

Application Data

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SAFETY INSTRUCTIONS

⚠ WARNING

Failure to follow these instructions may result in serious injury or death.

CONTENTS UNDER PRESSURE. Compressor contains oil and refrigerant under pressure. Pressure must be relieved before installation, servicing, or opening any connections.

HOT and COLD surface temperatures can occur during operation and can result in severe burns or frostbite.

USE ONLY approved refrigerants and refrigeration oils.

CHECK THE REFRIGERANT TYPE. Charge only with refrigerant that conforms to AHRI Standard 700.

⚠ DANGER

Failure to follow these instructions will result in severe personal injury or death.

ELECTRIC SHOCK HAZARD. Do not operate compressor or provide electric power to it unless the compressor terminal box is installed and the terminal box cover is in place and secured.

DO NOT provide power to unit or turn on compressor unless suction and discharge service valves are open.

DO NOT remove the compressor terminal box cover until all electrical sources have been disconnected.

NEVER EXCEED specified test pressures. System strength/tightness test pressure may not exceed the compressor maximum test pressure on the nameplate. Close shutoff valves to isolate the compressor if necessary.

DO NOT USE oxygen or other industrial gases for tightness/pressure testing. Use nitrogen or inert gas.

Only qualified, authorized, and appropriately trained HVAC or refrigeration personnel, should install, commission, and maintain this equipment.

Use appropriate personal safety equipment where required. Safety goggles, gloves, protective clothing, safety boots, and hard hats should be worn where necessary.



Scan QR Code for link to Carlyle literature website.
<https://bit.ly/3J8liEP>

INTRODUCTION

This manual is for the application of the Carlyle 06T semi-hermetic twin screw compressors. The operational limits, required accessories, and operational guidelines are contained in this manual and must be complied with to stay within the compressor warranty guidelines.

Features of Carlyle 06T Compressors

The Carlyle 06T screw compressors are gear-driven twin screw compressors. The gear drive yields the benefits of light weight and footprint. One of the key features of the Carlyle screw compressor is that all the semi-hermetic models have the same physical dimensions and port locations. The compressors range between 15 and 50 nominal horsepower, and are designed for use in commercial refrigeration, process cooling, environmental chamber, and air conditioning applications. Screw compression technology yields the benefits of smooth continuous pumping of refrigerant with minimal vibration. The addition of variable speed drives to these compressors is an ideal complement for very tight capacity control over a wide speed range. Most models can run up to 70 Hz yielding extra capacity that can be used to meet the design day load allowing for a smaller compressor running at lower speeds during lighter load conditions. This application guide is intended to set the required guidelines of system design and operation to maximize the reliability of the Carlyle 06T twin screw compressors. For applications outside the parameters listed in this guide, please contact Carlyle Application Engineering. See Fig. 1 and 2 for compressor and screw features. See Fig. 3 for model number nomenclature.

Control Points

OIL SYSTEM:

Maximum oil temperature entering compressor:

- 190°F (88°C)

Minimum oil temperature entering compressor:

- 80°F (27°C)

Oil Filter Pressure Drop Protection (discharge pressure minus oil pressure):

- Cutout: 45 psi (3 Bar)
- Alarm: 25 psi (1.6 Bar)

Minimum oil pressure differential (oil inlet pressure to suction pressure)

- Cutout: 45 Psi (3 Bar)
(Must be measured for each compressor)

FLOATING HEAD PRESSURE

Oil pressure at the compressor must be a minimum of 45 psi (3 bar) above suction pressure. To maintain this, the discharge pressure must be maintained at this 45 psi (3 bar) **plus** the pressure drop in the oil filters **plus** any flow losses in the oil supply piping.

MOTOR TEMPERATURE CONTROL

- LonCEM protection
or

- Carlyle recommends liquid injection to mitigate motor temperatures above 180°F (82°C). The compressor must shutdown with motor temperatures exceed 240°F (116°C).

DISCHARGE TEMPERATURE CONTROL

- LonCEM protection
or
- Carlyle recommends liquid injection to mitigate discharge temperatures above 205°F (96°C). The compressor must shutdown with discharge temperatures exceed 230°F (110°C).

REVERSE ROTATION PROTECTION

- LonCEM protection
or
- Manual reset low pressure switch connected to discharge port and set at 10 in. of vacuum, (0.33 bar). This pressure switch is intended only for commissioning and should be removed from the system prior to long term operation.
or
- Carlyle Approved Line/Load Phase Monitor

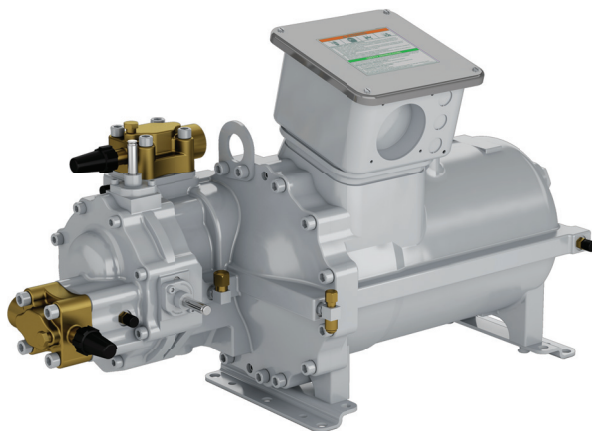


Fig. 1 — 06T Screw Compressor



Fig. 2 — 06T Screw

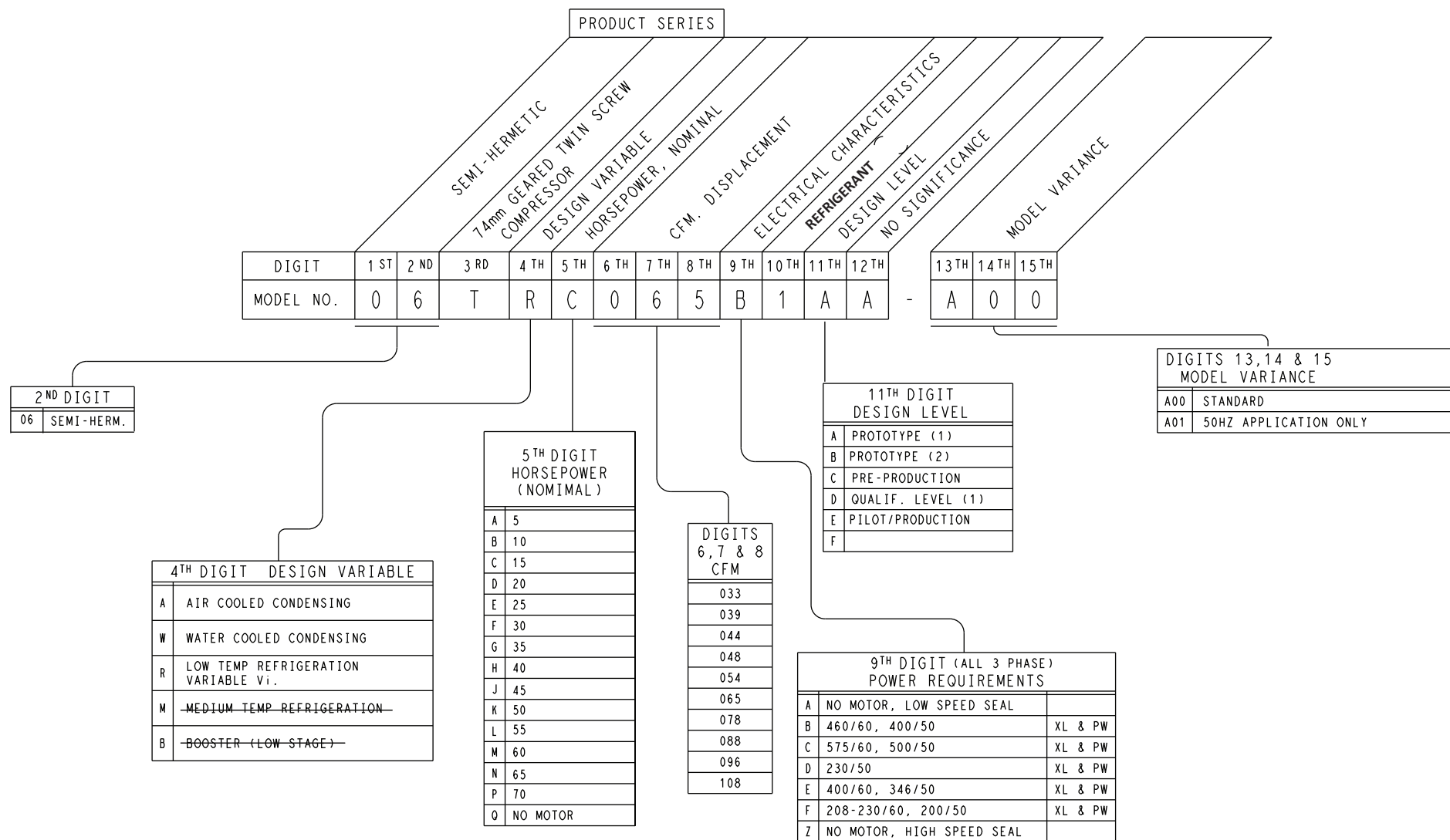


Fig. 3 — 06T Model Number Nomenclature

GENERAL INFORMATION

Certification

The 06T compressors are UL listed under file number SA4936. CSA file number is LR29937; CSA report number is LR29937-579c. For UL and CSA approvals it is essential that the overcurrent protection follow the guidelines specified in section “Overcurrent Protection” on page 15 of this guide. Both UL and CSA approvals have been obtained for all voltage combinations listed in section “Allowable Voltage Range” on page 15. 60 Hz compressors have been listed.

