



Scroll compressors

VCH099-116-132

For CRAC | Single, R410A



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Safety and warnings

Danfoss scroll compressors are designed and manufactured with state of the art technology. There is an added emphasis placed on safety and reliability. Critical 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 informational, with the intent to educate customers as to how the compressors should properly function. If you need any additional assistance, please contact Danfoss Technical Support. In any case, Danfoss manufacturing accepts no liability as a result of misuse or improper integration of the compressor unit.

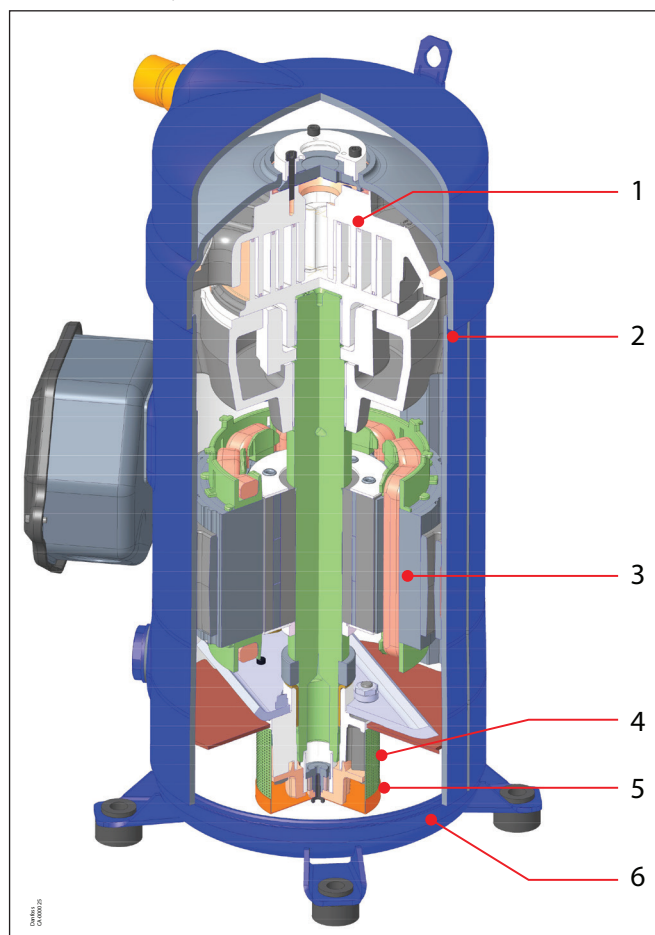
Introduction

Product description

Danfoss scroll compressor VCH099-116-132 for R410A is optimized for China, Computer room air conditioning (CRAC) application.

Cut Away VCH099-116-132

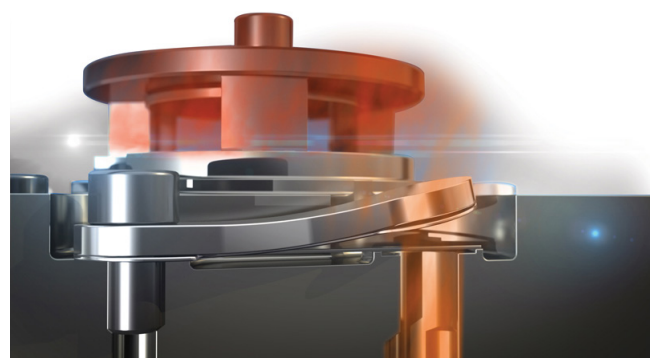
Figure: Cut Away VCH099-116-132



1	Optimize scroll set PR, combine IDV design and optimize efficiency for CRAC application
2	Optimize structure design, reduce compressor acoustic at high speed
3	New designed high efficiency motor, improve efficiency at part-load condition
4	Oil strainer controls the risk of system debris in the oil circuit
5	Gearotor oil pump ensures low speed bearing lubrication
6	Compact compressor outline design, beneficial for system unit layout

How do IDVs work?

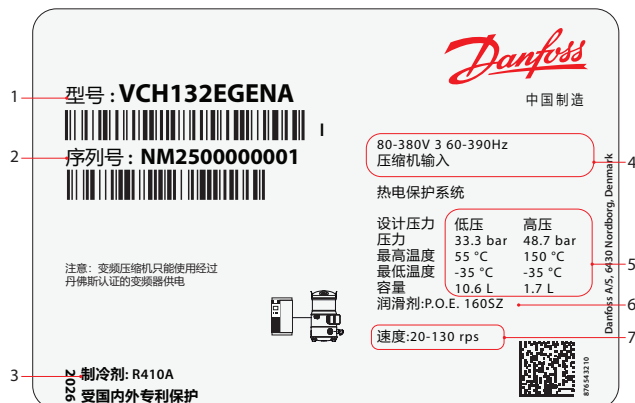
Figure: Intermediate Discharge Valve (IDV)



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.

Product identification

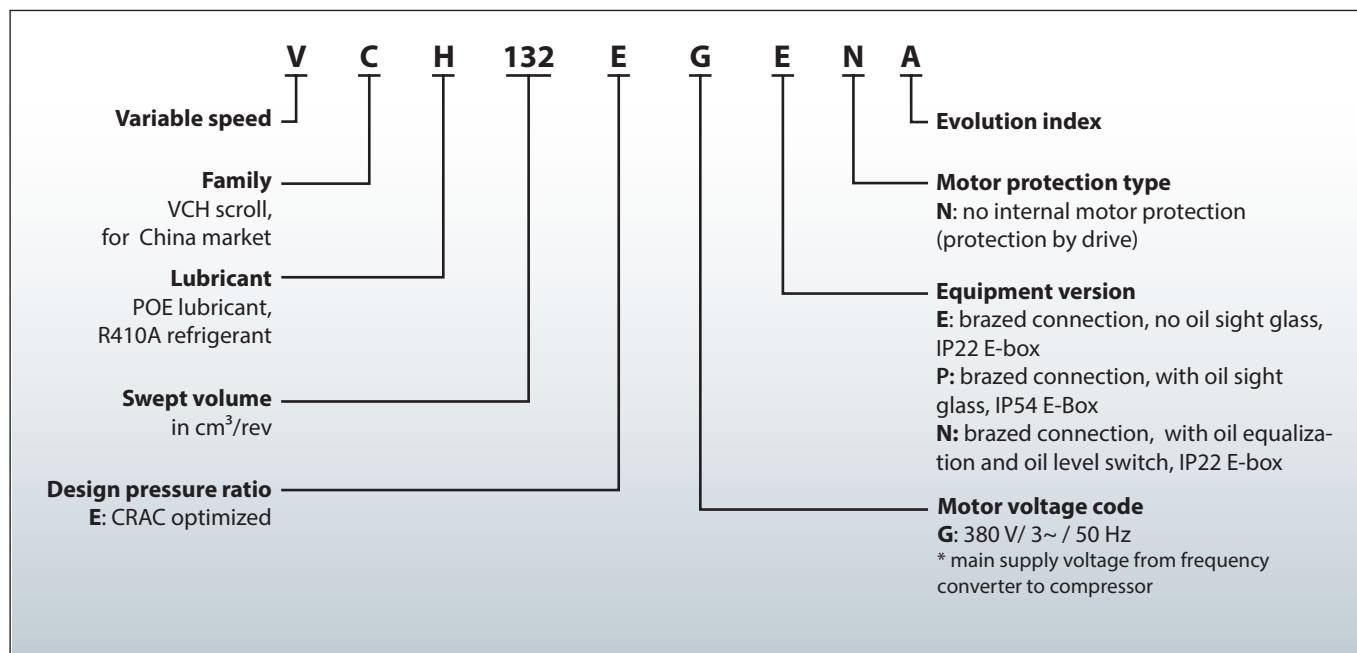
Name Plate



1	Model number
2	Serial number
3	Refrigerant
4	Supply voltage to CDC frequency converter
5	Housing service pressure
6	Factory charged lubricant
7	Compressor speed

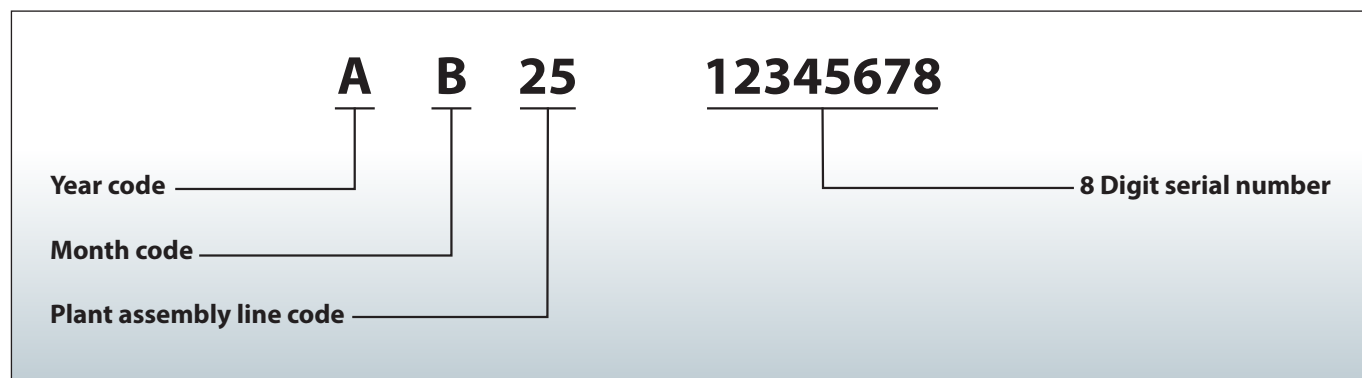
Nomenclature

The example below presents the compressor nomenclature which equals the technical reference as shown on the compressor nameplate. Code numbers for ordering are listed in section Ordering.



Compressors serial number

The example below presents the compressor nomenclature which equals the technical reference as shown on the compressor nameplate. Code numbers for ordering are listed in section Ordering.



Year code		Month code		Plant assembly line code	
Year	Code	Month	Code	Plant	Code
1990, 2010	A	January	A	Trévoux, France	11
1991, 2011	B	February	B		
1992, 2012	C	March	C		
1993, 2013	D	April	D	Wuqing ,China	25
1994, 2014	E	May	E		
1995, 2015	F	June	F		
1996, 2016	G	July	G		
1997, 2017	H	August	H		
1998, 2018	J	September	J		
1999, 2019	K	October	K		
2000, 2020	L	November	L		
2001, 2021	M	December	M		
2002, 2022	N				
2003, 2023	P				
2004, 2024	Q				
2005, 2025	R				
2006, 2026	S				
2007, 2027	T				
2008, 2028	U				
2009, 2029	V				

Internal free volume

Products	Internal free volume at LP side without oil	
	litre	cu.inch
VCH099-116-132	10.6	647

Refrigerants

General Information

When choosing a refrigerant, different aspects must be taken into consideration:

- Legislation (now and in the future)
- Safety
- Application envelope in relation to expected running conditions
- Compressor capacity and efficiency
- Compressor manufacturer recommendations & Guidelines

Additional points could influence the final choice:

- Environmental considerations
- Standardisation of refrigerants and lubricants
- Refrigerant cost
- Refrigerant availability

R410A

R410A is a HFC blend (R32: 50%; R125: 50%) with a zero Ozone Depletion Potential (ODP=0) and a Global Warming Potential of 1924/AR5 (2088/AR4). It is a near-azeotropic mixture with a temperature glide less than 0.2 K.

With its high net refrigeration effect coupled to a high density, the R410A has appeared in last decade to be the preferred refrigerant for use in commercial air conditioners and heat pumps.

Technical specification

Compressor size

Compressor can be sized on peak load, for best applied cost, or optimal efficiency. For optimal efficiency, see our performance details in Coolselector software.



For regular updates and detailed capacities, please refer to [Coolselector®2](#).

Compressor specification

Com- pressor model	Swept volume		Displacement								Oil charge		Net weight	
			30 rps		60 rps		90 rps		120 rps					
	cm3/r	cu.in/ rev	m³/h	cu.ft/h	m³/h	cu.ft/h	m³/h	cu.ft/h	m³/h	cu.ft/h	dm³	oz	kg	lbs
VCH132	130	7.92	14.04	496	28.08	992	42.12	1487	56.16	1983	3.3	128	63	139
VCH116	116	7.07	12.53	442	25.06	885	37.58	1327	50.11	1770	3.3	128	62	137
VCH099	99	6.03	10.69	378	21.38	755	32.08	1133	42.77	1510	3.3	128	61	134

Sound and vibration data

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.

Sound level

Model	Frequency RPS	Without acoustic hood (dBA)
VCH132	90	85
VCH116	90	85
VCH099	90	85

Note:

Nominal sound power for reference at ARI A/C (7.2°C/54.4°C/11.1°C/8.3°C) (45°F/130°F/20°F/15°F) conditions measured in free space.

Max. tolerance +3dBA for individual compressor.

