GUARDIAN

NOTES on FAULT DIAGNOSIS

Operation and Setup Manual

This section gives a few useful notes which may be of help to service personnel in diagnosing refrigeration and / or controller problems

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GETTING STARTED

Directly connected refrigeration components.

For the case controls to operate, it is fundamental that the mechanical and electrical items associated with it, are in good order.

eg. TEV set up correctly, Filters clean, Fan blades free.

Indirectly connected refrigeration components.

Similarly, conditions at a case, under control from other system areas must be satisfactory.

eg. Evaporating and condensing temperatures.

Physical condition of controls.

Check for possible damage by external factors. eg Water, Heat, Impact, Vermin etc.

Electrical wiring faults.

a. Condition All wiring visually ok, no loose tails, no signs of overload, if problems are found corrective action must be taken.

b. Fusing All fuses intact and of correct ratings.
In the event of finding a failed device replace only when the fault has been cleared.

c. Supply Present and correct voltage.

Settings.

Check that all adjustable values eg setpoints, timers, and all software switches
eg defrost type, temperature probe type, are correct and match the required operating conditions and physical equipment.

COOLING CONTROL PROBLEMS

Case not reaching desired temperature.

a. Incorrect control parameters
Check all settings

b. External refrigeration conditions not satisfied.
eg. Evaporating and condensing temperatures. refrigerant charge
Check and remedy if necessary.

Controller in the wrong operating mode

eg OFF or FANS only
Switch to AUTO mode and allow start up timer.

Controller/case DEFROST cycle (PAGE REF) in progress.

Allow cycle to complete and pull down operation to begin.

LSV / AKV valve not operating at all.

Check that the controller is calling for cooling
if true then check that the voltage is reaching the valve coil. If it is then the coil may be OPEN circuit, or the actuating mechanism broken, replace as necessary.

NOTE; There may be a fuse fitted in the valve supply line.
Check to see if it has blown,
if so then the valve coil has probably failed SHORT circuit.
Check the coil out BEFORE replacing the fuse.
If the voltage is not reaching the coil and the wiring is OK, then check the supply to the controllers relay, measure (AC V) between neutral and the relay common
If supply voltage is not present, there may be a fuse fitted in the valve supply line.
Check to see if it has blown, if so then the valve coil has probably failed SHORT circuit.
check the coil out BEFORE replacing the fuse.

If the supply is present, then the controller output relay may be faulty. Check this by measuring (AC V) between the valve output terminal and neutral.
Its best to force the valve on and off using the TEST mode when doing this. If the output relay is found to be faulty then replace the controller

SUCTION valve not operating

Check that the controller is calling for suction
The suction valve can be electrically checked out in exactly the same manner as a LSV valve the only difference being its relay output terminal

FAN motors not operating.

Check that the controller is calling for FAN operation, if true then check that the voltage is reaching the motor terminals. If it is then the motor has probably failed OPEN circuit (replace the motor) or its thermal fuse has blown (This may be replaceable).
If no voltage is present, Check the fuse in the FAN motor supply line, if it has blown then the motor has probably been stalled (eg from ice build up) or has failed SHORT circuit (replace the motor)

If no voltage is present and the fuse is good, Then check the supply to the controllers relay, measure (AC V) between neutral and the relay common, if supply voltage is not present then check its source.

If the supply is present, then the controller output relay may be faulty. Check this by measuring (AC V) between the FANS output terminal and neutral. It's best to force the FANS on and off using the TEST mode when doing this. If the output relay is found to be faulty then replace the controller.

NOTE If the controller is operating a multi case section or a cold-store cooler. Then the fan motors will almost certainly be operated by a secondary relay or contactor. In this instance the action of the controller is only to energise this secondary switch, therefore any circuits and protection beyond this must be checked. (Refer to the SITE wiring diagrams).

DEFROST heater or HOT GAS valve permanently energised.

HOT GAS systems check if voltage is being applied to the coil of the hot gas valve.

ELECTRIC heater systems check to see if voltage is being applied to the heating elements
If supply voltage is present, Check that the controller is not calling for a defrost output (it should not be) If it is then a DEFROST cycle is in progress and should be allowed to complete be cancelled.

