ENGINEERING
TOMORROW

Application Guide

Inverter scroll compressors
VZF hybrid manifold VZF+DSF

R32

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Contents

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 application guideline describes the operating characteristics, design features and application requirements for hybrid manifolding of the Danfoss DSF fixed-speed compressor and the VZF inverter compressor in air-conditioning and heat pump applications.

To ensure proper parallel installation and running conditions, the following recommendations must be followed:

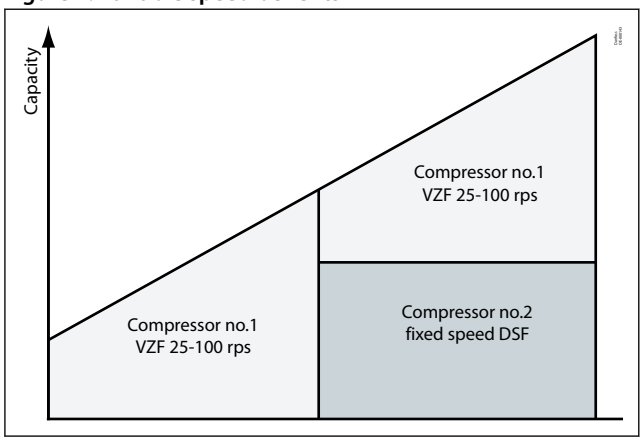
- It is essential to respect all the instructions given in these guidelines; please refer to the instruction leaflet supplied with each compressor and the application guidelines for single compressors.
- For additional system components related to specific application requirements, the supplier recommendations must always be respected.

Benefits

A parallel compressor installation refers to a system of interconnected compressors with a common suction line and a common discharge line. The technique of mounting compressors in parallel is also called manifolding. The hybrid manifolding in this application guideline refers to the manifolding of the Danfoss inverter compressor (VZF) and fixed speed compressor (DSF), which has several benefits.

The main reason is to reduce operating cost through controlling capacity and power consumption to a greater extent. This is achieved by both staggering the compressor switch-on sequences and regulating the speed of the inverter compressor which allows the parallel system to continuously match its power with the capacity needed.

Figure 1: Variable speed benefits



A second reason for manifolding the inverter compressor and the fixed speed compressor is improved part-load efficiency. In the variable speed+fixed speed parallel installation, the system can run either only the inverter compressor at lower load or both the inverter and fixed speed compressors at a higher load with the fixed speed compressor operating at 100% load.

Therefore, it will be possible to achieve a higher part-load efficiency. Thirdly, the capacity of the hybrid manifolding system can be widely regulated, for example 10% to 100%. The continuous capacity regulation allows for accurate temperature control and a comfortable indoor environment.

Dimensions

Tandem assemblies

Figure 2: Outline drawing number 1

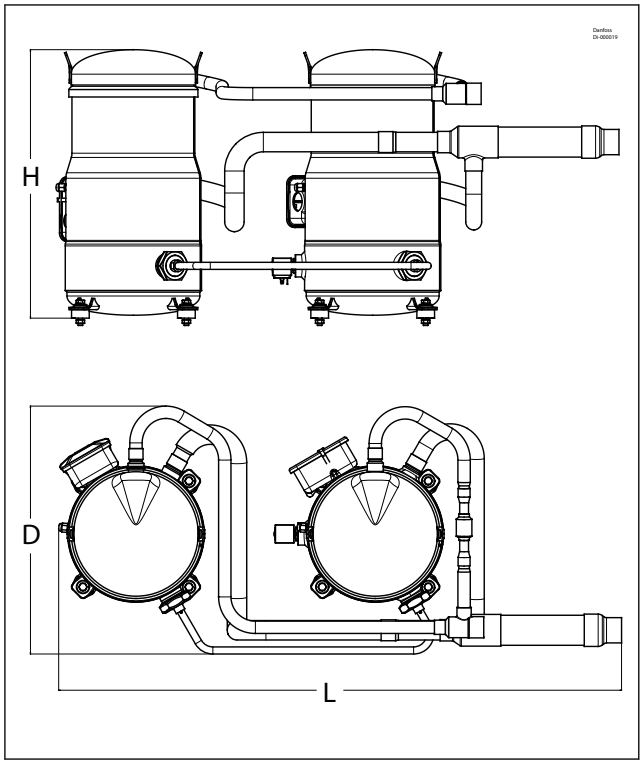


Figure 3: Outline drawing number 2

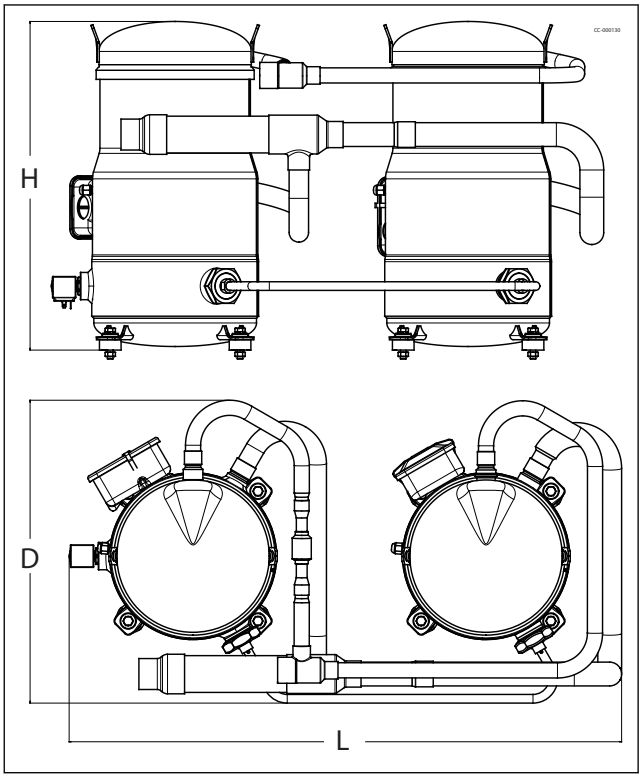


Table 1: Tandem

Tandem model	Composition	Motor code	Outline drawing number		Suction	Discharge	L (mm)	D (mm)	H (mm)
VZF188H	VZF088+DSF100	VZF with code J/G/H DSF with code 3/4/7	1	8560334	1" 5/8	1" 3/8	1011	445	482
			2	8560333	1" 5/8	1" 3/8	811	445	482
VZF203H	VZF088+DSF115		1	8560336	1" 5/8	1" 3/8	1011	445	540
			2	8560335	1" 5/8	1" 3/8	811	445	540
VZF218H	VZF088+DSF130		1	8560336	1" 5/8	1" 3/8	1011	445	540
			2	8560335	1" 5/8	1" 3/8	811	445	540

