Application Engineering

ZPV066 & ZPV096 Copeland Scroll Variable Speed Compressor

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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

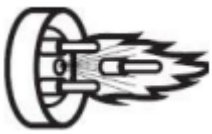
• OEMs are responsible for system design, selection of appropriate components, integration of this component into the system, and testing the system. OEMs must ensure that staff involved in these activities are competent and qualified.

• 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

This bulletin provides instructions on how to apply a Copeland Scroll variable speed compressor in a safe and reliable manner. The Copeland Scroll variable speed compressor will be referred to throughout this bulletin as the 'variable speed scroll' or the 'compressor.'

Product Description

ZPV066 and ZPV096 variable speed compressors are intended for use in commercial air conditioning, chiller, and heat pump applications. The variable speed scrolls utilize three-phase brushless permanent magnet (BPM) motors. The compressors have been qualified for use with Copeland EVC Drives which have been developed and qualified for BPM motor-compressors. The Copeland drives offer the highest level of compressor protection through the use of CoreSense protection algorithms. If use of a non-Copeland drive is desired, please work with Application Engineering to select an appropriate drive for the compressor application. See Third Party Drive requirements on the following page.

Compressor Data

Compressor mechanical, electrical, and performance data are available online in Online Product Information at Copeland.com/OPI. From this site, compressor drawings (PDF format) can be downloaded. Other drawing formats (IGES, DXF, and STP) can be obtained by contacting your Application Engineer.

Other performance data available to the system designer includes sound, vibration, and coefficient data for the polynomial equation used to represent tabular performance data.

Power Supply

The compressor and drive are an integral and optimized combination. The drive will convert the input voltage into a variable frequency and voltage to power the compressor. For more information on the drive power input requirements please see the Copeland EVC Drive user guide.

Ensure correct wiring at both the compressor and drive connections prior to starting the compressor to avoid a mis-wire or powered reverse situation. These situations may cause compressor damage.

⚠CAUTION

The variable speed compressor must be paired with the appropriate variable speed drive. Do not connect the power supply directly to the compressor.

Nomenclature

The model number of the variable speed scroll includes the approximate displacement in cubic centimeters per revolution. Figure 1 provides a complete explanation of all of the alpha and numeric characters in the compressor model number.

Agency Approval

Contact Application Engineering for agency approval details.

OEM LAB TESTING

Application Engineering should be consulted during the design, development, and production launch of the variable speed system to help ensure that the variable speed scroll is applied as intended, in a safe and reliable manner.

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Modeling System Performance

Modeling at any speed range in the approved envelope is facilitated by 20 coefficient data available from Application Engineering.

COMPRESSOR DESIGN FEATURES

The variable speed scroll has a number of design features that improve efficiency and reliability. Figure 7 shows the internal features that are unique to the variable speed scroll.

Compressor Motor

The brushless permanent magnet (BPM) motor in the variable speed scroll consists of a three-phase stator and a rotor embedded with high energy permanent magnets. The input voltage is a series of pulses of varying frequency at 120 degree intervals between phases.

Oil Pump

The variable speed scroll is equipped with an oil pump to ensure an adequate supply of oil to the bearing system throughout the operating speed range.

APPLICATION CONSIDERATIONS

Compressor Temperature Protection

A discharge line thermistor must be used to protect the compressor. The drive will shut down the compressor when the thermistor temperature exceeds 275°F (135°C). Please see the section Troubleshooting Scroll Temperature Trip for more information on the discharge line thermistor. Refer to Table 1 for more information.

Variable Speed Drive Options

Third Party Drive

The customer may use a third party drive. A third party control system must include: a discharge line thermistor that will signal the drive to shut down if the temperature exceeds 275°F (135°C), a soft start and stopping routine, an oil boost cycle similar to the Copeland EVC oil boost, and include the operating envelope. A third party drive must include short cycle protection similar to the Copeland EVC short cycle protection. Refer to Table 2 for compressor motor specifications and Table 5 for speed adjustment requirements.

Copeland EVC Drive Features

It's recommended that the Copeland variable speed drive (VSD) be used with the variable speed compressor. The Copeland VSD has custom built in features that may improve the longevity of the compressor and efficiency of the system. Refer to the Copeland EVC Drive user guide for more information.

Oil Boost

The Copeland EVC drive includes an oil boost cycle when the compressor operates at less than 1800 RPM. The oil boost cycle starts once the compressor operates for two hours at less than 1800 RPM. During the oil boost cycle, the drive forces the compressor to run for five minutes at 3600 RPM. After operating for five minutes at 3600 RPM, the drive allows the compressor to operate at less than 1800 RPM. The operating envelope shows the operating conditions of the oil boost cycle.

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Motor Protection

The Copeland EVC drive includes motor protection features for the compressor. The drive sets the maximum current limit, low voltage fold back which allows the compressor to ride through low voltage situations, which helps keep the compressor running to avoid nuisance trips. The drive also includes lost rotor avoidance and locked rotor detection. The lost rotor avoidance uses a custom algorithm to evade a speed error by reducing the speed by 200 RPM to 're-catch' the rotor.

Missing Phase Protection

The Copeland EVC drive includes compressor missing phase protection. The drive checks for a missing phase connection.

Short Cycle Protection

The Copeland EVC drive includes short cycling protection which checks the duration of the runtime and quantity of short cycles. The amount of runtime and the maximum allowable short cycles in 24 hours is adjustable. The default maximum short cycles in 24 hours is four. The default short cycle time is five minutes.

Resonance Avoidance Feature

The Copeland EVC drive includes a resonance avoidance feature which has the ability to skip a single frequency or a range of frequencies.

Discharge Temperature Protection

The thermistor will signal the drive to shut down if the temperature exceeds 275°F (135°C).

Copeland EVC Operating Envelope

When using the Copeland EVC drive, the compressor is designed to operate within the requirements of the operating envelope.

Copeland EVC Starting and Stopping Routine

The drive controls the starting and stopping routine of the variable speed scroll. This routine allows soft starting and controlled stopping, an advantage over traditional on-off control of fixed capacity units. Please refer to the Copeland EVC drive user guide for an exact explanation of the starting and stopping process.

The variable speed scroll compressor incorporates a fluid brake design to help mitigate reverse rotation during shutdown. A momentary reverse rotation sound may be heard. Refer to Table 5 for more information.

Other Features

Refer to the Copeland EVC drive user guide for more features and functions of the drive

Copeland EVC Drive and Variable Speed Scroll Set-Up

A quick start guide is available with the Copeland EVC drive. Application Engineering is available to assist during any part of this process.

Refrigerant

ZPV066 and ZPV096 compressors are approved for use with R-410A only. Use of refrigerants other than R410A voids the UL recognition of these compressor models since the motor overload system could be adversely affected.

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Operating Envelope

The compressor operating envelope at each speed represents the allowable range of operating conditions for the compressor at the superheat and subcooling values defined on the envelope. The most current and updated operating envelopes can be accessed in Online Product Information at Copeland.com/OPI. Contact Application Engineering if desired to operate at different speeds than published in the operating envelope.

Operating the compressor at evaporating temperatures that are higher than those specified in the envelopes for the given speed will result in a higher oil circulation rate. A higher oil circulation rate can reduce heat exchanger efficiency and possibly result in oil pump-out if the system has long interconnecting piping. Customers that choose to operate in these higher evaporating temperature areas should use a compressor sample with a sight tube during system development testing to ensure that an adequate level of oil is maintained in the compressor sump. Sight-tubed compressors for monitoring the oil level are available by contacting Application Engineering.

The lower right boundary of the operating envelope is the minimum compression ratio required to keep the scrolls loaded. Operation below this boundary could result in the compressor intermittently loading and unloading and noisy operation.