Screw Compressor Size (Displacement)

06T compressors are available in displacement sizes shown in Table 1.

Semi-hermetic compressors will be supplied with single voltage motors 208/230-v, 460-v and 575-v.

Table 1 — Displacement Sizes

MODEL NO.	60Hz		50Hz	
	ft ³ /min	m ³ /min	ft ³ /min	m ³ /min
06T—033	33	0.93	27.5	0.78
06T—039	39	1.10	32.5	0.92
06T—044	44	1.25	36.7	1.04
06T—048	48	1.36	40.0	1.13
06T—054	54	1.53	45.0	1.28
06T—065	65	1.84	54.2	1.53
06T—078	78	2.21	65.0	1.84
06T—088	88	2.49	73.3	2.08
06T—108	N/A	N/A	90.0	2.56

Compressor Mounting

The Carlyle 06T screw compressors may be rigid mounted. However, Carlyle recommends the use of isolation mounts for 06T compressors. These rubber mounts isolate the compressor from the system framework which helps to reduce noise transmission.

Oil Type

Carlyle screw compressors are approved for use on R-448A, R-449A, R-404A, R-507, R-134a, and R-22 with the oils shown in Table 2.

NOTE: For application purposes the Solest 120 is considered an equivalent viscosity at the Emkarate RL100E. The Solest 170 is required for R-22 systems without external oil coolers. R-22 systems with an external oil cooler may use the POE 100/120 weight oils.

Table 2 — Approved Oils

OIL	MANUFACTURER
Solest 120	CPI
Solest 170	CPI
Emkarate RL100E	Lubrizol

Ambient Conditions

The screw compressor is designed for specified ambient temperature ranges. See Table 3 for temperature ranges.

Table 3 — Ambient Temperature Ranges

COMPRESSOR TYPE	TEMPERATURE RANGE
Non-Operating	–40°F To 130°F (–40°C To 54°C)
Start-up	–40°F To 130°F (–40°C To 54°C)
Operating	–25°F To 130°F (–32°C To 54°C)

Installation Environment

The intended installation modes for the screw compressor are:

- Machine Rooms
- Enclosed Atmosphere External Environment
- Sheet Metal Enclosure

NOTE: The electrical terminal box is not approved for external applications.

Pressure Relief Valve

All compressor models contain an automatic reset high pressure relief valve. The pressure relief valve is located inside the compressor and will internally relieve the compressor discharge to the compressor suction at a pressure differential of 400 psi (27.6 bar).

NOTE: The relief valve is not field serviceable.

Discharge Check Valve

All compressor models are supplied with an internal discharge check valve. This check valve prevents the reverse flow of refrigerant through the compressor during compressor off cycles. A check valve in the discharge line is not required for parallel applications. It may be required for pump down on single compressor systems.

NOTE: The discharge check valve is field serviceable.

Compressor Inlet Screens

Filter screens are applied at all locations where liquid or gas enters the compressor, i.e., suction, economizer, and oil connections. For systems that operate below –25°F (–32°C), it is recommended that the suction screen be removed after 48 hours of system startup as the viscous oil can damage the screen. The compressor inlet screens are field serviceable and available through Carlyle distribution.

Service Valves

Suction and discharge connections will interface with the 2-1/2 in. bolt pattern service valves currently being used on the Carlyle reciprocating compressors. Rotalock®1 service valves are used for the economizer line shut off. See Table 4 for line sizes.

Table 4 — Service Valve Line Sizes

CONNECTION	CONNECTION SIZE (IN.)	
	MAX.	MIN.
Suction	1-5/8	1-1/8
Discharge	1-5/8	1-1/8
Economizer	7/8	7/8

All 06T compressors between 65 cfm and 108 cfm must use a flange at the discharge connection with an in-line ball valve for compressor isolation. With the exception of the 06TA660008 valves (now obsolete), standard 90-degree compressor isolation valves must not be used on the discharge of these 65, 78, 88, and 108 cfm compressors.

Condenser Pressure Control

Large fluctuations in head pressure may result in very poor oil separation which may result in nuisance oil level switch tripping. The condenser pressure must be controlled such that fluctuations are gradual. Carlyle screw compressors must always be applied with a minimum of one condenser fan (preferably variable speed) active and a means of minimum head pressure control for low ambient operation.

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OPERATION SPECIFICATIONS

Operational Envelopes

The following operational envelopes, based on 65°F (18°C) return gas, show the allowable operating suction and discharge pressure ranges for different refrigerants. See Fig. 4-6 for each refrigerant application.

Operation outside of these envelopes requires approval from Carlyle Application Engineering or warranty is voided. Oil cooling can be achieved using an oil cooler or with desuperheating valves as described in “Oil Cooler Selection” on page 10 of this manual.

