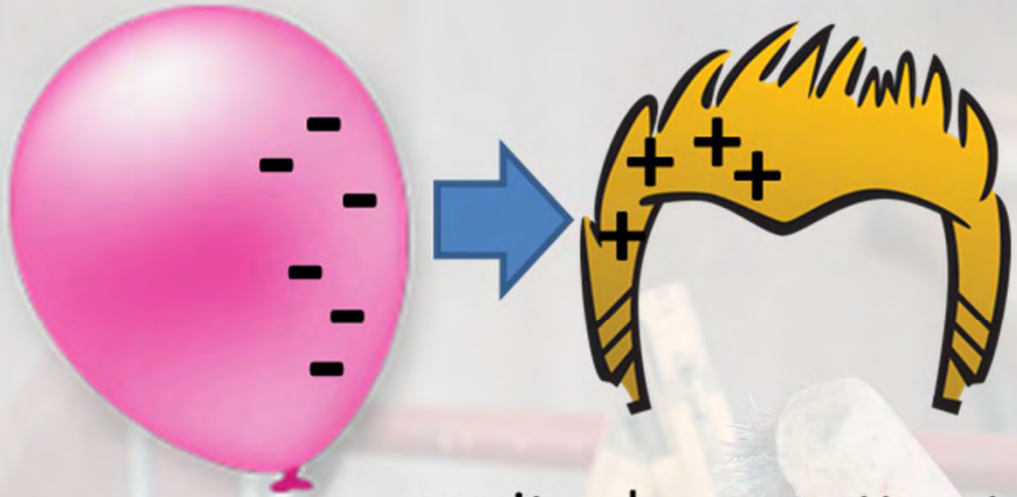
In the HVAC field we work with 2 different kinds of electricity. What are they?

Electrostatic electricity- it is stationary until discharged

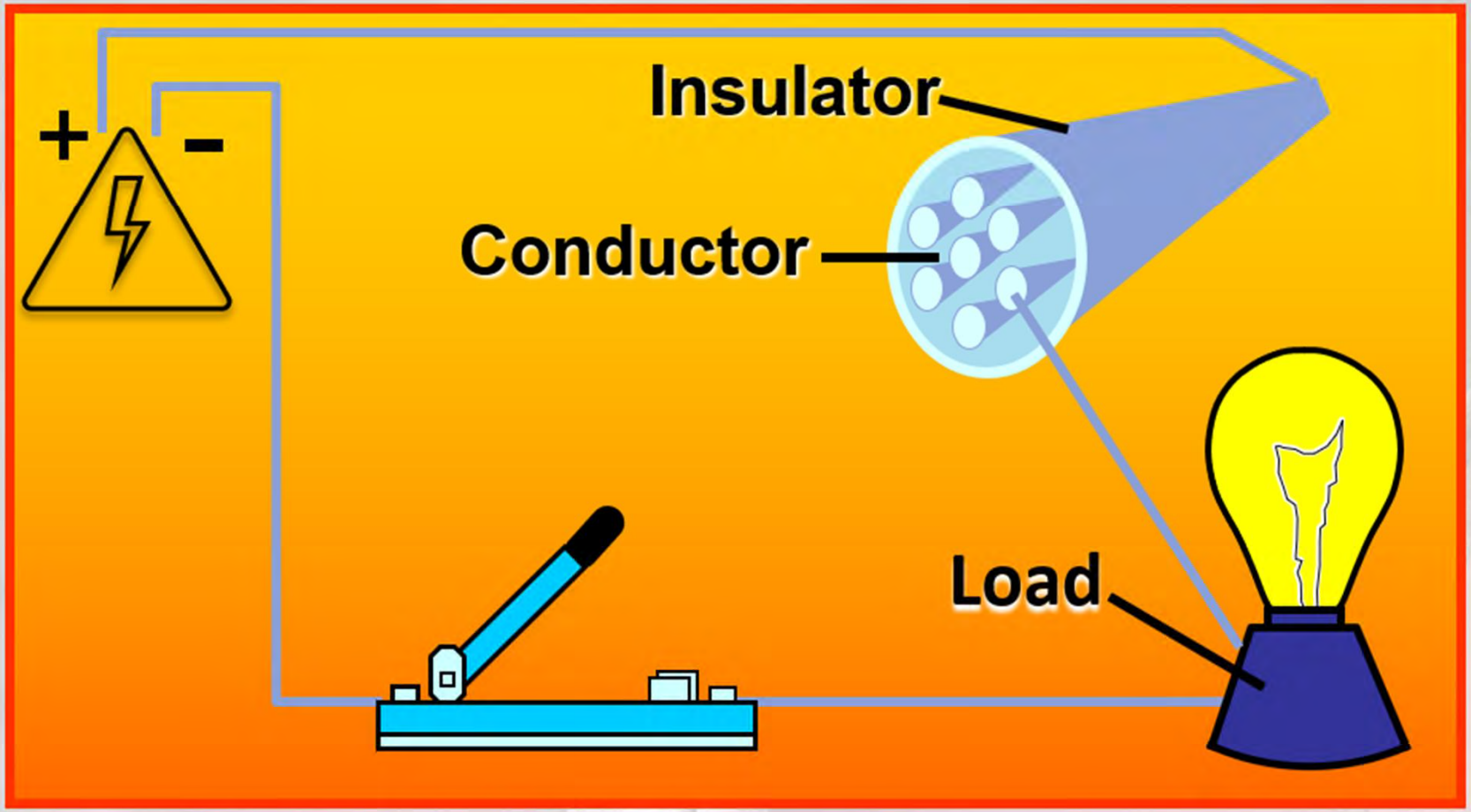


opposite charges attract

Current electricity- it moves or flows in a path or “circuit”

A **Conductor** is a material that allows current to flow

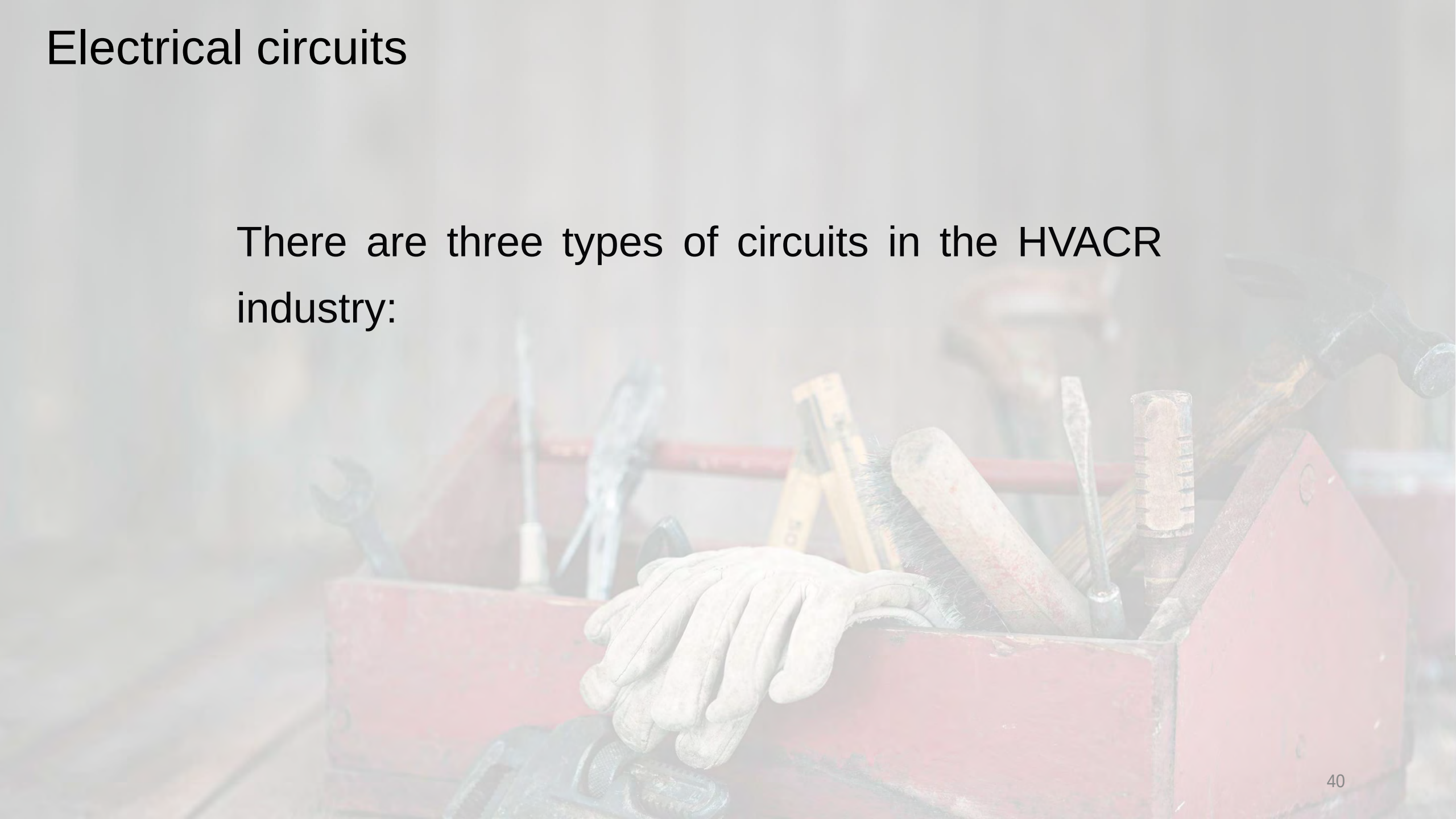
An **Insulator** blocks the flow of current.



A **load** is any device that consumes electrical energy or current

Electrical circuits

There are three types of circuits in the HVACR industry:



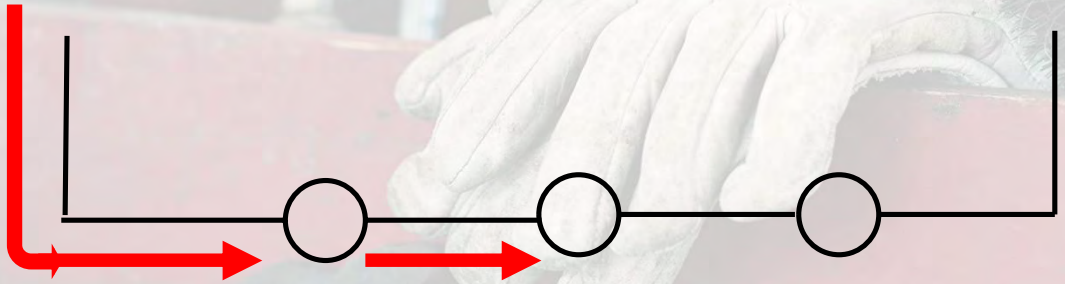
Series Circuit

- One path

Each load added to a series circuit reduces the amount of current flowing in the circuit.(voltage drop)

When one component in a series circuit fails, the entire circuit fails.

Safety switches are typically wired in this way.

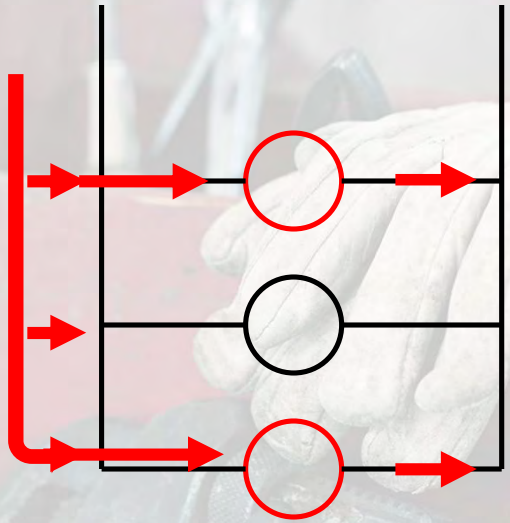


Parallel Circuit

- More than one path.
- Voltage is EQUAL at each load.
- When one component in a parallel circuit fails, the others continue to operate

Unlike the series circuit, we can add loads without reducing the amount of current to each load

Loads are typically wired in parallel

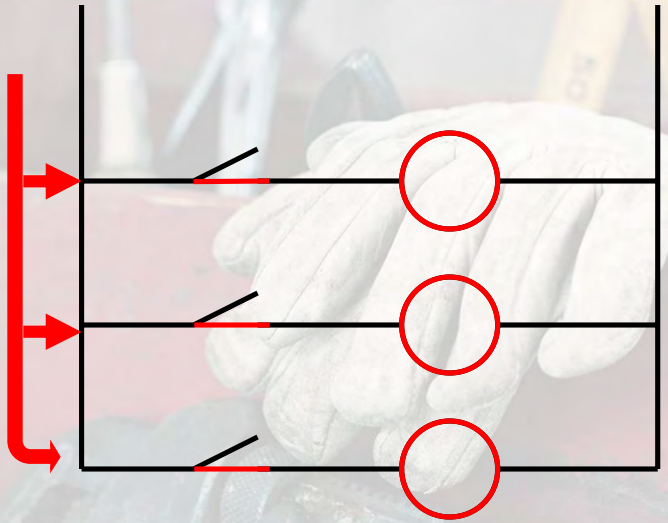


Electrical circuits

Series-Parallel Circuit

Loads are wired in parallel with each other, while control and protective devices are wired in series with the loads.

- More than one path
- Voltage is equal at each load
- Loads can be controlled or protected independently



HVAC Industry Standards

In order to read and understand an electrical diagram you need to know how different controls and loads are drawn.

SYMBOLS

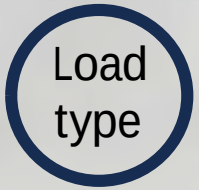
Wires connected

or

Wires not connected

Plug

Coil



Power consuming Load

Ground

Normally Open
Contact

Normally Closed Contact

SYMBOLS

Switch

Contacts

SINGLE POLE SINGLE THROW

NORMALLY OPEN

SPST - NO

SYMBOLS

Switch

Contacts

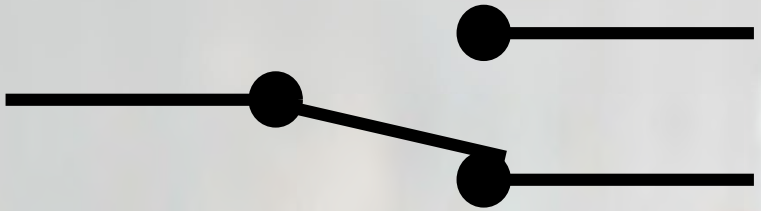
SINGLE **P**OLE **S**INGLE **T**HROW

NORMALLY **C**LOSED

SPST - NC

SYMBOLS

Switch

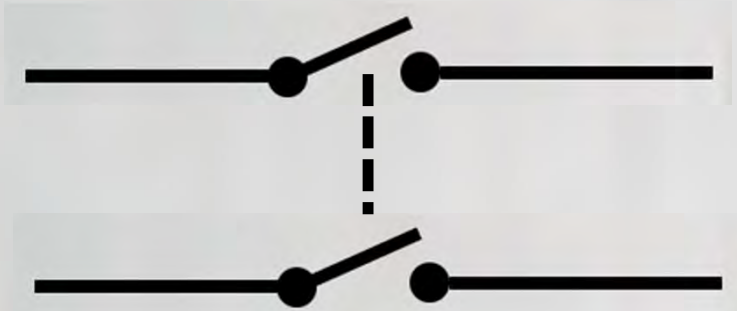


Contacts

SINGLE **P**OLE **D**OUBLE **T**HROW

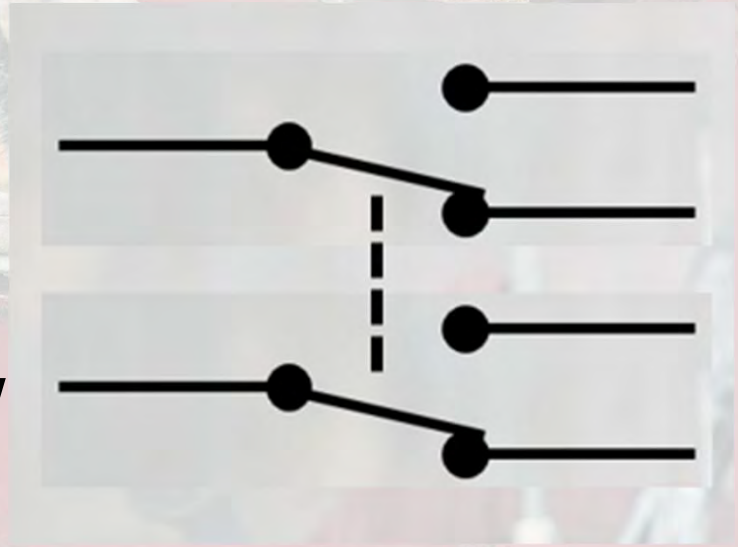
SPDT

SYMBOLS



DOUBLE **P**OLE **S**INGLE **T**HROW

DPST

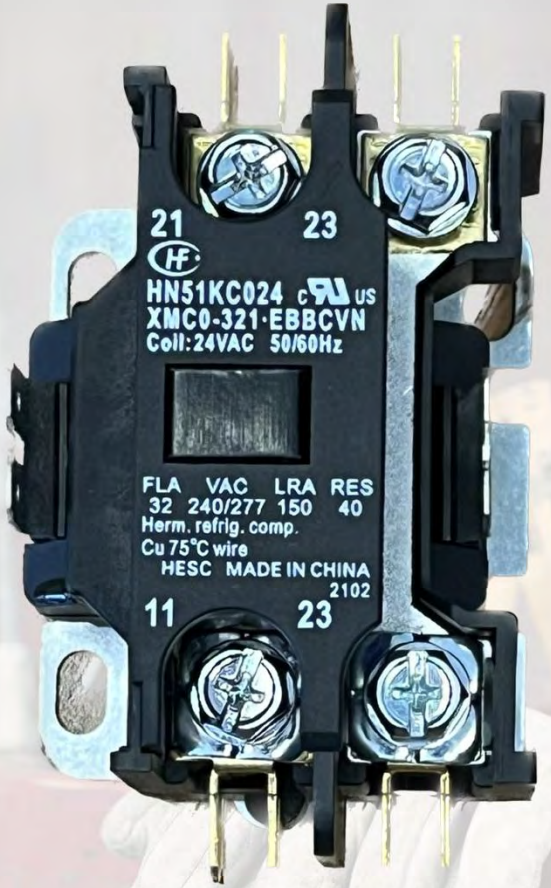


DOUBLE **P**OLE **D**OUBLE **T**HROW

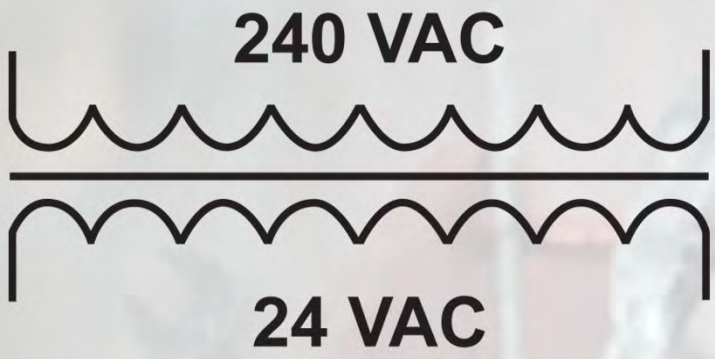
DPDT

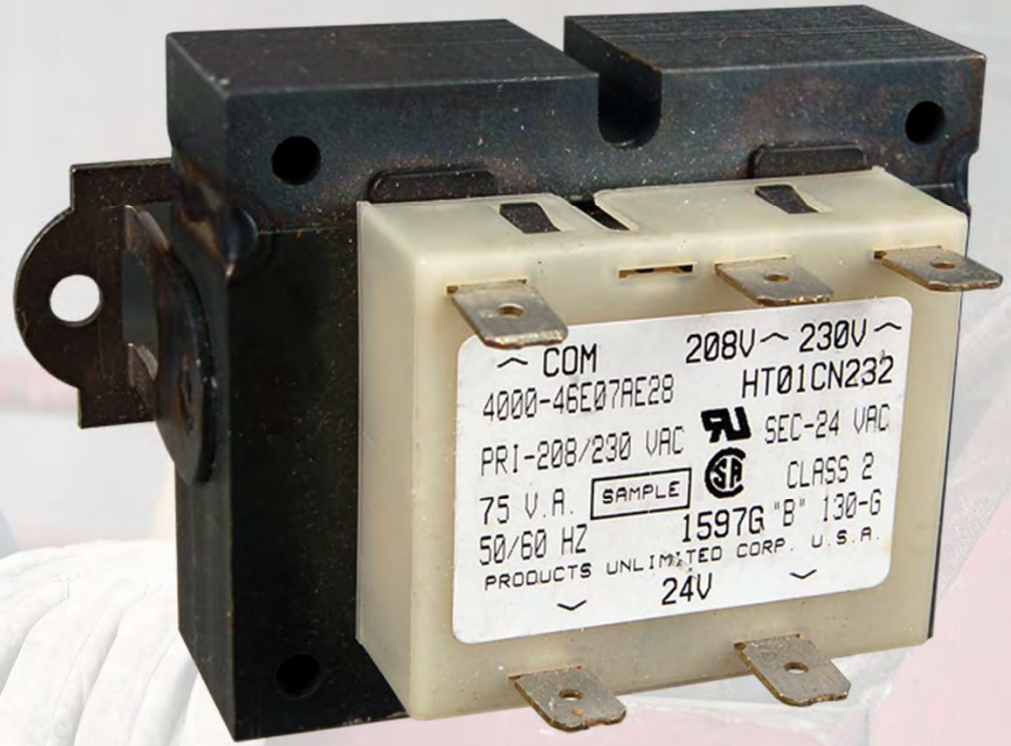
SYMBOLS

DPST OR SPDT OR SPST OR ?



Transformers





Temperature Activated Switches

Heating Thermostat

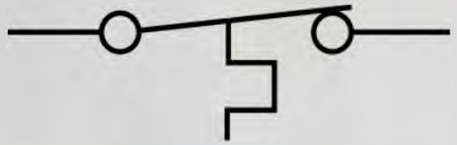
SPST Closes on Drop
(Operating Control)

Defrost Thermostat

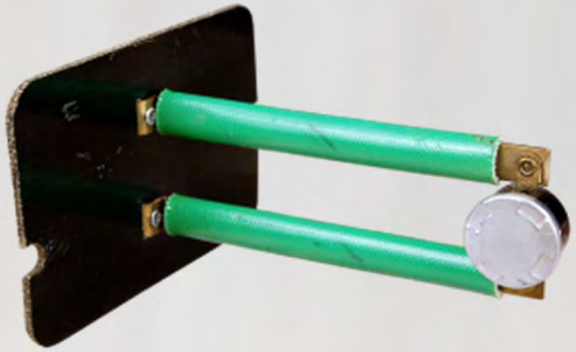
SPST Closes on Rise
(Operating Control)

Cooling Thermostat

Temperature Activated Switches



SPST Opens on Rise
(Safety Control)



Overtemperature
Limit Switch

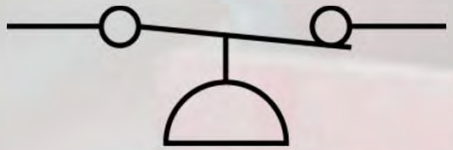
SPST Opens on Drop
(Safety Control)

Freeze Protection Thermostat

Pressure Switches

SPST Opens on Rise
(Safety Control)

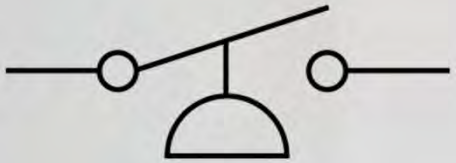
High-Pressure Switch



SPST Opens on Drop
(Safety Control)

Low-Pressure Switch

Pressure Switches



SPST Closes on Drop
(Operating Control)

Air Pressure
Switch

SPST Closes on Rise
(Operating Control)

Fan Cycling
Pressure Switch

Humidity Control

SPST Humidistat
Closes on Drop
(Operating Control)

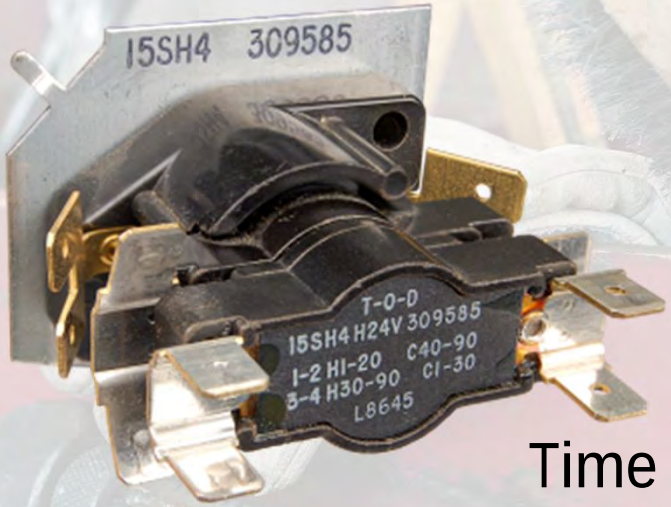
SPST De-Humidistat
Closes on Rise
(Operating Control)

Time Delay

Time Delay Relay
Delays Closing
(Mechanical/Thermal)
(Electronic)

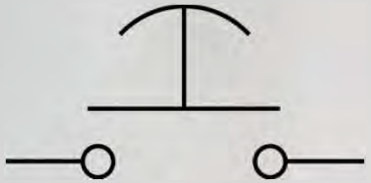
Time Delay Relay
(Electronic)

Time Delay Relay
Delays Opening
(Mechanical/Thermal)
(Electronic)



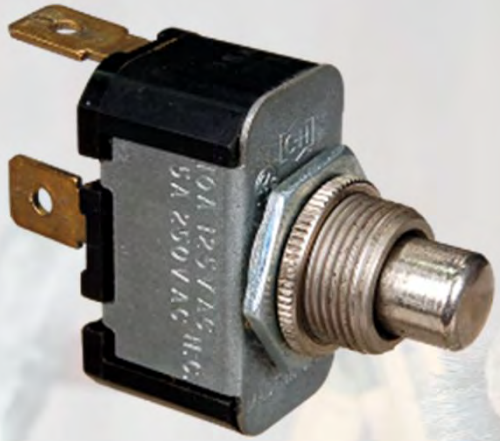
Time Delay Relay
(Thermal)

Manual Switches

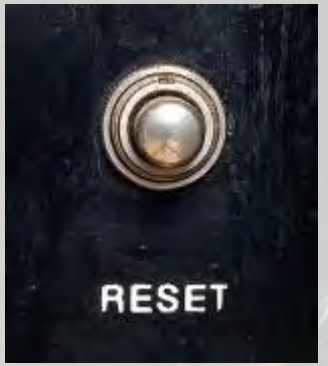


SPST Normally Open
Manually Operated
Push Button

SPST Normally Closed
Manually Operated
Push Button



Momentary Push Button



Fuses

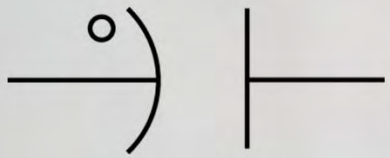
Fuse
- Fusible Link

One Time Fuse
(Fusible Link)

One Time
Fuse

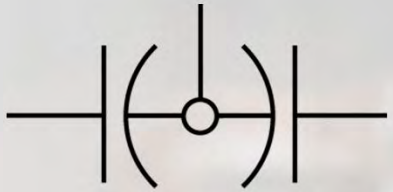
Capacitors

Electrical device that receives and stores an electrostatic charge

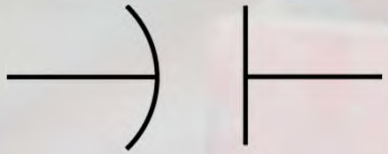


Run Capacitor
(Marked Terminal)

Run Capacitor



Dual Run
Capacitor



Start Capacitor

Start
Capacitor

Electrical Diagrams

- The electrical diagram for equipment provides the road map of how all the components connect together and how each component affects the system.
- The technician must become familiar with the different styles of diagrams and how they relate to the actual piece of equipment.

Diagram Components

Group of lines and electrical symbols usually arranged to show the operational sequence of the equipment.

- Power supply
- Path for the power
- Loads
- Switches
- Legend
- Notes

Legend and notes

LEGEND

FACTORY POWER WIRING	
FACTORY CONTROL WIRING	
FIELD CONTROL WIRING	
FIELD POWER WIRING	
COMPONENT CONNECTION	
FIELD SPLICE	
JUNCTION	
CAP	CAPACITOR
CB	CIRCUIT BOARD
*CCH	CRANKCASE HEATER
COMM	SYSTEM COMMUNICATION
COMP	COMPRESSOR
CONT	CONTACTOR
CS	COMP HIGH CAP SOLENOID
HPS	HIGH PRESSURE SWITCH
LPS	LOW PRESSURE SWITCH
* LS	LIQUID SOLENOID
OAT	THERMISTOR (OUTDOOR AIR)
OCT	THERMISTOR COIL
OFM	OUTDOOR FAN MOTOR
RVS	REVERSING VALVE SOLENOID
* SC	START CAPACITOR
SEV	SOLENOID EXPANSION VALVE
* SR	START RELAY
STATUS	SYSTEM FUNCTION LIGHT
TRAN	TRANSFORMER
*UC	UTILITY CURTAILMENT

* MAY BE FIELD INSTALLED

Important information for this specific equipment

NOTES:

1. Compressor furnished with inherent thermal protection.
2. To be wired in accordance with National Electric Code (N.E.C.) and local codes.
3. Outdoor unit control requires a minimum of 27 VA, 24 VAC control power.
4. Use copper conductors only. Use conductors suitable for at least 75°C (167°F).
5. If indoor section has a transformer with a grounded secondary, connect the grounded side to "C".
6. If any of the original wire, as supplied, must be replaced, use the same or equivalent wire.
7. Check all electrical connections inside control box for tightness.
8. Do not attempt to operate unit until service valves have been opened.
9. In case of a communicating indoor system, **MUST USE WITH USER INTERFACE LISTED IN PRE-SALE LITERATURE ONLY**.
10. In case of non-communicating indoor system disconnect factory provided wires from A, and B terminals. Use factory provided wires to connect to Y1, Y2, and C as required by Installation Instructions. Cap or remove unused factory provided wires.
11. For Communicating Control only.

