

CROSS REFERENCES TO ROCKWELL AUTOMATION PN-89262

# TCI

## **V1000 KLC-Series Motor Protection Filters** **Performance and Protection for Drives**





The V1000 KLC-Series output filters provide exceptional motor and cable protection in a compact design

The next installment of the KLC-Series Filter provides excellent protection in a user-friendly package. This compact design has been developed with space sensitive applications in mind. The V1000 greatly reduces motor failures on VFD applications by limiting the magnitude of voltage spikes to levels below 1000 volts and slows down the rate of change of PWM switching by a factor of three. The V1000 has demonstrated success in protecting the cable and motor insulation by reducing the damaging effects of reflected wave.

Common Mode currents, which can lead to bearing pitting and fluting, are typically reduced by 30%. Extensive testing has demonstrated that TCI's V1000 filter is effective at reducing Common Mode currents, without costly machine modifications.

Designed to be installed within ten feet of the drive output terminals, V1000 Filters are easily accessible for both installation and maintenance. The superior performance increases process uptime and motor life. The V1000 provides the outstanding performance that our customers have come to expect from the KLC-Series Output Filters.



### Manufacturer's Warranty

V1000 KLC-Series Output Filters are warranted against Manufacturer's defect for one year from the date of original purchase.

### Drawings/Specifications

Autocad compatible \*.dxf drawings and Acrobat Reader compatible \*.pdf drawings of all V1000 Series KLC Output Filters are available at [www.transcoil.com](http://www.transcoil.com) or by contacting TCI at (800) 824-8282.



## Typical Problems, Superior Solutions with KLC-Series Products

### *The Reflective Wave Phenomenon*

Variable Frequency Drives generate useful "fundamental" voltage and frequency using Pulse Width Modulation (PWM) for adjusting the speed of an AC motor. The Drive's inverter circuit "switches" (transitions from the off state to the on state) rapidly, producing a carrier containing the fundamental voltage and frequency. Voltage wave reflection is a function of the voltage rise time (dV/dT) and the length of the motor cables. The impedance on either end of the cable run does not match, causing voltage pulses to be reflected back in the direction from which it arrived. As these reflected waves encounter incoming waves, their values add, causing higher peak voltage. As wire length or carrier frequency increases, the overshoot peak voltage also increases. The KLC-Series Output Filters have been designed to limit peak voltage and increase voltage rise time. In specific applications, the V1000 has performed with cable runs of up to 3,000 feet.

