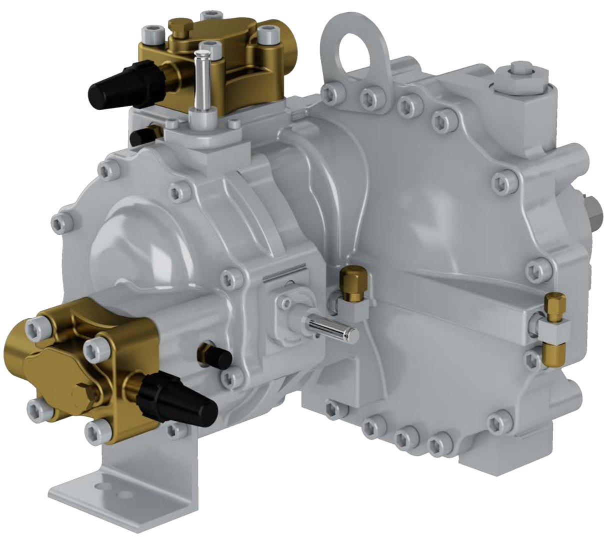
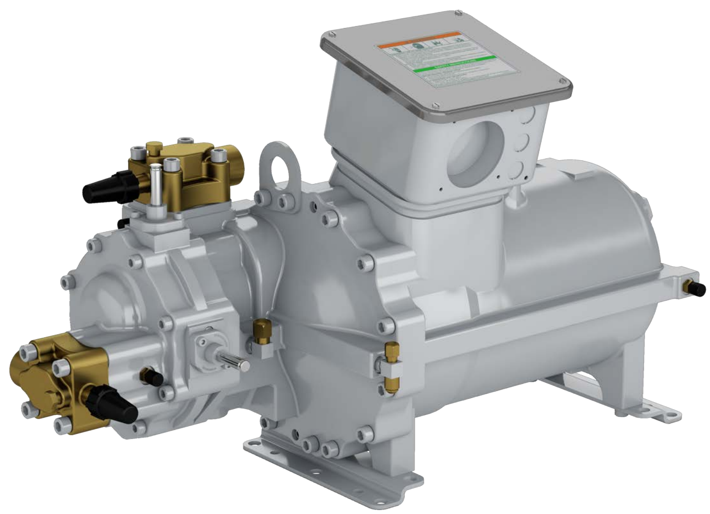


