

User Manual

Open Frame Passive Harmonic Filters

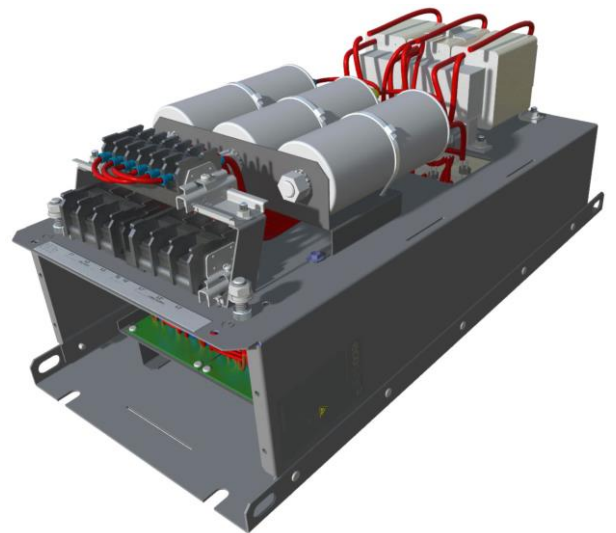


Ecosine EVO (THDi < 5%)

FN3440 (50Hz) for 380–415VAC

FN3450 (50Hz) for 440–500VAC

FN3452 (60Hz) for 380–480VAC



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Revision: 01 (August 2016)

The most current edition of these instructions (PDF format) can be obtained from your contact of the Schaffner organization.

Other technical documentation of our products is also available in the download area of our website www.schaffner.com

Document name:

User Manual ecosine Rev01.pdf

Version history

Revision	Date	Description
01	August 2016	Initial version

i. Ecosine EVO Open Frame

Ecosine EVO Product highlights

Schaffner ecosine EVO passive harmonic filters are configurable products which provide a tailored solution to each specific problem of current harmonics mitigation of 3-phase non-linear loads.

The three product lines, FN3440, FN3450 and FN3452 are applicable for low voltage 50Hz and 60 Hz systems and they are particularly suitable for AC and DC motor drives, battery chargers and other power electronics applications with 6-pulse front-end rectifiers.

Ecosine EVO filter technology represents an evolution of the previous generations of passive harmonic filters and introduces following aspects of novelty:

- | **Ecosine EVO is designed for the most demanding harmonic mitigation tasks.** Ecosine EVO filters FN3440, FN3450 and FN3452 are designed for three-phase diode and thyristor rectifier, to achieve THID $\leq 5\%$ even without DC-link choke included in the drive. The new generation ecosine EVO filters guarantee compliance with the toughest requirement of IEEE-519 and other stringent international power quality standards.
- | **Ecosine EVO demonstrates superior partial load performance.** The excellent performance of ecosine EVO filters not only reflects on mitigating harmonic current and bringing the THID down to 5% (diode rectifiers @ rated power), but also introducing minimum reactive power, even at partial or no load condition. The displacement power factor remains at $\cos\phi > 0.98$ @ 50% load.
- | **The modular concept of ecosine EVO offers optimal tailored solution.** Ecosine EVO are configurable filters, optional modules includes fan with aux. power supply, fan without aux. power supply, trap disconnect jumper and RC damper modules. Optimal solutions can be achieved by merely plugging a new module according to different installation conditions and drive setups.
- | **Most compact design, robust, reliable and ready to use.** IP00 version is available in Nov. 2016, IP20 version is available in March 2017.
- | Schaffner offers ecosine EVO product configurator (myecosine.com) to support customers in finding the best suited filter type.
- | The upgraded version of Schaffner Power Quality Simulator PQS3 provides the possibility to simulate ecosine EVO filters within the system. It furthermore offers quick and accurate performance checks.

This user manual is intended to support designers, installers, and application engineers with filter selection, installation, application, and maintenance. It provides helpful solutions to overcome harmonics mitigation challenges and answers frequently asked questions.

If you require additional support, please feel free to contact your local Schaffner representative.

ii. Important user notice




Schaffner ecosine EVO harmonic filters are designed for the operation on the input (grid) side of power electronic equipment with six-pulse rectifier front-ends in balanced three-phase power systems, like typically used in AC or DC motor drives and high power DC supplies. Filter suitability for a given application must be determined by the user on a case by case basis. Schaffner will not assume liability for any consequential downtimes or damages resulting from use or application of ecosine filters outside of their specifications. Ecosine filters are not designed for single-phase or split-phase applications.

iii. General Safety Notes and Installation Guidelines (Cautions and Warnings)

Important Information

These general safety notes do not only refer to ecosine EVO passive harmonic filters but to the whole group of power quality filters including active and passive harmonic filter (AHF, PHF), AC line chokes and output filters. Do not attempt to install, operate, maintain or inspect power quality filters until you have read through the safety notes and installation guidelines as well as installation manual and product specification. Do not use any Schaffner product until you have a full knowledge of the equipment, safety notes and installation guidelines. The same applies to all warnings placed on the the filters. Please ensure that those are not removed and their legibility is not influenced by external factors.

The following symbols, terms and designations are used in these general safety notes and installation guidelines:













Label	Description
	Follow these instructions to avoid hazardous conditions which could cause minor or moderate injury or may cause damages to the unit.
	Follow these instructions to avoid hazardous conditions which could result in death or serious injury.
	Indicates content to be noted by the reader.



General Installation Notes

- | Please read and follow the safety and application notes below.
- | Carefully inspect the shipping container and the product prior to the installation. In case of visual damage, don't install the filter and file a claim with the freight carrier involved.
- | Filters may be heavy. Follow the instructions for lifting heavy equipment defined by your company.
- | Use an appropriately sized threaded bolt for every mounting hole/slot provided by the filter flange. The strength class of the bolt must be determined by the installer, depending upon filter weight and the material of the mounting surface.
- | Connect the filter to the protective earth (PE) terminal(s).
- | Remove all line side power, then connect the phase terminal(s) and neutral terminal (if any) of the filter. The filter label may also indicate LINE (grid side terminals) and LOAD (power electronics terminals).
- | For the electrical connection of the filter terminals, apply the torques recommended on the filter label and/or in the published filter datasheets.

- | Cable or bus bar cross sections have to be chosen in accordance with national and international electric codes and applicable product standards governing the equipment that will incorporate the power quality filters and the equipment in use.
- | Some filters provide additional terminals, e.g. for over-temperature monitoring. These features have to be properly used before energizing the filter. If uncertain, please consult your local Schaffner representative.
- | Active Harmonic Filters (AHF) are working with current transformers (CTs) which are a 3rd party product and which are typically installed in electrical equipment with lethal high voltage levels. Before attempting to install CTs read the CT installation safety page provided by the CT manufacturer. Always consider transformer as a part of the circuit to which it is connected, and do not touch the leads and terminals or other parts of the transformer unless they are known to be grounded.
- | In order to get the maximum benefit out of your power quality filter, please also consult additional user manuals, installation manuals, whitepaper and other material, published in the download section of www.schaffner.com. These additional guidelines provide helpful hints for equipment related topics as well as technical knowledge.

Safety Notes and Regulations

Label on equipment	Safety note category	Safety note regulations
		Equipment installation, start-up, operation and maintenance (if any) have to be carried out by a trained and certified electrician or technician, who is familiar with safety procedures in electrical systems. Non-qualified persons are not allowed to use, install, operate or maintain PQ filters!
		High voltage potentials are involved in the operation of power quality equipment. Always remove power before handling energized parts of the filter, and let ample time elapse for the capacitors to discharge to safe levels (<42V). Residual voltages are to be measured both line to line and line to earth.
		Correct protective earthing of the equipment must be established and the user must be protected against supply voltage in accordance with applicable national and local regulations. Always practice the safety procedures defined by your company and by applicable national electric codes when handling, installing, operating or maintaining electrical equipment.
		Some product may include EMC filters which may cause leakage currents to ground. Always connect the filter to protective earth (PE) first, then continue with the wiring of phase/neutral terminals. When decommissioning the filter, remove the PE connection at the end.
		Using the direct OFF setting in AHF does not disconnect the equipment from mains and is thus not to be used as a safety switch.
		Follow the general installation and environmental condition notes closely. Ensure that cooling slots (if any) are free from obstructions that could inhibit efficient air circulation. Operate the filter within its electrical, mechanical, thermal and ambient specifications at all times.

	CAUTION	Power quality filters are lossy electrical components. Parts/surfaces of the equipment may get hot under load operating conditions.
	NOTICE	At altitudes above 2000m, please contact Schaffner prior to installation.
	NOTICE	Filter suitability for a given application must ultimately be determined by the user (the party that is putting the filter into operation) on a case by case basis. Schaffner will not assume liability for any consequential downtimes or damages resulting from use of filters outside their specifications.
	CAUTION	In case of uncertainty and questions please contact your local Schaffner partner for assistance (details per region available at www.schaffner.com).

Important safety considerations especially for ecosine passive harmonic filter



Note: Filter installation has to be carried out by a trained and certified electrician or technician, who is familiar with installation and safety procedures in three-phase power systems.

Warning: High voltage potentials are involved in the operation of ecosine filters. Always remove power before handling energized parts of the filter, and let ample time elapse (> 5 minute) for the capacitors to discharge to safe levels.