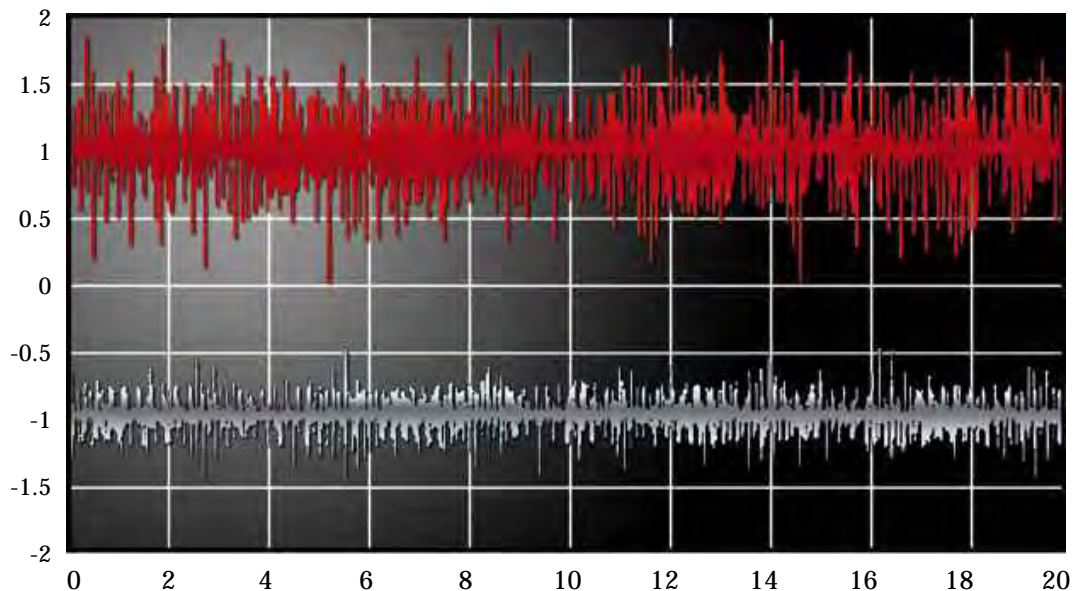
### *The Resonant Circuit Phenomenon*

Electrical systems of every nature have a natural frequency at which they operate. The natural frequency is determined by the equation: 
$$Fr = \frac{1}{2\pi * \sqrt{L * C}}$$
. Individual components within a system also operate at frequencies specific unto themselves. When system components have a resonant frequency that matches the natural resonant frequency of the entire system, peak voltages can quickly exceed standard reflective wave overshoots. The insertion of a V1000 ensures that the system resonance frequency remains sufficiently high in order to avoid matching the resonant frequency of any single component.



# Common Mode Motor Bearing Current

Common mode voltage occurs when the voltages on the three output lines of a drive do not sum “instantaneously” to zero. The V1000 substantially slows down the rate of change of PWM switching as seen by the load. This reduction in the rate of change results in increased capacitive coupling impedance between bearings and bearing races. This increase in impedance, in turn, reduces the damaging Common Mode currents and increases motor up-time.



30% Reduction in rms Common Mode Current with V1000 Applied

## dV/dT and Reflective Wave unsuppressed causes Motor failures

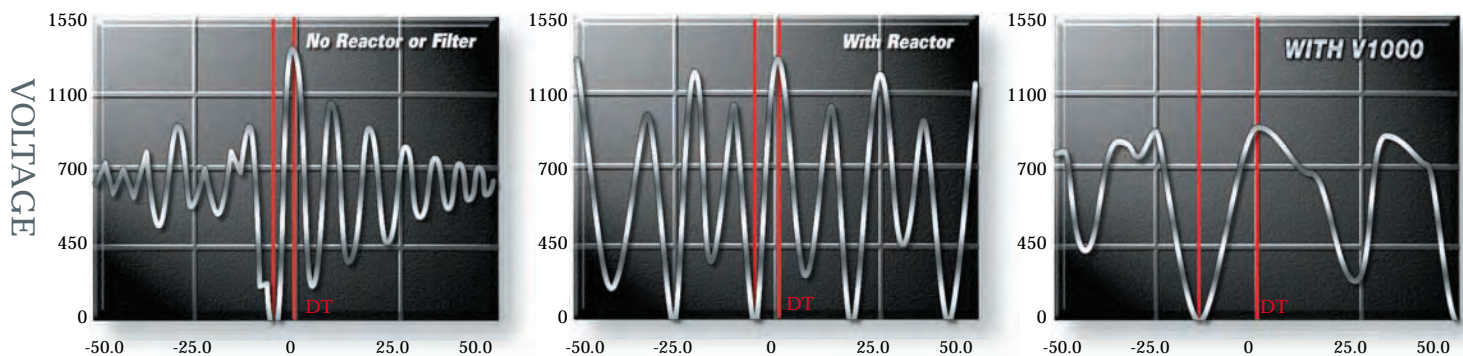
- Peak Voltages on a 460V system can commonly exceed 1500V, causing rapid breakdown of motor insulation, leading to motor failure. On 575 V systems, the peak voltages can easily reach 2100 V. If this is left uncontrolled, insulation failure may occur.
- The same peak voltages that damage the motor can also damage the cable. Since the V1000 filters are designed to be placed at the output of the Drive, these units will also protect the cable runs.

The added inductance of a V1000 filter will also help reduce motor heating, motor noise, and motor vibration by reducing the current harmonics in the system.

