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1 How to Read this Design Guide

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1.1.1 How to Read this Design Guide

This Design Guide will introduce all aspects of Output Filter for your VLT® FC Series Drive; From choosing the right Output Filter for the application to instructions about how to install it and how to program the Frequency Converter.

Danfoss Drives technical literature is also available online at www.danfoss.com/BusinessAreas/DrivesSolutions/Documentations/Technical+Documentation.

1.1.2 Symbols

Symbols used in this manual:

**NB!**

Indicates something to be noted by the reader.



Indicates a general warning.



Indicates a high-voltage warning.




Indicates default setting

1.1.3 Abbreviations

Alternating current	AC
American wire gauge	AWG
Ampere/AMP	A
Automatic Motor Adaptation	AMA
Current limit	I _{LIM}
Degrees Celsius	°C
Direct current	DC
Drive Dependent	D-TYPE
Electro Magnetic Compatibility	EMC
Electronic Thermal Relay	ETR
Drive	FC
Gram	g
Hertz	Hz
Kilohertz	kHz
Local Control Panel	LCP
Meter	m
Millihenry Inductance	mH
Milliampere	mA
Millisecond	ms
Minute	min
Motion Control Tool	MCT
Nanofarad	nF
Newton Meters	Nm
Nominal motor current	I _{M,N}
Nominal motor frequency	f _{M,N}
Nominal motor power	P _{M,N}
Nominal motor voltage	U _{M,N}
Parameter	par.
Protective Extra Low Voltage	PELV
Rated Inverter Output Current	I _{INV}
Revolutions Per Minute	RPM
Second	s
Synchronous Motor Speed	ns
Torque limit	T _{LIM}
Volts	V
I _{VLT,MAX}	The maximum output current.
I _{VLT,N}	The rated output current supplied by the frequency converter.

2 Safety and Conformity



2.1 Safety Precautions



Equipment containing electrical components may not be disposed of together with domestic waste. It must be separately collected with electrical and electronic waste according to local and currently valid legislation.

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MCC 101/102
Design Guide

2.1.1 CE Conformity and Labelling

What is CE Conformity and Labelling?

The purpose of CE labelling is to avoid technical trade obstacles within EFTA and the EU. The EU has introduced the CE label as a simple way of showing whether a product complies with the relevant EU directives. The CE label says nothing about the specifications or quality of the product.

The low-voltage directive (73/23/EEC)

Frequency converters must be CE labelled in accordance with the low-voltage directive of January 1, 1997. The directive applies to all electrical equipment and appliances used in the 50 - 1000 V AC and the 75 - 1500 V DC voltage ranges. Danfoss CE-labels in accordance with the directive and issues a declaration of conformity upon request.

Warnings

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When in use the filter surface temperature rises. DO NOT touch the filter during operation.



Never work on a filter in operation. Touching the electrical parts may be fatal - even after the equipment has been disconnected from the drive or motor.



Before servicing the filter, wait at least the voltage discharge time stated in the Design Guide for the corresponding VLT® to avoid electrical shock hazard

**NB!**

Never attempt to repair a defective filter

3 Introduction to Output Filters

3.1 Why use Output Filters

This chapter describes why and when to use Output Filters with Danfoss Drives frequency converters.

3.2 Which Filters for which Purpose

The table 3.1 below shows a comparison of du/dt and Sine-wave filter performance. It can be used to determine which filter to use with your application.

Performance criteria	du/dt filters	Sine-wave filters
Motor insulation stress	Up to 100 m cable (screened/unscreened) complies with the requirements of IEC60034-17 (general purpose motors). Above this cable length the risk of "double pulsing" increases.	Provides a sinusoidal phase-to-phase motor terminal voltage. Complies with IEC-60034-17* and NEMA-MG1 requirements for general purpose motors with cables up to 500 m (1 km for frame size D and above).
Motor bearing stress	Slightly reduced, only in high-power motors.	Reduces bearing currents caused by circulating currents. Does not reduce common-mode currents (shaft currents).
EMC performance	Eliminates motor cable ringing. Does not change the emission class. Does not allow longer motor cables as specified for the frequency converter's built-in RFI filter.	Eliminates motor cable ringing. Does not change the emission class. Does not allow longer motor cables as specified for the frequency converter's built-in RFI filter.
Max. motor cable length	100 m ... 150 m With guaranteed EMC performance: 150 m screened. Without guaranteed EMC performance: 150 m unscreened.	With guaranteed EMC performance: 150 m screened and 300 m unscreened (only conducted emissions). Without guaranteed EMC performance: up to 500 m (1 km for frame size D and above)
Acoustic motor switching noise	Does not eliminate acoustic switching noise.	Eliminates acoustic switching noise from the motor caused by magnetostriction.
Relative size	15-50% (depending on power size).	100%

Table 3.1: Comparison of du/dt and sine wave filters.

*) Not 690 V.

3.2.1 du/dt Filters

du/dt filters cut off frequencies are above the switching frequencies. They consist of inductors and capacitors in a low-pass filter arrangement. The inductance (L) and capacitance (C) values are shown in the tables in the section *Electrical Data - du/dt Filters* in the chapter *Selection of Output Filters*. They have lower L and C values, thus they are cheaper and smaller than Sine-wave filters

Features and benefits

du/dt filters reduce the voltage peaks and du/dt of the pulses at the motor terminals. The voltage at the motor terminals is still pulse-shaped, as shown in the figure (voltage waveform). The motor current has a sinusoidal shape without commutation spikes.

The role of the du/dt filters is to protect the motor insulation against premature ageing and flashover.

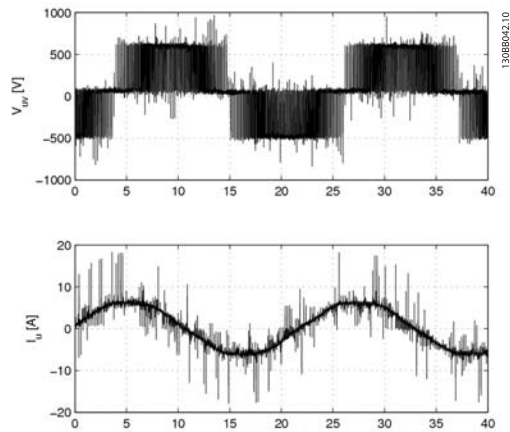
Voltage and current with and without filter:

