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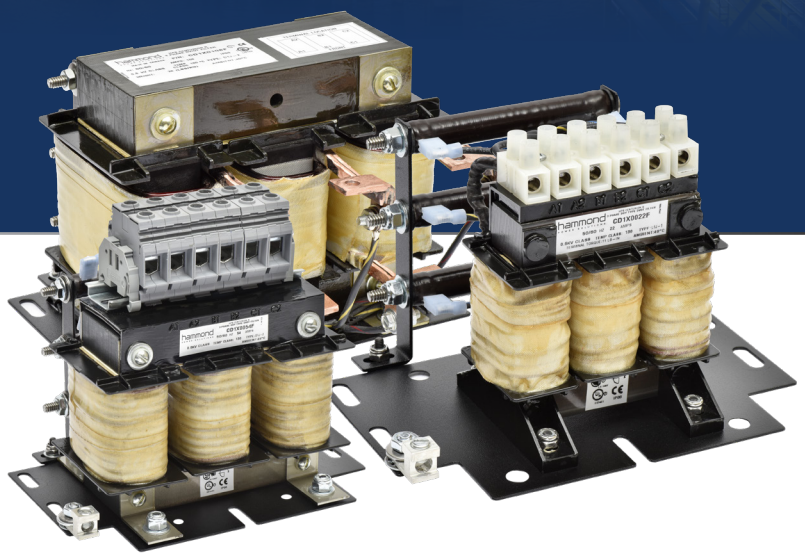
POWER SOLUTIONS

CENTURION D

dV/dT Filters



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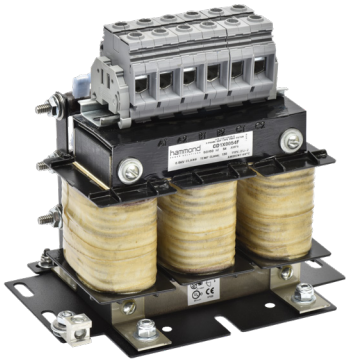
HPS dV/dT Filters

The HPS dV/dT filters are designed for use between variable frequency drives (VFD's) and motors when long cable lengths are used.

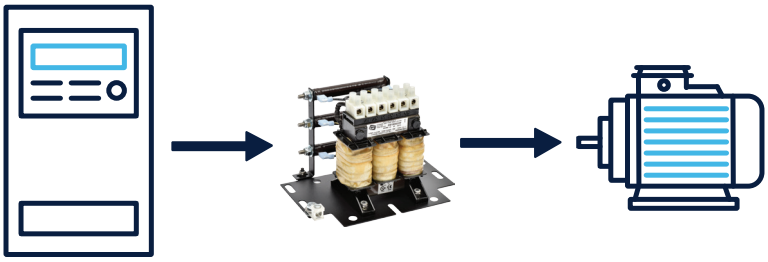
The HPS Centurion D1 dV/dT filter (D1) combines an inductor and parallel resistor network to mitigate both high frequency ringing and voltage spikes between the VFD and motor and within the motor's windings.

The D1 can mitigate the effects of reflected wave voltages greater than what a reactor alone can accomplish. The D1 filter provides protection to the motor by slowing down the rate of voltage increase (dV/dT) and minimizes the damaging peak voltages that occur within the motor's windings and along the length of cables feeding the motor.



HPS dV/dT Operation Principle

The term "dV/dT" refers to the change in voltage over change in time. With regards to VFD's, dV/dT is explained as the rapid change in voltage at the beginning or end of the square wave pulses that make up the pulse width modulated (PWM) output of a VFD that powers the motor. As the square wave pulses travel the electrical cable to the motor, the differences in impedance between the cable and motor windings cause some energy in the pulse to be "reflected". In applications where the distance between the motor and VFD is long, the voltage of two pulses can combine in the cable or motor windings. This creates voltage spikes that can be more than twice the VFD's DC bus voltage. Applications with long cables between the VFD and the motor can experience peak voltages up to 1600V in a 480V system and up to 2100V in a 600V system. These high peak voltages will cause premature motor insulation failures resulting in down time and lost revenue.