NOTE:
Tandem configurations are achieved by assembling individual compressors

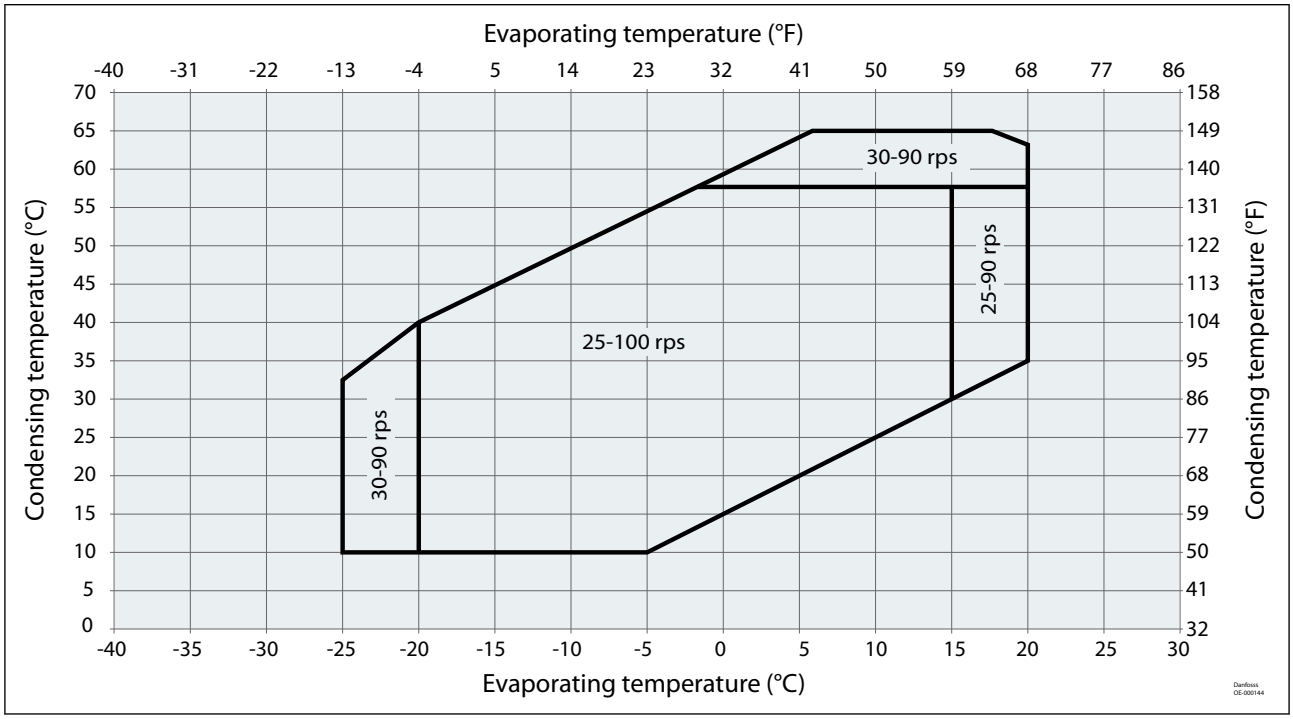
Operating envelope data

Requirement

The operating envelope for hybrid manifolding is shown below, and guarantees reliable operation of the compressor for steady-state operation. The steady-state operation envelope is valid for a suction superheat of between 5K and 30K.

Operating envelope

Figure 4: VZF manifold map (R32) - SH5K



Pressure settings

Table 2: Pressure settings

Pressure settings	R32	
	bar (g)	psi (g)
Working pressure range low side	1.7~15.9	25~231
Maximum high pressure safety switch setting	44.4	645
Minimum low pressure safety switch setting	1.5	22
Recommended pump-down switch settings	1.5 bar below nominal evaporating pressure with minimum 1.7 bar(g)	22 psi below nominal evaporating pressure with minimum 25 psig
Working pressure range high side	10~43	145~624

Mechanical connections

Design compressor mounting

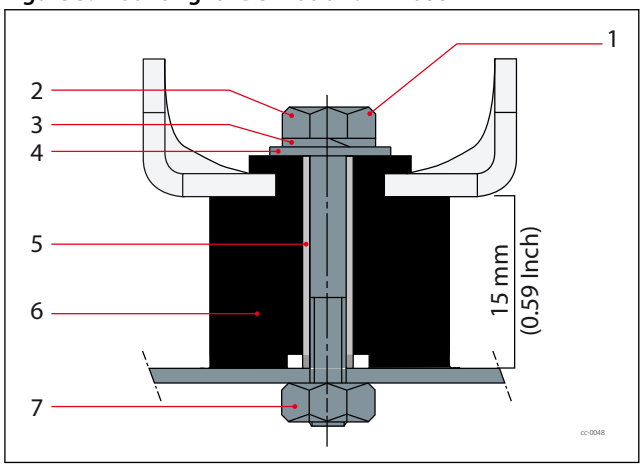
General requirements

The tandem is fixed to the frame using the flexible grommets that are supplied with the compressor or which are included in the accessory kit.

VZF188H Mounting feet

The compressors are fixed to the frame using rubber grommets, mounting sleeves, and washers (supplied with the compressors).

Figure 5: Mounting for DSF100 and VZF088



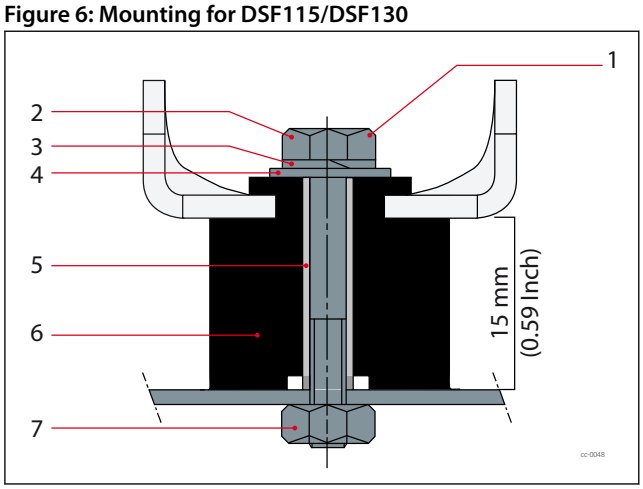
1	Tightening torque 15 Nm
2	HM 8 bolt
3	Lock washer
4	Flat washer
5	Steel mounting sleeve
6	Rubber grommet
7	Nut

VZF203H / VZF218H Mounting feet

The compressors are fixed to the frame using rubber grommets, mounting sleeves, and washers (supplied with the compressors).

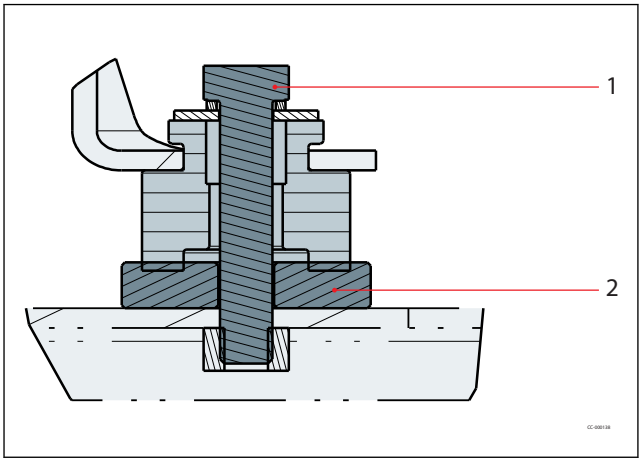
Because VZF088 is 7 mm smaller than DSF115/DSF130, in order to ensure that the oil equalization connection is at the same level for both compressors, an additional 7mm rigid spacer must be added under VZF088 (see drawing. The 7 mm rigid spacer is supplied with the tandem accessory kit).

Figure 6: Mounting for DSF115/DSF130



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

Figure 7: Mounting for VZF088



1	Tightening torque 15 Nm
2	Rigid spacer

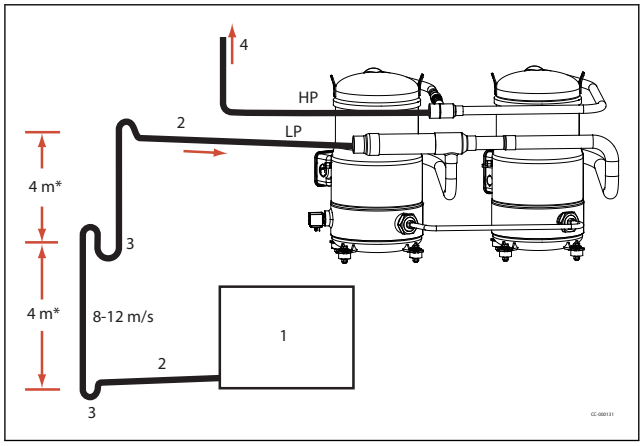
Design piping

General requirements

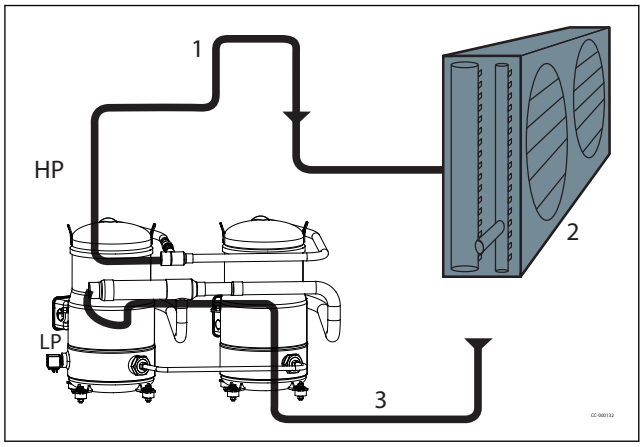
Proper piping practices should be employed to:

- Ensure adequate oil return, even under minimum load conditions (fixed speed compressor off, variable speed compressor at minimum speed, minimum evaporating conditions). If minimum refrigerant velocity cannot be reached, it is strongly recommended that an oil separator is used. For a validation test, the see section “Manage oil in the circuit”.
- Prevent condensed liquid refrigerant from draining back into the compressor when stopped (discharge piping upper loop). For validation tests, see the section “Manage off-cycle migration”.