Illustration 3.1: Without filter

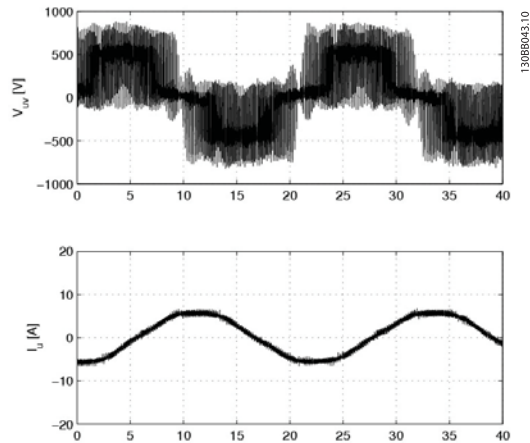


Illustration 3.2: With du/dt filter

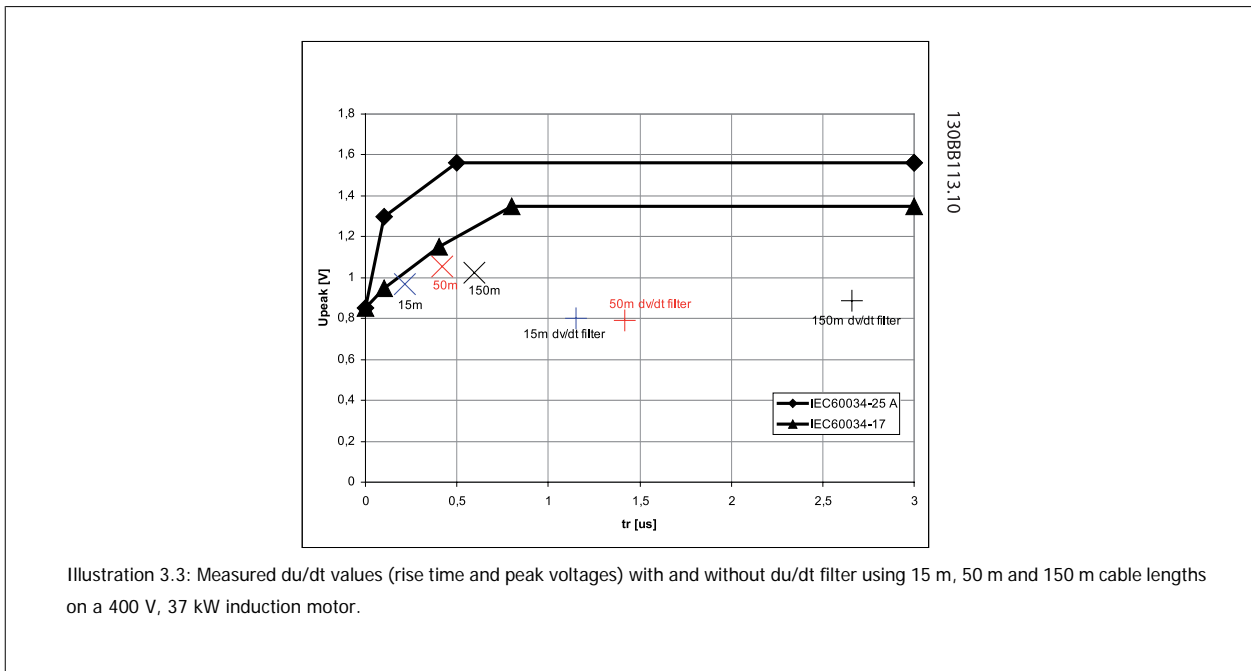
Advantages:

- Protects the motor against high du/dt values and voltage peaks hence prolongs the lifetime of the motor
- Allows the use of motors which are not specifically designed for converter operation, for example in retrofit applications

Application areas:

The typical application areas for du/dt filters are:

- Applications with frequent regenerative braking
- Motors that are not rated for frequency converter operation and fed through very short motor cables (less than 15 meters)
- Motors placed in aggressive environments or running at high temperatures
- Applications with risk of flash over
- Installations using old motors (retrofit) or general purpose motors not complying with IEC 60034-17
- Applications with short motor cables



The du/dt value decreases with the motor cable length whereas the peak voltage increases (see Illustration 3.3). Therefore it is recommended to use du/dt filters only in applications with cable length up to 150 meters. Above 150 meters Sine-wave filters are recommended.

Filter features:

- IP00 and IP20 enclosure in the entire power range
- Side by side mounting with the drive
- Reduced size, weight and price compared to the sine-wave filters
- Possibility of connecting screened cables with included decoupling plate
- Compatible with all control principle including flux and WC+
- Filters wall mounted up to 115 A and floor mounted above that size

3.2.2 Sine-wave Filters

The Danfoss Drives sine-wave filters are designed to operate with the VLT® FC Series Drives. They replace the LC-filter product range and are backwards compatible with the VLT 5000-8000 Series Drives. They consist of inductors and capacitors in a low-pass filter arrangement. The inductance (L) and capacitance (C) values are shown in tables in the section *Electrical Data - Sine wave Filters* in the chapter *Selection of Output Filters*.

Features and benefits

Sine-wave Filters reduce motor insulation stress and eliminate switching acoustic noise from the motor. Bearing stress is also reduced, especially in larger motors, above 50 kW. The filter does not act between motor phases and ground. This means that the motor cable length is limited by the leakage current. The motor losses are reduced because the motor is fed with a sinusoidal voltage, as shown in illustration 3.5. Moreover, the filter eliminates the pulse reflections in the motor cable thus reducing the losses in the frequency converter.

Advantages:

- Protects the motor against voltage peaks hence prolongs the lifetime
- Reduces the losses in the motor
- Eliminates acoustic switching noise from the motor
- Reduces semiconductor losses in the drive with long motor cables
- Decreases electromagnetic emissions from motor cables by eliminating high frequency ringing in the cable
- Reduces electromagnetic interference from unscreened motor cables
- Reduces the bearing current thus prolonging the lifetime of the motor

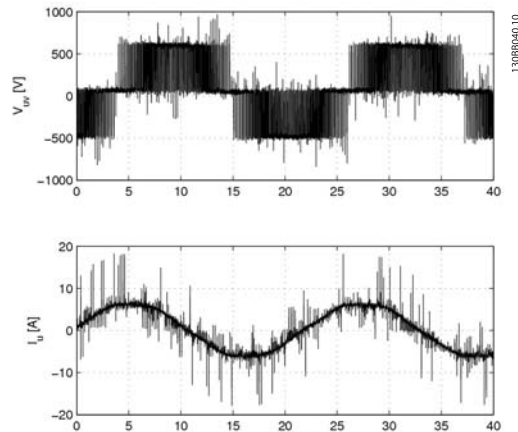
Voltage and current with and without filter:

Illustration 3.4: Without filter

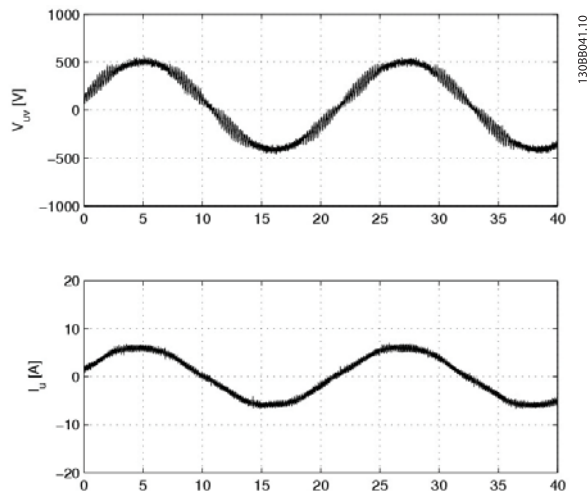


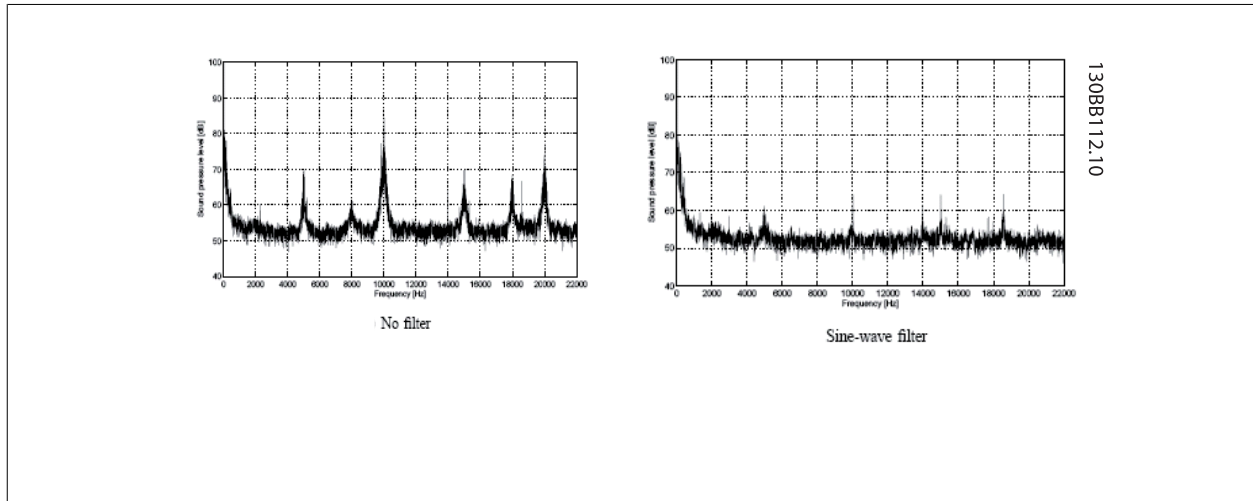
Illustration 3.5: With sine-wave filter

Application areas:

The typical applications of sine-wave filters are:

- Applications where the acoustic switching noise from the motor has to be eliminated
- Retrofit installations with old motors with poor insulation
- Applications with frequent regenerative braking and motors that are not rated for frequency converter operation
- Applications where the motor is placed in aggressive environments or running at high temperatures
- Applications with motor cables above 150 meters up to 300 meters (with both screened and unshielded cable. The use of motor cables longer than 300 meters depends on the specific application)
- Applications where the service interval on the motor has to be increased
- 690 V applications with general purpose motors
- Medium voltage - before the step-up transformer

Relative motor sound pressure levels measurements with and without filter



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Features:

- IP00 and IP20 enclosure in the entire power range
- Compatible with all control principle including flux and WC+
- Side by side mount with drive up to 75 A
- Filter enclosure matching the drive enclosure
- Possibility of connection unscreened and screened cables with included decoupling plate
- Filters wall mounted up to 75 A and floor mount above
- Parallel filter installation is possible with applications in the high power range

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4 Selection of Output Filters

4.1 How to Select the Correct Output Filter

An output filter is selected based on the nominal motor current. All filters are rated for 160% overload for 1 minute, every 10 minutes.