## VOLTAGE RISE TIME

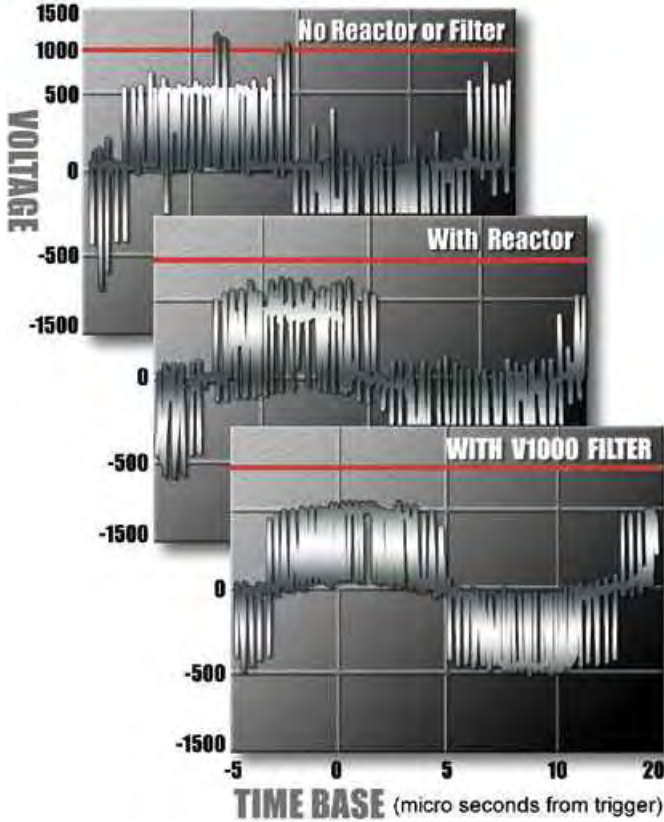
While peak voltages can commonly exceed 1500V, it is important to note that these same spikes can have a rise time, dV/dT, in excess of 7500V/ $\mu$ s. Such high rise times can cause significant damage to the motor windings and the insulation system, resulting in premature motor failure. The life of the motor can be greatly extended by limiting both the magnitude of the voltage spikes to levels below 1000V and the dV/dT at the motor terminals to levels less than 1000V/ $\mu$ s on 480V systems.

Carrier Frequency 8KHZ; 500 Feet of Cable Rate of voltage rise at motor terminals

