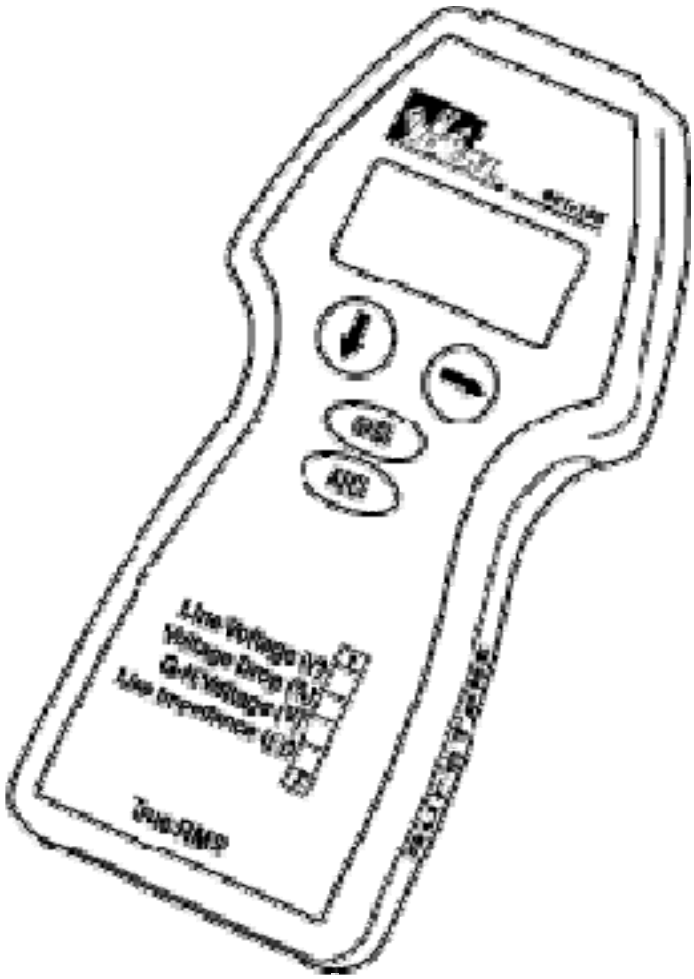
IDEAL INDUSTRIES INC.
TECHNICAL MANUAL
MODEL 61-160 series

The Service Information provides the following information

- Precautions and safety information
- Specifications
- Performance test procedure
- Calibration and calibration adjustment procedure



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Introduction

⚠ Warning

To avoid shock or injury, do not perform the verification tests or calibration procedures described in this manual unless you are qualified to do so. The information provided in this document is for the use of qualified personnel only.

⚠ Caution

The 61-150 and 61-160 serials contain parts that can be damaged by static is charge. Follow the standard practices for handling static sensitive devices.

For additional information about IDEAL INDUSTRIES and its product and services, visit IDEAL INDUSTRIES web site at: ***www.idealindustries.com***

SAFETY

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 the product only as specified.

It is recommended that you read through the Operation or User manual before starting. Not all Caution, Warning, or Danger precautions are listed in this manual.

⚠ CAUTION

These statements identify conditions or practices that could result in damage to the equipment or other property.

⚠ WARNING

These statements identify conditions or practices that could result in personal injury or loss of life.

Specific precautions

Do not operate without covers: To avoid personal injury, do not apply any voltage to the product without the covers in place.

Electric overload: Never apply a voltage to a Contact on the product that is outside the range specified for that connector.

Avoid electric shock: To avoid injury or loss of life, use care when connecting and disconnect adapter cord to a receptacle or while using the adapter with alligator connectors..

Do not operate in wet/damp conditions: To avoid electric shock, do not operate this product in wet or damp conditions.