The upper left boundary of the envelope represents the maximum compression ratio when operating with 20F° (11°C) suction superheat. If the operating condition approaches this boundary of the envelope the compressor discharge temperature will begin to approach the maximum scroll temperature allowed by the discharge line thermistor.

If operating the compressor below 1800 RPM, an oil boost cycle is required. Refer to the note in the operating envelope.

For applications where the voltage is below the rated minimum voltage, the drive speed may be limited. The limitation may also be affected by the ambient temperature.

High Pressure Control

WARNING

A high-pressure control must be used in all applications

A high-pressure control must be used with these compressors since they do not employ an internal pressure relief valve (IPR). The maximum cut-out setting must not exceed 650 psig (45 bar). The switch should be wired in series with the unit contactor to immediately stop compressor operation if there is a high-pressure event. The high-pressure control should have a manual reset feature for the highest level of system protection. If an auto reset high pressure control is used, the compressor should be locked out after three consecutive trips. If a pressure transducer is used to protect against high discharge pressure events the transducer and control logic should comply with U.L. and/or local safety requirements.

Low Pressure Control

A low-pressure control is required to protect against loss of charge and other system fault conditions that can lead to compressor overheating. A low-pressure cut-out switch located in the suction line with a cut-out setting no lower than 20 psig (1.4 bar) is required in all heat pump applications. For air conditioning units, a cut-out setting no lower than 55 psig (3.8 bar) will adequately protect against most low-pressure faults. A higher level of protection for air conditioning units can be realized if the cut-out setting is increased to 95 psig (6.6 bar) to prevent evaporator coil icing.

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Discharge Temperature Protection

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.

ZPV066 and ZPV096 compressors do not have an internal discharge gas temperature protection. In order for the variable speed drive to operate properly a thermistor should be attached to the compressor discharge line as close as possible and less than 6" (15cm) from the compressor discharge fitting. The thermistor is designed for a 7/8" (22 mm) line and should be properly insulated. See Table 6 of AE-1328 for thermistor temperature vs resistance values. Refer to Table 1 for part numbers of discharge line thermistors. Figure 6 illustrates the discharge thermistor.

Motor Overload Protection

The drive will provide motor over current protection in the event the compressor becomes mechanically locked or if the load on the compressor motor is abnormally high. The input power supply to the drive must be properly fused.

The molded plug power connection option is not available for the 208/230 volt ZPV0962E-5*9 compressor due to the current limit of the molded plug power cable.

Oil Type

The variable speed scrolls are charged with polyol ester (POE) oil. See the compressor nameplate for the original oil charge. A complete recharge should be approximately four fluid ounces (118cc) less than the nameplate value. Copeland Ultra 32-3MAF, available from Copeland Wholesalers, should be used if additional oil is needed in the field. Mobil Arctic EAL22CC, Emkarate RL22, Emkarate 32CF and Emkarate 3MAF are acceptable alternatives.

CAUTION! POE oil 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, and spills should be cleaned up quickly with paper towels, soap and water.

Maximum Tilt Angle

Applications, such as transportation air conditioning or mobile radar applications, may require the compressor to operate at some angle from vertical. Service personnel may be required to maneuver a unit through a stairwell or other cramped area that might require tilting the unit. The maximum allowable tilt angles from horizontal for individual compressors (not tandem or trio applications) are summarized below:

Max. tilt angle with compressor running = 15°

Max. tilt angle with compressor not running = 60°

Contaminant Control

Copeland Scroll compressors leave the factory with a miniscule amount of contaminants. Manufacturing processes have been designed to minimize the introduction of solid or liquid contaminants.

Dehydration and purge processes ensure minimal moisture levels in the compressor and continuous auditing of lubricant moisture levels assure that moisture isn't inadvertently introduced into the compressor.

Moisture levels should be maintained below 50 ppm for optimal performance**. A filter-drier is required on all R-410A and POE lubricant systems to prevent solid particulate contamination, oil dielectric strength degradation, ice formation, oil hydrolysis, and metal corrosion**. It is the system designer's responsibility to make sure the filter-drier is adequately sized to accommodate the contaminants from system manufacturing processes that leave solid or liquid contaminants in the evaporator coil, condenser coil, and interconnecting tubing plus any contaminants introduced during the field installation process. Molecular sieve and activated alumina are two filter-drier materials designed to remove moisture and mitigate acid formation. A 100%

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molecular sieve filter can be used for maximum moisture capacity. A more conservative mix, such as 75% molecular sieve and 25% activated alumina, should be used for service applications.

Refrigerant Piping

Particular attention must be given to the system refrigerant pipe size with the variable speed scrolls. ASHRAE guidelines for pipe sizing should be followed to ensure that refrigerant velocities are high enough at low speeds to ensure oil return to the compressor. At the same time, high refrigerant velocities at high speed operation can result in excessive pressure drop and loss of system efficiency. A careful evaluation and compromise in pipe sizing will likely have to be settled upon. A compressor sample with a sight-tube for monitoring the oil level should be used during system development to ensure an adequate oil level is maintained at operating conditions and speeds.

If testing shows a gradual, continuous loss of oil in the compressor sight-tube over long run cycles at low speed, an oil boost cycle should be incorporated into the system logic. An oil boost cycle is accomplished by ramping the compressor speed up to a higher speed to increase the refrigerant flow rate to flush or sweep oil back to the compressor. Frequency and duration of a recovery cycle depends on many variables and would have to be determined through testing for each system type and configuration. A default method could be to initiate a recovery cycle at regular intervals.

Long Pipe Lengths / High Refrigerant Charge

Some system configurations may contain higher-than-normal refrigerant charges either because of large internal coil volumes or long line sets. If such a system also contains an accumulator, then the permanent loss of oil from the compressor may become critical. If the system contains more than 20 pounds (9 kg) of refrigerant, it is our recommendation to add one fluid ounce of oil for every 5 pounds (15 ml/kg) of refrigerant over this amount. If the system contains an accumulator the manufacturer of the accumulator should be consulted for a pre-charge recommendation.

Other system components such as shell and tube evaporators can trap significant quantities of oil and should be considered in overall oil requirements. Reheat coils and circuits that are inactive during part of the normal cycle can trap significant quantities of oil if system piping allows the oil to fall out of the refrigerant flow into the inactive circuit. The oil level must be carefully monitored during system development, and corrective action should be taken if the compressor oil level falls more than 1.5"(40 mm) below the center of the sight-glass. **The compressor oil level should be checked with the compressor 'off' to avoid the sump turbulence when the compressor is running.**

These compressors are available to the OEM with a production sight-glass that can be used to determine the oil level in the compressor in the end-use application. These compressors are also available to the OEM with an oil Schrader fitting on the side of the compressor to add additional oil if needed because of long lengths of piping or high refrigerant charge. No attempt should be made to increase the oil level in the sight-glass above the 3/4 full level. A high oil level is not sustainable in the compressor and the extra oil will be pumped out into the system causing a reduction in system efficiency and a higher-than-normal oil circulation rate.

Discharge Check Valve

ZPV066 and ZPV096 compressors use a shutdown valve located in the discharge fitting. This check valve is not a low-leak-back check valve and will leak when pressure differential across the check valve is low.

Suction and Discharge Tube Design

Proper tube design must be taken into consideration when designing the tubing connecting the variable speed scroll to the system. The tubing should provide enough 'flexibility' to allow normal starting and stopping of the compressor without exerting excessive stress on the tube joints.

