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Application Engineering

COPELAND

B U L L E T I N

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Application Guidelines for ZF*K5E & ZB*K5E Copeland Scroll™
K5 Compressors for Refrigeration 8-17 HP with CoreSense™ Diagnostics

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Revision Tracking R15

Pg. 9   Capacity data was updated and ZF54E model was added in "**ARI Low Temperature Ratings"** table.

Pg. 11   Reference to Emerson Climate Technologies Representative was changed to Emerson Application Engineer.

Pg. 28 Copeland Scroll K5 compressor figure changed. New figure shows EXV main option for liquid injection.

Safety Instructions

Copeland Scroll™ compressors with CoreSense™ Diagnostics are manufactured according to the latest U.S. and European Safety Standards. Particular emphasis has been placed on the user's safety. Safety icons are explained below and safety instructions applicable to the products in this bulletin are grouped on Page 3. These instructions should be retained throughout the lifetime of the compressor. **You are strongly advised to follow these safety instructions.**

Safety Icon Explanation

⚠ **DANGER** **DANGER** indicates a hazardous situation which, if not avoided, will result in death or serious injury.

⚠ **WARNING** **WARNING** indicates a hazardous situation which, if not avoided, could result in death or serious injury.

⚠ **CAUTION** **CAUTION,** used with the safety alert symbol, indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

NOTICE **NOTICE** is used to address practices not related to personal injury.

CAUTION **CAUTION,** without the safety alert symbol, is used to address practices not related to personal injury.

🔥 **FLAMMABLE** **FLAMMABLE**

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Instructions Pertaining to Risk of Electrical Shock, Fire, or Injury to Persons

⚠ WARNING	ELECTRICAL SHOCK HAZARD • Disconnect and lock out power before servicing. • Discharge all capacitors before servicing. • Use compressor with grounded system only. • Molded electrical plug must be used when required. • Refer to original equipment wiring diagrams. • Electrical connections must be made by qualified electrical personnel. • Failure to follow these warnings could result in serious personal injury.
⚠ WARNING	PRESSURIZED SYSTEM HAZARD • System contains refrigerant and oil under pressure. • Remove refrigerant from both the high and low compressor side before removing compressor. • Never install a system and leave it unattended when it has no charge, a holding charge, or with the service valves closed without electrically locking out the system. • Use only approved refrigerants and refrigeration oils. • Personal safety equipment must be used. • Failure to follow these warnings could result in serious personal injury.
⚠ WARNING	BURN HAZARD • Do not touch the compressor until it has cooled down. • Ensure that materials and wiring do not touch high temperature areas of the compressor. • Use caution when brazing system components. • Personal safety equipment must be used. • Failure to follow these warnings could result in serious personal injury or property damage.
⚠ CAUTION	COMPRESSOR HANDLING • Use the appropriate lifting devices to move compressors. • Personal safety equipment must be used. • Failure to follow these warnings could result in personal injury or property damage.

Safety Statements

• Refrigerant compressors must be employed only for their intended use.

• Only qualified and authorized HVAC or refrigeration personnel are permitted to install commission and maintain this equipment.

• Electrical connections must be made by qualified electrical personnel.

• All valid standards and codes for installing, servicing, and maintaining electrical and refrigeration equipment must be observed.

Introduction

The Copeland Scroll™ refrigeration compressor product offering has developed the K5 compressor for the 8 to 17 HP size range. The scope of this bulletin will cover the application parameters unique to the ZB*K5E and ZF*K5E refrigeration scrolls with CoreSense™ technology.

A new CoreSense Diagnostics module with digital capacity control and EXV injection control has been added on all K5 compressors with the part number (543-0209-00/998-0340-00). To see differences between the old vs new module please see Figure 38.

Nomenclature

The Copeland Scroll compressor model numbers include the nominal capacity at the standard 60 Hertz "ARI" rating conditions with R-404A refrigerant.

Example
ZBD76K5E-TFD-260

Z	= Copeland Scroll
B	= Application (B: Medium Temperature, F: Low Temperature)
D	= Digital Capacity
76K	= Nominal Capacity (kBTU/hr)
5	= Model Variation Identifier for the K5 refrigeration scroll
E	= Oil Type (POE)
TFD	= Motor Version
260	= Bill of Materials

Approved Refrigerants

Application	Model Number	HP	Approved Refrigerants
Low Temperature	ZF34K5E	10	R-22, R-404A, R-407A/C, R-407F, R-448A, R-449A, R-507
	ZF41K5E	13	
	ZFD41K5E	13	
	ZF49K5E	15	
	ZF54K5E	17	
Medium Temperature	ZB58K5E	8	R-22, R-134a, R-404A, R-407A/C, R-407F, R-448A, R-449A, R-507
	ZB66K5E	9	
	ZB76K5E	10	
	ZBD76K5E	10	
	ZB95K5E	13	
	ZB114K5E	15	
	ZBD114K5E	15	

NOTE: For the latest approved refrigerants and lubricants, refer to Form 93-11, Emerson Accepted Refrigerants/Lubricants, or contact your Application Engineer.

NOTE: The ZB*K5 compressors are each applicable with R-134a, however, Emerson Climate Technologies has released the ZB*K5B series for optimum performance for lower R-134a-like pressures. Performance is based on ARI conditions. 20 °F evap. 120 °F condensing. See the following table for specific model numbers.

Optimized R-134a ZB*K5B Compressors

Model	Hertz	Voltage
ZB47K5B-TFD	60	460
	50	380/420
ZB68K5B-TFD	60	460
	50	380/420

⚠ **CAUTION**

POE must be handled carefully and the proper protective equipment (gloves, eye protection, etc.) must be used when handling POE lubricant. POE must not come into contact with any surface or material that might be harmed by POE, including without limitation, certain polymers (e.g. PVC/CPVC and polycarbonate).

Medium Temperature Digital Compressor Operation

The digital scroll is capable of seamlessly modulating its capacity from 10% to 100%. A normally closed (de-energized) solenoid valve is a key component for achieving modulation. When the solenoid valve is in its normally closed position, the compressor operates at full capacity, or loaded state. When the solenoid valve is energized, the two scroll elements move apart axially, or into the unloaded state. The solenoid coil must be controlled by the same voltage that is powering the CoreSense Diagnostic module. During the unloaded state, the compressor motor continues running, but since the scrolls are separated, there is no compression. During the loaded state, the compressor delivers 100% capacity and during the unloaded state, the compressor delivers 0% capacity. A cycle consists of one loaded state and one unloaded state. By varying the time of the loaded state and the unloaded state, an average capacity is obtained. The lowest achievable capacity is

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10% which equates to 2 seconds of pumping during one 20 second cycle.

An example for the 20 second controller cycle: In any 20 second cycle, if the loaded time is 10 seconds and the unloaded time is 10 seconds, the average capacity is 50%, or if the loaded time is 5 seconds and the unloaded time is 15 seconds the capacity during that 20 second period is 25%. See Figure 39 for a graphical representation of the digital cycle, and Figure 40 and Figure 41 for a graph showing solenoid on-time vs. compressor capacity.

Medium Temperature Digital operation is controlled by the CoreSense Diagnostics module and has a patented algorithm that allows the compressor to run at 10%. If the compressor's discharge line temperature rises at a high rate of change over time the CoreSense Diagnostics module will increase the compressor capacity until discharge line temperature is at a safe operating temperature. To operate with a 10% minimum capacity please confirm that DIP switch 1 (EXV) in the top left corner on the CoreSense Diagnostics module (See Figure 38) IS IN THE OFF POSITON. For correct DIP switch settings please see Figure 43.

Low Temp Digital Compressor Operation

Due to lower mass flows the low temperature digital compressor operation is restricted to 30%-100%. By restricting to 30% minimum capacity this ensures enough mass flow to the compressor for safe operation. To operate with a 30% minimum capacity Please confirm that DIP switch 1 on the digital and EXV DIP switches in the top left corner on the CoreSense Diagnostics Module (See Figure 38) IS IN THE ON POSITON. For correct DIP switch settings please see Figure 44.

A normally closed (de-energized) solenoid valve is a key component for achieving modulation. When the solenoid valve is in its normally closed position, the compressor operates at full capacity, or loaded state. When the solenoid valve is energized, the two scroll elements move apart axially, or into the unloaded state. The Solenoid coil must be controlled by the same voltage that is powering the CoreSense Diagnostic module. During the unloaded state, the compressor

motor continues running, but since the scrolls are separated, there is no compression. During the loaded state, the compressor delivers 100% capacity and during the unloaded state, the compressor delivers 0% capacity. A cycle consists of one loaded state and one unloaded state. By varying the time of the loaded state and the unloaded state, an average capacity is obtained. The lowest achievable capacity is 30% which equates to 6 seconds of pumping during one 20 second cycle.

An example for the 20 second controller cycle: In any 20 second cycle, if the loaded time is 10 seconds and the unloaded time is 10 seconds, the average capacity is 50%, or if the loaded time is 6 seconds and the unloaded time is 14 seconds the capacity during that 20 second period is 30%. See Figure 39 for a graphical representation of the digital cycle, and Figure 41 for a graph showing solenoid on-time vs. compressor capacity.

How it Works

The digital scroll compressor unloads by taking advantage of the Copeland Scroll compressor's axial compliance. All Copeland Scroll compressors are designed so that the compression elements can separate axially. See Figure 39 for internal view.

The digital solenoid can be controlled two ways with the CoreSense Diagnostics module:

1. Through a 1-5v signal. For tables of digital capacity (%) vs. analog input (v) see Tables 7A and 7B

2. Via mod-bus communication

The 8.0 HP and larger digital scroll compressors employ a solenoid valve that is mounted on the side of the compressor that vents the intermediate cavity to the low side of the compressor during the unloaded state. During the loaded state, the solenoid valve is de-energized and the intermediate cavity is pressurized to load the floating seal and scrolls axially.

Operating Envelope

Operating envelopes for the K5 compressors for refrigeration are depicted in Figure 2 through Figure 14.

Extended ZF*K5E Operating Envelope

Figure 10 presents an extended envelope for the ZF*K5E scroll. While this product is optimized for a low temperature application, in some instances the ZF*K5E, either with vapor injection or no injection at all, can be applied in a medium temperature application. This may be done to use common model numbers in a system or to apply vapor injection for additional cooling capacity.

When applying with vapor injection, it should be noted that the total amount of internal subcooling is limited by the injection pressure at the compressor. In medium temperature operation, this value is typically higher than when a ZFK5 is applied at low temperature and therefore the minimum subcooled liquid temperature allowable exiting the economizer is higher (depending on the refrigerant this may be as high as 75°F). Refer to Emerson's Product Selection Software for estimated values by compressor model.

NOTE: If applying without vapor injection the injection port should be plugged. The vapor injection fitting is a Rotalock design with a 1" x 14 rotalock thread size, the fitting can be capped using the rotalock to stub tube adaptor kit # 998-0034-18. A ½" copper line can be inserted into the stub end of the adaptor and sealed off. The rotalock adaptor with the supplied Teflon seal will effectively seal the port and will not damage the fitting or the compressor.

ZF*K5E Low Temperature K5 Compressors for Refrigeration

The low temperature models are provided with an injection port that can be used for either liquid or vapor injection.

Liquid Injection

When using the ZF*K5E scrolls for liquid injection operation, a discharge temperature control (DTC) valve or an EXV (Electronic Expansion Valve) must be applied. The purpose of the DTC/EXV valve is to eliminate the need for a standard capillary tube. The DTC/EXV valve is approved for all refrigerants in this product range. A DTC/EXV valve must also be used for ZF**K5E applications with R-407A, R-407C, R-407F, R-448A and R-449A with vapor injection via a special T-

fitting adapter. Further details and part numbers related to the DTC/EXV valve are listed in Table 1 at the end of this bulletin.

DTC Valve Specifications

The following components are not required, but they are recommended for liquid injection.

Sight Glass - A sight glass can be installed before the DTC valve to allow for visual inspection for the presence of liquid refrigerant.

Filter/Drier - A filter/drier can be installed upstream of the injection circuit to avoid the possibility of the DTC screen blockage due to contaminants.

Figure 20 a representation of typical systems, depicting the location of these components.

Installation of DTC Valve

The valve bulb must be installed in the top cap thermal well to adequately control scroll temperatures. The valve should be tightened on the injection fitting to a torque of 216-245 in. lbs. (24.4 - 27.7 Nm). A 90° orientation on the valve is recommended, however it will function properly in any orientation. The capillary tube connecting the valve to the bulb should be positioned such that it does not contact the compressor during operation. Do not bend the capillary tube within 1" (25.4mm) of the valve.

The DTC valve comes with an insulating cap. If this additional height from the cap is an issue, the valve cap could be replaced with high temperature insulation. This should be applied to insulate and protect the valves remote bulb assembly. This will reduce the total height requirement by 0.5" (12.7mm).

Suggested Application Techniques for All Liquid Injection Applications

For the most efficient thermal sensing, spread a thin film of thermal grease around the DTC valve bulb/thermistor before installing into the top cap well. However, for proper functioning of the valve this is not required.
For service purposes, a mechanical ball valve (not provided by Emerson) is also recommended in the liquid and vapor injection line. For the liquid injection system

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to be effective, a minimum of 5°F subcooled liquid at the at the DTC/EXV inlet is required.

NOTE: To ensure adequate temperature control, take care to not damage the DTC valve bulb/thermistor when installing. Damage of DTC valve bulb/thermistor could result in improper injection.

EXV Valve Specifications

The EXV valve is a 12 VDC stepper valve. It has 500 steps from fully open to fully closed. It consumes 6 watts of power. It is controlled via the CoreSense module. It adjusts open and closed based off the temperature read from the Top cap thermistor.

The following components are not required, but they are recommended for liquid injection.

Sight Glass - A sight glass can be installed before the EXV valve to allow for visual inspection for the presence of liquid refrigerant.

Filter/Drier - A filter/drier can be installed upstream of the injection circuit to avoid the possibility of the EXV screen blockage due to contaminants.

EXV Installation

The EXV valve is to be installed vertically with stepper motor locked into position. See Figure 42 for correct orientation. To ensure the valve has the proper mounting, calibration and control, only the Emerson supplied stepper valve (P/N 998-0340-00) should be used with CoreSense Diagnostics for Copeland Scroll K5 refrigeration compressors. See Table 5 for a detailed list of parts included on this kit.

NOTE: When using an EXV stepper valve a liquid line shutoff solenoid will need to be installed on the liquid line. This is in the event of a power loss that will leave the EXV motor in its current position and potentially allow liquid to enter the compressor while off. A vapor line shut off may be needed in the event of a motor protection trip where the control circuit is not opened. It is recommended to use a current sensing relay to ensure that liquid line solenoid is to be closed when compressor is off.

Vapor Injection

The ZF*K5E 8-17 HP scroll compressors can also be applied with vapor injection by implementing an economizer circuit in the system. Economizing is accomplished by utilizing a subcooling circuit similar to that shown in Figure 19 at the end of this bulletin. This mode of operation increases the refrigeration capacity and in turn the efficiency of the system.

The schematic shows a system configuration for the economizer cycle. A heat exchanger is used to provide subcooling to the refrigerant (HX) before it enters the evaporator. This subcooling process provides the increased capacity gain for the system, as described above. During the subcooling process a small amount of refrigerant is evaporated and superheated. This superheated refrigerant is then injected into the mid compression cycle of the scroll compressor and compressed to discharge pressure. This injected vapor also provides cooling at higher compression ratios, similar to liquid injection of standard ZF scroll compressors. The benefits provided will increase as the compression ratio increases, thus, more gains will be made in summer when increased capacity may actually be required.

An example of the additional capacity available when using vapor injection is depicted in the following table.

ARI Low Temperature Ratings (-25°F/105°F, R-404A)		
Model	With EVI*	Without EVI*
ZF34K5E	47,300 Btu/hr	32,000 Btu/hr
ZF41K5E	58,500 Btu/hr	40,200 Btu/hr
ZFD41K5E	58,500 Btu/hr	40,200 Btu/hr
ZF49K5E	66,500 Btu/hr	48,000 Btu/hr
ZF54K5E	75,500 Btu/hr	54,100 Btu/hr

* Maximum possible subcooling
* Without EVI is "0" subcooling

NOTE: For performance of ZF*K5E models with other refrigerants, refer to the Online Product Information at Emerson.com.

Discharge Temperature Control with Vapor Injection

Although using vapor injection offers some inherent compressor cooling, when using the ZF*K5E scrolls with R-407A/C/F or R-448A/R-449A and vapor injection

additional cooling is required to operate across the whole operating map of the compressor. To provide this extra cooling a T-fitting and DTC or EXV valve should be installed onto the compressor's injection port. The T-fitting will meter liquid from the DTC or EXV valve into one side of the fitting, while vapor flows in through the other side. See Figure 21 at the end of this bulletin for an example schematic. This is different than the current method used on other Copeland vapor injected scrolls (ZF*KVE models) which use the Copeland Demand Cooling to inject liquid in the vapor line of the compressor based on a discharge line temperature reading.

NOTE: Just as with liquid injection operation, when using the DTC valve with vapor injection ensure that the thermal bulb and discharge thermistor are well insulated.

When using vapor injection with R-404A/R-507, the DTC/EXV valve and T-fitting are not required. A discharge line thermistor is supplied with the CoreSense Diagnostics assembly (more information on CoreSense Diagnostics is found later in this bulletin). The thermistor should be placed no more than 6 inches (15.2 cm) from the discharge of the compressor. Only when using DTC valve, the thermistor should be well insulated to ensure accurate temperature sensing on the discharge line.

System Configuration

There are two methods of controlling refrigerant flow at the EVI heat exchanger - downstream and upstream extraction.

Downstream Extraction

The downstream extraction is the preferred method employed in the United States. In downstream extraction, the TXV is placed between the liquid outlet and vapor inlet of the heat exchanger. The advantage of downstream extraction is that subcooling is ensured because the liquid is further subcooled as it flows through the heat exchanger. Therefore, more subcooled liquid enters the TXV which increases the probability that the valve will not hunt. The disadvantage with this method is that it is not as efficient as the upstream method; however, the difference is too small for practical purposes. See Figure 21.

Upstream Extraction

In upstream extraction, the TXV is placed between the condenser and the heat exchanger. The TXV regulates the flow of subcooled refrigerant out of the condenser and into the heat exchanger. With this type of configuration there is a potential for flash gas which would cause the valve to hunt. See Figure 22.

Heat Exchanger Piping Arrangements

Best subcooling effect is assured if counter flow of gas and liquid is provided as shown (see Figure 23). In order to guarantee optimum heat transfer, the plate heat exchanger should be mounted vertically and vapor should exit it at the top.

For more information on applying ZF*K5E scrolls with an economized vapor injection (EVI) circuit refer to **AE4-1327**.

Accumulator Requirements

Due to the Copeland Scroll compressor's inherent ability to handle liquid refrigerant in flooded start and defrost operation conditions, accumulators may not be required. An accumulator is required on single compressor systems with refrigerant charges over 17 lbs. On systems with defrost schemes or transient operations that allow prolonged, uncontrolled liquid return to the compressor, an accumulator is required unless a suction header of sufficient volume is used to prevent liquid migration to the compressor.

Superheat Requirements

In order to assure that liquid refrigerant does not return to the compressor during the running cycle, attention must be given to maintaining proper superheat at the compressor suction inlet. Emerson recommends a minimum of 20°F (11°C) superheat, measured on the suction line 6 inches (152mm) from the suction valve, to prevent liquid refrigerant floodback.

Another method to determine if liquid refrigerant is returning to the compressor is to accurately measure the temperature difference between the compressor oil crankcase and the suction line. During continuous operation, we recommend that this difference be a minimum of 50°F (27°C). This "crankcase differential temperature" requirement supersedes the minimum

suction superheat requirement in the last paragraph. To measure oil temperature through the compressor shell, place a thermocouple on the bottom center (not the side) of the compressor shell and insulate from the ambient.

During rapid system changes, such as defrost or ice harvest cycles, this temperature difference may drop rapidly for a short period of time. When the crankcase temperature difference falls below the recommended 50°F (27°C), our recommendation is the duration should not exceed a maximum (continuous) time period of two minutes and should not go lower than a 25°F (14°C) difference.

Contact your Emerson Application Engineer regarding any exceptions to the above requirements.

Crankcase Heater

Crankcase heaters are required, on outdoor systems, when the system charge exceeds 17 lbs.

Table 2 includes crankcase heaters intended for use only where there is limited access. The heaters are not equipped for use with electrical conduit. Where applicable electrical safety codes require heater lead protection, a crankcase heater terminal box should be used. Recommended crankcase heater terminal cover and box numbers are also listed in Table 2 If there are any questions concerning the application, contact Application Engineering.

Pressure Controls

Both high and low pressure controls are required. The minimum and maximum pressure setpoints are shown in Table 4.

IPR Valve

There is no internal pressure relief valve in these larger horsepower scrolls. Therefore, a high pressure control located prior to any shut-off valves is mandatory. There is an access port located on the compressor discharge rotalock fitting to accommodate this control.

Motor Protection

Motor protection in the K5 compressor for refrigeration is either by internal line break (ILB) or solid state protection with positive temperature coefficient (PTC) sensors. The type of motor protection is based on the

compressor motor version. An "F" in the second character indicates line break while a "W" indicates PTC protection. For example, a ZF34K5E-T<u>F</u>C has ILB and a ZB95K5E-T<u>W</u>C uses PTC sensors.

PTC Motor Protection

There are four PTC (Positive Temperature Coefficient) internal thermistors connected in series that react with avalanching resistance in the event of high temperatures. The thermistors are used to sense motor temperatures. The thermistor circuit is connected to the protector module terminals S1 and S2. When any thermistor reaches a limiting value, the module interrupts the control circuit and shuts off the compressor. After the thermistor has cooled sufficiently, it will reset. However, the module has a 30 minutes time delay before reset after a thermistor trip.

Programmable Logic Controller Requirements

If the INT69 (071-0660-00) module is applied in conjunction with a Programmable Logic Controller, it is important that a minimum load is carried through the M1-M2 control circuit contacts.

The minimum required current through the module relay contacts needs to be greater than 100 milliamps but not to exceed 5 amps. If this minimum current is not maintained, this has a detrimental effect upon the long-term contact resistance of the relay and may result in false compressor trips.

PLC operated control circuits may not always provide this minimum current. In these cases, modifications to the PLC control circuit are required. Consult your Application Engineering Department for details.

Kriwan INT69 Module and Sensor Functional Check

Module specifications are listed in Table 3 at the end of this bulletin. Refer to Figure 27 and Figure 28 for wiring schematic. The following field troubleshooting procedure can be used to evaluate the solid state control circuit:

Motor Protector Module Voltage Supply Troubleshooting

- Verify that all wire connectors are maintaining a good mechanical connection. Replace any

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connectors that are loose.

