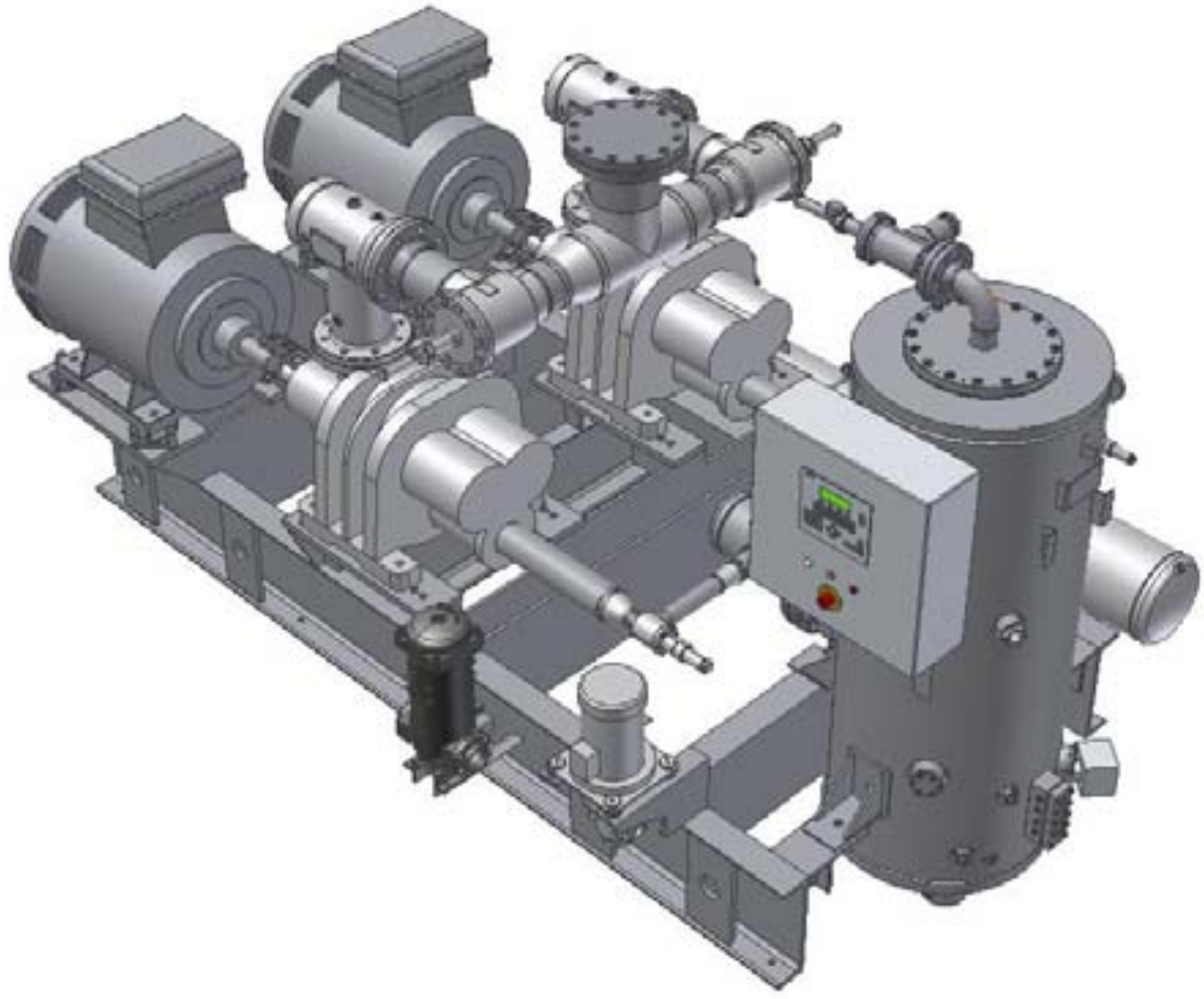
GEA Grasso
Refrigeration Division

Screw Compressor Packages
Grasso SPduo
Large Series

Operating manual



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Process flow diagram

The Grasso Duo Pack LARGE series of screw compressor packages consists of the following main assemblies and components:

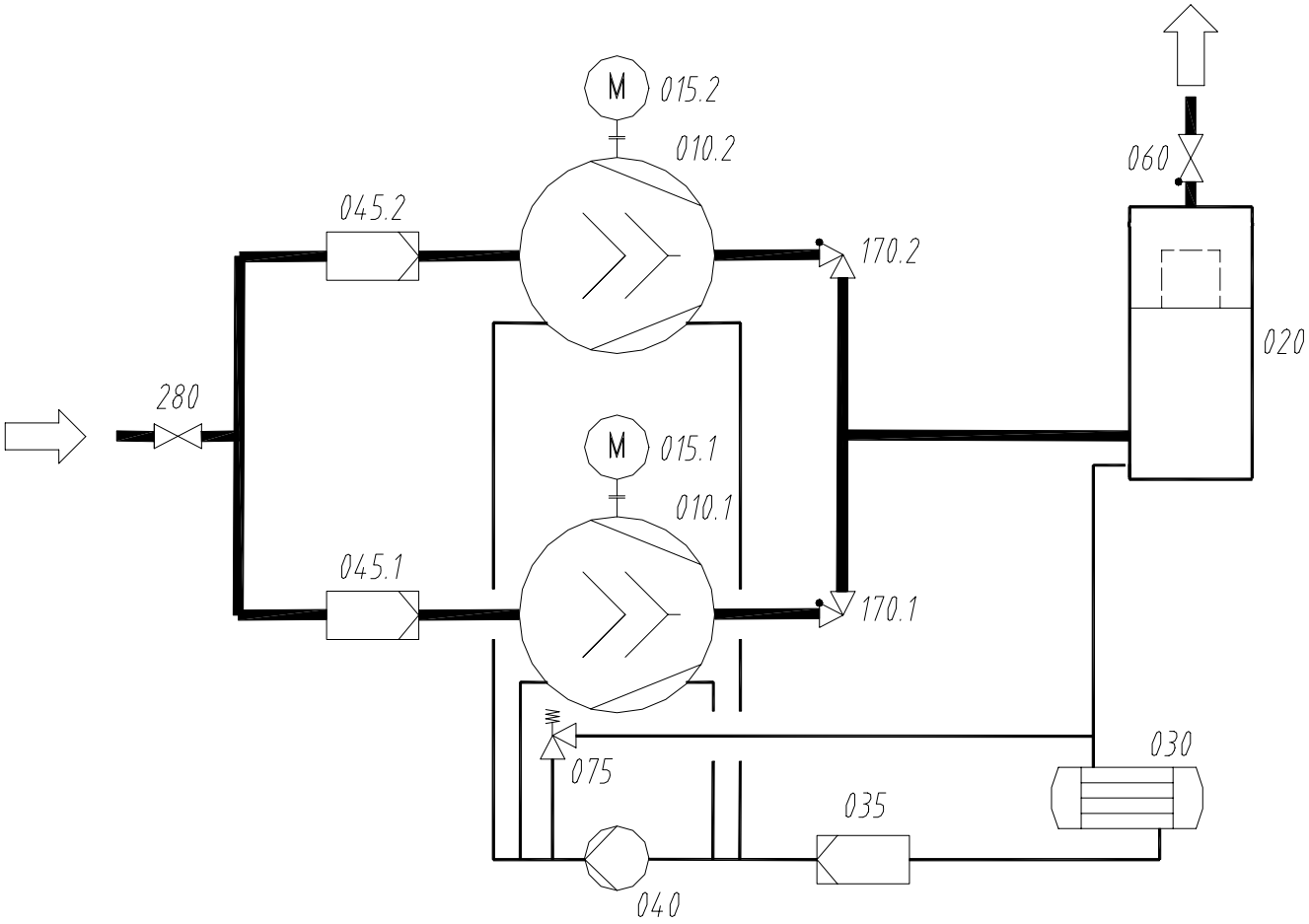


Figure 1: Process flow diagram: Duo Pack LARGE screw compressor package

010*	screw compressor
015*	compressor drive motor
020	oil separator
030	water-cooled oil cooler (Design also possible as coolant-cooled oil cooler, Item 200)
035	oil filter
040	oil pump
045*	suction filter
060	check valve - discharge side
075	oil pressure regulating valve
170*	check valve – compressor discharge side
280	stop valve – suction side
*	designed for each screw compressor

Mode of operation

Screw compressor packages Series DUO PACK LARGE are refrigeration system components and serve to compress refrigerants such as ammonia and R22 (other operating media - as R134a, R404a, R507 - on request).

