EXTECH®

User Manual

AC Circuit Load Tester

Model CT70

Introduction

Congratulations on your purchase of the CT70 AC Circuit Load Tester.

This device can detect circuit and wiring problems such as: Poor ground impedance, false grounds, missing ground fault protection, low voltage availability under load, and high ground-to-neutral voltage. In addition, the CT70 tests GFCI and EPD circuits.

Circuit and wiring issues listed above can introduce shock hazards (from grounding issues) and can comprise performance of machinery and equipment (from poor ground impedance, lack of sufficient voltage under load and/or high ground-to-neutral voltage). In addition, fire can result from the heat generated by high resistance points in a circuit.

Proper wiring habits have been shown to greatly increase power quality performance.

This meter is shipped fully tested and calibrated and, with proper use, will provide years of reliable service.

Features

- True RMS measurements
- Voltage drop measurements on 12A, 15A, and 20A loads for 120 V circuits
- Voltage drop measurements on 5A, 8A, and 10A loads for 230 V circuits
- Voltage measurements: Line, ground-to-neutral, and peak
- Measures frequency of the voltage
- Checks 3-wire receptacle configuration
- Finds false grounds
- Tests GFCI and EPD circuits

Safety

International Safety Symbols

This symbol, adjacent to another symbol or terminal, indicates the user must refer to the manual for further information.

This symbol, adjacent to a terminal, indicates that, under normal use, hazardous voltages may be present

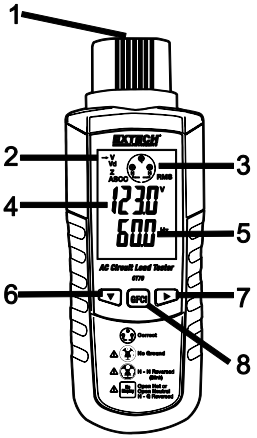
Double insulation

WARNING This **WARNING** symbol indicates a potentially hazardous situation, which if not avoided, could result in death or serious injury.

CAUTION This **CAUTION** symbol indicates a potentially hazardous situation, which if not avoided, may result damage to the product.

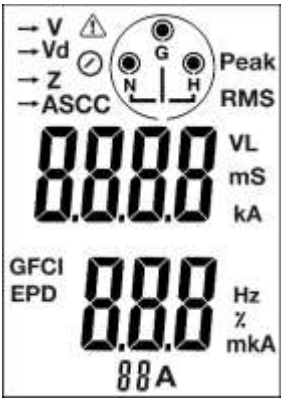
Description

Meter Description



1. AC power cable connection
2. Measurement results menu
3. Hot-Neutral-Ground coded measurement result
4. Primary reading display
5. Secondary reading display
6. Down arrow button
7. Right arrow button
8. GFCI test button

Display Description



A	Amperes (Current)
V	Voltage
Vd	Voltage Drop
%	Percent Voltage Drop
VL	Voltage load
Z	Impedance
Hz	Hertz (cycles per second)
Ω	Ohms (Resistance)
mS	Milliseconds
ASCC	Available Short Circuit Current
Peak	Ground to positive peak measurement
RMS	Root Mean Square
GFCI	Ground Fault
EPD	Equipment Protection Device test
NEUT	Neutral
OL	Overload
m, M, k	Unit of measure prefixes: milli, mega, and kilo

Operation Overview

The CT70 AC Circuit Load Tester can test outlets or circuits under load for proper wiring, reverse polarity, and the presence of a ground. The CT70 uses a simple menu-driven display to allow the user to quickly see line voltage, voltage drop under full load, ground-to-neutral voltage, and line impedance. The GFCI testing utility is performed separately per UL-1436, disrupting the flow of electricity if a functioning GFCI is present.

Note: To avoid the buildup of heat during load testing, allow at least 20 seconds to elapse between tests. In addition to the safety benefits, this will allow the meter to maintain its stated accuracy during repeated tests.

Warning: To avoid damage to the instrument, do not use this device on the output of a UPS system, a light dimmer, or a square wave generator.

