



## Application guidelines

# Danfoss scroll for refrigeration LLZ013 to 033 - low temperature

50 - 60 Hz - R404A - R507

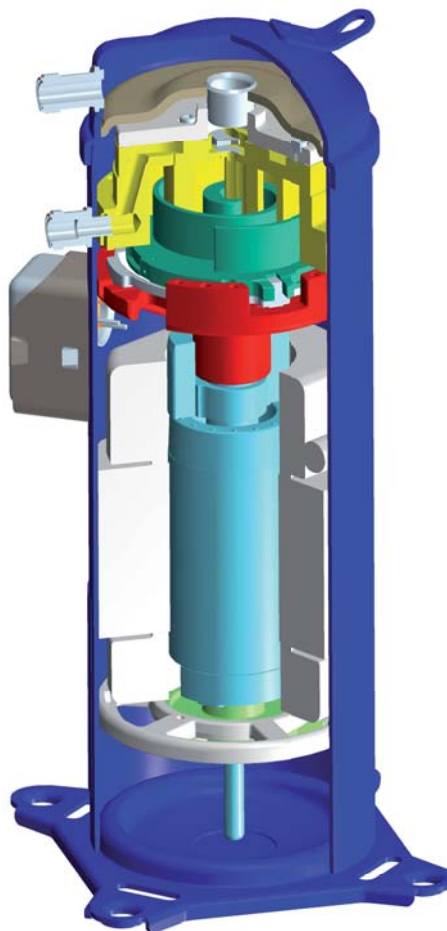




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Danfoss scroll compressor for refrigeration, LLZ, with its unique scroll design and manufacturing process flexibility, offers a highly efficient solution for demanding refrigeration applications.

This new family of refrigeration scroll compressors includes 5 sizes of low temperature scroll compressors designed for commercial refrigeration applications. These compressors are engineered for refrigeration and offer cooling capacity from 5 to 12 kW (4 to 10 HP) at common voltages and frequencies as well as any of the common refrigerants (R404A - R507).



In the LLZ range of refrigeration scrolls, two kinds of compressors will be provided: economized and standard compressors. The refrigeration economized compressor has been developed to provide improved performance and an enlarged operating envelope. The economized compressor system presents benefits over standard refrigeration compressor systems of equivalent horse power due to the following:

- Capacity improvement: The capacity is improved without increasing compressor displacement, as it is increased by further increasing system subcooling with a heat exchanger acting as an economizer. Furthermore a smaller economized

compressor can be used to achieve the same capacity as a larger standard compressor, leading to cost advantages.

- Efficiency improvement: With a suitable size of heat exchanger, the efficiency improves due to the fact that the gain in capacity is greater than the increase in power that the compressor consumes.
- Enlarged operating envelope: The injection of vapour through the economized line will reduce the discharge temperature and therefore enlarge the operating envelope based on the same suction status.

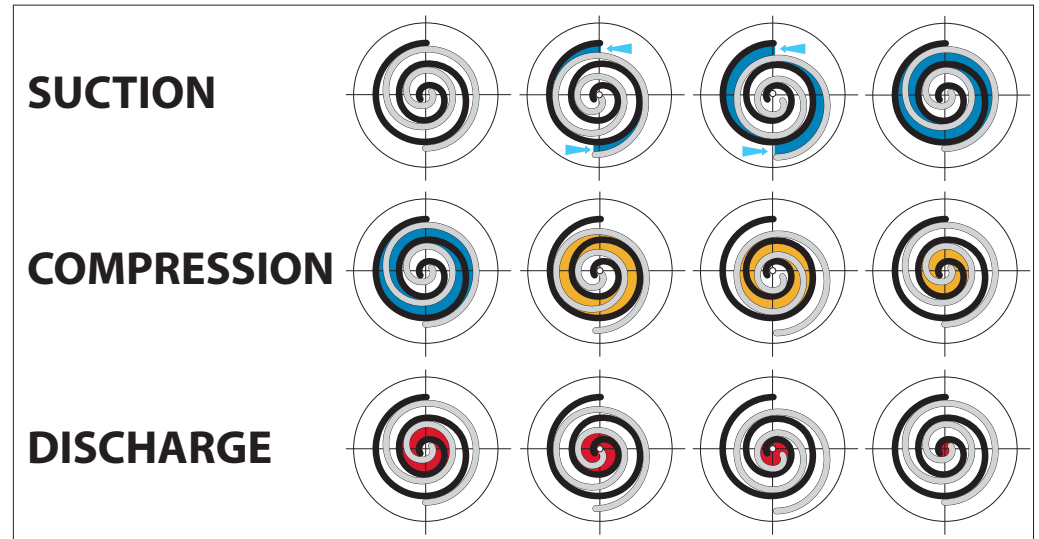
### The scroll compression process

The entire scroll compression process is illustrated below. The centre of the orbiting scroll traces a circular path around the centre of the fixed scroll. This movement creates compression pockets between the two scroll elements.

Low pressure suction gas is trapped within each crescent-shaped pocket as it forms; continuous motion of the orbiting scroll serves to seal the pocket, which decreases in volume as the

pocket moves towards the centre of the scroll set with a corresponding increase in gas pressure. Maximum compression is achieved, as the pocket reaches the discharge port at the centre.

Scroll compression is a continuous process: when one pocket of gas is being compressed during the second orbit, another gas quantity enters a new pocket formed at the periphery, and simultaneously, another is being discharged.



Danfoss scroll compressors are manufactured using the most advanced machining, assembly, and process control techniques. In the design of both the compressor and the factory, very

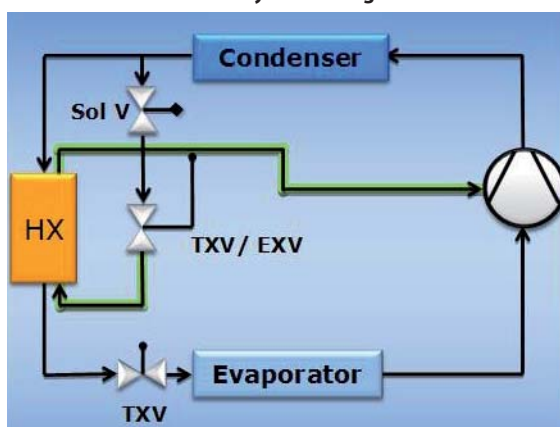
high standards of reliability and process control are first priority. The result is a highly efficient product with the highest reliability obtainable, and a low sound level.

### Theory of economized cycle

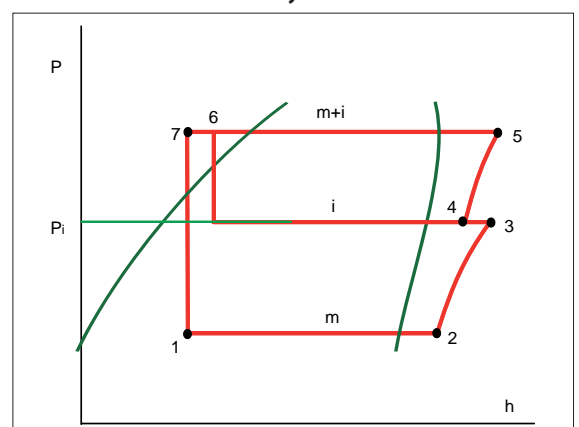
The below schematic shows a system configuration with a heat exchanger acting as an economizer for economized cycle (12345671). The economizer is used to provide subcooling to the refrigerant leaving the condenser before it enters into the evaporator. This subcooling process provides an increased capacity gain for the system. Meanwhile, another small amount of

refrigerant leaving the condenser goes through the expansion device and is then evaporated and superheated. The superheated refrigerant is then injected into the mid-compression cycle of the compressor and compressed together with the suction flow. The injected vapour also provides cooling and therefore lowers the discharge temperature.

Economizer system configuration



Economizer cycle 12345671



## Application Guidelines Compressor model designation

### Nomenclature

	Type	Size	Motor	Features												
	<b>LLZ</b>	<b>013</b>	<b>T4L</b>	<b>Q9</b>												
<b>Application</b> L: low temperature refrigeration																
<b>Family, Refrigerant &amp; lubricant</b> LZ: R404A - R507 / R407A*, PVE lubricant																
<b>Nominal capacity</b> In thousand Btu/h at 60 Hz, ARI, LBP conditions																
<b>Model variation</b> T: design optimised for refrigeration																
				<b>Other features</b> <table border="1"> <thead> <tr> <th></th> <th>Oil sight glass</th> <th>Oil equalisation</th> <th>Oil drain</th> <th>LP gauge port</th> <th>Gas equalisation port</th> </tr> </thead> <tbody> <tr> <td><b>9</b></td> <td>Threaded</td> <td>None</td> <td>Schrader</td> <td>None</td> <td>None</td> </tr> </tbody> </table>		Oil sight glass	Oil equalisation	Oil drain	LP gauge port	Gas equalisation port	<b>9</b>	Threaded	None	Schrader	None	None
	Oil sight glass	Oil equalisation	Oil drain	LP gauge port	Gas equalisation port											
<b>9</b>	Threaded	None	Schrader	None	None											
				<b>Tubing and electrical connections</b> <b>Q:</b> rotolock connections, screw terminals												
				<b>Motor protection</b> <b>L:</b> internal motor protection												
				<b>Motor voltage code</b> <b>2:</b> 200-220V/3~ /50 Hz & 208-230V/3~ /60 Hz <b>4:</b> 380-415V/3~ /50 Hz & 460V/3~ /60 Hz <b>7*:</b> 500V/3~ /50 Hz & 575V/ 3~ /60 Hz <b>9*:</b> 380V/3~ /60 Hz												

\* R407A and motor code 7 & 9 will be qualified in 2014

Note:  
LLZ033 will be released in 2014

### Label

MADE IN CHINA

**Model No: LLZ018T4LQ9**

**Serial No: DE2500001578**

**Tech No: LSH722EX01**

480 V 3 ~ 60 Hz  
380-415 V 3 ~ 50 Hz

LRA:90 A MAX OPER.14.4A  
Lubricant: PVE32 / 1.62L  
Refrigerant:R404A/R507

CE C UL US CCC

2013

Thermally protected  
PROTECTED BY DOMESTIC AND FOREIGN PATENTS

**WARNING**  
Installation and servicing shall be performed by trained personnel only. Failure to observe these safety warnings could result in serious injury or death.  
ELECTRIC SHOCK HAZARD: Turn off power before servicing. (Discharge all capacitors.)  
Keep terminal cover in place and securely fastened whenever power is applied to the compressor. Use this equipment on a grounded system only.  
HIGH PRESSURE: System contains refrigerant and oil under pressure. Remove pressure from both the high and low side before servicing, wear safety goggles.  
FIRE HAZARD: Use tubing cutter to remove compressor. Do not use torch as oil may catch fire.

**CAUTION**  
Use only manufacturer's approved refrigerants, lubricants and electrical components. Unauthorized refrigerant / lubricant / electrical component could cause fires, explosions, electrical shorting.

For details refer to multi language instructions and technical documentation available on Danfoss website at <http://cc.danfoss.com>.