Operation as heat pump is also possible.

Refrigerant circuit

The screw compressors draw in refrigerant vapour via the suction filters and then discharges the compressed vapour into the plant via the check valves (on screw compressors discharge side) and the oil separator.

The discharge check valve prevents refrigerant from re-condensing in the oil separator.

The discharge check valve is built into the oil separator for Screw Compressor Packages with nominal sizes for the discharge side check valve up to NB 150.

The suction filter prevents dirt particles entrained in the suction flow from entering the compressor. The filter element features a very large filtering surface which is provided by the star-type folding of the element. The mesh size is 60 µm.

Gas oscillations which can arise in the compressor compression chamber at high pressure ratios during near zero delivery are avoided by a gas oscillation protection device. This consists of a pressure equalisation line between the oil separator and the compressor working chamber.

This pressure equalisation line is only used with compressors that have an internal volume ratio Vi ≥ 3.6, because only these compressors reach the critical pressure ratio $\frac{p}{p_o} \geq 8$.

Oil Circuit

The screw compressors are run with oil overfeed. Refrigeration compressor oil is fed to the compressors during the compression process for lubrication, sealing, noise reduction and to remove some of the heat of compression. After the compression process, the oil is separated from the refrigerant in the oil separator.

The oil supply for both compressors in the Duo Pack is realised via an oil pump and an oil coiler in the oil circuit.

oil Separation

The refrigerant-oil mixture is led into the lower part of the vertical oil separator. There, the first step of oil separation is performed by a combined agglomerator/ demister. The lower part of the oil separator is also used as an oil receiver.

The fine separation of the aerosol-type oil portion from the refrigerant is carried out in the upper part of the oil separator by means of coalescing cartridges. The oil separated in the fine section of the oil separator is returned to the compressors suction side via an additional injection orifice.

Oil Cooling

Before the oil which has been heated in the compressor can be returned to the compressor for re-use, it must be cooled to a temperature that ensures a sufficient oil viscosity.

oil filter

After cooling, the oil passes into the oil filter which holds back solid particles from the full oil flow.

The star-folded glass fibre element has, due to its large surface area, a large retention capacity and therefore a long service life. The filter has a fineness of 10 - 15 µm.

oil pump

The oil pump runs for pre- and during compressor operation.

It draws the refrigeration compressor oil from the receiver space in the oil separator, through the oil cooler and oil filter and pumps it to the bearings, the balance piston, the shaft seal, to the capacity control system and, if fitted, to the compressor's hydraulic Vi adjustment system.

The oil pump pumps more oil than the compressor uses. This surplus quantity of oil is returned to pump suction via the spring loaded oil pressure regulating valve. The check valve controls the pressure difference Δp between the discharge and suction sides of the pump.

The set value Δp is given in the R+I flow chart

Oil injection

The injection oil is fed without a pump via the oil injection regulating valves.

The required compressor discharge temperature is set via the oil injection regulating valves.

The oil injection regulating valve has a built-in non-return function to prevent refrigerant from being drawn into the oil pump.

Function oil

Compressor is fed with function oil from a second compressor port. The functional oil ensures the oil supply to the bearings, the compensation piston, and the gland.

Pump pressure supplies the compressor with function oil.

Solenoid valves oil supply

Solenoid valves are used to supply the screw compressor with oil. They prevent continued oil feed if the compressor is shutdown or the MIN end position of the corresponding compressor's control slide is reached.

The solenoid valves are switched via the controls. Further information is given in the GSC controls manual.

Oil circuit, miscellaneous

A multi-function block (MF-block) is flanged on oil filter as an oil distribution system (Standard). The oil flow is distributed via the bore-holes and drains to different sections of the screw compressor. All for controlling the oil circuit necessary fittings and valves are integrated in the MF-block. Thus, a concentrated operator unit is available for the screw compressor package (see product description).

The oil filter with MF-block is fitted with an oil drain and refilling stop valve which may be connected to a separate oil pump or receiver.

Vent valves are fitted to the suction and oil filters for maintenance and repair purposes.

SAFETY DEVICES

Rated current limiter (016) Safety device of the compressor driving motor	Rated Current limitation is provided by the present compressor control system. When the rated motor current is exceeded, the compressor capacity control slide is driven in the MIN direction until the motor current reaches an allowable level. The normal capacity control is then enabled again.
Thermistor motor protection (017) Safety device of the compressor driving motor	Thermistor which shuts down the compressor drive motor when its winding temperature limit has been exceeded.
Thermistor motor protection (018) Safety device of the compressor driving motor	Pt100 which shuts down the compressor drive motor when its winding temperature limit has been exceeded.
check valve - discharge side (060)	prevents refrigerant re-condensing into the oil separator.
Oil pressure regulating valve (075)	regulates the oil differential pressure between the oil pump suction and discharge sides. The oil pressure regulating valve is integrated into the multifunction block (Standard). The oil pressure regulating valve is separately mounted for special operating conditions with external oil filter. **Set value:** see specifications and und R+I flow chart
Discharge pressure transducer (105) Safety devices to prevent the discharge pressure from being exceeded	The compressor control switch off the drive motor when the discharge temperature limit has been exceeded. **Limit value p** = see Technical Data
Oil circuit monitoring Safety device to prevent the differential pressure between the oil pressure after oil pump **(pressure transducer 110)** and the compressor discharge pressure **(pressure transducer 105)** from falling too low	When the pressure difference between oil pressure after oil pump and compressor discharge pressure falls below the specified limit value. **Limit value Δp** = see Specifications
Resistance thermometer (120) Safety device to prevent the discharge temperature from being exceeded	The compressor control switch off the drive motor when the discharge temperature limit has been exceeded. **Limit value t** = see Specifications

Resistance thermometer (125)
Safety device to prevent the oil temperature from being exceeded

The compressor control switch off the drive motor when the discharge temperature limit has been exceeded.

Limit value t_{oil} (refrigerant ammonia) = see Specifications
Limit value t_{oil} (refrigerant R 22) = 45 ± 5 °C
Other refrigerants on request.

The minimum oil viscosity for safe compressor operation is ≥ 7 cSt. With refrigerant soluble oils, it should be guaranteed that the minimum oil viscosity is maintained depending on the discharge pressure and temperature, oil temperature, as well as the type of oil. The oil temperature for R22 is thus only a standard value.

Pressure relief valve (340)

protects the compressor against impermissibly high pressures. The pressure relief valve must be connected with the suction pipe on site.
Pickup pressure see specifications and R+I flow chart

The pressure relief valve must be connected to the suction side on installing the package in the refrigeration plant.

Safety valve (345)
on oil separator

protects the screw compressor package against impermissibly high pressure.

Blow-off pressure see specifications and R+I flow chart

If the screw compressor package is integrated in refrigeration plant with an emergency blow-off station, only the connection at the oil separator is used.

available as an option, depending on the required acceptance

Safety pressure limiter (350)

with two separate reset lockout device, of which one can only be reset using tools (see UVV VBG 20). The safety pressure limiter shuts down the compressor's drive motor if the compression discharge pressure exceeds the set value.

Switching off pressure 1 see Specifications
Switching off pressure 2 see Specifications

If the oil separator cannot be precluded from filling up with liquid by more than 90% of its volume, the purchaser must provide an additional safety valve against liquid pressure at the oil separator. The design is in compliance with DIN 8975-7, 7.5.1.1.

Thermostat (361)
oil heater

Setpoint see Specifications

Temperature limiter (362)
oil heater

shuts down the oil heating if a certain surface temperature is exceeded at the oil heating.

CAPACITY CONTROL

All screw compressors used in the package series are fitted with a continuous capacity control with a range of 25 -100 %.

The capacity is adjusted by shortening the compressor stroke. The defining factor for the compression process is the effective rotor length; this is altered by a hydraulically operated control slide.

The position of the control slide is indicated by the position transducer. The compressor controller indicates optically by LED means that the MIN or MAX end position has been reached. The display can indicate the slide position relative to its full load position in percent.

The hydraulic slide adjustment is controlled by four solenoid valves which are contained in one block.

