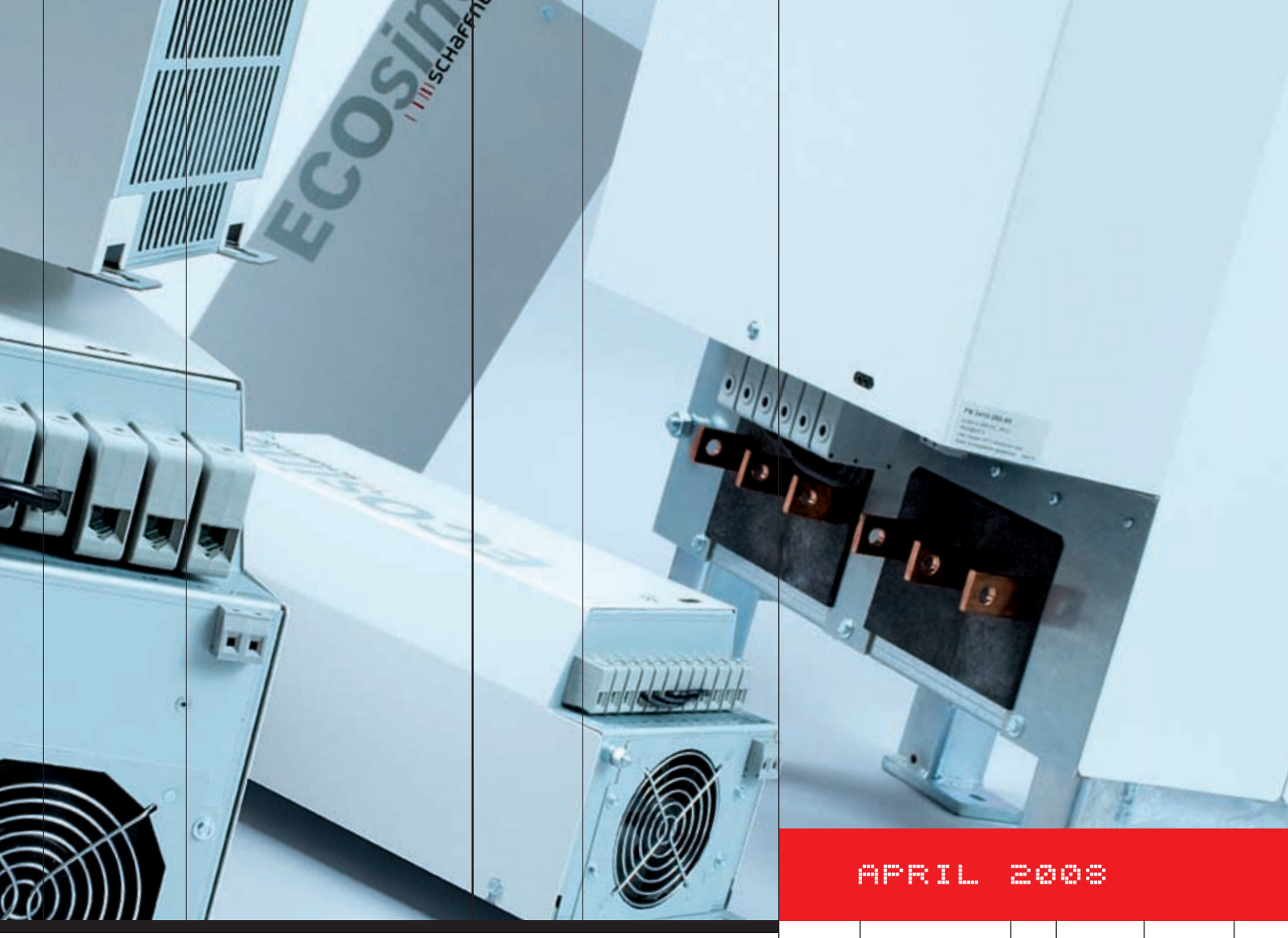
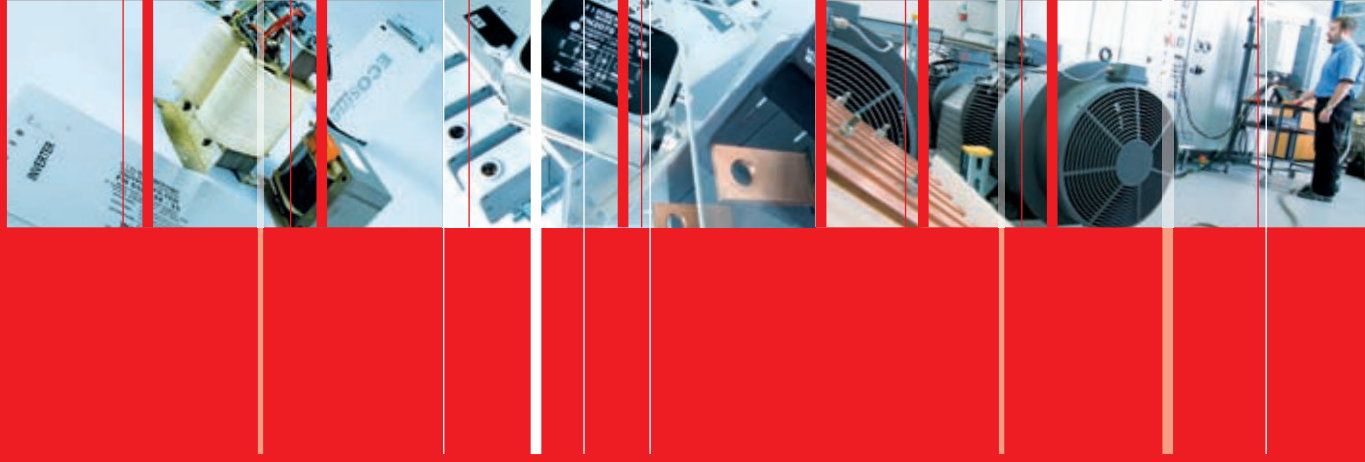


