GENERAL®

AC CIRCUIT ANALYZER

USER'S MANUAL

CA10

Please read this manual carefully and thoroughly before using this product.

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INTRODUCTION

The CA10 is a special-purpose electrical tester designed to quickly identify and locate single faults in low-voltage (120/240V) AC distribution lines (branch circuits). It can also test the reliability and response time of GFCIs (ground fault circuit interrupters) and RCDs (residual current devices) and check the wiring of outlet sockets. The instrument's ease of use, versatility and accuracy make it the ideal electrician's tool for preventing shocks, sparks, electrical fires, equipment damage and poor equipment performance.

KEY FEATURES

- Measures a branch circuit's line voltage, peak voltage, neutral-to-ground voltage and frequency
- Calculates a circuit's voltage drop in response to a 12A, 15A or 20A load in order to check the circuit's integrity
- Measures the impedance of hot, neutral and ground conductors as well as available short-circuit current (ASCC)
- Tests the reliability and response time of GFCIs (ground fault circuit interrupters) and RCDs (residual current devices)
- Measures and displays True RMS values of all voltages except peak voltages
- Identifies wiring configurations and detects wiring faults and missing ground wires
- Compatible with 2- and 3-phase circuits
- 2.4 in. diagonal LCD with 30-second backlight
- Familiar menu/sub-menu operation
- Data hold and 30-minute auto power off functions
- Includes 1 ft. long test cable and standard tripod mount
- Powered by six "AAA" batteries (included)
- One-year limited warranty

SAFETY INSTRUCTIONS

⚠ ***WARNING!*** ⚠

Exercise caution when working with exposed wiring.

Do not use this instrument on circuits carrying voltages higher than 265VAC.

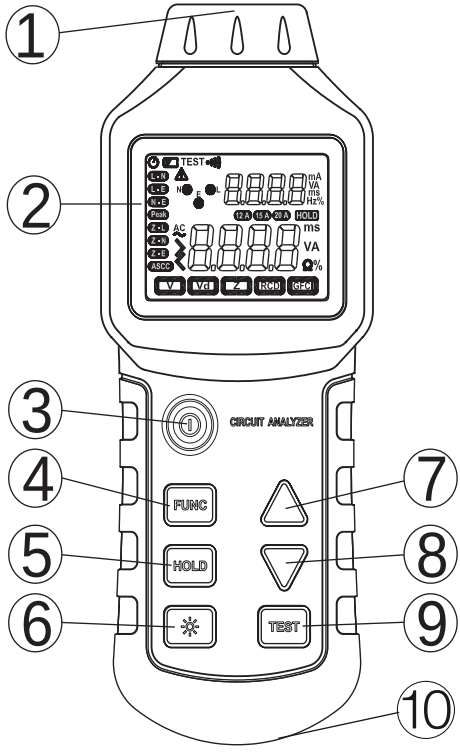
WHAT'S IN THE BOX

The CA10 comes in an illustrated box containing a soft canvas carrying case. Inside the case are the instrument, a 20 in. (0.5m) long test cable, six "AAA" batteries and this user's manual.

PRODUCT OVERVIEW

Fig. 1 shows the controls, indicators and physical features of the CA10. Familiarize yourself with their names and functions before moving on to the Setup Instructions and Operating Instructions.

Fig. 2 shows all possible indications on the CA10's LCD.



1. Test cable socket
2. LCD
3. ⏻ (POWER on/off) button
4. **FUNC** button
5. **HOLD** button
6. ☼ (Backlight) button
7. Submenu ▲ (up one line) button
8. Submenu ▼ (down one line) button
9. **TEST** button
10. Battery compartment (on back)

Fig. 1. The controls, display and physical features of the CA10

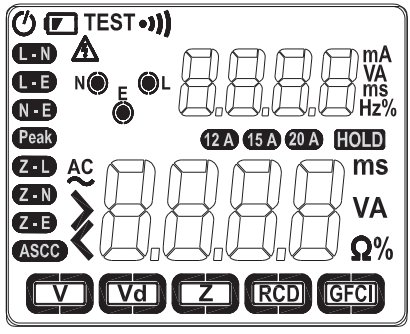


Fig. 2. All possible indications on the CA10's LCD

SETUP INSTRUCTIONS

INSTALL BATTERIES

The CA10 is powered by six "AAA" batteries (included).