4.1.1 Product Overview

To simplify the Filter Selection Table below shows which Sine-wave filter to use with a specific drive. This is based on the 160% overload for 1 minute every 10 minutes and is to be considered guideline.



Mains supply 3 x 240 to 500 V							
Rated filter current at 50 Hz	Minimum switching frequency [kHz]	Maximum output frequency [Hz] With derating	Part No. IP20	Part No. IP00	Frequency converter size		
					200-240 V	380-440 V	441-500 V
2.5	5	120	130B2439	130B2404	PK25 - PK37	PK37 - PK75	PK37 - PK75
4.5	5	120	130B2441	130B2406	PK55	P1K1 - P1K5	P1K1 - P1K5
8	5	120	130B2443	130B2408	PK75 - P1K5	P2K2 - P3K0	P2K2 - P3K0
10	5	120	130B2444	130B2409		P4K0	P4K0
17	5	100	130B2446	130B2411	P2K2 - P4K0	P5K5 - P7K5	P5K5 - P7K5
24	4	100	130B2447	130B2412	P5K5	P11K	P11K
38	4	100	130B2448	130B2413	P7K5	P15K - P18K	P15K - P18K
48	4	100	130B2307	130B2281	P11K	P22K	P22K
62	3	100	130B2308	130B2282	P15K	P30K	P30K
75	3	100	130B2309	130B2283	P18K	P37K	P37K
115	3	100	130B2310	130B2284	P22K - P30K	P45K - P55K	P55K - P75K
180	3	100	130B2311	130B2285	P37K - P45K	P75K - P90K	P90K - P110
260	3	100	130B2312	130B2286		P110 - P132	P132
410	3	100	130B2313	130B2287		P160 - P200	P160 - P200
480	3	100	130B2314	130B2288		P250	P250
660	2	100	130B2315	130B2289		P315 - P355	P315 - P355
750	2	100	130B2316	130B2290		P400	P400 - P450
880	2	100	130B2317	130B2291		P450 - P500	P500 - P560
1200	2	100	130B2318	130B2292		P560 - P630	P630 - P710
1500	2	100	2X 130B2317	2X 130B2291		P710 - P800	P800

Table 4.1: Filter Selection

Mains supply 3 x 525 to 600/ 690 V							
Rated filter current at 50 Hz	Minimum switching frequency [kHz]	Maximum output frequency [Hz]	Part No. IP20	Part No. IP00	Frequency converter size		
					525-600 V	525-690 V	
13	2	100	130B2341	130B2321	PK75 - P7K5		
28	2	100	130B2342	130B2322	P11K - P18K		
45	2	100	130B2343	130B2323	P22K - P30K	P37K	
76	2	100	130B2344	130B2324	P37K - P45K	P45K - P55K	
115	2	100	130B2345	130B2325	P55K - P75K	P75K - P90K	
165	2	100	130B2346	130B2326		P110 - P132	
260	2	100	130B2347	130B2327		P160 - P200	
303	2	100	130B2348	130B2329		P250	
430	1.5	100	130B2370	130B2341		P315 - P400	
530	1.5	100	130B2371	130B2342		P500	
660	1.5	100	130B2381	130B2337		P560 - P630	
765	1.5	100	130B2382	130B2338		P710	
940	1.5	100	130B2383	130B2339		P800 - P900	
1320	1.5	100	130B2384	130B2340		P1M0	

Table 4.2: Filter Selection

4.2 Electrical Data - du/dt Filters

du/dt Filter 3x380-500 V IP00

Enclosure Type	Current rating		Switching Frequency kHz	Power [kW]		Filter Losses		L-value mH	C-Value nF				
	@50 Hz A	@60 Hz A		@380-440 V kW	A	@441-500 V kW	A			@ 380 V W	@ 500 V W		
130B2385	24	23	18	4	11	24	21	11	21	60	55	0.25	3.3
130B2386	45	43	34	4	15	32	27	15	27	60	55	0.13	6.8
130B2387	75	71	56	3	30	61	52	30	52	85	80	0.08	10
130B2388	110	105	82	3	45	90	80	55	80	130	120	0.053	15
130B2389	182	173	136	3	75	147	130	90	130	180	160	0.032	22
130B2390	280	266	210	3	110	212	190	132	190	260	240	0.02	33
130B2391	400	380	300	3	160	315	303	200	303	290	290	0.015	47
130B2275	500	475	375	3	250	480	443	315	443	590	550	0.012	68
130B2276	750	712	562	2	315	600	540	355	540	590	550	0.0075	100
130B2393	910	864	682	2	450	800	730	500	730	900	850	0.0065	100
130B2394	1500	1425	1125	2	630	1120	1050	710	1050	1050	1100	0.004	200
130B2395	2300	2185	1725	2	800	1460	1380	1000	1380	1200	1200	0.0026	300

du/dt Filter 3x380-500 V IP20

IP 20 Part-No.	Enclosure Type				Switching Frequency kHz	Power [kW]		Filter Losses		L-value mH	C-Value nF		
	Current rating @50 Hz		Current rating @60 Hz			@380-440 V		@441-500 V				@ 380 V	@ 500 V
	A	A	A	A		kW	A	kW	A			W	W
130B2396	24	23	18	18	11	24	11	21	60	55	0.25	3.3	
130B2397	45	43	34	34	15	32	15	27	60	55	0.13	6.8	
130B2398	75	71	56	56	18.5	37.5	18.5	34	65	60			
					22	44	22	40	70	65			
					30	61	30	52	85	80	0.08	10	
					37	73	37	65	100	90			
130B2399	110	105	82	82	45	90	55	80	130	120	0.053	15	
					55	106	75	105	140	140			
130B2400	182	173	136	136	75	147	90	130	180	160	0.032	22	
					90	177	110	160	200	190			
130B2401	280	266	210	210	110	212	132	190	260	240	0.02	33	
					132	260	160	240	310	280			
130B2402	400	380	300	300	160	315	200	303	290	290	0.015	47	
					200	395	250	361	340	320			
130B2277	500	475	375	375	250	480	315	443	590	550	0.012	68	
					315	600	355	540	590	550			
130B2278	750	712	562	562	355	658	400	590	620	580	0.0075	100	
					400	745	450	678	700	680			
130B2405	910	864	682	682	450	800	500	730	900	850	0.0065	100	
					500	880	560	780	980	900			
					560	990	630	890	950	950			
130B2407	1500	1425	1125	1125	630	1120	710	1050	1050	1100	0.004	200	
					710	1260	800	1160	1100	1150			
					800	1460	1000	1380	1200	1200			
130B2410	2300	2185	1725	1725	1000	1700	1100	1530	1250	1150	0.0026	300	

du/dt Filter 3x525-690 V IP00

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IP 00 Part-No.	Enclosure Type			Switching Frequency kHz	Power [kW]		Inductor Losses		L-value mH	C-Value nF
	@50 Hz A	@60 Hz A	@100 Hz A		@525-600 V kW	@690 V kW	@ 690 V W	@ 525-550 V W		
130B2414	28	26	21	4	11	15	18	13	0-36	2.35
130B2415	45	42	34	4	11	15	18	13	0.23	3.4
130B2416	75	71	56	3	11	15	18	13	0.14	7.5
130B2417	115	109	86	3	11	15	18	13	0.09	7.5
130B2418	165	157	124	3	11	15	18	13	0.06	11
130B2419	260	247	195	3	11	15	18	13	0.04	16.5
130B2420	310	294	232	3	11	15	18	13	0.03	23.5
130B2235	430	408	322	3	11	15	18	13	0.018	34
130B2236	530	503	397	2	11	15	18	13	0.02	34
130B2280	630	598	472	2	11	15	18	13	0.012	50
130B2421	765	726	573	2	11	15	18	13	0.013	50
130B2422	1350	1282	1012	2	11	15	18	13	0.008	84

