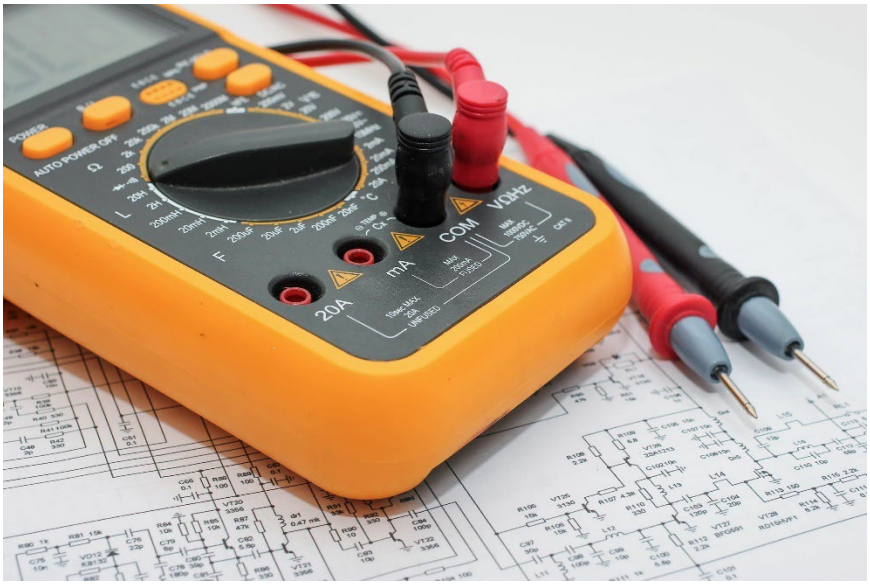
1. Safety First: Essential Precautions

Before you begin, always prioritize your safety to prevent electric shock and damage to your equipment.

- **De-energize the circuit** if **POSSIBLE** before connecting or disconnecting probes.
- **Inspect your tools** and make sure the probes of your multimeter are in good condition with no exposed wire.
- **Never touch the metal tips** of the probes with your bare hands while testing a live circuit.
- **Set the correct mode and range** to avoid damaging the meter.



2. Understanding Your Multimeter

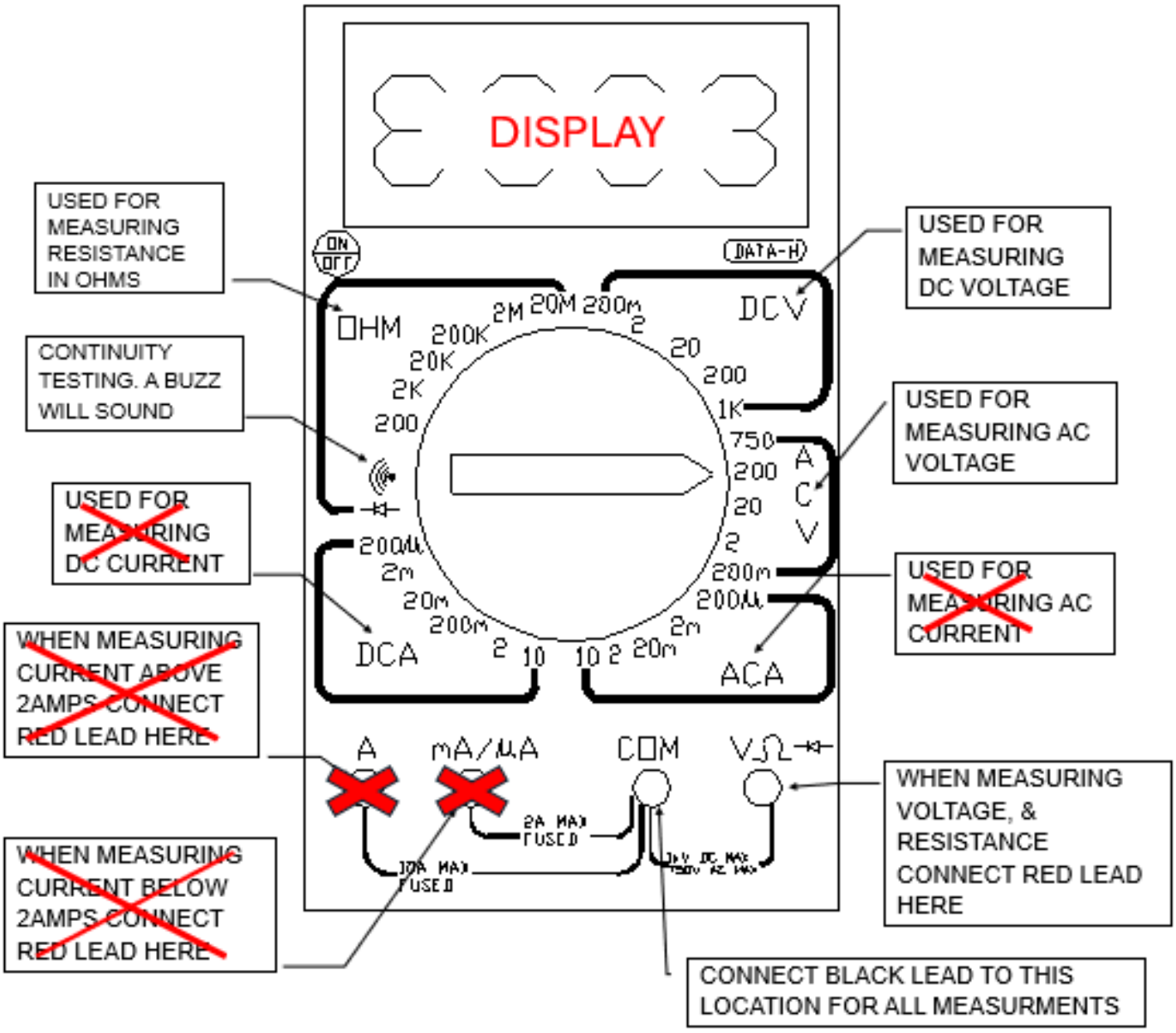
Reladyne employees that have to troubleshoot electrical circuits on equipment should only use a **DIGITAL MULTIMETER**, issued by Reladyne.