Because the variable speed scroll has a broad mechanical running frequency range, it will be almost impossible to avoid all of the natural frequencies that may exist in the system piping. The system designer must carefully evaluate these resonant frequency conditions and either a) avoid them by not allowing the compressor speed to align with the resonant frequency, or b) evaluate the risk and life of the piping system when the compressor is allowed to run at frequencies that are coincident with natural frequencies of the piping system. To do part 'b', strain gauging the

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system piping is required. For assistance in evaluating strain gauging results contact Application Engineering.

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 frequency, load fluctuations, and shipping vibration. The guidelines above may be helpful; however, testing should be performed for each system designed. For further assistance and analysis of test results please contact Application Engineering.

Compressor Mounting

ZPV066 and ZPV096 compressors have pierced holes in the mounting feet so mounting grommets with a relief are not required. Table 1 lists the recommended mounting parts. It is extremely important to use the correct durometer grommet and to have consistent durometer quality. Wrong or inconsistent durometer of the mounting grommets can result in sound and vibration complaints. For additional information on grommet durometer please consult with Application Engineering.

Discharge Mufflers

For a variable speed compressor, discharge pulse will generally decrease as speed increases or if compression ratio decreases. As speed decreases or if compression ratio increases the discharge pulse will increase. Fixed capacity or two-step capacity units have typically had discharge gas pulsation mufflers only in heat pump applications. A variable capacity heat pump and/or air conditioner may both require a discharge gas pulsation muffler. Discharge pulse amplitude and frequency and their effects on the piping system must be taken into account. If testing determines that a muffler is needed to attenuate discharge pulse, a hollow shell muffler such as the Copeland Flow Controls APD164S must be used.

The mufflers should be located a minimum of six inches (15 cm) to a maximum of 18 inches (46cm) from the compressor for most effective operation. The farther the muffler is placed from the compressor within these ranges the more effective it may be. If adequate attenuation is not achieved, use a muffler with a larger cross-sectional area to inlet-area ratio.

Airborne Sound Control

In addition to structure and gas borne sound transmission, special consideration needs to be given to compressor airborne sound. A-weighted, steady-state sound data is available from Application Engineering. Sound data is also available at the nominal cooling condition of 50°F (10°C) evaporating and 115°F (46°C) condensing at 5400 RPM. If airborne sound attenuation is required for the application, Fabricating Services (www.fabsrv.com) is one manufacturer of custom sound solutions

Expansion Devices

The expansion device is a crucial component of the variable capacity system. Fixed-orifice devices, which are chosen or optimized at one particular operating condition, will not have the ability to control the refrigerant flow across a wide range of operating pressures and flow rates required by the variable capacity system.

To better control superheat, an electronic expansion valve (EXV) is recommended. Electronic expansion valves have the ability to more precisely control superheat at lower settings over a wider operating range than a TXV. They also have the capability to be driven completely closed during the off-cycle, minimizing off-cycle migration.

Regardless of which expansion device is used, the manufacturer's recommendations on the application of the valve should be followed in all cases.

Reversing Valves

A variable speed scroll has a real advantage during the defrost cycle. By taking advantage of the higher speeds and flow rates, defrost time will typically be shorter than a system with a fixed or two-step capacity compressor. This reduces the time heat is required during the defrost cycle.

⚠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. Conditions that result in 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 pressure). It can also result in elevated compressor sound levels. During a defrost cycle, when the reversing valve abruptly changes the refrigerant flow direction, the suction and discharge pressures will go outside of the operating envelope. The condition will usually cross the diagonal line representing the lower right hand corner of the envelope. The sound that the compressor makes during this transition period is normal, and the duration of the sound will depend on the coil volume, outdoor ambient, and system charge.

The reversing valve solenoid should be wired so that the valve does not reverse when the system is shut off by the operating thermostat in the heating or cooling mode. If the valve is allowed to reverse at the system shutoff, suction and discharge pressures are reversed to the compressor. This will result in pressures equalizing through the compressor which can cause the compressor to slowly rotate backwards until the pressures equalize. This condition does not affect the compressor durability but can cause unexpected sound after the compressor is turned off.

Accumulators

The use of accumulators is very dependent on the application. The variable speed scroll has an inherent ability to handle liquid refrigerant during occasional operating flood back situations. Systems designed with EXV or TXV refrigerant control may not require an accumulator if testing assures the system designer that there will be no flood back throughout the operating range. To test for flood back conditions and to determine if the accumulator or EXV/TXV design is adequate, please see the **Application Tests** section. A large-area protective screen no finer than 30x30 mesh is required to protect this small orifice from plugging. Tests have shown that a small screen with a fine mesh can easily become plugged causing oil starvation to the compressor bearings. The size of the accumulator depends upon the operating range of the system and the amount of system refrigerant charge. System modeling indicates that heat pumps that operate down to and below 0°F (-18°C) will require an accumulator that can hold around 70% to 75% of the system charge. Behavior of the accumulator and its ability to prevent liquid slugging and subsequent oil pump-out at the beginning and end of the defrost cycle should be assessed during system development. This will require special accumulators and compressors with sight tubes and/or sight glasses for monitoring refrigerant and oil levels.

Off-Cycle Migration Control

Off-cycle migration control is important for long term compressor reliability and to minimize nuisance complaints associated with flooded start conditions. Off-cycle migration control is recommended when the system charge exceeds 15.0 lbs (7 kg). Off-cycle migration control is required when the system charge exceeds 18 lbs (8 kg). In lieu of using a conventional wrap-around crankcase heater, the drive has a programmable feature that will utilize the motor windings.

If off-cycle migration control is required, and no off-cycle migration testing across the range of expected indoor/outdoor temperatures is performed, the stator heater must be powered to at least 100 Watts when the compressor is 'off'. To use fewer than 100 Watts or to comply with future DOE requirements for off-cycle power consumption, off-cycle migration testing must be performed. A 70 watt crankcase heater may be used instead of the motor windings to provide heat to the base.



Stator heat for off-cycle migration must not be energized when the system is in a vacuum or if there is no refrigerant charge in the system. The system low pressure cut-out control can be used as an indicator of the presence of refrigerant charge.

Manifolded Compressors

Multiple compressor assemblies are available for purchase from Copeland. In lieu of purchasing the assembled manifold, the OEM can choose to purchase the manifold-ready compressor and perform the assembly in their factory. Drawings of tandem and trio compressor assemblies are available from Copeland by contacting your Application Engineer.

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NOTICE: Customers who choose to design and build their own manifolds for tandem and trio compressor assemblies are ultimately responsible for the reliability of those manifold sets.

The suction manifold is close to a symmetrical layout with the design intent of equal pressure drop to each compressor. A straight length of pipe is connected to the suction manifold "T" connection to serve as a flow straightener to make the flow as uniform as possible. The discharge manifold is the less critical of the two manifolds in terms of pressure drop. Low pipe stress and reliability are its critical design characteristics. Support for the discharge manifold between the compressors should be no closer than a straight distance of 14" (356 mm) from the discharge tee.

For tandem compressor applications, tubing stress levels should be closely evaluated. If excess stress levels occur, the Resonance Avoidance Feature in the Copeland EVC drive may be used.

Manifolded Applications

Manifolded compressors follow the same application guidelines as single compressors outlined in this bulletin. The refrigerant charge limit for manifolded compressors is shown in Table 4. A manifolded circuit with charge over the limit must have a crankcase heater or stator heating applied to both compressors.

Oil levels in the individual sight-glasses will vary, depending on whether one or more compressors in the manifolded set are operating and if the manifolded set is made up of equal or unequal compressor capacities. Because of the unequal oil levels that can exist, oil levels should be viewed with the compressors off to allow the oil level to stabilize between the compressor sumps. With the compressors off, oil should be visible in the individual compressor sight-glasses.

