ENGINEERING
TOMORROW

Application Guide

Scroll Compressors
VZN086-104-140-175-220

Single, R290/R513A with CDS203



www.danfoss.com

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Safety and warnings

Danfoss scroll compressors are designed and manufactured with state of the art technology and follow European and US regulations. There is an added emphasis placed on safety and reliability. Critical instructions are highlighted with the following icons:

This icon indicates instructions to avoid safety risk.

This icon indicates instructions to avoid reliability risk.

The purpose of this guideline is informational, with the intent to educate customers as to how the compressors should properly function. If you need any additional assistance, please contact Danfoss Technichal Support. In any case, Danfoss manufacturing accepts no liability as a result of misuse or improper integration of the compressor unit.

Introduction

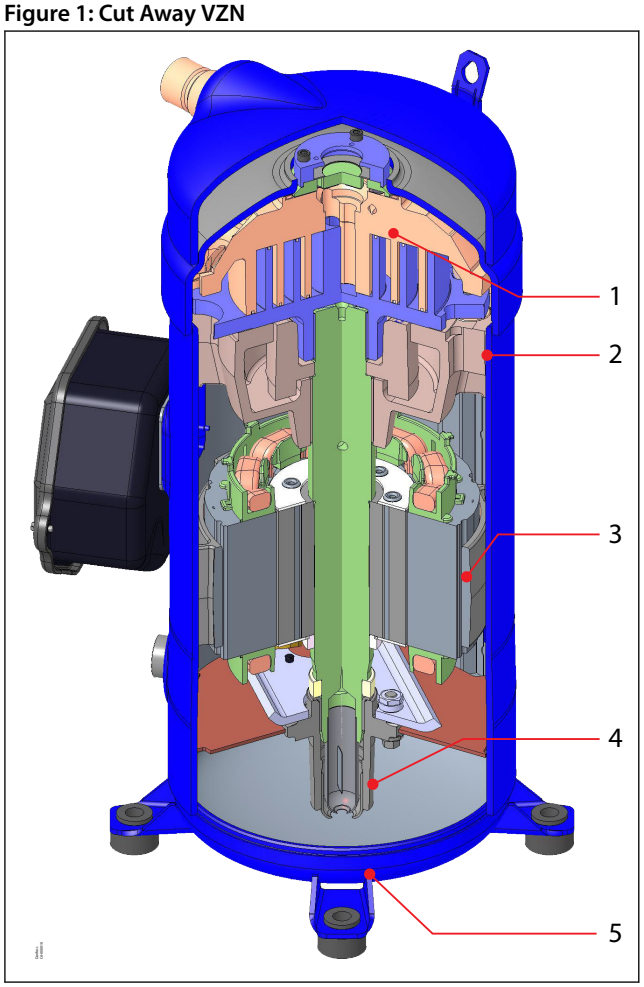
Product description

The VZN variable speed scroll family meets the broad needs of light-commercial HVAC systems (20–200 kW): it is a highly versatile solution suitable for heating or cooling applications—comfort or process—operating with natural refrigerant R290 as well as A1 HFOs such as R513A. Its wide operating range, from −30 °C to +25 °C evaporating and up to 82 °C condensing, combined with its large capacity modulation enabled by the newly qualified CDS203, delivers best-in-class seasonal efficiency for high-temperature heat pumps, chillers, and even CRAC units.

NOTE:
R290 is classified as A3 flammable refrigerant.

Cut Away VZN

Figure 1: Cut Away VZN

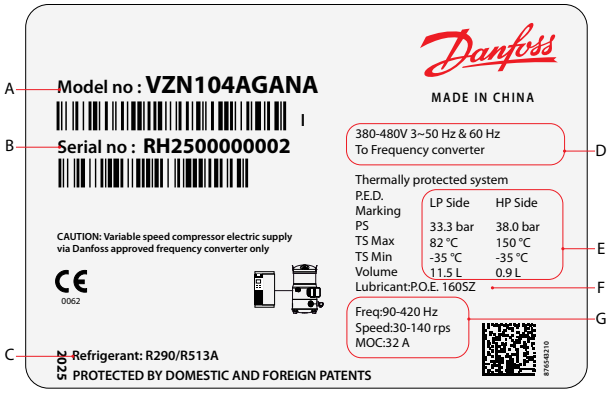


1	Optimize scroll set PR and efficiency combine light commercial chillers application and heat pump application
2	New shell structure design, reduce compressor acoustic at high speed
3	New designed high efficiency motor, improve efficiency at heating condition
4	New design oil strainer reduce the oil stirring when compressor running
5	Compact compressor outline design, beneficial for system unit layout

Product identification

Nameplate

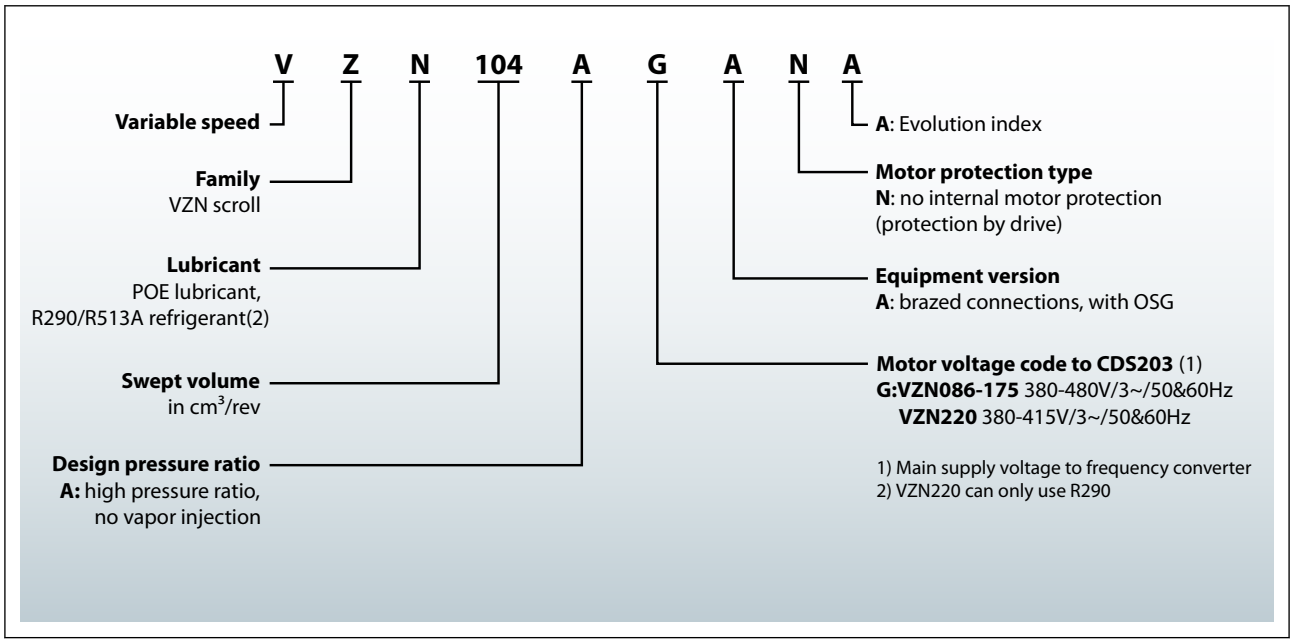
Figure 2: Nameplate



A	Model number
B	Serial number
C	Refrigerant
D	Supply voltage to CDS frequency converter
E	Housing service pressure
F	Factory charged lubricant
G	Compressor frequency & Max Operating Current

Nomenclature

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



Compressors serial number

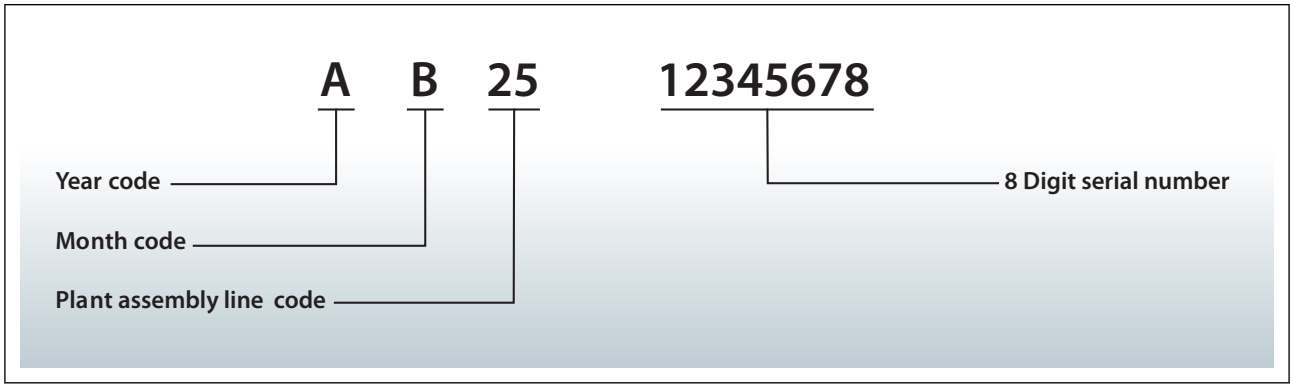


Table 1: Serial number code legend table

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

Certificates, declarations and approvals

VZN scroll compressors comply with the following approvals and certificates. Certificate are listed in: Coolselector®2

Table 2: Certificates, declarations and approvals

Certificates, declarations and approvals	Certification logo	Models
CE (European Directive)	CE	All VZN models
EMC 2014/30/EU		All VZN models

Pressure equipment directive 2014/68/EU

Table 3: Pressure equipment directive 2014/68/EU

Products	VZN086-104-140-175-220	VZN086-104-140-175
Refrigerant	Fluids R290	Fluids R513A
Group	Group 1	Group 2
Category PED	III	II
Evaluation module	H	D1
TS-service temperature LP	-35°C<Ts<82°C	-35°C<Ts<75°C
TS-service temperature HP	-35°C<Ts<150°C	-35°C<Ts<150°C
Ps-service pressure LP	33.3 bar.g	24.0 bar.g
Ps-service pressure HP	38 bar.g	29.0 bar.g

NOTE:
R290 is classified as A3 flammable refrigerant.

Low voltage directive 2014/35/EU

Table 4: Low voltage directive 2014/35/EU

Products	VZN086-104-140-175-220
Declaration of conformity ref. Low voltage Directive 2014/35/EU	Contact Danfoss

Declaration related to A3

Danfoss marks all compressors that are qualified for A3 refrigerants with a sticker indicating the usage of such refrigerants. Systems using flammable refrigerants must be executed correctly while observing safety rules, as specified in corresponding safety standards such as, but not limited to EN 378. They must comply with any and all applicable legislation and regulations. Ensuring compliance remains the user's responsibility. CDS203 15/18/22/30/40KW frequency converter for VZN086-104-140-175-220 are not to be considered a source of ignition when used together with A3 classified refrigerants and are compliant against clauses 22 1 16 and 22.117 from UL/IEC60335-2-40.

Internal free volume

Table 5: Internal free volume

Products	Internal free volume at LP side without oil (litre)	Internal free volume at HP side without oil (litre)
VZN086	11.5	0.9
VZN104	11.5	0.9
VZN140	10.8	1.3
VZN175	10.8	1.3
VZN220	14.5	2.1

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

R290

R290 is a Hydrocarbons with a zero Ozone Depletion Potential (ODP=0) and a low Global Warming Potential (GWP: 3/AR4) natural substance found in natural gas (up to 20%).

R290 is a technically splendid refrigerant with a high thermodynamic efficiency and has been used as refrigerant for almost 100 years serving a variety of applications with many different capacities.

R290 is non-toxic, but highly flammable, and under certain atmospheric concentrations easily reacts with oxygen and burns or create an explosion. R290 is categorized as an A3 refrigerant according to ISO817 classification Please refer to European regulation and directives about the use if refrigerant of the A3 safety group (EN378, EN60335).

R513A

R513A is an HFO/HFC Blend, with similar thermodynamic properties to the R134a. R513A is an Azeotrope refrigerant with a negligible glide. R513A has zero ozone depletion potential (ODP=0) and a Global Warming Potential (AR5) at 631.

Technical specification

Compressor size

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



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

Compressor specification

Table 6: Compressor specification

Compressor model	Swept volume		Displacement										Oil charge		Net weight	
			30rps		60rps		90rps		120rps		140rps					
	cm3/rev	cu.ln/rev	m3/h	cu.ft/h	m3/h	cu.ft/h	m3/h	cu.ft/h	m3/h	cu.ft/h	m3/h	cu.ft/h	dm3	oz	kg	lbs
VZN086	86.0	5.25	9.29	328	18.58	656	27.86	984	37.15	1312	43.34	1531	3.3	112	56	123
VZN104	104.0	6.35	11.23	397	22.46	793	33.70	1190	44.93	1587	52.42	1851	3.3	112	56	123
VZN140	140.0	8.54	15.12	534	30.24	1068	45.36	1602	60.48	2136	70.56	2492	3.3	112	65	143
VZN175	175.0	10.68	18.90	667	37.80	1335	56.70	2002	75.60	2670	88.20	3115	3.3	112	65	143
VZN220	222.0	13.43	23.76	839	47.52	1678	71.28	2517	95.04	3356	110.88	3916	4.0	135	85	187

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

Model	Sound level dB(A)	High attenuation acoustic hood code number	Generic acoustic hood code number
	-3 / 38 / 5 / 5 @90 rps without hood		
VZN086	79	120Z0916	120Z0914
VZN104	80	120Z0916	120Z0914
VZN140	82	120Z0915	120Z0913
VZN175	84	120Z0915	120Z0913
VZN220	84	NA	NA

NOTE:
Nominal sound power for reference at (-3°C/38°C/5°C/5°C) (26.6°F/100.4°F/9°F/9°F) conditions measured in free space.
- Max. tolerance +3dBA for individual compressor.
- With high attenuation acoustic hood in the table, sound level can decrease by 14dB(A), with generic acoustic hood in the table, sound level can decrease by 9dB(A). Nominal value on a generic compressor, deviation +/- 1dB(A) depending on the VZN model and the rotation speed.

R290 is classified as A3 flammable refrigerant.

Operating envelope data

Operating envelope

Figure 3: R290 Operating map

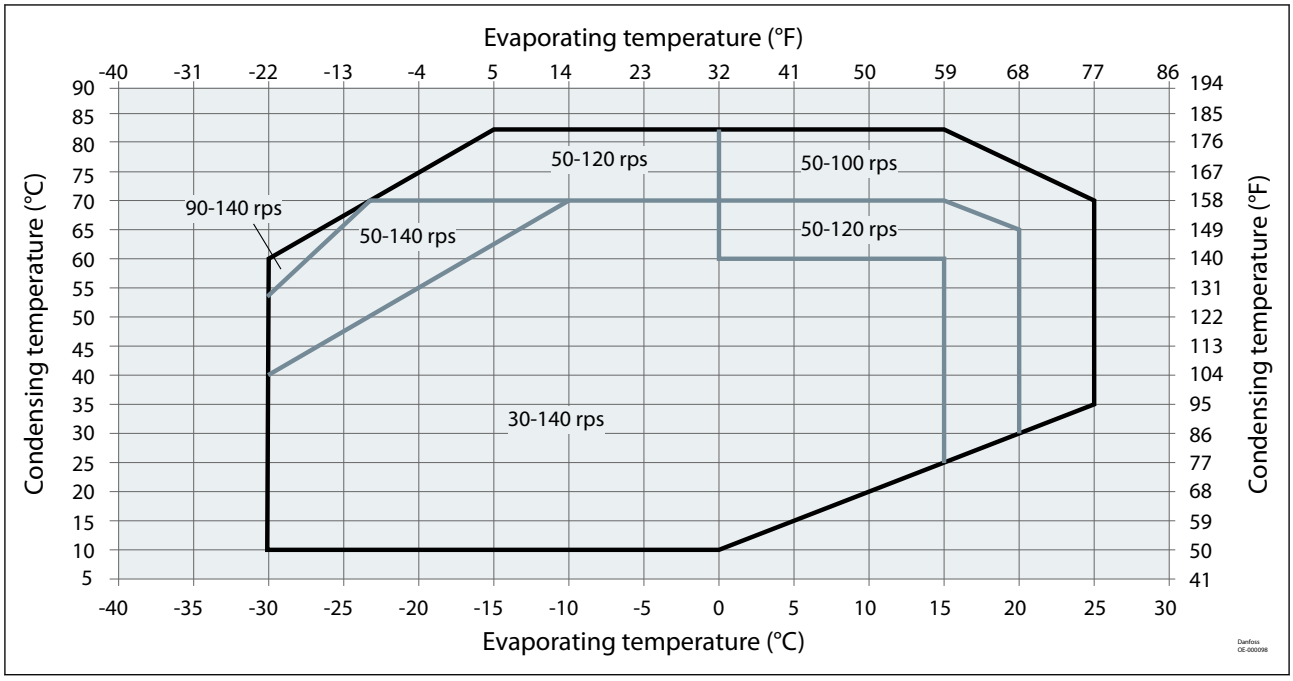
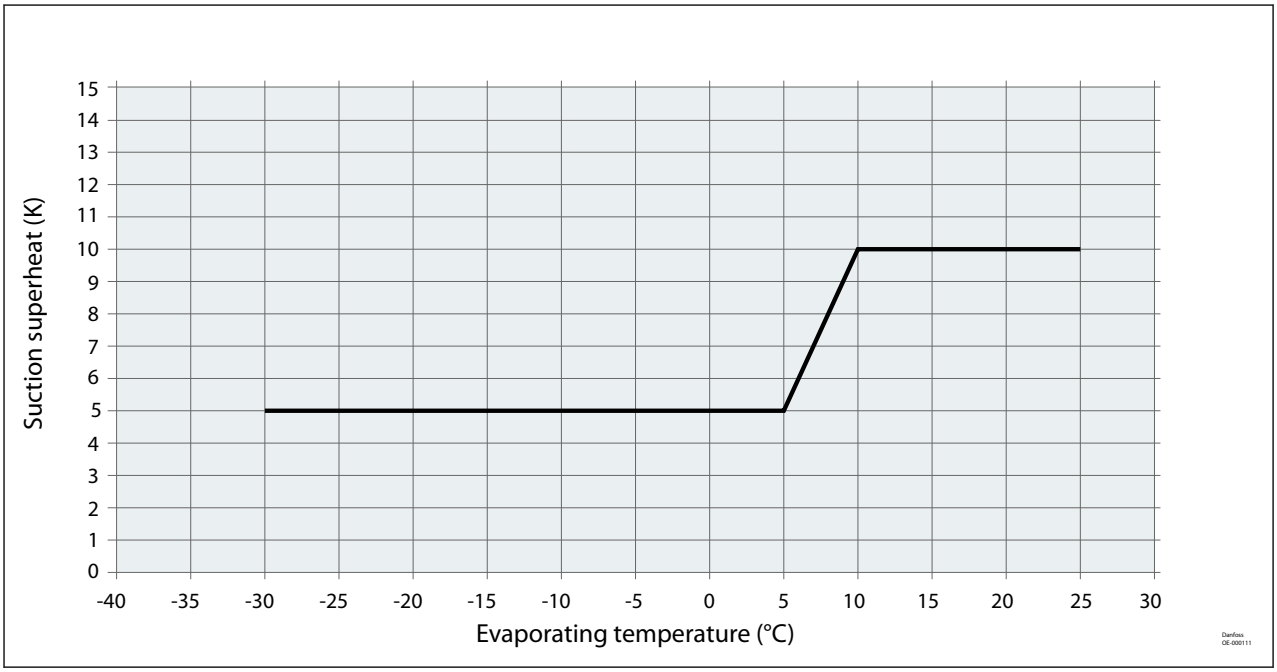


Figure 4: R290 Minimum suction superheat



NOTE:
Discharge sensor 120Z0823 can get connected to the CDS203, to limit the speed of VZN when discharge temperatures becomes too high.

Figure 5: R513A Operating map for standard drive

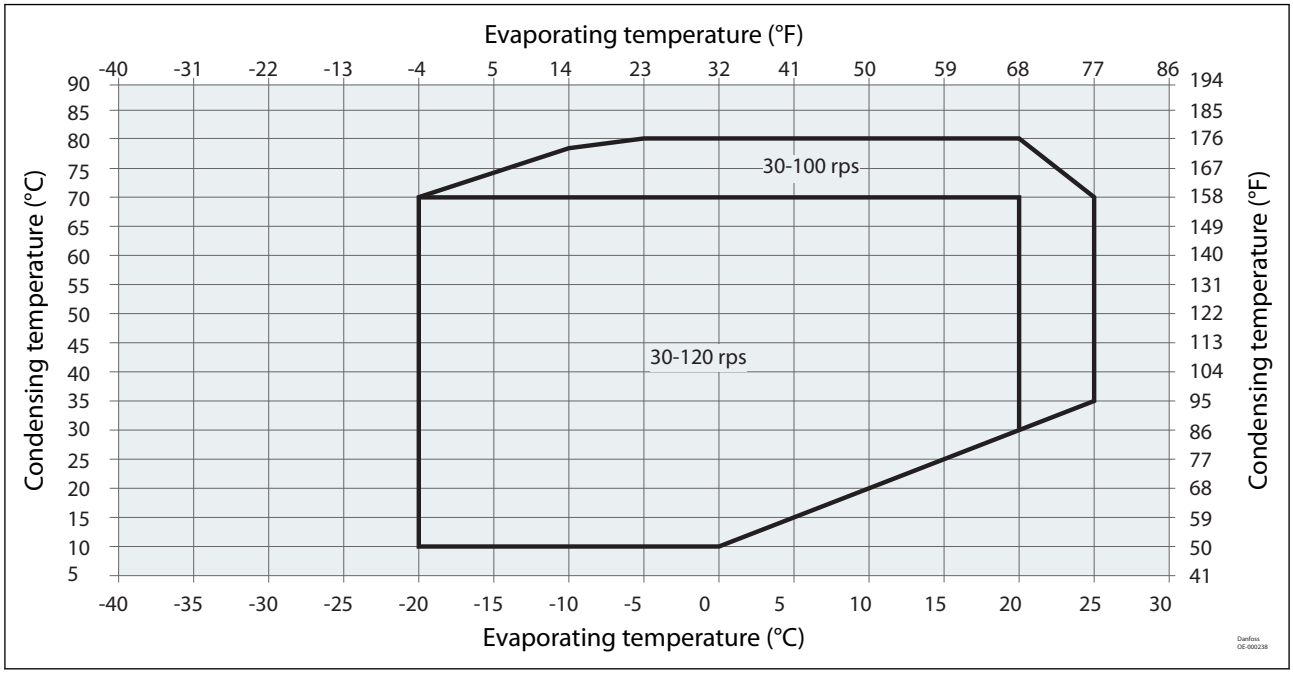


Figure 6: R513A Operating map for downsize drive

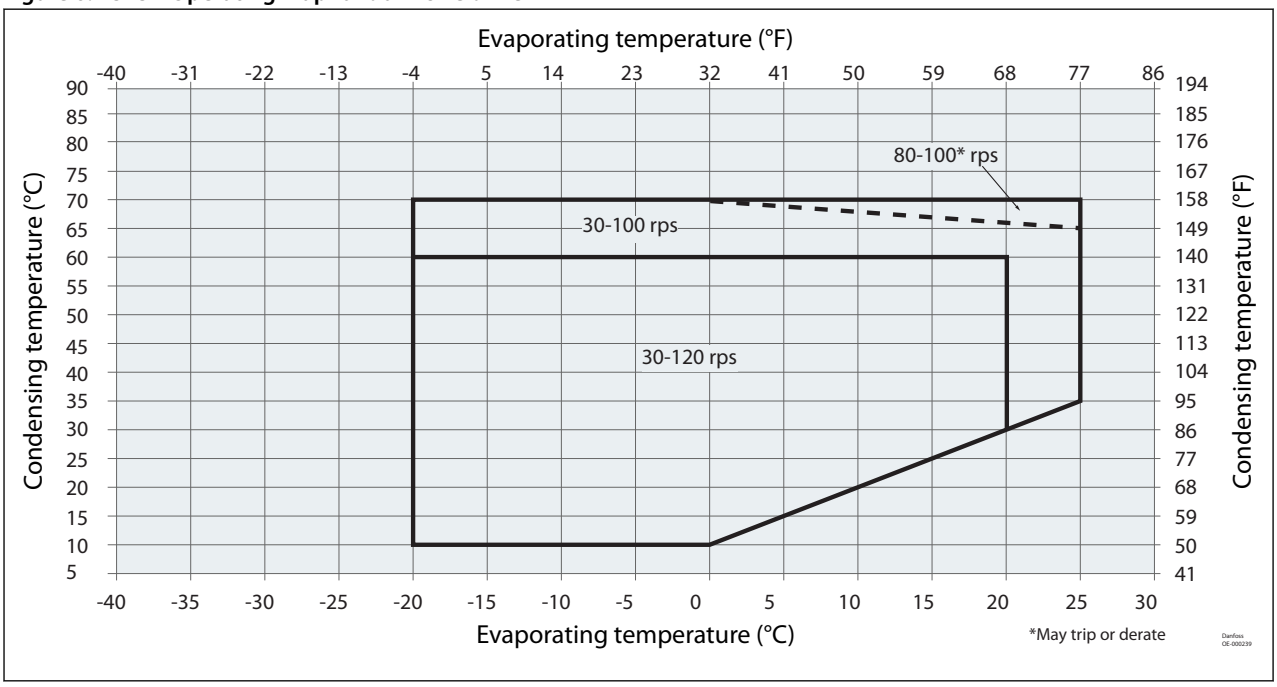
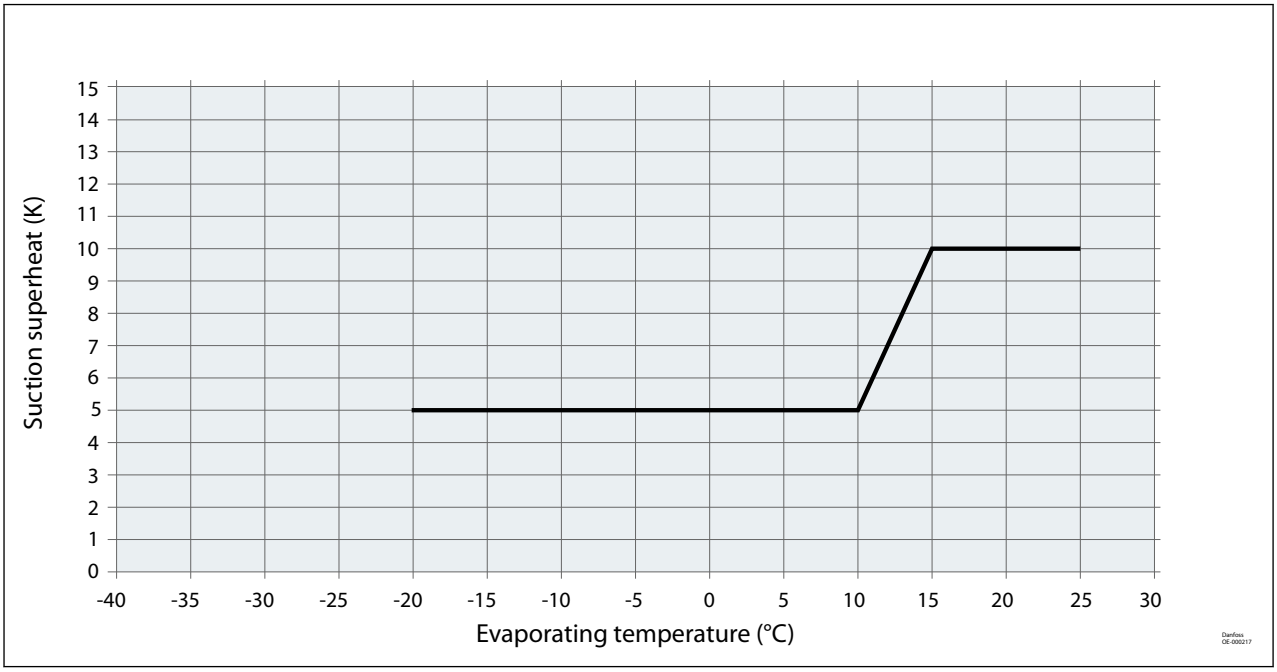


Figure 7: R513A Minimum suction superheat



For VZN R513A, 2 kinds of map defined according to standard drive and downsize drive.

Compressor model	Standard drive	Downsize drive
VZN086	CDS203 15kW	CDS203 11kW
VZN104	CDS203 18.5kW	CDS203 11kW
VZN140	CDS203 22kW	CDS203 15kW
VZN175	CDS203 30kW	CDS203 18.5kW

Higher suction superheat may lead to discharge temperature above 150°C for VZN086-175 with R290/R513A and above 150°C for VZN220 with R290.

Moreover, the discharge gas temperature must not exceed 150°C for VZN086-104-140-175-220.

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

NOTE:
R290 is classified as A3 flammable refrigerant.

Pressure settings

Table 7: Pressure settings

Pressure settings	VZN086-104-140-175-220	VZN086-104-140-175	VZN086-104-140-175
	R290	R513A for std drive	R513A for downsize drive
	bar(g)		
Working pressure range high side	5.4-31.5	3.5-25.9	3.5-20.8
Working pressure range low side	0.7-8.5	0.5-6.1	0.5-6.1
Maximum high pressure safety switch setting	33	27.3	21.9
Minimum low pressure safety switch setting	0.5	0.3	0.3
Recommended pump-down switch settings	1.5 bar below nominal evaporating pressure		
Minimum low pressure pump-down switch setting	0.7	0.5	0.5

NOTE:
R290 is classified as A3 flammable refrigerant.

Dimensions

VZN086-104-140-175-220 With oil sight glass

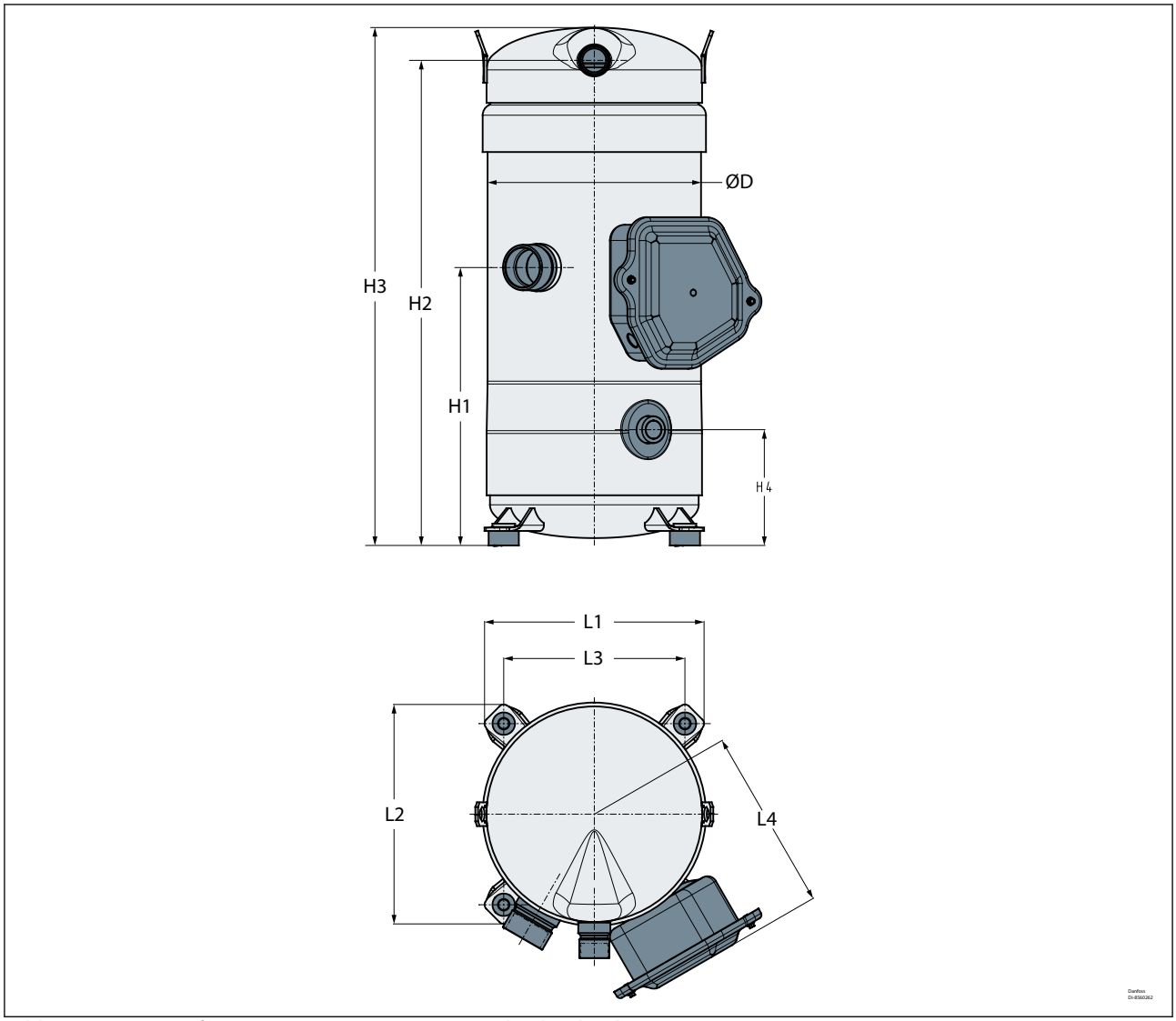


Table 8: Dimensions for VZN086-104-140-175-220 with oil sight glass

compressor model	D		H1		H2		H3		H4		L1		L2		L3		L4		Outline drawing number
	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	
VZN086	224.4	8.83	292.25	11.5	486.25	19.1	521.75	20.5	121.75	4.79	230.8	9.09	230.8	9.09	190.5	7.5	191.7	7.5	8560258
VZN104	224.4	8.83	292.25	11.5	486.25	19.1	521.75	20.5	121.75	4.79	230.8	9.09	230.8	9.09	190.5	7.5	191.7	7.5	8560258
VZN140	224.4	8.83	292.25	11.5	510.14	20.1	544.64	21.4	121.75	4.79	230.8	9.09	230.8	9.09	190.5	7.5	191.7	7.5	8560262
VZN175	224.4	8.83	292.25	11.5	510.14	20.1	544.64	21.4	121.75	4.79	230.8	9.09	230.8	9.09	190.5	7.5	191.7	7.5	8560262
VZN220	244.4	9.62	324.50	12.7	566.50	22.5	604.00	23.8	115.25	4.54	228.3	8.98	228.3	8.98	190.5	7.5	204.0	8.0	8560353

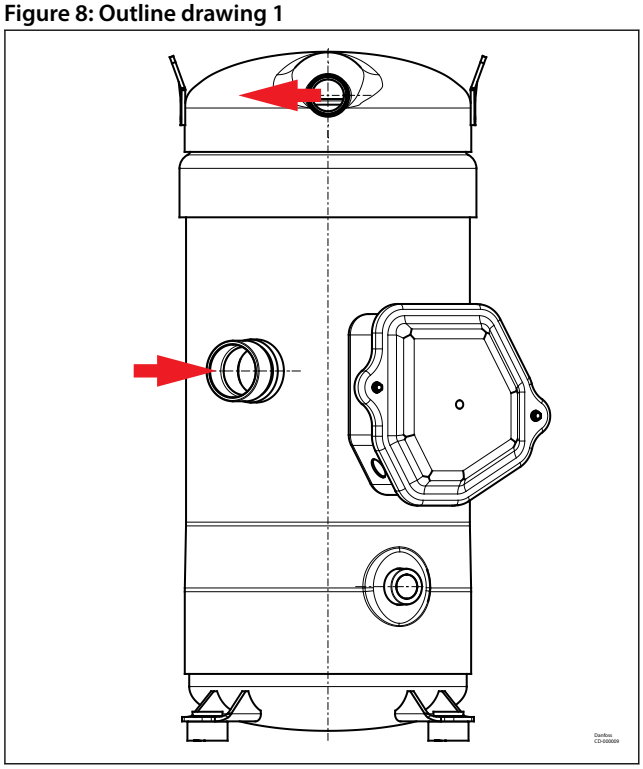
Mechanical connections

Connection Details

Table 9: Connection Details

Connection Details		VZN086-104-140-175	VZN220
Suction connection		1″5/8	
Discharge connection		1″1/8	1″3/8
Oil sight glass		welding	
Outline		1	1

Figure 8: Outline drawing 1



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

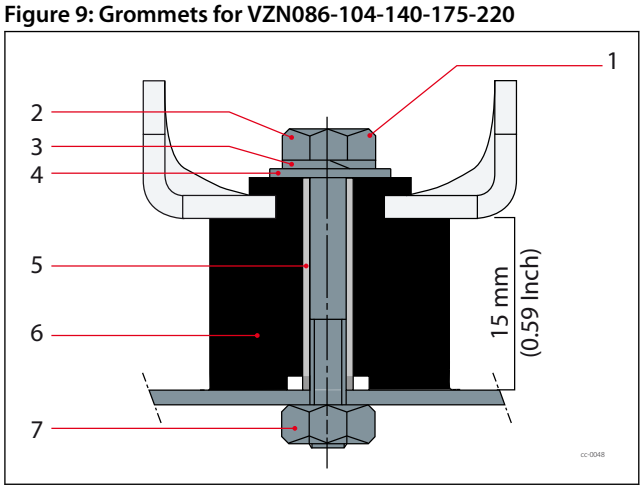
Design compressor mounting

Grommets

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

The required bolt size for the VZN086-104-140-175-220 compressors is HM8-40. This bolt must be tightened to a torque of 15 Nm (11 ft/lbs.).