APRIL 2008

ECOsine™
Advanced Passive Harmonic Filters

SCHAFFNER
energy efficiency and reliability

www.myecosine.com



schaffner group

Schaffner is the international leader in the fields of electromagnetic compatibility and power quality, supplying components that support the efficient and reliable use of electric energy. Customers benefit from the technological know-how of the Schaffner Group in the development, manufacturing and marketing of high-performance products that offer optimized and fault-free operation and compliance with all major quality and performance standards. With its products and services, the Schaffner Group plays a key role in promoting technologies that support renewable energies, ensures the reliable functioning of electronic equipment and systems and meets the requirements for greater energy efficiency.

A global one-stop shop

EMC filters

- PCB filters
- IEC inlet filters
- Single-phase filters
- Three-phase filters
- Three-phase + neutral line filters
- Open frame filters

RFI suppression chokes

Feedthrough filters and capacitors

Automotive components

Customized solutions

Power Quality

- Line reactors
- dv/dt reactors and filters
- Sine wave filters
- Harmonic filters
- Regen reactors and filters
- Transformers

Customized solutions

A better way to Power Quality

Schaffner ECOsine™ harmonic filters represent an economical solution to the challenge of load-applied harmonics mitigation in three-phase power systems. With a plug-and-play approach and more compact dimensions than comparable products, they can be quickly installed and easily commissioned. They increase the reliability and service life of electric installations, help utilize electric system capacity better, and are the key to meet Power Quality standards such as IEEE 519.

Schaffner ECOsine™ harmonic filters provide:

- Efficient mitigation of harmonic currents.
- Compliance with IEEE 519 and other Power Quality standards.
- Increased equipment service life and system reliability in mission-critical applications.
- More efficient utilization of electric system capacity (e.g. distribution transformers).
- Long-term savings in system operation and maintenance cost. Support energy savings.
- Fast and simple plug-and-play operation.
- Very compact and light-weight filter concept.
- Seamless integration with previously installed DC chokes or EMI filters.

ECOsine™ filters calm your harmonic waves. Schaffner ECOsine™ filters can be applied to virtually any kind of power electronics with front-end six-pulse rectifiers, where harmonic current distortion needs to be reduced to defined limits. Typical applications, where the above-mentioned non-sinusoidal consumers of power can account for a significant portion of the load, include:

- Equipment with front-end six-pulse rectifier
- AC and DC motor drives
- Factory automation equipment
- UPS and three-phase power supplies
- Water/wastewater treatment facilities
- Oil and gas exploration
- Heavy industry and machinery
- Self-contained systems (e.g. ships)
- Electronic welders
- Battery chargers
- HVAC installations
- Mission-critical processes

c UL US LISTED

CE

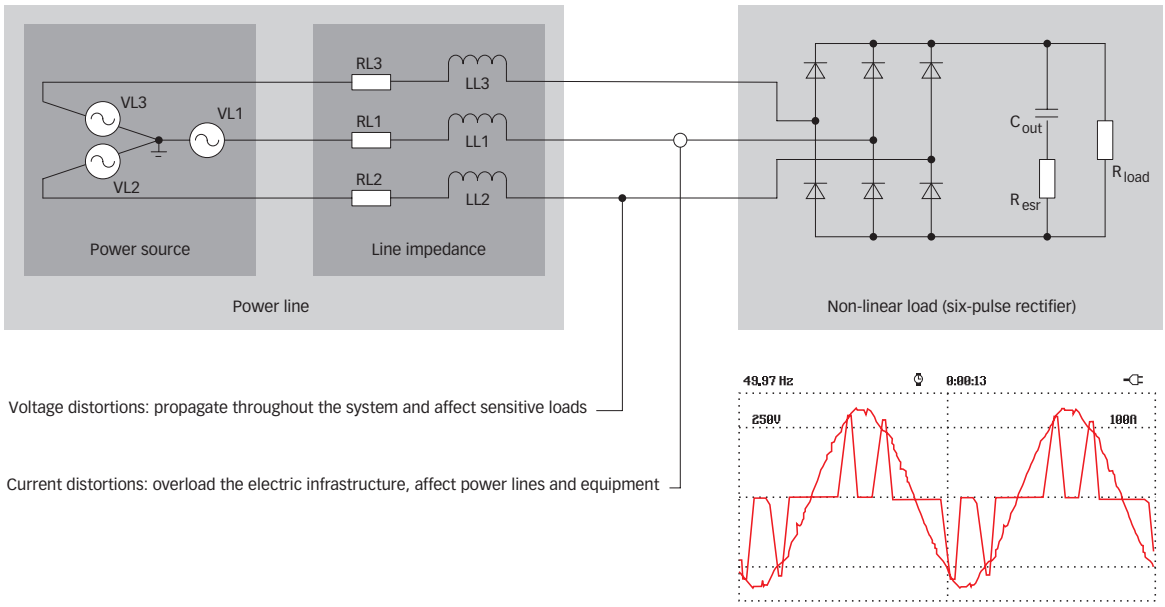
RoHS
2002/95/EC

Harmonics are a serious problem

Power Quality in times of blackouts and brownouts. Power Quality has become the buzzword of entire industries. While definitions diverge, nobody disputes its importance and the consequences of poor Power Quality. Often, electric utilities end up in the line of fire of frustrated customers. However, many disturbances – like electromagnetic interferences or harmonics – are not attributable to the utility company, but to the user of the electric power supply and the nature of the connected loads.

Creation of harmonic currents and voltages. Modern consumers of power, such as variable speed drives for motor controls, switch-mode power supplies in home electronics, or ballasts in fluorescent lamps, significantly contribute to energy saving and a more efficient use of electricity. However, the nature of their operation causes a non-sinusoidal current to be drawn from the grid. This non-sinusoidal current consists of the fundamental 50 or 60Hz wave and its integer multiples, the harmonics.

Harmonic currents flow through system impedances, transformers, reactors etc., and cause harmonic voltages. As a result, the supply voltage of other consumers connected to the same branch of the grid is distorted, raising questions about equipment service life, function, and reliability.



Harmonics have a serious impact. Harmonics reduce system efficiency and waste precious energy. Harmonic currents overload and overheat electric installations, distribution transformers, breakers, fuses, conductors etc. They cause premature system ageing or generate the requirement for an increase in electric system capacity. Harmonics overload capacitor banks in VAR compensation equipment and cause malfunctions in electronic controls, disturbances in sensitive medical devices, or crashes in communication networks.

Financial consequences. Unfortunately, harmonics mitigation is considered an expensive nuisance. Very often it is not budgeted for in the planning phase of a project. However, the decision to ignore this issue can potentially lead to a much more substantial cost impact. The capacity of electric installations may have to be increased. Equipment may fail prematurely. Disturbances may cause production downtime. Utility companies may even issue Power Quality violation penalties to the point where an entire factory has to be temporarily disconnected from the grid.