6001115P01

### Serial number

S 03 09 K 12345

Manufacturing location \_\_\_\_\_

Production week \_\_\_\_\_

Production year \_\_\_\_\_

Incremental number \_\_\_\_\_

## Model with economizer

Voltage	Refrigerant	Model	HP	Nominal cooling capacity*		Power input*	Efficiency*		Swept Volume	Displacement	Oil Charge	Net Weight (with oil)
				W	Btu/h		COP W/W	EER Btu/h/W				
50Hz	R404A**	LLZ013	4	4 151	14163	3 051	1.36	4.64	67.4	11.7	1.62	42
		LLZ015	5	4 954	16903	3 555	1.39	4.74	83.5	14.5	1.62	42
		LLZ018	6	5 901	20134	4 092	1.44	4.91	97.6	17	1.62	43
		LLZ024	8	7 411	25286	5 057	1.47	5.02	120.2	20.9	2.51	46
		LLZ033	10	9 284	31677	7 355	1.26	4.30	168.7	29.4	2.51	45
60Hz	R404A**	LLZ013	4	4 987	17016	3 528	1.41	4.81	67.4	14.2	1.62	42
		LLZ015	5	5 914	20179	4 211	1.4	4.78	83.5	17.5	1.62	42
		LLZ018	6	7 067	24113	4 799	1.47	5.02	97.6	20.5	1.62	43
		LLZ024	8	8 755	29872	5 857	1.49	5.08	120.2	25.3	2.51	46
		LLZ033	10	11 874	40514	8 048	1.48	5.05	168.7	35.4	2.51	45

\* Condition: T0: -35°C, Tc: 40°C, RGT: 20°C, SC: 0K

Motor voltage code 4: 400V/3~/50Hz & 460V/3~/60Hz

\*\*R507 performance data are nearly identical to R404A performance data

Note: LLZ033 data is preliminary

## Model without economizer

Voltage	Refrigerant	Model	HP	Nominal cooling capacity*		Power input*	Efficiency*		Swept Volume	Displacement	Oil Charge	Net Weight (with oil)
				W	Btu/h		COP W/W	EER Btu/h/W				
50Hz	R404A**	LLZ013	4	2 314	7 895	2 366	0.98	3.34	67.4	11.7	1.62	42
		LLZ015	5	2 866	9 779	2 776	1.03	3.51	83.5	14.5	1.62	42
		LLZ018	6	3 371	11 502	3 150	1.07	3.65	97.6	17	1.62	43
		LLZ024	8	4 305	14 689	3 959	1.09	3.72	120.2	20.9	2.51	46
		LLZ033	10	5 731	19 554	5 934	0.97	3.31	168.7	29.4	2.51	45
60Hz	R404A**	LLZ013	4	2 842	9 697	2 774	1.02	3.48	67.4	14.2	1.62	42
		LLZ015	5	3 492	11 915	3 307	1.06	3.62	83.5	17.5	1.62	42
		LLZ018	6	4 157	14 184	3 799	1.09	3.72	97.6	20.5	1.62	43
		LLZ024	8	5 189	17 705	4 611	1.13	3.86	120.2	25.3	2.51	46
		LLZ033	10	7 147	24 386	6 505	1.1	3.75	168.7	35.4	2.51	45

\* Condition: T0: -35°C, Tc: 40°C, SH: 10K, SC: 0K

Motor voltage code 4: 400V/3~/50Hz & 460V/3~/60Hz

\*\*R507 performance data are nearly identical to R404A performance data

Note: LLZ033 data is preliminary



## Application Guidelines Technical specifications

### Model with economizer R404A/R507

	Model	To	-40		-35		-30		-25		-20		-15		-10	
		Tc	Qo	Pe	Qo	Pe	Qo	Pe	Qo	Pe	Qo	Pe	Qo	Pe	Qo	Pe
50Hz	LLZ013T4	30	3 500	2.38	4 300	2.55	5 300	2.71	6 400	2.86	7 600	3.00	8 800	3.13	10 100	3.25
		40			4 200	3.05	5 100	3.22	6 100	3.38	7 200	3.53	8 400	3.67	9 600	3.79
		50					4 800	3.89	5 800	4.09	6 800	4.29	7 900	4.47	9 000	4.64
	LLZ015T4	30	4 200	2.82	5 100	2.98	6 200	3.16	7 500	3.32	8 900	3.47	10 600	3.58	12 300	3.64
		40			5 000	3.56	6 000	3.77	7 200	3.98	8 600	4.18	10 100	4.34	11 700	4.46
		50					5 800	4.57	6 900	4.85	8 100	5.11	9 500	5.34	11 000	5.53
	LLZ018T4	30	5 000	3.24	6 100	3.43	7 400	3.63	8 900	3.83	10 700	4.00	12 600	4.12	14 700	4.19
		40			5 900	4.09	7 200	4.34	8 600	4.58	10 200	4.81	12 000	5.00	14 000	5.13
		50					6 900	5.27	8 200	5.58	9 700	5.88	11 300	6.15	13 100	6.36
	LLZ024T4	30	6 200	4.01	7 700	4.24	9 300	4.49	11 200	4.73	13 400	4.94	15 800	5.09	18 500	5.17
		40			7 400	5.06	9 000	5.36	10 800	5.66	12 800	5.94	15 100	6.18	17 500	6.34
		50					8 600	6.51	10 300	6.90	12 100	7.27	14 200	7.60	16 400	7.86
	LLZ033T4	30	8 100	5.68	10 000	5.92	12 300	6.20	14 900	6.47	17 700	6.71	20 700	6.89	23 800	6.96
		40			9 300	7.36	11 500	7.69	13 900	8.03	16 700	8.34	19 500	8.60	22 400	8.77
		50					10 800	9.59	13 100	10.09	15 700	10.57	18 300	11.00	21 000	11.36
60Hz	LLZ013T4	30	4 100	2.73	5 200	2.94	6 300	3.12	7 600	3.29	8 900	3.44	10 400	3.57	12 100	3.68
		40			5 000	3.53	6 100	3.73	7 200	3.92	8 500	4.08	9 900	4.23	11 400	4.36
		50					5 800	4.53	6 900	4.78	8 000	5.02	9 300	5.24	10 700	5.44
	LLZ015T4	30	5 100	3.32	6 100	3.56	7 500	3.77	9 000	3.96	10 800	4.12	12 700	4.27	14 900	4.42
		40			5 900	4.21	7 200	4.47	8 700	4.72	10 300	4.96	12 100	5.19	14 100	5.43
		50					6 900	5.40	8 300	5.72	9 800	6.05	11 400	6.38	13 200	6.72
	LLZ018T4	30	6 100	3.78	7 300	4.06	8 900	4.30	10 800	4.51	12 900	4.70	15 200	4.87	17 800	5.04
		40			7 100	4.80	8 600	5.10	10 400	5.38	12 300	5.65	14 500	5.92	16 900	6.19
		50					8 300	6.16	9 900	6.52	11 700	6.89	13 700	7.27	15 700	7.66
	LLZ024T4	30	7 500	4.62	9 100	4.95	11 000	5.25	13 300	5.50	16 000	5.73	18 900	5.95	22 000	6.15
		40			8 800	5.86	10 700	6.22	12 800	6.56	15 300	6.89	18 000	7.22	20 900	7.55
		50					10 300	7.51	12 300	7.96	14 500	8.41	16 900	8.87	19 500	9.35
	LLZ033T4	30	10 100	6.26	12 600	6.66	15 200	7.07	18 100	7.48	21 400	7.89	25 300	8.27	30 000	8.62
		40			11 900	8.05	14 400	8.55	17 100	9.07	20 200	9.59	23 700	10.11	27 800	10.60
		50					13 600	10.63	16 200	11.27	19 000	11.92	22 100	12.59	25 700	13.24

Condition:

To: Evaporating temperature in °C

Return gas temperature = 20°C

Tc: Condensing temperature in °C

Subcooling = 0K

LLZ033 will be released in 2014

Qo: Cooling Capacity in W

Pe: Power input in kW

### Model with economizer R404A/R507

	Model	To	-40		-35		-30		-25		-20		-15		-10	
		Tc	Qo	Pe	Qo	Pe	Qo	Pe	Qo	Pe	Qo	Pe	Qo	Pe	Qo	Pe
50Hz	LLZ013T4	30	2 000	1.94	2 700	2.10	3 600	2.25	4 600	2.40	5 800	2.53	7 100	2.62	8 600	2.66
		40	1 600	2.19	2 300	2.37	3 100	2.55	4 000	2.74	5 000	2.91	6 100	3.06	7 400	3.17
		50							3 200	3.14	4 100	3.35	5 000	3.55	6 100	3.73
	LLZ015T4	30	2 600	2.28	3 400	2.48	4 400	2.69	5 600	2.89	7 100	3.08	8 900	3.25	10 900	3.38
		40	2 100	2.57	2 900	2.78	3 700	3.01	4 800	3.26	6 100	3.50	7 600	3.74	9 400	3.96
		50							3 900	3.69	4 900	3.98	6 200	4.28	7 700	4.58
	LLZ018T4	30	3 000	2.59	4 000	2.81	5 200	3.05	6 600	3.28	8 400	3.50	10 400	3.69	12 800	3.83
		40	2 500	2.91	3 400	3.15	4 400	3.42	5 700	3.69	7 100	3.98	8 900	4.24	11 000	4.49
		50							4 600	4.18	5 800	4.52	7 300	4.86	9 100	5.19
	LLZ024T4	30	3 900	3.25	5 100	3.54	6 600	3.83	8 500	4.12	10 700	4.40	13 300	4.63	16 400	4.81
		40	3 200	3.66	4 300	3.96	5 600	4.29	7 200	4.64	9 100	5.00	11 400	5.33	14 100	5.64
		50							5 800	5.25	7 400	5.68	9 300	6.10	11 600	6.52
	LLZ033T4	30	5 300	4.82	6 900	4.98	8 900	5.32	11 200	5.76	14 000	6.23	17 300	6.66	21 100	6.97
		40	4 300	6.02	5 700	5.93	7 500	6.14	9 500	6.55	12 000	7.09	14 900	7.70	18 300	8.30
		50							7 500	7.78	9 600	8.34	12 100	9.06	15 000	9.88
60Hz	LLZ013T4	30	2 600	2.27	3 400	2.46	4 400	2.65	5 500	2.81	6 800	2.94	8 300	3.03	10 100	3.06
		40	2 100	2.57	2 800	2.77	3 700	2.99	4 700	3.20	5 900	3.39	7 300	3.56	8 900	3.69
		50							3 800	3.63	4 800	3.88	6 100	4.11	7 500	4.32
	LLZ015T4	30	3 200	2.74	4 100	2.98	5 300	3.22	6 700	3.46	8 400	3.68	10 300	3.85	12 600	3.96
		40	2 600	3.07	3 500	3.31	4 500	3.58	5 800	3.86	7 200	4.15	9 000	4.41	11 000	4.63
		50							4 700	4.34	5 900	4.67	7 400	5.00	9 200	5.31
	LLZ018T4	30	3 800	3.15	4 900	3.42	6 300	3.70	8 000	3.98	9 900	4.23	12 300	4.42	15 000	4.55
		40	3 200	3.53	4 200	3.80	5 400	4.11	6 800	4.44	8 600	4.77	10 700	5.07	13 100	5.32
		50							5 600	4.99	7 000	5.36	8 800	5.74	10 900	6.10
	LLZ024T4	30	4 700	3.82	6 200	4.15	7 900	4.49	10 000	4.83	12 400	5.13	15 300	5.37	18 700	5.53
		40	3 900	4.28	5 200	4.61	6 700	4.99	8 500	5.39	10 700	5.78	13 300	6.15	16 300	6.46
		50							6 900	6.05	8 800	6.51	11 000	6.97	13 600	7.41
	LLZ033T4	30	6 600	5.37	8 500	5.65	10 800	6.08	13 600	6.63	16 900	7.26	20 800	7.96	25 400	8.69
		40	5 500	6.36	7 100	6.51	9 200	6.87	11 700	7.43	14 600	8.14	18 100	8.98	22 100	9.92
		50							9 400	8.61	11 900	9.30	14 800	10.18	18 300	11.22

Condition:

