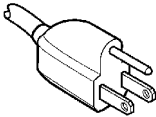
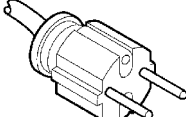
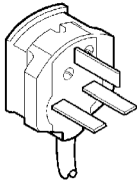
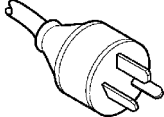
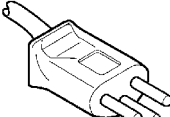
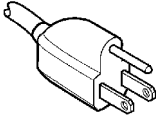
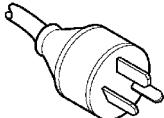


Figure 33: TCPA300 and TCPA400 replaceable parts

Table 38: TCPA300 and TCPA400 replaceable parts list

Fig. & index number	Tektronix part number	Serial no. effective	Serial no. discont'd	Qty	Name & description
38-1	174-4676-XX			1	CABLE ASSEMBLY,DC, POWER SUPPLY
-2	210-0457-XX			4	NUT,PL,ASSEM WA:6-32 X 0.312,STL CD PL,W/LOCKWASHER
-3	119-6721-XX			1	FAN,TUBEAXIAL:12VDC,0.10A,1.2W,14CFM,5600RPM,32DBA,50MM X 50MM X 15MM, W/3.5 IN LEADS, 2-PIN C
-4	050-3547-XX			1	PANEL,REAR:0.046 AL,W/LABEL;TCPA300 /TCPA400
-5	119-0420-XX			1	FILTER,RFI:LINE 6A,250VAC,DC-400HZ,LEAKAGE CURRENT 2UA AT 220V/55HZ,FN223B-6/06
-6	211-0038-XX			2	SCREW,MACHINE:4-40 X 0.312,FLH,100 DEG,STL CD PL,POZ
-7	380-1157-XX			1	HOUSING:MAIN AMPLIFIER,PLASTIC
-8	211-0747-XX			20	SCREW,MACHINE:6-32 X 0.188,PNH,STL,CDPL,T-15 TORX DR
-9	348-1525-XX			2	FOOT:FRONT,SANTOPRENE,BLACK,64 DEROMETER,TEXTURED
-10	174-4721-XX			1	CABLE ASSEMBLY,AC, POWER SUPPLY
-11	390-1213-XX			1	CABINET:RIGHT AMPLIFIER AC,0.032 AL
-12	211-0720-XX			1	SCR,ASSEM WSHR:6-32 X 0.500,PNH,STL,CDPL,T-15 TORX DR,MACHINE
-13	671-5434-XX			1	CIRCUIT BOARD:MAIN,TCPA300
	671-5354-XX			1	CIRCUIT BOARD:MAIN,TCPA400
-14	214-5018-XX			3	HEAT SINK,MISC:CLIP,TO-220 TRANSISTOR,PHOSPHOR BRONZE CLIP FOR TO-220,0.25 IN W X 0.507 IN L, F
-15	614-1018-XX			1	FRONT PANEL ASSY, TCPA300,W/CABLE ASSY,SP:FLAT FLEX
	614-1019-XX			1	FRONT PANEL ASSY, TCPA400,W/CABLE ASSY,SP:FLAT FLEX
-16	390-1209-XX			1	CABINET:LEFT AMPLIFIER DC,0.032 AL
-17	119-6823-XX			1	POWER SUPPLY:40W,AC-DC,90-264 VAC IN,15V 2.6A OR 3.3A (W/20 CFM AIRFLOW) OUT,SAFETY CONTROLLED

**Table 39: Power cord identification**

Plug configuration	Normal usage	Option number/
	North America 120 V	Standard 161-0066-00
	Universal Euro	A1 161-0066-09
	United Kingdom	A2 161-0066-10
	Australia	A3 161-0066-11
	Switzerland	A5 161-0154-00
	Japan	A6 161-A005-00
	China	AC 161-0306-00
	No power cord supplied.	A99

