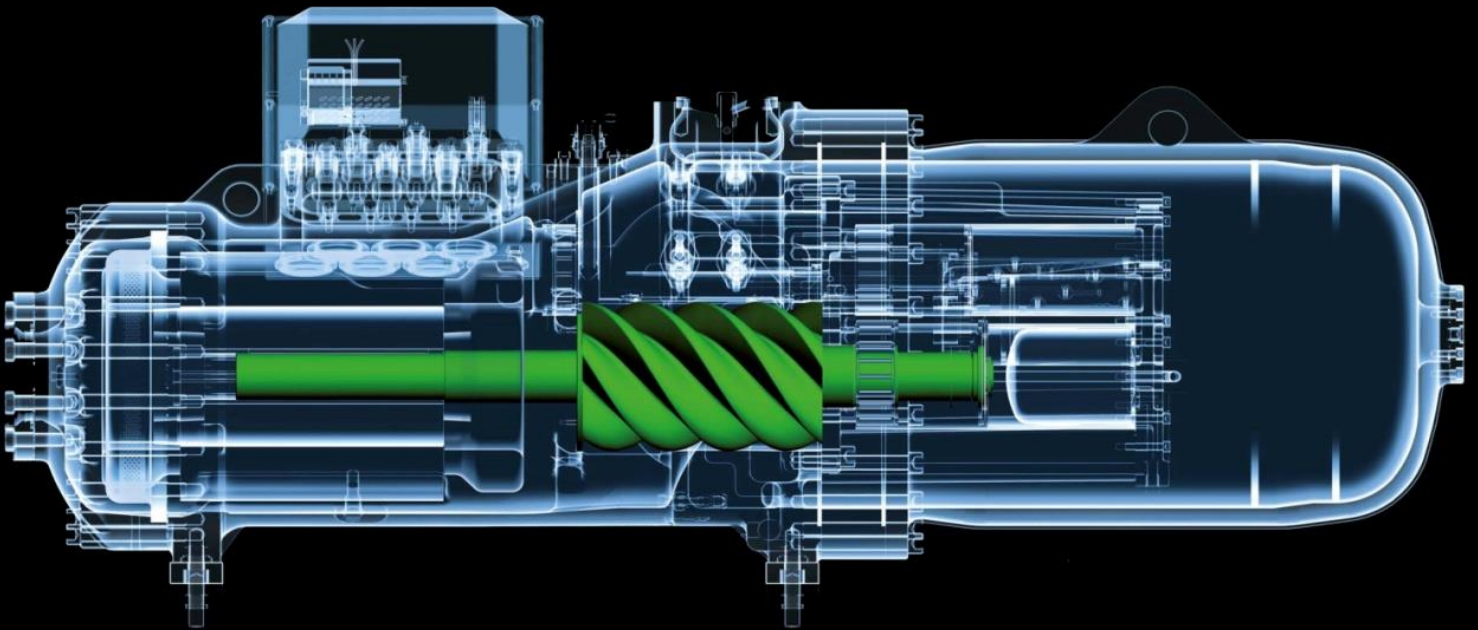
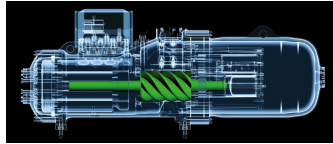


CS Screw Compressor Troubleshooting Guidelines

SG-0004-01 April 2014





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BITZER Screw Compressors CS High Temp Series
Troubleshooting Guidelines

The intention of this document is to serve as general guidelines. The information contained is not intended to replace specific equipment and/or system manufacturer's information or guidelines. BITZER implies no liability for the information contained. It is BITZER's implicit intention that nothing contained in this guide replaces any past, present or future warranty policy of BITZER and/or any other manufacturer's equipment


These guidelines are supplied as a recommended procedure for troubleshooting the CS screw compressor

These guidelines are not a replacement for information specific to that of the manufacturer or the manufacturer's system technical product information.

Each system may vary in design, usage and specifications. This document is intended for use specific to the compressor only and not intended to be a "catch all" for any and every possible application of the compressor.

BITZER's intention is that only qualified and certified (where applicable) individuals specific to the refrigeration industry use the information contained and all standard refrigeration handling and safety practices must be followed at all times.

BITZER's intention is that all electric work is performed by qualified and certified (where applicable) individuals and all standard electrical safety practices must be followed at all times.

WARNING
This icon indicates instructions to avoid personal injury and material damage 

CAUTION
This icon indicates instructions to avoid property damage and possible personal injury 

HIGH VOLTAGE
This icon indicates operations with a danger of electric shock 

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Section 1: General Information

1.1 Additional information can be found in the following publications:

- SH-170 Application Guidelines CSH.3 and CSW Series
- SH-170 Application Guidelines CSH.1 Series
- SB-170 Semi-Hermetic Compact Screw Compressor Operating Instructions
- ST-120 Standard Protection Devices for Screw Compressors
- ST-122 Electronic Module SE-E2 Technical Information
- TB-0016 Liquid Injection Oil Cooling Guidelines
- TB-0017 Oil Draining and Recharging for BITZER CS Compressors
- TB-0035 Replacing the Discharge Check Valve for BITZER Screw Compressors

1.2 Module Types:

The BITZER CS Screw compressors utilize a Standard Electronic Module of 2 types.