05T



06T

05T / 06T SCREW COMPRESSOR APPLICATION GUIDE

Carlyle™

Contents

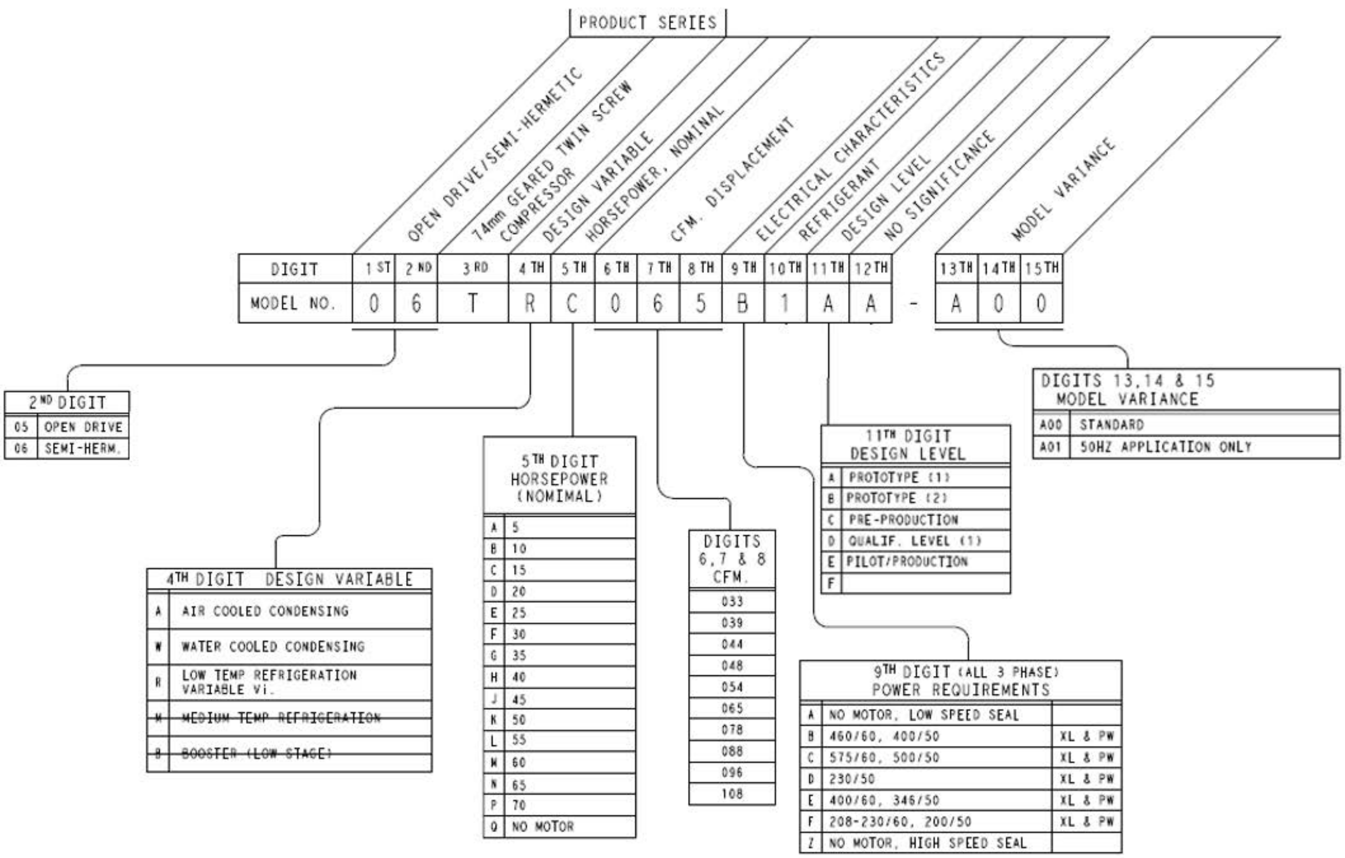
General Introduction

This manual is for the application of the Carlyle 06T semi-hermetic and 05T open drive 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 05T/06T Compressors

The Carlyle 06T and 05T 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, as do all the open drive models. 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 and 05T twin screw compressors. For applications outside the parameters listed in this guide, please contact Carlyle Application Engineering. Unless otherwise noted, all information contained in this application guide applies to both the 06T and 05T models.

06T MODEL NUMBER NOMENCLATURE



Summary of Control Points

Oil System:

Maximum oil temperature entering compressor:

- 06T models: 190°F (88°C)
- 05T models: 180°F (82°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 inches 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

1.0 General Information

1.1 Certification

The 06T compressors are UL listed under file number is 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 5.2 of this guide. Both UL and CSA approvals have been obtained for all voltage combinations listed in Section 5.3. 60 Hz compressors have been listed.

1.2 Screw Compressor Size (Displacement)

06T compressors are available in the following displacement sizes:

	60Hz		50Hz	
MODEL NO.	**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

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

1.3 Compressor Mounting

The Carlyle 05T/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.

1.4 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 following oils:

Oil	Manufacturer
Solest 120	CPI
Solest 170	CPI
Emkarate RL100E	Lubrizol

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.

1.5 Ambient Conditions

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

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)

1.6 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.

1.7 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). The relief valve is not field serviceable.

1.8 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. The discharge check valve is field serviceable.

1.9 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.

1.10 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® service valves are used for the economizer line shut off. The line sizes are as follows:

Connection	Connection Size	
	MAX.	**MIN.**
Suction	**1-5/8"**	**1-1/8"**
Discharge	**1-5/8"**	**1-1/8"**
Economizer	**7/8"**	**7/8"**

All 05T compressors and 06T compressors between 65cfm and 108cfm 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 108cfm compressors.

1.11 Condenser Pressure Control

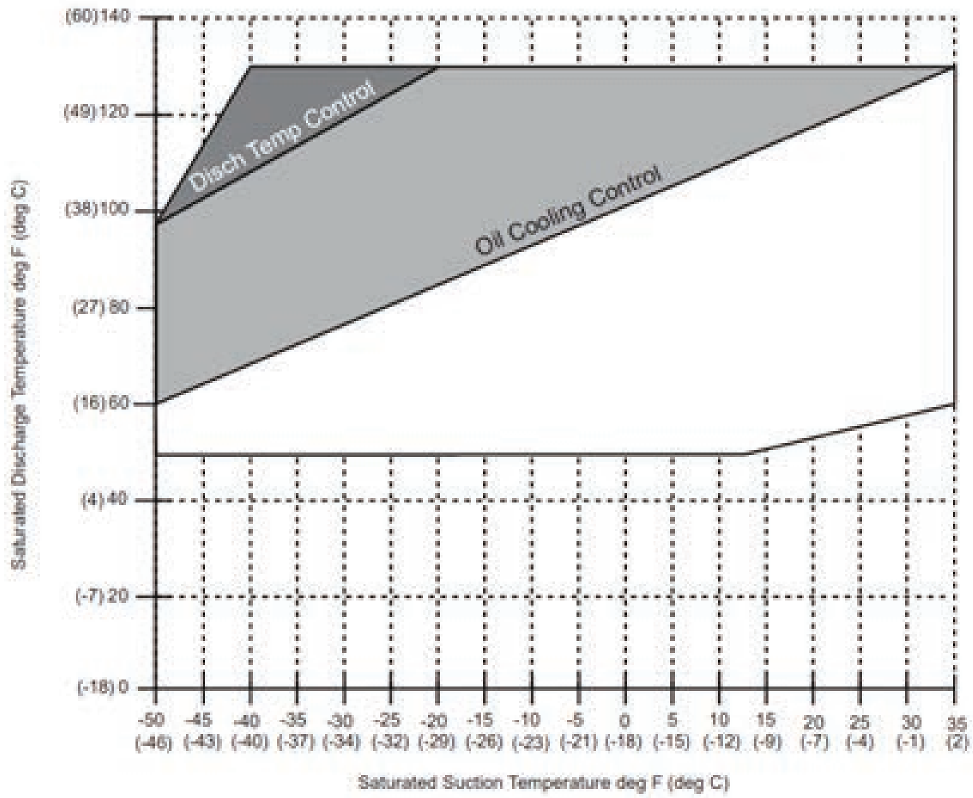
Large fluctuations in head pressure may result in very poor oil separation which may result in nuisance oil level switch tripping. The condenser pressure must be controlled such that fluctuations are gradual. Carlyle screw compressors must always be applied with a minimum of one condenser fan (preferably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