A digital multimeter has a dial to select the function and range, two probes (red lead for positive, VΩ⊣⊢) and (black lead for negative, COM), and a digital display.

Reladyne Employee's should not use an analog multimeter.

NOTE: (all Reladyne issued multimeters should go through a yearly calibration procedure before being put in service).

Typical digital Multimeter



For all purposes and safety of Reladyne Employee's, only use the OHM's, DCV and the ACV slots on the bottom of the digital multimeter. Never use the **A** or **mA/µA** slots on the bottom of the multimeter.
If you have to check for (**A**) amperage (**AMPS**), use a clamp meter, Supplied by Reladyne.
Reladyne Employee's should never have to check for milliamps or microamps (**mA/µA**).

SAFETY: The reason not to use the amperage functions on a multimeter. The multimeter must be in line with the current flow.

3. Measuring Voltage on a digital Multimeter

DCV (Direct Current Voltage): Rotate the dial on the digital multimeter to either show V⎓ or "**DCV**" (Direct Current Voltage). On the body of the meter. Depending on the meter. This is to measure for DC **Voltage**.

- **DC:** Used for testing batteries, power supplies, embedded controllers in (IVT), PLC's/ HMI's in (CVT's/SSV's), Mist Monitors, Level transmitters, Transducers, LED's (light emitting diode) typically overhead lights, and any DC powered electronics.
- For DC Voltage always connect the red lead on the positive side of the component/circuit and the Black Lead on the negative side of the component/circuit.
  If they are placed backwards, you will read a negative voltage. Just change them around.
- If you are trying to read a voltage on the component/circuit and get an **OL** or **1** on the display of the multimeter. Rotate the dial to the right to the next highest number until you read a value.
- If you don't know what the voltage is. Rotate the dial too the highest setting on DCV. Then turn the dial to the left until you get an **OL** or **1** on the display, then rotate the dial one turn to the right to read a value.

NOTE: Think of DC-Direct current, like water in a hose. It can only flow in one direction. That is why the Red Lead must be on the positive side of the power, and the Black Lead has to be on the negative side of the power.

ACV (Alternating Current Voltage): Rotate the dial on the digital multimeter to either "**V~**," or "**ACV**," (Alternating Current Voltage). On the body of the meter. Depending on the meter. This is to measure for AC **Voltage**.

