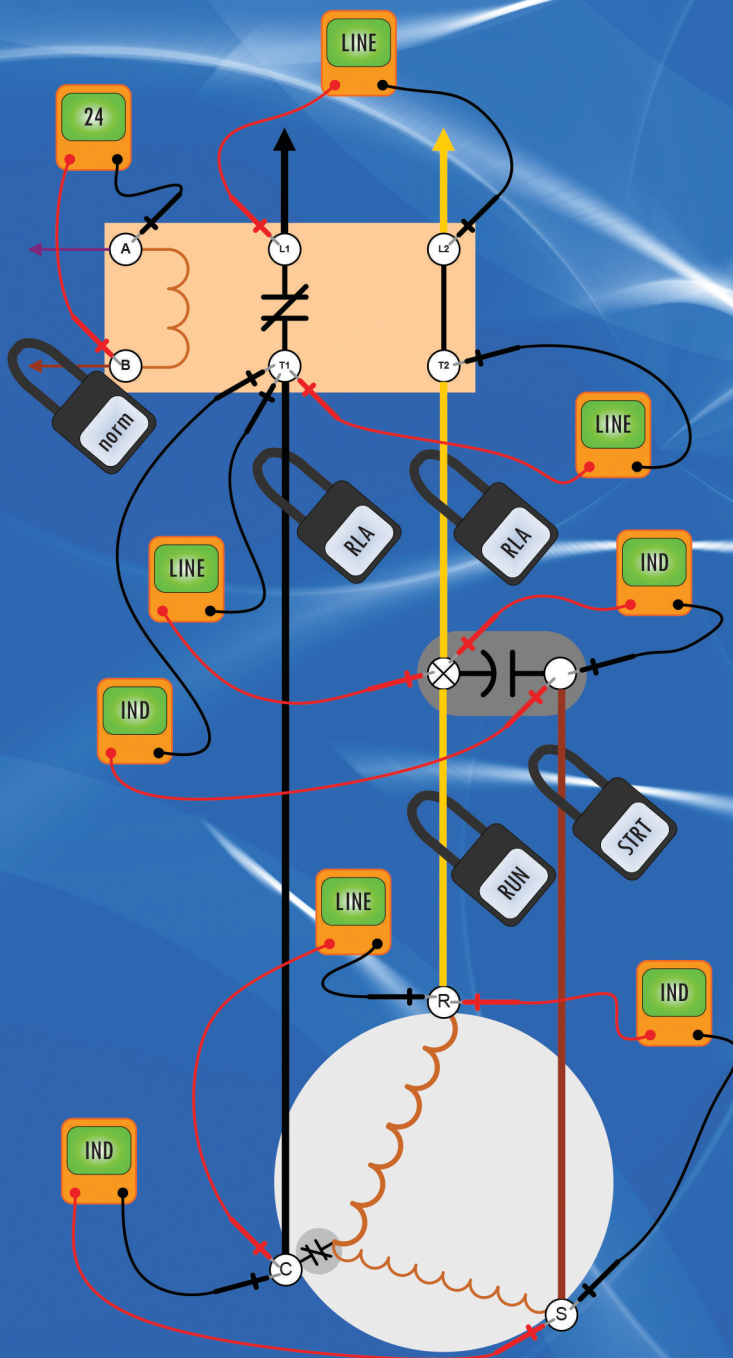
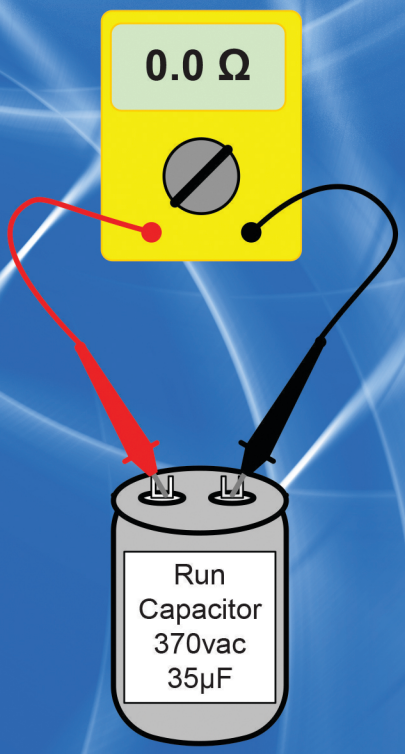
ProficienTECH
UNITARY PRODUCTS TRAINING SYSTEM

BASIC TROUBLESHOOTING TECHNICAL TRAINING







FAN-1517

Johnson Controls

Johnson Controls Unitary Products
Basic Troubleshooting
Technical Training

This manual presents information and guidelines for proper installation, adjustment, operation, and maintenance of Johnson Controls Unitary Products equipment. Read the Installation Manual, Tech Guide, and all available product information before attempting assembly, installation, start up, adjustment, or operation of any system. This information is NOT for homeowners or do-it-yourself projects. It is intended for HVAC service and installation technicians that have the proper industry training, as well as safety and operations training regarding electrical and gas systems. This manual is intended as a general guide, and may not reflect exactly the current designs, or all of the options available to our customers. Please contact your local technical support representative regarding specific details of a particular unit model, configuration, or installation. Every effort was made to ensure the accuracy of the information in this manual. The information and specifications contained in this manual are subject to change without notice. Johnson Controls Unitary Products reserves the right to change such specifications at any time without incurring obligation.

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Chapter 1 - Introduction

As with other HVAC equipment, detection of mechanical and electrical faults follows troubleshooting procedures that provide the technician with information to both recognize symptoms and properly identify the “root-cause” source of the fault.

Before power is disconnected to the unit, during inspection or troubleshooting, the UCB and ignition control should be checked for active flash code or alarm indicators.

Prior to beginning troubleshooting, a general inspection of the unit should be made to assess and correct any maintenance-related items such as:

- Dirty filters should be replaced
- Fouled indoor and outdoor coils should be cleaned
- Obvious refrigerant leaks should be repaired
- Blockages in condensate drainage should be cleared
- The heat compartment should be inspected
- Worn items on the belt-drive indoor blower should be corrected
- Outdoor fans should turn freely

Correction of maintenance-related items is often the solution for many trouble calls, and is needed before in-depth troubleshooting can proceed.

When beginning troubleshooting, do not assume that the direction of rotation for the indoor blower and scroll compressors is correct. Reverse rotation of the indoor blower is indicated by inadequate indoor airflow or low current draw of the motor, and can be visually confirmed as the blower wheel coasts down after power disconnection. Reverse rotation of a scroll compressor is indicated by little or no difference in suction and discharge pressures, low current draw of the motor, and noisy operation (experienced technicians may recognize the distinct noise).

On initial startup, the reverse rotation is corrected by swapping two incoming power leads to the unit. If reverse rotation of the 3Ø components in the unit occurs at a point after proper rotation is established during initial startup, then the power supply should be examined for reverse phasing issues. The immediate correction for reverse phasing of the power supply, is to swap two incoming power leads to the unit. The addition of a phase monitor to the unit is the long-term solution to prevent unit damage due to reverse phasing of an unreliable power supply. If only a single 3Ø component is found to have reverse rotation, it is likely that the previous servicer’s practices are at fault, and two power leads must be swapped to the component.

Measurement of indoor airflow volume should be the initial information that the technician gathers for troubleshooting of HVAC systems. Indoor airflow volume is often overlooked as a factor in unit performance issues and faults.

Indoor airflow volume can be easily measured by:

- Removing the plastic plugs from the pressure drop taps located on the rear of the unit
- Using an incline manometer, Magnehelic gauge or digital manometer to measure the pressure difference at the taps
- Referencing the dry-coil pressure drop tables in the Installation Manual. The technician should read 400±50 CFM per ton of cooling capacity on 100% return air applications



While unit performance is rated at indoor airflows as low as 300 CFM/ton or as high as 500 CFM/ton, operation at these extremes tends to be unforgiving of minor system deficiencies and produces troubleshooting readings that approach normal. The recommendation in this manual of 400±50 CFM per ton of cooling capacity on 100% return air applications is intended for best stability of unit operation and reliability of troubleshooting readings.

While dry-coil evaporator pressure drop is a convenient way to measure indoor airflow volume, it can be of benefit to supplement or verify the reading with other methods:

- **External static pressure**: Measured and used with blower performance data from the unit literature to find indoor airflow volume. For this method to be accurate, the unit must be clean and an account of blower wheel speed, unit options and accessories be made.
- **Heating temperature rise**: With confirmed gas or electric heat output capacity, this method can be used with the sensible heat formula to calculate airflow volume. In cases where dirt is fouling the coil, causing the evaporator pressure drop to be elevated, the temperature rise calculation will show less airflow volume than the evaporator pressure drop indicates.
    - Sensible heat formula: (valid for altitudes below 4000 feet)
        - CFM = Heating output BTUs ÷ (Temperature Rise x 1.08)
            - 80% AFUE gas heat heating output BTUs = Measured input BTUs x 0.8
            - 3-phase electric heat Heating Output BTUs = Voltage at elements x single-leg amperage draw of elements x 5.91
- **Cooling mode leaving air temperature chart**: Instead of a direct measurement of airflow volume, the information in the cooling mode leaving air temperature chart shows a ratio of 400 CFM per ton of cooling capacity produced. In cases where 400 CFM/ton is indicated by the evaporator pressure drop, but dirt is fouling the coil, supply air temperatures will be below the figures in the chart. In cases where 400 CFM/ton is established by the evaporator pressure drop but cooling capacity is reduced, supply air temperatures will be above the figures in the chart.
  The cooling mode leaving air temperature chart can also help confirm the range of indoor airflow. If the supply air temperatures are 3°F below the figures in the chart, the airflow is approximately 350 CFM/ton. If supply air temperatures are 3°F above the figures in the chart, the airflow is approximately 450 CFM/ton.
- **Air outlet measurement**: Air outlet measurements are taken using a balometer or other device to find indoor airflow volume. Duct leakage problems should be investigated in cases where the air volume of outlet measurements is lower than that measured through the unit by evaporator pressure drop, temperature rise or external static methods.

Proper indoor airflow volume is essential to troubleshooting both electrical and mechanical faults. Refrigerant circuit performance readings, such as superheat and subcooling, should only be considered valid if indoor airflow is in the correct range.

Chapter 2 - Safety

This manual must be used in conjunction with and Does Not Supersede the Installation Manual and the Tech Guide provided with the equipment. Always read and follow all instructions before installing equipment. Understand and pay particular attention to the signal words DANGER, WARNING, and CAUTION.

⚠DANGER

An overpressure protection device, such as a pressure regulator, must be installed in the gas piping system upstream of the furnace and must act to limit the downstream pressure to the gas valve so it does not exceed 0.5 PSI (14" w.c. (3.48 kPa). Pressures exceeding 0.5 PSI (14" w.c. (3.48 kPa) at the gas valve will cause damage to the gas valve, resulting in a fire or explosion or cause damage to the furnace or some of its components that will result in property damage and loss of life.

Figure 2-1 - Danger label

Danger - indicates an imminently hazardous situation, which, if not avoided, will result in death or serious injury.

⚠WARNING

Before performing service or maintenance operations on unit, turn off main power switch to unit. Electrical shock could cause personal injury. Improper installation, adjustment, alteration, service or maintenance can cause injury or property damage. Refer to this manual. For assistance or additional information consult a qualified installer, service agency or the gas supplier.

Figure 2-2 - Warning label

Warning - indicates a potentially hazardous situation, which, if not avoided, could result in death or serious injury.

⚠ CAUTION

This system uses R-410A Refrigerant which operates at higher pressures than R-22. No other refrigerant may be used in this system. Gauge sets, hoses, refrigerant containers and recovery systems must be designed to handle R-410A. If you are unsure, consult the equipment manufacturer.

Figure 2-3 - Caution label

Caution - indicates a potentially hazardous situation, which, if not avoided, may result in minor or moderate injury. It is also used to alert against unsafe practices and hazards involving only property damage.

Safety Alert Symbol



When this symbol is identified within this manual, the technician should be alert to the potential for personal injury.

Figure 2-4 - Safety Alert Symbol

Specific Safety Rules

Follow these specific safety rules for a safe application:

- Air conditioning systems utilizing gas heating can only use natural gas or propane (LP) gases as an approved fuel. LP applications require installation of the appropriate LP conversion kit. Refer to the unit rating plate or Installation Manual for information on proper inlet and manifold pressures
- Install air conditioning systems only in locations and positions as specified in the Installation Manual
- Provide adequate clearances for service, combustion and ventilation air to the unit. The recommended clearances are specified in the Installation Manual
- Test for gas leaks as specified in the Installation Manual
- Only connect the equipment to a duct system which has an external static pressure within the allowable range as specified in the Installation Manual
- These units are not to be used for temporary heating or cooling of buildings or structures under construction. Improper installation will shorten equipment life, reduce product efficiency, and void the warranty
- Always install the system to operate within the equipment's intended temperature and operating ranges
- The size of the unit should be based on an acceptable and approved heat load calculation for the structure being conditioned

Safety Requirements

Follow these safety requirements for a safe application:

- All equipment should be installed in accordance with all national and local building/ safety codes and requirements, local plumbing or waste water codes, and other applicable codes. In the absence of local codes, install in accordance with the most recent National Electrical Code, National Fuel Gas Code, and/or Natural Gas and Propane Installation Code (latest editions)
- Only approved heat accessories shall be installed on these air conditioning units
- Refer to the unit rating plate for the equipment model number, and refer to the Installation Manual for proper air plenum dimensions
- Provide clearances from combustible materials as listed under Clearances to Combustibles in the Installation Manual and the equipment rating plate.
- Provide clearances for servicing
- Failure to carefully read and follow all instructions in this manual and the equipment Installation Manual can result in equipment malfunction, death, personal injury and/or property damage
- Check the rating plate and power supply to be sure that the electrical characteristics match. All commercial units use nominal 208/230 volts AC or nominal 460 volts AC, 3 Phase, 60-Hertz power supply. DO NOT CONNECT THIS APPLIANCE TO A 50 HZ POWER SUPPLY OR A VOLTAGE OTHER THAN THE RANGE SPECIFIED ON THE UNIT DATA TAG
- The equipment shall be installed so the access panels are readily available and the electrical components are protected from water infiltration

- Installing and servicing HVAC equipment can be hazardous due to the electrical and mechanical components. Only trained and qualified personnel should install, repair, or service HVAC equipment. When working on equipment, observe precautions in the manuals and on the labels attached to the unit and other safety precautions that may apply
- The Installation Manual covers minimum requirements needed to conform to existing national standards and safety codes. In some instances, these instructions exceed certain local codes and ordinances. These instructions are required as a minimum for safe installation and operation

General Awareness

Safety is ALWAYS the primary concern for everyone. On the job injuries can be significantly reduced when proper guidelines are followed. Always be aware of all company, local, state and/or OSHA (Occupational Safety and Health Administration) regulations.

Job Site Safety

Keeping the job site clean of trash, extra tools and equipment will significantly reduce the chance for injuries. Since each job is unique and has its own hazards, all new workers to the area should be made aware of the location of fire and first-aid equipment, fire escape routes, and other dangers.

Hazardous Materials

Many different chemicals and compounds are used in the service and installation of HVAC systems. Please read the directions and use caution along with PPDs whenever handling these materials. Read and understand the MSDS (Material Safety Data Sheets) for all materials used.

Confined Spaces

Never enter or work in a confined space without taking the appropriate precautions. Have someone available outside the space ready to assist or summon help if necessary. Even spaces that seem relatively safe can quickly become hazardous if a pipe were to break and fill the space with refrigerant, steam, poisonous fumes or other gases. Welding or brazing in a confined space is especially hazardous.

Pressure

High pressures have always been part of the HVAC profession. With the new refrigerants, such as R-410A, it is even more crucial that technicians realize the dangers of these gases. Wear the proper personal protective devices including safety glasses and gloves. Proper hose ratings and manifolds are required for the new high pressure refrigerants.

Electrical Safety

Jewelry should be removed prior to any electrical work being performed. Ensure that the equipment disconnect switch removes the primary power source prior to taking resistance readings or disconnecting any wires or connections. Removal of system power should be verified with the

voltage function of a multi-meter. All electrical safety guidelines should be followed at all times. Only trained, qualified technicians should perform electrical maintenance, installation, inspections and troubleshooting of electrical equipment.

Electrocution occurs when a current as low as 6 to 200mA flows through the heart, disrupting its normal operation and causing death. Electrical shock is an injury that occurs as a result of exposure to an electrical current. Inspect all extension cords and power tools regularly.

Fuses and circuit breakers are designed to protect equipment, not people. For personal electrical protection, GFCI or Ground Fault Circuit Interrupters are highly recommended.

Lock-Out Tag-Out



Figure 2-5 - Lockout device

OSHA Standards cover the servicing and maintenance of machines and equipment, in which unexpected energizing or start up of the machines or equipment, or release of stored energy, could cause injury to employees.

These standards establish minimum requirements for the control of such hazardous energy. To ensure safety, put a lock that is tagged with the technician's name on the electrical disconnect or breaker of the equipment or circuit which is being serviced.

Be aware of others who may be working on the same circuit or other circuits served by the same electrical panel. The technician should also be aware that other technicians may not have used the proper Lock-Out, Tag-Out procedures.

Fire Safety and Burns

While brazing, keep the area clear of combustible material or use a heat shield to help reduce risk of fire.

Check equipment regularly and never try to modify or repair regulators.

When servicing the refrigeration circuit, improper use of equipment and tools can result in serious burns that are associated with refrigerants. This may include frostbite, which is a deep tissue injury. Proper personal protection devices must be in use when servicing the refrigeration system.

Personal Safety

Personal safety includes remaining aware of the surroundings at all times, using properly maintained tools, and correct use of items designed for personal protection.

Personal Protection Devices (PPD)

Hard Hat: Hard hats must be worn when there is a danger of head injury.

Safety Glasses: Eye protection should be worn at all times while on a job site.

Gloves: Assist in the prevention of serious injury to the hands from serious cuts as well as injuries from high pressure gases such as refrigerants. Rubber gloves can protect the technician's hands from chemicals when inspected and worn properly.
Safety Shoes: Work shoes with steel toes for foot protection. There are also electrical safety shoes that can aid in protecting the technician against electrical shock and/or electrocution. At a minimum, leather work shoes with rubber soles are required.

Respirator: Used in a confined space where the air can be dissipated by refrigerant which can cause asphyxiation.

Safety Harness: Used when working above grade level. Ladders must be tied down. Ensure that PPDs provide the intended protection. They should be inspected regularly, used properly and never altered or modified in any way.

Clothing

Rotating and moving components pose a serious risk. Loose fitting clothing and ties should not be worn when servicing rotating equipment. If any clothing becomes entangled in moving parts, serious injury or death is a likely result.

Jewelry

Serious injury or death can result if jewelry makes contact with an energized circuit or is caught in moving parts. Leave jewelry at home or in your service bag or service vehicle.

Lifting

To avoid back injuries, always adhere to proper lifting techniques. Be aware of personal limitations and seek help with items that are too heavy to safely lift. A back support belt may provide additional protection.

Chapter 3 - Refrigerant Circuit

This section focuses on cooling operation. Heat pump heating mode and the reheat mode of reheat units are not specifically covered. The principles discussed in this section can be adapted to heat pump reverse-cycle operation in heating mode, and the condenser in the indoor airstream of a reheat unit.

Before beginning refrigerant circuit troubleshooting, assess and correct any maintenance-related items; ensure indoor airflow volume is in the proper range; and confirm that outdoor air, evaporator entering air dry bulb and wet bulb temperatures are within the limitations published for the unit. Valid information for refrigerant circuit troubleshooting can only be obtained if these conditions are correct.

Performance will be impacted if the refrigerant charge of the circuit is a few ounces too low or too high. The pressure taps should be accessed only when necessary, and low-loss gauge hoses used to prevent the refrigerant circuit from being undercharged. High-quality electronic leak detectors, capable of detecting R-410A at leak rates of 1/10 ounce per year, should be used when the refrigerant circuit is leak tested. Recovery, evacuation to 500 microns, and re-charging to the weight listed on the unit data plate is the primary method to ensure the circuit operates with an accurate refrigerant charge. A complete recharge by weight is the only approved method of “charge adjustment” for heat pump units in the heating mode or for cooling units in low ambient conditions.

Subcooling charge verification methods may be used when a complete recharge by weight is not practical, and conditions are within limitations that permit cooling operation.

Both subcooling and superheat measurements are significant to troubleshooting the refrigerant circuit. The range of conditions the unit may normally operate in will result in variations from the subcooling and superheat values listed in the Installation Manual. Abnormal subcooling and superheat values are indicators of deficiencies affecting the refrigerant circuit. Both acceptable and abnormal superheat and subcooling values for troubleshooting circumstances are detailed throughout this section.

Simplicity control boards protect the unit from damage due to major deficiencies affecting the refrigerant circuit. Refrigerant circuit troubleshooting and corrective actions based on the Simplicity board flash code indicators, and fault shutdown history are relatively straightforward since only gross system errors will cause the safety trips that trigger fault indication. The appendix table describes the conditions that initiate flash codes and action for correction.

More subtle deficiencies in the refrigerant circuit may not trip safeties, but are equally important since occupant comfort and the long-term reliability of the unit are adversely affected. Measurements that assess the condition of the refrigerant circuit will be needed for troubleshooting:

- Suction pressure - indicates the evaporator saturation temperature.
- Suction line temperature - used to find the suction superheat.
- Discharge pressure - indicates the condenser saturation temperature.
- Liquid line temperature - used to find the liquid subcooling.
- Compressor current draw - indicates the loading (work) of the compressor.
- Discharge line temperature - indicates extremes of suction superheat (primarily used for heat pumps in the heating mode).

Two significant indicators that are calculated from these measurements:

Suction Superheat

Calculated by subtracting the evaporator saturation temperature from the suction line temperature.

Suction line temperature - Evaporator saturation temperature = Suction superheat

Liquid Subcooling

Calculated by subtracting the liquid line temperature from the condenser saturation temperature.

Condenser saturation temperature - Liquid line temperature = Liquid subcooling

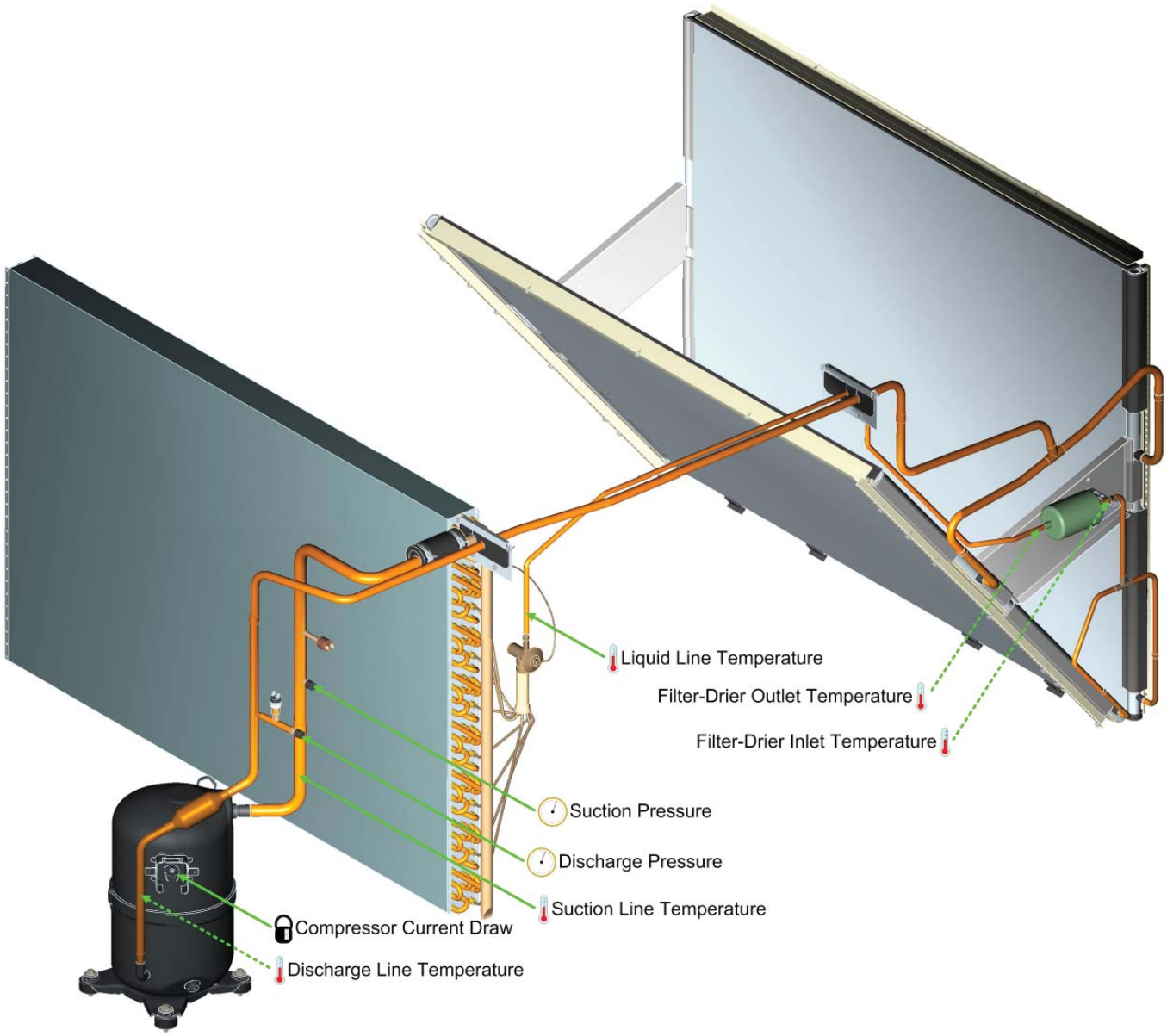


Figure 3-1 - Refrigerant circuit troubleshooting measurements (general locations)

For best accuracy, these readings are taken after 10 minutes of compressor operation. “Normal” values for the above measurements and indicators change with the variations throughout the product line. Also, the dynamics of system operation produce change in the measurements and indicators. These readings should be considered when making a troubleshooting diagnosis.

Normal Measurements

While none of the measurements and indicators stand alone or are firmly fixed, some tendencies, limits and ranges can be expected as follows:

Suction pressure	Along with discharge pressure, this contributes to the loading of the compressor.
Evaporator saturation temperature	Extended operation below 32° F will cause evaporator icing and freezestat trips. Operation above 50° F results in little or no humidity removal.
Suction line temperature	Extended operation above 60° F can cause compressor overheating and motor protector trips.
Discharge pressure	Along with suction pressure, contributes to the loading of the compressor
Liquid line temperature	Should be at or above outdoor temperature. A restriction exists upstream if liquid line temperature is below outdoor temperature.
Compressor current draw	Operation below RLA can be expected for most unit loading conditions. Operation at RLA occurs at maximum unit loading conditions. RLA may be briefly exceeded following startup under high unit loading conditions. Extended operation above RLA will cause compressor overheating and motor protector trips.
Discharge line temperature	If above 250° F damage to the refrigeration oil will occur, and is an indicator of excessive suction superheat. If below 120° F it is an indicator of extremely low suction superheat.
Suction superheat	Typically, ranges from 5° to 15° F on units equipped with TXVs. A superheat of 0° F indicates imminent compressor damage due to liquid slugging. A superheat exceeding 25° F can cause compressor overheating and motor protector trips.
Liquid subcooling	Typically, ranges from 5° to 15° on units equipped with TXVs. A subcooling of 0° F indicates there is not completely liquid entering the metering device.

The rate of refrigerant flow through the circuit influences both suction superheat and liquid line subcooling. Variances in the discharge to suction pressure differential, which varies compressor pumping rates to a degree, and the opening of the metering device are factors that affect the refrigerant flow rate in the circuit. In regard to only refrigerant flow rates, it can be said that increased flow rates result in lower suction superheat and liquid line subcooling, and decreased flow rates result in greater suction superheat and liquid line subcooling.

The heat transfer done at the coils also influences suction superheat and liquid line subcooling. Specifically, the heat rejection of the condenser affects liquid subcooling, and the loading (indoor airflow volume and entering air wet bulb temperature) of the evaporator affects suction superheat. In regard to coil heat transfer, it can be said that increased heat transfer results in greater suction superheat and liquid line subcooling, and decreased heat transfer results in lower suction superheat and liquid line subcooling.

In the dynamics of system operation, the rate of refrigerant flow and the heat transfer of the coils are factors that are not separable. Suction superheat and liquid line subcooling essentially summarize these factors. An understanding of the factors that influence suction superheat and liquid line subcooling is important to how this summarized information is used in troubleshooting diagnosis.

The relationship of the rate of refrigerant flow, and heat transfer of the coils with the resulting suction superheat and liquid line subcooling indications are most evident in refrigerant circuits with fixed orifice metering devices. The refrigerant flow rate of a circuit with a fixed orifice metering device is primarily determined by the discharge to suction pressure differential. The extremes of the normal operation range for the unit are the clearest examples of what suction superheat and liquid line subcooling indications can be expected:

- Operation under conditions of maximum outdoor temperature and minimal evaporator loading elevates the discharge to suction pressure differential. This increases the refrigerant flow rate, and lowers the heat transferred at the coils resulting in the lowest suction superheat and liquid line subcooling indicators
- Operation under conditions of minimum outdoor temperature and maximum evaporator loading reduces the discharge to suction pressure differential. This reduces the refrigerant flow rate, the raises the heat transferred at the coils resulting in the highest suction superheat and liquid line subcooling indicators

Suction superheat is the indicator for the fixed orifice charging because it is better defined, and more precise over the operating range of the unit. The superheat figures follow the relationship of the rate of refrigerant flow and the heat transfer of the coils. For a given evaporator entering air wet bulb temperature, as outdoor temperature increases, superheat decreases. For a given outdoor temperature, as evaporator entering air wet bulb temperature increases, superheat increases.

The relationship of the rate of refrigerant flow and the heat transfer of the coils with the resulting suction superheat and liquid line subcooling indications also applies to refrigerant circuits with thermal expansion valve metering devices. However, the refrigerant flow rate of the circuit is actively modulated by the TXV opening and closing to maintain the setting for suction superheat at the TXV bulb. This results in much smaller changes to suction superheat and liquid line subcooling indicators over the operating range of the unit than is seen with fixed orifice metering devices. The nominal 10°F subcooling value listed in the Installation Manuals should vary no more than ±5°F over the full operating range of the unit. The superheat setting of TXVs differs slightly from model to model and typically is 8 to 12°F. Superheat measured at the compressor suction line connection should read 5 to 15°F over the full operating range of the unit.

TXV Guidelines

- TXVs require that the refrigerant entering the valve be completely liquid. TXV performance cannot be assessed when liquid line subcooling is zero degrees
- TXVs require a true reading of suction line temperature to accurately maintain superheat. The TXV sensing bulb must make firm contact with the suction line and be insulated. Excessively low suction superheat leading to compressor damage will occur if the TXV sensing bulb is not making firm contact with the suction line. For units having two or more refrigerant circuits, confirm that the sensing bulb is placed on the suction line of the proper circuit
- TXVs tend to “over-control” under most operating conditions. A TXV will continuously adjust the position it is open to maintain the suction superheat setting. Suction superheat and liquid line subcooling readings will normally be seen to oscillate slightly as the TXV modulates refrigerant flow in the circuit. When TXV “hunting” (more rapid opening and closing of the valve) occurs, suction superheat and liquid line subcooling will be seen to have greater oscillation. “Hunting” is typically not the fault of the TXV.

This abnormal condition is primarily caused by excessively low evaporator loading, and will worsen if refrigerant flow rates are also low

- TXVs can only open so far. If exposed to extremely high evaporator loading and high suction superheat, the TXV will be forced to its maximum open position. Under these conditions, the TXV will not modulate to maintain suction superheat. TXV performance cannot be assessed until the evaporator loading (indoor airflow volume and entering air wet bulb temperature) is within the limitations for the unit

Refrigerant Circuit Deficiencies

The principles for understanding the tendencies and dynamics of system operation over the operating range of the unit also applies to troubleshooting deficiencies. Refrigerant circuit deficiencies can be categorized as follows:

Coil airflow

- Inadequate condenser airflow
- Inadequate evaporator airflow
- Excessive evaporator airflow

Refrigerant

- Undercharged
- Overcharged
- Non-condensibles

Restriction to refrigerant flow

Reduced compressor pumping capacity

Each deficiency is indicated by abnormalities in the following troubleshooting measurements:

- Suction pressure
- Suction line temperature
- Discharge pressure
- Liquid line temperature
- Compressor current draw
- Discharge line temperature
- Suction superheat
- Liquid subcooling

Coil Airflow

Inadequate Condenser Airflow

Indicator	Measurement	Notes
Discharge pressure	Elevated	
Liquid line temperature	Significantly above outdoor temperature	At higher ambient operation “significant” would be liquid line temperature more than 25° F above outdoor temperature.
Compressor current draw	Elevated	
Suction superheat	Reduced / no change	Lowered for circuits with fixed orifice metering devices if liquid line subcooling is present. Circuits with TXV metering devices will have little noticeable difference if liquid line subcooling is present.
Liquid subcooling	Reduced or zero	

Other indications:

- High pressure switch trips and lockouts
- Elevated discharge air temperature from the condenser
- Overheating of condenser fan motors. Motor thermal protection trips and bearing lubricant “cooked out” of motor. Compressor motor thermal protection trips and eventual compressor damage

Inadequate condenser airflow and diminished heat transfer of the coil increases in severity as outdoor temperatures become warmer. Troubleshooting indications will also be more pronounced as outdoor temperatures become warmer.

Possible causes:

- Dirt fouling the condenser coil. Thoroughly clean the coil using a non-acid condenser coil detergent and adequately rinse with water
- Inadequate clearance for condenser air intake or discharge
- Condenser fan motor failure including failure of the associated wiring, capacitor, contactor and low ambient controls
- Miss-positioned or improper condenser fan blade

Inadequate Evaporator Airflow

Indicator	Measurement	Notes
Suction pressure	Reduced	Saturation temperature at or below 32° F.
Suction line temperature	Reduced	
Compressor current draw	Reduced	
Discharge line temperature	Reduced	
Suction superheat	Reduced or Zero	
Liquid subcooling	Elevated	Due to overall reduction in circuit heat transfer.

Other indications:

- Freezestat trips and lockouts
- Low pressure switch trips and lockouts
- Evaporator icing
- Reduced supply air temperature
- Liquid slugging of the compressor. Compressor damage is imminent

Inadequate evaporator airflow, and diminished heat transfer of the coil increases in severity as evaporator coil loading lessens. Troubleshooting indications will also be more pronounced as evaporator coil loading lessens.

Possible causes:

- Dirt fouling of the air filters. Replace or clean as needed
- Dirt fouling of the evaporator coil. Thoroughly clean using a non-acid evaporator coil detergent
- Restriction of the duct system including inadequately sized or collapsed ducts, closed fire or balancing dampers
- Improper blower setup. The blower wheel speed is adjusted too low
- Blower belt loose or broken
- Blower motor failure including failure of the associated wiring and contactor
- Blower wheel dirty, misaligned or has failed

Excessive Evaporator Airflow

Indicator	Measurement	Notes
Suction pressure	Elevated	Saturation temperature above 50° F.
Suction line temperature	Elevated	Exceeds 60° F.
Compressor current draw	Elevated	
Discharge line temperature	Elevated	
Suction superheat	Elevated	
Liquid subcooling	Reduced	Due to overall increase in circuit heat transfer.

Other indications:

- Little or no humidity removal or condensate
- Increased supply air temperature
- Blower motor thermal protection trips
- Overheating of the compressor. Compressor motor thermal protection trips, and eventual compressor damage

Excessive evaporator airflow and increased heat transfer of the coil increases in severity as evaporator coil loading increases.

Troubleshooting indications will also be more pronounced as evaporator coil loading increases.

Possible causes:

- Improper blower setup. The blower wheel speed is adjusted too high.
- Improper setup of fresh air accessories.
- Ductwork that has broken open.

Refrigerant Charge

Undercharged

Indicator	Measurement	Notes
Suction pressure	Reduced	
Suction line temperature	Elevated	
Discharge pressure	Reduced	
Liquid line temperature	Reduced	At or near outdoor ambient temperature.
Compressor current draw	Reduced	
Discharge line temperature	Elevated	
Suction superheat	Elevated	
Liquid subcooling	Reduced	At or near zero.

Other indications:

- Little or no humidity removal or condensate
- Increased supply air temperature
- Low pressure switch trips
- Partial evaporator icing with eventual freezestat trips after longer run times
- Overheating of the compressor. Compressor motor thermal protection trips, and eventual compressor damage

Troubleshooting indications will be more pronounced as the severity of the undercharge increases.

Possible causes:

- Refrigerant leak. Identify location of leak with electronic detector
- Service practices. Improper or excessive attachment of gauge set to pressure taps, and omission or poor sealing of pressure tap caps

Overcharged

Indicator	Measurement	Notes
Suction pressure	Slightly Elevated	
Suction line temperature	Reduced	
Discharge pressure	Slightly Elevated	
Liquid line temperature	Reduced	At or near outdoor ambient temperature.
Compressor current draw	Slightly Elevated	
Discharge line temperature	Reduced	
Suction superheat	Reduced or Zero	
Liquid subcooling	Elevated	Exceeds 15° F on circuits with TXV.

Other indications:

- Little or no humidity removal or condensate
- Increased supply air temperature
- High pressure switch trips and lockouts if severely overcharged
- Slugging of the compressor. Compressor damage is imminent

Troubleshooting indications will be more pronounced as the severity of the overcharge increases, and outdoor temperature increases. Key indicators are suction superheat and liquid subcooling; suction and discharge pressure will not noticeably increase until the refrigerant storage capacity of the coils is exceeded.

Possible causes:

- Service practices. Review indoor airflow volume. Overcharging is often done in an attempt to compensate for inadequate indoor airflow.

Non-Condensibles

Indicator	Measurement	Notes
Suction pressure	Normal or Reduced	
Suction line temperature	Elevated	
Discharge pressure	Elevated	
Liquid line temperature	Reduced	At or near outdoor ambient temperature
Compressor current draw	Elevated	
Discharge line temperature	Elevated	
Suction superheat	Elevated	
Liquid subcooling	Elevated	

Other indications:

- Little or no humidity removal or condensate
- Increased supply air temperature
- Partial evaporator icing and eventual freezestat trips after longer run times

- High pressure switch trips and lockouts if severe condition exists
- Overheating of the compressor. Compressor motor thermal protection trips, and eventual compressor damage

Troubleshooting indications will be more pronounced as the severity of the non-condensibles increases and outdoor temperature increases. Non-condensibles tend to “settle” in the condenser, reducing coil heat transfer and artificially increasing discharge pressure while the rest of the circuit is effectively undercharged.

Possible causes:

- Service practices. Air, water vapor, nitrogen, etc. left in the circuit from improper evacuation

Restriction to Refrigerant Flow

Indicator	Measurement	Notes
Suction pressure	Reduced	
Suction line temperature	Elevated	
Discharge pressure	Briefly Elevated	Immediately following compressor start, saturation temperature at or near outdoor ambient temperature afterwards.
Liquid line temperature	---	At or near outdoor ambient temperature at points upstream of the restriction, lower than outdoor ambient temperature at points downstream of the restriction.
Compressor current draw	Briefly Elevated	Immediately following compressor start, lowered afterwards.
Discharge line temperature	Elevated	
Suction superheat	Elevated	
Liquid subcooling	Elevated	

Other indications:

- Little or no humidity removal or condensate
- Increased supply air temperature
- Partial evaporator icing and eventual freezestat trips after longer run times
- Overheating of the compressor. Compressor motor thermal protection trips, and eventual compressor damage

Restriction to refrigerant flow is most likely to be in the liquid line components: the tubing of the liquid line, filter-drier or metering device. Liquid line temperature should drop no more than 3°F from condenser outlet to the metering device inlet. No more than 2°F drop should be measured from inlet to outlet of the filter-drier. Clogging of the metering device inlet screen, loss of the TXV bulb charge or the TXV failing to open all result in troubleshooting indicators for restricted refrigerant flow with no significant temperature drop from condenser outlet to metering device inlet.

Possible causes:

- Service practices. Clogging of the components from particulates left in the circuit from poor cleanliness, and water vapor left in the circuit from improper evacuation
- Clogging of the filter-drier
- Compressor damage. Clogging of the components from particulates in the circuit due to mechanical or electrical damage to the compressor
- TXV failure. Loss of bulb charge from sensing line breakage, overheating of the TXV due to torch-work in the vicinity

Reduced Compressor Pumping Capacity

Indicator	Measurement	Notes
Suction pressure	Elevated	
Suction line temperature	Elevated	
Discharge pressure	Reduced	
Liquid line temperature	Reduced	At or near outdoor ambient temperature.
Compressor current draw	Elevated / Reduced	Elevated if internal pressure relief is triggered, reduced if scroll reverse rotation, reduced if the pumping unit is damaged, elevated if compressor bearings are also damaged.
Discharge line temperature	Elevated	
Suction superheat	Elevated	
Liquid subcooling	Elevated	

Other indications:

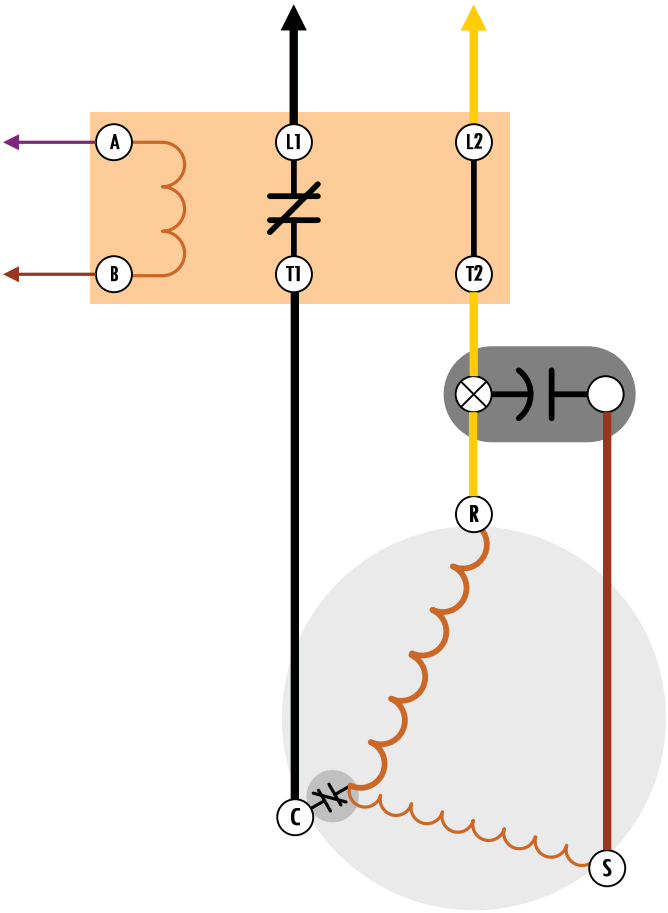
- Little or no humidity removal or condensate
- Increased supply air temperature
- Overheating of the compressor. Compressor motor thermal protection trips
- Unusual compressor noise. Mechanical clatter or gas bypass within the compressor

Reduced compressor pumping capacity does not always indicate the compressor has failed, and is a secondary result of other refrigerant circuit deficiencies. In cases of reverse scroll rotation or triggering of the internal pressure relief, the compressor will remain functional if timely corrections are made to the system. Liquid slugging should be suspected if the pumping unit is damaged (the scroll or reciprocating valves are broken), the compressor has seized or otherwise failed. The other refrigerant circuit deficiencies may not be evident until the failed compressor has been replaced. Care must then be taken to examine the troubleshooting indicators, particularly indoor airflow and suction superheat, to prevent repeat failures.

Possible causes:

- All those listed under other refrigerant circuit deficiencies.

Chapter 4 - PSC Fan Motor



A systematic approach to line voltage component electrical troubleshooting will provide the greatest diagnostic accuracy. The following method requires that the equipment be powered. The technician must exercise care and caution to avoid electrical shock and other personal safety hazards.

The accompanying diagram is a simplified version representing the line voltage components which connect to the 1Ø PSC condenser fan or power exhaust motors.

Component and wiring details may vary, but the principles of 1Ø PSC motor troubleshooting remain the same.

Figure 4-1

From the top, the items diagrammed are:

- Up arrows represent the connection to the unit's power connection for the 1Ø PSC motor
- A contactor (tan rectangle), single-pole shown. Two-pole contactors are also used in some applications
- A run capacitor (dark gray oval)
- 1Ø PSC, internally-protected motor; either condenser fan or power exhaust fan motor (light gray circle)

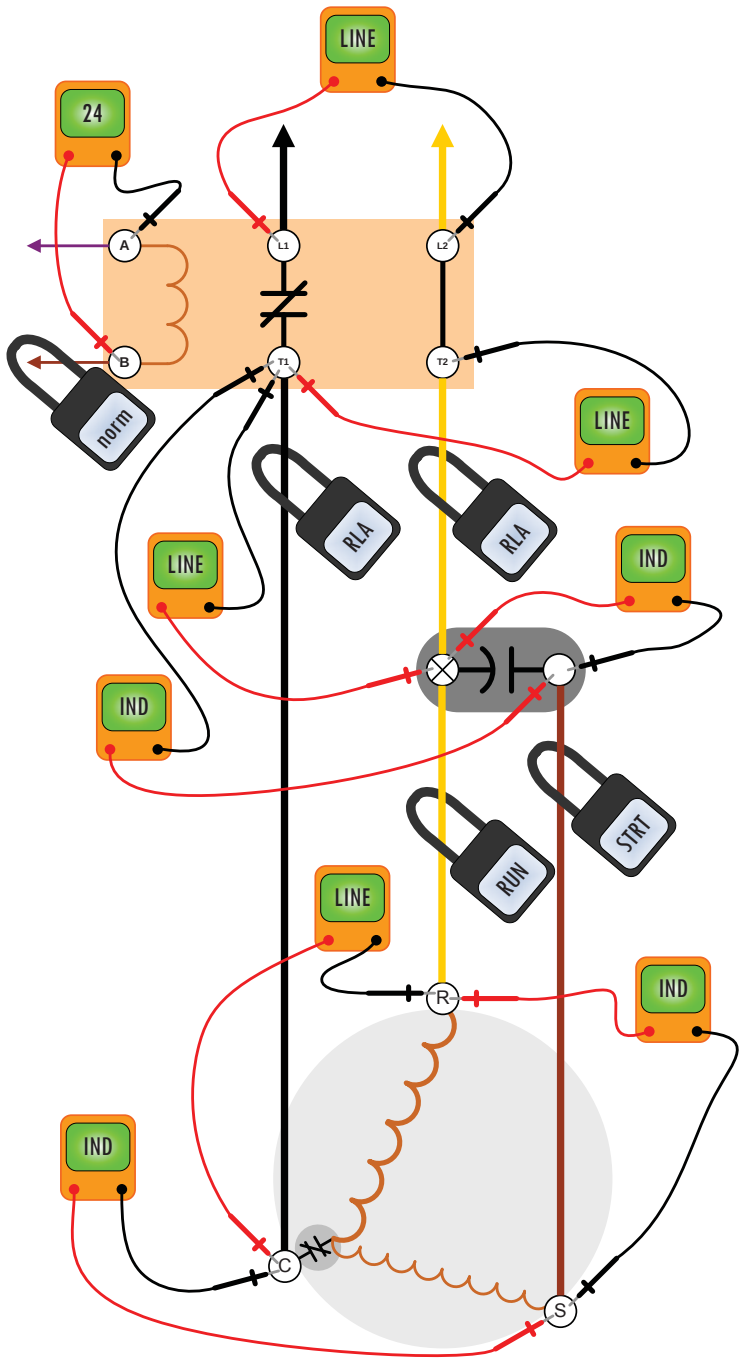


Figure 4-2

Electrical troubleshooting of the line voltage components uses:

- Voltage readings of the 1Ø PSC motor line voltage circuit
- Amperage readings of the 1Ø PSC motor line voltage circuit
- Confirmation that the 24 volt contactor coil circuit is complete and enabled

The technician's understanding of what readings are normal, as well as recognition of abnormal readings, is key to electrical troubleshooting.

The illustration shown depicts normal readings for an operating 1Ø PSC motor line voltage circuit as follows:

- The presence of 24 volts and normal current draw (typically 1 amp or less) at the contactor coil confirms that the 24 volt circuit is complete and enabled
- Current draw of the motor is reasonably close to the motor's R.L.A. through the motor Common (black wire), and the incoming terminal of the capacitor (yellow wire – contactor T2 to X-identified capacitor terminal)
- The motor's current draw through the RUN winding (yellow wire – incoming X-identified terminal of the capacitor to motor Run) is somewhat less than the current draw through the motor common.
- The motor's current draw through the STaRT winding (brown wire – outgoing unidentified terminal of the capacitor to motor Start) is somewhat less than the current draw the motor run winding

Due to the operating characteristics of 1Ø PSC motors, and the measurement capabilities of meters, it is not necessarily abnormal for the sum of the run and start winding current draw readings to not exactly equal the current draw of the motor common. For most circumstances, the current draw reading of motor common should be used to determine the motor's true current draw.

Line voltage is read at the following points in the circuit:

- Incoming lugs of the contactor – L1 to L2
- Outgoing lugs of the contactor – T1 to T2
- At any points from contactor T1 through motor C (black) to any points from contactor T2 through motor R (yellow)

INDuced voltage is read at any point in the circuit from contactor T2 through motor R (yellow) to the outgoing unidentified terminal of the capacitor through motor S (brown wire).

A differing INDuced voltage is read at any points in the circuit from contactor T1 through motor C (black) to the outgoing unidentified terminal of the capacitor through motor S (brown wire).



Induced voltage reading will vary due to variations in applied line voltage and the operating characteristics of particular 1Ø PSC motors.

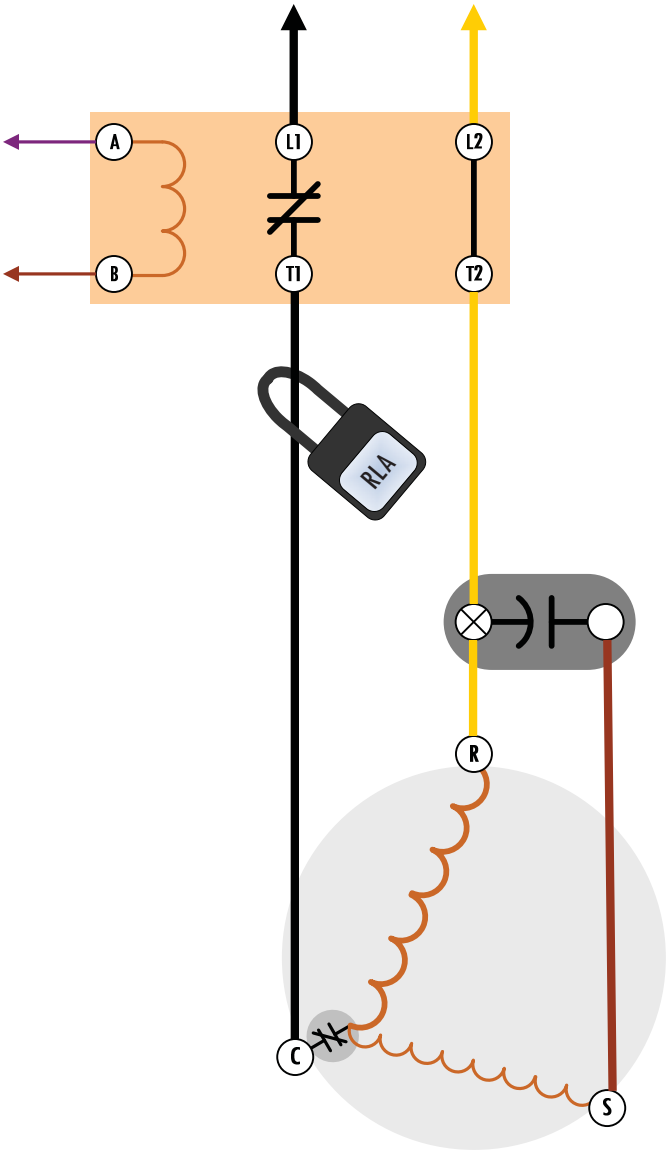
Reference readings (provided for example only) for induced voltages of the 1Ø PSC condenser motors with 230 volts applied to 208/230 volt units, and 480 volts applied to 460 volt units:

R to S

- 208/230v, 1/3 HP: 333 volts
- 460v, 1/3 HP: 373 volts

C to S

- 208/230v, 1/3 HP: 247 volts
- 460v, 1/3 HP: 390 volts



A starting point for electrical troubleshooting is to find the motor's R.L.A. and L.R.A. on the unit or motor data plate. Next, readings of the current draw of the motor common, the run winding and the start winding are taken. These readings are used to indicate the type of problem, as well as the urgency and care needed for troubleshooting.

When HIGHer than normal current draw exists on any portion of the line voltage circuit, extreme energies are present that can quickly cause failures that pose safety hazards to the technician.

Troubleshooting readings should be made with the motor energized only for the brief periods needed for the readings to register if HIGHer than normal current draw exists on any portion of the line voltage circuit. This can be accomplished by quick off-on-off cycling of the disconnect or 24 volts to the the contactor coil; whichever is practical.

Avoid manually "pushing in the contactor" because of the following:

- The potential for electrical burns exists due to the compromised contactor arc shielding
- The close proximity to live voltage components increases the risk of electrical shock
- Unit safeties are effectively bypassed

Figure 4-3

If the current draw of the motor common reads reasonably close to the motor's R.L.A., as illustrated, the line voltage circuit is complete and the motor should be operating. If this reading is taken at times when the motor is supposed to be off, further electrical troubleshooting will be required.

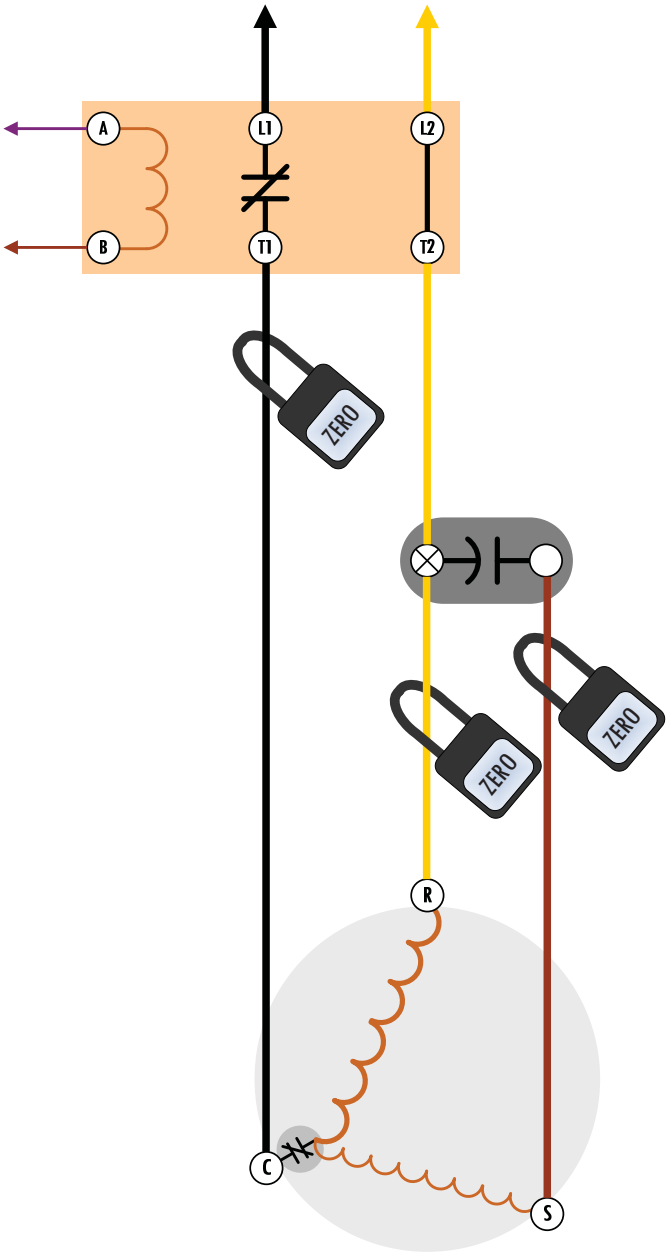


Figure 4-4

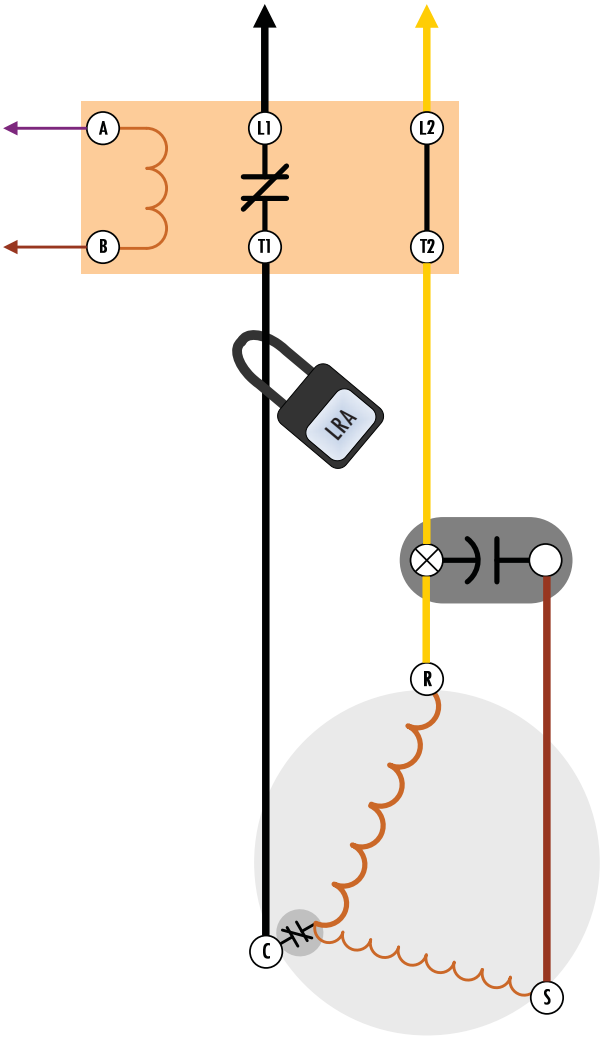
If the current draw readings are:

- motor Common: ZERO
- Run winding: ZERO
- Start winding: ZERO

Then the line voltage circuit is currently open.

The open circuit may be temporary, such as in the case when the motor internal protector has tripped due to overheating, and a secondary result of another condition. However, during periods with zero current draw there is little chance of further damage to the line voltage circuit or equipment.

If the current draw of motor common reads significantly lower than R.L.A., the line voltage circuit is complete, but the motor is likely operating at a reduced load. Causes for reduced load typically stem from mechanical problems.



If the current draw of motor common reads L.R.A., the line voltage circuit is complete, but the motor is likely locked. Causes for a locked motor typically stem from mechanical problems.

When the motor is locked, the motor's internal protector may trip, fuses may blow, the circuit protection may trip or equipment damage may result. All of these issues add greater complexity to the electrical troubleshooting process.

Figure 4-5

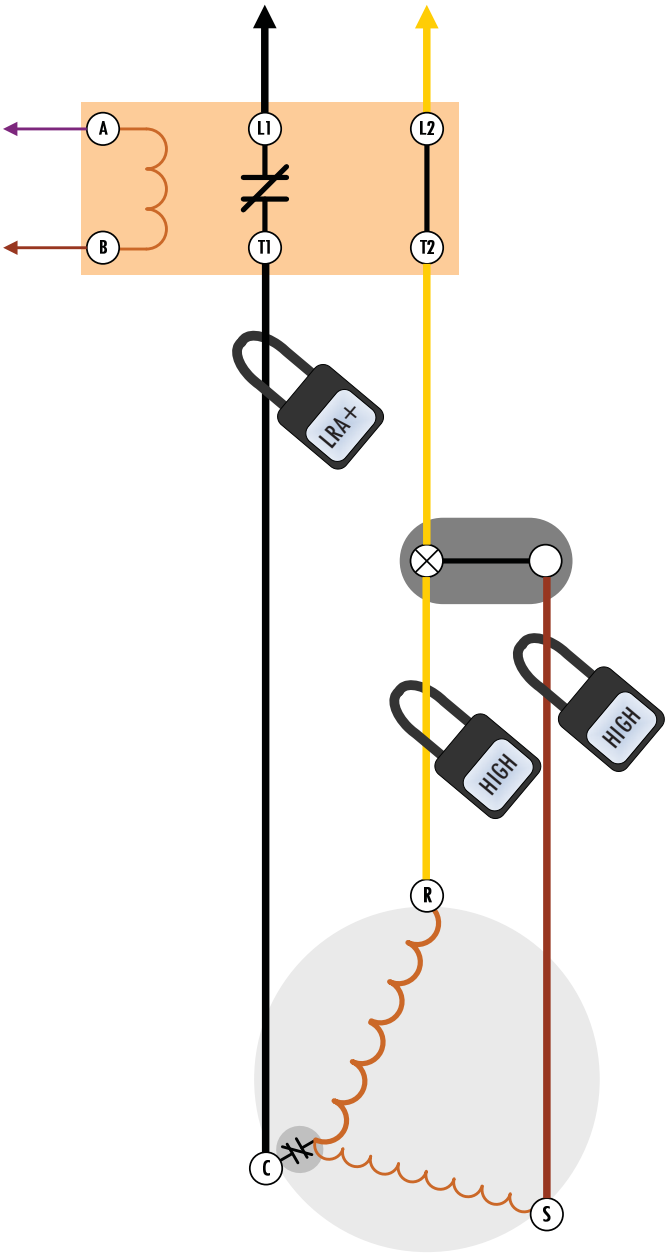


Figure 4-6

If the current draw readings are:

- motor Common: above L.R.A.
- Run winding: HIGH
- Start winding: HIGH

Then the capacitor or motor windings are likely shorted.

