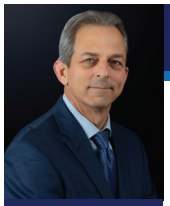

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ADV. Electrical Troubleshooting

serviceteam TRAINING

Presented by Mark Cukro

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Objectives

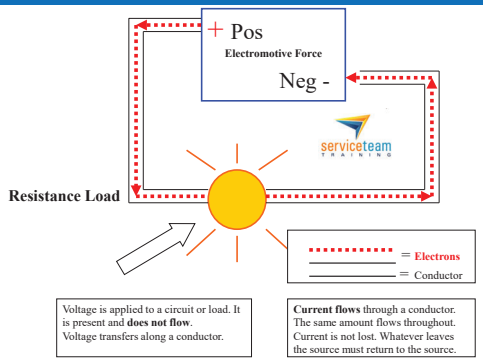
- **Troubleshoot more effectively**
- Apply different search methods
- Reduce diagnostic time
- Test a circuit in seconds
- Tips for applying new methods in the field

Troubleshooting

What are you troubleshooting?

Time	Fault – specific of non-specific
Temperature	Consistent or inconsistent
Airflow	Frequency of the fault
Water Flow	Point of origin
Energy	Point of termination
A Function	Electrical
Operator Error	Mechanical
Error Code	Other considerations for same fault
Overall Performance	Overall success rates

Basic Electrical Circuit

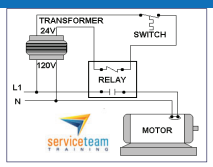


Simple Circuit

3 basic requirements for a circuit

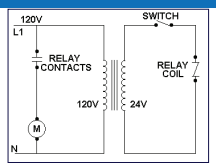
1.Source
2.Path
3.Load

Pictorial and Schematic Diagrams



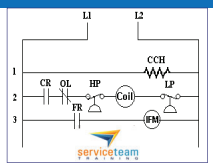
Pictorial diagrams
Show how components are **actually wired**.

However, they become cumbersome when too many components are involved.



Schematic diagrams
Present the logic of the circuit in an organized fashion.

Schematic diagrams are less cluttered because **they use symbols** to represent components.



A ladder diagram
is arranged with the power supply lines drawn vertical as the legs of a ladder.

Each horizontal line contains one load and its control switches.

Multimeters

A multimeter is a meter that will make several different measurements.
It will measure: **Voltage, Resistance, and Current**

Test leads

Meter scale
Wires that go from the meter to what
Displays what is being measured
is being measured

Function switch

Range selector
Selects what will be measured
Selects range of value
A/C, D/C current or resistance

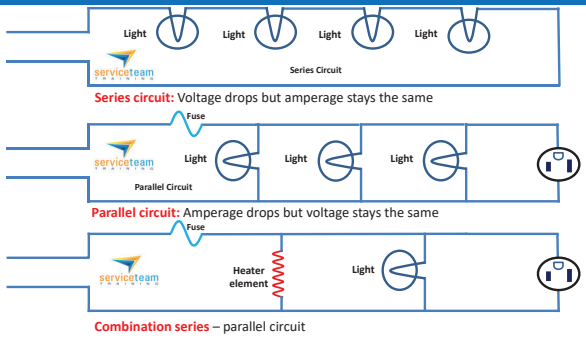
Multimeters

Front Panel Symbols

Symbol	Meaning
V ⎓	V DC
V ∿	V AC
mV	millivolts (.001V or 1/1,000V)
A	Amps
mA	milliamps (.001A or 1/1000A)
µA	microA (.000001A or 1/1,000,000A)
Ω	Resistance (Ohms)
kΩ , MΩ	kilo-Ohms, Megohms
)))	Continuity beeper

Symbols	Measurement Functions	Descriptions
V∼	AC Voltage	Measures amount of AC Electrical Pressure
V⎓	DC Voltage	Measures amount of DC Electrical Pressure
mV	Milli Volts	.00V or 1/1000V
A	Amperes	Measures amount of electron flow
mA	Milli Amperes	.001 or 1/1000A
Ω	Ohms	Measurement of resistance to the flow of electron
⊣⊢	Diode	Device used to control direction of electron flow
)))	Audible Continuity	Audible indication of continuity for low resistance
⊣⊢	Capacitance	Device used to store electrical potential

Types of Circuits

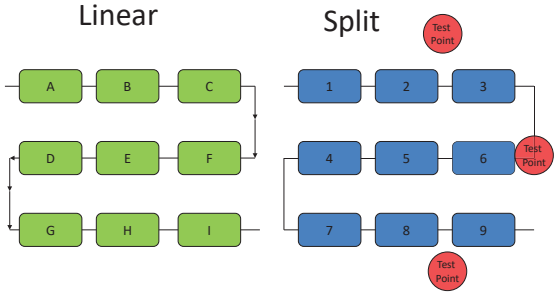


Series circuit: Voltage drops but amperage stays the same

Parallel circuit: Amperage drops but voltage stays the same

Combination series – parallel circuit

Search Methods

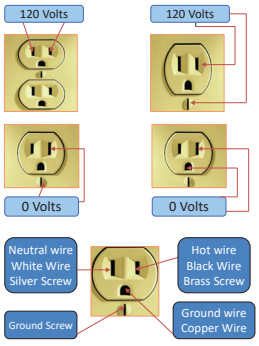


Measuring Voltage

Measuring line voltage under

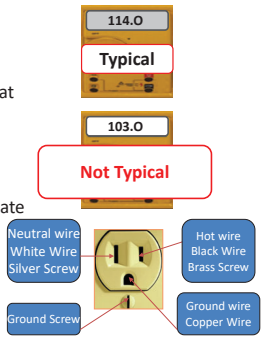
No-Load conditions

- Line voltage is the voltage coming from the wall receptacle.
- No-load conditions mean **Nothing** is turned on and **Everything** is off
- Line voltage should be **120 V** under no-load conditions