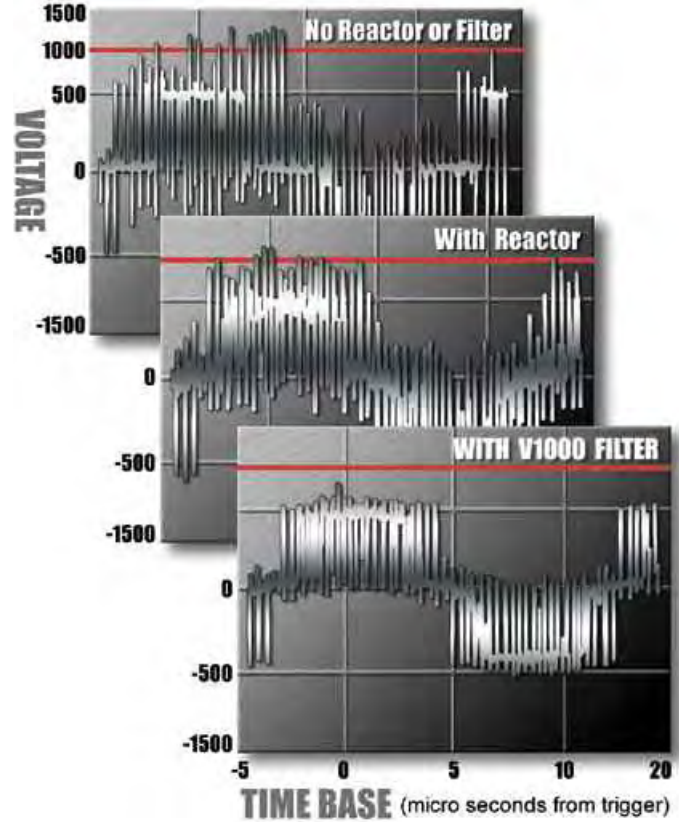


# Carrier Frequency 2.5KHZ

70 Feet of Cable

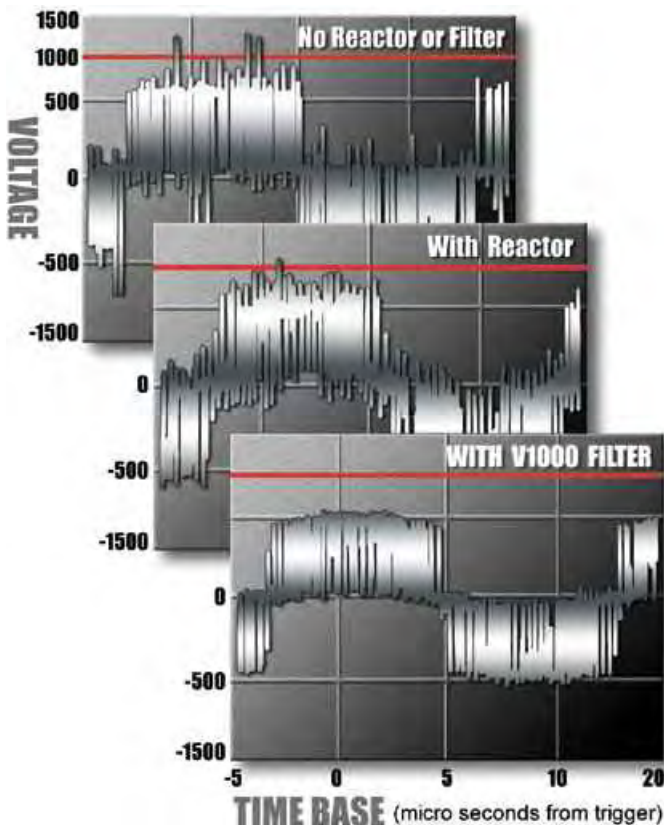


500 Feet of Cable

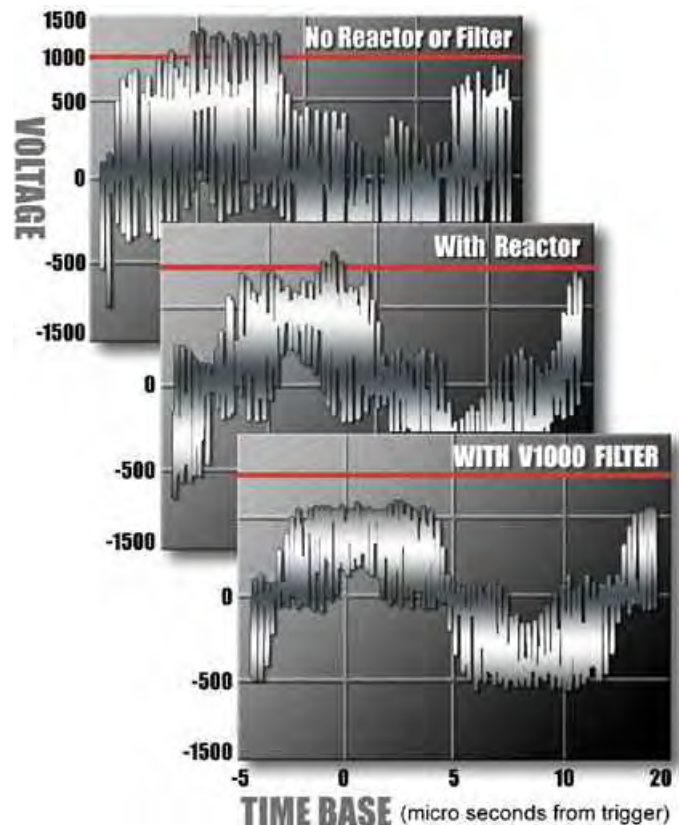


# Carrier Frequency 8KHZ

70 Feet of Cable



500 Feet of Cable



V1000 OPEN FILTER	PART NUMBER	NEC MOTOR HP			RATED CURRENT	WATTS LOSS	DIMENSIONS (inches)			WEIGHT	PART NUMBER HEAVY DUTY
		480V	600V	240V			HEIGHT	WIDTH	DEPTH		
		V1K2A00	0.75	1			-	2	75		
V1K3A00	1 - 1.5	2	0.5	3	75	9.00	5.50	7.25	8	V1K3A00EX	
V1K4A00	2	3	0.75	4	75	9.00	5.50	7.25	8	V1K4A00EX	
V1K6A00	3	-	1 - 1.5	6	80	9.00	5.50	7.25	8	V1K6A00EX	
V1K8A00	5	5	2	8	90	9.00	5.50	8.25	8	V1K8A00EX	
V1K12A00	7.5	10	3	12	95	9.00	5.50	8.25	8	V1K12A00EX	
V1K16A00	10	-	5	16	95	9.00	5.50	8.25	12	V1K16A00EX	
V1K18A00	10	15	-	18	110	9.00	5.50	8.25	12	V1K18A00EX	
V1K21A00	15	-	-	21	110	9.00	5.50	8.25	12	V1K21A00EX	
V1K25A00	15	20	7.5	25	110	9.00	5.50	8.25	12	V1K25A00EX	
V1K27A00	20	25	-	27	110	9.00	5.50	8.25	14	V1K27A00EX	
V1K35A00	25	30	10	35	130	12.00	8.00	9.00	17	V1K35A00EX	
V1K45A00	30	40	15	45	135	12.00	8.00	9.00	17	V1K45A00EX	
V1K55A00	40	50	20	55	145	12.00	8.00	9.00	23	V1K55A00EX	