- Since 2003, the SE-E1 has been the standard module and are 110/220 dual voltage.
- An optional module, the SE-E2 is used for VFD and Soft Starter applications.
- The SE-E1 module is pre-wired inside the terminal box. The module monitors discharge gas / oil temperature via a PTC sensor. The module also monitors motor winding temperature via the motor sensors embedded into the motor windings which are wired in series and connected to the module. Phase sequence control for direction of rotation is also monitored and pre-wired to terminals 1, 2 and 3.
- Both modules require a manual reset. Module power must be interrupted to reset the relay.
- Prior to 2003, module type INT69VSY-II was used and is shown below.



Standard SE-E1



Optional SE-E2



Obsolete INT69VSY-II

Module Types Continued:

Technical Data for the SE-E1 and INT69VSY-II Modules:

PTC Thermistors	Oil Temperature PTC Sensor
Trips > 11.4 kohms (+/- 20%)	@ 60 to 100 ohms at 95°F ambient
Resets < 2.95 kohms (+/- 20%)	Trip temperature @ 251°F
Ambient Temperature Range	Relay (terminals 11 and 14)
-22°F to 158°F	Maximum inductive current 2.5 amps
PTC Motor Sensors	Maximum Motor Voltage Imbalance
@ 300-500 ohms at 95°F amb.	10% Phase to Phase
Trip temperature @ 212°F	Motor Voltage Frequency Range
	SE-E1 / 50-60Hz
	SE-E2 / 20-100Hz

1.3 Oil Type Requirements and Approved Oils:

Oil type requirements / Approved oils:

Verify the correct oil is used for the various approved refrigerant type.

For the CSH1 or CSH3 series:

- R22 = B320SH POE oil only.
- R134A, R407C, R507A and R404A = BSE170 oil only.

For the CSW series:

- R134A = BSE170L.
- R407C = BSE170.
- R22 = B320SH POE oil only.

Check the oil level at both full and reduced loads.

Proper oil level will be visible in the sight glass at all times while the compressor is in operation.

During start-up, the oil level may drop and foaming can occur. Foaming during start-up is normal and will disappear after the compressor operation becomes stable. If the foaming does not disappear after a few minutes of operation, this can be a symptom of excessive liquid refrigerant and should be corrected.

During shutdown, the oil level should also be visible.

1.4 Additional Oil Cooling via Liquid Injection:

Additional oil cooling via liquid injection.

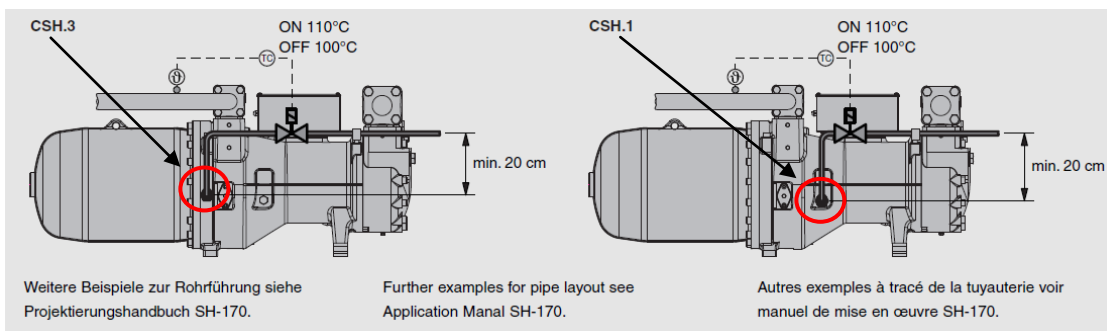
- Depending on the refrigerant and the operating parameters (high condensing and/or low evaporating temperatures), when the compressor is running reduced loads, additional liquid injection oil cooling should be used. If the discharge gas temperature is >230°F, liquid injection should be used.
- Contact Application Engineering for assistance to obtain the proper liquid injection oil cooling kits which can easily be installed on site.

Low Discharge Temperature:

- Low discharge gas temperature can result from very low superheat settings at the suction inlet and/or economizer inlet which causes liquid refrigerant to be introduced through-out the compression cycle.
- This can lead to premature bearing and mechanical wear as the liquid displaces the oil.
- Excessive foaming in the compressor sight glass is also a symptom of low superheat values.

Liquid Injection Oil Cooling Continued:

Piping layout when liquid injection oil cooling is used: Note the different locations between the CSH.1 and CSH.3



Section 2: Commissioning

2.1 CS Screw Compressor Operating and Temperature Recommendations:

BITZER CS Screw Compressor Operating Temperature Recommendations:

- Max discharge line temperature (outside) = 250°F.
- Min discharge line temperature (outside):
It must be ensured by sufficient suction superheat that the discharge gas temperature is at least: 54°F above condensing temp when using R22 and R407C and at least 36°F above condensing temperature for refrigerants R134A, R404A and R507A.
- Max oil temperature = 251°F.
When the discharge gas temperature is above 230°F, additional oil cooling should be used.
- Min suction superheat = 5°F.
- Maximum suction superheat = 35°F*
* Typical suction superheat = 12-14°F.

