

Operating instructions

Refrigeration screw compressor
SR, SR-H, BSR



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Translation of the original operating instructions!

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1 General

1.1 Information regarding the operating instructions

These operating instructions provide important information on how to deal with the machine. A precondition for safe operation is the observance of all specified safety and handling instructions.

Furthermore, all statutory provisions, local accident prevention regulations and general safety regulations valid for the application area of the machine must be observed.

Carefully read the operating instructions before starting any work! It is a product component and must be kept in direct proximity of the machine, well accessible to the personnel at all times.

When passing the machine on to third parties, the operating instructions must also be handed over.

General

1.2 Pictogram explanation

Warning notes

Warning notes are characterised by pictograms in these operating instructions. The warning notes are marked by signal words expressing the extent of the hazard.

It is absolutely essential to observe the notes and to proceed with caution in order to prevent accidents as well as bodily injuries and property damage.



DANGER!

... points to an immediately dangerous situation, which can lead to death or serious injuries if it is not avoided.



WARNING!

... points to a potentially dangerous situation, which can lead to death or serious injuries if it is not avoided.



ATTENTION!

... points to a potentially dangerous situation, which can lead to minor or light injuries if it is not avoided.



CAUTION!

... points to a potentially dangerous situation, which may lead to property damage if it is not avoided.

Hints and recommendations



NOTE!

... highlights useful hints and recommendations as well as information for an efficient and trouble-free operation.

1.3 Limitation of Liability

All specifications and notes in these operating instructions were compiled with consideration to the valid standards and regulations, the state of the art as well as to our long-standing knowledge and experience.

The manufacturer is not liable for damages caused by:

- Non-observance of the operating instructions
- Improper use
- Deployment of non-trained personnel
- Arbitrary modifications
- Technical changes
- Use of non-approved spare and wear parts

The actual scope of supply may differ from the explanations and illustrations described in this manual in case of special designs, if additional order options are made use of, or due to latest technical changes.

Incidentally, the responsibilities agreed upon in the delivery contract, the general terms and conditions as well as the manufacturer's conditions of delivery and the statutory provisions valid at the time of contract conclusion shall apply.

Warranty

The manufacturer guarantees the correct functioning of the applied process technology and the performance parameters identified.

The warranty period commences on the date the machine is delivered to the customer.

Components are exempted from the warranty and from claims for defects as far as wear and tear damage is concerned.

1.4 Copyright protection

Surrendering the operating instructions to third parties without written permission of the manufacturer is not permitted.



NOTE!

Content details, texts, drawings, pictures and other illustrations are protected by copyright and are subject to industrial property rights. Any improper use shall be liable to prosecution.

Any type and form of duplication – also of extracts – as well as the exploitation and/or communication of the contents are not permitted without the manufacturer's written declaration of consent.

General

1.5 Spare Parts



WARNING!

Risk of injury by incorrect spare parts!

Incorrect or defective spare parts can result in damage, malfunctions or total failure and also impair safety.

Therefore:

- Use only the manufacturer's original spare parts.

Procure spare parts from authorised dealers or directly from the manufacturer. Refer to page 2 for address.

1.6 Warranty conditions

Warranty conditions, see "General delivery and payment conditions".

1.7 Customer Service

Our customer service can be contacted for any technical advice. Information about the responsible contact person can be retrieved by telephone, fax, E-mail or via the Internet at any time, refer to manufacturer's address on page 2.

2 Safety

2.1 Intended use

The machine is only intended for compressing filtered refrigerant gas according to specifications. The machine has been developed for installation into cooling systems.

Only use machine for the intended use.

All specifications in the operating instructions must be strictly adhered to (technical data, operating data, permissible working range), refer to chapter 10 in this regard.

All types of claims due to damage arising from improper use are excluded. The operator alone shall be responsible for any damage arising from improper use.

2.2 Acceptance and monitoring

The machine was produced according to the requirements for the CE & PD-marking. Any local acceptance and monitoring provisions are not considered - unless expressly agreed.

2.3 Operator's responsibility

The machine is used for industrial purposes.

The operator of the machine is therefore subject to the legal obligations concerning operational safety.

The provisions valid at the place of installation as well as the safety and accident prevention regulations of the Institution for statutory accident insurance and prevention must be observed. The operator must in particular:

- inform himself on the valid industrial safety regulations.
- determine the additional hazards that arise from the special working conditions at the machine's place of installation by means of a hazard assessment.
- implement the necessary rules of conduct for operation of the machine at the place of installation by means of user instructions.
- check at regular intervals during the machine's entire period of use whether the user instructions correspond to the current state of the body of rules and regulations.
- adapt the operating instructions – if necessary – to the new regulations, standards, and operating conditions.
- clearly regulate the responsibilities for installing, operating, maintaining and cleaning the machine.

Safety

- ensure that all employees working on or with the machine have read and understood the operating instructions. In addition he must at regular intervals train the employees in how to deal with the machine and inform them about potential hazards.

In addition, it is the operator's responsibility to ensure that:

- the machine is always in a technically perfect condition.
- the machine is maintained in accordance with specified maintenance intervals.
- all safety devices are regularly examined for completeness and operability.

2.4 Operating personnel

2.4.1 Requirements



WARNING!

Risk of injury in case of inadequate qualification!

Improper handling can lead to considerable bodily injuries and property damage.

Therefore:

- Have any activities only carried out by the individuals designated for that purpose.

The operating instructions specify the following qualification requirements for the different fields of activity:

- **Instructed persons**
have been instructed during instructions provided by the operator with regard to the work assigned to them and possible hazards arising from improper conduct.
- **Specialised staff**
is due to its technical training, knowledge and experience as well as due to its knowledge of the pertinent regulations able to carry out the work assigned to it and to independently recognise potential hazards.

2.5 Personal protective equipment

When handling the machine, it is necessary to wear personal protective equipment, in order to minimise health hazards.

- Before carrying out any work, properly don the necessary protective equipment such as gloves, safety goggles and safety mask if required and wear during work.

Ensure sufficient ventilation! The locally applicable safety provisions must be applied, e.g. UVV VBG 20.

2.6 Occupational safety and special risks

The remaining risks that result from the hazard analysis are specified in the following section.

Observe the safety notes listed here and the warning notes in the other chapters of these instructions to reduce health hazards and to avoid dangerous situations.

Danger pictograms on the device

The relevant dangerous spots on the machine are identified by these pictograms:



DANGER!

General danger pictogram!

- ... denotes general dangerous situations for individuals. Non-observance of the safety instructions can result in severe injuries or death.



DANGER!

Danger of burns!

- ... denotes the presence of a hot or very cold surface.

Safety

Hazard notes and occupational safety

For your own safety and that of the machine, the following information must be observed and complied with:

Improper operation



DANGER!



Danger due to improper operation!

- Only use machine in a perfect technical condition. Malfunctions that are relevant for safety have to be promptly eliminated.
- Conversions of the machine are not permissible and can impair safety.
- Before carrying out regular maintenance, cleaning and repair work, switch off power supply and secure machine against restarting (switch off drives).
- Never bridge any safety equipment or put it out of operation.
- Any work on the machine and/or on electrical equipment must be carried out by specialised staff.
- Repair and maintenance work may only be carried out when the machine is stationary. Secure the machine against restarting.
- The machine may not be under pressure or in a state of vacuum while work is being carried out on it. Ensure that there is ambient pressure in the machine.
- The drive's protective equipment may only be removed when the machine is stationary and has to be correctly refitted after completion of work.
- Only dismantle accidental contact protection after machine and pressure pipe have cooled down.
- It is an environmental protection requirement that any liquids and gases arising during maintenance work (e.g. oil and coolant) must be collected and disposed of in an environmentally compatible manner.

Moving components**WARNING!****Risk of injury by moving components!**

Powered rotating components can cause the most serious injuries!

Therefore during operation:

- It is absolutely forbidden for individuals to stay in the hazard area or in the immediate vicinity!
- Do not put safety devices and/or functions out of operation and do not render them inoperative or bypass them.
- Never reach into open outlets and inlets or into running equipment.

Before entering the hazard area:

- Switch off power supply and secure against restarting.
- Wait for standstill of lagging components.
- Wait for automatic dissipation and/or discharge of residual energies (compressed gas/pressure balance).

Compressed gas**WARNING!****Risk of injury due to compressed gas!**

Pneumatic energies can cause the most serious injuries.

In case of damage to individual components, refrigerant gas can be discharged under high pressure and injure e.g. the eyes. Therefore:

- Before starting any work, first depressurise pressurised components. Pay attention to accumulators. Accumulator pressure must also be completely relieved.

Signposting**WARNING!****Risk of injury due to illegible pictograms!**

Labels and signs can become dirty or unrecognisable in the course of time.

Therefore:

- Always keep safety, warning and operating instructions in a well legible condition.
- Immediately replace damaged or obliterated signs or labels.

Safety

Improper transport



Danger!

Danger by falling down or tilting of the machine!

The weight of the machine may injure a person and cause serious bruising!

Therefore:

- Depending on the dead weight and size of the machine, use a pallet on which the machine can be moved by means of a fork lift.
- For lifting the machine, use suitable lifting gear (slings, etc.) that is designed for the weight of the machine.
- When putting the slings in position, take care to avoid putting stress on individual components.
- Only use attachment points with eye bolts provided for that purpose.

Start-up, operation



WARNING!

Risk of injury due to improper start-up and operation

Improper start-up and operation can lead to serious bodily injuries or property damage. Therefore:

- Have all work during initial operation exclusively performed by the manufacturer's employees or by his authorized representatives or by trained personnel.
- Start-up and operation may only be performed by adequately qualified personnel who have been authorized and instructed by the operator.
- Check compression system for tightness before initial commissioning.
- Before the start of any work, ensure that all covers and protective devices are correctly installed and function correctly.
- Never override any protective equipment during operation.
- Pay attention to tidiness and cleanliness in the working area! Loosely stacked or scattered components and tools are accident sources.

Maintenance and troubleshooting**WARNING!****Risk of injury due to improper maintenance and troubleshooting!**

Improper maintenance and troubleshooting can lead to serious bodily injuries or property damage. Therefore:

- Maintenance work and troubleshooting work may only be carried out by sufficiently qualified and instructed personnel.
- Secure machine against restarting, switch off drives!
- Before starting any work, provide for sufficient space and freedom of movement during assembly.
- Pay attention to tidiness and cleanliness in the assembly area! Loosely stacked or scattered components and tools are accident sources.

If components must be replaced:

- Pay attention to correct installation of spare parts.
- Properly reassemble all fastening elements.
- Observe screw tightening torques.
- Check compression system for tightness before re-commissioning.
- Before restarting, ensure that all covers and protective devices are correctly installed and function correctly.
- After completion of maintenance work and troubleshooting, check correct functioning of safety equipment.

Design and function

3 Design and function

3.1 Design

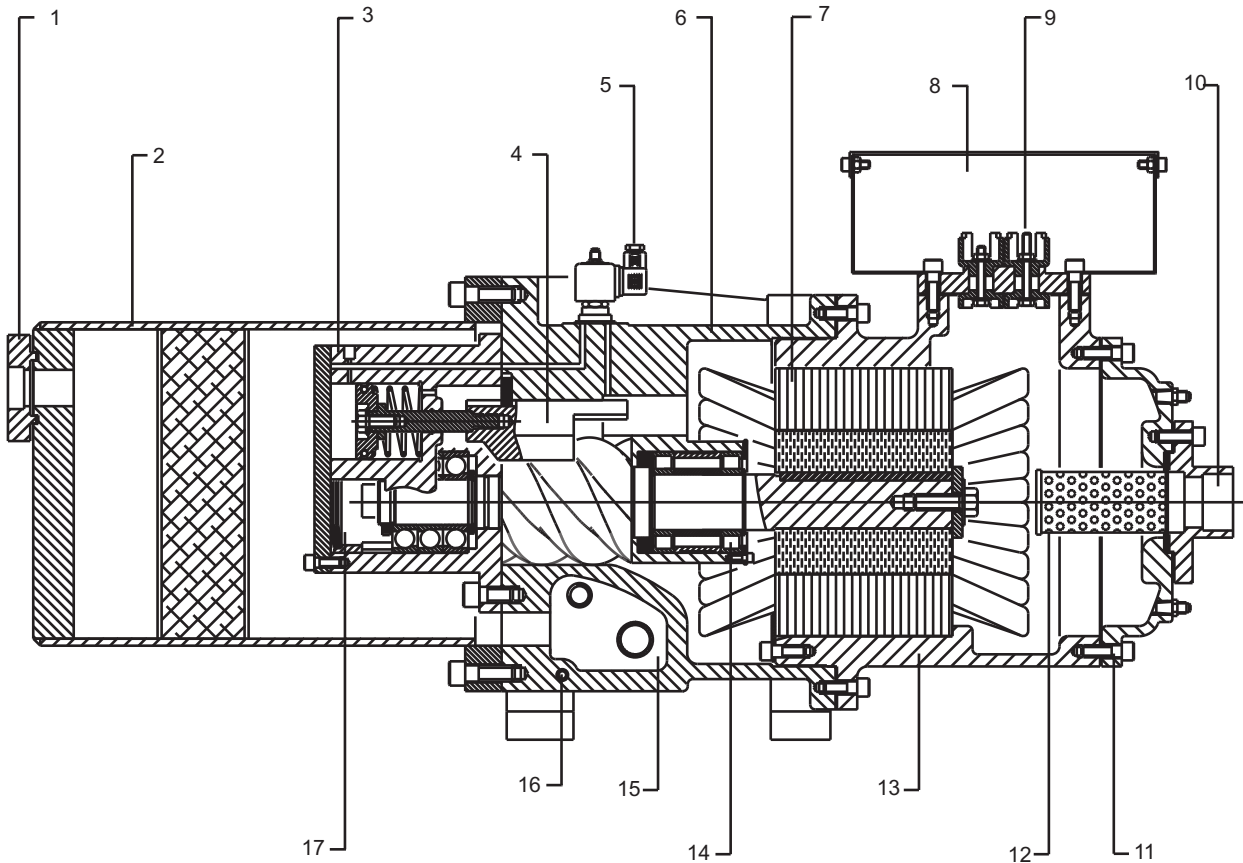


Fig. 1: Compressor structure for SR series

- | | | |
|-------------------------------|---|-------------------------------|
| 1. Discharge flange | 8. Cable box | 13. Motor housing |
| 2. Oil separator | 9. Motor connection and thermistor assembly | 14. Bearings - suction side |
| 3. Adjustment cylinder | 10. Suction flange | 15. Oil indicator |
| 4. Control slider | 11. Motor front cover | 16. Heating |
| 5. Modulation solenoid valve | 12. Suction filter | 17. Bearings – discharge side |
| 6. Compressor casing | | |
| 7. Motor stator / motor rotor | | |

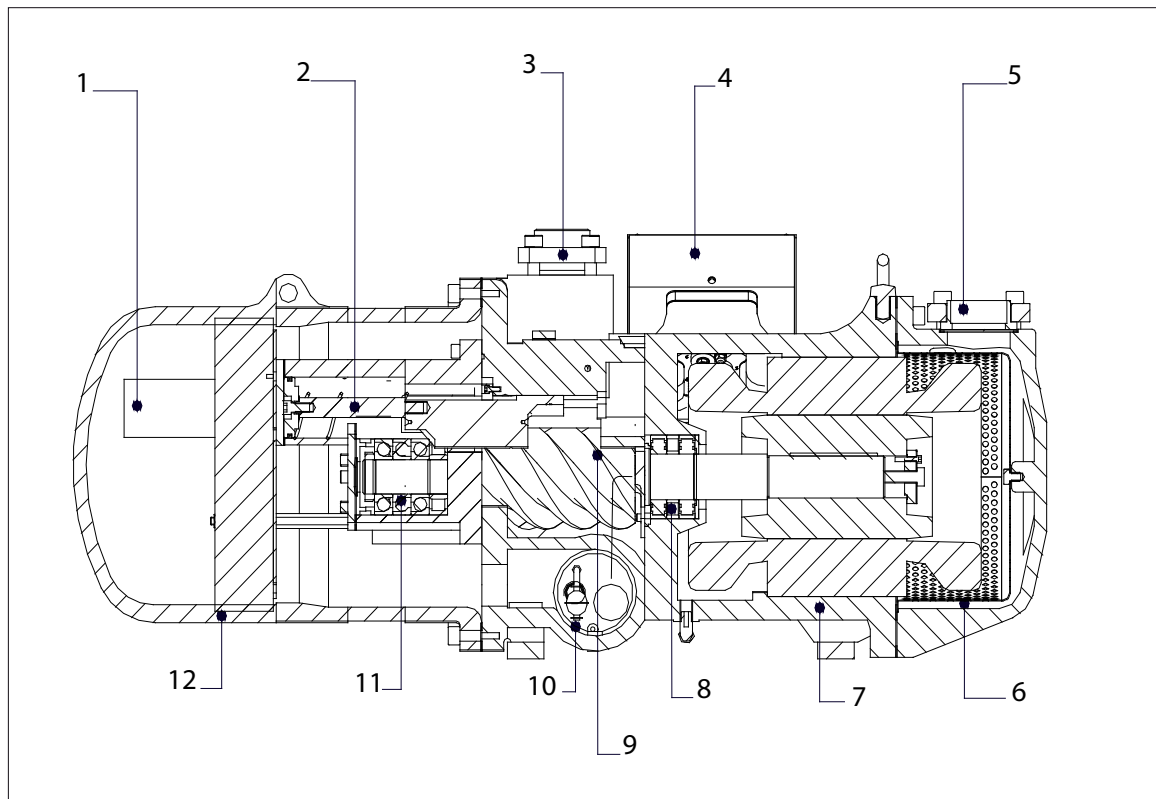


Fig. 2: Compressor structure for BSR series

- | | | |
|-----------------------|----------------------------|-------------------------------|
| 1. Muffler (silencer) | 5. Suction flange | 9. Male rotor |
| 2. Control slider | 6. Suction filter | 10. Oil indicator |
| 3. Discharge flange | 7. Compressor casing | 11. Bearings – discharge side |
| 4. Cable box | 8. Bearings - suction side | 12. Oil separator |

Casing

The housing is an important part of the refrigeration screw compressor. The housing contains the rotors, bearings, the capacity control slider and other parts of the compressor. To achieve a high efficiency, the housing is produced in precise processing centres and inspected by a coordinate measuring machine. The required accuracy and quality in the compressor is ensured by this. The housing with double-walled design consists of high-strength cast iron. Not only is it able to resist intense high pressure, but also reduces the noise level in operation. With its strong and stiff design, the compressor is easily suitable for long-term operation.

Design and function

Rotors	The compressor assumes the latest patented asymmetric rotor profile (tooth ratio 5:6). The rotors are produced by advanced CNC grinding machines to achieve best accuracy and quality. The rotors have best clearance in continuous operation as well, and achieve the highest efficiency.
Bearings	Highly precise, large axial and radial bearings are used to support the male and female rotors. This ensures a long service life. An effective lubrication system further extends the bearing's service life. With the compressor running, the differential pressure injects lubricant into all bearings.
Suction filter	Installed at the suction end of the compressor, the filter prevents foreign bodies or contaminated particles from entering the compressor and warranty regular compressor operation. We recommend that the filter be removed shortly after commissioning and cleaned to ensure continuous regular operation and extend the operation duration.
Oil filter	The oil filter is located in the oil tank below the compressor housing. Oil flowing through the control piston cylinder, the bearings and rotors, must be filtered and cleaned to prevent foreign bodies or steel particles from entering and damaging parts. The oil filter must be cleaned regularly to keep the oil channels clean; this specifically applies after initial commissioning of the compressor.
Drive motor	With its highly efficient two-pole, three-phase induction motor, class F, the installed PTC thermistor and INT69/INT69FSY protective module for precise monitoring of the winding temperature, the compressor is running securely under regular conditions. It is suitable for star-delta or direct start-up.
Oil separator	The structure of the installed oil separator uses a three-stage filter mechanism with a highly dense filter element for best oil separation effects. The effect exceeds 99%.
Capacity control and solenoid valves	The capacity control slider mechanism controls the required refrigerant flow as a reaction to the cooling system load change. The compressor offers a linear capacity control by default. 4-stage control is optional. Various installed volume ratios can be used for certain operating conditions. This leads to high energy efficiency.

