Power Quality

FUSECO

Active Harmonic Filters

144

Sinexcel Active Harmonic Filters (AHF)

SiC technology (operates at 40kHz up to 90kHz)
THDi < 5%
3 & 4 wire options in each unit
Wall Mounted Solutions
Load balancing and reactive power (PFC)
Up to 1200A from a single cabinet solution
Meets AS/NZS 61000.3.6 standards and IEEE 519-2022 recommendations

Sinexcel

Passive Harmonic Filters

152

MTE Matrix AP Passive Filters

5% THDi performance
Adaptive passive technology
Reduces energy costs
Better power factor
Compatibility with generators
Meets IEEE 519-2022 requirements for harmonic current

MTE

Line & Load Reactors

156

MTE RL Reactors

Applied to the load side and line side of a VSD
Reduces harmonic distortion
Reduces surge currents
Eliminates nuisance tripping
Improves power factor
Extends lifespan of VSD rectifier

MTE

Motor Protection

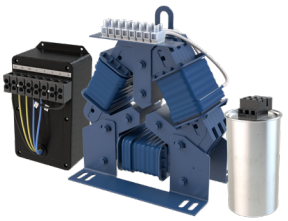
158

Sine Wave Filters

- Increases motor life
- Allows for the use of longer motor cables
- Reduces motor audible noise, vibration and heat
- Reduces radiated emissions
- Protects your motor cable
- Reduction of bearing currents

schaffner MORE POWER TO YOU

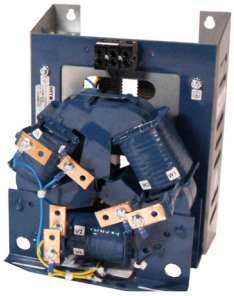
MTE AN SL INDUSTRIES COMPANY



dV/dT Filters

- Provides >50% common mode reduction, peak voltage protection, and rise time reduction - all in one filter.
- Protects motors from long lead peak voltages
- Prevents voltage spikes from exceeding 1kV
- Increases motor bearing life and up-time

MTE AN SL INDUSTRIES COMPANY



Voltage Regulators

162

Wide Range of Voltage Regulators

- Indoor and outdoor solutions available
- Wide input range (184-287V for 230V)
- Precise regulation (±3%)
- Features complete line conditioning
- 96-98% efficiency
- Single & Three phase available
- 3kVA to 4,000kVA

HOSSONI®

RFI/EMI Filters

164

Schaffner RFI Filters

- Single Phase & 3 phase available
- Blocks radio frequencies that cause electrical interference
- Reduces inverter instability
- Reduces control systems interference

schaffner MORE POWER TO YOU

Power Quality

The term 'Power Quality' is used to describe the quality or 'fitness' of electric power that drives an electrical load and the load's ability to function properly. Without the proper power, an electrical device may malfunction, fail prematurely or not operate at all.

DIRTY POWER CLEAN POWER

The term 'clean power' is used to describe electricity that is considered to be of good quality (see below) with particular reference to a very low harmonic content. Therefore, the term 'dirty power' is used to describe electricity that is considered to be of low quality (opposite to the above) with particular reference to a very high harmonic content.

Fuseco is committed to providing power quality solutions that represent great value. Current generation technology applied with a practical, proven approach that represents a sensible value for money outcome.

The following list of characteristics are considered to be necessary for 'good power quality'.

1. It must have a continuity of service (not be interrupted).

Contact Fuseco to discuss solutions that are often used to provide continuity of supply in the event of 'power outages'.

2. It must have a very low harmonic content.

Harmonics can be created by non-linear loads such as variable speed drives, lighting and computer servers / data centers. Refer to pages 156-173 for information on harmonic mitigation solutions.

3. It must have a very low variation in the voltage magnitude.

Voltage regulators are often used to provide a stable voltage supply in challenging electrical environments. Refer to pages 174-175 for more information.

4. It must have very low transient voltages and currents.

In most cases, these phenomena are a by-product of the system load, especially environments with mechanical or high speed switching. Active Harmonic Filters (refer pages 156-163) and SVG units (refer pages 127-134) can provide improvements this area.

If we look beyond the power quality of the supply, there are also considerations regarding the power quality of a particular localised electrical environment. The power supply may be of good quality, however if the loads in a particular system are challenging (eg. non-linear, mechanical & high speed switching environments), the resulting power quality of that system may be poor.

In these cases, Active Harmonic Filters on pages 156-163 can be employed within a customised solution to improve the quality and efficiency of that particular electrical environment. Contact Fuseco for specific solutions to challenging electrical environments.

Power Quality – Applications

Solar Inverters can create RFI. RFI filters can be installed to eliminate or reduce the issues.

Hydraulic Systems Hydraulic Systems that manage the movement of water (eg, bathrooms, kitchens, waste and irrigation) incorporate pumps, motors and VSDs that propagate harmonics.

Lighting Systems can create RFI and harmonics due to operational high frequency switching.

HVAC Systems that manage heating, air ventilation and air conditioning incorporate pumps, motors and VSDs, resulting in the propagation of harmonics.

Vertical Transport Systems such as elevators, lifts and escalators incorporate VSDs, resulting in the propagation of harmonics.

The Distribution Boards on each floor are a location where harmonic mitigation devices are often installed to reduce the system harmonic content.

The Main Switchboard is the location where Power Factor Correction Solutions are installed to bring the system power factor to unity and Active Harmonic Filters are installed to mitigate harmonics to comply with IEEE 519-2022 and AS/NZS 61000.3.6

Data Centers & Computer Server Rooms utilise systems that can create harmonics and a leading power factor.

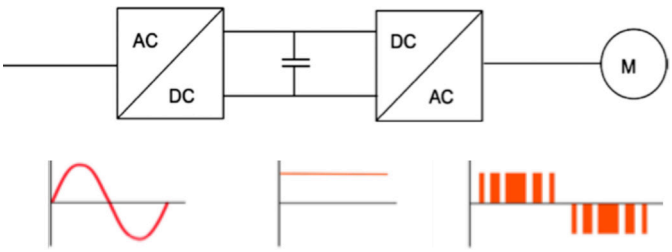
FUSECO

VSDs and Harmonics

For motors to be used in a practical and useful way, we need to be able to control their speed of operation. A Variable Speed Drive (VSD), also known as a Variable Frequency Drive (VFD) is a programmable device that controls motor speed.

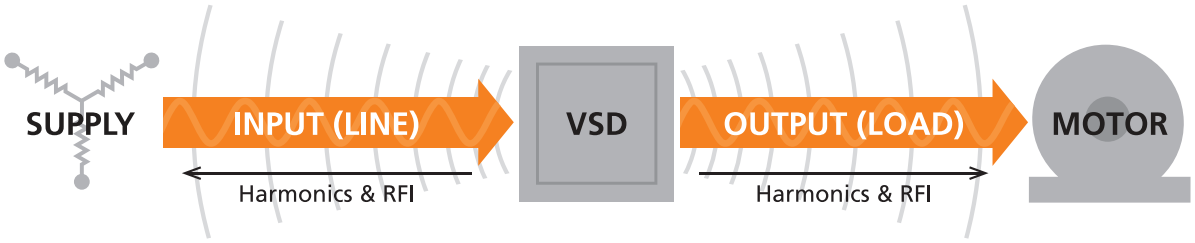
A VSD works by having a rectifier section at the input and this creates DC voltage on the DC bus (needed for switching). The inverter section at the output side provides the Pulse Width Modulation (PWM) waveform. A drive changes the speed of the motor by changing the frequency to the motor. As an aside, the impedance of the motor is determined by the inductive reactance in the windings, and it changes as the frequency changes.

Rectifier DC Bus Inverter IGBT



PWM is employed to control the voltage and frequency to the motor drive. DC voltage is applied to the motor by controlled pulses at high frequency, which results in voltage that approximates a sine wave of the chosen frequency.

This PWM method creates harmonics in the system. The switching also creates radio frequency interference (RFI) and voltage spikes that can be up to 1200V at the motor terminals. The high switching frequency can also lead to 'capacitive bearing currents' that flow through the motor bearings and can damage the bearing surfaces. A portion of the harmonics are reflected back to the VSD by the motor, creating further issues in the electrical environment.



The presence of harmonics in an electrical system can result in:

- Degradation of motors, especially the bearings and insulation = higher costs.
- Significant reduction of the lifespan of equipment due to excessive heat = higher costs.
- Although you will get billed for the power that you are supplied, a large percentage of that power may be unusable = higher costs.
- Unusual events such as flickering lights, alarms going off, or MCB's, MCCB's, RCD's and Earth Leakage devices tripping for no apparent reason = more down time = higher costs.

VSDs are prolific creators of harmonics in electrical systems and as a result, most of the harmonic mitigation effort focuses on the input side and output side of a VSD. For the mitigation of harmonics on the input side (line side) of a VSD we recommend Line Reactors, Passive Harmonic Filters and Active Harmonic Filters. For the mitigation of harmonics on the output side (load side) of a VSD we recommend Load Reactors, dV/dT Filters and Sine Wave Filters.

Sellers of VSDs please note:

- Customers are becoming more aware of the damage caused by VSD related harmonics. Harmonic mitigation products are now being offered to customers as a 'value-add', in essence as an 'insurance policy' against the detrimental effects of harmonically rich environments, enhancing the longevity of both the motors and the drives.
- These products are also used on the input side of a drive in situations where harmonics are causing issues and in cases where a site needs to comply to supply authority requirements for harmonic content coming back onto the grid.
- Harmonic mitigation products MUST be considered for applications with long cable runs and/or multiple VSDs in the one environment.

Harmonic Mitigation Solutions

SUPPLY

INPUT (LINE)

VSD

OUTPUT (LOAD)

MOTOR

Active Harmonic Filters

- Reduces harmonics to 5% or less
- Simultaneous compensation of 2nd to 50th harmonic order
- Provides leading & lagging power factor correction
- Load balancing
- Reduces supply sags & surges
- Meets AS/NZS 61000.3.6 standards and IEEE 519-2022 recommendations

Passive Harmonic Filters (Low Pass Filters)

- Reduces harmonics to 5%
- Reduces cable heating & energy losses
- Improves power factor and reduces system losses
- Minimises interference with other equipment
- Easy installation and operation
- Meets AS/NZS 61000.3.6 standards and IEEE 519-2022 recommendations

Line Reactors (Chokes, Inductors, Line Filters)

- Reduces harmonic distortion
- Reduces surge currents
- Virtually eliminates nuisance tripping
- Improves power factor
- Extends lifespan of semiconductors
- Meets AS/NZS 61000.3.6 standards and IEEE 519-2022 recommendations

RFI Filters

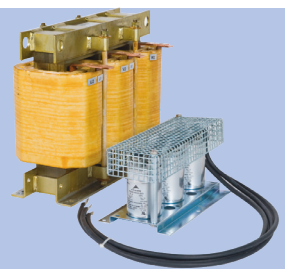
- Blocks radio frequencies that cause electrical interference
- Reduces inverter instability
- Improves radio & TV reception
- Reduces control systems interference

Load Reactors (Motor Chokes, Inductors, Load Filters)

- Reduces harmonic distortion
- Reduces surge currents
- Protects motors from long lead effects
- Reduces reflective currents
- Reduces motor temperatures & audible noise
- Meets AS/NZS 61000.3.6 standards and IEEE 519-2022 recommendations

dV/dT Filters

- Protects motors from long lead peak voltages
- Prevents voltage spikes from exceeding 1kV
- Increases motor bearing life & up-time
- Reduces common mode noise and currents
- Reduction of motor temperatures & peak voltages
- Meets AS/NZS 61000.3.6 standards and IEEE 519-2022 recommendations



Sine Wave Filters

- Allows for the use of unshielded cables (lower project costs)
- Allows for the use of longer motor cables
- Reduces eddy currents, stray flux losses & bearing currents
- Eliminates torque ripple & voltage wave reflection
- Reduces motor noise, vibration & heat
- Meets AS/NZS 61000.3.6 standards and IEEE 519-2022 recommendations

Power Quality Standards

Australian Standards

The relevant standard for harmonic voltage distortion in Australia is AS/NZS 61000.3.6 and it is compatible with the IEEE 519-2022 recommendations. If the supply authority is dissatisfied with the degree of voltage distortion at the point of common coupling (PCC), harmonic filtering may be specified to comply with the Australian Standards.

Odd harmonics, non-multiples of 3		Odd harmonics, multiples of 3 (triplens)		Even harmonics	
Order, h	% harmonic voltage	Order, h	% harmonic voltage	Order, h	% harmonic voltage
5	5	3	5	2	2
7	5	9	1.5	4	1
11	3.5	15	0.3	6	0.5
13	3	21	0.2	8	0.5
17	2	>21	0.2	10	0.5
19	1.5			12	0.2
23	1.5			>12	0.2
25	1.5				
>25	0.2 + 1.1(25/h)				

NOTE: total harmonic distortion (TDHV) 8% max

IEEE 519-2022

The IEEE is the Institute of Electrical and Electronics Engineers. IEEE 519-2022 'Recommended Practices and Requirements for Harmonic Control in Electric Power Systems', was published in 1981. The document established the levels of voltage distortion that are acceptable to a distribution system and has been widely applied in establishing required harmonic correction throughout the electrical industry.

The new IEEE 519, updated in 2022, sets forth limits for both harmonic voltages on the utility transmission and distribution systems and harmonic currents within the industrial distribution systems. Since harmonic voltages are generated by the passage of harmonic currents through distribution system impedances, by controlling the currents or system impedances within the industrial facility, one can control harmonic voltages on the utility distribution.

IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems

Table 10-3 of IEEE Std 519-2022

ISC/IL	Individual harmonic limits. Harmonics values are in % of maximum demand load												TDD
	2≤h<6		6≤h<11		11≤h<17		17 < h <23		23 ≤ h < 35		35 ≤ h ≤ 50		
	Odd	Even	Odd	Even	Odd	Even	Odd	Even	Odd	Even	Odd	Even	
<20*	4.0	2.0	4.0	4.0	2.0	2.0	1.5	1.5	0.6	0.6	0.3	0.3	5.0
20<50	7.0	3.5	7.0	7.0	3.5	3.5	2.5	2.5	1.0	1.0	0.5	0.5	8.0
50<100	10.0	5.0	10.0	10.0	4.5	4.5	4.0	4.0	1.5	1.5	0.7	0.7	12.0
100<1000	12.0	6.0	12.0	12.0	5.5	5.5	5.0	5.0	2.0	2.0	1.0	1.0	15.0
>1000	15.0	7.5	15.0	15.0	7.0	7.0	6.0	6.0	2.5	2.5	1.4	1.4	20.0

Note:
- Current Distortion Limits for General Distribution Systems (120V through 69,000V)
- Maximum Harmonic Current Distortion in Percent of I L • Individual Harmonic Order (Odd Harmonics)
- Even harmonics are limited to 25% of the odd harmonic limits above
- Current distortions that result in a DC offset, e.g. half-wave converters, are not allowed
- All power generation equipment is limited to these values of current distortion, regardless of actual ISC/IL (ISC = maximum short-circuit current at PCC; IL = maximum demand load current, fundamental frequency component, at PCC)

Site Audit

A Power Quality Site Audit is a service offered by Fuseco to our customers and the industry. A power quality consultant visits your site and conducts a power quality audit of your electrical system.

This involves setting up sophisticated measuring equipment on site that monitors and records all of the electrical activity that is occurring within the system over a period of time. The equipment is compact, easily transportable to most locations and can be set up indoors or outdoors.

An analysis of the recorded data usually helps to reveal any harmful harmonics, voltage supply and power factor issues. Our consultant will consider the data and present you with a power quality report, outlining the observed issues and suggesting solutions if required.

Audits are useful in determining electricity usage inefficiencies and identifying damaging harmonics which occur in electrical systems.

Even correctly functioning power systems require routine auditing to ensure early identification of any potential issues and proactive servicing requirements to keep power equipment operating to its full potential and the electrical environment complying to the Australian Standard AS/NZS 61000.3.6 and compatible with the IEEE 519-2022 recommendations.