To install the batteries:

1. Turn the unit over.

2. Remove the one Philips-head screw securing the battery compartment cover (Figure 1, Callout 10) and set it aside.

3. Remove the battery compartment cover and set it aside as well.

4. Install the six supplied "AAA" batteries in the compartment, making sure to match the polarity marks on the batteries with the marks stenciled inside the compartment.

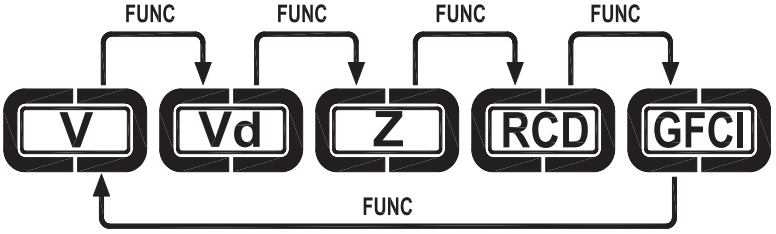
5. Replace the battery compartment cover and secure it with the Philips-head screw.

ATTACH TEST CABLE

The test cable included with the CA10 has a plug compatible with American-style 110VAC sockets. To attach the cable, plug it into the three-pronged socket at the top of the CA10 (Fig. 1, Callout 1).

OPERATING INSTRUCTIONS

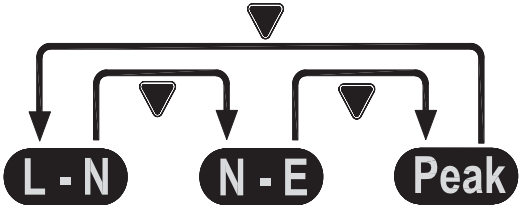
The symbols of the five main parameters/functions tested by the CA10—voltage (V), voltage drop (Vd), conductor impedance (Z), RCD performance and GFCI performance—are shown below as they appear on the bottom line of the LCD. Use the **FUNC** button to move from any test to the test on its right. When a test is selected, the border around its text icon is highlighted.



MEASURING VOLTAGE PARAMETERS

The CA10 can measure four parameters of an AC circuit voltage: 1) the True RMS value of its phase voltage (**L-N**), 2) the True RMS voltage to earth (ground) of its neutral line (**N-E**), 3) the peak value of the voltage (**Peak**), and 4) the frequency of the voltage. Each of the first three parameters is measured and displayed by choosing it from a submenu made available after the **FUNC** button has been used to select **V**. By contrast, the frequency of each of the three parameters is displayed on the top line of the LCD.

To begin, plug the free end of the test cable into any outlet of the circuit to be tested. Press the ▲ or ▼ button to cycle through the three submenu options in either direction, as shown in the figure below. The text icon of the parameter being measured appears at the left of the display. The table below the figure shows the normal measurement result for each of the four parameters. It also lists possible causes of, and remedies for, abnormal results.