Safety devices

Safety device	Recommended settings	
	SR-Series	BSR-Series
Oil level switch	Time delay settings 15 - 30 seconds. If the oil level is too low for 15-30 seconds straight, the compressor is shut off. Check the reason for this problem.	
Motor winding protection (connected to the PTC temperature control module)	Trip temperature: $130\pm 5^{\circ}\text{C}$, Reset temperature: $110\pm 5^{\circ}\text{C}$.	
Discharge temperature protection (connected to the PTC temperature control module)	Trip temperature: $110\pm 5^{\circ}\text{C}$, Reset temperature: $90\pm 5^{\circ}\text{C}$.	
Phase / phase loss protection	Phase sequence: External devices must be considered	The electric wiring configuration is presented in chapter 10.5.
High/low pressure switch	The maximum discharge pressure shall not exceed 25 bar.	
Overcurrent protection relay	The set value can be determined from the maximum current displayed in the performance data under permissible operating range. See performance data manual.	
Differential pressure switch (at the oil filter)	Setting: 1 – 1.5 bar	
Minimum pressure difference between discharge and suction side in operation	5 bar	
Relief / safety valve	The maximum trigger pressure must not exceed 28 bar.	

Note: These safety devices correspond to the minimum requirements necessary for protection of the compressor in operation.

Table 1: Safety devices

Notes when using a phase-leading capacitor

- Connect phase-leading capacitor at least 0.5 seconds after compressor starts up.
- The upper limit of the power factor compensation is 0.95.
- Disconnect phase-leading capacitor at least one second before switching off the compressor.
- Generally, the phase-leading capacitor is only activated while the compressor is in operation.

Design and function

Function

Functional principle

Refrigerant is sucked in via the suction flange. Two screw rotors compress the gas at continuous oil injection. The rotors are running contact-free to the casing. The compressed gas reaches the condenser via the discharge flange.

Lubrication

Bearings and rotors are supplied with oil through an oil filter by differential pressure via an integrated oil supply.

Cooling

Heat is dissipated to the housing surface via the oil and thus to the ambient air. Depending on load, the oil may have to be cooled externally.

Drive

Three-phase induction motor, two-pole.

3.2 Control and display elements

Depending on installation situation, different display elements and monitoring devices are present for pressure and temperature, fill level and power input.

The devices at the compressor are either already integrated in the monitoring device of the cooling system or still have to be integrated.

3.3 Capacity control in four steps

The capacity is controlled optionally either in four steps or smooth (linear).

Moving the control slider to specific positions sets the compressor capacity. Part of the refrigerant flows back into the inlet to regulate the refrigerant flow.

The capacity control in four-step mode comprises:

- the control slider
- three NC-solenoid valves (NC = normally closed)
- A piston with spring
(adjustable range: 25%, 50%, 75%, 100%)

The spring force returns the control slider to the initial (start-up) position when switching off the compressor. During operation, the oil-hydraulic differential pressure pushes the piston towards capacity increase. The precise position of piston and slider is determined by opening and closing the oil channels via the assigned solenoid valves.

The cold water temperature or other system requirements to the refrigerant flow control the open/closed sequence of the solenoid valves. The hydraulic oil is injected from the oil tank by the pressure difference (between suction and discharge pressure). The hydraulic oil flows into the hydraulic adjustment cylinder and operates the piston resp. the slider.

A capillary tube determines the oil flow after it has gone through the oil filter.

The capacity control system malfunctions in the following case:

- if the oil filter is clogged
- if the capillary tube is clogged
- if a solenoid valve fails

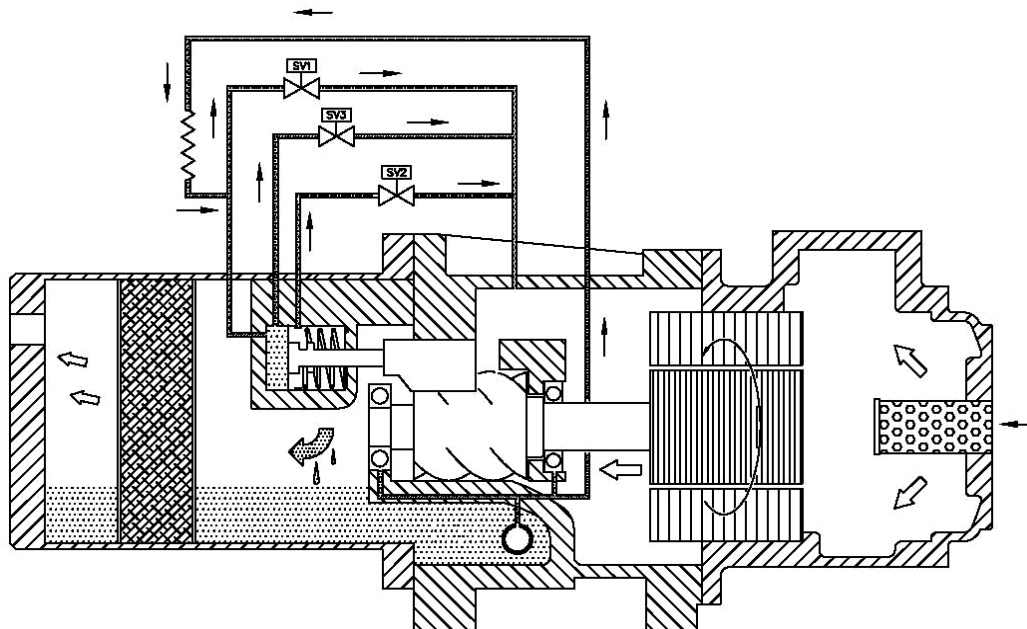


Fig. 3: Capacity control and oil circuit for SR series

Control sequence of the SR series solenoid valves

Solenoid valve	SV 1	SV 2	SV 3
Status	(NC)	(NC)	(NC)
100%	OFF	OFF	OFF
75%	OFF	ON	OFF
50%	OFF	OFF	ON
25% (Start)	ON	OFF	OFF

OFF = deactivated; ON = activated.

Table 2: Control sequence of the SR series solenoid valves

Design and function

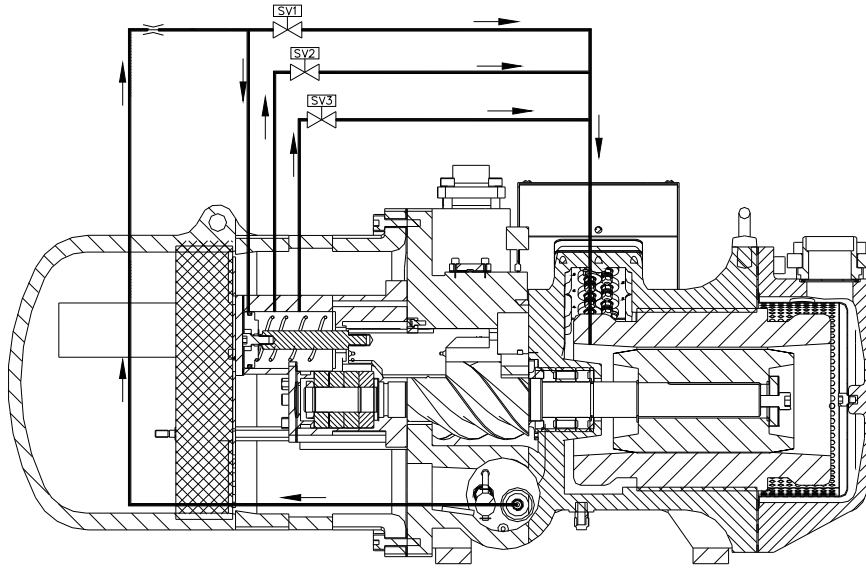


Fig. 4: Capacity control and oil circuit for BSR series

Control sequence of the BSR series solenoid valves

Solenoid valve	SV 1	SV 2	SV 3
Status	(NC)	(NC)	(NC)
100%	OFF	OFF	OFF
75%	OFF	OFF	ON
50%	OFF	ON	OFF
25% (Start)	ON	OFF	OFF

OFF = deactivated; ON = activated.

Table 3: Control sequence of the BSR series solenoid valves

Start-up: 25% capacity

- The load position must be minimised for easier activation of the compressor.
- With SV1 activated, the control oil is sent directly to the low-pressure side. The slider does not move and keeps the maximum opening in the suction side to deviate the refrigerant.

After completion of the start-up phase:

- After deactivation / closing of SV1, the load slowly increases.
- We recommend running the compressor at a load of 25% for about 30 seconds before increasing the load.

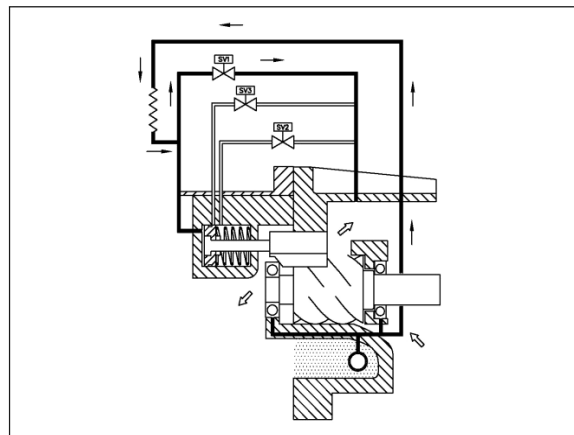


Fig. 5: 25% capacity / start-up position SR series

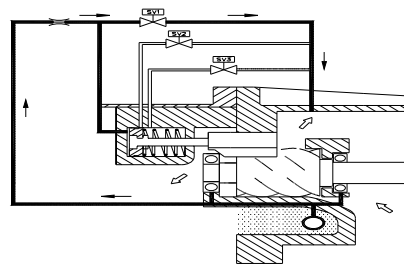


Fig. 6: 25% capacity / start-up position BSR series

Design and function

Partial load: 50% capacity

- SV3 (for BSR: SV2) is activated in the same manner as SV1 previously at minimum load to achieve a load position of 50%.

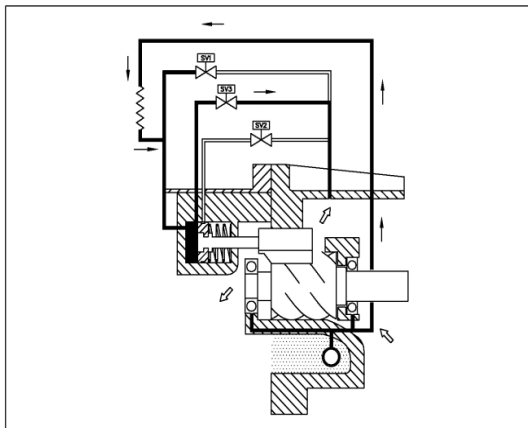


Fig. 7: 50% capacity SR series

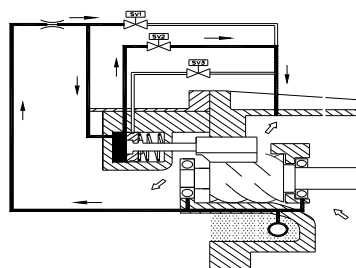


Fig. 8: 50% capacity BSR series

Partial load: 75% capacity

For load increase: SV2 (for BSR: SV3) is activated in the same manner as SV3 previously (for BSR: SV2) to achieve a load position of 75%.

Load reducing from full load: After system feedback with requirement of lower capacity:

- SV2 (for BSR: SV3). Oil flows back to the low-pressure side through the associated valve channel.
- The piston returns to the outlet of the SV2 oil line.
- The control slider moves accordingly. A partial refrigerant volume flows through the bypass opening back to the low-pressure side.

This action reduces the outlet volume and lets the compressor run at a capacity of 75%.

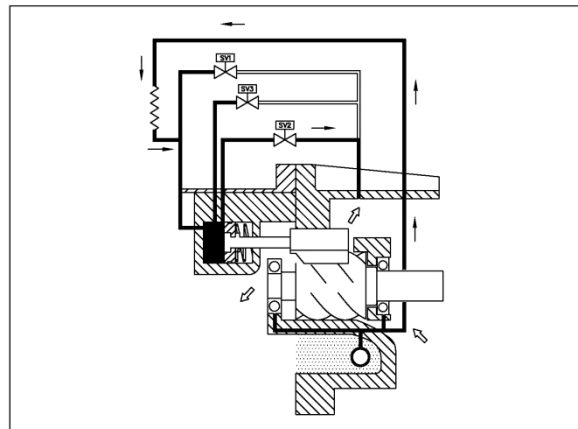


Fig. 9: 75% capacity SR series

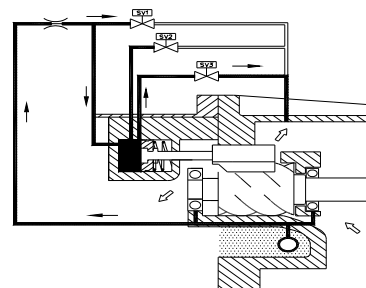


Fig. 10: 75% capacity BSR series

Design and function

Full load: 100% capacity

After completion of the start-up phase:

- SV1, SV2 and SV3 are deactivated and closed.
- Oil flows right into the cylinder and pushes the piston and therefore the slider forward
- The bypass opening reduces slowly

When the opening is fully closed, the compressor runs at a load of 100%.

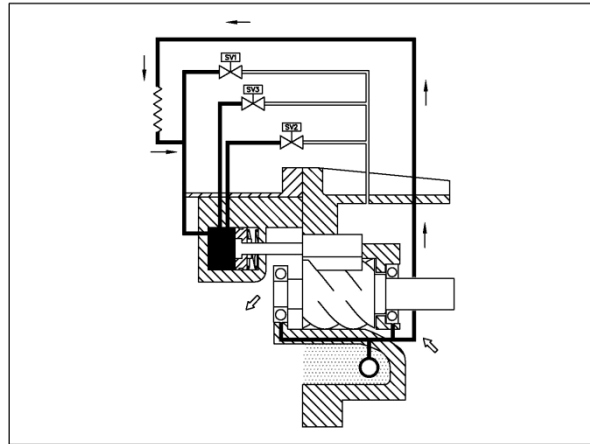


Fig. 11: 100% capacity SR series

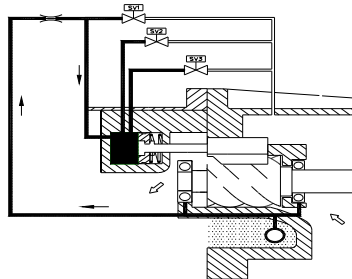


Fig. 12: 100% capacity BSR series

3.4 Linear capacity control

The basic principle of the linear (smooth) capacity control corresponds to the four-step system but with a different control logic for the solenoid valves.

The linear capacity control uses an NO (normally open) (BSR: NC) and one or two NC (normally closed) solenoid valves to control load increase or reduction.

Capacity control range: 25%-100%

The compressor system uses an NC solenoid valve SV1 to deviate oil from the cylinder.

Oil is sent through into the cylinder through a NO solenoid valve SV2 (BSR: SV0; NC).

The system reacts dynamically to the actual load requirement and controls activation or deactivation of the solenoid valves SV1 and SV2 (BSR: SV0) to continually adjust the compressor output between 25% and 100% load.

The recommended pulse time of the solenoid valves is approx. 0.1 - 0.5 seconds; it is adjusted according to the actual operating condition.

After activation of the compressor:

- SV1 is activated. Oil is sent directly to the low-pressure side. SV 2 (BSR: SV0) is deactivated.
- The control slider is kept in the start-up position by the spring force on the pistons.
- the compressor starts securely at a load of 25 %
- When the starting procedure is completed, all solenoid valves are deactivated (SR series). SV0 is activated as for the BSR series. The load is increased to 100 %.

If the compressor is to run in a fixed load position to achieve a stable cooling capacity, SV1 is permanently deactivated and SV2 activated (BSR: SV0 and SV1 remain deactivated).

Load changes control the activation/deactivation of SV1 and SV2 (BSR: SV0) via the system. This adjusts the output of the compressor to the actual load requirement.

SV2 is deactivated briefly to increase performance (BSR: SV0 is activated). A small amount of oil runs into the hydraulic cylinder. The control slider is moved towards "Closing the bypass opening".

To reduce performance, SV1 is briefly activated. A small amount of oil runs from the hydraulic cylinder. The slider is moved towards "Increasing the bypass opening".

Design and function

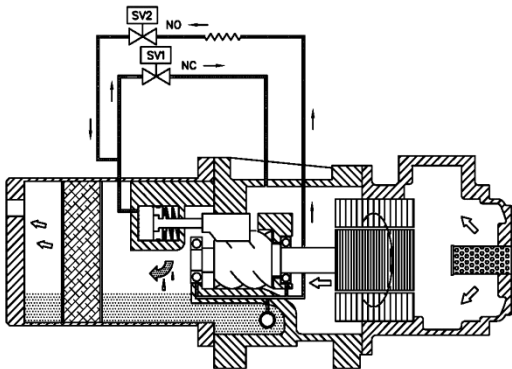


Fig. 13: Linear capacity control 25%-100%
SR-Series

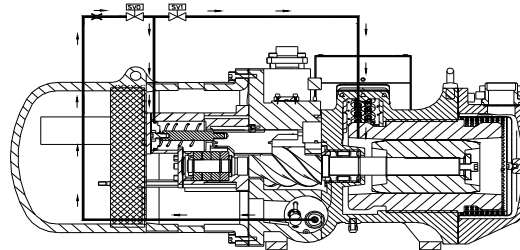


Fig. 14: Linear capacity control 25%-100%
BSR-Series

Control sequence of the solenoid valves (25%-100%) SR-Series

Solenoid valve	SV 1 (NC)	SV 2 (NO)
Status		
Start	ON	OFF
Load increase	OFF	OFF
Load reduction	ON	OFF
Switch off	OFF	ON

OFF = deactivated; ON = activated.

Table 4: Control sequence of the SR series solenoid valves (25% - 100%)

Control sequence of the solenoid valves (25%-100%) BSR-Series

Solenoid valve	SV 0 (NC)	SV 1 (NC)
Status		
Start	OFF	ON
Load increase	ON	OFF
Load reduction	OFF	ON
Switch off	OFF	OFF

OFF = deactivated; ON = activated.

Table 5: Control sequence of the BSR series solenoid valves (25% - 100%)

Capacity control range: 50%-100%

If the compressor is running permanently at low load (25%), the motor may overheat or a then excessive expansion valve emits too much liquid refrigerant into the compressor space.

Therefore, a minimum operating capacity of 50% should be complied with for linear capacity control.

- SV1 is activated (bypassing oil) to ensure that the compressor is started at minimum load.
- An NC solenoid valve SV3 (BSR: SV2) is used to divert oil from the cylinder.
- An NO (BSR: NC) solenoid valve SV0 is used to feed oil into the cylinder.
- Control of the SV0 and SV3 (BSR: SV2) valve (SV1 deactivated) cause the compressor to work between 50% and 100% load only.
- The recommended pulse time of the solenoid valves is approx. 0.1 - 0.5 seconds; it is adjusted according to the actual operating condition.

Starting at a load of 25%:

- SV1 is activated. Oil is deviated from the hydraulic cylinder through the SV1 oil channel to the low-pressure side of the compressor (SV0 and SV3 (BSR: SV2) are deactivated)
- The slider is kept in its starting position for 25% capacity by the spring force.
- After completion of start-up, SV0 and SV1 remain deactivated (BSR: SV0 activated and SV1 deactivated). SV3 is activated for 180 seconds (recommendation). The compressor is running on 50% capacity.
- Then all solenoid valves are deactivated (BSR: SV0 remains activated) to increase the compressor output to 100% (full load) or adjust it as required.

Compressor in operation:

- To run the compressor in a fixed position, SV1 and SV3 must be deactivated (BSR: SV0, SV1 and SV2 deactivated). Activate SV0. This will lead to stable refrigerating capacity output.
- For load changes, the control system activates or deactivates SV0 and SV3 (BSR: SV2) and adjusts the compressor output to the actual load requirements.
- SV0 is deactivated briefly to increase performance (BSR: activated). A small amount of oil runs into the hydraulic cylinder. The slider is adjusted towards performance increase.
- To reduce performance, SV3 (BSR: SV2) is activated briefly. A small amount of oil runs from the hydraulic cylinder. The slider is adjusted towards performance decrease.

