

# Instructions

**Tektronix**

**CT-1/CT-2  
Current Transformer**

**070-7957-01**

**CE**

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Printed in the U.S.A.

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In order to obtain service under this warranty, Customer must notify Tektronix of the defect before the expiration of the warranty period and make suitable arrangements for the performance of service. Tektronix will provide such service at Customer's site without charge during the warranty period, if the service is performed within the normal on-site service area. Tektronix will provide on-site service outside the normal on-site service area only upon prior agreement and subject to payment of all travel expenses by Customer. When or where on-site service is not available, Customer shall be responsible for packaging and shipping the defective product to the service center designated by Tektronix, with shipping charges prepaid. Tektronix shall pay for the return of the product to Customer if the shipment is to a location within the country in which the Tektronix service center is located. Customer shall be responsible for paying all shipping charges, duties, taxes, and any other charges for products returned to any other locations.

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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.

## To Avoid Fire or Personal Injury

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

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

**Ground the Product.** To avoid electric shock, the mounting stud must be connected to earth ground.

**Do Not Operate in Wet/Damp Conditions.**

**Do Not Operate in an Explosive Atmosphere.**

**Keep Product Surfaces Clean and Dry.**

## Symbols and Terms

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



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

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

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**Symbols on the Product.** The following symbols may appear on the product:



WARNING  
High Voltage



Protective Ground  
(Earth) Terminal



CAUTION  
Refer to Manual



Double  
Insulated



# Introduction

The CT-1 and CT-2 are high-frequency, bidirectional current probes. The CT-1 is a 1 GHz current probe and the CT-2 is a 200 MHz current probe. Each current probe comes with a P6041 probe cable to allow you to connect directly to an oscilloscope to make measurements.

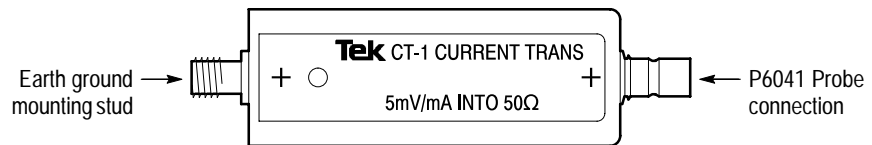


Figure 1: CT-1 current probe

The CT-1 and CT-2 are available as separately purchased units (Option 09). See the *Replaceable Parts List* at the end of this manual for ordering information.

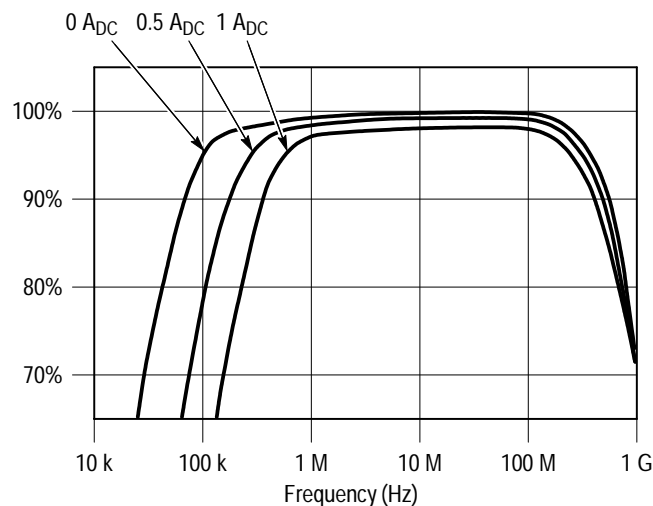
This manual provides information on four subjects:

- *Description*
- *Operation*
- *Specifications*
- *Replaceable Parts List*

## Description

The CT-1 (1 GHz) and CT-2 (200 MHz) are current probes designed for either permanent or temporary installation in the device-under-test (DUT). These probes are particularly useful for measuring high-frequency currents in solid state circuitry with minimum circuit loading. Due to bidirectional compatibility, the CT-1 and CT-2 can be used to inject a signal or as an interstage transformer.

