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1 How to Read this Design Guide

This Design Guide will introduce all aspects of output filters 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.

1.1.1 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

1.1.2 Abbreviations

1

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	n_s
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.

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.

2

Warnings

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 defect filter.

NB!
The filters presented in this design guide are specially designed and tested for Danfoss Drives frequency converters (FC 102/202/301 and 302). Danfoss takes no resposibility for the use of third party output filters.

NB!
The phased out LC-filters were developed for the VLT5000 series and are not compatible with the VLT FC-series frequency converters.

NB!
690 V applications:
For motors not specially designed for frequency operation or without double insulation, Danfoss highly recommend the use of either du/dt or Sinus Wave filters.

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. It is divided into three sections:

- Protection of Motor Insulation
- Reduction of Motor Acoustic Noise
- Reduction of High Frequency Electromagnectic Noise in Motor Cable

3.2 Protection of Motor Insulation

3.2.1 The Output Voltage

The output voltage of the power converter is a series of trapezoidal pulses with a variable width (pulse width modulation) characterized by a pulse rise-time t_r.

When a transistor in the inverter switches, the voltage across the motor
increases by a dU/dt ratio that depends on:

- the motor cable (type, cross-section, length, screened or unscreened, inductance and capacitance)
- the high frequency range surge impendance of the motor

Because of the impedance mismatch between the cable characteristic impedance and the motor surge impedance a wave reflection occurs causing a ringing voltage overshoot at the motor terminals - see following illustration. The motor surge impedance decreases with the motor size resulting in reduced mismatch with the cable impedance. The lower reflection coefficient (Γ) reduces the wave reflection and thereby the voltage overshoot.
In the case of parallel cables the cable characteristic impedance is reduced, resulting in a higher reflection coefficient higher overshoot. For more information please see IEC61800-8.

3

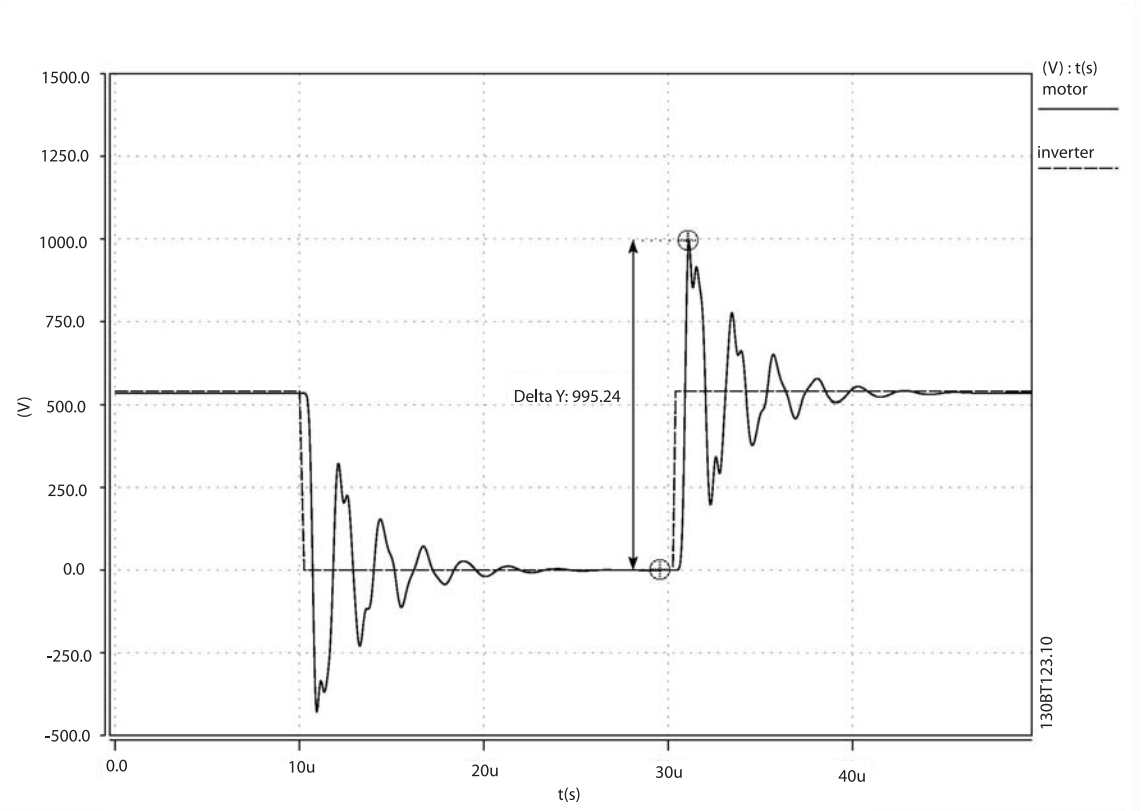


Illustration 3.1: Example of converter outpout voltage (dotted line) and motor terminal voltage after 200 meters of cable (solid line).

Typical values for the rise time and peak voltage U_{PEAK} are measured on the motor terminals between two phases.

Two different definitions for the risetime t_r are used in practice. The international IEC standards define the rise-time as the time between 10 % to 90 % of the peak voltage U_{peak}. The US National Electrical Manufacturers Association (NEMA) defines the rise-time as the time between 10 % and 90 % of the final, settled voltage, that is equal to the DC link voltage U_{DC}. See figures on following page.

To obtain approximate values for cable lengths and voltages not mentioned below, use the following rules of thumb:

1. Rise time increases with cable length.
2. U_{PEAK} = DC link voltage x (1+Γ); Γ represents the reflection coefficient and typical values can be found in table below (DC link voltage = Mains voltage x 1.35).
3. $$du/dt = \frac{0.8 \times U_{PEAK}}{t_r} \text{ (IEC)}$$
   $$du/dt = \frac{0.8 \times U_{DC}}{t_{r(NEMA)}} \text{ (NEMA)}$$

(For du/dt, rise time, Upeak values at different cable lengths please consult the drive Design Guide)

Motor power [kW]	Zm [Ω]	Γ
<3.7	2000 - 5000	0.95
90	800	0.82
355	400	0.6

Table 3.1: Typical values for reflection coefficients (IEC61800-8).

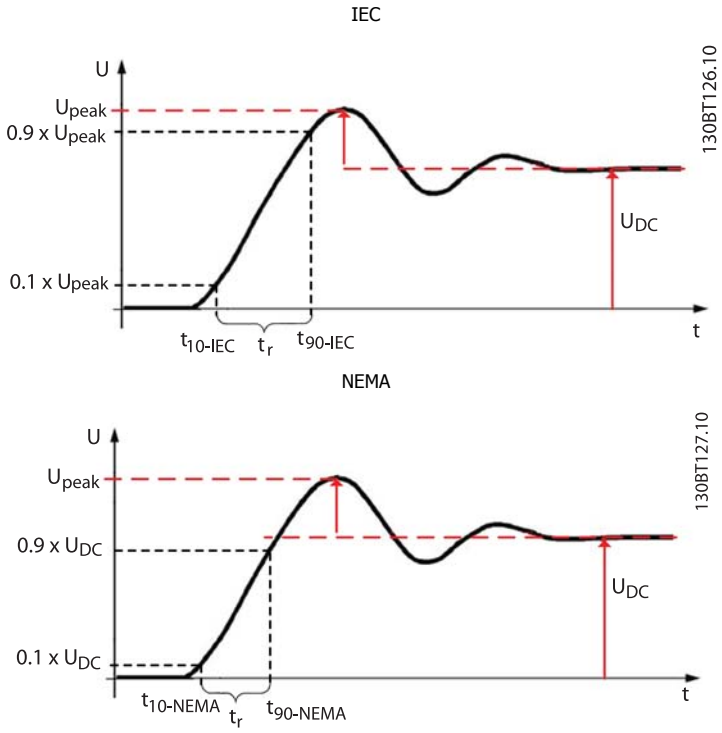


Illustration 3.2: The IEC and NEMA definitions of risetime t_r

Various standards and technical specifications present limits of the admissible U_{peak} and t_r for different motor types. Some of the most used limit lines are shown in the figure below:

- IEC60034-17 – limit line for general purpose motors when fed by frequency converters, 500 V motors.
- IEC60034-25 – limit for converter rated motors: curve A is for 500 V motors and curve B is for 690 V motors.
- NEMA MG1 – Definite purpose Inverter Fed Motors.
- 690 V motors with simple insulation – typical limit line from motor manufacturers.

If in your application the resulting U_{peak} and t_r exceed the limits that apply for the motor used, an output filter should be used for protecting the motor insulation.

