ENGINEERING
TOMORROW

Application guidelines

Danfoss scroll compressors
VLZ065 version B
Single

R404A/R448A/R449A CDS drive

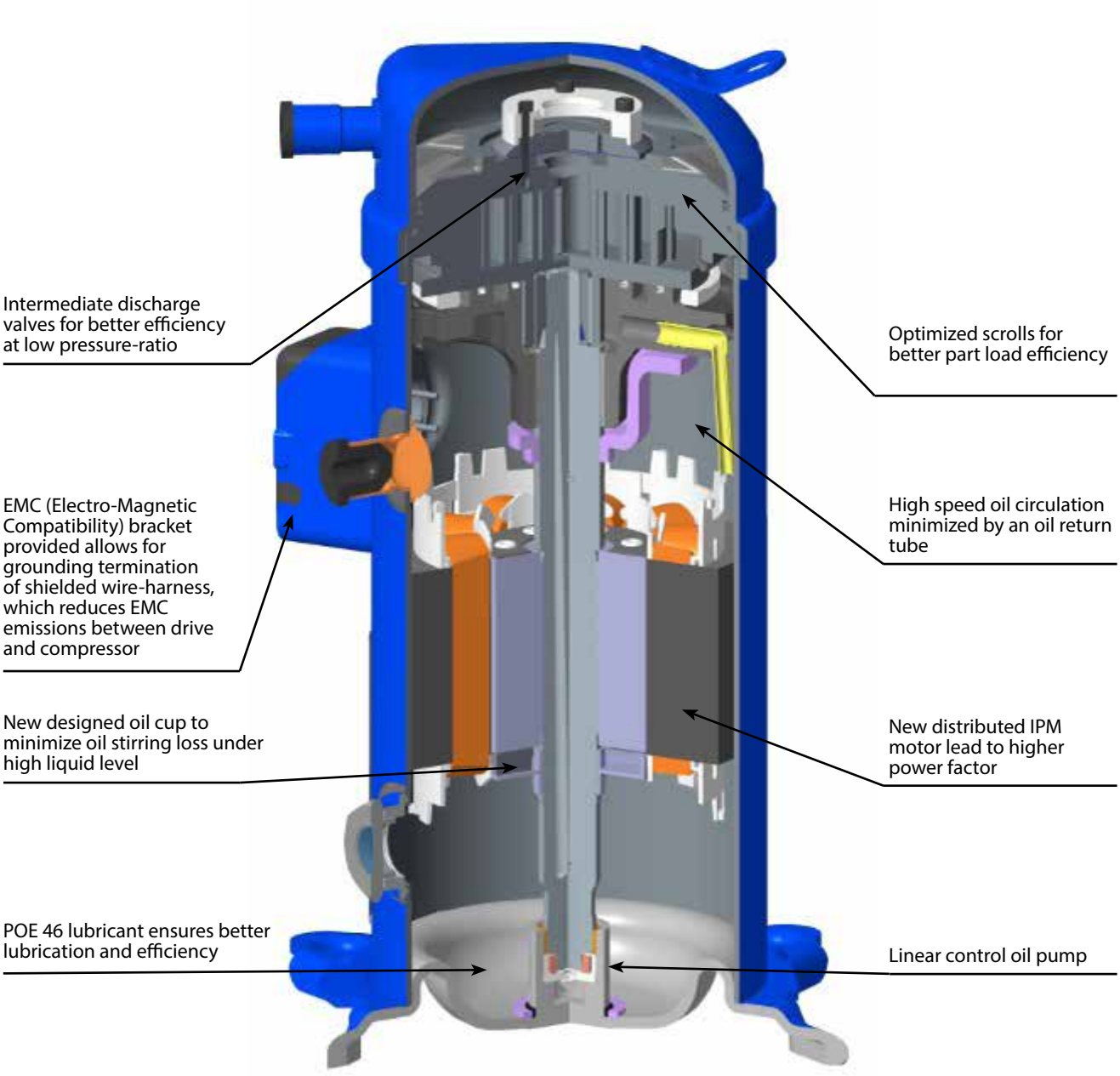
http://cc.danfoss.com

Danfoss scroll compressors are designed and manufactured according to the state of the art and to valid European and US regulations. Particular emphasis has been placed on safety and reliability. Related instructions are highlighted with the following icons:

 This icon indicates instructions to avoid safety risk.

 This icon indicates instructions to avoid reliability risk.

The purpose of this guideline is to help customers qualify compressors in the unit. You are strongly advised to follow these instructions. For any deviation from the guidelines, please contact Danfoss Technical Support. In any case, Danfoss accepts no liability as a result of the improper integration of the compressor into the unit by the system manufacturer.



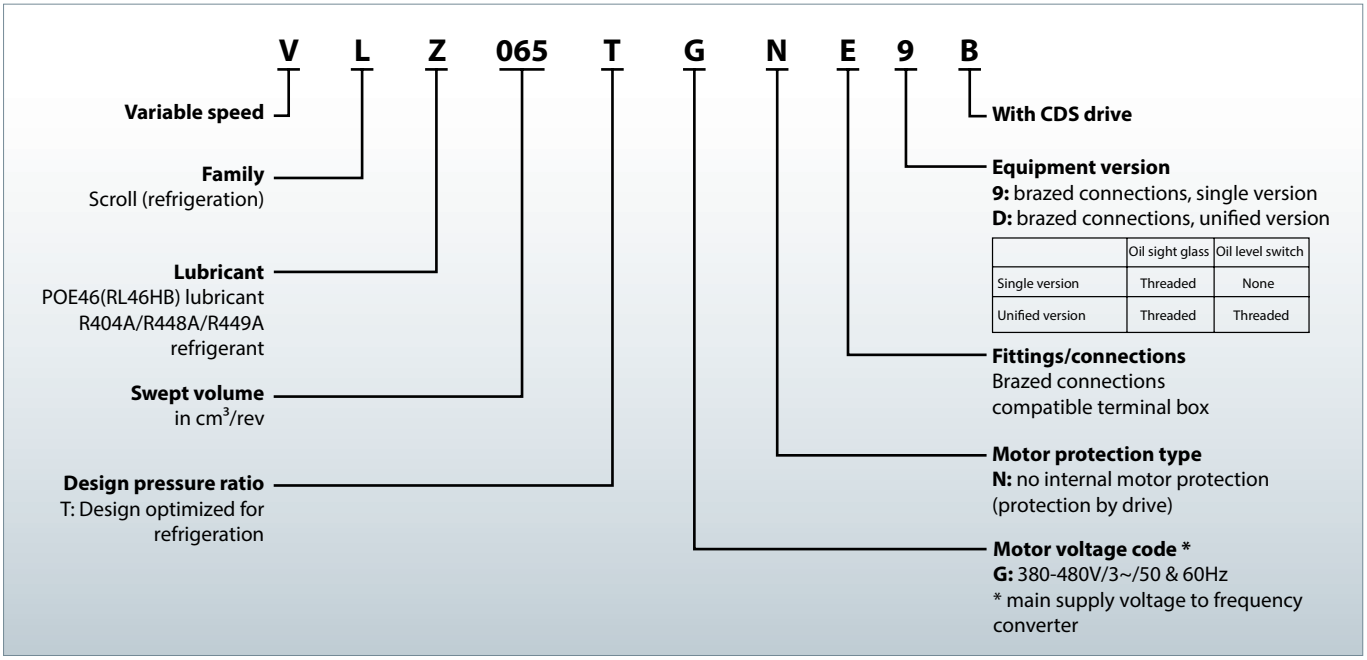
How do IDVs work?

Danfoss Intermediate Discharge Valves (IDVs) are located close to the discharge side of the compressor. They reduce excessive compression of refrigerant under part-load conditions while maintaining the same cooling capacity. The IDVs open when discharge pressure falls below the built-in optimization point. They adapt the effort of the motor to the varying load and pressure conditions in the system, thus reducing the effort of the motor and its electrical consumption and improving the system's seasonal energy efficiency.

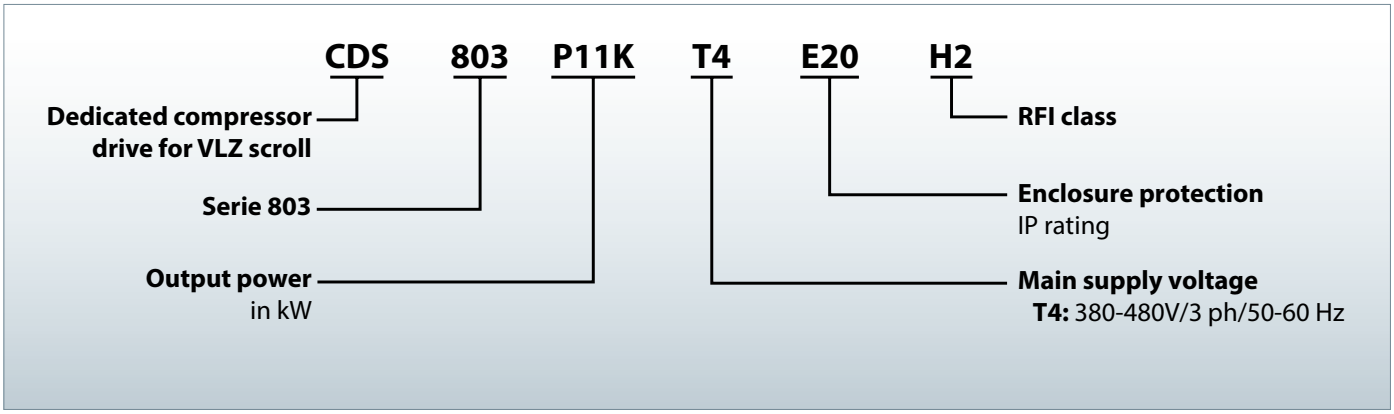
Compressor model designation

Nomenclature

Compressor nomenclature



Frequency converter nomenclature



Compressor size

To have the optimum compressor selection, select a compressor size which achieves the peak load system cooling capacity demand at its maximum speed.

Detailed performances can be found in datasheets and in selection programs.

Frequency converter variants

Different frequency converter variants are available according to:
1. Mains supply voltage
2. IP class (CDS803 drives are available in IP20 housings)
3. RFI (Radio Frequency Interference) class H2.
4. Printed Circuit Board (PCB) coated or not coated.

Compressor and frequency converter combinations

When the compressor size and mains voltage have been defined in the above selection criteria, the code number tables from the "Ordering information and packaging" section provides the appropriate frequency converter sizes and up to four corresponding code numbers for each compressor model.

⚠ **Note this compressor is equipped with a six-pole electrical motor so the applied frequency from the inverter will be 90Hz for 1800 rpm up to 330 Hz for 6600 rpm.**

Please refer to the table below

		min	max
Compressor speed	rps	30	110
	rpm	1800	6600
Drive output frequency	Hz	90	330

Technical specifications

Compressor specifications

Compressor model	Swept volume		Displacement								Oil charge		Net weight	
			1800 rpm		3000 rpm		3600 rpm		6600 rpm					
	(cm^3/rev)	(cu.in/rev)	(m^3/h)	(cu.ft/h)	(m^3/h)	(cu.ft/h)	(m^3/h)	(cu.ft/h)	(m^3/h)	(cu.ft/h)	(dm^3)	(oz)	(kg)	(lbs)
VLZ065	65.1	4.0	7.0	249	11.7	413	14.1	498	25.8	911	1.57	53	35	77

Frequency converter specifications

Mains supply voltage	T4: 380 - 480 V ±10% (3-phase)
Supply frequency	50 / 60 Hz
Output voltage	0 - 100 % of supply voltage
Inputs	4 digital (0-24V), 2 analog (0/±10V or 4-20mA, scalable)
Programmable outputs	2 analog (0/4-20mA) or 2 digital (0-24V)
Protection functions	Over-current protection, low / high current handling
Compressor functions	Motor protection, compressor ramp up/down control

POE

The POE oil RL46HB(215PZ) is an ISO VG 46 synthetic polyol ester (POE) lubricant formulated specifically for use in refrigeration and air conditioning compressors using HFC refrigerants.

This product provides effective wear protection for steel and aluminum surfaces for increased system life and improved efficiency and is suitable for both initial fill and service fill. The combination of low temperature characteristics and unparalleled chemical and thermal stability enable the use of RL46HB over a wide operating temperature range.

R448A & R449A

R448A and R449A are two HFO-based refrigerants with similar properties. Both have a GWP below 1500 and comply with the EU F-gas regulation.

They can be used as alternatives to R404A refrigerants in MBP application.

R448A&R449A have zero ozone depletion potential (ODP = 0). R448A&449A are especially suitable for low evaporating temperature applications but they can also be applied to medium evaporating temperature applications. R448A &449A are mixtures and have big temperature glide, and therefore must be charged in their gas phase.

R404A

R404A is an HFC refrigerant. R404A has zero ozone depletion potential (ODP = 0). R404A is also suitable for low evaporating temperature applications but it can also be applied to medium evaporating temperature applications. R404A is a mixture and has a very small temperature glide, and therefore must be charged in its liquid phase, but for most other aspects this small glide can be neglected.

Because of the small glide, R404A is often called a near-azeotropic mixture.

Designation	Composition	ODP	GWP	Safety group	Boiling temp °C	Temp glide °C	Critical temp °C	Critical pressure bar	Cond temp @ 26babs
R404A	52% R143a - 44% R125 - 4% R134a	0	3943	A1	-45.5	0.8	73.0	36.9	55.8
R448A	21% R134a - 20% R1234yf 26% R125 - 26% R32 - 7% R1234ze	0	1273	A1	-46.1	6.1	83.7	48.0	58.1
R449A	24.3% R32 - 24.7% R125 25.3% R1234yf - 25.7% R134a	0	1282	A1	-45.7	6.0	83.9	44.5	58.2

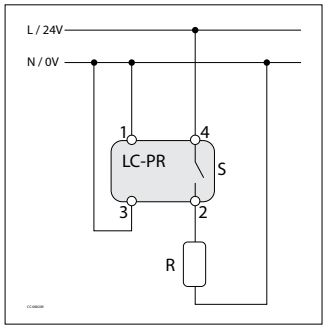
OIL level sensor

A TEKLAB LC-PR optical-electrical level sensor is fixed on the inverter compressor. The oil level sensor prism is fixed on the compressor, the electrical part is ordered by accessory kit. The oil level sensor monitors the compressor oil level and sends oil level signal to relay: It already has relay internally. A 5±2 seconds delay is recommended to mitigate oil level fluctuation and avoid false alarms.

- Lack of oil: Relay between 2 and 4 will be opened internally, output is open. LED in sensor is red.

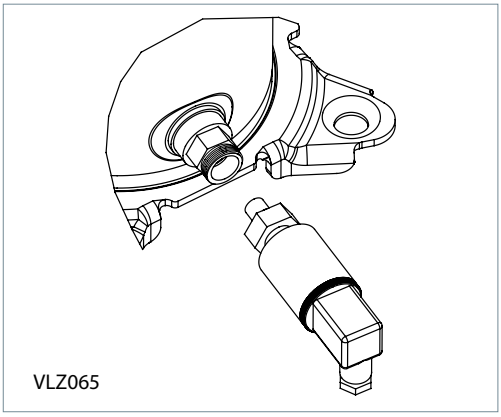
- Enough oil: Relay between 2 and 4 will be closed internally, output is closed. LED in sensor is green.