Suction and discharge manifolds are not designed to support system piping. Support means must be provided by the system designer to support suction and discharge lines so that stress is not placed on the manifolds.

The compressors in a manifolded set can be started/stopped in any desired sequence. To help reduce inrush current, starting the compressors individually is recommended. Should a compressor fail in the tandem set the complete tandem should be removed from the unit and replaced with a new tandem set. Replacing individual compressors is discouraged because of the care that must be used when installing the oil equalization tube and the availability of manifolds to the aftermarket**.**

Please consult with Application Engineering during the development of systems with trio compressor assemblies. Trio compressor assemblies are sensitive to system operating conditions and configurations which will affect oil balancing. Trio compressor assemblies must be qualified for each application.

Manifolded compressor assemblies are available for purchase from Copeland. In lieu of purchasing the assembled tandem, the OEM has the option to purchase the tandem-ready compressors to assemble the compressors into a tandem configuration. Drawings of the tandem manifolds are available by contacting your application engineer. Manifold ready compressors are designated with a -4XX bill of material number at the end of the model number (e.g. ZPV0662E-4X9-455). **Customers that choose to design and build their own manifolds for tandem and trio compressors are ultimately responsible for the reliability of those manifold sets.**

APPLICATION TESTS

New system designs should be evaluated throughout the entire expected operating range of the unit to ensure the system will perform reliably throughout the life of the product. Test data, taken throughout the operating range of the unit, should be closely scrutinized to help identify gross errors in system design that may produce conditions that could lead to compressor failure.

General Application Tests

In addition to the tests outlined above, off-cycle migration tests are recommended if the system charge amount exceeds 11 pounds (7 kg) and less than 100 watts of the stator heat option is selected. The purpose of the off-cycle migration test is to ensure that stator heat is great enough to minimize off-cycle migration after long compressor 'off' periods. System faults, such as low or loss of indoor air-flow, loss of outdoor air-flow, and low/overcharge

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conditions should all be evaluated to ensure the compressor and service technician are protected against any adverse condition.

NOTICE The tests outlined above are for common applications of compressors in this family. Please consult with Application Engineering on applications outside of those outlined above for the appropriate application tests.

ASSEMBLY LINE PROCEDURES

Installing the Compressor

WARNING

Use care and the appropriate material handling equipment when lifting and moving compressors. Personal safety equipment must be used.

Copeland Scroll compressors leave the factory dehydrated, with a dry air holding charge. If compressors are stored in a cold ambient (i.e. outside during the winter), the suction and discharge plugs should not be removed until the compressor has had sufficient time to warm up to the plant ambient temperature. The suggested warm up time is one hour per 4°F (2°C) difference between outdoor and indoor temperature. It is suggested that the larger suction plug be removed first to relieve the internal pressure. Removing the smaller discharge plug could result in a spray of oil out of this fitting since some oil accumulates in the head of the compressor after Copeland's run test. The inside of both fittings should be wiped with a lint free cloth to remove residual oil prior to brazing. A compressor containing POE oil should never be left open longer than 20 minutes.

Assembly Line Brazing Procedure

WARNING

Personal safety equipment must be used during brazing operation. Heat shields should be used to prevent overheating or burning nearby temperature sensitive parts. Fire extinguishing equipment should be accessible in the event of a fire.

Figure 4 discusses the proper procedures for brazing the suction and discharge lines to a scroll compressor.

NOTICE It is important to flow nitrogen through the system while brazing all joints during the system assembly process. Nitrogen displaces the air and prevents the formation of copper oxides in the system. If allowed to form, the copper oxide flakes can later be swept through the system and block screens such as those protecting capillary tubes, expansion valves, and accumulator oil return holes. Any blockage of oil or refrigerant may damage the compressor resulting in failure.

Pressure Testing

WARNING

Never pressurize the compressor to more than 475 psig (33 bar) for leak checking purposes. Never pressurize the compressor from a nitrogen cylinder or other pressure source without an appropriately sized pressure regulating and relief valve.

The pressure used on the line to meet the U.L. burst pressure requirement must not be higher than 475 psig (33 bar). Higher pressure may result in permanent deformation of the compressor shell and possible misalignment or bottom cover distortion.

Assembly Line System Charging Procedure

Systems should be charged with liquid on the high side to the extent possible. The majority of the charge should be pumped in the high side of the system to prevent low voltage starting difficulties, hipot failures, and bearing washout during the first-time start on the assembly line. If additional charge is needed, it should be added as liquid to the low side of the system with the compressor operating. Pre-charging on the high side and adding liquid on the low side of the system are both meant to protect the compressor from operating with abnormally low suction pressures during charging.

NOTICE: Do not operate the compressor without enough system charge to maintain at least 55 psig (3.8 bar) suction pressure. Do not operate the compressor

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with the low pressure cut-out disabled. Do no operate with a restricted suction or liquid line.

Depending on the discharge pressure, allowing pressure to drop below 55 psig (3.8 bar) for more than a few seconds may overheat the scrolls and cause early drive bearing damage.

NOTICE: Do not use the compressor to test the opening set point of a high pressure cutout. Bearings are susceptible to damage before they have had several hours of normal running for proper break in.

'Hipot' (AC High Potential) Testing

CAUTION

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

Copeland Scroll compressors are configured with the motor down and the pumping components at the top of the shell. As a result, the motor can be immersed in refrigerant to a greater extent than hermetic reciprocating compressors when liquid refrigerant is present in the shell. In this respect, the scroll is more like semi-hermetic compressors that have horizontal motors partially submerged in oil and refrigerant. When Copeland Scroll compressors are hipot tested with liquid refrigerant in the shell, they can show higher levels of leakage current than compressors with the motor on top. 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 **AE4-1294 for megohm testing recommendations. Under no circumstances should the hipot test be performed while the compressor is under a vacuum.**

U.L. sets the requirement for dielectric strength testing and they should be consulted for the appropriate voltage and leakage values.

Final Run Test

Customers that use a nitrogen final run test must be careful to not overheat the compressor. Nitrogen is not a good medium for removing heat from the compressor, and the scroll tips can be easily damaged with high compression ratios and/or long test times. Copeland Scroll compressors are designed for use with refrigerant, and testing with nitrogen may result in a situation where the compressor does not develop a pressure differential (no pump condition). When testing with nitrogen, the compressor must be allowed to cool for several minutes between tests.

Unbrazing System Components

WARNING

Before attempting to braze, it is important to recover all refrigerant from both the high and low side of the system.

If the refrigerant charge is removed from a scroll-equipped unit by recovering one side only, it is very possible that either the high or low side of the system remains pressurized. If a brazing torch is then used to disconnect tubing, the pressurized refrigerant and oil mixture could ignite when it escapes and contacts the brazing flame. Instructions should be provided in appropriate product literature and assembly (line repair) areas. If compressor removal is required, the compressor should be cut out of the system rather than unbrazed. See **Figure 4** for proper compressor removal procedure.

SERVICE PROCEDURES

The drive offers a two wire 485 interface. This enables the drive set-up, operation and monitoring to be carrier out with a PC or controller if required. The drive only supports Modbus RTU protocol. Refer to the Copeland EVC drive user guide for more information.

Electrical Troubleshooting

CAUTION

The compressor must always have the green ground wire attached to the ground. The other end of the green wire must be connected to the appropriate ground terminal on the drive.

The BPM motors used in the variable speed scrolls are three-phase. The winding resistance for each compressor-motor is published in the **Online Product Information**. The three windings should always have line to line continuity because there is no internal overload at the center of the motor windings to open and take the motor off-line. If one or more of the windings shows continuity to ground, the compressor must be replaced.



Energizing a variable speed scroll with a grounded winding can cause irreversible damage to the drive.