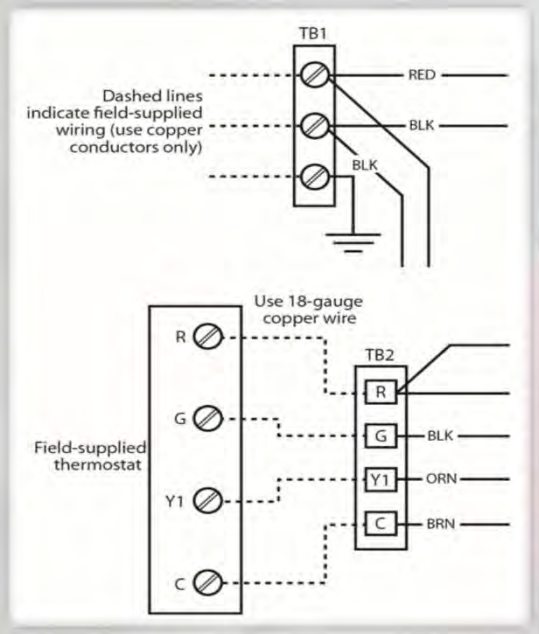
Types of Diagrams

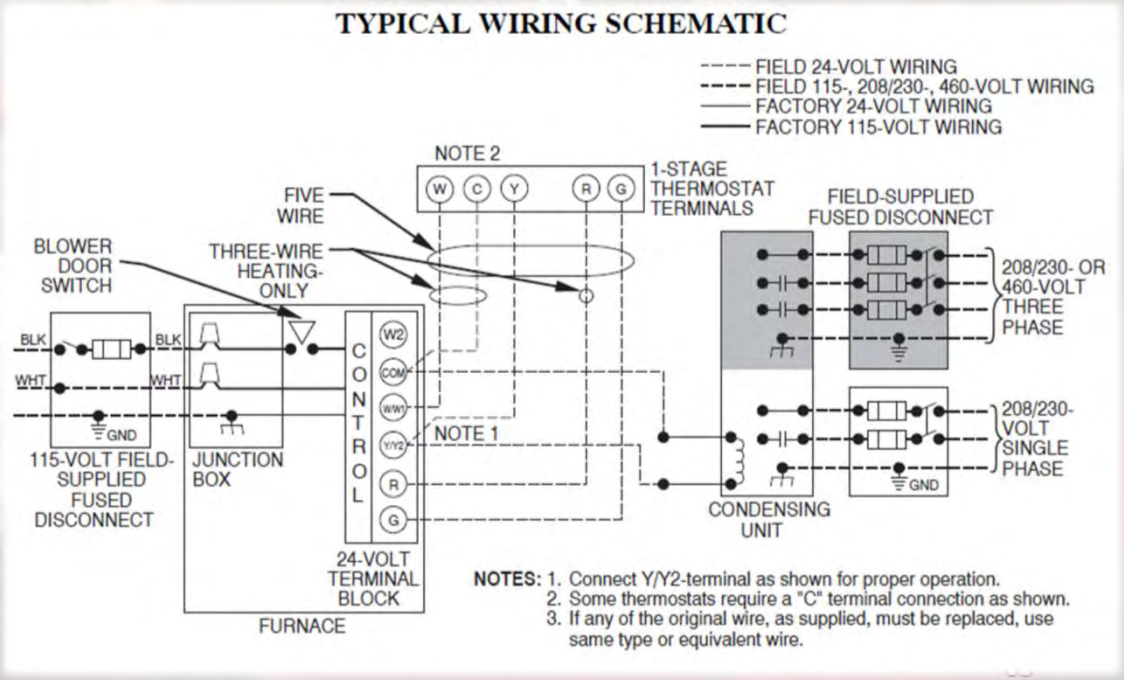
- Installation
- Component Arrangement
- Connection
- Ladder

Installation Diagram

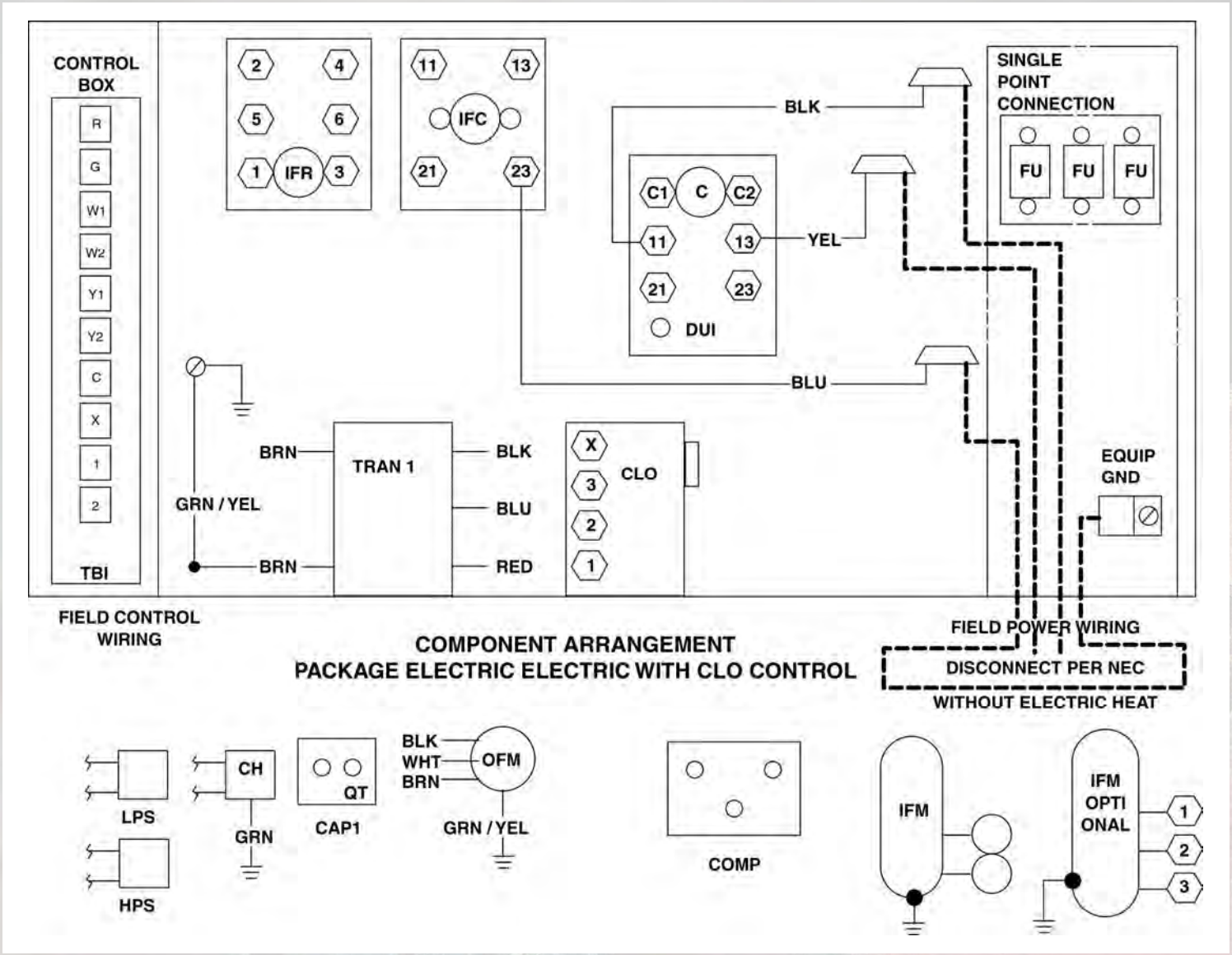
The installation diagram shows all of the wiring connections that need to be made in the field in order for the unit to operate, including:

- Power supply
- Thermostat wiring
- Connections between indoor and outdoor units
- External components.

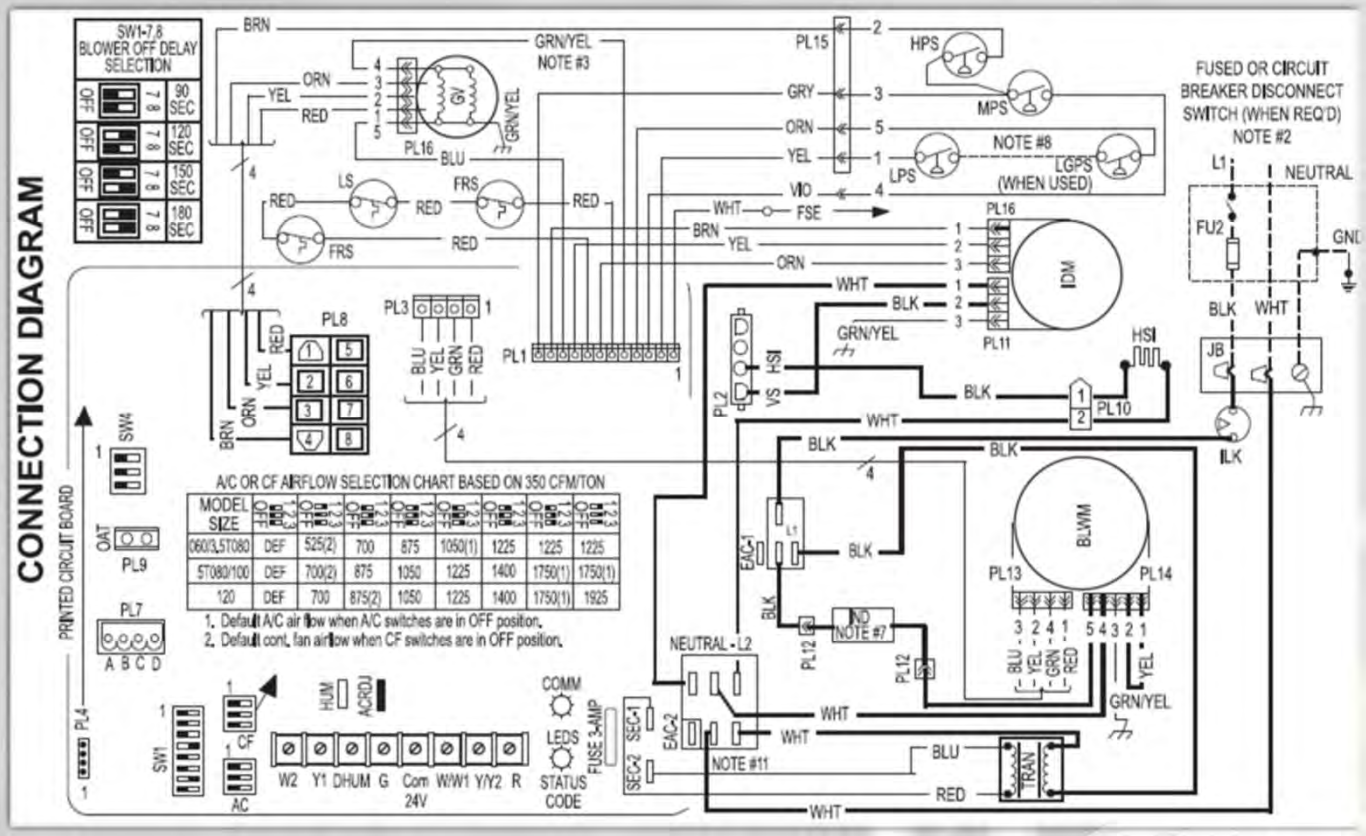


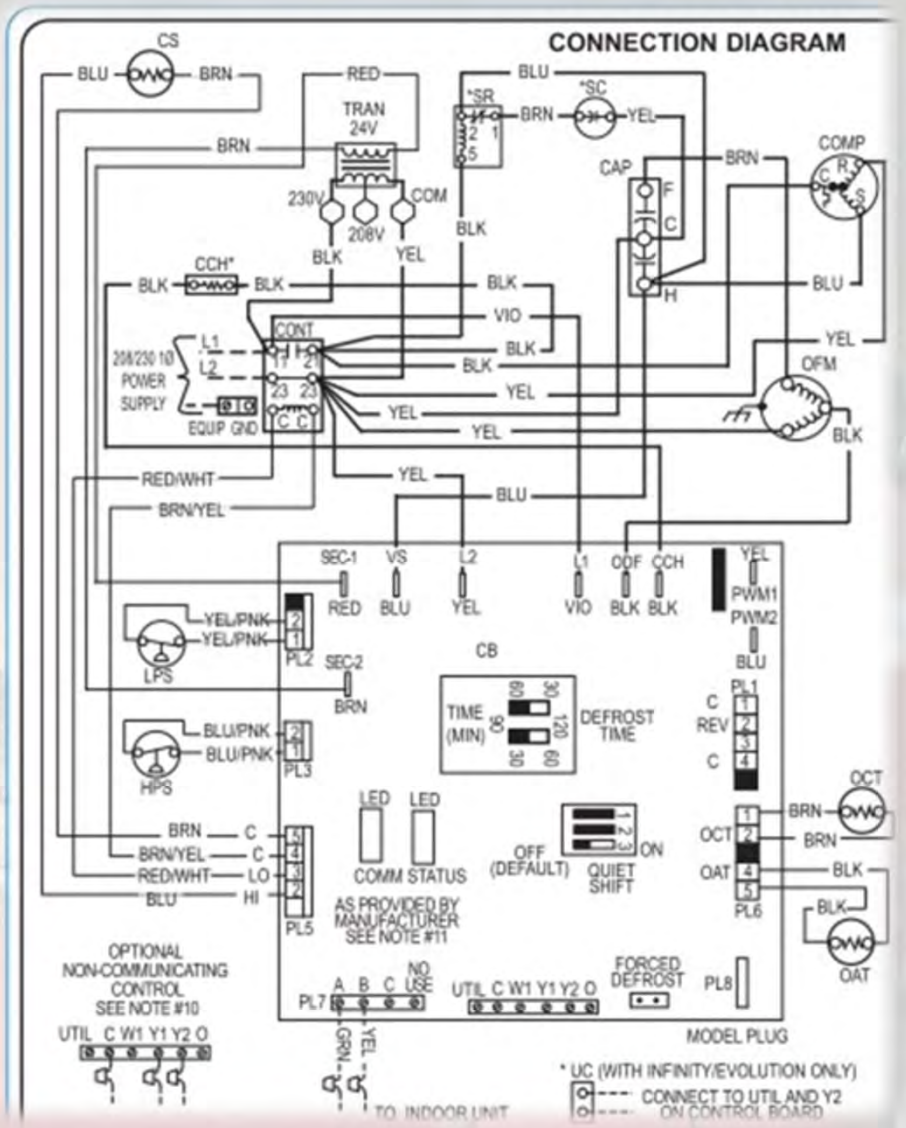


Component Location Diagram



Connection Diagram





Ladder Diagram

The ladder diagram will be the most commonly used diagram.

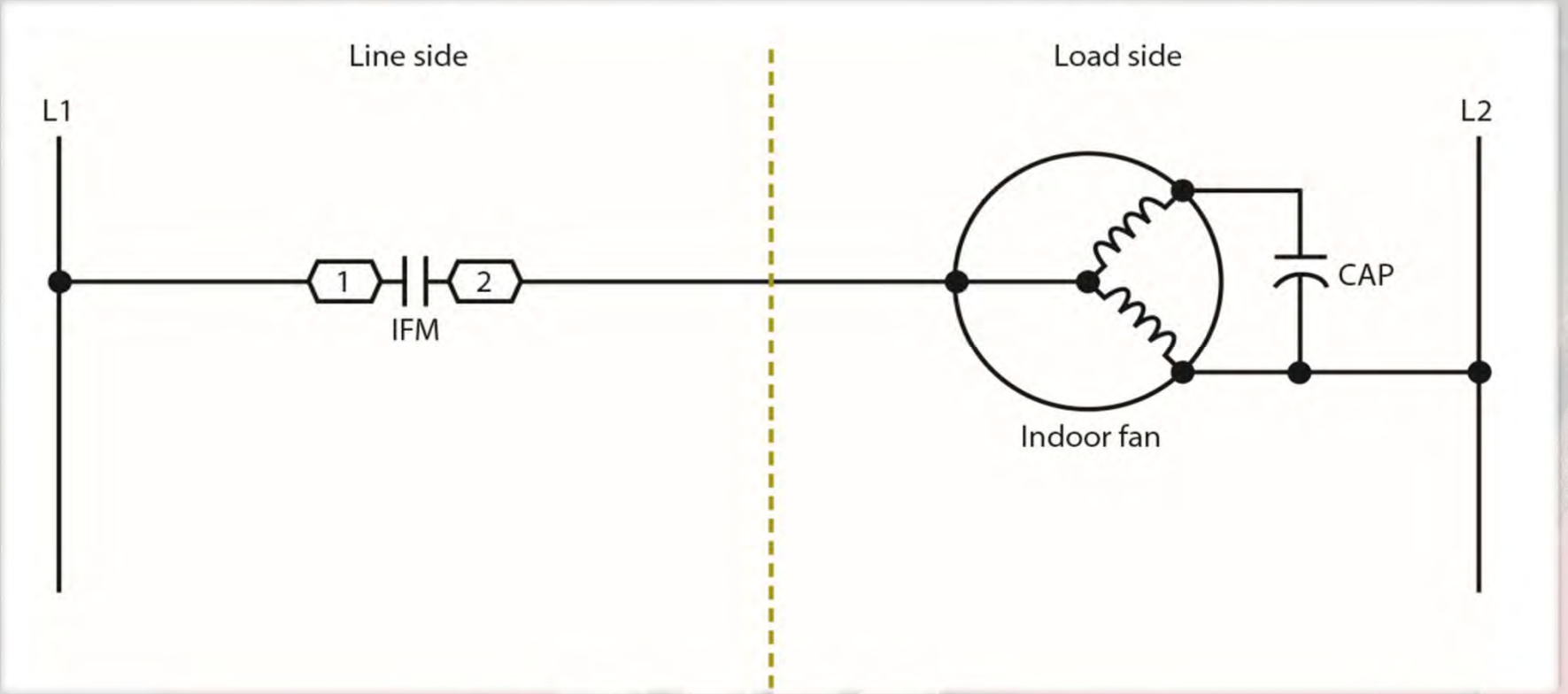
Provides the best indication of how the components affect the system.

Starts with the power supply down the sides like the rails of the ladder.

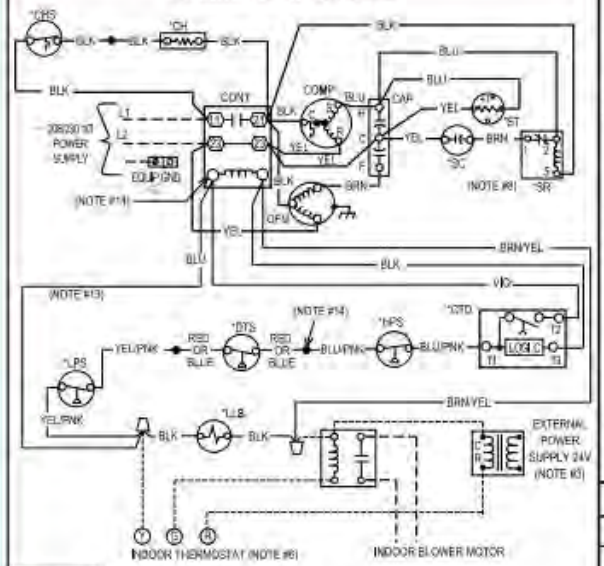
Ladder Diagram

- Schematics are meant to be read from left to right
- Loads are generally placed on the right side of the drawing with the switches to the left.
- The left side of the switch is called the line side because it is connected to the line.
- The right side of the switch is called the load side because it is connected to the load.

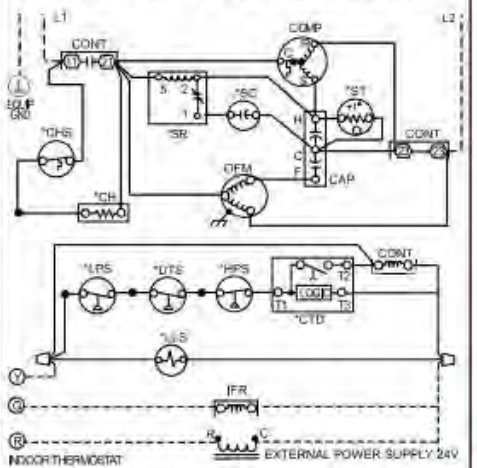
Ladder Diagram



CONNECTION DIAGRAM



SCHEMATIC DIAGRAM (LADDER FORM)



LEGEND

	FACTORY POWER WIRING	COMP	COMPRESSOR
	FACTORY CONTROL WIRING	*CTD	COMPRESSOR TIME DELAY
	FIELD CONTROL WIRING	*DTS	DISCHARGE TEMPERATURE SWITCH
	FIELD POWER WIRING	*HPS	HIGH PRESSURE SWITCH
	COMPONENT CONNECTION	IFR	INDOOR FAN RELAY
	FIELD SPLICE	*LLS	LIQUID LINE SOLENOID VALVE
	JUNCTION	*LPS	LOW PRESSURE SWITCH
CONT	CONTACTOR	OFM	OUTDOOR FAN MOTOR
CAP	CAPACITOR (DUAL RUN)	*SC	START CAPACITOR
*CH	CRANKCASE HEATER	*SR	START RELAY
*CHS	CRANKCASE HEATER SWITCH	*ST	START THERMISTOR

*** MAY BE FACTORY OR FIELD INSTALLED**

NOTES:

1. Symbols are electrical representation only.
2. Compressor and fan motor furnished with inherent thermal protection.
3. To be wired in accordance with National Electric N.E.C. and local codes.
4. N.E.C. class 2, 24 V circuit, min. 40 VA required. 60 VA on units installed with LLS.
5. Use copper conductors only. Use conductors suitable for at least 75°C (167°F).
6. Connection for typical cooling only thermostat. For other arrangements see installation instructions.
7. If indoor section has a transformer with a grounded secondary, connect the grounded side to the BRN/YEL lead.
8. When start relay and start capacitor are installed, start thermistor is not used.
9. If any of the original wire, as supplied must be replaced, use the same or equivalent wire.
10. Check all electrical connections inside control box for tightness.
11. Do not attempt to operate unit until service valves have been opened.
12. Do not rapid cycle compresser. Compressor must be off 3 minutes to allow pressures to equalize between high and low side before starting.
13. Wire not present if LPS, DTS, HPS and/or CTD are used.
14. BLU or RED wire connected to contactor coil when DTS used and LPS, HTS, CTD not used.

CONDENSING UNIT CHARGING INSTRUCTIONS

For use with units using R-410A refrigerant

REQUIRED LIQUID LINE TEMPERATURE

Liquid Pressure at Service Valve (psig)	Required Subcooling Temperature (°F) 6	8	10	12	14	16
251	78	76	74	72	70	68
259	80	78	76	74	72	70
268	82	80	78	76	74	72
274	84	82	80	78	76	74
283	86	84	82	80	78	76
291	88	86	84	82	80	78
299	90	88	86	84	82	80
308	92	90	88	86	84	82
317	94	92	90	88	86	84
326	96	94	92	90	88	86
336	98	96	94	92	90	88
345	100	98	96	94	92	90
354	102	100	98	96	94	92
364	104	102	100	98	96	94
374	106	104	102	100	98	96
384	108	106	104	102	100	98
395	110	108	106	104	102	100
406	112	110	108	106	104	102
416	114	112	110	108	106	104
427	116	114	112	110	108	106
439	118	116	114	112	110	108
450	120	118	116	114	112	110
462	122	120	118	116	114	112
474	124	122	120	118	116	114

COOLING ONLY CHARGING PROCEDURE

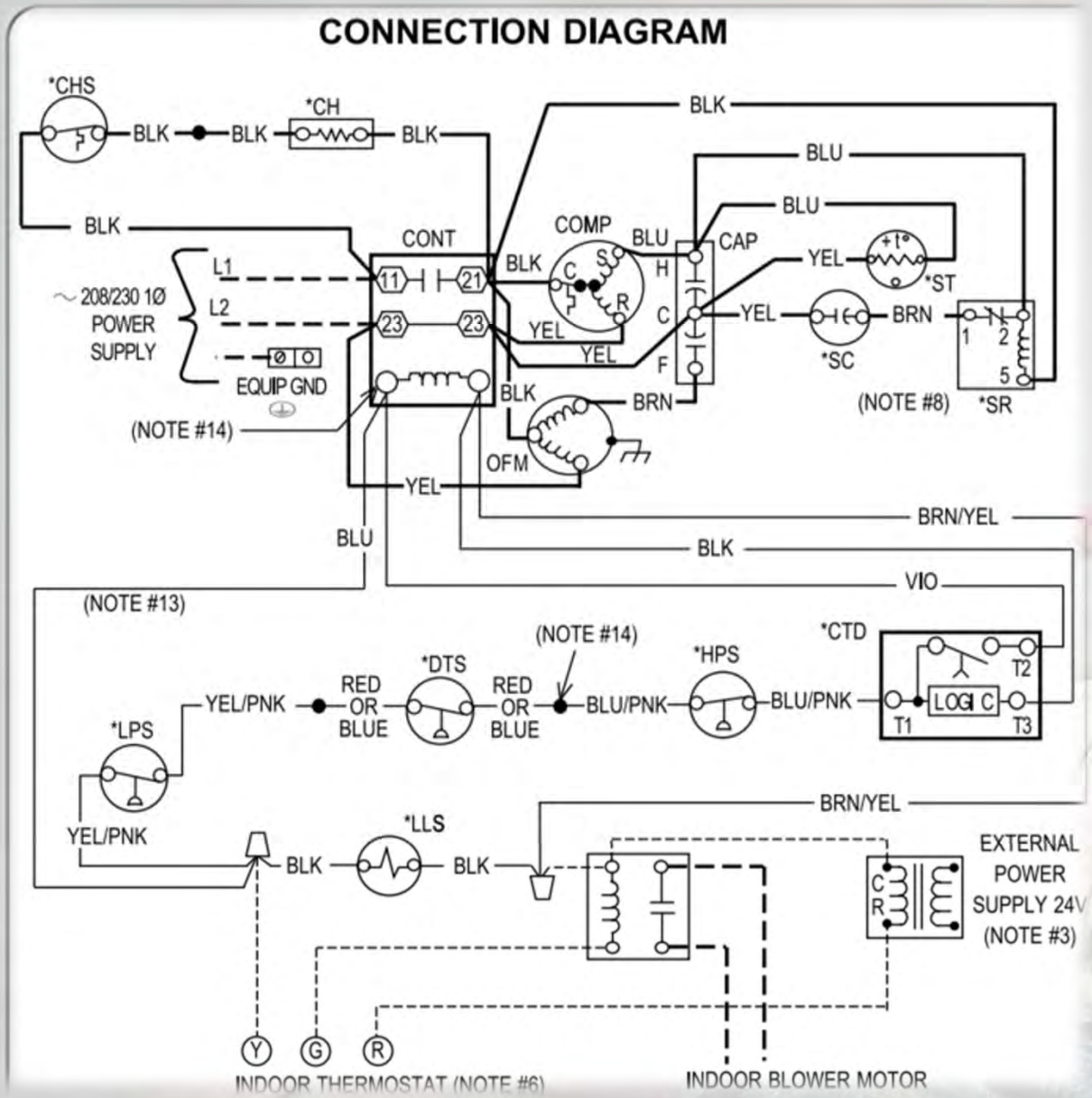
1. Only use sub cooling charging method when OD ambient is greater than 70°F and less than 100°F, indoor temp is greater than 70°F and less than 80°F and line set is less than 50 ft.
2. Operate unit a minimum of 15 minutes before checking the charge.
3. Measure liquid service valve pressure by attaching an accurate gauge to the service port.
4. Measure the liquid line temperature by attaching an accurate thermistor type or electronic thermometer to the liquid line near the outdoor coil.
5. Refer to unit rating plate for required subcooling temperature.
6. Find the point where the required subcooling temperature intersects the measured liquid service valve pressure.
7. To obtain the required subcooling temperature at specific liquid line pressure, add refrigerant if liquid line temperature is higher than indicated. When adding refrigerant, charge in liquid form using a flow restricting device into suction service port. Recover refrigerant if temperature is lower. Allow a tolerance of +/- 3°F.

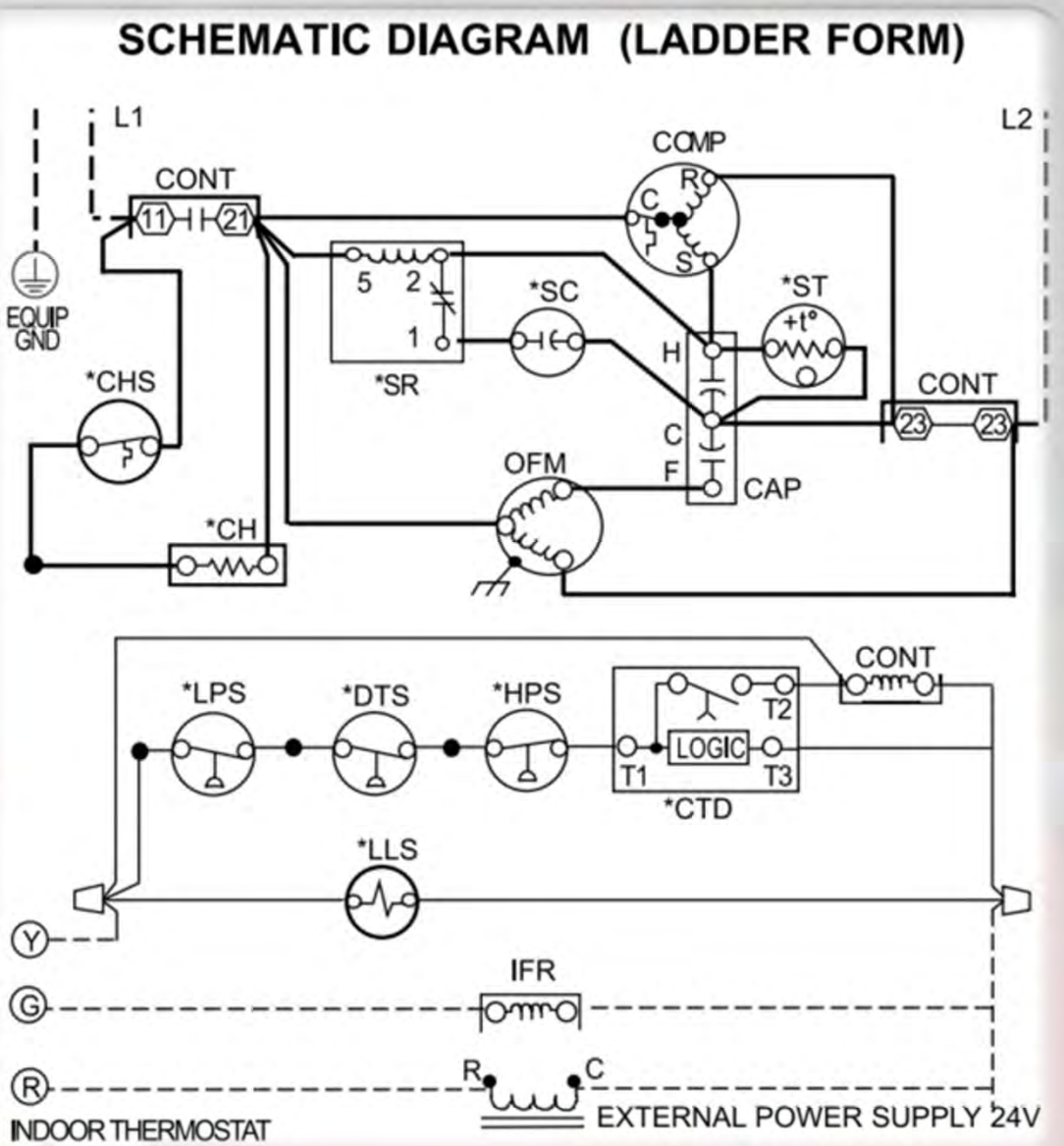
⚠ CAUTION

1. Compressor damage may occur if system is over charged.
2. This unit is factory charged with R-410A in accordance with the amount shown on the rating plate. The charge is adequate for most systems using matched coils and tubing not over 15 feet long. Check refrigerant charge for maximum efficiency. See Product Data Literature for required Indoor air Flow Rates and for use of line lengths over 15 feet.
3. Relieve pressure and recover all refrigerant before system repair or final disposal. Use all service ports and open all flow-control devices, including solenoid valves.
4. Never vent refrigerant to atmosphere. Use approved recovery equipment.