The control slide travel speeds in the MIN and MAX directions should be approximately the same during operation to ensure better compressor control.

START UP

Screw compressor Type P, R, S, V, Y

The solenoid valve block for capacity control is external located for screw compressors type P, R, S, V and Y.

During start-up of the screw compressor package, the oil pump runs for generating the oil pressure required for control slide adjustment.

One of the start-up requirements for the compressor drive motor is that the control slide of the compressor be in its MIN end position.

If the control slide of the compressor is not in its MIN end position, the command to reduce capacity is given and the control slide is driven to its MIN end position.

The solenoid valve block can be used for all compressors with fixed Vi at all operating conditions. The solenoid valves are pulsed by the control system and energised in pairs.

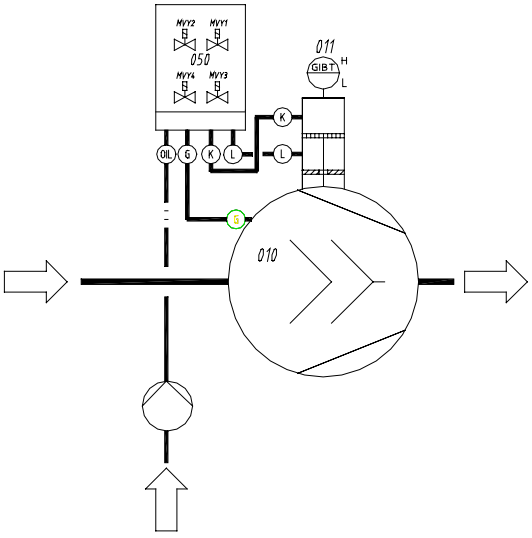


Figure 2: block with 4 solenoid valves

010	screw compressor
011	control slide position indicator
050	solenoid valve block – capacity control
(K)–(K)	oil supply capacity control, control direction: part load
(L)–(L)	oil supply capacity control, control direction: full load
(G)–(G)	oil return capacity control
(Oil)	pressure oil port of oil pump

	SV Y1	SV Y2	SV Y3	SV Y4
capacity ↑	open	closed	closed	open
capacity ↓	closed	open	open	closed

The capacity control slide travel speed in the MIN direction is determined by the fine adjustment of the position screw (S6). The capacity control slide travel speed in the MAX direction is determined by the fine adjustment of the position screw (S5). The position screw (S7) is opened approximately 2 turns and is only operated when, despite a fully opened adjustment screw (S6), the capacity control slide travel speed in the MAX direction is too slow.

The pressure limitation valve (DV) guarantees a maximal overpressure Δp = 6 bar in relation to suction pressure (for travel speed in the MAX direction). The adjusting speed is decreased by throttling screws S5 and S6.

The adjustment screws S5, S6 and S7 as well as the pressure limiting valve DV are integrated into the solenoid valve block for capacity control.

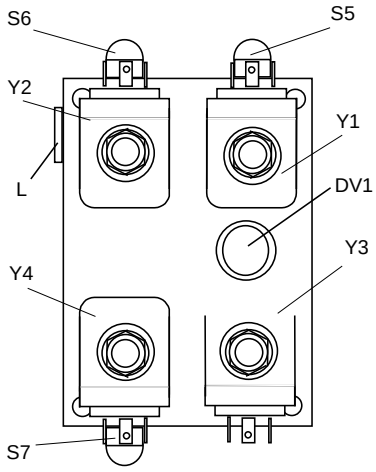


Figure 3: External view of the automatic load regulation's solenoid valve block

Screw compressor Type P, R, S, V, Y with hydraulic Vi-adjustment

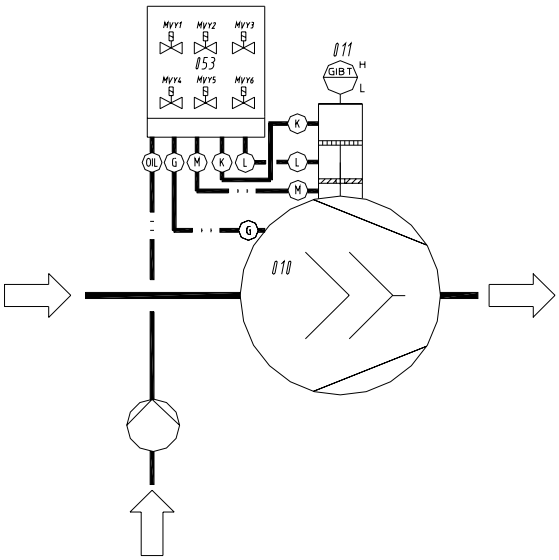


Figure 4: block with 6 solenoid valves

010 screw compressor

011 control slide position indicator

053 solenoid valve block – capacity control and hydraulic Vi-adjustment

(K)–(K) oil supply capacity control, control direction: part load

(L)–(L) oil supply capacity control, control direction: full load

(G)–(G) oil return capacity control

(M)–(M) oil supply / oil return at hydraulic Vi-adjustment

(Oil) pressure oil port of oil pump

The solenoid valves are set as follows for the adjustment:

	SV Y1	SV Y2	SV Y3	SV Y4
capacity ↑	open	closed	closed	open
capacity ↓	closed	open	open	closed

	SV Y5	SV Y6
capacity ↑	closed	open
Full load operation	closed	open
capacity ↓	open	closed

Setting the adjustment speed

The throttle screws S24 and S25 are used to control the quantity and are used to set the adjustment speed. The adjusting speed is decreased by throttling the valves.

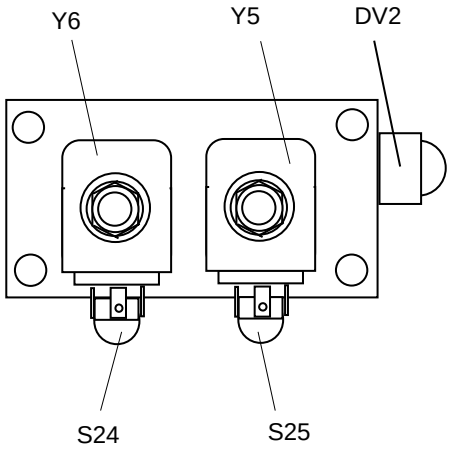


Figure 5: External view of the solenoid valve block of the hydraulic Vi-adjustment

– capacity increase: actuating S24
capacity decrease: actuating S25

– Adjustment time between the limit positions: 60...(30) sec. Set the throttles so that the adjustment time is roughly the same in both directions.

– The adjustment must be carried out while the oil is at the operating temperature.

Screw compressor Type W, Z, XA, XB, XC, XD

The solenoid valve block is flanged onto the screw compressor housing for types W, Z, XA, XB, XC, XD. The connections K, L and M are omitted.

The automatic load regulation and the hydraulic Vi-adjustment are described in Chapter 4 of the screw compressor manual.

2

Read the ´Operating Instructions´before starting the screw compressor unit/ chiller.

The ´Operating Instructions´ is an extract from the GSC User Manual, containing the most important information for the operator.

The indexes are identical with those of the GSC User Manual.

For more specific information see GSC User Manual or press the HELP key to obtain more information about the selected parameter.

The GSC is supplied with text in native language.

CONTENTS

1. DESCRIPTION OF THE GRASSO SYSTEM CONTROL

1.1.1. View

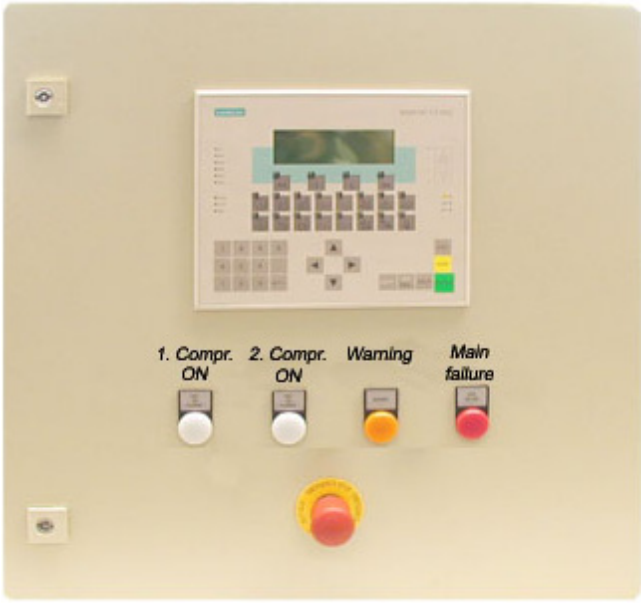


Figure 1.1: View of outside of switchgear cabinet

1.1.2. Lamps/ Push buttons

White indicator light (Running)

This indicator lamp flashes slowly when the compressor unit is in the "Ready" state.

