Tech Tips II Feb. _08_ _Temperature Systems Inc._

Madison - Green Bay - Milwaukee - Rockford

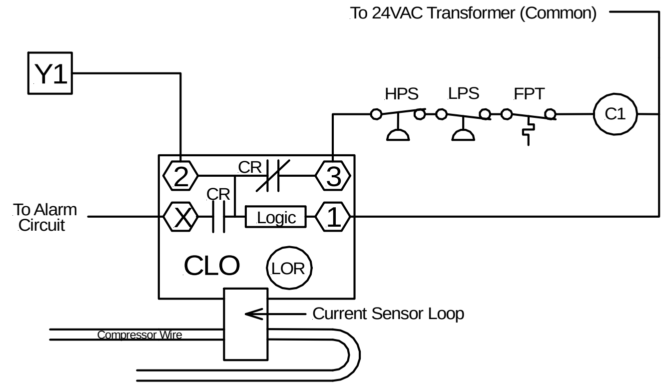
Rooftop Units (RTU)

Understanding the CLO

CLO stands for **C**urrent-Sensing **L**ock **O**ut. It may also be referred to as a **C**ompressor **L**ock **O**ut. A CLO board provides a lock-out function in the event of a safety trip. Its main function is to prevent the restart of the compressor or unit if the safety devices themselves are not manual reset. The CLO will keep the compressor or unit locked out until power is momentarily interrupted to the CLO.

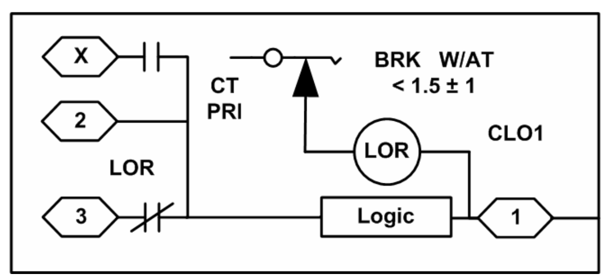
With 18 to 30 VAC applied to Terminals 1 & 2, and 2.5 amps applied simultaneously through the current sensor loop, the control relay mounted on the CLO must remain de-energized. When current through the current sensing loop is reduced to 0.5 amps, the control relay must energize within 1 second and open a normally-closed contact between Terminals 2 & 3, and close a normally-closed contact between Terminals 2 & X (X is energized to provide a 24VAC signal in a lock-out condition).

The following is the typical control circuit to which a CLO is applied:



In the above diagram, if the HPS (High Pressure Switch), LPS (Low Pressure Switch), or FPT (Freeze Protection Thermostat) should open, Compressor Contactor (C1) will be locked out.

Below is a more accurate representation of the CLO printed circuit board.



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After years of Capillary tubes and Thermal Expansion Valves (TXVs) Carrier has found long term reliability in the use of the Accutrol system of metering.

This method creates a fixed orifice for each distributor feeding into to the evaporator. Following is the recommended test procedure for troubleshooting refrigerant restriction issues.

Accutrol Test Procedure

Over the years manufactures have used many methods of introducing a pressure drop in the refrigeration system to create the cooling effect many interpret as air conditioning.

Recommended Test Method

Locate the short pieces of tubing that contain the Accutrols. This piece of tubing is located between the liquid header and the indoor coil.

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You **must** be able to physically see this piece of tubing during the test.

1. Disconnect the power to the unit to prevent hazard of electrical shock.
2. Locate indoor fan contactor and remove the indoor fan motor wires and insulate.
3. Install a jumper between R & Y on the low voltage terminal strip.
4. Install refrigerant gauges to monitor system pressures.
5. Minimize convective air currents through the indoor coil.
6. Turn power on to the unit to run the compressor and condenser fan(s).
7. Observe the short sections of tubing that contain the Accutrol and note time to frost on all pieces of tubing. They should all frost within 30 to 45 seconds of each other (downstream of the Accutrol) as long as the saturated suction temperature is 32°F or lower. Time may vary slightly due to convective air currents and the size of the coil. Tubing that frost slowly (more than 90 seconds) or do not frost are restricted or missing, and require repair or replacement of the evaporator coil.
8. If all pieces of tubing frosted normally, disconnect power to the unit and remove the jumper between R & Y. Reconnect the indoor fan motor wires. Reinstall unit panels and restore power to the unit.
Some evaporator coils that have plugged restricted or missing Accutrols can be repaired by replacing the liquid line header which includes new Accutrols. Other coils can be repaired by installing a TXV assembly in place of the Accutrols. In extreme cases, the entire evaporator coil will have to be replaced.