VFD

HPS Centurion D1
dV/dT Filter

Motor

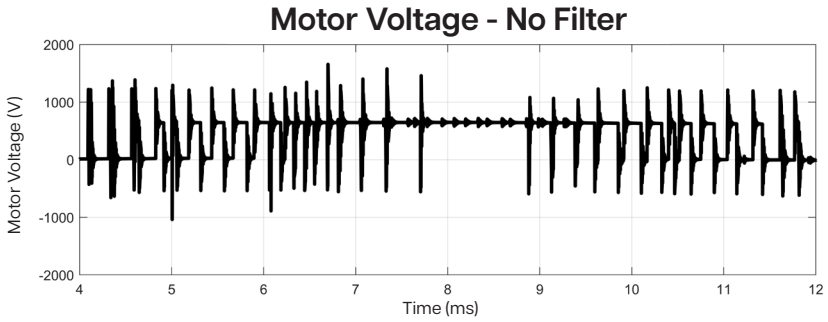
Applications

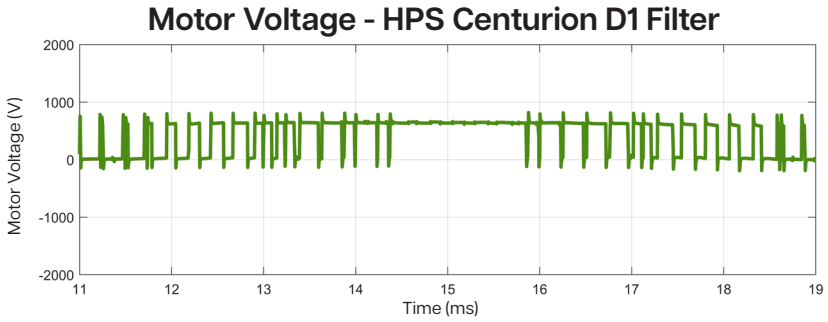
The HPS Centurion D1 series dV/dT filters are designed for applications with long cables between the VFD and the motor. VFD manufacturers often have recommendations on when to use dV/dT filters within their manuals. They should always be installed close to the VFD. Typical applications include:

- Oil & Gas Pumps
- Wastewater Treatment Plants
- HVAC Systems
- Pulp & Paper
- Irrigation Fields

The Reflected Wave Phenomenon

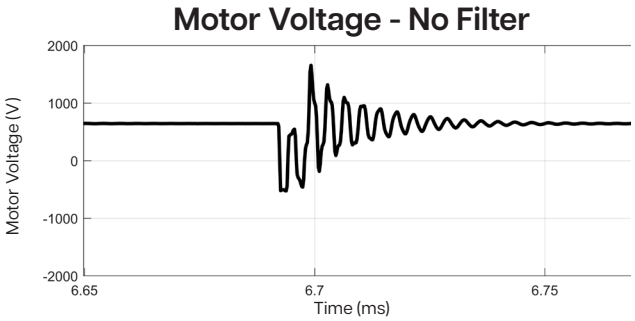
The reflected wave phenomenon in motor drives systems refers to the overvoltage at the motor or along the cables feeding it. The reflected wave phenomena occurs due to a mismatch between the cable's characteristic impedance and the motor's surge impedance. In addition, the high switching frequency and the fast rise time of the switching devices (IGBT) of the variable frequency drive (VFD) increase the magnitude of the reflected wave's voltage. The high rate of change in voltage with respect to time (dV/dT) of the IGBTs causes a high voltage to be developed in the windings of motors, resulting in motor insulation stress.

