AE4-1430 R2 **October 2019**

Copeland Scroll™ Compressor Multiples for Air Conditioning

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Safety Instructions

Copeland Scroll™ compressors are manufactured according to the latest U.S. and European Safety Standards. 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.

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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.

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INTRODUCTION

This bulletin describes the features, application requirements, and other pertinent technical information of Copeland Scroll compressors that are assembled with manifolds into multiple arrangements (tandem, trio, etc.).

Specific scroll model family application bulletins should be referenced for additional information and design features. A partial list is provided below. For additional bulletins and compressor information, please refer to the Online Product Information (OPI) at **Emerson.com/OPI**.

•	**AE4-1365** 5 to 12 Ton ZP*K3, ZP*KC and ZP*KW R410A Copeland Scroll Compressors
•	**AE4-1331** ZP16 to ZP44K3E and ZP14 to ZP61K5E R410a 1/5 to 5 Ton Copeland Scroll Compressors
•	**AE4-1303** 7 to 15 Ton ZR*KC and ZP*KC Copeland Scroll Compressors
•	**AE4-1388** 20-40 Ton ZP*KC and ZR*KC Copeland Scroll Compressors

Compressor assemblies in multiple arrangements are available for purchase from Emerson. In lieu of purchasing the assembled multiple, the OEM has the option to purchase the multiple-ready compressors to assemble the compressors into a multiple configuration in their manufacturing plant. Reference drawings of the manifolds are available by contacting your application engineer. For more information, see the 'Assembly' section.

NOTICE

OEMs that choose to design and build their own manifolds for multiple compressor assemblies are ultimately responsible for the reliability of those manifold sets.

For the availability for multiple compressor assemblies, please refer to the Multiples Availability Chart.

Product Selection Software – Modulation Simulator

A user-friendly modulation simulator tool is located within the Product Selection Software program. The Product Selection Software can be downloaded in the Online Product Information (OPI) at **Emerson.com/OPI**. This tool is ideal for easily identifying effective compressor combinations that warrant further system simulation using more advanced tools.

Nomenclature

The model numbers of the manifold multiples follow the same nomenclature convention as single fixed capacity compressors. An additional third character (and optional fourth character) describe the modulation type. See **Figure 6** for more information regarding nomenclature.

Placement Identification

Multiple compressors follow the same placement identification across all platforms and would be noted on the reference drawings. Looking from the electrical connection/terminal box side, the compressor on the far left is designated as 'A' and each compressor to the right of 'A' is sequentially referenced as 'B', 'C', etc.

MANIFOLD DESIGN

Suction Manifold

Multiples require a minimum straight length of entry into the suction manifold. A minimum requirement is 6X the diameter at the suction entrance tee of the multiple. The straight pipe serves to reduce turbulence to make the flow as uniform as possible going into the suction manifold. Some multiple assemblies use a flow restrictor to assist with oil balancing between the compressors. See flow restrictor section for more information.

Discharge Manifold

The discharge manifold is the less critical of the two manifolds in terms of pressure drop and flow. Low pipe stress and reliability are its critical design characteristics. Manifold options with bidirectional capability will need to have one of the outlets capped and brazed by the OEM or end-user. The overall length of the cap fitting should not exceed 3" (7.6 cm).

Equalization Manifold

There are three types of equalization methods. The OEL (Oil Equalization Line) is used to balance the oil between the compressors during the off cycle. The TPTL (Two Phase Tube Line) is used to balance the oil and shell pressure between the compressors during the off cycle. The gas equalization line is used to balance the shell pressure between the compressors and is used

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with an OEL or TPTL. See **Figure 4** for an example of the oil and gas equalization line.

Compressor Clamping

Clamping the compressors together may reduce resonance vibration concerns. No discharge tubing support should be included within 8" (20cm) downstream of the discharge manifold tee to avoid excessive vibration at the tee. Clamping in this method will provide some flexibility between the manifold and the clamp. Contact application engineering for more information on clamping for specific models.

Clamping is required when used with a ZPV variable speed compressor in multiple applications or if identified on the reference drawing for the specific model.