Design and function

SR-Series

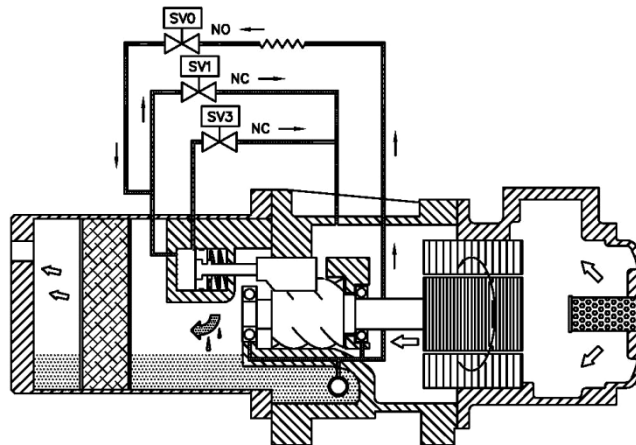


Fig. 15: Linear capacity control 50%-100% (SR-Series)

Control sequence of the solenoid valves (50%-100%)

Solenoid valve	SV 0 (NO)	SV 1 (NC)	SV 3 (NC)
Status			
Start	OFF	ON	OFF
Load increase	OFF	OFF	OFF
Load reduction	OFF	OFF	ON
Maintain load	ON	OFF	OFF

OFF = deactivated; ON = activated.

Table 6: Control sequence of the SR series solenoid valves (50% - 100%)

BSR-Series

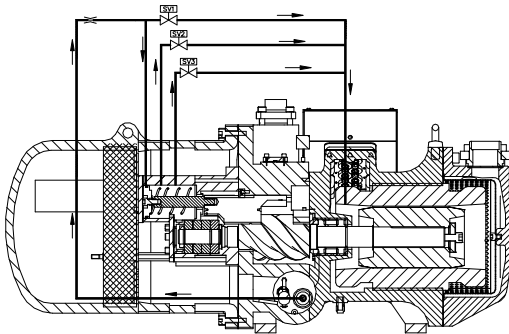


Abb. 16: Capacity control and oil circuit for BSR series

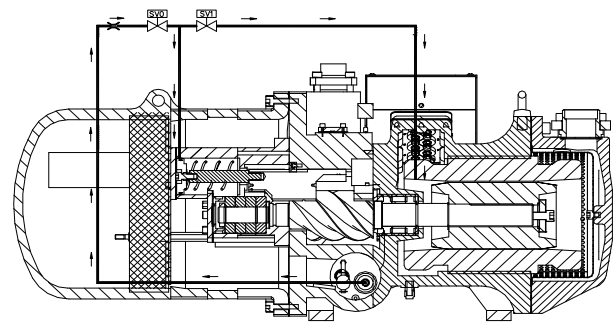


Abb. 17: Linear capacity control 50%-100% (BSR-Series)

Control sequence of the solenoid valves (50%-100%)

Solenoid valve	SV 0 (NC)	SV 1 (NC)	SV 2 (NC)
Status			
Start	OFF	ON	OFF
Load increase	ON	OFF	OFF
Load reduction	OFF	OFF	ON
Maintain load	OFF	OFF	OFF

OFF = deactivated; ON = activated.

Table 7: Control sequence of the BSR series solenoid valves (50% - 100%)

3.5 Applications

In the permissible operating range of the compressor, the operating conditions of the air-cooled or heat pump applications are more critical than for water-cooled applications. In the first case, the load is about 15% to 30% above the one in the latter, which leads to excessive outlet temperature, motor winding temperature and oil temperature. For the compressor to run normally, it must be cooled additionally via the liquid injection system or an oil cooler.

3.5.1 Thermal storage system

The evaporation temperature of thermal storage systems is at approx. -5°C to -15°C , in contrast to air conditioners. This leads to a higher compression ratio than in air conditioners with 0 to 5°C . The higher outlet temperature may trigger the protective device and switch off the compressor.

Equipment with a liquid injection system or an oil cooler permits maintaining a normal outlet temperature.

Apart from the required readjustment and adjustment of the temperature control switches, freezing protection switches, vacuum switches, capacity control and expansion valve, a second oil separator should be used for better oil return.

The oil return line of the oil separator is to connect to the low-pressure side of the compressor.

3.5.2 Liquid injection

Direct injection of liquid refrigerant into the compression chamber or the suction space of the compressor reduces the outlet and motor winding temperature.

If the outlet temperature reaches 100°C , the temperature switch emits a signal to the solenoid valve in the liquid line. The brine flows into the compression chamber or suction space / motor via the solenoid valve and throttle element. The latent heat of the brine provides the required cooling capacity to reduce the compressor temperature in operation under critical conditions.

if a thermal expansion valve is not specifically designed for liquid injection, a solenoid valve must be used to control opening and closing of the expansion valve and to render the system stable.

Special expansion valves for liquid injection control are, e.g., Danfoss TEAT20, Alco Serie 935 or Sporlan Y1037, etc.

Design and function

In the following, you will find the principle of liquid injection and typical alignments of the individual components.

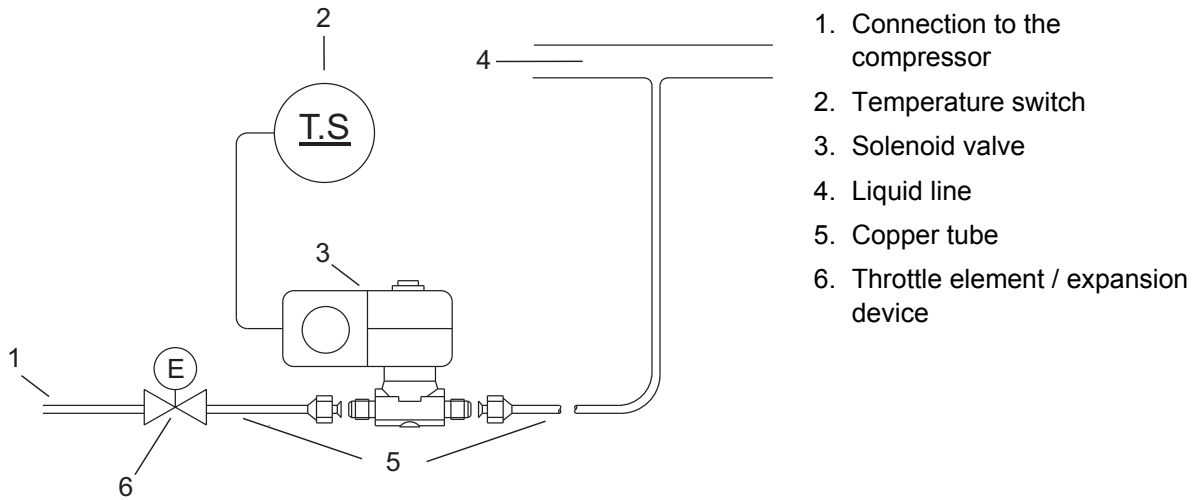


Fig. 18: Layout liquid injection

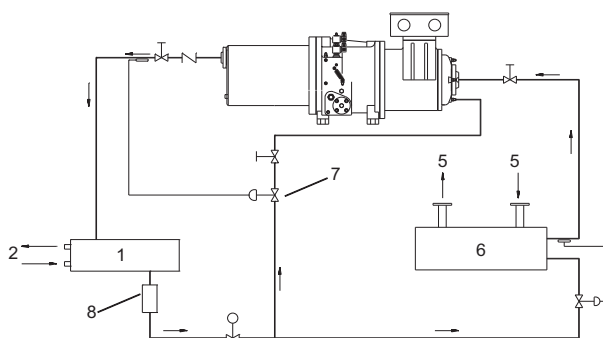
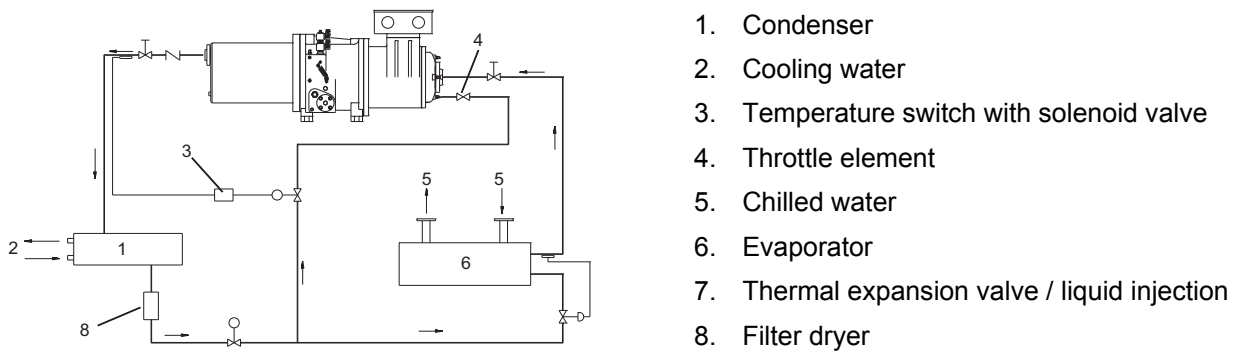
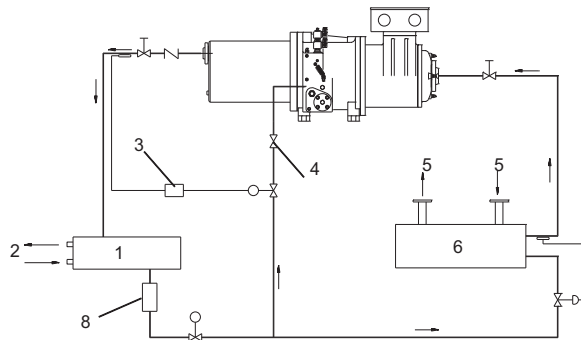
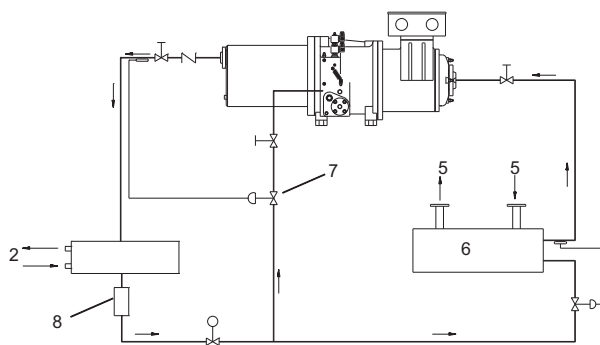


Fig. 19: Liquid injection – suction side



1. Condenser
2. Cooling water
3. Temperature switch with solenoid valve
4. Throttle element
5. Chilled water
6. Evaporator
7. Thermal expansion valve / liquid injection
8. Filter dryer



*Fig. 20: Liquid injection – Compression chamber
(medium pressure)*

Design and function

3.5.3 Economizer

The Economizer principle is comparable to two-stage compression. It may increase the compressor efficiency, particularly under high compression ratios.

The system alignments with relief vessels or liquid cooler are as follows:

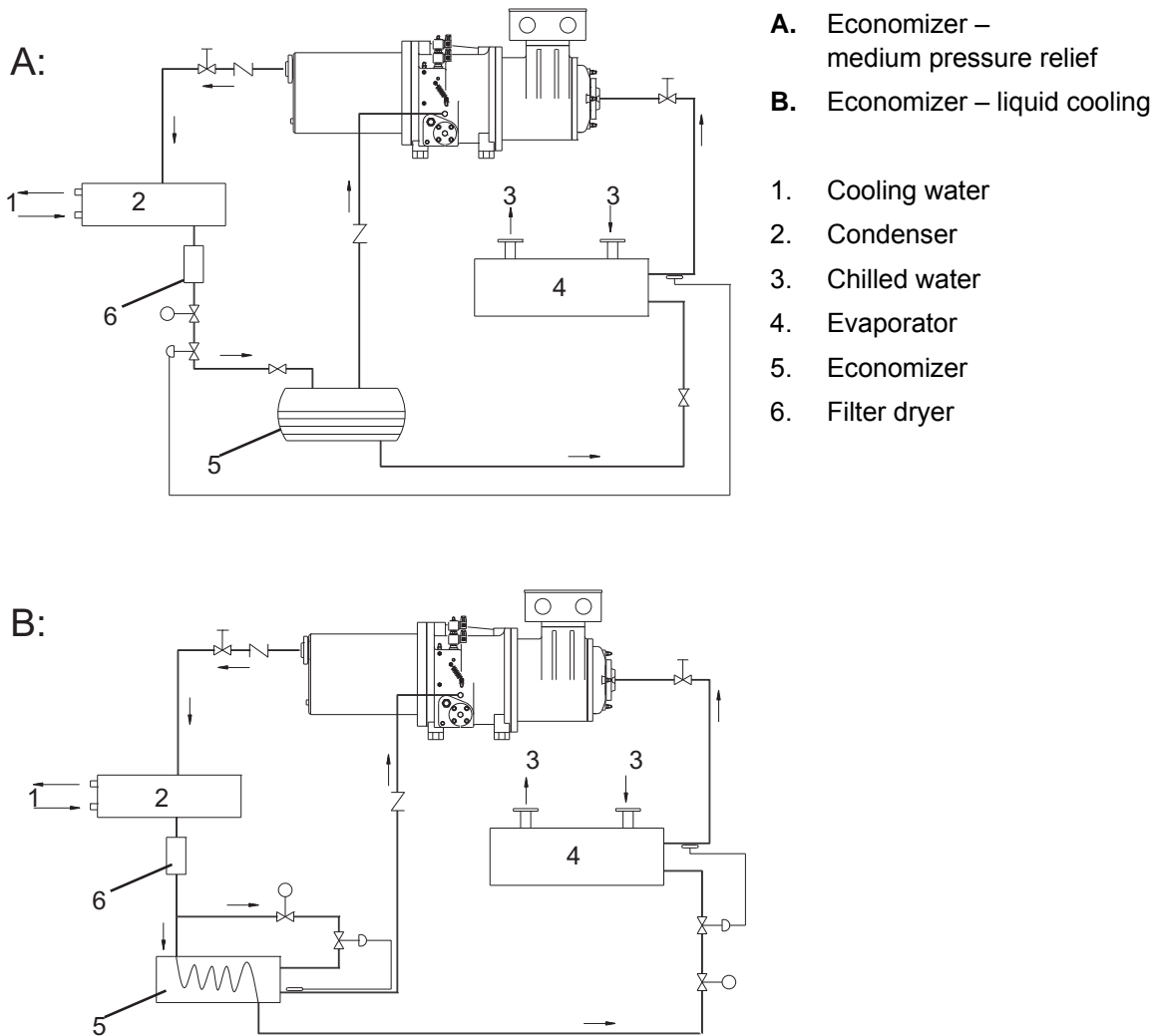


Fig. 21: Economizer

3.5.4 Oil cooler

An oil cooler must be installed for the operating types "air cooling" or "heat pump", in particular when the outlet temperature is above 100°C.

The oil temperature at the oil cooler exit should be between 50°C and 70°C and deviates depending on cooler performance and operating conditions of the compressor.

The recommended oil cooler capacity is indicated below:

Model ¹⁾	SR-1(H) SR-3(H)	SR-434(H)	SR-4(H) SR-561(H)	SR-6(H) SR-7(H)	SR-8(H)
Oil cooler capacity (kW)	14	18	28	35	49

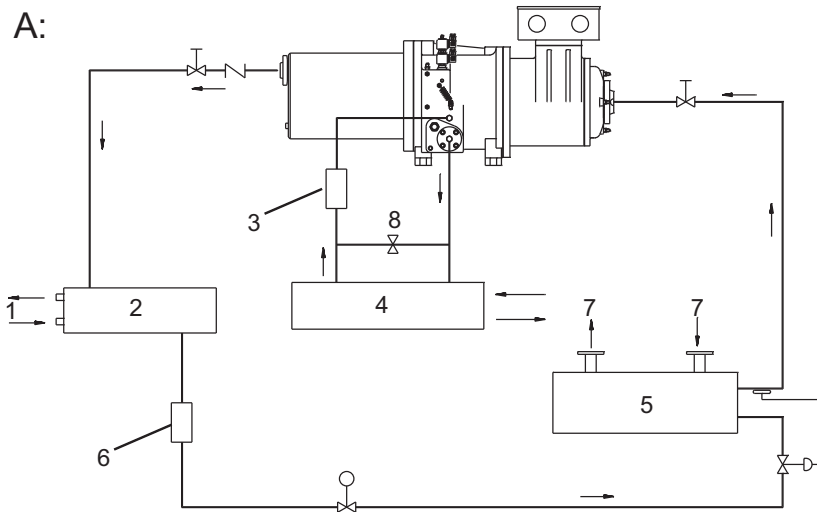
1) BSR-Series The recommended oil cooler capacity can be determined using the FuSheng design software.

Table 8: Oil cooler capacity (kW)

- Install an oil bypass valve or mixing valve (mixing cold and hot oil) if the oil outlet temperature is too low.
- The oil cooler can be cooled by air, brine or water.
- Independently of the cooling type, the maximum pressure drop across the oil cooler must not exceed 0.5 bar. Higher pressure drop may lead to malfunction of the capacity control and insufficient lubrication of the bearings.
- If an oil bypass valve is installed: Open the bypass valve when the outlet temperature of the refrigerant is below 70°C to return the uncooled oil into the compressor.
- If the outlet temperature of the refrigerant is above 70°C, close the bypass valve to guide oil via the oil cooler.

Design and function

A:



A. Oil cooling (water-cooled)

B. Oil cooling (air-cooled)

1. Cooling water

2. Condenser

3. Oil filter

4. Oil cooler

5. Evaporator

6. Filter dryer

7. Chilled water

8. Oil bypass valve

B:

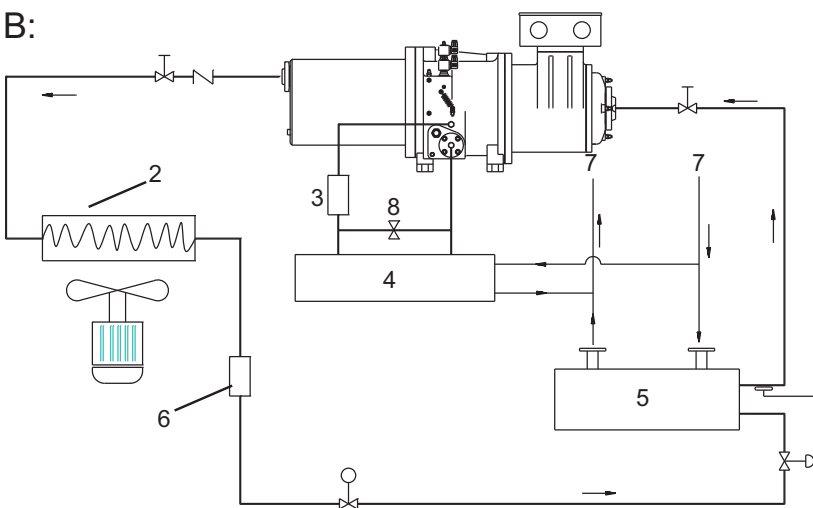


Fig. 22: Oil cooling

4 Transport and storage

4.1 Safety notes for transport

See chapter 2.6 Safety!

4.2 Transport

The machine fastened on a plate must be transported by means of a fork lift or suitable belts. The lifting gear must be designed for the weight of the machine.

For future transports:

- Seal all open connections pressure-right with flanges and protective caps (prevents penetration of dirt and water)
- Secure against vibrations
- Fill compressor inside with nitrogen (0.5 bar)
- Securely fasten the machine prior to transport (e.g. screw it onto a pallet)
- Transport and put down machine with a fork lift or secure with belts and lift with suitable lifting gear.

Delivery

- Use the two lifting eyelets at the compressor for lifting. Put two loops around the compressor and lift the compressor.
- The compressor must not be subjected to impact during transport and lifting.
- Keep the compressor horizontally aligned and avoid hard putting down on the floor.
- Avoid impact to the parts installed at the compressor, such as capillary lines, copper lines and their connections, solenoid valves, emptying valves and connection box.