A correctly functioning system could save you upwards of 30% off your power bills. In some industries and installations, that could translate to significant increases to your bottom line. By running an efficient system, you also use less energy and therefore help the environment.

To discuss our site analysis service in more detail, please contact a power quality consultant at Fuseco.

FUSECO

Selection Guide

		3% IMPEDANCE Reactors				5% IMPEDANCE Reactors				RFI FILTERS	
VOLTAGE		415V	415V	415V	415V	415V	415V	415V	415V	415V	415V
BRAND		MTE	MTE	TCI	TCI	MTE	MTE	TCI	TCI	SCHAFFNER	SCHAFFNER
kW	AMPS	IP00 (Open)	IP20 Nema 1, 2 (Enclosed)	IP00 (Open)	IP20 Nema 1, 2 (Enclosed)	IP00 (Open)	IP20 Nema 1, 2 (Enclosed)	IP00 (Open)	IP20 Nema 1, 2 (Enclosed)	3 Wire Low Leakage	3 Wire - Ultra Low Leakage (Data centre compatable)
0.18	0.4	RL-00103	RL-00113	KDRMA1L1	KDRMA1L1E01	RL-00102	RL-00112	KDRMA1H1	KDRMA1H1E01	FN3287-10-44-C26	FN3288-10-44-C21
0.25	0.6	RL-00103	RL-00113	KDRMA1L1	KDRMA1L1E01	RL-00102	RL-00112	KDRMA1H1	KDRMA1H1E01	FN3287-10-44-C26	FN3288-10-44-C21
0.37	0.9	RL-00202	RL-00212	KDRMA3L1	KDRMA3L1E01	RL-00203	RL-00213	KDRMA3H1	KDRMA3H1E01	FN3287-10-44-C26	FN3288-10-44-C21
0.55	1.3	RL-00202	RL-00212	KDRMA4L1	KDRMA4L1E01	RL-00203	RL-00213	KDRMA4H1	KDRMA4H1E01	FN3287-10-44-C26	FN3288-10-44-C21
0.75	1.8	RL-00201	RL-00211	KDRMA5L1	KDRMA5L1E01	RL-00202	RL-00212	KDRMA5H1	KDRMA5H1E01	FN3287-10-44-C26	FN3288-10-44-C21
1.1	2.6	RL-00403	RL-00413	KDRMA6L1	KDRMA6L1E01	RL-00404	RL-00414	KDRMA6H1	KDRMA6H1E01	FN3287-10-44-C26	FN3288-10-44-C21
1.5	3.5	RL-00402	RL-00412	KDRMA8L1	KDRMA8L1E01	RL-00404	RL-00414	KDRAA2H2	KDRAA2H2E01	FN3287-10-44-C26	FN3288-10-44-C21
2.2	4	RL-00803	RL-00813	KDRMA8L1	KDRMA8L1E01	RL-00804	RL-00814	KDRAA2H2	KDRAA2H2E01	FN3287-10-44-C26	FN3288-10-44-C21
3	6	RL-00803	RL-00813	KDRAA6L2	KDRAA6L2E01	RL-00804	RL-00814	KDRAA6H2	KDRAA6H2E01	FN3287-10-44-C26	FN3288-10-44-C21
4	7	RL-01202	RL-01212	KDRAA3L2	KDRAA3L2E01	RL-01203	RL-01213	KDRAA3H2	KDRAA3H2E01	FN3287-10-44-C26	FN3288-10-44-C21
5.5	10	RL-01202	RL-01212	KDRAA4L2	KDRAA4L2E01	RL-01203	RL-01213	KDRAA4H2	KDRAA4H2E01	FN3287-10-44-C26	FN3288-10-44-C21
7.5	14	RL-01802	RL-01812	KDRAA5L2	KDRAA5L2E01	RL-01803	RL-01813	KDRAA5H2	KDRAA5H2E01	FN3287-16-44-C26	FN3288-16-44-C21
11	20	RL-02502	RL-02512	KDRB2L	KDRB2LE01	RL-02503	RL-02513	KDRB2H	KDRB2HE01	FN3287-20-33-C26	FN3288-20-33-C21
15	27	RL-03502	RL-03512	KDRB1L	KDRB1LE01	RL-03503	RL-03513	KDRC3H	KDRC3HE01	FN3287-40-33-C26	FN3288-40-33-C21
18.5	33	RL-04502	RL-04512	KDRD1L	KDRD1LE01	RL-04503	RL-04513	KDRC1H	KDRC1HE01	FN3287-40-33-C26	FN3288-40-33-C21
22	40	RL-04502	RL-04512	KDRD2L	KDRD2LE01	RL-04503	RL-04513	KDRE2H	KDRE2HE01	FN3287-40-33-C26	FN3288-40-33-C21
30	55	RL-05502	RL-05512	KDRF2L	KDRF2LE01	RL-05503	RL-05513	KDRF1H	KDRF1HE01	FN3287-63-53-C26	FN3288-63-53-C21
37	66	RL-08002	RL-08012	KDRF4L	KDRF4LE01	RL-08003	RL-08013	KDRF2H	KDRF2HE01	FN3287-80-34-C26	FN3288-80-34-C21
45	80	RL-10002	RL-10012	KDRF3L	KDRF3LE01	RL-10003	RL-10013	KDRH2H	KDRH2HE01	FN3287-80-34-C26	FN3288-80-34-C21
55	97	RL-13002	RL-13012	KDRF3L	KDRF3LE01	RL-13003	RL-13013	KDRH2H	KDRH2HE01	FN3287-100-35-C26	FN3288-100-35-C21
75	130	RL-16002	RL-16012	KDRH2L	KDRH2LE01	RL-16003	RL-16013	KDRG3H	KDRG3HE01	FN3287-160-40-C26	FN3288-160-40-C21
90	160	RL-20002B14	RL-20012B14	KDRH1L	KDRH1LE01	RL-20003B14	RL-20013B14	KDRG1H	KDRG1HE01	FN3287-160-40-C26	FN3288-160-40-C21
110	195	RL-25002B14	RL-25012B14	KDRG3L	KDRG3LE01	RL-25003B14	RL-25013B14	KDRJ1H	KDRJ1HE01	FN3359-250-28	–
132	230	RL-32002B14	RL-32012B14	KDRG3L	KDRG3LE01	RL-32003B14	RL-32013B14	KDRJ1H	KDRJ1HE01	FN3359-250-28	–
160	280	RL-32002B14	RL-32012B14	KDRG1L	KDRG1LE01	RL-32003B14	RL-32013B14	KDRL1H	KDRL1HE01	FN3359-320-99	–
200	350	RL-40002B14	RL-40012B14	KDRG2L	KDRG2LE01	RL-40003B14	RL-40013B14	KDRL2H	KDRL2HE01	FN3359-400-99	–
250	440	RL-50002	RL-50012	KDRJ1L	KDRJ1LE01	RL-50003	RL-50013	KDRL4H	KDRL4HE01	FN3359-600-99	–
280	490	RL-50002	RL-50012	KDRL1L	KDRL1LE01	RL-50003	RL-50013	KDRL5H	KDRL5HE01	FN3359-600-99	–
315	550	RL-60002	RL-60012	KDRL2L	KDRL2LE01	RL-60003	RL-60013	KDRL6H	KDRL6HE01	FN3359-600-99	–
335	590	RL-60002	RL-60012	KDRL2L	KDRL2LE01	RL-60003	RL-60013	KDRL6H	KDRL6HE01	FN3359-600-99	–
355	620	RL-75002	RL-75012	KDRL3L	KDRL3LE01	RL-75003	RL-75013	KDRS1H	KDRS1HE01	FN3359-800-99	–
400	700	RL-75002	RL-75012	KDRL3L	KDRL3LE01	RL-75003	RL-75013	KDRS1H	KDRS1HE01	FN3359-800-99	–
450	790	RL-90002B14	RL-90012B14	KDRS1L	KDRS1LE01	RL-90003B14	RL-90013B14	KDRS2H	KDRS2HE01	FN3359-800-99	–
500	880	RL-100002B14	RL-100012B14	KDRX2L	KDRX2LE01	RL-100003B14	RL-100013B14	KDRX2H	KDRX2HE01	FN3359-1000-99	–
560	980	RL-100002B14	RL-100012B14	KDRX3L	KDRX3LE01	RL-100003B14	RL-100013B14	KDRX3H	KDRX3HE01	FN3359-1000-99	–
630	1100	RL-120002B14	RL-120012B14	KDRX1L	KDRX1LE01	RL-120003B14	RL-120013B14	KDRX4H	KDRX4HE01	FN3359-1600-99	–
670	1170	RL-120002B14	RL-120012B14	KDRX1L	KDRX1LE01	RL-120003B14	RL-120013B14	KDRX4H	KDRX4HE01	FN3359-1600-99	–
710	1240	RL-140002	RL-140012	KDRY1L	KDRY1LE01	RL-140003	RL-140013	KDRY2H	KDRY2HE01	FN3359-1600-99	–
800	1400	RL-150002	RL-150012	KDRY2L	KDRY2LE01	RL-150003	RL-150013	KDRY1H	KDRY1HE01	FN3359-1600-99	–
1000	1740	Special	Special	Special	Special	Special	Special	Special	Special	FN3359-2500-99	–
1200	2100	Special	Special	Special	Special	Special	Special	Special	Special	FN3359-2500-99	–
1320	2500	–	–	–	–	–	–	–	–	FN3359-2500-99	–

Selection Guide

		dV/dT FILTERS			SINE WAVE FILTER		PASSIVE HARMONIC FILTER		
VOLTAGE		600V	600V	600V	500V	500V	415V	415V	415V
BRAND		MTE	MTE	MTE	SCHAFFNER	SCHAFFNER	MTE	MTE	MTE
kW	AMPS	IP00 (Open)	IP20 Nema 1, 2 (Enclosed)	Nema 3R (Enclosed)	IP00 (Open)	IP20 (Enclosed)	IP00 (Open)	IP20 Nema 1, 2 (Enclosed)	Nema 3R (Enclosed)
0.18	0.4	–	–	–	–	–	–	–	–
0.25	0.6	–	–	–	–	–	–	–	–
0.37	0.9	–	–	–	FN5420-2.3-88-E0XXT	FN5420-2.3-44-E2XXT	–	–	–
0.55	1.3	DVSP0003E	DVSG0003E	DVSW0003E	FN5420-2.3-88-E0XXT	FN5420-2.3-44-E2XXT	–	–	–
0.75	1.8	DVSP0003E	DVSG0003E	DVSW0003E	FN5420-2.3-88-E0XXT	FN5420-2.3-44-E2XXT	–	–	–
1.1	2.6	DVSP0003E	DVSG0003E	DVSW0003E	FN5420-3.1-88-E0XXT	FN5420-3.1-44-E2XXT	–	–	–
1.5	3.5	DVSP0004E	DVSG0004E	DVSW0004E	FN5420-5.9-88-E0XXT	FN5420-5.9-44-E2FXT	MAPP0006C	MAPG0006C	MAPW0006C
2.2	4	DVSP0004E	DVSG0004E	DVSW0004E	FN5420-5.9-88-E0XXT	FN5420-5.9-44-E2FXT	MAPP0006C	MAPG0006C	MAPW0006C
3	6	DVSP0007E	DVSG0007E	DVSW0007E	FN5420-10-88-E0XXT	FN5420-10-44-E2FXT	MAPP0006C	MAPG0006C	MAPW0006C
4	7	DVSP0009E	DVSG0009E	DVSW0009E	FN5420-10-88-E0XXT	FN5420-10-44-E2FXT	MAPP0008C	MAPG0008C	MAPW0008C
5.5	10	DVSP0012E	DVSG0012E	DVSW0012E	FN5420-13-89-E0XXT	FN5420-13-33-E2FXT	MAPP0011C	MAPG0011C	MAPW0011C
7.5	14	DVSP0017E	DVSG0017E	DVSW0017E	FN5420-18-89-E0XXT	FN5420-18-33-E2FXT	MAPP0014C	MAPG0014C	MAPW0014C
11	20	DVSP0022E	DVSG0022E	DVSW0022E	FN5420-26-92-E0XXT	FN5420-26-33-E2FXT	MAPP0021C	MAPG0021C	MAPW0021C
15	27	DVSP0027E	DVSG0027E	DVSW0027E	FN5420-32-92-E0XXT	FN5420-32-33-E2FXT	MAPP0027C	MAPG0027C	MAPW0027C
18.5	33	DVSP0035E	DVSG0035E	DVSW0035E	FN5420-38-92-E0XXT	FN5420-38-33-E2FXT	MAPP0034C	MAPG0034C	MAPW0034C
22	40	DVSP0045E	DVSG0045E	DVSW0045E	FN5420-45-92-E0XXT	FN5420-45-34-E2FXT	MAPP0044C	MAPG0044C	MAPW0044C
30	55	DVSP0055E	DVSG0055E	DVSW0055E	FN5420-60-92-E0XXT	FN5420-60-34-E2FXT	MAPP0052C	MAPG0052C	MAPW0052C
37	66	DVSP0080E	DVSG0080E	DVSW0080E	FN5420-75-99-E0XXT	FN5420-75-35-E2FXT	MAPP0066C	MAPG0066C	MAPW0066C
45	80	DVSP0080E	DVSG0080E	DVSW0080E	FN5420-90-99-E0XXT	FN5420-90-35-E2FXT	MAPP0083C	MAPG0083C	MAPW0083C
55	97	DVSP0110E	DVSG0110E	DVSW0110E	FN5420-110-99-E0XXT	FN5420-110-35-E2FXT	MAPP0103C	MAPG0103C	MAPW0103C
75	130	DVSP0130E	DVSG0130E	DVSW0130E	FN5420-145-99-E0XXT	FN5045-180-99	MAPP0128C	MAPG0128C	MAPW0128C
90	160	DVSP0160E	DVSG0160E	DVSW0160E	FN5420-180-99-E0XXT	FN5045-180-99	MAPP0165C	MAPG0165C	MAPW0165C
110	195	DVSP0200E	DVSG0200E	DVSW0200E	FN5420-200-99-E0XXT	FN5045-260-99	MAPP0208C	MAPG0208C	MAPW0208C
132	230	DVSP0250E	DVSG0250E	DVSW0250E	FN5420-250-99-E0XXT	FN5045-260-99	MAPP0240C	MAPG0240C	MAPW0240C
160	280	DVSP0305E	DVSG0305E	DVSW0305E	FN5420-300-99-E0XXT	FN5045-410-99	MAPP0320C	MAPG0320C	MAPW0320C
200	350	DVSP0365E	DVSG0365E	DVSW0365E	FN5420-400-99-E0XXT	FN5045-410-99	MAPP0403C	MAPG0403C	MAPW0403C
250	440	DVSP0515E	DVSG0515E	DVSW0515E	FN5420-480-99-E0XXT	FN5045-480-99	MAPP0482C	MAPG0482C	MAPW0482C
280	490	DVSP0600E	DVSG0600E	DVSW0600E	FN5420-630-99-E0XXT	FN5045-660-99	MAPP0636C	MAPG0636C	MAPW0636C
315	550	DVSP0600E	DVSG0600E	DVSW0600E	FN5420-630-99-E0XXT	FN5045-660-99	MAPP0636C	MAPG0636C	MAPW0636C
335	590	DVSP0600E	DVSG0600E	DVSW0600E	FN5420-630-99-E0XXT	FN5045-660-99	MAPP0636C	MAPG0636C	MAPW0636C
355	620	–	–	–	FN5420-710-99-E0XXT	FN5045-660-99	MAPP0636C	MAPG0636C	MAPW0636C
400	700	–	–	–	FN5420-800-99-E0XXT	FN5045-750-99	MAPP0786C	MAPG0786C	MAPW0786C
450	790	–	–	–	FN5420-1000-99-E0XXT	FN5045-880-99	MAPP0850C	MAPG0850C	MAPW0850C
500	880	–	–	–	FN5420-1000-99-E0XXT	FN5045-1200-99	MAPP1000C	MAPG1000C	MAPW1000C
560	980	–	–	–	FN5420-1000-99-E0XXT	FN5045-1200-99	MAPP1000C	MAPG1000C	MAPW1000C
630	1100	–	–	–	FN5040-1200-99	FN5045-1200-99	MAPP1200C	MAPG1200C	MAPW1200C
670	1170	–	–	–	FN5040-1200-99	FN5045-1200-99	MAPP1200C	MAPG1200C	MAPW1200C
710	1240	–	–	–	–	–	–	–	–
800	1400	–	–	–	–	–	–	–	–
1000	1740	–	–	–	–	–	–	–	–
1200	2100	–	–	–	–	–	–	–	–
1320	2500	–	–	–	–	–	–	–	–

Sinexcel Active Harmonic Filter (AHF)

Harmonics are extra frequencies that when present in an electrical system, cause the current and voltage to be distorted and deviate from sinusoidal waveforms. Harmonic currents are caused by non-linear loads connected to the distribution system (rectifiers, discharge lighting, or saturated magnetic devices). A load is said to be non-linear when the current it draws does not have the same waveform as the supply voltage.