- Measure the voltage across T1-T2 to ensure proper supply voltage.

- Determine the control voltage by using a voltmeter and then measure the voltage across the M1-M2 contacts:

  a) If the measured voltage is equal to the control volts then the M1-M2 contacts are open.
  b) If the measurement is less than 1 volt and the compressor is not running, then the problem is external to the motor protector module.
  c) If the voltage is greater than 1 volt but less than the control voltage, the motor protector module is faulty and should be replaced.

Sensor Troubleshooting

- Remove the leads from S1-S2, and then by using an Ohmmeter to measure the resistance of the incoming leads.

CAUTION

Use an ohmmeter with a maximum of 9 VDC for checking – do not attempt to check continuity through the sensors with any other type of instrument. Any external voltage or current may cause damage requiring compressor replacement.

  a) During normal operation, this resistance value should read less than 4500 ohms ±20%.
  b) If the M1-M2 contacts are open, the measured S1-S2 value is above 2750 ohms ±20% and the compressor has been tripped less then 30 minutes then the module is functioning properly.

- If the S1-S2 wire leads read less than 2750 ohms ±20% and the M1-M2 contacts are open, reset the module by removing the power to T1-T2 for a minimum of 5 seconds.

- Replace all wire leads and use a voltmeter to verify the M1-M2 contacts are closed.

- If the M1-M2 contacts remain open and S1-S2 are less than 2500 ohms, remove leads from the S1-S2 contacts and jumper together, using a 100 ohm resistor.

CAUTION

Compressor should start at this time. HOWEVER, DO NOT LEAVE JUMPER IN PLACE FOR NORMAL SYSTEM OPERATIONS. THE JUMPER IS USED FOR DIAGNOSTIC PURPOSES ONLY.

Compressor Voltage Supply Troubleshooting

- Remove phase sensing leads from the module from L1/L2/L3.

- Use a voltmeter to measure the incoming 3 phase voltage on L1/L2/L3. WARNING: L1/L2/L3 could be at a potential up to 600VAC.

- Ensure proper voltage on each phase.

- Remove power to the module for a minimum of 5 seconds to reset and replace all wire leads. Re-energize the module. If the M1-M2 contacts are open with proper voltage to T1-T2, L1/L2/L3 and proper resistance to S1-S2 then the module is faulty and should be replaced.

Oil Management for Rack Applications

Copeland Scroll K5 refrigeration compressors may be used on multiple compressor parallel rack applications. This requires the use of an oil management system to maintain proper oil level in each compressor crankcase. The sight glass connection supplied can accommodate the mounting of the oil control devices.

Unlike semi-hermetic compressors, scroll compressors do not have an oil pump with accompanying oil pressure safety controls. Therefore, an external oil level control is required.

The OMB oil level management control combines the functions of level control and timed compressor shut-off should the level not come back to normal within a set period of time. This device has been found to provide excellent performance in field tests on scroll compressors and is recommended for parallel system applications. Refer to Table 4 for oil monitoring accessory part numbers.

Immediately after system start-up the oil reservoir level will fluctuate until equilibrium is reached. It is advisable to monitor the oil level during this time to assure sufficient oil is available. This will prevent unnecessary trips of the oil control system. Additional information on oil management in Copeland Scroll compressors can

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be found in Application Engineering bulletin **AE17-1320**.

Discharge Mufflers

Gas flow through scroll compressors is continuous with relatively low pulsation. External mufflers applied to piston compressors may not be required on Copeland Scroll compressors. Due to system variability, individual tests should be conducted by the system manufacturer to verify acceptable levels of sound and vibration.

Compressor Mounting

Compressor mounting must be selected based on application. Consideration must be given to sound reduction and tubing reliability. Some tubing geometry or "shock loops" may be required to reduce vibration transferred from the compressor to external tubing. Mounting kit part numbers are listed in Table 4.

Mounting for Rack Systems – Specially designed steel spacers and rubber isolator pads are available for Copeland Scroll 8 -17 HP rack applications. This mounting arrangement limits the compressors motion thereby minimizing potential problems of excessive tubing stress. Sufficient isolation is provided to prevent vibration from being transmitted to the mounting structure. This mounting arrangement is recommended for multiple compressor rack installations. See **Figure 24** for a detail of this mounting system.

Condensing Units – For 8 -17 HP Copeland Scroll condensing unit applications applying the ZB95/114 and ZF49/54, standard mounts (55-65 durometer) are recommended (kit # 527-0210-00) **Figure 25**.

For condensing units applying the ZB58/66 /ZB(D)76 and ZF34/ZF(D)41 the softer mounts (35-45 durometer) mounts are recommended. (Kit # 527-0116-00) **Figure 26**.

Tubing Considerations – Proper tube design must be taken into consideration when designing the tubing connecting the scroll to the remaining system. The tubing should provide enough "flexibility" to allow normal starting and stopping of the compressor without exerting excessive stress on the tube joints. In addition, it is desirable to design tubing with a natural frequency away from the normal running frequency of the compressor. Failure to do this can result in tube resonance and unacceptable tubing life. Figure 15 is an example of an acceptable tubing configuration.

CAUTION

These examples are intended only as guidelines to depict the need for flexibility in tube designs. In order to properly determine if a design is appropriate for a given application, samples should be tested and evaluated for stress under various conditions of use including voltage, frequency, and load fluctuations, and shipping vibration. The guidelines above may be helpful; however, testing should be performed for each system designed.

Connection Fittings, Service Valves, and Adapters

The fitting sizes for 8 through 17 HP scroll compressors are shown in Table 5.

Deep Vacuum Operation

⚠ WARNING

Do not run a Copeland Scroll compressor in a deep vacuum. Failure to heed this advice can result in arcing of the Fusite pins and permanent damage to the compressor.

A low pressure control is required for protection against deep vacuum operation. See *Pressure Control* section for proper set points. (Table 6)

Scroll compressors (as with any refrigerant compressor) should never be used to evacuate a refrigeration or air conditioning system. See **AE24-1105** for proper system evacuation procedures.

Unbrazing System Components

If the refrigerant charge is removed from a scroll unit by bleeding the high side only, it is sometimes possible for the scrolls to seal, preventing pressure equalization through the compressor. This may leave the low side shell and suction line tubing pressurized. If a brazing torch is then applied to the low side, the pressurized refrigerant and oil mixture could ignite as it escapes and contacts the brazing flame. It is important to check both the high and low sides with manifold gauges before unbrazing or in the case of assembly line repair, remove refrigerant from both the high and low sides. Instructions should be provided in appropriate product literature and assembly (line repair) areas.

High Potential (Hipot) Testing

Many Copeland™ compressors are configured with the motor below the compressor. As a result, when liquid

refrigerant is within the compressor shell the motor can be immersed in liquid refrigerant to a greater extent than with compressors with the motor mounted above the compressor. When Copeland compressors are hipot tested and liquid refrigerant is in the shell, they can show higher levels of leakage current than compressors with the motor on top because of the higher electrical conductivity of liquid refrigerant than refrigerant vapor and oil. This phenomenon can occur with any compressor when the motor is immersed in refrigerant. The level of current leakage does not present any safety issue. To lower the current leakage reading, the system should be operated for a brief period of time to redistribute the refrigerant to a more normal configuration and the system hipot tested again. See bulletin AE4-1294 for megohm testing recommendations. Under no circumstances should the Hipot or Megohm test be performed while the compressor is under a vacuum.

NOTE: The solid state electronic module components and internal sensors are delicate and can be damaged by exposure to high voltage. Under no circumstances should a high potential test be made at the sensor terminals or sensor leads connected to the module. Damage to the sensors or module may result.

Three Phase Scroll Compressors – Directional Dependence

Scroll compressors are directional dependent; i.e. they will compress in one rotational direction only. Three phase scrolls will rotate in either direction depending on power phasing. Since there is a 50/50 chance of connected power being "backwards", contractors should be warned of this. Appropriate instructions or notices should be provided by the OEM.

Verification of proper rotation can be made by observing that the suction pressure drops and the discharge pressure rises when the compressor is energized.

No time delay is required on three phase models to prevent reverse rotation due to brief power interruptions. The CoreSense module will provide reverse rotation protection.

Copeland Scroll Compressor Functional Check

Copeland Scroll compressors do not have internal suction valves. It is not necessary to perform functional

compressor tests to check how the compressor will pull suction pressure. This type of test may damage a scroll compressor. The following diagnostic procedure should be used to evaluate whether a Copeland Scroll compressor is functioning properly.

1. Verify proper unit voltage.

2. Normal motor winding continuity and short to ground checks can be used to determine proper motor resistance or if an internal short to ground has developed.

3. With service gauges connected to the suction and discharge pressure fittings, turn on the compressor. If suction pressure falls below normal levels the system is either low on charge or there is a flow blockage.

4. If the suction pressure does not drop and the discharge pressure does not rise, reverse any two of the compressor power leads and reapply power to verify the compressor was not wired to run in the reverse direction.

The operational compressor current draw should be compared to published performance curves at the operating conditions (pressures and voltages). Significant deviation (± 15%) from published values may indicate a faulty compressor.

CoreSense Diagnostics™ Module for Refrigeration Compressors

The CoreSense Diagnostics module (see Figure 38) for Copeland Scroll refrigeration compressors (referred to as "the CoreSense module" in this document) is a breakthrough innovation for troubleshooting refrigeration system faults.

New K5E compressors come with a new CoreSense module version (part number 543-0209-**), but some compressors in the field may still have the old module version (part number 543-0174-**). The difference between old and new version is the addition of the new Digital compressor control and EXV control. The new module can be identified by location of terminals: M1, M2 and L1,L2; new module has M1 and M2 terminal located at left side (front view). See Figure 38 for more details.

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The CoreSense module is installed in the electrical box of all 8-17 HP K5 refrigeration scroll compressors. By monitoring and analyzing data from the Copeland compressors via module power, discharge line thermistor, and the current transducer (referred to as "CT" in this document), the CoreSense module can accurately detect the cause of electrical and system related issues. A flashing LED indicator communicates the alert code and guides the service technician more quickly and accurately to the root cause of a problem.

The CoreSense module can provide both compressor protection and lockout capability. Compressor protection means that the CoreSense module will trip the compressor when any of the following severe alert conditions (Codes 1, 2, 4, 6, 7 or 9) are detected. A trip condition is when the protector on a compressor opens and stops current flow into the compressor motor. As a result, the compressor shuts down. A trip condition will reset after short cycle time and when trip condition is not present.

If lockout is enabled and a preset number of alarm events happen, the CoreSense module will not allow the compressor to start (Codes 1, 4, 6 or 7) until the situation is corrected and the module is manually reset. The module can be reset by cycling power to the module.

CORESENSE MODULE LED OVERVIEW

CoreSense Diagnostics™ Module for Refrigeration Compressors with Digital and EXV Capability.

The CoreSense module has the ability to shut down the compressor if the compressor contactor coil is wired through the M1-M2 relay.

The LEDs will flash a number of times consecutively, pause and then repeat the process. To identify an alert code number, count the number of consecutive flashes. Detailed descriptions of specific alert codes are shown in Table 8.

The CoreSense module will continue to display the alert code until the condition returns to normal or if module power is cycled to the device.

Yellow LED:

FLASHING: Alerts of an abnormal system condition via Alert Codes

SOLID: Demand is present but no current is detected. All protective shutdowns will auto reset in their allotted time

Red LED:

FLASHING: Indicates the CoreSense module is locked out on the flashing Alert Code. Manual power cycle reset is required to restart the compressor

Green LED:

FLASHING: Alert Codes that do NOT have a protective shutdown associated with them.

Blue LED:

Flashing indicates alert codes for Digital only. Alert Codes that do NOT have a protective shutdown associated with them. A solid Blue LED represents compressor unloaded.

Some troubleshooting tips for the CoreSense module are listed in Table 9 at the end of this document.

Product Specifications

Operating Temp: -40° to 150°F (-40° to 65°C)
Storage Temp: -40° to 175°F (-40° to 80°C)
Power Supply Range: 85-265VAC, 50-60 Hz
Working amperage for CT module: 3-200A

NOTE: The CoreSense module is not accurate below 3 Amps. If the current drawn by the compressor during operation falls below 3 Amps, the module may indicate a nuisance fault condition and alarm.

In low current application, it is applicable to loop the power leads through the current sensor twice to double the current value the sensor reads and eliminate the low current nuisance trips.

NOTE: The 2X current reading may need to be addressed at the system or rack controller.

The CoreSense module connections are standard male electrical flag terminals.

Maximum continuous contactor coil current is 2A with a max inrush current of 20A.

Compressor Lead Wiring

The compressor leads must be routed through the holes in the CT module marked T1, T2, and T3. Only the compressor lead wires should be placed through the CT module.

CoreSense Module Mounting

The CoreSense module will come pre-mounted inside the compressor terminal box. The module is mounted so all LEDs are in front of the light pipes in the terminal covers so codes are visible when the terminal box cover is installed on the terminal box. The CoreSense module should be installed inside the terminal box with a torque of 8 inch pounds.

110-230VAC CoreSense Module Power Wiring

The CoreSense module requires 110-230VAC power between to the L1 and L2 terminals. The module should remain powered through all states of compressor on/off operation. Refer to wiring schematic examples.

Demand Wiring for (543-0174-**)

The CoreSense module requires a demand signal to operate properly. The demand signal input, labeled D on the module, should always be connected to the compressor demand so that the demand signal input is 110 or 220VAC with respect to L2.

See Figure 27 for proper wiring diagrams. Choose the appropriate diagram depending on how the demand signal will be fed to the module.

Demand Wiring for (543-0209-**)

For CoreSense Diagnostics module (543-0209-**) a demand relay is no longer needed. Control voltage (110/220V) is needed at the D terminal. For digital models, the D terminal is used to monitor control voltage only. The demand signal comes from the RS485 network OR the 1-5V analog input. For fixed capacity models, the demand signal input comes from the D terminal, and is 110 or 220VAC with respect to L2.

See Figure 28 for proper wiring diagram

Protection/Contactor Control Wiring for CoreSense Diagnostics Module (543-0174-**)

The M1-M2 relay on the CoreSense module is a normally open relay. When the module is powered and there are no protective faults, the relay is energized and does not cycle on/off. On a detected protection condition, the CoreSense module will de-energize the relay to stop the motor from running. The relay is not used as a cycling device for normal compressor operation. The cycling device must be supplied externally from the module.

Protection/Contactor Control Wiring for CoreSense Diagnostics Module (543-0209-**)

The M1-M2 relay on the CoreSense module is a normally open relay. M1-M2 relay cycles with demand of the compressor. This eliminates the need for the cycling device to be supplied externally from the module. On a detected protection condition, the CoreSense module will de-energize the relay to stop the motor from running.

Discharge Temperature Protection with CoreSense Diagnostics for K5 Compressors

Copeland Scroll K5 compressors for refrigeration with CoreSense Diagnostics come standard with discharge temperature protection. Depending on the application and refrigerant a certain mode of protection will be used whether it is a top cap thermistor or DTC valve with discharge line thermistor or an EXV valve with a top cap thermistor. The CoreSense module identifies the protection device based on the pin locations in the connector. Figure 29, Figure 30 and Figure 31 depict the installation of the top cap thermistor and discharge line thermistor, respectively.

Table 1 at the end of this bulletin identifies the discharge temperature protection device by application and refrigerant. Table 4 identifies the service part numbers for those devices.

Communication DIP Switch Configuration

The communication module on the CoreSense Diagnostics module is equipped with a 10 switch DIP switch used for selection of the Modbus™ address,

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baud rate, parity, and other operating conditions to simplify service and start-up procedures. See Figure 32. For more information on DIP switch settings, Table 11 lists the purpose for each switch.

NOTE: Cycle power after changing any of the DIP settings for changes to take effect.

The following steps cover the DIP switch settings throughout the commissioning process for a multiple compressor system with communications to the E2:

1. Switches 1 through 5 are used for setting the address. Each CoreSense Diagnostics device that is connected to a rack controller must have a unique node address (as determined by the DIP switch settings).

2. Switch 6 defines the communications baud rate for the CoreSense Diagnostics module. If the switch is "off", the baud rate is 19200. If the switch is "on" the baud rate is 9600. The baud rate for each of the CoreSense devices should be set to match the rack controller. The default baud rate is 19200 ("off") for the CoreSense Diagnostics module. To determine the baud rate in the E2, follow these steps:

    - From the main menu select 7 (System Configuration)
    - Press 3 (System Information)
    - Press 1 (General Controller Info)
    - Access the Serial Communications Tab by pressing CTRL + 3
    - Use the Page Down button or scroll down to view the settings for COM4

3. Switch 7 defines the communication parity. The default parity setting for the CoreSense Diagnostics module is no parity. If the switch is set to "on" the module will communicate using even parity. The parity setting must match the parity setting of the rack controller.

4. Switch 8 is used to set the network mode (on) for the module. The default setting is stand alone mode (off). Network mode will generate a communications error if the rack controller fails to communicate with the device. For standalone mode, no communications are expected so the communication error is blocked

Cable Routing / Daisy Chain Configuration

A second set of DIP switches are used for compressor operation. See Table 12 for default configuration and application guidelines for DIP switches. The CoreSense Diagnostics module can communicate with a rack controller using Modbus™ protocol. The communication cable is wired from the rack controller to the first compressor. Additional compressors are wired in a daisy chained configuration. Refer to Figure 34 and Figure 36.

A shielded, twisted pair cable such as Belden #8761 (22AWG) should be used for the communication wiring. Passing the communications wire through the grommet in the plastic housing will help reduce abrasion to the wiring. Appropriate strain relief is recommended.

NOTE: The RS485 is polarity sensitive. "+" wires must connect to other "+" terminals, and "-" wires must connect to other "-" terminals. The shield wire is connected to the center terminal, or "0 volt" position.

Terminations

The last compressor in the daisy chain must be "terminated" by setting the DIP switch number 10 to the "on" (up) position. For all other compressors, the number 10 DIP switch should remain in the "off" (down) position.

More information: The E2 jumpers on the Network Interface Board should be set for "terminated". Refer to Figure 34.

COMMISSIONING

Modules using a communications network must be commissioned as part of the E2 rack controller setup. The commissioning process uploads compressor asset information (model and serial number) into the rack controller for future reference. Once the commissioning process is completed, the controller will supervise and communicate with the module unless the node is deleted. Refer to section titled *Modbus™ Communication to CoreSense Diagnostics for K5 Compressors* for more details on commissioning the

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K5 scrolls in an Emerson Retail Solutions E2 rack controllers.

NOTE: For digital capacity using an E2 controller, an enhanced suction group must be enabled.

The CoreSense Diagnostics module does not need to communicate to the rack controller in order to provide compressor protection. Using the communication process is optional, but provides for information flow to the controller for proofing, remote reset, asset information, and fault history and compressor status. Skip to section titled **Stand Alone Mode** if the communication feature will not be used.

Stand Alone Mode

If running a K5 with CoreSense Diagnostics without communication to a rack controller, DIP switch 8 should be set to "Off" (down).

Modbus™ Communication to CoreSense Diagnostics for K5 Compressors

K5 compressors equipped with a communication module are capable of communicating via open Modbus to a rack controller. The steps on the following pages are provided to commission K5 scrolls in an Emerson E2 with firmware version 3.0 or newer. For other rack controllers, contact the manufacturer.

CoreSense Diagnostics with EXV and digital capability uses two sets of DIP switches: a communication set with 10 DIP switches on the center of the module, and a compressor operation set with 6 DIP switches on the top left corner of the module.

For a description of the DIP switches please see Figure 32 and Figure 33.

Digital and EXV DIP Switches

Switch 1 is for Liquid injection being controlled by the EXV. The "ON" position enables the EXV.

Switch 2 is for Digital Capacity Control. The "ON" position enables Digital Capacity.

Switch 3 is for Failsafe. The "ON" position will allow the compressor to run at 100% if communications is lost. If in the "OFF" position the compressor will become off if communications is lost.

Switch 4 – Affects standard Mobus. For applications using IPRO or XWeb (Dixell) 'non-standard Modbus' turn SW4 ON Standard Emerson Climate Technologies Modbus, the DIP switch orientation doesn't matter.
For all other standard Modbus, DIP switch 4 should be in the OFF position.
*
SW5: Is to return to factory defaults for all configuration and erase the module history, use SW5 to reset the module. To reset SW5 must transition from off to on within 5 seconds of module power up.

Switch 6 Is for Lockouts enabled. The "ON" position will enable lockouts

General Guidelines and More Information

For general Copeland Discus compressor and digital control guidelines please log in to Online Product Information at Emerson.com/OPI, refer to the Application Engineering Bulletins listed below, or contact your Application Engineer.