For customers who needs UL certificates, please order 24V AC/DC sensor.



S - Sensor
R - External Load / Relay

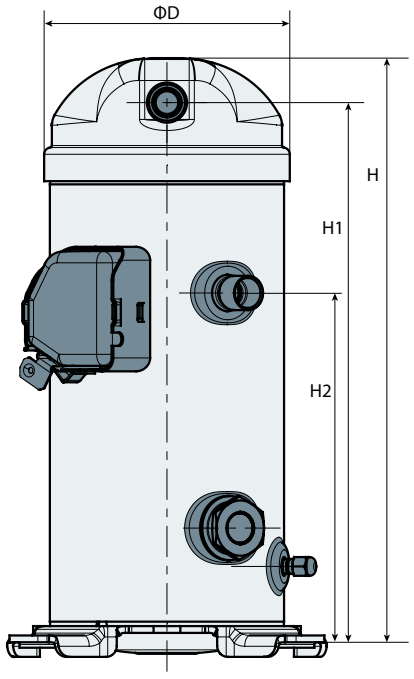
Oil level sensor is a special component which assembles on variable speed compressor. The oil level sensor prism is fixed on the compressor, the electrical part and the pre-wired connectors are ordered by accessory kit.



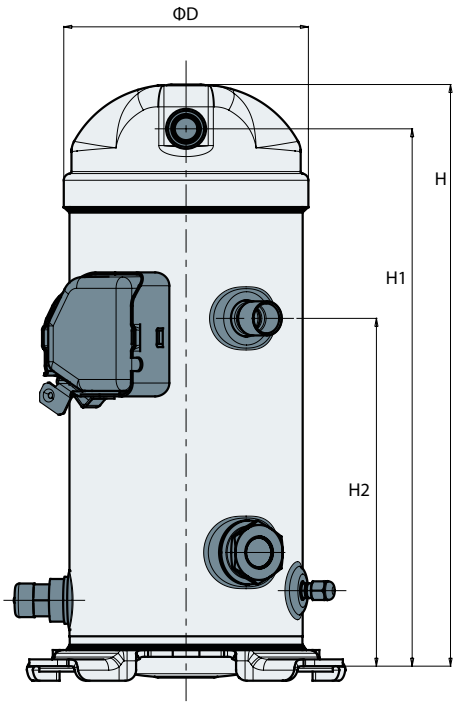
VLZ065

Dimensions

VLZ065G

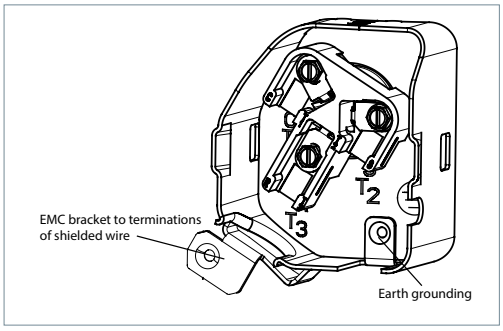


Single version

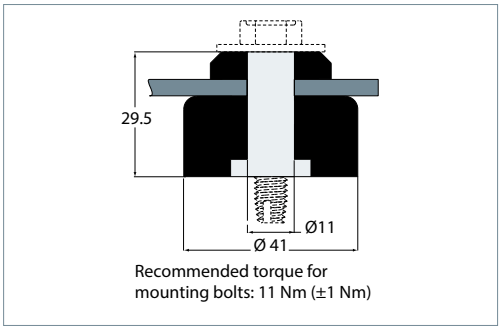


Unified version

Terminal box



Mounting Grommet



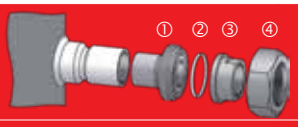
Version	Compressor model	D		H		H1		H2		L1		L2		Outline drawing number
		(mm)	(inch)	(mm)	(inch)	(mm)	(inch)	(mm)	(inch)	(mm)	(inch)	(mm)	(inch)	
Single	VLZ065	183.5	7.22	436	17.17	403	15.87	261	10.28	190.5	7.5	190.5	7.5	8590007
Unified	VLZ065	183.5	7.22	436	17.17	403	15.87	261	10.28	190.5	7.5	190.5	7.5	8590013

Connection Details

	VLZ065 single version
Suction connection	Brazed 7/8"
Discharge connection	Brazed 3/4"
Oil sight glass	Threaded (1"1/8 – 18 UNF)
Oil equalization connection	-
Shrader	Male 1/4" Flare incorporating a Schrader valve

1) VLZ compressors single versions come equipped with a threaded oil sight glass with 1"1/8 – 18 UNEF connection. It can be used for a visual check of oil amount and condition.

2) Schrader: The oil fill connection and gauge port is a 1/4" male flare connector incorporating a Schrader valve.



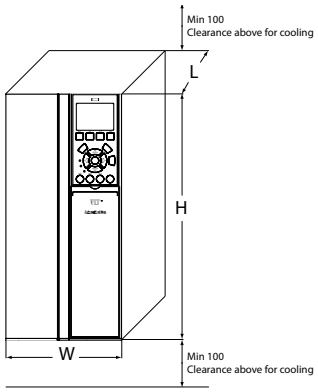
Compressor models	Brazed connection size		Rotolock adaptor set (①adaptor, ②gasket, ③sleeve, ④nut)			Rotolock adaptor (① adaptor only)
			Rotolock	Solder sleeve ODF	Code Number	Code Number
VLZ065	Suction	7/8"	1-1/4"	7/8"	120Z0128	120Z0367
	Discharge	3/4"	1-1/4"	3/4"		120Z0366

VLZ compressors are all delivered with suction and discharge brazed connections only. They are copper-plated steel connections.

Rotolock adaptors are available, refer to the information above.

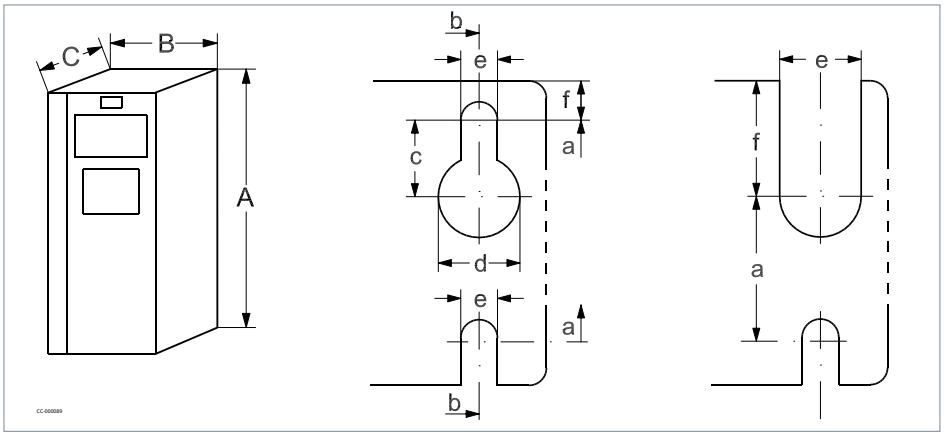
CDS803 Frequency converter

Frequency converter dimensions depend on supply voltage, IP rating and power. The table below gives an overview of the overall dimensions and drive enclosures. Details for each drive enclosure are on the following pages.

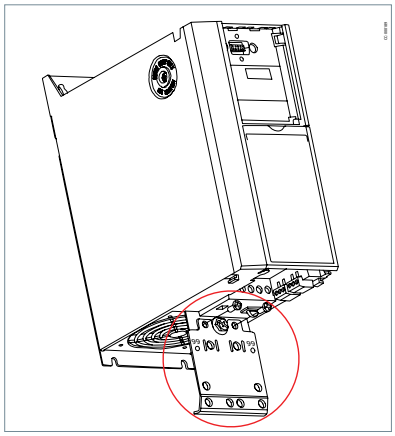


Drive supply voltage	Drive power kW	Compressor voltage code	Compressor model	IP20			
				Drive en- closure	Overall drive size [H x W x L] mm (inch)	Clearance above/ below mm (inch)	Bracket supplied (mm^2)
T4: 380-480/3/50-60	11	G	VLZ065	H5	402 × 150 × 255 (15.8 × 5.9 × 10)	100 (4)	1pcs, Φ2-11 1pcs, Φ3-18 1pcs, Φ6-23

Drive outline dimensions



Decoupling plate



Enclosure		Height						Width				Depth		Mounting hole						Max. Weight	
Frame	IP Class	A		A[1)]		a		B		b		C		d		e		f			
		(mm)	(inch)	(mm)	(inch)	(mm)	(inch)	(mm)	(inch)	(mm)	(inch)	(mm)	(inch)	(mm)	(inch)	(mm)	(inch)	(mm)	(inch)	kg	lb
H5	IP20	334	13.1	402	15.8	314	12.4	150	5.9	120	4.7	255	10	12.6	0.5	7	0.28	8.5	0.33	9.5	20.9

A[1)] Including decoupling plate.

The dimensions are only for the physical units, but when installing in an application it is necessary to add space for free air passage both above and below the units.
The amount of space for free air passage is listed in "frequency converter dimensions - Clearance above/below (mm/inch)".

Supply voltage

Because VLZ compressors are powered by a frequency converter, the mains frequency, 50 or 60 Hz, is no longer an issue. Only the mains voltage is to be taken into account. Never connect the VLZ compressor directly to the mains power supply in case of motor burnt.

Voltage code	Mains voltage range of drive
G	380-480V / 3ph / 50Hz & 60Hz (±10%)

Compressor electrical specifications

Compressor rated voltage (V)	Model	RW(Ω) at 20°C line to line	Max Operating Current (A)
400	VLZ065-G	0.177Ω±7%	19

RW: Winding resistance per winding, measured at motor terminals

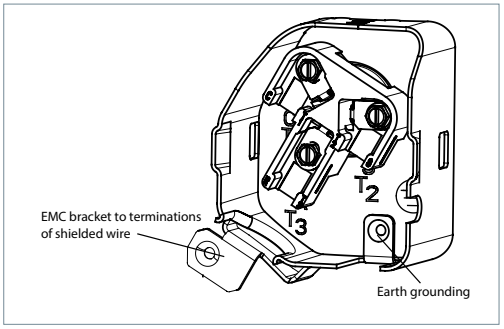
MOC (Max Operating Current)

Max. operating current is the max. continuous current output from drive to compressor within operating map.

MOC is tested at max. load condition with nominal voltage. MOC is printed on the nameplate, it can be used to select cable and contractor for customer by adding some safety coefficient.

Wiring connections

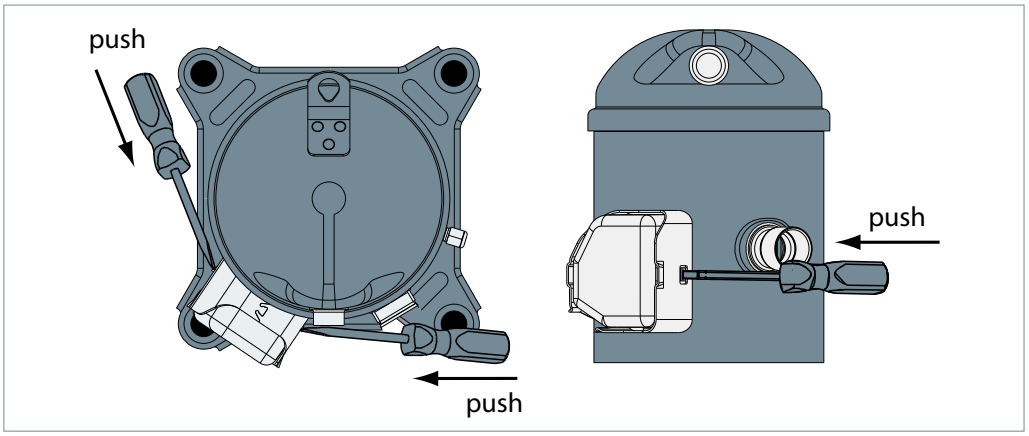
Electrical power is connected to the compressor terminals by Ø 4.8mm (3/16") screws. The maximum tightening torque is 3Nm. Use a 1/4" ring terminal on the power leads.



Terminal cover mounting

The terminal cover and gasket should be installed prior to operation of the compressor. The terminal cover has two outside tabs, 180 degrees apart, that engage the terminal fence. When installing the cover, check that it is not pinching the lead wires.

Terminal cover removal



Fuses

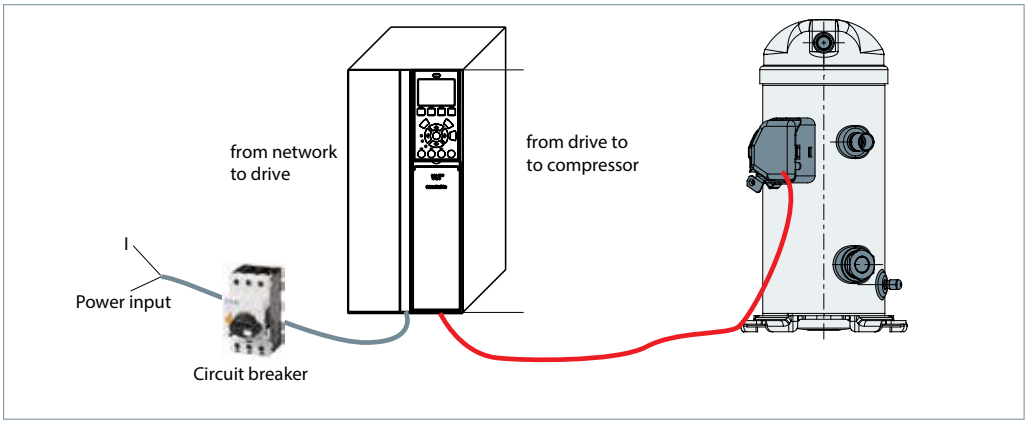
Danfoss recommends using the fuses listed below to protect service personnel and property in case of component break-down in the frequency converter.

For circuit breakers, Moeller types have been tested and are recommended.

Model		Power	UL Compliant fuses				Non -UL	Recommended circuit breaker
			Bussmann				Maximum fuse	IP20
		[kW]	Type RK5	Type RK1	Type J	Type T	Type G	Moeller type
3 × 380-480 V	VLZ065	11	FRS-R-80	KTS-R80	JKS-80	JJS-80	63	PKZM4-50

Wire sizes

Below table lists maximum wiring sizes for the motor compressor power supply cables.



Voltage range	From network to frequency converter			From frequency converter to compressor		
	Type	mm²	AWG	Type	mm²	AWG
380 - 480 V	CDS803-11kW	6	10	VLZ065	6	10

Note: The wire size in the guideline is the maximum wire size that connectors can accept but not the actual needed cable. The needed cable size should be specified by the OEM depending on the unit design, ambient temperature, the wire material, current, etc...

Soft-start control

The CDS803 frequency converter generates by design a compressor soft start with a default initial ramp up refer to 'Manage speed limit'.

Current inrush will not exceed the frequency converter maximum current.

Basically seen from the mains, the inrush peak reachs a level which is only a few percent more than the rated nominal current.

