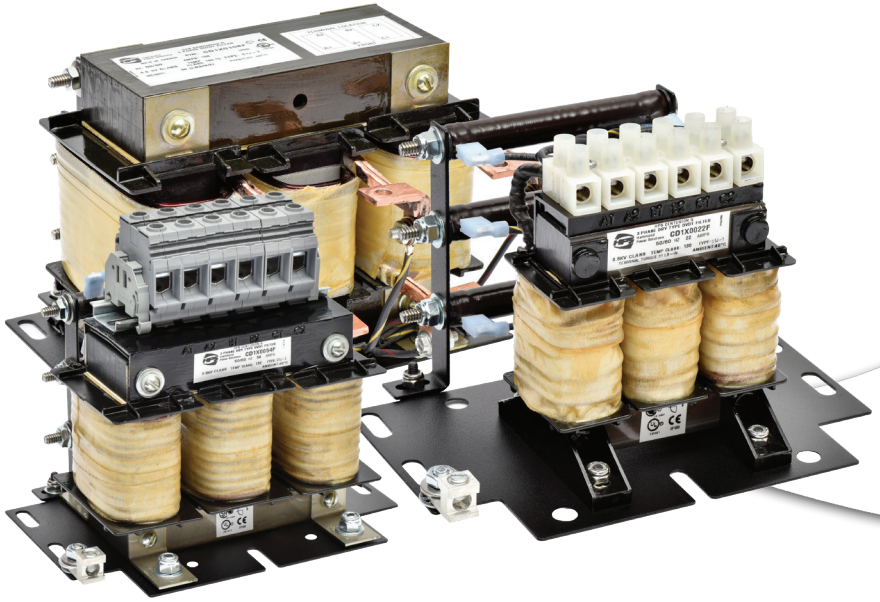


HPS Centurion D

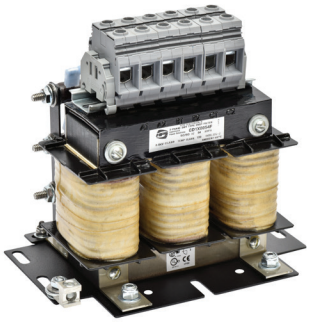
dV/dT Filters

Hammond Power Solutions

HPS dV/dT Filters

HPS dV/dT Filters

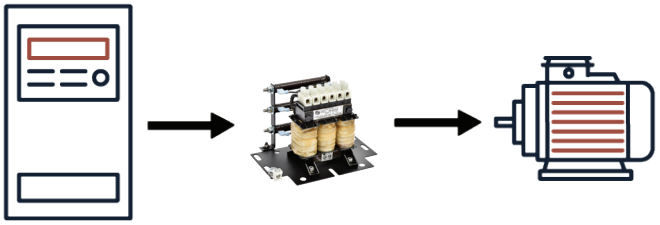
The HPS dV/dT filters are specifically designed for use between variable frequency drives (VFD's) and motors when longer cable lengths are used.



The HPS Centurion D1 dV/dT filter (D1) combines an inductor and parallel resistor network to mitigate both high frequency components and voltage spikes between the VFD and motor. 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 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 a high voltage condition of twice or more 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 motor winding failures and premature motor insulation failure resulting in down time and lost revenue.



APPLICATIONS

The HPS Centurion D1 series dV/dT filters are specifically designed for applications with long cables between the VFD and the motor. They should always be installed next to the IGBT variable frequency drive. Typical applications include:

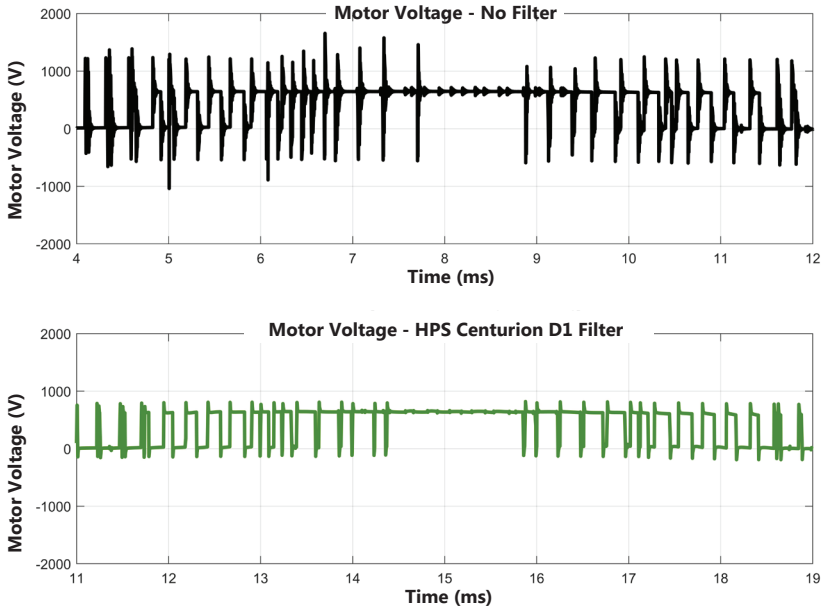
- Oil & Gas Pumps
- Wastewater Treatment Plants
- HVAC Systems
- Pulp & Paper
- Irrigation Fields



How dV/dT Filters Deliver Motor Protection

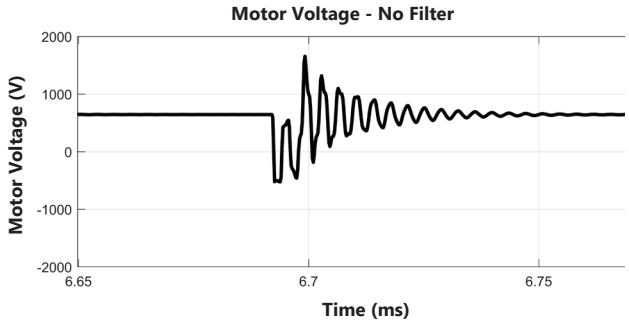
The Reflected Wave Phenomenon

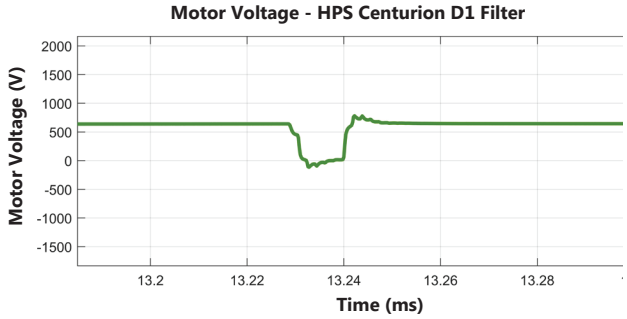
The reflected wave phenomenon in motor drives systems refers to the overvoltage at the motor or along the cables feeding it. The reflected wave phenomena occurs due to mismatch between the cable characteristic impedance and the motor surge impedance. In addition, the high switching frequency and the fast rise time of the switching devices (IGBT) of the variable frequency drive (VFD) increase the magnitude of the reflected wave. 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:

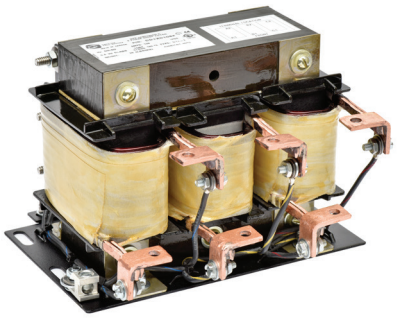
- Peak voltage seen by the motor
- Rise time of the pulses
- Pulses ringing





HPS dV/dT Filters

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 - 4kHz
Inverter Operating Frequency:	up to 60Hz
Insulation System:	130°C (2A - 54A), 180°C (>55A)
Voltage Drop:	<3%
Motor Lead Length:	600 ft (consult HPS for longer motor lengths)[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:	-25°C to 40°C (suitable to 50°C)
Altitude:	<1000M
Cooling Method:	Natural convection
Enclosure Type:	Open, Type 1

PART NUMBER GUIDE

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

Product Line:
C - Centurion

Type:
D - dV/dT Filter

Model:
1 - D1

System Voltage:
X - up to 600V
(480V & 600V applications)

Current Rating (Amps):
3A to 108A

3A	0003
17A	0017
108A	0108

Enclosure:
F - Open Frame
E - Type 1

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.