If the controller is not calling for a defrost output, then check (AC V) between its output terminal and neutral NO voltage should be present. If voltage is present then the controller relay output has failed. Replace the controller.

NOTE Electric DEFROST heaters are often driven by a secondary relay or contactor.
This is the most likely point of failure. (Contacts can weld together). Check by measuring the voltage across its coil (should be zero) and between its Normally Open contact and neutral (should also be zero). If not then the relay or contactor has failed

PROBE or TRANSDUCER FAULTS

Temperature measurement - thermistor probes.

Thermistor probes are usually 2 wire devices. The resistance changes in a non-linear fashion with respect to temperature. Two types are available Negative Temperature Coefficient (resistance decreases with temperature rise) or Positive Temperature Coefficient (resistance increases with temperature rise).
Refrigeration applications usually use NTC.
Not all thermistors are the same, always use the exact type specified by the controller manufacturer.

All probes on a controller give FAIL displays or inaccurate values.

This is most likely to be a failure of the measurement electronics of the controller or a cabling fault if common wiring is used. Disconnect any one of the probes and check its resistance against tabular data. If a sensible value is obtained, then check the controller by substitution. If the value is unrealistic then check out the wiring.

A single probe gives a FAIL display or an inaccurate value.

This is most likely to be a failure of the probe itself, or its wiring. Don't rule out the controller though, check the particular channel out using either a spare probe or a fixed resistor.

Typical problems

1. **Probe fails SHORT circuit.**
2. **Probe fails OPEN circuit.**
3. **Probe drifts and becomes inaccurate**
4. **Wiring or connector faults.**
5. **Probe is detached from its point of measurement.**

Items 1 to 4 can only really be found by using a meter to check out the circuit, Disconnect the probe from the controller and measure its resistance, OPEN or SHORT circuits are easy to spot. But if inaccuracy is suspected then the only answer is to fit a calibrated sensor at the same point as the suspect and compare readings. It may be easier to just replace a suspect probe and test it at a later date.

Temperature measurement - resistance thermometers.

Resistance thermometer probes are fundamentally 2 wire devices. However they are often connected in a 3 or 4 wire configuration, this is to compensate for resistance in the connecting cable. The resistance of the probe changes in a near linear fashion with respect to temperature. Resistance always decreases with temperature rise. Refrigeration applications usually use 2 types PT100 or PT1000. The number signifies the resistance in ohms at 0 Deg C. The change in resistance per Deg C is 0.385 ohm for PT100 types and 3.85 ohms for PT1000 types. These values are approximate but should be good enough to pass or fail a suspect item.

eg A PT1000 probe at 15 Deg C Resistance = 1000 + (15 X 3.85) = 1057.75 ohms

eg A PT100 probe measures 90 ohms Temperature = (90 - 100) / 0.385 = - 26 Deg C

Problems

A. All probes on a controller give FAIL displays or inaccurate values.
This is most likely to be a failure of the measurement electronics of the controller or a cabling fault if common wiring is used. Disconnect any one of the probes and check its resistance against tabular data. If a sensible value is obtained, then check the controller by substitution. If the value is unrealistic then check out the wiring.

B. A single probe gives a FAIL display or an inaccurate value.
This is most likely to be a failure of the probe itself, or its wiring. Don't rule out the controller though, check the particular channel out using either a spare probe or a fixed resistor.

Typical problems
1. **Probe fails SHORT circuit.**
2. **Probe fails OPEN circuit.**
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Items 1 to 4 can only really be found by using a meter to check out the circuit, disconnect the probe from the controller and measure its resistance OPEN or SHORT circuits are easy to spot, If it is connected in a 3 or 4 wire configuration then all the wires must be connected correctly. But if inaccuracy is suspected then the only answer is to fit a calibrated sensor at the same point as the suspect and compare readings. It may be easier to just replace a suspect probe and test it at a later date.

Pressure Transducers.

