ENGINEERING
TOMORROW

Application Guide

# Inverter scroll compressors
# VZH028-035-044

Single | R410A, R454B, R452B


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.

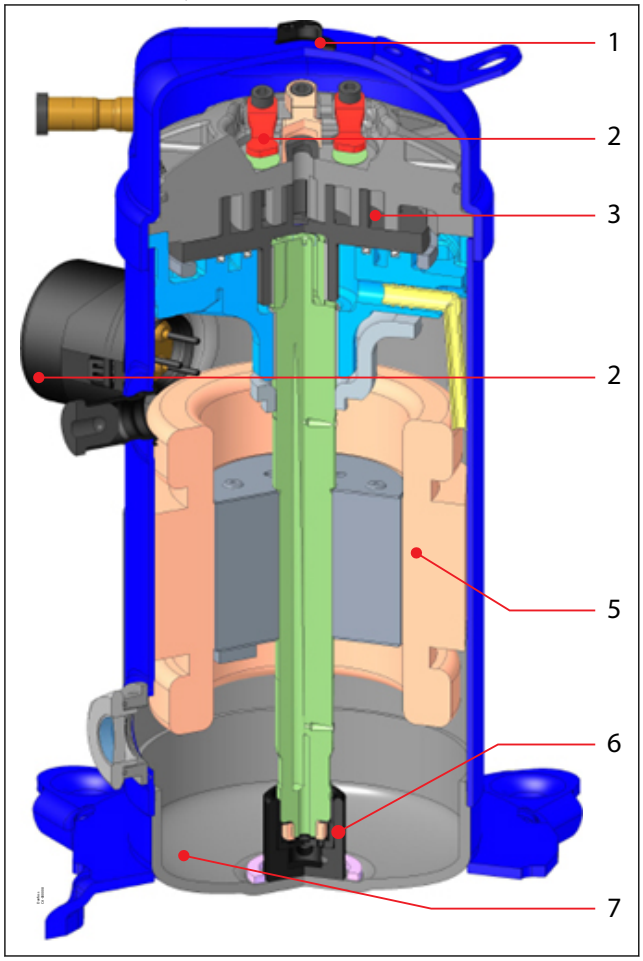
This icon indicates instructions to avoid reliability risk.

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

## Cut Away VZH

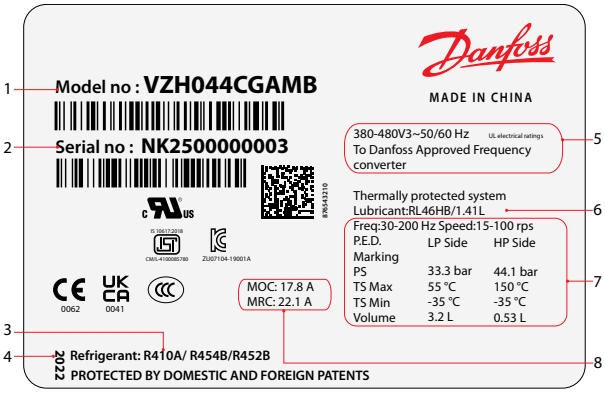
**Figure 1: Cut Away VZH**




| | |
|---|---|
| **1** | Discharge sensor (dome sensor) for high discharge temperature monitoring, sensor is fitted into top bracket. Discharge sensor is optional. |
| **2** | Intermediate discharge valves for better efficiency at low pressure-ratio |
| **3** | Scrolls with optimized volume ratio lead to better heat pump application |
| **4** | EMC (Electro-Magnetic Compatibility) bracket provided allows for grounding termination of shielded wire-harness, which reduces EMC emissions between drive and compressor |
| **5** | New distributed IPM motor lead to higher power factor |
| **6** | Linear control oil pump |
| **7** | POE lubricant |

# Product identification

## Name Plate




| | |
|---|---|
| 1 | Model number |
| 2 | Serial number |
| 3 | Refrigerant |
| 4 | Manufacturing year |
| 5 | Supply voltage |
| 6 | Lubricant |
| 7 | PED information |
| 8 | MOC and MRC |

## Compressor nomenclature

**V Z H 044 C G A M B**

**Variable speed**

**Family**
VZH scroll

**Lubricant**
POE lubricant, R454B/R452B/R410A refrigerant

**Swept volume**
in $cm^3$/rev

**Design pressure ratio**
**C**: IDV and IEER optimized

**Motor voltage code to CDS803***
**G**: 380-480V/3~/50 & 60 Hz
**J**: 200-240V/3~/50 & 60Hz
**H**: 525-600V/3~/50 & 60HZ
* main supply voltage to frequency converter

**Equipement version**
**A**: brazed connections, OSG version
**D:** brazed connections, OLS+OSG version

| | Oil sight glass | Oil level switch |
|---|---|---|
| OSG (oil sight glass) version | Threaded | None |
| OLS(oil level sensor)+ OSG version, | Threaded | Threaded |

**Motor protection type**
**M**: no internal motor protection (protection by drive), multi-refrigerant

**Evolution index**

## Compressors serial number

**A B 25** — **12345678**

Year code

Month code

Plant assembly line code

8 Digit 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

VZH scroll compressors comply with the following approvals and certificates. Certificate are listed on:
Documentation for Commercial Compressor | Danfoss

**Table 2: Certificates, declarations and approvals**

| Certificates, declarations and approvals | Certification logo | Models |
|---|---|---|
| CE (European Directive) | | VZH028-035-044 OSG version, code G/H/J |
| UKCA | | VZH028-035-044 OSG version, code G/H/J |
| UL | | VZH028-035-044 all Models |
| EMC 2014/30/EU | | VZH028-035-044 OSG version, code G/J |
| KC | | VZH028-035-044 OSG version, code G |
| CCC | | VZH028-035-044 OSG version and OLS+OSG version, code G |
| BIS | | VZH028-035-044 OSG version, code G/J |

## Low voltage directive 2014/35/EU

**Table 3: Low voltage directive 2014/35/EU**

| Products | VZH028-035-044 |
|---|---|
| Declaration of conformity ref. Low voltage Directive 2014/35/EU | Contact Danfoss |

## Internal free volume

**Table 4: Internal free volume**

| Products | Internal free volume at LP side without oil (liter) |
|---|---|
| VZH028 | 3.2 |
| VZH035 | 3.2 |
| VZH044 | 3.2 |

# 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
- Standardization 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.

### R452B

R452B is a HFO/HFC blend (R32: 67%; R125: 7%; R1234yf: 26%) with a zero Ozone Depletion Potential(ODP=0) and a low Global Warming Potential (GWP: 676/AR5 ; 698/AR4). It is a near-azeotropic mixture with a temperature glide around 1 K.

R452B has very close capacities versus R410A and due to its very limited discharge temperature difference it appears today as the best candidate for a direct drop in of R410A.

R452B is classified A2L with low flammability properties. Please refer to European regulations and directives about the use of refrigerant of the A2L safety group ( EN378, EN60335). Outside Europe refer to the local regulation.

### R454B

R454B is a HFO/HFC blend (R32 :68.9%; R1234yf: 31.1%) with a zero Ozone Depletion Potential (ODP=0) and a low Global Warming Potential (GWP: 467/AR5; 466/AR4). It is a near-azeotropic mixture with a temperature glide around 1 K.

R454B has very close match to R410A in terms of capacity and discharge temperature difference, and it offers better efficiencies compared to R410A.

R454B is classified A2L with low flammability properties. Please refer to European regulations and directives about the use of refrigerant of the A2L safety group (EN378, EN60335). Outside Europe refer to the local regulation

# Technical specifications

## Compressor size

Inverter technology offers more flexibility in compressor selection than fixed-speed compressors. Selection of the right inverter compressor size can be made by different methods:

1. Maximum cooling capacity: Select a compressor size which achieves the peak load system cooling capacity demand at its maximum speed.
2. Nominal cooling capacity: Select a compressor size which achieves the nominal system cooling capacity at a rotational speed of 3600 – 4500 rpm (60 – 75 rps).
3. Best Seasonal Efficiency Ratio: Select a compressor size which achieves the minimum system cooling demand at its minimum speed. Ensure that the compressor is able to cover the peak load system cooling capacity. This selection makes the compressor run for a maximum time at part load where the system efficiency is highest.

Performance tables at three speeds can be found in the following pages. Detailed performances can be found in datasheets and in selection programs.

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

**NOTE:**
All performance test data after run-in 72hr

## Compressor specifications

| Compressor model | Swept volume | Displacement | | | | Oil charge | Net weight |
|---|---|---|---|---|---|---|---|
| | | 15 rps | 50 rps | 60 rps | 100 rps | | |
| | ($cm^3$/rev) | ($m^3$/h) | ($m^3$/h) | ($m^3$/h) | ($m^3$/h) | (Liters) | (kg) |
| VZH028 | 27.8 | 1.5 | 5.0 | 6.0 | 10.0 | OSG version: 1.41L<br>OLS+OSG version: 1.33L | 26 |
| VZH035 | 34.9 | 1.9 | 6.3 | 7.5 | 12.6 | OSG version: 1.41L<br>OLS+OSG version: 1.33L | 27 |
| VZH044 | 44.5 | 2.4 | 8.0 | 9.6 | 16.0 | OSG version: 1.41L<br>OLS+OSG version: 1.33L | 27 |

# 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 and acoustic hood

For all VZH models, noise level given in table does not include bottom hood attenuation.

| Model | Refrigerant | Frequency RPS | 200V | | 400V | | 575V | |
|---|---|---|---|---|---|---|---|---|
| | | | Without acoustic hood (dBA) | With acoustic hood (dBA) | Without acoustic hood (dBA) | With acoustic hood (dBA) | Without acoustic hood (dBA) | With acoustic hood (dBA) |
| VZH028-044 | R410A | 60 | 77 | 70 | 77 | 70 | 77 | 70 |
| | | 90 | 84 | 77 | 84 | 77 | 84 | 77 |
| | R454B/R452B | 60 | 80 | 73 | 80 | 73 | 80 | 73 |
| | | 90 | 86 | 79 | 86 | 79 | 86 | 79 |

:

*The maximum sound power: +5dBA*

*Average sound power for reference at ARI A/C conditions measured in free space.*

*Please notice below two phenomenon is also normal for variable speed compressor:*

*1. At light load and low speed condition the compressor may produce certain discharge pulsation.*

*2. In some situations when the compressor stops working, there may still be some noise which lasts around 2 seconds. The electromagnetic noise is caused by drive anti-reverse protection.*

## Mechanical vibrations

Vibration isolation constitutes the primary method for controlling structural vibration. VZH scroll compressors are designed to produce minimal vibration during operations. The use of rubber isolators on the compressor base plate or on the frame of a manifolded unit is very effective in reducing vibration being transmitted from the compressor(s) to the unit. Once the supplied rubber grommets have been properly mounted, vibrations transmitted from the compressor base plate to the unit are held to a strict minimum. In addition, it is extremely important that the frame supporting the mounted compressor be of sufficient mass and stiffness to help dampen any residual vibration potentially transmitted to the frame.

For further information on mounting requirements, please refer to the section on mounting assembly.

# Operating envelope data

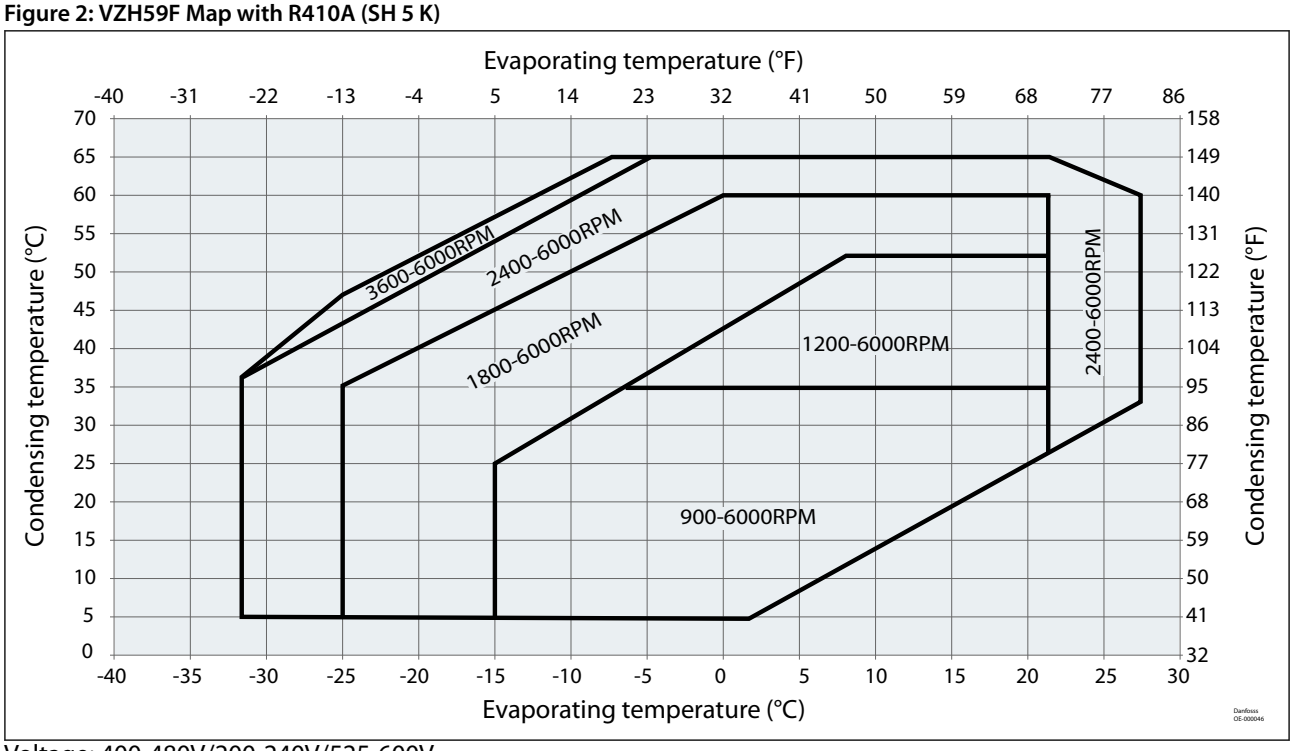
## Application envelopes

The operating envelopes for VZH scroll compressors are given in the figures below, where the condensing and evaporating temperatures represent the range for steady state operation. Under transient conditions, such as start-up and defrost, the compressor may operate outside this envelope for short periods. The figures below show the operating envelopes for VZH compressors with refrigerants R410A/R454B/R452B. Due to bearing loads and scroll stability, there will be speed restrictions on the envelops. The operating limits serve to define the envelope within which reliable operation of the compressor is guaranteed:

- Maximum discharge gas temperature: +135°C for R410A or 155°C for R454B/R452B.
- Minimum suction superheat should be above 5 K and minimum sump superheat should refer to the “off-cycle migration” chapter due to the risk of liquid flood back.
- Attention to suction line insulation to reduce useless superheat.
- Minimum and maximum evaporating and condensing temperatures as per the operating envelopes.
- VZH drive can only protect the compressor from over current. Customers need to have a high pressure, low pressure sensor and discharge temperature thermostat to fully protect the envelop. Since out of map running will threaten the reliability of compressor, customers must qualify map protection under all extreme conditions.