2.2 CS Screw Compressor Cycling Rates:

BITZER CS Screw Compressor Cycling Rates:

Number of starts per hour (relating to compressor/motor size):

- 35hp thru 90hp (CS65/75) = 6 starts per hour maximum.
- 110hp thru 300hp (CS85/95) = 4 starts per hour maximum.

2.3 Checks Before Starting:

Checks before starting:

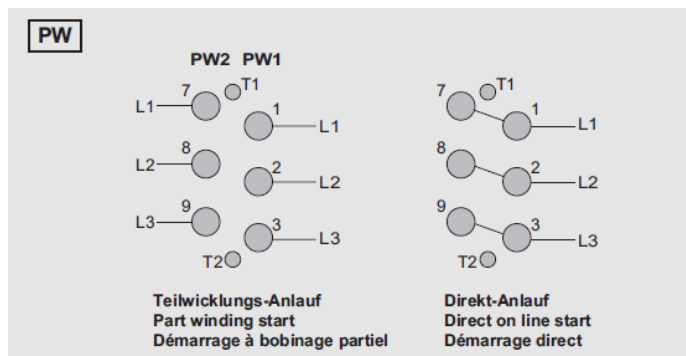
- Terminal lug nuts, bolts: After shipping, installation and prior to initial start-up, all terminal bolts and nuts should be checked for tightness.

- Ensure all safety switches are in their proper positions.
- All system and compressor safety features/devices have been checked and verified to be in the correct operational positions.
- Refrigerant charging: Never use the compressor to charge initial refrigerant to a system.
- Charge liquid refrigerant into the high side of the system (condenser – receiver) and ensure the liquid cannot feed back into the compressor while charging.
- Adding refrigerant after the initial charging process is completed or for topping off purposes, the vapor style of charging is preferred. If liquid refrigerant is charged, short periods of charging are acceptable however, maintain proper compressor superheat and oil levels.
- Check High and Low pressure switches and ensure they have been adjusted.
- Check all wiring connections inside of the terminal box.
- Visual safety checks of the compressor and system.
- Compressor oil level should be visible in the sight glass.
- Crankcase heater should be energized for @24 hours prior to initial start and the oil temperature measured at the crankcase should be 30°F above ambient.

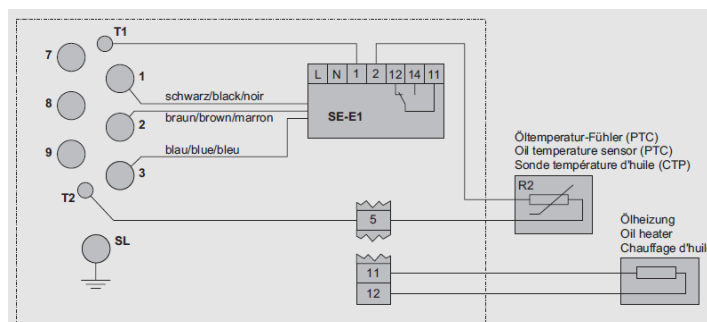
2.4 Electrical Connection:

Electrical Connection:

- Check voltage and frequency data on nameplate and ensure the system is the same.
- All wiring should be according to the instructions in the terminal box.
- Terminals T1-T2 and the PTC sensor wires should not come into contact with control voltage.
- For Part Winding Start set-up, the maximum switch over time is .5 seconds.



Example of terminal box wiring diagram inside of the terminal box:



2.5 Starting (Compressor):

Starting (Compressor):

Check the Direction of Rotation:

It is VERY important to ensure that screw compressors operate in the correct rotation.

- Screw compressors can only be operated in one direction of rotation; otherwise, substantial damage can occur.
- Connect a pressure gauge to the suction service valve and ensure the port is open with the service valve almost closed.
- BUMP START the compressor for approximately .5 to 1 second maximum.
- If the direction of rotation is correct, the suction pressure will drop immediately.
- A rise in suction pressure or a cutout of the electronic module will indicate a wrong direction of rotation. If this happens, change over two of the electrical phases at the terminals of the common supply line and check rotation again.
- After rotation is verified and correct, open the suction service valve to normal position.



3.0 Operating Parameters:

Operating Parameters.

Also Appendix A for a complete list of recommended readings:

Operating Parameters Continued:

3.0 Oil Level Check:

- The oil level should be visible in the sight glass at all times when the compressor is in operation. The level can vary slightly in the sight glass as the compressor loads and unloads.

3.1 Safety the High and Low Pressure Controls:

- These devices should be set in accordance with the application limits. They should be set based on specific system operating parameters.

3.2 Check and Record Operating Data:

- SST and suction superheat.
- SCT and liquid temperature.
- ECO and suction superheat if used.
- Discharge gas temperature.
- Oil temperature (taken at the crankcase).
- Current and voltage.

3.3 Setting of the Condenser Pressure Control:

- The setting must be made so that a minimum pressure differential of at least 70 psi is reached after 20 seconds from start between the suction and discharge pressure for proper oil lubrication and movement throughout the compressor.