General recommendations are described in the figures below:



1	Evaporator
2	0.5% slope 4 m/s or more
3	U trap, as short as possible
4	To condenser
*****	Maximum



1	Upper loop
2	Condenser
3	3D flexibility

- Piping should be designed with adequate three-dimensional flexibility to avoid excess vibration. It should not be in contact with the surrounding structure, unless a proper tubing mount has been installed. For more information on noise and vibration, see the section “Sound and vibration data” in the application guideline for Danfoss VZH Gen3 scroll compressors (AB300034185311en).

Tandem assembly

Figure 8: Left suction

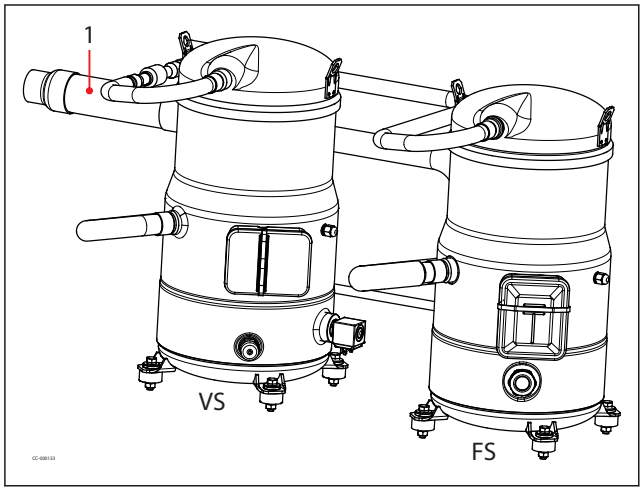
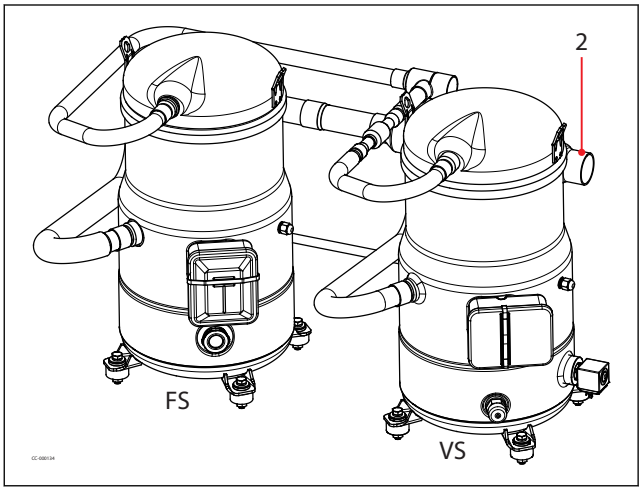


Figure 9: Right suction



1	Suction on Left
2	Suction on Right

FS	Fixed speed
VS	Variable speed

Table 3: Tandem assembly

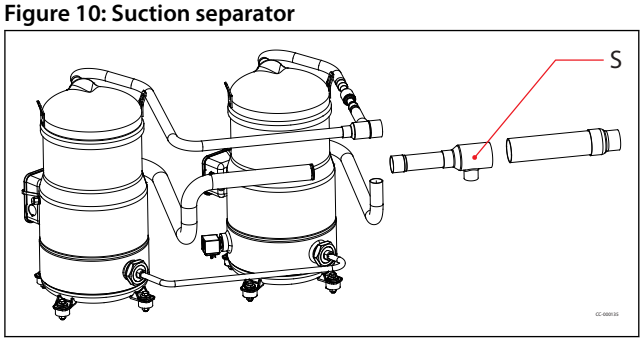
Fixed speed + Variable speed	Tandem model	Suction direction	Hz of FS compressor	Suction separator code	Tandem accessory kit code
VZF088+DSF100	VZF188H	Left/Right	50	120Z0869	120Z0809 (with 24V oil level sensor)
			60	120Z0868	
VZF088+DSF115	VZF203H	Left/Right	50	120Z0869	120Z0807 (with 24V oil level sensor)
			60	120Z0868	
VZF088+DSF130	VZF218H	Left/Right	50	120Z0867	120Z0807 (with 24V oil level sensor)
			60	120Z0866	

NOTE:
The tandem accessory includes oil equalization kits and oil level sensor. For compressors that need a UL certificate, please order the accessory kit with the 24V oil level sensor.

Suction separator

The suction connections of the two individual compressors are interconnected by a suction separator, which is supplied as an accessory.

Figure 10: Suction separator

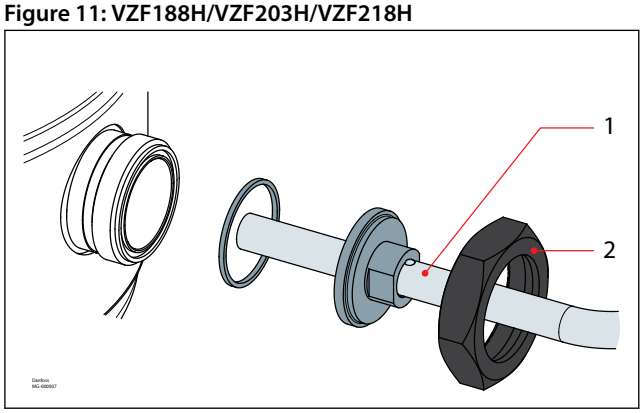


S	Suction separator

Oil equalization design

The two compressors are connected by a ½" oil equalization pipe. To fix the oil equalization connection rotolock, use the adaptor sleeves and the seal gasket which were included in the tandem accessory kit.

Figure 11: VZF188H/VZF203H/VZF218H



1	½"
2	Tightening torque 100NM
	Supplied with the compressor
	Included in tandem kit
	Not supplied

Application

Manage superheat

Manage Superheat

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

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

Requirement

In the steady-state condition, the expansion device must ensure a suction superheat of between 5K and 30K.

System evaluation

Table 4: System evaluation

Basic unit single exchanger as evaporator and condenser	Advance unit Multiple exchangers as evaporator or condenser (heat-recovery, exchanger, four-pipe chiller…)	Non-reversible	Reversible	Suction accumulator	Test
X		X		Optional	Liquid flood back test
X		-	X	Recommended	Liquid flood back test Defrost test
	X	X		Mandatory	Liquid flood back test
	X		X	Mandatory	Liquid flood back test Defrost test

Test, criteria and solutions

Table 5: Test, criteria and solutions

Test No	Purpose	Test condition	Pass criteria	Solutions
Liquid flood back test	Steady-state	Liquid flood back testing must be carried out under expansion valve threshold operating conditions: Variable speed On at min.speed / fixed speed Off Running conditions corresponding to the lowest foreseeable evaporation, and highest foreseeable condensation In case of reversible system, the test must be done in both cooling and heating mode If advanced unit, test in all possible configurations	Suction superheat >5K	1. Check expansion valve selection and setting (EXV) check measurement chain and PID. 2. Add a suction accumulator[1]
	Transient	Tests must be carried out in the most unfavourable conditions: • fan staging • compressor ramping up and down	The oil superheat must not be more than 60 sec below the safe limit defined in the dilution chart (see graph below)	
Defrost test	Check liquid flood back during defrost cycle	The defrost test must be carried out in the most unfavorable conditions (at 0°C evaporating temperature)	The oil superheat must not be more than 60 sec below the safe limit defined in the dilution chart (see graph below)	1. In reversible systems, the defrost logic can be worked out to limit the liquid flood back effect. (For more details see "Control logic") 2. Add a suction accumulator[1]

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

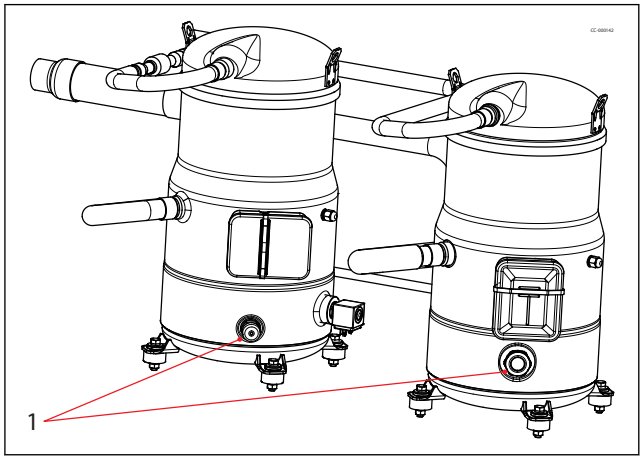
Placing oil temperature sensor

The oil temperature sensor must be placed between the oil sight glass and the compressor baseplate for fixed speed compressor, and beside the oil level sensor for the variable speed compressor.