2.0 Operating Specifications

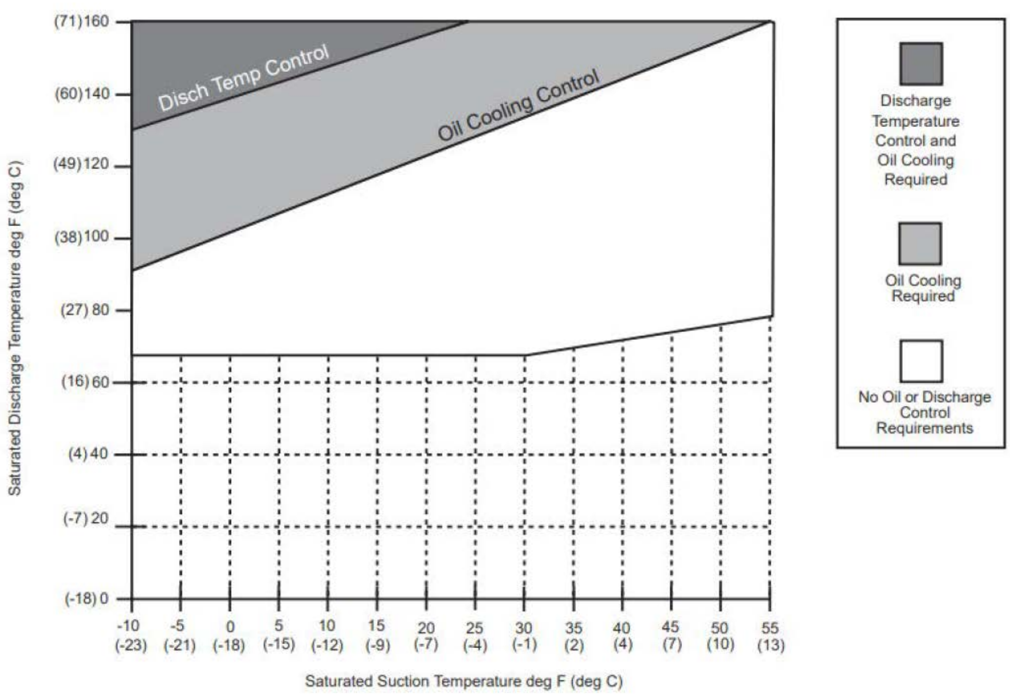
2.1 Operational Envelopes

The following operational envelopes, based on 65°F (18°C) return gas, show the allowable operating suction and discharge pressure ranges for different refrigerants. 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 Cooling Systems, Section 3.8).

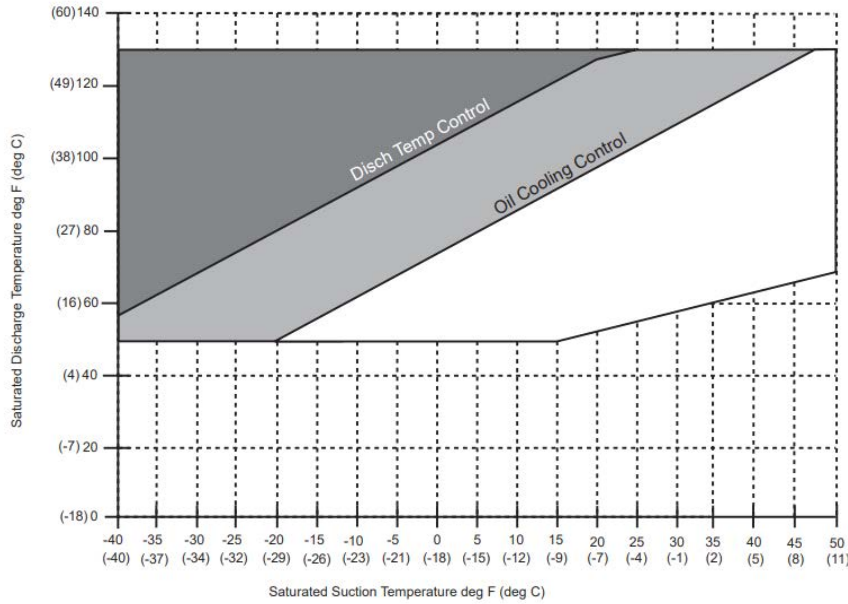
R-448A, R-449A, R-507 & R-404A APPLICATIONS



R-134a Applications



R-22 APPLICATIONS



2.2 Vapor Temperature Limits

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

Vapor Temp	Min.	Max.
Suction	10°F SH* (6K)	100°F (38°C)
Economizer	Saturated** Vapor	—

*SH = Superheat
**The maximum economizer pressure allowable is 175.3 psig (13.1 bar)

2.3 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.

2.4 Variable Speed Operation

The Carlyle screw compressor is compatible with variable speed drives, the table below shows the 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. The rate of compressor speed change for the 05T open-drive models is required to be no greater than 500 rpm/min.

Compressor Model	Nominal HP	Min. Hz	Max. Hz	Open Motor Type*
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	—
05T—033	15	50	140	4-POLE
	30	25	70	2-POLE
05T—039	20	40	140	4-POLE
	35	20	70	2-POLE
05T—044	20	35	120	4-POLE
	40	20	60	2-POLE
05T—048	25	20	70	4-POLE
05T—054	25	20	70	4-POLE

*Open Motor Type applies to 05T models only.

