Application Engineering

6 to 10 Ton ZPS*KC Copeland Scroll Two-Stage Compressors

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Contents

Safety

Important Safety Information 2
Responsibilities, Qualifications and Training 2
Terminal Venting and Other Pressurized System Hazards 2
Flammable Refrigerant Hazards 3
Electrical Hazards 3
Hot Surface and Fire Hazards 3
Lifting Hazards 3
POE Oil Hazards 3
Precautions 3
Signal Word Definitions 5

INTRODUCTION

How It Works 6
Capacity Control 6
Nomenclature 6

APPLICATION CONSIDERATIONS

Operating Envelope 7
High Pressure Control 7
Low Pressure Control 7
Discharge Temperature Protection 7
Crankcase Heat 7
Defrost Cycle 7
Unloader Solenoid Wiring 8
Standard Wiring with 24 Volts 8
Part-Load Starting 8
Wired with CoreSense Diagnostics 8

APPLICATION TEST

ASSEMBLY LINE PROCEDURES

Hipot (AC High Potential) Testing 9

SERVICE PROCEDURES

Unloader Test Procedure with Standard 24 Volt Wiring 9
Unloader Test Procedure with CoreSense 9

FIGURES AND TABLES

Figure 1 - ZPS*KC 6
Figure 2 - Full Load Operating Envelope 11
Figure 3 - Example of 24 Volt Modulation Control Wiring 11
Figure 4 - Example of Modulation Control Wiring with CoreSense 12
Figure 5 - Crankcase Heater Location 12

Table 1 - Compressor Refrigerant Charge Limits 13
Table 2 - Solenoid Resistance Values 13
Table 3 - Compressor Accessories 14

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Safety

Important Safety Information

Those involved in the design, manufacture, and installation of a system, system purchasers, and service personnel may need to be aware of hazards and precautions discussed in this section and throughout this document. OEMs integrating the compressor into a system should ensure that their own employees follow this bulletin and provide any necessary safety information to those involved in manufacturing, installing, purchasing, and servicing the system.

Responsibilities, Qualifications and Training

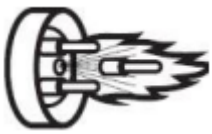
• OEMs are responsible for system design, selection of appropriate components, integration of this component into the system, and testing the system. OEMs must ensure that staff involved in these activities are competent and qualified.

• OEMs are also responsible for ensuring that all product, service, and cautionary labels remain visible or are appropriately added in a conspicuous location on the system to ensure they are clear to any personnel involved in the installation, commissioning, troubleshooting or maintenance of this equipment.

• Only qualified and authorized HVAC or refrigeration personnel are permitted to install, commission, troubleshoot and maintain this equipment. Electrical connections must be made by qualified electrical personnel.

• Observe all applicable standards and codes for installing, servicing, and maintaining electrical and refrigeration equipment.

Terminal Venting and Other Pressurized System Hazards



If a compressor's electrical terminal pin loses its seal, pressurized oil, refrigerant, and debris may spray out. This is called "terminal venting".

The ejected debris, oil, and refrigerant can injure people or damage property. The oil and refrigerant spray can be ignited by electrical arcing at the terminal or any nearby ignition source, producing flames that may project a significant distance from the compressor. The distance depends on the pressure and the amount of refrigerant and oil mixture in the system. The flames can cause serious or fatal burns and ignite nearby materials.

Each compressor has a terminal cover or molded plug that covers electrical connections. The cover or plug helps to protect against electric shock and the risks of terminal venting. If terminal venting occurs, the cover or plug helps contain the spray of refrigerant and oil and reduces the risk of ignition. If ignition occurs, the plug or cover helps contain the flames. However, neither the terminal cover nor the molded plug can completely eliminate the risk of venting, ignition, or electric shock.

See copeland.com/terminal-venting for more details about terminal venting. Additionally, a compressor's refrigerant lines keep refrigerant and oil under pressure. When removing or recharging refrigerant from this component during service, this can pose a pressurized fluid hazard.

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Flammable Refrigerant Hazards



If flammable refrigerant is released from a system, an explosive concentration can be present in the air near the system. If there is an ignition source nearby, a release of flammable refrigerant can result in a fire or explosion. While systems using flammable refrigerant are designed to mitigate the risk of ignition if the refrigerant is released, fire and explosion can still occur.

