

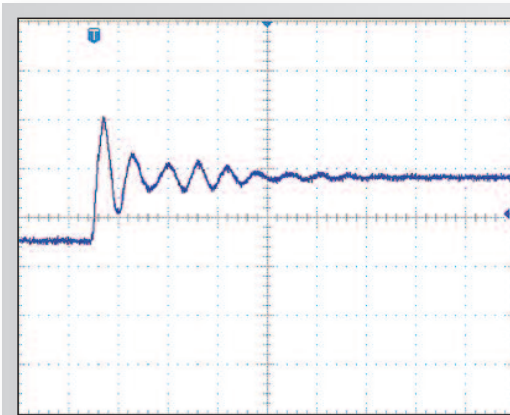
Introduction

Motors controlled by VFDs or servo drives require additional attention to avoid overvoltage spikes, known as dV/dt . Voltage wave reflection is a function of the voltage rise time (dV/dt) and the length of the motor cables. This phenomenon creates additional overvoltage spikes which cause premature degradation and failure to the motor insulation.

The challenge for OEMs, system integrators and distributors is to ensure that the installed motors are well protected from overvoltage. Markets using VFDs have adopted a special motor, better known as, a motor rated VFD or inverter duty motor.

The motor rated VFD construction can change significantly based on the manufacturer. However following the National Electrical Manufacturer's Association (NEMA), the greatest difference between a standard motor and an inverter duty motor is the winding insulation.

For example, a nominal 480 Vac AC drive using a standard grade motor should maintain performance and function with peak voltage up to 1000V. For inverter duty rated motors the acceptable peak voltage is typically 1500V.



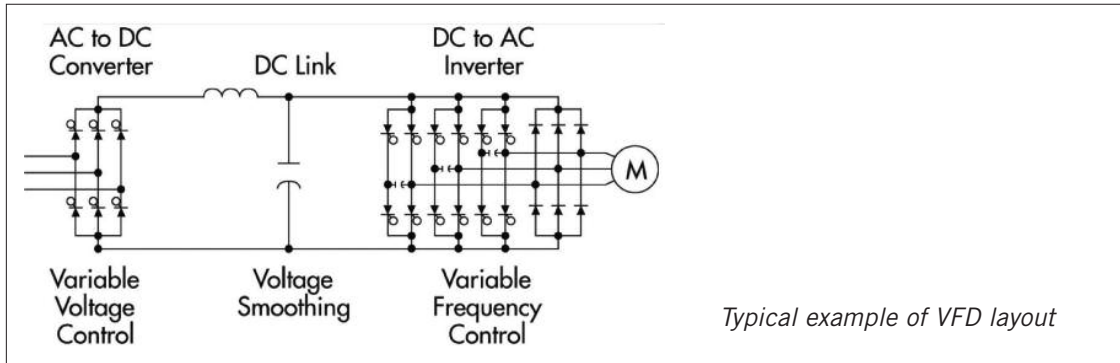
Typical example of dV/dt measured on the motor with cable length of 50m (150 ft)

Theory

To better understand what causes motor failure and unforeseen challenges, it is best to first understand how a VFD is assembled. VFDs are made up of three major parts:

- The rectifier - takes incoming AC power and converts it to DC power
- The DC link - several capacitors used for energy storage from the output of the rectifier
- The inverter - produces 2-20 kHz signal used to generate the output waveform to the motor using pulse width modulation (PWM)

PWM is a technique which generates the width of a pulse based on modulation signal information. Due to this technique, the dV/dt presents a significant concern.



The Solution

Enerdoor has developed the motor protection series to protect motors from harmful overvoltage and dV/dt spikes generated by the drive's output.

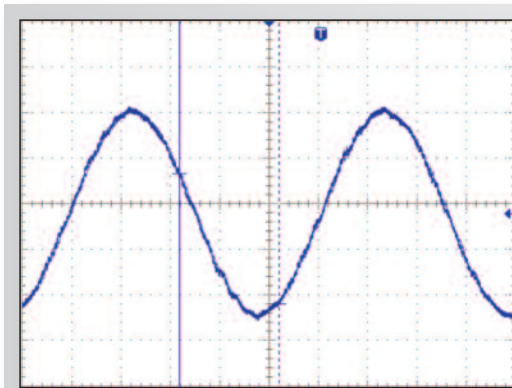
This is particularly useful for applications with variable frequency drives and servo drives. Enerdoor solutions include: common mode and differential mode chokes, sine wave filters and snubbers; all of which are designed to work with various carrier frequencies, output frequencies and applications.

Specific Solutions

Sine Wave Filters: This series reduces the effect of the PWM by converting the drive's output to a true sine waveform, eliminating dV/dt .