Operating envelope data

Operating envelope

Figure: VCH099 envelope map

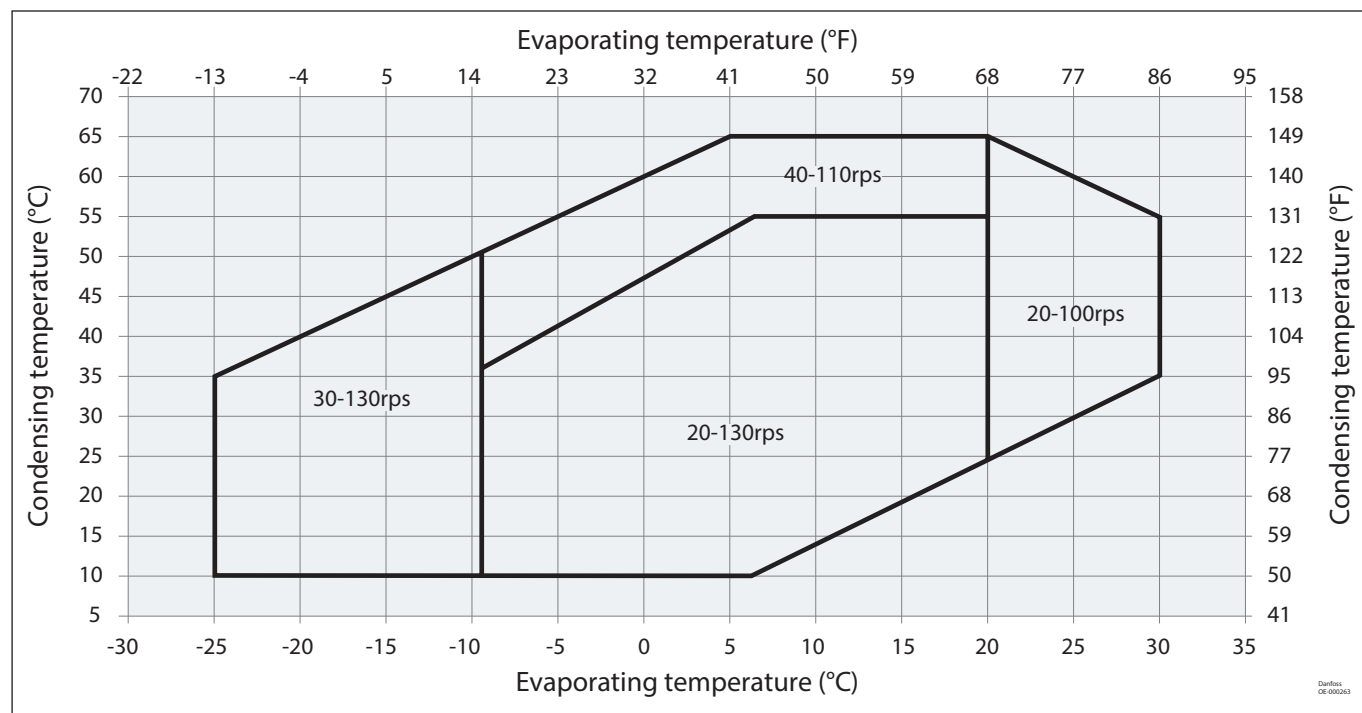
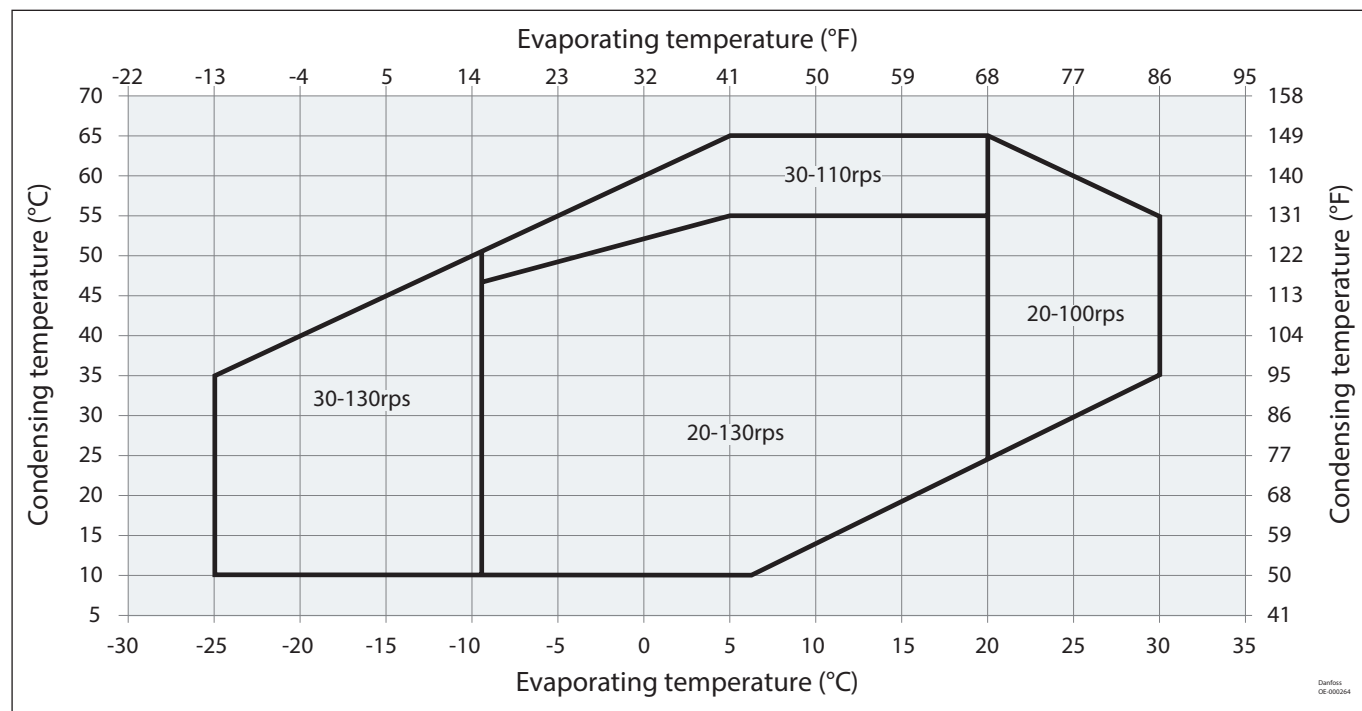


Figure: VCH116-132 envelope map



Note:

Steady-state operation envelope is valid for a suction superheat within 5K range at nominal Voltage.

In every instance, the discharge temperature must be kept below 135°C

When using third party drive, this map limit must be considered for safe operation of the compressor but may be limited by drive capability.

Pressure settings

Pressure settings	R410A	
	bar (g)	psi (g)
Working pressure range low side	2.3~17.8	32~258
Working pressure range high side	9.8~41.6	142.3~603.6
Maximum high pressure safety switch setting	44	638
Minimum low pressure safety switch setting	2	29

Dimensions

VCH132

Figure: VCH132EGENA Outline drawing

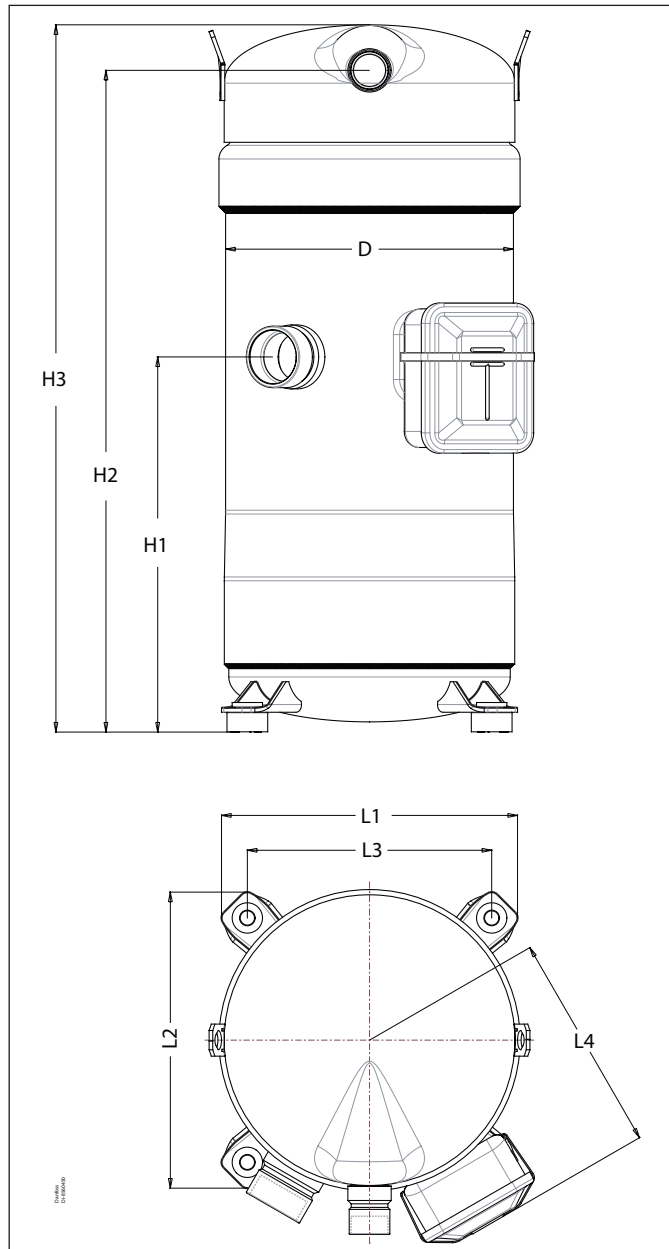
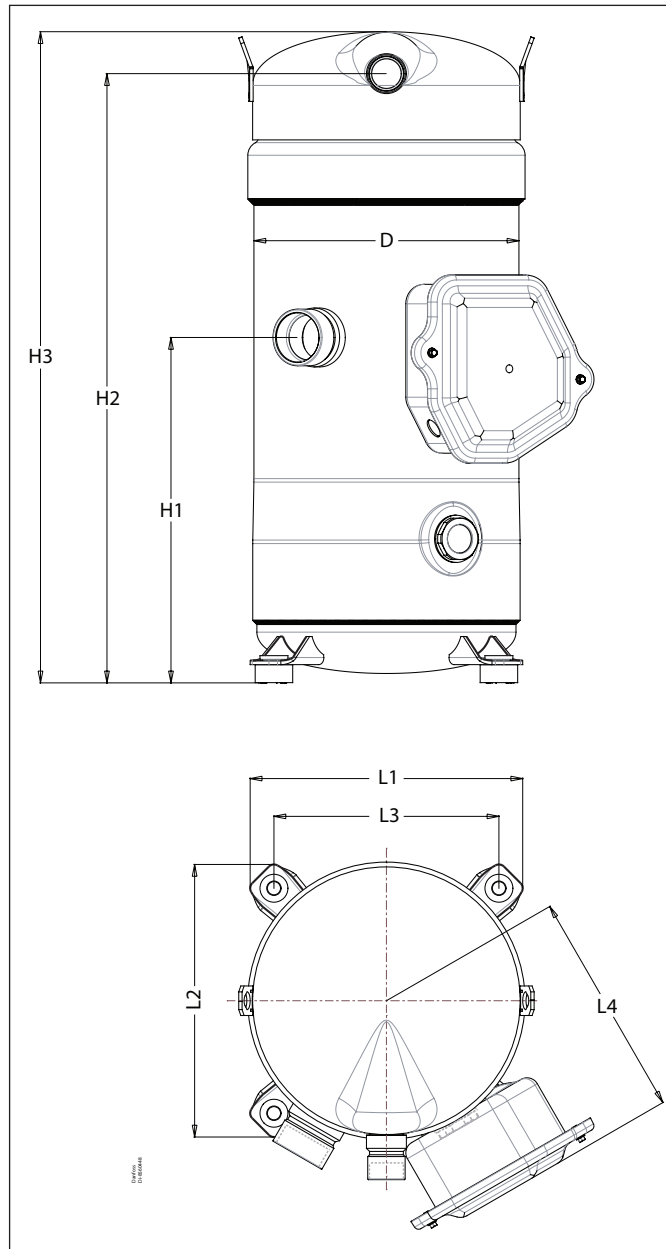
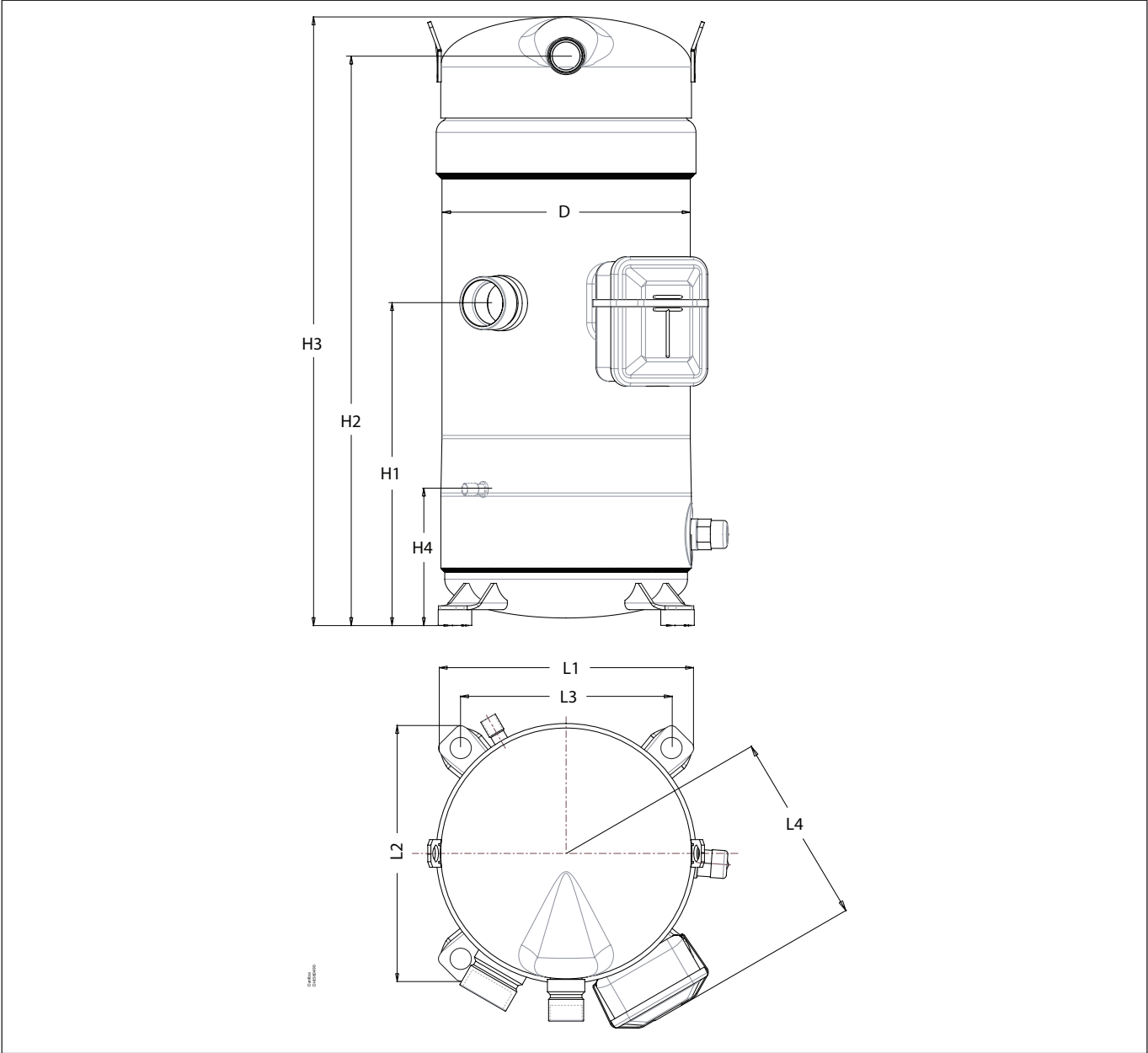


