ENGINEERING
TOMORROW

Application Guide

Scroll compressors
NCH290

R410A, 50Hz

www.danfoss.com

Contents

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 Technichal Support. In any case, Danfoss manufacturing accepts no liability as a result of misuse or improper integration of the compressor unit.

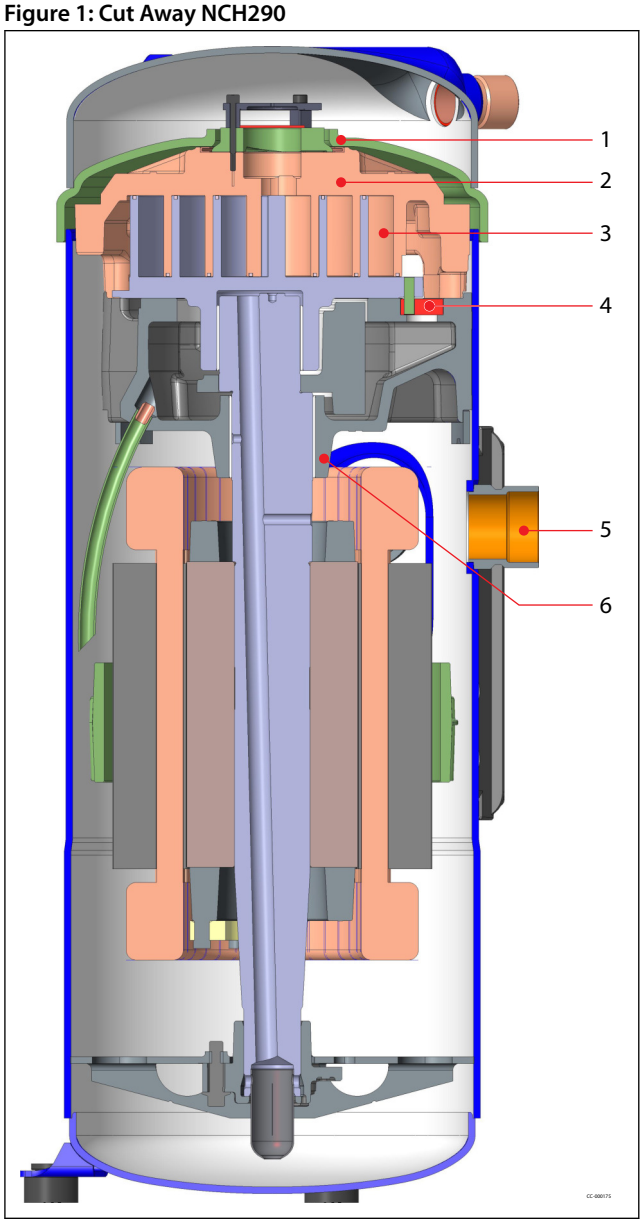
Introduction

Product description

Danfoss scroll compressor NCH290 for R410A is available as single compressor.

Cut Away NCH290

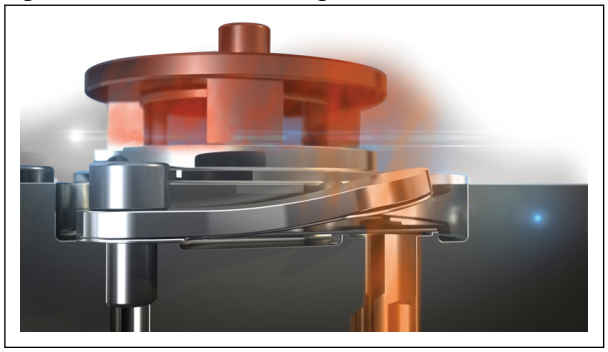
Figure 1: Cut Away NCH290



1	Second upper cap to better prevent heat and pressure impact to scroll operating from high pressure side
2	Scroll with IDV for better seasonal efficiency and liquid handling capability
3	Optimized scroll wrap
4	Orbital disk to replace Oldham coupling for overall upgrade of performance/liquid handling/ lightweight design
5	High position suction port for better oil sump temperature control
6	Lead free polymer bearings improve behavior under poor lubrication conditions

How do IDVs work?

Figure 2: Intermediate Discharge Valve (IDV)

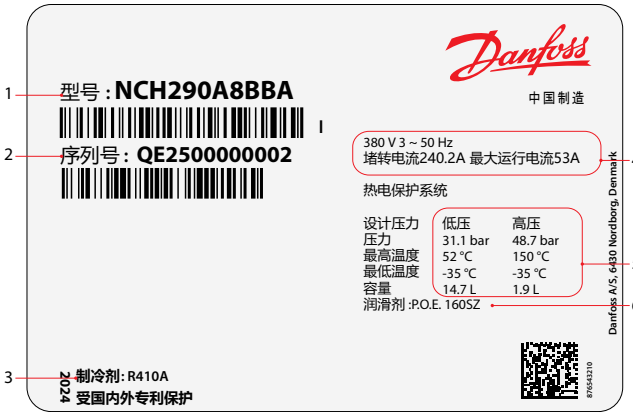


Danfoss Intermediate Discharge Valves (IDVs) are located close to the discharge side of the compressor. They reduce excessive compression of refrigerant under part-load conditions while maintaining the same cooling capacity. The IDVs open when discharge pressure falls below the built-in optimization 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

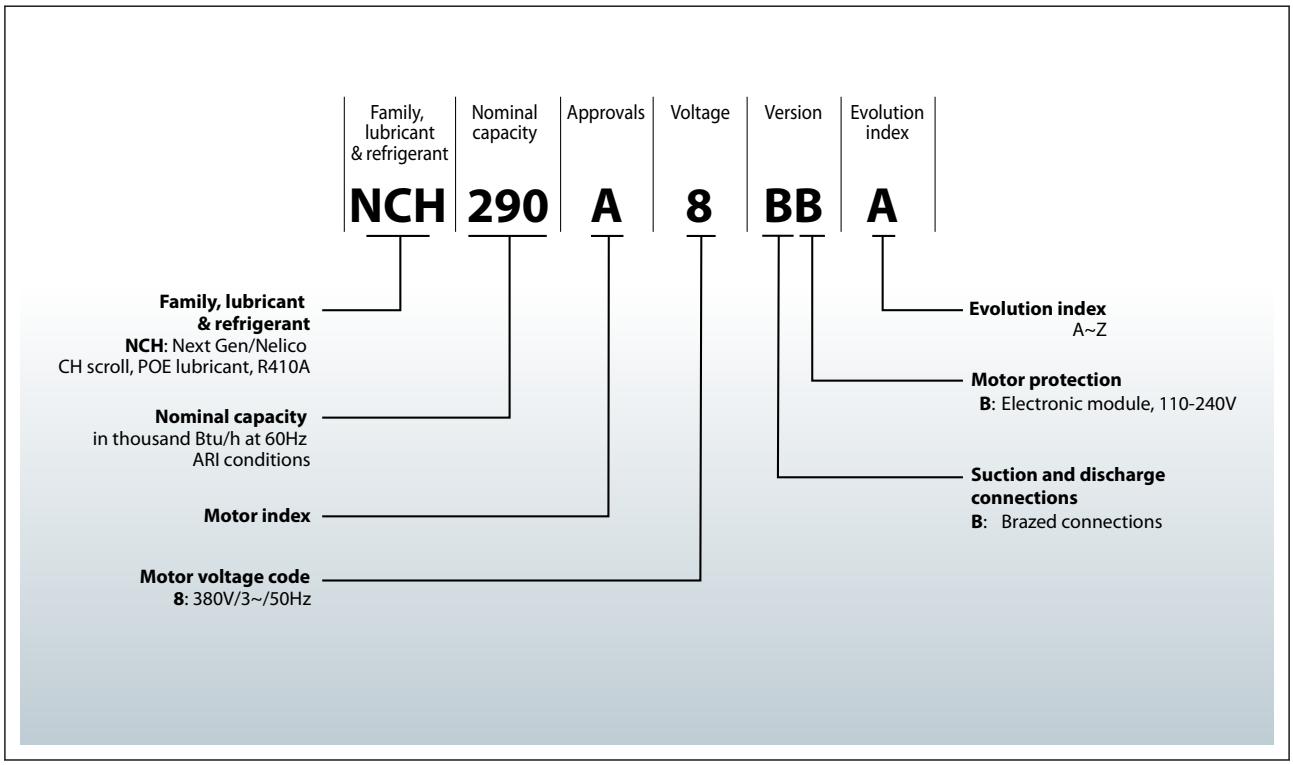
Figure 3: Name Plate



1	Model number
2	Serial number
3	Refrigerant
4	Supply voltage, Starting current & Maximum operating current
5	Housing service pressure
6	Factory charged lubricant