2.5 Compressor Cycling

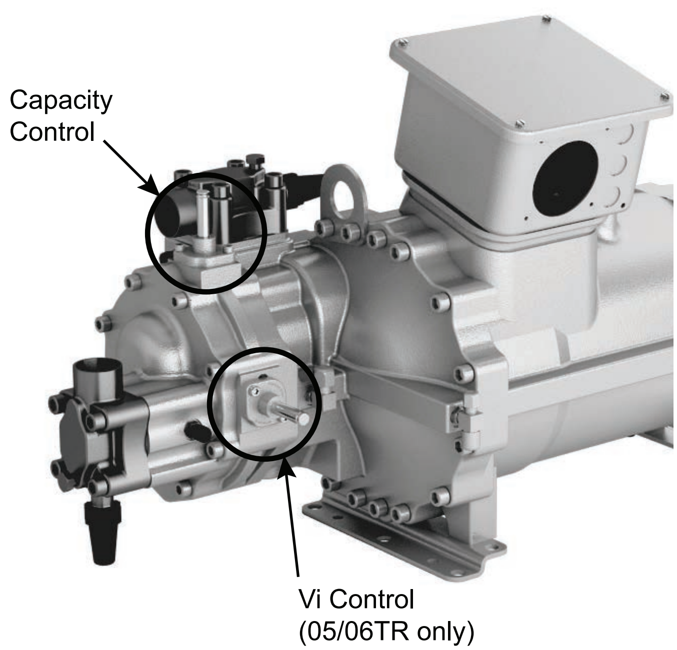
Although compressor cycling is an effective means of capacity control, frequent starting and stopping shortens the compressor life. Carlyle screw compressors should not be stop/start cycled for capacity control more than six times an hour and should run for at least 5 minutes after each start.

2.6 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 tables below).

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%	—	—	—



The 05T/06T screw compressors can be run unloaded continually without affecting the reliability of the compressor.

2.7 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 (+/-3%).

2.8 Low Suction Pressure Cut Out

A low suction pressure cut out must protect the compressor from operating below 10 inches 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.

2.9 Volume Index (Vi) Control

All low temperature models (05TR/06TR) are supplied with a Vi control valve that allows for two Vi settings (see chart below). 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® controller continuously monitors the operating pressure ratio and controls Vi output accordingly. The older CEM requires external controls to accomplish the same task.

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	—

2.10 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 gage 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 gage 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 startup to ensure proper compressor rotation. The LonCEM module eliminates the need for a mechanical low-pressure switch and line/load phase monitor. See Appendix A for descriptions of operation applications for the LonCEM module.

2.11 Mufflers

Screw compressors emit gas pulsations result 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-inches (15cm) of the compressor discharge service valve.

3.0 Oil Management System

3.1 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.

3.2 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 the reducing fittings required to couple to the oil separator.

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 20fps (feet per second) (6.1 mps [meters per second]) and the maximum velocity should be no more than 75fps (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 05T/06T screw compressor applications.

3.3 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.

3.4 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.

3.5 Oil Pressure Protection

The 05T/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 Section 3.9 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.

3.6 Oil Solenoids

A normally closed solenoid is required in the oil feed line to each compressor, see Section 3.12 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.

3.7 Discharge Temperature Control

The 06T semi-hermetic screw compressors can be operated for most applications without external oil cooling. 05T open drive screw compressors require external oil cooling any time the system discharge temperature may exceed 180°F(82°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.

See Operating Envelopes in Section 2.1 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 inches (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.

The tables presented at the bottom of this page present desuperheating valve size and part number information for those applications where an oil cooler is not used.

DESUPERHEATING VALVE SIZING WITHOUT OIL COOLER

Compressor Model	R-448A, R-449A, R-404A & R-507		R-22		R-134a	
	Low Temp.	Med Temp.	Low Temp.	Med/High Temp.	Medium Temp.	High Temp.
Low Temp.						
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*		EA02ZD030		Not Required	Not Required
06TRD039	EA02ZD002*		EA02ZD050			
06TRD044	EA02ZD002*		EA02ZD050			
06TRE048	EA02ZD030*		EA02ZD050			
06TRE054	EA02ZD050*		EA02ZD050			
06TRF065	EA02ZD050*		EA02ZD100			
06TRG078	EA02ZD050*		EA02ZD100			
06TRH088	EA02ZD050*		EA02ZD100			
06TRK108	EA02ZD050*		EA02ZD100			
Med Temp/High Temp						
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**	Not Required	Not Required
06TAE039				EA02ZD050**		
06TAF044				EA02ZD050**		
06TAF048				EA02ZD050**		
06TAG054				EA02ZD050**		
06TAG065				EA02ZD100**		
06TAH078				EA02ZD100**		
06TAK088				EA02ZD100**		

* Operation with Evap. condensers below -25°F (-32°C) SST may not require any additional desuperheating. Contact Carlyle Application Engineering for limits.
**Operation with Evap. condensers above +10°F (-12°C) SST may not require any additional desuperheating. Contact Carlyle Application Engineering for limits.

NOTE: 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.

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	32.1	30.6	29.9	27.6	9.4	9.4	8.4	8.0
KH51ZZ182	Maximum 3 compressors	69.1	65.7	62.4	59.1	18.7	17.8	16.9	16.0
KH51KK183	Maximum 4 compressors	102.6	97.7	92.8	87.9	27.8	26.5	25.2	23.9
KH51KK183	Maximum 5 compressors	134.1	127.7	121.3	114.9	26.2	34.4	32.7	30.1

*Maximum Number of Compressors Based on Oil Cooler Pressure Drop of Less Than 6 PSID (.41 bar)

3.8 Oil Cooler Selection

Oil coolers are required for 06T compressors where the oil temperature can exceed 190°F (88°C) and for 05T compressors where it can exceed 180°F (82°C). The CARWIN selection software should be used to determine operating conditions where this will occur. For initial reference, the operating envelopes in Section 2.1 may be used as an initial reference.