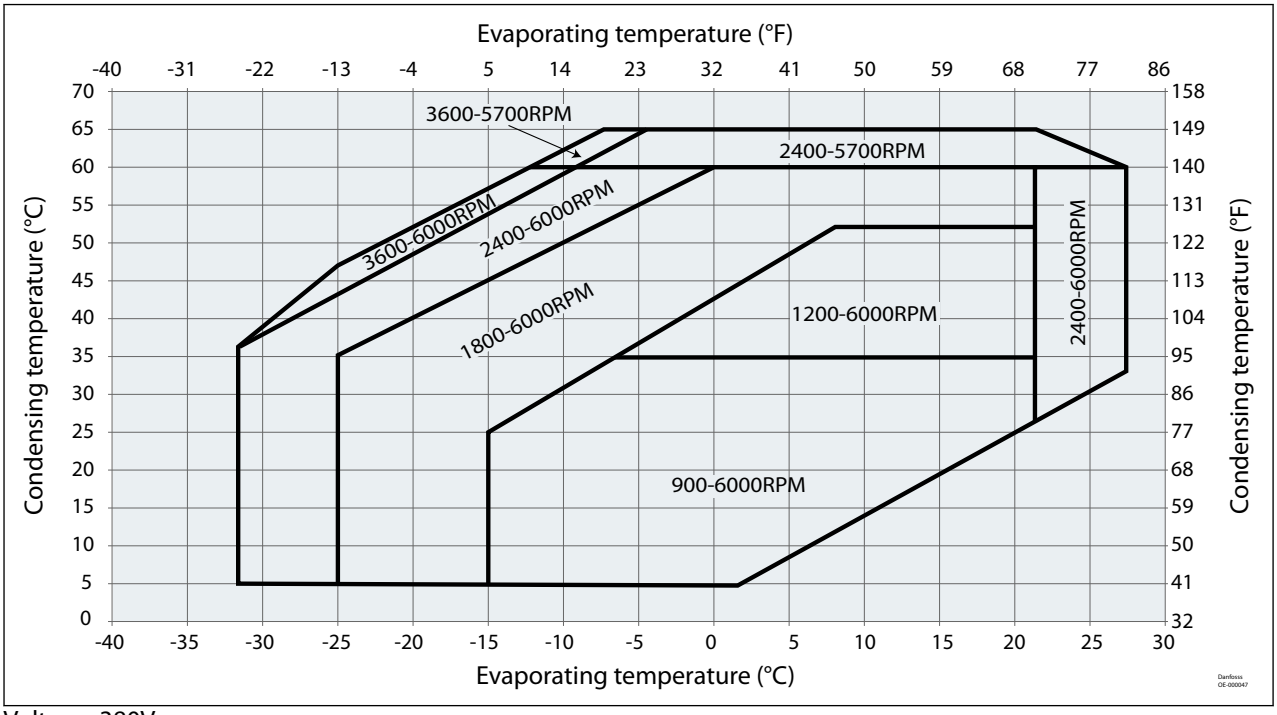
## Application envelopes for index B

**Figure 2: VZH59F Map with R410A (SH 5 K)**



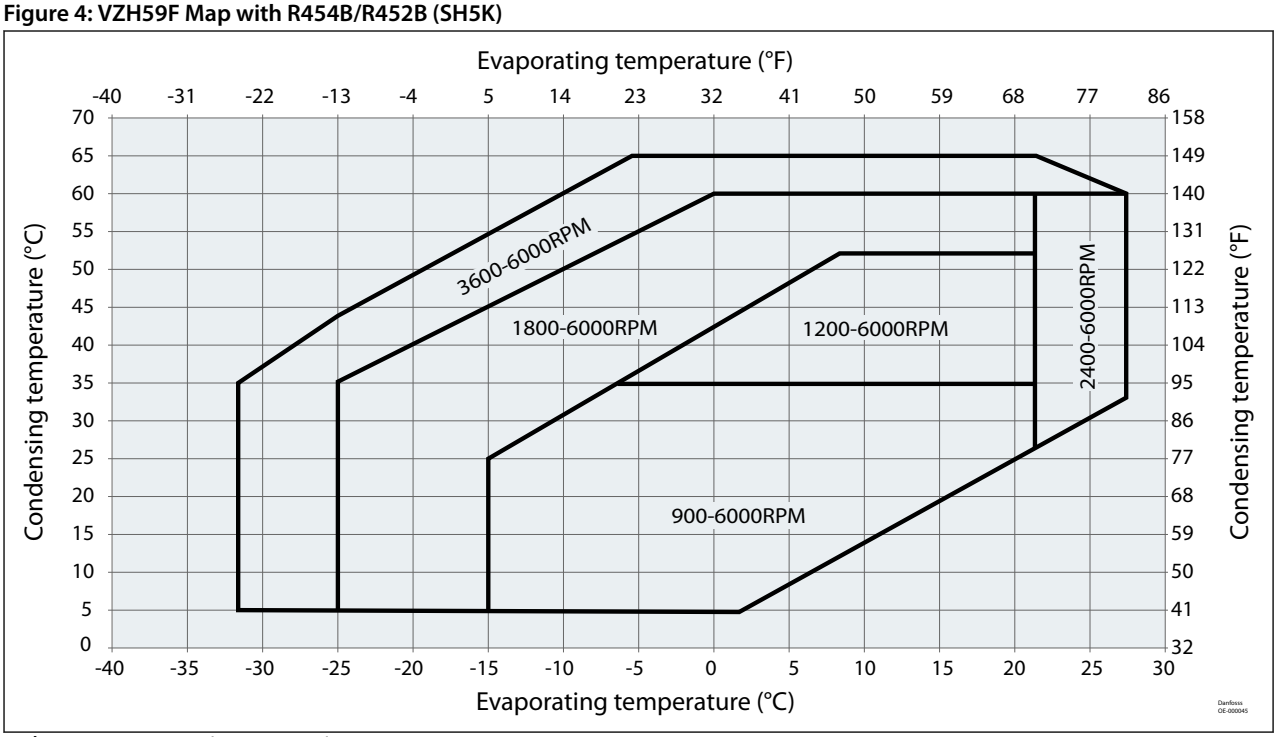

Voltage: 400-480V/200-240V/525-600V

**Figure 3: VZH59F Map with R410A (SH 5 K)**



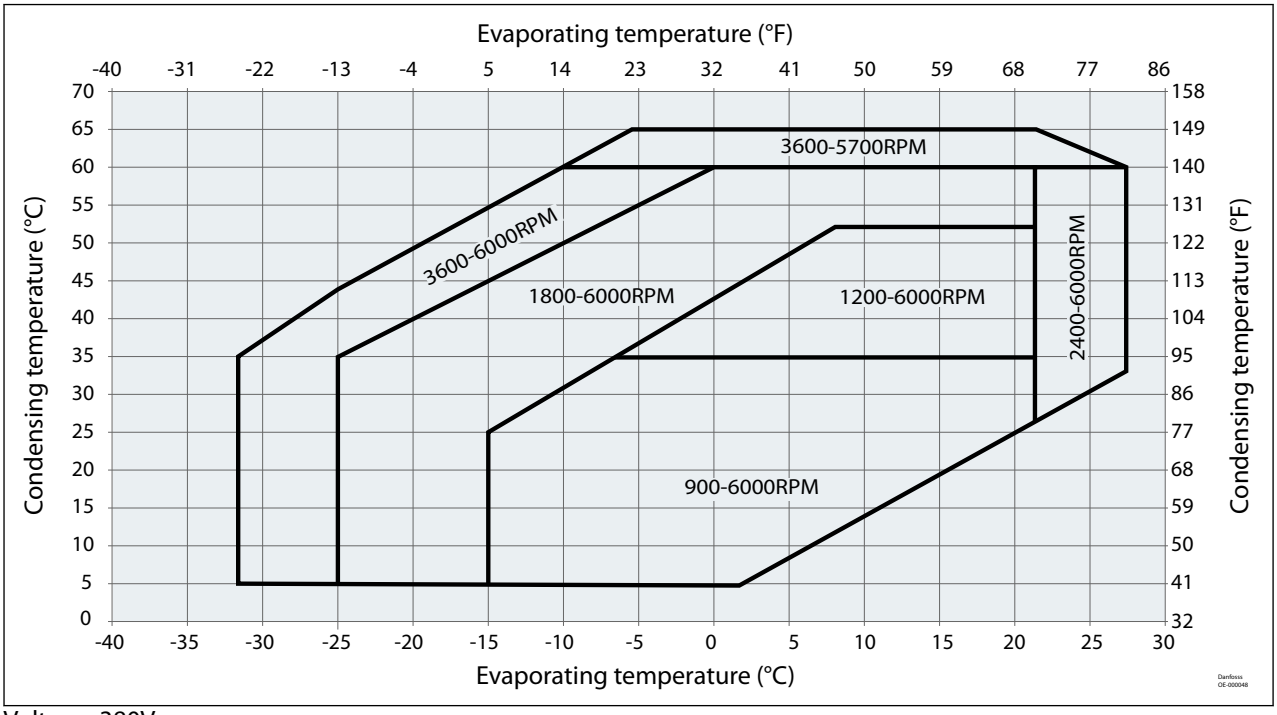

Voltage: 380V

**Figure 4: VZH59F Map with R454B/R452B (SH5K)**




Voltage: 400-480V/200-240V/525-600V

**Figure 5: VZH59F Map with R454B/R452B (SH5K)**




Voltage: 380V

## Pressure settings

**Table 5: Pressure settings**

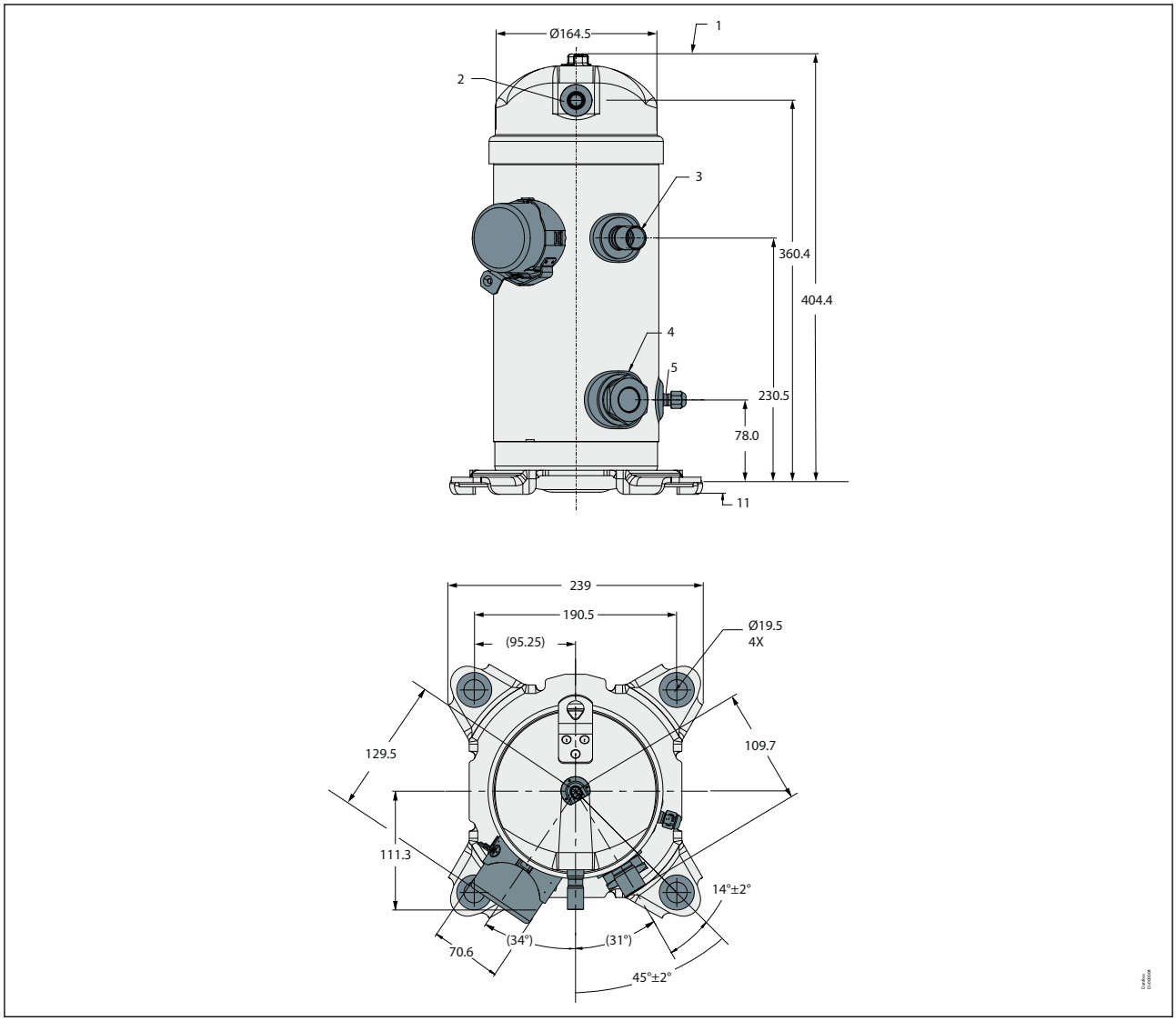
| Pressure settings | | R410A | R454B/R452B |
|---|---|---|---|
| Working pressure range high side | bar (g) | 8.3 - 41.6 | 7.5 - 38.5 |
| Working pressure range low side | bar (g) | 1.5 - 16.4 | 1.3 - 15.0 |
| Maximum high pressure safety switch setting | bar (g) | 43.7 | 40.4 |
| Minimum low pressure safety switch setting (1) | bar (g) | 1.3 | 1.1 |
| Minimum low pressure pump-down switch setting (2) | bar (g) | 1.5 | 1.3 |

(1) LP safety switch shall never be bypassed.
(2) Recommended pump-down switch settings: 2.2 bar below nominal evaporating temperature with minimum of 1.5bar(R410A) and 1.3bar(R454B/R452B)

# Dimensions

## VZH028-035-044G OSG version

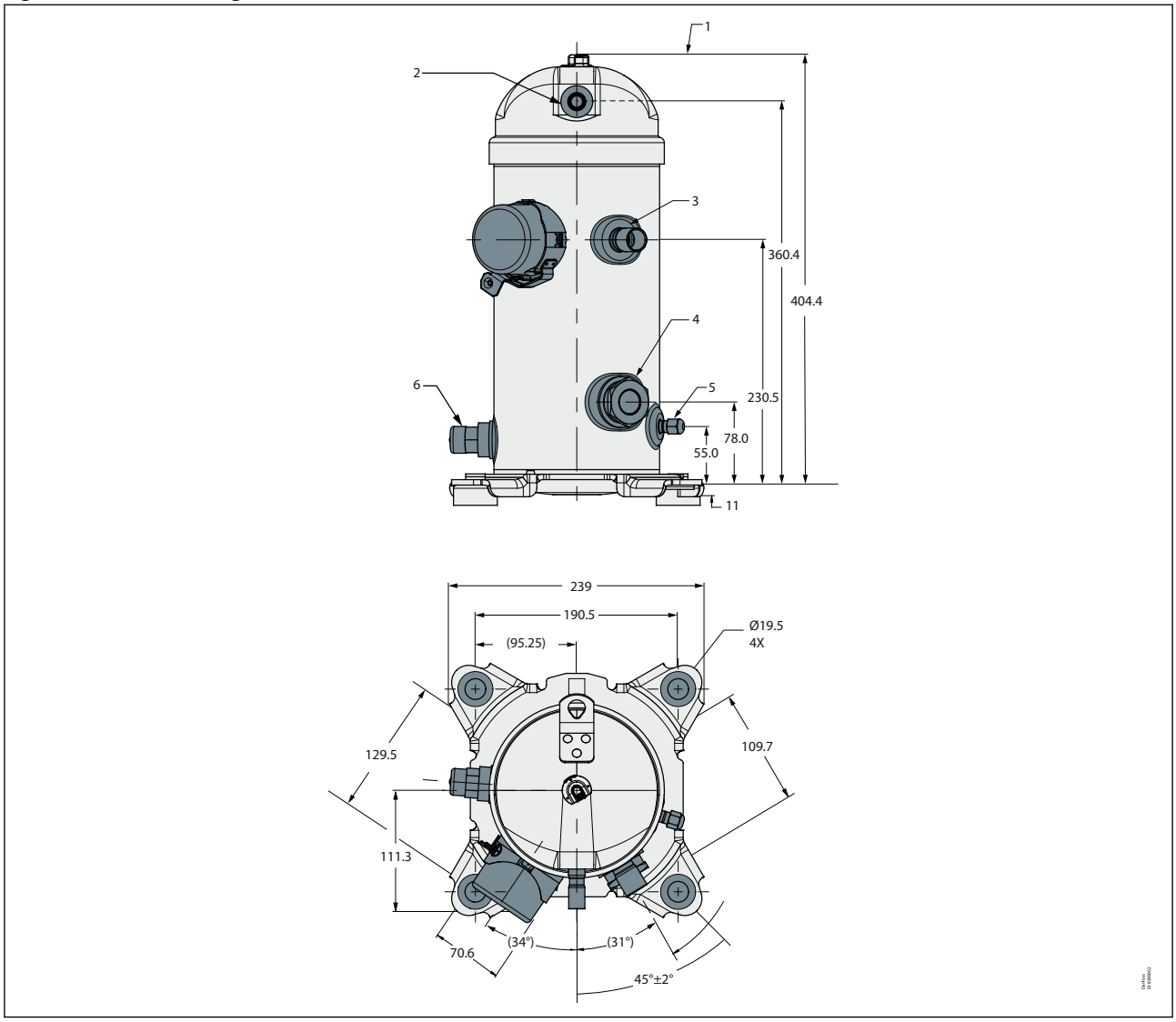
**Figure 6: Outline drawing**




| | |
|---|---|
| **1** | Top of sensor bracket |
| **2** | Discharge line 1/2" |
| **3** | Suction 3/4" |
| **4** | Oil Sight Glass 1 1/8" |
| **5** | Schrader valve and cover |

## VZH028-035-044G OLS+OSG version

**Figure 7: Outline drawing**




| | |
|---|---|
| 1 | Top of sensor bracket |
| 2 | Discharge line 1/2" |
| 3 | Suction 3/4" |
| 4 | Oil Sight Glass 1 1/8" |
| 5 | Schrader valve and cover |
| 6 | Oil level sensor prism |

## Sight glass / Oil level

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

## Schrader valve

The oil fill and drain connection and gauge port is a 1/4" male flare connector incorporating a schrader valve.

## Oil level sensor

A TEKLAB optical-electrical oil level sensor(LC-PR) prism is fixed on the inverter compressor, the electrical part is ordered by accessory kit. The oil level sensor monitors the compressor oil level and sends oil level signal to relay: It already has relay internally. Regarding this oil level signal, a 5±2 seconds delay is recommended to be used to consider the oil level fluctuation which may trigger false alarms.

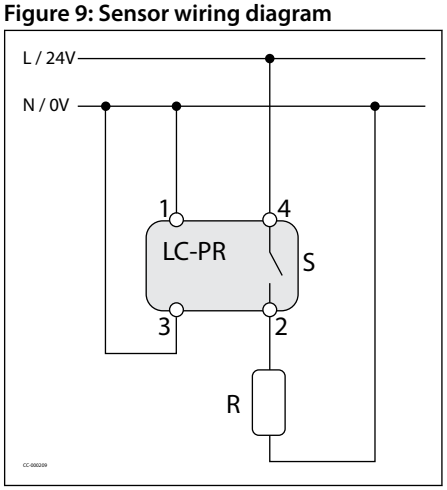
**Lack of oil**: Relay between 2 and 4 will be opened internally, output is open. LED in sensor is red.

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

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

**Figure 8: LC-PR**

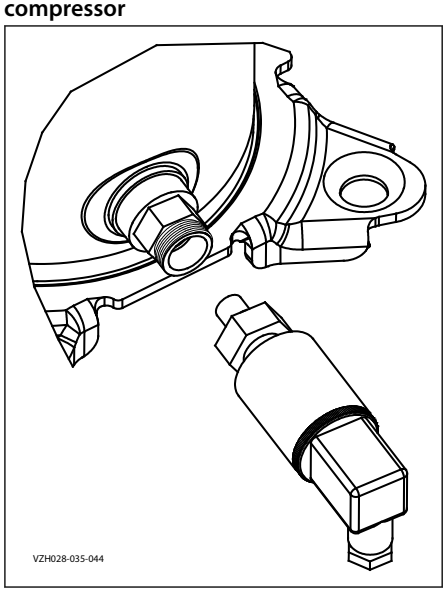
**Figure 9: Sensor wiring diagram**




| | |
|---|---|
| **S** | Sensor |
| **R** | External Load / Relay |

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

**Figure 10: Oil level sensor on compressor**



# Mechanical connections

## Connection Details

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

| | Suction | Discharge |
|---|---|---|
| VZH028-035-044 | 3/4" | 1/2" |

Rotolock adaptors are available, refer to the “Accessories” section.

**Figure 11: Rotolock adaptor set**

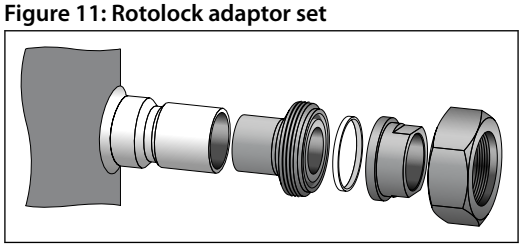
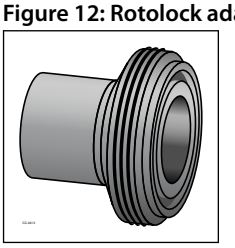


**Figure 12: Rotolock adaptor**



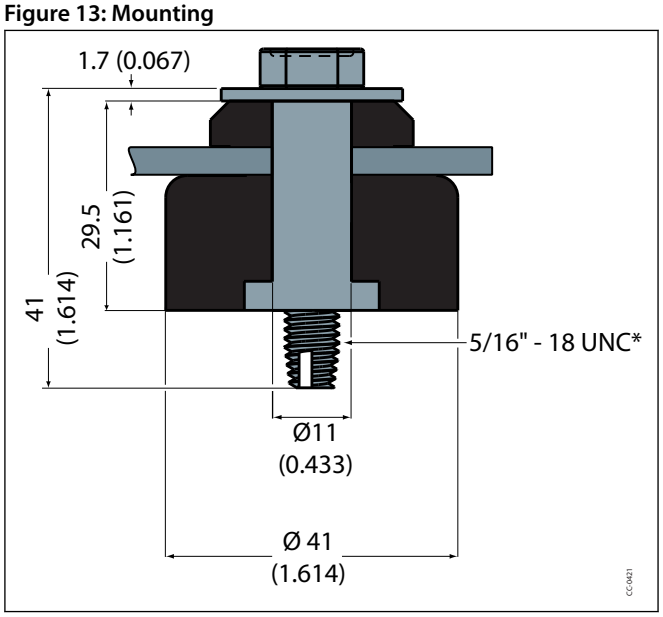
| Compressor models | Brazed connection size | Rotolock adaptor set | | | Rotolock adaptor |
|---|---|---|---|---|---|
| | | Rotolock | Solder sleeve ODF | Code Number | Code Number |
| VZH028-044 | Suction 3/4" | 1-1/4" | 3/4" | 120Z0126 | 120Z0366 |
| | Discharge 1/2" | 1" | 1/2" | | 120Z0365 |

## Design compressor mounting

### Grommets

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

**Figure 13: Mounting**




### Max inclination

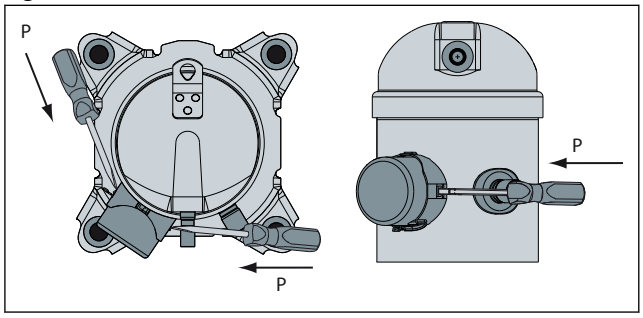
Maximum inclination from the vertical plane, while operating must not exceed 7 degrees.

## Terminal cover mounting

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

## Terminal cover removal

**Figure 14: Terminal cover removal**




| | |
|---|---|
| **P** | Push |

# Design piping

## Essential piping design considerations

The working pressure in systems with R410A/R454B/R452B is about 50%~60% higher than in systems with R22 or R407C. Consequently, all system components and piping must be designed for this higher pressure level.

Proper piping practices should be employed to ensure adequate oil return, even under minimum load conditions with special consideration given to the size and slope of the tubing coming from the evaporator. Tubing returns from the evaporator should be designed so as not to trap oil and to prevent oil and refrigerant migration back to the compressor during off-cycles.

In systems with R410A/R454B/R452B, the refrigerant mass flow will be lower compared to R22/R407C systems. To maintain acceptable pressure drops and acceptable minimum gas velocities, the refrigerant piping must be reduced in size compared to R22 / R407C systems. Take care also to not create overly high pressure drops as in R410A systems the negative impact of high pressure drops on the system efficiency is stronger than in R22/R407C systems.

The design in this guideline is for short circuit application. However, for long circuit and split system application, an oil separator and an external non-return valve are recommended for use based on system qualification status. CDS frequency converter integrates a special feature in the compressor functions in order to improve and secure the oil recovery from the system. Refer to “Oil Return Management” section.

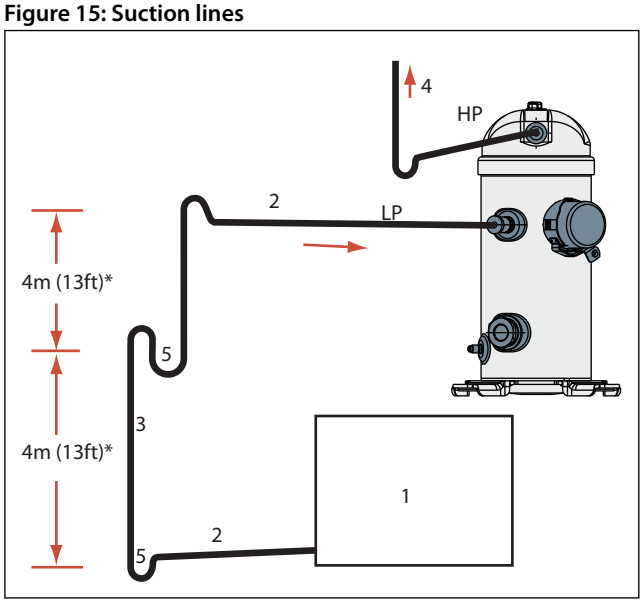
Piping should be designed with adequate three-dimensional flexibility. It should not be in contact with the surrounding structure, unless a proper tubing mount has been installed. This protection proves necessary to avoid excess vibration, which can ultimately result in connection or tube failure due to fatigue or wear from abrasion. Aside from tubing and connection damage, excess vibration may also transmitted to the surrounding structure and generate an unacceptable noise level within that structure. For more information on noise and vibration, see “Sound and Vibration Management” section.

## Suction lines

If the evaporator lies above the compressor, as is often the case in split or remote condenser systems, the addition of a pump-down cycle is strongly recommended. If a pump-down cycle were to be omitted, the suction line must have a loop at the evaporator outlet to prevent refrigerant from draining into the compressor during off-cycles.

If the evaporator were situated below the compressor, the suction riser must be trapped so as to prevent liquid refrigerant from collecting at the outlet of the evaporator while the system is idle, which would mislead the expansion valve’s sensor (thermal bulb) at start-up.

**Figure 15: Suction lines**




| | |
|---|---|
| **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. |

## Discharge lines

When the condenser is mounted at a higher position than the compressor, a suitably sized U-shaped trap close to the compressor is necessary to prevent oil leaving the compressor from draining back to the discharge side of the compressor during off cycle. The upper loop also helps avoid condensed liquid refrigerant from draining back to the compressor when stopped.

