06ZC, ZF, ZJ VARIABLE SPEED TWIN SCREW COMPRESSOR APPLICATION GUIDE

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INTRODUCTION

The 06Z screw compressor family is a variable frequency drive, twin screw, oil injected helical rotor compressor. This manual is for the Carlyle® variable speed screw compressor product line, which is comprised of three frame model sizes 06ZC, ZF, and ZJ. Carlyle offers distinct versions of the variable screw compressor for Medium/High Temperature applications qualified with R-134a, R-1234ze, or R-513A refrigerants.

The following compressor features are offered:

- Variable Vi valve to optimize compressor efficiency.
- Integrated discharge muffler.
- Wide variable speed range to maximize compressor capacity.
- Standard 2-pole induction motors.

The operational limits, required accessories, and operational guidelines are contained in this manual must be complied with to stay within the compressor warranty guidelines.

R-134a, R-1234ze, or R-513A Applications

The 06Z series compressors are designed for air-cooled R-134a, R-1234ze, or R-513A applications only.

Each variable screw compressor is designed to be applied with a dedicated, performance-matched oil separator. This compressor / oil separator assembly can be applied in a medium-temperature or high-temperature refrigeration circuit. Carlyle offers the required oil separators as shown on page 20 of this application guide.

Scope

This application guide is intended to familiarize system designers with the variable screw compressor and to provide technical information necessary to assure safe and reliable compressor operation.

Certifications

UL and CSA approvals have been obtained for specific 06Z screw compressor models applied with R-134a, R-1234ze, or R-513A.

UL File #: SA4936

CSA File #: SA4936

UL, CSA, and CE approvals have been obtained for all voltage combinations shown on page 18 of this guide. These compressor models also comply with the EC Low Voltage and Machinery Directives.

Compressor Offerings

The three variable speed frame sizes (06ZC, 06ZF, and 06ZJ) are optimized for application in economized refrigeration circuits. Table 1 notes the available variable speed screw compressor model offering.

Manufacturer reserves the right to discontinue, or change at any time, specifications or designs without notice and without incurring obligations.

Table 1 — Variable Speed Screw Compressor Offering

MODEL NUMBER	NOMINAL HP	VOLTS/ HERTZ	SPEED RANGE	MOTOR TYPE
06ZCE1H3AA06013	130	460V - 100 Hz	25 - 105 Hz	2-pole Induction
06ZCE1T3AA06013		380V - 100 Hz		
06ZCE1Y6AA06013		200V - 100 Hz		
06ZFC2H3AA06013	215	460V - 98 Hz	25 - 98 Hz	
06ZFC2T3AA06013		380V - 98 Hz		
06ZFC2Y6AA06013		200V - 98 Hz		
06ZJG3H3AA06013	325	460V - 95 Hz	25 - 95 Hz	
06ZJG3T3AA06013		380V - 95 Hz		

Standard Features

See Fig. 1 for a description of the model number.

DISCHARGE CHECK VALVE

The discharge check valve is an axial movement type located within the compressor. The check valve is field serviceable by removing the oil separator or discharge line to access the valve in the compressor discharge housing.

COMPRESSOR MOTOR

The 06Z compressor has one standard motor offering**;** a 2-pole induction motor for improved compressor efficiency.

INTEGRATED DISCHARGE MUFFLER

The 06Z compressor is equipped with an integrated discharge muffler specifically designed to reduce discharge gas pulsation and resonance, resulting in reduced refrigerant line vibration and a quieter refrigeration system.

PRESSURE RELIEF VALVE

The 06Z screw compressors have an internal relief device, which is designed to relieve pressure from the high side to the low side of the compressor.

SUCTION AND ECONOMIZER SCREENS

To increase the reliability of the compressor, a screen has been incorporated as a standard feature into the suction inlet and economizer inlet of the compressor. The suction inlet screen is installed into the suction inlet of each compressor. The economizer inlet screen is supplied in the economizer flange package (which is included in the compressor component kit. Please refer to the economizer flange installation instruction document for more details.

CAPACITY CONTROL

All 06Z screw compressors are VFD capable as defined in Table 1 and do not utilize a slide valve unloading system. The compressor capacity may be varied continuously to a lower limit of 22% of the economized compressor's full load capacity for air-cooled applications.

VI CONTROL

All 06Z models are supplied with a Vi control valve which functions to maintain optimum compressor efficiency. The Vi control valve setting is variable and is actuated by the Carlyle PCM module, which continuously monitors the operating pressures and controls the Vi output accordingly. Depending on the operating condition and drive frequency, the compressor will run more efficiently with either the Vi control valve engaged or disengaged.

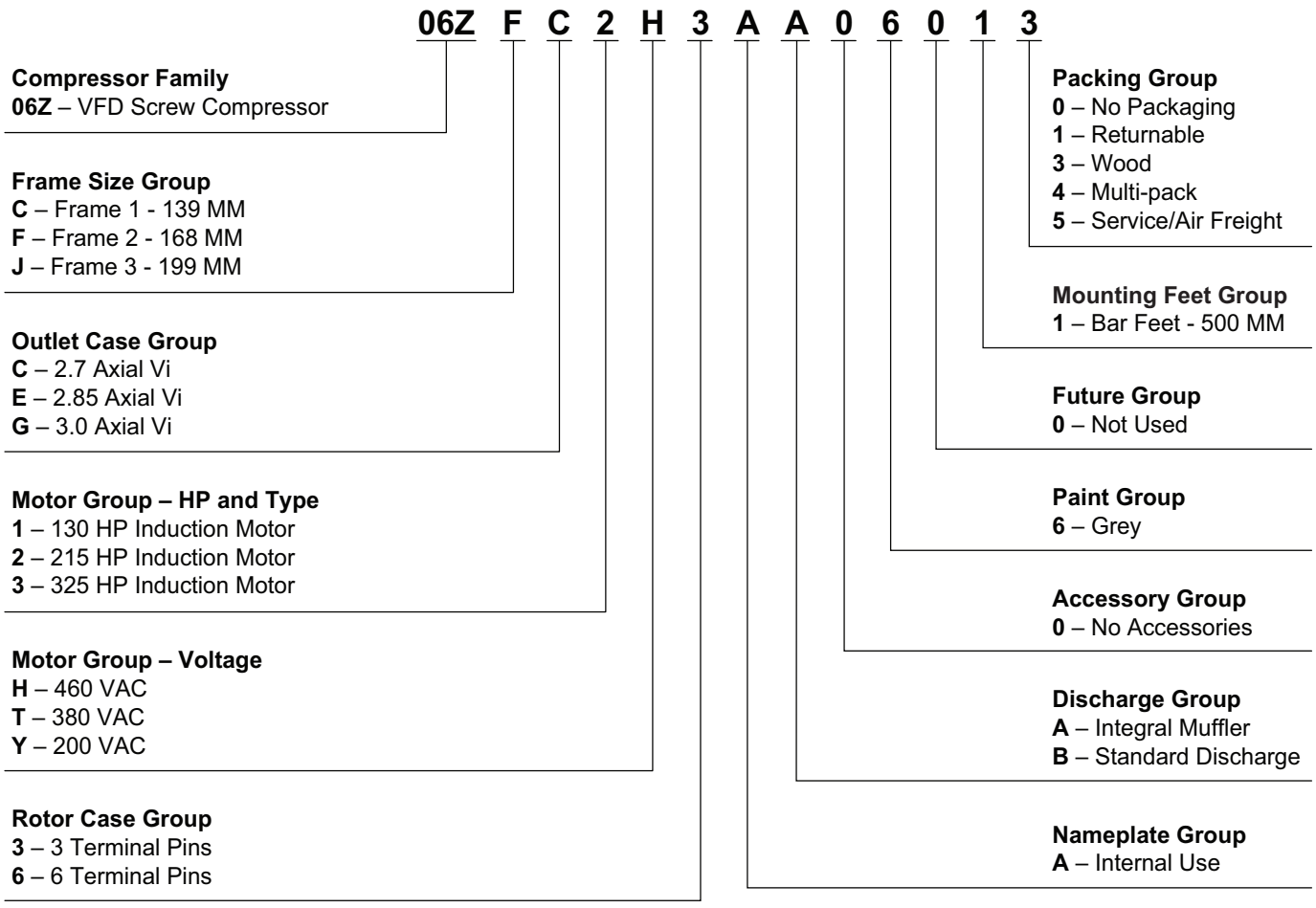


Fig. 1 — Model Number Nomenclature

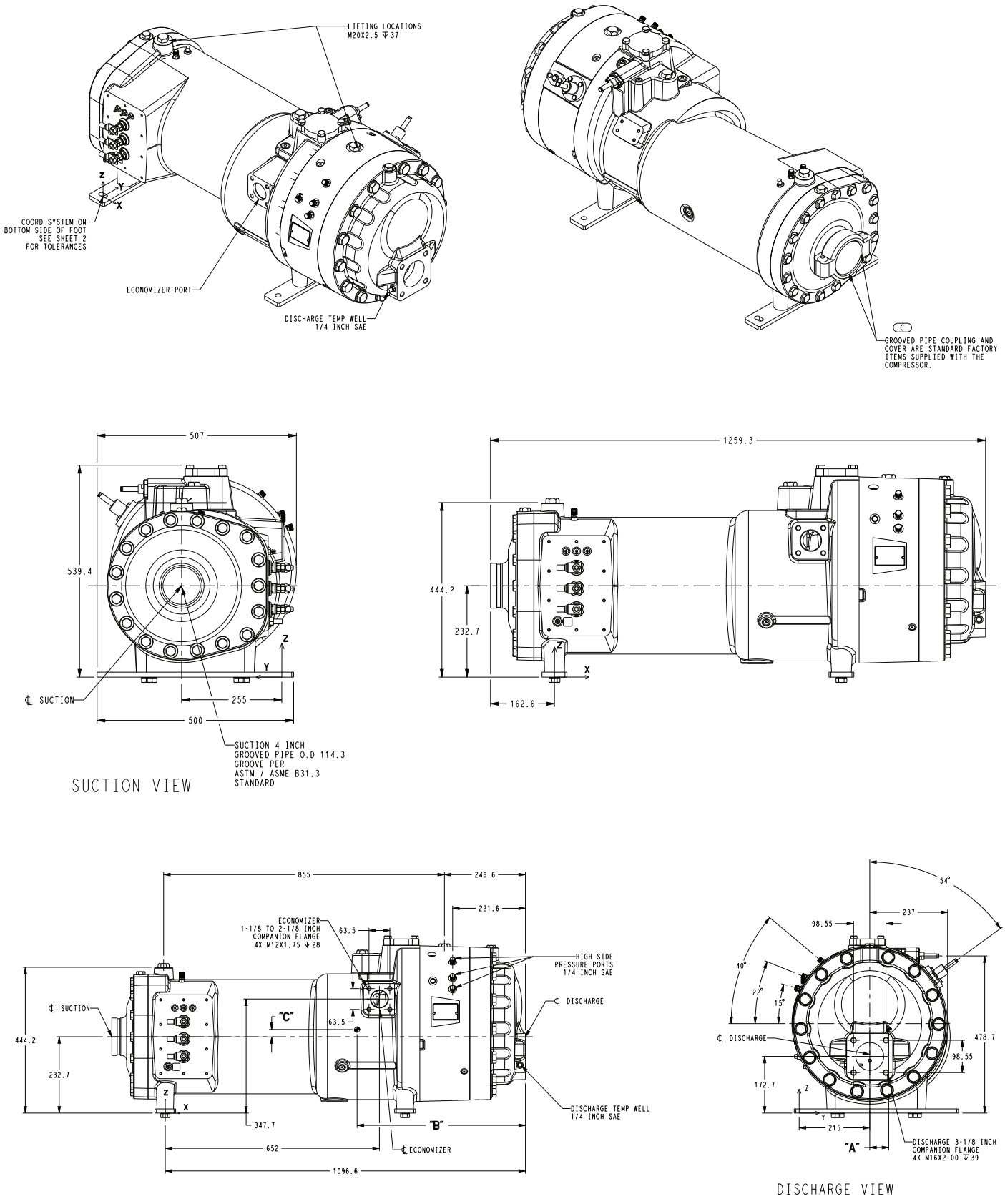


Fig. 2 — Compressor Physical Data and Connections (06ZC, Frame 1)