348336-101 REV.-

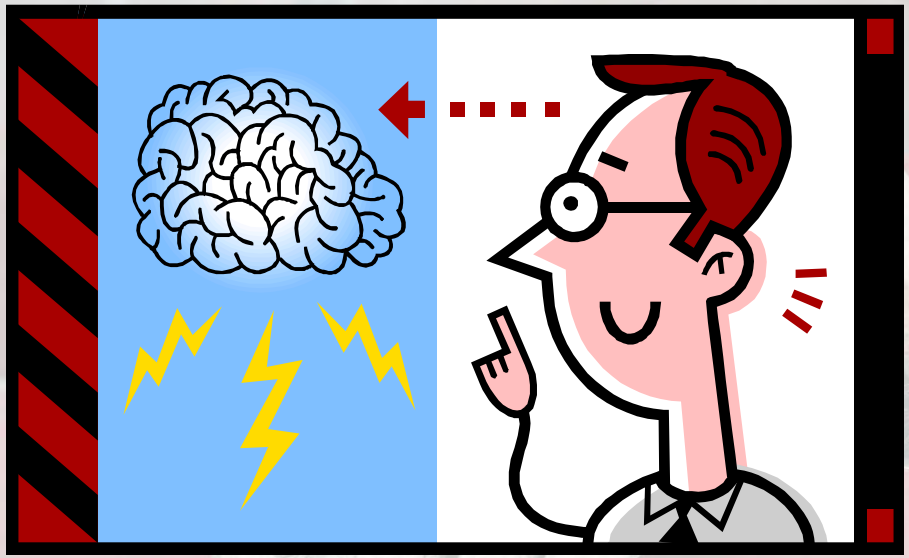
Point to point





3 most important tools …

- Eyes
- Ears
- Brain



Meters – Types

Analog

- Has a needle which deflects across a scale.

Digital

- Has solid state circuitry to produce a digital (**numerical**) read out.

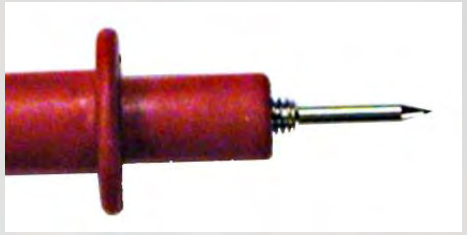
Multimeters

Analog Meters

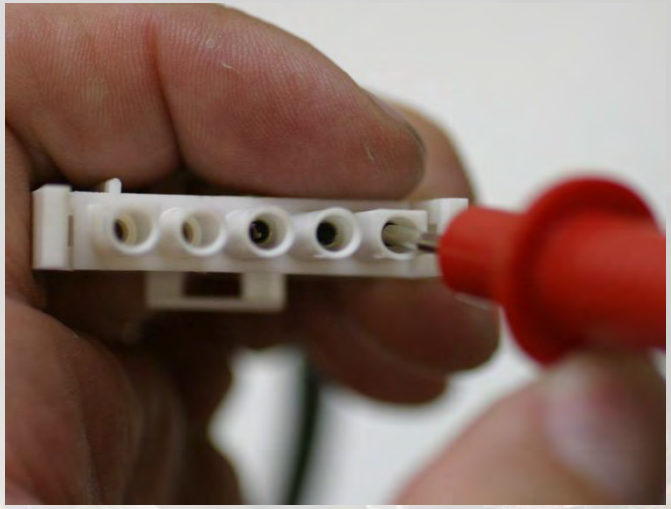
Digital Meters

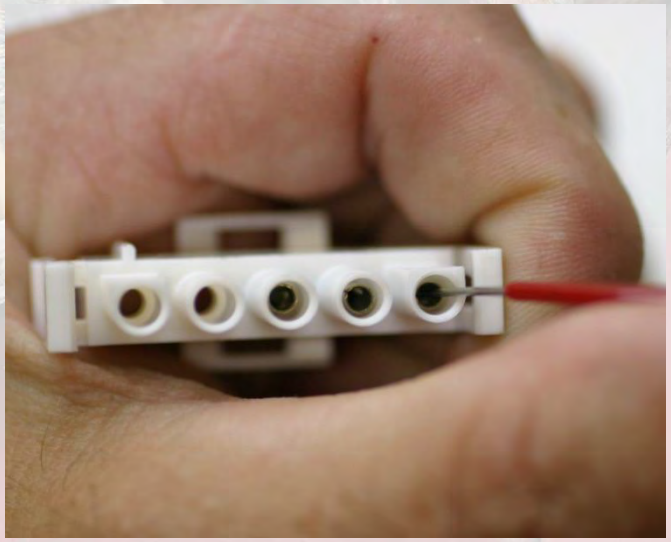
System Connectors

Test Pins



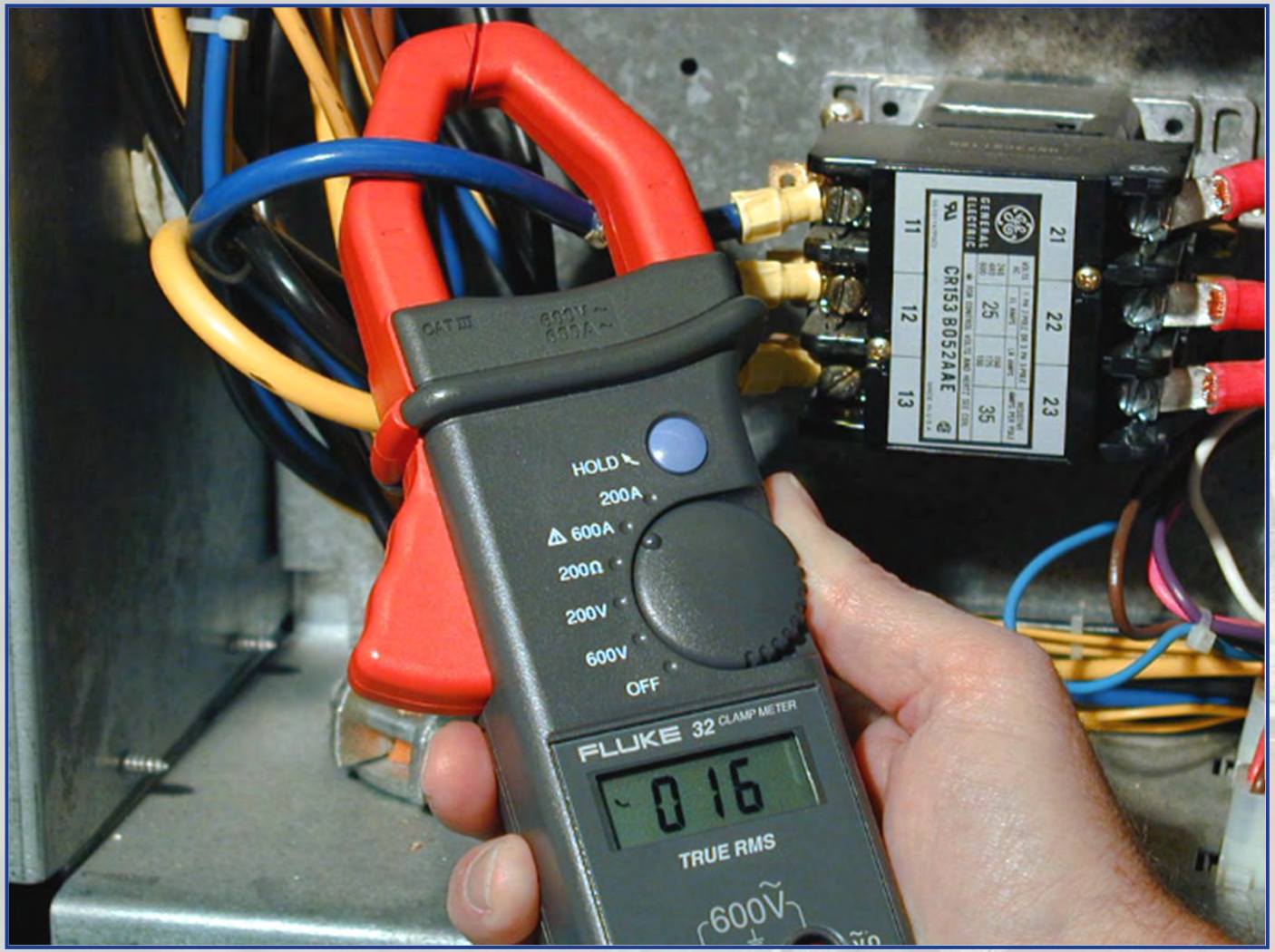
Motor Connectors



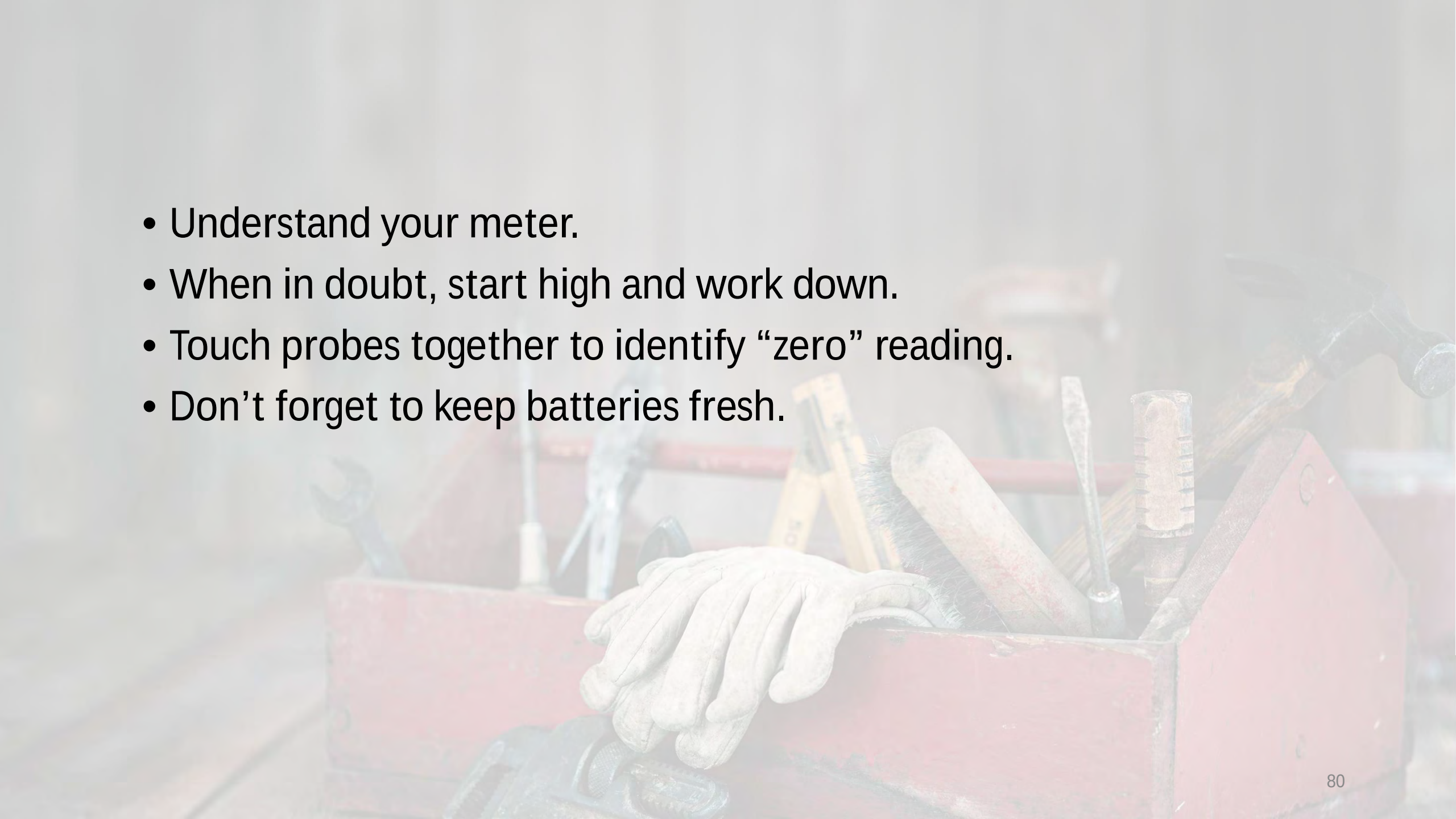



FLUKE

Clamp on Ammeter



- Understand your meter.
- When in doubt, start high and work down.
- Touch probes together to identify “zero” reading.
- Don’t forget to keep batteries fresh.



Digital meter features

- Volts
- Amps
- Ohms
- Capacitors (capacitance)
- Autorange or manual range

Symbols

AC-alternating current

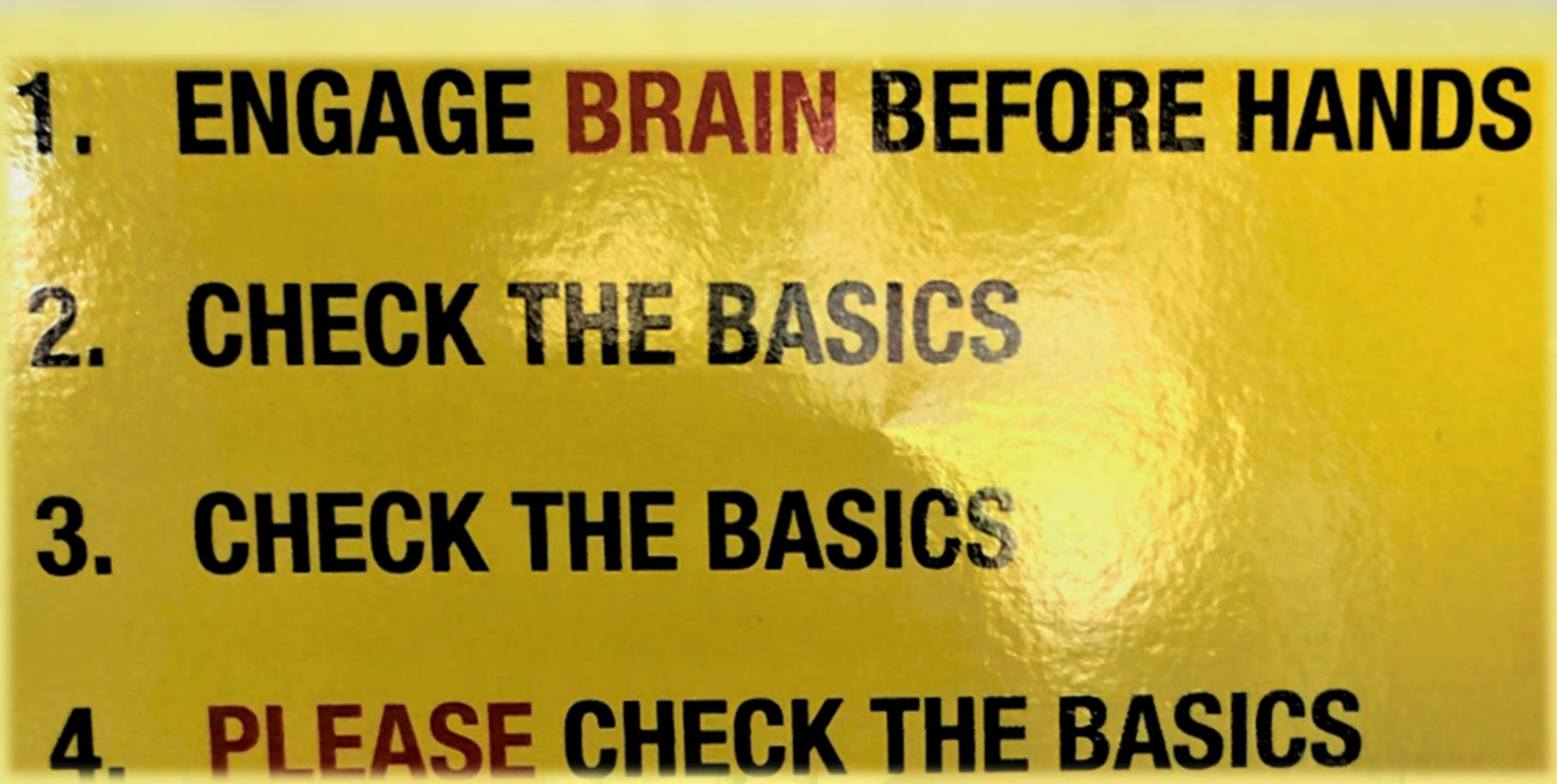
DC-direct current

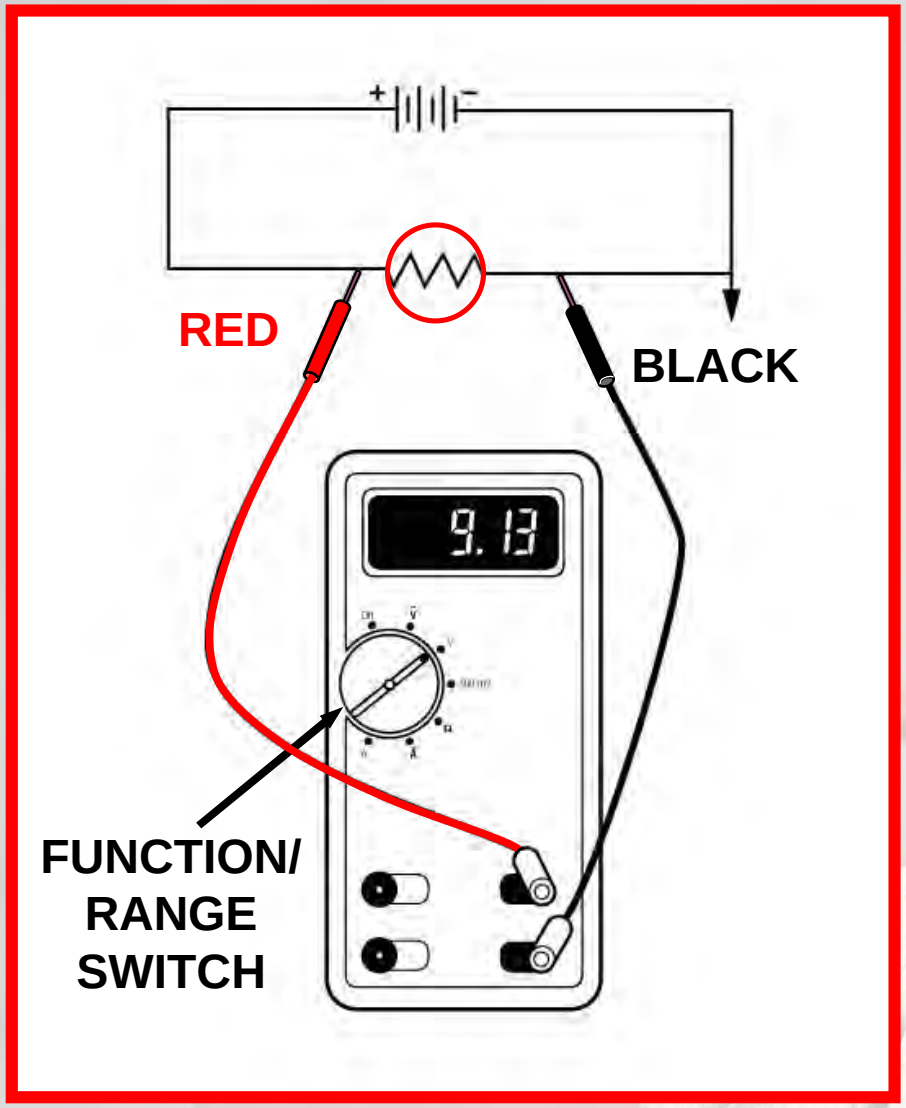
OHM-resistance

Audible(resistance)

Amps

Troubleshooting circuts

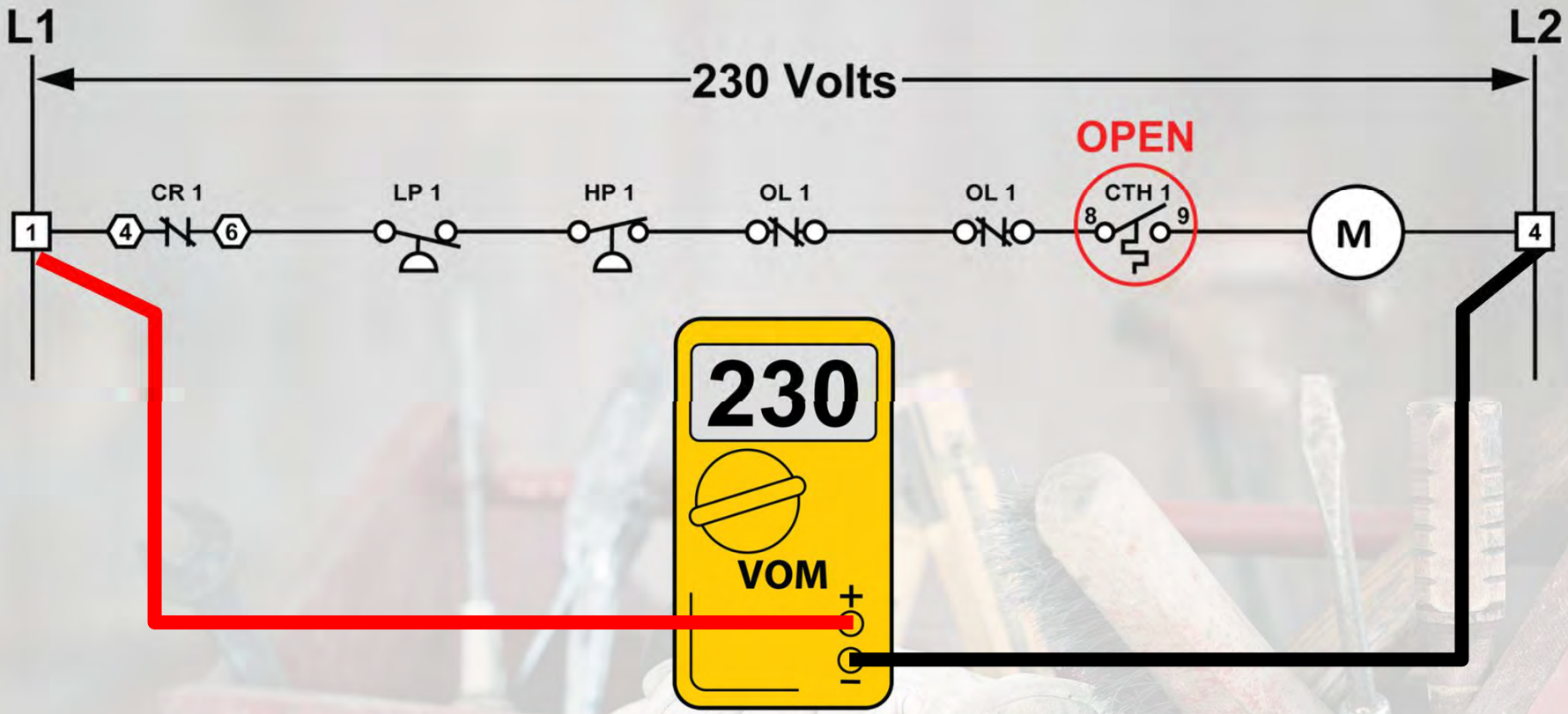




The voltmeter must be connected across the load or device being tested.

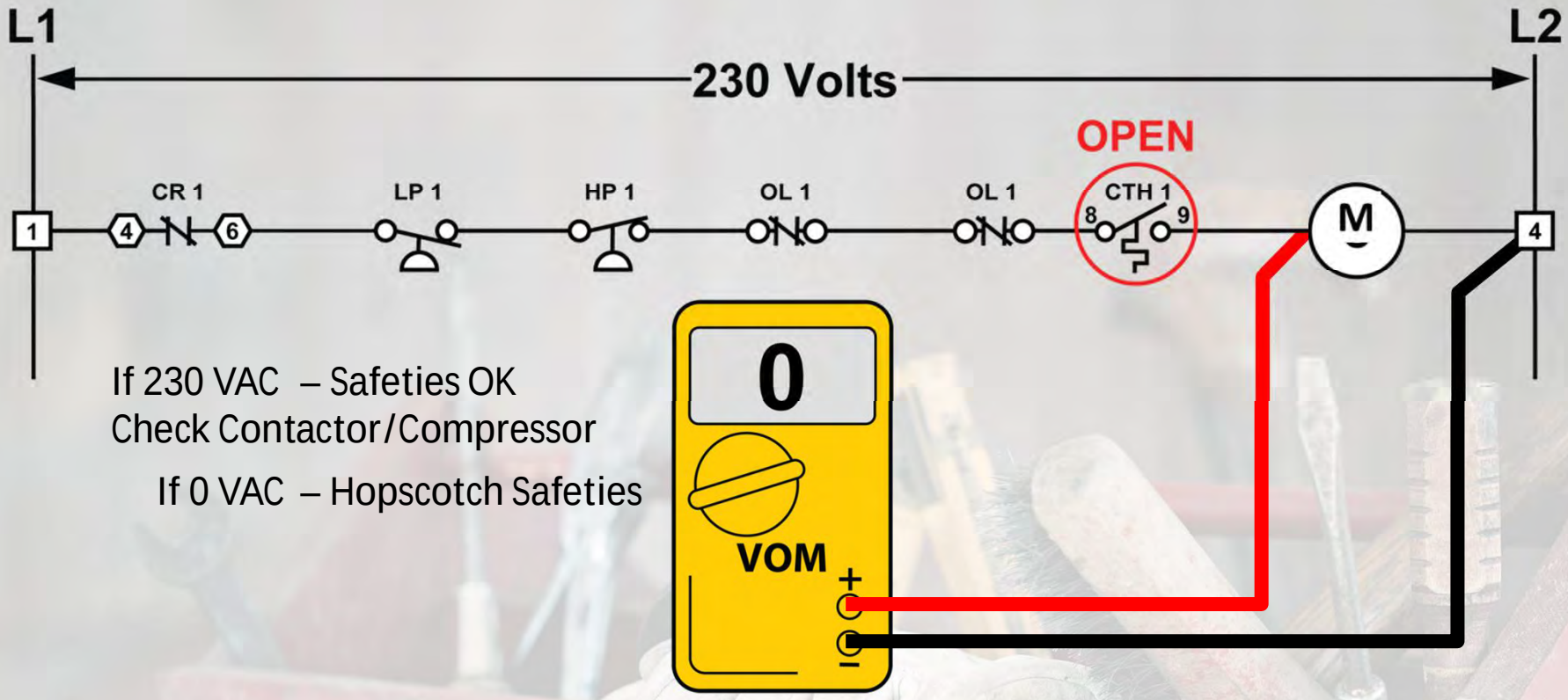
Hopscotch

Electrical Troubleshooting



With one lead on the line side and other lead on the load side,check for total circuit voltage

Electrical Troubleshooting



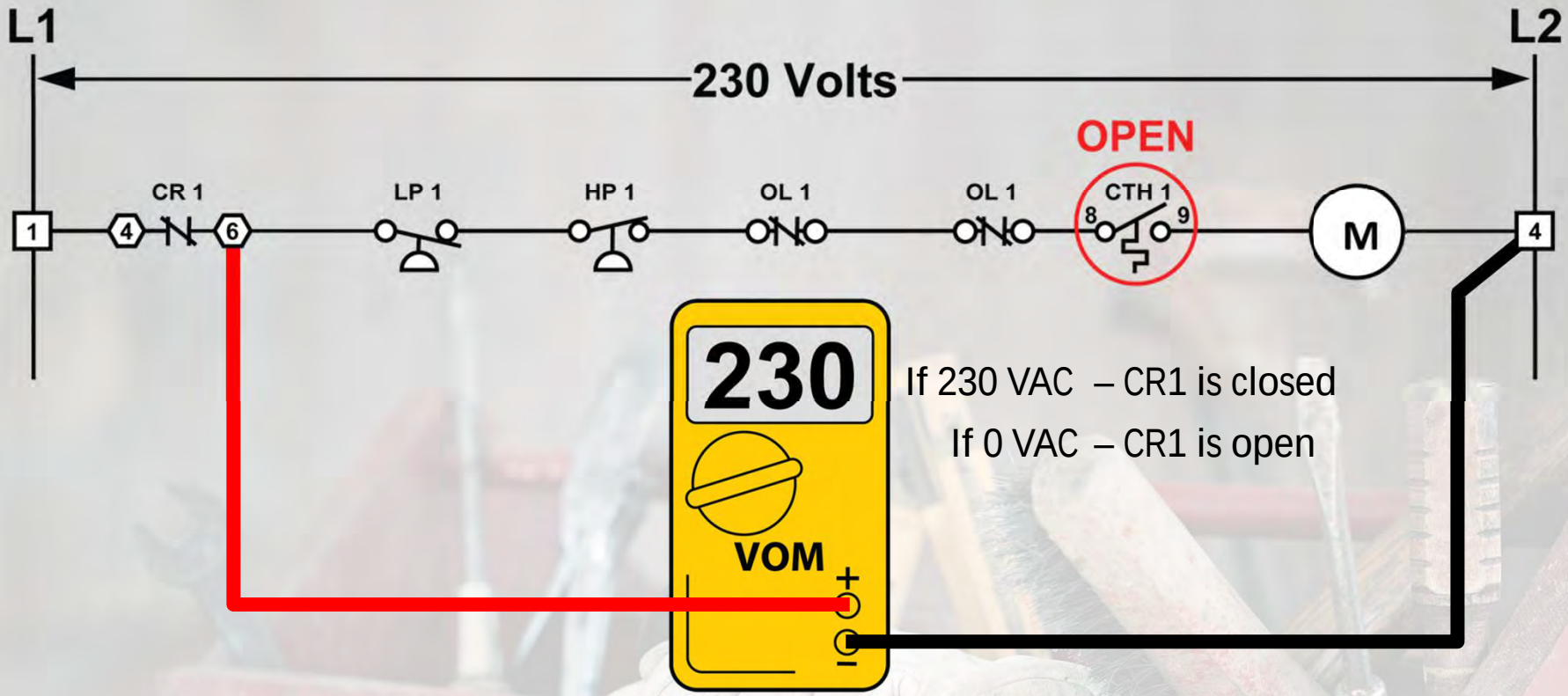
If 230 VAC – Safeties OK
Check Contactor/Compressor

If 0 VAC – Hopscotch Safeties

Next check voltage directly to the load in question.