To: Evaporating temperature in °C

Superheat = 10K

Tc: Condensing temperature in °C

Subcooling = 0K

Qo: Cooling Capacity in W

Pe: Power input in kW

LLZ033 will be released in 2014



## Model without economizer R404A/R507

	Model	To	-40		-35		-30		-25		-20		-15		-10	
		Tc	Qo	Pe	Qo	Pe	Qo	Pe	Qo	Pe	Qo	Pe	Qo	Pe	Qo	Pe
50Hz	LLZ013T4	30					4 000	2.25	5 000	2.40	6 200	2.53	7 500	2.62	9 000	2.66
		40					3 500	2.55	4 400	2.74	5 500	2.91	6 600	3.06	7 900	3.17
		50					3 000	2.92	3 800	3.14	4 700	3.35	5 600	3.55	6 600	3.73
	LLZ015T4	30					4 800	2.69	6 100	2.89	7 600	3.08	9 300	3.25	11 300	3.38
		40					4 300	3.01	5 400	3.26	6 700	3.50	8 200	3.74	9 900	3.96
		50					3 600	3.41	4 500	3.69	5 600	3.98	6 900	4.28	8 400	4.58
	LLZ018T4	30					5 700	3.05	7 200	3.28	8 900	3.50	11 000	3.69	13 300	3.83
		40					5 000	3.42	6 300	3.69	7 800	3.98	9 600	4.24	11 700	4.49
		50					4 200	3.87	5 300	4.18	6 600	4.52	8 100	4.86	9 900	5.19
	LLZ024T4	30					7 200	3.83	9 100	4.12	11 400	4.40	14 000	4.63	17 000	4.81
		40					6 400	4.29	8 000	4.64	10 000	5.00	12 300	5.33	14 900	5.64
		50					5 400	4.86	6 800	5.25	8 500	5.68	10 400	6.10	12 600	6.52
	LLZ033T4	30					9 700	5.32	12 100	5.76	14 900	6.23	18 200	6.66	22 000	6.97
		40					8 500	6.14	10 600	6.55	13 100	7.09	16 000	7.70	19 400	8.30
		50					7 000	7.46	8 800	7.78	10 900	8.34	13 400	9.06	16 300	9.88
60Hz	LLZ013T4	30					4 800	2.65	5 900	2.81	7 200	2.94	8 700	3.03	10 500	3.06
		40					4 200	2.99	5 300	3.20	6 500	3.39	7 900	3.56	9 500	3.69
		50					3 500	3.39	4 400	3.63	5 500	3.88	6 800	4.11	8 200	4.32
	LLZ015T4	30					5 800	3.22	7 200	3.46	8 900	3.68	10 800	3.85	13 100	3.96
		40					5 100	3.58	6 400	3.86	7 900	4.15	9 600	4.41	11 600	4.63
		50					4 300	4.03	5 400	4.34	6 700	4.67	8 200	5.00	10 000	5.31
	LLZ018T4	30					6 900	3.70	8 600	3.98	10 600	4.23	12 900	4.42	15 600	4.55
		40					6 100	4.11	7 600	4.44	9 400	4.77	11 500	5.07	13 800	5.32
		50					5 200	4.63	6 500	4.99	8 000	5.36	9 800	5.74	11 900	6.10
	LLZ024T4	30					8 600	4.49	10 700	4.83	13 200	5.13	16 100	5.37	19 400	5.53
		40					7 600	4.99	9 500	5.39	11 700	5.78	14 300	6.15	17 300	6.46
		50					6 500	5.62	8 100	6.05	10 000	6.51	12 200	6.97	14 800	7.41
	LLZ033T4	30					11 800	6.08	14 700	6.63	18 000	7.26	21 900	7.96	26 400	8.69
		40					10 400	6.87	13 000	7.43	16 000	8.14	19 500	8.98	23 400	9.92
		50					8 800	8.15	11 000	8.61	13 500	9.30	16 500	10.18	19 900	11.22

Condition:

To: Evaporating temperature in °C

Return gas temperature = 20°C

Tc: Condensing temperature in °C

Subcooling = 0K

Qo: Cooling Capacity in W

Pe: Power input in kW

LLZ033 will be released in 2014

## Model without economizer R404A/R507

	Model	To	-40		-35		-30		-25		-20		-15		-10	
		Tc	Qo	Pe	Qo	Pe	Qo	Pe	Qo	Pe	Qo	Pe	Qo	Pe	Qo	Pe
50Hz	LLZ013T4	30	2 000	1.94	2 700	2.10	3 600	2.25	4 600	2.40	5 800	2.53	7 100	2.62	8 600	2.66
		40	1 600	2.19	2 300	2.37	3 100	2.55	4 000	2.74	5 000	2.91	6 100	3.06	7 400	3.17
		50							3 200	3.14	4 100	3.35	5 000	3.55	6 100	3.73
	LLZ015T4	30	2 600	2.28	3 400	2.48	4 400	2.69	5 600	2.89	7 100	3.08	8 900	3.25	10 900	3.38
		40	2 100	2.57	2 900	2.78	3 700	3.01	4 800	3.26	6 100	3.50	7 600	3.74	9 400	3.96
		50							3 900	3.69	4 900	3.98	6 200	4.28	7 700	4.58
	LLZ018T4	30	3 000	2.59	4 000	2.81	5 200	3.05	6 600	3.28	8 400	3.50	10 400	3.69	12 800	3.83
		40	2 500	2.91	3 400	3.15	4 400	3.42	5 700	3.69	7 100	3.98	8 900	4.24	11 000	4.49
		50							4 600	4.18	5 800	4.52	7 300	4.86	9 100	5.19
	LLZ024T4	30	3 900	3.25	5 100	3.54	6 600	3.83	8 500	4.12	10 700	4.40	13 300	4.63	16 400	4.81
		40	3 200	3.66	4 300	3.96	5 600	4.29	7 200	4.64	9 100	5.00	11 400	5.33	14 100	5.64
		50							5 800	5.25	7 400	5.68	9 300	6.10	11 600	6.52
	LLZ033T4	30	5 300	4.82	6 900	4.98	8 900	5.32	11 200	5.76	14 000	6.23	17 300	6.66	21 100	6.97
		40	4 300	6.02	5 700	5.93	7 500	6.14	9 500	6.55	12 000	7.09	14 900	7.70	18 300	8.30
		50							7 500	7.78	9 600	8.34	12 100	9.06	15 000	9.88
60Hz	LLZ013T4	30	2 600	2.27	3 400	2.46	4 400	2.65	5 500	2.81	6 800	2.94	8 300	3.03	10 100	3.06
		40	2 100	2.57	2 800	2.77	3 700	2.99	4 700	3.20	5 900	3.39	7 300	3.56	8 900	3.69
		50							3 800	3.63	4 800	3.88	6 100	4.11	7 500	4.32
	LLZ015T4	30	3 200	2.74	4 100	2.98	5 300	3.22	6 700	3.46	8 400	3.68	10 300	3.85	12 600	3.96
		40	2 600	3.07	3 500	3.31	4 500	3.58	5 800	3.86	7 200	4.15	9 000	4.41	11 000	4.63
		50							4 700	4.34	5 900	4.67	7 400	5.00	9 200	5.31
	LLZ018T4	30	3 800	3.15	4 900	3.42	6 300	3.70	8 000	3.98	9 900	4.23	12 300	4.42	15 000	4.55
		40	3 200	3.53	4 200	3.80	5 400	4.11	6 800	4.44	8 600	4.77	10 700	5.07	13 100	5.32
		50							5 600	4.99	7 000	5.36	8 800	5.74	10 900	6.10
	LLZ024T4	30	4 700	3.82	6 200	4.15	7 900	4.49	10 000	4.83	12 400	5.13	15 300	5.37	18 700	5.53
		40	3 900	4.28	5 200	4.61	6 700	4.99	8 500	5.39	10 700	5.78	13 300	6.15	16 300	6.46
		50							6 900	6.05	8 800	6.51	11 000	6.97	13 600	7.41
	LLZ033T4	30	6 600	5.37	8 500	5.65	10 800	6.08	13 600	6.63	16 900	7.26	20 800	7.96	25 400	8.69
		40	5 500	6.36	7 100	6.51	9 200	6.87	11 700	7.43	14 600	8.14	18 100	8.98	22 100	9.92
		50							9 400	8.61	11 900	9.30	14 800	10.18	18 300	11.22

Condition:

To: Evaporating temperature in °C

Superheat = 10K

Tc: Condensing temperature in °C

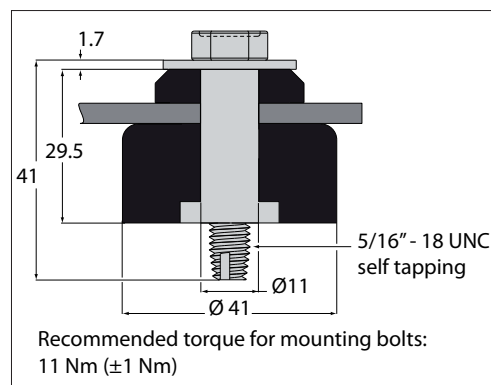
Subcooling = 0K

Qo: Cooling Capacity in W

Pe: Power input in kW

LLZ033 will be released in 2014

**LLZ013-015-018**



FRCC.PC.025.A1.02

Technical drawing of the front view of a square vacuum chamber. The drawing includes the following dimensions and labels:

- Overall width: 231.9
- Overall height: 231.9
- Top flange thickness: 108.8
- Top flange hole diameter: 4x Ø19.0 - 20.0
- Top flange hole spacing: 190.25-190.75
- Top flange hole offset: 95.25
- Top flange hole diameter: 133
- Top flange hole offset: 119.3
- Top flange hole diameter: 124.9
- Top flange hole offset: 95.25
- Top flange hole diameter: 190.25-190.75
- Top flange hole offset: 106.4 sight glass
- Top flange hole offset: 14°±2°
- Top flange hole offset: 73°
- Top flange hole offset: 45°±2°
- Top flange hole offset: 31°
- Top flange hole offset: 34°
- Top flange hole offset: 78.5-80.5
- Top flange hole offset: 124.9 suction line

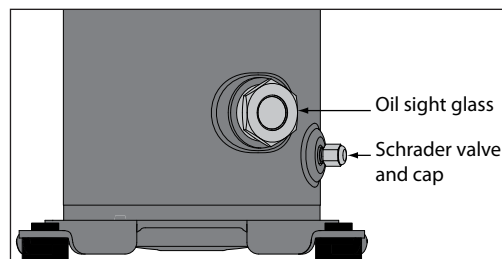


## Application Guidelines

## Dimensions

### Oil sight glass

LLZ scroll compressors come equipped with a threaded oil sight glass with 1"1/8 - 18 UNEF connection. It can be used for a visual check of the oil amount and condition or it may be replaced by an accessory oil management device. The oil level must be visible in the sight glass during operation.



### Schrader

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

### Suction and discharge connections

LLZ scroll compressors are factory delivered with rotolock connections only.

Compressor Models	Rotolock Sizes		
	Suction Fitting (in)	Discharge Fitting (in)	Econo Fitting (in)
LZL013	1"1/4	1"	1"
LLZ015	1"1/4	1"	1"
LLZ018	1"1/4	1"	1"
LLZ024	1"3/4	1"1/4	1"
LLZ033	1"3/4	1"1/4	1"

## Application Guidelines

## Electrical data, connections and wiring

### Motor voltage

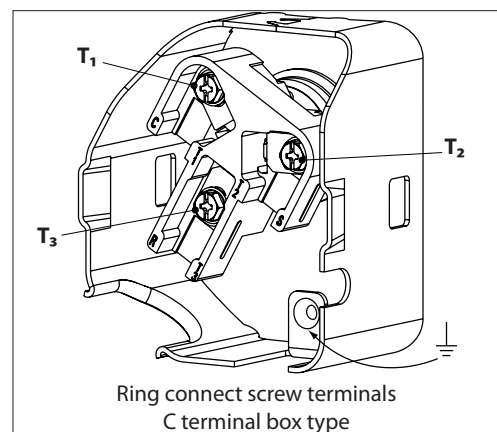
LLZ scroll compressors are available in 4 different motor voltages.