Table 1, General specifications

Display	OLED Graphics Display
Operating Range	108 to 264VAC
Voltage RMS	85 to 132VAC (61-165), 85 to 265 (61-164)
Ohms Function	0.00 Ω to 299 Ω
Percentage of Voltage Drop	0.1% to 50.0%
Voltage Drop	0.1V to 50.0V
Ground to Neutral Voltage	0.0V to 24.0V
GFCI current	Calculated E/R (R is a fixed internal resistor)
Over-range Indication on all functions	Display "OL" In Ohms Function readings > 2.99 will be displayed as **>3**
Operating Environment, Relative Humidity	0°C to 50°C (32°F to 122°F) 80%RH
Storage Environment:	0°C to 50°C (32°F to 122°F) at <80% RH
Case Construction:	ABS UL 94V/0/5VA rated
Safety	UL3111, and Design to comply with IEC
	1010-1 Cat III @ 150V AC RMS,
	UL for GFCI,
	UL for AFCI

Table 2, Ranges and Accuracy Specifications

Measurement	**Ranges**	**Resolution**	**Accuracy**
Line Voltage/Trms	85 to 280VAC	0.1V	1.0% ± 2 digits
Line Voltage/Peak	121 to 340VAC	0.1V	1.0% ± 2 digits
Frequency	45.0Hz to 65.0Hz	0.1Hz	1.0% ± 2 digits
% Voltage Drop	Calculated 12A, 15A and 20A	0.1%	2.5% ± 5 digits
Voltage Drop	Calculated 12A, 15A and 20A	0.1V	2.5% ± 5 digits
Neutral-Ground V	0.0V to 10.0V RMS	0.01v	2.5% ± 5 digits
[1] [2] Impedance - Hot , Neutral, & Ground	0.00Ω to 2.99Ω	0.01Ω	5.0% ± 5 digits
	> 2.99 Ω - Unspecified.		-.0-
GFCI Trip Time	1ms to 6500ms counter.	.0001mS	1.0% ± 2 digits
GFCI Trip Current	Between 6mA to 9mA	0.01A	1.0% ± 2 digits

[1]Resistance greater than 3 ohms on the Hot conductor or greater that 3 ohms on the neutral conductor should be verified via alterative methods.

[2] Resistance greater than 3 ohms on the ground should be verified via an alterative method**.**

PERFORMANCE VERIFICAITONS

Perform the following analysis. If the meter operates within the specifications listed in Table 2 the meter is functioning correctly. If the meter does not conform to any of the listed limits unit should be returned to Ideal Industries, Inc for calibration.

Note: the accuracy of this performance test is affected by the assigned or standardized values. The unit is initially set up in IDEAL Industrials testing lab in San Diego Ca. under strict environmental and standard test conditions. Environmental and test circuit conditions can effect the verification process. The methods for standardizing a circuit and the assignment of performance verification values will have a direct impact on the accuracy of the test.

Two methods can be used to determine performance. These are the Calculated Voltage Drop Method and Measured Voltage Drop Method. The circuit to which the SureTest is attached should be a dedicated branch circuit used for the purpose of performance testing the accuracy.

Calculated Voltage Drop Method

- Test should be conducted with a dedicated branch circuit where the wire size and distance and wire impedance is known.
- If at all possible the test should have only one receptacle and if not possible test should be conduct on the first receptacle of a branch circuit.
- It is recommended that the circuit be Isolated from other wiring to minimize any inductance on the circuit.
- Use the following formulas as a basis to calculate circuit performance. The Suretest should yield results that conform to Table 4.

Basic Formula Single Phase circuit, Two Wire with ground

- Vd = Drop in circuit voltage
- %Vd = Percent of Voltage Drop
- R =Resistance per Feet of conductor (Ohms/Ft.) [3]
- I = Current in conductor (Amperes)
- L = length of one conductor in Feet
- D = Cross section area of conductor (Circular mils) [3]
- K = Resistivity of Conductor @75°C[4]

12 AWG @ 60 Ft.
R= .00201 per Ft. or 2.01/1000
D= 6530 Circular Mil for 12awg
L= 60
K=12.9

$$Vd = \frac{2(12.9) \times 60 \times 12}{6530}$$

$$2.844 = \frac{18576}{6530}$$

OR

Vd= 12 x 2(.00201 x 60)
2.894 = 12 x .2412

[3]Can be found in Chapter 9-Table 8 of NEC Code Book
[4]K=12.9 for Copper conductors and 21.9 for Aluminum

Vd = $\frac{2K \times L \times I}{}$ or Vd= 2(R x L) x I

%Vd= (Vd/Vrms)x100

Measured Voltage Drop Method

Before we get into the standardization method of a branch circuit it would be good to go over the difference of Voltage drop {VD} verses % of Voltage Drop {%VD}. In a branch circuit there is a Current* Resistance {IR} voltage drop across the wire. This is due to the resistance of each conductor as a function of wire size, length, and device connections. For most branch circuits the resistance or impedance stays constant while the current varies. The higher the current the greater the voltage drops. As an example to perform a voltage drop test and check the % of voltage drop you would need to perform the following test in the field.