V1K80A00	50 - 60	75	25 - 30	80	255	12.00	8.00	9.00	23	V1K80A00EX	
V1K110A00	75	100	40	110	245	12.00	8.00	10.25	40	V1K110A00EX	
V1K130A00	100	125	50	130	270	8.50	11.75	9.50	55	V1K130A00EX	
V1K160A00	125	150	60	160	260	8.50	11.75	10.50	60	V1K160A00EX	
V1K200A00	150	200	75	200	265	8.50	11.75	9.25	60	V1K200A00EX	
V1K250A00	200	250	100	250	290	8.50	11.75	9.25	65	V1K250A00EX	
V1K305A00	250	300	-	300	325	8.75	11.75	12.25	80	V1K302A00EX	
V1K362A00	300	350	150	360	300	8.75	11.75	12.00	80	V1K361A00EX	
V1K420A00	350	450	-	420	450	10.00	11.75	13.75	95	V1K420A00EX	
V1K480A00	400	500	200	480	475	10.00	11.75	13.75	100	V1K480A00EX	
V1K600A00	500	600	-	600	515	12.75	15.00	13.75	130	V1K600A00EX	
V1K750A00	600	700	-	750	770	12.75	15.00	14.50	135	V1K750A00EX	

The watts loss information provided within the selection charts are based on the effects of a sine-triangle modulated waveform at full load current, 60Hz fundamental, with a carrier frequency setting of 4 kHz and a lead length of 500 (wire) feet using THHN cable. It is important to note that as system specifics vary, so shall the watts loss. Typical testing results have indicated that the V1000 has an efficiency rating of 98% or better.

