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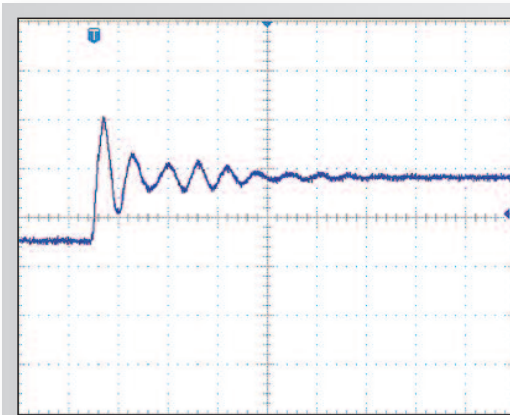
Typical example of dV/dt measured on the motor with cable length of 50m (150 ft)

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.

Typical example of VFD layout
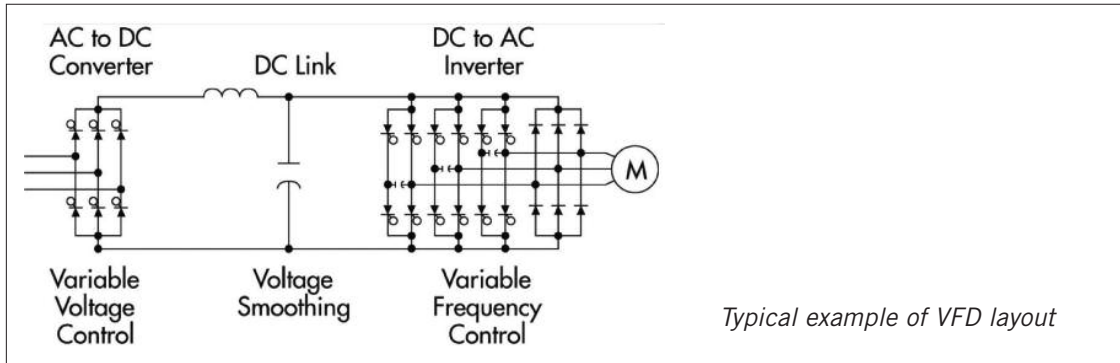
The Solution

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.
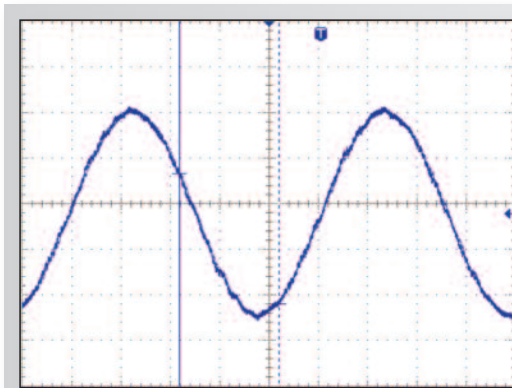

Typical example of a waveform between the VFD and motor using an Enerdoor sine wave filter FIN915SFH

Engineered by FINMOTOR

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.

Waveform Intensity: 95%
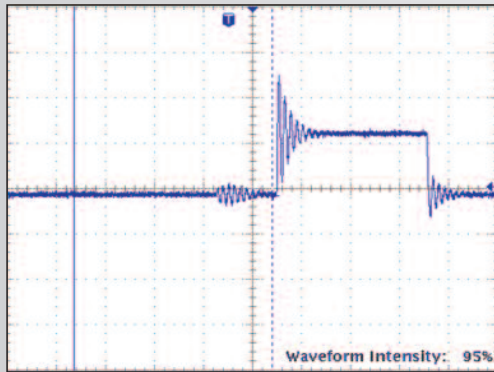
Typical measurement of dV/dt on the motor side of VFD with cable length of 100m (300ft)
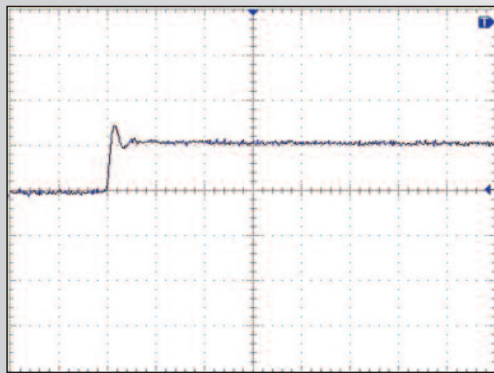
Typical measurement of dV/dt on the motor side of VFD with cable length of 100m (300ft) with Enerdoor snubber FIN47SNB installed