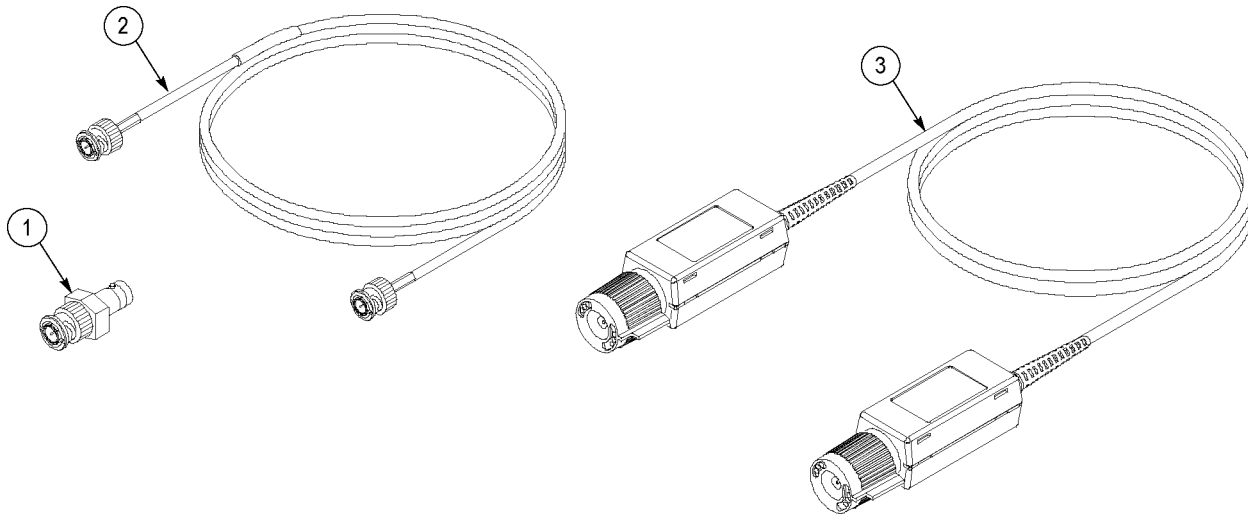


Figure 34: TPCA300 and TPCA400 standard accessories

Table 40: TPCA300 and TPCA400 standard accessories parts list

Fig. & index number	Tektronix part number	Serial no. effective	Serial no. discont'd	Qty	Name & description
39-1	011-0049-XX			1	TERMINATOR,BNC:COAXIAL,50 OHMS,2W,BNC
-2	012-0117-XX			1	CABLE ASSY:COAX,RFD,50 OHM,30.0L,MALE,BNC X MALE,BNC
-3	012-1605-XX			1	CABLE ASSY RF:TEKPROBE INTERFACE
	020-3025-XX			1	DOCUMENTATION KIT, TPCA300/400 AMPS & TCP300/400 PROBES, INCLUDES DOCUMENTATION CD AND PRINTED SAFETY & INSTALLATION BOOKLET