Contact Application Engineering for installation instructions for the clamping.

Flow Restrictors

NOTICE

Necessary care should be taken when servicing manifold sets.

Some uneven or cross model family multiples may require a flow restrictor placed in the correct location to properly balance oil in the compressors. Contact Application Engineering for reference drawing of the manifolds for the correct size and location if required.

VARIABLE SPEED

Multiples with variable speed compressor offerings are qualified with one drive varying the speed of one compressor in the manifold set. Oil balance, oil return and vibration testing is strongly recommended for variable speed compressor multiple applications. If it's desired for a drive to vary the speed of additional compressors in a multiple application contact application engineering.

Fixed Capacity Compressors

Contact application engineering for more information on using a variable speed drive with a fixed capacity ZP, ZR or ZH compressor in manifold applications. Refer to **AE4-1388** for starting, stopping, ramp up and ramp down requirements for the single compressor. Proper starting and stopping of the ZP, ZR and ZH compressor is critical for proper oil lubrication to the internal components of the compressor. Refer to **Table 7** for the approved speed ranges for the ZP, ZR and ZH fixed capacity compressors.

Variable Speed Compressors

The ZPV compressors are available in compressor multiples assemblies. Proper starting, stopping, ramp up and ramp down are built into the drive software. Refer to the dedicated operating envelope for the allowable speed in the envelope. This information can be found in the Online Product Information (OPI) at Emerson.com/OPI.

APPLICATION CONSIDERATIONS

The following general application guidelines should be considered during the design and development of a system using manifold scroll compressors in multiple arrangements.

Operating Envelopes

For even multiples (Z*T, Z*Y, Z*DD, Z*DT, Z*SS, Z*ST, Z*DY, Z*SY, Z*VV) reference the specific scroll model family bulletin for approved operating envelopes.

For uneven multiples (Z*U, Z*M, Z*DU, Z*SU, Z*SR, Z*DM, Z*SM, Z*VT, Z*VU) utilizing different scroll product families, contact application engineering for approved operating envelopes.

Multiples Control Module

Contact application engineering for information regarding the Emerson multiples controller.

Compressor Cycling

Any sequence of start/stop cycles is permitted, however, there is no set answer to how often scroll compressors can be started and stopped in an hour since it is highly dependent on system configuration. There is no minimum off time because Copeland Scroll compressors start unloaded, even if the system has unbalanced pressures. The most critical consideration is the minimum run time required to return oil to the compressor after startup. To establish the minimum run time, obtain a sample compressor equipped with a sight tube (available from Emerson) and install it in a system with the longest connecting lines and highest internal volume that the system may have. The minimum on time becomes the time required for oil lost during compressor startup to return to the compressor sump and restore a minimal oil level. Sight glasses are installed in multiples which includes a TPTL equalization line. Sight glasses

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are not located in the OEL. **Contact Application Engineering for the minimum oil level required. The oil level should be checked with the compressor "off" to avoid the sump turbulence when the compressor is running.**

Cycling the compressor for a shorter period than this, for instance, to maintain very tight temperature control, may result in progressive loss of oil and damage to the compressor. Scroll compressors with CoreSense™ Communications provide a configurable short cycle protection feature via Modbus with the system controller.

It is recommended to delay 5 seconds before starting or stopping another compressor. Starting or stopping two or more compressors together should be avoided to limit tubing stresses.

Long Pipe Lengths / High Refrigerant Charge

Some systems may contain higher than normal refrigerant charges. Systems with large reheat coils, low ambient condenser flooding, or systems with multiple heat exchangers are among some system configurations that may require additional lubricant. Some scroll compressors will have sight glasses for oil level viewing, the oil level should always be checked during OEM assembly, field commissioning, and field servicing. The oil level must be carefully monitored during system development. The compressor oil level should be checked with the compressor "off" to avoid the sump turbulence when the compressor is running. 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. An estimation of the amount of additional to add to the compressor(s) after the initial 20 pounds of refrigerant is listed in **Table 1**.

Refrigerant Piping Design

Proper line sizing is important for tandem and trio applications. Multiple capacity steps allow for various refrigerant velocities in the system. Refrigerant piping without proper line sizing for part load conditions may not allow for the oil to properly return to the compressor.