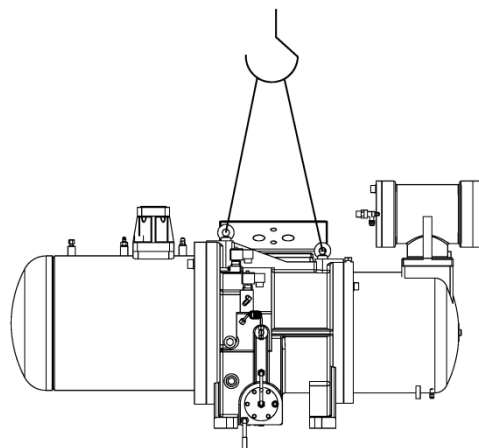


Fig. 23: Compressor delivery

Transport and storage

4.3 Storage

Storage of packages

Store packages under the following conditions:

- Do not store outdoors.
- Store dry and dust free.
- Do not expose to aggressive media.
- Protect against solar irradiation.
- Avoid mechanical vibrations.
- Storage temperature: -10 to + 60 °C
- Relative humidity: max. 95%, non-condensing
- If storage lasts longer than 3 months, regularly check the general condition of all parts and of the packaging.
- Do not loosen any flanges and closures (nitrogen sealing gas).
- Bags with desiccant may be placed in components intended for export (overseas). These bags keep moisture away from the component's workspace. Remove bag before the components are connected.

5 Start-up and operation

5.1 Safety during start-up

See chapter 2.6 Safety!

5.2 Commissioning and start-up



CAUTION!

The machine must always have a sufficient amount of oil. A new compressor is always delivered filled with oil. The oil level must be at the top display level (refill oil if required). For information the oil level, see compressor type label or tables (Tab. 13 and Tab. 14, page 58 and Tab. 17, page 60 and Tab. 18, page 61)

Installation

- Attach suitable anti-vibration pads (5-10mm) below the compressor support to prevent vibrations and noise of the compressor.
- Keep the compressor in a well-ventilated place (low humidity, low heat). Ensure that there is enough space for future maintenance and servicing work.
- Only install the compressor horizontally.

Evacuating the system

Evacuate the system at the suction and outlet ends

- Use the largest available connection pipe for extraction.
- Increase ambience temperature when extracting the system in winter or in cold environments.
- Do not measure motor insulation during evaluation; this may severely damage the motor winding.

Start-up and operation

Inspection prior to initial start-up

Check the following items before initial commissioning:

- Compressor for transport damage.
- Correctness / reconciliation of data on the name plate
- Pipework for cleanliness, free passage and leak tightness. Welding residue (slag) and other foreign bodies will cause compressor damage if sucked in.
- Pipelines and connections for tightness. Both must resist an overpressure of 30 bar.
- Rotating direction of the drive via a phase sequence switch.
- Oil level: the oil must be filled up to the top indicator level.
- Check that the oil heating is switched on before start-up. We recommend heating up the oil for 8 hours if the compressor was switched off for an extended period.
- Check that all manual valves are open (maintenance valves for cooling water in-/outlet, chilled water and refrigerant lines).
- Direction of installation and function of non-return valve.
- Safety valve function.
- Suction and pressure lines must be installed in a closed loop.
- Check if capillary pipes are bent or broken. Replace damaged capillary pipes before operation.

Work to be performed before and during installation

Perform the following work before installation:

Release nitrogen (if compressor was filled with nitrogen):

- First open the test connection on the suction side to release the nitrogen with which the compressor is charged (0.5 bar), before parts will be fitted.
- The new compressor was filled with refrigeration oil in the plant before delivery. Since the special oil is strongly hygroscopic, it must not be exposed to atmosphere for more than 15 minutes after opening of the compressor or before installation takes place.
- Evacuation and refrigerant filling according to separate instructions.

Check compressor:

- Check that the power cables to the motor and the outlet temperature switch are firmly installed.

Electrical system:

- Check that the voltages and frequencies of the power supply (main and control voltage) are correct.
- Check that the insulation resistances phase to phase and phase to ground are above 10 MΩ.
- Check that the motor is grounded and the terminal clamps are fixed tightly.
- Check that the settings of control and monitoring devices are correct.

Observe:

- Do not measure the insulation resistance during the evacuation process and not before completion of refrigerant filling.
- After completion of refrigerant filling, the resistance measured must not be less than 500 MΩ (measured at 500 V DC). Otherwise, ensure that the cooling system was evacuated as required. If the moisture concentration in the refrigerant is too high or pipelines leak, perform corrective action to solve the problem.
- Use a 9 V DC Ohmmeter to measure the motor protection device resistance (PTC-Thermistor). The measurement must not be performed with a Mega-Ohmmeter.

Pipe system:

- Check if there are any leaks in the pipelines connected to the suction and pressure sockets (welding or solder pints) and accessories.

Start-up and operation

Start-up

- Open shut-off devices
- Switch on drive.
- Check correct compressor rotating direction at first commissioning
- Check drive speed.

Notes on operation

- Check the rotating direction right after activation. Ensure that the suction pressure drops slowly and the outlet pressure rises slowly. Otherwise, switch off the compressor **at once**. Change the phase sequence and repeat the inspection process. Switch on the compressor again briefly.
- If you found any unusual vibrations or noise in operation, switch off the compressor at once and contact your Fu Sheng service representative.
- The recommended overheating range of the compressor is 5-10°C (R22, R134a), 8-12°C (R407C) at suction. Overheating beyond this range may cause damage to the compressor. The temperature may become too high if the compressor starts up under high initial load. High overheating may cause the motor protection device to switch off the compressor.
- Insufficient overheating may cause liquid hammering and can damage the compressor. This also leads to a lower oil level in the compressor, which causes insufficient lubrication of the bearings.
- If the compressor is running in a cooling system or in a high humidity ambient, condensation may form at the motor connection and cause electrical shock. Apply insulation resin to the motor connections to reject condensation and avoid danger of short circuit.

In environments with low temperatures, the following settings are recommended to maintain the minimum pressure difference at above 5 bar:

- Control the on/off status of the condenser cooling fan via pressure switch.
- Install pressure retention valve between compressor and condenser.

Inspections during operation

The operator must inspect the following data **every 20 minutes** during operation:

- Discharge pressure (see Tab. 11) / condensation temperature
- Suction pressure / evaporation temperatures
- Suction gas overheating
- End temperature
- Oil level

**NOTE!**

In the permissible operating range of the Fu-Sheng compressor, operating conditions are more critical under air-cooled or heat pump applications than in water-cooled ones. The load is higher by about 15% to 30% in the first case than in the second. This leads to increased outlet temperature, motor coil temperature and oil temperature. For the compressor to run normally, a liquid injection system or oil cooler must be installed to additionally cool the compressor (see chapter 3 "Setup and function").

Notes for the test run

We recommend installation of an additional filter in the suction line before the suction filter of the compressor for a test run.

- Open these filters, the suction filter and oil filter and clean the filters after the compressor has run for 2-4 hours.
- Clean the lines and evaporator. If there is any welding residue or other particles in the system, they may get into the suction filter and clog it. This and a high pressure drop may damage the suction filter. The foreign bodies can then freely enter the compressor and may damage motor, bearing or control slider.



Start-up and operation

Start-up sequence

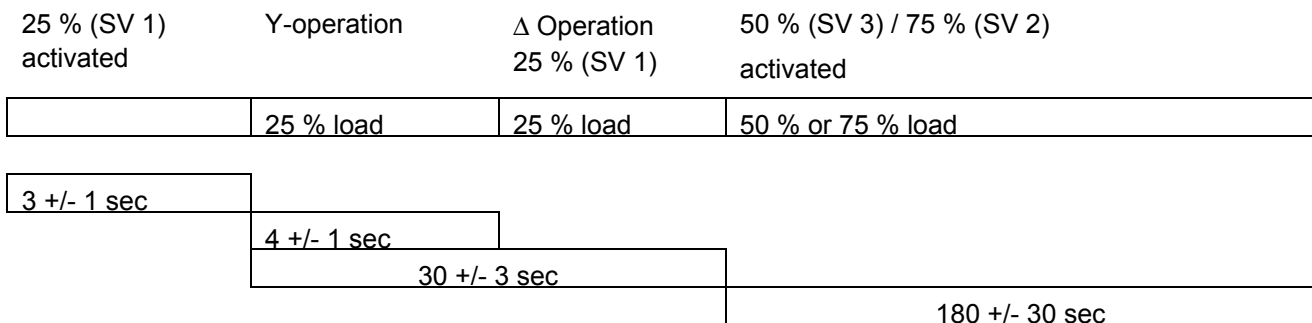
Switching from Y-Δ:

The switch-over time of the magnetic contact must be below 40 ms.

Observe the capability to eliminate light arcs when setting the switch-over time.

After completing the entire starting process, observe the returned chilled water temperature. If this temperature is too low, the load is below the rated load. In this case, frequent turn-on procedures will occur; the compressor's service life is reduced if the compressor runs at full load right after start-up.

This leads to the recommended control sequence of the compressor (load increase/reduction):



Recommended control sequence of the compressor load increase/reduction

Use the temperature of the chilled water or hot water as parameter for load increase/reduction for stable operation.

- If the capacity control of the compressor is based on the temperature of the chilled water and the temperature is above 11°C, the compressor will run at a load of 100%.
- At a temperature of 11-10°C, the compressor runs at a load of 75%.
- At a temperature of 10-9°C, the compressor runs at a load of 50%.
- At a temperature of less than 8°C, the compressor switches off.

If reactivation of the compressor would be set to a temperature of 9°C the motor would start/stop very frequently. The short start/stop cycle prevents heat collected in the motor winding from being completely dissipated through the cooling system. The lubrication circuit is also insufficient.

To avoid this, the switch-on temperature must be at 12°C or above.

Before any switch-off, the compressor should run at a load of 25% for 20 - 30 seconds so that the control slider is put securely in the starting position for the next start-up.

Switch off compressor

- Switch off drive.
- Close shut-off valves (service purposes only).

5.3 Inspections to be performed**Oil level check**

Check the oil level and fill up oil if required.

- To use a different oil type, empty and clean the compressor's inside completely before filling in new oil. Do not mix different oil brands.
- Contact a FuSheng service employee before using any other special oils.
- After oil change, switch the oil heating to heating and evacuate the system.

Since synthetic oil is very hygroscopic, it must not be exposed to atmosphere for more than 15 minutes after the compressor was opened.

Non-return valve inspection

The non-return valve is maintenance free, but is subject to wear like any other moving part. We recommend at least annual visual inspection. In this connection, the non-return valve must be dismantled, cleaned, freed of deposits and checked for free motion.

Safety valve inspection

The safety valve is no regulating device!

The operational capability must be checked on start-up and later at weekly intervals.

The safety valve must be secured against maladjustment. Blocking or manipulating the safety valve can have penal consequences if it gives rise to an accident. Any warranty claims shall also be forfeited in such a case.

The nominal opening pressure may not exceed the maximum permissible final overpressure (see Tab. 11) or the permissible system pressure, provided that the latter is lower.

6 Maintenance

6.1 Safety during maintenance work

See chapter 2.6 Safety!

Personal protective equipment

The following must be worn during all maintenance work:

- Safety working clothing
- Protective gloves
- Safety shoes
- Safety goggles

Environmental protection

Observe the following information with regard to environmental protection during maintenance:

- Remove emerging, used or excessive grease at all lubricating points that are manually supplied with lubricant and dispose of in accordance with valid local regulations.
- Collect exchanged oil and refrigerant in suitable containers and dispose of in accordance with valid local regulations.

6.2 Maintenance schedule

The following describes the maintenance work that is necessary for an optimum, trouble-free operation. Maintenance intervals must be observed.

If increased wear of individual components or functional groups is determined during regular inspections, the operator has to reduce the required maintenance intervals on the basis of the actual signs of wear.

Changes compared to normal operation (increased power consumption, temperatures, vibrations, noises, etc. or response of monitoring systems) lead to the assumption that the functions are impaired. These then have to be subjected to an inspection by specialised staff.

In case of queries regarding the maintenance work and intervals: contact the manufacturer (service address, see page 2).

For maintenance schedule refer to next page.

Maintenance schedule

[hours] Maintenance work	Intervals								
	1000	2500	5000	10.000	15.000	20.000	25.000	30.000	
Check electrical insulation ¹⁾		x	x	x	x	x	x	x	
Check oil filter ²⁾			x (BSR)					x	
Check suction filter			x (BSR)					x	
Check lubricant ²⁾		x	x (BSR)	x		x		x	
Replace lubricant				x		x		x	
Check oil level	x	x	x	x	x	x	x	x	
Check vibration/noise ³⁾	x	x	x	x	x	x	x	x	
Check suction and pressure-side rotor end surfaces								x	
Check bearings								x	
Replace bearings (all concurrently)								x	
Check for leaks								x	

¹⁾ Check before activation after extended deactivation.

²⁾ For series BSR, check lubricant/check oil filter and replace after 100 hours

³⁾ In case of deviations, contact the service department of Fu Sheng.

Table 9: Maintenance schedule


NOTE!

After overhauling, perform pressure test at the compressor to ensure that no leaks have occurred.

6.3 Performance of maintenance work

Cleaning the compressor

Observe the following when cleaning the compressor:

1. Switch off compressor and secure against restarting.
2. Remove soiling.
 - Do not use aggressive cleaning agents.
 - No water may penetrate the compressor. Caution when using a high-pressure cleaner.
 - After wet cleaning, warm up the compressor for a few minutes.

Maintenance

Oil change

- Depressurise the compressor by evacuating the refrigerant (observe the notes for performance and disposal).
- Open oil drain screw, drain oil. Close oil drain screw and refill oil.
- To use a different oil type, empty and clean the compressor's inside completely before filling in new oil. Never mix different oil brands.
- Contact a FuSheng service employee before using any other special oils.
- After oil change, switch the oil heating to heating and extract the system.

Since synthetic oil is strongly moisture binding, it must not be exposed to atmosphere for more than 15 minutes after the compressor was opened.

Evacuation and refrigerant filling according to separate instructions.

Pipe system

The welded parts of the pipes must resist a pressure of at least 30 bar.

Remove all welding residue after welding to avoid foreign bodies entering the compressor and causing damage.

Procedure if the motor is burned

1. Remove the defective compressor.
2. Recycle the contaminated refrigerant.
3. Replace the filter dryer.
4. Evacuate the system at once and charge it with nitrogen to avoid ingress of ambient moisture.
5. Install the new compressor and perform a one-hour test run.
6. Replace the refrigeration oil and the filter dryer and perform another one-hour test run.
7. Ensure that the system purity and oil are suitable for a permanent run. If not, repeat the described procedure until the result is acceptable.

Notes on pressure reduction ("pump-down")

- This procedure must not be performed during the standard control procedure, unless shut-down is absolutely vital for inspection or maintenance.
- Continue to monitor the outlet temperature.
- Stop the process at once when the outlet temperature switch has triggered.
- The minimum suction pressure for "pump-down" must not undercut 0.5 bar (overpressure).

Contamination in the system

Contamination in the cooling system has a direct effect on the serviced life and efficiency of the compressor:

- Reduce the non-condensable gas share in the cooling system.

Refrigerant with moisture clogs the pipes with frozen water and causes rust on the components; it damages the motor winding insulation and leads to copper deposits at the rotors.

- If the refrigerant line is very long, extract the system by connecting lines from different parts of the chilling water set to the vacuum pump. This will let you achieve the required vacuum.
- Regularly replace the filter dryer. This reduces or removes the moisture share in the line. Otherwise, contamination may clog the suction filter. This causes a pressure drop.
- If the ΔP of the suction filter is larger than 30 kPa (4.3 psi), this causes contamination by foreign particles. The filter must be cleaned at once.
- After installing the compressor and taking it into operation, measure ΔP of the suction filter to ensure cleanliness of the copper pipes in the heat exchangers and the refrigerant line parts.

Safety valve inspection

The safety valve must be secured against maladjustment. Functional testing is carried out by manual activation with the machine running.

Action at lengthy standstill

During a lengthier standstill, we recommend to put the compressor into operation every 4 weeks for approx. 15 minutes.

Malfunions

7 Malfunions

This chapter describes possible causes of malfunions and troubleshooting tasks.

Reduce the maintenance intervals if similar malfunions occur repeatedly due to above-average intensive use so intervals correspond to the actual load.

Contact the manufacturer in case of malfunions that cannot be repaired with the aid of the following information (→ p. 2)!

7.1 Safety

See chapter 2.6 Safety!

Personnel

- The trouble shooting work described at this point can be carried out by the operator, unless otherwise indicated.
- Some work may only be carried out by specially trained specialised staff or exclusively by the manufacturer himself. This is specifically pointed out in the description of the individual malfunions.
- Only electrical specialists may carry out work on the electrical system.
- Components and parts may only be replaced by specialised staff.

Personal protective equipment

See chapter 6.1

Environmental protection

See chapter 6.1

7.2 Recommissioning after corrective action

After corrective action or trouble shooting:

1. Start in accordance with the instructions in chapter „start-up“.

7.3 Malfunction table

Malfunction:	Possible cause	Corrective action	Execution
Flow rate too low	Suction filter clogged	Clean or replace filter cartridge	Operator
	Capacity slider does not move	Check capacity slider Check solenoid valves	Specialised staff
Abnormal noise development	Bearing defective	Replace bearing	Manufacturer
	Lack of lubricating oil	Fill up oil	Operator
	Lots of liquid in the suction	Increase suction side overheating	Specialised staff
	Impurities in the machine	Clean machine	Specialised staff
	Inner parts / screws have come loose	Check compressor	Manufacturer
	Rotors touch each other or the housing	Check compressor	Manufacturer
	Electromagnetic noise	Localise components and check / replace	Specialised staff Manufacturer
Outlet / discharge temperature too high	Pressure loss in suction system too high; suction filter contaminated	Clean or replace filter cartridge	Operator
	End overpressure too high	Comply with maximum end overpressure (see Tab. 11, page 54)	Specialised staff
	Thermometer defective	Replace thermometer	Specialised staff
	Overheating too high	Check evaporator	Specialised staff
	Load too high	Comply with operating parameters (see Tab. 11, page 54)	Operator
	Oil level not sufficient	Fill up oil	Operator
	Bearing failure	Check compressor	Manufacturer
	Compression rate too high	Check suction pressure and / or end pressure	Operator
Operating pressure is not achieved	Connection lines open	Check valve settings	Operator
	Pressure gauge defective	Replace pressure gauge	Specialised staff
Power requirement too high	Discharge pressure too high	Comply with permissible end pressure (see Tab. 11, page 54)	Operator
	Shut-off valve not fully open	Fully open shut-off valve	Operator
Safety valve blows off	Pressure line clogged	Fully open shut-off valve	Operator

Malfuncions

Malfunction:	Possible cause	Corrective action	Execution
Temperature protection switch motor winding activated	Too high compressor overheating from overload	Comply with operating parameters (see Tab. 11, page 54)	Operator
	Discharge pressure too high	Lower condensation temperature	Operator
	Temperature protection switch defective	Replace switch	Specialised staff
	Electrical system failed	Check power supply	Specialised staff
	Defective motor winding leads to high temperature increase	Check motor winding	Manufacturer
Motor cannot be started	Voltage too low or incorrect	Check power supply	Specialised staff
	Phase loss or phase inversion	Check cable connections	Specialised staff
	Motor protection switch activated	Reset	Specialised staff
	Motor failure	Check motor	Manufacturer
	Motor not connected correctly	Check cable connections	Specialised staff
	Service valve pressure side closed	Open valve all the way	Operator
	Discharge pressure switch is activated	Reset pressure switch	Operator
	Capacity slider is not in the start-up position / start under load	Check switching condition of the solenoid valves	Specialised staff
Capacity slider does not move	High oil viscosity due to low oil temperature	Switch on oil heating	Operator
	Capillary tube clogged	Clean system	Specialised staff
	Solenoid valve opening clogged	Clean valve	Specialised staff
	Solenoid valve coil failed	Replace coil	Specialised staff
	Piston ring worn	Replace piston ring	Specialised staff
	Oil filter or oil channels clogged	Clean system Replace filter	Specialised staff
	Oil level too low	Fill up oil	Operator
	Temperature switch/ controller failed (cooling system)	Check / replace device	Specialised staff
Oil loss	Return flow of too much liquid refrigerant and insufficient overheating	Readjust operating parameters	Specialised staff
	Bad oil circulation due to too-low flow speed	Check system design	Specialised staff Manufacturer
	Pipelines too long and/or oil collects in the pipe bends	Check pipe line placement	Specialised staff Manufacturer

Table 10: Malfunction table

8 Spare Parts

Customer Service

In case of queries regarding the product, spare part orders and repairs, please contact our customer service: see page 2 or phone: +49 (0)178 – 44 97 8 97

9 Decommissioning and disposal

A compressor that is no longer usable should not be recycled as complete unit, but disassembled into individual components and recycled according to material types. Non-recyclable materials have to be disposed of in an environmentally compatible manner.

