

# Encapsulated Submersible Motors, 6" and 8"

# GB

## Assembly and operating instructions

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**Declaration of Conformity for Franklin Electric Submersible Motors:**

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# 1 With this document

These assembly and operating instructions form an integral part of the submersible motor and describe its safe, intended use in all operating phases.

**Storage and handing over**

- ⇒ Keep the assembly and operating instructions in the immediate vicinity of the motor.
- ⇒ Hand the assembly and operating instructions over to every subsequent user of the motor.

**Application**

These assembly and operating instructions only apply to the motors described here.

## 1.1 Warning notices and warning symbols

Warning notices point out special dangers and indicate the measures that can be taken to avoid the danger. Warning notices come in three levels:

Warning word	Meaning
<b>DANGER</b>	Immediate danger to life and health
<b>WARNING</b>	Possible danger to life and health
<b>CAUTION</b>	Possible danger of slight injury or material damage

Warning notices are built up as follows:



**Warning word**

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*Type and source of danger as well as the possible consequences of measures not being observed!*

- ⊙ *Forbidden actions.*
  - ⇒ *Measures to avoid the danger.*
- 

## 1.2 Instructions and highlights

In these assembly and operating instructions, we use the following symbols and, for improved legibility and uniform identification, highlights:

- Insulation measuring unit (this indicates a listing)
- ☑ Instructions ... observed (this indicates a condition)
- ⇒ Switch off the motor. (this indicates an instruction to take action)
- Motor has stopped. (this indicates the result of the action)
- Immediately switch off** the motor... (you can see a highlight in bold here)



**Note**

*Specifically, important information is given here. You should observe this information to ensure correct and safe operation of the motor.*

## 2 Safety

This section describes the safety rules which you have to observe for the safe use of submersible motors. Possible sources of danger and the relevant safety measures are listed here.

### 2.1 Intended use

#### Loss of guarantee and exclusion of liability

- Franklin Electric submersible motors are only intended for integration with a machine in order to drive the relevant machine under water. They must only be put into use if the machine fulfils the provisions of the applicable directives and statutory provisions.
- Permanent magnet motors are to be operated by Variable frequency drive (VFD)
- Installation location: Vertical (Mandatory mounting position: vertical, shaft up. Only one diameter step allowed, i.e. 6" motor on 8" pump). Horizontal (only allowed if the pump size is identical to the motor size, e.g. 6" motor with 6" pump). The pump has to sufficient "Down Thrust" transmit to the motor.
- The submersible motors must only be used in clean, highly fluid media, such as drinking or process water.
- The following media are not allowed: air, highly flammable, explosive media and wastewater.
- Franklin Electric shall not be liable for the damage resulting from any further, non-intended use. The risk of such use rests solely with the user.

### 2.2 Target group

The electrical system must only be installed by professional staff (qualified electrical engineers or electrical machine technicians).

### 2.3 General safety instructions

The following safety measures must be observed prior to putting the motor into use:

- Do not carry out any other work on the motor than described in these instructions.
- Only use the motor under water (the motor and the short motor cable must be fully submersed).
- Do not implement any changes or conversions to the motor or its electrical connections.
- Never open the motor.
- Never use the motor in combination with damaged pump units or parts.
- Only work on the motor when it is switched off. No work or checks require the motor to be running.
- Switch off the power supply to the motor before carrying out any work on it.
- Make sure that nobody can switch on the voltage unexpectedly while work is being carried out on the motor.
- Never work on electrical systems during a thunderstorm.
- Make sure immediately after ending the work that all protective and safety devices have been fitted again and are operational.
- Before switching on the motor, make sure that all electrical connections and safety devices have been checked and that all fuses and safeties have been set correctly.
- Make sure that no danger zones are freely accessible (e.g. rotating parts, suction locations, pressure output locations, electrical connections).
- Observe the pump manufacturer's commissioning instructions.
- If motors or pump units have been used in contaminated media they must be marked as such before handing them over to a third party (e.g. when submitting them for repair). Pay attention to possible residues in "Dead spaces" (diaphragm cover).
- Repairs must only be carried out by authorized professional workshops. Use only original Franklin Electric spare parts.
- Observe warning notices attached to the motor

### 3 Storage, transport, disposal

- Storage**
- ⇒ Store the motor in its original packaging until the time of installing it.
  - ⇒ If the motor is stored standing up, make sure that it cannot topple over (shaft always pointing up!).
  - ⇒ Do not store the motor in direct sunlight or within the reach of other heat sources.
  - ⇒ Observe the storage temperature (−15 - +60 °C, see Technical specifications).

**Transport**




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***Falling loads may cause lethal injuries or may crush parts of the body!***

- ⊙ Nobody is allowed to be located under suspended loads.
  - ⇒ Only use approved hoisting gear.
  - ⇒ Select the hoisting gear on the basis of the total weight to be transported.
- 

**Unpacking**

- ⇒ After unpacking the motor check it for possible damage, e.g. damage to the diaphragm cover, housing, endbell, connection and motor cable.
- ⇒ Immediately inform the supplier of any damage found.




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***Danger to life due to electrocution if the motor cable is damaged!***

- ⊙ Do **not** install the motor and do **not** put it into operation.
- 

**Disposal**

In order to avoid environmental damage:

- Avoid contamination by lubricants, detergents etc.
- Dispose of the motor and the packaging material in a proper, environmentally sound manner.
- Observe local regulations.

### 4 Technical specifications

Description	Value
Performance/model number	6": 4 - 45 kW (HighTemp90 up to 30 kW) models 236 ... (276 ...) 8": 30 - 150 kW (HighTemp75 up to 110 kW) models 239 ... (279 ...)
Voltage range	220 V ... 690 V, 3~ 50/60/100/120 Hz
Frequency tolerance	± 2%
Voltage tolerance (on the motor terminals)	50 Hz: −10 / +6 % of U <sub>N</sub> , i.e. at a nominal voltage of 380-415 V: 380V −10 % = 342V / 415V + 6 % = 440 V 60/100/120 Hz: +/- 10% of U <sub>N</sub>
Speed	approx. 2900 rpm at 50 Hz & 3450 rpm at 60 Hz, 100 Hz approx.. 3000 rpm, 120 Hz approx. 3600 rpm
Start alternatives	Direct starting, wye-delta-starting
Switching frequency	6" - Max. 20 switching actions per hour with a minimum off time of 3 min. 8" - Max. 10 switching actions per hour with a minimum off time of 3 min.
Protection	IP 68 according to IEC 60529
Insulation class	F (155°C)

Description	Value																											
Submersion depth	max. 350 m																											
Installation location	Vertical (Mandatory mounting position: vertical, shaft up. Only one diameter step allowed, i.e. 6" motor on 8" pump). Horizontal (only allowed if the pump size is identical to the motor size, e.g. 6" motor with 6" pump). The pump has to sufficient "Down Thrust" transmit to the motor. No general warranty when built-in in booster systems.																											
Operating temperature	$\geq -3\text{ }^{\circ}\text{C}$																											
Sound pressure level	$\leq 70\text{ dB(A)}$																											
Maximum axial thrust towards the motor	<table border="0"> <tr> <td>6" Standard:</td> <td>4 - 22 kW</td> <td>15.5 kN (optional: 45kN)</td> </tr> <tr> <td></td> <td>30 kW</td> <td>27.5 kN (optional: 45kN)</td> </tr> <tr> <td></td> <td>37 / 45 kW</td> <td>45 kN</td> </tr> <tr> <td>6" PM:</td> <td>4 - 22 kW</td> <td>15.5 kN (optional: 45 kN)</td> </tr> <tr> <td></td> <td>26 - 45 kW</td> <td>27.5 kN (optional: 45kN)</td> </tr> <tr> <td>6" HighTemp90°C:</td> <td>4 - 15 kW</td> <td>15,5 kN (optional: 45 kN)</td> </tr> <tr> <td></td> <td>18,5 kW</td> <td>27,5 kN (optional: 45 kN)</td> </tr> <tr> <td></td> <td>22/30 kW</td> <td>45 kN</td> </tr> <tr> <td>8" Standard and HighTemp75°C:</td> <td></td> <td>45 kN</td> </tr> </table>	6" Standard:	4 - 22 kW	15.5 kN (optional: 45kN)		30 kW	27.5 kN (optional: 45kN)		37 / 45 kW	45 kN	6" PM:	4 - 22 kW	15.5 kN (optional: 45 kN)		26 - 45 kW	27.5 kN (optional: 45kN)	6" HighTemp90°C:	4 - 15 kW	15,5 kN (optional: 45 kN)		18,5 kW	27,5 kN (optional: 45 kN)		22/30 kW	45 kN	8" Standard and HighTemp75°C:		45 kN
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	22/30 kW	45 kN																										
8" Standard and HighTemp75°C:		45 kN																										
Maximum axial thrust away from the motor (only for a short-time load of max. 3 minutes; independent of performance rating)	<table border="0"> <tr> <td>6":</td> <td>1400 N</td> </tr> <tr> <td>8"</td> <td>30 - 75 kW 1400 N</td> </tr> <tr> <td></td> <td>93 - 150 kW 3400 N</td> </tr> </table>	6":	1400 N	8"	30 - 75 kW 1400 N		93 - 150 kW 3400 N																					
6":	1400 N																											
8"	30 - 75 kW 1400 N																											
	93 - 150 kW 3400 N																											
Material	The person placing the order is responsible for selecting the correct material, specifically as regards its resistance in the medium to be transported. WW Version: Stator 304, powder-coated castings 304SS: Stator and castings in 304SS 316SS: Stator and castings in 316SS																											
Motor fluid	FES 91 (approved, water-based emulsion); FES92 (for HighTemp 75/90 motors)																											
Weight	Technical data sheets (see appendix)																											
Storage temperature	$-15\text{ }^{\circ}\text{C}$ to $+60\text{ }^{\circ}\text{C}$																											
Short motor cable	KTW and VDE- tested (HighTemp Motors with cable without KTW approval) 6": Motor cable 4.0 m length 8": Motor cable 8.0 m length																											
Connection flange	6", 8": NEMA flange (see appendix)																											
Temperature monitoring	PT100 temperature sensor for retrofitting SubTemp (Subtrol) temperature sensor + SubMonitor Connect tripping device PTC temperature sensor (only for 6" 4 - 30 kW, sensor with cable)																											
Medium temperature	6" Standard: 4-30kW Nominal 30°C; 37/45kW Nominal 50°C 6" PM: Nominal 30°C 6" HighTemp90: Nominal 90°C 8" Standard: Nominal 30°C 8" HighTemp75: Nominal 75°C																											
Coolant flow speed (is the speed of the medium flowing along the motor casing during normal operation)	Nominal 0.16 m/sec 6" PM Motors > 22 kW: 0,5 m/sec In the event of higher media temperatures operation is only allowed if you <ul style="list-style-type: none"> <li>• reduce the performance (De-Rating)</li> <li>• increase the coolant flow speed</li> </ul>																											

## 5 Putting the motor into use

### 5.1 Checking the motor prior to installing it

If a leak is visible or if the motor is more than one year old (e.g. in the event of re-use or after long storage):

⇒ Check the fluid level in the motor prior to installing it.

**Tools** You need the following tools for assembly and inspection work:

- Insulation measuring unit: 500 VDC testing
  - Filling Kit 308 726 103
- ⇒ Determine the age of the motor by checking the type plate (see Figure 5-1).

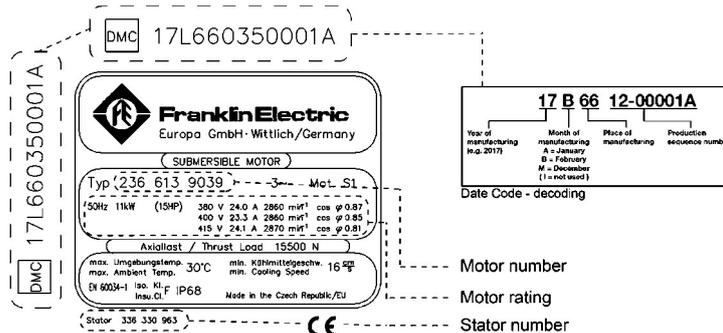


Figure 5-1: Type plate with date of manufacture

#### 5.1.1 Checking the motor fluid



**Motor damage due to being insufficiently filled!**

- ⇒ Fill the motor with sufficient motor fluid
- ⇒ Wear safety goggles and gloves when filling and draining the motor.

⇒ Top up using original motor fluid from Franklin Electric (5 litres concentrate Id. no. 308 353 941)  
**Never use distilled water!**

#### Filling volumes

- 6": max. 1.5 liter
- 8": max. 3.5 liter

#### Venting the motor

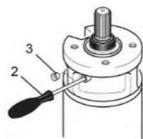


Figure 5-2: Venting the motor

- ⇒ Place the motor horizontally so that the filling valve is located at the highest position.
- ⇒ Remove the plug (3) from the filling valve.

Carefully push the test pin (2) into the filling valve until air and some fluid escape from it.

#### Checking the motor

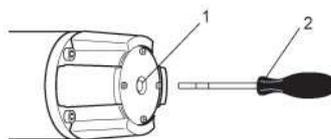


Figure 5-3: Checking the motor fluid

- ⇒ Feed the test pin (2) through the opening (1) in the diaphragm housing until you can feel resistance.
- ⇒ Measure the actual diaphragm distance to the side of the opening in the diaphragm cover.  
If the measured result is not identical to the target value:  
59 mm ± 2 mm (6"- motor-WW 4-30kW)  
25 mm ± 2 mm (6"- motor-304SS/316SS / 4-30kW)  
47 mm ± 2 mm (6"- motor-304SS/316SS - 37/45kW)  
47 mm ± 2 mm (6"- HighTemp90, 304SS/316SS)  
44 mm ± 2 mm (6"- 45kN Version)  
37 mm ± 2 mm (8"- motors all)

### Topping up the motor

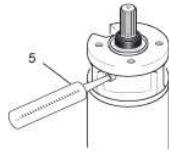


Figure 5-4: Topping up the motor fluid

- ⇒ Top up or drain motor fluid.
- ⇒ Apply the filling syringe (5) to the filling valve.
- ⇒ Top up the motor filling fluid until the value of the diaphragm position is lower than the target value.

- Adjusting the motor**
- ⇒ Adjust the diaphragm position by draining (see Venting) or topping up motor fluid until the target value is reached.
  - ⇒ Fit the plug (3) again.

## 5.2 Motor and pump assembly



**Note**

*This assembly and operating instructions only describe action steps related to the motor. You should also observe the pump unit manufacturer's instructions in all events.*

- Preparation**
- Short motor cable fitted (see 5.3.1)
  - Shaft protector removed
  - Motor shaft rotated manually before assembly – runs freely after overcoming static friction
  - Surfaces of parts to be connected are free from dust and dirt
  - Coupling attached to the pump shaft, slides on the motor shaft

### Assembly

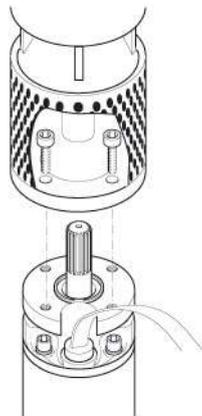


Figure 5-5: Pump assembly

- ⇒ Apply water-resistant, FDA approved, approved-free grease (e.g. Mobil FM 102, Texaco Cygnus) to the inner part of the coupling to the pump unit.
- ⇒ Make sure that the splined section is encased by an O-ring when the motor and the pump unit are assembled together.
- ⇒ Align the pump unit and motor shaft to each other, connect the pump unit and the motor.
- ⇒ Screw the motor to the pump unit, tighten the fixing screws crosswise as instructed.
  - 6": ½"-20 UNF-2B
  - 8": Bore Ø 17.5 mm
- ⇒ Protect the coupling location against contact.

## 5.3 Motor cable



**CAUTION**

**Motor damage due to damaged motor cable!**

- ⇒ Make sure that the motor cable is not in contact with any sharp edges.
- ⇒ Protect the cable against damage using the cable guard.

### 5.3.1 Connecting the short motor cable



**Note**

⇒ Always a **new** cable must be used

**Tools and Torques**

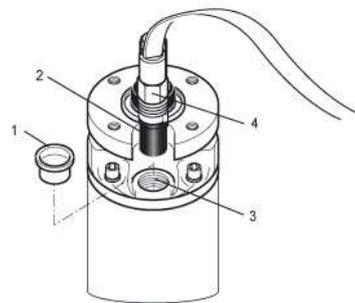
You need to use the following tools and torques for assembly and inspection work:

- 6" Motors WW (all Ratings) 60 N/m  $\pm$ 6 N/m; Wrench 1 3/16" (30,2 mm)
- 6" Motors 304SS/316SS (all Ratings) 60 N/m  $\pm$ 6 N/m; Wrench 1 3/16" (30,2 mm)
- 8" Motors (30 – 93kW) 74 N/m  $\pm$ 7 N/m; Wrench 1 3/16" (30,2 mm) oder 1 5/8" (42 mm)
- 8" Motors (110 – 150kW) 9,0 N/m  $\pm$ 1 N/m, Allen Key 3/16" (4,7 mm)

**Preparation**

- Remove the sealing plug (1)
- Clean and dry the surfaces of the plug (2) and the socket (3)

**Assembly**



- ⇒ Pull back the jam nut (4) until the plug (2) is free
- ⇒ Apply FDA approved grease or Vaseline to the rubber casing surfaces
- ⇒ Apply acid-free grease to the thread of the union nut
- ⇒ Insert the plug (4) in the socket (3)

Figure 5-5: Connection of the short motor cable

### 5.3.2 Extending the motor cable

- The unit manufacturer's instructions regarding the cable connection have been observed
- Only extension cable and insulating material used which are suitable for the specific use (specifically drinking water) and which are approved for the temperatures occurring in the relevant medium
- Cable cross-sections: The tables in the appendix only serve as recommended suggestions. The fitter is responsible for the correct selection and dimensioning of the cable
- ⇒ Lay the cable along the pump.
- ⇒ Connect the ground conductor correctly (motors or integrated ground conductors are prepared for external grounding).
- ⇒ Protect the cable connection location against water penetration (shrink hoses, compounds or ready cable sets).
- ⇒ Make sure that the short motor cable is always fully surrounded by transport medium for proper cooling during operation.

## 5.4 Measuring the insulation resistance

This measurement is to be carried out using an insulation measuring unit (500 VDC) before and while submersing the fully assembled unit at the place of use.

- ⇒ Before submersing the unit, connect a measuring cable to the ground conductor.
- ⇒ Make sure that the contact points are clean.
- ⇒ Connect the other measuring cable to every core of the connected motor cable in succession. The insulation resistance is shown on the insulation measuring unit.

**For your information** Minimum insulation resistance (500 VDC; 1 min.; 20°C) **with extension cable:**

- for a new motor > 4 MΩ
- for a used motor > 1 MΩ

Minimum insulation resistance (500 VDC; 1 min.; 20°C) **without extension cable:**

- for a new motor > 400 MΩ
- for a used motor > 20 MΩ

## 5.5 Making the electrical motor connection

Following a new installation or maintenance works of the motor-driven pump system, it is required to carry out a resistant measurement on the earth wire. This measurement is to be done in compliance with the applicable regulations and with the appropriate measuring devices.



### **Danger to life due to electrocution!**

⇒ Prior to making the electrical motor connection make sure that there is no more voltage on the entire plant and that nobody can accidentally switch on the voltage again while the work is being carried out.

Observe the instructions on the motor type plate and dimension the electrical system accordingly. The connection examples in this chapter concern the actual motor and do not serve as recommendation for the upstream control elements.

### Energy supply by generator

- All action steps of the previous chapter have been carried out properly
- Additional safety instructions for submersible synchronous motors



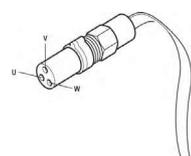
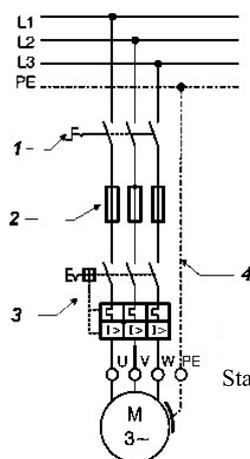
### **Note**

We urgently recommend that you discuss the plant dimensions with the generator manufacturer.

The voltage tolerance  $-10\%$  to  $+6\%$  -50Hz and  $\pm 10\%$  - 60Hz motors (on the motor terminals) and the deviation of a motor current from the mean value of all three currents must not be more than 5 %.

- Generator selected on the basis of the motor start behaviour, i.e. starting current with a mean  $\cos \phi$  of 0.5
  - Sufficient continuous generator power available
  - Voltage at start at least 55 % of the nominal voltage
- ⇒ You must follow the following switch-on sequences unconditionally:  
 first switch on the generator and then the motor.  
 first switch off the motor and then the generator.

### Fusing and motor protection

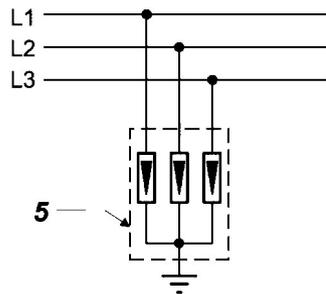


- ⇒ Provide an external mains switch (1) enabling the voltage to be removed from the system.
- ⇒ Provide fuses (2) for every single phase on site.
- ⇒ Provide a motor starting and protection switch (3) (see connection alternatives)
- ⇒ Provide an emergency stop system, if required for your specific application.
- ⇒ Ground the motor (4) (exterior grounding possible with all motors)

Standard:	6" PM	6" HiTemp90
U = black	U = grey	U = black
V = grey (blue)	V = brown	V = white
W = brown	W = black	W = red

Figure 5-10: Fusing and motor protection

**Surge voltage protection**

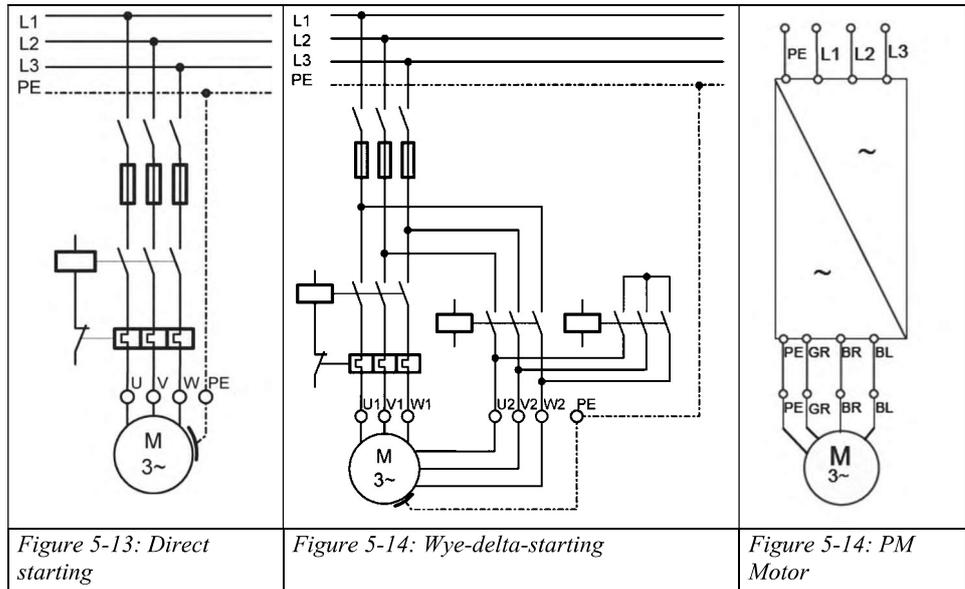


⇒ Integrate an overload protector in accordance with IEC 60099 in the power supply (lightning safety (5)).

Figure 5-12: Surge voltage protection

**Connection alternatives**

The motors can be used for clockwise and anti-clockwise rotation. The connection example shows the usual circuit with a right-hand field and an anti-clockwise direction of rotation:



**Motor safety switch**

A motor safety switch (overload relay) is absolutely necessary!

Only use thermal trips of tripping categories 10A or 10, with

- ⇒ tripping time < 10 s at 500 %  $I_N$  (nominal current),
- ⇒ phase sensitivity,
- ⇒ temperature compensation from 20 to 40 °C.
- ⇒ Set the motor protection unit to the value of the operating current measured without exceeding the rated motor current  $I_N$  (as indicated on the type plate).

## 6 Motor operation

### 6.1 Making sure that the motor is cooled sufficiently



**Caution**

#### *Damage to the motor and the motor cable due to overheating*

- ⇒ Make sure that the coolant flow speed along the motor is sufficient.
- ⇒ Make sure that the short motor cable is always fully surrounded by transport medium for proper cooling.

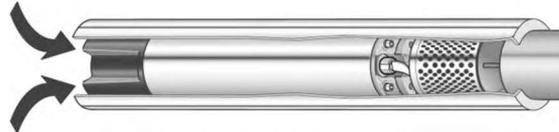


Figure 6-1: Cooling tube

If the required minimum coolant flow speed cannot be reached (e.g. if the inlet opening of the well is located above the motor or if using large-diameter wells):

- ⇒ Fit a cooling tube (see figure 6-1).
- ⇒ Make sure that the cooling tube encases the entire motor and the pump water inlet opening.  
The motor is force-cooled.

### 6.2 Providing a check valve and a level sensor

- ⇒ Provide one spring-loaded check valve in the production tube in case no such check valve has been fitted in the pump.
- ⇒ Ensure that the first check valve is no further than 7 m (metres) away from the pump.
- ⇒ Install a level sensor for wells with a highly varying water inflow.