Use a little thermal paste to improve conductivity. The sensor must also be thermally insulated correctly from the ambience.

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

Figure 12: Placing oil temperature sensor



1	Position to place Oil temperature sensor

For sump superheat requirement refer to single VZF series and DSF series compressor application guideline. VZF application guideline: TBD DSF application guideline: AB367332784529

Manage off-cycle migration

Off-cycle refrigerant migration happens:

- when the compressor is located at the coldest part of the installation, and refrigerant vapour then condenses in the compressor, or
- directly in the liquid phase as the result of gravity. When the compressor starts running again, the refrigerant diluted in the oil generates poor lubrication conditions. In extreme situations, this leads to liquid slugging that can damage compressor parts.

Requirement

The amount of liquid refrigerant in the compressors must not exceed the charge limit.

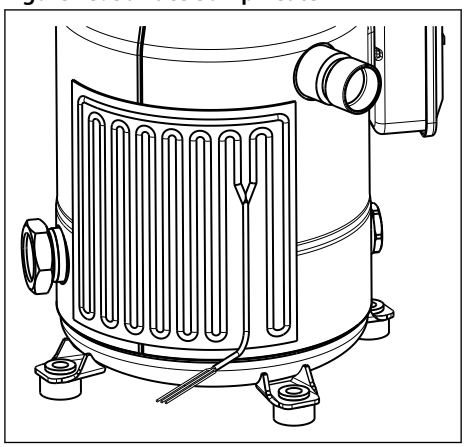
System evaluation

Table 6: System evaluation

Non split	Split	Below charge limit	Above charge limit	Surface sump heater	Non-return valve	Liquid line solenoid valve	Pump-down cycle
x		x		Optional	Mandatory	Mandatory	Optional
x			x	Mandatory	Mandatory	Mandatory	Recommended
	x	-	-	Mandatory	Mandatory	Mandatory	Recommended

Surface Sump heater

Figure 13: Surface Sump heater



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

Additional heater power or thermal insulation is needed in case the ambient temperature falls below -5°C and the wind speed is above 5 m/sec. The heater must be turned on whenever all the compressors are off.

Surface sump heater accessories are available from Danfoss (see section Accessories).

Liquid line solenoid valve (LLSV)

An Liquid line solenoid valve(LLSV) is used to isolate the liquid charge on the condenser side, thereby preventing refrigerant being transferred to the compressor during off-cycles. The electronic expansion valve that closes automatically including in power shut down situation can replace the LLSV. 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:
- evacuates refrigerant from oil
- set the sump saturating pressure much lower than ambiance temperature and due to that, avoid refrigerant condensation in the compressor.

Pump-down must be set higher than 1.7 bar(g). For more details on pump-down cycle see section Control logic.

Non return valve

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

See Section Prevent off cycle migration §Test and components required per application to know when to use non return valve

The following table displays present Danfoss non-return valve selection per each specific compressor.

DSF are with internal NRV, no need external NRV.

Table 7: Non return valve

Compressor model	NRV model
VZF088	NRV 16

NOTE:
This Selection is valid for evaporating temperature above -10°C(14°F). Below -10°C (14°F), smaller valve or a limitation of minimum speed may be required to guaranty valve stability,to get help on selection of valve, please contact Danfoss application engineer.

Refrigerant charge limit

Table 8: Refrigerant charge limit

Tandem models	Refrigerant charge limit(kg)
VZF188H/VZF203H/VZF218H	8.00

Manage speed limit

General requirements

Speed limit guarantees compressor reliability and must be respect. Details refer to single VZF guideline"Manage speed limit"

Manage oil in the circuit

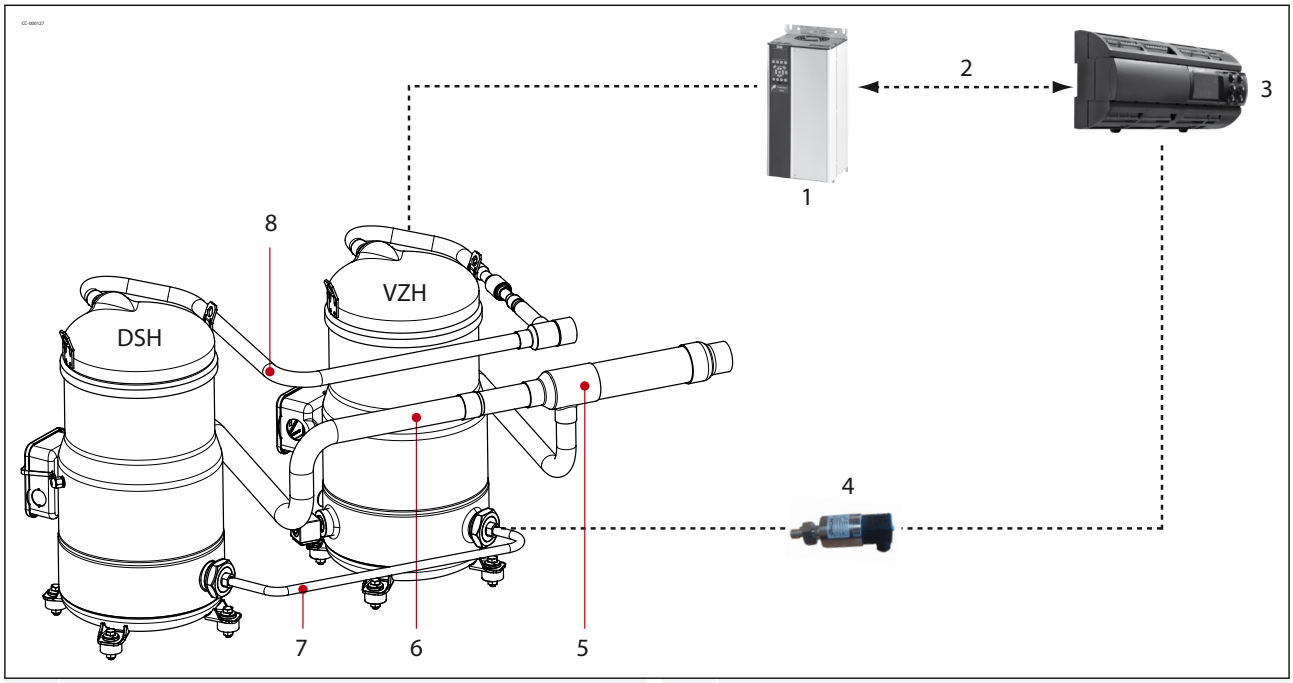
Oil management concept

System configuration

Hybrid manifolding systems use the dynamic system for oil balance. The suction connections between the two individual compressors are interconnected by a special suction separator design that allows most of oil feed into variable speed compressors.

An optical-electrical oil level sensor fixed in a variable speed compressor monitors the compressor oil level.