See additional info on **page 9** titled “Oil Balance Procedures”.

System Tubing Stress / Pipe Clamping

System tubing should be designed to keep tubing stresses under the endurance limit of the copper tubing type used (i.e. Type K, L, etc.). Start, stop and running (resonance) cases should be evaluated to ensure long term reliability. A clamping device may be required to minimize piping stress. Refer to the reference drawing for the installation requirements and torque requirements.

Suction and discharge tandem 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.

For variable speed applications, the suction and discharge tubing must be evaluated to determine the resonant frequencies. Once the resonant frequencies are known, they can be shifted to a desired range by changing the mass of the line for constant speed applications or they can be avoided for variable speed applications. Application engineering is available to recommend additional tests and to evaluate test results.

Off-Cycle Migration Control

Excessive migration of refrigerant to the compressor during the off-cycle can result in oil pump-out on start - up, excessive starting noise and vibration, bearing erosion, and broken scrolls if the hydraulic slugging pressure is high enough. For these reasons, off-cycle refrigerant migration must be minimized. The following three sections summarize off-cycle migration techniques.

Crankcase Heaters

A crankcase heater is required when the system charge exceeds the values listed in **Tables 2-5**. This requirement is independent of system type and configuration. The initial start-up in the field is a very critical period for any compressor because all load-bearing surfaces are new and require a short break-in period to carry high loads under adverse conditions. **The crankcase heater must be turned on a minimum of 12 hours prior to starting the compressor.** This will prevent oil dilution and bearing stress on initial startup.

Pump Down Cycle

Although not preferred, a recycling pump down cycle can be used to minimize off-cycle refrigerant migration to the compressor. The risk of a short cycling condition

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that can lead to oil pump out, excessive contactor wear, unnecessary energy use, and excessive low pressure cut-out switch cycles make recycling pump down undesirable. If a pump down cycle is desired by the system designer, a onetime pump down at the end of the cooling cycle is preferred over recycling pump down. In lieu of the pump down cycles mentioned above, simply closing a liquid line solenoid valve when the compressor cycles off is a good, simple, and cost effective method of minimizing off-cycle refrigerant migration.

Pump Out Cycle

A pump out cycle has been successfully used by some manufacturers of large rooftop units. After an extended off period, a typical pump out cycle will energize the compressor for up to one second followed by an off time of 5 to 20 seconds. This cycle is usually repeated a second time, the third time the compressor stays on for the cooling cycle.

If any of the above methods are employed, a crankcase heater must be used if the circuit charge amount exceeds the values listed in Table 2-5.

Floodback Management / Suction Accumulators

Proper control of liquid refrigerant in a system is an application concern and is largely beyond the control of the compressor manufacturer. If liquid refrigerant can flood through an air conditioning system and return to the compressor before being evaporated, it may cause damage to the compressor due to liquid slugging, loss of oil from the lower shell, or bearing washout. To protect against this condition on systems vulnerable to liquid damage, a suction accumulator may be necessary. The Copeland Scroll compressor's inherent ability to handle liquid refrigerant during occasional operating flood back situations makes the use of an accumulator unnecessary in most applications. In applications where uncontrolled flooding is common, an accumulator should be used to prevent excessive oil dilution and oil pump out.

Adequate oil levels must be maintained in all compressors, regardless of operation.

Maximum Tilt Angles

The maximum tilt angle of the multiple while the compressors are in operation will depend on which direction it is tilted. Contact application engineering for specific model requirements. In general, the maximum tilt angle for transport or maneuvering into location is 60º.

Compressor Replacement

NOTICE

Necessary care should be taken when servicing manifold sets.

Use care when handling and/or disassembling the suction manifolds as to not dislodge or remove flow restrictors, if provided. See the reference drawing for flow restrictor location and size.

For tandem and trio sets which include ZP16-ZP83, ZP91 and ZR48-ZR81 compressors it is recommended to replace the entire manifold due to the availability of manifolds to the aftermarket. The oil from the failed compressor will stay mostly in the failed compressor. Any contaminated oil that does enter the tandem circuit will be cleaned by the liquid line filter drier, and when used, the suction line filter drier. There are limited service compressor offerings for single compressors less than 10 tons in manifold applications.