When the capacitor is shorted, the excessive current through the motor's start winding can directly result in damage to the winding. Additionally, the motor's internal protector may trip, fuses may blow, the circuit protection may trip or equipment damage may result. All of these issues add greater complexity to the electrical troubleshooting process.

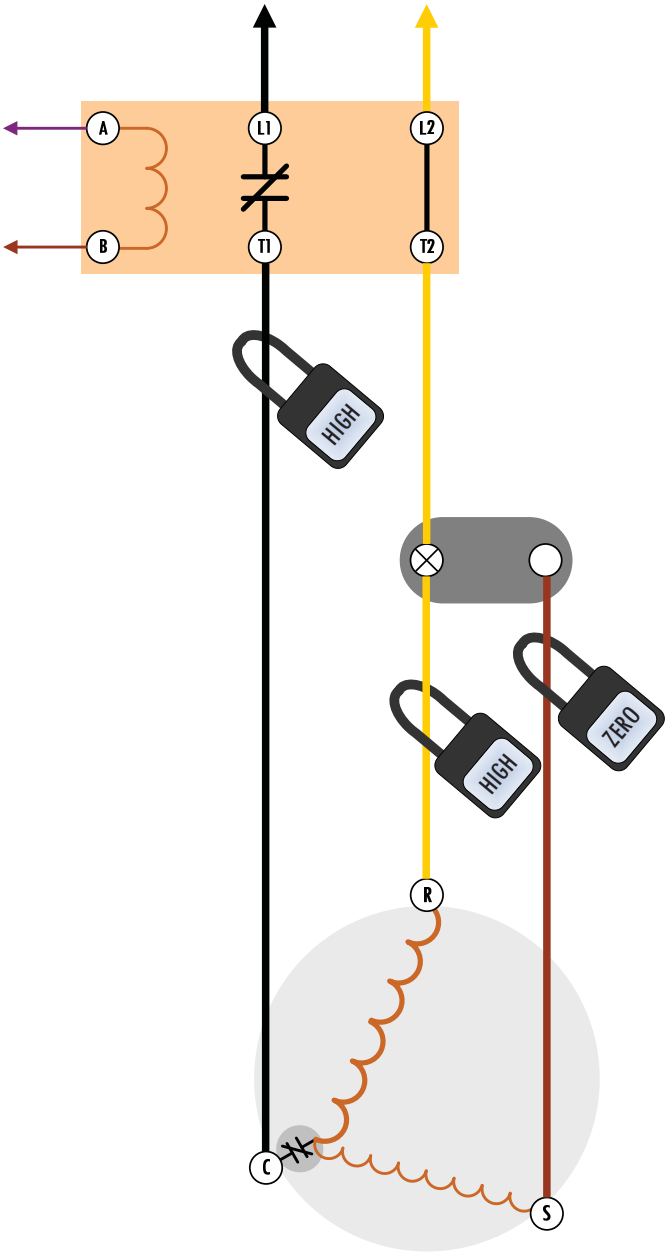


Figure 4-7

If the current draw readings are:

- motor Common: HIGH
- Run winding: HIGH
- Start winding: ZERO

Then the capacitor, motor start winding or connecting wiring is likely open.

When the circuit through the start winding is open, the excessive current through the motor's run winding can directly result in damage to the winding. Additionally, the motor's internal protector may trip, fuses may blow, the circuit protection may trip or equipment damage may result. All of these issues add greater complexity to the electrical troubleshooting process.

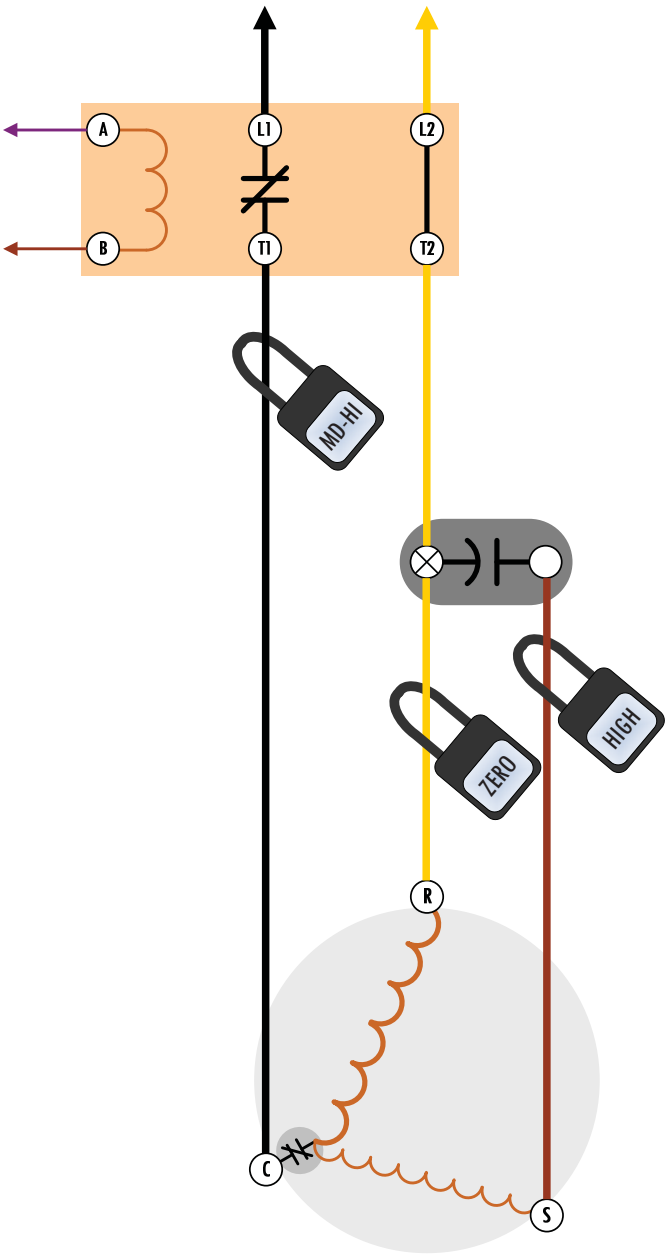


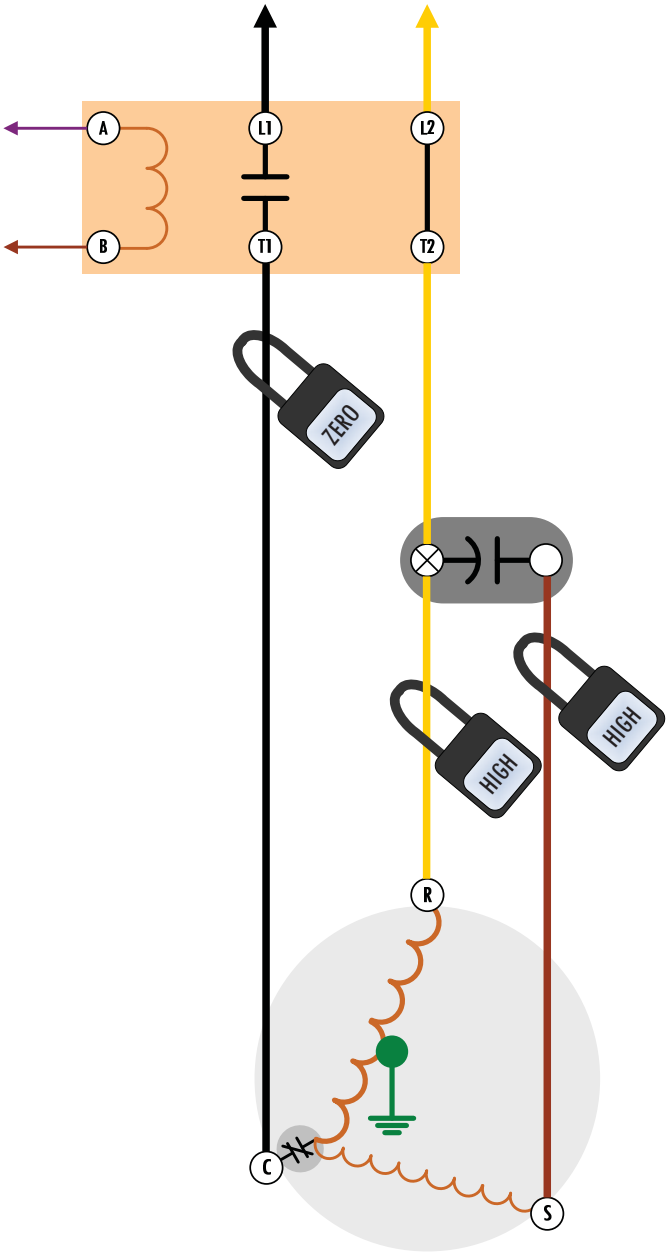
Figure 4-8

If the current draw readings are:

- motor Common: MoDerate to HIgh
- Run winding: ZERO
- Start winding: HIGH

Then the wiring connecting the X-identified capacitor terminal to the motor R terminal is open or the motor run winding is open.

When the circuit through the run winding is open, the excessive current through the motor's start winding can directly result in damage to the winding. Additionally, the motor's internal protector may trip, fuses may blow, the circuit protection may trip or equipment damage may result. All of these issues add greater complexity to the electrical troubleshooting process.



If there is current draw at times when the contactor is de-energized, and its contacts are known to be open, then the circuit has a fault to cabinet ground.

There is a great risk of electric shock to the technician in this scenario. For safety, the disconnect should turned off, and the line voltage circuit be checked for faults to ground with an ohmmeter to identify the problem.

Figure 4-9

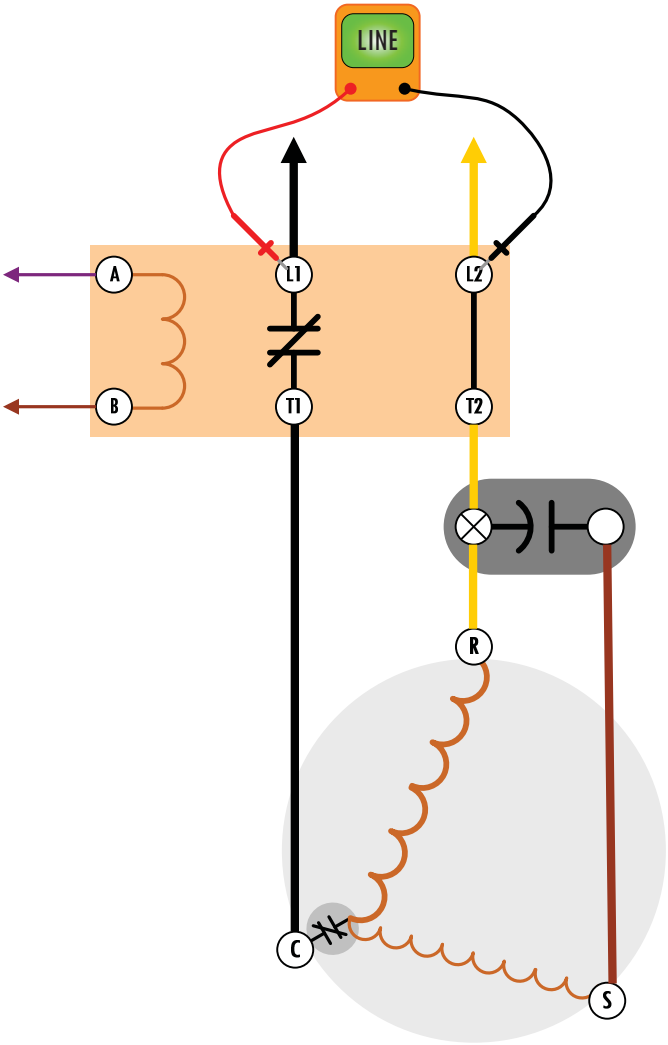


Figure 4-10

Once the current draw of motor common, the run winding and the start winding of the 1Ø PSC motor circuit has been read, a series of voltage readings, done briefly if any portion of the circuit reads HIGH current draw, are the next step in systematic electrical troubleshooting.

The voltage readings begin with confirmation that line voltage is available to the 1Ø PSC motor circuit.

Line voltage appropriate to the unit's rating should be read from the incoming lugs of the contactor:

- L1 to L2

If this reading is not present, then troubleshooting of the power supply is needed before proceeding further.

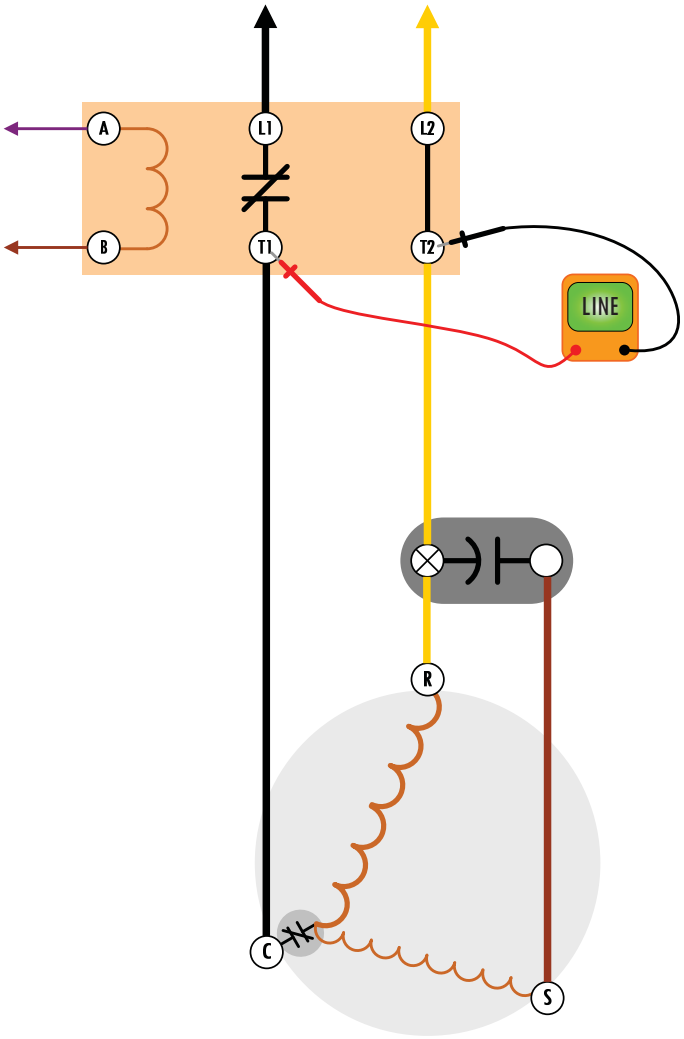


Figure 4-11

Next is confirmation that the contactor is energized, and its contacts are engaged. Line voltage should be read from the outgoing lugs of the contactor:

- T1 to T2

If this reading is not present, refer to Figure 4-14 for discussion.

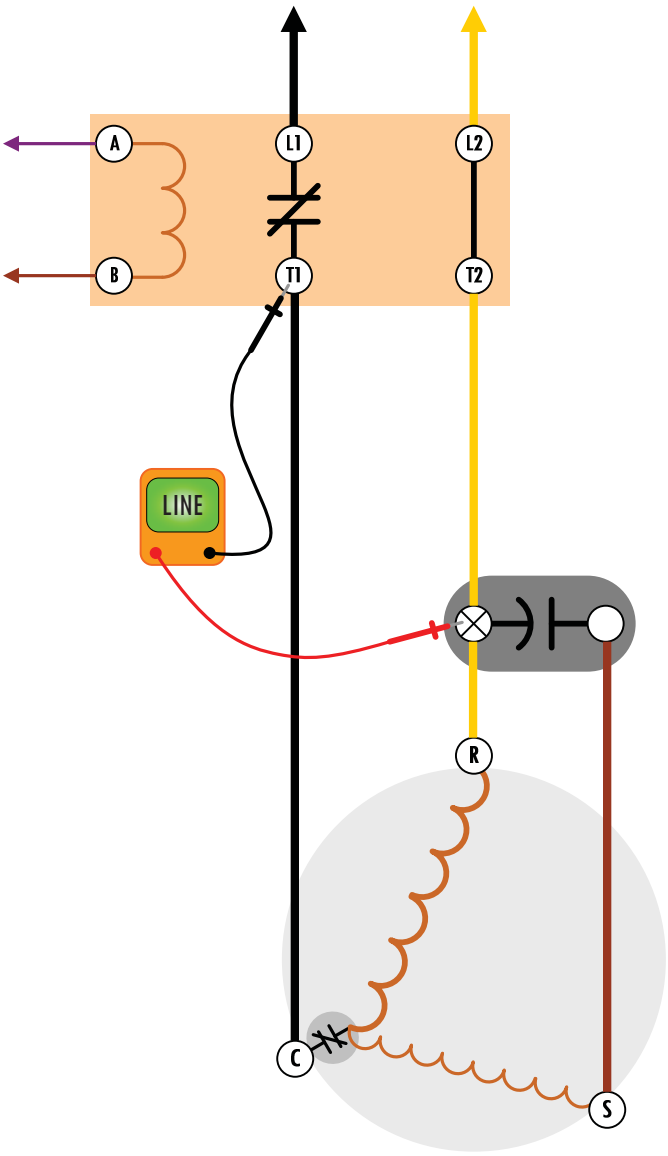


Figure 4-12

Next is confirmation that the line voltage circuit is complete at the incoming X-identified terminal of the capacitor.

Line voltage should be read from:

- Contactor T1 to the incoming X-identified terminal of the capacitor.

If this reading is not present, refer to Figure 4-15 for troubleshooting procedures.

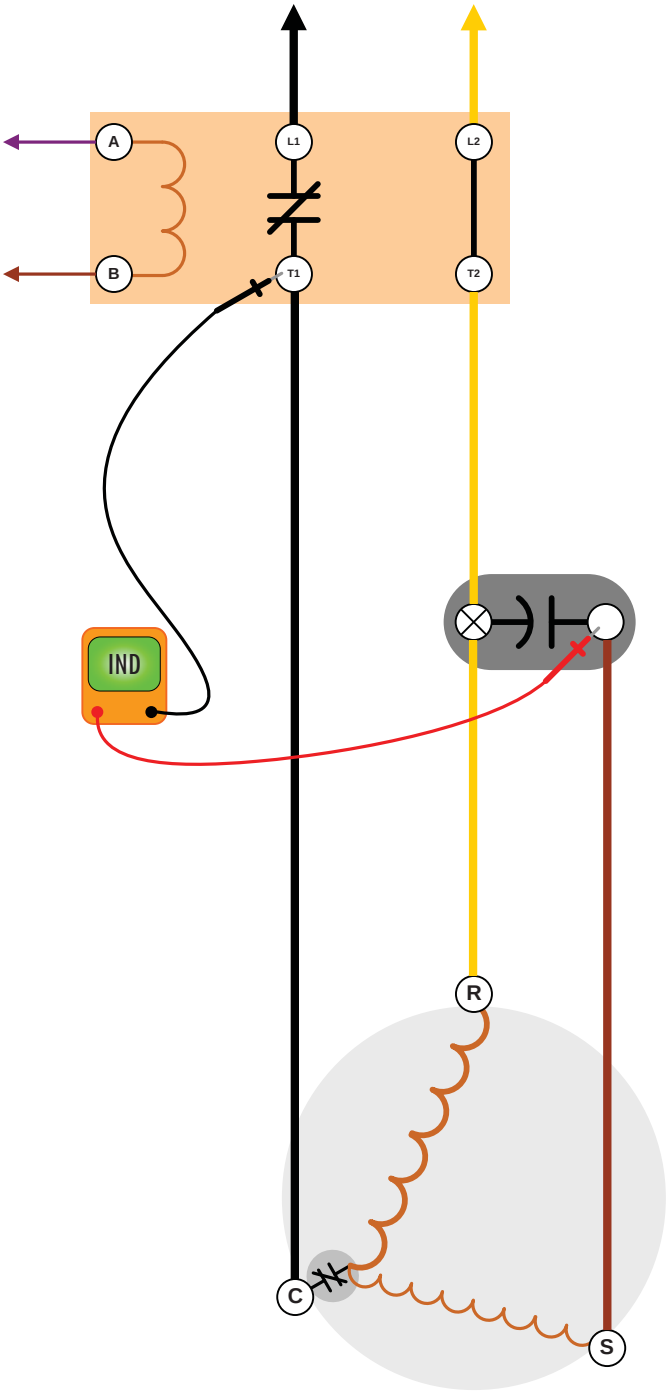


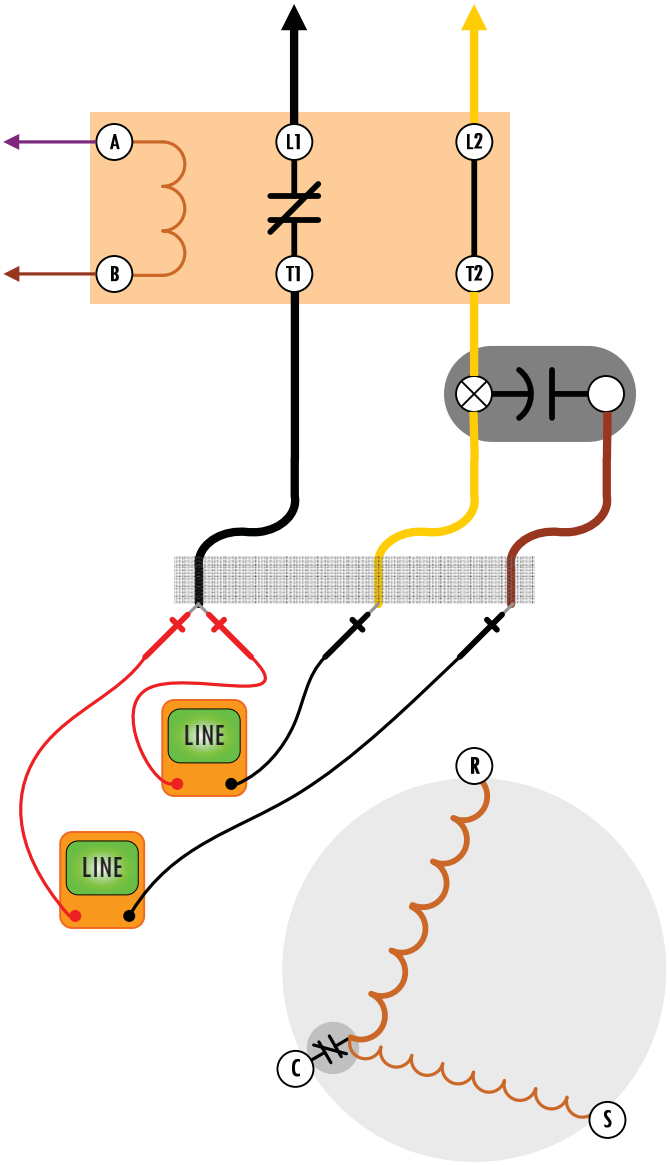
Figure 4-13

Next is confirmation that induced voltage is present at the outgoing unidentified terminal of the capacitor.

Induced voltage should be read from:

- Contactor T1 to the outgoing unidentified terminal of the capacitor.

If this reading is not present, refer to Figure 4-17 through Figure 4-21 for troubleshooting procedures.



Taking “live circuit” voltage readings at the unit’s condenser fan motors is not practical because of the extended wiring harness and weatherresistant plug terminal connection at the motor.

With the power disconnected to the unit, access the motor plug after removing the top condenser fan grille. The wire tie, used to secure the harness to the motor, is removed to separate the plug. While the plug is disconnected from the motor, the harness and motor terminations should be inspected for arcing, corrosion, damage from excessive heat, and other signs of loose connection.

Ohmmeter continuity checks of the motor can also be made at this point to determine if the motor windings are intact.

With the harness still disconnected, and the technician taking care to avoid electrical shock or shorts from the loose harness, power can be reapplied to the unit. Line voltage should be read from:

- Black harness wire to the yellow harness wire
- Black harness wire to the brown harness wire

Figure 4-14

Induced voltage will not be read at the brown wire because the source of the induced voltage, the start winding of an operating PSC motor, is disconnected.

If line voltage is not present, then at least one of the harness wires is open.

If line voltage is present as illustrated, it is likely, but not absolute, that the wiring harness is intact. Because the circuit is not under load, the readings will not detect poor or loose connections.

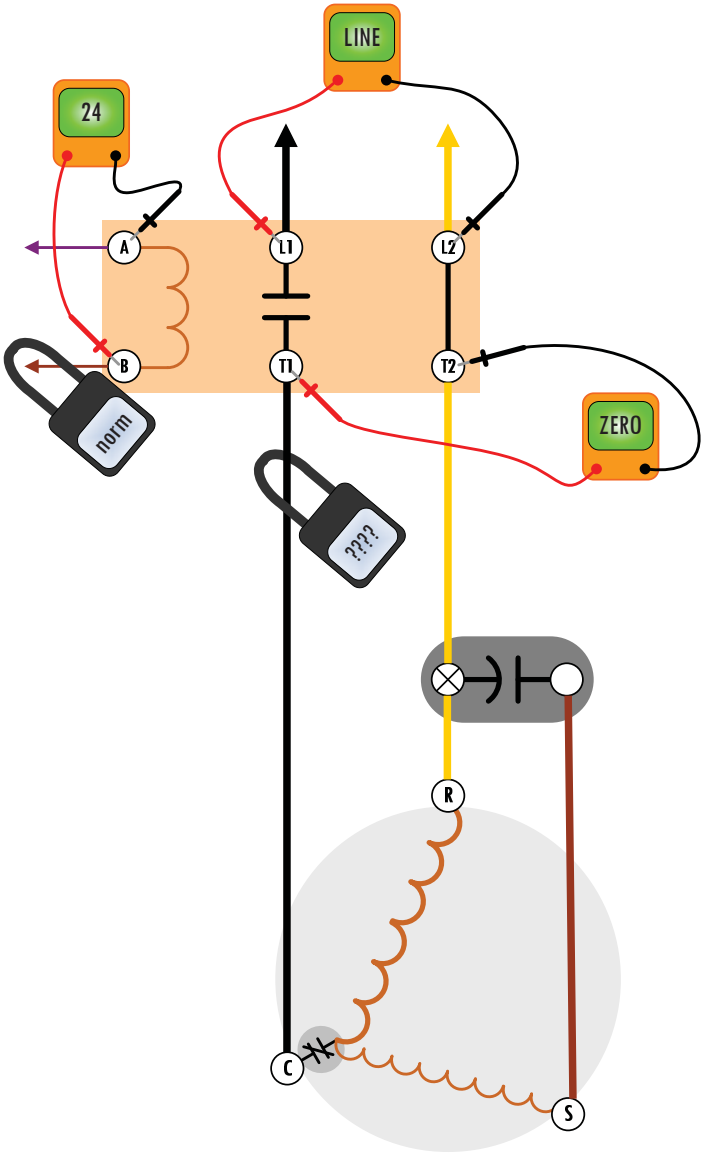


Figure 4-15

If line voltage is complete at the incoming lugs of the contactor, but is not complete at the outgoing lugs of the contactor, and the contactor coil is confirmed to be energized, then the contactor is faulty.

The technician should inspect the faulty contactor for indications of mechanical binding, such as water damage, corrosion or animals entering the contactor. Typically, these issues are corrected by properly sealing the unit's control compartment. Inspection of the faulty contactor can reveal failure due to excessively low control circuit voltage, such as overheating damage in the area of the contactor coil or contact point damage due to chattering.

If inspection shows the faulty contactor has evidence of excessive current draw through the contact points, then particular attention should be paid to the current draw through the contactor after corrections have been made.

When power is restored after repairs are made, overall current draw of the motor should be monitored to determine if a fault is causing high current draw (amp-meter segment of the illustration).

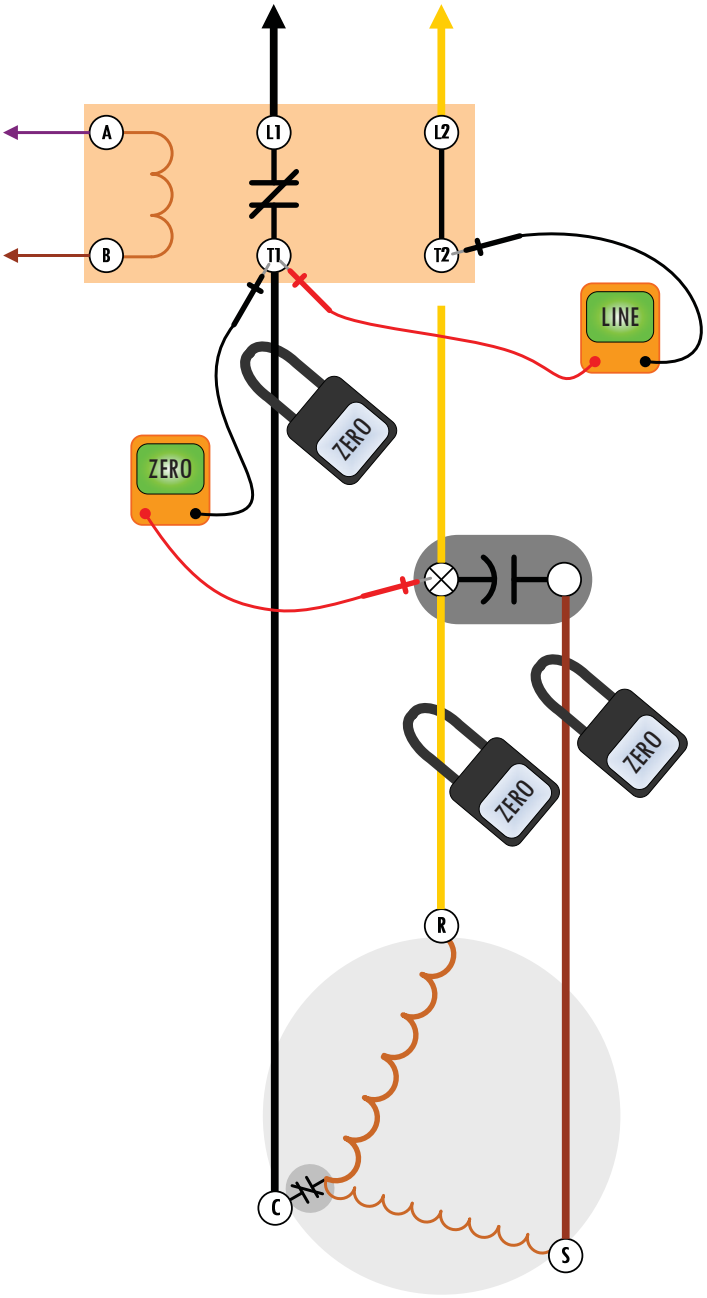


Figure 4-16

If line voltage is complete at the outgoing lugs of the contactor, but is not complete from contactor T1 to the incoming X-identified terminal of the capacitor, then the connections or wiring are faulty.

The readings illustrated show that either the contactor T2 to the incoming X-identified terminal of the capacitor connections or the wiring is electrically open. This fault also opens the line voltage circuit to the 1Ø PSC motor.

In many cases when these readings are found there will be visible discoloration or damage to the connections or wiring terminations. Typically, the component damage originates with loose connections.

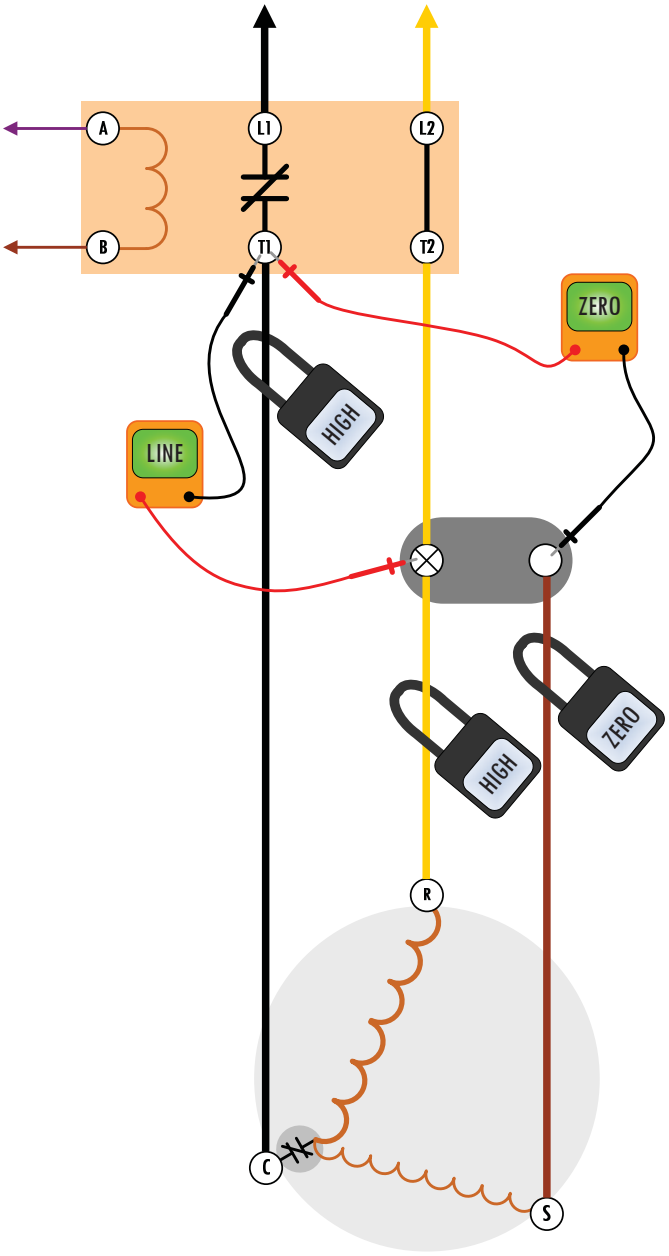


Figure 4-17

If line voltage is complete from contactor T1 to the incoming X-identified terminal of the capacitor, and the voltage from contactor T1 to the outgoing unidentified terminal of the capacitor is zero (or very low due to induced feedback from the start winding), then the capacitor is open.

The readings illustrated show an open capacitor. Along with the voltage readings, as described above, the current draw readings indicate the capacitor is open:

- motor Common: HIGH
- Run winding: HIGH
- Start winding: ZERO

With an open capacitor the PSC motor can not start on its own. If influences, such as wind blowing the fan blade, start the rotor turning, the PSC motor may run at reduced horsepower in either rotational direction. However, the increased current draw will shortly result in trips of the motor's internal thermal protector.

In many capacitor failure situations, there will be visible bulging or swelling of the capacitor's body. Often, the capacitor failure originates when voltage in excess of the nameplate maximum is applied to the circuit. Random, isolated cases of capacitor failures are usually attributed to "spikes" in voltage due to lightning storms. Chronic cases of capacitor failure may be attributed to excess voltage supplied to the building, which is the electric utility's or a qualifi ed electrician's responsibility to correct.

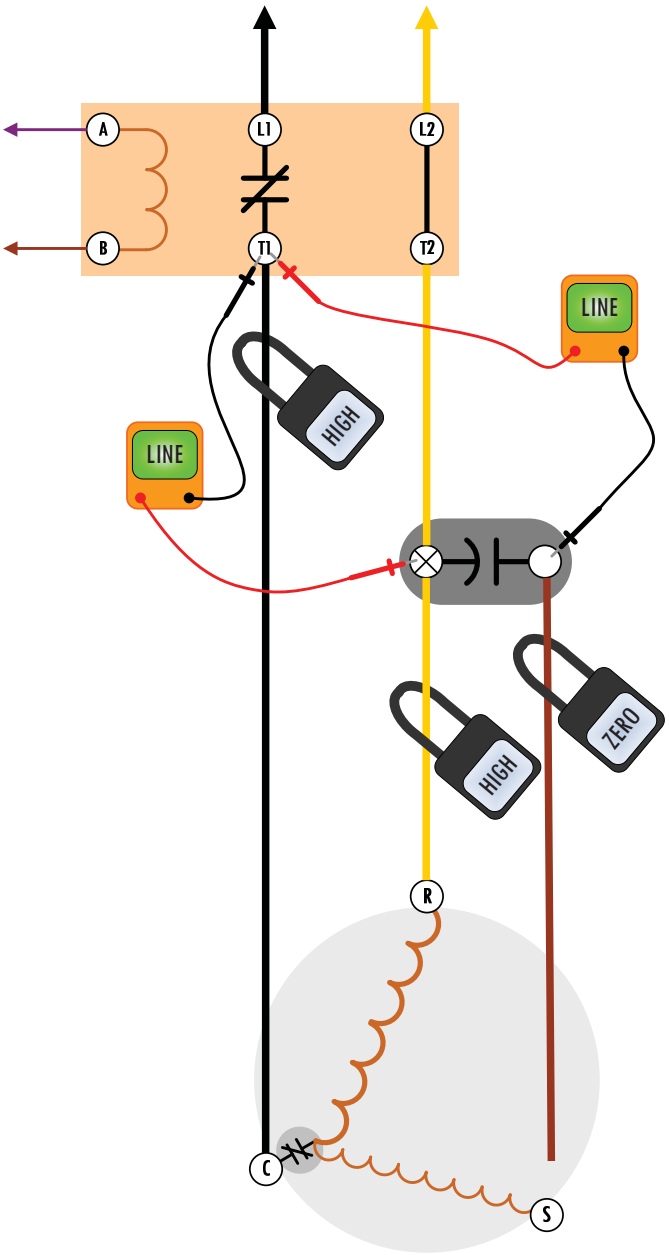


Figure 4-18

If the line voltage is complete from contactor T1 to the incoming X-identified terminal of the capacitor, and line voltage (not induced voltage) is read from contactor T1 to the outgoing unidentified terminal of the capacitor, and the current draw readings are:

- motor Common: HIGH
- Run winding: HIGH
- Start winding: ZERO

Then the circuit through the start winding is open. Either the connection to the outgoing unidentified terminal of the capacitor, the (brown) wire, the connection to the motor's S terminal, or the motor's start winding is open.

With an open start winding circuit the PSC motor can not start on its own. If influences, such as wind blowing the fan blade, start the rotor turning, the PSC motor may run at reduced horsepower in either rotational direction. However, the increased current draw will shortly result in trips of the motor's internal thermal protector.

The inspection, harness plug readings and motor continuity checks discussed in Figure 4-14 should be made to determine the point where the start winding circuit is open.

If the connections or wire is found to be open (illustrated), then re-termination/harness replacement will be needed for repair.

If the motor's start winding is open, it is likely due to either mechanical problems or a shorted capacitor. Motor replacement will be needed for repair, the capacitor should be checked for shorting, and the current draw of the replacement motor should be monitored.

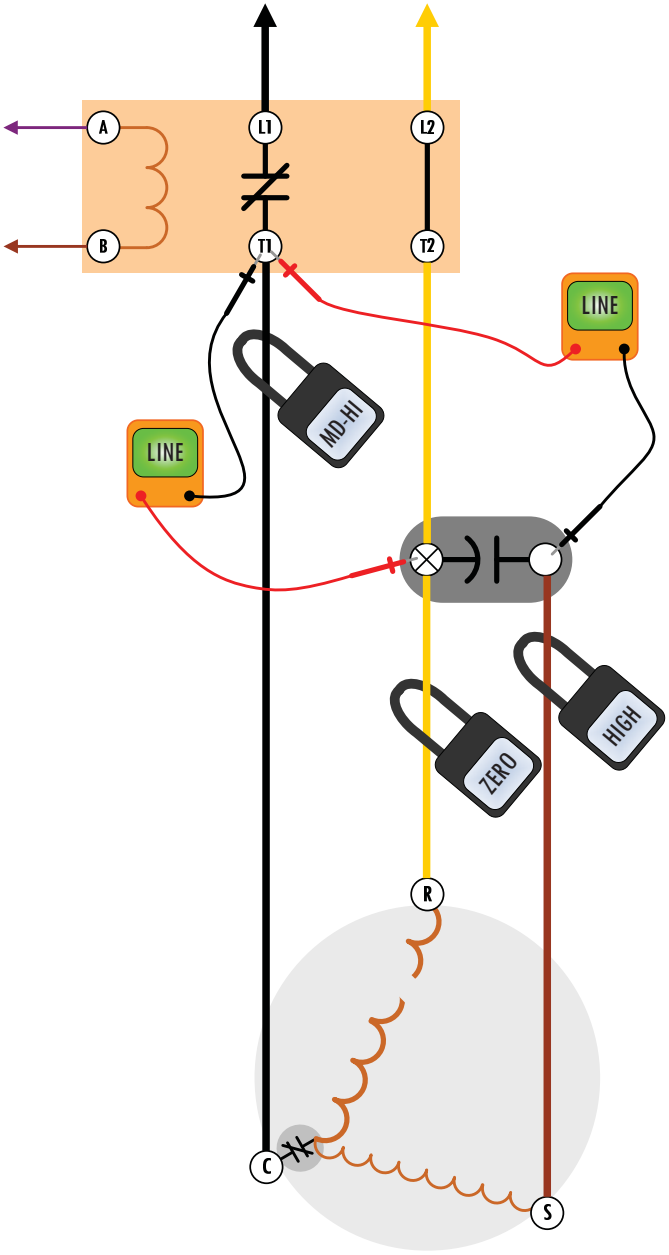


Figure 4-19

If line voltage is complete from contactor T1 to the incoming X-identified terminal of the capacitor, and line voltage (not induced voltage) is read from contactor T1 to the outgoing unidentified terminal of the capacitor, and the current draw readings are:

- motor Common: MeDium to HIGH
- Run winding: ZERO
- Start winding: HIGH

Then the circuit through the run winding is open. Either the connection to the X-identified terminal of the capacitor, the (yellow) wire between the capacitor and motor, the connection to the motor's R terminal or the motor's run winding is open.

With an open run winding circuit the PSC motor can not start on its own. If influences, such as wind blowing the fan blade, start the rotor turning, the PSC motor may run at reduced horsepower in either rotational direction. However, the increased current draw will shortly result in trips of the motor's internal thermal protector.

The inspection, harness plug readings and motor continuity checks discussed in the Figure 4-14 should be made to determine the point where the run winding circuit is open.

If the connections or wire is found to be open, then re-termination or harness replacement will be needed for repair.

If the motor's run winding is found to be open (illustrated), it is likely due to mechanical problems or an open start winding circuit. Motor replacement will be needed for repair, and the current draw of the replacement motor should be monitored.

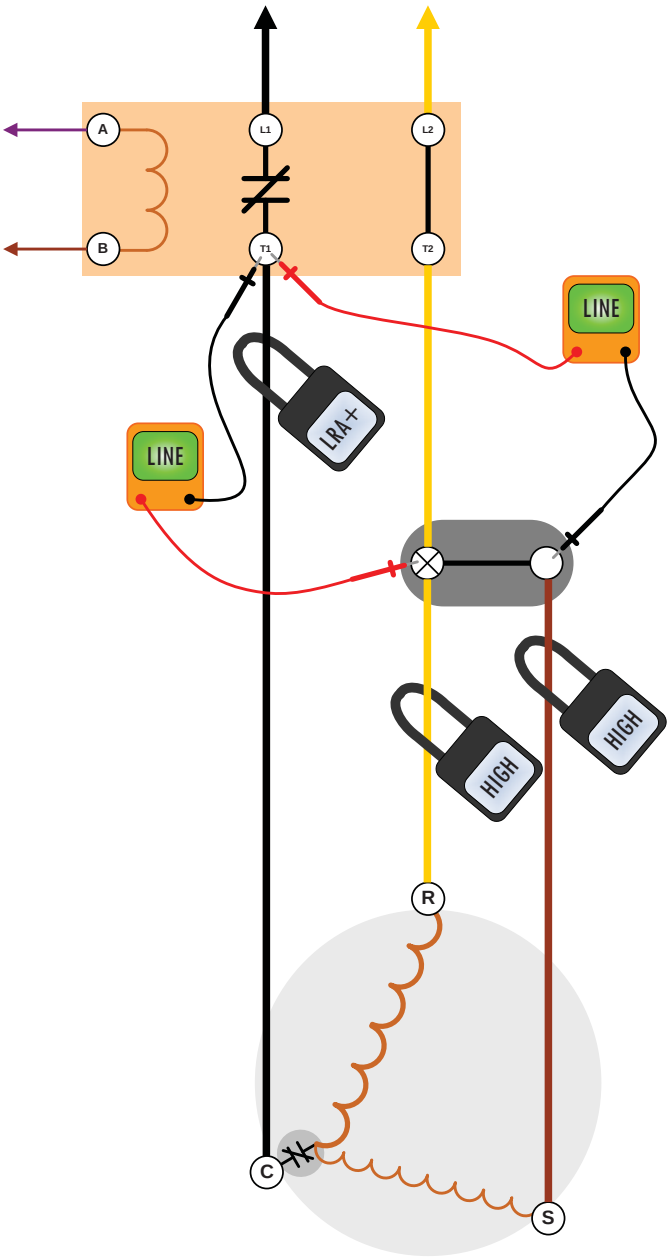


Figure 4-20

If line voltage is complete from contactor T1 to the incoming X-identified terminal of the capacitor, and line voltage (not induced voltage) is read from contactor T1 to the outgoing unidentified terminal of the capacitor, and the current draw readings are:

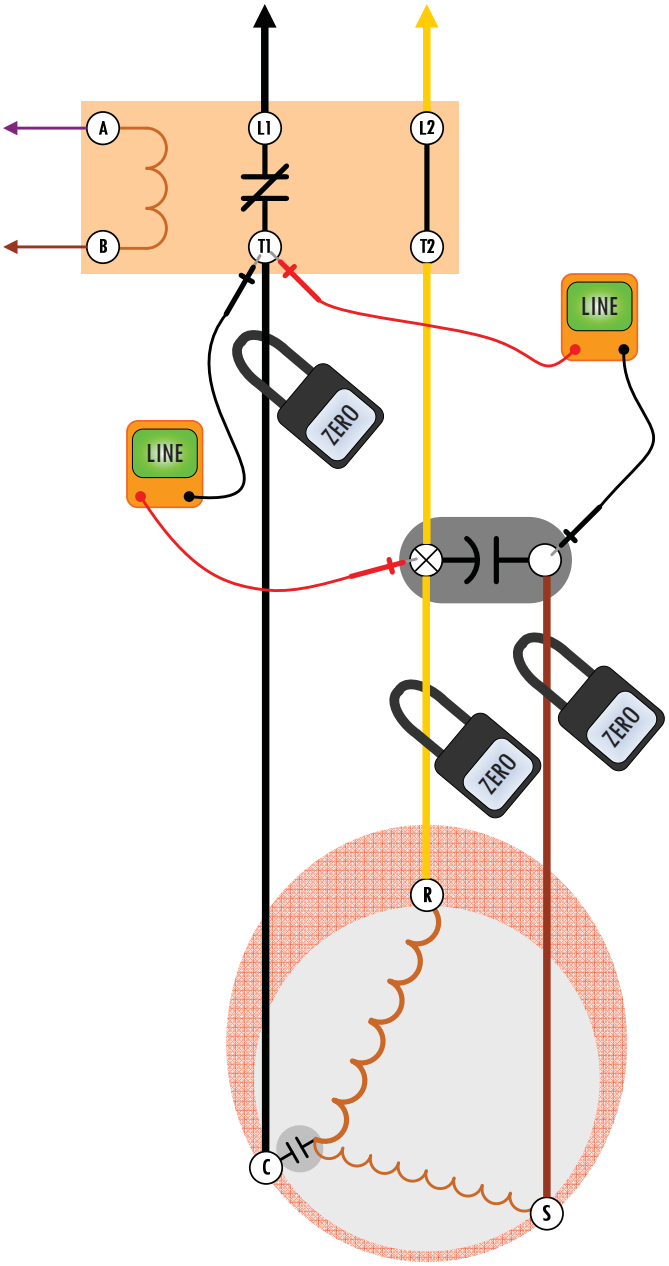
- motor Common: LRA+
- Run winding: HIGH
- Start winding: HIGH

Then either the capacitor or motor windings are shorted.

With either the the capacitor or motor windings shorted the PSC motor can not start on its own. If influences, such as wind blowing the fan blade, start the rotor turning, the PSC motor may run at reduced horsepower in either rotational direction. However, the increased current draw will shortly result in trips of the motor's internal thermal protector.

Continuity checks with an ohmmeter will be needed to determine whether the capacitor or motor windings are shorted.

If the capacitor is found to be shorted, there may also be visible bulging or swelling of the capacitor's body. Often, the capacitor failure originates when voltage in excess of the nameplate maximum is applied to the circuit. Random, isolated cases of capacitor failures are usually attributed to "spikes" in voltage due to lightning storms. Chronic cases of capacitor failures may be attributed to excess voltage supplied to the building, which is the electric utility's or a qualified electrician's responsibility to correct.



If line voltage is complete from contactor T1 to the incoming X-identified terminal of the capacitor, and line voltage (not induced voltage) is read from contactor T1 to the outgoing unidentified terminal of the capacitor, and the current draw readings are:

- motor Common: ZERO
- Run winding: ZERO
- Start winding: ZERO

Then the circuit through the motor is open.

If this condition is accompanied with motor overheating (illustrated), then the motor's internal thermal protector is tripped. An overheated motor should be disconnected from power to allow the motor to cool so the thermal protector can reset. Internal thermal protector trips can be caused by the electrical problems discussed throughout this section or by mechanical problems.

If the readings listed above are measured, and the motor is cool, then one of the following conditions exists:

- The black wire connection to the motor's C terminal is open
- Both the brown wire connection to the motor's S terminal, and the yellow wire connection to the motor's R terminal are open
- Both motor windings are open
- The internal thermal protector has failed

Figure 4-21

The inspection of harness plug readings and motor continuity checks discussed in Figure 4-14 should be made to determine the point where the motor circuit is open. If the connections or wire is found to be open, then re-termination or harness replacement will be needed for repair.

When condernser fan motor failures occur, the technician should not overlook excessive air temperature over the motor caused by poor condenser airflow as the source of the failure.

If both motor windings are open, then the internal thermal protector has failed. The cause of this failure is likely due to either mechanical problems or a shorted capacitor. Motor replacement will be needed for repair, the capacitor must be checked for shorting, and the current draw of the replacement motor must be monitored.

Chapter 5 - 3Ø High Voltage

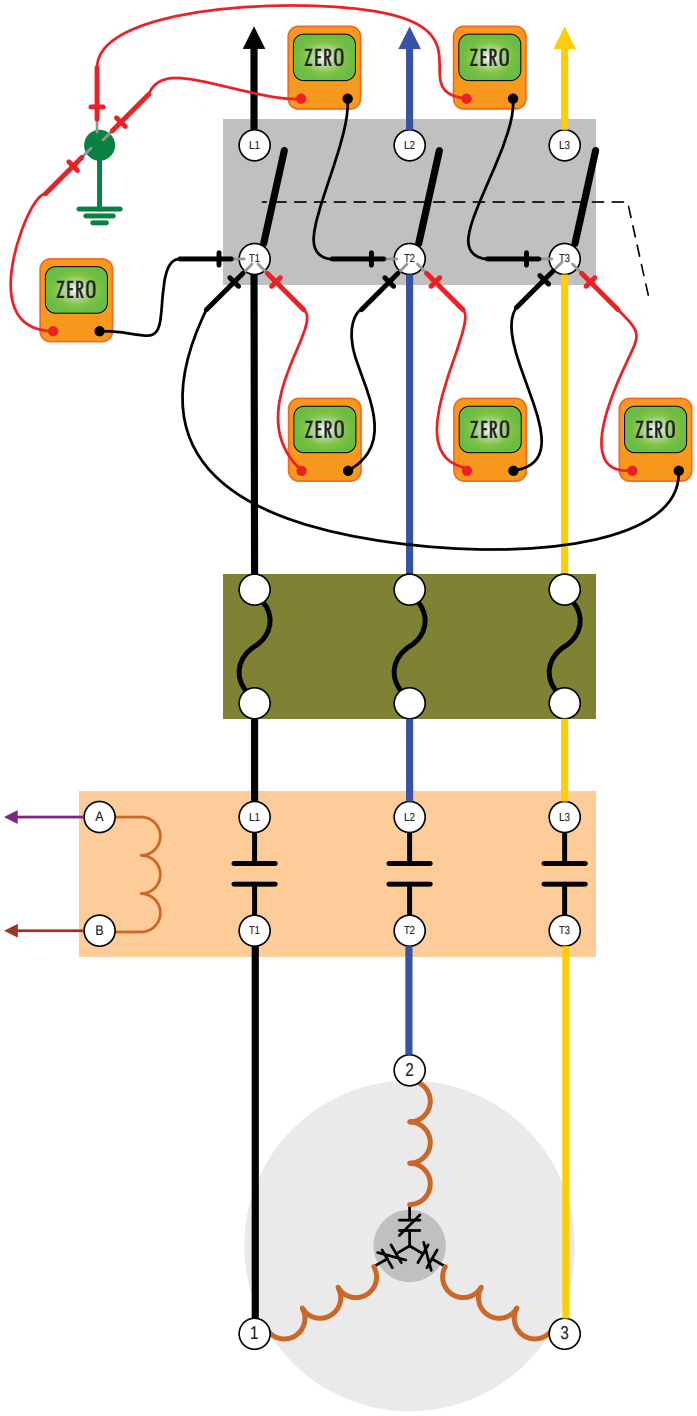


Figure 5-1

High voltage troubleshooting is relatively uncomplicated since the circuitry is limited to disconnect, fuses, contactor, motor and the associated wiring.

Many troubleshooting procedures require that power remain on to the unit for valid readings. The technician must be attentive to his/her personal safety when working on a unit that is powered. Other procedures for maintenance, service and repair require that the unit power be disengaged. To prevent electrical shock, the technician should ensure line voltage is fully disengaged any time that the disconnect handle is placed in the “off” position. With a trusted AC voltmeter, make the following readings from the outgoing side (or unit side) of the disconnect:

- T1 to T2
- T2 to T3
- T1 to T3
- T1 to cabinet ground
- T2 to cabinet ground
- T3 to cabinet ground

As illustrated, all readings should be zero volts with the disconnect in the “off” position to ensure that line voltage is disengaged.

Also note that some units, most frequently those with electric heat, may have more than one line voltage power supply. In these cases all disconnects will need to be placed in the “off” position, and individually checked as described above to ensure that all line voltage has been disengaged from the unit.

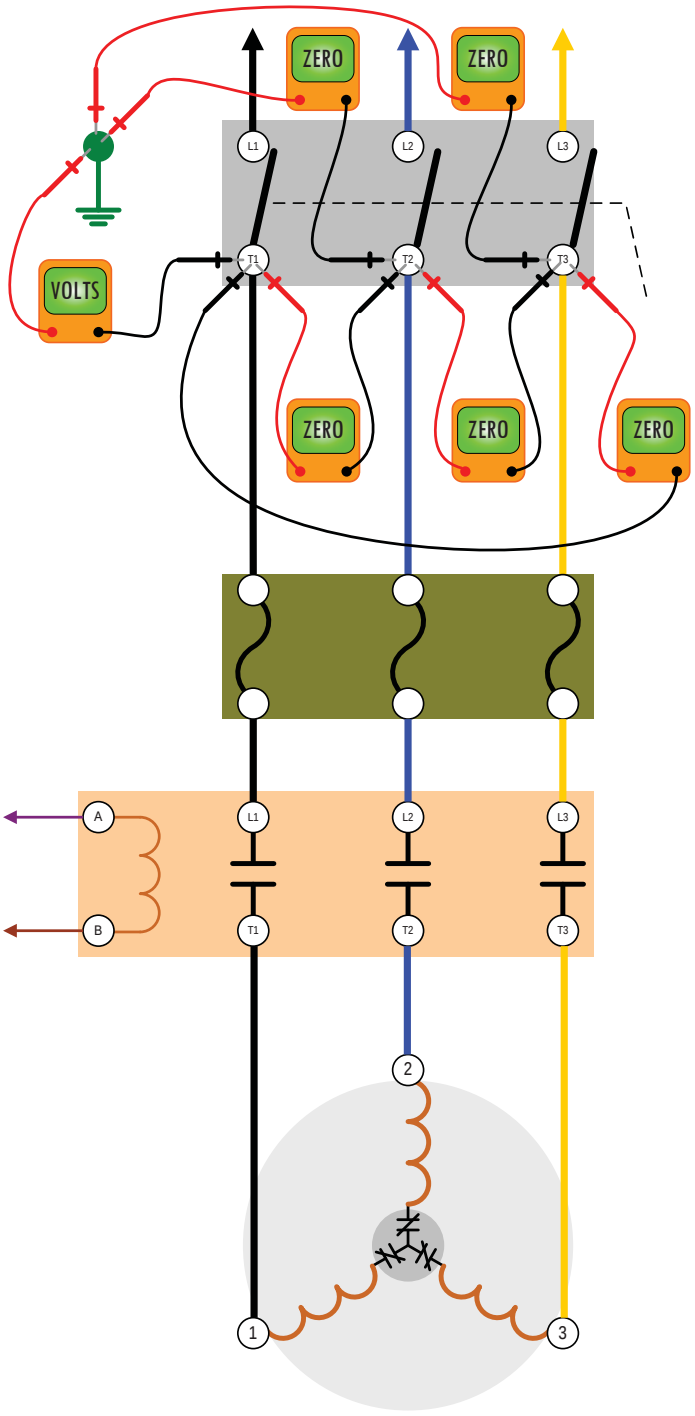


Figure 5-2

If any of the following readings, from the outgoing side (or unit side) of the disconnect, show voltage, there is risk of electrical shock to the technician since line voltage is still present to the unit.

- T1 to T2
- T2 to T3
- T1 to T3
- T1 to cabinet ground
- T2 to cabinet ground
- T3 to cabinet ground

The example illustrated shows all readings to be zero volts except for T1 to cabinet ground. This is an indication that, even though the disconnect handle is in the “off” position, the L1 to T1 knife-blade of the disconnect has not disengaged line voltage to the unit.

The power to the unit must be shut off from the main power-panel if the disconnect will not fully disengage line voltage. A qualified electrician should then replace the failed disconnect.

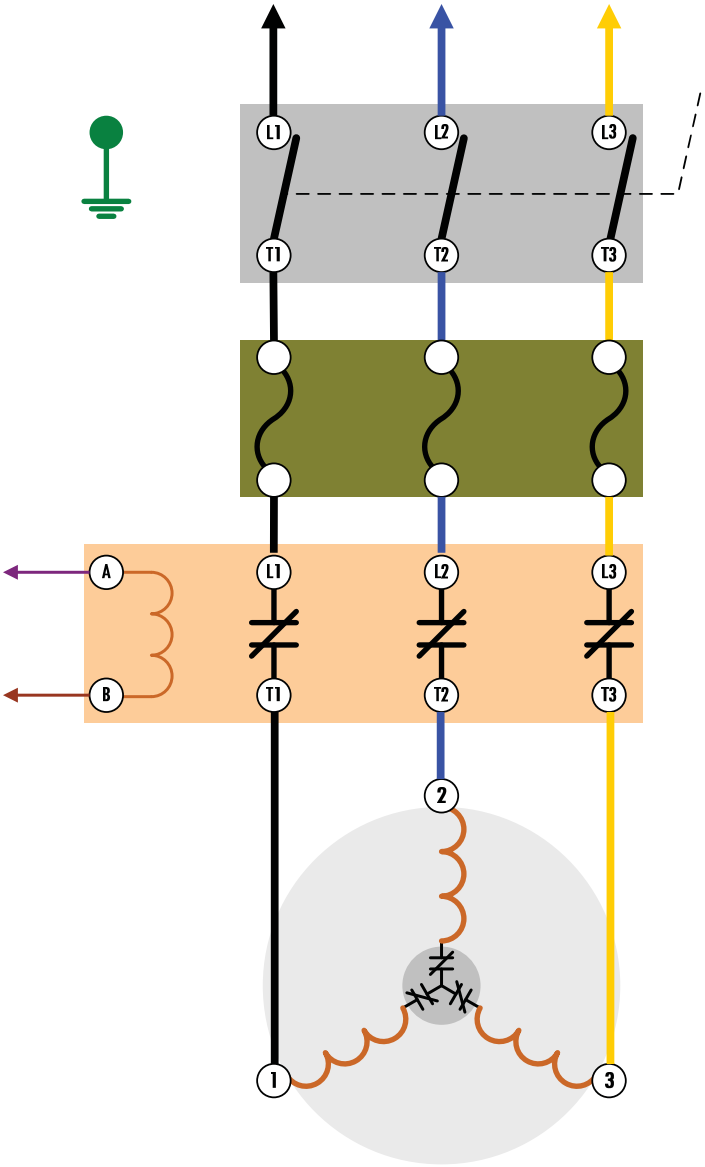


Figure 5-3

A systematic approach to line voltage component electrical troubleshooting will provide the greatest diagnostic accuracy. The following method requires that the equipment be powered. The technician must exercise care and caution to avoid electrical shock and other personal safety hazards.

