SURETEST® CIRCUIT ANALYZER

PGT-61-164

User Manual

PROSTAT®

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PROSTAT® PGT-61-164 SURETEST® CIRCUIT ANALYZER

WARNING
To maintain stated accuracies during repeated use, allow 20 seconds between insertions to adequately dissipate any heat buildup during the load testing.

I. Introduction

Utilizing patented technology, the SureTest circuit analyzer "look behind walls" to identify wiring problems that can lead to personal shock hazards, electrical fires, or equipment performance issues. Personal shock hazards stem from poor grounding, false grounds, and/or no ground fault protection. Electrical fires are primarily caused from arc faults and high resistance points that lead to glowing connections in the circuit wiring. And, equipment performance issues arise due to insufficient voltage available under load, poor impedance, and high ground-to-neutral voltage. In fact, it's estimated that 80% of power quality performance issues are related to the faulty wiring issues stated above.

Product Features

- True RMS
- Measures voltage drop under 12, 15 and 20-amp loads
- Measures voltage: Line, Ground-to-Neutral, Peak, Frequency
- Measures Hot, Neutral and Ground conductor impedances
- Identifies proper wiring in 3-wire receptacles
- Identifies false (bootleg) grounds
- Tests GFCI's for proper operation
- Includes two 12 inch extension cord

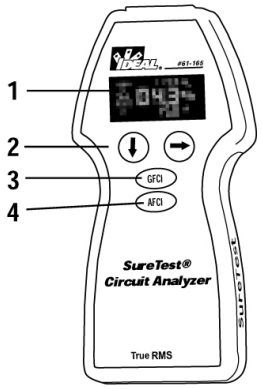
II. General Operation

The PGT-61-164 SureTest Circuit Analyzer takes only seconds to test each outlet and circuit under a full load. This test tool checks for various wiring conditions including: correct wiring, polarity reversal and no ground per UL-1436. A simple menu gives access to measurements of line voltage, voltage drop under a full load condition, ground-neutral voltage and line impedances. The ground fault circuit interrupter (GFCI) test is performed separately, in accordance with UL-1436 and will disrupt the electrical supply if a functional GFCI is present.

WARNING
Do not use on outputs from UPS system, light dimmers or square wave generating equipment, as damage to the analyzer will occur.

SureTest Circuit Analyzer

1. Menu Structure
2. Navigation Buttons
3. GFCI Test Button
4. AFCI Test Button (Not included on the 61-164)



III. Menu Navigation

The microprocessor's top priorities are to take live measurements and then analyze the data. Hence, the microchip occasionally will not recognize the keypad buttons being rapidly depressed, while it's executing these changes.

The measurements taken by the SureTest Model 61-164 are broken into five main menus positioned down the left side of the display: Wiring Configuration (• • •), Voltage (**V**), Voltage Drop ($\mathbf{V_D}$), ASCC, and Impedance (**Z**). To navigate to each of the main menus, use the down arrow button (↓).

The Wiring Configuration (• • •**)** screen indicates correct wiring, reverse polarity, hot/ground reversal and no ground conditions by sequencing the three balls. The label on the back of the product explains the wiring sequence indications.

The Voltage (**V**) menu displays the True RMS line voltage in real-time. This main menu has a sub-menu positioned horizontally at the bottom of the screen that displays the line voltage (RMS HN), ground-to-ground voltage (**RMS GN**), Peak Voltage (**PEAK**), and Frequency (**HZ**). To navigate through the submenu, use the side arrow button (→).

The Voltage Drop ($\mathbf{V_D}$) screen dual displays percent voltage drop with a 15 amp load along with the resultant loaded voltage ($\mathbf{V_L}$). This main menu has a submenu, which also displays the percent voltage drop and loaded voltage with 20 amp and 12 loads. To navigate through the submenu, use the side arrow button (→).

The ASCC screen displays the **A**vailable **S**hort-**C**ircuit **C**urrent that the branch circuit can deliver through the breaker during a bolted fault (dead-short) condition.

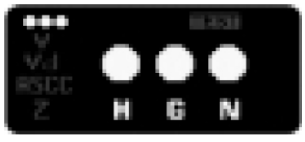
The Impedance (**Z**) main menu displays the impedance in ohms (**Ω**) of the hot conductor. This main menu has a sub-menu positioned horizontally at the bottom of the screen that also displays the neutral (**N**) and ground (**G**) conductor impedances. To navigate through the submenu, use the side arrow button (→). Note that testing the ground impedance will trip a GFCI protected circuit.

IV. GFCI Test Button

Depressing this button displays the GFCI main menu. Two tests can be performed in this menu: **GFCI** and **EPD**. The GFCI tests Ground Fault Circuit Interrupting devices by faulting 6-9mA from hot-to-ground per UL-1436. The EPD tests those breakers, which have an Equipment Protective Device feature that trips the breaker if a ground fault of greater than 30mA is detected. Pressing the side arrow button (→) navigates between these two sets. Once the desired test is highlighted, depress the GFCI test button on the keypad to activate the test.

