

SSPMA

Sump and Sewage Pump Manufacturers Association

Since 1956, we are a North American trade organization of sump, effluent, and sewage pump manufacturers and their suppliers.

Working together to:

- train wastewater and plumbing professionals, and
- create product performance and safety standards.

SSPMA members collaborate with each other and government regulators to educate consumers and professionals on the latest products, their application, proper sizing techniques, safe installation and use, and good maintenance practices.



Pumps bearing the “SSPMA-Certified” seal have been tested by the member manufacturer in accordance with SSPMA Industry Standards.



The Standards are designed to provide accurate performance data for sump, effluent and sewage pumping equipment, to assist in their proper application and selection.



SSPMA MEMBERS

Barnes Pumps / Crane Pumps & Systems

Champion Pump Company, Inc.

Eco-Flo Products Inc. / Ashland Pump Company

Franklin Electric / Little Giant

Glentronics, Inc.

Goulds Water Technology, a xylem brand

Liberty Pumps

Pentair Water

Superior Pump Company

Zoeller Company



SSPMA ASSOCIATE MEMBERS

AK Industries

Alderon Industries

John Crane, Inc.

LevelGuard / Touch Sensor Technologies

See Water, Inc.

SJE-Rhombus

Topp Industries, Inc.



Troubleshooting Pumps, Panels, Switches With Digital Multimeters

Bo Gell

Product Manager – Wastewater
Goulds Water Technology

Agenda

- Safety
- Digital Multimeters
- Tests
 - Line To Line Resistance, Insulation Resistance, Capacitor, Amps, Voltage

Warning

⚠️ WARNING All electrical work must be performed by a qualified technician. Always follow the National Electrical Code (NEC), or the Canadian Electrical Code, as well as all local, state and provincial codes. Code questions should be directed to your local electrical inspector. Failure to follow electrical codes and OSHA safety standards may result in personal injury or equipment damage. Failure to follow manufacturer's installation instructions may result in electrical shock, fire hazard, personal injury or death, damaged equipment, provide unsatisfactory performance, and may void manufacturer's warranty.

Electrical Shock

Lethality due to electric shock is dependent on:

Current

Duration

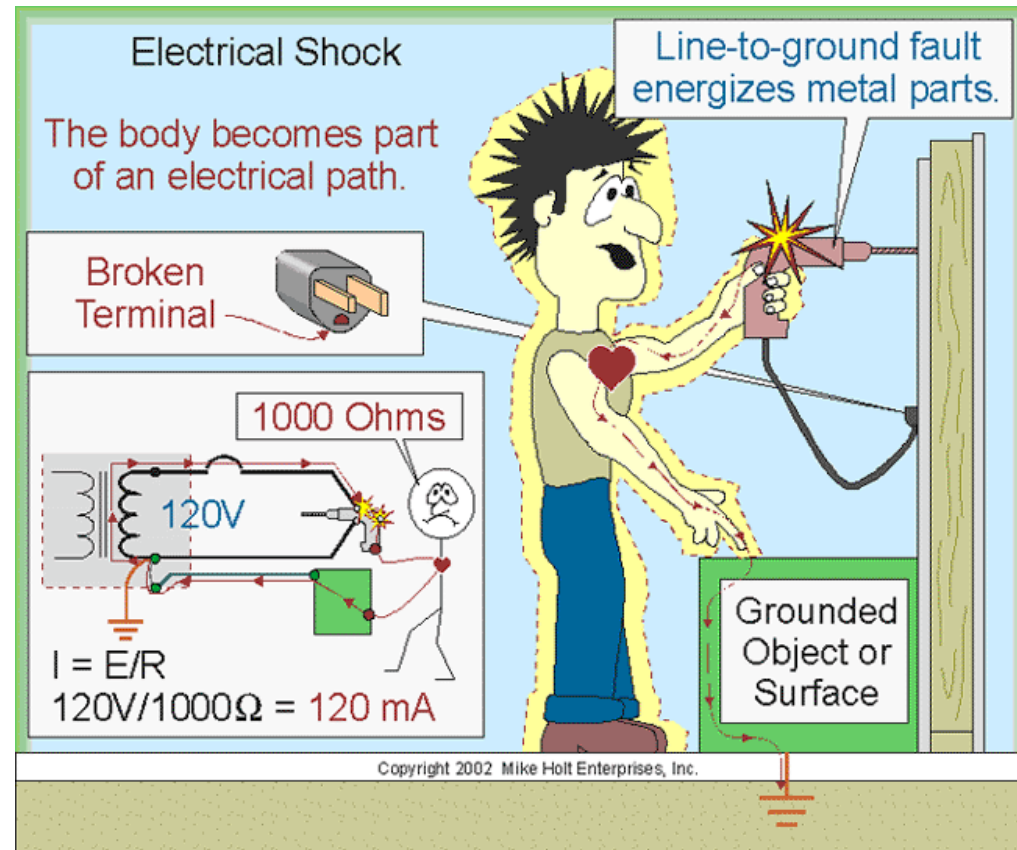
Pathway

Voltage

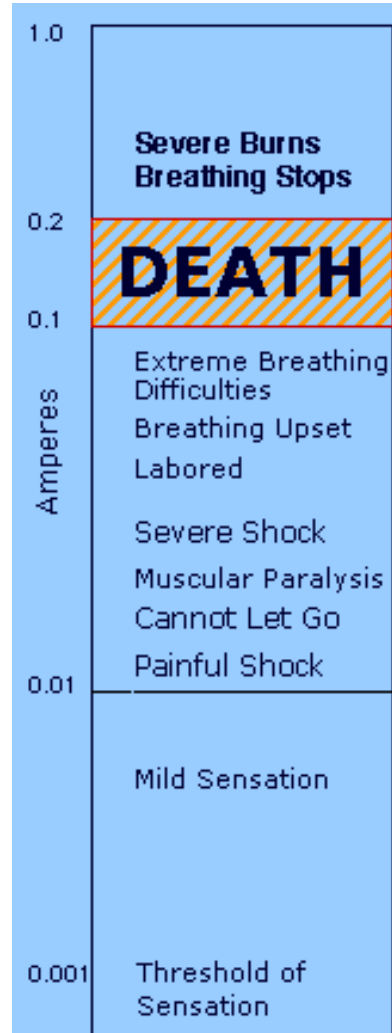


Electrical Shock

Body (skin) resistance can vary from 100,000 ohms to 500 ohms depending on moisture and skin conditions. Cardiac arrest can occur with a current as little as **60 mA**.



Effects Of Current In The Human Body



Current	Reaction
Below 1 mA	Generally not perceptible
1 mA	Faint tingle
5 mA	Slight shock felt, not painful but disturbing; average individual can let go; strong involuntary reactions can lead to other injuries
6 to 25 mA (women)	Painful shock, loss of muscular control
9 to 30 mA (men)	The freezing current or let-go range; individual cannot let go but can be thrown away from the circuit if extensor muscles are stimulated
50 to 150 mA	Extreme pain, respiratory arrest, severe muscular contractions; death possible
1,000 to 4,300 mA	Rhythmic pumping action of the heart ceases; muscular contraction and nerve damage occur; death likely
10,000 mA	Cardiac arrest, severe burns; death probable

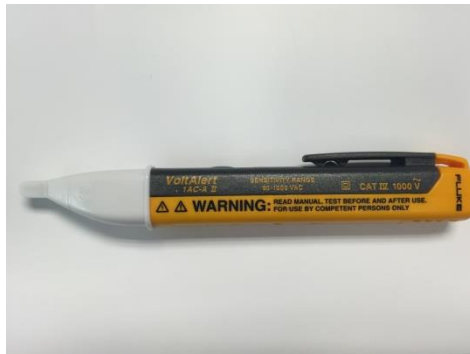
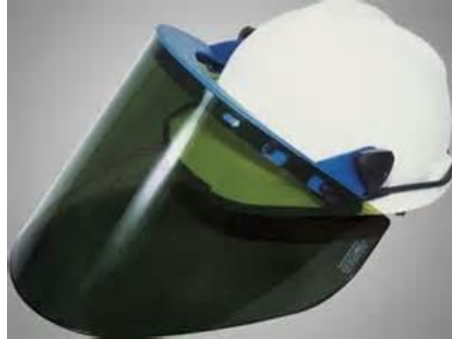
Table 1. Effects of Electric Current in the Human Body

WARNING – Graphic Photo On Next Slide!



Only 20% of electric shock patients die from the effects of shock, the rest die from internal and external burns

Personal Safety Equipment



CAT Ratings - Meters

CAT ratings established by IEC determines the maximum voltage spike an instrument can withstand



Rated voltage	IEC 61010-1 2nd Edition			UL 61010B-1 (UL 3111-1)		
	CAT IV	CAT III	CAT II	CAT III	CAT II	CAT I
150V	4,000V	2,500V	1,500V	2,500V	1,500V	800V
300V	6,000V	4,000V	2,500V	4,000V	2,500V	1,500V
600V	8,000V	6,000V	4,000V	6,000V	4,000V	2,500V
1,000V	12,000V	8,000V	6,000V	8,000V	6,000V	4,000V
Resistance	2 ohms	2 ohms	12 ohms	2 ohms	12 ohms	30 ohms

CAT Ratings - Meters



Meter ratings and capabilities vary by manufacturer. Before working with a new meter, be sure to familiarize yourself with all operating and safety procedures for that meter contained in the users manual.

Independent testing is the key to safety compliance

How can you tell if you're getting a genuine CAT III or CAT II meter? It's not always easy. It is possible for a manufacturer to self-certify its meters as CAT II or CAT III without any independent verification. Beware of wording such as "Designed to meet specifications..." Designer's plans are never a substitute for an actual independent test. The IEC (International Electrotechnical Commission) develops and proposes standards, but it is not responsible for enforcing the standards.

Look for the symbol and listing number of an independent testing lab such as UL, CSA, TÜV or other recognized approval agency. That symbol can only be used if the product successfully completed testing to the agency's standard, which is based on national/ international standards. UL 3111, for example, is based on IEC 1010. In an imperfect world, that is the closest you can come to ensuring that the multimeter you choose was actually tested for safety.

LISTED

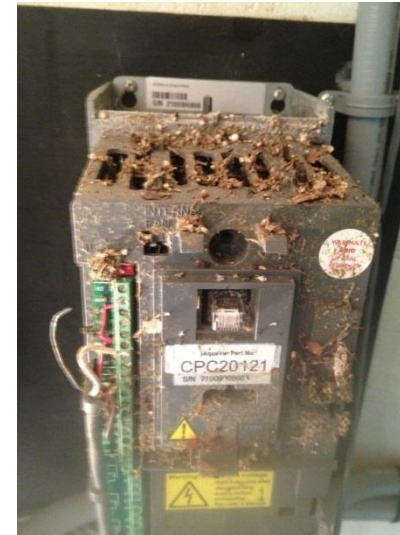


Troubleshooting Basics

Never Overlook The Obvious

Power on?