For tandem and trio sets which include ZP90, ZP103-ZP485 and ZR84-ZR380 compressors it is recommended to replace the individual compressor and reuse the existing suction and discharge manifolds. The failed compressor should be carefully removed, and the manifolds cut in such a way that a coupling and short piece of copper can reconnect the new compressor. The replacement oil equalization line should be formed to the exact same outline and dimensions as the line that is being replaced. To reconnect the oil equalization line to the compressor, the oil in one or both compressors need to be lowered below the oil fitting on the compressor. To do this, oil should either be removed from the compressors or the compressors should be tilted back a minimum of 12 degrees from horizontal to move the oil away from the fitting (see **Figure 3**).

Changing a compressor in a multiples configuration that use rotalock connected manifolds simplifies the change out process. After the refrigerant is recovered, and it is verified with gauges that no residual refrigerant pressure is in the section of the system being serviced, the suction and discharge rotalock fittings can be disconnected from the failed compressor. Always use new rotalock O-ring seals when connecting the replacement compressor.

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NOTICE

Because of the extensive testing necessary to prove the acceptability of a manifold designs and the critical nature of oil equalization to system reliability, Emerson does not recommend field construction of manifolds unless an Emerson approved oil equalization system is used. In the absence of such a system, Emerson specifications require a factory designed and tested and oil equalization system.

Oil levels in the individual sight-glasses will vary, depending on whether one or more compressors in the multiple set are operating and if the multiple 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 on the “off” state, oil should be visible in the sight glass. If oil is not visible, additional oil should be added to the system. **The above procedure is extremely important during the unit commissioning process in the field and must be performed. Failure to add oil to the system to account for large refrigerant charges and large internal surface areas can result in compressor wear.**

ASSEMBLY LINE PROCEDURES

Compressor Handling

⚠WARNING

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

The suction and discharge plugs should be left in place until the compressor is set into the unit. If possible, the compressor should be kept vertical during handling. The discharge connection plug should be removed first before pulling the suction connection plug to allow the dry air pressure inside the compressor to escape. Pulling the plugs in this sequence prevents oil mist from coating the suction tube making brazing difficult.

Lifting Devices

When lifting manifold compressor assemblies, all compressors must be lifted by their respective lifting rings simultaneously.

Mounting

Many OEM customers source the mounting parts directly from the supplier, however Emerson's grommet design and durometer recommendations should be followed for optimal vibration reduction through the mounting feet.

OEM Multiples Assembly

NOTICE

OEMs that choose to design and build their own manifolds for multiple compressor assemblies are ultimately responsible for the reliability of those manifold sets.

The following procedure outlines the basic steps for OEMs to assemble multiple ready compressors into a multiple manifold configuration:

1. Mount compressors to the rails using the appropriate hardware. Mounting bolts should be snug, but not tight, so some movement of the compressor is possible for aligning the manifolds.

2. Install the suction and discharge manifolds. If the manifolds are brazed to the compressors standard brazing practices with a nitrogen purge should be followed. If the manifolds are connected to the compressors with rotalock fittings, torque the rotalock fittings to the value specified in the individual compressor bulletin.

3. Tilt the tandem assembly back approximately 12 degrees from horizontal so the oil flows away from the oil fittings and sight glasses on the compressors (see **Figure 3**). If the oil manifold is a TPTL the compressor sight glasses needs to be removed prior to installing the TPTL. The TPTL Rotalock fitting should be torqued to the value listed in **Table 6**. If the oil manifold is an OEL the Schrader fittings can now be removed by unscrewing them. Removing the Schrader fittings exposes the stub that is used to braze the OEL to each compressor. **The oil equalization stubs of both compressors should be wiped clean with a lint-free towel to remove any oil residue before brazing.** Install the oil manifold to the individual compressors and torque the rotalock fittings to

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the value specified in the individual compressor bulletin.