The accompanying diagram is a simplified version representing the line voltage components which connect to the 3Ø compressor or indoor blower motor. (1Ø PSC condenser fan and power exhaust motors are covered separately)

From the top, the items diagrammed are:

- Up-arrows represent the connection to the power-panel
- A factory-installed or field-mounted power disconnect switch (gray rectangle)
- A fuse block (olive rectangle); may be integral to the disconnect, factory installed in the unit, a portion of a field-installed accessory or omitted depending on circumstances
- A 3-pole contactor (tan rectangle)
- 3Ø, internally-protected motor; either compressor or indoor blower motor. (gray circle)

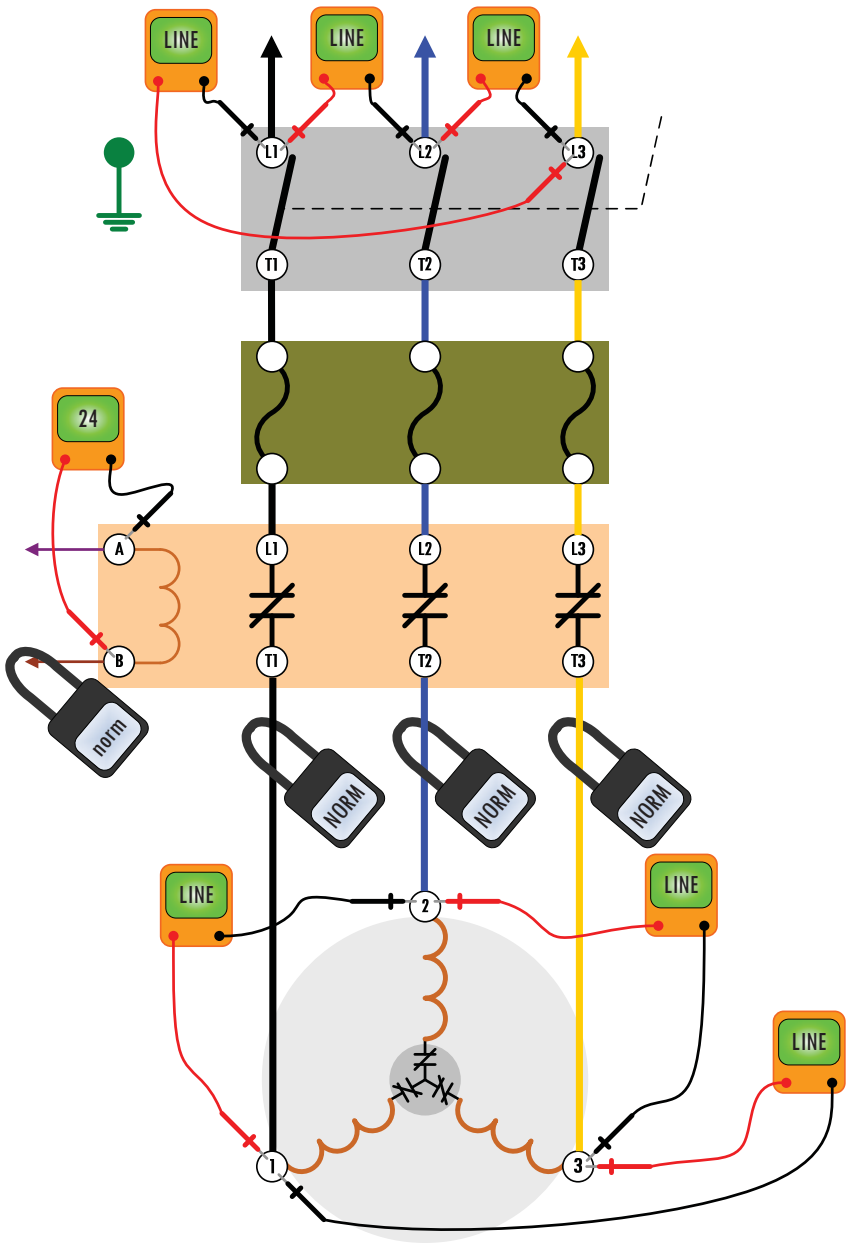


Figure 5-4

Electrical troubleshooting of the line voltage components use:

- Voltage readings of the 3Ø line voltage circuit
- Amperage readings of the 3Ø line voltage circuit
- Confirmation that the 24 volt contactor coil circuit is complete and enabled

The technician's understanding of readings that are normal, as well as recognition of abnormal readings, is key to electrical troubleshooting.

The illustration shows normal readings for an operating 3Ø motor circuit:

- The presence of 24 volts, and normal current draw (typically 1 amp or less) at the contactor coil will confirm the 24 volt circuit is complete and enabled
- The current draw of the motor is NORMal (reasonably close to the motor's R.L.A.) on all three "legs"

Line voltage is read throughout the circuit from any combination of two "legs" (or phases):

- Leg 1 (black) to Leg 2 (blue)
- Leg 2 (blue) to Leg 3 (yellow)
- Leg 1 (black) to Leg 3 (yellow)

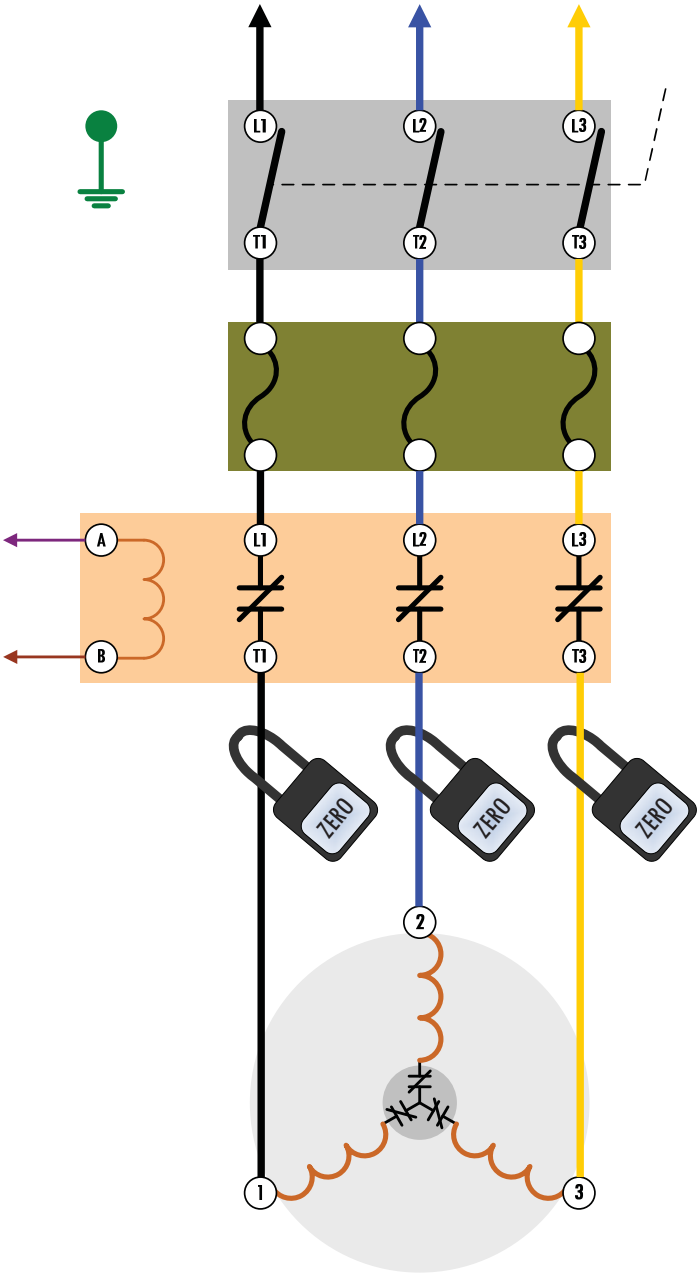


Figure 5-5

The following diagrams and descriptions discuss troubleshooting methods used to identify a variety of problem conditions. While each condition is discussed in isolation, there may be multiple problems existing on a circuit at the same time.

When beginning the electrical troubleshooting process, find the motor's R.L.A. and L.R.A. on the unit/motor data plate. Then read the current draw of each of the 3Ø "legs" of the line voltage circuit. These readings are used to indicate the type of problem, as well as the urgency and care needed for troubleshooting. If each leg of the circuit reads NORMal, as shown in the previous illustration, the 3Ø line voltage circuit is complete and the motor should be operating. If this reading is taken when the motor is supposed to be off, further electrical troubleshooting will be required.

If each leg of the circuit reads zero, as illustrated in Figure 5-5, the 3Ø line voltage circuit is currently open. The open circuit may be temporary, if the motor's internal overload tripped due to overheating. In this case, the open circuit may be a secondary result of another condition. However, during periods with zero current draw there is little chance of further damage to the 3Ø line voltage circuit or equipment.

If each leg of the circuit reads significantly lower than R.L.A. the 3Ø line voltage circuit is complete, but the motor is likely operating at a reduced load. Potential causes for reduced load include reverse rotation or mechanical problems.

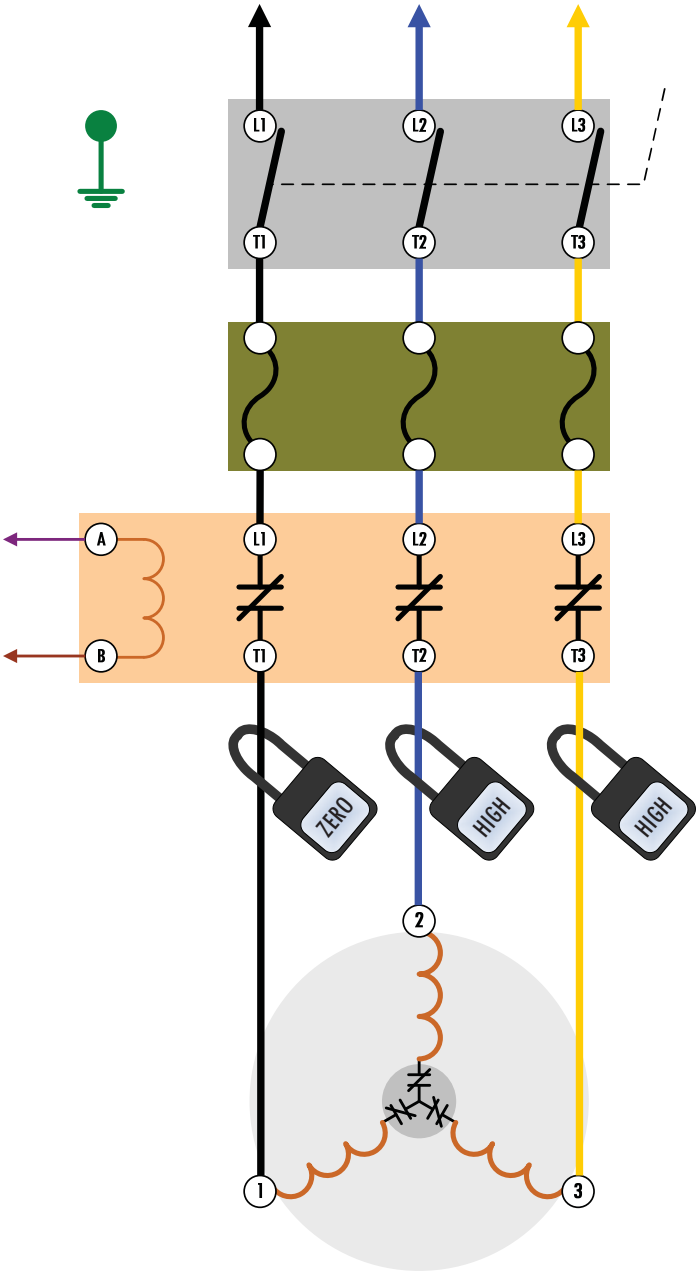


Figure 5-6

A HIGH current draw condition, significantly greater than R.L.A., on any of the 3Ø “legs” of the line voltage circuit requires greater urgency and care for troubleshooting. In this situation, abnormal conditions exist that can be hazardous to the technician or cause further damage to the equipment.

Troubleshooting readings should be made with the motor energized only for the brief periods needed for the readings to register if HIGH current draw exists on any of the 3Ø “legs” of the line voltage circuit. This can be accomplished by quick off-on-off cycling of the disconnect or 24 volts to the the contactor coil; whichever is practical.

Avoid manually “pushing in the contactor” because of the following:

- The potential for electrical burns exists due to the compromised contactor arc shielding
- The close proximity to live voltage components increases the risk of electrical shock
- Unit safeties are effectively bypassed

If only one leg of the circuit reads HIGH current draw, a component of the 3Ø line voltage circuit very likely has a fault to cabinet ground. There is a great risk of electric shock to the technician in this situation. For safety, the disconnect should turned off and the 3Ø line voltage circuit be checked for faults to ground with an ohmmeter to identify the problem.

If two legs of the circuit read HIGH current draw, and the remaining leg reads ZERO current draw, as seen in Figure 5-6, one leg of the 3Ø line voltage circuit is incomplete (or lost). This condition is also referred to as a “single phased” circuit. If this condition exists, even for a short time period, the following (which add greater complexity to the troubleshooting process) may occur:

- The motor’s internal protector may trip
- Fuses may blow
- The circuit breaker in the power panel may trip
- Equipment damage may result

If all three legs of the circuit read HIGH current draw, the 3Ø line voltage circuit is complete; however, if L.R.A. is read, the motor cannot start or is locked due to mechanical failure. If higher than L.R.A. is read at any one or combination of legs, there is a short present.

When all three legs of the circuit read HIGH current draw extreme energies are present that can quickly cause failures that pose safety hazards to the technician. Additionally, the following conditions (which add greater complexity to the troubleshooting process) may occur:

- The motor's internal protector may trip
- Fuses may blow
- The circuit breaker in the power panel may trip
- Equipment damage may result

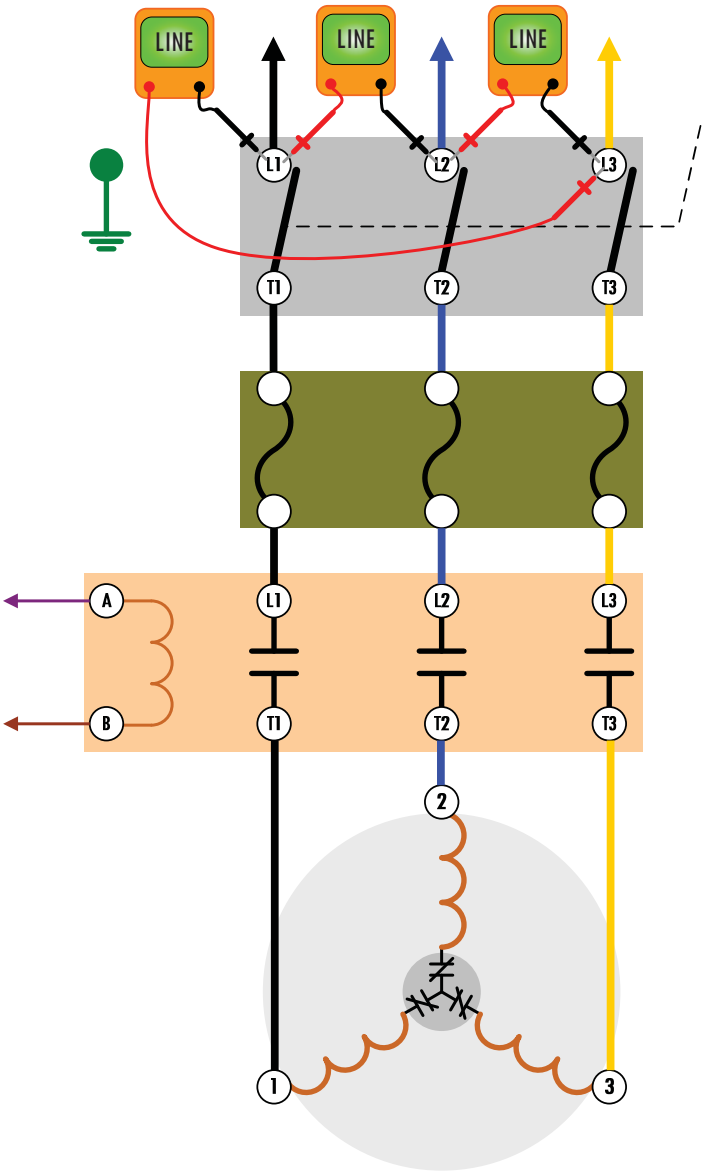


Figure 5-7

After the current draw of each of the 3Ø "legs" of the line voltage circuit has been measured, then a series of voltage readings, done briefly if any legs read HIGH current draw, are the next step in systematic electrical troubleshooting.

The voltage readings begin with confirmation that 3Ø line voltage is available to the unit. Line voltage appropriate to the unit's rating must be read from the incoming lugs of the disconnect to the following:

- L1 to L2
- L2 to L3
- L1 to L3

If these readings are not present, refer to Figure 5-14 through Figure 5-20 for further troubleshooting procedures.

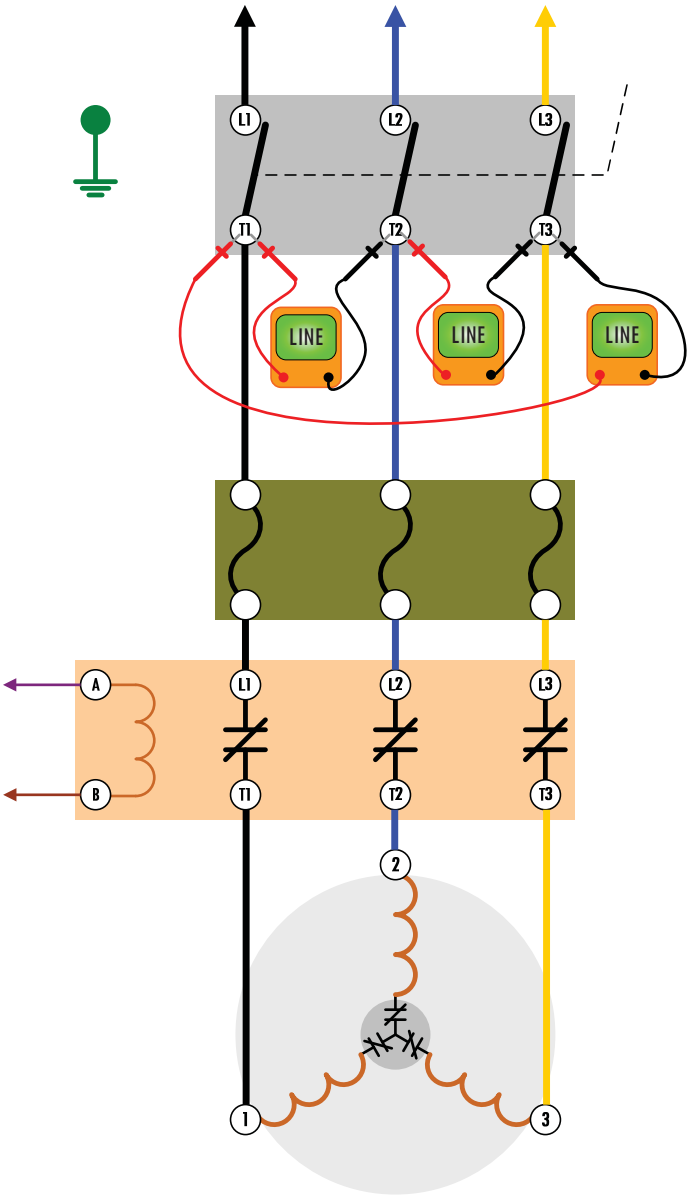


Figure 5-8

Next is confirmation that the switch-gear of the disconnect is intact.

Line voltage should be read from the outgoing lugs of the disconnect:

- T1 to T2
- T2 to T3
- T1 to T3

If these readings are not present, refer to Figure 5-21 for further troubleshooting procedures.

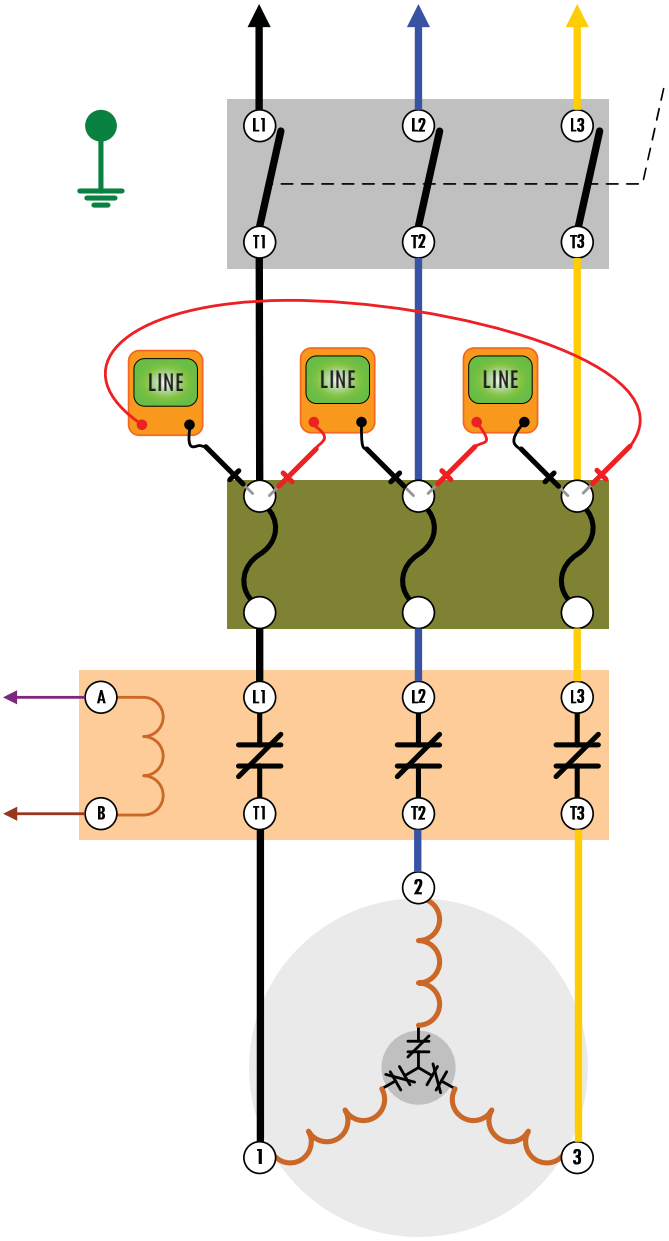


Figure 5-9

Next is confirmation that the disconnect to fuse-block wiring, and connections are intact. Line voltage should be read from the incoming lugs of the fuse-block:

- Leg 1 (black) to Leg 2 (blue)
- Leg 2 (blue) to Leg 3 (yellow)
- Leg 1 (black) to Leg 3 (yellow)

If these readings are not present, refer to Figure 5-22 for further troubleshooting procedures.

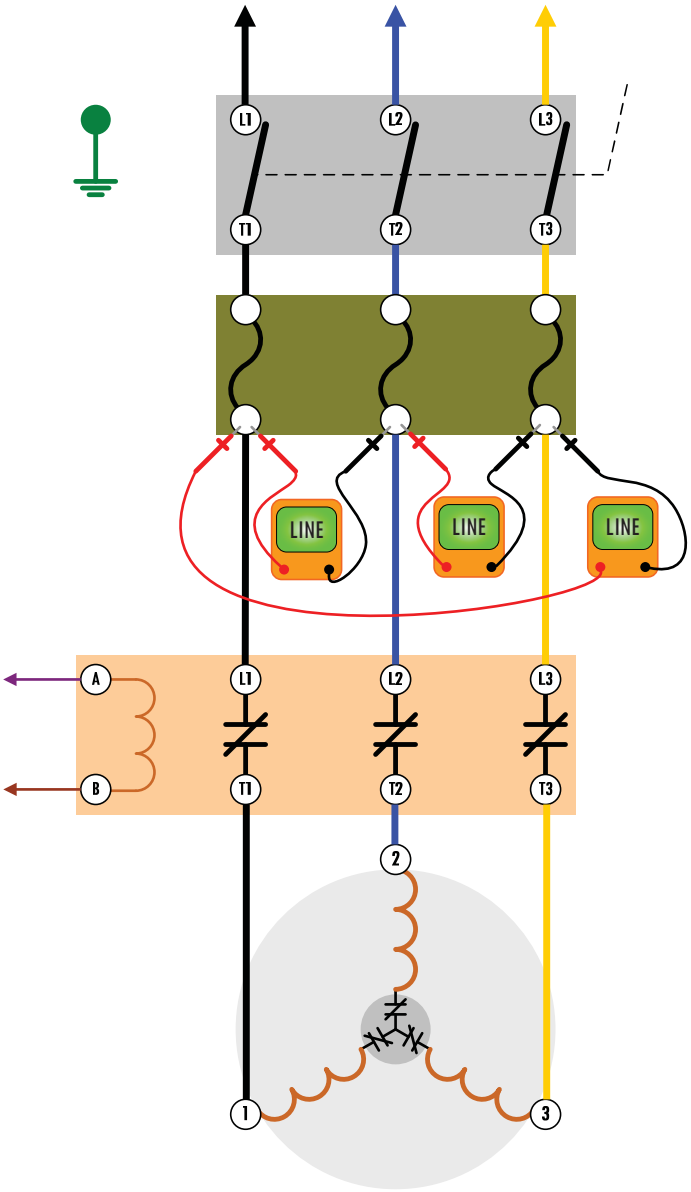


Figure 5-10

Next is confirmation that there are no blown fuses, and that the fuse-holders and connections are intact.

Line voltage should be read from the outgoing lugs of the fuse-block:

- Leg 1 (black) to Leg 2 (blue)
- Leg 2 (blue) to Leg 3 (yellow)
- Leg 1 (black) to Leg 3 (yellow)

If these readings are not present, refer to Figures 5-23 and 5-24 for further troubleshooting procedures.

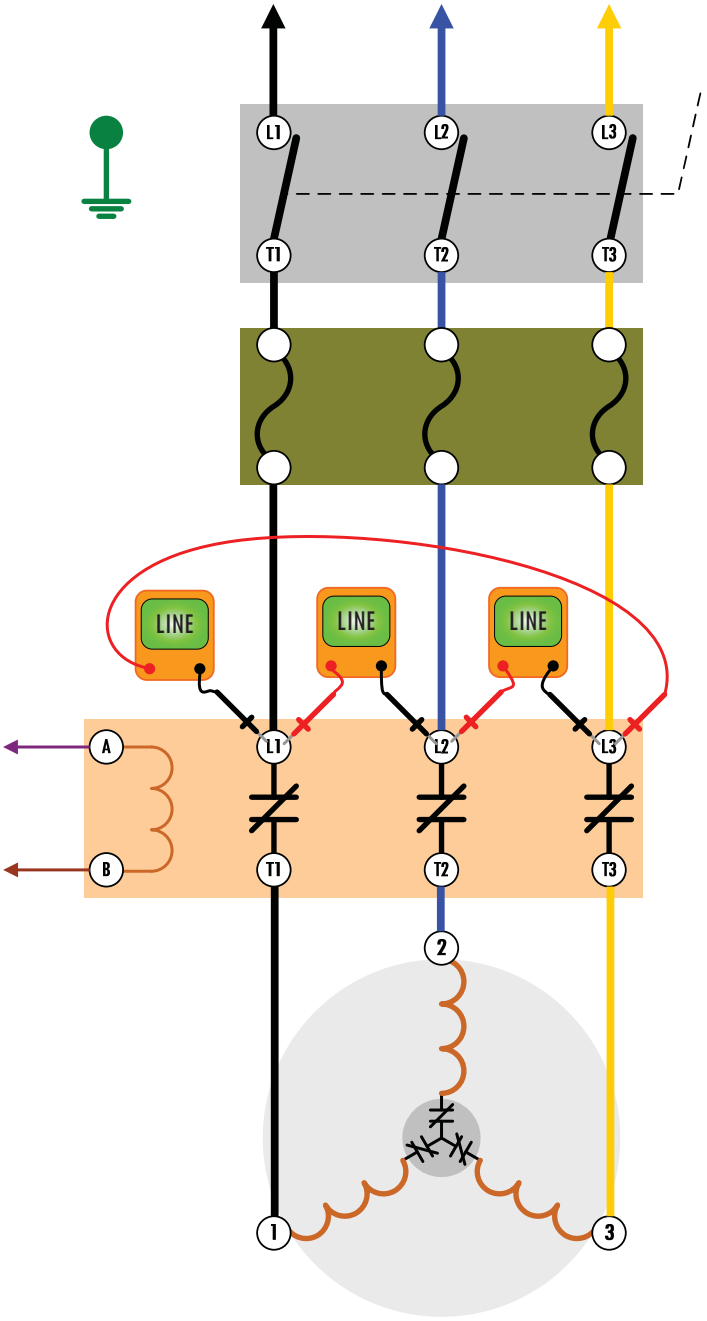


Figure 5-11

Next is confirmation that the fuse-block to contactor wiring and connections are intact. Line voltage should be read from the incoming lugs of the contactor:

- L1 to L2
- L2 to L3
- L1 to L3

If these readings are not present, refer to Figure 5-25 for further troubleshooting procedures.

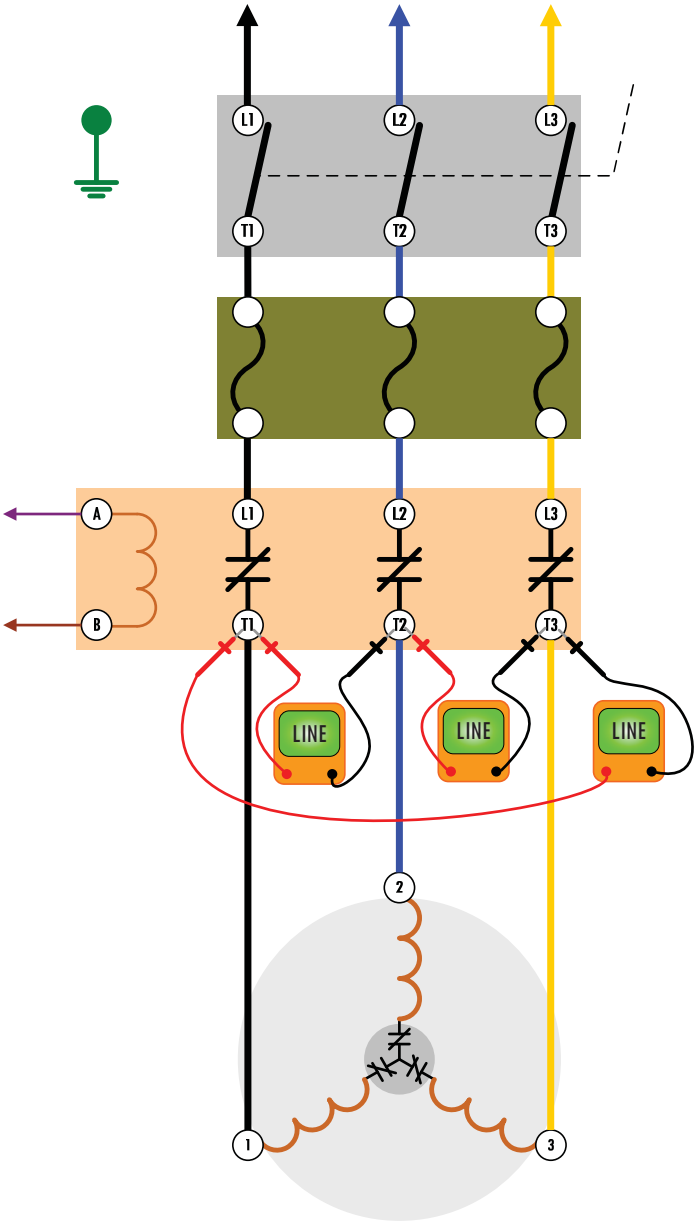


Figure 5-12

Next is confirmation that the contactor is energized, and its contacts are engaged.

Line voltage should be read from the outgoing lugs of the contactor:

- T1 to T2
- T2 to T3
- T1 to T3

If these readings are not present, refer to Figures 5-26 and 5-27 for further troubleshooting procedures.

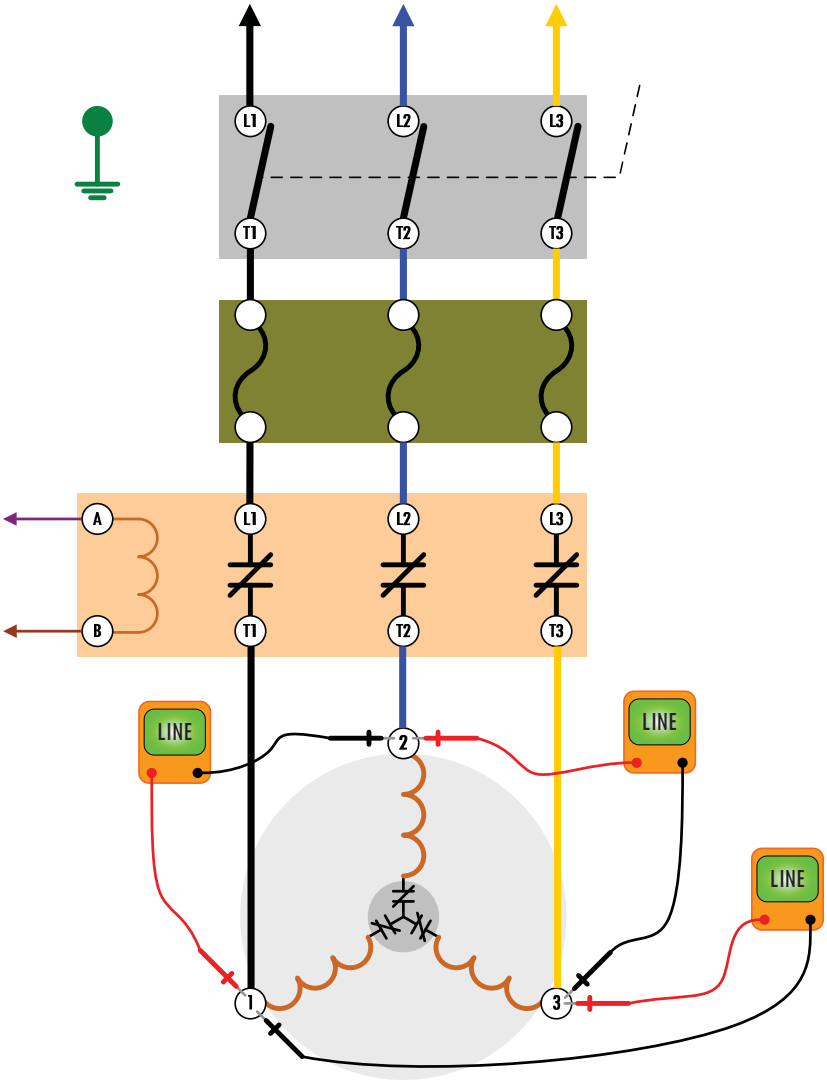


Figure 5-13

The final voltage reading confirms that the wiring and connections to the motor are intact.

Line voltage should be read from the terminals of the motor:

- Leg 1 (black) to Leg 2 (blue)
- Leg 2 (blue) to Leg 3 (yellow)
- Leg 1 (black) to Leg 3 (yellow)

If these readings are not present, refer to Figure 5-28 through Figure 5-37 for further troubleshooting procedures.

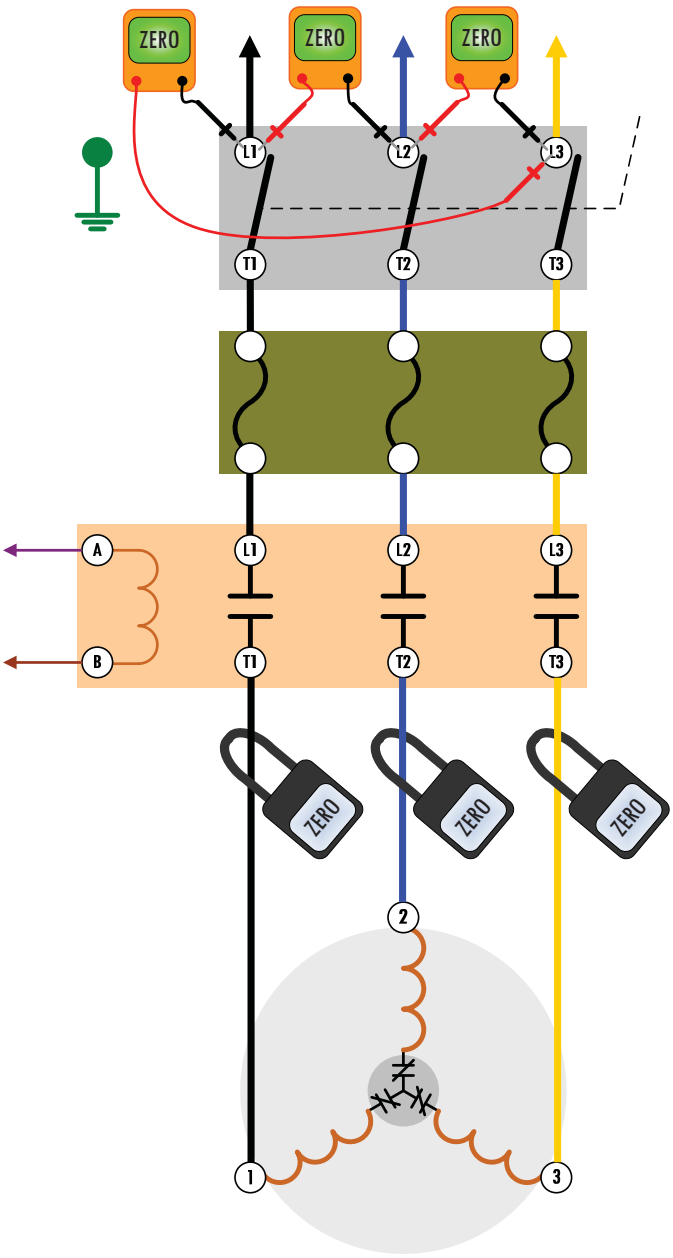


Figure 5-14

If ZERO voltage is read from all combinations of the incoming lugs of the disconnect:

- L1 to L2
- L2 to L3
- L1 to L3

Then at least two legs of the 3Ø circuit from the power panel have been lost.

The next step is to determine whether only two legs or all three legs of the 3Ø circuit from the power panel have been lost.

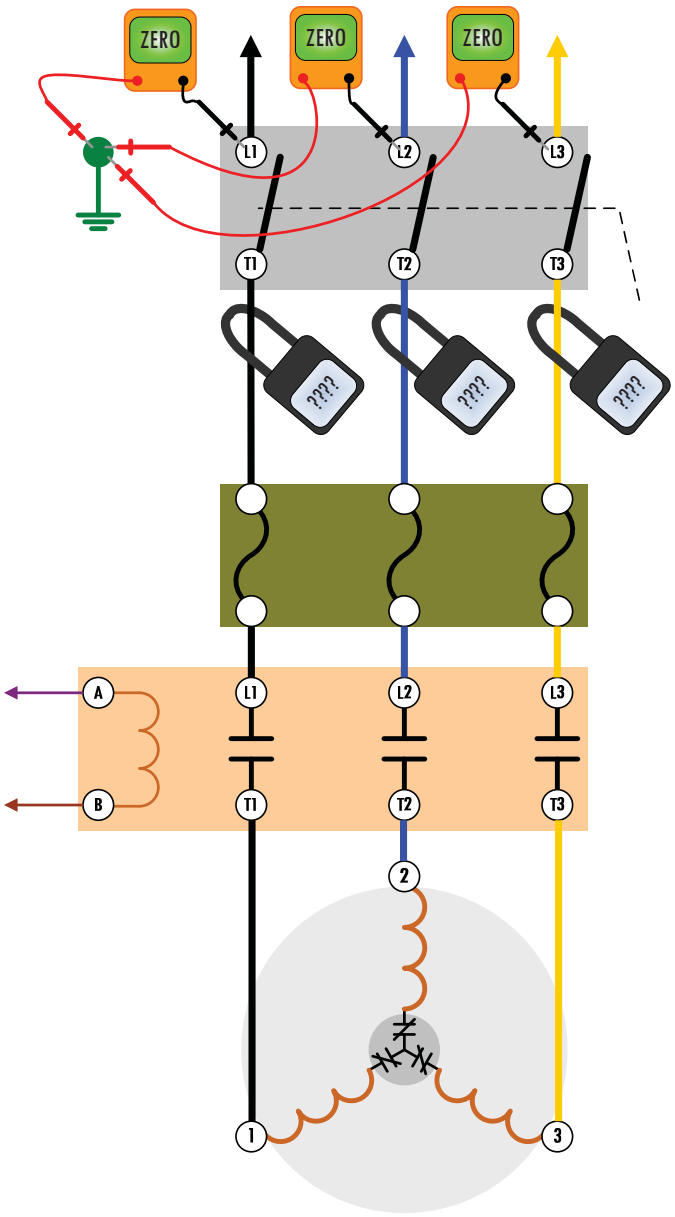


Figure 5-15

With the disconnect “off”, if ZERO voltage is read from all combinations of the incoming lugs of the disconnect to cabinet ground:

- L1 to cabinet ground
- L2 to cabinet ground
- L3 to cabinet ground

Then all three legs of the 3Ø circuit from the power panel have been lost.

This condition may be caused by a lack of power to the power panel or incomplete wiring to the disconnect. Correction of power issues of this type and are not typically the HVAC technician’s responsibility, and a qualified electrician should be consulted.

The technician may be able to restore the 3Ø line voltage if this condition is due to a turned “off” or tripped breaker or if all three fuses of a fused power panel are blown.

With the disconnect remaining “off”, use an ohmmeter to check for shorted or grounded components. This should be done prior to restoring power to the unit.

Once corrections have been made to restore power, before turning on the disconnect, the 3Ø line voltage to the incoming lugs of the disconnect should be confirmed as follows:

- L1 to L2 reads line voltage
- L2 to L3 reads line voltage
- L1 to L3 reads line voltage

When the disconnect is turned “on”, overall current draw of the unit should be monitored to determine if a unit fault is causing high current draw (amp-meter segment of the illustration).

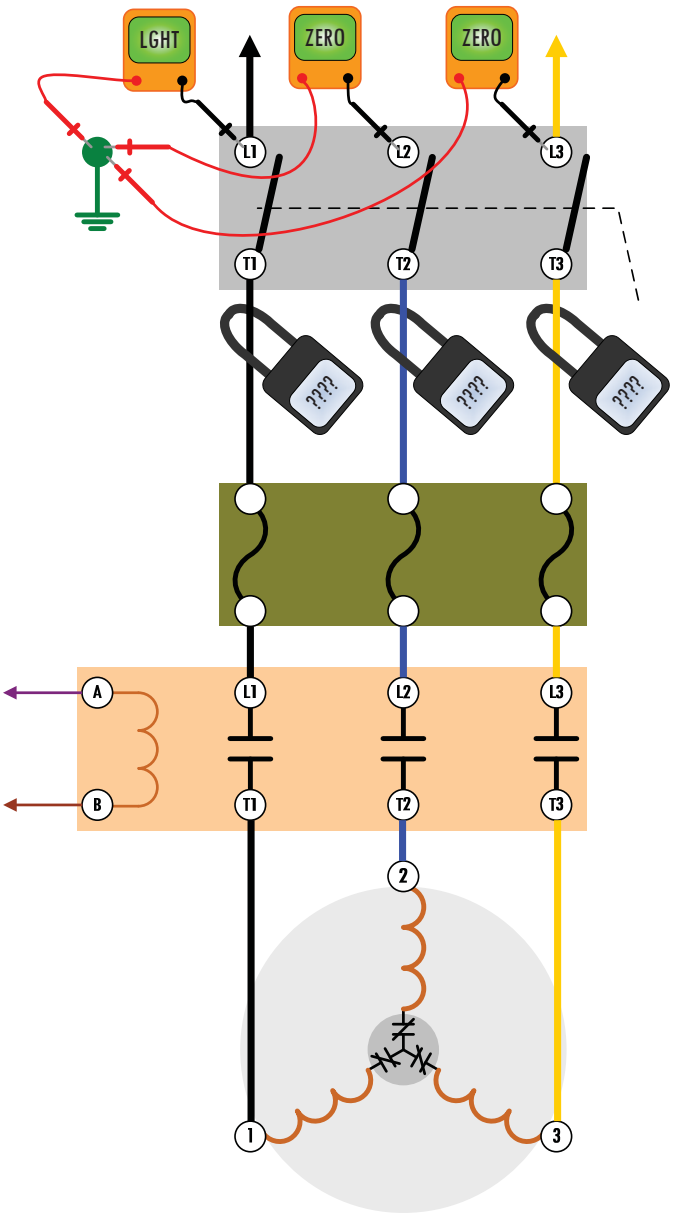


Figure 5-16

With the disconnect “off”, if voltage (LiGHTing circuit typically.) is read from any one of the incoming lugs of the disconnect to cabinet ground:

- L1 to cabinet ground
- L2 to cabinet ground
- L1 to cabinet ground

Then two legs of the 3Ø circuit from the power panel have been lost. (L1-black remains, L2-blue & L3-yellow lost in the illustration)

This condition poses the risk of a hazardous electric shock because the presence of live voltage is not apparent until the second level of voltage readings to cabinet ground are performed. With this condition the disconnect should be locked and tagged out until repairs to the incoming power supply are complete.

This condition may be caused by the following issues:

- Incomplete power to the power panel
- Incomplete power wiring to the disconnect
- A failed circuit breaker

Correction of power issues of this type are not typically the HVAC technician’s responsibility, and a qualified electrician should be consulted.

The technician may be able to restore the 3Ø line voltage if this condition is caused by failure of two of the three fuses of a fused power panel. With the disconnect remaining “off”, an ohmmeter check for shorted or grounded components should be completed prior to restoring power to the unit.

Once corrections have been made to restore power, before turning on the disconnect, the 3Ø line voltage to the incoming lugs of the disconnect must be confirmed as follows:

- L1 to L2 reads line voltage
- L2 to L3 reads line voltage
- L1 to L3 reads line voltage

When the disconnect is turned “on”, overall current draw of the unit should be monitored to determine if a unit fault is causing high current draw (amp-meter segment of the illustration).

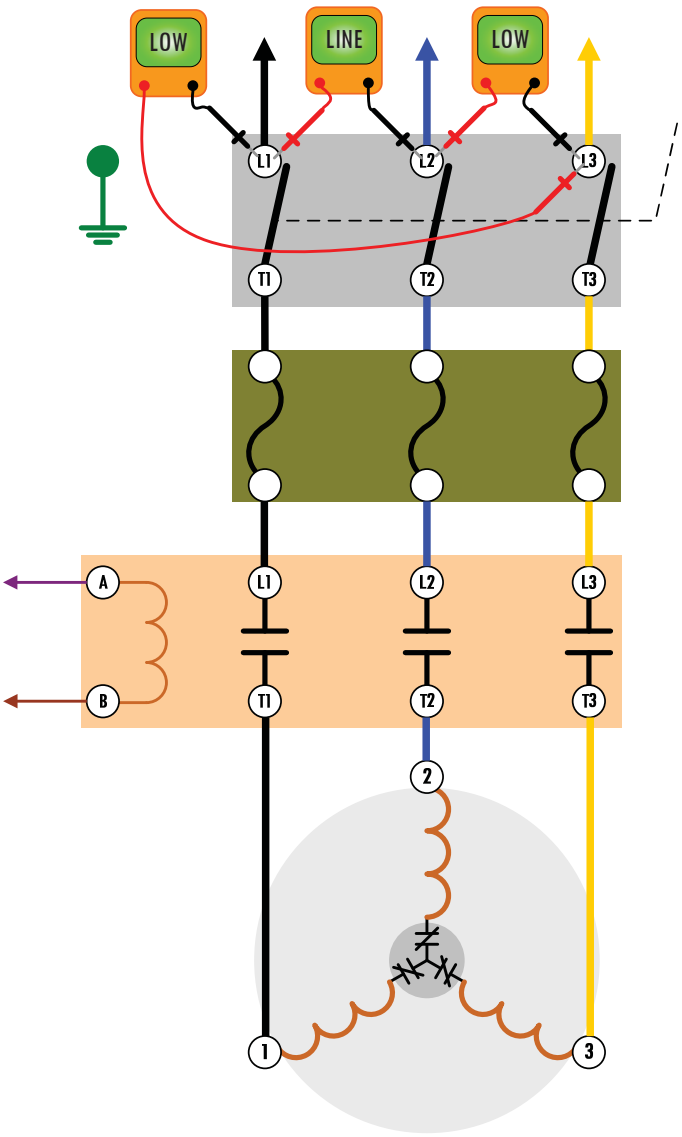


Figure 5-17

If less than line voltage is read from any combination of the incoming lugs of the disconnect:

- L1 to L2
- L2 to L3
- L1 to L3

Then the 3Ø circuit is not complete from the power panel. This condition is often referred to as “single phasing”.

The illustration depicts the loss of the yellow, phase 3 leg from the power panel where:

- L1 to L2 reads line voltage
- L2 to L3 reads “LOW” (significantly below line voltage)
- L1 to L3 reads “LOW” (significantly below line voltage)

“LOW” readings can be present when circuits on the leaving side of the disconnect produce “feedback” voltage to the lost leg.

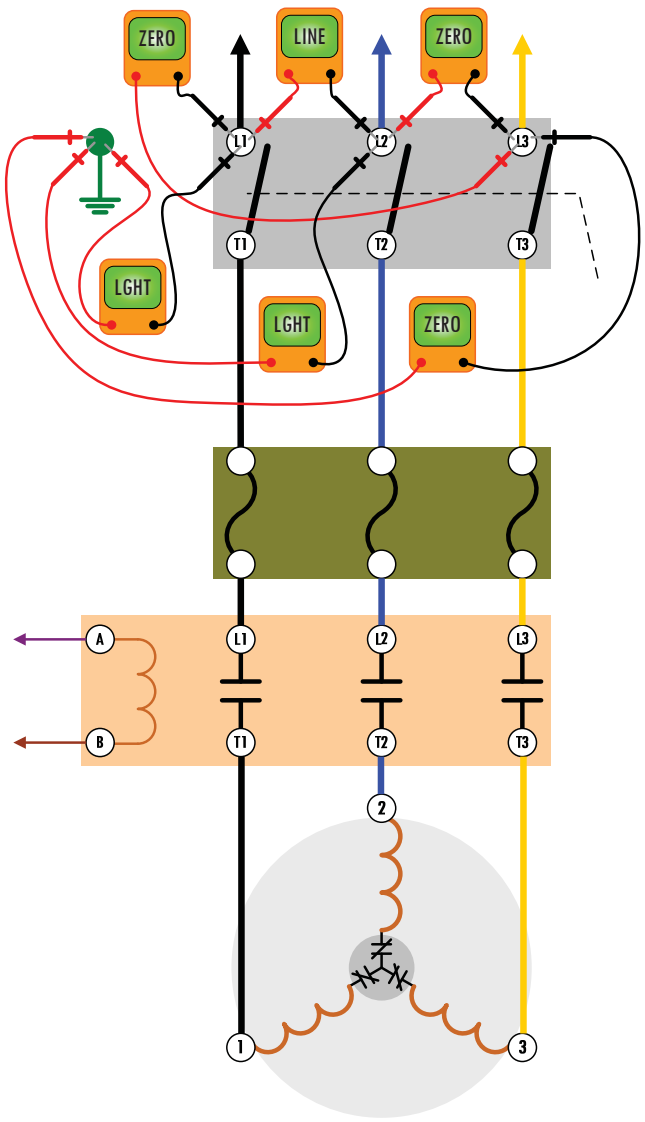


Figure 5-18

To eliminate the path for feedback voltage, the disconnect is placed in the “off” position to allow clarification of the voltage readings. With the disconnect “off”, the readings are:

- L1 to L2 reads line voltage
- L2 to L3 reads ZERO
- L1 to L3 reads ZERO

In most troubleshooting situations, voltage readings to cabinet ground on a 3Ø circuit can be misleading due to feedback voltage. However, the situation illustrated is an exception.

Because feedback voltage is eliminated to the incoming 3Ø circuit with the disconnect “off”, further confirmation of the loss of a leg to the incoming 3Ø circuit can be made through voltage readings to cabinet ground. Legs that remain “live” will indicate lighting circuit voltage (LGHT) to cabinet ground:

- There will be 115 volts read when 208 volts is supplied from wye-wound power supply transformers.
- There will be 120 volts read on two legs when 240 volts is supplied from deltawound power supply transformers, and the remaining “wild” leg will read ˜190 volts.
- There will be 277 volts read when 460 volts is supplied from wye-wound power supply transformers.

In the example illustrated:

- L1 to cabinet ground reads lighting circuit voltage
- L2 to cabinet ground reads lighting circuit voltage
- L3 to cabinet ground reads zero volts

These voltage readings confirm that the yellow, phase 3 leg of the incoming 3Ø circuit has been lost.

At locations other than those with a fused power panel, a qualified electrician should be consulted if the incoming 3Ø circuit is incomplete in the manner described above.

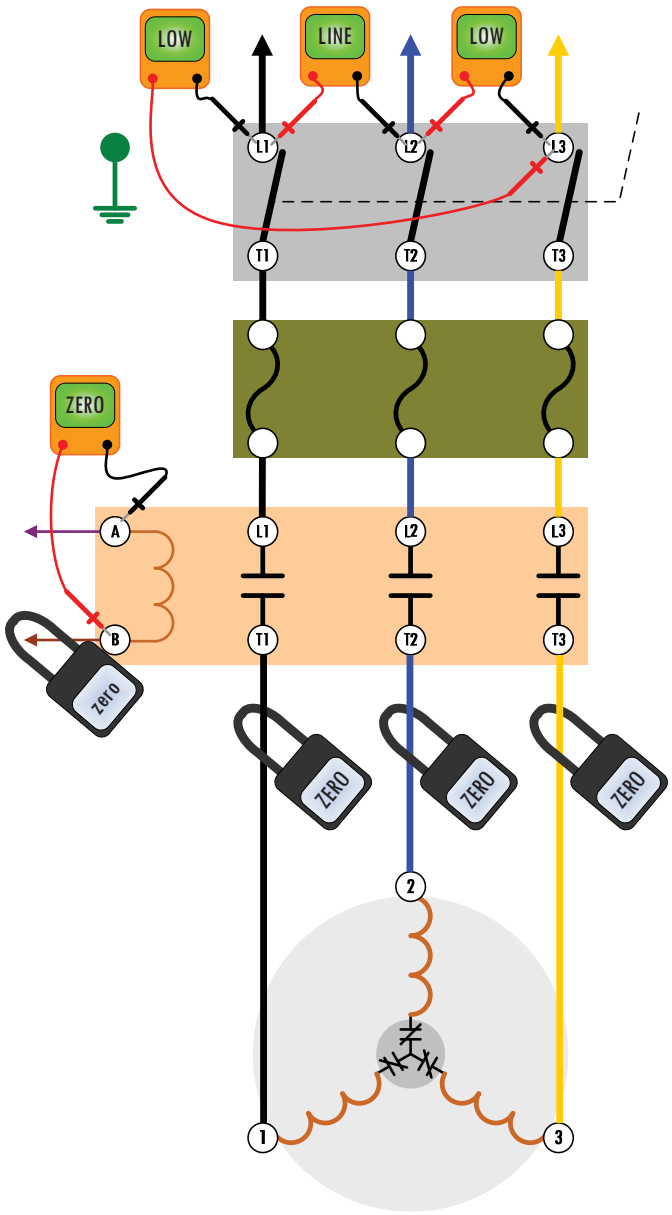


Figure 5-19

The control transformer primary is factory-wired to black (phase 1) and yellow (phase 3) within the unit.

If either of these legs are lost from the incoming 3Ø circuit or at any point prior to the connection to the control transformer primary, then 24 volts will not be available.

Without 24 volts, the unit's controls cannot function, the contactor coil will not be energized (illustrated) and the unit will be idle.

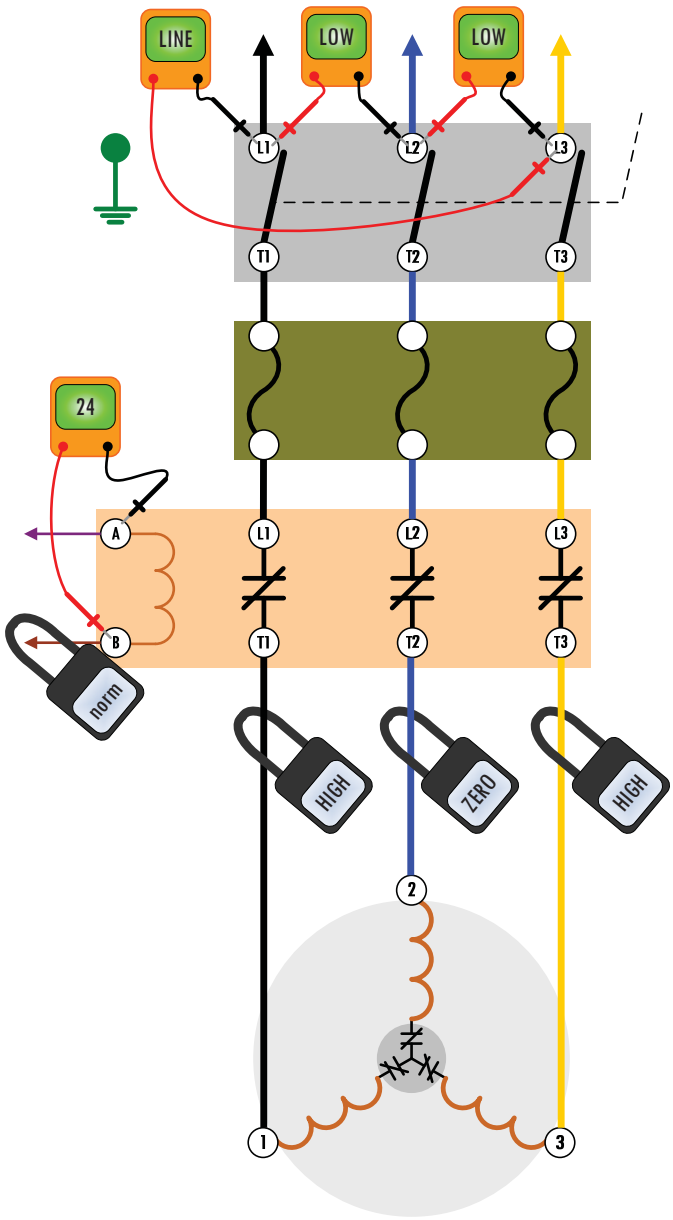


Figure 5-20

The control transformer primary is factory-wired to black (phase 1) and yellow (phase 3) within the unit. If the blue (phase 2) leg is lost, the control transformer primary remains energized and 24 volts will be available.

With 24 volts available, the unit's controls function and the contactor coil can be energized (illustrated).

However, the 3Ø motor will be "single-phased" if a leg is lost from the incoming 3Ø circuit or at any point prior to the connection to the motor. If the 3Ø motor is single-phased, there will be zero current on the leg that is lost, and the other two legs will have high current draw.

If the motor was turning and the leg was lost, it may continue to turn while single-phased at reduced power. This may result in the motor stalling. While the motor is turning, the two legs that are drawing current will read significantly greater than R.L.A.

If the motor is not turning when the leg is lost, and attempts to start while single-phased or has stalled, the two legs that are drawing current will read at or near L.R.A.

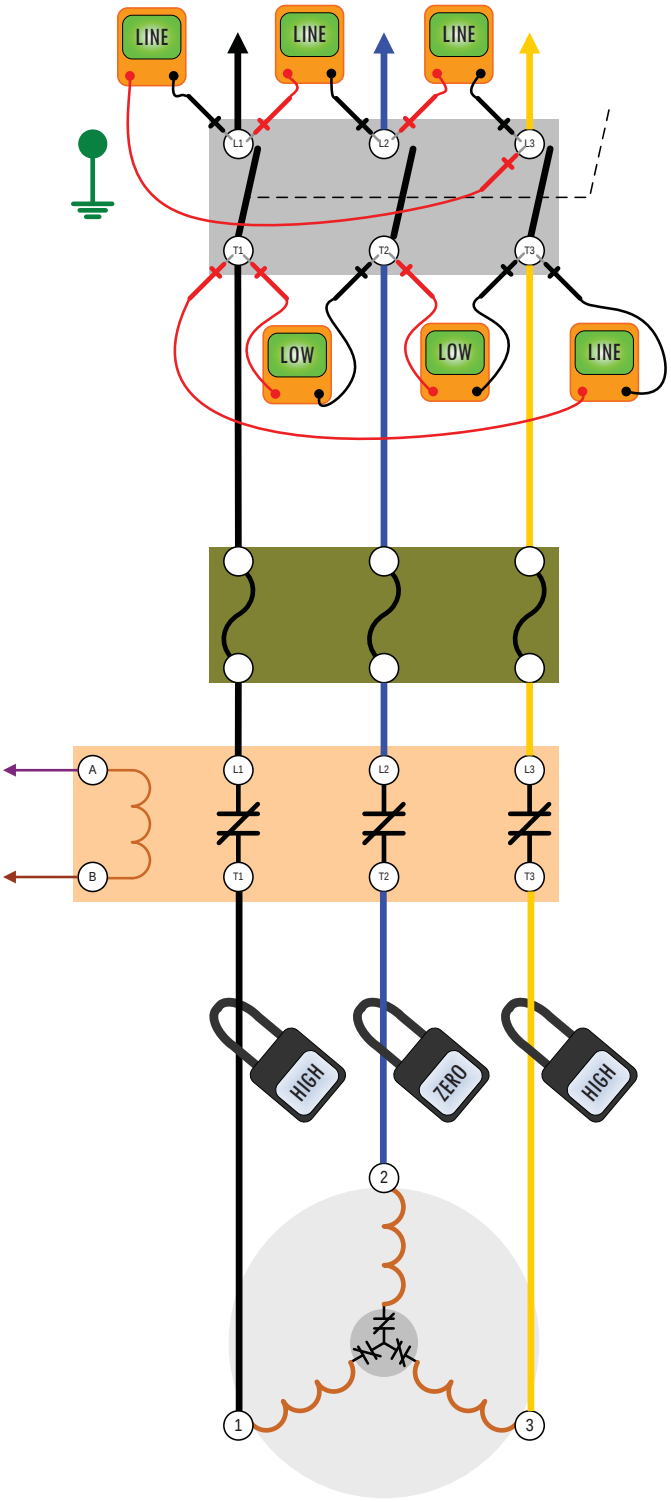


Figure 5-21

If the 3Ø line voltage is complete at the incoming lugs of the disconnect, but is not complete at the outgoing lugs of the onpositioned disconnect, then the connections or switch-gear of the disconnect are faulty. In most cases where the disconnect is faulty, a qualified electrician will need to be consulted for repairs.