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

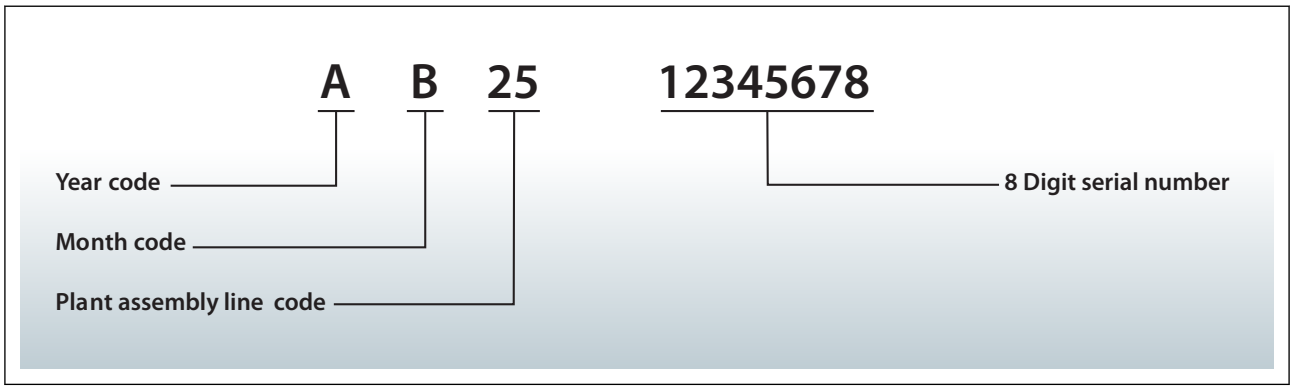


Table 1: Serial number code legend table

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				

Certificates, declarations and approvals

Internal free volume

Table 2: Internal free volume

Products	Internal free volume without oil					
	Low pressure side		High pressure side		Total	
	[litre]	[cu.inch]	[litre]	[cu.inch]	[litre]	[cu.inch]
NCH290	14.7	897	1.9	116	16.6	1013

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

50 Hz data

Table 3: Technical specification 50 Hz data

Model	Nominal tons 60 Hz	Swept volume		Displacement (50 Hz) [1]		Oil charge		Net weight [2]	
	TR	cm^3/rev	cu.in/rev	m^3/h	cu.ft/h	dm^3	oz	kg	lbs
NCH290	25	272	16.6	47.3	1670	4.4	148.8	89.2	196.6

[1] Displacement at nominal speed: 2900rpm at 50 Hz
[2] Net weight with oil charge

Performance data

R410A 50 Hz

Table 4: 50 Hz Performance data

Model		Nominal tons 60 Hz	Nominal cooling capacity		Power input	COP	E.E.R.
		TR	W	Btu/h	kW	W/W	Btu/h/W
50Hz	NCH290	25	71350	243680	22.5	3.17	10.82

NOTE:
TR: Ton of Refrigeration,
COP: Coefficient Of Performance
EER: Energy Efficiency Ratio
Standard rating conditions For 50 Hz: Evaporating temperature: 7.2°C (45°F), Condensing temperature: 54.4°C (130°F), Superheat: 11.1K (20°F), Subcooling: 8.3K (15°F)

Subject to modification without prior notification.

Data given for motor code 4 compressor with above conditions

For regular updates and detailed capacities, please refer to Coolselector®2.

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.

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.

Table 5: Compressor sound radiation

Compressor model	50 Hz
	Sound power dB(A)
NCH290	82

NOTE:
Sound power is given at ARI conditions, measured in free space.

Mechanical vibrations

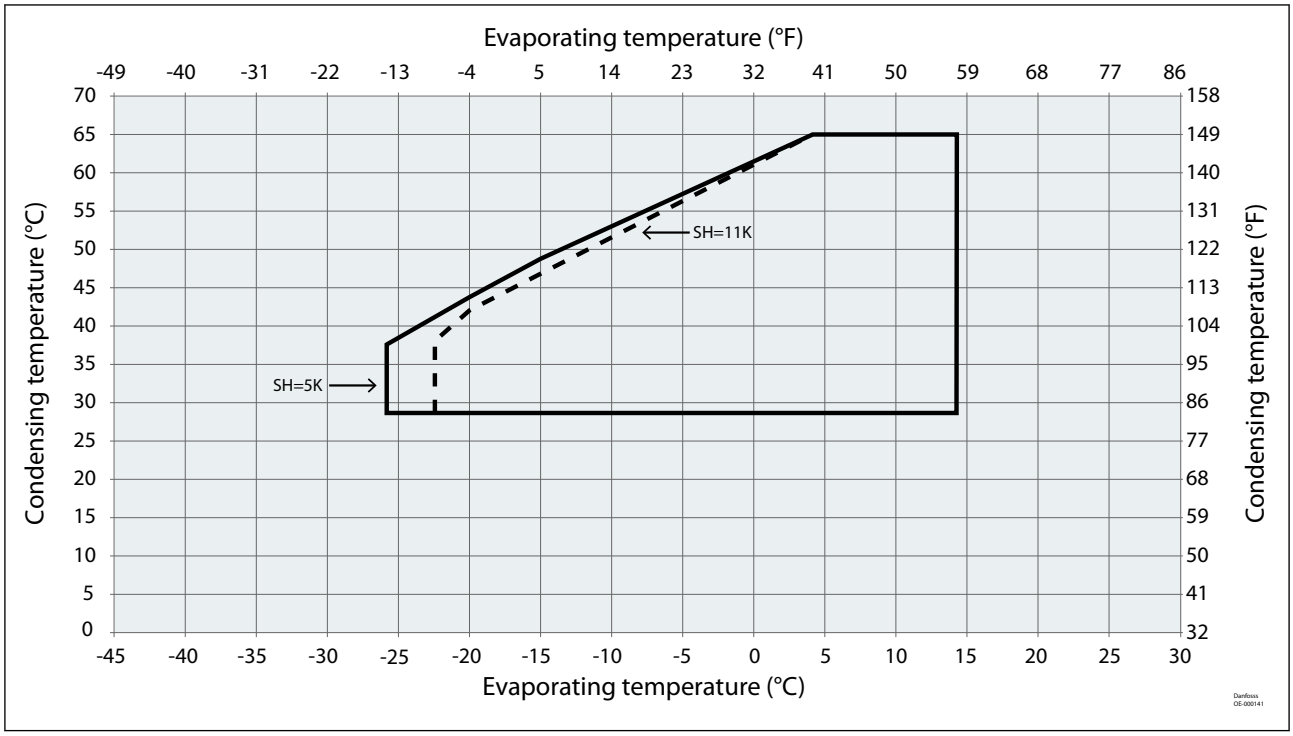
A compressor generates some vibrations that propagate into the surrounding parts and structure. The vibration level of a NCH compressor alone does not exceed 154µm peak to peak. However, when system structure natural frequencies are close to running frequency, vibrations are amplified due to resonance phenomenon.

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

Operating envelope data

Operating envelope

Figure 4: R410A - NCH290



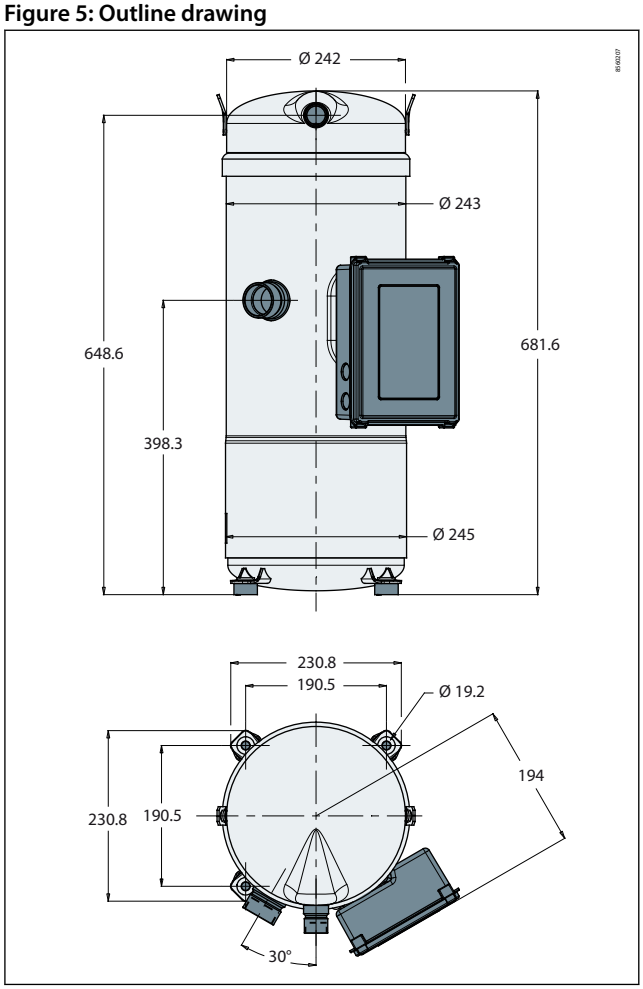
Pressure settings

Table 6: Pressure settings

Pressure settings		R410A
Working range high side	bar(g)	16.9-41.6
Working range low side	bar(g)	2.2-11.2
Maximum high pressure safety switch setting	bar(g)	43
Minimum low pressure safety switch setting	bar(g)	1.5

Dimensions

Figure 5: Outline drawing



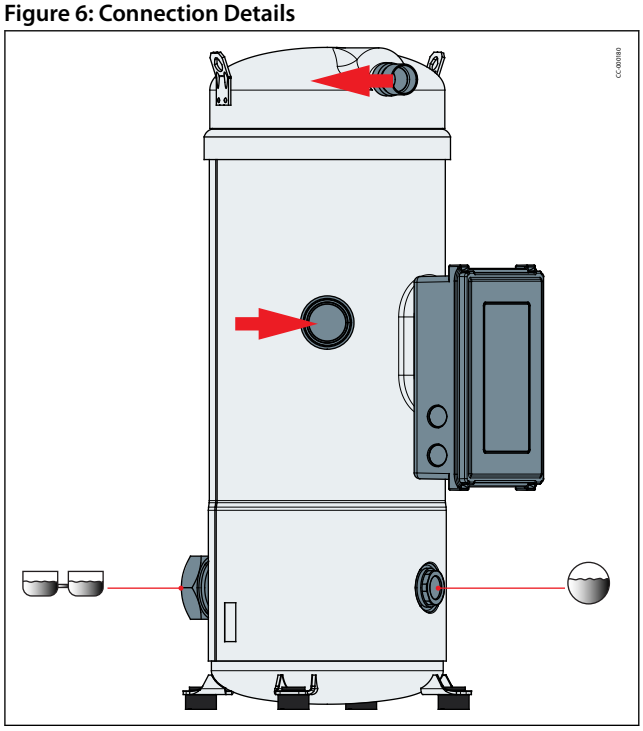
Mechanical connections

Connection Details

Table 7: Connection Details

Connection Details		NCH290
Suction connection		Brazed 1"5/8
Discharge connection		Brazed 1"1/8
Oil sight glass		None
Oil equalization connection		None

Figure 6: Connection Details



Design compressor mounting

General requirements

Compressors must be mounted with flexible grommets.