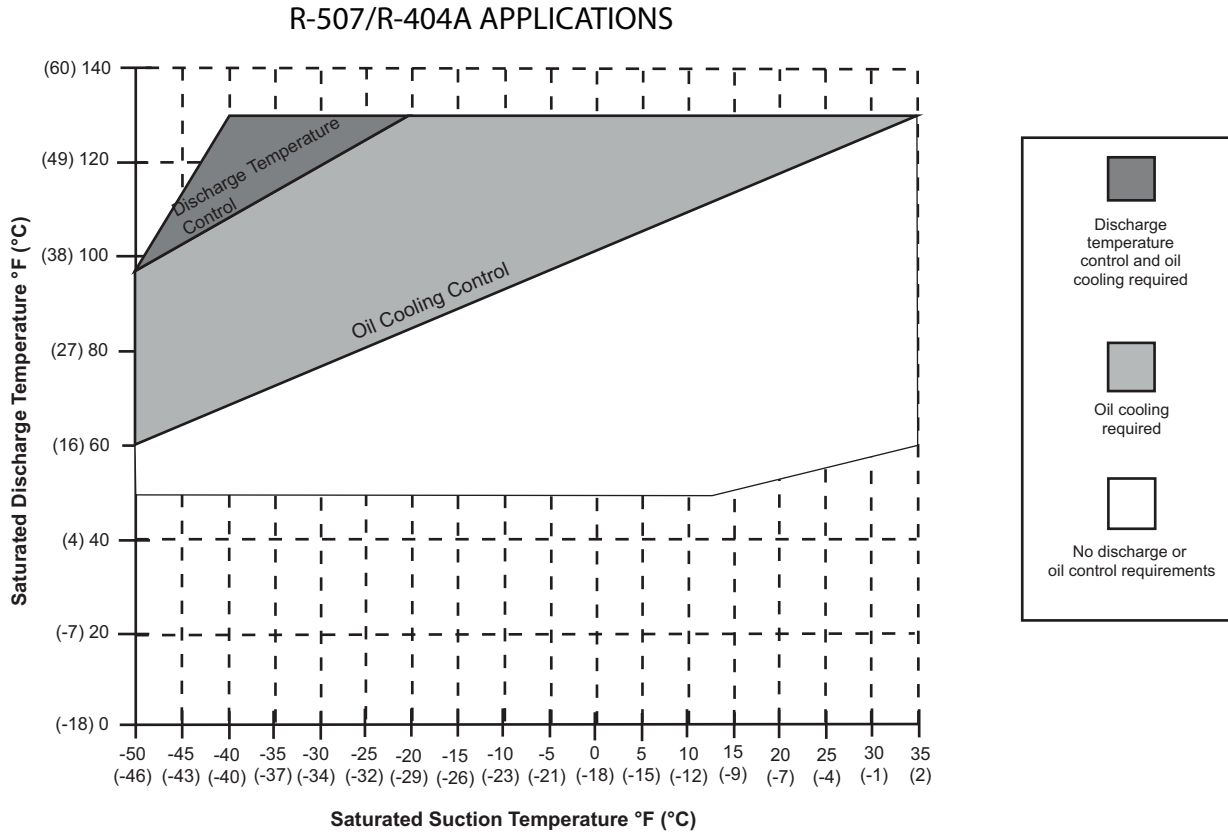


Fig. 4 — R-448A, R-449A, R-507 and R-404A Applications

R-134a APPLICATIONS

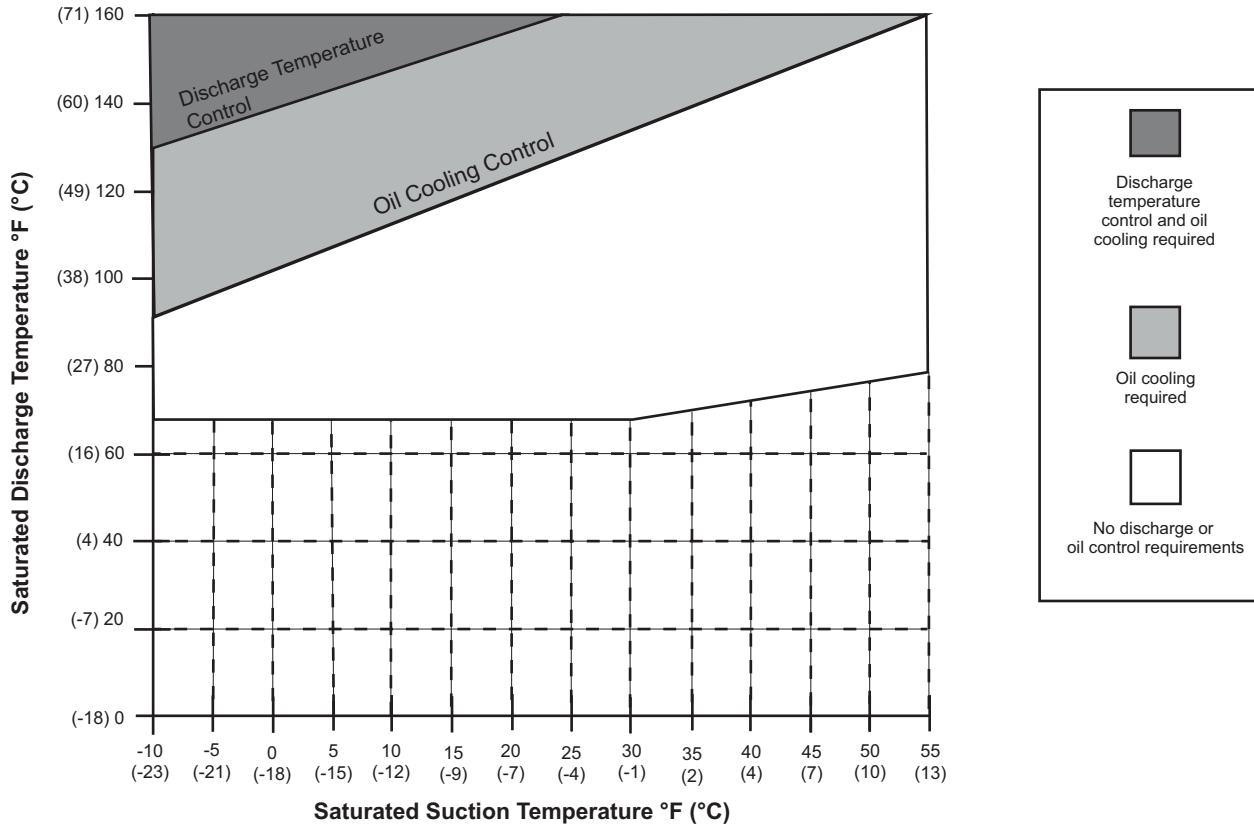


Fig. 5 — R-134a Applications

R-22 APPLICATIONS

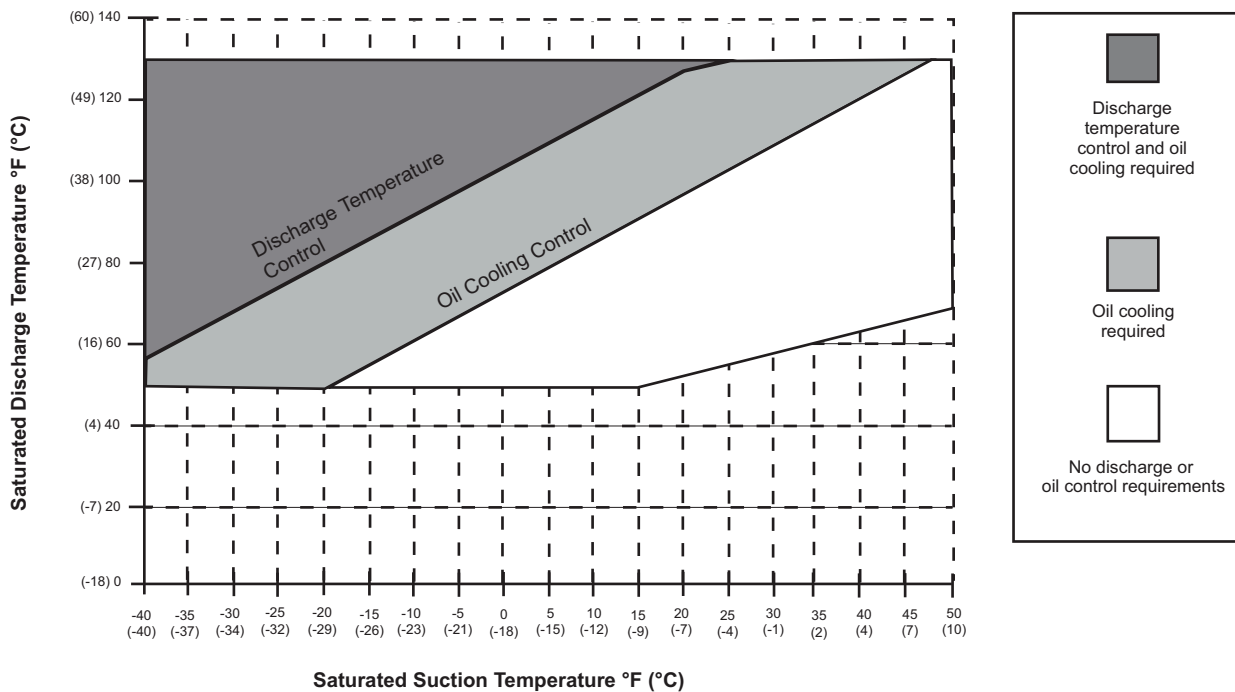


Fig. 6 — R-22 Applications

Vapor Temperature Limits

Any application of screw compressors must operate within the limits defined by the application maps for the various refrigerants and applications. See Table 5.

Table 5 — Temperature Limits

VAPOR TEMPERATURE	MIN.	MAX.
Suction	10°F SH ^a (6K)	100°F (38°C)
Economizer	Saturated ^b Vapor	—

NOTE(S):

a. SH = Superheat

b. The maximum economizer pressure allowable is 175.3 psig (13.1 bar)

Minimum Oil Pressure Differential

A minimum pressure differential of 45 psi (3 bar) is required between suction and oil pressure (at the compressor). Applications below this minimum range will require the use of an external oil pump.

Variable Speed Operation

The Carlyle screw compressor is compatible with variable speed drives. See Table 6 for compressor model allowable speed range.

Carlyle does not recommend the screw compressor operate at maximum frequency for prolonged periods of time.

Operation above 60 Hz requires adequate motor cooling. When overspeeding, there will be an increased power consumption required to supply the additional capacity. This will also increase the required motor cooling load. It is important that the motor cooling system be capable of handling the increased cooling required for the motor. Oil return, economizer return gas, and the motor cooling valve all assist in cooling the motor. Carlyle recommends applying the largest motor cooling valve with all screw compressors applied using inverters.

Compressors should ramp-up to the minimum speed within 15 seconds at start-up. After compressor start, Carlyle recommends that the rate of compressor speed change be limited to 600 rpm/min for the 06T semi-hermetic compressors.

Table 6 — Allowable Speed Ranges

COMPRESSOR MODEL	NOMINAL HP	MIN. Hz	MAX. Hz
06T—033	15	50	70
06T—039	20	40	70
06T—044	20	35	70
06T—048	25	30	70
06T—054	25	30	70
06T—065	30	25	70
06T—078	35	20	68
06T—088	40	20	60
06T—108	50	20	50

Compressor Cycling

Although compressor cycling is an effective means of capacity control, frequent starting and stopping shortens the compressor life. Carlyle screw compressors should not be stop/start cycled for capacity control more than **six times an hour** and should run for at least 5 minutes after each start.