The readings illustrated show that the L2 to T2 switch-gear or connections of the disconnect are electrically open, and the line voltage circuit is “single-phased”.

Power panel breaker trips, blown fuses and motor protector trips are typical related damage when the line voltage circuit is “single-phased”.

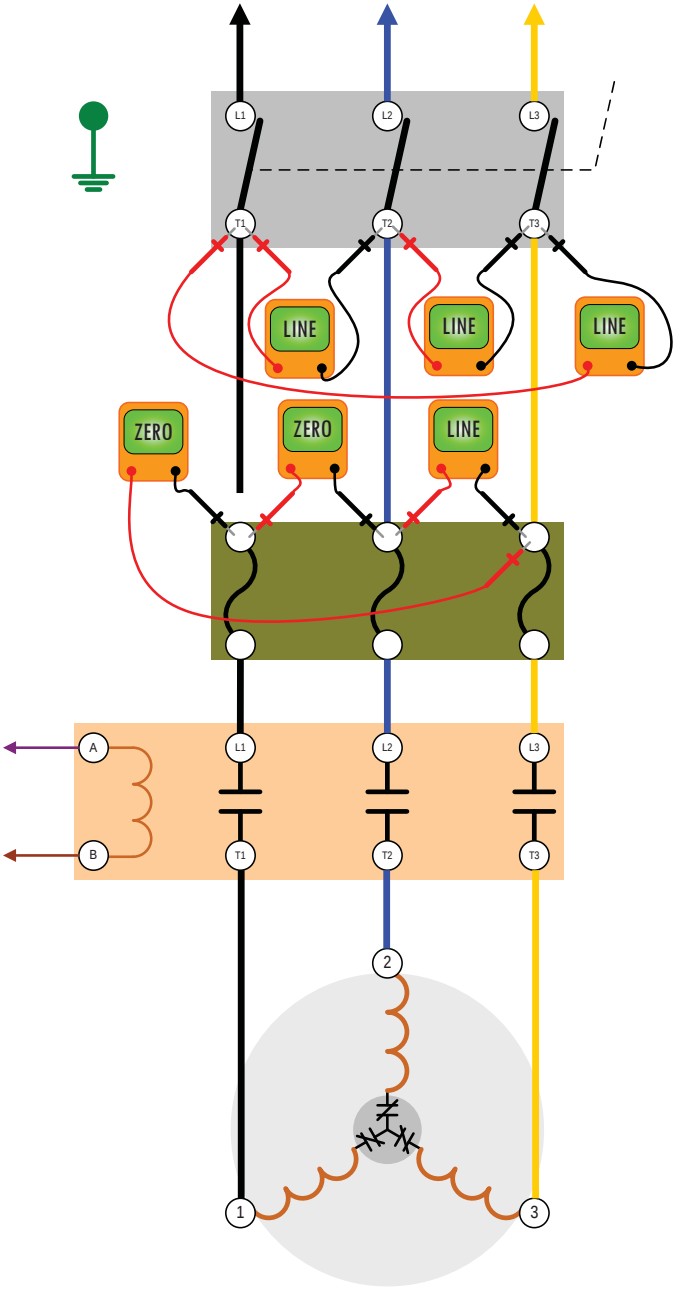


Figure 5-22

If the 3Ø line voltage is complete at the outgoing lugs of the disconnect, but is not complete at the incoming lugs of the fuse block, then the connections or wiring between the disconnect and fuse block are faulty.

Often when these readings are found there will be visible discoloration or damage to the connections or wiring terminations. Typically, the component damage originates with loose connections.

The readings illustrated show that the disconnect T1 to fuse block Leg 1 (black) wiring or connections are electrically open, and the line voltage circuit is “single-phased”.

Power panel breaker trips, blown fuses and motor protector trips are typical related damage when the line voltage circuit is “single-phased”.

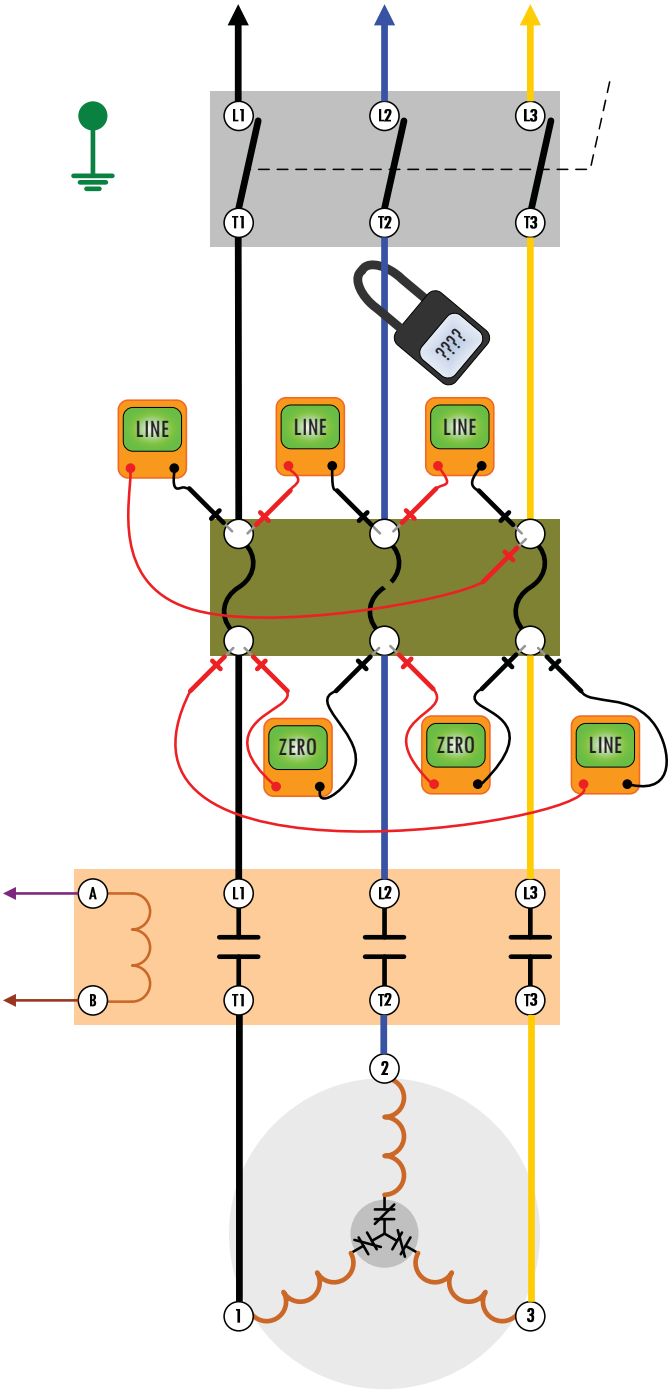


Figure 5-23

If the 3Ø line voltage is complete at the incoming lugs of the fuse block, but is not complete at the outgoing lugs of the fuse block, then at least one fuse has blown or the connections of the fuse block are faulty. The readings illustrated show that the fuse block Leg 2 (blue) fuse is blown (open), and the line voltage circuit is “single-phased”. Power panel breaker trips, blown fuses and motor protector trips are typical related damage when the line voltage circuit is “single-phased”. In cases where blown fuses are found, the fuses and fuse holders should be inspected for loose connections that will lead to repeat failures. Visible discoloration or damage due to heating, and arc traces are indicators of loose fuse holders. The fuse block will need to be replaced if the fuse holders are faulty. In cases where the faulty fuse holder is integral to the disconnect, a qualified electrician will need to be consulted for repairs.

Once corrections have been made to replace the fuse or fuse block and power is restored, the current draw of the unit, with emphasis on the leg that had the blown fuse, should be monitored to determine if a unit fault is causing high current draw (amp-meter segment of the illustration).

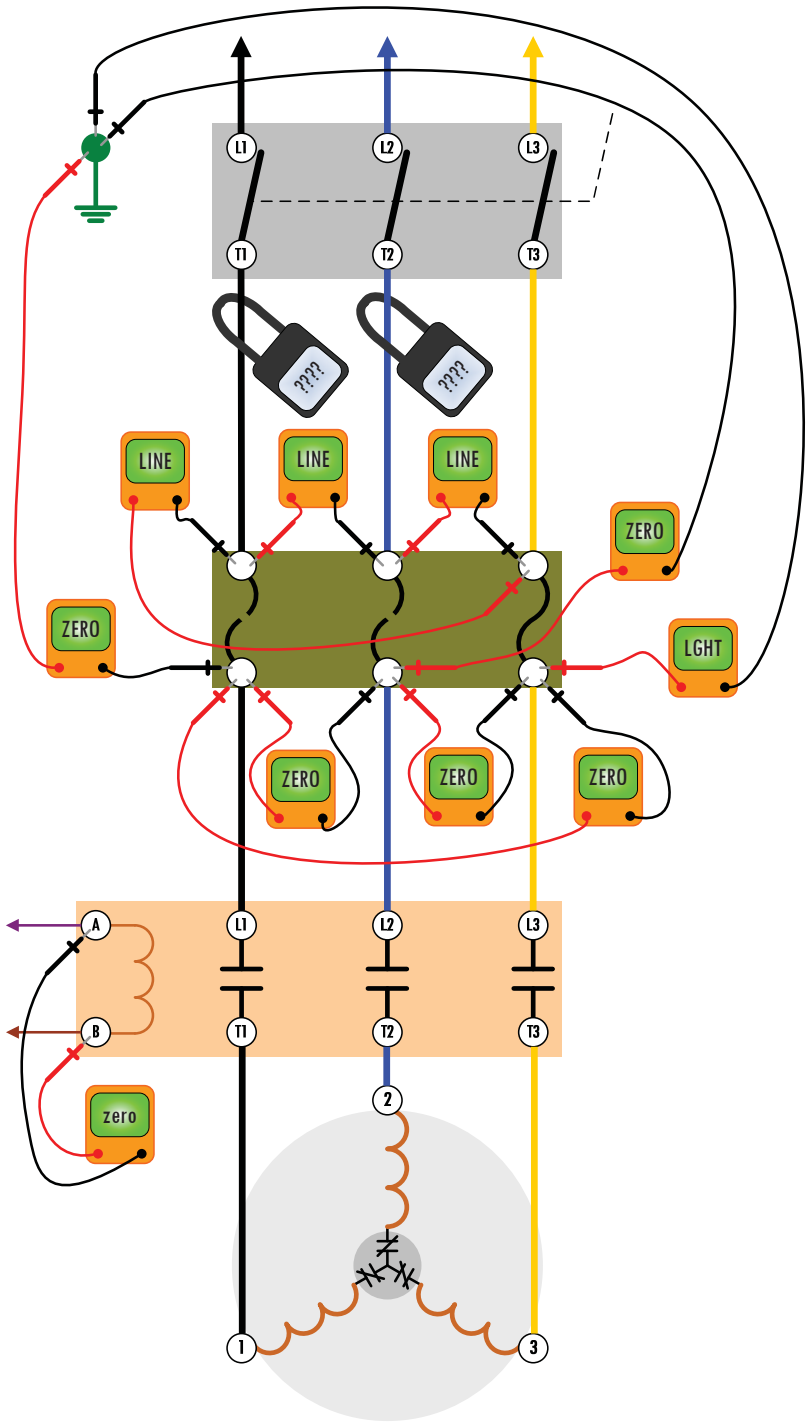


Figure 5-24

Often, two fuses will blow when the 3Ø line voltage is complete at the incoming lugs of the fuse block, but is not complete at the outgoing lugs of the fuse block.

The readings illustrated show that both the fuse block Leg 1 (black), and the Leg 2 (blue) fuses are blown. To determine which fuses are blown, and to prevent "feedback", the technician should ensure that the contactor is de-energized (voltmeter at the contactor segment of the illustration).

In this scenario, if "feedback" is present with the contactor coil deenergized it is likely that the contactor contacts are not disengaged.

Next, readings to cabinet ground are made from each outgoing lug of the fuse block:

- Leg 1 (black) to cabinet ground
- Leg 2 (blue) to cabinet ground
- Leg 3 (yellow) to cabinet ground

The leg with the intact fuse will read the lighting circuit voltage to cabinet ground, while each leg with a blown fuse will indicate zero volts to cabinet ground.

Once the blown fuses have been replaced and power is restored, the current draw of the unit, with emphasis on the legs that had blown fuses, should be monitored to determine if a unit fault is causing high current draw (amp-meter segment of the illustration).

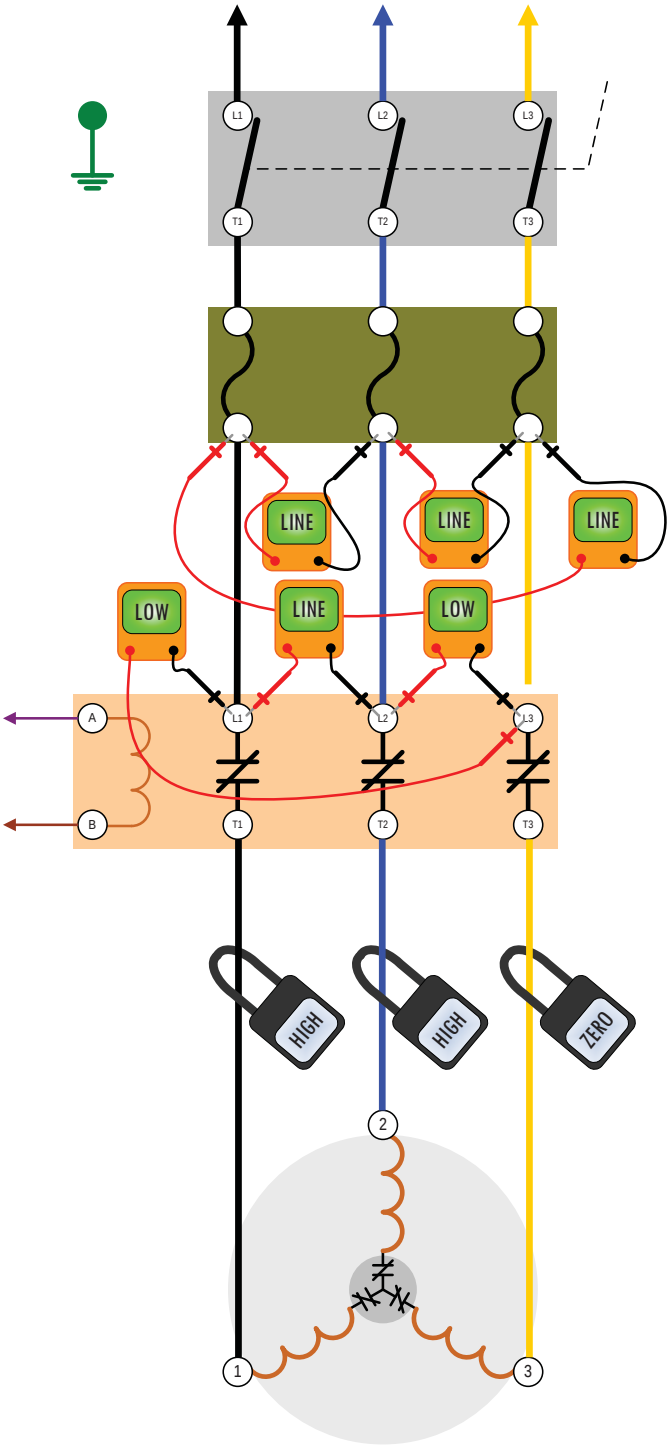


Figure 5-25

If the 3Ø line voltage is complete at the outgoing lugs of the fuse block, but is not complete at the incoming lugs of the contactor, then the connections or wiring the connecting between the fuse block and contactor are faulty.

Often when these readings are found there will be visible discoloration or damage to the connections or wiring terminations. Typically, the component damage originates with loose connections.

The illustration shows that the fuse block Leg 3 (black) to contactor L3 wiring or connections are electrically open, and the line voltage circuit is “single-phased”.

Power panel breaker trips, blown fuses and motor protector trips are typical related damage when the line voltage circuit is “single-phased”.

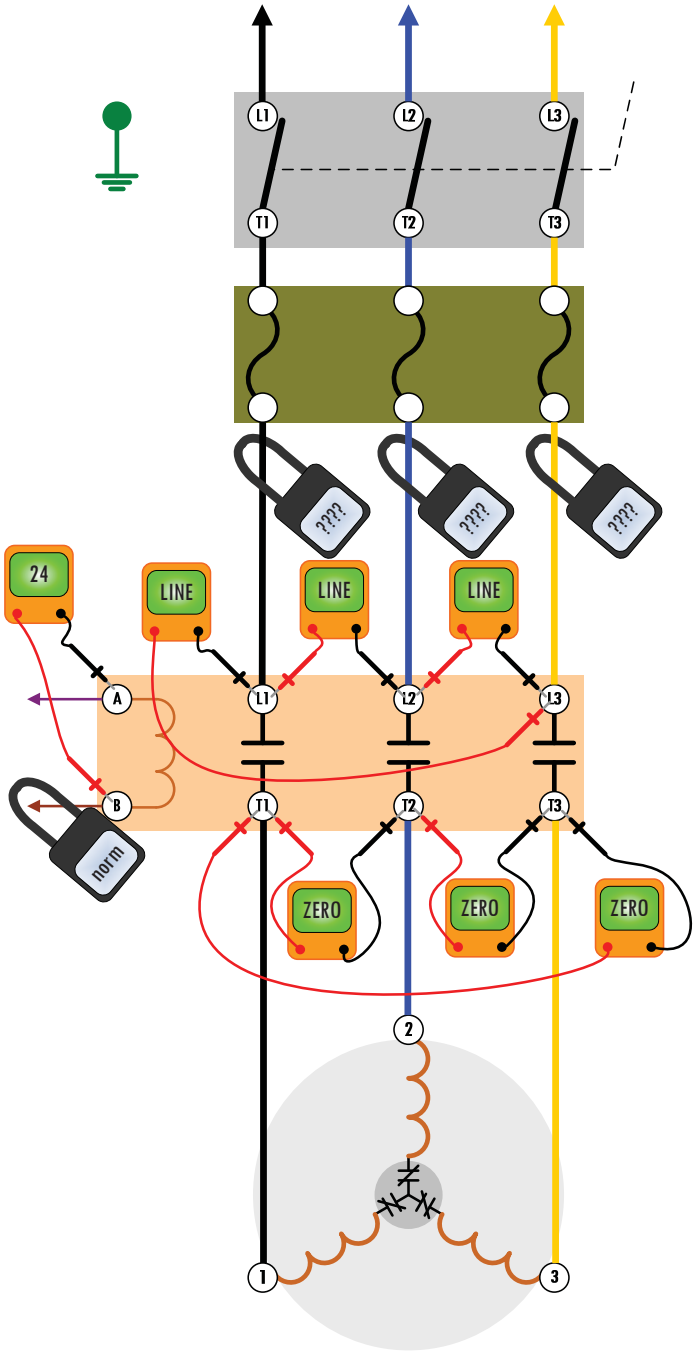


Figure 5-26

If the 3Ø line voltage is complete at the incoming lugs of the contactor, but is not complete at the outgoing lugs of the contactor, and the contactor coil is confirmed to be energized, then the contactor is faulty.

Inspect the faulty contactor for indications of mechanical binding such as water damage, corrosion or animals entering the contactor. Typically, these problems can be prevented by properly sealing the unit's control compartment. Inspection of the faulty contactor can reveal if the failure was due to excessively low control circuit voltage, such as overheating damage in the area of the contactor coil or contact points damage due to chattering.

If inspection indicates that the faulty contactor has evidence of excessive current draw through the contact points, then particular attention should be paid to the current draw through the contactor after the fault has been corrected.

When power is restored after repairs are made, overall current draw of the unit should be monitored to determine if a unit fault is causing high current draw (amp-meter segment of the illustration).

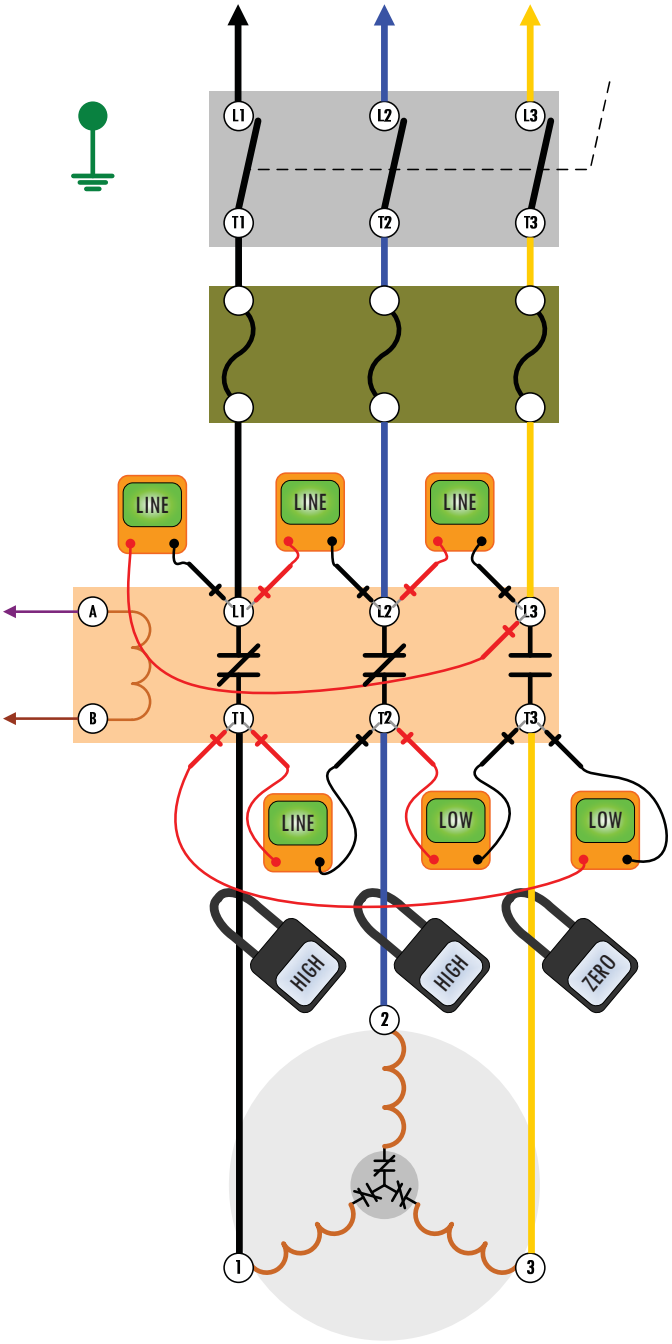


Figure 5-27

This illustration shows a faulty contactor's Leg 1 and Leg 2 contacts engaged (closed), but the leg 3 contacts are disengaged (open) as follows:

- T1 to T2: LINE
- T1 to T3: LOW (feedback)
- T2 to T3: LOW (feedback)

The line voltage circuit is "single-phased".

Power panel breaker trips, blown fuses and motor protector trips are typical related damage when the line voltage circuit is "single-phased".

If the contactor coil was energized while the illustrated readings were taken, then the L3-T3 set of contacts have failed open. If the contactor coil was de-energized while these readings were taken, then both the L1-T1 and L2-T2 sets of contacts are shorted. Regardless of whether the coil is energized, when readings like those illustrated occur, the contactor is faulty.

As discussed in Figure 5-26, the technician should inspect the faulty contactor for indications of the cause of failure in order to make proper repairs.

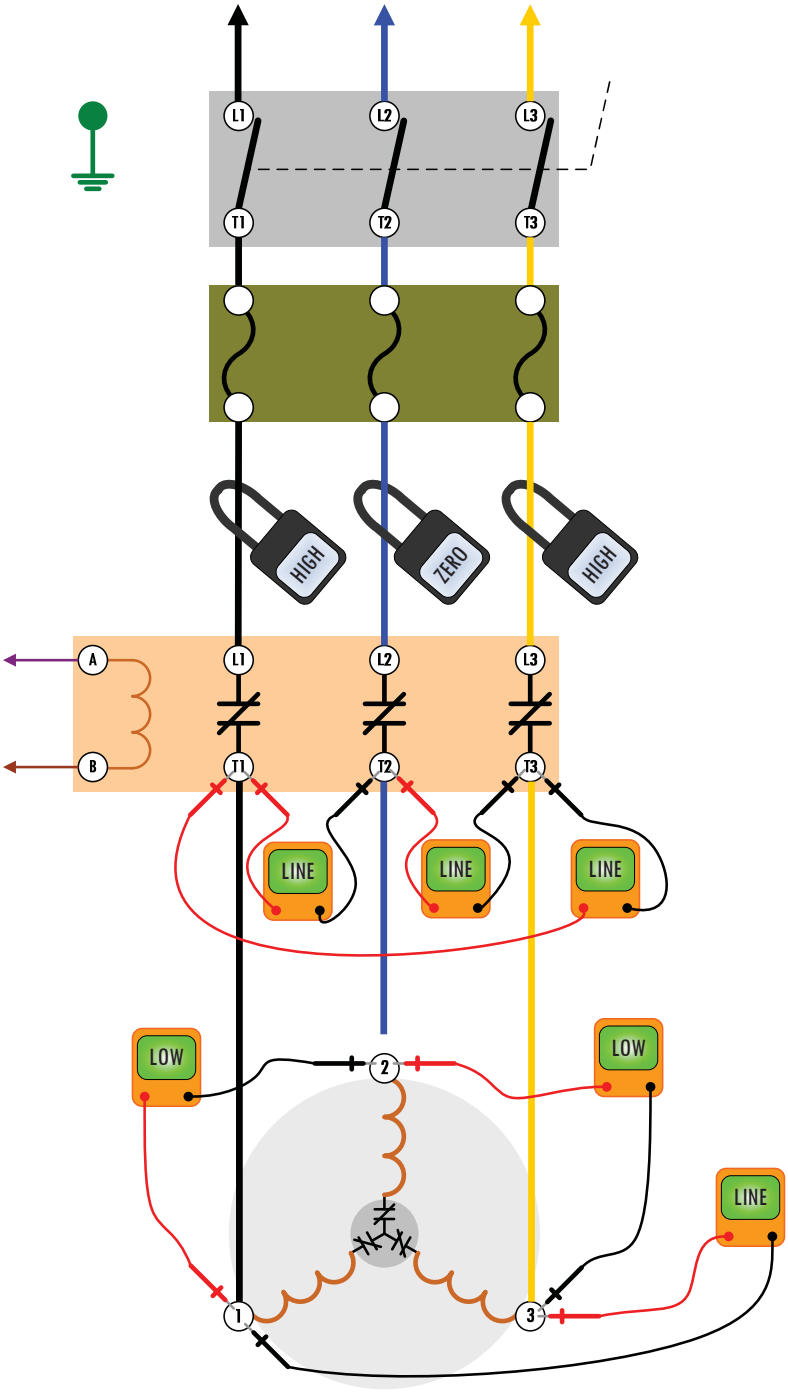


Figure 5-28

If the 3Ø line voltage is complete at the outgoing lugs of the contactor, but is not complete at the motor lugs, then the connections or wiring are faulty. The readings illustrated show that the contactor T2 to motor terminal 2 connections or wiring are electrically open, and the line voltage circuit is “single-phased”.

Often, when these readings are found there will be visible discoloration or damage to the connections or wiring terminations. Typically, the component damage originates with loose connections.

Power panel breaker trips, blown fuses and motor protector trips are typical related damage when the line voltage circuit is “single-phased”.

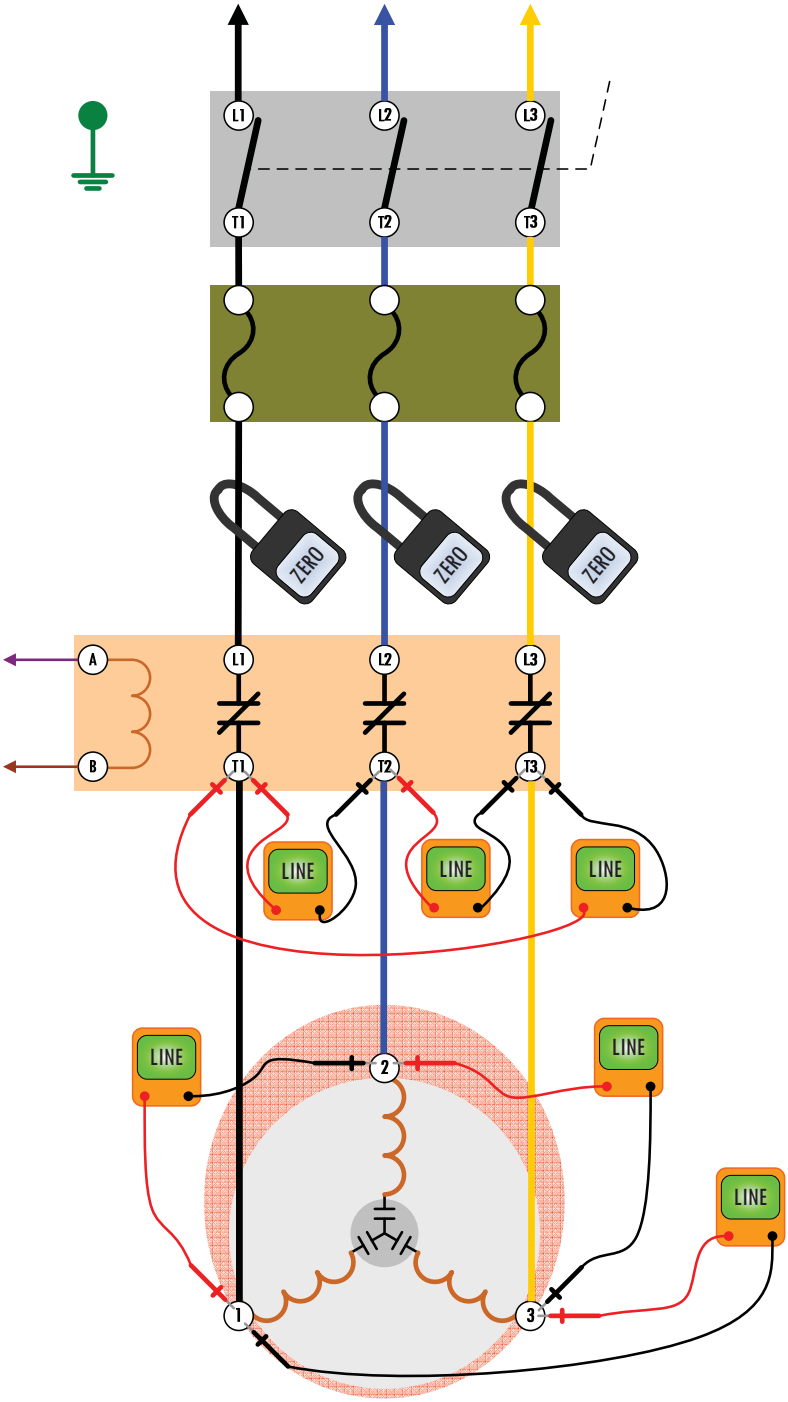


Figure 5-29

If the 3Ø line voltage is complete at the outgoing lugs of the contactor, and is complete at the motor lugs; however, the current draw of all three legs is ZERO, then an issue exists that has opened the motor winding circuit. The most likely cause for this issue is that the motor's internal thermal protection has tripped.

The readings illustrated show the motor's internal thermal protection tripped, and was accompanied by high motor temperature.

In cases where these readings and high motor temperature are found, allow time for the motor to cool before troubleshooting further.

Motor overheating, leading to the internal protector trip can be due to line voltage circuit faults described throughout this section or due to mechanical faults. Typical mechanical faults include:

- Inadequate motor cooling (high suction superheat on compressors, extremely low airflow on blowers)
- Reversed rotation
- Excessive loading
- Mechanical breakage
- Locked rotor

If these readings are found in conjunction with cool motor temperatures, it is likely that the motor's internal thermal protection has failed due to excessive cycling from the causes listed for motor overheating. Replacement of the motor and investigation of the original cause for motor overheating will be required.

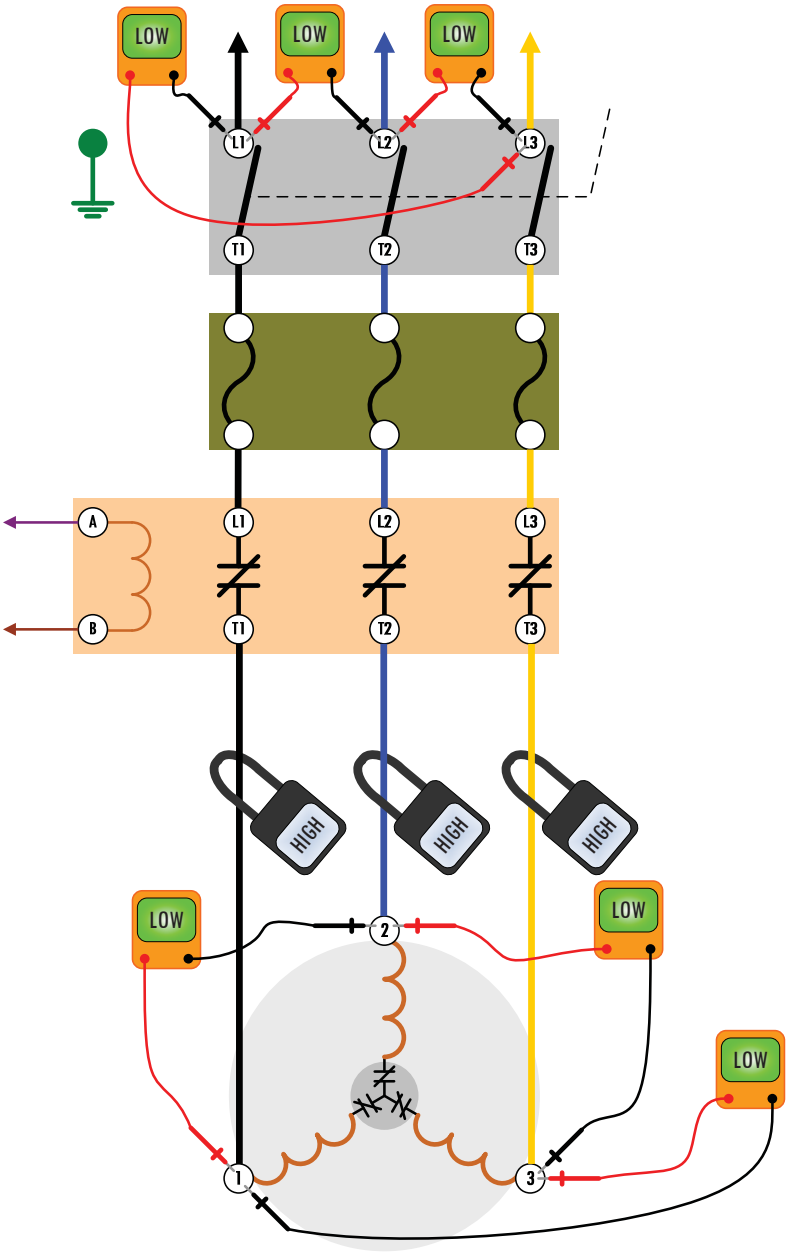


Figure 5-30

If the 3Ø line voltage circuit is complete, but the voltage to any or all of the motor terminals is below the nameplate minimum, then the motor will either not start or will run with excessively high current draw.

The best indication of this issue occurs when the line voltage circuit is loaded (the motor is drawing current). The readings illustrated show the line voltage circuit is loaded, and the voltage present throughout the circuit on all three legs is lower than name plate minimum voltage required. When readings similar to these are found, it is typically due to low line voltage to the building or inadequate electrical supply to the unit. In most circumstances, these issues will require that a qualified electrician be consulted for repairs.

Power panel breaker trips, blown fuses and motor protector trips are typical related damage when the voltage to the motor terminals is below the nameplate minimum.

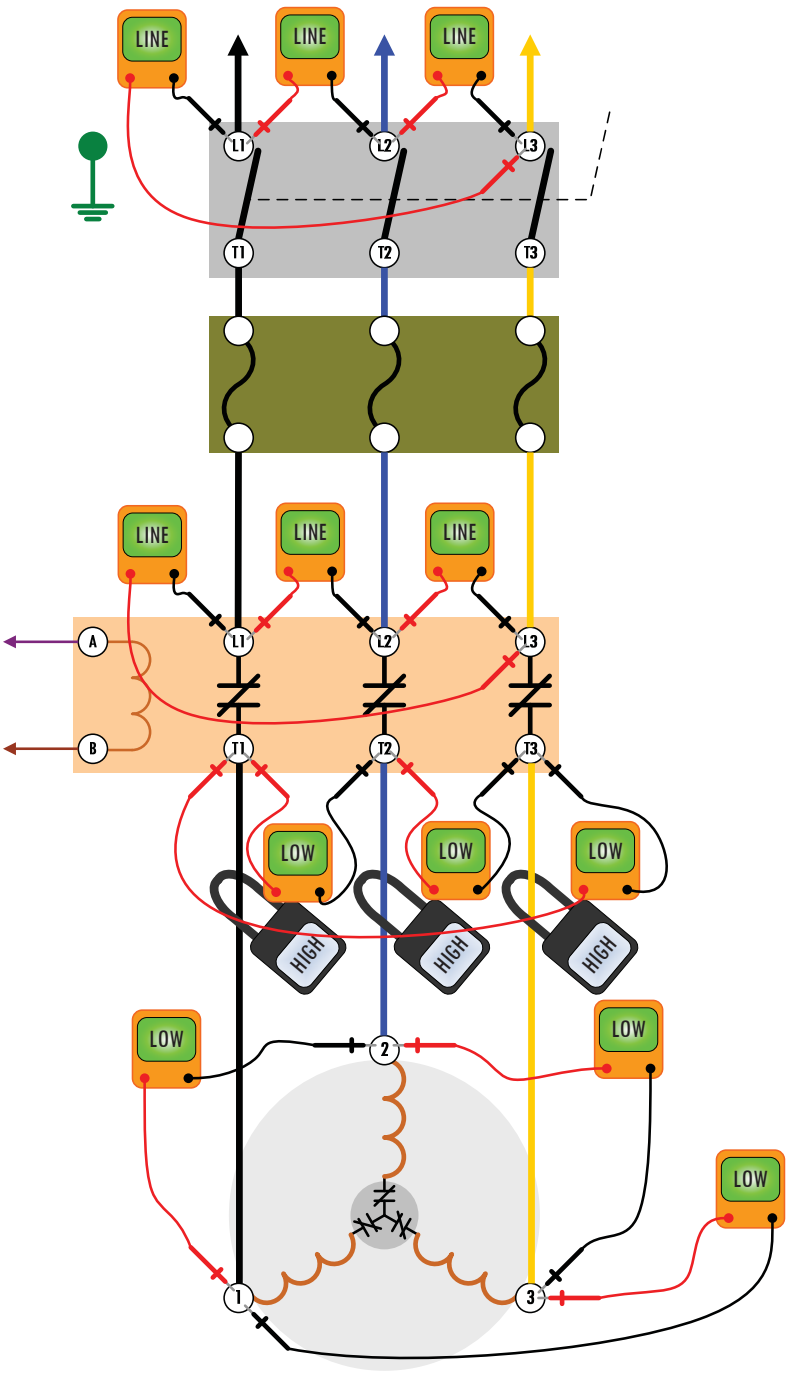


Figure 5-31

If the 3Ø line voltage circuit is complete with full line voltage supplied to the incoming lugs of the disconnect, but the voltage to any or all of the motor terminals is below the nameplate minimum, then components within the circuit have issues which result in voltage drop. The drop in voltage can be due to poor connections, inadequately sized wire or damaged components. If the voltage to any or all of the motor terminals is below the nameplate minimum, the motor will either not start or will run with excessively high current draw.

The best indication of this issue occurs when the line voltage circuit is loaded (the motor is drawing current). The readings illustrated show the line voltage circuit is loaded, and the contactor is the component in the circuit that is causing the drop in voltage. Full line voltage is present to the incoming lugs of the contactor, but lower than name plate minimum voltage is present in the circuit at the outgoing lugs of the contactor and to the motor terminals. When readings such as these are found, where voltage drops through a component, it is typically due to either a poor connections at the component or a faulty component.

Power panel breaker trips, blown fuses and motor protector trips are typical related damage when the voltage to the motor terminals is below the nameplate minimum.

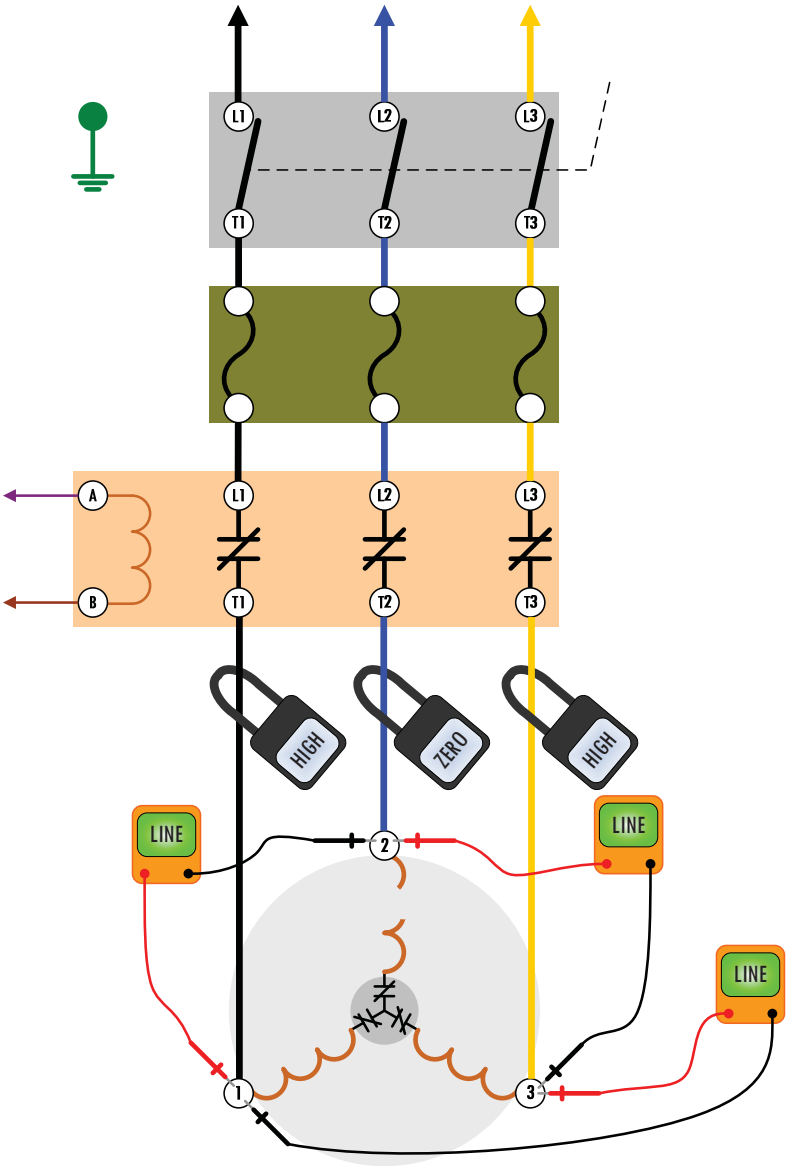


Figure 5-32

If the 3Ø line voltage circuit is complete to the motor terminals, but the current draw is HIGH on two legs, and ZERO on the remaining leg (indicating “single phasing”) then the motor has failed with an open winding.

The readings illustrated show the winding attached to terminal 2 has opened. When these readings are found, the technician should further investigate for electrical and mechanical faults that likely contributed to the motor winding failure.

Power panel breaker trips, blown fuses and motor protector trips are typical related damage when the motor has failed with an open winding.

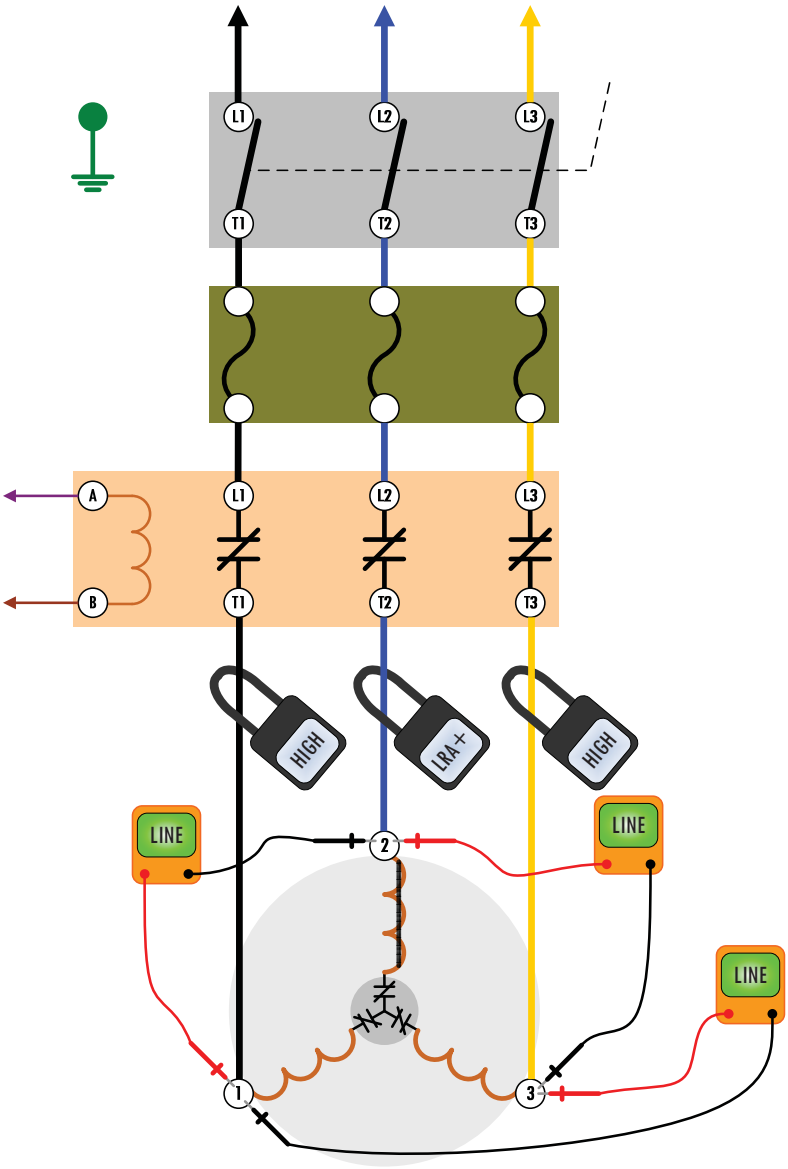


Figure 5-33

If the 3Ø line voltage circuit is complete to the motor terminals, but the current draw is HIGH on two legs, and LRA+ on the remaining leg, then the motor is likely to have failed with a shorted winding.

The technician must exercise extreme caution when working around equipment that has shorted components. Very high energies exist and the potential for ground-faults pose safety risks.

With the power off, the technician should confirm the motor winding short with ohmmeter continuity checks.

The readings illustrated show the winding attached to terminal 2 has shorted. When these readings are found, the technician should further investigate for electrical and mechanical faults that likely contributed to the motor winding failure.

Power panel breaker trips, blown fuses and motor protector trips are typical related damage when the motor has failed with a shorted winding.

There is no distinct difference in current draw and voltage readings for "cross-winding" shorts, winding-to-winding shorts or winding shorts to cabinet ground.

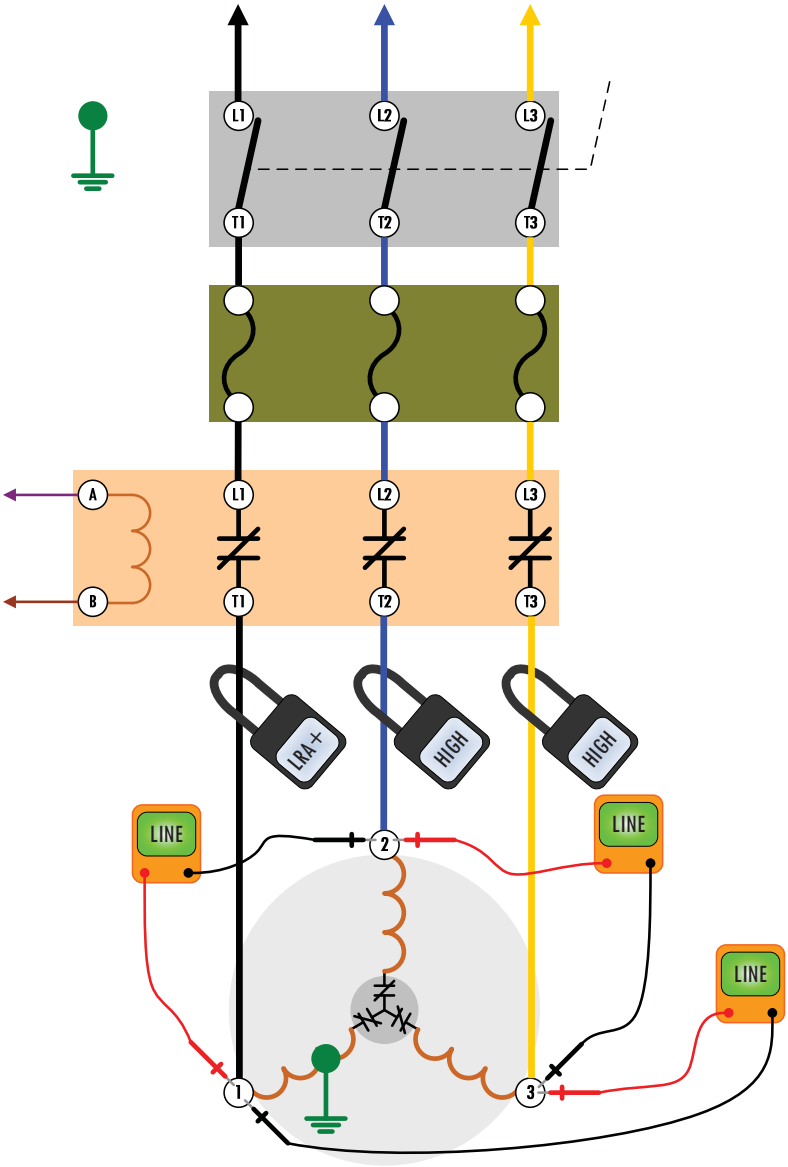


Figure 5-34

If the 3Ø line voltage circuit is complete to the motor terminals, but the current draw is HIGH on two legs, and LRA+ on the remaining leg, then the motor is likely to have failed with a shorted winding.

The technician must exercise extreme caution when working around equipment that has shorted components. Very high energies exist, and the potential for ground-faults pose safety risks. With the power off, the technician should confirm the motor winding short with ohmmeter continuity checks. The measurements illustrated show the winding attached to terminal 1 has shorted to cabinet ground. When these indications are found, the technician should further investigate for electrical and mechanical faults that likely contributed to the motor winding failure.

Power panel breaker trips, blown fuses and motor protector trips are typical related damage when the motor has failed with a shorted winding.

There is no distinct difference in current draw and voltage readings for "cross-winding" shorts, winding-to-winding shorts or winding shorts to cabinet ground.

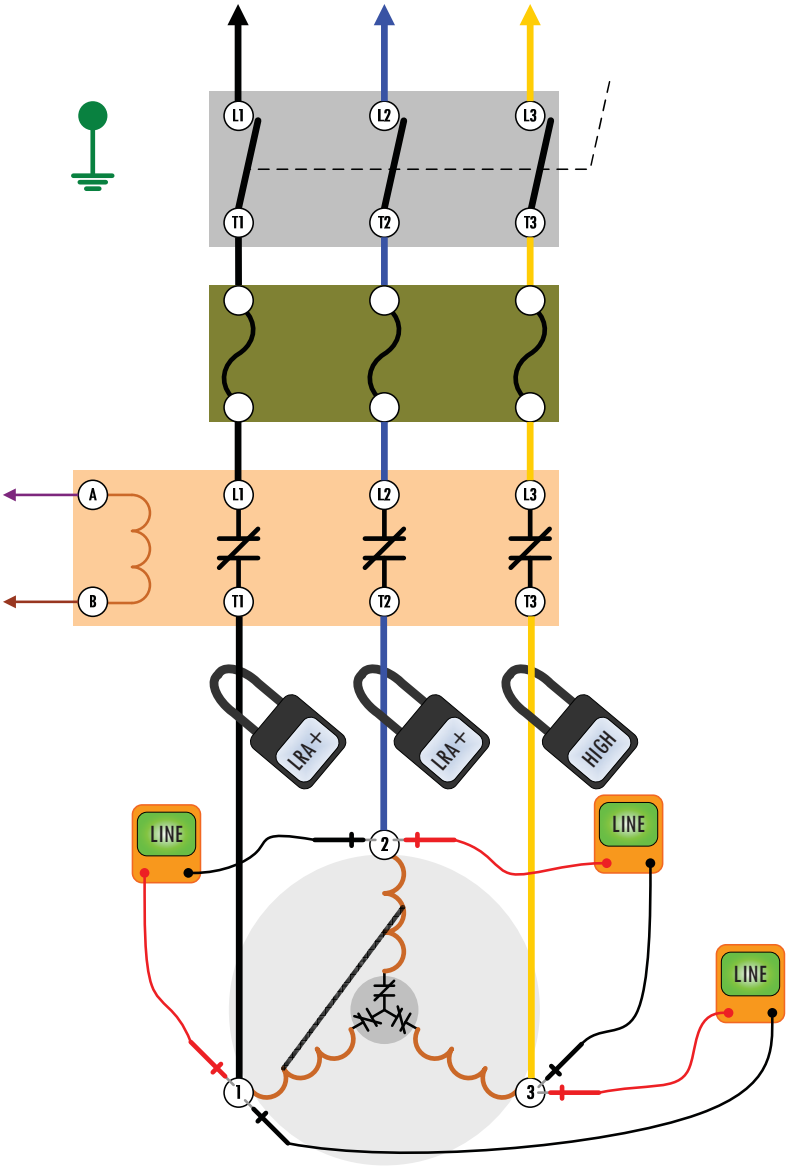


Figure 5-35

If the 3Ø line voltage circuit is complete to the motor terminals, but the current draw is LRA+ on two legs, and HIGH on the remaining leg, then the motor is likely to have failed with a winding-to-winding short.

The technician must exercise extreme caution when working around equipment that has shorted components. Very high energies exist, and the potential for ground-faults pose safety risks.

With the power off, the technician should confirm the motor winding short with ohmmeter continuity checks. The readings illustrated show a winding-to-winding short between the winding attached to terminal 1 and the winding attached to terminal 2. When these readings are found, the technician should further investigate for electrical and mechanical faults that likely contributed to the motor winding failure.

Power panel breaker trips, blown fuses and motor protector trips are typical related damage when the motor has failed with a shorted winding.

There is no distinct difference in current draw and voltage readings for "cross-winding" shorts, winding-to-winding shorts or winding shorts to cabinet ground.

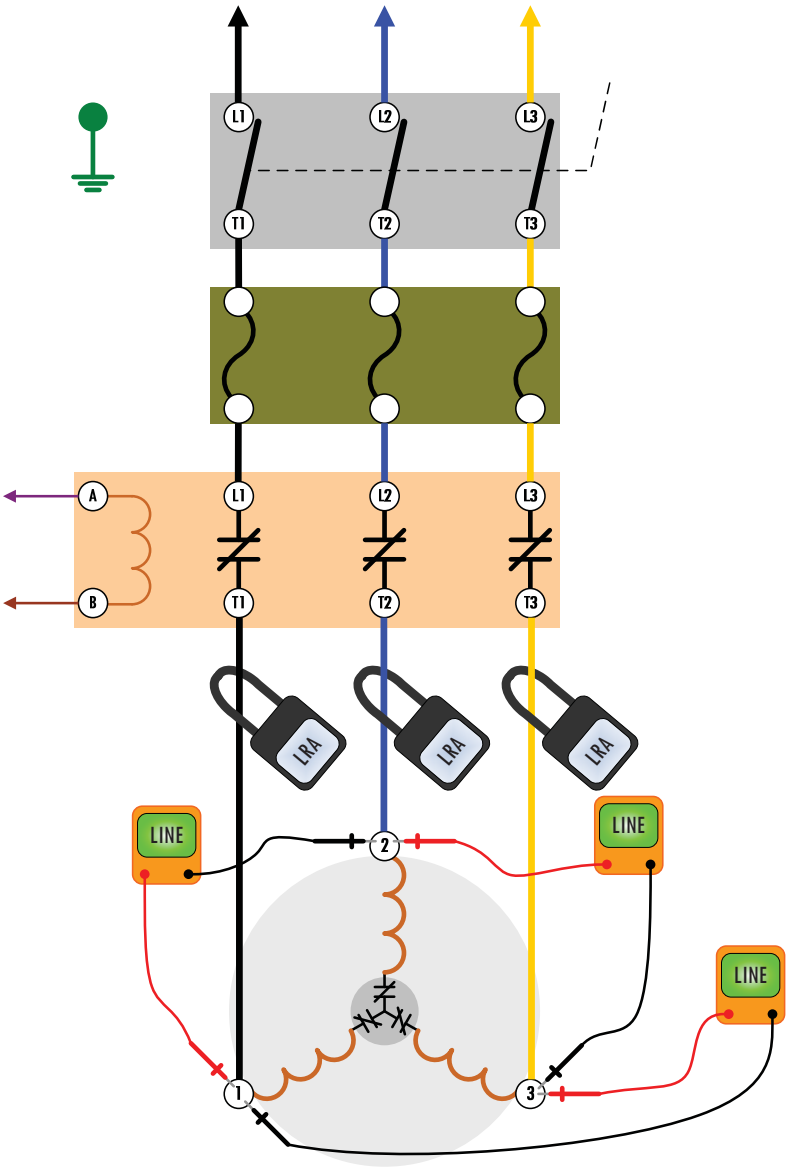


Figure 5-36

If the 3Ø line voltage circuit is complete to the motor terminals, and the current draw is LRA on all three legs, then the motor is locked.

The readings illustrated show the motor locked. When these readings are found, the technician should further investigate for mechanical faults that likely contributed to the motor locking. Power panel breaker trips, blown fuses and motor protector trips are typical related damage when the motor is locked.

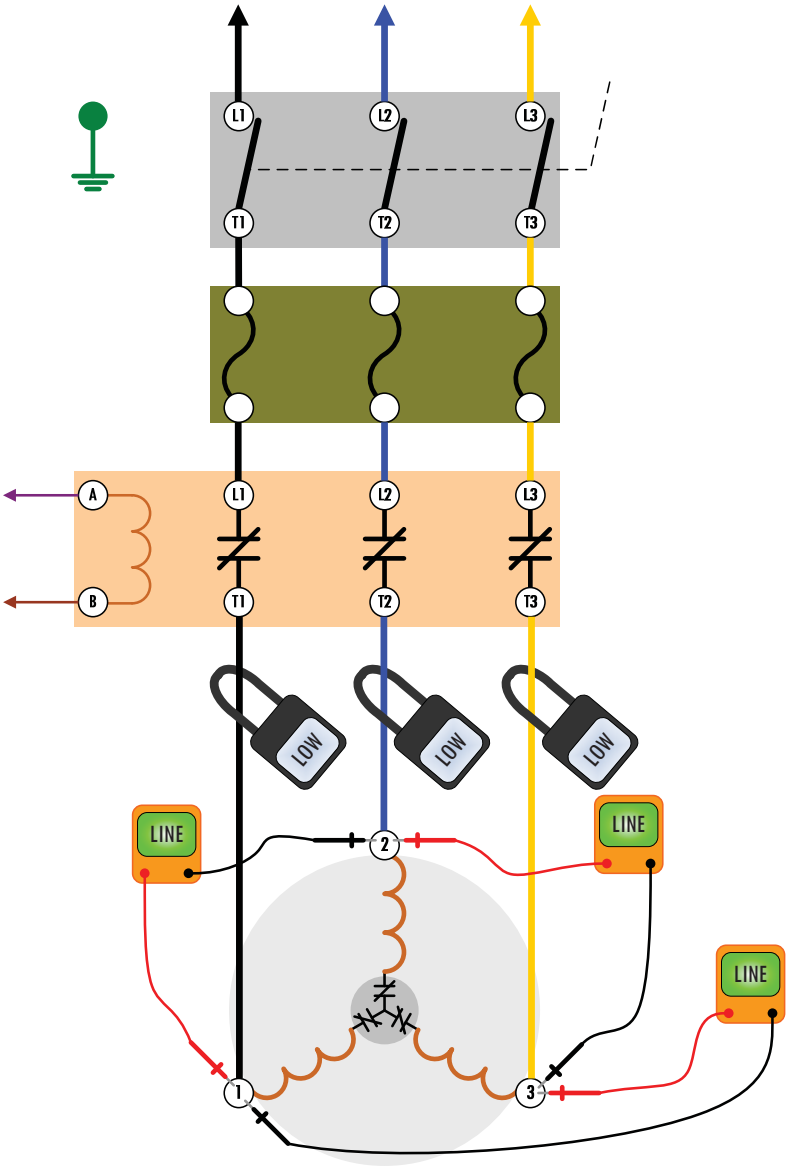


Figure 5-37

If the 3Ø line voltage circuit is complete to the motor terminals, and the current draw is LOW on all three legs, then the motor is lightly loaded.