Hall Effect Switch Troubleshooting

Integrated Gas Control (IGC)

LED Indication	Error Code	Description
ON	Normal Operation	No problems detected by IGC board
OFF	Hardware Failure	An IGC board component has failed - replace IGC board
1 Flash	Fan On/Off Delay Modified	Fan ON delay or OFF delay has been modified due to trips on limit switch
2 Flashes	Limit Switch Fault	Limit switch is open
3 Flashes	Flame Sense Fault	Flame sensor detected a flame with the gas valve closed
4 Flashes	Five Consecutive Limit Switch Faults	Limit switch cycled on and off 5 times during a single call for heat
5 Flashes	Ignition Lock-out Fault	No ignition within 15 minutes
6 Flashes	Inducer Switch Fault	No signal from the Hall Effect Sensor for 60 seconds
7 Flashes	Rollout Switch Fault	Rollout switch is open
8 Flashes	Internal Control Fault	Can be either a hardware or software problem on the IGC board
9 Flashes	Software Lock-out	Software problem on IGC board. Cycle power to the board. Replace board if error code reoccurs

Integrated Gas Controller (IGC)

All units are equipped with a direct spark ignition system and 100% lock-out. It provides a visual display of operational or sequential problems when the power supply is uninterrupted. An onboard LED can be observed through the viewport.
When a break in power occurs, the IGC will be reset (resulting in a loss of fault history) and the evaporator fan on/off times delay will be reset. During servicing, refer to the label on the control box cover, or the following table for an explanation of LED error code descriptions.

Tools needed:
Voltmeter capable of measuring DC volts

With the three-wire plug unplugged:
With power applied to the unit, unplug the three-wire plug and measure the pins as follows:
1. Connect the negative or black lead of the meter to pin three on the circuit board.
2. Connect the positive or red lead of the meter to pin one.
3. The meter should read between 7.5 and 10 volts DC.
4. Move the red or positive lead to pin two. It should read between 21 and 24 volts DC.

5. Replace the circuit board if these pins are outside these readings.

With the three-wire plug plugged in:
With power applied to the unit and the three wire plug in place, measure the pins as follows:
1. Connect the negative or black lead of the voltmeter to pin three on the circuit board.
2. Connect the positive or red lead of the voltmeter to pin one.
3. Slowly rotate the induced draft motor. On half of one rotation of the induced draft motor shaft the voltage reading should be less than 1 volt DC. On the other half of one rotation the voltage reading should be between 6.5 and 9 volts DC.
4. If the voltage reading is not less than 1 volt DC on half of the rotation of the motor shaft and not between 6.5 volts and 9 volts DC of the other half of the shaft rotation, replace the Hall Effect Switch.
5. Move the red or positive lead to pin two. It should read between 16.5 and 21 volts. If not, replace the Hall Effect Switch.

Free Cooling & Economizers: a great way to save

A compressor requires vast amounts of energy to operate. By keeping the running time of the compressor to a minimum and running the compressor as close as possible to peak efficiency, the result can be in substantial energy savings. An air conditioning system is designed to work most efficiently when it is hot outside. That is when the maximum amount of cooling is required. When the outdoor temperature falls below 65°F it begins to lose efficiency; unless, the system was specifically designed to run at a lower ambient.

Carrier economizer intake hood

Before modern air conditioning systems where available, buildings were constructed so no area of the building was more than 15 to 20 feet away from a window. This was the only means to ventilate and cool a building. In today's larger modern buildings it is very rare to even find a window that will open. The building is totally dependent on mechanical cooling systems. Instead of windows, fresh air is drawn into the building via the ventilation systems and mechanical compressors provide cooling. These systems can also utilize the cool outdoor air in place of the mechanical compressors to provide cooling when required. During the spring, fall, winter, and during the cool nights, there is no need to run the compressors. Outdoor air can provide all the cooling needs. When the temperatures are below 55°F, 100% of the cooling can come from outdoor air and partial cooling when outdoor temperatures are as high as 74°F.