Hopscotch

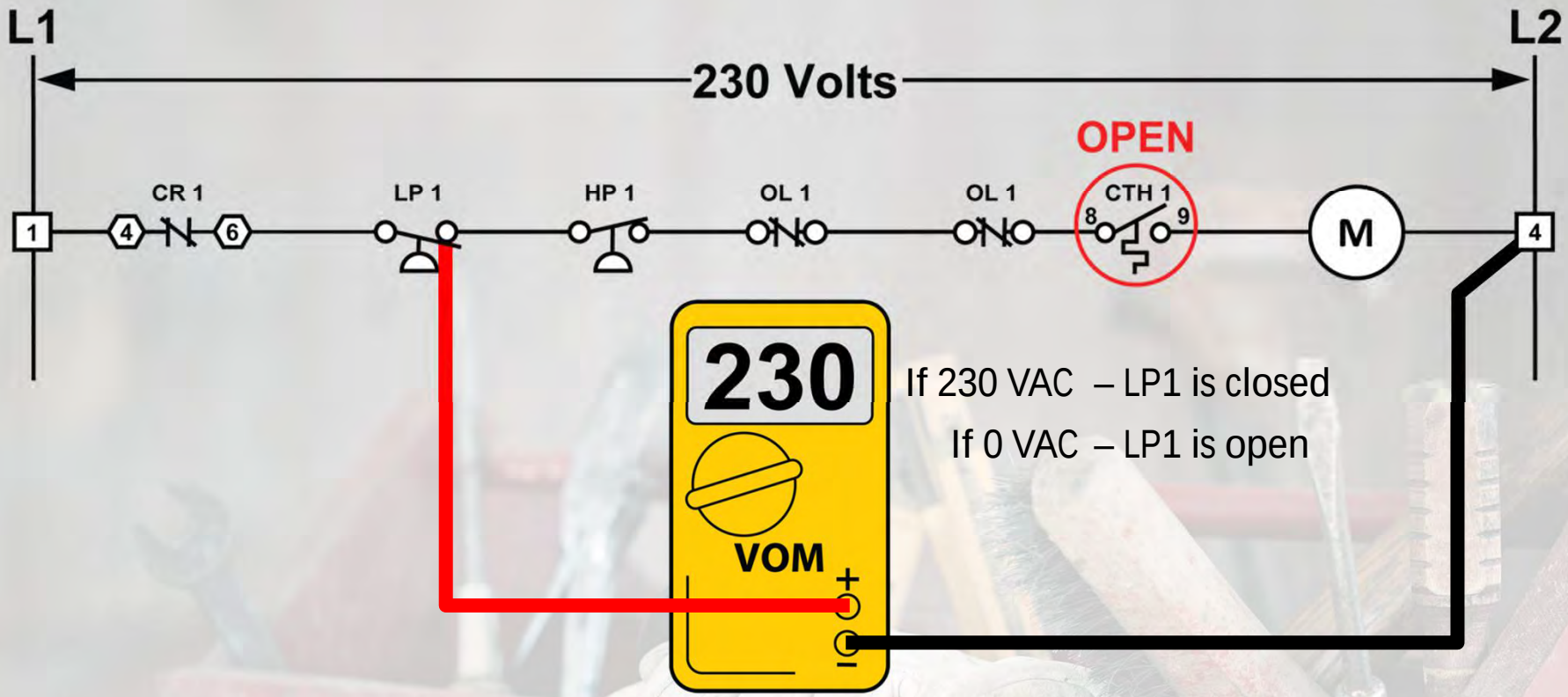
Electrical Troubleshooting



Troubleshoot the safety circuit, working from the "line side" toward the load in question

Hopscotch

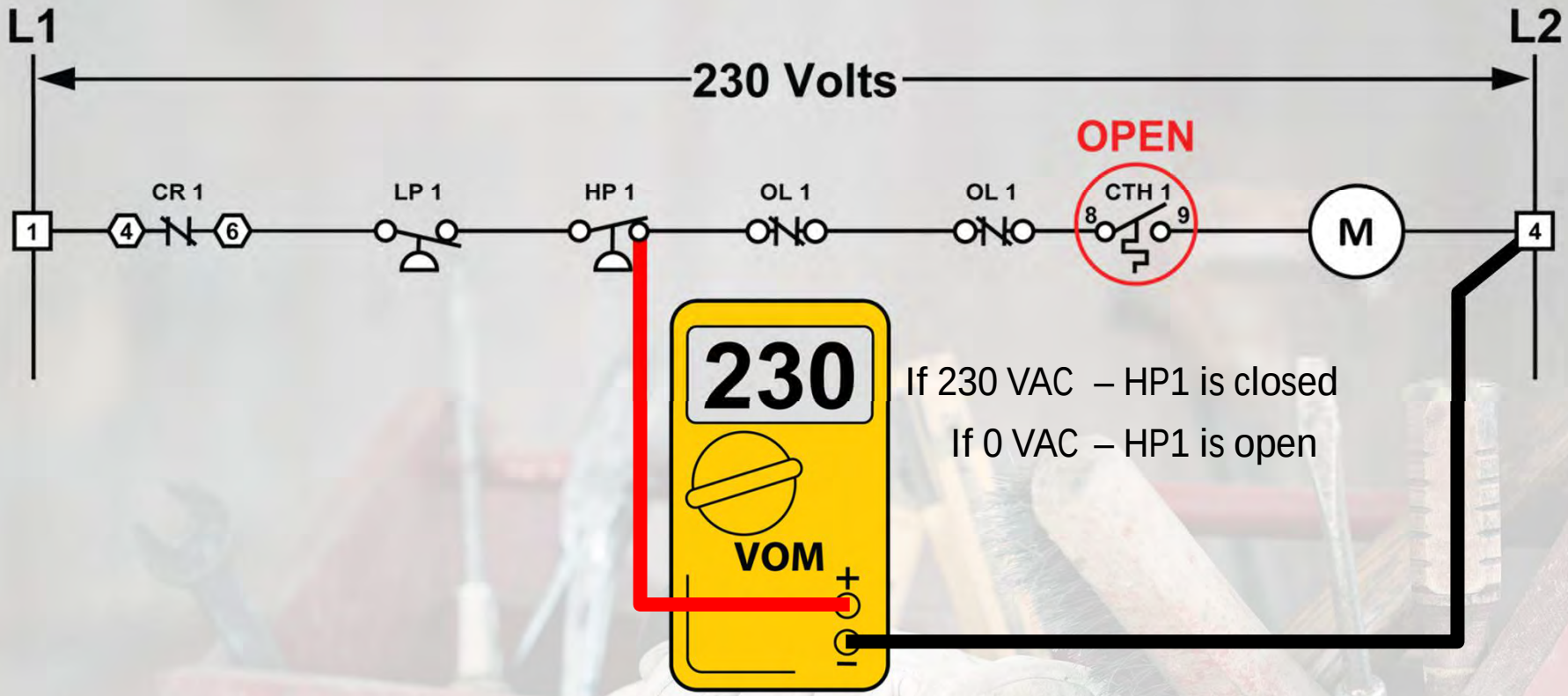
Electrical Troubleshooting



Troubleshoot the safety circuit, working from the "line side" toward the load in question.

Hopscotch

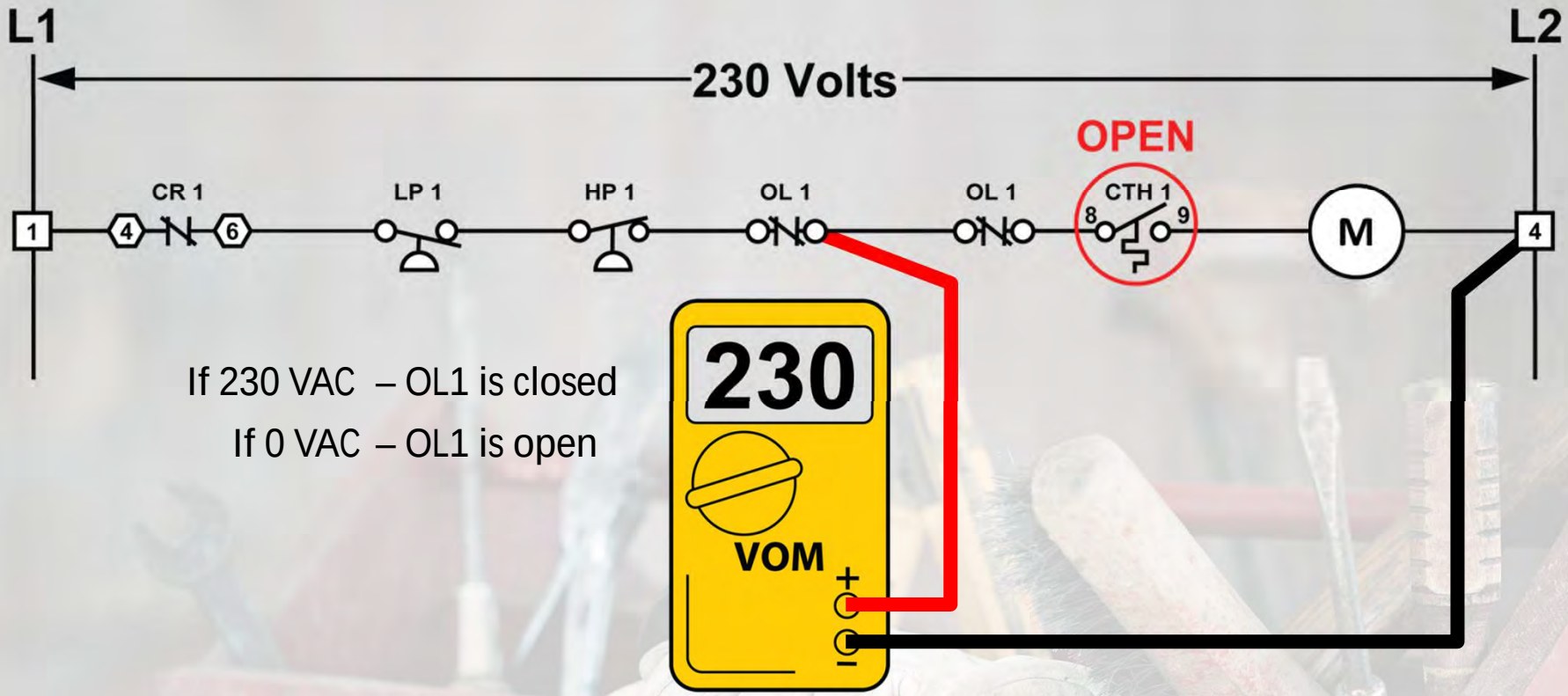
Electrical Troubleshooting



Troubleshoot the safety circuit, working from the "line side" toward the load in question.

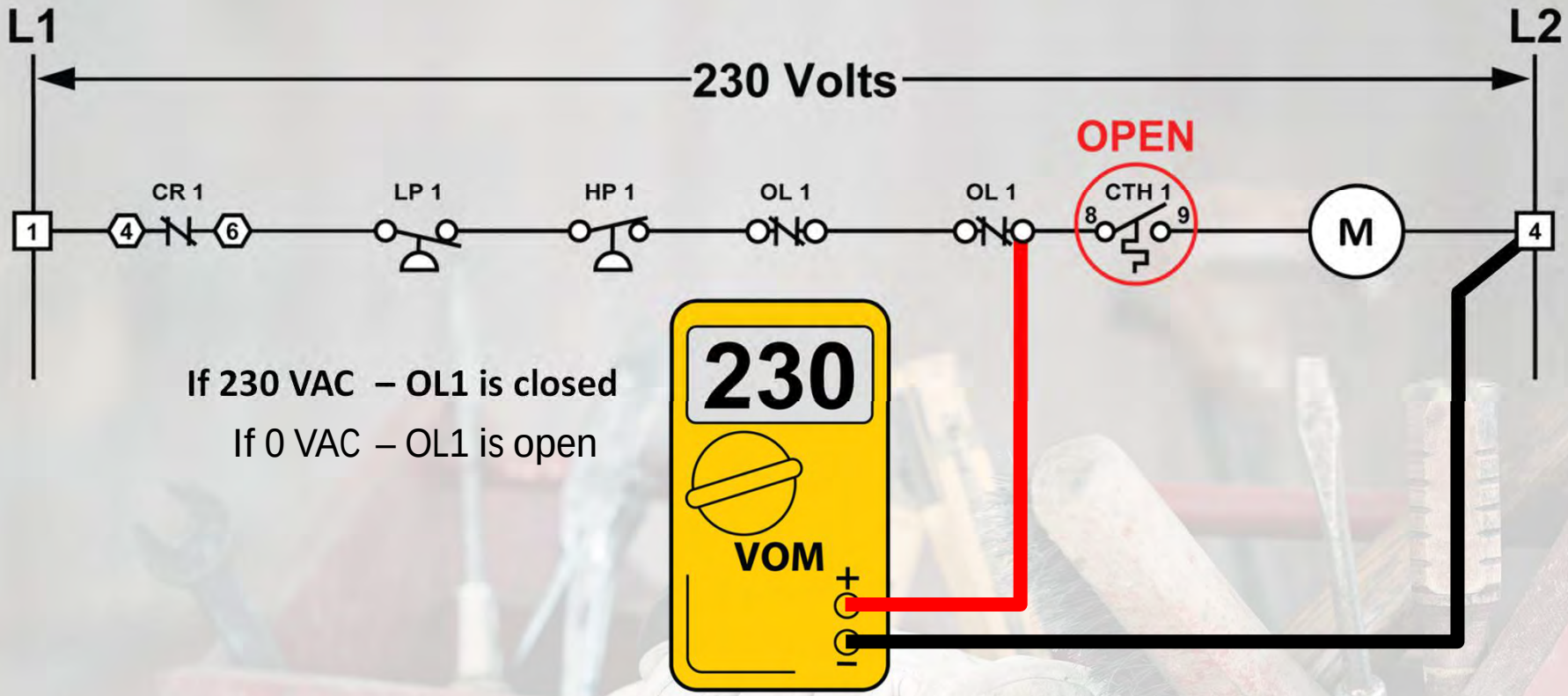
Hopscotch

Electrical Troubleshooting



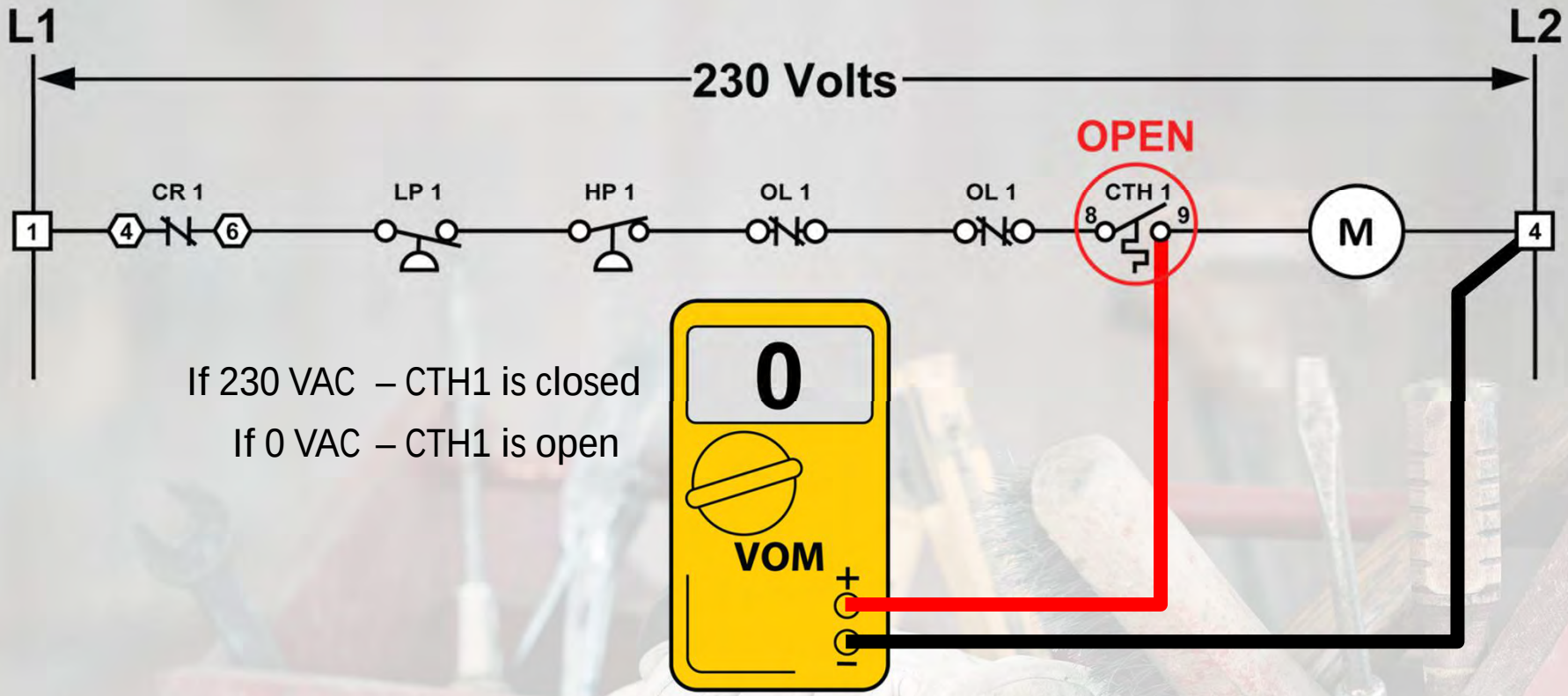
Troubleshoot the safety circuit, working from the "line side" toward the load in question.

Electrical Troubleshooting



Troubleshoot the safety circuit, working from the "line side" toward the load in question.

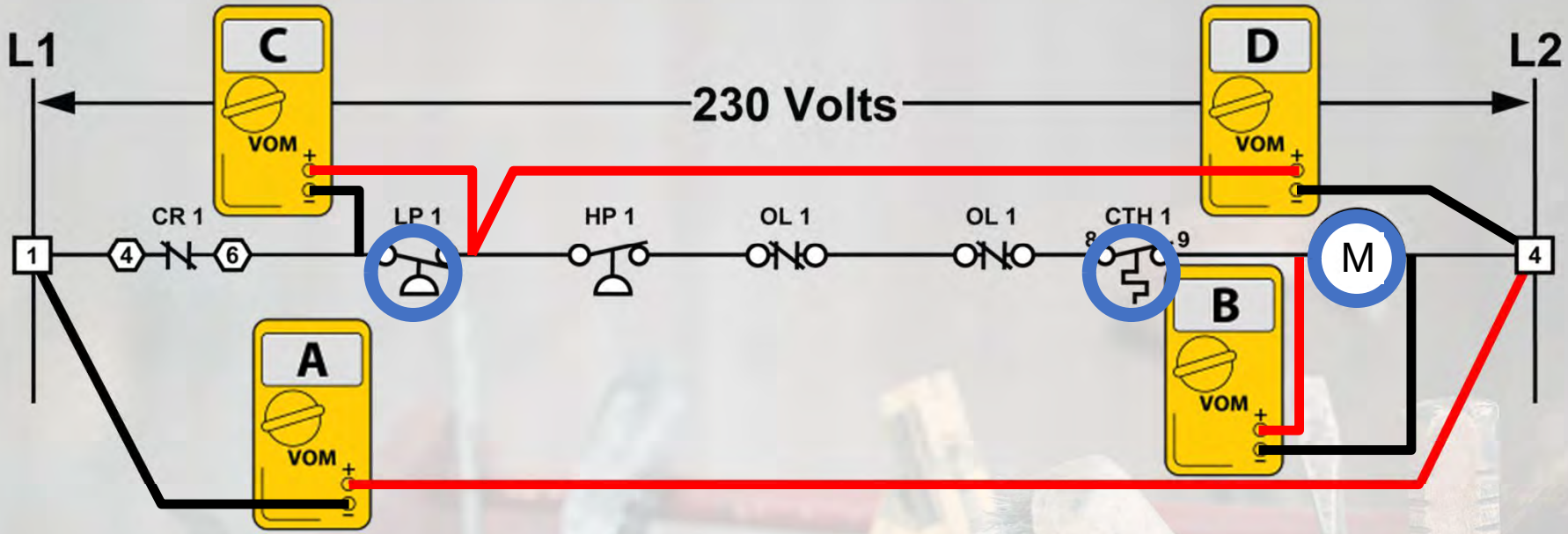
Electrical Troubleshooting



Troubleshoot the safety circuit, working from the "line side" toward the load in question.

Hopscotch

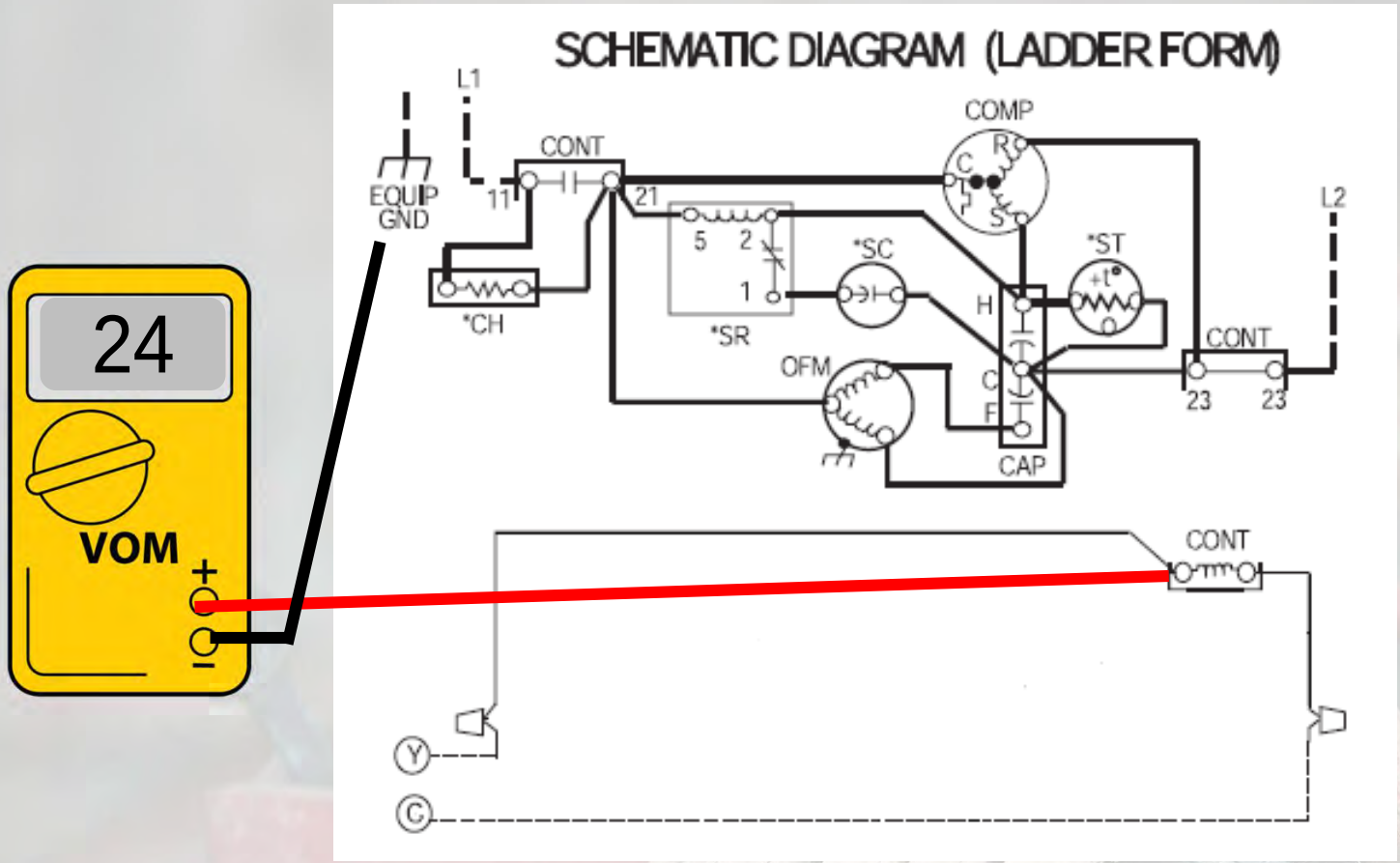
Voltmeter Placement Exercise



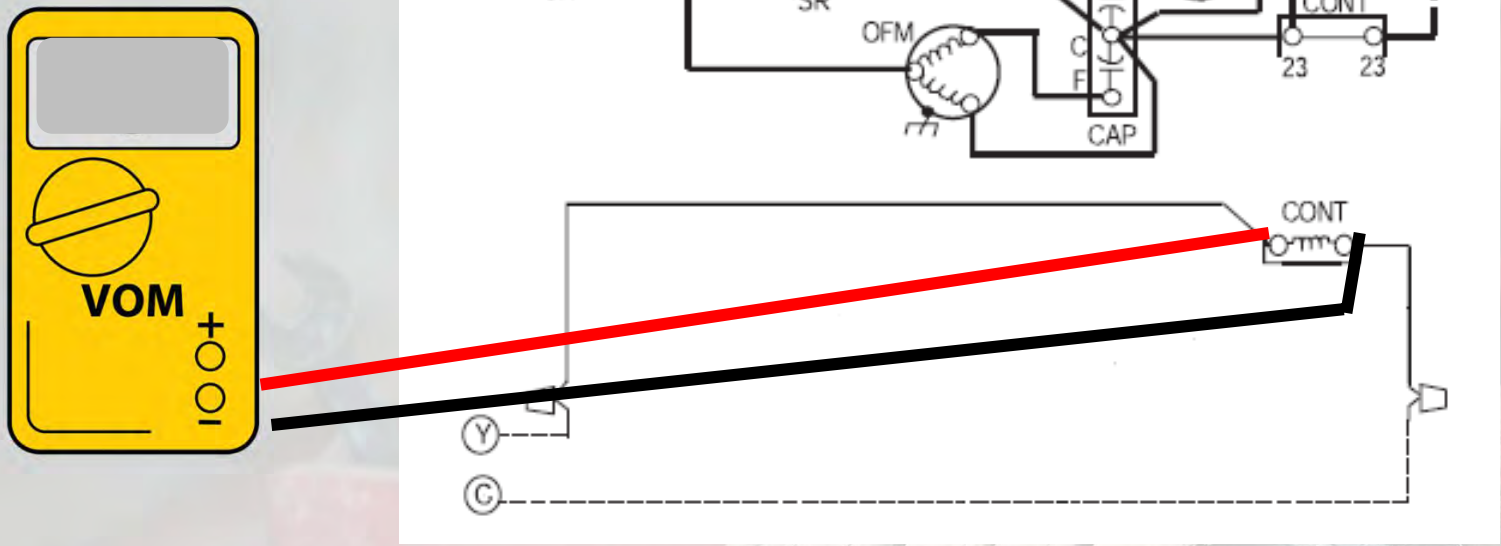
CR1	LP1	HP1	OL1	OL1	CTH1	M	METER			
							A	B	C	D
C	C	C	C	C	C	C	230			
C	C	C	C	C	C	O				
C	O	C	C	C	C	C				
C	O	C	C	C	O	C				