Section 4: Maintenance and Repair

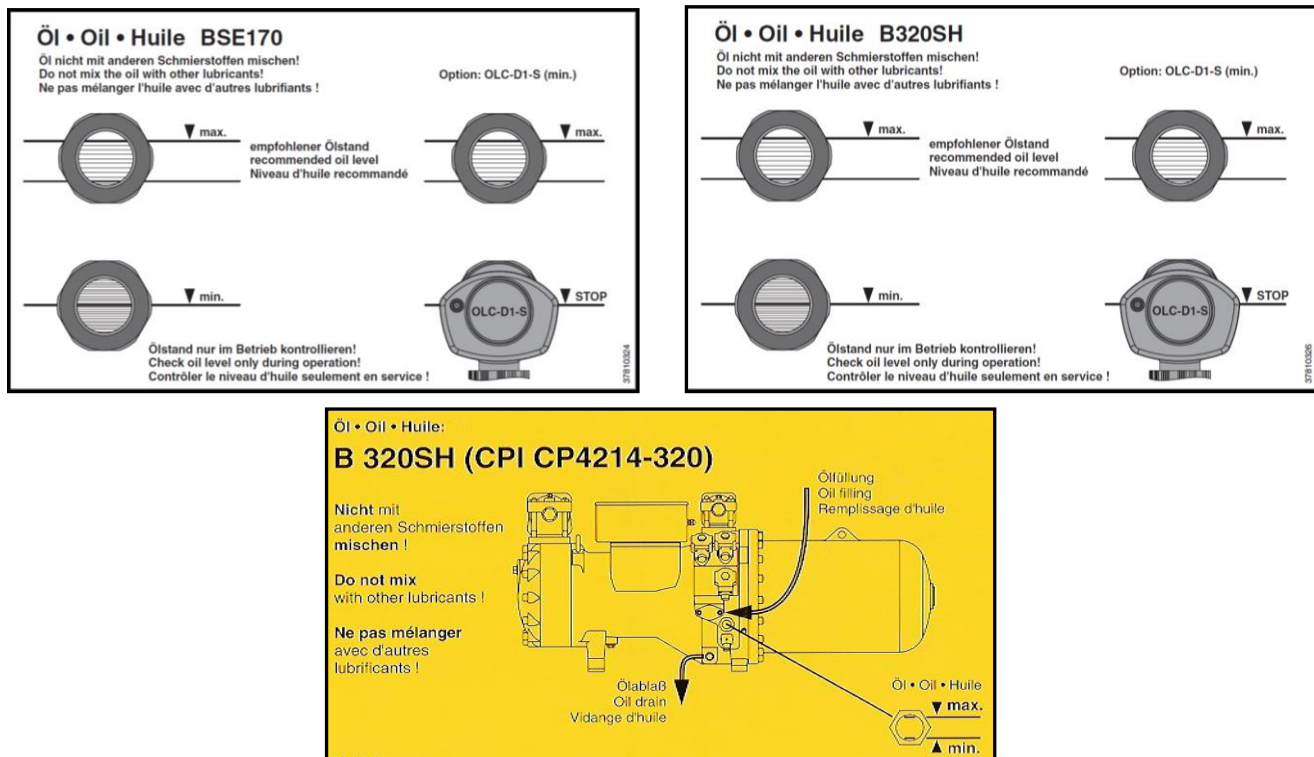
BITZER CS Screw Compressor Maintenance and Repair:

BITZER CS screw compressors do not have any internal valves and therefore are relatively maintenance free. However, the following points should be checked as planned maintenance:

4.1 Oil Supply:

- Annual oil checks and even oil analysis is recommended.
- If it becomes necessary to add or change oil, care must be taken because the oils used are very hygroscopic and should not remain open to the atmosphere for long periods of time.
- Additional information can be found in TB-0017 Oil Draining and Recharging Guidelines for BITZER CS screw compressors.

The examples below show actual oil labels supplied on each compressor:



4.2 Integrated Discharge Check Valve:

- Each screw compressor has an internal discharge check valve located under the discharge service valve.
- After shutdown, the compressor will spin backwards for a short period of time until the pressure in the oil separator and the suction side equalizes.
- If the check valve becomes dirty or faulty, the length of reverse rotation at shutdown will increase and the valve must be inspected and/or replaced.
- Further information can be found in TB-0035 Replacing the Discharge Check Valve.

4.3 Internal Oil Filter:

- Each screw compressor has a lifetime 10 micron oil filter. This filter requires no maintenance as it is an internal component of the compressor.

4.4 Crankcase Heater:

- The heaters are installed in a well and can be removed if replacement is required without isolating the refrigerant in the compressor.

4.5 Safety Devices:

- All safety devices including the low and high pressure cutout switches should be checked as per the manufacturer's recommendations.
- These screw compressors have an installed electronic module which requires no maintenance with the exception of checking for electrical terminal tightness on a yearly basis.