Yellow indicator light (Warning)

This lamp flashes if an operating condition reaches a preset value (Warning /Pre-alarm).

Red indicator light (Alarm)

This lamp flashes if an operating condition exceeds its permitted value, the machine shuts down on alarm.

Emergency Stop button

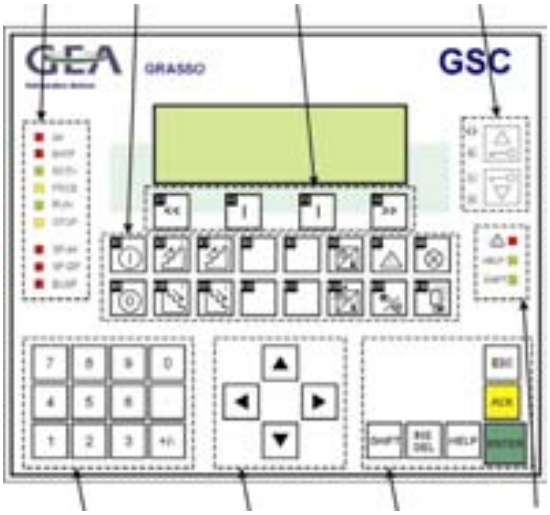
This red button can be used to switch the compressor unit off at any time in case of an emergency. The operator terminal controls remain functional.

1.2 Operator terminal

The operator terminal is the interface between the operator and the control unit.

All switching, operating and control actions are carried out via this operator terminal.

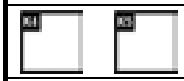
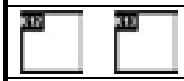
system LED's function keys soft keys CPU operating mode setting



digital keybord cursor keys system keys system keys LED's

Figure 1.3: GSC operator terminal

1.2.1. Key assignment

Taste	Function
	Go to the **menu item** described in the text display directly above
	**Back** to previous display **Move** to next display
	**Switch on the compressor unit, start enabled**
	**Start 1st compressor** (Press key for 5 sec. in operation mode "Manual") **Increase capacity of 1st compressor** (In case of manual capacity control only)
	**Start 2nd compressor** (Press key for 5 sec. in operation mode "Manual") **Increase capacity of 2nd compressor** (In case of manual capacity control only)
	No function
	Call up **display of actual values**
	Call up **alarm signals**
	**Lamp test**
	**Switch off the compressor unit, start disabled**
	**Stop 1st compressor** (Press key for 5 sec. in operation mode "Manual") **Reduce capacity of 1st compressor** (In case of manual capacity control only)
	**Stop 2nd compressor** (Press key for 5 sec. in operation mode "Manual") **Reduce capacity of 2nd compressor** (In case of manual capacity control only)
	No function
	Call up **controls** – settings
	Call up **operating mode** setting
	Call up the **menu overview**
	**Return** or cancel input
	**Acknowledge,** reset failure and warning
	**Confirm input**
	Display of a **help** text
	**Switch over** to the 2nd keyboard level
	**Cursor keys**

☞ **Special function of the shift key**

SHIFT +	Change to the **"Status display"**
SHIFT +	Change to the **"Language selection"** or **"Contrast menu"**
SHIFT +	Change to the **"Digital inputs / outputs display"**
SHIFT +	Change to the **"Date, Time"** menu
SHIFT + ▲ or ▼	Change between **compressor 01** and **02**

1.2.3 Call up table of contents

To get to the table of contents, press the key. A list of the available menus is then displayed.

Number	Title	Help text HELP
05	Actual values	Display of all unit's actual values
10	Control settings	Display and set up of all control parameters
15	Operating modes	Selection of operation mode
20	Limit values	Set up of alarm, warning and limitation parameters
25	Alarms	Display of current and previous alarms
30	Timer settings	Set up of timers
35	Unit Options	Selection of unit option menus
50	Configuration	Enter: - Refrigerant used - Compressor type - With/without economiser - Scaling of the sensors – etc
90	Main system menu	

To get to these menus, position the cursor on the menu name (using the ▲ or ▼ key) and confirm with the ENTER key.

☞ **Parameter changes in menu 20, 30, 35, 50 can cause serious damage to the screw compressor unit or chiller!**

1.3. Status display

To get to the status display, press the ESC key several times, or press the SHIFT key and then  .

This display shows all of the information shown in the first actual values screen plus the status of the compressor unit.

PV	□□□□	SP	□□□□
Pos	□□□□	Imot	□□□□
Tc	□□□□	Dpoil	□□□□
Operating status			

PV:	Process Value, display in °C/R (pressure) or °C (temp)
SP:	Set Point display in °C / °C/R
Pos:	Capacity slide position in %
Imot:	Motor current in A
Tc:	Discharge pressure in °C/R
dPoil:	Differential oil pressure in bar
Operating status:	eg Running, Off, Slide to min, Motor in Star etc.

☞ See menu 05 (actual values) for more detailed information

The operating status provides information about each screw compressor of the DuoPack unit.

SHIFT + ▲ or ▼ Change between **compressor 01** and **02**

The following status messages are possible:

Initialisation	Initialisation of the controller after swithing on the power supply or after saving the configuration (save, RAM → ROM)
Start to start 01/02	Start delay between two starts is active.
Oil drain 01/02	Oil drain delay is active, the oil pump has run too long by itself. (Minimum slide position has not been reached during start or stop procedure)
Standby 01/02	Compressor unit ready for switching on, but one or more starting conditions are still not fulfilled e.g. process variable still below set point
External start 01/02	The controller is waiting for an external signal to enable the start of the unit.
Slide to min 01/02	Starting procedure commenced, slide moving towards minimum position.
Starting 01/02	Compressor motor has been started, and the running feedback signal from the starter panel has not yet been received.
Running 01/02	Running feedback signal from the starter panel has been received. Unit in operation.
Limit suct press 01/02	A capacity limitation is active (suction pressure too low), capacity control solenoid to reduce capacity is opened.
Limit disch press 01/02	A capacity limitation is active (discharge pressure too high), capacity control solenoid to reduce capacity is opened.
Limit mot current 01/02	A capacity limitation is active (motor current too high), capacity control solenoid to reduce capacity is opened.
Limit ext temp 01/02	A capacity limitation is active (external temperature too low), capacity control solenoid to reduce capacity is opened.
Limit oil temp 01/02	A temperature limitation is active (oil temperature too high), refrigerant injection is enabled (optional).

Stopping 01/02	The compressor unit has received a shutdown command, the capacity slide is moved towards its minimum position
Compressor off 01/02	The compressor is switched off
Stop to start 01/02	Start delay between stop and next start is active
Failure01/02	A failure has occurred, which is still active.
italic writing	Text display flashes
Normal writing	Text display is static

The overall status of the Grasso SPduo is displayed with the LEDs in  and  .

Key	Colour	Status	Explanation
	Green	Flashing	The Grasso SPduo has received a start request. One compressor may start.
	Green	Continuous light	One compressor is running.
 + 	None	OFF	The Grasso SPduo is switched off, there is an alarm active. The alarm light on the cabinet is active.
	Red	Continuous light	The Grasso SPduo is switched off.

4. SYSTEM DESCRIPTION GSC

The system LEDs are located on the front of the GSC. These system LEDs provide information about the status of the controller.

4.1. Explanation of the system LED

The position of the system LED is given in Chapter 1.2, Fig.1.3.