V. Testing Procedure

Wiring Verification



Immediately after being inserted into a receptacle, the SureTest displays the IDEAL logo while it performs a battery of tests. The first test result displayed is the wiring condition. The SureTest checks for the following conditions and indicates the test result on the display.

Wiring Condition	Display Indication H	G	N
Correct Wiring	○	○	○
No Ground	○	●	○
Polarity Reversal	✳	○	✳
Open/Hot Neutral	●	●	●
False Ground			

Legend

○ On
● Off
✳ Flashing

If the wiring condition is other than normal, the SureTest is limited on its measurements that can be performed. If a no ground condition exists, only the line voltage and voltage drop measurement are available. In a hot/ground reversal, open neutral or open hot condition, the unit will not have any power so the display will be blank.

Notes:
1) Will not detect two hot wires in a circuit.
2) Will not detect a combination of defects.
3) Will not detect reversal of grounded and grounding conductors.

False Ground Indication
NEC article 250-23(a) only allows for a neutral to ground bond to occur at the main panel. The SureTest suggests any improper neutral-to-ground bonds within 15-20 feet upstream (towards the panel) of the tester. If this bond improperly occurs in the branch circuit through a bootleg ground via a jumper wire at the outlet device or inadvertent contact of the ground wire to the neutral connection, the SureTest indicates a false ground condition. Note that if the SureTest is within 15-20 feet of the main panel, the unit will indicate a false ground condition on a properly wired circuit due to its close proximity to the proper ground-neutral bond in the main panel.

Voltage Measurements
The line voltage measurement should be 120 VAC +/-10% fluctuation at 60 Hz. The peak voltage should be 1.414 times the rms line voltage reading for a clean sine waveform. Ground-to-neutral voltage should be less than 2 VAC. In a single-phase circuit, a higher ground-neutral voltage indicates excessive current leakage between the neutral and ground conductors. In a 3-phase circuit with a shared neutral, a high ground-neutral voltage could indicate an unbalanced load between the three phases or harmonic distortion on the shared neutral. Excessive ground-neutral voltage may result in inconsistent or intermittent equipment performance.

Troubleshooting Tips for Voltage Issues

WARNING
Do not exceed the unit's maximum voltage rating of 250VAC!

MEASUREMENT	EXPECTED RESULT	PROBLEM	POSSIBLE CAUSES	POSSIBLE SOLUTIONS
Line Voltage 120 VAC 220 VAC	108-132 VAC 198-242 VAC	High/low	Too much load on theload on circuit	Redistribute loads on the circuit
			High Resistance connection within the circuit or at the panel	Locate high resistance connection/ device and repair/replace
			Supply voltage too high/low	Consult Power company
Neutral-Ground Voltage	< 2 VAC Voltage	High G-N >2 VAC	Current leaking from neutral to ground	Idenify source of leakage; multiple bonding points, equipment or devices
			Unbalanced 3-phase system	Check load balance and redistribute load
			Triplen harmonics returning on neutral in 3-phase system	Oversize neutral to impedance. Reduce harmonic effect via filter or other methods
Peak Voltage 120 VAC 220 VAC	153-185 VAC 280-342 VAC	High/Low Peak voltage	Supply voltage Too high/low	Consult power company
			High Peak Loads on line caused by electronic equipment on line	Evaluate number of electronic devices on circuit and redistribute if necessary
Frequency	60 HZ	High/Low Frequency	Supply frequency Too high/low	Consult power Company

Voltage Drop (V_D) Measurements
The SureTest measures the line voltage, applies a load on the circuit, measures the loaded voltage, then calculates the voltage drop. Results are displayed for 12A, 15A, and 20A loads. The National Electrical Code recommends 5% as the maximum voltage drop for branch circuits for reasonable efficiency (NEC article 210-19, FPN 4). And, the voltage under load ($\mathbf{V}_L$) should not drop below 108VAC for reliable equipment operation.

A good branch circuit should start out with less than 5% voltage drop at the furthest receptacle from the panel at the end of the cable run. Then, each receptacle tested in sequence towards the panel should show a steady decrease in voltage drop. If the voltage drop is above 5% and does not noticeably decrease, as you get closer to the first device on the circuit, then the problem is between the device and the panel, and the circuit breaker connections. High resistance points can usually be identified as hot spots using an infrared thermometer or by measuring the voltage across the breaker. If the voltage drop exceeds 5% but noticeably decreases as you nearer the panel, the circuit may have undersized wire, too long of a cable run, or too much current on the circuit. Check the wire to ensure that it is 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 is a high impedance point at or between two receptacles. It is usually located at a termination point, such as a bad splice or loose wire connection, but it might also be a bad receptacle.