4. Torque the compressor to rail mounting bolts to the value specified in the individual compressor bulletin.
5. If required, install clamping system per general assembly drawing and torqueing procedure.

MULTIPLES TESTING PROCEDURES

There are a minimal number of tests the system designer will want to run to ensure the system operates as intended. These tests should be performed during system development and are dependent on the system type and amount of refrigerant charge. These application tests are to help identify gross errors in system design that may produce conditions that could lead to compressor wear. Oil balancing tests must be performed to demonstrate oil balancing between the compressors. Compressors with sight tubes for viewing a wide range of oil levels is appropriate for this type of testing. See additional information on viewing oil levels on **page 8**. The least amount of testing will evaluate the minimum and maximum flow conditions at which the compressors will be required to operate, with min and max suction superheat.

For variable speed applications, the above oil balancing and system oil return tests are required to be performed. The concern is a very low oil level after extended hours of operation at low speed.

Oil Balancing & Return Procedure

1. **Define Application:** All relevant combinations of running speed, staging and operating conditions should be evaluated.

2. **Check for Oil Balance:**
   a. Minimum mass flow rate condition expected in system (all compressors operating)
   b. Maximum mass flow rate condition expected in system (all compressors operating)
   c. Full load rating point (all compressors operating)
   d. Other points of interest that could be achieved while running all compressors

3. **Check for Oil Return:**
   a. Minimum mass flow rate expected (one compressor operating, test compressors individually)
   b. Maximum mass flow rate expected (one compressor operating only)
   c. Cycling Test: Run at a low mass flow rate condition, switch on the 2nd compressor for five minutes, back to max mass flow rate for 30 minutes, and repeat.

Oil Balance & Return Testing

1. Prior to starting any testing, mark a line on the oil sight tube corresponding to nominal and minimum oil level. See **Figure 1.** Contact application engineering for minimum oil level.

2. Achieve steady state condition where it is desired to take oil balance measurement.

3. Close ball valve on oil equalization line. See **Figure 2.**

4. Stop compressors.

5. Wait 1 minute for oil level to stabilize.

6. Read oil level in oil sight tube, record this as a distance (in mm) from the nominal oil level line.

7. Open ball valve allows oil levels to equalize across the line.

8. Record compressor oil levels again, relative to oil level line.
   -Check for net oil gain/loss from system

9. Resume testing.

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Figure 1 - Sight Tube

Figure 2 - Equalization Valve

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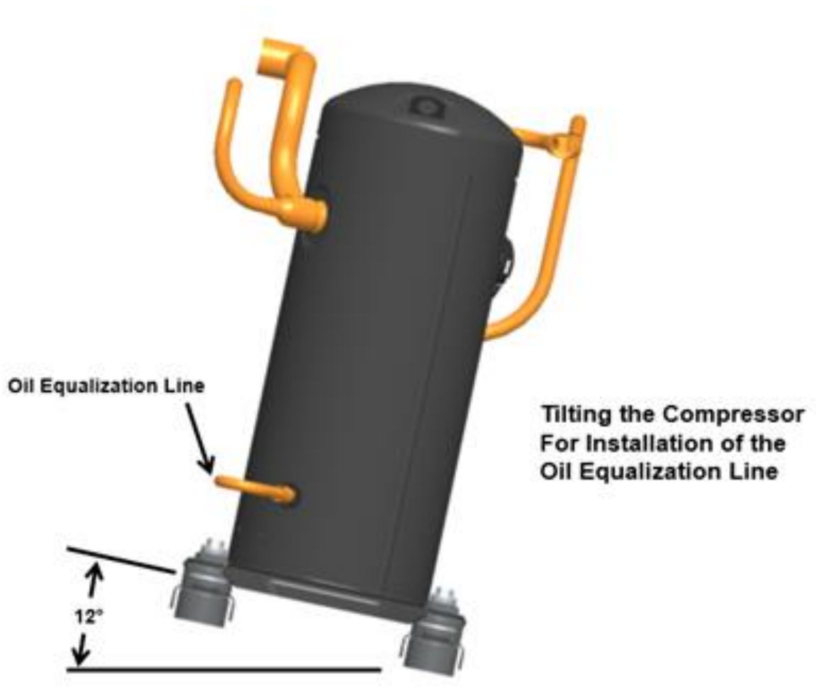