- **AC:** Used for testing incoming power on all customer connections on LSC Equipment. All AC panels for IVT's, JD's, EXP's, VFP's, Jr's, Thermojets, any type of Air heaters or Oil Heaters or any AC components used on LSC equipment.

- Volts (DCV's), (ACV), Ohm's, Buzzer for Ohm's.

NOTE: AC Voltage, if you don't know what the expected voltage is you're trying to measure, then always start with a higher range for AC voltage to protect the multimeter. Then rotate the dial to the right (lower ranges) to find the reading.
Many modern meters have an "auto-range" feature that simplifies this step.

4. Measuring Ohms on a digital multimeter

Ohm (Ω): Turn off the power to the equipment and or component to be tested. Confirm the circuit is completely dead. Measuring resistance on a live circuit can damage the multimeter and pose a safety risk**.** Ensure the probes are connected correctly to the multimeter. Black lead in (**COM**) plug, Red lead in ( ) plug. Rotat ∨⎍⊣⊣l on the digital multimeter to the OHM ranges.

- If you don't have auto-ranging, start with the highest expected range 20KΩ, 200KΩ.
- If the display reads "OL" (Overload) or "1," the resistance in the component/circuit is higher than the selected range, so switch to the next highest range.
- If you're testing for a value of Ohms in a component/circuit and the reading is too low (like 0.00), switch to a lower range for better precision. If you're testing an open or closed switch, contact, etc. then (0.00) is what you're looking for.

Zero the Leads (Optional but Recommended):

- To verify that the multimeter is functioning properly. Touch the metal tips of the red and black probes together. The display should read **0.0** or a very small number (usually 0.5 Ω or less). This accounts for the resistance of the probes and leads themselves.
  Since resistance is always positive, the polarity of the probes doesn't matter.
- When testing a component (typically an ON/OFF switch, Level switch, Pressure switch, etc.). it is Recommended to use the **BUZZER** on the multimeter. This way you can hear the buzzer and see the value on the meter.
- Probes need to be placed on each side of the type of switch you have under test.
- If the switch is **CLOSED,** the multimeter will read (000). Or a small value. If you want the multimeter to read zero. Switch the meter dial to the next highest range.
- If the switch is **OPEN,** the multimeter will read "OL" (Overload) or "1".

For LSC Equipment, typically the technician operating the multimeter in Ohm's is usually looking for the (000) closed switch or "OL" (Overload) or "1" open switch.

Typically the only time a technician needs to see an Ohm's value is when they are checking air heaters or oil heater elements to determine if the element is any good or not.

To determine if the element has the correct Ohm's, you need to calculate the for resistance. Use the formula, Where

$$R = \frac{V^2}{P}$$

R is Resistance in Ohms
V² is Rated Voltage in Volts
P is Rated Power in Watts

Example Calculation

Where the symbol for the V^2 squared on a calculator, needs to be put into the Scientific mode, so you can get to the X^2.

Real World Example: using LSC part number: 77780179 (AIR / OIL HEATER ELEMENT 115 VAC 850 WATT) Stamped on the side of the heater element on the IVT.

Single-phase heater is rated at **115V** and **850W:** $R = \frac{115\ V^2}{850\ W} = \frac{13225}{850} = 15.5\Omega$

Using a calculator, type in the voltage 115 then press X^2 on the calculator. This will give you the square root value of 13,225, then divide by 850. This will give you the Ohm's of 15.5 Ω for the heater elements. Regardless, whether you use 115 volts, 120 volts, 220 volts, 240 volts. Still the same formula.

ON LSC Equipment, when looking for the Voltage and Watts: If it's an **OIL** heater look for the tag on the heater housing or if it's an **AIR** heater it's stamped on the element. If you can't find either you will have to use the data sheet for the component.

Note: The actual resistance of a heating element *when cold* will be slightly lower than this calculated value (which represents its resistance at operating temperature). But will be close.

Once the calculated value is determined. Use the multimeter set on Ohms to read the actual value. Be sure to go across the elements. On an **OIL** heater, it is possible that it can come with a thermostat. You'll need to go to the other side of the thermostat directly to the elements for an accurate reading.

AIR heaters usually don't come with a thermostat.