Section 5: Troubleshooting

5.1 Compressor Will Not Start or Run:



- *If a compressor fails to start and run properly, it is important that the compressor be checked to determine its condition. It is possible that "external electrical components" may be defective, the module has tripped, a safety device has tripped or other conditions which may be preventing the compressor from starting. If the compressor is not the source of the problem, replacing the compressor will only result in the unnecessary expenditure of time and money while the original problem still exists.*



- If there is no voltage at the compressor terminals, follow the compressor and/or system wiring diagrams and check back from the compressor to the power supply to find where the circuit is interrupted.
- Check all controls (low pressure, high pressure, thermostats, oil level switch if used, etc to see if the contact points are closed. Check all contacts.
- Check all fuses to ensure one is not blown, open dis-connects or loose connections.
- If voltage is available at the compressor terminals and the voltage is lower than 90% of rated voltage listed on the compressor nameplate voltage, it is possible the motor may not develop enough starting torque for the motor.
- Check to determine proper wire sizes are adequate, all electrical connections are tight, the circuit is not overloaded and/or the power supply is adequate.
- Inspect the Contactors.
- Check the electronic module inside the terminal box for proper connections per the wiring diagrams.
- If there are multiple compressors at the site with the same module, try switching the modules and see if the problem persists.

5.2 Compressor Starts but Immediately Trips the Module:

Compressor Starts But Immediately Trips on the Module:



- Checking the phase sequence. Bump start the compressor for approximately .5 to 1 second maximum to check rotation.
- If the rotation is correct, the suction will drop and the discharge pressure will rise.
- A rise in the suction pressure or a cut-out of the electronic module indicates a wrong direction of rotation.
- Change over two of the electrical phases at the terminals of the common supply line and repeat the process.
- Also review section "2.5" Check the direction of rotation.

Additional items to verify:

For part winding start systems:

- Ensure that PW1 and PW2 are correctly wired. L-1 should be phased (wired) with L-7, L-2 with L-8 and L-3 with L-9.
- Check the switch over timing from PW1 to PW2. The maximum switch over time should be .5 to a maximum of 1 second.

For direct on line start systems:

- Ensure the supplied jumper bars are installed between L-1 and 7, L-2 and 8, L-3 and 9. See wiring diagrams in electrical connection section.

5.2.1 Compressor Starts, Runs Briefly and then Shuts Down:

- If the compressor starts and shuts down after a normal fault due to temperature, each module has a general alarm output which can be checked across terminals 11 and 12.
- The trip point is @>11.5 kohms and resets @<2.95 kohms.
- Note: the power must be energized to the module to check resistance across 11 and 12 to verify terminals 11 and 14 are open.
- The motor winding trip temperature is >212°F while the oil-discharge gas temperature trip is >251°F.
- Excessive motor winding temperature is commonly caused by high return gas temperatures, low voltage or excessive reduced loads. If the module tripped due to these conditions, wait for the motor to cool. The module will allow the compressor to restart once sufficient temperature levels are reached. When restarted, check suction gas superheat and adjust to maintain a maximum of 20°F at 100% load and/or 25% minimum load, check for proper distribution of power across all 3 legs and check the suction pressure. Also check to verify that the compressor is not logged with liquid refrigerant. If the rotor housing is full of liquid refrigerant, the compressor may not be able to start, resulting in locked rotor conditions.
- Excessive discharge gas-oil temperature is commonly caused by high return gas temperatures, frequent start stops (in excess of 4-6 starts per hour depending on frame size), operation outside of the design envelope, lack of oil in the compressor, low refrigerant charge, excessive operation at reduced loads, poor oil quality and/or inadequate compressor cooling. If the module tripped on high discharge gas-oil temperature, the compressor will have to cool before it can be re-started. On restart, check the operating parameters to see if they are in the design specifications and make sure that the oil level in the sight glass is within view during steady state operation.

5.2.2 Compressor Starts but Trips Repeatedly on Overload or Breaker Protection:

- If possible, check the compressor suction and discharge pressures while the compressor is operating.
- Be sure the refrigerant is compatible with the compressor and the temperature range is within the limitations of the compressor.
- If pressures are excessive, check the condenser, remove non-condensables from the system, check / modify the system controls or take other action as may be necessary to avoid excessive operating pressures.
- An excessively low suction pressure may indicate a loss of charge or low evaporator load. Check controls and low pressure control settings.
- The CS compressor motors are refrigerant cooled and may not be getting enough cooling across the motor.
- Most systems will have pressure ports to aid in checking system pressures.
- Excessive temperatures on the suction and discharge lines may also indicate abnormal operating parameters.
- If possible, check the line voltage at the motor terminals while the compressor is running.



The voltage should be within 10% of the nameplate voltage rating. If outside these limits, the voltage supply must be brought within the acceptable range or a compressor with different electrical characteristics may have to be used.

Check the amperage while the compressor is in operation on each line. The values should be within 10% of the published data maximum for the existing operating conditions. High amperage can be caused by low voltage, high discharge pressure, high suction pressure, high oil levels and/or possible abnormal wear internally. Check amperage on all 3 or 6 legs depending on application (DOL or PWS). One or two high amperage legs can cause an unbalanced motor which can lead the motor to overheat.