		Motor voltage code 2	Motor voltage code 4	Motor voltage code 7	Motor voltage code 9
Nominal voltage	50 Hz	200-220 V - 3 ph	380-415 V - 3 ph	-	-
Voltage range	50 Hz	180 - 242 V	340 - 460 V	-	-
Nominal voltage	60 Hz	208-230 V - 3 ph	460 V - 3 ph	575 V - 3 ph	380 V - 3 ph
Voltage range	60 Hz	187 - 253 V	414 - 506 V	517 - 632 V	342 - 418 V

### Wiring connections

LLZ scroll compressors will only compress gas while rotating counter-clockwise (when viewed from the compressor top). Three-phase motors will start and run in either direction, depending on the phase angles of the supplied power. Care must be taken during installation to ensure that the compressor operates in the correct direction (see "Phase sequence and reverse rotation protection").

The drawings hereafter show electrical terminal labelling and should be used as a reference when wiring the compressor. For three phase applications, the terminals are labelled T1, T2, and T3.

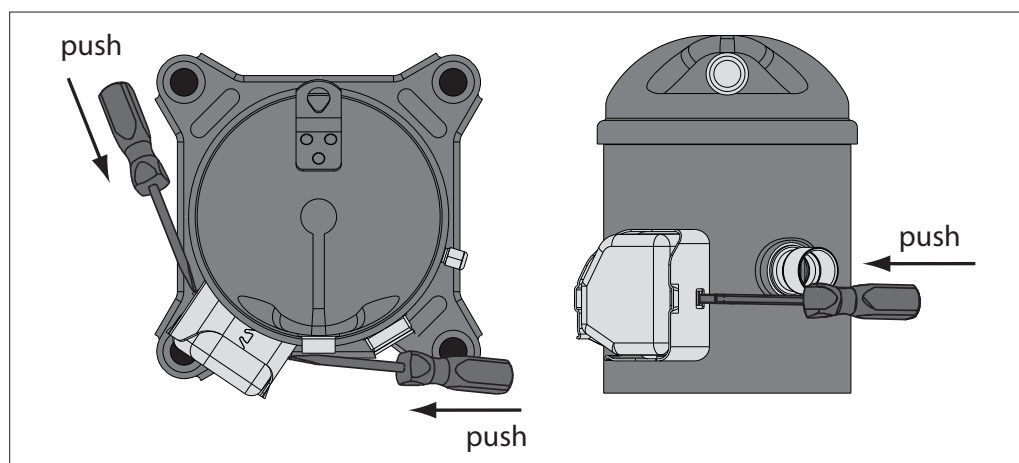


### Terminal cover mounting

The terminal cover and gasket should be installed prior to operation of the compressor. Respect the "up" marking on gasket and cover and ensure

that the two outside tabs of the cover engage the terminal box.

### Terminal cover removal



### IP rating

The compressor terminal box IP rating according to CEI 529 is **IP22** for all models.

- First numeral, level of protection against contact and foreign objects  
**2** protection against object size over 12.5 mm (fingers or similar)
- Second numeral, level of protection against water  
**2** protection against dripping water when tilted up to 15°

The IP rating can be upgraded to IP54 with an accessory kit (see section "Spare parts and accessories").

### Three phase electrical characteristics

Model		LRA	RLA	MCC assigned	MOC		Winding Resistances (Ohm)		
		A	A	A	Economized cycle	Standard cycle	T1-T3	T1-T2	T2-T3
Motor voltage code 4 380-415 V / 3 ph / 50 Hz. 460 V / 3 ph / 60 Hz	LLZ013T4	62.0	8.0	12.0	9.8	8.0	0,60	0,60	0,61
	LLZ015T4	88.5	9.6	15.0	12.0	9.8	0,50	0,50	0,50
	LLZ018T4	90.0	10.0	15.0	14.4	11.8	0,43	0,43	0,44
	LLZ024T4	95.0	13.5	21.0	18.3	15.0	0,37	0,37	0,37
	LLZ033T4	N/A	N/A	N/A	N/A	N/A	0,32	0,32	0,33
Motor voltage code 2 200-220 V / 3ph / 50Hz 208-230 V / 3 ph / 60 Hz	LLZ013T2	123.0	17.9	25.0	20.0	16.4	2,30	2,30	2,40
	LLZ015T2	180.0	18.5	29.0	23.0	18.9	1,69	1,69	1,69
	LLZ018T2	184.0	20.0	31.0	29.4	24.1	1,61	1,70	1,66
	LLZ024T2	190.0	25.6	40.0	34.7	28.4	1,48	1,48	1,48
	LLZ033T2	N/A	N/A	N/A	N/A	N/A	1,30	1,30	1,30

#### LRA (Locked Rotor Amp)

LRA is the higher average current as measured on a mechanically blocked compressor tested under nominal voltage. LRA is printed on the nameplate.

The LRA value can be used as a rough estimation for the starting current. However in most cases, the real starting current will be lower. Many countries have defined limits for the starting current in domestic use. A soft starter can be applied to reduce starting current.

#### MCC (Maximum Continuous Current)

The MCC is the current at which the internal motor protection trips under maximum load and low voltage conditions.

This MCC value is the maximum at which the compressor can be operated in transient conditions and out of the application envelope. Above this value the overload will switch off to protect the motor.

#### Max Oper. A (Maximum Operating Amp)

The Max Oper. A is the current when the compressor operates at maximum load conditions and 10% below nominal voltage.

This value, which is the max rated load current for the compressor, is new on the nameplate.

Max Oper. A can be used to select cables and contactors.

In normal operation, the compressor current consumption is always less than the Max Oper. A value.

#### Winding resistance

Winding resistance is the resistance between indicated terminal pins at 25°C (resistance value +/- 7%).

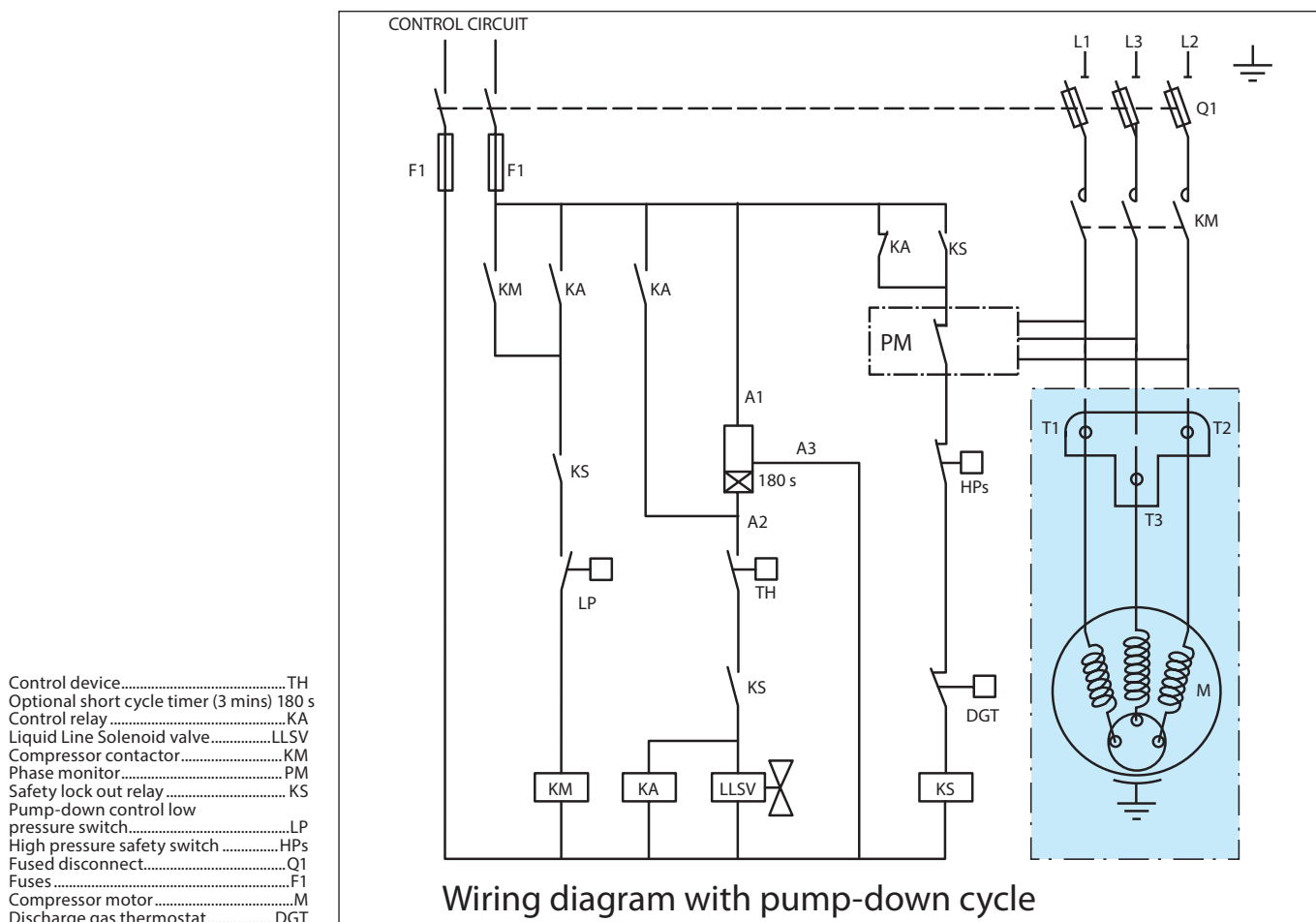
Winding resistance is generally low and it requires adapted tools for precise measurement. Use a digital ohm-meter, a '4 wires' method and measure under stabilised ambient temperature. Winding resistance varies strongly with winding temperature. If the compressor is stabilised at a different value than 25°C, the measured resistance must be corrected using the following formula:

$$R_{t_{amb}} = R_{25^{\circ}\text{C}} \frac{a + t_{amb}}{a + t_{25^{\circ}\text{C}}}$$

$t_{25^{\circ}\text{C}}$ : reference temperature = 25°C  
 $t_{amb}$ : temperature during measurement (°C)  
 $R_{25^{\circ}\text{C}}$ : winding resistance at 25°C  
 $R_{amb}$ : winding resistance at  $t_{amb}$   
 coefficient  $a = 234.5$

## Electrical wiring diagram

Suggested wiring diagram with "one shot" pump down cycle and safety lock-out relay



## Internal motor protection

LLZ scroll compressors are equipped with an internal line break protector mounted on the motor windings. The protector is an automatic reset device, containing a snap action bimetal switch.

Internal protectors respond to over-current and overheating. They are designed to interrupt

motor current under a variety of fault conditions, such as failure to start, running overload and fan failure.

If the internal overload protector trips out, it must cool down to about 60°C to reset. Depending on ambient temperature, this may take up to several hours.

## Phase sequence and reverse rotation protection

The compressor will only operate properly in a single direction. Use a phase meter to establish the phase orders and connect line phases L1, L2 and L3 to terminals T1, T2 and T3, respectively. For three-phase compressors, the motor will run equally well in both directions. Reverse rotation results in excessive noise; no pressure differential between suction and discharge; and suction line warming rather than immediate cooling.

A service technician should be present at initial start-up to verify that supply power is properly phased and that the compressor and auxiliaries are rotating in the correct direction.

For LLZ phase monitors are required. The selected phase monitor should lock out the compressor from operation in reverse.