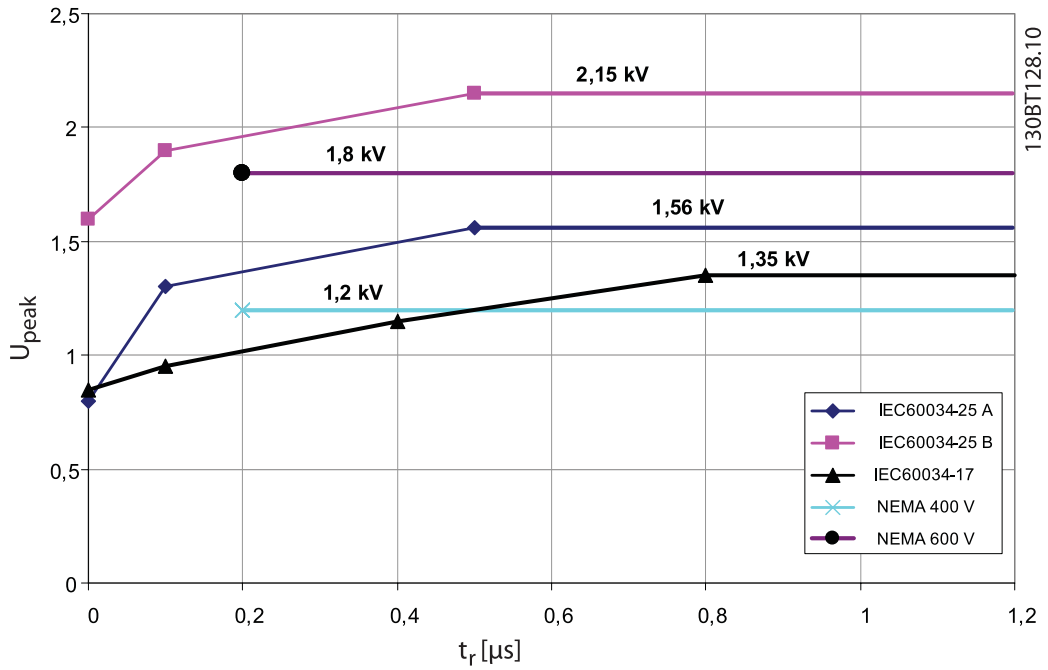


Illustration 3.3: Limit lines for U_{peak} and risetime t_r.

3.3 Reduction of Motor Acoustic Noise

The acoustic noise generated by motors has three main sources:

1. The magnetic noise produced by the motor core, through magnetostriction
2. The noise produced by the motor bearings
3. The noise produced by the motor ventilation

When a motor is fed by a frequency converter, the pulsewidth modulated (PWM) voltage applied to the motor causes additional magnetic noise at the switching frequency and harmonics of the switching frequency (mainly the double of the switching frequency). In some applications this is not acceptable. In order to eliminate this additional switching noise, a sine-wave filter should be used. This will filter the pulse shaped voltage from the frequency converter and provide a sinusoidal phase-to-phase voltage at the motor terminals.

3.4 Reduction if High Frequency Electromagnectic Noise in Motor Cable

When no filters are used, the ringing voltage overshoot that occurs at the motor terminals is the main high-frequency noise source. This can be seen in the figure below that shows the correlation between the frequency of the voltage ringing at the motor terminals and the spectrum of the high-frequency conducted interference in the motor cable.
Besides this noise component, there are also other noise components such as:

- The common-mode voltage between phases and ground (at the switching frequency and its harmonics) - high amplitude but low frequency.
- High-frequency noise (above 10 MHz) caused by the switching of semiconductors - high frequency but low amplitude.

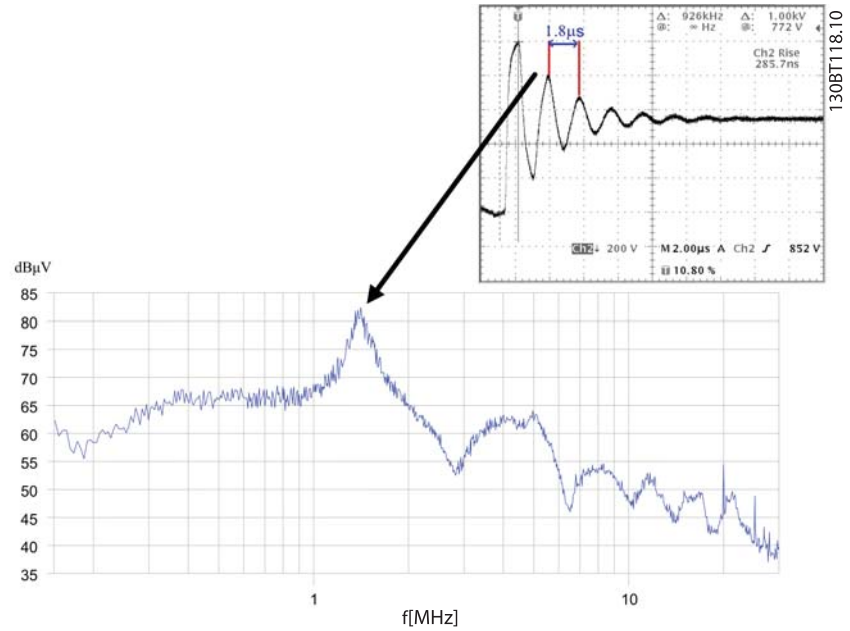


Illustration 3.4: Correlation between the frequency of the ringing voltage overshoot and the spectrum of noise emissions.

When an output filter is installed following effect is achieved:

- In the case of dV/dt filters the frequency of the ringing oscillation is reduced below 150 kHz.
- In the case of sine-wave filters the ringing oscillation is completely eliminated and the motor is fed by a sinusoidal phase-to-phase voltage.

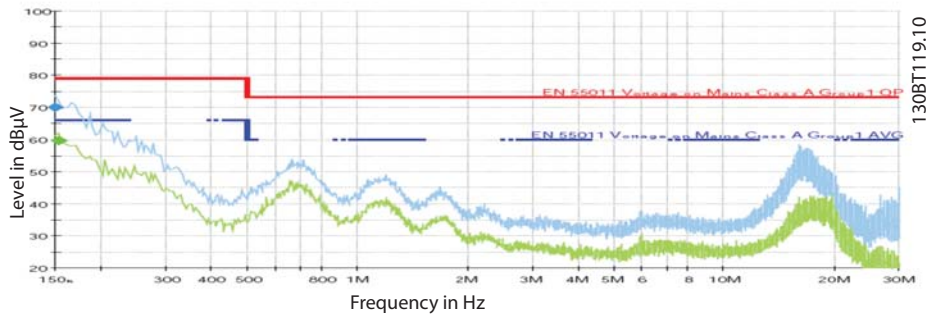


Illustration 3.5: Mains line conducted noise, no filter.

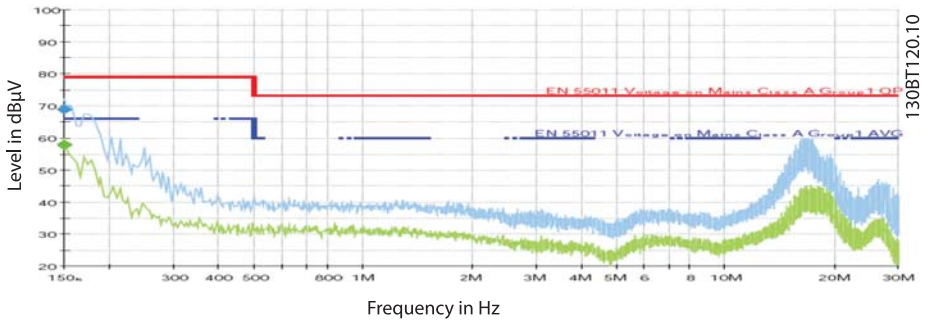


Illustration 3.6: Mains line conducted noise, sine-wave filter.

Remember, that the other two noise components are still present. The use of unshielded motor cables is possible, but the layout of the installation should prevent noise coupling between the unshielded motor cable and main line or other sensitive cables (sensors, communication, etc.). This can be achieved by cable segregation and placement of the motor cable in a separate, continuous and grounded cable tray.

3.5 Which Filter for which Purpose

The table 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 150 m cable (screened/unscreened) complies with the requirements of IEC60034-17 (general purpose motors). Above this cable length the risk of "double pulsing" (two time mains network voltage) 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 VLT 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. Without guaranteed EMC performance: up to 500 m (1 km for VLT 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%
Voltage drop**	0.5%	4-10%

Table 3.2: Comparison of du/dt and sine wave filters.

*) Not 690 V.

**) See general specification for formula.

3.5.1 du/dt Filters

The du/dt filters consist of inductors and capacitors in a low pass filter arrangement and their cut off frequencies are above the nominal switching frequency of the drive. 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. With a du/dt filter the voltage wave form is still pulse shaped but the current is sinusoidal - see illustrations below

Features and benefits

du/dt filters reduce the voltage peaks and du/dt of the pulses at the motor terminals. The du/dt filters reduce du/dt to approx. 500 V / sec. The voltage at the motor terminals is still pulse-shaped, as shown in the following illustration *With du/dt filter*. The motor current has a sinusoidal shape without commutation spikes.