du/dt Filter 3x525-690 V IP20

IP 20 Part-No.	Enclosure Type			Current rating		Switching Frequency kHz	Power [kW]				Filter Losses		L-Value mH	C-Value nF
	@50 Hz A	@60 Hz A	@100 Hz A	@525-600 V kW	A		@690 V kW	A	@690 V W	@ 525-550 V W				
130B2423	28	26	21	11	18	15	11	13	60	80	100	120	0.36	2.35
130B2424	45	42	34	22	34	30	22	30	100	120	120	120	0.23	3.4
130B2425	75	71	56	37	52	45	37	54	120	130	140	140	0.14	7.5
130B2426	115	109	86	55	83	75	55	86	160	190	190	160	0.09	7.5
130B2427	165	157	124	90	131	110	90	131	240	280	280	240	0.06	11
130B2428	260	247	195	150	192	160	150	192	280	300	300	280	0.04	16.5
130B2429	310	294	232	180	242	200	180	242	340	340	340	340	0.03	23.5
130B2238	430	408	322	260	344	315	260	344	500	600	600	500	0.018	34
130B2239	530	503	397	300	429	400	300	429	700	700	700	700	0.02	34
130B2274	630	598	472	375	523	500	450	596	800	800	800	800	0.012	50
130B2430	765	726	573	480	630	630	560	730	950	980	980	980	0.013	50
130B2431	1350	1282	1012	670	898	800	670	896	900	900	900	900	0.008	64
				820	1060	1000	820	1060	1000	1100	1100	1100		
				970	1260	1200	970	1317	1200	1200	1200	1200		

4.3 Electrical Data - Sine-wave Filters

Sine-wave Filter 3x380-500 V IP00

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Part-No. IP 00	Current rating			Switching Frequency kHz	Power [kW]			Filter Losses			L-value mH	C-Value uF		
	@50 Hz A	@60 Hz A	@100 Hz A		@200-240 V kW	A	@380-440 V kW	A	@441-500 V kW	A			@200 V-240 V W	@380 V-440 V W
130B2404	2.5	2.5	2*	5	0.25	1.8	0.37	1.3	1.1	50	45	45	29	1
130B2406	4.5	4	3.5*	5	0.37	2.4	0.75	2.4	2.1	60	60	60	13	2.2
130B2408	8	7.5	5*	5	0.55	3.5	1.1	3	1.1	65	70	65	6.9	4.7
130B2409	10	9.5	7.5*	5	0.75	4.6	1.5	4.1	1.5	80	80	80	5.2	6.8
130B2411	17	156	13	5	2.2	10.6	5.5	13	5.5	90	110	100	3.1	10
130B2412	24	23	18	4	3	12.5	7.5	16	7.5	125	125	115	2.4	10
130B2413	38	36	28.5	4	5.5	24.2	11	24	11	150	150	150	1.6	10
130B2281	48	45.5	36	4	7.5	30.8	15	32	15	160	170	160	1.1	14.7
130B2282	62	59	46.5	3	11	46.2	22	44	22	270	270	260	0.85	30
130B2283	75	71	56	3	15	59.4	30	61	30	300	310	280	0.75	30
130B2284	115	109	86	3	18.5	74.8	37	73	37	350	350	330	0.5	60
130B2285	180	171	135	3	22	88	45	90	55	450	460	430	0.3	99
130B2286	260	247	195	3	30	115	55	106	75	500	500	500	0.2	141
130B2287	410	390	308	3	37	143	75	147	90	650	600	600	0.13	198
130B2288	480	456	360	3	45	170	90	177	110	680	700	680	0.11	282
130B2289	660	627	495	3	110	212	132	260	160	820	820	800	0.14	423
130B2290	750	712	562	2	132	260	160	240	240	900	900	880	0.2	495
130B2291	880	836	660	2	160	315	200	303	303	1050	1050	1050	0.11	564
130B2292	1200	1140	900	2	200	395	250	361	361	1200	1200	1100	0.075	846
2x130B2291	1500			2	250	480	315	443	443	2900	2900	2800		
2x130B2292	1700			2	315	600	355	540	540	3400	3400	3300		
					355	658	400	590	590	3600	3600	3400		
					400	745	450	678	678	3600	3600	3600		
					450	800	500	730	730	3800	3800	3800		
					500	880	560	780	780					
					560	990	630	890	890					
					630	1120	710	1050	1050					
					710	1260	800	1160	1160					
					800	1460	1000	1380	1380					
					1000	1700	1100	1530	1530					

*) 120 Hz

Sine-wave Filter 3x380-500 V IP20

Part-No. IP 20	Current rating			Switching Frequency kHz	Power [kW]			Filter Losses			L-value mH	C-Value uF		
	@50 Hz A	@60 Hz A	@100 Hz A		@200-240 V kW	A	@380-440 V kW	A	@441-500 V kW	A			@200 V-240 V W	@380 V-440 V W
130B2439	2.5	2.5	2*	5	0.25 0.37	1.8 2.4	0.37 0.55 0.75	1.3 1.8 2.4	0.37 0.55 0.75	1.1 1.6 2.1	50 60	45 50 60	29	1
130B2441	4.5	4	3.5*	5	0.55	3.5	1.1 1.5	3 4.1	1.1 1.5	3 3.4	65 70	60 65	13	2.2
130B2443	8	7.5	5.5*	5	0.75	4.6	2.2	5.6	2.2	4.8	75	70	6.9	4.7
130B2444	10	9.5	7.5*	5	1.5	7.5	3	7.2	3	6.3	80	80	5.2	6.8
130B2446	17	16	13	5	2.2	10.6	4	10	4	8.2	90	90	3.1	10
130B2447	24	23	18	4	5.5	24.2	11	24	11	21	150	150	2.4	10
130B2448	38	36	28.5	4	7.5	30.8	15	32	15	27	170	170	1.6	
130B2307	48	45.5	36	4	11	46.2	22	44	22	40	270	270	1.1	14.7
130B2308	62	59	46.5	3	15	59.4	30	61	30	52	300	310	0.85	30
130B2309	75	71	56	3	18.5	74.8	37	73	37	65	350	350	0.75	30
130B2310	115	109	86	3	22	88	45	90	55	80	450	460	0.5	60
130B2311	180	171	135	3	37	143	75	147	90	130	650	600	0.3	99
130B2312	260	247	195	3	45	170	90	177	110	160	680	700	0.2	141
130B2313	410	390	308	3	110	212	132	260	160	240	820	800	0.13	198
130B2314	480	456	360	3	132	260	160	260	160	240	900	880	0.11	282
130B2315	660	627	495	2	160	315	200	315	200	303	1050	1050	0.14	423
130B2316	750	712	562	2	200	395	250	361	250	361	1200	1100	0.12	495
130B2317	880	836	660	2	250	480	315	443	315	443	1400	1350	0.11	564
130B2318	1200	1140	900	2	315	600	355	540	355	540	2000	2000	0.075	846
2x130B2317	1500			2	355	658	400	590	400	590	2900	2800		
2x130B2318	1700			2	400	745	450	678	450	678	3400	3300		
					450	800	500	730	500	730	3600	3400		
					500	880	560	780	560	780	3600	3600		
					560	990	630	890	630	890	3600	3600		
					630	1120	710	1050	710	1050	3800	3800		
					710	1260	800	1160	800	1160				
					800	1460	1000	1380	1000	1380				
					1000	1700	1100	1530	1100	1530				

Sine-wave Filter 3x525-690 V IP00

4

Part-No. IP00	Current rating			Switching Frequency kHz	Power [kW]			Filter losses			L-value mH	C-Value uF
	@50 Hz A	@60 Hz A	@100 Hz A		@525-600 V kW	A	@690 V kW	A	@525-600 V W	@690 V W		
130B2321	13	12.35	9.75	2	0.75	1.7		120			11.7	47
					1.1	2.4		125				
					1.5	2.7		125				
					2.2	4.1		130				
					3	5.2		130				
					4	6.4		140				
					5.5	9.5		160				
					7.5	11.5		170				
130B2322	28	26.5	21	2	11	18	13	180	230	180	5.5	10
					15	22	18.5	230	250	230		
					18.5	27	22	250	280	250		
130B2323	45	42.5	33.5	2	22	34	34	300	300	300	3.4	20
					30	41	37	330	360	360		
130B2324	76	72	57	2	37	52	54	420	450	450	2	33
					45	62	55	450	500	500		
130B2325	115	109	86	2	55	83	86	750	750	750	1.3	47
					75	100	90	800	850	850		
130B2326	165	157	123	2	90	131	131	1000	1000	1000	0.9	66
					110	155	155	1100	1100	1100		
130B2327	260	247	195	2	150	192	192	1050	1050	1050	0.6	94
					180	242	242	1200	1200	1200		
130B2329	303	287	227	2	220	290	290	1600	1600	1600	0.5	136
					260	344	344	1800	1800	1800		
130B2241	430	408	322	1.5	300	429	410	2050	2000	2000	0.35	272
130B2242	530	503	397	1.5	375	523	500	2500	2400	2400	0.28	340
130B2337	660	627	495	1.5	450	596	570	2800	2700	2700	0.23	408
					480	630	630	2850	2850	2850		
130B2338	765	726	573	1.5	560	730	710	3800	3800	3800	0.2	476
130B2339	940	893	705	1.5	670	898	896	3300	3350	3350	0.16	612
					900	998	900	3350	3350	3350		
130B2340	1320	1250	990	1.5	820	1060	1060	4300	4300	4300	0.12	816
					970	1260	1200	4600	4700	4700		