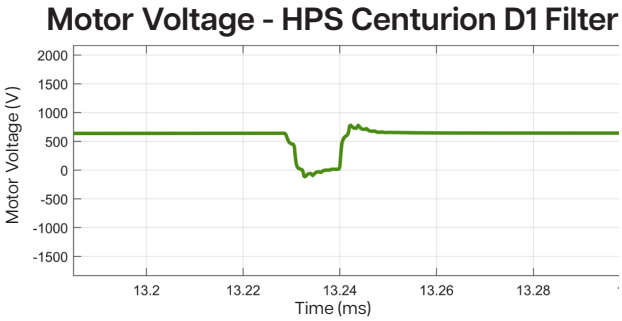




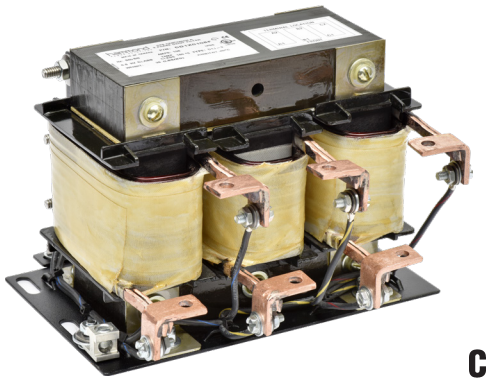
HPS Centurion D1 Series dV/dT filter is engineered to mitigate reflected wave by reducing:

- Peak voltage seen by the motor
- Rise time of the pulses
- Pulses ringing





Typical Performance



Electrical Product Characteristics

System Voltage Rating:	up to 600V (480V-600V applications)
Current Rating:	2A to 108A (consult HPS for higher ratings)

Technical Product Characteristics

Inverter Switching Frequency:	2kHz to 4kHz (consult HPS for higher switching frequency)
Inverter Operating Frequency:	up to 60Hz
Insulation System:	130°C (2A - 54A), 180°C (>55A)
Voltage Drop:	<3%
Motor Lead Length:	Up to 1000ft (600ft & 1000ft models available[1, 2]
Peak Voltage At Motor:	150% of DC bus voltage
Approvals:	cUL Listed

Notes:
[1] VFD rated cable recommended
[2] Maximum motor cable size to achieve 5% voltage drop (including 2% from the filter)
Maximum lead length and carrier frequency can vary depending on motor cable type

Environmental Conditions

Ambient Operating Temperature:	Open Style: Up to 50°C
	Enclosed Style: Up to 40°C
Altitude:	<1000M
Cooling Method:	Natural convection
Enclosure Type:	Open, Type 1 (Type 3R available upon request)

Part Number Guide

	Product Line	Type	Model	Voltage	Current Rating				Enclosure	Cable Length
Example	C	D	1	X	0	0	2	5	F	1

Family	Model	Voltage	Current Rating (Amps)	Enclosure	
C - Centurion	1 - D1 Model	X - up to 600V (480V & 600V applications)	3A to 108A	F - Open Frame	600 ft*
Type			3A 0003	E - Type 1	1 - 1000 ft
D - dV/dT Filter			17A 0017		
			108A 0108		

**Default options - ignore if all following characters are default values.*

Selection Guide

System Voltage, the input voltage to the VFD, has a major effect on the reflected wave phenomenon. Typically, the reflected wave is twice of the DC bus voltage.

$$\sqrt{2}*\text{System Voltage}=\text{DC Bus Voltage}$$

$$\sqrt{2}=>1.414*480\ \text{VAC}=679\ \text{VDC Bus}$$

$$\text{Reflected Wave}=2*679\ \text{Volts} \sim 1360\ \text{volts}$$

Modern motor insulation systems can typically handle reflected wave issues from 208 VAC and 240 VAC systems due to the lower DC bus voltage. North American 480 VAC and 600 VAC systems can experience motor damage from reflected waves. Please consult with HPS for any application that may require the use of dV/dT filters at voltages below 480V or output carrier frequencies above 4kHz. In addition to mitigating reflective wave issues, dV/dT filters can also lower the VFD's output voltage rise time and reduce the peak voltage seen by the motor and cabling. This can have the added benefit of reducing the motors temperature rise and audible noise.

Select the filter based on Full Load Amps (FLA) of the motor.