Figure: VCH132EGPNA Outline drawing



Compressor model	D		H1		H2		H3		L1		L2		L3		L4		Outline drawing number
	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	
VCH132EGENA	222.4	8.83	292.25	11.51	515.65	20.3	551.15	21.7	230.8	9.09	230.8	9.09	190.5	7.5	171.1	6.74	8560450
VCH132EGPNA	224.4	8.83	292.25	11.51	515.65	20.3	551.15	21.7	230.8	9.09	230.8	9.09	190.5	7.5	191.7	7.55	8560448

Figure: VCH132EGNNA Outline drawing



Compressor model	D		H1		H2		H3		H4		L1		L2		L3		L4		Outline drawing number
	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	
VCH132EGNNA	224.4	8.83	292.25	11.51	515.65	20.3	551.15	21.7	121.75	4.79	230.8	9.09	230.8	9.09	190.5	7.5	171.1	6.74	8560490

VCH116/099

Figure: VCH116/099EGENA Outline drawing

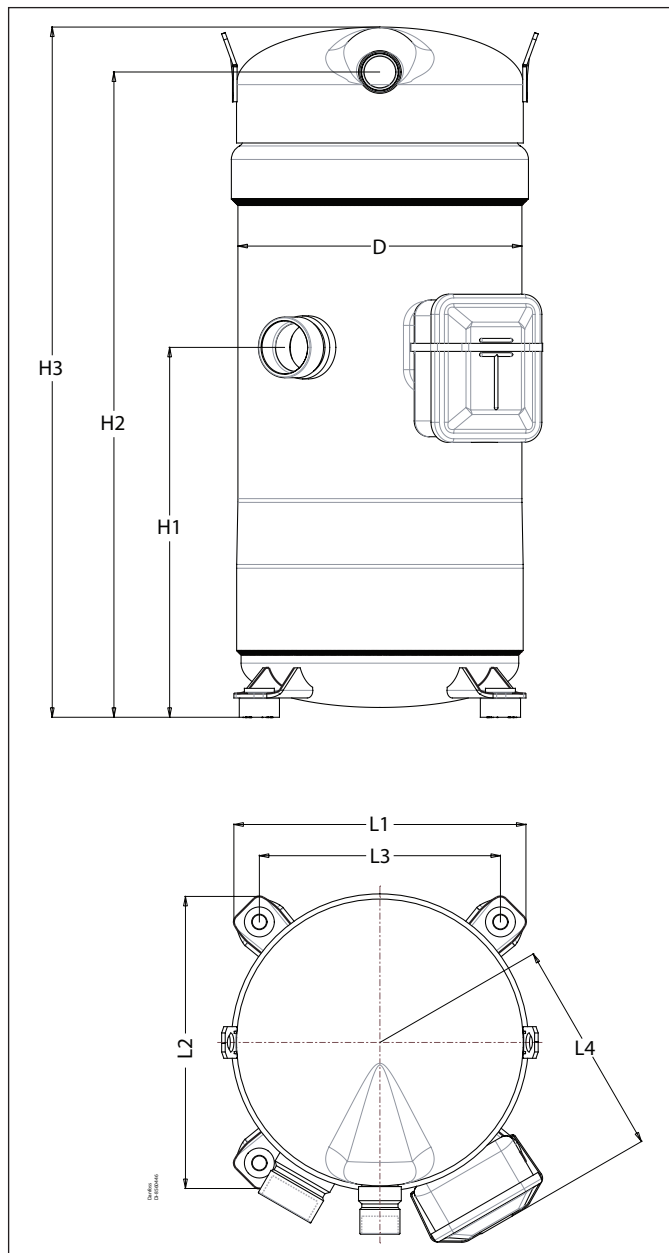
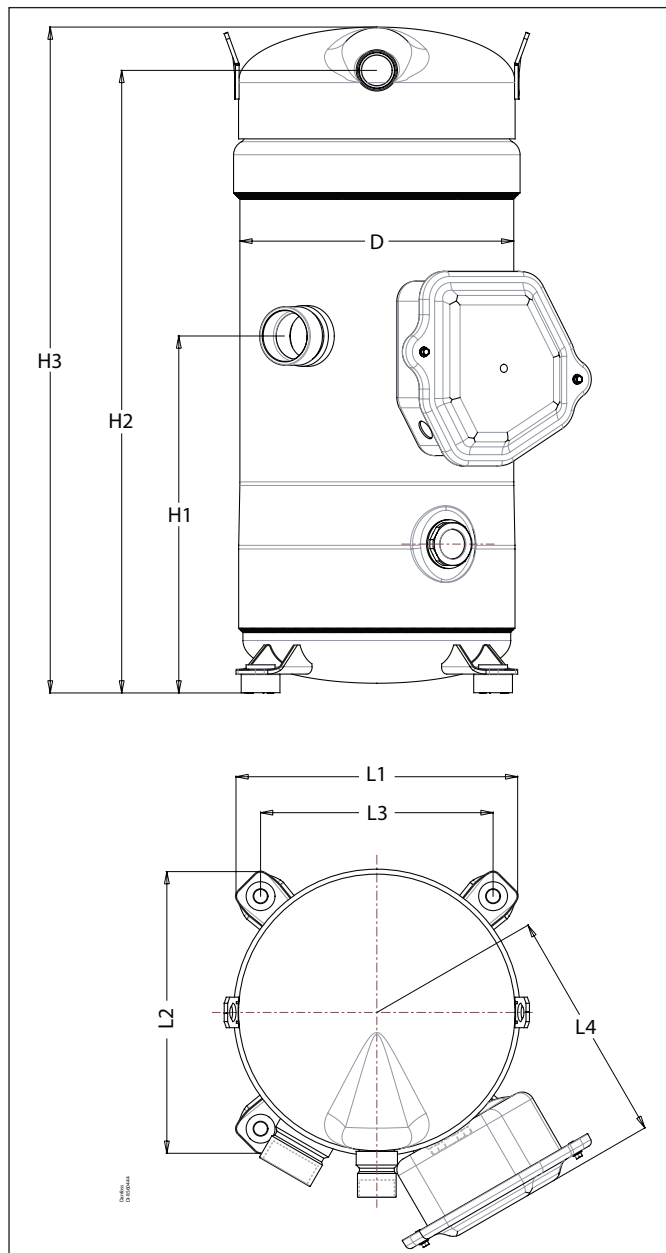


Figure: VCH116/099EGPNA Outline drawing



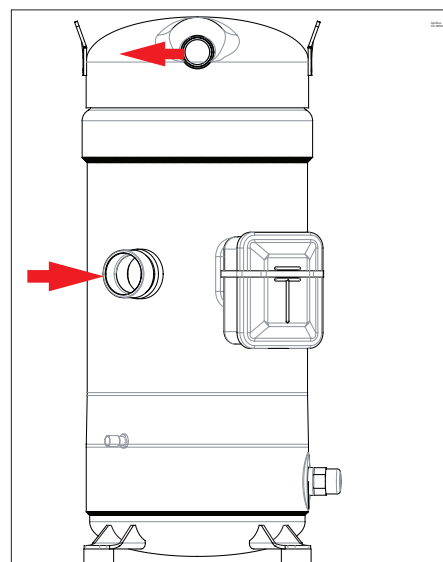
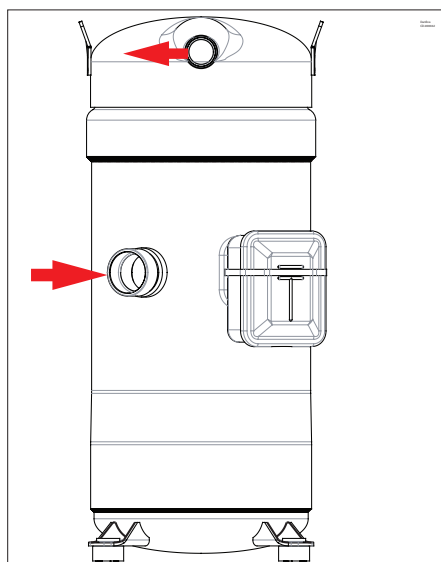
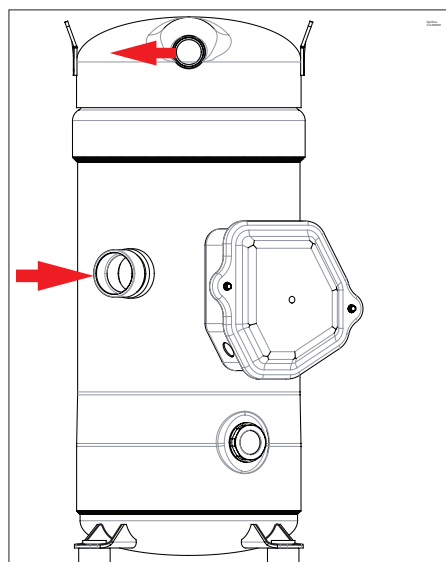
Compressor model	D		H1		H2		H3		L1		L2		L3		L4		Outline drawing number
	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	
VCH116EGENA/ VCH099EGENA	224.4	8.83	292.25	11.51	509.85	20.07	545.35	21.47	230.8	9.09	230.8	9.09	190.5	7.50	171.1	6.74	8560446
VCH116EGPNA/ VCH099EGPNA	224.4	8.83	292.25	11.51	509.85	20.07	545.35	21.47	230.8	9.09	230.78	9.09	190.5	7.50	191.7	7.55	8560444

Mechanical connections

Connection Details

Connection Details		VCH132EGPNA/ VCH116EGPNA/ VCH099EGPNA	VCH132EGENA/ VCH116EGENA/ VCH099EGENA	VCH132EGNNA
Suction connection		1"5/8	1"5/8	1"5/8
Discharge connection		1"1/8	1"1/8	1"1/8
Oil sight glass		Threaded(1"1/8-18UNF)	-	-
OEQ connection		-	-	1/2"
OLS connection		-	-	Threaded (M20 X 1.5)
Outline		1	2	3

Figure: VCH099-116-132EGPNA (outline 1) Figure: VCH099-116-132EGENA (outline 2) Figure: VCH132EGNNA (outline 3)



VCH compressors are all delivered with oil equalization, suction and discharge brazed connections only. They are copper-plated steel connections.

Table: Brazed connection

Compressor models	Brazed	
	Connection	Size
VCH099-116-132	Suction	1"5/8
	Discharge	1"1/8
	Oil equalization	1/2"*

* 1/2" oil equalization only for VCH132EGNNA

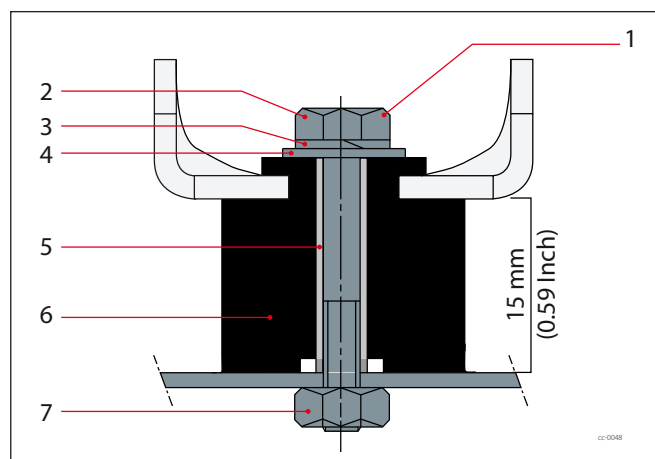
Design compressor mounting

Grommets

Compressors must be mounted with flexible grommets and metal sleeve delivered with compressor. The grommets attenuate the transmission of compressor vibrations to the base frame. The grommets must be compressed until contact between the flat washer and the steel mounting sleeve is established.

The required bolt size for the VCH099-116-132 compressor is HM8-40. This bolt must be tightened to a torque of 15 Nm (11 ft/lbs.).

Figure: Grommets for VCH099-116-132



1	Tightening torque 15 Nm
2	HM 8 bolt
3	Lock washer
4	Flat washer
5	Steel mounting sleeve
6	Rubber grommet
7	Nut

Max inclination

During operation, the maximum inclination from the vertical plane must not exceed 3 degrees.

System design generalities

Compressor capacity and modulation

⚠ Usually, compressors are selected to cover peak load cooling/heating capacities between 70-130 rps.

Modulation (difference between minimum speed and maximum speed) is a very important point for unit design. The larger the modulation number, the more challenging the unit design will be. This would consequently increase unit cost.

The minimum compressor speed must be defined according to unit need. It often makes sense to set unit minimum speed higher than minimum compressor speed qualified by Danfoss.

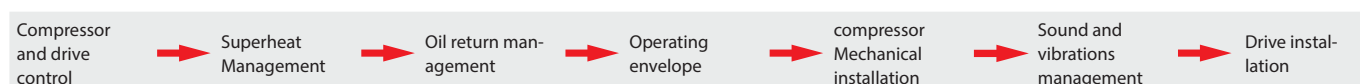
Differences between variable speed and fix in speed unit design

Variable speed compressors were created with state of the art technology with the intent to be efficient and precise. Speed variations have led to challenges that must be addressed by unit design.

Variable speed compressor is a great technology to design efficient and precise unit, however, speed variation leads to challenges that must be addressed by unit design. The first challenge is linked to part of the load operation. Unit design must ensure that oil is returning back to the compressor, even while it is at the lowest speed. The expansion device must also ensure safe superheat across speed range. The second challenge is due to variation of speed itself.

On the opposite hand, on a variable speed system, compressor speed is permanently changing according to load. Consequently, expansion valve must adapt quickly enough to guaranty proper superheat control during transient.

Variation of compressor speed can also lead its own challenges for vibrations. While in fix speed, only one frequency is excited by the compressor. In variable speed, the whole compressor frequency range may excite the system. The chance of going through resonant frequency is then more greatly increased. The following chapters give details advices to integrate variable speed compressor in a unit. Designing a variable speed unit requires to go through all of them to define necessary safeties and qualifications.



Electrical connections

Wiring connections

Electrical power is connected to the compressor terminals by #10-32 UNF 2A screws. The maximum tightening torque is 3 Nm. Use a 1/4" ring terminal on the power leads.

▲ For VCH099-116-132 IP22 model, a special Plug should be used on the E-Box before connecting the electric wire to protect against accidental contact with electrical parts inside and protect against the wire and E-Box hard contacting.