See copeland.com/flammable-refrigerants for more information on flammable refrigerant safety.

Electrical Hazards



Until a system is de-energized, and capacitors have been discharged, the system presents a risk of electric shock.

Hot Surface and Fire Hazards



While the system is energized, and for some time after it is deenergized, the compressor may be hot. Touching the compressor before it has cooled can result in severe burns. When brazing system components during service, the flames can cause severe burns and ignite nearby combustible materials.

Lifting Hazards



Certain system components may be very heavy. Improperly lifting system components or the compressor can result in serious personal injury. Use proper lifting techniques when moving.

POE Oil Hazards

This equipment contains polyol ester (POE) oils. Certain polymers (e.g., PVC/CPVC and polycarbonate) can be harmed if they come into contact with POE oils. If POE oil contacts bare skin, it may cause an allergic skin reaction.

Precautions

• Always wear personal protective equipment (gloves, eye protection, etc.).

• Keep a fire extinguisher at the jobsite at all times.

• Keep clear of the compressor when power is applied.

- IMMEDIATELY GET AWAY **if you hear unusual sounds in the compressor. They can indicate that terminal pin ejection may be imminent. This may sound like electrical arcing (sizzling, sputtering or popping). However, terminal venting may still occur even if you do not hear any unusual sounds.**

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• Never reset a breaker or replace a blown fuse without performing appropriate electrical testing

- **A tripped breaker or blown fuse may indicate an electrical fault in the compressor. Energizing a compressor with an electrical fault can cause terminal venting. Perform checks to rule out an electrical fault.**

• Disconnect power and use lock-out/tag-out procedures before servicing.

- Before removing the terminal cover or molded plug, check that ALL electrical power is disconnected from the unit. Make sure that all power legs are open. (Note: The system may have more than one power supply.)

- Discharge capacitors for a minimum of two minutes

- Always use control of hazardous energy (lock-out/tag-out) procedures to ensure that power is not reconnected while the unit is being serviced.

• Allow time for the compressor to cool before servicing.

- Ensure that materials and wiring do not touch high temperature areas of the compressor.

• Keep all non-essential personnel away from the compressor during service.

• For A3 refrigerants (R290) remove refrigerant from both the high and low sides of the compressor. Use a recovery machine and cylinder designed for flammable refrigerants. Do not use standard recovery machines because they contain sources of ignition such as switches, high- and low-pressure controls and relays. Only vent the R290 refrigerant into the atmosphere if the system is in a well-ventilated area.

• Never use a torch to remove the compressor. Only tubing cutters should be used for both A2L and A3 refrigerants.

• Use an appropriate lifting device to install or remove the 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.

• Always wear appropriate safety glasses and gloves when brazing or unbrazing system components.

• Charge the system with only approved refrigerants and refrigeration oils.

• Keep POE oils away from certain polymers (e.g., PVC/CPVC and polycarbonate) and any other surface or material that might be harmed by POE oils. Proper protective equipment (gloves, eye protection, etc.) must be used when handling POE lubricant. Handle POE oil with care. Refer to the Safety Data Sheet (SDS) for further details.

• Before energizing the system:

1. Securely fasten the protective terminal cover or molded plug to the compressor, and

2. Check that the compressor is properly grounded per the applicable system and compressor requirements.

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Signal Word Definitions

The signal word explained below are used throughout the document to indicate safety messages.



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



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



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

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INTRODUCTION

The ZPS*KC two-stage modulated Copeland Scroll™ compressors are ideally suited for commercial and light commercial applications where a capacity stage reduction and part-load efficiency are desired. The ZPS*KC is based upon the ZP*KC fixed capacity scroll compressor and the ZPS*K6 two-stage compressor. (Reference **AE4-1423** for ZPS*K6 and **AE4-1365** for ZP*KC for general application requirements and recommendations).

How It Works

A 24-volt DC solenoid valve inside the compressor provides the means to modulate the compressor. When the solenoid valve is energized the compressor is in full-load and when de-energized the compressor is in part-load. When the ZPS*KC solenoid is energized a 3-way solenoid valve provides pressure to a lift ring assembly that is used to open and close the scroll modulation ports. A single-speed motor continues to run while the scroll modulates between the two capacity stages. See Figure 1 for hardware pictorial.