Mechanical Unloading

All Carlyle screw compressors are equipped with one step of mechanical unloading. The unloader valve is controlled by a solenoid mounted on the compressor body. **The compressor is unloaded when the solenoid is de-energized and loaded when the solenoid is energized.** The compressor should always be started unloaded (for a minimum time determined by the control module) which will provide a soft start by partially relieving the compression chamber back to suction. Unloaded

operation reduces the effective capacity by 30% to 62%, depending on the model and system condition. See Table 7 and Fig. 7.

NOTE: The 06T screw compressors can be run unloaded continually without affecting the reliability of the compressor.

Table 7 — Estimated Percentage Unloading By Model

COMPRESSOR MODEL	50HZ OPERATION		60HZ OPERATION	
	06TR MODELS	06TA MODELS	06TR MODELS	06TA MODELS
06T—033	62%	52%	60%	50%
06T—039	61%	51%	59%	49%
06T—044	60%	50%	58%	48%
06T—048	59%	49%	56%	46%
06T—054	58%	48%	55%	45%
06T—065	55%	45%	50%	40%
06T—078	50%	40%	45%	35%
06T—088	47%	37%	40%	30%
06T—108	45%	—	—	—

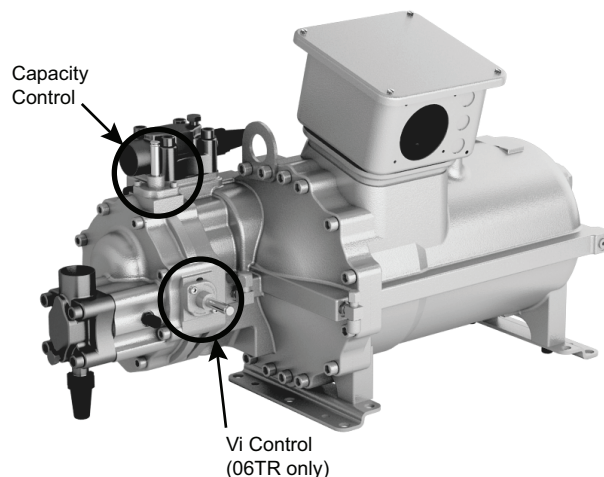


Fig. 7 — Control Locations

High Discharge Pressure Control

A high pressure cut out must protect the compressor from exceeding 350 psig (25.2 bar). The compressor may be brought back online after the discharge pressure falls below 300 psig (21.4 bar). The maximum pressure differential (discharge-suction) is 350 psi. The internal pressure relief valve will open if the pressure differential exceeds 400 psi ($\pm 3\%$).

Low Suction Pressure Cut Out

A low suction pressure cut out must protect the compressor from operating below 10 in. of vacuum pressure. Each compressor must be individually protected with a low pressure switch connected to the low side access port. The compressor may be brought back online after a 3 minute delay.

Volume Index (Vi) Control

All low temperature models 06TR are supplied with a Vi control valve that allows for two Vi settings (see Table 8). This dual Vi allows for optimum efficiency over a wide range of head pressures. The Vi must be set to low (solenoid de-energized) during start-up for a minimum of 30 seconds. The Vi may then be set as desired for optimum energy efficiency. The following table reflects the operational recommendations for the Vi control.

Carlyle also recommends the use of a small deadband at this change-over point to avoid unnecessary short cycling of the Vi solenoid. The LonCEM^{®1} controller continuously monitors the operating pressure ratio and controls Vi output accordingly. The older CEM requires external controls to accomplish the same task.

Table 8 — 06T Vi Settings

COMPRESSOR MODEL	SYSTEM PRESSURE RATIO	Vi SETTING	SOLENOID STATE
06TR	>5.0	High: 4.0	Energized
	<5.0	Low: 2.8	De-energized
06TA	All	Fixed: 2.8	—

Reverse Rotation Protection

Correct compressor rotation is critical for compressor reliability. The compressor can fail within 2 seconds of start-up if it is not rotating in the correct direction. Installation of a pressure gauge at the discharge pressure access fitting in the compressor body (measuring the pressure upstream of the integral discharge check valve) is recommended during initial start-up or whenever the compressor is serviced. The gauge should be monitored to ensure increasing discharge pressure at start-up.

The LonCEM protection module uses a pressure sensor to monitor the discharge pressure change at start-up to ensure proper compressor rotation. The LonCEM module eliminates the need for a mechanical low-pressure switch and line/load phase monitor. See Carlyle 06T Screw Compressor LonCEM Electronic Module Installation Guide for more information on LonCEM module.



LonCEM Electronic Module Installation Guide
<https://bit.ly/41aBxMu>

Mufflers

Screw compressors emit gas pulsations resulting in radiated noise from the discharge line and oil separator. The addition of a muffler is required in all applications to reduce discharge line and oil separator noise levels. The muffler should be located within 6 in. (15 cm) of the compressor discharge service valve.

OIL MANAGEMENT SYSTEM

Oil Separator

An oil separator is required on all Carlyle screw compressor systems. The screw compressors do not have an oil sump for storage of the system oil charge. The selection of the oil separator should consider the desired oil circulation rates as well as storage of oil for the entire bank of compressors.

Piping Configuration

The inlet piping from the compressor to the separator should follow a few simple rules:

1. The discharge header should be one consistent size throughout.
2. Step changes in the line diameter should be avoided with the exception of reducing fittings required to couple to the oil separator.

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To optimize the performance of the vortex separators, they should be piped with a 90° elbow in the discharge line (turning in the same direction as the vortex) just prior to entering the oil separator.

Inlet piping to the separator must be sized to maintain enough velocity at the minimum load condition of the rack. The minimum velocity should be no less than 20 fps (feet per second) (6.1 mps [meters per second]) and the maximum velocity should be no more than 75 fps (22.9 mps). Velocities above this limit may result in excessive pressure drop across the oil separator.

Steel oil piping is not recommended for use with 06T screw compressor applications.

System Oil Charge

The system oil charge will vary depending on the size of the separator used, size of the oil cooler (where applicable), oil manifold, and natural refrigerant piping traps and coating.

Oil Level Switch

An oil level switch is required and must be located in the bottom of the oil separator or reservoir. The level switch is used to monitor the oil level and act as a safety in case of low oil levels. **The float switch must be wired to open all the compressor control circuits on the rack during cases of low oil level.** The float switch will be normally closed when adequate oil is in the separator or reservoir sump. **The oil level switches are generally pilot duty devices, their electrical switching capacity should be validated to ensure they are not overloaded.** During transient conditions where significant foaming is present in the oil sump, the oil level switch may rapidly fluctuate causing nuisance tripping. System controls must be designed to discriminate these nuisance conditions from real low oil level conditions.

Oil Pressure Protection

The 06T screw compressors are lubricated using oil fed from the high pressure side of the system. To ensure adequate lubrication the pressure of the oil feed to each compressor must be a minimum of 45psi (3 bar) above suction pressure. Care should be taken to avoid large pressure drops between the oil separator (discharge pressure) and this oil feed to the compressor (oil pressure). See “Oil Filter” on page 10 for addition details on these pressure drops.

The LonCEM protection module provides comprehensive oil pressure protection through the use of discharge pressure, oil pressure and suction pressure transducers to monitor operating pressures.

Refer to the LonCEM Installation and Operations Guide for a complete description of the application and operation of the LonCEM module.

Oil Solenoids

A normally closed solenoid is required in the oil feed line to each compressor, see Fig. 8 for oil system schematics.

To avoid excessive pressure drop, the internal port size must be 5/16 in. diameter or larger. An oil strainer is required before each oil solenoid (or as an integral part of the solenoid). The solenoid will protect the compressor from being filled with oil from the high pressure oil feed line during the off cycle. Each solenoid must be properly wired to the Carlyle LonCEM (per installation instructions) of the compressor it is controlling. The valve must be open during the on cycle and closed during the off cycle. Manually adjustable valves must be checked to ensure the manual operation stem is completely back seated (ensuring the valve is closed when the solenoid is de-energized).

⚠ CAUTION

When testing the control circuit without the compressor running, the oil line must be valved off so that the compressor will not be filled with oil.

Whenever possible use control logic to determine that the compressor is running before opening the oil solenoid.

Discharge Temperature Control

The 06T semi-hermetic screw compressors can be operated for most applications without external oil cooling. 06T screw compressors require external oil cooling any time the system discharge temperature may exceed 190°F (88°C). The CARWIN Selection Software can be used to estimate the discharge temperature for a given application. The CARWIN tool allows for selections to be made with or without an oil cooler.