The special Plug is in the accessory list, customer can book it independently. It is also OK that customer make the plug by themselves.

VCH099-116-132 with IP54 E-Box is IP class optimization. For VCH099-116-132 with IP54 E-Box model, a cable gland, conduit connector or approved electrical fittings must be used on electrical box's knockouts to protect against accidental contact with electrical parts inside.

Motor protection

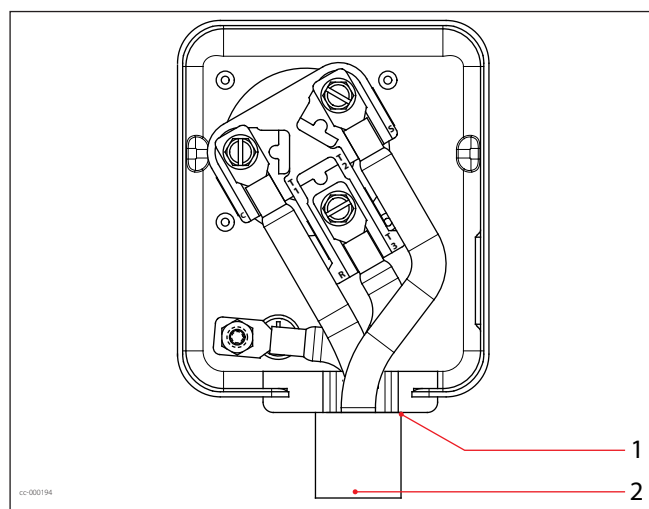
VCH099-116-132 scroll compressors are not equipped with an internal motor protector. Motor protection should be provided by the variable speed drive. All parameters should be preset in order to guaranty locked rotor or overload current protection.

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

VCH099EGENA/VCH116EGENA/VCH132EGENA /VCH132EGNNA

The terminal box is provided with a Ø36mm (Ø1.4 inch) U hole for power supply.

Figure: Terminal box for VCH099-116-132 with IP22 E-box

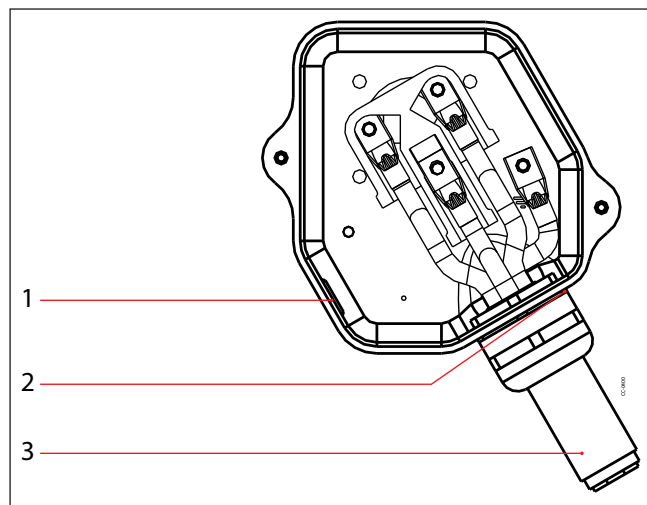


1	Ø 36 mm (1.4 inch) hole
2	Power supply

VCH099EGPNA/VCH116EGPNA/VCH132EGPNA

The terminal box is provided with a Ø40.5mm (Ø1.59inch) hole (ISO40) for power supply and a Ø16.5mm (Ø0.65inch) knockout (ISO16).

Figure: Terminal box for VCH099-116-132 with IP54 E-box



1	Ø 16.5mm (φ0.65inch) knockout
2	Ø 40.5mm (φ1.59inch) hole
3	Power supply

Electrical specifications

IP rating

For VCH099-116-132 IP22 version, terminal box IP22 rating according to IEC60529 is after installing the U plug 120Z0852 on the E-box.

For VCH099-116-132 IP54 version, terminal box IP54 rating according to IEC60529 is after correctly sized IP54 rated cable glands are used.

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

Compressors 3 phase electrical characteristics

Volt to drive	Compressor	RW ⁽¹⁾	MOC
		(ohm)	(A)
380V	VCH132	0.057	57
	VCH116	0.057	51
	VCH099	0.071	44

⁽¹⁾ Winding resistance per winding (in CDC100 parameter list)

Note: Parameter 1-30 in the frequency converter settings reflects the winding resistance per winding. This is not the same value as measured at the 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 can be used to select cable and contactor for customer by adding some safety coefficient.

Phase sequence and reverse rotation protection

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

- Frequency converter terminal U to VCH terminal T1
- Frequency converter terminal V to VCH terminal T2
- Frequency converter terminal W to VCH terminal T3

If compressor T1/T2/T3 and frequency converter U, V & W terminals are not matching, the compressor can operate in a reverse rotation. This results in excessive noise and no pressure differential between suction and discharge, and suction line warming rather than immediate cooling. The compressor can be rapidly damaged in these conditions. Reverse rotation of the compressor for only a few seconds can quickly cause irreversible damage to the scroll sets. Before starting always review the wiring and be prepared to shutoff immediately in case of noise. If reverse rotation symptoms occur, shut the compressor down and connect the phases to their proper terminals. Allow the compressor to run and then check amps at operating condition versus Danfoss published performance data to see if there was damage.

Application

Manage Operating envelope

Requirement

⚠ The solid line envelope is valid for a suction superheat within 5K (9°F) at nominal voltage. Higher suction superheat may lead to discharge temperatures above 135°C.

Moreover, the discharge gas temperature must not exceed 135°C.

The Operating envelope data for VCH099-116-132 guarantees reliable operations of the compressor for steady-state operation.

High pressure switch

⚠ ⚠ The high-pressure switch must be set at or below “Maximum high pressure switch setting”. The high-pressure switch must never be bypassed or delayed and must be placed in a lockout circuit to prevent cycling.

If a discharge valve is used, the HP switch must be connected to the service valve gauge port, which cannot be isolated.

For CDC100 drive, HP switch can be connected to STO (Safe Torque Off) or to an external contactor placed between frequency convertor and compressor.

Figure: VCH132/116 CRAC map

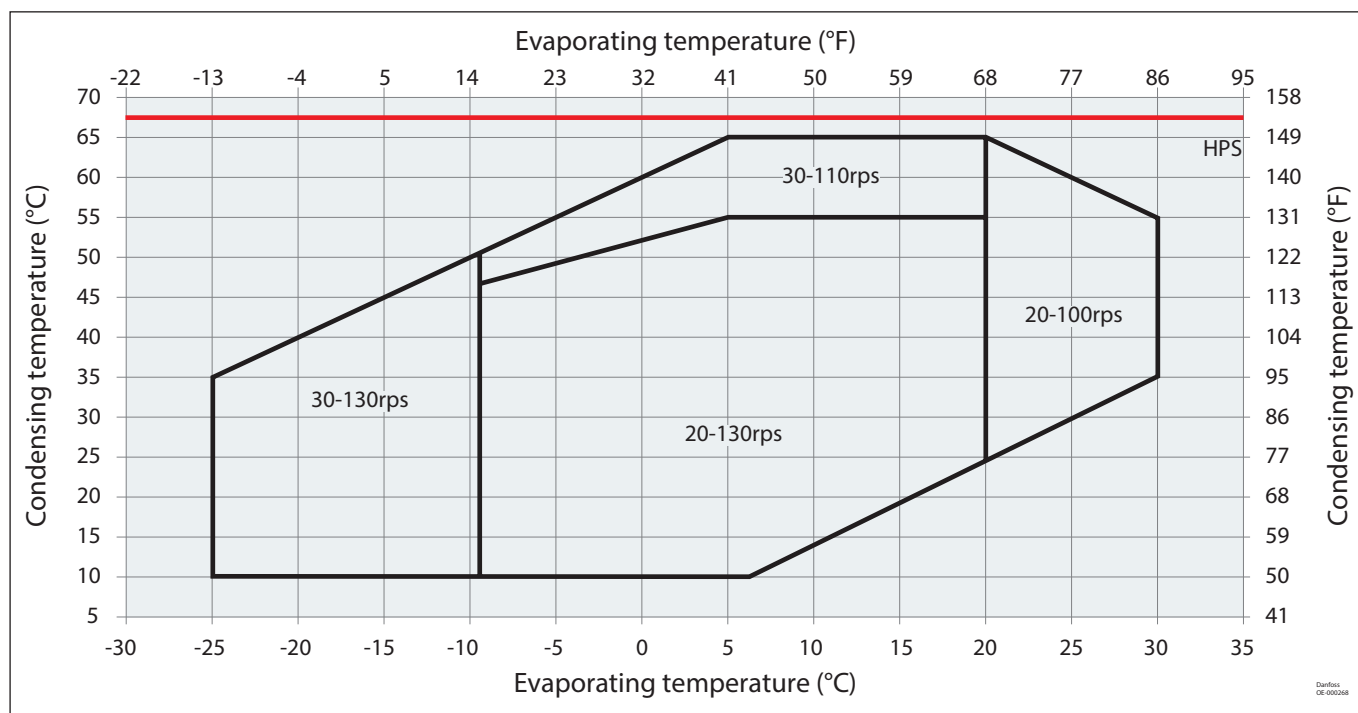
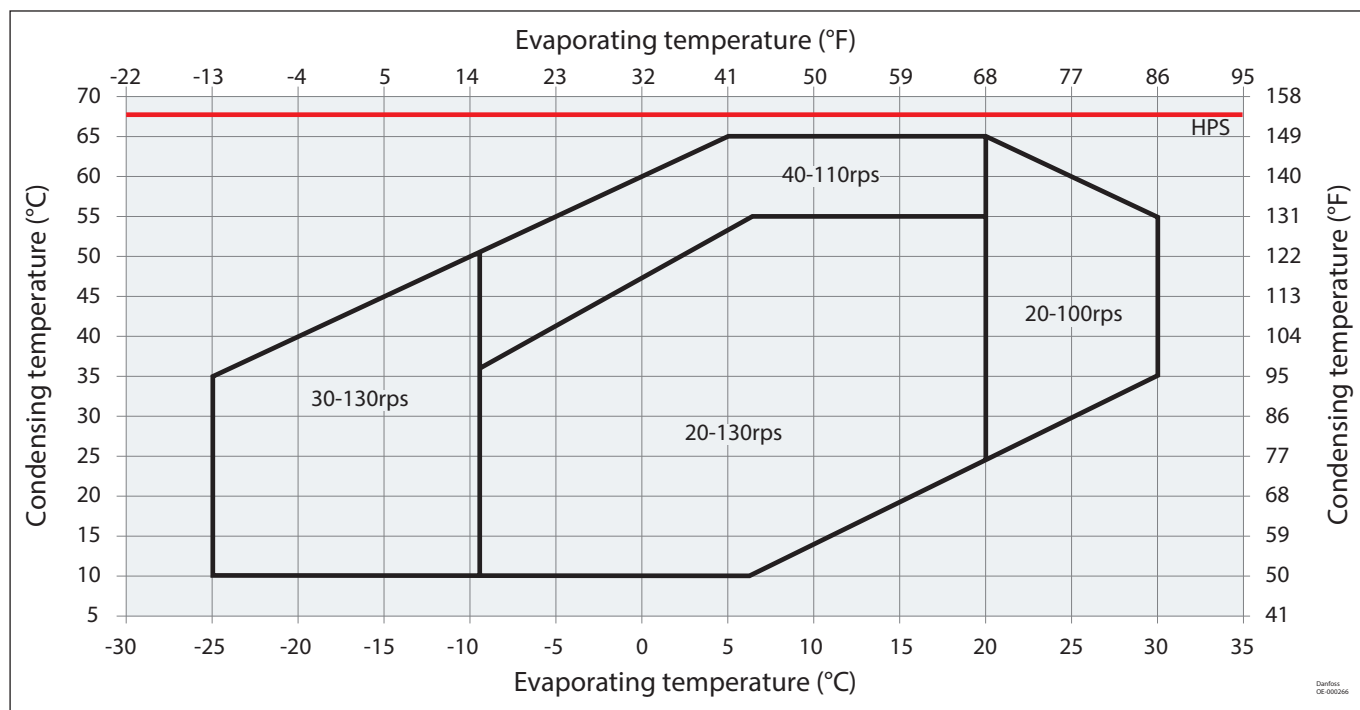


Figure: VCH099 CRAC map



HPS High pressure safety switch (44 barg)

Low pressure switch

⚠ The low-pressure switch must be set at or above "Minimum Low pressure switch setting". Operating at low pressures may cause damage to the compressor due to low mass flow through it. The LP switch must be an immediate, no delay feature.

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

For a manual or automatic reset, there is a maximum of 5 auto resets during a period of 12 hours. After this threshold is crossed, a manual reset will be required.