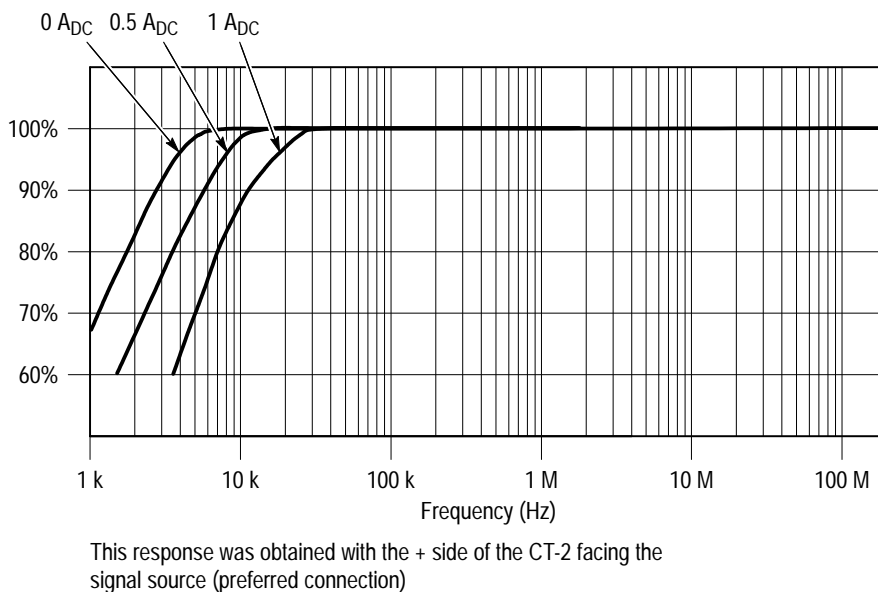
The probes inductively measure current through a conductor and develop a voltage proportional to the current. For each mA of input current, they output 5 mV (1 mV for CT-2) of signal when properly terminated. Since the CT-1 and the CT-2 are dynamic current probes (non-DC), the presence of DC current affects their performance. Figures 2 and 3 show the influence of DC current on frequency response.



This response was obtained with the + side of the CT-1 facing the signal source (preferred connection above 800 MHz)

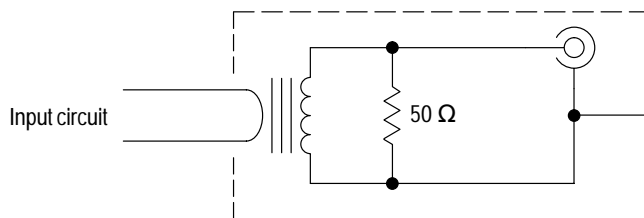
Figure 2: CT-1 frequency response vs. DC current





**Figure 3: CT-2 frequency response vs. DC current**

The CT-1 and CT-2 consist of a current transformer and a flexible probe cable that attaches between the transformer and the oscilloscope. In addition, the CT-1 and CT-2 have an internal termination resistor that reduces reflections that allows the transformer to be disconnected from the probe cable and left in the circuit. Figure 4 shows a simplified circuit of the CT-1 and CT-2.



**Figure 4: CT-1 and CT-2 simplified circuit**

# Specifications

Table 1 lists the electrical characteristics of the CT-1 and CT-2 Transformers when they are connected to the P6041 Probe cable. The environmental and physical characteristics follow Tables 1 and 2.