Variable Speed Drives are prolific creators of harmonics in electrical systems and as a result, most of the harmonic mitigation effort focuses on the input side and output side of a VSD. Harmonics are very harmful within an electrical system and can have serious consequences. The presence of harmonics reduces the life of equipment. It is possible that the investment that you made in your motors & drives will not be realised if they are damaged and need replacing before their expected life span. This can be very expensive. Harmonic mitigation is taking action to minimise the presence of harmonics in your electrical system and can achieve great cost savings as well as comply with the Australian standards for harmonic voltage distortion.

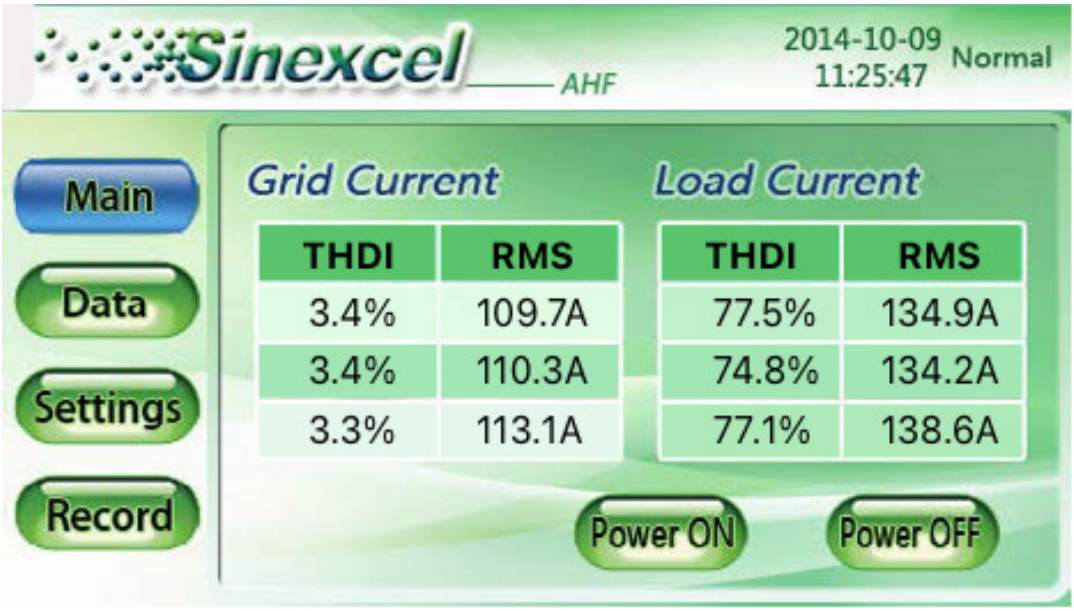
- SiC-MOSFET Technology
- Unprecedented Performance
- 3 & 4 Wire Options in Each Unit
- Wall Mounted Solutions
- Load Balancing

The Sinexcel AHF (Active Harmonic Filter)

Sinexcel have applied new generation thinking and innovative design principles to create a new range of Active Harmonic Filters that have redefined what is possible from a cost vs performance vs space perspective. Their performance and ease of use is unsurpassed, able to compensate the 2nd to the 50th harmonic order or the simultaneous compensation of all 50 harmonic orders in real time!

Operating with up to 99% efficiency, the Sinexcel AHF offers instantaneous, dynamic harmonic compensation, ideal for the challenging demands of modern electrical environments. The Sinexcel AHF are a compact, light-weight and modular design, available in wall mounting and rack/cabinet configurations. The Sinexcel AHF has set the standards for all others to follow.

AHF in Action



This screen shot is from a Sinexcel AHF unit operating at one of our customer locations.

Please note:

- The Load Current THDI, which is the Total Harmonic Distortion Current across the 3 phases at the site. It is between 74.8% and 77.5% which is very high.
- The Grid Current THDI, which is the Total Harmonic Distortion Current across the 3 phases after the Sinexcel Active Harmonic Filter has compensated the current. It is between 3.3% and 3.4% which is a significant reduction in harmonics. This is an exceptional result and indicative of the advanced performance of the Sinexcel 3-level topology and the algorithms employed by Sinexcel engineering.
- The second benefit is the reduction in the RMS current as shown by the Load and Grid RMS figures in the display. This is achieved by the injection of the compensating current from the Sinexcel Active Harmonic Filter to reduce the damaging effects of the load harmonics and the natural by-product of this is the correcting of the distortion power factor.

Unprecedented Performance

- Up to 150A capability from a single wall-mounted module – can be parallel connected for unlimited capacity.
- Up to 150A capability from a single rack-mounted module.
- Up to 1350A capability from a single cabinet solution

FUSECO

The AHF Range

Wall-Mount Solutions

25A & 35A
440W x 150D x 485H (mm)
Weight: 18kg

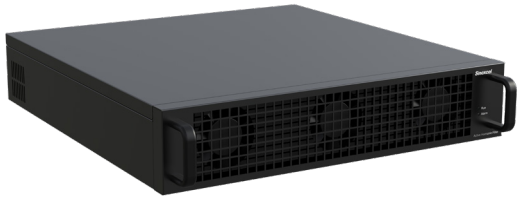
50A & 60A
500W x 180D x 540H (mm)
Weight: 23kg

75A
500W x 190D x 586H (mm)
Weight: 28kg

100A (P5 Series)
500W x 88D x 520H (mm)
Weight: 18kg

150A (P5 Series)
500W x 100D x 520H (mm)
Weight: 25kg

300A (P5 Series)
500W x 220D x 646H
Weight: 50kg



Rack-Mount Solutions

25A & 35A
440W x 490D x 150H (mm)
Weight: 18kg

50A & 60A
500W x 515D x 180H (mm)
Weight: 23kg

75A
500W x 586D x 190H (mm)
Weight: 28kg

100A (P5 Series)
500W x 520D x 88H (mm)
Weight: 18kg

150A (P5 Series)
500W x 520D x 100H(mm)
Weight: 25kg

300A (P5 Series)
500W x 646D x 220H
Weight: 50kg

The AHF Range

Flexi-Cabinet Series

Capacity: Up to 1350A (9x 150A)
800W x 800D x 2200H (mm)

Features
- Large Capacity
- Top or Bottom Cable Entry
- IP21 or IP31

Top Vent Series

Capacity: Up to 600A (4x 150A)
800W x 600D x 2200H (mm)

Capacity: Up to 750A (5x 150A)
1000W x 600D x 2200H (mm)

Capacity: Up to 900A (6x 150A)
1200W x 600D x 2200H (mm)

Features
- Only 600mm deep
- Flush Against the Wall
- Top Ventilated
- Top or Bottom Cable Entry
- IP21 or IP31

IP54 Series

Capacity: Up to 450A (3x 150A)
800W x 600D x 2000H (mm)
Note: Flush Against the Wall, Top Vent
2 x 300mm Doors, 400mm Plinth

Capacity: Up to 900A (6x 150A)
700W x 900D x 1800H (mm)

Capacity: Up to 1200A (8x 150A)
1000W x 1000D x 2200H (mm)

Features
- Flush against the wall (450A)
- Bottom Cable Entry
- IP54

FUSECO

Features & Benefits

SiC-MOSFET Technology

- Sinexcel are the first to implement silicone carbide technology
- Operates at 40kHz (up to 95kHz when required)

Compact Size and Light Weight

- Can be wall mounted and installed in small spaces.
- Wall mounted units can be parallel connected for unlimited capacity.

Harmonics Compensation Capability

- Harmonics filtering performance THDi < 5%.
- Selection of every harmonic to the 50th order.
- Filter up to 50 harmonics simultaneously.
- Harmonic filtering levels [%] can be pre-configured.
- Resonance protection by means of pre-configuring harmonic filtering levels for the potential resonance zones.
- Capable of suppressing ripple currents effectively and promote a high compensation precision for the output waveform with respect to the sinusoidal waveform.
- Unique 3-level topology based on a zero voltage transformation design & incorporating a high frequency inductor technology results in up to 98.5% efficiency.

99% Efficiency

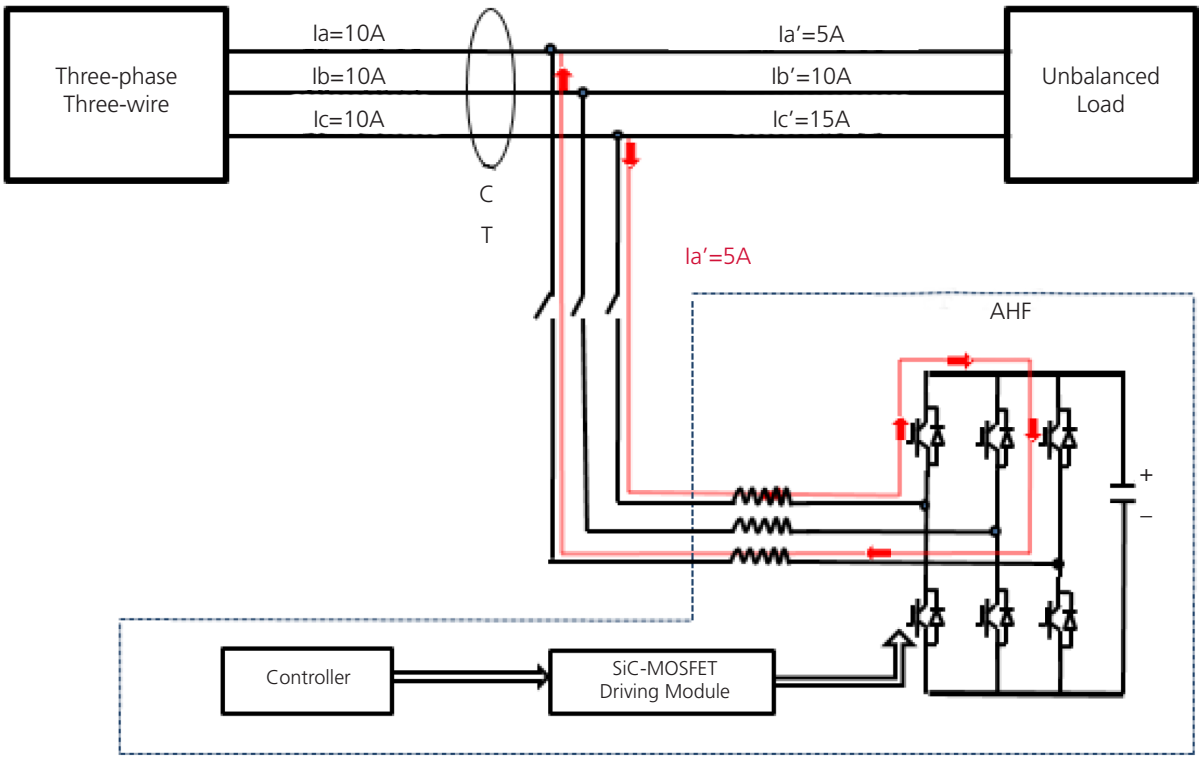
- Unprecedented performance
- 0-110% compensation of each harmonic from the 2nd to the 50th harmonic!

Load Balancing and Reactive Power

- Capable of measuring each phase and then redirecting the existing load current to balance the phases.
- Also capable of using their remaining capacity to dynamically inject reactive power to correct the power factor.
- It is possible for the user to program the unit to prioritise load balancing or reactive power, depending on the application.

Available in Various Configurations

- 3-Wire and 4-Wire versions available
- Available in 690V
- Available in IP20, IP21, IP31 and IP54 versions to suit a wide variety of industry applications



User-friendly Interface and Monitoring

- Very easy to operate.
- Online monitoring and programming available. Presents information in terms of numerical data, waveform analysis, etc.
- Incorporates a backlit HMI graphical user interface, offering direct control, complete configuration, monitoring and harmonic analysis of the AHF without the need of a PC.

Flexibility and Ease of Commissioning

- Designed to be a 'Plug and Play' experience for the user.
- Available in wall mounting or rack/cabinet options.
- Unlimited parallel operation of modular AHF units in combination as per system requirements.
- Installation & commissioning process is the industry benchmark for simplicity and ease of use.

Extended Warranty Available

Standards

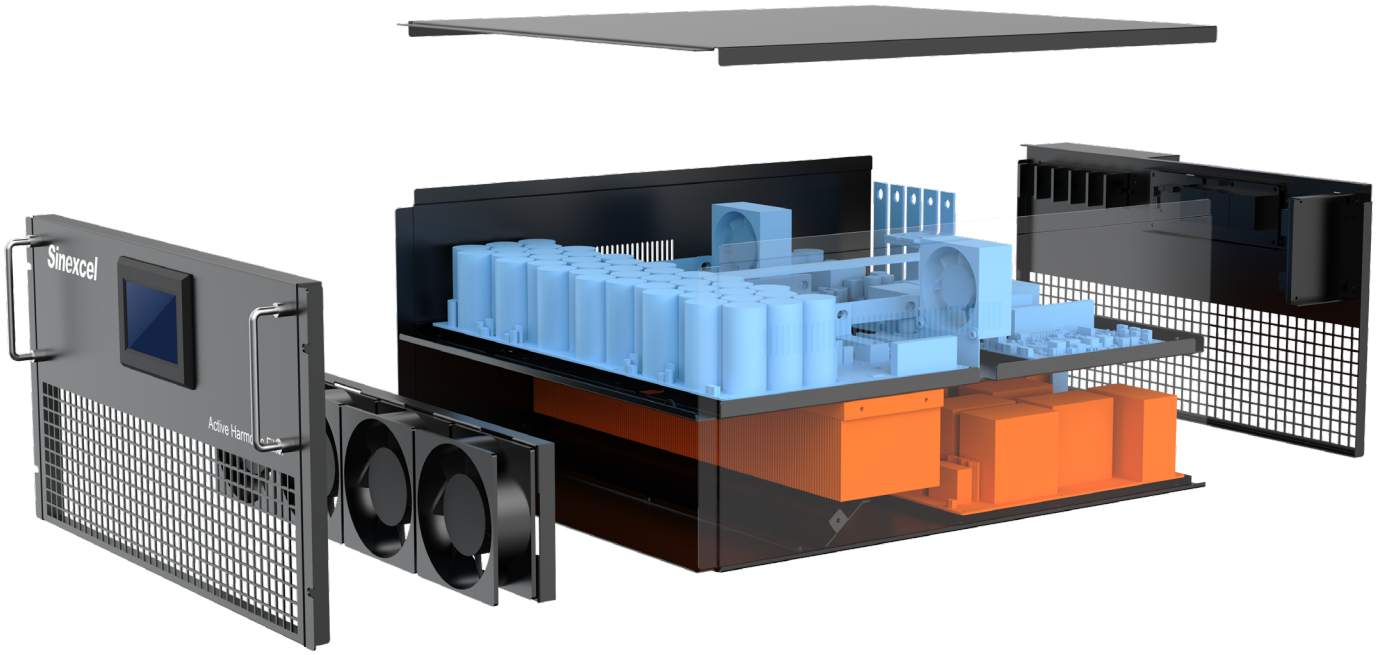
IEC61000 / IEC60146 / EN55011 / EN50091 / IEEE519

Measurements

- Provides a comprehensive set of measurement data for analysis, such as:
- Network RMS voltages and currents
- Network Voltage and current distortions (THDu and THDi)
- Total RMS load currents and THDi
- System frequency
- Load factor
- Compensated RMS currents
- Comparison of PF (before and after)
- Graphical waveform of network voltages and currents, load and compensated currents
- Harmonic spectrum for network and load currents, from 2nd to 50th harmonic order

Designed for Efficiency and Minimal Maintenance

- Minimises dust ingress
- Electronic components separated from heat producing components and housed in their own sealed compartment, resulting in greater protection from the effects of heat and dust ingress.
- Optimum heat dissipation
- Heat sinks, IGBT's, inductors and other heat producing components housed in a separate compartment optimised for efficient ventilation and cooling.