Troubleshooting Tips for Voltage Drop

MEASUREMENT	EXPECTED RESULT	PROBLEM	POSSIBLE CAUSES	POSSIBLE SOLUTIONS
Voltage Drop	<5%	High Voltage Drop	Too much load on theload on circuit	Redistribute loads on the circuit
			Undersized wire for length of run	Check code requirement and re-wire if necessary
			High resistance connection within the circuit or al the panel	Locate high resistance connection/ device and repair/replace

ASCC Measurement
The SureTest calculates the **A**vailable **S**hort-**C**ircuit **C**urrent (ASCC) that the branch circuit can deliver through the breaker during a bolted fault (dead-short) condition.

The ASCC is calculated by dividing the line voltage by the circuit's line impedance (hot + neutral). Depressing the side arrow (→) displays the worst-case scenario where all three conductors (hot, neutral, ground) are shorted together – the neutral and ground provide a lower impedance via a parallel return path. Note that this second test will trip a GFCI. See the following equations for clarification.

ASCC1 = Line Voltage (VHN)/ (Hot Ω + Neu Ω) 

ASCC2 = Line Voltage (VHN)/ (Hot Ω + 1/(1/ Neu Ω + 1/Grd Ω) 

Impedance (Z) Measurements
If the voltage drop measurement exceeds 5%, analyze the hot and neutral impedances. If one is significantly higher than the other, the problem is with the conductor with the much higher impedance. Then, check all connections on that conductor back to the panel. If both impedance appear high, the source can be undersized wire for the length of run, a bad device, or poor connections at the pigtails, devices, or panel.

The ground impedance measured should be less than 1 ohm as a rule of thumb to ensure that fault current has a sufficient path back to the panel. IEEE states the ground impedance should be less than 0.25 ohms to ensure the ground conductor can safely return any fault current which could damage equipment on the circuit. Surge suppression systems require a good ground to adequately protect equipment from transient overvoltages. Note that a small amount of current is applied to the ground conductor to accurately measure its impedance. By the inherent nature of this test, a GFCI protected circuit will trip unless the device is temporarily removed from the circuit.

MEASUREMENT	EXPECTED RESULT	PROBLEM	POSSIBLE CAUSES	POSSIBLE SOLUTIONS
Hot and Neutral Impedance	<0.48Ω/ foot of 14 AWG wire	High Conductor impedance	Too much load on branch circuit	Redistribute loads on the circuit
	<0.03Ω/ foot of 12 AWG wire		Undersized wire for length of run	Check code requirements and re-wire if necessary
	<0.01Ω/ foot of 10 AWG wire		High resistance connection within the circuit or at the panel	Locate high resistance connection/ device and repair/replace
Ground Impedance	< 1Ω to protect people	High ground impedance	Undersized wire for length of run	Check code requirements and re-wire if necessary
	<0.25Ω to protect equipment		High resistance connection within the circuit or at the panel	Locate high resistance connection/ device and repair/replace

VI. GFCI Testing

To test the GFCI device, the SureTest creates an imbalance between the hot and neutral conductors by leaking a small amount of current from hot to ground using a fixed value resistor. The trip current should not be less than 6mA or greater than 9mA per UL-1436. A functional GFCI should sense a imbalance and disconnect the power. The SureTest displays the actual trip current in milliamps and trip time in milliseconds.

To conduct a GFCI test, press the GFCI button to enter the GFCI main menu. The GFCI symbol in the display should be highlighted as the default test. If EPD is lit, then use the side arrow (→) to highlight the GFCI symbol. Then, press the GFCI button to activate the test. The actual current being leaked to ground is displayed. The TEST icon and hourglass symbol appear on the display to let the user know that the GFCI test is being performed. The GFCI device should trip within the UL established guideline causing the display to blank out with the loss of power. When the FDCI device is reset, the unit displays the actual trip time that the GFCI took to respond to the current imbalance and open the circuit. Pressing the down arrow button (↓) returns it to the wiring verification mode. If the GFCI fails to trip, the SureTest terminates the test after 6.5 seconds. Further inspection should determine whether the GFCI circuitry is faulty, the FDCI is installed incorrectly, or if the circuit is protected by a GFCI device.

UL Guideline for trip time:

$$T = \left(\frac{20}{I}\right) 1.43$$ where: **T = milliseconds (ms)**, **I = milliamps (mA)**

Notes:

1) In order to test a GFCI in a 2-wire system (no ground), the #61-175 ground continuity adapter (sold separately) must be used. Connect the alligator clip on the adapter to a ground source, such as to a metal, water or gas pipe.

2) All appliances or equipment on the ground circuit being tested should be unplugged to help avoid erroneous reading.