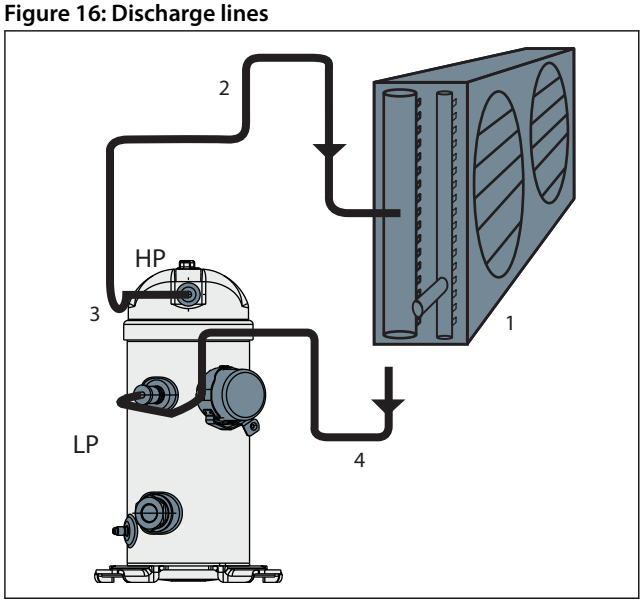
For inverter applications with long lines we recommend the use of an oil separator even if it is only the condenser which is far away from the unit.

Piping must also be designed with care in order to make sure the remaining oil not trapped by the oil separator is properly carried over the system.

Basic principal is shown here. Note that for the discharge line, following the same principle as for the suction line with a U-trap every 4 m must be applied between discharge U-trap and upper U-trap where the condenser is above the compressor unit.

We also recommend installing one check valve on the discharge line to the condenser next to the condenser to avoid the possibility of having the discharge tube full of liquid during off cycles; discharge lines flooded by liquid which may create start-up issues by drive over-torque or HP switch trip.

**Figure 16: Discharge lines**




| | |
|---|---|
| **1** | Condenser |
| **2** | Upper loop |
| **3** | U Trap |
| **4** | 3D flexibility |

# Electrical connections

VZH028/035/044 scroll compressors are designed to operate without any assistance.

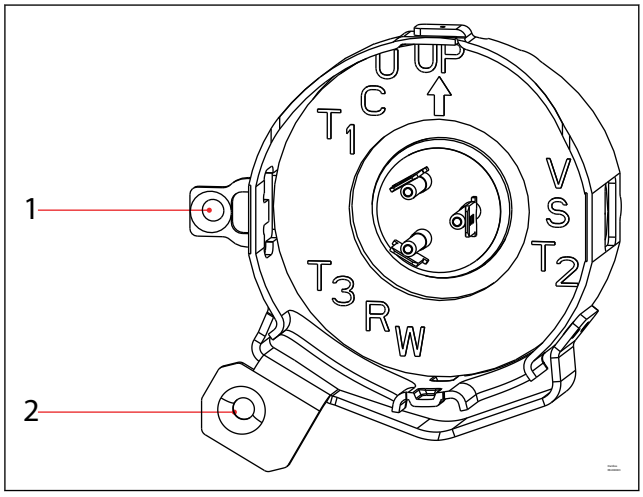
## Wiring connections

VZH scroll compressors will only compress gas while rotating counter-clockwise (when viewed from the top of the compressor).

The drawing shows electrical terminal labeling and should be used as a reference when wiring the compressor.

U, V & W of the drive and the compressor must be connected accordingly.

For use of EMC bracket with shielded cable, it is recommended to have a thread cutting screw (#10-32) having a torque of 3NM.




| | |
|---|---|
| **1** | Earth grounding |
| **2** | EMC bracket to terminations of shielded wire |

### Motor protection

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

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

## Electrical Specifications

### IP rating

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

| Element | Numerals or letters | Meaning for the protection of equipment |
|---|---|---|
| First characteristic numeral<br>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 |

| Element | Numerals or letters | Meaning for the protection of equipment |
|---|---|---|
| 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 |

## Voltage imbalance

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

Mains imbalance function in CDS frequency converter can be set to “[0] Trip” or “[1] Warning” in 14.12 parameter. It is, by default, factory preset to “[1] Warning”.

Then the compressor electrical motor is never affected by main voltage imbalance situations which are made completely transparent by the frequency converter.

## Compressor three phase electrical characteristics

| Compressor rated voltage (V) | Model | RW(Ω) at 20°C line to line | MOC | MRC |
|---|---|---|---|---|
| 414v max. | VZH044CG | 0.708±7% | 15.5 | 22.1 |
| | VZH035CG | | 12.4 | 15.1 |
| | VZH028CG | | 10.3 | 11.2 |
| 210 V max. | VZH044CJ | 0.185±7% | 33.3 | 41 |
| | VZH035CJ | | 26.6 | 28.3 |
| | VZH028CJ | | 22 | 21 |
| 414v max. | VZH044CH | 0.708±7% | 15.5 | 20.9 |
| | VZH035CH | | 12.4 | 20.9 |
| | VZH028CH | | 10.3 | 10.4 |

| | |
|---|---|
| **RW** | Winding resistance per winding, measured at motor terminals |

**MOC (Max Operating Current)**

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

MOC is tested at max. load condition with nominal voltage.

MOC is printed on the nameplate, it can be used to select cable and contactor for customer by adding some safety coefficient.

**MRC (Maximum current of the drive in normal or abnormal condition)**

MRC value is in conformity with the following standard(s) or other normative document(s), provided that the product is used in accordance with our instructions.

CSA C22.2 No. 60335-2-34 Household and similar electrical appliances - Safety - Part 2-34: Particular requirements for motor-compressors, Edition 2, Issue Date 11/2017 UL 60335-2-34 HOUSEHOLD AND SIMILAR ELECTRICAL APPLIANCES - SAFETY - PART 2-34: PARTICULAR REQUIREMENTS FOR MOTOR-COMPRESSORS, Edition 6, Issue Date 11/03/2017

CAN/CSA-C22.2 No. 60335-1 Household and Similar Electrical Appliances - Safety - Part 1: General Requirements, Edition 2, Issue Date 10/2016 UL 60335-1 SAFETY OF HOUSEHOLD AND SIMILAR APPLIANCES, PART 1: GENERAL REQUIREMENTS, Edition 6, Issue Date 10/31/2016

## Phase sequence and reverse rotation protection

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

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

If compressor and drive U, V & W terminals are not matching, the compressor can operate in a reverse rotation. This results in excessive noise, no pressure differential between suction and discharge, and suction line warming rather than immediate cooling. The compressor can be rapidly damaged in these conditions. To protect compressors from reverse rotation, one of below actions is required:

- Use pressure sensors to monitor pressure difference between discharge and suction of the compressor, and for normal operation, discharge pressure should be at least 1 bar higher than suction pressure within 30 s running after compressor starting.

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

## Anti-reverse protection

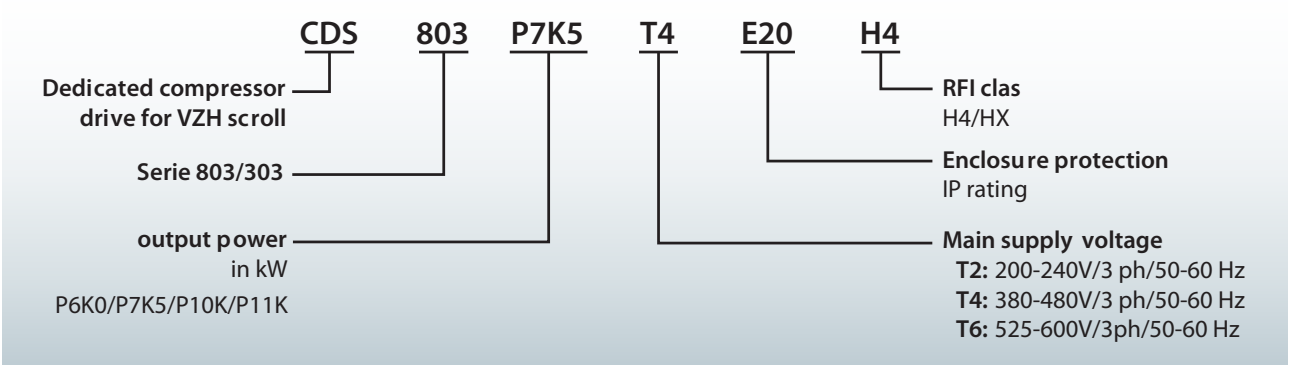
In some cases when compressors stop under low mass flow low speed condition, discharge valve may not seal discharge port fast enough, thus compressors may run in a reverse rotation due to the residual pressure difference and generate a big noise. Running in the wrong direction will reduce the reliability and lifetime of the compressor. The drive shall prevent the compressors scroll set from running the wrong way during stop with anti reverse protection.

To activate the function, the customer must be able to enable and disable the ANTI-REVERSE PROTECTION.

# Frequency converter

## Product identification

### Frequency converter nomenclature




### VLT Compressor Drives literatures

VLT Compressor Drives User's Manual (FRCC.ES.017.A1.02) introduces different VLT Compressor Drives literatures: Operating instructions, MCT 10 set-up, Modbus RTU instructions, VLT drawings, etc.

## Technical specification

### Frequency converter specifications

| Functions | Specifications | |
|---|---|---|
| Mains supply voltage | CDS803-T2: 200 - 240 V +/-10% (3-phase) | |
| | CDS803-T4: 380 - 480 V +/-10% (3-phase) | |
| | CDS303-T6: 525 - 600V +/-10% (3-phase) | |
| Supply frequency | 50 / 60 Hz | |
| Output voltage | 0 - 100 % of supply voltage | |
| Standby power | T2: P6K0/P7K5: 23.17W | P10K: 26.23W |
| | T4: P6K0/P7K5: 11.3W | P10K: 25.5W |
| | T6: P7K5: 17W | P11K: 29kW |
| Inputs | CDS803: 4 digital (0 - 24 V), 2 analog (0 /±10 V or 4 - 20 mA, scalable) | |
| | CDS303: 6 digital (0-24V), 2 analog (0/+-10V or 4-20mA, scalable) | |
| Programmable outputs | CDS803: 2 digital (0- 24 V), 2 analog (0-24 V), 2 relay | |
| | CDS303: 2 digital(0-24V), 1 analogue(0-24V), 2 relay | |
| Protection functions | Over-current protection, low / high current handling | |
| Compressor functions | Pressostat / thermostat function (CDS303 only), short cycle protection, oil return management | |

### Frequency converter variants

Different frequency converter variants are available according to:

1. Mains supply voltage:
   - 380-480V/3ph/50-60Hz
   - 200-240V/3ph/50-60Hz
   - 525-600V/3ph/50-60Hz
2. IP class CDS803 and CDS303 are available in IP20 housings
3. RFI (Radio Frequency Interference) class H4 for CDS803 and HX(no filter) for CDS303
4. Printed Circuit Board (PCB) coated for CDS803 and not coated for CDS303

## Compressor and frequency converter combinations

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

**NOTE:**
This compressor is equipped with a four-pole electrical motor so the applied frequency from the inverter will be 30 Hz for 15 rps (900 rpm) up to 200 Hz for 100 rps (6000 rpm).

Please refer to the table below:

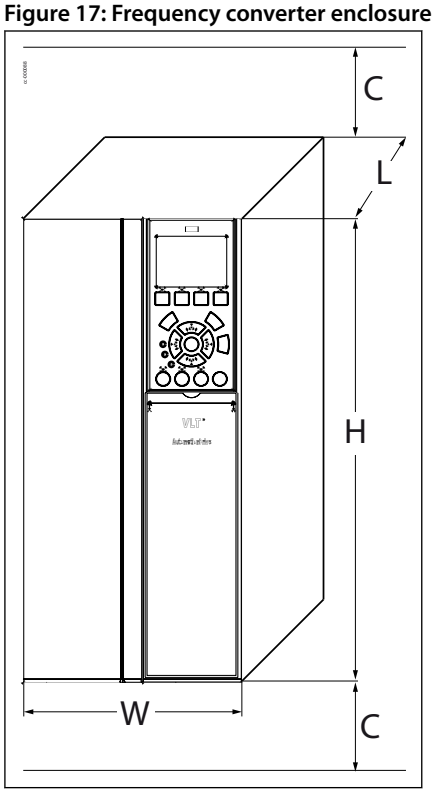
| | Unit | Min. | Max. |
|---|---|---|---|
| Compressor speed | rps | 15 | 100 |
| | rpm | 900 | 6000 |
| Drive output frequency | Hz | 30 | 200 |

# Dimensions

## Frequency converter dimensions

Frequency converter dimensions depend on supply voltage, IP rating and power. The table below gives an overview of the overall dimensions and different drive enclosures (H3, H4). Details for each drive enclosure are on the following pages.

**Figure 17: Frequency converter enclosure dimensions**




| | |
|---|---|
| C | Min. 100 Clearance above for cooling |

**Table 6: Frequency converter enclosure dimensions IP20**

| Drive supply voltage | Drive power kW | Compressor voltage code | Compressor model | IP20 | | | |
|---|---|---|---|---|---|---|---|
| | | | | Drive enclosure | Overall drive size [H x W x L] mm (inch) | Overall drive size (H x W x L) mm incl. decoupling plate | Clearance above/ below |
| T2: 200-240/3/50-60 | 6 | J | VZH028 | H4 | 296x135x241 | 359x135x241 | 100/4 |
| | 7.5 | | VZH035 | H4 | 296x135x241 | 359x135x241 | 100/4 |
| | 10 | | VZH044 | H5 | 334x150x255 | 402x150x255 | 100/4 |

| Drive supply voltage | Drive power kW | Compressor voltage code | Compressor model | IP20 | | | |
|---|---|---|---|---|---|---|---|
| | | | | Drive enclosure | Overall drive size [H x W x L] mm (inch) | Overall drive size (H x W x L) mm incl. decoupling plate | Clearance above/ below |
| T4: 380-480/3/50-60 | 6 | G | VZH028 | H3 | 255x100x206 | 329x100x206 | 100/4 |
| | 7.5 | | VZH035 | H3 | 255x100x206 | 329x100x206 | 100/4 |
| | 10 | | VZH044 | H4 | 296x135x241 | 359x135x241 | 100/4 |
| T6: 525-600/3/50-60 | 7.5 | H | VZH028 | A3 | 268x130x205 | 374x130x205 | 100/4 |
| | 11 | | VZH035 | B3 | 399x165x249 | 420x165x249 | 100/4 |
| | 11 | | VZH044 | B3 | 399x165x249 | 420x165x249 | 100/4 |

## CDS803 frequency converter

**Figure 18: Drive outline dimensions**

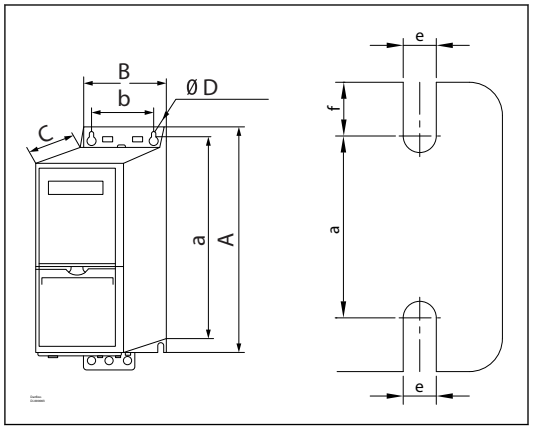



**Figure 19: Decoupling Plate**

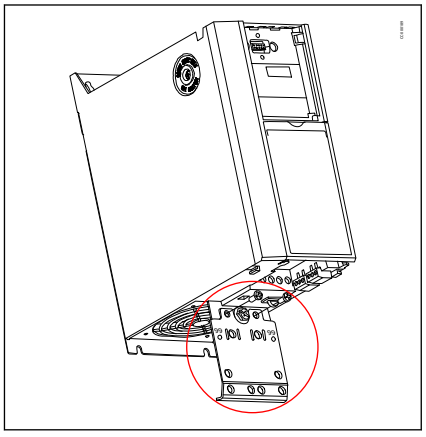


**Table 7: Drive outline dimensions**

| Enclosure | | Height (mm) | | | Width (mm) | | Depth (mm) | Mounting hole (mm) | | | Max. Weight |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Frame | IP Class | A | A[1] | a | B | b | C | d | e | f | kg |
| H3 | IP20 | 255 | 329 | 240 | 100 | 74 | 206 | 11 | 5.5 | 8.1 | 4.5 |
| H4 | IP20 | 296 | 359 | 275 | 135 | 105 | 241 | 12.6 | 7 | 8.4 | 7.9 |
| H5 | IP20 | 334 | 402 | 314 | 150 | 120 | 255 | 12.6 | 7 | 8.5 | 9.5 |

[1] Including decoupling plate

**NOTE:**

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

## CDS303 frequency converter

**Figure 20: Drive outline dimensions**

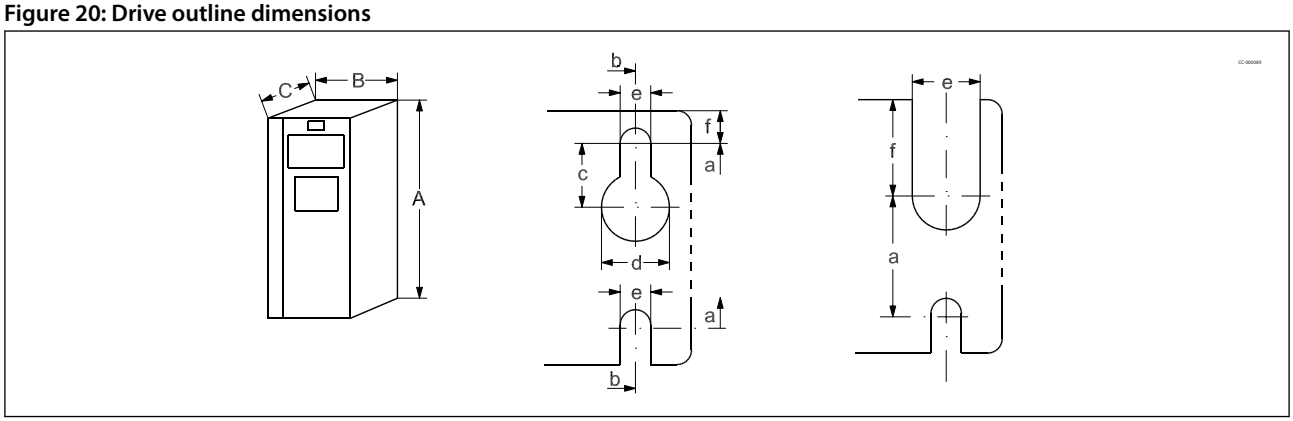


**Table 8: Drive outline dimensions**

| Enclosure | | Height (mm) | | | Width (mm) | | Depth (mm) | Mounting hole (mm) | | | Max. Weight |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Frame | IP Class | A | A[1] | a | B | b | C | d | e | f | kg |
| A3 | IP20 | 268 | 374 | 257 | 130 | 110 | 205 | 11 | 5.5 | 9 | 6.6 |
| B3 | IP20 | 399 | 420 | 380 | 165 | 140 | 249 | 12 | 6.8 | 7.9 | 12 |

[1] Including decoupling plate

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

## Electrical connections

### Wire sizes

Below table lists recommended wiring sizes for the motor compressor power supply cables. These wiring sizes are valid for a cable length up to 20m.

| Voltage range | From network to frequency converter | | | From frequency converter to compressor | | |
|---|---|---|---|---|---|---|
| | Type | mm² | AWG | Type | mm² | AWG |
| 200 - 240 V | CDS803-6kW(IP20) | 6 | 10 | VZH028-J | 6 | 10 |
| | CDS803-7.5kW(IP20) | 6 | 10 | VZH035-J | 6 | 10 |
| | CDS803-10kW(IP20) | 6 | 10 | VZH044-J | 6 | 10 |
| 380 - 400 V | CDS803-6kW(IP20) | 4 | 10 | VZH028-G | 4 | 10 |
| | CDS803-7.5kW(IP20) | 4 | 10 | VZH035-G | 4 | 10 |
| | CDS803-10kW(IP20) | 4 | 10 | VZH044-G | 4 | 10 |
| 525 - 600 V | CDS303-7.5kW(IP20) | 4 | 10 | VZH028-H | 6 | 10 |
| | CDS303-11kW(IP20) | 4 | 10 | VZH035-H | 6 | 10 |
| | CDS303-11kW(IP20) | 4 | 10 | VZH044-H | 6 | 10 |

: *1.The wire size here is the guideline but not the actual cable required. The required cable size should be specified by the OEM depending on the unit design, ambient temperature, the wire material, current, etc.*

### Wiring and EMC protection

The motor compressor power supply from the CDS803/303 frequency converter to the VZH compressor must be done with a braided screened/shielded cable. This cable needs to have its screen/shielding conduit connected to earth on both ends. Avoid terminating this cable connection with twisting ends (pigtails) because that would result in an antenna phenomenon and decrease the effectiveness of the cable.

Control cables to the CDS803/303 frequency converter must use the same installation principles as the motor power supply cable.