Case Study - Wallumbilla Gas Hub

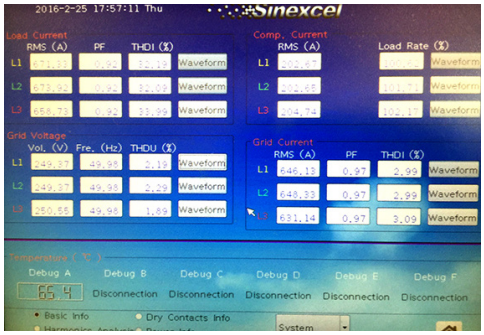
Located in remote central Queensland, the Wallumbilla Gas Hub is a major part of the Australian natural gas infrastructure network. The function of this facility is to compress the natural gas that is extracted from the ground in that area and pipe it to Brisbane and Rockhampton. To comply with the requirements, Fuseco supplied a Sinexcel 200A Active Harmonic Filter in an IP54 cabinet due to its exceptional performance, small footprint and flexibility.

The Challenge

Part of the design specification was a defined electrical harmonic level for the site. The majority of the load comprises of VSD's and the Engineering team decided to use an Active Harmonic Filter to mitigate the harmonics at the main switchboard and comply with the requirements. The electricity supply to the site consists of the local grid and two generators. When running at full load all three of these supplies are required to power the site.

The Solution

Fuseco selected the Sinexcel 200A Active Harmonic Filter (AHF) due to its exceptional performance, small footprint and flexibility. In this case an IP54 version was installed to comply with the customer's requirements. One of the challenges of this site was that the incoming supply was soft and unpredictable which necessitated the use of two large generators on-site. It was deemed important for the AHF to be able to operate efficiently in such an environment that often had three independent synchronised power supplies.



The Outcome

The results were immediate and the performance of the AHF was above and beyond the requirements of the specification, the Supply Authority and the manufacturer of the two generators.

If we refer to the screen shot from the AHF's touch screen post installation, we can note the following points:

1. The harmonic content of the load is 32%, which is quite typical of VSD loads (top left)
2. The Sinexcel AHF mitigated the load harmonics down to approx. 3% (bottom right)
3. As a result of the compensation by the AHF the corresponding grid voltage harmonics is approx. 2% (bottom left)

The Sinexcel AHF - Benefits

Sinexcel have applied new generation thinking and innovative design principles to create a new range of Active Harmonic Filters that have redefined what is possible from a cost vs performance vs space perspective. Their performance and ease of use is unsurpassed, able to compensate the 2nd to the 50th harmonic order or the simultaneous compensation of all 50 harmonic orders in real time! Operating with 97% efficiency, the Sinexcel AHF offers instantaneous, dynamic harmonic compensation, ideal for the challenging demands of modern electrical environments. The Sinexcel AHF are a compact, light-weight and modular design, available in wall mounting and rack/cabinet configurations. The Sinexcel AHF has set the standards for all others to follow.

- Compact Size and Light Weight.
- Harmonics Compensation Capability - Compensates 2nd to 50th harmonic order or simultaneous compensation of all 50 harmonic orders.
- Algorithm Intelligence.
- 3-Level Topology.
- Ease of Installation and Commissioning ('Plug and Play')
- User-friendly Interface and Monitoring.
- Also available in 690V.
- 1 year warranty.
- Complies with IEC61000 / IEC60146 / EN55011 / EN50091 / IEEE519

Installation of Current Transformers (CT's)

The current transformer (CT) plays a key role in the normal operation of an AHF/SVG, so the correct selection and installation of CT's is vital. In a 3-phase 3-wire system, two CT's are required, each installed on phase A and phase C; while in 3-phase 4-wire system, three CT's are required, each installed on the circuits of phase A, phase B and phase C.

In the AHF/SVG module, the allowable ratio of an external CT is 50:5 (min) – 30,000:5 (max). The ratio can be selected between the two levels in accordance with the actual load current. When selecting the CT ratio, the actual magnitude of load current should be taken into consideration so as to obtain a more accurate compensation. Generally, a selection of x1.5 of the maximum current during normal operation is preferred, and an appropriate level of margin is recommended to ensure more accurate harmonic suppression.

For example, suppose the maximum load current detected is 1,000A. The best selection of CT ratio is between

1,500:5 to 2,000:5. The accuracy of the external CT should be above level 0.2 (solid core) or above level 0.5 (split core). A lower degree of accuracy may affect the compensation accuracy.

Solid Core CT's

SERIES	DESCRIPTION	RATIO RANGE (5A Secondary)	BUSBAR (mm)	CABLE DIAMETER (mm)
TUC30 Series	Solid Core	200-600	30 x 10	25
TUC40 Series	Solid Core	50-1000	40 x 10	32
TUC50 Series	Solid Core	400-2000	50 x 10	40
TUC60 Series	Solid Core	400-2000	60 x 10	51
TUC80 Series	Solid Core	400-2500	80 x 30	65
TU100PSH Series	Solid Core	400-5000	100 x 30 80 x 50	85

Split Core CT's

SERIES	DESCRIPTION	RATIO RANGE (5A Secondary)	BUSBAR (mm)	CABLE DIAMETER (mm)
TA30P Series	Split Core	100-400	30 x 20	20
TA60P Series	Split Core	250-1000	60 x 30	30
TA80P Series	Split Core	250-1000	80 x 50	50
TA100P Series	Split Core	250-2000	100 x 80	80
TA125P Series	Split Core	500-3000	125 x 80	80
TA160P Series	Split Core	500-5000	160 x 80	80

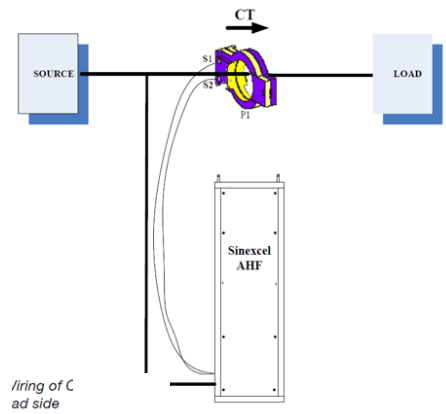
Installation on the Load Side

As shown in the figure below, the signal is sent to the AHF/SVG by a CT installed at the load side. In a 3-phase 4-wire system, one set of 3 CT's is required to detect the current of the harmonic source. The polarity of the CT's must be correct and the phase rotation must also be correct.

Installation on the Supply Side

If it's not possible to install the CT's on the load side, they can be installed on the supply side. When using one module you can have one set of CT's on the supply side.

However when using multiple modules, a second set of CT's must be connected in parallel on the cables supplying the AHF/SVG to measure the combined output of the modules therefore subtracting it from the main measuring CTs as per the diagram below.



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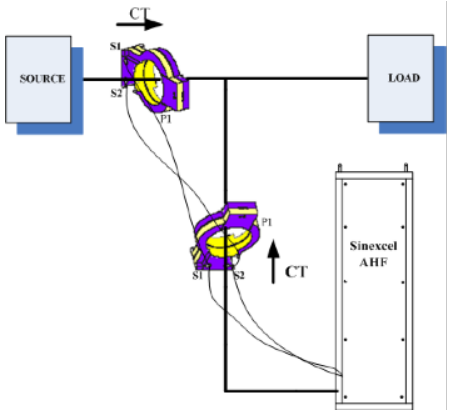


Please note that the above diagrams are indicative of some common installations. For other configurations, please contact Fuseco.

FUSECO

MTE Matrix® AP Filters (5% THD)

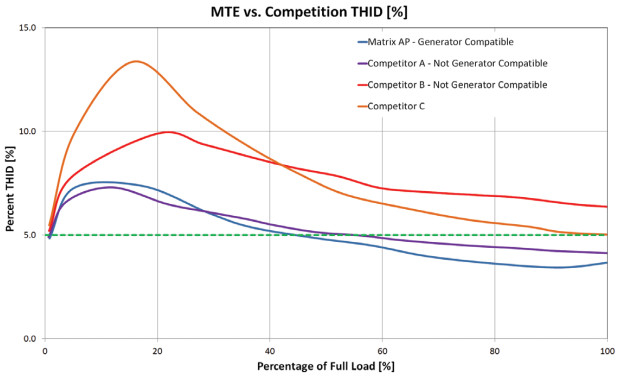
The key to success: Adapt.

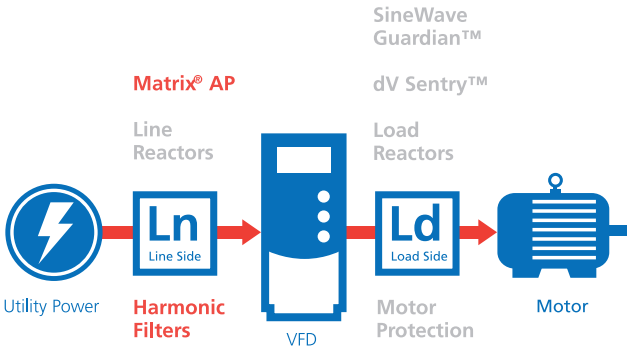
Adaptive Passive Technology for superior harmonic mitigation at varying loads.

The MTE Matrix AP is the most advanced passive filter on the market today. Most traditional filters work fine at 100% power load but severely under-perform at lower loads.

The MTE Matrix AP has Adaptive Passive Technology that virtually eliminates harmonic distortion by adapting to various power loads. Its unique design generates less heat, is easy to install and maintain and is generator compatible.

It delivers better THDi performance, increases the reliability and service life of electric installations, increases energy efficiency and allows you to meet Power Quality standards such as IEEE 519-2022.





Key Features:

- **5% THDi Performance**
  The MTE Matrix AP offers equal to or better than 5% THDi performance at full load current and starts to achieve that 5% performance from loads as low as 40% of full load current.
- **Adaptive Passive Technology**
  The Matrix AP features MTE's patented Adaptive Passive Technology for superior harmonic mitigation and better THDi performance over a wider load range.
- **3 Year Warranty (industry leading)**
- **Reduce Maintenance Costs**
  Extends the service life of electrical equipment due to the virtual elimination of CEMF and the skin effect, the Matrix AP extends the life of electrical equipment, especially transformers and motors.
- **Ease of Installation**
  Passive filters are virtually 'Plug and Play'.
- **Reduces Downtime**
  Alleviates system downtime by preventing blown fuses and tripped circuit breakers.
- **Intelligent Design - Less Cost to Install**
  The unique design of the MTE Matrix AP filter incorporates only one reactor which has the input and the shunt coil on the same core. This requires less cabling and connections by the installer, therefore less cost to install.
- **Enclosed Filters Do Not Require Fans**
  When the Matrix AP filters are built within an enclosure to comply with IP20 or IP21 requirements, their unique patented design results in such low heat loss that they do not require fan assisted cooling. This design removes the traditional risk of filter damage in the event of a fan malfunction.
- **Better Power Factor and Compatibility with Generators**

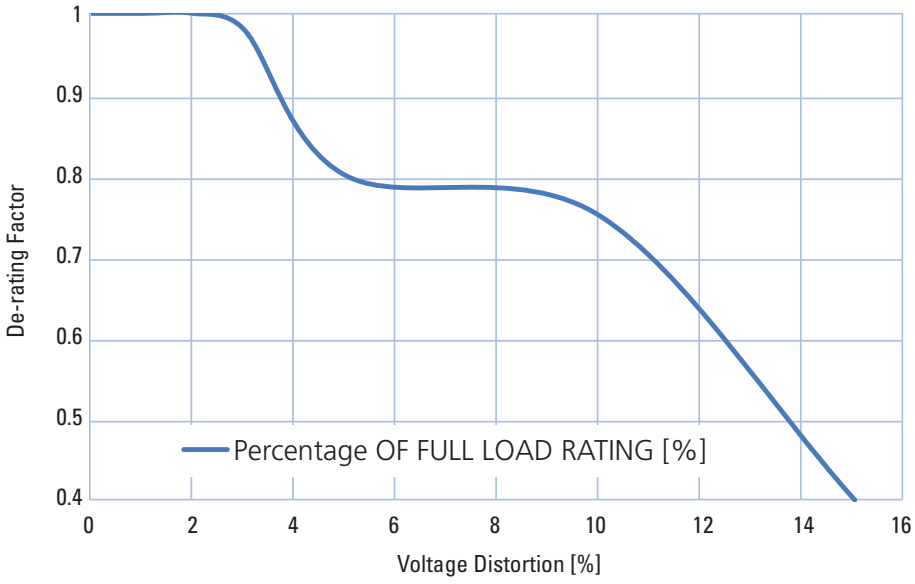
Performance Specifications

Input Voltages	480V 60Hz 380V/400V/415V 50Hz 600V 60Hz 690V 50Hz
Total Harmonic Current Distortion	8% Max at 30% Load 5% Max at Full Load
Load	6 pulse rectifier
Input Voltage	Nominal voltage VAC +/– 10%, 3 Phase
Frequency	Nominal Frequesncy +0.75Hz
Insertion loss at full load	<4%
Efficiency	97% – 99%
Operating Temperature	–40°C to +50°C Open Panel Filters –40°C to +40C°–45°C Enclosed Filters –40°C to +90°C Storage
Altitude without Derating	1000 meters (3,300 feet)

Performance with Unbalanced Line Voltage (Typical)

All Components at Nominal Values and Worse Case Service Conditions	
100% Load	
Nominal THDi	4.2%
1% Unbalance	4.4%
2% Unbalance	4.8%
3% Unbalance	5.4%
30% Load	
Nominal THDi	7.0%
1% Unbalance	7.3%
2% Unbalance	7.9%
3% Unbalance	8.8%

Voltage Distortion De-Rating Curve



This plot assists in proper de-rating of a Matrix AP Harmonic Filter in environments with a given voltage distortion. Example: In a system with 10% voltage distortion, a Matrix filter will need to be oversized by 25% to obtain the same performance as an appropriate filter in a 0% distortion environment.