## Voltage imbalance

For three-phase applications the voltage measured at the compressor terminals for each

phase should be within  $\pm 2\%$  of the average for all phases.




## Application Guidelines

## Approvals and certifications

### Approvals and certificates

LLZ scroll compressors comply with the following approvals and certificates.

Certificates are listed on the product datasheets:  
<http://www.danfoss.com/odsg>

CE 0062 or CE 0038 (European Directive)		All LLZ models
UL (Underwriters Laboratories)		Models with motor code 2 & 4
CCC		LLZ013-015-018 at 50Hz
Other approvals/certificates		Contact Danfoss

### Conformity to directives

Pressure equipment directive 97/23/EC  
Machinery directive 98/35/EC annex II b

Low voltage directive 2006/95/EC  
Electromagnetic compatibility 2004/108/CE

Products	LLZ013 to 033
Refrigerating fluids	Group 2
Category PED	I
Evaluation module	no scope
Service temperature - Ts	-40°C < Ts < 55°C
LLZ - Service pressure - Ps	24.73 bar(g)
Declaration of conformity	contact Danfoss
Marking of conformity	CE

### Internal free volume

Products	Internal free volume at LP side without oil (litre)
LLZ013-015-018	4.74
LLZ024-033	5.95

## Application Guidelines

## Operating conditions

The scroll compressor application range is influenced by several parameters which need to be monitored for a safe and reliable operation. These parameters and the main recommendations for good practice and safety devices are explained hereunder.

- Refrigerant and lubricants
- Motor supply
- Compressor ambient temperature
- Application envelope (evaporating temperature, condensing temperature, return gas temperature)

### Refrigerant and lubricants

#### 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 and guidelines

Additional points could influence the final choice:

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

#### R404A

R404A is an HFC refrigerant. R404A has zero ozone depletion potential (ODP = 0). R404A is especially suitable for low evaporating temperature applications but it can also be applied to medium evaporating temperature applications. R404A is a mixture and has a very

small temperature glide, and therefore must be charged in its liquid phase, but for most other aspects this small glide can be neglected. Because of the small glide, R404A is often called a near-azeotropic mixture.

#### R507

R507 is an HFC refrigerant with properties comparable to R404A. R507 has no ozone depletion potential (ODP = 0). As with R404A, R507 is particularly suitable for low evaporating

temperature applications but it can also be used for medium evaporating temperature applications. R507 is an azeotropic mixture with no temperature glide.

#### PVE

Polyvinyl ether (PVE) is an innovative refrigeration lubricant for HFC refrigerant systems. PVE is as hygroscopic as existing polyolester lubricants (POE), but PVE doesn't chemically react with water; no acids are formed and compressor evacuation is easier.

The compressor technology applied in LLZ scroll compressors in combination with PVE lubricant provides the best possible result in terms of reliability and compressor lifetime.

#### Motor supply

LLZ scroll compressors can be operated at nominal voltages as indicated in table section "Motor voltage". Under-voltage and over-voltage

operation is allowed within the indicated voltage ranges.

#### Compressor ambient temperature

LLZ scroll compressors can be applied from -35°C to 50°C ambient temperature. The compressors are designed as 100% suction gas

cooled without need for additional fan cooling. Ambient temperature has very little effect on the compressor performance.

#### High ambient temperature

In case of enclosed fitting and high ambient temperature it is recommend to check the temperature of power recommended wires and conformity to their insulation specification.

In case of safe tripping by the internal compressor overload protection the compressor must cool down to about 60°C before the overload will reset. A high ambient temperature can strongly delay this cool-down process.

#### Low ambient temperature

Although the compressor itself can withstand low ambient temperature, the system may require specific design features to ensure safe

and reliable operation. See section 'Specific application recommendations'.

## Application envelope

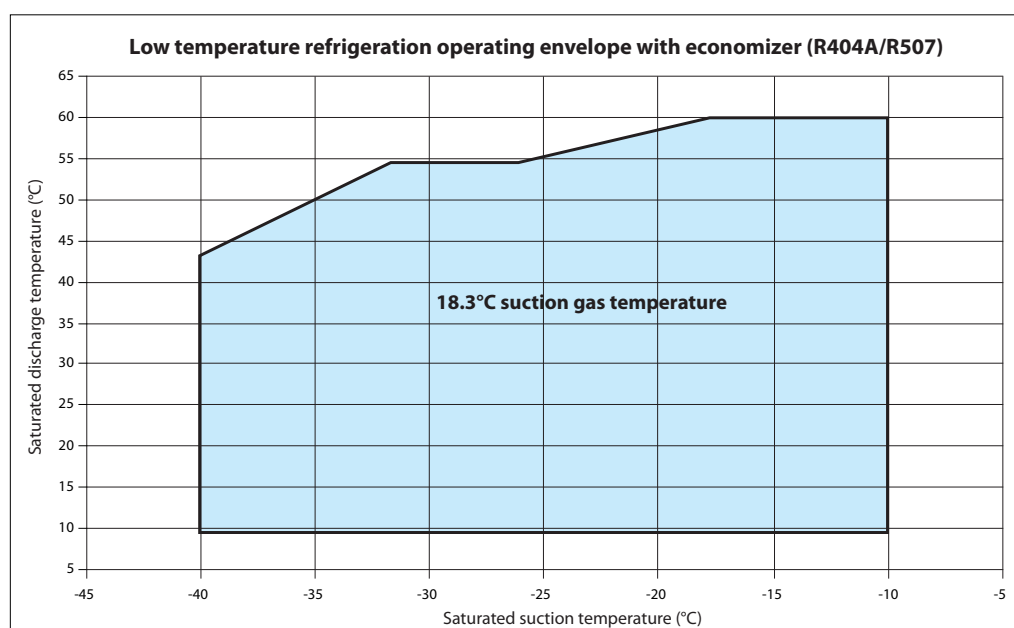
The operating envelopes for LLZ scroll compressors are given in the figures below, where the condensing and evaporating temperatures represent the range for steady-state operation. Under transient conditions, such as start-up and defrost, the compressor may operate outside this envelope for short periods.

The figures below show the operating envelopes for LLZ scroll compressors with refrigerants

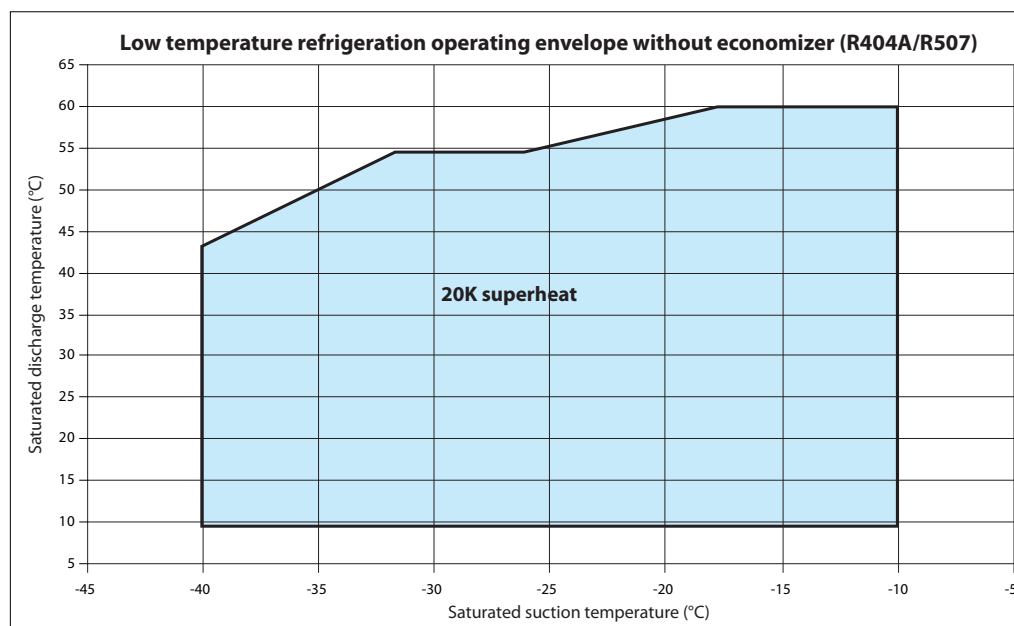
R404A/507. The operating limits serve to define the envelope within which reliable operations of the compressor are guaranteed:

- Maximum discharge gas temperature: +135°C
- A suction superheat below 5 K is not recommended due to the risk of liquid flood back
- Minimum and maximum evaporating and condensing temperatures as per the operating envelopes.

## With economizer



## Without economizer



The difference between the operating envelope with and without economizer is the suction status. The operating envelope with economizer is based on 18.3°C RGT (return gas temperature) which equals 58.3 K suction superheat at -40°C evaporating temperature. While the operating

envelope without economizer is based on 20 K suction superheat. Consequently, the economizer can achieve the same envelope with much higher suction superheat. In other words, the economizer can enlarge the envelope based on the same suction superheat.

**Maximum discharge gas temperature**

The discharge temperature depends mainly on the combination of evaporating temperature, condensing temperature and suction gas superheat. Discharge gas temperature should be controlled with an isolated thermocouple or

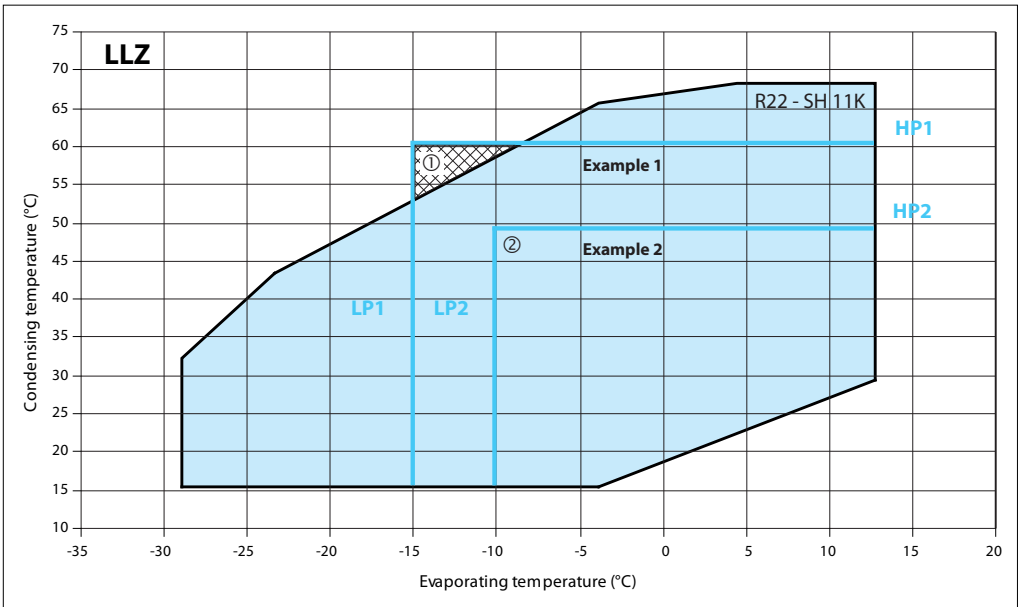
thermostat attached to the discharge line 15 cm (6 inches) from the compressor shell. Maximum discharge gas temperature must not exceed 135°C (275°F) when the compressor is running within the approved operating envelope.

**Discharge gas temperature protection (DGT)**

DGT protection is required if the high and low pressure switch settings do not protect the compressor against operations beyond its specific application envelope. Please refer to the examples below, which illustrate where DGT protection is required (n°1) and where it is not (n°2).