There are 2 dampers on a typical economizer that modulate when the outdoor conditions are right. An outside damper opens to draw air into the building and a return air damper closes, cutting off the return airflow from the building. When this outdoor damper opens, the extra added air will pressurize the inside the building, just like blowing up a balloon. This can cause outside doors to blow open or doors that open to the inside to stick closed. A small amount of pressure can have a big effect. A pressure relief damper is used upstream of the return air damper to relieve this pressure in the building. This may be a very simple metal square the will swing open under a small amount of pressure; or a large mechanical systems will use a mechanical damper that opens in conjunction with the intake damper and a fan to expel the extra air.

The dampers are driven by an electric or pneumatic actuator, which is controlled from an outdoor temperature or enthalpy control. The control switches the system from mechanical cooling to economizer cooling when the outdoor conditions are right. Preferably, an enthalpy control is used to sense both humidity and temperature. Some units have temperature only controls that do not take into consideration the effects of humidity. Enthalpy is a thermodynamic function of a system, equivalent to the sum of the internal energy of the system plus the product of its volume multiplied by the pressure exerted on it by its surroundings (in HVAC terms this is temperature + humidity). If the enthalpy of the outdoor air is less than the enthalpy of the indoor air by volume, then the outdoor air can be used for cooling the building. The enthalpy control dial is marked with A, B C, D. Each point represents a range of conditions. At the high end of the scale, "A" which is equal to 62F° at 90% RH through to 85°F at 10% RH and at the low end of the scale is, "D" which is equal to 52°F at 90% RH to 73°F at 10% RH.

In many cases both the minimum damper position for fresh air and enthalpy set point dials are on the same control. Some economizers use just a temperature control mounted on the intake hood with the minimum damper position controlled by a potentiometer on the actuator. Whenever the fan is running, the damper should drive to the minimum fresh air position. This may only amount to a slight crack in the damper opening but is enough to provide a standard 10% of the total fan volume of fresh air. Whenever the fan is off, this damper should drive completely closed by a return spring or back-up power. Turn power off at the rooftop unit while the fan is running and you should see the damper move closed.

When the outdoor conditions are below the control set point and the room thermostat is calling for cooling, the supply air fan will start and the economizer damper will modulate without starting the compressor. If the thermostat fan switch is set to "On or the system is in Occupied" the fan runs continuously and the damper will already be at the minimum fresh air position. A second control modulates the damper position to maintain a constant supply air temperature. A Mixed Air Temperature (MAT) control (often) fixed at 55°F will determine how far the damper drives. The MAT Control will modulate the outside damper open and close the return air damper until it achieves the set point. If the outdoor air temperature is above 55°F then the outdoor damper should move to 100% open position. If the outdoor temperature is below 55°F the outdoor damper will move towards the closed position and mix the outdoor air with the return air maintaining 55°F. An integrated control allows the compressor and the economizer to run at the same time by using a two-stage thermostat. When the first-stage calls for cooling, the economizer opens. If the conditions do not improve in the space and the temperature in the building continues to climb, the thermostat will then call for second-stage cooling. This brings on the first-stage compressor to provide additional cooling required. If the outdoor temperature is too cold to run the compressor another control called a "Low Ambient Lock-out" will prevent the compressor from starting. By keeping the mechanical compressor off a little longer we can maximize the savings with the economizer.

The dampers should be tested every year to ensure it functions as required. Moisture and dirt can cause the dampers to bind after many years of operation. If the damper sticks in the open position it will waste a great deal of energy in both the winter and the summer. Excessive fresh air in the winter can also create excessive condensation and/or crack the heat exchanger from stress caused by extreme temperature differences. Regularly check the seals around the damper. If the dampers stick closed, the lack of fresh air will make the interior air stale and can even result in high CO, CO_2 and/or VOC levels in the building.

Economizers are available as an option on most rooftop packaged units and can be built into any field built mechanical ventilation system. Economizers are far too often overlooked in consideration of the initial capital cost. As part of the complete mechanical systems, the extra cost is a minimum that would add less then 3% to the construction cost. In the price competitive market of rooftop replacements where just the equipment is quoted, economizers can be deleted in order to improve the price. The cost difference on a single piece of equipment with a fully functional economizer, or a manual air intake, or no intake hood can be 15% or more on a packaged rooftop unit. Over the life of the equipment the economizer will pay for itself many times over. Energy prices are only going to go up which will shorten the pay back and help the environment.