Measure the residual voltage with a suitable equipment (e.g. multi meter) before touching any conductor or terminal.

Warning: Follow the installation instructions closely. Ensure that fans and cooling slots are free from obstructions that could inhibit efficient air circulation. Do not operate the filter in ambient conditions outside of specifications.

Note: Do not operate ecosine filters on unsymmetrical loads, on linear loads, or with single-phase equipment.

Note: Always use an upstream disconnect or protection device as required by most national and international electric codes.

Note: Always connect the filter to protective earth (PE) first, then continue with the wiring of the trap-disconnect (if needed) and phase connectors. And vice-versa for disconnection of the filter.

Note: Follow the Schaffner instructions closely when doing maintenance work. Use exclusively spare parts recommended and approved by Schaffner.

Note: Always practice the safety instructions defined by your company when handling, installing, operating, or maintaining ecosine harmonic filters.

Note: In case of uncertainty and questions please contact your local Schaffner partner for assistance.

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1. Ecosine EVO filter designation

Ecosine EVO is the new generation of Schaffner Passive Harmonic Filter, they are introduced with new designations, which contains 4 parts, and they are connected with '-' symbol, as shown in Figure 1.

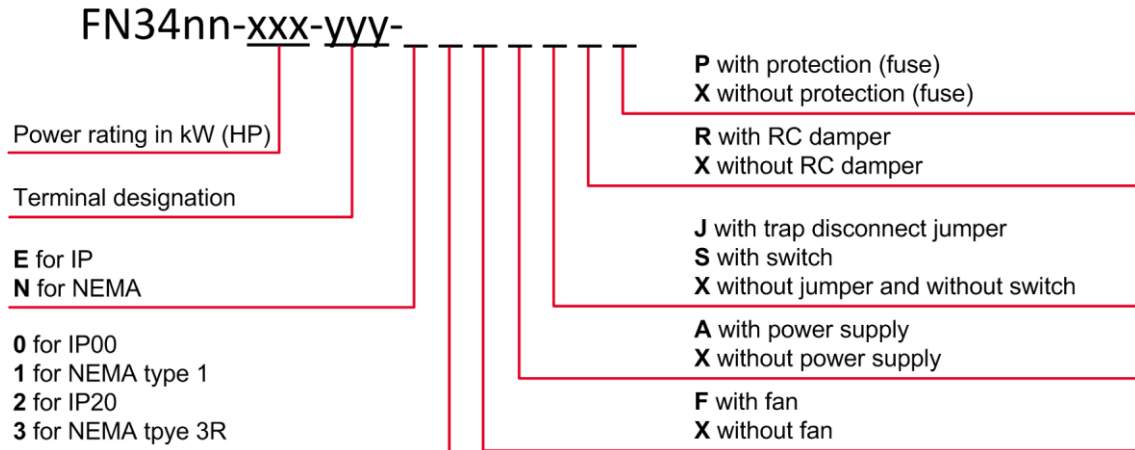


Figure 1 Ecosine EVO designation

- The first part of the designation '**FN34nn-xxx-yyy-E0_ _ _ _ _**' distinguishes the three ecosine EVO families.

	FN3440	FN3450	FN3452
Operating frequency	50 Hz	50 Hz	60 Hz
Nominal operating voltage	3x 380 to 415VAC	3x 440 to 500VAC	3x 440 to 480VAC

- The second part of the designation '**FN34nn-xxx-yyy-E0_ _ _ _ _**' indicates the **motor drive power rating**, in kW for 50Hz filters and HP for 60Hz filters. Please note that ecosine EVO filters are not using current rating in the designation anymore.
- The third part of the designation '**FN34nn-xxx-yyy-E0_ _ _ _ _**' indicates the power terminal types, more information see Table 1.
- The fourth part of the designation '**FN34nn-xxx-yyy-E0_ _ _ _ _**' contains seven slots, the first two reveal the protection category of the filter. The latter five slots represent the presence of optional modules in the filter, as shown in Figure 1. Please find more information in section 2.4, 2.5 and 2.6.

Schaffner offers an online **Product Configurator** (myecosine.com) and the Schaffner Power Quality Simulator **PQS3** (pqs.schaffner.com) to select and verify the most suitable ecosine EVO filter for your application.

Examples:

FN3440-22-115-E0XXJR X: Filter for 50Hz, 380–415VAC grid, motor drive power rating 22kW, with 20mm² terminals, open frame (IP00), filter contains trap disconnect jumper and RC damper modules.

FN3452-150-116-E0XXXXX: Filter for 60Hz, 440–480VAC grid, motor drive power rating 150HP, with 24mm² terminals, open frame (IP00), filter contains no optional modules.

Table 1 Ecosine EVO filter power terminals designation

Filter power terminals

Terminal designation	Screw thread	Flex wire AWG	Screw Torque Value	Max width cable lug	Frame size
			[Nm]	[mm]	
110	M3	14-22	0.5	7	A
112	M4	10-22	1.2	10	B, C
113	M6	6-18	3.0	16	D
115	M8	1/0-8	8	20	E
116	M8	3/0-8	8	17.5	G
118	M10	3/0-500 kcmil	10	21	H

Filter's signal and earth terminals

Terminal type	Screw thread	Screw Torque Value	Frame size
		[Nm]	
Signal	M3*	0.5	All
Earth (PE)	M5	4.0	A
Earth (PE)	M6	8.0	B
Earth (PE)	M6	8.0	C
Earth (PE)	M8	14.0	D
Earth (PE)	M8	14.0	E
Earth (PE)	M10	25.0	F
Earth (PE)	M10	25.0	G
Earth (PE)	M10	25.0	H

* Max width cable lug = 7 mm

2. Filter selection

Ecosine EVO passive harmonic filters need to be carefully selected and configured in order to enjoy maximum benefits. Besides the enclosed selection tables and the product datasheets, Schaffner advises to verify the selection by using Schaffner Power Quality Simulator tool PQS3, pqs.schaffner.com.

Step 1: Grid frequency

Determine, whether the system in consideration will be operated in a 50Hz or 60Hz electricity grid, and select the corresponding filter family according to the following table:

50Hz grid	Europe, Middle East, parts of Asia, parts of South America	FN 3440 / FN 3450
60Hz grid	North and Central America, parts of Asia, parts of South America	FN 3452

Note: a 50Hz filter will not provide satisfying harmonics mitigation in a 60Hz grid, and vice versa.

Step 2: Grid voltage

Verify, that the grid configuration is suitable for standard ecosine EVO filters according to the following table:

50Hz grid	Nominal voltage 380–415VAC	TN, TT, IT configuration
50Hz grid	Nominal voltage 440–500VAC	TN, TT, IT configuration
60Hz grid	Nominal voltage 440–480VAC	TN, TT, IT configuration

Step 3: Rectifier/Drive input power

The individual filter must be selected by the actual rectifier/drive input power (kW, HP). It is important to select the filter as close as possible to the effective input power of the rectifier/drive.

Note that if the rectifier/drive is being operated very close to its rated power, then the filter can be selected by the motor drive's nominal power rating. However, if the drive will be operated e.g. at only 66% of its rated power, then a smaller filter should be selected in order to get maximum harmonics mitigation performance and the optimum in terms of cost, size, and weight.

Please refer to the following examples:

Example 1:

Power line rating: 400V, 50Hz

Drive rating: 380–500V, 50–60Hz, 15kW, 22.5A, B6-diode rectifier

Planned rectifier/drive input real power: 15kW (100% of drive rating)

➔ **Recommended filter according to the filter selection table FN 3440: Type FN3440-15-113**

Example 2:

Power line rating: 500V, 50Hz

Drive rating: 380–500V, 50–60Hz, 15kW, 18A, B6-diode rectifier

Planned rectifier/drive input real power: 15kW (100% of drive rating)

➔ **Recommended filter according to the filter selection table FN 3450: Type FN3450-15-113**

Example 3:

Power line rating: 400V, 50Hz

Drive rating: 380–500V, 50–60Hz, 15kW, 22.5A, diode rectifier

Planned rectifier/drive input real power: 10kW (66% of drive rating)

➔ **Recommended filter according to the filter selection table FN3440: Type FN 3440-11-113**

Example 4:

Power line rating: 480V, 60Hz

Drive rating: 380–500V, 50–60Hz, 30HP, 41A, diode rectifier

Planned rectifier/drive input real power: 30HP (100% of drive rating)

➔ **Recommended filter according to the filter selection table FN3452: Type FN 3452-30-113**

OVERRATING THE FILTER DOES NEVER MAKE SENSE, BECAUSE OF THE INHERENT LOWER HARMONICS MITIGATION PERFORMANCE AT LIGHT LOAD, AS WELL AS HIGHER PRICE, SIZE, AND WEIGHT.

Please refer to Table 2, Table 3, Table 4 to select suited filters.