International requirements. International Power Quality standards such as IEEE 519-1992, EN 61000-3-12, EN 50160, EN 12015, G5/4 or AS 2279 define – among many other things – distortion limits and recommend harmonics mitigation practices. IEEE 519-1992 is probably the most widely accepted set of recommendations that defines maximum permissible current and voltage distortion percentages at the point of common coupling (PCC) under full load conditions. The applicable limit depends upon the system loading parameters, i.e. the relation between the maximum short circuit current (I_{SC}) and the maximum demand load current (I_L) at the PCC.

IEEE 519-1992 current distortion limits [%]

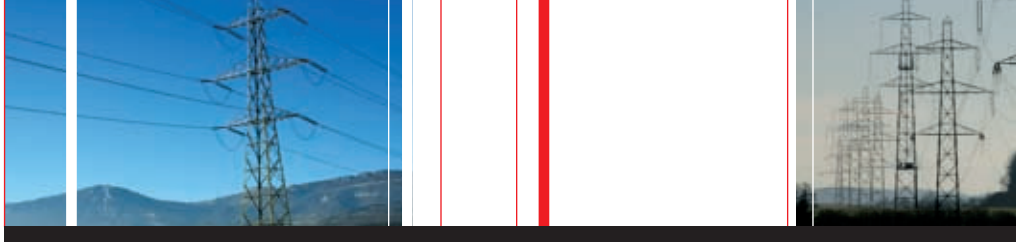
		Harmonic order (odd harmonics)				
I_{SC}/I_L	TDD	<11	11≤h<17	17≤h<23	23≤h<35	35≤h
<20	5.0	4.0	2.0	1.5	0.6	0.3
20<50	8.0	7.0	3.5	2.5	1.0	0.5
50<100	12.0	10.0	4.5	4.0	1.5	0.7
100<1000	15.0	12.0	5.5	5.0	2.0	1.0
>1000	20.0	15.0	7.0	6.0	2.5	1.4

Maximum harmonic current distortion in percent of I_L (even harmonics are limited to 25% of the odd harmonic limits above).

IEEE 519-1992 voltage distortion limits [%]

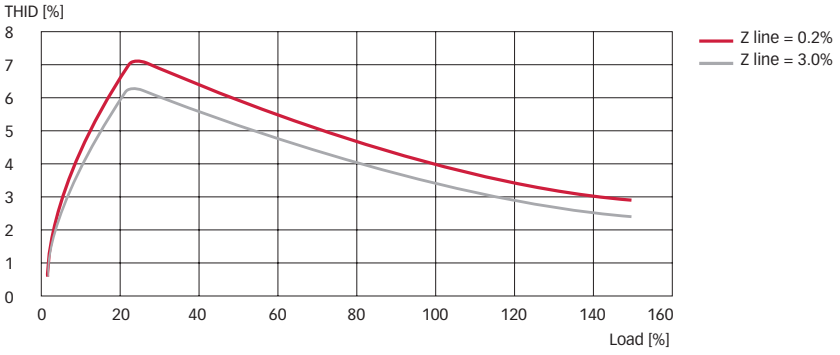
Special applications (hospitals, airports)	3
General systems applications	5
Dedicated systems (100% non-linear loads)	10

Please consult the published standards or local utility codes for more details about your individual harmonics mitigation requirements.