Refer to “Operational Envelopes” on page 5 for operating conditions that may require the use of external oil cooling.

An external oil cooler will reduce both the discharge and motor temperatures within their respective limits, however, additional refrigerant injection may still be required. For screw compressors this injection is either by the motor cooling valve and/or at

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

Under some conditions the motor cooling valve alone can accommodate this extra cooling requirement. For conditions requiring additional discharge temperature cooling, a desuperheating valve is recommended. It should be selected to start opening at a discharge temperature of 190°F (88°C) and be fully open at 200°F (93.3°C). The bulb should be located on the discharge line within 6 in. (15cm) of the compressor discharge service valve. A properly sized solenoid valve should be located upstream to ensure positive shut-off when the compressor is off.

See Tables 9 and 10 for desuperheating valve size and part number information for those applications where an oil cooler is not used.

Table 9 – Desuperheating Valve Sizing without Oil Cooler^a

COMPRESSOR MODEL	R-448A, R-449A, R-404A and R-507		R-22		R-134a	
	Low Temp.	Med Temp.	Low Temp.	Med/High Temp.	Medium Temp.	High Temp.
Low Temperature						
SCT Range	90°F to 120°F (32°C to 49°C)		70°F to 120°F (21°C to 49°C)		70°F to 150°F (21°C to 65°C)	70°F to 150°F (21°C to 65°C)
06TRC033	EA02ZD001 ^b		EA02ZD030		Not Required	Not Required
06TRD039	EA02ZD002 ^b		EA02ZD050			
06TRD044	EA02ZD002 ^b		EA02ZD050			
06TRE048	EA02ZD030 ^b		EA02ZD050			
06TRE054	EA02ZD050 ^b		EA02ZD050			
06TRF065	EA02ZD050 ^b		EA02ZD100			
06TRG078	EA02ZD050 ^b		EA02ZD100			
06TRH088	EA02ZD050 ^b		EA02ZD100			
06TRK108	EA02ZD050 ^b		EA02ZD100			
Medium/High Temperature						
SCT Range		70°F to 130°F (21°C to 34°C)		70°F to 130°F (21°C to 54°C)		
06TAD033		Not Required		EA02ZD030 ^c	Not Required	Not Required
06TAE039				EA02ZD050 ^c		
06TAF044				EA02ZD050 ^c		
06TAF048				EA02ZD050 ^c		
06TAG054				EA02ZD050 ^c		
06TAG065				EA02ZD100 ^c		
06TAH078				EA02ZD100 ^c		
06TAK088				EA02ZD100 ^c		

NOTE(S):

a. A valve with a 190°F(88°C) temperature setting is required. Alternate desuperheating valve sizing or manufacturers must be approved by Carlyle Application Engineering.

b. Operation with evaporator condensers below -25°F (-32°C) SST may not require any additional desuperheating. Contact Carlyle Application Engineering for limits.

c. Operation with evaporator condensers above +10°F (-12°C) SST may not require any additional desuperheating. Contact Carlyle Application Engineering for limits.

Table 10 – Compressor Model Part Numbers (without Oil Cooler)

Oil Cooling Capacity		kBtu/hr				kW/hr			
Fan Speed		60Hz				50Hz			
Ambient Air Temperature		95°F	100°F	105°F	110°F	35°C	38°C	41°C	43°C
KH51ZZ181	Maximum 2 compressors ^a	32.1	30.6	29.9	27.6	9.4	9.4	8.4	8.0
KH51ZZ182	Maximum 3 compressors ^a	69.1	65.7	62.4	59.1	18.7	17.8	16.9	16.0
KH51KK183	Maximum 4 compressors ^a	102.6	97.7	92.8	87.9	27.8	26.5	25.2	23.9
KH51KK183	Maximum 5 compressors ^a	134.1	127.7	121.3	114.9	26.2	34.4	32.7	30.1

NOTE(S):

a. Maximum number of compressors based on oil cooler pressure drop of less than 6 psid (.41 bar).

Oil Cooler Selection

Oil coolers are required for 06T compressors where the oil temperature can exceed 190°F (88°C). The CARWIN selection software should be used to determine operating conditions where this will occur. For initial reference, the operating envelopes on page 5 may be used.

The oil cooler should be sized based on an oil flow rate of approximately 2 gallons per minute (7.6 liters/minute) per compressor. However, it should be noted that the actual oil flow rate will vary based on the specific operating condition. Oil cooler loads may be obtained from the CARWIN selection software. With an oil cooler, the maximum oil temperature leaving the oil cooler is 170°F (77°C). Systems using external oil coolers also require controls that prevent the oil temperature from dropping below 80°F (27°C).

Acceptable means of control are fan cycling or oil cooler bypass or mixing valves. Mixing valves are recommended for any oil coolers that are integrated into the system condenser coil. For direct expansion oil coolers rejecting heat into the refrigeration circuit caution must be taken to ensure that the return gas temperature is within operating guidelines.

Oil Filter

Carlyle screw compressors are designed with rolling element bearings to provide exceptional life. Oil to the bearings must pass through a 3 micron filter which is required on all Carlyle screw compressor systems.

NOTE: Use of the Carlyle 3 micron filter element is required. Use of a non-Carlyle approved filter element will void compressor warranty. The use of a second redundant filter in parallel is recommended to allow for servicing of one filter while the other maintains the operability of the equipment.

If more than five compressors are fed by the oil system, three parallel oil filter elements (2 for operation, 1 for redundancy) should

be used to avoid excessive pressure drop through the filter elements. The oil filter should be located downstream from any oil coolers, as close to the compressors as possible.

For Oil Filter Pressure Drop Protection use:

1. LonCEM protection or
2. Carlyle recommends maximum allowable pressure drop across the oil filters of 45psid (3bar). Compressors should be shutdown above this limit. Carlyle also recommends an alert (shutdown not required) when the pressure drop rises above 25psid (~1.5bar).

Oil Sump Heaters

The heater must be energized during the system off cycle if used. This is required in all air conditioning systems and is recommended in refrigeration systems to keep refrigerant out of the oil sump during compressor off cycles. Carlyle typically recommends flexible heaters that are applied on the outside of the oil separator shells. Carlyle recommends 500W heaters for shells 12 in. and smaller and 100W for heaters larger than 12 in. Direct immersion heaters may also be used. Carlyle advises caution with these immersion heaters, localized temperatures surrounding the heater element should not create issues with the lubricant.

Oil Sight Glass

A sightglass is required in the main oil line. The sightglass must be located after the oil filters and just prior to the first compressor on a multiple compressor rack. To aid service personnel in verifying oil flow to any given compressor Carlyle recommends a sightglass be placed in each branch oil line between the compressor and its oil solenoid. See Fig. 8 and Table 11.