Check connections

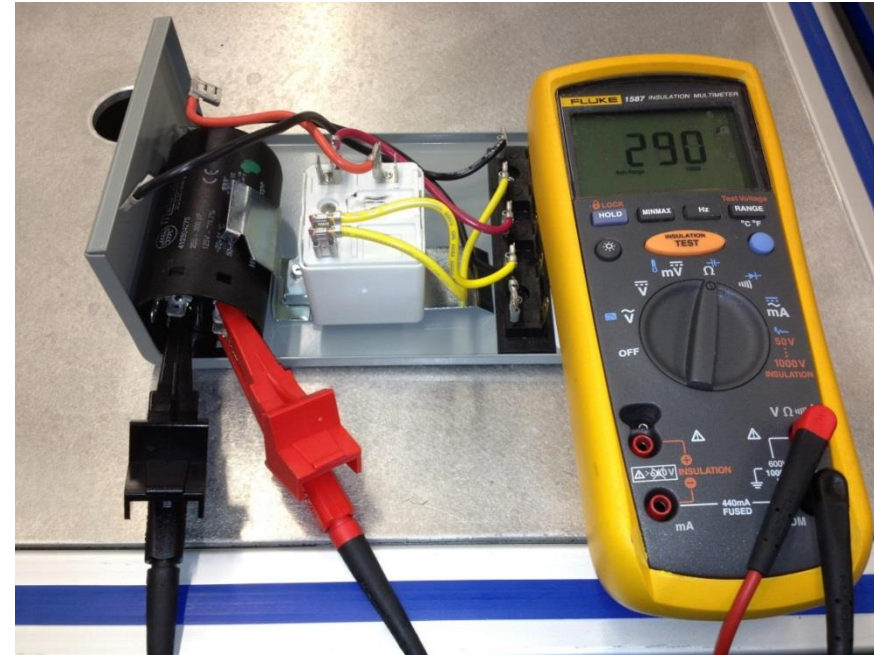


Troubleshooting Basics

Look For The CAUSE Of Failure, Rather Than Treating The EFFECT

IE – Replacing Control Box

Bad components, or is something causing the component to fail?



Troubleshooting Basics

Buy A Quality RMS Multimeter

AC/DC Voltage and Amperage, Resistance, Frequency, Capacitance,
Insulation resistance

Know Your Meter! (Read the manual)

Measure Voltage & Amperage – Write Down

Line to line voltage

Line to ground voltage

Amperage – Start, Run, Winding?, Based on performance

Amperage changes with voltage

Take Digital Photo Of Installation And Send

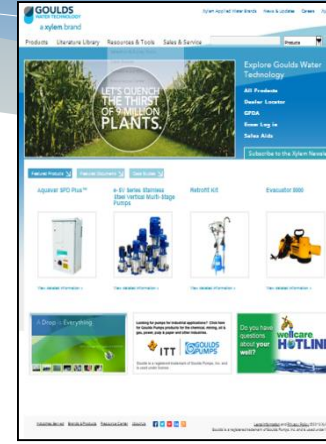
Tools



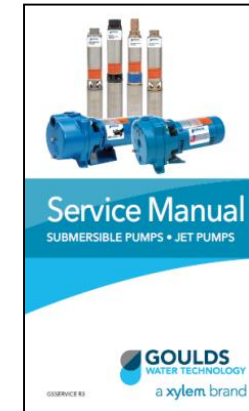
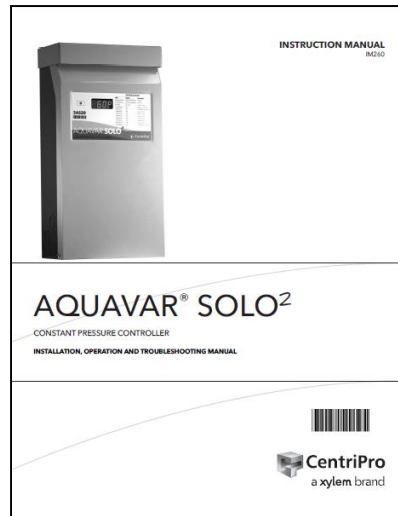
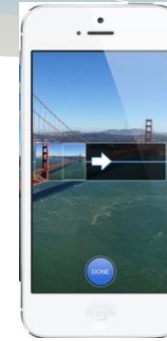
Quality Multimeter



Tech Support



Website/App



Simpson 372

MAID, IOM, SM

TROUBLESHOOTING



FAILURE TO DISCONNECT AND LOCKOUT ELECTRICAL POWER BEFORE ATTEMPTING ANY SERVICE CAN CAUSE SHOCK, BURNS OR DEATH.