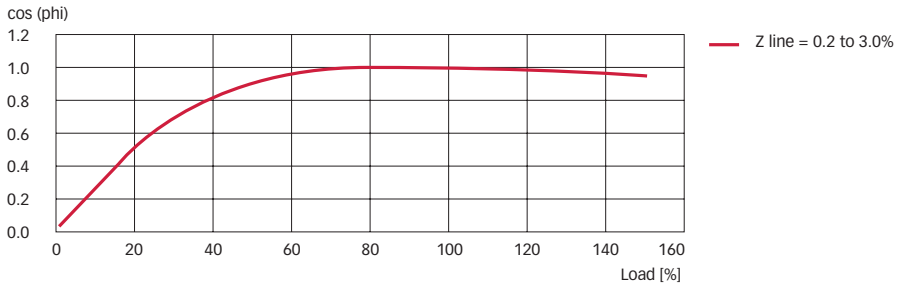


ECOsine™ – getting a grip on harmonics

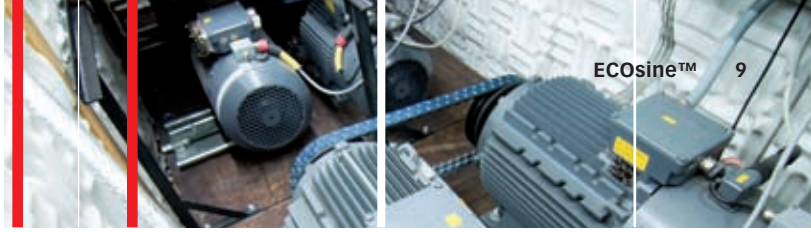
Reliable harmonics mitigation. The best place to eliminate harmonics is right at their source, i.e. at the individual non-linear load. Only then can the propagation of harmonic currents and voltages throughout the system be avoided. Schaffner ECOsine™ filters are uniquely able to master this challenge. They provide a low impedance path for harmonic currents required by the rectifier, thus significantly reducing the amount of harmonics flowing through the electric distribution system. As a result, the non-linear load virtually draws a sinusoidal current from the grid. In a typical motor drive system, the total harmonic current distortion (THID) is reduced to well below 8% at any load condition, and to <5% at full load. Compliance with the toughest total demand distortion (TDD) levels according to table 10-3 of IEEE 519 is therefore ensured.



High performance – not only at full load. Often manufacturers promote filter performance only at full load because light load conditions can be a challenge in terms of both harmonics mitigation and capacitive current. Schaffner ECOsine™ filters not only guarantee the THID rating of 8% maximum over the entire load range, but also limit the amount of capacitive current in all conditions.

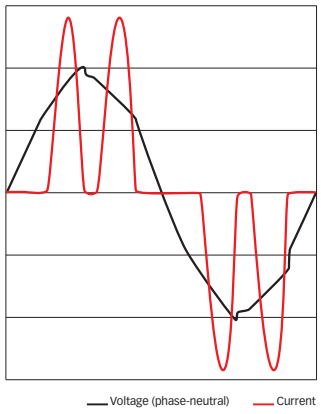


An external capacitor disconnect switch can easily be installed, if capacitive current under light load conditions has to be suppressed. You can obtain more information on this subject from the Schaffner ECOsine™ application note.

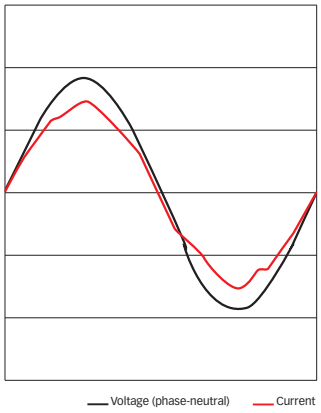


Cost and energy savings. Schaffner ECOsine™ filters reduce harmonics and ensure that a clean sinusoidal current is drawn from the grid. Both true RMS and peak current are reduced in the process, thus lowering the burden on the electric installation.

Without Schaffner ECOsine™



With Schaffner ECOsine™



Example with 5.5kW drive

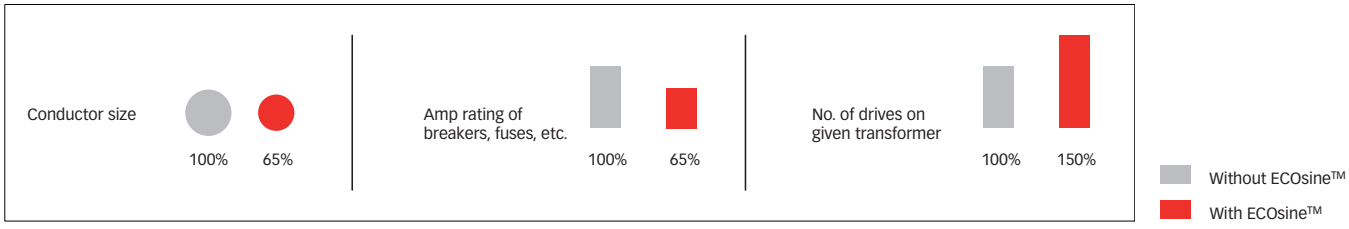
Current:
I_{in} = 11A_{rms} (for power = 5.5kW)
THID = 92 %
PWHD = 37 %
Individual harmonics: 5th – 74 %
7th – 51 %
11th – 13 %
13th – 5 %