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.

3.9 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.

Oil Filter Pressure Drop Protection:

LonCEM protection

— or —

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).

3.10 Oil Sump Heaters

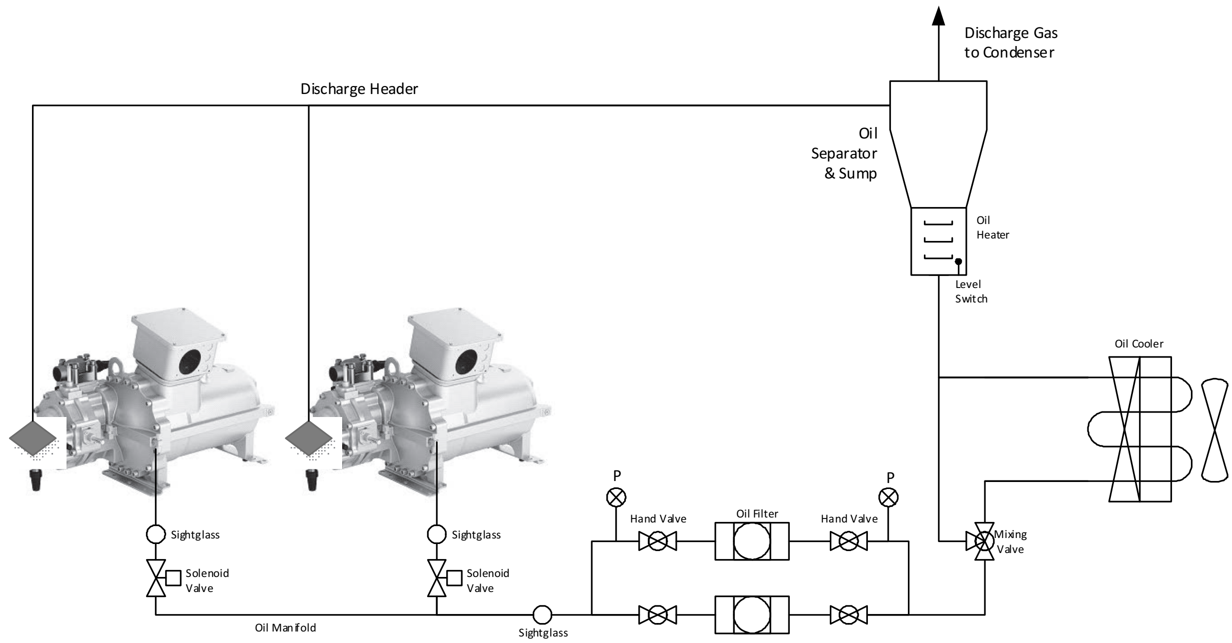
The heater must be energized during the system off cycle if used. This is required in all air conditioning systems and is recommended in refrigeration systems to keep refrigerant out of the oil sump during compressor off cycles. Carlyle typically recommends flexible heaters that are applied on the outside of the oil separator shells. Carlyle recommends 500W heaters for shells 12 inches and smaller and 100W for heaters larger than 12 inches. 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.

3.11 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.

3.12 Oil System Schematics

OIL SYSTEM SCHEMATIC



3.13 Oil Line Manifold Selection Table

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*
3	6 gpm	$^7/_8$	0.52	2.31	5.15*	8.76*
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*
3	22.8 l/min	$^7/_8$	1.18	5.23	11.6*5	19.81*
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

* 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.

NOTES:

1. Viscosity of 10 cSt is based on 130°F (54°C) oil with 10% refrigerant dilution.
2. 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.
3. Viscosity of 100 cSt is based on 100°F (38°C) oil, no refrigerant dilution.
4. Viscosity of 170 cSt is based on 100°F (38°C) oil, with no refrigerant dilution.