### 6.3 Switching on the motor

- ☑ All action steps of the previous chapter have been carried out properly
- ⇒ Switch on the motor using the mains switch in the control cabinet.
- ⇒ Measure the following values after switching on:
  - Motor operating current in every phase
  - Mains voltage when motor is running
  - Level of the medium to be transported
- ⇒ **Immediately switch off the motor if:**
  - the nominal current as specified on the type plate is exceeded,
  - voltage tolerances of more than -10 % / +6 % to 50Hz and +/- 10% to 60/100/120Hz, relative to the nominal voltage are measured on the motor,
  - there is a risk of the motor running dry,
  - a motor current deviates from the mean value of all three currents by more than 5 %.

### 6.4 Operating a motor with a frequency converter



#### **Note**

*When operating a motor with a frequency converter, the relevant operating manual must be observed!*

- ⇒ Permanent magnet motors are to be operated by Variable frequency drive (VFD)
- ⇒ VFD operation is only permitted up to a supply voltage of 460 V. For higher voltages, please contact Franklin Electric Europa GmbH.
- ⇒ Make sure that the motor current in all operating levels of the regulating range does not exceed the nominal motor current indicated on the type plate.

- ⇒ Adjust the frequency converter so that the limit values for the nominal motor frequency of min. 30 Hz and max. the value of the nominal motor frequency are observed.
- ⇒ Limit any voltage peaks on the motor when using a frequency converter to the following values: max. voltage rises 500 V/μs, max. voltage peak 1000V.
- ⇒ Make sure that the running up time from 0 to 1800 rpm and the deceleration time from 1800 to 0 rpm is maximum one second.
- ⇒ Dimension the cable such that power loss due to additional filters is taken into consideration.
- ⇒ Make sure that the required coolant flow speed along the motor is also observed with frequency converter operation.

## 6.5 Operating a motor with a soft starter



**Note**

*When operating a motor with a soft starter, the relevant operating manual must be observed!*

- ⇒ Set the starting voltage of the soft starter to 55 % of the nominal voltage and set the running up and delay times to max. three seconds.
- ⇒ Bridge the soft starter after running up, using a contactor.

## 7 Maintenance and service

The motor is maintenance-free; no maintenance or service activities are necessary.

## 8 Troubleshooting

Fault	Remedy
Unusual noises, problems with the true running of the pump or the pump switching on and off too frequently.	⇒ Try to find the cause of the fault on the pump unit.
The pump repeatedly switches off	<ul style="list-style-type: none"> <li>⇒ Have the insulation resistance checked by a professional (see chapter 5.4).</li> <li>⇒ If no cause can be found in the motor or the motor cable: Have the electrical system checked.</li> </ul>

## 9 Service

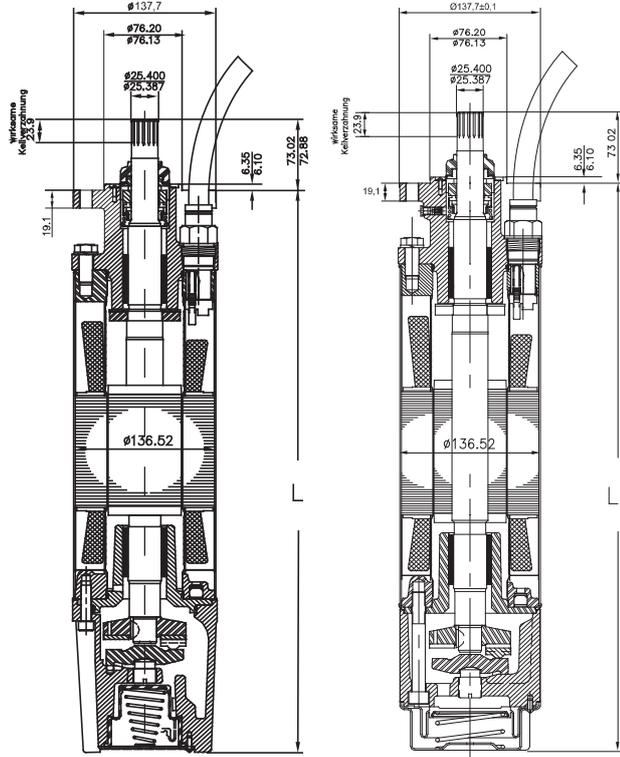
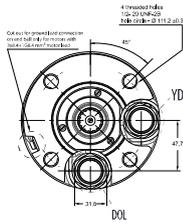
- Repairs must only be carried out by authorised professional workshops (only use original Franklin Electric spare parts).
- Please note the additional safety instructions for submersible synchronous motors
- If you have any questions or problems, please contact your dealer or contact Franklin Electric via web: [franklinwater.eu](http://franklinwater.eu) or mail to [service-de@franklinwater.eu](mailto:service-de@franklinwater.eu).

## 10 Appendix

Page	Explanation
Page A	Outline drawings 6" / 8" Standard Motors
Page B	Outline drawings HiTemp 75/90 Motors
Page C	Motor Test Report (MTR)
Page D	Cable cross-sections DOL and YD



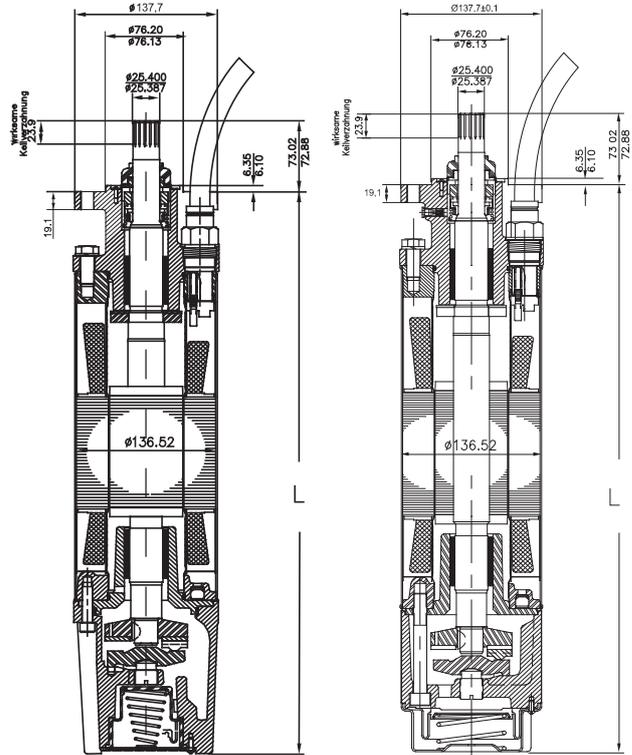
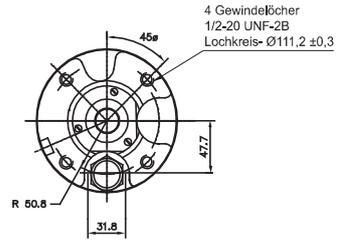
6" Encapsulated



WW (Water Well)

304SS / 316SS

6" Encapsulated PM



WW (Water Well)

304SS / 316SS

P <sub>N</sub> [kW]	WW L [mm]	304SS* L [mm]	316SS** L [mm]	Motor Package Size [mm]	Shipping Weight [kg]***	
					DOL	YΔ
4	581,2	570,7	570,7	155 x 212 x 800	41,3	40,3
5,5	614,4	604,0	604,0		44,9	43,9
7,5	646,2	635,8	635,8		49,0	48,0
9,3	678,7	668,3	668,3	155 x 212 x 1070	51,3	50,3
11	711,2	700,8	700,8		54,7	53,7
15	776,2	765,8	765,8		60,5	59,5
18,5	841,5	831,1	831,1		67,1	66,1
22	906,5	896,1	896,1		73,1	72,1
30	1036,6	1026,2	1026,2	155 x 212 x 1200	87,7	87,7
37	-	1476,7	1476,7	223 x 267	136	
45	-	1629,2	1629,2	x 1823	156	

P <sub>N</sub> [kW]	WW L [mm]	304/316 L [mm]	Motor Package Size [mm]	Shipping Weight [kg]
4 - 11	634,5	625,2	155 x 212 x 800	45
13 - 22	793,5	784,2	155 x 212 x 1070	61
26 - 45	1020,5	1011,2		84

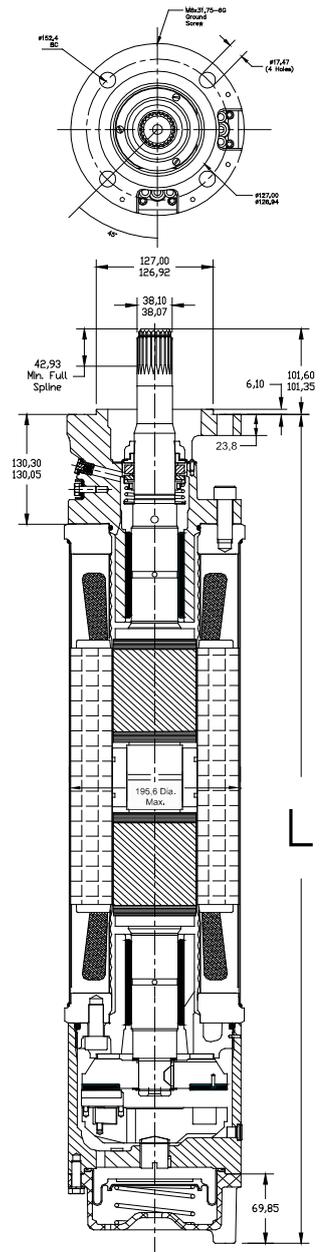
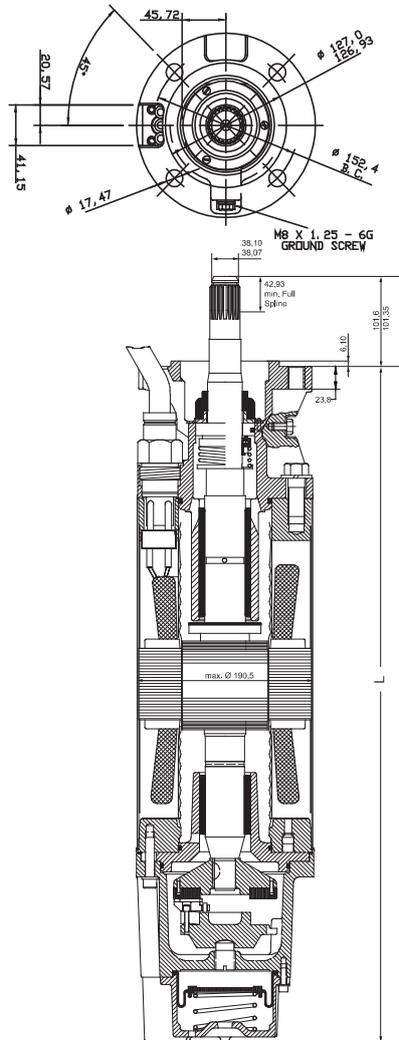
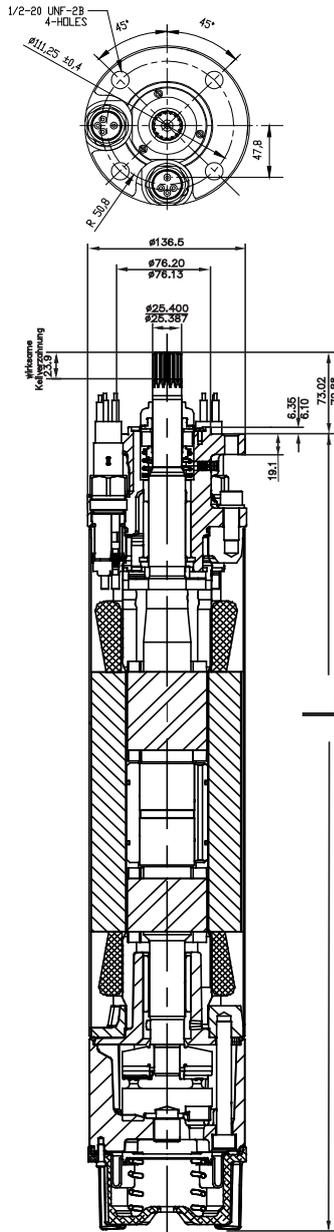
\* HighThrust Version + ~60mm  
 \*\* HighThrust Version + ~70mm  
 \*\*\* HighThrust Version + ~4Kg



**6" Encapsulated  
HighTemp 90°C**

**8" Encapsulated**

**8" Encapsulated  
HighTemp 75°C**



P <sub>N</sub> [kW]	L [mm]	Motor Package Size [mm]	Shipping Weight [kg]
3.7	670,5	190,5 x 273,5 x 876,3	55
5.5	735,5		61
7.5	800,6		68
11	866		73
15	931		81
18,5	1061		94
22	1429	222,2 x 273,5 x 1822,4	138
30	1581,6		152

P <sub>N</sub> [kW]	L [mm]	Motor Package Size [mm]	Shipping Weight [kg]
30	925	228 x 430 x 1308	145
37	1000		157
45	1077		172
55	1264		227
75	1455		265
93	1748		318
110	1976		381
130	2179		420
150	2408		494

P <sub>N</sub> [kW]	L [mm]	Motor Package Size [mm]	Shipping Weight [kg]
30	1138	432 x 245 x 1295	182
37	1265		207
45	1455		252
55	1747		318
75	1976		382
93	2179		421
110	2408		473



FEE - NO.: \_\_\_\_\_

VISIT DATE: \_\_\_\_\_

### Motor Test Report

Additional comments under "Remarks"

<b>1. CUSTOMER / USER</b>			
Company: _____	Country: _____	Town: _____	
Talked To: _____	Tel.: _____	Assembler: _____	
<b>2. MOTOR</b>			
Model-Nb.: _____	Rating [kW]: _____	Voltage [V]: _____	Hz: _____
Date Code: _____	Sequenz-Nb.: _____	Stator-Nb.: _____	Material: _____
Built in: _____	Equipped for: _____	Worked with: _____	
Worked for: <input type="checkbox"/> Month: _____	<input type="checkbox"/> Days: _____	<input type="checkbox"/> Hours: _____	<input type="checkbox"/> Date failed: _____
<b>3. INSTALLATION</b>			
<input type="checkbox"/> Vertical	<input type="checkbox"/> Horizontal	Pump Make: _____	Type: _____
Well depth [m]: _____	Well diameter [cm]: _____	Pump at [m]: _____	Water inlet at [m]: _____
Cable lenght [m]: _____	Cable square[m]: _____	Protection make: _____	Type: _____
Water: _____	Temperature: _____	PH-Value: _____	Setting [A]: _____
<b>4. EXTERNAL MEASUREMENTS</b>			
Shaft high: _____	Upper End Bell: _____	Shaft Rotation: _____	Slinger: _____
Stator Shell: _____	Lower End Bell: _____	Deposits: _____	Valve: _____
Splines: _____	Diaphragm Pos.: _____	Lead Insul.: _____	Connector: _____
Nameplate: _____	Leakage: _____	Lead Clamp: _____	Hi-Pot: _____
Lead Sealing: _____	Plug Resin: _____		
<b>5. ELECTRICAL MEASUREMENTS</b>			
Phase 1 [Ω]: _____	Phase 2 [Ω]: _____	Phase 3 [Ω]: _____	
Mainphase [Ω]: _____	Startphase [Ω]: _____	Insulation Resist. [MΩ]: _____	
<b>6. TEARDOWN</b>			
Prong: _____	Windings: _____	Winding Splicing: _____	
Filling Liquid: _____	Diaphragm: _____	Segments: _____	
Thrust Bearing: _____	Lower Radial Bearing: _____	Upper Radial Bearing: _____	
Sleeve Lower Shaft End : _____	Sleeve Upper Shaft End : _____	Up-Thrust Bearing: _____	
Shaft Seal : _____	Liner : _____	Rotor Core PM: _____	
Stator Endring : _____	Cage Thrust Bearing : _____	Pressure Test Line : _____	
Pressure Test Stator PU : _____			
<b>7. CONTROL BOX</b>			
Control Box Type: _____	Defective: _____		
<b>8. REMARKS</b>			
Tech. Warranty : _____	Com. Warranty: _____	<input type="checkbox"/> Repair	<input type="checkbox"/> Scrap
Signature: _____	Date: _____	Entered into EDP: _____	Defect: _____ Cause: _____
			Date: _____



maximum lengths in meters for 400V / 50Hz and 3% voltage drop at 50°C ambient temperature and 90°C at copper wire																			
Jacketed Drop Cable Length																			
DOL - Delta start																			
rating		cable size mm <sup>2</sup> , copper wire - 90°C rated insulation																	
KW	HP	2,5	4	6	8,4	10	16	25	35	50	70	95	120	150	185	240	300	400	500
4	5,5	95	155	230	325	385	605	915											
5,5	7,5	70	110	170	235	280	440	670	915										
7,5	10	50	80	126	175	205	325	500	685	935									
9,3	12,5	40	65	100	145	170	270	410	565	770	1030								
11	15		55	85	120	140	225	345	470	645	865	1110							
13	17,5		50	75	105	125	195	300	410	560	750	965							
15	20		40	65	90	105	170	265	360	495	665	855	1030						
18,5	25			50	75	85	140	210	290	400	530	680	810	950					
22	30				64	75	120	180	250	340	455	585	700	815	945				
26	35					60	100	150	210	290	385	500	600	705	815	970			
30	40						85	135	185	250	335	430	515	600	695	820	935		
37	50							105	150	205	270	350	420	485	565	665	760	875	980
45	60							90	125	175	235	310	375	445	520	630	730	860	980
52	70							80	110	155	210	270	325	385	450	540	625	735	840
55	75								105	145	195	255	305	360	420	505	580	685	770
60	80								95	135	185	240	290	345	400	485	560	660	750
67	90									120	160	210	255	300	350	415	480	565	640
75	100									105	145	185	225	270	315	375	435	510	580
83	111									95	130	170	210	250	290	350	405	480	540
85	114										125	160	195	230	265	315	365	425	480
93	125										115	150	185	215	255	300	350	410	460
110	150											120	145	170	200	235	270	310	350
130	175												130	155	180	215	250	290	330
150	200													145	170	205	235	275	280
185	250															140	160	185	210
220	300															130	150	175	200
250	335																125	145	160
300	400																		150
350	470																		120
400	540																		

Wye - Delta start																			
rating		cable size mm <sup>2</sup> , copper wire - 90°C rated insulation																	
KW	HP	2,5	4	6	8,4	10	16	25	35	50	70	95	120	150	185	240	300	400	500
4	5,5	145	230	350	485	575	900												
5,5	7,5	106	170	250	350	420	660	1010											
7,5	10	75	125	185	260	310	490	750	1025										
9,3	12,5	60	100	155	215	255	405	620	845	1160									
11	15	50	85	130	180	210	340	520	715	980									
13	17,5	45	75	110	155	185	295	450	615	845	1125								
15	20	40	65	95	135	160	260	395	540	740	995								
18,5	25	30	50	80	110	130	210	320	435	600	800	1025							
22	30		45	65	95	110	180	275	375	510	685	875	1050						
26	35		35	55	80	95	150	230	315	435	580	750	900	1055					
30	40			50	70	80	130	200	275	375	500	645	775	905	1045				
37	50				55	65	105	160	220	305	410	525	625	730	845	1000			
45	60					55	90	135	190	260	355	460	560	665	780	945	1095		
52	70					50	80	120	165	230	310	405	490	580	680	815	940		
55	75						75	115	155	220	295	380	460	545	635	760	875	1025	
60	80						70	105	145	205	275	360	435	510	605	725	840	990	1130
67	90						60	95	130	180	240	315	380	450	525	625	720	845	960
75	100							85	115	160	215	280	340	405	470	565	655	765	875
83	111							75	105	145	200	260	315	375	435	525	610	715	820
85	114							70	100	135	185	240	290	345	400	475	550	640	725
93	125							65	95	130	175	230	275	325	380	455	525	615	695
110	150									105	140	180	220	255	300	355	405	465	525
130	175									95	125	160	195	230	270	325	375	435	495
150	200										105	140	170	200	230	275	320	400	420
185	250											110	130	155	180	210	240	280	315
220	300												115	140	160	195	225	260	300
250	335													105	125	140	170	220	250
300	400														110	125	150	175	205
350	470															125	145	170	190
400	540															110	130	150	170

The voltage drop losses in the cable cross-section has a linear uniformity and can easily be converted from 3% to the respective voltage drop losses and the resulting length. An example: 45 KW motor DOL with cable cross section 25mm<sup>2</sup> has a max. cable length of 90 meters. What length can be achieved up to 5% voltage drop losses? Calculation: Length 90 m / 3 (%) x 5 (%) = 150 m



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**Franklin Electric**



## **Franklin Electric**

Franklin Electric Europa GmbH  
Rudolf Diesel Strasse 20  
54516 Wittlich / Germany

Single member - Company subject to the control  
and coordination of Franklin Electric Co., Inc.

NOTE: Franklin Electric Europa GmbH reserves the right to amend specification without prior notice.



# **VS 8" Series**

## **50 Hz**

### **VS 78 - 97**



## 8" STAINLESS STEEL SUBMERSIBLE PUMPS

### APPLICATION

- Municipal water works
- Water distribution and pressure boosting
- Irrigation and sprinkler systems, water treatment plants, filtration and reverse osmosis
- Industrial cooling and processing
- Mining industry, drainage and dewatering
- Fire-fighting equipment
- Fountains

### FEATURES

- Stainless steel components for durability and robustness, guaranteeing longevity and trouble-free operation. Many design technical features make this pump range very compact and extremely reliable, to ensure applications in the most complex and severe conditions.
- External stainless steel sleeve to improve stiffness and assure permanent alignment of all the components
- Motor adapter and discharge head may be removed without disturbing the impeller / diffuser stack
- Built-in check valve and over size pump shaft
- Easy maintenance without the need of special tools

### PUMP SPECIFICATION

- Flow: up to 120 m<sup>3</sup>/h at 50 Hz
- Head: up to 500 m (50 Bar) at 50 Hz
- Water temperature range: Minimum: -5 °C  
Maximum: +60 °C for all versions
- Maximum allowable amount of sand 100 g/m<sup>3</sup>
- Rotation: counter clockwise when looking into the discharge
- Pump can work continuously in vertical or horizontal position

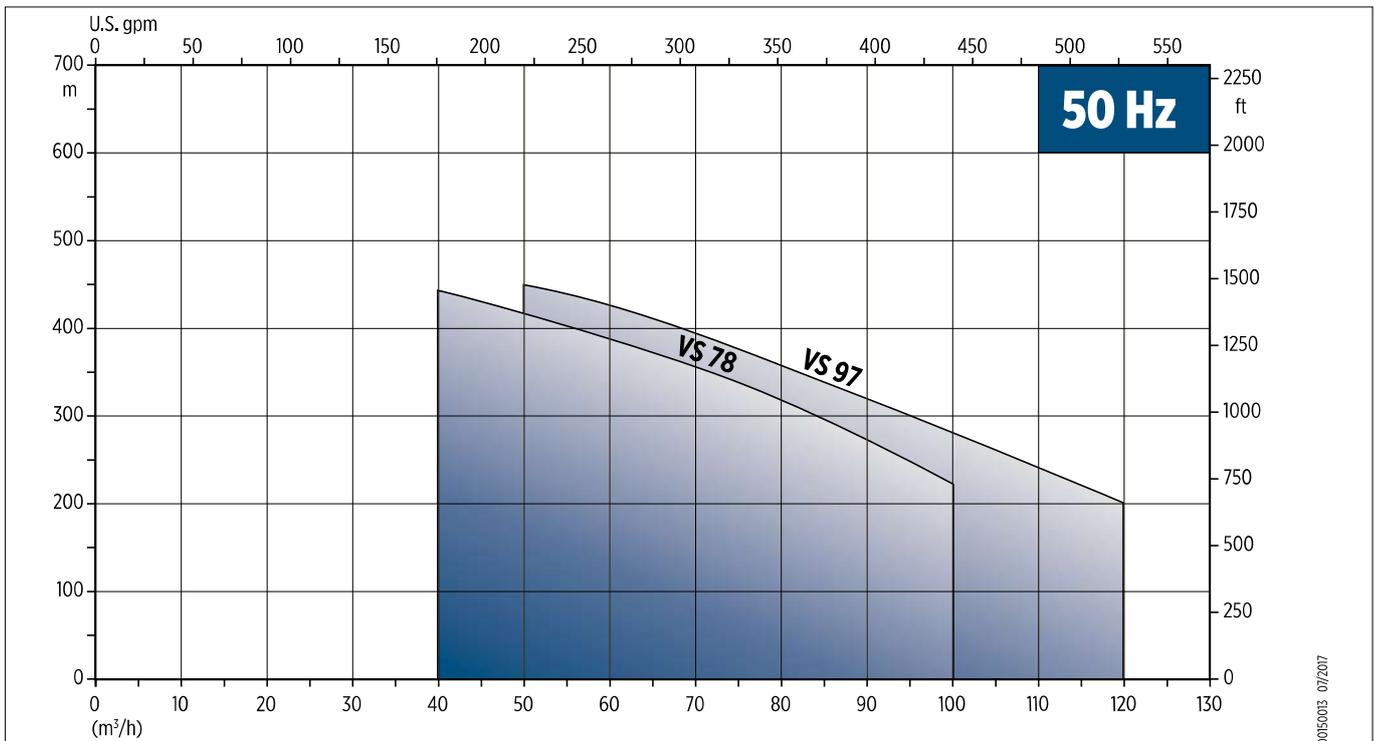
### MOTOR SPECIFICATION

- Motor adapter in compliance with NEMA standard
- For more information consult the product catalog of Submersible motors