Warning: Use only the supplied power/test cord (CT70-AC) with this equipment

Interpreting Measurement Results

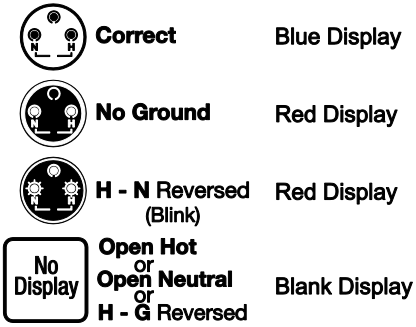
Important note: The CT70 is a microprocessor controlled device that prioritizes its tasks. Taking a reading and analyzing the results are its top priorities. This is why, at times, the keypad may not respond immediately. The internal computer places a higher priority on completing a test than on recognizing a keystroke. To minimize this effect, press and hold a key until the display menu changes.

In addition to the main Wiring Configuration icon, shown on the meter display, the measurement modes are accessed using the four (4) menu items shown on the left side of the display. The menu items are:

1. Voltage (V)
2. Voltage drop (Vd)
3. ASCC (Available short circuit current)
4. Impedance (Z)

Use the ▼ button to scroll the menu list.

The wiring configuration screen shows correct wiring, reverse polarity wiring, and 'no ground' conditions. The three circles on the wiring configuration icon indicate the wiring status. The circles are coded, changing appearance (clear, solid, and flashing) to indicate the measurement results. A table is provided below for interpreting the circle code.



The Voltage menu displays the True RMS line voltage. Use the ► button to scroll the Voltage sub-menu (line voltage, ground-to-neutral voltage, Peak Voltage (P), and Frequency (Hz)).

The Voltage Drop (Vd) window indicates percent voltage drop (with 15A load) and the Loaded Voltage (Vl). The voltage drop sub-menu offers a load voltage result for 20A and 12A loads. Use the ► button to scroll the sub-menu.

The Impedance (Z) window indicates the impedance in ohms of the hot conductor. The impedance sub-menu displays the neutral (N) and ground (G) conductor impedances. Use the ► button to move through the sub-menu.

Note that testing ground impedance will trip a GFCI circuit.

The ASCC window indicates the Available Short Circuit Current that the branch current can move through a breaker in a short circuit situation.

GFCI Button

The GFCI (Ground Fault Circuit Interrupt) feature performs two tests:

GFCI: Faults a circuit when 6 to 9mA from hot to ground is detected

EPD (Equipment Protective Device): For breakers equipped with an EPD, the breaker trips for ground faults greater than 30mA.

To display the GFCI main menu window, press the GFCI button. To toggle the two tests use the ► button. Once the desired test is selected, press the GFCI button to start the test. These tests are further detailed below.

Testing Procedures

Test 1: Wiring Verification

The wiring configuration is the first test result that is displayed. Refer to the table presented earlier in the user guide for the test result key.

For wiring conditions other than normal, the CT70 is limited in the type of tests it can perform on a circuit until the circuit's wiring issues are resolved. For 'no ground' conditions, only the line voltage and voltage drop tests can be made. For reverse polarity conditions, open neutral, or open hot conditions the meter will not display since power will not be available.

Notes:

- The meter cannot sense two hot wires in a circuit
- The meter cannot display the results of more than one circuit issue at time
- The meter cannot sense ground reversals

Test 2: Voltage Measurements

Warning: Do not take measurements on circuits with voltages higher than 300VAC (maximum voltage rating).

Line voltage measurements should be 120VAC ±10% at 60Hz, or 230V +/- 10% at 50Hz. For noise-free sine waves, the peak voltage should be 1.414 times the rms line voltage reading. Ground to neutral voltage should be less than 2 VAC in which case the display backlight will appear blue in color, if ground to neutral voltage is greater than 2 VAC the backlighting appears in red.

Higher ground to neutral voltages indicates excessive current leakage between the neutral and ground conductors. Excessive ground to neutral voltage may result in inconsistent or intermittent equipment performance.