V1000 ENCLOSED FILTER	PART NUMBER (ENCLOSED)	NEC MOTOR HP			RATED CURRENT	WATTS LOSS	DIMENSIONS (inches)			WEIGHT	PART NUMBER HEAVY DUTY
		480V	600V	240V			HEIGHT	WIDTH	DEPTH		
		V1K2A01	0.75	1			-	2	75		
V1K3A01	1 - 1.5	2	0.5	3	75	9.00	5.50	10.00	11	V1K3A01EX	
V1K4A01	2	3	0.75	4	75	9.00	5.50	10.00	11	V1K4A01EX	
V1K6A01	3	-	1 - 1.5	6	80	9.00	5.50	10.00	11	V1K6A01EX	
V1K8A01	5	5	2	8	90	9.00	5.50	10.00	11	V1K8A01EX	
V1K12A01	7.5	10	3	12	95	9.00	5.50	10.00	11	V1K12A01EX	
V1K16A01	10	-	5	16	95	9.00	5.50	10.00	15	V1K16A01EX	
V1K18A01	10	15	-	18	110	9.00	5.50	10.00	15	V1K18A01EX	
V1K21A01	15	-	-	21	110	9.00	5.50	10.00	15	V1K21A01EX	
V1K25A01	15	20	7.5	25	110	9.00	5.50	10.00	15	V1K25A01EX	
V1K27A01	20	25	-	27	110	9.00	5.50	10.00	15	V1K27A01EX	
V1K35A01	25	30	10	35	130	12.00	8.00	11.50	23	V1K35A01EX	
V1K45A01	30	40	15	45	135	12.00	8.00	11.50	23	V1K45A01EX	
V1K55A01	40	50	20	55	145	12.00	8.00	11.50	23	V1K55A01EX	
V1K80A01	50 - 60	75	25 - 30	80	255	12.00	8.00	11.50	29	V1K80A01EX	
V1K110A01	75	100	40	110	245	16.50	18.00	15.00	68	V1K110A01EX	
V1K130A01	100	125	50	130	270	16.50	18.00	15.00	83	V1K130A01EX	
V1K160A01	125	150	60	160	260	16.50	18.00	15.00	83	V1K160A01EX	
V1K200A01	150	200	75	200	265	16.50	18.00	15.00	93	V1K200A01EX	
V1K250A01	200	250	100	250	290	16.50	18.00	15.00	93	V1K250A01EX	
V1K305A01	250	300	-	300	325	16.50	18.00	30.00	117	V1K302A01EX	
V1K362A01	300	350	150	360	300	16.50	18.00	30.00	117	V1K361A01EX	
V1K420A01	350	450	-	420	450	16.50	18.00	30.00	132	V1K420A01EX	
V1K480A01	400	500	200	480	475	16.50	18.00	30.00	138	V1K480A01EX	
V1K600A01	500	600	-	600	515	16.50	18.00	30.00	168	V1K600A01EX	
V1K750A01	600	700	-	750	770	16.50	18.00	30.00	180	V1K750A01EX	

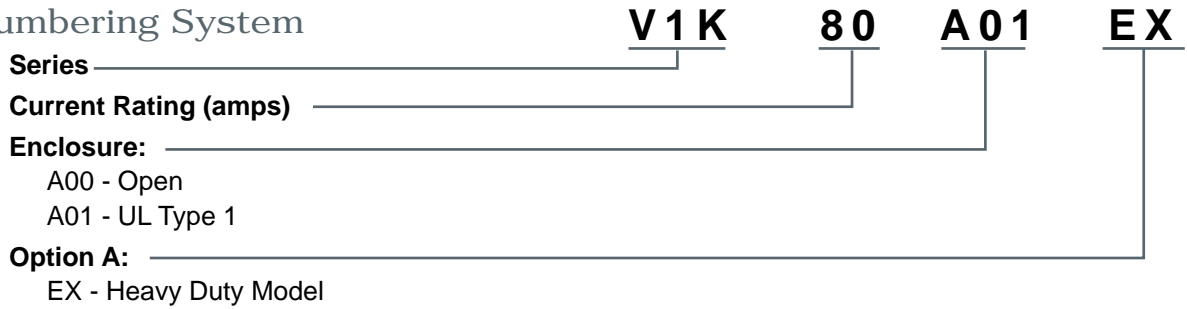
#### The dv/dt Guarantee

Properly sized and applied, TCI guarantees that the V1000 will limit motor terminal peak input voltage to 150% of the bus voltage with a wire lead length of 1000 feet and a carrier frequency of 4 kHz. Maximum lead length and carrier frequency can vary depending on wire lead type. If a properly selected, installed, and loaded V1000 filter fails to meet the guaranteed performance levels, TCI will provide the necessary components or replacement filter at no additional charge. TCI does not take responsibility for additional installation or removal costs, to include, but not limited to, replacement of third party equipment.