Figure 3 - OEL installation Tilt

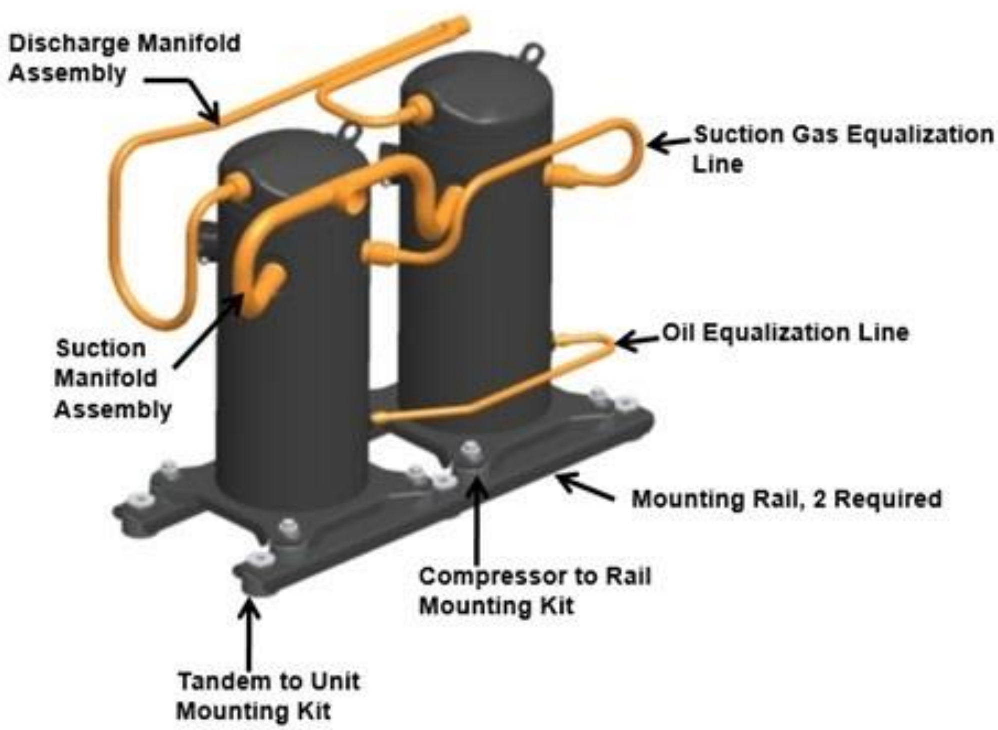

Figure 4 - Typical K5 Tandem

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Figure 5 - Compressor Clamping (If Require)