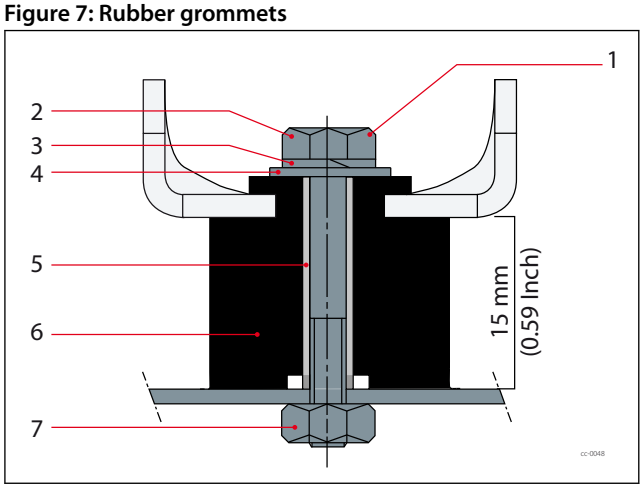
During operation, the maximum inclination from the vertical plane must not exceed 3 degrees.

Requirements mounting (recommended solution)

Compressors NCH290 is delivered with rubber grommets and steel mounting sleeve used to isolated the compressor from 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 NCH290 compressors is HM8-40. This bolt must be tightened to a torque of 15Nm.

Figure 7: Rubber grommets



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

Part 5 and 6 are delivered along with compressor

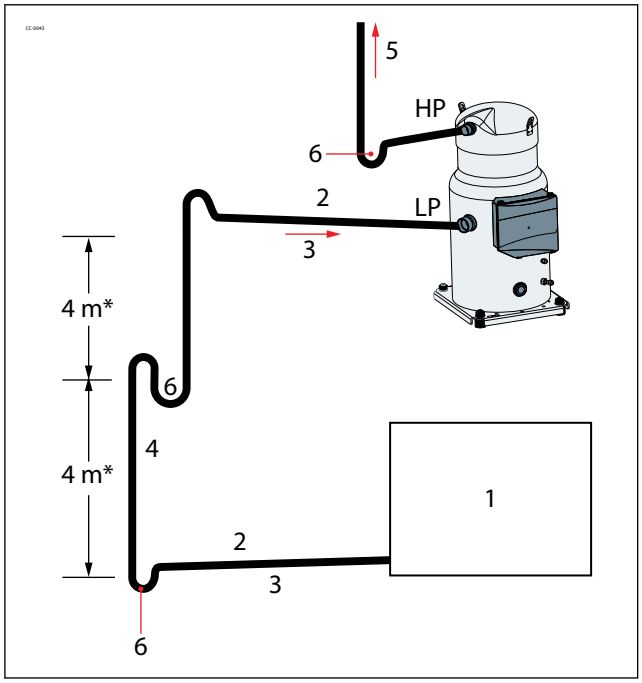
Design piping

General requirements

Proper piping practices should be employed to:

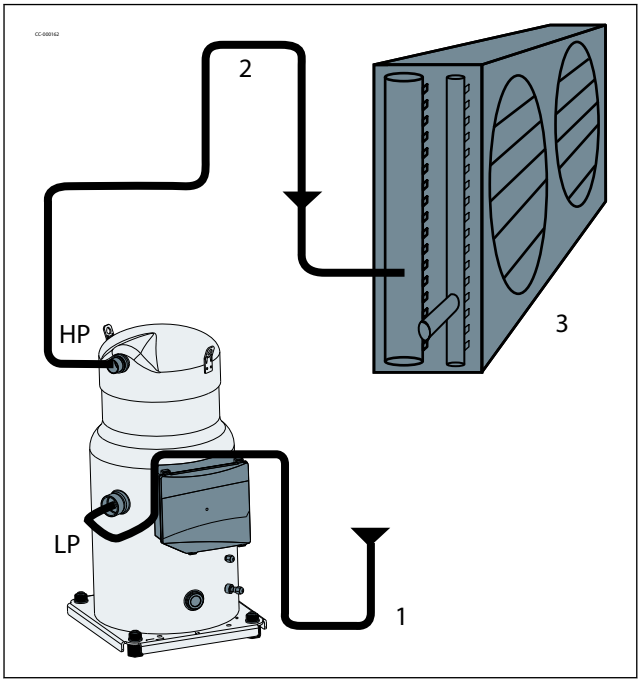
1. Ensure adequate oil return, even under minimum load conditions (refrigerant speed, piping slopes…). For validation tests see section Manage oil in the circuit.
2. Avoid condensed liquid refrigerant from draining back to the compressor when stopped (discharge piping upper loop). For validation tests see section Manage off cycle migration.
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 Sound and vibration data.

Figure 8: Proper piping - Evaporator



1	Evaporator
2	0.5% slope
3	4m/s or more
4	8 to 12 m/s
5	To condenser
6	U-trap, as short as possible
*****	Max.

Figure 9: Proper piping - Condenser



1	3D flexibility
2	Upper loop
3	Condenser

Electrical connections

Wiring connections

According to compressor model, electrical power is connected to the compressor terminals by 4.8mm (10-32) screws. The maximum tightening torque is 3 Nm.

⚠ Cable gland or similar protection component must be used on electrical box's knockouts to against accidental contact with electrical parts inside.

NCH290

The terminal box is provided with 1 triple knockouts and 1 single knockout for power supply and 2 double knockouts 2 for the safety control circuit.

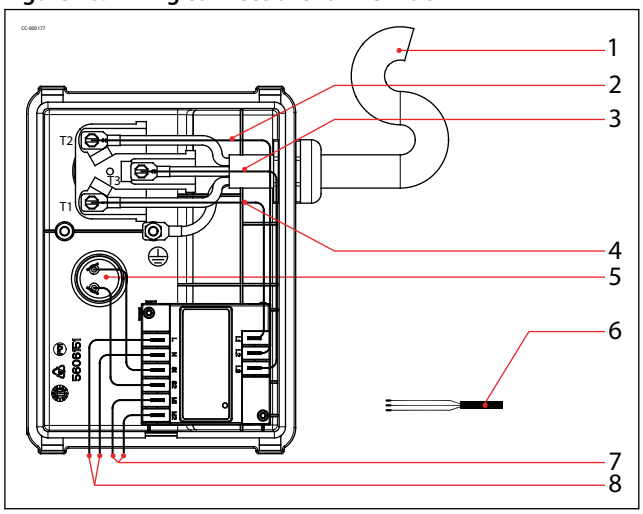
The 2 power supply knockouts accommodate the following diameters:

- Ø 25.5mm & Ø 32.7mm & Ø 36.8mm
- Ø 36mm

The 2 others knockouts are as follows:

- Ø 22.8mm (x2)
- Ø 16.5mm & 22.5mm

Figure 10: Wiring connections for NCH290



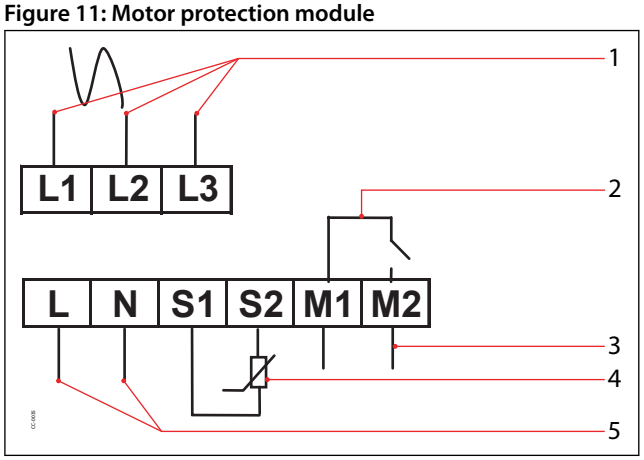
1	Power supply
2	Blue
3	Brown
4	Black
5	Faston 1/4" tabs
6	Sump heater
7	M1, M2 Control circuit
8	Module power supply

Motor protection module

The motor protection modules come preinstalled within the terminal box. Phase sequence protection connections and thermistor connections are pre-wired and should not be removed.

The module must be connected to a power supply of the appropriate voltage. The module terminals are 6.3mm (0.25inch) size Faston type.

Figure 11: Motor protection module



1	Phase sequence input
2	Internal control contact
3	Safety circuit
4	Thermistor connection
5	Module power

Electrical Specifications

Motor voltage

Danfoss scroll compressors NCH is available in motor voltages as listed below.

Table 8: Motor voltage

Frequency	Motor voltage code	Code 8
50 Hz	Nominal voltage	380-3ph

NOTE:

Voltage range

Nominal voltage ± 10%.

The voltage range indicates where the compressor can run in the majority of the application envelope. A boundary voltage supply which accumulates under specific conditions such as high ambiance, high superheat, or map boundary conditions, may lead to a compressor trip.