Sine-wave Filter 3x525-690 V IP20

Part-No. IP20	Current rating			Switching Frequency kHz	Power [kW]			Filter losses			L-value mH	C-Value uF
	@50 Hz A	@60 Hz A	@100 Hz A		@525-600 V kW	A	@525-550 V kW	A	@525-600 V W	@690 V W		
130B2341	13	12.35	9.75	2	0.75 1.1 1.5 2.2 3 4 5.5 7.5	1.7 2.4 2.7 4.1 5.2 6.4 9.5 11.5	11 18 22 27 34 41 46	13 18 22 27	120 125 125 130 130 140 160 170		11.7	7.7
130B2342	28	26.5	21	2	11 15 18.5 18.5	18 22 27	11 15 18 22	13 18 22	230 250 280	180 230 250 280	5.5	10
130B2343	45	42.5	33.5	2	22 30 37	34 41 46	30 37 46	34 46	300 330 360	300 360 360	3.4	20
130B2344	76	72	57	2	37 45 55 75	52 62 83 100	45 55 73 86 90	54 73 86 108	420 450 750 800	450 500 750 850	2	33
130B2345	115	109	86	2	75 90	100	90 110	108 131	800 1000	850 1000	1.3	47
130B2346	165	157	123	2	90 110	131 155	110 132	131 155	1100 1100	1000 1100	0.9	66
130B2347	260	247	195	2	150 180	192 242	160 200	192 242	1050 1200	1050 1200	0.6	94
130B2348	303	287	227	2	220 260 300	290 344 429	250 315 400	290 344 410	1600 1800 2050	1600 1800 2000	0.5	136
130B2270	430	408	322	1.5	375 450 480	523 596 630	500 560 630	500 570 630	2500 2800 2850	2400 2700 2850	0.35	272
130B2271	530	503	397	1.5	560 670	730 898	710 800	730 896	3800 3300	3800 3350	0.28	340
130B2381	660	627	495	1.5	820 970	1060 1260	1000 1200	1060 1317	4300 4600	4300 4700	0.23	408
130B2382	765	726	573	1.5							0.2	476
130B2383	940	893	705	1.5							0.16	612
130B2384	1320	1250	990	1.5							0.12	816

4.4 General Specifications

Surroundings:

Isolation class:

EIS 155	2.5 A up to 75 A
EIS 180	115 A up to 1320 A
Max. allowed ambient temperature	45°C

Electrical data:

	2.5 kV / 1min.
Over voltage test [voltage/time]	AC and DC
Overload capacity	1.6x rated current for 1 minute, every 10 minutes

General noise level:

Sine- wave filter:

4 - 5 kHz	76 dBA
3 kHz	80 dBA
2 kHz	86 dBA
1.5 kHz	90 dBA
maximum	96 dBA

du/dt filter:

4 - 5 kHz	73 dBA
3 kHz	76 dBA
2 kHz	80 dBA
1.5 kHz	86 dBA
maximum	90 dBA

Voltage drop (phase to phase):

Sine- wave filter 500 V:

2.5 A	40 V
4.5 A - 480 A	30 V
660 A - 1200 A	50 V

Sine-wave filter 690 V:

4.5 A - 480 A	83 V
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du/dt filter 500 V

4.5 A - 480 A	3.3 V
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du/dt filter 690 V

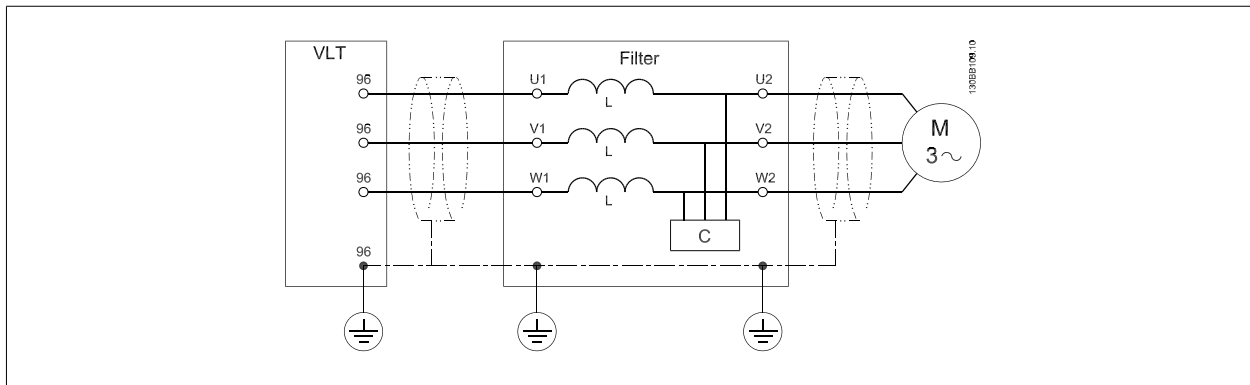
4.5 A - 480 A	5.5 V
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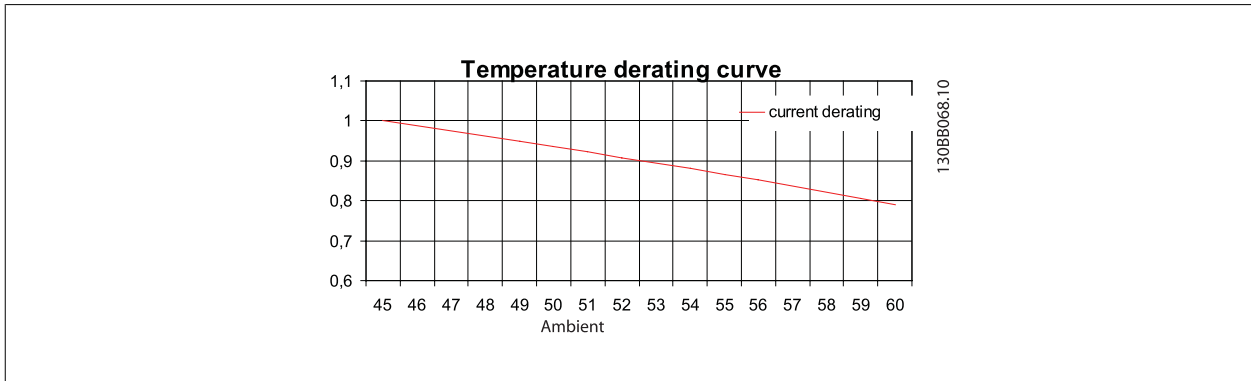
Approval references:

file: E304619

UL508 (up to 115 A)

CE





4.4.1 du/dt Filter

Technical Specifications	
Voltage rating	3 x 200-500 V AC and 3 x 525-690 V AC
Nominal current I-N @ 50 Hz	11 – 1200 A for higher power modules can be paralleled
Motor frequency	0-60 Hz without derating. 100/120 Hz (up to 10 A) with derating
Ambient temperature	-25° to 40°C side by side mount, without derating
Min. switching frequency	f _{min} 1,5 kHz – 4 kHz, depending on filter type
Max. switching frequency	f _{max} 8 kHz
Overload capacity	160% for 60 sec. every 10 min.
Enclosure degree	IP00 and IP20
Approval	CE, UL508

4.4.2 Sine Wave Filter

Technical Specifications	
Voltage rating	3 x 200-500 V AC and 3 x 525-690 V AC
Nominal current I-N @ 50 Hz	2,5 – 1200 A for higher power modules can be paralleled
Motor frequency	0-60 Hz without derating. 100/120 Hz (up to 10 A) with derating
Ambient temperature	-25° to 40°C side by side mount, without derating
Min. switching frequency	f _{min} 1,5 kHz – 5 kHz, depending on filter type
Max. switching frequency	f _{max} 8 kHz
Overload capacity	160% for 60 sec. every 10 min.
Enclosure degree	IP00 and IP20
Approval	CE, UL508

5

5 How to Install

5.1 Mechanical Mounting

5.1.1 Safety Requirements of Mechanical Installation



Pay attention to the requirements that apply to integration and field mounting kit. Observe the information in the list to avoid serious damage or injury, especially when installing large units.