This may not be an abnormal condition if circumstances exist where light motor loading is expected. However, this is an abnormal condition if circumstances exist where moderate to high motor loading is expected. Also, adequate time should be allowed for system stabilization after startup when observing compressor motor loading. The readings illustrated show the motor lightly loaded. When readings such as these are found the technician should further investigate for reverse rotation, abnormally low load conditions or mechanical faults that were likely to have contributed to the light motor loading.

Chapter 6 - Capacitors

A thorough understanding of capacitor troubleshooting is needed when servicing HVAC equipment. Improper troubleshooting of capacitors often results in condemning motors when the capacitor itself was the faulty component.

Before using a multi-meter or capacitor analyzer to evaluate a run or start capacitor, the capacitor must be discharged using a bleed resistor. The bleed resistor should be approximately a 20,000Ω 2 watt resistor. Do not use a screw driver to bleed the capacitor. Using a screw driver can damage the capacitor.

When troubleshooting capacitors, the three main faults to test for are open, shorted, or grounded capacitors.

Functional capacitors will have an infinite reading between any of the terminals to the shell of the capacitor and will have a measured microfarad reading between terminals that is within the percentage rating on the capacitor data label.

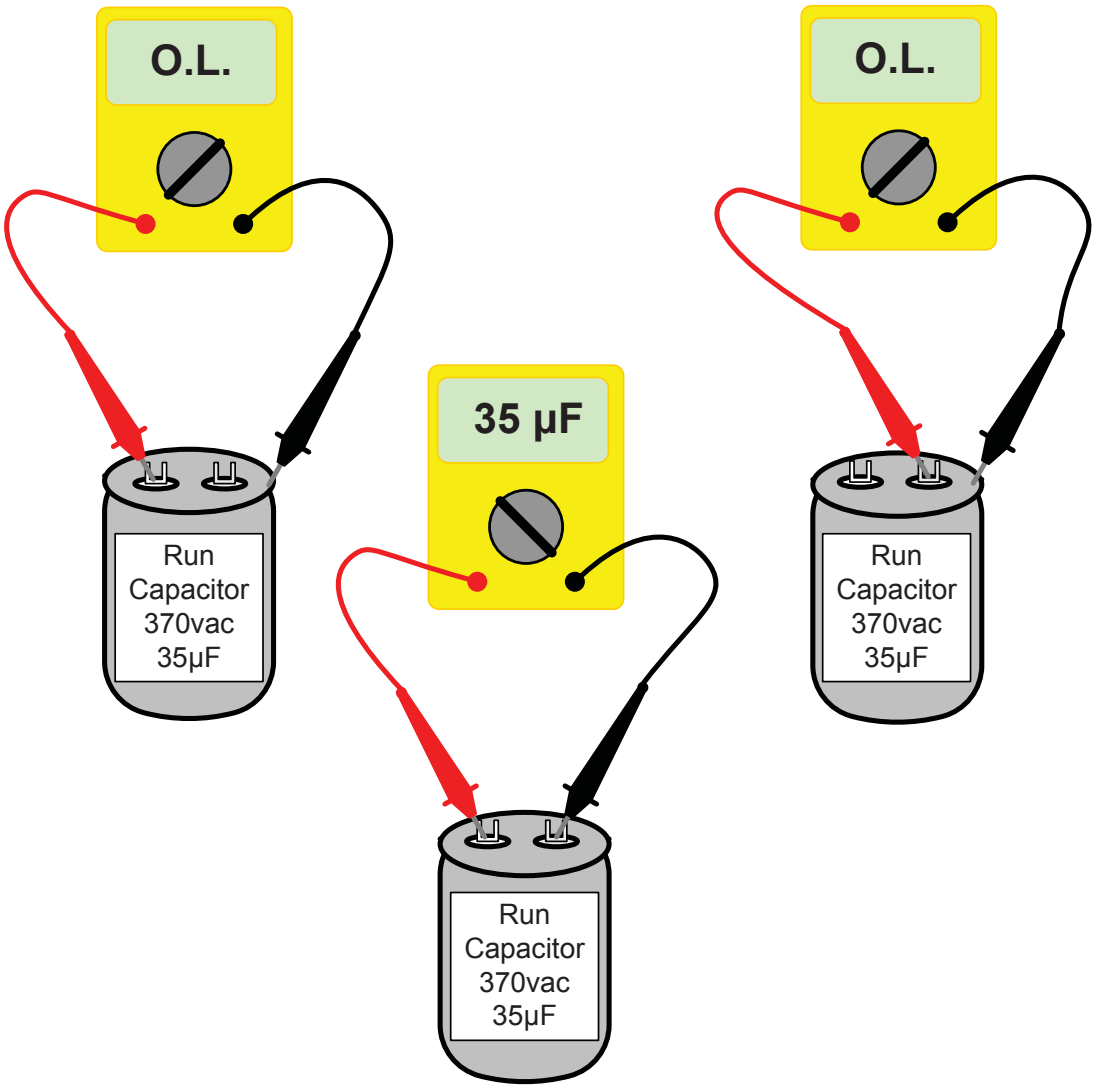


Figure 6-1 - Example Good Capacitor Readings

It can be determined if the capacitor is charging and discharging with a standard ohm meter but, to read microfarads, a capacitor analyzer should be used. Some multi-meters have this capability. If the readings are outside of the rating on the capacitor data plate, the capacitor should be replaced. Figure 6-1 is an example of a potentially good capacitor.

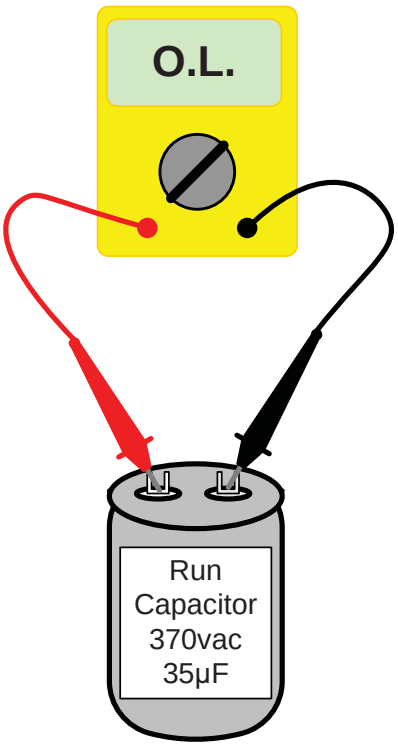


Figure 6-2 - Example of Open Capacitor

Open capacitors will have an infinite reading between the terminals on the capacitor when using an ohm meter to troubleshoot the capacitor. This is represented by an infinite reading or O.L. on the multi-meter as indicated in Figure 6-2. If a capacitor analyzer is used the instructions with the meter should be followed.

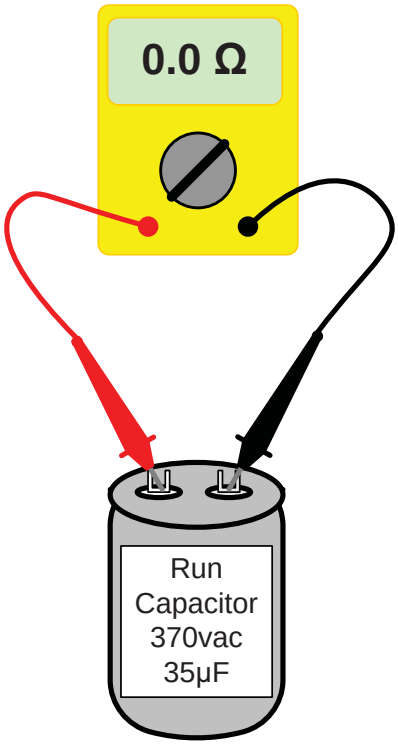


Figure 6-3 - Example of Shorted Capacitor

Shorted capacitors will have a reading of zero ohms of resistance between the terminals of the capacitor as indicated in Figure 6-3. If a capacitor is shorted, the readings between terminals will not fluctuate. Instead the readings between the terminals will stay steady and in most situations will read less than 1 ohm of resistance. The technician should verify the readings by reversing the meter leads to the capacitor terminals. If the resistance begins to increase or decrease, the capacitor is not shorted.

Grounded capacitors will have a measurable resistance from any of the capacitor terminals to the shell as shown in Figure 6-4.

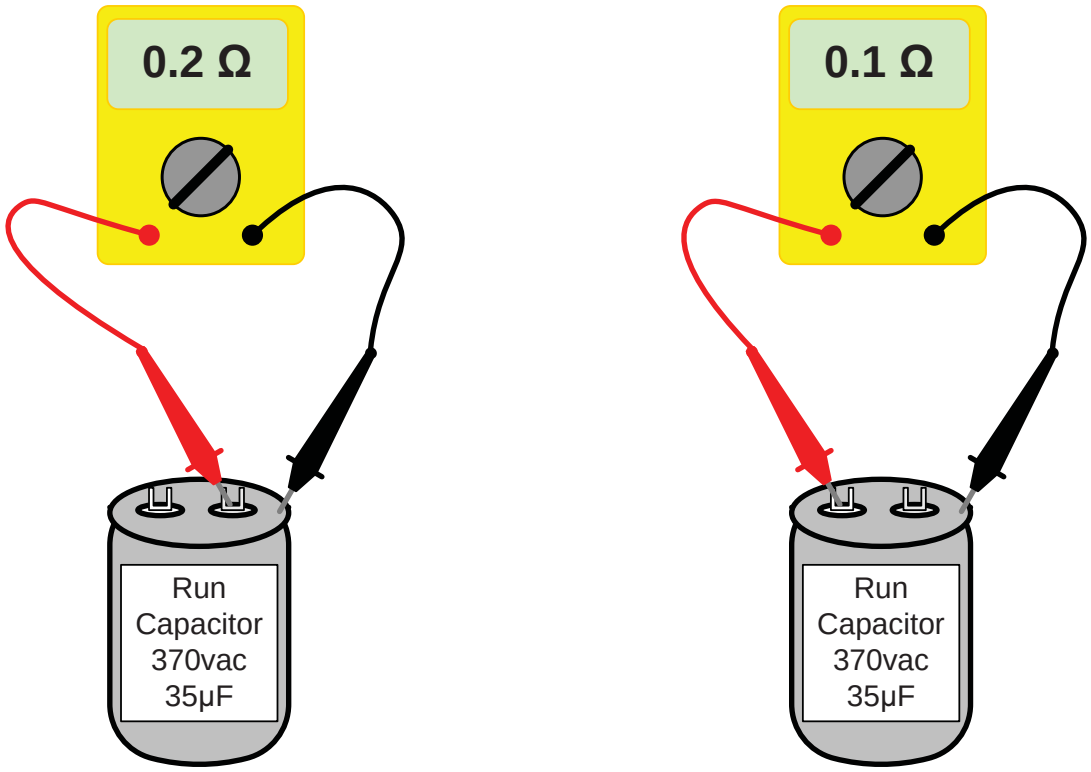


Figure 6-4 - Example of Grounded Capacitor

Chapter 7 - ECM 142R

If the ECM is operational, normal function may cause the motor to rock back and forth on start up. This is not abnormal and the motor will not need to be replaced due to this symptom.

If the system is working properly but the motor appears to run slower than it should, the motor is good. High efficiency systems, especially those with optimized fan blades, will run the motor slower to decrease noise.

If the system is noisy, running a high head pressure, tripping the high pressure switch or the compressor overloads, check the following:

- Check and clean if necessary the condensing coils and any shrouds. This motor will not compensate for lack of airflow through dirty coils
- Confirm all fan blades are shaped the same, in good condition and not rubbing on the shroud. Also confirm the fan blade hub bolt is secure on the motor shaft. Verify the motor is secure in its mount and the mount legs are secure to the unit

The ECM has a molded waterproof connection with a long five conductor wiring harness that connects to low and high voltage terminations inside the control cabinet of the unit. The wiring harness is not replaceable, removable or repairable. If the condenser fan ECM is not operating, the cause could be an open/shorted wiring harness, improper voltages or loose/corroded connections or the ECM. The molded connection does not allow voltage measurements at the ECM.

If the ECM is not operational, check for voltage on the respective terminals during cooling operation in the control cabinet:

- Check for proper high voltage and ground. Locate compressor contactor M1 terminals T1 and T3 and Ground connections. Confirm voltage is within unit limitations. Correct any voltage issues and worn or broken connections.
- Check for proper low voltage control signal (24 Volts AC). Locate the control signal connection from the control board terminal C1 output to compressor contactor M1 low voltage control side (24 Volts AC). Confirm voltage is 24 Volts AC. Correct any voltage issues and worn or broken connections.

If voltages and connections are normal, the ECM needs to be replaced as an entire assembly. The ECM assembly wiring harness, control module or the motor module cannot be replaced separately. After ECM replacement make sure wiring harness is free of the fan blade and not pinched in mountings or cabinet through points.

Chapter 8 - Standard Simplicity

Simplicity controls assist with troubleshooting through status indicators, fault reporting and Simplicity PC software access. These control-based aides, together with traditional electrical troubleshooting methods, permit accurate diagnosis of problems. Simplicity controls also offer configuration options through on-board buttons and Simplicity PC software access. However, miss-configuration of the multiple settings available in Simplicity controls can produce unfavorable results for a given application. Simplicity control based troubleshooting falls in these basic sub-categories:

- Conditions that produce and corrective actions for flash codes
- Software configuration review
- Confirmation that the hardwired inputs and outputs are intact

Simplicity Lite Flash Codes

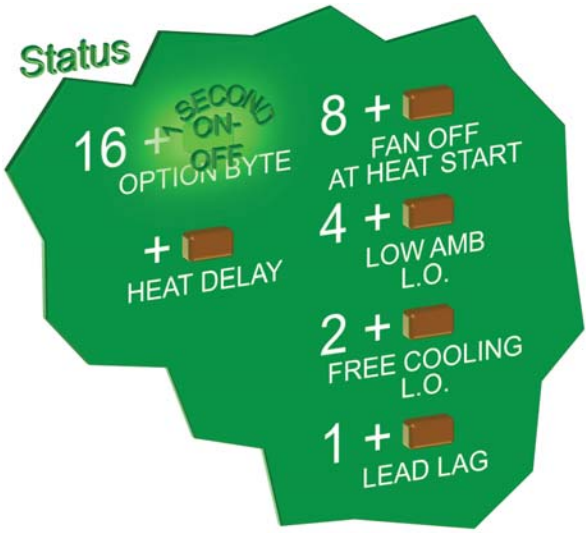
Simplicity Lite Flash Codes			
Flash Code	**Description**	**Category**	**Technician Corrective Action**
Heartbeat	Normal operation - no status or error information currently needs to be displayed	Status	
Off	No power to control - 24 volts AC is not present to the control's R and C terminals. Alternately: The control has catastrophic damage that will not allow the LED display - It is likely that there will be visible physical evidence of the damage	Status/ Error	Verify line voltage is present at the primary of the 75VA transformer, verify 24 volts AC is present at the secondary of the 75VA transformer. Verify 24 volts AC is present from the control's C to SD terminals indicating the 3.2A control circuit breaker and phase monitor contacts are closed. Verify 24 volts AC is present from the control's C to R terminals indicating the smoke detector and/or shutdown relay contacts are closed.
On	The control's microprocessor has not passed its self-check	Error	Cycle power to the control to eliminate the possibility that transient voltage conditions such as surges, brownouts, etc. have not created a false indication. If the steady on LED indication repeats, the control will need to be replaced and potential causes for failure, such as excessive voltage, RF interference, etc. should be investigated.
2 Flashes	Compressor anti short-cycle delay active - the compressor is being requested but has been off for less than 5 minutes (default ASCD timing)	Status	If desired, the technician can zero the present ASCD by pressing the TEST RESET button once.

Simplicity Lite Flash Codes			
Flash Code	**Description**	**Category**	**Technician Corrective Action**
3 Flashes	Compressor high pressure lock-out - HPS1 is currently open with compressor requested or HPS1 has opened three times in a two hour period. HPS1 trips at 625+/-25 psig on R-410A units.	Error	Verify that the condenser coil is clean and unobstructed. Verify that the condenser fan(s) have fuses intact, contactor(s) operable and motor(s) functioning. Verify that the refrigerant circuit is not overcharged. Reheat unit: verify P266 condenser fan speed controller function.
5 Flashes	Compressor low pressure lock-out - LPS1 is currently open with compressor requested or LPS1 has opened three times in a one hour period. LPS1 trips at 50+/-5 psig on R-410A units. Note that LPS1 is ignored during the first 30 seconds of compressor operation when outdoor temperatures are above 45°F (LAS open) and for the first 120 seconds of compressor operation when outdoor temperatures are below 45°F (LAS open)	Error	Verify items listed under “Compressor Freezestat Lock-out” and FS1 trip setting to elimate the possibilty of indoor coil icing leading to the LP1 trips. Verify that the refrigerant circuit is not undercharged or restricted.
7 Flashes	Compressor freezestat lock-out - FS1 is currently open with compressor requested or FS1 has opened three times in a two hour period. FS1 trips at 26+/-5°F.	Error	Correct the inadequate indoor airflow condition. Verify filters, indoor coil and blower wheel are clean. Verify that the blower belt(s) are properly maintained and adjusted; the blower motor fuses are intact, contactor and motor are operable and wheel has the correct rotation. Verify that the ducting is not restrictive. Verify indoor air volume is at least 350 CFM per ton cooling capacity by measuring the indoor coil pressure drop and comparing the reading to the chart in the Installation Manual. Verify that the compressor contactor disengages and is not sticking closed or has welded contacts
9 Flashes	Heat section fault or heating limit has opened - 24 volts AC has not been received at the control’s MV terminal within five minutes of initiation of a W1 input, or 24 volts AC at the control’s LIMIT terminal is currently not present, or 24 volts AC was lost at the control’s LIMIT terminal three times in a two hour period	Error	Check the gas heat ignition control for fault indication and make proper corrections. Verify voltage from C to W1 is less than 2 volts AC when there is no heating call from the thermostat. Correct the inadequate indoor airflow condition. Verify filters, indoor coil and blower wheel are clean. Verify that the blower belt(s) are properly maintained and adjusted; the blower motor fuses are intact, contactor and motor are operable and wheel has the correct rotation. Verify that the ducting is not restrictive. Verify indoor air volume is at least the minimum required for the heat section by measuring the indoor coil pressure drop and comparing the reading to the chart in the Installation Manual.

Simplicity Lite Flash Codes			
Flash Code	**Description**	**Category**	**Technician Corrective Action**
10 Flashes	Compressor held off due to low outdoor temperature - the low ambient switch has closed. LAS closes at 45+/-3°F, opens at 55+/-3°F	Status	With setup option “All Compressors Off in Low Ambient” ON, the compressor will be held off when the LAS is closed. With setup option “All Compressors Off in Low Ambient” OFF, when there is a cooling demand the compressor will operate in the 10 minute on/5 minute off low ambient cycle in which freezestat trips will disable the compressor but does not accumulate counts toward a freezestat hard lockout.
11 Flashes	Compressor held off due to economizer in free cooling mode - Standard (Honeywell module) economizer: there is input voltage to the control’s Y1 terminal, passed through to the Y1 output pin and an open economizer interlock contact interrupts the voltage to the ECON pin. Intelli-Comfort board controlled economizer: free cooling mode is operating and the compressor is held off	Status	On units that do not have an economizer, correct the loose or missing jumper-plug for economizer bypass in the unit’s wiring harness (located in the return air compartment). Intelli-Comfort board controlled economizer: With setup option “All Compressors Off in Free Cooling” ON, the compressor will be held off when the economizer is in free cooling mode. With setup option “All Compressors Off in Free Cooling” OFF, when there is first stage cooling demand the economizer operates in free cooling mode and when there is a second stage cooling demand the compressor will operate to supplement the economizer.
13 Flashes	Contactor(s) held off due to low voltage - voltage to the control’s R & C terminals is either below 19.2 volts AC preventing additional contactors from being energized or is below 16 volts AC preventing any contactors from being energized	Status	Verify full line voltage is being applied to the 75VA transformer primary and that 208/230 volt units have the proper primary tap connected. Monitor that the current of the 75 VA transformer secondary does not exceed 3 amps. If possible, it is best to to take the following readings while there is load on the control circuit. Verify 24 volts at the 75VA transformer secondary. Verify 24 volts at terminals C & SD to assure there is no voltage drop through the control circuit breaker or phase monitor contacts. Verify 24 volts at terminals C & R to assure there is no voltage drop through the smoke detector or shut-down relay contacts. If 3 amps or more is drawn on the 75VA transformer secondary, investigate and correct the cause of the short or overload on the 24 volt circuits.
14 Flashes	EEPROM storage failure - the microprocessor has detected a fault in the control’s memory	Error	Cycle power to the control to eliminate the possibility that transient voltage conditions such as surges, brownouts, etc. have not created a false indication. If the EEPROM Storage Failure indication repeats, the control will need to be replaced and potential causes for failure, such as excessive voltage, RF interference, etc. should be investigated.

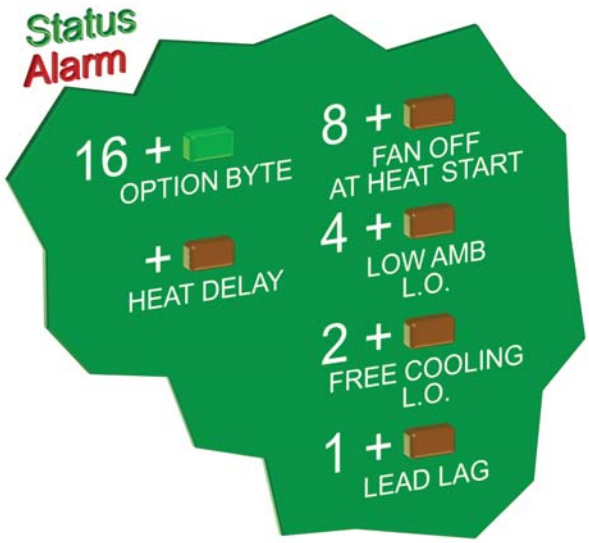
Simplicity 1A Flash Codes

Heartbeat



Normal operation - no status or error information currently needs to be displayed.

Off

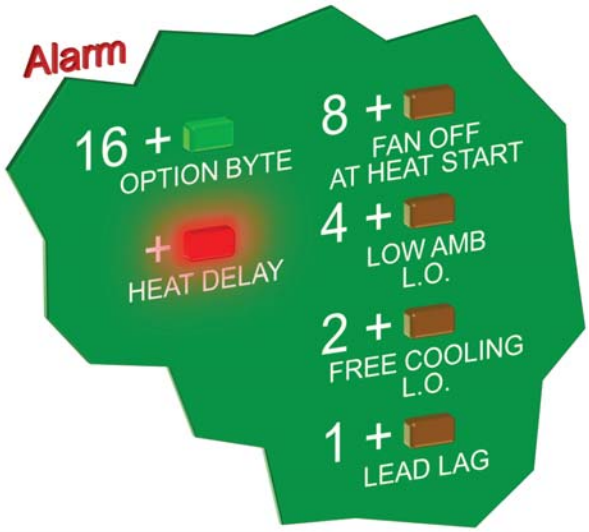


No power to control - 24 volts AC is not present to the control's R and C terminals. Alternately: The control has catastrophic damage that will not allow the LED display. It is likely that there will be visible physical evidence of the damage.

<u>Corrective Action</u>

- Verify line voltage is present at the primary of the 75VA transformer
- Verify 24 volts AC is present at the secondary of the 75VA transformer
- Verify 24 volts AC is present from the control's C to SD terminals indicating the 3.2A control circuit breaker and phase monitor contacts are closed
- Verify 24 volts AC is present from the control's C to R terminals indicating the smoke detector and shutdown relay contacts are closed

On

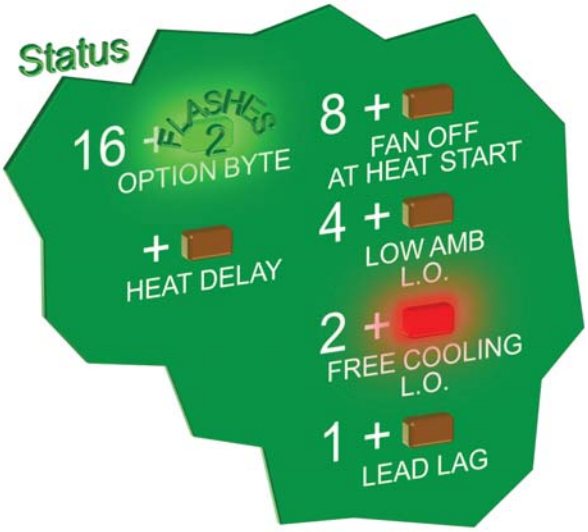


The control's microprocessor has not passed its self-check.

Corrective Action

- Cycle power to the control to eliminate the possibility that transient voltage conditions such as surges, brownouts, etc. have not created a false indication
- If the steady on LED indication repeats, the control will need to be replaced and potential causes for failure, such as excessive voltage, RF interference, etc. must be investigated

2 Flashes

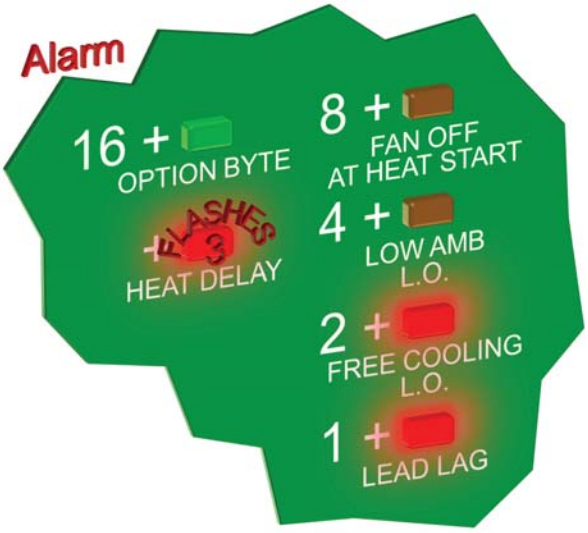


The compressor anti short-cycle delay is active - a compressor is being requested, but has been off for less than 5 minutes (default ASCD timing).

Corrective Action

- If desired, the technician can zero the present ASCD by pressing the TEST RESET button once

3 Flashes

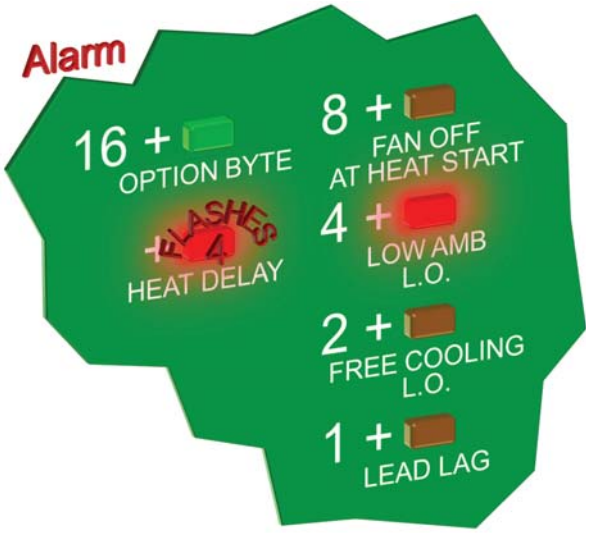


Compressor 1 high pressure lock-out - HPS1 is currently open with compressor 1 requested or HPS1 has opened three times in a two hour period. HPS1 trips at 625+/-25 psig on R-410A units.

Corrective Action

- Verify that condenser coil is clean and unobstructed
- Verify that the condenser fan(s) for have fuses intact, contactor(s) operable and motor(s) functioning
- Verify that refrigerant circuit 1 is not overcharged

4 Flashes

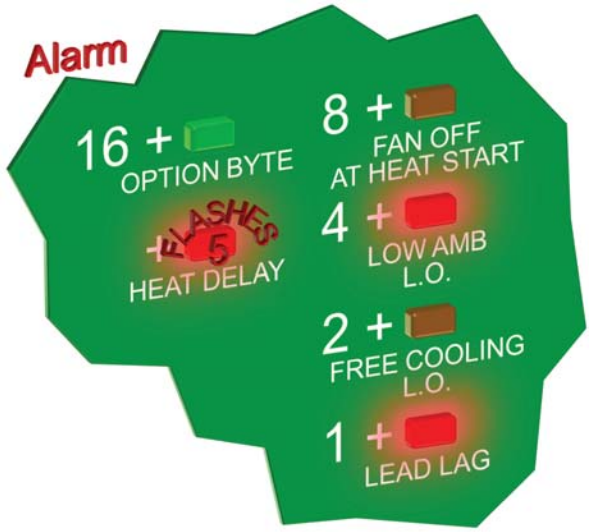


Compressor 2 high pressure lock-out - Compressor 1 high pressure lock-out - HPS2 is currently open with compressor 2 requested or HPS2 has opened three times in a two hour period.

Corrective Action

- On 3 through 5 ton units, correct the loose or missing jumper at the HPS2 pins

5 Flashes



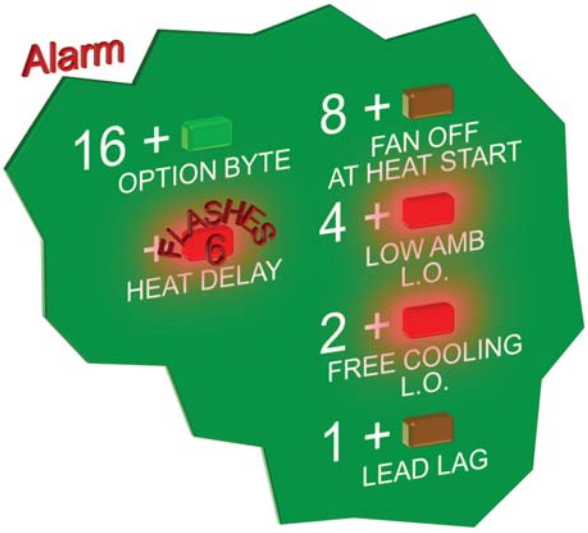
Compressor 1 low pressure Lock-out - LPS1 is currently open with compressor 1 requested or LPS1 has opened three times in a one hour period. LPS1 trips at 50+/-5 psig on R-410A units or 22+/-5.

Note that LPS1 is ignored during the first 30 seconds of compressor operation.

Corrective Action

- Verify items listed under compressor 1 freezestat lock-out and FS1 trip setting to eliminate the possibility of indoor coil icing leading to the LP1 trips
- Verify that refrigerant circuit 1 is not undercharged or restricted

6 Flashes

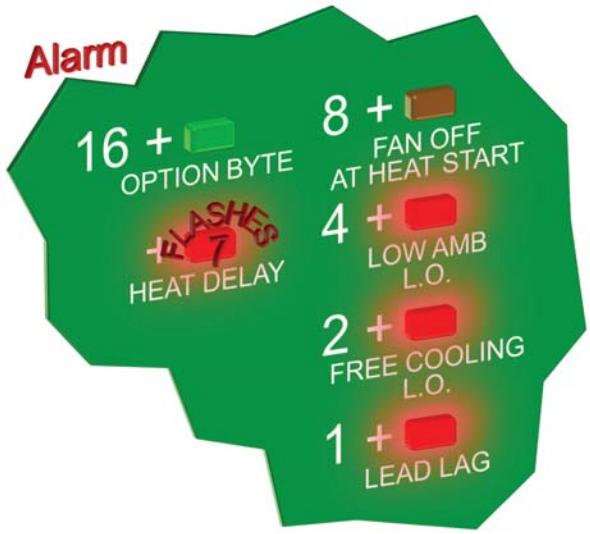


Compressor 2 low pressure lock-out - LPS2 is currently open with compressor 2 requested or LPS2 has opened three times in a one hour period.

Corrective Action

- Correct the loose or missing jumper at the LPS2 pins

7 Flashes

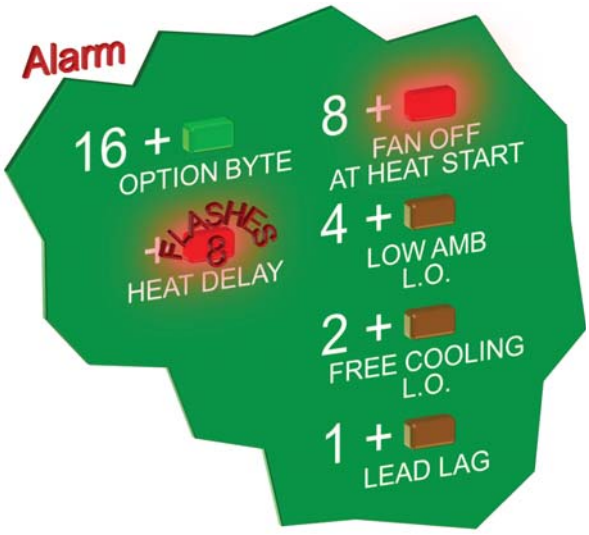


Compressor 1 freezestat lock-out - FS1 is currently open with compressor 1 requested or FS1 has opened three times in a two hour period. FS1 trips at 26+/-5°F.

Corrective Action

- Correct the inadequate indoor airflow condition
- Verify that the filters, indoor coil and blower wheel are clean
- Verify that the blower belt(s) are properly maintained and adjusted
- Verify that the blower motor fuses are intact, and that the contactor and motor are operable
- Verify that the blower wheel has the correct rotation
- Verify that the ducting is not restrictive
- Verify that indoor air volume is at least 350 cfm per ton cooling capacity by measuring the indoor coil pressure drop and comparing the reading to the chart in the Installation Manual
- Verify that compressor 1 contactor disengages and is not sticking closed or has welded contacts

8 Flashes

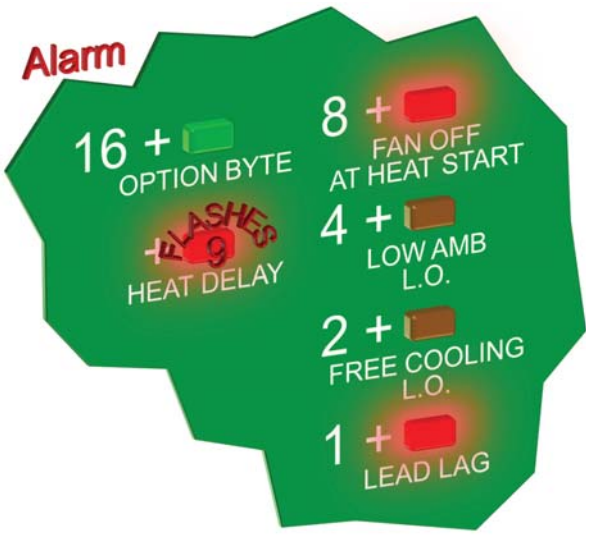


Compressor 2 freezestat lock-out - FS2 is currently open with compressor 2 requested or FS2 has opened three times in a two hour period.

Corrective Action

- Correct the loose or missing jumper at the FS2 pins

9 Flashes

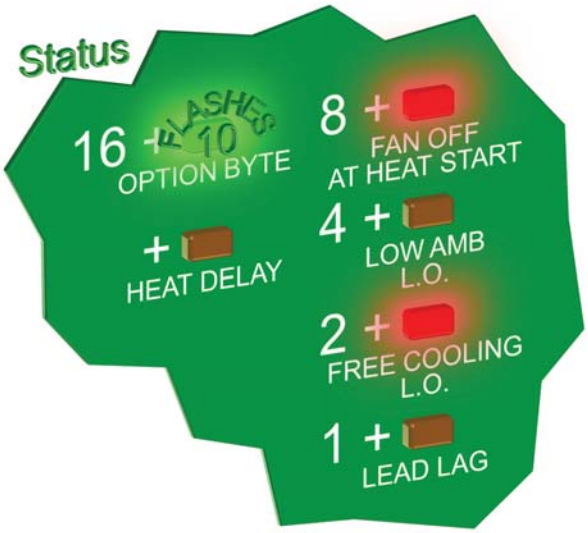


Heat section fault or heating limit has opened - 24 volts AC was lost at the control's LIMIT terminal, or 24 volts AC has not been received at the control's MV terminal within five minutes of initiation of a W1/W2 input, or 24 volts AC has not been lost at the control's MV terminal within five minutes of termination of a W1 input.

Corrective Action

- Check the gas heat ignition control for fault indication and make proper corrections
- Verify that voltage from C to W1 & W2 is less than 2 volts AC when there is no heating call from the thermostat
- Correct the inadequate indoor airflow condition
- Verify filters, indoor coil and blower wheel are clean
- Verify that the blower belt(s) are properly maintained and adjusted
- Verify that the blower motor fuses are intact, and the contactor and motor are operable.
- Verify that the blower wheel has the correct rotation
- Verify that the ducting is not restrictive
- Verify indoor air volume is at least the minimum required for the heat section by measuring the indoor coil pressure drop and comparing the reading to the chart in the Installation Manual

10 Flashes

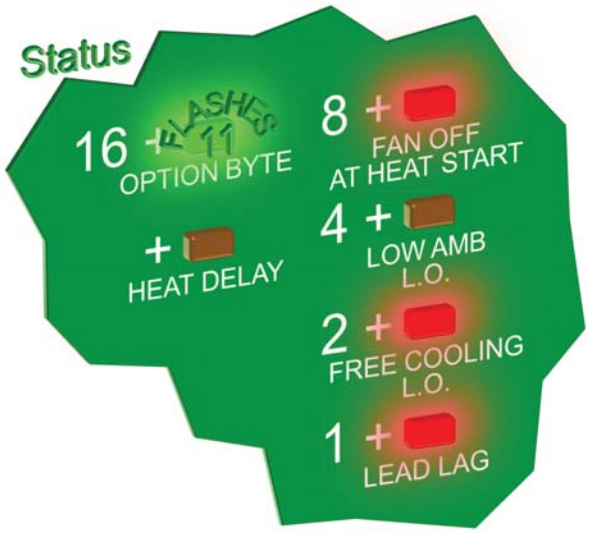


Compressors held off due to low outdoor temperature - the low ambient switch has closed. LAS closes at 45+/-3°F, opens at 55+/-3°F.

Corrective Action

- With “Option Setup LOW AMB L.O.” enabled (LED on), all of the compressors will be held off when the LAS is closed
- With “Option Setup LOW AMB L.O.” disabled, when there is a cooling demand, compressors will operate in the 10 minute on and 5 minute off low ambient cycle. Freezestat trips will disable the associated compressor, but do not accumulate counts toward a freezestat hard lockout

11 Flashes

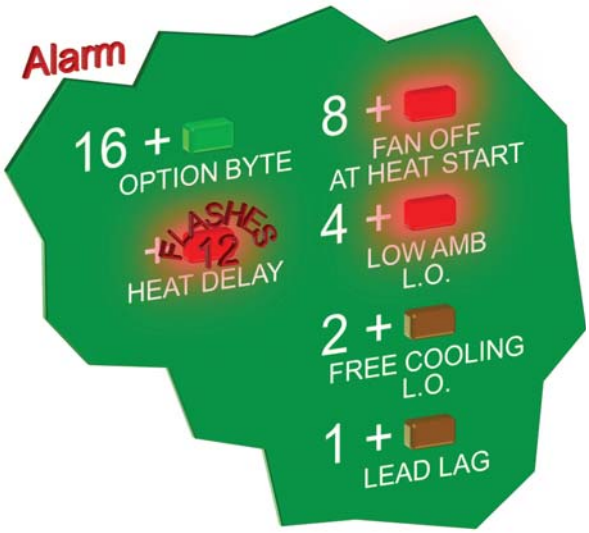


Compressor(s) held off due to economizer in free cooling mode - Unit equipped with the standard (Honeywell module) economizer: there is input voltage to the control’s Y1 terminal, which is passed through to the Y1 OUT pin. An open economizer interlock contact interrupts the voltage to the ECON pin. Unit equipped with a VAV-VFD board controlled economizer: the unit is operating in free cooling mode, and 1 or more compressors are held off.

Corrective Action

- With “Option Setup FREE COOLING L.O.” enabled (LED on), all of the compressors will be held off when the economizer is in free cooling mode
- With “Option Setup FREE COOLING L.O.” (LED off) disabled, when there is a 1st stage cooling demand, the economizer operates in free cooling mode. When there is a 2nd stage cooling demand, one compressor will operate to supplement the economizer
- On units that do not have an economizer, correct the loose or missing jumper-plug for economizer bypass in the unit’s wiring harness (located in the return air compartment)

12 Flashes

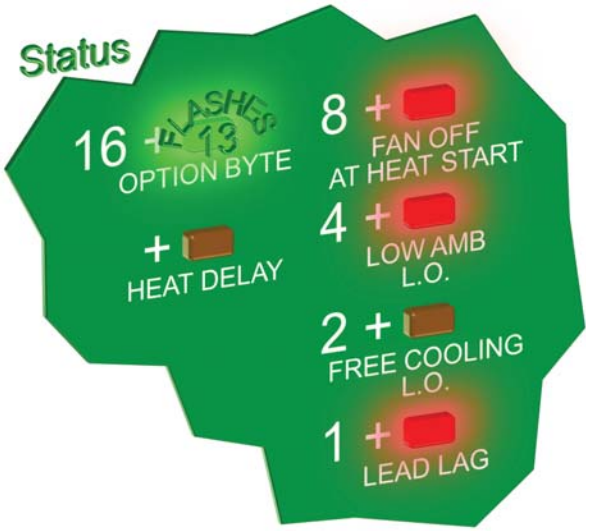


Unit locked-out due to fan overload trip -the fan overload safety contacts are currently open or have opened three times, for 5 or more seconds, in a two hour period or have opened once for 15 or more minutes.

Corrective Action

- Investigate the cause of the excessive current draw on the indoor blower motor that has led to the overload trip. Potential causes include: blower mis-adjustment, low line voltage, phase loss, a blown fuse, contactor failure, and motor winding damage
- On units that do not have an indoor blower overload relay, correct the loose or missing jumper at the FAN OVER pins

13 Flashes

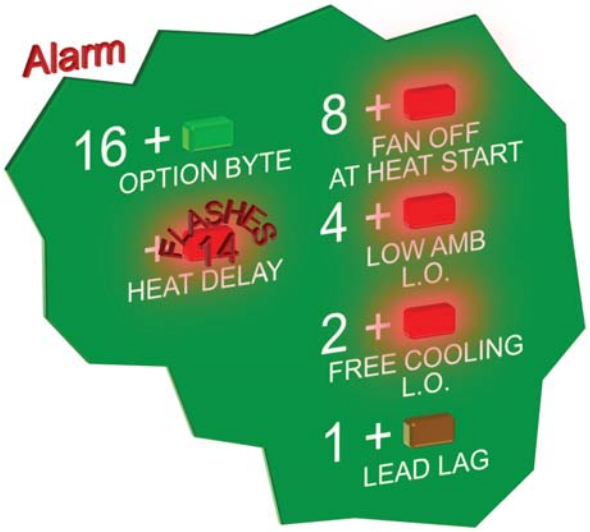


Contactor(s) held off due to low voltage - voltage to the control's R & C terminals is either below 19.2 volts AC, preventing additional contactors from being energized, or is below 16 volts AC preventing any contactors from being energized.

Corrective Action

- Verify that full line voltage is being applied to the 75VA transformer primary, and that 208/230 volt units have the proper primary tap connected
- Verify that the current of the 75 VA transformer secondary does not exceed 3 amps. If possible, it is best to take the following readings while there is load on the control circuit
- Verify 24 volts at the 75VA transformer secondary
- Verify 24 volts at terminals C & SD to assure that there is no voltage drop through the control circuit breaker or phase monitor contacts
- Verify 24 volts at terminals C & R to assure that there is no voltage drop through the smoke detector or shut-down relay contacts
- If 3 amps or more is drawn on the 75VA transformer secondary, investigate and correct the cause of the short or overload on the 24 volt circuits

14 Flashes

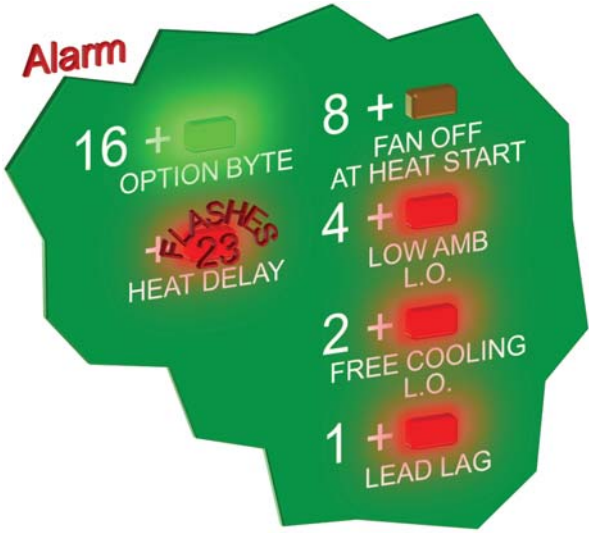


EEPROM storage failure - the microprocessor has detected a fault in the control's memory.

Corrective Action

- Cycle power to the control to eliminate the possibility that transient voltage conditions such as surges, brownouts, etc. have created a false indication
- If the "EEPROM Storage Failure" indication repeats, the control will need to be replaced, and potential causes for failure (excessive voltage, RF interference, etc.) should be investigated

23 Flashes



Board-to-board communication with the VAV-VFD board has been lost.

Corrective Action

- Verify that the VAV-VFD board is powered, and does not have a steady on indication
- Verify that the small harness from COM OUT of Simplicity 1A connects to COM IN of the VAV-VFD board (it may be connected through other boards)
- With small-scale test leads, verify typical voltages (+/-0.25 volts DC) of the connected harness terminals: gray to yellow = 1.5 to 3.0 volts DC (pulsing), gray to violet = 2.25 to 3.5 volts DC (pulsing)
- With the small harness disconnected, verify Simplicity 1A communication circuits are intact by measuring typical voltages (+/-0.25 volts DC) of the COM OUT pins: gray to yellow = 1.5 to 2.25 volts DC (pulsing), gray to violet = 2.75 to 3.5 volts DC (pulsing)
- With the small harness disconnected, verify VAV-VFD board communication circuits are intact by measuring typical voltages (+/-0.25 volts DC) of the COM IN pins: gray to yellow = 3.75 to 4.25 volts DC, gray to violet = 0.5 to 1.25 volts DC

Intelli-Comfort II Flash Codes

Simplicity Intelli-Comfort II Flash Codes			
Flash Code	**Description**	**LED Indication**	**Corrective Action**
Heartbeat	Normal operation - no status or error information currently needs to be displayed	1 sec ON/OFF	
Off	No power to control - 24 volt AC is not present to the control's R and C terminals. Alternately: The control has catastrophic damage that will not allow the LED display - It is likely that there will be visible physical evidence of the damage		Verify line voltage is present at the primary of the 75VA transformer, verify 24 volts AC is present at the secondary of the 75VA transformer. Verify 24 volts AC is present from the Simplicity 1A C to SD terminals indicating the 3.2 amp control circuit breaker and phase monitor contacts are closed. Verify 24 volts AC is present from the Simplicity 1A C to R terminals indicating the smoke detector and/or shutdown relay contacts are closed. Verify 24 volts AC is present from the Simplicity 1A 2-pin output C to R terminals indicating the Simplicity 1A circuitry is intact. Verify 24 volts AC is present from the Simplicity VAV-VFD board 2-pin input C to R terminals indicating the wiring harness is intact.
On	The control's microprocessor has not passed its self-check	ON Steady	Cycle power to the control to eliminate the possibility that transient voltage conditions such as surges, brownouts, etc. have not created a false indication. If the steady on LED indication repeats, the control will need to be replaced and potential causes for failure, such as excessive voltage, RF interference, etc. should be investigated.
2 Flashes	Board-to-board communication with the Simplicity 1A has been lost.	2 Flashes	Verify that the Simplicity 1A board is powered and does not have a steady on indication. Verify that the small harness from COM OUT of Simplicity 1A connects to COM IN of the VAV-VFD board (may be by way of other boards). With small-scale test leads, verify typical voltages (+/-0.25 volts DC) of the connected harness terminals: gray to yellow = 1.5 to 3.0 volts DC (pulsing), gray to violet = 2.25 to 3.5 volts DC (pulsing). With the small harness disconnected, verify Simplicity 1A communication circuits are intact by measuring typical voltages (+/-0.25 volts DC) of the COM OUT pins: gray to yellow = 1.5 to 2.25 volts DC (pulsing), gray to violet = 2.75 to 3.5 volts DC (pulsing). With the small harness disconnected, verify VAV-VFD board communication circuits are intact by measuring typical voltages (+/-0.25 volts DC) of the COM IN pins: gray to yellow = 3.75 to 4.25 volts DC, gray to violet = 0.5 to 1.25 volts DC.

Simplicity Intelli-Comfort II Flash Codes			
Flash Code	**Description**	**LED Indication**	**Corrective Action**
3 Flashes	Space temperature sensor error - the sensor input is open (greater than 350KΩ) or shorted (less than 200Ω).	3 Flashes	Verify that the wiring connecting the sensor to the VAV-VFD board is not open, shorted or shorted to cabinet ground. With the sensor disconnected from the wiring harness confirm the sensor is not shorted to cabinet ground. Measure the temperature at the sensor and measure the resistance of the sensor. Compare measured values to the Sensor Temperature vs. Resistance Chart, replace sensor if it is not within 10% of the proper value.
4 Flashes	Supply air temperature sensor error - the sensor input is open (greater than 350KΩ) or shorted (less than 200Ω).	4 Flashes	Verify that the wiring connecting the sensor to the VAV-VFD board is not open, shorted or shorted to cabinet ground. With the sensor disconnected from the wiring harness confirm the sensor is not shorted to cabinet ground. Measure the temperature at the sensor and measure the resistance of the sensor. Compare measured values to the Sensor Temperature vs. Resistance Chart, replace sensor if it is not within 10% of the proper value.
5 Flashes	Return air temperature sensor error - the sensor input is open (greater than 350KΩ) or shorted (less than 200Ω)	5 Flashes	Verify that the wiring connecting the sensor to the VAV-VFD board is not open, shorted or shorted to cabinet ground. With the sensor disconnected from the wiring harness confirm the sensor is not shorted to cabinet ground. Measure the temperature at the sensor and measure the resistance of the sensor. Compare measured values to the Sensor Temperature vs. Resistance Chart, replace sensor if it is not within 10% of the proper value.
6 Flashes	Outside air temperature sensor error - the sensor input is open (greater than 350KΩ) or shorted (less than 200Ω).	6 Flashes	Verify that the wiring connecting the sensor to the VAV-VFD board is not open, shorted or shorted to cabinet ground. With the sensor disconnected from the wiring harness confirm the sensor is not shorted to cabinet ground. Measure the temperature at the sensor and measure the resistance of the sensor. Compare measured values to the Sensor Temperature vs. Resistance Chart, replace sensor if it is not within 10% of the proper value.

Simplicity Intelli-Comfort II Flash Codes			
Flash Code	**Description**	**LED Indication**	**Corrective Action**
7 Flashes	Outside air humidity sensor error - the sensor input is 0 volts DC or greater than 10 volts DC.	7 Flashes	Verify that the sensor input has not been enabled through software access though no sensor is physically present. If a sensor is physically present: Verify that the wiring connecting the sensor to the VAV-VFD board is not open, shorted or shorted to cabinet ground. Verify 24 volts AC is present from C to R at the VAV-VFD OH connector indicating the board's circuitry is intact. Verify 24 volts AC is present from COM to 24VAC at the sensor indicating the wiring is intact and the sensor is powered. Measure the RH% at the sensor and verify the output from COM to OUT at the sensor is 1 volt DC per 10% RH indicating the sensor is functional. Verify the same 1 volt DC per 10% RH input is present at from C to OH at the VAV-VFD connector indicating the wiring is intact.
8 Flashes	Return air humidity sensor error - the sensor input is 0 volts DC or greater than 10 volts DC.	8 Flashes	Verify that the sensor input has not been enabled through software access though no sensor is physically present. If a sensor is physically present: Verify that the wiring connecting the sensor to the VAV-VFD board is not open, shorted or shorted to cabinet ground. Verify 24 volts AC is present from C to R at the VAV-VFD RH connector indicating the board's circuitry is intact. Verify 24 volts AC is present from COM to 24VAC at the sensor indicating the wiring is intact and the sensor is powered. Measure the RH% at the sensor and verify the output from COM to OUT at the sensor is 1 volt DC per 10% RH indicating the sensor is functional. Verify the same 1 volt DC per 10% RH input is present at from C to RH at the VAV-VFD connector indicating the wiring is intact.
9 Flashes	Indoor air quality sensor error - the sensor input is 0v DC or greater than 10 volts DC.	9 Flashes	Verify that the sensor input has not been enabled through software access though no sensor is physically present. If a sensor is physically present: Verify that the wiring connecting the sensor to the VAV-VFD board is not open, shorted or shorted to cabinet ground. Verify 24 volts AC is present from C to R at the VAV-VFD IAQ connector indicating the board's circuitry is intact. Verify 24 volts AC is present from COM to 24VAC at the sensor indicating the wiring is intact and the sensor is powered. Measure the ppm CO_2 at the sensor and verify the output from COM to OUT at the sensor is 1 volt DC per 200 ppm CO_2 (assuming default sensor scaling is used) indicating the sensor is functional. Verify the same 1 volt DC per 200 ppm CO_2 input is present at from C to IAQ at the VAV-VFD connector indicating the wiring is intact.

Simplicity Intelli-Comfort II Flash Codes			
Flash Code	**Description**	**LED Indication**	**Corrective Action**
10 Flashes	Outdoor air quality sensor error - the sensor input is 0 volts DC or greater than 10 volts DC.	10 Flashes	Verify that the sensor input has not been enabled through software access though no sensor is physically present. If a sensor is physically present: Verify that the wiring connecting the sensor to the VAV-VFD board is not open, shorted or shorted to cabinet ground. Verify 24 volts AC is present from C to R at the VAV-VFD OAQ connector indicating the board's circuitry is intact. Verify 24 volts AC is present from COM to 24VAC at the sensor indicating the wiring is intact and the sensor is powered. Measure the ppm CO_2 at the sensor and verify the output from COM to OUT at the sensor is 1 volt DC per 200 ppm CO_2 (assuming default sensor scaling is used) indicating the sensor is functional. Verify the same 1 volt DC per 200 ppm CO_2 input is present at from C to OAQ at the VAV-VFD connector indicating the wiring is intact.
11 Flashes	Air proving switch error - 24 volts AC has not been received through a closed air proving switch circuit within 90 seconds of fan output start. After a 30 minute delay the control will retry fan operation. Lockout occurs with 3 consecutive fan start errors. Also can indicate that the air proving switch circuit opened for longer than 2 seconds during fan operation. Also can indicate that the air proving switch circuit did not open within 90 seconds of the termination of the fan output. VAV Unit Note: APS error will be indicated but unit operation will continue if the duct pressure sensor reports greater than 0.05" w.c. during fan operation	11 Flashes	Verify that the air proving switch input has not been enabled through software access though no switch is physically present. If a switch is physically present: Verify that the blower belts are intact . Verify that the blower fuses are not blown, the contactor is operable, the blower wheel rotates in the proper direction, the current draw of the motor is not excessive, VFD errors are present and all associated line voltage wiring is intact. Verify the sensing tubing of the APS is intact and sensing blower discharge pressure. Verify that the wiring connecting the sensor to the VAV-VFD board is not open, shorted or shorted to cabinet ground. Verify 24 volts AC is present from C to the right hand pin at the VAV-VFD APS connector indicating the board's circuitry is intact. Verify 24 volts AC is present/lost when appropriate from C to the left hand pin at the VAV-VFD APS connector indicating the wiring is intact and the switch is functional.

Simplicity Intelli-Comfort II Flash Codes			
Flash Code	**Description**	**LED Indication**	**Corrective Action**
12 Flashes	Limit 2 trip error - 24 volts AC through a closed limit switch of heat section 2 has been lost to the Limit 2 input. Lockout occurs with 3 limit switch openings in a 1 hour period.	12 Flashes	Verify that the Limit 2 input has been properly configured through software access. If a limit switch is physically present: Verify proper gas manifold pressure. Correct the inadequate indoor airflow condition. Verify filters, indoor coil and blower wheel are clean. Verify that the blower belt(s) are properly maintained and adjusted; the blower motor fuses are intact, contactor and motor are operable and wheel has the correct rotation. Verify that the ducting is not restrictive. Verify indoor air volume is at least the minimum required for the heat section by measuring the indoor coil pressure drop and comparing the reading to the chart in the Installation Manual. Verify that the wiring connecting the switch to the VAV-VFD board is not open, shorted or shorted to cabinet ground. Verify 24 volts AC is present from C to the LIMIT 2 terminal of the VAV-VFD board indicating the wiring is intact and the switch is closed.
13 Flashes	Smoke purge cycle status - 24 volts AC has been received at the PUR input initiating the smoke purge cycle.	13 Flashes	THE BUILDING MAY BE ON FIRE! - IMMEDIATELY ASSESS PERSONAL SAFETY! Provided there is not a fire/smoke alarm active: Coordinate with the fire/smoke alarm supervisor to ensure that the fire/ smoke panel provides a close-for-purge contact for the PUR input. Verify that the wiring connecting the fire/smoke panel contact to the VAV-VFD board R and PUR terminals is not shorted.
14 Flashes	VFD error - 24 volts AC has been received at the Limit 2 input indicating the VFD alarm contacts have closed.	14 Flashes	Verify that the Limit 2 input has been properly configured through software access. If a VFD is physically present: Check the VFD for fault indication and make proper corrections. Verify that the wiring connecting the VFD alarm contacts to the VAV-VFD board is not shorted. Verify 24 volts AC is not present from C to the LIMIT 2 terminal of the VAV-VFD board indicating the VFD alarm circuit is shorted.
15 Flashes	Dirty filter switch status - 24 volts AC has been received through the dirty filter differential pressure switch continuously for 10 minutes indicating the filters are fouled.	15 Flashes	Verify that the filters are clean. Verify that the dirty filter pressure differential switch is properly adjusted for the filters in use and the associated pressure drop for the air volume of the unit. Verify that the wiring connecting the switch to the VAV-VFD board is not shorted.

Simplicity Intelli-Comfort II Flash Codes			
Flash Code	**Description**	**LED Indication**	**Corrective Action**
16 Flashes	Economizer minimum position alarm - conditions for Cooling or Heating Supply Air Temperature Alarms must be present. Also, minimum position setting must be greater than 20% and outdoor temperature must be more than +/-20*F from the *Supply Air Temp Alarm Setpoint for Cooling/Heating*. Overriding of minimum position to close the outdoor air damper for 10 minutes to prevent Cooling or Heating Supply Air Temperature Alarms.	16 Flashes	Verify that minimum position, Supply Air Temp Alarm Setpoint for Cooling and Supply Air Temp Alarm Setpoint for Heating have been properly configured through software access. Review conditions for Cooling or Heating Supply Air Temperature Alarms.
17 Flashes	Space temperature alarm - after 10 minutes of heat/cool operation, space temperature has not been within space temperature setpoint +/- the value set for Space Temp Trending Alarm Temp nor has space temperature shown a trend to move toward setpoint within the time set for Space Temp Trending Alarm Time. The space temperature is not responding to the unit's heat/cool operation.	17 Flashes	Verify that the Space Temp Trending Alarm Temp and the Space Temp Trending Alarm Time have been properly configured through software access. Verify that the space/return sensor is properly located and is accurately sensing space temperature. Verify that the unit's heat section and compressors are operable and check alarm history for error flash codes that prevent heat/cool operation.
18 Flashes	Heating water coil freezestat alarm - 24 volts AC through a closed heating water coil freezestat has been lost to the FSHW input. Status-only indication above 40*F outdoor temperature, unit operation will not be affected. At outdoor temperatures 40*F or below the indoor fan is stopped, outdoor air dampers are closed and the heating water valve is opened to 100%.	18 Flashes	Verify that hydronic heating has not been enabled through software access though no hydronic heating is physically present. If hydronic heating is physically present and enabled through software access: verify that the required field-installed freezestat is present and wiring to FSHWR & FSHW terminals is intact. Investigate the causes of the heating water coil freezestat trip such as excessively cool supply air temperatures in cooling mode, excessive outside air or outside air damper leakage in cooler outdoor temperatures.
19 Flashes	Cooling supply air temperature alarm - supply air temperature did not fall below the Supply Air Temp Alarm Setpoint for Cooling after 10 minutes of cooling operation.	19 Flashes	Verify that minimum position and Supply Air Temp Alarm Setpoint for Cooling have been properly configured through software access. Verify proper indoor airflow volume. Verify that the unit's compressors are operable and check alarm history for error flash codes that prevent cooling operation.