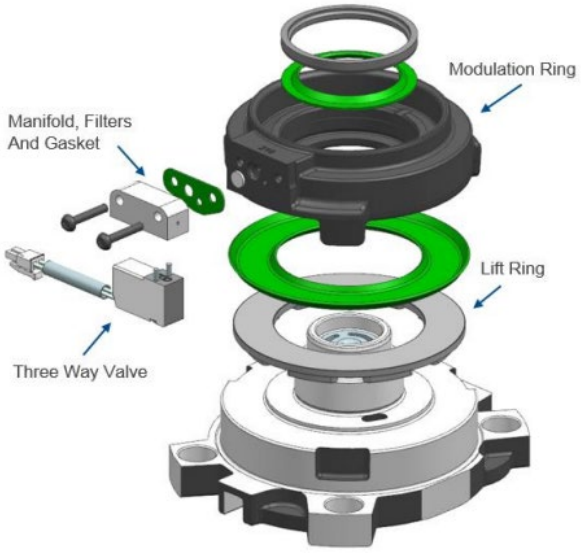


*Figure 1 - ZPS*KC*

Capacity Control

The compression process of a scroll compressor is described in **AE4-1365, Figure 8**. At any point in the compression process, there are several pockets within the scroll that are compressing gas. Modulation is achieved by venting a portion of the gas in the first suction pocket back to the low side of the compressor thereby reducing the effective displacement of the compressor. Full capacity is achieved by blocking these ports, thus increasing the displacement to 100%. When the solenoid is energized, the compressor is in full-load or 100% of its capacity. When the solenoid is de-energized the compressor is in part-load or approximately 67% of its full-load capacity. The loading and unloading of the two-stage scroll are done “on the fly” without shutting off the motor between stages. The unloaded mode default was chosen for two reasons:

1. It is expected that most run hours will be in a low capacity, part-load mode.
2. It allows a simple two-stage thermostat to control capacity through the second stage in both cooling and heating.

Nomenclature

The model numbers of the Copeland Scroll compressors include the approximate nominal 60Hz capacity at AHRI operating conditions of 45°F(7.2°C) evaporating temperature and 130°F (54.4°C) condensing temperature. An example would be the ZPS83KCE-TF5 which has 83,000 Btu/hr (24.3. kW) at the above mentioned full-load condition. Both full and part-load performance data are published throughout the entire operating envelope and can be found in the Online Product Information(OPI) at **Copeland.com/OPI**

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APPLICATION CONSIDERATIONS

In most respects, the two-stage scroll will operate like a standard scroll in both the high and low capacity mode. The basic application guidelines in AE4-1365 should be adhered to for ZPS*KC compressors. There are a few important differences outlined below that must be observed when designing a system with the Copeland Scroll ZPS*KC two-stage compressor.

Operating Envelope

The ZPS*KC compressor family is approved for use with R410a only. The ZPS*KC compressors can operate at full-load capacity throughout the entire specified operating envelope, see Figure 2. There are operating envelope limitations in part load. Contact Application Engineering for more information. The envelope represents acceptable operating conditions with 20°F (11°K) superheat in the return gas.

High Pressure Control

A high-pressure cut-out is recommended for the highest level of system reliability. If a high-pressure cut-out control is used the maximum setting should not exceed 650 psig (45 bar). The high-pressure cut-out control should have a manual reset for the highest level of system protection**. It is not recommended to use the compressor to test the high-pressure switch function during the unit assembly line run test**.

Low Pressure Control

A low-pressure cut-out is recommended on all ZPS*KC applications for the highest level of system reliability. The low-pressure cutout should be set no lower than 20 psig (1.4 bar) for heat pumps and 55 psig (3.8 bar) for air-conditioning units.

Discharge Temperature Protection

NOTICE

The ZPS*KC two-stage compressor does not have Internal Pressure Relief valve.

CAUTION

Compressor top cap temperatures can be very hot. Care must be taken to ensure that wiring or other materials which could be damaged by these temperatures do not come into contact with these potentially hot areas.