The **FIN915SF** model is used with fundamental frequencies up to 25kHz.

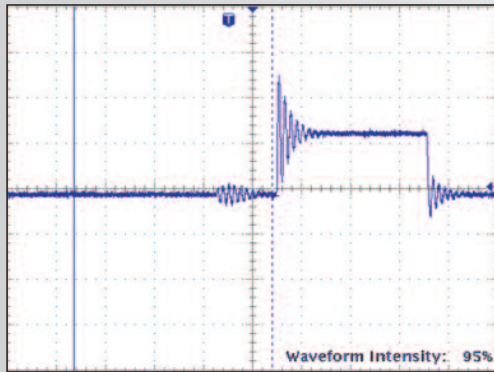
The high frequency inductance **FIN960F** is a unique solution used for synchronous motor spindle applications with output frequencies ranging from 1 Hz to 10 kHz.



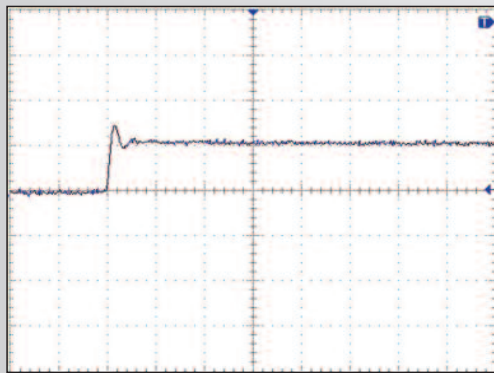
Typical example of a waveform between the VFD and motor using an Enerdoor sine wave filter FIN915SFH



Snubber: Enerdoor snubber **FIN47SNB** is a unique solution to reduce common mode and differential mode noise. The snubber is used in parallel to the system and is an ideal solution for clients in need of improving the reliability of winding insulation and bearings.



Typical measurement of dV/dt on the motor side of VFD with cable length of 100m (300ft)



Typical measurement of dV/dt on the motor side of VFD with cable length of 100m (300ft) with Enerdoor snubber FIN47SNB installed



Filter Selection Guide	Description	Current Range (A)	Voltage	CONNECTORS				FEATURES					APPLICATIONS					Approval	
				Cables	Terminal Blocks	Screws	Bus Bar	Common Mode Attenuation	Differential Mode Attenuation	Very Long Cable Applications	Output Frequency >75Hz	Compact Case	Long Cable Application >300m	CNC Machine	High Frequency Spindle Motor	Motor Controlled by VFD <100m	Closed Loop Motor Application		
Motor Protection																			
FIN900	3-phase	10-280	0-600	X	X	X		X					X		X		X		
FIN930	3-phase	6-200	0-600		X			X									X		
FIN950U	3-phase	8-300	0-600		X		X	X									X		
FIN5955	3-phase	3-20	0-600		X			X			X		X		X		X	UL US	
FIN5958	3-phase	12-110	0-600		X			X		X	X	X	X	X	X		X		
FIN5980P	3-phase	9-22	0-480	X	X								X					UL US	
FIN5983	3-phase	12-60	0-600		X							X	X				X	UL US	
FIN960F	3-phase	10-1000	0-750		X			X		X			X	X					
FIN905SF	3-phase	5-880	0-600		X		X	X	X		X								
FIN915SFH	3-phase	5-1100	0-600		X			X	X	X				X					
FIN47SNB	3-phase plus neutral	-	0-600		X					X		X	X				X	X	
FINSTP	star point to ground	-	0-600		X					X	X	X	X				X	X	UL US

Enerdoor motor protection reduces harmful dV/dt generated by variable frequency drives imposed onto the motor. Motor protection devices are designed to work in various applications of switching frequencies and frequency outputs.

This series carries CE and UL approvals and offers a current range from 3 to 1100A. Enerdoor motor protection includes common mode and differential mode inductance, sine wave filters and snubbers.

Unique features include: high linearity vs frequency and current, very low operating temperatures, and compact dimensions.