Simplicity Intelli-Comfort II Flash Codes			
Flash Code	**Description**	**LED Indication**	**Corrective Action**
20 Flashes	Heating supply air temperature alarm - supply air temperature did not rise above the Supply Air Temp Alarm Setpoint for Heating after 10 minutes of heating operation.	20 Flashes	Verify that minimum position and Supply Air Temp Alarm Setpoint for Heating have been properly configured through software access. Verify proper indoor airflow volume. Verify that the unit's heat section is operable and check alarm history for error flash codes that prevent heating operation.
21 Flashes	Duct pressure alarm - Either the Duct Pressure Shutdown Setpoint has been exceeded or 0 volts DC/more than 5 volts DC has been received at the DUCT PRES input.	21 Flashes	Measure supply duct pressure. Verify the Duct Pressure Shutdown Setpoint and Duct Pressure Setpoint have been properly configured through software access. If measured duct static pressure is excessive, make appropriate corrections to minimum flow settings of the VAV boxes, unit indoor airflow volume and ducting. Verify that the supply duct static pressure transducer sensing tubing is intact and properly located. Verify that the supply duct static pressure transducer wiring is intact and the transducer is powered with 24 volts AC. Compare the measured supply duct pressure to the volts DC output of the transducer: 0" w.c. = 0 volts DC output, 1" w.c. = 1 volt DC output, 2" w.c. = 2 volts DC output, 3" w.c. = 3 volts DC output, 4" w.c. = 4 volts DC output, 5" w.c. = 5 volts DC output. Verify the volts DC output of the transducer is received at the DUCT PRES input.

Control Circuit, Input and Output Troubleshooting

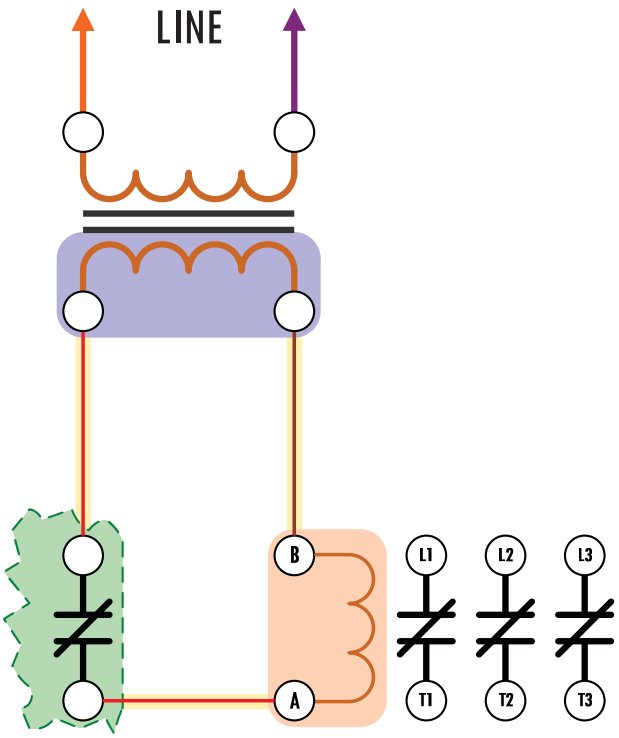


Figure 8-1

The 24 volt control circuits can be described in the same general terms as any other electrical circuit: source, path (includes a controlling device), and load.

Specifically for control circuits, the source is the secondary of the line voltage to 24 volt transformer.

The path is the wiring and connectors of the circuit. Depending on the circuit, the wiring and connectors can be both the factory-installed harnesses within the unit and the field-installed wiring external to the unit.

For most of the 24 volt output circuits, the controlling device is one of the Simplicity family of control boards. Switches such as high pressure, low pressure, space thermostat, and heat section limit are the controlling devices for binary input circuits. Analog (variable) controlling devices such as thermistors and pressure sensors are used with input circuits of Intelli-Comfort and VAV-VFD boards. Verifying that the controlling device has the correct operation for the conditions present is a key to proper troubleshooting. For output circuits, where the Simplicity board is the controlling device, the best way to verify the binary contact is energized or that the analog signal is being produced is through Simplicity PC software access. Measurement of temperature or pressure that the switches are exposed to, and comparing that to the on/off settings provides information for verifying the operation of the controlling devices in binary input circuits.

The loads of the 24 volt control circuits are the devices that consume the 24 volts power. On a basic cooling-only unit, the indoor blower, compressor contactor coils, and the microprocessor of the Simplicity control board are the 24 volt control circuit loads. Gas heat section loads are the ignition control and gas valve. Electric heat accessory loads include the contactor coils and control relay coils of the heat section. The power for an electronic thermostat, smoke detectors, economizer module, and actuator are examples of 24 volt control circuit loads added with accessory devices. The 24 volt control circuit loads of VAV units include the power to the pressure transducers, humidity sensors, CO2 sensors, and actuators.

In the simplified example of a 24 volt control circuit, Figure 8-1 the source is the transformer secondary (highlighted in blue), the path is the wiring and connections of the circuit (highlighted in yellow), the controlling device is the Simplicity board contact (highlighted in green), and the load is the contactor coil (highlighted in orange).

The following descriptions for troubleshooting the 24 volt control circuits of units incorporate, and progressively build on systematic methods for:

- Making sure that the source is available
- Ensuring the path is intact
- Verifying the controlling device permits operation
- Confirming that the load is functional

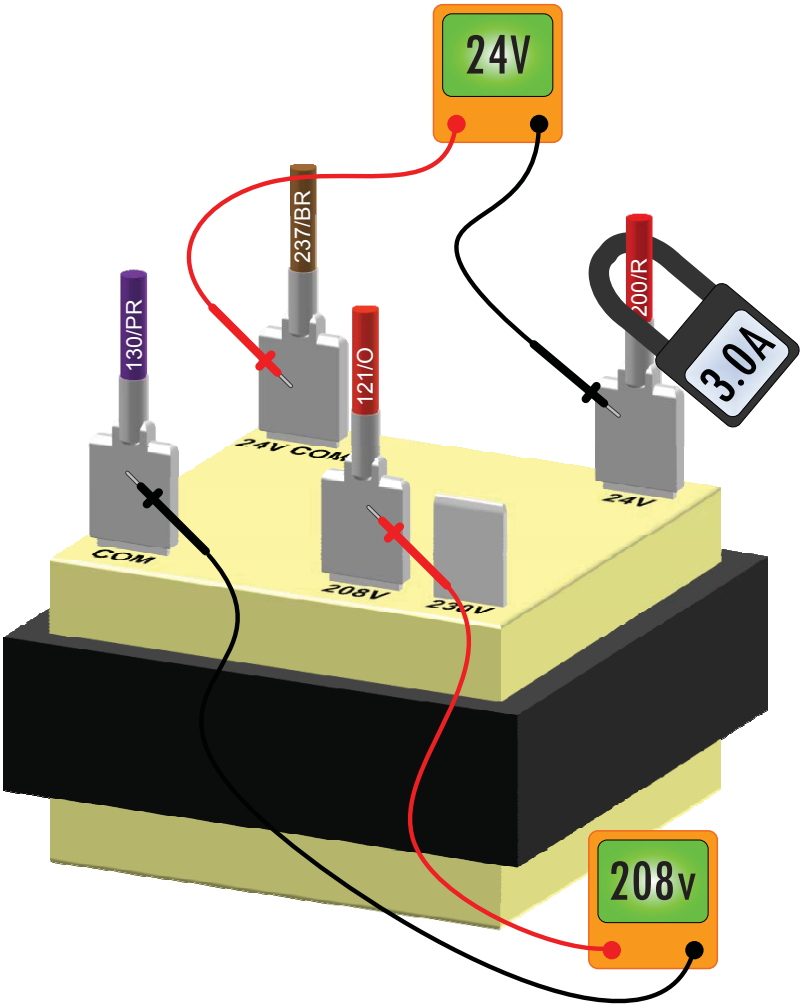


Figure 8-2

Confirmation that 24 volts is supplied to the Simplicity board will be needed if the board's status LED is not lit low voltage fault codes occur.

The appropriate line voltage for the application must be read from the primary terminals of the T1 transformer. Units using 208/230 volts have taps for both 208 and 230 volts, as illustrated in Figure 8-2 and 8-3. If the application specifies 208 volts, the 121/O wire must be moved from the "as shipped" 230 volt tap to the 208 volt tap.

If line voltage is low or absent to the T1 transformer primary terminals, then troubleshooting of the line voltage circuit will be needed before any 24 volt circuit troubleshooting can proceed.

Current draw of the transformer secondary / 24 volt circuit should be monitored while troubleshooting the control circuits. Current draw in excess of 3.1 amps will cause a drop in secondary voltage on the 75VA T1 transformer, and trips of the 3.2 amp control circuit breaker. Excessive current draw indicates shorting exists in the 24 volt circuit. Correction of the shorted or grounded 24 volt wiring or component will be needed before any 24 volt circuit troubleshooting can proceed.

When line voltage is present at the transformer primary terminals, current draw of the 24 volt circuit is less than 3.1 amps (75VA), and the transformer windings are intact, then 24 volts will be read from the secondary terminals.

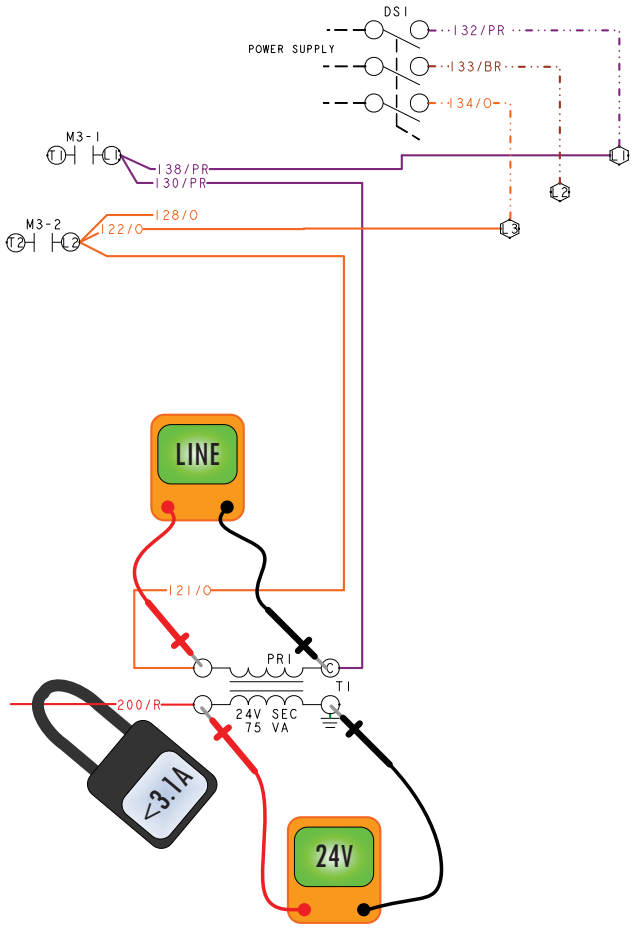


Figure 8-3

If line voltage is present at the transformer primary terminals, current draw of the 24 volt circuit is less than 3.1 amps (75VA), and 24 volts is not read from the secondary terminals, then the transformer windings have failed. In nearly all cases where transformer failure occurs, the smaller gauge wire of the primary winding is damaged due to shorts or overloads of the secondary / 24 volt circuit. The 24 volt circuit should be investigated for shorts, and upon transformer replacement the current draw of the secondary / 24 volt circuit should be closely monitored.

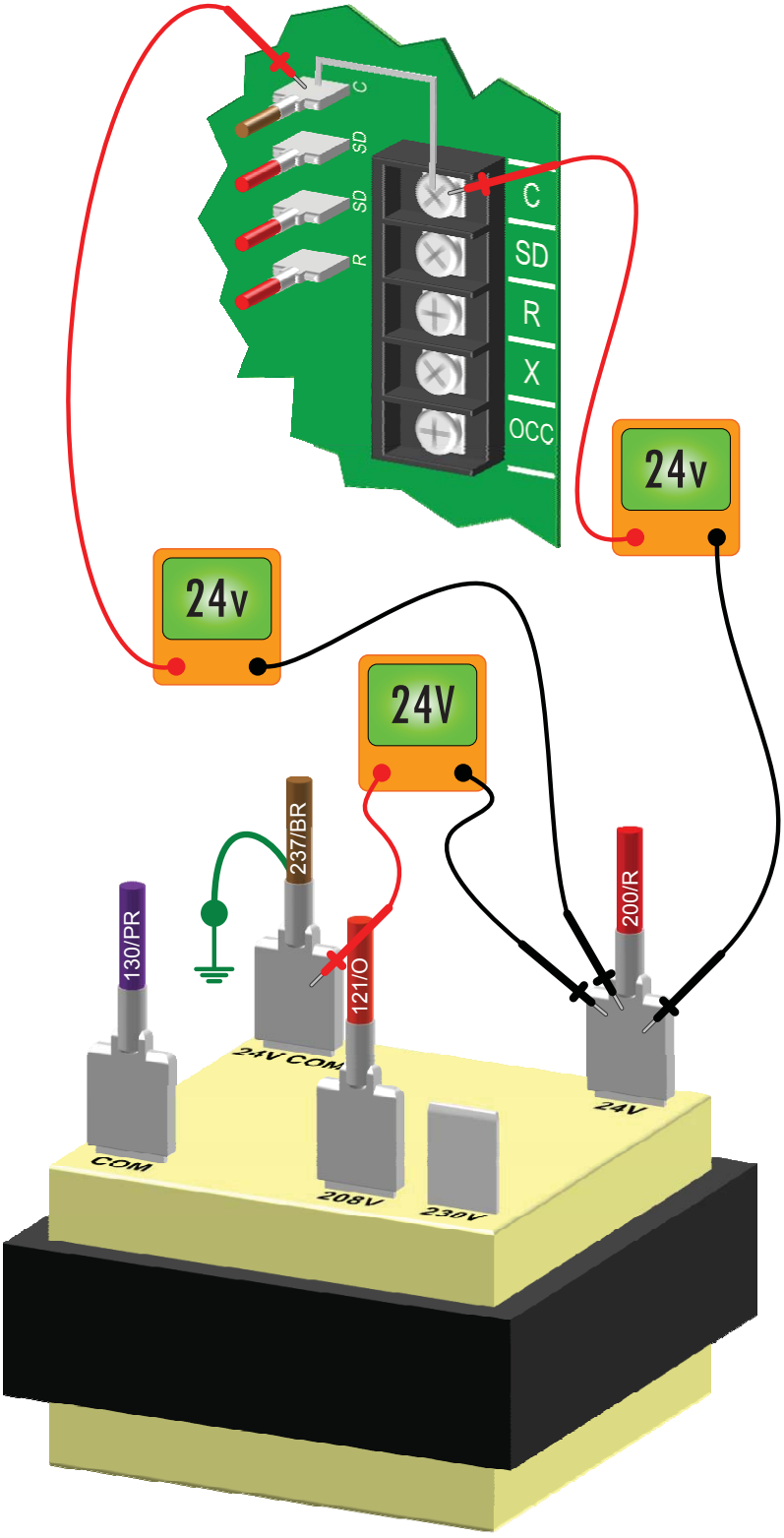


Figure 8-4

With 24 volts read from the secondary terminals, the 24 volt common can be confirmed to be intact.

A continuous chain of wiring, nearly all color-coded brown, connects 24 volt common to the 24 volt circuit loads in the unit. A reading of 24 volts from the transformer 24 volt hot (200/R wire) to the Simplicity (Lite illustrated throughout this section) board's C push-on terminal confirms the 24 volt common wiring to the Simplicity board is intact.

If 24 volts is not read, then the 24 volt common wiring to the Simplicity board is open and will need to be repaired.

Similarly, the 24 volt common wiring to other 24 volt circuit loads can be confirmed to be intact by reading 24 volts from the transformer 24 volt hot (200/R wire) to the 24 volt common terminal (brown wire) of the individual loads.

Further, a reading of 24 volts from the transformer 24 volt hot (200/R wire) to the Simplicity board's C screw terminal confirms the 24 volt common circuit trace of the Simplicity board is intact.

If 24 volts is not read to the Simplicity board's C screw terminal while the 24 volt common wiring to the Simplicity board is intact to the push-on C terminal, then the circuit trace is open and the board will need to be replaced. In cases where the circuit trace to the Simplicity board's C screw terminal has opened it is likely due to shorting of the field-installed wiring external to the unit. Correction of the causes for this shorting should be investigated, and the current draw of the transformer secondary / 24 volt circuit should be closely monitored to prevent repeat failure of the replacement board.

After 24 volts common is confirmed, use it as a fixed reference (one voltmeter lead is "anchored" to 24 volt common) for other 24 volt circuit readings for troubleshooting. Unless otherwise noted, a fixed common reference is also used in the text descriptions that are used in this section.

While 24 volts common is also connected to cabinet ground, the best practice is to use a component wiring termination for a fixed reference of 24 volts common rather than the unit cabinet. This ensures that the 24 volt common reference is reliable, and not compromised by paint or corrosion on the surface of the cabinet. However, at points where a meter lead can not reach a component terminal, using the cabinet as a 24 volt common reference may be the only practical alternative available to the technician.

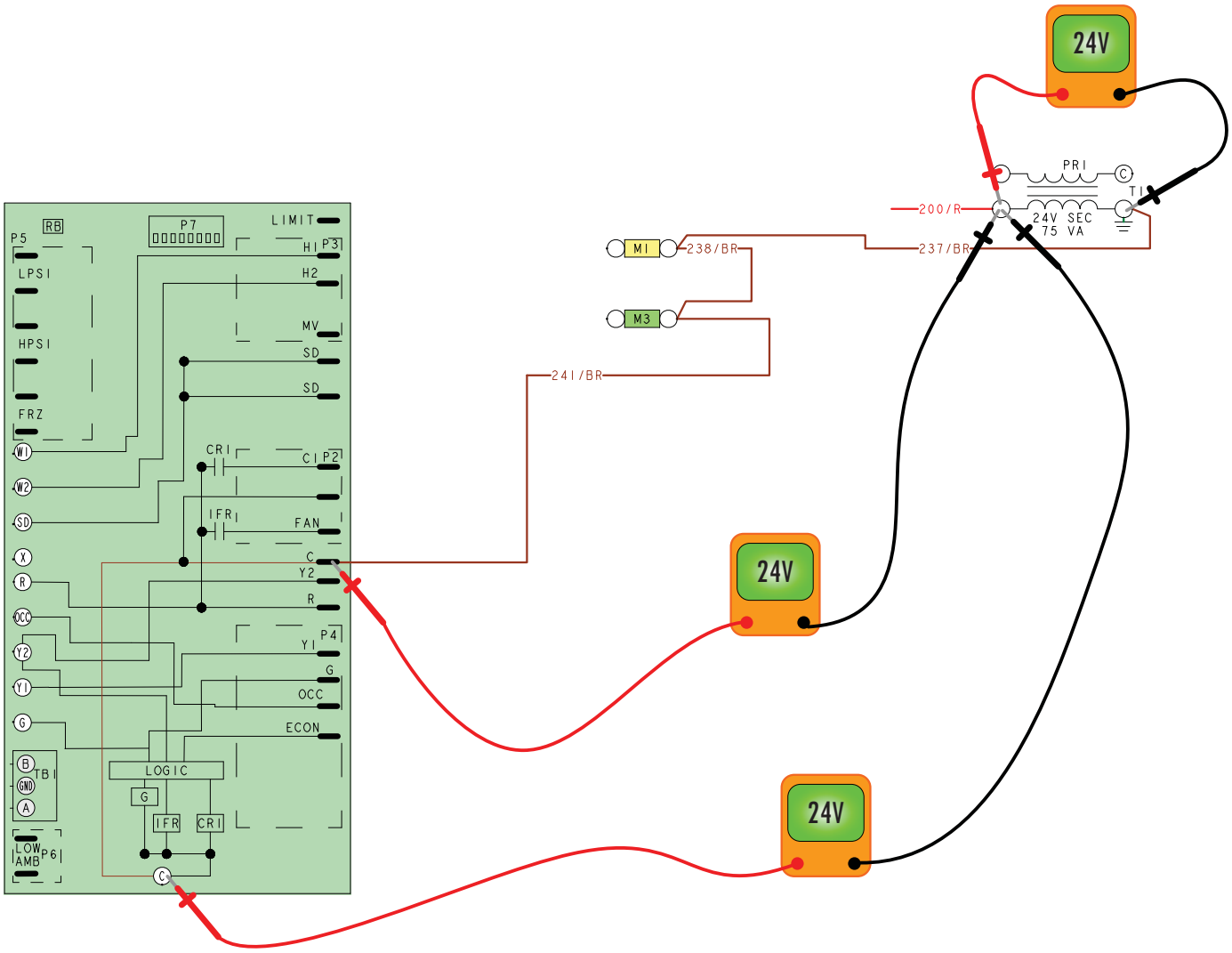


Figure 8-5

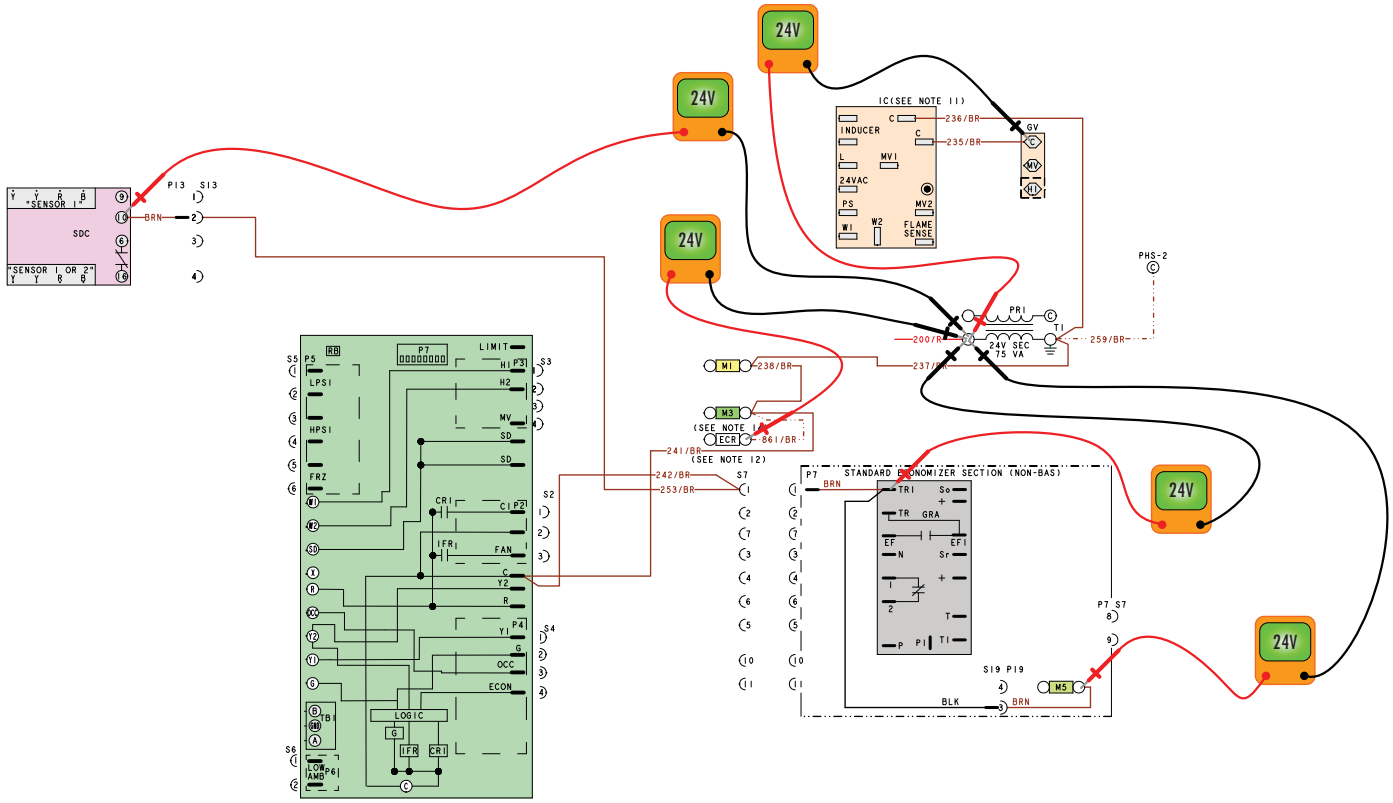


Figure 8-6

Confirm that the 24 volt common wiring to 24 volt circuit loads is intact by reading 24 volts from the transformer 24 volt hot (200/R wire) to the 24 volt common terminal (brown wire) of the individual loads.

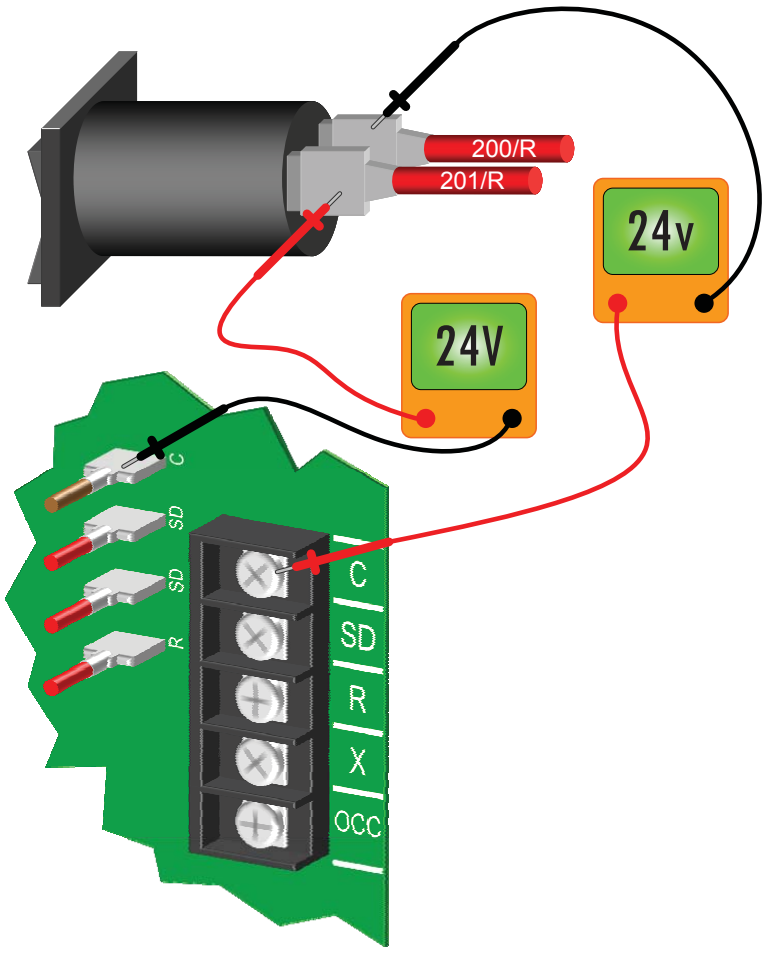


Figure 8-7

With 24 volts measured from the secondary terminals, and the 24 volt common confirmed to be intact, troubleshooting can be done on the 24 volt "hot" portion of the circuit.

Using 24 volt common for a fixed reference and using a series of voltage readings (one voltmeter lead "anchored" to 24 volt common), is the most reliable method for accurate troubleshooting. Starting with voltage being present from the source, readings are taken in sequence at available points in the circuit, ending at the load. Where voltage is present, the circuit is complete to that point in sequence. If voltage is lost at the next point in sequence, the incomplete (open) circuit is located between the point where voltage was present and lost.

This method also uses the circuit's current draw for troubleshooting information. If there is source voltage, but zero current draw, then the circuit is open. If there is excessive current draw, but zero voltage present, then the circuit is shorted. If voltage is present, and current draw is "normal", the circuit is complete.

Similarly, voltage at the load and current draw of the load provide troubleshooting information. If the circuit is found to be complete, and voltage is present up to the load, but with zero current draw from the load, then the load is known to be open. If the current draw of the load is excessive, then the load is known to be shorted. Voltage present at the load, and normal current draw indicate the load is electrically intact; however, mechanical issues may exist that prevent the component's function.

Since the normal current draw of the Simplicity board as an isolated load is too low to register on most meters used in the field, any significant current draw readings are likely from other loads or circuits.

At this point, confirm that 24 volts is supplied to the Simplicity board, the voltage source (the transformer secondary) is known to be available, and the common is known to be intact. Voltage readings that "walk" through the circuit to the load (the Simplicity board) are completed next.

A reading of 24 volts at the incoming terminal of the control circuit breaker (200/R wire) indicates the wiring and connections from the transformer secondary to the control circuit breaker are intact. If 24 volts is not present, then the 200/R wire or connections are open.

A reading of 24 volts at the outgoing terminal of the control circuit breaker (201/R wire) indicates the control circuit breaker is closed (not tripped).

If 24 volts is not present at the outgoing terminal of the control circuit breaker, then the control circuit breaker is tripped or open. Before proceeding, the control circuit should be closely monitored for excessive current draw. If the circuit breaker has tripped, the reset lever will protrude slightly, and can be pressed to reset the trip. If pressing the reset lever does not close the breaker, then the breaker has failed. In cases where the circuit breaker trips or fails it is likely due to shorting of the 24 volt circuit. The causes for shorting must be investigated and corrected, and the current draw of the transformer secondary / 24 volt circuit should be closely monitored to prevent repeat trips or failures.

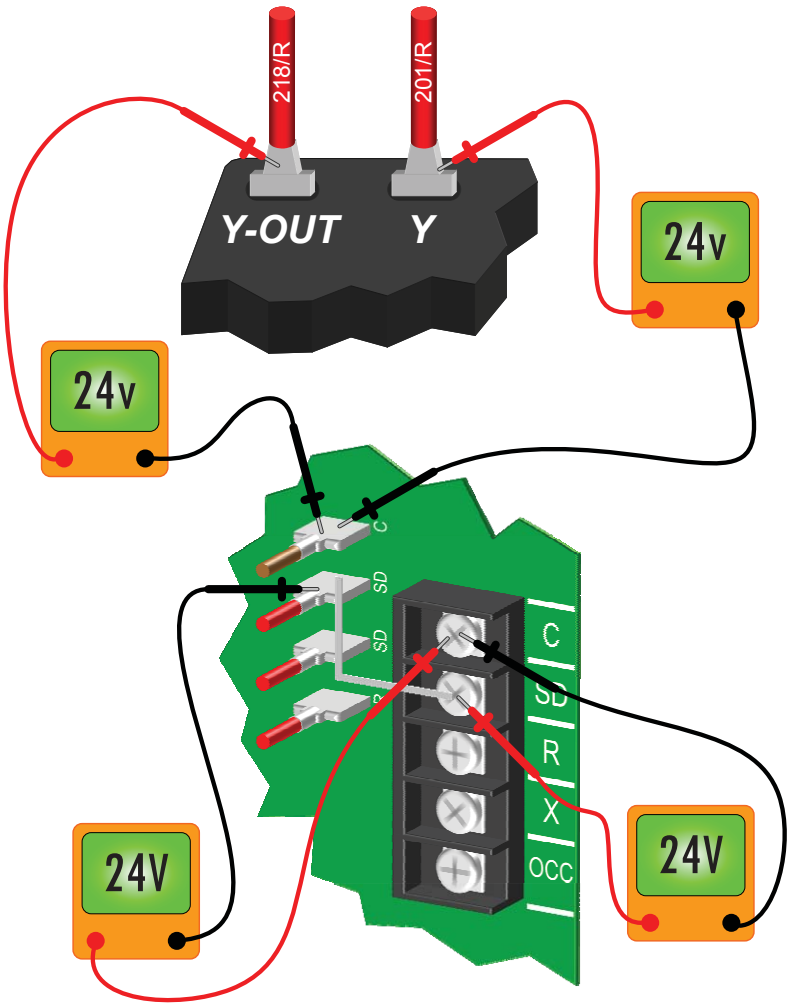


Figure 8-8

A reading of 24 volts at the incoming Y terminal of the optional phase monitor (201/R wire) indicates the wiring and connections from the control circuit breaker to the phase monitor are intact. If 24 volts is not present, then the 201/R wire or connections are open.

A reading of 24 volts at the outgoing Y-OUT terminal of the optional phase monitor (218/R wire) indicates the phase monitor is closed (not tripped).

If 24 volts is not present, then the phase monitor is tripped or open. When tripped, the phase monitor's LED will be lit to indicate that the line voltage circuit has had phase loss or voltage under what is proper for equipment operation. Correction of the causes for the line voltage circuit issues should then be investigated.

A reading of 24 volts at the push-on SD terminal of the Simplicity board (201/R wire or 218/R wire with phase monitor option) indicates the wiring and connections from the control circuit breaker, and phase monitor are intact. If 24 volts is not present then the 201/R or 218/R wire or connections are open.

Further, a reading of 24 volts at the SD screw terminal of the Simplicity board confirms the SD circuit trace of the Simplicity board is intact. If 24 volts is not read to the Simplicity board's SD screw terminal while 24 volts is intact to the push-on SD terminal, then the circuit trace is open and the board will need to be replaced. In cases where the circuit trace to the Simplicity board's SD screw terminal has opened, it is likely due to shorting of the field-installed wiring external to the unit. Correction of the causes for this shorting should be investigated, and current draw of the transformer secondary / 24 volt circuit should be closely monitored to prevent repeat failure of the replacement board.

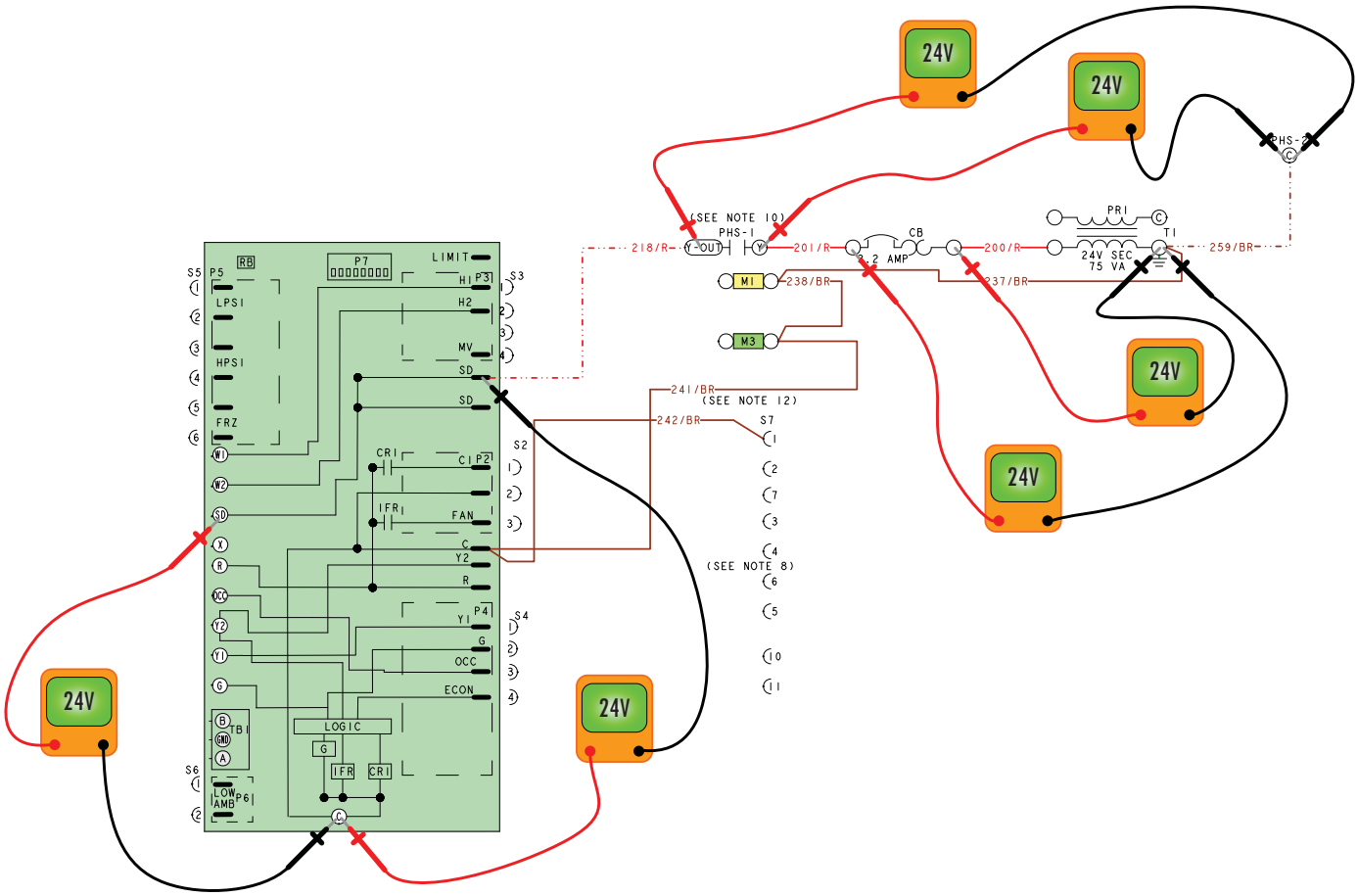


Figure 8-9

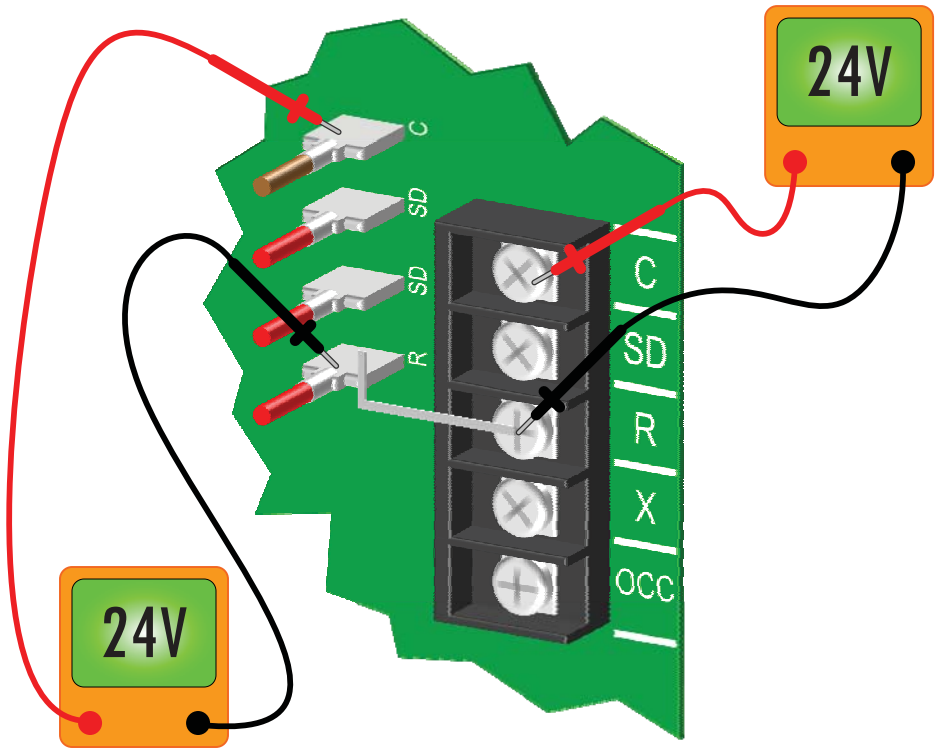


Figure 8-10

A reading of 24 volts at the push-on R terminal of the Simplicity board (225/R wire or 289/R with user shutdown relay option) indicates the smoke detector/shutdown wiring and connections are intact and the smoke detector/shutdown devices are not tripped. The LED of the Simplicity board will also flash a status indication.

If 24 volts is not present, then the smoke detector/shutdown wiring or connections are open or the smoke detector/shutdown devices are tripped. The cause and correction for the open circuit depends on the options found with the unit.

For units without smoke detector or user shutdown relay options,

the wiring or connections between the SD and R terminals are open. The jumper plugs in the wiring harness at the locations for unit-mounted supply and return smoke detector options should be closely examined for proper seating.

For units with unit-mounted (factory accessory) or field installed duct-mounted smoke detectors: the wiring or connections may be open and the smoke detector(s) should be examined for indications of trips. The technician should assess building safety when smoke detectors trip. If the building is safe, and the cause for the smoke detector trip no longer exists, the technician should then follow the smoke detector vendor's instructions for reset.

For units with the user shutdown relay option: the wiring or connections may be open and the voltage to the shutdown relay coil should be measured. The shutdown relay is typically controlled by the building's automation system. If 24 volts is present at the shutdown relay coil, the technician should assess building safety, and coordinate corrective action with the administrator of the building's automation system.

Further, a reading of 24 volts at the R screw terminal of the Simplicity board confirms the R circuit trace of the Simplicity board is intact.

If 24 volts is not read to the Simplicity board's R screw terminal while 24 volts is intact to the push-on R terminal, the circuit trace is open, and the board will need to be replaced. In cases where the circuit trace to the Simplicity board's R screw terminal has opened, it is likely that a short exists in the field-installed wiring external to the unit. The causes for this short should be corrected, and the current draw of the transformer secondary / 24 volt circuit should be closely monitored to prevent repeat failure of the replacement board.

If 24 volts is present to the R terminal, and the LED of the Simplicity board does not flash a status indication, then the board has failed and will need to be replaced. Causes for the board failure include excessive voltage, water on the board, and incompatible wall thermostat. These potential causes should be investigated and corrected to prevent repeat failure of the replacement board.

The example in Figure 8-11 illustrates 24 volt readings on the smoke detector/shut down circuit, and are only a portion of the accessible points that are available

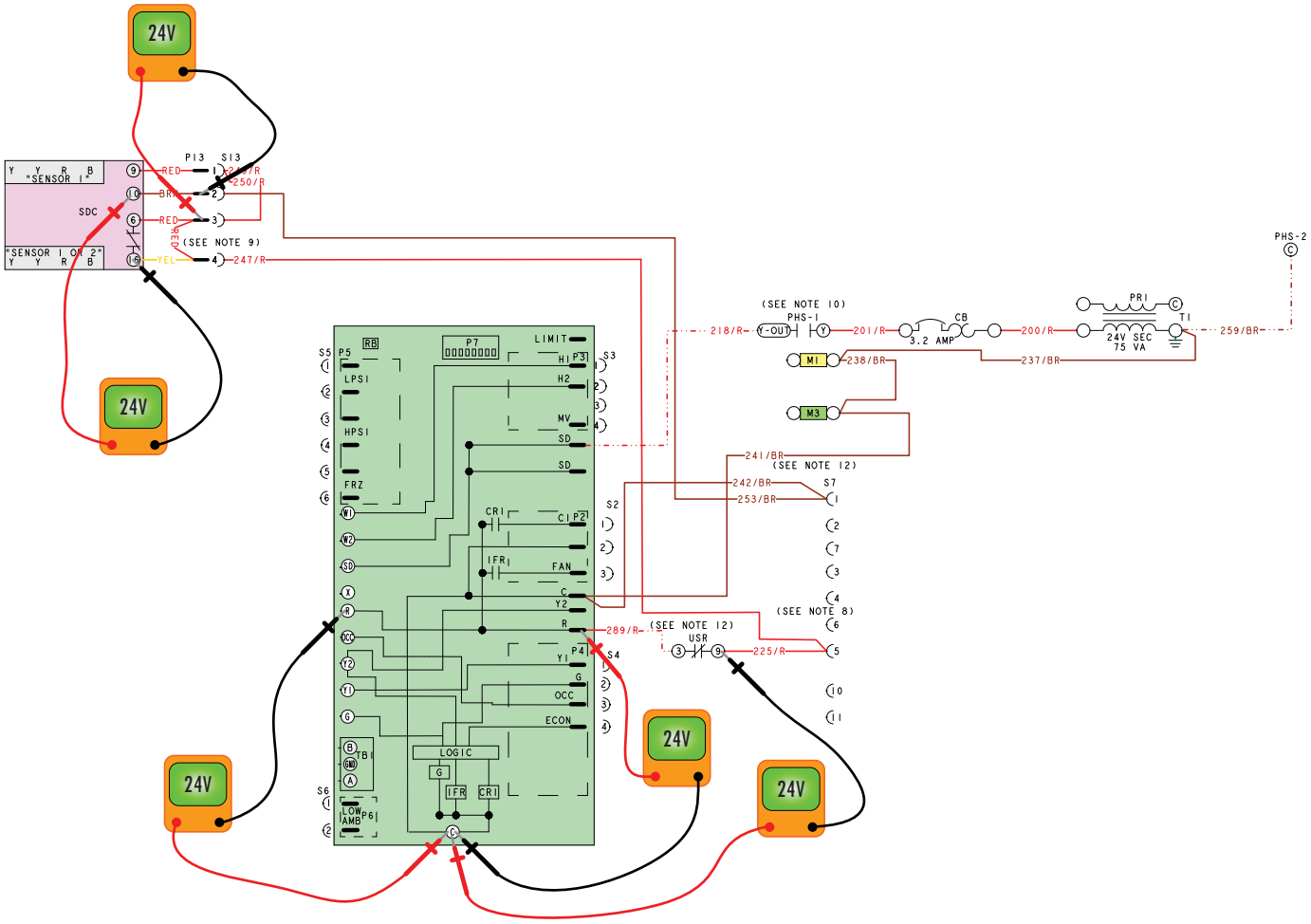


Figure 8-11

Inputs

Description	Value	Unit(s)
Cool 1 (Y1)	ON	

Figure 8-12

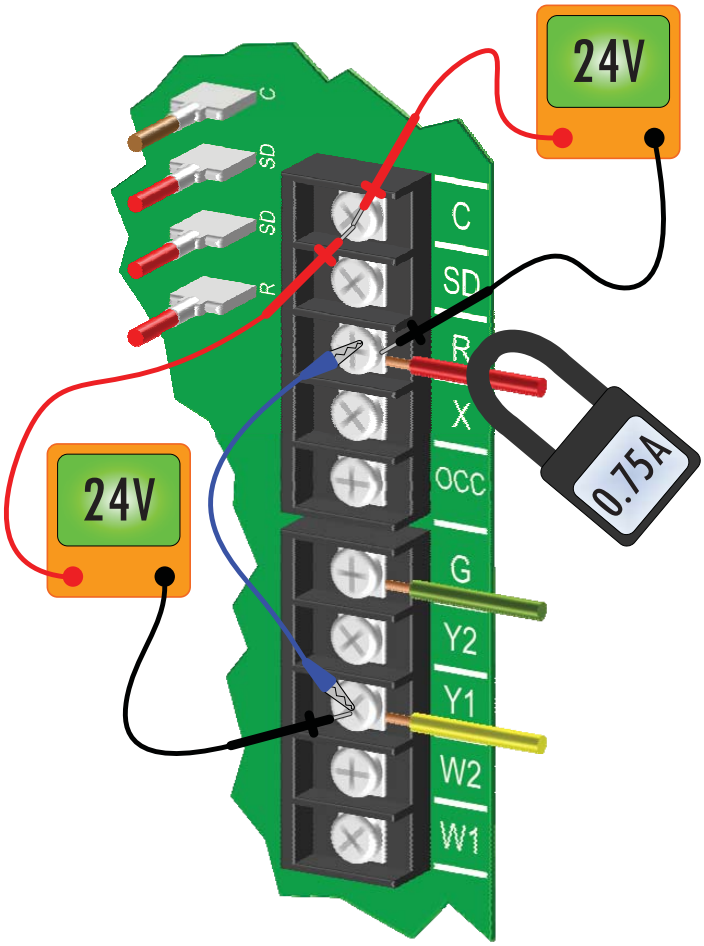


Figure 8-13

Troubleshooting binary (switched) inputs to Simplicity boards begins by confirming that the board is powered as previously discussed:

- The transformer secondary provides 24 volts
- Control circuit common is confirmed to be intact
- The smoke detector/shutdown circuit is complete
- 24 volts is present to R and C
- The LED of the Simplicity board flashes a status indication

The Simplicity Lite board is shown in the examples that follow. Troubleshooting the binary inputs of other boards in the Simplicity family is similar.

The field-connected wire from the R screw terminal provides power to the space thermostat which then switches 24 volts "hot" to the field-connected inputs (W1, W2, Y1, G, OCC & Y2) when space conditions demand. Current through the wire field-connected to the R screw terminal should be monitored during troubleshooting of the field-connected inputs. Slightly more than 0.75 amps is the highest current through the wire field-connected to the R screw terminal expected under normal conditions, this occurs with a two-stage gas heat demand (W1+W2 inputs), and when powering a digital thermostat. If there is excessive current through the wire field-connected to the R screw terminal, it is likely due to either wiring errors that produce a direct short (24 volt "hot" conductors to common) or shorts to ground (24 volt "hot" conductors to the building's electrical ground) in the field-connected wiring.

When the field-connected inputs receive 24 volts (Y1 input illustrated), the Simplicity board will either energize the output associated with that input or display a status flash code to indicate the reason the output is not energized.

An exception to the above condition occurs if the function associated with the input has been disabled through Simplicity software access. An example would be if the "Cooling Mode Operation Enabled" was set to OFF, then a Simplicity board will not react to Y1 or Y2 inputs.

Voltage as low as 2 volts to the field-connected terminals can be "recognized" by the Simplicity board as a full input. To avoid potential input conflicts with Simplicity boards, "power-stealing" thermostats that draw their operating power from the W1 or other input terminals should not be used.

If an electronic (triac) switching thermostat is used, 24 volts may be read at the field-connected inputs without the Simplicity board "recognizing" the input. This is due to voltage loss and half-wave rectification issues with triacs. To determine if this is the cause, temporarily connect a jumper wire from R to the screw terminal input. If the Simplicity board then reacts as expected with the jumper wire connected, correction must be made to provide the board with the required "dry-contact" inputs, either by the proper replacement space thermostat or through the addition of isolation relays to the existing electronic switching thermostat.

If 24 volts is not present at the field-connected inputs, then one or more of the following items exist:

- There is no demand from the space
- The space thermostat is improperly configured or connected
- The field-connected wiring is open or improperly terminated

If 24 volts is present at the field-connected inputs when there is no demand from the space, then one or more of the following items exist:

- The space thermostat is improperly configured or connected
- The field-connected wiring is shorted to another 24 volt "hot" conductor or improperly terminated

The status of the field-connected inputs can also be read through Simplicity PC.

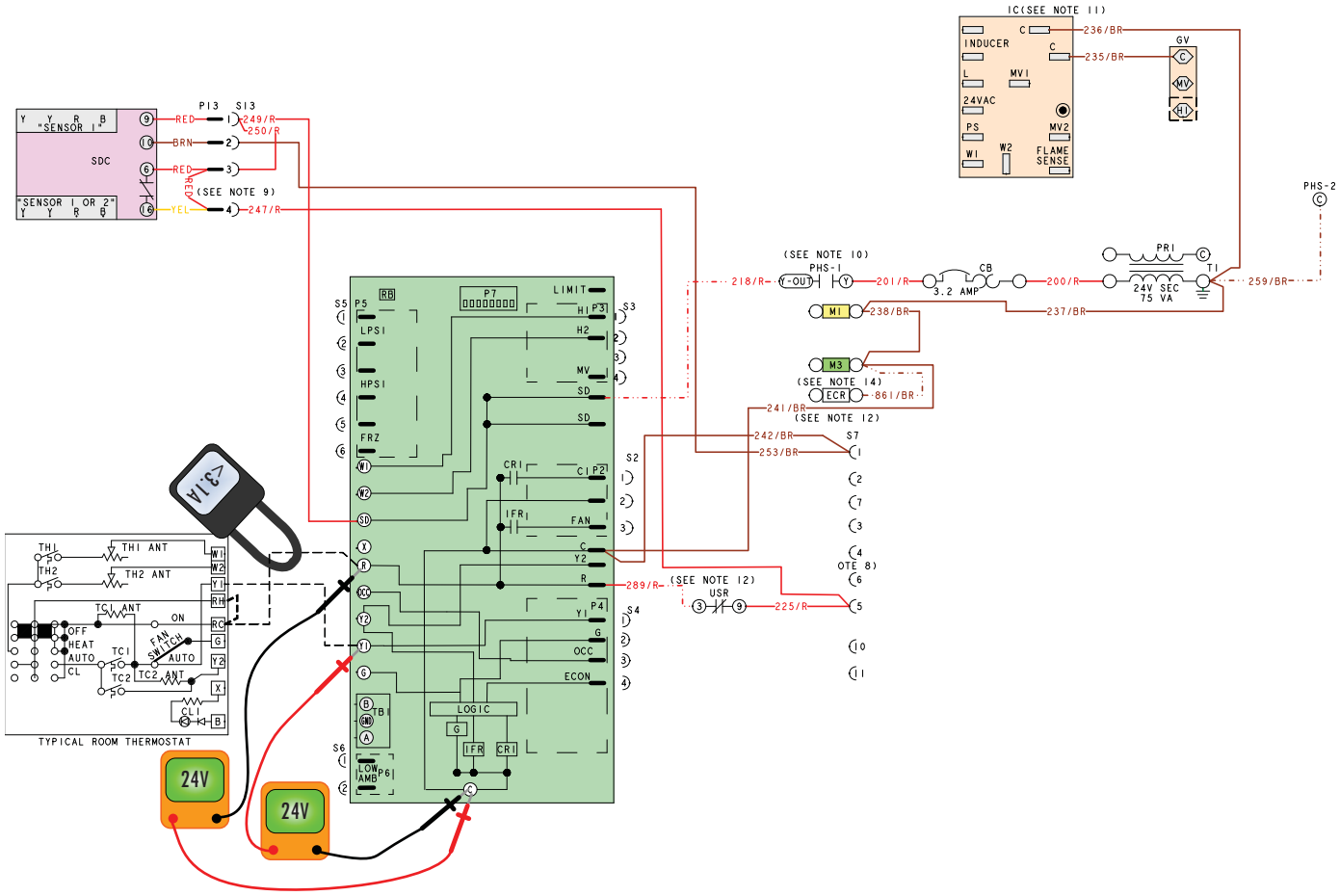
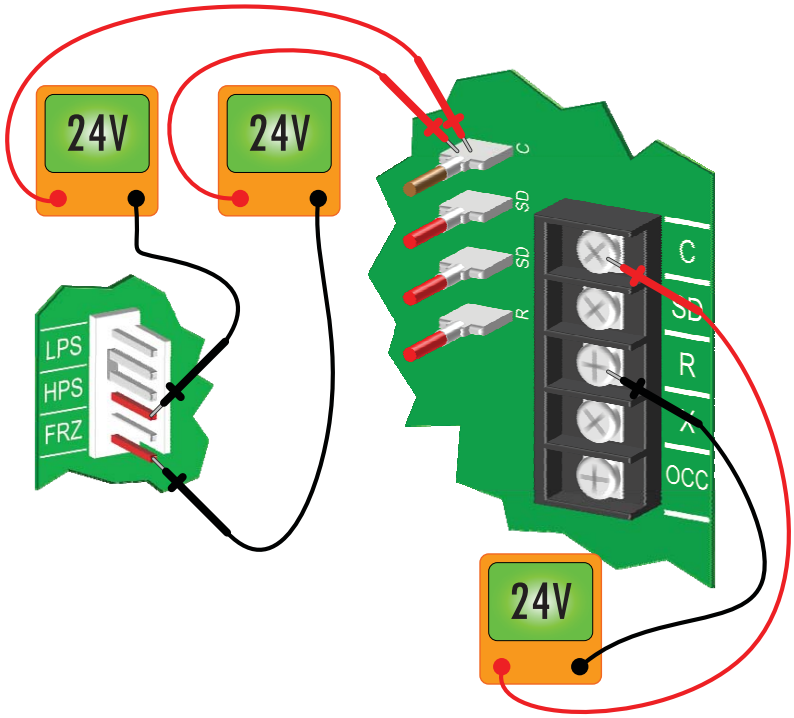


Figure 8-14

Confirming the 24 volt inputs to the field-connected screw terminals (Y1 example).



Troubleshooting of the binary inputs to Simplicity boards that are from the unit wiring harness (factory-wired and from field-added accessories) also begins with confirming that the board is powered as previously discussed:

- The transformer secondary provides 24 volts
- Control circuit common is confirmed to be intact
- The smoke detector/shutdown circuit is complete
- 24 volts is present to R and C
- The LED of the Simplicity board flashes a status indication

Figure 8-15

Through circuit traces on the Simplicity Lite board, the R terminal also connects 24 volt “hot” to one pin of the set that connects to the FRZ, HPS and LOW AMB switches. In detail, 24 volts from R is always connected to the following pins:

- FRZ: P5-6 (wire BLK)
- HPS: P5-4 (wire 217/OR)
- LOW AMB: P6-1 (wire BLU)

24 volts “hot” passes through the corresponding switch to provide input to the remaining pin of the set:

- FRZ: P5-5 (wire BLK)
- HPS: P5-3 (wire 216/OR)
- LOW AMB: P6-2 (wire BLK)

One pin of the HPS set also connects through circuit trace to the right pin of the LPS set:

- HPS: P5-3 (wire 216/OR) to LPS P5-2 (wire 215/BL)

24 volt “hot” continues through the lo pressure switch to provide input to the remaining pin of the set:

- LPS: P5-1 (wire 214/BL)

The LIMIT input receives 24 volts “hot” from the SD terminal through closed LS and ALS (gas heat) switches, and intact associated wiring and connectors.

The MV input receives 24 volts “hot” from R under the following conditions:

- The space thermostat sends input to the W1 screw terminal (1st stage heating call)
- The circuit trace from the W1 screw terminal to H1 pin on the Simplicity board is intact. (Electric heat & HP – the H1 to MV jumper is intact)
- The gas heat ROS and PS switches are closed
- The gas heat ignition control permits the gas valve to be energized
- The associated wiring and connectors are intact

The ECON input receives 24 volts “hot” from R under the following conditions:

- The space thermostat sends input to the Y1 screw terminal (1st stage cooling call)
- The circuit trace from the Y1 screw terminal to Y1 output pin on the Simplicity board is intact. (w/o standard economizer – the wiring harness jumper plug is intact)
- The contact from terminal 1 to 2 of the standard (Honeywell) economizer module is closed. (free cooling is not permitted)
- The associated wiring and connectors are intact

Current through the wire connected to the outgoing 24 volt “hot” pin or terminal should be monitored during troubleshooting of the inputs from the unit wiring harness. Normally, current through these wires is very low since the load of the circuit is the Simplicity microprocessor. If there is excessive current through the wire connected to the outgoing 24 volt “hot” pin or terminal it is likely due to shorts to ground (24 volt “hot” conductors to the unit’s cabinet ground) in the wiring associated with that binary input.

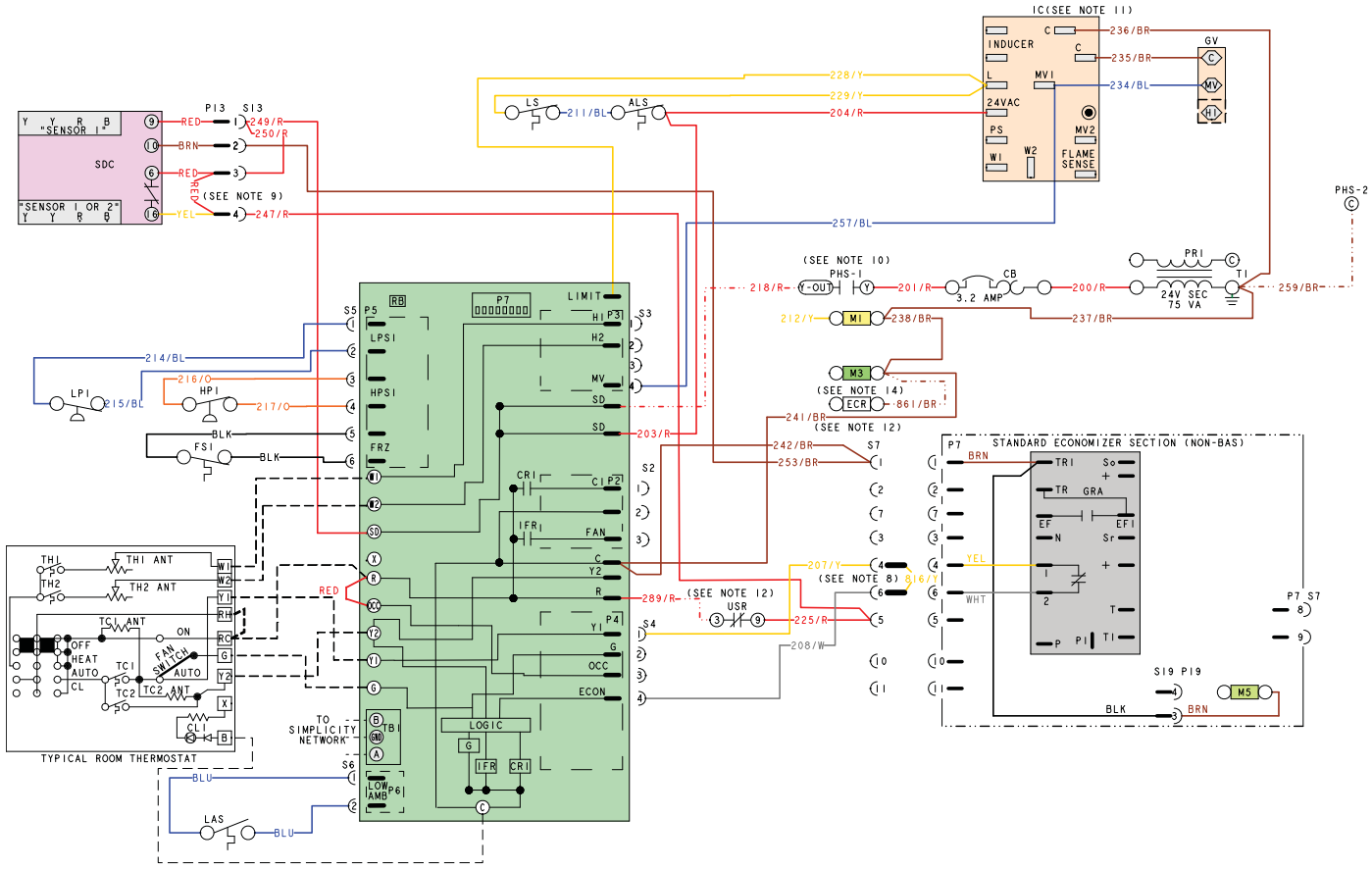


Figure 8-16 - 24 volt “hot” and common circuits with wiring harness binary inputs to Simplicity Lite. Note switch settings for binary inputs.