Meaning of the status and error displays

Display	Meaning	Explanation
SF (red)	C7-CPU-centralised fault	**Lights up for:** - Hardware errors - Firmware errors - Programming errors - Parameterising errors - Computational errors - Time errors - Faulty internal memory storage - Battery failure or if standby supply missing for MAINS ON - Peripheral error in the internal peripheral functions Further information about the malfunction that has occured can be read out of the diagnosis memory using the PG.
BATF (red)	Battery error	**Lights up**, if battery - does not have enough voltage, - is defective, - is missing.
DC5V (green)	Voltage supply for C7	**lights up,** if the internal DC 5V supply is OK.
RUN (green)	Operating state RUN of the C7-CPU	**lights up,** if the C7 CPU application program is running. **flashes** (2Hz) during the C7 CPU start up (the STOP lamps also lights up; after the STOP lights go off, the outputs are released).
STOP (yellow)	Operating state STOP of the C7 CPU	**lights up,** if the C7 is not processing a CPU-application program. **flashes** at 1-second intervals, if C7 CPU general reset(MRES) is required.
SF-IM (red)	Switching module - centralised fault	**lights up**, if the connection between C7 and the extension rack is interrupted.
⚠ (red)	Alarm active	**lights up,** if a malfunction has been confirmed, but is still active. **flashes,** if a further malfunction has been activated.
Help (green)	Help text available	**lights up,** if a help text is available.
Shift (green)	Switch over function active	**lights up,** if the SWITCHOVER function is active.

6. ALARMS

6.1.3 View active alarms and warnings

The ´Status mode´is displayed by pressing the ESC key several times. The most important actual values are shown in the first three rows and in the 4th row the status message is shown.

By scrolling with the cursor keys ▲ and ▼ all active alarms and warnings are displayed.

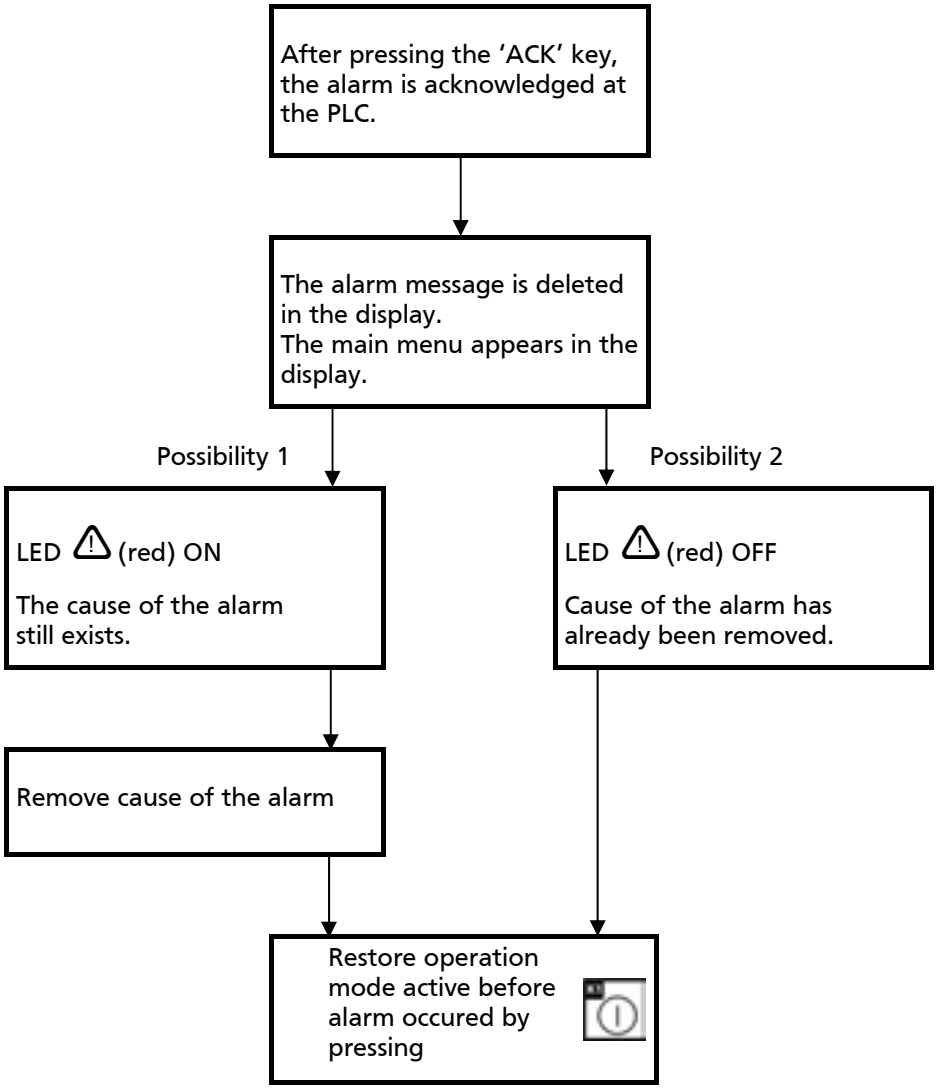
6.5 No alarm signal and the compressor will not start

Compressor will not start, although there is no active alarm.

Key „ON“ has been pressed and the LED K1 “ON“ is flashing.

Cause		Remedy
No ‘start release’ signal	The input ´start release´ is not closed.	Close input or install a link.
‘Auto Start dly’ active	The time setting ‘Auto start dly’ in ‘control settings menu’ has not yet expired.	Wait until the delay time has expired.
‘Start to start’ delay active	The time setting ‘Start to start’ in ‘Timer settings’ menu has not yet expired.	Wait until the delay time has expired.
PV < (SP + ½ NZ) PV= Process value SP = Set point NZ= Neutral zone		Check set point and neutral zone settings in ´Control settings´menu. **Attention:** In case of suction pressure control the set point value is entered in degrees Celsius.

7.2 Restart following Alarms



☞ **Attention! It is not possible to restart the compressor as long as the cause of the alarm still exists!**

Display of the cause(s) of the alarms after deleting the display on view (press the ACK key) or in the case that several alarms have occurred simultaneously:

Step	Procedure
1	Call up the 'Alarms' menu by pressing the key.
2	Select the 'View' menu item for the alarms by pressing the key. The errors that have occurred can be viewed here with the date and time at which they occur.

☞ **For more detailed explanations for reading the error messages, see Chapter 1.2.2.2. (GSC User Manual).**

3

GENERAL INFORMATION

The compressor unit must be operated only by trained and qualified staff who are familiar with the contents of the user manual for Grasso screw compressor units.

The safety regulations for the refrigeration plant must always be observed in order to prevent damage to the compressor unit and injury to the operating staff.

TRANSPORT AND STORAGE

Screw compressor units are high-quality products which must be handled with due care. Protect the equipment from impacts and place it down carefully.

When transported by crane, the screw compressor unit must have the same position as in operation. Do not use attaching points other than those provided for this purpose.

The attaching points are designated by the following symbol:

Figure 1: Designation of the attaching points.

It is forbidden to utilize fittings or pipes for attaching the screw compressor unit.

Due to the size of the Duo Pack LARGE screw compressor package type series, a split design is possible for transport. In this case the attachment points are not located in one plane. The ropes must be longer than 3 m and the difference in height of the individual attachment points must be compensated for by suitable extensions.

A means of precluding damage to the surface must be provided (timber or Armaflex supports).

Shackles must be used.

Position the screw compressor unit on the transport vehicle such that it is prevented from sliding and tilting. The competent staff member or the company is responsible for ensuring transport safety.

The storage area of screw compressor units shall be roofed, plain and paved and secured against access of unauthorized persons. The unit is to be protected against knocks and impacts.

Turn the shaft of the compressor at least every four weeks (approx. 10 revolutions).

At the same time, check the nitrogen filling and recharge to the specified overpressure of 2 bar, if required. Dry nitrogen with a residual moisture of ≤ 300 ppm is used for this purpose.

INSTALLATION

Rigid installation

The frame of the screw compressor unit is placed on foundation bolts on a prepared foundation. The frame must be levelled with suitable shims such that the coarse alignment (radial and angular misalignment ≤ 0,25 mm) at the coupling is attained again. Then tighten the foundation bolts.

Anti-vibration mounting

The frame of the screw compressor unit shall be aligned with the levelling bolts until the coarse alignment (radial and angular misalignment ≤ 0,25 mm) at the coupling is attained again.

ASSEMBLY

Assembly of the components.

If a split design is used for the screw compressor package, the various individual parts must be assembled in accordance with the general layout drawing and the labelling.

The size and weight of the individual parts are given on the general layout drawing.

Connecting the pipes

All pipes and electric cables must be connected so that no mechanical tension occurs.

Purge the nitrogen filling of the screw compressor unit by opening the vent valves before connecting the pipes.

Establish all pipe connections so that the transmission of thermal expansion and vibration to the screw compressor unit is limited as far as possible.