2.1 Filter selection table FN3440 (50 Hz, 3x380 ... 415VAC)

Table 2 FN3440 filter selection table

Filter	Rated load power @ 400 V/50 Hz [kW]	Current rating line choke [Arms]	Weight [kg]	Terminals	Frame size
FN3440-1-110-E0_____*	1.1	1.63	6.6	110	A
FN3440-2-110-E0_____*	2.2	3.26	9.6	110	A
FN3440-4-112-E0_____*	4	5.93	13.2	112	B
FN3440-6-112-E0_____*	5.5	8.17	16.9	112	C
FN3440-8-112-E0_____	7.5	11.1	20.9	112	C
FN3440-11-113-E0_____	11	16.3	28.2	113	D
FN3440-15-113-E0_____	15	22.2	32.0	113	D
FN3440-19-113-E0_____	19	28.2	33.3	113	D
FN3440-22-115-E0_____	22	32.5	47.5	115	E
FN3440-30-115-E0_____	30	44.4	49.3	115	E
FN3440-37-115-E0_____	37	54.8	59.8	115	E
FN3440-45-115-E0_____	45	66.7	66.8	115	E
FN3440-55-115-E0_____	55	81.6	69.3	115	E
FN3440-75-116-E0_____	75	111	117.6	116	G
FN3440-90-116-E0_____	90	134	138.6	116	G
FN3440-110-118-E0_____	110	164	157.9	118	H
FN3440-132-118-E0_____**	132	197	176.3	118	H
FN3440-160-118-E0_____**	160	240	201.8	118	H
FN3440-200-118-E0_____**	200	300	249.7	118	H

* Filter rating which does not require forced cooling or fan module

** Filter rating which does not require RC damping module for rectifiers with EMI filter

2.2 Filter selection table FN3450 (50 Hz, 3×440 ... 500VAC)

Table 3 FN3450 filter selection table

Filter	Rated load power @ 480 VAC/50 Hz [kW]	Current rating line choke [Arms]	Weight [kg]	Terminals	Frame size
FN3450-1-110-E0_*****	1.1	1.35	5.8	110	A
FN3450-2-110-E0_*****	2.2	2.75	8.4	110	A
FN3450-4-112-E0_*****	4	4.99	11.3	112	B
FN3450-6-112-E0_*****	5.5	6.77	14.0	112	B
FN3450-8-112-E0_*****	7.5	9.24	16.9	112	C
FN3450-11-112-E0_****	11	13.6	20.9	112	C
FN3450-15-113-E0_****	15	18.5	28.2	113	D
FN3450-19-113-E0_****	19	23.3	32.0	113	D
FN3450-22-113-E0_****	22	27.0	36.0	113	D
FN3450-30-115-E0_****	30	36.9	47.5	115	E
FN3450-37-115-E0_****	37	45.4	53.9	115	E
FN3450-45-115-E0_****	45	55.2	63.1	115	E
FN3450-55-115-E0_****	55	67.5	66.8	115	F
FN3450-75-115-E0_****	75	92.5	88.1	115	F
FN3450-90-116-E0_****	90	111	120.1	116	G
FN3450-110-116-E0_****	110	135	140.6	116	G
FN3450-132-118-E0_****	132	163	160.9	118	H
FN3450-160-118-E0_*****	160	198	181.1	118	H
FN3450-200-118-E0_*****	200	248	216.8	118	H
FN3450-250-118-E0_*****	250	310	256.7	118	H

* Filter rating which does not require forced cooling or fan module

** Filter rating which does not require RC damping module for rectifiers with EMI filter

2.3 Filter selection table FN3452 (60 Hz, 3×380 ... 480VAC)

Table 4 FN3452 filter selection table

Filter	Rated load power @ 480 V/60 Hz [kW]	Rated load power @ 480 V/60 Hz [HP]	Current rating line choke [Arms]	Weight [kg]	Weight [lbs]	Terminals	Frame size
FN3452-1-110-E0X_*****	1.1	1.5	1.37	5.7	12.6	110	A
FN3452-3-110-E0X_*****	2.2	3	2.76	7.9	17.4	110	A
FN3450-5-112-E0X_*****	3.7	5	4.57	10.1	22.3	112	B
FN3452-8-112-E0X_*****	5.6	7.5	6.91	12.7	28.0	112	B
FN3452-10-112-E0X_*****	7.5	10	9.29	13.6	30.0	112	B
FN3452-15-112-E0X_*****	11	15	13.8	18.0	39.7	112	C
FN3452-20-113-E0X_****	15	20	18.5	26.8	59.1	113	D
FN3452-25-113-E0X_****	19	25	23.1	30.8	67.9	113	D
FN3452-30-113-E0X_****	22	30	27.8	35.6	78.5	113	D
FN3452-40-115-E0X_****	30	40	37.2	46.0	101.4	115	E
FN3452-50-115-E0X_****	37	50	46.2	51.1	112.6	115	E
FN3452-60-115-E0X_****	45	60	55.6	59.2	130.5	115	E
FN3452-75-115-E0X_****	56	75	69.3	59.9	132.0	115	F
FN3452-100-115-E0X_****	75	100	92.5	82.4	181.6	115	F
FN3452-125-116-E0X_****	93	125	115	116.2	256.1	116	G
FN3452-150-116-E0X_****	112	150	139	137.1	302.2	116	G
FN3452-200-118-E0X_****	149	200	184	169.7	374.0	116	H
FN3452-250-118-E0X_*****	186	200	231	186.9	411.9	118	H
FN3452-300-118-E0X_*****	224	300	279	251.9	555.2	118	H

* Filter rating which does not require forced cooling or fan module

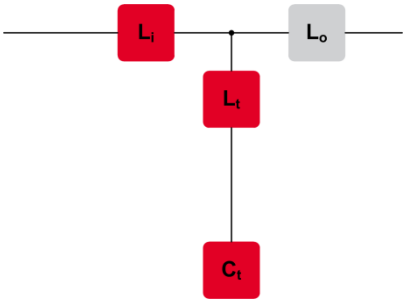
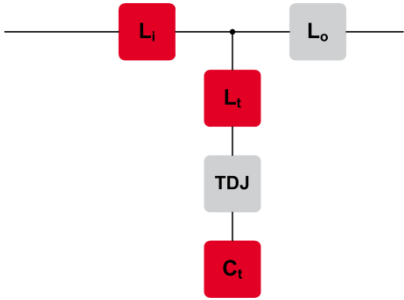
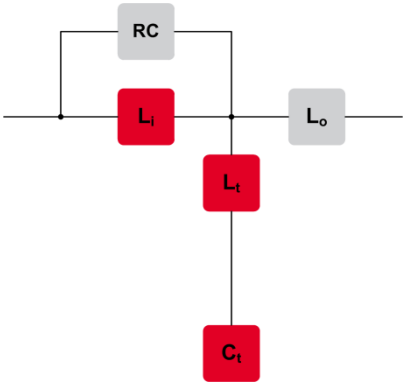
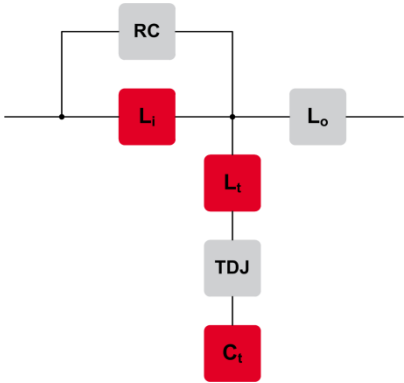
** Filter rating which does not require RC damping module for rectifiers with EMI filter

2.4 Filter configurations and designations if external air flow available for cooling

If there is external air flow is available for cooling in the installation, then the filters do **not contain fan** and do **not contain aux. power supply**.

The open frame filter configurations are shown in Table 5, if external air flow is available for cooling,

Table 5 Filter configurations if external air flow available for cooling

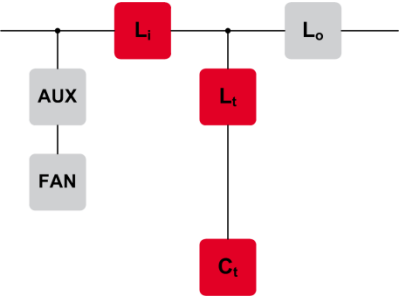
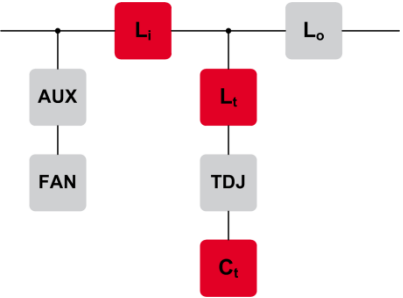
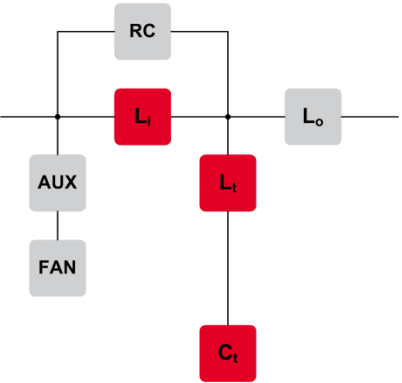
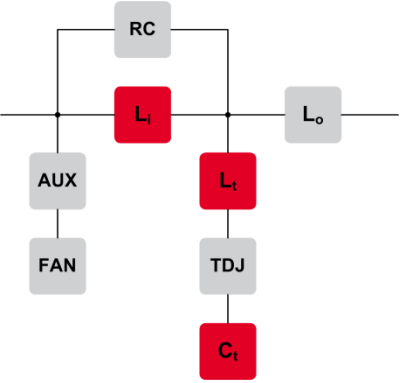
<p>E0XXXXX</p> <p>– For rectifiers without DC-link choke</p> 	<p>E0XXJXX</p> <p>– For rectifiers without DC-link choke – Filters contain trap disconnect jumper</p> 
<p>E0XXXXRX</p> <p>– For rectifiers without DC-link choke and with EMI filter – Filters contain RC damper module</p> 	<p>E0XXJRXX</p> <p>– For rectifiers without DC-link choke and with EMI filter – Filters contain RC damper module and trap disconnect jumper</p> 

2.5 Filter configurations and designation with embedded ventilation

If external air flow for cooling is not available, then the filters contain embedded ventilation, which means the filters **contain fan and aux. power supply**.