Phase sequence and reverse rotation protection

The compressor will only operate properly in a single direction. If electrical connections are done correctly between the drive and the compressor terminals (compressor T1/T2/T3 and drive terminals U, V & W matching), the drive will provide correct phase supply to the compressor, and reverse rotation will be not possible:

- CDS terminal U (96) to VLZ terminal T1
- CDS terminal V (97) to VLZ terminal T2
- CDS terminal W (98) to VLZ terminal T3

If compressor T1/T2/T3 and drive U, V & W terminals are not matching, the compressor can operate in a reverse rotation. This results in excessive noise, no pressure differential between suction and discharge, and suction line warming rather than immediate cooling. The compressor can be rapidly damaged in these conditions. If reverse rotation symptoms occur, shut the compressor down and connect the phases to their proper terminals.

Mains connection to the CDS frequency converter order has no influence on the output phase sequence which is managed by the frequency converter.

IP rating

The compressor terminal box IP rating according to IEC529 is IP22.

Element	Numerals or letters	Meaning for the protection of equipment
First characteristic numeral		Against ingress of solid foreign objects
	0	(non protected)
	1	≥ 50 mm diameter
	2	≥ 12.6 mm diameter
	3	≥ 2.5 mm diameter
	4	≥ 1.0 mm diameter
	5	dust protected
	6	dust tight
Second characteristic numeral		Against ingress of water with harmful effects
	0	(non protected
	1	vertically dripping
	2	dripping (15° tilted)
	3	spaying
	4	splashing
	5	jetting
	6	powerful jetting
	7	temporary immersion
	8	continuous immersion

Motor protection

VLZ scroll compressors are not equipped with an internal motor protector. Motor protection is provided by the variable speed drive. All parameters are factory preset in order to guaranty locked rotor or overload current protection.

When a warning situation is reached in the current control, the CDS frequency converter will automatically reduce the compressor speed in order to keep the motor current of the compressor below the maximum allowed.

Voltage imbalance

The maximum allowable voltage imbalance between each phase is 3%. Voltage imbalance causes high amperage over one or several phases, which in turn leads to overheating and possible drive damage.

Approvals and certificates

VLZ compressors comply with the following approvals and certificates.

CE (European Directive)	CE	VLZ code G
EMC Class A Group 1 2014/30/EU	cULus	VLZ compressor and drive package

Low voltage directive 2014/35/EU

Products	VLZ065
Declaration of conformity ref. Low voltage directive 2014/35/EU	Contact Danfoss

Internal free volume

Products	Internal free volume at LP side without oil (lite/cu.inch)
VLZ065	4.7/287

Direct and indirect exposure of drive to water

IP20 drives are intended for indoor or cabinet mounting. Application example: drive fitted in a machine room, basement or in an electrical cabinet together with other electric / electronic components such as the unit controller or contactors.

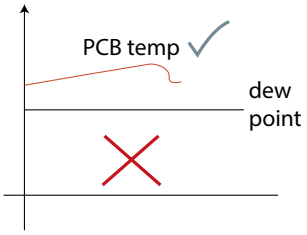
It is recommended to place drive at least 30cm from ground to protect against floods.

Condensation

Condensation must always be avoided. There is a specific risk of condensation when the frequency converter or some of its components are colder than moist ambient air. In this situation, the moisture in the air can condense on the electronic components.

- Operating with the frequency converter constantly connected to the mains can help to reduce the risk of condensation. Install a cabinet heater in situations where there is a real possibility of condensation due to ambient conditions.

- If the drive is IP 20, then evaluate and prevent possibility of condensation above drive. Example: condensation on metallic frame above drive, piping… If unavoidable, solutions like cabinet heater, a pace heater, top hat on the drive, insulation in the electric panel can be a solution.



- Water resulting of condensation must not accumulate on the bottom of electric panel. Provide a drain for condensed water to run out if necessary.

- No other forced cooling then internal drive fan.

Dust Exposure

Avoid Dust forms and deposits on the surface of the drive and inside on circuit boards and the electronic components. These deposits act as insulation layers and hamper heat transfer to the ambient air, reducing the cooling capacity. The components become warmer. This causes accelerated aging of the electronic components, and the service life of the unit decreases. Dust deposits on the heat sink in the back of the unit also decrease the service life of the unit.

The drive cooling fans have small bearings into which dust can penetrate and act as an abrasive. This leads to bearing damage and fan failure.

Under the conditions described above, it is advisable to clean the frequency converter during periodic maintenance. Remove dust off the heat sink and fans and clean the filter mats.

Mechanical Mounting Clearance

For optimal cooling conditions, mount the drive on vertical position. Allow a free air passage above and below the frequency converter. See Table below:

Enclosure type	H5
a [mm / inch]	100 / 3.94
b [mm / inch]	100 / 3.94

Horizontal mounting is NOT the preferred position, however if unavoidable, lay PCB on the left side (270°) to avoid condensation accumulation on the electronics.

Ambient temperature

The maximum ambient temperature for the drive is 52°C.

Make sure that the clearance limits described above are respected.

The drive must be installed on a wall or on a back plate to ensure proper cooling.

Do not place the drive under direct sunlight. Insulation inside the electrical panel can reduce impact of sun radiation.

Test at the unit at highest ambient maximum load is recommended. Look for over temperature drive alarm.

The drive could operate lower to -10C with proper operation, such as inside the cabinet, install the space heater. LCP operating temperature is -10 ~ 50 °C.

Temperature during storage/transport : -30 to +65/70 °C (-22 to +149/158 °F)

EMC

Frequency converter (and other electrical devices) generate electronic or magnetic fields that may interfere with their environment. The electromagnetic compatibility (EMC) of these effects depends on the power and the harmonic characteristics of the devices.

The EMC product standard for frequency converters defines 4 categories (C1, C2, C3, and C4) with specified requirements for emission and immunity. Below table states the definition of the 4 categories and the equivalent classification from EN 55011.

Category	Definition	Equivalent emission class in EN 55011
C1	Frequency converters installed in the first environment (home and office) with a supply voltage less than 1000 V.	Class B
C2	Frequency converters installed in the first environment (home and office) with a supply voltage less than 1000 V, which are not plug-in and not movable, and must be installed and commissioned by a professional.	Class A Group 1
C3	Frequency converters installed in the second environment (industrial) with a supply voltage lower than 1000 V.	Class A Group 2
C4	Frequency converters installed in the second environment with a supply voltage equal to or above 1000 V or rated current equal to or above 400 A or intended for use in complex systems.	No limit line. Make an EMC plan

VLZ compressor with drive package achieve EMC Class A Group 1 emission and immunity requirements.

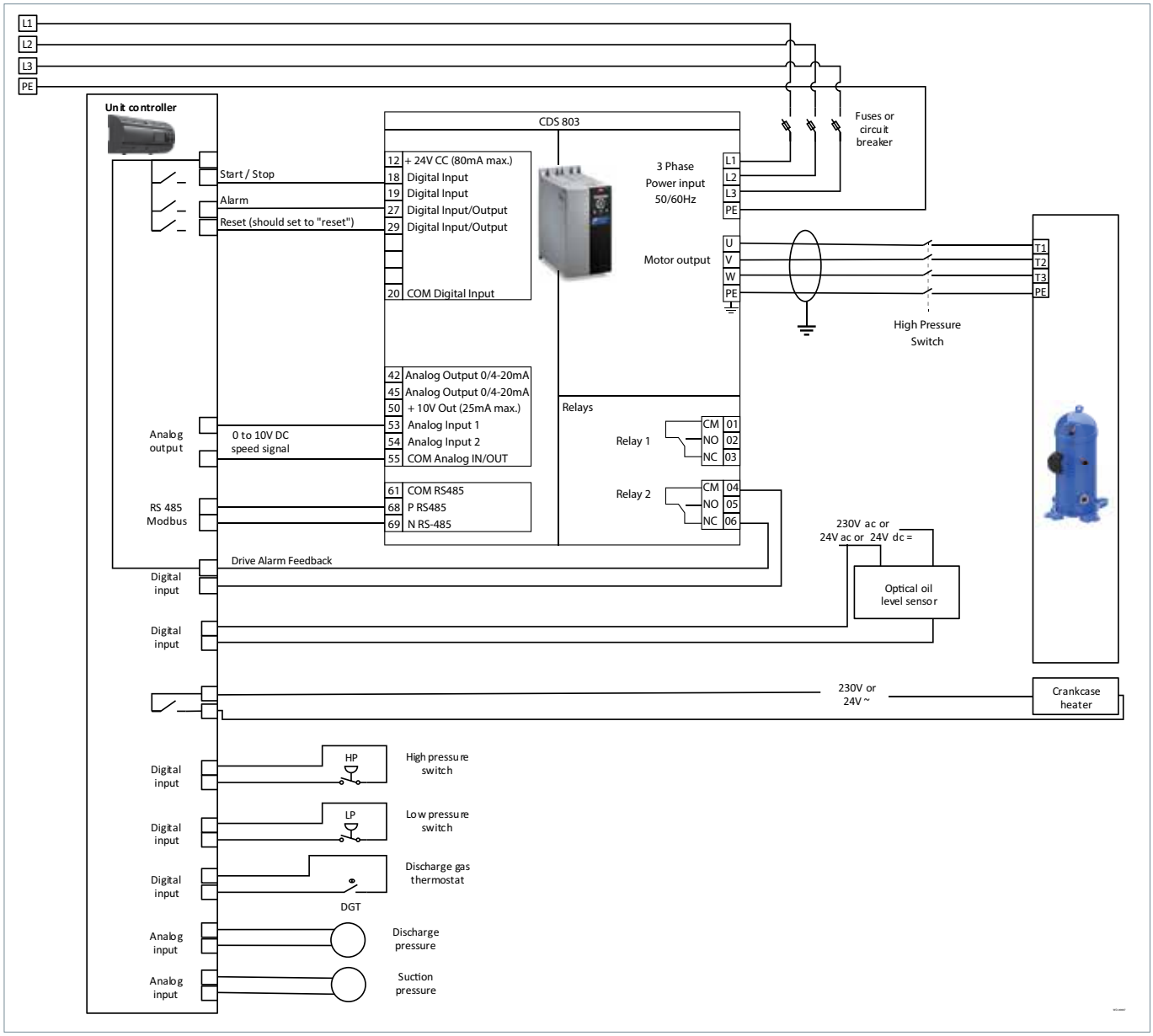
EMC best practices

- Use screened (shielded) cables for motor, control wiring and communication.
- Separate cables for input power, motor wiring and control wiring. Failure to isolate power, motor, control and communication cables can result in unintended behavior or reduced performance. Minimum 200 mm (7.9 in) clearance between power, motor and control cables is required.
- Ensure VFD proper grounding.
- Motor cables should be as short as possible to reduce noise level and leakage currents.
- Use the decoupling plate to fix and terminate cables(Refer to EMC correct installation of a frequency drive CDS803).

The frequency converter is pre-set for speed open loop control. This means that the speed set-point is given by a 0-10V, where 0V corresponds to the minimum compressor speed and 10V is maximum compressor speed.

The unit controller must have full control of the compressor operation and application protections such as compressor envelope control, oil return management and short cycling protection.

Below is the Danfoss proposed system configuration and wiring.



NOTE 1: Only relevant parameters or the ones different from factory defaults are shown.
NOTE 2: Oil boost, short cycle protection to be programmed in the unit controller
NOTE 3: Use an output contactor (CDS803)

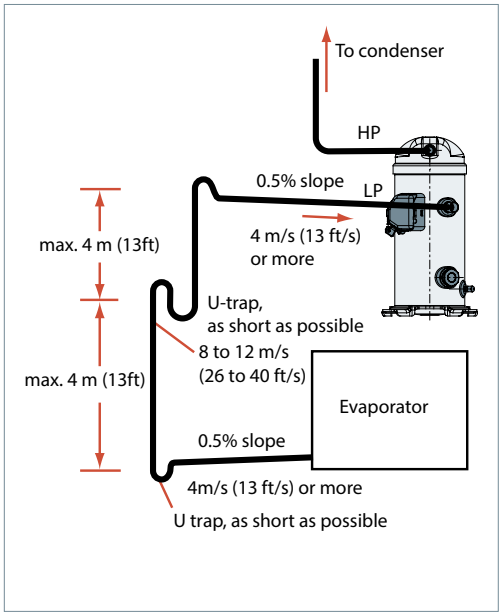
General requirements

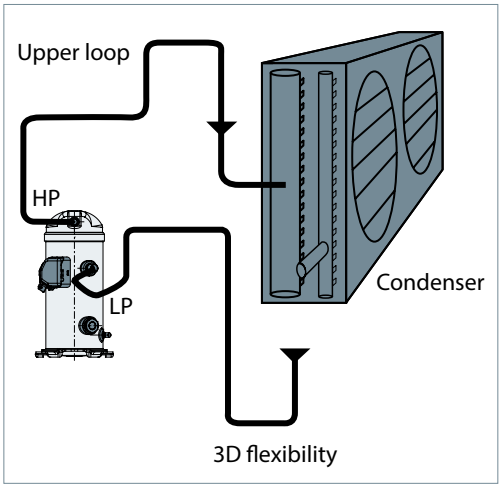
Proper piping practices should be employed to:

1. Ensure adequate oil return, even under minimum load conditions (refrigerant speed, piping slopes…). For validation tests see section "Manage oil in the circuit".

2. Avoid condensed liquid refrigerant from draining back to the compressor when stopped (discharge piping upper loop). For validation tests see section "Manage off cycle migration".

General recommendations are described in the figures below:





3. Piping should be designed with adequate three-dimensional flexibility to avoid excess vibration. It should not be in contact with the surrounding structure, unless a proper tubing mount has been installed.

For more information on noise and vibration, see section on: "Sound and vibration management".

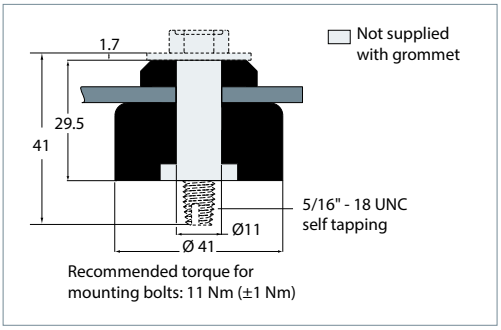
General requirements

Compressors used in single applications must be mounted with flexible grommets.

During operation, the maximum inclination from the vertical plane must not exceed 7 degrees.

Single requirements

All compressors are delivered with four rubber grommets and metal sleeves. Compressors must always be mounted with these grommets. Recommended torque for mounting bolts: 11 Nm (±1 Nm).



Requirement

R Oil level must be visible or full in the sight glass when the compressor is running and when all compressors of the circuit are stopped.

For VLZ, an oil separator is mandatory to use to guarantee oil return.

System evaluation

Single compressor

1. Since each installation is unique, test cannot validate the oil return, **Oil separator*** is mandatory
2. Pay special attention to "Piping design" on field
3. Oil level must be checked and adjusted at commissioning.

Test, criteria and solutions

Test N°	Purpose	Test condition	Pass criteria	Solutions
1	Check proper oil return	 Lowest foreseeable evaporation, and highest foreseeable condensation. **Minimum speed running** 6 hours.	Oil level must be visible or full in the sight glass when the compressor is running.	1. Top-up with oil, generally 1-2% of the total system refrigerant charge (in weight). Above 3% look for potential oil trap in the system. 2. Adjust oil boost function, for more details see section "Oil management logic".