**Table 1: Electrical characteristics**

Specification	CT-1 with P6041 Probe	CT-2 with P6041 Probe
Sensitivity (see Figures 2 and 3)	5 mV/mA, $\pm 3\%$ into a 50 $\Omega$ load	1 mV/mA, $\pm 3\%$ into a 50 $\Omega$ load
Pulse Response	Rise time: < 0.35 ns, 10% to 90% Aberrations: < 5% as seen by a 1 GHz system	Rise time: < 0.5 ns, 10% to 90% Aberrations: + 4%, -8% as seen by a 200 MHz system
L/R time constant	Approximately 5 $\mu$ s	Approximately 125 $\mu$ s
Insertion Impedance	50 $\Omega$ termination: 1 $\Omega$ shunted by approximately 5 mH Unterminated: 2 $\Omega$ shunted by approximately 5 mH	50 $\Omega$ termination: 0.04 $\Omega$ shunted by approximately 5 $\mu$ H Unterminated: 0.08 $\Omega$ shunted by approximately 5 $\mu$ H
Frequency Response	25 kHz to 1 GHz	1.2 kHz to 200 MHz
Turns Ratio	1:5	1:25
Capacitive Loading	#14 bare wire: typically 1.5 pF #20 bare wire: typically 0.6 pF	#16 bare wire: typically 1.8 pF #22 bare wire: typically 0.7 pF
Maximum Bare Wire Voltage (uninsulated)	175 V <sub>RMS</sub> CAT I 1000 V (DC + peak AC) <3.25% duty factor	175 V <sub>RMS</sub> CAT I 1000 V (DC + peak AC) <3.25% duty factor
Signal Delay (with P6041 Probe Cable)	Approximately 2.8 ns measured from 50% points on leading edge of the current step and output voltage CT-1 Transformer only: 0.4 ns	Approximately 5.8 ns measured from 50% points on leading edge of the current step and output voltage CT-2 Transformer only: 0.3 ns
Effect of Direct Current (see Figures 6 and 7)	Approximately 0.3 A <sub>DC</sub> increases decay by a factor of 2	Approximately 0.3 A <sub>DC</sub> increases decay by a factor of 2
Amp $\times$ Second Rating	1 amp $\mu$ sec When this product is exceeded, the core saturates and the CT-1 output drops to zero	50 amp $\mu$ sec When this product is exceeded, the core saturates and the CT-2 output drops to zero
Pulse Current Rating	12 amps	36 amps
RMS Current Rating	0.5 amperes maximum	2.5 amperes maximum
Output Connector	Amphenol Sub-Minax #27-3	Amphenol Sub-Minax #27-3

**Table 2: General specifications (CT-1 and CT-2)**

<b>Environmental</b>	
Meets all Class IV instrument specifications	
Operating Temperature	0° C to +55° C
Nonoperating Temperature	-62° C to +82° C
<b>Mechanical</b>	
Dimensions	<p>Hole size: CT-1 1.78 mm (0.070 in.) CT-2 1.32 mm (0.052 in.)</p> <p>6-32 mounting stud</p> <p>38.6 mm (1.52 in.)</p> <p>Connector</p> <p>15 mm (0.59 in.)</p> <p>10.3 mm (0.406 in.)</p>
P6041 Probe cable length	106.68 mm (42 in.)
Weight	15 gm (0.525 oz.) without P6041 47 gm (1.655 oz.) with P6041
<b>Certifications and compliances</b>	
EC Declaration of Conformity – Low Voltage	<p>Compliance was demonstrated to the following specification as listed in the Official Journal of the European Communities:</p> <p>Low Voltage Directive 73/23/EEC, as amended by 93/68/EEC</p> <p>EN 61010-1:1993</p> <p>Safety requirements for electrical equipment for measurement, control, and laboratory use</p>
Installation Category Descriptions	<p>Terminals on this product may have different installation category designations. The installation categories are:</p> <p>CAT III Distribution-level mains (usually permanently connected). Equipment at this level is typically in a fixed industrial location</p> <p>CAT II Local-level mains (wall sockets). Equipment at this level includes appliances, portable tools, and similar products. Equipment is usually cord-connected</p> <p>CAT I Secondary (signal level) or battery operated circuits of electronic equipment</p>

# Operation

This section describes how to install the CT-1 or CT-2, discusses low-frequency probing, and provides information on safety and product care.

## Installing the CT-1 or CT-2

The CT-1 or CT-2 transformers can be attached to the chassis or circuit board to measure current in transistors, diodes, or other components. Any number of transformers can be used.

When observing the output of a CT-1 or CT-2 transformer, ensure it is terminated into  $50\ \Omega$ . If the oscilloscope input is not  $50\ \Omega$ , use a suitable matching terminator (see recommended accessories in the *Replaceable Parts List*).

Figure 5 shows the output of the CT-1 compared with the input pulse from a 250 ps fast-rise pulse generator and the output of the CT-2 as seen by a 100 MHz oscilloscope system.

If the CT-1 or CT-2 is connected so that the positive (+) label side faces the signal source, the input current and output voltage will be in phase. This is the preferred connection. For pulses with a risetime slower than 1 ns, the CT-1 or CT-2 may be connected in either polarity.