Voltage imbalance

The maximum allowable voltage imbalance is 2%. Voltage imbalance causes high amperage over one or several phases, which in turn leads to overheating and possible motor damage. Voltage imbalance is given by the formula:

$$\%\ \text{voltage imbalance} = \frac{|\ Vavg - V1{-}2\ | + |\ Vavg - V1{-}3\ | + |\ Vavg - V2{-}3\ |}{2 \times Vavg} \times 100$$

Vavg	Mean voltage of phases 1, 2, 3.
V1-2	Voltage between phases 1 and 2.
V1-3	Voltage between phases 1 and 3.
V2-3	Voltage between phases 2 and 3.

IP rating

The compressor terminal box according to IEC60529 is IP54 for all models when correctly sized IP54 rated cable glands are used.

First numeral, level of protection against contact and foreign objects

5 - Dust protected

Second numeral, level of protection against water

4 - Protection against water splashing

Terminal box temperature

The temperature inside the terminal box must not exceed 70°C (158°F). Consequently, if the compressor is installed in an enclosure, precautions must be taken to avoid that the temperature around the compressor and in the terminal box would rise too much. A ventilation installation on the enclosure panels may be necessary. If not, the electronic protection module may not operate properly. Any compressor damage related to this will not be covered by Danfoss warranty. In the same manner, cables must be selected in a way that ensures the terminal box temperature does not exceed 70°C (158°F).

Three phase electrical characteristics

Table 9: Motor voltage code 8

Compressor model	LRA	Max. operating current	Winding resistance
	A	A	Ω
NCH290	240.2	53	0.63

LRA (Locked Rotor Amp)

Locked Rotor Amp value is the higher average current as measured on mechanically blocked compressors tested under nominal voltage. The LRA value can be used as a rough estimation for the starting current. However, in most cases, the real starting current will be lower. A soft starter can be applied to reduce starting current.

MOC (Maximum Operating Current)

The max operating current is the amperage the compressor will draw when it operates at maximum load of operating envelope within the voltages printed on the nameplate.

MOC can be used as a basis for contactors selection.

Winding resistance

Winding resistance is the resistance between phases at 25°C (77°F) (resistance value +/- 7%). Winding resistance is generally low and it requires adapted tools for precise measurement. Use a digital ohm-meter, a “4 wires” method and measure under stabilised ambient temperature. Winding resistance varies strongly with winding temperature. If the compressor is stabilised at a different value than 25°C (77°F), the measured resistance must be corrected using the following formula:

$$R_{tamb} = R_{25°C\ (77°F)} \frac{a + t_{amb}}{a + t_{25°C\ (77°F)}}$$

$t_{25°C}$	reference temperature = 25°C (77°F)
t_{amb}	temperature during measurement °C (°F)
$R_{25°C\ (77°F)}$	winding resistance at 25°C (77°F)
R_{amb}	winding resistance at tamb
a	Coefficient a = 234.5

Motor protection

NCH290

The Compressor is delivered with a pre-installed motor protection module inside the terminal box. This device provides efficient and reliable protection against overheating and overloading as well as phase loss/reversal.

The motor protector comprises a control module and PTC sensors embedded in the motor winding.

The motor temperature is being constantly measured by a PTC thermistor loop connected on S1-S2 . If any thermistor exceeds its response temperature, its resistance increases above the trip level (4500 Ω) and the output relay then trips – i.e. contacts M1-M2 are open. After cooling to below the response temperature (resistance < 2750 Ω), a 5-minute time delay is activated.

After this delay has elapsed, the relay is once again pulled in – i.e. contacts M1-M2 are closed. The time delay may be cancelled by means of resetting the mains (L-N -disconnect) for approximately 5 sec.

A red/green twin LED is visible on the module. A solid green LED denotes a fault free condition. A blinking red LED indicates an identifiable fault condition:

Figure 12: PTC Overheat

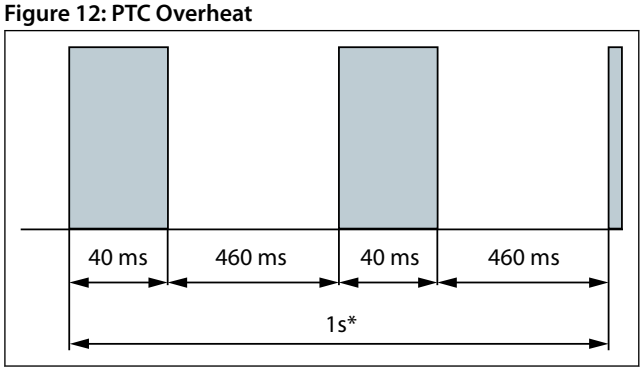
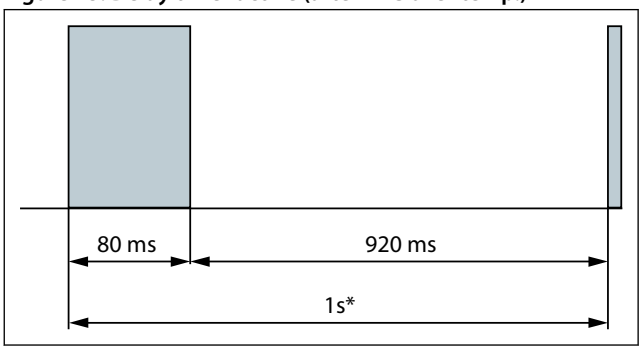


Figure 13: Delay timer active (after PTC over temp.)



*	approx. 1 second

While not compulsory, an additional thermal magnetic motor circuit breaker is still advisable for either alarm or manual reset.

Then it must be set below MOC value (at max operating current):

- When the motor temperature is too high, then the internal PTC over temp. and module is activated.
- When the current is too high the thermal magnetic motor circuit breaker will trip before the module activate therefore offering possibility of manual reset.

Phase sequence and reverse rotation protection

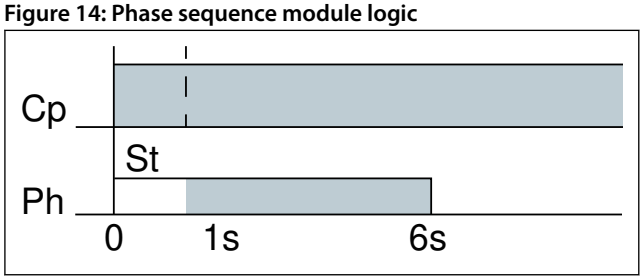
Use a phase meter to establish the phase orders and connect line phases L1, L2 and L3 to terminals T1, T2 and T3, respectively.

NCH290

The Compressor is delivered with an electronic module which provides protection against phase reversal and phase loss at start-up.

The phase sequencing and phase loss monitoring functions are active during a 5-sec window 1 second after compressor start-up (power on L1-L2-L3).

Figure 14: Phase sequence module logic



Cp	Compressor
Ph	Phase monitoring
St	start

Should one of these parameters be incorrect, the relay would lock out (contact M1-M2 open). The red LED on the module will show the following blink code.

Figure 15: In case of phase reverse error

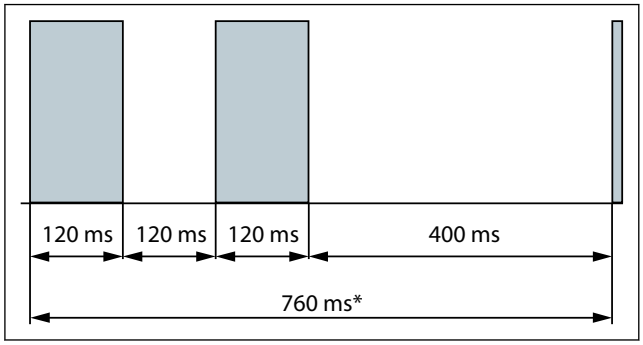
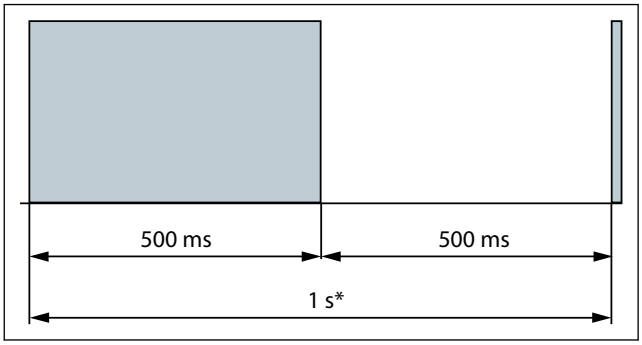


Figure 16: In case of phase loss error:



*	Approximate

The lockout may be cancelled by resetting the power mains (disconnect L-N) for approximately 5 seconds.

For more detailed information see " Instructions for electronic module" AN160986418236.

Application Guideline

Manage oil in the circuit

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.

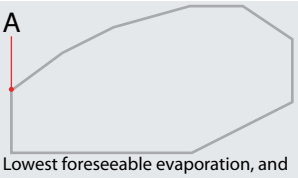
System evaluation

Table 10: Manage oil in the circuit - System evaluation

Compressor
Test No.1

Test, criteria and solutions

Table 11: Manage oil in the circuit - Test, criteria and solutions

Test No.	Purpose	Test conditions	Pass criteria	Solutions
1	Check proper oil return	 Lowest foreseeable evaporation, and highest foreseeable condensation. **Minimum number of compressor** running for 6 hours. For reversible system, perform test in both heating and cooling mode.	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.	1. Top-up with oil, generally 3% of the total system refrigerant charge (in weight). Above 3% look for potential oil trap in the system. 2. Integrate a function in control logic to run all compressors simultaneously in order to boost oil return (for more details see section broken link: X016444) 3. Oil separator can be added

Manage sound and vibration

Sound radiations

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.
2. Use of sound-insulation materials on the inside of unit panels is also an effective mean to reduce sound 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.

Gas pulsation

The compressor has been designed and tested to ensure that gas pulsation is optimized for the most commonly encountered air conditioning pressure ratio.