The open frame filter configurations are shown in Table 6, if external air flow is not available and embedded ventilation is equipped.

Table 6 Filter configurations with embedded ventilation

<p>E0FAXXX</p> <ul style="list-style-type: none"> – For rectifiers without DC-link choke – Filters contain fan and aux. power supply 	<p>E0FAJXX</p> <ul style="list-style-type: none"> – For rectifiers without DC-link choke – Filters contain fan, aux. power supply and trap disconnect jumper 
<p>E0FAXRX</p> <ul style="list-style-type: none"> – For rectifiers without DC-link choke and with EMI filter – Filters contain fan, aux. power supply and RC damper module 	<p>E0FAJRX</p> <ul style="list-style-type: none"> – For rectifiers without DC-link choke and with EMI filter – Filters contain fan, aux. power supply, RC damper module and trap disconnect jumper 

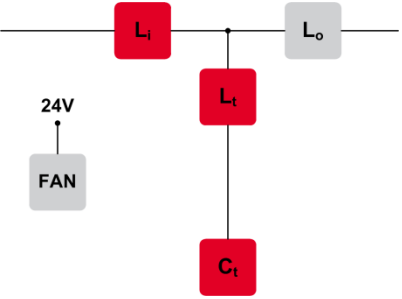
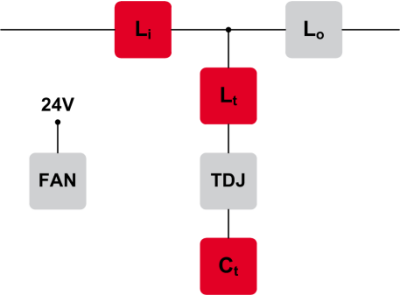
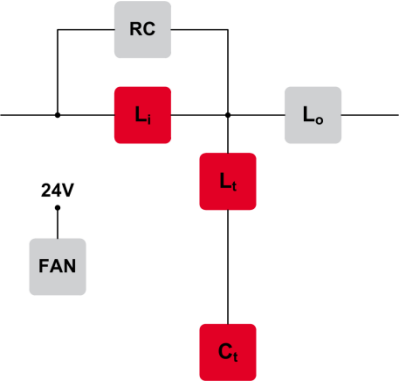
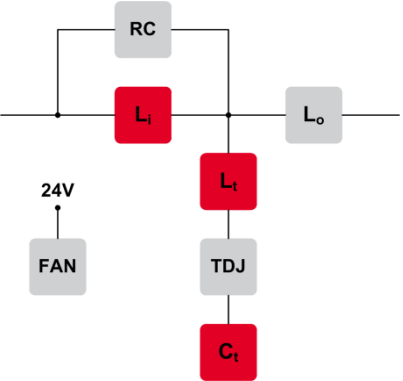
Remark: Frame sizes A, B, C do not require air-flow for cooling and hence they are not equipped with FAN and AUX.

2.6 Filter configurations and designation if external aux. power supply for the fan is available

If there is an external 24V DC power supply available to the fan, then the filters **contain fan** but do **not contain aux.power supply**, user should provide aux. power supply to the fan.

The open frame filter configurations are shown in Table 7, if external air flow is not available but external aux.power supply for the fan is available.

Table 7 Filter configurations if external aux.power supply for the fan is available

<p>E0FXXXX</p> <ul style="list-style-type: none"> - For rectifiers without DC-link choke - Filters contain fan 	<p>E0FXJXX</p> <ul style="list-style-type: none"> - For rectifiers without DC-link choke - Filters contain fan and trap disconnect jumper 
<p>E0FXXRX</p> <ul style="list-style-type: none"> - For rectifiers without DC-link choke and with EMI filter - Filters contain fan and RC damper module 	<p>E0FXJRX</p> <ul style="list-style-type: none"> - For rectifiers without DC-link choke and with EMI filter - Filters contain fan, RC damper module and trap disconnect jumper 

Remark: Frame sizes A, B, C do not require air-flow for cooling and hence they are not equipped with FAN.

3. Filter description

3.1 General electrical specifications FN 3440 (50Hz filters)

Nominal operating voltage:	3x 380 to 415VAC
Voltage tolerance range:	3x 342 to 457VAC
Operating frequency:	50Hz ±1Hz
Network:	TN, TT, IT
Nominal motor drive input power rating:	1.1 to 200kW
Total harmonic current distortion THID: ²⁾	<5% @ rated power ¹⁾
Total demand distortion TDD: ²⁾	According to IEEE 519
Efficiency:	>98% @ nominal line voltage and power
Drive dc-link voltage: ³⁾	-5% ~ +10% nominal V _{DC}
High potential test voltage: ⁴⁾	P → E 2160 VAC (1s)
SCCR: ⁵⁾	100kA, fuses according UL class J
Protection category:	IP00 (Open Frame)
Pollution degree:	PD3 (according to standard IEC 60664-1)
Cooling:	Internal fan cooling or external cooling ⁶⁾
Overload capability:	1.6x rated current for 1 minute, once per hour
Capacitive current @ no load:	<20% of rated input current, at 400VAC
Ambient temperature range:	-25°C to +45°C fully operational +45°C to +70°C derated operation ⁷⁾ -25°C to +85°C transportation and storage
Flammability class:	UL 94V-2
Insulation class of magnetic components:	N (200°C), H (180°C)
Design corresponding to:	Filter: UL 61800-5-1, EN 61800-5-1 Chokes: EN 61558-2-20 or EN 60076-6
MTBF @ 45°C/415V (Mil-HB-217F):	>200,000 hours
MTTR:	<15 minutes (capacitor modules and fan modules)
Lifetime (calculated):	≥10 years
Safety monitor output signal:	Thermal switch NC 180° C (UL-approved) to detect overload of chokes

¹⁾ THID ~5% at rated power for filter < 4kW.

²⁾ System requirements: THVD <2%, line voltage unbalance <1%
 Performance specification for six-pulse diode rectifiers. SCR rectifier front-ends produce different results, depending upon the firing angle of the thyristors.

³⁾ Conditions: line impedance <3%

⁴⁾ Repetitive tests to be performed at max. 80% of above levels, for 2 seconds.

⁵⁾ External UL-rated fuses required.

⁶⁾ Please check the inlet air flow required for cooling in Table 9

⁷⁾ $I_{derated} = I_{nominal} \times \sqrt{((70^{\circ}\text{C} - T_{amb}) / 25^{\circ}\text{C})}$

3.2 General electrical specifications FN 3450 (50Hz filters)

Nominal operating voltage:	3x 440 to 500VAC
Voltage tolerance range:	3x 396 to 550VAC
Operating frequency:	50Hz ±1Hz
Network:	TN, TT, IT
Nominal motor drive input power rating:	1.1 to 250kW
Total harmonic current distortion THID: ²⁾	<5% @ rated power ¹⁾
Total demand distortion TDD: ²⁾	According to IEEE 519
Efficiency:	>98% @ nominal line voltage and power
Drive dc-link voltage behavior: ³⁾	-5% ~ +10% nominal V _{DC}
High potential test voltage: ⁴⁾	P → E 2160 VAC (1s)
SCCR: ⁵⁾	100kA, fuses according UL class J
Protection category:	IP00 (Open Frame)
Pollution degree:	PD3 (according to standard IEC 60664-1)
Cooling:	Internal fan cooling or external cooling ⁶⁾
Overload capability:	1.6x rated current for 1 minute, once per hour
Capacitive current @ no load:	<20% of rated input current, at 480VAC
Ambient temperature range:	-25°C to +45°C fully operational +45°C to +70°C derated operation ⁷⁾ -25°C to +85°C transportation and storage
Flammability class:	UL 94V-2
Insulation class of magnetic components:	N (200°C), H (180°C)
Design corresponding to:	Filter : UL 61800-5-1, EN 61800-5-1 Chokes : EN 61558-2-20 or EN 60076-6
MTBF @ 45°C/415V (Mil-HB-217F):	>200,000 hours
MTTR:	<15 minutes (capacitor modules and fan modules)
Lifetime (calculated):	≥10 years
Safety monitor output signal:	Thermal switch NC 180° C (UL-approved) to detect overload of chokes

¹⁾ THID ~5% at rated power for filter < 4kW.

²⁾ System requirements: THVD <2%, line voltage unbalance <1%
 Performance specification for six-pulse diode rectifiers. SCR rectifier front-ends produce different results, depending upon the firing angle of the thyristors.

