

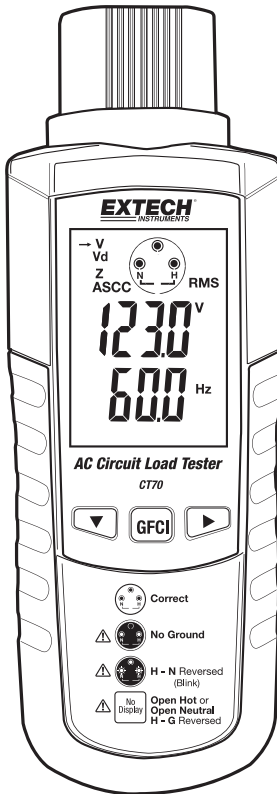
User's Guide

EXTECH[®] INSTRUMENTS

A FLIR COMPANY

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
- 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



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

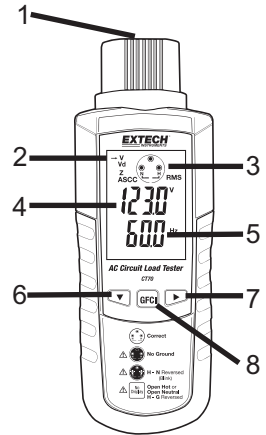


This **CAUTION** symbol indicates a potentially hazardous situation, which if not avoided, may result damage to the product.

Description

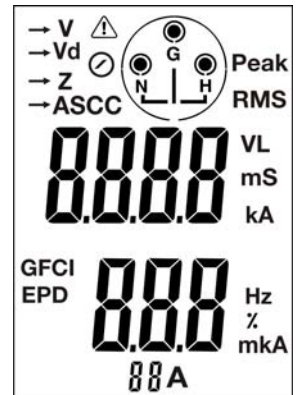
Meter Description

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.

| | | |
|---|---|---------------|
|  | Correct | Blue Display |
|  | No Ground | Red Display |
|  | H - N Reversed (Blink) | Red Display |
|  | Open Hot or Open Neutral or H - G Reversed | Blank Display |

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 (VI). 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 $\pm 10\%$ at 60Hz. 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 120V $\pm 10\%$) | 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 |
| | 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 for 12A, 15A, and 20A loads are provided. 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:

$$\text{ASCC} = \text{Line Voltage} / \text{Hot impedance} + \text{Neutral impedance}$$

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: 0.048 Ω / 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: 1 Ω for personal protection) | Undersized wiring | Check code and rewire if necessary |
| High Ground impedance (Limit: 0.25 Ω 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 | 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 | 32°F to 122°F (0°C to 50°C) |
| Storage Temperature | 32°F to 122°F (0°C to 50°C) |
| Operating Humidity | Max 80% |
| Storage Humidity | Max 80% |
| Case construction | ABS UL 94V/0/5VA rated |
| Altitude | 6561.7 ft. (2000m) |
| Dimensions | 8 x 2.8 x 2" (203 x 71 x 51 mm) |
| Weight | 11.2 oz. (317.5g) |
| 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. |

Maintenance

WARNING: To avoid electrical shock, remove all inputs before opening the case.

Cleaning and Storage

Periodically wipe the case with a damp cloth and mild detergent; do not use abrasives or solvents to clean the instrument.

Pack the meter away safely when not in use. Do not allow the meter to remain connected to live circuitry when not in use.

Warranty

EXTECH INSTRUMENTS CORPORATION (a FLIR company) warrants this instrument to be free of defects in parts and workmanship for **one year** from date of shipment (a six month limited warranty applies to sensors and cables). If it should become necessary to return the instrument for service during or beyond the warranty period, contact the Customer Service Department for authorization. Visit our website www.extech.com for contact information. A Return Authorization (RA) number must be issued before any product is returned to Extech. The sender is responsible for shipping charges, freight, insurance and proper packaging to prevent damage in transit. This warranty does not apply to defects resulting from action of the user such as misuse, improper wiring, operation outside of specification, improper maintenance or repair, or unauthorized modification. Extech specifically disclaims any implied warranties or merchantability or fitness for a specific purpose and will not be liable for any direct, indirect, incidental or consequential damages. Extech's total liability is limited to repair or replacement of the product. The warranty set forth above is inclusive and no other warranty, whether written or oral, is expressed or implied.

Calibration and Repair Services

Extech offers repair and calibration services for the products we sell. Extech also provides NIST certification for most products. Call the Customer Service Department for information on calibration services available for this product. Extech recommends that annual calibrations be performed to verify meter performance and accuracy.

Support lines: U.S. 877-439-8324, Intl. 603-324-7800

Technical support: Option 3; E-mail: support@extech.com

Repair & Returns: Option 4; E-mail: repair@extech.com

Product specifications subject to change without notice

Visit our website: www.extech.com

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