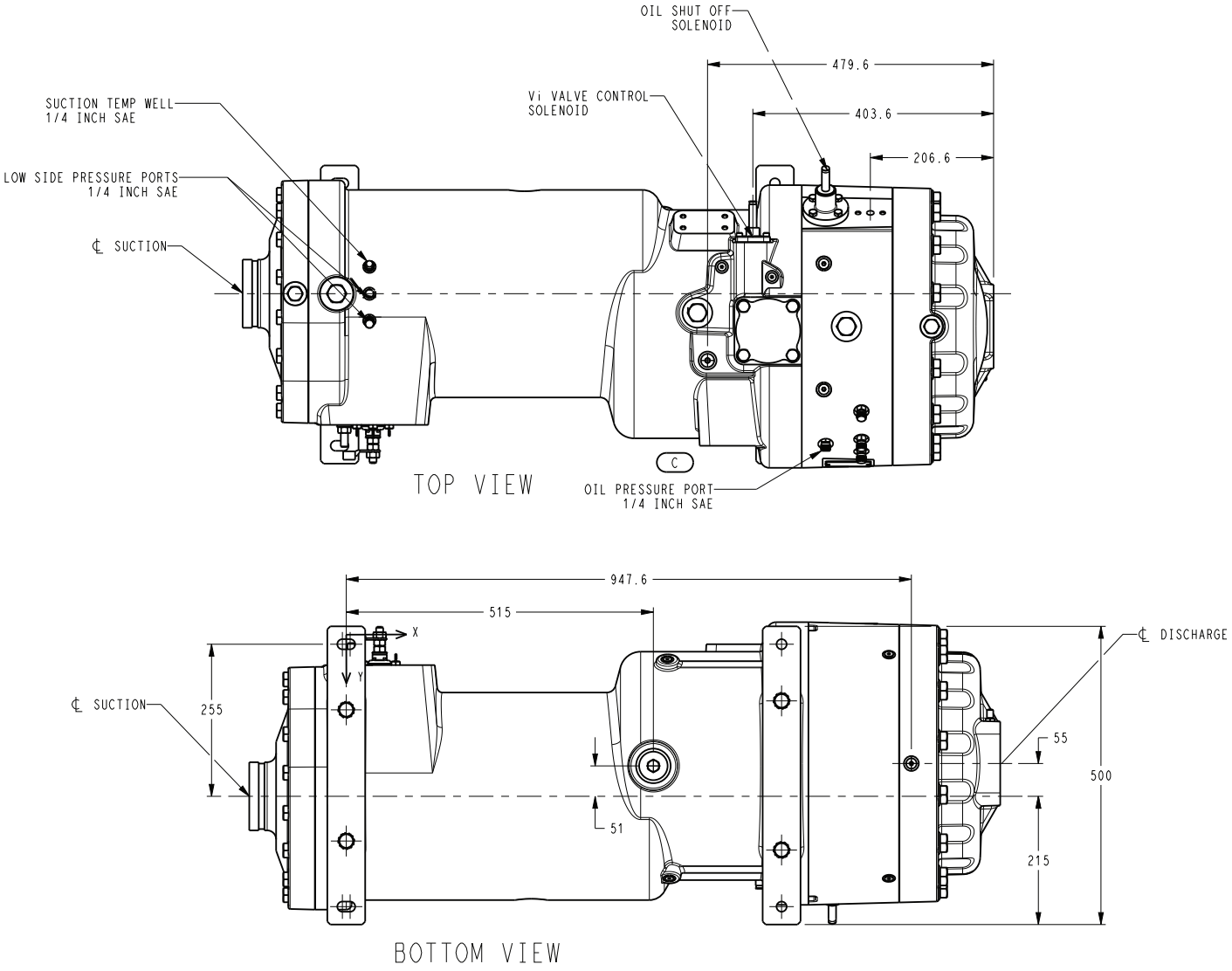


Fig. 2 — Compressor Physical Data and Connections (06ZC, Frame 1) (cont)

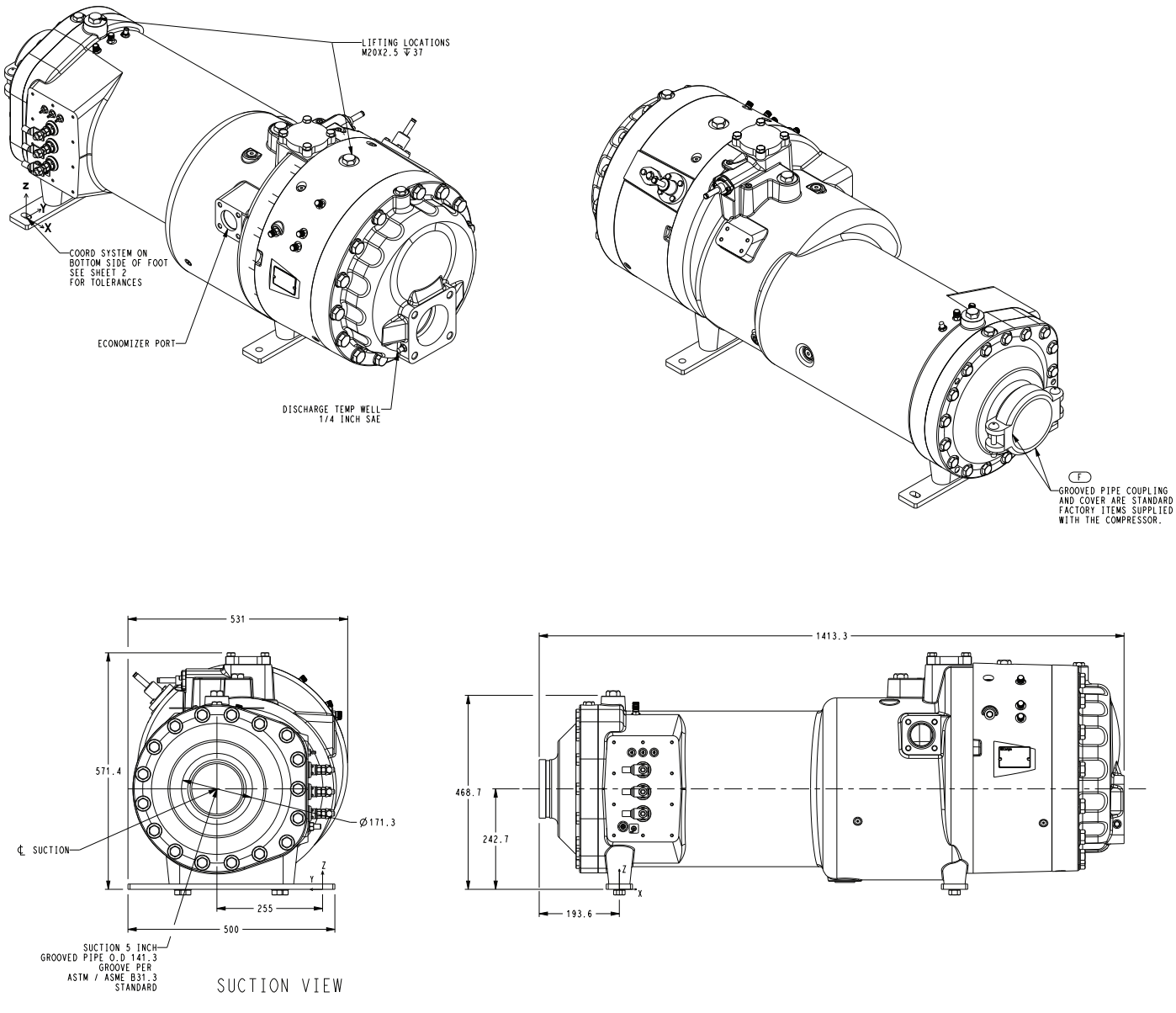


Fig. 3 — Compressor Physical Data and Connections (06ZF, Frame 2)

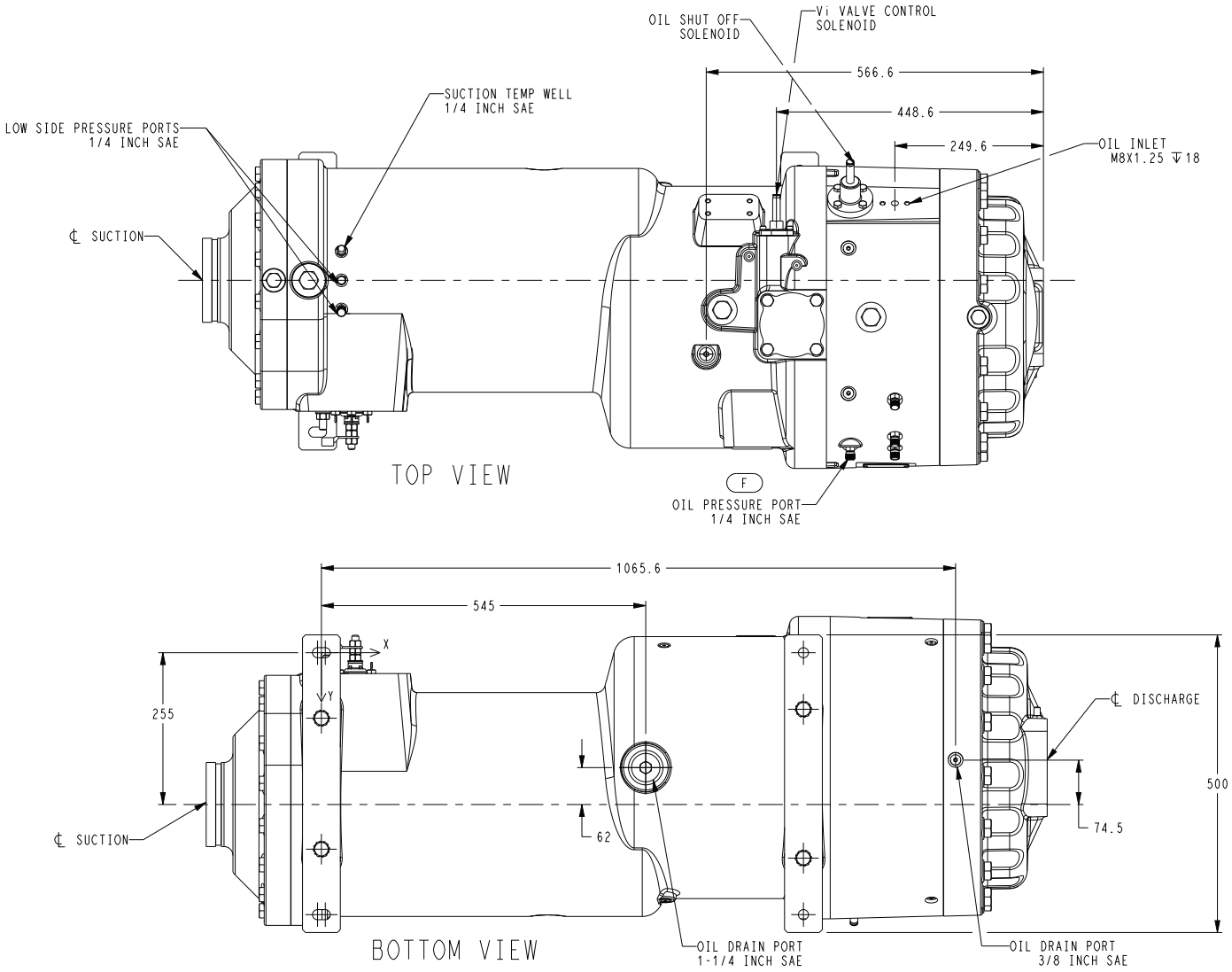


Fig. 3 — Compressor Physical Data and Connections (06ZF, Frame 2) (cont)