Note: C – Closed O - Open

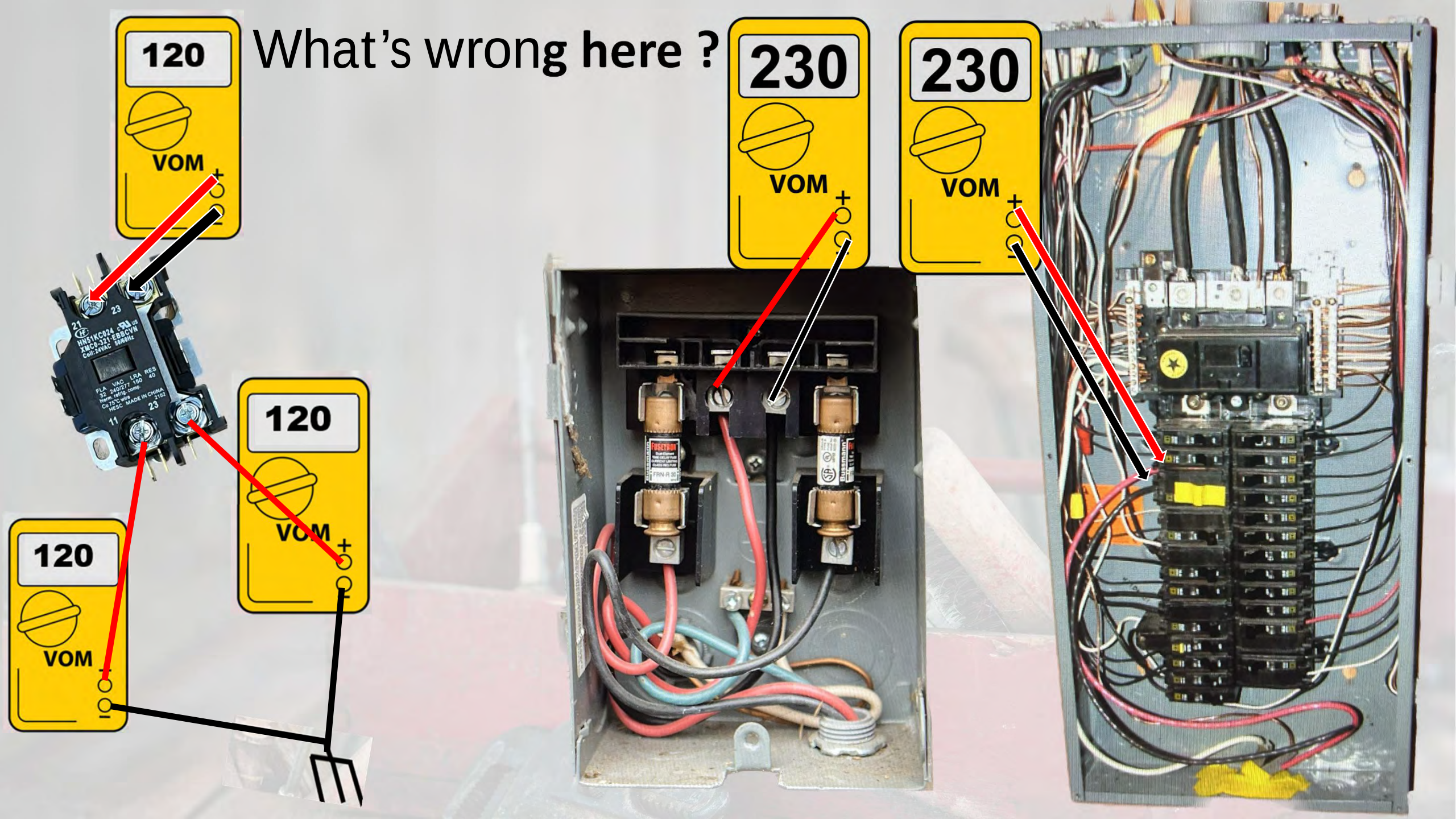
Testing single leg voltage with ground

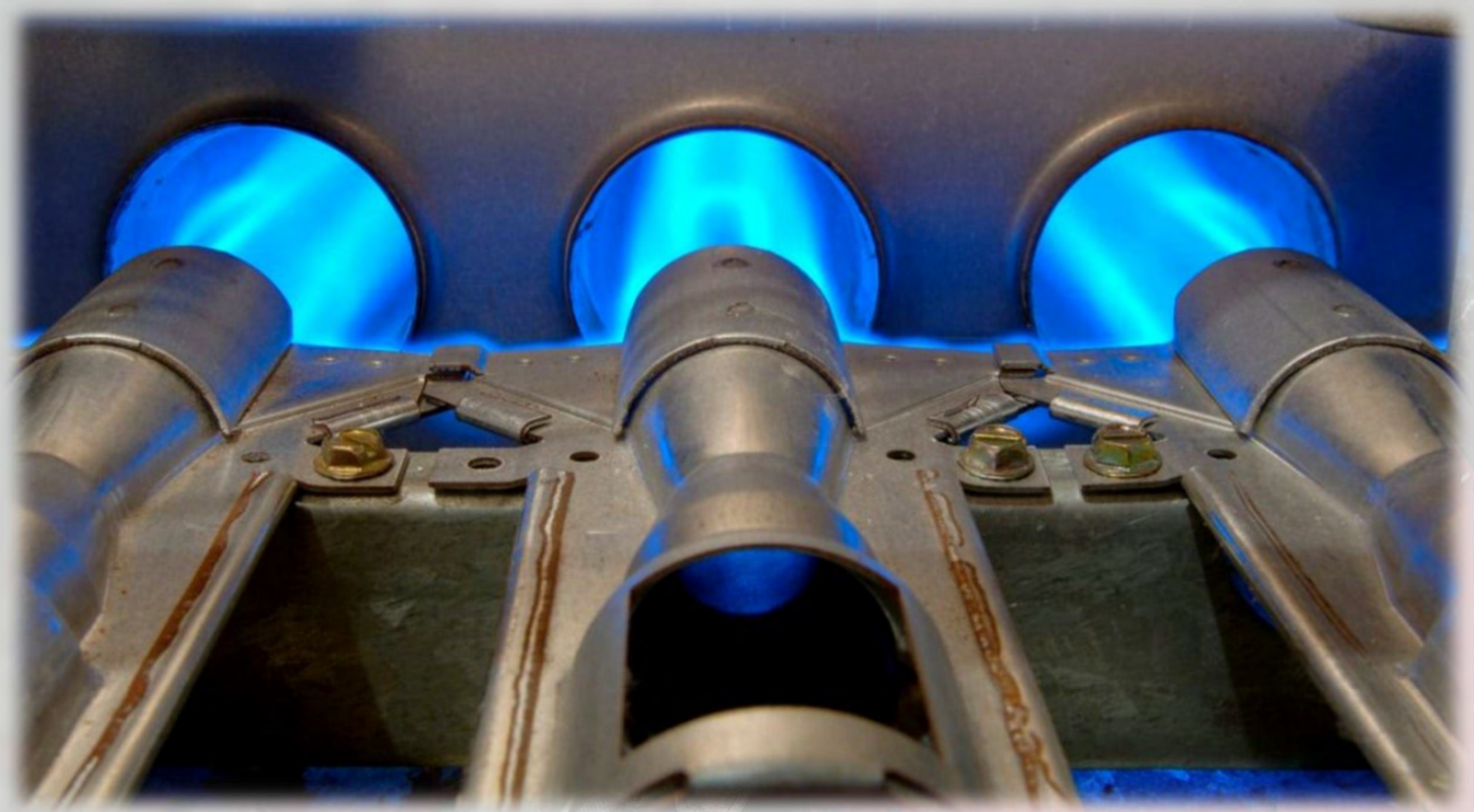


Testing across one leg voltage



What's wrong here ?



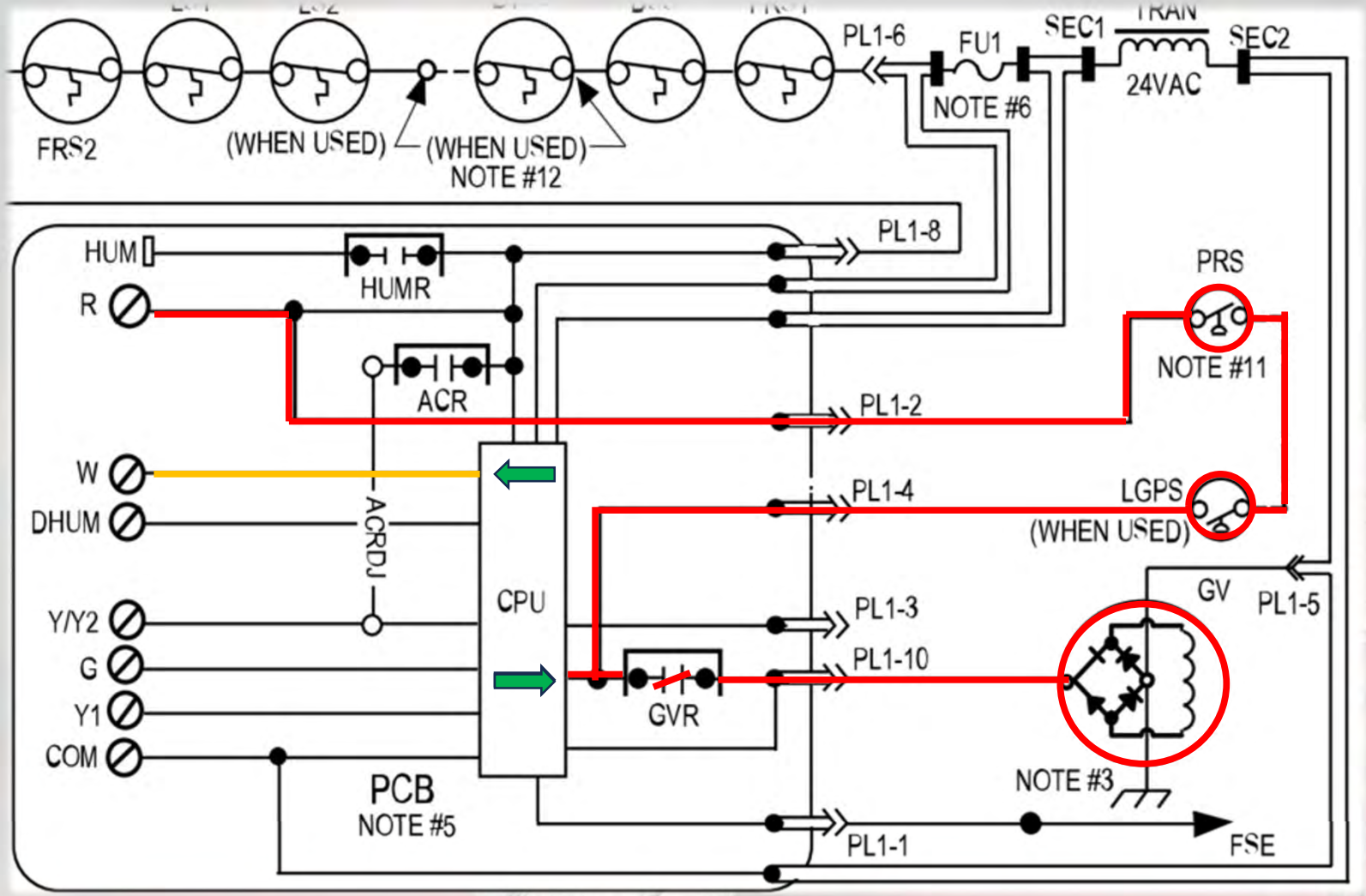


Sequence of operation

- Call for heat
- Safety switches positions confirmed
- Inducer starts pre-purge cycle
- Pressure switches reconfirmed
- HSI energized
- Gas valve energized
- Flame proven
- Blower time delay energized
- Blower starts

- What is it doing?
- What should it be doing?
- What is it not doing?

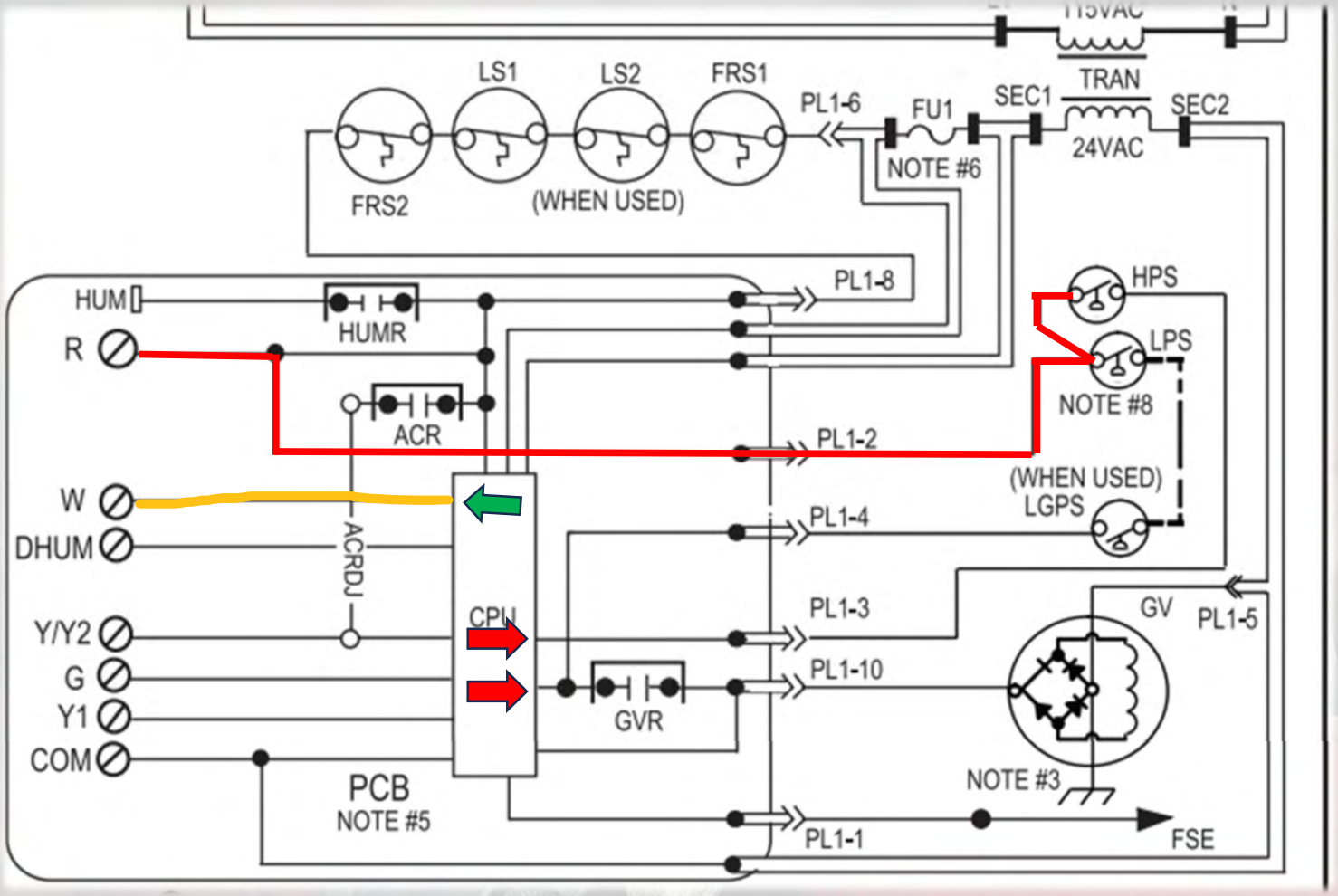
Single stage 80%



Pressure switch proving

Single Stage 90%

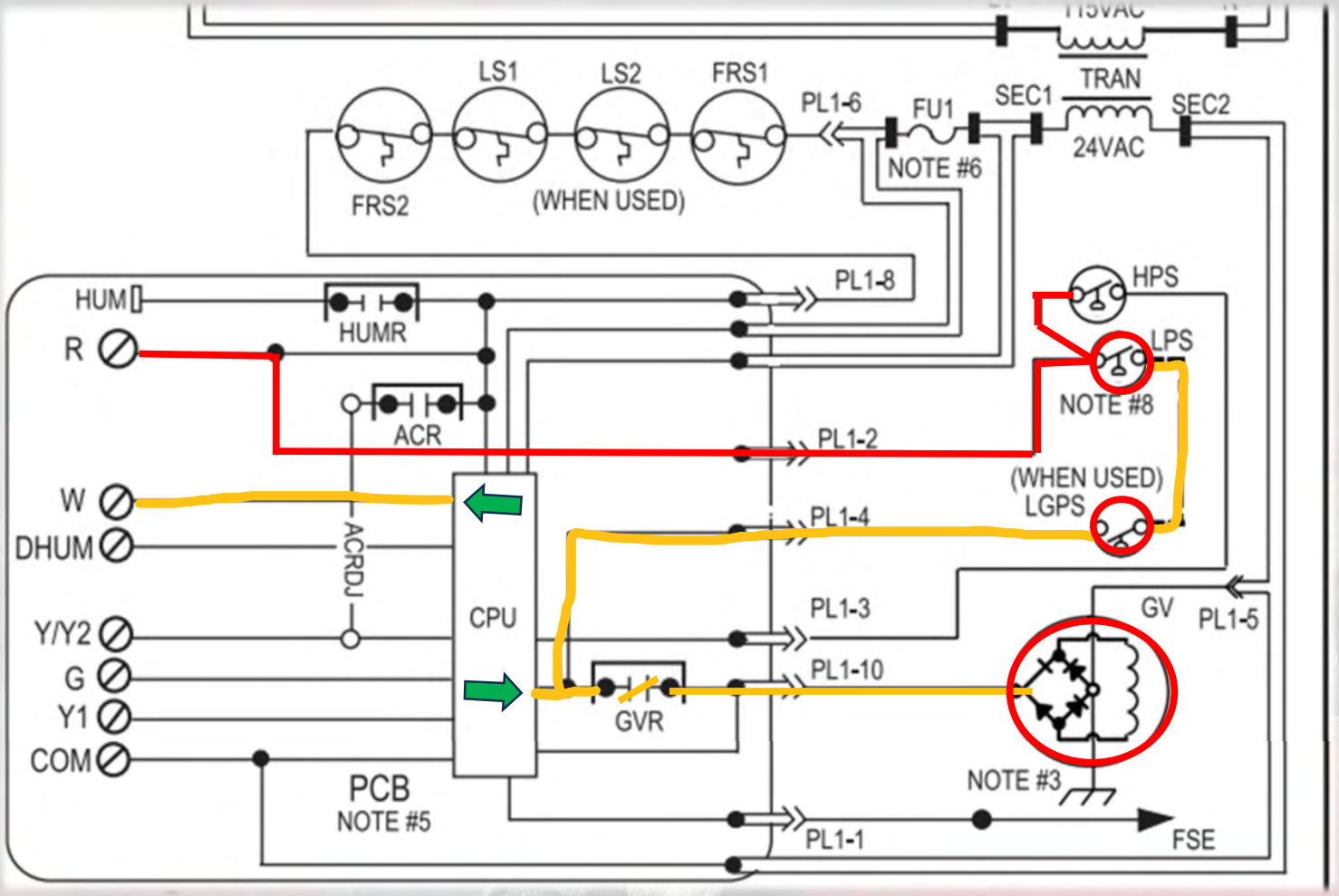
Code 23- Pressure switch did not open - Immediate with call for heat
Inducer won't power on



Pressure switch proving

Single Stage 90%

Pressure switch proving w/ inducer energized
HPS is ignored for 60seconds after burners ignite



Pressure switch proving

Single Stage Furnace

Pressure switch faults: Code 32 LPS or 31 HPS stuck open

How do I know what switch to check?

When did fault appear?

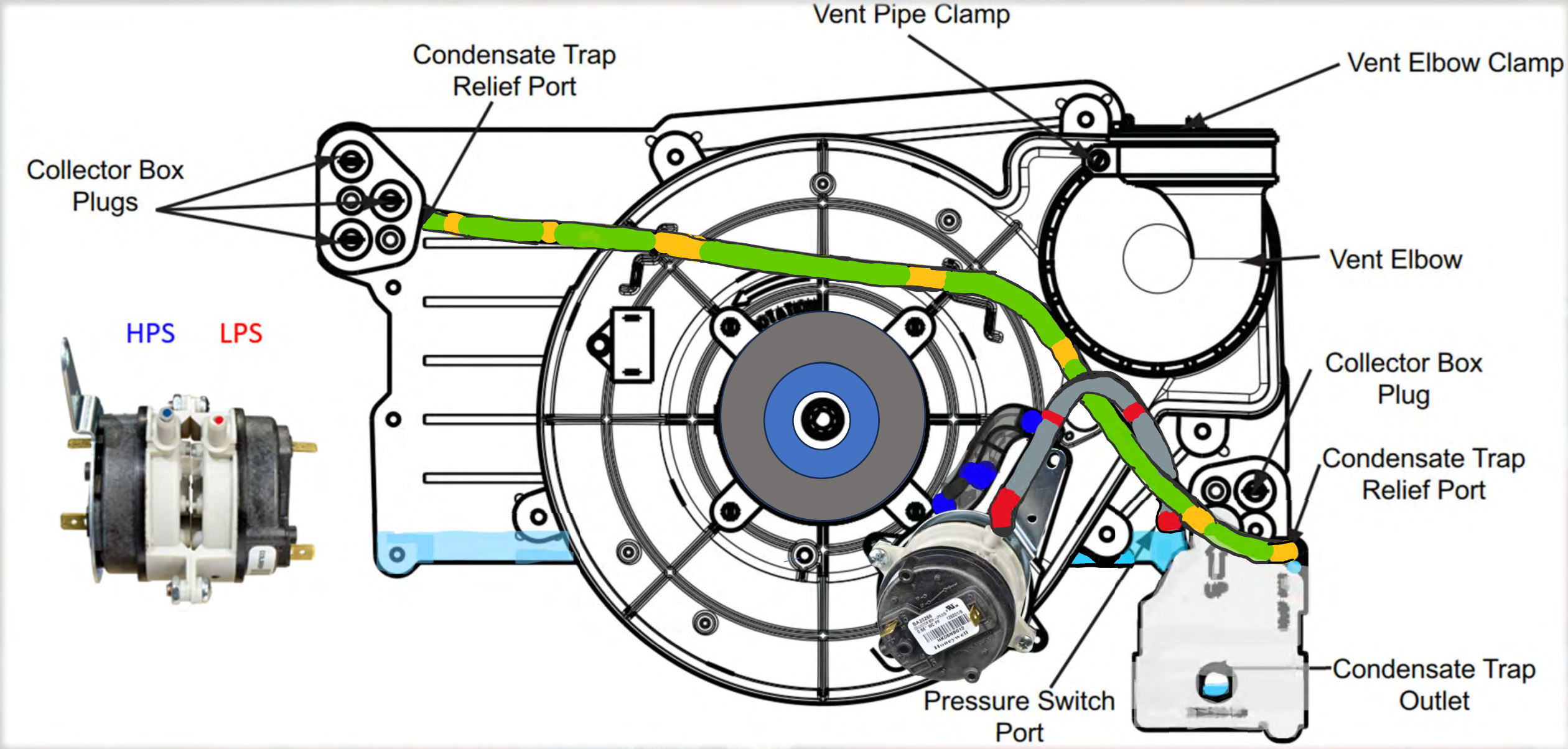
Inducer energized/no ignitor

Code 32-LPS did not close - Collector box pressure switch
(Monitors condensate drainage)

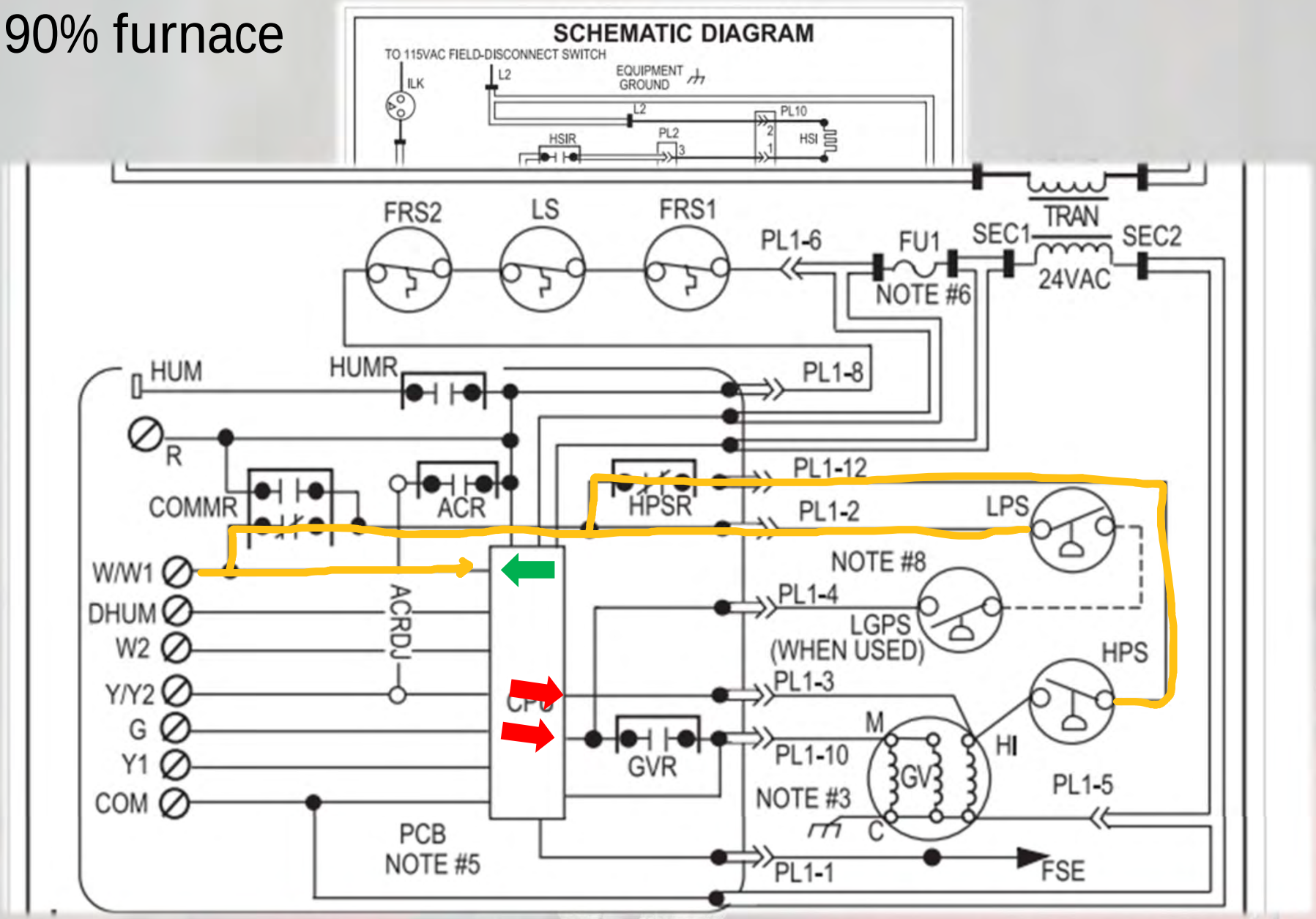
60 seconds after ignition of burners

Code 31-HPS did not close – Inducer housing pressure switch
(Monitors flue vent)