Voltage Measurement Troubleshooting Suggestions

Problems	Likely Causes	Possible Solutions
Out of tolerance Line Voltage (Line should be within ±10% of the stated line voltage)	Overloaded circuit	Redistribute loads
	Connection within circuit or at the panel has excessive resistance	Repair high resistance connection
	Utility company problem	Contact the power utility company
High Ground to Neutral voltage (Readings > 2VAC indicated a problem)	Neutral to Ground current leakage	Identify leakage, check for multiple bonding points
Peak Voltage out of tolerance (For 120V Line, Peak should measure between 153 - 183V)	Supply voltage out of tolerance	Contact power utility company
(for 230V Line, peak should measure between 292 – 357)	High peak loads on circuit	Redistribute electronic devices
Frequency out of tolerance (50/60Hz)	Supply frequency out of tolerance	Contact power utility company

Test 3: Voltage Drop Measurements

To determine voltage drop, the CT70 measures line voltage, factors in the load, measures the loaded voltage, and then calculates the voltage drop.

Results are provided for 120V circuits, with 12A, 15A, and 20A loads and 230V circuits with 5A, 8A, 10A loads.

For nominal efficiency, a voltage drop of 5% is the maximum recommended by the National Electrical Code (NEC) board. When a voltage drop measurement of less than 5% is made, the meter's display backlight turns blue in color. If the voltage drop is higher than 5%, the meter display appears in red.

An efficient branch circuit should have less than 5% voltage drop at the furthest receptacle from the breaker panel at the termination of the cable run. A steady decrease in the voltage drop should then be measured for each receptacle tested in sequence towards the breaker panel.

If the voltage drop is higher than 5% and does not noticeably decrease as the testing moves closer to the first device on the circuit, then the problem lies between the first device and the breaker panel. Visually check the terminations at the first device, the wiring between the device and the panel, and the circuit breaker connections.

High resistance points can be identified as hot spots using an infrared (IR) thermometer or by measuring the voltage across the breaker. If a voltage drop measurement exceeds 5% but noticeably decreases as the testing moves closer to the panel, then the circuit may have an undersized wire, too long of a cable run, or excessive current on the circuit. Check the wires to ensure that they are sized per code and measure the current on the branch circuit. If a voltage drop reading changes significantly from one receptacle to the next, then the problem could be a high impedance point at or between two the receptacles. It is usually located at a termination point, such as a bad splice or loose wire connection, but could also be a faulty receptacle.

Voltage Drop Measurement Troubleshooting Suggestions

Problems	Likely Causes	Possible Solutions
Voltage drop > 5%	Overloaded circuit	Redistribute loads
	Wrong wire gauge size for length of cable run	Check code and rewire if necessary
	High resistance connection in the circuit or at the panel	Locate bad connection and rewire or replace

Test 4: ASCC Measurements

The CT70 calculates the ASCC (Available Short Circuit Current) that a branch circuit can deliver through a breaker in a dead short circuit condition.

The ASCC is calculated by dividing the line voltage by the circuit's line impedance. See equation below:

ASCC = Line Voltage / Hot impedance + Neutral impedance

Use the ► button to simulate a situation where all three conductors (hot, neutral, and ground) are shorted together. Note that this second test will trip a GFCI.

Test 5: Impedance (Z) Measurements

The impedance measurement capability of the CT70 is used to check Hot and Neutral impedance when voltage drop measurements are too high (greater than 5%). To determine where the problem is, measure the impedances and analyze the data as follows:

- If one impedance measurement is exceedingly higher than the other then the problem is with the conductor that shows the higher impedance.
- If both impedances are high the problem could be an undersized conductor, a faulty load, or poor connections.

Ground impedance should be less than 1 Ω, preferably in the 0.25 Ω region to ensure that the ground conductor can safely return current when necessary.

Surge suppressors require good grounding to adequately protect against transient voltages.

Note: A small amount of current is applied to the ground conductor during impedance measurements and can trip a GFCI circuit.

High Impedance Troubleshooting Suggestions

Problems	Likely Causes	Probable Solutions
High hot and/or neutral impedance (Limit: 0.048Ω / ft of 14 AWG wire)	Excessive loading	Redistribute loads
High hot and/or neutral impedance (Limit: 0.03 Ω / ft of 12 AWG wire)	Undersized wiring	Check code and rewire if necessary
High hot and/or neutral impedance (Limit: 0.01 Ω / ft of 10 AWG wire)	High resistance connection in the circuit or at the panel	Locate bad connection and rewire or replace
High Ground impedance (Limit: 1Ω for personal protection)	Undersized wiring	Check code and rewire if necessary
High Ground impedance (Limit: 0.25Ω for equipment protection	High resistance connection in the circuit or at the panel	Locate bad connection and rewire or replace

Test 6: GFCI (Ground Fault Circuit Interrupter) Testing

A 'GFCI' can protect personnel from shock hazards. The CT70 tests GFCI circuits by forming a Hot-Neutral imbalance, leaking small amounts of current (6 to 9 mA) from Hot to Ground through a fixed resistance.