Parameter	Normal Measurement Result	Actual Result	Possible Cause of Abnormal Result	Remedy
			Circuit is overloaded	Redistribute circuit load
Phase Voltage **L-N** (Nominal Voltage ± 10%)	108 to 132V (120V circuit) 198 to 242V (240V circuit)	Voltage is too high or too low	High impedance point(s) in breaker box or circuit	Visually inspect all connection points to detect or rule out loose connections and defective outlets. If none are apparent, locate points of high impedance using an infrared thermometer (IRT) to detect their heat, or a voltmeter to detect excessive voltage drops across parts. Repair or replace defective wiring/parts.
Voltage to earth of neutral line **N-E**	>2V	>2V	Supply voltage is too high or too low	Consult your electricity provider
			Leakage current	Find source of leakage (a multi-point ground, a device or piece of equipment) and repair or replace
			Three-phase imbalance	Check and redistribute load
			Harmonic interference	Install spectral filter or take other steps to reduce interference
Peak Voltage (1.414 x Phase Voltage, or T_{RMS} value of Phase Voltage)	153 to 185V (120V circuit) 280 to 342V (240V circuit)	Voltage is too high or too low	Supply voltage is too high or too low	Consult your electricity provider
			Electronic device in circuit is distorting the AC sine wave	Identify and relocate (if necessary) the device
Frequency	60Hz (120V circuit) 50Hz (240V circuit)	Frequency is too high or too low	Supply frequency is too high or too low	Consult your electricity provider

Troubleshooting tips: 1) In a single-phase circuit, if the value of L-N is high the leakage current in the neutral line or the earth line will also be high. 2) In a three-phase circuit with a neutral line, if the value of N-E is high the three-phase load is either unbalanced or the neutral line is affected by harmonic interference.

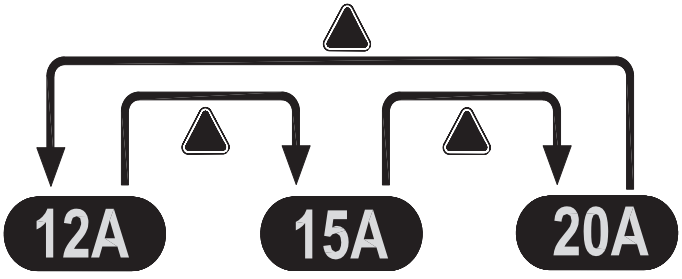
MEASURING VOLTAGE DROP

The CA10 can calculate and display a circuit's voltage drop in response to application of a 12A, 15A or 20A dummy load. In all three cases, the voltage drop displayed on-screen as a percentage is based on the True RMS value of the drop on the circuit's phase (live) line.

To select the voltage drop test, press the **FUNC** button until **Vd** is highlighted. Then, for 120V circuits, press the ▲ or ▼ button to select the 15A or 20A test (see figure below) to match the rating (maximum load) of the circuit. Alternatively, select the 12A test for a 15A or 20A circuit to avoid tripping the breaker of a "preloaded" circuit (i.e., a circuit serving other loads during the load test). For 240V circuits, select the 12A test.

To begin, plug the free end of the test cable into the branch circuit's outlet that is furthest from the breaker box (distribution panel). Press the **TEST** button (Fig. 1, Callout 9) to initiate the test. The test result, a percentage, will appear on the lower readout of the display.

The normal measurement result of the voltage drop test is a number less than 8%. If your result for the most distant outlet in the circuit is <8%, there is no need to check any other outlet(s) of the circuit closer to the breaker box. If your result is greater than 8%, repeat the test on the outlet that is next-closest to the breaker box. Keep repeating the test until you get a normal measurement result. A voltage drop of more than 8% is usually caused by loose connections, poorly spliced conductors, or conductors that are too thin for the circuit's load.



The table below lists the possible causes of an abnormal result and suggests remedies and additional troubleshooting steps to take.

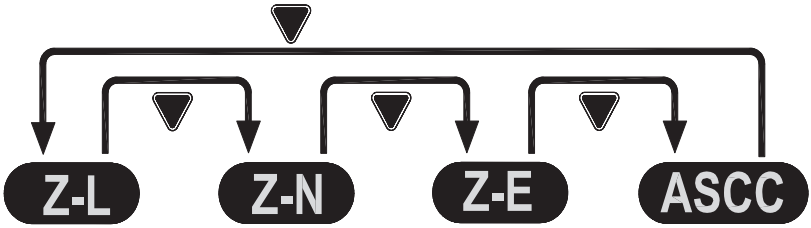
Parameter	Normal Measurement Result	Actual Result	Possible Cause of Abnormal Result	Remedy
Voltage drop	0 to 8%	Voltage drop is too high	Circuit is overloaded	Redistribute load
			Conductors are too thin for circuit length and/or circuit's current	Replace wiring with heavier-gauge conductors suitable for circuit's rating
			High impedance point(s) in breaker box or circuit	Visually inspect all connection points to detect or rule out loose connections and splices, broken or improperly attached twist-on connectors (wire nuts), and defective outlets. If none are apparent, locate points of high impedance using an infrared thermometer (IRT) to detect their heat, or a voltmeter to detect excessive voltage drops across parts. Alternatively, run the **Z-L** and **Z-N** impedance tests described in the next section on the hot and neutral conductors; if one conductor produces a much higher reading than the other, it is defective. Repair or replace defective wiring/parts.