All ZPS*KC two-stage compressors have Therm-ODisc temperature protection. The Therm-O-Disc™ or TOD is a temperature-sensitive snap disc device located between the high and low pressure side of the scroll. It is designed to open and route excessively hot discharge gas back to the internal motor overload when the internal discharge gas exceeds 290°F (144°C).

Crankcase Heat

A crankcase heater is required for systems containing more than 120% of the compressor refrigerant charge limit listed in **Table 1**. This includes long line length systems where the extra charge will increase the standard factory charge above the 120% limit.

Available crankcase heaters are listed in **AE4-1365** or Copeland.com/OPI. Refer to Figure 5 for proper installation of the crankcase heater.

WARNING

Crankcase heaters must be properly grounded.

Defrost Cycle

Defrosting with the compressor in full-load, versus part-load, is highly recommended and will help defrost the

outdoor coil in a shorter period, reduce sound, and help the reversing valve shift positions during low outdoor ambient temperatures when flow conditions can be low.

CAUTION

Reversing valve sizing must be within the guidelines of the valve manufacturer. Required pressure drop to ensure valve shifting must be measured throughout the operating range of the unit and compared to the valve manufacturer's data. Low ambient heating conditions with low flow rates and low pressure drop across the valve can result in a valve not shifting. This can result in a condition where the compressor appears to be not pumping (i.e. balanced pressures). It can also result in elevated compressor sound levels.

Unloader Solenoid Wiring

NOTICE

The current in the ZPS*KC modulation solenoid circuit must be less than 0.9 mA for the solenoid valve to change from full-load to part-load. If the current is greater than 0.9 mA the solenoid valve can stay in full-load. A time delay relay or another current consuming load in series with the modulation solenoid could result in current greater than 0.9 mA.

Standard Wiring with 24 Volts

A nominal 24-volt direct current coil activates the internal unloader solenoid in the ZPS*KC compressors. The input control circuit voltage must be 18 to 28-volt AC or DC. The maximum solenoid VA is 5. The external solenoid electrical connection is made with a molded plug assembly, see **Table 3** for the appropriate part number. This plug contains a full wave rectifier to supply direct current to the unloader coil if the control circuit is AC. If the control circuit is DC, the same plug with the full wave rectifier can be used as the full wave rectifier will have no effect on the DC voltage input. When a DC power source is used, the polarity of the DC input to the plug isn't critical. The rectified molded plug can be sourced from some of the same suppliers of the molded electrical plug used to power the compressor motor. A simple wiring diagram is shown in **Figure 3.**

Part-Load Starting

There are several benefits associated with starting the compressors in part-load. Improved starting is realized during a low voltage and/or flooded start condition whereby stress on the motor, scrolls, and 3-way modulation valve is significantly reduced. Starting in part-load can result in the compressor starting and accelerating to full speed faster, thereby reducing the perception of light dimming. Part-load starting also reduces the inrush current on the 24 volt transformer. For the highest level of system reliability, part-load starting is recommended for all ZPS*KC compressors.

Wired with CoreSense Diagnostics

CoreSense provides both diagnostics and active protection, in addition to modulation features. Please read **2005ECT-191** for more information on CoreSense Diagnostics for modulated compressors. A simple wiring diagram for CoreSense is shown in **Figure 4**. See **Table 3** for applicable compressor models that can utilize CoreSense Diagnostics modules.

APPLICATION TEST

Refer to the **Application Tests** section of **AE4-1365** for the application tests to run to help ensure a reliable application. Consult with your Copeland Application Engineer if interpretation of application test results are required.

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ASSEMBLY LINE PROCEDURES

Hipot (AC High Potential) Testing

CAUTION

Use caution with high voltage and never hipot when compressor is in a vacuum.

If the 24-volt modulation solenoid circuit is dielectric (hipot) strength tested, the maximum applied voltage should not exceed 1,000 volts RMS for 1 second at 2.0mA maximum leakage current.

SERVICE PROCEDURES

CAUTION

Use caution when troubleshooting energized circuits.

Unloader Test Procedure with Standard 24 Volt Wiring

If it is suspected that the unloader is not working, the following methods may be used to verify operation.