***Oil separator**

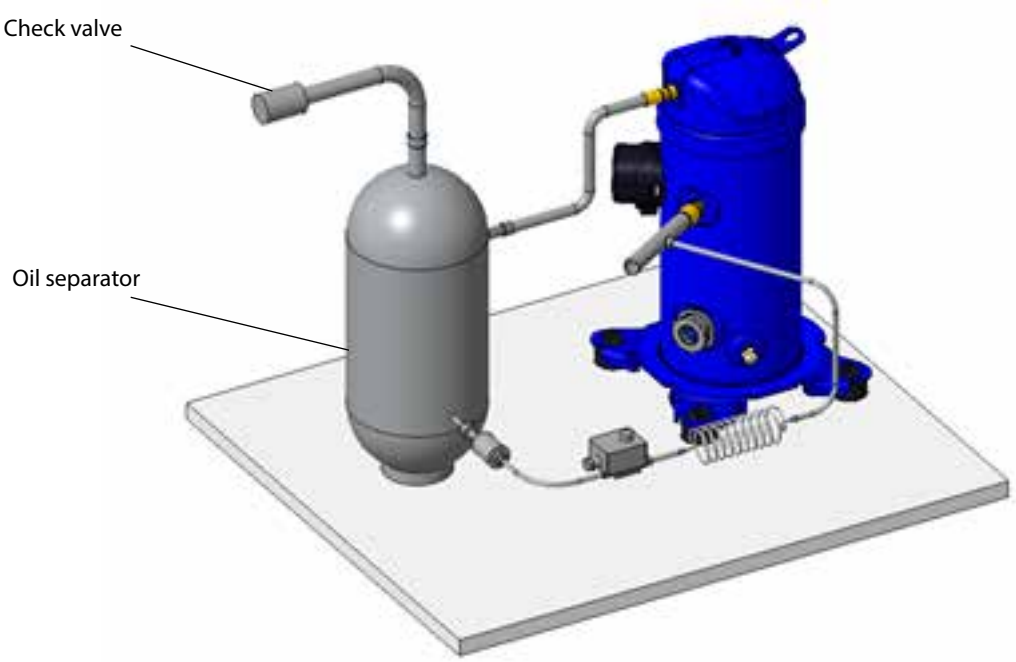
Oil separator which has the internal reintegration system is recommended, such as floating ball oil separator.

Oil return injection **must be done in suction line** and not in oil sump. If there is a suction accumulator, place the oil return on suction pipe, between suction accumulator and compressor suction port.

In any case, the T° measurement used for superheat control, (bulb or sensor) must be placed before the oil injection.

NRV must be used at outlet of oil separator to prevent Compressor Off Cycle migration issues.

Do not place the oil separator in the air flow, to avoid having oil separator acting as a condenser.



Typical sounds and vibrations in systems can be broken down into the following three categories:
- Sound radiation (through air)
- Mechanical vibrations (through parts and structure)
- Gas pulsation (through refrigerant)

The following sections focus on the causes and methods of mitigation for each of the above sources.

Compressor sound radiation

For sound radiating from the compressors, the emission path is air and the sound waves are travelling directly from the machine in all directions.

Sound levels are as follows:
- For compressors running alone:

Compressor model	Frequency RPS	380V		Acoustic hood code number
		Sound power dB(A)	Attenuation dBA ①	
VLZ065	60	79	7	120Z5084
	110	88	8	

Sound power and attenuation are given at ARI conditions, measured in free space
① Attenuation given with acoustic hood
Materials are UL approved

Mitigations methods:
We can consider two means to reduce compressors sound radiations:
1. Acoustic hoods are quick and easy to install and do not increase the overall size of the compressors. Acoustic hoods are available from Danfoss as accessories. Refer to the table above for sound levels, attenuation and code numbers.
2. Use of sound-insulation materials on the inside of unit panels is also an effective means to reduce radiation.

Note: During compressor shut down, a short reverse rotation sound is generated. The duration of this sound depends on the pressure difference at shut down and should be less than 3 seconds. This phenomenon has no impact on compressor reliability.

Mechanical vibrations

A compressor generates some vibrations that propagate into the surrounding parts and structure. The vibration level of a VLZ compressor alone does not exceed 76 µm peak to peak. However, when system structure natural frequencies are close to running frequency, vibrations are amplified due to resonance phenomenon.

A high vibration level is damageable for piping reliability and generates high sound levels.

Mitigations methods:
1. Danfoss VLZ scroll compressors are designed to produce minimal vibration during operations. To ensure minimum vibrations transmission to the structure, strictly follow mounting requirements (mounting feet, rails etc..). For further information on mounting requirements, please refer to "Design compressor mounting".

2. Ensure that there is no direct contact (without insulation) between vibrating components and structure.

3. Resonance phenomenon
To avoid resonance phenomenon, pipings and frame must have natural frequencies as far as possible from running frequencies.

This could be challenging on a variable system as all resonant frequencies between min speed to maximum speed will be exited.

It is mandatory to check that piping vibrations are acceptable across speed range. This test can be done by increasing slowly speed and monitoring piping behavior through, strain gage, acceleration, or displacement measurement. As alternative visual check with strobe light can also emphasis high piping displacement.

If some resonant frequencies generate high piping vibration, problem can be solved by increasing piping stiffness with brackets or changing layout. Dampers can also be installed to mitigate vibration.

If some frequencies continue to produce unacceptable vibration levels, speed by-pass is adjustable in the frequency converter, in order to avoid some frequency ranges. Four by-pass ranges are adjustable, and settings can be made in parameter group 4-6.

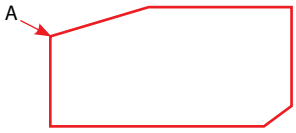
Gas pulsation

The Danfoss VLZ scroll compressor has been designed and tested to ensure that gas pulsation is optimized for the most commonly encountered air conditioning pressure ratio. Manifolded compressors are equivalents to lagged sources of gas pulsation. Therefore, pulse level can vary during time.

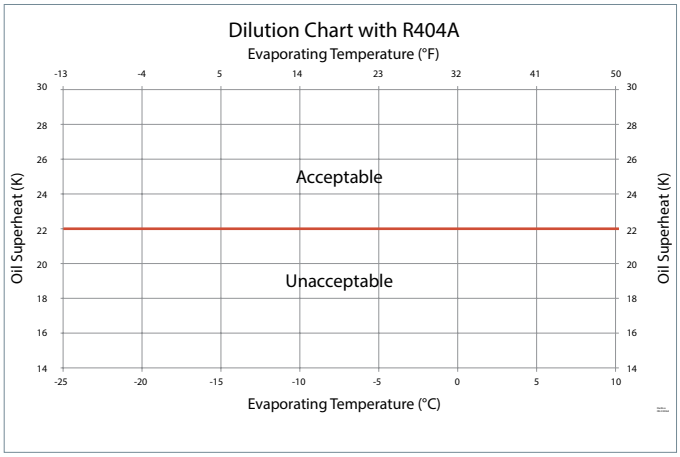
Mitigations methods:
If an unacceptable level is identified, a discharge muffler with the appropriate resonant volume and mass can be installed.

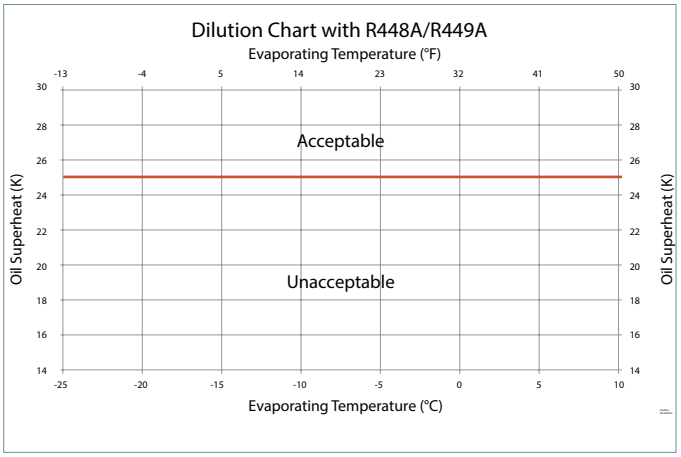
	During normal operation, refrigerant enters the compressor as a superheated vapor. Liquid flood back occurs when a part of the refrigerant entering the compressor is still in liquid state.	Liquid flood back can cause oil dilution and, in extreme situations lead to liquid slugging that can damage compression parts.
Requirement	In steady state conditions the expansion device must ensure a suction superheat within 5K.	
System evaluation	VLZ is designed for non-reversible application. Liquid flood back test should be performed	on unit as following table, otherwise, a suction accumulator is mandatory

Test, criteria and solutions

Test N°	Purpose	Test condition	Pass criteria	Solutions
Liquid flood back test	Steady-state	Liquid flood back testing must be carried out under expansion valve threshold operating conditions: •Lowest foreseeable evaporation, and highest foreseeable condensation. •Minimum speed running. For reversible system, perform test in both heating and cooling mode 	Suction superheat >5K	1. Check expansion valve selection and setting. -For Thermostatic expansion valve (TXV) check bulb position... -For Electronic expansion valve (EXV) check measurement chain and PID.... 2. Add a suction accumulator*.
	Transient	Tests must be carried out with most unfavorable conditions : • fan staging, • compressor staging • …	Oil superheat shall not be more than 30 sec below the safe limit defined in the Dilution Chart. (See graph above)	

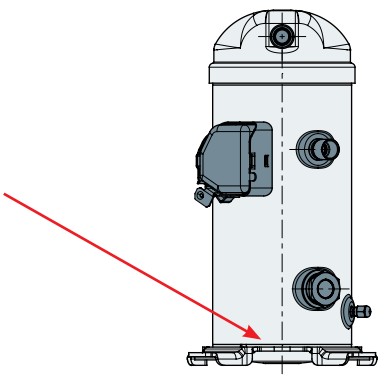
*Suction accumulator offers protection by trapping the liquid refrigerant upstream from the compressor. The accumulator should be sized at least 50 % of the total system charge. Suction accumulator dimensions can impact oil return (gas velocity, oil return hole size…), therefore oil return has to be checked according to section "Manage oil in the circuit".





Oil temperature sensor must be placed between oil sight glass and compressor baseplate. Some thermal paste shall be used to improve the conductivity. The sensor must also be correctly thermally insulated from the ambiance.

The Oil superheat is defined as:
(Oil temperature - Evaporating temperature)



Manage off cycle migration

Off -cycle refrigerant migration happens:
• when the compressor is located at the coldest part of the installation, refrigerant vapor condenses in the compressor.
• or directly in liquid-phase by gravity or pressure difference.

When the compressor restarts, the refrigerant diluted in the oil, or stored in evaporator, generates poor lubrication conditions, and may reduce bearings lifetime. In extreme situations, this leads to liquid slugging that can damage the compressor scroll set.

Requirement

· Compressor can tolerate occasional flooded start, but it should remain exceptional situation and unit design must prevent that this situation from happening at each start.
· Right after start, liquid refrigerant must not flow massively to compressor.

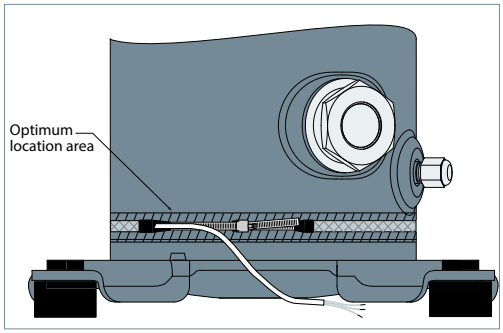
· The protective measures must be taken to limit risk of liquid slugging and extreme dilution at start.
R VLZ is designed for split system application. The External Non-Return Valve is mandatory to use.

System evaluation

Ensure tightness between condenser & evaporator when system is OFF
• Thermostatic expansion Valve (TXV), Liquid Line Solenoid Valve LLSV** strongly recommended
• Electronic expansion valve (EXV) must close when system stops including in power shut down situation

Since each installation is unique, refrigerant charge may vary
• Belt type heater*
• Liquid Line Solenoid Valve**+ pump-down cycle***
• External Non-Return Valve

*Crankcase heater
The belt crankcase heaters are designed to protect the compressor against off-cycle migration of refrigerant.
Additional heater power or thermal insulation might be needed in case of ambient temperature below -5°C (23°F) and a wind speed above 5m/second (16.4 feet/second).
The heater must be turned on whenever all the compressors are off.
Crankcase heater accessories are available from Danfoss (see section "Accessories").



**Liquid line solenoid valve (LLSV)
A LLSV is used to isolate the liquid charge on the condenser side, thereby preventing against charge transfer to the compressor during off -cycles. The quantity of refrigerant on the low-pressure side of the system can be further reduced by using a pump-down cycle in association with the LLSV.

***Pump-down cycle
By decreasing pressure in the sump, pump down:
• Evacuates refrigerant from oi.l
• Set the sump saturating pressure much lower than ambiance temperature and due to that, avoid refrigerant condensation in the compressor.

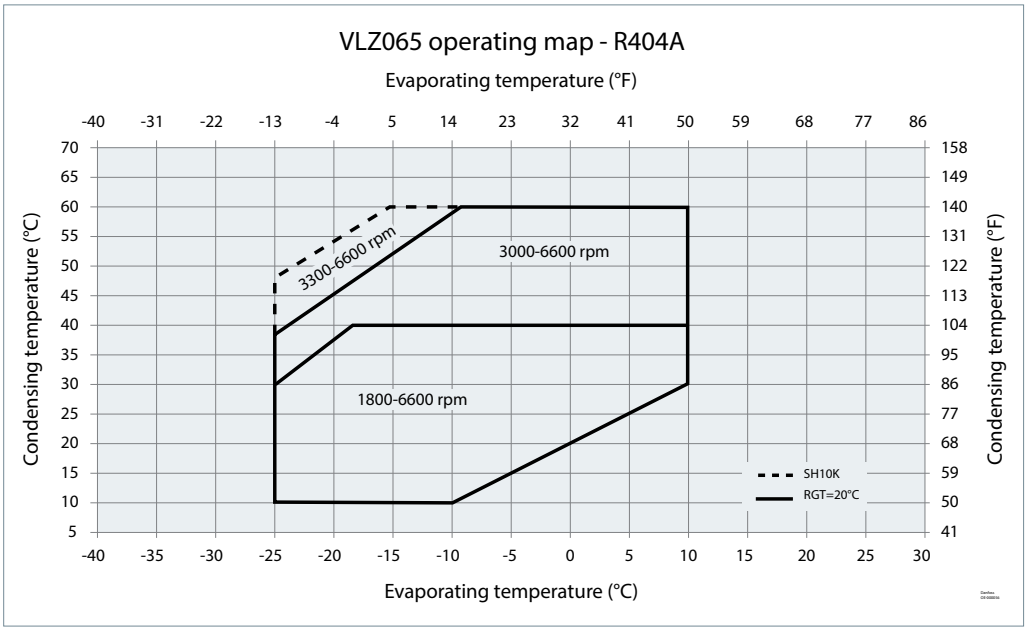
For more details on pump-down cycle see section "Control Logic".