Measuring the current in the three individual wires feeding the compressor will provide no useful information to the service technician, other than to show that each winding of the compressor is drawing current. The more appropriate measurement is the current input to the drive. Current input to the drive can be compared to the published values of MCC and RLA.

Compressor Replacement After a Motor Burn

In the case of a motor burn, the majority of contaminated oil will be removed with the compressor. The rest of the oil is cleaned with the use of suction and liquid line filter driers. A 100% activated alumina suction filter drier is recommended but must be removed after 72 hours. See AE24-1105 for cleanup procedures and **AE11-1297** for liquid line filter-drier recommendations.

NOTICE: It is highly recommended that the suction accumulator be replaced if the system contains one. This is because the accumulator oil return orifice or screen may be plugged with debris or may become plugged shortly after a compressor failure. This will result in starvation of oil to the replacement compressor and a second failure.

Start-Up of a New or Replacement Compressor

It is good service practice, when charging a system with a scroll compressor, to charge liquid refrigerant into the high side only. It is not good practice to dump liquid refrigerant from a refrigerant cylinder into the crankcase of a stationary compressor. If additional charge is required, charge liquid into the low side of the system with the compressor operating.



Do not start the compressor while the system is in a deep vacuum.

Internal arcing may occur when any type of compressor is started in a vacuum.

NOTICE: Do not operate the compressor without enough system charge to maintain at least 55 psig (3.8 bar) suction pressure. Do not operate with a restricted suction or liquid line. Do not operate with the low pressure cut-out disabled.

Allowing suction pressure to drop below 55 psig (3.8 bar) for more than a few seconds may overheat the scrolls and cause early drive bearing damage. Never install a system in the field and leave it unattended with no charge, a holding charge, or with the service valves closed without securely locking out the system. This will prevent unauthorized personnel from accidentally ruining the compressor by operating with no refrigerant flow.

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Figure 1 - Compressor Nomenclature

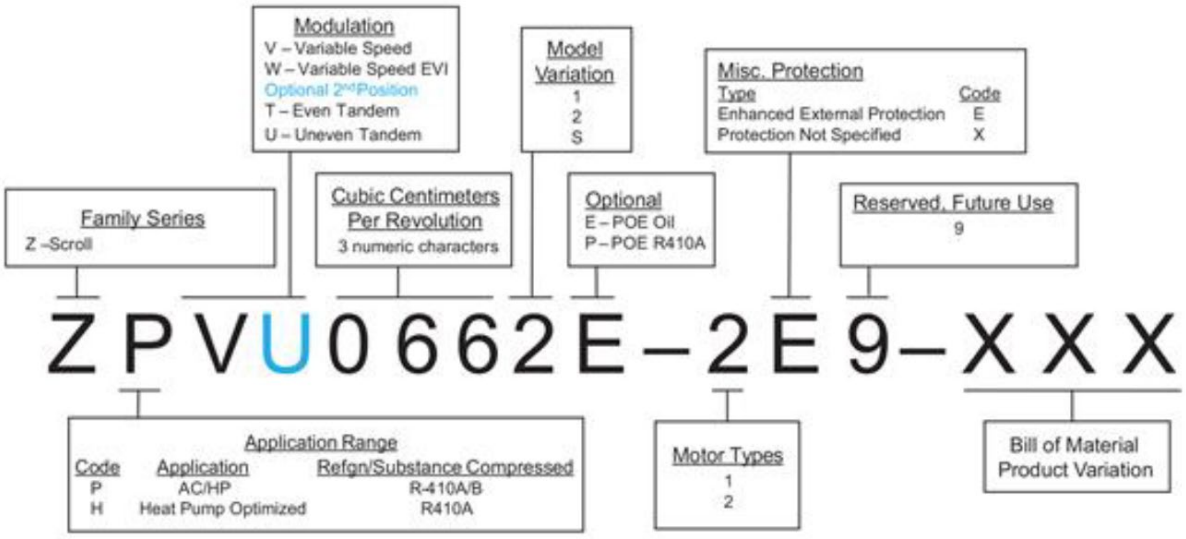


Figure 2 - EV Nomenclature

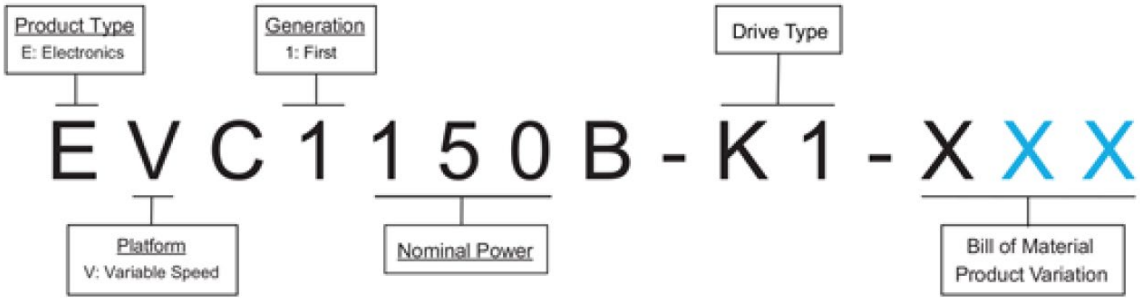
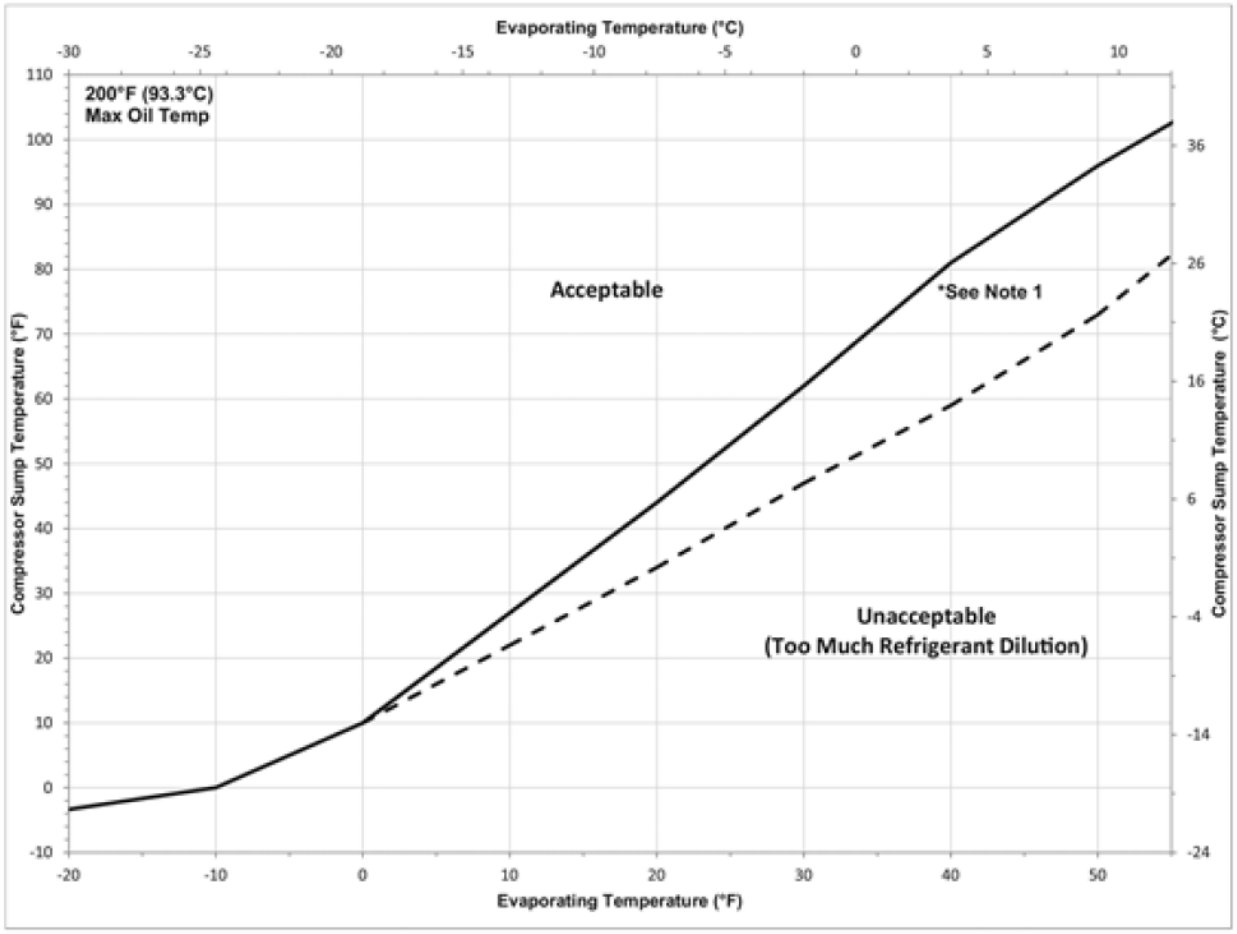