AE4-1327	**Economized Vapor Injection (EVI) Compressors**
AE17-1320	**Oil Management for Copeland Scroll™ Compressors in Parallel Applications**
AE24-1105	**Principles of Cleaning Refrigeration Systems**
AE4-1294	**Megohm Values of Copeland™ Compressors**
AE8-1328	**Copeland™ Digital Compressor Controller**

```
                                                                      ┌──────────────────┐
                            Start                                     │    WARNING!      │
                                                                      │ Disconnect and   │
                                                                      │ lockout the power│
                                                                      │ before proceeding│
                                                                      └──────────────────┘
```

Is the compressor running? — No → **Is the compressor overheated?** — Yes → Allow time to cool

Is the compressor overheated? — No → Perform troubleshooting to determine why the compressor isn't running

Allow time to cool → Put the system back into operation and retest

WARNING! Disconnect and lockout the power before proceeding → Remove one wire from the modulation coil

Is the compressor running? — Yes → Observe the compressor suction & discharge pressures

Observe the compressor suction & discharge pressures → **Are pressures changing with the modulation cycle?** — Yes → Operation is normal

Remove one wire from the modulation coil → Measure the resistance of the coil

Are pressures changing with the modulation cycle? — No → Measure the voltage at the modulation coil terminals

Measure the resistance of the coil → **Coil has continuity and isn't grounded?** — No → Replace modulation coil

Measure the voltage at the modulation coil terminals → **Is voltage present, coinciding with the modulation cycle?** — No → Troubleshoot the modulation control

Coil has continuity and isn't grounded? — Yes → Replace modulation valve, follow valve replacement instructions

Replace modulation coil → Put the system back into operation and retest

Is voltage present, coinciding with the modulation cycle? — Yes →

Figure 1 Modulation Troubleshooting

R-404/R-507
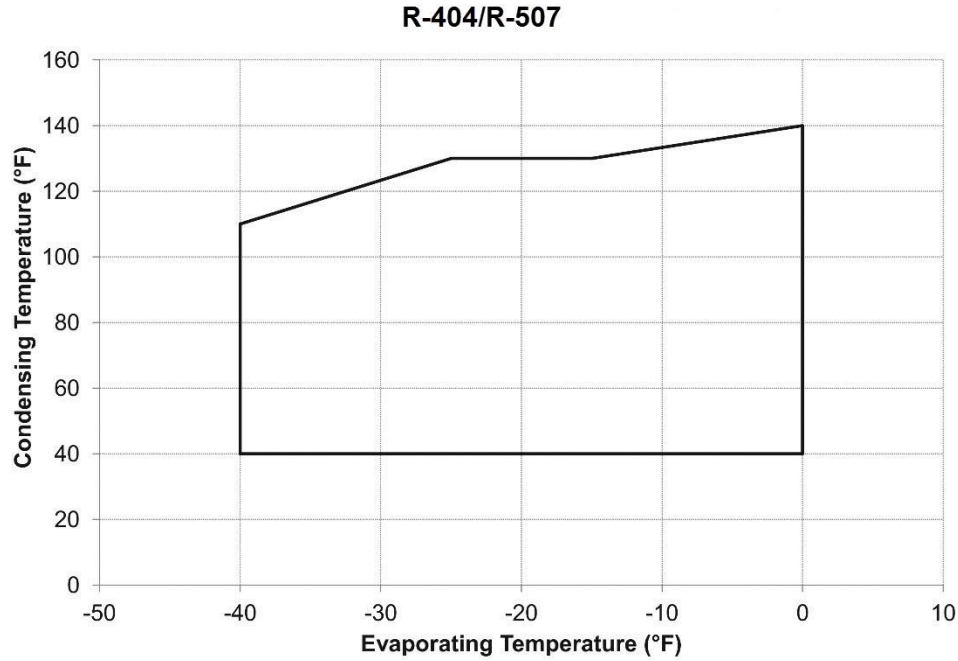
Figure 2 - ZF*K5E Low Temperature Vapor Injection Operating Map (65°F Return Gas) Part A

R-407A / R-407C / R-407F / R-448A / R-449A
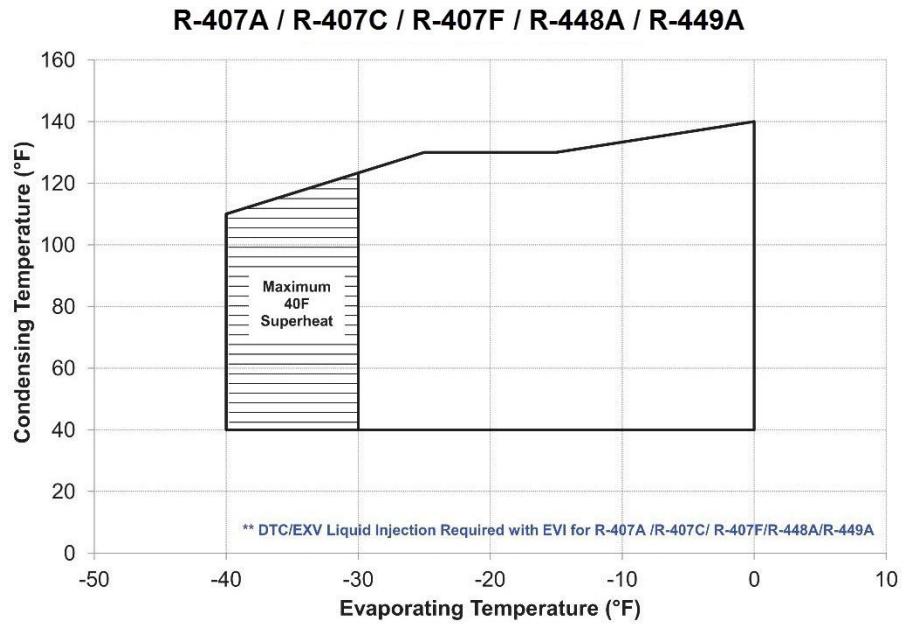
Figure 3 - ZF*K5E Low Temperature Vapor Injection Operating Map (65°F Return Gas) Part B

20

R-404A / R-507 / R-407A / R-407C / R-407F / R-448A / R449A
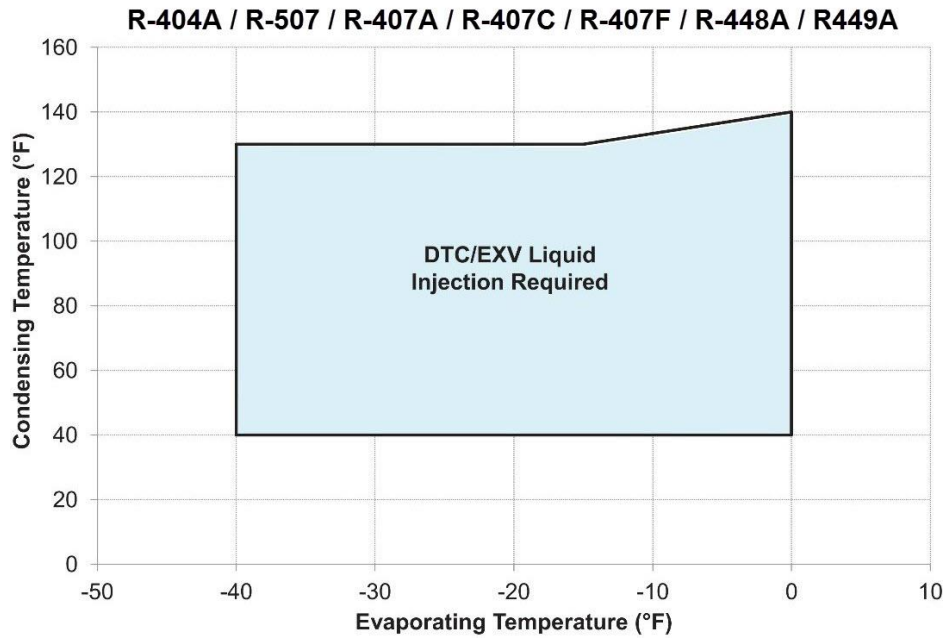
Figure 4 – ZF*K5E Low Temperature Liquid Injection-- Operating Map (65°F Return Gas) Part A

R-22
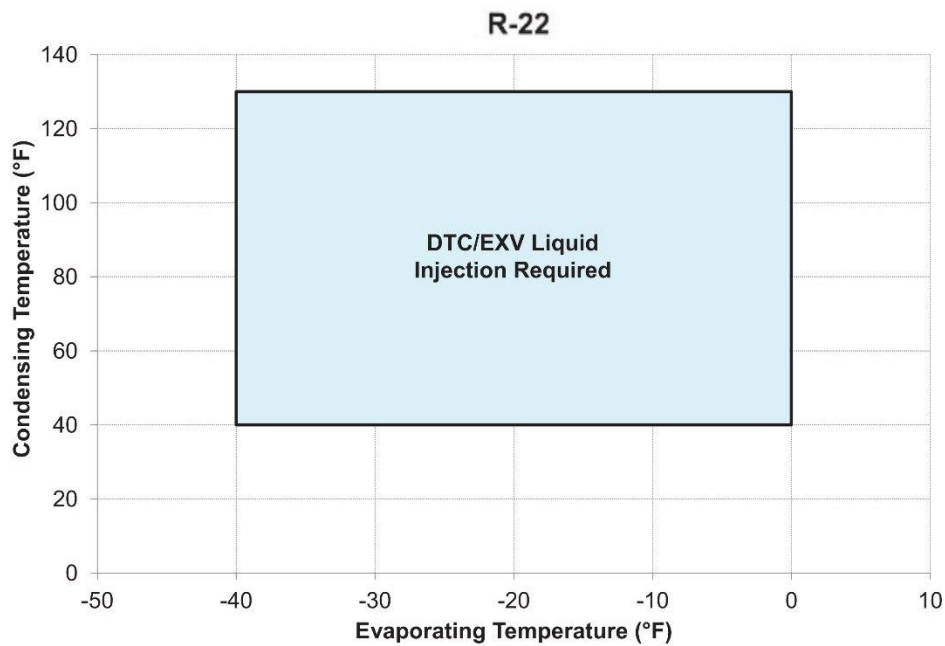
Figure 5 - ZF*K5E Low Temperature Liquid Injection-- Operating Map (65°F Return Gas) Part B

R-404A / R-507 / R-407A / R-407C / R-407F
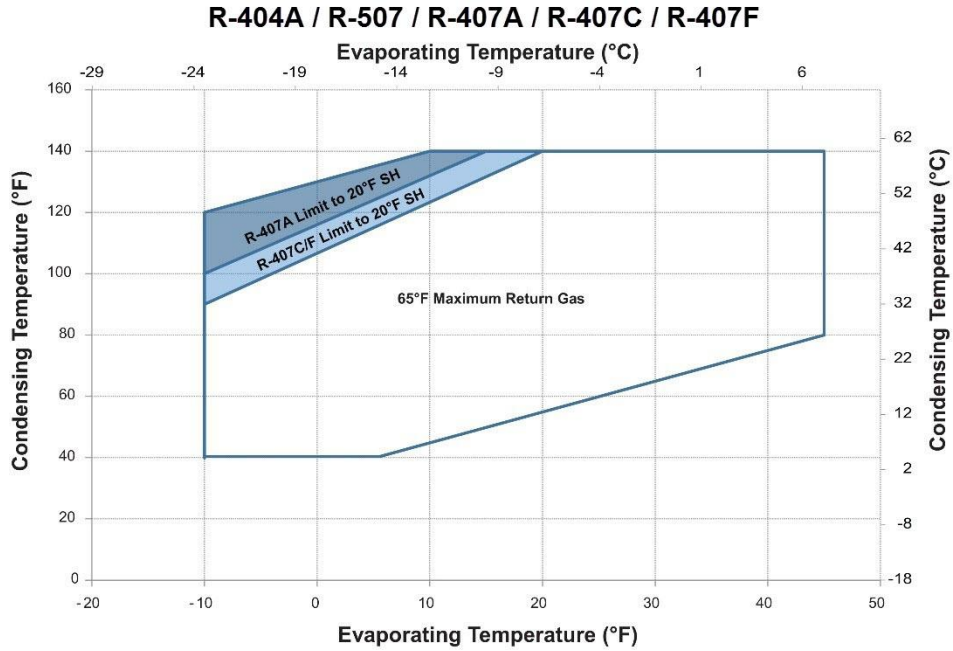
Figure 6 - ZB*K5E Medium Temperature Operation Map - (65°F Return Gas) Part A

R-448A / R-449A
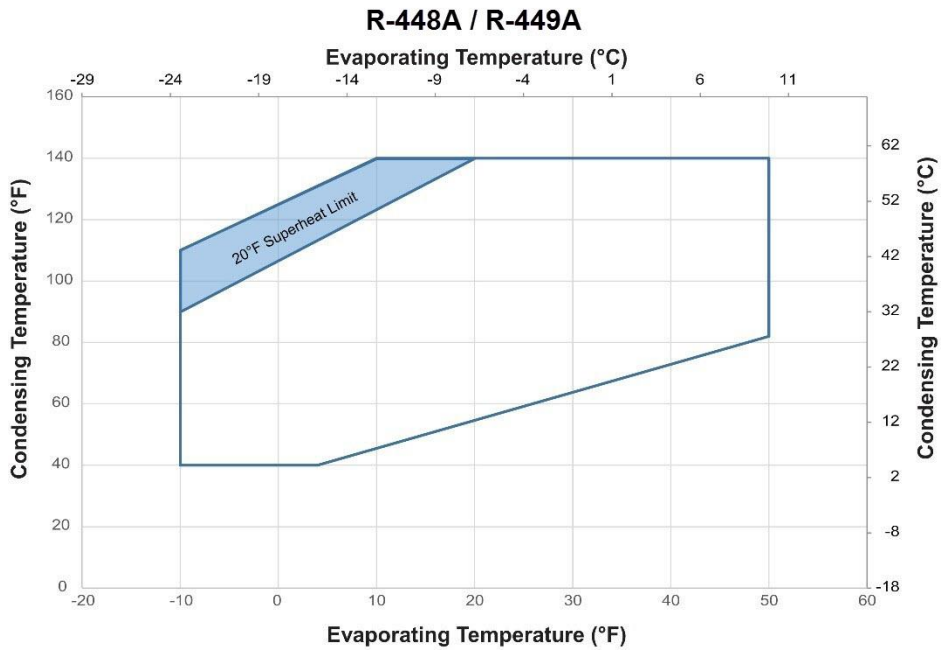
Figure 7 - ZB*K5E Medium Temperature Operation Map - (65°F Return Gas) Part B

R-22
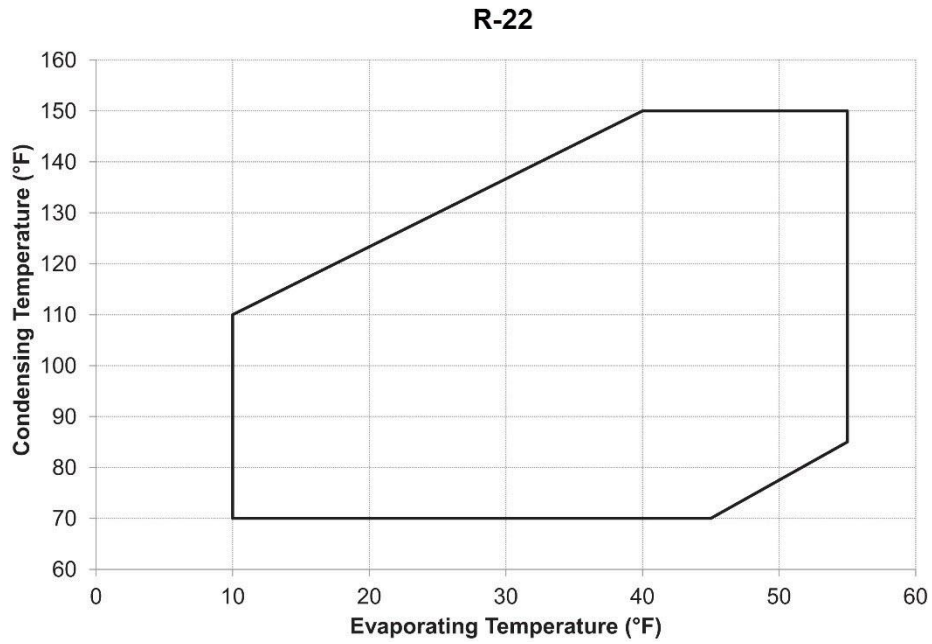
Figure 8 - ZB*K5E Medium/High Temperature Operation Map - (65°F Return Gas)

R-134a
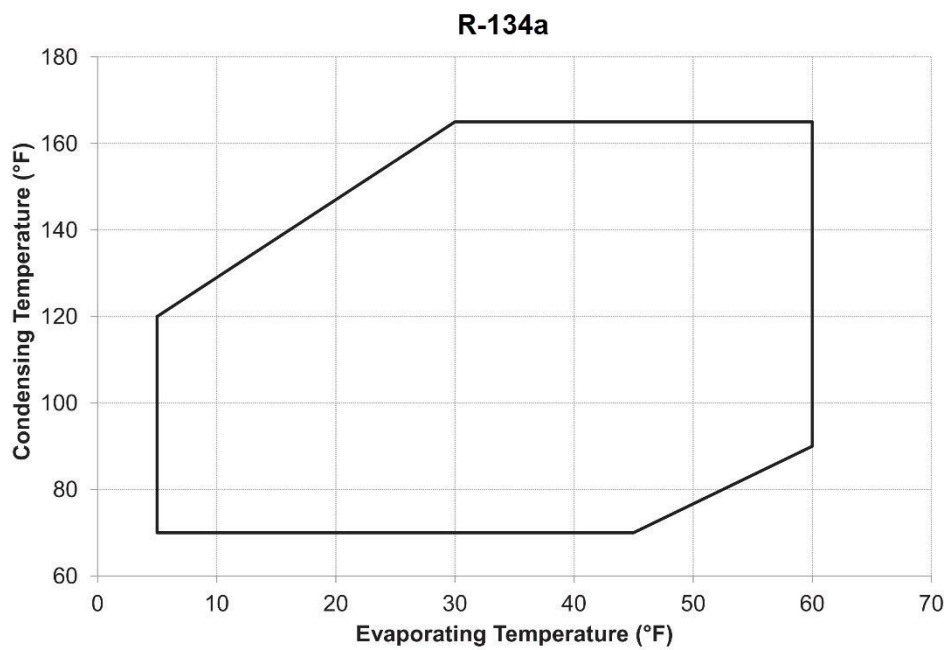
Figure 9 - ZB*K5E High Temperature Operation Map - (20°F Superheat)

R-404A / R-407A / R-407C / R-448A / R-449A / R-507 / R-22*
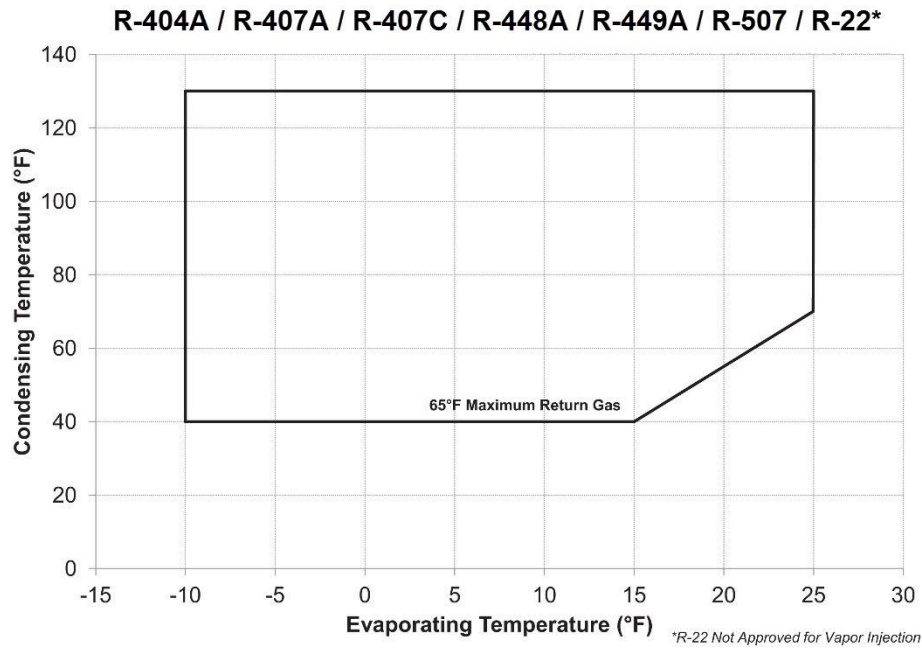
Figure 10 – ZF*K5E (Excluding ZF49K5E-ZF54K5E) Medium Temperature Operating Map with and without Vapor Injection

R-404A / R-507
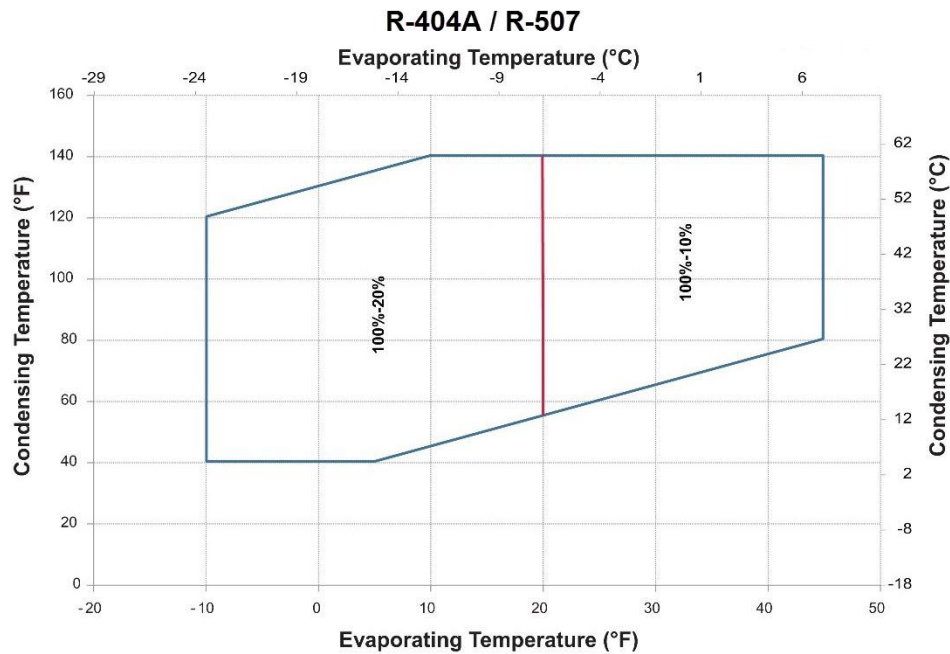
Figure 11 – ZBD*76 Compressor Operating Envelope WITHOUT CoreSense Diagnostics Controlling Digital Capacity Part A

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R-407A / R-407C / R-407F / R-448A / R449A
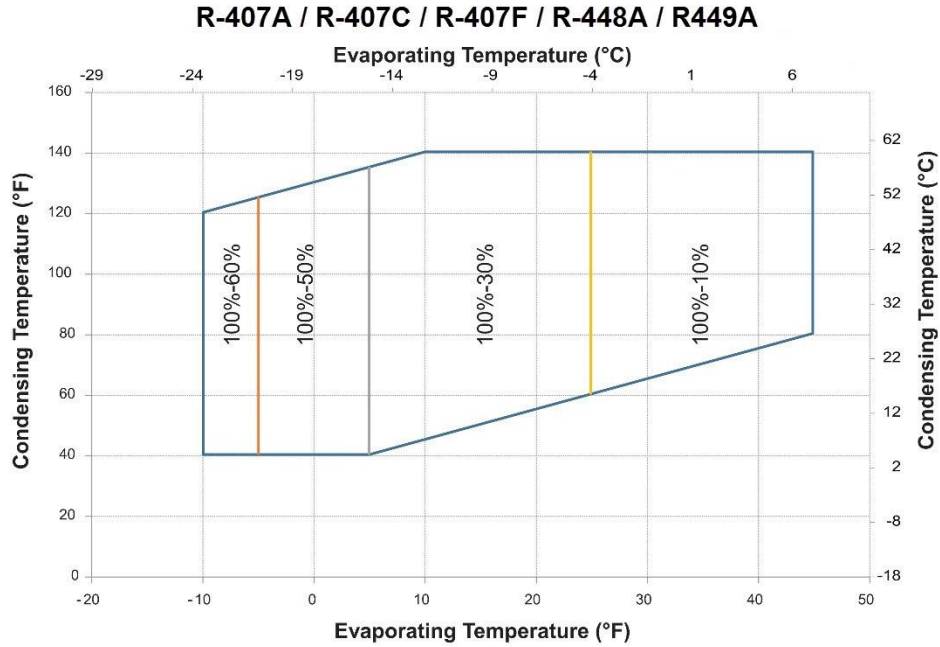
Figure 12 – ZBD*76 Compressor Operating Envelope WITHOUT CoreSense Diagnostics Controlling Digital Capacity Part B