SYMPTOM	PROBABLE CAUSE	RECOMMENDED ACTION
<p>MOTOR NOT RUNNING</p> <p>NOTE: If circuit breaker “OPENS” repeatedly, DO NOT reset. Call qualified electrician.</p> <p>a) Manual operation</p>	Motor thermal protector tripped.	Allow motor to cool. Insure minimum pump submergence. Clear debris from casing and impeller.
	Open circuit breaker or blown fuse. Pump impeller binding or jammed.	Determine cause, call a qualified electrician.
<p>b) Automatic operation</p> <p>NOTE: Check the pump in manual mode first to confirm operation. If pump operates, the automatic control or wiring is at fault. If pump does not operate, see above.</p>	Power cable is damaged. Inadequate electrical connection in control panel.	<p>Check motor amp draw. If two or more times higher than listed on pump nameplate, impeller is locked, motor bearings or shaft is damaged. Clear debris from casing and impeller, consult with dealer.</p>
	No neutral wire connected to control panel. Inadequate electrical connection in control panel. Defective liquid level switch.	<p>Resistance between power leads and ground should read infinity. If any reading is incorrect, call a qualified electrician.</p> <p>Inspect control panel wiring. Call a qualified electrician.</p> <p>With switch disconnected, check continuity while activating liquid level switch. Replace switch, as required.</p>
	Insufficient liquid level to activate controls. Liquid level cords tangled.	<p>Allow liquid level to rise 3" to 4" (76 mm - 101 mm) above turn-on level.</p> <p>Untangle cords and insure free operation.</p>

Simpson 372

The Simpson Ohmmeter Model 372 Series 3 is a six range instrument. It measures values from 0.2 to 50 M with an accuracy of $\pm 3\%$ of arc.

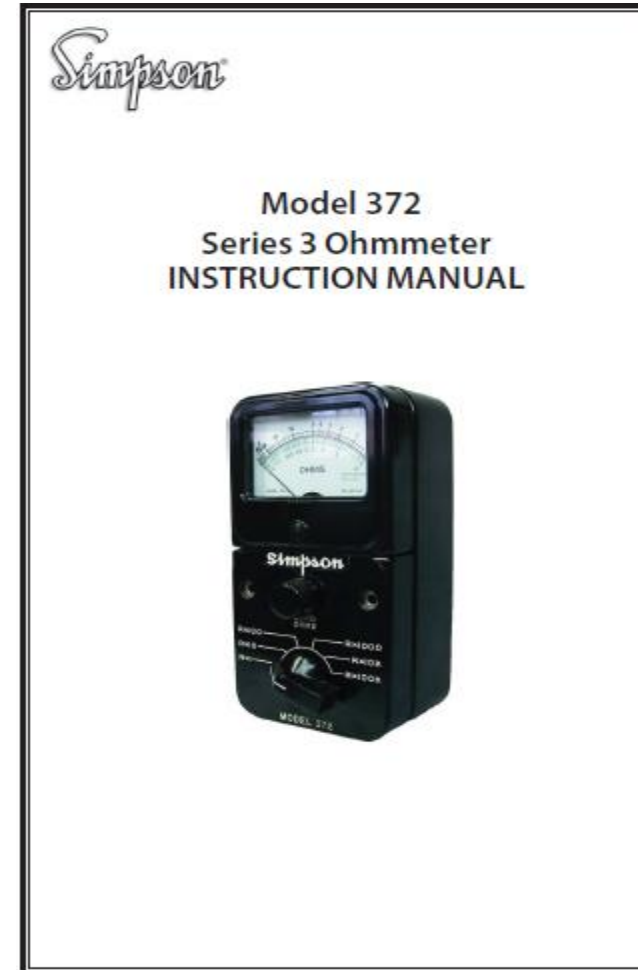
For best results, select the range in order that the attained readings are near mid scale.

Units can be repaired and or calibrated.
(May provide new leads)

Simpson Electric

National or local service centers

Older units can be retrofitted with replacement battery.



Meter Guidelines

Do not use the Meter or test leads if they appear damaged, or if the Meter is not operating properly. If in doubt, have the Meter serviced.

Always use the proper terminal, switch position, and range for measurements before connecting Meter to circuit under test.

Verify the Meter's operation by measuring a known voltage.

Do not apply more than the rated voltage as marked on the Meter, between the terminals or between any terminal and earth ground.

Use caution with voltages above 30 V ac rms, 42 V ac peak, or 60 V dc. These voltages pose a shock hazard.

Replace the battery as soon as the low battery indicator appears.

Disconnect circuit power and discharge all high-voltage capacitors before testing resistance, continuity, diodes, or capacitance.

Do not use the Meter around explosive gas or vapor.

When using the test leads, keep your fingers behind the finger guards.

Remove test leads from the Meter before opening the Meter case or battery door. Never operate the Meter with the cover removed or the battery door open.

Comply with local and national safety requirements when working in hazardous locations.

Use proper protective equipment, as required by local or national authorities when working in hazardous areas.

Avoid working alone.

Use only the replacement fuse specified or the protection may be impaired.

Check the test leads for continuity before use. Do not use if the readings are high or noisy.

Fluke 1587

Fluke 1587 - Insulation Multimeter

The Meter measures or tests the following:

- AC / DC voltage and current
- Resistance
- Voltage and current frequency
- Temperature (Model 1587)
- Diodes (Model 1587)
- Continuity
- Capacitance (Model 1587)
- Insulation testing



RMS

RMS Voltage

AC voltage rises positive and falls negative 60 times per second, so how do you state its value? Industry practice is to quote the RMS voltage. RMS is a value 70.7% of the peak positive voltage. An RMS voltage will produce exactly the same heating rate in a resistive load as a DC voltage of the same value. RMS is the acronym for the mathematical steps used in its derivation. Square the voltage at all moments in an AC cycle, take the mean of these, and then take the square root of the mean. For reasons lost in obscurity, the steps are stated in reverse sequence, Root Mean Square.