Voltage and current with and without du/dt filter:

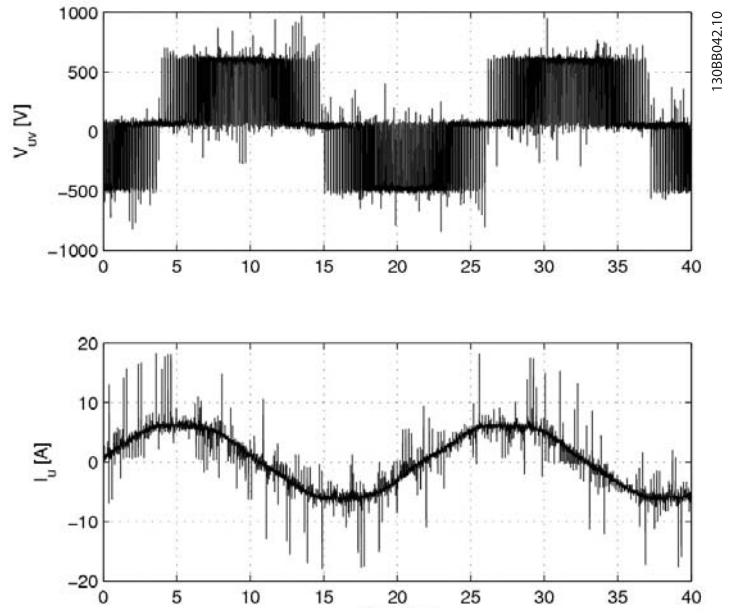


Illustration 3.7: Without filter

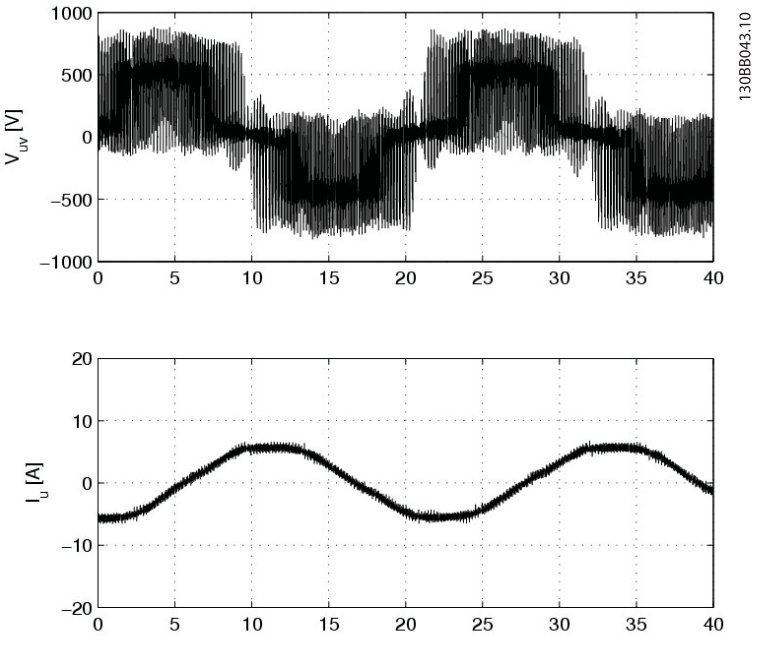


Illustration 3.8: With du/dt filter

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

3

Application areas:

Danfoss recommends the use of du/dt filters in the following applications:

- 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 600034-25
- Applications with short motor cables

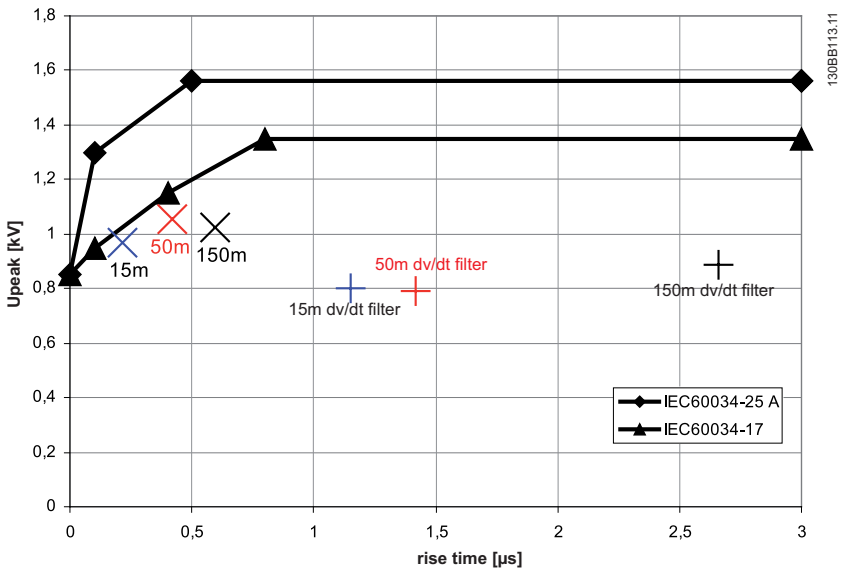


Illustration 3.9: Measured du/dt values (rise time and peak voltages) with and without du/dt filter using 15 m, 50 m and 150 m cable lengths on a 400 V, 37 kW induction motor.

The du/dt value decreases with the motor cable length whereas the peak voltage increases (see illustration above). The Upeak value depends on the Udc from the drive and as Udc increases during motor braking (generative) Upeak can increase to values above the limits of IEC60034-17 and thereby stress the motor insulation. Danfoss therefore recommends du/dt filters in applications with frequent braking. Furthermore the illustration above shows how the Upeak increases with the cable length. As the cable length increases the cable capacitance rises which leads to double pulsing (more than 2 times Udc) that stress the motor. Therefore it is recommended to use du/dt filters only in applications with cable lengths 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 principles including flux and V V C+
- Filters wall mounted up to 115 A and floor mounted above that size

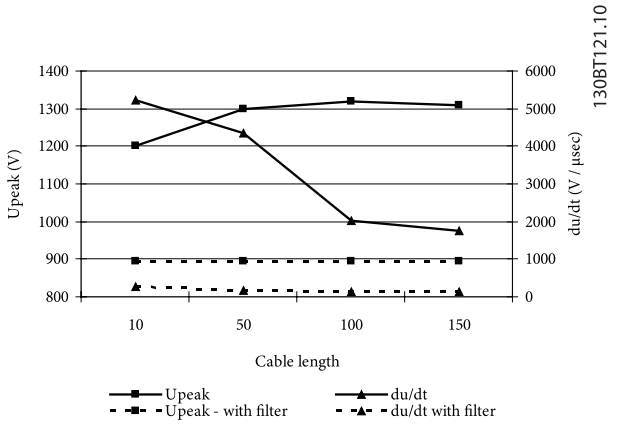


Illustration 3.10: 525V - with and without du/dt filter

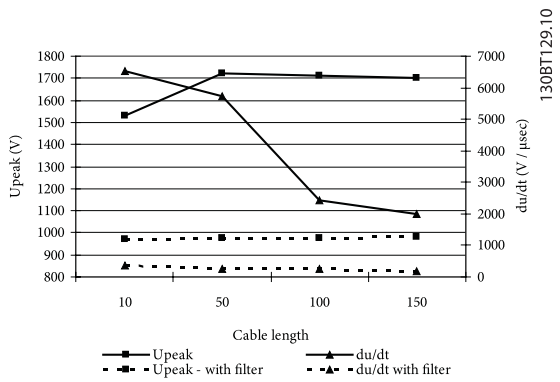


Illustration 3.11: 690V - with and du/dt filter

Source: Test of 690 V 30kW VLT FC-302 with MCC 102 du/dt filter

The illustrations above show how Upeak and rise time behaves as a function of the motor cable length. In installations with short motor cables (below 5-10 m) the rise time is short which causes high du/dt values. The high du/dt can cause a damaging high potential difference between the windings in the motor which can lead to breakdown of the insulation and flash-over. Danfoss therefore recommends du/dt filters in applications with motor cable lengths shorter than 5 meters.