Test equipment needed:

- True RMS Digital multimeter with ACV accuracy of 0.25% and ACC measurement accuracy of 0.5% or better
- 8 to 12 Ampere, 1500W load with accuracy of .25% or better

Measurements:

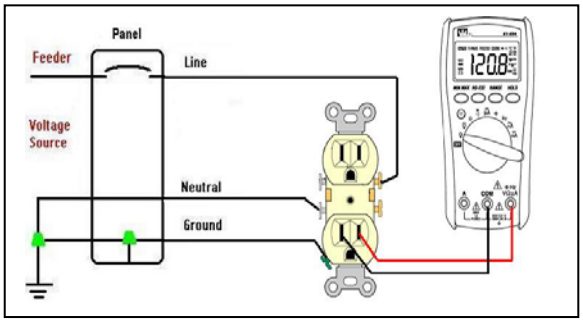
- Measure the Branch circuit voltage at no load
- Measure the Branch circuit voltage and current under load
  - The current measurement is very critical use the best method possible
  - The VD and %VD below would be for the load current measurement.

Calculate Voltage drop for any load we would use the following

- Vd= rZ * A
- %Vd=(Vd/V)*100

For the following example the no load Voltage is 120V, loaded Voltage 115 with an 8 amp load.

V = Voltage no-load
$_{L}V$ = Voltage with load
VD = Voltage no-load - Voltage w-Load
I = Load Current
rZ = Total circuit Impedance



Total circuit Impedance is:

- rZ =(V(no-load)-$_{L}$V (w-load))/I
- rZ =(120-115)/8
- rZ =5/8
- rZ =.625

The %Vd at 8 amps would be

- %Vd= (Vd/Vno-load) x 100
- %Vd= (5/120) x 100
- %Vd= (..0416) x 100
- %Vd= 4.16

It should be noted that the higher the current the large the IR voltage drop and % of Voltage Drop. To check the accuracy of the UUT at 12amp, 15amp and 20 amps we will use the impedance as found with the 8 amp load of rZ = 0.625. With this impedance we can calculate the VD and % VD for any load current.

So for a 12 amp load with a no load voltage of 120V the %VD is :

- Vd= I x R
- Vd= 12 x .625
- Vd=7.5
- %Vd= (Vd/Vno-load) x 100
- %Vd= (7.5/120) x 100
- %Vd= (.0625) x 100
- %Vd= 6.25

STANDARDIZING A BRANCH CIRCUIT

This is the most straightforward way of standardizing a branch circuit for testing the SureTest™. This procedure should be conducted only by qualified personnel. It is highly recommended that a license electrician be present to assist with the measurements of the conductors of the branch circuit being standardize

Recommended equipment:

- Constant Load of 8 to 10 amps at 1500W. It is highly recommended that this loads be as stable as possible with little drift or error due to temperature variations.
- High accuracy True RMS voltage meter with accuracy of .25% or better.
- AC Current meter with and accuracy of .5% or better.
- Low resistance switch, or method to move Load from High and Neutral to High and ground during test

The following measurements should be taking on a dedicated branch circuit if possible. If there is any change in Line voltage or load on source during test it will have an adverse effect on the measurement.

For best results AC current should be measured using the series method on the High or Hot conductor. The voltage and current measurements should be recorded with each step list below.