1 and 2 Stage 90% Furnaces



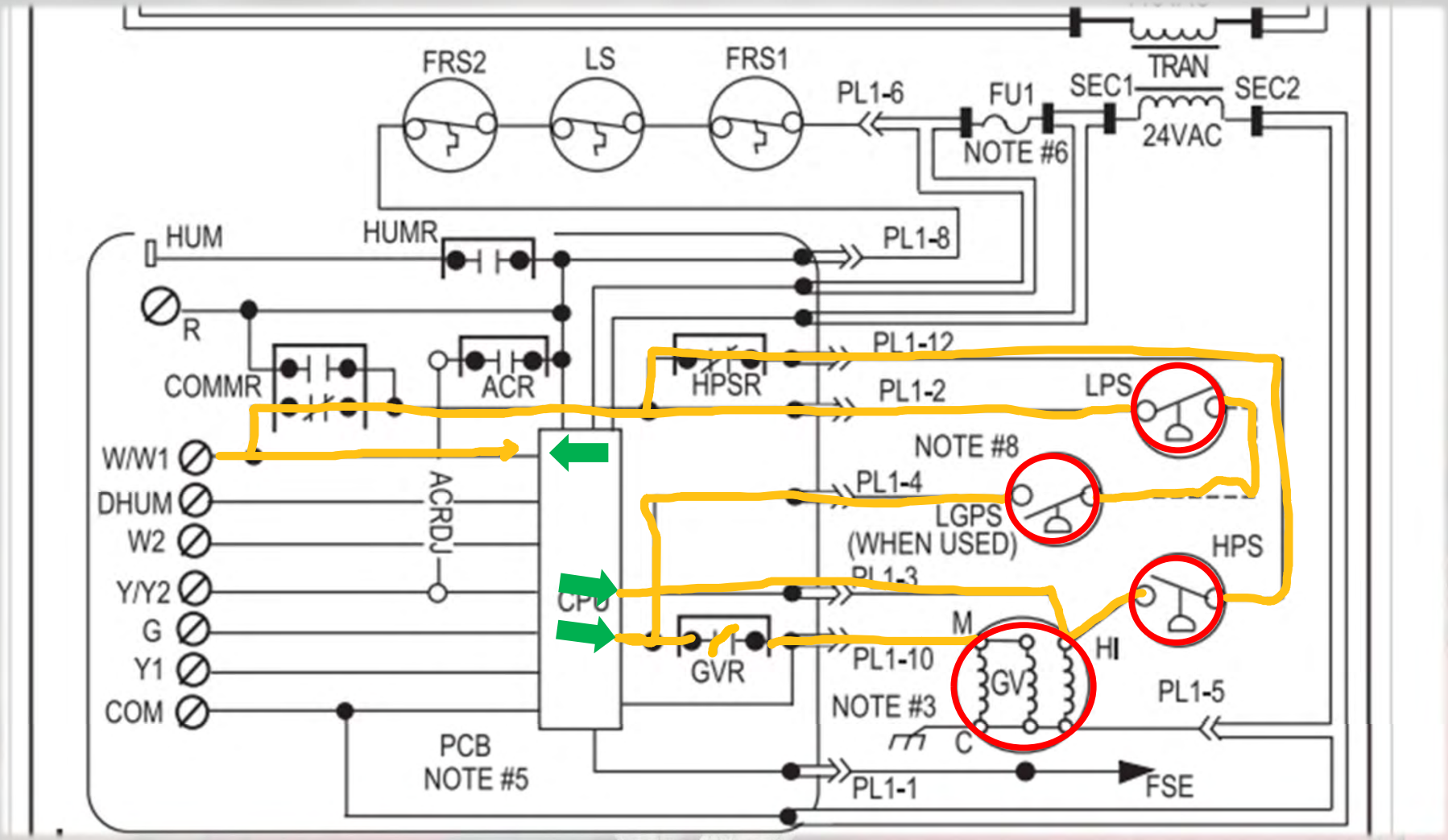
2 Stage 90% furnace



Pressure switch proving

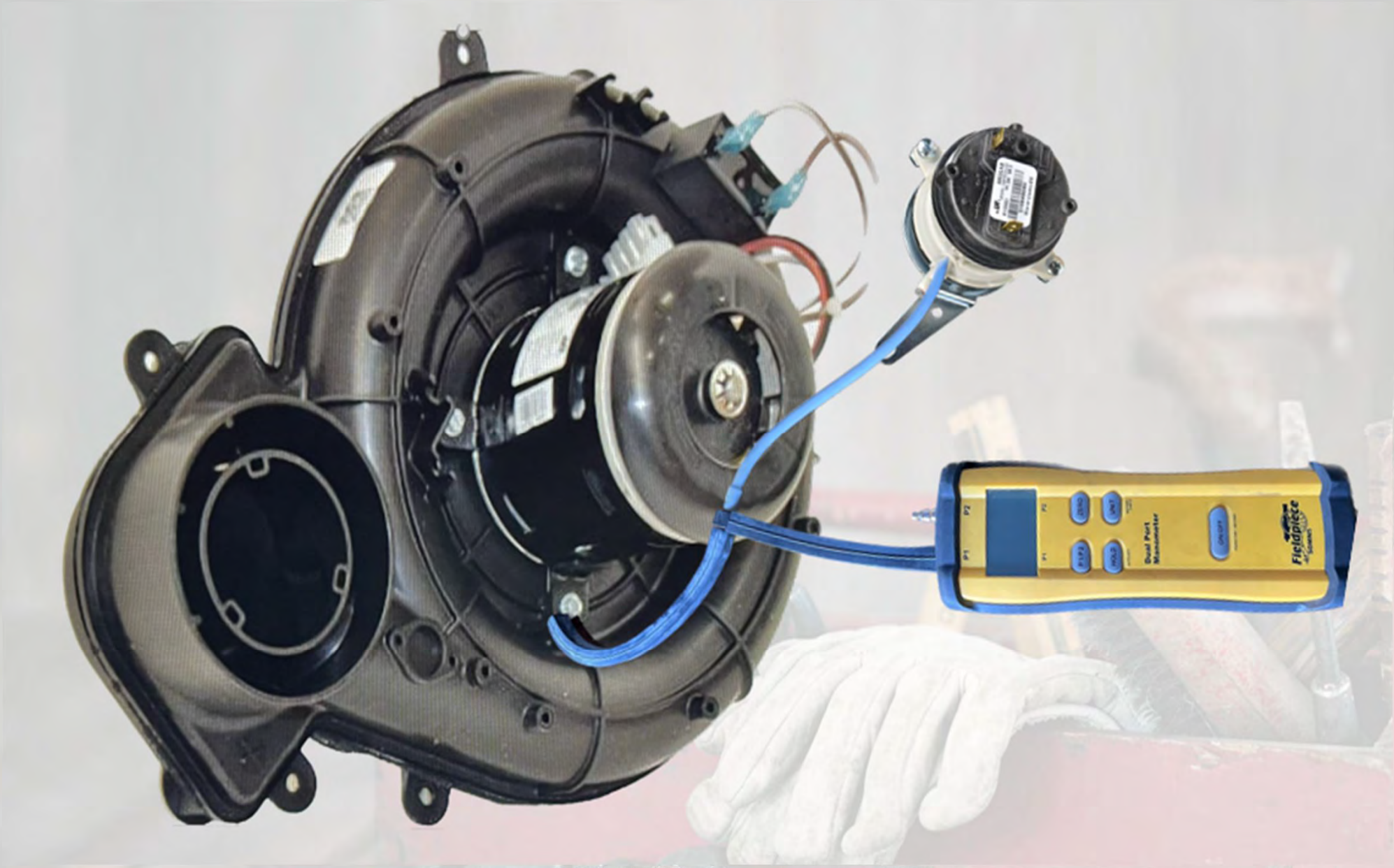
2 Stage 90% furnace

Inducer energizes

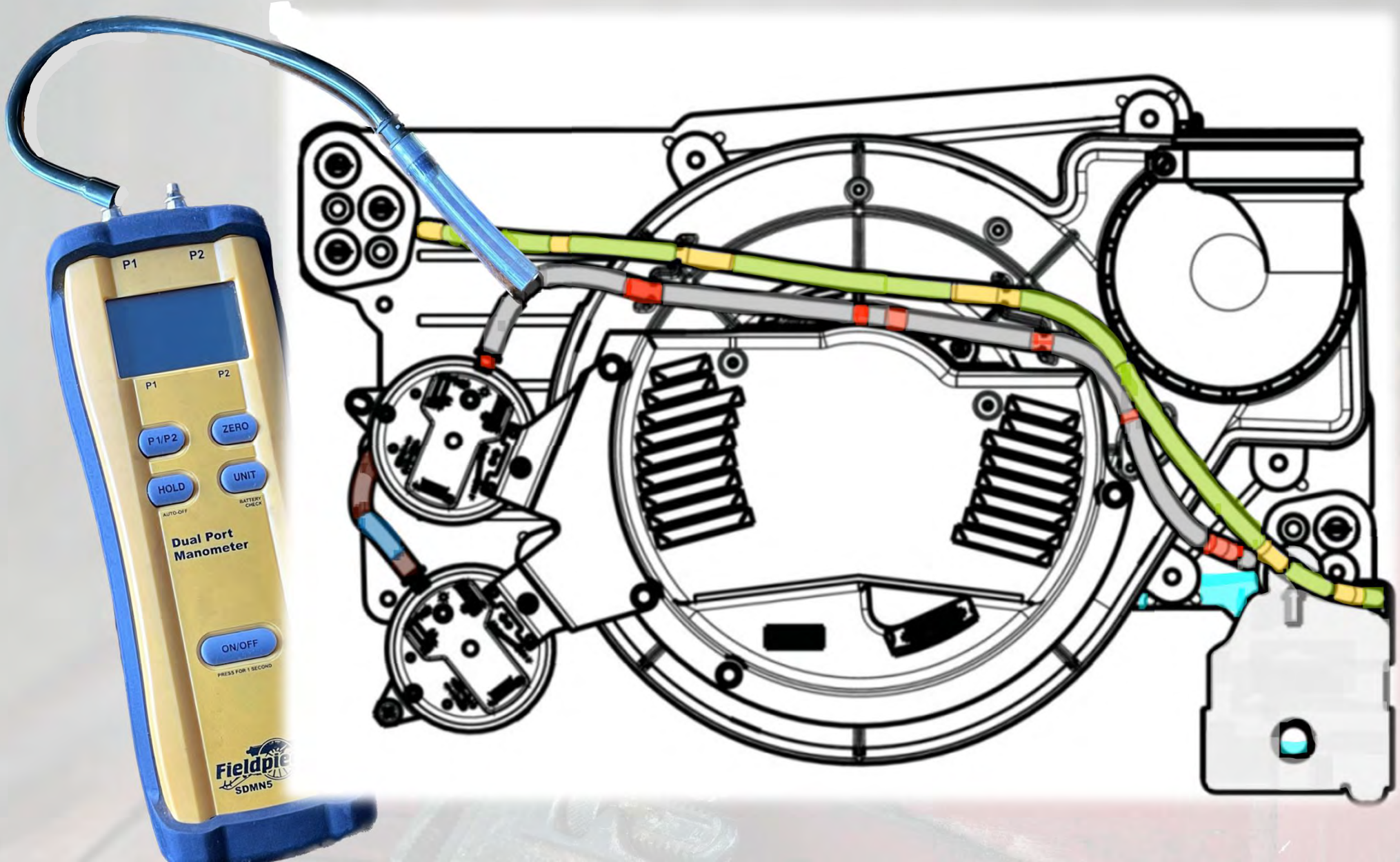


Pressure switch proving

How do I check if the pressure switch is good



How do I test the pressure switch?

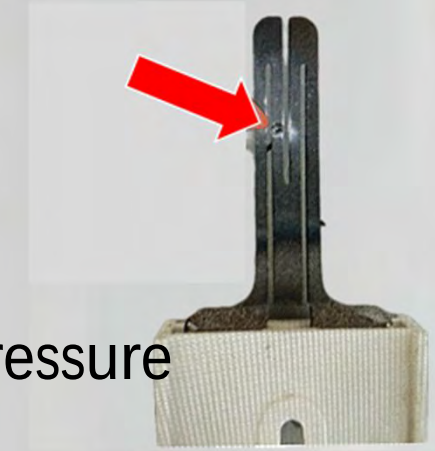


What causes pressure switch faults:

Look for: blockage in flue/water in flue pipe due to sagging or improper slope, vent sizing and length, plugged condensate drain, water in pressure switch, pressure switch tubing disconnected/damaged/obstructed, failed pressure switch

Ignition faults:

- A good HSI should ohm between 40-70ohms
- Gas pressure should be set per manufacturer specs for that FAU (not all furnaces require the same pressures)
- Inlet gas pressure needs to be minimum 1”w.c. above the required outlet pressure
- Did all burners ignite –are crossovers clear-manifold clean-no soot
- Flame sensor microamps .5min microamps-6.0microamps (4.0-6.0 nominal)



ALTITUDE RANGE		AVG. GAS HEAT VALUE AT ALTITUDE	SPECIFIC GRAVITY OF NATURAL GAS							
			0.58		0.60		0.62		0.64	
	ft (m)	(Btu/cu ft)	Orifice No.	Mnfld Press High/Low	Orifice No.	Mnfld Press High/Low	Orifice No.	Mnfld Press High/Low	Orifice No.	Mnfld Press High/Low
U.S.A. and Canada		900	43	3.8 / 1.6	42	3.2 / 1.4	42			
	0	925	43	3.6 / 1.5	43	3.7 / 1.6	43			
	(0)	950	43	3.4 / 1.4	43	3.5 / 1.5	43			
		975	44	3.7 / 1.6	44	3.8 / 1.6	43			
	to	1000	44	3.5 / 1.5	44	3.6 / 1.5	44			
		1025	44	3.3 / 1.4	44	3.5 / 1.5	44			
	2000	1050	44	3.2 / 1.3	44	3.3 / 1.4	44			
	(610)	1075	45	3.7 / 1.6	45	3.8 / 1.6	44			
		1100	46	3.7 / 1.6	46	3.8 / 1.6	45	3.8 / 1.6	44	3.2 / 1.4

Capacitors

Capacitors are designed to assist a motor either in starting or running.

- **Start** capacitor – gives the motor higher starting torque
- **Run** capacitor– gives the motor a higher operating efficiency
- **MFD** (Microfarad) rating is the **capacitance** of the capacitor.
- **Voltage** rating – use the voltage rating of the one designed for the motor (will typically be higher than line).

Rules for Capacitor Replacement

Always try to use an exact replacement capacitor
with respect to voltage and capacitance.
Any changes or deviations from the original
must be marked.
If another size must be used, always go bigger not smaller

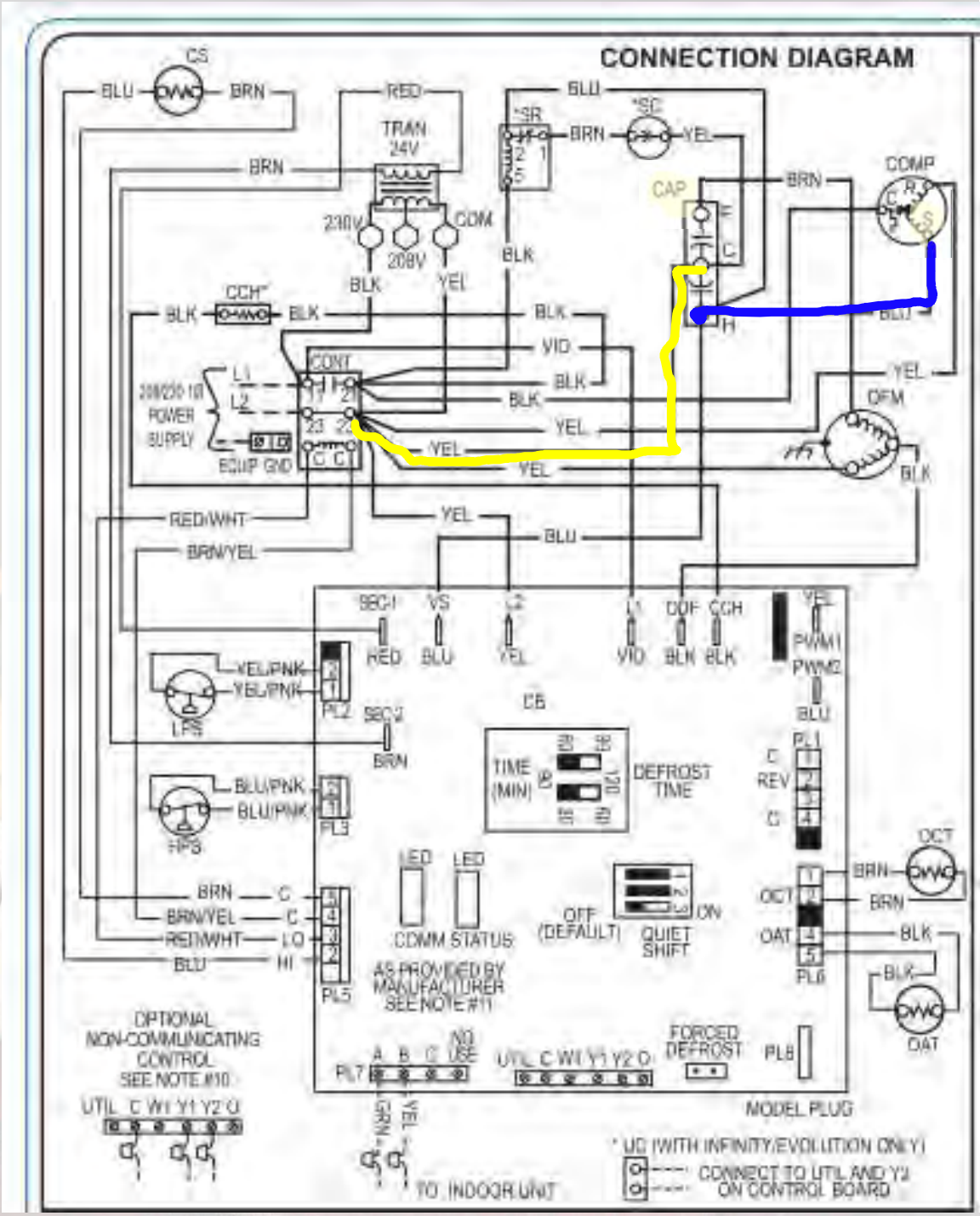
1. The voltage rating on the replacement capacitor must be equal to or greater than the voltage rating on the original capacitor.

2. The Start capacitor must be equal to or no more than +20%* of the original capacitance.
   The Run capacitor must be within ± 10% of the original.

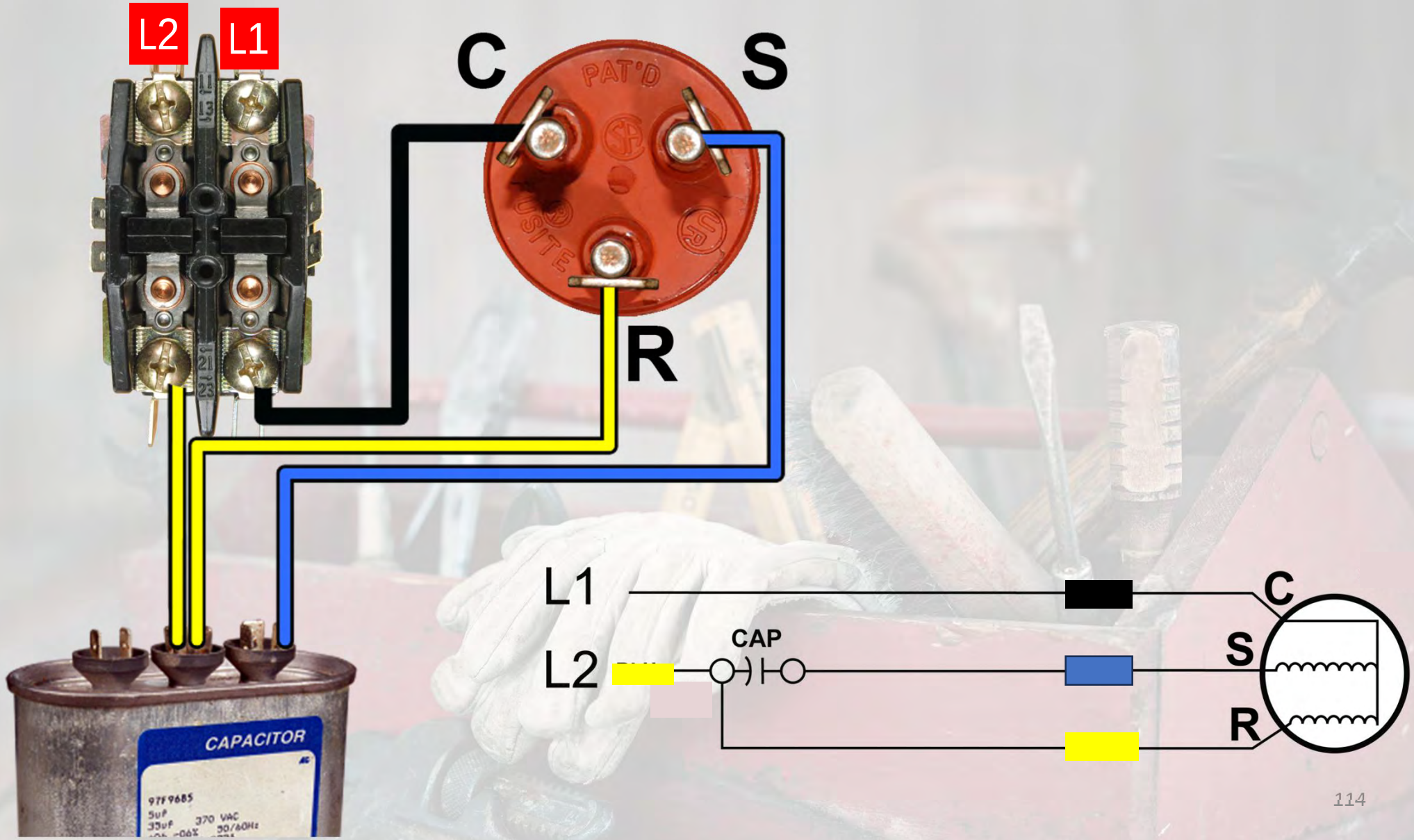
* *If the start capacitor is undersized, the motor might not start. If the start capacitor is oversized, the high current may burn out the motor.*

Run Capacitor

- Lowers the running current of the motor
- Improves the running efficiency
- Reduces the motor winding temperature
- Extends the life of the motor
- Continuous duty – Series start winding
- Metal casing and oil help to dissipate heat

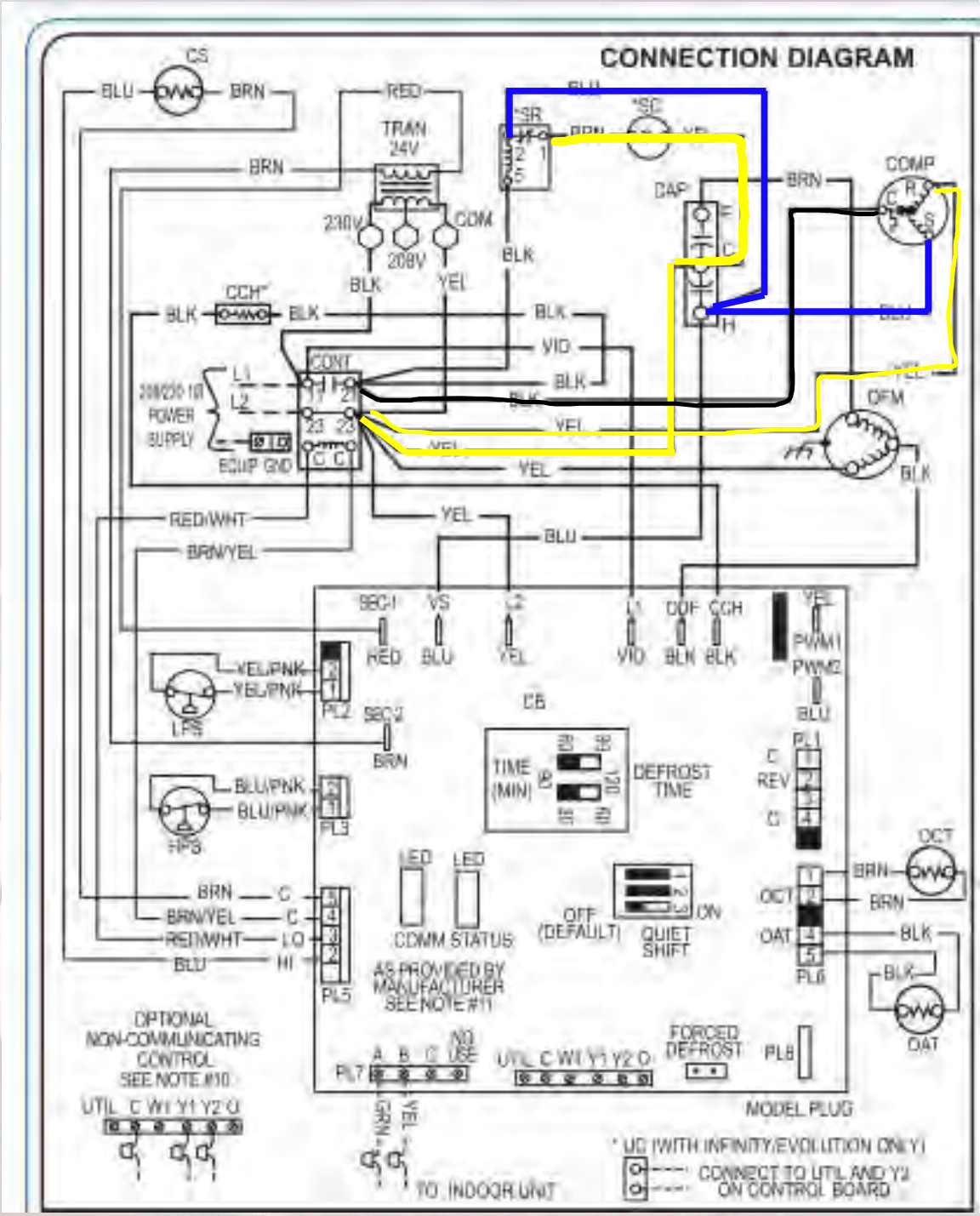


Run Capacitor

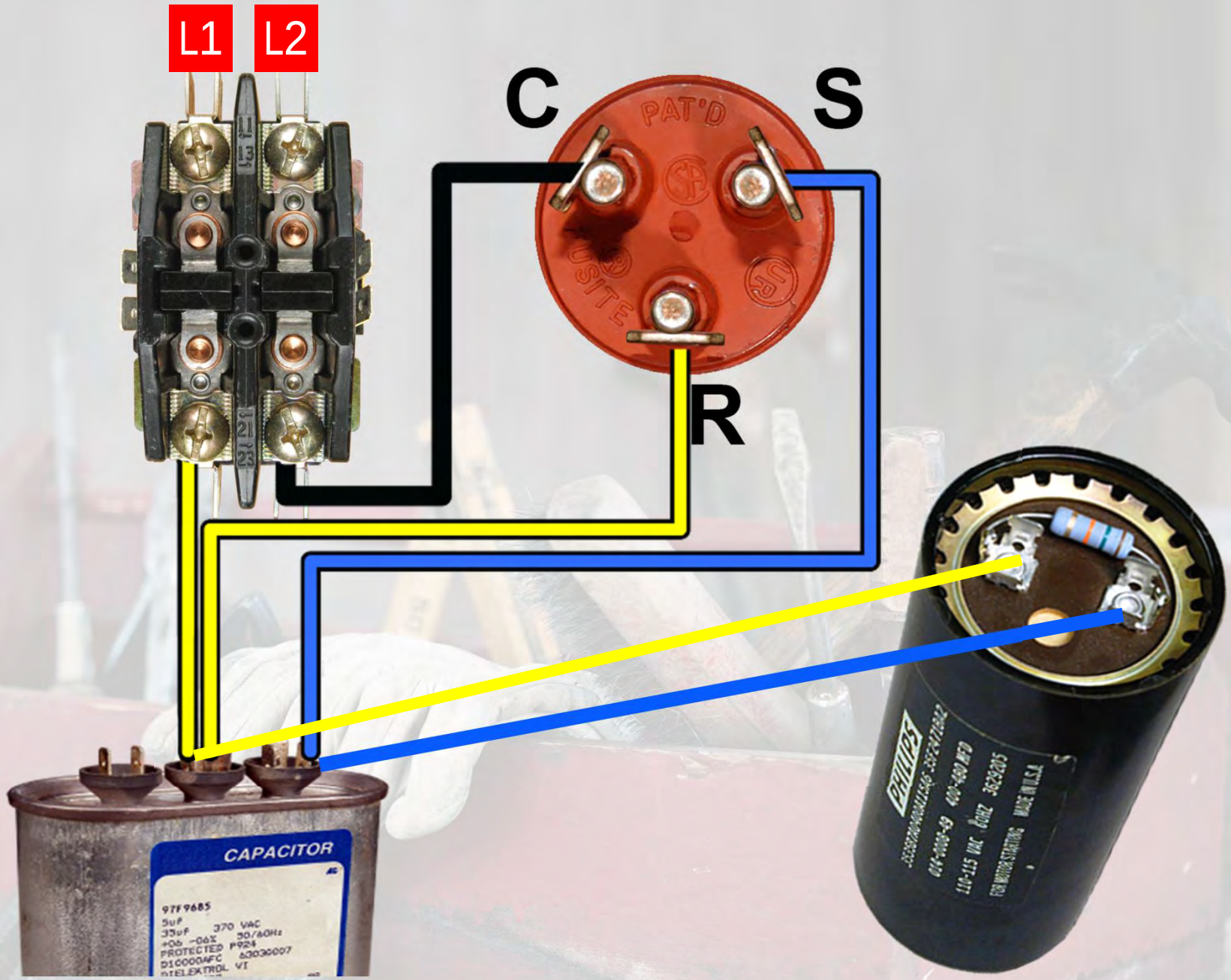


Start Capacitors

- Short time in circuit –
- Centrifugal switch or potential type start relay (3 seconds)
- Series with start winding
- High µF rating – Physically small
- High starting torque



Start Capacitor



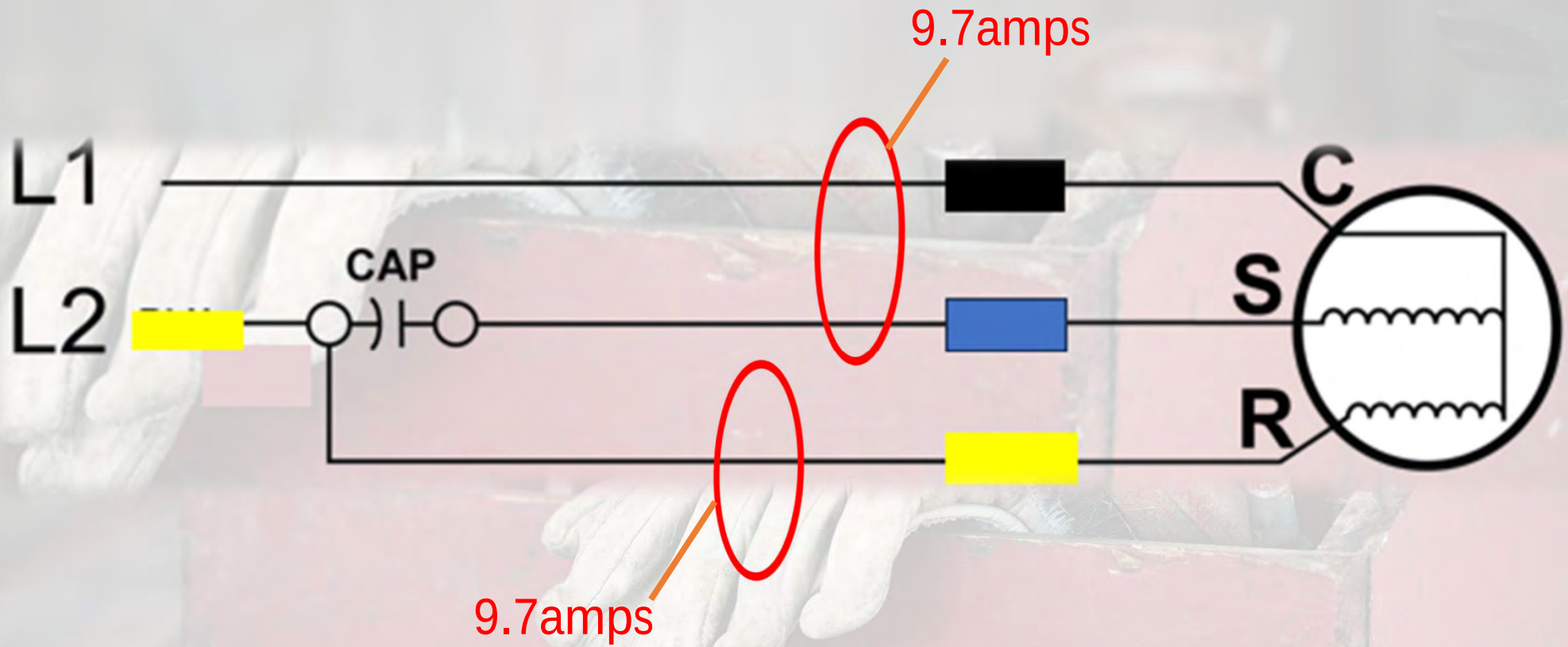
CAUTION!