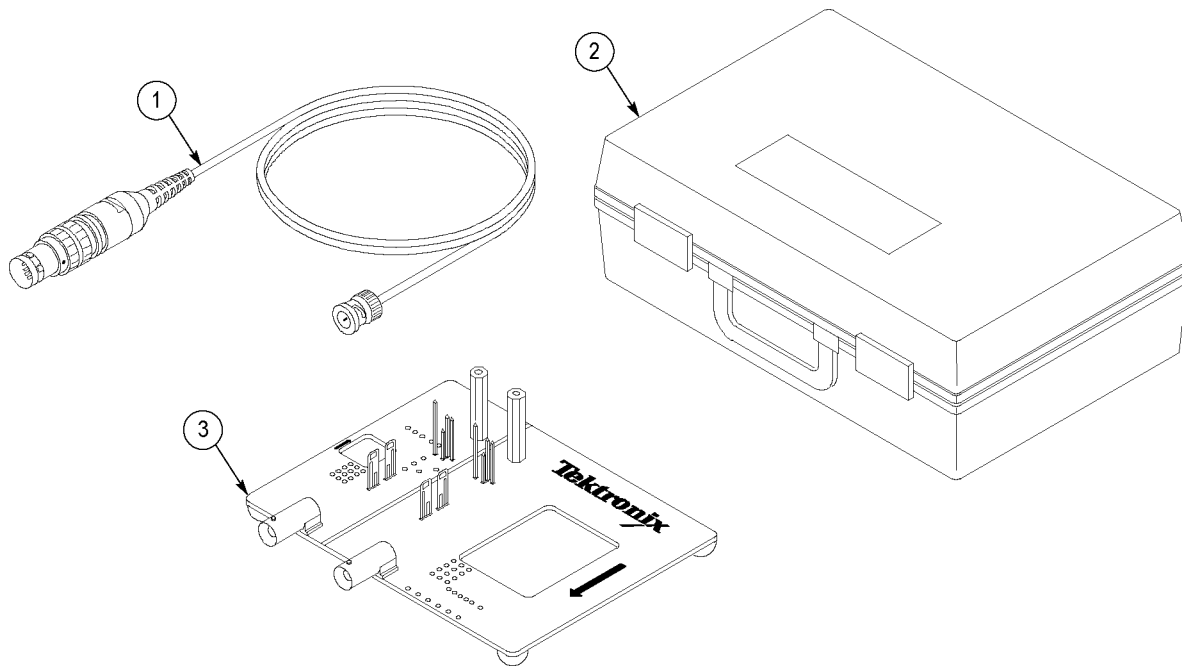


Figure 35: TPCA300 and TPCA400 optional accessories

Table 41: TPCA300 and TPCA400 optional accessory parts list

Fig. & index number	Tektronix part number	Serial no. effective	Serial no. discont'd	Qty	Name & description
40-1	174-4765-XX			1	CABLE ASSY, CALIBRATION ADAPTER
-2	016-1922-XX			1	CASE, TRANSIT, CURRENT MEASUREMENT SYSTEM
-3	067-1478-XX			1	POWER MEASUREMENTS DESKEW FIXTURE, TCP200,TCP300, A6300 SERIES PROBES
	TDSPWR2			1	TDSPWR2 POWER MEASUREMENT AND ANALYSIS SOFTWARE