1000 ft Cable Length

NEC 480 HP	NEC 600 HP	Part Number	HPS Amp Rating	Weight Lbs. [kg]	Overall Dimensions - Inches [mm]			Watts Loss*	Dim. Fig. #	Enclosed Figure
					Width	Depth	Height			
0.5-1.5	0.5-2	CD1X0003F1	3	4.0 [1.8]	8.00 [203.20]	6.00 [152.40]	5.50 [139.70]	50	1	N1
2	3	CD1X0004F1	4	4.0 [1.8]	8.00 [203.20]	6.00 [152.40]	5.50 [139.70]	52	1	N1
3	5	CD1X0007F1	7	4.0 [1.8]	8.00 [203.20]	6.00 [152.40]	5.50 [139.70]	58	1	N1
5	7.5	CD1X0009F1	9	6.0 [2.7]	8.00 [203.20]	6.00 [152.40]	5.50 [139.70]	54	1	N1
7.5	10	CD1X0012F1	12	6.0 [2.7]	8.00 [203.20]	6.00 [152.40]	5.50 [139.70]	57	1	N1
10	15	CD1X0017F1	17	6.0 [2.7]	8.00 [203.20]	6.00 [152.40]	5.50 [139.70]	64	1	N1
15	20	CD1X0022F1	22	6.0 [2.7]	8.00 [203.20]	6.00 [152.40]	5.50 [139.70]	76	1	N1
20	25	CD1X0027F1	27	14.0 [6.2]	8.00 [203.20]	6.00 [152.40]	7.25 [184.15]	37	2	N1
25	30	CD1X0035F1	35	14.0 [6.2]	8.00 [203.20]	6.00 [152.40]	7.25 [184.15]	47	2	N1
30	40	CD1X0045F1	45	14.0 [6.2]	8.00 [203.20]	6.00 [152.40]	7.25 [184.15]	57	2	N1
40	50	CD1X0054F1	54	14.0 [6.2]	8.00 [203.20]	6.00 [152.40]	7.25 [184.15]	70	2	N1
50	60	CD1X0065F1	65	28.0 [12.4]	9.00 [228.60]	7.50 [190.50]	7.00 [177.80]	89	3	N2
60	75	CD1X0080F1	80	28.0 [12.4]	9.00 [228.60]	7.50 [190.50]	7.00 [177.80]	108	3	N2
75	100	CD1X0108F1	108	28.0 [12.4]	9.00 [228.60]	7.50 [190.50]	7.00 [177.80]	158	3	N2

**Typical watt losses at 480V system, 2kHz switching frequency, 60Hz*

Selection Guide Continued

600 ft Cable Length

NEC 480 HP	NEC 600 HP	Part Number	HPS Amp Rating	Weight Lbs. [kg]	Overall Dimensions - Inches [mm]			Watts Loss*	Dim. Fig. #	Enclosed Figure
					Width	Depth	Height			
0.5-1.5	0.5-2	CD1X0003F	3	4.0 [1.8]	8.00 [203.20]	6.00 [152.40]	5.50 [139.70]	38	1	N1
2	3	CD1X0004F	4	4.0 [1.8]	8.00 [203.20]	6.00 [152.40]	5.50 [139.70]	40	1	N1
3	5	CD1X0007F	7	4.0 [1.8]	8.00 [203.20]	6.00 [152.40]	5.50 [139.70]	46	1	N1
5	7.5	CD1X0009F	9	6.0 [2.7]	8.00 [203.20]	6.00 [152.40]	5.50 [139.70]	42	1	N1
7.5	10	CD1X0012F	12	6.0 [2.7]	8.00 [203.20]	6.00 [152.40]	5.50 [139.70]	45	1	N1
10	15	CD1X0017F	17	6.0 [2.7]	8.00 [203.20]	6.00 [152.40]	5.50 [139.70]	53	1	N1
15	20	CD1X0022F	22	6.0 [2.7]	8.00 [203.20]	6.00 [152.40]	5.50 [139.70]	66	1	N1
20	25	CD1X0027F	27	14.0 [6.2]	8.00 [203.20]	6.00 [152.40]	7.25 [184.15]	32	2	N1
25	30	CD1X0035F	35	14.0 [6.2]	8.00 [203.20]	6.00 [152.40]	7.25 [184.15]	42	2	N1
30	40	CD1X0045F	45	14.0 [6.2]	8.00 [203.20]	6.00 [152.40]	7.25 [184.15]	52	2	N1
40	50	CD1X0054F	54	14.0 [6.2]	8.00 [203.20]	6.00 [152.40]	7.25 [184.15]	65	2	N1
50	60	CD1X0065F	65	28.0 [12.4]	9.00 [228.60]	7.50 [190.50]	7.00 [177.80]	78	3	N2
60	75	CD1X0080F	80	28.0 [12.4]	9.00 [228.60]	7.50 [190.50]	7.00 [177.80]	97	3	N2
75	100	CD1X0108F	108	28.0 [12.4]	9.00 [228.60]	7.50 [190.50]	7.00 [177.80]	147	3	N2