Lo-Pass Filter

The 1587 is equipped with an ac low-pass filter. When measuring ac voltage or ac frequency (B), press the blue button to activate the Low-Pass Filter function (K). The Meter continues measuring in the selected ac mode, but now the signal diverts through a filter that blocks unwanted frequencies above 800 Hz. **The low pass filter can improve measurement performance on composite sine waves that are typically generated by inverters and variable frequency motor drives.**

Autoranging is not available with the Low-Pass filter function.

Unsafe Voltage

To alert you to the presence of a potentially hazardous voltage, when the Meter detects a voltage ≥ 30 V or a voltage overload (OL), the lightning symbol is displayed.

Fuse

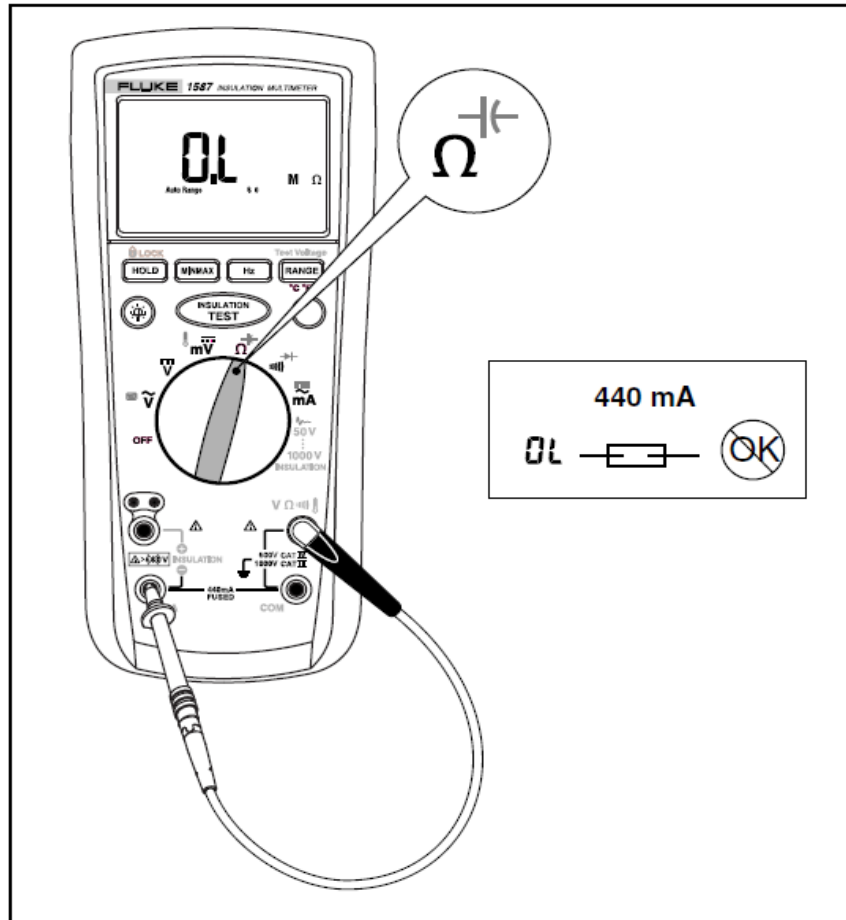
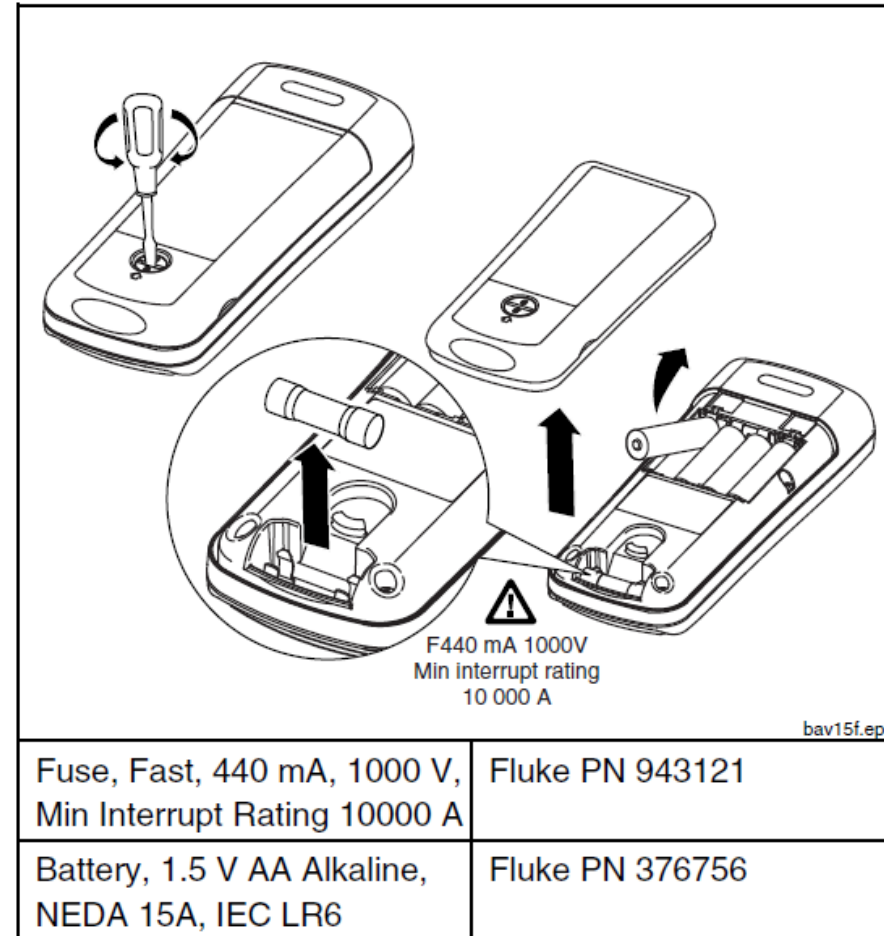