Figure: VCH132/116 CRAC map

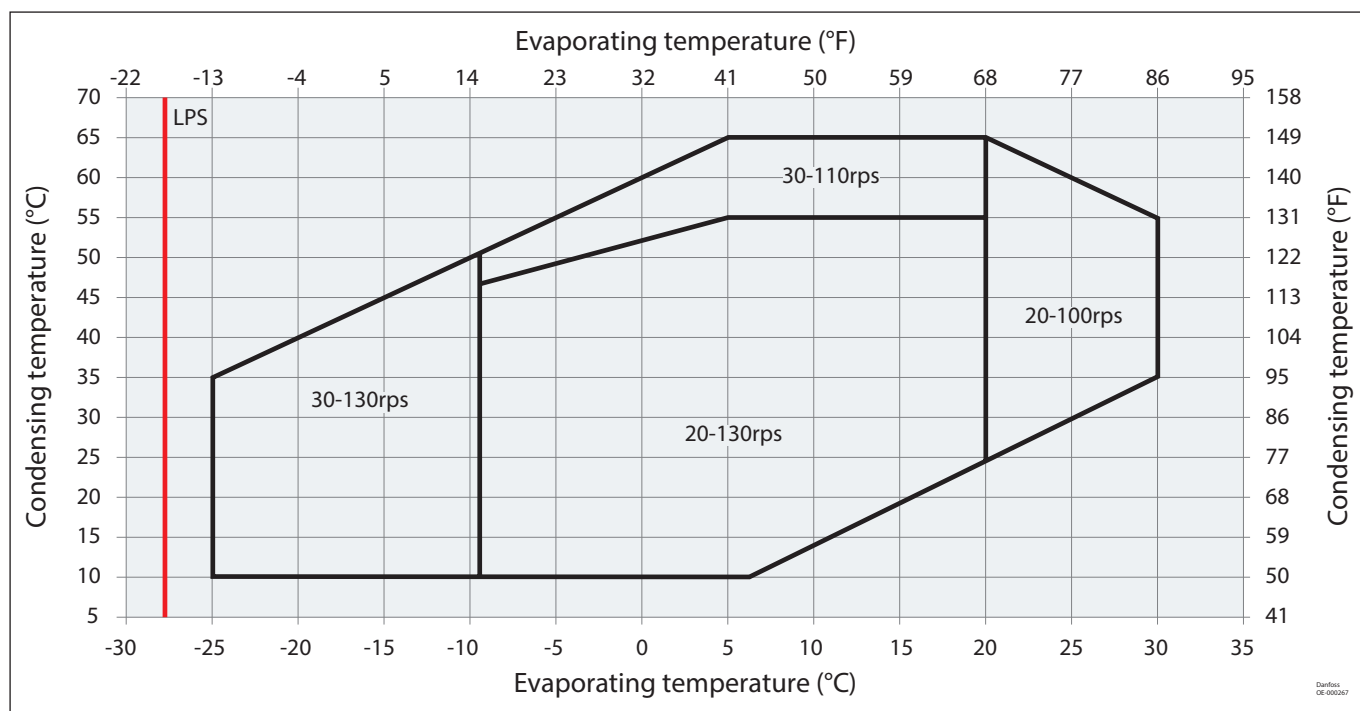
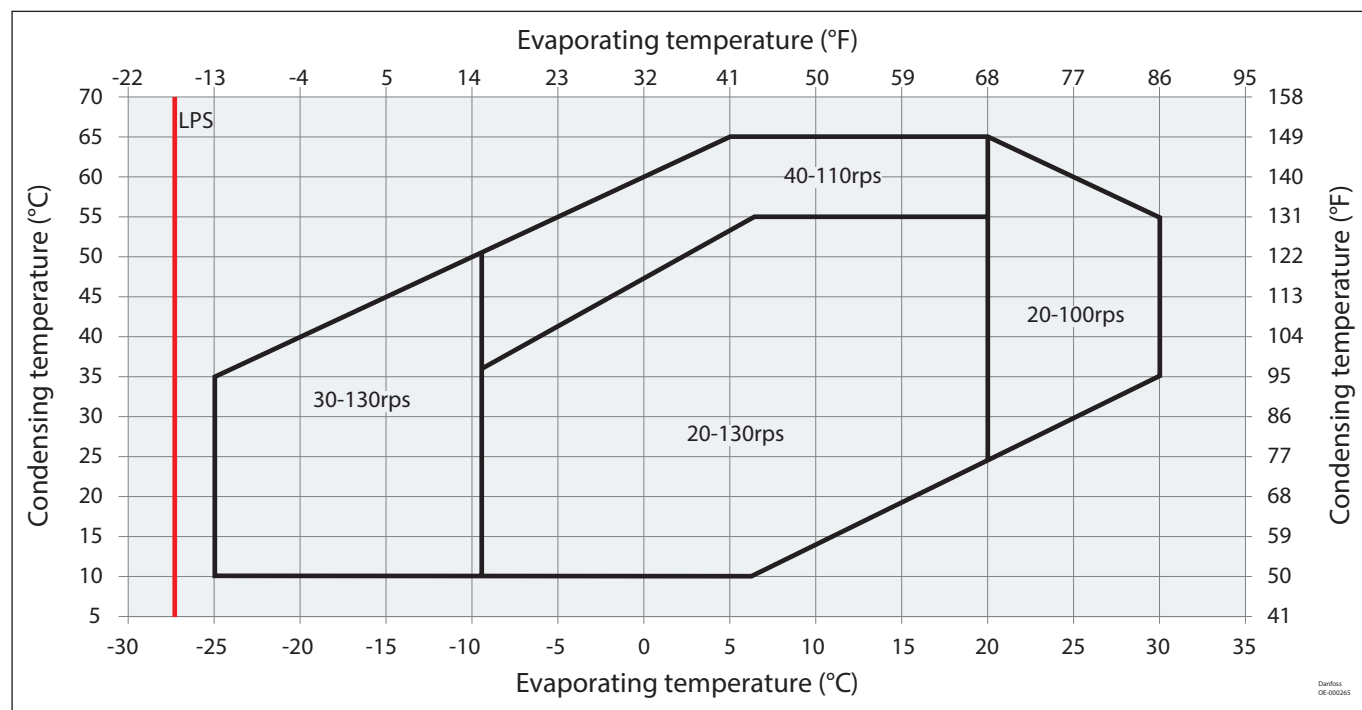


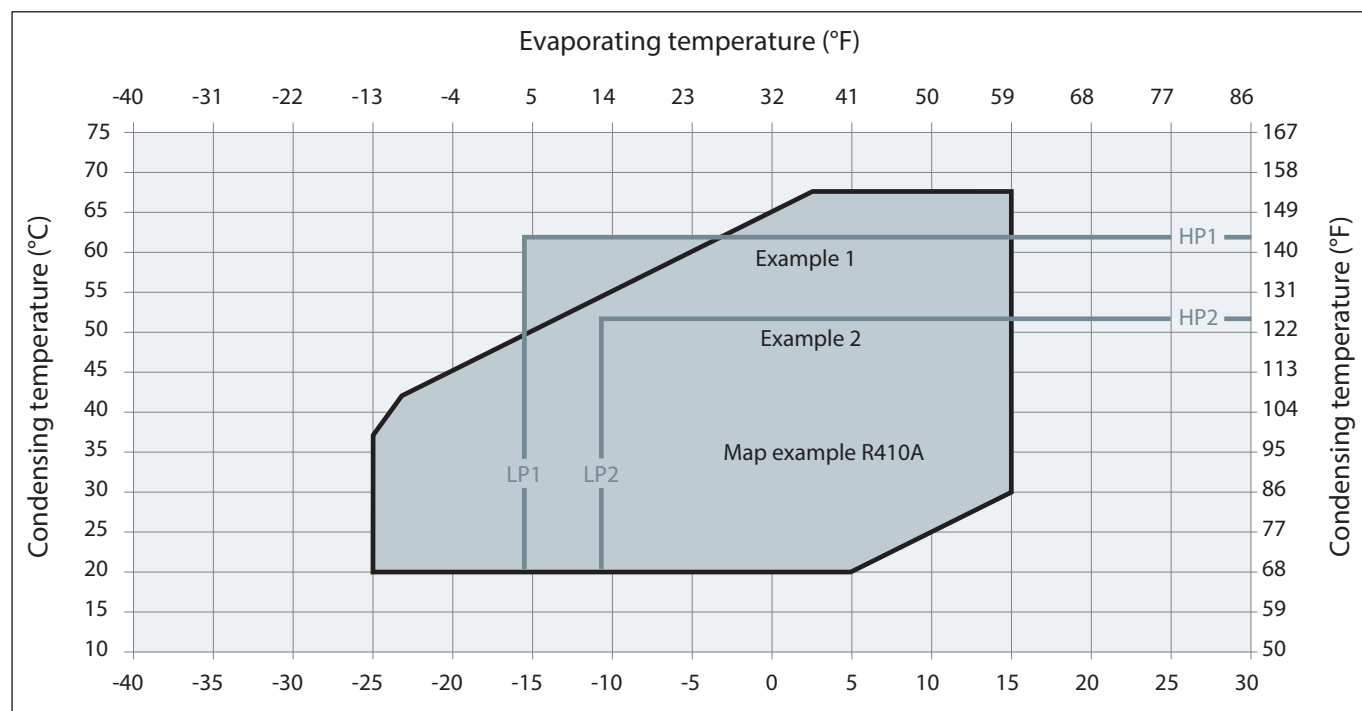
Figure: VCH099 CRAC map



LPS Low pressure safety switch (1 barg)

Discharge temperature protection

⚠ Discharge gas temperature protection (DGT) is required if the high and low pressure switch settings do not protect the compressor against operations beyond its specific application envelope (example)



Example 1 (R410A, SH = 6K/10.8°F)

LP switch setting: LP1 = 3.3 bar (g) (-15.5°C/4.1°F)

HP switch setting: HP1 = 38 bar (g) (62°C/143.6°F)

Risk of operation beyond the application envelope. DGT protection required.

Example 2 (R410A, SH = 6K/10.8°F)

LP switch setting: LP2 = 4.6 bar (g) (-10.5°C/13.1°F)

HP switch setting: HP2 = 31 bar (g) (52°C/125.6°F)

No risk of operation beyond the application envelope. No DGT protection required.

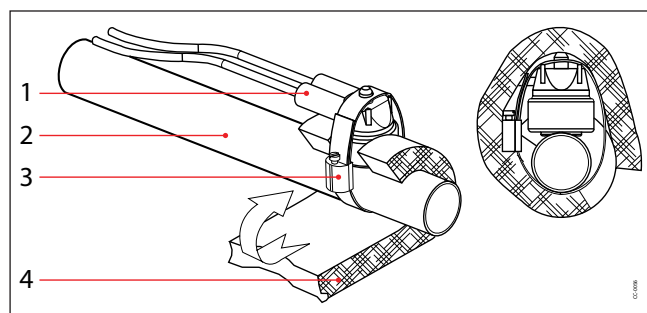
The discharge gas thermostat accessory kit (code 7750009) or the discharge temperature sensor is required for installation as shown below. DGT installation must respect the below requirements:

1. The thermostat or the temperature sensor must be attached to the discharge line within 150mm (5.91 inch) from the compressor discharge port and must be thermally insulated and tightly fixed on the pipe.
2. The DGT should trip the compressor at a discharge gas temperature set point. Manual or Automatic Reset - maximum of 5 auto resets during a period of 12 hours, then manual reset is required.

The switch can be integrated directly in safety chain of compressor or treated by unit controller. With variable speed compressors, the thermostat can be replaced by a discharge temperature sensor, then the unit controller can change compressor speed to keep the discharge temperature lower than the limit.

For VCH099-116-132 with R410A, the discharge gas temperature protection should be set to open at a maximum discharge temperature of 135°C (275°F). the discharge gas thermostat kit (code 7750009) or the discharge temperature sensor could be used.

Figure: Discharge temperature protection



1	Thermostat or temperature sensor
2	Discharge line
3	Bracket
4	Insulation

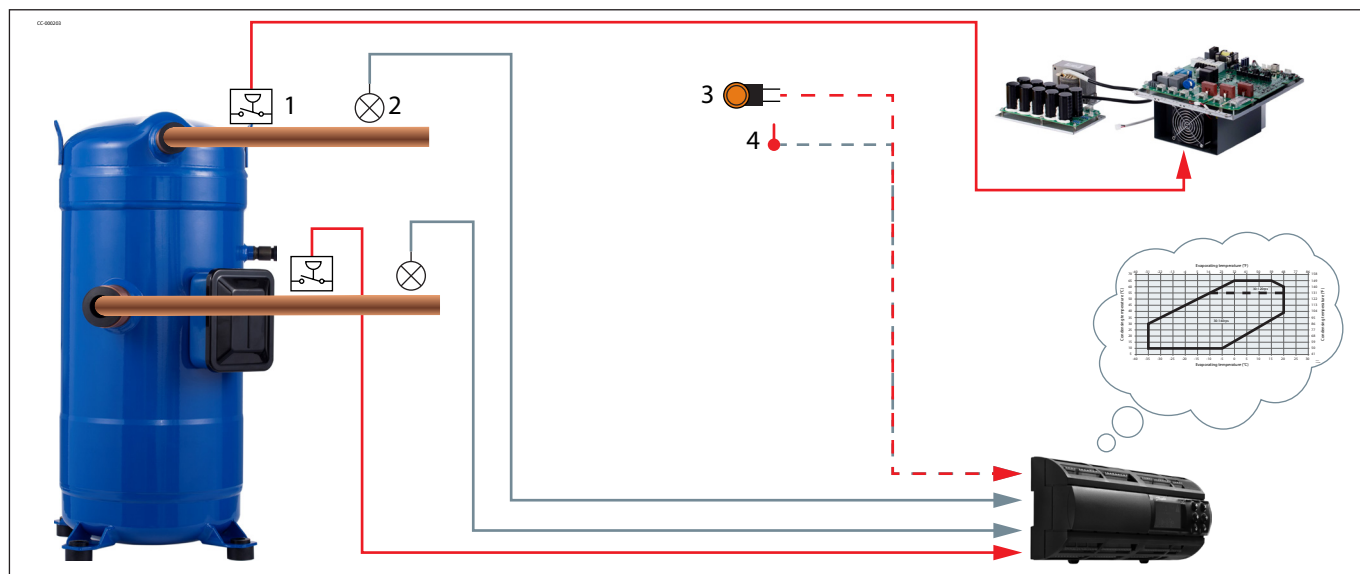
Protection and control of envelope

Low pressure (LP) switch and high pressure (HP) switches are necessary to protect the compressor. Depending on high pressure and low pressure limitations, a discharge gas thermostat (DGT) may also be necessary, see Discharge temperature protection.

For variable speed compressors, it is recommended that the unit controller continuously controls evaporating and condensing temperatures to check that the compressor is running within the defined envelope. This solution offers much better protection than only basic protection (HP, LP, DGT), and offers the possibility to adjust running conditions to avoid tripping (for example reduce compressor speed when reaching high pressure limit).