Applications for Passive Filters

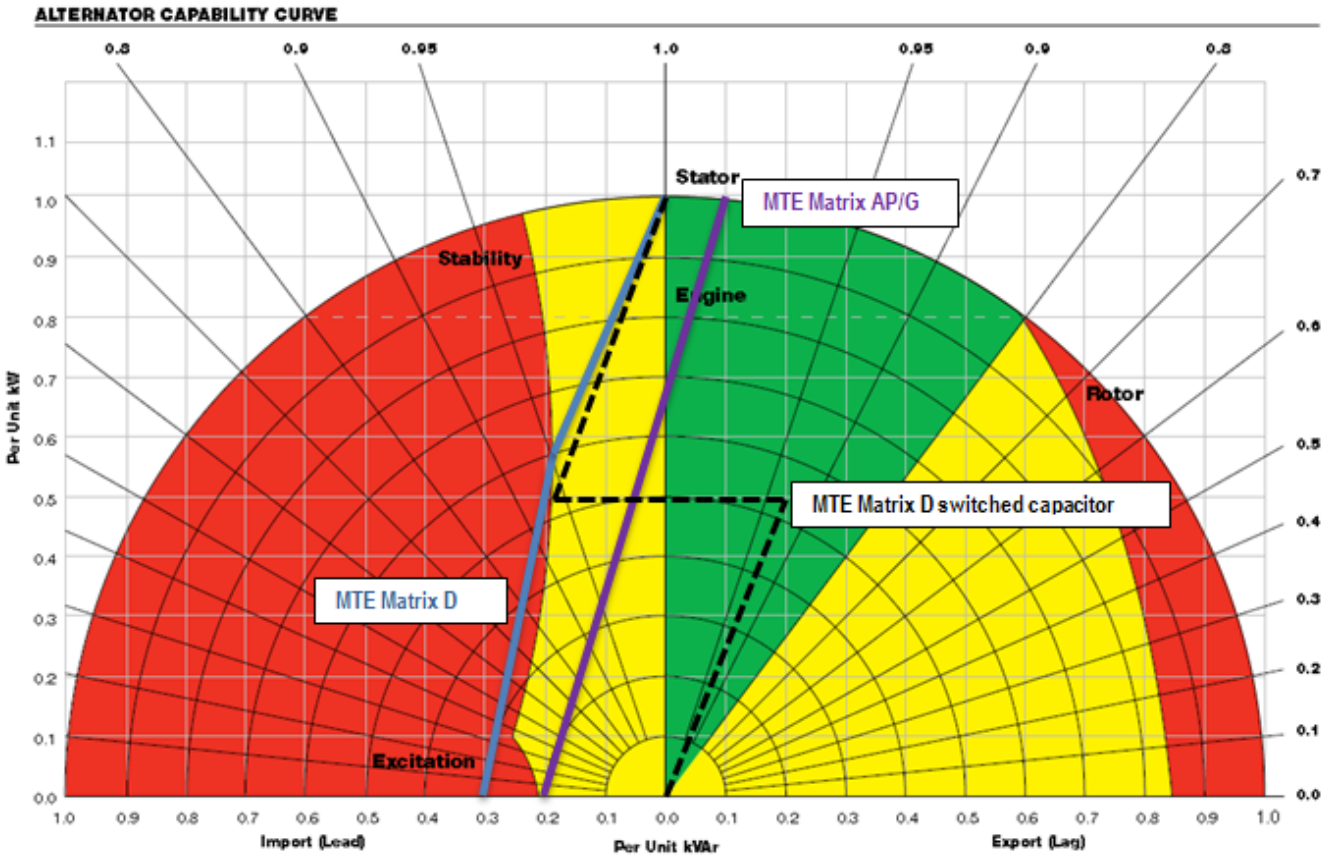
Passive Harmonic Filters for Generator Power Supply Applications

The ability of a generator to handle leading power factor loads is often raised as a concern. Although it is true that excessive capacitive reactive power can cause voltage regulation, excitation control and other issues with a generator's operation, generators can tolerate a leading power factor at certain levels. All generator manufacturers publish reactive power capability curves for their generators from which a user can determine the acceptable levels of reactive power for the generator, both capacitive and inductive.

Six pulse VSD loads operated with a passive harmonic filter have characteristics that can impose a leading power factor (kVAr) onto the power source. While these loads are typically not a problem for utility power sources, leading power factor can cause a generator to shut down or prevent certain loads from operating properly under generator power. Control systems used in generators are very sensitive to capacitive kVAr from loads and exceeding their limit will result in the generator shutting down due to over-voltage.

At the same time, VSD manufacturers have started to use Passive Harmonic Filters to limit the harmonic current distortion feeding back to the power source. A Passive Harmonic Filter can produce a leading power factor at light loads and this can be very disruptive to generator operation. At light loads there may be excess filter capacitance, causing a leading power factor on the generator. A utility supply simply absorbs the reactive power output because it is extremely large relative to the filter system. The ideal solution is to choose a harmonic filter that will not adversely affect the generator's operation.

To work with generators, the harmonic filter's capacitance must not exceed the alternator's ability to absorb reverse kVAr loading. The ideal choice should be a filter that has a low kVAr (15% of its kW rating) such as the MTE Matrix AP filter. The Matrix AP filter possesses better control of leading power factor and will always be in the 'generator safe operating area'. Due to the fact that the Matrix AP filter operates in a safe power factor range for gen-sets, most applications do not require the capacitors switched in and out. This results in an increase in the life span of the capacitors.



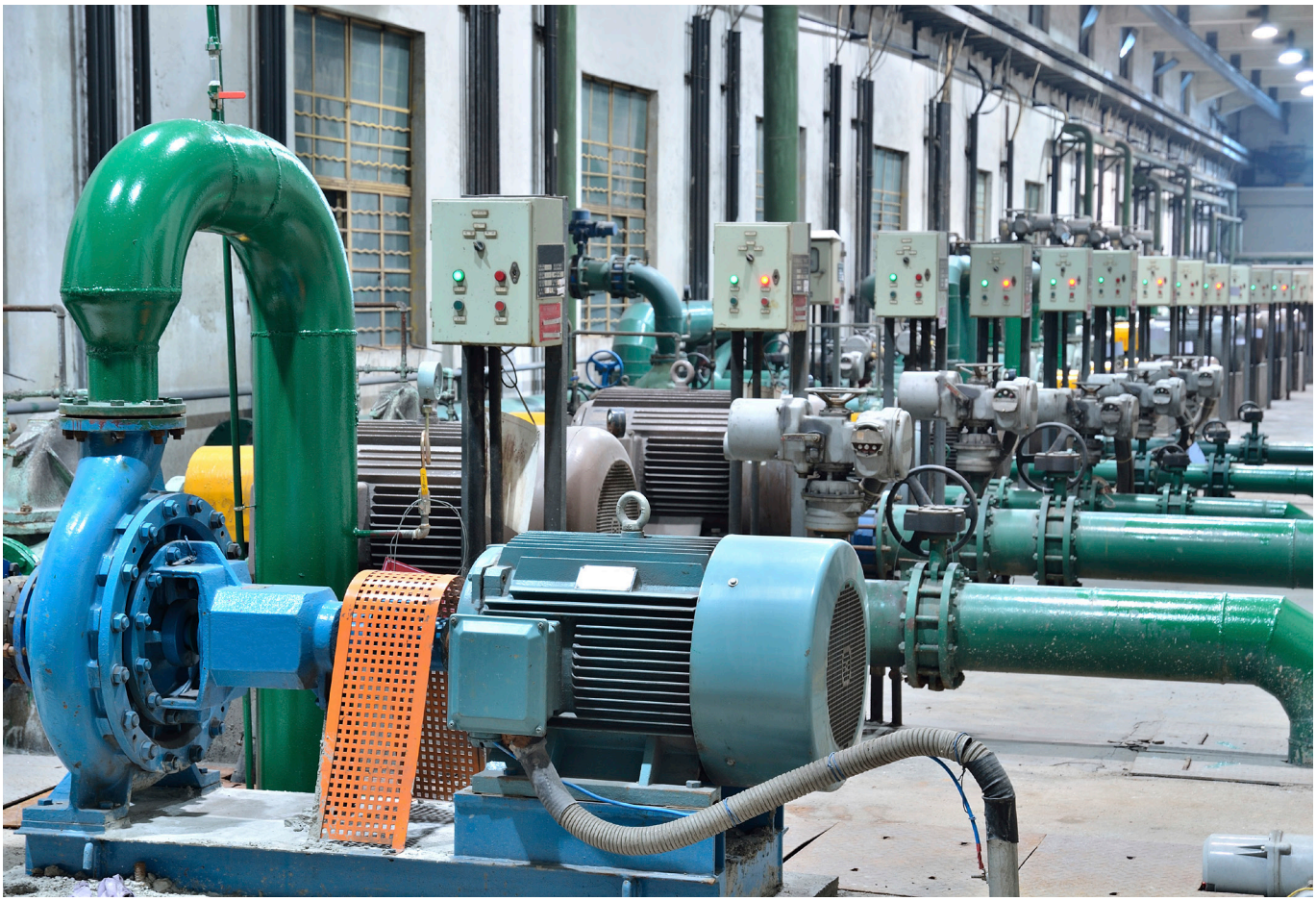
Irrigation and Pumping Station Applications

The use of VSDs in the electrical systems of irrigation and pumping stations has grown by 60% in the last five years. This clearly indicates that the concept of saving energy is being accepted and adopted rapidly within the industry.

The remote area irrigation systems and pumping stations equipped with VSDs often experience problems related to harmonics on grid or generator supply. This often leads to disturbances in the supply systems of nearby residential areas. For these remote sites, achieving the mitigation of harmonics in the electrical system can be a big challenge.

Solutions for Harmonic Mitigation and the Protection of Motors

- As a general guide, for cable runs up to 30m, reactors can be a cost effective solution.
  Refer to page 158 for information on our range of MTE reactors
- For cable runs of 30m – 100m, dV/dt filters are a suitable choice and also provide the added benefit of protecting motors from long lead peak voltages and voltage spikes.
  Refer to page 163 for information on our range of MTE dV Sentry dV/dT Filters
- For cable runs above 100m, sine wave filters are a great choice. With their ability to reduce eddy currents, stray flux losses, bearing currents, torque ripple and voltage wave reflection, sine wave filters provide the ultimate motor protection.
  Refer to page 160-162 for information on our range of Sine Wave Filters
- The design of the MTE Matrix AP passive filters is suitable for such remote applications as they are extremely robust, reliable and virtually ‘plug and play’. The specially designed capacitors with screw on terminals provide reliability and require minimal maintenance. Furthermore, they mitigate the harmonics (THDi) to <5%.
  Refer to page 154-155 for information on the MTE Matrix AP Filters
- For IP54 applications, the TCI HG7 series of passive harmonic filters is ideal.



FUSECO

MTE RL Series

Peace of mind included.

Reactors provide a cost effective solution to power quality degradation due to the increase in non-linear loads such as those produced by variable speed drives (VSDs).

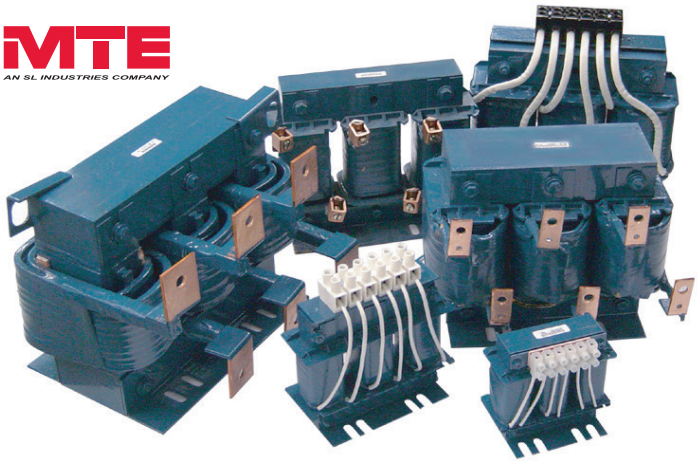
The MTE RL series of line and load reactors are best-in-class power quality units with a long history of proven performance. Rugged and robust, they are unequalled in absorbing power line disturbances that can damage or shut down VSDs and other sensitive equipment. They are built to withstand even the most severe power spikes. They work on both the line side and load side to give you an easy solution that reduces nuisance tripping, reduces harmonic distortion and minimises long lead effects.

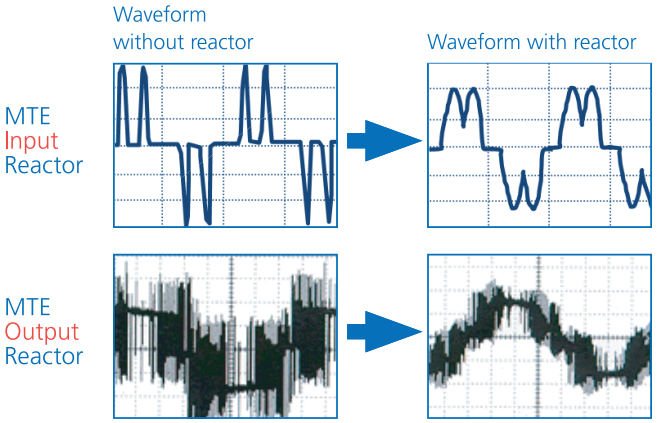
The RL series reactors are a robust, high performance filtering solution for virtually any 4 or 6-pulse rectifier or power conversion unit. There is no need to de-rate these reactors. They are harmonic compensated and protected to assure optimum performance in the presence of harmonics, and can help you meet IEEE 519-2022.

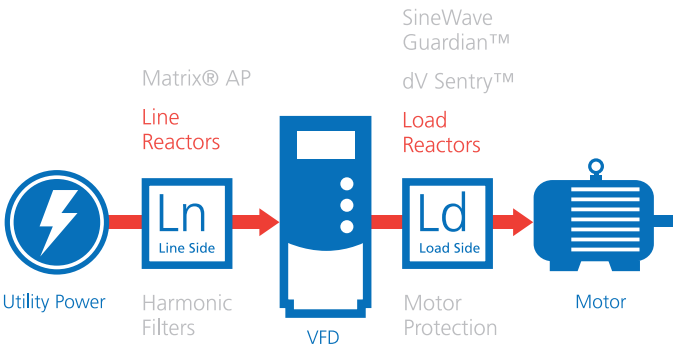
Improved power quality, enhanced productivity and complete peace of mind are easy with RL line/load reactors.

Key Features:

- **Available for 1A to 1,500A applications**
- **Impedance options 3% and 5%**
- **Most robust, highest continuous service factor**
- **Low watts loss**
- **Ease of installation**
- **Reduces energy costs**
- **Reduces audible noise**
- **Available in multiple cabinet designs IP00, IP20 & NEMA 3R**
- **Performance and durability that is unmatched by the competition**
- **3 year warranty (industry leading)**







Preliminary Performance Specifications

Impedence Levels	3% and 5%
Continuous Service Factor	Reactors rated 1 to 750 Amps – 150% of rating Reactors rated above 750 Amps – 125% of rating
Overload Rating	200% of rated for 30 minutes 300% of rated for 1 minute
Voltage Range	208V – 690V
Current Range	1A – 1,500A
Temperature Rise	135°C
Ambient Temperature	–40°C to 50°C
Altitude Maximum	1,000 meters
Fimda,emta;Freqiemcu	50/60Hz
Inductance Curve	100% at 100% Current 100% at 150% Current 50% at 350% Current