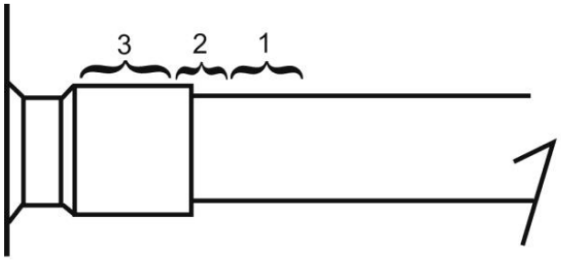
Figure 3 - -Oil Dilution Chart



Note 1: Operation in this refrigerant dilution area is safe in air-to-air heat pump heating mode. For other applications, such as AC only, review expansion device to raise superheat. A cold sump may result in high refrigerant migration after shut down.

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Figure 4 - Scroll Suction Tube Brazing



New Installations

- The copper-coated steel suction tube on scroll compressors can be brazed in approximately the same manner as any copper tube.
- Recommended brazing materials: Any silfos material is recommended, preferably with a minimum of 5% silver. However, 0% silver is acceptable.
- Be sure suction tube fitting I.D. and suction tube O.D. are clean prior to assembly. If oil film is present wipe with denatured alcohol, Dichloro-Trifluoroethane or other suitable solvent.
- Using a double-tipped torch apply heat in Area 1. As tube approaches brazing temperature, move torch flame to Area 2.
- Heat Area 2 until braze temperature is attained, moving torch up and down and rotating around tube as necessary to heat tube evenly. Add braze material to the joint while moving torch around joint to flow braze material around circumference.
- After braze material flows around joint, move torch to heat Area 3. This will draw the braze material down into the joint. The time spent heating Area 3 should be minimal.
- As with any brazed joint, overheating may be detrimental to the final result.

Field Service

WARNING

Remove refrigerant charge from both the low and high side of the compressor before cutting the suction and discharge lines to remove the compressor. Verify the charge has been completely removed with manifold gauges.

- To disconnect: Reclaim refrigerant from both the high and low side of the system. Cut tubing near compressor.
- To reconnect:
  - Recommended brazing materials: Silfos with minimum 5% silver or silver braze material with flux.
  - Insert tubing stubs into fitting and connect to the system with tubing connectors.