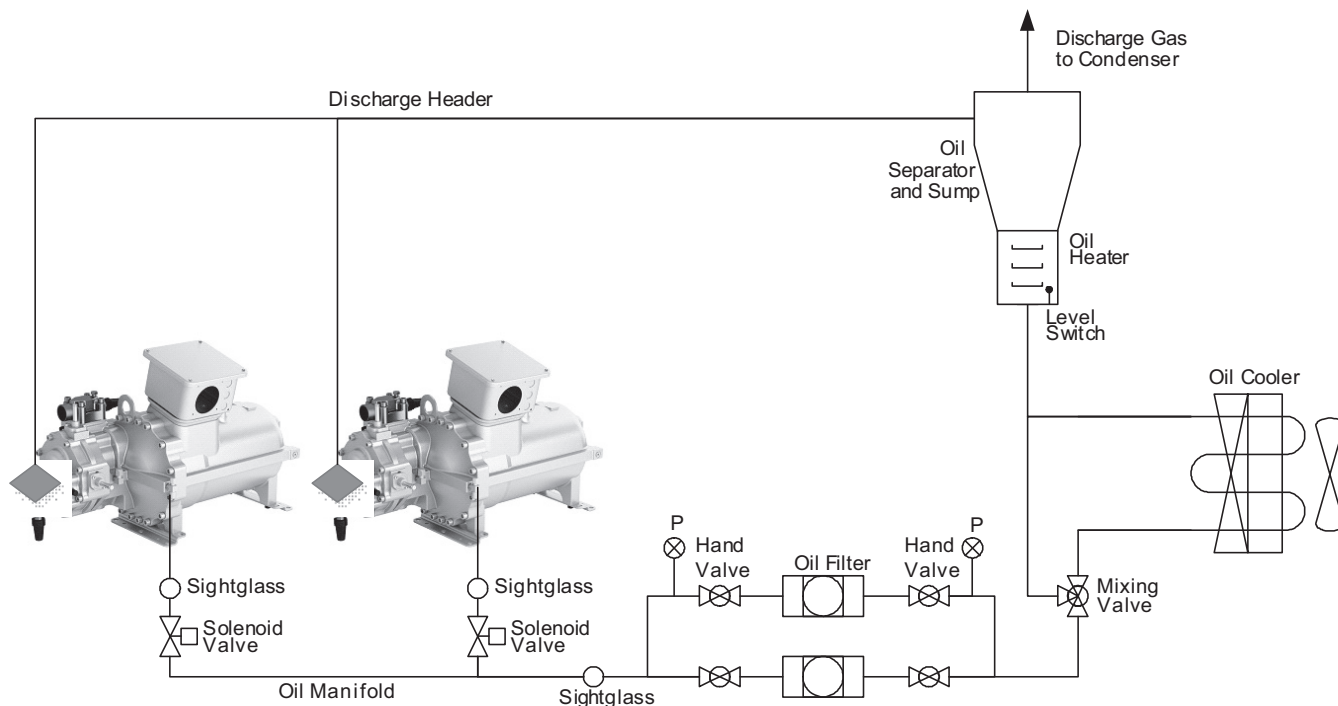


Fig. 8 — Oil System Schematics

Table 11 — Oil Line Manifold Selection^{a,b,c,d}

Oil Manifold for Pressure Drop (for POE100 oils)						
NUMBER OF COMPRESSORS	FLOW RATE	MANIFOLD SIZE	at 10 cSt	at 45 cSt	at 100 cSt	at 170 cSt
English						
	Pressure Drop (psi) per 10 feet of Manifold					
1	2 gpm	7/8	0.17	0.77	1.72	2.92
2	4 gpm	7/8	0.34	1.54	3.43	5.83 ^e
3	6 gpm	7/8	0.52	2.31	5.15 ^e	8.76 ^e
4	8 gpm	1-1/8	0.22	0.97	2.16	3.67
5	10 gpm	1-1/8	0.27	1.21	2.69	4.58
Metric						
	Pressure Drop (kPa) per 1 meter of Manifold					
1	7.6 l/min	7/8	0.38	1.74	3.89	6.60
2	15.2 l/min	7/8	0.77	3.48	7.76	13.19 ^e
3	22.8 l/min	7/8	1.18	5.23	11.65 ^e	19.81 ^e
4	30.4 l/min	1-1/8	0.50	2.19	4.89	8.30
5	38.0 l/min	1-1/8	0.61	2.74	6.08	10.36

LEGEND

cSt — Centistokes

NOTE(S):

- a. Viscosity of 10 cSt is based on 130°F (54°C) oil with 10% refrigerant dilution.
- b. Viscosity of 45 cSt is based on 130°F (54°C) oil, no refrigerant dilution or 80°F (27°C) oil with 10% refrigerant dilution.
- c. Viscosity of 100 cSt is based on 100°F (38°C) oil, no refrigerant dilution.
- d. Viscosity of 170 cSt is based on 100°F (38°C) oil, with no refrigerant dilution.
- e. If 170 POE oil is used, Carlyle recommends use of the next larger size copper line if pressure drop is greater than 5.0 psi. This will typically reduce pressure drop to 30% of value shown.

REFRIGERANT MANAGEMENT SYSTEM

Suction and Interstage Piping

The suction and interstage manifolds should be piped in such a way that liquid cannot gravity drain into any compressor. Carlyle recommends that the manifold be located below the compressor body. An inverted trap must be used coming off the top of the suction header if it is above the compressor body.

Steel refrigerant piping is not recommended for use with 06T screw compressor applications. The contaminants associated with the steel pipe will overload the 3 micron filters used in the oil system increasing the chances of oil related compressor failures. See Fig. 9 and 10.

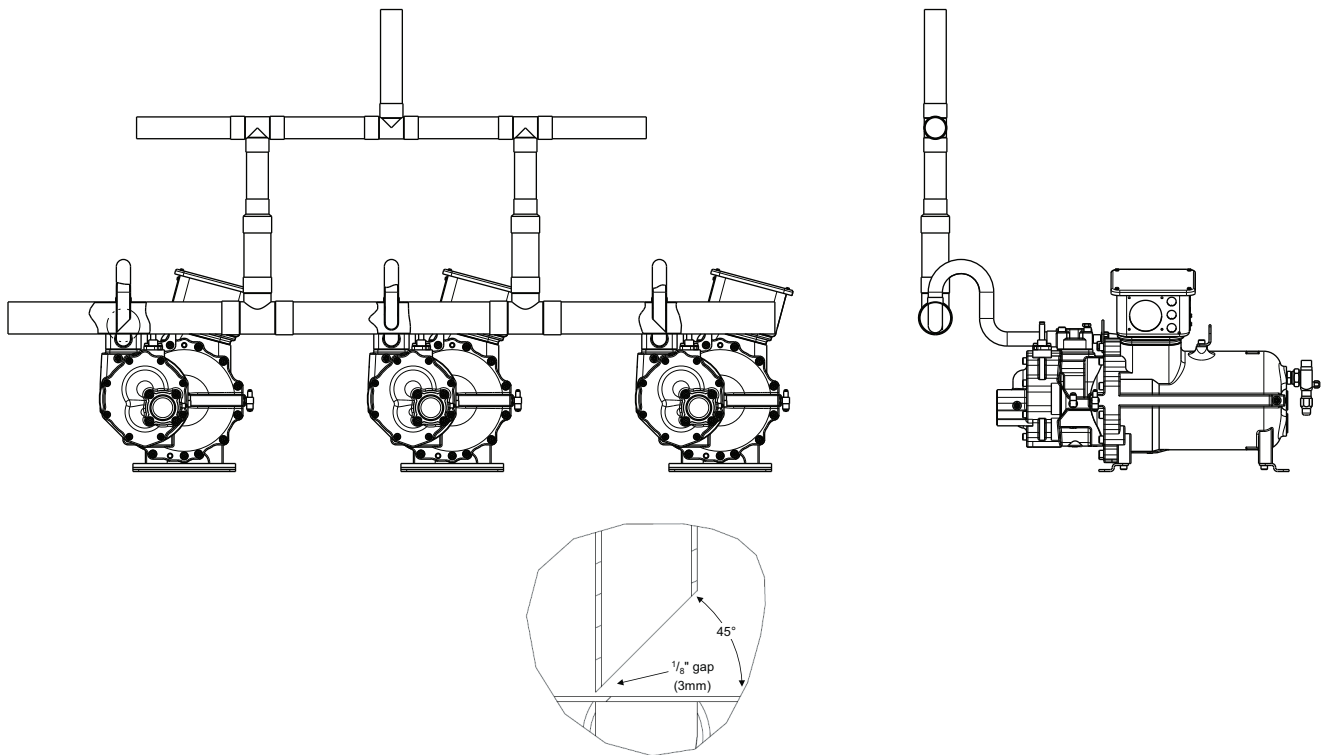
Mechanical subcooling via interstage manifolds are commonly applied with parallel 06T rack designs. The gas exiting the sub-cooler is used to provide additional motor cooling in 06T models. This design reduces the amount of liquid injection required for

motor cooling. The manifold acts to efficiently distribute refrigerant gas to each compressor. Interstage headers should be designed similar to suction line manifolds. See Fig. 11.

A normally closed solenoid valve is required in the interstage line feeding each compressor on a parallel rack. This valve is required to eliminate interstage to suction pressure leak back during the off cycle of any compressor. This valve must open only when the compressor is in operation.

Check valves are also required in the interstage line feeding each compressor on a parallel rack as shown. The check valve must be located upstream of the motor cooling valve for each compressor and downstream of the solenoid valve.

Compressors operating with different saturated suction temperatures can have a significant difference in interstage pressure. Separate subcoolers are recommended for each suction temperature group. See Fig. 11.



NOTE: If suction or interstage piping is to be located above the compressor the recommendations in the figure below also apply.