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

Mitigation Methods

1. To ensure minimum vibrations transmission to the structure, strictly follow Danfoss mounting requirements (mounting feet, rails etc..). For further information on mounting requirements, please refer to section Design compressor mounting.
2. Ensure that there is no direct contact (without insulation) between vibrating components and structure.
3. To avoid resonance phenomenon, pipings and frame must have natural frequencies as far as possible from running frequencies(50 Hz). Solutions to change natural frequencies are to work on structure stiffness and mass (brackets, metal sheet thickness or shape…)

Manage Operating envelope

Requirement

R The Operating envelope data for NCH scroll compressors guarantees reliable operations of the compressor for steady-state operation.

Steady-state operation envelope is valid for a suction superheat within 5K to 30K range at nominal Voltage.

High and low pressure protection

R Low-pressure (LP) and high-pressure (HP) safety switches must never be bypassed nor delayed and must stop all the compressors.

LP switch auto restart must be limited to 5 times within 12 hours.

! HP safety switch must be reset manually.

Depending on application operating envelope, you must define HP and LP limits within operating envelope and pressure setting table above.

Discharge temperature protection

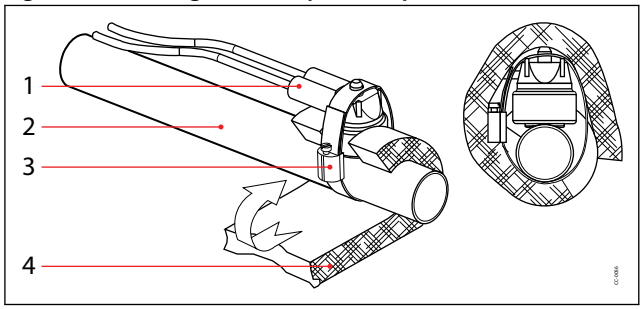
NCH

For NCH, the external 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.

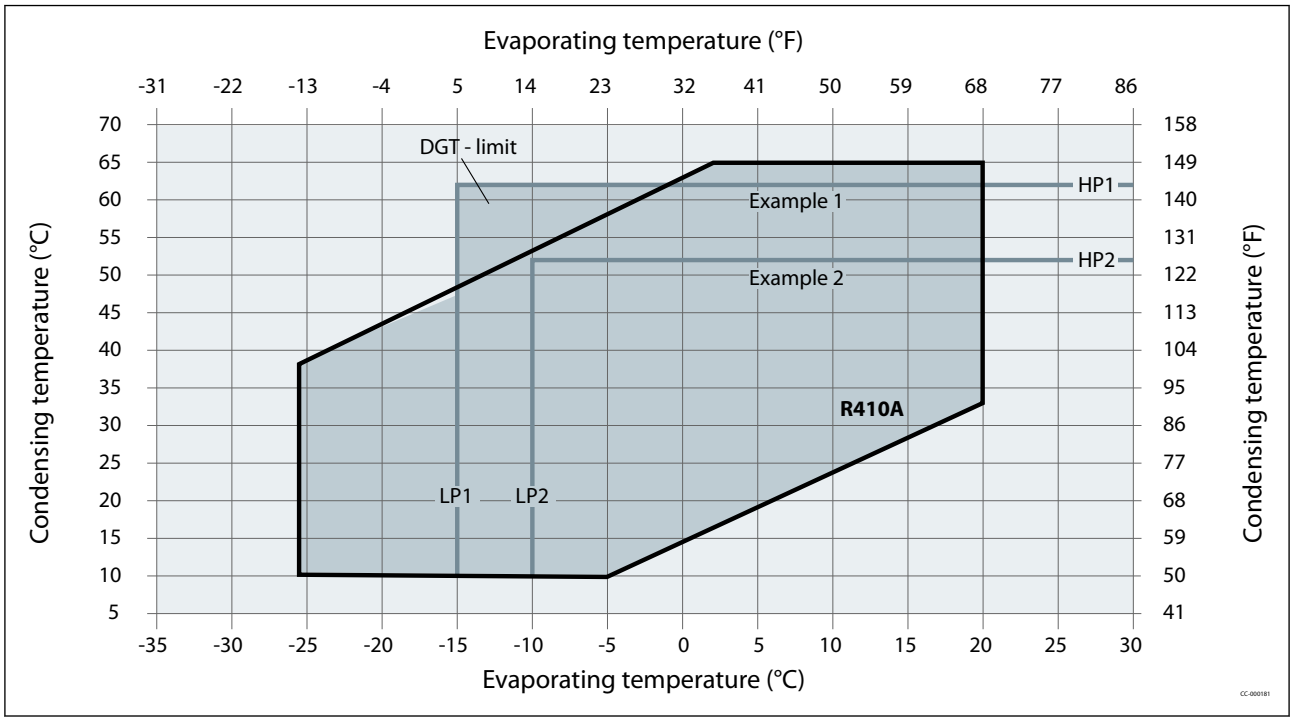
The discharge gas thermostat accessory kit (code 7750009) includes all components required for installation as shown on the right. DGT installation must respect below requirements:

- The thermostat must be attached to the discharge line within 150mm (5.91inch) 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.

Figure 17: Discharge Gas Temperature protection (DGT)



1	Thermostat
2	Discharge line
3	Bracket
4	Insulation



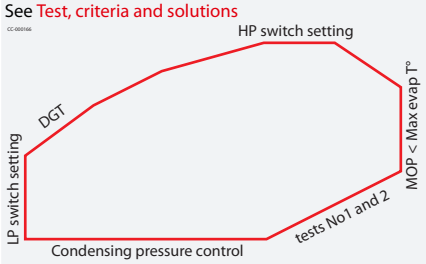
Example 1 (R410A, SH = 11K)
LP switch setting: LP1 = 3.8 bar (g) (-15°C), HP switch setting: HP1 =38 bar (g) (62°C)
Risk of operation beyond the application envelope.
DGT protection required.

Example 2 (R410A, SH = 11K)
LP switch setting: LP2 = 4.7 bar (g) (-10°C), HP switch setting: HP2 = 31 bar (g) (52°C)
No risk of operation beyond the application envelope.
No DGT protection required.

System evaluation

HP and LP must be monitored to respect operating envelope limitations. We consider two types of operating envelope management:

Table 12: System evaluation

Basic	Advanced
• HP and LP switch • MOP (Max Operating Pressure) ensured by expansion device • Condensing pressure control • DGT external	• HP and LP sensor • Operating envelope limits integrated into control logic • DGT external
See Test, criteria and solutions 	

Test, criteria and solutions

Table 13: Test, criteria and solutions

Test No.	Purpose	Test condition	Pass criteria	Solutions
1	Ensure compressor operate within envelope	Start test at minimum foreseeable evaporating temperature (minimum ambient temerature...)	Continuous running within envelope	Work on compressor staging, fan staging, water flow etc.
2		Perform a defrost test if reversible unit		

Manage superheat

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 the compressor.

Requirement

In steady state conditions the expansion device must ensure a suction superheat within 5K to 30K (9 to 54°F).

System evaluation

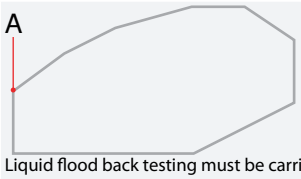
Use the table in relation with the application to quickly evaluate the potential tests to perform.

Table 14: System evaluation

Application	Tests to perform
Non reversible	Liquid flood back test
Reversible	Liquid flood back test Defrost test

Test, criteria and solutions

Table 15: Test, criteria and solutions

Test	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 number of compressor running. For reversible system, perform test in both heating and cooling mode.	Suction superheat >5K (9°F) and the oil superheat shall not be more than 60 sec below the safe limit defined in the Dilution Chart.	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 [1]
	Transient	Tests must be carried out with most unfavorable conditions : • fan staging, • compressor staging • …	Oil superheat shall not be more than 60 sec per hour below the safe limit defined in the Dilution Chart.	
Defrost test	Check liquid floodback during defrost cycle	Defrost test must be carried out in the most unfavorable conditions (at 0°C (32°F) evaporating temperature).	Oil superheat shall not be more than 60 sec per hour below the safe limit defined in the Dilution Chart.	1. Check defrost logic. In reversible systems, the defrost logic can be worked out to limit liquid floodback effect. (for more details see Control logic). 2. Add a suction accumulator [1]

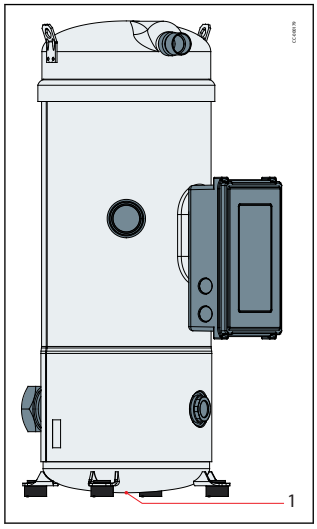
[1] Suction accumulator offers protection by trapping the liquid refrigerant upstream from the compressor. The accumulator should be sized at least 50 % of the total system charge. Suction accumulator dimensions can impact oil return (gas velocity, oil return hole size…), therefore oil return has to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

Placing oil temperature sensor

Oil temperature sensor must be placed on the bottom of the 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)