Bellow expansion joints made of steel and flexible metal tubes can be used for refrigerant and oil lines, bellow expansion joints made of rubber for water connections.

Provide all pipe connections with fixed points arranged immediately at the unit.

The following works must be carried out:

- Connecting suction pipe
- Connecting pressure pipe
- Fixing in the overflow valve in the suction pipe (if not already installed in the factory).

if units are equipped with a safety valve

- Connection of the safety valve (various designs possible) to the blow-off pipe.

if units are equipped with a water cooled oil cooler:

- oil cooler water connection

if units are equipped with a refrigerant cooled oil cooler:

- refrigerant feed line from h.p. receiver (note geodetic height above oil cooler)
- evaporated refrigerant line to condenser

if an economizer is used, then connect

- economizer suction line to supercharging

Connecting the electric cables

Connect the following:

- compressor drive motor
- control device current supply
- oil heater

FIRST COMMISSIONING

☞ **The following procedures should be completed in the sequence in which they are described:**

1. Pressure test, tightness test

The necessary safety precautions should be taken before performing the pressure test. The pressure test is performed with dried, oil-free air, or with dry nitrogen.

To test the parts which have been repaired for tightness, they are subjected to a pressure of any above atmospheric pressure (but not higher than the allowed operation pressure of the unit) using dry air or nitrogen for a period of 3 hours.

It is permissible for the pressure to fall by 2% during the 3 hours. Consideration must be given to variations in the ambient temperature.

Before starting the compression test remove or shut off control and regulating devices which could be damaged at the mentioned test pressure.

A record should be kept of the pressure test, noting the pressure in the pipes tested, the ambient temperature and the temperature outside in the shade at hourly intervals.

Reinstall any removed measuring, control and regulating devices after completion of the compression test if leakproofness of the screw compressor unit has been shown.

2. Drying, vacuum

After the pressure test has been completed, the system is evacuated and subjected to a vacuum test for 3 hours.

The plant is evacuated to remove air and moisture.

The obtained vacuum may rise by a maximum of 5 torr within 6 h.

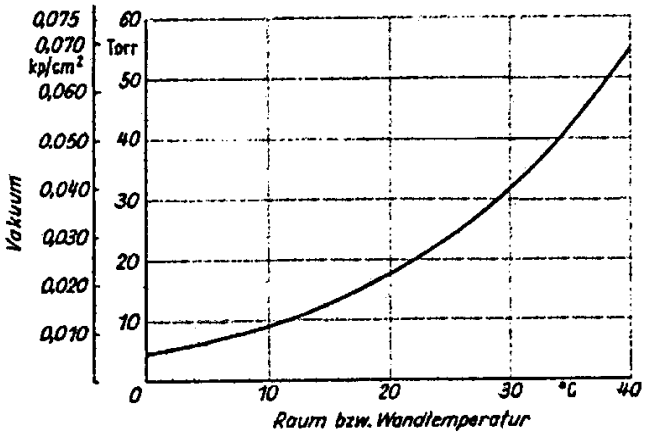


Figure 1: Vacuum required for removing moisture from refrigeration plants

Shut the compressors off when the specified vacuum is attained; record the measured values hourly. Following the vacuum value, enter the machinery hall temperatures, the outside temperatures in the shade. After the vacuum test can follow the pressure compensation with the refrigerant.

Shut the oil pump during evacuation!

3. Filling oil

The vacuum present in the SCU before pressure compensation may be utilized for oil charging. After the pressure compensation and for refilling with oil a separate oil recharging pump is required.

Check the oil grade to be charged. See contract or project or Grasso recommendation.

Link the connection of the oil draining/oil charging stop valves (090)/(275) with the oil charging tank.

Shift the valves to the operating position before oil charging (see P&I diagram).

Open shut-off valve (090) until the oil level has reached at the top of the oblong sight glass in the oil separator.

Oil charging of oil separator has to carry out general via the oil cooler.

4. Checking the failure monitoring

The failure monitoring can be checked in accordance with the operating instructions for the control device (Grasso System Control GSC – user instruction 637700).

5. Checking the direction of rotation of the oil pump motor

The oil pump is started with the driving motor electrically blocked. The stop valves are in the operating position.

The direction of the arrow given for the oil pump must correspond to the direction of rotation of the electric motor.

Since the slide ring shaft seal of the oil pump is dependent on the direction of rotation and can be damaged when this direction is wrong, checking must be reduced to a very short running period (less than 2 seconds).

The adjusted differential pressure between the oil pump discharge side and the suction side of the oil pressure control valve is checked with the oil pump rotating in the correct direction.

It must not fall below the prescribed set value (see R+I flow chart).

While the compressor is not running and the oil has not yet reached the operating temperature, the differential pressure can be slightly higher than the indicated value.

The differential pressure can be changed by rotating the spindle on the oil pressure control valve. (The differential pressure is increased by turning it inwards and vice versa).

6. Checking the adjustment of the control slide

The adjustment of the control slide can be checked in accordance with the operating instructions for the control device (Grasso System Control GSC – user instruction 637700).

7. Checking the oil circuit monitoring while the oil pump is running

The circuit monitoring while the oil pump is running can be checked in accordance with the operating instructions for the control device (Grasso System Control GSC – user instruction 637700).

8. Checking the failure shutdown when the temperature is exceeded

The failure shutdown when the temperature is exceeded can be checked in accordance with the operating instructions for the control device (Grasso System Control GSC – user instruction 637700).

9. Checking the direction of rotation of the driving motor

The coupling must not yet connect motor and compressor!

Secure the electric switchgear so as to prevent the compressor driving motor from being switched on accidentally.

With the control slide in the MIN or MAX position, it should be possible to rotate the compressor shaft easily and smoothly by hand. When checking the direction of rotation of the compressor driving motor pay attention to the conditions for switching the compressor on.

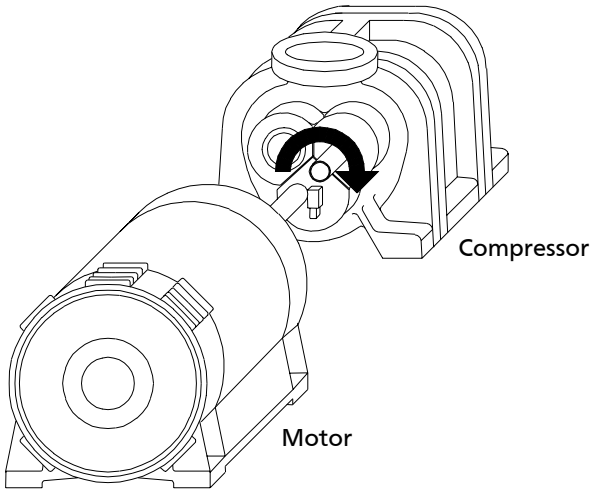


Figure 3: Rotation direction of the compressor drive motor

The compressor driving motor is operated in star-delta connection for a short period in the operating mode "MANUAL". After that the compressor driving motor has to switch off.

If the direction of rotation of the motor is wrong, it should be corrected while the electric switchgear is secured to prevent the motor from being switched on accidentally. The motor must then idle for at least 1h.

The coupling protection must be in place during this running-in period as required in the labour safety regulations.

After checking the direction of rotation of the driving motor the coupling may be connected with the motor.

10. Mounting the coupling

The electric switchgear is then again secured to prevent it from being switched on accidentally. Mount the coupling, observe instructions of separate documentation (see product description).

The values for radial and angular deviations given in the coupling documentation must be checked and if necessary corrected.

The real values have to record at data sheet 631632gbr (see chapter 5 of product description). Please send back a copy of the filled data sheet to:

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Holzhauser Straße 165

13509 Berlin
GERMANY

Phone: +49 (0)30 - 43 592 766
Fax: +49 (0)30 - 43 592 759

Pay attention to maintenance instructions:
Regrease the coupling at the prescribed intervals!

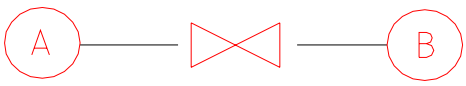
OPERATING POSITION OF VALVES

For the positions of the manually controllable fittings for the operation of the SCP see P&I diagram.

The layout and symbols used in the R+I flow charts comply with the specifications of EN 1861, Issue April 1998.

The valve positions must match the specifications given in the R+I flow chart to ensure trouble free operation!