Fig. 9 — Suction and Interstage Header Schematic (Header Located ABOVE Compressor inlet)

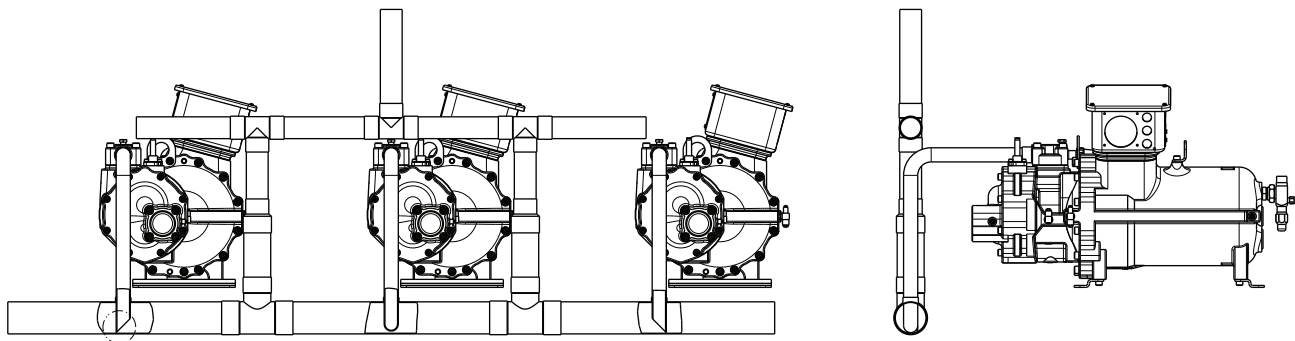


Fig. 10 — Suction and Interstage Header Schematic (Header Located Below Compressor Inlet)

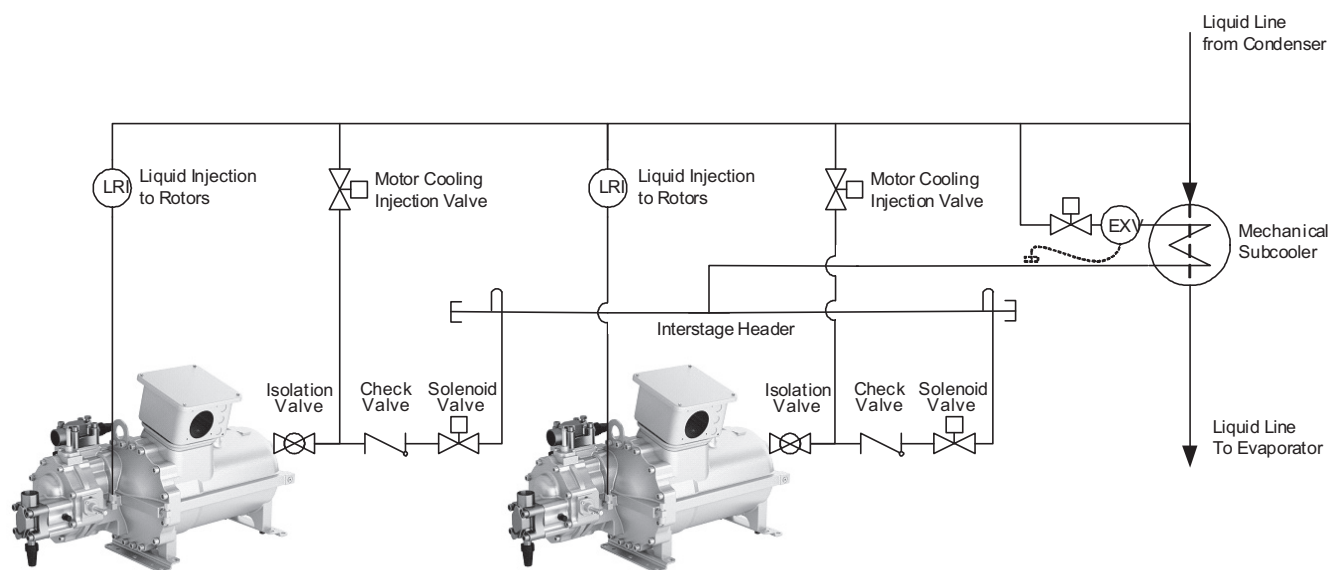


Fig. 11 — Interstage Schematic With Injection to Motor and Rotors

ELECTRICAL DATA

Thermal Protection

The compressor motor windings are protected from extreme temperatures by the LonCEM module. All compressors are supplied with two 5K NTC (Negative Thermal Coefficient) thermistors in

the motor windings. The module will limit the maximum motor temperature to 240°F (116°C) and is an automatic reset device. Only one 5K sensor is used; the other is a spare. The temperature vs. resistance characteristics of the thermistors are shown below. See Table 12.

Table 12 — Temperature vs. Resistance Table

TEMPERATURE			RESISTANCE			TEMPERATURE			RESISTANCE			TEMPERATURE			RESISTANCE		
°C	°F	ohms	°C	°F	ohms	°C	°F	ohms	°C	°F	ohms	°C	°F	ohms	°C	°F	ohms
0	32.0	16,352.4	38	100.4	886.9	76	168.8	715.93	114	237.2	228.38						
1	33.8	15,515.2	39	102.2	2,772.1	77	170.6	692.68	115	239.0	222.24						
2	35.6	14,750.0	40	104.0	2,662.4	78	172.4	670.34	116	240.8	216.29						
3	37.4	14,027.1	41	105.8	2,557.8	79	174.2	648.82	117	242.6	210.53						
4	39.2	13,343.8	42	107.6	2,457.7	80	176.0	628.09	118	244.4	204.95						
5	41.0	12,697.8	43	109.4	2,362.1	81	177.8	608.11	119	246.2	199.54						
6	42.8	12,086.3	44	111.2	2,270.8	82	179.6	588.88	120	248.0	194.3						
7	44.6	11,508.0	45	113.0	2,183.45	83	181.4	570.36	121	249.8	189.22						
8	46.4	10,960.8	46	114.8	2,099.93	84	183.2	552.5	122	251.6	184.3						
9	48.2	10,442.6	47	116.6	2,020.04	85	185.0	535.29	123	253.4	178.5						
10	50.0	9,951.8	48	118.4	1,943.6	86	186.8	518.7	124	255.2	174.89						
11	51.8	9,486.8	49	120.2	1,870.5	87	188.6	502.7	125	257.0	170.41						
12	53.6	9,046.3	50	122.0	1,800.49	88	190.4	487.28	126	258.8	166.06						
13	55.4	8,628.7	51	123.8	1,733.46	89	192.2	474.4	127	260.6	161.83						
14	57.2	8,232.5	52	125.6	1,669.66	90	194.0	458.06	128	262.4	157.74						
15	59.0	7,857.0	53	127.4	1,607.81	91	195.8	444.2	129	266.0	153.77						
16	60.8	7,500.6	54	129.2	1,548.95	92	197.6	430.85	130	267.8	149.91						
17	62.6	7,126.3	55	131.0	1,492.54	93	199.4	417.96	131	269.6	146.17						
18	64.4	6,841.3	56	132.8	1,438.46	94	201.2	405.51	132	271.4	142.54						
19	66.2	6,526.4	57	134.6	1,386.62	95	203.0	393.49	133	273.2	139.02						
20	68.0	6,526.8	58	136.4	1,336.93	96	204.8	381.89	134	275.0	136.6						
21	69.8	5,971.6	59	138.2	1,289.26	97	206.6	370.69	135	276.8	132.27						
22	71.6	5,710.0	60	140.0	1,243.53	98	208.4	359.87	136	278.6	129.04						
23	73.4	5,461.3	61	141.8	1,199.7	99	210.2	349.41	137	280.4	125.91						
24	75.2	5,225.0	62	143.6	1,157.59	100	212.0	339.32	138	285.8	122.87						
25	77.0	5,000.0	63	145.4	1,117.18	101	213.8	329.55	139	287.6	119.91						
26	78.8	4,786.0	64	147.2	1,078.37	102	215.6	320.12	140	289.4	117.04						
27	80.6	4,582.4	65	149.0	1,041.15	103	217.4	311.0	141	281.2	114.25						
28	82.4	4,338.5	66	150.8	1,005.38	104	219.2	302.18	142	287.6	111.54						
29	84.2	4,203.9	67	152.6	971.03	105	221.0	293.65	143	289.4	108.9						
30	86.0	4,028.0	68	154.4	938.02	106	222.8	285.41	144	291.2	106.34						
31	87.8	3,860.5	69	156.2	906.3	107	224.6	277.43	145	293.0	103.86						
32	89.6	3,700.8	70	158.0	875.81	108	226.4	269.72	146	294.8	101.43						
33	91.4	3,548.5	71	159.8	846.5	109	228.2	262.26	147	296.6	99.074						
34	93.2	3,403.5	72	161.6	818.31	110	230.0	255.03	148	298.4	95.785						
35	95.0	3,265.1	73	163.4	791.21	111	231.8	248.04	149	300.2	94.559						
36	96.8	3,133.1	74	165.2	765.14	112	233.6	241.28	150	302.0	92.393						
37	98.6	3,007.1	75	167.0	740.06	113	235.4	234.72									

Overcurrent Protection

06T screw compressors must be protected with a three-phase manual-reset type of overcurrent protection. See Table 14.