³⁾ Conditions: line impedance <3%

⁴⁾ Repetitive tests to be performed at max. 80% of above levels, for 2 seconds.

⁵⁾ External UL-rated fuses required.

⁶⁾ Please check the inlet air flow required for cooling in Table 9.

⁷⁾ $I_{derated} = I_{nominal} \times \sqrt{((70^{\circ}\text{C} - T_{amb}) / 25^{\circ}\text{C})}$

3.3 General electrical specifications FN 3452 (60Hz filters)

Nominal operating voltage:	3x 440 to 480VAC
Voltage tolerance range:	3x 396 to 528VAC
Operating frequency:	60Hz ±1Hz
Network:	TN, TT, IT
Nominal motor drive input power rating:	1.5 to 300 HP (1.1 to 224 kW)
Total harmonic current distortion THID: ²⁾	<5% @ rated power ¹⁾
Total demand distortion TDD: ²⁾	According to IEEE 519
Efficiency:	>98% @ nominal line voltage and power
Drive dc-link voltage: ³⁾	-5% ~ +10% nominal V _{DC}
High potential test voltage: ⁴⁾	P → E 2160 VAC (1s)
SCCR: ⁵⁾	100kA, fuses according UL class J
Protection category:	IP00 (Open Frame)
Pollution degree:	PD3 (according to standard IEC 60664-1)
Cooling:	Internal fan cooling or external cooling ⁶⁾
Overload capability:	1.6x rated current for 1 minute, once per hour
Capacitive current @ no load:	<20% of rated input current, at 480VAC
Ambient temperature range:	-25°C to +45°C fully operational +45°C to +70°C derated operation ⁷⁾ -25°C to +85°C transportation and storage
Flammability class:	UL 94V-2
Insulation class of magnetic components:	N (200°C), H (180°C)
Design corresponding to:	Filter : UL 61800-5-1, EN 61800-5-1 Chokes : EN 61558-2-20 or EN 60076-6
MTBF @ 45°C/415V (Mil-HB-217F):	>200,000 hours
MTTR:	<15 minutes (capacitor modules and fan modules)
Lifetime (calculated):	≥10 years
Safety monitor output signal:	Thermal switch NC 180° C (UL-approved) to detect overload of chokes

¹⁾ THID ~5% at rated power for filter < 6HP.

²⁾ System requirements: THVD <2%, line voltage unbalance <1%
 Performance specification for six-pulse diode rectifiers. SCR rectifier front-ends produce different results, depending upon the firing angle of the thyristors.

³⁾ Conditions: line impedance <3%

⁴⁾ Repetitive tests to be performed at max. 80% of above levels, for 2 seconds.

⁵⁾ External UL-rated fuses required.

⁶⁾ Please check the inlet air flow required for cooling in Table 9.

⁷⁾ $I_{\text{derated}} = I_{\text{nominal}} \times \sqrt{((70^{\circ}\text{C} - T_{\text{amb}}) / 25^{\circ}\text{C})}$

3.4 Additional electrical specifications

Ecosine EVO passive filters general electrical specifications refer to operating altitudes up to 2000m a.s.l. (6600ft).

Operation between 2000m and 4000m (6600ft and 13123ft) requires a derating for current and clearance according to IEC 60664-1 (table A.2), hereafter enclosed:

Table 8 Altitude correction factors

Table A.2 – Altitude correction factors

Altitude m	Normal barometric pressure kPa	Multiplication factor for clearances
2 000	80,0	1,00
3 000	70,0	1,14
4 000	62,0	1,29
5 000	54,0	1,48
6 000	47,0	1,70
7 000	41,0	1,95
8 000	35,5	2,25
9 000	30,5	2,62
10 000	26,5	3,02
15 000	12,0	6,67
20 000	5,5	14,5

Remark: Do not use ecosine EVO passive harmonic filters in altitudes above 4000m without consulting Schaffner first.

Table 9 Inlet air flow required for cooling

Frame size	Min air volume*	
	[m ³ /h]	CFM [ft ³ /min]
A, B, C	0	0
D	128	75
E	204	120
F, G	408	240
H	612	360

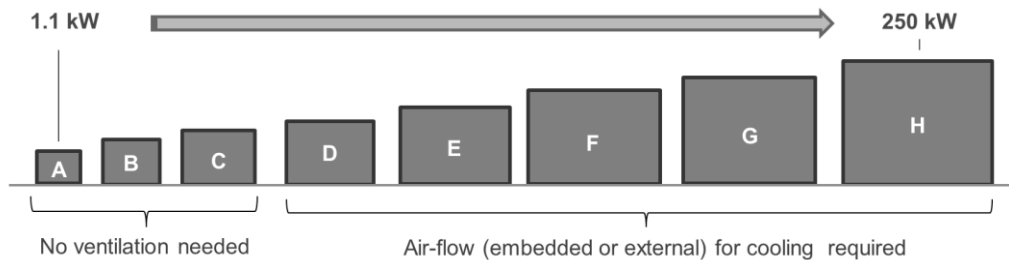
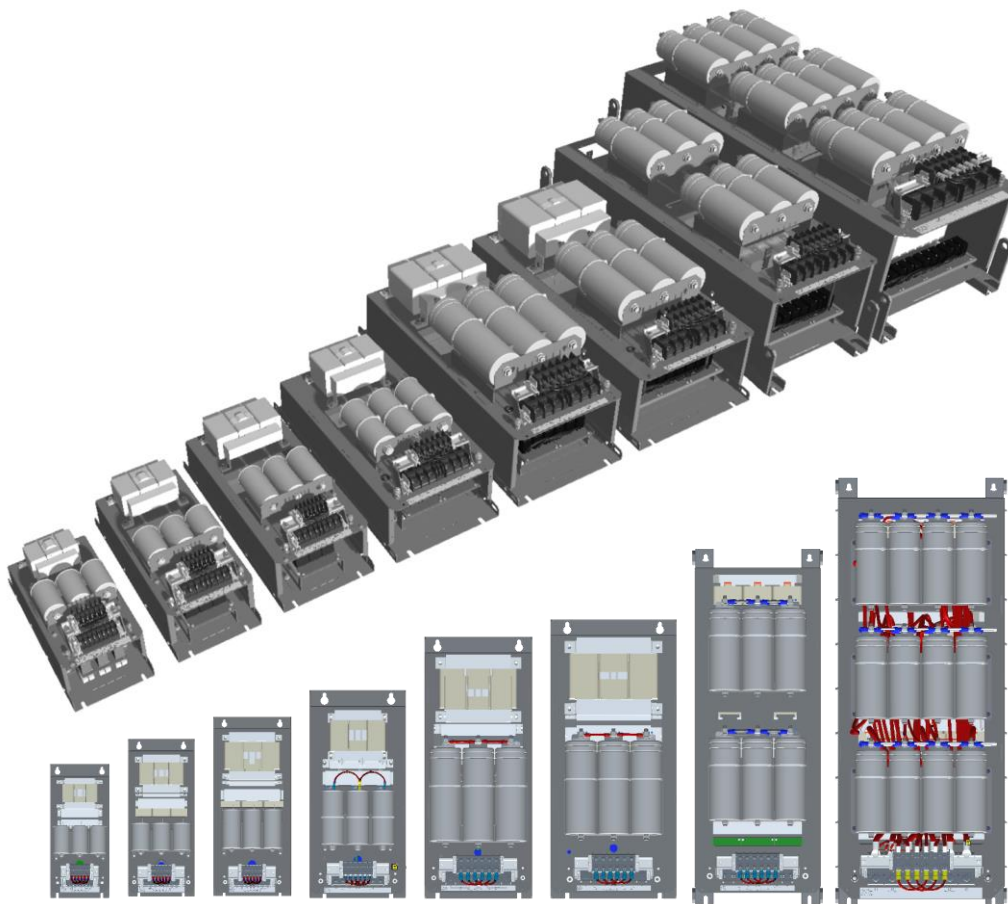
* External air flow required for filter configurations without embedded ventilation

Remark: External air flow is required for the cooling at filter's inlet as defined in the table only for filters without embedded ventilation.