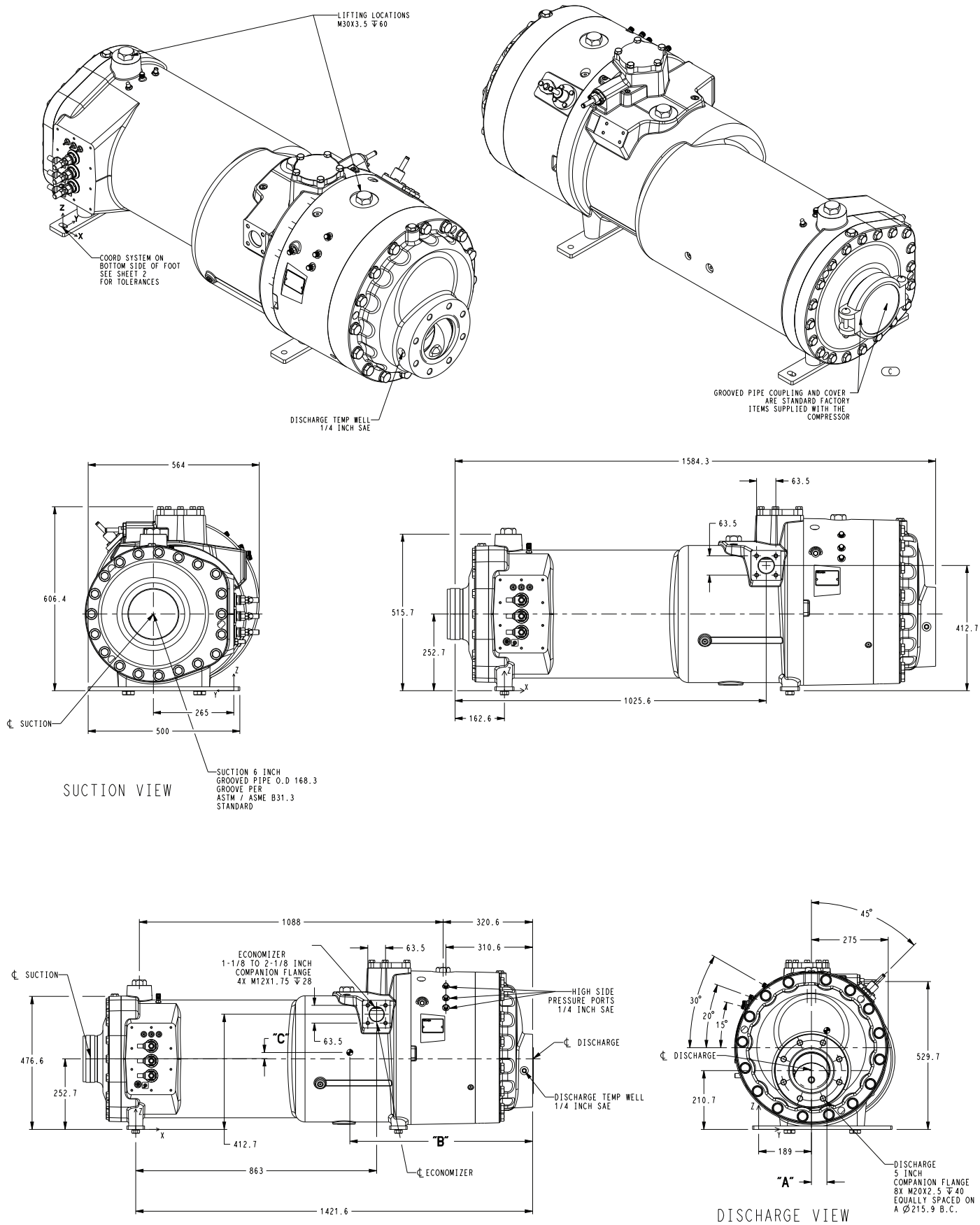


Fig. 4 — Compressor Physical Data and Connections (06ZJ, Frame 3)

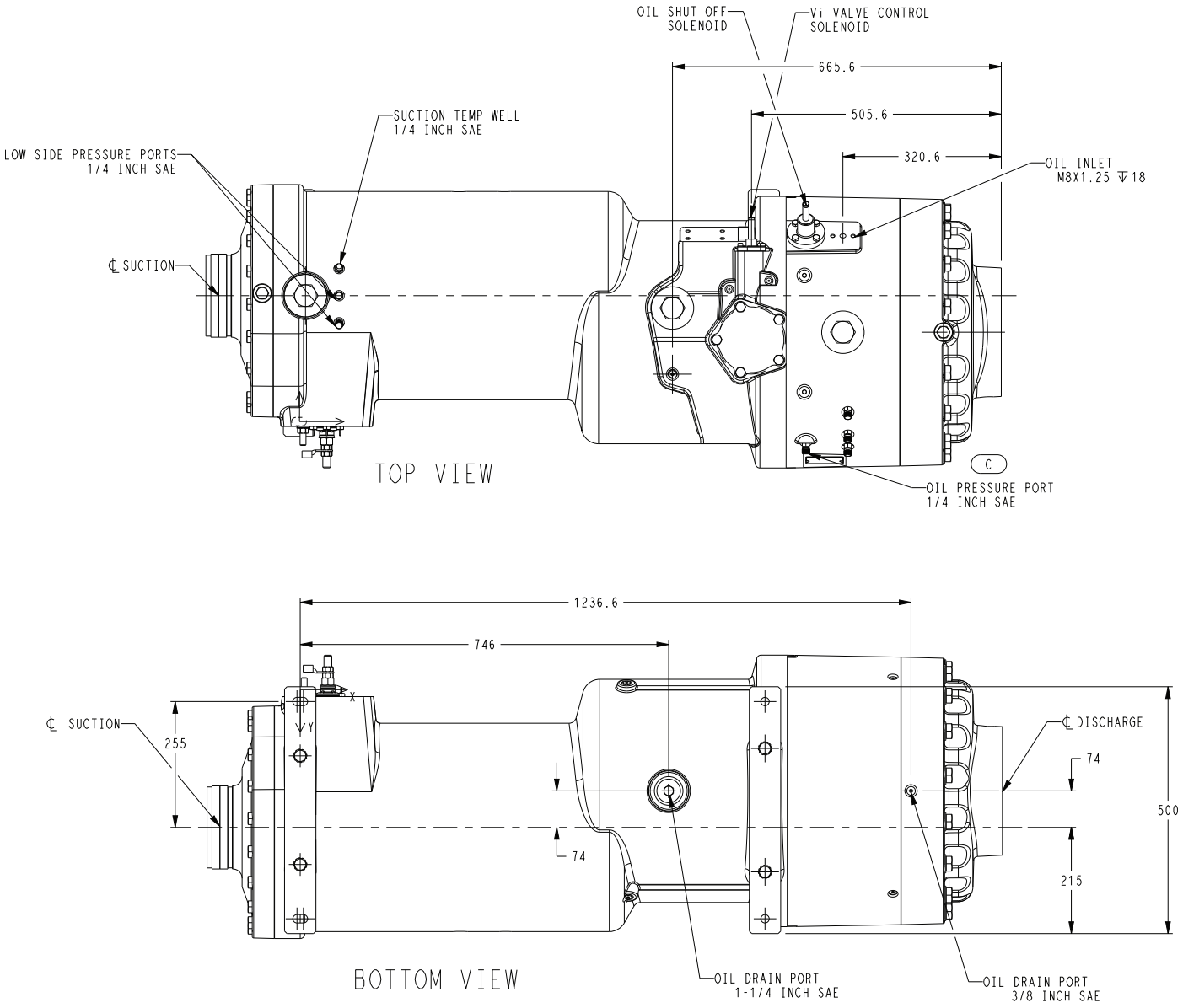


Fig. 4 — Compressor Physical Data and Connections (06ZJ, Frame 3) (cont)

MEDIUM/HIGH TEMPERATURE SYSTEM DESIGN CONSIDERATIONS

Refrigerants and Lubricants

APPROVED REFRIGERANTS

The 06Z screw compressor is specifically designed for use in R-134a, R-1234ze, or R-513A systems.

APPROVED LUBRICANTS

The following lubricants are approved for use with 06Z screw compressor:

- Carrier Material Spec PP47-13, PP47-14, PP47-32, or PP47-34, Viscosity Grade ISO 220

The following lubricants are approved for use with 06Z screw compressor with R-1234ze:

- Carrier Material Spec PP47-38, Viscosity Grade ISO 220

⚠ CAUTION

EQUIPMENT DAMAGE HAZARD

Failure to follow this caution may result in damage to equipment.

All POE oils are very hygroscopic (will readily pick up and retain moisture from the air). Damaging acids can form if moisture is present. Oil should only be used from a properly sealed container.

ASSEMBLY GREASE

On occasion, it may be necessary to use an assembly grease to retain an O-ring within its groove. The following assembly grease is approved for use with the 06Z screw compressor:

- Approved Lubricant — Parker Super-O-Lube
- Carrier Part Number — 19XL680001

TERMINAL PIN DIELECTRIC GREASE

Carlyle recommends that compressor motor terminal pins are coated with dielectric grease (P/N 06TT660050) to reduce the effects of condensation that may form on the terminal pins.

Environmental Considerations

OPERATING AMBIENT TEMPERATURE

The screw compressor is designed for the following ambient temperature ranges:

Non-Operating: –40°F to 176°F (–40°C to 80°C)

Operating: –31°F to 131°F (–35°C to 55°C)

SALT-SPRAY REQUIREMENTS

The compressor has been tested through 500 hours of salt-spray in compliance with ASTM specification B-117.