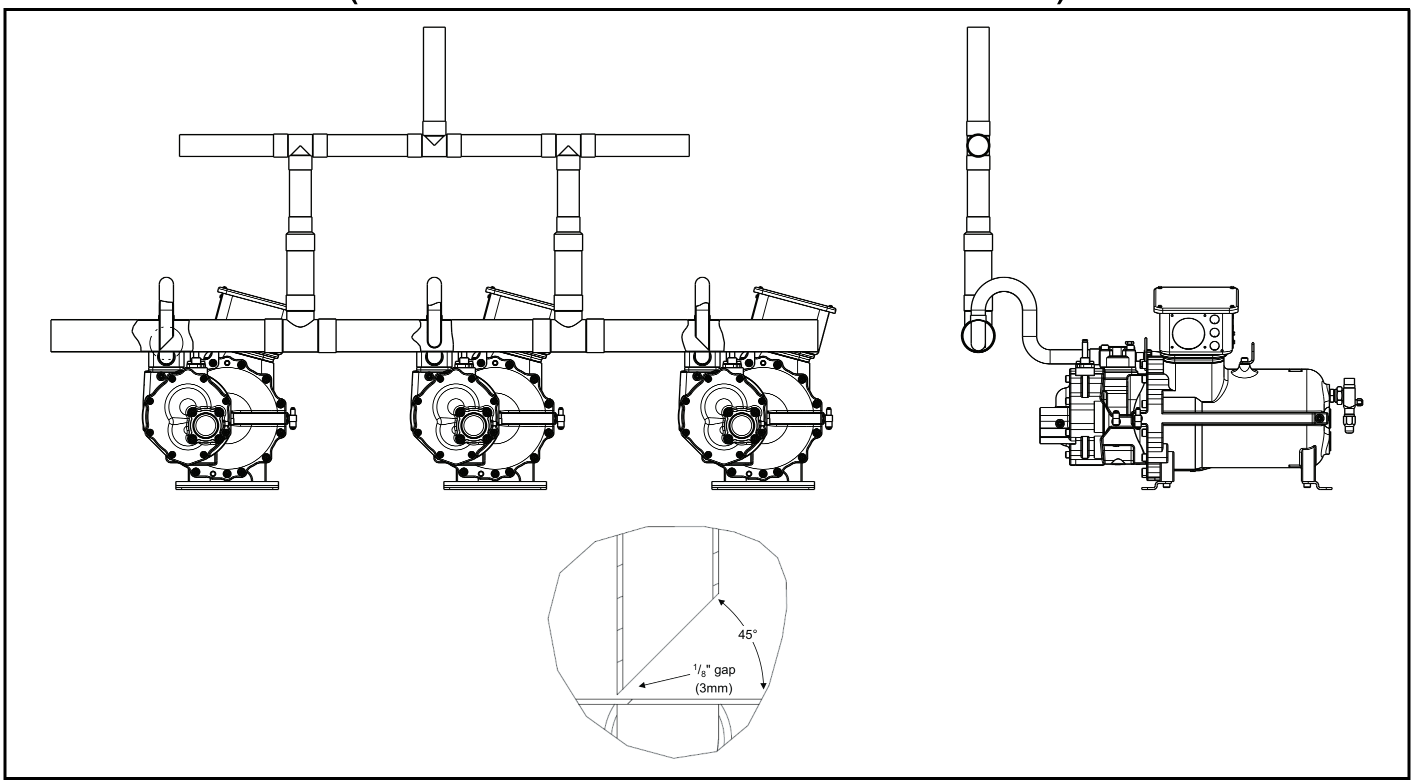
4.0 Refrigerant Management System

4.1 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.

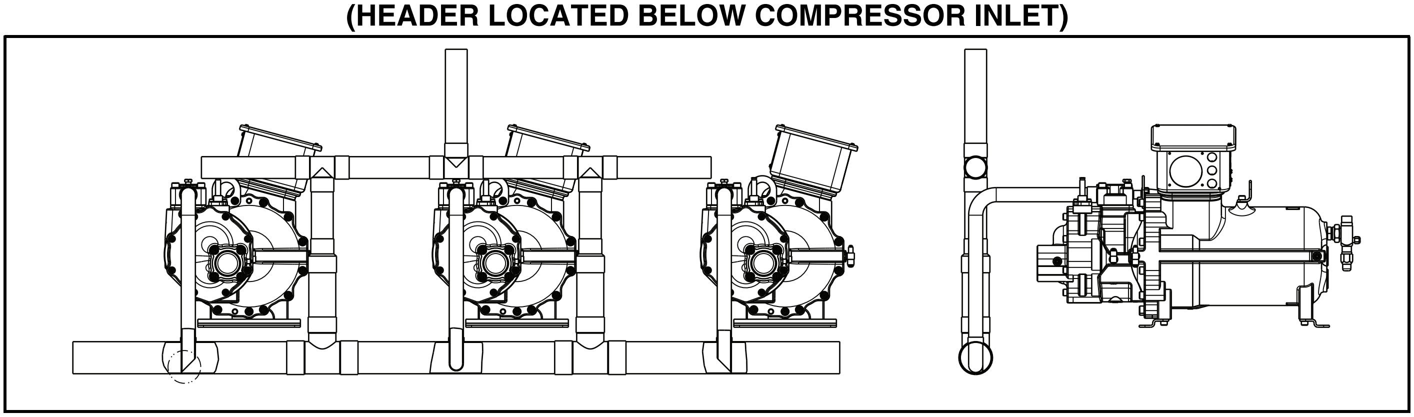
Steel refrigerant piping is not recommended for use with 05T/06T screw compressor applications. The contaminants associated with the steel pipe will overload the 3 micron filters used in the oil system increasing the chances of oil related compressor failures.

SUCTION AND INTERSTAGE HEADER SCHEMATIC (HEADER LOCATED ABOVE COMPRESSOR INLET)