Figure 15. Testing the Fuse

bav14f.eps



Fuse, Fast, 440 mA, 1000 V,
Min Interrupt Rating 10000 A

Fluke PN 943121

Battery, 1.5 V AA Alkaline,
NEDA 15A, IEC LR6

Fluke PN 376756

Figure 16. Replacing the Fuse and Battery

Testing The Batteries

To test the batteries, press **HOLD** and turn to the rotary switch to the **INSULATION** position. This initiates a battery test and displays the charge level of the battery.



Resistance

Due to the inability to 'zero out' the digital meter, check resistance of the leads and subtract from your resistance readings



VARI

Power On

- * **V**oltage
- * **A**mperage

Power Off

- * **R**esistance
- * **I**nsulation

AC Voltage

Input -

Typical Allowable Range $\pm 10\%$

Low Voltage = Higher Amps

Test Under Load

Line To Line

Line To Ground

Output On Drive –

Varies

Need Lo Pass Filter To Accurately Measure



Voltage

VOLTAGE CHECKOUT 3Ø STARTER

Checking Voltage at Fused Disconnect and Magnetic Starter



WARNING!

Power is **ON** during voltage checking.

1. To check voltage: Use voltmeter on L1, L2 and L3 in sequence. Check should be made at four locations.
Step 1 Checking incoming power supply.
Step 2 Checking fuses.
Step 3 Checking contact points
Step 4 Checking heaters.
2. When checking voltage, all other major electrical appliances (that could be in use at the same time) should be running.
3. If incoming power supply readings are not within the limits (see chart), call your power supplier.

NOTE:Phase to phase - full line voltage.

Voltage Limits		
Name Plate ▼	Measured Volts	
	Minimum	Maximum
208V 3Ø	188	228
230V 3Ø	207	253
460V 3Ø	414	506
575V 3Ø	518	632

Phase to neutral - ½ full line voltage.
(depending on transformer connection)

Amperage

What Is It?

Hydraulic Analogy

Voltage \approx Pressure

Current \approx Flow

Resistance \approx Friction Loss

What It Means –

Currents above these values indicate system problems.

Amperage

What Are Good Values?

MODELS

Order Number	HP	Phase	Volts	RPM	Impeller Dia. (In.)	Max. Amps	LRA	KVA Code	Full Load Motor Eff.	Resistance		Wt. (Lbs.)
										Start	Line-Line	
WS0311B	0.33	1	115		4.69	10.7	30.0	M	54	11.9	1.7	63
WS0318B			208			6.8	19.5	K	51	9.1	4.2	
WS0312B			230			4.9	14.1	L	53	14.5	8.0	
WS0511B	0.5	1	115		5.00	14.5	31.1	J	55	9.3	1.4	65
WS0518B			208			8.0	19.5	K	51	9.1	4.2	
WS0512B			230			7.3	16.5	J	54	11.7	5.6	
WS0538B		3	200			3.8	12.3	K	75	NA	6.7	
WS0532B			230			3.3	9.7	K	75	NA	9.9	
WS0534B			460			1.7	4.9	K	75	NA	39.4	
WS0537B			575			1.4	4.3	K	68	NA	47.8	

Amperage

How Do I Measure It?