Operating Limits and Controls

The following operating envelopes show where the compressor can be operated in both direct expansion and flooded applications (see Fig. 5).

AIR-COOLED CONDENSING WITH R-134A, R-1234ZE, OR R-513A FULL LOAD OPERATING ENVELOPE WITH LIQUID INJECTION

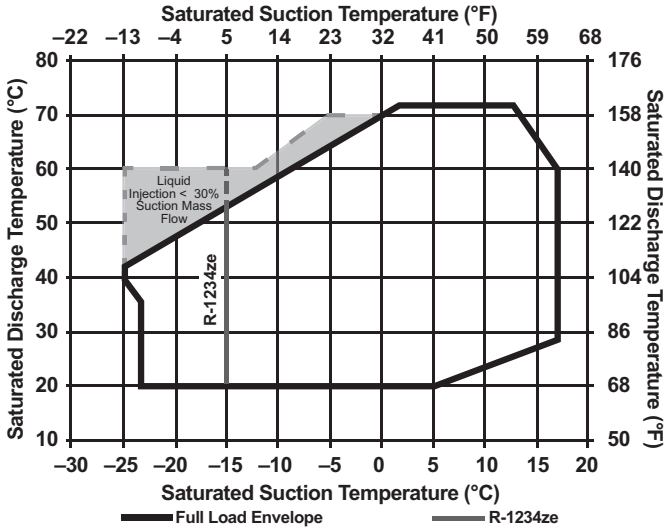


Fig. 5 — Full Load Operating Envelope with Liquid Injection

START-UP AND SUCTION PRESSURE TRANSIENTS

Operating a screw compressor without refrigerant flow through the compressor can be harmful. When this occurs, the evaporator typically will go into a vacuum, leading to very high pressure ratios and little mass flow to carry the heat away from the screw rotors. This situation most often occurs during start-up when the refrigerant may be in another part of the system. This is tolerable for short periods of time. **The compressor should not be allowed to operate with a suction pressure less than 0 psig (vacuum) for more than 1 minute after a "cold" start.** If a compressor is allowed to operate for longer periods of time without refrigerant flow, catastrophic damage to the screw rotors, rotor housing, and discharge housing may occur, requiring compressor replacement.

OIL SUPPLY TEMPERATURE TO COMPRESSOR

To reduce the possibility of liquid refrigerant becoming entrained in the oil, it is recommended that the temperature of the oil entering the compressor is kept above the outdoor ambient as shown in Fig. 6 and Table 2.

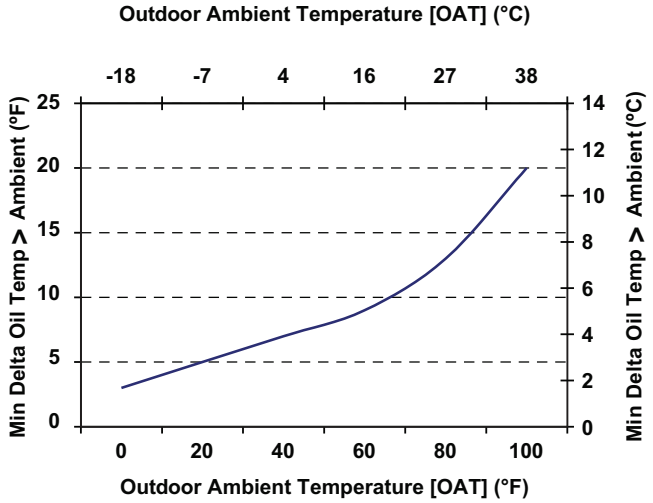


Fig. 6 — Oil Temperature

Table 2 — Allowable Temperature Ranges

CONTROL POINT	MINIMUM	MAXIMUM
Discharge Gas	20°F (11°C) superheat	210°F (99°C)
Economizer Gas	Saturated Liquid	9°F (5°C) superheat
Suction Gas	Saturated Vapor	10°F superheat. Best for low discharge temperatures
Oil Supply at Compressor	Refer to Fig. 6	210°F (99°C)
Motor Windings	No limit	275°F (135°C)

COMPRESSOR ROTATION CONTROL

Correct compressor rotation is one of the most critical application considerations. Powered reverse rotation, even for a very short duration, can seriously affect the reliability of the compressor.

The reverse rotation protection scheme must be capable of determining the direction of rotation and stopping the compressor within 1 second. Reverse rotation is most likely to occur at initial start-up or whenever the wiring to the compressor terminals is disturbed.

To minimize the possibility for reverse rotation operation, Carlyle recommends the following procedures:

1. During initial run test of the unit, a suitable low pressure switch should be temporarily installed on the high-pressure port of the compressor and be wired to open the compressor control circuit. The purpose of this switch is to protect the compressor against any wiring errors at the compressor terminal pins. The electrical contacts of the switch must be wired in the control circuit of the compressor start components to shut off the compressor in the event it is operating in reverse rotation. This switch would remain in place for the duration of the run test. At the end of the run test the switch would be removed so that it could be used on the next unit or compressor to be tested.
2. For service replacement compressors, a similar protection system is recommended. The unit service literature will make reference to this switch and provide instructions on how to temporarily install the low-pressure switch into the safety circuit for the compressor. Each service compressor will be supplied with Installation Instructions documenting the procedure for installing and using the switch. The switch will remain in place until the compressor has been started and direction of rotation has been verified; at this point the switch will be removed.

The low-pressure switch must be suitable for the applied refrigerant, and the switch must be manually resettable and open when the pressure falls below vacuum. The switch is a manual reset type that can be reset after the pressure has once again risen above 1.7 bar (25 psia). It is critical that the switch be a manual reset type to prevent the compressor from short cycling in the reverse direction.

If a switch is not available, a manifold gage connected to the discharge housing of the compressor BEFORE THE DISCHARGE CHECK VALVE can be used. If the compressor can be "bumped" or "jogged" very quickly (<1 second) while someone is watching the gage, compressor rotation can be determined without damage to the compressor. If the pressure drops, the compressor is rotating backwards and will have to be rewired. If the pressure goes up, the compressor is spinning in the correct direction.

REFRIGERATION SYSTEM DESIGN CONSIDERATIONS

In order to eliminate the possibility of refrigerant migrating into the oil separator and compressor, Carlyle recommends the application of a positive-seal, discharge check valve to be installed in the discharge line after the oil separator.

Certain operating conditions may result in motor temperatures and/or discharge gas temperatures that exceed the recommended operating parameters.

Carlyle's Solutions software can be used to estimate the discharge temperature for a given application.

Carlyle requires that some form of liquid injection be applied to control/reduce motor and discharge gas temperatures to be within recommended guidelines.

Motor cooling valves are available through Carlyle, and they should be applied to inject liquid into the compressor suction line. For 06Z screw compressor applications, this injection is accomplished using a motor cooling valve that injects liquid into the suction line entering the compressor.

Carlyle also offers de-superheating valves. These valves inject liquid at the economizer line or economizer port to assist in controlling discharge gas temperatures. For screw compressor applications, discharge gas temperature control is accomplished using a de-superheating valve that injects liquid into the economizer port or the economizer line.

Because refrigerant injection for discharge gas cooling eventually flows into the screw rotor chamber after the suction gas is trapped, compressor capacity is not significantly affected.

Carlyle recommends the application of our qualified Control Module package (P/N 6BSB000929), which provides the following safety control functionality:

- Discharge Temperature Monitoring
- Oil Level Monitoring
- Oil Flow-Rate/Supply Monitoring

Table 3 — Control Points Summary

REVERSE ROTATION / OPERATION WITH SUCTION PRESSURE IN VACUUM • Control must detect and prevent reverse rotation of the compressor within 1 second of compressor start-up. • Compressor must not operate in a vacuum, as measured at the suction pressure port, for greater than 1 minute.
OIL PRESSURE CONFIRMATION / SAFETY • Three pressures must be observed to ensure that the oil pressure is suitable for compressor operation: suction, discharge, and oil. • Oil pressure safety control must be manually reset. • Oil pressure must be maintained as follows: 1. $\mathbf{P}_{OIL} > [0.7 \times (\mathbf{P}_{DISCHARGE} - \mathbf{P}_{SUCTION}) + \mathbf{P}_{SUCTION}]$ 2. $\mathbf{P}_{OIL} > [\mathbf{P}_{SUCTION} + 1.0$ bar] 75 seconds after start
OIL SUPPLY CONFIRMATION / OIL LEVEL SWITCH • Oil supply to the compressor must be maintained during operation at all times. • Compressor operation must be stopped if the required oil level switch is open for 5 continuous seconds. • Oil supply solenoid valve must be closed during OFF cycles.
OIL FILTER DIFFERENTIAL PRESSURE • Compressor operation must be stopped if the pressure differential measured between the entering and leaving oil filter locations exceeds 30psid. • The oil filter supply tubing design should apply valves to allow for the isolation and replacement of the filter without removing the system refrigerant charge.
MOTOR TEMPERATURE LIMITATION • Motor temperatures must be continuously monitored during compressor operation. • Motor temperatures must not exceed 275°F (135°C).
COMPRESSOR SHORT CYCLING • Control must provide for a 10-minute minimum time delay before restarting the 06Z compressor. • The maximum number of compressor START cycles per hour is 6.
MAXIMUM DISCHARGE GAS TEMPERATURE • Discharge gas temperatures must not exceed 210°F (99°C). • Control must prevent compressor operation when discharge gas temperatures exceed this maximum.
MAXIMUM OIL TEMPERATURE • Oil temperatures must not exceed 210°F (99°C). • Control must prevent compressor operation when oil temperatures exceed this maximum.
RUN-PROOF • Current must be monitored to detect welded contacts on a contactor or single-phase condition. • Oil flow must be resumed if a contactor is determined to be welded shut. • Compressor must be shut down if a single-phase condition is detected.
LIQUID LINE SOLENOID / ECONOMIZER • A liquid line solenoid valve is required to shut off liquid flow to the compressor during OFF cycles. • Controlling this valve allows for additional capacity reduction during low load conditions. • Economizer refrigerant mass flow cannot exceed 30% of the suction mass flow.

MEDIUM/HIGH TEMPERATURE SYSTEM OIL MANAGEMENT (R-134a, R-1234ze)

Oil Pressure Requirements

System pressure is used to generate the oil pressure required to lubricate bearings and provide the oil that acts as a seal between the screw rotors and the bores. Oil flow and level is monitored continuously during compressor operation.

The oil pressure must meet the following criteria, based on $\mathbf{P}_{DISCHARGE}$, $\mathbf{P}_{SUCTION}$, and $\mathbf{P}_{OIL}$, as shown in Fig. 7:

1. $\mathbf{P}_{OIL} > [0.7 \times (\mathbf{P}_{DISCHARGE} - \mathbf{P}_{SUCTION}) + \mathbf{P}_{SUCTION}]$
2. $\mathbf{P}_{OIL} > [\mathbf{P}_{SUCTION} + 1.0 \text{ bar}]$ 75 seconds after start

The unit control system must monitor the oil pressure differential, as well as the operating condition, so the compressor can be shut down if the minimum requirements are not met for any duration exceeding 15 seconds.

This time delay has two functions: first, to avoid nuisance tripping during normal and transient operation, and second, to allow the system sufficient time to develop pressure differential during start-up.