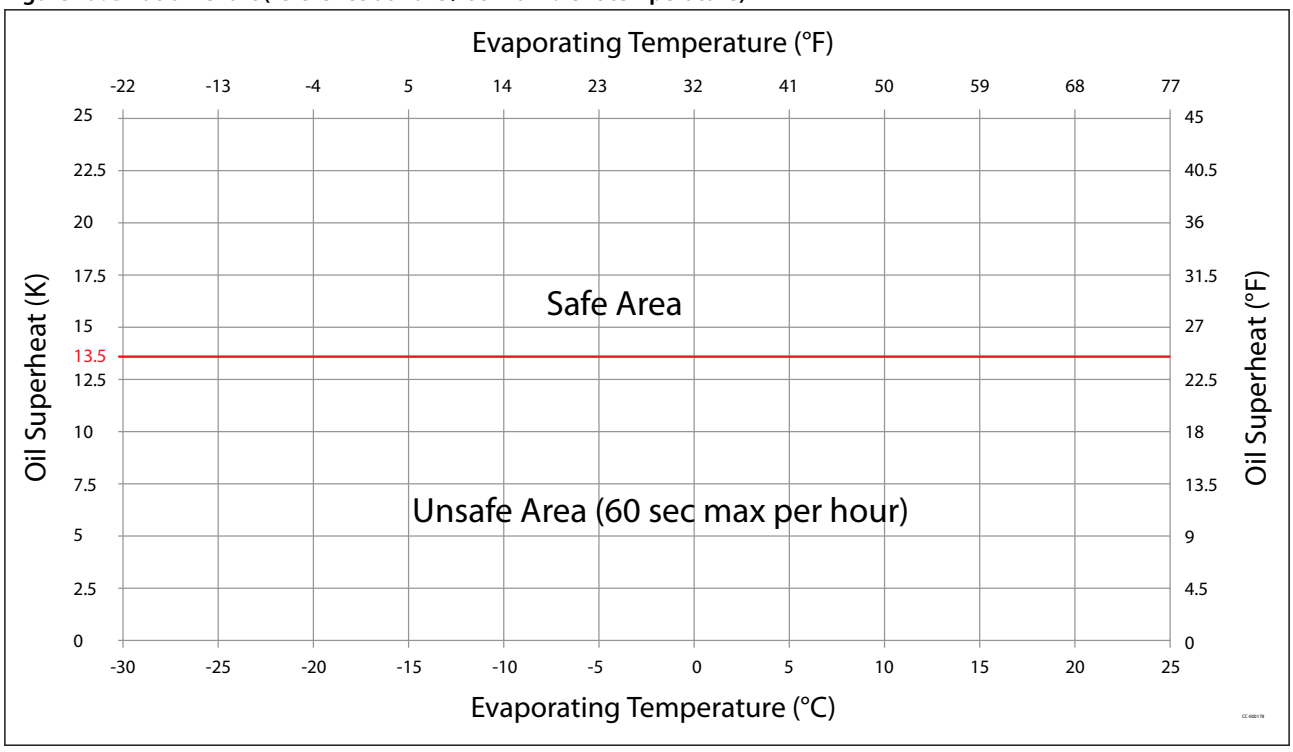
Figure 18: Placing oil temperature sensor



1	Oil temperature sensor must be placed on the bottom of the baseplate.

Dilution Chart

Figure 19: Dilution Chart (reference at 20°C / 68°F ambient 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 life time. 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 happen at each start.
- Right after start, liquid refrigerant must not flow massively to compressor
- The charge limit is a threshold beyond some protective measures must be taken to limit risk of liquid slugging and extreme dilution at start.

System evaluation

Use the table below in relation with the system charge and the application to quickly define necessary safeties to implement.

Table 16: System charge

BELOW charge limit	ABOVE charge limit
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 stop including in power shut down situation • R An External Non-Return Valve is recommended. Outlet water temperature>50°C, External Non-Return Valve is mandatory	
• R Surface Sump Heater	
Recommend a suction accumulator [1]	Require a suction accumulator

[1] Suction accumulator offers protection by trapping the liquid refrigerant upstream from the compressors. 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.

Surface Sump heater

The surface sump heater are designed to protect the compressor against off-cycle migration of refrigerant.

The surface sump heater is located on the compressor shell. For better standby energy consumption, Danfoss provides 80W surface sump heater. The selection of surface sump heater could be refered to Table 17: surface sump selection principle

Figure 20: NCH290

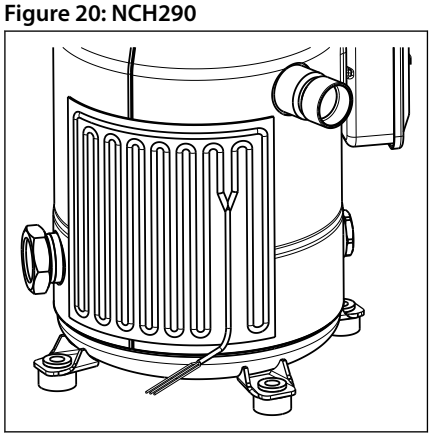


Table 17: surface sump selection principle

Compressor Surrounding Ambient	Surface Sump Heater
Unit has no enclosure, with wind	80W SSH
Unit has no enclosure, wind >5m/s (ft/s)& ambient temperature <-5°C	80W SSH + additional SSH/thermal insulation

The heater must be turned on whenever all the compressors are off. Surface sump heater accessories are available from Danfoss (see section broken link: X014125).

Liquid line solenoid valve (LLSV)

A Liquid line solenoid valve (LLSV) is used to isolate the liquid charge on the condenser side, thereby preventing against charge transfer to the compressor during off -cycles.

Charge limits

Table 18: Charge limits

Models	Composition	Refrigerant charge limit	
		kg	lbs
NCH290	-	13.5	29.7

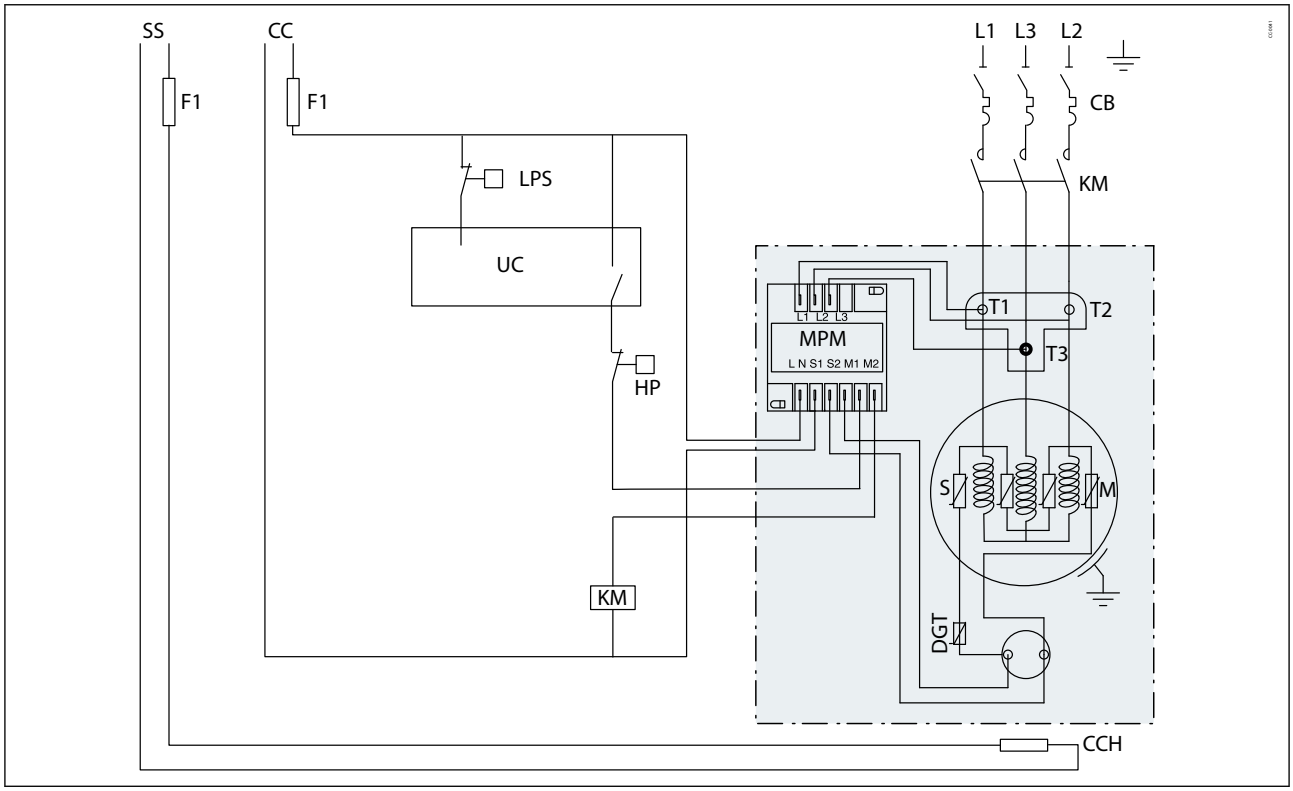
Power supply and electrical protection

Wiring information Requirements

- Protect the compressor from short circuit and overcurrent by a thermal magnetic motor circuit breaker set to Max. operating current or lower (see table in section Three phase electrical characteristics).
- The compressor is delivered with a pre-installed motor protection module inside the terminal box that must be powered on.
- HP safety switch, DGT and electronic module relay output (M1-M2, must be wired in the safety chain. Other safety devices such as LP can be either hardware or software managed.
- Provide separate electrical supply for the heaters so that they remain energized even when the machine is out of service (e.g. seasonal shutdown).