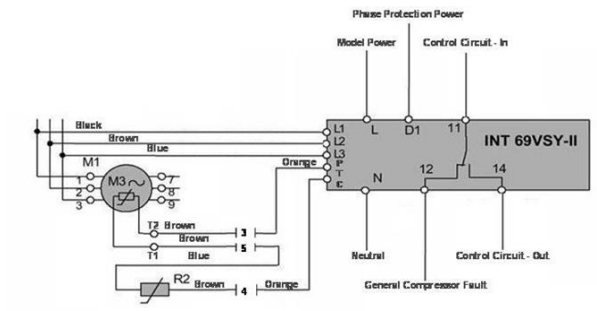
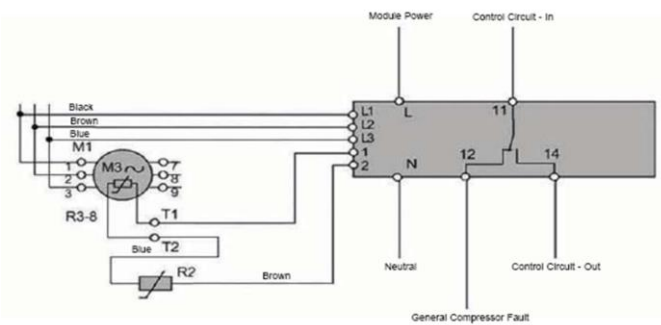
- Check all wiring as per the wiring diagram in the terminal box and/or the system diagrams.
- Ensure that jumper bars should be used (direct on line starting) or not to be used with PWS (part winding start) systems. Ensure they are tight, if used.

If all checks are within normal and acceptable ranges, the module may be weak or defective and should be replaced.

5.3 Checking the Module:

- To properly check the resistance values of the module components (motor winding sensors, discharge gas temperature sensor), each item should be disconnected and checked at ambient temperatures.
- To check the motor winding PTC sensor values between T1 and T2, unplug each brown wire and place meter across the two terminals and compare to values shown in section B Module types.
- The temperature sensor is located near the oil sight glass in the compressor crankcase on models from @2003 to present. Models older than 2003, the sensor is located near the discharge service valve area. The sensor will trip when the temperature exceeds 251°F which is @11.4 kohms. To check the values of the discharge gas and oil temperature sensor, disconnect the respective leads (blue and brown) inside the terminal box from the connection inputs per the wiring instructions and compare to values shown in section B Module types.
- Note: When checking the module to verify the relay has tripped, caution must be exercised when the module power is energized when checking across terminals 11 and 12.

Below are examples of the module wiring:



5.4 Compressor is Noisy During Start-up and then Returns to Normal Sound:

- This is an indication of liquid refrigerant existing in the compressor before starting.
- Refrigerant returning to the compressor during off cycles will also lead to a flooded start condition.
- Determine the source of refrigerant entering the compressor. Possible checks should include the expansion and/or solenoid valve for not closing at shutdown.
- If the compressor has liquid injection oil cooling and depending on the type of valve used, if the compressor was “injecting” at normal shutdown and the liquid line solenoid valve (required and highly recommended to prevent this) is faulty, then liquid will enter the compressor through the eco port on the CSH.1 series or the liquid injection port on the CSH.3 series even during the off cycle.
- If the compressor has liquid injection oil cooling, the liquid supply must have a solenoid valve to “close off” the liquid supply to prevent liquid from entering the compressor when not required.
- Another symptom of liquid refrigerant is present in the compressor is possible tripping on the motor overloads (depending on the actual set points) due to periods of excessive torque.
- The installed crankcase heater must be energized whenever the compressor is off or idle. The heater is designed to aid and/or help in boiling off small amounts or minor amounts of refrigerant in the crankcase.
- If the circuit has a pumpdown cycle, check to ensure this is operating correctly. Note, the pumpdown should not be allowed to pull-down less than 5 psi.

5.5 During Shutdown, the Compressor Spins in Reverse:

- Each compressor has an internal discharge check valve. This valve prevents refrigerant from entering the compressor through the discharge during shutdown and/or idle conditions.
- When the compressor shuts down, the rotors will spin in reverse until the internal pressures equalized. This is normal.
- The rotors will spin in reverse for around 3 seconds. If the rotors spin longer than 3-5 seconds, the discharge check valve may be dirty, worn or possibly faulty and must be inspected and/or replaced.

5.6 Compressor is Noisy While in Operation:

- This is an indication of liquid refrigerant in the compressor.
- Check the superheat values at both the compressor suction side and the eco inlet if used. The recommended superheat values are 5°F minimum to 20°F maximum at both full load and minimum load.
- If the compressor has liquid injection oil cooling, verify that the compressor is not flooding at this connection. Check the expansion device and the solenoid valve in this circuit to ensure they are not leaking and/or defective.

5.7 Compressor Runs but does not Refrigerate:

- Check the refrigerant charge and operating pressures. Any abnormal operating conditions must be corrected.
- If the suction pressure is high and the evaporator and condenser are functioning normally, check the compressor amperage draw. An amperage draw within 5% of published rating data, corrected for actual measure voltage, indicates normal compressor operation. An amperage draw considerably above published rating data for the given operating pressures indicates possible compressor mechanical wear and the compressor should be considered for inspection.
- Using the BITZER software available on line at www.bitzerus.com and inputting your suction and discharge pressures will show the expected amperages.