### AVAILABLE ON REQUEST

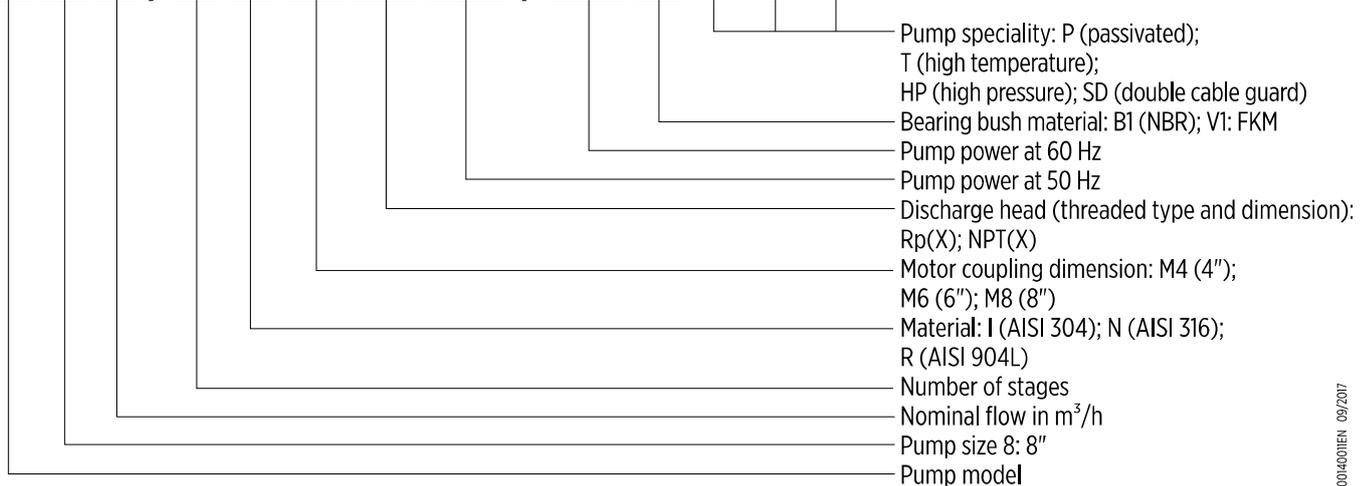
- Pump material: 316 Stainless steel (N) version (DIN/EN 1.4401)  
904L (R) version (DIN/EN 1.4539)  
See specified material variant in Materials/fluids compatibility table on page 50
- Double cable guard
- Discharge head: Rp 4" for I and N versions  
Rp 6" for R version

## FAMILY CURVES



## PUMP IDENTIFICATION CODE

VS 8 78 / 15 I M8 Rp5 5505 / 9306 B1 P HP SD



## PUMPS AND MOTORS RANGE

Type	Versions			Motor power range [kW]	
	I EN 1.4301	N EN 1.4401	R EN 1.4539	I e N	R
VS78	○	○	●	7.5 ÷ 93	30 ÷ 93
VS97	○	○	●	9.3 ÷ 110	30 ÷ 93

○ = Version available ● = Version available only with 6" motor coupling

## MATERIALS/FLUIDS COMPATIBILITY

Pos.	Parts description	Type	Material					
			I Version		N Version		R Version	
			AISI	DIN / EN	AISI	DIN / EN	AISI	DIN / EN
10.00	Discharge head	Stainless steel	304	1.4301	316	1.4401	904L	1.4517
10.01	Valve	Stainless steel	316	1.4401	316	1.4401	2205	1.4462
10.02	Sealing O-ring	-	NBR		NBR		NBR	
10.03	Outer case locking nuts	Stainless steel	316	1.4401	316	1.4401	2205/904L	1.4462/1.4539
10.04	Valve support	Stainless steel and PTFE	316	1.4401	316	1.4401	904L	1.4539
10.05	Seeger ring	Stainless steel	316	1.4401	316	1.4401	904L	1.4539
10.06	Spring	Stainless steel	316	1.4401	316	1.4401	2205	1.4462
20.00	Outer case	Stainless steel	304	1.4301	316	1.4401	2205	1.4462
20.01	Suction strainer	Stainless steel	316	1.4401	316	1.4401	904L	1.4539
20.02	Cable guard	Stainless steel	316	1.4401	316	1.4401	904L	1.4539
20.03	Initial spacer	Stainless steel	316	1.4401	316	1.4401	904L	1.4539
20.04	Flange and screws	Stainless steel	304	1.4301	316	1.4401	904L	1.4517/1.4539
20.05	Motor adapter	Stainless steel	304	1.4301	316	1.4401	904L	1.4517
30.00	Pump shaft	Stainless steel	329	1.4460	329	1.4460	329	1.4460
30.01	Coupling	Stainless steel	431/ 329	1.4057/ 1.4460	316/ 329	1.4401/ 1.4460	2205/ 904L	1.4462/ 1.4539
30.02	Upper up-thrust washer	Stainless steel	329	1.4460	329	1.4460	329	1.4460
30.03	Lower up-thrust washer	Stainless steel	329	1.4460	329	1.4460	329	1.4460
30.04	Upper journal sleeve <sup>(1)</sup>	Stainless steel with ceramic casting	-	-	-	-	-	-
30.05	Screw and washer	Stainless steel	316	1.4401	316	1.4401	904L/329	1.4539/1.4460
30.06	Up-thrust ring	PTFE + Graphite	-	-	-	-	-	-
40.00	Diffuser	Stainless steel	304	1.4301	316	1.4401	904L	1.4539
40.01	Secondary bearing bush	-	NBR		NBR		NBR	
40.02	Floating neck ring	PTFE	-	-	-	-	-	-
40.03	Flange clamping neck ring	Stainless steel	316	1.4401	316	1.4401	904L	1.4539
50.00	Impeller	Stainless steel	316	1.4401	316	1.4401	904L	1.4539
50.01	Split cone	Stainless steel	316	1.4401	316	1.4401	329	1.4460
50.02	Split cone nut	Stainless steel	316	1.4401	316	1.4401	329	1.4460

1) Only for models with more than 8 stages

## VS 78

TABLE OF HYDRAULIC PERFORMANCE AT 50 HZ

Pump model	R Vers.	RATED POWER		Q = DELIVERY										
				m <sup>3</sup> /h 0	30	40	50	60	70	80	90	100	110	120
				l/min 0	500	666	833	1000	1166	1333	1500	1666	1833	2000
		[kW]	[HP]	H = TOTAL HEAD METERS COLUMN OF WATER [m]										
VS 78/2	●	7.5	10	40	38	35	32	30	29	24	20	18		
VS 78/3	●	11	15	60	55	51	49	45	41	36	30	24		
VS 78/4	●	15	20	80	74	70	65	60	55	49	41	32		
VS 78/5	●	18.5	25	99	92	88	81	75	69	60	51	41		
VS 78/6	●	22	30	119	110	104	98	89	81	71	60	49		
VS 78/7	●	30	40	139	130	122	114	105	96	85	72	58		
VS 78/8	●	30	40	159	149	140	131	120	110	98	82	67		
VS 78/9	●	30	40	180	168	158	147	135	123	110	92	73		
VS 78/10	●	37	50	197	183	172	160	148	134	119	100	79		
VS 78/11	●	37	50	216	202	190	176	162	148	130	110	87		
VS 78/12	●	45	60	248	232	219	205	189	172	153	131	106		
VS 78/13	●	55	75	269	252	237	221	205	188	168	142	115		
VS 78/14	●	55	75	289	271	256	239	220	201	180	153	123		
VS 78/15	●	55	75	309	290	274	255	235	215	192	165	132		
VS 78/16	●	75	100	332	311	294	275	252	231	208	177	143		
VS 78/17	●	75	100	352	330	312	291	269	246	220	188	151		
VS 78/18	●	75	100	373	350	330	309	284	260	232	198	161		
VS 78/19	●	75	100	394	370	348	325	300	275	245	210	170		
VS 78/20	●	75	100	415	389	368	343	316	290	259	220	179		
VS 78/21	●	75	100	436	409	385	360	331	304	271	231	189		
VS 78/22	●	93	125	457	428	404	378	347	320	284	243	198		
VS 78/23	●	93	125	478	446	421	394	362	332	297	254	207		
VS 78/24	●	93	125	498	467	440	411	379	348	310	265	216		

● = Pump available in R (AISI 904L) version

## VS 97

TABLE OF HYDRAULIC PERFORMANCE AT 50 Hz

Pump model	R Vers.	RATED POWER		Q = DELIVERY										
				m <sup>3</sup> /h 0	30	40	50	60	70	80	90	100	110	120
				l/min 0	500	666	833	1000	1166	1333	1500	1666	1833	2000
		[kW]	[HP]	H = TOTAL HEAD METERS COLUMN OF WATER [m]										
VS 97/2	●	9.3	12.5	42	41	39	36	32	30	29	26	22	19	15
VS 97/3	●	15	20	63	60	58	53	49	45	42	39	33	29	21
VS 97/4	●	18.5	25	84	81	77	71	65	60	57	51	45	38	30
VS 97/5	●	22	30	104	101	95	88	80	74	69.5	62	55	46	37
VS 97/6	●	30	40	127	122	115	107	98	90	84	77	68	57	46
VS 97/7	●	30	40	148	143	135	123	115	106	99	90	79	68	52
VS 97/8	●	37	50	168	160	151	140	130	120	110	100	88.5	74	59
VS 97/9	●	37	50	188	180	170	158	147	133	124	113	99	83	66
VS 97/10	●	45	60	219	211	200	185	172	159	148	137	120	103	82
VS 97/11	●	55	75	241	232	220	204	189	175	162	149	132	113	91
VS 97/12	●	55	75	262	253	240	221	207	191	178	162	143	123	99
VS 97/13	●	55	75	284	275	260	241	223	207	191	177	155	132	108
VS 97/14	●	75	100	309	297	282	261	242	226	209	191	169	145	121
VS 97/15	●	75	100	330	319	303	280	260	240	222	205	181	155	130
VS 97/16	●	75	100	352	340	322	299	279	258	238	220	194	165	139
VS 97/17	●	75	100	373	361	342	319	294	272	252	232	207	176	147
VS 97/18	●	93	125	398	382	363	337	313	289	268	247	219	188	155
VS 97/19	●	93	125	419	403	382	354	330	305	282	260	230	197	164
VS 97/20	●	93	125	440	423	404	372	347	320	298	273	241	208	171
VS 97/21	●	93	125	462	445	422	391	363	337	312	289	255	219	171
VS 97/22		110	150	484	466	442	410	381	353	328	301	267	229	190
VS 97/23		110	150	507	487	463	430	399	370	341	315	279	239	199

● = Pump available in R (AISI 904L) version

# VS 78 50 Hz

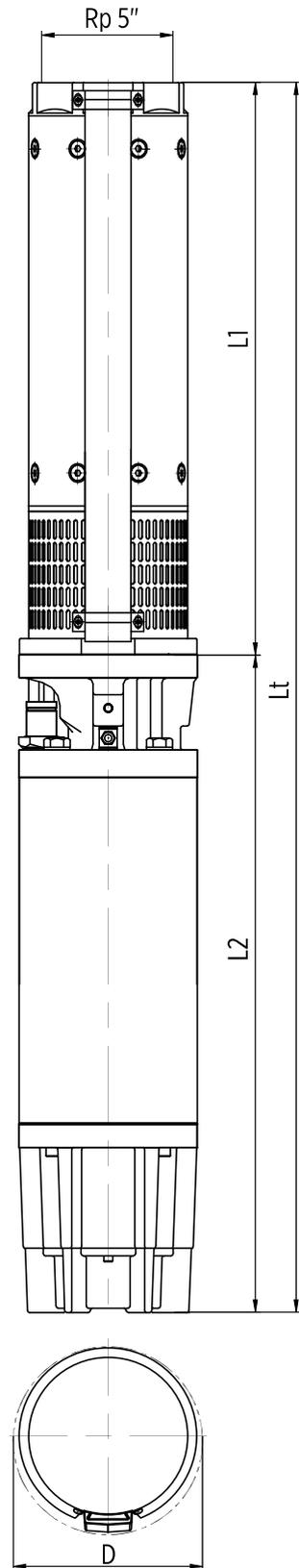
## TECHNICAL DATA - PUMPS WITH ENCAPSULATED MOTOR

Pump model	Motor			Dimensions					Pump weight [Kg]
	Type	[kW]	[HP]	L1 [mm]	L2 [mm]	Lt [mm]	D [mm]		
							1 cable	2 cable	
VS 78/2	E6	7.5	10	644	646	1290	188	194	77
VS 78/3	E6	11	15	770	771	1481	188	194	87
VS 78/4	E6	15	20	896	776	1672	188	194	57
VS 78/5	E6	18.5	25	1022	841.5	1863.5	188	194	109
VS 78/6	E6	22	30	1148	906.5	2054.5	188	194	120
VS 78/7	E6	30	40	1274	1036.5	2310.5	188	194	140
VS 78/8	E6	30	40	1400	1036.5	2436.5	188	194	145
VS 78/9	E6	30	40	1526	1036.5	2562.5	188	194	150
VS 78/10	E6	37	50	1652	1405	3057	188	194	206
VS 78/11	E6	37	50	1778	1405	3183	188	194	211
VS 78/12	E8	45	60	1909	1077	2986	200	202	254
VS 78/13	E8	55	75	2035	1394	3429	200	202	259
VS 78/14	E8	55	75	2161	1394	3555	200	202	294
VS 78/15	E8	55	75	2287	1394	3681	200	202	299
VS 78/16	E8	75	100	2413	1496	3909	200	202	342
VS 78/17	E8	75	100	2539	1496	4035	200	202	347
VS 78/18	E8	75	100	2665	1496	4161	200	202	352
VS 78/19	E8	75	100	2791	1496	4287	200	202	357
VS 78/20	E8	75	100	2917	1496	4413	200	202	361
VS 78/21	E8	75	100	3043	1496	4539	200	202	366
VS 78/22	E8	93	125	3169	1748	4917	200	202	449
VS 78/23	E8	93	125	3295	1748	5043	200	202	454
VS 78/24	E8	93	125	3421	1748	5169	200	202	459

## TECHNICAL DATA - PUMPS WITH REWINDABLE MOTOR

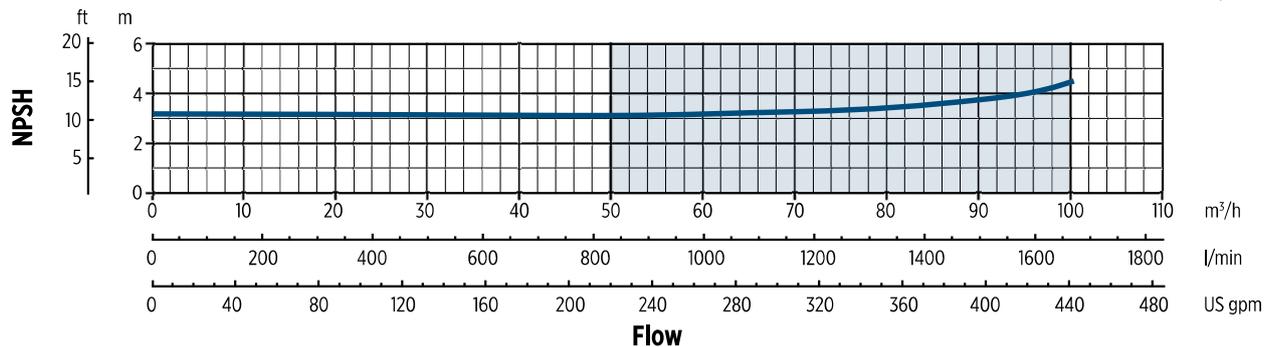
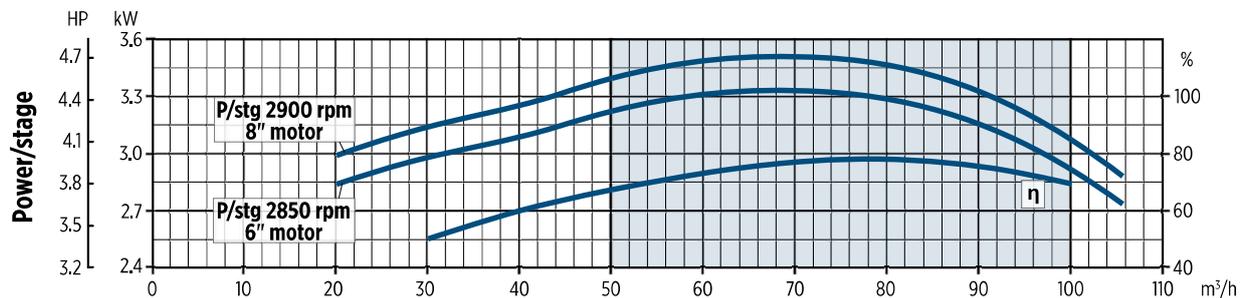
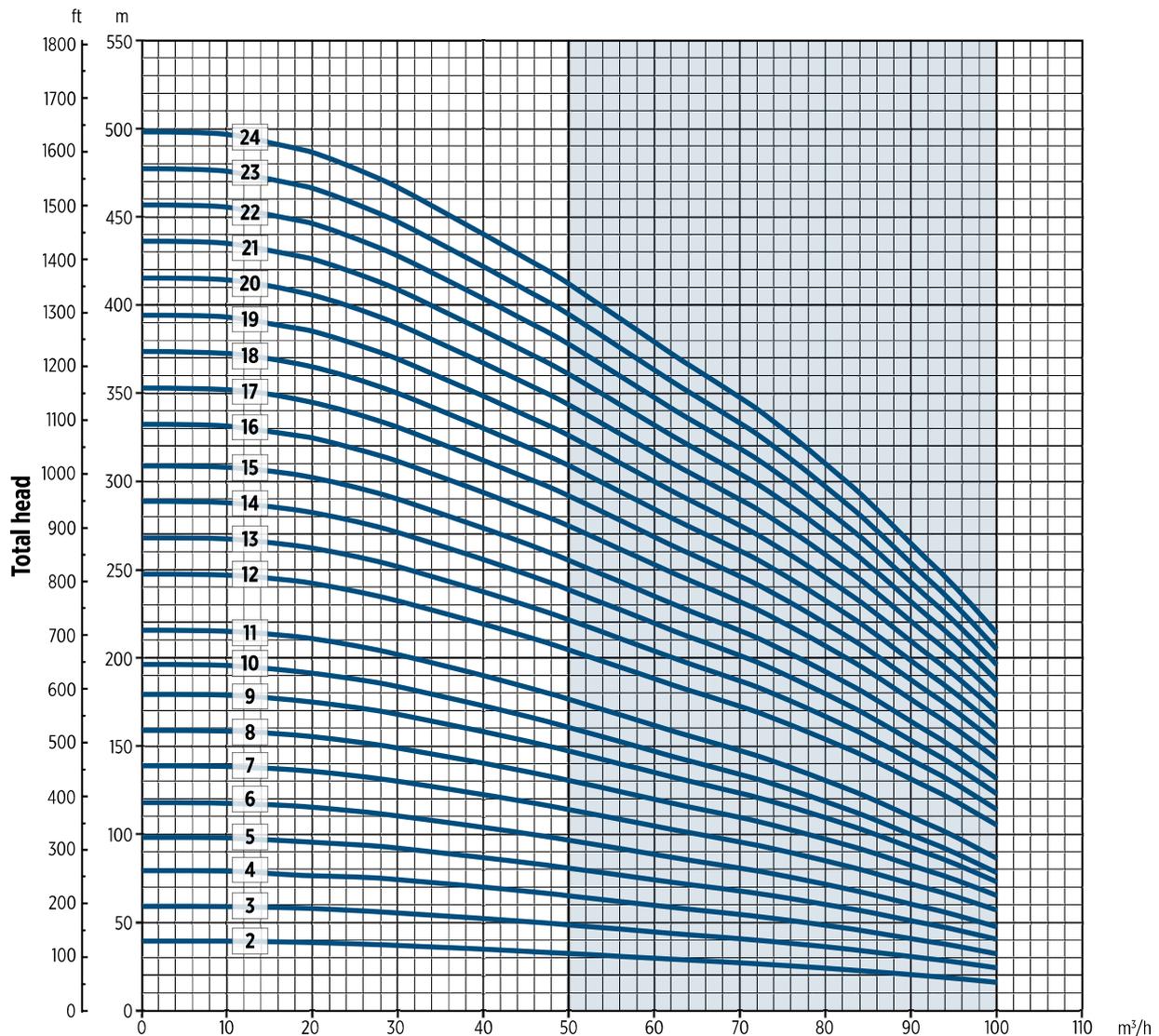
Pump model	R vers.	Motor			Dimensions					Pump weight [Kg]
		Type	[kW]	[HP]	L1 [mm]	L2 [mm]	Lt [mm]	D [mm]		
								1 cable	2 cable	
VS 78/2	●	6RW	7.5	10	644	719	1363	188	194	82
VS 78/3	●	6RW	11	15	770	779	1549	188	194	92
VS 78/4	●	6RW	15	20	896	874	1770	188	194	96
VS 78/5	●	6RW	18.5	25	1022	919	1941	188	194	116
VS 78/6	●	8RW	30	40	1022	1140	2162	197	199.5	190
	●	6RW	22	30	1148	1009	2157	188	194	130
VS 78/7	●	8RW	30	40	1148	1140	2288	197	199.5	193
	●	6RW	26	35	1274	1114	2388	188	194	146
VS 78/8	●	8RW	30	40	1274	1140	2288	197	199.5	198
	●	6RW	30	40	1400	1214	2614	188	194	161
VS 78/9	●	8RW	30	40	1400	1140	2540	197	199.5	203
	●	6RW	30	40	1526	1214	2740	188	194	166
VS 78/10	●	8RW	30	40	1526	1140	2666	197	199.5	208
	●	6RW	37	50	1652	1294	2946	188	194	178
VS 78/11	●	8RW	37	50	1652	1140	2792	197	199.5	213
	●	6RW	37	50	1778	1294	3072	188	194	183
VS 78/12	●	8RW	37	50	1778	1140	2918	197	199.5	218
	●	6RW	45	60	1909	1230	3139	197	199.5	238
VS 78/13	●	8RW	52	70	2035	1340	3375	197	199.5	266
VS 78/14	●	8RW	52	70	2161	1340	3501	197	199.5	271
VS 78/15	●	8RW	55	75	2287	1340	3627	197	199.5	276
VS 78/16	●	8RW	60	80	2413	1470	3883	197	199.5	300
VS 78/17	●	8RW	67	90	2539	1470	4009	197	199.5	305
VS 78/18	●	8RW	67	90	2665	1470	4135	197	199.5	310
VS 78/19	●	8RW	75	90	2791	1560	4351	197	199.5	332
VS 78/20	●	8RW	75	100	2917	1560	4477	197	199.5	336
VS 78/21	●	8RW	75	100	3043	1560	4603	197	199.5	341
VS 78/22	●	8RW	83	110	3169	1560	4729	197	199.5	378
VS 78/23	●	8RW	83	110	3295	1560	4855	197	199.5	383
VS 78/24	●	8RW	93	125	3421	1740	5161	197	199.5	388

● = Pump available in R (AISI 904L) version



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# PERFORMANCE CURVES AT 50 Hz



The hydraulic characteristics are guaranteed, according to ISO standard 9906:2012, grade 3B

# VS 97 50 Hz

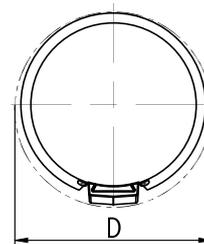
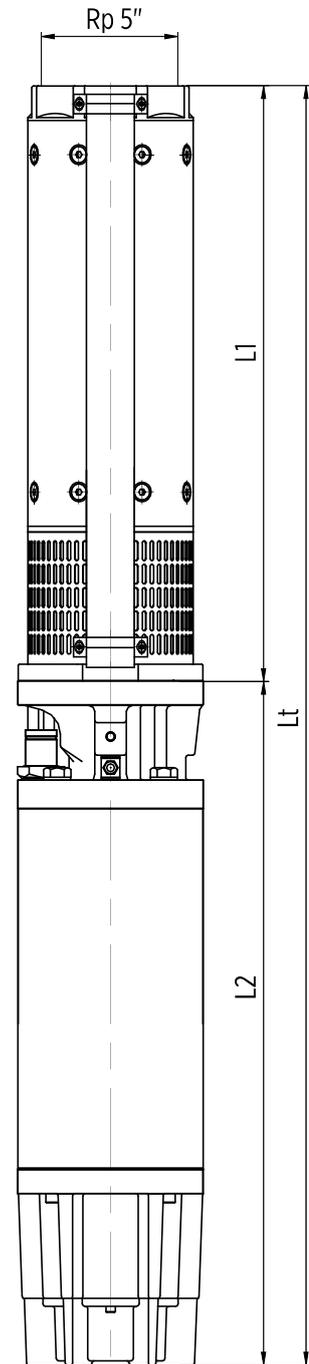
## TECHNICAL DATA - PUMPS WITH ENCAPSULATED MOTOR