Operation of VCH099-116-132 is not allowed across the envelope at all speeds. Depending on speed range needed and unit controller capability, two types of envelope controls can be considered:

1. Limited speed range to have only one envelope Example 1
2. Full speed range with unit controller maintaining speed according to evaporating and condensing temperature Example 2



1	Pressure switches
2	Pressure sensor
3	Discharge thermostat
4	Temperature sensor
—	Protection
—	Control

Example 1 with limited speed range from 50rps (3000rpm) to 100rps (6000rpm)

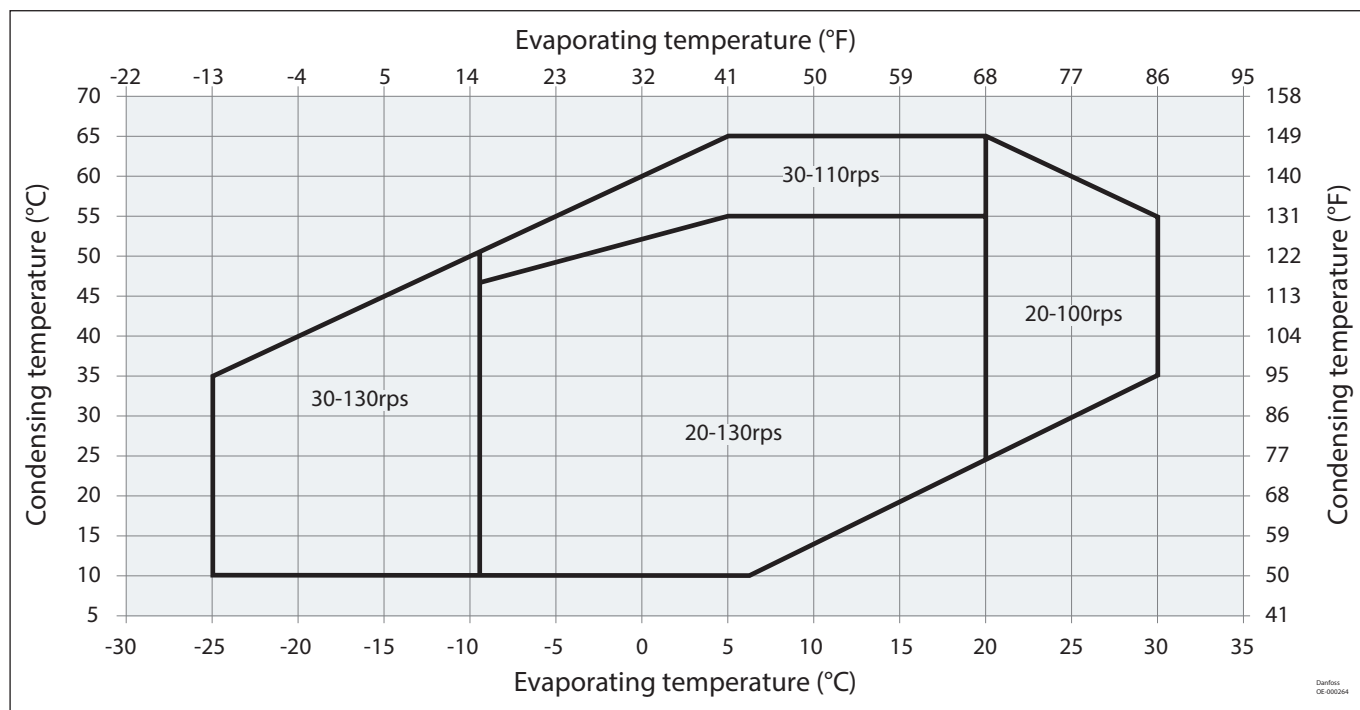
Safeties required High pressure switch, Low pressure switch, Discharge gas thermostat set @135°C (275°F) if necessary see Discharge temperature protection.

Frequency converter setting Adjust the minimum and maximum reference (speed setpoint) limits accordingly:

Minimum reference 3000 rpm (50 rps).

Maximum reference 6000 rpm (100 rps).

Envelope control The unit controller continuously measures evaporating and condensing temperatures in order to maintain the compressor within the envelope independently of compressor speed.

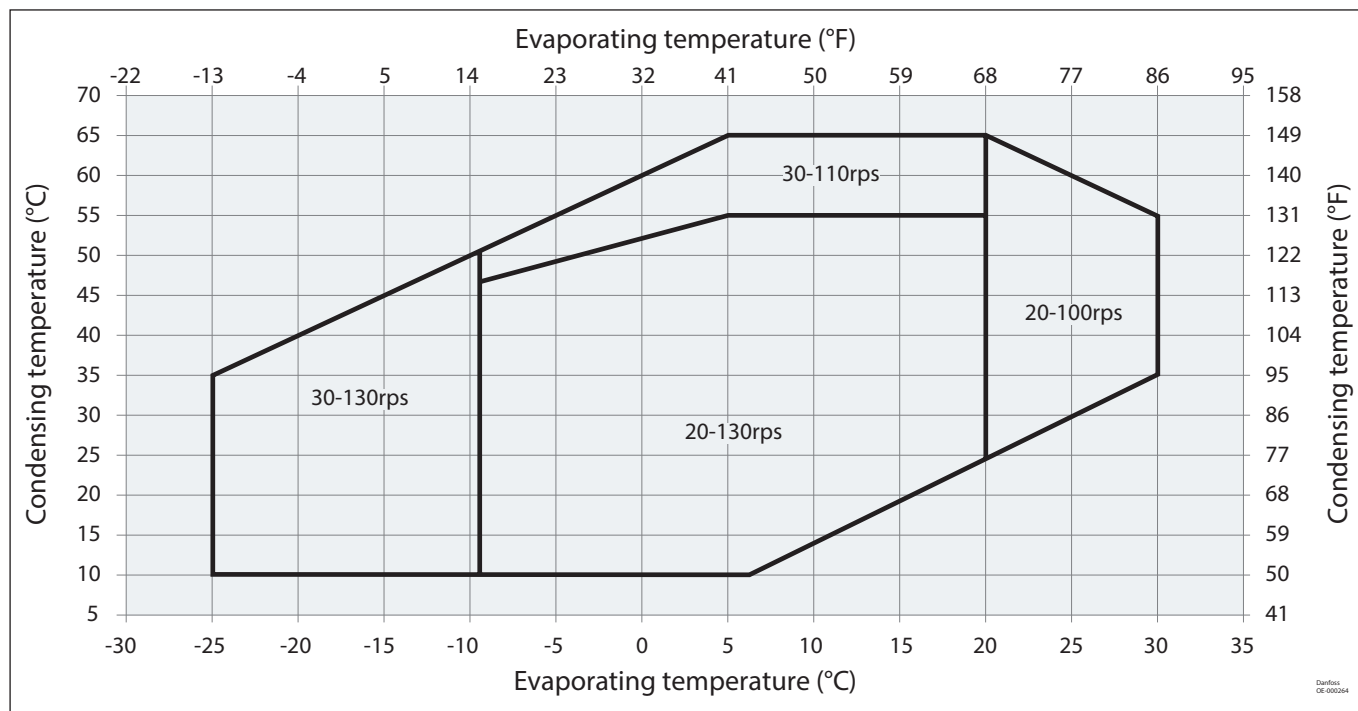


Example 2 with full speed range from 20rps (1200rpm) to 130rps (7800rpm)

Safeties required High-pressure switch, Low pressure switch, Discharge gas thermostat set @135°C (275°F) if necessary see Discharge temperature protection.

Frequency converter setting No parameter change required, keep default value

Envelope control The unit controller continuously measures evaporating and condensing temperatures, as well as maintains compressor speeds according to specific zone restrictions.



MOP (Max Operating Pressure Control)

⚠ In steady state, it is essential to prevent the compressor running with evaporating temperature higher than the specified envelope. Operation at a higher evaporating temperature may cause compressor damage due to high dilution and low viscosity of lubricant.

This protection can be achieved by using MOP function on expansion device. MOP is a feature of EXV that limit the maximum suction pressure of the unit. MOP setting must be equal or lower than max evaporating temperature stated in operating envelope.

Complementary to MOP of expansion device, the unit controller can increase compressor speed to keep evaporating temperature lower than limit

Manage sound and vibration

Sound level

The sound radiating from the compressor is emitted through the air, the sound waves travel in all directions from the compressor.

We can consider two means to reduce compressors sound radiations: Acoustic hoods are quick and easy to install and do not increase the overall size of the compressors.

Acoustic hoods are not supplied from Danfoss as accessories, but Danfoss can supply hood design support if customer needed.

The use of sound insulation on the inside of the unit panels is an effective way to mitigate sound. You can find sound level in "sound and vibration data" section "sound level".

Vibrations

⚠ Compressor generates some vibrations that propagate into the surrounding parts and structure. The vibration level of a VCH099-116-132 compressor alone does not exceed 127 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.

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 minimum speed to maximum speed will be excited.

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

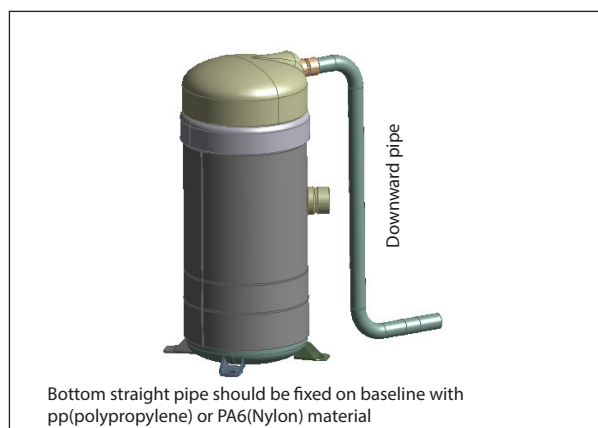
If some resonant frequencies generate high piping vibration, problem can be solved by increasing piping stiffness with brackets or changing layout. Dampers can also be installed to mitigate vibration.

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.

Ensure that there is no direct contact between vibrating components and structure.

Vibration optimization proposal for system unit pipe design which connect with compressor discharge port

- Downward pipe with min. stress comparing with other type;
- Stress decreased as straight pipe length and bend radius increased.
- Bottom straight pipe should be fixed on baseplate with PP(polypropylene) or PA6 (Nylon) material



Gas pulsation

The Danfoss VCH099-116-132 scroll compressor has been designed and tested to ensure that gas pulsation is optimized for the most commonly encountered heat pump pressure ratio.

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

Oil return management

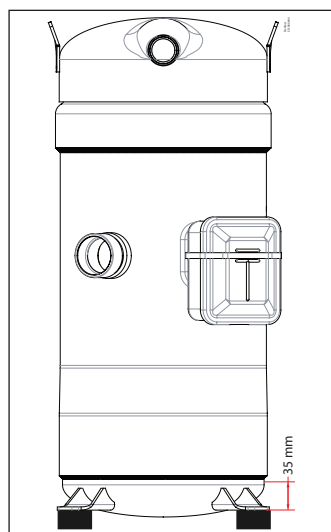
⚠ During operation, compressors always discharge amount of oil with refrigerant when start-up. After a while, some oil will return into the compressor but some will take part in refrigerant cycle or gets trapped somewhere in the system. When too much oil gets trapped or takes part in refrigerant cycle and doesn't return into the compressor, compressor may not have enough oil to operate properly.

System with reheat coils, multiple or split evaporator and condenser have a high potential to reduce mass flow and can be susceptible to oil logging. Furthermore, more oil will take part in refrigerant cycle because of large refrigerant charge quantity.

VCH099-116-132 has large speed range and large capacity range. Customer unit design has large deviation such as the dimension of condenser, evaporator, suction accumulator, pipes. Oil separator installation is mandatory for the application in order to reduce oil loss risk.

Customer can define the oil loss evaluation tests according to the unit design and application. At the same time, customer should refer to below general proposal of Danfoss variable speed compressor. Qualification of the units should be done in unfavorable conditions with each feature engaged and disengaged to check oil return management and oil loss risk of compressor.

During customer unit test especially for oil management test, an oil level sensor or and oil sight glass at the lowest safety level should be added into the test compressor, the install position refer to the picture. If oil level is above the centerline in oil sight glass or oil level sensor doesn't trip compressor during oil return and oil loss risk qualification test in lab, then it means no oil loss risk in field where oil sight glass or oil level sensor is not installed for the standard compressor.



Note: The measurement is taken by considering the center of the oil sight glass or oil level sensor

Oil return test

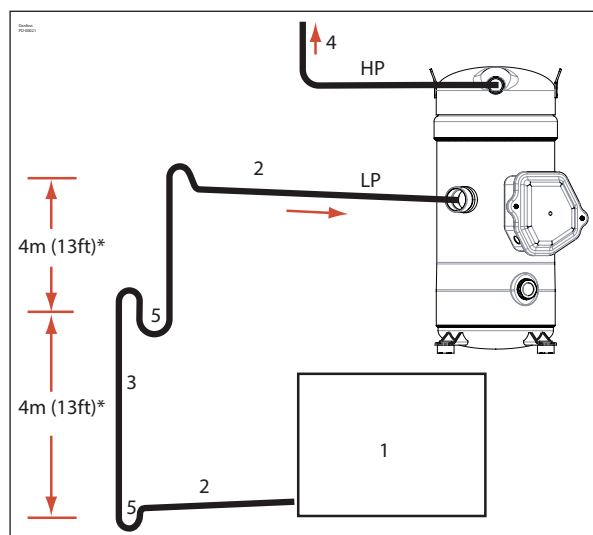
Test conditions	Pass criteria	Comments
Most un-favourable conditions for oil return are as be-low: 1. Lowest refrigerant velocity and mass flow at low Te and lowest speed for both cold start up test and continuous running test 2. Highest refrigerant velocity and mass flow at high Te and highest speed For reversible unit, repeat test in both heating and cooling mode For advanced unit (Multiple exchangers roof top re-heat coil, four-pipe chiller...) repeat test in all possible configuration	Oil level must be above centerline or full in oil sight glass Compressor with oil level sensor, no oil level sensor trip	If oil return test fails: 1. Check if potential oil trap in the system 2. Adjust oil management parameters to optimize oil returning 3. Add additional oil or oil separator in the system till oil is visible in the sight glass

Piping recommendations to ensure oil return

⚠ Oil return is highly linked to refrigerant velocity in pipes. The most unfavorable conditions for oil return are at lowest refrigerant velocity corresponding to lowest evaporating T° and minimum compressor speed. Another most unfavorable conditions for oil level safety are at high refrigerant velocity and mass flow corresponding to highest evaporating T and maximum compressor speed, which means more oil quantity will take part in refrigerant cycle while less oil is left inside compressor.

General recommendations are described in the figures below: To guaranty reliability, it is essential to fully qualify oil return especially in most unfavourable conditions. Take particular care to units with reheat coil or multiple exchangers.

Systems with reheat coils, multiple or split evaporator and/or condensers can be susceptible to oil logging. A means to empty or pump out circuitry when not engaged should be implemented to prevent oil logging.



1	Evaporator
2	0.5% slope, 4m/s or more (13ft/s or more)
3	8 to 12m/s (26 to 40ft/s)
4	To condenser
5	U-trap, as short as possible
*	max.

Oil separator

⚠ Oil separator is mandatory, it removes oil from the compressor's discharge gas, and return it to the compressor's crankcase. Oil separators are located close to the compressor in the discharge line.