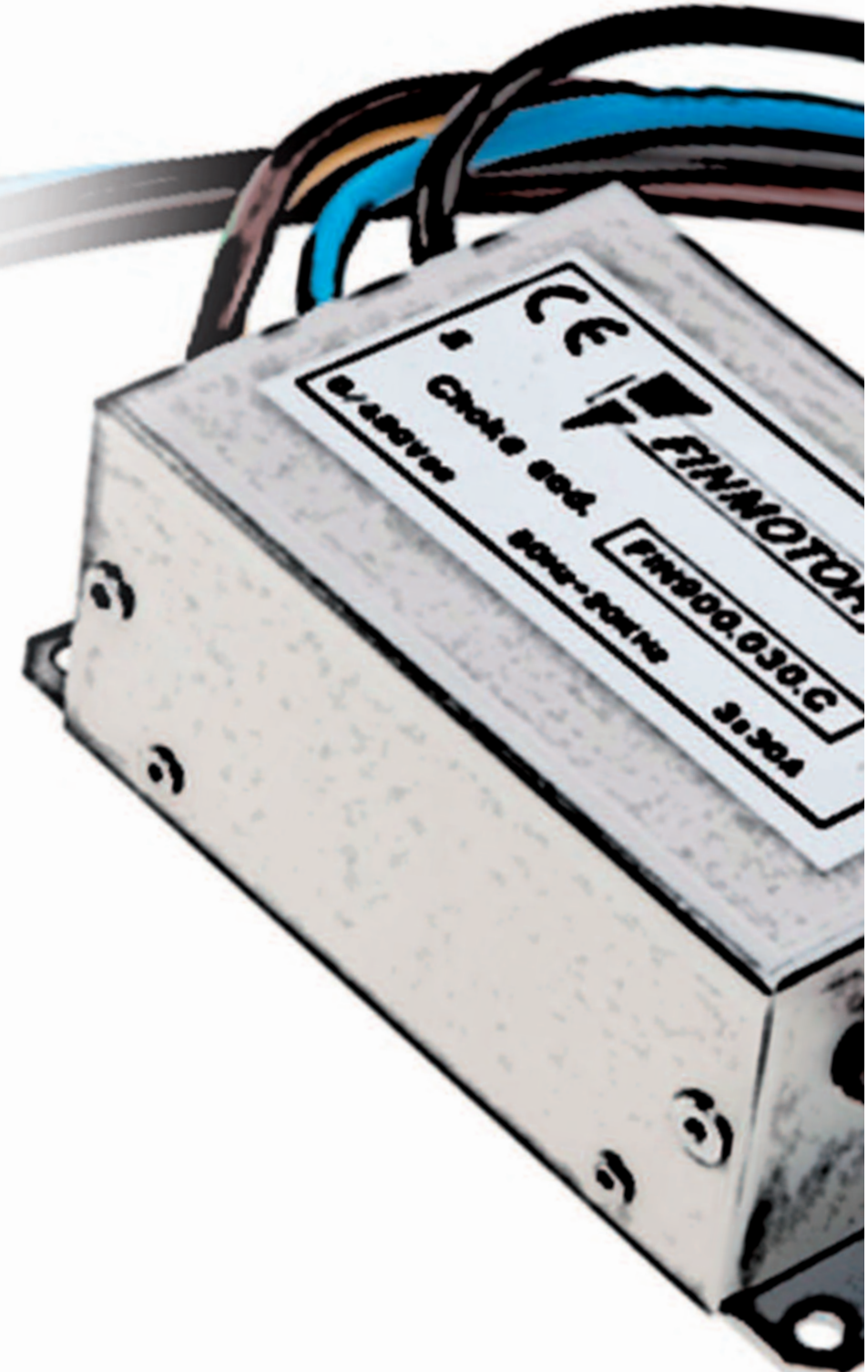
The FIN960F high frequency inductance is a unique solution used for synchronous spindle motor applications. This line works with frequency output up to 2 kHz while allowing the motor to operate at a low temperature.

The FIN905SF and FIN915SFH sine wave filters reduce the PWM effect, convert the PWM to a sine wave and eliminate dV/dt . These lines work with applications in open or closed loop feedback.

The FIN905SF works with frequency output up to 70 Hz. The FIN915SFH line is used with fundamental frequencies up to 2 kHz while maintaining a very low application temperature.

Motor protection applications include:

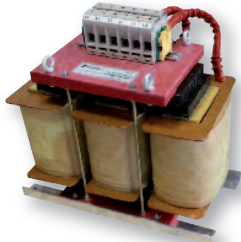
- Motors controlled by drives
- Pumps and conveyors
- Automated machinery
- Closed loop motor applications
- High speed motors
- CNC machinery
- Long cable applications
2,500m (8,200 ft)
- Process plants
- Water treatment plants
- Packaging machinery





Datasheet 3/2019

High frequency differential mode choke with excellent attenuation for high speed motors

APPROVALS:

FIN960F.(010 - 1000).M
FEATURES

- Rated current from 10 to 1000A
- Increases motor life
- Protects against voltage spikes on the motor
- Customizable per motor specifics to optimize the system