Pump model	Motor			Dimensions					Pump weight [Kg]
	Type	[kW]	[HP]	L1 [mm]	L2 [mm]	Lt [mm]	D [mm]		
							1 cable	2 cable	
VS 97/2	E6	9,3	12,5	644	678,5	1322,5	188	194	79
VS 97/3	E6	15	20	770	776	1546	188	194	93
VS 97/4	E6	18,5	25	896	841,5	1737,5	188	194	105
VS 97/5	E6	22	30	1022	906,5	1928,5	188	194	115,5
VS 97/6	E6	30	40	1148	1036,5	2184,5	188	194	135
VS 97/7	E6	30	40	1274	1036,5	2310,5	188	194	140
VS 97/8	E6	37	50	1400	1405	2805	188	194	196
VS 97/9	E6	37	50	1526	1405	2931	188	194	201
VS 97/10	E8	45	60	1657	1077	2734	200	202	244
VS 97/11	E8	55	75	1783	1394	3177	200	202	279
VS 97/12	E8	55	75	1909	1394	3303	200	202	284
VS 97/13	E8	55	75	2035	1394	3429	200	202	289
VS 97/14	E8	75	100	2161	1496	3657	200	202	332
VS 97/15	E8	75	100	2287	1496	3783	200	202	337
VS 97/16	E8	75	100	2413	1496	3909	200	202	342
VS 97/17	E8	75	100	2539	1496	4035	200	202	346,5
VS 97/18	E8	93	125	2665	1748	4413	200	202	429,5
VS 97/19	E8	93	125	2791	1748	4539	200	202	434,5
VS 97/20	E8	93	125	2917	1748	4665	200	202	439
VS 97/21	E8	93	125	3043	1748	4791	200	202	444
VS 97/22	E8	110	150	3169	1976	5145	200	202	512
VS 97/23	E8	110	150	3295	1976	5271	200	202	517

## TECHNICAL DATA - PUMPS WITH REWINDABLE MOTOR

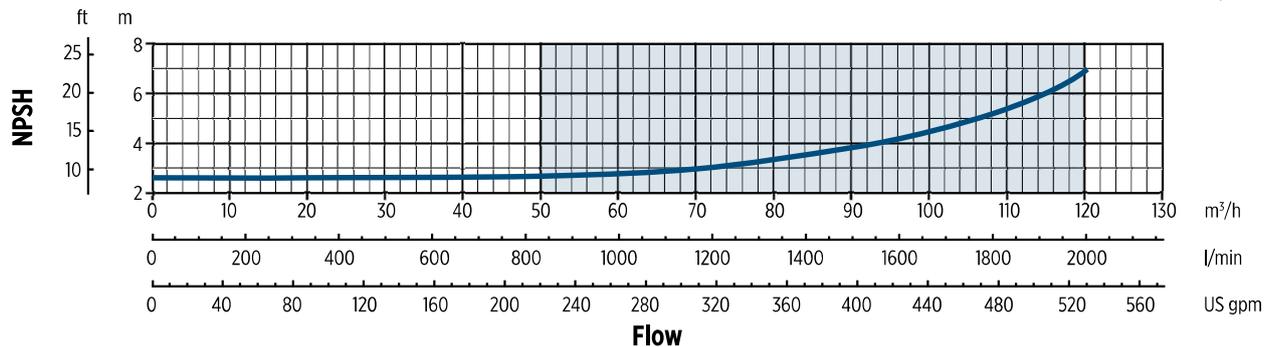
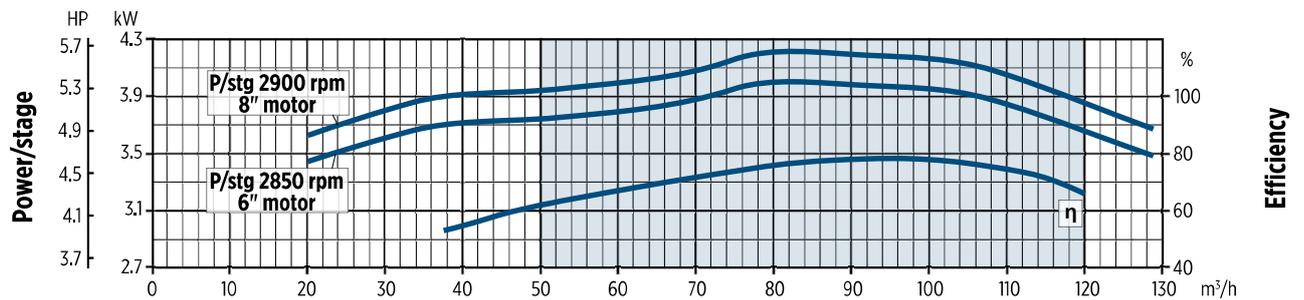
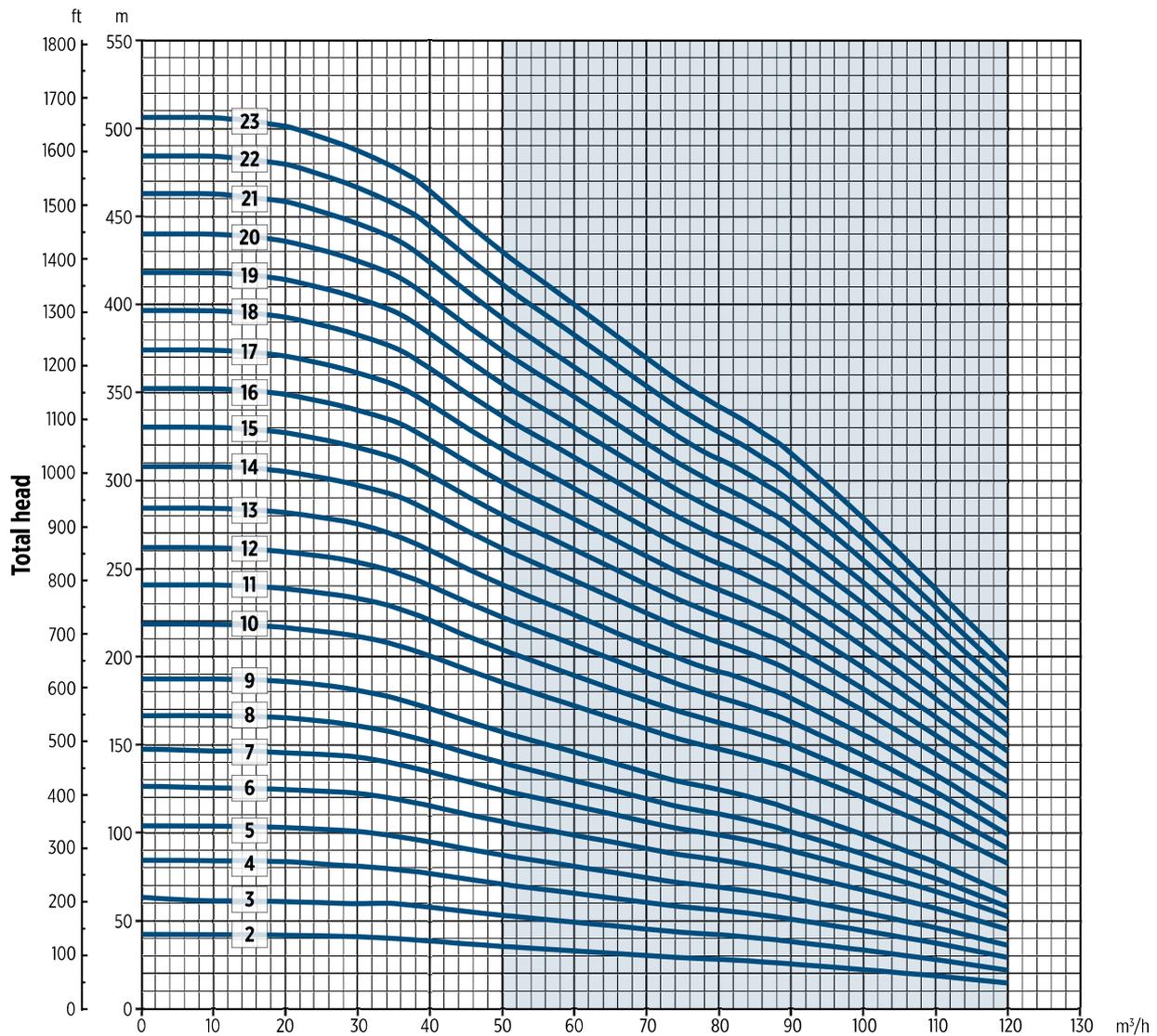
Pump model	R vers.	Motor			Dimensions					Pump weight [Kg]
		Type	[kW]	[HP]	L1 [mm]	L2 [mm]	Lt [mm]	D [mm]		
								1 cable	2 cable	
VS 97/2	●	6RW	9,3	12,5	644	749	1393	188	194	84,5
VS 97/3	●	6RW	13	17,5	770	829	1599	188	194	97,5
VS 97/4	●	6RW	18,5	25	896	919	1815	188	194	111,5
VS 97/5	●	6RW	22	30	1022	1009	2031	188	194	125
	●	8RW	30	40	1022	1140	2162	197	199,5	188
VS 97/6	●	6RW	26	35	1148	1114	2262	188	194	141
	●	8RW	30	40	1148	1140	2288	197	199,5	193
VS 97/7	●	6RW	30	40	1274	1214	2488	188	194	156
	●	8RW	30	40	1274	1140	2414	197	199,5	198
VS 97/8	●	6RW	37	50	1400	1294	2694	188	194	168
	●	8RW	37	50	1400	1140	2540	197	199,5	203
VS 97/9	●	6RW	37	50	1526	1294	2820	188	194	173
	●	8RW	37	50	1526	1140	2666	197	199,5	208
VS 97/10	●	8RW	45	70	1657	1230	2887	197	199,5	228
VS 97/11	●	8RW	52	70	1783	1340	3123	197	199,5	256
VS 97/12	●	8RW	52	75	1909	1340	3249	197	199,5	261
VS 97/13	●	8RW	55	90	2035	1340	3375	197	199,5	266
VS 97/14	●	8RW	67	90	2161	1470	3631	197	199,5	290
VS 97/15	●	8RW	67	90	2287	1470	3757	197	199,5	295
VS 97/16	●	8RW	75	100	2413	1560	3973	197	199,5	317
VS 97/17	●	8RW	75	100	2539	1560	4099	197	199,5	321,5
VS 97/18	●	8RW	83	110	2665	1560	4225	197	199,5	358,5
VS 97/19	●	8RW	83	110	2791	1560	4351	197	199,5	363,5
VS 97/20	●	8RW	93	125	2917	1740	4657	197	199,5	368
VS 97/21	●	8RW	93	125	3043	1740	4783	197	199,5	373

● = Pump available in R (AISI 904L) version



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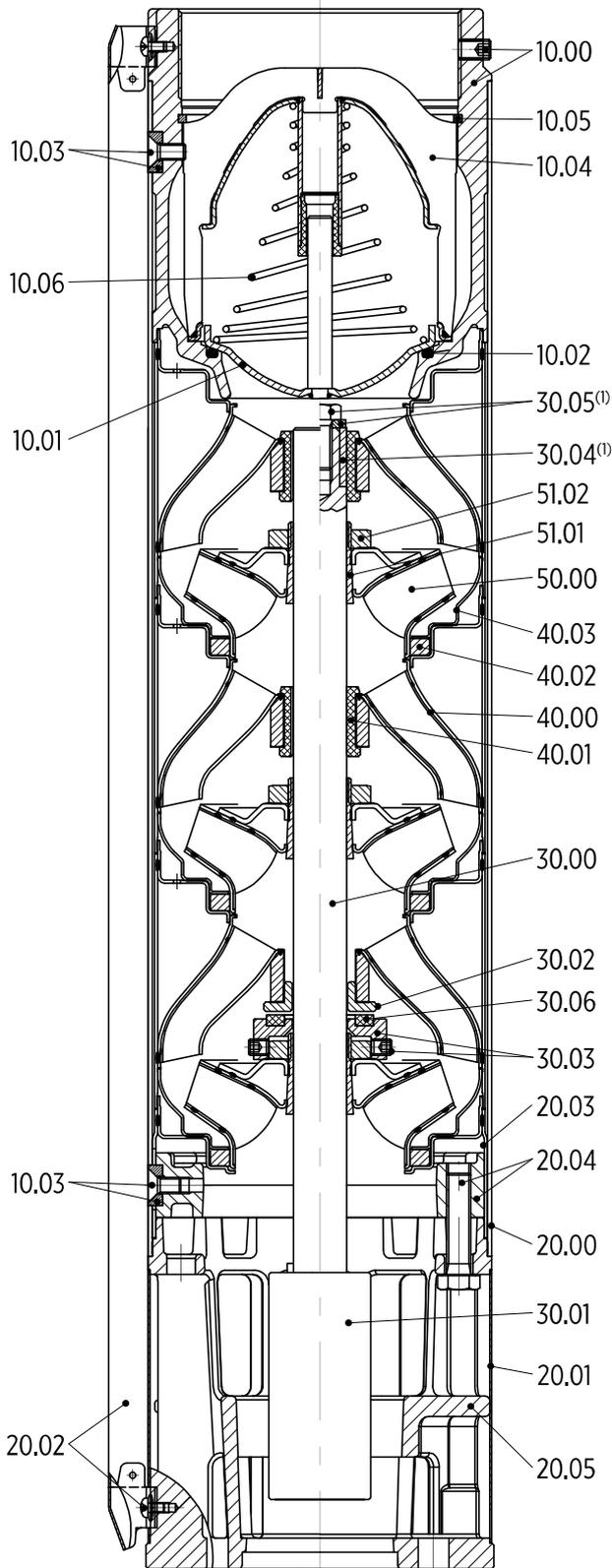
# PERFORMANCE CURVES AT 50 Hz



The hydraulic characteristics are guaranteed, according to ISO standard 9906:2012, grade 3B

# VS 78-97

## PUMP SECTION AND LIST OF MAIN COMPONENTS



Ref. N.	Description
10.00	Discharge head
10.01	Valve
10.02	Sealing O-ring
10.03	Outer case locking nuts
10.04	Valve support
10.05	Seeger ring
10.06	Spring
20.00	Outer case
20.01	Suction strainer
20.02	Cable guard
20.03	Initial spacer
20.04	Flange
20.05	Motor adapter
30.00	Pump shaft
30.01	Coupling
30.02	Upper up-thrust washer
30.03	Lower up-thrust washer
30.04 <sup>(1)</sup>	Upper journal sleeve
30.05 <sup>(1)</sup>	Screw and washer
30.06	Up-thrust ring
40.00	Diffuser
40.01	Secondary bearing bush
40.02	Floating neck ring
40.03	Flange clamping neck ring
50.00	Impeller
51.01	Split cone
51.02	Split cone nut

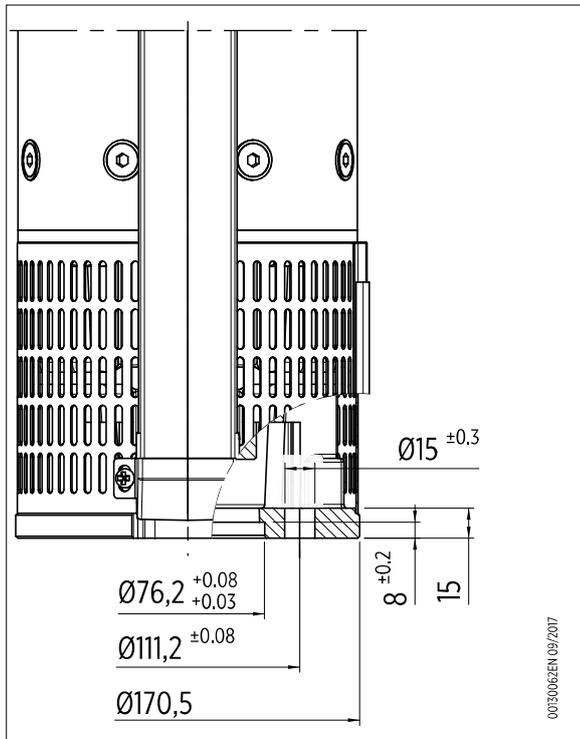
*1) only for types with more than 8 stages*

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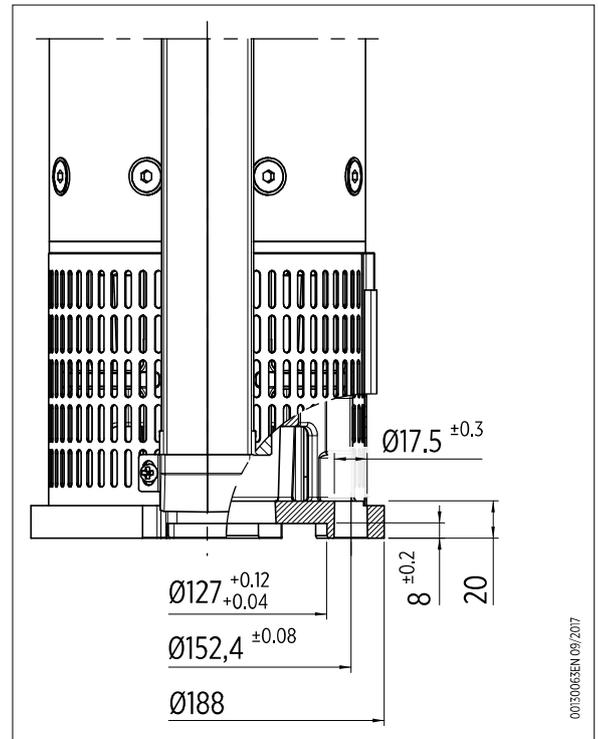
# VS 78-97 MOTOR ADAPTER AND DIMENSIONS

## APPENDIX B

### 4" MOTOR ADAPTER FOR I AND N VERSION



### 6" MOTOR ADAPTER FOR I, N AND R VERSION







## Output Filters Design Guide

VLT<sup>®</sup> AutomationDrive FC 300

VLT<sup>®</sup> AQUA Drive FC 200

VLT<sup>®</sup> HVAC Drive FC 100

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# 1 How to Read this Design Guide

This Design Guide will introduce all aspects of output filters for your frequency converter; from choosing the right output filter for the application to instructions about how to install it and how to program the frequency converter.

Danfoss technical literature is also available online at [www.danfoss.com/BusinessAreas/DrivesSolutions/Documentations/Technical+Documentation](http://www.danfoss.com/BusinessAreas/DrivesSolutions/Documentations/Technical+Documentation).

## 1.1.1 Symbols

Symbols used in this manual

### NOTE

Indicates something to be noted by the reader.



Indicates a general warning.



Indicates a high-voltage warning.

★ Indicates default setting

## 1.1.2 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	sec.
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

## 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 - 1000V AC and the 75 - 1500V DC voltage ranges. Danfoss CE-labels in accordance with the directive and issues a declaration of conformity upon request.

##### 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 frequency converter or motor.



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

#### NOTE

Never attempt to repair a defect filter.

#### NOTE

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

#### NOTE

The phased out LC-filters that were developed for the VLT5000 series and are not compatible with the VLT FC 100/200/300.

However, the new filters are compatible with both FC-series and VLT 5000-series

#### NOTE

690V applications:

For motors not specially designed for frequency converter operation or without double insulation, Danfoss highly recommend the use of either dU/dt or Sine-Wave filters.

#### NOTE

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.

#### NOTE

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 overheating of the filter and should be avoided.

## 3 Introduction to Output Filters

### 3.1 Why use Output Filters

This chapter describes why and when to use Output Filters with Danfoss frequency converters. It is divided into 4 sections:

- Protection of Motor Insulation
- Reduction of Motor Acoustic Noise
- Reduction of High Frequency Electromagnetic Noise in Motor Cable
- Bearing currents and shaft voltage

- the motor cable (type, cross-section, length, screened or unscreened, inductance and capacitance)

- the high frequency surge impedance 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 *Illustration 3.1*. The motor surge impedance decreases with the increase of motor size resulting in reduced mismatch with the cable impedance. The lower reflection coefficient ( $\Gamma$ ) reduces the wave reflection and thereby the voltage overshoot. Typical values are given in *Table 3.1*.

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 IEC 61800-8.

### 3.2 Protection of Motor Insulation

#### 3.2.1 The Output Voltage

The output voltage of the frequency 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 terminal increases by a  $dU/dt$  ratio that depends on:

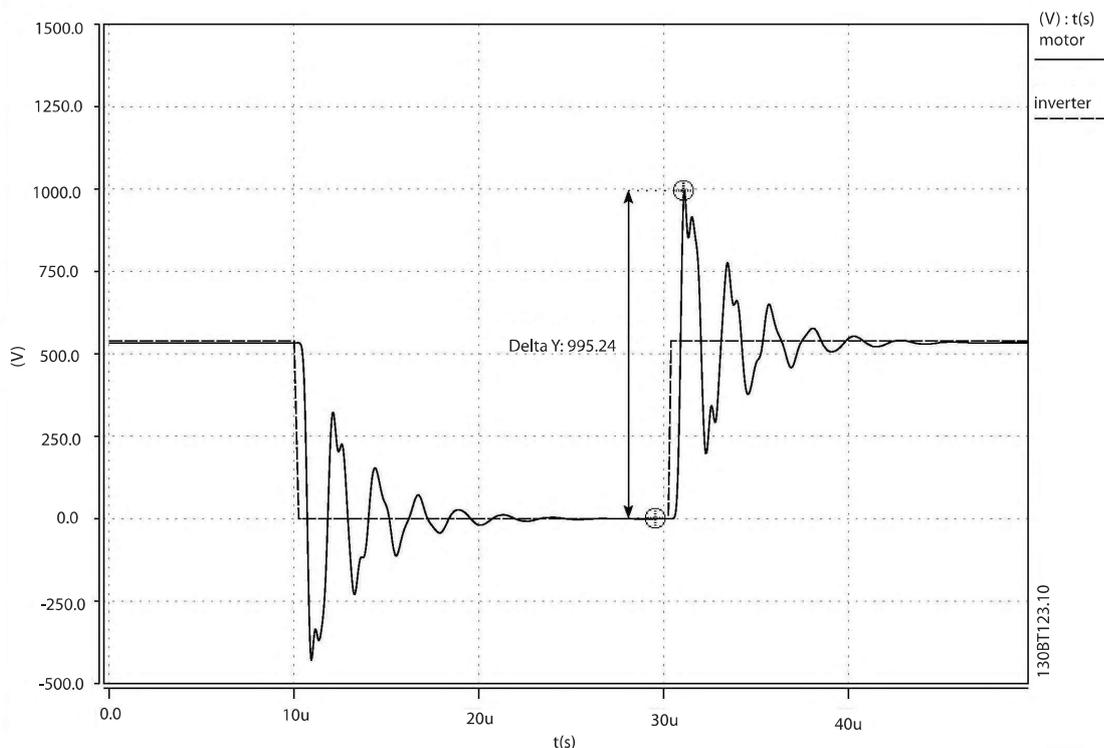


Illustration 3.1 Example of Converter Output Voltage (dotted line) and Motor Terminal Voltage After 200m of Cable (solid line)

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 *Illustration 3.2* and *Illustration 3.3*.

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.  $U_{PEAK} = DC \text{ link voltage} \times (1 + \Gamma)$ ;  $\Gamma$  represents the reflection coefficient and typical values can be found in table below (DC link voltage = Mains voltage  $\times$  1.35).
3.  $dU/dt = \frac{0,8 \times U_{PEAK}}{t_r}$  (IEC)  
 $dU/dt = \frac{0,8 \times U_{DC}}{t_{r(NEMA)}}$  (NEMA)

(For  $dU/dt$ , rise time,  $U_{peak}$  values at different cable lengths please consult the drive Design Guide)

Motor power [kW]	$Z_m$ [ $\Omega$ ]	$\Gamma$
<3.7	2000 - 5000	0.95
90	800	0.82
355	400	0.6

Table 3.1 Typical Values for Reflection Coefficients (IEC 61800-8).

The IEC and NEMA Definitions of Risetime  $t_r$

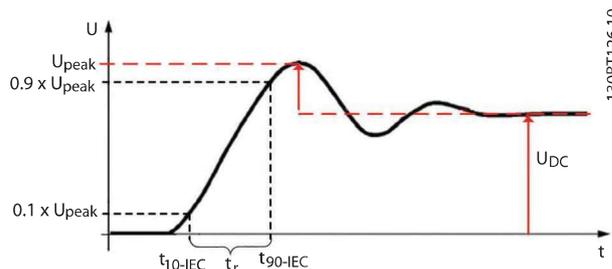


Illustration 3.2 IEC

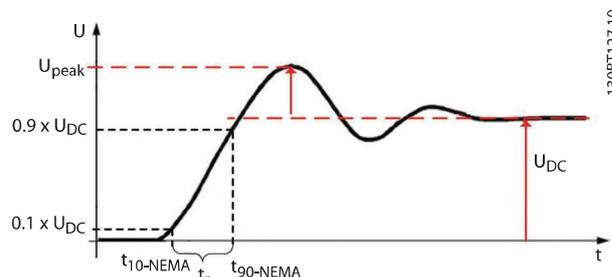


Illustration 3.3 NEMA

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 *Illustration 3.4*

- IEC 60034-17 – limit line for general purpose motors when fed by frequency converters, 500V motors.
- IEC 60034-25 – limit for converter rated motors: curve A is for 500V motors and curve B is for 690V motors.
- NEMA MG1 – Definite purpose Inverter Fed Motors.

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.

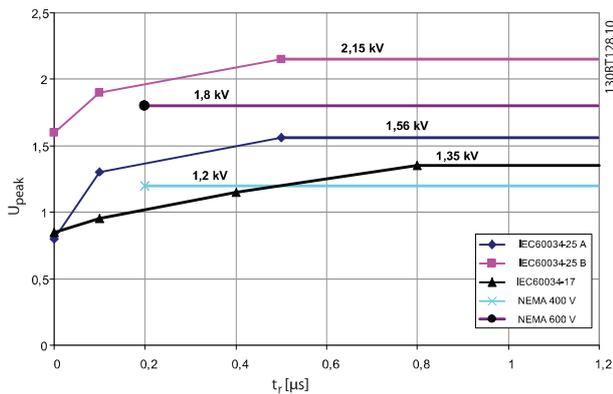


Illustration 3.4 Limit Lines for  $U_{peak}$  and Risetime  $t_r$ .