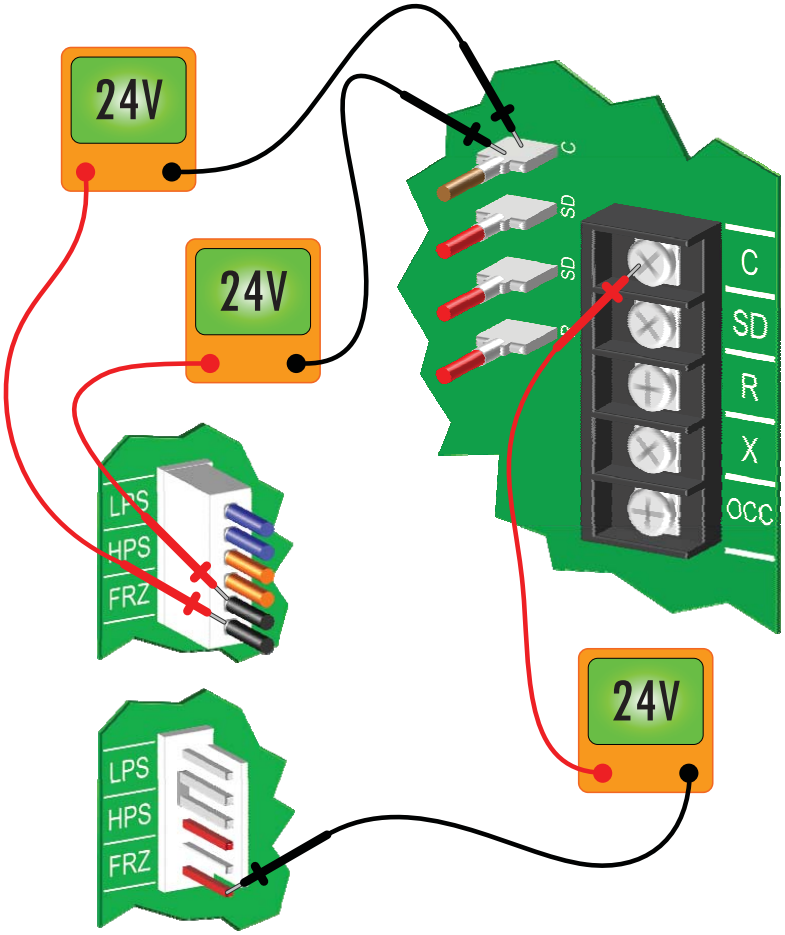


Figure 8-17

The binary inputs from the unit wiring harness, that have muti-pin connectors to Simplicity boards, require additional care in the techniques used to obtain voltage readings. Slim-point voltmeter test leads should be used in order to prevent damage to the connectors as well as provide contact to the metal terminal within the plastic housing of the muti-pin connector for reliable voltage readings. Forcing test leads or prying within the connector should be avoided to prevent damage.

Because the FRZ, HPS, LPS, LOW AMB and LIMIT binary inputs have 24 volts "hot" normally available, voltage readings of these input circuit are valid under all circumstances. However, when voltage readings of these circuits are used in conjunction with the LED status display of the Simplicity board, the technician should consider the following:

1. Binary input circuit switches often reset during the time between the event that caused a lock-out status display indication and the arrival of service personnel

2. The Simplicity board will display a status indication associated with a binary input only when unit operation is affected:

    a. No status indication will be displayed if FRZ, HPS or LPS refrigerant circuit inputs open without compressor operation being requested
    b. Prior to hard lock-out, Simplicity Lite boards display a corresponding status indication when the FS, HPS or LPS refrigerant circuit inputs open with compressor operation being requested
    c. The Simplicity board displays an ASCD indicator (flash code 2) alternating with the open refrigerant circuit input indicator while the compressor ASCD is active, even if the input has returned closed

There should be 24 volts read at the "always hot" terminal of the muti-pin connector of binary inputs from the unit wiring harness (FRZ illustrated). For reliable voltage readings, the test leads must contact the metal of the terminal. If 24 volts is not read, the multi-pin connector should be removed from the board (additional flash codes can result from removing the connector), and a voltage reading taken at the "always hot" pin. If 24 volts is present at the pin, the terminal of the connector is not making contact, and the wire will need to be re-terminated for repair. If 24 volts is not read at the pin, the board circuit trace that connects the pin to R is damaged, and the board will need to be replaced.

If board replacement is required, the input circuit should be investigated for shorts and corrections made to prevent repeat failures of the board.

The freezestat is encapsulated and does not have terminals on the body of the switch that are accessible. The next accessible point in the FRZ input circuit is the left terminal of the input set. There should be 24 volts read with a closed switch (not tripped). If 24 volts is not read at this point then the freezestat switch is open. If the line temperature is below the “close” setting of the switch, then correction to the unit fault (likely to be indoor airflow below 350 CFM per ton in the case of a FRZ trip) must be made. If line temperature is above the “close” setting of the switch, the switch has failed and will need to be replaced. To prevent repeat switch failures, investigate the causes of the failure, such as excessive switch cycling. Typically, thorough investigation leads to correction of the unit fault (likely to be indoor airflow below 350 CFM per ton in the case of a FRZ trip) when safety switches fail.

If 24 volts is present at the left pin, and the input is not reported “ON” when viewed through Simplicity PC software, then the terminal of the connector is not making contact and the wire will need to be re-terminated for repair.

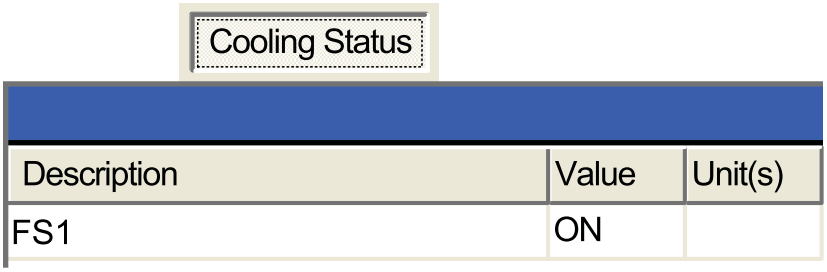


Figure 8-18

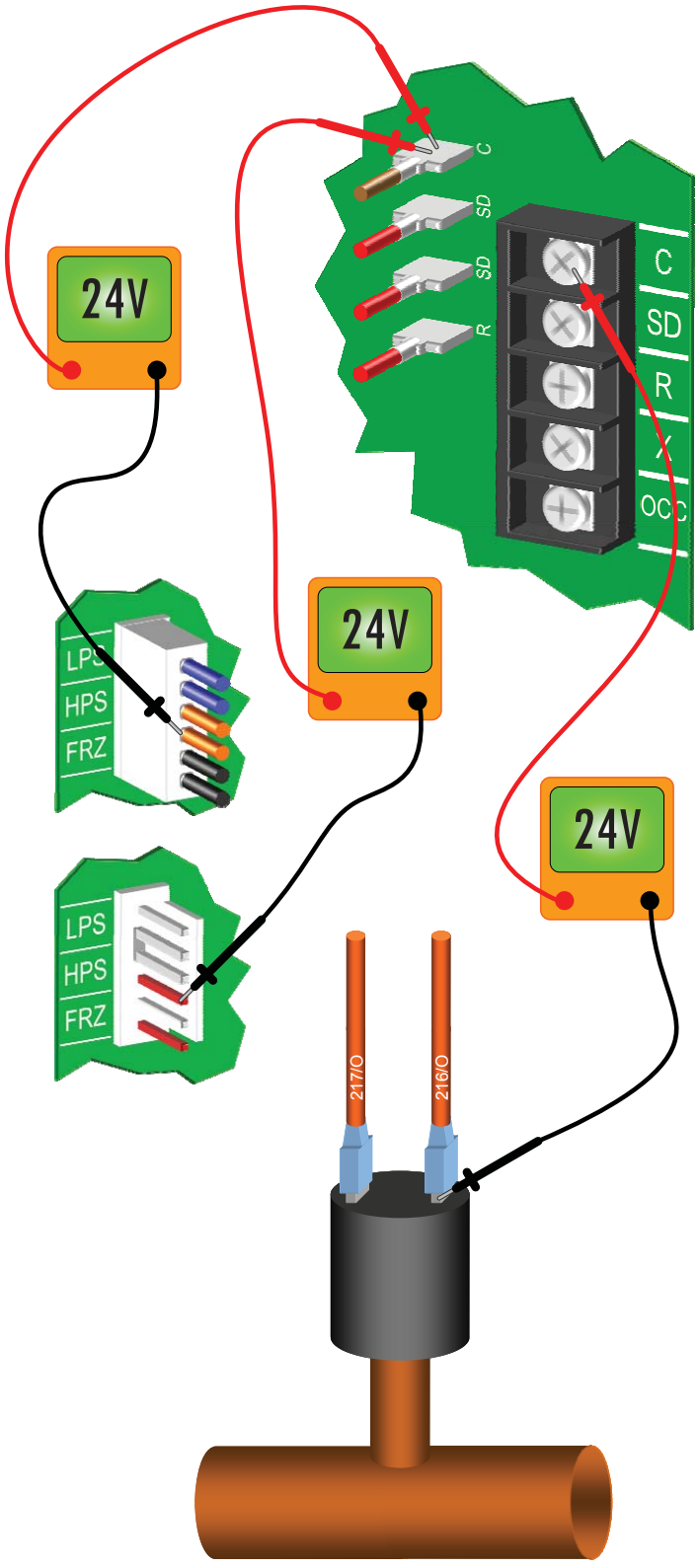


Figure 8-19

The HPS and LPS binary inputs are grouped in a four pin set on the Simplicity board, and have more accessible points for voltage readings. Methods for troubleshooting differ somewhat from other binary inputs.

There should be 24 volts read at the “always hot” lower/right HPS terminal of the multi-pin connector from the unit wiring harness (216/O). For reliable voltage readings, the test leads must contact the metal of the terminal. If 24 volts is not read, the multi-pin connector should next be removed from the board (additional flash codes can result from removing the connector), and a voltage reading taken at the “always hot” pin. If 24 volts is present at the pin, the terminal of the connector is not making contact, and the wire will need to be re-terminated for repair. If 24 volts is not read at the pin, the board circuit trace that connects the pin to R is damaged, and the board will need to be replaced. If board replacement is required, the input circuit should be investigated for shorts and corrections made to prevent repeat failures of the board.

There should be 24 volts read at the incoming terminal of the high pressure switch (wire 216/O). For reliable voltage readings, the test leads must contact the metal of the terminal. If 24 volts is not read, the connections or (216/O) wire are open and will need repaired.

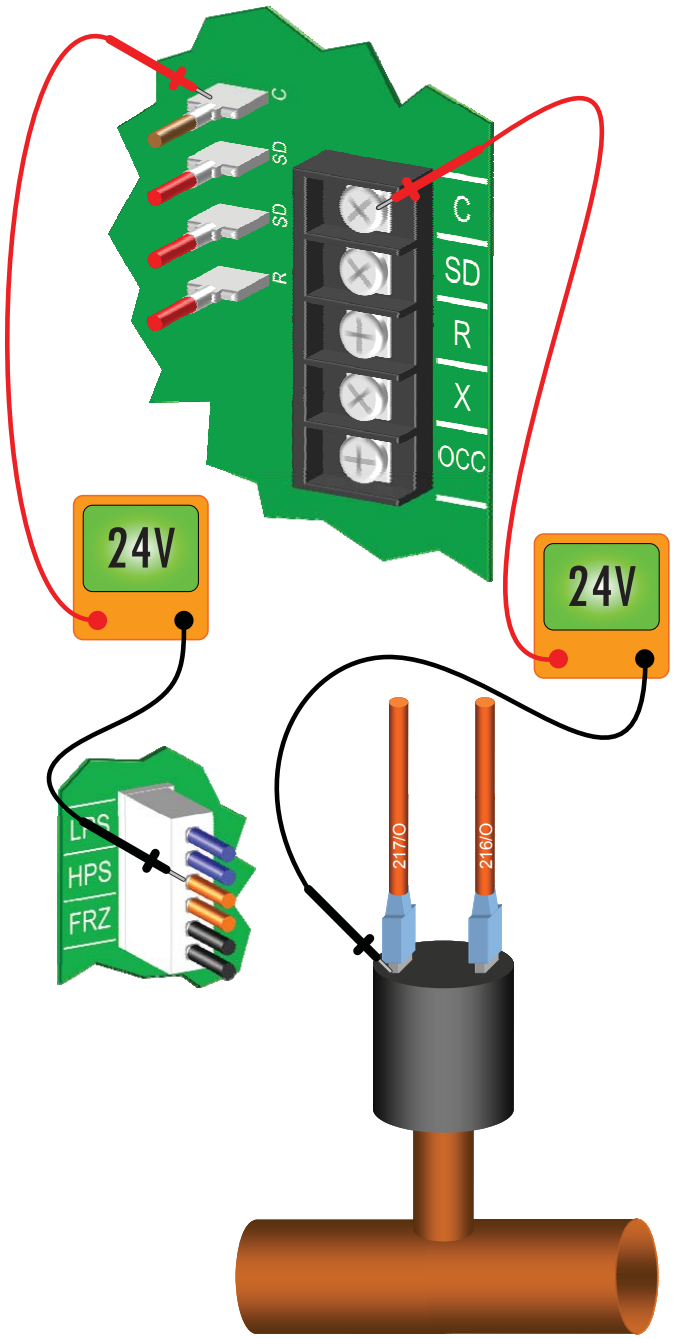


Figure 8-20

If 24 volts is read at the outgoing terminal of the high pressure switch (wire 217/O) the switch is closed (not tripped). If 24 volts is not read at this point, the high pressure switch is open. If the line pressure is above the close setting of the switch, then correction to the unit fault (likely to be related to diminished airflow through the condenser or a gross overcharge of the refrigerant circuit) should be made. If line pressure is below the close setting of the switch, the switch has failed and will need to be replaced. To prevent repeat switch failures, investigate the causes of failure, such as excessive switch cycling. Typically, thorough investigation leads to correction of the unit fault (likely to be related to diminished airflow through the condenser or a gross overcharge of the refrigerant circuit) when high pressure safety switches fail.

There should be 24 volts read at the top/left HPS terminal of the muti-pin connector from the unit wiring harness (217/O). If 24 volts is not read, then the connections or (217/O) wire are open and will need repaired. If 24 volts is present at the top/left HPS pin, and the input is not reported ON when viewed through Simplicity PC software, then the terminal of the connector is not making contact and the wire will need to be re-terminated for repair.

Cooling Status

Description	Value	Unit(s)
HPS1	ON	

Figure 8-21

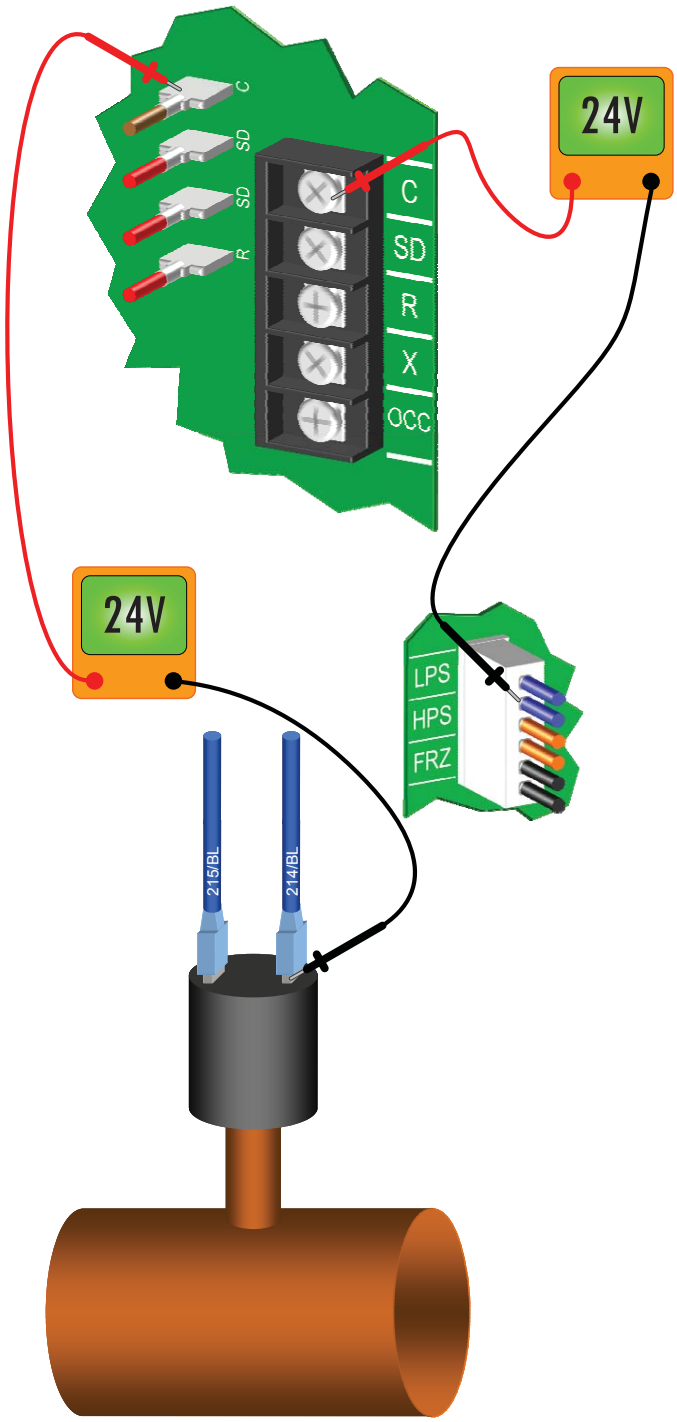


Figure 8-22

There should be 24 volts read at the lower/right LPS terminal of the muti-pin connector from the unit wiring harness (214/BL). If 24 volts is not read, it is likely that the terminal of the connector is not making contact, and the (214/BL) wire will need to be re-terminated for repair. It is also possible when 24 volts is not read at the lower/right LPS terminal of the muti-pin connector, that the board circuit trace that connects the top/left HPS pin to the lower/right LPS pin is damaged (determined by ohm continuity check of the pins), and the board will need to be replaced. If board replacement is required, the input circuit should be investigated for shorts, and repairs must be made to prevent repeat failures of the board.

There should be 24 volts read at the incoming terminal of the low pressure switch (wire 214/BL). For reliable voltage readings, care must be taken so the test leads contact the metal of the terminal. If 24 volts is not read, the connections or (214/BL) wire are open and will need to be repaired.

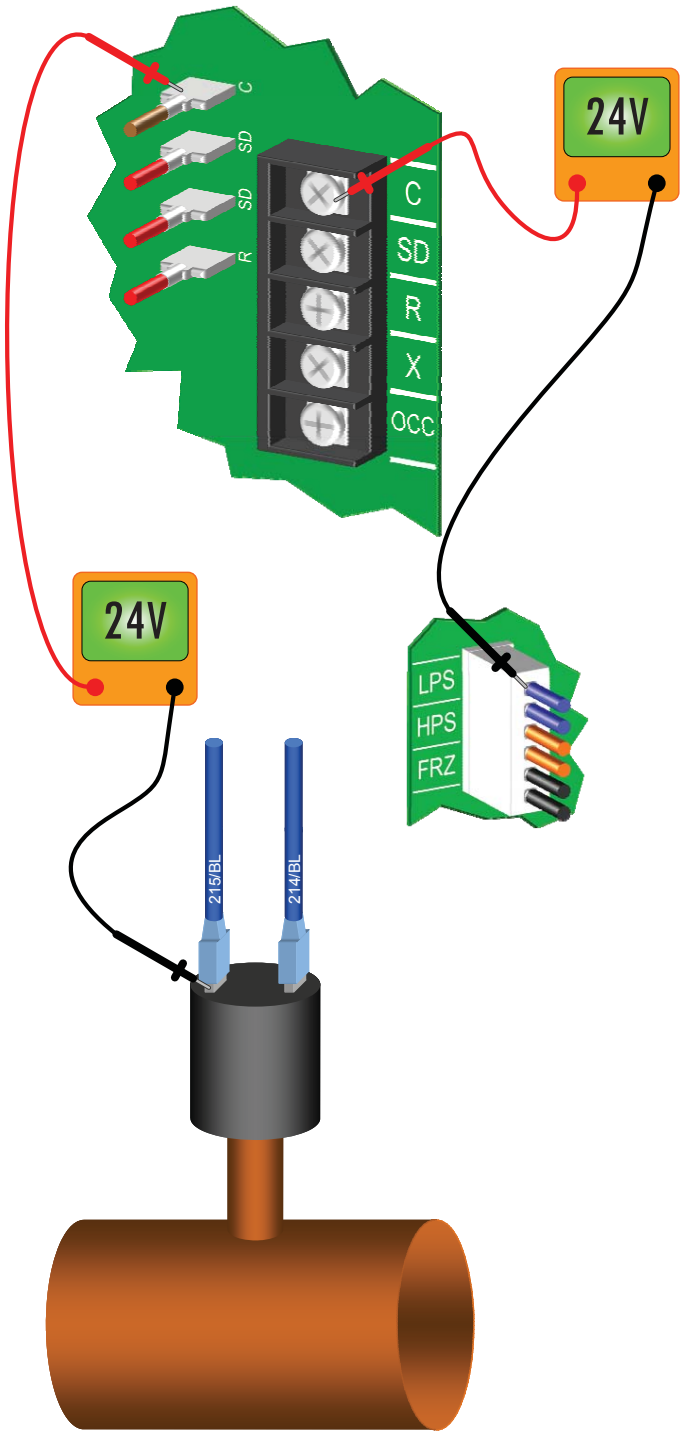


Figure 8-23

There should be 24 volts read at the outgoing terminal of the low pressure switch (wire 215/BL), indicating the switch is closed (not tripped). If 24 volts is not read at this point, the low pressure switch is open. If the line pressure is below the close setting of the switch, then correction to the unit fault (likely to be related to a loss of charge of the refrigerant circuit or diminished airflow through the evaporator) should be made. If line pressure is above the close setting of the switch, the switch has failed and will need to be replaced. To prevent repeat switch failures, investigate the causes of the failure, such as excessive switch cycling. Typically, thorough investigation leads to correction of the unit fault (likely to be related to a loss of charge of the refrigerant circuit or diminished airflow through the evaporator) when low pressure safety switches fail.

There should be 24 volts read at the top/left LPS terminal of the muti-pin connector from the unit wiring harness (215/BL). If 24 volts is not read, the connections or (215/BL) wire are open and will need to be repaired. If 24 volts is present at the top/left LPS pin, and the input is not reported ON when viewed through Simplicity PC software, the terminal of the connector is not making contact and the wire will need to be re-terminated for repair.

Cooling Status

Description	Value	Unit(s)
LPS1	ON	

Figure 8-24

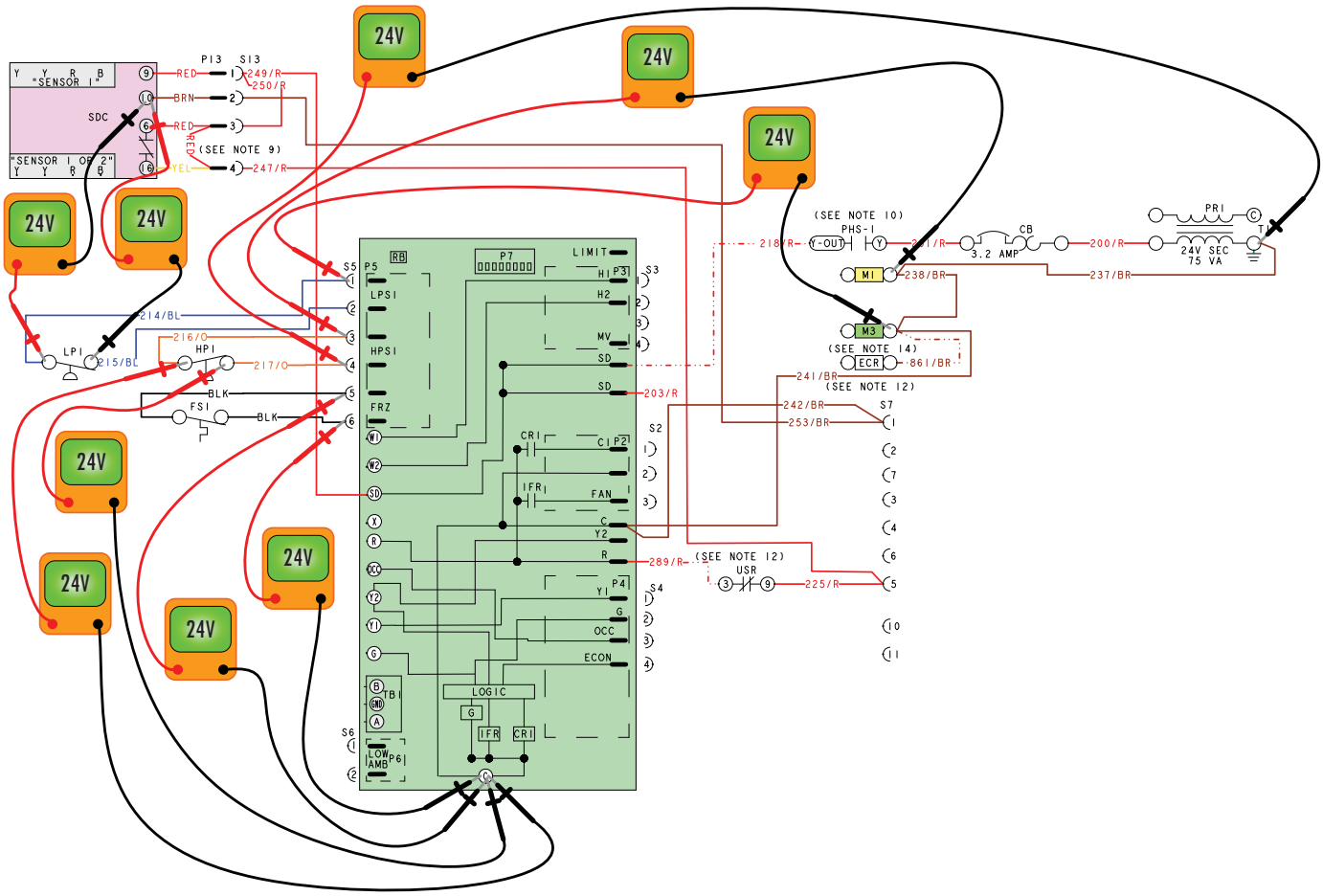


Figure 8-25 - Example of HPS/LPS and FRZ binary input

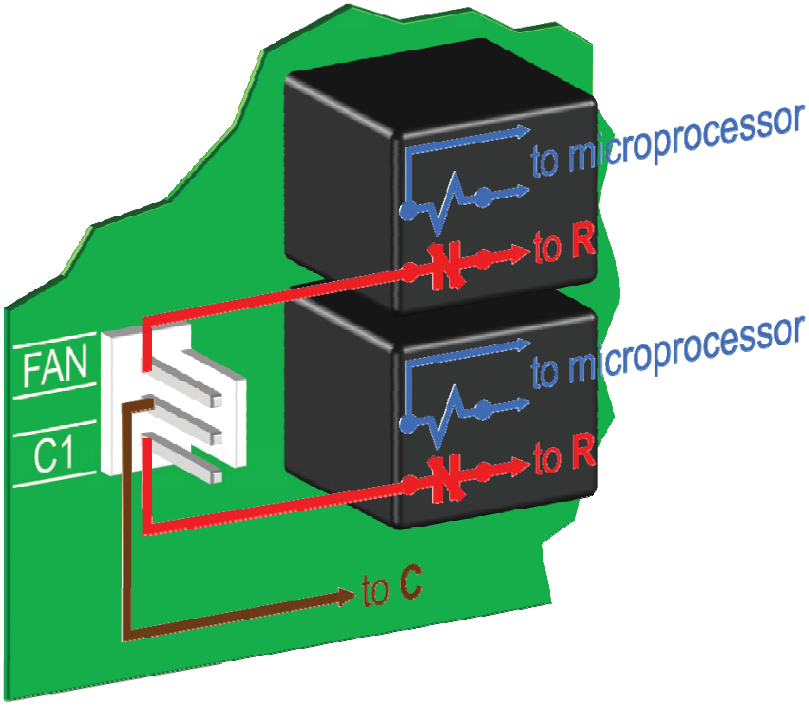


Figure 7-26

The Simplicity board binary outputs have relays that are energized by the microprocessor, and relay contacts that switch 24 volts “hot” to control circuit loads. Simplicity Lite outputs C1 and FAN switch 24 volts “hot” from the R terminal to the output pins.

For units produced through mid-2011 and prior, the G(OUT) output which coordinates powering of the standard economizer module/motorized outside air with indoor blower operation is connected by circuit trace to the G screw terminal input. For units produced in mid-2011 and later, the G(OUT) output is connected by circuit trace to the FAN output pin.

The X screw terminal is also a binary output for alarm indication at a thermostat LED.

The illustration shows Simplicity output relays and pins with a diagram of the C1 and FAN output relays in the energized position.

Binary output circuit troubleshooting begins by confirming that the output is permitted, and the output relay is energized by the microprocessor to close the output relay contact. A number of operational conditions and configuration parameters can influence the microprocessor's decision to energize an output. The definitive method to confirm the output is energized is to view the output status through Simplicity PC software access. ("ON" in the Value column indicates the output is energized by the microprocessor).

Outputs

Description	Value	Unit(s)
Output: Compressor (C1)	ON	
Output: Fan	ON	

Figure 8-27

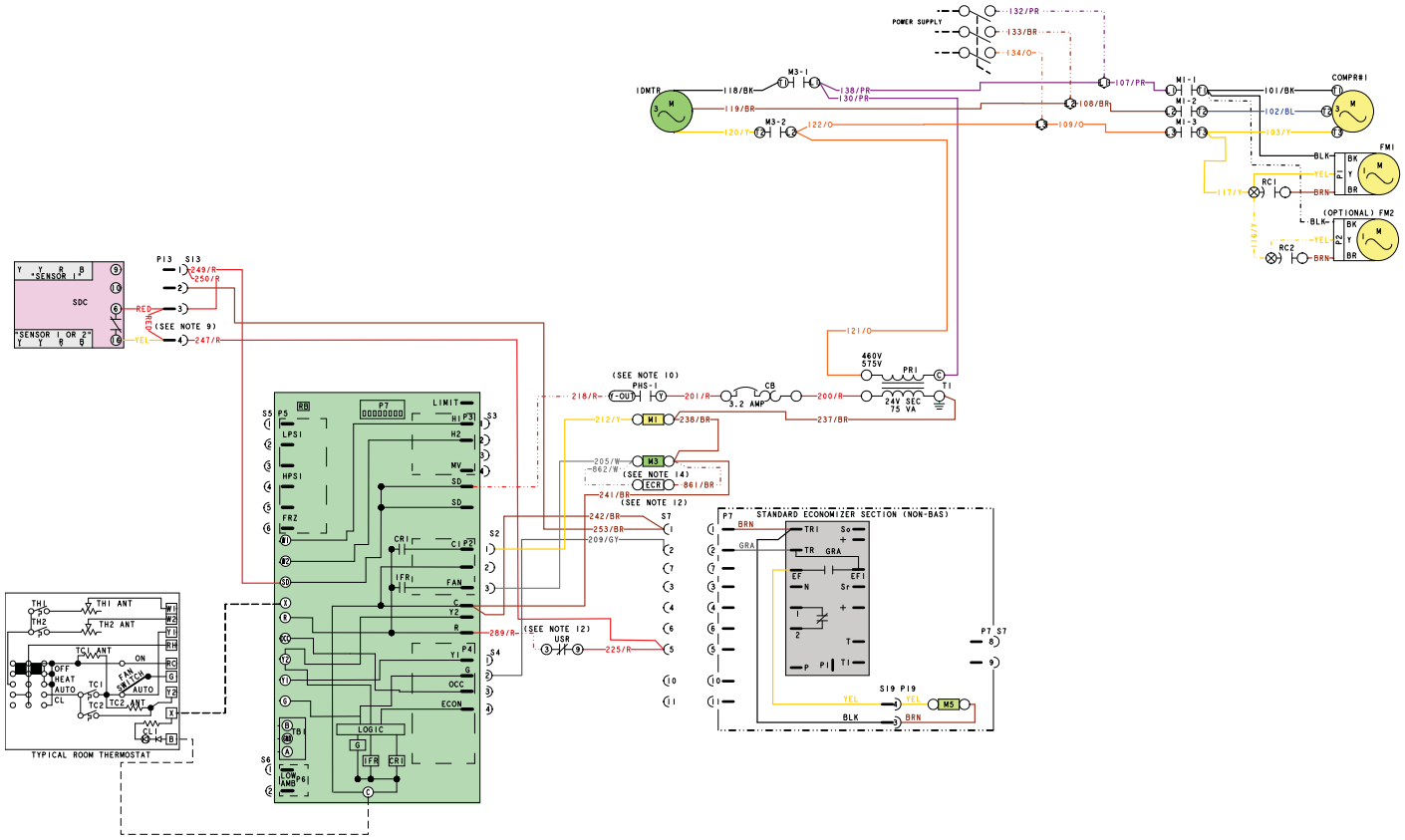


Figure 8-28 - Example of Simplicity Lite binary outputs and related devices

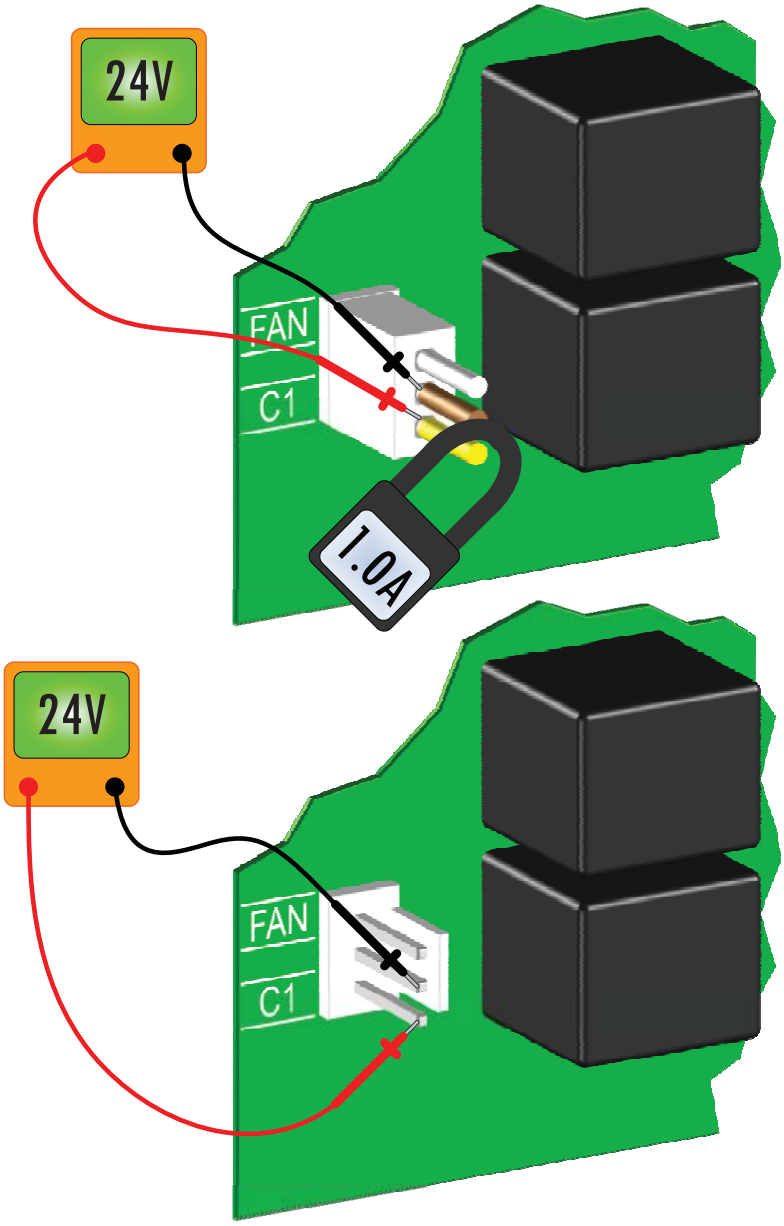


Figure 8-29

Using methods discussed previously for confirming the source, 24 volts should be read at the R terminal. If 24 volts is not read, correction to the separate source is needed.

The current draw of the output circuit should be monitored while troubleshooting. Excessive current draw (more than 3.1 amps when a 75VA transformer powers the outputs) indicates shorting exists in the output circuit. Correction of the shorted or grounded output wiring or component will be needed before troubleshooting can proceed. Zero current draw indicates the output circuit is open, and further troubleshooting steps will be needed to identify the cause of the open circuit.

With the output status confirmed ON through Simplicity PC software access, 24 volts should be read at the terminal of the muti-pin connector from the unit wiring harness (yellow wire 212/Y at the C1 output in the illustration). For reliable voltage readings, the test leads must contact the metal of the terminal. If 24 volts is not read, the multi-pin connector should next be removed from the board (note that all outputs are disconnected with the connector removed).

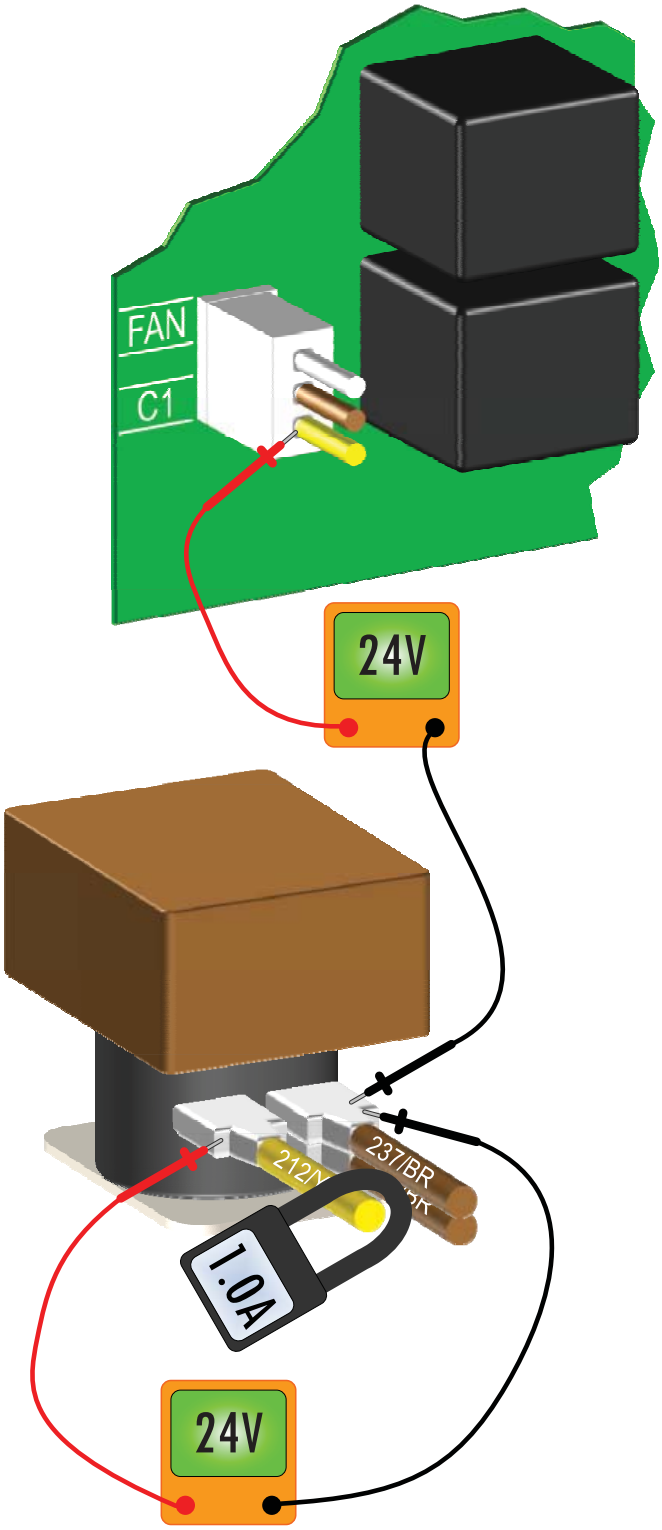


Figure 8-30

If 24 volts is present at the pin, the terminal of the connector is not making contact, and the wire will need to be re-terminated for repair. If 24 volts is not read at the pin, the output relay contact or the connecting circuit traces are damaged and the board will need to be replaced. If board replacement is required, the output circuit should be investigated for shorts and corrections made to prevent repeat failures of the board.

With 24 volts read at the terminal of the muti-pin connector from the unit wiring harness, 24 volts should be read at the “hot” terminal of the contactor coil (wire 212/Y). If 24 volts is not read, the connections or (212/Y) wire are open and will need repaired. If 24 volts is present at the “hot” terminal of the contactor coil, and the output current draw is zero, then the contactor coil is open. If 24 volts is present at the “hot” terminal of the contactor coil, and the output current draw is normal, but the contactor does not engage (the line voltage contacts do not close), then it is likely there is a mechanical issue with the contactor, such as a faulty armature or burned contacts. If 24 volts is present at the “hot” terminal of the contactor coil, and the contactor coil current draw is excessive (typically these readings can only be made briefly before control circuit breaker trip), then the contactor has shorted.

When the coil fails open, shorts, or the contactor has mechanical issues that prevent operation, replacement of the contactor will be needed for repair. Causes for the failure should be investigated and corrections made to prevent repeat failures.

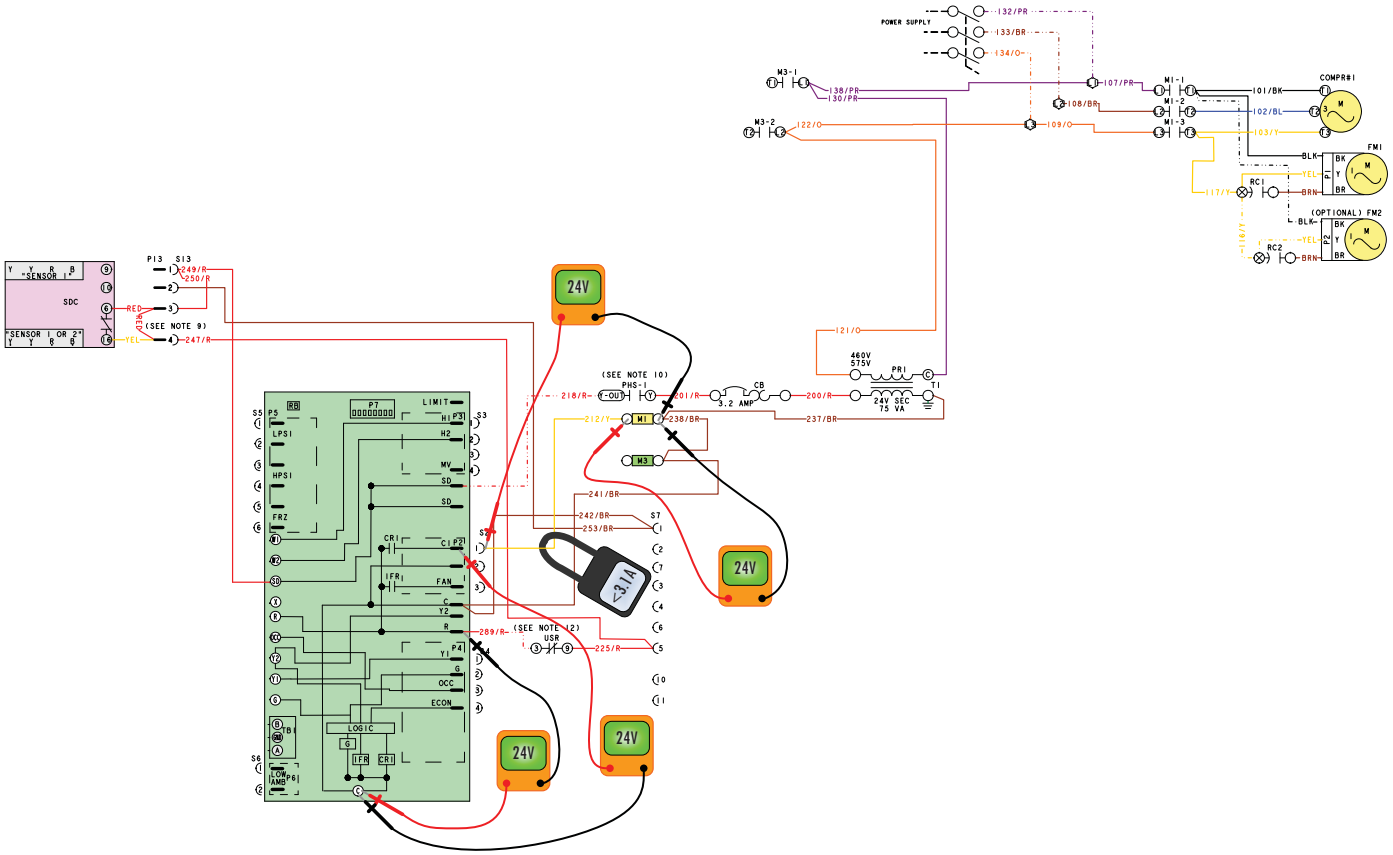


Figure 8-31 - Simplcity Lite C1 binary output and related devices

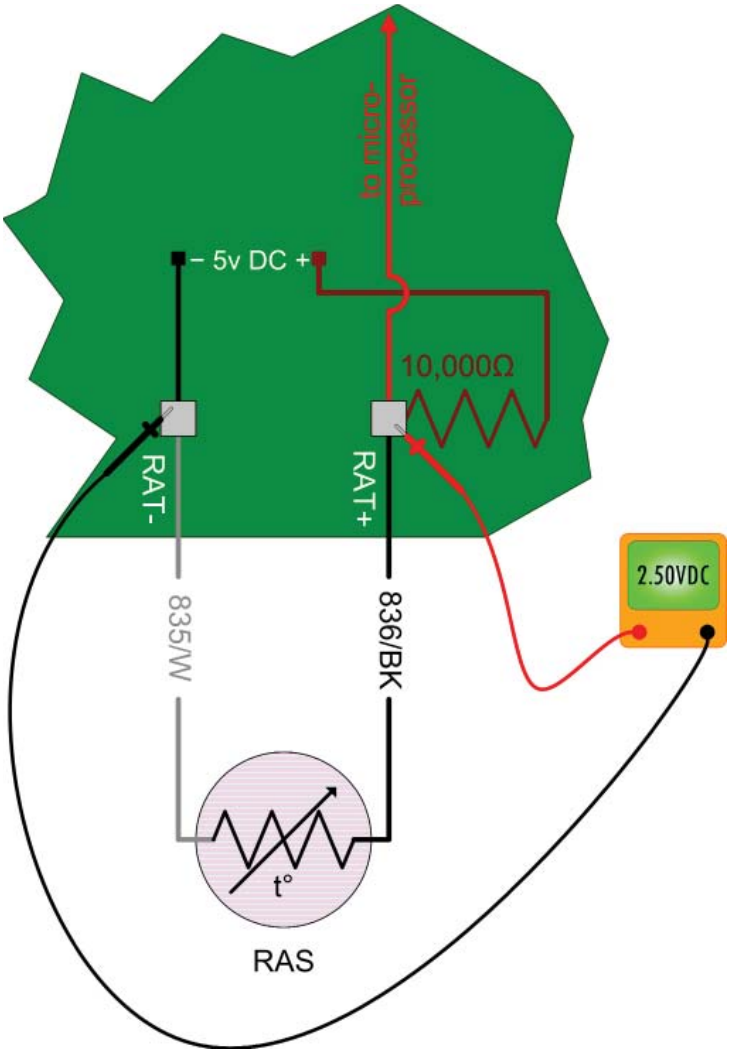


Figure 8-32

Simplicity Intelli-Comfort and VAV-VFD boards have analog (or variable) inputs from temperature sensors for OAT, RAT, SAT and ST. These thermistors have a resistance of 10,000Ω at 77°F, and vary resistance with temperature change (resistance decreases with temperature increase and resistance increases with temperature decrease). These are also termed “Type III negative temperature coefficient” or “10K NTC” thermistors.

The temperature sensor circuits of Intelli-Comfort and VAV-VFD boards have an on-board 5 volts DC source powered from the 24 volts AC to the board’s R terminal. The 5 volts DC source has the negative connected to the “–“ pin of the temperature sensor input, and the positive connected to a 10,000Ω reference/dropping resistor in series with the “+” pin of the temperature sensor input. The temperature sensor is connected to the input pins, and the Simplicity board microprocessor “reads” the DC voltage from negative to the “+” pin (the point between the resistances of the circuit). A simplified diagram of the Intelli-Comfort RAT input is illustrated in the example.

The input pins and terminals are the primary points of access for voltage readings when troubleshooting the sensor circuit. Secondary points of access may be available at wiring harness connectors for some sensors or units. The voltage at the pins equates to the following:

- 0.00-0.05 volts DC: shorted circuit (sensor failure alarm flash code)
- 0.05-0.52 volts DC: 180°F maximum value reported (actual sensor temperature may be 350°F to 180°F)
- 0.52-2.49 volts DC: 180 to 77°F
- 2.50 volts DC: 77°F
- 2.51-4.85 volts DC: 77 to −40°F
- 4.85-4.95 volts DC: −40°F minimum value reported (actual sensor temperature may be −40°F to −87°F)
- 4.95-5.00 volts DC: open circuit (sensor failure alarm flash code)

The voltage readings in conjunction with supporting resistance readings provide information for troubleshooting the temperature sensor circuits.

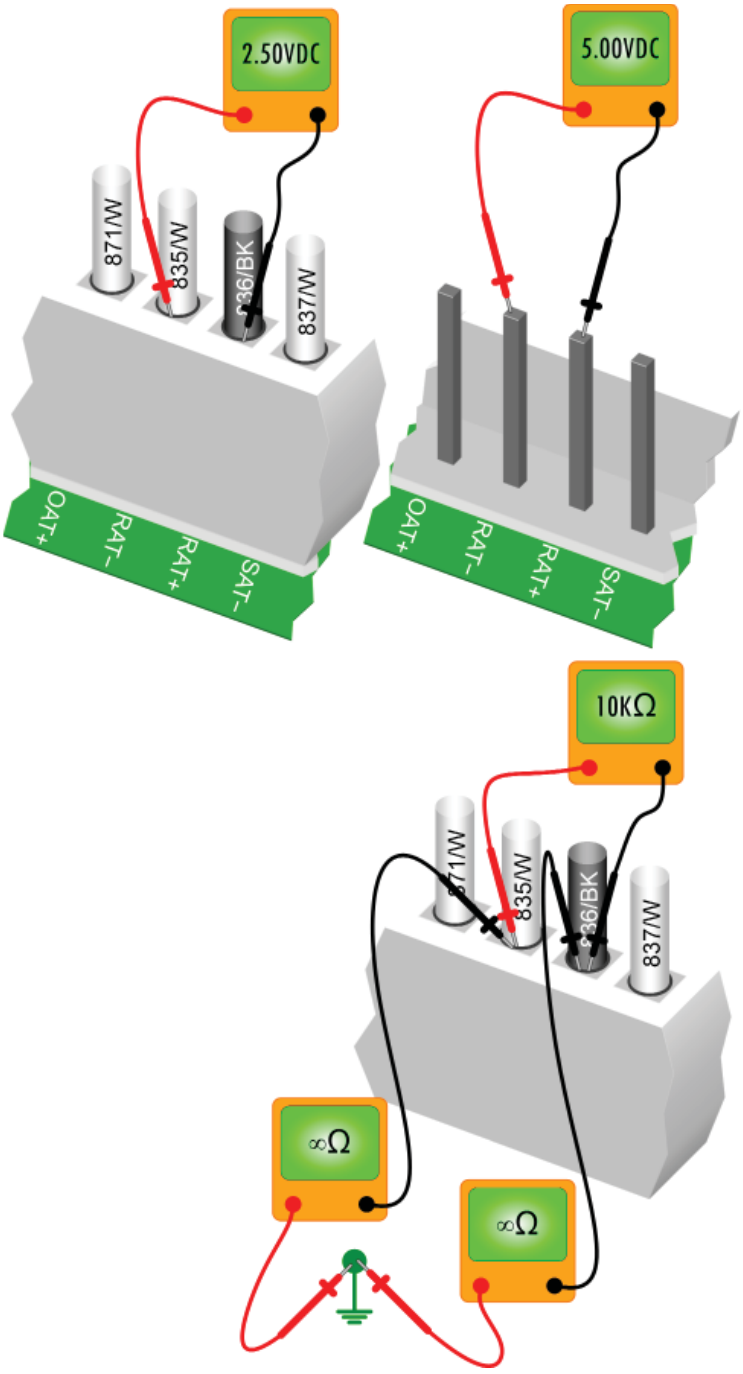


Figure 8-33

Troubleshooting of the temperature sensors is needed when sensor failure alarms occur or when the temperature reported by the sensor does not agree with that being measured.

Using an accurate temperature probe, a temperature reading should be taking in close proximity to the sensor.

The temperature sensor inputs from the unit wiring harness have muti-pin connectors to Simplicity boards, and require additional care in the techniques used to obtain voltage readings. Slim-point voltmeter test leads should be used to prevent damage to the connectors, as well as provide contact to the metal terminal within the plastic housing of the muti-pin connector. Forcing test leads or prying within the connector should be avoided to prevent damage.

Next, a voltage corresponding to the temperature the sensor is exposed to is read at the input terminals (wire 836/W to wire 836/BK).

If less than 0.50 volts DC is read with the sensor temperature below 180°F, the multi-pin connector should then be removed from the board (additional flash codes can result from removing the connector), and a voltage reading taken at the sensor pins. A reading of 5.00 volts DC should be read at the sensor pins with the connector removed. If zero, or significantly less than 5.00 volts DC is read at the pins, then the sensor input circuitry of the board is damaged, and the board will need to be replaced. Causes for the damage must be investigated to prevent repeat failures. This type of failure can occur if the sensor wiring shorts to another voltage source.

If 5.00 volts DC is read at the pins with the connector removed, then resistance readings of the sensor terminals in the multi-pin connector should be taken. If the resistance reading between terminals corresponds to the temperature of the sensor, and there is not continuity to cabinet ground from either terminal, then one or both terminals are not making connection with the pins and the wires will need to be re-terminated for repair. If the resistance reading between terminals is very low / zero ohms or there is continuity to cabinet ground from either terminal, then the sensor or associated wiring is shorted or has faults to ground. If the sensor can be isolated from the wiring harness, resistance readings of the sensor can then be taken to determine if the sensor is intact. It may be necessary to replace the sensor or associated wiring to correct the issue.

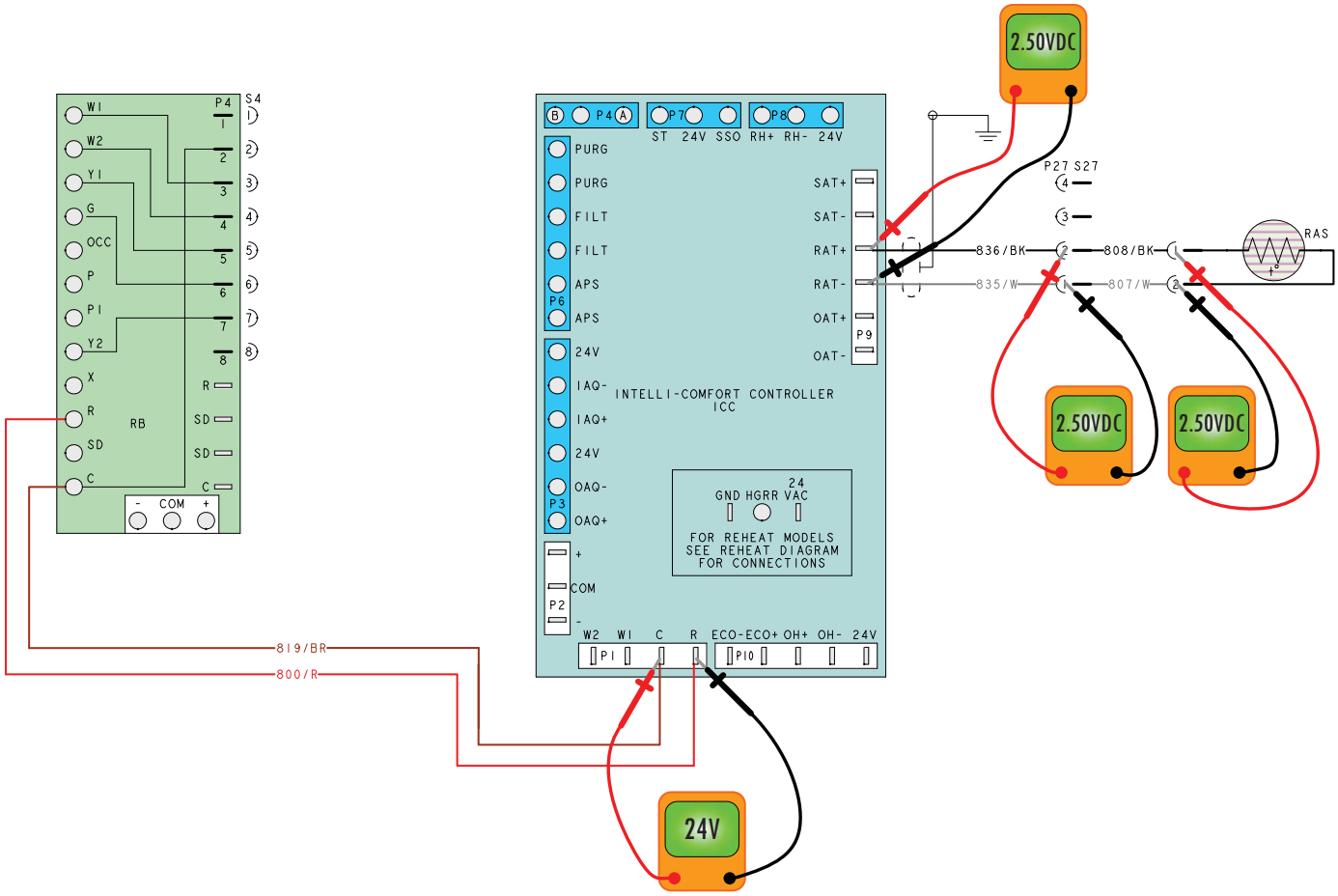


Figure 8-34

If more than 4.85 volts DC is read with the sensor temperature above −40°F, the sensor or associated wiring is open at a point beyond the multi-pin connector. If the sensor can be isolated from the wiring harness, resistance readings of the sensor can be taken to determine if the sensor is intact. It may be necessary to replace the sensor or associated wiring to correct the issue.

Minor differences in voltage and corresponding temperature readings can be expected due to instrument accuracy. However, equipment operation can be affected when reported temperatures are beyond a ±3°F tolerance.

If the voltage reading at the pins is higher than what corresponds to the temperature measured at the sensor (reported temperature is 3°F or more below the measured temperature), then there is added resistance in the sensor circuit. Potential causes of this condition include poor wiring harness connections or moisture invasion of the sensor due to a cracked casing. To repair, the wiring connections or sensor should be replaced.

If the voltage reading at the pins is lower than what corresponds to the temperature measured at the sensor (reported temperature is 3°F or more above the measured temperature), then there is reduced resistance in the sensor circuit. Potential causes of this condition include shorting of the wiring harness or moisture invasion of the sensor due to a cracked casing. To repair, the wiring connections or sensor should be replaced.

Verification of the temperature reported by the sensors can also be done through Simplicity PC software access.