Follow **New Installation** brazing

Figure 5 - How Scroll Works

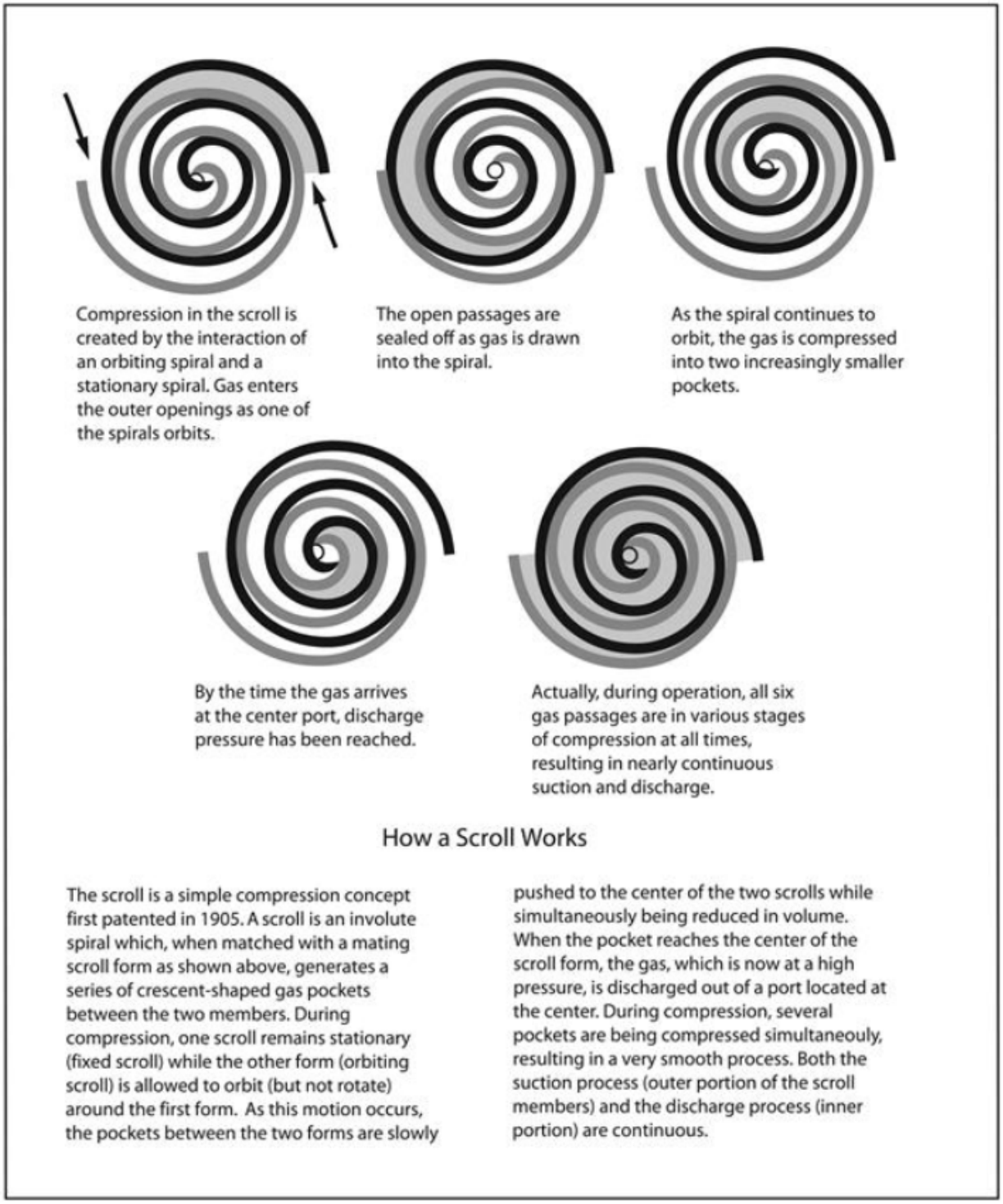


Figure 6 - Discharge Thermostat



Figure 7 - Cross Sectional View

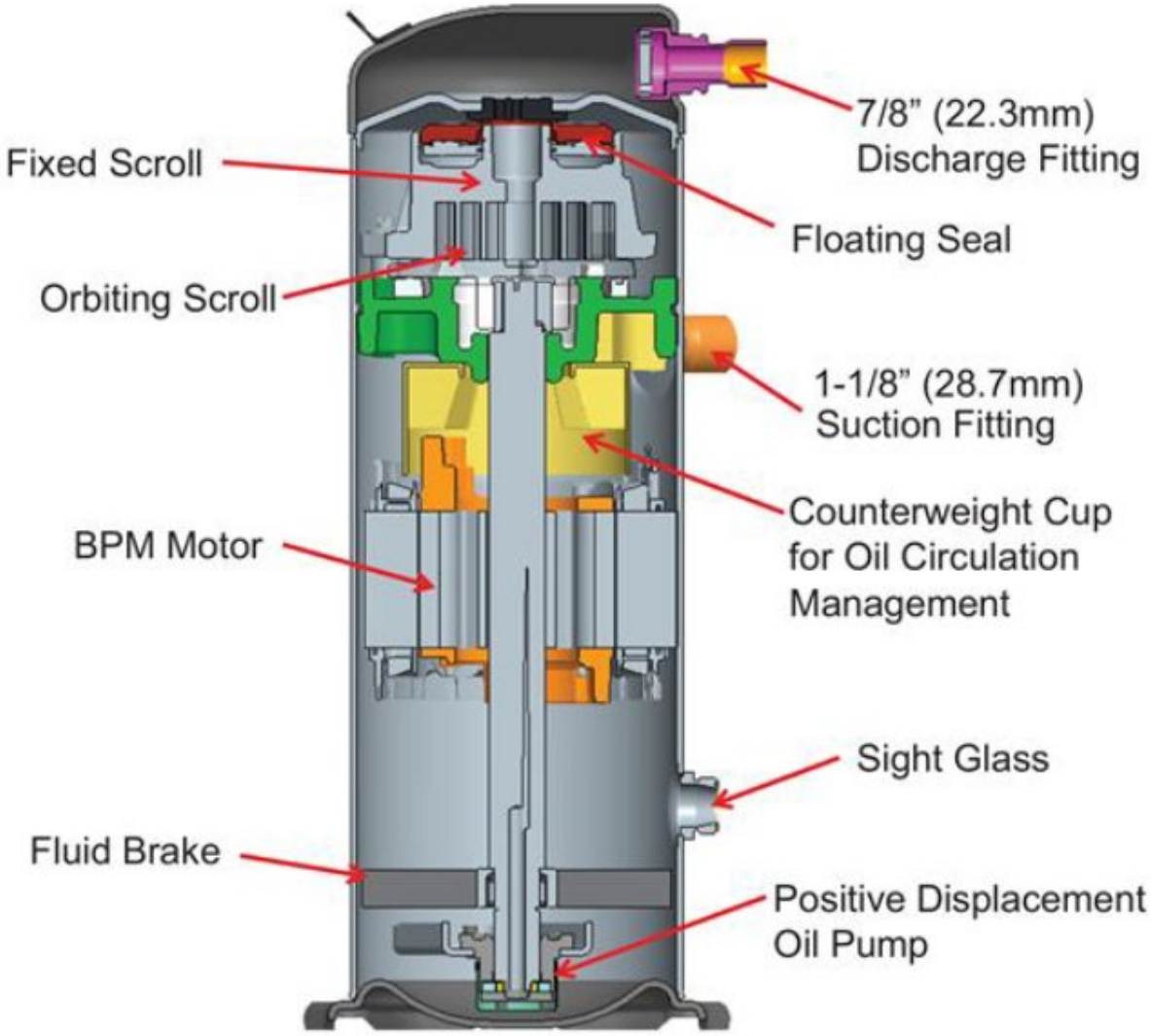
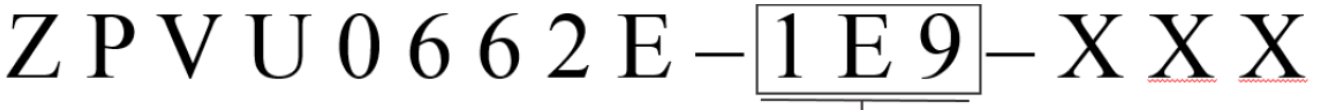


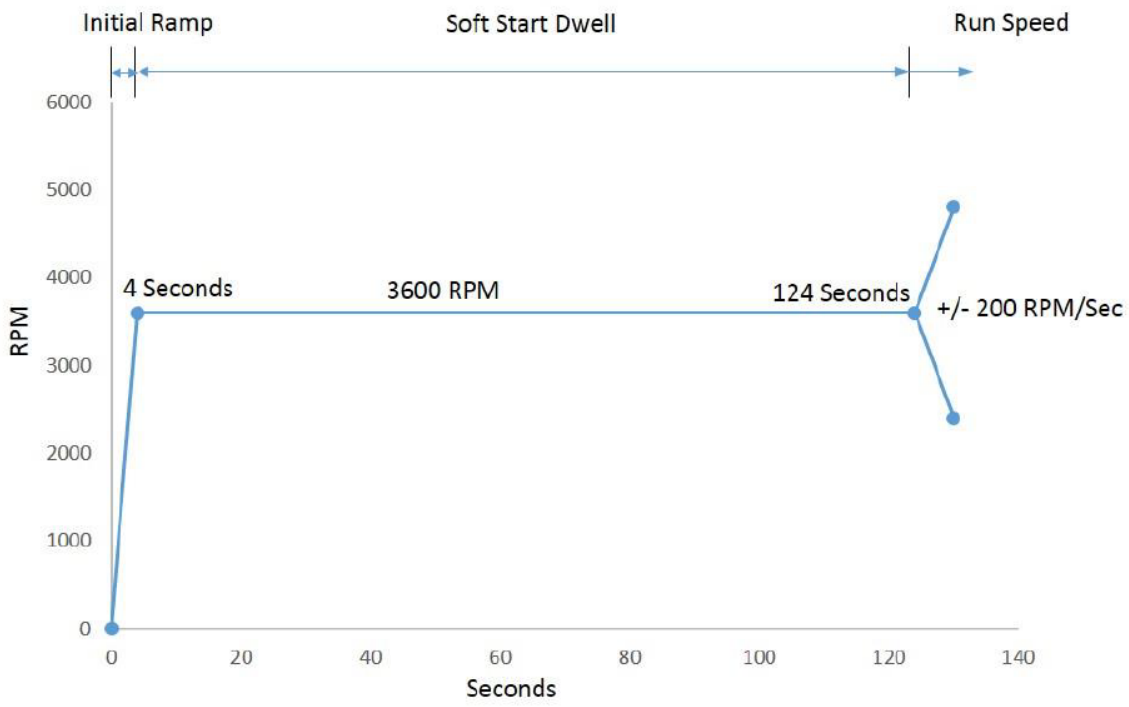
Figure 8 - Electrical Nomenclature for Multiples



Electricals For Multiples

First Character	Second Character					Third Character
Follows VS Motor Type	**VS**	**+**	**Fixed**	**=**	**Tandem**	Follows Fixed Electrical Code
	E	+	E	=	E	
	E	+	F	=	Z	
	E	+	W	=	Y	
	X	+	E	=	B	
	X	+	F	=	C	
	X	+	W	=	G	
	Examples					
	5E9	+	TF5	=	5Z5	
	4X9	+	TF7	=	4C7	
	7E9	+	TED	=	7ED	
	7X9	+	TEE	=	7BE	