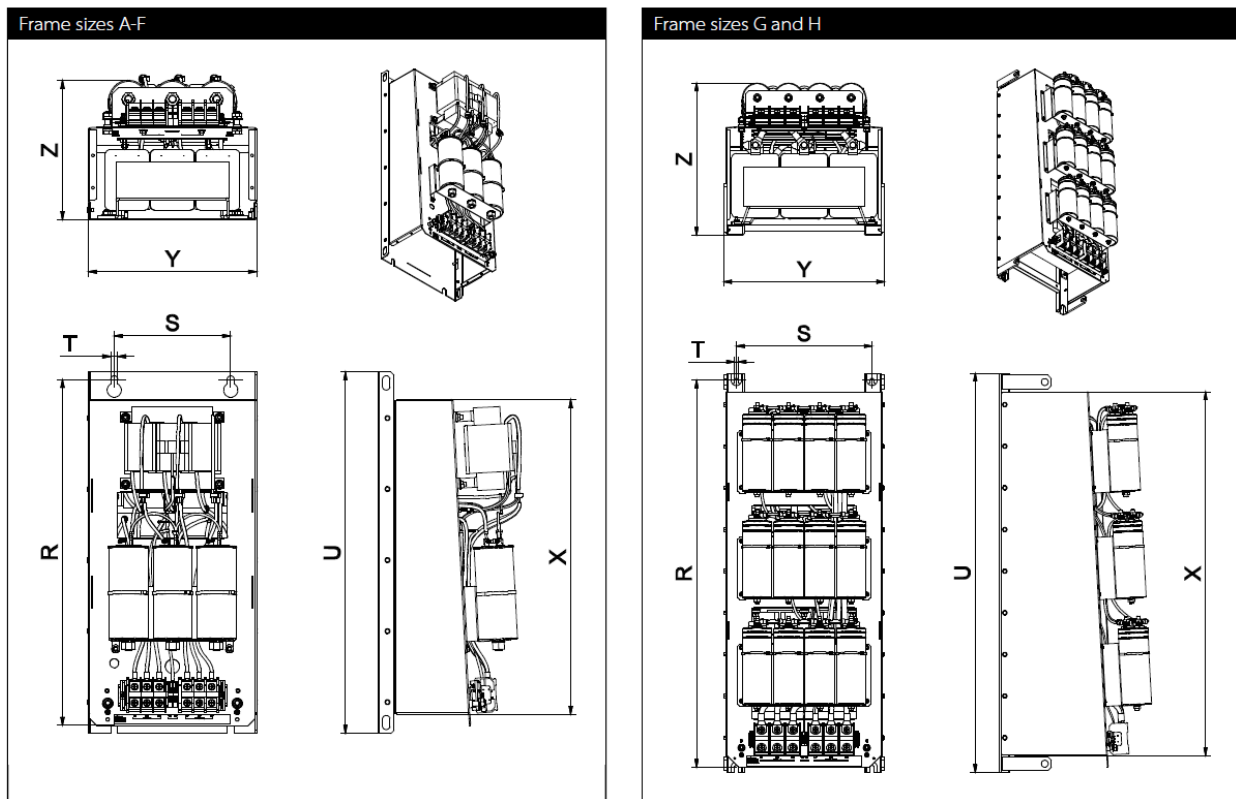
3.5 Mechanical frame sizes

Ecosine EVO passive filters are implemented on a base plate or base frame featuring 8 different frame sizes or footprints (A to H), from the lowest to the highest rating. Dimensions and footprint are provided in section 3.6.

In particular, frame sizes A to C do not require air-flow (embedded fan or external ventilation); details are provided in filter selection tables, Table 2 Table 2, and Table 3.



3.6 Ecosine EVO filter footprint



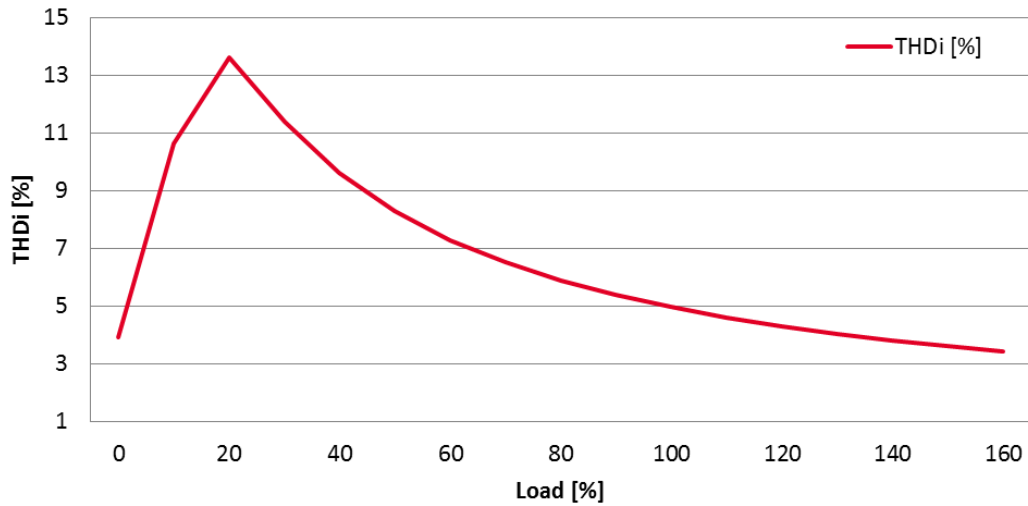
Dimensions

Frame	Drill pattern [mm]			Base [mm]			Volume [mm]	
	R	S	T	U	X	Y	Z	
A	340	120	7	360	302	160	185	
B	405	120	7	370	370	180	206	
C	460	150	7	425	430	210	221	
D	540	180	11	483	491	260	252	
E	680	220	11	705	634	290	339	
G	920	280	11	960	863	353	396	
H	1115	390	11	1150	1053	462	456	

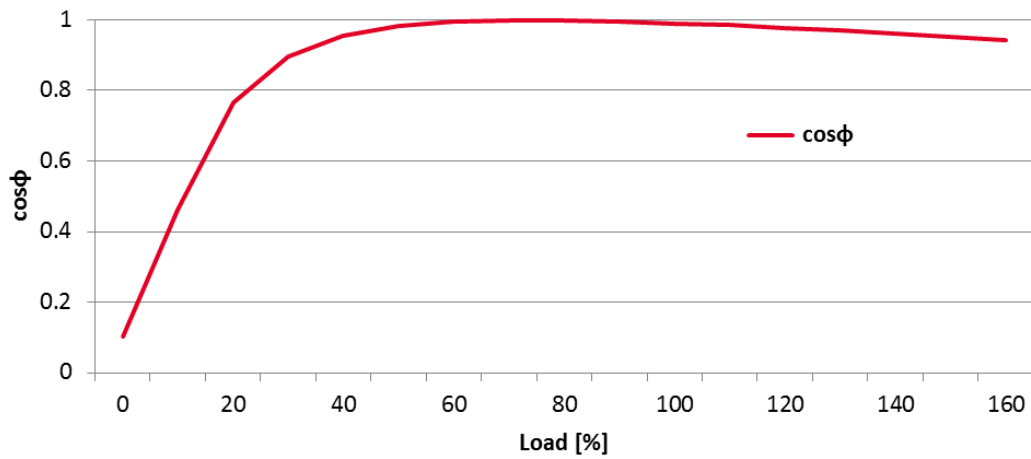
Figure 2 Dimensions of all frame sizes

3.7 Performance characteristics

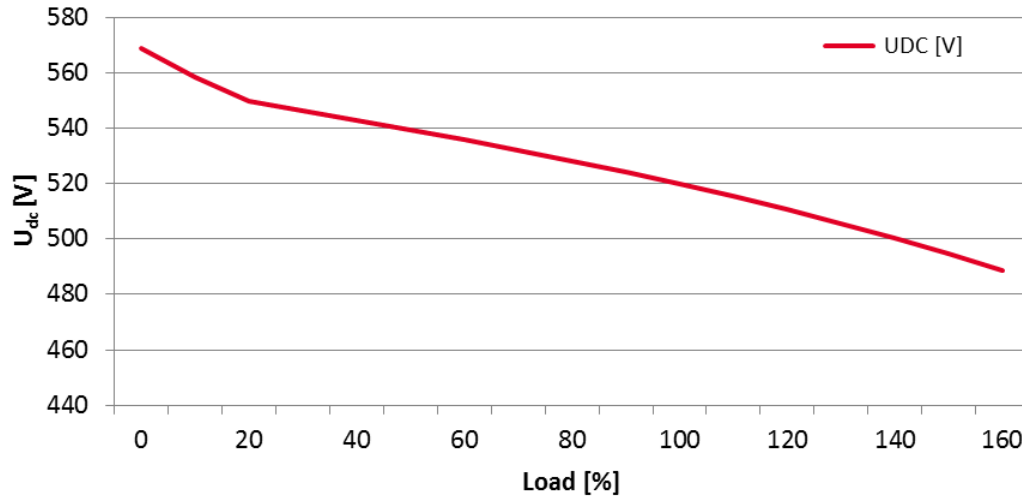
THDi vs. load (diode rectifier front-ends)



Power factor vs. load (diode rectifier front-ends)