- *Turn Off System Power*
- *Discharge Capacitors*

Capacitor Testing With Digital Meter

Testing capacitor under load

Common + Start = Run



OHMs

Open or
Infinite resistance

Short or
Zero resistance

Checking ohms on a contactor coil

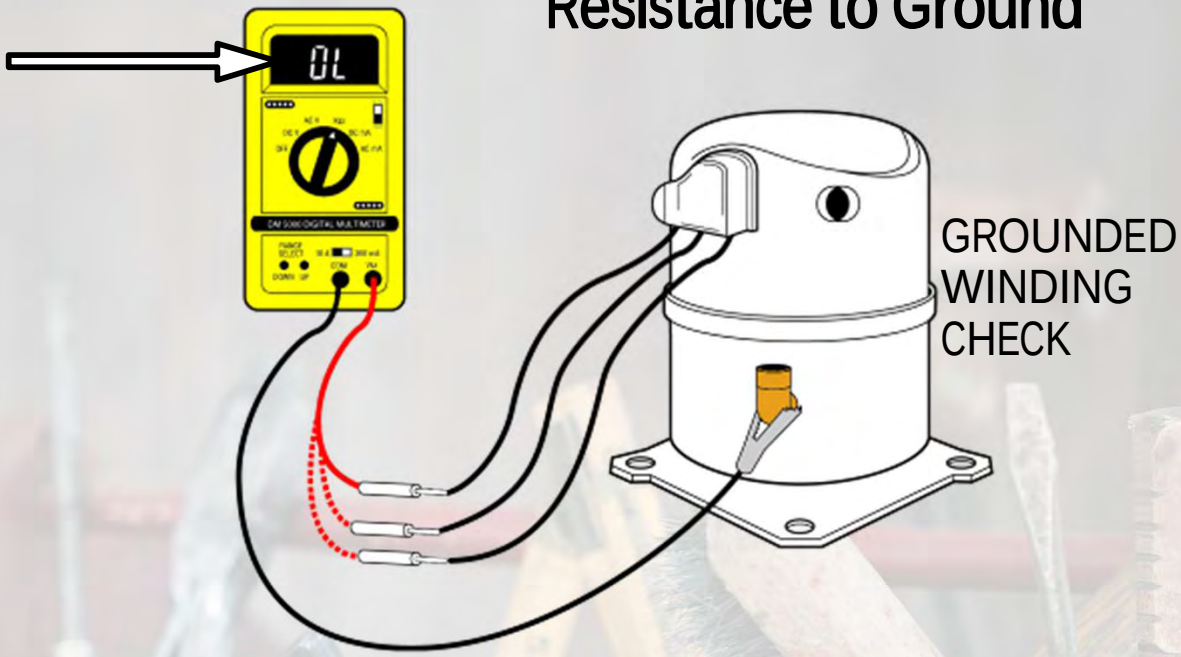
15-20ohms is nominal

OL = open coil

6 ohms or below = shorted coil

Ohmmeters

NORMAL READING
INFINITE OR
HIGH RESISTANCE
(1,000 OHMS PER VOLT)



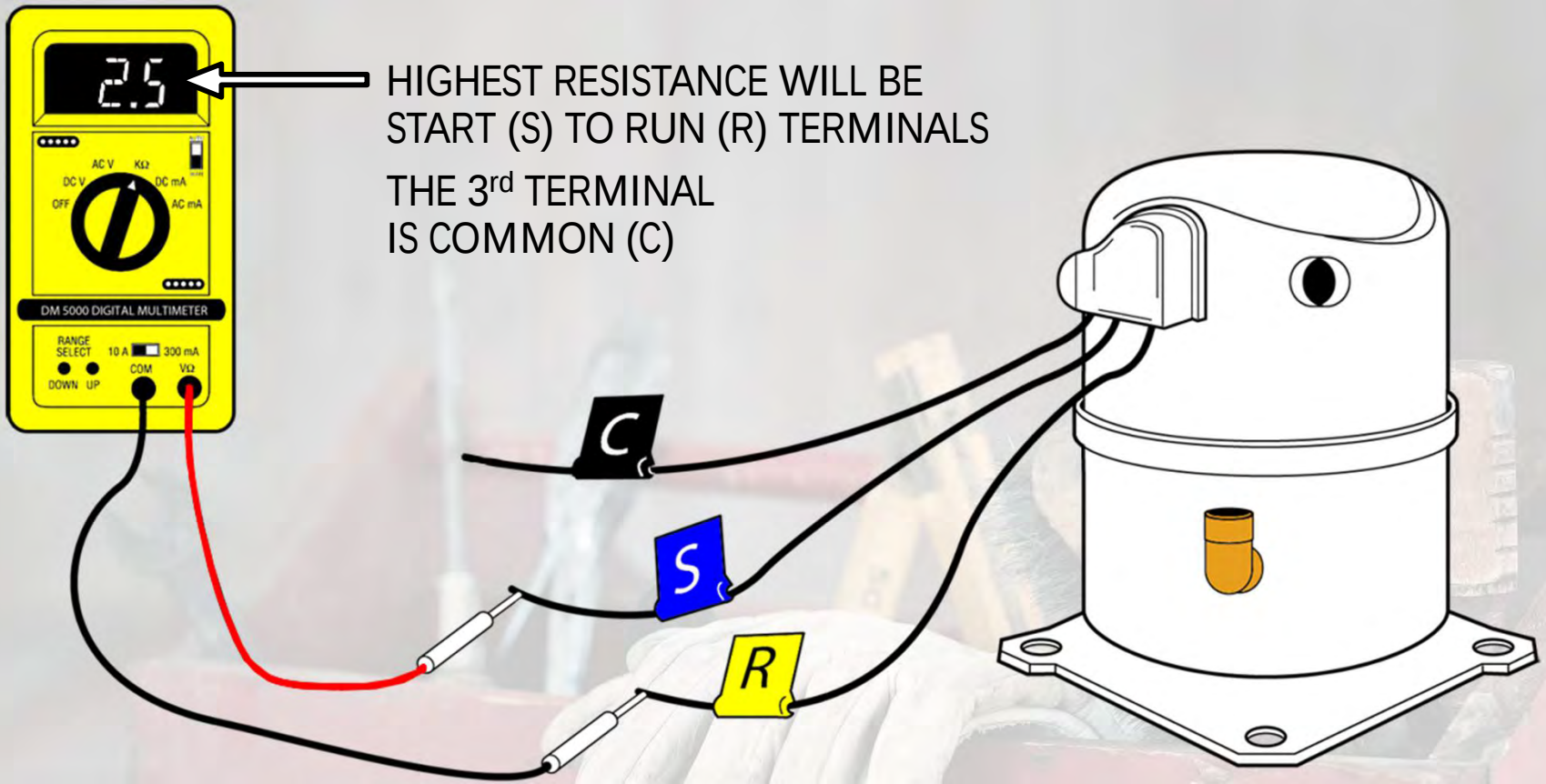
Resistance to Ground

GROUNDED
WINDING
CHECK

CAUTION: FALSE (mega ohm) READING TO GROUND CAN BE MEASURED IF LIQUID REFRIGERANT IS PRESENT IN THE COMPRESSOR SHELL.

Ohmmeters

Identifying Terminals of a Single-Phase Motor



HIGHEST RESISTANCE WILL BE START (S) TO RUN (R) TERMINALS

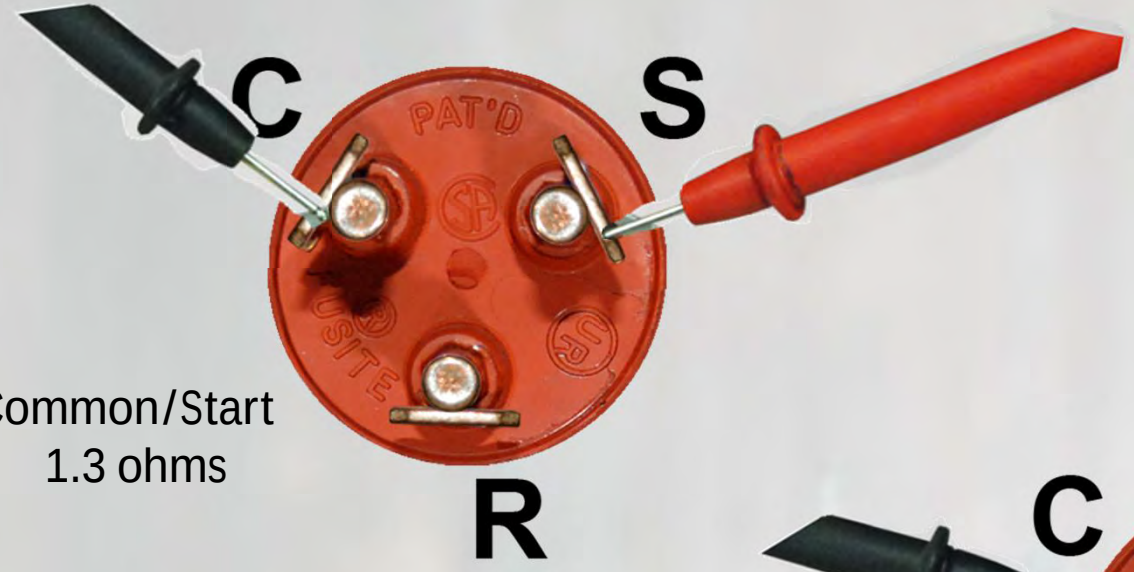
THE 3rd TERMINAL IS COMMON (C)

COMMON TO START WILL BE THE NEXT HIGHEST READING

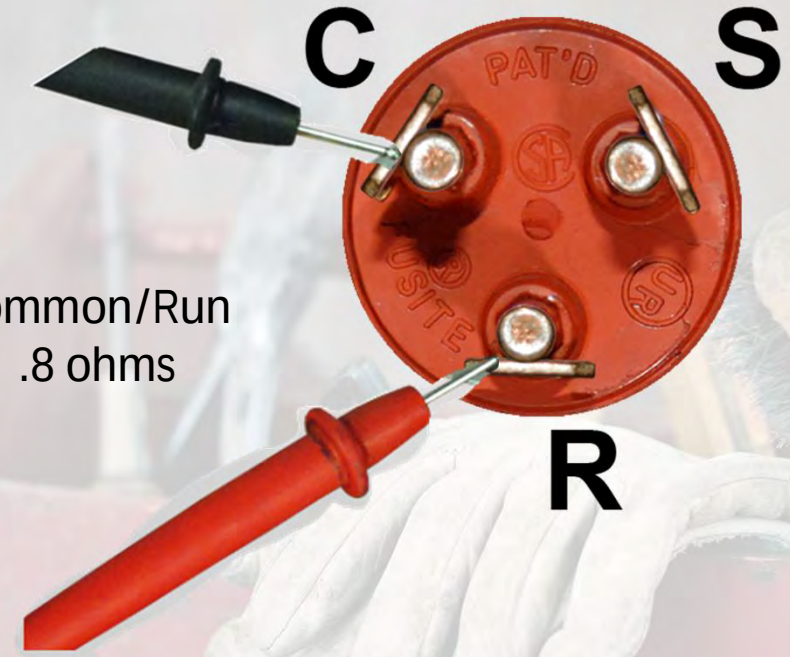
COMMON TO RUN WILL BE THE LOWEST RESISTANCE

SINGLE PHASE COMPRESSOR TESTING

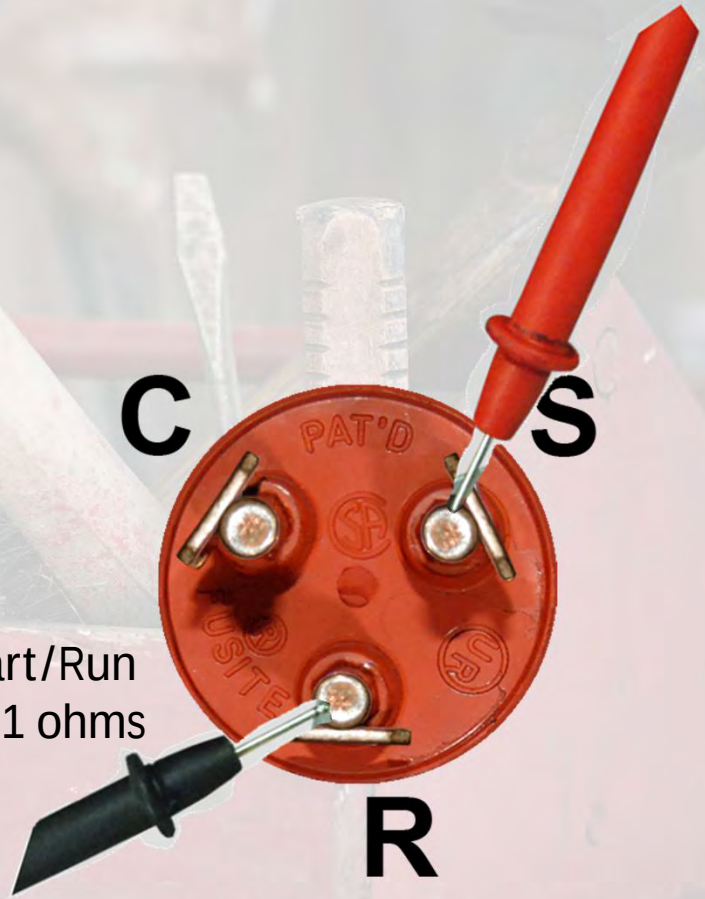
Common/Start + Common/Run = Start/Run



Common/Start
1.3 ohms



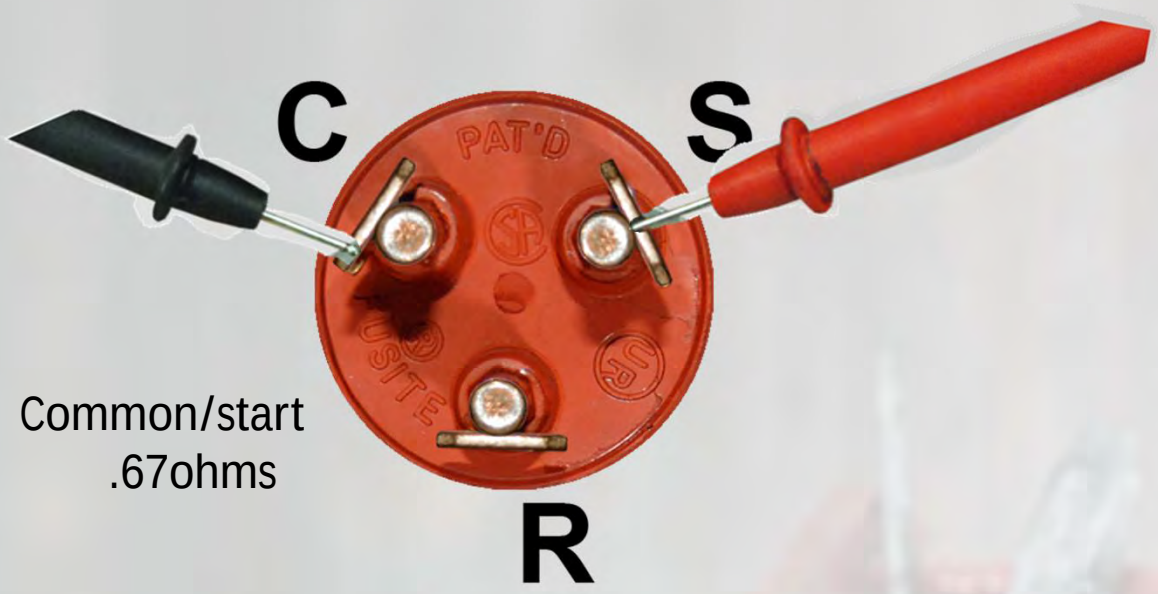
Common/Run
.8 ohms



Start/Run
2.1 ohms

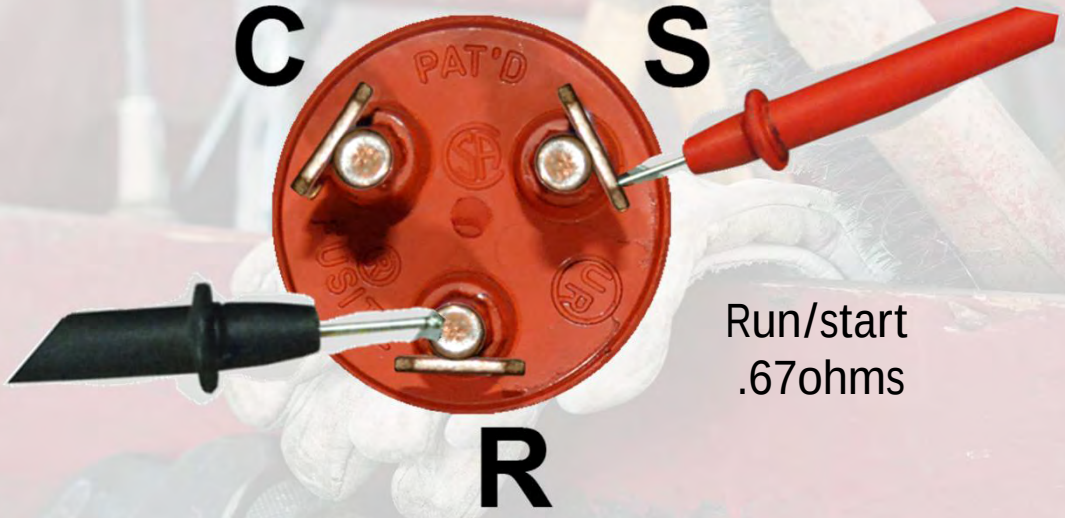
3 PHASE/ Inverter driven compressor testing

All windings have equal values



Common/start
.67ohms

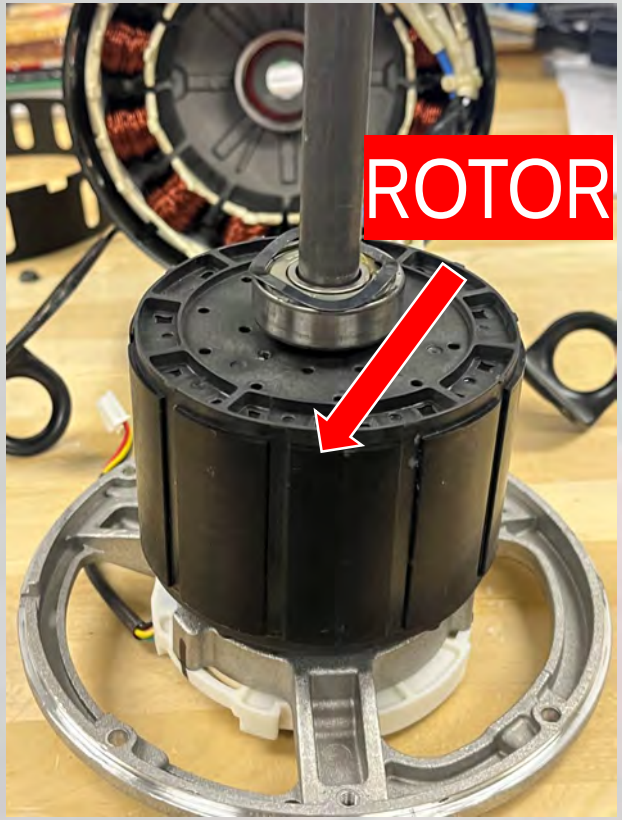
Common/run
.67ohms

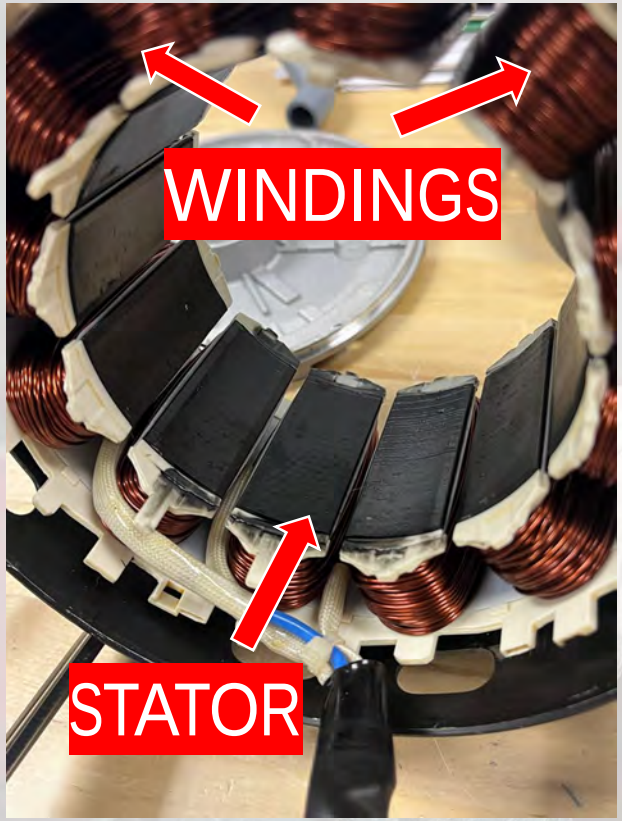


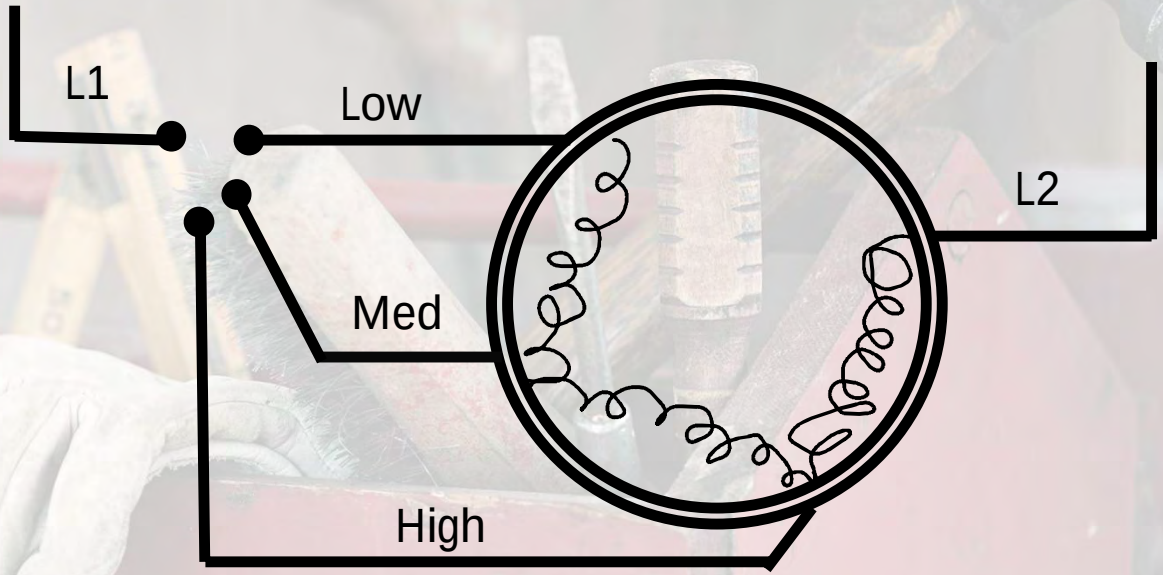
Run/start
.67ohms

How a motor works

A magnet(rotor) attached to the end of a rotating shaft is positioned inside a stationary conducting ring(stator) that is wrapped with a long, continuous piece of wire(windings). When electricity is passed through the wire, the wire induces a small electric current in each section it passes. Thus, creating a magnetic force that spins the magnet. The more coils that have electricity passing through them the slower the motor goes.







Motor resistance to determine speed

Place one lead on common wire(white) and with other lead ohm out other wires from motor

Less resistance, faster you go

ECM motor facts (Electronically commutated motor)

- Has constant 120vac whenever furnace is powered up
- The 120vac is rectified into Vdc then the frequency of pulses determines the speed of the motor
- Speed and torque setting of the motor are set with dipswitches on control board

ECM Variable speed constant airflow

Infinity® Control

- **Variable-Speed Constant Airflow (VCA) ECM**
- Fully Communicating
  - Maximum performance when paired with an Infinity® AC/HP, wall control and zoning
- Variable-speed communicating motor maintains constant airflow
  - Airflow selection through wall control or dipswitches
- Constant airflow, even as ESP increases
  - Control board communicates to and from motor to maintain constant CFM

VCA ECM
Motor

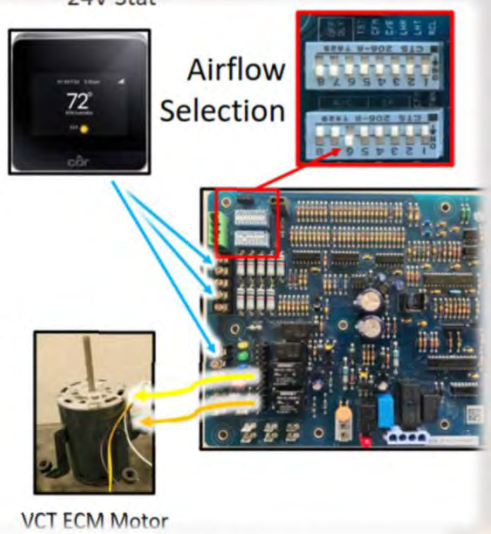
Confirm 120 vac to motor

Disconnect PL3 from board (or PL13 from motor)
PL3-1 ,PL3-2 (red+,green-) 12vdc supply
PL3-3,PL3-2 (yellow,green) stable 5vdc signal input
PL3-4,PL3-2 (blue,green) near 0vdc w/ slight fluctuation

ECM Variable speed constant torque

Variable-Speed Constant Torque (VCT) ECM

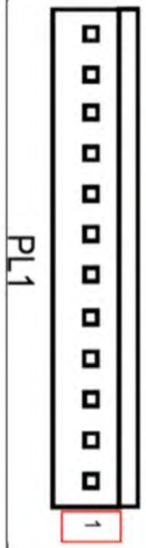
- One-way communication
- Speed selections via DIP switches
- Control board communicates torque to motor based on DIP switches
- Airflow reduced as ESP increases (constant torque)



Variable Speed ECM Motor Connections

- Two electrical connections on an ECM motor
- Line (or High) Voltage
  - Supplies power through the rectifier to the stator windings
- PWM signal
  - Supplies a 0-to-15 VDC signal to the control module of the motor
    - Yellow lead is torque command
    - Brown lead is 15 VDC for signal supply
  - Allows the furnace control to run the motor at any torque setting within the motor range

PL1 Low Voltage Main Harness Connector



Pin #	Function		Voltage
PL1-12	Input to High-Heat Pressure Switch		24 VAC
PL1-11	15 VDC. (PWM driven Blower Motor)		15 VDC
PL1-10	Output to Main Gas Valve		24 VAC
PL1-9	Motor Torque Control Signal. (PWM driven Blower Motor)	Off-No call present	12 VDC
		Component Self-Test	6 to 8 VDC
PL1-8	Output from Limit Switch		24 VAC
PL1-7	No connection		0
PL1-6	24 VAC to Limit Switch Circuit		24 VAC
PL1-5	Ground		0
PL1-4	Output from Low-Heat Pressure Switch		24 VAC
PL1-3	Output from High-Heat Pressure Switch		24 VAC
PL1-2	Input to Low-Heat Pressure Switch		24 VAC
PL1-1	Flame proving input		115 VAC

Voltages shown are referenced to ground except PL1-11 & PL1-9. PL1-11 & PL1-9 are referenced to COM
Location of Pin 1 (noted in red box) is printed on the circuit board.

PL16 yellow lead to com
standby 10-12vdc(approx.)
operating 6-8vdc

PL16 brown lead to com
constant 15vdc

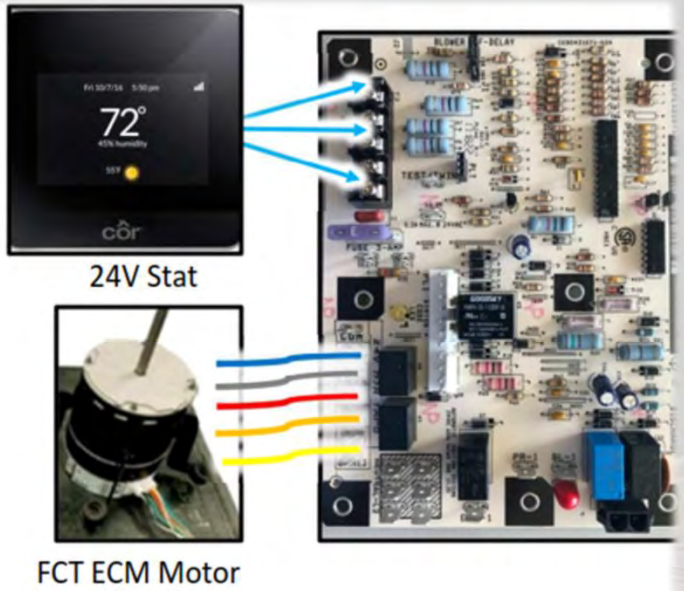
Motor Control Voltages During Component Self Test

1. Remove blower door.
2. Remove the wire from the thermostat "R" terminal from the control board or disconnect the communication connector from the control board.
3. Turn Setup Switch, SW1-6 (TST) "ON."
4. Manually close blower door switch.

Function during Component Self Test after SW1-6 turned "ON"	Start Time	End Time	Voltage	
	0 Sec	0 Sec	Yellow wire of PL16 to Com	Brown wire of PL16 to Com
Inducer starts in high speed and stays running	0 Sec	10 Sec	10 to 12 VDC	15 VDC
Hot surface igniter turns on	10 Sec	25 Sec	10 to 12 VDC	15 VDC
Blower motor turns on at 50% PWM	25 Sec	40 Sec	6 to 8 VDC	15 VDC
Inducer shifts to low speed	40 Sec	50 Sec	10 to 12 VDC	15 VDC
Inducer turns off	50 Sec	50 Sec	10 to 12 VDC	15 VDC

ECM Fixed speed constant torque

- **Fixed-Speed Constant Torque (FCT) ECM**
- Non-communicating
- Speeds programmed into motor
- Low voltage from control board to motor
- Airflow reduced as ESP increases (constant torque)



Speed depends on terminal energized

DLS
Indoor fan motor

If fan motor rotation is not detected it could be due to either mechanical or electrical failure.

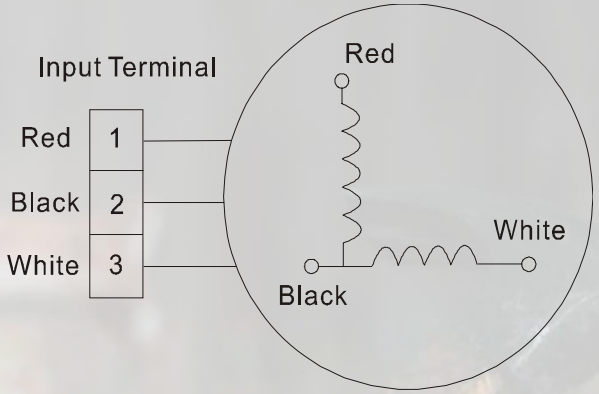
- Check that the motor is free to rotate and not seized.
- Check that the motor is electrically sound, windings not open or shorted
- Check power output from PCB to fan motor

Brushless DC Motor

DLS

Indoor fan motor

Indoor fan motor problem (AC motor)



Measure the resistance value of each winding by using the multi-meter.