Figure 9 - Start Up Procedure



A

Figure 10 - Shut Down Procedure

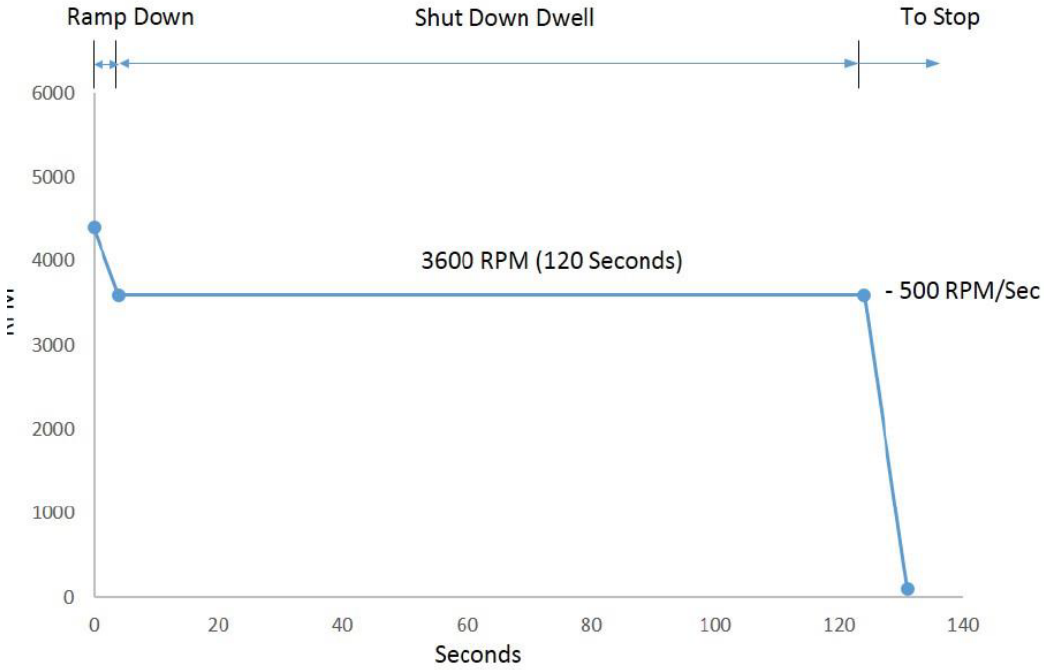


Table 1 - Compressor Accessories & Service Parts

Part Category	Part Description	Part Number	Models	Notes
Mounting	Compressor Mounting Kit	527-0239-01	ZPV066 and ZPV096	
Oil	POE Oil	32-3MAF		Purchase from Copeland Wholesaler
	Oil Adjustment Fitting	510-0715-00		
	Oil Sight-Glass	070-0040-00		
	Sight-Glass Rotalock Nut	005-1514-00		
	O-Ring Seal for Sight-Glass	020-0028-05		
Crankcase Heater	Crankcase Heater, 240V, 70W	018-0095-00		21' Leads
	Crankcase Heater, 480V, 70W	018-0095-01		21' Leads
	Crankcase Heater, 575V, 70W	018-0095-02		21' Leads
	Crankcase Heater, 120V, 70W	018-0095-07		48' Leads
	Crankcase Heater, 400V, 70W	018-0095-08		48' Leads
	Crankcase Heater Junction Box	998-7024-00		
Electrical	Terminal Cover	005-1494-00		
	Terminal Cover Gasket	020-1390-00		
	Terminal Block	021-0227-03		All Voltages
	Terminal Block Screw	100-0550-01		3) Required, 10-32 Screw x 1/2'
	Grounding Screw	100-0605-01		10-32 x 8mm Long, Taptite Screw
	Molded Plug	529-0099-00		8 Gauge Wire, 42" Leads, 55 Amp Max
Diagnostics & Protection	Discharge Line Thermistor	085-0261-00		Molex Connector Not Included
	Thermistor Clip	032-0688-04		7/8' Clip
Suction & Discharge	Discharge Rotalock O-Ring Seal	020-0028-02		
	Suction Rotalock O-Ring Seal	020-0028-03		
	Discharge Rotalock Service Valve, 7/8'	998-0510-90		
	Suction Rotalock Service Valve, 1-1/8'	998-0510-99		
	Discharge Rotalock Adapter to 7/8' Sweat	998-0034-08		
	Suction Rotalock Adapter to 1-3/8' Sweat	998-0034-10		
	7/8' Discharge Stub to 1-1/4'-12 Rotalock Adapter	998-0034-02		
	1-1/8' Suction Stub to 1-3/4'-12 Rotalock Adapter	998-0034-03		

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Multiples	Suction Manifold	Manifolds are not available for sale to the aftermarket. Contact Application Engineering if drawings of manifolds are needed.		
	Discharge Manifold			
	Oil Equalization Tube			
	Gas Equalization Manifold			
	Mounting Kit, Compressor to Rails	527-0182-01	ZPV066 and ZPV096 tandem	2 kits required per tandem; Includes bolts, washers, and steel spacers
	Tandem Mounting Kit, Rails to Unit	527-0177-00		Includes sleeves, washers, and grommets (65-75 durometer)
	Tandem Rail	574-0053-00		2 rails required per tandem

Table 2 - Compressor Motor Specification

Attribute	Unit	ZPV066	ZPV096
Dielectric Strength Leakage Current	mA	6	6
Dielectric Strength Test Voltage	Volts-AC	2,500	2,500
Dielectric Strength Test Time	Seconds	1	1
Motor Poles	#	6	6
Motor Input Frequency	Hertz	50-360	60-360
Recommended Switching Frequency	Hertz	6,000	6,000

Table 3 - Copeland Compressor & Drive Selection

Drive Model	**Compressor Model**	**Compressor Rated Voltage**	**Drive Voltage Input Range**	**Drive** Nominal Power
EVC1150B -J1-124	ZPV0662E-5E9	230	200-240	15kW
EVC1150B -K2-124	ZPV0662E-4E9	380	380-480	
EVC1150B -K1-124	ZPV0662E-7E9	460	380-480	
EVC1150B -L1-124	ZPV0662E-7E9	575	500-575	
EVC1185B -J1-124	ZPV0962E-5E9	230	200-240	18kW
EVC1185B -K2-124	ZPV0962E-4E9	380	380-480	
EVC1185B -K1-124	ZPV0962E-7E9	460	380-480	
EVC1185B -L1-124	ZPV0962E-7E9	575	500-575	

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Table 4 - Compressor Refrigerant Charge Limits

Model	Charge Limit		120% x Limit*		Tandem Charge Limit	
	Pounds	Kg	Pounds	Kg	Pounds	Kg
ZPV066 & ZPV096	15	7	18	8	18	8

Table 5 - Speed Adjustment

	Speed Range (RPM)	Defaul (RPM)	Acceleration RPM/Sec		Deceleration RPM/Sec		Note
			Range	**Default**	**Range**	**Default**	**1**
Start	3600-7200	3600	400-1000	1.0	NA	NA	
Run	1000-7200	+/- 200 RPM/S					
Stop	1000-7200	3600 or Envelope Minimum	NA	NA	50-500	2.0	2,3,4

Notes:

1. Once the compressor reaches 3600 RPM, hold for two minutes prior to accelerating or decelerating.
2. If envelope control is active, reduce the speed by 30% for a default of three minutes. After two minutes and the command has not changed, decelerate to the minimum envelope speed and shut down the compressor.
3. If envelope control is not active and the speed is above 3600 RPM, decelerate 3600 RPM for a default of three minutes. After two minutes and the command has not changed, shut down the compressor.
4. If envelope control is not active and the speed is below 3600 RPM, maintain current speed for a default of three minutes. After two minutes and the command has not changed, shut down the compressor.

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Revision Tracking R5

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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