### 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

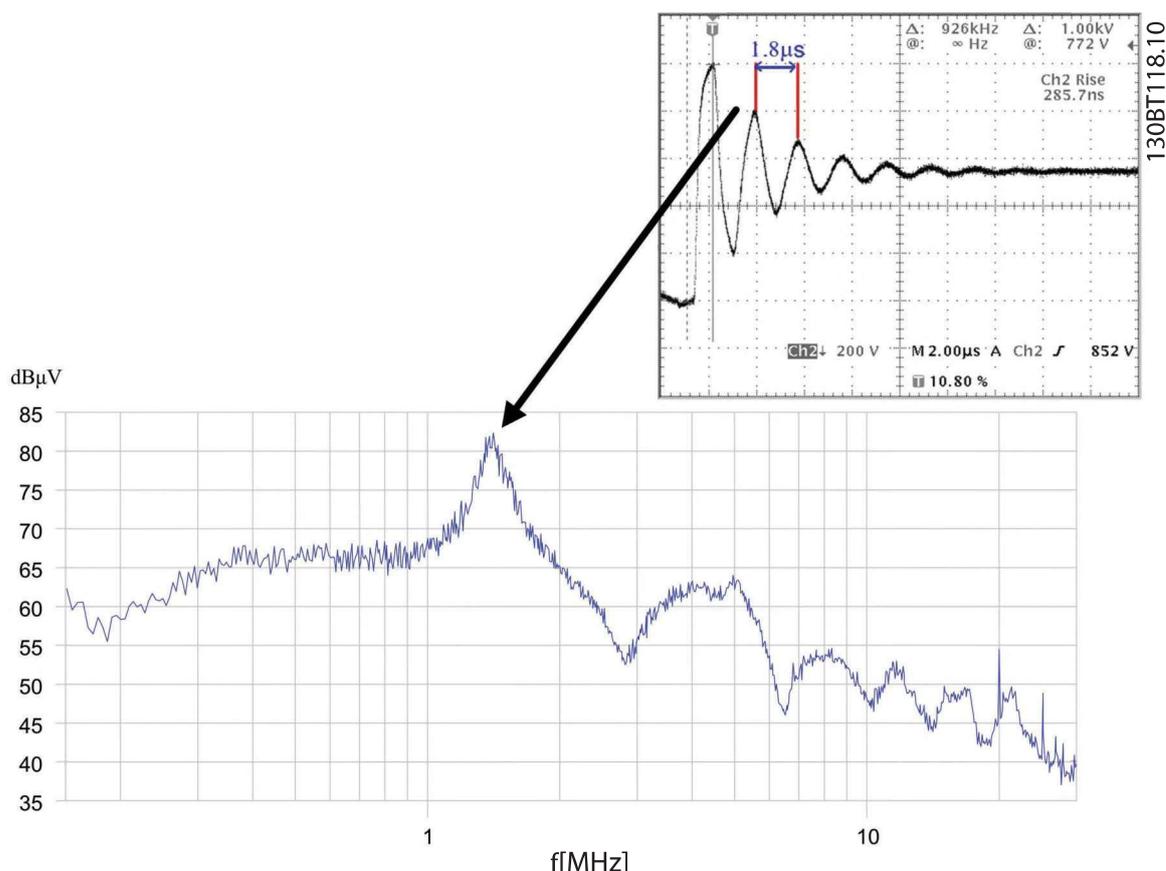
When a motor is fed by a frequency converter, the pulswidth modulated (PWM) voltage applied to the motor causes additional magnetic noise at the switching frequency and harmonics of the switching frequency (mainly the double of the switching frequency). In some applications this is not acceptable. In 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 of High Frequency Electromagnetic Noise in the Motor Cable

When no filters are used, the ringing voltage overshoot that occurs at the motor terminals is the main high-frequency noise source. *Illustration 3.5* 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 10MHz) caused by the switching of semiconductors - high frequency but low amplitude.



**Illustration 3.5** 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  $dU/dt$  filters the frequency of the ringing oscillation is reduced below 150kHz.
- 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.

Remember, that the other two noise components are still present. This is illustrated in the conducted emission measurements shown in *Illustration 3.7* and *Illustration 3.8*. The use of unshielded motor cables is possible, but the layout of the installation should prevent noise coupling between the unshielded motor cable and the mains 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 What are Bearing Currents and Shaft Voltages?

Fast switching transistors in the frequency converter combined with an inherent common-mode voltage (voltage between phases and ground) generate high-frequency bearing currents and shaft voltages. While bearing currents and shaft voltages can also occur in direct-on-line motors, these phenomena are accentuated when the motor is fed from a frequency converter. The majority of bearing damages in motors fed by frequency converters are because of vibrations, misalignment, excessive axial or radial loading, improper lubrication, impurities in the grease. In some cases, bearing damages are caused by bearing currents and shaft voltages. The mechanism that causes bearing currents and shaft voltages is quite intricate and beyond the scope of this Design Guide. Basically, two main mechanisms can be identified:

- Capacitive coupling: the voltage across the bearing is generated by parasitic capacitances in the motor.
- Inductive coupling: caused by circulating currents in the motor.

The grease film of a running bearing behaves like isolation. The voltage across the bearing can cause a breakdown of the grease film and produce a small electric discharge (a spark) between the bearing balls and the running track. This discharge produces a microscopic melting of the bearing ball and running track metal and in time it causes the premature wear-out of the bearing. This mechanism is called *Electrical Discharge Machining* or EDM.

#### 3.5.1 Mitigation of Premature Bearing Wear-Out

There are a number of measures that can be taken for preventing premature wearing and damage of the bearings (not all of them are applicable in all cases – combinations can be used). These measures aim either to provide a low-impedance return path to the high-frequency currents or to electrically isolate the motor shaft for preventing currents through the bearings. Besides, there are also mechanical related measures.

##### Measures to provide a low-impedance return path

- Follow EMC installation rules strictly. A good high-frequency return path should be provided between motor and frequency converter, for example by using shielded cables.
- Make sure that the motor is properly grounded and the grounding has a low-impedance for high-frequency currents.
- Provide a good high-frequency ground connection between motor chassis and load.
- Use shaft grounding brushes.

##### Measures that isolate the motor shaft from the load

- Use isolated bearings (or at least one isolated bearing at the non-driving end NDE).
- Prevent shaft ground current by using isolated couplings.

##### Mechanical measures

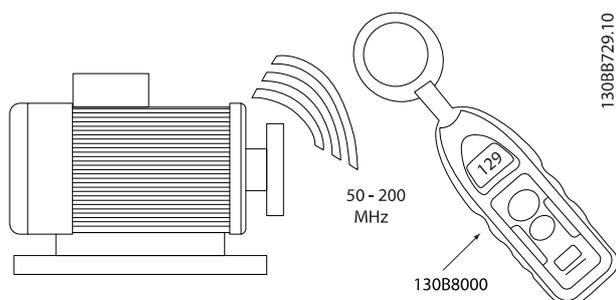
- Make sure that the motor and load are properly aligned.
- Make sure the loading of the bearing (axial and radial) is within the specifications.
- Check the vibration level in the bearing.
- Check the grease in the bearing and make sure the bearing is correctly lubricated for the given operating conditions.

One of the mitigation measures is to use filters. This can be used in combination with other measures, such as those presented above. High-frequency common-mode (HF-CM) filters (core kits) are specially designed for reducing bearing stress. Sine-wave filters also have a good effect.  $dU/dt$  filters have less effect and it is recommended to use them in combination with HF-CM cores.

### 3.5.2 Measuring Electric Discharges in the Motor Bearings

3

The occurrence of electric discharges in the motor bearings can be measured using an oscilloscope and a brush to pick up the shaft voltage. This method is difficult and the interpretation of the measured waveforms requires a deep understanding of the bearing current phenomena. An easy alternative is to use an electrical discharge detector (130B8000), as shown in *Illustration 3.6*. Such a device consists of a loop antenna that receives signals in the frequency range of 50MHz – 200MHz and a counter. Each electric discharge produces an electromagnetic wave that is detected by the instrument and the counter is incremented. If the counter displays a high number of discharges it means that there are many discharges occurring in the bearing and mitigation measures have to be taken to prevent the early wear out of the bearing. This instrument can be used for experimentally determining the exact number of cores needed to reduce bearing currents. Start with a set of 2 cores. If the discharges are not eliminated, or drastically reduced, add more cores. The number of cores presented in the table above is a guiding value that should cover most applications with a generous safety margin. If the cores are installed on the drive terminals and you experiment core saturation because of long motor cables (the cores have no effect on bearing currents), check the correctness of the installation. If cores keep saturating after the installation is made according to EMC best practice, consider moving the cores to the motor terminals.



**Illustration 3.6 Electrical Discharge Detector**

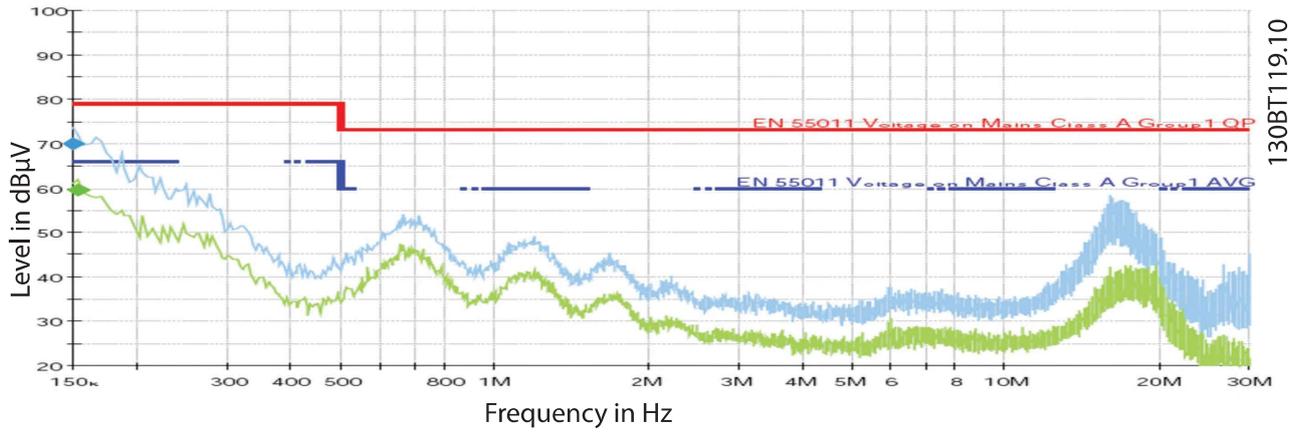


Illustration 3.7 Mains Line Conducted Noise, No Filter

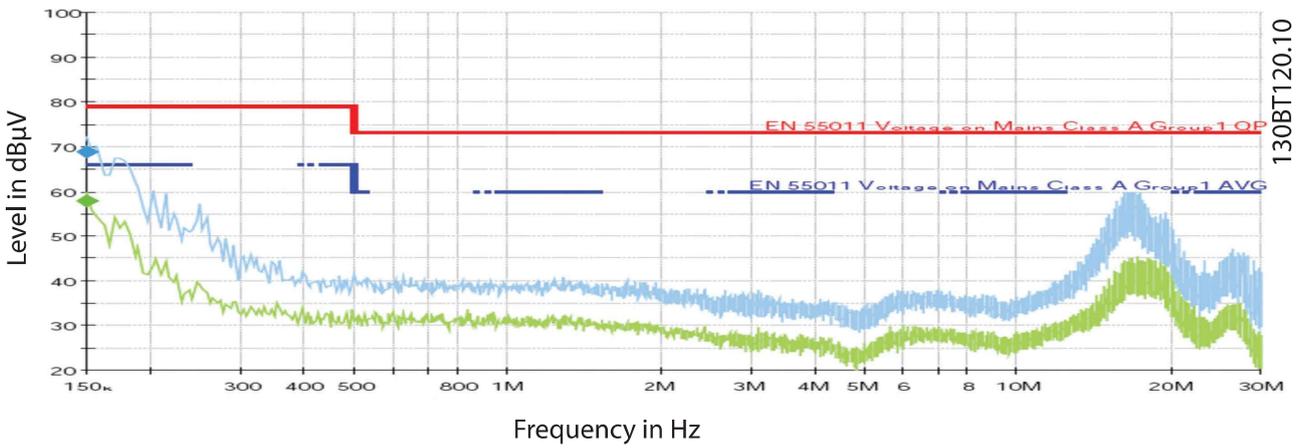


Illustration 3.8 Mains Line Conducted Noise, Sine-wave Filter

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### 3.6 Which Filter for which Purpose

Table 3.2 shows a comparison of dU/dt, Sine-wave filter, and HF-CM performance. It can be used to determine which filter to use with your application.

Performance criteria	dU/dt filters	Sine-wave filters	High-frequency common-mode filters
Motor insulation stress	Up to 150m cable (screened/unscreened) complies with the requirements of IEC 60034-17 <sup>1</sup> (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 <sup>1</sup> and NEMA-MG1 requirements for general purpose motors with cables up to 500m (1km for VLT frame size D and above).	Does not reduce motor insulation stress
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).	Reduces bearing stress by limiting common-mode high-frequency 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.	Reduces high-frequency emissions (above 1MHz). Does not change the emission class of the RFI filter. Does not allow longer motor cables as specified for the frequency converter.
Max. motor cable length	100m ... 150m With guaranteed EMC performance: 150m screened. Without guaranteed EMC performance: 150m unscreened.	With guaranteed EMC performance: 150m screened and 300m unscreened. Without guaranteed EMC performance: up to 500m (1km for VLT frame size D and above)	150m screened (frame size A, B, C), 300 m screened (frame size D, E, F), 300 m unscreened
Acoustic motor switching noise	Does not eliminate acoustic switching noise.	Eliminates acoustic switching noise from the motor caused by magnetostriction.	Does not eliminate acoustic switching noise.
Relative size	15-50% (depending on power size)	100%	5 - 15%
Voltage drop	0.5%	4-10%	none

**Table 3.2 Comparison of dU/dt and Sine-wave Filters**

- 1) Not 690V.
- 2) See general specification for formula.

#### 3.6.1 dU/dt Filters

The dU/dt filters consist of inductors and capacitors in a low pass filter arrangement and their cut off frequency is above the nominal switching frequency of the frequency converter. The inductance (L) and capacitance (C) values are shown in the tables in 4.2 *Electrical Data - dU/dt Filters*. Compared to Sine-wave filters they have lower L and C values, thus they are cheaper and smaller. With a dU/dt filter the voltage wave form is still pulse shaped but the current is sinusoidal - see following illustrations.

#### 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. 500V/μs.

#### 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

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 not complying with IEC 60034-25
- 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 (less than 15m)
- 690V applications

Voltage and current with and without dU/dt filter:

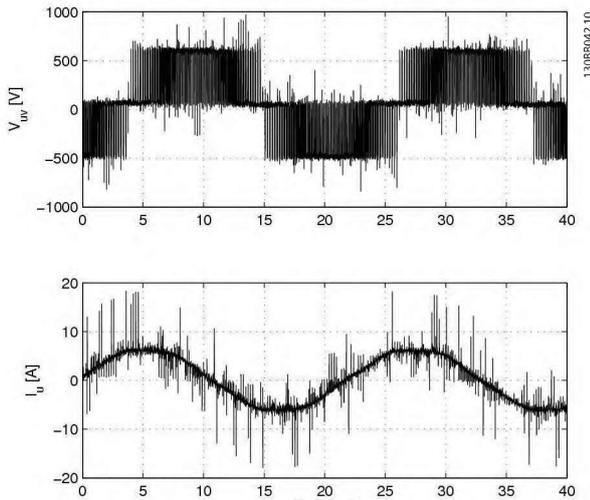


Illustration 3.9 Without Filter

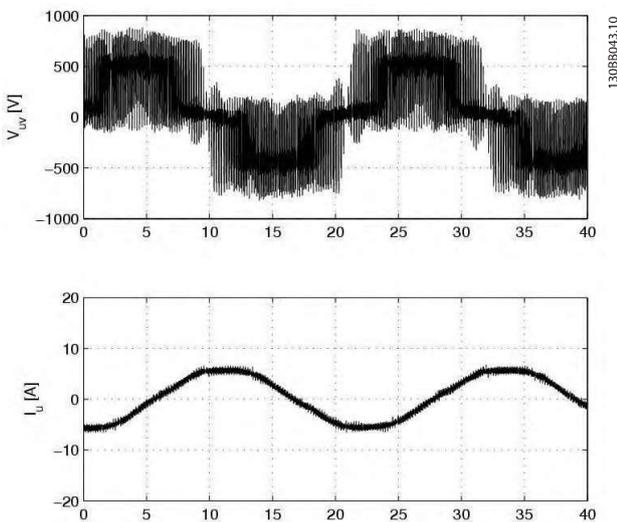


Illustration 3.10 With dU/dt Filter

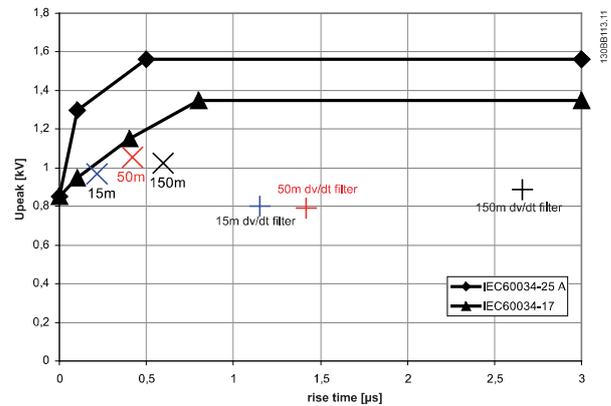


Illustration 3.11 Measured dU/dt values (rise time and peak voltages) with and without dU/dt filter using 15m, 50m and 150m cable lengths on a 400V, 37kW induction motor.

The dU/dt value decreases with the motor cable length whereas the peak voltage increases (see Illustration 3.11). The U<sub>peak</sub> value depends on the U<sub>dC</sub> from the frequency converter and as U<sub>dC</sub> increases during motor braking (generative) U<sub>peak</sub> can increase to values above the limits of IEC 60034-17 and thereby stress the motor insulation. Danfoss therefore recommends dU/dt filters in applications with frequent braking. Furthermore the illustration above shows how the U<sub>peak</sub> increases with the cable length. As the cable length increases, the cable capacitance rises and the cable behaves like a low-pass filter. That means longer rise-time t<sub>r</sub> for longer cables. Therefore it is recommended to use dU/dt filters only in applications with cable lengths up to 150m. Above 150m dU/dt filters have no effect. If further reduction is needed, use a sine-wave filter.

Filter features

- IP00 and IP20/23/54 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 VVC<sup>PLUS</sup>
- Filters wall mounted up to 177A and floor mounted above that size

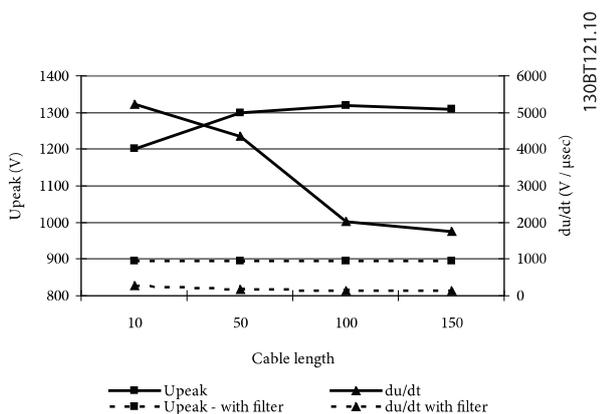


Illustration 3.12 525V - With and Without dU/dt Filter

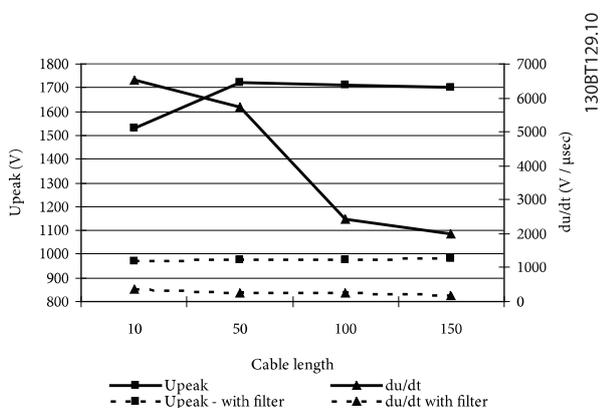


Illustration 3.13 690V - With and Without dU/dt Filter

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

Illustration 3.12 and Illustration 3.13 show how  $U_{peak}$  and rise time behaves as a function of the motor cable length. In installations with short motor cables (below 5-10m) 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 15m.

### 3.6.2 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 sinusoidal 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. Sine-wave filters enable use of longer motor cables in applications where the motor is installed far from the frequency converter. 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 3.2.

The Danfoss Sine-wave filters are designed to operate with the VLT® FC 100/200/300. 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 4.3 Electrical Data - Sine-wave Filters.

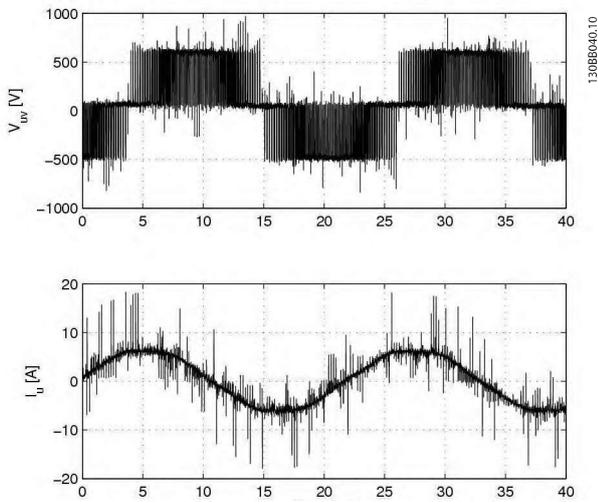
#### Features and benefits

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 3.12. Moreover, the filter eliminates the pulse reflections in the motor cable thus reducing the losses in the frequency converter.

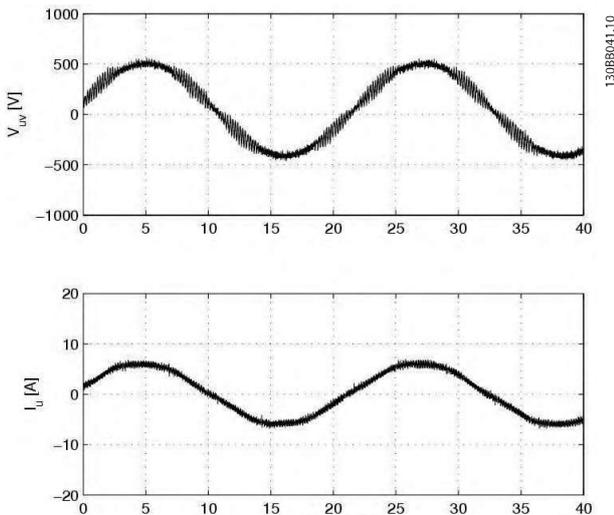
#### Advantages

- 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 unshielded motor cables
- Reduces the bearing current thus prolonging the lifetime of the motor

**Voltage and current with and without Sine-wave filter**



**Illustration 3.14 Without Filter**



**Illustration 3.15 With Sine-wave Filter**

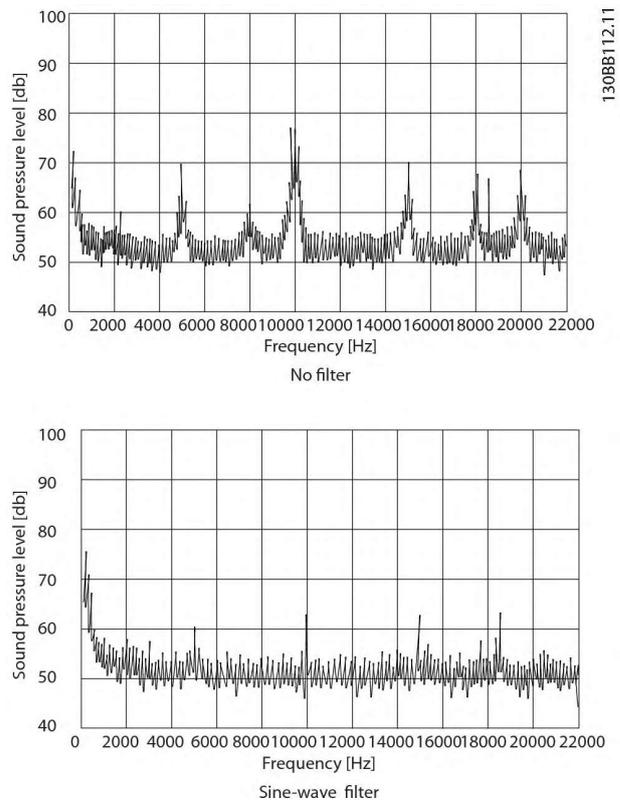
**Application areas**

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 do not comply with IEC 60034-17
- Applications where the motor is placed in aggressive environments or running at high temperatures

- Applications with motor cables above 150m up to 300m (with both screened and unscreened cable). The use of motor cables longer than 300m depends on the specific application
- Applications where the service interval on the motor has to be increased
- 690V applications with general purpose motors
- Step up applications or other applications where the frequency converter feeds a transformer

**Example of relative motor sound pressure level measurements with and without Sine-wave filter**



**Features**

- IP00 and IP20 enclosure in the entire power range (IP23 for floor standing filters)
- Compatible with all control principle including flux and VVC<sup>PLUS</sup>
- Side by side mount with the frequency converter up to 75A
- Filter enclosure matching the frequency converter enclosure
- Possibility of connecting unscreened and screened cables with included decoupling plate
- Filters wall mounted up to 75A and floor mount above

- Parallel filter installation is possible with applications in the high power range

### 3.6.3 High-Frequency Common-Mode Core Kits

**3**

High-frequency common-mode (HF-CM) core kits are one of the mitigation measures to reduce bearing wear. However, they should not be used as the sole mitigation measure. Even when HF-CM cores are used, the EMC-correct installation rules must be followed. The HF-CM cores work by reducing the high-frequency common-mode currents that are associated with the electric discharges in the bearing. They also reduce the high-frequency emissions from the motor cable which can be used, for example, in applications with unshielded motor cables.