1. Operate the system and measure compressor amperage. Cycle the unloader on and off at ten second intervals. An increase in compressor amperage should be observed when switching from part-load to full-load and a reduction in compressor amperage should be observed when changing from full-load to part-load. The percent change in current depends on the operating conditions and voltage.
2. Shut off power and remove the control circuit molded plug from the compressor and measure the unloader solenoid coil resistance. The solenoid coil should have continuity and not be grounded or have infinite resistance. If the coil resistance is infinite, zero, or grounded, the compressor must be replaced. See **Table 2** for modulation solenoid resistance values.
3. Check the molded plug. Voltage check: Apply control voltage to the plug wires (18 to 28 VAC). The measured DC voltage at the connectors in the plug should be around 15 to 27 VDC.

   Resistance check: Measure the resistance from the end of one molded plug lead to either of the two female connectors in the plug. One of the connectors should read zero ohms while the other should read infinity. Repeat with other connector. The same female connector as before should read zero while the other connector again reads infinity. Reverse polarity on the ohmmeter leads and repeat. The female connector that read infinity previously should now read close to zero ohms. Replace plug if either of these test methods doesn't show the desired results.

Unloader Test Procedure with CoreSense

If it is suspected that the unloader is not working, the following methods may be used to verify operation.

1. Operate the system and measure compressor amperage. Cycle the unloader on and off at ten second intervals by applying and removing Y2 voltage to the module. Wait five seconds after power is applied to Y2 before taking a reading. An increase in compressor amperage should be observed when switching from part-load to full-load and a reduction in compressor amperage should be observed when changing from full-load to partload. The percent change in current depends on the operating conditions and voltage.
2. If Step 1 does not give the expected results remove the solenoid plug from the compressor and with the unit running and the thermostat calling for Y2 to be energized test the voltage output at the plug with a dc voltmeter. The reading should be 18 to 28 VDC for CoreSense Diagnostics module. If not, unplug the harness

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from the module and check voltage at the “DC Sol” pins of the module. The module will not power the unloader solenoid if the compressor is not running or Fault Code 1 or 9 is active.

3. If the correct DC voltage is at the control circuit molded plug measure the unloader coil resistance. The solenoid coil should have continuity and not be grounded or have infinite resistance. If the coil resistance is infinite, zero, or grounded, the compressor must be replaced.

For more information on service practices refer to **Service Procedures** in **AE4-1365.**