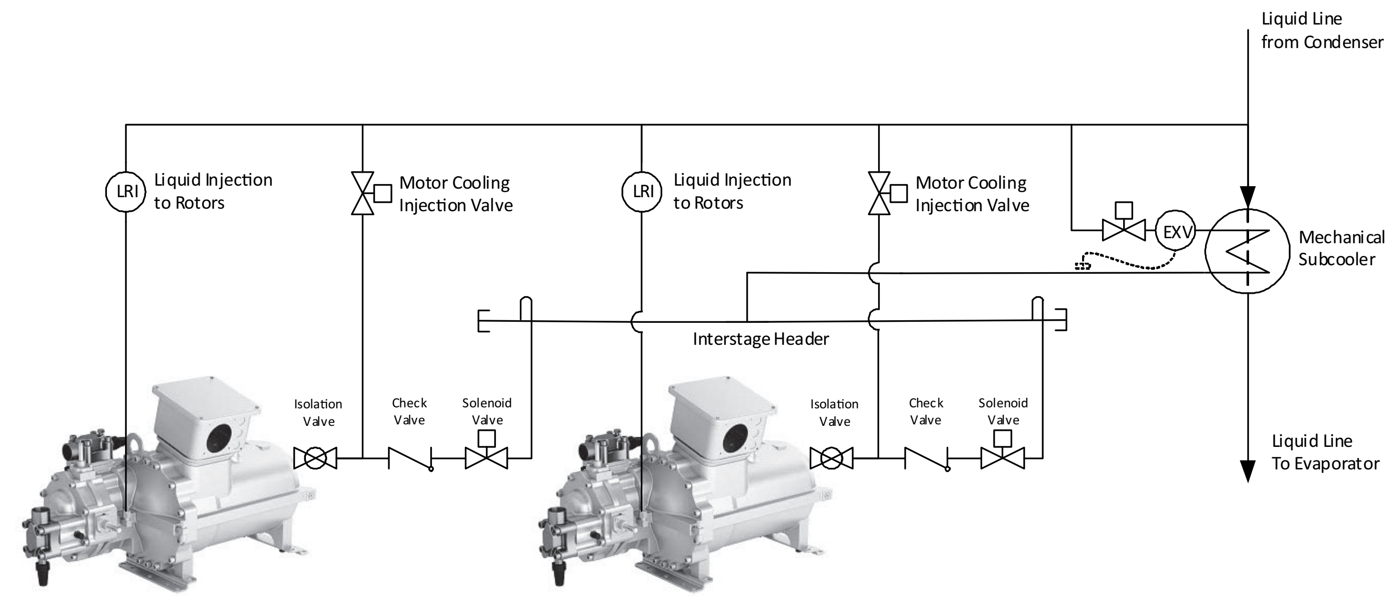
NOTE: If suction or interstage piping is to be located above the compressor the recommendations in the figure below also apply.

SUCTION AND INTERSTAGE HEADER SCHEMATIC (HEADER LOCATED BELOW COMPRESSOR INLET)



Mechanical subcooling via interstage manifolds are commonly applied with parallel 05T/06T rack designs. The gas exiting the subcooler 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.

INTERSTAGE SCHEMATIC WITH INJECTION TO MOTOR AND ROTORS



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.

5.0 Electrical Protection

5.1Thermal 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.

TEMPERATURE VS. RESISTANCE TABLE

TEMPERATURE		RESISTANCE
°C	°F	OHMS
0	32.0	16,352.4
1	33.8	15,515.2
2	35.6	14,750.0
3	37.4	14,027.1
4	39.2	13,343.8
5	41.0	12,697.8
6	42.8	12,086.3
7	44.6	11,508.0
8	46.4	10,960.8
9	48.2	10,442.6
10	50.0	9,951.8
11	51.8	9,486.8
12	53.6	9,046.3
13	55.4	8,628.7
14	57.2	8,232.5
15	59.0	7,857.0
16	60.8	7,500.6
17	62.6	7,126.3
18	64.4	6,841.3
19	66.2	6,526.4
20	68.0	6,526.8
21	69.8	5,971.6
22	71.6	5,710.0
23	73.4	5,461.3
24	75.2	5,225.0
25	77.0	5,000.0
26	78.8	4,786.0
27	80.6	4,582.4
28	82.4	4,338.5
29	84.2	4,203.9
30	86.0	4,028.0
31	87.8	3,860.5
32	89.6	3,700.8
33	91.4	3,548.5
34	93.2	3,403.5
35	95.0	3,265.1
36	96.8	3,133.1
37	98.6	3,007.1

TEMPERATURE		RESISTANCE
°C	°F	OHMS
38	100.4	886.9
39	102.2	2,772.1
40	104.0	2,662.4
41	105.8	2,557.8
42	107.6	2,457.7
43	109.4	2,362.1
44	111.2	2,270.8
45	113.0	2,183.45
46	114.8	2,099.93
47	116.6	2,020.04
48	118.4	1,943.6
49	120.2	1,870.5
50	122.0	1,800.49
51	123.8	1,733.46
52	125.6	1,669.66
53	127.4	1,607.81
54	129.2	1,548.95
55	131.0	1,492.54
56	132.8	1,438.46
57	134.6	1,386.62
58	136.4	1,336.93
59	138.2	1,289.26
60	140.0	1,243.53
61	141.8	1,199.7
62	143.6	1,157.59
63	145.4	1,117.18
64	147.2	1,078.37
65	149.0	1,041.15
66	150.8	1,005.38
67	152.6	971.03
68	154.4	938.02
69	156.2	906.3
70	158.0	875.81
71	159.8	846.5
72	161.6	818.31
73	163.4	791.21
74	165.2	765.14
75	167.0	740.06

TEMPERATURE		RESISTANCE
°C	°F	OHMS
76	168.8	715.93
77	170.6	692.68
78	172.4	670.34
79	174.2	648.82
80	176.0	628.09
81	177.8	608.11
82	179.6	588.88
83	181.4	570.36
84	183.2	552.5
85	185.0	535.29
86	186..8	518.7
87	188.6	502.7
88	190.4	487.28
89	192.2	474.4
90	194.0	458.06
91	195.8	444.2
92	197.6	430.85
93	199.4	417.96
94	201.2	405.51
95	203.0	393.49
96	204.8	381.89
97	206.6	370.69
98	208.4	359.87
99	210.2	349.41
100	212.0	339.32
101	213.8	329.55
102	215.6	320.12
103	217.4	311.0
104	219.2	302.18
105	221.0	293.65
106	222.8	285.41
107	224.6	277.43
108	226.4	269.72
109	228.2	262.26
110	230.0	255.03
111	231.8	248.04
112	233.6	241.28
113	235.4	234.72