#### Minimum System Requirements

In order to achieve the performance levels as stated in this guarantee, the electrical system must adhere to the following: The V1K must be sized at no more than 110% of the drive output current rating. The V1K must be sized to have regular line current loading of no less than 25% of its current rating. If the load has a potential for overhauling, the drive must be equipped with braking resistors or other features limiting bus voltage to no more than the level of the peak line voltage. The V1K must be wired no more than 12 feet from the drive.

## Part Numbering System



## Flexible Armored THHN Cable

Units 35 Amps and Below

Frequency (kHz)	Cable Leads (feet)			
	100'	101' - 500'	501' - 1000'	> 1000'
2	V1000 - STD	V1000 - STD	V1000 - STD	V1000 - EX
4	V1000 - STD	V1000 - STD	V1000 - STD	V1000 - EX
6	V1000 - STD	V1000 - STD	V1000 - EX	MotorGuard
8	V1000 - STD	V1000 - EX	MotorGuard	MotorGuard

Units 45 Amps to 750 Amps

Frequency (kHz)	Cable Leads (feet)			
	100'	101' - 500'	501' - 1000'	> 1000'
2	V1000 - STD	V1000 - STD	V1000 - STD	V1000 - EX
4	V1000 - STD	V1000 - STD	V1000 - STD	V1000 - EX
6	V1000 - STD	V1000 - STD	V1000 - STD	V1000 - EX
8	V1000 - STD	V1000 - EX	V1000 - EX	V1000 - EX

## Flat Cable or VFD Cable

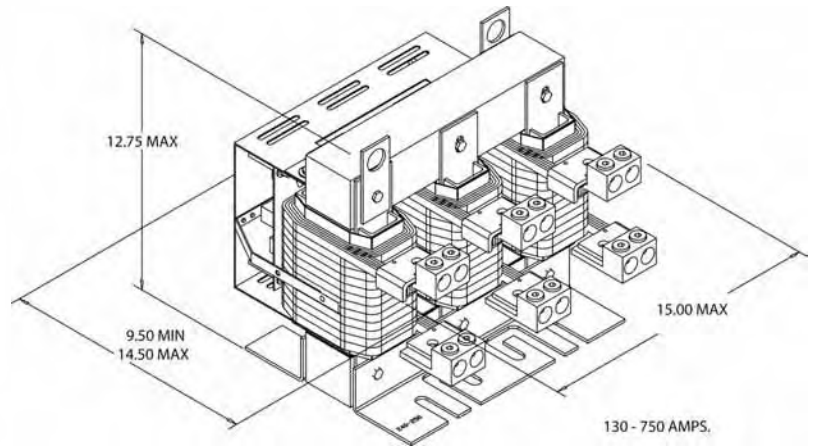
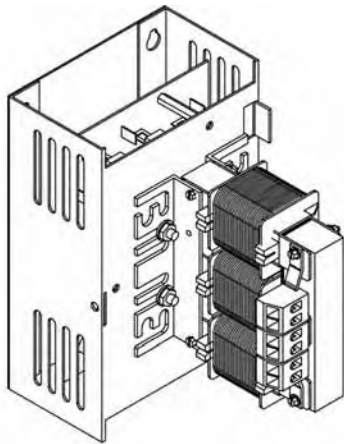
Units 35 Amps and Below

Frequency (kHz)	Cable Leads (feet)			
	100'	101' - 500'	501' - 1000'	> 1000'
2	V1000 - STD	V1000 - STD	V1000 - STD	V1000 - EX
4	V1000 - STD	V1000 - STD	V1000 - EX	MotorGuard
6	V1000 - STD	V1000 - STD	MotorGuard	MotorGuard
8	MotorGuard	MotorGuard	MotorGuard	MotorGuard