The wiring diagrams below are examples for a safe and reliable compressor wiring:

Figure 21: Wiring



CB	Thermal magnetic motor circuit breaker	**M**	Compressor motor
CC	Control circuit	**MPM**	Motor Protection Module
DGT	Discharge gas thermistor (embedded in compressor)	**Ph**	Phase sequence relay
		S	Thermistor chain (motor and discharge temperature)
F1	Fuses		
HP	High pressure safety switch	**SS**	Seprate supply
KM	Compressor contactor	**SSH**	Surface sump heater
LPS	Safety pressure switch	**UC**	Unit Controller

Control logic

Safety control logic requirements

Table 19: Safety control logic requirements

Safeties	Tripping conditions		Re-start conditions	
	Value	Time	Value	Time
HP safety switch	See Pressure settings table from section Operating envelope data	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.
Electronic module (Motor protection, DGT)	Contact M1-M2 opened			

Cycle rate limit requirements

Danfoss requires a minimum compressor running time of 2 minutes to ensure proper oil return and sufficient motor cooling.

Additionally, compressor must not exceed 12 starts per hour. 12 starts per hour must not be considered as an average, this is the maximum number of starts acceptable to keep a good regulation accuracy during low load.

Oil management logic recommendations

In some cases, oil management can be enhanced by control logic:

- If oil return test failed, a function can be integrated in control logic to run all compressors simultaneously during 2 minutes every hour in order to boost oil return. Time and delay can be fine-tuned by oil return test N°1 in section Manage oil in the circuit. During oil boost, pay special attention to superheat management to avoid liquid flood back.
- In trio system, after running long time in same state with 2 or 3 compressors, (1+2+3) or (1+2), (2+3) or (3+1), oil unbalance may appears. A function can be implemented in control logic to stop all compressors during one minute every two hours in order to balance oil. Time and sequence can be fine-tuned during Oil balancing test in section Manage oil in the circuit.

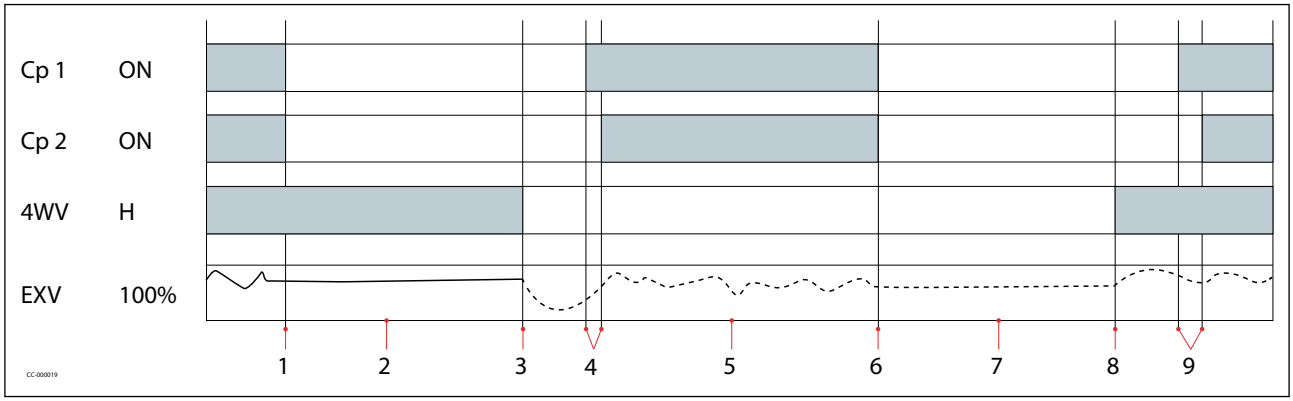
Defrost logic recommendations / Reversible systems

In reversible systems, the defrost logic can be worked out to limit liquid flood back effect by:

1. Running full load during defrost to share liquid refrigerant between all compressors.
2. Reducing refrigerant flooding to compressor by transferring liquid refrigerant from one exchanger to the other before reversing valve thanks to pressures.

The following defrost logic combines both advantages:

Figure 22: Defrost logic advantages



Cp 1	Compressor 1
Cp 2	Compressor 2
ON	On
H	Heating
1	Defrost start. Stop all compressors
2	4 Way Valve (4WV) stays in heating mode. EXV opened to transfer liquid from outdoor to indoor exchanger thanks to pressure difference.
3	When pressures are almost balanced[1], change 4WV to cooling mode.
4	Start Cp1 and Cp 2 with 0.5 seconds delay between 2 successive starts
5	Defrost
6	Defrost end. Stop all compressors
7	4 WV stays in cooling mode. EXV opened to transfer liquid from indoor to outdoor exchanger thanks to pressure difference
8	When pressures are almost balanced[1], change 4WV to heating mode.
9	Start Cp1 and Cp 2 with 0.5 seconds delay between 2 successive starts

R In reversible systems, to ensure compressor reliability, the 4-way valve must not reverse when the compressor is stopped due to heating or cooling demand (stop on thermostat).

[1] EXV Opening degree and time have to be set to keep a minimum pressure for 4 way valve moving. In any case, defrost logics must respect requirements and tests described in sections Manage superheat and Operating envelope data.

Non Return Valve (NRV)

For NCH290, an external Non Return Valve (NRV) in the discharge line is recommended.

Reduce moisture in the system

R Excessive air and moisture

- Can increase condensing pressure and cause 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

- The compressors are delivered with < 100ppm moisture level.
- At the time of commissioning, system moisture content may be up to 100ppm.
- During operation, the filter drier must reduce this to a level between 20 and 50ppm.

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 compressors with polyolester oil, Danfoss recommends using the Danfoss DML (100% molecular sieve) solid core filter drier.

Assembly line procedure

Compressor storage

Store the compressor not exposed to rain, corrosive or flammable atmosphere between -35°C (-31°F) and 70°C (158°F) when charged with nitrogen and between -35°C (-31°F) and 52°C (125.6°F)

Compressor holding charge

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

Respect the following sequence to avoid discharge check valve gets stuck in open position:

- Remove the suction plug first
- Remove the discharge plug afterwards

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 scroll compressor is equipped with two lift rings on the top shell.

- Always use both these rings 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).

Figure 23: Heavy

Figure 24: Correct

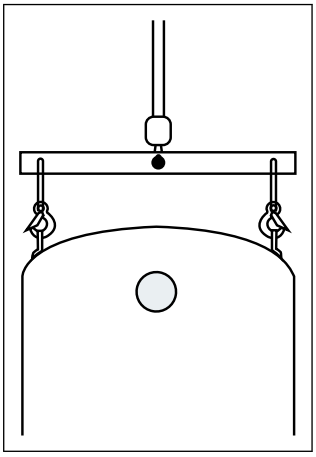


Figure 25: Incorrect

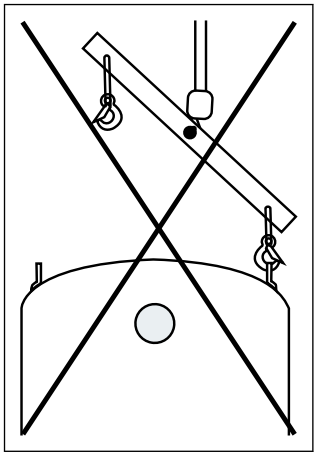
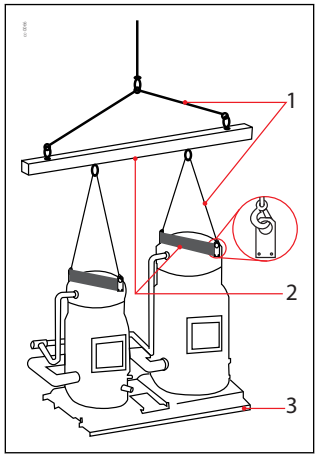


Figure 26: Handling



1	Slings
2	Spreader bars
3	Frame

Piping assembly

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

Table 20: System cleanliness

Circuit contamination possible cause:	Requirement:
Brazing and welding oxides	During brazing, flow nitrogen through the system.
Particles and burrs	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 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.
- It is recommended to use double-tipped torch using acetylene to ensure a uniform heating of connection.
- For discharge connections brazing time should be less than 2 minutes to avoid NRVI damages if any.
- To enhance the resistance to rust, a varnish on the connection is recommended.

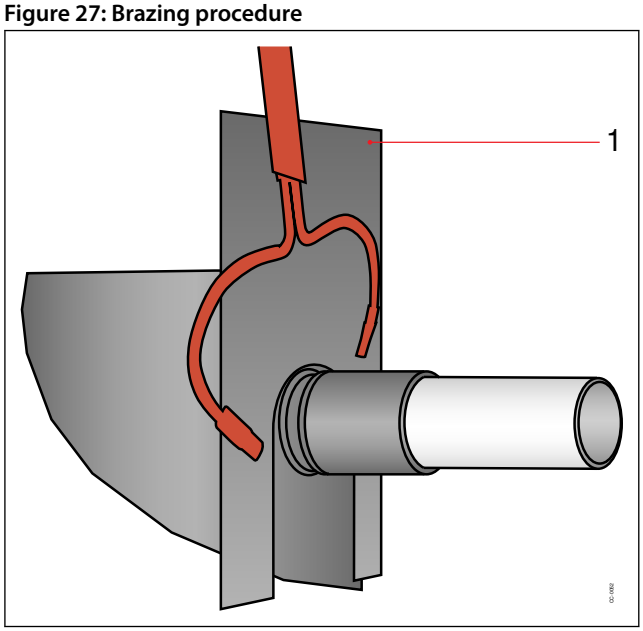
The compressor connectors are made of steel copper coated, which benefit to protect against corrosion and facilitate adhesion during brazing operation.

As per standards practice in the refrigeration industry, Danfoss Commercial Compressor recommend to use of silver cadmium free solder alloy and flux (added or flux coated rods). The significant silver content in these brazing alloy will help the brazing operation, providing an excellent fluidity and a limited heating temperature. It will bring also a good resistance to corrosion, a proper elongation compatible with system vibration, and good behavior under thermal variation improving the strength of connection and limiting fractures and refrigerant leaks. (Crucial with A2L refrigerants) A typical content of 34% Ag (Silver) is recommended by Danfoss.