The filter is cooled by natural convection.

To protect the unit from overheating it must be ensured that the ambient temperature *does not exceed the maximum temperature stated for the filter*.

Locate the maximum temperature in the paragraph *Derating for Ambient Temperature*.

If the ambient temperature is in the range of 45 °C - 55 °C, derating of the filter will become relevant.

5

5.1.2 Mounting

- Mount the filter vertically with the output (motor side) at the bottom (in case of wall-mount).
- Do not mount the filter close to other heating elements or heat sensitive material (such as wood)
- The filter can be side-mounted with the frequency converter. There is no requirement for spacing between the filter and frequency converter.

5.1.3 Earthing

The filter must be earthed before switching the power on (high leakage currents).

Common mode interferences are kept small by ensuring that the current return path to the VLT has the lowest possible impedance.

- Choose the best earthing possibility (e.g. cabinet mounting panel)
- Use the enclosed (in accessory bag) protective earth terminal to ensure the best possible earthing
- Remove any paint present to ensure good electrical contact
- Ensure that the filter and VLT make solid electrical contact (high frequency earthing)
- The filter must be earthed before switching the power on (high leakage currents)

5.1.4 Screening

It is recommended to use screened cables to reduce the radiation of electromagnetic noise into the environment and prevent malfunctions in the installation.

- Cable between the VLT output (U, V, W) and filter input (U1, V1, W1) to be screened or twisted.
- Use preferably screened cables between the filter output (U2, V2, W2) and the motor. When unscreened cables are employed it should be ensured that the installation minimizes the possibility of cross-couplings with other cables carrying sensitive signals. This can be achieved by measures such as cable segregation and mounting in earthed cable trays.
- The screen on screened cables must be solidly connected at both ends to the housings (e.g. housing of filter and motor).
- All screen connections must exhibit the smallest possible impedance, i.e. solid, large area connections, both ends of screened cable.
- For maximum cable length consult the Design Guide of the VLT in question

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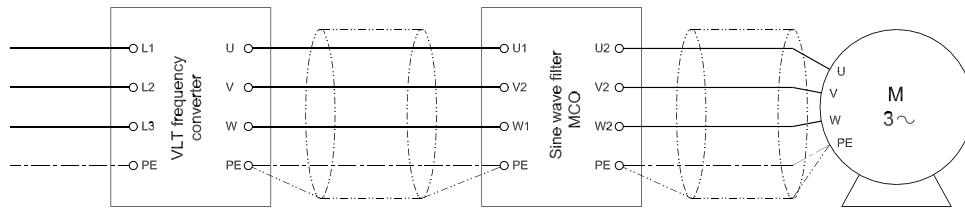
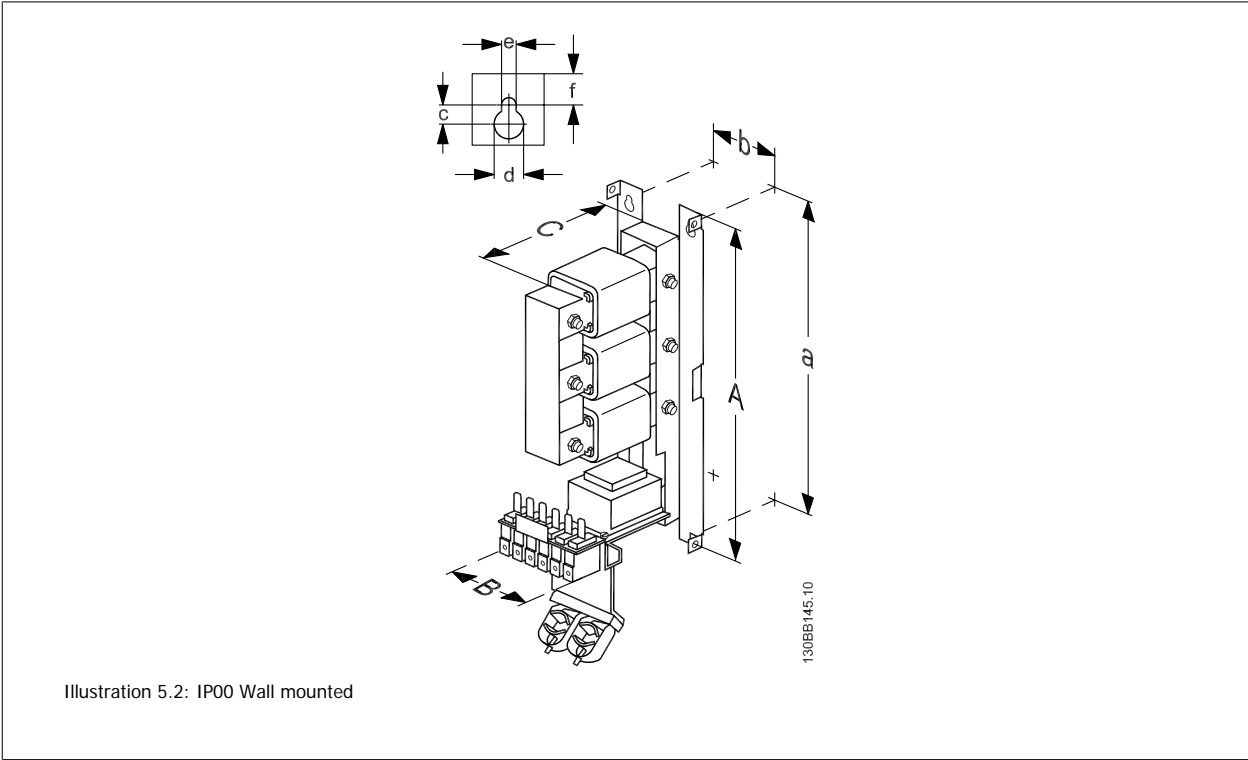