FIGURES AND TABLES

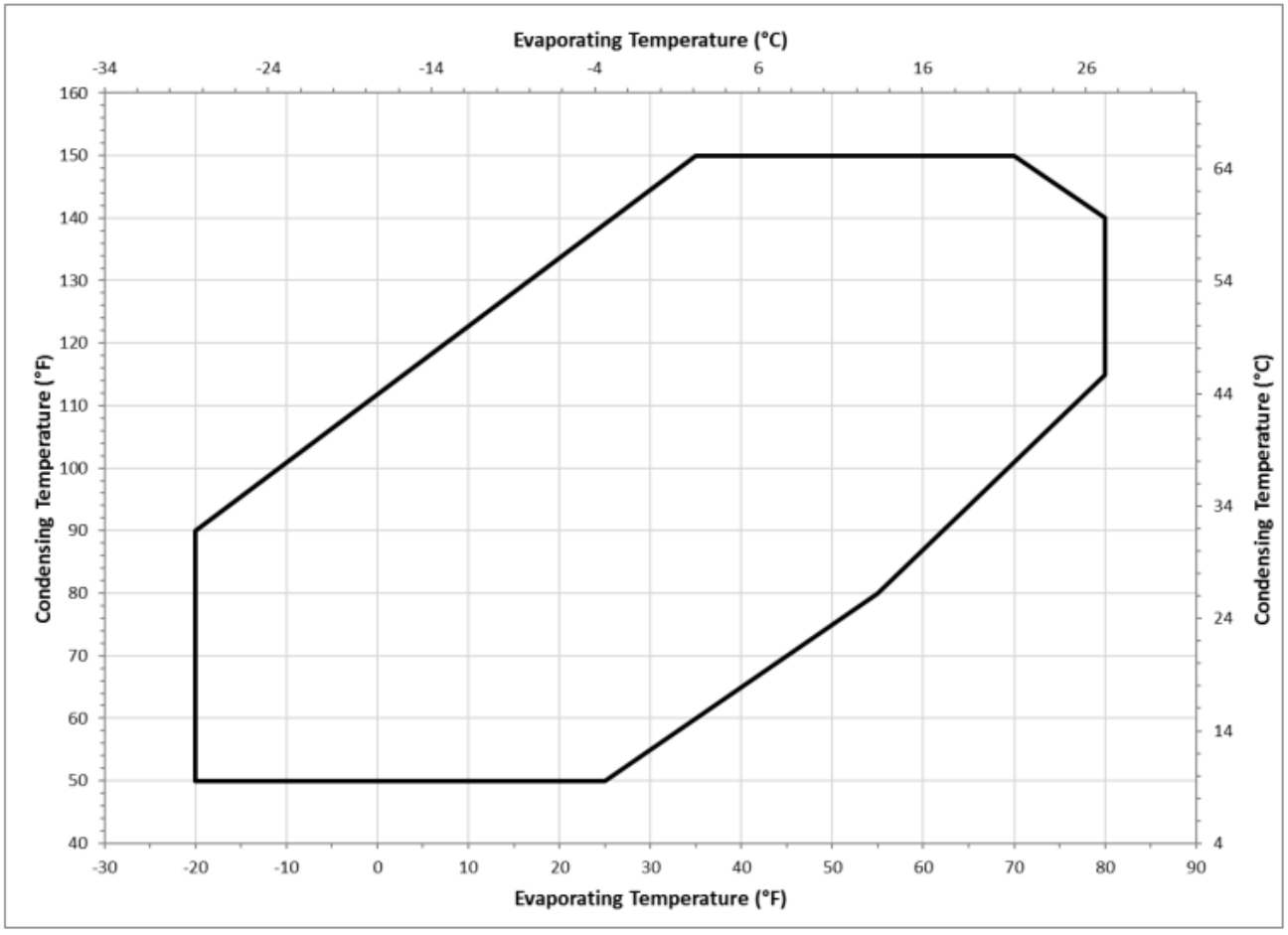


Figure 2 - Full Load Operating Envelope

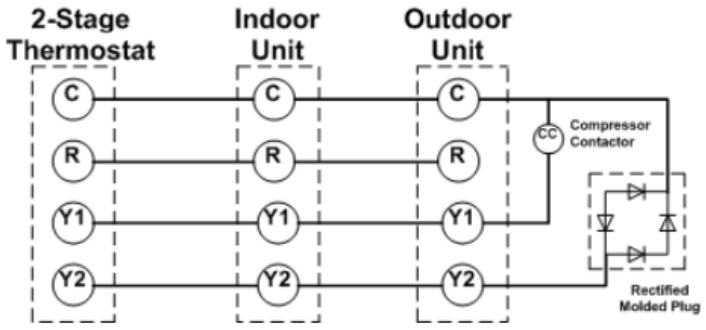


Figure 3 - Example of 24 Volt Modulation Control Wiring

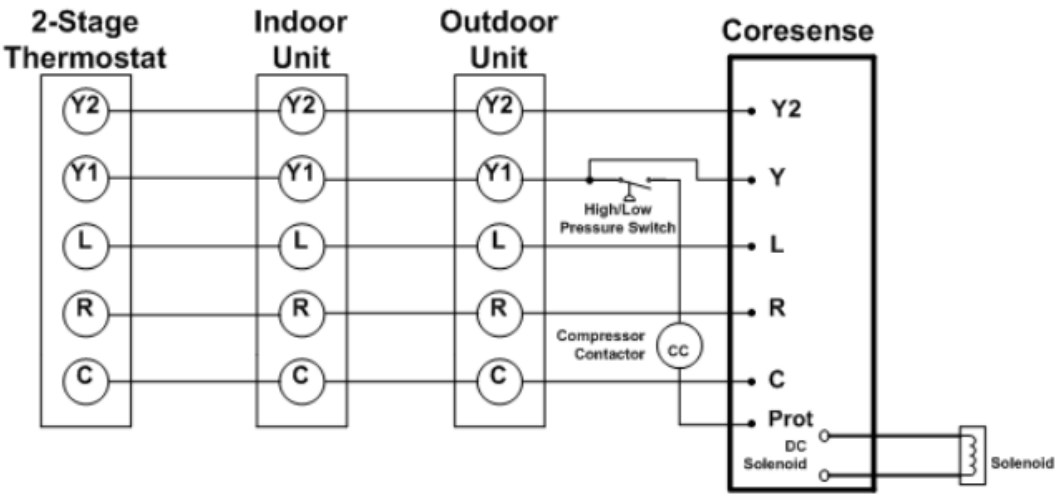


Figure 4 - Example of Modulation Control Wiring with CoreSense

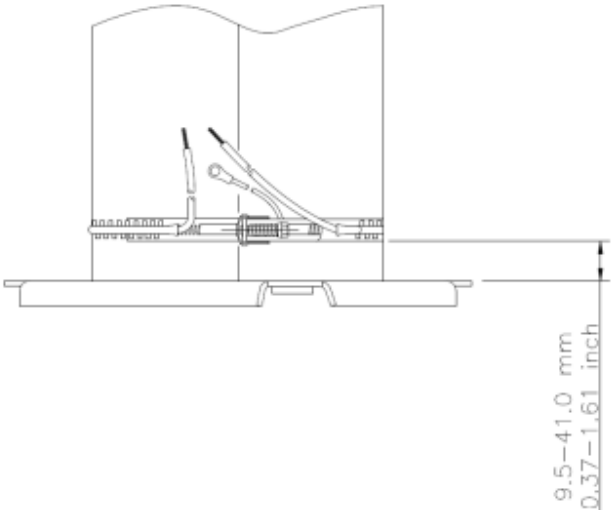


Figure 5 - Crankcase Heater Location

Connect the heater so that the connection point straddles the compressor seam weld.

WARNING

Verify the correct crankcase heater voltage for the application and ensure heater is properly grounded

Table 1 - Compressor Refrigerant Charge Limits

Model	Frame Size*	Charge Limit		120% x Limit**	
		Pounds	kg	Pounds	kg
ZPS67 - 91KC	70	10	4.5	12.0	5.4
ZPS104 - 122KC	70	11	5	13.0	6

*Approximate Shell Diameter (e.g. 70 = 7.3 Inches)

**Charge Allowance For System

Table 2 - Solenoid Resistance Values

Compressor Family	Compressor Models	Solenoid Resistance
ZPS*KC	All Models	1640 Ω

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Table 3 - Compressor Accessories

Part Category	Part Description	Part Number	Models	Notes
Mounting	Compressor Mounting Kit	527-0116-00	ZPS67-83KC	35-45 Durometer
	Compressor Mounting Kit	527-0221-00	ZPS91-122KC	35-45 Durometer