# Current Probes Replaceable Parts

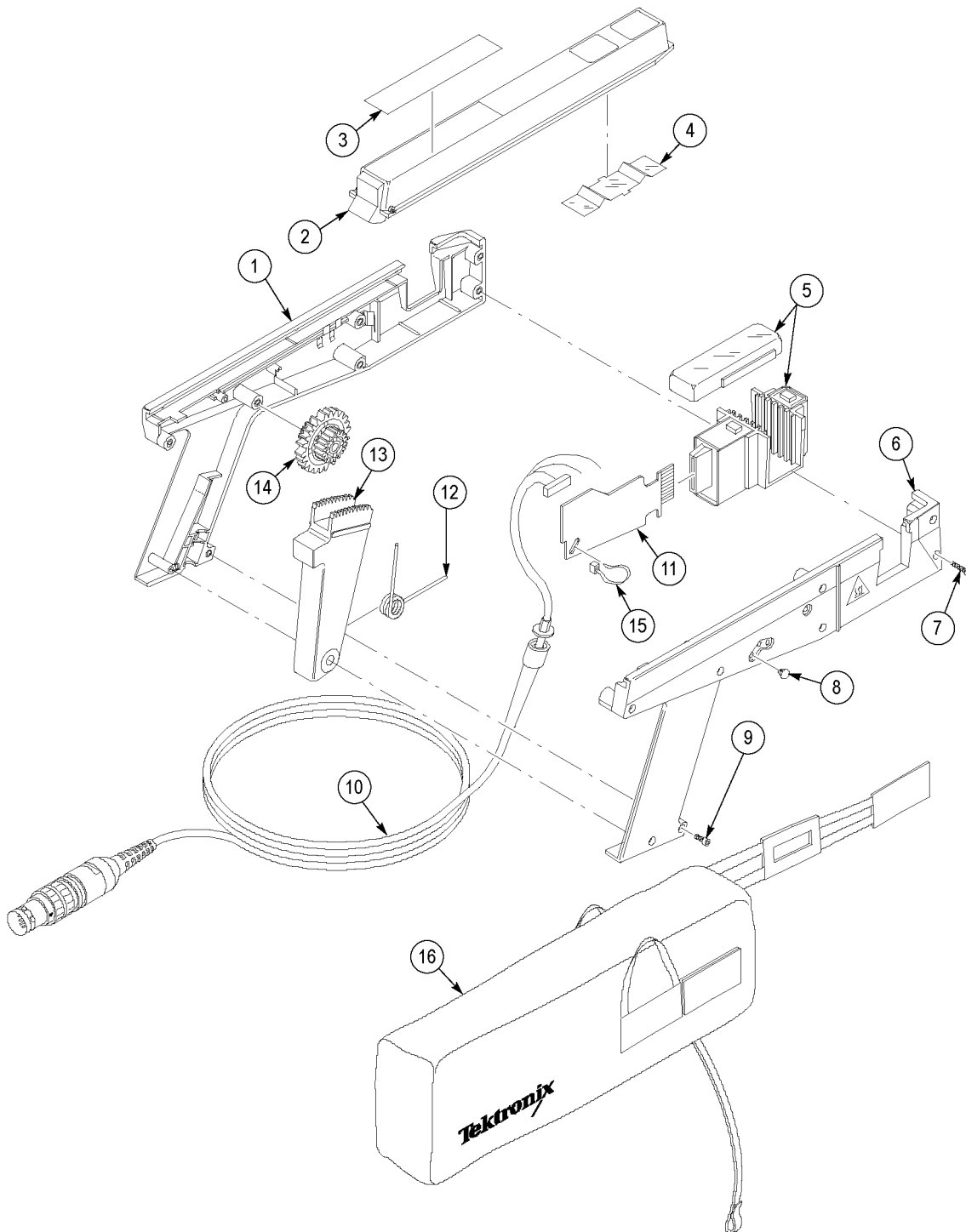


Figure 36: TCP303 replaceable parts

**Table 42: TCP303 replaceable parts list**

Fig. & Index Number	Tektronix Part Number	Serial Number Effective	Serial Number Discont'd	Qty	Name & Description
42-1	204-0713-XX			1	BODY HALF,PROBE:LEFT W/CONTACTS
-2	351-0955-XX			1	SLIDE ASSEMBLY:WITH WARNING LABEL
-3	335-0912-XX			1	MARKER,IDENT:PROBE ID LABEL,TCP303
-4	214-2422-XX			1	SPRING,FLAT:UPPER CAN
-5	050-3663-XX <sup>1</sup>	B010000	B019999	1	TRANSFORMER:SUBASSEMBLY, TOP AND BOTTOM, TCP303
	120-2028-XX	B020000		1	TRANSFORMER:SUBASSEMBLY, TOP AND BOTTOM, TCP303
-6	204-0712-XX			1	BODY HALF,PROBE:RIGHT W/CONTACTS
-7	211-0093-XX			6	SCREW,CAP:4-40 X 0.75,SCH,STL,CD PL,HEX REC
-8	348-0023-XX			4	PLUG,HOLE:U/W0.14 DIA HOLE,WHT PLSTC
-9	211-0183-XX			2	SCREW,CAP:4-40 X 0.5,SCH,STL,CD PL,HEX REC
-10	050-3663-XX <sup>1</sup>	B010000	B019999	1	PROBE SUBASSY, TESTED BOARD AND CABLE, TCP303
	174-4962-XX	B020000		1	CABLE ASSEMBLY, TCP303, RF, COAX, 12 COND, JBX CONNECTOR, SAFETY CONTROLLED, W/LEMO CONNECTOR
-11	050-3663-XX <sup>1</sup>	B010000	B019999	1	PROBE SUBASSY, TESTED BOARD AND CABLE, TCP303
	679-6287-XX	B020000		1	CIRCUIT BOARD ASSEMBLY, TCP303
-12	214-2446-XX			1	SPR,HLCL,TRSN:0.1 OD X 0.5 L,MUSIC WIRE
-13	367-0218-XX			1	HANDLE,SQUEEZE:PROBE P6301
-14	401-0352-XX			1	GR CLUSTER,SPUR:(2)18 AND (1) 24 T,PLASTIC
-15	343-0149-XX			1	STRAP, TIEDOWN,E,6.75L,PLASTIC
<b>Standard Accessories</b>					
-16	016-1924-XX			1	COVER,PROBE,LARGE
	071-1185-XX			1	INSTRUCTION SHEET,TCP300/400 SERIES CURRENT PROBES

<sup>1</sup> TCP303 probes with S/N B010000 - B019999: The original transformer and cable/circuit board subassemblies must be replaced as a set. (Order Replacement Kit Number 050-3663-XX.) This kit updates the probe to the equivalent of a serial number B020000 and above, allowing the separate components to be replaced in the future.