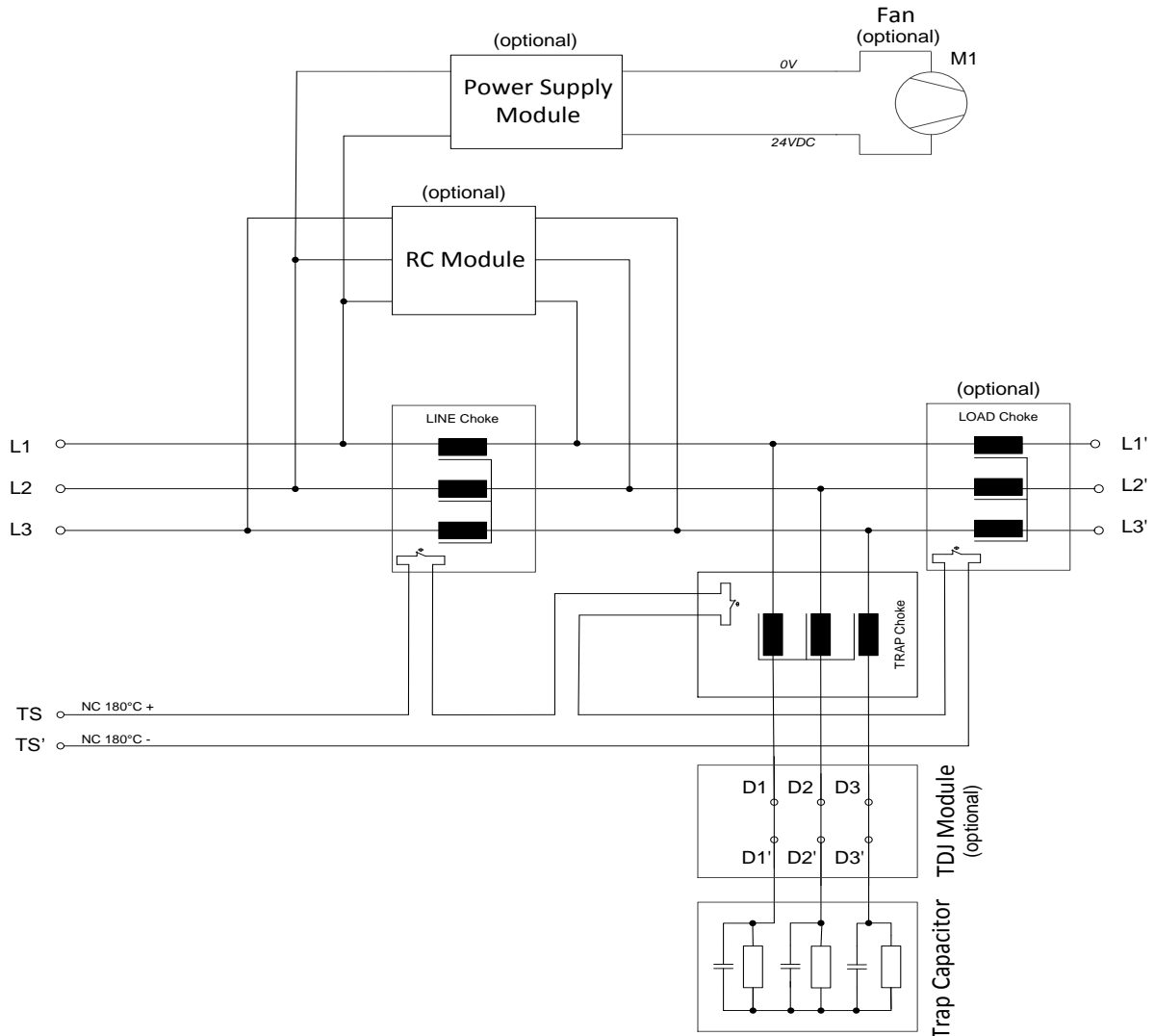


Drive dc-link voltage vs. load (diode rectifier front-ends)



In thyristor rectifier applications, filter characteristics depend upon the firing angle of the thyristors.

3.8 Functional diagram



Filter terminals	Line L1/L2/L3	3 terminal blocks
	Load L1'/L2'/L3'	3 terminal blocks
	Signal	Connecting terminals to thermal switch NC 180°C (UL-approved) to detect overload in chokes
	PE	Protective earth. Threaded stud with washer and nut
	Trap disconnect D1, D2, D3 D1', D2', D3'	3 couples of terminals. For optional configurations with TDJ, wire bridges are installed for immediate operation of the filter. They allow for the connection of an external contactor for load dependent disconnection of the trap circuit, if needed.
Function blocks	Chokes	Power magnetic components incl. temperature sensors
	Capacitors	Power capacitors incl. discharge resistors
	Fan	Field replaceable fan for choke air cooling
	Power supply	Internally generated 24VDC source for fan supply
	RC damper	RC damper module, as option configurable in case of rectifier equipped with EMI filter

4. Filter appearance and elements

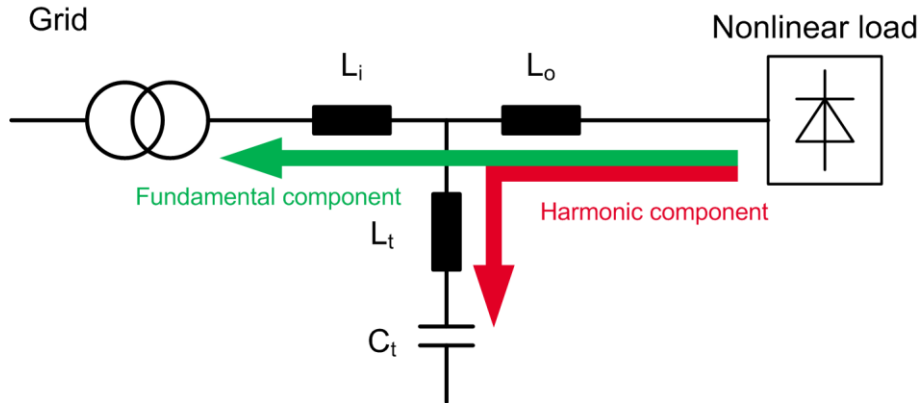


Figure 3 Ecosine EVO working principle

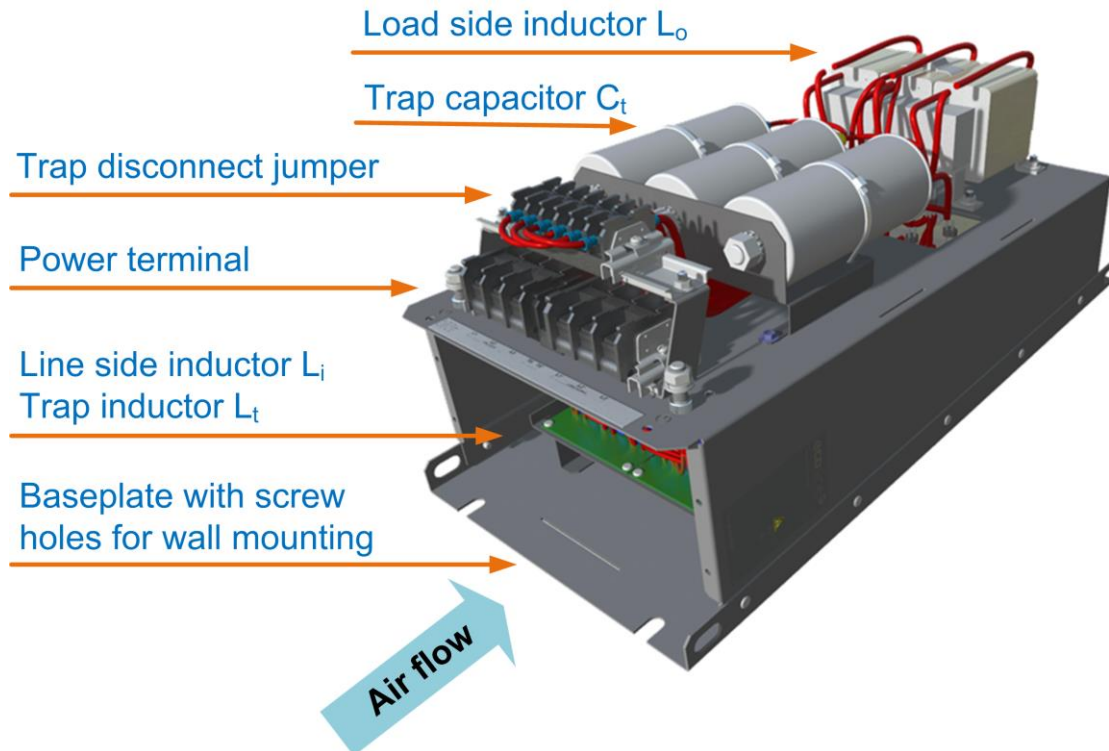


Figure 4 Ecosine EVO elements

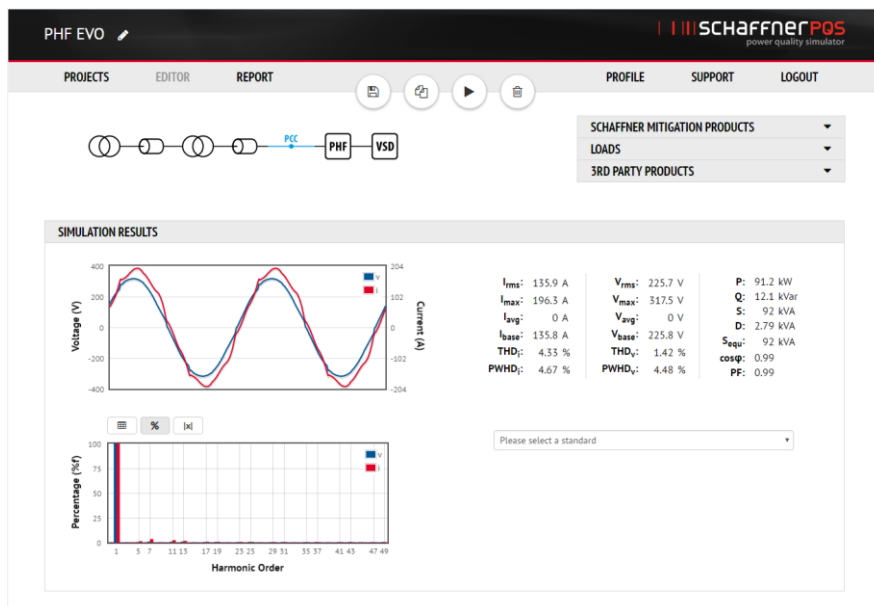
5. Performance verification using the Schaffner's PQS3

The new ecosine EVO filters are included and ready to simulate in Schaffner Power Quality Simulator tool PQS (pqs.schaffner.com), which enable users to simulate and verify the system performance taking into account the most important design requirements and system's boundary conditions.