Ground and the voltage ratings do not apply when installed on a fully insulated conductor. The 175 V rating is based on long term applications that may degrade the insulation. The voltage on bare signal wire must be limited to the  $175\ V_{RMS}$  and the 1000 V DC + peak AC ratings.

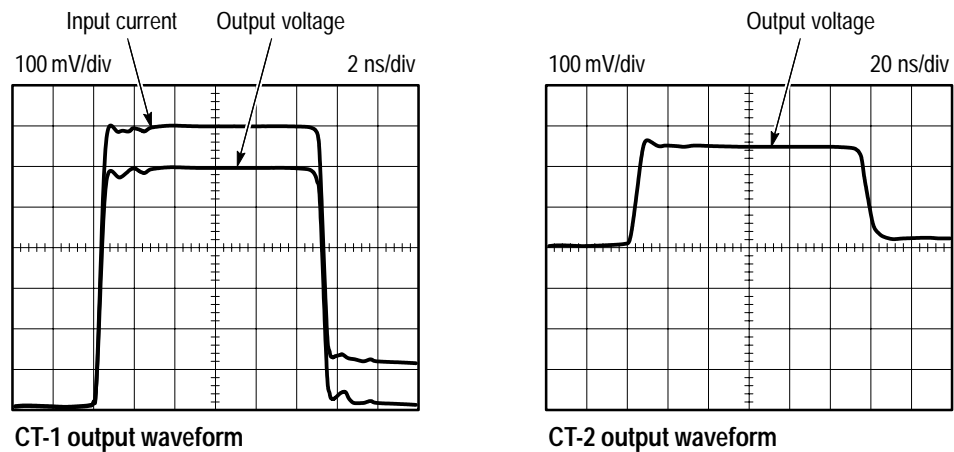


Figure 5: CT-1 and CT-2 output waveform

## Low Frequency Response

The low-frequency response of the current transformer is proportional to the inductance of the transformer windings. A DC component in the current being measured tends to reduce this inductance. Figures 2 and 3 show this effect in the frequency domain.

This effect is also seen in the time domain. Figure 6 shows that the pulse tilt is increased in the presence of significant DC current. The DC current required to increase the tilt by a factor of two is about 0.3 A. Pulse currents that start at zero and remain unidirectional have a DC component that the user should consider.

When droop is present at low frequencies, the apparent overall peak-to-peak height from top to bottom is not the true current. The height of a flat-top pulse still can be measured accurately by observing the transition edge of the pulse. In Figure 7, the 50 mA pulse is faithfully reproduced at the high-to-low transition at the center of the screen.

Pulse width, tilt, and the lower 3 dB frequency are related by the formula:

$$\text{Percent tilt} = 200\pi T_p f_1$$

Where:

$T_p$  = pulse width

$f_1$  = lower 3 dB frequency

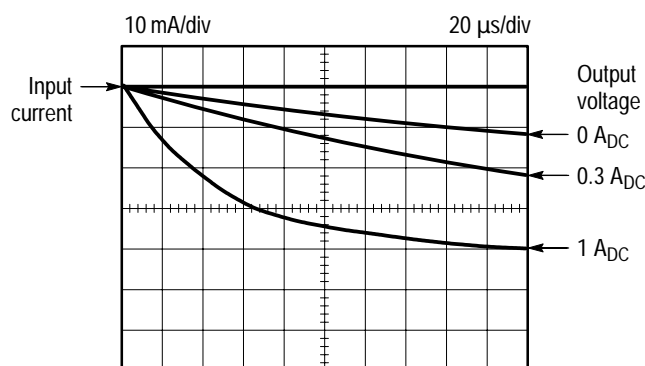
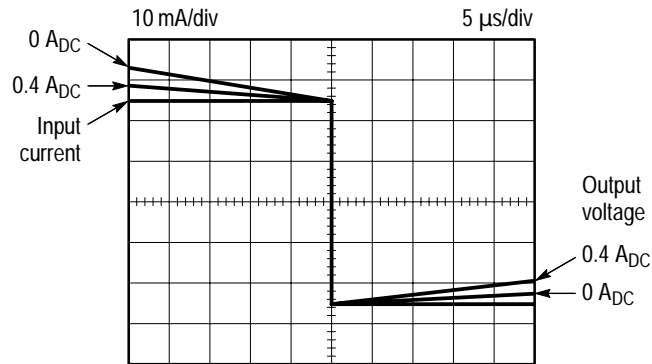


Figure 6: CT-1 decay characteristics referenced to front corner



**Figure 7: CT-2 decay characteristics referenced to transition**

Additional consideration needs to be given to the amp second rating of the transformer. The product of the pulse current and the pulse duration should be less than the amp second rating to keep the transformer core from saturating. When saturation occurs, the output voltage falls to zero.