BENEFITS

- Low power loss with frequency output up to 30 kHz
- No ventilation required
- Excellent performance versus frequency and current
- Available in open frame or enclosure

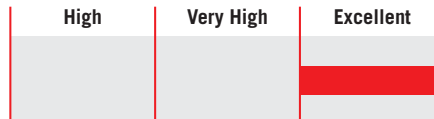
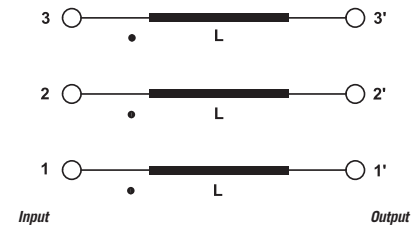
MARKETS

- High speed motors
- CNC machinery
- Woodworking machinery

ORDERING CODE

FIN960F	.050	.M	010
Model	Current (A)	Connection	Inductance value (L)

M = Terminal block

ATTENUATION INDICATOR

ELECTRIC DIAGRAM

TECHNICAL SPECIFICATIONS

Nominal voltage	0 / 750 Vac
Output frequency	0 - 30 kHz
Rated current	10 to 1000A
Carrier frequency (PWM)	0 - 60 kHz
Potential test voltage phase to phase	2400 Vdc (2 sec.)
Potential test voltage phase to ground	3200 Vdc (2 sec.)
IP Protection	IP20
Saturation current	4 x Rated current (Switch ON) 2 x In 10 seconds 1.5 In for 10 minutes 1.5 x Nominal current
Climatic class	-40 / +85° C
MTBF at 40°C	250.000 Hrs

ELECTRICAL CHARACTERISTICS **CONNECTIONS**

FIN960F	Rated Current (S1)	Peak Current (S6)	Power Loss (W)	LINE			PE
				Solid Cable (mm ²)	Stranded Cable (mm ²)	Terminal Block Torque (Nm)	Torque (Nm)
.050.M010	50	75	70	2.5 - 50	2.5 - 35	5	5
.110.M010	110	150	110	10 - 70	10 - 50	6	6
.160.M010	160	200	150	10 - 95	10 - 50	10	10
.095.M020	95	130	90	10 - 70	10 - 50	6	6
.130.M025	130	160	115	10 - 95	10 - 70	10	10
.160.M025	160	180	170	10 - 95	10 - 70	10	10
.090.M030	90	120	60	10 - 70	10 - 50	6	6
.050.M040	50	75	80	2.5 - 50	2.5 - 35	5	5
.110.M040	110	150	280	10 - 70	10 - 50	6	6
.200.M040	200	240	580	16 - 150	16 - 95	20	20
.085.M060	85	120	280	10 - 70	10 - 50	6	6
.135.M060	135	165	300	10 - 95	10 - 70	10	10
.170.M060	170	205	520	10 - 95	10 - 70	10	10
.120.M100	120	145	305	10 - 70	10 - 50	6	6
.200.M100	200	240	820	16 - 250	16 - 95	20	20

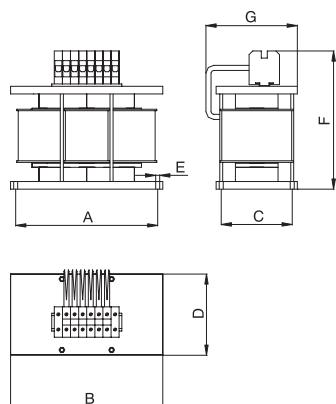
Custom nominal current and inductance value combinations are available to accommodate specific motor characteristics and working cycles.

S1 (100%) at 40C° - S6 (40% 2 min) at 40C°

MECHANICAL DIMENSIONS mm

FIN960F	A	B	C	D	E	F	G	Weight Kg.	Case
.050.M010	230	250	80	100	7	270	120	6	1
.110.M010	240	260	110	140	7	270	150	18	2
.160.M010	370	400	170	230	12	350	250	37	3
.095.M020	240	260	110	140	7	270	150	20	2
.160.M025	500	540	200	260	12	500	300	75	5
.130.M030	500	540	200	260	12	500	300	65	5
.050.M040	280	300	140	160	8	280	180	19	6
.110.M040	500	540	200	260	12	500	300	65	5
.200.M040	500	540	200	260	12	500	300	120	5
.085.M060	500	540	200	260	12	500	300	65	5
.135.M060	500	540	200	260	12	500	300	88	5
.170.M060	500	540	200	260	12	500	300	105	5
.120.M100	500	540	200	260	12	500	300	95	5
.200.M100	660	700	320	390	12	600	410	200	7

CASE 1, 2, 6



CASE 3, 4, 5, 7