Filter Selection Guide

Motor Protection	Description	Current Range (A)	Voltage	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	Approval
				CONNECTORS				FEATURES					APPLICATIONS					
FIN900	3-phase	10-280	0-600	✗	✗	✗		✗				✗		✗		✗		
FIN930	3-phase	6-200	0-600		✗			✗									✗	
FIN950U	3-phase	8-300	0-600		✗		✗	✗								✗		
FIN5955	3-phase	3-20	0-600		✗			✗				✗		✗		✗		cULus
FIN5958	3-phase	12-110	0-600		✗			✗			✗	✗	✗	✗	✗		✗	
FIN5980P	3-phase	9-22	0-480	✗	✗									✗				cULus
FIN5983	3-phase	12-60	0-600		✗								✗	✗			✗	cULus
FIN960F	3-phase	10-1000	0-750		✗			✗		✗				✗	✗			
FIN905SF	3-phase	5-880	0-600		✗		✗	✗	✗				✗					
FIN915SFH	3-phase	5-1100	0-600		✗			✗	✗	✗						✗		
FIN47SNB	3-phase plus neutral	-	0-600		✗			✗			✗		✗			✗	✗	
FINSTP	star point to groud	-	0-600		✗					✗	✗	✗	✗			✗	✗	cULus

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
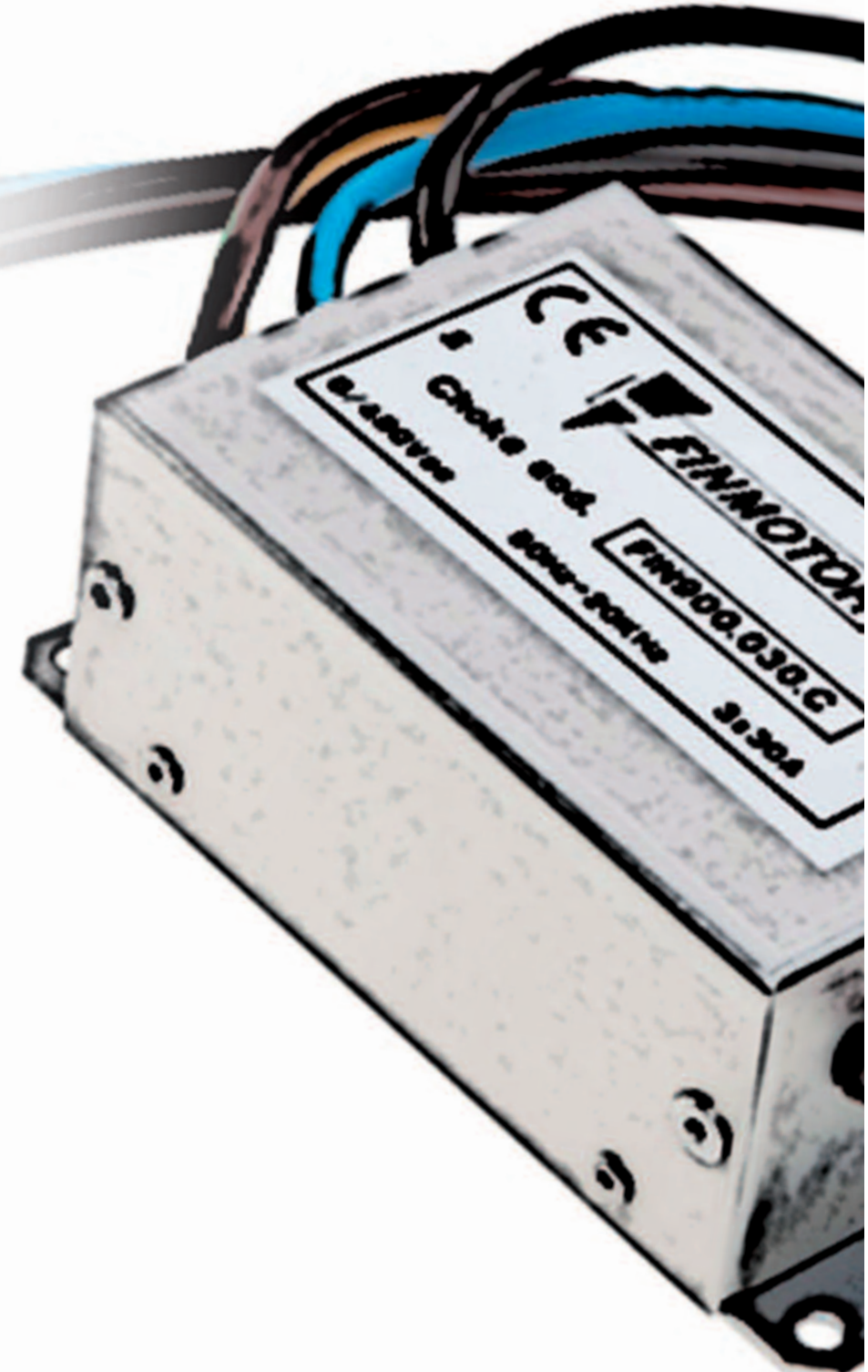
Common mode choke with high attenuation for reducing dV/dt and high frequency
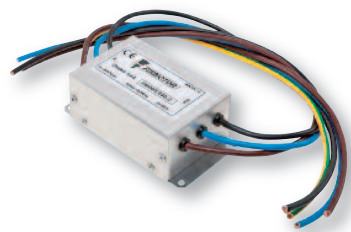
Datasheet 3/2019