Illustration 5.1: Block diagram

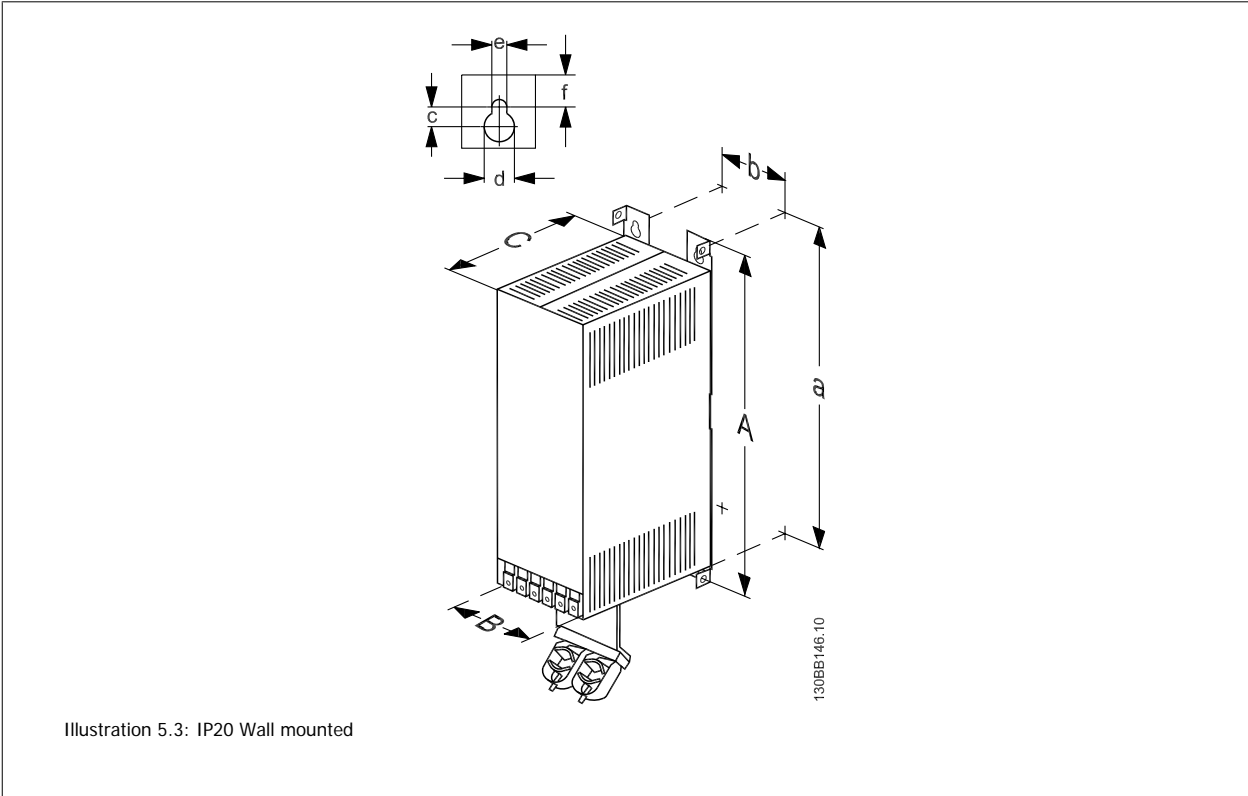
5.2 Mechanical Dimensions

5.2.1 Sketches

Wall Mounted



5



Floor Mounted

5

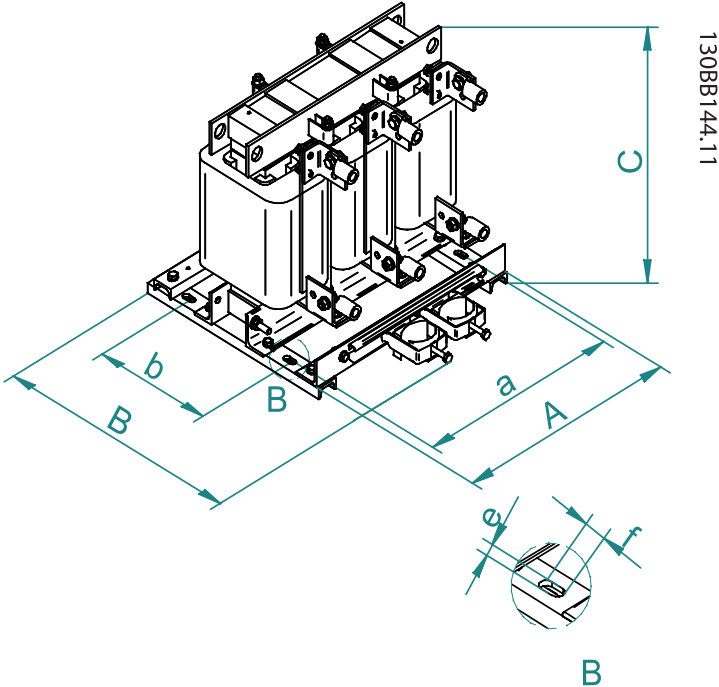


Illustration 5.4: IP00 Floor mounted

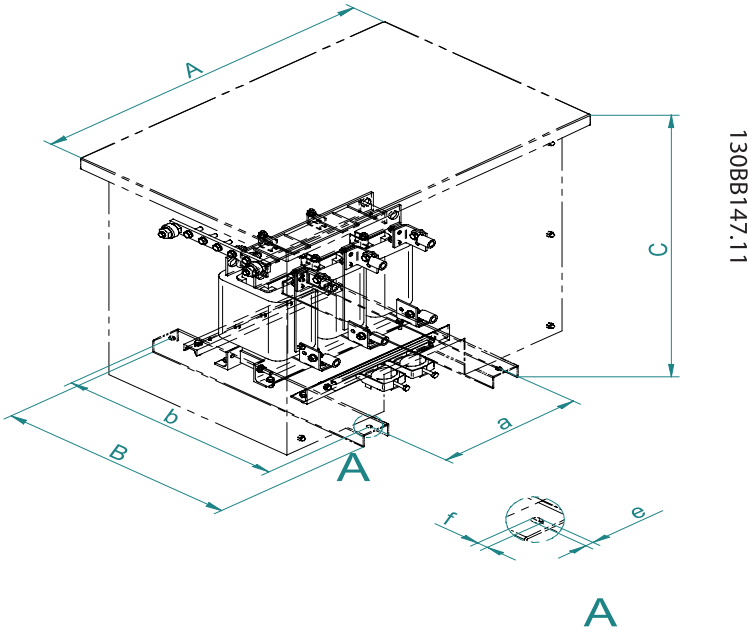


Illustration 5.5: IP20 Floor mounted

5.2.2 Physical Dimensions

Code number	IP	Measurements / Dimensions										du/dt 500 V - Physical dimensions					Mounting Direction	Wire cross section		Terminal Screw torque Nm
		A	a	B	b	C	c	d	e	f	Weight kg	mm ²	AWG							
130B2385	IP00	268	257	120	90	205	8	11	6.5	6.5	5.2	16	20 - 10	2						
130B2396	IP20									5.2										
130B2386	IP00	330	312	170	125	260	12	19	9	9	7.5	50	8 - 6	8						
130B2397	IP20									9.3										
130B2387	IP00	330	312	170	125	260	12	19	9	9	8.8	50	6 - 4	8						
130B2398	IP20									10.7										
130B2388	IP00	330	312	170	125	260	12	19	9	9	10.9	50	4 - 2	8						
130B2399	IP20									12.8										
130B2389	IP00	210	175	350	170	270	12	19	9	9	14	M10	2 - 1/0	18						
130B2400	IP20	610	440	440	400	462				33										
130B2390	IP00	240	190	400	210	298		11	20	23		M10	2/0 - 4/0	18						
130B2401	IP20	670	500	500	460	522		11	15	50										
130B2391	IP00	240	190	330	210	400		11	20	33		M12	5/0 - 6/0	30						
130B2402	IP20	610	440	440	400	463		11	15	60										
130B2275	IP00	265	215	386	190	431		11	20	30		M12	6/0	30						
130B2277	IP20	670	215	500	460	522		11	15	58										
130B2276	IP00	300	240	490	430	430		11	20	52.3		2 x M12	For field wiring use cooper bus bars only	30						
130B2278	IP20	770	550	550	510	602		11	15	52.2										
130B2393	IP00	300	240	490	250	440		11	20	56.9		2 x M12	For field wiring use cooper bus bars only	30						
130B2405	IP20	770	550	550	510	602		11	15	56.9										

Table 5.1: 500 V du/dt filter

5

Code number	IP	690 V du/dt filter - Physical dimensions													Mounting Direction		Max. wire crosssection		Terminal screw torque Nm
		Measurements / Dimensions						690 V du/dt filter - Physical dimensions							Weight	Wall/Floor	mm ²	AWG	
A	a	B	b	C	c	d	e	f	Weight	Wall/Floor	mm ²	AWG	Nm						
130B2414	IP00	376	312	150	120	260	12	19	9	9	7	20 - 8	2						
130B2423	IP20								8.3	Wall	16								
130B2415	IP00	404	312	170	125	260	12	19	9	9	7.6	8 - 6	8						
130B2424	IP20								9.4	Wall	50								
130B2416	IP00	404	312	170	125	260	12	19	9	9	10	6 - 4	8						
130B2425	IP20								11.8	Wall	50								
130B2417	IP00	404	312	170	125	260	12	19	9	9	10.4	4 - 2	8						
130B2526	IP20								12.2	Wall	50								
130B2418	IP00	265	215	373	200	288	13	20	15	Floor	M10	2 - 1/0	18						
130B2427	IP20								45	Floor	M10								
130B2419	IP00	265	215	390	190	400	13	20	18	Floor	M10	2/0 - 4/0	18						
130B2428	IP20	670	500	500	460	522	11	15	47	Floor	M10								
130B2420	IP00	265	215	390	190	400	13	15	18	Floor	M10	2/0 - 4/0	18						
130B2429	IP20	670	500	500	460	522	11	15	47	Floor	M10								
130B2235	IP00	265	215	418	190	437	11	15	27	Floor	M12	4/0 - 5/0	18						
130B2238	IP20	670	500	500	460	522	11	15	52	Floor	M12								
130B2236	IP00	265	215	425	190	533	13	15	28	Floor	M12	4/0 - 5/0	30						
130B2239	IP20	770	550	550	510	602	11	15	60	Floor	M12								
130B2280	IP00	265	252	415	280	436	13	20	35	Floor	M12	5/0	30						
130B2274	IP20	670	215	490	460	522	11	15	63	Floor	M12								
130B2421	IP00	136	310	520	474	734	13	23	55	Floor	M12	5/0 - 6/0	30						
130B2430	IP20	1150	308	850	760	856	11	15	130	Floor	M12								
130B2422	IP00	445	310	503	470	750	11	15	55	Floor	M12	For field wiring use cooper bus bars only	30						
130B2431	IP20	1150	760	850	820	736	11	15	130	Floor	M12								