The compressor must be shut down and prevented from restarting when the low oil pressure safety is tripped. The safety should be a manual reset type that locks out compressor operation until the system is serviced.

Carlyle offers a Compressor Protection Module package to provide protection against loss of oil flow, oil level, and elevated discharge gas temperature.

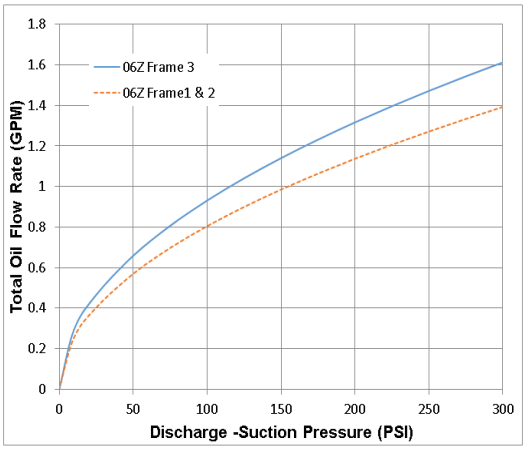
Oil Separator Recommendations

The 06Z VFD compressor requires an oil separator. The combined oil capacity of the oil separator sump, the oil reservoir, and the oil cooler, should be greater than the values shown in Table 4.

Table 4 — Oil Capacity

COMPRESSOR MODEL	OIL SEPARATOR PART NUMBER	TYPE	INLET DIAMETER (IN.)	OIL CHARGE (GPM)
06ZC	30XV50059401	Vertical	3.125	7
06ZF	30XV50122601	Vertical	4.125	7
06ZJ	30XV80004301	Horizontal	4.500	8

The separator should be selected to provide a maximum oil carryover leaving the separator required by that system/application. Approximate oil flow versus compressor pressure differential (Discharge Pressure - Suction Pressure) is shown in Fig. 7. Additional oil charge may be required for systems that have longer tubing sets.



LEGEND

A/C — Air-Cooled

Fig. 7 — Oil Supply at Compressor

Oil Heater Recommendations for Air-Cooled Models

For the typical oil separators used with the a 500-watt flexible strip heater is recommended. The heater should be wired to operate when the compressor is OFF. This minimizes the migration of refrigerant to the oil stored in the sump. Figure 6 shows the minimum oil temperatures that must be maintained when the compressor is not operating based on the outdoor ambient temperature (OAT). If the application will allow refrigerant to collect in the compressor, then a heater must be installed on the compressor. Running unit water that is at least 20°F (11°C) below OAT, if possible, can be used to prevent refrigerant from collecting in the compressor. Carlyle recommends that the oil temperature be monitored in warm climate applications and that the oil separator heater be cycled off if oil temperatures reach 190°F (88°C).

Oil Level Safety Switch

An oil level safety switch must be installed in the sump of the oil separator or the oil reservoir, depending on the system design. Carlyle recommends an oil level safety switch that interrupts compressor operation if oil levels are below adequate levels. Enough oil should remain in the sump when the switch is opened for the compressor to operate for at least one minute before completely running out of oil.

Oil Filter

Provisions should be made to isolate the oil filter using some combination of shutoff valves and/or check valves, see Fig. 8. This will allow for the filter element to be replaced without removing or isolating the charge in the unit.

Because of the long bearing life requirements, filtration for this compressor is very stringent. The Beta Ratio for this filter is greater than or equal to 200 for a five micron particle size evaluated using ISO 16889 ($\beta(5) \geq 200$).

Filter areas must also be sufficient to avoid premature clogging of the filter during normal operation. An alarm in the controls should be signaled any time the pressure drop across the filter ($\mathbf{P}_{DISCHARGE} - \mathbf{P}_{OIL}$) exceeds 40 psid, indicating the filter needs to be replaced.

PCM Controller Operation

GENERAL DESCRIPTION

The 06Z controller module will function to control compressor's Vi control valve and protect the compressor and provide LED fault status indication for:

- Oil Level Protection
- Oil Flow Protection
- Motor Cooling Protection
- Discharge Temperature Protection
- Transducer Sensor Failure
- Temperature Thermistor Failure

The following controller kit, P/N 6BSB000929, is available through Carlyle. It is highly recommend the PCM Controller application guide 575-012 be thoroughly reviewed. The 575-012 application guide is located on the Carlyle website www.carlylecompressor.com.

PCM CONFIGURATION

The PCM can be configured to function in the following modes of operation:

- Slide Valve Control and Compressor Protection (06T Models only).
- Vi Piston Control and Compressor Protection (06Z Models only).
- Compressor protection (both 06Z and 06T models).

Configuring the PCM can be accomplished through:

1. Downloading BACView software to a laptop.
2. Interfacing PCM to a laptop via Carlyle interface cable P/N: USB-L.

To allow easier transmission of data across a network between the PCM and the System Controller, the PCM is pre-configured with the following protocol networks:

- BACnet[1]
- Modbus[2]
- N2 Open
- LonWorks[3] (requires optional card)
- RS485 Communication Port

If applying the Carlyle PCM module, the accessories listed in Table 5 are required.

Table 5 — Required Accessory List

PART NUMBER	DESCRIPTION	APPLICATION
6BSB000929	Medium/High Temperature Controller Kit	R-134a & R-1234ze
USB-L	PCM Interface Cable	Cable interface between controller and laptop

PCM CONTROLLER DISPLAY FEATURES

To configure and setup the PCM controller, the Virtual BACView software must be installed on a laptop. Once the software is installed, the user will use the 12-ft interface cable (Carlyle Part# USB-L) to communicate between the laptop and the PCM (see Fig. 8). The Virtual BACView software can be downloaded from www.carlylecompressor.com under the support software page.

This setup will also be applied to monitor compressor parameters and field service/troubleshooting work.

1. BACnet is a registered trademark of ASHRAE (American Society of Heating, Refrigerating, and Air-Conditioning Engineers).
2. Modbus is a registered trademark of Schneider Electric.
3. LonWorks is a registered trademark of Echelon Corporation.

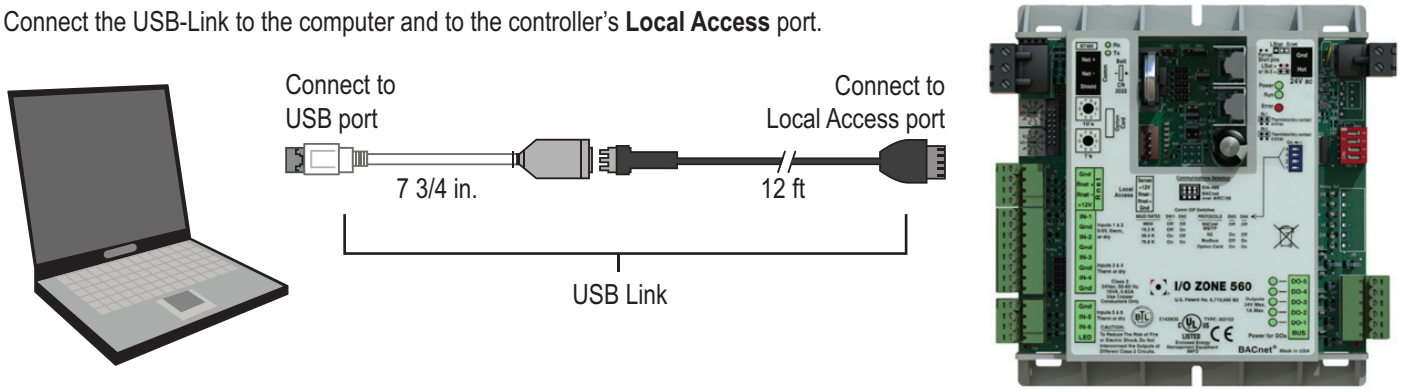


Fig. 8 — PCM Local Access Connection

PCM INPUTS/OUTPUTS

See Fig. 9 for descriptions of the PCM Inputs and Outputs.

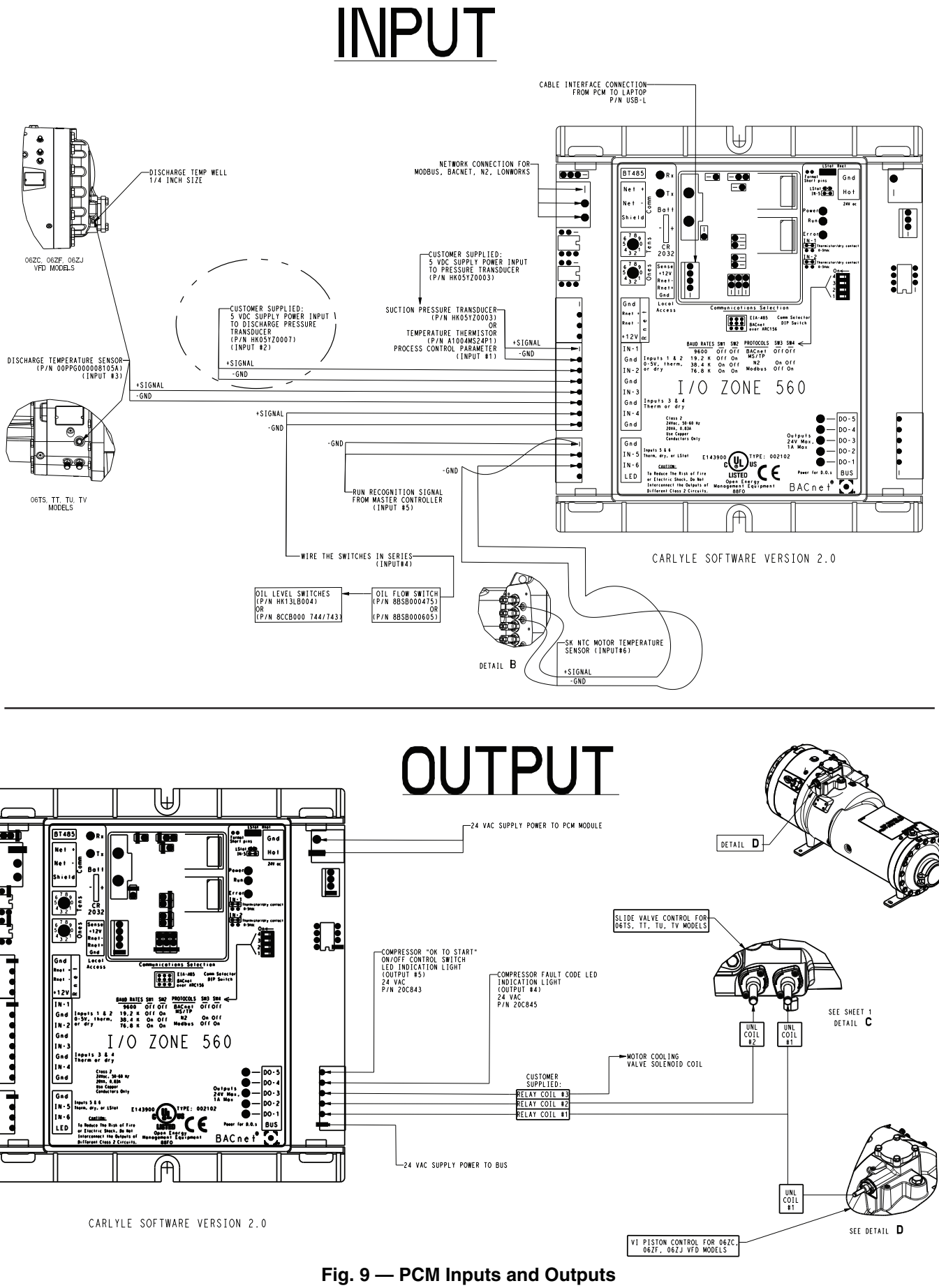


Fig. 9 — PCM Inputs and Outputs

VI PISTON CONTROL

Compressor models 06ZC, 06ZF, 06ZJ are specifically designed for VFD application ONLY and do not incorporate a slide valve for capacity control. To optimize compressor efficiency, the compressor is equipped with a Vi piston valve to optimize the compression process, see Fig. 10. The PCM controller will control the Vi piston automatically based on the compressor's suction and discharge pressure ratio.