Figure 9: Grommets for VZN086-104-140-175-220



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

Max inclination

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

System design generalities

Compressor capacity and modulation

R Usually, compressors are selected to cover peak load cooling/heating capacities between 70-140 rps.

Modulation (difference between minimum speed and maximum speed) is a very important point for unit design. The larger the modulation number, the challenging the unit design will be. This would consequently increase unit cost. For example, very low speed running may require the installation of an oil separator to guarantee oil return.

The minimum compressor speed must be defined according to unit need. It often makes sense to set unit minimum speed higher than minimum compressor speed qualified by Danfoss. When running longer time at low speed, an oil-boost might be required, this functionality can get covered by the functions available in the CDS203.

Differences between variable speed and fix speed in unit design

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

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

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

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

Compressor and drive control → Superheat Management → Oil return management → Operating envelope → compressor Mechanical installation → Sound and vibrations management → Drive installation

Electrical connections

Wiring connections

Particular attention must be paid in A3 refrigerant systems as any work on the energized terminals in the compressor terminal box could create an ignition.

Do not touch the energized terminals with a tool or cable when the compressor is energized.

Compressors operating with flammable refrigerants shall use only the qualified terminal box supplied with the compressor.

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

⚠ A cable gland, conduit connector or approved electrical fittings must be used on electrical box's knockouts to protect against accidental contact with electrical parts inside.

Motor protection

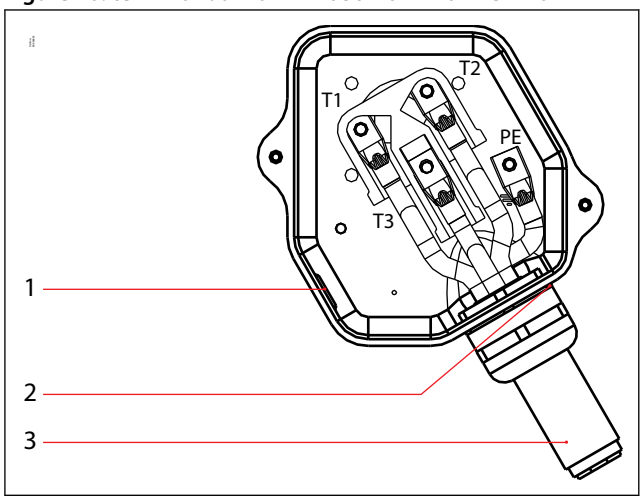
VZN scroll compressors are not equipped with an internal motor protector. Motor protection is provided by the variable speed drive. All parameters are factory preset in order to guaranty locked rotor or overload current protection.

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.

VZN086-104-140-175-220

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

Figure 10: terminal box for VZN086-104-140-175-220



1	Ø16.5mm (Ø0.65inch) knockout
2	Ø40.5mm (Ø1.59inch) hole
3	Power supply

Electrical specifications

IP rating

The compressor terminal box IP rating according to CEI529 is IP54 when correctly sized IP54 rated EMC cable glands are used.

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

Fuses / circuit breakers for CDS203

Suitable fuses to provide wiring protection of the input power cable should be installed in the incoming supply line. The fuses must comply with any local codes or regulations in place. In general, type gG (IEC 60269) or UL type J fuses are suitable; however in some cases type aR fuses may be required. The operating time of the fuses must be below 0.5 seconds.

Where allowed by local regulations, suitably dimensioned type B MCB circuit breakers of equivalent rating may be utilized in place of fuses, providing that the clearing capacity is sufficient for the installation.

Table 10: Fuses / circuit breakers for CDS203

Part Number	Power Rating		Input Current	Continuous Output Current	Overload Output Current	Maximum Output Cable Size	Maximum Motor Cable Length	
	kW	HP	A	A	A	awg	m	ft
CDS203-24P11K-3FXXX	11	15	22	24	31.2	10	20/10	66/33
CDS203-34P15K-3FXXX	15	20	26.5	30	39	6	20/10	66/33
CDS203-34P18K-3FXXX	18.5	25	30.8	39	50.7	6	20/10	66/33
CDS203-44P22K-3FXXX	22	30	37.9	46	59.8	2	20/10	66/33
CDS203-44P30K-3FXXX	30	40	51.9	58	75.4	2	20/10	66/33
CDS203-54P40K-3FXXX	40	50	65.6	75	97.5	2	20/10	66/33

NOTE:
Maximum permissible motor cable without the use of output filters is 10m with shielded cable and 20m with unshielded cable – for all ratings.

Table 11: Fuses for installations compliant with IEC61800-5-1

Part Number	Power Rating		Fuse
	kW	HP	
CDS203-24P11K-3FXXX	11	15	J Type 32 Amp
CDS203-34P15K-3FXXX	15	20	A4J50 by Mersen
CDS203-34P18K-3FXXX	18.5	25	A4J50 by Mersen
CDS203-44P22K-3FXXX	22	30	A4J70 by Mersen
CDS203-44P30K-3FXXX	30	40	A4J70 by Mersen
CDS203-54P40K-3FXXX	40	50	J Type 100 Amp

NOTE:
Testing was carried out using Ferraz Shawmut AJT fuse range. Fuses / MCB's of a lower rating than in the table above can also be used.

Table 12: Fuses for installations compliant with UL 61800-5-1

Part Number	Power Rating		Fuse
	kW	HP	
CDS203-24P11K-3FXXX	11	15	L70QS 35 Amp
CDS203-34P15K-3FXXX	15	20	A4J50 by Mersen
CDS203-34P18K-3FXXX	18.5	25	A4J50 by Mersen
CDS203-44P22K-3FXXX	22	30	A4J70 by Mersen
CDS203-44P30K-3FXXX	30	40	A4J70 by Mersen
CDS203-54P40K-3FXXX	40	50	AJT100 by Mersen

NOTE:
Drive models, CDS203-34P15k-3FXXX, CDS203-34P18k-3FXXX, CDS203-44P22k-3FXXX, CDS203-44P30k-3FXXX & CDS203- 54P40k-3FXXX are suitable for use on a circuit capable of delivering not more than 100kA RMS symmetrical Amperes at max Volts and when protected with Class J fuses with ratings in the above table

Compressors 3 phase electrical characteristics

Table 13: Compressors 3 phase electrical characteristics

Refrigerant	Volt	Compressor	RW[1]	MOC	MRC
			(Ohm)	(A)	(A)
R290	380-480 Volt	VZN086	0.085	27	26.5
		VZN104	0.085	32	30.8
		VZN140	0.06	42	37.9
		VZN175	0.06	52	51.9
	380-415 Volt	VZN220	0.039	66	65.6
R513A Standard Drive	380-480 Volt	VZN086	0.085	23	26.5
		VZN104	0.085	27	30.8
		VZN140	0.06	37.5	37.9
		VZN175	0.06	47	51.9
R513A Downsize Drive	380-480 Volt	VZN086	0.085	19	22
		VZN104	0.085	21.8	22
		VZN140	0.06	27	26.5
		VZN175	0.06	35	30.8

[1] Winding resistance per phase

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 (Max Rated Current)

Maximum rated current is the current at the input of drive and value is the current rating of drive.

Phase sequence and reverse rotation protection

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

- CDS terminal U to VZN terminal T1
- CDS terminal V to VZN terminal T2
- CDS terminal W to VZN terminal T3

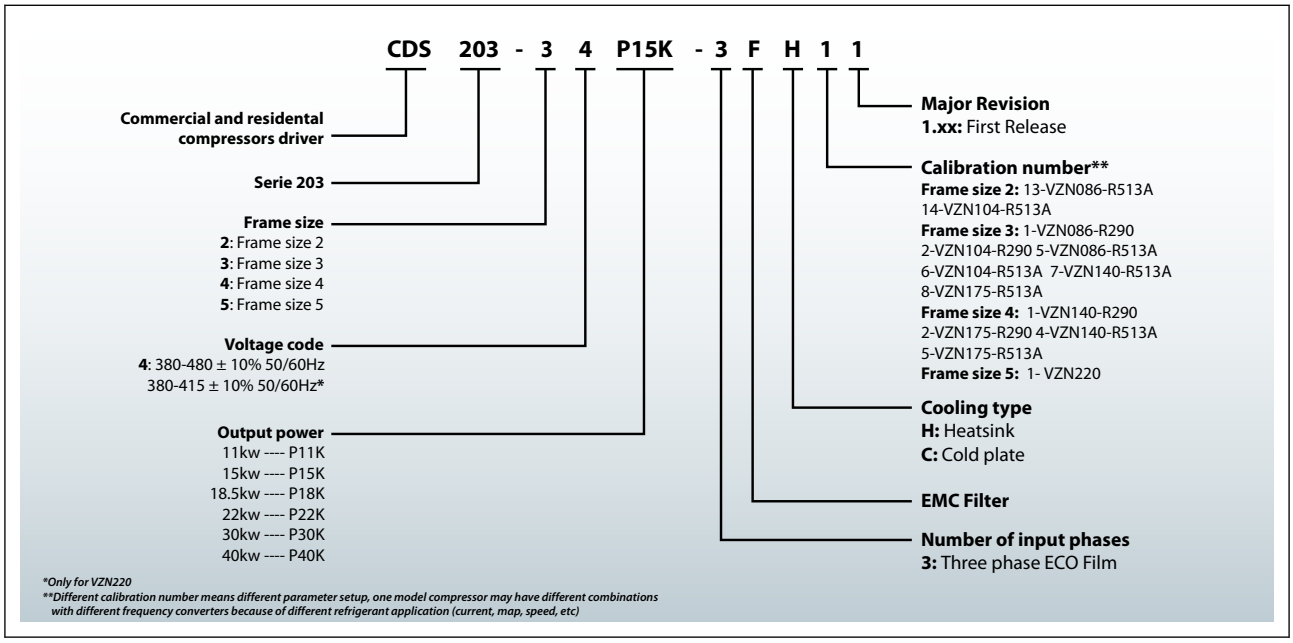
If compressor T1/T2/T3 and drive U, V & W terminals are not matching, the compressor can operate in a reverse rotation. This results in excessive noise and no pressure differential between suction and discharge, and suction line warming rather than immediate cooling (damage is in seconds, very little temp delta can be measured). The

compressor can be rapidly damaged in these conditions. Reverse rotation of the compressor for only a few seconds can quickly cause irreversible damage to the scroll sets. Before starting always review the wiring and be prepared to shutoff immediately in case of noise. If reverse rotation symptoms occur, shut the compressor down and connect the phases to their proper terminals. Allow the compressor to run and then check amps at operating condition versus Danfoss published performance data to see if there was damage.

Frequency converter CDS203

Product identification

Frequency converter nomenclature



*Only for VZN220
**Different calibration number means different parameter setup, one model compressor may have different combinations with different frequency converters because of different refrigerant application (current, map, speed, etc)

Technical specification

Frequency converter technical specifications

Table 14: Frequency converter technical specifications

Features	Description
Mains supply voltage	FS 2,3,4: 380-480V ±10% (3-phase) FS 5: 380-415V ±10% (3-phase)
Supply frequency	50 / 60 Hz
Output voltage	0 - 100 % of supply voltage
Inputs	1 digital (0-24V), 1 analog (0-10V or 0-20mA or 4-20mA or PTC) 2 STO (safe torque off), 1 RS485 Modbus serial communication
Programmable outputs	1 relay
Protection functions	Over-current protection, high current handling
Compressor functions	Motor protection, compressor ramp up/down control, oil boost

Frequency converter variants

Different frequency converter variants are available according to Cooling type:

- Heatsink
- Cold plate: An inlet temperature of 30 to 50 °C is recommended to prevent condensation.

Operating Frequency and Speed Range

This compressor is equipped with a six poles electrical motor so the applied frequency from the inverter will be 90 Hz for 30 rps (1800 rpm) up to 420 Hz for 140 rps (8400 rpm). Please refer to the table below

Table 15: Conversion table speed and frequency relationship for 6 poles motor

Compressor speed			Drive output frequency
min./max.	rps	rpm	Hz
min.	30	1800	90
max.	140	8400	420

Dimensions

CDS203 Frequency converter dimensions

Frequency converter dimensions depend on supply voltage and power. The table below gives an overview of the overall dimensions and different drive enclosures Frame Size 2,3,4 and 5. Details for each drive enclosure are on the following pages.

CDS203 11kW frame size 2 drive dimensions - Heatsink version

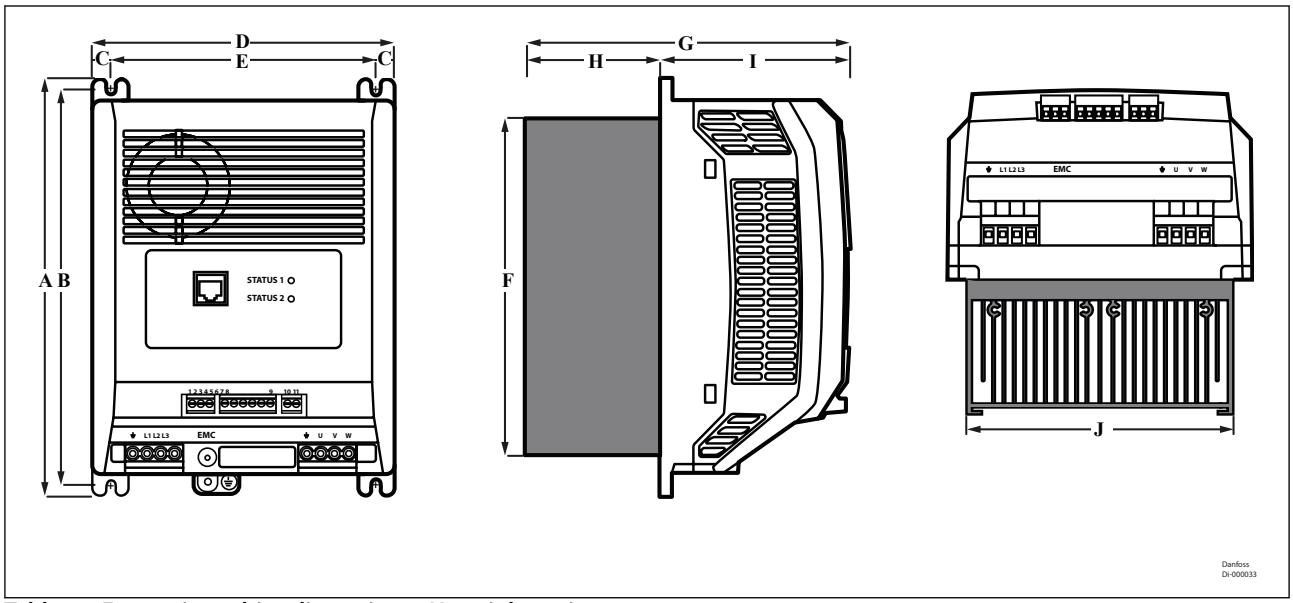


Table 16: Frame size 2 drive dimensions - Heatsink version

Frame size	A		B		C		D		E		F		G		H		I		J	
	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in
2	226.3	8.9	215.2	8.5	10	0.4	165.3	6.5	144.8	5.7	182	7.2	177	7	71.7	2.8	104.4	4.1	145	5.7

Tightening Torques		
	Required Torque	
Control Terminals	0.5 Nm	4.5 lb-in
Power Terminals	1 Nm	9 lb-in

Weights	
All Heatsink Drives	3.1 kg

CDS203 15kW/18kW frame size 3 drive dimensions - Heatsink version

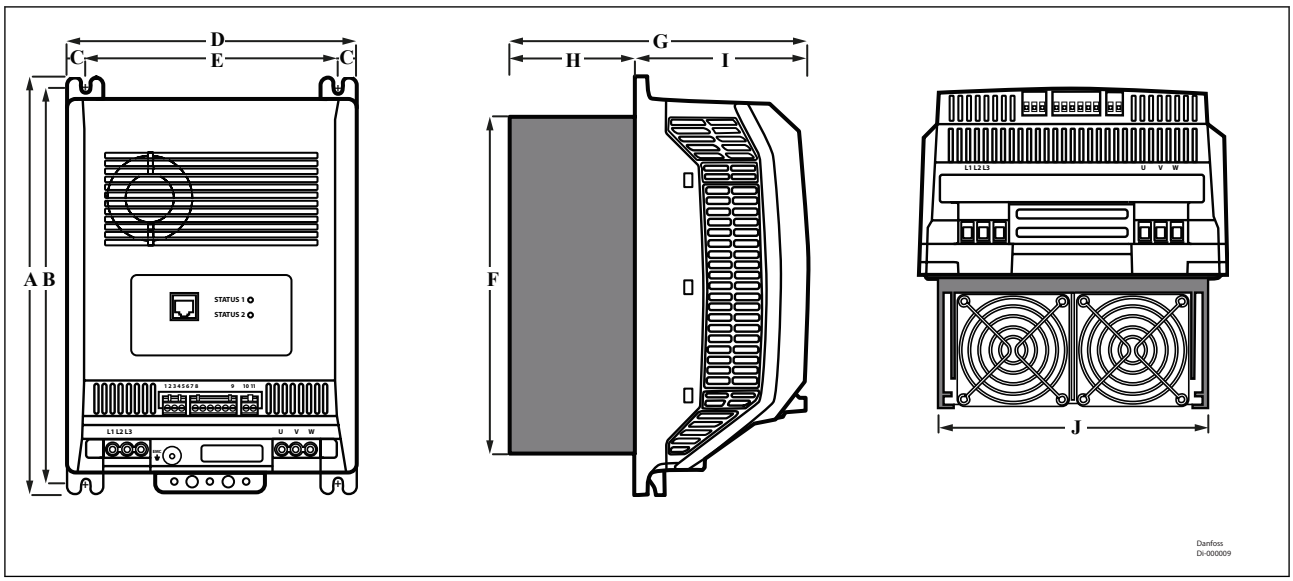


Table 17: Frame size 3 drive dimensions - Heatsink version

Frame size	A		B		C		D		E		F		G		H		I		J	
	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in
3	277.5	10.9	262.6	10.3	12.4	0.5	193.6	7.6	168.9	6.6	224	8.8	200.3	7.9	84.3	3.3	116	4.6	170	6.7

Tightening Torques		
	Required Torque	
Control Terminals	0.5 Nm	4.5 lb-in
Power Terminals	2 Nm	18 lb-in

Weights	
All Heatsink Drives	5 kg

CDS203 22kW/30kW frame size 4 drive dimensions - Heatsink version

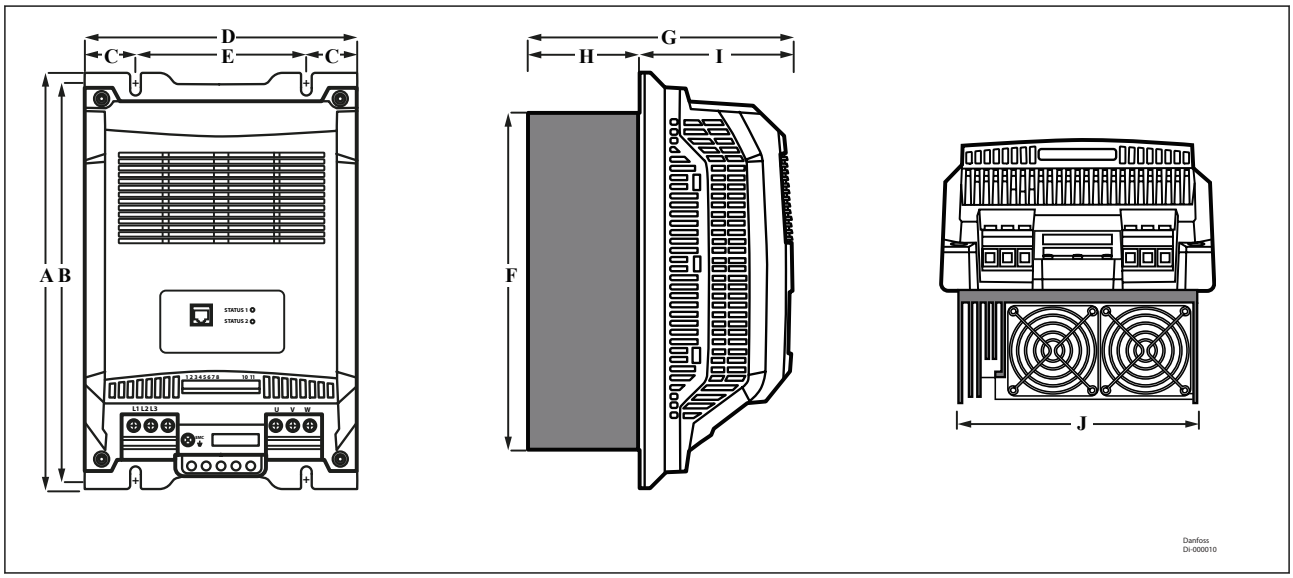


Table 18: Frame size 4 drive dimensions - Heatsink version

Frame size	A		B		C		D		E		F		G		H		I		J	
	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in
4	364	14.3	337	13.3	44.8	1.8	239.5	9.4	150	5.9	291.5	11.5	231	9.1	98	3.9	133	5.2	209.5	8.2

Tightening Torques		
	Required Torque	
Control Terminals	0.5 Nm	4.5 lb-in
Power Terminals	2 Nm	18 lb-in

Weights	
All Heatsink Drives	9.5kg

CDS203 40kW frame size 5 drive dimensions - Heatsink version

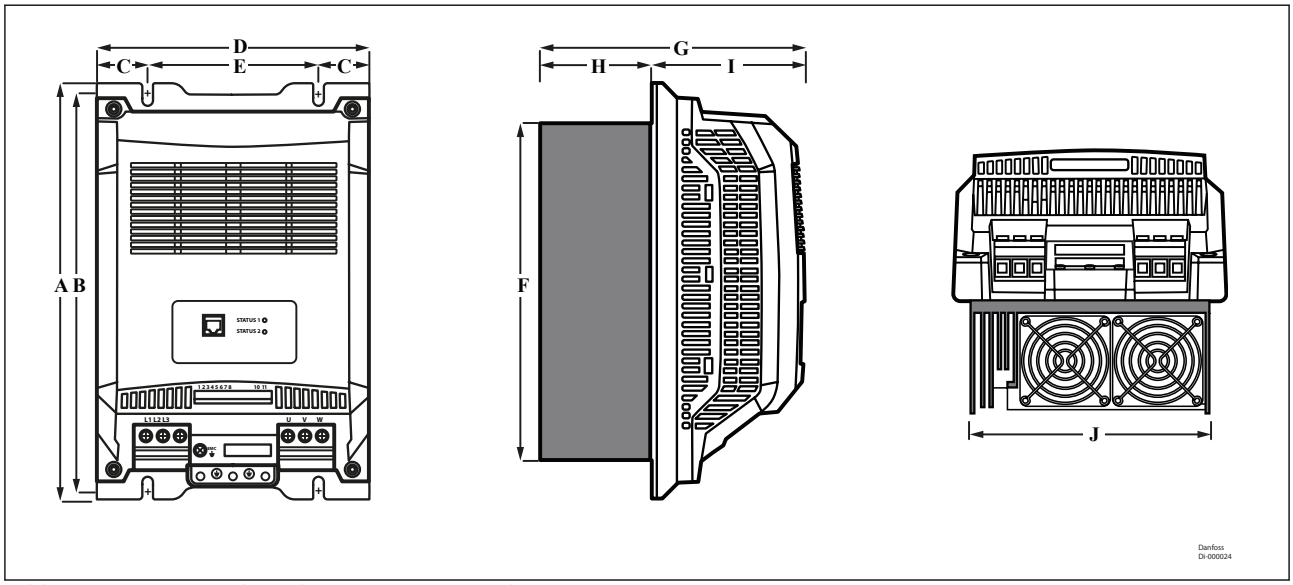


Table 19: Frame size 5 drive dimensions - Heatsink version

Frame size	A		B		C		D		E		F		G		H		I		J	
	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in
5	364	14.3	337	13.3	44.8	1.8	239.5	9.4	150	5.9	291.5	11.5	239.5	9.4	107	4.2	133	5.2	209.5	8.2

Tightening Torques		
	Required Torque	
Control Terminals	0.5 Nm	4.5 lb-in
Power Terminals	2 Nm	18 lb-in

Weights	
All Heatsink Drives	10 kg

CDS203 11kW frame size 2 drive dimensions - Coldplate version

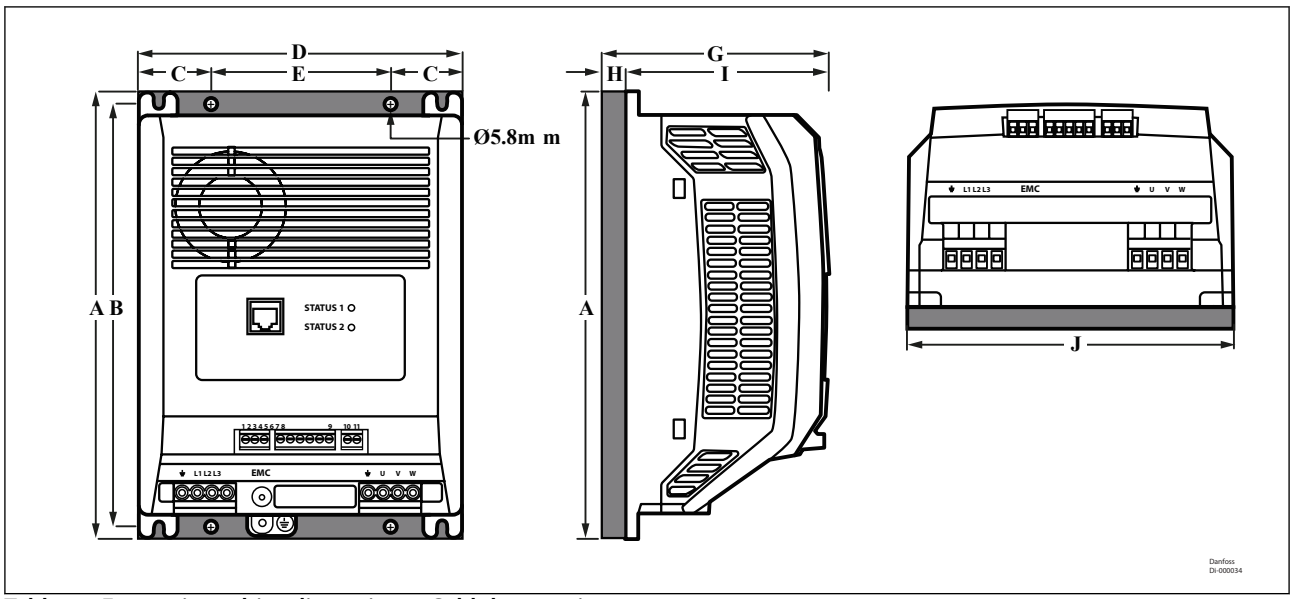


Table 20: Frame size 2 drive dimensions - Coldplate version

Frame size	A		B		C		D		E		G		H		I		J	
	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in
2	226.3	8.9	215.2	8.5	37.6	1.4	165.3	6.5	90	3.5	113.9	4.5	9.5	0.4	104.4	4.1	165.3	6.5

Tightening Torques		
	Required Torque	
Control Terminals	0.5 Nm	4.5 lb-in
Power Terminals	1 Nm	9 lb-in

Weights	
All Coldplate Drives	2 kg

CDS203 15kW/18kW frame size 3 drive dimensions - Cold plate version

Figure 11: Frame Size 3 Drive - Coldplate Version

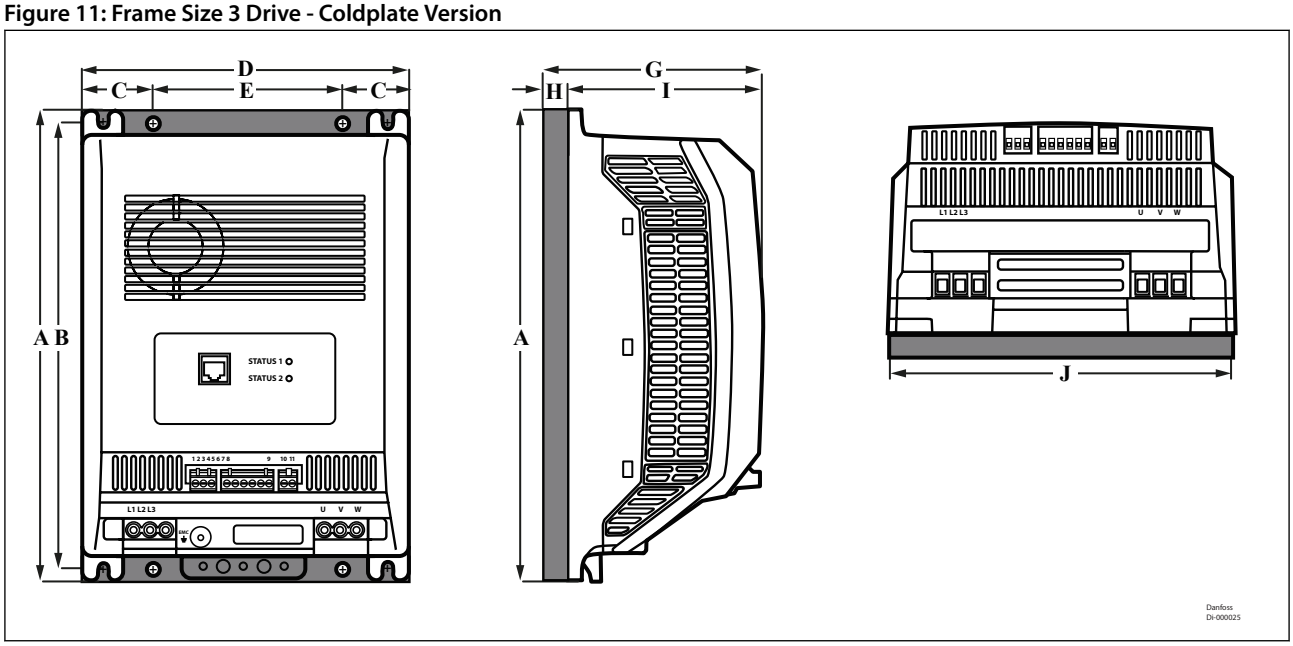


Table 21: Frame size 3 drive dimensions - Cold plate version

Frame size	A		B		C		D		E		G		H		I		J	
	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in
3	277.8	10.9	262.6	10.3	41.8	1.6	193.6	7.6	110	4.3	125.8	5	9.8	0.4	116	4.6	194.1	7.6

Tightening Torques		
	Required Torque	
Control Terminals	0.5 Nm	4.5 lb-in
Power Terminals	2 Nm	18 lb-in

Weights	
All Coldplate Drives	3.1 kg

CDS203 22kW/30kW frame size 4 drive dimensions - Cold plate version

Figure 12: Frame Size 4 Drive - Coldplate Version

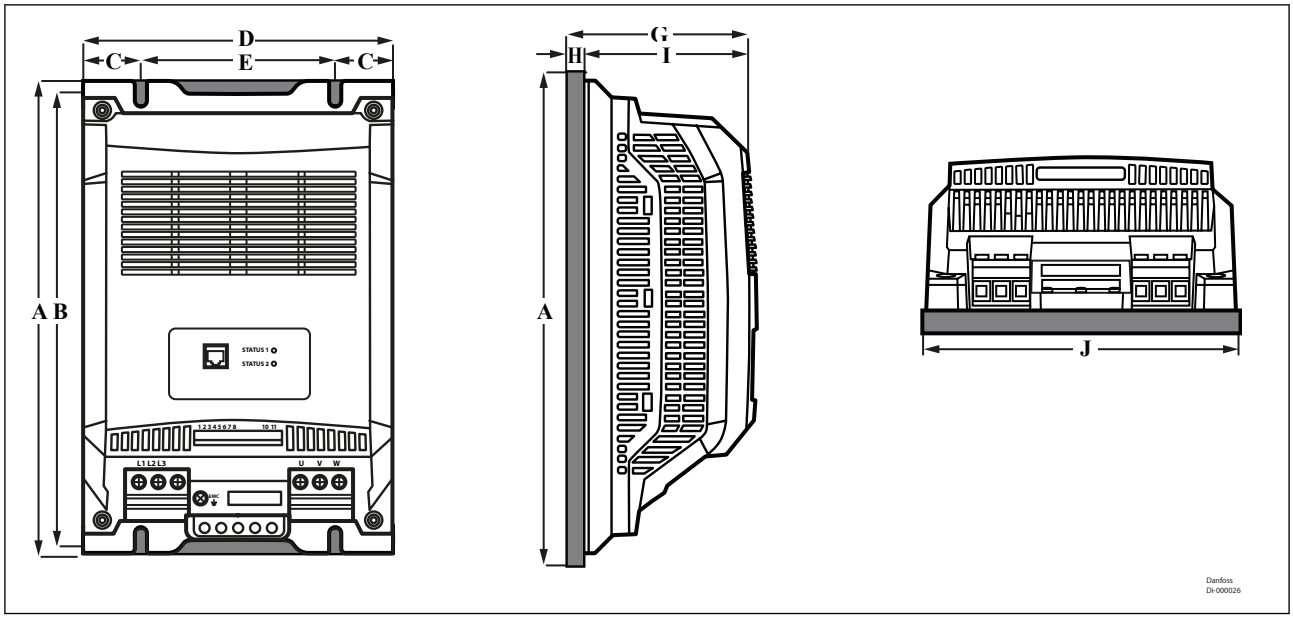


Table 22: Frame size 4 drive dimensions - Cold plate version

Frame Size	A		B		C		D		E		F		G		H		I		J	
	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in
4	364	14.3	337	13.3	310	12.2	239.5	9.4	150	5.9	44.8	1.8	140.3	5.5	98	4.4	130.5	5.1	232.5	9.2

Tightening Torques		
	Required Torque	
Control Terminals	0.5 Nm	4.5 lb-in
Power Terminals	2 Nm	18 lb-in