## 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 4.1* shows which Sine-wave filter to use with a specific frequency converter. 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 500V							
Rated filter current at 50Hz	Minimum switching frequency [kHz]	Maximum output frequency [Hz] With derating	Code number IP20	Code number IP00	Frequency converter size		
					200-240V	380-440V	441-500V
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	130B3181	130B3179	P22K - P30K	P45K - P55K	P55K - P75K
180	3	100	130B3183	130B3182	P37K - P45K	P75K - P90K	P90K - P110
260	3	100	130B3185	130B3184		P110 - P132	P132
410	3	100	130B3187	130B3186		P160 - P200	P160 - P200
510	3	100	130B3189	130B3188		P250	P250
660	2	70	130B3192	130B3191		P315 - P355	P315 - P355
800	2	70	130B3194	130B3193		P400	P400 - P450
1020	2	70	2 x 130B3189	2 x 130B3188		P450 - P500	P500 - P560
1320	2	70	2 x 130B3192	2 x 130B3191		P560 - P630	P630 - P710
1530	2	70	3 x 130B3189	3 x 130B3188		P710 - P800	P800
1980	2	70	3 x 130B9192	3 x 130B3191			P1M0

Table 4.1 Filter Selection

Mains supply 3 x 525 to 600/690V						
Rated filter current at 50Hz	Minimum switching frequency [kHz]	Maximum output frequency [Hz] With derating	Code number IP20	Code number IP00	Frequency converter size	
					525-600V	525-690V
13	2	70	130B3196	130B3195	PK75 - P7K5	
28	2	100	130B4113	130B4112	P11K - P18K	
45	2	100	130B4115	130B4114	P22K - P30K	P37K
76	2	100	130B4117	130B4116	P37K - P45K	P45K - P55K
115	2	100	130B4119	130B4118	P55K - P75K	P75K - P90K
165	2	70	130B4124	130B4121		P110 - P132
260	2	100	130B4126	130B4125		P160 - P200
303	2	70	130B4151	130B4129		P250
430	1.5	60	130B4153	130B4152		P315 - P400
530	1.5	100	130B4155	130B4154		P500
660	1.5	100	130B4157	130B4156		P560 - P630
868	1.5	60	2 x 130B4153	2 x 130B4152		P710
1060	1.5	100	2 x 130B4155	2 x 130B4154		P800 - P900
1590	1.5	60	3 x 130B4155	3 x 130B4154		P1M0

Table 4.2 Filter Selection

Generally the output filters are designed for the nominal switching frequency of the frequency converter.

## NOTE

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.

## NOTE

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.

### 4.1.2 HF-CM Selection

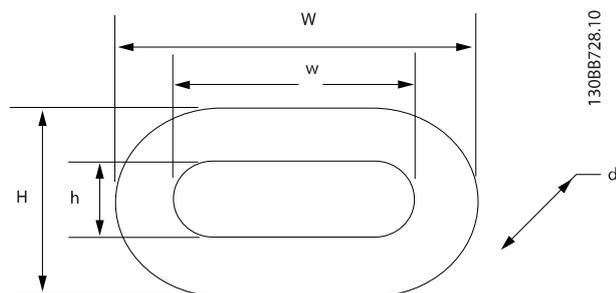
The cores can be installed at the frequency converter's output terminals (U, V, W) or in the motor terminal box.

When installed at the frequency converter's terminals the HF-CM kit reduces both bearing stress and high-frequency electromagnetic interference from the motor cable. The number of cores depends on the motor cable length and frequency converter voltage and a selection table is shown below.

Cable length [m]	A- and B frame		C frame		D frame		E- F frame	
	T5	T7	T5	T7	T5	T7	T5	T7
50	2	4	2	2	2	4	2	2
100	4	4	2	4	4	4	2	4
150	4	6	4	4	4	4	4	4
300	4	6	4	4	4	6	4	4

When installed in the motor terminal box the HF-CM kit reduces only bearing stress and has no effect on the electromagnetic interference from the motor cable. Two cores are sufficient in most cases, independent of the motor cable length.

Danfoss provides the HF-CM cores in kits of two pieces/kit. The cores are oval shaped for the ease of installation and are available in four sizes: for A and B frames, for C frames, for D frames, for E and F frames. For F frame frequency converters, one core kit shall be installed at each inverter module terminals. Mechanical mounting can be made with cable ties. There are no special requirements regarding mechanical mounting.



In normal operation the temperature is below 70°C. However, if the cores are saturated they can get hot, with temperatures above 70°C. Therefore it is important to use the correct number of cores to avoid saturation. Saturation can occur if the motor cable is too long, motor cables are paralleled or high capacitance motor cables, not suitable for frequency converter operation, are used. Always avoid motor cables with sector-shaped cores. Use only cables with round-shaped cores.

### CAUTION

Check the core temperature during commissioning. A temperature above 70°C indicates saturation of the cores. If this happens add more cores. If the cores still saturate it means that the cable capacitance is too large because of: too long cable, too many parallel cables, cable type with high capacitance.

#### Applications with parallel cables

When parallel cables are used the total cable length has to be considered. For example 2 x 100m cables are equivalent with one 200m cable. If many paralleled motors are used a separate core kit should be installed for each individual motor.

The ordering numbers for the core kits (2 cores/package) are given in the following table.

VLT frame size	Danfoss part no.	Core dimension [mm]					Weight [kg]	Packaging dimension [mm]
		W	w	H	h	d		
A and B	130B3257	60	43	40	25	22	0.25	130x100x70
C	130B3258	102	69	61	28	37	1.6	190x100x70
D	130B3259	189	143	126	80	37	2.45	235x190x140
E and F	130B3260	305	249	147	95	37	4.55	290x260x110



Code number	IP00 IP20/IP23 <sup>1)</sup>	Filter current rating at given voltage and motor frequency VLT power and current size [A] <sup>2)</sup>	380V @ 60Hz and 200/440V @ 50Hz	460/480V @ 60Hz and 500/525V @ 50Hz <sup>3)</sup>	575/600V @ 60Hz	690V @ 50Hz	380 - 440V kW A	441 - 500V kW A	525 - 550V kW A	551 - 690V kW A	Maximum filter losses W	Filter data L C μH nF
2 x 130B2851	IP00											
2 x 1302852	IP23						710	1260	800	1160	750	988
or												
3 x 130B2849	IP00											
3 x 130B3850	IP23											
2 x 130B2853	IP00											
2 x 130B2854	IP23											
or												
3 x 130B2851	IP00										900	945
3 x 130B2852	IP23											
3 x 130B2853	IP00						800	1460	1000	1380	850	1108
3 x 130B2854	IP23						1000	1700	1100	1530	1000	1317
2 x 130B2849	IP00						450	800	500	730	500	659
2 x 130B2852	IP23						500	880	560	780		

1) The filter enclosure is IP20 for wall-mounted filters and IP23 for floor-mounted filters

2) For derating with motor frequency consider 60Hz rating=0.94 x 50Hz rating and 100Hz rating= 0.75 x 50Hz rating

3) 525V operation requires a T7 drive

## 4.3 Electrical Data - Sine-wave Filters

Code Number	Filter Current Rating		Switching Frequency		VLT Power and Current Ratings						Filter Losses			L-value mH	C <sub>r</sub> -Value <sup>1</sup> µF
	IP00 IP20 (IP23) <sup>2</sup>	@ 50Hz A	@ 100Hz A	kHz	@ 200-240V kW	A	@ 380-440V kW	A	@ 441-500V kW	A	@ 200-240V W	@ 380-440V W	@ 441-500V W		
130B2404	IP00	2.5	2.5	2*	5	0.25	1.8	0.37	1.1	1.1	0.37	1.1	45	29	1
130B2439	IP20	2.5	2.5	2*	5	0.37	2.4	0.75	2.1	2.1	60	60	50	29	1
130B2406	IP00	4.5	4	3.5*	5	0.55	3.5	1.1	3	1.1	60	60	60	13	2.2
130B2441	IP20	4.5	4	3.5*	5	0.55	3.5	1.5	3.4	3.4	70	70	65	13	2.2
130B2408	IP00	8	7.5	5*	5	0.75	4.6	2.2	4.8	4.8	65	70	70	6.9	4.7
130B2443	IP20	8	7.5	5*	5	1.1	6.6	2.2	5.6	5.6	75	70	70	6.9	4.7
130B2409	IP00	10	9.5	7.5*	5	1.5	7.5	3	7.2	3	80	80	80	5.2	6.8
130B2444	IP20	10	9.5	7.5*	5	1.5	7.5	3	7.2	3	80	80	80	5.2	6.8
130B2411	IP00	17	156	13	5	2.2	10.6	5.5	13	5.5	90	110	100	3.1	10
130B2446	IP20	17	156	13	5	3	12.5	5.5	13	5.5	100	110	100	3.1	10
130B2412	IP00	24	23	18	4	5.5	24.2	11	24	11	150	150	150	2.4	10
130B2447	IP20	24	23	18	4	5.5	24.2	11	24	11	150	150	150	2.4	10
130B2413	IP00	38	36	28.5	4	7.5	30.8	15	32	15	170	170	160	1.6	10
130B2448	IP20	38	36	28.5	4	7.5	30.8	18.5	37.5	18.5	160	180	170	1.6	10
130B2281	IP00	48	45.5	36	4	11	46.2	22	44	22	270	270	260	1.1	14.7
130B2307	IP20	48	45.5	36	4	11	46.2	22	44	22	270	270	260	1.1	14.7
130B2282	IP00	62	59	46.5	3	15	59.4	30	61	30	300	310	280	0.85	30
130B2308	IP20	62	59	46.5	3	15	59.4	30	61	30	300	310	280	0.85	30
130B2283	IP00	75	71	56	3	18.5	74.8	37	73	37	350	350	330	0.75	30
130B2309	IP20	75	71	56	3	18.5	74.8	37	73	37	350	350	330	0.75	30
130B3179	IP00	115	109	86	3	22	88	45	90	55	470	470	470	0.51	15
130B3181	IP23	115	109	86	3	30	115	55	106	75	105	105	105	0.51	15
130B3182	IP00	180	170	135	3	37	143	75	147	90	130	130	130	0.33	25
130B3183	IP23	180	170	135	3	45	170	90	177	110	160	160	160	0.33	25
130B3184	IP00	260	246	195	3	110	212	132	132	132	190	190	190	0.34	25
130B3185	IP23	260	246	195	3	132	260	160	160	160	240	240	240	0.34	25

\*) 120Hz

<sup>1</sup>Equivalent STAR-connection value

<sup>2</sup>IP23 - All floor mounted filters

Table 4.4 Sine-wave Filter 3x380-500 V IP00/IP20/IP23

Code Number	IP00 IP20 (IP23) <sup>2</sup>	Filter Current Rating		Switching Frequency kHz	VLT Power and Current Ratings				Filter Losses			C <sub>y</sub> -Value <sup>1</sup> µF
		@ 50Hz A	@ 60Hz A		@ 100Hz A	@ 200-240V kW	@ 200-240V A	@ 380-440V kW	@ 380-440V A	@ 441-500V kW	@ 441-500V A	
130B3186	IP00	410	390	308	3	160	315	200	303	1150	0.25	33
130B3187	IP23	510	456	360	3	250	480	315	443	1450	0.14	66
130B3188	IP00	660	627	495	3	315	600	355	540	2000	0.15	106
130B3189	IP23	800	712	562	2	400	745	450	678	3000	0.1	153
2 x 130B3188	IP00	1020	912	720	2	450	800	500	730	2900		
2 x 130B3189	IP23	1320	1254	990	2	560	990	630	890	4000		
3 x 130B3188	IP00	1530	1368	1080	2	710	1260	800	1160	4350		
3 x 130B3189	IP23	1980	1881	1485	2	1000	1700	1100	1530	6000		

\*) 120Hz  
<sup>1</sup>Equivalent STAR-connection value  
<sup>2</sup>IP23 - All floor mounted filters

**Table 4.5 Sine-wave Filter 3x380-500V IP00/IP20/IP23**



Code Number	IP00 IP20(IP23) <sup>2</sup>	Filter Current Rating			Switching Frequency kHz	VLT Power and Current Ratings						Filter losses			L-value mH	C <sub>p</sub> -Value <sup>1</sup> µF
		@ 50Hz A	@ 60Hz A	@ 100Hz A		@ 525-550V kW	@ 525-550V A	@ 525-600V kW	@ 525-600V A	@ 690V kW	@ 690V A	@ 525-550V W	@ 525-600V W	@ 690V W		
2 x 130B4142	IP00	860	814	646	1.5	970	1260	1200	1260	1000	1317					
2 x 130B4153	IP23					560	730	710	730	460	630	4300				
2 x 130B4154	IP00	1060	1004	796	1.5	670	898	800	850	630	763					
2 x 130B4155	IP23					900	945	710	939			4800				
3 x 130B4154	IP00	1590	1506	1194	1.5	820	1060	1000	1060	800	1108					
3 x 130B4155	IP23					970	1260	1200	1260	1000	1317	7200				

<sup>1</sup>Equivalent STAR-connection value

<sup>2</sup>IP23 - All floor mounted filters

Code Number	Filter Current Rating @ 50Hz		Filter Current Rating @ 60Hz		Filter Current Rating @ 100Hz		Switching Frequency kHz	VLT Power and Current Rating @ 200-240V		VLT Power and Current Rating @ 380-440V		VLT Power and Current Rating @ 441-500V		Filter losses @ 200-240V		Filter losses @ 380-440V		Filter losses @ 441-500V		L-value mH	C <sub>v</sub> -Value <sup>1</sup> μF
	A	A	A	A	A	A		kW	A	kW	A	kW	A	A	W	W	W	W	W		
130B2542	10	10	8	5	2.2	10.6	4	10	4	8.2	60	60	60	60	60	60	60	60	60	5.3	1.36
130B2543	17	17	13.6	5	3	12.5	5.5	13	5.5	11	100	100	100	100	100	100	100	100	100	3.1	2.04

Table 4.7 Sine-wave Foot Print Filter 3x200-500V IP20

### 4.3.1 Spare Parts/Accessories

Protective earth (PE) grounding plate for IP00 and IP20 wall mounted filters. The accessory bag also includes all necessary screws and cable fixations.

Wall mounted Sine-wave filters		Accessory bag
IP00	IP20	
130B2404	130B2439	130B0385
130B2406	130B2441	
130B2408	130B2443	
130B2409	130B2444	
130B2411	130B2446	
130B2412	130B2447	
130B2413	130B2448	
130B2341	130B2321	
130B2281	130B2307	130B0387
130B2282	130B2308	
130B2283	130B2309	
130B2835	130B2836	130B4175
130B2838	130B2839	130B4176
130B2841	130B2842	130B4177

Nom. filter current rating (200-380/460/600/690V) [A]	Filter code number	Accessory bag
44/40/32/27	130B2835 130B2836	130B4175
90/80/58/54	130B2838 130B2839	130B4176
106/105/94/86	130B2841 130B2842	130B4176
177/160/131/108	130B2844 130B2845	130B4127

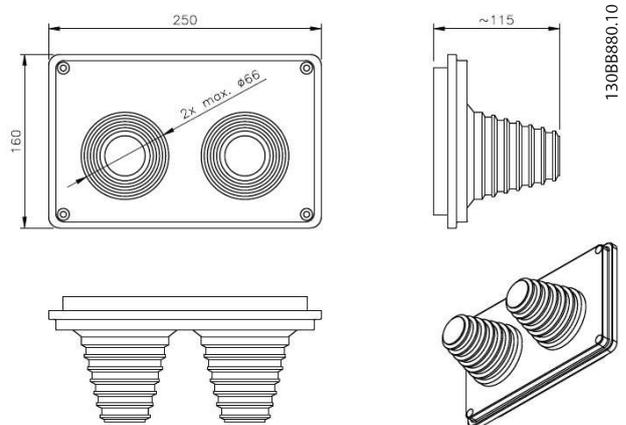
#### Accessories - L-shapes

Voltage	Current	IP	Danfoss part no.	L-shape
500	115	00	130B3179	---
	115	23	130B3181	---
	180	00	130B3182	---
	180	23	130B3183	---
	260	00	130B3184	130B3137
	260	23	130B3185	130B3137
	410	00	130B3186	130B3138
	410	23	130B3187	130B3138
	510	00	130B3188	130B3138
	510	23	130B3189	130B3138
	660	00	130B3191	130B3139
	660	23	130B3192	130B3139
	800	00	130B3193	130B3139
	800	23	130B3194	130B3139

Voltage	Current	IP	Danfoss part no.	L-shape
690	13	00	130B3195	---
	13	20	130B3196	---
	28	00	130B4112	---
	28	20	130B4113	---
	45	00	130B4114	---
	45	20	130B4115	---
	76	00	130B4116	---
	76	23	130B4117	---
	115	00	130B4118	---
	115	23	130B4119	---
	165	00	130B4121	130B3137
	165	23	130B4124	130B3137
	260	00	130B4125	130B3137
	260	23	130B4126	130B3137
	360	00	130B4129	130B3138
	360	23	130B4151	130B3138
	430	00	130B4152	130B3138
	430	23	130B4153	130B3138
	530	00	130B4154	130B3138
	530	23	130B4155	130B3138
660	00	130B4156	130B3139	
660	23	130B4157	130B3139	

### 4.3.2 Cable Glands for Floor Standing Filters

Nom. filter current rating (200-380/460/600/690V) [A]	Filter code number	Spare part no.
315/303/242/192	130B2848	130B4178
480/443/344/290	130B2850	
658/590/500/450	130B2852	
880/780/630/630	130B2854	



## 4.3.3 Terminal Kits

4

Voltage	Current	IP	Danfoss part no.	Spare parts
500	115	00	130B3179	-
	115	23	130B3181	130B4178
	180	00	130B3182	-
	180	23	130B3183	130B4178
	260	00	130B3184	-
	260	23	130B3185	130B4178
	410	00	130B3186	-
	410	23	130B3187	130B4178
	510	00	130B3188	-
	510	23	130B3189	130B4178
	660	00	130B3191	-
	660	23	130B3192	130B4178
	800	00	130B3193	-
	800	23	130B3194	130B4178
690	13	00	130B3195	130B4175
	13	20	130B3196	130B4175
	28	00	130B4112	130B4175
	28	20	130B4113	130B4175
	45	00	130B4114	130B4176
	45	20	130B4115	130B4176
	76	00	130B4116	-
	76	23	130B4117	130B4178
	115	00	130B4118	-
	115	23	130B4119	130B4178
	165	00	130B4121	-
	165	23	130B4124	130B4178
	260	00	130B4125	-
	260	23	130B4126	130B4178
	360	00	130B4129	-
	360	23	130B4151	130B4178
	430	00	130B4152	-
	430	23	130B4153	130B4178
	530	00	130B4154	-
	530	23	130B4155	130B4178
660	00	130B4156	-	
660	23	130B4157	130B4178	

### 4.4 Sine-Wave Filters

Technical Specifications	
Voltage rating	3 x 200-500V and 500-690V AC
Nominal current @ 50Hz	up to 800A (500V) and 660A (690V). F frame current ratings are achieved by filter paralleling, one filter per inverter module.
Motor frequency derating	
50Hz	Inominal
60Hz	0.94 x Inominal
100Hz	0.75 x Inominal
Minimum switching frequency	nominal switching frequency of the respective FC 102, 202 or 302 x 0.80
Maximum switching frequency	8kHz
Overload capacity	160% for 60 seconds, every 10 minutes.
Enclosure degree	IP00, IP20 for wall-mounted, IP23 for floor mounted.
Ambient temperature	-10° to +45°C
Storage temperature	-25° to +60°C
Transport temperature	-25° to +70°C
Maximum ambient temperature (with derating)	55°C
Maximum altitude without derating	1000m
Maximum altitude with derating	4000m
Derating with altitude	5%/1000m
MTBF	1481842 h
FIT	1.5 10 <sup>6</sup> /h
Tolerance of the inductance	± 10%
Degree of pollution EN 61800-5-1	II
Overvoltage category EN 61800-5-1	III
Environmental Conditions Load	3K3
Environmental Conditions Storage	1K3
Environmental Conditions Transport	2K3
Noise level	< frequency converter
Approvals	CE (EN 61558, VDE 0570), RoHS, cULus file E219022 (pending)

The voltage drop across the inductor 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

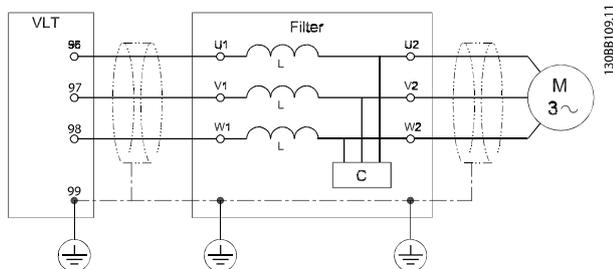
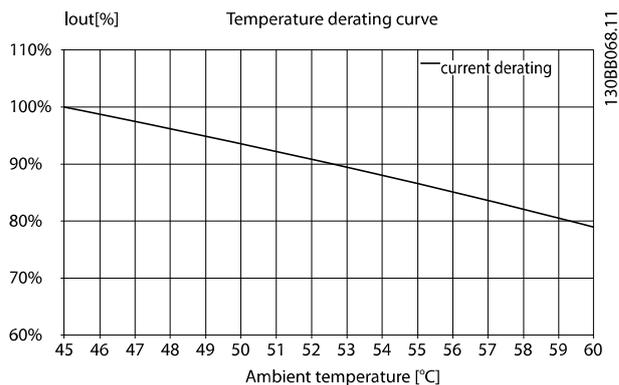


Illustration 4.1 Filter Diagram



## 4.4.1 dU/dt Filters

Technical Specifications	
Voltage rating	3 x 200-690V
Nominal current @ 50Hz	up to 880A. F frame current ratings are achieved by filter paralleling, one filter per inverter module.
Motor frequency derating	
50Hz	Inominal
60Hz	0.94 x Inominal
100Hz	0.75 x Inominal
Minimum switching frequency	no limit
Maximum switching frequency	nominal switching frequency of the respective FC 102, 202 or 302
Overload capacity	160% for 60 seconds, every 10 minutes.
Enclosure degree	IP00, IP 20 for wall-mounted, IP23 for floor mounted. IP21/NEMA 1 available for wall-mounted using separate kits.
Ambient temperature	-10° to +45°C
Storage temperature	-25° to +60°C
Transport temperature	-25° to +70°C
Maximum ambient temperature (with derating) Maximum altitude without derating	55°C
Maximum altitude without derating	1000m
Maximum altitude with derating	4000m
Derating with altitude	5%/1000m
MTBF	1481842 h
FIT	1.5 10 <sup>6</sup> / h
Tolerance of the inductance	± 10%
Degree of pollution EN 61800-5-1	II
Overvoltage category EN 61800-5-1	III
Environmental Conditions Load	3K3
Environmental Conditions Storage	1K3
Environmental Conditions Transport	2K3
Noise level	< frequency converter
Approvals	CE (EN61558, VDE 0570), RoHS, cULus file E219022 (pending)

### 4.4.2 Sine-Wave Foot Print Filter

#### Technical Specification

Voltage rating	3 x 200-500V AC
Nominal current I-N @ 50Hz	10 – 17A
Motor frequency	0-60Hz without derating. 100/120Hz 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	$f_{min}$ 5kHz
Max. switching frequency	$f_{max}$ 16kHz
Overload capacity	160% for 60 sec. every 10 minutes.
Enclosure degree	IP20
Approval	CE, RoHS

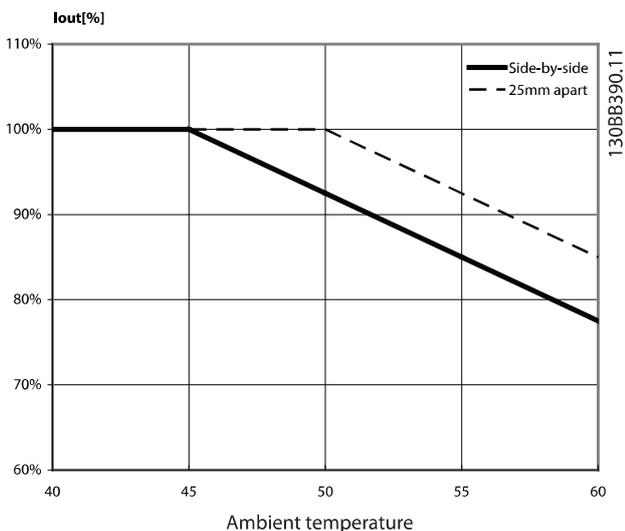


Illustration 4.2 Temperature Derating

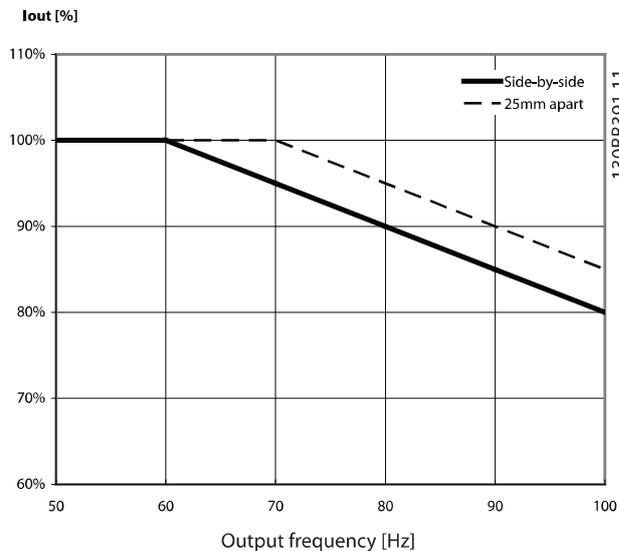


Illustration 4.3 Output Frequency Derating

## 5 How to Install

### 5.1 Mechanical Mounting

#### 5.1.1 Safety Requirements for Mechanical Installation

#### **⚠ WARNING**

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 terminals 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 is minimum 100mm (200mm for foot print filters).
- The surface temperature of IP20/23 units does not exceed 70°C.
- The surface temperature of IP00 filters can exceed 70°C and a hot surface warning label is placed on the filter.