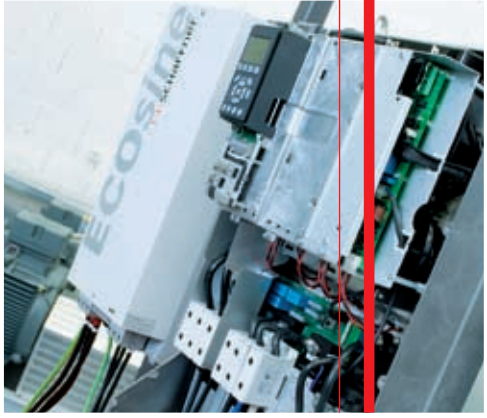
Voltage:
U_{in} = 480V_{rms} (phase-phase)
THVD = 4.4 % (for I_{sc}/I_L = 150)

Current:
I_{in} = 7.5A_{rms} (for power = 5.5kW)
THID = 4.0 %
PWHD = 5.2 %
Individual harmonics: 5th – 2.0 %
7th – 2.2 %
11th – 2.0 %
13th – 1.4 %

Voltage:
U_{in} = 480V_{rms} (phase-phase)
THVD = 0.12 % (for I_{sc}/I_L = 150)

Transformers, conductors, fuses, breakers etc. experience less electric and thermal stress, and can therefore be downsized already in the planning phase. In an existing installation, the capacity of the distribution transformer can be utilized more efficiently, and more electric consumers (e.g. motor drives) can be operated without investments in electric system upgrades.

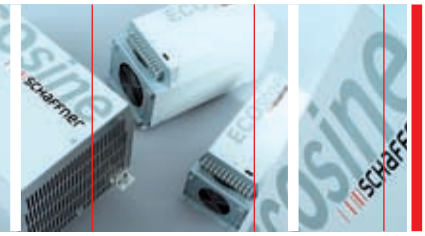




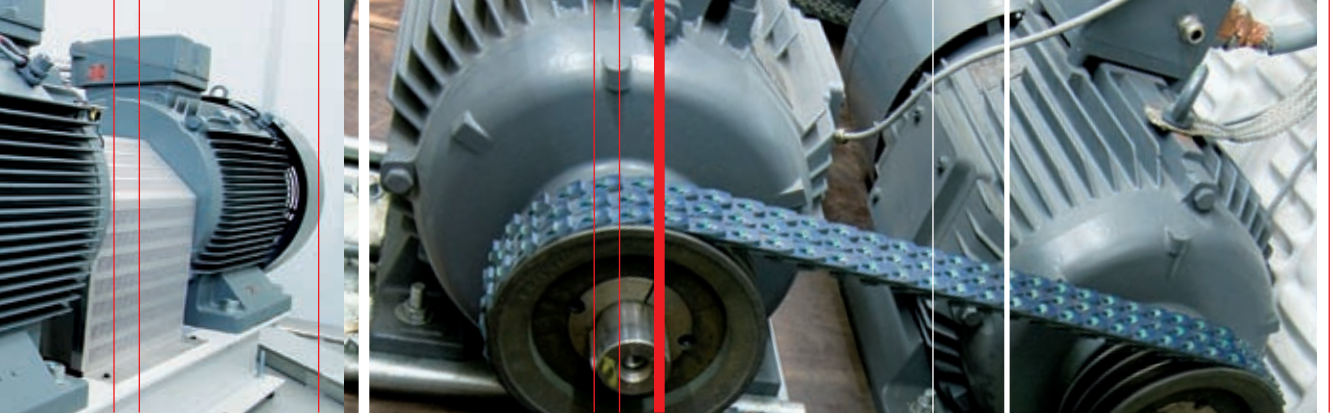
Equipment longevity, reliable production uptime. Because of their unique design, ECOsine™ filters add impedance to the supply, thus providing all the benefits of traditional Schaffner AC line reactors. In motor drive applications, for example, they eliminate nuisance tripping, and protect the rectifier and DC-link capacitors from mains transients. Longer equipment service life and reliable operation of mission-critical applications reduce cost of ownership and help safeguard profits.

Simply plug-and-play. Schaffner ECOsine™ filters are "black boxes" with three input and three output connectors. They can easily be incorporated into existing designs without requiring an in-depth system analysis or highly trained specialists. ECOsine™ filters do not attract harmonics from other parts of the system and do not cause system resonances. They have been designed to operate smoothly with DC-link chokes and EMI filters installed in the same system.