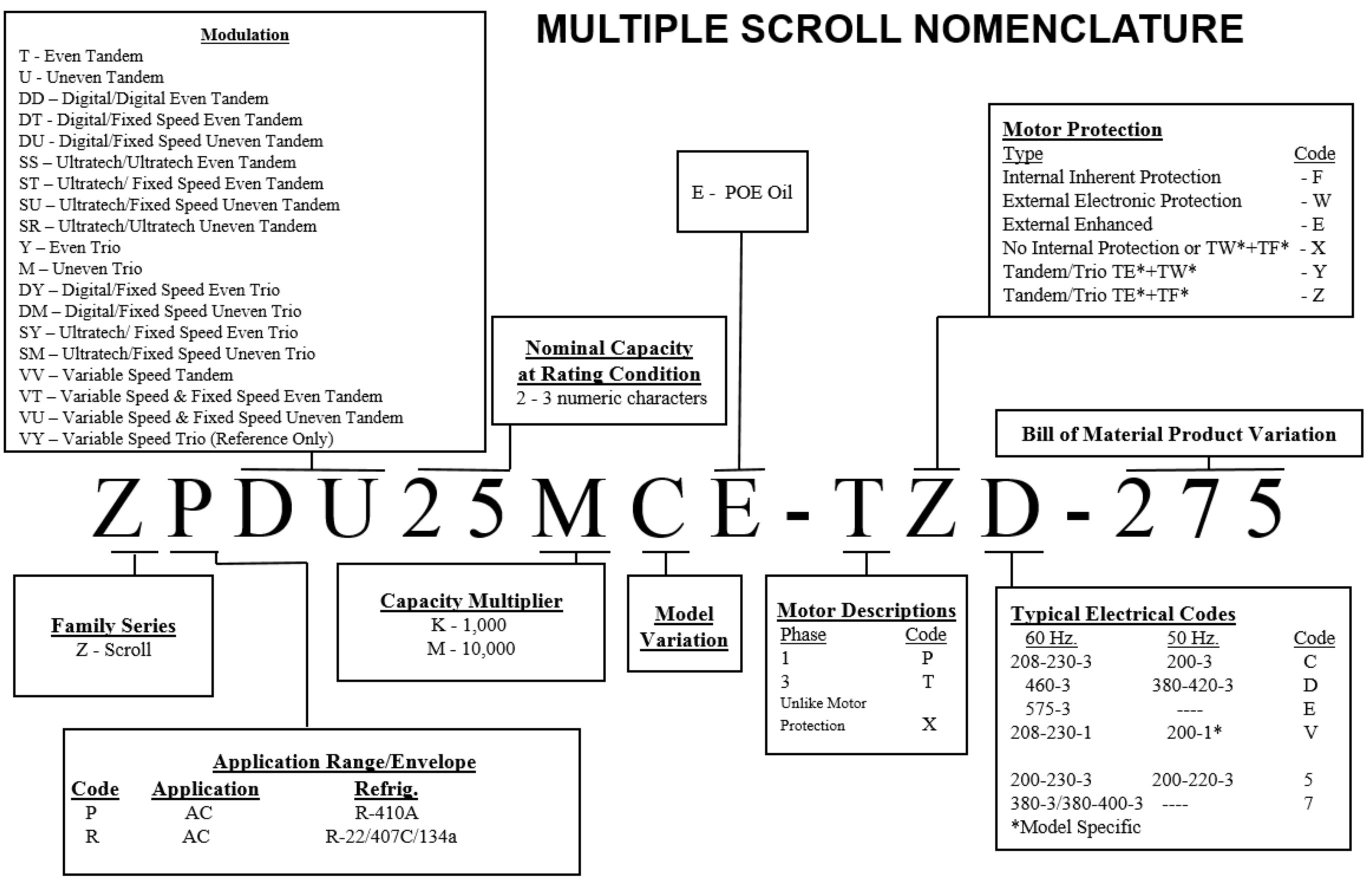

Figure 6 - Nomenclature

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Table 1 - Additional Oil

	ZP14-61K5, ZP14-ZP54K6	ZR61-81, ZP61-83KC, ZP91, ZP104, ZP122	ZR84-190, ZP90, ZP103, ZP120 & ZP137-182	ZR250-380, ZP235-ZP485
Tandems	0.3 oz.	0.4 oz.	0.7 oz.	0.7 oz.
Trios	0.3 oz.	0.4 oz.	0.7 oz.	0.7 oz.

1. The table should be used as an estimate only. Correct oil charge should be verified.
2. The table indicates the additional ounces of oil per pound of refrigerant after the initial 20 LBS of refrigerant.
3. Digital & two stage models follow the fixed capacity compressor suggestion.

Table 2 - ZP*KC, ZP*K3 & ZP*K5 Refrigerant Charge Requirements for Crankcase Heaters