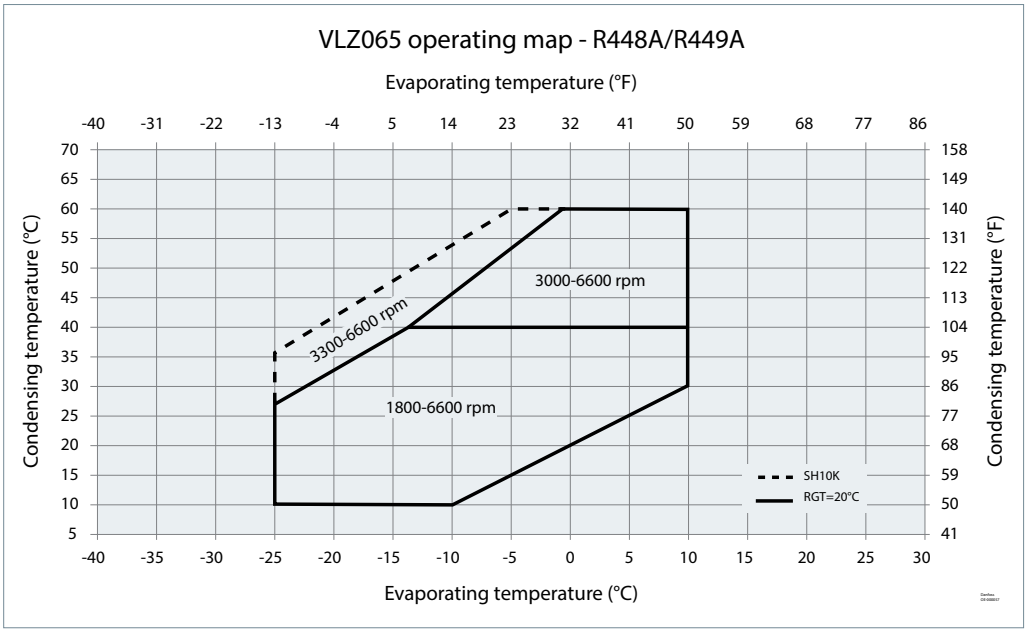
Requirement

The operating envelope for VLZ scroll compressors is given in the figures below and guarantees reliable operations of the compressor for steady-state operation.

Moreover, the discharge gas temperature must not exceed 135°C (275°F). Steady-state operation envelope is valid for a suction superheat above 10K.

Single envelope control





Pressure settings		R404A	R448A/R449A
Working range high side	bar(g)	7.2-27.7	6.2-26.2
Working range low side	bar(g)	1.5-7.2	1.0-6.2
Maximum high pressure safety switch setting*	bar(g)	29.1	27.6
Minimum low pressure safety switch setting	bar(g)	1.3	0.8
Minimum low pressure pump-down switch setting**	bar(g)	1.5	1.0

*Maximum allowable pressure on high pressure side according to PED regulation.
**Recommended pump-down switch settings: 1.5 bar below nominal evap.

System evaluation

VLZ drive can only protect the compressor from over current. To manage operating envelop, an advanced envelope protection principle needs to be used with variable speed compressors. This solution offers much better protection than basic protection, and also offers the possibility to adjust running conditions to avoid tripping (for example reduce compressor speed when reaching high pressure limit).

The advanced protection principle is based on a permanent measurement of suction and discharge pressure. Unit controller is permanently checking that the compressor is running within the defined envelope.

When compressor reach a limit, controller can act on different parameter to avoid unit tripping.

On top of suction and discharge pressure limitations, the discharge T° must remain below 135°C (275°F).

Low pressure switch and high pressure switch remain necessary as an ultimate protection.

The whole envelope can be used on the whole speed range, see "Single application envelope"

Depending on speed range needed, two types of controls to be considered as below (R404A as examples):

- Speed range limited from 3000RPM to 6600RPM
- Full speed range from 1800RPM to 6600RPM

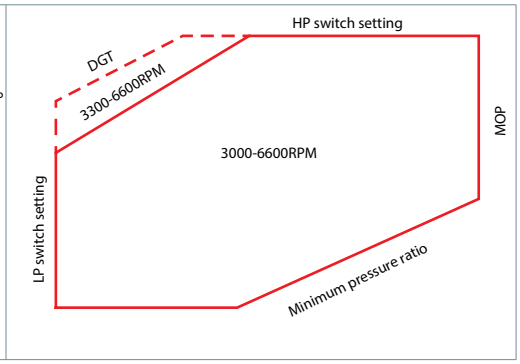
Single envelope control: Limit speed range from 3000RPM to 6600RPM

Controller do not need to manage speed limitation according to operating conditions.

Protection required
- HP switch*
- LP switch*
- DGT set @ 135°C (275°F) if necessary see "Discharge T° protection"

- Measurements of suction and discharge pressure, unit controller with is permanently maintaining compressor within its envelope.

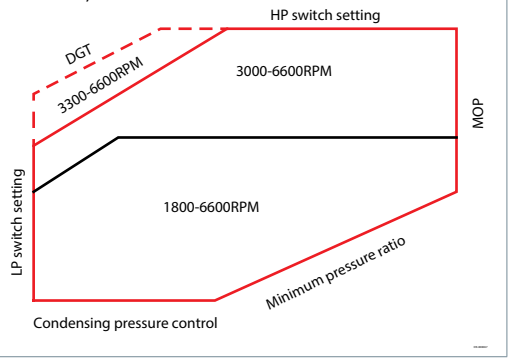
- drive setting:
parameter 4-11[Motor speed low limit(rpm)]:
set value as 3000



Multiple envelope control: Speed range <3000 allowed

Controller needs to manage speed limitation according to operating conditions.

Below 2400RPM oil boost function is disabled by default but could be enabled by OEM (more details **"Oil management logic"**)

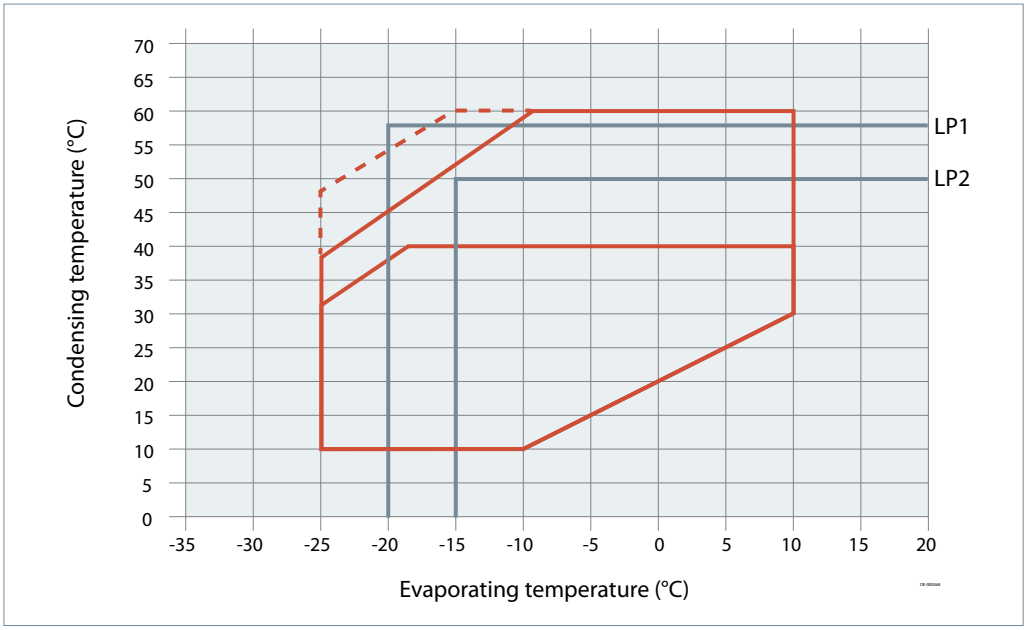
Protection required • HP switch* • LP switch* • DGT set @ 135°C (275°F) if necessary see §Discharge T° protection •Measurements of suction and discharge pressure, unit controller is permanently maintaining compressor within its envelope **with right minimum speed** •drive setting: parameter 4-11[Motor speed low limit(rpm)]: keep default value as 1800	See "Test, criteria and solutions" 

*for more details see "Control Logic"

Test N°	Purpose	Test condition	Pass criteria	Solutions
1	Check reaction of system to oil boost	Stabilized the system in area below minimum speed (2400RPM) until oil boost happen	No unsafties happen Superheat requirement fulfilled	Modify ramp-up Modify superheat control

Discharge temperature protection

Discharge gas temperature (DGT) protection is required if the high and low pressure switch settings do not protect the compressor against operations beyond its specific application envelope. Please refer to below R404A examples below, which illustrate where DGT protection is required (Ex. 1) and where it is not (Ex. 2). Please notice the envelope boundaries change based on different speed limits.



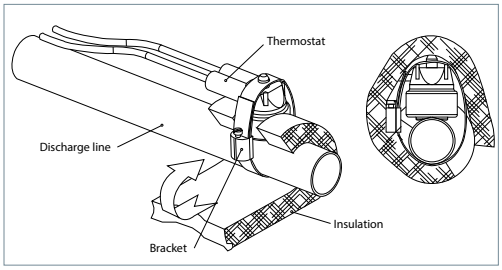
Example 1 (R404A, SH=10K)
LP switch setting:
LP1=2bar(g) (-20°C)
HP switch setting:
HP1=26.5bar(g) (58°C)
Risk of operation beyond the application envelope.
DGT protection required

Example 2 (R404A, SH=10K)
LP switch setting:
LP2=2.6bar(g) (-15°C)
HP switch setting:
HP2=22bar(g) (50°C)
No risk of operation beyond the application envelope

Continuous operations beyond the compressor's operating range will cause serious damage to the compressor.

The discharge gas thermostat accessory kit (code 7750009) includes all components required for installation as shown on the right. DGT installation must respect below requirements:

- The thermostat must be attached to the discharge line within 150 mm (5.91 inch) from the compressor discharge port and must be thermally insulated and tightly fixed on the pipe.
- The DGT should be set to open at a discharge gas temperature of 135°C (275°F) or lower.



MOP (Max operating pressure) control

In steady state, it is essential to prevent the compressor running when evaporating T° is higher than the specified envelope. Operating the compressor higher than maximum evaporating temperature will cause low viscosity of lubricant and lead to high dilution. Eventually the compressor will get damaged.

This protection can be achieved by using MOP function on expansion device. MOP is a feature added to EXV's (also to TXV's) that limit the maximum suction pressure of the unit. The customer would need to set this at the10°C (50°F) limit we have on our VS operating envelope.

Regardless of EXV or TXV, customer needs to qualify the expansion device. Testing needs to be done at both max and min operating conditions to guarantee the valve closes enough on the min and opens far enough on the max.

Complementary to MOP, the unit controller can increase compressor speed to keep evaporating T° lower than limit.

Condensing pressure control

In steady state, the condensing T° must be maintained at a T° within envelope. This can be done by using fan speed controller, or constant pressure valve. Keep condensing pressure at a minimum level is also important to maintain the pressure differential across the thermostatic expansion valve and prevent cut out on the LP protection in cold ambient.

As an alternative the unit controller can increase compressor speed to keep condensing T° lower than limit.

Minimum pressure ratio

In steady state, the pressure ratio must be a T° within envelope. 2 types of control can be considered:

- Set the minimum condensing T° at 30°C (86°F) together with MOP set at 10°C (50°F).
- Unit controller monitors permanently Condensing and Evaporating T°, and adjust compressor speed or condensing T° to keep running conditions within envelope.

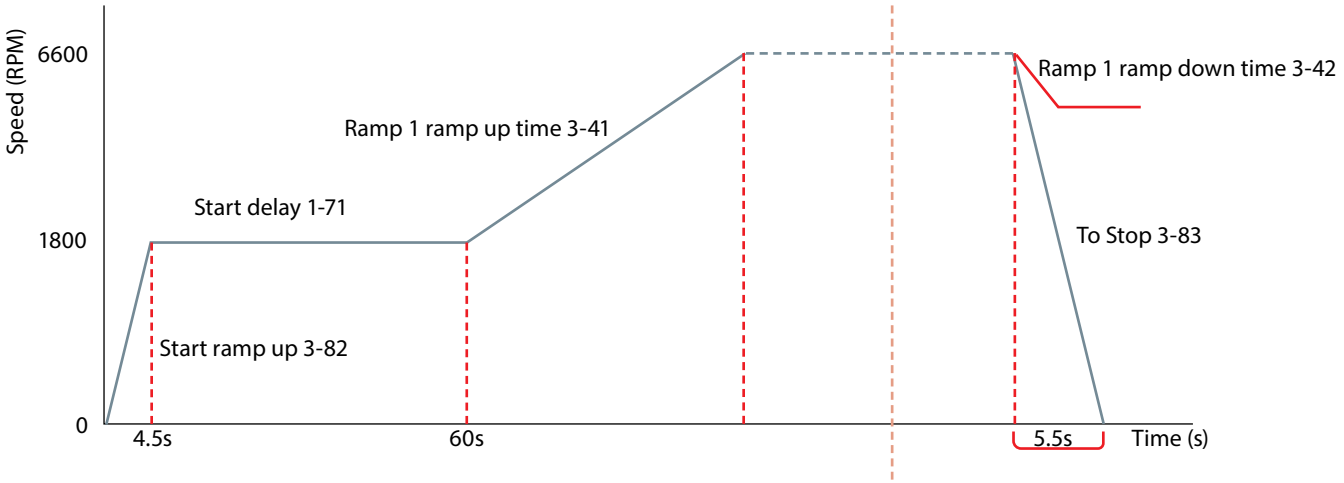
Speed limit requirement

R Speed limit guarantees compressor reliability and must be respected. In drive control logic, default setting values have been qualified by Danfoss.

Customer could change the default values if the changes have been qualified by OEM.

Start/Stop/Ramp setting

R



Drive parameter		Description	Default value (s)
1-71	Start delay	keep running @ 1800 RPM within a certain duration	60
3-41	Ramp 1 ramp up time	It is used to define speed ramp up slope. Speed ramp up slope is defined under condition that increases compressor speed from 0 rpm to 6000 rpm in a certain period(s, ramp1 ramp up time) Eg: if current speed is 3000rpm and desired speed is 4000rpm, then compressor will reach 4000 rpm in 30s	180
3-42	Ramp 1 ramp down time	It is used to define speed ramp down slope. Speed ramp down slope is defined under condition that decreases compressor speed from 6000 rpm to 0rpm in a certain period (s, ramp1 ramp down time) Eg: if current speed is 4000rpm and desired speed is 3000rpm, then compressor will reach 3000 rpm in 30s	180

Safety control logic requirements

	Tripping conditions		Re-start conditions	
	Value	Time	Value	Time
HP switch	See Pressure settings table from section "Manage operating envelope"	Immediate, no delay. No by- pass	Conditions back to normal. Switch closed again	Manual reset
LP safety switch				Maximum 5 auto reset during a period of 12 hours, then manual reset.

High pressure

According to EN378-2, a high-pressure (HP) safety switch is required to shut down the compressor. The high-pressure switch can be set to lower values depending on the application and ambient conditions. The HP switch must either be placed in a lockout circuit or consist of a manual reset device to prevent cycling around the high-pressure limit. If a discharge valve is used, the HP switch must be connected to the service valve gauge port, which must not be isolated. For CDS803 drive, HP switch can be connected to STO (Safe Torque Off) input 37 or to an external contactor placed between drive and compressor. Must remove the jumper (factory supplied) before connecting HP switch on terminals T37 and T12.