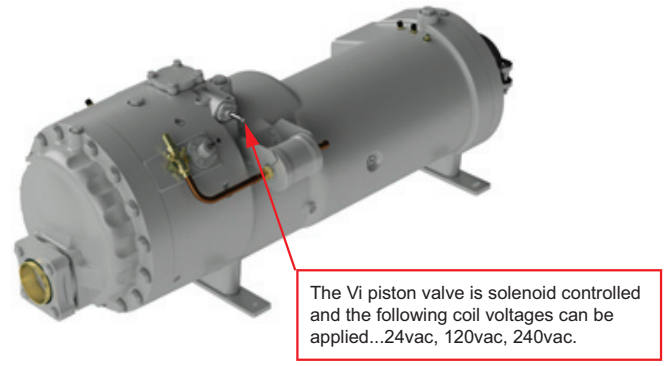


Fig. 10 — Vi Piston Valve Location

PCM CONFIGURATION SETUP

These compressor models will be capacity controlled with an external VFD drive. Therefore the PCM module will be required for compressor protection and Vi control only. Configuration can be accessed through the controller setup menu, see Fig. 11.

Configure PCM per the following three options (Fig. 12):

1. Vi Piston and Compressor Protection.
2. Vi Piston only.
3. Compressor protection only

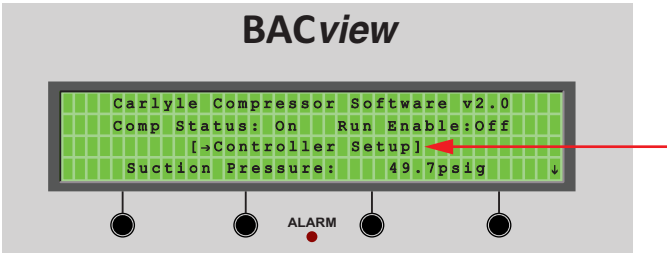


Fig. 11 — Controller Setup Menu

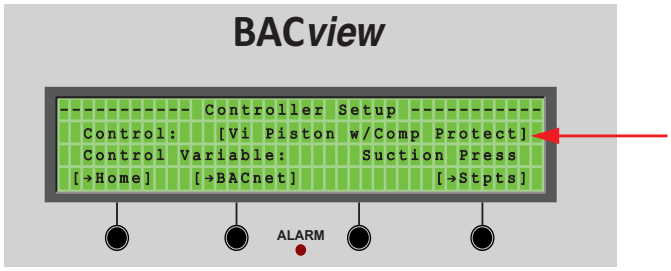


Fig. 12 — PCM Configuration Menu

COMPRESSOR PROTECTION

Motor and discharge temperature control for a screw compressor is critical. Excessive motor and discharge gas temperatures can cause premature compressor failure; therefore control of these temperatures is very important. The PCM monitors these temperatures through the use of the factory-installed 5K thermistor in the motor windings and a field-installed 5K thermistor in the compressor discharge temperature thermo-well. When the thermistors indicate an overheated condition, the PCM will perform the following:

- Energize a liquid injection valve, sending cool liquid into the motor compartment.
- Trip the compressor off.

Motor Temperature (Tm) will have the following functions.

- Control a motor cooling valve to provide liquid injection to the motor compartment.
- Turn the compressor off on an overheated motor temperature condition.
- See Table 6: Motor and Discharge Temperature Control Points.

Discharge Temperature (Td) will have the following functions.

- Turn the compressor off on a high discharge temperature condition.
- See Table 6: Motor and Discharge Temperature Control Points.

LED FAULT INDICATION

The PCM will provide an LED alarm output signal to the System Controller when a compressor fault condition arises. See Table 7.

Table 6 — Motor and Discharge Temperature Control Points

ALC CONTROLLER	INJECTION ON (°F)	INJECTION OFF (°F)	SHUTDOWN COMPRESSOR (°F)	MANUALLY RESET COMPRESSOR (°F)	TIME DELAY REQUIRED BEFORE MANUAL RESET (seconds)
Discharge Temperature (Td)	NA	NA	Td > 225	Td < 175	30
Motor Cooling Temperature (Tm)	Tm > 240	Tm < 225	Tm > 270	Tm < 225	30

Table 7 — LED Fault Description

FAULT DESCRIPTION	LED INDICATION (OUTPUT#4)	OUTPUT #5	COMPRESSOR	MANUAL RESET REQUIRED
HIGH DISCHARGE TEMPERATURE TRIP	Solid red	Opens/De-energized	OFF	Yes
HIGH MOTOR TEMPERATURE TRIP	Constant blinking	Opens/De-energized	OFF	Yes
COMPRESSOR OIL TRIP	One blink and 2-second pause	Opens/De-energized	OFF	Yes
FAULTY SUCTION TRANSDUCER/THERMISTOR SENSOR	Two blinks and 2-second pause	Opens/De-energized	OFF	Yes
FAULTY MOTOR TEMPERATURE THERMISTOR	Three blinks and 2-second pause	Opens/De-energized	OFF	Yes
FAULTY DISCHARGE TEMPERATURE THERMISTOR	Four blinks and 2-second pause	Opens/De-energized	OFF	Yes
FAULTY DISCHARGE TRANSDUCER	Five blinks and 2-second pause	Opens/De-energized	OFF	Yes

COMPRESSOR DESIGN PRESSURES

Compressor Requirements

The compressor is designed to meet the UL and ASHRAE safety code for refrigeration compressors. The manufacturing facilities for the compressor conduct pressure burst tests in accordance with ASHRAE-15, UL safety codes, and the Pressure Equipment 97/23/CEE directive.

Design Pressures

PRESSURE RELIEF VALVE

The internal relief valve is designed to open when the pressure differential between suction and discharge pressure is greater than 27.6 bar (400 psid) for R-134a, R-1234ze, or R-513A. The valve will close and seal again after the pressure difference falls below the set value. If the valve does not fully reseal after opening, higher discharge temperatures may result.

HYDROSTATIC DESIGN PRESSURES

The design pressures for the compressor castings are listed in Table 8.

Table 8 — Compressor Design Pressures

PRESSURE TYPE	APPLICATION	DISCHARGE	ECONOMIZER	SUCTION
HYDROSTATIC STRENGTH (BURST) TEST PRESSURE	R-134a R-1234ze R-513A	1520 psig (10.5 MPa)	820 psig (5.7 MPa)	440 psig (3 MPa)
PROOF TEST PRESSURE		405 psig (2.8 MPa)		
MAXIMUM OPERATING PRESSURE		304 psig (2.1 MPa)	130 psig (0.9 MPa)	61 psig (0.4 MPa)
		228 psig (1.6 MPa)	94 psig (0.7 MPa)	42 psig (0.3 MPa)
LEAK TEST PRESSURE		305 psig (2.1 MPa)		
UL 60335-2-34 DESIGN PRESSURE		186 psig (1.3 MPa)	N/A	88 psig (0.6 MPa)
		136 psig (0.9 MPa)		61 psig (0.4 MPa)

NOTE: All pressures listed are gage pressures. Add 14.7 psi (0.1 MPa) to obtain absolute pressure, if necessary.

VARIABLE FREQUENCY DRIVE GUIDELINES

Scope

Carlyle has conducted an extensive qualification program for our R-134a, R-1234ze, or R-513A compressors and has approved the following compressors for VFD application only. A summary of the qualified models is presented in Table 9.

Table 9 — Variable Speed Model Summary

MODEL NUMBER	NOMINAL HP	NOMINAL VOLTS/ HERTZ	SPEED RANGE
06ZCE1H3AA06013	130	460V - 100 Hz	25 - 105 Hz
06ZCE1T3AA06013		380V - 100 Hz	
06ZCE1Y6AA06013		200V - 100 Hz	
06ZFC2H3AA06013	215	460V - 98 Hz	25 - 98 Hz
06ZFC2T3AA06013		380V - 98 Hz	
06ZFC2Y6AA06013		200V - 98 Hz	
06ZJG3H3AA06013	325	460V - 95 Hz	25-95 Hz
06ZJG3T3AA06013		380V - 95 Hz	

Compressor motor protection must be provided by the VFD. Carlyle Application Engineering should be contacted to verify that the over-current protection meets Carlyle's requirements for UL-rated motor overload protection and to verify the required overload settings.

It is important to work with the drive manufacturer to select a drive appropriate for the application. Refrigeration screw compressors provide a constant torque loading to the drive and also have unique starting torque requirements. It is important that the appropriate criteria are taken into consideration when selecting the type and size of the drive. The drive should not be sized on the nominal HP rating of the compressor, but based on the electrical data, including Nominal Voltage and MCC (Maximum Continuous Current), available in Tables 12-14.

It is also important to review items associated with the wiring of the compressor and associated control system wiring, as special precautions may be required to avoid interference between the drive and other control wiring. There may also be restrictions on the length and routing of the wires from the drive to the compressor. These items should be reviewed with the drive manufacturer to ensure all application guidelines are followed when installing the drive. See Fig. 13 for compressor connection details.

Compressor Protection Limits and Guidelines

The compressors have been approved with an allowable speed range as noted in Table 9. Motor current, discharge temperature and motor temperature requirements must be monitored and maintained within the allowable ranges through the entire VFD speed range.

DISCHARGE TEMPERATURE

1. Compressor must be forced to 100% load if discharge temperature ≥ 200°F (93.3°C).
2. Do no allow further reduction in compressor speed if discharge temperature ≥ 190°F (87.8°C).
3. Discharge temperature liquid injection into the compressor's economizer port is required to maintain discharge temperature limits when operating the compressor below 60 Hz.

MOTOR TEMPERATURE

1. Compressor must be forced to Nominal Voltage as stated in "Compressor Input Voltage."
2. If operating at max speed, reducing speed will allow motor to run on the rated V/F curve if motor temperature ≥ 260°F (126.7°C)

NOTE: Different temperature limits may be required, depending on the accuracy and response time of the sensors and control system that are used, as well as the overall stability of the system and desired safety factor.

MOTOR CURRENT

1. Compressor overcurrent protection must be provided by the VFD.
2. The drive must trip at the MCC value listed in Tables 12-14.
3. It is recommended to use the MHA value as "Nominal" motor current with a protection factor of 1.1.
4. Motor cooling liquid injection into the suction line is required to maintain the motor temperature limits when operating the compressor below 60 Hz.