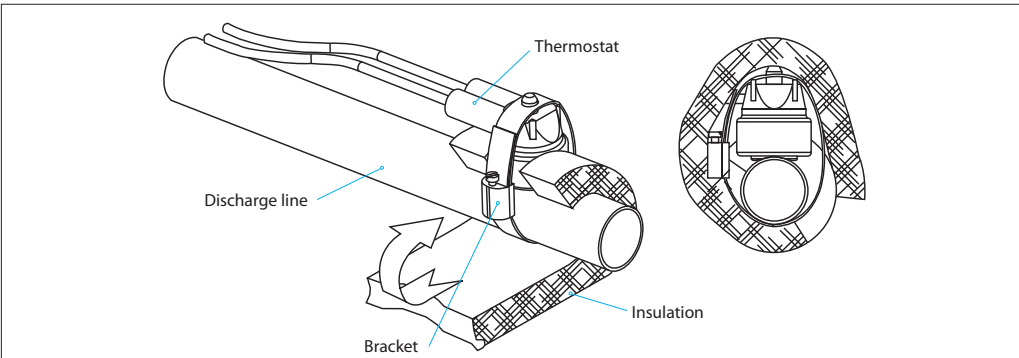
The compressor must not be allowed to cycle on the discharge gas thermostat. Continuous operations beyond the compressor's operating range will cause serious damage to the compressor!

A DGT accessory is available from Danfoss: refer to section "Spare parts and accessories".



Example 1 (R22, SH = 11 K)  
LP switch setting: LP1 = 2 bar (g) (-15°C)  
HP switch setting: HP1 = 23.8 bar (g) (61°C)  
① The LP and HP switches do not protect sufficiently against operation outside the envelope. DGT protection is required to avoid operation in the hatched area.

Example 2 (R22, SH = 11 K)  
LP switch setting: LP2 = 2.5 bar (g) (-10°C)  
HP switch setting: HP2 = 18 bar (g) (49°C)  
② The LP and HP switches protect against operation outside the envelope. No DGT protection required.



## Application Guidelines

## Operating conditions

### High and low pressure protection

		R404A/R507
Working pressure range high side	bar(g)	5.94~27.74
Working pressure range lower side	bar(g)	0.33~3.34
Maximum high pressure safety switch setting	bar(g)	29.7
Minimum low pressure safety switch setting ①	bar(g)	0.30
Recommended pump-down switch settings	bar(g)	1.5 bar below nominal evaporating pressure
Min low pressure pump-down switch setting	bar(g)	1.0

① LP safety switch shall never have time delay.

### High pressure

LLZ scroll compressors are not equipped with an internal pressure relief valve; therefore a high pressure switch is required to shut down the compressor should the discharge pressure exceed the values shown in the table above.

The high-pressure switch can be set to lower values depending on the application and

ambient conditions. The HP switch must either be placed in a lockout circuit or consist of a manual reset device to prevent cycling around the high-pressure limit. If a discharge valve is used, the HP switch must be connected to the service valve gauge port, which must not be isolated.

### Low pressure

A low pressure (LP) safety switch is recommended. LLZ scroll compressors exhibit high volumetric efficiency and may draw very low vacuum levels, which could induce scroll instability and electrical arcing at the internal cluster. The minimum low-pressure safety switch setting is given in the above table. For systems

without pump-down, the LP safety switch must either be a manual lockout device or an automatic switch wired into an electrical lockout circuit. The LP switch tolerance must not allow for vacuum operations of the compressor. LP switch settings for pump-down cycles with automatic reset are also listed in the table above.

### On/off cycling (cycle rate limit)

Depending on the application, a number higher than 12 starts per hour can reduce the service life of the motor-compressor unit. A one-minute time out is recommended.

The system must be designed in a way that provides a minimum compressor running time of two minutes so as to provide for sufficient

motor cooling after start-up along with proper oil return. Note that the oil return may vary since it depends upon system design.

Danfoss recommends a restart delay timer to limit compressor cycling.

## General

Successful application of scroll compressors is dependent on careful selection of the compressor for the application. If the compressor is not correct for the system, it will operate

beyond the limits given in this manual. Poor performance, reduced reliability, or both may result.

## Essential piping design recommendations

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

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

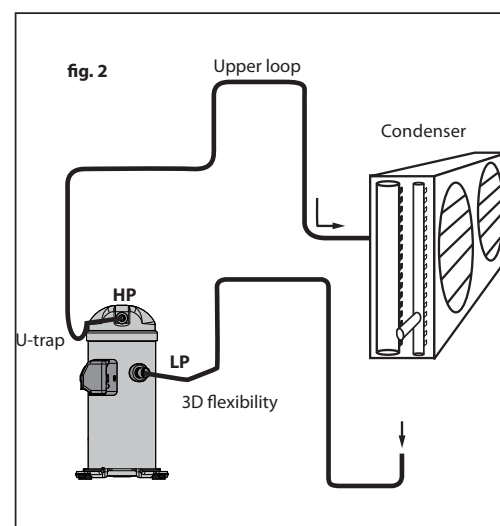
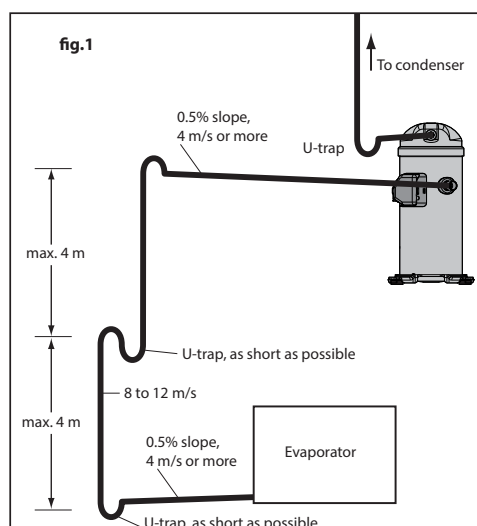
If the evaporator is situated below the compressor, the suction riser must be trapped to ensure the oil return to the compressor (see fig.1).

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

draining back to the compressor when stopped (see fig. 2). The maximum elevation difference between the indoor and outdoor section cannot exceed 8 m. System manufacturers should specify precautions for any applications that exceed these limits to ensure compressor reliability.

Economizer heat exchanger piping shall be arranged in a count flow of gas and liquid as below to assure optimum heat transfer and therefore best subcooling effect.

Piping should be designed with adequate three-dimensional flexibility (figure 2). It should not be in contact with the surrounding structure, unless a proper tubing mount has been installed. This protection proves necessary to avoid excess vibration, which can ultimately result in connection or tube failure due to fatigue or wear from abrasion. Aside from tubing and connection damage, excess vibration may be transmitted to the surrounding structure and generate an unacceptable sound level within that structure as well (for more information on sound and vibration management").

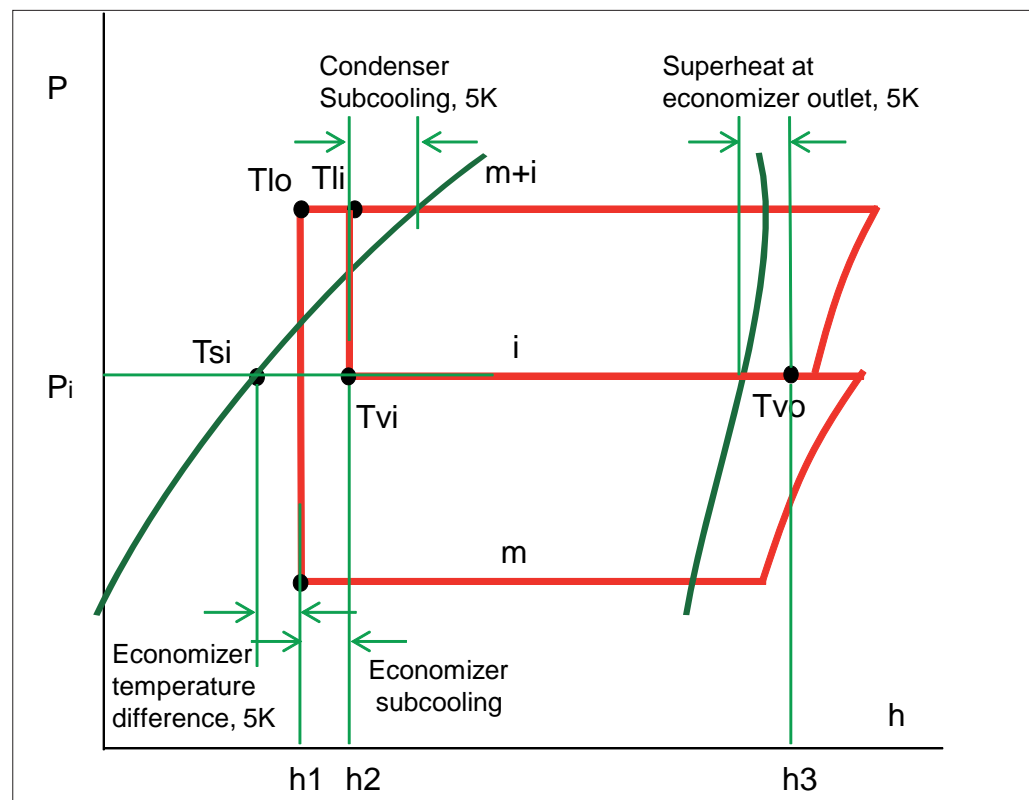


### Economizer selection

The key parameter in determining proper economizer size is Saturated Injection Temperature (Tsi). Tsi is provided by Danfoss selection software and this value has been validated through extensive testing at variable operating conditions. In order to optimize system performance while maintaining system reliability and functionality, the economizer should be sized based on 5 K condenser subcooling, 5K economizer temperature difference and 5K economizer superheat

as indicated in the below chart. Once these parameters are set, the economizer load can be calculated by the below equation.

Economizer load = Evaporating mass flow,  $m$  (Enthalpy of liquid entering economizer,  $h_2$  - Enthalpy of liquid leaving economizer,  $h_1$ ) = Economizer injection mass flow,  $i$  (Enthalpy of vapour leaving economizer,  $h_3$  - Enthalpy of vapour entering economizer,  $h_2$ ).





## Refrigerant charge limit

LLZ scroll compressors can tolerate liquid refrigerant up to a certain extent without major problems. However, excessive liquid refrigerant in the compressor is always unfavourable for service life. Besides, the installation cooling capacity may be reduced because of the evaporation taking place in the compressor and/or the suction line instead of the evaporator. System design must be such that the amount of liquid refrigerant in the

compressor is limited. In this respect, follow the guidelines given in the section "essential piping design recommendations" in priority. Use the tables below to quickly evaluate the required compressor protection in relation with the system charge and the application. More detailed information can be found in the paragraphs hereafter. Please contact Danfoss for any deviation from these guidelines.

Model	Refrigerant charge limit (kg)
LLZ013-015-018	4.54
LLZ024-033	7.26

Depending on test results, crankcase heaters, Liquid Line Solenoid Valve, pump down or suction accumulator must be applied (see below)

	BELOW charge limit	ABOVE charge limit
Packaged units	<input checked="" type="checkbox"/> No test or additional safeties required	<div>REQ</div> Off cycle migration test <div>REQ</div> Liquid flood back test
System with remote heat exchanger	<div>REC</div> Off cycle migration test	<div>REQ</div> Off cycle migration test <div>REQ</div> Liquid flood back test

REC

 Recommended

REQ

 Required

☒ No test or additional safeties required

Note: for special conditions such as low ambient temperature, low load operation or brazed plate heat exchangers please refer to corresponding sections

## Off-cycle migration

Off-cycle refrigerant migration is likely to occur when the compressor is located at the coldest part of the installation, when the system uses a bleed-type expansion device, or if liquid could migrate from the evaporator into the compressor sump by gravity. If too much liquid refrigerant accumulates in the sump, it will saturate the oil and lead to a flooded start. When the compressor starts, the refrigerant evaporates abruptly under the sudden decrease of the bottom shell

pressure, causing the oil to foam. In extreme situations, this might result in too much oil leaving the compressor, which must be avoided as it causes irreversible damages due to possible lack of lubrication.