Units 45 Amps to 750 Amps

Frequency (kHz)	Cable Leads (feet)			
	100'	101' - 500'	501' - 1000'	> 1000'
2	V1000 - STD	V1000 - STD	V1000 - STD	V1000 - EX
4	V1000 - STD	V1000 - STD	V1000 - EX	MotorGuard
6	V1000 - STD	V1000 - EX	MotorGuard	MotorGuard
8	MotorGuard	MotorGuard	MotorGuard	MotorGuard

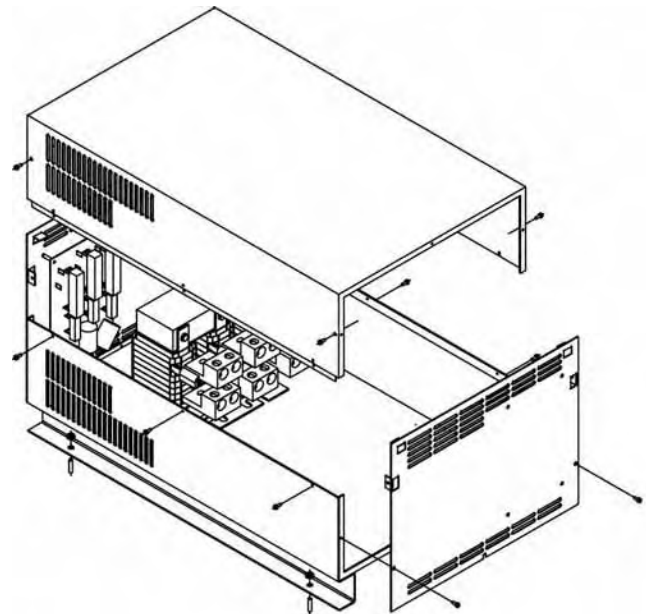
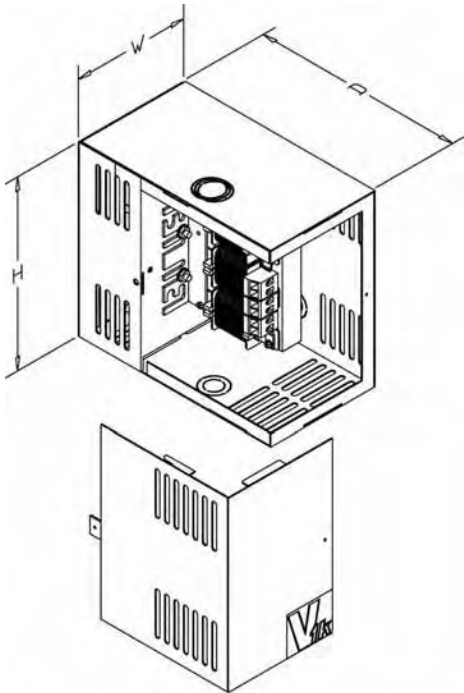
# V1000 OPEN



AMPS.	H	W	D <sub>MAX</sub>	MH	MW	MS
2-27	9.0	5.5	8.25	8.0	4.5	.25
35-110	12.0	8.0	10.25	11.25	7.0	.25



# V1000 ENCLOSED



AMPS.	H	W	D	MH	MW	MS
2-27	9.0	5.5	10.0	8.0	4.5	.25
35-80	12.0	8.0	11.5	11.25	7.0	.25

AMPS.	D	MD	MD1	MW	MS
110-250	15.0	11.0	2.0	16.5	.38
305-750	30.0	23.00	3.50	16.5	.38

# SPECS

## **V1000 Product Specifications**

- 3 Phase, 600V Class
- UL Listed
- Manufacturer's Warranty
- Performance Guarantee
- High Performance
- NEMA 1 enclosures available
- Inductor uses Distributed Gap Technology
- 40 degrees C ambient temperature
- 180 degrees C or 220 degrees C Inductor insulation rating
- Designed to mitigate the negative effects of very long motor leads and has reached lengths of up to 3000 feet
- Single motor or multiple motor capable



***Performance and Protection For Drives***