3.5.2 Sine-wave Filters

Sine-wave filters (are designed to) let only low frequencies pass. High frequencies are consequently shunted away which results in a sinusoidal phase to phase voltage waveform and sinusoidal current waveforms. With the sinusoidal waveforms the use of special frequency converter motors with reinforced insulation is no longer needed. The acoustic noise from the motor is also damped as a consequence of the sinusiodal wave condition. The sine-wave filter also reduces insulation stress and bearing currents in the motor, thus leading to prolonged motor lifetime and longer periods between services. Sinewave filters enable use of longer motor cables in applications where the motor is installed far from the drive. As the filter does not act between motor phases and ground, it does not reduce leakage currents in the cables. Therefore the motor cable length is limited - see table *Comparison of du/dt and sine wave filters* in section *Which Filters for which Purpose*

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

As described above Sine-wave filters reduce motor insulation stress and eliminate switching acoustic noise from the motor. The motor losses are reduced because the motor is fed with a sinusoidal voltage, as shown in illustration *525V - with du/dt filter.* 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

3

Voltage and current with and without Sine-wave filter:

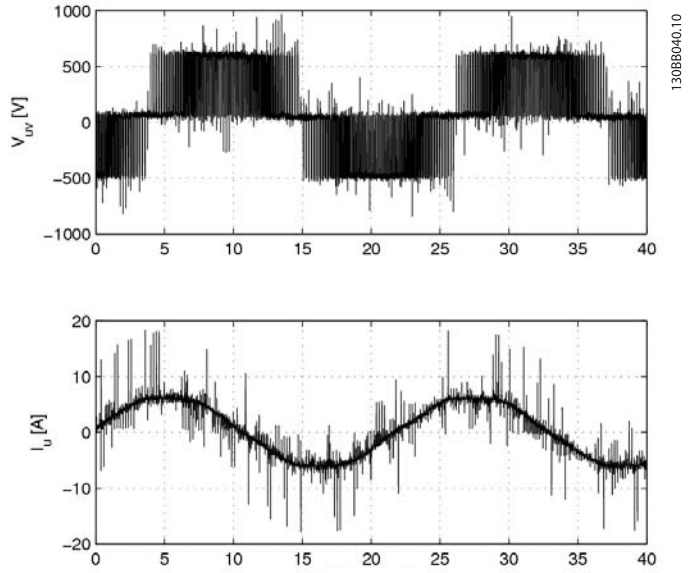


Illustration 3.12: Without filter

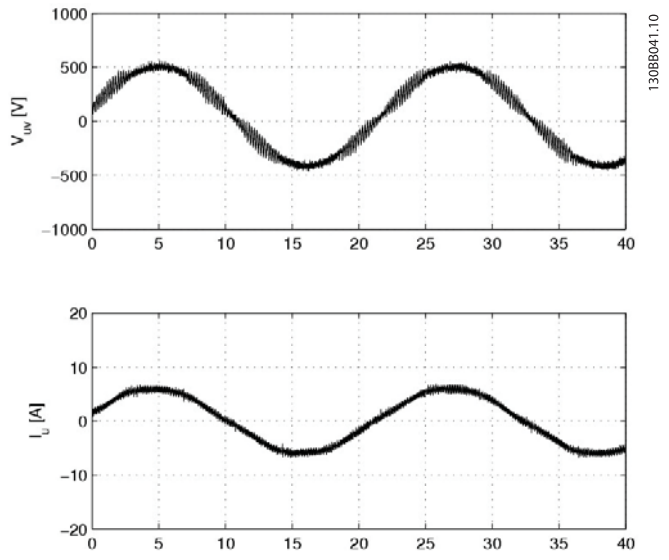


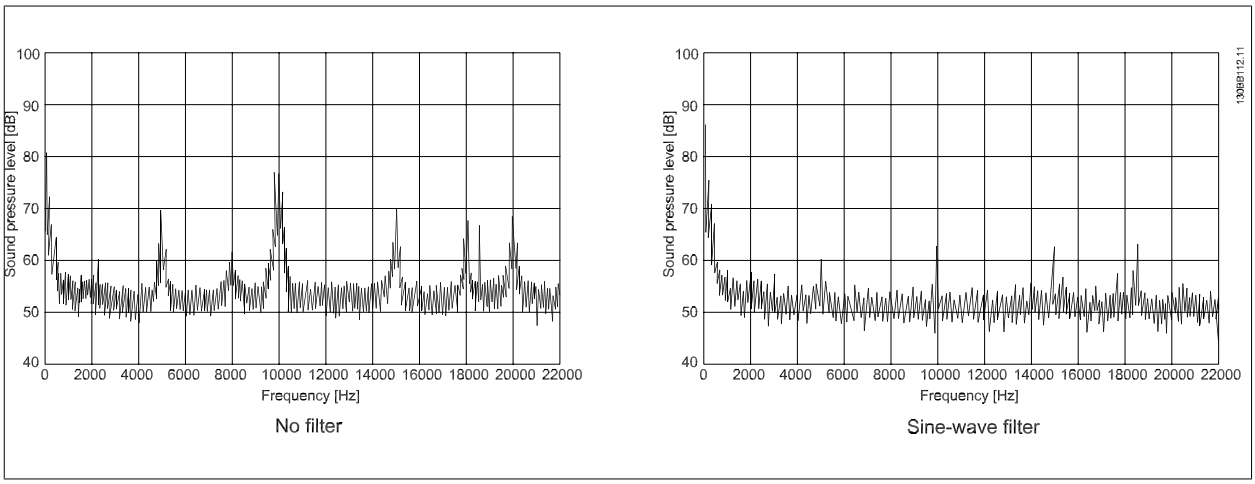
Illustration 3.13: With sine-wave filter

Application areas:

Danfoss recommends the use of Sine-wave filters in the following applications:

- 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 not complying with IEC60034-17
- 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 unscreened 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
- Step up applications or other applications where the frequency converter feeds a transformer

Example of relative motor sound pressure levels measurements with and without Sine Wave filter



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

4

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	Code number IP20	Code number 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	120	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	70	130B2315	130B2289		P315 - P355	P315 - P355
750	2	70	130B2316	130B2290		P400	P400 - P450
880	2	70	130B2317	130B2291		P450 - P500	P500 - P560
1200	2	70	130B2318	130B2292		P560 - P630	P630 - P710
1500	2	70	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] With derating	Code number IP20	Code number IP00	Frequency converter size	
					525-600 V	**525-690 V**
13	2	70	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	70	130B2346	130B2326		P110 - P132
260	2	100	130B2347	130B2327		P160 - P200
303	2	70	130B2348	130B2329		P250
430	1.5	60	130B2370	130B2341		P315 - P400
530	1.5	100	130B2371	130B2342		P500
660	1.5	100	130B2381	130B2337		P560 - P630
765	1.5	60	130B2382	130B2338		P710
940	1.5	100	130B2383	130B2339		P800 - P900
1320	1.5	60	130B2384	130B2340		P1M0

Table 4.2: Filter Selection

Generally the output filters are designed for the nominal switching frequency of the VLT FC-Series drives

NB!

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

NB!

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.

4.2 Electrical Data - du/dt Filters

du/dt Filter 3x380-500 V IP00

Code Number IP00/IP20	VLT Frame Size	Filter Current Rating @50 Hz A	Filter Current Rating @60 Hz A	Filter Current Rating @100 Hz A	Switching Frequency kHz	VLT Power and Current Ratings @380-440 V kW	@380-440 V A	@441-500 V kW	@441-500 V A	Filter Losses @ 380 V W	Filter Losses @ 500 V W	L-value mH	C_Y-Value[1] nF
130B2385	B	24	23	18	4	11	24	11	21	60	55	0.25	3.3
130B2396													
130B2386	B	45	43	34	4	15	32	15	27	60	55	0.13	6.8
130B2397						18.5	37.5	18.5	34	65	60		
						22	44	22	40	70	65		
130B2387	C	75	71	56	3	30	61	30	52	85	80	0.08	10
130B2398						37	73	37	65	100	90		
130B2388	C	110	105	82	3	45	90	55	80	130	120	0.053	15
130B2399						55	106	75	105	140	140		
130B2389	C/D	182	173	136	3	75	147	90	130	180	160	0.032	22
130B2400						90	177	110	160	200	190		
130B2390	D	280	266	210	3	110	212	132	190	260	240	0.02	33
130B2401						132	260	160	240	310	280		
130B2391	D	400	380	300	3	160	315	200	303	290	290	0.015	47
130B2402						200	395	250	361	340	320		
130B2275	E	500	475	375	3	250	480	315	443	590	550	0.012	68
130B2277													
130B2276	E	750	712	562	2	315	600	355	540	590	550	0.0075	100
130B2278						355	658	400	590	620	580		
						400	745	450	678	700	680		
130B2393	F	910	864	682	2	450	800	500	730	900	850	0.0065	100
130B2405						500	880	560	780	980	900		
130B2394	F	1500	1425	1125	2	560	990	630	890	950	950	0.004	200
130B2407						630	1120	710	1050	1050	1100		
						710	1260	800	1160	1100	1150		
						800	1460	1000	1380	1200	1200		
130B2395	F	2300	2185	1725	2	1000	1700	1100	1530	1250	1150	0.0026	300
130B2410													