LLZ scroll compressors can tolerate occasional flooded starts as long as the system has been evaluated.

A suitable test to evaluate the risk of off-cycle migration is the following:

- Stabilise the non running system at 5°C ambient temperature.
- Raise the ambient temperature to 20°C and keep it for 10 minutes.
- Start the compressor and monitor sump temperature, sight glass indication and sound level.

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

A noisy start, oil loss from the sump and sump cool down are indications for migration. Depending on the amount of migration graduate measures shall be taken:

- Crankcase heater
- Liquid line solenoid valve
- Pump down cycle

Crankcase heater: when the compressor is idle, the oil temperature in the sump must be maintained at no lower than 10 K above the saturation temperature of the refrigerant on the low-pressure side. This requirement ensures that the liquid refrigerant is not accumulating in the sump. A crankcase heater is only effective if capable of sustaining this level of temperature

difference. Tests must be conducted to ensure that the appropriate oil temperature is maintained under all ambient conditions (temperature and wind). Below -5°C ambient temperature and a wind speed of above 5m/sec, it is recommended to thermally insulate the heaters in order to limit the surrounding energy losses.

Due to the Danfoss scroll compressors inherent ability to handle liquid refrigerant, crankcase heaters are not required when the system charge does not exceed the recommended maximum charge.

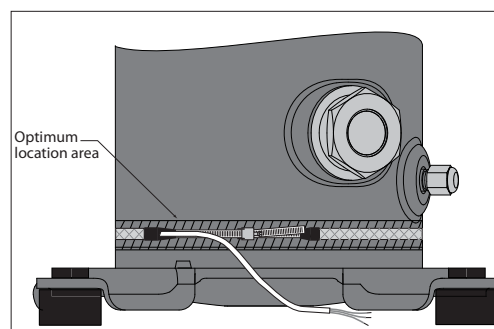
Since the total system charge may be undefined, a crankcase heater is recommended on all systems with remote heat exchangers. In addition, any system containing a refrigerant charge in excess of the maximum recommended system charge for compressors requires a crankcase heater.

Belt-type crankcase heater accessories are available from Danfoss (see section "Spare parts and accessories").

The heater must be energized whenever the compressor is off.

⚠ Provide separate electrical supply for the heaters so that they remain energized even when the machine is out of service (e.g. seasonal shutdown).

It is recommended that the heater be turned on for a minimum of 12 hours prior to starting the compressor.



Liquid line solenoid valve (LLSV): This feature is very convenient and can be used on all types of applications.

An LLSV is used to isolate the liquid charge in the high pressure side, thereby preventing against

charge transfer or excessive migration to the compressor during off-cycles. The quantity of refrigerant remaining in 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: Once the system has reached its set point and is about to shut off, the LLSV on the liquid line closes. The compressor then pumps the majority of the refrigerant charge into the high pressure side before the system stops on the low pressure pump-down switch. This step reduces the amount of charge on the low side in order to prevent off-cycle migration.

A pump-down cycle represents one of the most effective ways to protect against the off-cycle migration of refrigerant; however it is only convenient to apply on application with thermostatic control.

Rack application with pressostatic control can use timer delay to empty the evaporators before the stop. Time should be carefully set to not interfere with the low safety pressure switch.

For low pressure pump-down switch settings, refer to page 24. For suggested wiring diagrams, please see page 17.

Under certain conditions, the internal valve may not completely seal, and due to the refrigerant back flow the compressor might restart during pump-down applications. Repeated short cycling can result in a compressor breakdown. It is

recommended to install an external magnetic check valve (such as Danfoss Part No. 120Z5046) close to the compressor's discharge connector so the discharge volume is minimized.

A magnetic check valve is recommended for this as it offers the best solution regarding minimal required and maximal pressure drop over the wide application envelope of the LLZ scroll compressors. If a Danfoss NRV check valve is applied it has to be carefully selected for the specific operation conditions of the individual system.

Tests for pump down cycle approval:

- As the pump-down switch setting is inside the application envelope, tests should be carried out to check unexpected cut-out during transient conditions (i.e. defrost – cold starting). When unwanted cut-outs occur, the low pressure pump-down switch can be delayed. In this case a low pressure safety switch without any delay timer is mandatory.
- While the thermostat is off, the number of pressure switch resets should be limited to avoid short cycling of the compressor. Use dedicated wiring and an additional relay which allows for one shot pump-down.

The pump-down allows to store all the refrigerant in the high pressure side circuit. On unitary or close-coupled systems, where the system refrigerant charge is expected to be both correct and definable the entire system charge may be stored in the condenser during pump-down if all components have been properly sized.

Other application needs a liquid receiver to store the refrigerant.

Receiver dimensioning requires special attention. The receiver shall be large enough to contain part of the system refrigerant charge but it shall not be dimensioned too large. A large receiver easily leads to refrigerant overcharging during maintenance operation.

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**Liquid flood back**

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

A continuous liquid flood back will cause oil dilution and, in extreme situations, lead to lack of lubrication and high rate of oil leaving the compressor.

Liquid flood back test: repetitive liquid flood back testing must be carried out under TXV threshold operating conditions-a high pressure ratio and minimum evaporator load, along with the measurement of suction superheat, oil sump temperature and discharge gas temperature.

the discharge gas temperature be less than 35K above the saturated discharge temperature, this indicates liquid flood back.

During operations, liquid flood back may be detected by measuring either the oil sump temperature or the discharge gas temperature. If at any time during operations, the oil sump temperature drops to within 10K or less above the saturated suction temperature, or should

Continuous liquid flood back can occur with a wrong dimensioning, a wrong setting or malfunction of the expansion device or in case of evaporator fan failure or blocked air filters.

A suction accumulator providing additional protection as explained hereunder can be used to solve light continuous liquid flood back.

Suction accumulator: a suction accumulator offers protection against refrigerant flood back at start-up, during operations or defrosting by trapping the liquid refrigerant upstream from the compressor. The suction accumulator also protects against off-cycle migration by providing additional internal free volume to the low side of the system.

A suction accumulator must be carefully dimensioned, taking into account the refrigerant charge as well as the gas velocity in the suction line. Depending on the operating conditions it may happen that the recommended connections of the accumulator are one size smaller than the suction line.

## Low ambient application

### Low ambient start-up

Under cold ambient conditions ( $<0^{\circ}\text{C}$ ), upon start-up the pressure in the condenser may be so low that a sufficient pressure differential across the expansion device cannot be developed to properly feed the evaporator.

As a result, the compressor may go into a deep vacuum, which can lead to compressor failure due to internal arcing and instability in the scroll wraps. Under no circumstances should the compressor be allowed to operate under vacuum. The low-pressure control must be set in accordance with the table on page 24 in order to prevent this from happening.

Early feeding of the evaporator and management of the discharge pressure could help to attenuate these effects.

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

### Low ambient operations

It is recommended that the unit be tested and monitored at minimum load and low ambient conditions as well. The following considerations should be taken into account to ensure proper system operating characteristics.

The expansion device should be sized to ensure proper control of the refrigerant flow into the evaporator. An oversized valve may result in erratic control. This consideration is especially important in manifolded units where low load conditions may require the frequent cycling of compressors. This can lead to liquid refrigerant entering the compressor if the expansion valve does not provide stable refrigerant super-heat control under varying loads.

The superheat setting of the expansion device should be sufficient to ensure proper superheat levels during low loading periods. A minimum of 5 K stable superheat is required.

Head pressure control under low ambient conditions: Several possible solutions are available to prevent the risk of compressor to vacuum and low pressure differential between the suction and discharge pressures.

In air-cooled machines, cycling the fans with a head pressure controller will ensure that the fans remain off until the condensing pressure has reached a satisfactory level. Variable speed fans can also be used to control the condensing pressure. In water-cooled units, the same can be performed using a water regulator valve that is also operated by head pressure, thereby ensuring that the water valve does not open until the condensing pressure reaches a satisfactory level. The minimum condensing pressure must be set at the minimum saturated condensing temperature shown in the application envelopes.

Under very low ambient conditions, in which testing has revealed that the above procedures might not ensure satisfactory condensing and suction pressures, the use of a head pressure control valve is recommended. Note: This solution requires extra refrigerant charge, which can introduce other problems. A non-return valve in the discharge line is recommended and special care should be taken when designing the discharge line.

For further information, please contact Danfoss.

## Scroll and reciprocating

Unlike the reciprocating compressor, a scroll does not have dead volume. Neither does it have a suction valve causing pressure drop. As a result a scroll compressor has a high volumetric efficiency even at low suction pressure. In systems such as ice makers and milk cooling tanks this high capacity at low temperature shortens the cooling time.

When moving from a reciprocating compressor to a scroll compressor, the selection shall always be made based on cooling capacity at the application rating point. Never make a selection based on equivalent displacement.

## Application Guidelines

## Specific application recommendations

### Low load operations

The compressor should be run for a minimum period to ensure that the oil has sufficient time to properly return to the compressor sump and

that the motor receives enough cooling under conditions of lowest refrigerant mass flow.

### Brazed plate heat exchangers

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

Due to the small volume of the brazed plate heat exchanger, no pump-down cycle is normally required. The suction line running from the heat exchanger to the compressor must be trapped to avoid refrigerant migration to the compressor.

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

### Water utilising systems

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

Common causes for water leaks are corrosion and freezing.

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

**Freezing:** When water freezes into ice its volume expands which can damage heat exchanger walls and cause leaks. During off periods water inside heat exchangers could start freezing when ambient temperature is lower than 0°C. During on periods ice banking could occur when the circuit is running continuously at too low load. Both situations should be avoided by connecting a pressure and thermostat switch in the safety line.

## Application Guidelines

## Sound and vibration management

### Starting sound level

During start-up transients it is natural for the compressor sound level to be slightly higher than during normal running. LLZ scroll compressors exhibit very little increased start-up transient sound. If a three-phase model is miswired, the compressor will run in reverse. Reverse

compressor rotation is characterised by an objectionable sound. To correct reverse rotation, disconnect power and switch any two of the three power leads at the unit contactor. Never switch leads at the compressor terminals.

### Running sound level

LLZ are designed with features to reduce the sound level when a compressor is running.

Average sound levels below is at ARI LBP condition.

Model	50 Hz		60 Hz	
	Sound power (dBA) Without jacket	Sound power (dBA) With jacket	Sound power (dBA) Without jacket	Sound power (dBA) With jacket
LLZ013	78	70	80	72
LLZ015	80	72	83	75
LLZ018	83	73	84	74
LLZ024	85	75	86	76
LLZ 033	85	75	86	76

### Stopping sound level

LLZ scroll compressor have a unique discharge valve design that minimizes stopping noise. This results in very low shutdown sound.

### Sound generation in a refrigeration system

Typical sound and vibration in refrigeration systems encountered by design and service engineers may be broken down into the following three source categories.

Sound radiation: This generally takes an airborne path.

Mechanical vibrations: These generally extend along the parts of the unit and structure.

Gas pulsation: This tends to travel through the cooling medium, i.e. the refrigerant.

The following sections will focus on the causes and methods of mitigation for each of the above sources.

### Compressor sound radiation

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

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

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

Due to the unique design of a full-suction gas and oil cooled motor, compressor body insulation across its entire operating range is possible.