Crankcase Heater	Reference AE4-1365 or Online Product Information at Copeland.com/OPI			
	Crankcase Heater Junction Box	998-7024-00	All Models	
Electrical	Grounding Screw	100-0605-00	All Models	10-32 x 8mm Long, Taptite Screw
	Molded Plug	529-0370-00	ZPS67-91KC	10 Gauge, 42" Leads
	Molded Plug	529-0099-00	ZPS104-122	8 Gauge, 42" Leads
	Molded Plug Retainer Clip	032-0717-00	ZPS67-91KC	Locks the Molded Plug To Fence
	Modulation Plug	529-0061-00	All Models	Rectified Plug, OEM Use
	Modulation Plug	529-0062-00	All Models	OEM Use With CoreSense
	Modulation Plug	529-0138-01	All Models	OEM & Service, Universal Plug For All Applications
	Flexible Metal Conduit Retainer	032-7051-01	ZPS67-91KC	use with 032-0717-00
Diagnostics & Protection	CoreSense™ Diagnostics Module	543-0038-01	ZPS67-91KC	3-Phase Applications
	Discharge Line Thermostat	998-0071-02	ZPS104-122	Fits 7/8" tube
	Discharge Line Thermostat	998-7022-02	ZPS67-83KC	Fits 1/2" tube
Suction & Fittings	Reference AE4-1365 or Online Product Information at Copeland.com/OPI			

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Revision Tracking R2

The document format has been updated to the new Copeland format

All occurrences of "Emerson" have been removed

A note regarding A3 and R290 venting has been updated

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