A good GFCI circuit will sense this imbalance and switch off the power. The CT70 displays the current value in mA. To test a GFCI circuit:

1. Plug the meter into the receptacle under test.
2. Press the CT70 GFCI button to enter the GFCI test mode menu.
3. GFCI is the default test and the letters 'GFCI' should appear on the lower side of the meter's display. If not, press the ► button once to switch to 'GFCI'.
4. Press the GFCI button again to start the test. The current that is leaked to ground will display. The rotating display affect lets the user know that the test is in progress.
5. The GFCI circuit should typically trip within 200ms (the meter's display will switch off because the power has been removed by the GFCI circuit).
6. When the GFCI circuit is reset, the CT70 will display the elapsed time from start of test to power down.
7. Press any button to return the meter to normal operation mode.
8. If the GFCI circuit fails to respond in 6.5 seconds, the CT70 stops the test automatically and 'OL' will display on the meter.

Notes:

1. To test a GFCI circuit on a two wire system, a three-to-two wire adaptor must be used with the adaptor manually connected to ground (cold water pipe, for example).

2. Appliances connected to the circuit under test should be disconnected to avoid measurement errors.

Test 7: EPD (Equipment Protective Device) GFCI Testing

An EPD device can protect equipment as well as personnel. The CT70 tests EPD circuits by forming a Hot-Neutral imbalance, leaking current from Hot to Ground through a fixed resistance. A larger amount of current (30mA) is used than would normally be used to test a standard GFCI (6 to 9mA). A good EDP/GFCI circuit will sense this imbalance and switch off the power. The CT70 displays the current value in mA.

To test an EPD/GFCI circuit:

1. Plug the meter into the receptacle under test.
2. Press the CT70 GFCI button to enter the GFCI test mode menu.
3. GFCI is the default test and the letters 'GFCI' will appear on the lower left side of the meter's display. Press the ► button once to switch to 'EPD'.
4. Now follow steps 4 through 8 in Test 6 (GFCI) above.

Specifications

Measurement Specifications		
	Range and Resolution	**Accuracy**
Line Voltage (Single phase)	100.0 to 250.0 VAC	± (1.0% + 0.2V)
Peak Line Voltage	121.0 to 350.0 VAC	± (1.0% + 0.2V)
Frequency	45.0 to 65.0 Hz	± (1.0% + 0.2Hz)
Voltage drop (%)	0.1 to 99.9%	± (2.5% + 0.2%)
Voltage (under load)	10.0 to 250.0 VAC	± (2.5% + 0.2V)
Neutral to Ground Voltage	0.0 to 10.0 VAC	± (2.5% + 0.2V)
Impedance	0.00 to 3.00 Ω (Hot)	± (2.5% + 0.02Ω)
	>3 Ω (Neutral, Ground)	Unspecified
GFCI Trip Current	6.0 to 9.0mA	± (1.0% + 0.2mA)
EPD Trip Current	30.0 to 37.0mA	± (1.0% + 0.2mA)

General Specifications

Display	128 x 64 LED with backlighting
Voltage display update rate	2.5 seconds max.
Over range indication	'OL' display
Equipment Power Rating	100 to 250 VAC 3.9 VA, 45 to 65Hz, 18.0mA
Operating Temperature	0°C to 50°C (32°F to 122°F)
Storage Temperature	0°C to 50°C (32°F to 122°F)
Operating Humidity	Max 80%
Storage Humidity	Max 80%
Case construction	ABS UL 94V/0/5VA rated
Altitude	2000m (6561.7 ft)
Dimensions	203 x 71 x 51 mm (8 x 2.8 x 2")
Weight	317.5g (11.2 oz.)
Safety approvals	CE, ETL
General safety	For indoor use and in accordance with the requirements for double insulation to IEC1010-1 (2001): EN61010-1 (2001) Overvoltage Category II 300V Pollution Degree 2.