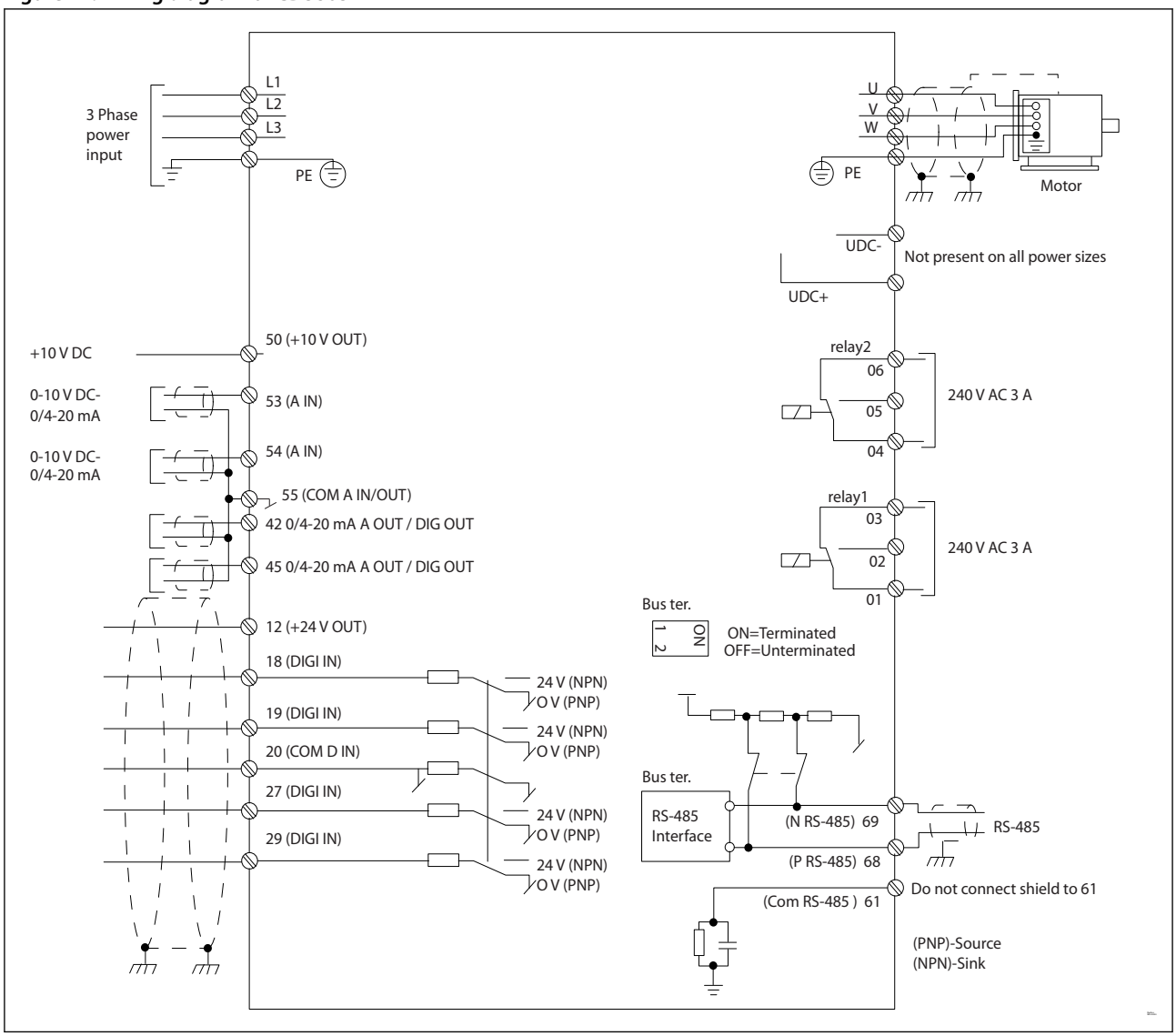
The motor compressor cable must be installed in a conduit separated from the control and mains cables.

Physical installation of the frequency converter on the mounting plate must ensure good electrical contact between the mounting plate and the metal chassis of the converter. Use star washers and galvanically conductive installation plates to secure good electrical connections. Refer to instructions MG18N202/MG34M402 for tightening torques and screw sizes.

tightening torques and screw sizes. Note that the CDS803/303 must be mounted on a plain wall to ensure a good air flow through its heat exchanger.

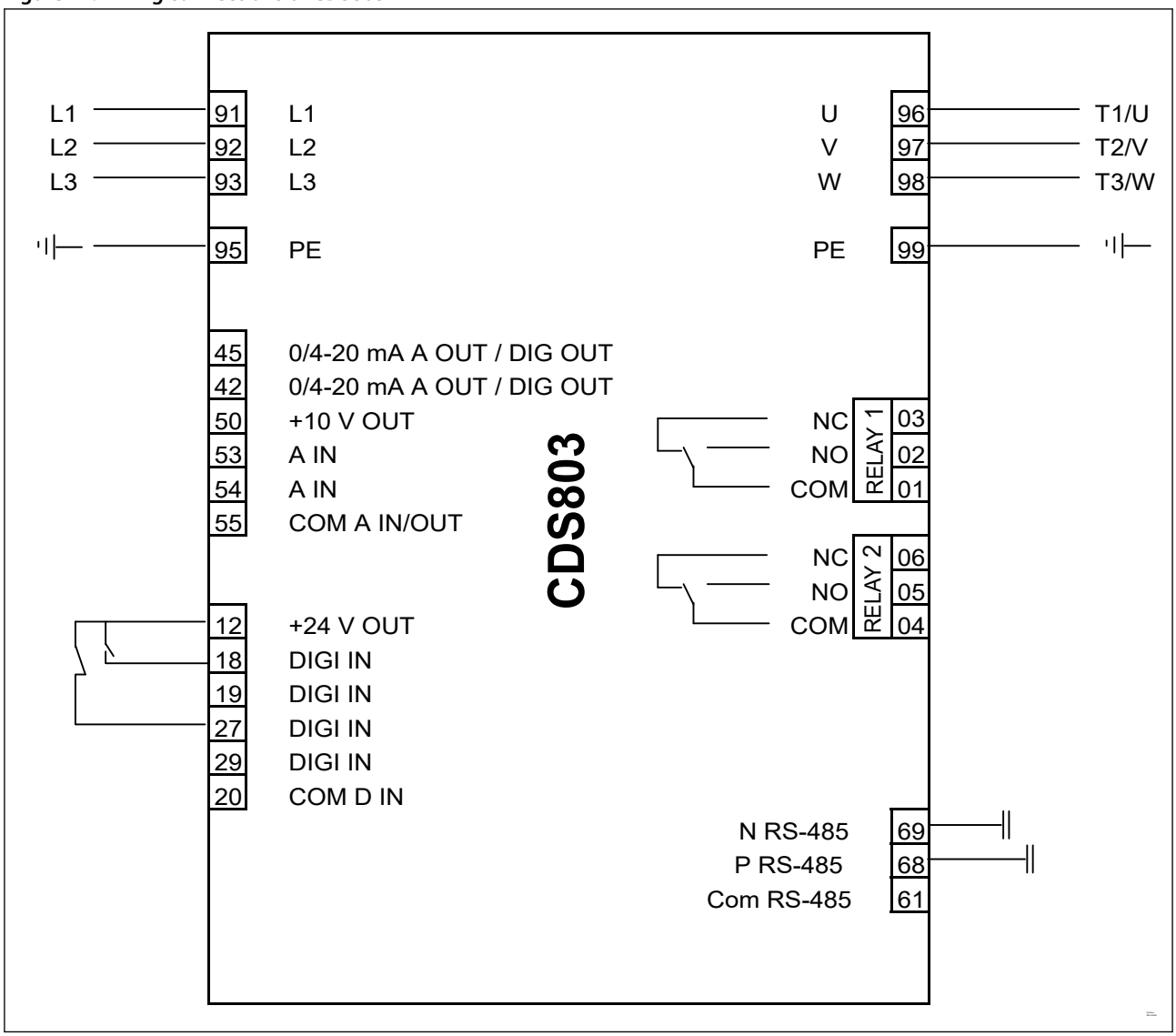
## Wiring diagram of CDS803

**Figure 21: Wiring diagram of CDS803**



## Wiring connections of CDS803

**Figure 22: Wiring connections of CDS803**




| | |
|---|---|
| **A** | Analog |
| **DIGI** | Digital |
| **IN** | Input |
| **OUT** | Output |
| **COM** | Common |
| **NC** | Normally-closed |
| **NO** | Normally-open |

The CDS803 frequency converter is factory preset with parameters for the open loop control principle. The process loop control principle can be selected by changing parameters in the “Quick menu.”

Open loop: preset on input 53

0 - 10 V control Frequency converter in slave mode

Process loop: preset on input 54

4 - 20 mA control

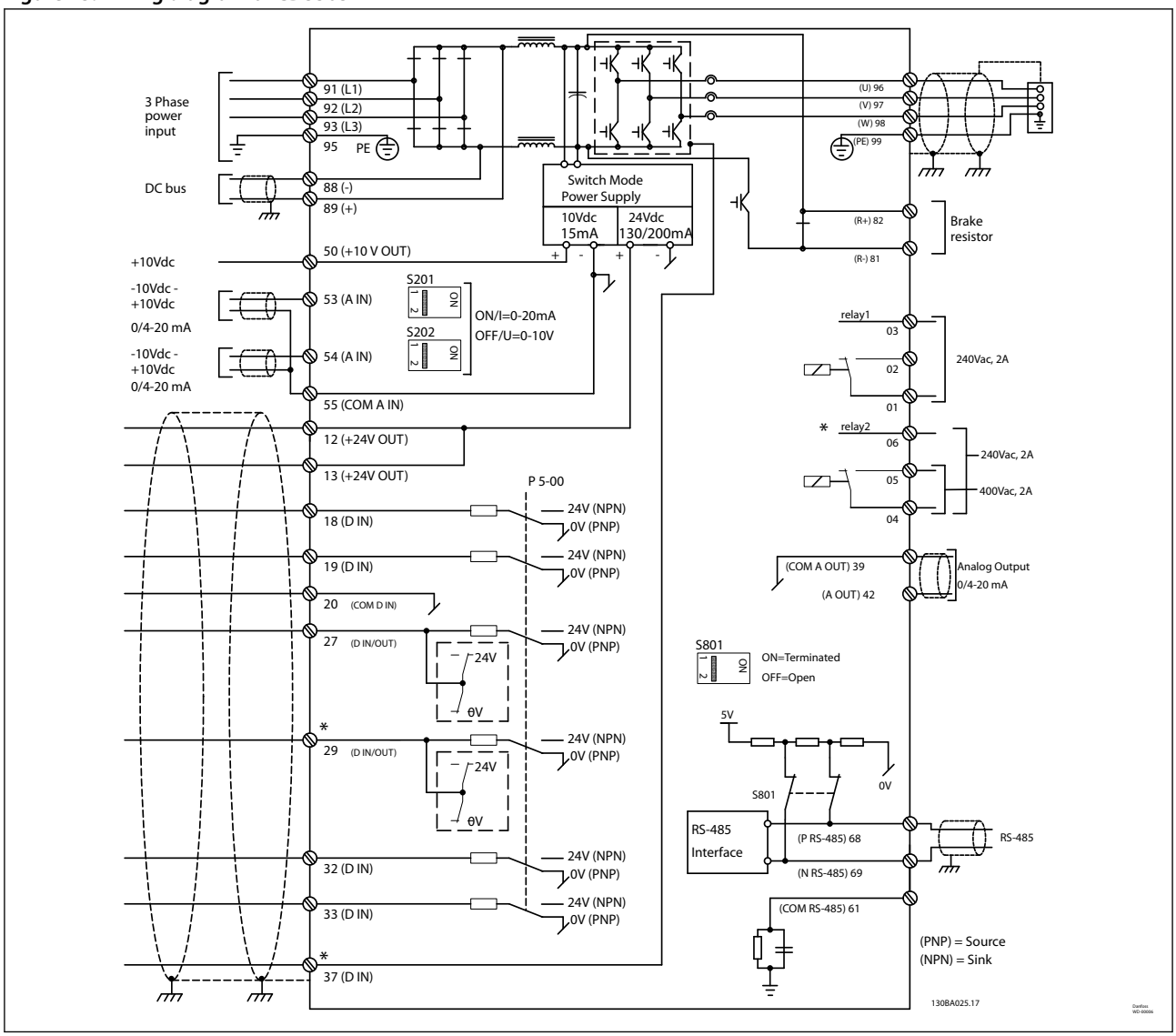
Frequency converter under own PID controller

| | | Open loop | Process loop |
|---|---|---|---|
| 91,92,93 | 3 phases mains input | X | X |
| 95 | Earth | X | X |
| 42,45 | 0/4-20 mA Analogue Output or Digital Output | - | - |
| 50 | +10V DC Output | - | - |
| 53 | 0-10V or 4-20mA Analogue Input | X | - |
| 54 | 0-10V or 4-20mA Analogue Input | - | X |
| 55 | Com Analogue In/Out | X | - |
| 12 | +24V output | - | - |
| 18 | External On/Off(NO) | X | X |
| 19 | Digital Input | - | - |
| 27 | Safety Device e.g.: HP/LP switch | X | X |
| 29 | Digital Input | - | - |
| 20 | Com Digital Input | - | - |
| 98 | To Compressor T3 | X | X |
| 97 | To Compressor T2 | X | X |
| 96 | To Compressor T1 | X | X |
| 99 | Earth | X | X |
| 03,02,01 | Relay 1 | - | - |
| 06,05,04 | Relay 2 | - | - |
| 69,68 | RS485 Bus | - | - |
| 61 | RS485 Bus Com | - | - |

| | |
|---|---|
| - | Optional connection |
| X | Mandatory connection |

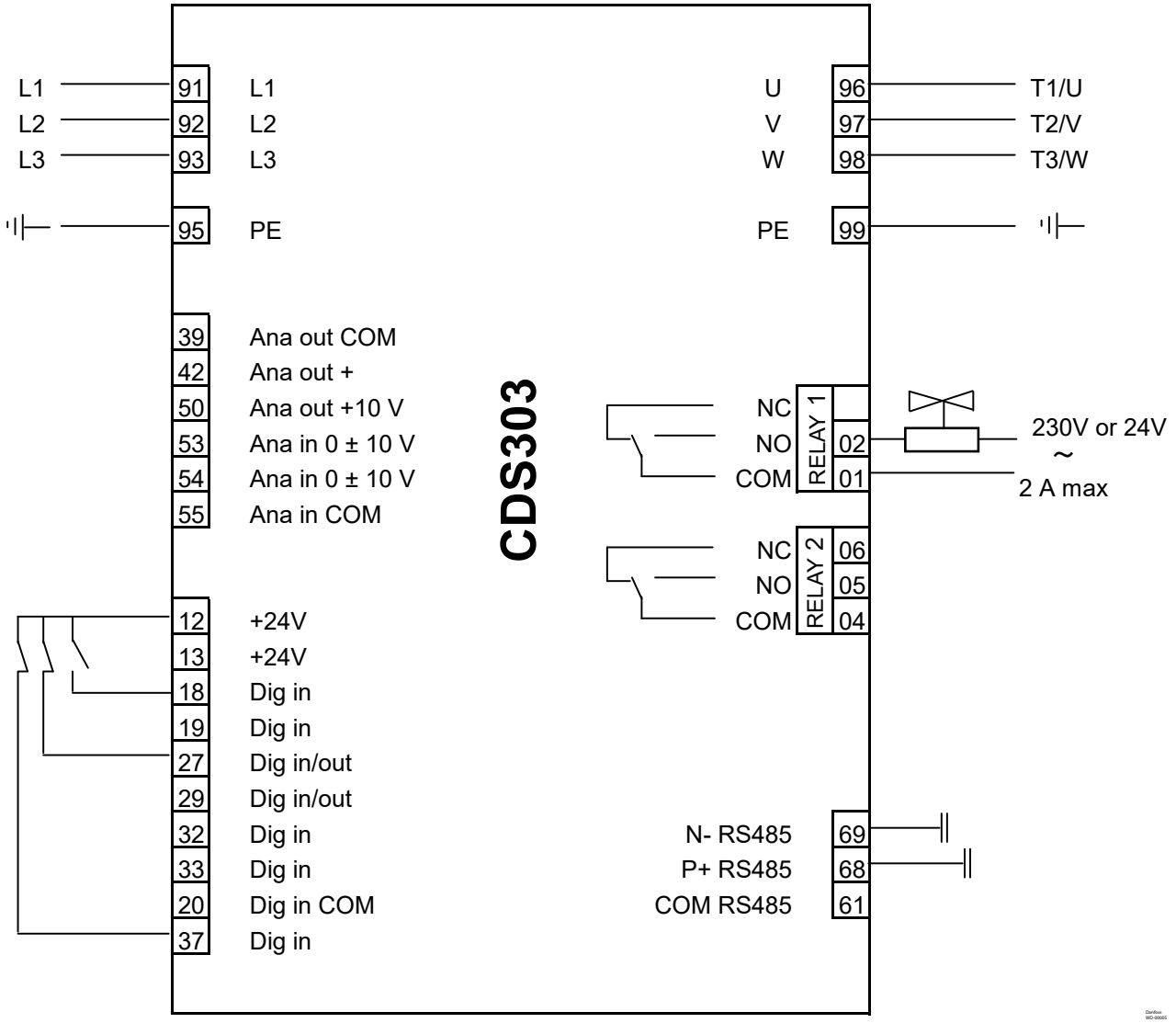
## Wiring diagram of CDS303

**Figure 23: Wiring diagram of CDS303**



## Wiring connections of CDS303

**Figure 24: Wiring connections of CDS303**




| | |
|---|---|
| **A** | Analog |
| **DIGI** | Digital |
| **IN** | Input |
| **OUT** | Output |
| **COM** | Common |
| **NC** | Normally-closed |
| **NO** | Normally-open |

The CDS303 frequency converter is factory preset with parameters for the open loop control principle. The process loop control principle can be selected by changing parameters in the "Quick menu".

Open loop: preset on input 53

0 - 10 V control

Frequency converter in slave mode

Process loop: preset on input 54

4 - 20 mA control

Frequency converter under own PID controller

T37 is CE and UL approved for STO, Safety Torque Function

| | | Open loop | Process loop |
|---|---|---|---|
| 91, 92, 93 | 3 Phase mains input | X | X |
| 95 | Earth | X | X |
| 39, 42 | Analogue output | - | - |
| 50 | Analogue output | - | - |
| 53 | PLC+ (0 to 10 V) | X | - |
| 54 | Sensor - | - | X |
| 55 | PLC- | X | - |
| 12 | HP/LP switch | X | X |
| 12 | External On/Off (NO) | X | X |
| 13 | Factory bridged to 37 | X | X |
| 13 | Sensor + | - | X |
| 18 | External On/Off (NO) | X | X |
| 19 | Digital input | - | - |
| 27 | LP switch (NC) / safety devices | X | X |
| 29 | Digital input/output | - | - |
| 32, 33 | Digital input | - | - |
| 20 | Digital input Common | - | - |
| 37 | Factory bridged to 13 / HP switch | X | X |
| 98 | To compressor terminal T3 | X | X |
| 97 | To compressor terminal T2 | X | X |
| 96 | To compressor terminal T1 | X | X |
| 99 | To compressor earth connection | X | X |
| 02, 01 | Relay 1 to oil solenoid valve | X | X |
| 06, 05, 04 | Relay 2 | - | - |
| 69, 68 | RS485 Bus | - | - |
| 61 | RS485 Bus Common | - | - |

| | |
|---|---|
| - | Optional connection |
| X | Mandatory connection |

## Electrical Specifications

### Supply voltage

Because VZH compressors are powered by a frequency converter, the mains frequency, 50 or 60 Hz, is no longer an issue. Only the mains voltage is to be taken into account. With 3 motor voltage codes, the most common mains voltages and frequencies are covered.

**Table 9: Mains voltage range of drive**

| Voltage code | Mains voltage range of drive |
|---|---|
| J | 200-240 V / 3 ph / 50 Hz & 200-240 V / 3 ph / 60 Hz (±10%) |
| G | 380-480 V / 3 ph / 50 Hz & 380-480 V / 3 ph / 60 Hz (±10%) |
| H | 525-600 V / 3ph / 50Hz & 525-600 V /3ph / 60Hz (±10%) |

⚠ Never connect the VZH compressor directly to the mains power supply in case of frequency converter defect.

### Fuses / Circuit breakers

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

For circuit breakers, Moeller types have been tested and are recommended. Other types of circuit breakers may be used provided they limit the energy to a level equal to or lower than the Moeller types.

**Table 10: Fuses - CDS803**

| CDS 803 | UL Compliant fuses | | | | | Recommended circuit breaker |
|---|---|---|---|---|---|---|
| | UL | | | | Non UL | IP20 |
| | Bussmann | Bussmann | Bussmann | Bussmann | Max fuse | |
| | Type RK5 | Type RK1 | Type J | Type T | Type G | Moeller type |
| 3x200-240 V IP20 | | | | | | |
| 4 TR/VZH028 | FRS-R-50 | KTN-R50 | JKS-50 | JJN-50 | 50 | PKZM4-50 |
| 5 TR/VZH035 | FRS-R-50 | KTN-R50 | JKS-50 | JJN-50 | 50 | PKZM4-50 |
| 6.5 TR/VZH044 | FRS-R-60 | KTN-R60 | JKS-60 | JJN-60 | 60 | PKZM4-63 |
| 3x380-480 V IP20 | | | | | | |
| 4 TR/VZH028 | FRS-R-25 | KTS-R25 | JKS-25 | JJS-25 | 25 | PKZM4-25 |
| 5 TR/VZH035 | FRS-R-25 | KTS-R25 | JKS-25 | JJS-25 | 25 | PKZM4-25 |
| 6.5 TR/VZH044 | FRS-R-30 | KTS-R30 | JKS-30 | JJS-30 | 30 | PKZM4-36 |

**Table 11: Fuses - CDS303**

| CDS 303 | | EN50178 Compliant fuses | | UL Compliant fuses | | | | | | Recommended circuit breaker |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Bussmann | | | SIBA | Little fuse | | |
| | | Size | Type | Type RK1 | Type J | Type T | Type RK1 | Type RK1 | Type RK1 | Moeller type |
| 525-600V | CDS303-7.5kW | 20A | gG | KTS-R20 | JKS-20 | JJS-20 | 5017906-020 | KLSR020 | A6K-20R | PKZM4-50 |
| | CDS303-11kW | 30A | gG | KTS-R30 | JKS-30 | JJS-30 | 5017906-030 | KLSR030 | A6K-30R | PKZM4-50 |

**Soft-start control**

The CDS803/303 frequency converter generates by design a compressor soft start with an default initial ramp up.