R-404A / R-407C / R-407F / R-448A / R-449A / R-507
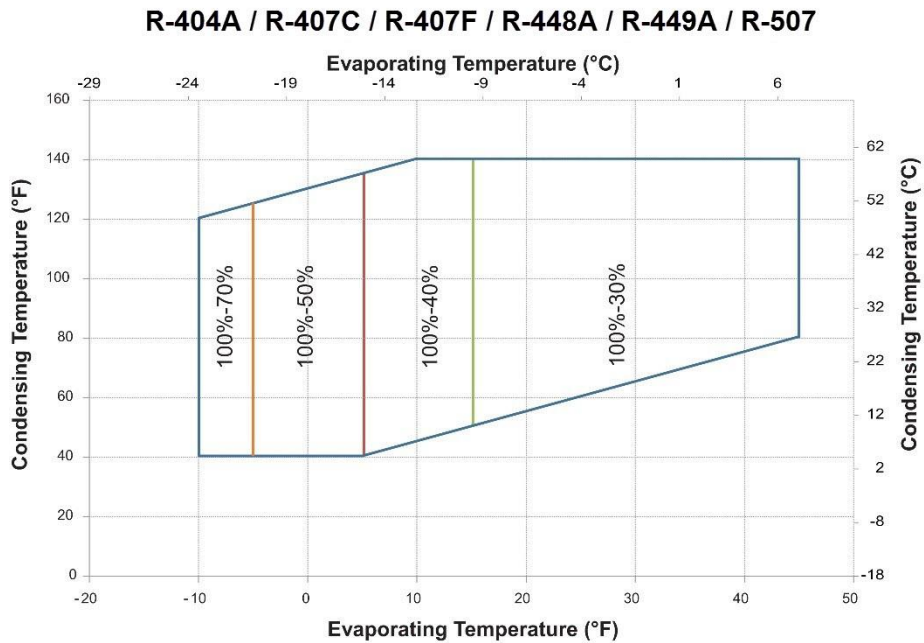
Figure 13 - ZBD114 Compressor Operating Envelope WITHOUT CoreSense Diagnostics Controlling Digital Capacity Part A

R-407A
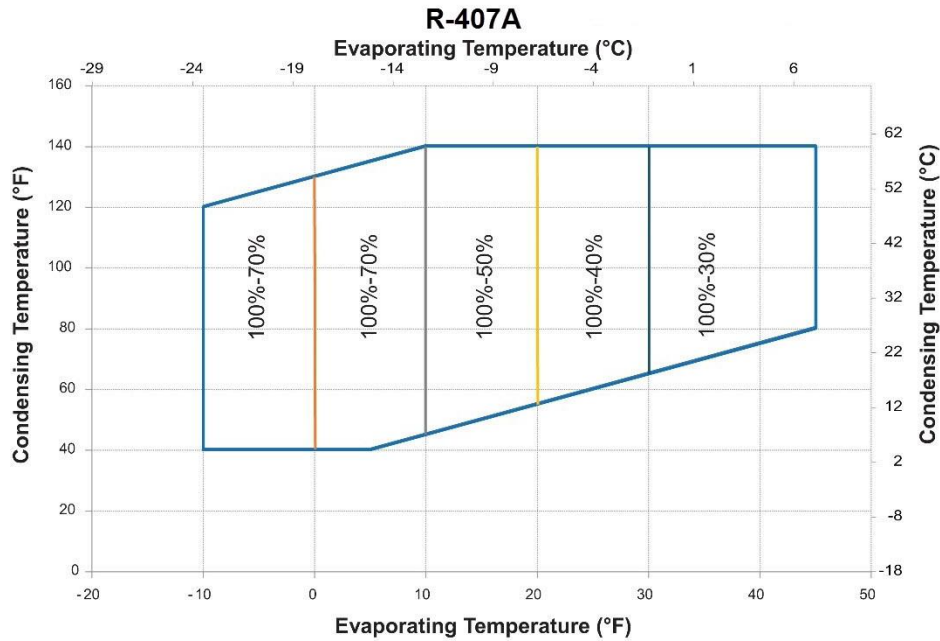
**Figure 14 - ZBD114 Compressor Operating Envelope WITHOUT
CoreSense Diagnostics Controlling Digital Capacity Part B**

NOTE: minimum capacity is assumed running at a continuous minimum capacity. These Minimum capacity restrictions ONLY apply when NOT using CoreSense™ Diagnostics

NOTE: Envelope restrictions will vary slightly between refrigerants.

FILTER DRIER

SUCTION MANIFOLD

KEEP MIN (SEE NOTE 6)

<12"

<12"

CONTINUOUS TUBING (NO ELBOWS)

<30"
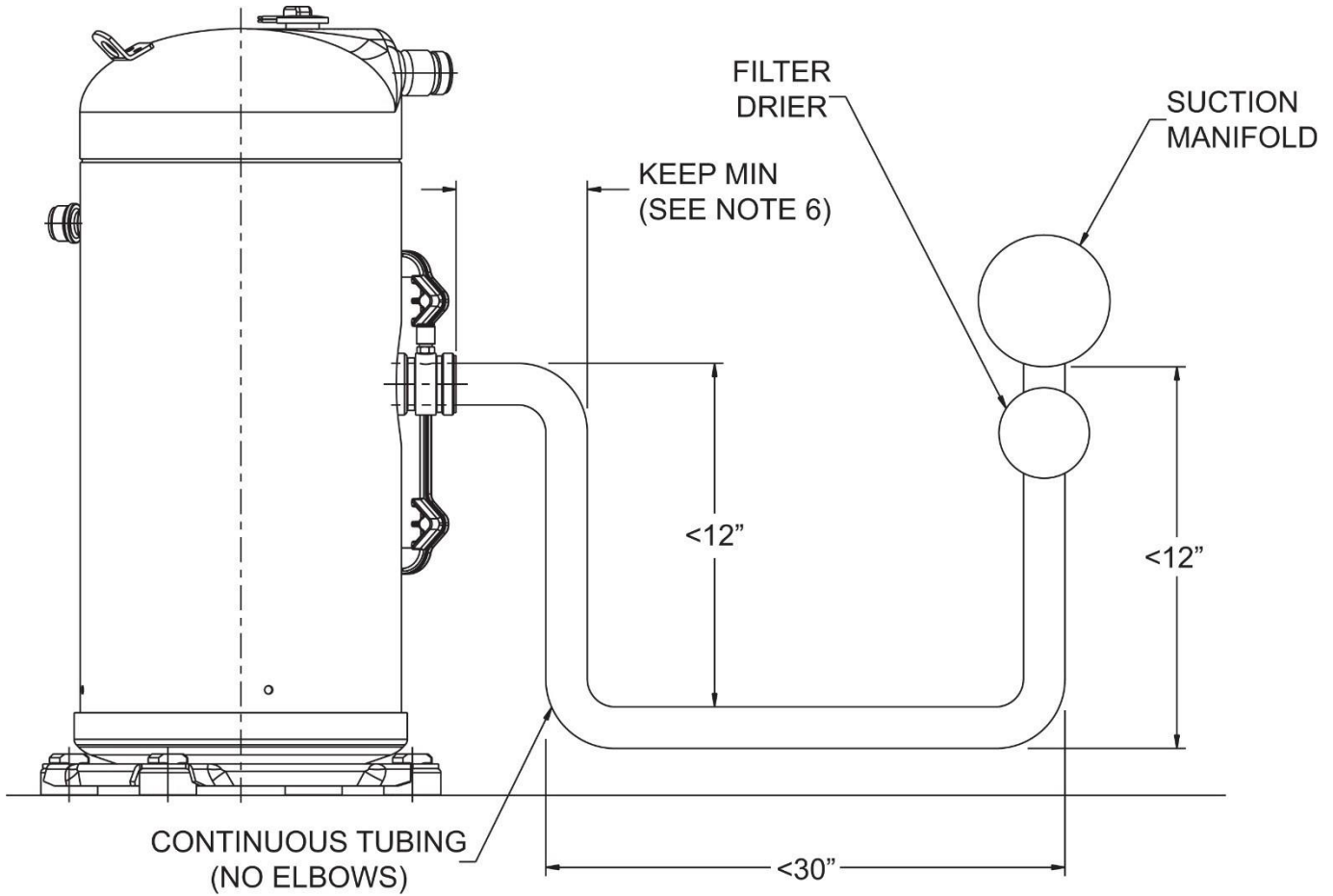
Figure 15 - Typical Suction Tubing

Notes:
 (1) The above tubing configurations are guidelines to minimize tube stress.
 (2) Follow similar guidelines for discharge tubing and oil return tubing as needed.
 (3) If a run over 30" is required, intermediate clamps may be necessary.
 (4) Do not hang weights on tubing (e.g. filter drier on suction tubing) except after clamps or close to the header.
 (5) This dimension should be made as short as possible but still insuring a proper braze joint.
 (6) The above tubing recommendations are based on "no elbow joints". The use of continuous tubing is preferred.

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Electronic Liquid Injection Valve Kits
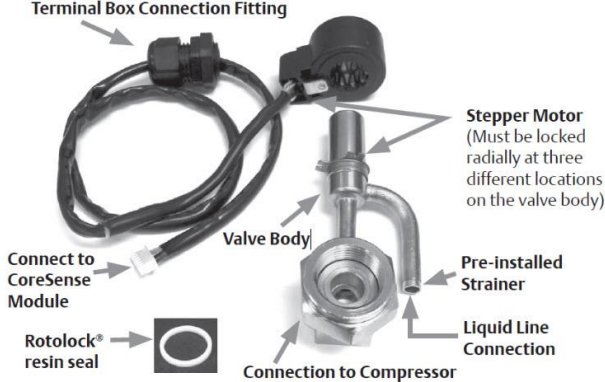
**Figure 16 - Copeland Scroll K5
compressor, including EXV valve kit**
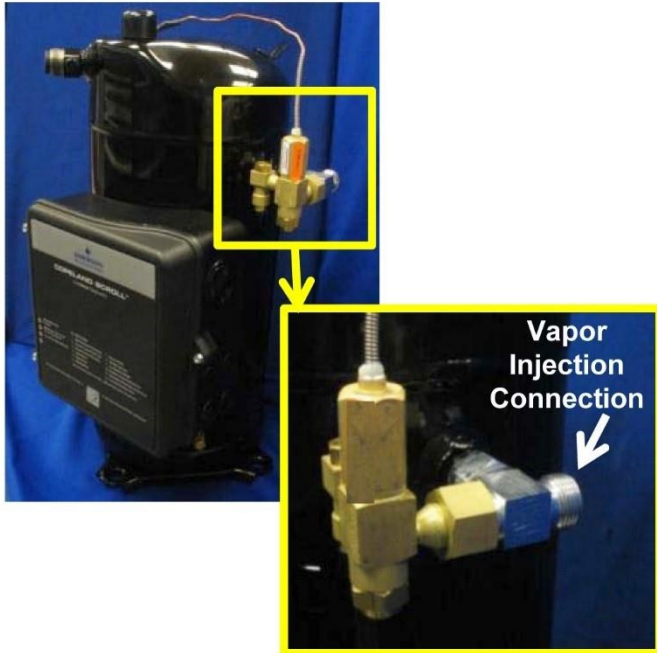
Figure 17 - EVI Scroll with DTC and T-fitting Adapter*

Figure 18 - Liquid Injection Scroll with DTC Valve

***Note: Only for service purpose in ZF**K5E compressors**
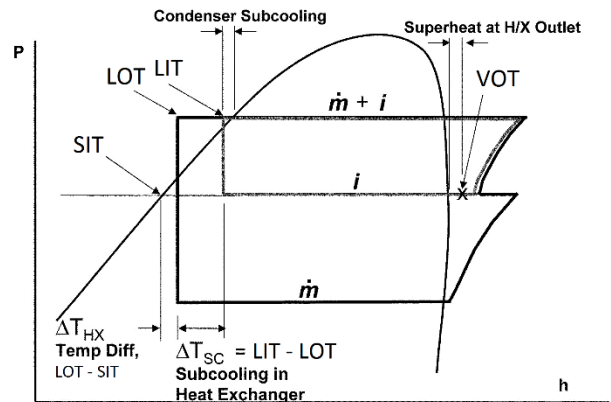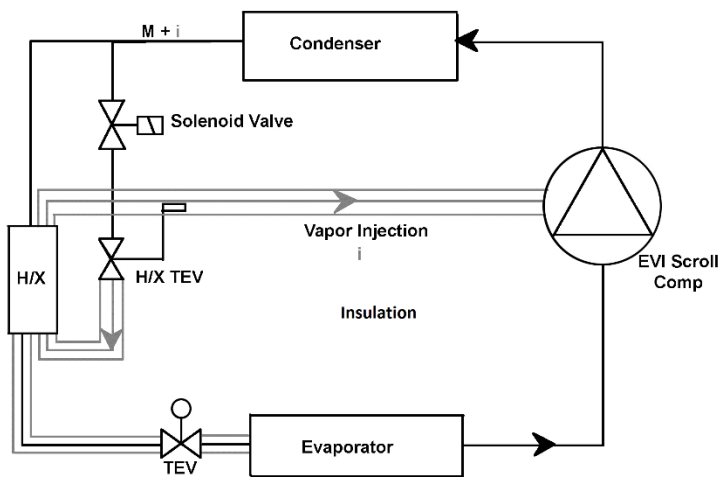
Figure 19 - Circuit Diagram and cycle for EVI

29
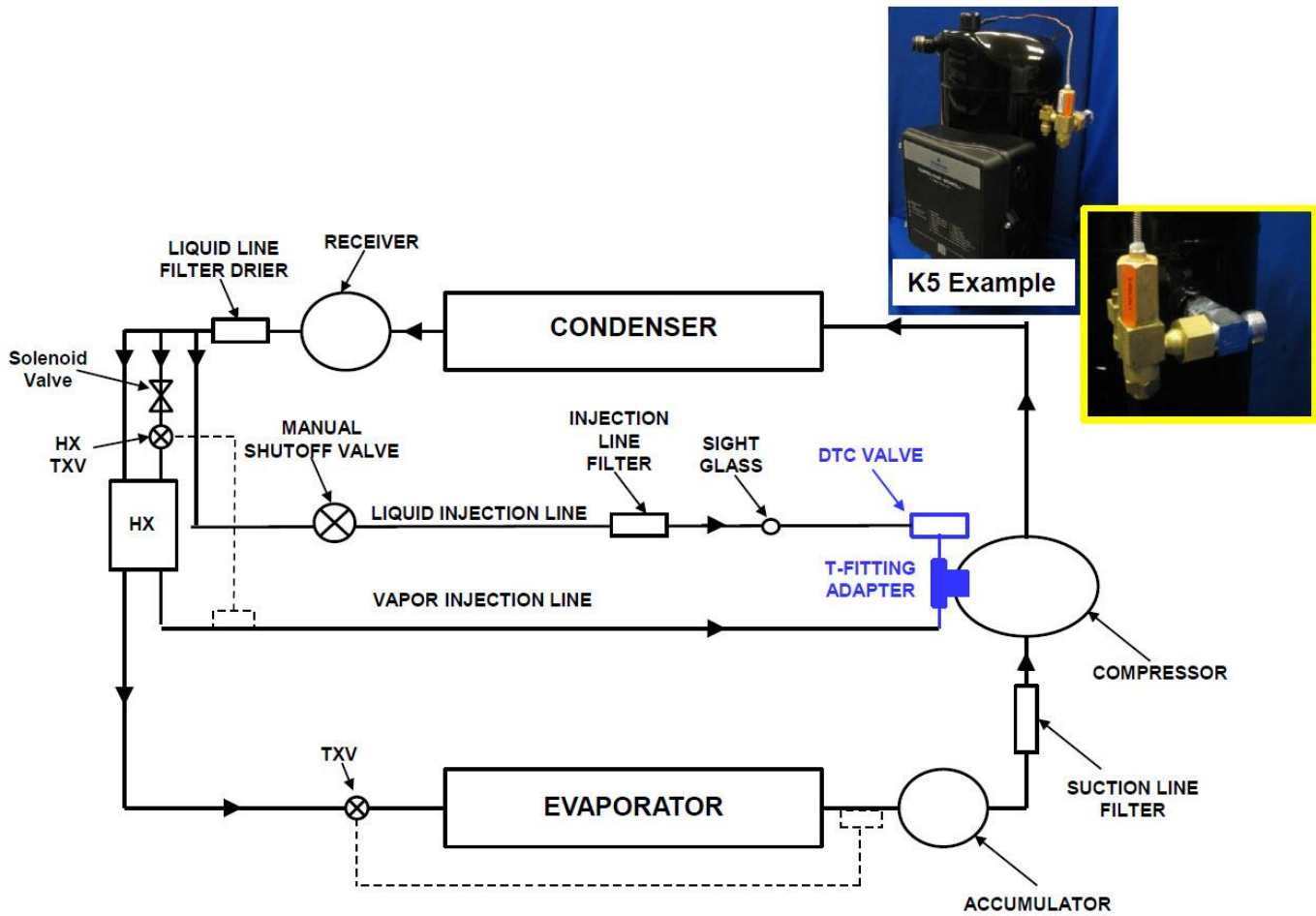
Figure 20 Typical Single Compressor System Schematic with Wet Injection using a DTC Valve
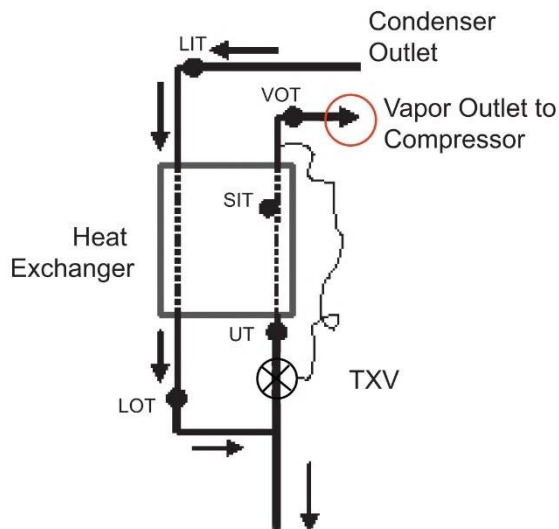
Figure 21 - Downstream Extraction
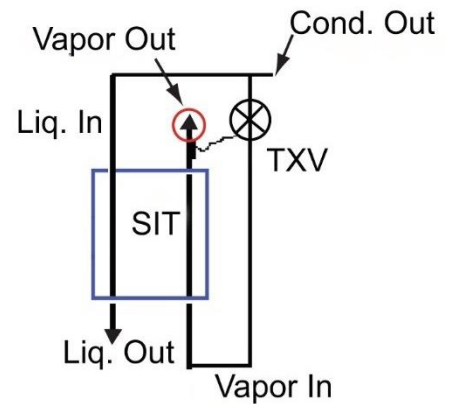
Figure 22 - Upstream Extraction

VO = Vapor temperature leaving H/X
VI = Vapor temperature entering H/X
LI = Liquid temperature entering H/X
LO = Subcooled liquid leaving H/X
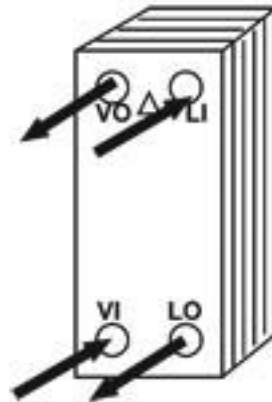
Figure 23 - H/X Piping Arrangement

028-0188-22
SLEEVE

027-0400-00
RUBBER GROMMET

KIT #527-0210-00
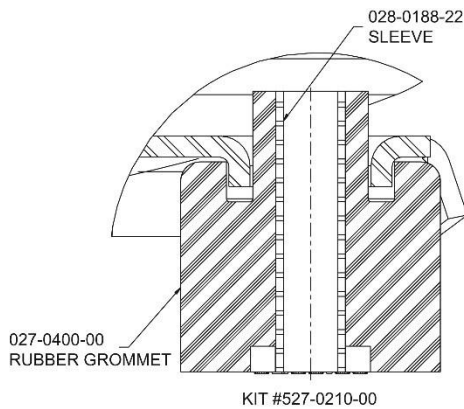
Figure 25 - 8–13 HP Condensing Unit Mounting for Models ZB95-ZB(D)114 and ZF49-54

102-0283-00
WASHER

027-0115-00
RUBBER PAD

027-0383-00
STEEL SPACER

KIT# 998-0178-00
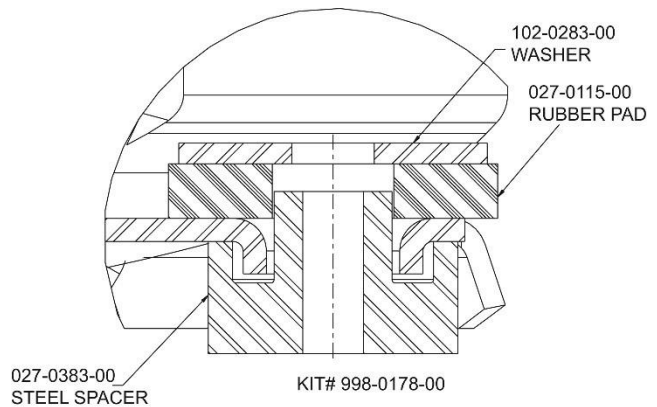
Figure 24 - 8–17 HP Copeland Scroll Compressor Rack Mounting Kit for *K5

TUBE-MOUNTING SLEEVE
PER BOM CHART
028-0188-16

SPACER-EXTERNAL MOUNT
PER BOM CHART
027-0186-00

SECTION A - A   527-0116-00
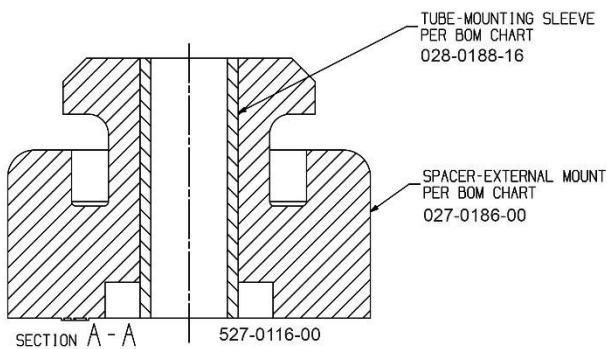
Figure 26 - 13–17 HP Condensing Unit Mounting for Models ZB58-66, ZB(D)76 and ZF34-ZF(D)41
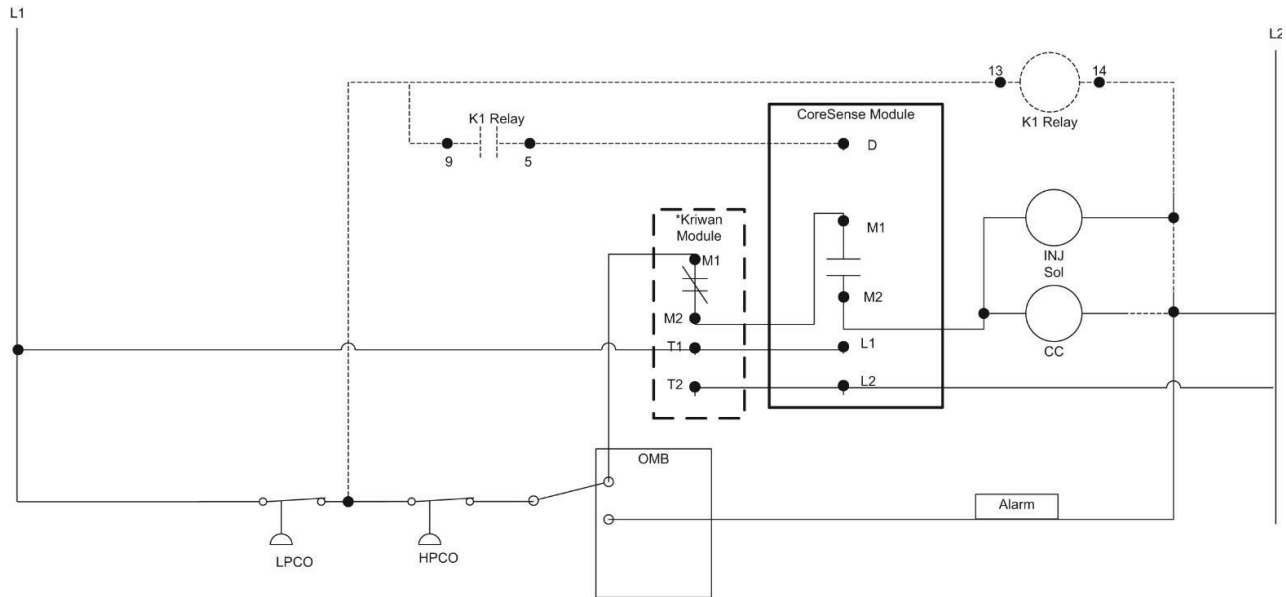
Figure 27 - CoreSense Module with Pressure Safety Control

** The physical location of M1/M2 & L1/L2 have changed on the CoreSense module **

Note: If Kriwan module is used, wire in series with CoreSense module, as indicated in diagram.