Pressure transducers are usually of two types, the difference being electrical. The simplest is where the resistive bridge of the internal strain gauge is brought straight out to terminals on the device.
Most transducers in present use are of a type having built in amplification and signal conditioning circuitry, usually a 4 - 20 mA 2 wire system. In this case 4 mA is used to power the circuitry, any extra absorbed indicates the pressure reading, up to 20 mA which is full scale. Transducers of differing measurement ranges are available in both electrical types.

Problems (4 - 20 mA)

A. All transducers on a controller give FAIL displays or inaccurate values.

This is most likely to be a failure of the measurement electronics of the controller or a cabling fault if common wiring is used. Check that a DC supply voltage is being provided to the transducers, it should be between12 and 24 volts. If this is not present then a fuse may be blown or an electronic overload activated, replace or reset. If the supply is ok then check the controller by substitution.

B. A single transducer gives a FAIL display or an inaccurate value.

This is most likely to be a failure of the transducer itself, or its wiring. Don't rule out the controller though, check the particular channel out using a spare transducer or a 4 - 20 mA simulator.

Typical problems

1. Transducer fails SHORT circuit.
2. Transducer fails OPEN circuit.
3. Transducer drifts and becomes inaccurate
4. Wiring or connector faults.

Items 1 to 4 can only really be found by using a meter to check out the circuit, disconnect a wire from the transducer and insert a meter set to read a 30 mA scale. Note the current at a known pressure.

Use the formula below to determine if the current is correct for the pressure.

CURRENT=4+((16X(PRESSURE-SCALE MIN))/(SCALE MAX-SCALE MIN))

eg A known pressure of 12 b using a -1 b to 24 b transducer

CURRENT=4+((16X(12--1))/(24--1)

CURRENT=4+((16X13)/(25)=4+(208/25)=4+8.32=12.32 mA

INPUT / OUTPUTS

Digital inputs. Low level

A volt free digital input is a type where the supply to the external switch is generated by the controller, and then fed back to the controller, if the switch is made. The voltages are not necessarily referenced to system earth.

A low voltage input is a type where an external voltage level often 12 V dc or 24 V ac is applied between two terminals on the controller (one of which is often a common for multiple inputs).

Problems Volt Free

1. **Input is always ON (or Short Circuit)**
2. **Input is always OFF (or Open Circuit)**
3. **Input is intermittent**

All these scenarios can be either problems with the external switch, the wiring, or the controller. Check out the controller by applying a short or open circuit to its terminals, if there is still disagreement then substitute the controller. Check the switch and wiring by disconnecting the circuit at the controller, measure resistance with a meter whilst operating the switch.

Problems Low Voltage

1. **Input is always ON (or Signal Present)**
2. **Input is always OFF (or Signal Absent)**
3. **Input is intermittent.**

Check that the Signal is being applied or not applied as the case may be, to the input terminals on the controller. By measuring at the controller terminals with a voltmeter. If a disagreement is found then substitute the controller.

Digital inputs Mains Voltage

A mains voltage input is a type where an external voltage level often 110 or 240 V ac is applied between two terminals on the controller (usually it is the same voltage level as the controller supply). The signal is normally referenced to mains Neutral. The controller may look for the signal between 2 separate terminals (where one is usually connected to neutral by external wiring) or just use 1 terminal for the signal, using the neutral of its power supply connection as the reference.

Problems Mains Voltage

1. Input is always ON (or Signal Present)
2. Input is always OFF (or Signal Absent)
3. Input is intermittent.

Check that the Signal is being applied or not applied as the case may be, to the input terminals on the controller. By measuring at the controller terminals with a voltmeter. If a disagreement is found then substitute the controller.

Relay outputs.

Problems

1. Relay is always ON (or Energised)
2. Relay is always OFF (or De-energised)

To check out relay circuits use the TEST mode on the controller to force the relay to On and Off positions. Measure the switched voltage at the output terminal, this should follow the required action. (Providing that the supply is present at the common terminal). If disagreement is found then substitute the controller. Note however that most relay failures are caused by an overload current, so it's likely that a further fault may exist. This should be investigated and rectified first.

Solid State outputs.