**Typical watt losses at 480V system, 2kHz switching frequency, 60Hz*
NOTE: The motor HP ratings above are for reference only.

CORE & COIL DRAWINGS

Fig. # 1

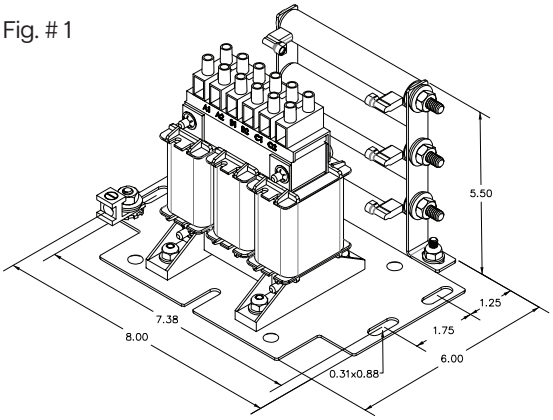


Fig. # 2

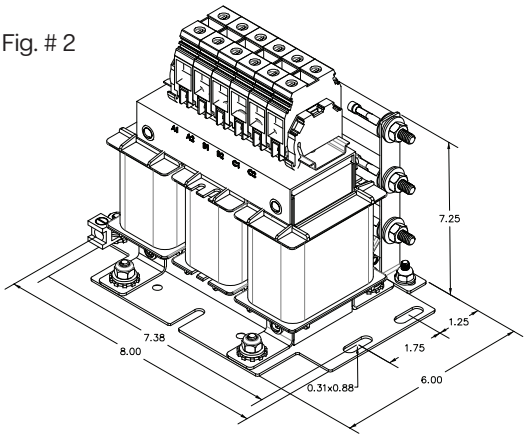
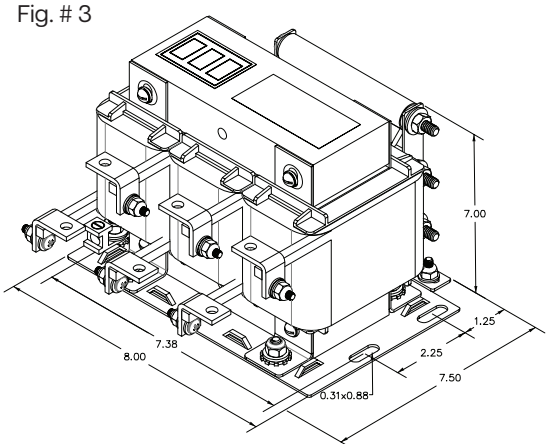
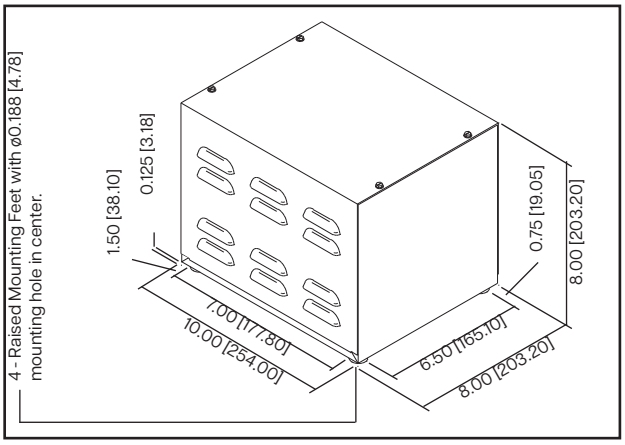