#### 5.1.3 Mechanical Installation of HF-CM

The HF-CM cores have an oval shape to allow easier installation. They should be placed around the three motor phases (U, V and W). It is important to put all three motor phases through the core, else the core will saturate. It is also important not to put the PE or any grounding wires through the core, else the core will lose its effect. In most applications several cores have to be stacked.

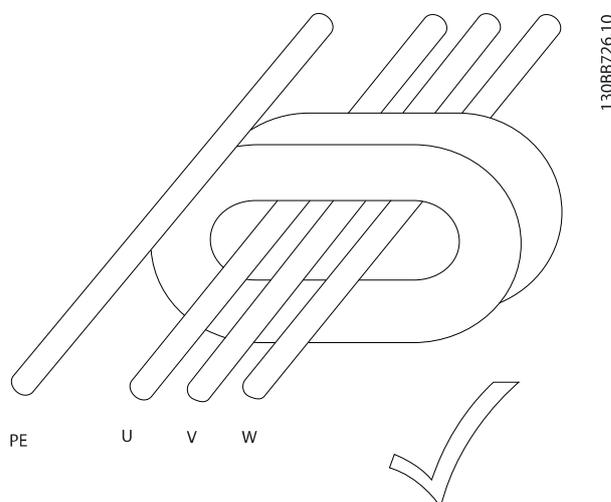


Illustration 5.1 Correct Installation

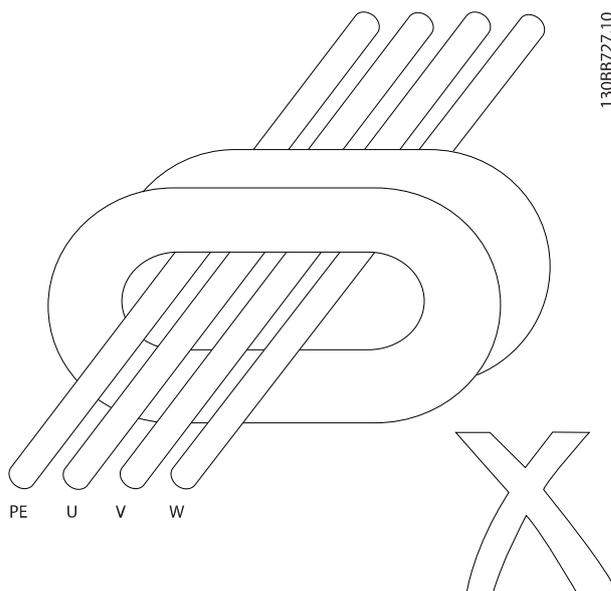


Illustration 5.2 Wrong Installation. The PE should not go through the core.

The cores can vibrate due to the alternating magnetic field. When close to the cable's isolation or other parts, it is possible that the vibration causes the wearing of the core or cable isolation material. Use cable ties to secure the cores and cable.

### 5.1.4 Earthing of Sine-wave and dU/dt Filters

#### **⚠ WARNING**

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 frequency converter 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 frequency converter make solid electrical contact (high frequency earthing)
- The filter must be earthed before switching the power on (high leakage currents)

### 5.1.5 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 frequency converter 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 cable screen must be solidly connected at both ends to the chassis (e.g. housing of filter and motor).
- If IP00 filters are installed in cabinets and screened cables are used, the screen of the motor cable should be terminated at the cabinet cable entry point.
- All screen connections must exhibit the smallest possible impedance, i.e. solid, large area connections, both ends of screened cable.
- Maximum cable length between frequency converter and output filter:  
Below 7.5kW: 2m  
Between 7.5 - 90kW: 5-10m  
Above 90kW: 10-15m

#### **NOTE**

The cable between frequency converter and filter should be kept as short as possible

#### **NOTE**

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

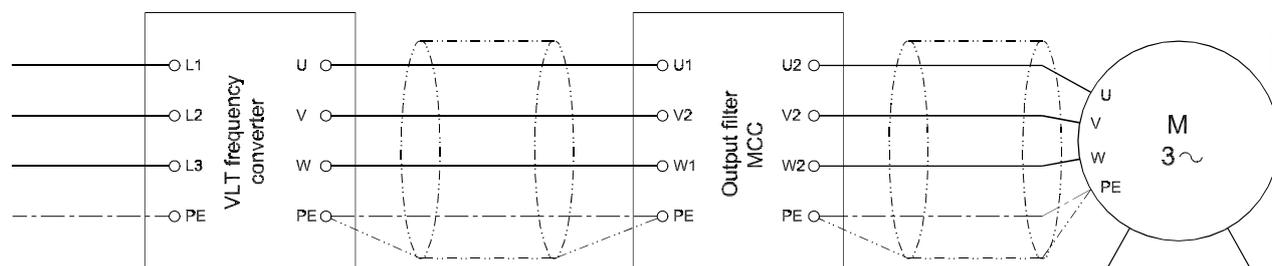


Illustration 5.3 Wiring Diagram

For F frame frequency converters parallel filters shall be used, one filter for each inverter module. The cables or bus bars between inverter and filter should have the same length for each module. The paralleling connection should be after the dU/dt filter/sine-wave filter, either at the filters' terminals or at the motor terminals.

5.2 Mechanical Dimensions

5.2.1 Sketches

Wall Mounted Sine-wave filters

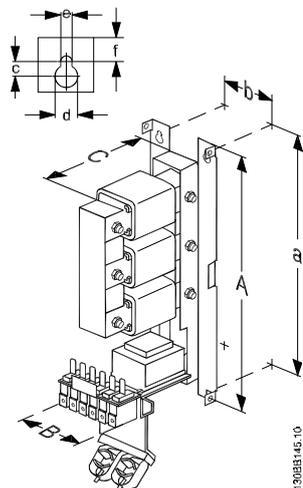


Illustration 5.4 IP00 Wall Mounted

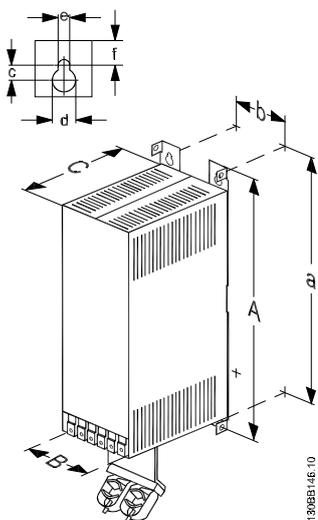


Illustration 5.5 IP20 Wall Mounted

Floor Mounted Sine-wave filters

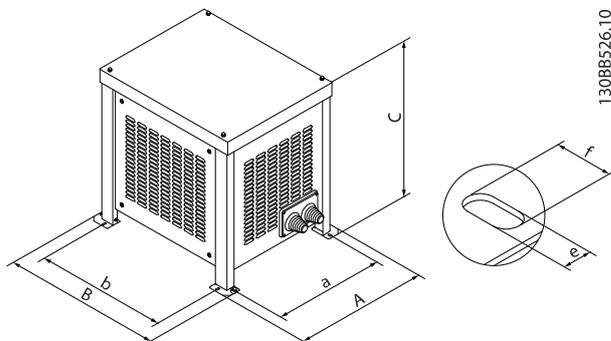


Illustration 5.6 IP23 Floor Mounted

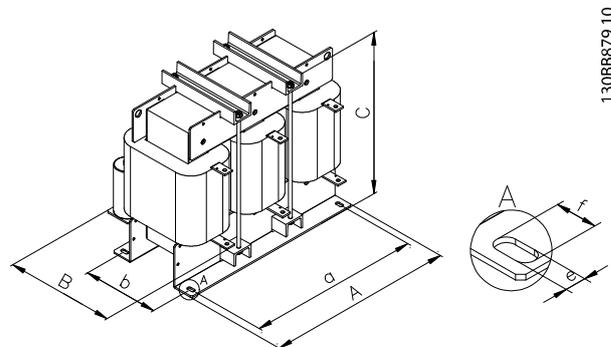


Illustration 5.7 IP00 Floor Mounted

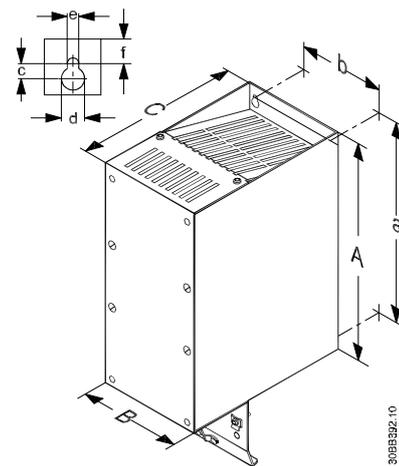


Illustration 5.8 IP20 Wall Mounted Foot Print Filters

Wall mounted dU/du filters

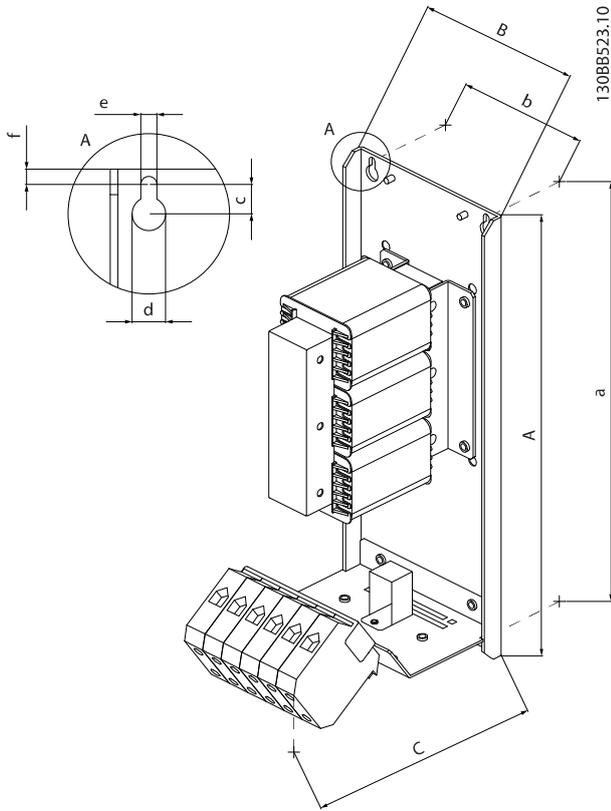


Illustration 5.9 IP00 Wall Mounted

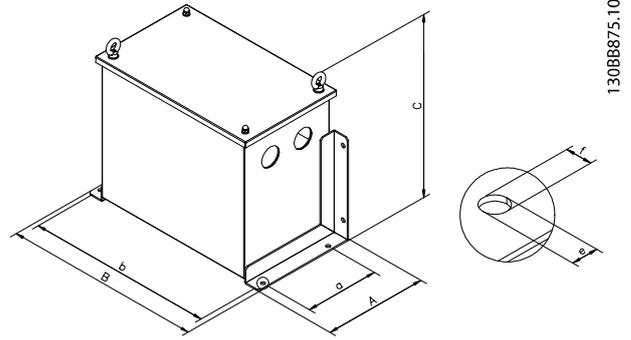


Illustration 5.11 IP54 Floor/Wall Mounted

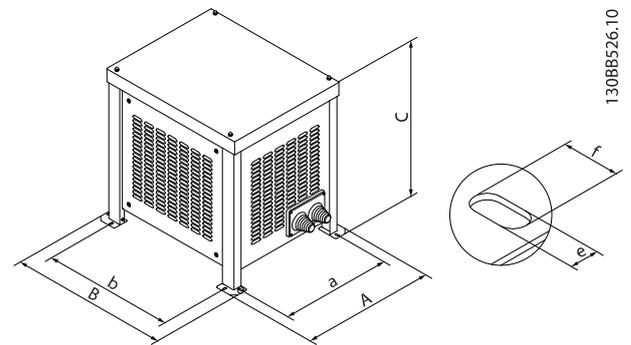


Illustration 5.12 IP23 Floor Mounted

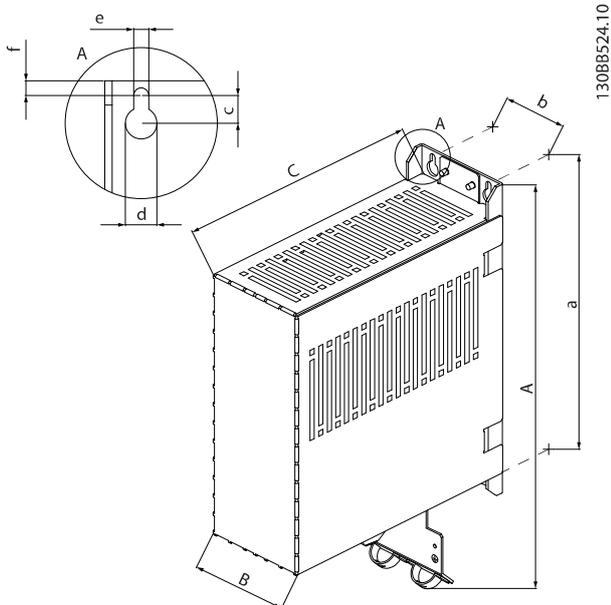


Illustration 5.10 IP20 Wall Mounted

Floor mounted dU/du filters

5

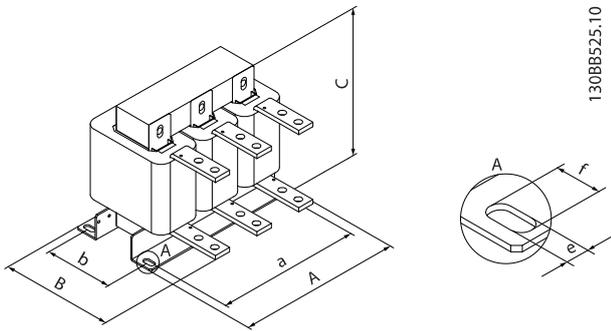
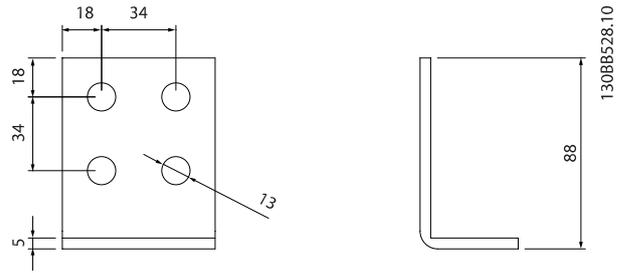


Illustration 5.13 IP00 Floor Mounted

130BB525.10



130BB528.10

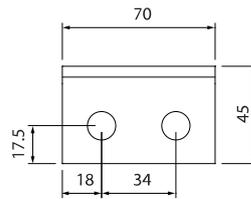


Illustration 5.16 L-shaped Terminal Kit 130B3138

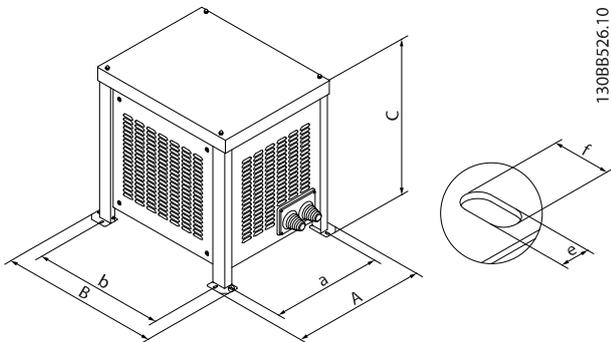
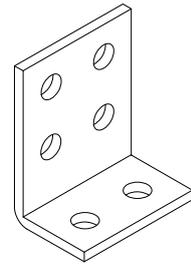
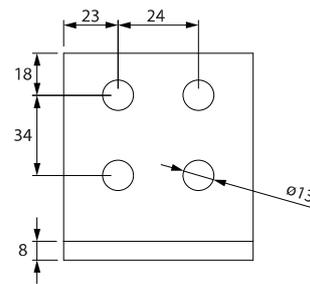


Illustration 5.14 IP23 Floor Mounted

130BB526.10



130BB529.10

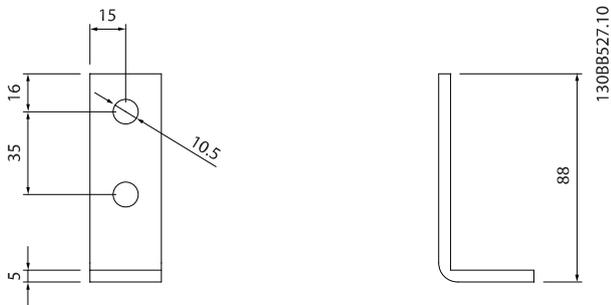
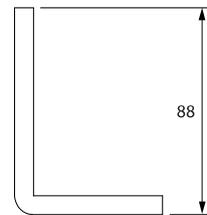


Illustration 5.15 L-shaped Terminal Kit 130B3137

130BB527.10

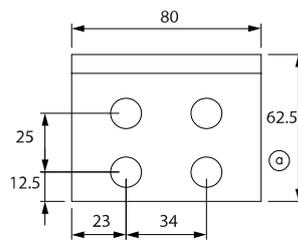
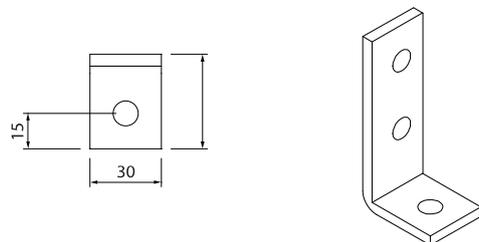
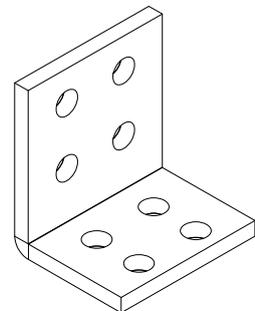


Illustration 5.17 L-shaped Terminal Kit 130B3139



5.2.2 Physical Dimensions

Code number	Enclosure Dimensions [mm]			Weight			Mounting		Wire cross section		Terminal screw torque	L-shaped terminal kit <sup>1)</sup>	Part no.		
	A (height)	B (width)	C (depth)	a	b	c	d	e	f	kg				mm <sup>2</sup>	AWG
130B2835	IP00	295	115	279	85	170	11.5	13	6.2	6	4.6	16	6	4/3	N/A
130B2836	IP20	370	118	279	85	242	11.5	13	6.2	6	6.3	16	6	4/3	N/A
130B2838	IP00	395	155	379	125	220	11.5	13	6.2	6	12.7	50	1	6/4.5	N/A
130B2839	IP20	475	157	379	125	248	11.5	13	6.2	6	16.2	50	1	6/4.5	N/A
130B2841	IP00	395	155	379	125	220	11.5	13	6.2	6	22	50	1	6/4.5	N/A
130B2842	IP20	475	158	379	125	248	11.5	13	6.2	6	25.5	50	1	6/4.5	N/A
130B2844	IP00	445	185	429	185	235	11.5	13	6.2	6	27	95	3/0	12/9	N/A
130B2845	IP20	525	188	429	188	335	11.5	13	6.2	6	30	95	3/0	12/9	N/A
130B2847	IP00	300	190	275	100	235			11	22	33	M10		18/13.3	130B3137
130B2848	IP23	425	700	325	660	620			13	17	64.5	M10		18/13.3	130B3137
130B2849	IP00	300	275	275	250	235			11	22	36	2 x M10		30/22.1	130B3138
130B3850	IP23	425	700	325	660	620			13	17	67.5	2 x M10		30/22.1	130B3138
130B2851	IP00	350	250	325	250	270			11	22	47	2 x M10		30/22.1	130B3138
130B2852	IP23	425	700	325	660	620			13	17	78.5	2 x M10		30/22.1	130B3138
130B2853	IP00	400	290	375	290	283			11	22	72	4 x M10		30/22.1	130B3139
130B2854	IP23	792	940	660.5	779	918			11	22	182	4 x M10		30/22.1	130B3139

<sup>1)</sup> For floor mounted filters, an optional terminal connection kit is available for the ease of installation. Please see the L-shaped terminal kit sketches. The kit is not included in the filter delivery and should be ordered separately.

Table 5.1 200-690V dU/dt Filters - Physical Dimensions

Code number	Enclosure	Measurements / Dimensions									Weight	Mounting direction	Max. wire cross section		Terminal screw torque	L-shaped terminal kit <sup>1)</sup>
		A (height)	a	B (width)	b	C (depth)	c	d	e	f			kg	Wall/Floor		
130B2404	IP00	200	190	75	60	205	7	8	4.5	5	2.5	wall	4	24 - 10	0.6/0.44	N/A
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	N/A
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	N/A
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	N/A
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	N/A
130B2446	IP20										9.1					
130B2412	IP00	330	312	150	120	260	12	19	9	9	14.4	wall	16	20 - 4	2/1.5	N/A
130B2447	IP20										16.9					
130B2413	IP00	430	412	150	120	260	12	19	9	9	17.7	wall	16	20 - 4	2/1.5	N/A
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	N/A
130B2307	IP20					260					39					
130B2282	IP00	610	580	170	125	260	12	19	9	20	36	wall	50	6 - 1/0	8/5.9	N/A
130B2308	IP20										41					
130B2283	IP00	610	580	170	135	260	12	19	9	20	50	wall	50	6 - 1/0	15/11.1	N/A
130B2309	IP20										54					
130B3179	IP00	520	-	470	400	334	175	13	26	26	95	floor		2.0-6.0	N/A	N/A
130B3181	IP23	918	898	904	779	792	661	11	22	205						
130B3182	IP00	580	-	470	400	311	150	13	26	127						
130B3183	IP23	918	898	904	779	792	661	11	22	237						N/A
130B3184	IP00	520	-	500	450	350	200	13	26	197						130B3137
130B3185	IP23	918	898	904	779	792	661	11	22	307						
130B3186	IP00	520	-	500	450	400	250	13	26	260						130B3138
130B3187	IP23	918	898	904	779	792	661	11	22	370						
130B3188	IP00	520	-	500	450	400	250	13	26	265						130B3138
130B3189	IP23	1161	1141	1260	1099	991	860	11	22	425						
130B3191	IP00	620	-	620	575	583	250	13	26	410						130B3139
130B3192	IP23	1161	1141	1260	1099	991	860	11	22	570						

<sup>1)</sup> For floor mounted filters, an optional terminal connection kit is available for the ease of installation. Please see the L-shaped terminal kit sketches. The kit is not included in the filter delivery and should be ordered separately.

Table 5.2 500V Sine-wave Filter - Physical dimensions

Code number	Enclosure	Measurements / Dimensions						Weight		Mounting direction	Max. wire cross section		Terminal screw torque	L-shaped terminal kit <sup>1)</sup>
		A (height)	a	B (width)	b	C (depth)	c	d	e		f	kg		
130B3193	IP00	620	-	620	575	583	250	13	26	410				
130B3194	IP23	1161	1141	1260	1099	991	860	11	22	610	floor		130B3139	
2 x 130B3188	IP00												N/A	
2 x 130B3189	IP23												N/A	
2 x 130B3191	IP00												N/A	
2 x 130B3192	IP23												N/A	
3 x 130B3188	IP00												N/A	
3 x 130B3189	IP23												N/A	
3 x 130B3191	IP00												N/A	
3 x 130b3192	IP23												N/A	

<sup>1)</sup> For floor mounted filters, an optional terminal connection kit is available for the ease of installation. Please see the L-shaped terminal kit sketches. The kit is not included in the filter delivery and should be ordered separately.