Weights	
All Coldplate Drives	5 kg

CDS203 40kW frame size 5 drive dimensions - Cold plate version

Figure 13: Frame Size 5 Drive - Coldplate Version

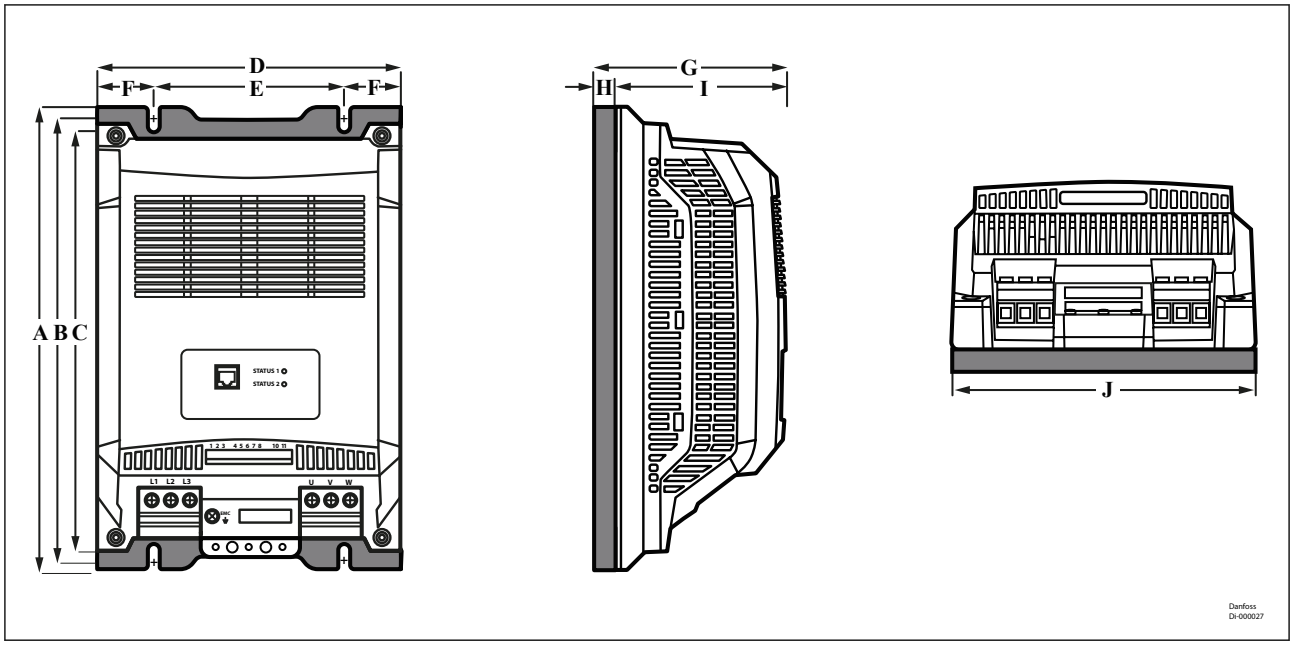
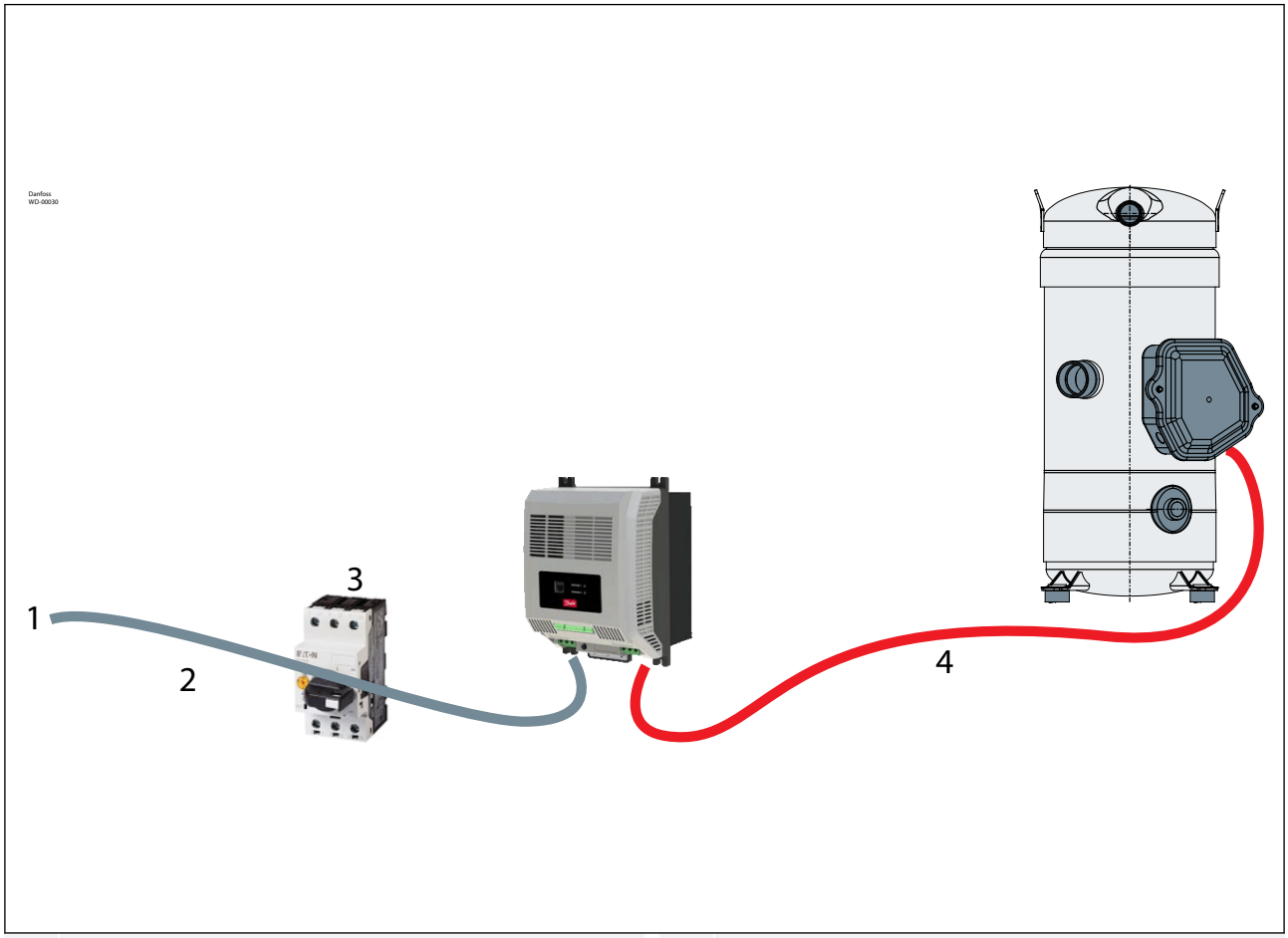


Table 23: Frame size 5 drive dimensions - Cold plate version

Frame Size	A		B		C		D		E		F		G		H		I		J	
	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in
5	364	14.3	337	13.3	310	12.2	239.5	9.4	150	5.9	44.8	1.8	140.3	5.5	98	4.4	130.5	5.1	232.5	9.2

Electrical connections

Wire sizes



1	Power input	3	Fuses/Circuit breaker
2	From network to drive	4	From drive to to compressor

Table 24: Maximum wiring sizes for the motor compressor power supply cables

Voltage range	From network to frequency converter			From frequency converter to compressor		
	Type	mm²	AWG	Type	mm²	AWG
380 - 480 V	CDS203 - 15 kW	16	6	VZN086 R290/R513A Std drive	16	6
380 - 480 V	CDS203 - 18.5 kW	16	6	VZN104 R290/R513A Std drive	16	6
380 - 480 V	CDS203 - 22 kW	35	2	VZN140 R290/R513A Std drive	35	2
380 - 480 V	CDS203 - 30 kW	35	2	VZN175 R290/R513A Std drive	35	2
380 - 415 V	CDS203 - 40 kW	35	2	VZN220	35	2
380 - 480 V	CDS203 - 11 kW	6	10	VZN086 R513A Down-size drive	6	10
380 - 480 V	CDS203 - 11 kW	6	10	VZN104 R513A Down-size drive	6	10
380 - 480 V	CDS203 - 15 kW	16	6	VZN140 R513A Down-size drive	16	6
380 - 480 V	CDS203 - 18.5 kW	16	6	VZN175 R513A Down-size drive	16	6

NOTE:
The wire size values are the maximum size the converter can accept. The required cable size should be specified by the OEM depending on the unit design, ambient temperature, the wire material, current, etc...

Electrical specifications

Supply voltage

Because VZN 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.

VZN all published data, Coolselector data and polynomials are based on 400V frequency converter power supply for code G.

Table 25: Mains voltage range of drive

Voltage code	Mains voltage range of drive
G	Frame size 2,3,4:380-480V ±10% (3-phase)
	Frame size 5: 380-415V ±10% (3-phase)

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

Fuses / circuit breakers

For details please see Fuses / circuit breakers for CDS203.

Soft-start control

The CDS203 frequency converter generates by design a compressor soft start.

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.

Frequency converter installation

Direct and indirect exposure of frequency converter to water

For outdoor use the electrical cabinet must be IP54. Application example: rooftop units or condensing units.

It is recommended to place frequency converter at least 30cm (11.81 inches) from ground to protect against floods.

Dust Exposure

Avoid dust from depositing on the frequency converter surface, circuit boards and other electric components. These deposits act as insulation layers and hamper heat transfer to the ambient air, reducing the cooling capacity. The increased heat load causes an accelerated aging of the electrical components, thus decreasing the service life. Dust deposits that accumulate on the heat sink located on the back of the VFD will also decrease the service life of the unit.

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

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

Mechanical mounting

CDS203 11kW frame size 2 ventilation and clearance

In order for the frequency converter to maintain its temperature, a minimum clearance is required around the frequency converter as shown in the diagram below:

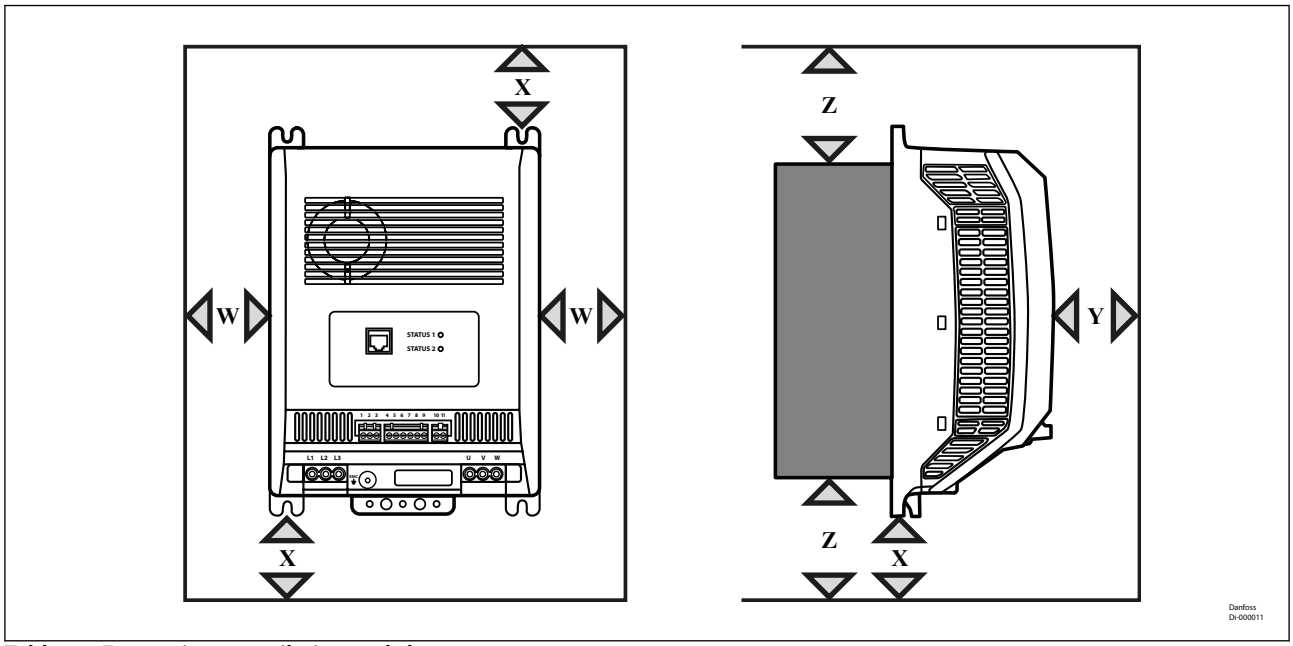


Table 26: Frame size 2 ventilation and clearance

W		X		Y		Z	
mm	in	mm	in	mm	in	mm	in
20	0.78	78	3.07	10	0.39	100	3.94

CDS203 15kW/18kW frame size 3 ventilation and clearance

In order for the frequency converter to maintain its temperature, a minimum clearance is required around the frequency converter as shown in the diagram below:

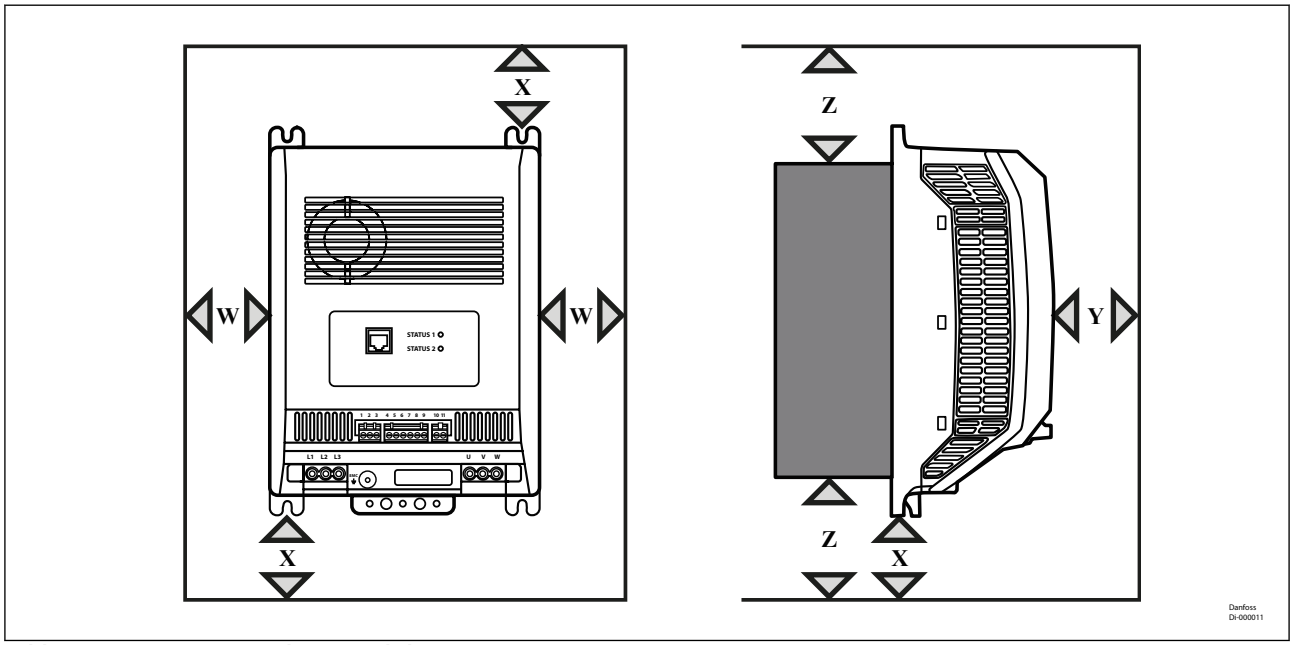


Table 27: Frame size 3 ventilation and clearance

W		X		Y		Z	
mm	in	mm	in	mm	in	mm	in
20	0.78	75	2.95	20	0.78	100	3.94

CDS203 22kW/30kW frame size 4 ventilation and clearance

In order for the frequency converter to maintain its temperature, a minimum clearance is required around the frequency converter as shown in the diagram below:

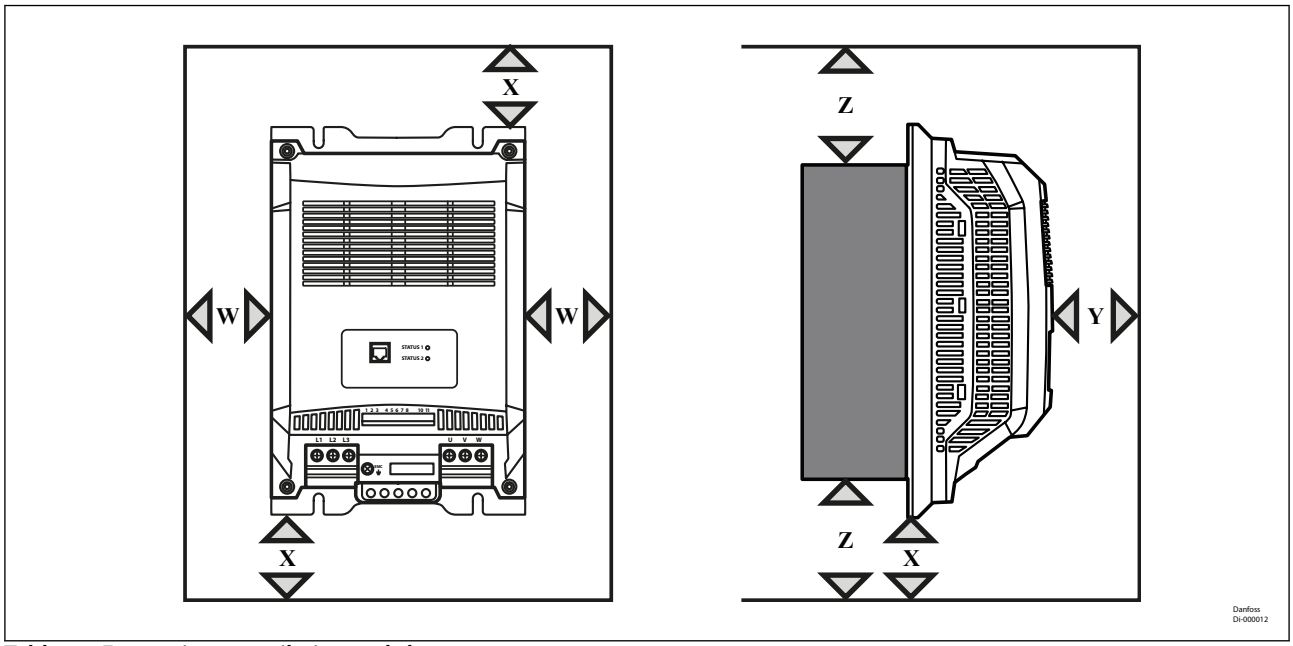


Table 28: Frame size 4 ventilation and clearance

W		X		Y		Z	
mm	in	mm	in	mm	in	mm	in
20	0.78	65	2.56	20	0.78	100	3.94

CDS203 40kW frame size 5 ventilation and clearance

In order for the frequency converter to maintain its temperature, a minimum clearance is required around the frequency converter as shown in the diagram below:

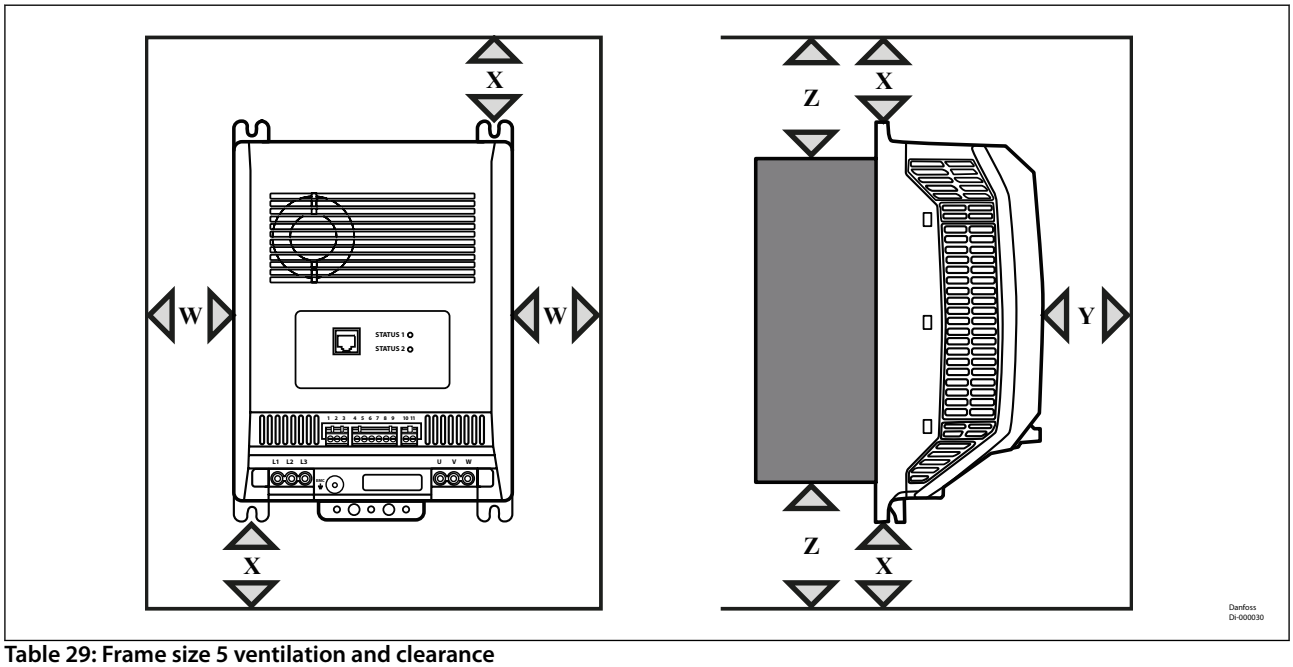


Table 29: Frame size 5 ventilation and clearance

W		X		Y		Z	
mm	in	mm	in	mm	in	mm	in
20	0.787	20	0.78	20	0.78	100	3.94

CDS203 11kW frame size 2 through panel mounting

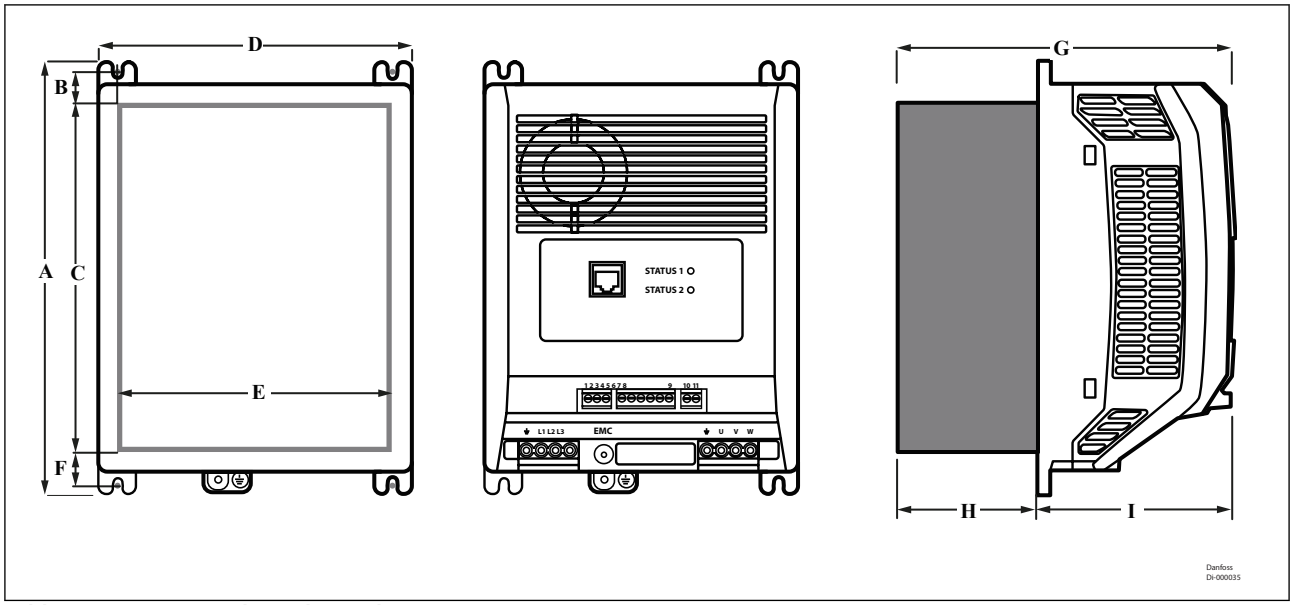


Table 30: Frame size 2 through panel mounting

A		B		C		D		E		F		G		H		I	
mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in
226.3	8.9	15.6	0.6	184	7.2	165.3	6.5	147	5.8	15.6	0.6	178	7	73.6	2.9	104.4	4.1

CDS203 15kW/18kW frame size 3 through panel mounting

Through panel mounting is the most efficient installation in terms of both panel space and thermal management. With the heatsink protruding through the back of the electrical panel, the heat generated by the drive will be exhausted outside of the electrical panel.

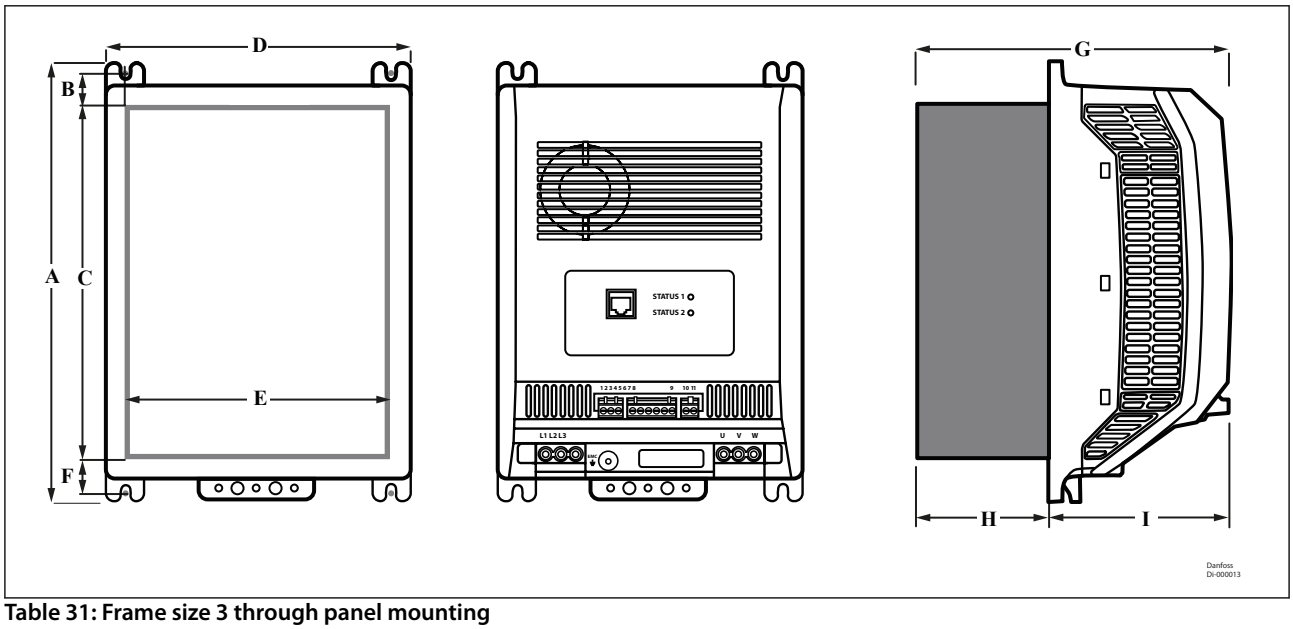


Table 31: Frame size 3 through panel mounting

A		B		C		D		E		F		G		H		I	
mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in
277.5	10.9	18.8	0.7	227.1	8.9	193.6	7.6	173.1	6.8	16.7	0.7	200.3	7.9	84.3	3.3	116.0	4.6

CDS203 22kW/30kW frame size 4 through panel mounting

Through panel mounting is the most efficient installation in terms of both panel space and thermal management. With the heatsink protruding through the back of the electrical panel, the heat generated by the drive will be exhausted outside of the electrical panel.

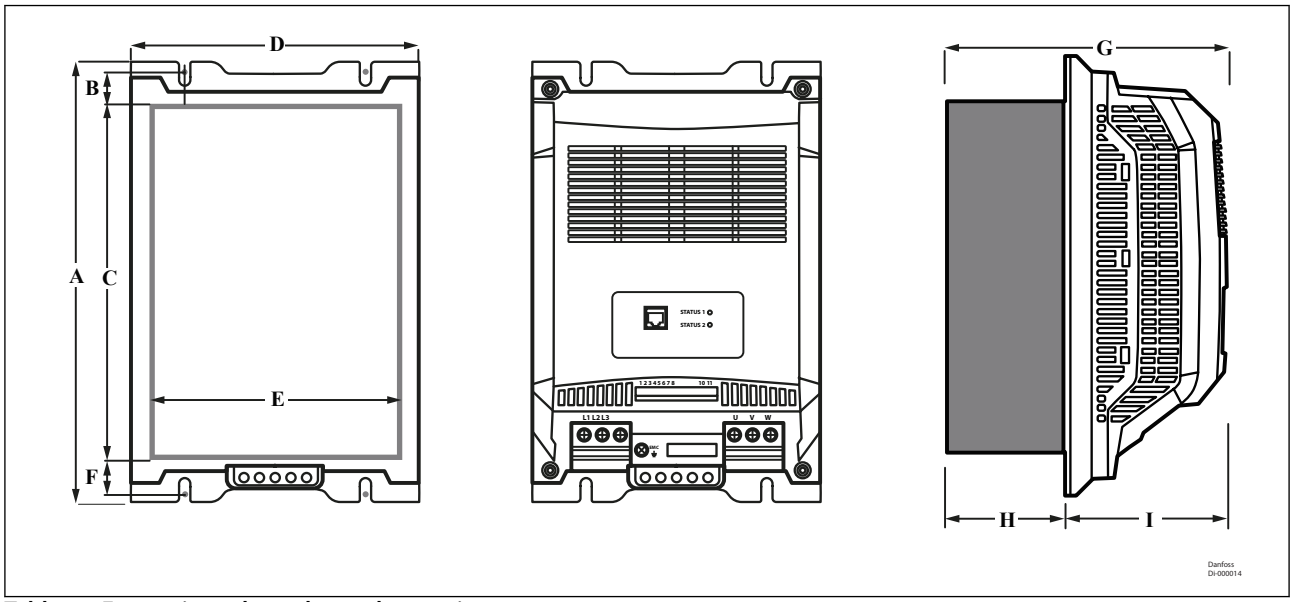


Table 32: Frame size 4 through panel mounting

A		B		C		D		E		F		G		H		I	
mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in
364	14.3	21.8	0.9	294.5	11.6	239.5	9.4	212.5	8.4	19.9	0.8	231	9.1	98	3.9	133	5.2

CDS203 40kW frame size 5 through panel mounting

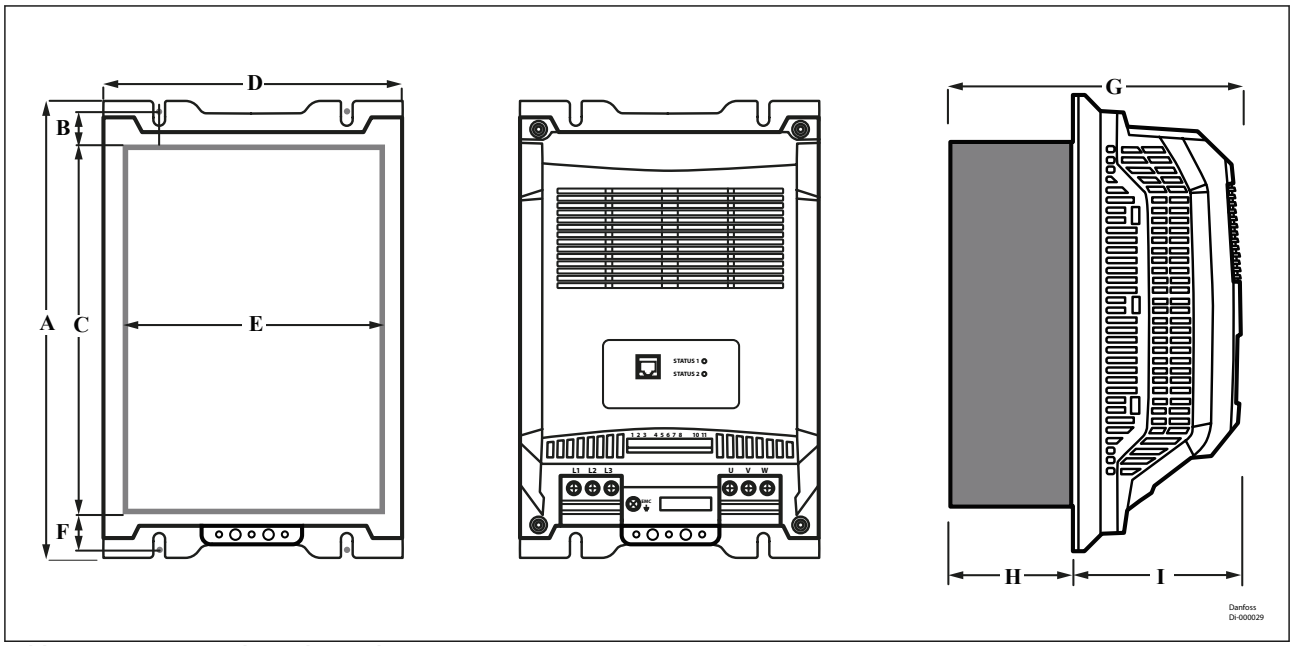


Table 33: Frame size 5 through panel mounting

A		B		C		D		E		F		G		H		J	
mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in
364	14.3	21.4	0.8	293	11.5	239.5	9.4	212.5	8.4	20.3	0.8	239.5	9.4	107	4.2	133	5.2

CDS203 11kW frame size 2 panel mounting (with the panel mounting kit)

If the installation does not lend itself to through panel mounting, the frequency converter can be mounted to a back-plate of a panel using the optional panel mounting kit.

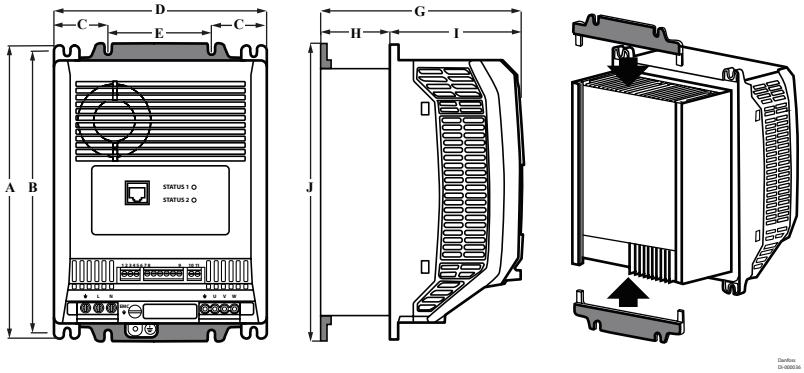


Table 34: Frame size 2 panel mounting (with the panel mounting kit)

A		B		C		D		E		G		H		I		J	
mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in
226.3	8.9	215.2	8.5	42.6	1.6	165.3	6.5	80	3.1	178	7	73.6	2.9	104.4	4.1	228	9

CDS203 15kW/18kW frame size 3 panel mounting (with the panel mounting kit)

If the installation does not lend itself to through panel mounting, the frequency converter can be mounted to a back-plate of a panel using the optional panel mounting kit.