**Mechanical vibrations**

Vibration isolation constitutes the primary method for controlling structural vibration. LLZ scroll compressors are designed to produce minimal vibration during operations. The use of rubber isolators on the compressor base plate or on the frame of a manifolded unit is very effective in reducing vibration being transmitted from the compressor(s) to the unit. Rubber grommets are supplied with all LLZ scroll compressors. Once the supplied rubber grommets have been properly mounted, vibration transmitted from the compressor base plate to the unit are held to a strict minimum. In addition, it is

extremely important that the frame supporting the mounted compressor be of sufficient mass and stiffness to help dampen any residual vibration potentially transmitted to the frame. The tubing should be designed so as to both reduce the transmission of vibrations to other structures and withstand vibration without incurring any damage. Tubing should also be designed for three-dimensional flexibility. For more information on piping design, please see the section entitled "Essential piping design considerations".

**Gas pulsation**

The LLZ scroll compressors have been designed and tested to ensure that gas pulsation has been minimized for the most commonly encountered refrigeration pressure ratio. On installations where the pressure ratio lies beyond the typical range, testing should be conducted under all expected conditions and operating

configurations to ensure that minimum gas pulsation is present. If an unacceptable level is identified, a discharge muffler with the appropriate resonant volume and mass should be installed. This information can be obtained from the component manufacturer.



## Application Guidelines

## Installation

Each LLZ scroll compressor is shipped with printed Instructions for installation. These Instructions can also be downloaded from our

website [www.danfoss.com](http://www.danfoss.com) or directly from:  
<http://instructions.cc.danfoss.com>

### System cleanliness

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

The presence of non-condensable substances and system contaminants, such as metal shavings, solder and flux, have a negative impact on compressor service life. Many of these contaminants are small enough to pass through

a mesh screen and can cause considerable damage within a bearing assembly. The use of highly hygroscopic PVE oil in LLZ scroll compressors requires that the oil be exposed to the atmosphere just as little as possible.

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

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

### Compressor handling and storage

Compressors are provided with a lifting lug. This lug should always be used to lift the compressor. Once the compressor is installed, the lifting lug should never be used to lift the complete installation. The compressor must be handled

with caution in the vertical position, with a maximum inclination of 15° from vertical. Store the compressor between -35°C and 55°C, not exposed to rain or corrosive atmosphere.

### Compressor mounting

Maximum inclination from the vertical plane, while operating must not exceed 7 degrees. All compressors are delivered with four rubber grommets and metal sleeves. Compressors

must always be mounted with these grommets. Recommended torque for mounting bolts: 11 Nm ( $\pm 1$  Nm).

### Compressor holding charge

Each compressor is shipped with a nominal dry nitrogen holding charge between 0.4 bar and 0.7 bar, and is sealed with elastomer plugs. The plugs should be removed with care to avoid oil loss when the holding charge is released. Remove the suction plug first and the discharge plug

afterwards. The plugs shall be removed only just before connecting the compressor to the installation in order to avoid moisture entering the compressor. When the plugs are removed, it is essential to keep the compressor in an upright position to avoid oil spillage.

## Application Guidelines

## Installation

### Vacuum evacuation and moisture removal

Moisture obstructs the proper functioning of the compressor and the refrigeration system.

Air and moisture reduce service life and increase condensing pressure, and cause excessively high discharge temperatures, which can destroy the lubricating properties of the oil. Air and moisture also increase the risk of acid formation, giving rise to copper plating. All these phenomena can cause mechanical and electrical compressor failure.

For these reasons it is important to perform a vacuum dehydration on the system to remove all residual moisture from the pipe-work after assembly;

LLZ scroll compressors are delivered with <100 ppm moisture level. The required moisture level in the circuit after vacuum dehydration must be <100 ppm for systems with an LLZ scroll compressor.

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

### Liquid line filter driers

A properly sized and type of drier is required. Important selection criteria include the driers water content capacity, the system refrigeration capacity, and the system refrigerant charge. The drier must be able to reach and maintain a moisture level of 50 ppm end point dryness (EPD). Danfoss recommends DML (100% molecular sieve) driers for LLZ scroll compressors (R404A, R507) with PVE oil.

For servicing of existing installations where acid formation may be present, the Danfoss DCL solid core filter drier containing activated alumina is recommended.

After burn out, remove and replace the liquid line filter drier and install a Danfoss type DAS burnout drier of the appropriate capacity. Refer to the DAS drier instructions and technical information for correct use of the burnout drier on the liquid line.

### Refrigerant charging

It is recommended that system charging be done using the weighed charge method, adding refrigerant to the high side of the system. Charging the high and low sides of a system with gas simultaneously at a controlled rate is also an acceptable method. Do not exceed the recommended unit charge, and never charge liquid to the low side.

Vacuum or charge from one side can seal the scrolls and result in a non-starting compressor. When servicing, always ensure that LP/HP pressures are balanced before starting the compressor.

Be sure to follow all government regulations regarding refrigerant reclamation and storage.

### Insulation resistance and dielectric strength

Insulation resistance must be higher than 1 megohm when measured with a 500 volt direct current megohm tester.

Each compressor motor is tested at the factory with a high potential voltage (hi-pot) that exceeds the UL requirement both in potential and in duration. Leakage current is less than 0.5 mA.

LLZ scroll compressors are configured with the pump assembly at the top of the shell, and the motor below. As a result, the motor can be partially immersed in refrigerant and oil. The presence of refrigerant around the motor windings will result in lower resistance

values to ground and higher leakage current readings. Such readings do not indicate a faulty compressor, and should not be cause for concern.

In testing insulation resistance, Danfoss recommends that the system be first operated briefly to distribute refrigerant throughout the system. Following this brief operation, retest the compressor for insulation resistance or current leakage.

Never reset a breaker or replace a fuse without first checking for a ground fault (a short circuit to ground). Be alert for sounds of arcing inside the compressor.

## Packaging

### Single pack



Compressors are packed individually in a cardboard box. They can be ordered in any quantity. Minimum ordering quantity = 1. As far as possible, Danfoss will ship the boxes on full pallets of six or nine compressors according below table.

Each box also contains the following accessories:

- 4 grommets
- 4 assemblies of self tapping US thread bolts, washers and sleeves
- 4 additional sleeves
- 1 screw for earth connection
- Depending on model and shipping type a run capacitor may be included (see table).

Compressor models	Length (mm)	Width (mm)	Height (mm)	Gross weight (kg)
LLZ013	1170	815	730	381
LLZ015	1170	815	730	381
LLZ018	1170	815	730	387
LLZ024	1170	815	775	405
LLZ033	1170	815	775	401

### Industrial pack



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

Each industrial pack pallet contains the following accessories:

- 4 grommets per compressor
- 4 sleeves per compressor

Compressor models	Nbr*	Length (mm)	Width (mm)	Height (mm)	Gross weight (kg)	Static stacking pallets
LLZ013	12	1170	815	665	538	4
LLZ015	12	1170	815	665	538	4
LLZ018	12	1170	815	665	550	4
LLZ024	12	1170	815	720	586	4
LLZ033	12	1170	815	720	579	4

\* nbr: number of compressors per pack

## Packaging details

		Danfoss pallets	
Code number		121L....	
Pack type		Industrial pack	Single pack
Compressors per pallet		12	6 *
Static stacking of pallets **		4	4
Shipped accessories	Run capacitor (for single phase models)	Not included	Included
	Screw for earth connection	Included	Included
	4 grommets per compressor	Included	Included
	4 assemblies of self tapping US thread bolt + washer + sleeve per compressor	Not included	Included
	4 extra sleeves per compressor	Included	Included

\* Quantity for full pallets. Single packs can be ordered per 1.

\*\* Stacking only allowed for full pallets with identical products per pallet

**Single pack**

	Compressors	Model variation	Connections	Features	Voltage code 2	Voltage code 4
Danfoss pallet	LLZ013	T	Q	9	121L9519	121L9517
	LLZ015	T	Q	9	121L9515	121L9513
	LLZ018	T	Q	9	121L9511	121L9509
	LLZ024	T	Q	9	121L9507	121L9505
	LLZ033	T	Q	9	121L9503	121L9501

**Industrial pack**

	Compressors	Model variation	Connections	Features	Voltage code 2	Voltage code 4
Danfoss pallet	LLZ013	T	Q	9	121L9518	121L9516
	LLZ015	T	Q	9	121L9514	121L9512
	LLZ018	T	Q	9	121L9510	121L9508
	LLZ024	T	Q	9	121L9506	121L9504
	LLZ033	T	Q	9	121L9502	121L9500

## Application Guidelines Spare parts and accessories

### Crankcase heater



Type	Code No	Description	Application	Packaging	Pack Size
	120Z5040	Belt type crankcase heater, 70 W, 240 V, CE mark, UL (Wire length: 1270 mm)	All models	Multipack	4
	120Z5041	Belt type crankcase heater, 70 W, 400/460 V, CE mark, UL (Wire length: 1270 mm)		Multipack	4
	120Z5042	Belt type crankcase heater, 70 W, 575 V, CE mark, UL (Wire length: 1270 mm)		Multipack	4
	120Z0059	Belt type crankcase heater, 65 W, 230V, CE mark, UL (Wire length: 1000 mm)		Multipack	6
	120Z0060	Belt type crankcase heater, 65 W, 400 V, CE mark, UL (Wire length: 1000 mm)		Multipack	6

### Discharge temperature protection



Type	Code No	Description	Application	Packaging	Pack Size
	7750009	Discharge thermostat kit	All models	Multipack	10
	7973008	Discharge thermostat kit	All models	Industry pack	50

### Magnetic discharge non return valve



Type	Code No	Description	Application	Packaging	Pack Size
	120Z5046	Magnetic discharge non return valve	All models	Multipack	6

### Lubricant



Type	Code No	Description	Application	Packaging	Pack Size
320HV	120Z5034	PVE lubricant, 0.95 litre can	LLZ	Multipack	12

## Application Guidelines Spare parts and accessories

### Mounting hardware



Type	Code No	Description	Application	Packaging	Pack Size
	120Z5067	Mounting kit for 1 scroll compressor including 4 grommets, 4 sleeves, 4 bolts, 4 washers, rotolock connection kit for suction, discharge and economizer fitting for 1 scroll compressor including 3 Teflon seals, 2 nuts, 3 sleeves.	LLZ013/015/018	single	1
	120Z5068	Mounting kit for 1 scroll compressor including 4 grommets, 4 sleeves, 4 bolts, 4 washers, rotolock connection kit for suction, discharge and economizer fitting for 1 scroll compressor including 3 Teflon seals, 2 nuts, 3 sleeves.	LLZ024/033	single	1

### IP54 upgrade kit



Type	Code No	Description	Application	Packaging	Pack Size
	118U0057	IP54 upgrade kit	All models	Multipack	6

### Acoustic hood



Type	Code No	Description	Application	Packaging	Pack Size
	120Z5043	Acoustic hood	LLZ013-015-018	Single pack	1
	120Z5044	Acoustic hood	LLZ024-033	Single pack	1



Danfoss Commercial Compressors is a worldwide manufacturer of compressors and condensing units for refrigeration and HVAC applications. With a wide range of high quality and innovative products we help your company to find the best possible energy efficient solution that respects the environment and reduces total life cycle costs.

We have 40 years of experience within the development of hermetic compressors which has brought us amongst the global leaders in our business, and positioned us as distinct variable speed technology specialists. Today we operate from engineering and manufacturing facilities spread across three continents.



Danfoss Inverter scroll compressors



Danfoss Air Conditioning scroll compressors



Danfoss Heat Pump scroll compressors



Maneurop® Inverter reciprocating compressors



Danfoss Refrigeration scroll compressors



Maneurop® Reciprocating Compressors



Optyma™ & Optyma Plus™ Condensing Units



Light commercial reciprocating compressors (manufactured by Secop)

Our products can be found in a variety of applications such as rooftops, chillers, residential air conditioners, heatpumps, coldrooms, supermarkets, milk tank cooling and industrial cooling processes.

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