Compressor Input Voltage

The variable speed drive should fix the output voltage based on a constant Volts-per-Hz curve running through the nominal voltage and frequency stated in Tables 10 and 11, regardless of the nominal voltage supplied to the compressor. The drive should maintain a constant V-Hz over the range of operation and should limit the speed of the drive if the appropriate voltage cannot be maintained. Under voltage should limit the speed (Hz) until the constant V-Hz curve is reached. The VFD should also limit the amperage of the compressor to the MCC (maximum continuous current) value (lower amperage limits may be applied depending on the application).

Table 10 — Variable Speed Drive Input Voltage / Compressor Motor Voltage

Variable Speed Drive Input Voltage	Compressor Motor Voltage
208/230V-3-60Hz	200V
380V-3-60Hz	380V
460V-3-60Hz	460V
575V-3-60Hz	460V
200V-3-50Hz	200V
400V-3-50Hz	380V

Figure 14 shows two sample voltage curves showing compressor motor voltage (V) versus operating speed (Hz). As shown in the graph, the motor voltage is lowered at lower operating speeds while maintaining a fixed Volts/ Hz value. 06ZC and 06ZF models allow operation at higher speeds than "nominal" and is expected that the drive will be in constant horse-power output (fixed voltage) during that operation.

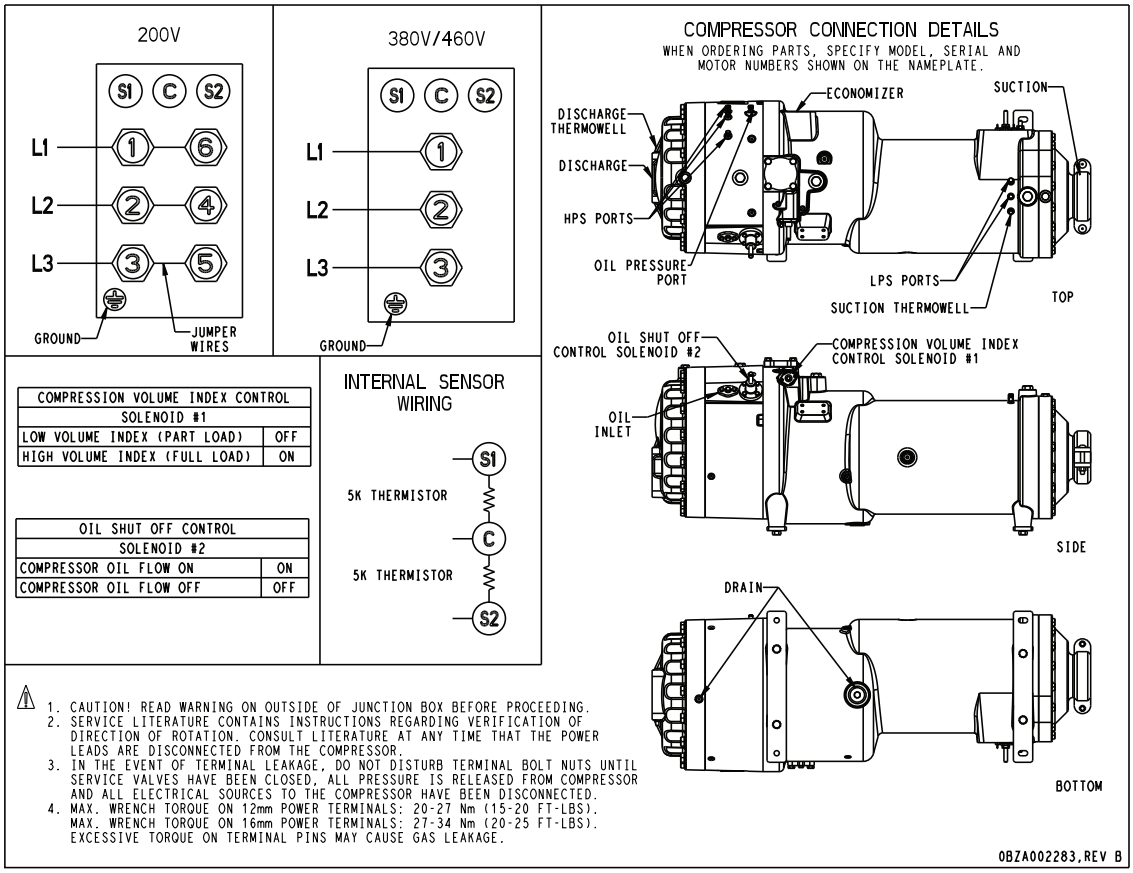


Fig. 13 — Compressor Connection Details

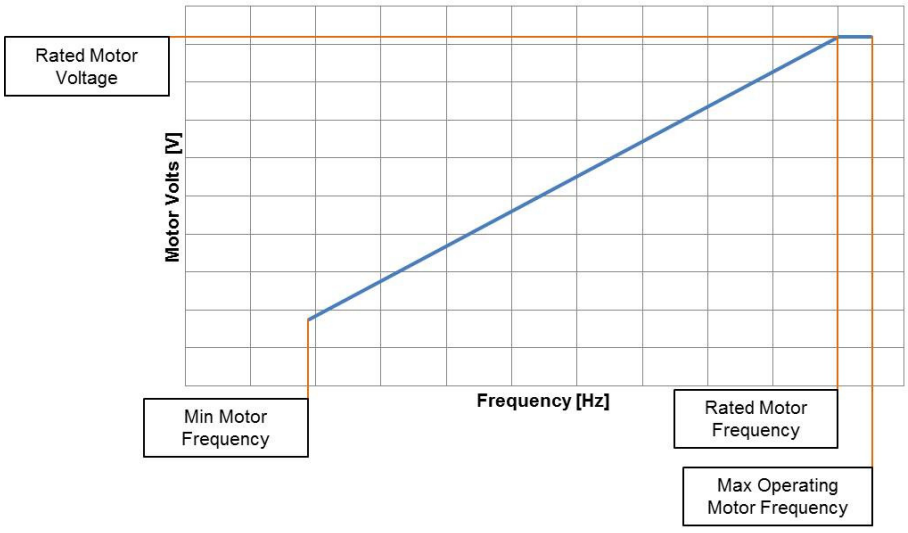


Fig. 14 — Sample Compressor Motor Voltage Curves

Table 11 — VFD Part Number Selection Guide

PART NUMBER	VFD OUTPUT VOLTAGE	VFD (kW)	MCC OUTPUT AT 45C (AMPS)	ENCLOSURE RATING	WEIGHT (LBS)	DANFOSS FUSE PIN	FUSE RATING
HR46ZY014	208/230	160	564	IP54	275	176F3174	800A 700V
HR46ZY030				IP20			
HR46ZY006 & 027	380/460	110	212/190	IP54 & IP20	135	176F3171	350A 700V
HR46ZY006 & 028		132	260/240	IP54 & IP20	135	176F3171	350A 700V
HR46ZY008 & 031		160	315/302	IP54 & IP20	135	176F3172	400A 700V
HR46ZY010 & 021		200	395/361	IP54 & IP20	275	176F3173	550A 700V
HR46ZY011 & 022		250	480/443	IP54 & IP20	275	176F8335	630A 700V
HR46ZY019		315	588/535	IP20	275	176F3174	800A 700V
HR46ZY016		400	745/678	IP20	600	176F8592	900A 700V
HR46ZY018		450	800/730	IP20	600	176F8592	900A 700V

Table 12 — Air-Cooled Motor Data R-134a

COMPRESSOR BASE MODELS	MOTOR SIZE	MOTOR VOLTAGE (VOLTS-PH-FREQ)	FREQ. RANGE		R-134a ELECTRICAL DATA		
			MIN	MAX	RLA	MHA	MCC
06ZC	130 Hp	200V - 3 - 100 Hz	25 Hz	105 Hz	390	496	546
		380V - 3 - 100 Hz	25 Hz	105 Hz	205	261	287
		460V - 3 - 100 Hz	25 Hz	105 Hz	169	215	237
06ZF	215 Hp	200V - 3 - 95 Hz	25 Hz	98 Hz	618	787	865
		380V - 3 - 95 Hz	25 Hz	98 Hz	325	414	455
		460V - 3 - 95 Hz	25 Hz	98 Hz	269	342	377
06ZJ	325 Hp	380V - 3 - 95 Hz	25 Hz	98 Hz	566	720	792
		460V - 3 - 95 Hz	25 Hz	98 Hz	468	596	655

Table 13 — Air-Cooled Motor Data R-1234ze

COMPRESSOR BASE MODELS	MOTOR SIZE	MOTOR VOLTAGE (VOLTS-PH-FREQ)	FREQ. RANGE		R-1234ze ELECTRICAL DATA		
			MIN	MAX	RLA	MHA	MCC
06ZC	130 Hp	200V - 3 - 100 Hz	25 Hz	105 Hz	312	397	437
		380V - 3 - 100 Hz	25 Hz	105 Hz	164	209	230
		460V - 3 - 100 Hz	25 Hz	105 Hz	136	173	190
06ZF	215 Hp	200V - 3 - 95 Hz	25 Hz	98 Hz	495	630	693
		380V - 3 - 95 Hz	25 Hz	98 Hz	260	331	364
		460V - 3 - 95 Hz	25 Hz	98 Hz	216	275	302
06ZJ	325 Hp	380V - 3 - 95 Hz	25 Hz	98 Hz	453	577	634
		460V - 3 - 95 Hz	25 Hz	98 Hz	375	477	525

Table 14 — Air-Cooled Motor Data R-513A

COMPRESSOR BASE MODELS	MOTOR SIZE	MOTOR VOLTAGE (VOLTS-PH-FREQ)	FREQ. RANGE		R-513A ELECTRICAL DATA		
			MIN	MAX	RLA	MHA	MCC
06ZC	130 Hp	200V - 3 - 100 Hz	25 Hz	105 Hz	398	507	557
		380V - 3 - 100 Hz	25 Hz	105 Hz	210	267	294
		460V - 3 - 100 Hz	25 Hz	105 Hz	173	220	242
06ZF	215 Hp	200V - 3 - 95 Hz	25 Hz	98 Hz	631	803	883
		380V - 3 - 95 Hz	25 Hz	98 Hz	332	423	465
		460V - 3 - 95 Hz	25 Hz	98 Hz	275	350	385
06ZJ	325 Hp	380V - 3 - 95 Hz	25 Hz	98 Hz	578	736	809
		460V - 3 - 95 Hz	25 Hz	98 Hz	478	608	669

LEGEND

MHA — Must Hold Amps
MCC — Maximum Continuous Current
RLA — Rated Load Amps

NOTES:

MHA = Max load current at rated voltage

MCC = MHA * 1.1

RLA = MCC / 1.4

COMPRESSOR ELECTRICAL DATA

Allowable Voltage Range

The motors for the 06Z compressor are designed to function in the voltage ranges listed in Table 15.