√2*System Voltage=DC Bus Voltage
√2=>1.414*480 VAC=679 VDC Bus
Reflected Wave=2*679 Volts ~ 1360 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. 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.

NEC 480 HP	NEC 600 HP	Part Number*	HPS Amp Rating	Weight Lbs. [kg]	Approx. 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]	170	1	N1
2	3	**CD1X0004F**	4	4.0 [1.8]	8.00 [203.20]	6.00 [152.40]	5.50 [139.70]	175	1	N1
3	5	**CD1X0007F**	7	4.0 [1.8]	8.00 [203.20]	6.00 [152.40]	5.50 [139.70]	180	1	N1
5	7.5	**CD1X0009F**	9	6.0 [2.7]	8.00 [203.20]	6.00 [152.40]	5.50 [139.70]	175	1	N1
7.5	10	**CD1X0012F**	12	6.0 [2.7]	8.00 [203.20]	6.00 [152.40]	5.50 [139.70]	180	1	N1
10	15	**CD1X0017F**	17	6.0 [2.7]	8.00 [203.20]	6.00 [152.40]	5.50 [139.70]	185	1	N1
15	20	**CD1X0022F**	22	6.0 [2.7]	8.00 [203.20]	6.00 [152.40]	5.50 [139.70]	200	1	N1
20	25	**CD1X0027F**	27	14.0 [6.2]	8.00 [203.20]	6.00 [152.40]	7.25 [184.15]	210	2	N1
25	30	**CD1X0035F**	35	14.0 [6.2]	8.00 [203.20]	6.00 [152.40]	7.25 [184.15]	220	2	N1
30	40	**CD1X0045F**	45	14.0 [6.2]	8.00 [203.20]	6.00 [152.40]	7.25 [184.15]	235	2	N1
40	50	**CD1X0054F**	54	14.0 [6.2]	8.00 [203.20]	6.00 [152.40]	7.25 [184.15]	250	2	N1
50	60	**CD1X0065F**	65	28.0 [12.4]	9.00 [228.60]	7.50 [190.50]	7.00 [177.80]	260	3	N2
60	75	**CD1X0080F**	80	28.0 [12.4]	9.00 [228.60]	7.50 [190.50]	7.00 [177.80]	275	3	N2
75	100	**CD1X0108F**	108	28.0 [12.4]	9.00 [228.60]	7.50 [190.50]	7.00 [177.80]	315	3	N2

NOTE: The motor HP ratings above are for reference only.