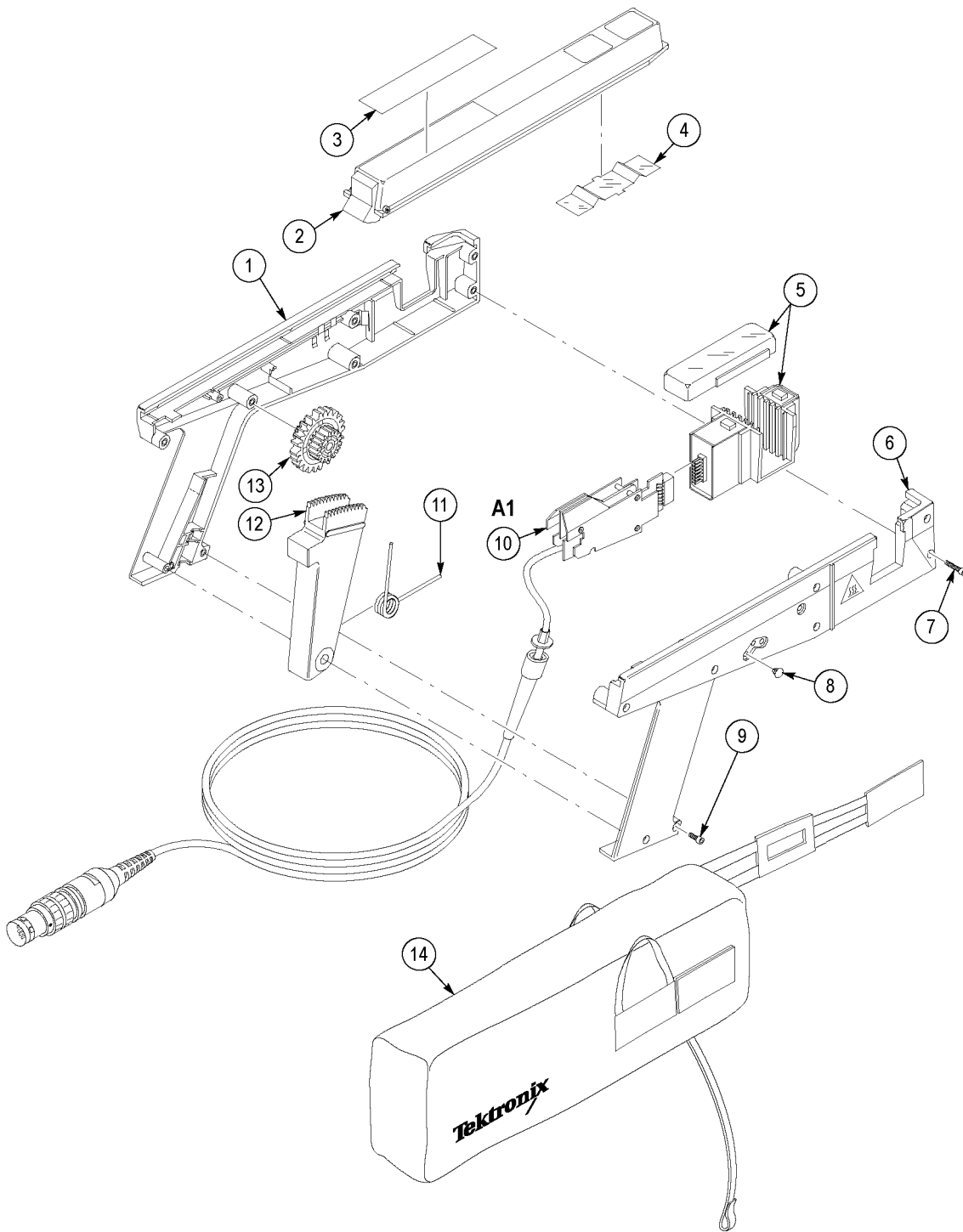


Figure 37: TCP404XL replaceable parts

**Table 43: TCP404XL replaceable parts list**

<b>Fig. &amp; Index Number</b>	<b>Tektronix Part Number</b>	<b>Serial No. Effective</b>	<b>Serial No. Discont'd</b>	<b>Qty</b>	<b>Name &amp; Description</b>
43-1	204-0713-XX			1	BODY HALF,PROBE:LEFT W/CONTACTS
-2	351-0955-XX			1	SLIDE ASSEMBLY:WITH WARNING LABEL
-3	335-0913-XX			1	MARKER,IDENT:PROBE ID LABEL,TCP404XL
-4	214-2422-XX			1	SPRING,FLAT:UPPER CAN
-5	120-1962-XX			1	TRANSFORMER:SUBASSEMBLY, TOP AND BOTTOM, TCP404XL
-6	204-0712-XX			1	BODY HALF,PROBE:RIGHT W/CONTACTS
-7	211-0093-XX			6	SCREW,CAP:4-40 X 0.75,SCH,STL,CD PL,HEX REC
-8	348-0023-XX			4	PLUG,HOLE:U/W0.14 DIA HOLE,WHT PLSTC
-9	211-0183-XX			2	SCREW,CAP:4-40 X 0.5,SCH,STL,CD PL,HEX REC
-10	174-4816-XX			1	PROBE SUBASSY, TESTED BOARD AND CABLE, TCP404XL
-11	214-2446-XX			1	SPR,HLCL,TRSN:0.1 OD X 0.5 L,MUSIC WIRE
-12	367-0218-XX			1	HANDLE,SQUEEZE:PROBE P6301
-13	401-0352-XX			1	GR CLUSTER,SPUR:(2)18 AND (1) 24 T,PLASTIC
<b>Standard Accessories</b>					
-14	016-1924-XX			1	COVER,PROBE,LARGE
	071-1185-XX			1	INSTRUCTION SHEET,TCP300/400 SERIES CURRENT PROBES

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# Glossary

## **amp-second product**

The unit of measure defining the maximum amount of pulsed current that can be measured before the probe core becomes saturated. The amp-second rating applies only to measurement values between the maximum continuous and maximum pulse current ratings of the probe. The amp-second rating is equal to the peak current multiplied by the pulse width at the 50% point.

## **auto-balance**

A process that removes unwanted DC offsets from the TCPA300 and TCPA400 circuitry to ensure maximum measurement accuracy. This process is performed during the probe degauss routine.

## **bucking current**

Current fed back by the TCPA300 and TCPA400 to the current probe during DC and low-frequency AC measurements. Bucking current nulls most of the magnetic field in the probe core, allowing linear DC and AC measurements simultaneously.

## **conventional current flow**

The flow of the positive charge in a conductor. Conventional current flow is from positive to negative. The arrows on current probes point in the direction of conventional current flow. Conventional current flow is in the opposite direction of *electron current flow*.