The code agency certifications of the 06T compressor is contingent upon the use of appropriate overcurrent protection. Properly selected overcurrent devices protect the compressors against running overcurrent, locked rotor, as well as primary and secondary single phasing faults.

Overcurrent protection must comply with the following:

- Manual Reset
- The device must trip at or below the maximum MCC listed for the compressor. Settable devices may require settings that differ from the maximum allowed current. Consult the manufacturer's documentation for proper setting of these devices.
- To minimize nuisance tripping risks, the maximum ratio between the must trip and must hold values cannot be larger than 1.15.
- Locked Rotor Trip Timing:
 - Across-the-Line Start: Device must trip in 2 to 6 seconds

The 06T compressor motor may be protected using a recognized variable speed drive that meets these compressor protection requirements. The system designer is responsible to program these requirements appropriately.

If the end user is not intending on using the full published operating envelope; the overcurrent protection can be sized to trip at lower values than the maximum MCC.

Allowable Voltage Range

The allowable voltage variation at the compressor terminals for the 06T screw compressors is shown in Table 13.

Table 13 — Allowable Voltage Variation

MODEL NO. DIGIT 9	NOMINAL VOLTAGE	VOLTAGE RANGE	
		MIN.	MAX.
B	460-3-60	396	528
	400-3-50	342	456
C	575-3-60	495	660
F	208/230-3-60	187	264
	200-3-50	180	230

Table 14 — Compressor Motor Overcurrent Protection

06TR LOW TEMP COMPRESSORS				VOLTAGE (V-Ph-Hz)	06TA MED/HIGH TEMP COMPRESSORS			
COMPRESSOR MODEL	HP	MAXIMUM CONTINUOUS CURRENT (amps)	LOCKED ROTOR CURRENT (amps)		COMPRESSOR MODEL	HP	MAXIMUM CONTINUOUS CURRENT (amps)	LOCKED ROTOR CURRENT (amps)
06TRC033F2EA	15	90	286	208/230-3-60 200-3-50	06TAD033F2EA	20	104	348
06TRD039F2EA	20	104	348		06TAE039F2EA	25	128	433
06TRD044F2EA	20	104	348		06TAF044F2EA	30	163	510
06TRE048F2EA	25	128	433		06TAF048F2EA	30	163	510
06TRE054F2EA	25	128	433		06TAG054F2EA	35	182	610
06TRF065F2EA	30	154	611		06TAG065F2EA	35	181	721
06TRG078F2EA	35	181	721		06TAH078F2EA	40	203	825
06TRH088F2EA	40	203	825		06TAK088F2EA	50	230	974
06TRC033B2EA	15	46	142		06TAD033B2EA	20	49	173
06TRD039B2EA	20	49	173		06TAE039B2EA	25	64	215
06TRD044B2EA	20	49	173	460-3-60 400V-3-50	06TAF044B2EA	30	76	253
06TRE048B2EA	25	64	215		06TAF048B2EA	30	76	253
06TRE054B2EA	25	64	215		06TAG054B2EA	35	88	305
06TRF065B2EA	30	76	253		06TAG065B2EA	35	89	323
06TRG078B2EA	35	89	323		06TAH078B2EA	40	101	370
06TRH088B2EA	40	101	370		06TAK088B2EA	50	114	440
06TRK108B2EA	50	114	440		—	—	—	—
06TRC033C2EA	15	33.5	114		06TAD033C2EA	20	39	138
06TRD039C2EA	20	39	138		06TAE039C2EA	25	53	172
06TRD044C2EA	20	39	138		06TAF044C2EA	30	62	202
06TRE048C2EA	25	53	172	575-3-60	06TAF048C2EA	30	62	202
06TRE054C2EA	25	53	172		06TAG054C2EA	35	78	242
06TRF065C2EA	30	62	219		06TAG065C2EA	35	72	258
06TRG078C2EA	35	72	258		06TAH078C2EA	40	81	296
06TRH088C2EA	40	81	296		06TAK088C2EA	50	92	351

MOTOR TEMPERATURE CONTROL

Motor Cooling Control

The motors in the 06T compressors are not located in the suction gas stream like other compressors. These motors require cooling to maintain reliable operation. Motor barrel insulation is recommended on compressors with suction temperatures below -15°F (-26°C) to prevent frost build-up on the compressor motor barrel. See Fig. 12.

All motors must have a steady flow of cooling while in operation to avoid thermal shock to the motor. There are two methods for providing this cooling; economizer flow from the mechanical subcooler or liquid injection directly into the motor barrel.

When using economizer flow, the superheat leaving the mechanical subcooler should be set in the range of 10 to 20°F (6 to 11°C) superheat above saturated intermediate temperature. For parallel applications, an intermediate header is required to distribute economizer gas to each compressor. A solenoid valve is required to isolate each compressor from this intermediate header when the compressor is not operating. This solenoid valve can be controlled with the LonCEM module.

When using only liquid injection, the 1-ton liquid injection valve (part no. EF28BZ001) must feed liquid refrigerant to the compressor motor at any time the compressor is in operation.

For both economizer gas cooling and liquid injection, the motor may require additional cooling when operating under high loads. A supplemental liquid injection valve (part no. EF28BZ007) should be installed to provide this additional cooling. This supplement valve can be controlled with the LonCEM module.

COMPRESSOR SELECTIONS AND PERFORMANCE DATA

CARWIN Compressor Selection Software

The performance of the 06T screw compressors can be estimated using the CARWIN compressor selection tool. CARWIN is a web-based application available at <https://carwin.carlylecompressor.com>.

Subcooler Selection

The use of mechanical subcoolers are recommended to increase both the capacity and operating efficiency of the compressors. Subcooler loads can also be estimated using CARWIN.

Carlyle recommends sizing and piping the subcooler for parallel flow. Parallel flow through the subcooler results in better control of the subcooler by reducing TXV hunting.

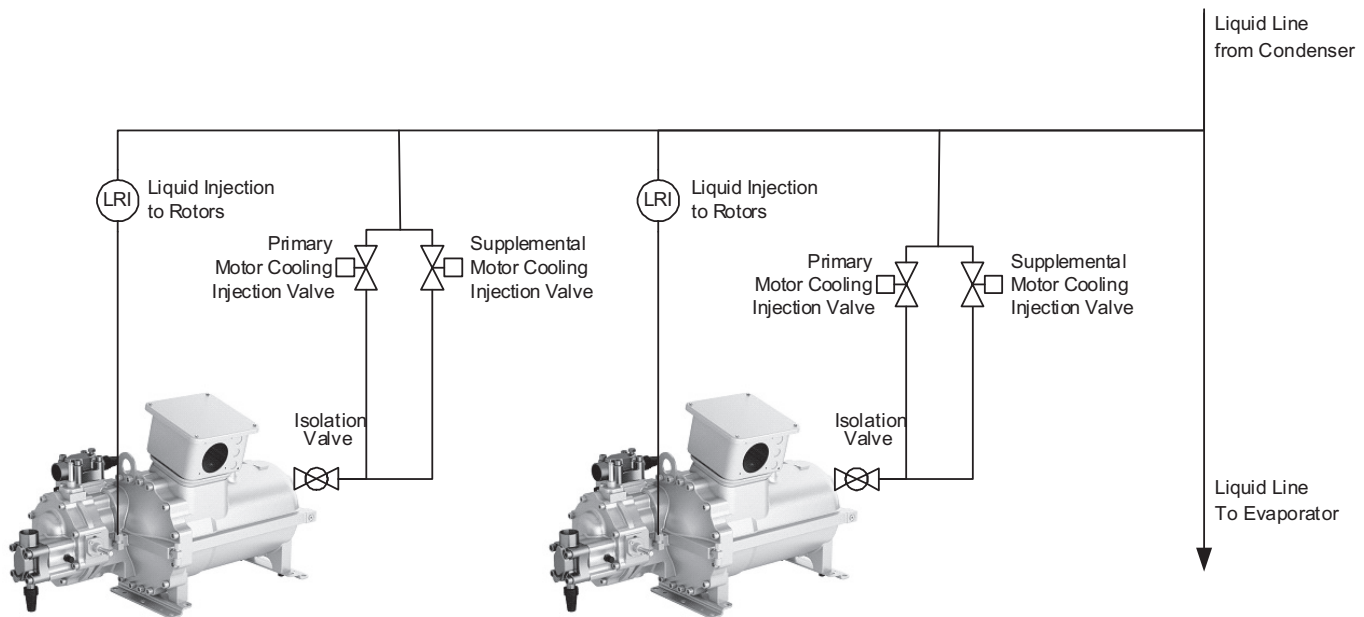


Fig. 12 — Motor Cooling Control System