**Table 5.3 500V Sine-wave Filter - Physical Dimensions**

Code number	Enclosure	Measurements / Dimensions										Weight	Mounting direction	Max. wire cross section		Terminal screw torque	L-shaped terminal kit <sup>1)</sup>
		A (height)	a	B width	b	C depth	c	d	e	f	kg			mm <sup>2</sup>	AWG		
130B3195	IP00	465	449	115	85	270	225	13	6.2	6.5	18		wall	16	20 - 8	2/1.5	N/A
130B3196	IP20	465	449	118	85	243	-	13	6.2	6.5	21						
130B4112	IP00	505	489	155	125	270	225	13	6.2	6.5	27		floor	16	20 - 8	15/11.1	N/A
130B4113	IP23	505	489	158	125	310	-	13	6.2	6.5	31						
130B4114	IP00	625	609	155	125	370	300	13	6.2	6.5	43		floor	50	8 - 6	15/11.1	N/A
130B4115	IP23	625	609	158	125	310	-	13	6.2	6.5	49						
130B4116	IP00	520	-	470	400	332	175	13	26	107		floor	95	6 - 4	15/11.1	N/A	
130B4117	IP23	715	699	798	676	620	502	11	22	142							
130B4118	IP00	520	-	470	400	332	175	13	26	123		floor	95	4 - 2	15/11.1	N/A	
130B4119	IP23	715	699	798	676	620	502	11	22	160							
130B4121	IP00	470	-	500	450	400	200	13	26	160		floor	Ø10.5	2 - 1/0	15/11.1	130B3137	
130B4124	IP23	918	898	940	779	792	661	11	22	270							
130B4125	IP00	535	-	660	575	460	250	13	26	315		floor	Ø10.5	2/0 - 4/0	18/13.3	130B3137	
130B4126	IP23	1161	1141	1260	1099	991	860	11	22	475							
130B4129	IP00	660	-	800	750	610	275	13	26	513		floor	2 x Ø13	2/0 - 4/0	18/13.3	130B3138	
130B4151	IP23	1161	1141	1260	1099	991	860	11	22	673							
130B4152	IP00	660	-	800	750	610	275	13	26	485		floor	2 x Ø13	4/0 - 5/0	18/13.3	130B3138	
130B4153	IP23	1161	1141	1260	1099	991	860	11	22	645							
130B4154	IP00	660	-	800	750	684	350	13	26	600		floor	2 x Ø13	4/0 - 5/0	30/22.1	130B3138	
130B4155	IP23	1161	1141	1260	1099	991	860	11	22	760							
130B4156	IP00	490	-	800	750	713	375	13	26	745		floor	4 x Ø13	5/0	30/22.1	130B3139	
130B4157	IP23	1161	1141	1260	1099	991	860	11	22	905							
2 x 130B4152	IP00														5/0 - 6/0	30/22.1	N/A
2 x 130B4153	IP23																
2 x 130B4154	IP00														6/0	30/22.1	N/A
2 x 130B4155	IP23																
3 x 130B4154	IP00														6/0	30/22.1	N/A
3 x 1304155	IP23																

<sup>1)</sup> For floor mounted filters, an optional terminal connection kit is available for the ease of installation. Please see the L-shaped terminal kit sketches. The kit is not included in the filter delivery and should be ordered separately.

Table 5.4 690V Sine-wave filter - Physical Dimensions

Code Number	Foot Print	Dimensions						Weight	Mounting Direction	Max. Wire Cross Section				
		A (height)	a	B (width)	b	C (depth)	c				d	e	f	[kg]
130B2542	A2	282	257	90	70	202	10	11	6	15	8	4	4	wall
130B2543	A3	282	257	130	110	212	10	11	6	15	11.5	4	4	wall

Table 5.5 Foot Print Sine-Wave Filter - Technical Data

Part number	Enclosure	Dimensions [mm]						Weight g	Mounting	Wire cross section	Terminal screw torque	L-shaped terminal kit <sup>1</sup>	
		A (height)	B (width)	C (depth)	a	b	c						d
IP54		200	320	304	250	9	9	15.7	floor	16	6	4/3	N/A
130B2837	IP54	230	420	400	355	9	9	39.8	floor	50	1	6/4.5	N/A
130B2840	IP54	275	470	446	460	11	14	59.6	floor	50	1	6/4.5	N/A
130B2843	IP54	275	470	446	460	11	14	61.8	floor	95	3/0	12/9	N/A
130B2846	IP54												

Table 5.6 200-690V dU/dt Filters - Physical Dimensions

## 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.

### NOTE

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.

### NOTE

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 SFVM
14-01	Switching Frequency	Choose value for individual filter
14-55	Output Filter	Choose Sine-wave filter fixed
14-56	Capacitance Output Filter	Set the capacitance <sup>1)</sup>
14-57	Inductance Output Filter	Set the inductance <sup>1)</sup>

<sup>1)</sup> For FLUX control principle only. Values can be found in 4.2 *Electrical Data - dU/dt Filters* and 4.3 *Electrical Data - Sine-wave Filters*.

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Data Sheet

# Pressure transmitter Type **MBS 3000** and **MBS 3050**

For general industrial purposes



The compact pressure transmitter, type MBS 3000, is designed for use in industrial and hydraulic applications, and offers a reliable pressure measurement, even under harsh environmental conditions.

The compact heavy duty pressure transmitter MBS 3050 with integrated pulse-snubber is designed for use in hydraulic applications with severe medium influences like cavitation, liquid hammer or pressure peaks and offers a reliable pressure measurement, even under harsh environmental conditions.

The flexible pressure transmitter programme covers different output signals, absolute or gauge (relative) versions, measuring ranges from 0 – 1 to 0 – 600 bar. A wide range of pressure and electrical connections are available.

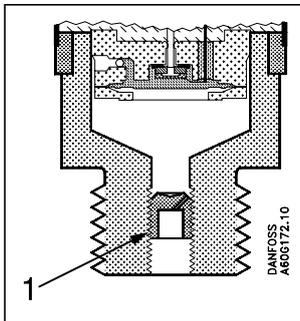
Excellent vibration stability, robust construction, and a high degree of EMC/EMI protection equip the pressure transmitter to meet the most stringent industrial requirements.

## Features

- Designed for use in severe industrial and hydraulic environments
- Resistant to cavitation, liquid hammer and pressure peaks (MBS 3050)
- Enclosure and wetted parts of acid-resistant stainless steel (AISI 316L)
- Pressure ranges in relative (gauge) or absolute from 0 up to 600 bar
- All standard output signals: 4 – 20 mA, 0 – 5 V, 1 – 5 V, 1 – 6 V, 0 – 10 V, 1 – 10 V, Ratiometric output signal: 10-90% of supply voltage
- A wide range of pressure and electrical connections
- Fully digitally compensated
- For use in ATEX zone 2 explosive atmospheres
- UL approved

## Applications

### **Application and media conditions for MBS 3050**



1 Pulse-snubber

### **Application for MBS 3050**

Cavitation, liquid hammer and pressure peaks may occur in hydraulic systems with changes in flow velocity, e.g. fast closing of a valve or when a pump starts and stops.

The problem may occur on the inlet and outlet side of the application, even at rather low operating pressures.

### **Media condition for MBS 3050**

Clogging of the nozzle may occur in liquids containing particles. Mounting the transmitter in an upright position minimizes the risk of clogging, because the flow in the nozzle is limited to the start-up period until the dead volume behind the nozzle orifice is filled. The media viscosity has only little effect on the response time. Even at a viscosities up to 100 cSt, the response time will not exceed 4 ms.

## Product specification

### Technical data

**Table 1: Performance (EN 60770)**

Accuracy (incl. non-linearity, hysteresis and repeatability)	≤ ± 0.5% FS (typ.) ≤ ± 1% FS (max.)
Non-linearity BFSL (conformity)	≤ ± 0.2% FS
Hysteresis and repeatability	≤ ± 0.1% FS
Thermal zero point shift	≤ ± 0.1% FS / 10K (typ.) ≤ ± 0.2% FS / 10K (max.)
Thermal sensitivity (span) shift	≤ ± 0.1% FS / 10K (typ.) ≤ ± 0.2% FS / 10K (max.)
Response time: Liquids with viscosity < 100 cSt	< 4 ms
Response time: Air and gases (MBS 3050)	< 35 ms
Overload pressure (static)	6 × FS (max. 1500 bar)
Burst pressure	6 × FS (max. 2000 bar)
Power-up time	< 50 ms
Durability, P: 10 – 90% FS	> 10 × 10 <sup>6</sup> cycles
MTTFd - Calculation based on the SN 29500	> 100 years

**Table 2: Electrical specifications**

Nom. output signal (short-circuit protected)	4 – 20 mA	0 – 5, 1 – 5, 1 – 6 V	0 – 10 V, 1 – 10 V	Ratiometric 10 – 90% of [U <sub>B</sub> ]
Supply voltage [U <sub>B</sub> ], polarity protected	9 – 32 V DC	9 – 32 V DC	15 – 32 V DC	4.5 – 5.5 V DC
Supply – current consumption	–	≤ 5 mA	≤ 8 mA	≤ 5 mA at 5 V DC
Supply voltage dependency	< 0.1% FS / 10 V	< 0.05% FS / 10 V		–
Ratiometricity	–	–		< 0.05% FS / 4.5 – 5.5 V
Output limitation	22.4 mA	0-5 V: 5.75 V 1-5 V: 5.6 V 1-6 V: 6.75 V	0-10V: 11.5 V	≈ supply voltage
Sink / Source	–	< 1 mA		
Load [R <sub>L</sub> ] (load connected to 0 V)	R <sub>L</sub> ≤ (U <sub>B</sub> - 9 V) / 0.02 A	R <sub>L</sub> ≥ 10 kΩ	R <sub>L</sub> ≥ 15 kΩ	R <sub>L</sub> ≥ 10 kΩ at 5 V DC

**Table 3: Environmental conditions**

Sensor operating temperature	Normal	-40 – 85 °C
	ATEX Zone 2	-20 – 85 °C
Media temperature range		-40 – 85 °C
Ambient temperature range (depending on electrical connection)		See <a href="#">Electrical connections</a>
Compensated temperature range		0 – 80 °C
Transport/storage temperature range		-50 – 85 °C
EMC – Emission		EN 61000-6-3
EMC – Immunity		EN 61000-6-2
Insulation resistance		> 100 MΩ at 500 V DC
Vibration stability	Sinusoidal	15.9 mm-pp, 5 Hz – 25 Hz 20 g, 25 Hz – 2 kHz
	Random	7.5 g <sub>rms</sub> , 5 Hz – 1 kHz
Shock resistance	Shock	500 g / 1 ms
	Free fall	1 m
Enclosure (depending on electrical connection)		See <a href="#">Electrical connections</a>

**Table 4: Explosive atmospheres**

Zone 2 applications <sup>(1)</sup>	<b>II 3G</b> <b>Ex ce IIA T3 Gc</b> <b>-20 °C &lt; Ta &lt; +85 °C</b>	EN60079-0; EN60079-7
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<sup>(1)</sup> When used in ATEX Zone 2 areas at low temperatures the cable and plug must be protected against impact.



## Electrical connections

Table 6: Electrical connections

Type code	A1 & A6	A3 & A0	E3	A8	C8	D9	G1
	<p>EN 175301-803-A, Pg 9 &amp; Pg 11</p>	<p>2 m screened cable</p>	<p>IEC 61076-2-101 M12 x 1; 4-pin</p>	<p>AMP Superseal 1.5 series (male)</p>	<p>ISO 15170-A1-3.2-Sn Bayonet</p>	<p>AMP 173065, male Flying leads 125 mm</p>	<p>AMP Econoseal J series (male)</p>
Ambient temperature	-40 – 85 °C	-30 – 85 °C	-25 – 90 °C	-30 – 85 °C	-40 – 85 °C	-40 – 85 °C	-30 – 85 °C
Enclosure (IP protection fulfilled together with mating connector)	IP65	IP67	IP67	IP67	IP67/IP69	IP67	IP67
Atex Zone 2 enclosure	IP54						
Material	Glass filled polyamide, PA 6.6 <sup>(1)</sup>	Polioliyfin cable with PE shrinkage tubing	Nickel plated brass, CuZn/Ni	Glass filled polyamide, PA 6.6 <sup>(2)</sup>	Glass filled polyester PBT <sup>(2)</sup>	Glass filled polyester PBT <sup>(2)</sup>	Glass filled polyamide, PA 6.6 <sup>(1)</sup>
Electrical connection, 4 – 20 mA output (2 wire)	Pin 1: + supply Pin 2: ÷ supply Pin 3: not used  Earth: Connected to MBS enclosure	Brown wire: + supply Black wire: ÷ supply Red wire: not used Orange: not used Screen: not connected to MBS enclosure	Pin 1: + supply Pin 2: not used Pin 3: not used Pin 4: ÷ supply	Pin 1: + supply Pin 2: ÷ supply Pin 3: not used	-	Pin 1: + supply Pin 2: ÷ supply Pin 3: not used	Pin 1: + supply Pin 2: ÷ supply/ common Pin 3: not used
Electrical connection, 0 – 5 V, 1 – 5 V, 1 – 6 V, 0 – 10 V, 1 – 10 V output	Pin 1: + supply Pin 2: ÷ supply/ common Pin 3: + output  Earth: Connected to MBS enclosure	Brown wire: + output Black wire: ÷ supply Red wire: + supply Orange: not used Screen: not connected to MBS enclosure	Pin 1: + supply Pin 2: not used Pin 3: + output Pin 4: ÷ supply/ common	Pin 1: + supply Pin 2: ÷ supply/ common Pin 3: + output	-	Pin 1: + supply Pin 2: ÷ supply Pin 3: + output	Pin 1: + supply Pin 2: ÷ supply/ common Pin 3: + output
Electrical connection Ratio-metric output, 10-90% of supply voltage	Pin 1: + supply Pin 2: ÷ supply Pin 3: output/ common  Earth: Connected to MBS enclosure	Brown wire: output Black wire: ÷ supply Red wire: Common <sup>(3)</sup> Orange: not used Screen: not connected to MBS enclosure	Pin 1: + supply Pin 2: not used Pin 3: output Pin 4: ÷ supply/ common	Pin 1: + supply Pin 2: ÷ supply Pin 3: output/ common	Pin 1: + supply Pin 2: ÷ supply/ common Pin 3: + output Pin 4: Not used	-	Pin 1: + supply Pin 2: ÷ supply/ common Pin 3: + output

<sup>(1)</sup> Female plug: Glass filled polyester, PBT

<sup>(2)</sup> Wire: PTFE (teflon) Protection sleeve: PBT mesh (polyester)

<sup>(3)</sup> Common

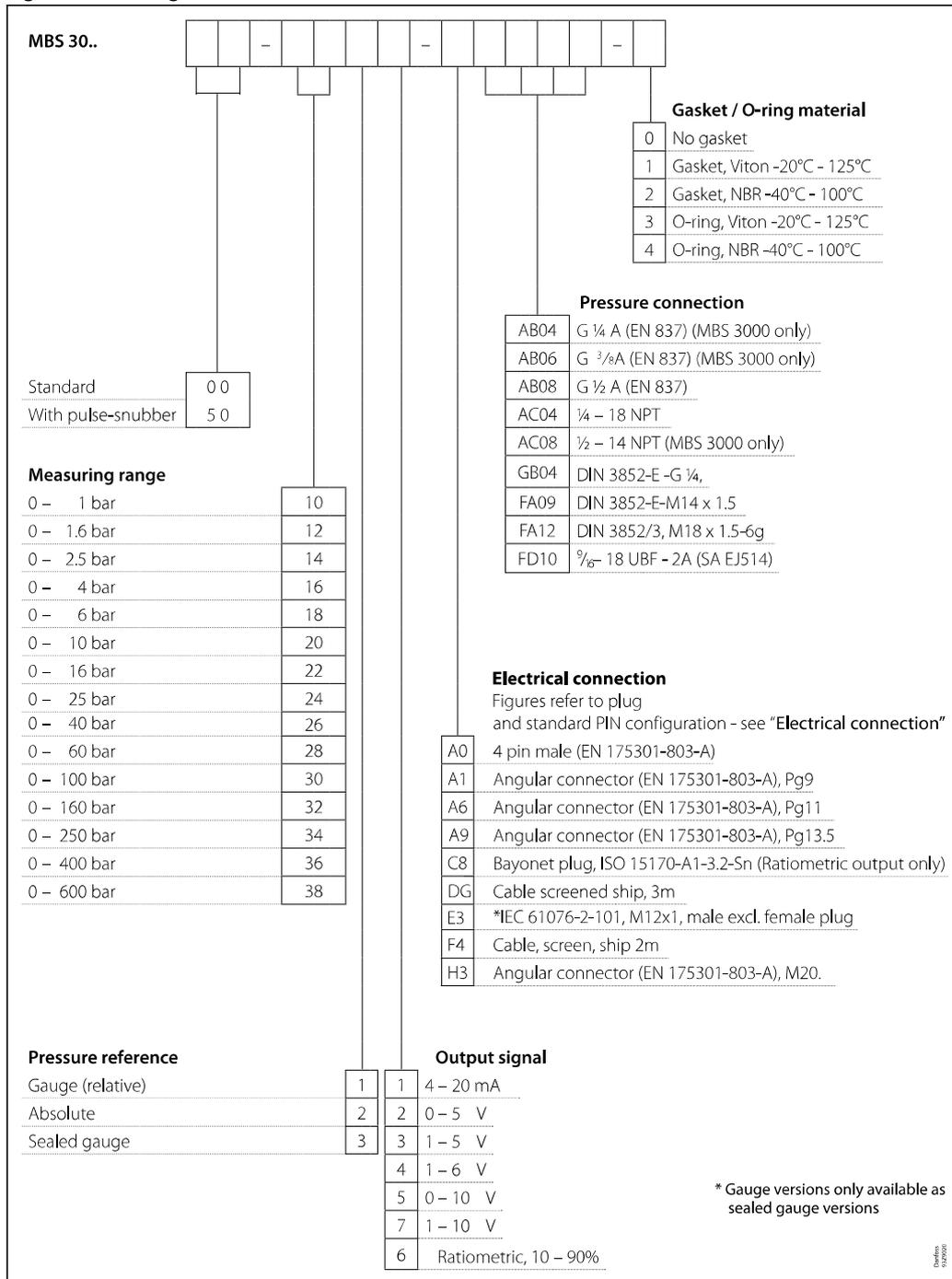
**NOTE:**

Please check [store.danfoss.com](http://store.danfoss.com) to find the correct variant for your requirements.

## Ordering

### Ordering standard

Figure 1: Ordering standard



**NOTE:**

Non-standard build-up combinations may be selected. However, minimum order quantities may apply. Please contact your local Danfoss office for further information.

## Certificates, declarations, and approvals

The list contains all certificates, declarations, and approvals for this product type. Individual code number may have some or all of these approvals, and certain local approvals may not appear on the list.

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**Table 7: Certificates and declarations**

File name	Document type	Document topic	Approval authority
060G9688.00	Manufacturers Declaration	-	Danfoss
097R0004.01	Manufacturers Declaration	RoHS	Danfoss
UA.1O146.D.00075-19	UA Declaration	EMCD/LVD	LLC CDC EURO TYSK
084R1022.01	Manufacturers Declaration	China RoHS	Danfoss
087R0017.00	Manufacturers Declaration	Simple apparatus	Danfoss
E31024	Electrical Safety Certificate	-	UL
E311982	Electrical Safety Certificate	-	UL
E494625	Electrical Safety Certificate	-	UL
E227388	Electrical Safety Certificate	-	UL
064G9615.10	EU-UK Declaration	ATEX/EMCD/RoHS	Danfoss
060R3160.00	Manufactures Declaration	-	Danfoss
CRN.OF18477.5123467890YTN	Pressure Safety Certificate	-	TSSA

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Nr.5090

UAB "Automatizavimo sprendimai"

Įmonės kodas: 300153892

Tilžės g. 164-2, LT-76296 Šiauliai

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Direktorius



ROBERTAS BRICKAS

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Pirmą kartą išduotas 2007 m. gruodžio 14 d.

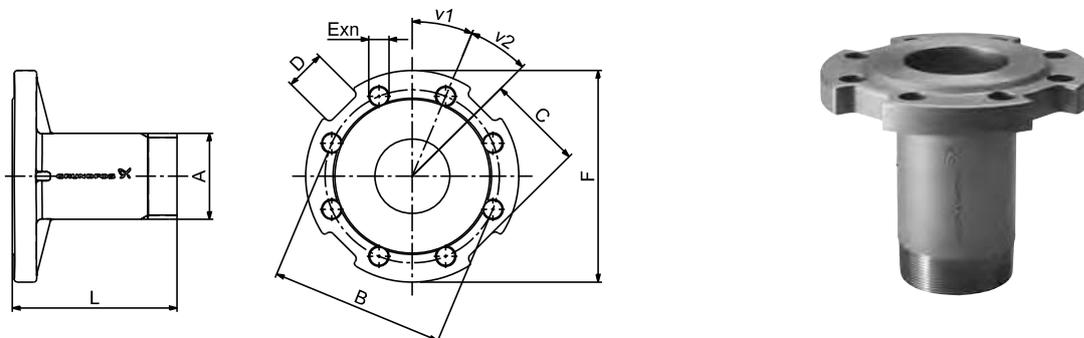
Kvalifikacijos atestatų registras skelbiamas [www.spsc.lt](http://www.spsc.lt)

### 3. Mechanical accessories

#### Connecting pieces / Adaptors

The tables below show the range of connecting pieces for connection of thread-to-flange and thread-to-thread.

##### Thread-to-flange (standard flange to EN 1092-1)



TM01 2396 4508 - GrA2552 3706

Fig. 11 Dimensional sketch and photo of the connecting piece thread-to-flange

Type	Pump outlet	Connecting piece	Thread-to-flange										Product number	
			A	Dimensions [mm]						v1	v2	n	EN 1.4308	EN 1.4517
				B	C	D	E	F	L					
SP 17	Rp 2 1/2	R 2 1/2 → DN 50 PN 16/40	R 2 1/2	125	65	40	∅19	∅165	170	30	30	4	00120125	00120911
		R 2 1/2 → DN 65 PN 16/40	R 2 1/2	145	71	30	∅19	∅185	170	22.5	22.5	8	00120126	00120910
		R 2 1/2 → DN 80 PN 16/40	R 2 1/2	160	82.5	40	∅19	∅200	170	22.5	22.5	8	00120127	00120909
SP 30 SP 46 SP 60	Rp 3	R 3 → DN 65 PN 16/40	R 3	145	71	30	∅19	∅185	170	22.5	22.5	8	00130187	00130920
		R 3 → DN 80 PN 16/40	R 3	160	82.5	40	∅19	∅200	170	22.5	22.5	8	00130188	00130921
		R 3 → DN 100 PN 40	R 3	180/190	100	40	∅19/∅23	∅235	170	22.5	22.5	8	00130189	00130922
		R 3 → DN 100 PN 16	R 3	180/190	100	40	∅19/∅23	∅235	180	22.5	22.5	8	00130210	00130867
SP 46 SP 60	Rp 4	R 4 → DN 100 PN 16	R 4	180	100	40	∅19	∅235	180	22.5	22.5	8	00140077	00140737
		R 4 → DN 100 PN 40	R 4	190	100	40	∅23	∅235	180	22.5	22.5	8	00140071	00140577
SP 77 SP 95	Rp 5	R 5 → DN 100 PN 16	R 5	180	82	35	∅19	∅220	195	22.5	22.5	8	00160159	00160657
		R 5 → DN 100 PN 40	R 5	190	82	35	∅23	∅235	195	22.5	22.5	8	00160148	00160646
		R 5 → DN 125 PN 16	R 5	210	99	37	∅19/∅28	∅250	195	22.5	22.5	8	00160157	00160655
		R 5 → DN 125 PN 40	R 5	220	99	37	∅19/∅28	∅270	195	22.5	22.5	8	00160149	00160647
		R 5 → DN 150 PN 16	R 5	240	115	36	∅23	∅285	195	22.5	22.5	8	00160161	00160659
SP 125 SP 160 SP 215	Rp 6	R 6 → DN 150 PN 40	R 5	250	115	36	∅28	∅300	195	22.5	22.5	8	00160150	00160648
		R 6 → DN 125 PN 16	R 6	210	99	36	∅19	∅250	195	22.5	22.5	8	00170170	00170694
		R 6 → DN 125 PN 40	R 6	220	99	36	∅28	∅270	195	22.5	22.5	8	00170159	00170596
		R 6 → DN 150 PN 16	R 6	240	114	36	∅23	∅285	195	22.5	22.5	8	98518437	98518487
		R 6 → DN 150 PN 40	R 6	250	114	36	∅28	∅300	195	22.5	22.5	8	00170160	00170597
		R 6 → DN 200 PN 16	R 6	295	134	36	∅23	∅340	195	15	15	12	00170161	00170598
		R 6 → DN 200 PN 40	R 6	320	151	36	∅31	∅375	200	15	15	12	00170162	00170599



SISTEMŲ  
REGISTRAS

# SERTIFIKATAS

Nr. SRS23/157

2023-06-21

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Kuršių g. 7, LT-48107 Kaunas, Lietuva  
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vadybos sistema atitinka žemiau išvardintų standartų reikalavimus:

**LST EN ISO 9001:2015 (ISO 9001:2015)**  
**LST EN ISO 14001:2015 (ISO 14001:2015)**  
**LST ISO 45001:2018 (ISO 45001:2018)**

Sertifikavimo sritys:

SKYSČIŲ TIEKIMO SISTEMŲ GAMYBA, PARDAVIMAS, MONTAVIMAS IR REMONTAS  
SKYSČIŲ SIURBLIŲ PARDAVIMAS, MONTAVIMAS IR REMONTAS

Šis sertifikatas galioja iki 2026-06-23  
Pirmą kartą sertifikuota nuo 2014-06-25



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ISO/IEC 17021-1

Nr. LA 04005



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Info@sertifikuoti.lt  
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# FRANKLIN TRAINED WORKSHOP

This is to certify that

**Vandens siurbiai UAB in Siauliai, Lithuania**

has been satisfactorily trained on the analysis, maintenance and repair of Franklin Electric products and is hereby authorized to render these services.

Wittlich, March 19, 2012



**Franklin Electric Europa GmbH**

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