Steps	Load	Measurement	Current
1	No-Load	V= No load Voltage H-N	N/A
2	Load H-N,	V1= Voltage H-N	
3	Load H-N,	V2 =Voltage H-G	
4	Load H-G,	V3=Voltage H-N	
5	Load H-G,	V4=Voltage H-G	

To calculate the impedance of each conduct enter the values from the table above and calculate the impedance each conductor

Calculated Impedance
$rZ^1=(V-V_1)/I$
$rN=(V_2-V_1)/I$
$rG=(V_3-V_4)/1$
$rH^1=(rZ-rN)^1$

rZ = Total branch circuit Impedance
rN = Impedance of neutral conductor
rG = Impedance of the Ground wire
rH= Impedance of the Hot or High conductor

[1] ***If the method used to measure current employs a shunt resistor the internal shunt resistance of the meter should be taken into account in your calculations. On most DMM's this shunt resistance is around 0.1 ohm.***

Enter "Calculated Impedance" measurements into Table 3 below.

Measure the PEAK voltage and enter in Table3

Measure Frequency and enter into Table 3

Measure Neutral to Ground Voltage and enter into Table 3

Enter calculated %VD for 12 amps, 15 amps, and 20 amps and enter in to Table 1 below *Reference Measured Voltage drop section*

For best accuracy monitor RMS Voltage, Peak Voltage, N-G voltage during UUT test. These measured values could change.

Performance Verification Preparation
To complete the performance verification the Measured Values column must be filled out in Table 3 through standardization practice or calculated methods. See STANDRADIZING A BRANCH CIRCUIT above. Then plug in the Surtest and take readings to fill out the SureTest Reading column in Table 3

Note: *The SureTest™ only takes reading when first plugged in. AC line voltage, peak and Frequency are the only continuous updated reading. Ground impedance is only measured when the meter goes to that reading. If you are on a GFI protected circuit the ground impedance measurement will most likely trip the device.*

A comparison of the Standardized Measured Values to the SureTest Readings should yield results in accordance to the range and accuracy specification listed in Table 2.

Table 3, Standardized Data

	Measured Value	SureTest Reading
AC Line Voltage	*V*	*V*
AC Peak Voltage	*V*	*V*
AC line Frequency	*Hz*	*Hz*
% Voltage Drop 12A	*%*	*%*
% Voltage Drop 15A	*%*	*%*
% Voltage Drop 20A	*%*	*%*
Neutral to Ground V	V	V
Hot Conductor	Ω	Ω
Neutral Conductor	Ω	Ω
Ground Conductor	Ω	Ω

Table 4 illustrates how to combine the branch circuit measured values with the specifications from Table 2 to create a table of values between which the SureTest reading should fall between to verify that it is with calibration.

Table 4, Example of Field tested

Field Test for 61-164/61-165							Enter SureTest
Function	Measured Values	Specification	count	% error	Low Limit	High Limit	Readings
AC Line	122.00	1% +/- 1 digit	0.10	0.010	120.68	123.32	121.9
AC Peak	172.51	1% +/- 1 digit	0.10	0.010	170.68	174.33	172.0
AC Freq	60.00	1% +/- 1 digit	0.10	0.010	59.30	60.70	60
%VD 12	4.40	2.5% +/- 5 digit	0.50	0.025	3.79	5.01	4.4
%VD 15	5.50	2.5% +/- 5 digit	0.50	0.025	4.86	6.13	5.3
%VD 20	7.33	2.5% +/- 5 digit	0.50	0.025	6.64	8.01	7.2
N-G Voltage	0.50	2.5% +/- 5digit	0.50	0.025	-0.01	1.01	0.5
Hot	0.34	5% +/- 5	0.05	0.050	0.27	0.40	0.32
N	0.11	5% +/- 5	0.05	0.050	0.06	0.17	0.13
Gd	0.20	5% +/- 5	0.05	0.050	0.14	0.26	0.22

The GFCI / Time test cannot be done in the field

High Resistance Ground Fault Test (GFCI)

A ground fault circuit-interrupter, the device should be capable of interrupting the electrical circuit when there is a fault between 6mA and 264 mA with in the time interval of T in the following relationship

$$T = \left(\frac{20}{1}\right)^{1.43}$$

Calibration and calibration adjustment procedure

The SureTest 61-160 Series cannot be field calibrated. If Calibration is required please call 800-435-0705 for return instructions.

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