[1]Equivalent STAR-connection value

Code Number IP00/IP20	VLT Frame Size	Filter Current Rating @50 Hz A	@60 Hz A	@100 Hz A	Switching Frequency kHz	VLT Power and Curent Ratings @550 V kW	A	@575 V Hp	A	@690 V kW	A	Inductor Losses @ 690 V W	@ 525-550 V W	L-value mH	C_Y-Value[1] nF
130B2414	B	28	26	21	4	7.5	14	11	13	11	13	60		0-36	2.35
130B2423						11	19	15	18	15	18	80			
						15	23	20	22	18.5	22	100			
						18.5	28	25	27	22	27	120			
130B2415	C	45	42	34	4	22	36	30	34	30	34	100		0.23	3.4
130B2424						30	43	40	41	37	41	120	120		
130B2416	C	75	71	56	3	37	54	50	52	45	52	120	130	0.14	7.5
130B2425						45	65	60	62	55	62	140	140		
130B2417	C	115	109	86	3	55	87	75	83	75	83	160	160	0.09	7.5
130B2426						75	113	100	108	90	108	190	190		
130B2418	D	165	157	124	3	90	137	125	131	110	131	240	240	0.06	11
130B2427						110	162	150	155	132	155	280	280		
130B2419	D	260	247	195	3	132	201	200	192	160	192	280	280	0.04	16.5
130B2428						160	253	250	242	200	242	300	300		
130B2420	D	310	294	232	3	200	303	300	290	250	290	340	340	0.03	23.5
130B2429															
130B2235	E	430	408	322	3	250	360	350	344	315	344	500	500	0.018	34
130B2238						300	395	400	380	355	380	600	600		
130B2236	F	530	503	397	2	315	429	400	410	400	410	700	700	0.02	34
130B2239															
130B2280	F	630	598	472	2	400	523	500	500	500	500	800	800	0.012	50
130B2274						450	596	600	570	560	570	800			
130B2421	F	765	726	573	2	500	659	650	630	630	630	950	850	0.013	50
130B2430						560	763	750	730	710	730		980		
130B2422	F	1350	1282	1012	2	670	889	950	850	800	850	900		0.008	84
						750	988	1050	945	900	945	900	900		
130B2431						850	1108	1150	1060	1000	1060	1000	1100		
						1000	1317	1350	1260	1200	1260	1200	1200		

[1]Equivalent STAR-connection value

4.3 Electrical Data - Sine-wave Filters

Sine-wave Filter 3x380-500 V IP00/IP20

Code Number IP00/IP20	VLT Frame Size	Filter Current Rating @50 Hz	@60 Hz	@100 Hz	Switching Frequency	VLT Power and Current Ratings @200-240 V		@380-440 V		@441-500 V		Filter Losses @ 200-240 V	@ 380-440 V	@ 441-500 V	L-value	C_y-Value[1]
		A	A	A	kHz	kW	A	kW	A	kW	A	W	W	W	mH	uF
130B2404								0.37	1.3	0.37	1.1		45	45		
130B2439		2.5	2.5	2*	5	0.25	1.8	0.55	1.8	0.55	1.6	50	50	50	29	1
						0.37	2.4	0.75	2.4	0.75	2.1	60	60	60		
130B2406	A	4.5	4	3.5*	5			1.1	3	1.1	3		60	60	13	2.2
130B2441						0.55	3.5	1.5	4.1	1.5	3.4	65	70	65		
130B2408	A	8	7.5	5*	5	0.75	4.6					65			6.9	4.7
130B2443						1.1	6.6	2.2	5.6	2.2	4.8	75	70	70		
						1.5	7.5	3	7.2	3	6.3	80	80	80		
130B2409	A	10	9.5	7.5*	5			4	10	4	8.2		95	90	5.2	6.8
130B2444																
130B2411	A	17	156	13	5	2.2	10.6					90			3.1	10
130B2446						3	12.5	5.5	13	5.5	11	100	110	100		
						3.7	16.7	7.5	16	7.5	14.5	125	125	115		
130B2412	B	24	23	18	4	5.5	24.2	11	24	11	21	150	150	150	2.4	10
130B2447																
130B2413	B	38	36	28.5	4			15	32	15	27		170	160	1.6	10
130B2448						7.5	30.8	18.5	37.5	18.5	34	160	180	170		
130B2281	B	48	45.5	36	4	11	46.2	22	44	22	40	270	270	260	1.1	14.7
130B2307																
130B2282	C	62	59	46.5	3	15	59.4	30	61	30	52	300	310	280	0.85	30
130B2308																
130B2283	C	75	71	56	3	18.5	74.8	37	73	37	65	350	350	330	0.75	30
130B2309																
130B2284	C	115	109	86	3	22	88	45	90	55	80	450	460	430	0.5	60
130B2310						30	115	55	106	75	105	500	500	500		
130B2285	D	180	171	135	3	37	143	75	147	90	130	650	600	600	0.3	99
130B2311						45	170	90	177	110	160	680	700	680		
130B2286	D	260	247	195	3			110	212	132	190		820	800	0.2	141
130B2312								132	260	160	240		900	880		

*) 120 Hz

[1]Equivalent STAR-connection value

Sine-wave Filter 3x380-500 V IP00/IP20

Code Number IP00/IP20	VLT Frame Size	Filter Current Rating @50 Hz A	@60 Hz A	@100 Hz A	Switching Frequency kHz	VLT Power and Current Ratings @200-240 V kW	A	@380-440 V kW	A	@441-500 V kW	A	Filter Losses @ 200-240 V W	@ 380-440 V W	@ 441-500 V W	L-value mH	C_Y-Value[1] uF
130B2287	E	410	390	308	3			160	315	200	303		1050	1050	0.13	198
130B2313								200	395	250	361		1200	1100		
130B2288	E	480	456	360	3			250	480	315	443		1400	1350	0.11	282
130B2314																
130B2289	F	660	627	495	3			315	600	355	540		2000	1900	0.14	423
130B2315								355	658	400	590		2100	2000		
130B2290	F	750	712	562	2			400	745	450	678		2900	2800	0..2	495
130B2316																
130B2291	F	880	836	660	2			450	800	500	730		3400	3300	0.11	564
130B2317								500	880	560	780		3600	3400		
130B2292	F	1200	1140	900	2			560	990	630	890		3600	3600	0.075	846
130B2317								630	1120	710	1050		3800	3800		
2x130B2291	F	1500			2			710	1260	800	1160					
2X130B2317								800	1460	1000	1380					
2x130B2292	F	1700			2			1000	1700	1100	1530					
2X130B2318																

*) 120 Hz

[1]Equivalent STAR-connection value

Sine-wave Filter 3x525-690 V IP00/IP20

Code Number IP00/IP20	VLT Frame Size	Filter Current Rating			Switching Frequency	VLT Power and Current Ratings						Filter losses			L-value	C_y-Value[1]
		@50 Hz	@60 Hz	@100 Hz		@525-550 V		@525-600 V		@690 V		@525-550 V	@525-600 V	@690 V		
		A	A	A	kHz	kW	A	kW	A	kW	A	W	W	W	mH	uF
130B2321 130B2341		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 130B2342	B	28	26.5	21	2	11	18			11	13		230	180 230	5.5	10
						15	22			15	18		250	250		
						18.5	27			18.5	22		280	280		
130B2323 130B2343	B	45	42.5	33.5	2	22	34			22	27		300	300	3.4	20
						30	41	30	46	37	46	360	330	360		
130B2324 130B2344	C	76	72	57	2	37	52	37	56	45	54	450	420	450	2	33
						45	62	45	76	55	73	500	450	500		
130B2325 130B2345	C	115	109	86	2	55	83	55	90	75	86	800	750	750	1.3	47
						75	100	75	113	90	108	850	800	850		
130B2326 130B2346	C	165	157	123	2	90	131	90	137	110	131	1050	1000	1000	0.9	66
						110	155	110	162	132	155	1150	1100	1100		
130B2327 130B2347	D	260	247	195	2	150	192	132	201	160	192	1100	1050	1050	0.6	94
						180	242	160	253	200	242	1250	1200	1200		
130B2329 130B2348	D	303	287	227	2	220	290	200	303	250	290	1600	1600	1600	0.5	136

[1]Equivalent STAR-connection value

Sine-wave Filter 3x525-690 V IP00/IP20

Code Number IP00/IP20	VLT Frame Size	Filter Current Rating @50 Hz	@60 Hz	@100 Hz	Switching Frequency	VLT Power and Current Ratings @525-550 V		@525-600 V		@690 V		Filter losses @525-550 V	@525-600 V	@690 V	L-value	C_Y-Value[1]
		A	A	A	kHz	kW	A	kW	A	kW	A	W	W	W	mH	uF
130B2241	E	430	408	322	1.5	260	344	250	360	315	344	1850	1800	1800	0.35	272
130B2270						300	429	315	429	400	410	2100	2050	2000		
130B2242	F	530	503	397	1.5	375	523	400	523	500	500	2500	2500	2400	0.28	340
130B2271																
130B2337	F	660	627	495	1.5	450	596	450	596	560	570	2800	2800	2700	0.23	408
130B2381						480	630	500	659	630	630	2900	2850	2850		
130B2338	F	765	726	573	1.5	560	730	560	763	710	730	3850	3800	3800	0.2	476
130B2382																
130B2339	F	940	893	705	1.5	670	898	670		800	986	3350	3300	3350	0.16	612
130B2383								750	939	900	898	3400		3350		
130B2340	F	1320	1250	990	1.5	820	1060	850	1108	1000	1060	4500	4300	4300	0.12	816
130B2384						970	1260	1000	1317	1200	1317	4700	4600	4700		