- Prior to decommissioning and disposal of the machine, it must be completely separated from the surrounding units.
- The operating media (oil and refrigerant) must be collected and disposed of professionally.
- The disassembly and disposal of the machine may only be carried out by specialised staff.
- The machine has to be disposed of in accordance with the respective country-specific regulations.

Technical data

10 Technical data

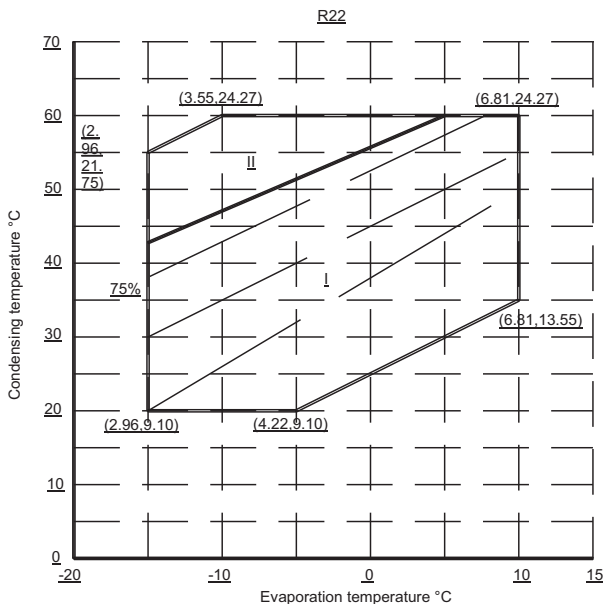
Permissible working range	Unit	Type SR	Type BSR
Ambient temperature	°C	-10 to +55	
Maximum suction pressure (R-22, R-407C)	[bar] ¹⁾	6	7
Maximum suction pressure (R-134 a)	[bar] ¹⁾	3	5
Maximum discharge pressure (R-22, R-407C)	[bar] ¹⁾	25	25
Maximum discharge pressure (R-134 a)	[bar] ¹⁾	19	20,5
Max. permissible discharge temperature	°C	110	
Start-stop cycle ²⁾	Minutes	After switching off, switch on again only after at least 10 minutes	
Switching on/off	h	No more than 6 times per hour	
Minimum operating duration	Minutes	At least 5 minutes	

¹⁾ Overpressure

²⁾ Before shutting down the compressor, the solenoid valve for 25% load is activated for performance reduction for 20-30 seconds. The control slider returns to the starting position for the next start-up. This warrants that the compressor can start in the minimum load condition. Switch on the oil heating to heat up the cold machine oil and thus keep the compressor on stand-by.

Tab. 11: Permissible working range

SR-Series application areas



X = evaporation pressure bar (abs.)

Y = condensation pressure bar (abs.)

Region I = application area without additional cooling

Region II = application area with additional cooling

----- Partial load range

Fig. 24: Application limits R-22

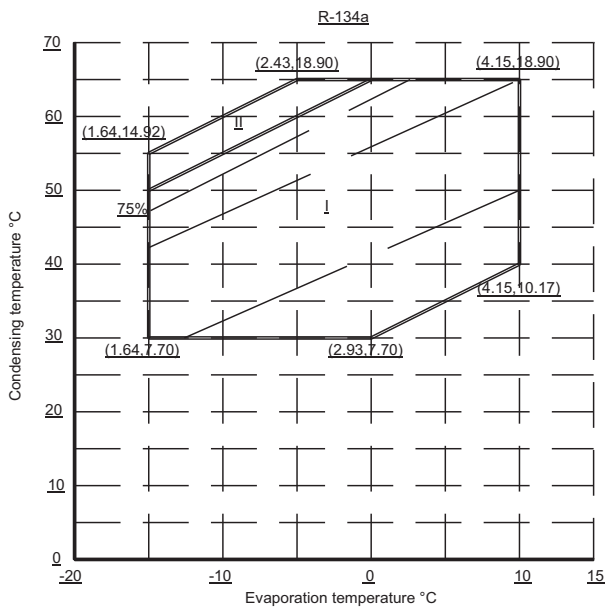


Fig. 25: Application limits R-134a

X = evaporation pressure bar (abs.)
 Y = condensation pressure bar (abs.)

Region I = application area without additional cooling

Region II = application area with additional cooling

----- Partial load range

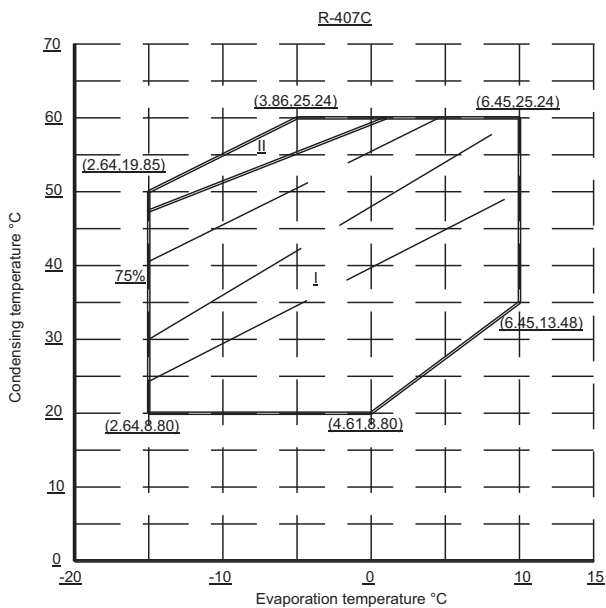


Fig. 26: Application limits R-407C

X = evaporation pressure bar (abs.)
 Y = condensation pressure bar (abs.)

Region I = application area without additional cooling

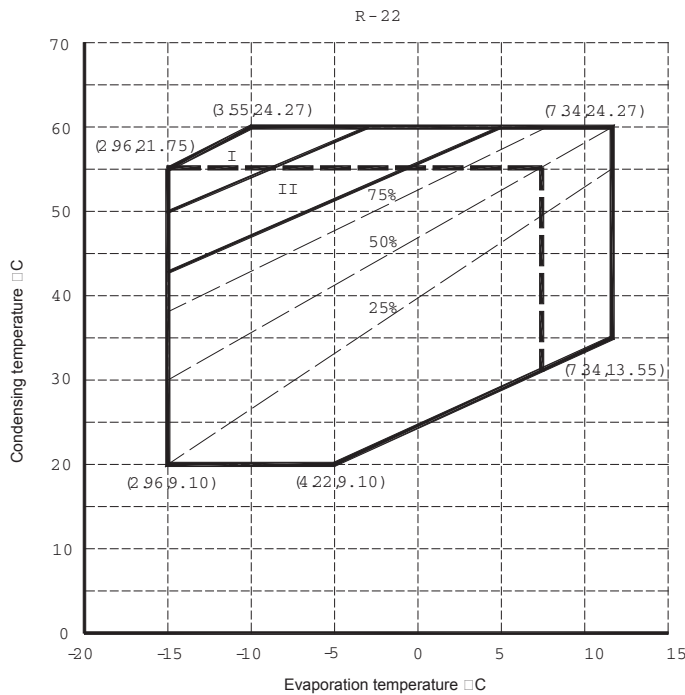
Region II = application area with additional cooling

----- Partial load range

The calculations are based on the dew point temperature.

Technical data

BSR-Series application areas



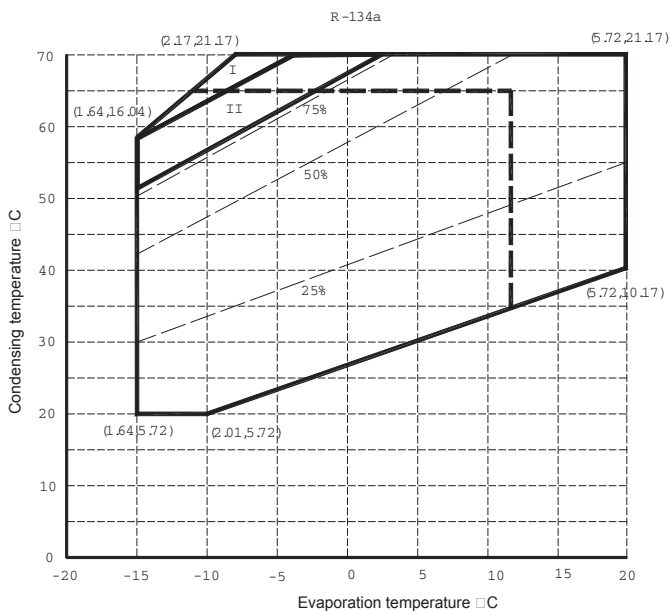
X = evaporation pressure bar (abs.)
 Y = condensation pressure bar (abs.)

Region I = Application area with liquid injection AND oil cooling

Region II = Application area with liquid injection OR oil cooling

- 100 % air-cooled area
- 100 % water-cooled area
- Partial load range

Fig. 27: Application limits R-22



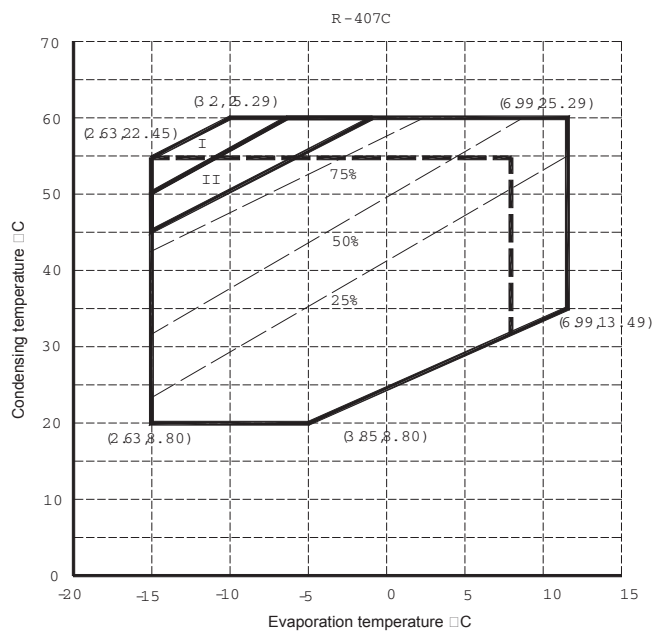
X = evaporation pressure bar (abs.)
 Y = condensation pressure bar (abs.)

Region I = Application area with liquid injection AND oil cooling

Region II = Application area with liquid injection OR oil cooling

- 100 % air-cooled area
- 100 % water-cooled area
- Partial load range

Fig. 28: Application limits R-134a



X = evaporation pressure bar (abs.)

Y = condensation pressure bar (abs.)

Region I = Application area with liquid injection AND oil cooling

Region II = Application area with liquid injection OR oil cooling

100 % air-cooled area

100 % water-cooled area

Partial load range

Fig. 29: Application limits R-407C

Power supply	Unit	Type SR	Type BSR
Voltage variation		+/- 10 % of the rated voltage	
Frequency variation		+/- 2 % of the rated frequency	
Voltage difference between phases		+/- 2.25 %	
Current difference between phases		+/- 5 %	

Table 12: Power supply

Technical data

Refrigerant application HCFC / R-22

Lubricant characteristics	Lubricant			
	CP-4214-150 FS 150R	CP-4214-320 FS 300R	SUNISO 4GSD	SUNISO 5GSD
Viscosity cst@40°C ASTM D445	168	298	54.9	94.6
Viscosity cst@100°C ASTM D445	20.2	32	5.97	7.78
Viscosity index ASTM D2270	150	149	0	37
Specific weight ASTM D1298/D1250	1.01	1.05	0.916	0.918
Pourpoint (°C) ASTM D97	-43	-35	-35	-27.5
Flash point (°C) ASTM D92	290	271	188	208
Voltage strength (kV) ASTM D877	42.0	42.5	>30	>30

Tab. 13: Lubricant for HCFC / R-22

Refrigerant application HFC / R-134a / R-407C

Lubricant characteristics	Lubricant	
	SOLEST-68 FS 070R	SOLEST-120 FS 120R
Viscosity cst@40°C ASTM D445	66.3	127.7
Viscosity cst@100°C ASTM D445	8.9	12.7
Viscosity index ASTM D2270	108	90
Specific weight ASTM D4052	0.957	0.951
Pourpoint (°C) ASTM D97	-43	-33
Flash point (°C) ASTM D92	263	251
Voltage strength (kV) ASTM D877	49.4	47.0

Tab. 14: Lubricant for HFC / R-134a / R-407C

Noise level SR-Series

Sound pressure level (dBA)								
SR-1	SR-2	SR-3	SR-434	SR-4	SR-5	SR-6	SR-7	SR-8
76.5	79.6	79.1	82.1	83.7	84.4	85.7	85.1	89.9

Table 15: Total sound pressure level of the SR series (in the area between 50 – 20,000 Hz)

Noise level BSR-Series

Sound pressure level (dBA)														
BSR-213	BSR-216	BSR-311	BSR-314	BSR-316	BSR-321	BSR-323	BSR-324	BSR-326	BSR-413	BSR-415	BSR-421	BSR-423	BSR-424	BSR-426
79.1	79.9	80.4	80.3	80.9	83.3	83.8	84.1	84.3	85.1	85.3	87.4	87.6	89.5	89.9

Table 16: Total sound pressure level of the BSR series (in the area between 125 – 8,000 Hz)

- The data are based on a measuring distance of 1 m around the compressor at operation with R22-refrigerant, 50°C condensing temperature and 0°C evaporating temperature.
- For any other compatible refrigerants like R-134a, R-407C and other working conditions within permissible limits, the sound pressure level fluctuates between +/- 2 dBA.
- The above data were measured according to ISO2151.

Technical data

10.1 Performance characteristics

10.1.1 Product specification SR-Series

Model		SR-1(H)	SR-2(H)	SR-3(H)	SR-434(H) -	SR-4(H)	SR-5(H)	SR-561(H) -	SR-6(H)	SR-7(H)	SR-8(H)		
compressor	Displacement	m ³ /h	174/145	220/183	265/221	349/291	434/362	519/432	594/495	668/557	842/702	998/832	
	Speed	rpm	2950/3550										
	Capacity control	%	25 (start) / 50 / 75 / 100 (steps) or 25 – 100 (smooth)										
	Refrigerant		R-22 / R407C										
	Lubrication		by differential pressure feeding										
	Type		3-ph., 2-pole induction motor										
Motor	Start method		Y-Δ or direct										
	Frequency	Hz	50/60										
	Voltage	V	380 – 400 / 460 (on request)										
	Isolation class		Class F										
	Protection device		PTC Thermistor										
	Heating	W	150				300						
	Hydraulic test	bar	R-407C/R22: 42 (high-pressure side)										
Oil charge*	ltrs	9	11	11	13	13	13	13	19	23	23		
Weight	kg	420	520	530	630	930	930	930	1100	1150	1250		

* Comment: When connecting an oil cooler, the oil quantity must be increased commensurate with the additional volume.

Fu Sheng reserves the right to make changes without notification.

Tab. 17: Product specification SR-Series

10.1.2 Product specification BSR-Series

Model		213	216	311	314	316	321	323	324	326	413	415	421	423	424	426		
compressor	Displacement (50 HZ)	m ³ /h	140	172	211	268	316	335	395	438	472	555	619	689	760	841	942	
	Displacement (60 HZ)	m ³ /h	168	206	254	322	379	402	474	526	566	665	742	827	912	1010	1130	
	Speed	rpm	2950/3550															
	Capacity control	%	25 (start) / 50 / 75 / 100 (steps) or 25 – 100 (smooth)															
	Refrigerant		R-134a / R-22 / R407C															
Motor	Type		3-ph., 2-pole induction motor															
	Start method		Y-Δ or direct															
	Frequency	Hz	50/60															
	Voltage	V	380 – 400 (50 Hz) / 460 (60 Hz) (on request)															
	Isolation class		Class F															
	Protection device		Phase monitor and PTC Thermistor															
	Heating	W	150					300										
	Hydraulic test	bar	R-407C/R22: 42 (high-pressure side); R-134a: 31 (high-pressure side)															
Dimensions suction port	Inch (mm)	2-5/8 (66.67)			3-1/8 (79.37)			4 (101.60)				5 (127.00)						
Dimensions discharge port	Inch (mm)	1-5/8 (41.27)			2-5/8 (66.67)			3-1/8 (79.37)				4 (101.60)						
Oil charge*	Litres	11			13			17				21		25				
Weight	kg	481	486	600	609	615	726	736	762	777	849	899	1115	1125	1135	1181		

* Comment: When connecting an oil cooler, the oil quantity must be increased commensurate with the additional volume.

Fu Sheng reserves the right to make changes without notification.

Tab. 18: Product specification BSR-Series

Technical data

10.2 Electrical data

10.2.1 Electrical data SR series

50 Hz / SR-series

Model		SR-1	SR-2	SR-3	SR-434	SR-4	SR-5/561	SR-6	SR-7	SR-8	
Rated power (kW)		37	45	52	72	93	108	149	168	199	
50 Hz / 380 V	Y star - LRA (A)	124	137	188	224	276	345	519	634	692	
	Δ Delta -LRA (A)	404	438	607	717	861	1070	1635	1980	2247	
	RLA (A)	69	85	96	129	171	203	272	306	352	
	Wire selected	Max. capacity (A)	48	59	68	93	123	143	195	218	256
		Nominal cross section (mm)	14	22	30	38	50	60	80	100	125
	NFB AF		100	225	225	225	400	400	600	600	600
	NFB AT (A)		100	125	150	200	300	300	500	500	600
	M, D Magnetic contact current (A)		50	65	80	90	125	150	200	220	300
	S Magnetic contact current (A)		35	35	50	50	80	80	125	150	150

Explanations:

LRA: locked rotor (amps) current (start-up current)

RLA: rated load (amps) current (rated current)

NFB: no fuse breaker (power switch)

AF: frame capacity (power category)

AT: interrupting current (trigger current)

Note: Observe the different requirements according to NEMA and IEC!