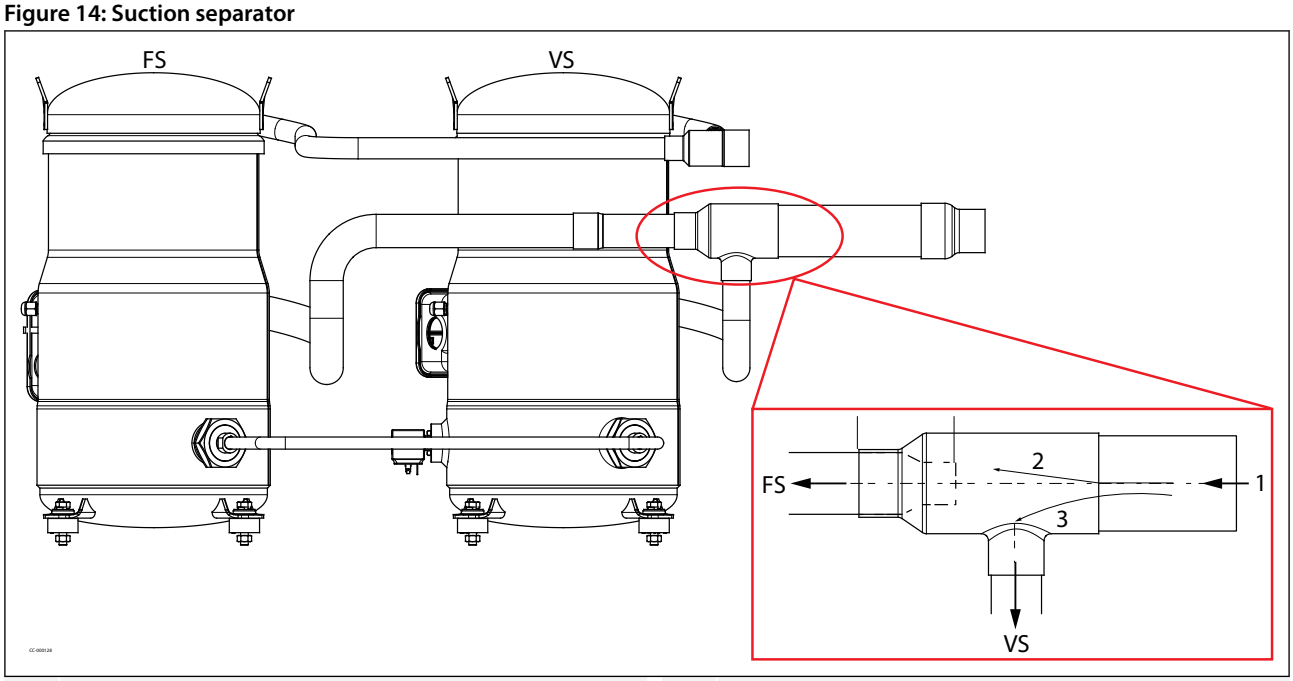
If the oil level drops below the limit, the OEM main controller activates the oil management logic.



1	Drive	**5**	Suction separator
2	ModBus	**6**	Suction line
3	OEM main controller	**7**	Oil equalization tube
4	Optical oil level sensor	**8**	Discharge line

Suction separator (Oil separator/gas restrictor)

Figure 14: Suction separator



FS	Fixed Speed Downstream compressor	**1**	Return Gas
VS	Variable Speed Upstream compressor	**2**	Oil poor gas flow
		3	Oil-rich gas flow

The hybrid manifolding system uses the dynamic oil balancing system.

The suction connections of the two individual compressors are interconnected by a suction separator that integrates a suction oil separator and a gas restrictor.

The variable speed compressor (VS) is installed in the upstream position (first on suction line) and fixed speed compressor (FS) is installed on downstream position.

The oil which clings back along the main suction line is separated and mainly flow to upstream compressor.

When the variable speed compressor runs below maximum speed, suction separator creates a pressure drop to ensure the sump pressure in the fixed speed compressor is lower than in variable speed compressor. Pressure difference forces the excess oil from the variable speed compressor to flow into the fixed speed compressor sump.

When the variable speed compressor runs at maximum speed sump pressure are balanced

Approved hybrid tandem configurations and capacity range

Different configurations of hybrid tandems are possible. All VZH models (high/low pressure ratio/different voltage) could be manifolded with fixed speed compressors.

Danfoss VSD : VZF compressor Drive™ 380-480 Volt

Table 9: Tandem configurations and capacity range for Motor code G

Model	Description	FS: 50Hz, VS:100Hz		FS: 60Hz, VS: 100Hz	
		kW	TR[(1)]	kW	TR[(1)]
VZF188H	VZF088+DSF100	76.006	21.6	81.206	23.1
VZF203H	VZF088+DSF115	80.996	23.0	86.766	24.7
VZF218H	VZF088+DSF130	84.296	24.0	91.316	26.0

[(1)] Ton of Refrigeration

Standard rating conditions: ARI standard, Refrigerant: R32, Evaporating temperature: 7.2°C, Condensing temperature: 54.4°C, Superheat: 11.1k, Subcooling: 8.3k

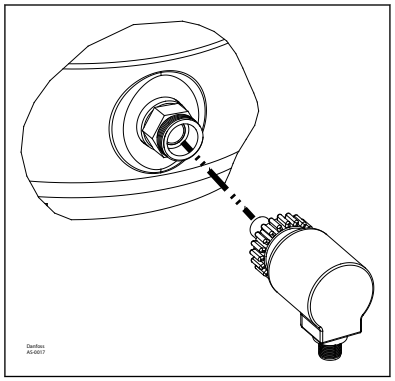
NOTE:
Subject to modification without prior notification

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

Oil level sensor

Oil level sensor is a special component which assembles on variable speed compressor. The screw-in mechanical part(prism) is already assembled on version"oil level sensor+oil sight glass". The electrical part is provided in oil level sensor accessory kit.

Figure 15: Oil level sensor on compressor



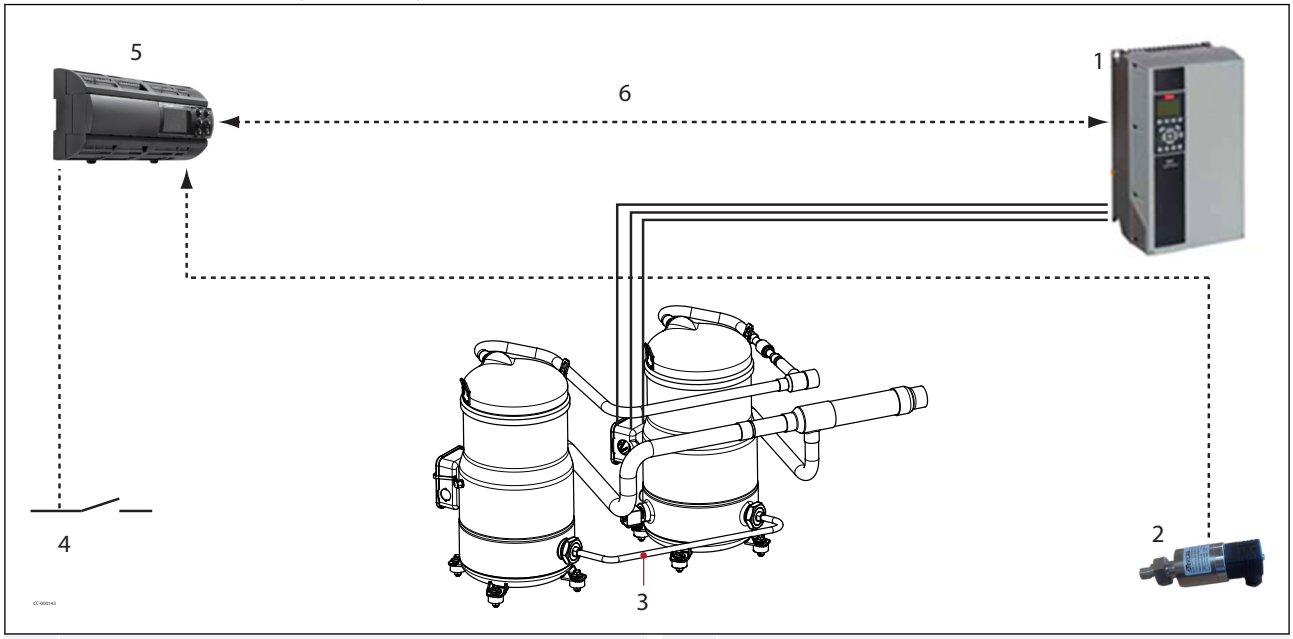
Oil management system for hybrid manifolding

The oil management system architecture for hybrid manifolding is described below.

An oil equalization tube between the variable speed compressor and the fixed speed compressor is used to maintain the oil balance.

An oil level sensor need to be installed on the variable speed compressor. The oil level sensor monitors the compressor oil level and send oil level signal to OEM main controller. When oil level is below the minimal, OEM controller enter in oil management mode to recover a proper oil level in compressor. If oil level cannot be recovered, controller stop the system.