[1]Equivalent STAR-connection value

Sine-wave Foot Print Filter 3x200-500 V IP20

Code Number	Filter Current Rating			Switching Frequency	VLT Power and Current Rating						Filter losses			L-value	Cy-Value[1]
	@50 Hz	@60 Hz	@100 Hz		@200-240 V		@380-440 V		@441-500 V		@200-240 V	@380-440 V	@441-500 V		
	A	A	A	kHz	kW	A	kW	A	kW	A	W	W	W	mH	uF
130B2542	10	10	8	5			4	10	4	8.2		60	60	5.3	1.36
					2.2	10.6									
130B2543	17	17	13.6	5	3	12.5	5.5	13	5.5	11	100	100	100	3.1	2.04
					3.7	16.7	7.5	16	7.5	14.5	100	100	100	3.1	2.04

4.4 General Specifications

Surroundings:	
Isolation class:	
EIS 155	2.5 A up to 75 A
EIS 180	115 A up to 2300 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

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
du/dt filter 500 V	
4.5 A - 480 A	3.3 V
du/dt filter 690 V	
4.5 A - 480 A	5.5 V

The voltage drop can be calculated using this formula:

$$ud = 2 \times \pi \times f_m \times L \times I$$

f_m = output frequency

L = filter inductions

I = current

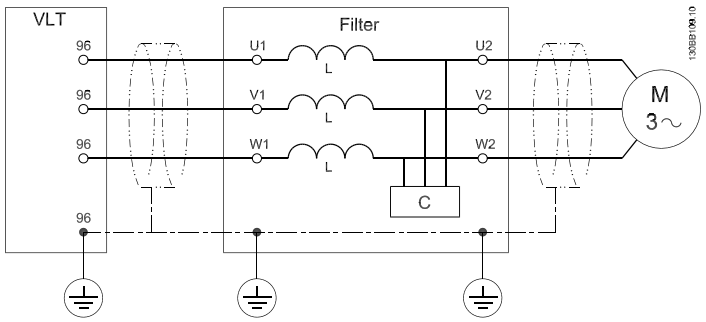
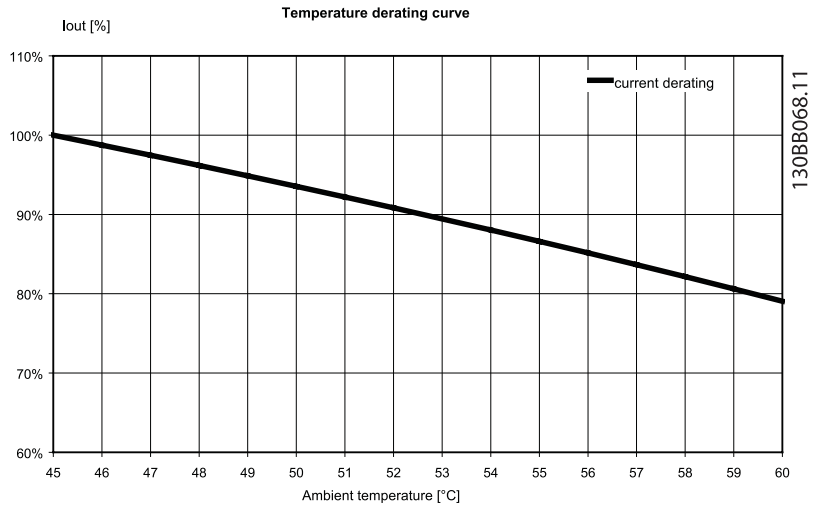


Illustration 4.1: Filter Diagram



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 with derating (only 500 V up to 10 A)
Ambient temperature	-25° to 45°C side by side mount, without derating
Min. switching frequency	no limit
Max. switching frequency	f_{max} 1.5 kHz - 4 kHz, depending on filter type
Overload capacity	160% for 60 sec. every 10 min.
Enclosure degree	IP00 and IP20 (IP23 all floor standing filters)
Approval	CE, UL and cUL(up to and including 115A), RoHS

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 with derating (only 500 V up to 10 A)
Ambient temperature	-25° to 45°C side by side mount, without derating
Min. switching frequency	f_{min} 1,5 kHz – 5 kHz, depending on filter type
Max. switching frequency	no limit
Overload capacity	160% for 60 sec. every 10 min.
Enclosure degree	IP00 and IP20 (IP23 all floor standing filters)
Approval	CE, UL and cUL(up to and including 115A), RoHS

4

4.4.3 Sine Wave Foot Print Filter

Technical Specification

Voltage rating	3 x 200-500 V AC
Nominal current I¬N @ 50 Hz	10 – 17 A
Motor frequency	0-60 Hz without derating. 100/120 Hz with derating (see derating curves below)
Ambient temperature	-25° to 45°C side by side mount, without derating (see derating curves below)
Min. switching frequency	fmin 5 kHz
Max. switching frequency	fmax 16 kHz
Overload capacity	160% for 60 sec. every 10 min.
Enclosure degree	IP20
Approval	CE, RoHS

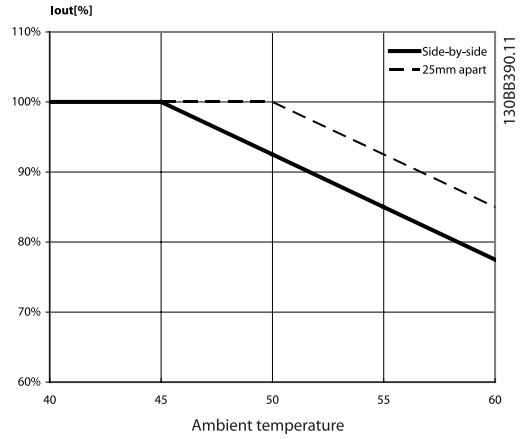


Illustration 4.2: Temperature derating

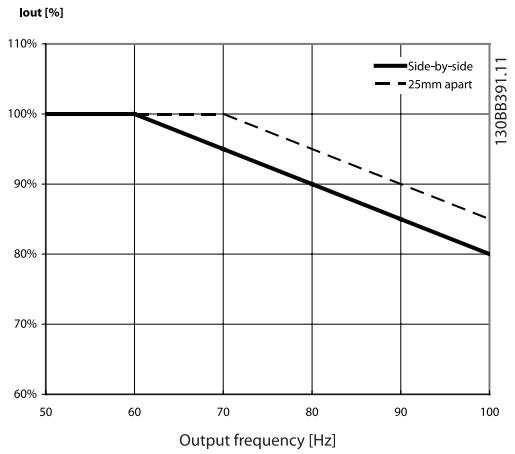


Illustration 4.3: Output frequency derating

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.

5.1.2 Mounting

- All wall mounted filters must be mounted vertically with the terminal at the bottom.
- 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.
- Top and bottom clearance minimum 100 mm (200 mm for foot print filters).

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 chassis (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 between VLT and output filter:
  Below 7.5kW: 2 meters
  Between 7,5 - 90kW: 5-10 meters
  Above 90kW: 10-15 meters

NB!
The cable between VLT and filter should be kept as short as possible

NB!
More than 10 meters is possible but Danfoss strongly discourge such installations, due to the risk of increased EMI and voltage spikes on the filter terminals.