- Valve ***opened*** during normal operation



- Valve ***closed*** during normal operation

COMMISSIONING

On completion of the above-mentioned work, the compressor unit can be commissioned in accordance with the operating instructions for the control device (Grasso System Control CSC – user instruction 637700).

CHECKING THE CONTROL SLIDE ADJUSTMENT TIMES

While the SCU is running, determine the adjustment times needed when the control slide is continually moved from the maximum end position to the minimum end position and back. For the automatic system to run smoothly, the adjustment times in either direction must be approximately the same.

Minimum adjustment time	30 sec.
Optimum adjustment time	60 sec.

The adjustment times are matched by means of throttle screws (DS) mounted on the solenoid valve plate.

Screwing inwards	Adjustment time ↑
Screwing outwards	Adjustment time ↓
Influencing towards Maximum	DS 5
Influencing towards Minimum	DS 6

CHECKING THE OIL COOLER

water cooled oil cooler

Checking the cooling water circuit and adjusting the cooling water control

Check whether the cooling water pumps are running and the hand-operated shut-off fittings in the cooling water circuit are in their operating positions. While the compressor unit is operating under project conditions, adjust the cooling water control so that the oil temperature lies within the permissible range.

refrigerant cooled oil cooler

Adjust a stable circuit by means of the valve in the refrigerant line coming from the receiving tank so as to achieve that the oil temperature lies within the permissible range. For guide values see Technical Data.

ADJUSTING THE AMOUNT OF INJECTION OIL AND THE OIL TEMPERATURE

Compressor units without refrigerant injection

The amount of injection oil and the oil temperature directly influence the discharge temperature of the compressor. The amount of injection oil is adjusted under project conditions through the injection oil control valve.

- Standard values for discharge temperature

	t	t_{max}
NH_3/HP	$t \geq t_{oil}$ + 15 K	95°C
NH_3/LP	$t \geq t_{oil}$ approx. 45...60°C	80°C
Freon/HP	ca. 80°C	95°C
Freon /LP	ca. 45...60°C	80°C

(see Specifications)

Compressor units with refrigerant injection

The oil temperature is changed by setting the injection oil control valve. The more the shut-off valve is throttled, the more the oil temperature decreases. If the oil temperature becomes too low or it reaches the lower range,

– the rated value for the discharge temperature should be set accordingly lower,
– the oil cooling system should be checked.

When the oil circuit is adjusted for the first time, the injection oil control valve is opened by approx. 1/2 rotation. The discharge temperature is then regulated to the value indicated in the *Technical Data* by means of the thermostatic expansion valve.

- Standard values for discharge temperature

	t
NH_3/ Freon	50 + 5 °C

(other refrigerants on request)

ADJUSTING THE COMPRESSOR CAPACITY

The capacity of the compressors can be adjusted independently automatically or controlled by hand. Suction pressure or one extern temperature are controlling values.

Reducing the capacity causes an increase in the suction pressure and vice versa. When doing so check the ammeter to ensure that the driving motor is not overloaded. If the current input is too high, the rated current limiting control comes into operation. This means that the overloaded compressor adjusts itself towards MIN until the current input reaches an acceptable level. The capacity can then be adjusted again without restriction.

COMMISSIONING/ SHUTTING DOWN

Attention must be paid to the information given in Chapter 4 for commissioning and shutting down the machines.

4

SCREW COMPRESSOR PACKAGE STANDSTILL FOR A LONGER PERIOD

- ❒ Switch off the compressor. Observe the user instructions of electrical installation.
- ❒ Close the stop valves (combined stop/ check valves) on suction and discharge sides.
- ❒ Close the stop valves (combined stop/ check valves) in economizer suction line. *)
- ❒ Close the refrigerant supply of thermosyphon - oil cooler. *)
- ❒ Close the refrigerant injection stop valve. *)
- ❒ Switch off the oil heater.

PROCEDURES DURING SCREW COMPRESSOR PACKAGE STANDSTILL

- ❒ Check the humidity contant of refrigerant and lubricating oil in case of packages standstill for a period longer than half a year, even in spite of gauge pressure in the package.
  The humidity contant is not allowed to differ essential from starting value.

MONTHLY

- ❒ Check the gauge pressure in the package. Check for leaks using a leakage detector.
- ❒ Switch on the oil pump for approx. 5 minutes.
- ❒ Turn the screw compressor shaft manual (min. 10 revolutions).

PROCEDURES 4 WEEKS BEFORE PACKAGE RECOMMISSIONING

- ❒ Check the humidity contant and ageing phenomena of lubricating oil. Analyse the oil and compare the values with the parameters of freh oil. Grasso recommends to change the oil at the latest after 1 year (ammonia) or 2 years (R22) (see Maintenance Instruction).
- ❒ Check the insulation resistance of the compressor drive motors (see electric motor User Instruction).
- ❒ Switch the oil pump on.
- ❒ Check the Screw Compressor Package for leaks.

PACKAGE RECOMMISSIONING AFTER 1 YEAR

- ❒ Change the oil filter elements (see Maintenance Instruction).
- ❒ The heater has to switched on at least one hour before starting the package.
- ❒ Open the stop valves (combined stop/ check valves) on suction and discharge sides.
- ❒ Open the stop valves (combined stop/ check valves) in economizer suction line. *)
- ❒ Open the refrigerant supply of thermosyphon - oil cooler. *)
- ❒ Open the refrigerant injection stop valve. *)
- ❒ Take care, that not all condensable gases are removed by venting during bringing the package into operation again. Check condensing pressure and condensing temperature (see Technical Data).
- ❒ Check the oil reservoirs and empty the oil if necessary.
- ❒ Switch on the compressor. Observe the user instructions of electrical installation. Make a Package function checkout for testing the sensor and actor technologies (ready for operation and indicating precision).

*) if assembled

NORMAL START-UP

- ❒ Move the valves into the operating position.
- ❒ The oil level in the oil separator must be within the permissible range.
- ❒ Check the cooling water/refrigerant supply of the oil coolers.
- ❒ The oil heater in the oil separator can be switched on while the compressor unit is not running. It is then automatically switched off when the unit is started and switched on when it is shut down. If the ambient temperature is below 5°C, the oil heater must be switched on at least one hour before the compressor unit is started. (This applies only when an oil heater is present).
- ❒ The motor current limitation has to set according to motor nominal data.
- ❒ Start the compressor unit in accordance with the operating instructions of the compressor unit control device.

TEMPORARY SHUT-DOWN

- ❒ If the compressor unit is shut down temporarily, the valves do not need to be operated; they remain in their operating positions. If there is a possibility of the temperature in the evaporator to rise above the cooling water temperature, the cooling water supply must be interrupted or the shut-off valve on the compressor suction side must be closed.
- ❒ If it is possible that the temperature in the evaporator rises above the ambient temperature of the compressor unit, the compressor suction-side shut-off valve must be closed.

SHUTTING DOWN FOR AN EXTENDED PERIOD

For a longer period of unit stand still see Instructions of Data Sheet 636277gbr!

5

GENERAL INFORMATION

The compressor unit must be serviced by appropriately trained operating staff only. These maintenance instructions shall be adhered to during all maintenance work.

Moreover, all labour safety and fire prevention instructions and the technical safety rules for refrigeration plants must also be observed.

The attached maintenance manual contains all the maintenance instructions and certifications for the first 10 years of performance of the Screw Compressor Package. The maintenance certification are given and signed following the inspection and maintenance by authorized fitters. This will prove as an evidence for the maintenance work done. During the guarantee period these maintenance certifications confirmed by authorized staff serve as a precondition for a possible guarantee claim put to Grasso.

If repairs are necessary, contact the service department of **Grasso GmbH Refrigeration Technology**.

Perform all maintenance work carefully to keep the SCU in good working order. Guarantee claims will be rejected if the customer failed to follow the Maintenance Instructions.