Table 5.2: 690 V du/dt filter - Physical dimensions

		500 V Sine-wave Filter - Physical dimensions														
Code number	IP	Measurements / Dimensions										Mounting direction		Max. wire cross section		Terminal screw torque Nm
		A	a	B	b	C	c	d	e	f	kg	Wall/Floor	mm ²	AWG		
130B2404	IP00	200	190	75	60	205	7	8	4.5	5	2.5	Wall	4	24 - 10	0.6	
130B2439	IP20									3.3						
130B2406	IP00	200	190	75	60	205	7	8	4.5	5	3.3	Wall	4	24 - 10	0.6	
130B2441	IP20									4.2						
130B2408	IP00	268	257	90	70	205	8	11	6.5	6.5	4.6	Wall	4	24 - 10	0.6	
130B2443	IP20									5.8						
130B2409	IP00	268	257	90	70	205	8	11	6.5	6.5	6.1	Wall	4	24 - 10	0.6	
130B2444	IP20									7.1						
130B2411	IP00	268	257	130	90	205	8	11	6.5	6.5	7.8	Wall	4	24 - 10	0.6	
130B2446	IP20									9.1						
130B2412	IP00	330	312	150	120	260	12	19	9	9	14.4	Wall	16	20 - 4	2	
130B2447	IP20									16.9						
130B2413	IP00	430	412	150	120	260	12	19	9	9	17.7	Wall	16	20 - 4	2	
130B2448	IP20									19.9						
130B2281	IP00	530	500	170	125	258	12	19	9	20	34	Wall	50	6 - 1/0	8	
130B2307	IP20									260						
130B2282	IP00	610	580	170	125	260	12	19	9	20	36	Wall	50	6 - 1/0	8	
130B2308	IP20									41						
130B2283	IP00	610	580	170	135	260	12	19	9	20	50	Wall	50	6 - 1/0	15	
130B2309	IP20									54						
130B2284	IP00	330	290	430	380	450			13	26	68	Floor	M8	1 - 2/0	15	
130B2310	IP20	670	500	500	460	522			11	15	87					
130B2285	IP00	450	400	524	235	402			13	26	87	Floor	M8	1 - 2/0	15	
130B2311	IP20	940	650	610	610	782			11	15	113		M10		18	
130B2286	IP00	450	400	536	445	506			13	26	125	Floor	M12	3/0	30	
130B2312	IP20	940	650	610	610	782			11	15	190		M10		30	
130B2287	IP00	480	430	560	330	675			13	25	190	Floor	M12	3/0	30	
130B2313	IP20	940	650	610	610	782			11	15	245				30	
130B2288	IP00	600	430	630	310	650			13	26	235	Floor	2xM12	4/0	30	
130B2314	IP20	1050	760	720	742				11	15	310				30	
130B2289	IP00	620	570	683	435	764			13	26	310	Floor	2xM12	5/0	30	
130B2315	IP20	1290	800	800	760	1152			11	15	445				30	

Table 5.3: 500 V Sine-wave Filter - Physical dimensions 1:2

5

500 V Sine-wave Filter - Physical dimensions														
Code number	IP	Measurements / Dimensions						Weight kg	Mounting direction Wall/Floor	Max. wire cross section		Terminal screw torque Nm		
		A	a	B	b	C	c			d	e		f	mm ²
130B2290	IP00	660	610	680	370	684		13	26	470	floor	2xM12	6/0	30
130B2316	IP20	1290		800	760	1152		11	15	605				
130B2291	IP00	760	610	682	380	893		13	26	640	floor	2xM12	6/0	30
130B2317	IP20	1290		800	760	1152		11	15	810				
130B2292	IP00	740	690	682	360	936		13	25	680	floor		For field wiring use cooper bus bars only	30
130B2318	IP20	1290	690	800	760	1152		11	15	815				

Table 5.4: 500 V Sine-wave Filter - Physical dimensions 2:2

690 V Sine-wave filter - Physical Dimensions																
Code number	IP	Measurements / Dimensions										Weight kg	Mounting direc- tion wall/floor	Max. wire cross section		Terminal screw torque Nm
		A	a	B	b	C	c	d	e	f	mm ²			AWG		
130B2321	IP00	430	412	150	120	260	12	19	9	9	9	14.5	wall	16	20 - 8	2
130B2341	IP20											16.7				
130B2322	IP00	270	220	410	240	368			13	26	30	30	floor	M8	20 - 8	15
130B2342	IP20	670		500	460	522			11	15	55					
130B2323	IP00	310	260	410	320	378			13	26	45	45	floor	M8	8 - 6	15
130B2343	IP20	670		500	460	522			11	15	70					
130B2324	IP00	360	310	410	320	440			13	26	75	75	floor	M8	6 - 4	15
130B2344	IP20	670		500	460	522			11	15	105					
130B2325	IP00	430	380	400	280	478			13	25	120	120	floor	M8	4 - 2	15
130B2345	IP20	670		500	460	522			11	15	150					
130B2326	IP00	480	430	490	610	542			13	26	165	165	floor	M8	2 - 1/0	15
130B2346	IP20	910		650	610	782			11	15	220					
130B2327	IP00	550	500	540	295	493			13	26	220	220	floor	M10	2/0 - 4/0	18
130B2347	IP20	910		650	610	782			11	15	285					
130B2329	IP00	540	490	660	760	641			13	26	228	228	floor	M10	2/0 - 4/0	18
130B2348	IP20	1290		800	760	1152			11	15	370					
130B2241	IP00	590	540	680	505	643			13	26	330	330	floor	M12	4/0 - 5/0	18
130B2270	IP20	1290		800	760	1152			11	15	550					
130B2242	IP00	680	630	650	350	794			13	26	430	430	floor	2xM12	4/0 - 5/0	30
130B2271	IP20	1260		800	760	1152			11	15	610					
130B2337	IP00	790	640	677	365	794			13	26	540	540	floor	2xM12	5/0	30
130B2381	IP20	1290		638	790	1152			11	15	675					
130B2338	IP00	900	640	684	430	884			13	26	540	540	floor	2xM12	5/0 - 6/0	30
130B2382	IP20	1290		800	760	1152			11	15	670					
130B2339	IP00	1140	660	584	453	928			13	26	700	700	floor	2xM12	6/0	30
130B2383	IP20	1260		800	760	1152			11	15	775					
130B2340	IP00	880	800	740	620	1054			13	26	1020	1020	floor	2xM12	6/0	30
130B2384	IP20	1304		860	860	1302			11	15	1020					

Table 5.5: 690 V Sine-wave filter - Physical Dimensions

5

6 How to Programme the Frequency Converter

- The VLT® switching frequency must be set to the value specified for the individual filter. Please consult the VLT® Programming Guide for the corresponding parameter values.
- With an output filter installed only a reduced Automatic Motor Adaption (AMA) can be used.
- The filters are designed for a max. frequency of 100/120 Hz (up to 10 A). For frequencies above 50 Hz the nominal current may have to be reduced (see filter nameplate).

Sine-wave filters can be used at switching frequencies higher than the nominal switching frequency, but should never be used at switching frequencies with more than 20% lower than the nominal switching frequency.

du/dt filters, unlike Sine-wave filters, can be used at lower switching frequency than the nominal switching frequency, but higher switching frequency will cause the overheating of the filter and should be avoided.

6.1.1 Parameter Settings

Parameter no.	Name	Suggested setting
14-00	Switching Pattern	For Sine-wave filters choose SFAVM
14-01	Switching Frequency	Sine-wave: Choose value* du/dt: Choose max. value*
14-55	Output Filter	Choose Sine-wave filter
14-56	Capacitance Output Filter	Set the capacitance*
14-57	Inductance Output Filter	Set the inductance*

*) Values can be found in the chapter *Selection of output filter* section *Electrical Data - du/dt Filters* and section *Electrical Data - Sine-wave Filters*

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