Load/Output/Pump

Typically Use Current Clamp

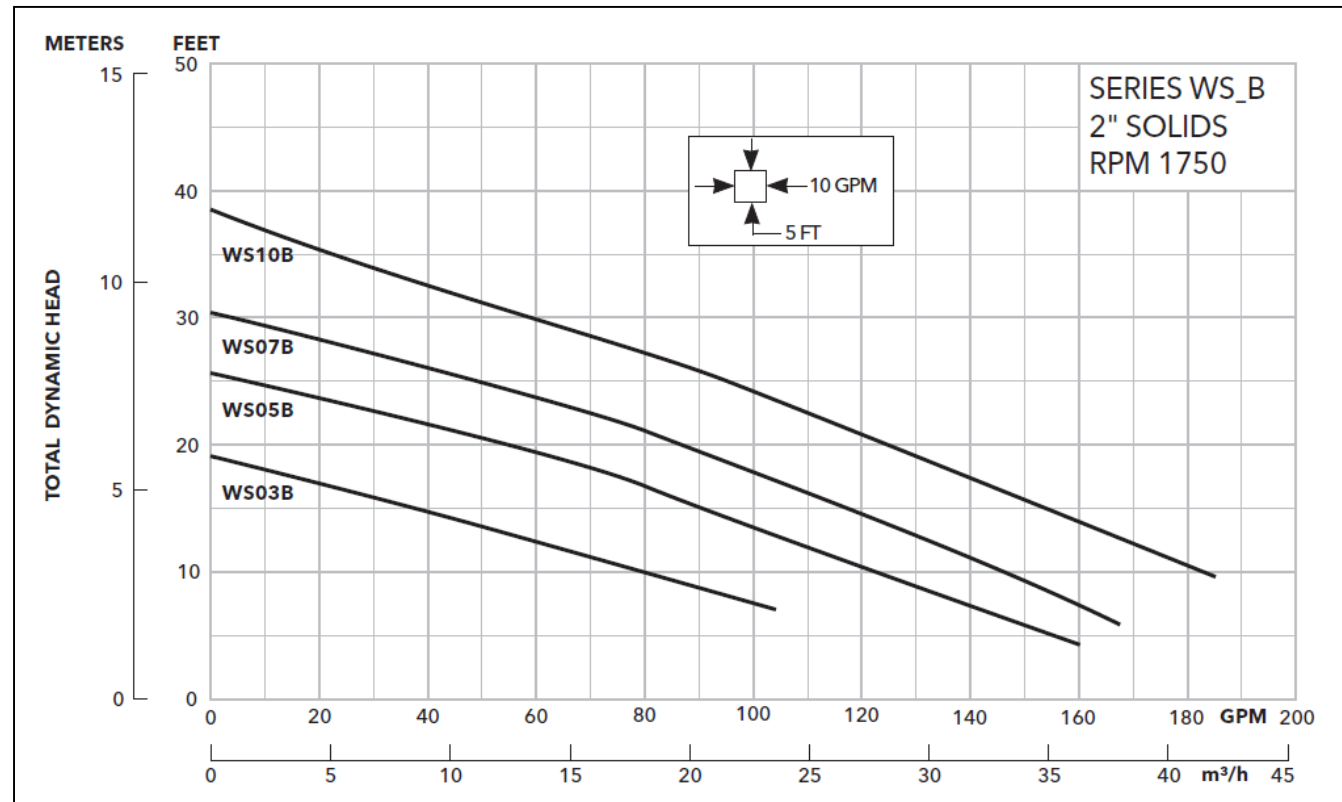
FLA, SFA, LRA

Max/Min/Avg



High Amps?

- Input Voltage
- Impeller
- Motor
- Duty Point



Winding Resistance

What Is It?

Resistance is simply that – similar to friction loss in a piping system – too much resistance generates heat – all motor windings have a specification for winding resistance

What it Means

1. If all ohm values are normal, the motor windings are neither shorted nor open, and the cable colors are correct.
2. If any one ohm value is less than normal, the motor is shorted.
3. If any one ohm value is greater than normal, the winding or the cable is open or there is a poor cable joint or connection.

Winding Resistance

What Are Good Values?

MODELS

Order Number	HP	Phase	Volts	RPM	Impeller Dia. (In.)	Max. Amps	LRA	KVA Code	Full Load Motor Eff.	Resistance		Wt. (Lbs.)
										Start	Line-Line	
WS0311B	0.33	1	115		4.69	10.7	30.0	M	54	11.9	1.7	63
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WS0512B			230			7.3	16.5	J	54	11.7	5.6	
WS0538B		3	200			3.8	12.3	K	75	NA	6.7	
WS0532B			230			3.3	9.7	K	75	NA	9.9	
WS0534B			460			1.7	4.9	K	75	NA	39.4	
WS0537B			575			1.4	4.3	K	68	NA	47.8	

Winding Resistance

How Do I Measure?



Winding Resistance

Is There Anything Else I Need To Know?



RULE OF THUMB

Add resistance of drop cable when checking pump in well. See Cable Resistance.

Size Cable	Paired Wire
	Resistance (ohms per foot)
14	.0050
12	.0032
10	.0020
8	.0013
6	.0008
4	.0005
2	.0003
0	.0002
00	.00015
000	.00013
0000	.00010

Insulation Resistance

What Is It?

If motor windings or cable has “leaks” in the insulation, the motor can trip protection like a short circuit.

To properly test wire insulation you “megger”, or test to see if a high voltage will “leak” to ground from the wire/winding.

This is similar to a “hydro” test of a pump system – if the pump seal does not leak at 360PSI, the insulation on the windings is less likely to leak when tested at 500 volts.

The Fluke 1587 can produce as much as 1000 volts (dc) to “megger” motor windings or submersible drop cable.

Insulation Resistance

What Are Good Values?

Based on Simpson 372...

INSULATION RESISTANCE READINGS

Normal Ohm and Megohm Values between all leads and ground

Condition of Motor and Leads	Ohm Value	Megohm Value
A new motor (without drop cable).	20,000,000 (or more)	20 (or more)
A used motor which can be reinstalled in well.	10,000,000 (or more)	10 (or more)
Motor in well. Readings are for drop cable plus		
New motor.	2,000,000 (or more)	2 (or more)
Motor in good condition.	500,000 - 2,000,000	.5 - 2
Insulation damage, locate and repair.	Less than 500,000	Less than .5

Insulation resistance varies very little with rating. Motors of all HP, voltage and phase ratings have similar values of insulation resistance.

Insulation resistance values above are based on readings taken with a megohmmeter with a 500V DC output. Readings may vary using a lower voltage ohmmeter, consult factory if readings are in question.

Insulation Resistance

How Do I Measure It?