TEMPERATURE		RESISTANCE
°C	°F	OHMS
114	237.2	228.38
115	239.0	222.24
116	240.8	216.29
117	242.6	210.53
118	244.4	204.95
119	246.2	199.54
120	248.0	194.3
121	249.8	189.22
122	251.6	184.3
123	253.4	178.5
124	255.2	174.89
125	257.0	170.41
126	258.8	166.06
127	260.6	161.83
128	262.4	157.74
129	266.0	153.77
130	267.8	149.91
131	269.6	146.17
132	271.4	142.54
133	273.2	139.02
134	275.0	136.6
135	276.8	132.27
136	278.6	129.04
137	280.4	125.91
138	285.8	122.87
139	287.6	119.91
140	289.4	117.04
141	281.2	114.25
142	287.6	111.54
143	289.4	108.9
144	291.2	106.34
145	293.0	103.86
146	294.8	101.43
147	296.6	99.074
148	298.4	95.785
149	300.2	94.559
150	302.0	92.393

5.2 Overcurrent Protection

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

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:
  a. Across-the-Line Start: Device must trip in 2 to 6 seconds
  b. Part Wind Start: Device must trip the first three connected legs in 2 to 6 seconds and the remaining three connected legs in 1 to 3 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.

For part wind start applications Carlyle recommends a 1 to 1.25 second time delay between energizing the first and second legs.

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.

5.3 Allowable Voltage Range

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

Model # 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

06TR LOW TEMP COMPRESSORS					06TA MED/HIGH TEMP COMPRESSORS			
COMPRESSOR MODEL	HP	MAXIMUM CONTINUOUS CURRENT	LOCKED ROTOR CURRENT	VOLTAGE	COMPRESSOR MODEL	HP	MAXIMUM CONTINUOUS CURRENT	LOCKED ROTOR CURRENT
06TRC033F2EA	15	90	286	208/230V-3-60Hz 200V-3-50Hz	**06TAD033F2EA**	20	104	348
06TRD039F2EA	20	104	348		**06TAE038F2EA**	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	460V-3-60Hz 400V-3-50Hz	**06TAD033B2EA**	20	49	173
06TRD039B2EA	20	49	173		**06TAE038B2EA**	25	64	215
06TRD044B2EA	20	49	173		**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	575V-3-60Hz	**06TAD033C2EA**	20	39	138
06TRD039C2EA	20	39	138		**06TAE038C2EA**	25	53	172
06TRD044C2EA	20	39	138		**06TAF044C2EA**	30	62	202
06TRE048C2EA	25	53	172		**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

6.0 Motor Temperature Control

6.1 Motor Cooling Control

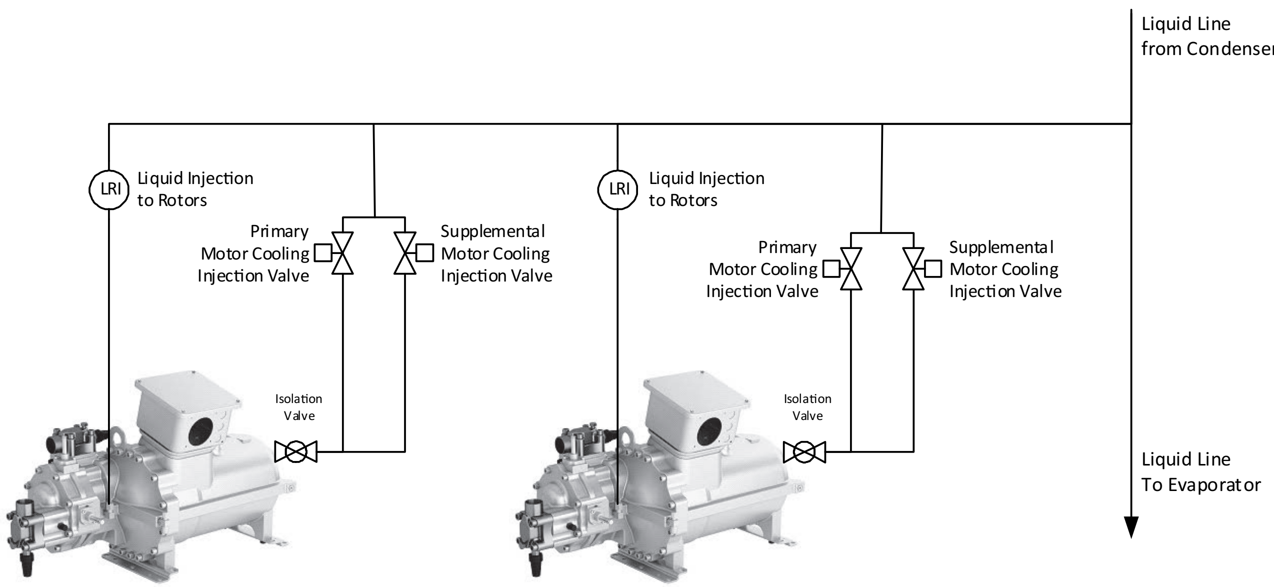
The motors in the 06T compressors are not located in the suction gas stream like other compressors. These motors require cooling to maintain reliable operation. Motor barrel insulation is recommended on compressors with suction temperatures below -15°F (-26°C) to prevent frost build-up on the compressor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

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 # 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 # EF28BZ007) should be installed to provide this additional cooling. This supplement valve can be controlled with the LonCEM module.



7.0 Compressor Selections and Performance Data

7.1 CARWIN Compressor Selection Software

The performance of the 06T/05T screw compressors can be estimated using the CARWIN compressor selection tool. CARWIN is a web-based application available at https://carwin.carlylecompressor.com

7.2 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.

NOTES:

NOTES:

Carlyle™

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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