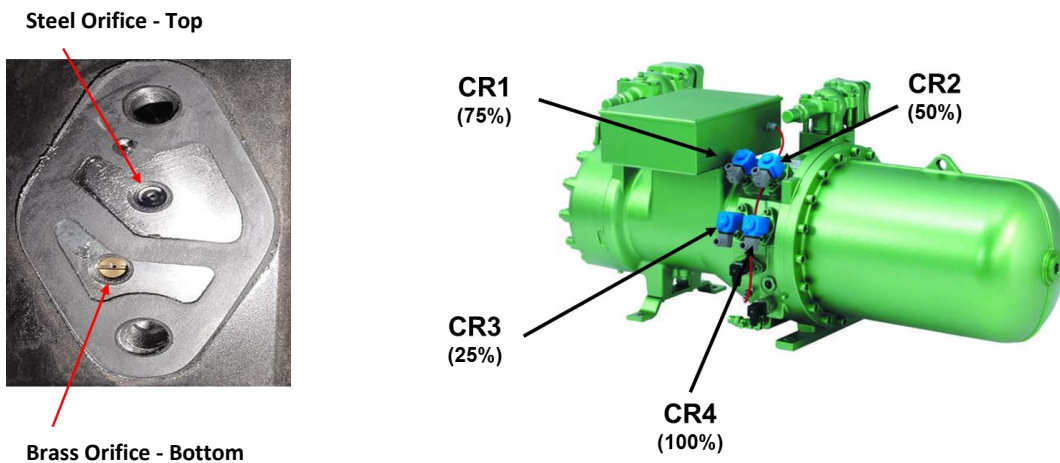
5.8 Compressor will not Load or Unload:

After verifying that all controller, relays, pulse timing, wiring, etc. are within system design parameters and no problems are found, the following steps can be used to verify that the slide valve is operating correctly.

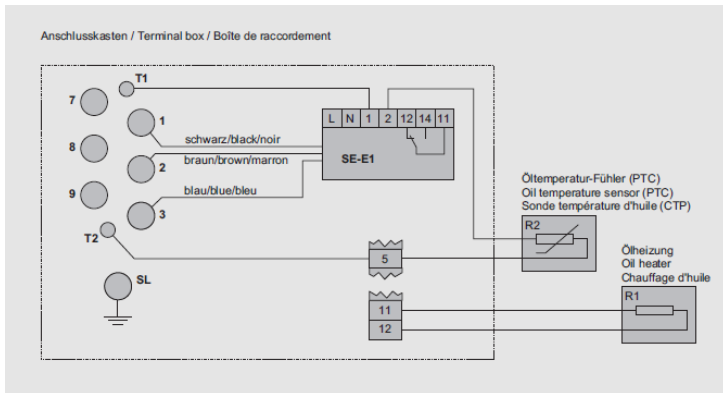
- Ensure that all coils are actually being energized to operate the solenoids as per the proper capacity control set-up.
- #4 solenoid is the maximum or 100%. #3 solenoid is the minimum or 25% solenoid.
- Ensure that the pulse timing is correct per the designed parameters. The BITZER screw compressors have “automatic start unloading”. The slide valve will automatically move to minimum during the off cycle or while in operation due to a spring located on the slide valve piston with no coil energized. The actual “on” time of #4 coil may not be long enough which can actually have no effect in moving the slide valve towards loaded even though there is a pulse to this solenoid. The “off” time of #4 may also be affecting the slide valve from moving. Remove the coil and visually inspect the solenoid stem to ensure it is not deformed which will prevent the plunger from operating correctly.
- If all checks are normal, then #4 solenoid may have to be removed to inspect the orifices underneath. These orifices control the actual time of travel for the slide valve.

After ensuring all electrical power is off to the compressor and the compressor has had the refrigerant removed following standard field practices, #4 coil can be removed to inspect the orifices.