MTE RL Reactor Selection Table

OPEN (IP00) PART NUMBER	AMP RATING	INDUCTANCE (mH)	WATTS LOSS	OPEN WEIGHT (kg)	SIZE (mm) H x W x D
RL-00102	1	50	12.8	0.95	89 x 97 x 31
RL-00103	1	36	11.9	0.95	89 x 97 x 31
RL-00201	2	12	7.5	1.81	104 x 112 x 71
RL-00202	2	20	11.3	1.81	104 x 112 x 71
RL-00403	4	9	20	2.26	104 x 112 x 86
RL-00404	4	12	21	2.72	104 x 112 x 86
RL-00803	8	5	25.3	4.98	122 x 152 x 86
RL-00804	8	7.5	28	5.89	122 x 152 x 86
RL-01202	12	2.5	31	4.53	127 x 152 x 84
RL-01203	12	4.2	41	8.16	127 x 152 x 84
RL-01802	18	1.5	43	5.44	135 x 152 x 89
RL-01803	18	2.5	43	7.25	155 x 206 x 102
RL-02502	25	1.2	52	6.35	147 x 183 x 89
RL-02503	25	1.8	61	9.07	147 x 183 x 109
RL-03502	35	0.8	54	7.25	147 x 183 x 102
RL-03503	35	1.2	54	13.6	188 x 229 x 119
RL-04502	45	0.7	62	12.7	188 x 229 x 119
RL-04503	45	1.2	65	17.69	185 x 229 x 135
RL-05502	55	0.5	67	12.24	178 x 229 x 135
RL-05503	55	0.85	71	18.59	178 x 229 x 152
RL-08002	80	0.4	86	14.96	183 x 229 x 165
RL-08003	80	0.7	96	27.66	216 x 274 x 173
RL-10002	100	0.3	84	16.78	185 x 229 x 173
RL-10003	100	0.45	108	33.56	210 x 274 x 156
RL-13002	130	0.2	180	19.5	183 x 229 x 173
RL-13003	130	0.3	128	29.02	216 x 279 x 156
RL-16002	160	0.15	149	23.13	211 x 274 x 152
RL-16003	160	0.23	138	32.65	216 x 292 x 229
RL-20002B14	200	0.11	168	24.49	191 x 229 x 211
RL-20003B14	200	0.185	146	45.35	211 x 274 x 254
RL-25002B14	250	0.09	231	36.28	216 x 274 x 229
RL-25003B14	250	0.15	219	56.69	284 x 366 x 262
RL-32002B14	320	0.075	264	46.26	229 x 274 x 254
RL-32003B14	320	0.125	351	72.57	286 x 366 x 267
RL-40002B14	400	0.06	333	53.52	286 x 381 x 292
RL-40003B14	400	0.105	293	67.58	286 x 366 x 318
RL-50002	500	0.05	340	53.52	292 x 366 x 292
RL-50003	500	0.085	422	95.25	292 x 366 x 338
RL-60002	600	0.04	414	79.37	286 x 366 x 305
RL-60003	600	0.065	406	122.47	286 x 366 x 381
RL-75002	750	0.029	630	86.18	292 x 366 x 318
RL-75003	750	0.048	552	120.2	368 x 366 x 356
RL-85002B14	850	0.027	930	97.52	394 x 452 x 394
RL-85003B14	850	0.042	1133	142.88	394 x 452 x 445
RL-90002B14	900	0.025	1020	97.52	394 x 452 x 394
RL-90003B14	900	0.04	1365	142.88	401 x 452 x 434
RL-100002B14	1000	0.022	1090	97.52	394 x 452 x 394
RL-100003B14	1000	0.038	1500	142.88	401 x 452 x 445
RL-120002B14	1200	0.019	1130	124.73	394 x 452 x 452
RL-120003B14	1200	0.03	1550	176.9	391 x 442 x 465
RL-140002	1400	0.016	1523	238.13	432 x 483 x 483
RL-140003	1400	0.027	1680	385.55	432 x 559 x 559
RL-150002	1500	0.015	1671	306.17	432 x 429 x 406
RL-150003	1500	0.025	1815	408.23	432 x 559 x 559

Impedance Rating:

- 3% impedance reactors are typically sufficient to absorb power line spikes and motor current surges. They will prevent nuisance tripping of drives or circuit breakers in most applications. They are also suitable for use as motor chokes/load reactors.
- 5% impedance reactors are best for reducing harmonic currents and frequencies. Use them when you must reduce VFD drive generated harmonics, and to reduce motor operating temperature, or to reduce motor noise. For complete IEE-519 compliance for VSD's please see the AP Matrix Passive Harmonic Filters on pages 154-155 or the Sinexcel Active Harmonic Filters on pages 146-151.

Please note:

- The recommended reactor selections above are based on fundamental current ratings. Contact Fuseco with any questions regarding the proper reactor selection.
- The effective impedance of the reactor changes with actual RMS current. A 5% impedance reactor becomes 3% if its current is reduced to 60%.
- Weights and dimensions are for reference only and are subject to change without notice.

FUSECO

Schaffner Sine Wave Filters

Deployed at the output side of a VSD, Schaffner sine wave filters are a proven motor protection solution that ensure system reliability and motor longevity.

Schaffner sine wave filters can facilitate the use of unshielded motor cables, the use of multiple motors in parallel on the same driver or the retrofit of modern drives in existing installations with old motors and unshielded cabling. A great investment for your electrical system.

FN 5420
530V
IP00 (open panel)

FN 5045
500V
IP20 (enclosed)

Key Features:

- Converts the rectangular PWM output voltage of motor drives into a smooth sine wave with low residual ripple.
- Allows for the use of unshielded cables (lower project costs).
- Allows for the use of longer motor cables.
- Reduces eddy currents, stray flux losses and bearing currents.
- Improves bearing life time because of bearing currents caused by circulating currents, eddy currents and stray flux losses.
- Eliminates torque ripple and voltage wave reflection.
- Eliminates premature motor damage caused by high dv/dt, over-voltages, cable ringing, motor overheating, pulse pattern stress and eddy current losses.
- Reduces motor noise, vibration and heat.
- Meets AS/NZ 61000.3.6 standards and IEEE 519-2022 recommendations. Complies with IEC 60034-17* and NEMA-MG1 requirements for general purpose motors.
- Available in 690V.

Technical Specifications

Nominal operating voltage	3x480 VAC
Rated operating voltage	3x530 VAC
Motor frequency	0...60 Hz (up to 200Hz with derating, see user manual)
Switching frequency fPWM	Min. 2 or 4kHz, max. 16kHz, see filter selection table
Impedance (uk)	6% @ 400 V, 50 Hz and rated current
Residual ripple voltage	<5%
Motor cable length	Up to 1'000 m or 2'000 m (see user manual)
Overvoltage category	III acc. IEC 60664-1
Pollution degree	3
High potential test voltage	P –> E 2480 VAC, 1 s
Protection category	IP00 (E0XXT versions) IP20 (E2FXT option, up to 110A version)
Overload capability	1.5× rated current for 1 minute, once per hour
Ambient temperature range	-40°C to +45°C fully operation +45°C to +100°C (up to 18A) or +70°C (26A and above) derated operation* -40°C to +70°C transport and storage
Design corresponding to	Filter: UL 61800-5-1, EN 61800-5-1 Chokes: EN 61558-2-20 or EN 60076-6
Climatic class	40/070/21
MTBF @ 45°C/480 V (Mil-HB-217F)	>500,000 hours
Flammability corresponding to	UL-94V-0

schaffner
MORE POWER TO YOU

OUTPUT FILTERS AND LOAD REACTORS	max voltage	Typical motor power [kW] / Rated current [A] (0 200 400 600 800 >1000)	features: dv/dt restriction	Overvoltage restriction	Motor temperature reduction	Red. acoustic motor noise	Sym. sinusoidal output signal	Asym. sinusoidal output signal	Eliminat. of bearing damage	Replaces cable shields	Connection to dc link required	Improves overall EMC	Reduces equipment downtime	typical applications: Motor drives	Servo drives, torque motors	High-speed motor applications	Appl. with long unshield. cabl.	Retrofit of motor drives
FN 5420	530 VAC	0.75 – 500 kW; 2.3 – 1000 A	●	●	●	●	●					●	●	●				●
FN 5040 HV	690 VAC	75 – 1200 kW; 13 – 1320 A	●	●	●	●	●					●	●	●				●

Sine Wave Filter Selection Table

Filter	Rated current @ 45°C/ 50Hz (A)	Typical motor drive power rating @ 400V* (kW)	Typical motor drive power rating @ 480V** (kW)	Nominal inductance (mH)	Capacitance connection	Nominal capacitance*** [µF]	Min. switching frequency [kHz]	Typical power loss**** [W]	Input/ Output terminals	Weight (kg)
FN5420-2.3-88-E0XXT	2.3	0.75	0.90	19.2	Y	3x0.47	4	41	88	1.20
FN5420-3.1-88-E0XXT	3.1	1.1	1.3	14.2	Y	3x0.68	4	45	88	1.55
FN5420-5.9-88-E0XXT	5.9	2.2	2.6	7.48	Y	3x1.5	4	76	88	2.2
FN5420-10-88-E0XXT	10.2	4.0	4.8	4.32	Y	3x2.2	4	91	88	5.1
FN5420-13-89-E0XXT	13.2	5.5	6.6	3.34	Y	3x3.0	4	123	89	5.5
FN5420-18-89-E0XXT	18	7.5	9.0	2.45	Y	3x3.7	4	150	89	6.6
FN5420-26-92-E0XXT	26	11	13	1.70	Y	3x5	4	127	92	9.5
FN5420-32-92-E0XXT	32	15	18	1.38	Y	3x6	4	196	92	11.9
FN5420-38-92-E0XXT	38	19	22	1.16	Y	3x8	4	229	92	12.1
FN5420-45-92-E0XXT	45	22	26	0.980	Y	3x8	4	272	92	13.7
FN5420-60-92-E0XXT	60	30	36	0.735	Y	3x12	4	283	92	18.5
FN5420-75-99-E0XXT	75	37	44	0.588	Y	3x15	4	154	99	21.5
FN5420-90-99-E0XXT	90	45	54	0.490	Y	3x20	4	239	99	25.0
FN5420-110-99-E0XXT	110	55	66	0.401	Y	3x20	4	283	99	28.5
FN5420-145-99-E0XXT	145	75	90	0.304	Y	3x100	2	472	99	56
FN5420-180-99-E0XXT	180	90	108	0.245	Y	3x150	2	658	99	58
FN5420-200-99-E0XXT	200	110	132	0.221	Y	3x150	2	707	99	60
FN5420-250-99-E0XXT	250	132	158	0.176	Y	3x200	2	882	99	76
FN5420-300-99-E0XXT	302	160	192	0.146	Y	3x250	2	936	99	98
FN5420-400-99-E0XXT	400	200	240	0.110	Y	3x300	2	1023	99	128
FN5420-480-99-E0XXT	477	250	300	0.092	Y	3x350	2	1318	99	155
FN5420-630-99-E0XXT	630	315	378	0.070	Y	3x500	2	1459	99	185
FN5420-710-99-E0XXT	710	355	426	0.062	Y	3x550	2	1922	99	220
FN5420-800-99-E0XXT	800	400	480	0.055	Y	3x600	2	2062	99	262
FN5420-1000-99-E0XXT	1000	500	600	0.044	Y	3x750	2	2315	99	366
FN5420-2.3-44-E2XXT	2.3	0.75	0.9	19.2	Y	3x0.47	4	41	44	2.4
FN5420-3.1-44-E2XXT	3.1	1.1	1.3	14.2	Y	3x0.68	4	45	44	2.8
FN5420-5.9-44-E2FXT	5.9	2.2	2.6	7.48	Y	3x1.5	4	76	44	4.0
FN5420-10-44-E2FXT	10.2	4.0	4.8	4.32	Y	3x2.2	4	91	44	6.8
FN5420-13-33-E2FXT	13.2	5.5	6.6	3.34	Y	3x3.0	4	123	44	7.2
FN5420-18-33-E2FXT	18	7.5	9.0	2.45	Y	3x3.7	4	150	33	7.9
FN5420-26-33-E2FXT	26	11	13	1.70	Y	3x5	4	127	33	11.8
FN5420-32-33-E2FXT	32	15	18	1.38	Y	3x6	4	196	33	14.2
FN5420-38-33-E2FXT	38	18.5	22	1.16	Y	3x8	4	229	33	14.4
FN5420-45-34-E2FXT	45	22	26	0.980	Y	3x8	4	272	34	21
FN5420-60-34-E2FXT	60	30	36	0.735	Y	3x12	4	283	34	25
FN5420-75-35-E2FXT	75	37	44	0.588	Y	3x15	4	154	35	30
FN5420-90-35-E2FXT	90	45	54	0.490	Y	3x20	4	239	35	34
FN5420-110-35-E2FXT	110	55	66	0.401	Y	3x20	4	283	35	38

* General purpose four-pole (1500 r/min) AC induction motor rated 400 V/50 Hz.
** General purpose four-pole (1500 r/min) AC induction motor rated 480 V/50 Hz.
*** Exact value depends on the motor cable length and type, switching frequency and further stray parameters of the system.

Required drive settings

Ensure the drive's switching frequency is set to the required minimum switching frequency (refer to selection table above). The mode of operation must be "scalar" (V/Hz) with a fixed switching frequency. Check the drives manufacturer manual whether special settings are necessary. In any doubt contact the drives manufacturer. CAUTION: If the motor drives settings are not correct the filter may be damaged.

FUSECO

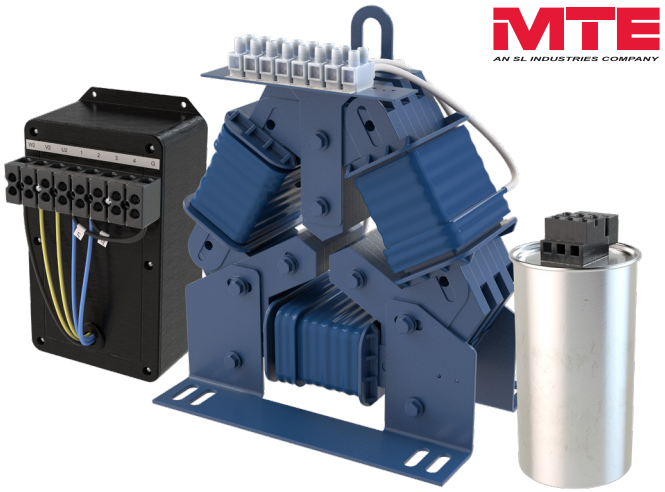
MTE SineWave Nexus™ Filters

An Optimal Integrated Solution for both Differential and Common Mode Filtering

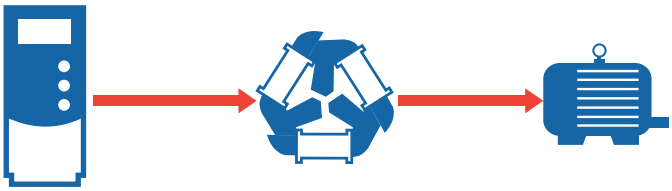
MTE's SineWave Nexus™ filter combines the performance of a sinewave filter with their patented common mode protection technology into a single passive device. It cleans the PWM waveform generated by a VSD and virtually eliminates common mode voltage which causes motor bearing failures. By filtering out the damaging common mode voltage, motor bearings are never subjected to those harmful voltages that cause pitting, frosting, or fluting damage that leads to motor failure.

Key Features:

- Reduces Common Mode voltage to zero
- Increases motor life
- Eliminates motor failures due to bearing currents
- Reduces motor noise and heating
- Protects motor cable
- Small Package Solution
- 3 year warranty (industry leading)

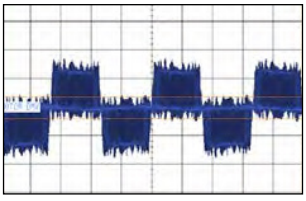


Application Configurations

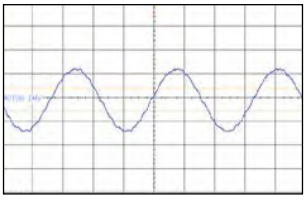


SineWave Nexus Performance

Total Harmonic Voltage Distortion

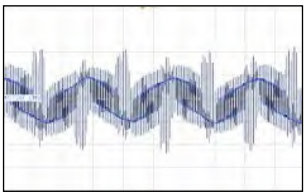


Without SineWave Nexus

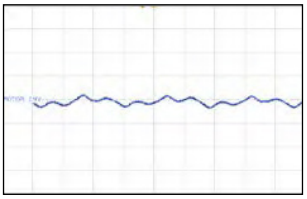


With SineWave Nexus

Common Mode Voltage

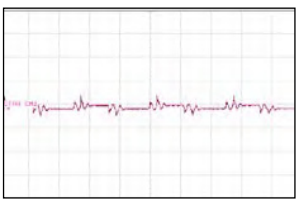


Without SineWave Nexus

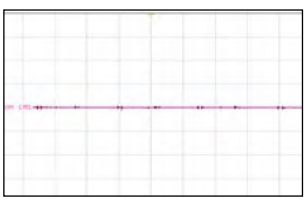


With SineWave Nexus

Common Mode Current



Without SineWave Nexus



With SineWave Nexus

Performance Specifications

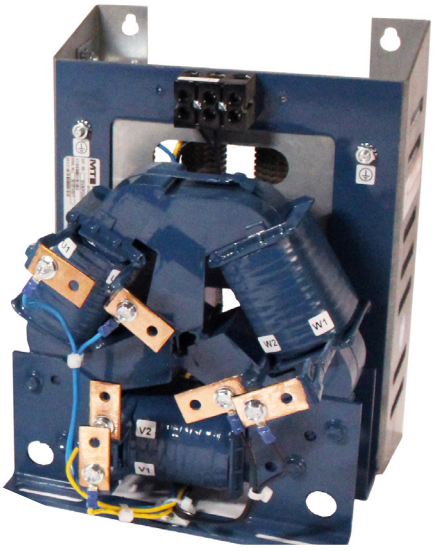
Input Voltage	380V - 600V +/- 10%; 60Hz
Current Range	2A - 160A (0.75 HP - 125 HP)
Harmonic Voltage Distortion	5% maximum @ 4-8kHz
Inverter Switching Frequency	2kHz to 8kHz
Inverter Operating Frequency	6Hz to 75Hz; >75Hz to 120Hz with derating
Insertion Loss (Voltage)	10% maximum @ 60Hz
Efficiency	>98%
Common Mode Attenuation	-20dB (>90% PWM common mode RMS voltage reduction) @ 4-8kHz
Maximum Sound Level	75dB @ 1 meter
Maximum Ambient Temperature	-40C to +60C modular filter -40C to +55C enclosed filter -40C to +90C storage
Altitude Without Derating	3,300 feet above sea level
Maximum Motor Lead Length	15,000 feet
Relative Humidity	0% to 95% non-condensing
Current Rating	100% RMS continuous; 150% for 1 minute intermittent

MTE dV Sentry™ dV/dT Filters

The future is here.