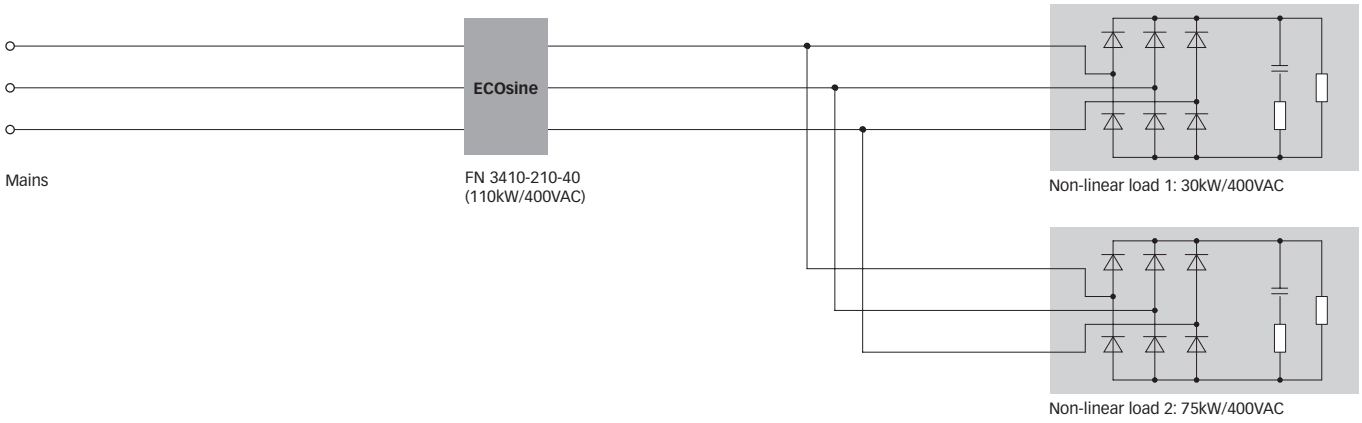
A superior inductor design and advanced thermal management result in the most compact filter package on the market today. Where traditional harmonics mitigation approaches require large standalone cabinets, the compact and light-weight design of ECOsine™ allows for filter integration right in the electric cabinet next to the motor drive.



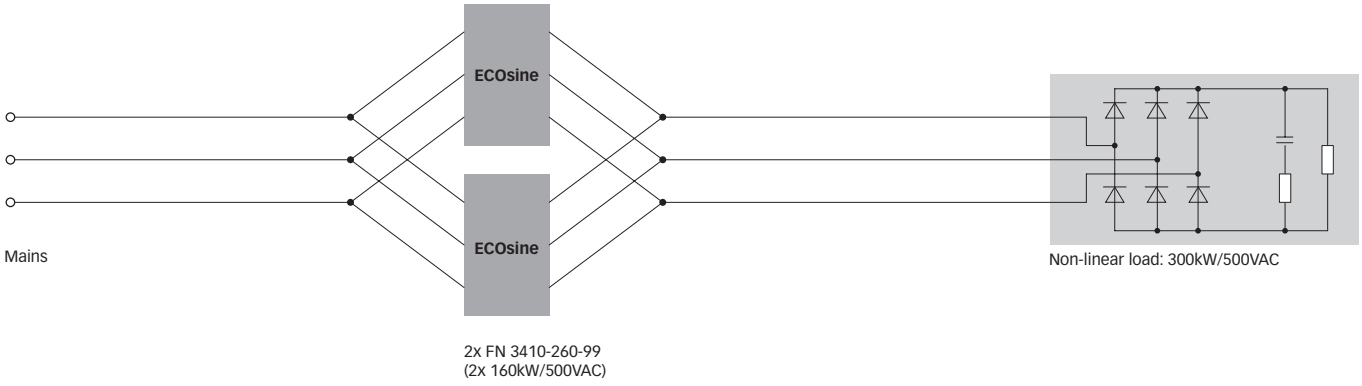
Straightforward filter selection. Schaffner ECOsine™ filters are available for 50Hz (FN 3410 series) and 60Hz (FN 3412 series) power grids. The ideal filter can easily be selected by determining the actual total power rating of the load (e.g. motor drive) to be connected to the filter. Alternatively, the filter can also be selected by the total specified motor drive input current (Arms) before filter installation. It is important to avoid over-specification of the filter because it operates best close to full load.



ECOsine™ filters are designed to be installed at the individual non-linear load. However, they can also reduce harmonics for multiple loads in parallel. If multiple loads are connected to one filter, the filter needs to be matched to the total resulting input power.



Two or more filters can be paralleled in case the total input power of a given load exceeds the largest available product.



Please consult the Schaffner ECOsine™ application note for more details about filter selection, installation, and application.