Model	Charge Limit		Model	Charge Limit	
	Pounds	kg		Pounds	kg
ZPT32-62K	12	5.4	ZPY273K	21	9.5
ZPT68-166K, ZPT182K	15	6.8	ZPY309K-411K	34	15.4
ZPT180K, ZPT206K, ZPT240K, ZPT274K	24	10.9	ZPY708-888K	54	24.5
ZPT208K, ZPT244K	16	7.3	ZPY115M, ZPY145M	65	29.4
ZPT308-364K	27	12.2			
ZPT470-592K	37	16.8	ZPM317K	11	5
ZPT770-970K	45	20.4	ZPM125-135M	64	29.4
ZPU47K, ZPU56K	8	3.6			
ZPU58K, ZPU62K, ZPU80K	9	4.1			
ZPU76-78K, ZPU85-174K	10	4.5			
ZPU171K, ZPU176-ZPU205K & ZPU213K	15	6.8			
ZPU210-223K, ZPU240-257K	16	7.3			
ZPU226K	11	5			
ZPU258K, ZPU272-319K	25	11.3			
ZPU259K	21	9.5			
ZPU336K	27	12.2			
ZPU418K	32	14.5			
ZPU532K	37	16.8			
ZPU567K	36	16.3			

*** Digital models follow the fixed capacity compressor requirements.**

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Table 3 -ZP*KZ Refrigerant Charge Requirements for Crankcase Heaters

Model	Charge Limit		Model	Charge Limit	
	Pounds	kg		Pounds	kg
ZPT274KZ	16	7.3	ZPY411KZ	16	7.3
ZPT308K, ZPT364KZ	18	8.2	ZPY462K, ZPY546KZ	18	8.2
ZPT464K, ZPT584KZ	TBD	TBD	ZPY696K, ZPY876KZ	TBD	TBD

Table 4 - ZPV Refrigerant Charge Requirements for Crankcase Heaters

Model	Charge Limit	
	Pounds	kg
ZPVU054-0952E	9	4.1
ZPVU159-2082E	15	6.8
ZPVU238-2632E	20	9.1

Table 5 – ZPS Refrigerant Charge Requirements for Crankcase Heaters

Model	Charge Limit		Model	Charge Limit	
	Pounds	kg		Pounds	kg
ZPSU58K5E	8	3.6	ZPSR70K5E	8	3.6
ZPSU60K5E	10	4.5	ZPSR89K5E	10	4.5
ZPSU66K5E	8	3.6	ZPSR11M5E	10	4.5
ZPSU69K5E	10	4.5	ZPSR15MCE	10	4.5
ZPSU79K5E	10	4.5			
ZPSU84K5E	10	4.5			
ZPSU93K5E	10	4.5			
ZPSU10MCE	10	4.5			
ZPSU11M5E	10	4.5			
ZPSU13MCE	10	4.5			
ZPSU16MCE	10	4.5			

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Table 6 - ZR Refrigerant Charge Requirements for Crankcase Heaters

Model	Charge Limit		Model	Charge Limit	
	Pounds	kg		Pounds	kg
ZRT96K	12	5.4	ZRU178K	24	10.9
ZRT108-162K	15	6.8	ZRU285-334K	25	11.3
ZRT188-288K	24	10.9	ZRU350K	27	12.2
ZRT320-380K	27	12.2	ZRU560K	41	18.6
ZRT500K	37	16.8			
ZRT600-760K	45	20.4	ZRY324-432K	34	15.4
			ZRY480-570K	38	17.2
			ZRY750K	54	24.5
			ZRY900K-114M	64	29

*** Digital models follow the fixed capacity compressor requirements.**

Table 7 - Torque Values

Part	Torque		
	Ft-lb	in-lb	N-m
Sight-Glass	25-30	300-360	57-81
Discharge Rotalock Valve	95-103	1150-1240	130-140
Suction Rotalock Valve	125-132	1505-1593	170-180
Schrader Valve	3.3-5.0	40-60	4.5-6.8

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Table 8 - Variable Speed Range for Fixed Capacity ZP, ZR & ZH Compressors

	ZP, ZR & ZH Single Compressor	ZP236-485KCE	ZH Tandems & Trios	ZP & ZR Even Tandems	ZP & ZR Uneven Tandems	ZP & ZR Even Trios	ZP & ZR Uneven Trios
Modulation Range	45-65 Hz	35-75 Hz	50-60 Hz	45-65Hz	50-60Hz	45-65Hz	50-60Hz

1. Extended speed ranges may be available for specific models. Contact Application Engineering for more information.

2. Refer to AE4-1388 for the detailed operating envelope for the ZP236KCE – ZP485KCE compressors.

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