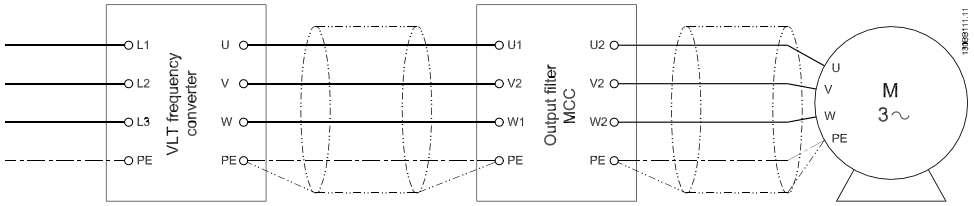


Illustration 5.1: Wirring diagram

5.2 Mechanical Dimensions

5.2.1 Sketches

Wall Mounted

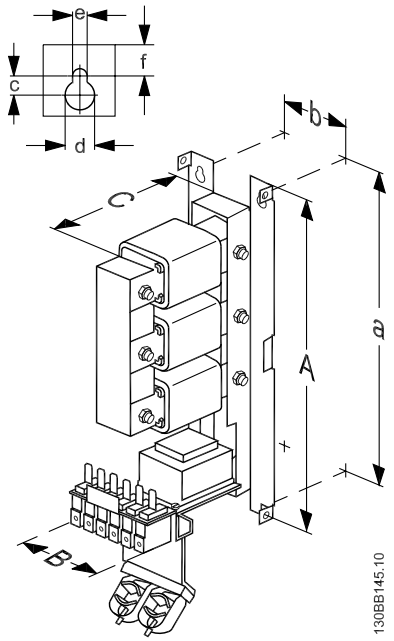


Illustration 5.2: IP00 Wall mounted

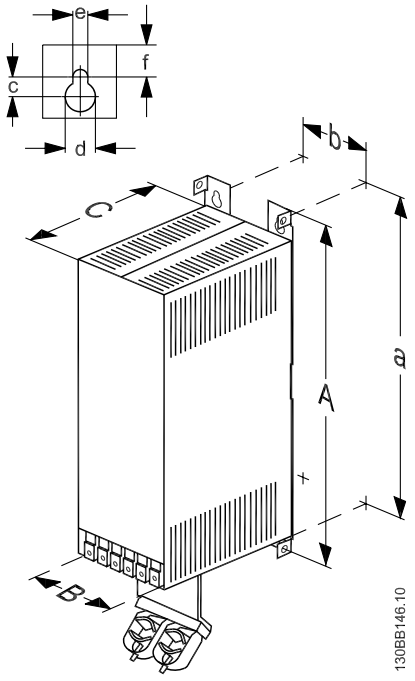


Illustration 5.3: IP20 Wall mounted

Floor Mounted

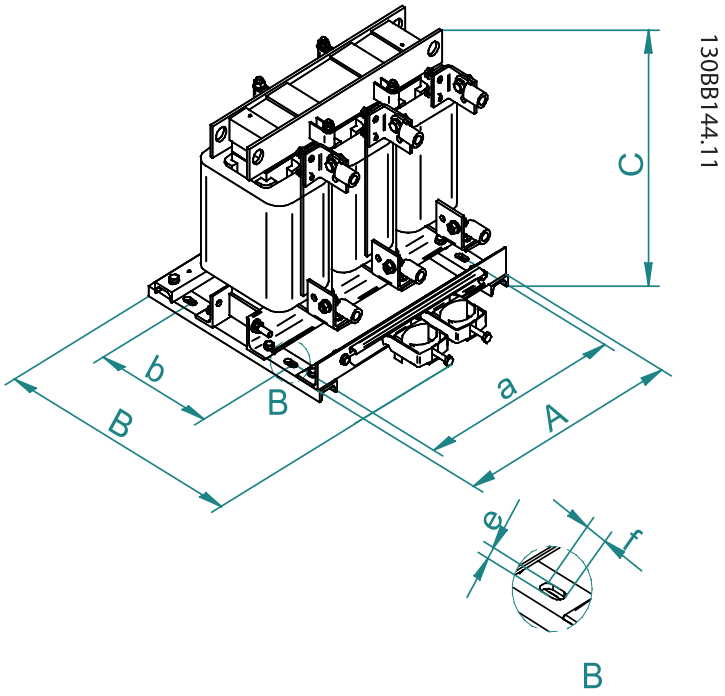


Illustration 5.4: IP00 Floor mounted

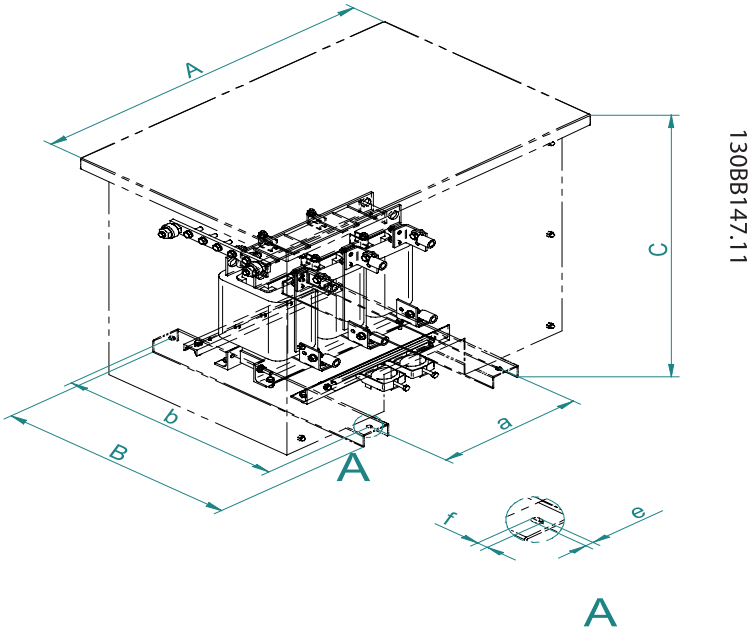


Illustration 5.5: IP23 Floor mounted

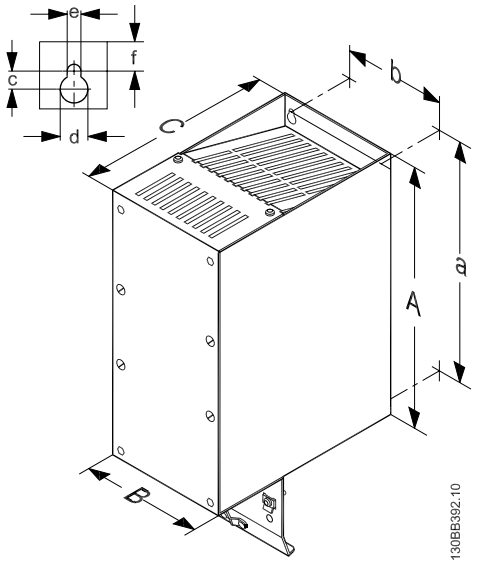


Illustration 5.6: IP20 Wall mounted foot print filters

5

5.2.2 Physical Dimensions

du/dt 500 V - Physical dimensions														
Code number	Enclosure	Measurements / Dimensions									Weight	Mounting Direction	Wire cross section		Terminal Screw torque
		A	a	B	b	C	c	d	e	f	kg	Wall/floor	mm^2	AWG	Nm/ft-lb
130B2385	IP00	268	257	120	90	205	8	11	6.5	6.5	5.2	wall	16	20 - 10	2/1.5
130B2396	IP20										5.2				
130B2386	IP00	330	312	170	125	260	12	19	9	9	7.5	wall	50	8 - 6	8/5.9
130B2397	IP20										9.3				
130B2387	IP00	330	312	170	125	260	12	19	9	9	8.8	wall	50	6 - 4	8/5.9
130B2398	IP20										10.7				
130B2388	IP00	330	312	170	125	260	12	19	9	9	10.9	wall	50	4 - 2	8/5.9
130B2399	IP20										12.8				
130B2389	IP00	210	175	350	170	270	12	19	9	9	14	wall	M10	2 - 1/0	18/13.3
130B2400	IP20	610		440	400	462					33				
130B2390	IP00	240	190	400	210	298			11	20	23	floor	M10	2/0 - 4/0	18/13.3
130B2401	IP23	670		500	460	522			11	15	50				
130B2391	IP00	240	190	330	210	400			11	20	33	floor	M12	5/0 - 6/0	30/22.1
130B2402	IP23	610		440	400	463			11	15	60				
130B2275	IP00	265	215	386	190	431			11	20	30	floor	M12	6/0	30/22.1
130B2277	IP23	670	215	500	460	522			11	15	58				
130B2276	IP00	300	240	490	430	430			11	20	52.3	floor	2 x M12	For field wiring use cooper bus bars only	30/22.1
130B2278	IP23	770		550	510	602			11	15	52.2				
130B2393	IP00	300	240	490	250	440			11	20	56.9	floor	2 x M12	For field wiring use cooper bus bars only	30/22.1
130B2405	IP23	770		550	510	602			11	15	56.9				