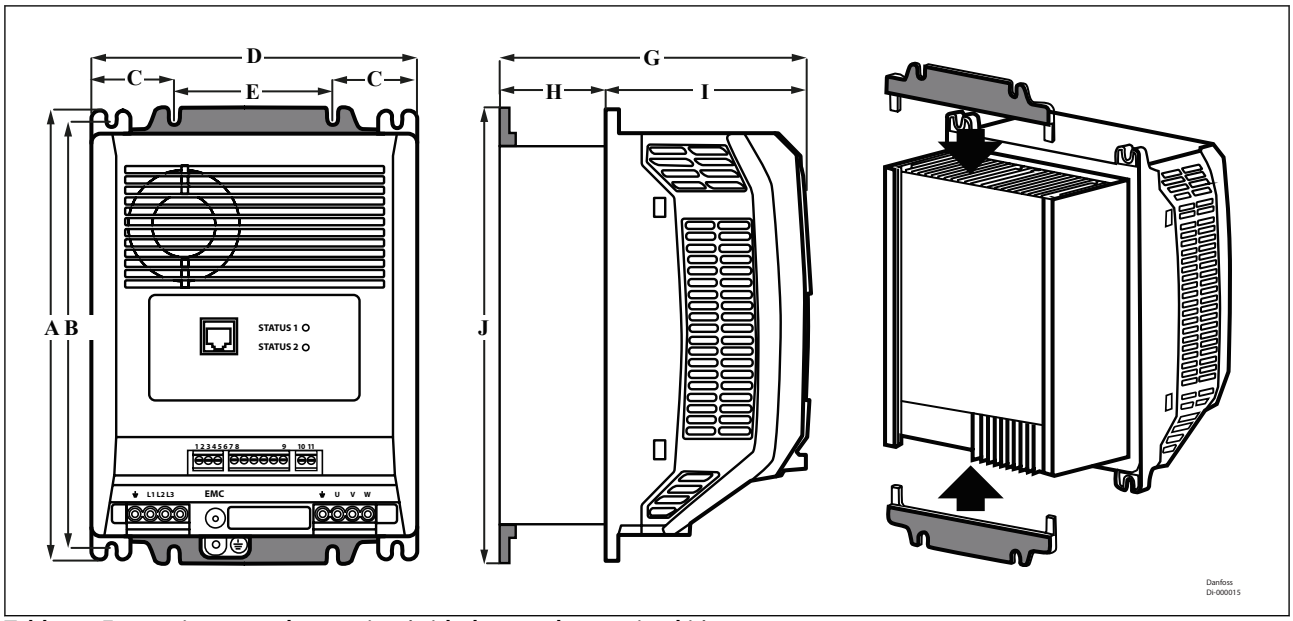


Table 35: Frame size 3 panel mounting (with the panel mounting kit)

A		B		C		D		E		G		H		I		J	
mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in
277.5	10.9	266	10.5	46.8	1.8	193.6	7.6	100	3.9	200.3	7.9	84.3	3.3	116	4.6	282	11.1

CDS203 22kW/30kW frame size 4 panel mounting (with the panel mounting kit)

If the installation does not lend itself to through panel mounting, the frequency converter can be mounted to a back-plate of a panel using the optional panel mounting kit.

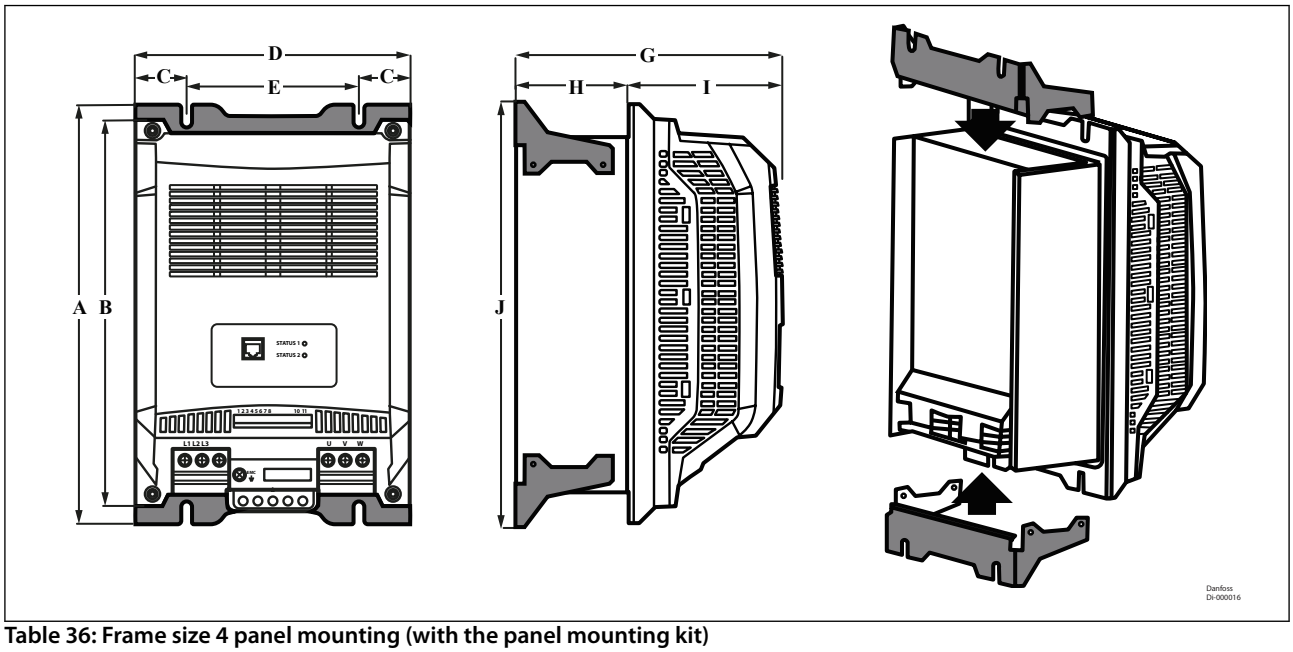


Table 36: Frame size 4 panel mounting (with the panel mounting kit)

A		B		C		D		E		G		H		I		J	
mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in
364	14.3	337	13.3	44.8	1.8	239.5	9.4	150	5.9	233.5	9.2	101.5	4	133	5.2	363.5	14.3

CDS203 40kW fame size 5 panel mounting (with the panel mounting kit)

If the installation does not lend itself to through panel mounting, the frequency converter can be mounted to a back-plate of a panel using the optional panel mounting kit.

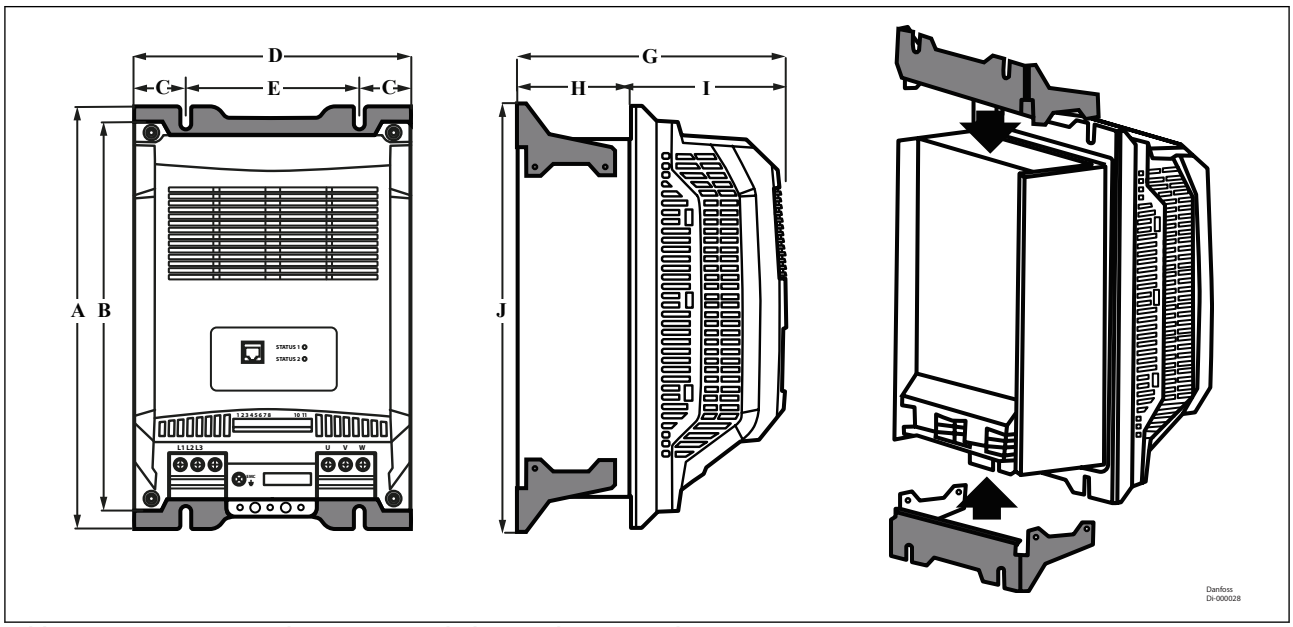


Table 37: Frame size 5 panel mounting (with the panel mounting kit)

A		B		C		D		E		G		H		I		J	
mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in
364	14.3	337	13.3	44.8	1.8	239.5	9.4	150	5.9	244	9.6	110	4.4	133	5.2	363.5	14.3

Drive ambient temperature

The maximum ambient temperature for the frequency converter operation is 60°C (140°F). Do not exceed the maximum temperature limit to make sure the frequency converter lifetime. The frequency converter could not operate lower to -20˚C (-4˚F) with proper operation, such as in the cabinet. If necessary, install a space heater to maintain the ambient temperature on the acceptable range. LCP is optional but its operating temperature is -10 - 50 ˚C.

High Ambient Temperature

In highest ambient environment, test the unit at maximum load condition is recommended. Look for over temperature alarms. Guidelines to support high ambient temperature:

- Ensure clearance limits above and below the frequency converter for air circulation are respected.
- The frequency converter must be installed on a panel wall or on a back plate to ensure proper cooling
- Do not place the frequency converter under direct sunlight.
- Insulation inside the electrical panel can reduce impact of sun radiation.
- Additional air conditioning of the cabinet may be required.

The frequency converter has built-in temperature sensors and reacts immediately to critical values via hard-coded limits. In case of over-temperature inside the frequency converter, it automatically derates the switching frequency and the maximum allowed output current to reduce the internal heat. This can cause the compressor to trip due to insufficient current to drive the compressor.

EMC

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

The EMC Product standard for frequency converters EN61800-3, define 4 categories (C1,C2,C3,C4) with specified requirements for emission. Table 38: Categories for EMC product standard states the definition of the 4 categories and the equivalent classification from EN55011, which is the product family standard for industrial, scientific and medical (ISM), for radio frequency disturbance limits.

The VZN compressor, when equipped with the CDS203 drive and its corresponding filter (116B9006), meets the Class A Group 1 requirements for both conducted and radiated emissions, in accordance with generic EMC standards.

Table 38: Categories for EMC product standard

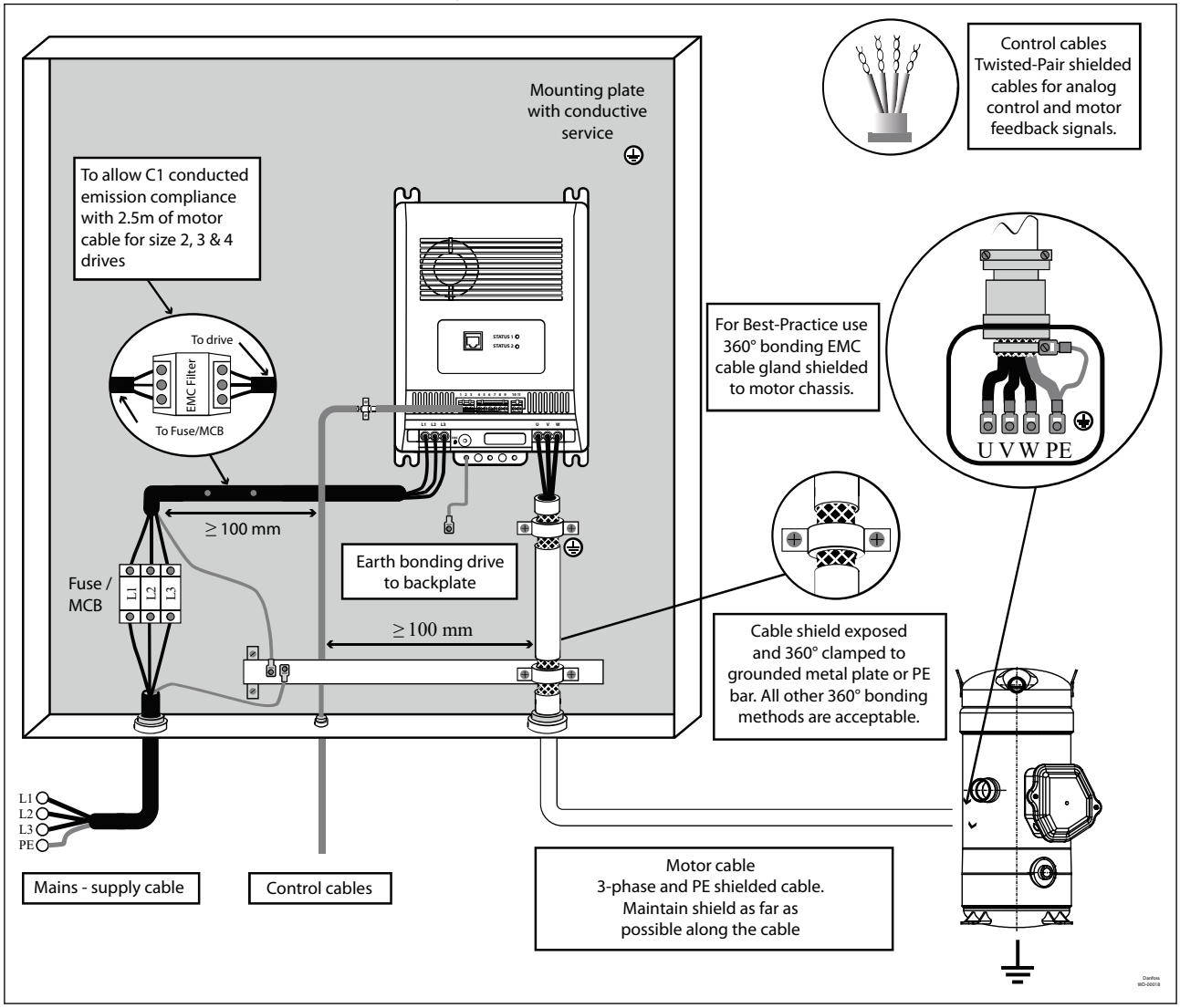
EN61800-3 Category and definitions		Equivalent emission class in EN 55011
C1	Frequency converters installed in the first environment (home and office) with a supply voltage less than 1000 V.	Class B
C2	Frequency converters installed in the first environment (home and office) with a supply voltage less than 1000 V, which are not plug-in and not movable, and must be installed and commissioned by a professional.	Class A Group 1
C3	Frequency converters installed in the second environment (industrial) with a supply voltage lower than 1000 V.	Class A Group 2
C4	Frequency converters installed in the second environment with a supply voltage equal to or above 1000 V or rated current equal to or above 400 A or intended for use in complex systems.	No limit line. Make an EMC plan

NOTE:
EMC level is measured on compressor + drive package running alone in a laboratory environment. EMC emission level will have to be repeated in the final system environment including all other electronic device that could influence the overall emission level.

EMC best practices

- Use screened (shielded) cables for motor, control wiring and communication.
- Separate cables for input power, motor wiring and control wiring. Failure to isolate power, motor, control and communication cables can result in unintended behavior or reduced performance. Minimum 200 mm (7.9 in) clearance between power, motor and control cables is required.
- Ensure VFD proper grounding
- Motor cables should be as short as possible to reduce noise level and leakage currents.

Figure 14: EMC correct installation of a frequency drive CDS203



EMC qualification reports are available upon request to Danfoss technical support.

Application with flammable refrigerants

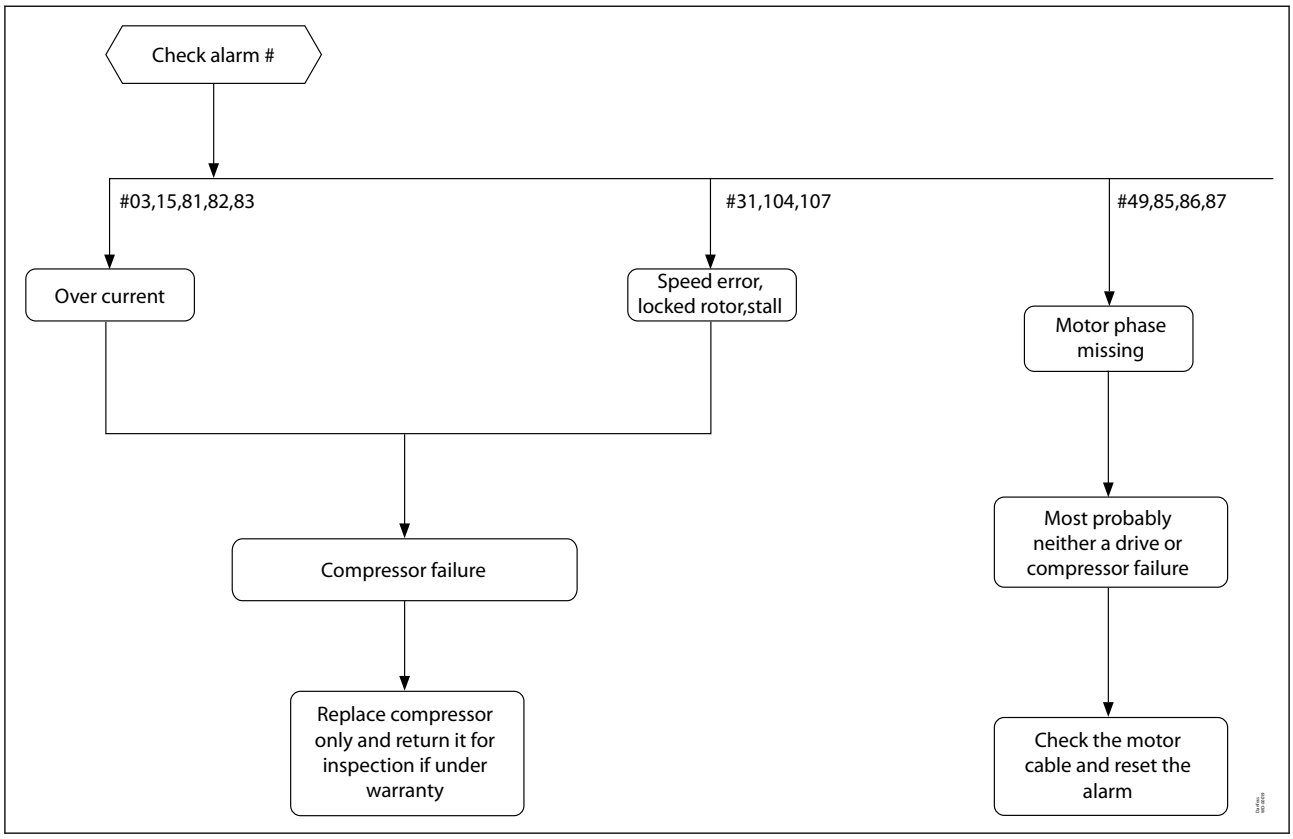
The CDS203 is not suitable for use in EX classified areas (Atex directive).

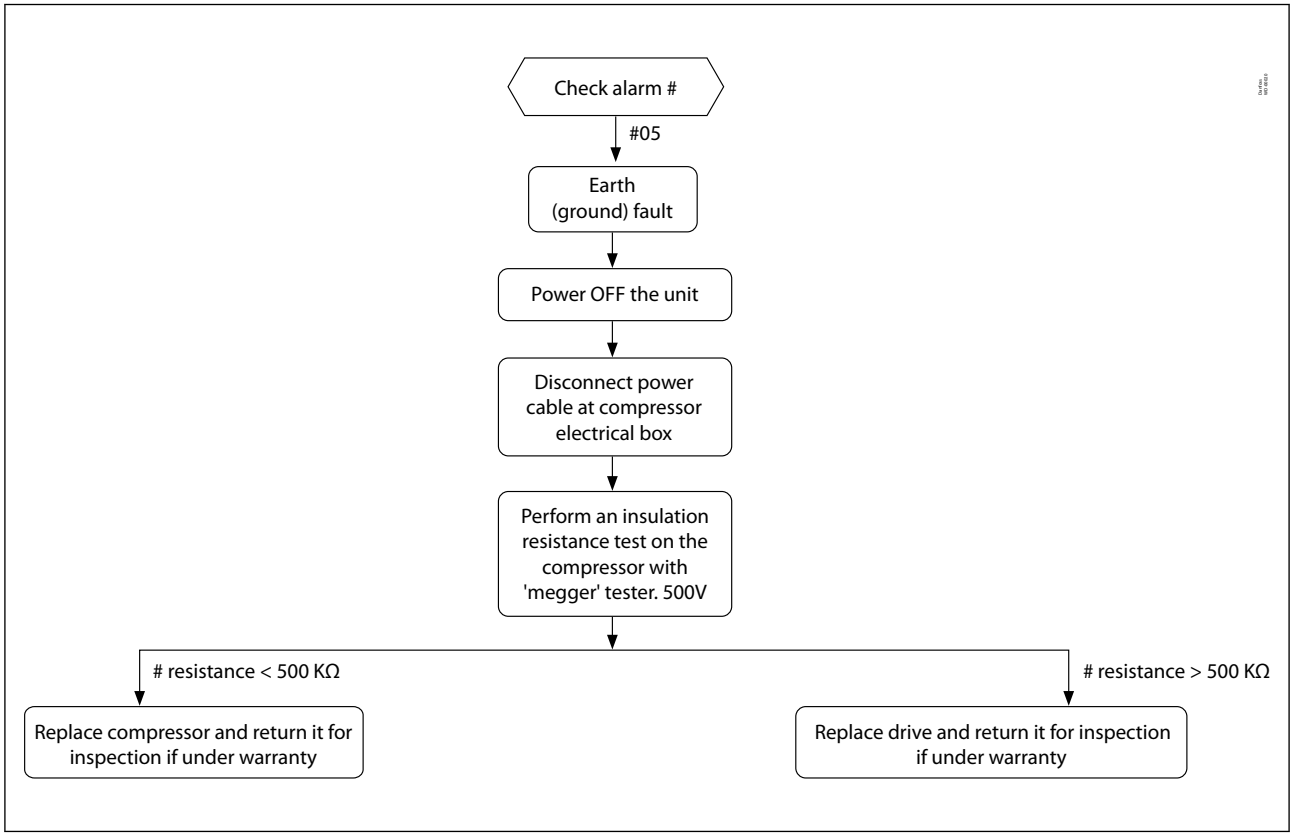
When this product is used with flammable refrigerants, the following considerations apply:

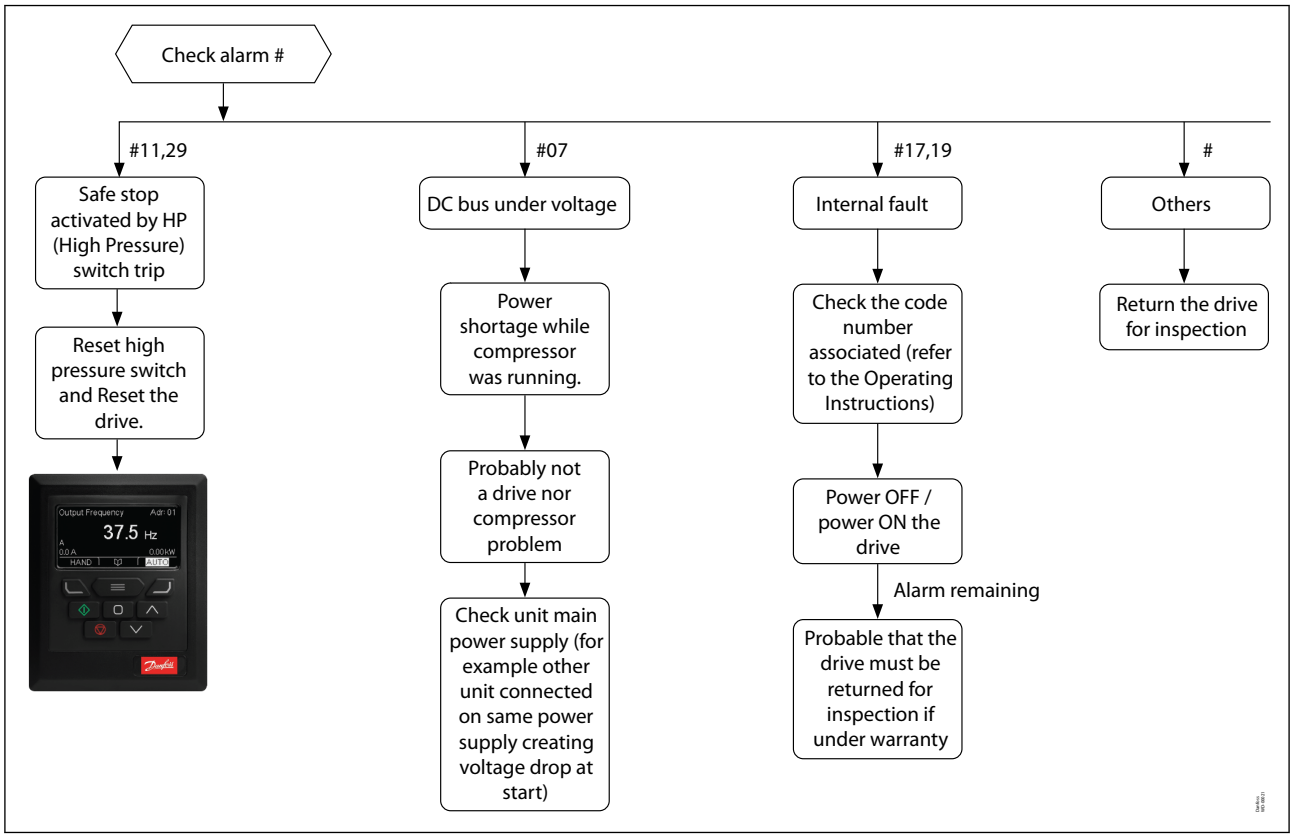
- The product has been evaluated in accordance with IEC 60335-2-40:2022 clause 22.116 and deemed compliant.
  - Electrical components within the drive that could normally create arcs or sparks are limited to the relays.
  - These relays have been independently tested as per clause 22.116.3 and are not considered an ignition risk.
- The product has been evaluated in accordance with IEC 60335-2-40:2022 clause 22.117 and deemed compliant.
  - Hot Surfaces within the product have been verified to remain below the auto-ignition temperatures by a margin of at least 100k.
  - The product has built-in protection to detect and trip under conditions of locked rotor, for system compliance in accordance with IEC 60335-2-34.
- It is still recommended and good practice to further mitigate the risk resulting from leaked refrigerant by the following:
  - Separate product from any area where flammable refrigerant could accumulate.
  - Ventilate areas where there is risk of accumulation of flammable refrigerant.

NOTE: ⚠ *The acceptability of the CDS203 in end use applications where flammable refrigerant is employed shall be reviewed and judged by the end use application.*

Troubleshooting

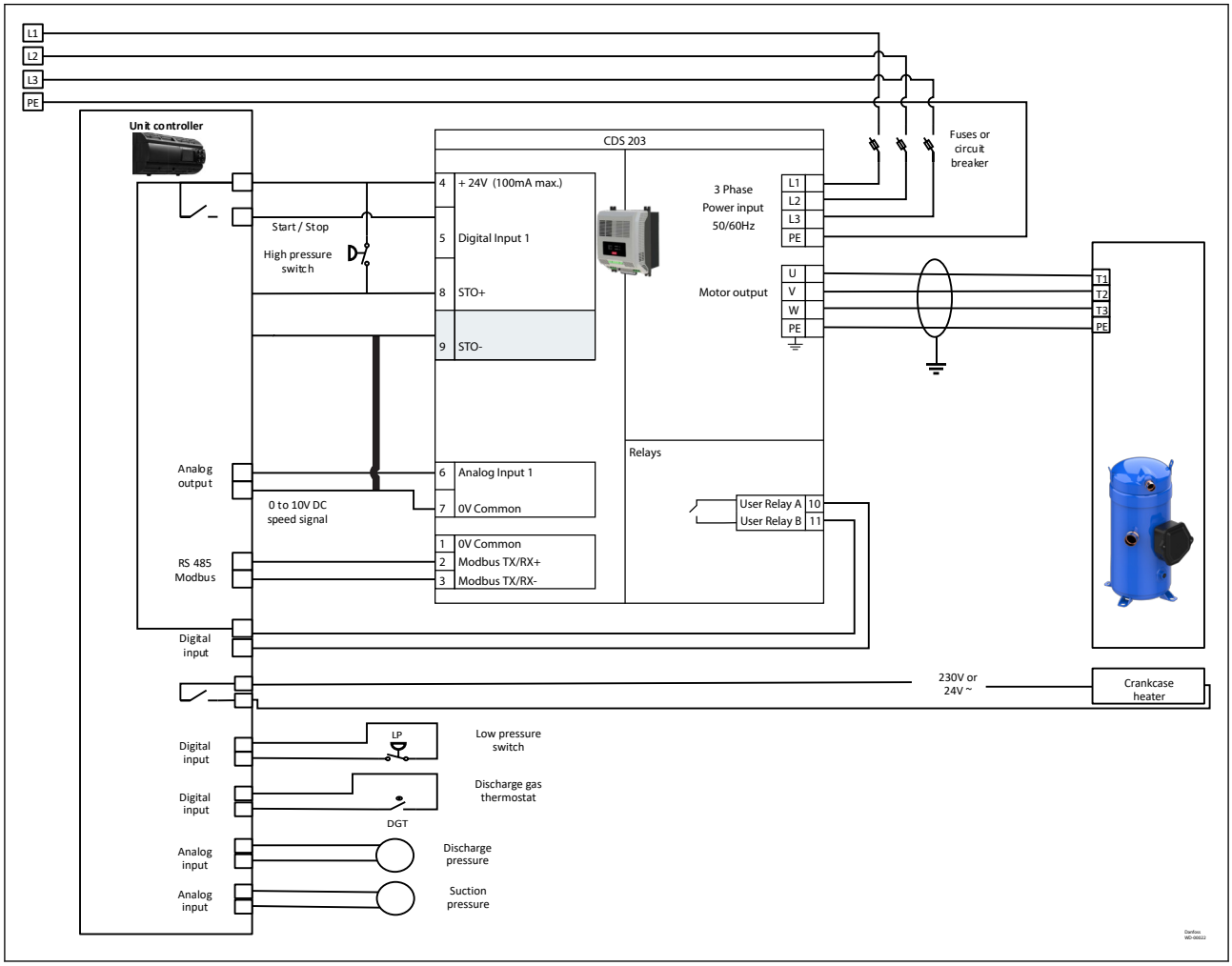





Check alarm #
#11,29
Safe stop activated by HP (High Pressure) switch trip
Reset high pressure switch and Reset the drive.
#07
DC bus under voltage
Power shortage while compressor was running.
Probably not a drive nor compressor problem
Check unit main power supply (for example other unit connected on same power supply creating voltage drop at start)
#17,19
Internal fault
Check the code number associated (refer to the Operating Instructions)
Power OFF / power ON the drive
Alarm remaining
Probable that the drive must be returned for inspection if under warranty
#
Others
Return the drive for inspection

Compressor and frequency converter control

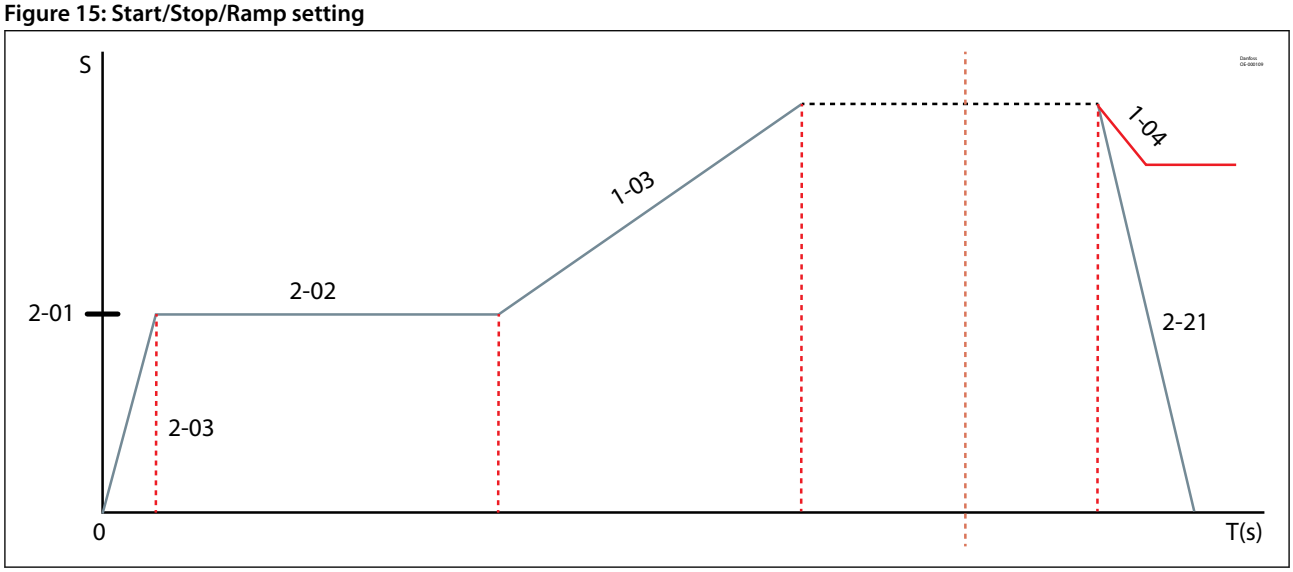
Typical control architecture



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 15: Start/Stop/Ramp setting



S	Speed
T(s)	Time

Table 39: Start/Stop/Ramp setting

Drive parameters		Description	Default value (recommended)	Range
2.02	Start speed time (s)	Start-up sequence: At start, compressor runs at start speed (2.01) and hold the Start speed time (2.02) During this time the speed set-point is ignored	60 s	10 - 120 s
2.01	Start speed (rps)		30 rps	Min 30 rps (Max from map)
1.03	Acceleration ramp time (s)	Defines speed ramp up slope. It means the time from 0 rps to 120 rps (rated speed) Eg: 240 s means ramp slope of 120 rps/240 s = 0.5 rps/s	240 s (0.5 rps/s)	40 - 655 s (0.2 to 3 rps/s)
1.04	Deceleration ramp time (s)	Defines speed ramp down slope.It means the time from 120 rps (rated speed) to 0 rps Eg: 240 s means ramp slope of 120 rps/240 s = 0.5 rps/s	240 s (0.5 rps/s)	40 - 655 s (0.2 to 3 rps/s)
2.03	Start ramp (s)	Acceleration from standstill to start speed (2.01). It means the time from 0 rps to 120 rps (rated speed) Eg: 3 s means ramp slope of 120 rps/3 s = 40 rps/s	2.7 s (45 rps/s)	2.5 - 3.5 s (34 to 48 rps/s)
2.21	Stop ramp (s)	Deceleration from current speed to stop. It means the time from 120 rps (rated speed) to 0 rps Eg: 3 s means ramp slope of 120 rps/3 s = 40 rps/s	2.7 s (45 rps/s)	2.5 - 3.5 s (34 to 48 rps/s)

Short cycle protection

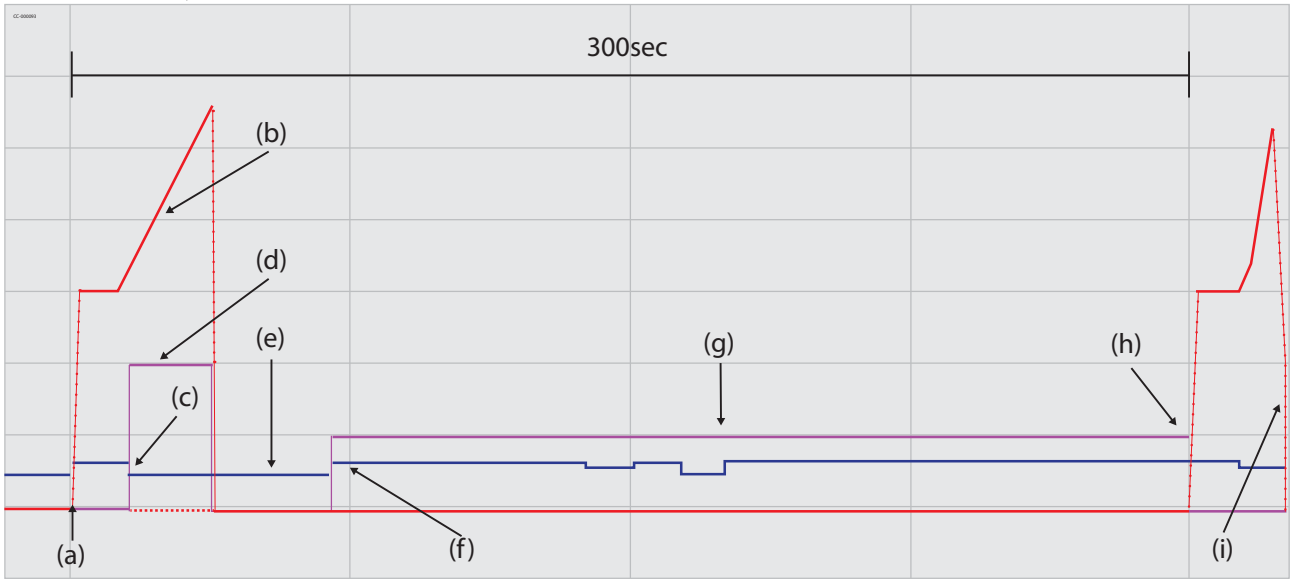
Minimum run time is necessary to ensure proper oil return to the compressor. A 3-minute minimum run time is usually recommended but some systems may require more time to establish proper superheat and stable oil return. Additionally, compressor must not exceed a maximum of 12 starts per hour. 12 starts per hour must not be considered as an average, this is the maximum number of starts acceptable to keep a good regulation accuracy during low load. Short cycle protection can be done either by the drive or the unit controller. The following table describes the parameters to adjust depending on which short cycle protection is selected.