Current inrush will not exceed the frequency converter maximum current.

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

## Drive Installation

Each compressor is shipped with printed instructions for installation. These instructions can also be downloaded from:

http://instructions.cc.danfoss.com

### High voltage test

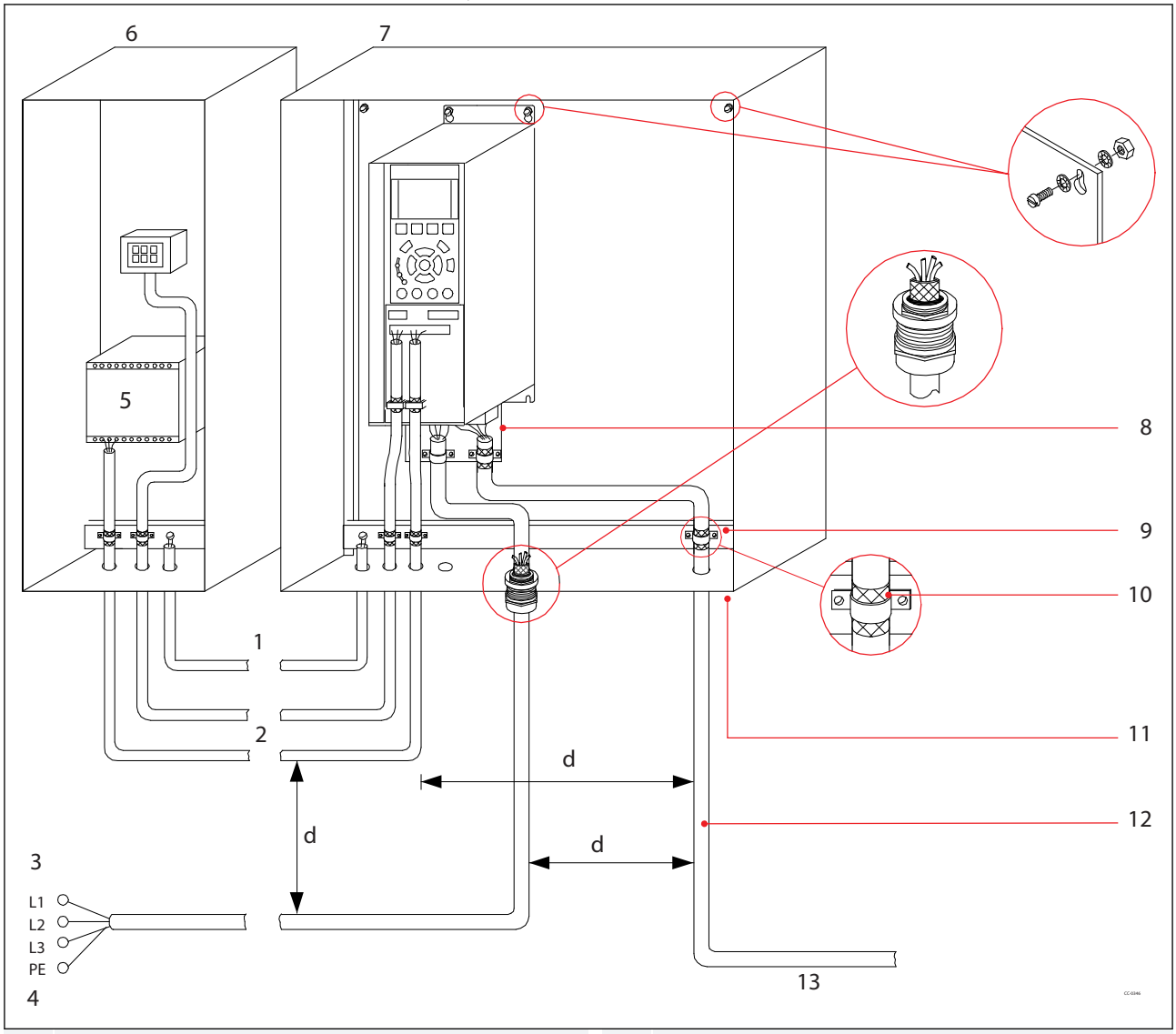
Carry out a high voltage test by short-circuiting terminals U, V, W, L1, L2 and L3. Energize by max. 1920 V DC for code G compressors and 1460V DC for code J compressors for one second between this short-circuit and the chassis. When running high voltage tests of the entire installation, frequency converter and compressor electrical motor compressor test can be conducted together. When conducting a high voltage test make sure the system is not under vacuum: this may cause electrical motor compressor failure. Please note, it is note recommended that a high voltage test be carried out too often as it may damage the motor.

### Temperature protection

If the temperature in the drive is too high, an alarm (CDS803/303: Alarm 69, Pwr. Card Temp) will be seen to trip the drive. When the drive shows this alarm, it's suggested that OEM controller has to be programmed based on the reading of the heatsink temperature received from the drive to lower the load to avoid a trip-lock. Contact Danfoss for more details.

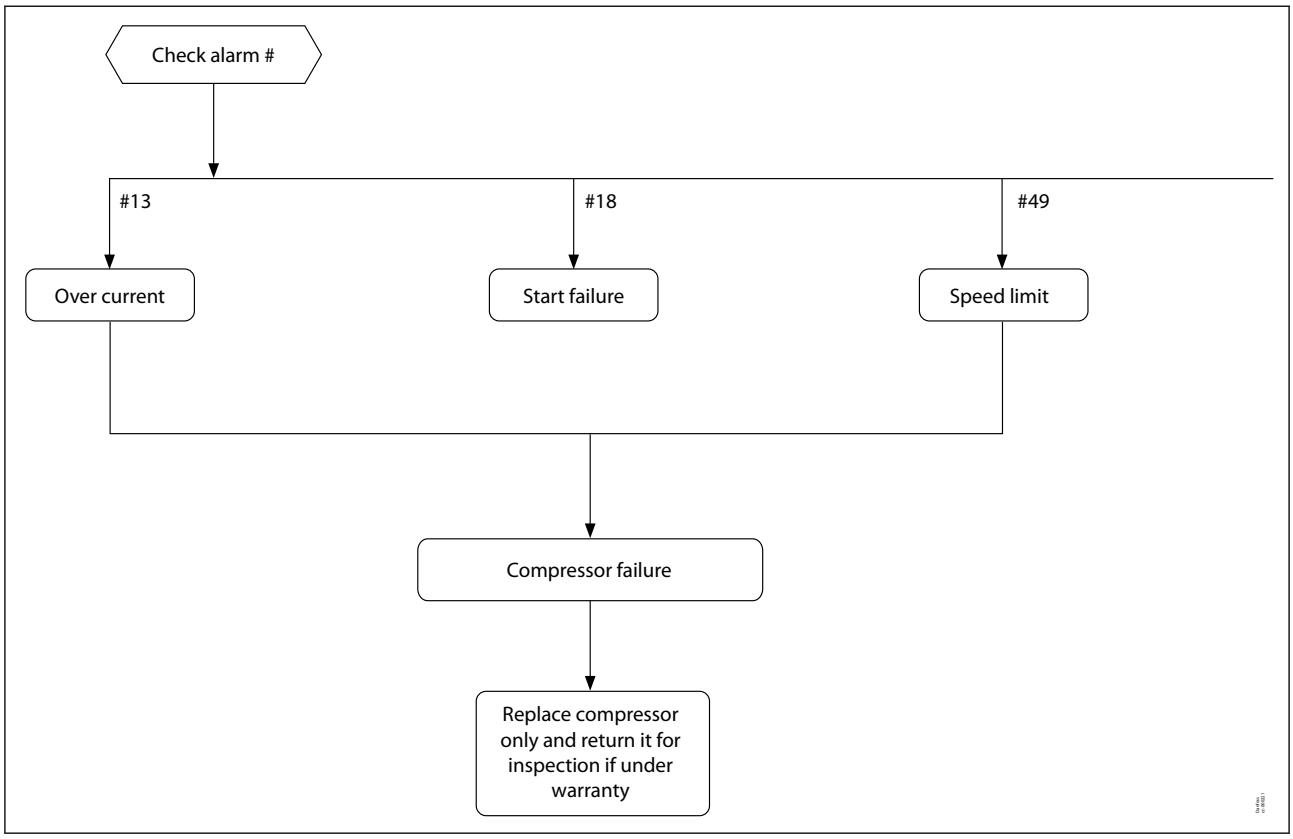
## EMC correct installation of an IP20 frequency drive CDS803/303

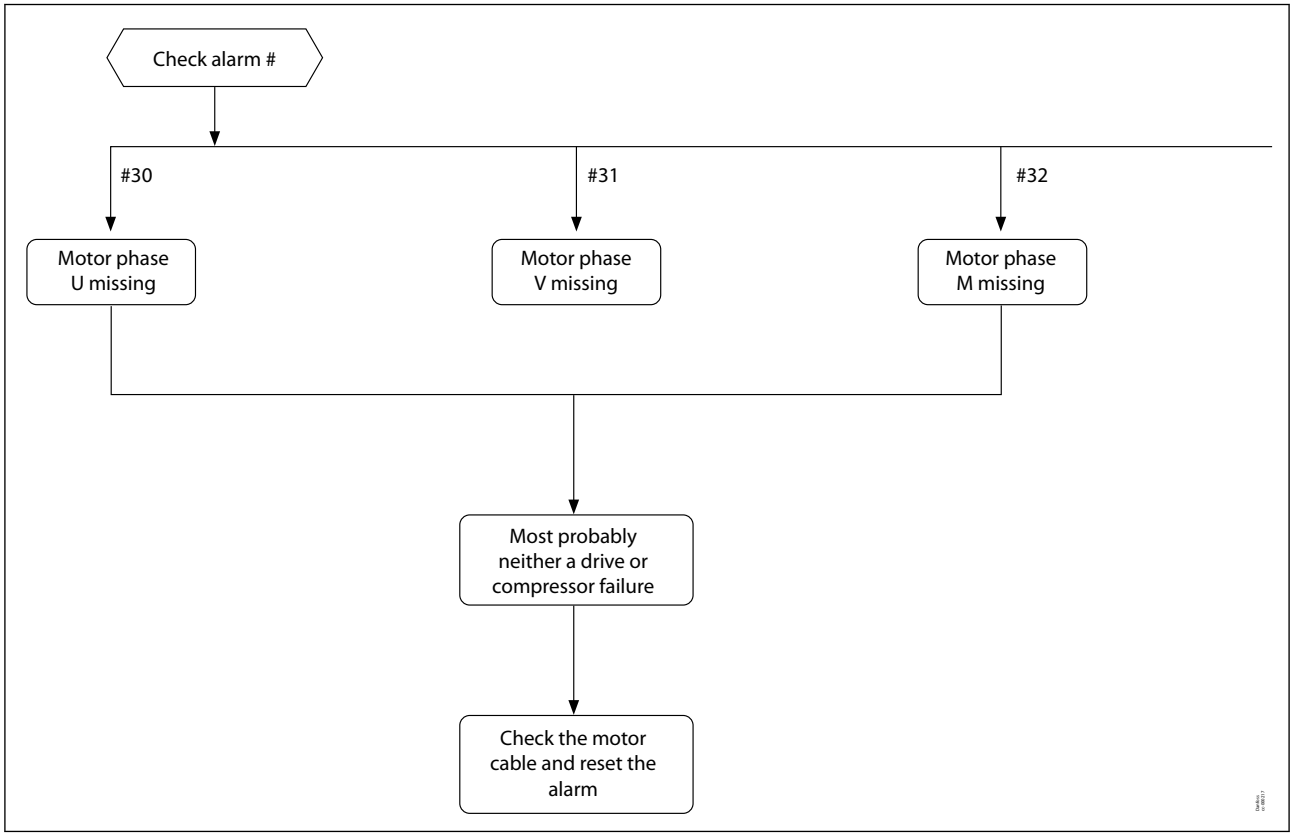
**Figure 25: EMC correct installation of an frequency drive CDS803/303**

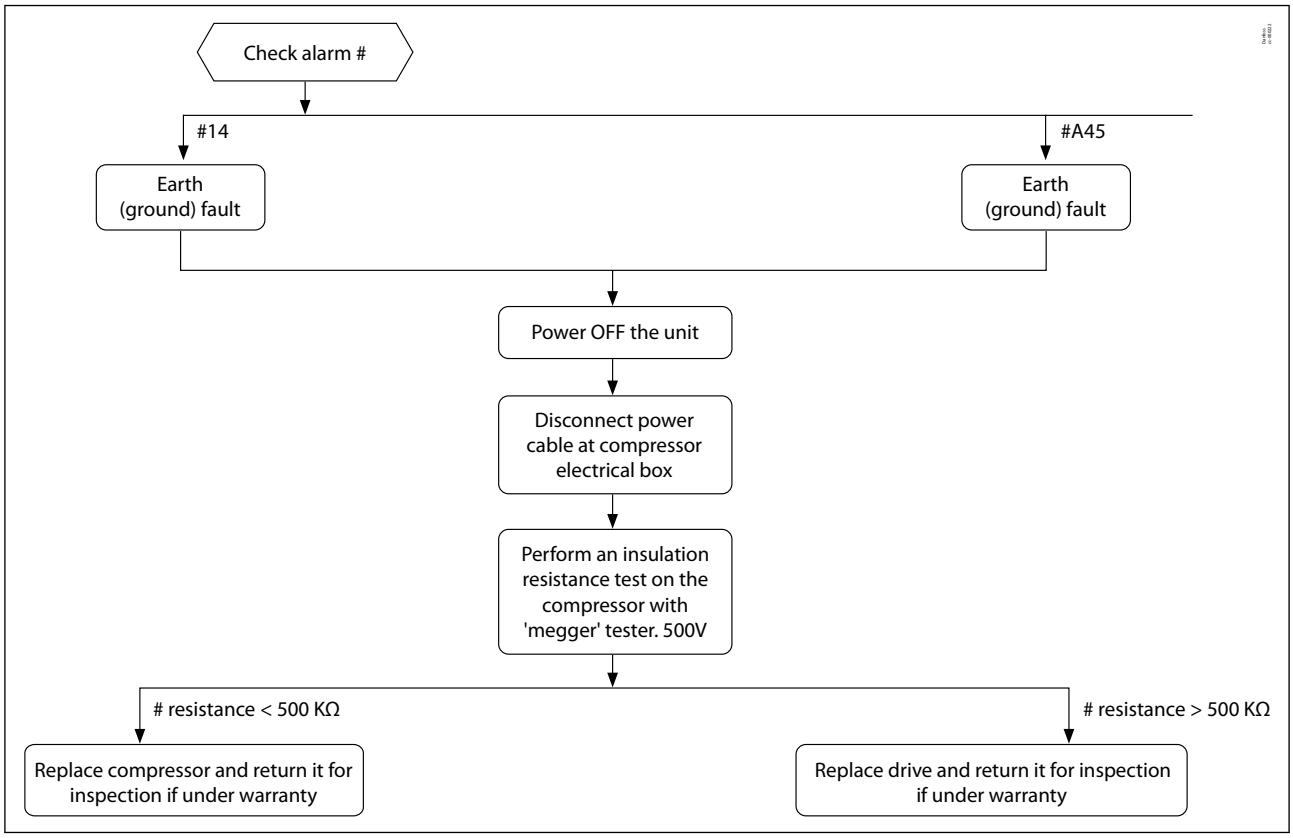


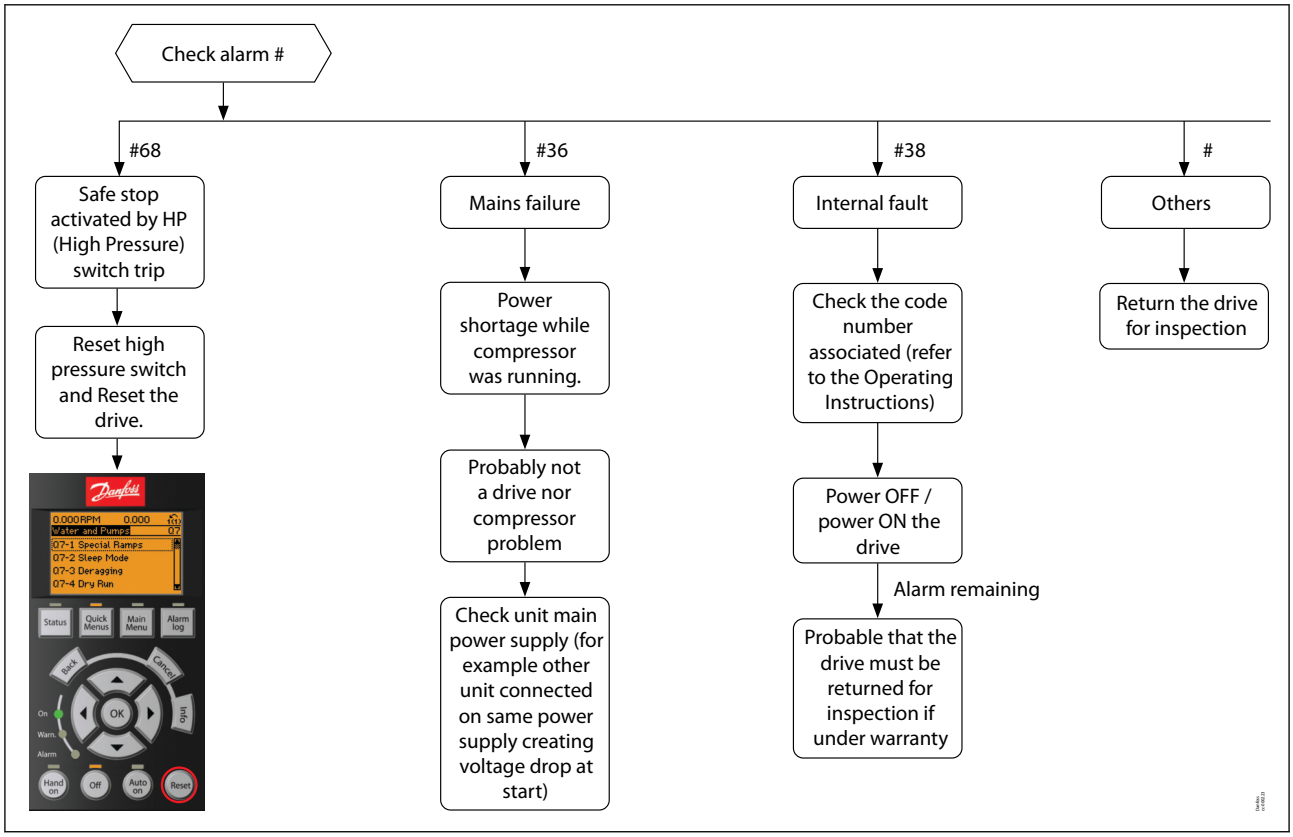

| | | | |
|---|---|---|---|
| **1** | Min. 0.025 in² (16 mm²) Equalizing cable | **8** | Decoupling plate |
| **2** | Control cables | **9** | Grounding rail |
| **3** | Mains supply | **10** | Cable insulation stripped |
| **4** | Reinforced protective ground | **11** | All cable entries in one side of panel |
| **5** | PLC | **12** | Motor cable |
| **6** | PLC etc. | **13** | Motor, 3 phases and protective ground |
| **7** | Panel | **d** | Min. 7.9 in (200 mm) between control cables, motor cable and mains cable |

## Troubleshooting




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


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

## Compressor and drive control

### Compressor start and stop, speed control

R Speed limit guarantees compressor reliability and must be respected. In drive control logic, default setting values have been qualified by Danfoss. It is not recommended to change default values.