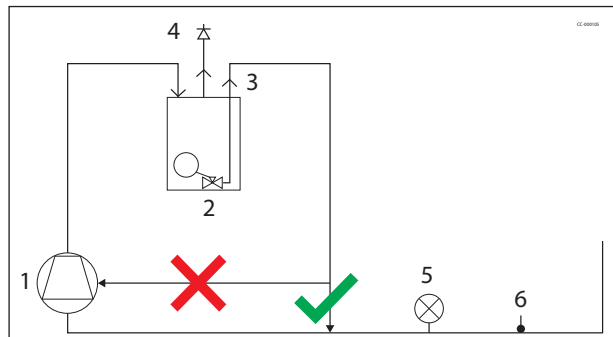
Floating valve oil separators are the easiest to implement in the system. Oil return connection must be done on the suction line after suction pressure and temperature sensors have been used for superheat control.

The outlet of the oil separator must be equipped with a non-return valve in order to prevent liquid refrigerant from migrating back from the condenser.

To avoid having the oil separator act as a condenser, do not place it in the airflow or oversize it. If airflow is unavoidable, the oil separator must be insulated.

Some separators require an initial oil charge to float the needle valve float.

For installation and dimensioning, always follow manufacturer recommendations



1	Compressor
2	Oil separator
3	Oil return
4	Non return valve
5	Pressure sensor
6	Temperature sensor

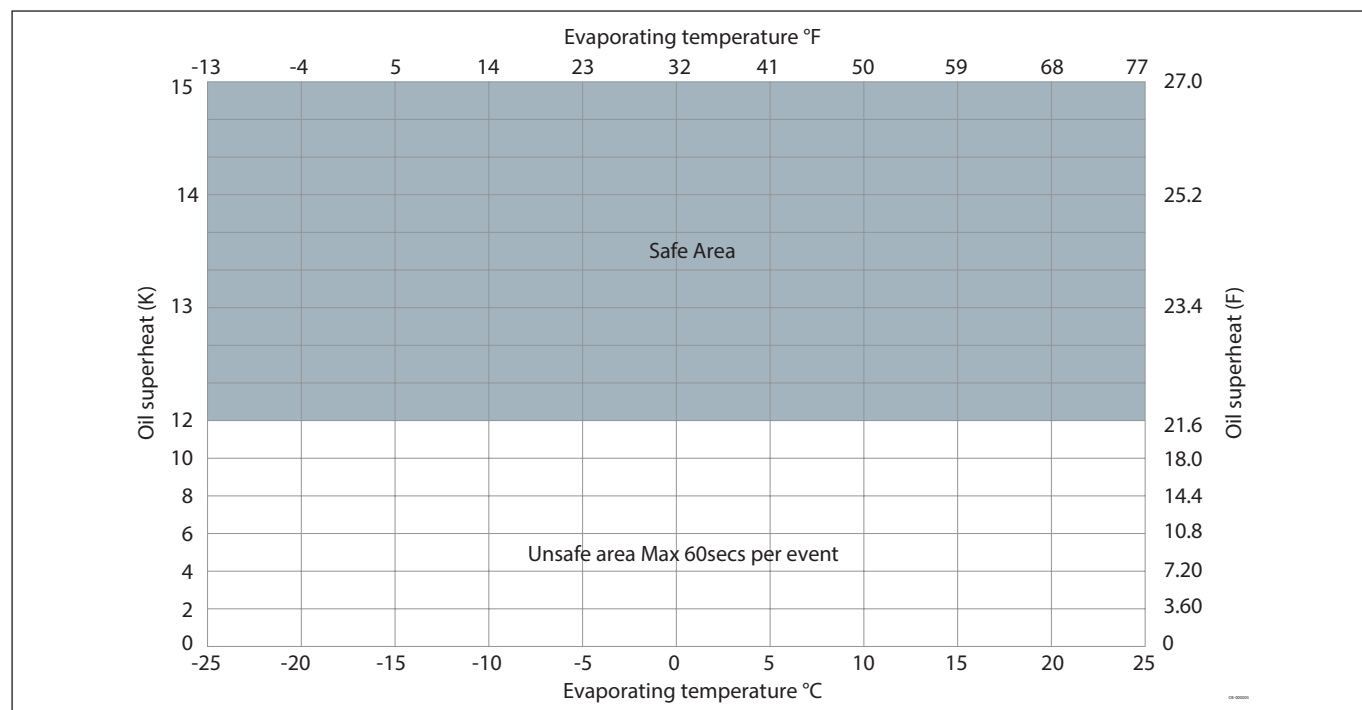
Manage Superheat

⚠ During normal operation, refrigerant enters the compressor as a superheated vapor. Liquid flood back occurs when some refrigerant returns to the compressor in a liquid state. Liquid flood back can cause oil dilution and, in extreme situations, lead to liquid slugging that can damage the compressor.

In steady state conditions, suction superheat must be maintained within 5K to 30K (9 to 54°F) and oil superheat must be higher than 12K (21.6°F). In transient conditions, oil superheat below 12K (21.6°F) must not last more than 60s per event. Note: oil superheat criterion is mainly used during qualification to confirm liquid flood back is acceptable. It is not mandatory to monitor it on production unit.

Oil superheat measurement during qualification

Figure: VCH099-116-132 R410A - Dilution chart (reference at 20°C / 68°F ambient temperature)



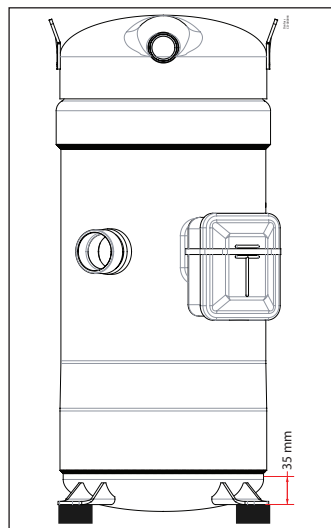
Placing oil temperature sensor

Inserted type oil temperature sensor such as PT100 should be placed the position as below picture.

Surface temperature thermal couple should be pasted on the bottom surface of compressor oil sump on the opposite side of suction tube. Thermal couple must be correctly thermally insulated from the ambient.

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

Figure: Placing oil temperature sensor



Note: The measurement is taken by considering the center of the oil sight glass or oil level sensor

Test and components required per application

Application		Tests and components required		
Non Revers-ible	Reversible(1)	Suction accumula-tor	Test	Comments
X		Optional	Pass liquid floodback test	If no test performed, suction accumulator is mandatory
	X	Recommended	Pass liquid floodback test Pass defrost test	

⁽¹⁾ Unit equipped with a 4-way valve.

Liquid floodback and defrost test

Test	Test conditions	Pass criteria	Comments
Liquid flood back test	1. Steady state Most unfavourable conditions for superheat control (expansion valve thresh-ol-d): Lowest evaporating T°, highest condens-ing T°, compressor at minimum speed. For reversible unit, repeat test in both heating and cooling mode For advanced unit (Multiple exchangers roof top reheat coil, four-pipe chiller...) repeat test in all possible configuration.	Suction superheat >5K (9°F) and stable Oil superheat above 12K(21.6°F)	If test fails, 1. Check EXV size selection 2. Check TXV settings and bulb position. 3. Check EXV measurement location and opti-mize EXV control 4. Add suction accumulator 5. Optimize heat exchange design and refrigerant charge quantity 6. Increase ramp-up and ramp down time to slow down compressor speed change
	2. Transient Test must be carried out with most common transient such: Compressor starts Fan staging Compressor speed ramp up and ramp down from min speed to max speed	Oil superheat must not be more than 60 sec be-low 12K(21.6°F).	
Defrost cycle	Defrost test must be carried out in the most un-favourable conditions (~ 0°C 32°F ambient con-ditions)	After defrost, Oil superheat must not be more than 60 sec below 12K(21.6°F).	Check defrost logic. 4 Way valve control and defrost logic Add suction accumulator

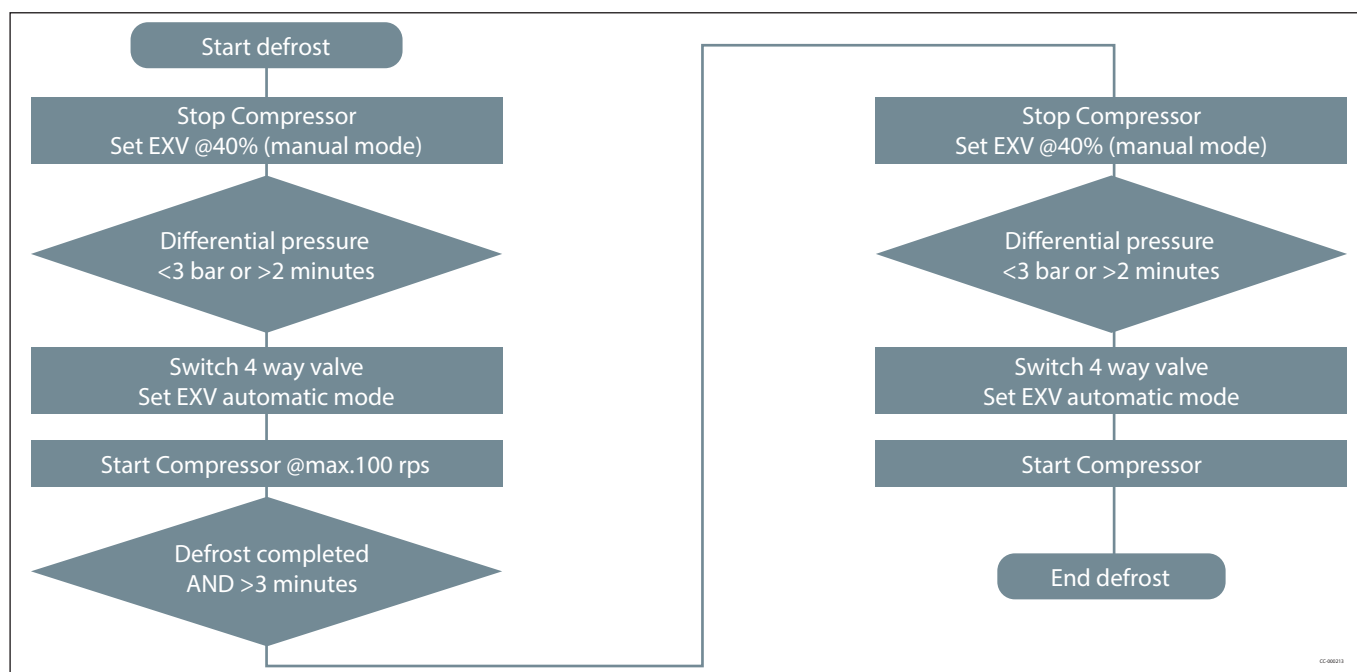
4 Way valve control and defrost logic

⚠ The main challenge of a system equipped with a 4-way valve is during the time of the switch period. After that switch, condenser becomes evaporator and vice versa. Pressurized liquid in condenser directly flows to the compressor suction and lead to oil dilution and in extreme case, liquid slugging.

Liquid flood back due to reversing cycle can be reduced by using pressure to transfer liquid refrigerant from one exchanger to the other before the 4-way valve switch. Following flow chart describes the strongly suggested sequence by Danfoss.

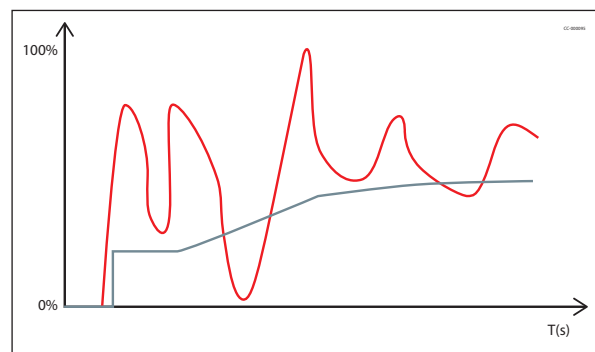
Time and pressure difference have to be fine-tuned during system qualification. EXV Opening degree and time have to be set to keep a minimum pressure difference to allow 4-way valve switch.

In any case, defrost logics must respect requirements and tests described in Manage Superheat and Operating envelope data sections. Maximum speed 100rps is proposed for defrost cycle.



Unit remotely controlled

If the system demand, and thus compressor speed, can be controlled remotely, for example by a building management system (BMS), it is essential to make sure the demand signal is consistent. Unit controller shall not directly transmit demand from external signal to compressor. Table below show some examples of erratic external demand signal and possible preventions.



—	External signal demand
—	Compressor speed
T	Time

System demand request	Example of prevention
Demand request changing very fast and often from 0 to 100%	Start in low load and ignore demand signal for the first 5 minutes and then smooth demand signal
Very frequent start and stop request	Ignore stop request for the first 5 min
Very frequent change from cooling to heating and vice versa	Do not allow change from cooling to heating and vice versa in less than 2h

Expansion valve

⚠ Role of expansion device is to open and close to maintain a proper superheat at outlet of evaporator (s)

- Electronic expansion device (EXV) is preferred to thermostatic expansion device (TXV) as it has a better ability to control superheat at low load.
- It is essential that valve closes when compressor stops.
- For TXV, liquid line solenoid valve is strongly recommended, and if not possible, suction accumulator can be used as an alternative.
- Bleed type valve is not accepted.
- For EXV, controller must be programmed to close it when the compressor stops, including in power shut down situation.

Suction accumulator

⚠ The role of suction accumulators is to collect any excess liquid that may come out of the evaporator during the transient period or low load conditions.

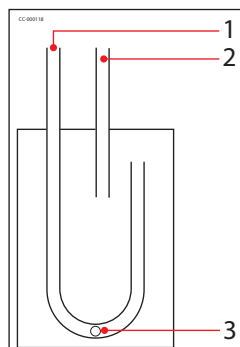
See §Test and components required per application in §Superheat management to know when to use suction accumulator.

Suction accumulator sizing must be made according to its manufacturer recommendation. Liquid capacity must be above 50% of system charge. To not penalize too much energy efficiency, the pressure drop generated by accumulator should be below 2°C evaporating temperature.

To prevent oil from getting trapped in the bottom of the suction accumulator, the suction line inside the accumulator (U shape) has a small orifice to drain the collected oil. Commonly used orifice diameter is about 1.8mm~2.0mm, this is up to the system unit design to get the balance between keeping oil return and avoiding too much refrigerant liquid return.

The superheat measurement must be done before suction accumulator.