Table 40: Short cycle protection

Drive parameters		Description	Value	Default
Short cycle protection is done by unit controller				
2.10/2.11/2.12	Short cycle protection	Short cycle protection done in unit controller: (preferred option)	0s/0s/0s	0s/12s/300s
Short cycle protection is done in drive; If short cycle protection enabled in drive, the Stop command will be ignored during minimum on time.				
2.10, 2.11, 2.12	Short cycle protection	Short cycle protection done by the drive.	0s/12s/300s	0s/12s/300s
2.12	Interval between starts	Start command is ignored until the timer (300s) has elapsed. Only then, can the compressor start.	300 sec	300 sec
2.11	Minimum on time	The compressor cannot stop until the set time (12s) has elapsed. The timer starts counting following a compressor start. **Stop** command is ignored.	12 sec	12 sec
2.10	Minimum off time	Minimum off time before next re-start.	0s	0s

The diagram below demonstrates how the function works:

Figure 16: Short cycle protection



(a)	Start signal is given by the unit controller
(b)	Compressor started
(c)	Compressor stop requested by the unit controller
(d)	Stop command is ignored.
(e)	Compressor stops when minimum run time (12s) has elapsed.
(f)	Start signal is given by the unit controller
(g)	Start command is ignored
(h)	Compressor starts after the timer interval between starts (300s) has elapsed.
(i)	Compressor Coast (stop) This command can override the time minimum run time and stop the compressor immediately.
300sec	Interval between starts

Frequency converter alarm

Frequency converter alarms can be a problem with the frequency converter itself or with the compressor. It is necessary to identify the alarm code to determine appropriate trouble shooting actions.

Frequency converter alarms will trip the compressor; therefore, the unit controller must get feedback that the frequency converter is in a fault condition.

The feedback is typically via frequency converter Relay output. This can also be done via modbus.

By default, alarms are reset automatically after 30s and the compressor restarts. If Modbus is selected as primary command source in par. 1-11 The autoreset function is disabled and the unit controller must reset the drive via Modbus or digital input or manual intervention will be required via the keypad.

If the specified number of automatic resets (10x) is reached within 10 minutes, the frequency converter enters manual reset mode.

Manual reset is via [Reset] key on the LCP, the digital input T32 or via Modbus. After the manual reset is performed, the frequency converter reset mode returns to automatic reset.

If an alarm cannot be reset, the reason may be that its cause has not been rectified, or the alarm is trip locked.

Trip lock

Alarms that are trip-locked offer additional protection, meaning that the mains supply must be switched off before the alarm can be reset. After being switched back on, the frequency converter is no longer blocked and may be reset as described above once the cause has been rectified.

Table 41: Trip lock

Par. nr.	Name	Set value	Default value
3-05	User Relay Output Function Select	Drive Tripped	Drive Healthy
2-13	Re-start Mode	Auto-10	Auto-10
7-02	Auto Reset Time Delay	30s	30s

Stop compressor in case of safeties (LP, HP, DGT)

Table 42: Stop compressor in case of safeties (LP, HP, DGT)

Safeties	Tripping conditions		Re-start conditions	
	Value	Time	Value	Time
HP safety switch	See Pressure setting and max DGT in Operating envelope	Immediate, no delay. No by-pass	Conditions back to normal Switch closed again	Manual reset
LP safety switch				Manual or Automatic Maximum 5 auto reset during a period of 12 hours, then manual reset.
DGT external				

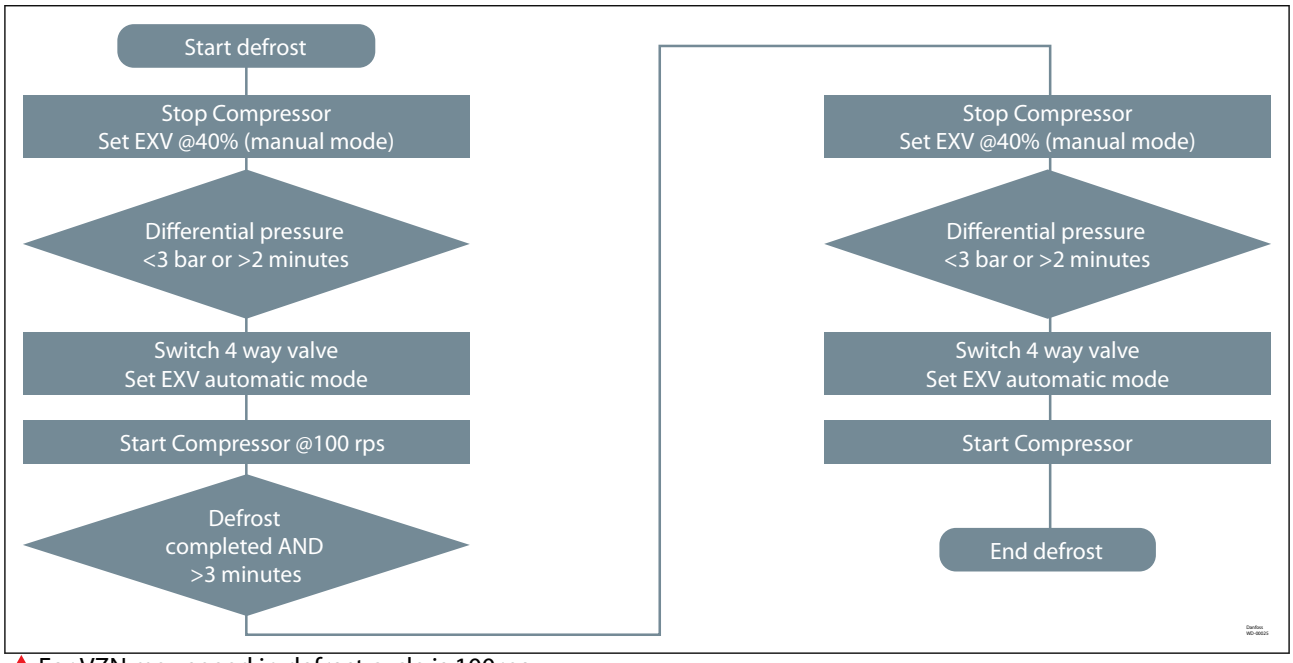
4 Way valve control and defrost logic

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

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

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

In any case, defrost logics must respect requirements and tests described in Manage Superheat and Operating envelope sections.

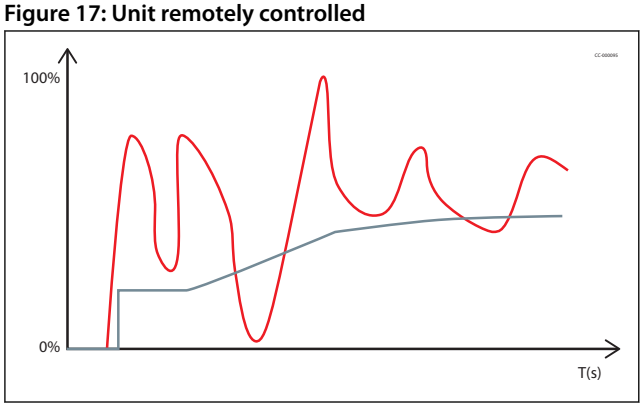


For VZN max speed in defrost cycle is 100rps

Unit remotely controlled

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

Figure 17: Unit remotely controlled



—	External signal demand
—	Compressor speed
T	Time

Table 43: Unit remotely controlled

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

Application

Manage Operating envelope

Requirement

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

In low evaporating temperatures, a suction superheat higher than 5K may lead to high gas discharge temperature. This discharge gas temperature must not exceed 150°C (section Discharge temperature protection).

Figure 18: R290 Operating map

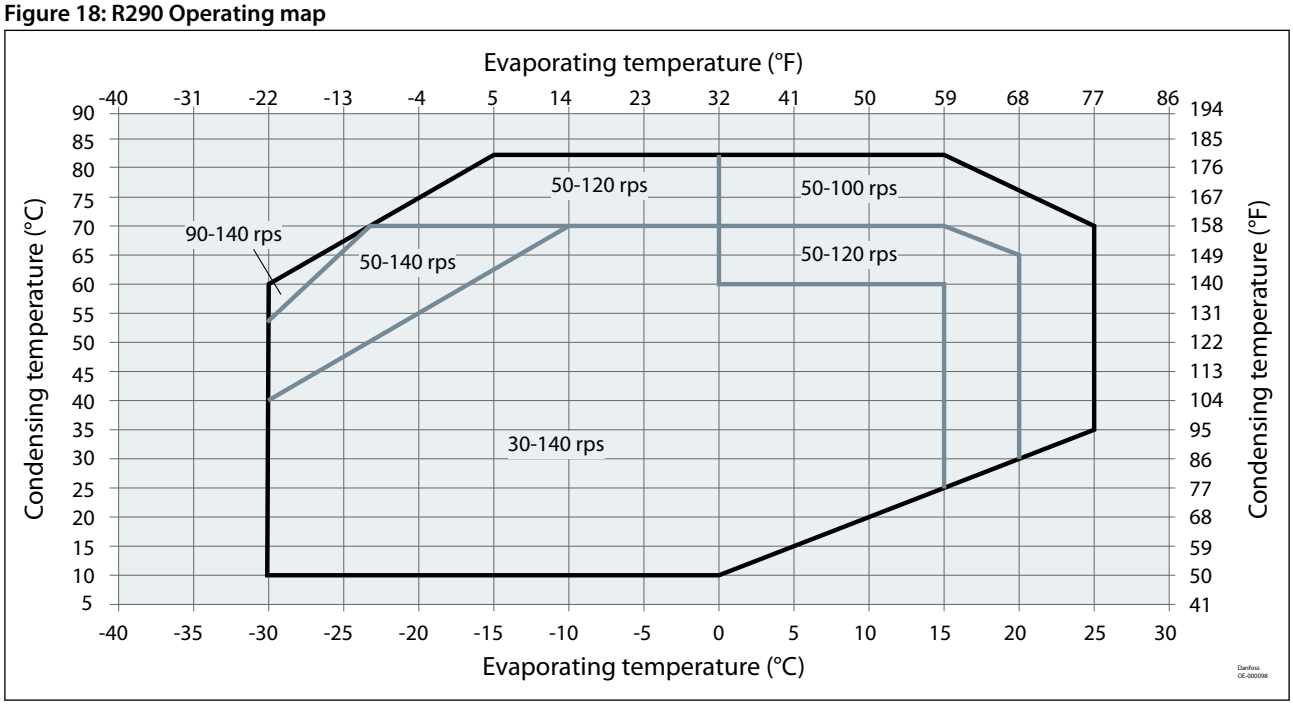


Figure 19: R290 Minimum suction superheat

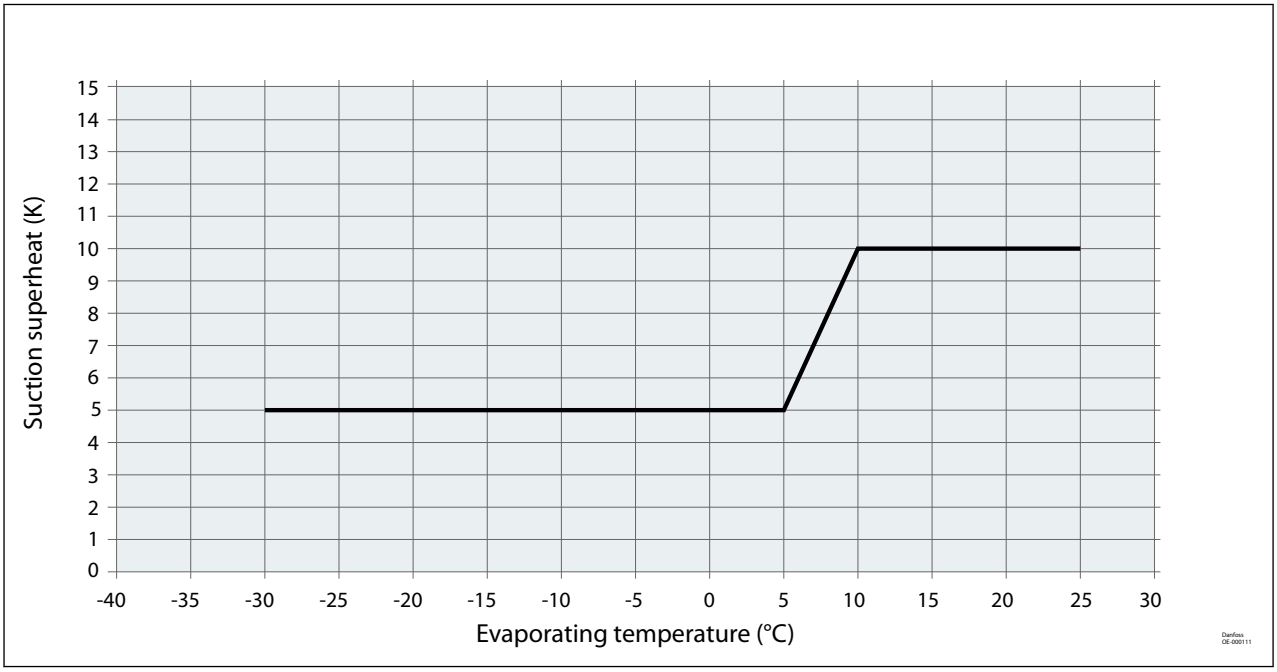


Figure 20: R513A Operating map for standard drive

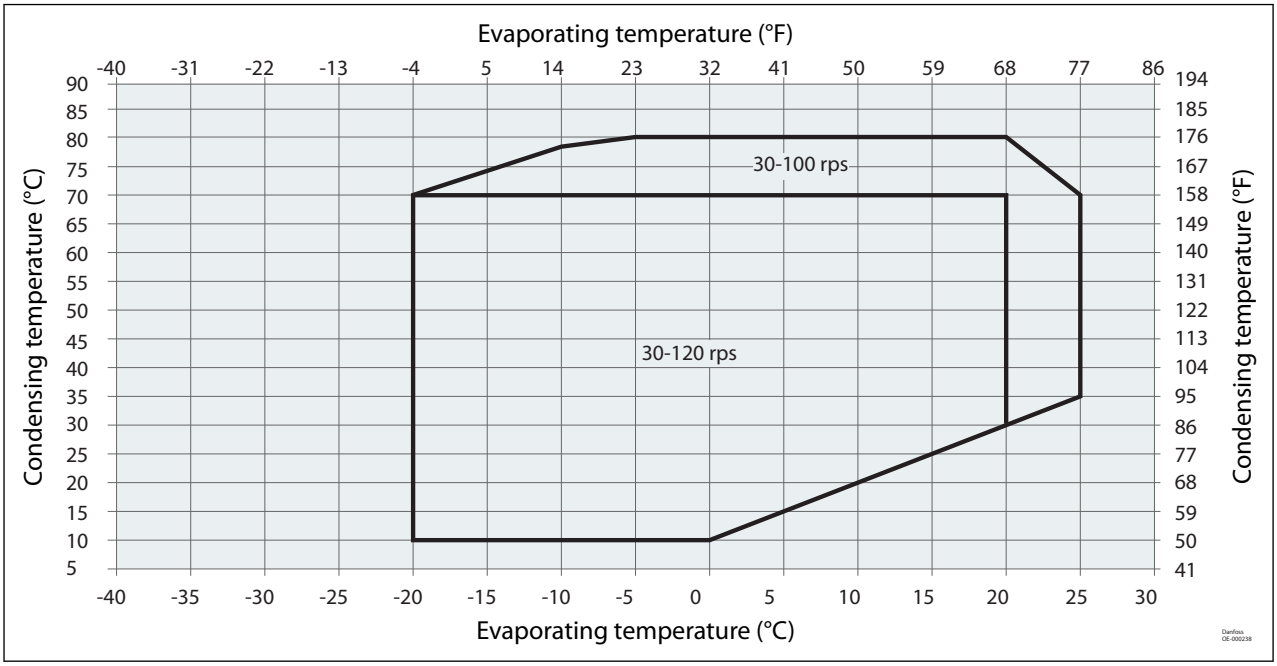


Figure 21: R513A operating map for downsize drive

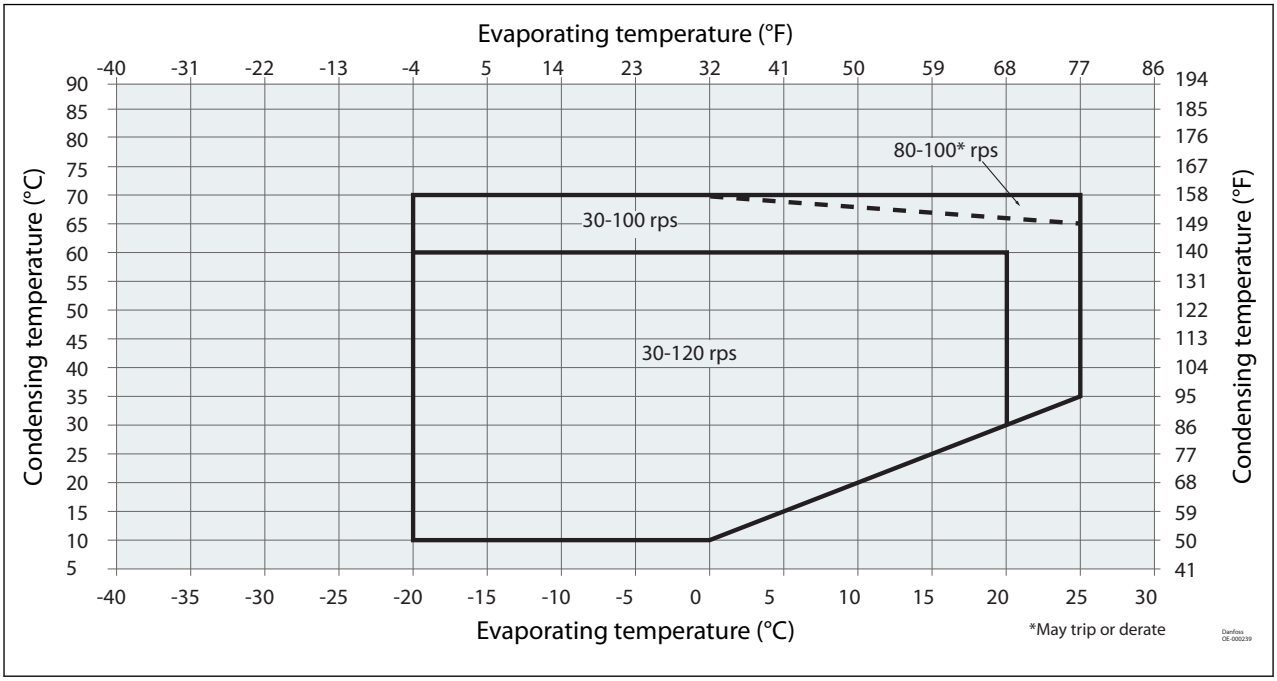
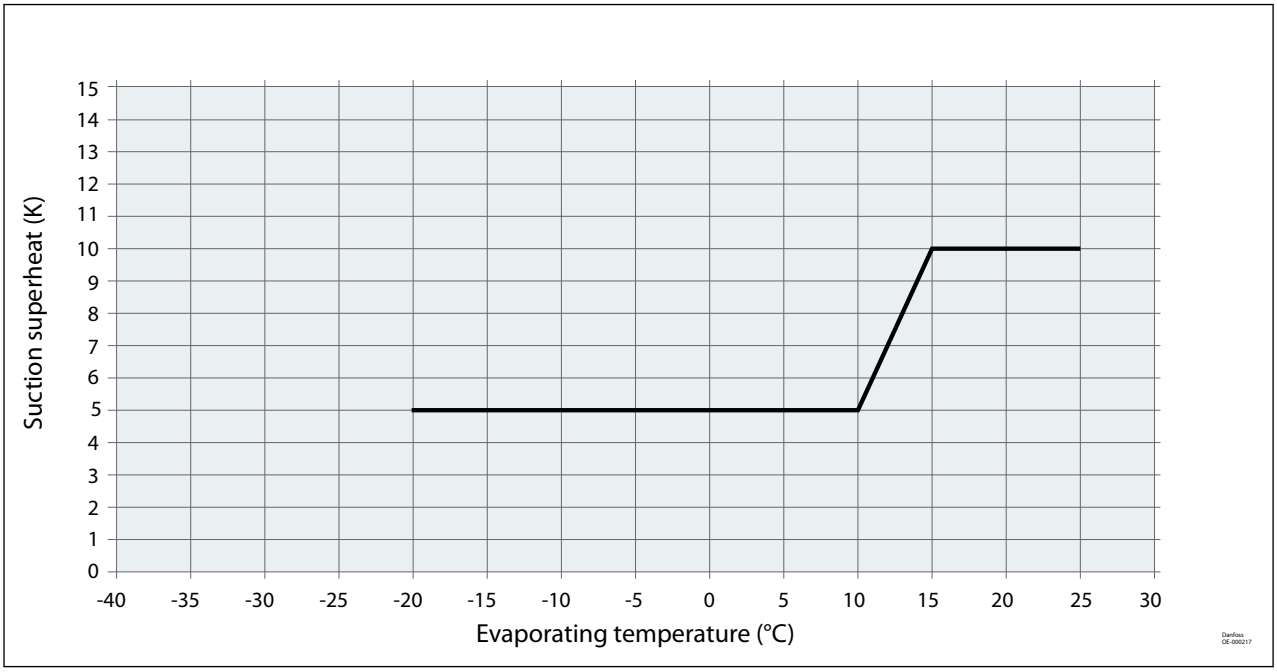


Figure 22: R513A Minimum suction superheat



NOTE:
R290 is classified as A3 flammable refrigerant.

High pressure switch

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

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

Figure 23: R290

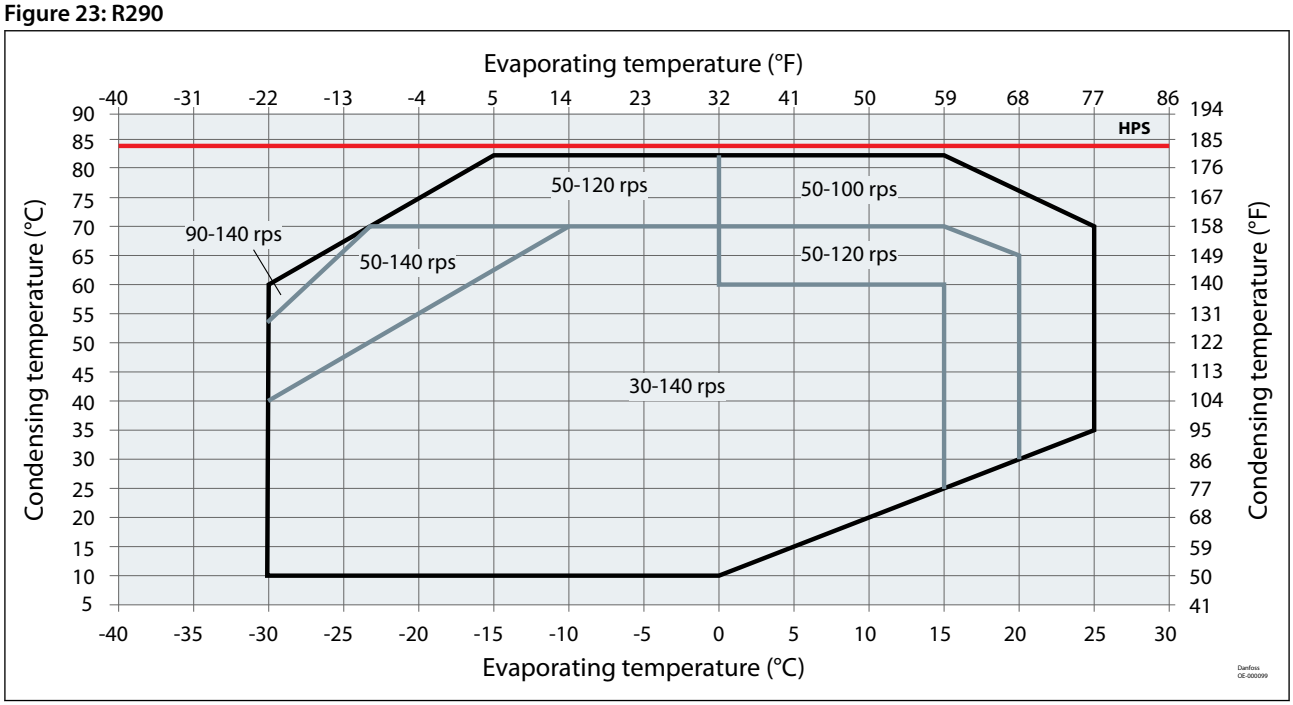


Figure 24: R513A for Standard drive

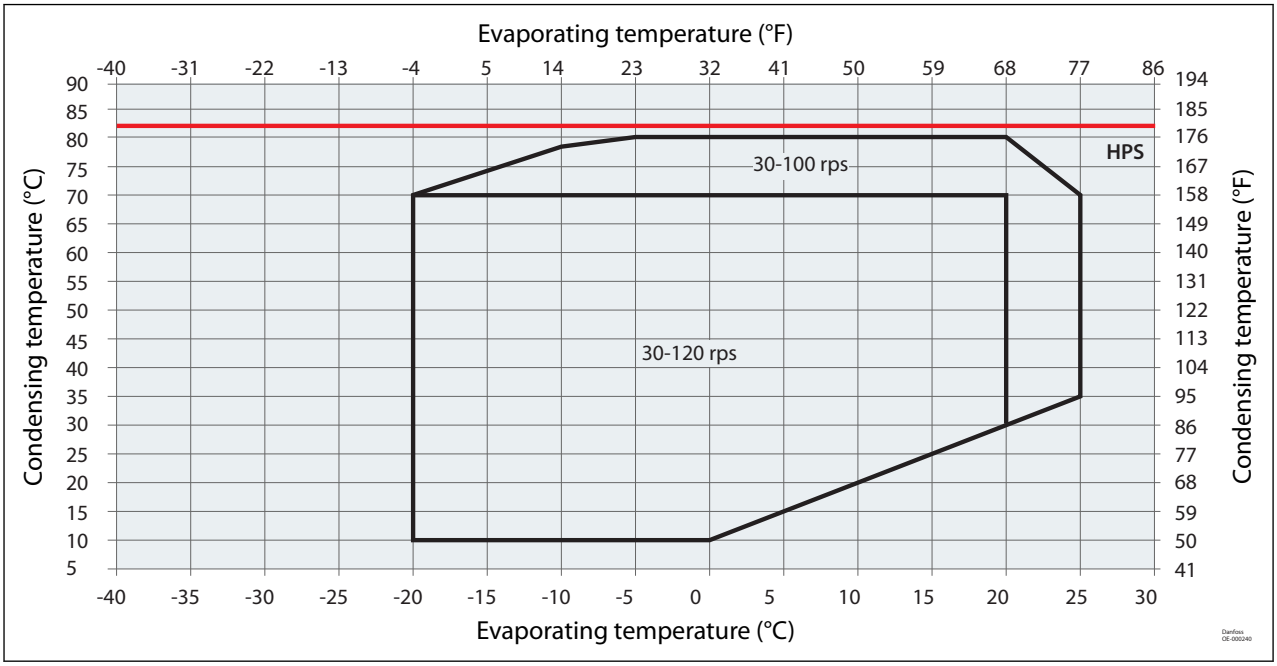
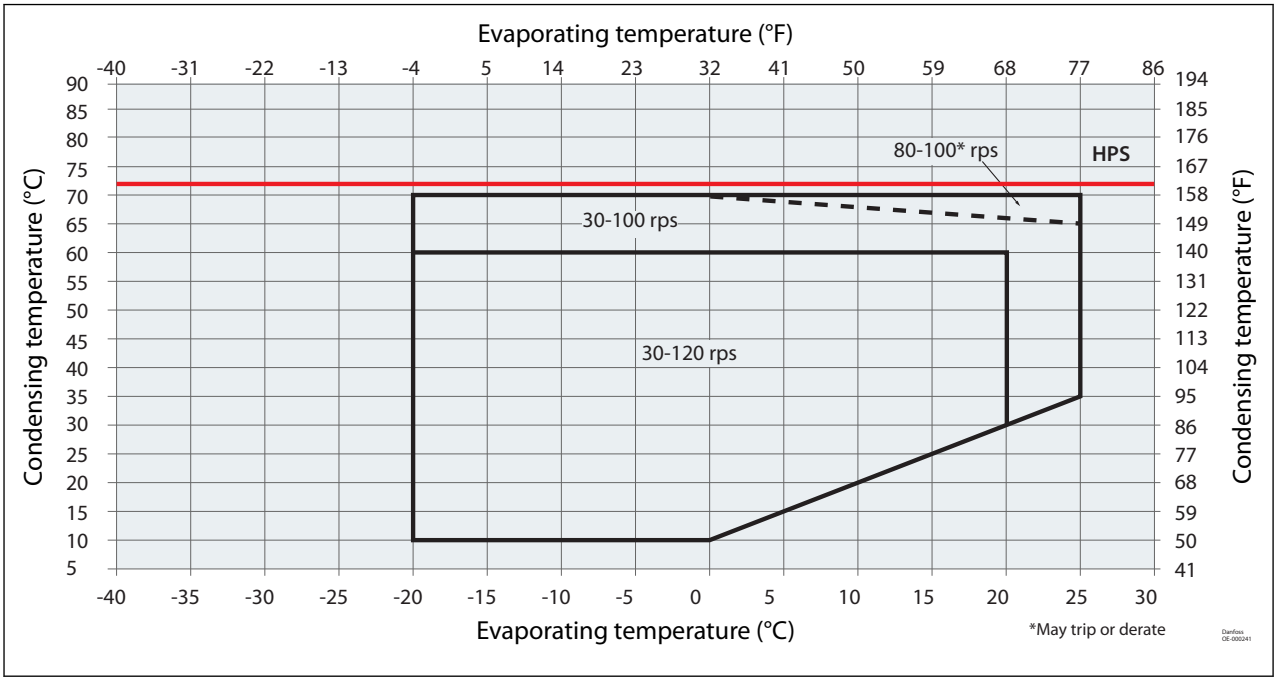