MTE's latest technological innovation has made the dV Sentry™ the revolutionary solution for motor protection. With its patented design, the dV Sentry™ is the first proven filter that provides common mode reduction, peak voltage protection and rise time reduction – all in one unit. This gives greater motor protection over time.

It features a small footprint and easy terminations to make installation faster and easier. It also runs quietly and radiates less heat than previous filters. The unique design of the dV Sentry™ allows for greater load side protection from voltage spikes and common mode voltage for your AC motors, cable and VFDs.



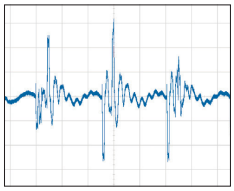
Key Features:

- **Patented design**
  Revolutionary new design provides over 50% common mode reduction, peak voltage protection, and rise time reduction - all in one filter.
- **Low watts loss**
  Reduces radiated heating in systems.
- **Small footprint**
  The dV Sentry's unique flat design, allows the filter to be easily integrated.
- **Strong robust design**
  Allows the filter to withstand challenging installation applications and other difficult environments.
- **Runs quieter**
  Unlike other 'noisy' filters in this class, the dV Sentry™ runs quieter - comparable to a normal conversation.
- **3 year warranty (industry leading)**

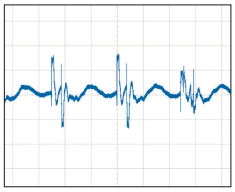
Performance Specifications

Input Voltage	380V – 600V
Current Range	3A – 600A
Available form factors	Panel NEMA 1/2 NEMA 3R
Max Peak motor Voltage	150% of DC bus voltage at 1000 feet
Rise Time	Less than 0.1uS
Insertion Loss	No more than 1.7% at 60Hz No more than 2.6% at 90Hz
Intermittent Current Ratings	150% continuous RMS (1 minute) 200% continuous RMS (10 seconds)
Carrier Frequency Range	3A – 110A: 900Hz – 10kHz (up to 14Khz with derating) 130A – 600A: 900Hz – 5kHz
Motor Frequency	Up to 90Hz without de-rating Up to 120Hz with de-rating
Agency Apporvals	UL, cUL, CE, and RoHS
Motor Audible Noise	Less thank 65dB
Service Temperatures	–40°C to 50°C Enclosed –40°C to 60°C Open
Warranty	3 years from the date of shipment

Common Mode Reduction

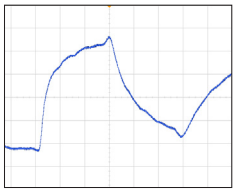


Without dV Sentry™

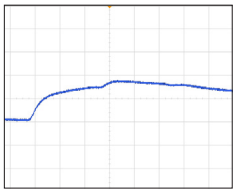


With dV Sentry™

Peak Rise Protection

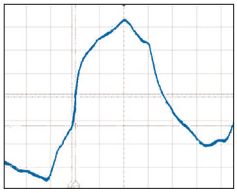


Without dV Sentry™

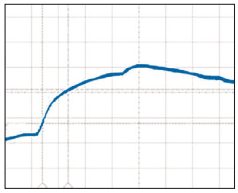


With dV Sentry™

Rise Time Reduction



Without dV Sentry™



With dV Sentry™

FUSECO

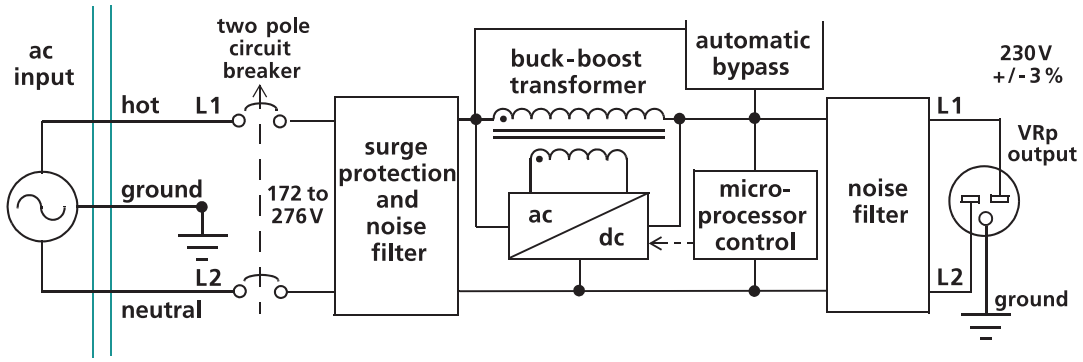
TSI Automatic Voltage Regulators

TSi Power's VRP & VRX range of automatic voltage regulators have a wide input range and precise regulation. Indoor AVR's are ideally suited to protecting sensitive equipment such as laboratory analysers, medical imaging systems & security scanners. Outdoor AVR's are ideally suited to end-of-line voltage correction. The TSi Power range features heavy duty electronics and magnetics designed to operate under worst case conditions. They incorporate industrial strength surge protection, unique AC-chopper technology for very high efficiency and complete line conditioning.

Key Features:

- VRX: Under normal input range of 172-276VAC (47-63Hz), output regulation will be 276VAC (±3%).
- VRP: Under normal input range of 184-287V for 230V with output regulated to ±3%.
- VRX range incorporates an aluminium enclosure that is rain tested to UL 50E / NEMA 3R.
- Complete line conditioning.
- The extended input voltage range is 160-330V with reduced regulation.
- 96-98% efficiency
- Fail-safe. No switching of the power path.
- Fast regulation & automatic bypass.
- Low impedance, low weight & quiet operation.
- 2 year limited warranty.

VRP/VRX System Architecture



VRP Single Phase 230V

- Available in 3, 5, 7.5, 10, 15 and 20 kVA
- Over/under voltage cut-off is available as an option
- Control PCB assembly is designed for easy replacement

VRP Three Phase 230/400V

- Available in 9, 15, 22.5, 30 and 45 kVA
- Other sizes are available upon request
- Over/under voltage cut-off is available as an option
- Control PCB assembly is designed for easy replacement

VRX Three Phase 230/400V

- Available in 15, 22.5 and 30kVA
- Ambient operating temperature range –20°C to +50°C
- Other sizes are available upon request
- Over/under voltage cut-off is available as an option
- Control PCB assembly is designed for easy replacement
- Wall mounting is standard. Pad or pole mounting available as an option

VRX Single Phase 230V

- Available in 3, 5, 7.5, 10, 15 and 20 kVA
- Ambient operating temperature range –20°C to +50°C
- Over/under voltage cut-off is available as an option
- Control PCB assembly is designed for easy replacement
- Wall mounting is standard. Pad or pole mounting available as an option

AC Voltage Regulators

A voltage regulator generates a fixed output voltage of a preset magnitude that remains constant regardless of changes to its input voltage or load conditions. Fuseco supplies a large range of Voltage Regulators to suit virtually every application. Contact the team at Fuseco to discuss your requirements.

Performance Specifications

Single Phase	500VA – 200kVA (Other ratings available upon request)
Three Phase	20kVA – 4,000kVA (Other ratings available upon request)
System Frequency	50/60Hz
Input Voltage	Single phase: 220, 230 or 240V selectable Three phase: 380, 400 or 415V selectable
Input Variation	Single phase: 140-270VAC selectable Three phase: ± 20%, 30% or 40% selectable
Output Accuracy	Single phase: ±3% Three phase: ±2-5% (adjustable)
Efficiency	Single phase: ≥90% Three phase: ≥95%
Adjusting time	≤1.5s (when input voltage within the change of 10%
Wave distortion	No additional wave distortion
Overload capability	2 times rated current, for 1 min
Bypass function	Manual or Automatic
Control	Manual or Automatic
Display	Input Voltage / Output Voltage / Input Current
Insulation resistance	≥2MΩ
Electrical strength	2000VAC for 1min without breakdown or flash over
Ambient temperature	-15°C to +40°C
Humidity	≤90%
Altitude	≤1000m

Key Features:

- Single phase unit: Under normal input range of 140-270VAC (50/60Hz), output regulation will be 220, 230 or 240VAC (±3%).
- Three phase unit: Under normal input range of 380, 400 or 415V ± 20%, 30% or 40% selectable. With output regulated to ±2 to 5% adjustable.
- Optional split-phase regulating
- No additional waveform distortion
- Protection: Over-voltage, over-current, phase failure and phase sequence
- Single phase ≥90%; Three phase ≥95% efficiency
- Fast regulation with manual or automatic bypass options.
- Automatic or manual start selectable
- Low impedance, low weight & quiet operation
- ≤1.5s Adjusting time
- 1 year factory warranty

SBW DBW

SVC

FUSECO

Single-Phase RFI & DC Filters

Single-phase filters for chassis or DIN-rail mounting are key for EMC compliance of higher power office equipment and low to medium power industrial applications. A broad selection of electrical and mechanical features allows a specific choice and deployment for countless applications. DC filters are specifically optimised for applications with DC supply like e.g. PV inverters.

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SINGLE PHASE FILTERS	Max voltage	Attenuation performance / Rated current [A]	1-stage filter circuit	2-stage filter circuit	3-stage filter circuit	For DC applications	With overvoltage protection	Low frequency attenuation	High frequency attenuation	Choice of connection style	DIN-rail mounting	Power supplies, SMPS	Medical equipment	Single-phase motor drives	Control unit in machine tools	PV inverters	Office, test & measure. equip.	General purpose
FN 332	250 VAC	1-10	●				●											●
FN 350	250 VAC	8 – 55	●									●		●			●	
FN 2010 (see page 178)	250 VAC	1 – 60	●							●			●					●
FN 2020 (see page 178)	250 VAC	1 – 60	●							●			●				●	●
FN 2030 (see page 178)	250 VAC	1 – 30	●				●	●	●	●			●				●	●
FN 2200	1200 VDC	25 – 2300	●			●		●	●			●				●		●
FN 2210 **FN 2211**	1000 VDC	250-2300	●			●		●	●			●				●		●
FN 2210 HV **FN 2211 HV**	1500 VDC	250-2300	●			●		●	●			●				●		●
FN 2410 (see page 178)	250 VAC 520 VAC (H)	8 – 100	●					●				●		●				
FN 2412	250 VAC 520 VAC (H)	8 – 45	●					●			●	●		●	●			
FN 2450	250 VAC	1 – 20	●					●	●			●	●				●	●
FN 2415 (see page 179)	250 VAC	6 – 16		●				●	●			●	●		●		●	●

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SINGLE-PHASE FILTERS	Max voltage	Attenuation performance / Rated current [A] (standard, high, very high; 0 20 40 60 80 100)	Features: 1-stage filter circuit	2-stage filter circuit	3-stage filter circuit	With earth line choke	With overvoltage protection	Low frequency attenuation	High frequency attenuation	Choice of connection style	TEMPEST protection	Typical applications: Power supplies, SMPS	Medical equipment	Single-phase motor drives	Control unit in machine tools	Interception protection	Office, test & measure. equip.	General purpose
FN 343	250 VAC	1-10		●		●											●	●
FN 2060 (see page 179)	250 VAC	1 30		●						●		●	●				●	●
FN 2070 (see page 179)	250 VAC	1 36		●					●	●		●	●	●			●	
FN 2080	250 VAC	1 16		●				●		●		●	●	●				
FN 2090 (see page 179)	250 VAC	1 30		●			●	●	●	●		●	●	●				
FN 700Z	250 VAC	6 20			●		●	●	●		●	●	●			●	●	
FN 352Z	250 VAC	6 30			●		●		●		●	●			●	●	●	

FUSECO

Single-Phase RFI Filters

FN 2010
250VAC

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FUSECO PART NUMBER	RATED CURR @40°C (25°C) (A)	LEAKAGE CURR @ 250VAC/50Hz (mA)	POWER LOSS @25°C/DC (W)	INDUCTANCE L (mH)	CAPACITANCE CX (µF)	CAPACITANCE CY (nF)	RESISTANCE R (KΩ)	WEIGHT (kg)
FN 2010-1-06	1 (1.15)	0.66	0.8	12	0.1	4.7	1000	0.065
FN 2010-3-06	3 (3.45)	0.66	1.1	2.5	0.1	4.7	1000	0.065
FN 2010-6-06	6 (6.9)	0.66	1.7	1	0.1	4.7	1000	0.065
FN 2010-10-06	10 (11.5)	0.66	2.5	0.8	0.1	4.7	1000	0.085
FN 2010-12-06	12 (13.8)	0.66	3.6	0.7	0.1	4.7	1000	0.085
FN 2010-16-06	16 (18.4)	0.66	2.5	0.7	0.1	4.7	1000	0.14
FN 2010-20-06	20 (23)	0.66	3.8	0.6	0.1	4.7	1000	0.21
FN 2010-30-08	30 (34.5)	0.79	6.3	0.7	0.47	10	1000	0.47
FN 2010-60-24	60 (69)	0.79	14.7	1	1.5	10	330	1.1

FN 2020
250VAC

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FUSECO PART NUMBER	RATED CURR @40°C (25°C) (A)	LEAKAGE CURR @ 250VAC/50Hz (mA)	POWER LOSS @25°C/DC (W)	INDUCTANCE L (mH)	CAPACITANCE CX (µF)	CAPACITANCE CY (nF)	RESISTANCE R (KΩ)	WEIGHT (kg)
FN 2020-1-06	1 (1.15)	0.66	0.8	12	0.15	4.7	1000	0.08
FN 2020-3-06	3 (3.45)	0.66	1.2	2.5	0.15	4.7	1000	0.08
FN 2020-6-06	6 (6.9)	0.66	1.5	1	0.15	4.7	1000	0.08
FN 2020-10-06	10 (11.5)	0.66	2.9	0.8	0.15	4.7	1000	0.085
FN 2020-12-06	12 (13.8)	0.66	3.6	0.7	0.15	4.7	1000	0.085
FN 2020-16-06	16 (18.4)	0.66	2.5	0.65	0.15	4.7	1000	0.14
FN 2020-20-06	20 (23)	0.66	3.8	0.6	0.15	4.7	1000	0.21
FN 2020-30-08	30 (34.5)	0.79	6.3	0.67	0.47	10	470	0.47
FN 2020-60-24	60 (69)	0.79	14.7	1	1.5	10	220	1.1