Low pressure

A low-pressure (LP) safety switch must be used. Deep vacuum operations of a scroll compressor can cause internal electrical arcing and scroll instability. VLZ compressors exhibit high volumetric efficiency and may draw very low vacuum levels, which could induce such a problem. The low-pressure switch must be set at or above "Minimum Low pressure switch setting".

The switch can be integrated directly in the safety chain of the compressor or it can be treated by the unit controller.

If the LP switch is connected to Terminal 27 Digital Input, it is necessary to keep a parameter of 5.12 to default value "coast inverse" to make sure LP cut-out has a higher priority than internal minimum run time function.

Electronic expansion valve

With variable capacity systems, an electronic expansion valve (EXV) is the strongly recommended solution to handle refrigerant mass flow variations. Danfoss recommends the use of ETS products. Ramp-up and ramp-down settings, of both EXV and compressor, must be done with great care.

Ramp-up of the EXV must be shorter than the ramp-up of the compressor, to avoid any low pressure operation on suction side of the compressor. The EXV can also be opened, up to a certain degree, before the startup of the compressor.

Ramp-down of the EXV must be longer than the ramp-down of the compressor, also to avoid low pressure operation (except with pump-down).

EXV should be closed, and remain closed, when the compressor is off, to avoid any liquid refrigerant entering the compressor.

Reverse rotation protection

Due to drive protection, compressors could work properly even if the power connection between the drive and mains are dis-matched. However, the wires between compressor and drive must be connected accordingly. To protect compressors from reverse rotation, pressure difference could be checked as a reference value. Use pressure sensors to monitor pressure difference between discharge and suction of the compressor, and for normal operation, discharge pressure should be at least 1 bar higher than suction pressure within 30 s running after compressor starting.

Short cycle protection

Short cycling protection requirements need to be implemented in OEM unit controller:

Meantime, the factory default setting needs to be disabled(28-00 short cycle protection change from default setting "enable" to "disable").

- 3 minutes minimum running time: in order to get oil return back from circuit to compressor sump

- 12 starts maximum per hour: to avoid threaten the lifetime of motor and other mechanics due to frequent starts, OEM needs to limit the starts cycles within 12 times per hour.

- 10s minimum OFF time: to make sure discharge valve is closed and motor is stopped before next start, OEM needs to set the minimum off time as 10 seconds.

Pump-down logic recommendations

Pump down is initiated prior to shutting down the last compressor on the circuit by de-energizing a liquid line solenoid valve or closing electronic expansion valve. When suction pressure reaches the cut-out pressure, compressor is stopped, and liquid solenoid valve or electronic expansion valve remains closed.

- R Continuous pump-down: Compressor restarts automatically when suction pressure increases up to 4 cycles maximum. A non-return valve in the discharge line is Mandatory.

Oil boost

An insufficient oil level can be the result of low refrigerant velocity in pipes and heat exchangers. An oil boost sequence consisting of increasing refrigerant velocity for short periods, at regular time intervals can improve oil return. Oil boost function can be done in 2 ways

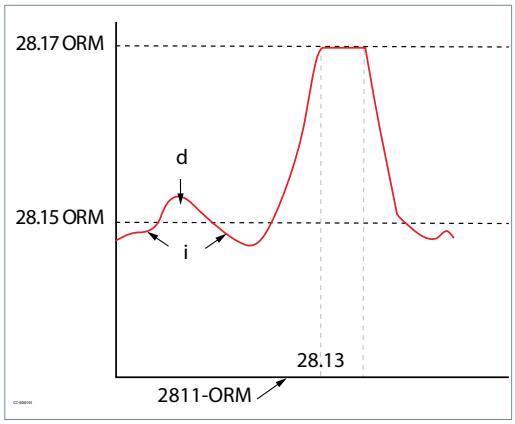
1. Using internal CDS drive oil boost function
2. Program oil boost function in unit controller and use optical oil level sensor to trig it.

As oil boost logic needs to increase / decrease speed, make sure expansion device is fast enough to maintain liquid flood back within acceptable limit during those transients.

CDS Drive oil boost function

If the compressor runs below ORM(Oil Return Management) Min Speed Limit, 28.14) for more than low speed running time, 28-11, then function will override the unit controller and accelerate compressor speed to ORM Boost Speed, 28.16 for Boost duration 28.13 (28.13 does not include the ramping up time). When the boost is finished, the compressor speed goes back to run on reference (speed setpoint) and the time counter is reset and restarting from zero.

On top of that compressor will boost to ORM Boost Speed, 28.16 at a fixed time interval as programmed in parameter 28-12.



28.17 ORM	28.17 ORM Boost speed
28.15 ORM	28.15 ORM Min speed limit
2811-ORM	2811-ORM Low Speed Running time
d	Decrease ORM time
i	Increase ORM time
28.13	Boost duration 28.13

Feedback and status message A feedback signal can be routed back to the unit controller via programable digital output, relay_2 or Modbus when an oil boost is initiated.

The unit controller can take actions to keep the system stabilized during the oil boost period. A status message “Oil Boost” is also displayed on the drive LCP during boost.

Drive parameters	Description	value	Default
05-02	Terminal 29 Mode	Output	Input
5-31	Terminal 29 Digital Output	Oil boost active	No operation
5-40.1	Function Relay	Oil boost active	VLT running
16-94 (read)	Ext. Status Word	1000000hex (bit 24)	

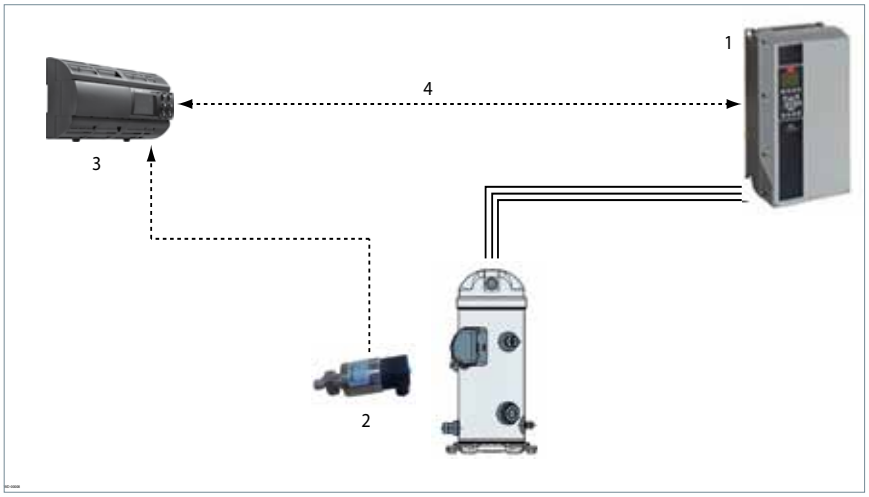
Drive parameters		Description	Default	Range
“28.10”	Oil return management	Enables/disables Oil Return Management	Enable	On / Off
“28.11”	Low speed running	Threshold for boost decision	120 min	1-1440 min
“28.12”	Fixed boost interval	Maximum time between oil return boosts	24h	1-168h
“28.13”	Boost duration	desired duration of oil boosts	60sec	10-255s
“28.15”	ORM Min speed limit	Minimum speed limit for trigger the ORM function	120Hz	90~180Hz
“28.17”	ORM boost speed	Boost speed for the ORM function	180Hz	par. 28.14 to 330Hz

Oil boost controlled by optical oil level sensor

CDS oil boost function is based on time and compressor speed. More advanced protection can be done using a compressor equipped with an optical oil level sensor and a logic embedded in the unit controller.

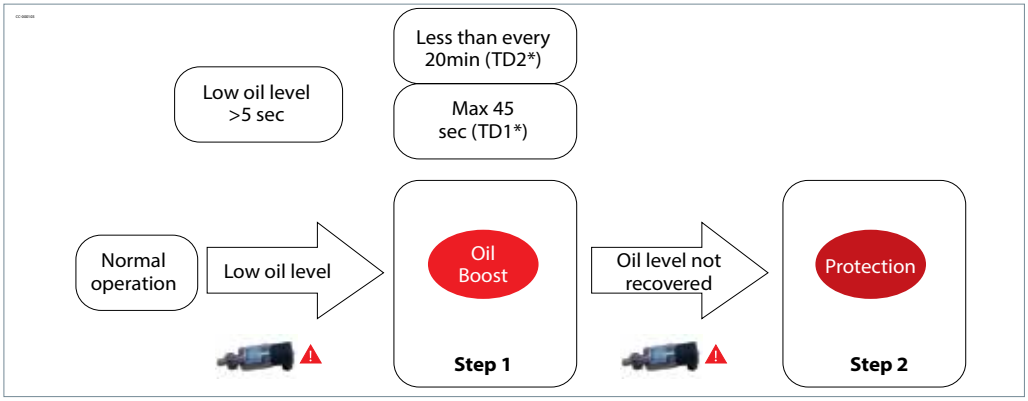
Details on optical oil level sensor in Product information

Drive parameters		Description	Default value
“28.10”	Oil return management	Disable (managed by unit controller)	Enable



1	Drive
2	Optical oil level sensor
3	Oil management logic embedded in unit controller
4	Modbus

The oil management control logic must include 2 steps.



Step 1 (oil boost) if oil level sensor detects low level for more than 5 seconds, oil is trapped in the system. Oil boost is activated (VS speed is increased). It increases refrigerant velocity in the system and recovers oil. TD1 is the maximum time to complete step 1. If oil is not recovered within TD1 switch to step 2. If oil is recovered within TD1, the compressor will come back to normal operation.

TD2 is the minimum interval between two step 1. In case of low oil level detection within a time <TD2, switch to step 1.

Step 2 (Protection) If the oil is still lower than the limit after having completed step 1, or if the oil level drips again
within a time <TD2, the controller must move forward in protection mode and stop the system in alarm.

Step 1 Oil boost function description

Return oil trapped in the system to compressor by increasing refrigerant mass-flow in the system.

Enter condition: Low oil level in VS compressor detected by oil level sensor.

Cancel condition: High oil level in VS compressor detected by oil level sensor.

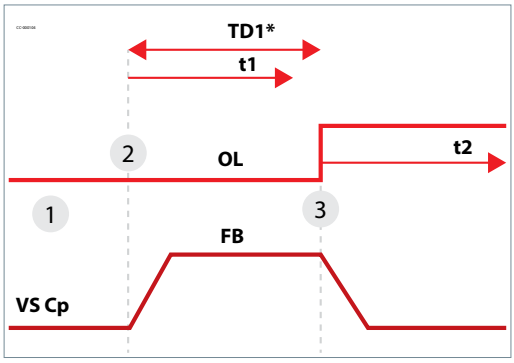
OR

t1>TD1, Oil boost duration exceeds Maximum Oil boost duration

Control sequence:

1. At initial state, VS (variable speed compressor) is ON.
2. Low oil level detected in compressor. Reset and Start t1.
3. VS compressor speed must increase to Fboost
4. When High oil level detected in VS compressor speed must be decreased to the initial speed

- Reset and start t2
- Reset



VS Cp	Variable speed compress
FB	FBoost
OL	Oil lack
TD1*	TD1 Max.

Step 2 Protection function description

Stop the compressor to prevent short of oil running.

Enter condition: Low oil level in VS compressor detected by oil level sensor.

AND

(t1>TD1, Oil boost duration exceeds TD1 OR t2<TD2, Interval between two Oil boost is < TD2)

Cancel condition: Manual Reset

Control sequence: Stop VS compressor

- Reset t1
- Reset t2

	Excessive air and moisture • can increase condensing pressure and cause excessively high discharge temperatures. • can create acid giving rise to copper platting. • can destroy the lubricating properties of the oil.	All these phenomena can reduce service life and cause mechanical and electrical compressor failure.
Requirements	VLZ compressors are delivered with < 100 ppm moisture level. At the time of commissioning, system moisture content may be up to 100 ppm.	During operation, the filter drier must reduce this to a level between 20 and 50 ppm.
Solutions	To achieve this requirement, a properly sized and type of drier is required. Important selection criteria include: • driers water content capacity, • system refrigeration capacity, • system refrigerant charge.	For new installations with VLZ compressors with POE oil, Danfoss recommends using the Danfoss DML (100% molecular sieve) solid core filter drier.

Compressor storage

- Store the compressor where is not exposed to rain, corrosive or flammable atmosphere.

- Store the compressor between -35°C and 70°C (-31°F and 158°F) when it is charged with nitrogen.

- Store the compressor between -35°C and 55°C (-31°F and 131°F) when it is charged with refrigerant.

Compressor holding charge

Each compressor is shipped with a nominal dry nitrogen holding charge between 0.3 and 0.7 bar (4 psi and 10 psi) and is sealed with elastomer plugs.

⚠ Respect the following sequence:

- Remove the nitrogen holding charge via the suction Schrader valve to avoid an oil mist blow out.
- Remove the suction plug first and the discharge plug afterwards to avoid discharge check valve gets stuck in open position.

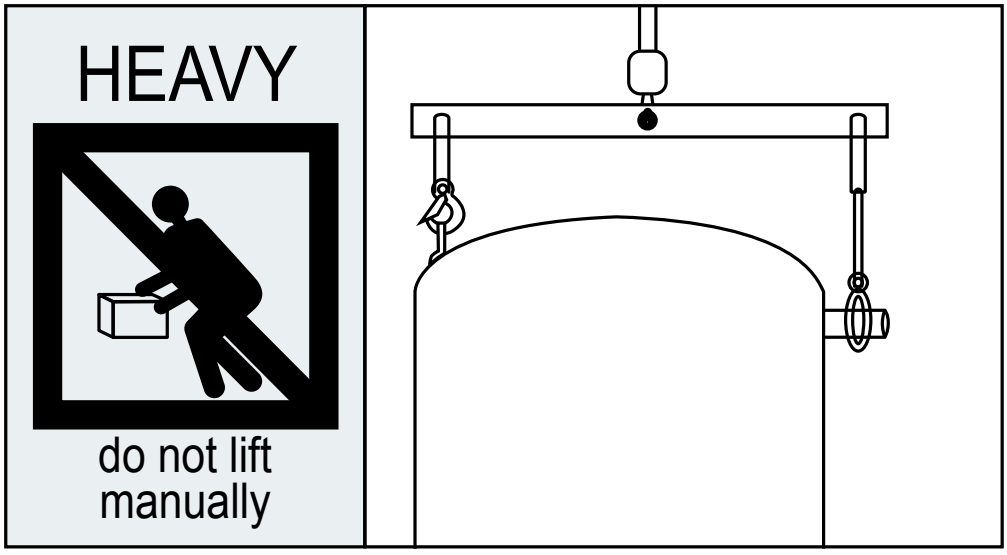
An opened compressor must not be exposed to air for more than 20 minutes to avoid moisture is captured by the POE oil.

Handling

⚠ Each Danfoss VLZ scroll compressor is equipped with one lift ring on the top shell.

- Always use one lift ring and discharge tube when lifting the compressor.
- Use lifting equipment rated and certified for the weight of the compressor or compressor assembly.
- A spreader bar rated for the weight of the compressor is highly recommended to ensure a better load distribution.
- The use of lifting hooks closed with a clasp is recommended.
- Never use the lift rings on the compressor to lift the full unit.

Maintain the compressor in an upright position during all handling manoeuvres (maximum of 15° from vertical).