Table 19: Electrical data of the SR series at 50 Hz

50 Hz / SR-H series

Model		SR-1H	SR-2H	SR-3H	SR-434H	SR-4H	SR-5/561H	SR-6H	SR-7H	SR-8H	
Rated power (kW)		45	52	67	81	108	131	168	199	221	
50 Hz / 380 V	Y star - LRA (A)	137	188	257	279	345	445	634	692	850	
	Δ Delta -LRA (A)	438	607	802	888	1070	1434	1980	2247	2647	
	RLA (A)	85	96	124	147	203	241	306	352	397	
	Wire selected	Max. capacity (A)	59	68	93	123	143	195	218	256	-
		Nominal cross section (mm)	22	30	38	50	60	80	100	125	-
	NFB AF		225	225	225	400	400	600	600	600	-
	NFB AT (A)		125	150	200	300	300	500	500	600	-
	M, D Magnetic contact current (A)		65	80	100	125	150	220	220	300	-
	S Magnetic contact current (A)		35	50	50	80	80	125	150	150	-

Table 20: Electrical data of the SR H series at 50 Hz

Technical data

10.2.2 Electrical data BSR series

Model		BSR (50 Hz, R-134a, air-cooled models (BSR***-HA))															
		213	216	311	314	316	321	323	324	326	413	415	421	423	424	426	
Rated power (kW)		23	28	35	43	50	55	64	71	76	91	101	115	127	140	156	
50 Hz / 380 V	Y star - LRA (A)	113	113	137	188	177	177	224	279	279	276	345	445	445	519	634	
	Δ Delta -LRA (A)	367	367	438	607	563	563	717	888	888	861	1070	1434	1434	1635	1980	
	RLA (A)	60	74	92	112	134	147	173	190	217	256	282	318	352	383	426	
	Wire selected	Max. capacity (A)	75	93	115	140	168	184	216	238	271	320	353	398	440	479	533
		Nominal cross-section (mm)	14	14	22	22	30	38	50	50	60	80	100	100	125	125	200
	NFB AF	100	225	225	225	225	250	250	250	400	400	600	600	600	800	800	
	NFB AT (A)	75	125	125	150	150	200	200	200	250	300	350	400	450	500	500	
	M, D Magnetic contact current (A)	60	74	92	112	134	147	173	190	217	256	282	318	352	383	426	
	S Magnetic contact current (A)	35	43	53	65	77	85	100	110	125	148	163	184	203	221	246	
50 Hz / 400 V	Y star - LRA (A)	113	113	137	188	177	177	224	279	279	276	345	445	445	519	634	
	Δ Delta -LRA (A)	367	367	438	607	563	563	717	888	888	861	1070	1434	1434	1635	1980	
	RLA (A)	58	71	88	108	128	140	165	183	207	243	271	307	337	365	411	
	Wire selected	Max. capacity (A)	73	89	110	135	160	175	206	229	259	304	339	384	421	456	514
		Nominal cross-section (mm)	14	14	22	22	30	30	38	50	60	80	80	100	125	125	150
	NFB AF	100	225	225	225	225	225	250	250	400	400	400	600	600	600	800	
	NFB AT (A)	75	125	125	150	150	150	200	200	250	300	300	400	400	450	500	
	M, D Magnetic contact current (A)	58	71	88	108	128	140	165	183	207	243	271	307	337	365	411	
	S Magnetic contact current (A)	33	41	51	62	74	81	95	106	120	140	156	177	195	211	237	
50 Hz / 415 V	Y star - LRA (A)	113	113	113	124	177	177	177	224	224	276	276	276	345	445	519	
	Δ Delta -LRA (A)	367	367	367	404	563	563	563	717	717	861	861	861	1070	1434	1635	
	RLA (A)	55	68	85	106	125	136	161	180	202	237	266	301	330	356	404	
	Wire selected	Max. capacity (A)	69	85	106	133	156	170	201	225	253	296	333	376	413	445	505
		Nominal cross-section (mm)	8	14	22	22	30	30	38	50	60	80	80	100	125	125	150
	NFB AF	100	225	225	225	225	225	250	250	400	400	400	600	600	600	800	
	NFB AT (A)	75	125	125	150	150	150	200	200	250	300	300	350	400	450	500	
	M, D Magnetic contact current (A)	55	68	85	106	125	136	161	180	202	237	266	301	330	356	404	
	S Magnetic contact current (A)	32	39	49	61	72	79	93	104	117	137	154	174	191	206	233	

Table 21: Electrical data of the BSR series, air-cooled models: 50 Hz, R-134a

50 Hz, R-22/R-407C, air-cooled models (BSR*-HB, BSR***-HC)**

Model		BSR															
		213	216	311	314	316	321	323	324	326	413	415	421	423	424	426	
Rated power (kW)		38	46	56	70	79	87	103	113	122	145	161	183	201	221	247	
50 Hz / 380V	Y star - LRA (A)	124	137	188	257	279	279	331	359	359	445	519	519	634	755	850	
	Δ Delta -LRA (A)	404	438	607	802	888	888	1023	1148	1148	1434	1635	1635	1980	2335	2647	
	RLA (A)	76	93	112	143	165	178	213	236	253	307	334	381	419	461	505	
	Wire selected	Max. capacity (A)	95	116	140	179	206	223	266	295	316	384	418	476	524	576	631
		Nominal cross-section (mm)	14	22	22	30	38	50	60	80	80	100	125	125	200	200	250
	NFB AF		225	225	225	250	250	250	300	400	400	600	600	600	800	800	800
	NFB AT (A)		125	125	150	200	200	200	250	300	300	400	400	450	500	550	600
	M, D Magnetic contact current (A)		76	93	112	143	165	178	213	236	253	307	334	381	419	461	505
	S Magnetic contact current (A)		44	54	65	83	95	103	123	136	146	177	193	220	242	266	292
	50 Hz / 400 V	Y star - LRA (A)	124	137	188	257	279	279	331	359	359	445	519	519	634	755	850
Δ Delta -LRA (A)		404	438	607	802	888	888	1023	1148	1148	1434	1635	1635	1980	2335	2647	
RLA (A)		73	88	108	139	160	172	208	231	246	296	320	364	405	445	488	
Wire selected		Max. capacity (A)	91	110	135	174	200	215	260	289	308	370	400	455	506	556	610
		Nominal cross-section (mm)	14	22	22	30	38	50	60	60	80	100	100	125	150	200	200
NFB AF		225	225	225	250	250	250	400	400	400	600	600	800	800	800	800	
NFB AT (A)		125	125	150	200	200	200	250	300	300	350	400	450	500	550	600	
M, D Magnetic contact current (A)		73	88	108	139	160	172	208	231	246	296	320	364	405	445	488	
S Magnetic contact current (A)		42	51	62	80	92	99	120	133	142	171	185	210	234	257	282	
50 Hz / 415 V		Y star - LRA (A)	124	137	188	257	279	279	331	359	359	445	519	519	634	755	850
	Δ Delta -LRA (A)	404	438	607	802	888	888	1023	1148	1148	1434	1635	1635	1980	2335	2647	
	RLA (A)	71	86	105	137	158	169	206	230	244	292	314	355	399	439	481	
	Wire selected	Max. capacity (A)	89	108	131	171	198	211	258	288	305	365	393	444	499	549	601
		Nominal cross-section (mm)	14	22	22	30	38	50	60	60	80	100	100	125	150	200	200
	NFB AF		225	225	225	250	250	250	400	400	400	600	600	600	800	800	800
	NFB AT (A)		125	125	150	200	200	200	250	300	300	350	400	450	500	550	600
	M, D Magnetic contact current (A)		71	86	105	137	158	169	206	230	244	292	314	355	399	439	481
	S Magnetic contact current (A)		41	50	61	79	91	98	119	133	141	169	181	205	230	253	278

Table 22: Electrical data of the BSR series, air-cooled models: 50 Hz, R-22 / R-407C

Technical data

Model		BSR (50 Hz, R-134a, water-cooled models (BSR***-WA))															
		213	216	311	314	316	321	323	324	326	413	415	421	423	424	426	
Rated power (kW)		19	24	29	36	42	46	54	60	64	77	85	97	106	118	131	
50 Hz / 380V	Y star - LRA (A)	113	113	113	124	177	177	177	224	224	276	276	276	345	445	519	
	Δ Delta -LRA (A)	367	367	367	404	563	563	563	717	717	861	861	861	1070	1434	1635	
	RLA (A)	44	53	65	80	95	104	122	135	153	178	198	227	249	275	295	
	Wire selected	Max. capacity (A)	55	66	81	100	119	130	153	169	191	223	248	284	311	344	369
		Nominal cross-section (mm)	5.5	8	14	14	22	22	30	30	38	50	50	60	80	80	100
	NFB AF	100	100	225	225	225	225	225	250	250	400	400	400	400	600	600	
	NFB AT (A)	50	75	125	125	125	150	150	200	200	250	250	300	300	350	350	
	M, D Magnetic contact current (A)	44	53	65	80	95	104	122	135	153	178	198	227	249	275	295	
	S Magnetic contact current (A)	25	31	38	46	55	60	70	78	88	103	114	131	144	159	170	
	50 Hz / 400 V	Y star - LRA (A)	113	113	113	124	177	177	177	224	224	276	276	276	345	445	519
Δ Delta -LRA (A)		367	367	367	404	563	563	563	717	717	861	861	861	1070	1434	1635	
RLA (A)		43	51	63	77	92	100	117	131	148	172	191	217	241	267	285	
Wire selected		Max. capacity (A)	54	64	79	96	115	125	146	164	185	215	239	271	301	334	356
		Nominal cross-section (mm)	5.5	8	14	14	22	22	30	30	38	50	50	60	80	80	100
NFB AF		100	100	100	225	225	225	225	225	250	250	400	400	400	600	600	
NFB AT (A)		55	75	75	125	125	125	150	150	200	200	250	250	300	300	350	
M, D Magnetic contact current (A)		43	51	63	77	92	100	117	131	148	172	191	217	241	267	285	
S Magnetic contact current (A)		25	29	36	44	53	58	68	76	85	99	110	125	139	154	165	
50 Hz / 415 V		Y star - LRA (A)	113	113	113	124	177	177	177	224	224	276	276	276	345	445	519
	Δ Delta -LRA (A)	367	367	367	404	563	563	563	717	717	861	861	861	1070	1434	1635	
	RLA (A)	40	48	60	75	91	99	115	129	145	170	188	212	238	265	282	
	Wire selected	Max. capacity (A)	50	60	75	94	114	124	144	161	181	213	235	265	298	331	353
		Nominal cross-section (mm)	5.5	8	14	14	22	22	30	30	38	50	50	60	80	80	100
	NFB AF	100	100	100	225	225	225	225	225	250	250	400	400	400	400	600	
	NFB AT (A)	50	75	75	125	125	125	150	150	200	200	250	250	300	300	350	
	M, D Magnetic contact current (A)	40	48	60	75	91	99	115	129	145	170	188	212	238	265	282	
	S Magnetic contact current (A)	23	28	35	43	53	57	66	74	84	98	109	122	137	153	163	

Table 23: Electrical data of the BSR series, water-cooled models: 50 Hz, R-134a

50 Hz, R-22/R-407C, water-cooled models (BSR*-WB, BSR***-WC)**

Model		BSR															
		213	216	311	314	316	321	323	324	326	413	415	421	423	424	426	
Rated power (kW)		31	37	45	57	65	71	84	92	99	118	131	149	163	180	201	
50 Hz / 380V	Y star - LRA (A)	113	124	137	188	224	224	279	331	359	345	445	445	519	634	755	
	Δ Delta -LRA (A)	367	404	438	607	717	717	888	1023	1148	1070	1434	1434	1635	1980	2335	
	RLA (A)	68	83	102	126	149	160	188	211	227	277	306	348	375	413	461	
	Wire selected	Max. capacity (A)	85	104	128	158	186	200	235	264	284	346	383	435	469	516	576
		Nominal cross-section (mm)	14	14	22	30	38	38	50	60	60	80	100	125	125	150	200
	NFB AF		225	225	225	225	250	250	400	400	400	600	600	600	600	800	800
	NFB AT (A)		125	125	125	150	200	200	250	250	300	350	400	450	500	500	550
	M, D Magnetic contact current (A)		68	83	102	126	149	160	188	211	227	277	306	348	375	413	461
	S Magnetic contact current (A)		39	48	59	73	86	92	109	122	131	160	177	201	217	238	266
	50 Hz / 400 V	Y star - LRA (A)	113	124	137	188	224	224	279	331	359	345	445	445	519	634	755
Δ Delta -LRA (A)		367	404	438	607	717	717	888	1023	1148	1070	1434	1434	1635	1980	2335	
RLA (A)		65	79	97	121	143	154	181	206	223	266	295	334	358	400	446	
Wire selected		Max. capacity (A)	81	99	121	151	179	193	226	258	279	333	369	418	448	500	558
		Nominal cross-section (mm)	14	14	22	30	30	38	50	60	60	80	100	125	125	150	200
NFB AF		225	225	225	225	250	250	250	400	400	400	600	600	600	800	800	
NFB AT (A)		125	125	125	150	200	200	200	250	300	300	350	400	400	500	550	
M, D Magnetic contact current (A)		81	99	121	151	179	193	226	258	279	333	369	418	448	500	558	
S Magnetic contact current (A)		47	57	70	87	103	111	130	149	161	192	213	241	259	289	322	
50 Hz / 415 V		Y star - LRA (A)	113	124	137	188	224	224	279	331	359	345	445	445	519	634	755
	Δ Delta -LRA (A)	367	404	438	607	717	717	888	1023	1148	1070	1434	1434	1635	1980	2335	
	RLA (A)	62	77	94	118	141	151	178	205	223	261	291	326	349	394	439	
	Wire selected	Max. capacity (A)	78	96	118	148	176	189	223	256	279	326	364	408	436	493	549
		Nominal cross-section (mm)	14	14	22	30	30	38	50	60	60	80	100	100	125	150	200
	NFB AF		255	225	225	225	250	250	250	400	400	400	600	600	600	800	800
	NFB AT (A)		125	125	125	150	200	200	200	250	300	300	350	400	400	500	550
	M, D Magnetic contact current (A)		62	77	94	118	141	151	178	205	223	261	291	326	349	394	439
	S Magnetic contact current (A)		36	44	54	68	81	87	103	118	129	151	168	188	202	227	253

Table 24: Electrical data of the BSR series, water-cooled models: 50 Hz, R-22 / R-407C

Technical data

Power switch selection (NFB-selection)

- The NFB selection is based on the frame capacity AF and the interrupting / trigger current AT(A).
- After determination of the AT, select the next-larger frame capacity AF:

AT(A) = starting current multiple factor (1.5-2.5) x motor rated current

- Never start two or more compressors at the same time in a water chiller with several compressors.
For different starting sequences, observe the formula:

AT(A) = starting current multiple factor x rated current of the largest motor + total of the rated currents of all other motors

Selection of the magnetic contact elements (MC)

- The I_{th} (thermal continuous current) (across the contact point), along with the operating and control voltages, is the most important factor in selecting the MC.
- The formula is: $I_{th} = \text{rated current of the motor} \times 1.25/\sqrt{3}$

10.3 Compressor dimensions

10.3.1 Outline dimensions SR-Series

Model	Dimensions [mm]												
	A	B	C	D	E	F	G	H	I	J	K	M	L
SR-1(H)	440	230	170	520	594	1336	578	260	448	24	235	-	465
SR-2.3(H)	460	232	188	518	594	1451	629	317	455	24	235	-	485
SR-434(H)	633	250	250	679	632	1440	634	420	277	18	300	699	358
SR-4(H)	817	315	225	751	840	1625	749	302	480	24	728	487	542
SR-5, 561 (H)	817	315	225	751	840	1657	749	334	480	24	728	487	542
SR-6(H)	860	340	255	754	866	1722	848	284	561	26	754	530	577
SR-7(H)	858	340	255	754	866	1753	848	319	561	26	754	530	577
SR-8(H)	930	310	285	771	747	2023	903	372	675	26	325	595	570

The specifications may be changed without notification.

Table 25: Outline dimensions SR-Series [mm]

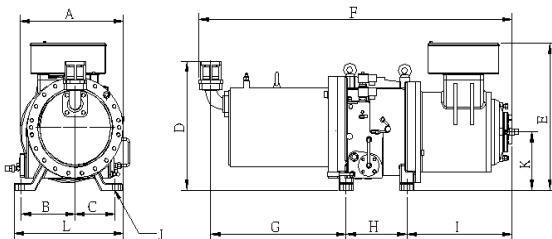


Fig. 30: Outline dimensions SR-1,2,3(H)

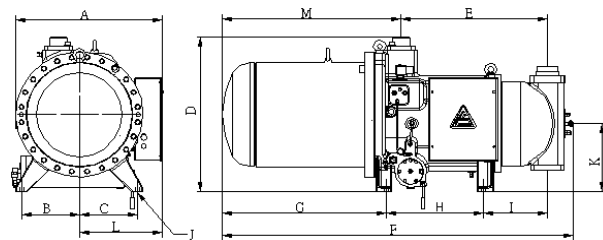


Fig. 31: Outline dimensions SR-434(H)

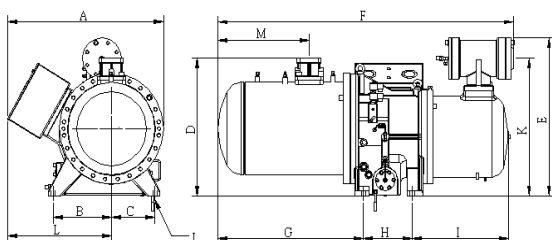


Fig. 32: Outline dimensions SR-4,5,561,6,7(H)

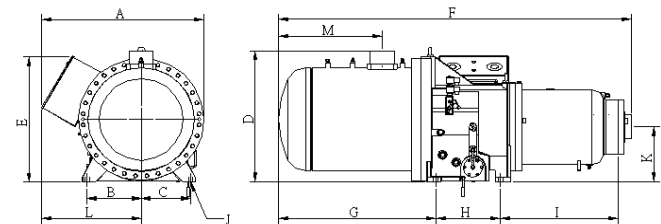


Fig. 33: Outline dimensions SR-8(H)

Technical data

10.3.2 Outline dimensions BSR-Series

Model BSR21X [mm]

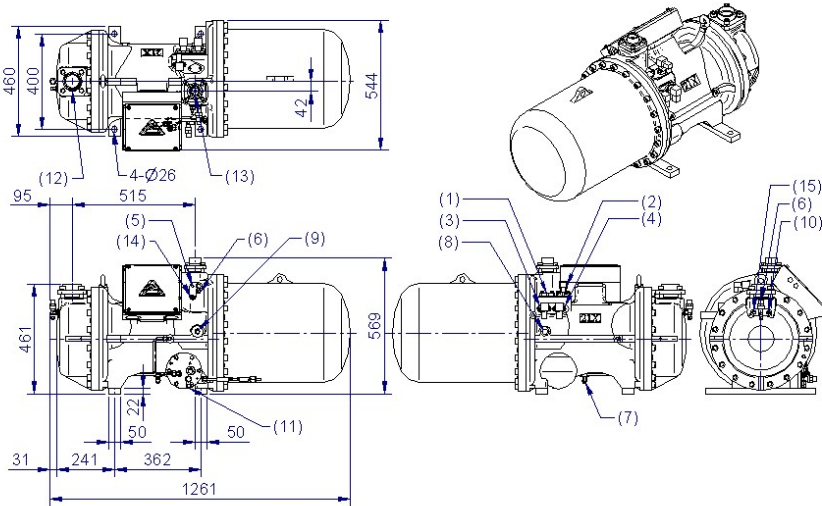


Fig. 34: Compressor dimensions BSR21X (mm)

1. Solenoid valve SV0 (smooth control optional)
2. Solenoid valve SV1 (25 %)
3. Solenoid valve SV2 (50 %)
4. Solenoid valve SV3 (75 %)
5. Low-pressure connection (LP-1/4" flare)
6. High-pressure connection (HP-1/4" flare)
7. Draining connection (3/8" flare)
8. Liquid injection connection (LI-1/2" flare)
9. Economizer port (ECO-3/4" NPT)
10. Spare connection (3/8" angle valve)
11. Draining valve (drain 3/8" angle valve)
12. Suction sleeve (SL, 67(2-5/8"))
13. Discharge sleeve (DL, 42(1-5/8"))
14. Discharge temperature PTC Thermistor (PTC sensor)
15. Spare connection (3/8" NPT)

Model BSR31X [mm]

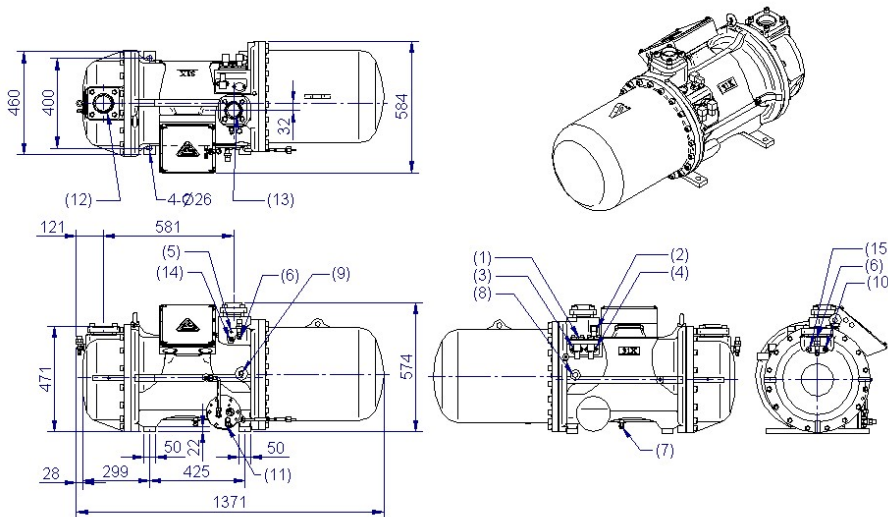


Fig. 35: Compressor dimensions BSR31X (mm)

1. Solenoid valve SV0 (smooth control optional)
2. Solenoid valve SV1 (25 %)
3. Solenoid valve SV2 (50 %)
4. Solenoid valve SV3 (75 %)
5. Low-pressure connection (LP-1/4" flare)
6. High-pressure connection (HP-1/4" flare)
7. Draining connection (3/8" flare)
8. Liquid injection connection (LI-1/2" flare)
9. Economizer port (ECO-3/4" NPT)
10. Spare connection (3/8" angle valve)
11. Draining valve (drain 3/8" angle valve)
12. Suction sleeve (SL, 80(3-1/8"))
13. Discharge sleeve (DL, 67(2-5/8"))
14. Discharge temperature PTC Thermistor (PTC sensor)
15. Spare connection (3/8" NPT)