Figure 25: R513A for downsize drive



HPS	High pressure switch

Low pressure switch

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

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

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

Figure 26: R290

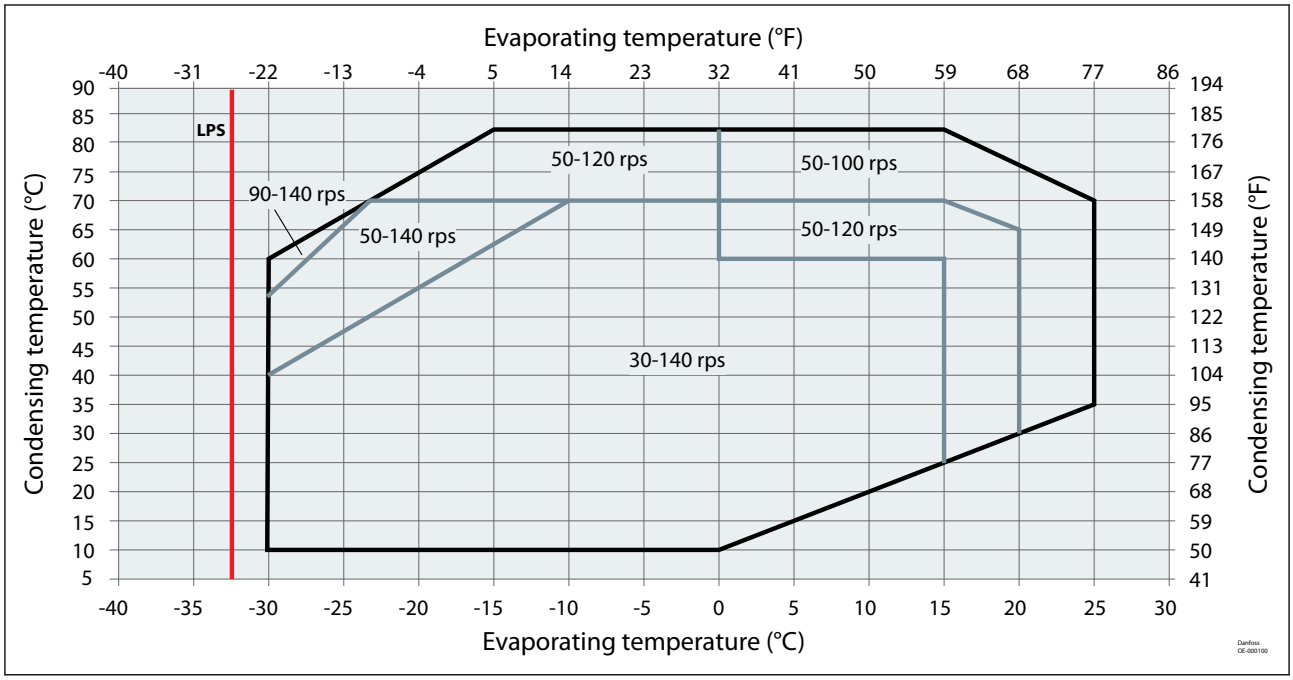


Figure 27: R513A for standard drive

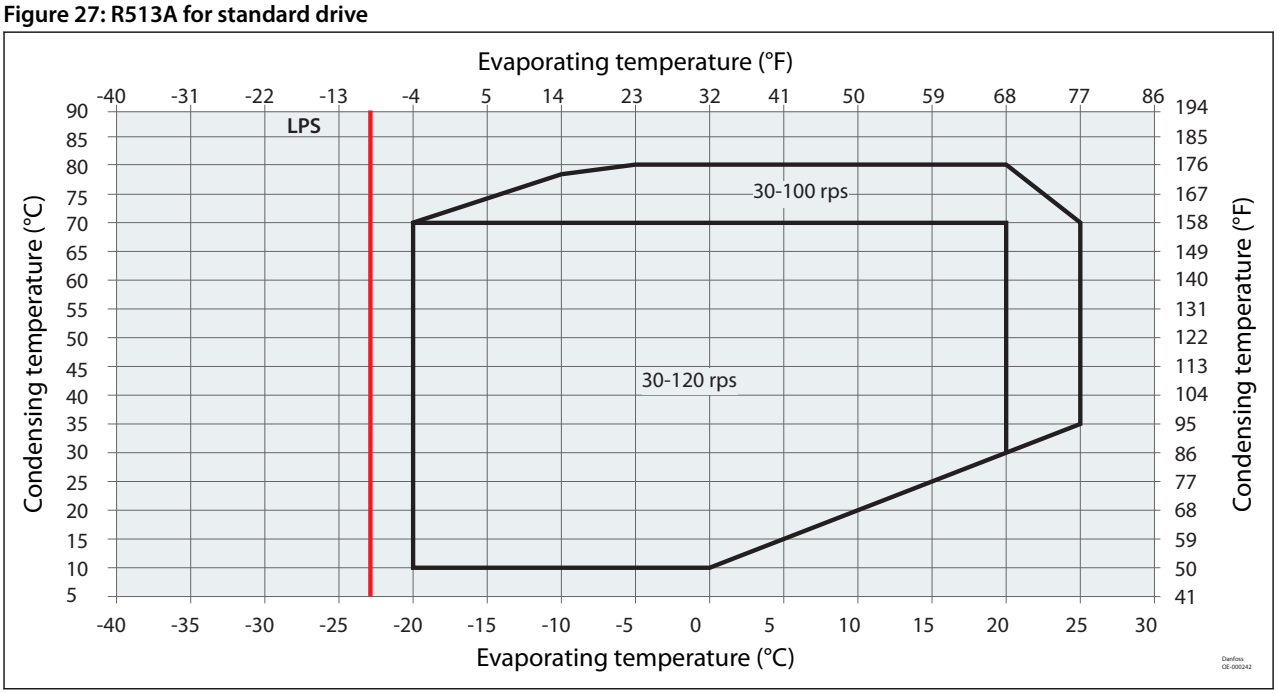
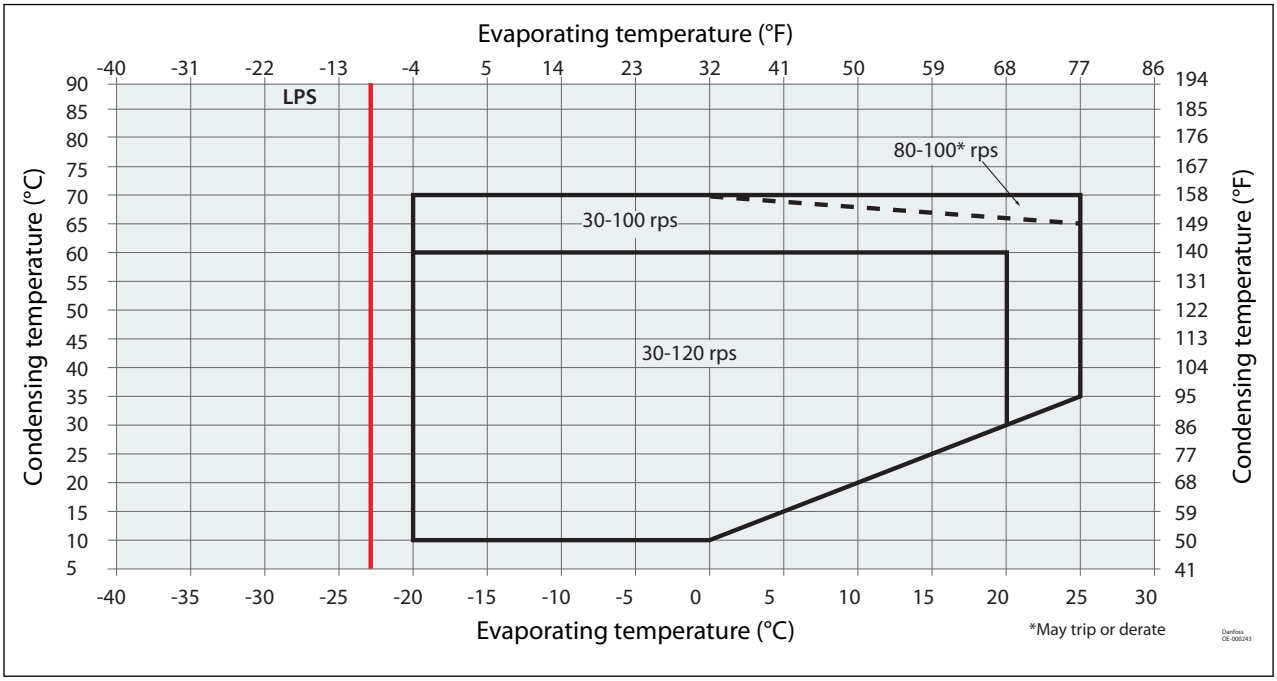


Figure 28: R513A for downsize drive



LPS	Low pressure switch

Discharge temperature protection

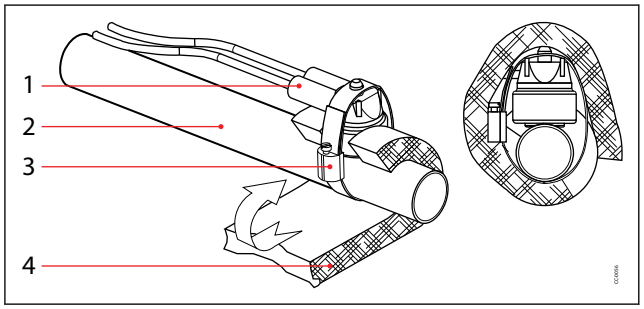
R Discharge gas temperature (DGT) protection is required.

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

The discharge temperature sensor (120Z0823) is mandatory to be used as shown. DGT installation must respect below requirements:

- The discharge temperature sensor must be attached to the discharge line within 150 mm (5.91 inch) from the compressor discharge port and must be thermally insulated and tightly fixed on the pipe.
- The unit controller can adjust compressor speed to keep the discharge temperature lower than the limit.
- The DGT should be set to open at maximum discharge temperature of 150°C (302°F).

Figure 29: Discharge temperature protection

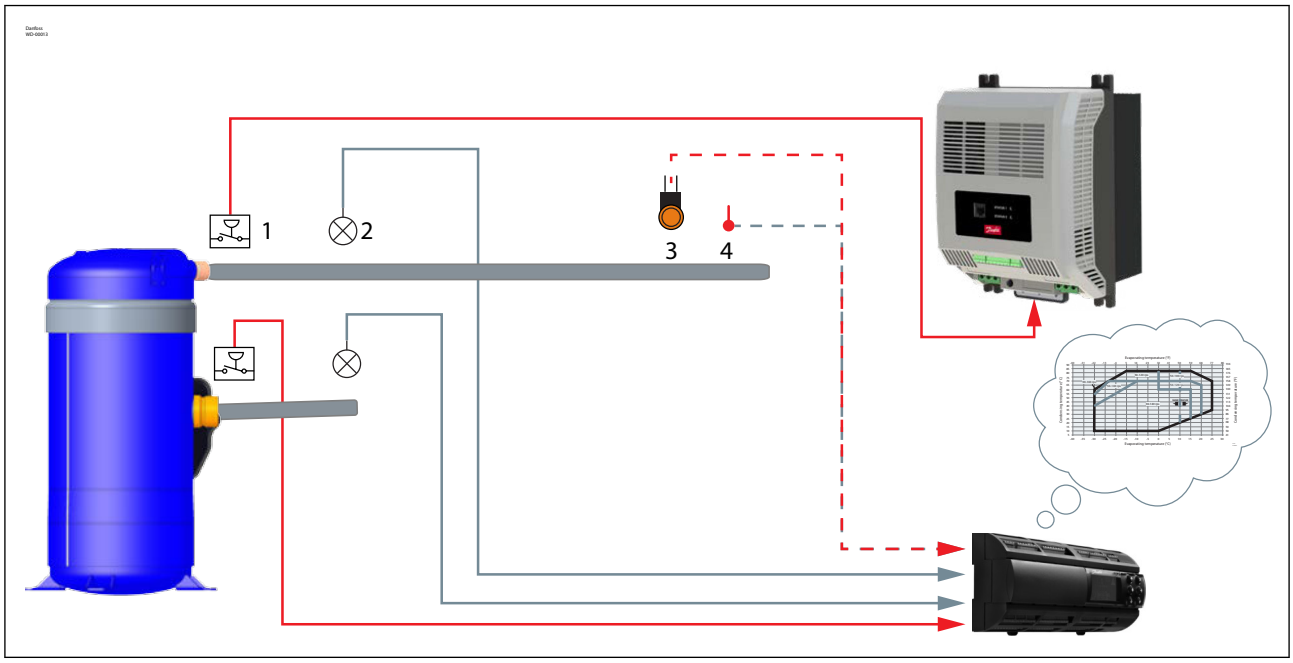


1	Temperature sensor
2	Discharge line
3	Bracket
4	Insulation

Protection and control of envelope

Low pressure (LP) switch and high pressure (HP) switches are necessary to protect the compressor. See Discharge temperature protection

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



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

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

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

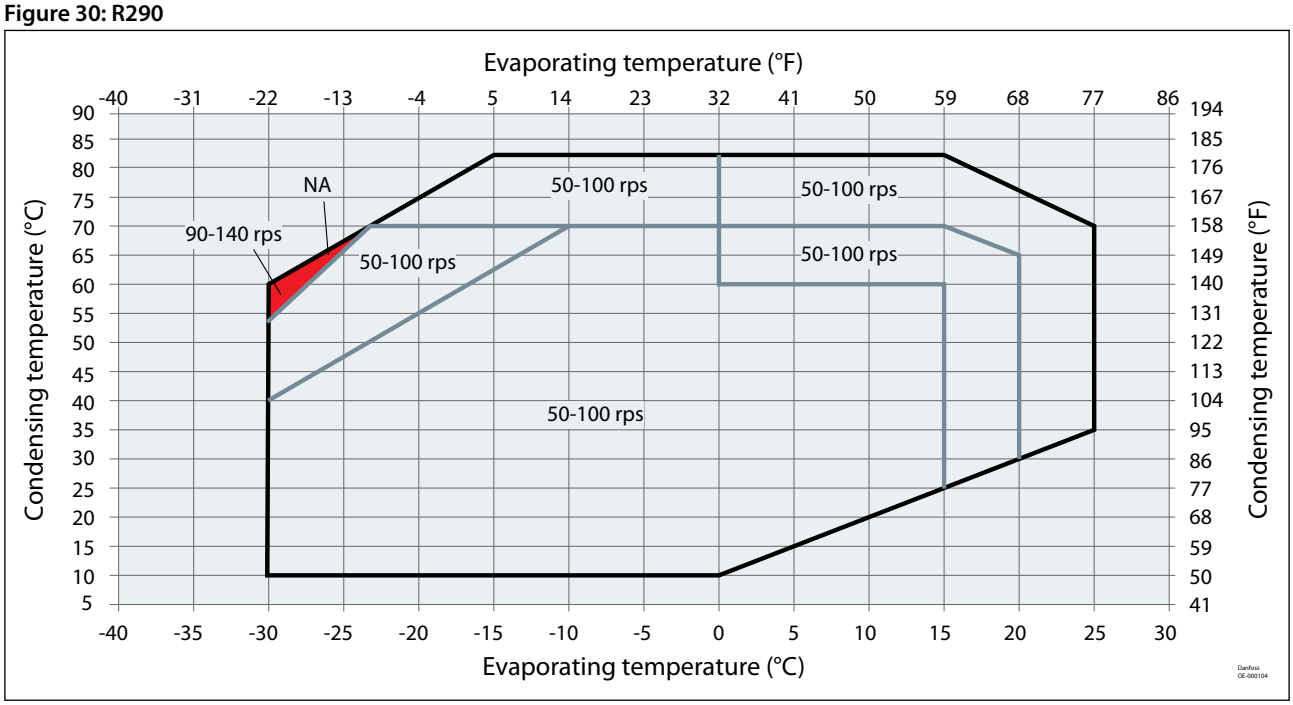
Example 1 with limited speed range from 50rps (3000rpm) to 100rps (6000rpm) for R290 and from 30rps (1800rpm) to 100rps (6000rpm) for R513A

Safeties required High pressure switch, Low pressure switch, Discharge gas temperature protection see Discharge temperature protection

Drive setting Adjust the minimum and maximum reference (speed setpoint) limits accordingly:
For R290, Par. 3-02 Minimum reference 3000 rpm (50 rps).
Par. 3-03 Maximum reference 6000 rpm (100 rps).
For R513A, Par. 3-02 Minimum reference 1800 rpm (30rps).
Par. 3-03 Maximum reference 6000 rpm (100rps).

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

Figure 30: R290



NA	Not Allowed

Figure 31: R513A for standard drive

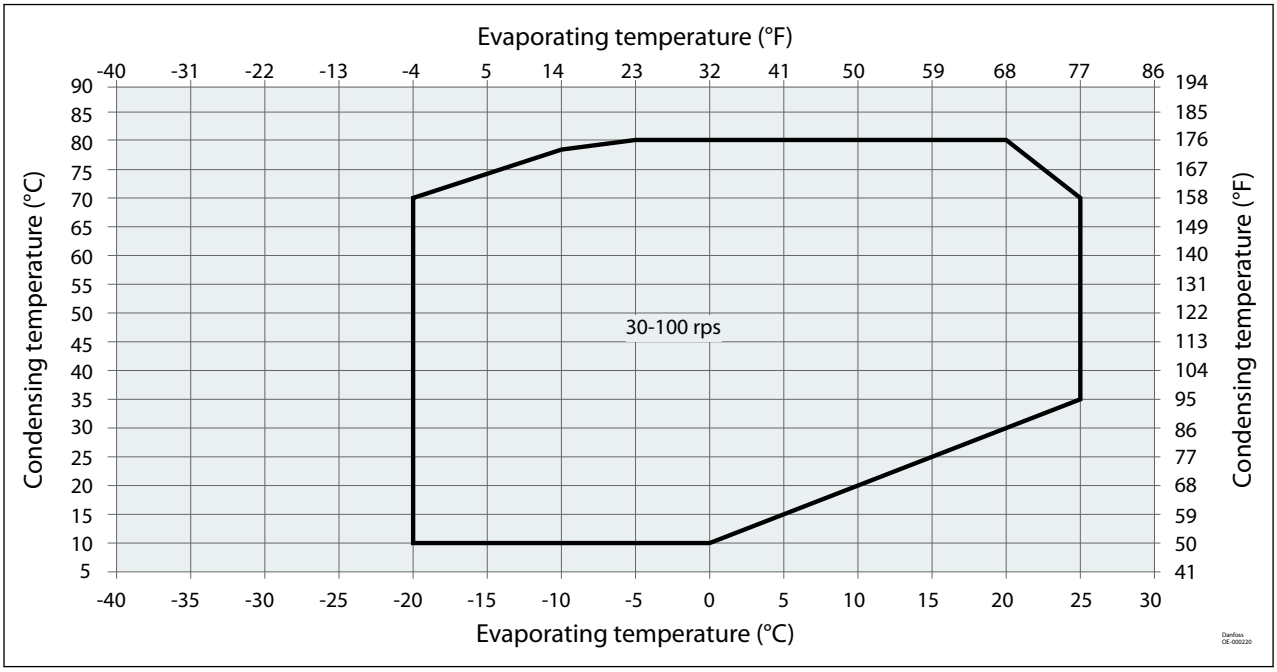
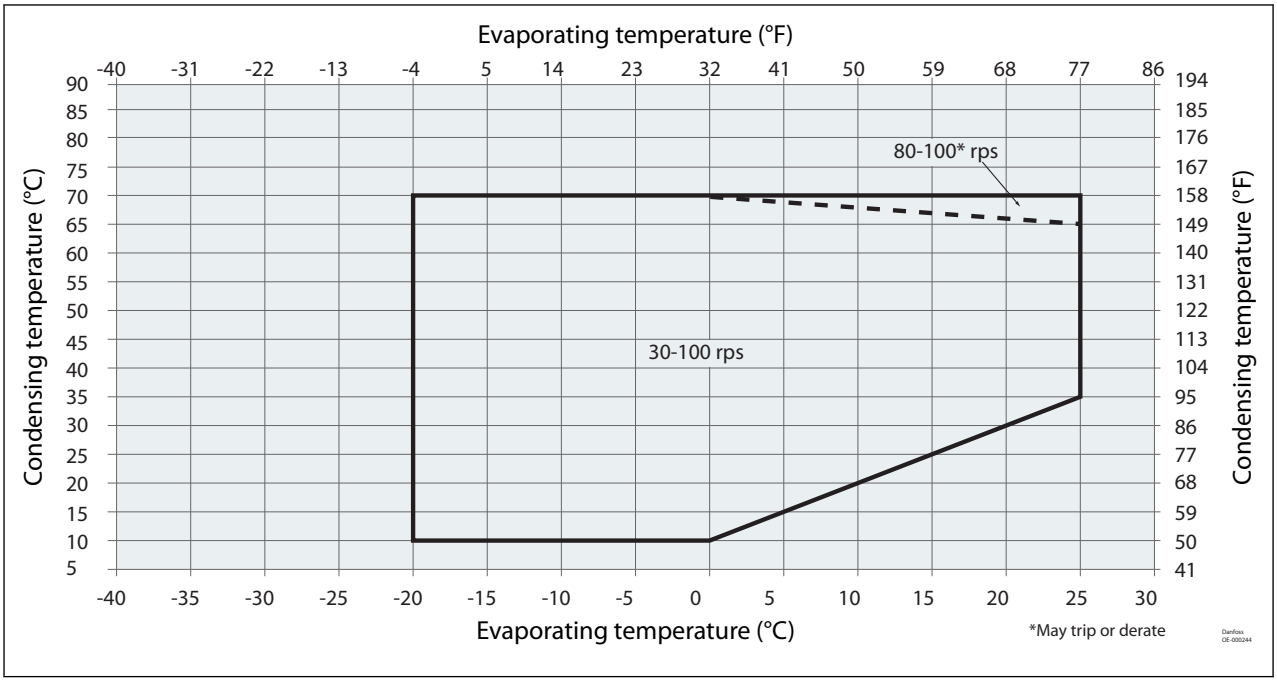


Figure 32: R513A for downsize drive



Example 2 with full speed range from 30rps (1800rpm) to 140rps (8400rpm) for R290 and from 30rps (1800rpm) to 120rps (7200rpm) for R513A

Safeties required High-pressure switch, Low pressure switch, Discharge gas temperature protection see Discharge temperature protection

Drive setting No parameter change required, keep default value

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

Figure 33: R290

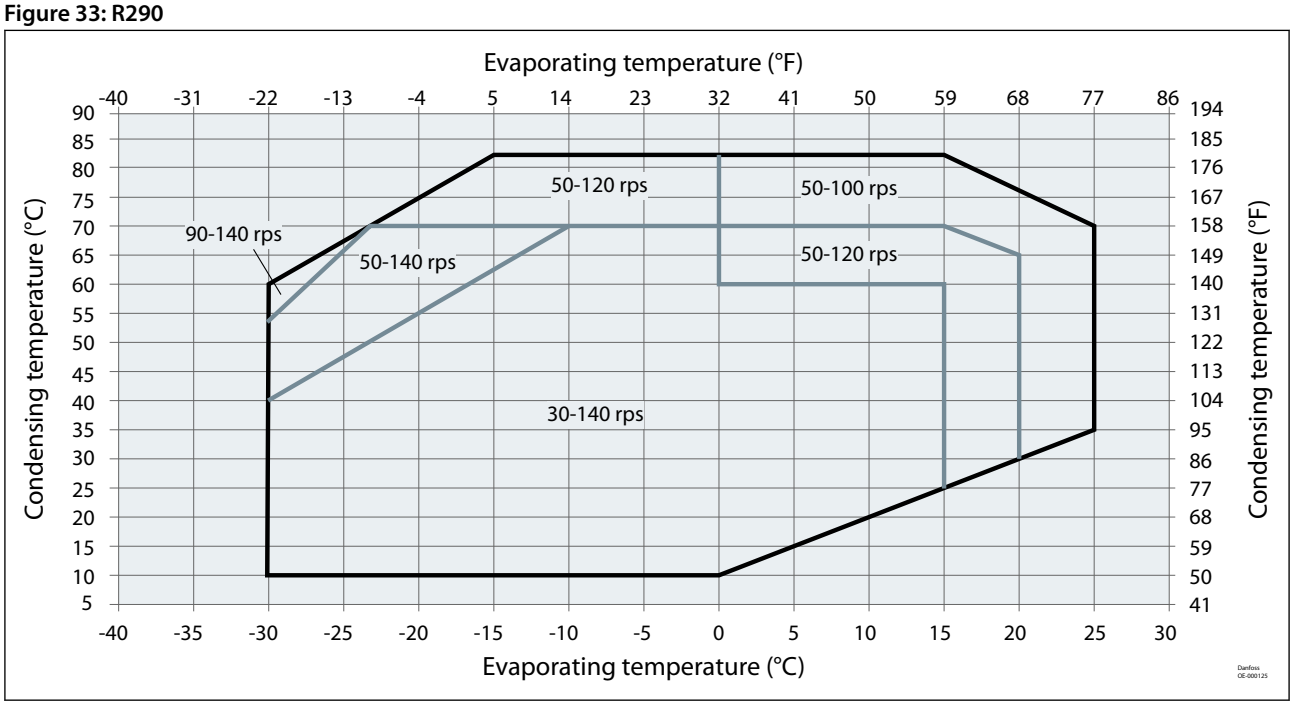


Figure 34: R513A for standard drive

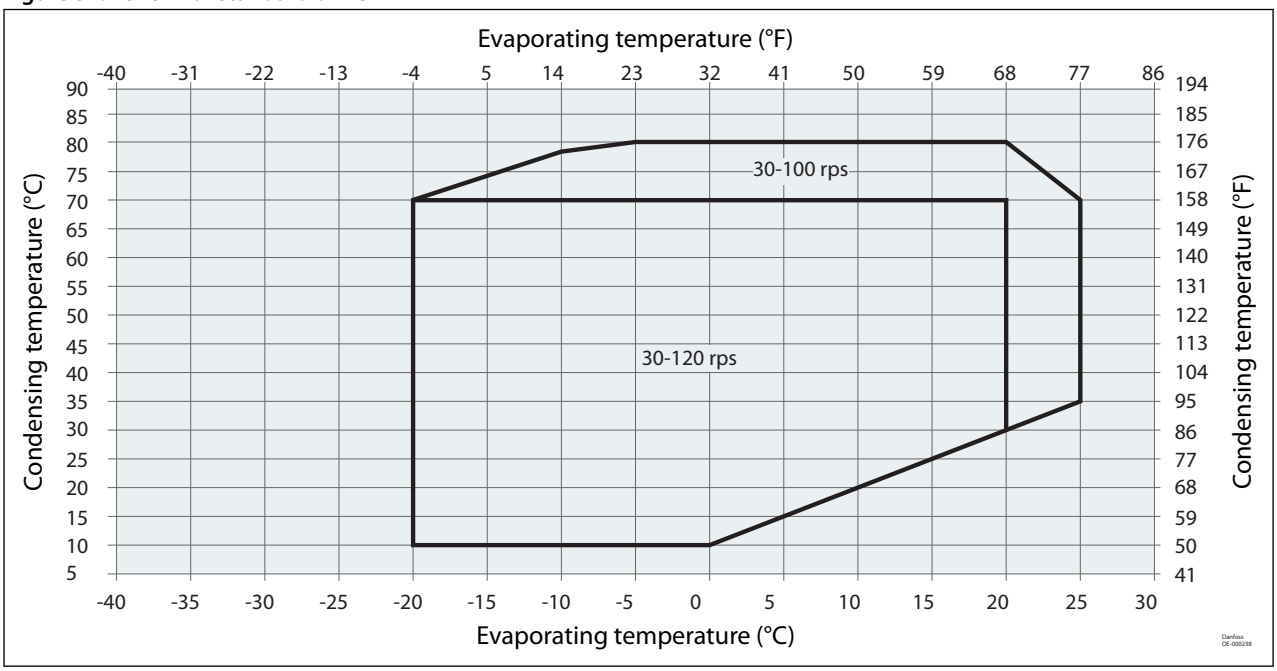
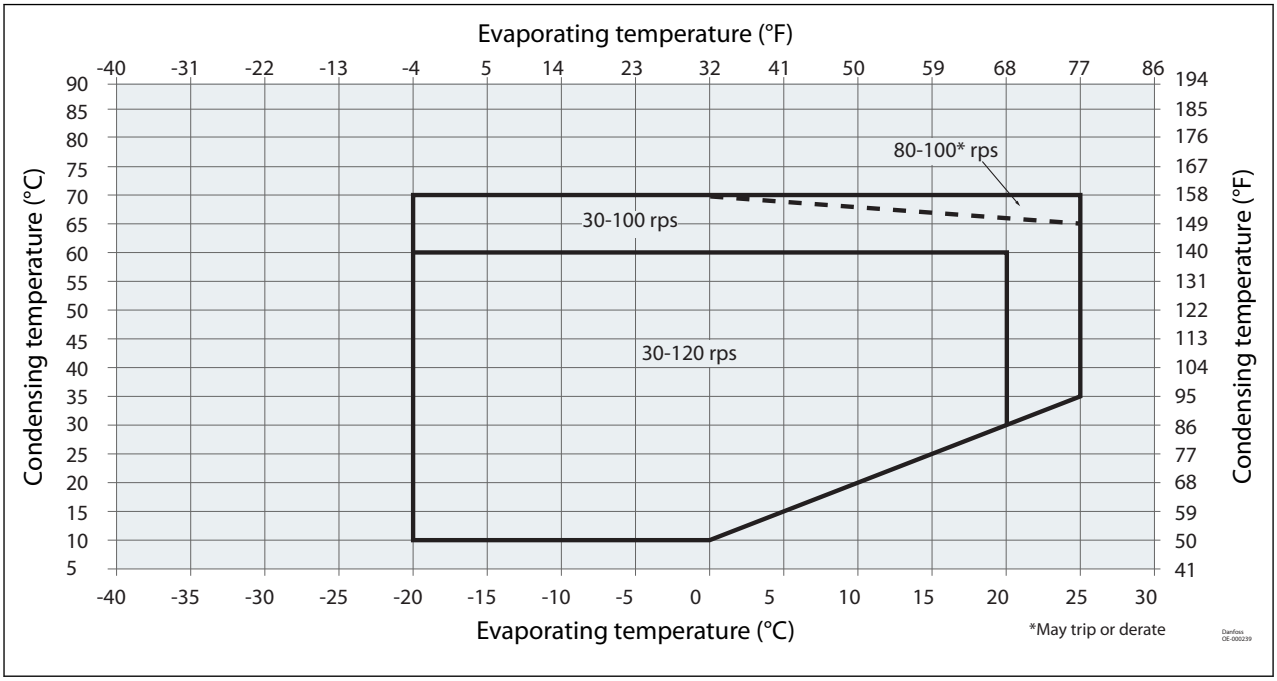


Figure 35: R513A for downsize drive



MOP (Max Operating Pressure Control)

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

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

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

Figure 36: R290

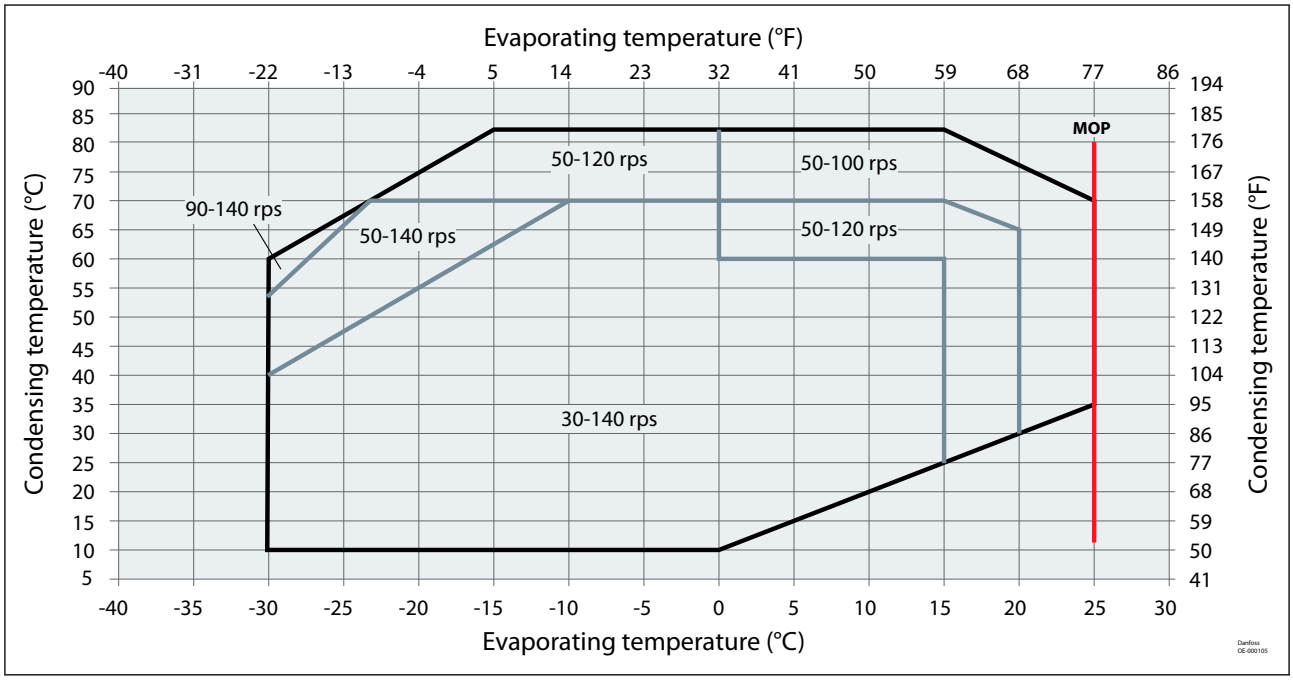


Figure 37: R513A for standard drive

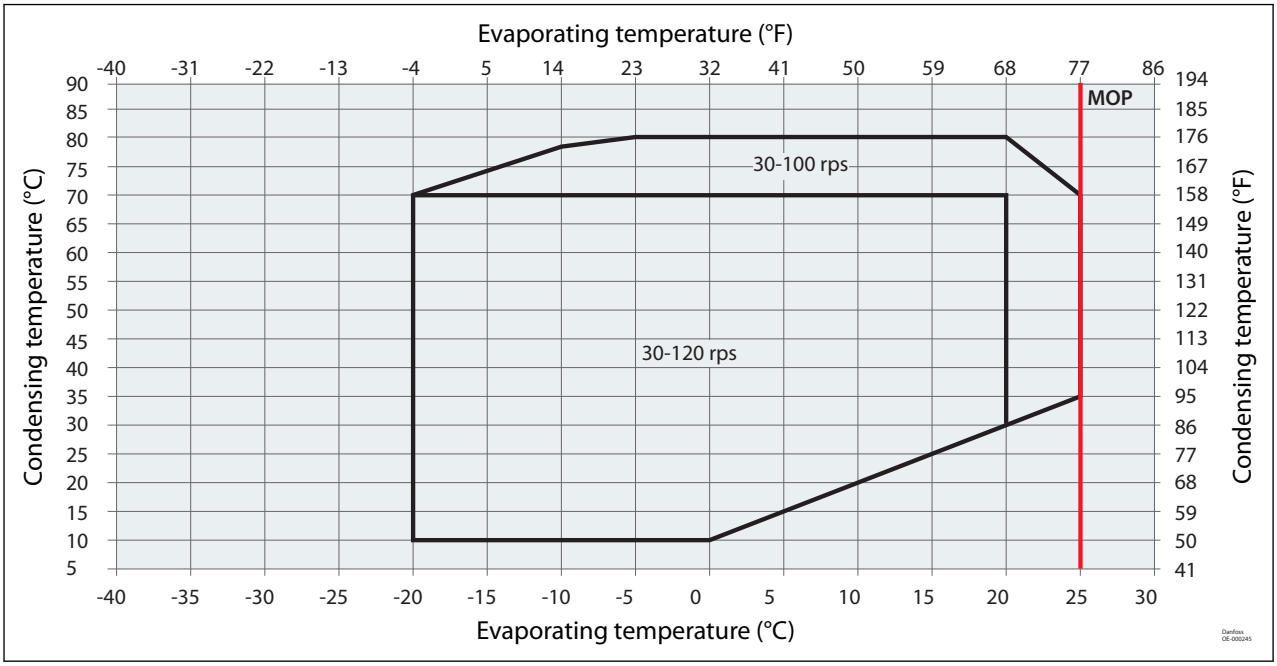
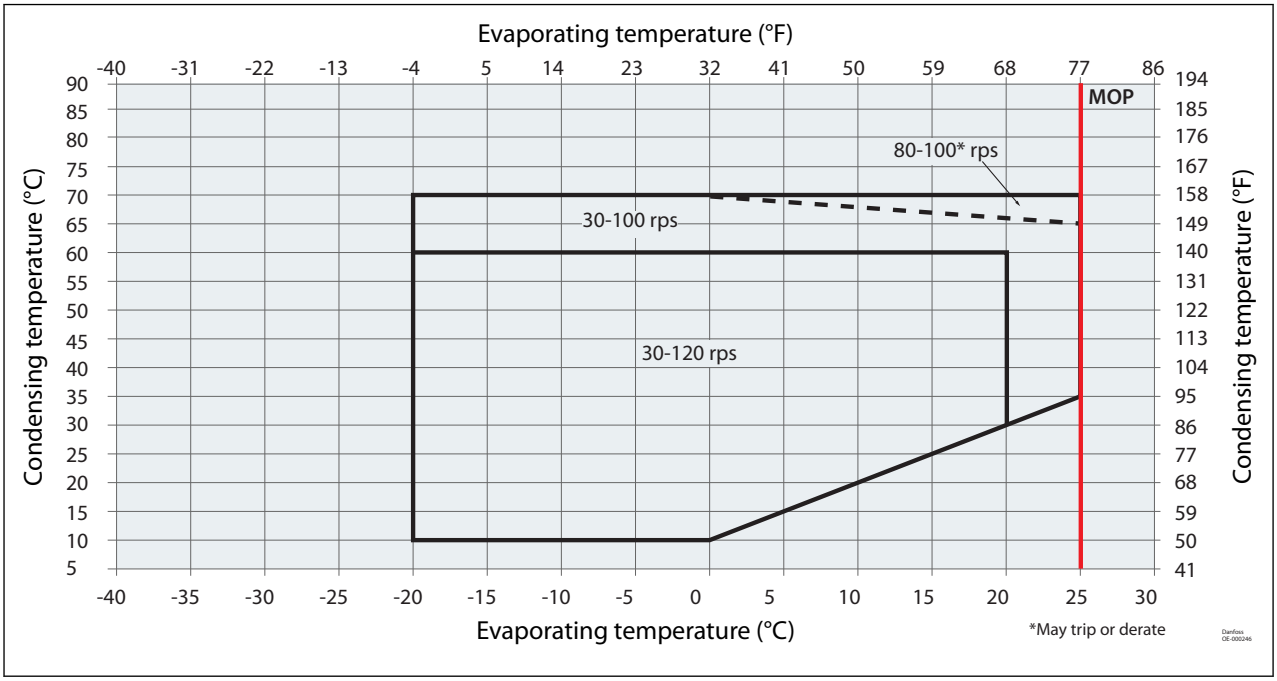


Figure 38: R513A for downsize drive



MOP	Max Operating Pressure

Manage sound and vibration

Sound level

Carefully check the system for vibrations in applications with A3 refrigerants.