Figure 16: Oil management system for hybrid manifolding



1	Drive	**4**	Power supply
2	Optical oil level sensor	**5**	OEM main controller
3	Oil equalization tube	**6**	ModBus

Oil management logic

In order to maintain the proper oil level in the compressors, an oil management control logic needs be implemented in the OEM controller.

The oil management control logic must include three steps.

1. In the case of low oil level detection, an oil balance mode (Variable speed on, Fixed speed off) is activated to recover oil from fixed speed to variable speed.
2. If oil level cannot be recovered in VS compressor, controller go to Oil boost Mode (Variable speed on, Fix Speed on) in order to recover oil trapped in system.
3. If the oil level is still below the limit after a full oil balance action and oil boost action have been completed, the controller must enter in protection mode, and stop the system in alarm.

For more detailed oil management logic, please refer to “Oil management logic” in the annex.

Requirement

Fixed speed compressor: The oil level must be visible or full in the sight glass when the compressor is running and when all the compressors in the circuit are stopped.

Variable speed compressor: This compressor is equipped with an oil level switch located at the minimum acceptable level. If the oil level drops below this limit, the controller must follow the oil logic (See “Oil management logic” in the annex).

Fixed speed compressor oil returned status need be monitored in OEM qualification test.

System evaluation

Table 10: System evaluation

Basic unit Single exchanger as evaporator and condenser	Advance unit Multiple exchangers as evaporator or condenser (heat-recovery, exchanger, four-pipe chiller…)	Non-reversible	Reversible	Non-split	Split	Oil separator	Test
X		-	-	X		Optional	Tests 1 & 2
	X	-	-	X		Recommended	Tests 1 & 2
-	-	-	-	-	X	Mandatory	Tests 1, 2 & 3

Test, criteria and solutions

Table 11: Test, criteria and solutions

Test no.	Purpose	Test condition	Pass criteria	Solutions
1	Oil return test under minimum mass flow	Variable speed **On** at minimum speed / Fixed speed **Off** Running condition corresponds to lowest foreseeable evaporation, and highest foreseeable condensation on the system Running for 6 hours For a reversible system, perform the test in both heating and cooling modes. If it is an advanced unit, test in all possible configurations	Variable speed: No lack of oil alarm No more than two oil boost cycles per hour	Look for potential oil trap Increase oil boost duration Top up with oil, generally 4% of the total system refrigerant charge (in weight) Oil separator can be added
		Variable speed **On** at minimum speed / Fixed speed **On** Running condition corresponding to lowest foreseeable evaporation, and highest foreseeable condensation on the system Running for 6 hours For a reversible system, perform the test in both heating and cooling modes. If it is an advanced unit, test in all possible configurations	Variable speed: No lack of oil alarm Fixed speed: Oil visible in sight glass	
2	Check oil management control logic is working	Variable speed On at 50 rps for VZF088 / Fixed speed **On** Running conditions corresponding to the lowest foreseeable evaporation, and the highest foreseeable condensation on the system. Running for 6 hours For a reversible system, perform the test in both heating and cooling modes. If it is an advanced unit, test in all possible configurations	No more than two oil balance cycles per hour Fixed speed: Oil visible in sight glass	Top up with oil, generally 4% of the total system refrigerant charge (in weight). If more than 4% is used, look for a potential oil trap in the system Oil separator can be added
3	Oil return in split system	Since each installation is unique, tests 1 and 2 cannot fully validate the oil return The oil level must be checked and adjusted at commissioning	Fix speed: Oil visible in sight glass No more than two oil balance cycles per hour	The oil separator is mandatory Pay special attention to "Piping design" Top-up with oil, generally 4% of the total system refrigerant charge (in weight). If more than 4% is used, look for a potential oil trap in the system

Assembly line procedure

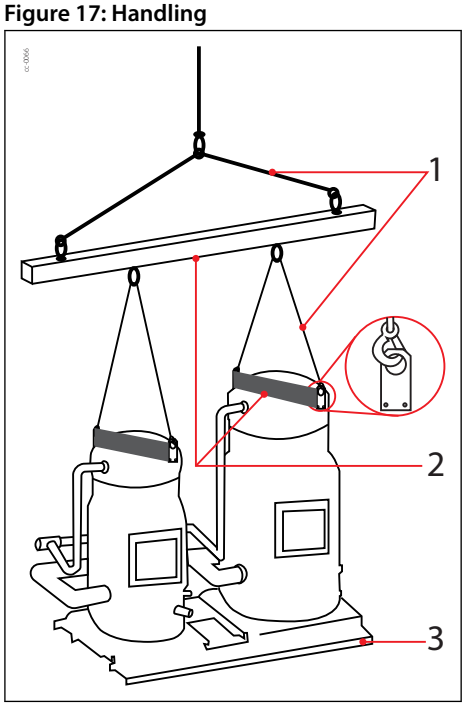
The installation and service procedure for a parallel system are similar to basic single-system installations. The selection of additional system components for parallel installations follows the basic system common rules. Please refer to the application guidelines for Danfoss VZF scroll compressors (TBD) for detailed installation and service procedures.

Handling

Danfoss Commercial Compressors recommends using the lift and handling devices as shown on the right, and that the following procedure be used to prevent damage:

- There are two lifting rings on each compressor. Use all four rings.
- Maximum loads authorized per sling and for the hoist hook must not be lower than the weight of the assembly.
- If the tandem unit is already installed as a complete installation, it must never be lifted using the lifting rings on the compressors.

Figure 17: Handling



1	Slings
2	Spreader bars
3	Frame

Ordering

To build a complete tandem installation, the customer must order two must order 2 compressors, one suction separator and one tandem accessory kit.

Compressor ordering codes

Danfoss VZH and DSH scroll compressors can be ordered in either industrial packs or in single packs. Please refer to the single compressor application guideline for compressor ordering information (AB503529860416en for VZF, AB367332784529en for DSF).

Accessory ordering codes

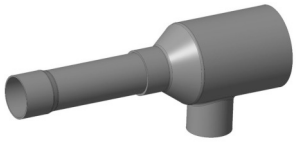
The suction separator and tandem kit can be ordered using the code numbers listed in the table below. The suction separator and the tandem kit selection should be based on compressor model, frequency of fixed speed compressor and oil level switch voltage.

Table 12: Accessory ordering codes

Tandem model	Variable speed compressor	Fixed speed compressor	Suction direction	Suction separator code			Tandem accessory kit		
				Hz of FS compressor	code	pack size	Voltage of oil level switch	code	Pack size
VZF188H	VZF088	DSF100	Left/Right	50Hz	120Z0869	1	24V	120Z0809	1
				60Hz	120Z0868	1	230V	120Z0810	1
VZF203H	VZF088	DSF115	Left/Right	50Hz	120Z0869	1	24V	120Z0807	1
				60Hz	120Z0868	1	230V	120Z0808	1
VZF218H	VZF088	DSF130	Left/Right	50Hz	120Z0867	1	24V	120Z0807	1
				60Hz	120Z0866	1	230V	120Z0808	1

Accessories and Spare parts

Suction separator



Code no.	Description	Application	Packaging	Pack size
120Z0866	Hybrid manifold suction separator	VZF218H-60Hz right/left suction	Single pack	1
120Z0867	Hybrid manifold suction separator	VZF218H-50Hz right/left suction	Single pack	1
120Z0868	Hybrid manifold suction separator	VZF188H/VZF203H-60Hz right/left suction	Single pack	1
120Z0869	Hybrid manifold suction separator	VZF188H/VZF203H-50Hz right/left suction	Single pack	1

Tandem accessory kit

Code no.	Description	Application	Packaging	Pack size
120Z0809	Oil level sensor 24V AC/DC, sleeves, gaskets	VZF188H with 24V oil level sensor	Single pack	1
120Z0810	Oil level sensor 230V AC, sleeves, gaskets	VZF188H with 230V oil level sensor	Single pack	1
120Z0807	Oil level sensor 24V AC/DC, sleeves, gaskets	VZF203H/VZF218H with 24V oil level sensor	Single pack	1
120Z0808	Oil level sensor 230V AC/DC, sleeves, gaskets	VZF203H/VZF218H with 230V oil level sensor	Single pack	1

Oil level sensor

Code no.	Description	Application	Packaging	Pack size
120Z0803	Oil level sensor 24V AC/DC	VZH088-117-170 manifolding version	Single pack	1
120Z0804	Oil level sensor 230V AC	VZH088-117-170 manifolding version	Single pack	1