Figure: Suction accumulator



1	outlet
2	Inlet
3	Orifice for oil return

Manage off cycle migration

General information

⚠ Off-cycle refrigerant migration happens:

- When the compressor is located at the coldest part of the installation, refrigerant vapour condenses in the compressor.
- Directly in liquid-phase by gravity or pressure difference.
- Refrigerant migrates to evaporator during off cycle

Poor lubrication when a compressor starts can reduce compressor bearing life. The oil can be diluted by liquid refrigerant that migrates to the crankcase in the off-cycle, or liquid refrigerant stored in evaporator slugging the compressor when it first re-starts. In extreme situations, this leads to liquid slugging that can damage the compressor scroll set.

Compressor charge limit

If the charge limit is exceeded, protective measures must be taken to limit the risk of liquid slugging and extreme dilution at start.

Compressor model	Refrigerant charge limit	
	Kg	lb
VCH099-116-132	13	29

Test and components required per application

Application				Components required		
Non Split ⁽¹⁾	Split	Below charge limit	Above charge limit	Belt sump heater	Non return valve	Comments
X		X		Mandatory	Mandatory for unit with water condenser (W/W or reversible A/C Chiller)	Ensure tightness between condenser & evaporator when system is OFF
X			X	Mandatory	Mandatory	1. If thermostatic expansion valve (TXV): Liquid line solenoid valve LLSV strongly recommended, if not possible Suction accumulator can be used as an alternative Bleed type valve not accepted
	X			Mandatory	Mandatory	2. If electronic expansion valve (EXV): must close when the system stops, including in power shut down situation or power loss

⁽¹⁾ Unit pre charge at OEM factory, no refrigerant piping done on field

⚠ To avoid condensed liquid refrigerant from draining back when the compressor is shut off, the condenser outlet must have an "upper loop" shape.

Sump heater

⚠ When the unit idles, refrigerant migrates to the coldest point of the system. Sump heater are designed to avoid compressor becoming the coldest point of system and accumulate refrigerant in sump.

See Test and components required per application to know when to use sump heater.

100W belt sump heater should be mounted on compressor shell to guarantee safe cold start-up even at the worst condition. Customer can select heater belt by themselves according the power, and it is not offered from Danfoss in accessory list.

Basing on customer unit design and application situation, customer can select lower power belt sump on condition that safe cold start-up can be guaranteed.

Sump heater control logic

⚠ The heater is typically controlled by a unit controller and shall be ON whenever all compressors within the circuit are OFF.

For units that may be totally power shut down on a regular basis, such as exhibition hall, it is strongly recommended to the heater to a secured power supply in order to maintain migration protection.

Sump crankcase heater installation is mandatory. When compressor is put on hold, crankcase heater should be powered on.

At commissioning, the surface sump heater must be energized at least 6 hours in advance to remove refrigerant from sump.

To optimize energy efficiency of heater, oil sump temperature can be permanently monitored by the unit controller, and the heater can be turned off when oil superheat (oil temperature – evaporating temperature) is above 12K (21.6°F).

To further protect against flooded starts, a logic can be programmed in the unit controller. After each unit power up, the compressor can start only if the oil super heat is above 12K (21.6°F). More details regarding the oil sump temperature measurement can be found in section "Application- Manage Superheat "

Non return valve

⚠ Non-return valve at discharge prevents from liquid or gas migration. Selection of non-return valve is a trade-off between pressure dropping at high speed, and the state of the valve stability while at low speed. Non-return valve is mandatory.

Compressor model	NRV model
VCH132	NRV22
VCH116/099	NRV19

Assembly line procedure

Reduce moisture in the system

⚠ Excessive air and moisture

- Can increase condensing pressure and cause high discharge temperatures.
- Can create acid giving rise to copper plating.
- Can destroy the lubricating properties of the oil.

All these phenomena can reduce service life and cause mechanical and electrical compressor failure.

Requirements

The 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's include:

- Driers water content capacity,
- System refrigeration capacity,
- System refrigerant charge.

For new installations of the compressors with POE oil, Danfoss recommends using the Danfoss DML (100% molecular sieve) solid core filter drier.

Compressor storage

Store the compressor in a manner that it is not corrosive or flammable atmosphere between -35°C to 70°C (-31°F to 158°F) when charged with nitrogen and between -35°C (-31°F) and 55°C (131 °F) when charged with R410A 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 10psi) 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

- Use lifting equipment rated and certified for the weight of the compressor or compressor assembly.
- 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).

Figure: Heavy do not lift manually



Figure: Handle with Spreader bar

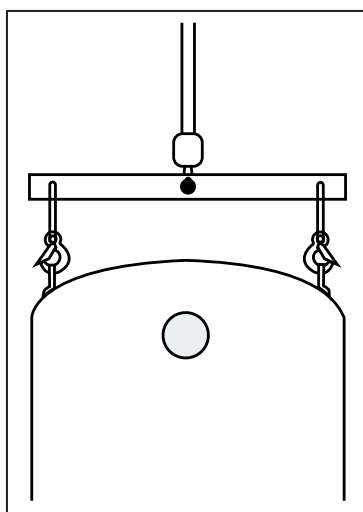
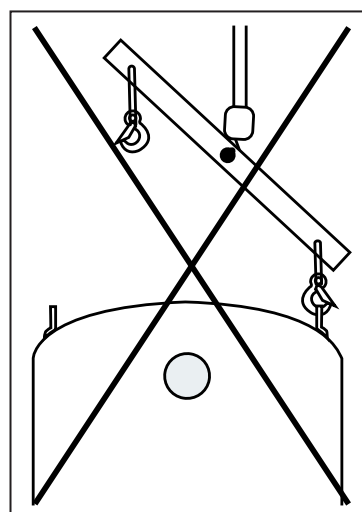


Figure: Incorrect handling



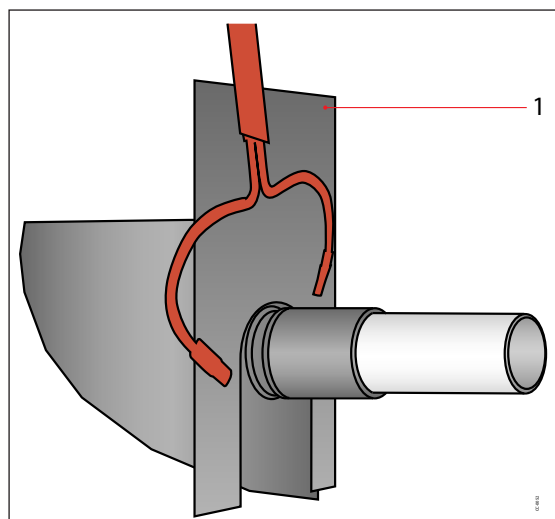
Piping assembly

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

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 pipe-work	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.



1 Heat shield

⚠ 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 indicated in table below

Maximum compressor test pressures	
Maximum compressor test pressure high side (HP)	53.6 bar(g) / (777 psig) HP-LP<37bar / (537psi)
Maximum compressor test pressure low side (LP)	36.7 bar(g) / (497 psig) LP-HP<5bar / (73psi) Maximum speed 4,8 bar/second (70psi/s) ⁽¹⁾

⁽¹⁾ An external non return valve is present on the discharge line and 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" AP000086421422.

Dielectric strength and insulation resistance tests

The tests are performed on each compressor in the factory, so it is not necessary and not recommended to do often Hipot test (dielectric withstand test) as it may damage the motor.

If a Hipot test has to be done anyway, following instructions must be followed.

Motor:

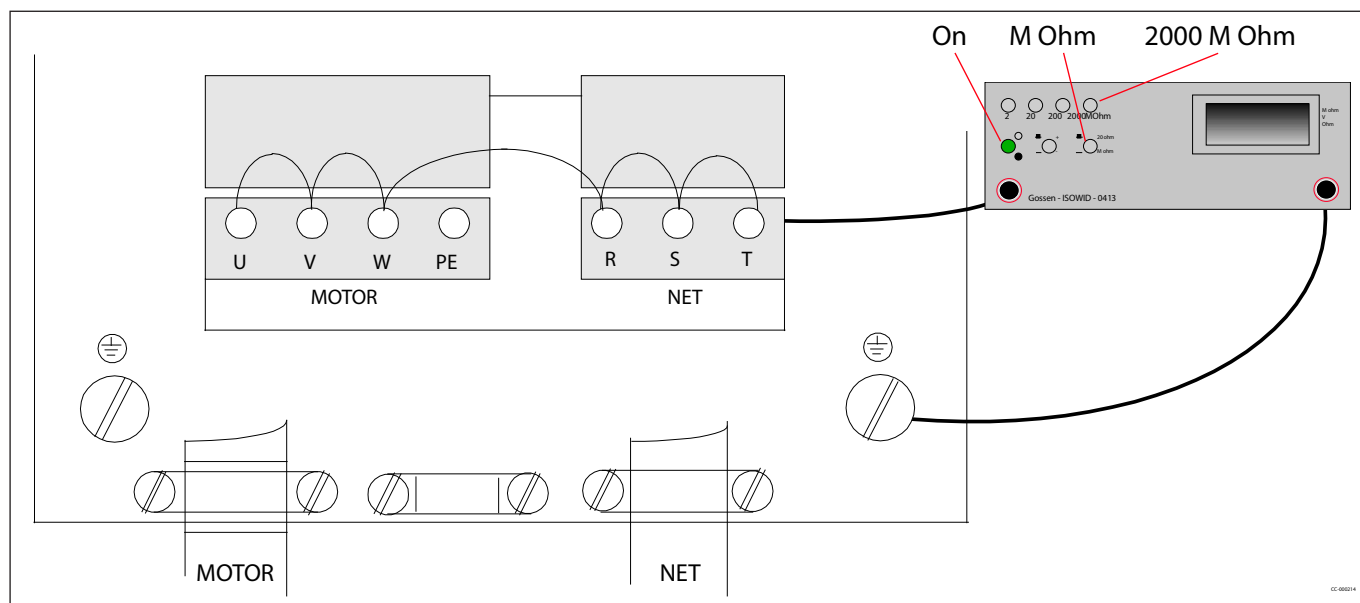
- 1800VDC (for code G) for 1 seconds must be applied; Further reduce test voltage if do more Hipot test.
- The current leakage must be below 5mA.

Drive, exemplified danfoss CDC100:

- Compressor not connected.
- R, S, T, U, V, W Terminals must be shortened and connected to high voltage terminal of the testing device, refer to the picture.
- DC voltage 2100V.

- Ramp up time 3 seconds, Full DC voltage must be established 2 seconds.
- The current leakage during the test must be below 10mA.
- Ramp down time to 0V in 25 seconds.

When conducting a high voltage test make sure the system is not under vacuum, this may cause electrical motor failure.



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

Commissioning

Preliminary check

Check electrical power supply:

- Phase order: Reverse rotation is obvious if the compressor does not build up pressure and sound level is abnormal high. VCH099-116-132 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 imbalance within tolerance: For more details refer to section Supply voltage.

Initial start-up

- Crankcase heaters must be energized at least 6 hours in advance to remove liquid 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
- Crankcase heaters must be energized at least 6 hours in advance to remove refrigerant.
- •Correct oil level in compressor sump indicates proper oil return

- Low foaming in sight glass and compressor sump temperature above 12K for VCH099-116-132 saturation temperature to show that there is no refrigerant migration taking place
- Current draw of compressor within acceptable values (MOC ratings)
- No abnormal vibrations and noise.

Oil level checking and top-up

In installations with good oil return and line runs up to 15m (49.2 feet), no additional oil is required. If installation lines exceed 15m (49.2 feet), additional oil may be needed. 3% of the total system refrigerant charge (in kg/lb) 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.

In the phase of system study, oil sight glass would be added.

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 visible in 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 any accessible connector on the compressor suction line and a suitable pump.

Dismantle and disposal



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

Packaging

Single pack

Compressor model	Height (mm)	Width (mm)	Depth (mm)	Weight (kg)
VCH099EGENA/ VCH116EGENA/ VCH132EGENA / VCH132EGNNA	718	565	470	77
VCH099EGPNA/ VCH116EGPNA/ VCH132EGPNA				

Industrial pack

Compressor model	Height (mm)	Width (mm)	Depth (mm)	Gross Weight (kg)	Static stacking pallets
VCH099EGENA/ VCH116EGENA/ VCH132EGENA VCH132EGNNA	1150	950	750	552	2
VCH099EGPNA/ VCH116EGPNA/ VCH132EGPNA					

Ordering

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

Single pack

Compressor model	Technical Name	Comercial Name
VCH132	VCH132EGENA	120G0658
	VCH132EGPNA	120G0656
	VCH132EGNNA	120G0672
VCH116	VCH116EGENA	120G0654
	VCH116EGPNA	120G0652
VCH099	VCH099EGENA	120G0650
	VCH099EGPNA	120G0648

Industrial pack

Compressor model	Technical Name	Comercial Name
VCH132	VCH132EGENA	120G0659
	VCH132EGPNA	120G0657
	VCH132EGNNA	120G0673
VCH116	VCH116EGENA	120G0655
	VCH116EGPNA	120G0653
VCH099	VCH099EGENA	120G0651
	VCH099EGPNA	120G0649

Accessories and Spare parts

E-box Plug

Code no.	Description	Application	Packaging	Pack size
120Z0852	VCH099-116-132 E-box plug	-	Multi pack	10

Mounting kits

Code no.	Description	Application	Packaging	Pack size
120Z0066	Mounting kit for 1 scroll compressor including 4 grommets, 4 sleeves, 4 bolts, 4 washers	VCH132	Single pack	1

Lubricant / oils

Type	Code no.	Description	Application	Packaging	Pack size
160SZ	7754023	POE lubricant, 160SZ, 1 litre can	VCH132 with R410A	Multipack	12

Spare parts for frequency converter

Code no.	Description	Application	Packaging	Pack size
133G1811	LCP display	Frequency converter CDC100	Single pack	1
133G1023	RFI option	Frequency converter CDC100	Single pack	1

Discharge thermostats and sensors

Code no.	Description	Application	Packaging	Pack size
120Z0157	Discharge temperature sensor / converter kit	VCH099-VCH116-VCH132	Single pack	1
120Z0158	Discharge temperature sensor	VCH099-VCH116-VCH132	Single pack	1
120Z0159	Discharge temperature converter	VCH099-VCH116-VCH132	Single pack	1
7750009	Discharge thermostat kit	VCH099-VCH116-VCH132	Multipack	10

Online support

Danfoss offers a wide range of support along with our products, including digital product information, software, mobile apps, and expert guidance. See the possibilities below.

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Climate Solutions • danfoss.com • +45 7488 2222

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