If Kriwan module is not used, wire M1 directly from safety circuit to M1 on CoreSense & M2 from contactor coil to M2 on CoreSense module.

** System control point only needed for fixed capacity compressors.
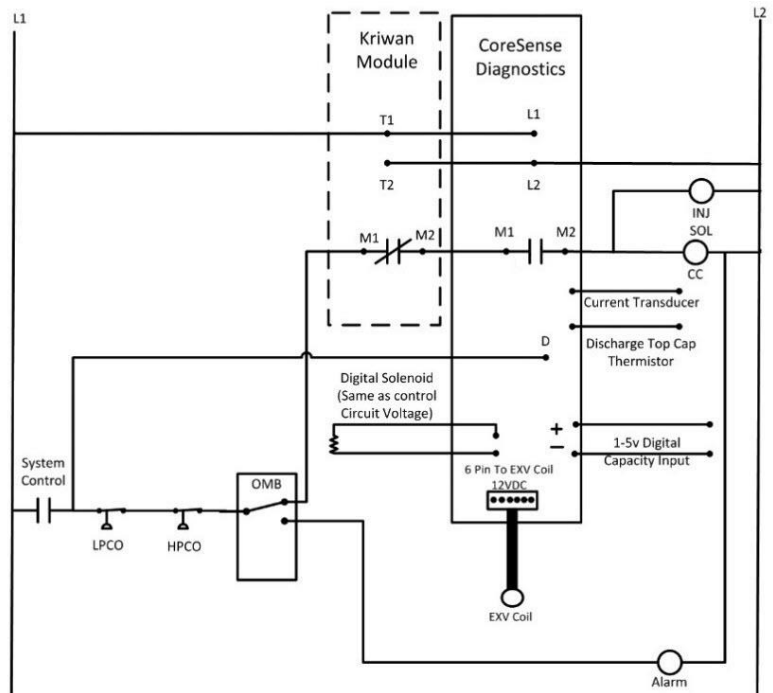
Figure 28 - CoreSense Diagnostics Module with Digital and EXV
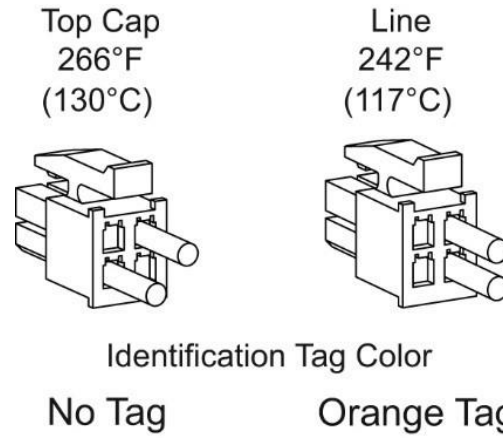
Figure 29 - Discharge Thermistor Connector (Viewed from Wire Side)
Nominal Shutdown Temperature Capability

Figure 30 - Top Cap Thermistor

The top cap thermistor should be installed with di-electric grease applied on the probe. When attaching the probe to the compressor, a high temperature silicone type sealant should be used not only to adhere the probe to the compressor, but to also prevent any moisture from entering the thermal well.

Figure 31 - Discharge Line Thermistor

The discharge line thermistor should be attached to the discharge about 6 inches from the discharge of the compressor and is only used with a DTC valve

NOTE: Although not depicted in this figure, the thermistor should be well insulated to ensure accurate temperature sensing.
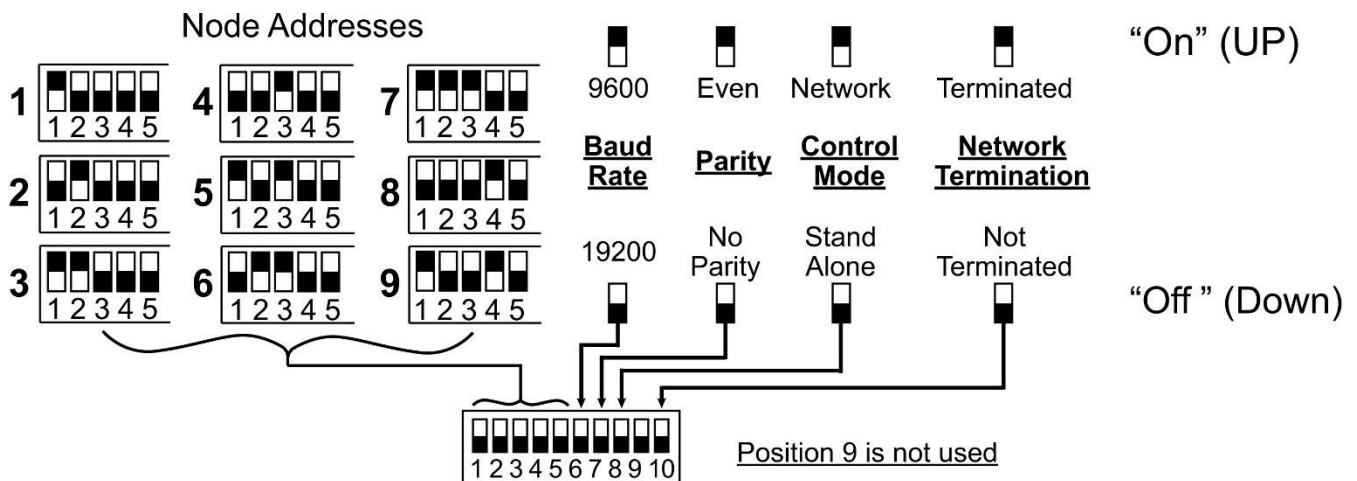
Figure 32 - K5 Communication Module DIP Switch Settings
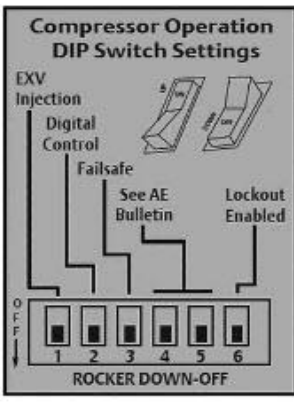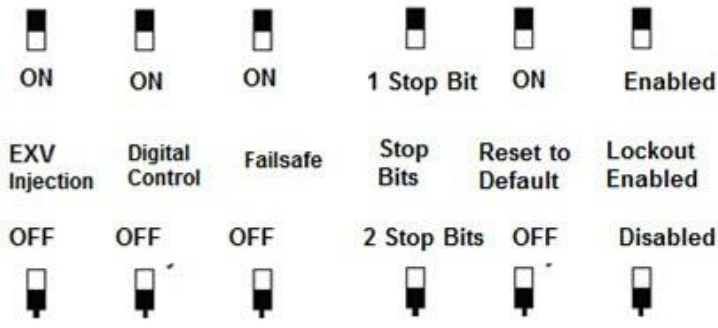
Figure 33 - Digital and EXV DIP Switches
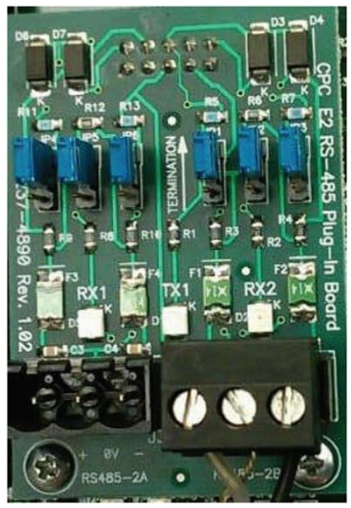
Figure 34 - E2 Jumpers
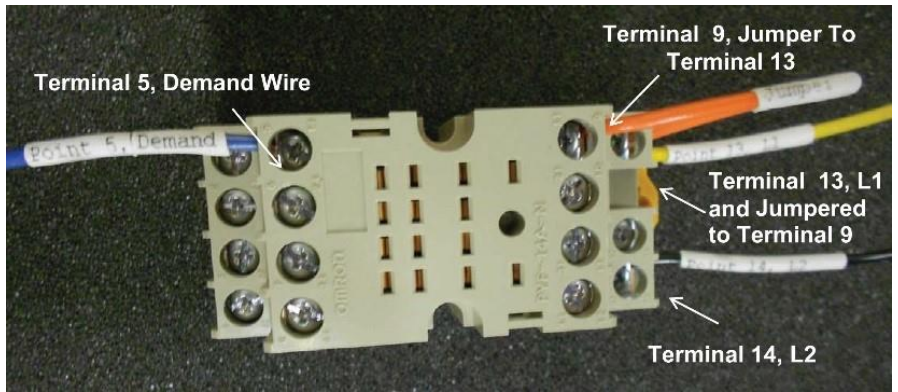
Figure 35 - Wiring Relay Example
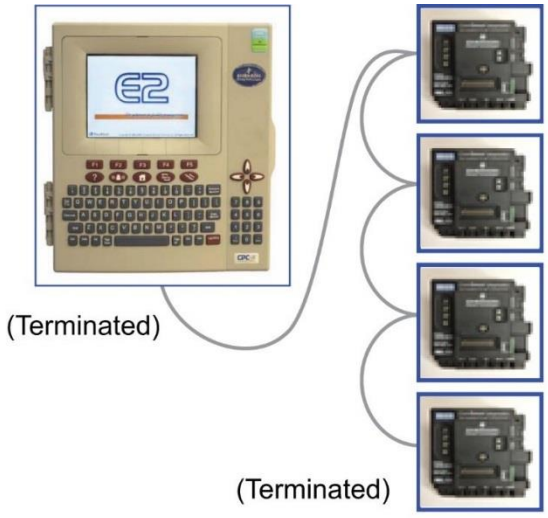
Figure 36 - RS485 Daisy Chain Connection
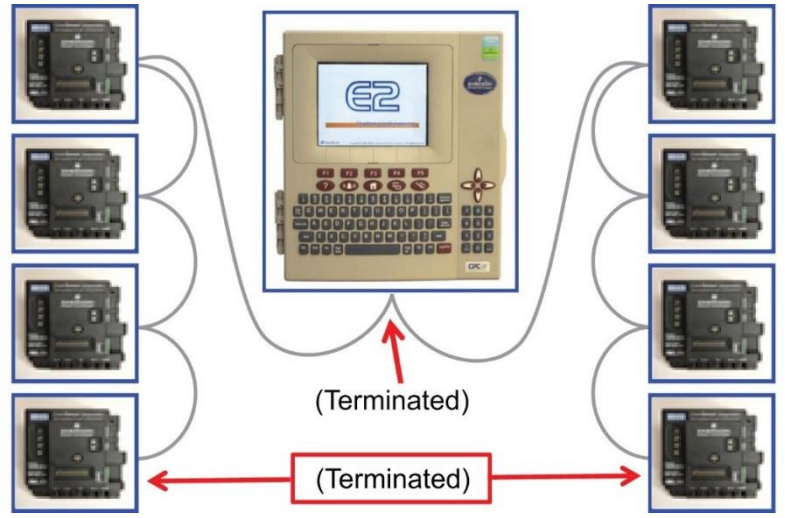
Figure 37 - Two Rack Daisy Chain Connection

35

Compressor Operation DIP Switches

Diagnostic LED Lights

Module Communication DIP Switches

Current Toroid Plugin

Digital Input 1-5V (Analog Input)

Top Cap Thermistor

Modbus® Communication Plugin

Ground Screw

Control Circuit

Module Power 110V/220V

Digital Solenoid Voltage Output (110/220V)

Liquid Injection Output (cord provided)

Areas highlighted in red circles show differences from the old CoreSense™ Diagnostics module to the new. Digital control and EXV control have been added to the module. The physical location of (M1,M2) and (L1,L2) has also changed.

Figure 38 - Comparison of old and new modules

Intermediate
Floating
Seal Cavity

Seal Cavity Vent

Removable External
Solenoid and Coil
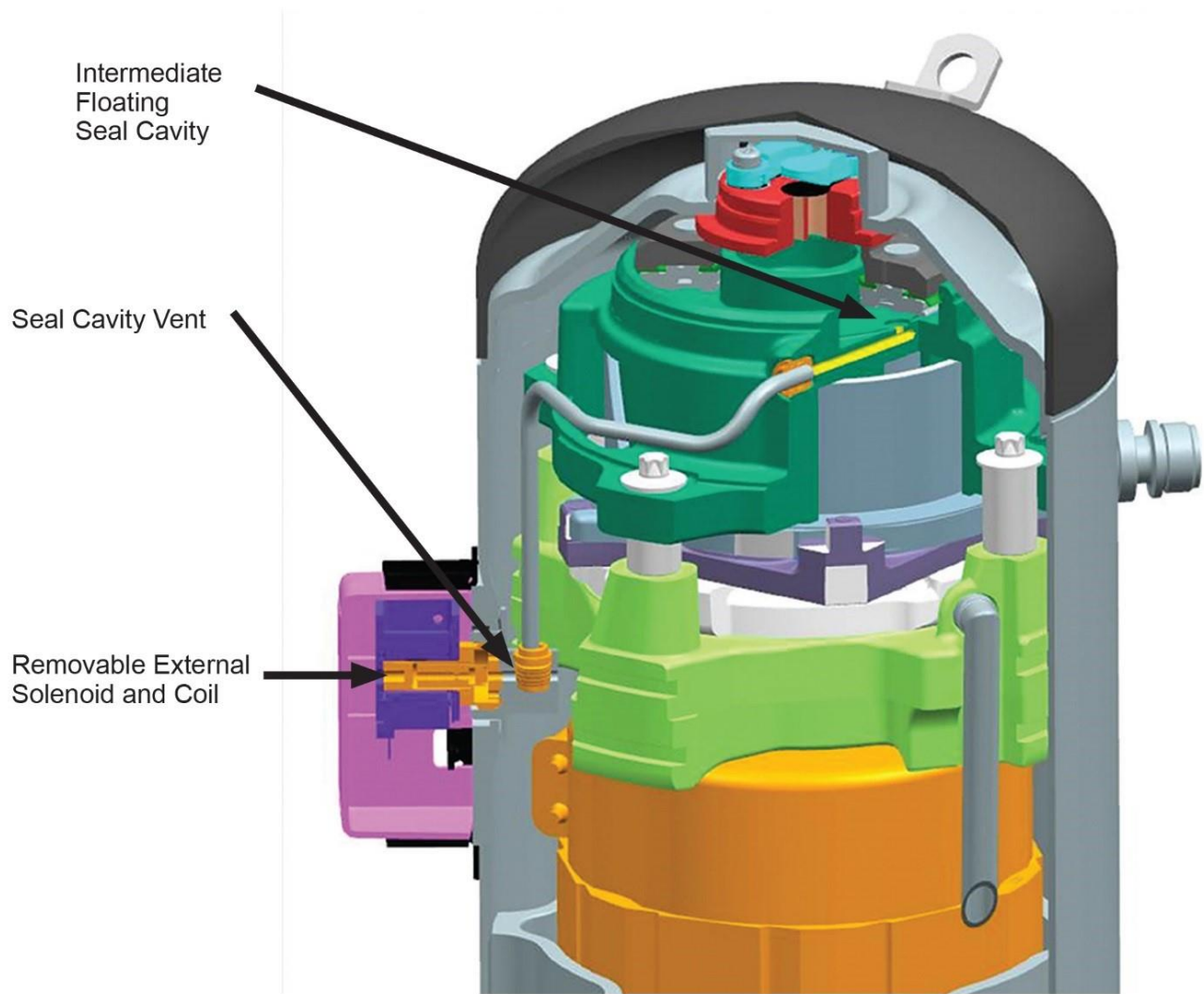
Figure 39 - Digital Compressor Cutaway View
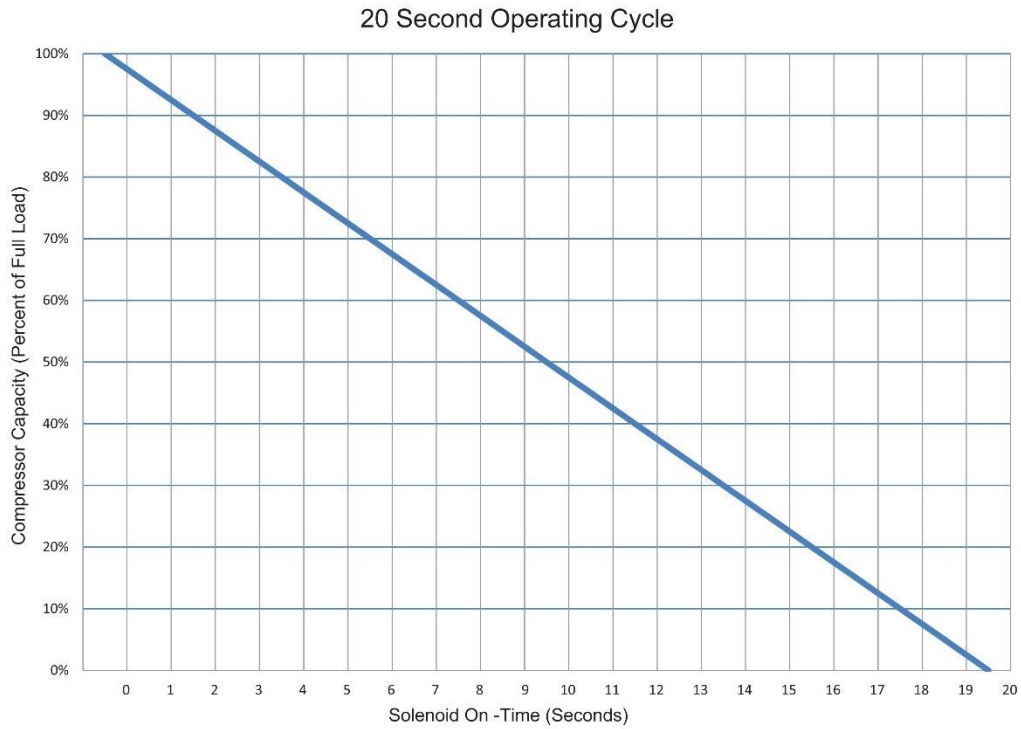
Figure 40 – ZBD*K5E Digital Operation Cycle Time
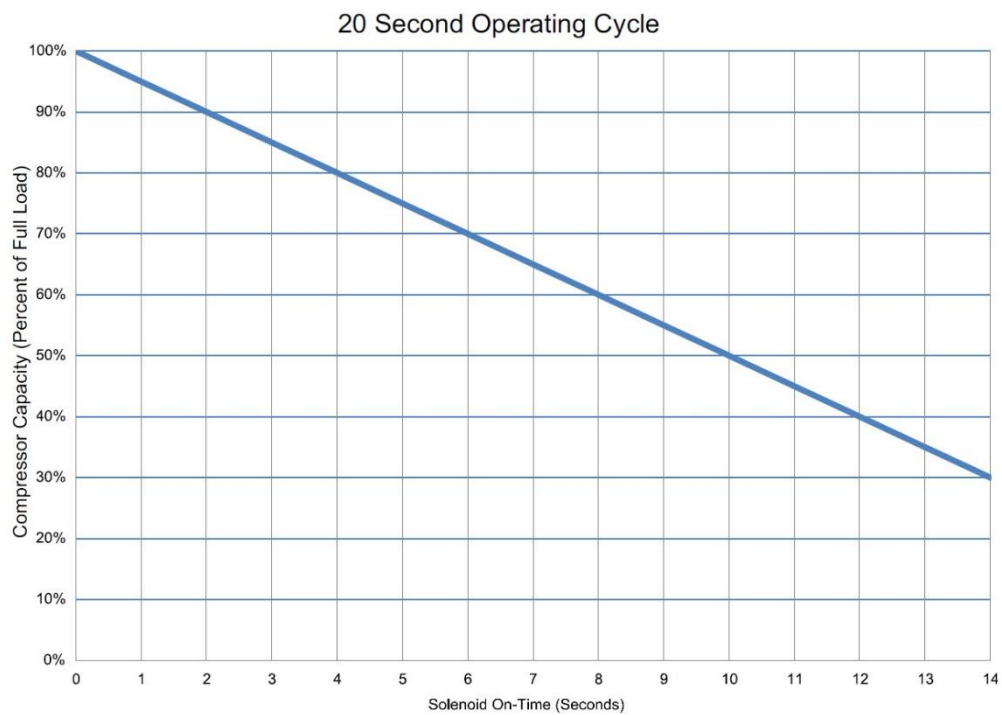
Figure 41 - ZFD*K5E Digital Operation Cycle Time

CoreSense™ Diagnostics + EXV Operation

1. Top Cap Temperature Sensor

4. EXV Stepper Motor. Changes Valve Opening and Closing Depending on the CoreSense Output Signal

Liquid out from the Valve and in to the Compressor

2. Input Signal to CoreSense Module

EXV Valve Assembly Kit 998-0340-00 Includes…
• Stepper Motor with Cable
• Valve Body
• Brazed Fitting

Liquid Line Input to the Valve (Liquid line Solenoid will be needed)

3. CoreSense Module 543-0209-00

4. CoreSense Output

T-Fitting with EXV for Wet Injection Application

Figure 42

Low Temperature Digital Operation 30%-100% and Enables Liquid Injection

Enables Digital Operation

Medium Temperature Digital Operation 10%-100%

Enables Digital Operation

Figure 44 - Low Temp ZFD*K5E Digital Operation DIP Switch Settings

Figure 43 - Medium Temp ZBD*K5E Digital Operation DIP Switch Settings

Table 1 - Injection Accessories

Application	Injection	Refrigerants	Required Kits	Reference Figure
ZB (Medium Temp)	N/A	All	Top Cap Thermistor is Factory Installed (no kits required)	See Figure 42
ZF (Low Temp)	Vapor Injection	404A/507	998-0229-00: Top Cap Thermistor Kit *Top Cap Thermistor is factory installed on -260 BOM	See Figure 42
		407A/C/F 448A/449A	998-0500-03: 250°F DTC Kit Including Temperature Probe 998-0177-00: KIT - Vapor Injection T-Fitting Adapter	See Figure 18
	Liquid Injection	All	998-0500-03: 250°F DTC Kit Including Temperature Probe	See Figure 17
		All	998-0340-00 Electronic Liquid Injection Valve Kit See **Table 5** for a detailed list of parts included on this kit.	See Figure 16 and Figure 43

Table 2 - External Wrap-Around Crankcase Heaters

Crankcase Heater Kit P/N	Crankcase Heater P/N	Volts	Watts	Lead Length (in)	Ground Wire Length (in)	Conduit Ready Box for Crankcase Heater
918-0047-00	018-0091-00	120	90	48	48	998-7029-00
918-0047-01	018-0091-01	240	90	48	48	
918-0047-02	018-0091-02	480	90	48	48	
918-0047-03	018-0091-03	575	90	48	48	

Table 3 - Kriwan INT69 Module Specifications

Emerson P/N	071-0660-00
Emerson Kit P/N	971-0641-00
Manufacture P/N	Kriwan 22 A 601
T1-T2 Module Power	
Voltage Supply	120/240V
Frequency	50/60 Hz
M1-M2 Module Output Contacts	
Maximum Voltage	264 VAC
Maximum Current	2.5 Amps
Minimum Current	100 milliamps
S1-S2 Thermal Protection	
Trip Out Resistance	4500 ±20%
Reset Resistance	2750 ±20%
Reset Time	30 min ±5 min.
Manual Reset	T1-T2 interrupt for minimum of 5 sec.