Piping assembly

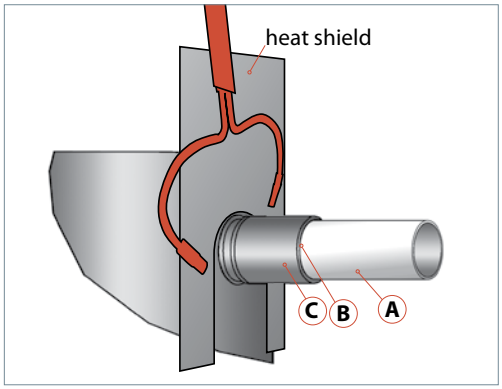
Good practices for piping assembly is a pre-requisite to ensure compressor service life (system cleanliness, brazing procedure...)

System cleanliness

Circuit contamination possible cause	Requirement
Brazing and welding oxides	During brazing, flow nitrogen through the system
Filings and particles from the removal of burrs in pipework	Remove any particles and burrs generated by tube cutting and hole drilling
Moisture and air	Use only clean and dehydrated refrigeration grade copper tubing Opened compressor must not be exposed to air more than 20 minutes to avoid moisture captured by PVE oil.

Brazing procedure:

- Brazing operations must be performed by qualified personnel.
- Make sure that no electrical wiring is connected to the compressor.
- To prevent compressor shell and electrical box overheating, use a heat shield and/or a heat-absorbent compound.
- Clean up connections with degreasing agent.
- Flow nitrogen through the compressor.
- Use flux in paste or flux coated brazing rod.
- Use brazing rod with a minimum of 5% silver content.
- It is recommended to use double-tipped torch using acetylene to ensure a uniform heating of connection.
- To enhance the resistance to rust, a varnish on the connection is recommended.



⚠ Before eventual un-brazing of the compressor or any system component, the refrigerant charge must be removed.

System pressure test and leak detection

⚠ The compressor has been strength tested and leak proof tested (<3g/year) at the factory.
For system tests:

- Always use an inert gas such as Nitrogen or Helium.
- Pressurize the system on HP side first then LP side.
- Do not exceed the following pressures:

Maximum compressor test pressures	
Maximum compressor test pressure high side (HP)	41.1 bar (g) / 596 psig HP-LP<36bar / 522 psi
Maximum compressor test pressure low side (LP)	33.3 bar (g) / 483 psig LP-HP<5bar / 73 psi Maximum speed 4,8 bar/ second (70 psi/s)*

* If an external non return valve is present on the discharge line, maximum pressurizing speed must be respected to ensure pressure equalization between LP and HP side over scroll elements.

Vacuum evacuation and moisture removal

Requirements:
- Never use the compressor to evacuate the system.
- Connect a vacuum pump to both the LP and HP sides.
- Evacuate the system to a pressure of 500 µm Hg (0.67 mbar / 0.02 in.Hg) absolute.

Recommendations:
- Energized heaters improve moisture removal.
- Alternate vacuum phases and break vacuum. with Nitrogen to improve moisture removal.

For more detailed information see "Vacuum pump-down and dehydration procedure" TI-026-0302.

Refrigerant charging

Initial charge:
- For the initial charge, the compressor must not run.
- Charge refrigerant as close as possible to the nominal system charge.
- This initial charging operation must be done in liquid phase between the condenser outlet and the filter drier.

If needed, a complement of charge can be done:
- In liquid phase while compressor is running by slowly throttling liquid in.
- Never bypass safety low pressure switch.

For more detailed information see "Recommended refrigerant system charging practice" FRCC.EN.050.

Dielectric strength and insulation resistance tests

The tests are performed on each compressor at the factory between each phase and ground.

- Carry out a dielectric strength test by short-circuiting terminals L1, L2 and L3. Energize by max. 1920 V DC(hi-pot) for code G compressors and 1460 V DC(hi-pot) for code J compressors for one second between this short-circuit and the chassis, and leakage current must be less than 5 mA. When running dielectric strength tests of the entire installation, frequency converter and compressor electrical motor compressor test can be conducted together. When conducting a dielectric strength test, make sure the system is not under vacuum: this may cause electrical motor compressor failure.

Do not use a megohm meter nor apply power to the compressor while it is under vacuum as this may cause internal damage.

Please note, it is not recommended that a dielectric strength test be carried out too often as it may damage the motor. Nevertheless, if such a test is necessary, it must be performed at a lower voltage.
- Insulation resistance is measured with a 500 V DC megohm tester and must be higher than 1 megohm.
- The presence of refrigerant around the motor windings will result in lower resistance values to ground and higher leakage current readings. Such readings do not indicate a faulty compressor. To prevent this, the system can be first operated briefly to distribute refrigerant.

Preliminary check

⚠ Check electrical power supply:

- Phase order: Reverse rotation is obvious if the compressor do not build up pressure and sound level is abnormal high. VLZ compressor will only operate properly in one direction. If electrical connections are done correctly between the drive and the compressor terminals (compressor terminals T1,T2,T3 and drive terminals U, V & W matching), the drive will provide correct phase supply to the compressor, and reverse rotation will be not possible: For more details refer to "Motor protection".
- Voltage and voltage unbalance within tolerance: For more details refer to section "Motor voltage".

Initial start-up

- Crankcase heaters must be energized at least 6 hours in advance to remove refrigerant.
- Do not provide any power to the drive unless suction and discharge service valves on compressor are open, if installed.
- Energize the drive. The compressor must start, according to defined ramp-up settings. If the compressor does not start, check wiring conformity.
- Check the frequency converter control panel: If any alarm is displayed check the wiring and in particular the polarity of the control cables. If an alarm is shown, refer to the frequency converter application manual. Verify in particular the combination of compressor, frequency converter and refrigerant.
- Check current draw and voltage levels on the mains. The values for the compressor electrical motor can be directly displayed on the frequency converter control panel.

System monitoring

The system must be monitored after initial startup for a minimum of 60 minutes to ensure proper operating characteristics such as:

- Proper metering device operation and desired superheat readings
- Suction and discharge pressure are within acceptable levels
- Correct oil level in compressor sump indicating proper oil return
- Low foaming in sight glass and compressor sump temperature 10K (18°F) above saturation temperature to show that there is no refrigerant migration taking place
- Acceptable cycling rate of compressors, including duration of run times.

A short cycling protection is provided in the CDS frequency converter. It is factory preset "enabled" with the following parameters in:
28.01 - interval between 2 starts: 300 seconds
28.02 - minimum run time: 60 seconds.

This minimum run time is set to guaranty long enough running time at start up in order to create enough refrigerant flow velocity in the system to recover the oil to the compressor sump.

- Current draw of compressor within acceptable values (RLA ratings)
- No abnormal vibrations and noise.

Oil level checking and top-up

In installations with good oil return and line runs up to 15 m (49 feet), no additional oil is required. If installation lines exceed 15 m (49 feet), additional oil may be needed. 1 or 2% of the total system refrigerant charge (in kg) can be used to roughly define the required oil top-up quantity (in liters) but in any case, the oil charge has to be adjusted based on the oil level in the compressor sight glass.

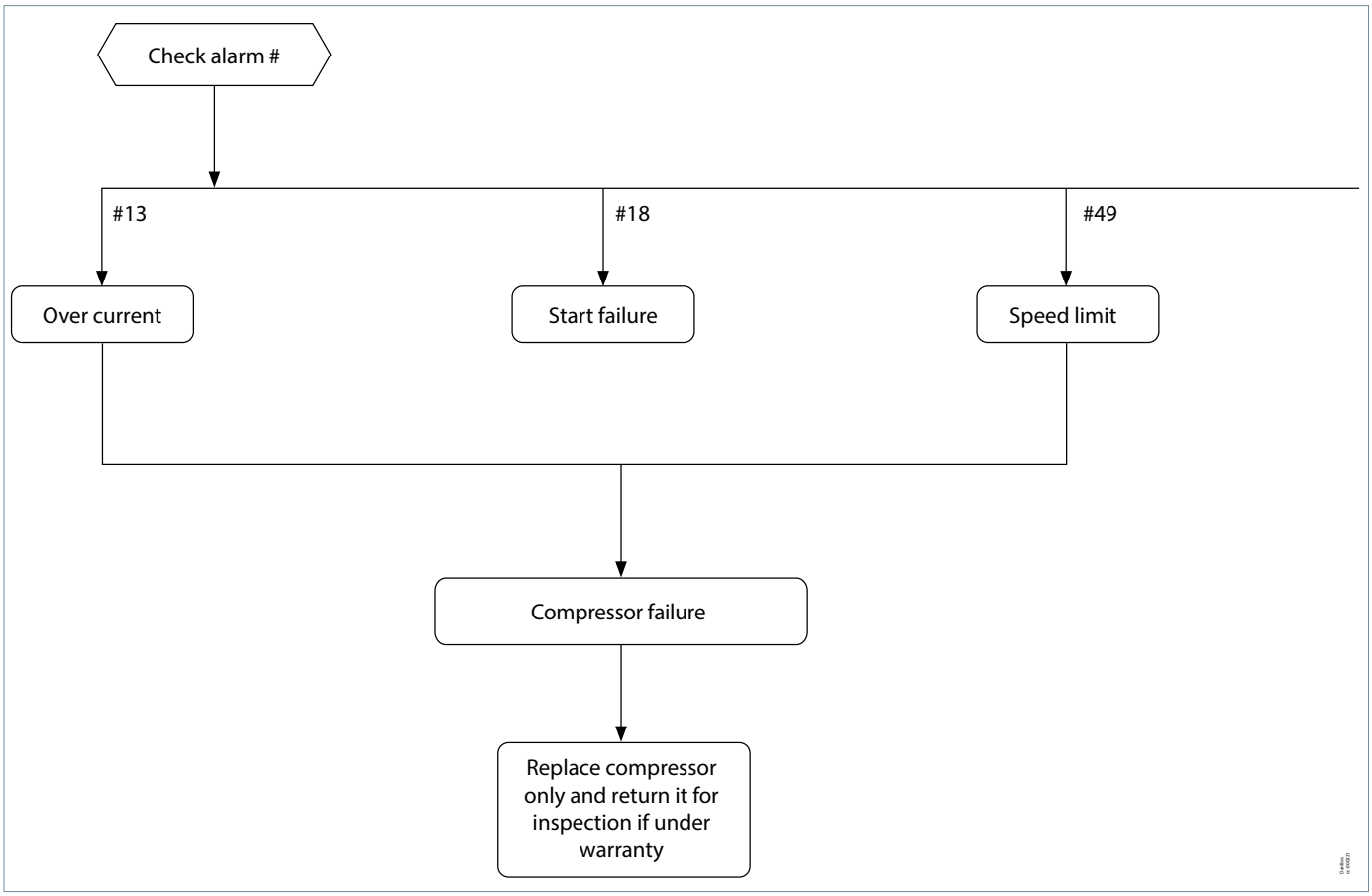
When the compressor is running under stabilized conditions, the oil level must be visible in the sight glass.

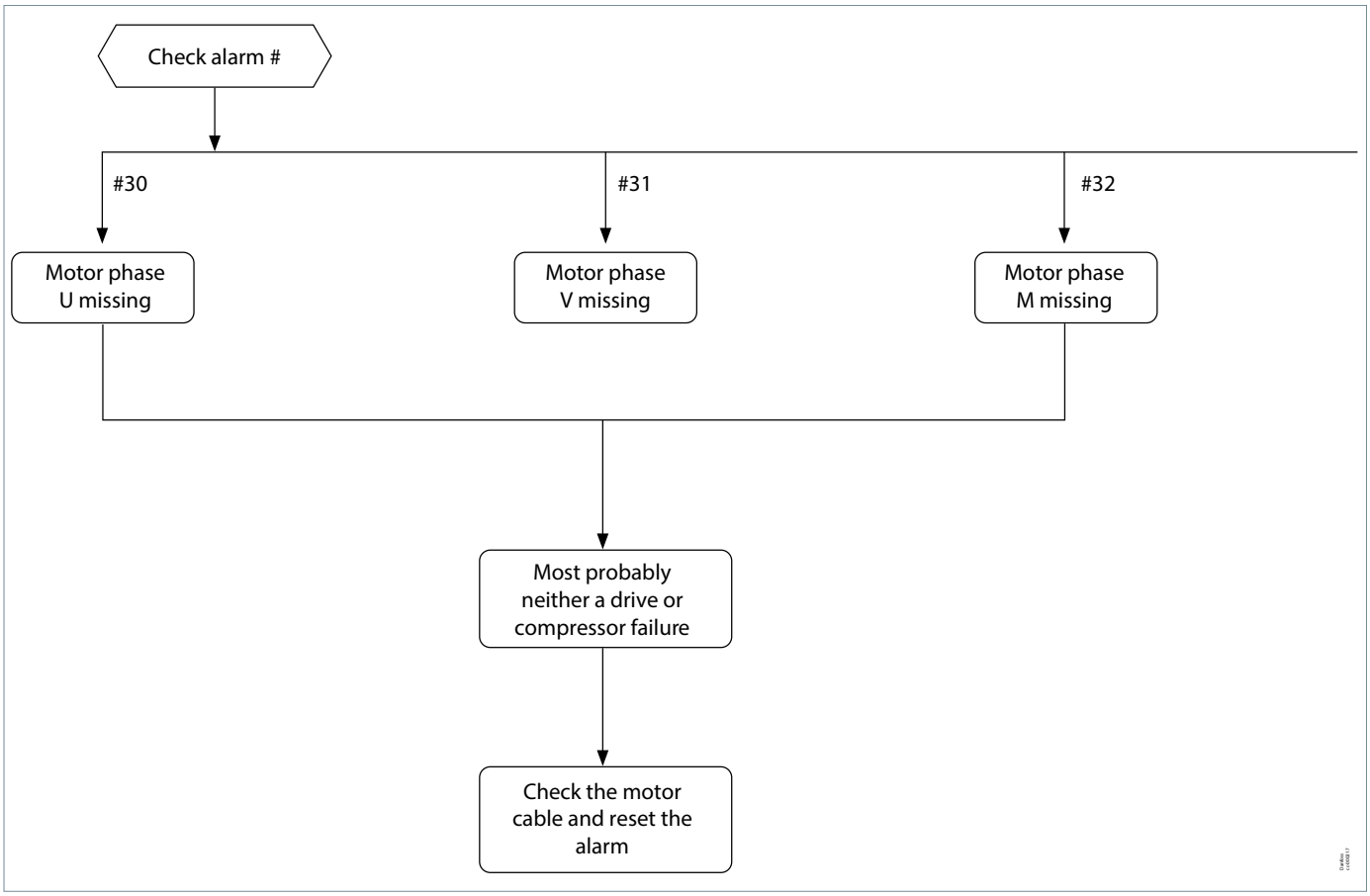
The presence of foam filling in the sight glass indicates large concentration of refrigerant in the oil and / or presence of liquid returning to the compressor.