Drawings

Core & Coil

Fig. # 1

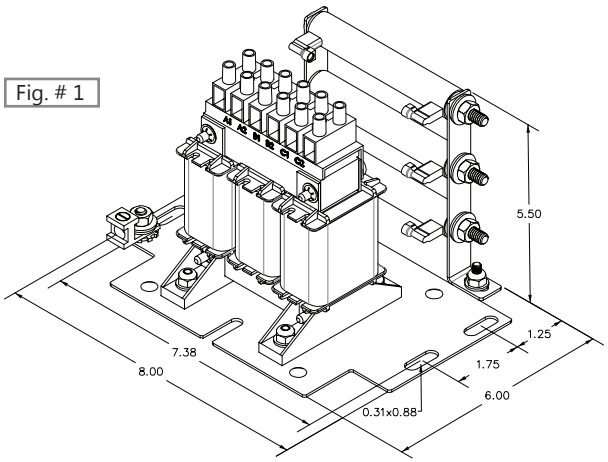


Fig. # 2

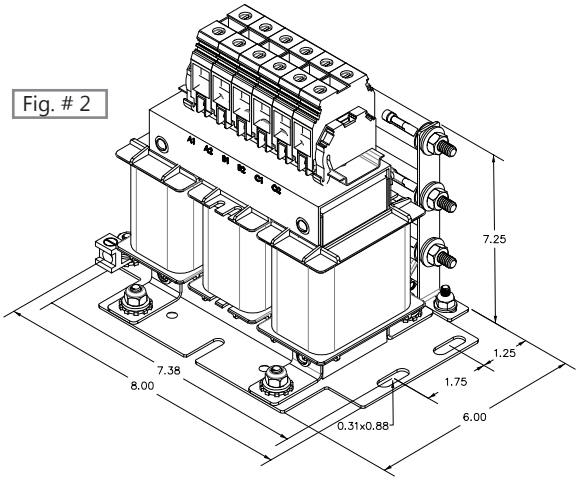
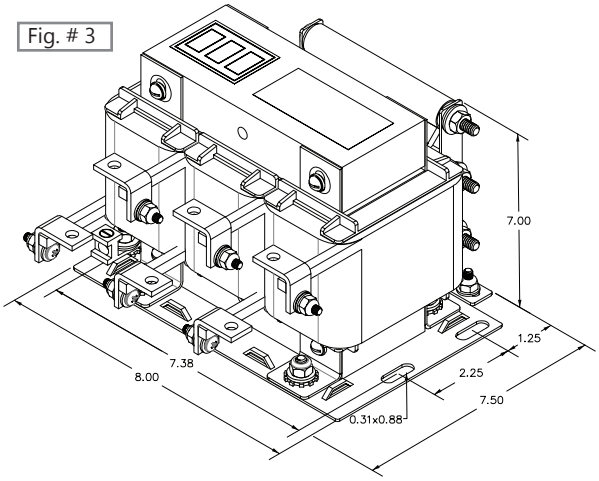
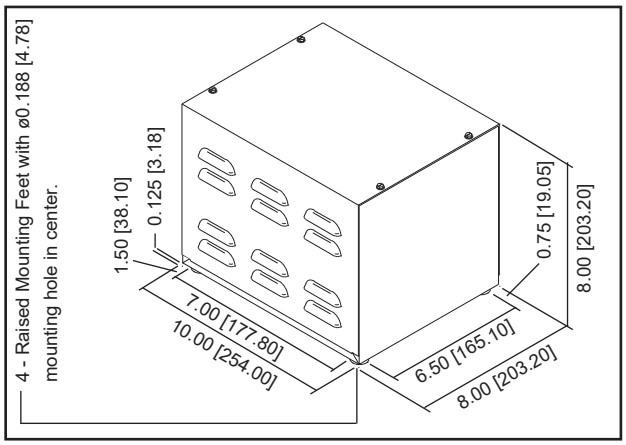


Fig. # 3



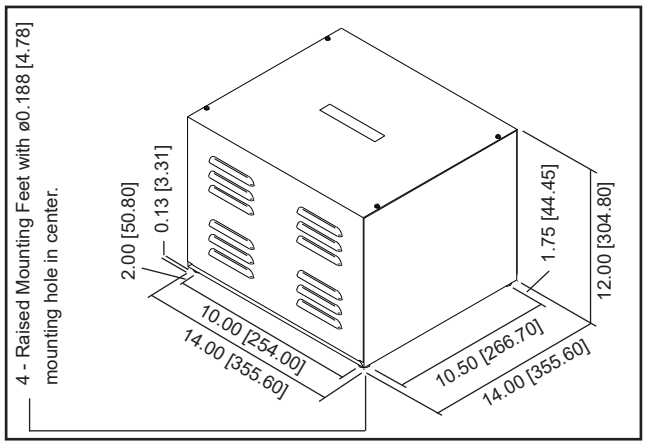
Type 1 Enclosed Drawings

'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

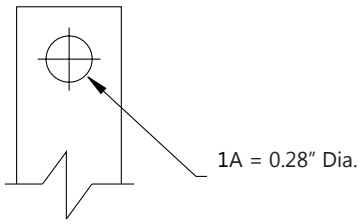


DIAGRAM 1

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
27	10-2 AWG
35	10-2 AWG
45	10-2 AWG
54	10-2 AWG
65	1A
80	1A
108	1A

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HPSDVDT
April 2022