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

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

Acoustic hoods are available from Danfoss as accessories, in § “Product information” section “sound levels”

The use of sound insulation on the inside of the of the unit panels is an effective way to mitigate sound. You can find sound level and acoustic hood accessories in § “Product information” section “Sound levels”

Vibrations

R Compressor generates some vibrations that propagate into the surrounding parts and structure. The vibration level of a VZN compressor alone does not exceed criteria for internal qualification. However, when system structure natural frequencies are close to running frequency, vibrations are amplified due to resonance phenomenon. A high vibration level is damageable for piping reliability and generates high sound levels.

To avoid resonance phenomenon, piping and frame must have natural frequencies as far as possible from running frequencies. This could be challenging on a variable system as all resonant frequencies between min speed to maximum speed will be excited.

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

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

If some frequencies continue to produce unacceptable vibration levels, speed by-pass is adjustable in the frequency converter, in order to avoid some frequency ranges. Four by-pass ranges are adjustable, and settings can be made in parameter 3.01/3.02/3.03/3.04

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

! Vibration can be the creation of flammable atmosphere. Carefully check the system for vibrations in applications with A3 refrigerants.

Gas pulsation

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

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

Oil return management

R During operation, compressors always discharge a small amount of oil with refrigerant. After a while, the oil should return to the compressor unless it gets trapped somewhere in the system. When too much oil gets trapped, the compressor may not have enough oil to operate properly.

The main parameters affecting oil return are gas velocity in pipings and exchangers, short cycling control and excessive and fast fluctuation of compressor speed.

Compressors with an oil level sight glass must be visible or full when the compressor is running and when the compressor is stopped. The unit controller must follow the oil logic described in Oil boost.

Systems with reheat coils or multiple have a high potential to reduce mass flow and can be susceptible to oil logging. A means to empty or pump out circuitry when not engaged should be implemented to prevent oil logging. Qualification of these units should be done in unfavorable conditions with each feature engaged and disengaged.

System evaluation

Table 44: Define tests and components required for your application

Application			Tests and components required		
Basic unit [1]	Advanced unit [2]	Non Split [3]	Oil separator	Test	Solutions
X			Optional	Oil return test	
	X	X	Recommended	Oil return test	

[1] Single exchanger as evaporator and condenser
[2] Multiple exchangers as evaporator or condenser (heat-recovery exchanger, roof top reheat coil, four-pipe chiller…)
[3] Unit pre charge at OEM factory, no refrigerant piping done on field

Oil return test

Table 45: Oil return test

Test conditions	Pass criteria	Solutions
Most unfavorable conditions for oil return (lowest and highest refrigerant velocity): 1. Lowest refrigerant velocity and mass flow at low Te and lowest speed for both start up test and continuous running test at low ambient temperature condition 2. Highest refrigerant velocity and mass flow at high Te and highest speed For reversible unit, repeat test in both heating and cooling mode For advanced unit (Multiple exchangers roof top reheat coil, four-pipe chiller…) repeat test in all possible configuration	Oil level must be visible or full in the sight glass when the compressor is running and when all compressors of the circuit are stopped.	If oil return test fails: Increase compressor minimum speed Tops up oil up to 10% of nominal oil charge (Above 10% look for potential oil traps in system) Adjust oil boost logic parameters see § oil management logic

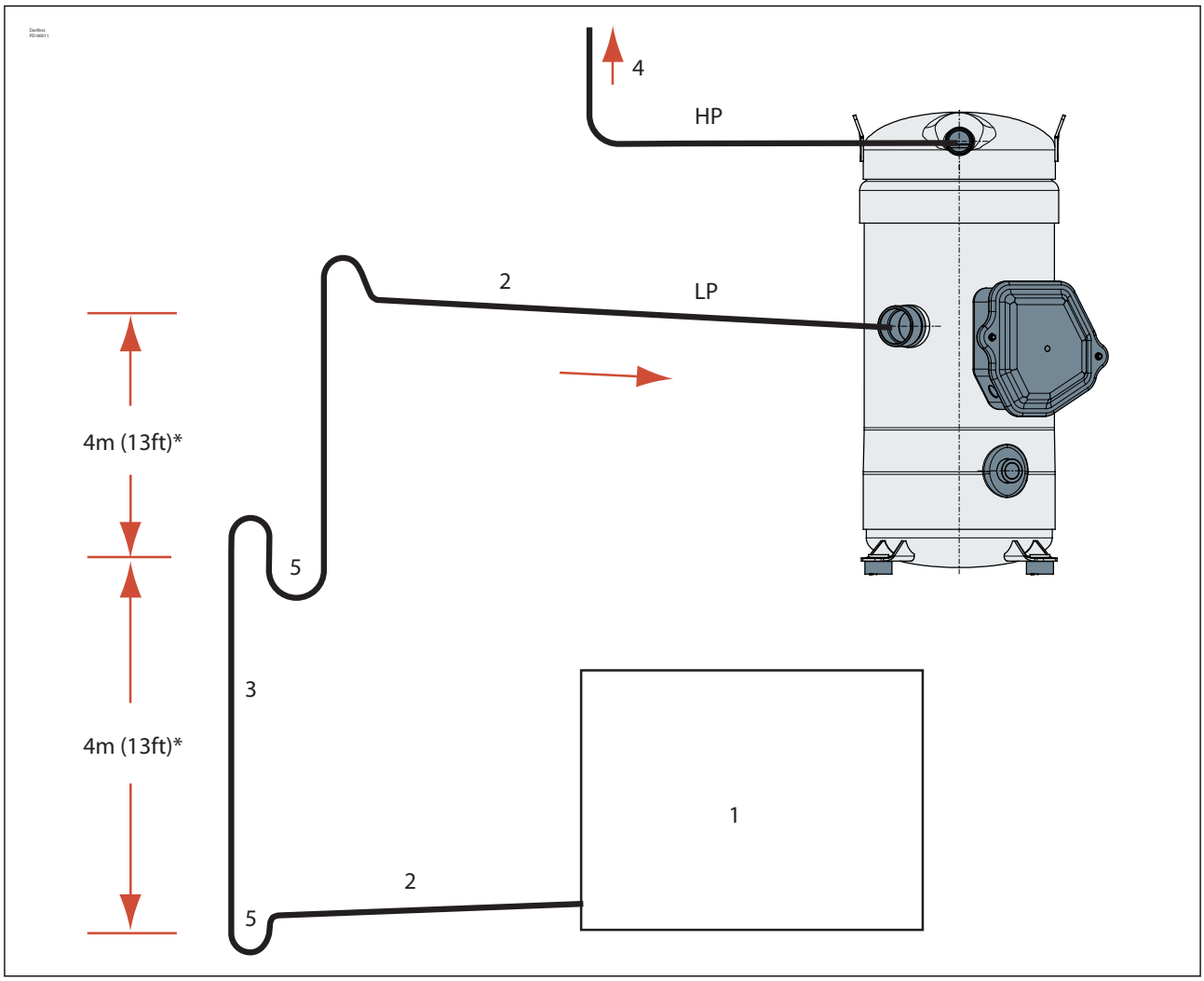
Piping recommendations to ensure oil return

Oil return is highly linked to refrigerant velocity in piping's. The most unfavorably conditions for oil return are when lowest refrigerant velocity that correspond to lowest evaporating T°, highest condensing T° and minimum compressor speed.

General recommendations are described in the figures below: As variable speed applications have a large speed range, it may be difficult to respect minimum refrigerant velocity in all conditions. To guaranty reliability, it is essential to fully qualify oil return especially in most unfavorable conditions. Take particular care to units with reheat coil or multiple exchangers, as velocity may be further reduced.

NOTE:
Relevant pipe sizing at suction and discharge are not necessarily those from the compressor. It has to be qualify within the operating range of the uni

Systems with reheat coils, multiple will reduce mass flow further and can be susceptible to oil logging. A means to empty or pump out circuitry when not engaged should be implemented to prevent oil logging. Qualification of these units should be done in unfavorable conditions with each feature engaged and disengaged.



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

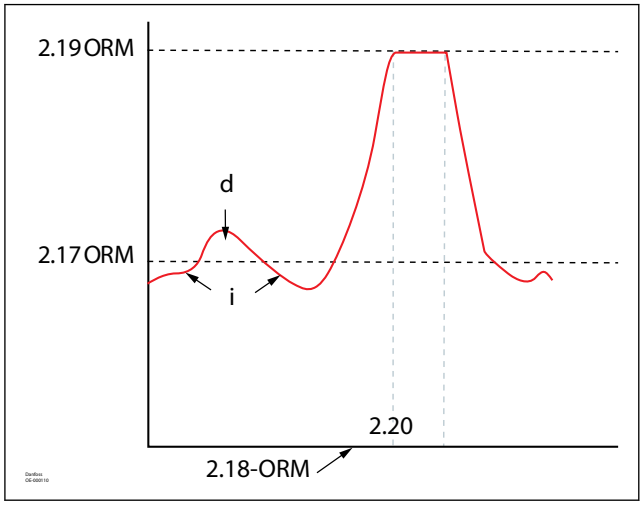
Oil boost

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

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

CDS frequency converter oil boost function

If the compressor runs below ORM(Oil Return Management) Oil Return Activation Speed , 2.17) for more than Oil Return Activation Time, 2.18, then function will override the unit controller and accelerate compressor speed to ORM Boost Speed, 2.19 for Oil Return Time 2.20 (2.20 does not include the ramping up time). When the boost is finished, the compressor speed goes back to run on reference (speed setpoint) and the time counter is reset and restarting from zero.



2.19 ORM	2.19 ORM Boost speed
2.17 ORM	2.17 ORM Min speed limit
2.18-ORM	2.18-ORM Low Speed Running time expire
d	Timer paused
i	Timer continues from previous value
2.20	Boost duration 2.20

Feedback and status message When this feature is activated, bit-14 of the status word will be HIGH (logic 1) and the status LED will indicate as follows:

LED 1	Constant green
LED 2	Fast flashing yellow

Table 46: Feedback and status message

Drive parameters	Description	value
Modbus Register 6	Status Word	4000hex(bit 14)

Table 47: Drive parameters

Drive parameters		Description	Default value	Range
"2.18"	Oil Return Activation Time(s)	Threshold for boost decision (If setting this parameter to "0s", then oil boost function will be disabled)	1800s	0-6000s
"2.20"	Oil Return Time	desired duration of oil boost	60sec	10-255s
"2.17"	ORM Min speed limit	The speed at or below which will activate the oil return timer	50rps 3000rpm	30-70rps
"2.19"	ORM boost speed	The min. speed that compressor will run once the oil return is activated from 2.17&2.18	70rps 4200rpm	par. 2.17 - 100rps

Oil separator

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

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

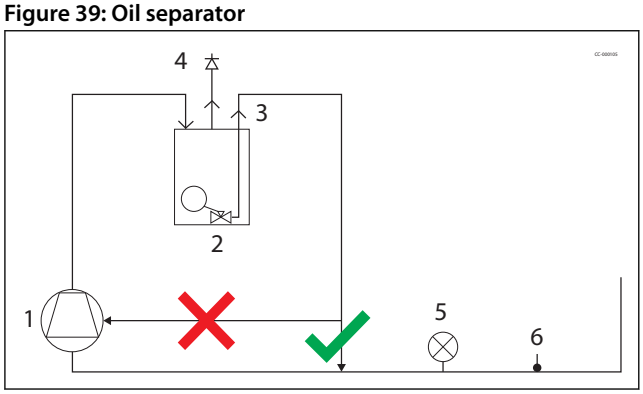
The outlet of the oil separator must be equipped with a non-return valve in order to prevent liquid refrigerant from migrating back from the condenser.

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

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

For installation and dimensioning, always follow manufacturer recommendations

Figure 39: Oil separator



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

Manage Superheat

Requirement

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

In steady state conditions, SSH must follow below requirements regarding the lowest SSH:

Figure 40: Minimum suction superheat for R290

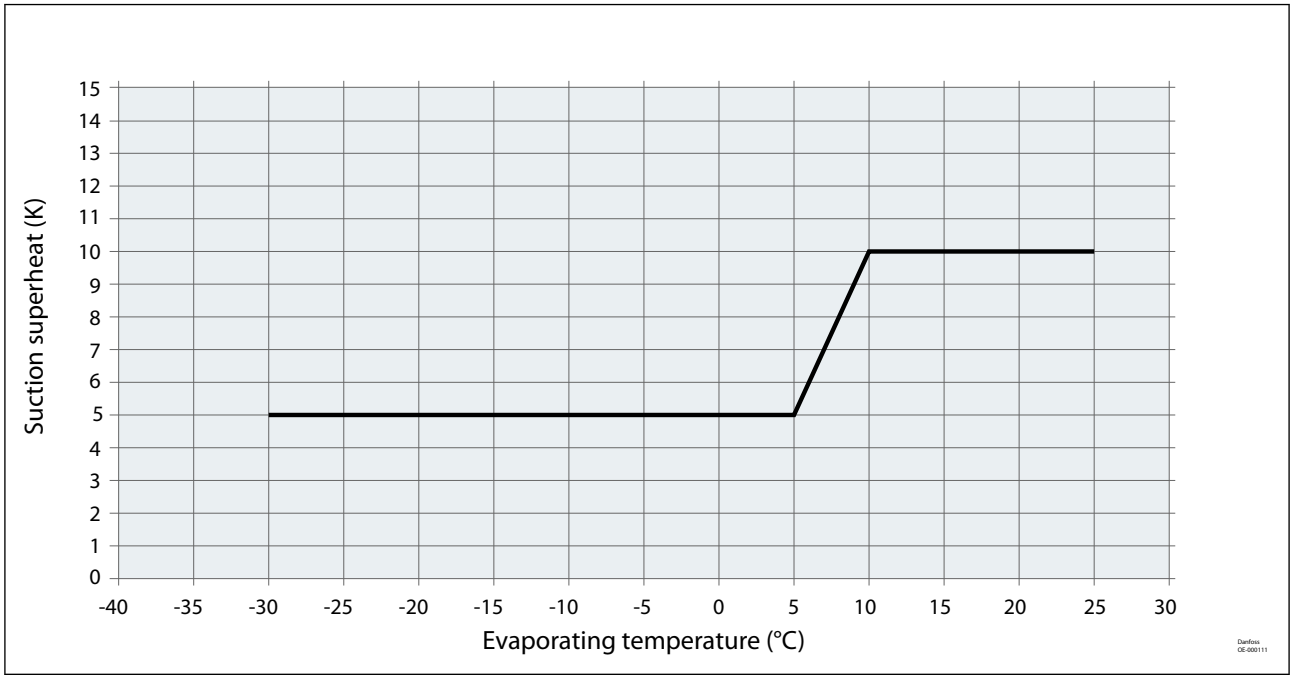
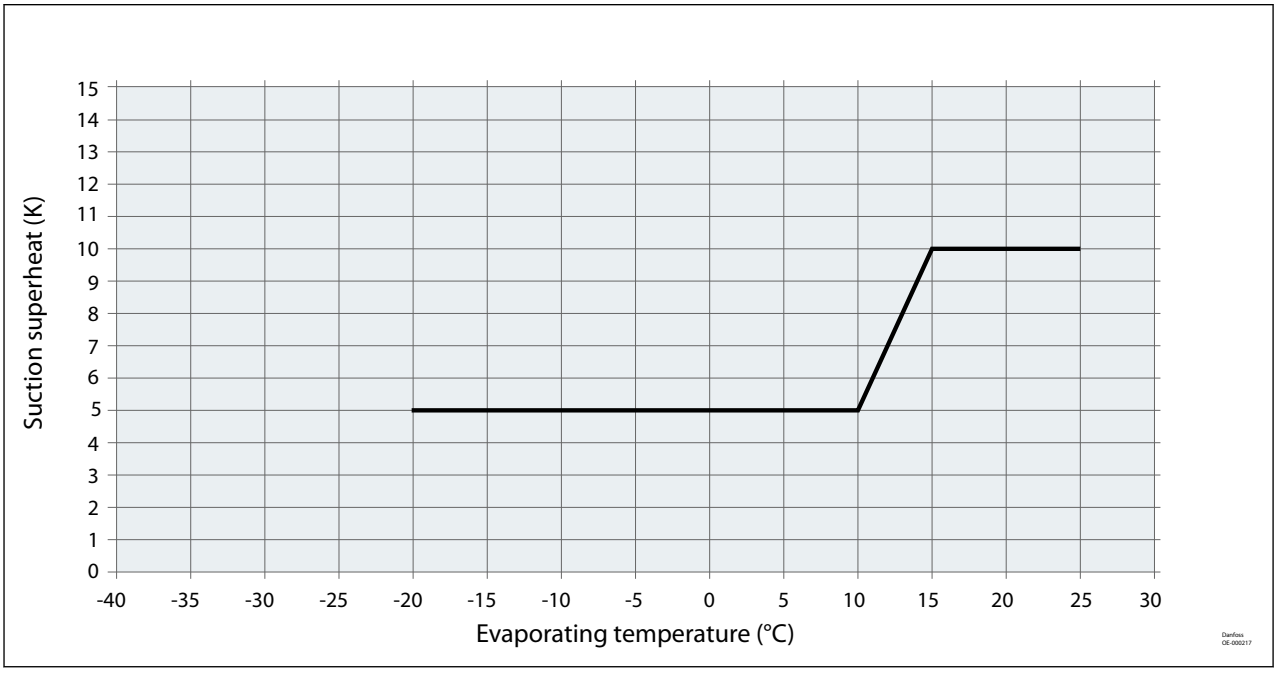


Figure 41: Minimum suction superheat for R513A



In any case, suction superheat must be below 30K. When following this SSH management requirements, oil superheat (see section Oil superheat requirement) will be maintained in a safe area.

Expansion valve

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

- Electronic expansion device (EXV) is preferred as it has a better ability to control superheat at low load.
- It is essential that valve closes when compressor stops.
- For EXV, controller must be programmed to close it when the compressor stops, including in power shut down situation.
- See MOP (Max Operating Pressure Control) in Manage Operating envelope.

Selection of expansion valve

Valve selection must ensure that load of the valve (Compressor capacity/Nominal valve Capacity) is within acceptable range across normal running condition of unit.

As a rule of thumb, load must be within 10% to 120% for EXV.

To define max load and min load of the valve, the first step is to define in which area of compressor envelope the unit will be used in normal operation.

The lowest load happens at lowest speed of compressor, minimum evaporating Temperature, Max condensing Temperature ①

The highest load happens at highest speed of compressor, maximum evaporating Temperature, Min condensing Temperature ②

Figure 42: R290

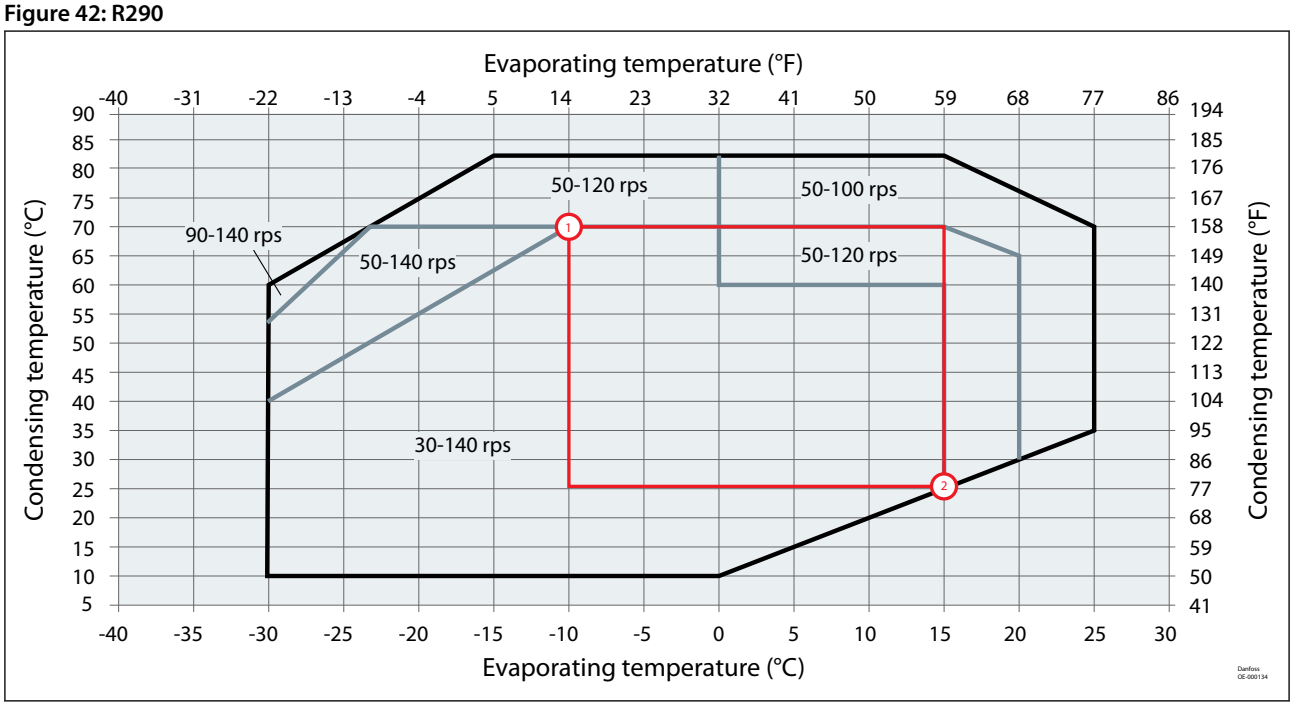


Figure 43: R513A for standard drive

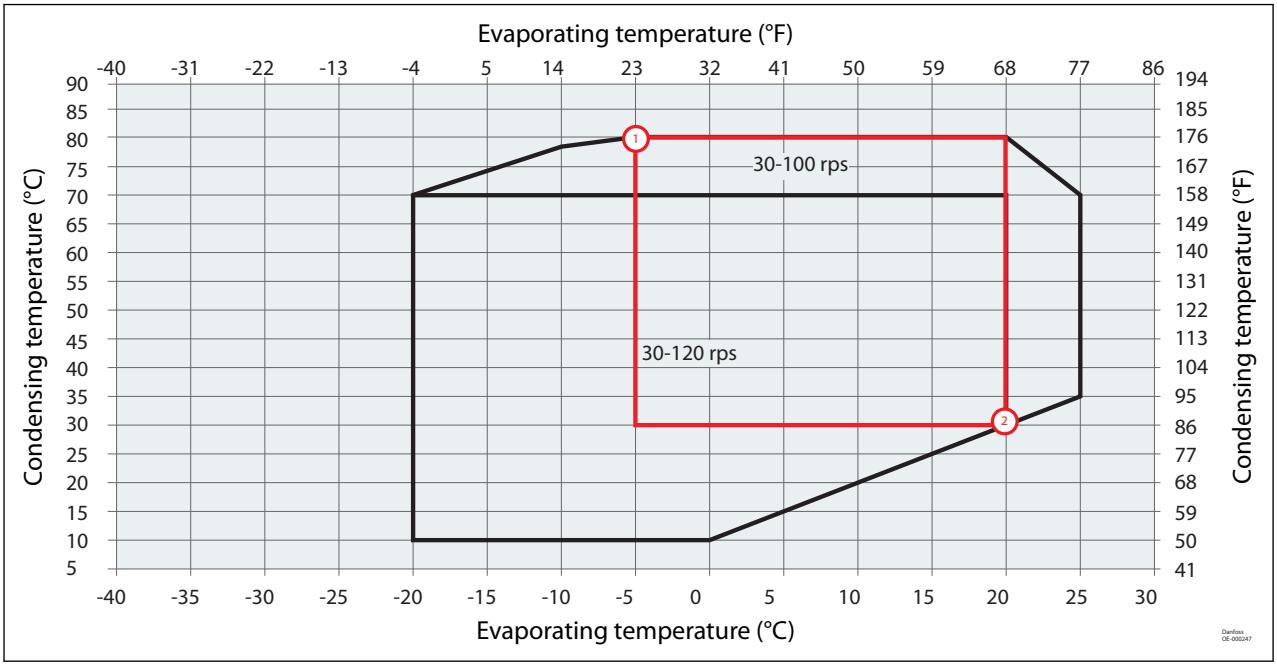
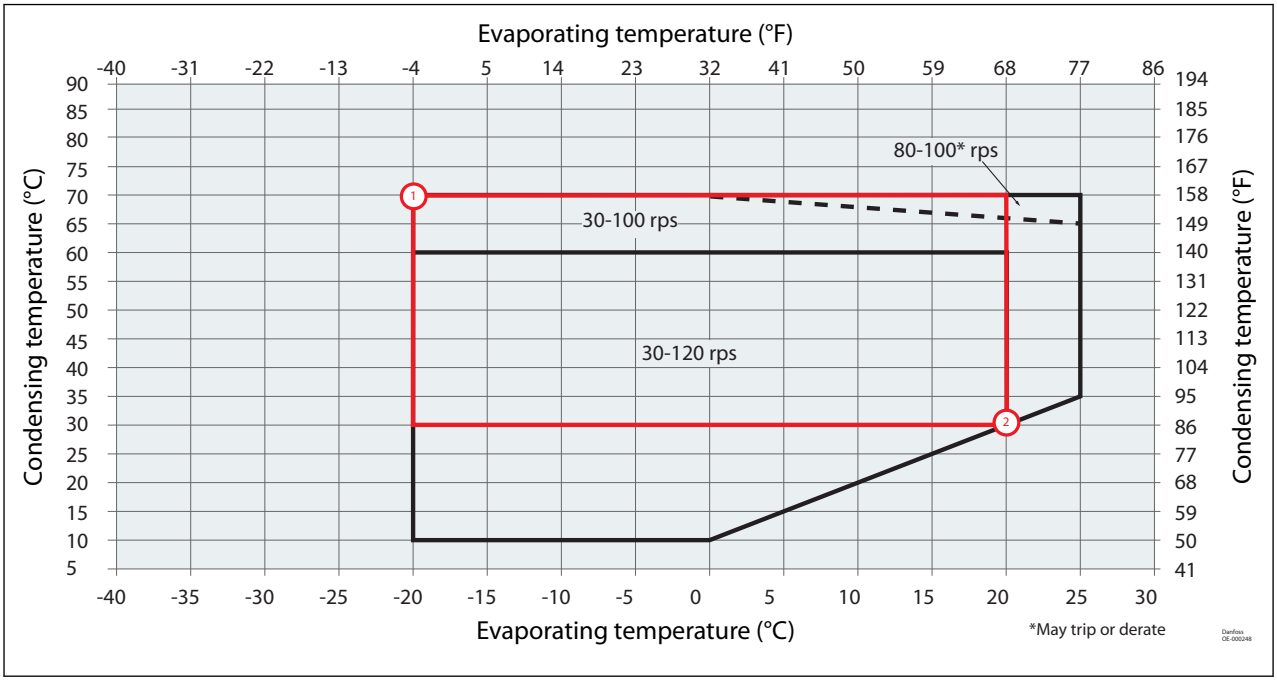


Figure 44: R513A for downside drive

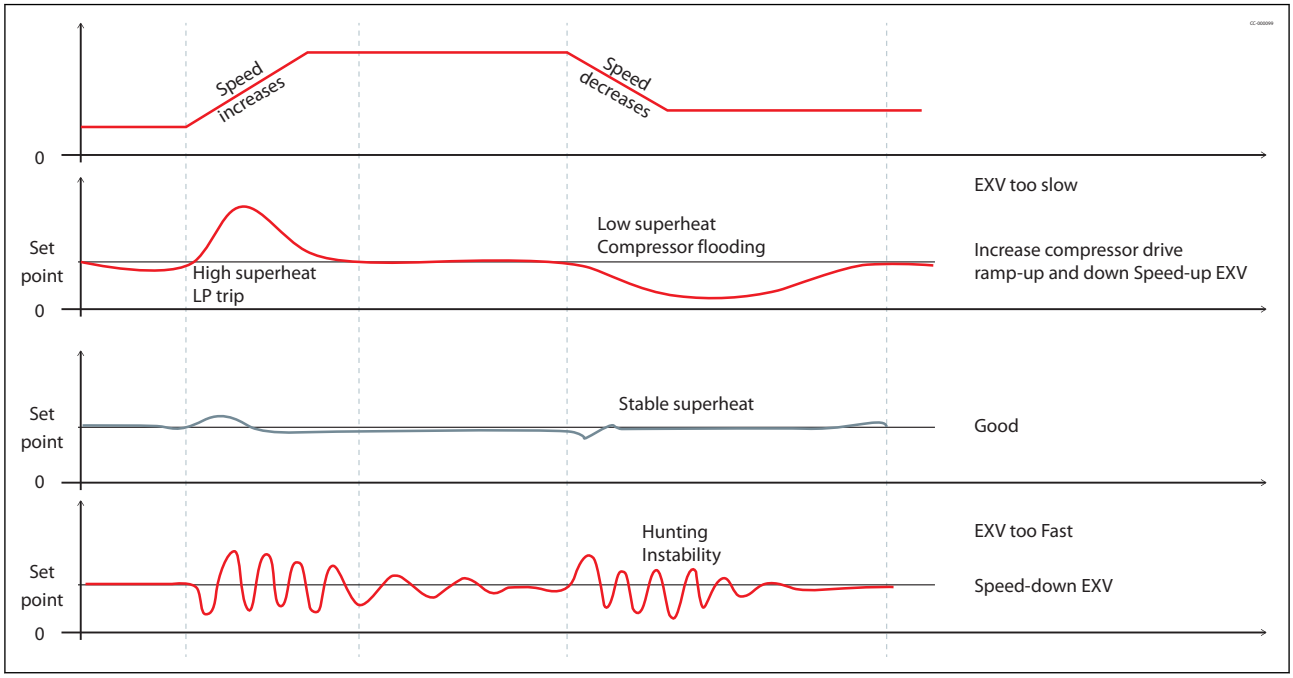


①	Lowest expansion valve load with lowest compressor speed
②	Highest expansion valve load with highest compressor speed

Adjustment of EXV control parameters

To have a proper superheat regulation with EXV, regulation parameters especially speed reaction must be tested and adjusted. In variable speed load is permanently changing and valve must be fast enough to handle compressor speed changes. It is common practice to have a slow reaction to maintain a stable superheat. This was acceptable in fixed speeds, as loads do not change. The use of prepositioning function usually indicates that the valve is not fast enough to handle any changes in speed.

Figure 45: EXV control parameters



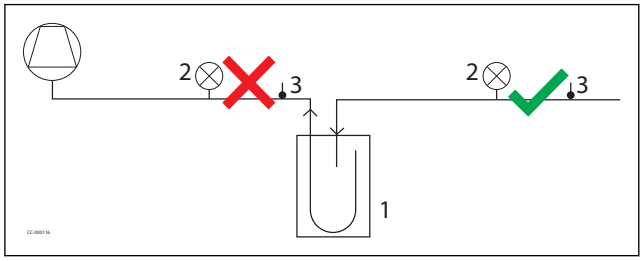
Location and installation of pressure and temperature sensor (EXV)

Good suction temperatures and pressures are essential to guaranty proper superheat control.

Suction pressure and temperature must be taken at the same location site carefully to avoid any potential ambient temperature influence. For non-reversible units, the superheat measurement must be taken as close as possible from the evaporator (as it leaves) and within the evaporator enclosure. For reversible systems, the measurements must be done after the 4-way valve.

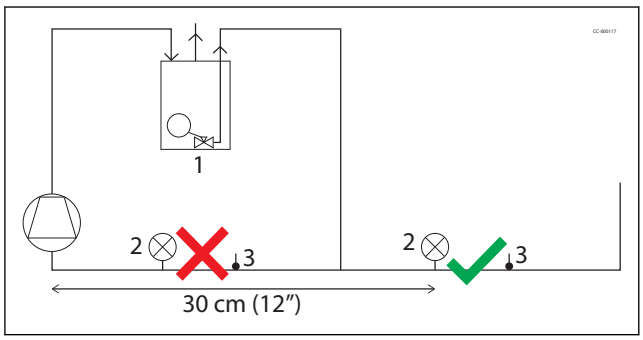
It is important to keep temperature measurements at a minimum piping distance of 30cm (12in) from any large mass components, such as 4-way valves, compressors, suction accumulators or pressure relief valves.

If suction accumulator is used measurement must be done upstream of it.



1	Suction accumulator
2	Pressure sensor
3	temperature sensor

If suction oil separator measurement must be done upstream of it.



1	Oil separator
2	Pressure sensor
3	temperature sensor

System evaluation

Table 48: Define tests and components required for your application

Application		Tests and components required		
Non-Reversible	Reversible [1]	Suction accumulator	Test	Solutions
X		Optional	Liquid refrigerant flood back test	If no test performed, suction accumulator is mandatory
	X	Recommended	Liquid refrigerant flood back test Defrost test	

[1] Unit equipped with a 4-way valve.