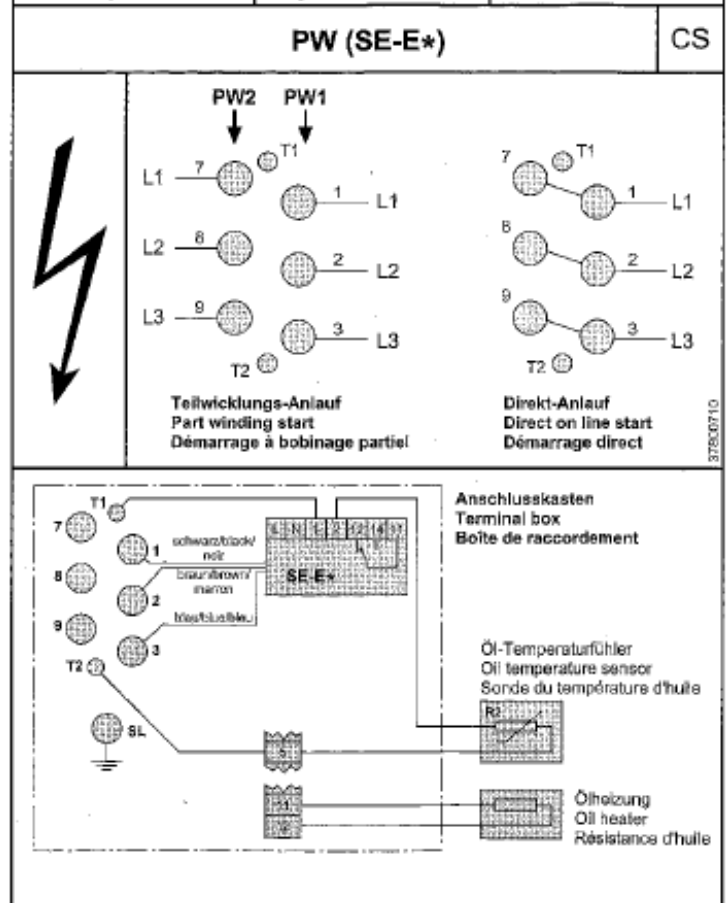
- Remove the (2) M8 bolts connecting the 2 bolt flanged solenoid on the compressor of #4 solenoid.
- Once removed, visually inspect to ensure no debris is "blocking" the orifice.
- Ensure the orifices are "tight" against the surfaces by checking for tightness. The orifices can also be removed to inspect for any debris that may be blocking the orifice. Use a metric allen wrench and/or a flat tip screwdriver.
- Re-assemble the compressor and follow standard procedures to vacuum and re-start the compressor
- There are no orifices located under #1, #2 or #3 solenoids. Only #4 has the orifices.



Section 6: Terminal Box Wiring Diagram:



<p>Verdichter ist mit elektronischer Schutzeinrichtung ausgerüstet!</p> <ul style="list-style-type: none"> Elektrischen Anschluss gemäß Schaltbild vornehmen. Beim Auslösen des Schutzgerätes liegen Überlastung, falsche Drehrichtung oder unzulässige Betriebsbedingungen vor: Ursache ermitteln und beseitigen! <p>Achtung! Klammern 1, 2, 5, T1 und T2 dürfen nicht mit Steuer- oder Betriebsspannung in Berührung kommen!</p>	<p>Compressor is equipped with electronic protection device!</p> <ul style="list-style-type: none"> The electrical connections should be made according to the wiring diagram. When the protection device cuts out, this indicates either an overload, wrong rotating direction or unpermissible operating conditions: Determine the source of the problem and correct it! <p>Attention! Terminals 1, 2, 5, T1 and T2 must not come into contact with supply or control voltage!</p>	<p>Le compresseur est équipé d'une protection électronique!</p> <ul style="list-style-type: none"> Réaliser le câblage électrique conformément au schéma de connexions. Lors de la mise à l'arrêt du dispositif de protection il y a des surcharges, faux sens de rotation ou des conditions d'exploitation inadmissibles: Déterminer la cause et y remédier ! <p>Attention ! Les bornes 1, 2, 5, T1 et T2 ne doivent pas venir en contact avec la tension de commande ou d'alimentation!</p>
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Appendix A: Screw Compressor Measurements Data.

Test Measurement Report for Screw Compressors CF-0017-01

Location: _____

System/Application Description. (Chiller, heat pump, etc): _____

Customer: _____

Date _____

Technician: _____

Refrigerant: _____ Oil Type: _____

Open Drive Only: Motor size (HP): _____

Compressor RPM: _____

Date / Time		Comp 1	Comp 2	Comp 3
Compressor, Serial No.				
Compressor, Model No.				
Compressor capacity	100/75/50?			
Rack # / Suct Grp # / Comp #				
Ambient Temp	°F			
Suction Pressure	psig			
Suction Line Temperature *	°F			
Discharge Pressure	psig			
Discharge line Temperature*	°F			
Oil Level (full/ part)	psig			
Oil Temp @ Oil Cooler	°F			
Oil Temp @ compressor Inlet	°F			
Economizer?	y/n			
Eco Pressure	psig			
Liquid injection	y/n			
Liquid Temp leaving subcooler	°F			
Eco Temp (@ compressor)	°F			
Voltage (note if any leg is diff)	V	/ /	/ /	/ /
Amperage Draw (note diff legs)	A	/ /	/ /	/ /
Total Running Hrs (or install date)	hr			
Cycles per hours (average)	#/hr			
Condenser (air or water)				
Liquid Temperature	°F			
Cooling Medium inlet Temp.	°F			
Cooling Medium outlet Temp.	°F			
Condenser Outlet Pressure	psig			
Evaporator (air/water/fluid)				
Sight Glass, Bubbles	y/n			
Liquid Temperature	°F			
Evaporator Outlet Pressure	psig			
Sat. Evaporating Temperature	°F			
Evap Outlet Gas Temperature	°F			
Medium inlet Temp.	°F			
Chilled Medium, outlet Temp.	°F			

Notes:

Please fill out as much information as possible. Attach any other notes that are relevant.

Use thermocouples if possible. Infrared is not considered as reliable for temperature measurements.

*Measure at compressor, ideally within 1' from compressor.