Table 4 - K5 Compressor for Refrigeration Additional Accessories

Accessory	Part Description	P/N
Mounting Parts	55-65 Durometer Mounting Parts Kit (for single compressor applications using ZB95-ZB(D)114, ZF49-ZF54)	527-0210-00
	Hard Mounting Parts Kit (for parallel rack applications)	998-0178-00
	35-45 Durometer Mounting Parts Kit (for single compressor application using ZB58/66, ZB(D)76 and ZF34, ZF(D)41)	527-0116-00
Service Valve Kits	Suction and Discharge Service Valves with Seals	998-5100-27
	Suction Rotalock Service Valve with Seal - 1 3/8" Stub Tube	998-0510-46
	Discharge Rotalock Service Valve with Seal - 7/8" Stub Tube	998-0510-39
Rotalock to Stub Tube Adapter Kits	Discharge Rotalock to Stub (1 1/4" 12 Thread to 7/8" Sweat)	998-0034-08
	Suction Rotalock to Stub (1 3/4" 12 Thread to 1 3/8" Sweat)	998-0034-13
	Vapor & Liquid Injection Rotalock to Stub (1" 14 Thread to 1/2" Sweat)	998-0034-18
Motor Protection	External Motor Protection Module for ZB95K5E-TWC, ZB(D)114K5E-TWC, ZB(D)114K5E-TWE	971-0641-00
Oil Monitoring OMB (Emerson Flow Controls P/Ns)	Oil Management Control w/ Junction Box 24V 50/60Hz	65365
	Oil Management Control w/ Series Relief Connector 24V 50/60Hz	65366
	Copeland Scroll OMB Adapter for K5 Refrigeration Scroll	66077
	Copeland Scroll OMB Adaptor for K5 Refrigeration Scroll (after May 2013)	66652
CoreSense Diagnostics	CoreSense Module for K5 Refrigeration Scroll (Pre January 2015)	943-0151-00
	CoreSense Current Sensor Module for K5 Refrigeration Scroll	943-0159-00
	CoreSense Module for K5 Refrigeration Scroll (After January 2015)	943-0209-00
	Thermistor Kit (Includes Top Cap and Discharge Line Thermistors)	998-0176-00
	Top Cap Thermistor Kit (Top Cap Thermistor Only)	998-0229-00
Crankcase Heater Kits	120V, 93W Wrap Around, 48" Lead Length 018-0091-21	918-0047-00
	240V, 93W Wrap Around, 48" Lead Length 018-0091-22	918-0047-01
	480V, 93W Wrap Around, 48" Lead Length 018-0091-23	918-0047-02
	575V, 93W Wrap Around, 48" Lead Length 018-0091-24	918-0047-03
	Conduit Ready Box for Crankcase Heater	998-7029-00
Liquid Injection Components	DTC Kit - 250°F Set Point DTC with 268°F Thermistor for Liquid Injection and R-407A/C/F Vapor Injection	998-0500-03
	Liquid Injection Adapter (For R407A/C/F Vapor Injection Applications Only)	998-0177-00
	EXV Liquid Injection Valve Kit (Includes EXV Valve with Compressor Connection & Wiring	998-0340-00
Digital Kits & Components	120V Digital Solenoid Coil	998-0060-04
	240V Digital Solenoid Coil	998-0060-09
	Digital Wire for CoreSense Analog Input	998-0341-00
	Digital Solenoid Coil Wire (CoreSense Module to Digital Solenoid Coil)	998-0342-00
	Closed Loop Digital Controller (Single Compressor Applications)	998-0189-00

Table 5 - Liquid Injection Kit # 998-0340-00 for K5 Compressors Models

Liquid Injection Parts List contained in Kit# 998-0340-00		
Description	**Qty**	**Part Number**
Liquid Injection Electronic Valve	1	510-0811-00
Stepper Motor	1	050-0345-00
Seal Rotalock Fitting	1	020-0028-00
Digital Solenoid Wire	1	029-0512-01

Note 1: Kit # **998-0340-00** is available for 15A serial number and after.

Note 2: DTC valve kit # **998-0500-03** was used on serial number 14L or earlier date code. That included both liquid injection and wet injection for EVI models as well.

Table 6 - K5 Compressor for Refrigeration (8 to 17 HP) Fitting Sizes

Fitting	Size (in.) -Thread
Suction Rotalock Connection	1 3/4"-12
Discharge Rotalock Connection	1 1/4"-12
Liquid/Vapor Injection Rotalock Connection	1"-14

Table 7 - High and Low Pressure Control Settings

Model	Control Type	R-404A / 507	R-134A	R-22 / R-407A / R-407C/ R-407F / R-448A/ R-449A
ZF* K5E	Low High	0 psig min. 400 psig max	---	2 in. Hg Min. 335 psig Max
ZB*K5E	Low High	17 psig min. 450 psig max	4 psig min. 263 psig max	37 psig min. 381 psig max

Table 8 - Low Temperature Digital Modulation

Digital Capacity %	Analog Voltage Input (Volts)	Digital Solenoid On time (Seconds)
100%	5.00	0
90%	4.60	2
80%	4.20	4
70%	3.80	6
60%	3.40	8
50%	3.00	10
40%	2.60	12
30%	2.20	14

Table 9 - Medium Temperature Digital Modulation

Digital Capacity %	Analog Voltage Input (Volts)	Digital Solenoid On time (Seconds)
100%	5.00	0
90%	4.60	2
80%	4.20	4
70%	3.80	6
60%	3.40	8
50%	3.00	10
40%	2.60	12
30%	2.20	14
20%	1.80	16
10%	1.40	18

Table 10 - R1011 Alert Code Descriptions

Alert Code		Code Description	Protection Shutdown (Default)	Protection Off Time (Default)	Consecutive Detections Until Lockout
Lockout feature is NOT enabled from the factory except on code 7					
✺✹	1	High Discharge Temp – see diagram for setting	Yes	20 Min.	4
✺	2	Excess System Limit Trips - 4 consecutvie system limit trips having 1-15 min runtime each	Yes	5 Min.	No Lockout
✺	3	Excessive Demand Cycling - Default is 240 cycles per 24 hr. period	No	-	-
✺✹	4	Locked Rotor - Compressor did not start within alloted time	Yes	20 Min.	4
✺	5	Demand Present - No current detected over 4 hr. period	No	-	-
✺✹	6	Phase Loss Detected	Yes	20 Min.	10
✹	7	Reversed Phase Detected	Yes	Until Module Is Reset	1
✺	8	Welded Contactor - Current detected without demand[1]	No	-	-
✺	9	Low Module Voltage	Yes	5 Min.	No Lockout
✺	10	Module Communications Error	No	-	-
✺	11	Discharge Temperature Sensor Error	No	-	-
✺	12	Current Transducer Error	No	-	-
✺ ✺ ✺	1 2 3	Digital Alert Codes: Loss of analog demand – Check analog voltage Network mode ON, 1-5V input present – Check position of DIP switch #8 Network model OFF, receiving Modbus™ communication – Check position of DIP switch #8			
Lockouts can be enabled by DIP switch 6 setting					
[1] Code 8 displays for 24 hours after last detection\nThe M1-M2 relay only opens during a protection shutdown. To reset module, cycle module power.\nModule must be reset for DIP switch changes to take effect.\nFor technical support call 1-888-367-9950 or visit EmersonClimate.com\nRefer to AE4-1383 for more details.					

Table 11 – CoreSense™ Diagnostics Module Troubleshooting

Status LED	Status LED Description	Status LED Troubleshooting Information
Green Alert LED Solid	Module has power	Supply voltage is present at module terminals
Green Alert LED 3 Flashes	Short Cycling 2 to 480 run cycles in 24hours ending with normal Alert Default is set to 240 per 24 hours	Check pressure or temperature control Possible loss of refrigerant Blocked Condenser
Green Alert LED 5 Flashes	Open Circuit Demand signal is present but no compressor current for four hours	Compressor circuit breaker or fuse(s) is open Compressor contactor has failed open High pressure switch is open and requires manual reset Open circuit in compressor supply wiring or connections Long compressor protector reset time due to high ambient temperature Compressor windings are damaged
Green Alert LED 8 Flashes	Welded Contactor No demand signal, but current has been detected in one or both phases Displayed for 24 hrs. after last detection	Contactor welded closed Control circuit transformer is overloaded Demand signal not connected to module - Demand signal could be from T-Stat or rack controller Verify Wiring
Green Alert LED 10 Flashes	Loss of Communication Communication lost between rack controller and module for 10 minutes or more	Check communications wiring Verify wiring follows application guidelines
Green Alert LED 11 Flashes	Discharge Temperature Sensor Error Short or Open Circuit Detected	Check discharge temperature sensor wiring and mounting Verify sensor is not shorted. 86k @ 77°F
Green Alert LED 12 Flashes	Current Transducer (CT) z	Verify CT is plugged into module Verify CT is not shorted
Yellow Alert LED Solid	Trip Demand present, no current is detected	Compressor protector is open - Check for high head pressure - Check compressor supply voltage Compressor circuit breaker or fuse(s) is open Broken wire or connector is not making contact Safety cutout switches open (HPCO, LPCO, OMB, etc.) Compressor contactor has failed open
Yellow Alert LED 1 Flash	High Discharge Line Temperature Trip See inside label to determine cut out temp.	Possible loss of refrigerant charge Blocked condenser Verify that discharge valve is open On low temperature scroll compressors check liquid injection
Yellow Alert LED 2 Flashes	System Trip Four consecutive compressor trips after run time of 1-15 minutes each	Excessive suction pressure or discharge pressure Improper wiring

Status LED	Status LED Description	Status LED Troubleshooting Information
Yellow Alert LED 4 Flashes	Locked Rotor Compressor is drawing current without rotating or four consecutive compressor trips after run time of 1-15 seconds	Low line voltage (contact utility if voltage at disconnect is low) Verify presence of all legs of power line Excessive liquid refrigerant in compressor Compressor bearings are seized Verify operating current
Yellow Alert LED 6 Flashes	Missing Phase Demand signal is present but current is missing in one phase	Improper wiring. Correct order of phases in wires Failed contactor. Check contacts for pitting Compressor current could be too low. Refer to specifications. Verify presence of all legs of power line
Yellow Alert LED 9 Flashes	Low Voltage Detected Control voltage dips below 85V for 110V or 170V for 220V	Low line voltage (contact utility if voltage at disconnect is low) Check wiring connections
Red Alert LED 1 Flash	LOCKED OUT ON: High Discharge Line Temperature Trip See inside label to determine cut out temp.	Possible loss of refrigerant charge Blocked condenser Verify that discharge valve is open On low temperature scroll compressors check liquid injection
Red Alert LED 4 Flashes	LOCKED OUT ON: 4 Consecutive Locked Rotors Detected Compressor is drawing current without rotating or four consecutive compressor trips after run time of 1-15 seconds	Low line voltage (contact utility if voltage at disconnect is low) Verify presence of all legs of power line Excessive liquid refrigerant in compressor Compressor bearings are seized Verify operating current
Red Alert LED 6 Flashes	LOCKED OUT ON: 10 Missing Phase Detections Demand signal is present but current is missing in one phase	Improper wiring. Correct order of phases in wires. Failed contactor. Check contacts for pitting. Compressor current could be too low. Refer to specifications. Verify presence of all legs of power line
Red Alert LED 7 Flashes	LOCKED OUT ON: 1 Reverse Phase Detected Demand signal is present but current is not detected in the correct sequence	Improper wiring. Correct order of phases in wires. Compressor current could be too low. Refer to specifications. Verify presence of all legs of power line

Table 12 - Demand Wiring

Demand Wiring Kit (998-0188-00)		
Item	**Control Voltage**	
	110/120	**220/240**
Relay Socket	032-0766-00	
Relay	040-1086-00	040-0187-00

Table 13 - K5 Dip Switch Settings

Dip Switch Number	**On**	**Off**
1 Through 5	Modbus™ Module Address	
6	Baud Rate= 9600	Baud Rate= 19,200
7	Even Parity	No Parity
8	Network	Stand Alone
9	Not Used	
10	Terminated	Not Terminated

Table 14 - CoreSense™ Module DIP Switch Scenarios

	Application	Medium Temperature		Low Temperature				
	Digital?	Digital	Non-Digital	Digital			Non-Digital	
	Compressor	ZBD**K5E	ZB**K5E	ZFD**K5E			ZF**K5E	
Factory Default	SW1: EXV Enabled	Off	Off	On			On	
	SW2: Digital Enabled	On	Off	On			Off	
	SW3: Failsafe On/Off	Off	Off	Off			Off	
	SW4: 1 or 2 Stop Bits	Off	Off	Off			Off	
	SW5: Reset to Default	Off	Off	Off			Off	
	SW6: Lockout Enabled	Off	Off	Off			Off	
	Application	All	All	Liq Inj	VI 407A	VI 404A	Liq Inj	VI 407A	VI 404A
Adjust	SW2: Digital Control	On for Rack	Off	On for Rack	On for Rack	On for Rack	Off	Off	Off
		Off w XC643	Off	Off w XC643	Off w XC643	Off w XC643	Off	Off	Off
	Option To Use Open Triac								
	*Liquid Inj. Line Solenoid	n/a	n/a	No	No	Yes	Yes	No	n/a
	*To use open Triac you must have a non digital compressor with switch number 2 set to the OFF position. (Triac is normally open)								

Needed, Same as Factory Default	Different Than Factory Default	Not Needed, No Change to Factory Default

APPENDIX A

E2 Programming Instructions for the CoreSense K5 compressor

1. Press to **enter the Main Menu. Select 7. System Configuration.**
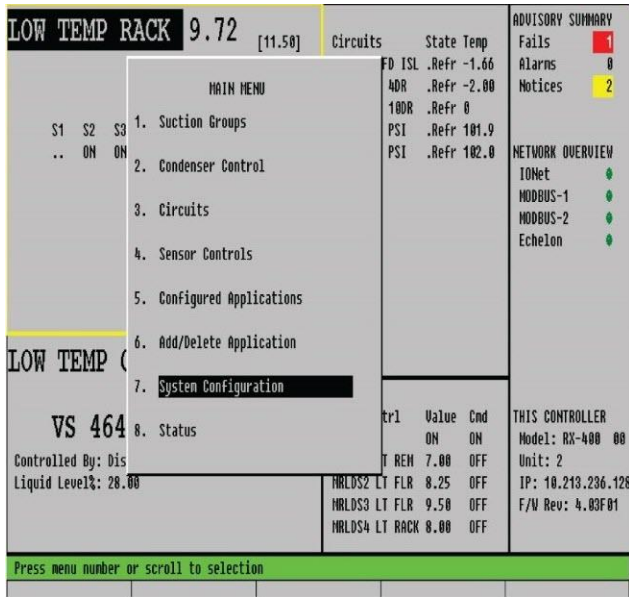
2. From the System Configuration Menu select 7. Network Setup
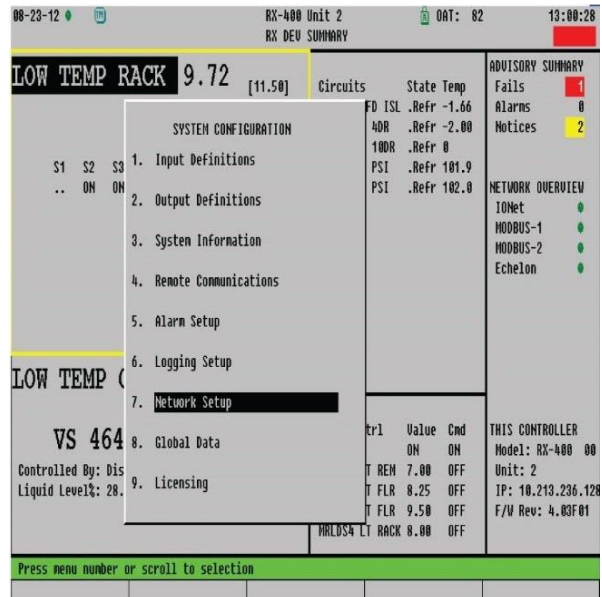
3. From the Network Setup Menu select:
2. Connected I/O Boards and Controllers
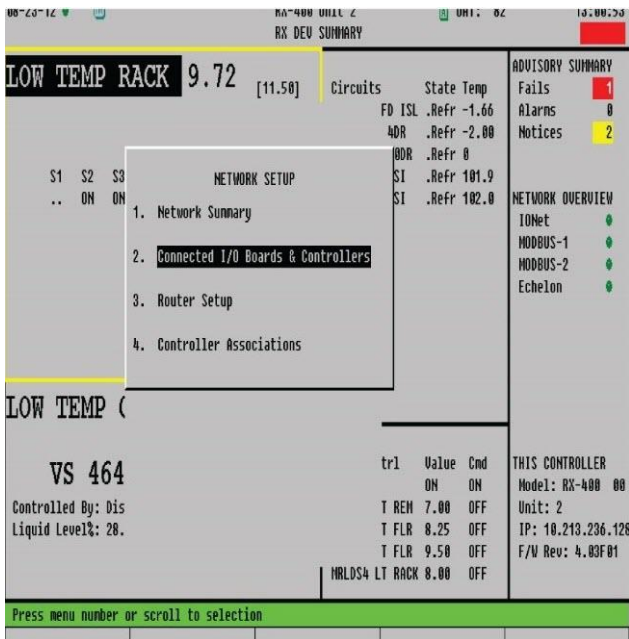
4. From the Setup Screen go to the C3: ECT Tab (Press Ctrl + 3)
5. In Option #9, enter the number of K5 compressors being controlled by the E2.