FIN900.(010 - 030).1C

FIN900.(010 - 030).C

FIN900.(010 - 280).V

FEATURES

- 5 Year warranty
- Protects against voltage spikes on the motor
- Compact design

MARKETS

- Motors controlled by drives
- Automated machinery
- Conveyors
- Pumps

BENEFITS
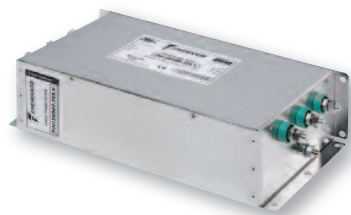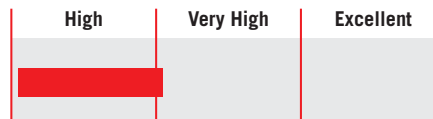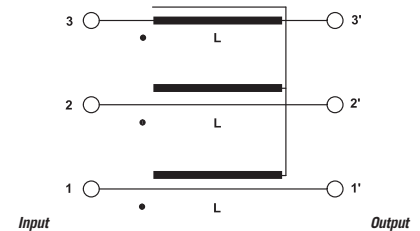
- Rated current from 10 to 280A
- Reduces voltage rise and high frequency noise
- Helps pass emission tests for the IEC61000-6-4 Standards

ORDERING CODE

FIN900	.016	.1C
Model	Current (A)	Connection

1 C = cable 200mm

2 C = cable 400mm

C = cable

V = screws

ATTENUATION INDICATOR

High	Very High	Excellent

ELECTRIC DIAGRAM

Input — 3 ○——L——○ 3' — *Output*
2 ○——L——○ 2'
1 ○——L——○ 1'

TECHNICAL SPECIFICATIONS

Nominal voltage	0 / 600 Vac
Output frequency	50 - 3500 Hz
Rated current	10 to 280A
Carrier frequency (PWM)	0 - 16 kHz
Potential test voltage phase to phase	1750 Vdc (2 sec.)
Potential test voltage phase to ground	2150 Vdc (2 sec.)
IP Protection	IP20
Overload capability	4 x Rated current (Switch ON)
	2 x In 10 seconds
	1.5 In for 10 minutes
Climatic class	-40 / +85° C
MTBF at 40°C	250.000 Hrs

ELECTRICAL CHARACTERISTICS

FIN900	Rated Current 40°C	Rated Current 50°C	Power Loss (W)
.010.1C	10	9	6
.016.1C	16	14	6
.030.1C	30	26	6

FIN900	Rated Current 40°C	Rated Current 50°C	Power Loss (W)
.010.C	10	9	6
.016.C	16	14	6
.030.C	30	26	6

FIN900	Rated Current 40°C	Rated Current 50°C	Power Loss (W)
.010.V	10	9	6
.016.V	16	14	10
.030.V	30	26	15
.050.V	50	45	23
.080.V	80	72	28
.100.V	100	90	45
.150.V	150	135	75
.200.V	200	180	83
.280.V	280	252	96

CONNECTIONS

LINE		PE	
d (mm)	Torque (Nm)	d1 (mm)	Torque (Nm)
-	-	M12	20
-	-	M12	20
-	-	M12	20

LINE		PE	
d (mm)	Torque (Nm)	d1 (mm)	Torque (Nm)
-	-	-	-
-	-	-	-
-	-	-	-

LINE		PE	
d (mm)	Torque (Nm)	d1 (mm)	Torque (Nm)
M4	1.2	M4	1.2
M5	4	M4	1.2
M5	4	M4	1.2
M6	6	M5	4
M6	6	M5	4
M8	14	M8	14
M8	14	M8	14
M10	18	M10	18
M12	18	M10	18