## **degauss**

A process of eliminating residual magnetism from the probe core by feeding a decaying sine wave into the core. The degaussing process should be performed before clamping the probe around a conductor, whenever the probe becomes saturated by current overloads, or whenever the probe is exposed to a magnetic field. The term is derived from one of the units of magnetic flux density.

## **electron current flow**

The flow of the electrons in a conductor. Electron current flow is from negative to positive. The arrows on current probes point in the opposite direction of electron current flow. Electron current flow is in the opposite direction of *conventional current flow*.

## **flux**

The density of a magnetic field. As the number of flux lines increases, the magnetic field strength increases. Current in the conductor under test generates flux lines in the probe core by inducing a voltage in the core.

**Hall device**

A thin, rectangular piece of semiconductor material located in the core of the current probe. The Hall device uses the Hall effect for DC and low-frequency AC measurements.

**Hall effect**

The effect that produces a voltage potential in the Hall device when magnetic lines of flux pass through the device. The voltage potential is directly proportional to the magnetic field strength. The voltage polarity is determined by the magnetic field polarity. A bias supply is required to produce the Hall effect. The TCP300A and TCP400 Series current probes use the Hall effect for DC and low-frequency AC measurements.

**insertion impedance**

The equivalent series impedance introduced to a test circuit when the current probe is clamped around a test conductor.

**magnetic susceptibility**

A figure expressing the amount of current induced into the probe by an external magnetic field of known intensity. The lower the figure is, the less the probe is influenced by external magnetic fields.

**saturation**

A condition that occurs when the magnetic field strength in the probe core exceeds the maximum level that the core can absorb. When saturation occurs the probe no longer responds linearly to an increase in magnetic field strength, resulting in measurement inaccuracies. A current overload condition will cause core saturation. After saturation occurs, the probe core usually retains residual magnetism, which continues to produce inaccuracies until the probe is degaussed. The probe should be degaussed after saturation occurs.

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