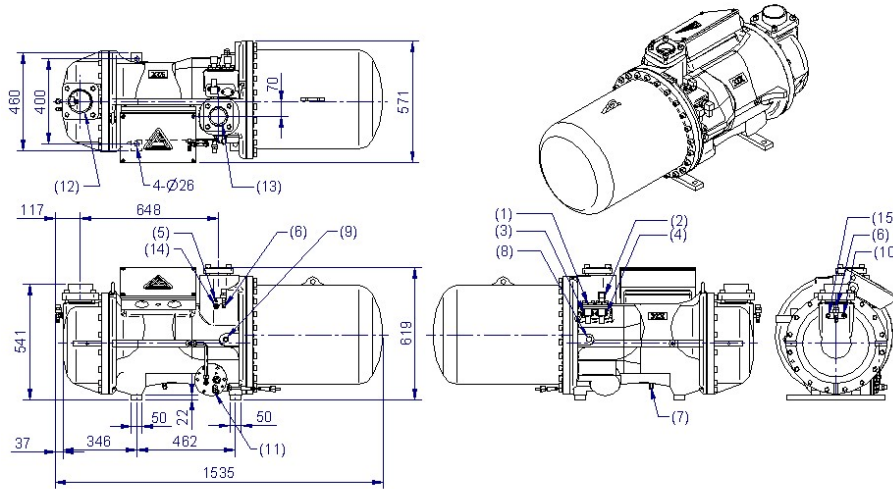
Model BSR32X [mm]


Fig. 36: Compressor dimensions BSR32X (mm)

1. Solenoid valve SV0 (smooth control optional)
2. Solenoid valve SV1 (25 %)
3. Solenoid valve SV2 (50 %)
4. Solenoid valve SV3 (75 %)
5. Low-pressure connection (LP-1/4" flare)
6. High-pressure connection (HP-1/4" flare)
7. Draining connection (3/8" flare)
8. Liquid injection connection (LI-1/2" flare)
9. Economizer port (ECO-3/4" NPT)
10. Spare connection (3/8" angle valve)
11. Draining valve (drain 3/8" angle valve)
12. Suction sleeve (SL, 104(4"))
13. Discharge sleeve (DL, 80(3-1/8"))
14. Discharge temperature PTC Thermistor (PTC sensor)
15. Spare connection (3/8" NPT)

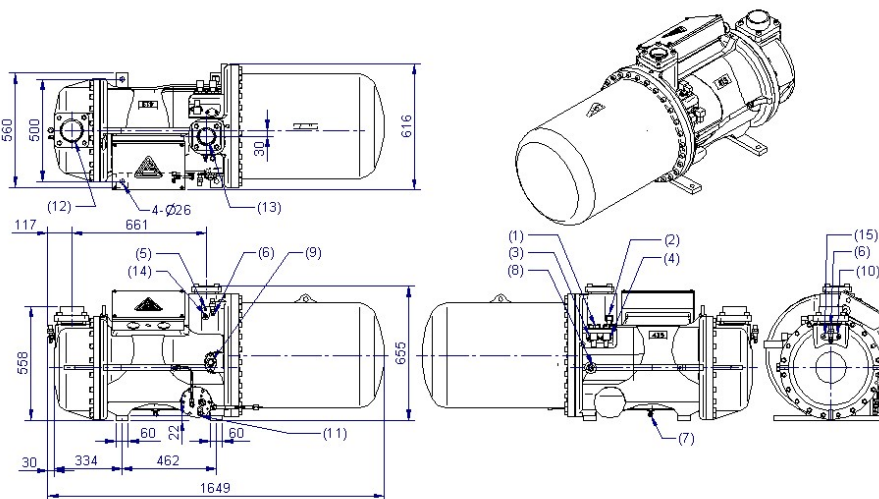
Model BSR41X [mm]


Fig. 37: Compressor dimensions BSR41X (mm)

1. Solenoid valve SV0 (smooth control optional)
2. Solenoid valve SV1 (25 %)
3. Solenoid valve SV2 (50 %)
4. Solenoid valve SV3 (75 %)
5. Low-pressure connection (LP-1/4" flare)
6. High-pressure connection (HP-1/4" flare)
7. Draining connection (3/8" flare)
8. Liquid injection connection (LI-3/4" flare)
9. Economizer flange (ECO 1")
10. Spare connection (3/8" angle valve)
11. Draining valve (drain 3/8" angle valve)
12. Suction sleeve (SL, 104(4"))
13. Discharge sleeve (DL, 80(3-1/8"))
14. Discharge temperature PTC Thermistor (PTC sensor)
15. Spare connection (3/8" NPT)

Technical data

Model BSR42X [mm]

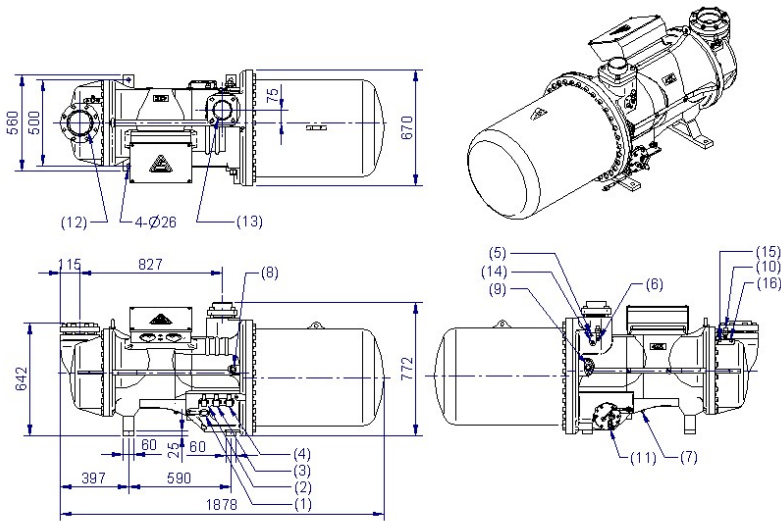


Fig. 38: Compressor dimensions BSR42X (mm)

1. Solenoid valve SV0 (smooth control optional)
2. Solenoid valve SV1 (25 %)
3. Solenoid valve SV2 (50 %)
4. Solenoid valve SV3 (75 %)
5. Low-pressure connection (LP-1/4" flare)
6. High-pressure connection (HP-1/4" flare)
7. Draining connection (3/8" flare)
8. Liquid injection connection (LI-3/4" flare)
9. Economizer flange (ECO 1")
10. Spare connection (3/8" angle valve)
11. Draining valve (drain 3/8" angle valve)
12. Suction sleeve (SL, 125(5"))
13. Discharge sleeve (DL, 104(4"))
14. Discharge temperature PTC Thermistor (PTC sensor)
15. Spare connection (3/8" NPT)

10.3.3 Connection flange dimensions Suction

SR-Series

Model	A	B	C	D	E	F	G	H	P.C.D.
SR-1-3(H)	65	54	50	98	5	20	25	40	130
SR-4/5/561/6/7 (H)	112	92.5	90	145	6	26	33	48	185
SR-8(H)	140	131	126	211.5	9	35	30	80	260
SR-434(H)	93	80	76	110	5	35	73	-	140

Table 26: Suction flange dimensions [mm]

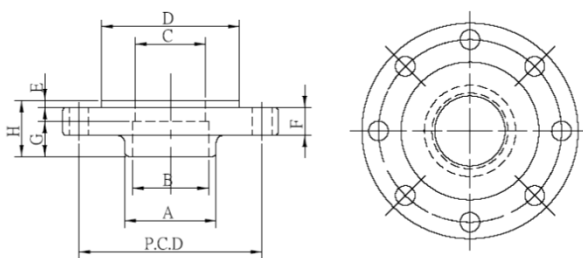


Fig. 39: Suction flange SR-1-3 (H)

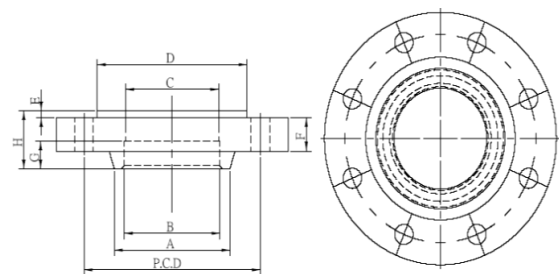


Fig. 40: Suction flange SR-4/5/561/6/7 (H)

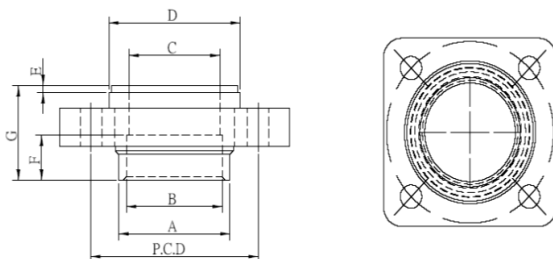


Fig. 41: Suction flange SR-434 (H)

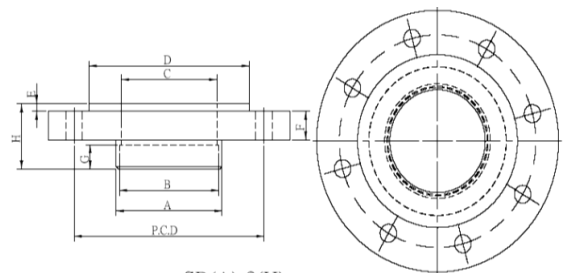


Fig. 42: Suction flange SR-8H

Technical data

BSR-Series

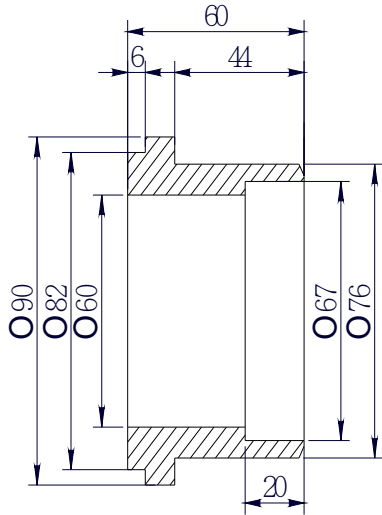


Fig. 43: Suction sleeve dimension BSR21X

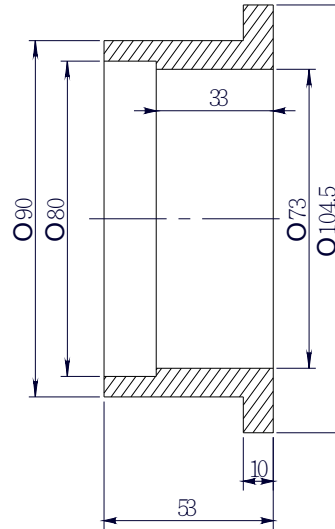


Fig. 44: Suction sleeve dimension BSR31X

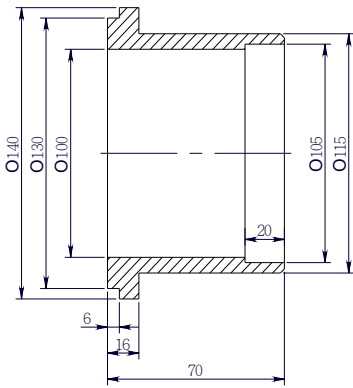


Fig. 45: Suction sleeve dimension BSR32X-41X

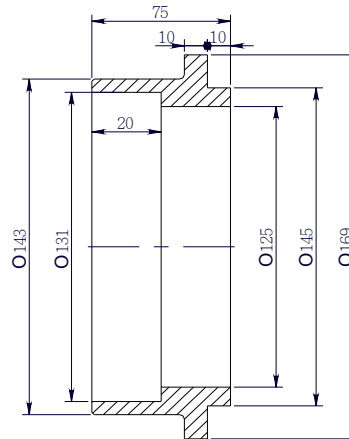


Fig. 46: Suction sleeve dimension BSR42X

10.3.4 Connection flange dimensions Discharge

SR-Series

Model	A	B	C	D	E	F	G	H	P.C.D.
SR-1-3(H)	46	41.5	58	70	6	15	26	-	90
SR-4/5/561/6/7 (H)	77.2	66	90	110	6	24	40	-	140
SR-8(H)	115	100	130	140	6	-	90	-	170
SR-434(H)	76	67	60	90	6	20	20	60	110

Table 27: Discharge flange dimensions [mm]

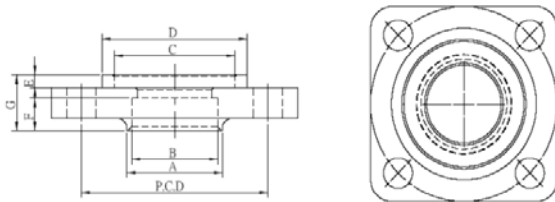


Fig. 47: Discharge flange SR-1-3(H)

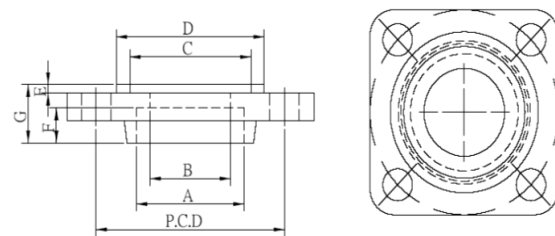


Fig. 48: Discharge flange SR-4/5/561/6/7 (H)

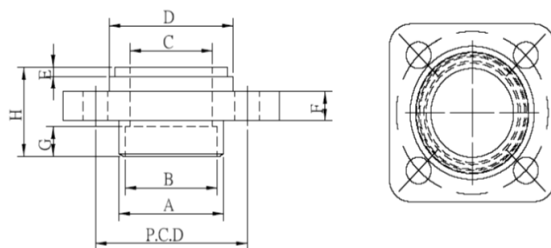


Fig. 49: Discharge flange SR-434(H)

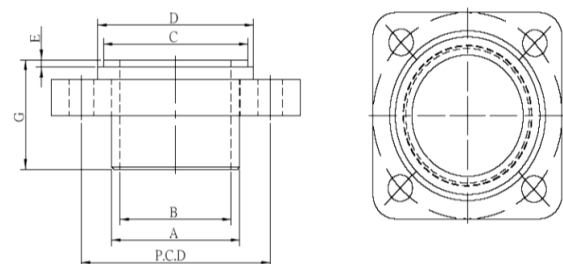


Fig. 50: Discharge flange SR-8(H)

Technical data

BSR-Series

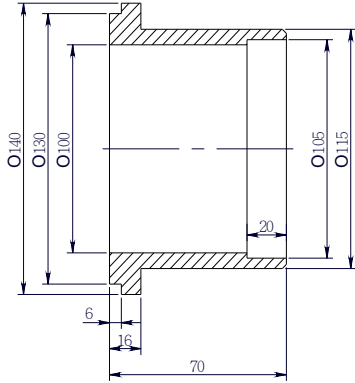


Fig. 51: Discharge sleeve dimension BSR21X

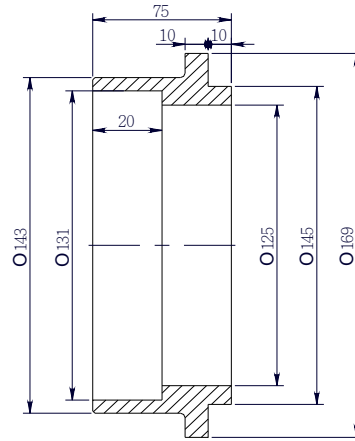


Fig. 52: Discharge sleeve dimension BSR31X

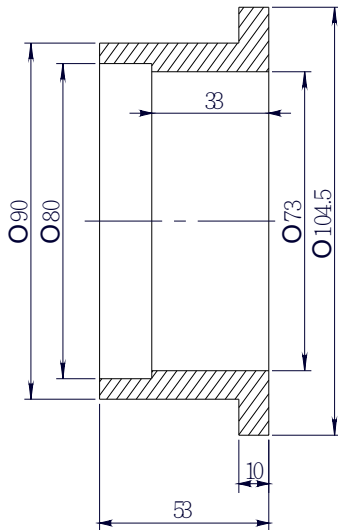


Fig. 53: Discharge sleeve dimension BSR32X-41X

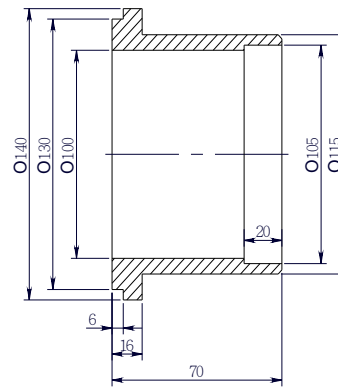


Fig. 54: Discharge sleeve dimension BSR42X

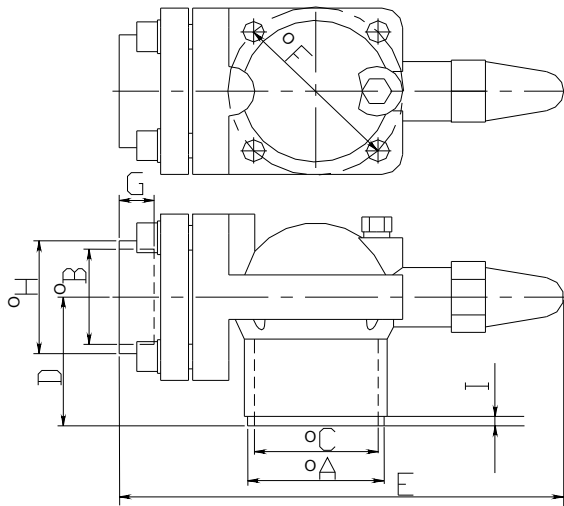
10.3.5 Service valve dimension


Fig. 55: Service valve (1-5/8", 2-5/8", 3-1/8", 4")

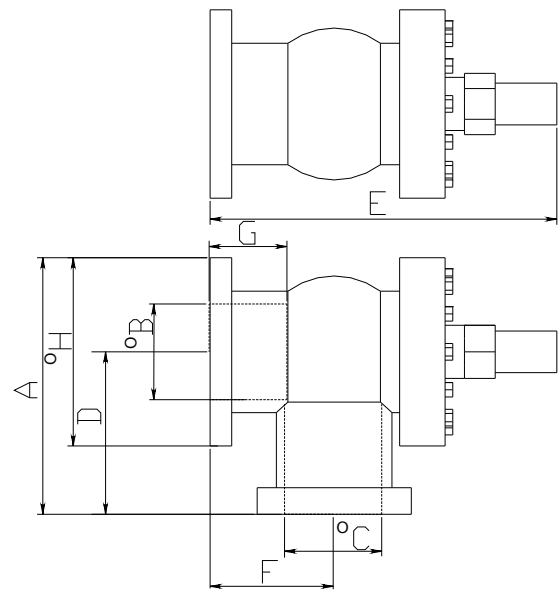


Fig. 56: Service valve (5")

Dimensions service valve [mm]

Dimensions Position	Dimensions				
	1-5/8 "	2-5/8 "	3-1/8 "	4 "	5 "
A	70	81.5	105	130	338
B	42	67	80	105	135
C	54	65	85	111	126
D	47	64	79	95	214
E	257	317	357	440	450
F	90	110	140	173	161
G	24	28	32	50.5	35
H	48.5	77	88.5	114.5	154
I	8	8	6	6	-

Table 28: Dimensions service valve [mm]

Technical data

Rated size service valve

Model \ Valve		Service valve suction	Service valve discharge
BSR213	SR-1(H)	2-5/8 "	1-5/8 "
	SR-2(H)		
BSR216	SR-3(H)		
BSR311	SR-434(H)	3-1/8 "	2-5/8 "
BSR314			
BSR316			
	SR-4(H)	4 "	2-5/8 "
	SR-5/561(H)		
BSR321	SR-6(H)	4 "	3-1/8 "
BSR323			
BSR324			
BSR326	SR-7(H)		
BSR413			
BSR415			
BSR421	SR-8(H)	5 "	4 "
BSR423			
BSR424			
BSR426			