Table 5.1: 500 V du/dt filter

690 V du/dt filter - Physical dimensions															
Code number	**Enclosure**	**Measurements / Dimensions**									**Weight**	**Mounting Direction**	**Max. wire crosssection**		**Terminal screw torque**
		A	a	B	b	C	c	d	e	f	Kg	Wall/Floor	mm^2	AWG	Nm/ft-lb
130B2414	IP00	376	312	150	120	260	12	19	9	9	7	Wall	16	20 - 8	2/1.5
130B2423	IP20										8.3				
130B2415	IP00	404	312	170	125	260	12	19	9	9	7.6	Wall	50	8 - 6	8/5.9
130B2424	IP20										9.4				
130B2416	IP00	404	312	170	125	260	12	19	9	9	10	Wall	50	6 - 4	8/5.9
130B2425	IP20										11.8				
130B2417	IP00	404	312	170	125	260	12	19	9	9	10.4	Wall	50	4 - 2	8/5.9
130B2526	IP20										12.2				
130B2418	IP00	265	215	373	200	288		13	20		15	Floor	M10	2 - 1/0	18/13.3
130B2427	IP23										45				
130B2419	IP00	265	215	390	190	400			13	20	18	Floor	M10	2/0 - 4/0	18/13.3
130B2428	IP23	670		500	460	522			11	15	47				
130B2420	IP00	265	215	390	190	400			13		18	Floor	M10	2/0 - 4/0	18/13.3
130B2429	IP23	670		500	460	522			11	15	47				
130B2235	IP00	265	215	418	190	437			11	15	27	Floor	M12	4/0 - 5/0	18/13.3
130B2238	IP23	670		500	460	522			11	15	52				
130B2236	IP00	265	215	425	190	533			13		28	Floor	M12	4/0 - 5/0	30/22.1
130B2239	IP23	770		550	510	602			11	15	60				
130B2280	IP00	265	252	415	280	436			13	20	35	Floor	M12	5/0	30/22.1
130B2274	IP23	670	215	490	460	522			11	15	63				
130B2421	IP00	136	310	520	474	734			13	23	55	Floor	M12	5/0 - 6/0	30/22.1
130B2430	IP23	1150	308	850	760	856			11	15	130				
130B2422	IP00	445	310	503	470	750			11	15	55	Floor	M12	For field wiring use cooper bus bars only	30/22.1
130B2431	IP23	1150	760	850	820	736			11	15	130				

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

500 V Sine-wave Filter - Physical dimensions															
Code number	Enslosure	Measurements / Dimensions									Weight	Mounting direction	Max. wire cross section		Terminal screw torque
		A	a	B	b	C	c	d	e	f	kg	Wall/Floor	mm^2	AWG	Nm/ft-lb
130B2404	IP00	200	190	75	60	205	7	8	4.5	5	2.5	wall	4	24 - 10	0.6/0.44
130B2439	IP20										3.3				
130B2406	IP00	200	190	75	60	205	7	8	4.5	5	3.3	wall	4	24 - 10	0.6/0.44
130B2441	IP20										4.2				
130B2408	IP00	268	257	90	70	205	8	11	6.5	6.5	4.6	wall	4	24 - 10	0.6/0.44
130B2443	IP20					206					5.8				
130B2409	IP00	268	257	90	70	205	8	11	6.5	6.5	6.1	wall	4	24 - 10	0.6/0.44
130B2444	IP20										7.1				
130B2411	IP00	268	257	130	90	205	8	11	6.5	6.5	7.8	wall	4	24 - 10	0.6/0.44
130B2446	IP20										9.1				
130B2412	IP00	330	312	150	120	260	12	19	9	9	14.4	wall	16	20 - 4	2/1.5
130B2447	IP20										16.9				
130B2413	IP00	430	412	150	120	260	12	19	9	9	17.7	wall	16	20 - 4	2/1.5
130B2448	IP20					259					19.9				
130B2281	IP00	530	500	170	125	258	12	19	9	20	34	wall	50	6 - 1/0	8/5.9
130B2307	IP20					260					39				
130B2282	IP00	610	580	170	125	260	12	19	9	20	36	wall	50	6 - 1/0	8/5.9
130B2308	IP20										41				
130B2283	IP00	610	580	170	135	260	12	19	9	20	50	wall	50	6 - 1/0	15/11.1
130B2309	IP20										54				
130B2284	IP00	330	290	430	380	450			13	26	68	floor	M8	1 - 2/0	15/11.1
130B2310	IP23	670		500	460	522			11	15	87				
130B2285	IP00	450	400	524	235	402			13	26	87	floor	M8	1 - 2/0	15/11.1
130B2311	IP23	940		650	610	782			11	15	113		M10		18/13.3
130B2286	IP00	450	400	536	445	506			13	26	125	floor	M12	3/0	30/22.1
130B2312	IP23	940		650	610	782			11	15	190		M10		
130B2287	IP00	480	430	560	330	675			13	25	190	floor	M12	3/0	30/22.1
130B2313	IP23	940		650	610	782			11	15	245				
130B2288	IP00	600	430	630	310	650			13	26	235	floor	2xM12	4/0	30/22.1
130B2314	IP23	1050		760	720	742			11	15	310				
130B2289	IP00	620	570	683	435	764			13	26	310	floor	2xM12	5/0	30/22.1
130B2315	IP23	1290		800	760	1152			11	15	445				

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

500 V Sine-wave Filter - Physical dimensions															
Code number	**Enclosure**	**Measurements / Dimensions**									**Weight**	**Mounting direction**	**Max. wire cross section**		**Terminal screw torque**
		A	a	B	b	C	c	d	e	f	kg	Wall/Floor	mm^2	AWG	Nm/ft-lb
130B2290	IP00	660	610	680	370	684			13	26	470	floor	2xM12	6/0	30/22.1
130B2316	IP23	1290		800	760	1152			11	15	605				
130B2291	IP00	760	610	682	380	893			13	26	640	floor	2xM12	6/0	30/22.1
130B2317	IP23	1290		800	760	1152			11	15	810				
130B2292	IP00	740	690	682	360	936			13	25	680	floor	2xM12	For field wiring use cooper bus bars only	30/22.1
130B2318	IP23	1290	690	800	760	1152			11	15	815				

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

690 V Sine-wave filter - Physical Dimensions															
Code number	Enclosure	Measurements / Dimensions									Weight	Mounting direction	Max. wire cross section		Terminal screw torque
		A	a	B	b	C	c	d	e	f	kg	wall/floor	mm^2	AWG	Nm/ft-lb
130B2321	IP00	430	412	150	120	260	12	19	9	9	14.5	wall	16	20 - 8	2/1.5
130B2341	IP20										16.7				
130B2322	IP00	270	220	410	240	368			13	26	30	floor	M8	20 - 8	15/11.1
130B2342	IP23	670		500	460	522			11	15	55				
130B2323	IP00	310	260	410	320	378			13	26	45	floor	M8	8 - 6	15/11.1
130B2343	IP23	670		500	460	522			11	15	70				
130B2324	IP00	360	310	410	320	440			13	26	75	floor	M8	6 - 4	15/11.1
130B2344	IP23	670		500	460	522			11	15	105				
130B2325	IP00	430	380	400	280	478			13	25	120	floor	M8	4 - 2	15/11.1
130B2345	IP23	670		500	460	522			11	15	150				
130B2326	IP00	480	430	490		542			13	26	165	floor	M8	2 - 1/0	15/11.1
130B2346	IP23	910		650	610	782			11	15	220				
130B2327	IP00	550	500	540	295	493			13	26	220	floor	M10	2/0 - 4/0	18/13.3
130B2347	IP23	910		650	610	782			11	15	285				
130B2329	IP00	540	490	660		641			13	26	228	floor	M10	2/0 - 4/0	18/13.3
130B2348	IP23	1290		800	760	1152			11	15	370				
130B2241	IP00	590	540	680	505	643			13	26	330	floor	M12	4/0 - 5/0	18/13.3
130B2270	IP23	1290		800	760	1152			11	15	550				
130B2242	IP00	680	630	650	350	794			13	26	430	floor	2xM12	4/0 - 5/0	30/22.1
130B2271	IP23	1260		800	760	1152			11	15	610				
130B2337	IP00	790	640	677	365	794			13	26	540	floor	2xM12	5/0	30/22.1
130B2381	IP23	1290	638	790	764	1152			11	15	675				
130B2338	IP00	900	640	684	430	884			13	26	540	floor	2xM12	5/0 - 6/0	30/22.1
130B2382	IP23	1290	418	800	760	1152			11	15	670				
130B2339	IP00	1140	660	584	453	928			13	26	700	floor	2xM12	6/0	30/22.1
130B2383	IP23	1260		800	760	1152			11	15	775				
130B2340	IP00	880	800	740	620	1054			13	26	1020	floor	2xM12	6/0	30/22.1
130B2384	IP23	1304	800	860		1302			11	15	1020				

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

Foot Print Sine Wave Filter - Technical Data													
Code Number	**Foot Print**	**Dimensions**									**Weight**	**Mounting Direction**	**Max. Wire Cross Section**
		A	a	B	b	C	c	d	e	f	[kg]		mm^2
130B2542	A2	282	257	90	70	202	10	11	6	15	8	wall	4
130B2543	A3	282	257	130	110	212	10	11	6	15	11.5	wall	4

Table 5.6: Foot Print Sine Wave Filter - Technical Data

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).

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

NB!
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 for Operation with Sine-wave Filter

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 fixed
14-56	Capacitance Output Filter	Set the capacitance*
14-57	Inductance Output Filter	Set the inductance*

*) For FLUX control principle only. 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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