FN 2030
250VAC

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FUSECO PART NUMBER	RATED CURR @40°C (25°C) (A)	LEAKAGE CURR @ 250VAC/50Hz (mA)	POWER LOSS @25°C/DC (W)	INDUCTANCE L (mH)	CAPACITANCE CX (µF)	CAPACITANCE CY (nF)	RESISTANCE R (KΩ)	WEIGHT (kg)
FN 2030-1-06	1 (1.1)	0.31	0.9	20	0.22	2.2	1000	0.058
FN 2030-3-06	3 (3.4)	0.47	2.2	14	0.33	3.3	1000	0.087
FN 2030-4-06	4 (4.5)	0.47	2.9	14	0.33	3.3	1000	0.092
FN 2030-6-06	6 (6.7)	0.66	3.2	8	0.47	4.7	680	0.1
FN 2030-8-06	8 (8.9)	0.66	3.1	8	0.47	4.7	680	0.17
FN 2030-10-06	10 (11.2)	0.66	5.3	8	0.47	4.7	680	0.196
FN 2030-12-06	12 (13.4)	0.79	7.6	4	1	10	330	0.185
FN 2030-16-06	16 (17.9)	0.79	6.1	4	1	10	330	0.225
FN 2030-20-06	20 (22.4)	0.79	4.6	4	1	10	330	0.285
FN 2030-30-08	30 (33.5)	0.79	6	2	1	10	330	0.326

FN 2410
250VAC

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FUSECO PART NUMBER	RATED CURRENT @50°C (40°C) (A)	LEAKAGE CURRENT @250 VAC /50 Hz	POWER LOSS @25°C/50Hz (W)	WEIGHT (kg)
FN2410-8-44	8 (8.8)	2.6	2.6	0.4
FN2410-16-44	16 (17.5)	2.6	3.5	0.5
FN2410-25-33	25 (27.4)	2.6	5.5	0.6
FN2410-32-33	32 (35.0)	2.6	5.6	0.7
FN2410-45-33	45 (49.3)	2.6	7.4	0.7
FN2410-60-34	60 (65.7)	2.6	5.5	1.8
FN2410-80-34	80 (87.6)	2.6	9.9	1.8
FN2410-100-34	100 (109.5)	2.6	15.4	1.8

Key Features

Rated currents from 1 to 100A

General purpose filtering performance

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FN 2415
250VAC

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FUSECO PART NUMBER	RATED CURR @40°C (25°C) (A)	LEAKAGE CURR @250 VAC/50 Hz (mA)	Power loss (W)	INDUCTANCE L (mH)	CAPACITANCE Cx (µF)	CAPACITANCE Cy (nF)	RESISTANCE R (kΩ)	WEIGHT (kg)
FN2415-6-29	6 (6.6)	7.85	2.2	8	3.3	100	220	0.4
FN2415-10-29	10 (11)	7.85	2.4	4.2	3.3	100	220	0.4
FN2415-16-29	16 (17.5)	7.85	4.3	3	3.3	100	220	0.4

FN 2060
250VAC

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FUSECO PART NUMBER	RATED CURR @40°C (25°C) (A)	LEAKAGE CURR @250 VAC/50 Hz (mA)	Power loss @25°C/DC (W)	INDUCTANCE L (mH)	CAPACITANCE Cx (µF)	CAPACITANCE Cy (nF)	RESISTANCE R (kΩ)	WEIGHT (kg)
FN2060-1-06	1 (1.2)	0.66	1.6	12	0.22	4.7	1000	0.12
FN2060-3-06	3 (3.5)	0.66	2.2	2.5	0.22	4.7	1000	0.12
FN2060-6-06	6 (6.9)	0.66	3.2	0.97	0.22	4.7	1000	0.12
FN2060-10-06	10 (11.5)	0.66	4.3	0.8	0.47	4.7	470	0.19
FN2060-12-06	12 (13.8)	0.66	6.2	0.58	0.47	4.7	470	0.19
FN2060-16-06	16 (18.4)	0.66	4.4	0.65	0.33	4.7	1000	0.26
FN2060-20-06	20 (23)	0.66	5.3	0.6	1	4.7	220	0.48
FN2060-30-08	30 (34.5)	0.79	9.1	0.6	1	10	220	0.95

FN 2070
250VAC

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FUSECO PART NUMBER	RATED CURR @40°C (25°C) (A)	LEAKAGE CURR @250 VAC/50 Hz (=)	Power loss @25°C/DC (W)	INDUCTANCE L (mH)	CAPACITANCE Cx (µF)	CAPACITANCE Cy (nF)	RESISTANCE R (kΩ)	WEIGHT (kg)
FN2070-1-06	1 (1.2)	0.66	2.4	22	0.33	4.7	1000	0.19
FN2070-3-06	3 (3.5)	0.66	2.2	9.8	0.47	4.7	470	0.25
FN2070-6-06	6 (6.9)	0.66	3.2	7.8	1	4.7	220	0.45
FN2070-10-06	10 (11.5)	0.66	9.1	4.5	1	4.7	220	0.67
FN2070-12-06	12 (13.8)	0.66	13.1	3.25	1	4.7	220	0.67
FN2070-16-06	16 (18.4)	0.66	9.6	2.8	1	4.7	220	1
FN2070-25-06	20 (23)	0.66	11.6	2	2.2	4.7	220	0.76
FN2070-36-08	30 (34.5)	0.79	13.1	1.23	2.2	4.7	220	0.79

FN 2090
250VAC

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FUSECO PART NUMBER	RATED CURR @40°C (25°C) (A)	LEAKAGE CURR @250 VAC /50 Hz	POWER LOSS @25°C/DC (W)	INDUCTANCE L (mH)	CAPACITANCE Cx (µF)	CAPACITANCE Cy1 (nF)	CAPACITANCE Cy2 (nF)"	RESISTANCE R (kΩ)	WEIGHT (kg)
FN2090-1-06	1 (1.1)	0.45	1.8	20	0.22	2.2	1	680	0.073
FN2090-3-06	3 (3.4)	0.45	3.7	14	0.33	2.2	1	470	0.158
FN2090-4-06	4 (4.5)	0.45	6.4	14	0.33	2.2	1	470	0.176
FN2090-6-06	6 (6.7)	0.61	7.1	8	0.47	3.3	1	330	0.191
FN2090-8-06	8 (8.9)	0.61	7.7	8	0.47	3.3	1	330	0.33
FN2090-10-06	10 (11.2)	0.61	8.4	8	0.47	3.3	1	330	0.369
FN2090-12-06	12 (13.4)	0.93	12.1	4	1	10	1	220	0.391
FN2090-16-06	16 (17.9)	0.93	10.7	4	1	10	1	220	0.425
FN2090-20-06	20 (22.4)	0.93	8.2	2.7	1	10	1	220	0.53
FN2090-30-08	30 (33.5)	0.93	10.1	1.5	1	10	1	220	0.548

FUSECO

Three-Phase RFI Filters

EMC/EMI filter solutions for industrial applications like motor drives and machine tools. Furthermore, these types of filters are also suitable for mainframe computer systems, large uninterruptible power supplies, medical equipment, wind turbine power stations and a vast array of other three-phase power electronics. LCL filters are used with active infeed converters (AFE) to allow a norm conform grid connection.

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MORE POWER TO YOU

THREE PHASE FILTERS	Max voltage	
FN 351	440 VAC 520 VAC (H)	8 – 280
FN 3025	520 VAC	10–50
FN 3026	520 VAC	10–50
FN 3100	520 VAC	35 – 300
FN 3120	520 VAC (H)	25 – 230
FN 3258	480 VAC 520 VAC (H)	7 – 180
FN 3268	520 VAC	7 – 180
FN 3270	520 VAC	10 – 1000
FN 3287 **FN 3288** (see page 181)	530 VAC	10 – 160
FN 3288 HV	690 VAC	10 – 160
FN 3310 **FN 3311**	520 VAC	250 – 2300
FN 3310 HV **FN 3311 HV**	690 VAC	250 – 2300
FN 3359 (see page 181)	520 VAC 690 VAC (HV)	150 – 2500
FN 6840	530 VAC	25 – 380

Three-Phase RFI Filters

Key Features

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MORE POWER TO YOU

- Industry standard EMC solution for three-phase PDS filtering
- Slim space-saving book-style housing
- Solid safety connector blocks or optional wire output connections
- Excellent attenuation performance
- HV versions for up to 690VAC
- HVIT versions for IT distribution networks
- P/L versions with low leakage current

FN3287-C26
530VAC

schaffner
MORE POWER TO YOU

FUSECO PART NUMBER	RATED CURR @ 50°C (40°C) (A)	TYPICAL DRIVE POWER RATING (kW)	LEAKAGE CURR @ 530VAC/50Hz (mA)	POWER LOSS @ 25°C (W)	WEIGHT (kg)
FN3287-10-44-C26-R65	10 (11)	5.5	2.2	7.5	0.7
FN3287-16-44-C26-R65	16 (17)	7.5	2.4	9.5	0.8
FN3287-20-33-C26-R65	20 (22)	11	2.5	10	0.9
FN3287-25-33-C26-R65	25 (27)	15	2.5	11.4	1
FN3287-40-33-C26-R65	40 (44)	22	2.5	22.6	1.5
FN3287-50-53-C26-R65	50 (55)	30	2.5	25.5	2.1
FN3287-63-53-C26-R65	63 (69)	37	2.5	32.1	2.2
FN3287-80-34-C26-R65	80 (88)	45	2.7	32.6	3.4
FN3287-100-35-C26-R65	100 (110)	55	2.7	33	4.2
FN3287-125-35-C26-R65	125 (137)	75	2.7	37.5	4.6
FN3287-160-40-C26-R65	160 (175)	90	2.7	38.4	6

FN3288-C21
530VAC

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FUSECO PART NUMBER	RATED CURR @ 50°C (40°C) (A)	TYPICAL DRIVE POWER RATING (kW)	LEAKAGE CURR @ 530VAC/50Hz (mA)	POWER LOSS @ 25°C (W)	WEIGHT (kg)
FN3288-10-44-C21-R65	10 (11)	5.5	0.4	7.1	0.8
FN3288-16-44-C21-R65	16 (17)	7.5	0.4	10.5	1
FN3288-20-33-C21-R65	20 (22)	11	0.4	10.7	1.2
FN3288-25-33-C21-R65	25 (27)	15	0.4	17.8	1.2
FN3288-40-33-C21-R65	40 (44)	22	0.4	21.6	1.8
FN3288-50-53-C21-R65	50 (55)	30	0.4	29.3	2.5
FN3288-63-53-C21-R65	63 (69)	37	0.4	34.5	2.7
FN3288-80-34-C21-R65	80 (88)	45	0.4	28.8	4.3
FN3288-100-35-C21-R65	100 (110)	55	0.4	36	5.1
FN3288-125-35-C21-R65	125 (137)	75	0.4	42.2	5
FN3288-160-40-C21-R65	160 (175)	90	0.4	46.1	6.6

FN 3359
520VAC

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MORE POWER TO YOU

FUSECO PART NUMBER	RATED CURR @ 50°C (40°C) (A)	TYPICAL DRIVE POWER RATING (kW)	LEAKAGE CURR @ 520VAC/50Hz (mA)	POWER LOSS @ 25°C (W)	WEIGHT (kg)
FN3359-150-28	150 (164)	75	5.1	24	5.8
FN3359-180-28	180 (197)	90	5.1	34	5.8
FN3359-250-28	250 (250)	132	5.1	49	9
FN3359-320-99	320 (350)	160	5.1	19	10.5
FN3359-400-99	400 (438)	220	5.1	29	10.5
FN3359-600-99	600 (657)	315	5.1	44	11
FN3359-800-99	800 (876)	400	5.3	39	20
FN3359-1000-99	1000 (1095)	560	5.3	60	20
FN3359-1600-99	1600 (1600)	900	5.1	131	17
FN3359-2500-99	2500 (2500)	1320	5.1	300	69

FUSECO

Three-Phase and Neutral Line RFI Filters

Three-phase and neutral line filters are a compact solution for the interference suppression on the mains input of cabinets and control units of equipment, ranging from industrial applications like machine tools to sensitive medical installations.

These typically involve separate and often insufficiently filtered frequency inverters and SMPS, causing current imbalance and significant interference problems.

As individual elements they may be interference suppressed already. The conjunction of several switching components in the same cabinet and a non-EMC conscious cabling will rise the demand for an additional RFI/EMI filter on the mains input of the whole installation.

Many times this is the only way to get the CE mark for the cabinet in accordance with the EMC directive.

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THREE-PHASE AND NEUTRAL LINE FILTERS	Max voltage
FN 354 (see page 183)	440 VAC
FN 355	440 VAC
FN 356 (see page 183)	440 VAC
FN 3256H (see page 183)	520 VAC (H)
FN 3280H (see page 183)	520 VAC (H)

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FN 354
440VAC

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FUSECO PART NUMBER	RATED CURRENT @40°C (25°C) (A)	LEAKAGE CURRENT @ 440 VAC/50 HZ (mA)	POWER LOSS @ 25°C/50 HZ (W)	WEIGHT (KG)
FN 354-4-05	4 (4.5)	0.1	2	0.23
FN 354-6-05	6 (6.7)	0.1	3.9	0.38
FN 354-12-05	12 (13.4)	0.1	7.8	1.1
FN 354-15-47	15 (16.8)	0.1	10.8	4.3
FN 354-25-47	25 (28)	0.2	16.9	4.4

FN 356
440VAC

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FUSECO PART NUMBER	RATED CURRENT @40°C (25°C) (A)	LEAKAGE CURRENT @ 440 VAC/50 HZ (mA)	POWER LOSS @ 25°C/50 HZ (W)	WEIGHT (KG)
FN 356-16-29	16 (18.4)	0.1	7	1.2
FN 356-25-33	25 (28.8)	0.1	10.1	1.5
FN 356-36-33	36 (41.5)	0.1	10.9	1.6
FN 356-50-33	50 (57.7)	0.1	15.8	2.3
FN 356-100-34	100 (115.0)	0.3	24	5.9
FN 356-150-28	150 (172.5)	1.7	45.9	8.1

FN 3256H
520VAC

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FUSECO PART NUMBER	RATED CURRENT @50°C (40°C) (A)	LEAKAGE CURRENT @ 520 VAC/50 HZ (mA)	POWER LOSS @ 25°C/50 HZ (W)	RESISTANCE R (KΩ)	RESISTANCE R1 (kΩ)	WEIGHT (kg)
FN3256H-8-29	8 (8.8)	0.6	2.7	1500	680	0.6
FN3256H-16-29	16 (17.5)	0.6	5	1500	680	0.7
FN3256H-25-33	25 (27)	0.6	9.8	1500	680	1.1
FN3256H-36-33	36 (39)	0.6	11.3	1500	680	1.2
FN3256H-64-34	64 (70)	0.6	17.2	1500	680	2.3
FN3256H-80-35	80 (88)	0.6	14.5	1500	680	3.5
FN3256H-120-35	120 (131)	0.9	25	1500	680	4.7
FN3256H-160-40	160 (175)	1.3	26.9	1500	680	5.7

FN 3280H
520VAC

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MORE POWER TO YOU

FUSECO PART NUMBER	RATED CURRENT @50°C (40°C) (A)	LEAKAGE CURRENT @ 520 VAC/50 HZ (mA)	POWER LOSS @ 25°C/50 HZ (W)	RESISTANCE R (KΩ)	RESISTANCE R1 (kΩ)	WEIGHT (kg)
FN3280H-8-29	8 (8.8)	10.7	2.7	1500	660	0.8
FN3280H-16-29	16 (17.5)	10.7	6	1500	660	0.8
FN3280H-25-33	25 (27)	10.7	11.6	820	660	1.3
FN3280H-36-33	36 (39)	10.7	14.8	820	660	1.6
FN3280H-64-34	64 (70)	10.7	18.4	820	660	2.7
FN3280H-80-35	80 (88)	10.7	18.9	1000	660	4.1
FN3280H-120-35	120 (131)	10.7	28.5	1000	660	5.9
FN3280H-160-40	160 (175)	10.7	30.7	1000	660	7.9
FN3280H-200-40	200 (219)	10.7	46.8	1000	660	8.5
FN3280H-300-99	300 (328)	42.1	20.3	1000	680	10
FN3280H-400-99	400 (438)	42.1	36	1000	680	10
FN3280H-600-99	600 (657)	42.1	64.8	1000	680	11

Notes