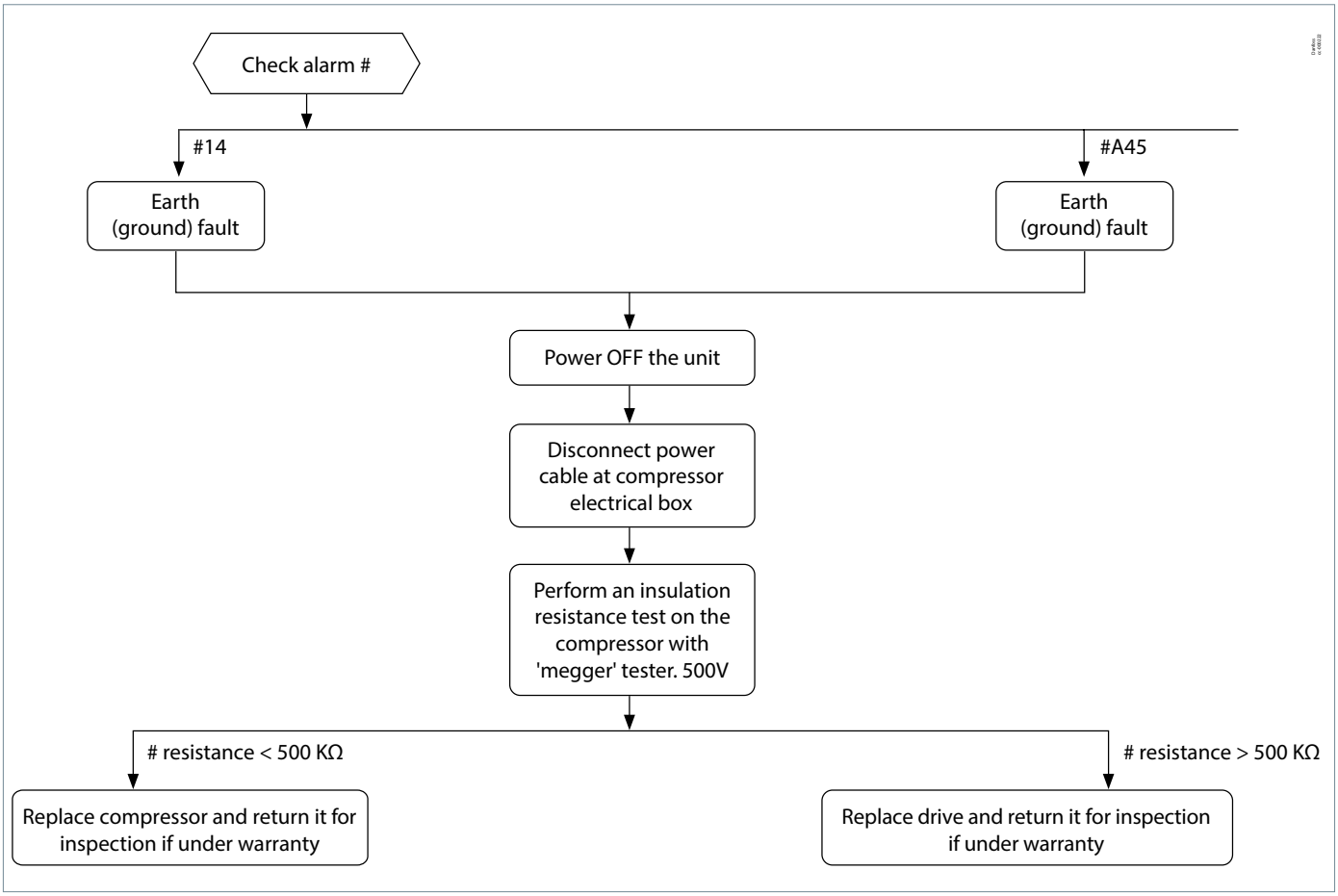
The oil level can also be checked a few minutes after the compressor stops, the level must be between 1/4 and 3/4 of sight glass.

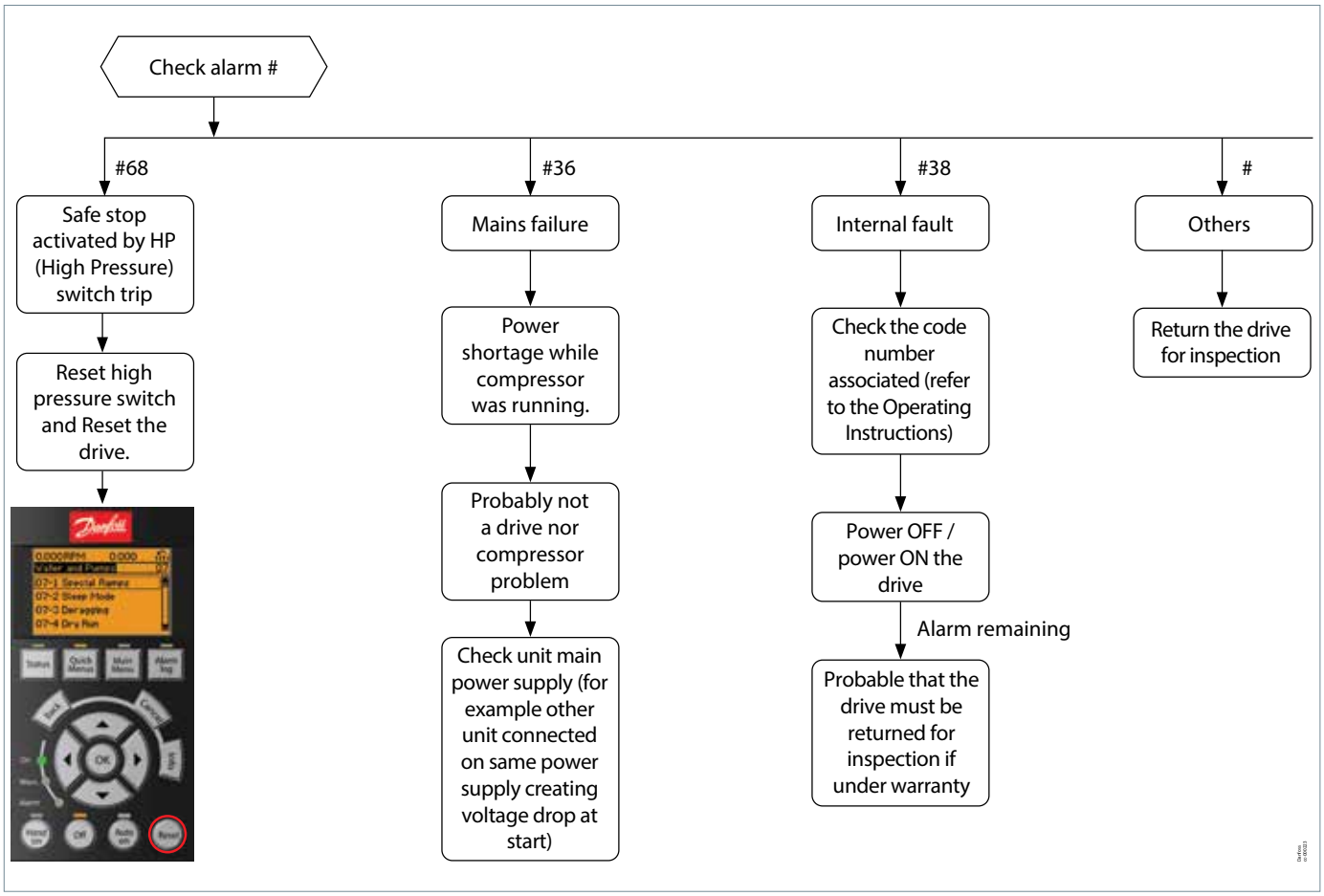
When the compressor is off, the level in the sight glass can be influenced by the presence of refrigerant in the oil.

Top-up the oil while the compressor is idle. Use the Schrader connector or any other accessible connector on the compressor suction line and a suitable pump. See news bulletin "Lubricants filling in instructions for Danfoss Commercial Compressors" TI 2-025-0402.


Check alarm #
#13
#18
#49
Over current
Start failure
Speed limit
Compressor failure
Replace compressor only and return it for inspection if under warranty


Check alarm #
#30
#31
#32
Motor phase U missing
Motor phase V missing
Motor phase M missing
Most probably neither a drive or compressor failure
Check the motor cable and reset the alarm


Check alarm #
#14
#A45
Earth (ground) fault
Earth (ground) fault
Power OFF the unit
Disconnect power cable at compressor electrical box
Perform an insulation resistance test on the compressor with 'megger' tester. 500V
resistance < 500 KΩ
resistance > 500 KΩ
Replace compressor and return it for inspection if under warranty
Replace drive and return it for inspection if under warranty


Check alarm #
#68
#36
#38
#
Safe stop activated by HP (High Pressure) switch trip
Mains failure
Internal fault
Others
Reset high pressure switch and Reset the drive.
Power shortage while compressor was running.
Check the code number associated (refer to the Operating Instructions)
Return the drive for inspection
Probably not a drive nor compressor problem
Power OFF / power ON the drive
Alarm remaining
Check unit main power supply (for example other unit connected on same power supply creating voltage drop at start)
Probable that the drive must be returned for inspection if under warranty

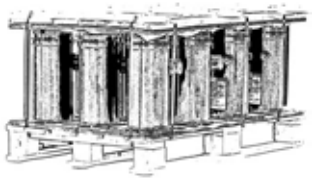
Danfoss recommends that compressors and compressor oil should be recycled by a suitable company at its site.

Single pack

Compressor single pack

Compressor model	Height		Width		Depth		Weight	
	(mm)	(inch)	(mm)	(inch)	(mm)	(inch)	(kg)	(lb)
VLZ065	524	20.6	292	11.5	286	11.3	38	84

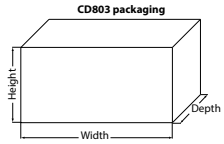
Compressor Industrial pack



Compressors are not packed individually but are shipped all together on one pallet. They can be ordered in quantities of full pallets only, multiples of 12 compressors, according to below table.

Compressor model	Nbr*	Length		Width		Height		Gross Weight		Static stacking pallets
		(mm)	(inch)	(mm)	(inch)	(mm)	(inch)	(kg)	(lb)	
VLZ065	12	1170	46.1	815	32.1	650	25.6	540	1190	3

Frequency converter single pack



Drive supply voltage	Drive power	IP20			
		Height (H)	Width (W)	Depth (D)	Weight
	(kW)	(mm)	(mm)	(mm)	(Kg)
T4: Code G	11	395	233	380	9.5

Ordering codes

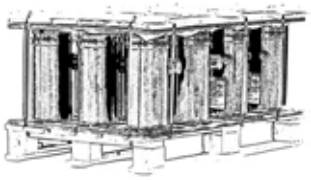
Compressor code numbers

Danfoss scroll compressors VLZ can be ordered in either industrial packs or in single packs. Drive can be ordered in single packs. Please use the code numbers from below tables for ordering.

Single pack

Compressor model	Equipment version	G 380-480V/3ph/50&60Hz	
		Compressor Name	Code no
VLZ065	Single	VLZ065TGNE9B/M	120G0397
	Unified	VLZ065TGNEDB/M	120G0395

Industrial pack



Compressor model	Equipment version	G 380-480V/3ph/50&60Hz	
		Compressor Name	Code no
VLZ065	Single	VLZ065TGNE9B/I	120G0398
	Unified	VLZ065TGNEDB/I	120G0396

VLZ converter order information

CDS803 Drive						
Voltage	Compressor	Model & power	IP class	RFI class	Drive name	Sales code
T4 380-480V/3ph/50&60Hz	VLZ065	CDS803 11kW	IP20	H2	CDS803P11KT4	132X3783

Accessories

Solder sleeve adapter set

Code n°	Description	Application	Packaging	Pack size
120Z0128	Rotolock adaptor set (1-1/4" ~ 7/8") , (1-1/4" ~ 3/4")	VLZ065	Multipack	6

Rotolock nuts and sleeves kit

Code n°	Description	Application	Packaging	Pack size
120Z5076	2 rotolock nuts 1"1/4 with sleeves and gaskets	VLZ065	Multipack	6

Rotolock adapter

Code n°	Description	Application	Packaging	Pack size
120Z0367	Adaptor (1-1/4" ~ 7/8")	VLZ065 suction	Multipack	10
120Z0366	Adaptor (1-1/4" ~ 3/4")	VLZ065 discharge	Multipack	10

Mounting kits

Code No	Description	Application	Packaging	Pack Size
120Z0622	Mounting kit for 1 scroll compressors including 4 grommets, 4 sleeves, 4 bolts, 4 washers, 2 grounding screws	VLZ065	Single pack	1

Crankcase heater

Code n°	Description	Application	Packaging	Pack size
120Z0060	Belt type crankcase heater, 65 W, 400 V, CE mark, UL (Wire length: 1000 mm)	VLZ065	Multipack	6
120Z5012	Belt type crankcase heater, 70W, 460V, CE mark, UL	VLZ065	Multipack	6

Discharge thermostat kit

Code n°	Description	Application	Packaging	Pack size
7750009	Discharge thermostat kit	VLZ065	Multipack	10
7973008	Discharge thermostat kit	VLZ065	Industry pack	50

Accessories

Lubricant

Code n°	Description	Application	Packaging	Pack size
120Z0648	POE lubricant, 215PZ(RL46HB),1 litre can	VLZ065	Multipack	12

Acoustic hoods

Code No	Description	Application	Packaging	Pack Size
120Z5084	Acoustic hood for scroll compressor	VLZ065	Single pack	1

Terminal box

Code No	Description	Application	Packaging	Pack Size
120Z5018	Square terminal box	VLZ065	Multipack	10

Oil level switch

Code No	Description	Application	Packaging	Pack Size
120Z0560	Oil level switch screw in- mechanical part	All models	Single pack	1
120Z0803	Oil level switch-electrical part(24V AC/DC) with relay*	All models	Single pack	1
120Z0804	Oil level switch-electrical part(230V AC) with relay*	All models	Single pack	1

* Danfoss does not provide c connector without cable, please order 2m and 8m pre-wired connectors in.the table of Connector for oil level sensor

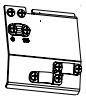
Connector for oil level sensor

Code No	Description	Application	Packaging	Pack Size
034G7073	M12 angle female connector cable 2m	Oil level sensor with relay	Single pack	1
034G7074	M12 angle female connector cable 8m	Oil level sensor with relay	Single pack	1

LCP's spare parts frequency converter

Code No	Description	Application	Packaging	Pack Size
120Z0581	LCP display	Frequency converter 803, VLZ065 code G	Single pack	1
120Z0617	LCP kit for remote mounting contains rubber sealing, 3m cable, bracket and screws	Frequency converter 803, VLZ065 code G	Single pack	1
132B0132	LCP 31 cable, 3m	Frequency converter 803, VLZ065 code G	Single pack	1

Decoupling plate



Frame	Compressor	Decoupling plate	packaging	Pack size
H5	VLZ065	120Z0583	Single pack	1

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Danfoss Commercial Compressors

is a worldwide manufacturer of compressors and condensing units for refrigeration and HVAC applications. With a wide range of high quality and innovative products we help your company to find the best possible energy efficient solution that respects the environment and reduces total life cycle costs.

We have 40 years of experience within the development of hermetic compressors which has brought us amongst the global leaders in our business, and positioned us as distinct variable speed technology specialists. Today we operate from engineering and manufacturing facilities spanning across three continents.

Danfoss Turbocor Compressors

Danfoss Inverter Scrolls

Danfoss Scrolls

Danfoss Optyma Condensing Units

Danfoss Maneurop Reciprocating Compressors

Danfoss Light Commercial Refrigeration Compressors

Our products can be found in a variety of applications such as rooftops, chillers, residential air conditioners, heat pumps, cold-rooms, supermarkets, milk tank cooling and industrial cooling processes.

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