Liquid floodback and defrost test

Table 49: Liquid floodback and defrost test

Test	Test conditions	Pass criteria	Solutions
Liquid flood back test	**1. Steady state** Most unfavorable conditions for superheat control (expansion valve threshold): **Lowest evaporating T°, highest condensing T °, compressor at minimum speed** For **reversible unit**, repeat test in both heating and cooling mode For advanced unit (Multiple exchangers roof top reheat coil, four-pipe chiller…) repeat test in all possible configuration	Suction superheat follows map requirement and stable Oil superheat meet below "Oil superheat requirement"	If test fails, check electronic expansion valve (EXV) measurement location and PID parameter and valve prepositioning Add suction accumulator Increase ramp-up and ramp down time to slow down compressor speed change Increase minimum speed
	2. Transient Test must be carried out with most common transient such: Compressor starts Fan staging Compressor speed ramp up and ramp down from min speed to max speed	Oil superheat must not be more than 60 sec below "Oil superheat requirement"	
Defrost cycle	Defrost test must be carried out in the most unfavorable conditions (~ 0°C 32°F ambient conditions)	After defrost, Oil superheat must not be more than 60 sec below "Oil superheat requirement"	Check defrost logic. 4 Way valve control and defrost logic Add suction accumulator

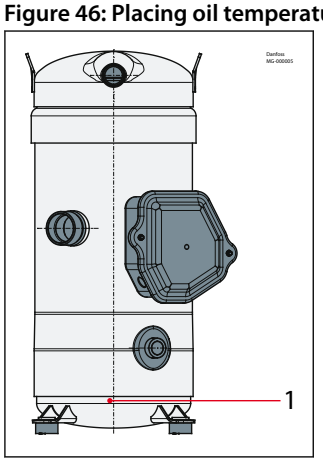
Oil superheat requirement

Placing oil temperature sensor during liquid flooback and defrost tests

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 46: Placing oil temperature sensor



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

Figure 47: Oil superheat criteria R290

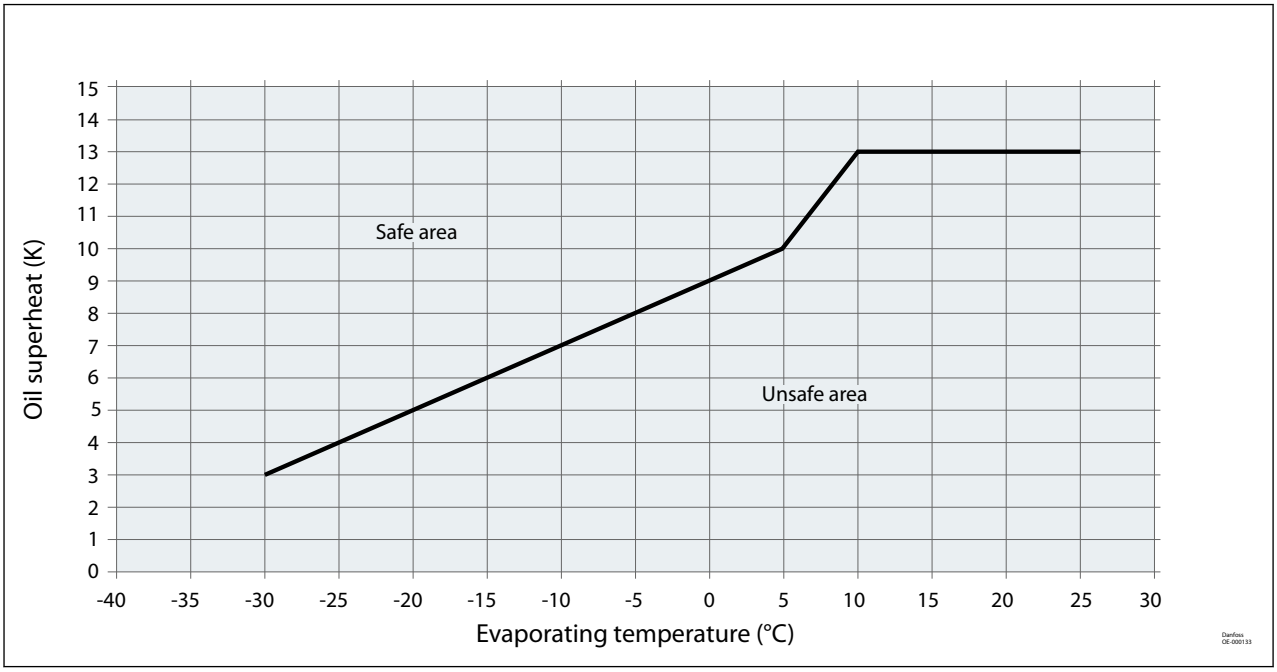
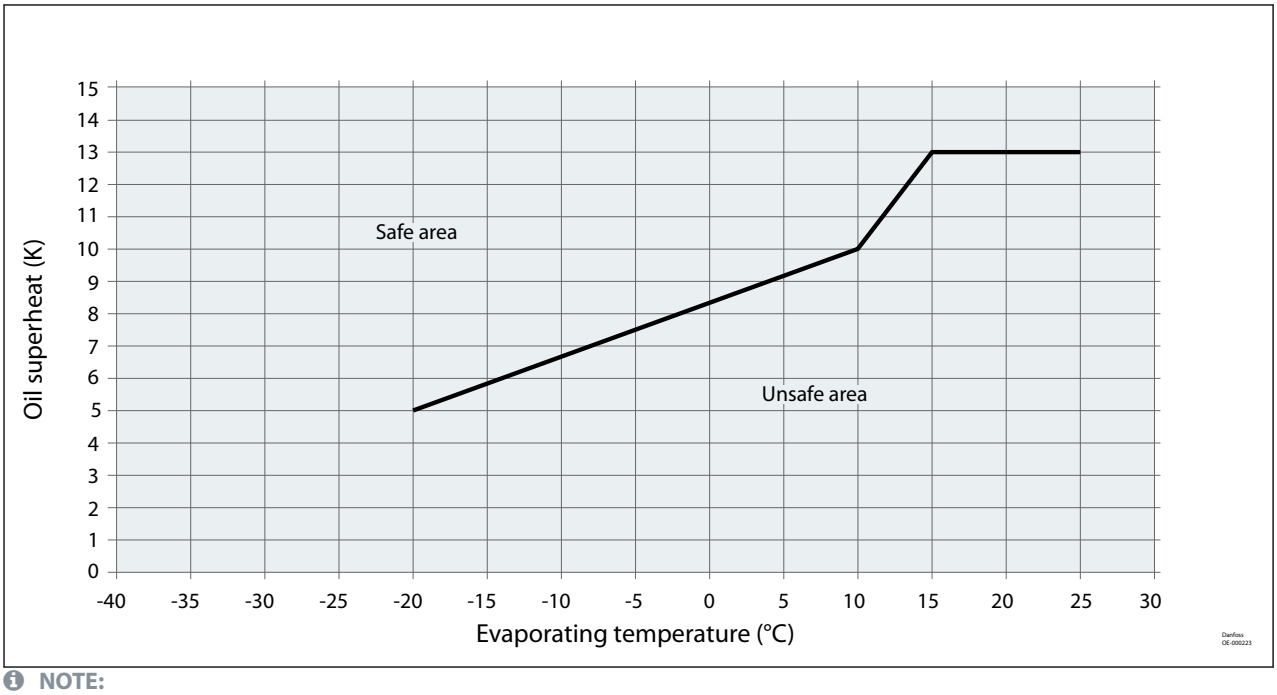


Figure 48: Oil superheat criteria R513A



NOTE:
Criteria : If compressor transiently runs in any "unsafe area", need go back to "safe area" in less of 60s.

Suction accumulator

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

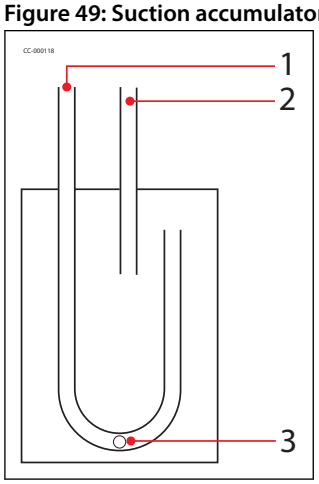
See §Test and components required per application in §Superheat management to know when to use suction accumulator.

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

To prevent oil from getting trapped in the bottom of the suction accumulator, the suction line inside the accumulator (U shape) has a small orifice to drain the collected oil. With variable speed compressors, the range of velocity is significant. The suction accumulator must be selected to be able to have a proper oil return at the lowest load of the unit, and enough oil return flow at high speed. Tests described in Table 45: Oil return test allow to valid this proper selection.

The superheat measurement must be done before suction accumulator.

Figure 49: Suction accumulator



1	outlet
2	Inlet
3	Orifice for oil return

Manage off cycle migration

General information

R Off -cycle refrigerant migration happens:

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

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

Requirement

- Compressor can tolerate occasional flooded start, but it should remain exceptional situation and unit design must prevent that this situation happen at each start.
- Right after start, liquid refrigerant must not flow massively to compressor.
- The charge limit is a threshold beyond some protective measures must be taken to limit risk of liquid slugging and extreme dilution at start.
- R Crankcase heater is mandatory.

Compressor charge limit

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

Table 50: Compressor charge limit

Compressor model	Refrigerant charge limit			
	R290		R513A	
	Kg	lb	Kg	lb
VZN086/104	3	6.6	6.5	14.3
VZN140/175	5	11	10.5	23.1
VZN220	7	15.4	-	-

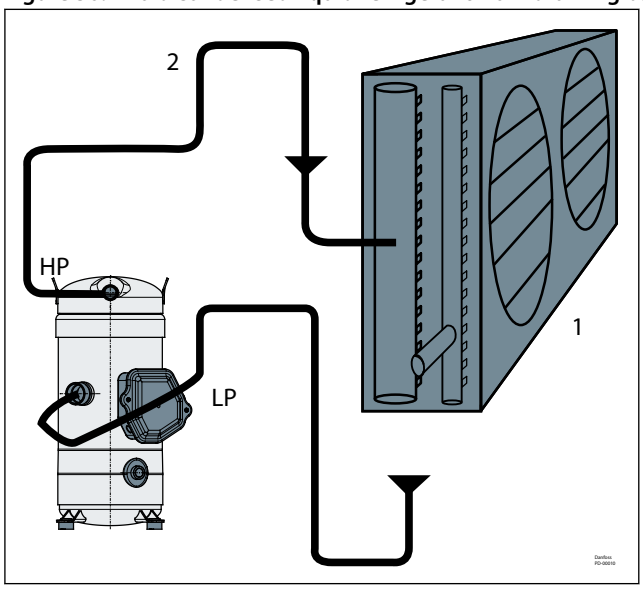
System evaluation

Table 51: Define tests and components required for your application

Application		Components required			
Below charge limit	Above charge limit	Crankcase heater	Non return valve	Pump down cycle	Comments
X		Mandatory	Mandatory for unit with water condenser (W/W or reversible A/C Chiller	Optional	Ensure tightness between condenser & evaporator when system is OFF Electronic expansion valve (EXV): must close when the system stops, including in power shut down situation or power loss
	X	Mandatory	Mandatory	Optional	

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

Figure 50: Avoid condensed liquid refrigerant from draining back



1	Condenser
2	Upper loop

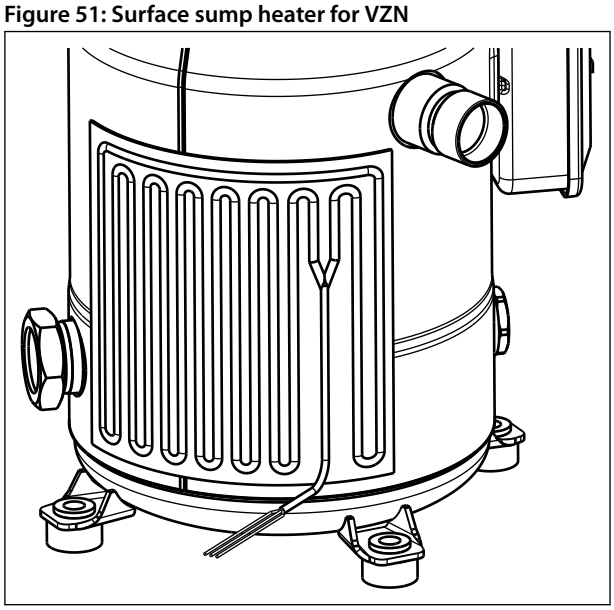
Crankcase heater

The crankcase heater is not an ignition source during normal operation in A3 systems but could become one when not installed properly according to installation instructions. Ensure correct electrical and mechanical installation.

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

See System evaluation Crankcase heater accessories are available from Danfoss (see section Accessories and Spare parts).

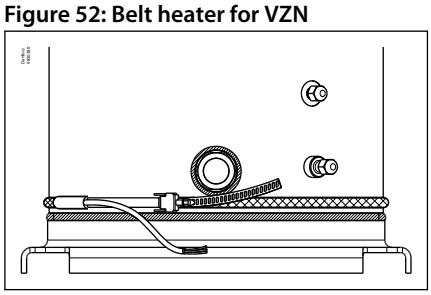
Figure 51: Surface sump heater for VZN



For VZN, the surface sump heater should be mounted on the compressor shell. For better standby energy consumption, Danfoss provides 80W surface sump heater and 65W belt heater. The selection shall be done according to following table:

Compressor Surrounding Ambient	Surface Sump Heater	Belt heater
Unit has enclosure, no wind	80W	65W
Unit has enclosure or no enclosure, Wind >5m/s(ft/s)&ambient temperture<-5°C	80W+additional SSH/thermal insulation	65W+additional Belt heater/thermal insulation

Figure 52: Belt heater for VZN



Crankcase control logic

The heater is typically controlled by a unit controller and shall be ON whenever compressor is OFF.

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

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

Liquid line solenoid valve (LLSV)

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

Pump down cycle

By decreasing pressure in the sump, pump down system:

- In A3 refrigerant systems, a flammable mixture can form inside the system during operation in a vacuum. Extreme attention shall be paid to system tightness. Make sure that air does not enter the system and that the pressure never falls below atmospheric pressure.
- Evacuates refrigerant from oil
- Sets the sump saturating pressure much lower than ambiance temperature and due to that, avoids refrigerant condensation in the compressor.

Pump down cut-out pressure setting shall be 1.5 bars (22 psi) below nominal evaporating pressure with a minimum of 0.7bars (g) (10psig) for R290 and 0.5bar (g) (7psig) for R513A.

Pump down cycle logic

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

"One shot pump down" should be used: when the last compressor of the circuit stops, suction pressure is decreased down to cut-out pressure. Even if suction pressure increases again, the compressor will not restart.

Assembly line procedure

Reduce moisture in the system

Excessive air and moisture

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

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

Requirements

VZN compressors are delivered with < 195 ppm moisture level. At the time of commissioning, system moisture content may be up to 195 ppm.

During operation, the filter drier must reduce this to a level between 20 and 50 ppm.

Solutions

To achieve this requirement, a properly sized and type of drier is required. Important selection criteria's include:

- driers water content capacity,
- system refrigeration capacity,
- system refrigerant charge.

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

Compressor storage

Store the compressor not exposed to rain, corrosive or flammable atmosphere between -35°C (-31°F) and 70°C (158°F) when charged with nitrogen and R290/R513A refrigerant.

Compressor holding charge

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

Respect the following sequence:

- Remove the suction plug first and the discharge plug afterwards to avoid discharge check valve gets stuck in open position.

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

Handling

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

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

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

Figure 53: Heavy do not lift manually



Figure 54: handle with Spreader bar

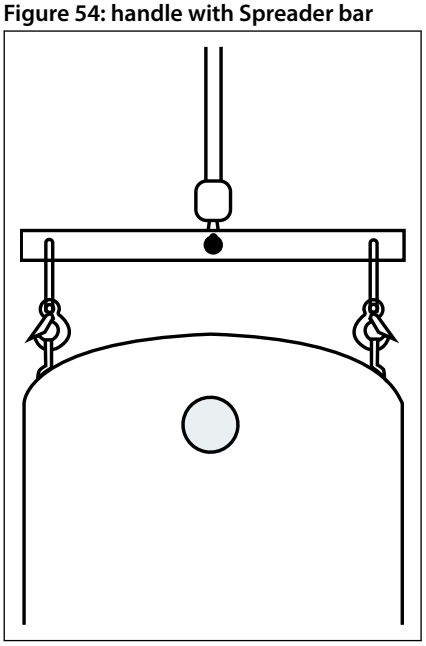
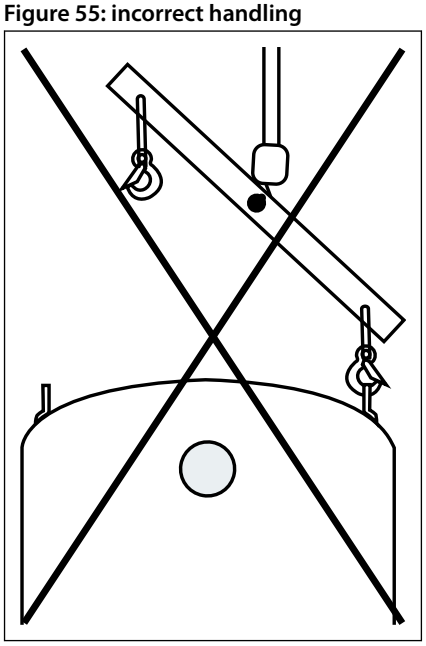


Figure 55: incorrect handling



Piping assembly

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

Table 52: System cleanliness

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

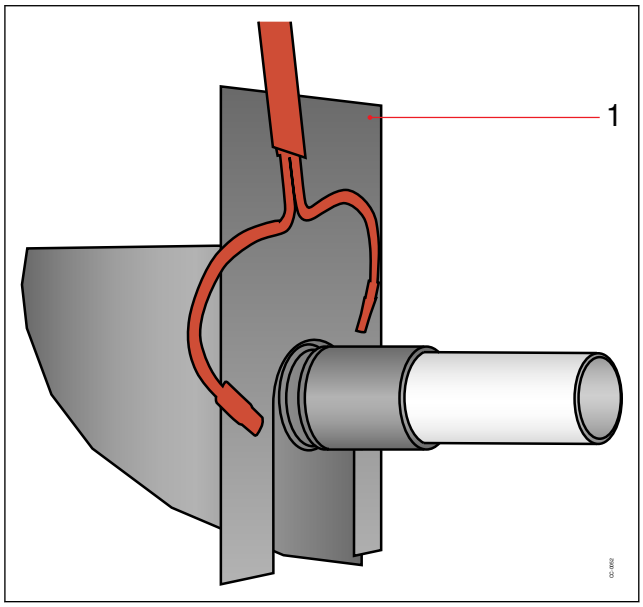
Brazing procedure:

- It is mandatory to flush oxygen-free nitrogen through the piping during the brazing process of systems using A3 flammable refrigerants
- Brazing operations must be performed by qualified personnel.
- Make sure that no electrical wiring is connected to the compressor.
- To prevent compressor shell and electrical box overheating, use a heat shield and/or a heat-absorbent compound.
- Clean up connections with degreasing agent
- Flow nitrogen through the compressor.
- Use flux in paste or flux coated brazing rod.
- It is recommended to use double-tipped torch using acetylene to ensure a uniform heating of connection.
- To enhance the resistance to rust, a varnish on the connection is recommended.

VZN compressors connectors are made of steel copper coated, which benefit to protect against corrosion and facilitate adhesion during brazing operation. As per standards practice in the refrigeration industry, Danfoss Commercial Compressor recommend to use of silver cadmium free solder alloy and flux (added or flux coated rods). The significant silver content in these brazing alloy will help the brazing operation, providing an excellent fluidity and a limited heating temperature. It will bring also a good resistance to corrosion, a proper elongation compatible with system vibration, and good behavior under thermal variation improving the strength of connection and limiting fractures and refrigerant leaks. (Crucial with A3 refrigerants).

A typical content of 30 – 40% Ag (Silver) is recommended by Danfoss.

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



1	Heat shield

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

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

System pressure test and leak detection

⚠ The compressor has been strength tested and leak proof tested (<1.2g/year) at the factory. For system tests:

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

Table 53: Maximum compressor test pressures

Maximum compressor test pressures	VZN
Maximum compressor test pressure high side (HP)	41.8bar(g) (606 psig) HP-LP<37bar (537 psi)
Maximum compressor test pressure low side (LP)	36.7 bar (g) (532 psig) LP-HP<5bar (73 psi) Maximum speed 4.8bar/s (70psi/s)[1]

[1] The maximum pressurizing speed must be respected to ensure pressure equalization between LP and HP side over scroll elements.

Vacuum evacuation and moisture removal

⚠ Requirements:

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

Recommendations:

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

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

Refrigerant charging

⚠ Initial charge:

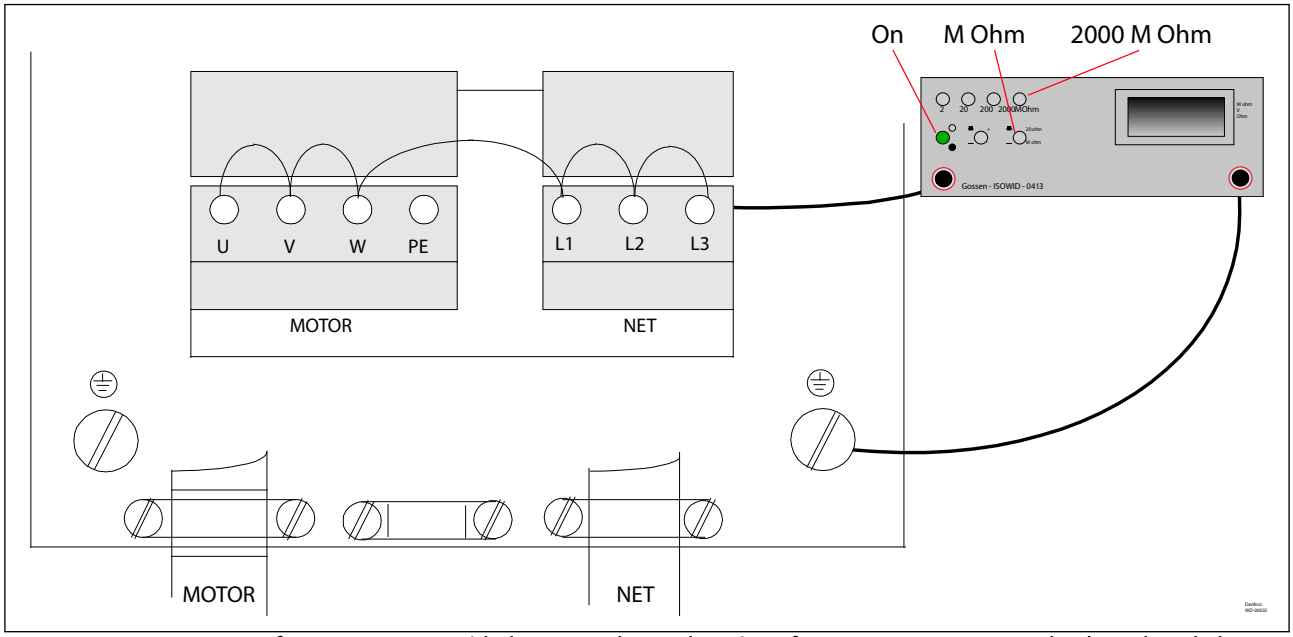
- For the initial charge, the compressor must not run.
- Charge refrigerant as close as possible to the nominal system charge.
- This initial charging operation must be done in liquid phase between the condenser outlet and the filter drier.

If needed, a complement of charge can be done, in liquid phase while compressor is running by slowly throttling liquid in.

Never bypass safety low pressure switch.

For more detailed information see “Recommended refrigerant system charging practice“ AP000086421422.

Dielectric strength and insulation resistance tests



It is not necessary to perform a Hipot test (dielectric withstand test) on frequency converters. This has already been done during factory final test.

If a Hipot test has to be done anyway, following instructions must be followed in order to not damage the frequency converter:

- Compressor not connected
- L1, L2, L3, U, V, W terminals must be shorten and connected to high voltage terminal of the testing device.
- Ground terminal (chassis) must be connected to low voltage terminal of the testing device.
- 2000VDC(for T2)/2150VDC(for T4)/2250VDC(for T6) for 1 seconds must be applied
- Ramp up time 3 seconds

- Full DC voltage must be established during 2 seconds
- The current leakage during the test must be below 1mA
- Ramp down time to 0V in 25 seconds. 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.

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

Commissioning

Preliminary check

Check electrical power supply:

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

Initial start-up

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

System monitoring

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

- Proper metering device operation and desired superheat readings
- Suction and discharge pressure are within acceptable levels
- Correct oil level in compressor sump indicates proper oil return
- Low foaming in sight glass and compressor sump temperature meet "Oil superheat requirement" to show that there is no refrigerant migration taking place
- Current draw of compressor within acceptable values (MOC ratings)
- No abnormal vibrations and noise.

Oil level checking and top-up

In installations with good oil return and line runs up to 15m (49.2 feet), no additional oil is required. If installation lines exceed 15m (49.2 feet), additional oil may be needed. 3% of the total system refrigerant charge (in kg/lb) can be used to roughly define the required oil top-up quantity (in liters) but in any case, the oil charge has to be adjusted based on the oil level in the compressor sight glass.

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

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

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

The oil level can also be checked a few minutes after the compressor stops, the level must be visible in sight glass.

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

Top-up the oil while the compressor is idle. Use any accessible connector on the compressor suction line and a suitable pump.

Dismantle and disposal



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

Packaging

Single pack



Table 54: Single pack

Compressor model	Height	Width	Depth	Weight
	(mm)	(mm)	(mm)	(kg)
VZN086/104	718	565	470	71
VZN140/175	718	565	470	80
VZN220	1100	565	470	100

Industrial pack

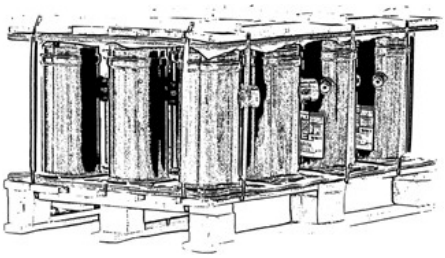


Table 55: Industrial pack

Compressor model	Number	Height	Width	Depth	Gross Weight	Static stacking pallets
		(mm)	(mm)	(mm)	(kg)	
VZN086/104	8	1150	950	750	504	2
VZN140/175	8	1150	950	750	576	2
VZN220	8	1150	950	800	724	2

Frequency converter pack

Figure 56: CDS203 packaging

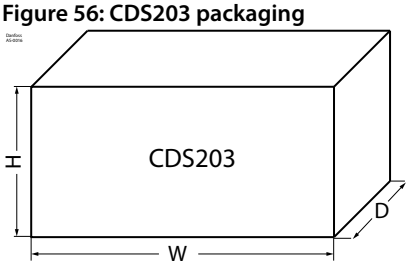


Table 56: Frequency converter single pack

Model	Height(H)	Width(W)	Depth(D)	Weight
	(mm)	(mm)	(mm)	(kg)
CDS203 FS2 Heatsink version for VZN086/104	203	340	204	3.7
CDS203 FS2 Coldplate version for VZN086/104	203	340	204	2.6
CDS203 FS3 Heatsink version for VZN086/104	252	371	240	5.84
CDS203 FS3 Coldplate version for VZN086/104	252	371	240	3.9
CDS203 FS4 Heatsink version for VZN140/175	300	420	320	11
CDS203 FS4 Coldplate version for VZN140/175	300	420	320	6.3
CDS203 FS5 Heatsink version for VZN220	300	420	320	11.5
CDS203 FS5 Coldplate version for VZN220	300	420	320	7

Table 57: Frequency converter industrial pack

Model	Number	Height(H)	Width(W)	Depth(D)	Weight
		(mm)	(mm)	(mm)	(kg)
CDS203 FS2 Heatsink version for VZN086/104	8	1000	600	800	37
CDS203 FS2 Coldplate version for VZN086/104	8	1000	600	800	28
CDS203 FS3 Heatsink version for VZN086/104	8	800	600	800	56.2
CDS203 FS3 Coldplate version for VZN086/104	8	800	600	800	40.2
CDS203 FS4 Heatsink version for VZN140/175	8	800	600	800	96.2
CDS203 FS4 Coldplate version for VZN140/175	8	800	600	800	59.4
CDS203 FS5 Heatsink version for VZN220	8	800	600	800	100.2
CDS203 FS5 Coldplate version for VZN220	8	800	600	800	64.2

Ordering

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

Single pack

Table 58: Single pack (R290 only)

Compressor model	Technical Name	Commercial Name
VZN086	VZN086AGANA	120G0471
VZN104	VZN104AGANA	120G0469
VZN140	VZN140AGANA	120G0467
VZN175	VZN175AGANA	120G0465
VZN220[1]	VZN220AGANA	120G0575

[1] VZN220 will be released in April 2026

Table 59: Single pack（R290 and R513A)

Compressor model	Technical Name	Commercial Name
VZN086	VZN086AGVNA	120G0594
VZN104	VZN104AGVNA	120G0592
VZN140	VZN140AGVNA	120G0590
VZN175	VZN175AGVNA	120G0588

NOTE:
These codes are just for R513A samples. In Q3 2026, new sales codes with R290/R513A/R454C will be released.

Industrial pack

Table 60: Industrial pack (R290 only)

Compressor model	Technical Name	Commercial Name
VZN086	VZN086AGANA	120G0472
VZN104	VZN104AGANA	120G0470
VZN140	VZN140AGANA	120G0468
VZN175	VZN175AGANA	120G0466
VZN220[1]	VZN220AGANA	120G0574

[1] VZN220 will be released in April 2026

Table 61: Industrial pack (R290 and R513A)

Compressor model	Technical Name	Commercial Name
VZN086	VZN086AGVNA	120G0595
VZN104	VZN104AGVNA	120G0593
VZN140	VZN140AGVNA	120G0591
VZN175	VZN175AGVNA	120G0589

NOTE:
These codes are just for R513A samples. In Q3 2026, new sales codes with R290/R513A/R454C will be released.

VZN voltage code CDS203

Table 62: Single pack

Compressor model	Frequency converter				
	Model	Power	Clooling type	Drive name	Sales codes
VZN086 R290	CDS203	15kW	Heat sink	CDS203-34P15K-3FH11	116B3001
			Coldplate	CDS203-34P15K-3FC11	116B4001
VZN104 R290	CDS203	18.5kW	Heat sink	CDS203-34P18K-3FH21	116B3002
			Coldplate	CDS203-34P18K-3FC21	116B4002
VZN140 R290	CDS203	22.0kW	Heat sink	CDS203-44P22K-3FH11	116B3003
			Coldplate	CDS203-44P22K-3FC11	116B4003

Compressor model	Frequency converter				
	Model	Power	Clooling type	Drive name	Sales codes
VZN175 R290	CDS203	30kW	Heat sink	CDS203-44P30K-3FH21	116B3004
			Coldplate	CDS203-44P30K-3FC21	116B4004
VZN220 R290	CDS203	40kW	Heat sink	CDS203-54P40K-3FH11	116B3013
			Coldplate	CDS203-54P40K-3FC11	116B4013
VZN086 R513A Std drive	CDS203	15kW	Heat sink	CDS203-34P15K-3FH51	116B3018
			Coldplate	CDS203-34P15K-3FC51	116B4018
VZN104 R513A Std drive	CDS203	18.5kW	Heat sink	CDS203-34P18K-3FH61	116B3019
			Coldplate	CDS203-34P18K-3FC61	116B4019
VZN140 R513A Std drive	CDS203	22.0kW	Heat sink	CDS203-44P22K-3FH41	116B3020
			Coldplate	CDS203-44P22K-3FC41	116B4020
VZN175 R513A Std drive	CDS203	30kW	Heat sink	CDS203-44P30K-3FH51	116B3021
			Coldplate	CDS203-44P30K-3FC51	116B4021
VZN086 R513A Downsize drive	CDS203	11kW	Heat sink	CDS203-24P11K-3FH131	116B3014
			Coldplate	CDS203-24P11K-3FC131	116B4014
VZN104 R513A Downsize drive	CDS203	11kW	Heat sink	CDS203-24P11K-3FH141	116B3015
			Coldplate	CDS203-24P11K-3FC141	116B4015
VZN140 R513A Downsize drive	CDS203	15kW	Heat sink	CDS203-34P15K-3FH71	116B3016
			Coldplate	CDS203-34P15K-3FC71	116B4016
VZN175 R513A Downsize drive	CDS203	18kW	Heat sink	CDS203-34P18K-3FH81	116B3017
			Coldplate	CDS203-34P18K-3FC81	116B4017

Table 63: Industrial pack

Compressor model	Frequency converter				
	Model	Power	Clooling type	Drive name	Sales codes
VZN086 R290	CDS203	15kW	Heat sink	CDS203-34P15K-3FH11	116F3001
			Coldplate	CDS203-34P15K-3FC11	116F4001
VZN104 R290	CDS203	18.5kW	Heat sink	CDS203-34P18K-3FH21	116F3002
			Coldplate	CDS203-34P18K-3FC21	116F4002
VZN140 R290	CDS203	22.0kW	Heat sink	CDS203-44P22K-3FH11	116F3003
			Coldplate	CDS203-44P22K-3FC11	116F4003
VZN175 R290	CDS203	30kW	Heat sink	CDS203-44P30K-3FH21	116F3004
			Coldplate	CDS203-44P30K-3FC21	116F4004
VZN086 R513A Std drive	CDS203	15kW	Heat sink	CDS203-34P15K-3FH51	116F3018
			Coldplate	CDS203-34P15K-3FC51	116F4018
VZN104 R513A Std drive	CDS203	18.5kW	Heat sink	CDS203-34P18K-3FH61	116F3019
			Coldplate	CDS203-34P18K-3FC61	116F4019
VZN140 R513A Std drive	CDS203	22.0kW	Heat sink	CDS203-44P22K-3FH41	116F3020
			Coldplate	CDS203-44P22K-3FC41	116F4020
VZN175 R513A Std drive	CDS203	30kW	Heat sink	CDS203-44P30K-3FH51	116F3021
			Coldplate	CDS203-44P30K-3FC51	116F4021
VZN086 R513A Downsize drive	CDS203	11kW	Heat sink	CDS203-24P11K-3FH131	116F3014
			Coldplate	CDS203-24P11K-3FC131	116F4014
VZN104 R513A Downsize drive	CDS203	11kW	Heat sink	CDS203-24P11K-3FH141	116F3015
			Coldplate	CDS203-24P11K-3FC141	116F4015
VZN140 R513A Downsize drive	CDS203	15kW	Heat sink	CDS203-34P15K-3FH71	116F3016
			Coldplate	CDS203-34P15K-3FC71	116F4016
VZN175 R513A Downsize drive	CDS203	18.5kW	Heat sink	CDS203-34P18K-3FH81	116F3017
			Coldplate	CDS203-34P18K-3FC81	116F4017

Accessories and Spare parts

Lubricant / oils

Type	Code no.	Description	Application	Packaging	Pack size
160SZ	7754023	POE lubricant, 160SZ, 1 liter can	VCZ all models	Multipack	12

Terminal boxes, covers & T-block connectors

Code no.	Description	Application	Packaging	Pack size
8173230	T block connector 52 x 57 mm	VZN086-175 models	Multipack	10
8173021	T block connector 60 x 75mm	VZN220 model	Multipack	10

Mounting kits

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

Acoustic hoods- lubricant, acoustic hoods and spare parts

Code no.	Description	Application	Packaging	Pack size
120Z0916	High attenuation acoustic hood	VZN086/104	Single pack	1
120Z0915	High attenuation acoustic hood	VZN140/175	Single pack	1
120Z0914	Generic acoustic hood	VZN086/104	Single pack	1
120Z0913	Generic acoustic hood	VZN140/175	Single pack	1

Discharge thermostats and sensors

Code no.	Description	Application	Packaging	Pack size
120Z0823	Discharge temperature sensor/converter	VZN all models	Single pack	1
120Z0158	Discharge temperature sensor	VZN all models	Single pack	1
120Z0824	Discharge temperature converter	VZN all models	Single pack	1

Crankcase heaters

Code no.	Description	Application	Packaging	Pack size
120Z0389	80W 230V surface sump heater CE and UL	VZN all models	Multipack	8
120Z0390	80W 400V surface sump heater CE and UL	VZN all models	Multipack	8
120Z0038	Belt type crankcase heater,65W,230V,CE and UL	VZN all models	Multipack	8
120Z0039	Belt type crankcase heater,65W,400V,CE and UL	VZN all models	Multipack	8
120Z0958	Belt type crankcase heater,55W,230V,CE and UL	VZN086-104-140-175	Multipack	8

LCP's Spare part frequency converter CDS203

Code no.	Description	Application	Packaging	Pack size
116B9002	CDS203-LCP	Frequency converter CDS203 / all VZN models	Single pack	1
116B9003	USB cable gateway for CoolSetting	Frequency converter CDS203 / all VZN models	Single pack	1

Brackets

Code number	Description	Application	Packaging	Pack size
116B9004	Brackets for CDS203 FS3	Frequency converter CDS203 FS3	Single pack	1
116B9005	Brackets for CDS203 FS4/FS5	Frequency converter CDS203 FS4/FS5	Single pack	1
116F9004	Brackets for CDS203 FS3	Frequency converter CDS203 FS3	Industrial pack	40
116F9005	Brackets for CDS203 FS4/FS5	Frequency converter CDS203 FS4/FS5	Industrial pack	8

EMC Filter

Code no.	Description	Application	Packaging	Pack size
116B9006	EMC filter for CDS203 FS3 FS4 FS5	VZN all models	Single pack	1

Updates

Release date (Year/Month)	Guideline literature number	List of changes
2024/09	AB478735922007en-010101	First release
2025/11	AB478735922007en-010201	Added R513A application for VZN086/104/140/175 Added VZN220 R290 model

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