Connector for oil level sensor

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

Crankcase Heater

Code no.	Description	Application	Packaging	Pack size
120Z0388	Surface sump heater, 80W, 24V, CE, UL	VZF088	Multipack	8
120Z0389	Surface sump heater, 80W, 230V, CE, UL	VZF088	Multipack	8
120Z0390	Surface sump heater, 80W, 400V, CE, UL	VZF088	Multipack	8
120Z0391	Surface sump heater, 80W, 460V,CE, UL	VZF088	Multipack	8
120Z0402	Surface sump heater, 80W, 575V, CE, UL	VZF088	Multipack	8
120Z0667	48W 24V surface sump heater CE and UL	DSF090 to 200	Single pack	1
120Z0668	48W 230V surface sump heater CE and UL	DSF090 to 200	Single pack	1
120Z0669	48W 400V surface sump heater CE and UL	DSF090 to 200	Single pack	1
120Z0670	48W 460V surface sump heater CE and UL	DSF090 to 200	Single pack	1
120Z0671	48W 575V surface sump heater CE and UL	DSF090 to 200	Single pack	1
120Z0388	80W 24V surface sump heater CE and UL	DSF090 to 200	Multipack	8
120Z0389	80W 230V surface sump heater CE and UL	DSF090 to 200	Multipack	8
120Z0390	80W 400V surface sump heater CE and UL	DSF090 to 200	Multipack	8
120Z0391	80W 460V surface sump heater CE and UL	DSF090 to 200	Multipack	8
120Z0402	80W 575V surface sump heater CE and UL	DSF090 to 200	Multipack	8

Model	Configration	NRV code	
VZF188H	VZF088+DSF100	VZF088	DSF100
		NRV16 (020B1059)	-
VZF203H	VZF088+DSF115	VZF088	DSF115
		NRV16 (020B1059)	-
VZF218H	VZF088+DSF130	VZF088	DSF130
		NRV16 (020B1059)	-

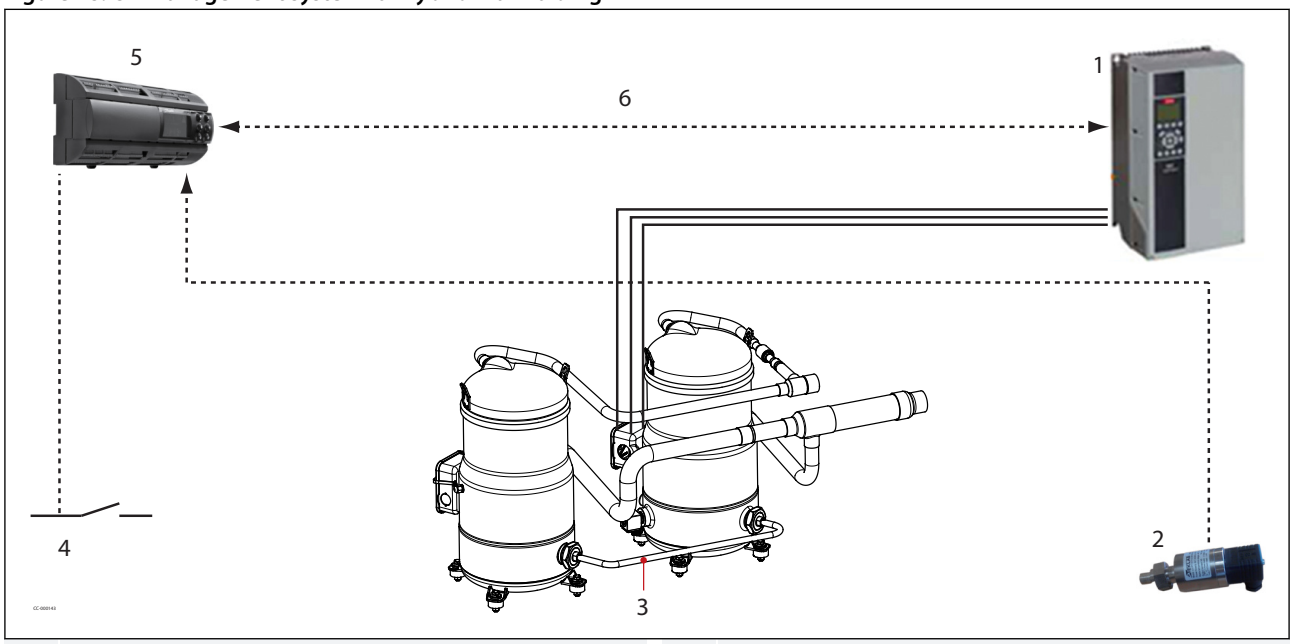
Annex

1. Oil Management logic

Oil management for hybrid manifolding system

An oil level sensor needs to be installed on the variable speed compressor. The oil level is permanently monitored by OEM main controller. When oil level is below the minimal, OEM controller enters in oil management mode to recover a proper oil level in compressor. If oil level cannot be recovered, controller stops the system.

Figure 18: Oil management system for hybrid manifolding



1	Drive	**4**	Power supply
2	Optical oil level sensor	**5**	OEM main controller
3	Oil equalization tube	**6**	ModBus

2. Oil management description

2.1 Basic rules

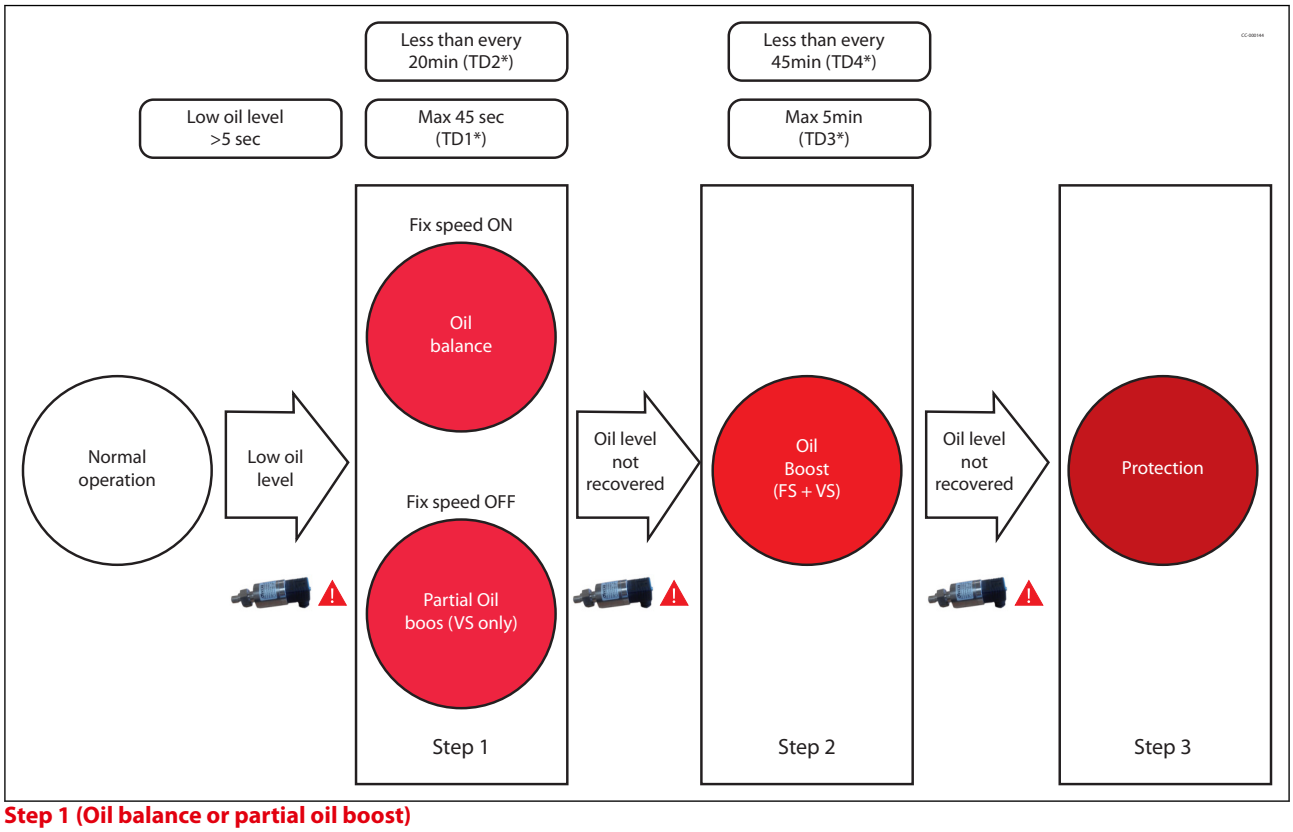
This specification describes the control logic to implement in OEM controller. This control logic must be implemented and thoroughly tested by OEM.