In addition to performing a GFCI test for evaluating personal protection from shock hazards, the SureTest can also conduct testing to ensure equipment protection from ground faults exceeding 30mA. The method of operation is the same as the GFCI test noted in the first paragraph above but uses a different resistor to create a 30mA leakage current from hot-to-ground. To conduct an EPD test on a Equipment Protective Device, press the GFCI button to enter the GFCI main menu. The GFCI symbol in the display should be highlighted as the default test. Press the side arrow (→) button to highlight the EPD symbol. Then, press the GFCI button to activate the test. The actual current being leaked to ground is displayed. The TEST icon and hourglass symbol appear on the display to let the user know that the EPD test is being performed. The EPD should trip causing the display to blank out with the loss of power. When the EPD is reset and power is restored, the unit displays the actual trip time that the EPD took to respond to the current imbalance and open the circuit. Pressing the down arrow button (↓) returns it to the wiring verification mode. If the EPD fails to trip, the SureTest terminates the test after 6.5 seconds. Further inspection should determine whether the EPD circuitry is faulty, the EPD is installed incorrectly, or if the circuit is protected by an EPD.

MEASUREMENT	EXPECTED RESULT	PROBLEM	POSSIBLE CAUSES	POSSIBLE SOLUTIONS
GFCI Test	GFCI trips within trip time	GFCI doesn't trip within proper trip time	GFCI maybe installed improperly	Check wiring for proper installation in accordance with manufacturer's instructions and NEC
		GFCI doesn't trip	GFCI may be defective	Check wiring and ground. Replace GFCI if necessary

Estimated Load on Line (ELL) Meassurement
The PGT-61-164 SureTest® mow estimates the load on a branch circuit to provide an indication of how much capacity in the circuit remains or to quicly check if the circuit is dedicated. This function is a rough estimate (no stated accuracy), as accurately measuring circuit current has to be done with a clamp meter at the electrical panel. The proprietary way in which these calculations are made allows the user to plug the unit into an outlet and quickly determine the current load on that branch circuit.

Both the distance of the SureTest® from the load and branch circuit impedance will affect the accuracy. Best accuracy is obtained by positioning the SureTest® in the same outlet as the largest load on line; otherwise, try to position the SureTest® between the load(s) and the electrical panel. The maximum amperage reported by the tester is 15A.

Maintenance
Clean case with a damp cloth and mild detergent. Do not use abrasives or solvents.

PGT-61-164 SureTest® Circuit Analyzer Specifications

General Specifications

Display: 128x64 OLED with backlight
Display update for Volt: Less than 2.5 times second
Over-range indication on all functions: Display “OL”

Operating Environment

Relative Humidity: 32°F to 122°F (0°C to 50°C) at <80% Rh
Storage Environment: 32°F to 122°F (0°C to 50°C) at <80% Rh
Case Construction: ABS UL 94 V/0/5VA Rated
Altitude: 6561.7 ft. (2000m)
Dimensions: 6.4” (L) x 3” (W) x 1.4” (D)
162mm (L) x 76mm (W) x 36mm (D)
Weight: 9.4 oz (267 g)
Safety: UL61010B-1, Cat III-300V
UL-1436 for AFCI, GFCI & Outlet

Accessories: Includes 12” plug adapter and instruction manual

Double Insulation
Instrument has been evaluated and complies with insulation category III, (Overvoltage category III) Pollution degree 2 in accordance with IEC-644. Indoor use.

Measurement Specifications

All specifications are at 23°C ± 5°C at less than 80% relative humidity
Accuracy is stated as ± ((% of range) + (counts))
AC converter is true rms sensing

MEASUREMENT	RANGE	RESOLUTION	ACCURACY
Line Voltage	85.0 – 250.0 VAC	0.1 V	1.0% ± .2 V
Peak Line Voltage	121.0 – 354.0 VAC	0.1 V	1.0% ± .2 V
Frequency	45.0 – 65.0 Hz	0.1 Hz	1.0% ± .2 V
% Voltage Drop	0.1% - 99.9%	0.1 %	2.5% ± .2 %
Voltage Loaded	10.0 – 250.0 VAC	0.1 V	2.5% ± .2 %
Neutral-Ground V	0.0 – 10.0 VAC	0.1 V	2.5% ± .2 %
Impedance – Hot Neutral, & Ground	0.0 Ω - 3.00 Ω 1.0 > 3 Ω	0.01 Ω	2.5% ± .02 Ω Unspecified
GFCI Trip Time	1mS to 6.500S counter	1 mS	1.0% ± .2mS
GFCI Trip Current	6.0 – 9.0 mA	0.1 mA	1.0% ± .2 mA
EPD Trip Current	30.0 – 37.0 mA	0.1 mA	1.0% ± .2 mA

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PROFESSIONAL STATIC CONTROL PRODUCTS

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