MEASURING CONDUCTOR IMPEDANCE

The CA10 can measure and display the impedance of all three circuit conductors as well as one impedance-related parameter (available short-circuit current, or ASCC). The three impedance values represent the impedances of the phase (live) line (**Z-L**), the neutral line (**Z-N**), and the earth (ground) line (**Z-E**). Available short-circuit current is a measure of the amount of current that would pass through the circuit's breaker if all of its conductors were to be short-circuited. It is calculated as Phase Voltage/(Live line impedance + Neutral line impedance). Using the terminology of the CA10: ASCC = (L-N)/(Z-L) + (Z-N).

Each of the four impedance parameters is measured and displayed by choosing it from a submenu made available after the **FUNC** button has been used to select **Z**.

To begin, plug the free end of the test cable into any outlet of the circuit to be tested. Press the ▲ or ▼ button to cycle through the four submenu options in either direction, as shown in the figure below. The text icon of the parameter selected for measurement appears at the left of the display. To initiate any test, press the **TEST** button.



The table below the figure shows the normal measurement result for each of the four parameters. It also lists possible causes of, and remedies for, abnormal results.

Parameter	Normal Measurement Result	Actual Result	Possible Cause of Abnormal Result	Remedy
Impedance of live and neutral conductors (Z-L and Z-N)	<0.15Ω/m for 14AWG conductor	Impedance is too high	Circuit is overloaded	Redistribute circuit load
	<0.1Ω/m for 12AWG conductor		Conductor is too thin for circuit length and/or circuit's current rating	Replace wiring with heavier-gauge conductors suitable for circuit's rating
	<0.03Ω/m for 10AWG line		High impedance point(s) in circuit or breaker box	Visually inspect all connection points to detect or rule out loose connections and defective outlets. If none are apparent, locate points of high impedance using an infrared thermometer (IRT) to detect their heat, or a voltmeter to detect excessive voltage drops across parts. Repair or replace defective wiring/parts.
Impedance of ground conductor (Z-E)	<1Ω for personnel safety	Impedance is too high	Conductor is too thin for circuit length and/or circuit's current rating	Replace wiring with heavier-gauge conductors suitable for circuit's rating
	<0.25Ω for equipment safety		High impedance point(s) in circuit or breaker box	Visually inspect all connection points to detect or rule out loose connections and defective outlets. If none are apparent, locate points of high impedance using an infrared thermometer (IRT) to detect their heat, or a voltmeter to detect excessive voltage drops across parts. Alternatively, run the **Z-L** and **Z-N** impedance tests on the hot and neutral conductors; if one conductor produces a much higher reading than the other, it is defective. Repair or replace defective wiring/parts.

Notes: 1) Be sure any surge suppression system used is properly grounded so it can continue to protect loads during transient overvoltage conditions. 2) Before measuring any parameter, remove any heavy loads from the circuit to avoid producing an inaccurate test result. 3) Before measuring **Z-E**, be sure to disconnect any RCDs from the circuit to avoid triggering them. 4) A ground connection is required to test the impedance of conductors in 2-wire systems.