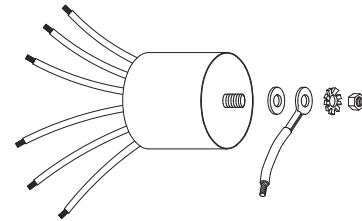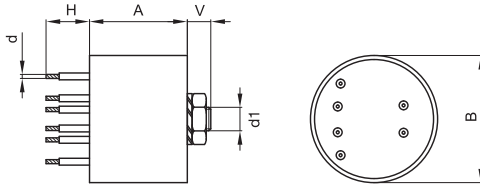## TYPICAL MEASUREMENT

Without FIN900

With FIN900
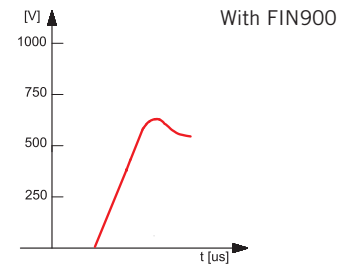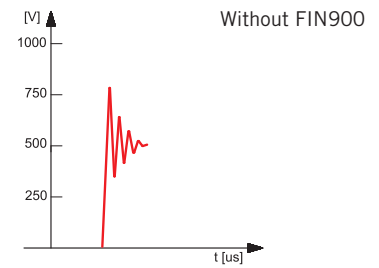
Example of measurement in a typical application using a servo drive

MECHANICAL DIMENSIONS mm

FIN900	A	B	d	V	d1	H	Weight Kg.	Case
.010.1C	60	65	2	12	M12	200	0.5	1C
.016.1C	60	65	2	12	M12	200	0.5	1C
.030.1C	60	65	2	12	M12	200	0.55	1C

CASE 1C

ASSEMBLY CONNECTION "1C"

FIN900	A	B	d	V	F	H	I	L	N	Weight Kg.	Case
.010.C	42	65	2	200	4.2	120	96	110	51	0.7	C
.016.C	42	65	2	200	4.2	120	96	110	51	0.7	C
.030.C	42	65	2	200	4.2	120	96	110	51	0.75	C

CASE C

ASSEMBLY CONNECTION "C"
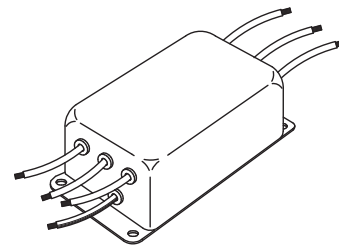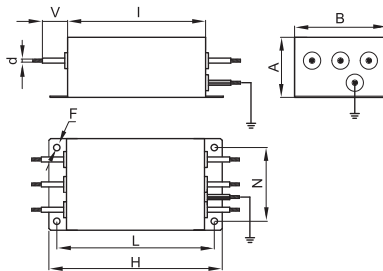
MECHANICAL DIMENSIONS mm

FIN900	A	B	C	d	d1	V	F	H	I	L	N	P	S	Weight Kg.	Case
.010.V	58	86	44	M4	M4	14	4.5	186	160	176	30	40	38	2	1
.016.V	58	86	44	M5	M4	14	4.5	186	160	176	30	40	38	2	1
.030.V	58	86	44	M5	M4	14	4.5	186	160	176	30	40	38	2	1
.050.V	58	86	44	M6	M5	14	4.5	186	160	176	30	40	38	2	1
.080.V	90	100	46	M6	M5	28	4.5	246	220	235	35	70	64	3	2
.100.V	90	185	84	M8	M8	25	6.5	356	320	340	77.5	70	69	5	3
.150.V	90	220	120	M8	M8	29	6.5	356	320	340	95	70	60	7	4
.200.V	90	220	120	M10	M10	29	6.5	356	320	340	95	70	60	7.5	4
.280.V	90	220	120	M12	M10	29	6.5	356	320	340	95	70	60	8	4

CASE 1, 2
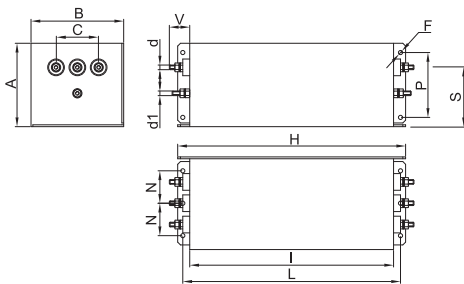
ASSEMBLY CONNECTION "V"
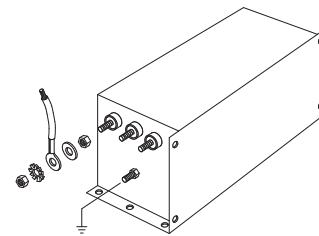
CASE 3, 4

ASSEMBLY CONNECTION "V"