**Figure 26: CDS803 Start/Stop/Ramp setting**

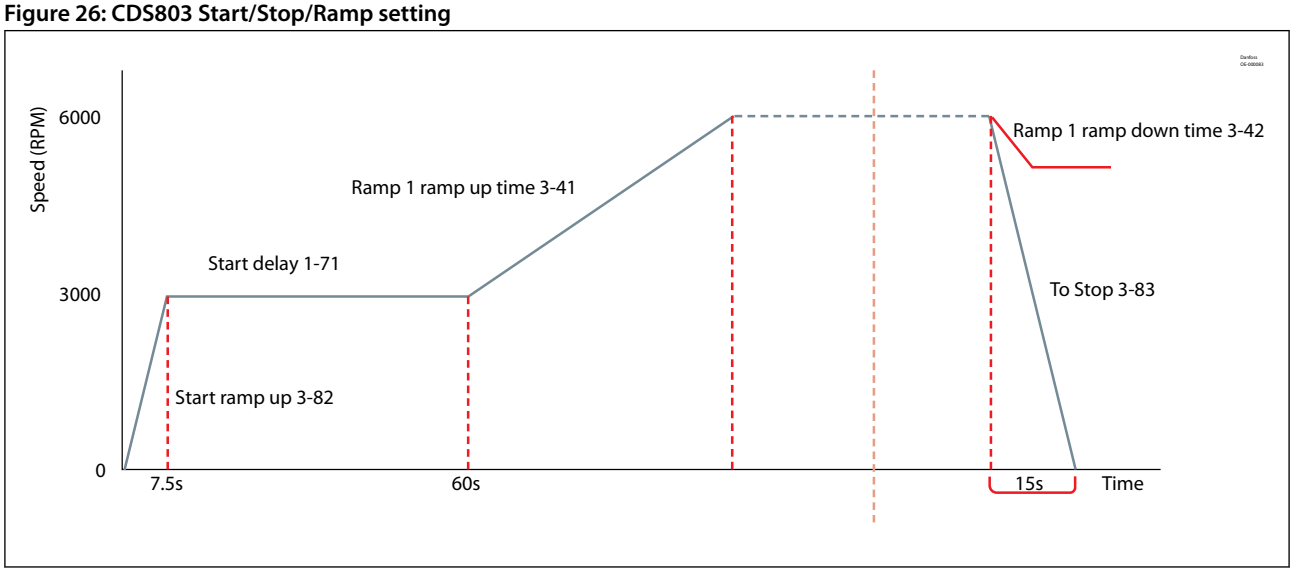



**Table 12: CDS803 Start/Stop/Ramp setting**

| Drive parameters | | Description | Default value (recommended) |
|---|---|---|---|
| 1.71 | Start delay (s) | keep running @ 3000 RPM within a certain duration | 60s |
| 3.41 | Ramp 1 ramp up time (s) | It is used to define speed ramp up slope. Speed ramp up slope is defined under condition that increases compressor speed from 0 rpm to 6000 rpm in a certain period(s, ramp1 ramp up time) Eg: if current speed is 3000rpm and desired speed is 4000rpm, then compressor will reach 4000 rpm in 15s | 90s |
| 3.42 | Ramp 1 ramp down time (s) | It is used to define speed ramp down slope. Speed ramp down slope is defined under condition that decreases compressor speed from 6000 rpm to 0rpm in a certain period (s, ramp1 ramp down time) Eg: if current speed is 4000rpm and desired speed is 3000rpm, then compressor will reach 3000 rpm in 5s | 30s |

**Figure 27: CDS303 Start/Stop/Ramp setting**

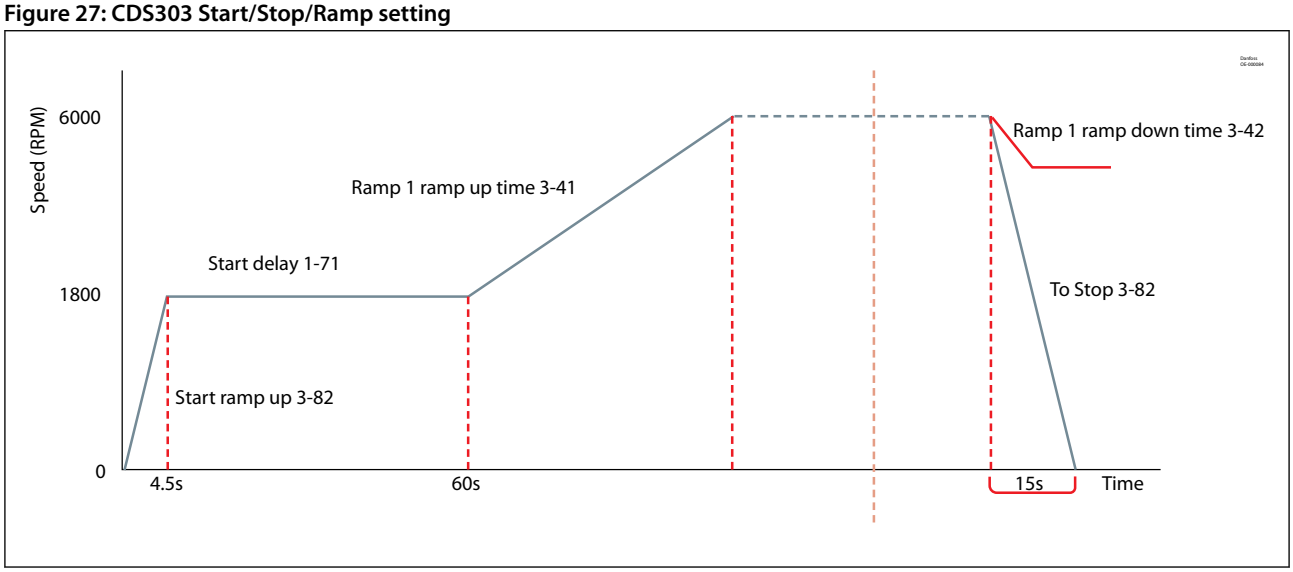


**Table 13: CDS303 Start/Stop/Ramp setting**

| Drive parameters | | Description | Default value (recommended) |
|---|---|---|---|
| 1.71 | Start delay (s) | keep running @ 1800 RPM within a certain duration | 60s |
| 3.41 | Ramp 1 ramp up time (s) | It is used to define speed ramp up slope. Speed ramp up slope is defined under condition that increases compressor speed from 0 rpm to 6000 rpm in a certain period(s, ramp1 ramp up time) Eg: if current speed is 3000rpm and desired speed is 4000rpm, then compressor will reach 4000 rpm in 30s | 180s |
| 3.42 | Ramp 1 ramp down time (s) | It is used to define speed ramp down slope. Speed ramp down slope is defined under condition that decreases compressor speed from 6000 rpm to 0rpm in a certain period (s, ramp1 ramp down time) Eg: if current speed is 4000rpm and desired speed is 3000rpm, then compressor will reach 3000 rpm in 30s | 180s |

# Application

## Manage Operating envelope

### Short cycle timer function

Short cycle control is provided directly by the CDS frequency converter, when parameter 28-00 is enabled.

The function is factory set to enabled, with minimum running time to 60 seconds and the interval between starts to 300 seconds.

Short cycle settings are accessible in the parameter 28.0x list, in the “compressor functions” menu.

If system is fully controlled by an external main controller, it is recommended to limit the start/ stop frequency to 12 times per hour.

### High pressure switch

According to EN378-2, a high-pressure (HP) safety switch is required to shut down the compressor. The high-pressure switch can be set to lower values depending on the application and ambient conditions. The HP switch must either be placed in a lockout circuit or consist of a manual reset device to prevent cycling around the high pressure limit. If a discharge valve is used, the HP switch must be connected to the service valve gauge port, which must not be isolated. The HP switch can be connected to the CDS803/303 input 27 or an external contactor which could be set before or after the drive.

Please note port 27 of CDS803/303 is not UL certificated and when connected with high pressure switch, no delay is permitted. OEM need to set port 27 to “coast reverse/coast and reset inverse” to get rid of minimum running time restriction.

If the contactor is placed between the drive and compressor, to make sure a proper start up, the contactor must be power on ahead of the drive gets fed at least 3 seconds earlier.

When the contactor acts as a high pressure switch, it has to be normally close switch. The contactor will only open when high pressure triggers or power off.

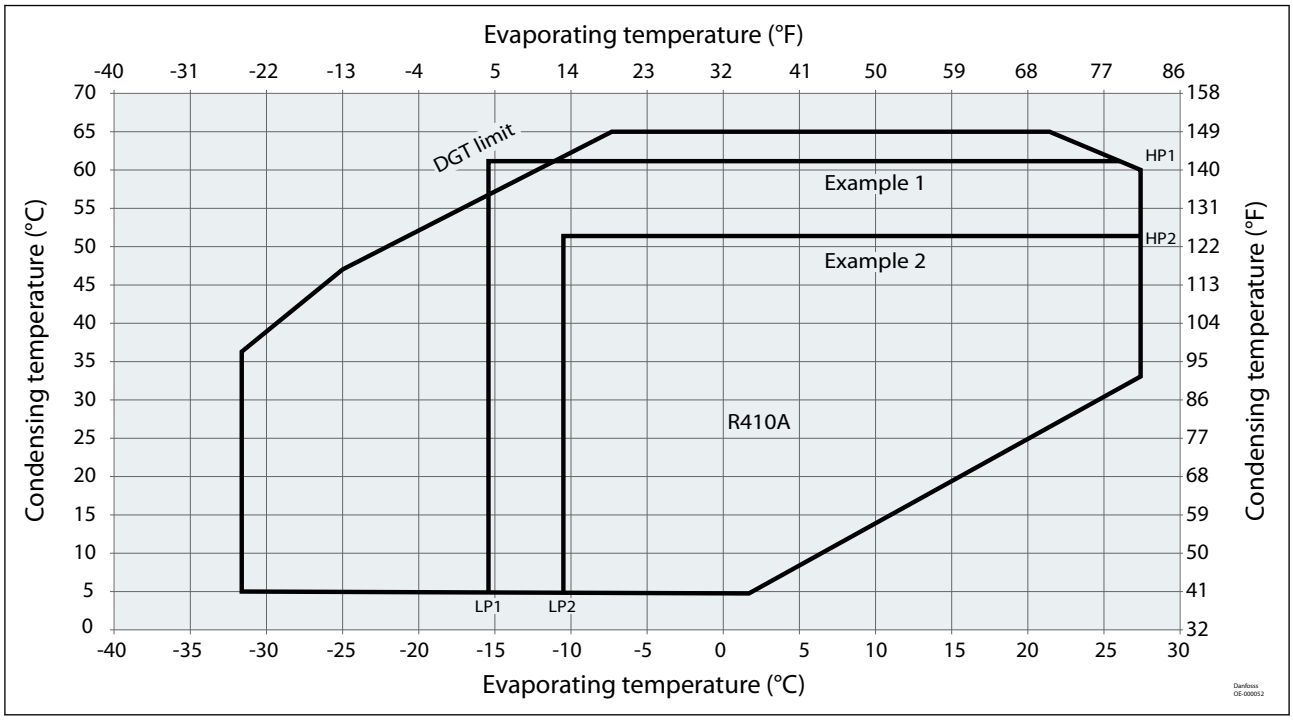
In case of HP cut out, the output contactor will open while compressor is running, thus a Motor Phase Loss alarm will occur.

### Low pressure switch

A low-pressure (LP) safety switch must be used. Deep vacuum operations of a scroll compressor can cause internal electrical arcing and scroll instability. VZH compressors exhibit high volumetric efficiency and may draw very low vacuum levels, which could induce such a problem. The minimum low-pressure safety switch (loss-of-charge safety switch) setting is given in the following table. For systems without pump-down, the LP safety switch must either be a manual lockout device or an automatic switch wired into an electrical lockout circuit. The LP switch tolerance must not allow for vacuum operations of the compressor. LP switch settings for pump-down cycles with automatic reset are also listed in the table below. The lock-out circuit or LP switch or series with other safety devices could be connected to CDS803/303 input 27. The low pressure switch must have the highest priority that shall not be by passed. It means when low pressure switch is activated, compressor minimum running time should not work. OEM need to set port 27 to “coast reverse/ coast and reset inverse” to get rid of minimum running time restriction.

### Discharge gas temperature protection

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




**Example 1** (R410A, SH = 5 K)
LP switch setting: LP1 = 3.3 bar (g) (-15.5°C)
HP switch setting: HP1 = 38 bar (g) (62°C)
Risk of operation beyond the application envelope.
DGT protection required.

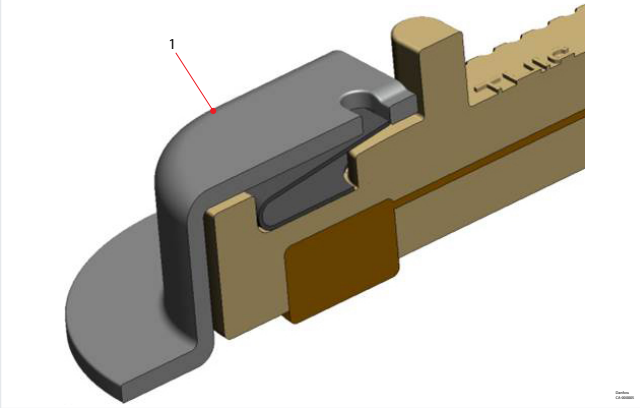
**Example 2** (R410A, SH = 5 K)
LP switch setting: LP2 = 4.6 bar (g) (-10.5°C)
HP switch setting: HP2 = 31 bar (g) (52°C)
No risk of operation beyond the application envelope.
No DGT protection required.

The discharge gas temperature must not exceed 135°C for R410A or 155°C for R454B/R452B.

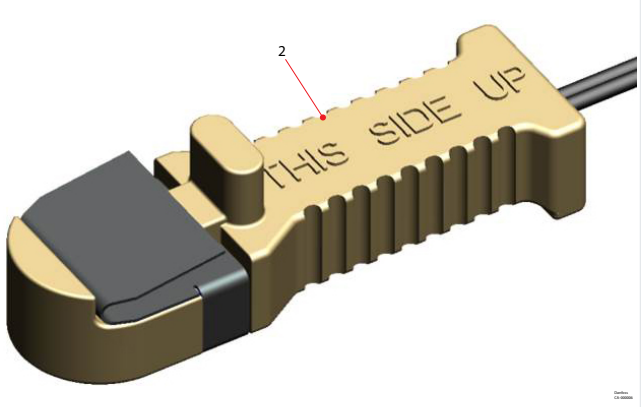
A discharge gas temperature protection device must be installed on all heat pumps. In reversible air-to-air and air-to-water heat pumps, the discharge temperature must be monitored during development test by the equipment manufacturer.

The compressor must not be allowed to cycle on the discharge gas thermostat. Continuous operations beyond the compressor's operating range will cause serious damage to the compressor.

VZH028-044 can install a discharge sensor/ dome sensor at the top of shell through a bracket and the sensor has to been connected and controlled by OEM controller. By installing it at the top of shell, the discharge sensor can monitor discharge temperature and work with OEM controller to limit discharge temperature within 135°C for R410A or 155°C for R454B/R452B. A customer might select NTC thermistor, 10KOhm@25°C type from "TOD Company" and this type of sensor could be fit into VZH top shell directly. The thermostat could also be attached to the discharge line within 150 mm from the compressor discharge port and must be thermally insulated and tightly fixed to the pipe.
: *The selected discharge sensor or thermostat must can bear max discharge temperature in operating envelope and must can be applied to the refrigerant R410A and A2L refrigerant R454B/R452B*




1-Bracket at the shell top




2-This side up

## Electronic expansion valve

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

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

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

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

## Heat exchangers

To obtain optimum efficiency of the complete refrigerant system, optimized R410A/R454B/R452B heat exchangers must be used. R410A/R454B/R452B refrigerant has good heat transfer properties: it is worthwhile designing specific heat exchangers to gain in size and efficiency.

An evaporator with an optimized R410A/R454B/R452B distributor and circuit will give correct superheat at outlet and optimal use of the exchange surface. This is critical for plate evaporators that generally have a shorter circuit and a lower volume than shell & tubes and air cooled coils.

For all evaporator types, special care is required for superheat control leaving the evaporator and oil return.

A sub-cooler circuit in the condenser that creates high sub-cooling will increase efficiency at high condensing pressure. In R410A/R454B/R452B systems the positive effect of sub-cooling on system efficiency will be significantly larger than in R22/ R407C systems.

Furthermore, for good operation of the expansion device and to maintain good efficiency in the evaporator it is important to have an adequate liquid sub-cooling. Without adequate sub-cooling, flash gas will be formed at the expansion device resulting in a high degree of vapor at the evaporator inlet leading to low efficiency.

# Manage sound and vibration

## Sound radiation

For sound radiating from the compressor, the emission path is airborne and the sound waves travel directly from the machine in all directions.

The VZH scroll compressor is designed to be quiet and the frequency of the sound generated is pushed into the higher ranges, which not only are easier to reduce but also do not generate the penetrating power of lower-frequency sound.

Use of sound-insulation materials on the inside of unit panels is an effective means of substantially reducing the sound being transmitted to the outside. Ensure that no components capable of transmitting sound/vibration within the unit come into direct contact with any non insulated parts on the walls of the unit.

Because of the VZH unique design of a fullsuction gas-cooled motor, compressor body insulation across its entire operating range is possible. Acoustic hoods are available from Danfoss as accessories. These hoods are quick and easy to install and do not increase the overall size of the compressors to a great extent.

### Gas pulsation

The VZH scroll compressor has been designed and tested to ensure that gas pulsation has been optimized for the most commonly encountered air conditioning pressure ratios. On heat pump installations and other installations where the pressure ratio lies beyond the typical range, testing should be conducted under all expected conditions and operating configurations to ensure that minimum gas pulsation is present. If an unacceptable level is identified, a discharge muffler with the appropriate resonant volume and mass should be installed. This information can be obtained from the component manufacturer.

## Manage oil in the circuit

### Oil management

Especially for split systems using variable speed compressor, in which every installation is unique and qualification of individual installations is not practical, Danfoss requires that OEMs install an oil separator (OS).

The requirement of an oil separator is also suitable for any other system with complex piping (long line set, U trap), multiple heat exchangers and elevation changes.

Many oil separator designs exist, the selection, requirements and recommendations of the oil Separator manufacturer should be followed.

Please note that Oil Separators are not 100% efficient and the OS efficiency will vary with different compressor running speeds. Customers should select the OS at the normal operating point at low speed.

When oil separators are installed, OEM customers need to evaluate the system performance efficiency at key rating speeds to consider the flow loss impact with the selected OS.

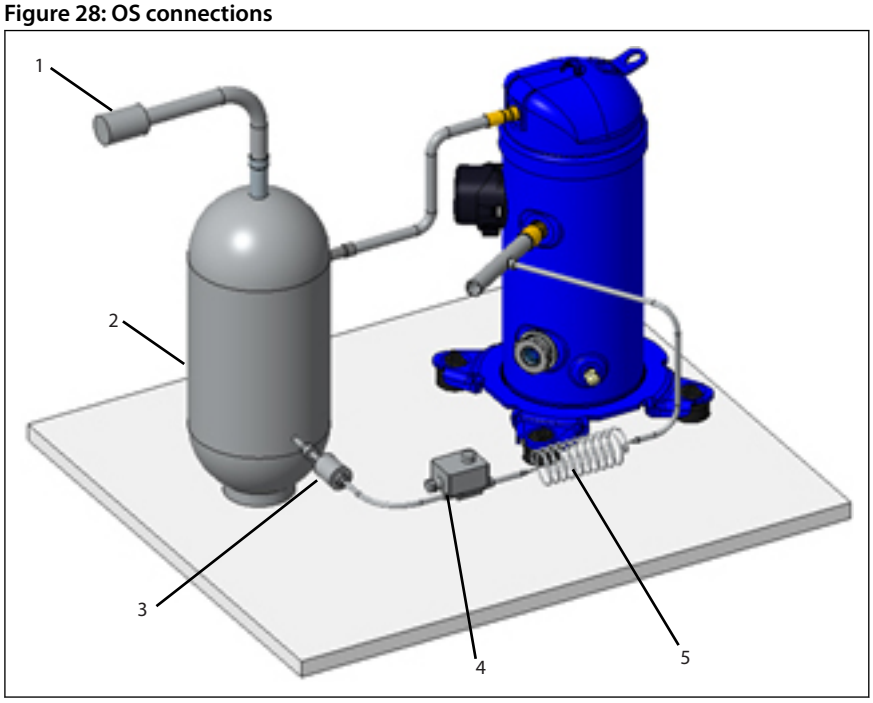
Danfoss recommends customers to use cyclonic oil separators. The following principles are recommended:

- OEM should select a common low speed running point to evaluate OS max efficiency.
- Qualify oil management reliability at maximum and minimum mass flow conditions in the operating envelope with the OS selected
- Evaluate system efficiency at all rating conditions to consider flow loss impact from the OS

For VZH028-035-044, the Schrader valve connection is close to the internal oil pump. To avoid reliability risks, please connect the OS to the compressor suction tube. Never return oil to the Schrader valve in order to avoid a potential negative impact on reliability, such as oil turbulence to the oil pump, etc..

For an illustration for OS connections to the compressor, please refer as below:

**Figure 28: OS connections**




| | |
|---|---|
| **1** | Check valve |
| **2** | Oil separator |
| **3** | Strainer |
| **4** | Solenoid valve |
| **5** | Capillary |

## Oil return management function

R The oil level must be visible in the oil sight glass

An insufficient oil level can be the result of oil depositing itself in pipes and heat exchangers or low velocity of compressors. The oil return management could be achieved by increasing velocity for short periods, at regular time intervals.

CDS integrates oil return management function together with compressor internal lubrication protection.

Internal lubrication protection: If compressor runs below 40 rps (ORM Min Speed Limit, 28-15) for more than 120 minutes (low speed running time, 28-11), then CDS internal lubrication function will accelerate compressor speed to 60 rps (minimum ORM Boost Speed, 28-17) for 1 minute (minimum duration, includes ramp up time, 28-13) to guarantee compressor inner parts get lubricated. In case slow acceleration condition, please make sure compressor maintain minimum speed 40 rps (80Hz) for at least 1 minute running.

Oil return function: To double ensure well lubrication, compressor speed will boost to 60 rps (minimum ORM Boost Speed, 28-17) at a fixed time intervals (as programmed in parameter 28- 12, default 24 hrs) any way. OEM could set 28-17 to a higher speed, such as 70 rps to secure oil management.

According to different application requirements, OEM can either add oil separator (including to add more oil in the system) or adjust oil return parameters or might need both actions to keep oil safety for compressor.

Oil management related parameters, 28-11, 28-12, 28-13,28-15 (CDS303 only), 28-17 (CDS303 only) could also be programmed by OEM.