TESTING RESIDUAL CURRENT DEVICES (RCDs)

The CA10 can measure how much current it takes to trip an RCD, and how quickly it responds to an event that should cause a trip. It does so by placing a resistance across the circuit's live and ground lines, generating a current between them. According to UL, it should take no more than 30mA to cause a trip. The CA10 measures and displays the triggering current (in mA) and the response time (in ms).

To select the RCD test, press the **FUNC** button until **RCD** is highlighted. Then plug the free end of the test cable into any outlet equipped with an RCD. To initiate the test, press the **TEST** button. During testing, the display will show the word **TEST** on the top line. If the device fails to be triggered, the analyzer will stop testing automatically after 6.5 seconds.

The table below shows the normal measurement result of RCD testing. It also lists possible causes of, and remedies for, an abnormal result.

Parameter	Normal Measurement Result	Actual Result	Possible Cause of Abnormal Result	Remedy
RCD reliability and response time	RCD trips within specified time	RCD is too slow to trip	RCD is installed improperly	Check that installation complies with manufacturer's requirement and relevant standards
		RCD fails to trip	RCD is defective	Repair or replace RCD

Notes: 1) Before testing, remove any heavy loads from the circuit to avoid producing an inaccurate test result. 2) A ground connection is required to test RCDs in 2-wire systems. 3) Another common name for a residual current device (RCD) is a residual current circuit breaker (RCCB).

TESTING GROUND FAULT CIRCUIT INTERRUPTERS (GFCIs)

The CA10 can measure how much current it takes to trip a GFCI, and how quickly it responds to a condition that should cause a trip. It does so by placing a resistance across the circuit's live and ground lines, generating a current between them. According to UL, it should take no more than 5mA to trigger a trip. The CA10 measures and displays the level of triggering current (in mA) and the response time (in ms).

To select the GFCI test, press the **FUNC** button until **GFCI** is highlighted. Then plug the free end of the test cable into any outlet equipped with a GFCI. To initiate the test, press the **TEST** button. During testing, the display will show the word **TEST** on the top line. If the device fails to be triggered, the analyzer will stop testing automatically after 6.5 seconds.

The table below shows the normal measurement result of GFCI testing. It also lists possible causes of, and remedies for, an abnormal result.

Parameter	Normal Measurement Result	Actual Result	Possible Cause of Abnormal Result	Remedy
GFCI reliability and response time	GFCI trips within specified time	GFCI is too slow to trip	GFCI is installed improperly	Check that installation complies with manufacturer's requirement and relevant standards
		GFCI fails to trip	GFCI is defective	Repair or replace GFCI

Notes: 1) Before testing, remove any heavy loads from the circuit to avoid producing an inaccurate test result. 2) A ground connection is required to test GFCIs in 2-wire systems.

TESTING OUTLET WIRING

The CA10 automatically checks the wiring of any outlet it is plugged into. The upper part of the display contains the following arrangement of three circles: N stands for the neutral conductor, L for the live conductor, and E for the earth (ground) conductor.

If the outlet's wiring is normal, all three circles will be filled in, as shown in the table on the next page. Different combinations of filled in (on), empty (off) and flashing circles indicate specific faults.

Wiring Condition	Screen Display L E N	Legend
Normal		○ Off ● On ✹ Flashing
No ground wire detected		
Live and neutral conductors are reversed		
Other conditions		

Any wiring abnormality will prevent the CA10 from performing tests to the full extent of its abilities. For example, in the absence of a ground wire the analyzer can only measure the circuit's phase voltage and voltage drop. Furthermore, the CA10 cannot detect the voltage between two live lines, multiple concurrent faults, or reversed neutral and ground conductors.

OTHER FUNCTIONS

Backlight. Pressing the ☼ button while the CA10 is powered on turns on the display backlight. If no button is pushed for 30 seconds, the backlight will turn off automatically. You can turn off the backlight manually by pressing the ☼ button again.

Auto Power Off (APO). A 30-minute APO function is automatically enabled when the CA10 is powered on. When APO is enabled (indicated by a clock icon (⏲) at the upper left of the display), if no button is pushed for 30 minutes the CA10 will automatically power off to extend battery life.