Table 15 — Compressor Motor Voltage Range

VOLTAGE CODE 7TH DIGIT	25 - 100 HZ		
	NOMINAL	MIN	MAX
H	460V	396V	506V
T	380V	342V	418V
Y	200V	180V	220V

ELECTRICAL CONNECTION REQUIREMENTS

Power Connections

Connect the compressor in accordance with the application drawing and the wiring diagram located on the terminal box lid. Power wires are to be connected to the terminal pins using ring terminals and jam nuts. The compressor terminals are copper feed-through pins with M12 metric threads for all models. The motor temperature thermistors and a separate 12 mm grounding lug connection are located in the terminal pin area. Terminal and sensor pin layout on the compressor is shown in Fig. 15 and 16 and Table 16.

Torque specifications are as follows:

- 15 to 20 lb-ft (20-27 Nm) on all 06Z compressors with 12 mm pins.
- Terminal pins to be coated with a dielectric grease, Carlyle P/N 06TT660050, instructions 99TA516132.

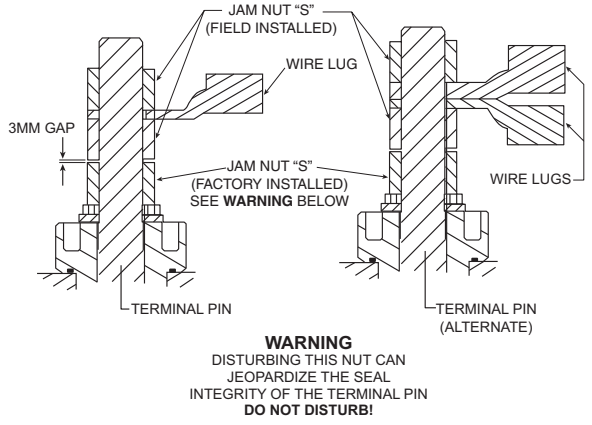


Fig. 15 — Terminal Pin Cross-Section

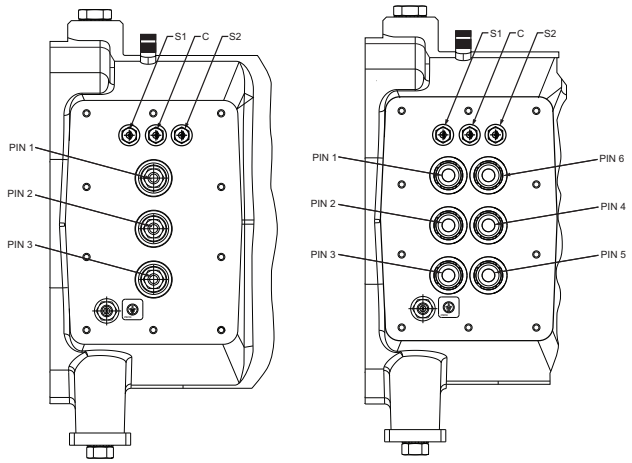


Fig. 16 — Motor Lead Connections

Table 16 — Configuration Wiring

CONNECTION	L1	L2	L3
3 PIN	Terminal Pin 1	Terminal Pin 2	Terminal Pin 3
6 PIN	Terminal Pin 1,6	Terminal Pin 2,4	Terminal Pin 3,6

Motor Windings Thermistor

Two motor winding thermistors, S1 and S2, are embedded directly into the windings of the compressor motor. The thermistors are an NTC type with a standard resistance of 5000 ohms at 77°F (25°C). All 06Z compressor motors are supplied with a spare thermistor to be used if the primary thermistor fails. See Fig. 17. The thermistor terminal connections are labeled S1 and S2 and are located above the main terminal pins (Fig. 16). Table 17 lists the resistance versus temperature characteristics.

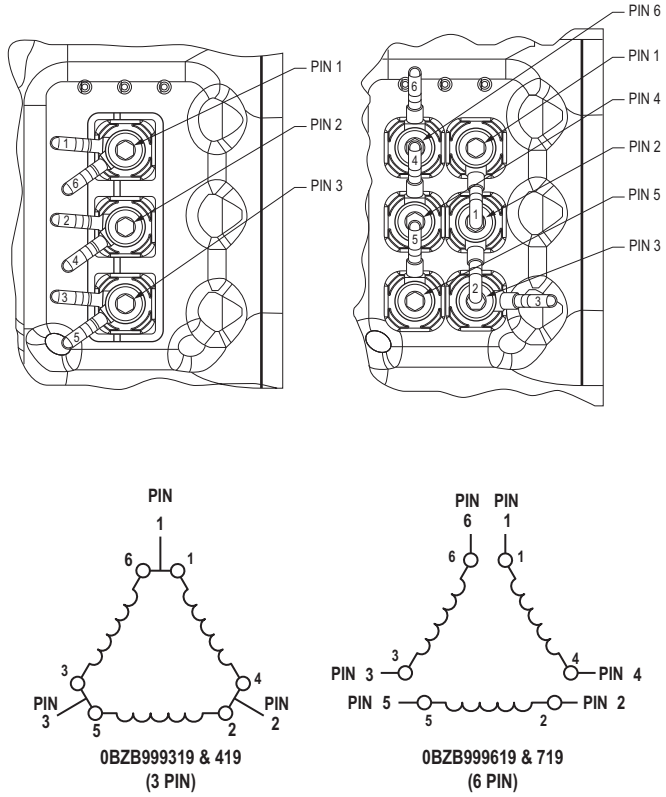


Fig. 17 — Schematic of Sensor Connections

Table 17 — Resistance/Temperature Characteristics

TEMPERATURE			RESISTANCE (OHMS)
C	±C	F	
–30	.35	–22	88,480.0
–25	.33	–13	65,205.0
–20	.30	–4	48,536.0
–15	.28	5	36,476.0
–10	.20	14	27,663.0
–5	.20	23	16,325.0
5	.20	41	12,696.0
10	.20	50	9,949.5
15	.20	59	7,855.5
20	.20	68	6,246.0
25	.20	77	5,000.0
30	.20	86	4,028.4
35	.20	95	3,265.7
40	.20	104	2,663.2
45	.20	113	2,184.2
50	.20	122	1,801.2
55	.20	131	1,493.1
60	.20	140	1,243.9
65	.20	149	1,041.4
70	.20	158	875.8
75	.23	167	739.7
80	.26	176	627.6
85	.29	185	534.9
90	.32	194	457.7
95	.35	203	393.3
100	.38	212	339.3
105	.41	221	293.8
110	.44	230	255.3
115	.47	239	222.6
120	.50	248	194.8

COMPRESSOR ACCESSORIES

See Tables 18-26 for compressor accessory usage.

Oil Separators

Table 18 — Oil Separator Usage

COMPRESSOR MODEL	PART NUMBER	TYPE	INLET DIAMETER	OIL CHARGE (GPM)
06ZC	30XV50092301	Vertical	3.125"	7
06ZF	30XV50122601	Vertical	4.125"	7
06ZJ	30XV80004301	Horizontal	4.50"	8

Accessory Kits

Table 19 — Accessory Package

PART NUMBER	COMPRESSOR USAGE		
	06ZC	06ZF	06ZJ
06ZC660001	X	—	—
06ZF660001	—	X	—
06ZJ660001	—	—	X

NOTE: One (1) kit required per compressor.

Economizers

Table 20 — Economizer Usage

PART NUMBER	COMPRESSOR USAGE		
	06ZC	06ZF	06ZJ
LL015B044	X	—	—
LL015B050	—	X	—
LL01SB056	—	—	X

PCM Controller

Table 21 — PCM Controller Application

PART NUMBER	DESCRIPTION	APPLICATION
6BSB000929	Medium/High Temp. Controller Kit	R-134a, R-1234ze, or R-513A
USB-L	PCM Interface Cable	Cable interface between controller and laptop

NOTES:
1. One Compressor Protection Module package required per compressor.
2. The interface cable is required to connect the controller module to a PC or laptop for setup and configuration. The cable is also required for Field Service to read information from the module.

Compressor Oil

Table 22 — Compressor Oil Usage

PART NUMBER	USAGE	QUANTITY
P903-2301	Medium/High Temperature — 06Z	1-Gallon Container
P903-2305	Medium/High Temperature — 06Z	5-Gallon Container

VFD Drive

See Table 23 for VFD Electrical and Physical Data.

Table 23 — VFD Drive Electric and Physical Data

PART NUMBER	VFD OUTPUT VOLTAGE	VFD (kW)	MCC OUTPUT AT 45C (AMPS)	ENCLOSURE RATING	WEIGHT (LBS)	DANFOSS FUSE P/N	FUSE RATING
HR46ZY014	208/230	160	564	IP54	275	176F3174	800A 700V
HR46ZY030				IP20			
HR46ZY006 & 027	380/460	110	212/190	IP54 & IP20	135	176F3171	350A 700V
HR46ZY006 & 028		132	260/240	IP54 & IP20	135	176F3171	350A 700V
HR46ZY008 & 031		160	315/302	IP54 & IP20	135	176F3172	400A 700V
HR46ZY010 & 021		200	395/361	IP54 & IP20	275	176F3173	550A 700V
HR46ZY011 & 022		250	480/443	IP54 & IP20	275	176F8335	630A 700V
HR46ZY019		315	588/535	IP20	275	176F3174	800A 700V
HR46ZY016		400	745/678	IP20	600	176F8592	900A 700V
HR46ZY018		450	800/730	IP20	600	176F8592	900A 700V

Motor Cooling Valves & Solenoid Coils

Table 24 — Motor Cooling Valve

PART NUMBER	COMPRESSOR USAGE		
	06ZC	06ZF	06ZJ
EF28BZ007 (1.4 TON)	X	X	X

Table 25 — Solenoid Coils

PART NUMBER	VOLTAGE
8BTB000295	24-1-50/60
8BTB000297	120-1-50/60
8BTB000298	208/230-1-50/60
8BTB000296	24 VDC

NOTES:
1. Motor cooling valves inject liquid into the suction line.
2. Motor cooling valves require one coil of the appropriate voltage.

De-Superheating Valves

Table 26 — De-Superheating Valve

CARLYLE PART NUMBER	SIZE (TON)
EA680045	3

NOTE: De-superheating valves inject liquid into the economizer line or the economizer inlet port.

PACKAGING AND STORAGE REQUIREMENTS

Packaging

Packaging for the 06Z screw compressor utilizes a wooden pallet and shrink-wrap plastic.

Shipping

All compressors that are shipped within the U.S. or internationally will be unstacked (single layer).

Storage

Although the 06Z compressors are painted to meet the 500 hours salt spray requirement, it is preferable to store the compressors indoors where they are shielded from the weather. Outdoor storage is permissible as long as temperatures stay within a temperature range of 40°F to 176°F (40°C to 80°C).

Weights and Dimensions

Compressor weights and dimensions are shown in Table 27.

Table 27 — Basic Compressor Weight and Dimensions (Without Electrical Box and Oil Separator)

MODEL	Weight		Dimensions					
			Height 'H'		Width 'W'		Length 'L'	
	lb	kg	in.	mm	in.	mm	in.	mm
06ZC	1717	779	21	539	20	507	50	1259
06ZF	2199	998	23	571	21	531	56	1413
06ZJ	2893	1312	24	606	22	564	62	1584

Manufacturer reserves the right to discontinue, or change at any time, specifications or designs and prices without notice and without incurring obligations

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Lit. No. 574-086 Rev. A

Replaces: 574-086
3-22