Table 29: Rated size of the service valve

10.4 Required maintenance space

10.4.1 Required maintenance space for the SR-series

Position \ Model	Model									
	SR-1(H)	SR-2(H)	SR-3(H)	SR-434(H)	SR-4(H)	SR-5(H)	SR-561(H)	SR-6(H)	SR-7(H)	SR-8(H)
A	15	15	15	12	-	-	-	-	-	20
B	27	27	27	27	27	27	27	27	27	27
C	30	30	30	35	35	35	35	40	40	45
D	30	30	30	30	35	35	35	40	40	45
E	15	15	15	15	15	15	15	15	15	15
F	10	10	10	10	10	10	10	10	10	10

Table 30: Required maintenance space for the SR-series [cm]

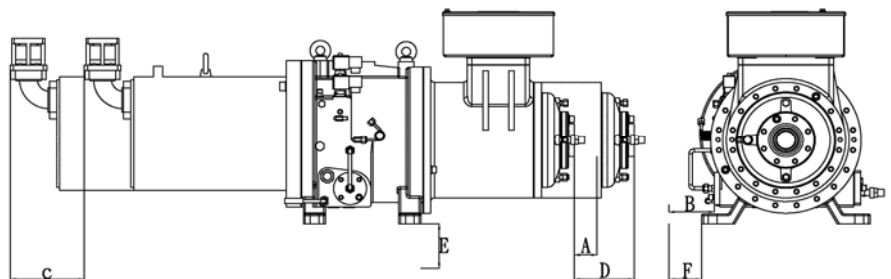


Fig. 57: SR-1~3(H)

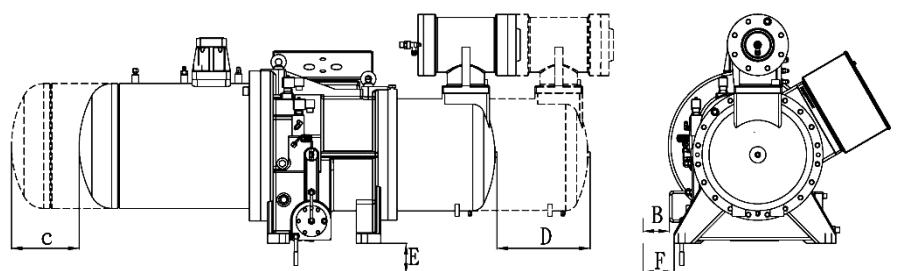


Fig. 58: SR-4~7(H)

Technical data

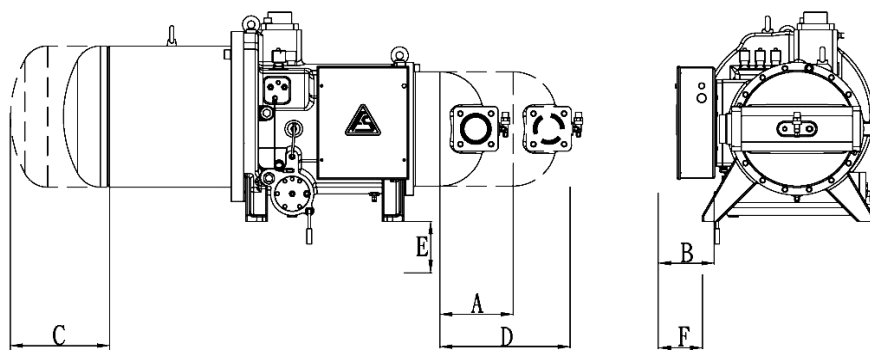


Fig. 59: SR-434(H)

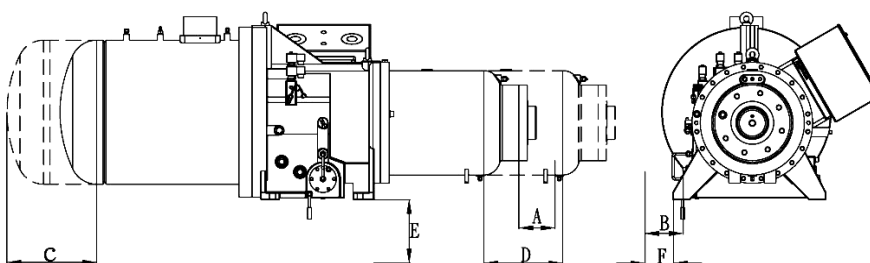
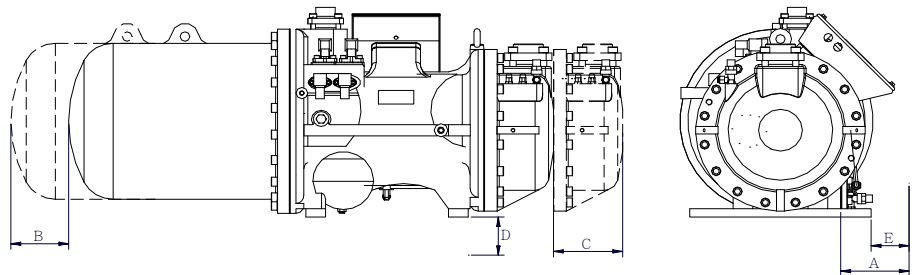
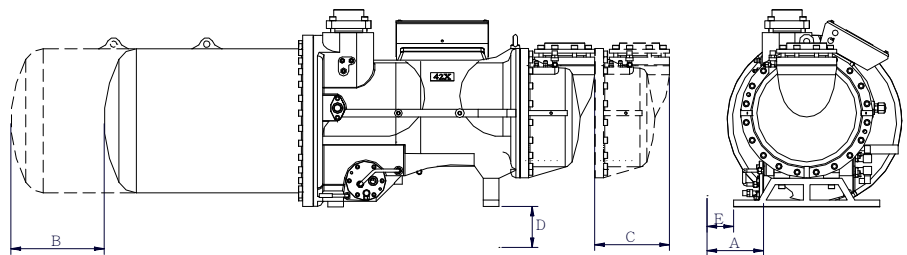


Fig. 60: SR-8(H)

10.4.2 Required maintenance space for the BSR-series

Position	Model				
	BSR21X	BSR31X	BSR32X	BSR41X	BSR42X
A Oil filter	25	25	25	25	25
B Oil separator	35	40	40	45	45
C Suction filter	20	20	20	20	20
D Vertical distance to the compressor base	15	15	15	15	15
E Horizontal distance to the compressor base	10	10	10	10	10

Table 31: Required maintenance space for the BSR-series [cm]

Fig. 61: BSR21X~41X

Fig. 62: BSR42X

Technical data

10.5 Electrical specifications

10.5.1 Electric wiring configuration (SR series)

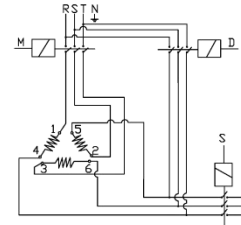
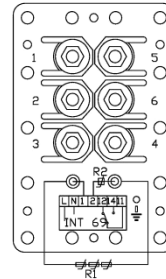
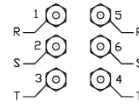
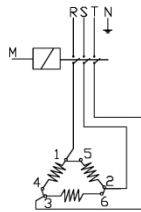
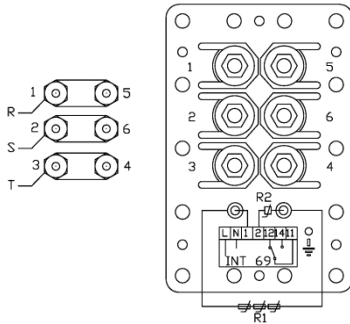


Fig. 63: Wiring configuration direct-on-line switching

Fig. 64: Wiring configuration star-delta switching

Note / attention Maximum permissible torque of the connection nuts: M12 : 50Nm ; M14 : 60Nm

R1: Motor Thermistor PTC

M, S: Start contactors

11/14: Control switching contact (NO) normally open

R2: End temperature thermistor PTC

M, D: Running contactors

11/12: Control switching contact (NC) normally closed

R-S-T: Power supply

L/N: Phase/Neutral 230V (115V) – 50 Hz/60Hz

1/2: Connection Thermistor (INT69)

Recommended wire diameter

Wire cross section (mm ²)	14	22	30	38	50	60	80	100	125	150	200	250	325	400	500
Permissible current (A)	55	70	90	100	120	140	165	190	220	250	300	355	415	475	535

Note: The conductors do not include the grounding line, zero line or signal line.

Table 32: Recommended wire cross-sections [mm²] SR series

10.5.2 Electric wiring configuration (BSR series)

Model BSR21X~31X

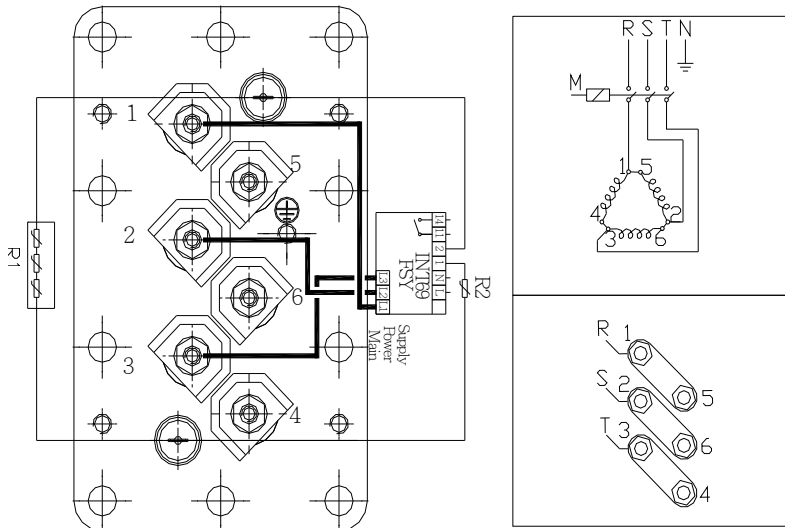


Fig. 65: Wiring configuration direct-on-line switching

Note / Attention: Maximum permissible torque of the connection nuts: 20 Nm

R1: Motor thermistor

R2: End temperature thermistor

R-S-T: Power supply

M: Main switch power supply

L/N: Phase/Neutral 230V (115V) – 50 Hz/60Hz

M1/M2: Protection circuit switching contact (NO) normally open

S1/S2: Connection for thermistor (INT69 FSY)

L1-L2-L3: Phase sequence / loss monitoring switch

Technical data

Model BSR21X~31X

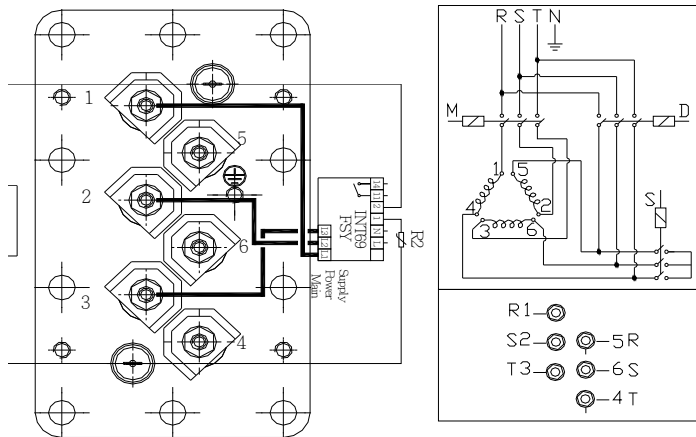


Fig. 66: Wiring configuration star-delta switching

Note / Attention: Maximum permissible torque of the connection nuts: 20 Nm

- | | | |
|--------------------------------|--|---|
| R1: Motor thermistor | L/N: Phase/Neutral 230V (115V) – 50 Hz/60Hz | L1-L2-L3: Phase sequence / loss monitoring switch |
| R2: End temperature thermistor | M1/M2: Protection circuit switching contact (NO) normally open | S: Start contactors |
| R-S-T: Power supply | S1/S2: Connection for thermistor (INT69 FSY) | D: Running contactors |
| M Main switch power supply | | |

Model BSR32X~42X

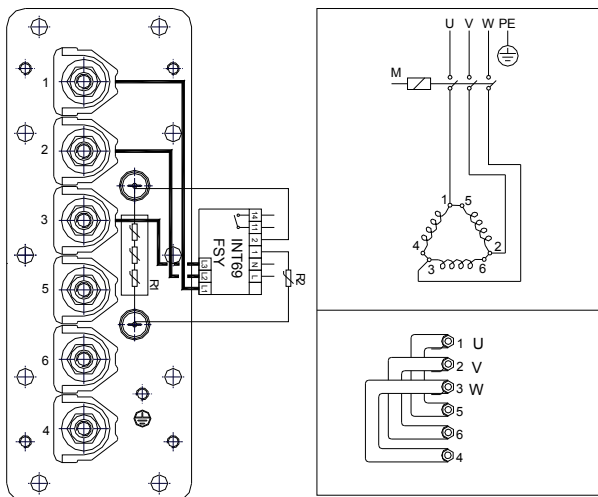


Fig. 67: Wiring configuration direct-on-line switching

Note / Attention: Maximum permissible torque of the connection nuts: 32 Nm

- | | | |
|--------------------------------|--|---|
| R1: Motor thermistor | M Main switch power supply | S1/S2: Connection for thermistor (INT69 FSY) |
| R2: End temperature thermistor | L/N: Phase/Neutral 230V (115V) – 50 Hz/60Hz | L1-L2-L3: Phase sequence / loss monitoring switch |
| R-S-T: Power supply | M1/M2: Protection circuit switching contact (NO) normally open | |

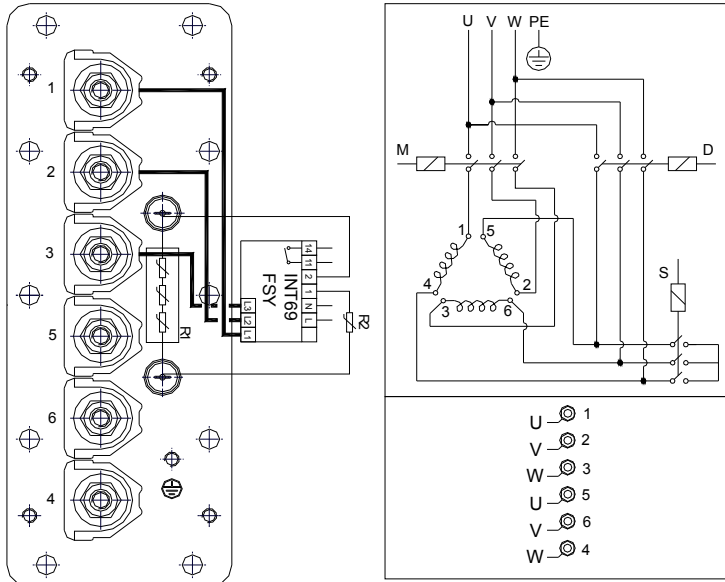
Model BSR32X~42X


Fig. 68: Wiring configuration star-delta switching

Note / Attention: Maximum permissible torque of the connection nuts: 32 Nm

R1: Motor thermistor

R2: End temperature thermistor

R-S-T: Power supply

M Main switch power supply

L/N: Phase/Neutral 230V (115V) – 50 Hz/60Hz

M1/M2: Protection circuit switching contact (NO) normally open

S1/S2: Connection for thermistor (INT69 FSY)

L1-L2-L3: Phase sequence / loss monitoring switch

S: Start contactors

D: Running contactors

Recommended wire diameter

Wire cross section (mm ²)	14	22	30	38	50	60	80	100	125	150	200	250	325	400	500
Permissible current (A)	55	70	90	100	120	140	165	190	220	250	300	355	415	475	535

Note: The conductors do not include the grounding line, zero line or signal line..

 Table 33: Recommended wire cross-sections [mm²] BSR series



Technical data

Start-up sequence

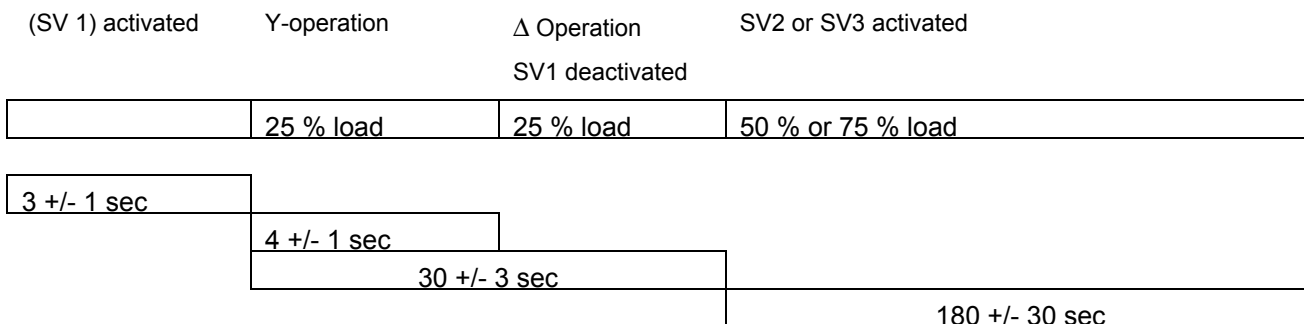
Switching from Y-Δ:

The switch-over time of the magnetic contact must be below 40 ms.

Observe the capability to eliminate light arcs when setting the switch-over time.

After completing the entire starting process, observe the returned chilled water temperature. If this temperature is too low, the load is below the rated load. In this case, frequent turn-on procedures will occur; the compressor's service life is reduced if the compressor runs at full load right after start-up.

This leads to the recommended control sequence of the compressor (load increase/reduction):



Recommended control sequence of the compressor load increase/reduction

Use the temperature of the returning cold water (chilled water) or hot water as parameter for load increase/reduction for stable operation.

- If the capacity control of the compressor is based on the temperature of the chilled water and the temperature is above 11°C, the compressor will run at a load of 100%.
- At a temperature of 11-10°C, the compressor runs at a load of 75%.
- At a temperature of 10-9°C, the compressor runs at a load of 50%.
- At a temperature of less than 8°C, the compressor switches off.

If reactivation of the compressor would be set to a temperature of 9°C the motor would start/stop very frequently. The short start/stop cycle prevents heat collected in the motor winding from being completely dissipated through the cooling system. The lubrication circuit is also insufficient.

To avoid this, the switch-on temperature must be at 12°C or above.

Before any deactivation, the compressor should run at a load of 25% for 20 - 30 seconds so that the control slider is put securely in the starting position for the next start-up.

10.6 Scope of delivery

Description	Model		
	SR	SR-H	BSR
Suction flange, gasket, plug / flange plate	S	S	S
Discharge flange, gasket, plug / flange plate	S	S	S
Suction filter	S	S	S
Oil filter	S	S	S
2 solenoid valves (start/smooth capacity control)	S	S	S
PTC-temperature protection for motor winding	S	S	S
Refrigeration oil	S	S	S
Oil heating	S	S	S
Oil level switch	S	S	S
PTC-end temperature protection	S	S	S
Oil drain valve	S	S	S
Economizer injection port – compression chamber	S	S	S
Liquid injection port – motor side	S	S	S
Connection for oil cooler (external)	N	S	S
Non-asbestos gaskets	S	S	S
Discharge check valve	S	S	S
Safety valve, discharge	O	S	S
Suction service valve	O	S	S
Discharge service valve	O	S	S
Anti-vibration pad	O	O	O
Capillary tube for liquid refrigerant injection	O	O	O
Electrical protection module INT69 / INT69FSY	S	S	S

S = Standard, O = Optional, N = Not applicable

Table 34: Supply list

Technical data

Oil heating	Model: 150 W or 300 W Standard voltage: 220V Other voltages available on request. Insulation value: 50M Ω or higher, measured with DC500V Mega-Ohmmeter.
Oil level switch	Insulation value: 10M Ω or higher, measured with DC200V Mega-Ohmmeter. Max. permissible voltage: AC230V Max. permissible current: 0.5A Dry-running protection: Opens at low oil level, remains closed at high oil level
PTC Control module for motor and discharge temperature: INT69 / INT69FSY	Voltage: 230V, 1 Phase (115V available on request) Relay: AC240, 2,5A 360VA, SPDT, Auto Reset.
PTC Temperature protection for motor winding	Max. permissible voltage for resistance measurement: DC 2.5V Resistance for ambience temperature: below 750 Ω Insulation resistance: 600V AC
PTC End temperature protection	Max. permissible voltage for resistance measurement: DC 2.5V Resistance for ambience temperature: below 550 Ω Insulation resistance: 600V AC
Solenoid valves	Standard control voltage 220V (Other voltages available on request)

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