The variable speed compressor (VS) is primary and the fixed speed compressor (FS) is Secondary. FS must not run alone.

As oil balancing logic needs to start / stop compressor as well as increase / decrease speed, make sure expansion device is fast enough to maintain liquid flood back within acceptable limit during those transients (Manage super heat chapter).

2.2 Oil management modes

The oil management control logic must include 3 steps.



Step 1 (Oil balance or partial oil boost)

In case of low oil level detection by Oil level sensor on VS, there is 2 possible actions according to fix speed state:

- **Fix speed is ON:** Oil can be trapped in fix speed compressor due to pressure unbalance. Oil balance mode is activated. FS is stopped and VS speed is increased; pressure in VS become lower than FS oil is coming back through oil equalization line.
- **Fix speed is OFF:** Oil is trapped in the system. Partial oil boost is activated. VS speed is increased to slightly increase refrigerant velocity in the system and recover oil, FS remain OFF

TD1 is the maximum time to complete Step 1: If oil is not recovered within TD1, switch to Step 2: If oil is recovered within TD1 come back to normal operation. TD2 is the minimum interval between two step 1. If step 1 is requested in less than TD2 after last step 1, switch immediately to step 2.

Step 2 (Full oil boost)

If oil level cannot be recovered within defined time, oil is trapped in the system. Full oil boost is activated. (VS speed is increased and fix starts (if not already ON). It considerably increases refrigerant velocity in the system and recovers oil.

TD3 is the maximum time to complete step 2. If oil is not recovered within TD3 switch to step 3. If oil is recovered within TD3 come back to normal operation. TD4 is the minimum interval between two step 2. In case of low oil level detection within a time <TD4, switch to step 3.

Step 3 (Protection)

If oil is still lower than limit after completed step 1 & 2, or if oil level drop within a time <TD4, controller must enter in protection mode, and stop the system in alarm.

NOTE:
TD time is adjustable. Please refer to “Parameter and variable table

2.3 Steps description

Oil balance

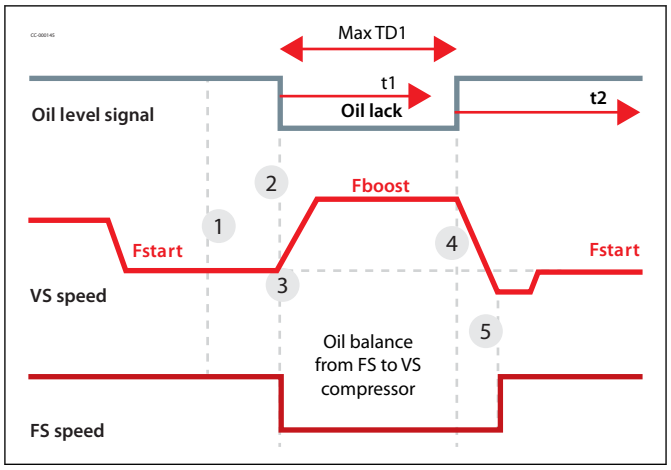
Function description: Balance oil from FS compressor to VS Compressor.

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

AND
FS compressor is ON
AND
t2>TD2, Interval between two Oil balance / Oil boost is > TD2
Cancel condition: High oil level in VS compressor detected by oil level sensor.

OR
t1>TD1, Oil balance duration exceed TD1
Control sequence

1. At the initial state, VS and FS compressor are ON.
2. Low oil level detected in VS compressor. Reset and Start t1.
3. FS compressor must stop. VS compressor speed must increase to Fboost.
4. When high oil level detected in VS compressor.
   - VS compressor speed must be decreased to minimal speed Fmin.
   - Reset and Start t2
   - Reset t1
5. When VS compressor speed reaches FStart, FS compressor must restart.



Partial oil boost

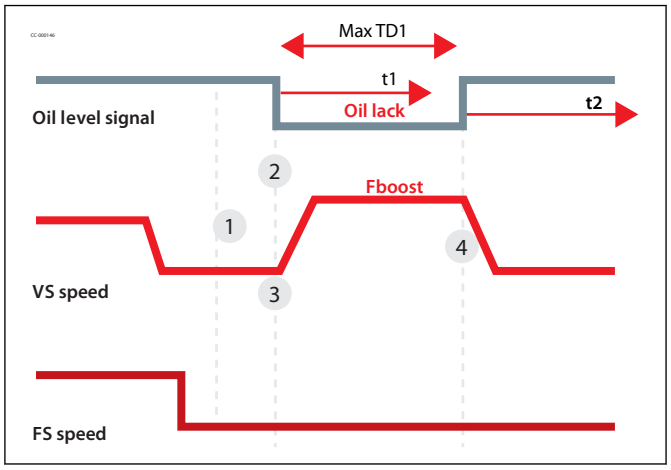
Function description: Return oil trapped in the system to compressors by increasing refrigerant mass-flow in the system.

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

AND
FS compressor is OFF
AND
t2>TD2, Interval between two Oil balance / Oil boost is > TD2
Cancel condition: High oil level in VS compressor detected by oil level sensor.

OR
t1>TD1,Partial oil Boost duration exceed TD1
Control sequence

1. At the initial state, VS compressor is ON and FS compressor is OFF.
2. Low oil level detected in VS compressor. Reset and start t1
3. VS compressor speed must increase to Fboost.
4. When high oil level detected in VS compressor
   - VS compressor speed must be decreased to the initial speed (Fstart)
   - Reset and start t2
   - Reset t1



Oil boost

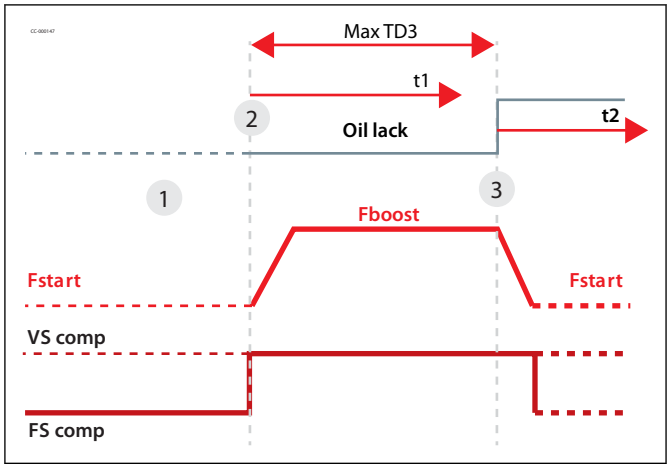
Function description: Return oil trapped in the system to compressors by increasing refrigerant mass-flow in the system.

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

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

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

OR
t1>TD3, Oil balance / boost duration exceeds Maximum Oil boost duration



Protection

Function description: Stop compressors to prevent short of oil running.

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

AND

(t1>TD3, Oil balance / boost duration exceeds TD3 OR t3<TD4, Interval between two Oil boost is < TD4)

Cancel condition: Manual Reset

Control sequence:

- Stop FS and VS compressor
- Reset t1
- Reset t2
- Reset t3

2.4 Parameter and variable

Table 13: Parameter and variable

Name	Text	Attribute	Range	Default	Unit
Fboost	Boost action frequency	parameter	25~100	70	Hz
TD1	Maximum oil balance / Partial oil boost duration	parameter	10~240	30	second
TD2	Interval minimum between two oil balance / Partial oil boost	parameter	10~60	20	minutes
TD3	Maximum boost duration	parameter	5~12	5	minutes
TD4	Interval minimum between two oil boost	parameter	45~120	45	minutes
t1	Oil balance/ Partial oil boost timer	Variable	-	-	second
t2	Interval between two oil balance / Partial oil boost	Variable	-	-	minutes
t3	Interval between two oil boost	Variable	-	-	minutes

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