Press **to save changes and return to the previous screen.**

EMERSON.
Climate Technologies

6. From the Network Setup Menu select *1. Network Summary*


```
8-23-12 ◆ ◌ ⒯                    RX-400 Unit 2        ⎙ OAT: 84        13:02:47
                                   SETUP              NAMES FULL      *ALARM*
1: This Unit  C2: IO Network  C3: ECT    C4:      C5: Echelon   ADVISORY SUMMARY
6:            C7:      C8:      C9:       C0:                   Fails          1
                  Num Network Ctrls: NetSetup                   Alarms         0
                                                                Notices        2
   ┌ECT──────────────────────────────────────────────x─┐
   │                                                  6 │      NETWORK OVERVIEW
   │              NETWORK SETUP                       3 │      IONet           ◆
   │                                                  9 │      MODBUS-1        ◆
   │   1.  Network Summary                            9 │      MODBUS-2        ◆
   │                                                  3 │      Echelon         ◆
   │   2.  Connected I/O Boards & Controllers         0 │
   │                                                  1 │
   │   3.  Router Setup                               4 │
   │                                                  3 │
   │   4.  Controller Associations                    1 │
   │                                                  4 │
   │    #11 : Perf Alert          0      63           │
   │    #12 : RLDS                0      15           │      THIS CONTROLLER
   │    #13 : Status Display      0       7           │      Model: RX-400  00
   │    #14 : WR T-Stat           0       0           │      Unit: 2
   │    #15 : XEV12D              0      99           │      IP: 10.213.236.128
   │    #16 : XEV22D              0      99           │      F/W Rev: 4.03F01
   │    #17 : XJ Scroll Unit      0      16 ▼         │
   └──────────────────────────────────────────────────┘
Press menu number or scroll to selection
```

7. The CoreSense™ K5 devices should be present on the Network. Select the CoreSense K5 module to be commissioned. Press F4: Commission


```
08-23-12 ◆ ◌ ⒯                    RX-400 Unit 2        ⎙ OAT: 83        13:04:44
                                 Network Summary      NAMES FULL      *ALARM*

 Name          Type          Network Address   Rev    Status      ADVISORY SUMMARY
                                                                   Fails          1
 ---------------------------------------------------------------   Alarms         0
 RX400 LT      RX400-Refrig     LONWorks:      2 4.03F01 This Controller  Notices  3
 CS-100 LT.01  CS100-Ckt Sucti  023DFBEA0100:  2 2.01B02 Online
 16AI_001      16AI             IONet:         1 0.00   Online     NETWORK OVERVIEW
 16AI_002      16AI             IONet:         2 0.00   Online     IONet          ◆
 16AI_003      16AI             IONet:         3 0.00   Online     MODBUS-1       ●
 16AI_004      16AI             IONet:         4 0.00   Online     MODBUS-2       ◆
 16AI_005      16AI             IONet:         5 0.00   Online     Echelon        ◆
 8RO_001       8RO              IONet:         1 0.00   Online
 8RO_002       8RO              IONet:         2 0.00   Online
 8RO_003       8RO              IONet:         3 0.00   Online
 8RO_004       8RO              IONet:         4 0.00   Online
 4AO_001       4AO              IONet:         1 0.00   Online
 4AO_002       4AO              IONet:         2 0.00   Online
 4AO_003       4AO              IONet:         3 0.00   Online
 IRLDS_001     IRLDS            IONet:         1 0.00   Online
 MFLEX ESR_001 MultiFlex ESR    IONet:         1 0.00   Online     THIS CONTROLLER
 CD05 01 ISLFRZ CtrlLink CD     MODBUS-1:      5 2.07F01 Online    Model: RX-400  00
 CD06 01 ISLFRZ CtrlLink CD     MODBUS-1:      6 2.07F01 Online    Unit: 2
 CT_001        CT Drive         MODBUS-1:     13 0.00   Online     IP: 10.213.236.128
 K5RS_001      K5 Ref Scroll    MODBUS-1:      - 0.00   Unknown    F/W Rev: 4.03F01
 LRS_002 LT    K5 Ref Scroll    MODBUS-1:      8 1.00F03 Online

  F1: DELETE RCRD   F2: STATUS   F3: NET STATUS   F4: COMMISSION   F5: SETUP
```

8. Select the Modbus™ that the CoreSense device is connected to. (If only Modbus™ network is connected, this step will automatically complete itself, skip to step 9)


```
8-23-12 ◆ ◌ ⒯                                        ⎙ OAT: 83        13:04:44
                                 Network Summary      NAMES FULL      
 Name          Type          Network Address   Rev    Status      ADVISORY SUMMARY
                                                                   Fails          1
 ----------------┌Select Network────────┐-----------------------  Alarms         0
 RX400 LT      RX400-Refrig│              │ 2 4.03F01 This Controller  Notices  3
 CS-100 LT.01  CS100-Ckt Su│             │ 2 2.01B02 Online
 16AI_001      16AI         │ 1.  MODBUS-2│ 1 0.00   Online
 16AI_002      16AI         │ 2.  MODBUS-1│ 2 0.00   Online     NETWORK OVERVIEW
 16AI_003      16AI         └──────────────┘ 3 0.00  Online     IONet          ◆
 16AI_004      16AI             IONet:         4 0.00   Online     MODBUS-1       ●
 16AI_005      16AI             IONet:         5 0.00   Online     MODBUS-2       ◆
 8RO_001       8RO              IONet:         1 0.00   Online     Echelon        ◆
 8RO_002       8RO              IONet:         2 0.00   Online
 8RO_003       8RO              IONet:         3 0.00   Online
 8RO_004       8RO              IONet:         4 0.00   Online
 4AO_001       4AO              IONet:         1 0.00   Online
 4AO_002       4AO              IONet:         2 0.00   Online
 4AO_003       4AO              IONet:         3 0.00   Online
 IRLDS_001     IRLDS            IONet:         1 0.00   Online
 MFLEX ESR_001 MultiFlex ESR    IONet:         1 0.00   Online     THIS CONTROLLER
 CD05 01 ISLFRZ CtrlLink CD     MODBUS-1:      5 2.07F01 Online    Model: RX-400  00
 CD06 01 ISLFRZ CtrlLink CD     MODBUS-1:      6 2.07F01 Online    Unit: 2
 CT_001        CT Drive         MODBUS-1:     13 0.00   Online     IP: 10.213.236.128
 K5RS_001      K5 Ref Scroll    MODBUS-1:      - 0.00   Unknown    F/W Rev: 4.03F01
 LRS_002 LT    K5 Ref Scroll    MODBUS-1:      8 1.00F03 Online
Press menu number or scroll to selection
                                                                   F5: CANCEL
```
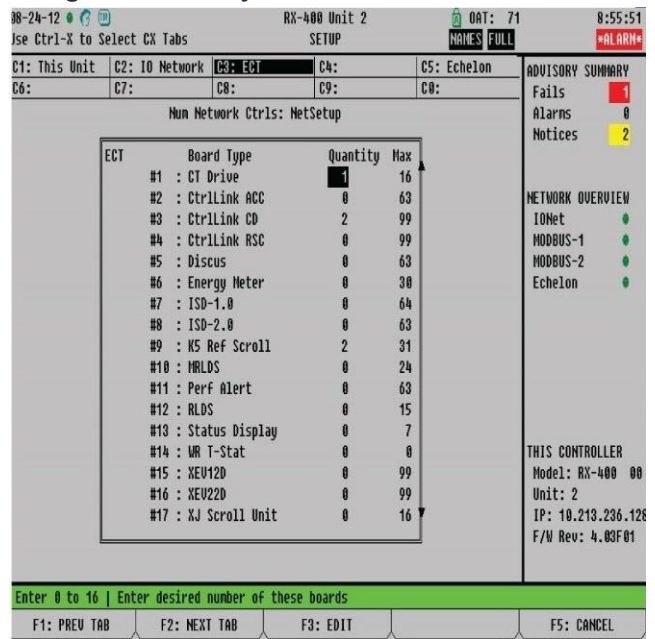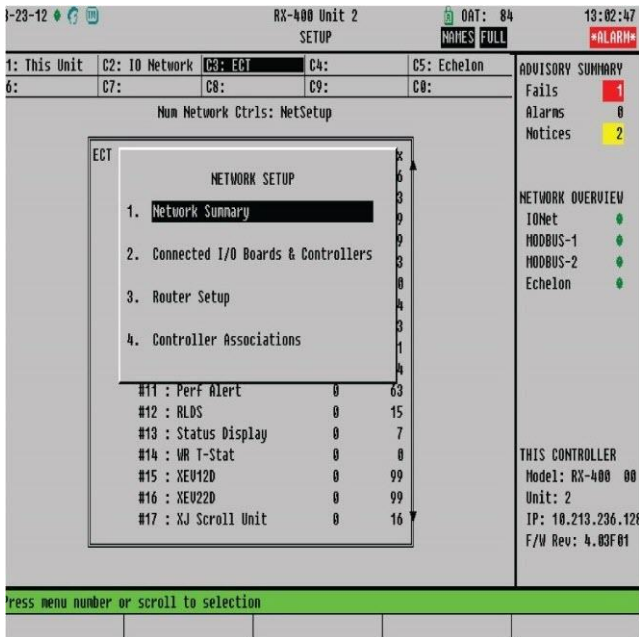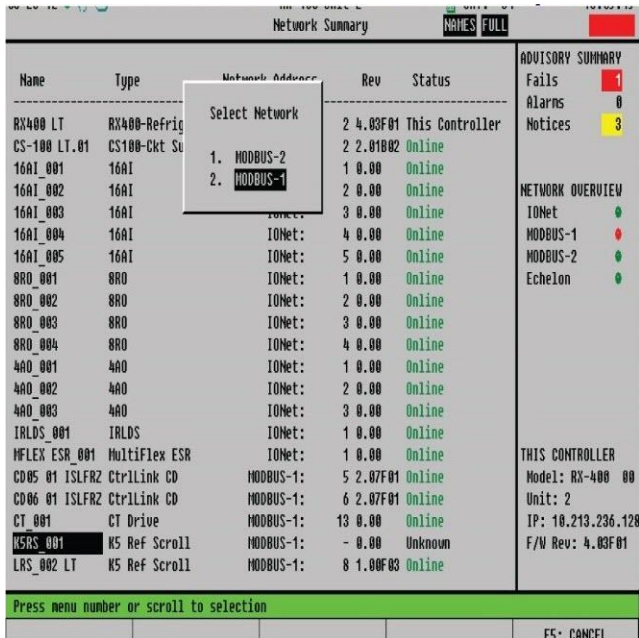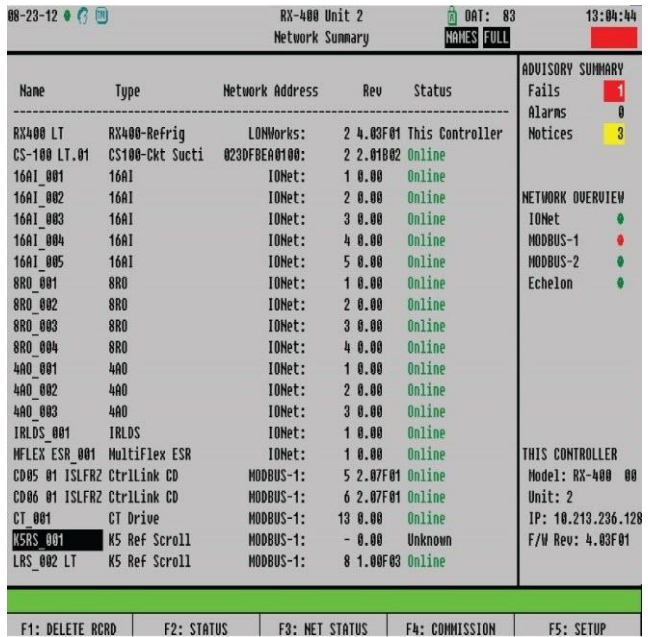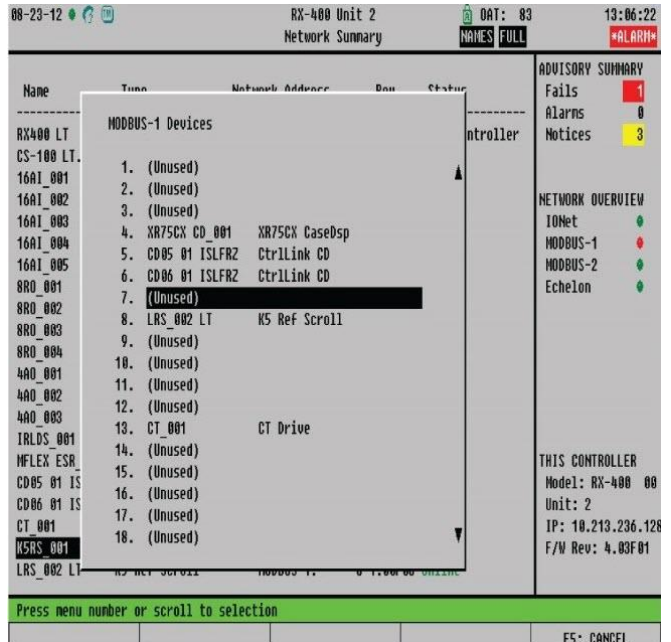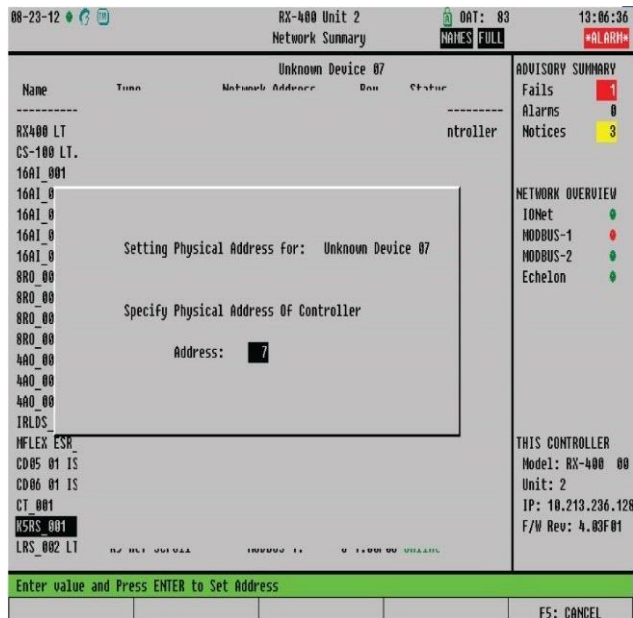
9. From the Modbus™ Device Menu select an unused space that matches the DIP switch Address of the CoreSense device and press Enter.


```
08-23-12 ◆ ◌ ⒯                    RX-400 Unit 2        ⎙ OAT: 83        13:06:22
                                 Network Summary      NAMES FULL      *ALARM*

 Name          Type          Network Address   Rev    Status      ADVISORY SUMMARY
                                                                   Fails          1
 ---------┌MODBUS-1 Devices───────────────────────┐------------    Alarms         0
 RX400 LT │                                       │    ntroller    Notices        3
 CS-100 LT│  1.  (Unused)                      ▲  │
 16AI_001 │  2.  (Unused)                         │
 16AI_002 │  3.  (Unused)                         │
 16AI_003 │  4.  XR75CX CD_001   XR75CX CaseDsp   │               NETWORK OVERVIEW
 16AI_004 │  5.  CD05 01 ISLFRZ  CtrlLink CD      │               IONet          ◆
 16AI_005 │  6.  CD06 01 ISLFRZ  CtrlLink CD      │               MODBUS-1       ●
 8RO_001  │  7.  (Unused)                         │               MODBUS-2       ◆
 8RO_002  │  8.  LRS_002 LT      K5 Ref Scroll    │               Echelon        ◆
 8RO_003  │  9.  (Unused)                         │
 8RO_004  │ 10.  (Unused)                         │
 4AO_001  │ 11.  (Unused)                         │
 4AO_002  │ 12.  (Unused)                         │
 4AO_003  │ 13.  CT_001          CT Drive         │
 IRLDS_001│ 14.  (Unused)                         │
 MFLEX ESR│ 15.  (Unused)                         │               THIS CONTROLLER
 CD05 01 IS│ 16. (Unused)                         │               Model: RX-400  00
 CD06 01 IS│ 17. (Unused)                         │               Unit: 2
 CT_001   │ 18.  (Unused)                      ▼  │               IP: 10.213.236.128
 K5RS_001 └───────────────────────────────────────┘               F/W Rev: 4.03F01
 LRS_002 LT     K5 Ref Scroll    MODBUS-1:    8 1.00F03 Online
Press menu number or scroll to selection
                                                                   F5: CANCEL
```
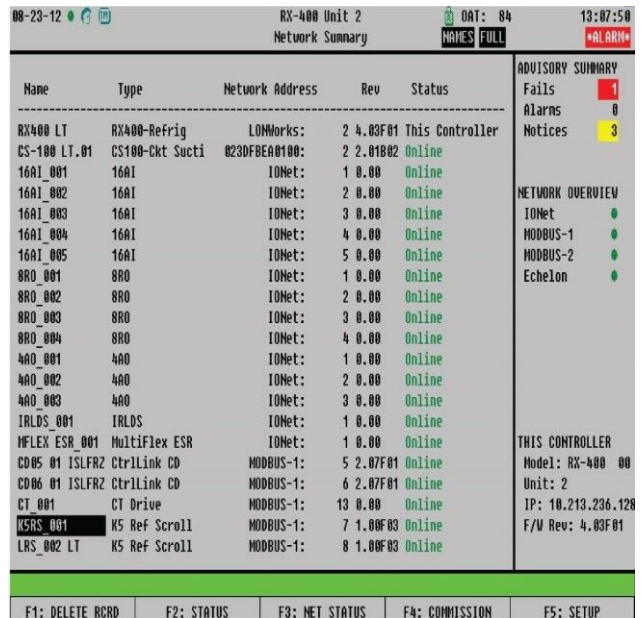
10. Verify the address matches the address assigned by the CoreSense module's DIP switch settings and press Enter.
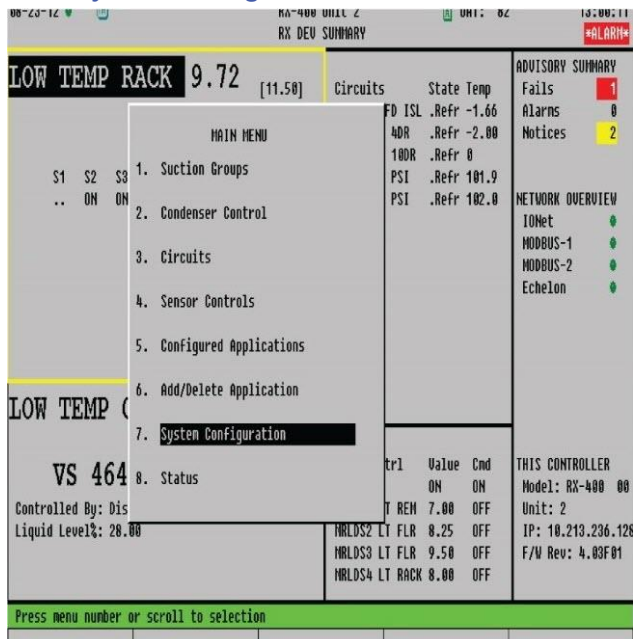
11. Press [icon] **to return to the Network Summary screen. The device should now be "Online".**
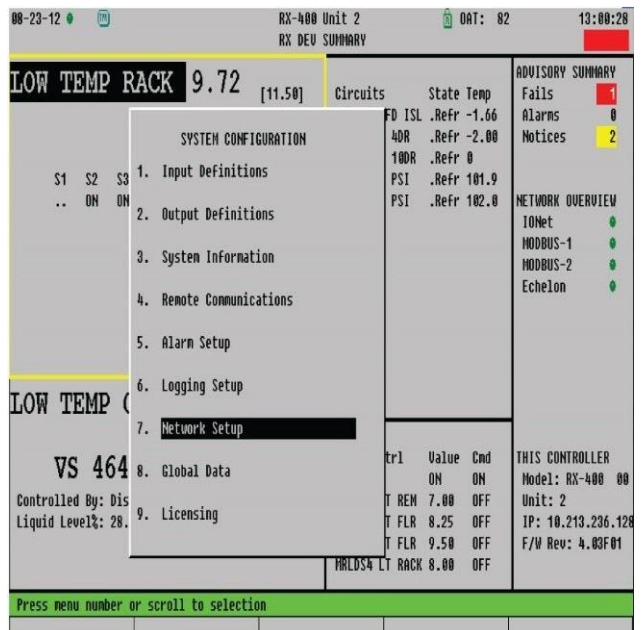**Repeat steps 8-10 to address the remaining CoreSense K5 modules.**

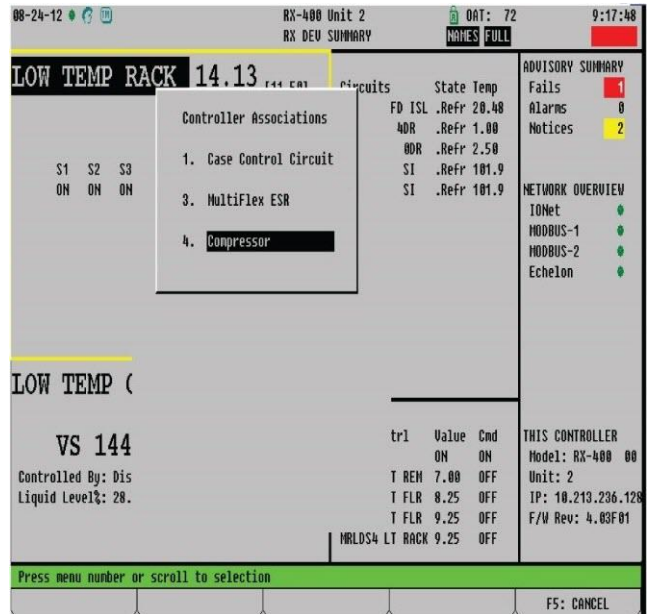**12. Once all the devices are addressed, press** [icon] **to save changes and exit the Network Summary.**

13. Press [Menu] **to enter the Main Menu. Select 7. System Configuration.**

14. From the System Configuration Menu select 7. Network Setup

3

15. From the Network Setup Menu, select *4. Controller Associations* . Then Select *4. Compressor* (Press Enter)
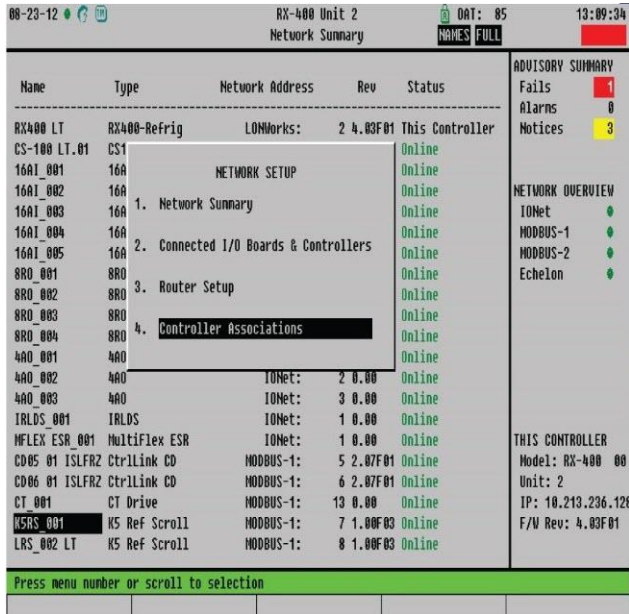
16. Highlight the Suction Group₂ field, select *F4: Look Up* (Press F4) and select the appropriate suction group for the device and press Enter.
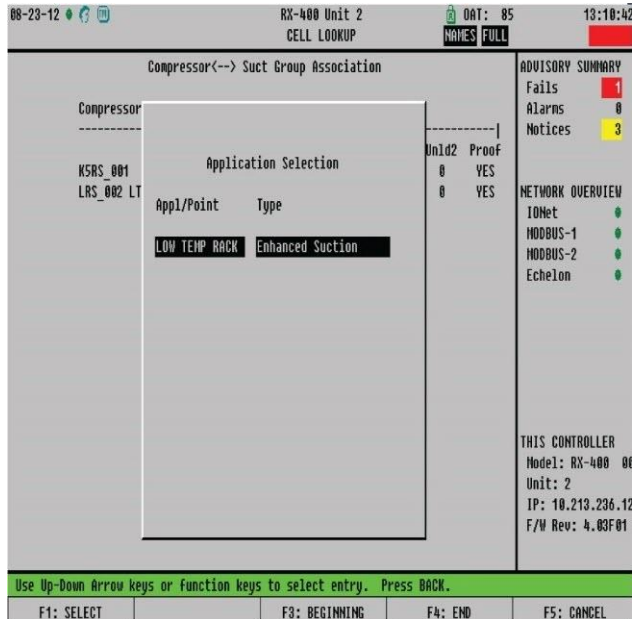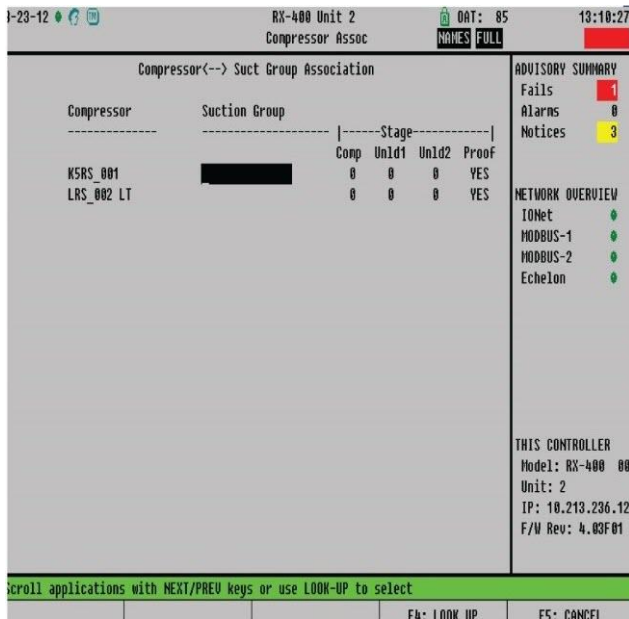
For more information on setting up suction groups in the E2, consult your Emerson Retail Solutions representative.