**Considering oil return risk, a split system with more than 10 m piping length requires mandatory application approval by Danfoss application specialists.**

| ID | Name | Factory setup | Unit |
|---|---|---|---|
| 2810 | Oil return management | ON | |
| 2811 | Low speed running time | 120 | min |
| 2812 | Fixed boost interval | 24 | h |
| 2813 | Boost duration | 60 | s |
| 2815 | ORM min speed limit | 80 | Hz |
| 2817 | ORM boost speed (Hz) | 120 | Hz |

## Oil return management

Oil return management function only works under auto mode: After running at low rpm (less than 40 rps) for 120 minutes, the internal lubrication algorithm in the drive will accelerate the compressor speed to 60 rps or above for 60 seconds to ensure sufficient lubrication of compressor moving parts.

**⚠ WARNING:**
This function is enabled by parameter 28-10 as default setting. Please notice when hands on mode is selected, oil return management will not work even if parameter 28-10 (oil return management) is set to on. If compressors run below 40 rps for more than 120 minutes, oil return fault alarm (A208) will report on LCP and stop the compressor. Please select hands on mode carefully and only select hands on mode if the OEM has implemented oil return management in the system controller and qualified oil management. Under such conditions, the compressor could run below 40 rps continually and meanwhile disable drive oil return management 28-10.

## Bearings lubrication

A specific oil pump ensures optimal bearing lubrication at all compressor speeds. The specific oil pump provides sufficient bearing lubrication at low speeds as well as to avoid excessive Oil Circulation Ratio (OCR) at high speeds.

# Manage Superheat

During normal operation, refrigerant enters the compressor as a superheated vapour. Liquid flood back occurs when some of the refrigerant entering the compressor is still in a liquid state.

Liquid flood back can cause oil dilution and, in extreme situations, lead to liquid slugging that can damage compression parts.

## Requirement

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

## System evaluation

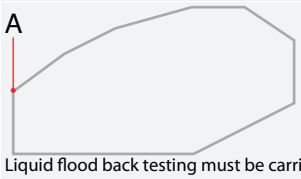
Use the table in relation with the application to quickly evaluate the potential tests to perform.

**Table 14: System evaluation**

| Application | Tests to perform |
|---|---|
| Non reversible | Liquid flood back test |
| Reversible | Liquid flood back test<br>Defrost test |

## Test, criteria and solutions

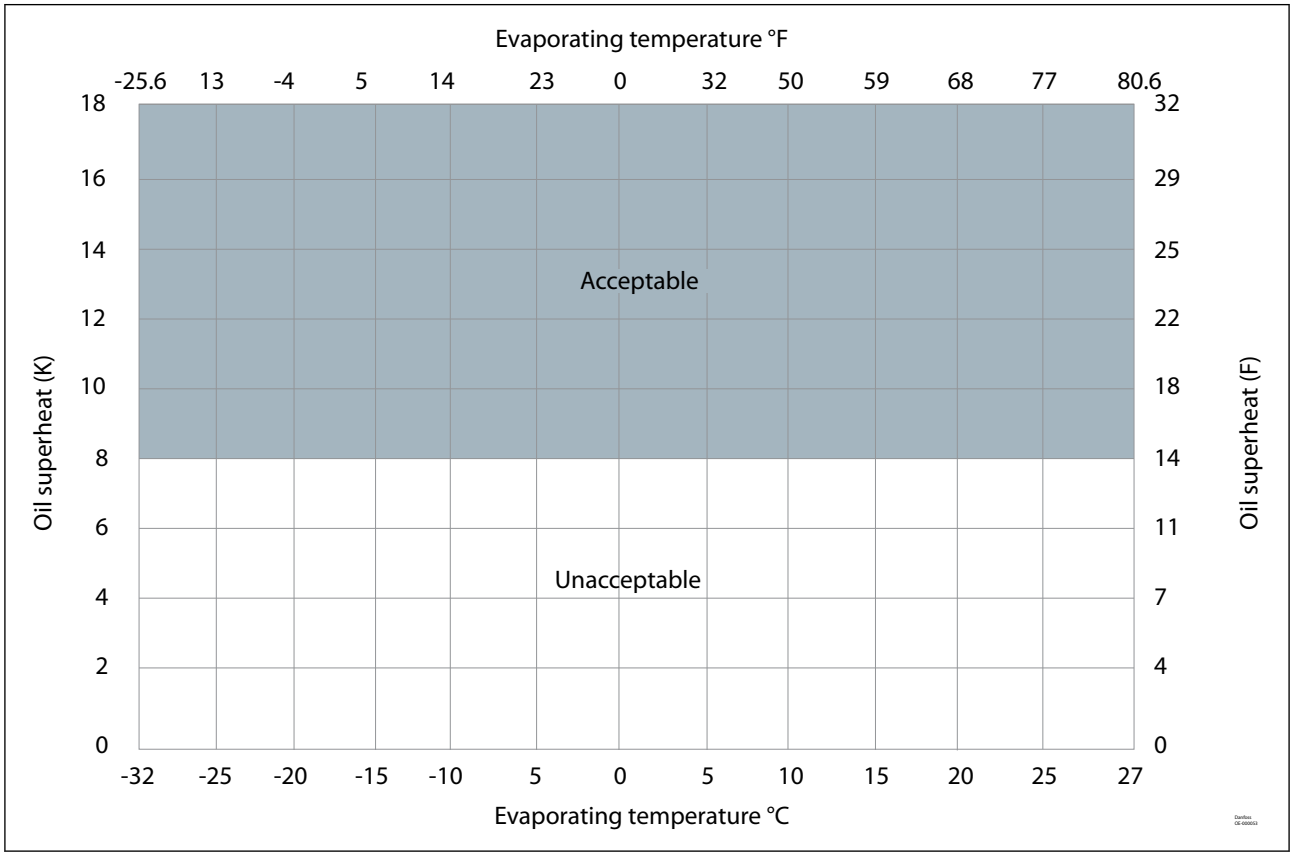
**Table 15: Test, criteria and solutions**

| 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:<br>• Lowest foreseeable evaporation, and highest foreseeable condensation.<br>• Minimum number of compressor running.<br>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.<br>◦ For Thermostatic expansion valve (TXV) check bulb position...<br>◦ For Electronic expansion valve (EXV) check measurement chain and PID....<br>2. Add a suction accumulator [(1)] |
| | Transient | Tests must be carried out with most unfavorable conditions :<br>• fan staging,<br>• compressor staging<br>• … | 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).<br>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.

## Dilution chart

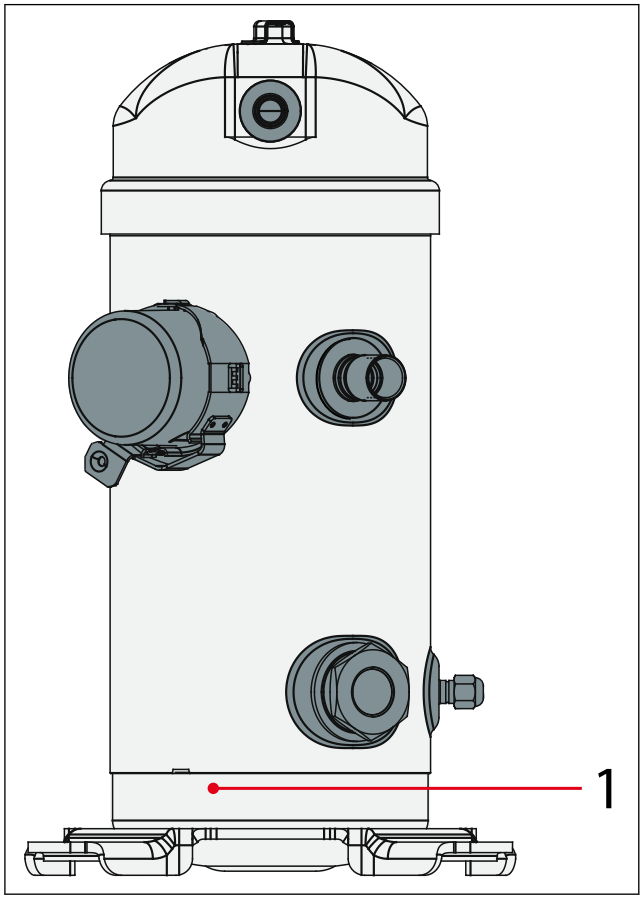
**Figure 29: R410A/R454B/R452B Dilution chart (reference at 20°C / 68°F ambient temperature)**



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

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

**Figure 30: Placing oil temperature sensor**




| | |
|---|---|
| 1 | Oil temperature sensor must be placed between oil sight glass and compressor baseplate |

## Liquid floodback during operation

Danfoss recommends the use of an electronic expansion valve for all air conditioning applications with VZH028-044 compressors. An EXV has two key benefits: it provides modulating control of the system under varying load conditions, and it protects the compressors from flood back during adverse running conditions. Exceptions to the use of EXV's with Danfoss variable speed compressors must be approved by Danfoss application engineering.

## Crankcase heating function

There is no crankcase heating function in CDS drives for VZH028-035-044. An external crankcase heater is required. Refer to accessory list for code numbers.

# Manage off cycle migration

## Off-cycle migration

Liquid refrigerant can find its way into the compressor by means of off-cycle migration or liquid flood back during operation.

Off-cycle refrigerant migration is likely to occur when the compressor is located at the coldest part of the installation, when the system uses a bleed-type expansion device, or if liquid is allowed to migrate from the evaporator into the compressor sump by gravity. If too much liquid refrigerant accumulates in the sump it will saturate the oil and lead to a flooded start: when the compressor starts running again, the refrigerant evaporates abruptly under the sudden decrease of the bottom shell pressure, causing the oil to foam. In extreme situations, this might result in liquid slugging (liquid entering the scroll elements), which must be avoided as it causes irreversible damage to the compressor.

The presence of liquid in the crankcase can be easily detected by checking the sump level through the oil sight glass. Foam in the oil sump indicates a flooded start.

VZH scroll compressors can tolerate occasional flooded starts as long as the total system charge does not exceed the maximum compressor refrigerant charge limit.

Off-cycle migration can be prevented by implementing a crankcase heating or adding a pump-down cycle to the operation cycle and a liquid line solenoid valve.

### Crankcase heater / sump heater

A crankcase heater is only effective if capable of sustaining this level of temperature difference. Tests must be conducted to ensure that the appropriate oil temperature is maintained under all ambient conditions (temperature and wind). Provide separate electrical supply for the heaters so that they remain energized even when the machine is out of service (eg. seasonal shut-down).

It's recommended that the heater be turned on for a minimum of 8 hours prior to starting the compressor.

### Liquid line solenoid valve (LLSV)

An LLSV may be used to isolate the liquid charge on the condenser side, thereby preventing against charge transfer or excessive migration to the compressor during off-cycles. When installed, EXV also ensures this function. The quantity of refrigerant on the low-pressure side of the system can be further reduced by using a pump-down cycle in association with the LLSV.

### Pump-down cycle

A pump-down cycle represents one of the most effective ways to protect against the off-cycle migration of liquid refrigerant. Once the system has reached its set point and is about to shut off, the LLSV on the condenser outlet closes. The compressor then pumps the majority of the refrigerant charge into the condenser and receiver before the system stops on the low pressure pump-down switch. This step reduces the amount of charge on the low side in order to prevent off-cycle migration. The recommended low-pressure pump-down switch setting is 2.2 bar below the nominal evaporating pressure. It shall not be set lower than 1.7bar(R410A) and 1.5bar(R454B/R452B).

An external non return valve is recommended to avoid liquid flood back from the high-pressure side.

### Liquid receiver

Refrigerant charge optimization varies with compressor speed. To avoid flash gas at low speed, a receiver may be necessary. Receiver dimensioning requires special attention.

The receiver shall be large enough to contain part of the system refrigerant charge, but shall not be too large, to avoid refrigerant overcharging during maintenance operations.

## Specific application recommendations

### Low ambient compressor operations

#### Low ambient start-up

Under cold ambient conditions, upon start-up the pressure in the condenser may be so low that a sufficient pressure differential across the expansion device cannot be developed to properly feed the evaporator. As a result, the compressor may go into abnormal low suction pressure, which can lead to compressor failure. Under no circumstances should the compressor be allowed to operate under vacuum. The low pressure control must be set in accordance with the table section "Pressure settings" in order to prevent this from happening.

Low pressure differentials can also cause the expansion device to "hunt" erratically, which might cause surging conditions within the evaporator, with liquid spillover into the compressor. This effect is most pronounced during low load conditions, which frequently occur during low ambient conditions.

### Head pressure control under low ambient conditions

Several possible solutions are available to prevent the compressor from drawing down to a vacuum upon start-up under low ambient conditions. In air-cooled machines, cycling the fans with a head pressure controller will ensure that the fans remain off until the condensing pressure has reached a satisfactory level. In water-cooled units, the same can be performed using a water regulator valve that is also operated by head pressure, thereby ensuring that the water valve does not open until the condensing pressure reaches a satisfactory level.

**NOTE:**
The minimum condensing pressure must be set at the minimum saturated condensing temperature shown in the application envelopes. Under very low ambient conditions, in which testing has revealed that the above procedures might not ensure satisfactory condensing and suction pressures, the use of a liquid receiver with condenser and receiver pressure regulators would be possible.

Condensing pressure control is also strongly recommended to improve any system efficiency. The most accurate value is to control the condensing temperature at 12 K above the ambient temperature for air cooled condensers.

For further information, please contact Danfoss Technical support.

### Crankcase heaters

A crankcase heating will minimize refrigerant migration caused by the large temperature gradient between the compressor and the remainder of the system.

Belt type crankcase heaters can be used, see section "Accessory". They can be connected to CDS relay 1 or 2.

### Low load operations

It is recommended that the unit is tested and monitored at minimum load and, if possible, during low ambient conditions as well. During conditions of low load on the system, the following considerations should be taken into account to ensure proper system operating characteristics.

- The superheat setting of the expansion device should be sufficient to ensure proper superheat levels during low loading periods. 5 K stable superheat is required. In addition, the refrigerant charge should be sufficient to ensure proper sub-cooling within the condenser so as to avoid the risk of flashing in the liquid line before the expansion device. The expansion device should be sized to ensure proper control of the refrigerant flow into the evaporator.

An oversized valve may result in erratic control. This can lead to liquid refrigerant entering the compressor if the expansion valve does not provide stable refrigerant super-heat control under varying loads.

- Condenser fans should be cycled in such a way that the minimum pressure differential is maintained between the suction and discharge pressures. Inverter fans can also be used to control the amount of heat to be removed from the condenser.
- The compressors should be run for a minimum period in order to ensure that the oil has sufficient time to properly return to the compressor sump and that the motor has sufficient time to cool under conditions of lowest refrigerant mass flows.

Refer to section “Oil return management function”.

## Brazed plate heat exchangers

A brazed plate heat exchanger needs very little internal volume to satisfy the set of heat transfer requirements. Consequently, the heat exchanger offers very little internal volume for the compressor to draw vapor from on the suction side. The compressor can then quickly enter into a vacuum condition. It is therefore important that the expansion device be sized correctly and that a sufficient pressure differential across the expansion device be available to ensure adequate refrigerant feed into the evaporator. This aspect is of special concern when operating the unit under low ambient and load conditions. For further information on these conditions, please refer to the previous sections.

Due to the small volume of the brazed plate heat exchanger, no pump-down cycle is normally required.

The suction line running from the heat exchanger to the compressor must be trapped to avoid refrigerant migration to the compressor.

When using a brazed plate condenser heat exchanger, a sufficient free volume for the discharge gas to accumulate is required in order to avoid excess pressure build-up. At least 1 meter of discharge line is necessary to generate this volume. To help reduce the gas volume immediately after start-up even further, the supply of cooling water to the heat exchanger may be opened before the compressor starts up so as to remove superheat and condense the incoming discharge gas more quickly.

Because of the large compressor capacity variation and VZH capability to run at low condensing temperature an EXV (electronic expansion valve) is mandatory.

## Reversible heat pump systems

Transients are likely to occur in reversible heat pump systems, i.e. a changeover cycle from cooling to heating, defrost or low-load short cycles. These transient modes of operation may lead to liquid refrigerant carry-over (or flood-back) or excessively wet refrigerant return conditions. As such, reversible cycle applications require specific precautions in order to ensure a long compressor life and satisfactory operational function. Compressors need to run at least 1 minute at 50 rps each time after reverse. Regardless of the refrigerant charge in the system, specific tests for repetitive flood-back are required to confirm whether or not a suction accumulator needs to be installed. The following considerations cover the most important issues when dealing with common applications. Each application design however should be thoroughly tested to ensure acceptable operating characteristics.

### Discharge temperature monitoring

Heat pumps frequently utilize high condensing temperatures in order to achieve a sufficient temperature rise in the medium being heated. At the same time, they often require low evaporating pressures to obtain sufficient temperature differentials between the evaporator and the outside temperature. This situation may result in high discharge temperature; as such, it is mandatory that a discharge gas safety control is included to protect the compressor from excessive temperatures. Operating the compressor at too high discharge temperatures can result in mechanical damage to the compressor as well as thermal degradation of the compressor lubricating oil and a lack of sufficient lubrication.

Refer to the “Discharge gas thermostat” section for frequency converter settings and accessories availability.

### Discharge line and reversing valve

The VZH scroll compressor is a high volumetric machine and, as such, can rapidly build up pressure in the discharge line if gas in the line becomes obstructed even for a very short period of time which situation may occur with slow acting, reversing valves in heat pumps. Discharge pressures exceeding the operating envelope may result in nuisance high-pressure switch cutouts and can generate excessive load on bearings and motor.

To prevent such occurrences, it is important that a 1-meter minimum discharge line length be allowed between the compressor discharge port and the reversing valve or any other restriction. This gives sufficient free volume for the discharge gas to collect and to reduce the pressure peak during the time it takes for the valve to change position. At the same time, it is important that the selection and sizing of the reversing or 4-way valve ensure that the valve switches quickly enough to prevent against too high discharge pressure and nuisance high-pressure cutouts.

Check with the valve manufacturer for optimal sizing and recommended mounting positions.

It is strongly recommended to reduce the compressor speed to 25/30 rps before the 4-way valve is moved from a position to another.

Refer also to high and low pressure protection.

### Defrost and reverse cycle

After the 4-way valve is moved to defrost position, and in order to shorten the defrost period, the compressor speed can be maintained at 70 rps or higher speed during the defrost period.

When the compressor is started again each time, compressor will run at 50 rps for at least 1 minute. Thus to avoid excessive liquid refrigerant to come back to the compressor sump.

#### Suction line accumulator

The use of a suction line accumulator is strongly recommended in reversible-cycle applications. This because of the possibility of a substantial quantity of liquid refrigerant remaining in the evaporator, which acts as a condenser during the heating cycle.

This liquid refrigerant can then return to the compressor, either flooding the sump with refrigerant or as a dynamic liquid slug when the cycle switches back to a defrost cycle or to normal cooling operations.

Sustained and repeated liquid slugging and flood back can seriously impair the oil's ability to lubricate the compressor bearings. This situation can be observed in wet climates where it is necessary to frequently defrost the outdoor coil in an air source heat pump. In such cases a suction accumulator becomes mandatory.

#### Water utilizing systems

Apart from residual moisture in the system after commissioning, water could also enter the refrigeration circuit during operation. Water in the system shall always be avoided. Not only because it can shortly lead to electrical failure, sludge in sump and corrosion but in particular because it can cause serious safety risks.

Common causes for water leaks are corrosion and freezing.

**Corrosion**: Materials in the system shall be compliant with water and protected against corrosion.

**Freezing**: When water freezes into ice its volume expands which can damage heat exchanger walls and cause leaks. During off periods water inside heat exchangers could start freezing when ambient temperature is lower than 0°C. During on periods ice banking could occur when the circuit is running continuously at too low load.

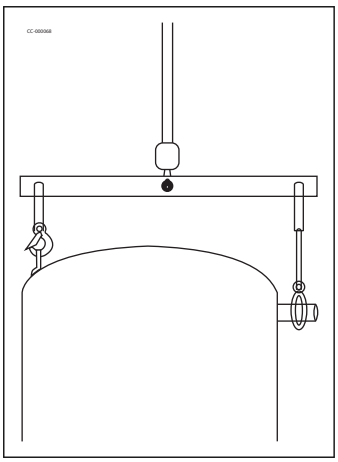
Both situations should be avoided by connecting a pressure and thermostat switch in the safety line.

## Assembly line procedure

### Compressor handling

Each VZH scroll compressor is equipped with one lift ring on the top shell. Always use the ring when lifting the compressor. Use lifting equipment rated and certified for the weight of the compressor. 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 certified to lift the weight of the compressor is also highly recommended. Always respect the appropriate rules concerning lifting objects of the type and weight of these compressors. Maintain the compressor in an upright position during all handling operations.

When the compressor is mounted as part of an installation, never use the lift rings on the compressor to lift the installation. The risk is that the lugs could separate from the compressor or that the compressor could separate from the base frame with extensive damage and possible personal injury as a result.

Never apply force to the terminal box with the intention of moving the compressor, as the force placed upon the terminal box can cause extensive damage to both the box and the components contained inside.

## Removing connections shipping plugs

Before the suction and discharge plugs are removed, the nitrogen holding charge must be released via the suction schrader valve to avoid an oil mist blowout. Remove the suction plug first and the discharge plug afterwards. The plugs should be removed only just before connecting the compressor to the installation in order to avoid moisture from entering the compressor. When the plugs are removed, it is essential to keep the compressor in an upright position so as to avoid oil spillage.