A solid state output (or relay) normally switches an AC voltage, either at mains level (110/240 V ac) or a lower AC voltage derived from a transformer (often 24 V ac). It has a common terminal for its supply voltage and an output terminal for the load. In normal operation it behaves in a similar manner to an electromechanical relay (Only it can switch on and off faster).

Problems

1. Relay is always ON (or Energised)
2. Relay is always OFF (or De-energised)

To check out relay circuits use the TEST mode on the controller to force the relay to On and Off positions. Measure the switched voltage at the output terminal, this should follow the required action. (Providing that the supply is present at the common terminal). If disagreement is found then substitute the controller. Note however that most relay failures are caused by an overload current, so it's likely that a further fault may exist. This should be investigated and rectified first.

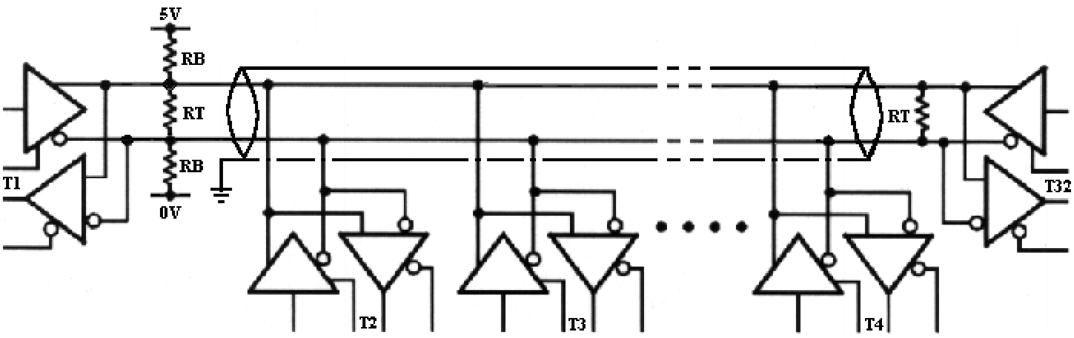
IMPORTANT NOTE

Solid state relays will always leak some current from Input to Output when in the OFF mode.

If the load is connected then this current will be absorbed and the voltage appears at the output terminal. However if the load is not present (eg an open circuit valve coil), then almost the full supply voltage will appear at the output terminal when measured by a meter. This is correct but can be misleading.

RS 485 Communication networks.

In its simplest form, RS485 is a bi-directional half duplex bus comprising a transceiver (driver and receiver) located at either end, and along a twisted pair cable.
RS485 allows for connection of up to 32 transceivers.
The bus is Terminated at each end, typically with 100 ohm resistors (RT)
The bus is Biased at one end, typically with 1000 ohm resistors (RB)
Networks used in refrigeration applications, Usually work on a master / slave principle, that is one point asks questions (central terminal) and many points reply with answers (controllers).
The questions are directed to the correct controller by means of an **address.**



Problems

No communications Single unit.

If a single unit does not communicate, then check its connection to the network and its settings (address, data rate, data format) also verify that the central system is actually requesting data from it. If all true then substitute the controller.

No communications Multiple units.

Multiple units failing to communicate can be caused by incorrect addressing (clashes)
Also since large systems may have multiple bus wiring, (the bus split into 5 or 8 highway sections), it is possible that all units on one cable run may appear to fail simultaneously. This is most likely a failure of a single unit (eg Stuck in transmit) that affects all others on the run. Test by disconnecting all and reconnecting one at a time.

No communications All units.

If total communication is lost (again this can be caused by failure of a single unit) it is best approached by starting at the Central unit and (assuming all setup data is correct) Re-building the network at a segment or unit level. Until the offending unit is located.

Sporadic operation

Sporadic operation can be caused by a faulty unit but more likely it is a bad connection, cable screen fault, or missing termination.

USEFUL TIP

If the data communication from the central unit is stopped (power still maintained)
The RS485 system will become a DC network with the A wire biased about 100 mV above the B wire, a failed unit will often upset this balance. By disconnecting a unit and measuring the voltage across the network pair a fault can be spotted at source.