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17. Scroll over to the Comp Stage and type in the compressor stage. (CoreSense Protection provides proofing only on the compressor.)
Note! The compressor stage number should correspond to the stage numbers in the suction group setup (Step 7)

```
08-23-12 ● (  ▥                    RX-400 Unit 2          🔋 OAT: 85          13:12:14
                              Compressor Assoc        NAMES FULL        ▮▮▮▮▮

              Compressor<--> Suct Group Association              ADVISORY SUMMARY
                                                                 Fails           1
         Compressor        Suction Group                         Alarms          0
         --------------    -------------------- |------Stage------------|   Notices   3
                                                Comp  Unld1  Unld2  Proof
         K5RS_001          LOW TEMP RACK          1      0      0    YES    NETWORK OVERVIEW
         LRS_002 LT                               0      0      0    YES    IONet         ◆
                                                                            MODBUS-1      ◆
                                                                            MODBUS-2      ◆
                                                                            Echelon       ◆



                                                                            THIS CONTROLLER
                                                                            Model: RX-400  00
                                                                            Unit: 2
                                                                            IP: 10.213.236.128
                                                                            F/W Rev: 4.03F01

      Enter Compressor Stage 1 to 16

                                                                            F5: CANCEL
```

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APPENDIX B

CoreSense™ Diagnostics for Copeland Scroll™ K5 Refrigeration Compressors Modbus™ Specification

TABLE OF CONTENTS

TABLE OF FIGURES

TABLE

1.0　　　Introduction

The CoreSense™ Diagnostics module for Copeland Scroll™ K5 refrigeration compressors provides the protection, diagnostics and communication features to the 8-15 HP scroll compressors. By monitoring and analyzing data from the Copeland Scroll compressors, the module can accurately detect the cause of electrical and system related issues. If an unsafe condition is detected, the module trips the compressor. A flashing LED indicator displays the ALERT code and guides the service technician more quickly and accurately to the root cause of a problem.

1.1 Abbreviations

Table 1 - Abbreviations

Abbreviation	Meaning
RTU	Remote Terminal Unit
DLT	Discharge Line Temperature
OAC	Overall Alarm Count (Total number of alarms since the module has been installed)
CRC	Cyclic Redundancy Check
CMD	Command

1.2 Intent

This document defines standard usage of the Modbus protocol specification for CoreSense Diagnostics modules for Copeland Scroll K5 refrigeration compressors. This will allow third party controllers to easily communicate to our products using a standard Modbus interface.

1.3 Scope

This document only defines the Modbus options that are used in the CoreSense Diagnostics module for Copeland Scroll K5 refrigeration comperssors; it is not intended to replace the Modbus protocol specification. Also, this specification defines the common usage of the physical layer and data link layers and some parts of the application layer interface.

1.4 References

For the details of the Modbus specification, refer to the Modicon Modbus Protocol Reference Guide PI–MBUS–300 Rev. J.

2.0 General Description

Modbus uses a three layer protocol:

- **Physical Layer:** The hardware interface.
- **Data Link Layer:** Defines the reliable exchange of messages.
- **Application Layer:** Defines message structures for the exchange of application specific information.

Modbus has some required features, some recommended features, and some optional features. This specification starts with the physical layer and then works up to the application layer. The application layer defined in this specification defines the standard Modbus memory map and data interchange.

Modbus is a protocol with a single master and multiple slave devices. The master device initiates all messages. The master device is typically a system controller and the slave devices are the CoreSense modules.

3.0 Module Type Identification

Two modules are used with Copeland Scroll K5 refrigeration compressors with CoreSense Diagnostics. The two modules can easily be differentiated by the physical look of the module. The pre January 2015 module has black plastic casing, while the new modules are gray with a silver banner. See pictures below to differentiate.

The main difference between the two is that the new module has EXV and digital capacity control.

3.1 CoreSense Diagnostics Pre January 2015 DIP Switch Settings & Configurations

There are two DIP switch panels on CoreSense Diagnostics module for Copeland Scroll K5 refrigeration compressors.
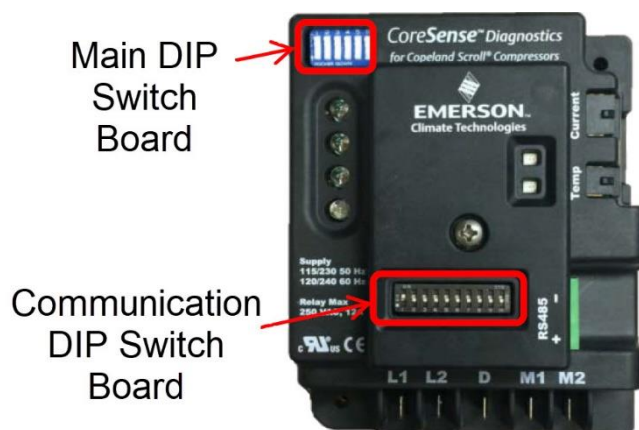

Fig. 1 - Pre January 2015 CoreSense™ Diagnostics DIPSwitch Panels

3.1.1 Main DIP Switch Board

DIP Switches 1-5 are reserved for future use. DIP switch 6 is used to enable/disable lockouts. The UP position enables lockout and the DOWN position disables lockout.

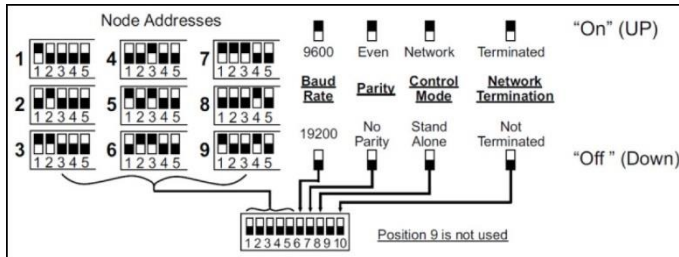### 3.1.2 Communication DIP Switch Board

Fig. 2 - Pre & After January 2015 Communication DIP

3.2 CoreSense Diagnostics After January 2015 DIP Switch Settings & Configurations
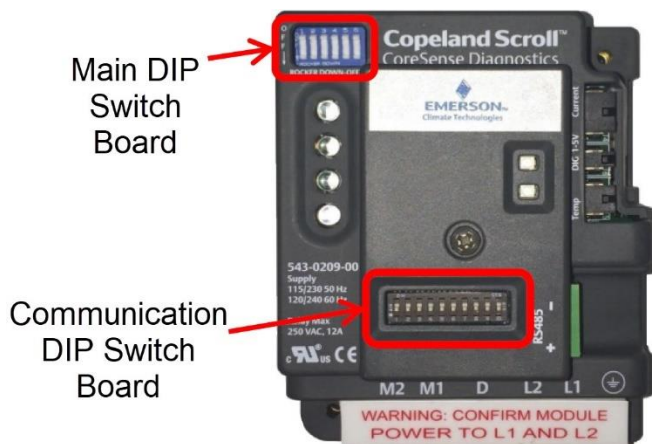
Fig. 3 - After January 2015 CoreSense™ Diagnostics DIP Witch Panels

3.2.1 Main DIP Switch Board
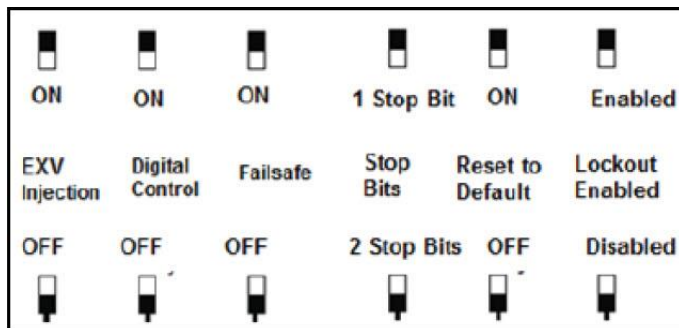
Fig. 4 - After January 2015 Main DIP Switch Board

3.2.2 Communication DIP Switch Board

4.0 Physical Layer

This layer defines the hardware interface to the network.

4.1 Topology

The CoreSense Diagnostics module for Copeland Scroll K5 refrigeration compressors uses the 'two-wire' configuration (two signal wires plus a ground). The standard configuration will be to directly wire to the cable forming a daisy-chain.

4.1.1 Wire Used

The recommended wire will be Belden 8761 that is a 22 AWG shielded twisted pair. The shield is also used as the circuit ground.

Fig. 5 - Recommended Communication Wire

4.1.2 Bus Bias

All master devices must provide a means to bias the network. The recommended pull-down on the RS485 '+' output is a 511 ohm resistor, but up to a 1K ohm resistor is acceptable. The recommended pull-up resistor on the RS485 '-' output is a 511 ohm resistor, but up to 1K ohms is acceptable. These bias resistors can either be always enabled or they can be enabled through jumpers. The bias is applied at one point in the network.

4.1.3 Termination

The last slave in the network shall have a 150 ohm resistor for termination. In this module, there is a termination DIP switch on the communication DIP switch panel. Position 10 DIP switch is used for termination. See Figure 2 for reference. The last CoreSense module in the network shall be terminated by sliding DIP switch 10 up, to the ON position. For the other CoreSense modules in the network, DIP switch 10 shall be down, in the OFF position.

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4.2 Data Signaling Rate

The communications port default settings are 19200, no Parity, 8 data, 2 Stop bits. The baud rate (19200 or 9600), parity (even or no parity) and stop bits (1 bit or 2 bit) are user selectable through DIP switches. Data length is not configurable. See **Fig. 2.** and **Fig. 4** for DIP switch reference.

4.2.1 Baud Rate Selection

CoreSense Diagnostics Modbus communication baud rate setting is configurable to either 19200 or 9600 through DIP switch number 6 on the communication panel. See **Fig. 2**.

ON = 9600
OFF = 19200 (Default)

4.2.2 Parity Selection

CoreSense Protection Modbus communication parity is user configurable (even or no parity) through DIP switch number 7. See **Fig. 2.**

ON = even parity
OFF = no parity (Default)

4.2.3 Stop Bits

CoreSense Diagnostics Modbus communication stop bits is user configurable to either be 1 or 2 stop bit. DIP switch number 4 on the main DIP switch board is used to configure stop bit. See Fig. 4.

ON = 1 stop bits
OFF = 2 stop bits (Default)

Note: Even parity will always be 1 stop bit.

4.3 Labeling

The module has a RS485 port with the connector pins, labeled from top to bottom as:

- '-' Negative

- Middle Connection is not labeled and is ground

- '+' Positive

See Figure 6 for reference.

4.4 Connector

A three position screw cable connector is used for Modbus communication.

4.5 Wiring and Connections

The Modbus wiring should be connected to module connector '-', 'GND', '+'

Fig. 6 - CoreSense™ Diagnostics Modbus Connection

Important! Note that RS485 is polarity sensitive. '+' wires must connect to other '+' terminals and '-' wires must connect to other '-' terminals. The shield wire is connected to the center terminal.

5.0 Data Link Layer

Modbus uses master/slave protocol where there is a single master device that initiates all messages. The Data Link Layer defines the reliable transfer of a message transferred from the master to one or more slave devices and the reliable transfer of the response message (when the command message is sent to a single device). The CoreSense module is a slave in the network and the rack controller is the master.

5.1 Node Address

The DIP switch setting combination gives the node address. The combination positions 1 through 5 will be used to define a node address from 1 to 31. Use Figure 7 and Table 2 for reference.

Note: To enable a DIP switch changes, power to the module must be cycle.
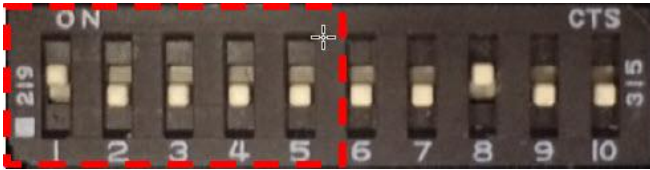
9

Fig. 7 - Switches 1 to 5 are used to set the module

Table 2 - Node Address DIP Configurations

Node Address	1	2	3	4	5
#1	ON	OFF	OFF	OFF	OFF
#2	OFF	ON	OFF	OFF	OFF
#3	ON	ON	OFF	OFF	OFF
#4	OFF	OFF	ON	OFF	OFF
#5	ON	OFF	ON	OFF	OFF
#6	OFF	ON	ON	OFF	OFF
#7	ON	ON	ON	OFF	OFF
#8	OFF	OFF	OFF	ON	OFF
#9	ON	OFF	OFF	ON	OFF
#10	OFF	ON	OFF	ON	OFF
#11	ON	ON	OFF	ON	OFF
#12	OFF	OFF	ON	ON	OFF
#13	ON	OFF	ON	ON	OFF
#14	OFF	ON	ON	ON	OFF
#15	ON	ON	ON	ON	OFF
#16	OFF	OFF	OFF	OFF	ON
#17	ON	OFF	OFF	OFF	ON
#18	OFF	ON	OFF	OFF	ON
#19	ON	ON	OFF	OFF	ON
#20	OFF	OFF	ON	OFF	ON
#21	ON	OFF	ON	OFF	ON
#22	OFF	ON	ON	OFF	ON
#23	ON	ON	ON	OFF	ON
#24	OFF	OFF	OFF	ON	ON
#25	ON	OFF	OFF	ON	ON
#26	OFF	ON	OFF	ON	ON
#27	ON	ON	OFF	ON	ON
#28	OFF	OFF	ON	ON	ON
#29	ON	OFF	ON	ON	ON
#30	OFF	ON	ON	ON	ON
#31	ON	ON	ON	ON	ON

5.2 RTU Transmission Mode

The Modbus communication in the CoreSense module uses the RTU mode. The default character framing will be an 11 bit character as follows:

- 1 start bit
- 8 data bits
- 2 stop bit (or if 'even parity' is selected 1 stop bit and 1 parity bit)

A standard 2 byte CRC is used for frame verification.

5.3 Response Message Timeout

As per the Modbus specification each device can define its own maximum timeout for the response to be sent to a request, the maximum timeout for the module is 1 sec.

6.0 Application Layer

The Application Layer defines the type of messages that will be sent and the format of the messages.

6.1 Available Functions

Table 3 - Standard Modbus Function Codes

Standard Modbus Function Codes Supported by CoreSense™ Diagnostics for Ref K5 Scroll				
Switch Number	Function Code	Function Name	Register	Access
1	0x04	Read Input Registers	Input Register	Read Only
2	0x03	Read Holding Registers	Holding Register	Read/Write
3	0x06	Write Single Register	Holding Register	Read/Write
4	0x10	Write Multiple Registers	Holding Register	Read/Write

6.2 Data Types

Modbus requires that all multiple byte data be sent in Big Endian format. In Big Endian system, the most significant value in the sequence is stored at the lowest storage address (i.e. first).

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6.3 Functions Supported

6.3.1 Input Register (Command 0x04)

Table 4 - Input Register (Command 0x04)

Address (Hex) Start	Address (Hex) Stop	Contents	Quantity	Data Description
0000	001B	Division Name	28	'X'
001C	0021	Product Name	6	X'
0022	0029	Product Code	8	'X'
002A	0030	Module Version Number	7	'X'
0077	0077	Seven Days of Compressor Run Time	7	Today compressor run time One counter means 6 minutes
0078	0078			Today-1 compressor run time One counter means 6 minutes
0079	0079			Today-2 compressor run time One counter means 6 minutes
007A	007A			Today-3 compressor run time One counter means 6 minutes
007B	007B			Today-4 compressor run time One counter means 6 minutes
007C	007C			Today-5 compressor run time One counter means 6 minutes
007D	007D			Today-6 compressor run time One counter means 6 minutes
007E	007E	Seven Days of Compressor Run Time	7	Today compressor start times One counter means 1 time
007F	007F			Today-1 compressor start times One counter means 1 time
0080	0080			Today-2 compressor start times One counter means 1 time
0081	0081			Today-3 compressor start times One counter means 1 time
0082	0082			Today-4 compressor start times One counter means 1 time
0083	0083			Today-5 compressor start times One counter means 1 time
0084	0084			Today-6 compressor start times One counter means 1 time
0085	0086	Total Compressor Run Time	2	One counter means 1 hours 0-4294967295
0087	0088	Total Compressor Start Times	2	One counter means 1 start 0-4294967295
008E	008E	Protection Trip For Seven Days	1	One counter means one time 0-65535
008F	0090	Protection Trip After Power Up	2	One counter means one time 0 - 4294967295

009B	009B		1	Alarm Id of tenth most recent alarm
009C	009C		1	Alarm Id of ninth most recent alarm
009D	009D		1	Alarm Id of eighth most recent alarm
009E	009E		1	Alarm Id of seventh most recent alarm
009F	009F	Ten Most Recent Alarm	1	Alarm Id of sixth most recent alarm
00A0	00A0		1	Alarm Id of fifth most recent alarm
00A1	00A1		1	Alarm Id of most fourth recent alarm
00A2	00A2		1	Alarm Id of third most recent alarm
00A3	00A3			Alarm Id of second most recent alarm
00A3	00A4		1	Alarm Id of most recent alarm

6.3.2 Hold Register (Command 0x03, 0x06, 0x10)

Table 5 - Hold Register (Command 0x03, 0x06, 0x10)

Address (Hex)		Contents	Quantity	Data Description
Start	Stop			
0025	0036	Compressor Module Number	18	'X'
0037	0042	Compressor Serial Number	12	'X'
0051	005C	Module Part Number	12	'X'
005D	0069	Module Serial Number	13	'X'
0076	0076	EXV Control Type	1	0x00 – Automatic based on the temperature; 0x01 - Manual control Default: Automatically
0077	0077	EXV Position for Manual Control	1	if the EXV control type is automatic, then ignore this item; 0~100 means the EXV open is 0%~100%
0078	0078	Proportionality Coefficient Set	1	0~65535 means 0~655.35
0079	0079	Integral Coefficient Set	1	0~65535 means 0~655.35
007A	007A	Differential Coefficient Set	1	0~65535 means 0~655.35
007B	007B	PID Sample Time	1	One Counter Means One Second (1~50s)
007D	007D	PID Set Point Value Set	1	0~65535 means -70~585.35°F The temperature value = (((High byte << 8) + Low byte) - 7000) / 100 The default value should be: 255°F
0080	0080	Minimum On Time	1	Default : 6 seconds Unit : 1 Seconds Range : 0 - 65535 seconds
0081	0081	Minimum Off Time	1	Default : 6 seconds Unit : 1 Seconds Range : 0 - 65535 seconds

0085	0085	Alert Trigger Parameters Configuration	20	DLT temp trip set point value, Unit : 0.01°F ; Range: -70 to 585.35 °F Set point = (Word - 7000)/ 100 (°F)
0086	0086			Default: 297°F DLT temp trip reset point value, Unit : 0.01°F ; Range: -70 to 585.35 °F Reset point =(Word -7000)/100 (°F)
0088	0088			Short Cycle Events Default : 240 0 – 65535
0089	0089			Open Circuit Delay Time Default : 180 minutes Unit : 1 minute Range : 180 – 360
008A	008A			Low Voltage Set point Unit : 0.01 v Range : 0 - 655.35v The master only can read and can't write to this unit.
009A	009A	Alert Off Time Configuration	26	DLT Alert off Time - Unit 1 minutes Default : 20 Minutes Range : 10 - 40
00B4	00B4	Lockout Status Configuration1	1	BIT0 - High Discharge Temperature Lockout Status: 1 - Enable / 0 - Disable BIT3 - Locked Rotor Lockout Status: 1 - Enable / 0 - Disable BIT5 - Missing Phase Lockout Status: 1 - Enable / 0 - Disable BIT6 - Reverse Phase Lockout Status: 1 - Enable / 0 - Disable Others bit: Not used.
00B6	00B6	Lockout Events	20	DLT Trip Lockout Events (Range 0-0xFFFF) Default val=0xFFFF
00B8	00B8			Locked Rotor Trip Lockout Events (Range 0-0xFFFF) Default val=0xFFFF
00B9	00B9			Missing Phase Lockout Events (Range 0-0xFFFF) Default val=0xFFFF
00BA	00BA			Reverse Phase Lockout Events (Range 0-0xFFFF) Default val=0xFFFF The master only can read and can't write to this unit.
00D0	00D0	Module Status Configuration	1	BIT0 - Compressor Run: (0 - Stop / 1 - Run) BIT1 - Remote Reset: (0 - No Action / 1 - Remote Reset)
00D4	00D4	UL1 Capacity Request	1	Default : 0-9% Unit : 1% Valid Range : 0% - 100%
00D6	00D6	Unloader Modulation Period	1	Default : 20 Seconds Unit : 1 Seconds Range : 0 - 65535 Seconds

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7.0 Troubleshooting

If the module communication doesn't respond, here is a list with some general steps for troubleshooting:

1. Check the wiring connection. Ensure the wiring is correctly connected and the connector is not loose.
2. Check the power to the CoreSense module. Check the power supply line and ensure the power is on and green LED is on.
3. Check the module network address. The address should match the address that the master has requested. Note: for the module, the address 0 is invalid.
4. Check your master data format setting. Ensure the master node data format setting is: RTU mode, 1 start bit, 8 data bit, no parity bit, 2 stop bit.
5. Check the master node baud rate setting. First, set your master node baud rate as 19200 and then try to communicate with the module. If the module does not respond, then set to 9600 baud rate and try again.

A third party PC debugging tool can also be used by sending the query shown in Table 6 for getting the firmware version number.

The response indicates the Version Number as 1.01R00 (this version number is only for an example, may change for different models).

	Address	CMD	Start		Length		CRC	
Request for version number	0 8	0 4	0 0	0 2	0 0	0 8	5 0	9 5

The request and response are hex value.

	Address	CMD	Bytes	1		.		0		1		R		0		0		CRC	
Response	0 8	0 4	1 0	0 0	3 1	0 0	2 E	0 0	3 0	0 1	3 0	0 2	5 0	0 1	3 0	0 1	3 7	8 4	