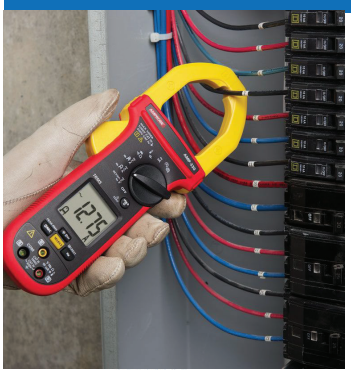


Measuring Voltage

- ***Line voltage under <u>load conditions</u>***
- Voltage under-load conditions will be slightly less
- More than **10%** difference means there is a fault that needs to be corrected.
- **<u>Test for ground</u>**
- Test between the long slot and the ground receptacle
- If there isn't a ground receptacle then touch the cover-plate screw



Measuring Current

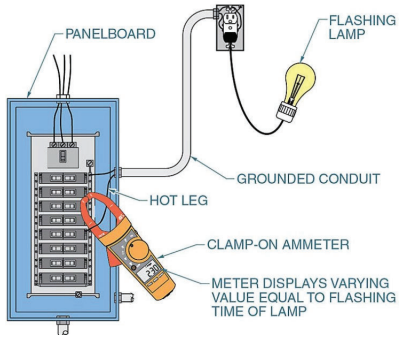


- Current is the **Flow** of electrons.
- Current must have a **Source**, **Path**, and a
- **Load** in order to flow.
- If current is present, you have a **Source** and a **Path**.

23

Locating a Circuit

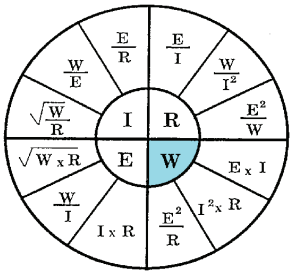
Flashing amps
Should match amp reading on meter



Troubleshooting

25

Wheel of Electricity

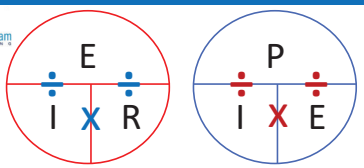


Volts (E), Amps (I), Ohms (R) or Watts (W)

can be calculated if you know two of the values.

26

Illustration of Ohm's Law

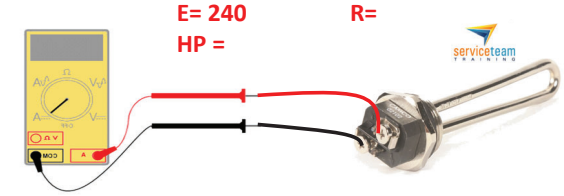


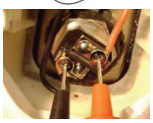
E (Voltage) Volts = _____ X _____
I (Current) Amps = _____ X _____
R (Resistance) Ohms = _____ X _____
P (Power) Watts = _____ X _____

27

Challenge

P = 4500 I = 4500 Watts
E= 240 R=
HP =





Electric Water Heater Element

Electrical Fast Facts & Basic Rules

- **Voltage** is the pressure or force
- **Amperage** is the flow of electrons
- **Ohms** is the measurement of resistance
- **Watts** is the amount of power an electric device consumes.
- **A watt-hour** (Wh) is the amount of energy consumed when a device uses one watt of power for one hour.

29

HVAC Fast Facts & Basic Rules

- 12,000 btu's in 1 ton of refrigeration
- 1 btu =
- **SEER**
- **FLA**
- **LRA**
- ▲ T°F
- 800 btu's per person in moderate 850 in moderate dancing (nightclub)
- 550 sq ft of area gets 1 ton of refrigeration
- 400 CFM minimum for 1 ton of refrigeration

30

Electrical Consumption

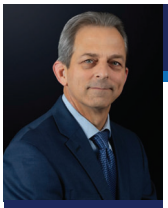
Device	Typical consumption	Cost per hour
Heat pump or central air	15,000 watts	$1.50
Water heater or clothes drier	4,000 watts	40 cents
Water pump	3,000 watts	30 cents
Space heater	1,500 watts	15 cents
Hair drier	1,200 watts	12 cents
Electric range burner	1,000 watts	10 cents
Refrigerator	1,000 watts	10 cents
Computer and monitor	400 watts	4 cents
Light bulb	60 watts	0.6 cents

This table assumes that a **kilowatt-hour** of electricity costs 10 cents, which is an average rate depending on your location.

Summary

- **Have the correct test equipment**
- **Build your skills** with using meters
- Know what type of circuit you are testing
- Know how each component works correctly
- **Match all ratings** on components and equipment
- Follow codes
- **Your safety is your responsibility first!**
- Trust the process of troubleshooting

- **Go home safe** ☺



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