## Probe Handling

Only normal handling considerations are necessary with the CT-1 and CT-2 transformers. They are sealed units and are not designed to be disassembled. If the transformer or cable is damaged, return it to Tektronix for replacement.



**CAUTION.** Dropping the CT-1 or CT-2 transformer may break the probe. Do not pull or stretch the P6041 cable or place objects on the cable. This may damage the probe cable.

# Replaceable Parts List

This section contains a list of the replaceable parts for the CT-1 and CT-2. Use this list to identify and order replacement parts.

## Parts Ordering Information

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

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

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

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

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

## 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 of the information you need for ordering replacement parts. The following table describes the content of each column in the parts list.

**Parts list column descriptions**

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

**Abbreviations**      Abbreviations conform to American National Standard ANSI Y1.1-1972.

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



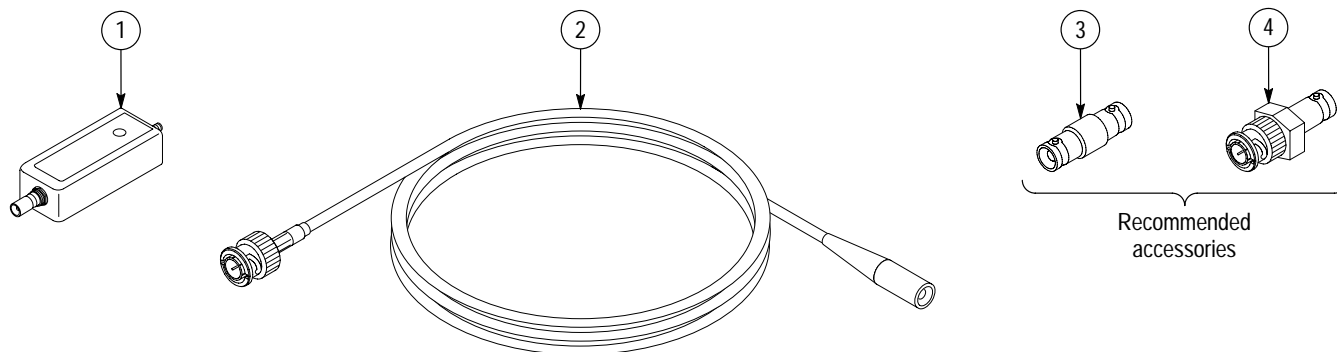


Figure 8: CT-1 and CT-2 accessories

Replaceable parts list

Fig. & index number	Tektronix part number	Serial no. effective	Serial no. discont'd	Qty	Name & description	Mfr. code	Mfr. part number
8-1					CURRENT TRANSFORMER:CT-1 OR CT-2 WITH P6041 (OPION 09 W/O P6041)		CT-1 OR CT-2
8-2				1	P6041	80009	P6041
8-3	103-0028-00			1	ADAPTER,CONN:BNC,FEMALE TO FEMALE,1.3 L,GOLD/NICKEL	24931	28A100-2
8-4	011-0049-01			1	TERMN,COAXIAL:50 OHM,2W,BNC	80009	011-0049-01
	070-7957-XX			1	MANUAL,TECH:CT1/CT2 PROBE,DP	TK2548	PER TEK DOCUMENTATION

Manufacturers cross index

Mfr. code	Manufacturer	Address	City, state, zip code
24931	BERG ELECTRONICS INC	BERG ELECTRONICS RF/COAXIAL DIV 2100 EARLYWOOD DR PO BOX 547	FRANKLIN, IN 46131
80009	TEKTRONIX INC	14150 SW KARL BRAUN DR PO BOX 500	BEAVERTON, OR 97077-0001
TK2548	XEROX CORPORATION	14181 SW MILLIKAN WAY	BEAVERTON, OR 97005