The use of self-flux alloys (as phosphorous alloys) is not recommended by Danfoss. This type of brazing require a higher working temperature, that may overheat the connectors, damaging the thin layer of copper ,resulting in phosphides creation and joint zone embrittlement.

For more detailed information see " Brazing technique for compressors connectors" AP192186420580.

Figure 27: Brazing procedure



1	Heat shield

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

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

Table 21: System pressure test and leak detection

Maximum compressor test pressures	NCH
Maximum compressor test pressure high side (HP)	53.6 bar (g) (777 psig) HP-LP<37 bar (537 psi)
Maximum compressor test pressure low side (LP)	36 bar (g) (522 psig) LP-HP<5bar (73psi) Maximum speed 4.8bar/s (70psi/s) [1]

[1] If an external non return valve is present on the discharge line, the 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 vacuum 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 before evaporator, 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

Several tests have been performed on each compressor at the factory between each phase and ground.

- Dielectric strength test is done with a high potential voltage (hi-pot) of 2Un +1000V AC at least, and leakage current must be less than 5 mA.
- Insulation resistance is measured with a 500 V DC megohm tester and must be higher than 1 megohm.

Recommendations:

- Additional dielectric test is not recommended as it may reduce motor lifetime. Nevertheless, if such as test is necessary, it must be performed at a lower voltage.
- Insulation resistance test can be done.
- 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.

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 do not build up pressure and sound level is abnormal high.

For NCH290 compressors equipped with an electronic module, reverse rotation will be automatically detected. For more details refer to section 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.
- A quicker start-up is possible by “jogging” the compressor to evacuate refrigerant. Start the compressor for 1 second, then wait for 1 to 2 minutes. After 3 or 4 jogs the compressor can be started. This operation must be repeated for each compressor individually.

System monitoring

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

- Correct superheat and subcooling.
- Current draw of individual compressors within acceptable values (max operating current).
- No abnormal vibrations and noise.
- Correct oil level.

If Oil Top-up is needed, it must be done while the compressor is idle. Use the schrader connector or any other accessible connector on the compressor suction line. Always use original Danfoss POE oil 160SZ from new cans. For more detailed information see “Lubricants filling in instructions for Danfoss Commercial Compressors” AP000086435866.

Dismantle and disposal

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

Packaging

Single pack

Table 22: Single pack packaging

Compressor model	Length		Width		Height		Gross weight	
	mm	inch	mm	inch	mm	inch	kg	lbs
NCH290	565	22.2	470	18.5	843	33.2	103	227

Industrial pack

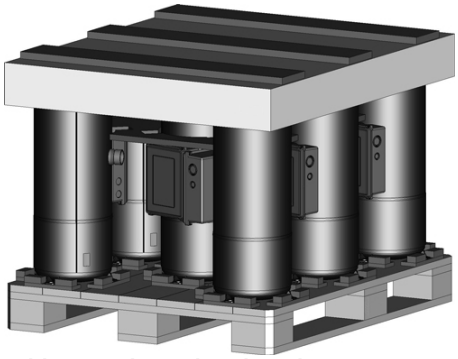


Table 23: Industrial pack packaging

Compressor model	Compressors per pack	Length		Width		Height		Gross weight		Static stacking pallets
		mm	inch	mm	inch	mm	inch	kg	lbs	
NCH290	8	1140	44.9	950	37.4	858	33.8	760	1675	2

Ordering

Compressor code numbers

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

The compressors are delivered with flexible grommets.

Single pack

Figure 28: Single pack

Table 24: Single pack compressors - R410A

Compressor model	Connections	Motor protection	Code no.
			8
			380/3/50
NCH290	Brazed	Module 110-240V [2]	120H2189

[2] Electronic motor protection, module located in terminal box.

Industrial pack

Figure 29: Industrial pack

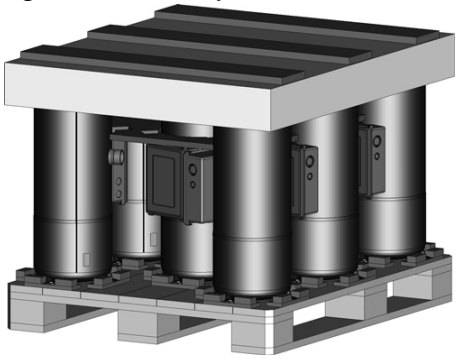


Table 25: Industrial pack compressors - R410A

Compressor model	Connections	Motor protection	Code no.
			8
			380/3/50
NCH290	Brazed	Module 110-240V [2]	120H2190

[2] Electronic motor protection, module located in terminal box.

Accessories and Spare parts

Solder sleeve adapter set

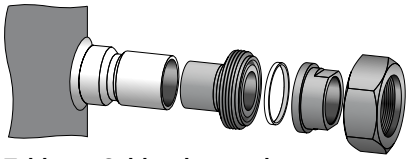


Table 26: Solder sleeve adapter set

Code no.	Description	Application	Packaging	Pack size
7765028	Rotolock adaptor set (2"1/4 ~ 1"5/8) , (1"3/4 ~ 1"1/8)	NCH290	Multipack	6

Rotolock adapter

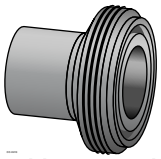


Table 27: Rotolock adapter

Code no.	Description	Application	Packaging	Pack size
120Z0432	Adaptor (2"1/4 Rotolock - 1"5/8 ODS)	Models with 1"5/8 ODF	Multipack	10

Gaskets

Table 28: Gaskets

Code no.	Description	Application	Packaging	Pack size
8156131	Gasket, 1"1/4	Models with 1"1/4 rotolock connection	Multipack	10
7956002	Gasket, 1"1/4	Models with 1"1/4 rotolock connection	Industry pack	50
8156132	Gasket, 1"3/4	Models with 1"3/4 rotolock connection	Multipack	10
7956003	Gasket, 1"3/4	Models with 1"3/4 rotolock connection	Industry pack	50
8156133	Gasket, 2"1/4	Models with 2"1/4 rotolock connection	Multipack	10
7956004	Gasket, 2"1/4	Models with 2"1/4 rotolock connection	Industry pack	50

Solder sleeve

Table 29: Solder sleeve

Code no.	Description	Application	Packaging	Pack size
8153004	Solder sleeve P02 (1"3/4 Rotolock - 1"1/8 ODF)	Models with 1"3/4 rotolock connection (R410A)	Multipack	10
8153008	Solder sleeve P04 (1"1/4 Rotolock - 3/4" ODF)	Models with 1"1/4 rotolock connection (R410A)	Multipack	10
8153012	Rotolock connector P05 (1"1/4 Rotolock - 7/8" ODF)	Models with 1"1/4 rotolock connection (R410A)	Multipack	10
8153013	Solder sleeve P07 (1"3/4 Rotolock - 7/8" ODF)	Models with 1"3/4 rotolock connection (R410A)	Multipack	10
8153003	Solder sleeve P10 (1"3/4 Rotolock - 1"3/8 ODF)	Models with 1"3/4 rotolock connection (R410A)	Multipack	10
8153006	Solder sleeve P03 (2"1/4 Rotolock - 1"5/8 ODF)	Models with 2"1/4 rotolock connection (R410A)	Multipack	10

Rotolock nut

Table 30: Rotolock nut

Code no.	Description	Application	Packaging	Pack size
8153123	Rotolock nut,1"1/4	Models with 1-1/4" rotolock connection	Multipack	10
8153124	Rotolock nut,1"3/4	Models with 1-3/4" rotolock connection	Multipack	10
8153126	Rotolock nut, 2"1/4	Models with 2-1/4" rotolock connection	Multipack	10

Motor protection modules

Table 31: Motor protection modules

Code no.	Description	Application	Packaging	Pack size
120Z0585	Electronic motor protection module, 110/240 V	NCH290	Single pack	1

Surface sump heaters

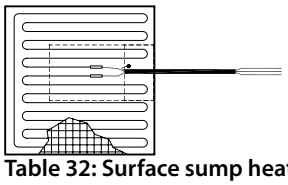


Table 32: Surface sump heaters

Code no.	Description	Application	Packaging	Pack size
120Z0389	80W 230V surface sump heater CE and UL	NCH290	Multipack	8
120Z0390	80W 400V surface sump heater CE and UL	NCH290	Multipack	8

Discharge temperature protection

Table 33: Discharge temperature protection

Code no.	Description	Application	Packaging	Pack size
7750009	Discharge thermostat kit	NCH290	Multipack	10
7973008	Discharge thermostat kit	NCH290	Industry pack	50

Mounting hardware

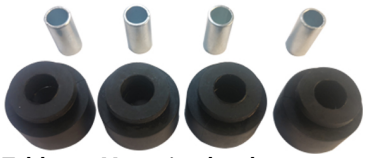


Table 34: Mounting hardware

Code no.	Description	Application	Packaging	Pack size
120Z0842	Mounting kit for scroll compressors. Grommets, sleeves	NCH290	Single pack	1

Lubricant

Table 35: Lubricant

Code no.	Description	Packaging	Pack size
7754023	POE lubricant, 1 litre can	Multipack	12
120Z0571	POE lubricant, 2.5 litre can	Multipack	4

Miscellaneous

Table 36: Miscellaneous

Code no.	Description	Packaging	Pack Size
8156019	Sight glass with gaskets (black & white)	Multipack	4
8156129	Gasket for oil sight glass, 1"1/8 (white teflon)	Multipack	10
7956005	Gasket for oil sight glass, 1"1/8 (white teflon)	Multipack	50
8154001	Danfoss Commercial Compressors blue spray paint	Single pack	1

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