Sensor Readings

Description	Value	Unit(s)
Return Air Temp	77.0	°F

Figure 8-35

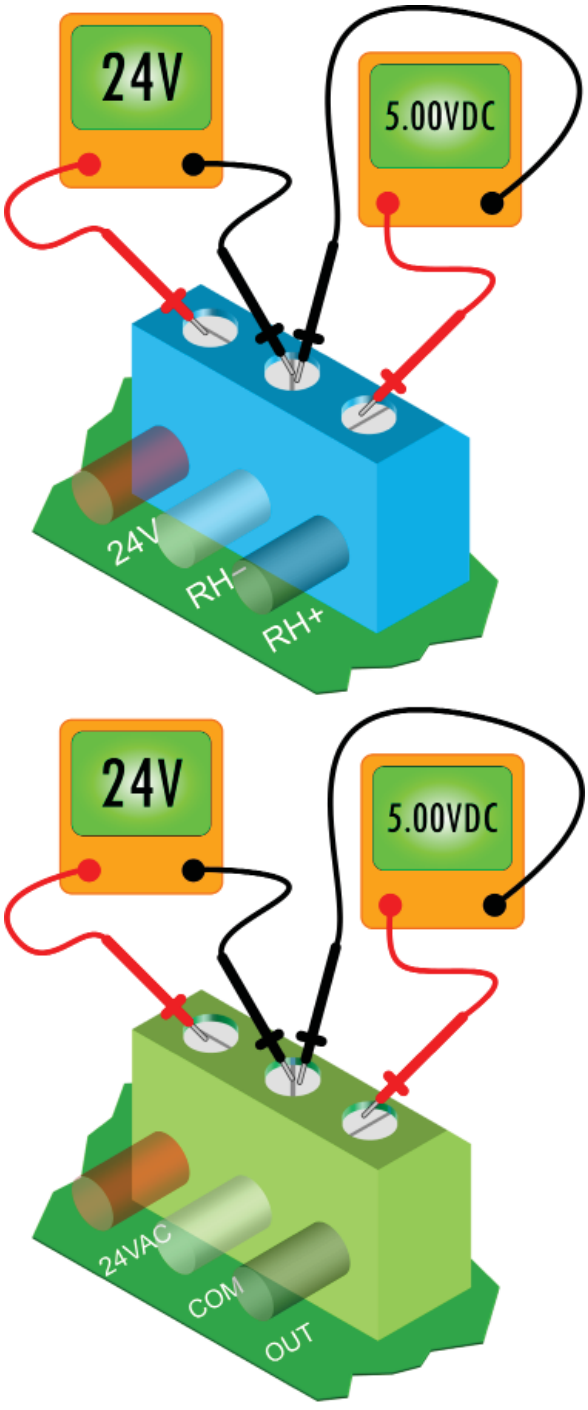


Figure 8-36

Simplicity Intelli-Comfort and VAV-VFD boards have analog (or variable) 0-10 volts DC inputs from humidity and air quality (CO2) sensors. VAV-VFD boards also include analog 0-5 volt DC inputs from static pressure sensors.

These devices require 24 volts AC for power. From circuit traces connected to the R terminal that powers the Simplicity board, 24 volts “hot” is provided for the devices from the 24V/R terminal of the input terminal block. 24 volts common for the device power is provided from the “–”/C terminal of the input terminal block.

The “–”/C terminal of the input terminal block is also the negative connection for the analog DC input. The “+” terminal of the input terminal block is the positive connection for the analog DC input. The illustrations show an Intelli-Comfort return air humidity sensor.

Terminal labeling of the device typically differs from that of the Simplicity board in that 24VAC is the 24 volt “hot” connection, COM is the 24 volt common/DC negative connection, and OUT is the positive DC output connection of the device. CO2 sensors can use numbered terminals that separate 24 volt AC power from the 0-10 volt DC device output. In any case, the positive DC output from the device connects to the “+” terminal of the Simplicity board input terminal block.

Troubleshooting the analog DC inputs begins with establishing the device has 24 volt power using the methods discussed previously with binary outputs. By doing so, the wiring and connections for the negative of the analog DC input are also confirmed to be intact when three wires to the input terminal block are used.

The next step in troubleshooting analog DC inputs is to measure the humidity, CO2 or static pressure to which the sensor is exposed. The DC voltage output of the sensor, and input to the Simplicity board should then correspond to the value measured. Minor differences in voltage and the corresponding values can be expected due to instrument accuracy.

However, equipment operation can be affected when reported values are beyond a ±5% (0.5 volts DC) tolerance.

If the voltage output of the sensor is below that which corresponds to the measured value, the positive DC output wire of the sensor should be disconnected, and the DC voltage re-measured. If the DC voltage at the sensor then corresponds to the measured value, the positive DC wiring from the sensor output to the Simplicity board is shorted (either to other wires or cabinet ground).

If the DC voltage at the sensor remains below that which corresponds to the measured value with the positive DC output wire of the sensor disconnected or reports a value that is beyond a ±5% (0.5 volts DC) tolerance, then the sensor has failed, and will need to be replaced. Causes for the failure, such as shorting to other voltage sources, should be investigated to prevent repeat failures.

If the DC voltage output of the sensor corresponds to the value measured, but the DC voltage to the input terminal block is lower or zero, then the positive DC wiring or connections from the sensor output to the Simplicity board are open. Re-termination or replacement of the wire will be needed for repair.

If the DC voltage input to the Simplicity board corresponds to the value measured, but is not properly reported when viewed through Simplicity PC software access, the input circuitry has failed, and the board will need to be replaced. Causes for the failure, such as shorting to other voltage sources, should be investigated to prevent repeat failures.

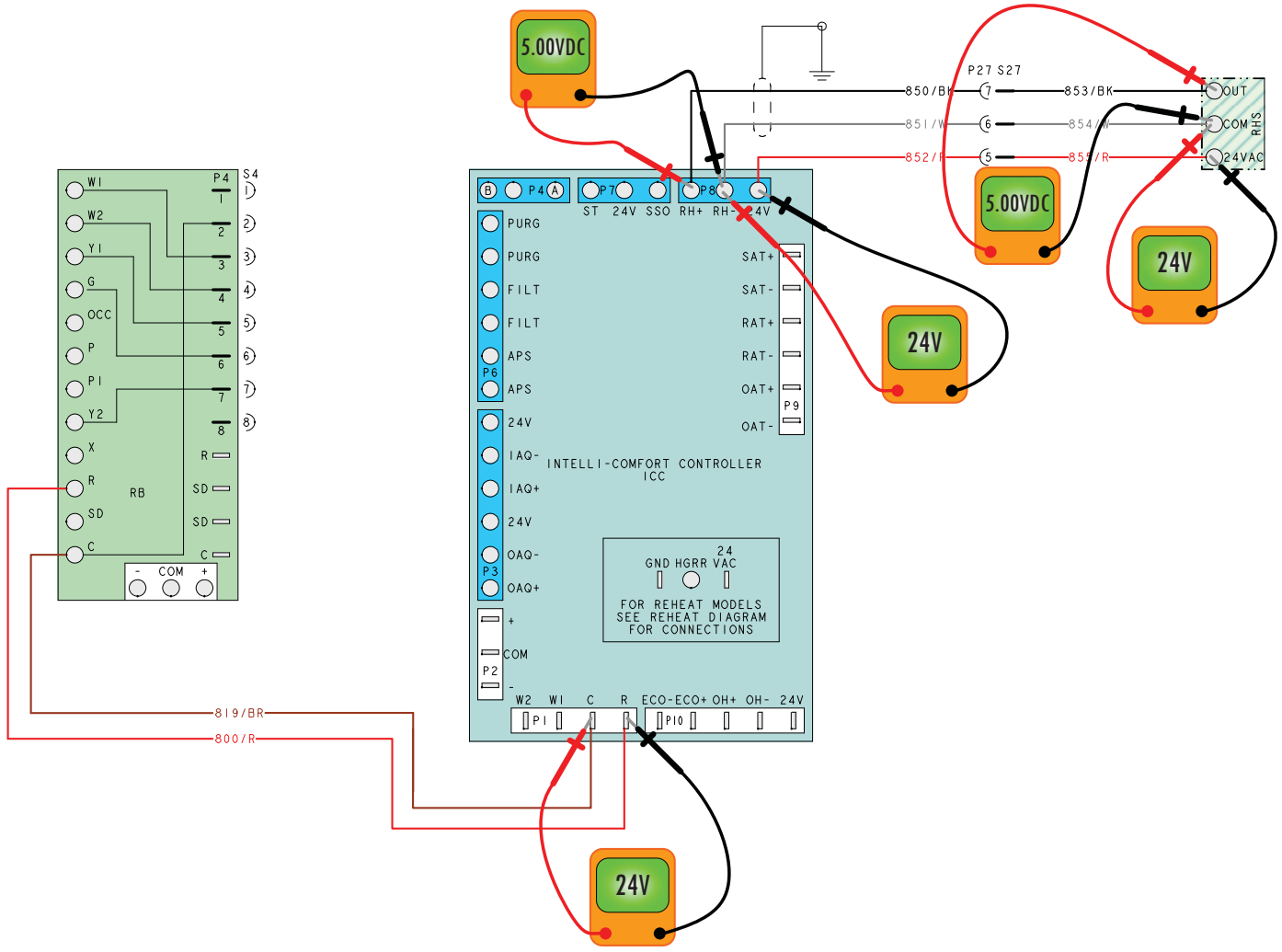


Figure 8-37

Sensor Readings

Description	Value	Unit(s)
Return Air Humidity Sensor Present	ON	
Return Air Humidity	50	%

Figure 8-38

Simplicity Intelli-Comfort and VAV-VFD boards have analog (or variable) 2-10 volt DC outputs to position the economizer actuator. VAV-VFD boards also include analog 2-10 volt DC outputs for the indoor blower VFD, power exhaust, hydronic heat, and hot gas reheat.

These devices also require 24 volts AC for power. This power is wired from the unit wiring harness, and may come from a transformer separate from the one powering the Simplicity board.

The “–”/C pin of the Simplicity board output may not be used if the output device uses a combined 24 volts AC common/analog DC negative connection. The “+” pin of the Simplicity board output is the positive connection to the analog DC output device. The illustration shows an Intelli-Comfort economizer actuator.

Terminal labeling of the device typically differs from that of the Simplicity board in that 24VAC+ is the 24 volts “hot” connection, 24VAC COM is the 24 volts common/DC negative connection, and 2-10VDC INPUT is the positive DC input connection of the device. VFDs can use numbered terminals that separate 24 volt AC connections from the 2-10 volt DC device input. In any case, the “+” output pin of the Simplicity board connects to the positive DC input of the device.

Troubleshooting the analog DC outputs begins with establishing the device has 24 volt power using the methods discussed previously with binary outputs. By doing so, the wiring and connections for the negative of the analog DC input are also confirmed to be intact when three wires to the input terminal block of the device are used.

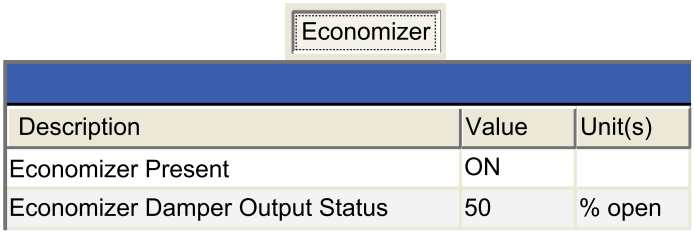


Figure 8-39

Next, troubleshooting of the 2-10 volt DC outputs continues with confirming the output position. Several operational conditions and configuration parameters can influence the microprocessor’s decision to position the output. The definitive method to confirm the position is to view the output status through Simplicity PC software access. The ##% in the “Value” column indicates the position of the 2-10 volt DC output requested by the microprocessor, and corresponds to the voltage that should be present at the output pin. If the output is disabled in configuration, 0% will be indicated, and there will be 0 volts DC at the output pin of the board. If the output is enabled in configuration, the ##% will be indicated and have a corresponding voltage at the output pin as follows:

- 0% = 2 volt DC output
- 50% = 6 volt DC output
- 100% = 10 volt DC output

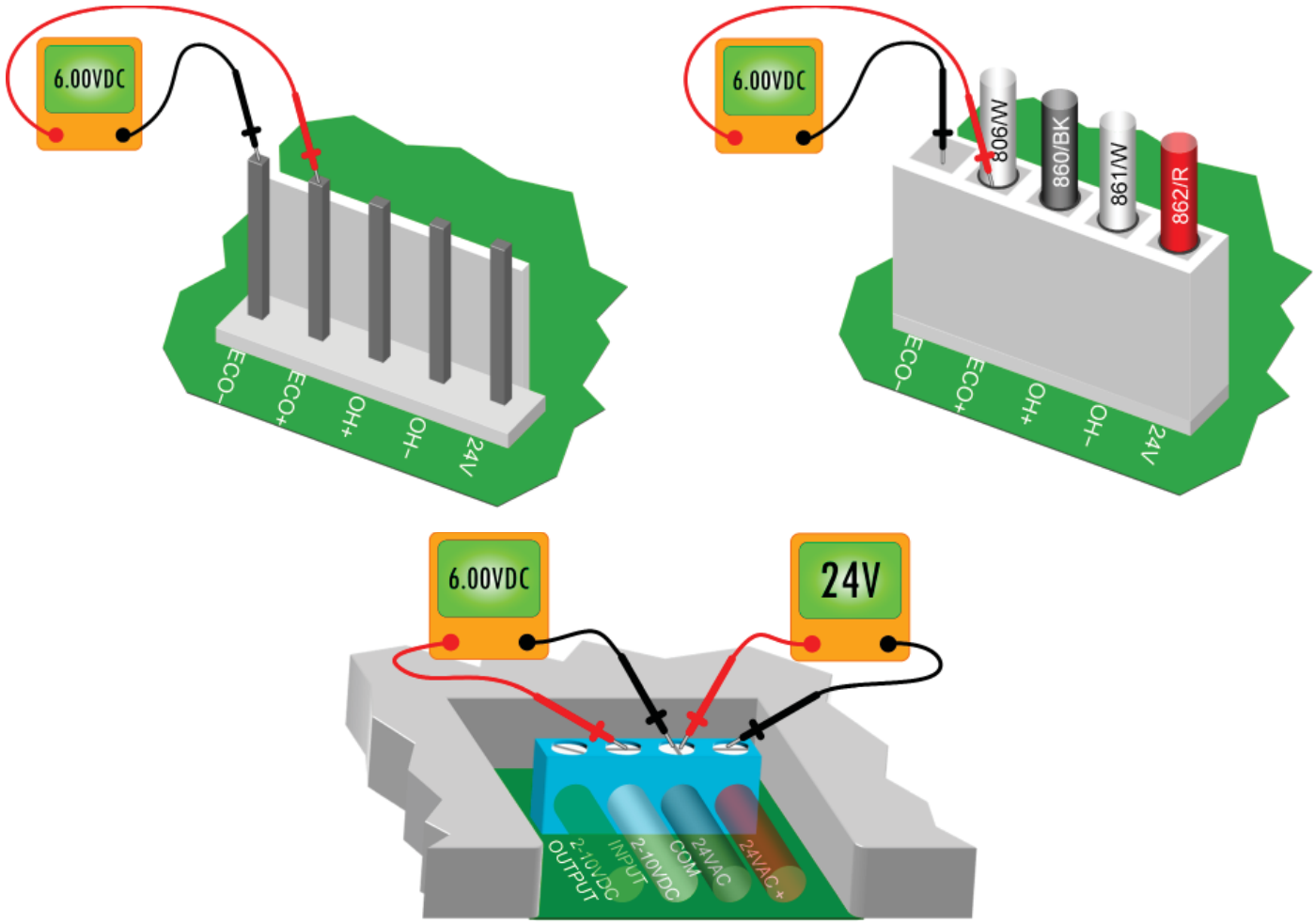


Figure 8-40

With the output “enabled”, the voltage corresponding to the reported position should be read at the “+” terminal of the multi-pin connector.

If zero volts is read, the multi-pin connector should be removed (outside humidity sensor faults can be expected in the case of the Intelli-Comfort economizer actuator illustrated), and the voltage at the output pins read. If the voltage corresponding to the reported position is read at the pins, then one of the following conditions has occurred:

- The “+” terminal of the multi-pin connector is not making contact with the pin
- The “+” output wiring is shorted to cabinet ground/”–“/common
- The “+” circuitry of the device is shorted

With the “+” wire disconnected from the actuator, continuity checks should be made to determine if the “+” wire has a fault (repair as needed). If continuity checks of the wire show no faults, the muti-pin connector is reconnected to the board. If voltage corresponding to reported position is read at the disconnected “+” wire at the device and falls to zero on re-connection to the device then the input circuitry of the device has shorted. Replacement of the device will be needed for repair. Causes for the failure, such as shorting to other voltage sources, should be investigated to prevent repeat failures.

If zero volts is read at the output pins with the multi-pin connector removed, then the Simplicity board output circuitry has failed. Replacement of the board will be needed for repair. Causes for the failure, such as shorting to other voltage sources, should be investigated to prevent repeat failures.

If the voltage corresponding to the reported position is read at the “+” terminal of the output device, and the device does not respond, then the following conditions may exist:

- Mechanical issues with the actuator, linkages, dampers or valve exist that prevent movement
- VFD alarms or configuration errors exist that prevent motor operation
- The input circuitry of the output device has failed. Replacement of the device will be needed for repair. Causes for the failure, such as shorting to other voltage sources, should be investigated to prevent repeat failures

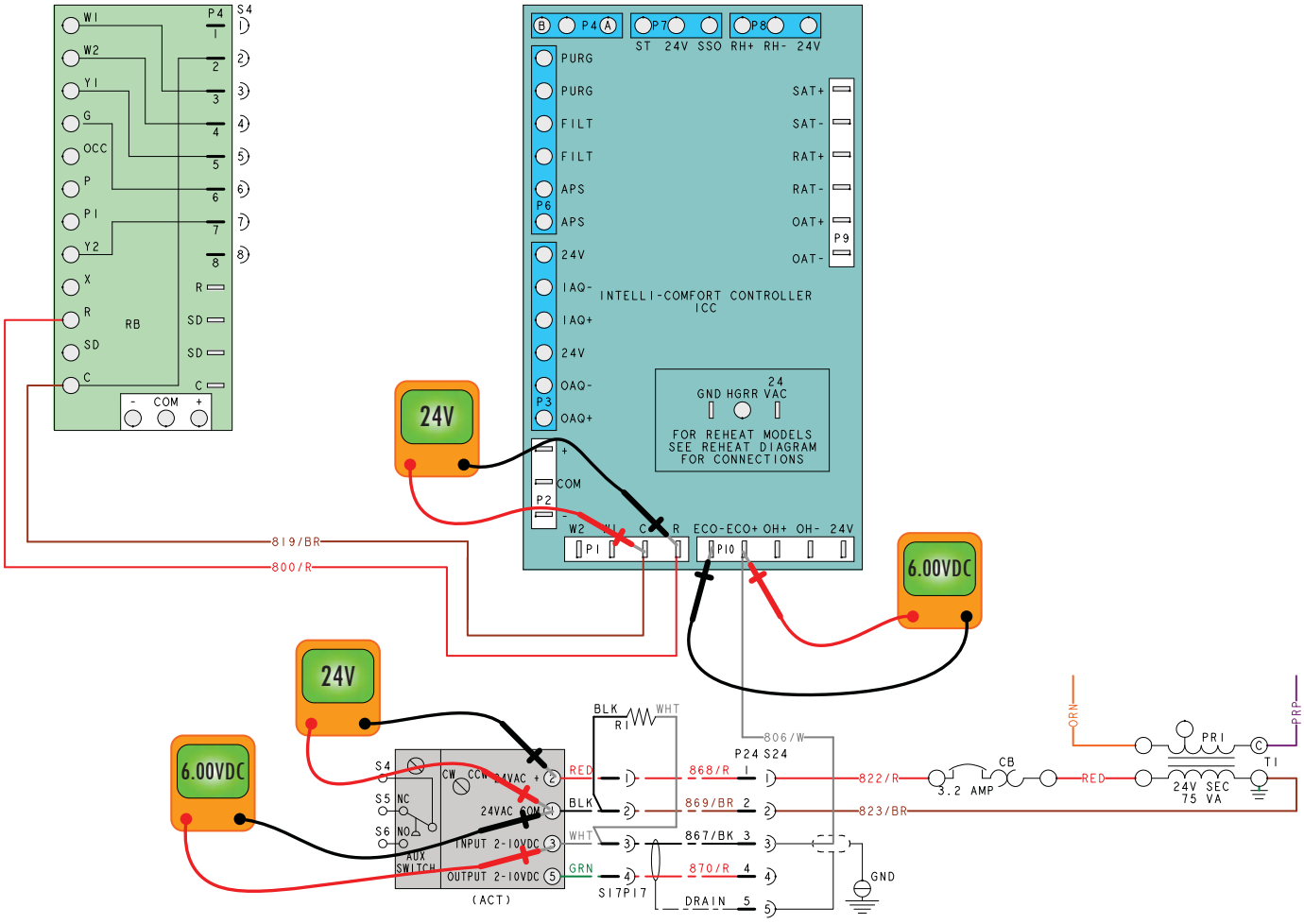


Figure 8-41

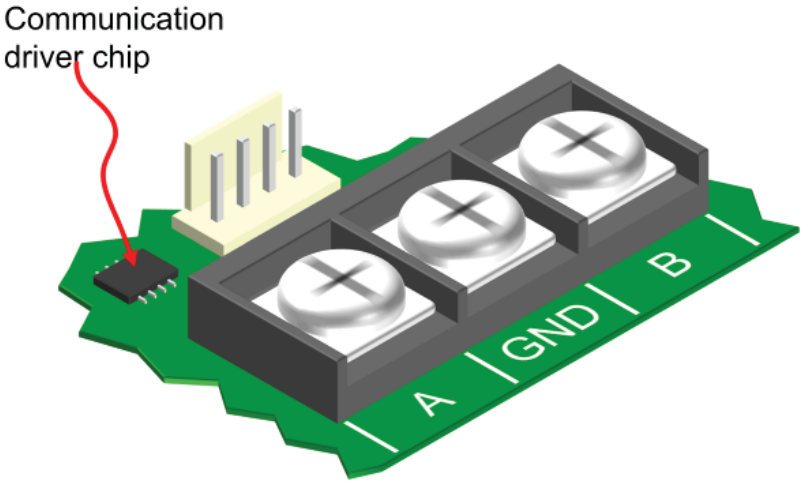


Figure 8-42

Simplicity boards have circuits for both internal and external communication. Board-to-board internal communication is used when Intelli-Comfort or VAV-VFD boards add features to the base Simplicity 1(A) board. External communication, connected to the RS485 port of the Simplicity 1A or Intelli-Comfort board, allows access to a single unit or multiple units when networked.

Internal and external communication circuits operate on less than 5 volts DC, and exposure to other voltage sources (including the 9 volt battery of an ohmmeter) will damage the board circuitry. An ohmmeter must only be used for communication troubleshooting when checking continuity of network wiring that has been disconnected from the Simplicity boards, adapters and translators. The communication driver chip on the Simplicity board is susceptible to damage from communication circuit problems. This small chip has eight prongs and is located in the vicinity of the communication terminals. It will often have visible damage if the communication circuit has been exposed to greater than 5 volts DC or other issues that cause spikes or surges. The communication driver chip of most Simplicity boards is un-socketed (soldered on the board), and if damaged, will require board replacement to restore communication features.

If the loss of external communication is the primary issue, the Simplicity board(s) will continue to operate the unit to maintain comfort; however, the comfort settings of Intelli-Comfort and VAV-VFD boards can only be changed through communication access with Simplicity PC or BAS integration.

The communication circuits use three terminals (pins). The outside two are positive DC, and the center is negative DC. The external connection (RS485 port) labels the screw terminals A, GND (or C) and B. The VAV-VFD board to Simplicity 1A internal communication COMM IN/COMM OUT connections have polarized mini-connectors to the three pins. When viewed from the board edge, the yellow wire (left pin), gray wire (center pin), and purple wire (right pin) are used for internal communication connections. The Intelli-Comfort board has a polarized mini-connector with white, brown and black wires to the three pins for internal communication to the Simplicity 1A RS485 connections.

The B terminal of the RS485 port will have the higher DC voltage of the two positive terminals. For VAV-VFD internal communication, the purple wire (right pin) will have the higher DC voltage of the two positive terminals. For Intelli-Comfort internal communication, the black wire (right pin) will have the higher DC voltage of the two positive terminals.

DC voltage readings of the communication circuit will vary under field conditions due to several factors as follows:

- The sensitivity of the voltmeter in the low DC voltage range
- The type of Simplicity board
- The adapters and translators attached to the communication circuit
- The number and type of boards connected in a network
- The length of wire used in a network

Also, if data is being transferred (alarms are present or information is requested from the boards), voltage “pulses” may be read on communication circuits. These pulses may briefly register approximately 0.1 to 1.0 volts DC higher/lower when read on voltmeters that have quicker sampling rates.

There are many variables which affect the normal voltage readings on communication circuits (especially when boards are connected in a network); thus, “firm” voltage readings can only be provided for the communication circuits of individual boards, and basic component combinations isolated from a network. These voltage readings can then serve as a baseline to confirm if the communication circuit of the board, adapter or translator are intact.

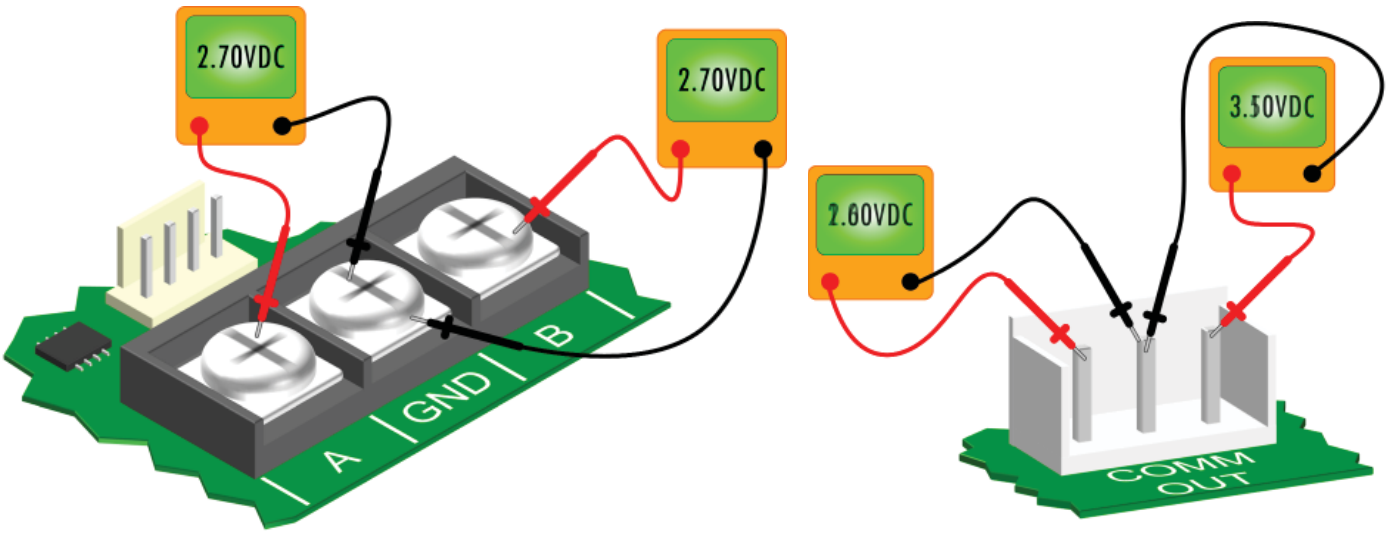


Figure 8-43

The reference baseline communication circuit voltage readings for powered boards, components, and basic combinations that follow are isolated from a network. These readings can vary depending on the sensitivity differences in various voltmeters.

Simplicity Lite

- A to GND: 2.35 volts DC
- B to GND: 2.35 volts DC

Simplicity 1

- A to GND: 0.15 volts DC
- B to GND: 0.43 volts DC

Simplicity 1A RS485

- A to GND: 2.70 volts DC
- B to GND: 2.70 volts DC

Simplicity 1A COMM OUT

- Yellow wire (left pin) to gray wire (center pin): 1.60-2.00 volts DC (pulsing)
- Purple wire (right pin) to gray wire (center pin): 3.10-3.50 volts DC (pulsing)

Intelli-Comfort RS485

- A to GND: 0.95 volts DC
- B to GND: 3.50 volts DC

Intelli-Comfort RS485 SIMPL

- White wire (left pin) to brown wire (center pin): 1.00 volts DC
- Black wire (right pin) to brown wire (center pin): 3.50 volts DC

VAV-VFD COMM OUT/COMM IN

- Yellow wire (left pin) to gray wire (center pin): 0.78 volts DC
- Purple wire (right pin) to gray wire (center pin): 4.12 volts DC

FREEnet Serial adapter

- A to GND: 0.01 volts DC
- B to GND: 2.68 volts DC

FREEnet USB adapter

- A to GND: 0.01 volts DC
- B to GND: 4.00 volts DC

MODlinc ModBUS

- A+ to GND: 3.2 volts DC
- B− to GND: 3.1 volts DC

Transporter

- Obtaining the voltage readings from the RJ12 terminals is impractical. Use the Transporter indicator lamps for communication troubleshooting.

Simplicity 1A COMM OUT connected to VAV-VFD COMM OUT/COMM IN

- Yellow wire (left pin) to gray wire (center pin): 1.90-2.60 volts DC (pulsing)
- Purple wire (right pin) to gray wire (center pin): 2.20-2.90 volts DC (pulsing)

Simplicity 1A RS485 connected to Intelli-Comfort

- A/white wire to GND/brown wire: 1.25 volts DC
- B/black wire to GND/brown wire: 3.33 volts DC

Again, the voltage readings for isolated boards, components, and basic combinations under field conditions should be close to that listed above. With the exception of FREEnet computer adapters, voltage readings of either zero or a full 5 volts DC typically indicate damage to the communication driver chip and related circuitry.

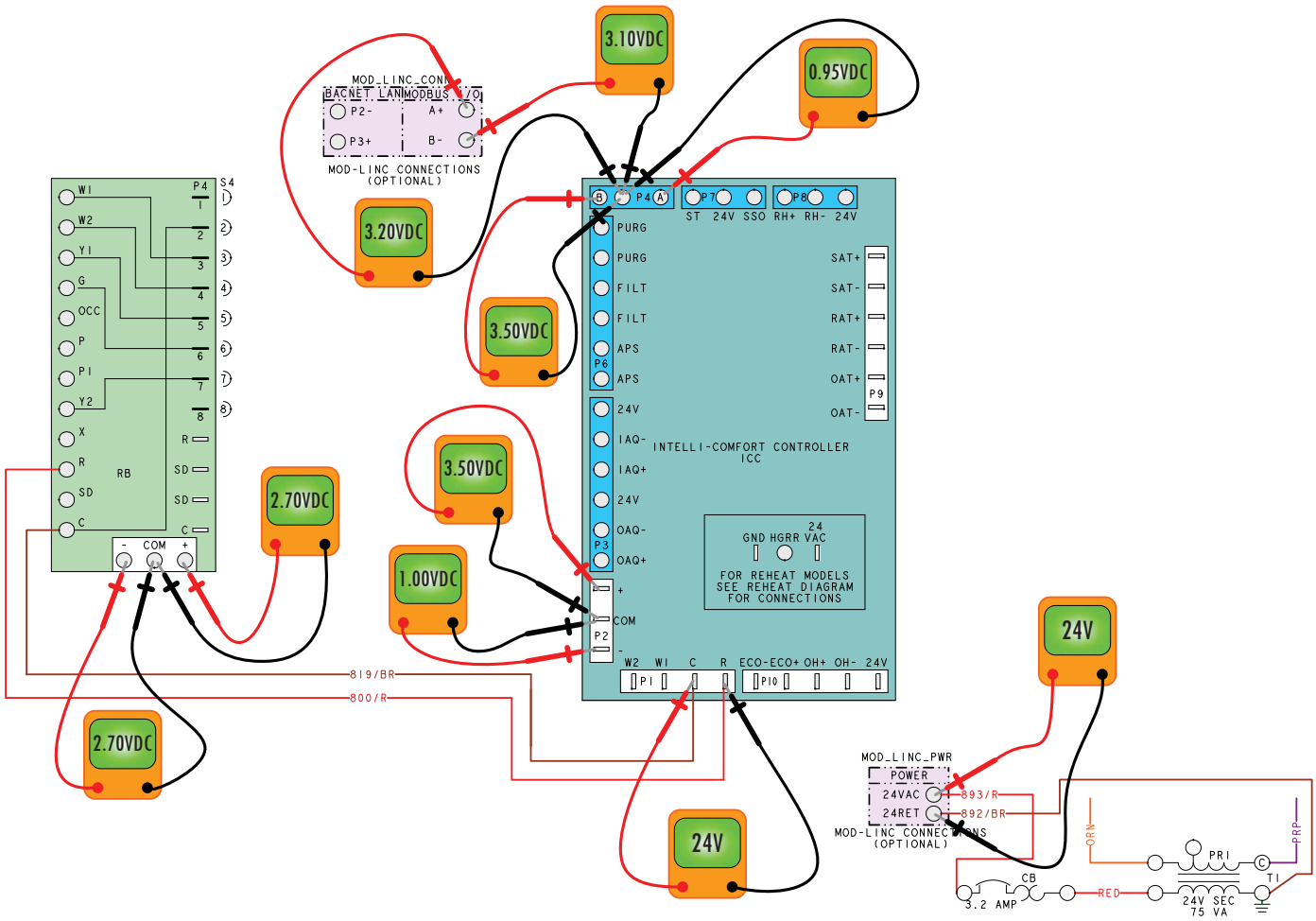


Figure 8-44

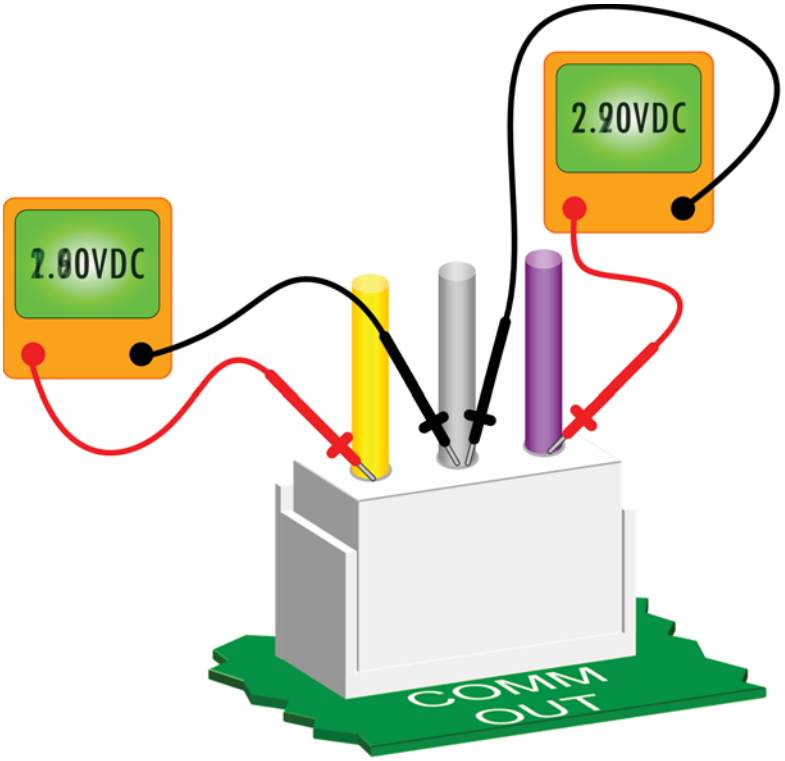


Figure 8-45

Troubleshooting of the internal, board-to-board communications will be needed when Simplicity 1A plus Intelli-Comfort or Simplicity 1A plus VAV-VFD “loss of communication” alarms occur.

Wire to terminal connection should be visually inspected to ensure proper polarity of the board-to-board communication circuit.

Baseline communication circuit voltages should read at both boards individually, and in combination. Simplicity 1A + VAV-VFD board combinations “self-configure” and require no additional action after both boards are powered, and the internal communication harness is connected to establish board-to-board communication. Simplicity 1A/Lite + Intelli-Comfort board combinations require that Simplicity Lite and Simplicity 1A board be addressed as “2” for board-to-board communication. The Simplicity 1A address can be reviewed or changed through presses of the COMM SETUP button.

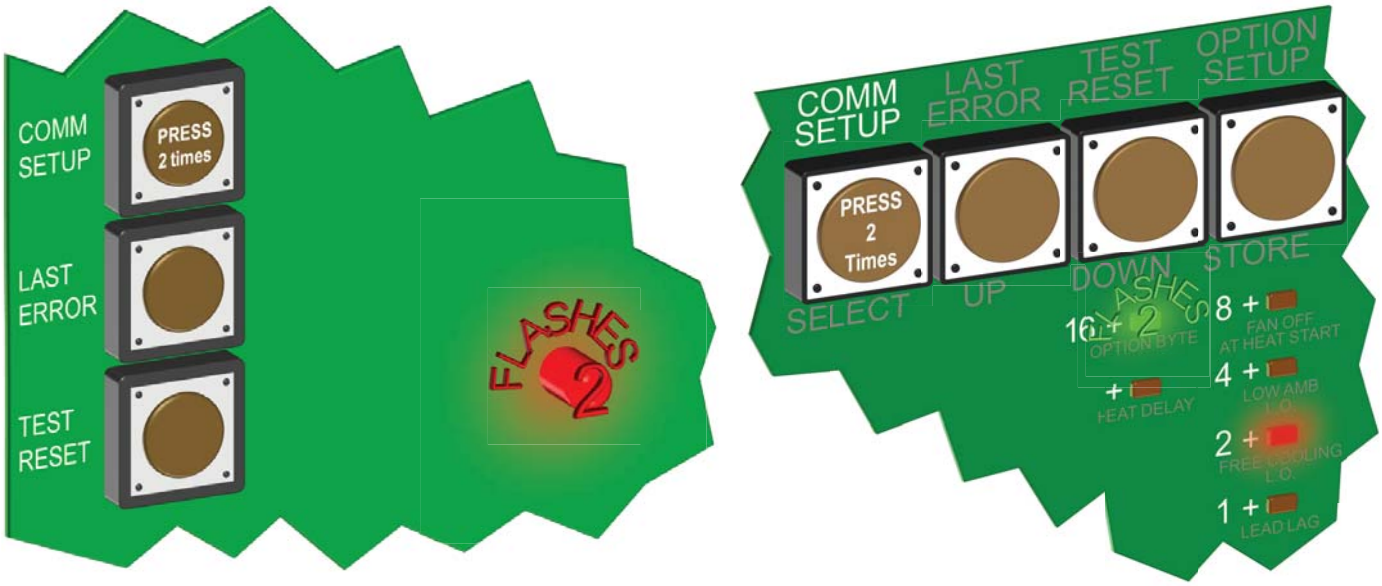
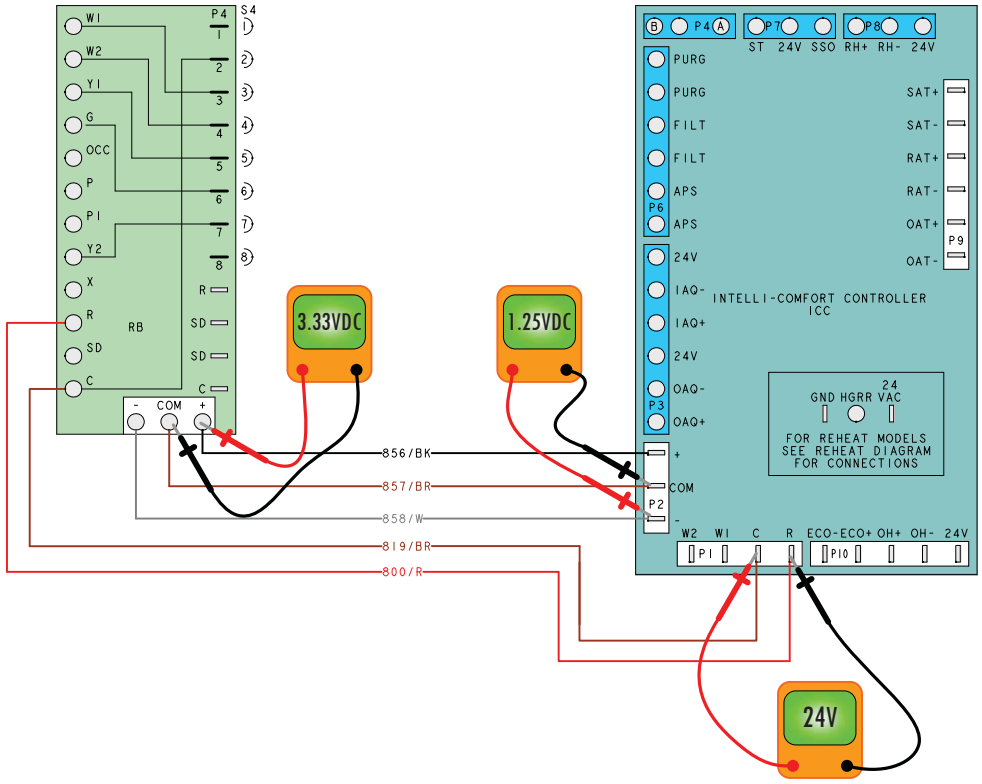


Figure 8-46

If baseline communication circuit voltages of either individual board differ significantly (either at or near zero or full 5 volts DC), the board has a damaged communication driver chip or related circuitry. Replacement of the board will be needed for repair. Causes for the failure, such as shorting to other voltage sources, should be investigated to prevent repeat failures.

If communication circuit voltages of both individual boards are reasonably close to the baseline, but either positive DC voltage reading falls to zero when the board-to-board communication harness is connected, the harness is shorted to GND or the cabinet. Replacement of the harness will be needed for repair. Causes for the failure, such as wire rubbing, should be investigated to prevent repeat failures.



If communication circuit voltages of both individual boards are reasonably close to the baseline, but the voltage readings do not change to that of the boards in combination when the board-to-board communication harness is connected, the harness is open. Replacement of the harness will be needed for repair. Causes for the failure, such as excessive wire tension or damage to the connectors, should be investigated to prevent repeat failures.

Figure 8-47

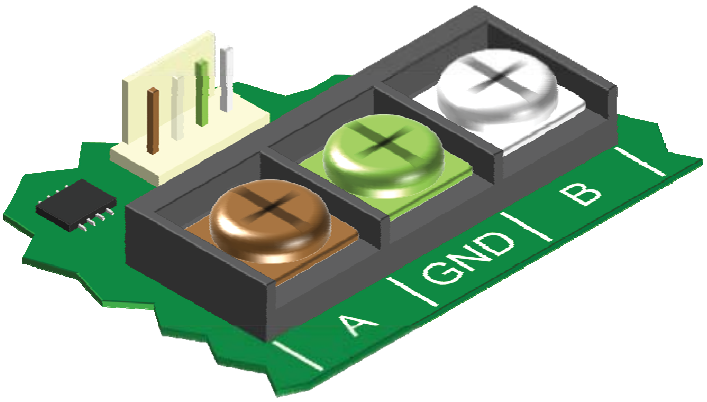


Figure 8-48

Troubleshooting of the external, RS485 communication circuits will be needed when Simplicity boards are unable to communicate to other devices. External communication may involve a single Simplicity board communicating to a computer adapter or translator device. External communication can also involve multiple Simplicity boards when networking is utilized.

Communication circuit voltages are verified to determine if function of components is possible. Verification of the following items for external communication (using factory-sourced adapters and translators) will resolve most “unable to communicate” issues.

When FREEnet computer adapters are used to access individual or networked Simplicity boards, proper connection of the adapter should be verified as follows.

Serial FREEnet adapter:

- Terminals TDA(−) and RDA(−) are jumpered, and connected to the Simplicity RS485 A terminal
- Terminals TDB(+) and RDB(+) are jumpered, and connected to the Simplicity RS485 B terminal
- Terminal GND is connected to the Simplicity RS485 GND terminal

USB FREEnet adapter:

- Terminal TDA(−) is connected to the Simplicity RS485 A terminal
- Terminals TDB(+) is connected to the Simplicity RS485 B terminal
- The top GND terminal is connected to the Simplicity RS485 GND terminal



The bottom set of terminals, RDA(−), RDB(+) and GND, are not used with the USB FREEnet adapter.

If the push-on service cable is used for temporary connection to the Simplicity board RS485 pins, the connections must be as follows:

- The brown wire connects to the adapter A terminal
- The white wire connects to the adapter B terminal
- The green wire connects to the adapter GND terminal

As detailed elsewhere in this manual, proper installation and setup of Simplicity PC software on the connected computer is needed for successful access when Simplicity PC is used.

For units with Intelli-Comfort boards, the physical connection between the external RS485 communication and the Intelli-Comfort board must be verified. The Simplicity Lite/1A board RS485 port is only used for internal communication.

For units with only the Simplicity Lite/1A or with the VAV-VFD board, the external RS485 communication physically connects to the Simplicity Lite/1A board RS485 port.

For units with MODlinc translators, verify that the MODlinc ModBUS A+ connects to Simplicity RS485 B, and MODlinc ModBUS B− connects to Simplicity RS485 A. MODlinc requires that the Simplicity board be addressed as 1 for communication. The Simplicity board address can be reviewed or changed through presses of the COMM SETUP button. The MODlinc translator will also need to be properly connected to a BACnet network, and have the DIP switches set for the proper BACnet address.

Troubleshooting of the external RS485 communication circuits, when Simplicity networking is utilized, includes verifying the baseline communication circuit voltages to confirm function of components is possible and verifying items for external communication using factory-sourced adapters. Networking issues can also be associated with multiple boards, and lengthy wire runs.

Any mix of the Simplicity family of boards (Simplicity 1(A) alone or with expansion boards, Intelli-Comfort, Lite and Elite) can be networked. The network is wired by "daisy chaining" the Simplicity board RS485 ports with18/3 shielded communication cable (with drain). Conductors of the communication cable connect the RS485 terminals of the Simplicity boards, A to A to A, B to B to B, and GND to GND to GND, to keep the polarity of the network consistent. The drain wire is joined at the mid-point connections of the daisy chain by wire nuts, and grounded to the end unit cabinet ground. The communication cable must be routed away from sources of electro-magnetic (EM) interference, such as power mains, as well as sources of radio frequency (RF) interference, such as florescent light ballasts. The boards should be addressed using the self-addressing scan of the Simplicity board. The Simplicity board address can also be set, reviewed or changed through presses of the COMM SETUP button. Without a FREEnet repeater, the network limitations are 2000' of cable and 64 boards. Each additional repeater extends the network limitations another 2000' of cable and 64 boards.

In addition to the baseline voltage readings for components, there are tools that assist communication network troubleshooting. A communication network may have thousands of feet of wiring to multiple units throughout the site. A marked floorplan or other diagram of the communication cable routing and unit addresses on site is a valuable reference when network issues require segmenting the external communication circuit to identify affected sections or components. A computer set up for a FREEnet adapter, and loaded with Simplicity PC software, provides indication of communication success or failure. A great deal of time can be saved, and several steps bypassed during communication network troubleshooting if the technician uses a portable laptop or handheld computer to access various points on a network.

Variables such as the number and type of boards, communication wire length, etc. can affect the actual voltages read on a functioning network. Typically, A to GND and B to GND will read 1.50-3.50 volts DC throughout the network. The B to GND readings should be at least 0.25 volts DC higher than A to GND. The following conditions are often causes for non-functioning communication networks:

- Incorrect wiring polarity at even a single connection can cause a loss of communication for the entire network
- Shorts to ground, GND wire, drain wire or shield will cause A to GND or B to GND voltage readings to be zero, and a loss of communication for the entire network will occur
- Communication driver chip failure at even a single board can cause a loss of communication for the entire network. A to GND or B to GND voltage readings may also be zero
- Inconsistent communication is typically due to voltage losses in the network. These losses can stem from communication driver chip failure or communication cable-related faults such as intermittent shorts, poor connections, excessive wire length, RF or EM interference
- When duplicate addresses, most likely to be address 1 or 2 for un-addressed Simplicity boards, exist on the network, there will typically be no communication from all boards with the duplicated address

Open communication network wiring or connections result in no communication with boards beyond the point in the network where the "open" exists. An open communication network may be noted on setup since the Simplicity self-address scan will begin a new sequence of "lowest available address" on each side of the break in the network. When troubleshooting an established network, a diagram

of the communication cable routing and unit addresses, and a computer set up for a FREEnet adapter, and loaded with Simplicity PC software are used to identify the portion of the network that is communicating. Logically, it is then known that the “open” is in the network segment just beyond the physical location of the last board communicating. Re-termination of the wiring or replacement of the open segment of the communication cable is typically needed for repair. Note that with an open in the network, A to GND and B to GND voltage readings will typically be “normal” on each side of the break. Other than confirming individual boards are intact and capable of communicating, voltage readings do not provide a reliable method for troubleshooting open network wiring or connections.

Troubleshooting duplicate addresses differs from open network wiring and connections in that only the duplicated address boards are not communicating. A site network diagram, and Simplicity PC software access help the technician identify which boards are not communicating, and their physical location. Correction of duplicate addresses is then done at the boards through presses of the COMM SETUP button. A to GND and B to GND voltage readings are “normal” for duplicated addresses, and do not provide information for troubleshooting.

The initial voltage readings from A to GND and B to GND provide some indication of the type of problem that exists when troubleshooting a loss of communication for the entire network. If zero volts is read from A to GND or B to GND, a wiring short or failed communication driver chip is likely to be at fault. If near “normal” voltages are read, incorrect polarity or interference (EM or RF) is likely to be at fault. Regardless of the cause, the method for detection is to temporarily segment the communication network to isolate the affected wire section or component.

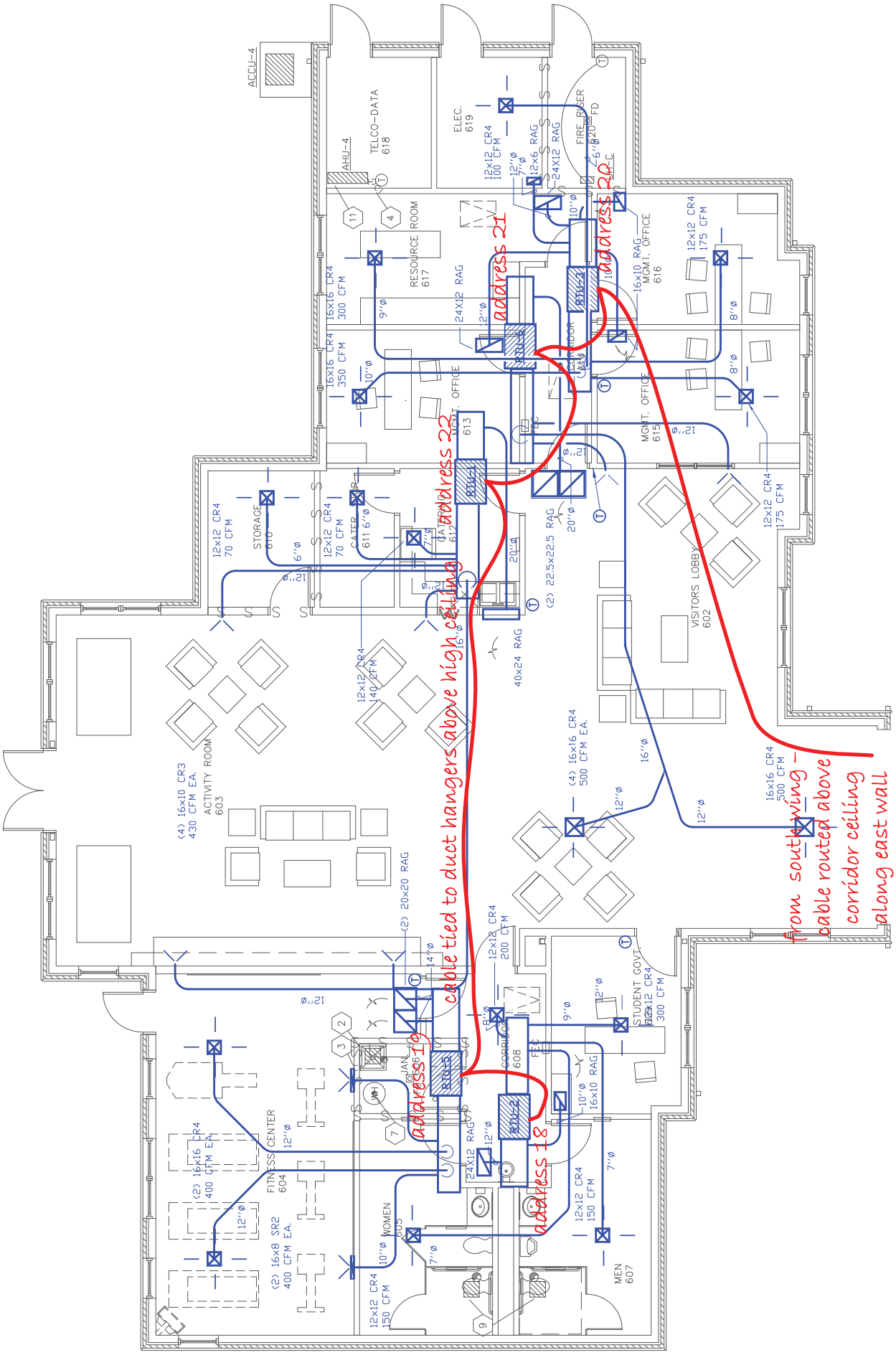


Figure 8-49 - Sample floorplan.

Using a diagram of the communication cable routing on site, a mid-point of the network is selected and temporarily disconnected. If, when accessed through Simplicity PC, communication is restored to the segment that remains connected, then the disconnected segment is affected. If communication is still lost in the connected segment, that segment of the network is affected. After reconnection of the temporary break at the mid-point of the network, the affected segment is then temporarily disconnected at its mid-point. Again, if communication is restored to the portion that remains connected, then the disconnected portion is affected. If communication is still lost in the connected portion, then that portion of the network is affected. This halving of the affected segment continues until the faulty wire section or component is isolated.

While a wiring shorts or failed communication driver chips can be detected with voltage readings, and incorrect polarity of the network wiring connections can be determined by visual inspection, the presence of interference (EM or RF) affecting the network is difficult to prove with HVAC tools. Steps to prevent or remedy the problems are usually the only options available to the technician. The materials of the network, such as shielded communication cable and continuous drain wire with grounded end connection, protect the communication network from being affected by most “ambient” interference present on commercial sites. The routing of the communication cable must be well away from sources of interference such as florescent lamp ballasts, power mains, large motors, etc. Whenever interference is suspected as being an issue the cable materials and routing should be inspected and corrections made as needed. Sites with sources of extreme interference, such as radio/television transmission towers, will need added measures, as recommended by Technical Support on a case-by-case basis, for successful communication.

Chapter 9 - Two Stage Compressor

Refrigerant circuit troubleshooting is primarily done with the two-stage scroll compressor operating at full capacity. This requires that the Simplicity 1A board C2 output, the rectifier external to the compressor and the internal bypass port solenoid of the compressor are all energized. Once it is ensured that compressor is operating at full capacity, the refrigeration circuit troubleshooting procedures described in the troubleshooting section of this manual apply.

The rectifier is located on the compressor and receives 24 volts AC input from the Simplicity 1A control board C2 output when second stage compressor operation is permitted. If the rectifier is working properly, it will produce 24 volts DC output to the second stage solenoid valve. With sufficient suction-to-discharge pressure differential, the solenoid valve will then close bypass ports of the scroll compression chamber for 100% cooling capacity.

If the compressor operates in first stage (67% capacity) but will not close the bypass ports to fully load the compressor on the second stage (100% capacity) the suction-to-discharge pressure differential must first be verified to be at least 50 to 75 PSI; then the Simplicity 1A control C2 output, rectifier, solenoid valve and associated wiring must be evaluated.

1. Verify that 24 volts AC is present at the Simplicity 1A C2 output.
    a. If 24 volts AC is not present, verify that C2 output is permitted:
        i. Demand for second stage cooling must be present either by Y2 thermostat input to the Simplicity 1A board or by the active cooling setpoint being more than 2.0°F below than the current space/return air temperature
        ii. Second stage operation must not be prevented by refrigerant safety input trips (Simplicity 1A HPS2, LPS2 or FS2 wiring harness jumpers loose/missing)
        iii. Anti-short cycle and inter-stage delay timers for the C2 output must be expired
        iv. C2 output must not be prevented by free cooling operation
        v. C2 output must not be prevented by supply air temperature below the Supply Air Temp Limit Cooling Setpoint (CV ONLY) parameter
2. Measure current draw of the rectifier/solenoid circuit – an intact rectifier/solenoid will normally draw approximately 0.2 amps
3. Verify that 24 volts AC is present at the rectifier input
    a. If 24 volts AC is not present, verify that wiring to the rectifier is intact
4. Verify that 24 volts DC is present at the rectifier output.
    a. If 24 volts AC is not present, the rectifier is faulty and must be replaced.
5. Verify the resistance of the solenoid is within the 300Ω to 1800Ω range and does not have continuity to case ground
    a. If the solenoid has failed open, shorted or grounded the compressor must be replaced

If steps 1 through 5 above do not indicate an electrical fault and compressor motor current draw does not increase when the C2 output/rectifier/solenoid circuit is energized; then a mechanical fault exists with the bypass port mechanism and the compressor must be replaced.

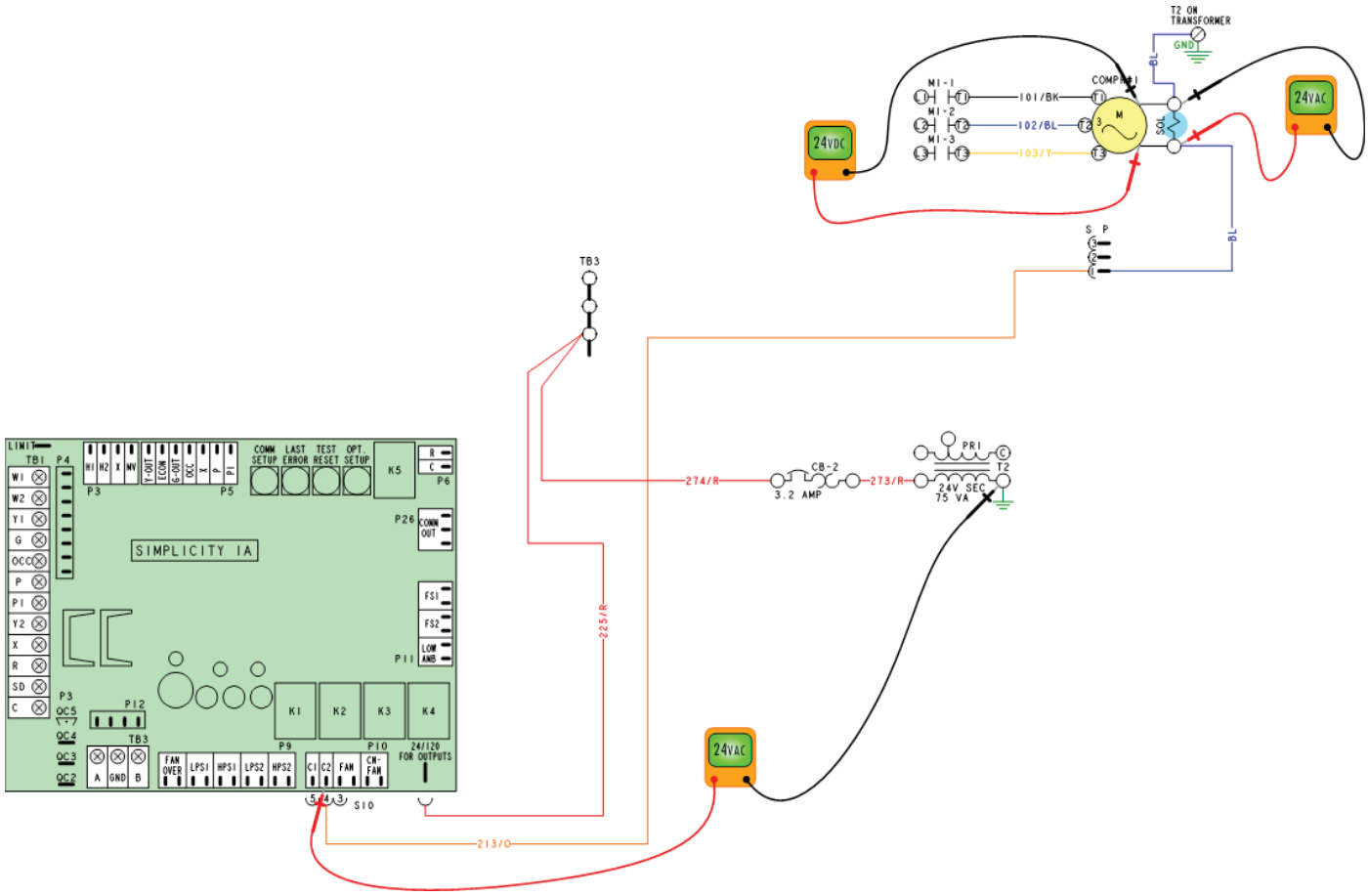


Figure 9-1 - Voltage and Amperage readings for second stage compressor operation