Pay attention to maintenance checklist

Checking of	all 24–72 hrs	weekly	monthly	Remarks
Final compression temperature	●			superheat must not be lower than 25 K, maximum final compression temperature 100°C
Oil temperature	●			see Technical Data, the viscosity shall not be lower than 7 cSt at 3000 rpm
oil pressure	●			the oil pressure must be at least 1 bar above the final compression pressure, a faulty oil pressure may be caused by a clogged oil filter
final compression pressure	●			compare with design value, determine the superheat on the discharge side by comparison with the final compression temperature
Oil level in oil separator	●			check the oil level in the sight glass; if it is below the bottom third of the sight glass, recharge oil
Oil heater			●	upon standstill of the SCU the heater, if any, must start operating automatically; if the thermostatic cutout disconnects the heater, this may be caused lack of oil
Adjustment of safety devices			●	compare setpoints in Technical Data
Capacity control		●		solenoid valves must switch audibly when the capacity is adjusted; check in operating mode "MANUAL"
Number of operating hours		●		see Maintenance schedule for necessary maintenance work
oil reservoir oil pump		●		Empty oil reservoir oil pump
oil reservoir rotary seal		●		Empty oil reservoir rotary seal

MAINTENANCE WORK

REPLACEMENT OF SUCTION FILTER

1. Close the discharge-side shut-off valve on the screw compressor unit.
2. Open suction-side shut-off valve and shut-off valve bypassing nonreturn valve - suction side - and thus compensate pressure with the l.p. side.
3. Close suction-side shut-off valve and bypass valve - non-return valve.
4. Draw off residual overpressure via vent valve of suction filter or release considering the safety rules.
5. Screw off housing cover.
6. Remove suction filter element.
7. Clean suction filter element, wash with appropriate fat-dissolving cleaning agent followed by blowing off with compressed air.
8. Replace O ring on suction filter element and reinsert suction filter element.
9. Replace O ring on cover, close cover reliably.
10. Evacuate the SCP using a vacuum pump.

Shut off oil pump

If evacuation is not possible, the SCU is vented in the subsequent step through the vent valve mounted on the suction filter. Collect escaping refrigerant and dispose of as required by law.

11. The SCU is pressurized with a slight overpressure via shut-off valve bypassing non-return valve - discharge side.
12. Check all components for leakproofness. Then perform a complete pressure compensation with the discharge line followed by a repeated leakage test of the SCU.

Since the compressor is not protected against coarse dirt particles during maintenance work on the suction filter, special care is necessary in addition to the usual cleanliness required while carrying such work.

OIL CHANGE

Note:

Aged oil features an increasing loss of lubricity. Because of this all rotating components of the compressor are endangered. The filter elements become prematurely clogged and must be cleaned and replaced at shorter intervals.

Maintenance work:

Take oil samples for analysis and comparison of the data with those of fresh oil at regular intervals. Examine the colouration of the oil visually and evaluate the degree of contamination.

Changing the oil:

1. The SCU must be run for at least half an hour to reach its operating temperature before the oil can be changed.
2. First shut down the compressor as described in the Operating Instructions.
3. Open the shut-off valves in the line bypassing the non-return valve -suction side - and the suction-side shut-off valve for pressure compensation between SCU and suction line. The refrigerant should preferably be drawn off (by screw compressor 1 or 2) to attain a pressure which lies approx. 1 to 3 bar above atmospheric pressure. Then reclose shut-off valves/bypass and suction side shut-off valve. Otherwise the pressure can be reduced by opening the vent valve on the suction filter and then disposing of the refrigerant as specified by law.
4. Drain waste oil through the oil draining/oil charging valves and dispose (Note: hazardous waste!). Then close valve and draw off refrigerant again until about atmospheric pressure is reached using a parallel compressor.
5. Otherwise depressurize the SCU by opening the vent valve - suction filter, taking into account the safety rules for refrigeration plants.
6. Open the drain plugs and valves on oil cooler, oil separator and oil filter with multi-function block to discharge the residual oil. Then reclose the drain plugs reliably.
7. Replace or clean the filter elements of oil filter and suction filter. (see oil filter change and suction filter change)
8. Evacuate the SCP using a vacuum pump.

Shut off oil pump

If evacuation is not possible, the SCU is vented in the subsequent step through the vent valve mounted on the suction filter. Collect escaping refrigerant and dispose of as required by law.

9. The SCU is pressurized with a slight overpressure via shut-off valve bypassing non-return valve - discharge side.
10. Check all components for leakproofness. Then perform a complete pressure compensation with the discharge line followed by a repeated leakage test of the SCU. Charge oil and start the SCU as specified in the Operating Instructions.

Notes on oil change intervals

The degree to which oil in refrigeration plants has aged must be checked by analysis and comparison of the data with those of fresh oil. Oil ageing can also be judged from the darkening of the oil colour and the deposits found in the oil filters. If the degree of ageing cannot be assessed reliably by laboratory analysis and the results of visual examination, it is advisable to change the oil at the following intervals (see Maintenance schedule).

Change oil in SCUs using **freons as refrigerant** after every **10000 operating hours** or after **2 years** at the latest.

Change oil in SCUs using **ammonia as refrigerant** after every **5000 operating hours** or after **1 year** at the latest.

OIL FILTER REPLACEMENT

1. Switch the unit off.
2. When the oil filter is heavily contaminated it may be necessary to replace it even if this is not provided according to the normal maintenance schedule.
3. Close the valves for changing oil filter as follows (acc. to P+I diagrams 634049e.doc, page 6 up to page 8 and documentation oil filter with multi-function block 634127e.doc, page 4 up to page 6):

065	stop valves before oil filter
070	stop valve - function oil
080	control valve - injectio oil with integrated check valve function *
220	stop valve bypassing oil cooler (optional only)
690	stop valve – oil supply of the solenoid valve block

* Do not forget to note the number of valve revolutions when you close the valve (080). You have to make the same number of valve revolutions when you open the valve (080) again. It's important, because the discharge temperature is dependant on the size of valve opening and possible vibrations in the oil line should be avoided.

4. Compensate pressure with atmospheric pressure.
5. Drain oil.
6. Remove oil filter cover of multifunction block.
7. Withdraw oil filter element and dispose in due manner if it is heavily contaminated.
8. Carefully insert a new oil filter element.
9. Close oil filter cover of multifunction block.
10. Open above-mentioned valves (see point 3). The valve (080) has to turned the correct number of revolutions back to starting position (see point 3).
11. Vent oil filter through the vent valve after completion of the pressure compensation.

OIL PUMP MAINTENANCE

An amount of leakage oil of up to one drop/minute is required for lubrication of the slide ring seal and thus permissible.

The slide ring seal is free of maintenance. If the amount of leakage oil is too large, replace it according to the Oil Pump Documentation.

The axial grooved ball bearing ist not adjustable. The axial play is predetermined by the manufacturer and cannot be changed.

The axial grooved ball bearing should be subjected to a visual examination and replaced according to the oil pump documentation, if required.

COUPLING MAINTENANCE

1. Place the SCU out of operation.
2. Secure the electric motor to prevent that is switched on accidentally.
3. Subject the lamination packages to a visual examination.
4. Check the tightening torques of the fitting screws.
5. Check the alignment of the electric motor and correct it according to the Steel Lamination Coupling Documentation, if required.
6. Regreasing the coupling (if provided for in the maintenance instructions for the coupling).

REPLACEMENT OF THE OIL FINE SEPARATION CARTRIDGES

1. Close the discharge and suction side shut-off fittings.
2. Draw off refrigerant and depressurize the SCP.
3. Check the pressure on the display of the compressor control device or connect a test pressure gauge.
4. Remove the pipe bend from the oil separator.
5. Remove the non-return valve built in the oil separator. This step is omitted if a non-return valve is used the discharge side of which can be shut off.
6. Remove the locking wire [3].
7. Loosen the hexagon head screws [2] used to attach the oil fine separation cartridges.
8. Remove the cartridge [1].
9. Mount the new cartridge in the reverse sequence.

Locking wire [3] must be re-attached !

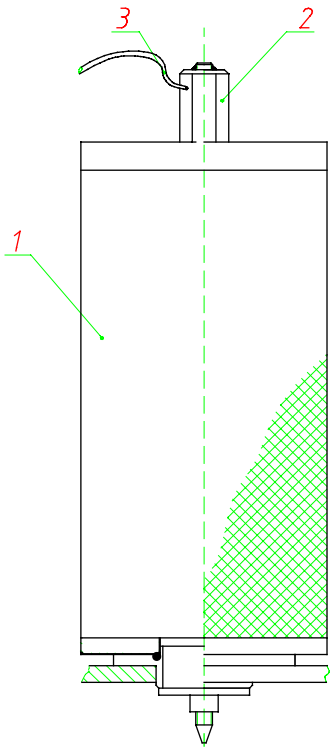


Fig. 1

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