## Refrigerant charging

For the initial charge, the compressor must not run and eventual service valves must be closed. Charge refrigerant as close as possible to the nominal system charge before starting the compressor. This initial charging operation must be done in liquid phase as far away as possible from the compressor. The best location is on the liquid line between the condenser outlet and the filter drier. Then during commissioning, when needed, a complement of charge can be done in liquid phase: slowly throttling liquid in on the low pressure side as far away as possible from the compressor suction connection. The refrigerant charge quantity must be suitable for both summer and winter operations.

Refer to news bulletin FRCC.EN.050 “Danfoss Commercial Compressors recommended refrigerant system charging practice” for more details.

## Refrigerant charge limits

VZH compressors can tolerate liquid refrigerant up to a certain extend without major problems. However, excessive liquid refrigerant in the compressor is always unfavorable for service life. Besides, the installation cooling capacity may be reduced because of the evaporation taking place in the compressor and/or the suction line instead of the evaporator. System design must be such that the amount of liquid refrigerant in the compressor is limited. In this respect, follow the guidelines given in the section: “Essential piping design recommendations” as a priority. If the refrigerant charge exceeds the values in table below, a suction line accumulator is strongly recommended.

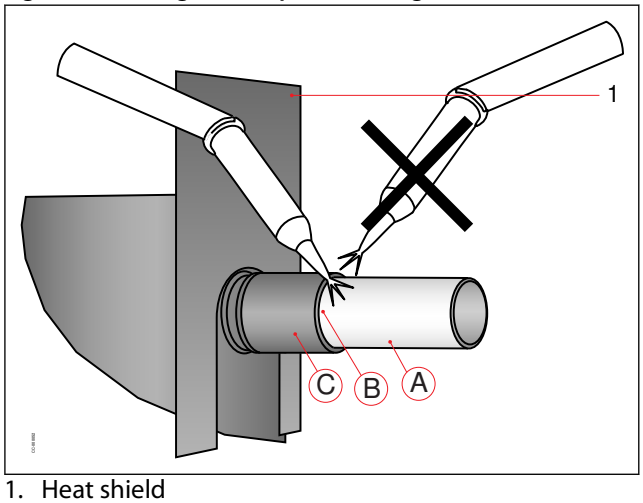
| Model | Refrigerant charge limit (kg) |
|---|---|
| VZH028-044 | 3.6 |

More detailed information can be found in the paragraphs hereafter. Please contact Danfoss technical support for any deviation from these guidelines.

## Piping assembly

When brazing the compressor fittings, do not overheat the compressor shell, which could severely damage certain internal components due to excessive heating. Use of a heat shield and/or a heat-absorbent compound is highly recommended. Due to the relatively sizable tubing and fitting diameters a double-tipped torch using acetylene is recommended for brazing operation on VZH compressors.

**Figure 31: Brazing the compressor fittings**




1. Heat shield

For brazing the suction and discharge connections, the following procedure is advised:

- Make sure that no electrical wiring is connected to the compressor.
- Protect the terminal box and compressor painted surfaces from torch heat damage (see diagram).
- Remove the Teflon gaskets when brazing rotolock connectors with solder sleeves.
- Use only clean refrigeration-grade copper tubing and clean all connections.
- Use brazing material with a minimum of 5% silver content.
- Purge nitrogen or $CO_2$ through the compressor in order to prevent against oxidation and flammable conditions. The compressor should not be exposed to the open air for extended periods.
- Use of a double-tipped torch is recommended.
- Apply heat evenly to area **A** until the brazing temperature is reached. Move the torch to area **B** and apply heat evenly until the brazing temperature has been reached there as well, and then begin adding the brazing material. Move the torch evenly around the joint, in applying only enough brazing material to flow the full circumference of the joint.
- Move the torch to area **C** only long enough to draw the brazing material into the joint, but not into the compressor.
- Remove all remaining flux once the joint has been soldered with a wire brush or a wet cloth. Remaining flux would cause corrosion of the tubing.

Ensure that no flux is allowed to enter into the tubing or compressor. Flux is acidic and can cause substantial damage to the internal parts of the system and compressor.

The polyolester oil used in VZH compressors is highly hygroscopic and will rapidly absorb moisture from the air. The compressor must therefore not be left open to the atmosphere for a long period of time. The compressor fitting plugs shall be removed just before brazing the compressor. The compressor should always be the last component brazed into the system.

⚠ Before eventual unbrazing the compressor or any system component, the refrigerant charge must be removed from both the high- and low-pressure sides. Failure to do so may result in serious personal injury. Pressure gauges must be used to ensure all pressures are at atmospheric level.

For more detailed information on the appropriate materials required for brazing or soldering, please contact the product manufacturer or distributor. For specific applications not covered herein, please contact Danfoss for further information.

### System cleanliness

The refrigerant compression system, regardless of the type of compressor used, will only provide high efficiency and good reliability, along with a long operating life, if the system contains solely the refrigerant and oil it was designed for. Any other substances within the system will not improve performance and, in most cases, will be highly detrimental to system operations.

The presence of non-condensable substances and system contaminants such as metal shavings, solder and flux, have a negative impact on compressor service life. Many of these contaminants are small enough to pass through a mesh screen and can cause considerable damage within a bearing assembly. The use of highly hygroscopic polyol ester oil in compressors requires that the oil be exposed to the atmosphere as little as possible. System contamination is one of main factors affecting equipment reliability and compressor service life. It is important therefore to take system cleanliness into account when assembling a refrigeration system.

During the manufacturing process, circuit contamination may be caused by:

- Brazing and welding oxides,
- Filings and particles from the removal of burrs in pipework,
- Brazing flux,
- Moisture and air.

Consequently, when building equipment and assemblies, the precautions listed in the following paragraphs must be taken.

### Tubing

Only use clean and dehydrated refrigeration grade copper tubing. Tube-cutting must be carried out so as not to deform the tubing roundness and to ensure that no foreign debris remains within the tubing. Only refrigerant grade fittings should be used and these must be of both a design and size to allow for a minimum pressure drop through the completed assembly. Follow the brazing instructions on next pages. Never drill holes into parts of the pipework where filings and particles can not be removed.

### Filter driers

For new installations with VZH compressors with polyolester oil, Danfoss recommends using the Danfoss DML 100% molecular sieve, solid core filter drier. Molecular sieve filter driers with loose beads from third party suppliers shall be avoided. For servicing of existing installations where acid formation is present the Danfoss DCL solid core filter driers containing activated alumina are recommended.

The drier is to be oversized rather than undersized. When selecting a drier, always take into account its capacity (water content capacity), the system refrigeration capacity and the system refrigerant charge.

### Copper to copper connections

When brazing copper-to-copper connections, the use of copper/phosphorus brazing alloy containing 5% silver or higher with a melting temperature of below 800°C is recommended. No flux is required during brazing.

### Dissimilar metals connections

When manipulating dissimilar metals such as copper and brass or steel, the use of silver solder and anti-oxidant flux is required.

## System pressure test and leak detection

### System pressure test

Always use an inert gas such as nitrogen for pressure testing. Never use other gasses such as oxygen, dry air or acetylene as these may form an inflammable mixture. Do not exceed the following pressures:

**Table 16:**

| | VZH028-035-044 |
|---|---|
| Maximum compressor test pressure (low side) | 33.3 bar (g) |
| Maximum compressor test pressure (high side) | 44.1bar(g) for OSG version |
| | 41.6bar(g) for OSG+OLS version |
| Maximum pressure difference between high and low side of the compressor | 36 bar (g) |

Pressurize the system on HP side first then LP side to prevent rotation of the scroll. Never let the pressure on LP side exceed the pressure on HP side with more than 5 bar.

### Leak detection

Leak detection must be carried out using a mixture of nitrogen and refrigerant or nitrogen and helium, as indicated in the table below. Never use other gasses such as oxygen, dry air or acetylene as these may form an inflammable mixture.

Pressurize the system on HP side first then LP side.

**Table 17:**

| Leak detection with refrigerant | Leak detection with a mass spectrometer |
|---|---|
| Nitrogen and R410A | Nitrogen and Helium |

## Vacuum pump down and moisture removal

Moisture obstructs the proper functioning of both the compressor and the refrigeration system. Air and moisture reduce service life and increase condensation pressure, which causes abnormally high discharge temperatures that are then capable of degrading the lubricating properties of the oil. The risk of acid formation is also increased by air

and moisture, and this condition can also lead to copper plating. All these phenomena may cause both mechanical and electrical compressor failures. The typical method for avoiding such problems is a vacuum pump-down executed with a vacuum pump, thus creating a minimum vacuum of 500 microns (0.67 mbar).

Please refer to News bulletin TI1-026-0302 “Vacuum pump down and dehydration procedure”.

## Commissioning

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

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

A short cycling protection is provided in the CDS frequency converter. It is factory preset “enabled” with the following parameters in:

28.01 - interval between 2 starts: 300 seconds

28.02 - minimum run time: 60 seconds.

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

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

**NOTE:**
This compressor is equipped with a four-pole electrical motor so the applied frequency from the inverter will be 30 Hz for 15 rps(900 rpm) up to 200 Hz for 100 rps (6000 rpm).

### Oil level checking and top-up

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

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

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

The oil level can also be checked a few minutes after the compressor stops, the level must be between ¼ and ¾ of sight glass.

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

VZH028-035-044 are factory charged with POE46(RL46HB)

Top-up the oil while the compressor is idle. Use the schrader connector or any other accessible connector on the compressor suction line and a suitable pump. See news bulletin “Lubricants filling in instructions for Danfoss Commercial Compressors.”

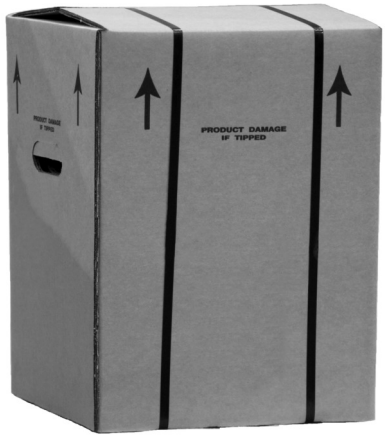
## Dismantle and disposal

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

# Packaging

## Single pack

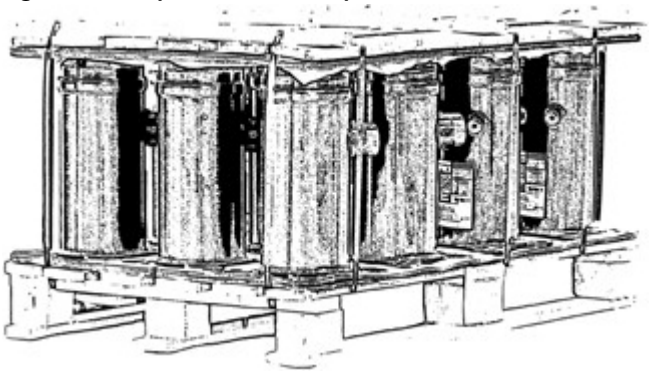
**Figure 32: Compressor single pack**




| Compressor model | Height (mm) | Width (mm) | Depth (mm) | Weight (kg) |
|---|---|---|---|---|
| VZH028/035/044 | 464 | 292 | 286 | 30 |

## Industrial pack

**Figure 33: Compressor Industrial pack**



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

| Compressor model | Nbr | Length (mm) | Width (mm) | Height (mm) | Gross Weight (kg) | Static stacking pallets |
|---|---|---|---|---|---|---|
| VZH028 | 12 | 1170 | 815 | 625 | 430 | 3 |
| VZH035 | 12 | 1170 | 815 | 625 | 450 | 3 |
| VZH044 | 12 | 1170 | 815 | 625 | 450 | 3 |

## Frequency converter single pack

**Figure 34: CDS803/303 packaging**

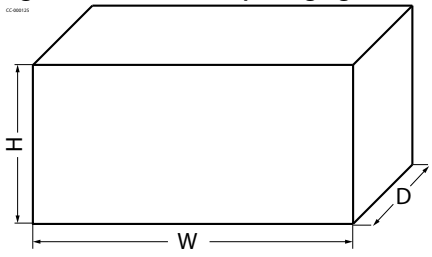


**Table 18: Frequency converter single pack**

| Drive supply voltage | Compressor | Drive enclosure | IP20 | | | |
|---|---|---|---|---|---|---|
| | | | Height (H) | Width (W) | Depth (D) | Weight |
| | | | (mm) | (mm) | (mm) | (Kg) |
| T2: Code J | VZH028/035 | H4 | 380 | 250 | 375 | 7.9 |
| | VZH044 | H5 | 420 | 290 | 375 | 9.5 |
| T4: Code G | VZH028/035 | H3 | 255 | 100 | 206 | 4.5 |
| | VZH044 | H4 | 380 | 250 | 375 | 7.9 |
| T6: Code H | VZH028 | A3 | 390 | 196 | 301 | 6.6 |
| | VZH035/044 | B3 | 349 | 500 | 330 | 13 |

# Ordering

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

## Single pack

**Table 19: Compressor codes with Certification CE, UKCA, UL**

| Compressor model | Equipment version | G | | J | | H | |
|---|---|---|---|---|---|---|---|
| | | Compressor Name | Code No | Compressor Name | Code No | Compressor Name | Code No |
| VZH028 | OSG | VZH028CGAMB | 120G0353 | VZH028CJAMB | 120G0383 | VZH028CHAMB | 120G0377 |
| VZH035 | OSG | VZH035CGAMB | 120G0355 | VZH035CJAMB | 120G0385 | VZH035CHAMB | 120G0379 |
| VZH044 | OSG | VZH044CGAMB | 120G0357 | VZH044CJAMB | 120G0387 | VZH044CHAMB | 120G0381 |

**Table 20: Compressor codes with Certification UL only**

| Compressor model | Equipment version | G | | J | | H | |
|---|---|---|---|---|---|---|---|
| | | Compressor Name | Code No | Compressor Name | Code No | Compressor Name | Code No |
| VZH028 | OSG+OLS | VZH028CGDMB | 120G0371 | VZH028CJDMB | 120G0365 | VZH028CHDMB | 120G0359 |
| VZH035 | OSG+OLS | VZH035CGDMB | 120G0373 | VZH035CJDMB | 120G0367 | VZH035CHDMB | 120G0361 |
| VZH044 | OSG+OLS | VZH044CGDMB | 120G0375 | VZH044CJDMB | 120G0369 | VZH044CHDMB | 120G0363 |

## Industrial pack

**Table 21: Compressor codes with Certification CE, UKCA, UL**

| Compressor model | Equipment version | G | | J | | H | |
|---|---|---|---|---|---|---|---|
| | | Compressor Name | Code No | Compressor Name | Code No | Compressor Name | Code No |
| VZH028 | OSG | VZH028CGAMB | 120G0354 | VZH028CJAMB | 120G0384 | VZH028CHAMB | 120G0378 |
| VZH035 | OSG | VZH035CGAMB | 120G0356 | VZH035CJAMB | 120G0386 | VZH035CHAMB | 120G0380 |
| VZH044 | OSG | VZH044CGAMB | 120G0358 | VZH044CJAMB | 120G0388 | VZH044CHAMB | 120G0382 |

**Table 22: Compressor codes with Certification UL only**

| Compressor model | Equipment version | G | | J | |
|---|---|---|---|---|---|
| | | Compressor Name | Code No | Compressor Name | Code No |
| VZH028 | OSG+OLS | VZH028CGDMB | 120G0372 | VZH028CJDMB | 120G0366 |
| VZH035 | OSG+OLS | VZH035CGDMB | 120G0374 | VZH035CJDMB | 120G0368 |
| VZH044 | OSG+OLS | VZH044CGDMB | 120G0376 | VZH044CJDMB | 120G0370 |

**NOTE:**
About other certification, please refer to Certificates, declarations and approvals

## VZH converter order information

| CDS803 drive | | | |
|---|---|---|---|
| Voltage | Compressor | Description | Code NO |
| T2 200-240V/3ph/50&60Hz | VZH028 | CDS803P6K0T2E20H4 | 134N4260 |
| | VZH035 | CDS803P7K5T2E20H4 | 134N4261 |
| | VZH044 | CDS803P10KT2E20H4 | 134L9470 |
| T4 380-480V/3ph/50&60Hz | VZH028 | CDS803P6K0T4E20H4 | 134N4262 |
| | VZH035 | CDS803P7K5T4E20H4 | 134N4263 |
| | VZH044 | CDS803P10KT4E20H4 | 134L9473 |

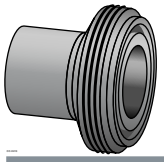
LCP: user interface 120Z0581 (accessory)

| CDS303 drive | | | |
|---|---|---|---|
| Voltage | Compressor | Description | Code NO |
| T6 525-600V/3ph/50&60Hz | VZH028 | CDS303P7K5T6E20HX | 134X8358 |
| | VZH035 | CDS303P11KT6E20HX | 135N3582 |
| | VZH044 | CDS303P11KT6E20HX | 135N3582 |

LCP: user interface 120Z0326 (accessory)

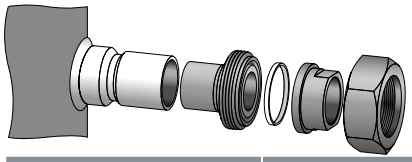
# Accessories and Spare parts

## Rotolock adaptor



| Code no | Description | Application | Packaging | Pack size |
|---|---|---|---|---|
| 120Z0366 | Rotolock adaptor (1-1/4" ~ 3/4") | VZH028-044 suction | Multipack | 10 |
| 120Z0365 | Rotolock adaptor (1" ~ 1/2") | VZH028-044 discharge | Multipack | 10 |

## Valves, adapters, connectors & gaskets for use on suction and discharge connections



| Code no | Description | Application | Packaging | Pack size |
|---|---|---|---|---|
| 120Z0126 | Solder sleeve adapter set (1"1/4 Rotolock, 3/4" ODF), (1" Rotolock, 1/2" ODF) | VZH028-044 | Multipack | 6 |

## Crankcase heaters

| Code no | Description | Application | Packaging | Pack size |
|---|---|---|---|---|
| 120Z5040 | Belt type crankcase heater,65W,230V,CE mark,UL(wire length: 1270mm) | VZH028-044 | Multipack | 4 |
| 120Z5041 | Belt type crankcase heater,55/70W,400/460V,CE mark,UL(wire length: 1270mm) | | Multipack | 4 |

## Acoustic hood

| Code no | Description | Application | Packaging | Pack size |
|---|---|---|---|---|
| 120Z5083 | Acoustic hood | VZH028-044 | Single pack | 1 |

## Oil level switch

| Code no. | Description | Application | Packaging | Pack size |
|---|---|---|---|---|
| 120Z0560 | Oil level switch screw in- mechanical part | All models | Single pack | 1 |
| 120Z0803 | Oil level switch-electrical part(24V AC/DC) with relay [1] | All models | Single pack | 1 |
| 120Z0804 | Oil level switch-electrical part(230V AC) with relay [1] | All models | Single pack | 1 |

[1] Danfoss does not provide connector without cable, please order 2m and 8m pre-wired connectors in the table of "Connector for oil level sensor"

## Connector for oil level sensor

| Code no. | Description | Application | Packaging | Pack size |
|---|---|---|---|---|
| 034G7073 | M12 angle female connector cable 2m | Oil level sensor with relay | Single pack | 1 |
| 034G7074 | M12 angle female connector cable 8m | Oil level sensor with relay | Single pack | 1 |

## Mounting kits

| Code no | Description | Application | Packaging | Pack size |
|---|---|---|---|---|
| 120Z0622 | Mounting kit for 1 scroll compressor including 4 grommets, 4 sleeves, 4 bolts, 4 washers, 2 grounding screws | VZH028-044 | Single pack | 1 |

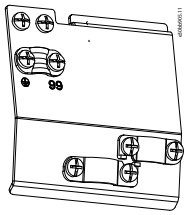
## Terminal boxes, covers & T-block connectors

| Code no | Description | Application | Packaging | Pack size |
|---|---|---|---|---|
| 120Z5015 | Terminal box cover | VZH028-044 | Multipack | 10 |

## Spare parts frequency converter

| Code no | Description | Application | Packaging | Pack size |
|---|---|---|---|---|
| 120Z0581 | LCP | Frequency converter 803 / VZH028-044 code G & code J | Single pack | 1 |
| 120Z0617 | LCP kit for remote mounting contains rubber sealing, 3m cable, bracket and screws | Frequency converter CDS803 / VZH028- 044 code G & code J | Single pack | 1 |
| 120Z0326 | LCP | Frequency converter CDS303/ VZH028-044 code H | Single pack | 1 |

## Decoupling Plate



| Frame | Compressor | | Decoupling plate | Packaging | Pack size |
|---|---|---|---|---|---|
| | 200-240V | 380-480V | | | |
| H3 | - | VZH028/035 | 120Z0582 | Single pack | 1 |
| H4 | VZH028/035 | VZH044 | 120Z0583 | Single pack | 1 |
| H5 | VZH044 | - | 120Z0583 | Single pack | 1 |

**NOTE:**
Use the decoupling plate for EMC correct installation

## Lubricant

| Code no. | Description | Application | Packaging | Pack size |
|---|---|---|---|---|
| 120Z0648 | POE lubricant, 215PZ(RL46HB),1 litre can | VZH028-044 | Multipack | 12 |

# Updates

| Release date (Year/Month) | Guideline codification number | List of changes | Reason for change |
|---|---|---|---|
| 2022/12 | AB436636362503en-010101 | - | First release |
| 2023/07 | AB436636362503en-000201 | - | code J/H and OLS version added |

ENGINEERING
TOMORROW

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