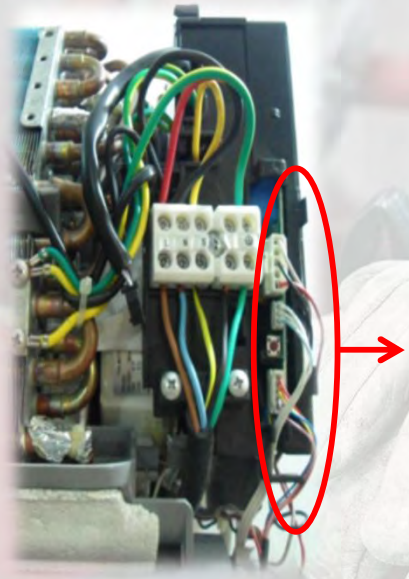
Position	Resistance Value		
	YKFG-20-4-5-11	YKFG-28-4-3-7	YKFG-45-4-22
Black - Red	400Ω±8% (20℃)	414Ω±8% (20℃)	172Ω±8% (20℃)
White - Black	383Ω±8% (20℃)	231Ω±8% (20℃)	138Ω±8% (20℃)

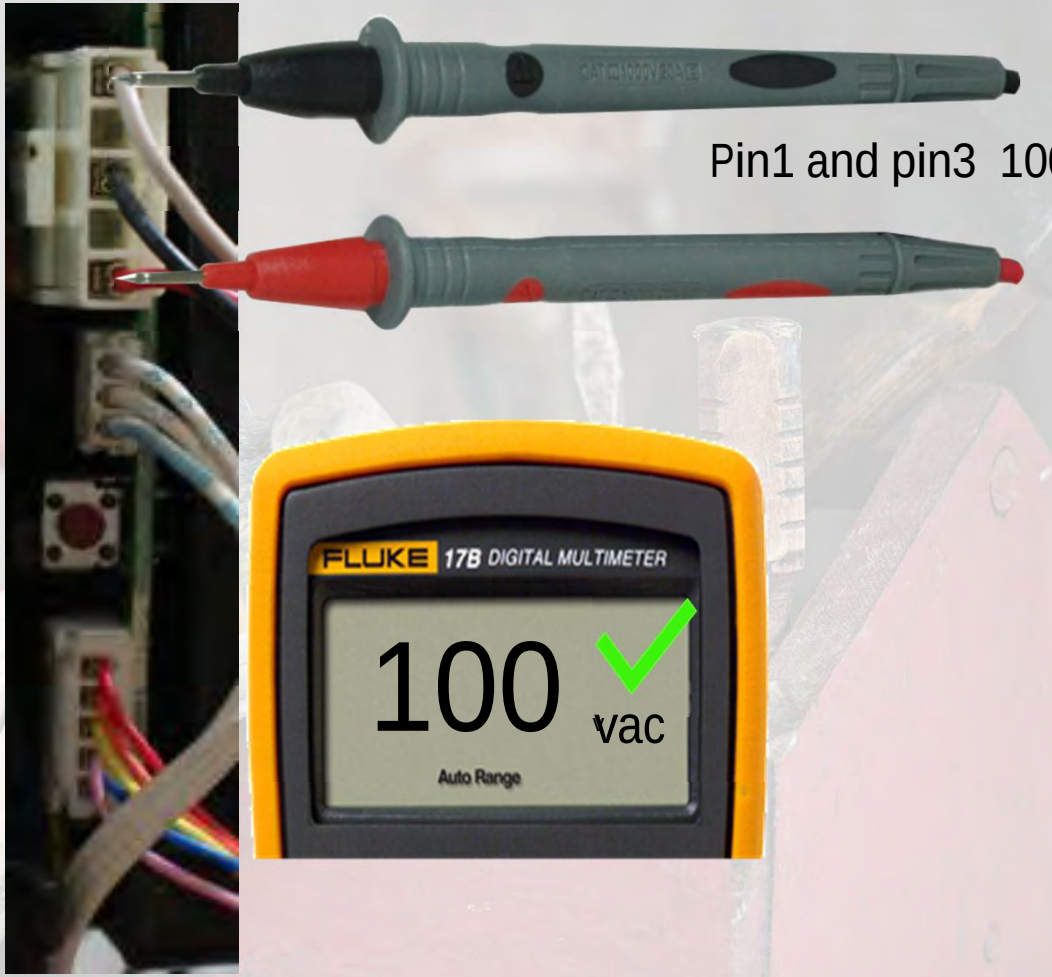
Check equipment literature for additional model #s not listed

DLS Indoor fan motor(AC)

Indoor PCB problem

Power on and set the unit running in fan mode at high fan speed. After running for 15 seconds, measure the voltage of pin1 and pin3 (Red-White). If the value of the voltage is less than 100V (208~240V power supply) or 50V (115V power supply), the PCB must have problems and need to be replaced.



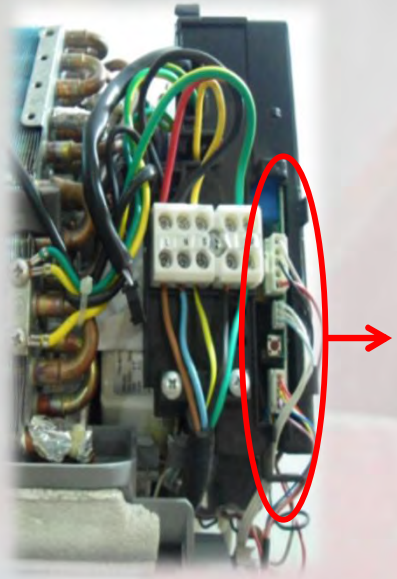


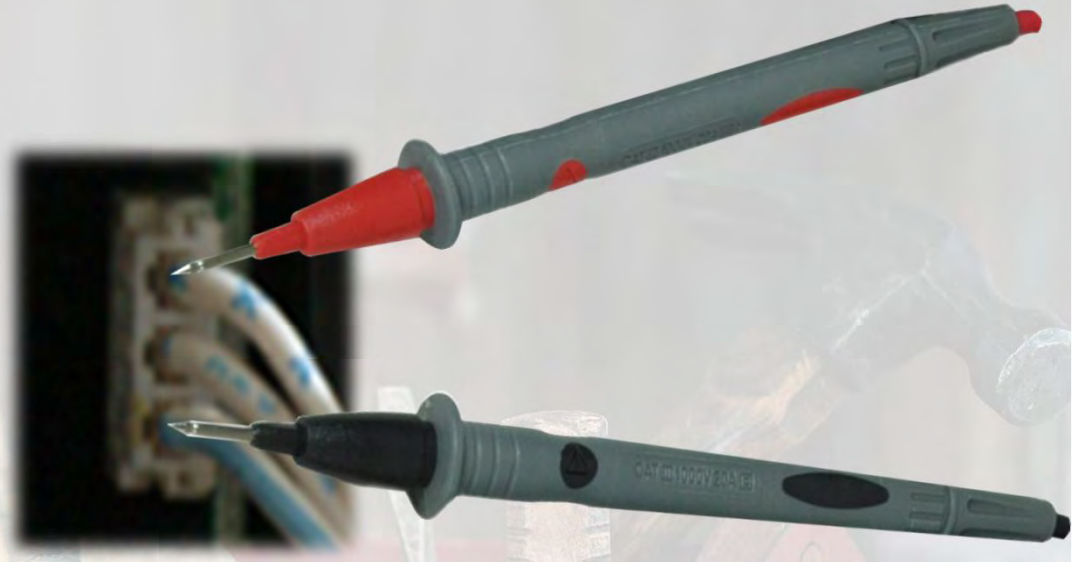
Pin1 and pin3 100V+

DLS

Indoor fan motor(ECM)

Pin1 and pin3 15vdc signal input to motor





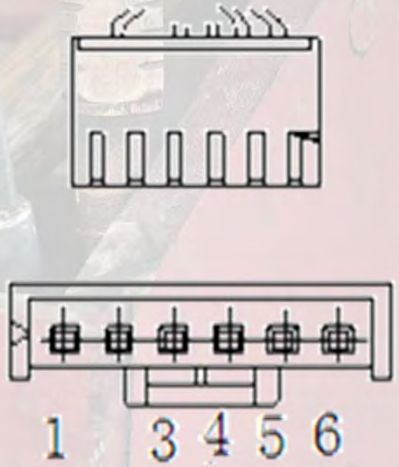
DLS

Indoor fan motor

Fan motor problem (DC motor that control chip inside the motor)

With power on and when the unit is in standby, measure the voltage of pin1-pin3, pin4-pin3 of fan motor connector. If the value of the voltage is not in the range showing in below table, the PCB must have problems and needs to be replaced.

NO.	Color	Signal	Voltage
1	Red	Vs/Vm	280V~380V
2	---	---	---
3	Black	GND	0V
4	White	Vcc	14-17.5V



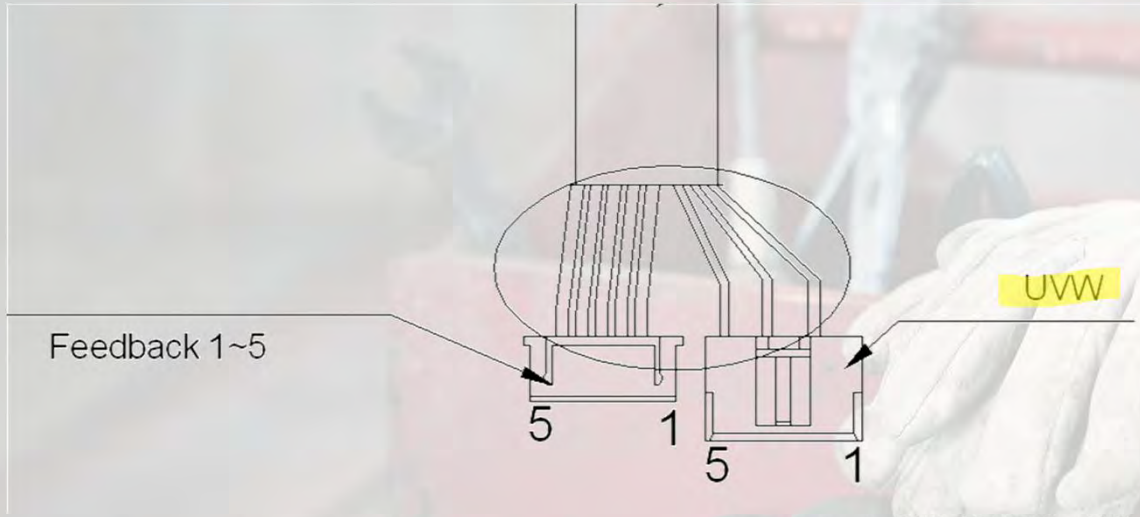
DC motor voltage input and output:

DLS

Outdoor fan motor

Outdoor fan motor problem (DC motor that control chip on the PCB)

Release the U V W connector. Measure the resistance of U-V, U-W, V-W. If the resistance is not equal to each other, then the fan motor must have a problem and will need to be replaced



Color	Yellow	Blue	Red
Signal	U	V	W

DLS

Outdoor fan motor

Fan Motor Resistance Check

Blue to Yellow

Blue to Red

Yellow to Red

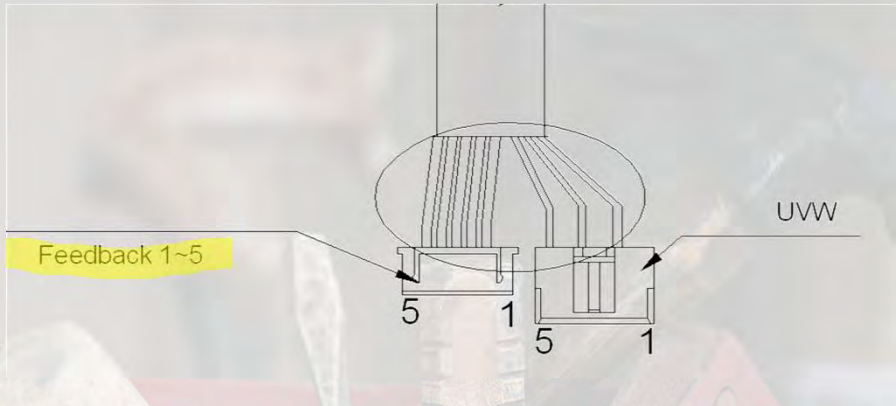
DLS

Outdoor fan motor

Outdoor fan motor problem (DC motor that control chip on the PCB)

1) Power on and the unit is in standby, measure the voltage of pin4-5 in feedback signal connector. If the value is not 5vdc, change the PCB. (Signal from board)

1) Rotate the fan by hand, measure the voltage of pin1-5, pin 2-5 and pin 3-5 in feedback signal connector. If any voltage is not positive voltage fluctuation, the fan motor has problems and need to be replaced. (Feedback signal from motor)



NO.	1	2	3	4	5
Color	Orange	Grey	White	Pink	Black
Signal	Hu	Hv	Hw	Vcc	GND

Reactor testing

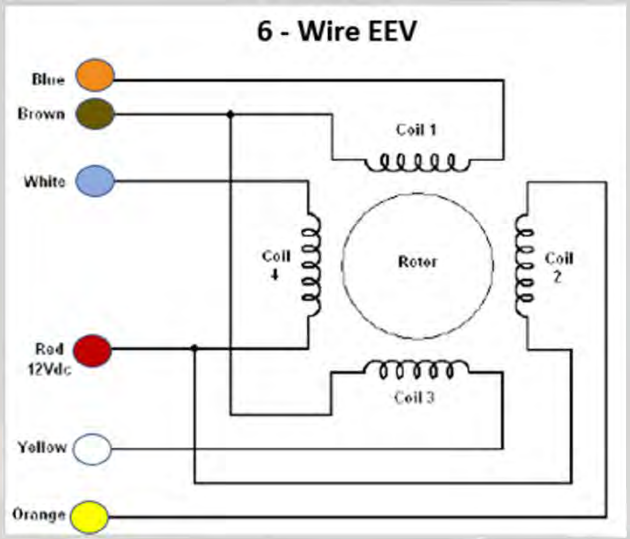
As reactor charges/resistance should go down to 0-1ohms

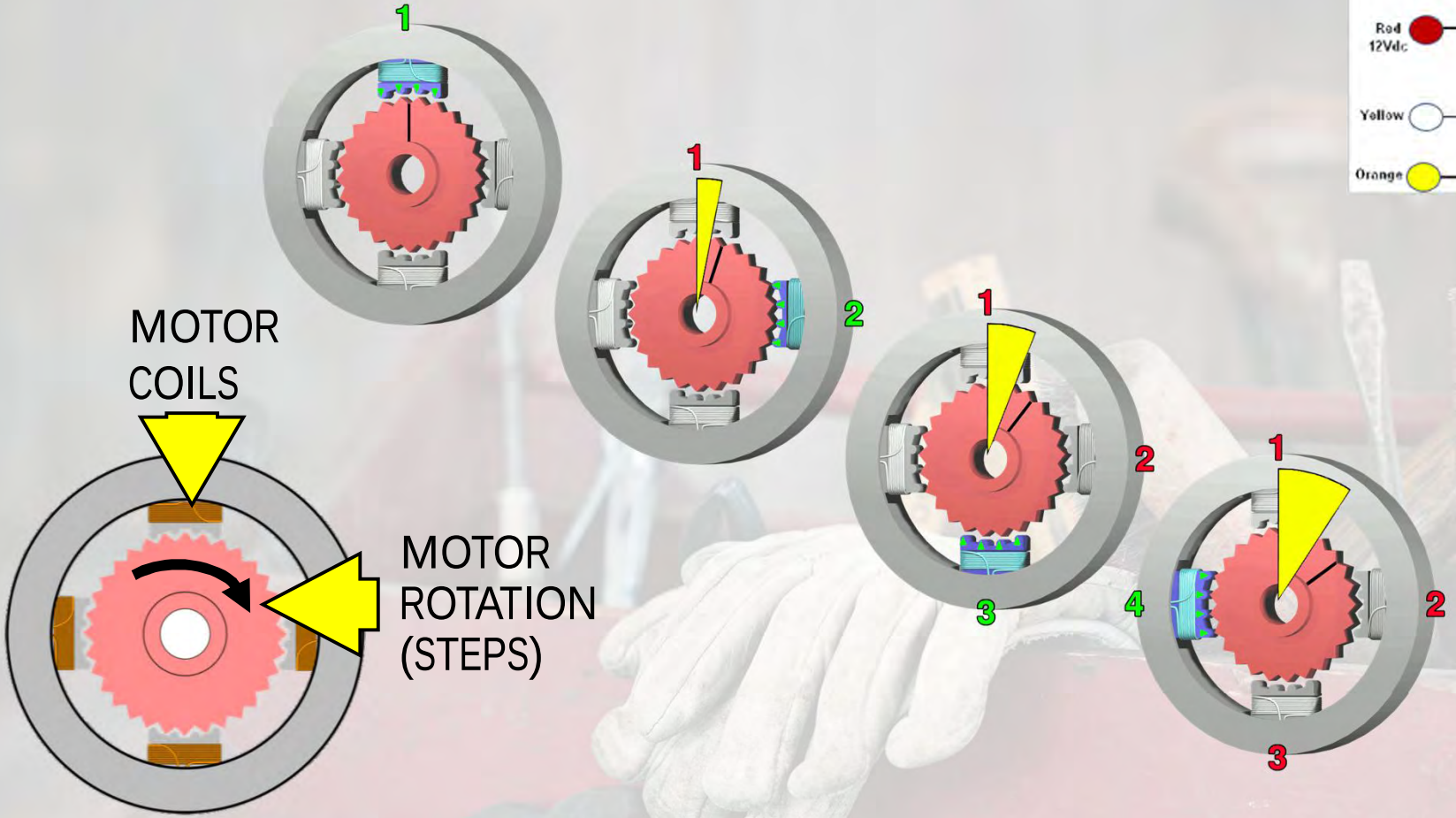
When powered 310vdc(standby)
280vdc(compressor operating)

Can I tell if an EEV has a restriction based on a temperature drop?

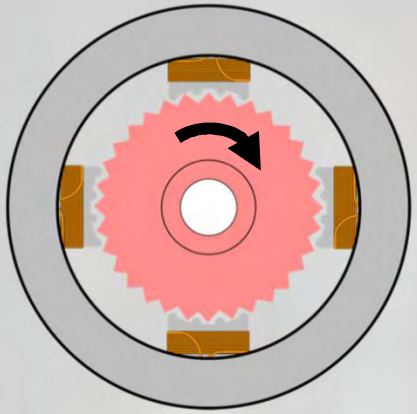
EEV

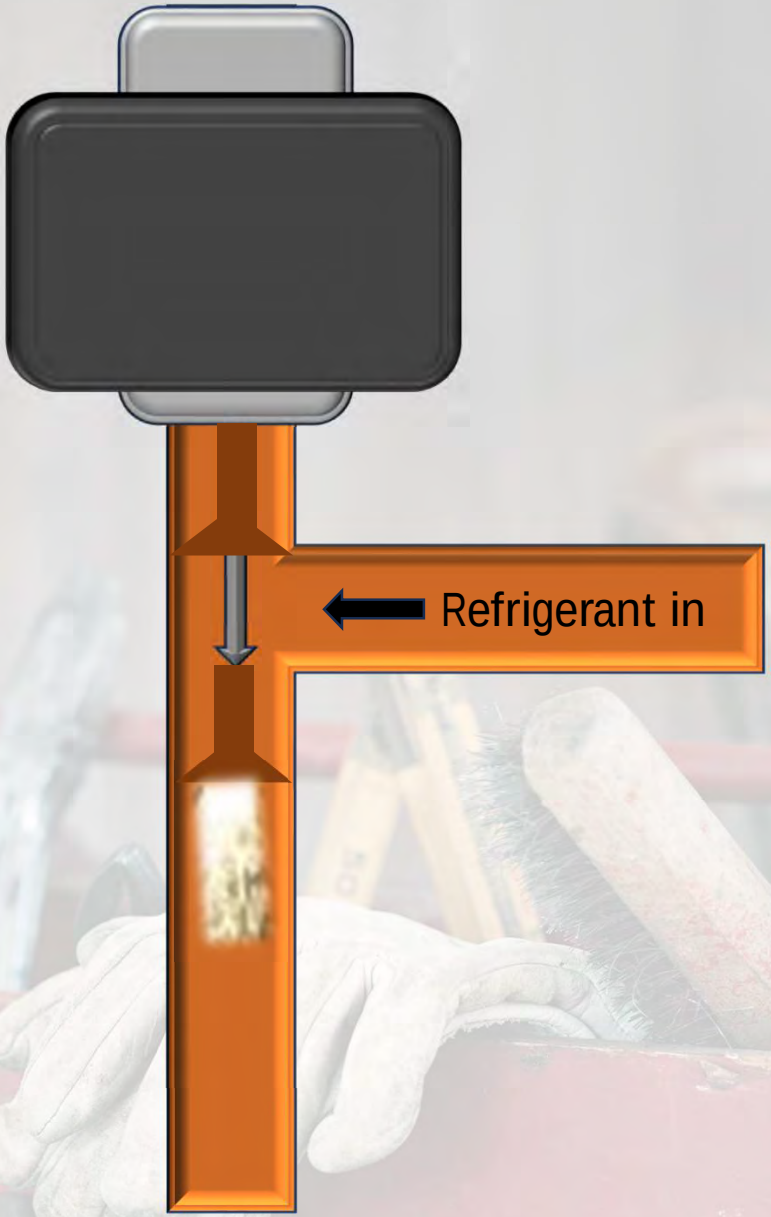
AS EACH SEQUENTIAL COIL
IS ENERGIZED, MOTOR ROTATES
OR “STEPS” IN INCREMENTS



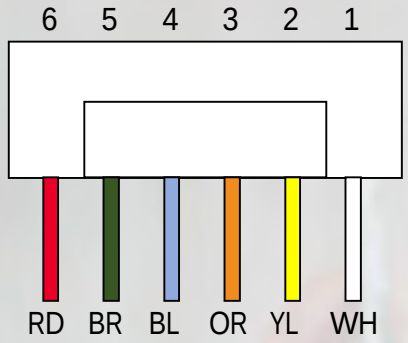


EEV





EEV



Measurement Pin	Normal Standard
6-4	50Ω
6-2	50Ω
5-3	50Ω
5-1	50Ω

Measurement Pin	Normal Standard
3-1	100Ω
2-4	100Ω
6-5	OL

DLS Communication simplified E1(EL01)

Communication failure between indoor and outdoor units

Common Causes:

- Wiring- (Communication doesn’t like to be interrupted by wire nuts or splices)
- Faulty Indoor PCB
- Faulty Outdoor PCB

DLS Communication simplified

Current Loop Communication

E1(EL01)-Communication failure between indoor and outdoor

Communication is measured between L2/S(1/2/3) -Red lead on L2 and Black lead on S terminal

Reading should pulse between positive and negative value (placing meter in manual range 100vdc scale is preferred)

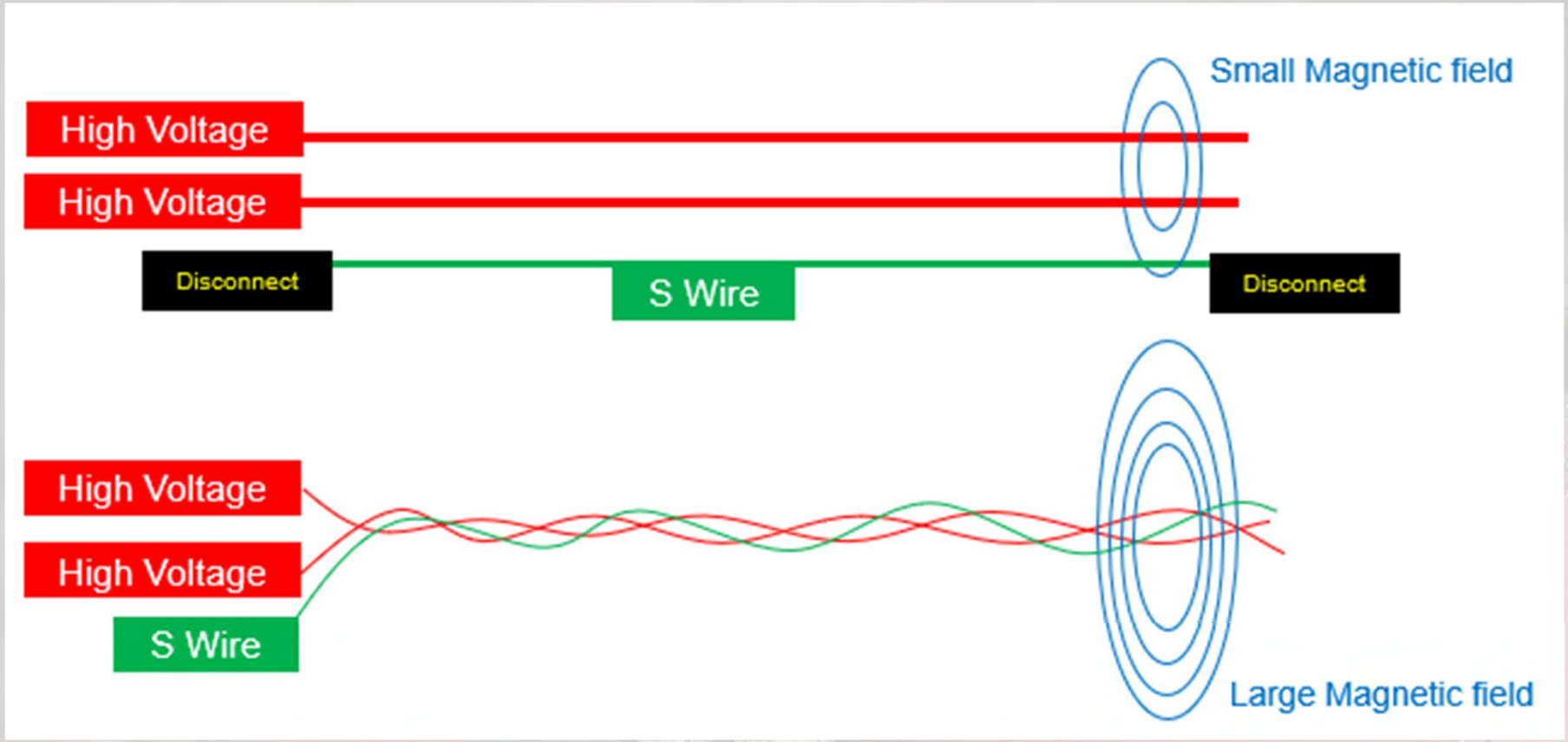
- If voltage remains positive, indicates a bad outdoor PCB and the PCB will need replaced
- If voltage does not pulse, and close to zero, indicates a bad indoor PCB or comm cable

If voltage does not pulse and is not close to zero, check for induced voltage

- Remove S wire from indoor and outdoor units and check for voltage between S and ground
  - If voltage is detected, run dedicated L2/S wires

Induced voltage

- Remove S wire from indoor and outdoor units and check for any voltage between S and ground
  - If voltage is detected, run dedicated L2/S wires



DLS Communication simplified RS-485 Communication Protocol

E1(EL01)-Communication failure between indoor and outdoor

- Disconnect S1/S2 from indoor and/or outdoor
- Check DC voltage between S1/S2
  - Normal range should fluctuate between .4vdc-3vdc
  - If voltage is lower than .2vdc on either side this indicates source of fault

Communication simplified

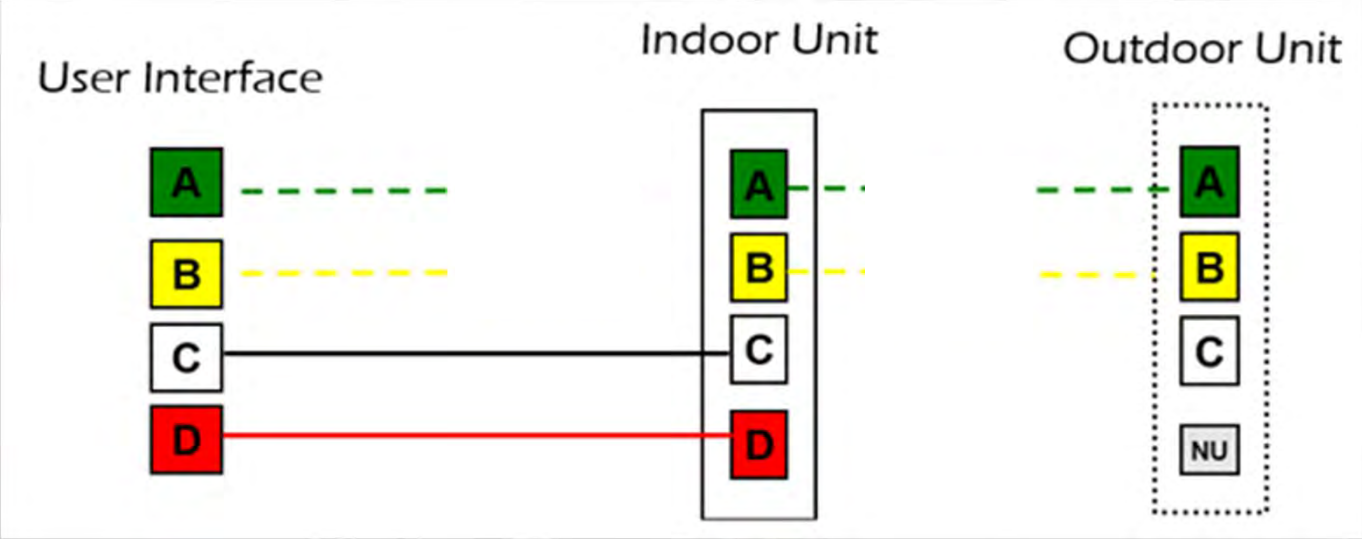
Infinity Communication (RS-485)

Fault codes 170-182

Facts:

- Each device has a comm driver
- Output voltage will fluctuate when connected to system
- Output voltage of comm driver will be steady when isolated

Isolate



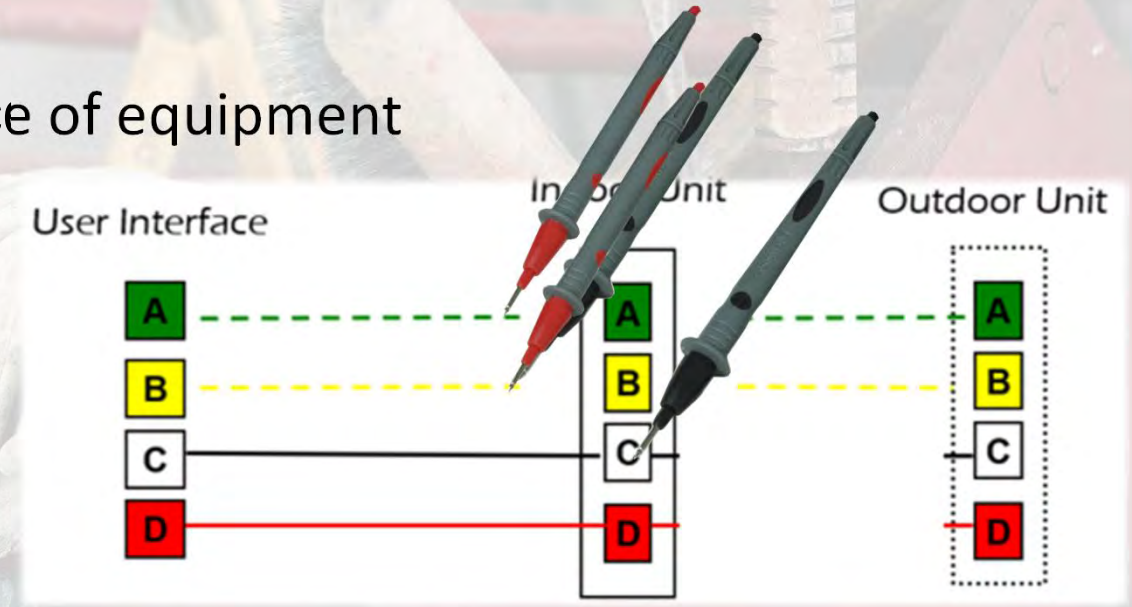
Communication simplified

Infinity Communication (RS-485)

Voltages of Comm driver when ISOLATED

Vdc between A&B 2-4vdc
Vdc between A&C 2-4vdc(may be slightly higher value than A&B)
Vdc between B&C Less than 1vdc

Look for same values at each piece of equipment



Questions

Comments