To disable the APO function, press and hold the **FUNC** button while pressing the ⏻ button to power on the unit. The clock icon will not be displayed.

Data Hold. Pressing the **HOLD** button freezes measurements of voltage parameters on the larger, lower readout. Other measurements cannot be held. To release the hold, press the **HOLD** button again.

SPECIFICATIONS

Parameter or Component	Measurement Range	Measurement Accuracy	Resolution
Line Voltage	85 to 265VAC	±1% of reading ± 0.2V	0.1V
Peak Voltage	121 to 374VAC	±1% of reading ± 0.2V	0.1V
Line Frequency	45 to 65Hz	±1% of reading ± 0.2Hz)	0.1Hz
Voltage Drop	0.1 to 99.9%	±2.5% of reading ± 0.2%	0.1%
Load Voltage	10 to 265V	±2.5% of reading ± 0.2V	0.1V
Neutral-to-Earth Voltage	0 to 10VAC	±2.5% of reading ± 0.2V	0.1V
Live, Neutral and Ground Line Impedance	0 to 3Ω	±2.5% of reading ±0.02Ω	0.01Ω
	> 3Ω	NA	
RCD Trip Time	1 ms to 6.5 sec.	±1% of reading ± 2 ms	1 ms
RCD Trip Current	30 to 37mA	±1% of reading ± 0.2mA	0.1mA
GFCI Trip Time	1 ms to 6.5 sec.	±1% of reading ± 2 ms	1 ms
Display	Backlit 2.4 in. (61mm) diagonal LCD		
Test Cable	12 AWG diameter, 12 in. (305mm) long		
Auto Power Off Trigger	30 minutes of inactivity		
Display Backlight Duration	30 seconds		
Operating/Storage Temperature	32° to 122°F (0° to 50°C)) @ <80% RH		
Dimensions	7.6 x 3.1 x 1.5 in. (193 x 78 x 39mm)		
Weight (Without Batteries)	10.4 oz. (295g)		
Power Source	Six “AAA” batteries		

OPERATING & MAINTENANCE TIPS

REPLACING THE BATTERIES

When the (low battery) icon appears on the top line of the display, it’s time to replace the unit’s six “AAA” batteries. Follow the instructions on p. 5 for opening and closing the battery compartment and installing the batteries.

HOUSEKEEPING HINTS

DO NOT expose the CA10 to:

- Direct sunlight
- High humidity or temperatures (above 104°F/40°C during operation or 140°F/60°C in storage)
- Corrosive or explosive gas
- Excessive dust
- Strong mechanical vibration or stress (dropping, for example) or electromagnetic radiation

If the instrument has been exposed to extreme temperatures, allow several hours for it to acclimate to your local conditions before using it.

Do not open the housing of the unit. Doing so voids its limited warranty and could disable its safety circuitry.

You may clean the housing of the CA10 with a soft, clean cloth and water or a mild detergent. Never use benzene, alcohol, acetone, ether, ketone, paint thinner, gasoline or an organic solvent. After cleaning, dry the CA10 thoroughly with a clean cloth before using it again.

WARRANTY INFORMATION

General Tools & Instruments' (General's) CA10 AC Circuit Analyzer is warranted to the original purchaser to be free from defects in material and workmanship for a period of one year. Subject to certain restrictions, General will repair or replace this instrument if, after examination, the company determines it to be defective in material or workmanship.

This warranty does not apply to damages that General determines to be from an attempted repair by non-authorized personnel or misuse, alterations, normal wear and tear, or accidental damage. The defective unit must be returned to General Tools & Instruments or to a General-authorized service center, freight prepaid and insured.

Acceptance of the exclusive repair and replacement remedies described herein is a condition of the contract for purchase of this product. In no event shall General be liable for any incidental, special, consequential or punitive damages, or for any cost, attorneys' fees, expenses, or losses alleged to be a consequence of damage due to failure of, or defect in any product including, but not limited to, any claims for loss of profits.

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