Determine Test Voltage

Test Each Lead To Ground



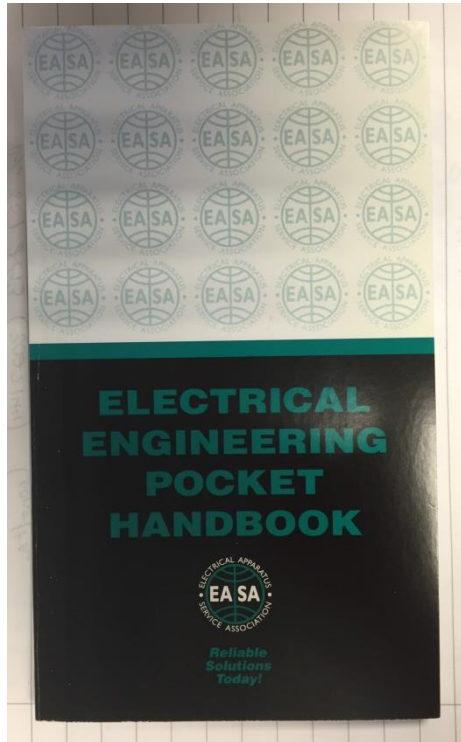
Test Voltage

Table C
Insulation Resistance Readings for Submersible Pump Motors

Test of motor winding to ground at end of power cable	Expected Meg Ohm Value*
A New motor	50 meg ohms or greater (higher is better)
Used motor, still in useable condition	20 meg ohms
Used motor which must be serviced prior to operating	5 meg ohms or lower
Moisture sensing probe system	Consult pump manufacture for resistance readings

* with meg ohm meter output voltage set to as close to the motor rated voltage as possible

Test Voltage



INSULATION RESISTANCE TEST

Test voltage should be applied for one minute (Reference: IEEE Std. 43, Sec. 5.4 and 12.2).

GUIDELINES FOR DC VOLTAGE TO BE APPLIED DURING INSULATION RESISTANCE TEST

WINDING RATED VOLTAGE (V) ^a	INSULATION RESISTANCE TEST DIRECT VOLTAGE (V)
<1000	500
1000 - 2500	500 - 1000
2501 - 5000	1000 - 2500
5001 - 12,000	2500 - 5000
>12,000	5000 - 10,000

^aRated line-to-line voltage for three-phase AC machines, line-to-ground for single-phase machines, and rated direct voltage for DC machines or field windings. Reference: IEEE Std. 43, Table 1.

POLARIZATION INDEX (P.I.) TEST

Frequency (Hz)

Used For Drives

Note: Follow direction of arrow on clamp



Continuity

- **Continuity**
 - **POWER OFF!**
 - May be used to identify floats



Capacitor (Power Off!)

Disconnect and Discharge the capacitor prior to test!

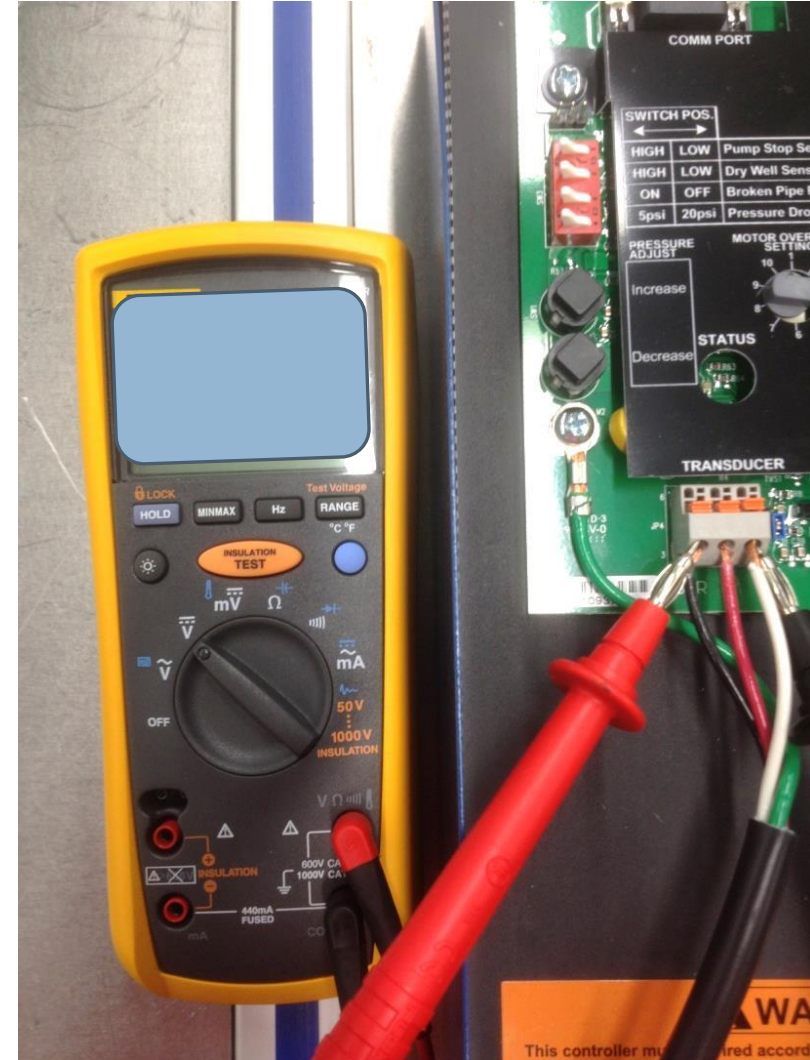


dc Voltage

Used For Drives With Voltage Transducers

Output to transducer

Input to drive



Sump and Sewage Pump Manufacturers Association

This concludes the education portion
of this session

Pumps bearing the “SSPMA-Certified” seal have been tested by the member manufacturer in accordance with SSPMA Industry Standards.



The Standards are designed to provide accurate performance data for sump, effluent and sewage pumping equipment, to assist in their proper application and selection.