Fig. # 3



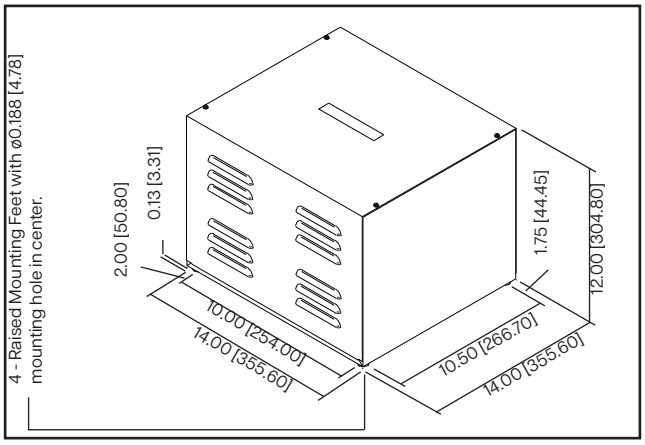
TYPE 1 ENCLOSED DRAWINGS

‘N1’ SERIES ENCLOSURE



All dimension in inches [mm]

‘N2’ SERIES ENCLOSURE



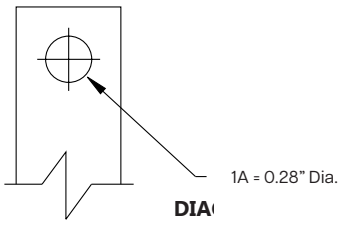
All dimension in inches [mm]

Conduit Size vs. Actual Knockout Size Reference Table

Standard Conduit Size	Actual Knockout Diameter
0.50 [12.70]	0.88 [22.23]
0.75 [19.05]	1.13 [28.58]
1.00 [25.40]	1.38 [34.93]
1.25 [31.75]	1.75 [44.45]
1.50 [38.10]	2.00 [50.80]
2.00 [50.80]	2.50 [63.50]
2.50 [63.50]	3.00 [76.20]
3.00 [76.20]	3.63 [92.08]
3.50 [88.90]	4.13 [104.78]

Please note the above table is not applicable for Stainless Steel enclosures.
All dimension in inches [mm]

Termination Details



AMP Rating	Terminal Detail
3	13-10 AWG
4	13-10 AWG
7	13-10 AWG
9	12-8 AWG
12	12-8 AWG
17	12-8 AWG
22	12-8 AWG

AMP Rating	Terminal Detail
27	10-2 AWG
35	10-2 AWG
45	10-2 AWG
54	10-2 AWG
65	1A
80	1A
108	1A

CANADA

Hammond Power Solutions

595 Southgate Drive
Guelph, Ontario N1G 3W6
Tel: (519) 822-2441 | Fax: (519) 822-9701
Toll Free: 1-888-798-8882

sales@hammondpowersolutions.com

UNITED STATES

Hammond Power Solutions

1100 Lake Street
Baraboo, Wisconsin 53913-2866
Tel: (608) 356-3921 | Fax: (608) 355-7623
Toll Free: 1-866-705-4684

sales@hammondpowersolutions.com

MEXICO

Hammond Power Solutions Latin America S.

Av. No. 800,
Parque Industrial Guadalupe
Guadalupe, NL, Mexico, C.P. 67190.
Tel: (819) 690-8000

sales@hammondpowersolutions.com

ASIA

Hammond Power Solutions Pvt. Ltd.

Plot No 6A, Phase -1, IDA,
Pashamylaram, Patancheru (M)
Sangareddy, 502 307, India
Tel: +91-994-995-0009

marketing-india@hammondpowersolutions.com

EMEA (SALES OFFICE)

Hammond Power Solutions SpA

Tel: +49 (152) 08800468

sales-emea@hammondpowersolutions.com

hammondpowersolutions.com

CENTDP-BBH2-EN
July 2023