Furthermore, a new online product configurator (myecosine.com) helps and guides users to select the best filter topology and choose the appropriate configurable functional options.



Simulate and estimate the performance of your selected ecosine EVO filters with Schaffner Power Quality Simulator PQS3.



FN344X SERIES

FULL PERFORMANCE LINE (400 V)

Filter	Load Power @ 400 VAC (kW)	DC-link or AC choke existing	EMI filter in front of drive
FN344x-1-110	1.10	<input type="checkbox"/>	<input type="checkbox"/>
FN344x-2-110	2.20	<input type="checkbox"/>	<input type="checkbox"/>
FN344x-4-112	4.00	<input type="checkbox"/>	<input type="checkbox"/>
FN344x-6-112	5.50	<input type="checkbox"/>	<input type="checkbox"/>
FN344x-8-112	7.50	<input type="checkbox"/>	<input type="checkbox"/>
FN344x-11-113	11.0	<input type="checkbox"/>	<input type="checkbox"/>
FN344x-15-113	15.0	<input type="checkbox"/>	<input type="checkbox"/>
FN344x-19-113	19.0	<input type="checkbox"/>	<input type="checkbox"/>
FN344x-22-115	22.0	<input type="checkbox"/>	<input type="checkbox"/>
FN344x-30-115	30.0	<input type="checkbox"/>	<input type="checkbox"/>
FN344x-37-115	37.0	<input type="checkbox"/>	<input type="checkbox"/>
FN344x-45-115	45.0	<input type="checkbox"/>	<input type="checkbox"/>
FN344x-55-115	55.0	<input type="checkbox"/>	<input type="checkbox"/>
FN344x-75-116	75.0	<input type="checkbox"/>	<input type="checkbox"/>
FN344x-90-116	90.0	<input type="checkbox"/>	<input type="checkbox"/>
FN344x-110-118	110	<input type="checkbox"/>	<input type="checkbox"/>
FN344x-132-118	132	<input type="checkbox"/>	<input type="checkbox"/>
FN344x-160-118	160	<input type="checkbox"/>	<input type="checkbox"/>

FN345X SERIES

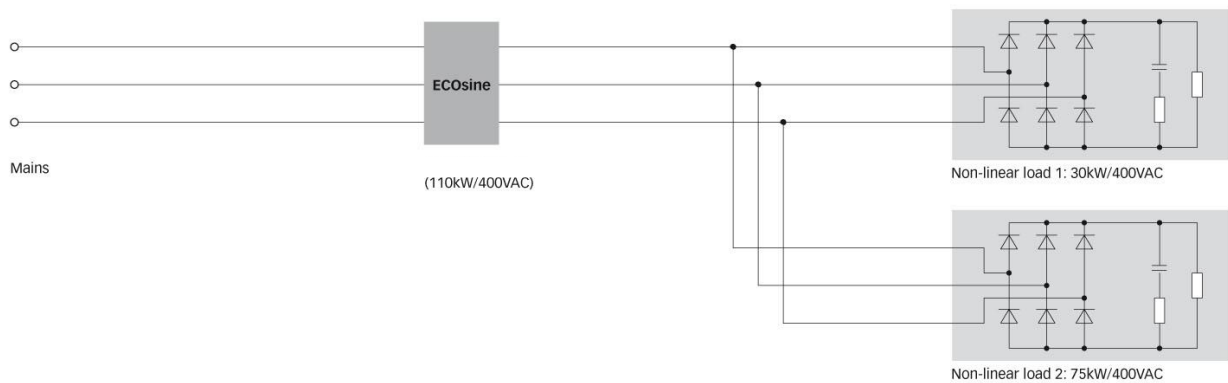
FULL PERFORMANCE LINE (480 V)

Filter	Load Power @ 400 VAC (kW)	DC-link or AC choke existing	EMI filter in front of drive
FN345x-1-110	0.917	<input type="checkbox"/>	<input type="checkbox"/>
FN345x-2-110	1.83	<input type="checkbox"/>	<input type="checkbox"/>
FN345x-4-112	3.33	<input type="checkbox"/>	<input type="checkbox"/>
FN345x-6-112	4.58	<input type="checkbox"/>	<input type="checkbox"/>
FN345x-8-112	6.25	<input type="checkbox"/>	<input type="checkbox"/>
FN345x-11-112	9.17	<input type="checkbox"/>	<input type="checkbox"/>
FN345x-15-113	12.5	<input type="checkbox"/>	<input type="checkbox"/>
FN345x-19-113	15.8	<input type="checkbox"/>	<input type="checkbox"/>
FN345x-22-113	18.3	<input type="checkbox"/>	<input type="checkbox"/>
FN345x-30-115	25.0	<input type="checkbox"/>	<input type="checkbox"/>
FN345x-37-115	30.8	<input type="checkbox"/>	<input type="checkbox"/>
FN345x-45-115	37.5	<input type="checkbox"/>	<input type="checkbox"/>
FN345x-55-115	45.8	<input type="checkbox"/>	<input type="checkbox"/>
FN345x-75-115	62.5	<input type="checkbox"/>	<input type="checkbox"/>
FN345x-90-116	75.0	<input type="checkbox"/>	<input type="checkbox"/>
FN345x-110-116	91.7	<input type="checkbox"/>	<input type="checkbox"/>
FN345x-132-118	110	<input type="checkbox"/>	<input type="checkbox"/>
FN345x-160-118	133	<input type="checkbox"/>	<input type="checkbox"/>

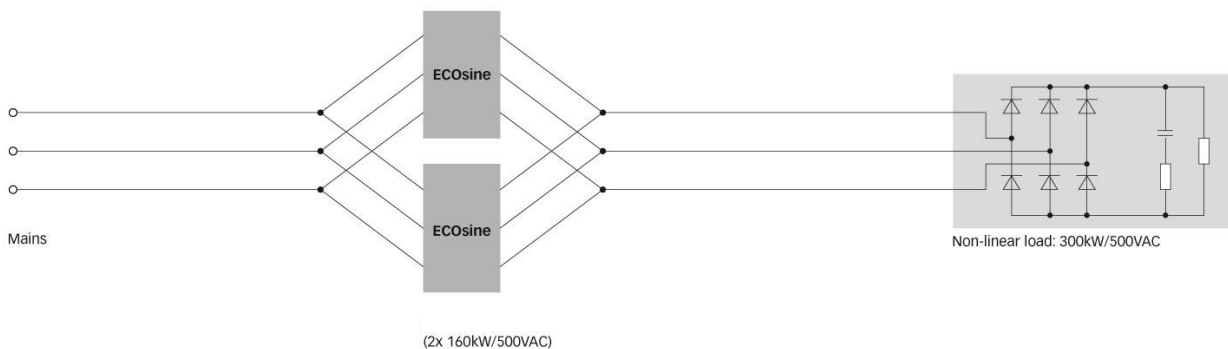
6. Filter application

Ecosine EVO filters are designed to mitigate harmonics of non-linear load, in particular of three-phase diode-type rectifiers. Contrary to “bus-applied or PCC” filters, which are being installed e.g. at the main feeder, they are specifically designed to be used with either an individual non-linear load, or with a group of non-linear loads.

One advantage of load-applied filtering is the fact that the upstream power (relative to the harmonic filter) is clean, i.e. unloaded by the harmonics. This can be of vital importance when the same power bus supplies both motor drives and sensitive loads. Ecosine EVO filters are also suitable for paralleling lower power non-linear loads on a higher power harmonic filter to improve overall system economy. In this case the total expected load power of all connected drives must match the filter.



If the expected input power exceeds the rating of the largest available filter, and a custom solution is not desired, then two or more filters can be wired in parallel. In this mode of operation, it is recommended to use filters with equal power ratings to ensure proper current sharing.



AC line reactors and/or dc-link chokes are not required when ecosine EVO filters are installed. For a new system, this situation helps to offset a good portion of the harmonic filter cost.

7. Filter installation

Please follow the simple steps below to ensure a safe and reliable filter function for many years.

Step 1: Visual inspection

All Schaffner ecosine filters have undergone rigorous testing before they left our ISO 9001:2008 certified factory. They are packaged with great care in a sturdy container for international shipment.

However, carefully inspect the shipping container for damage that may have occurred in transit. Then unpack the filter and carefully inspect for any signs of damage. Keep the shipping container for future transportation of the filter.

In the case of damage, please file a claim with the freight forwarder involved immediately and contact your local Schaffner partner for support. Under no circumstances install and energize a filter with visible transportation damage.

If the filter is not going to be put in service upon receipt, store within the original container in a clean, dry location, free of dust and chemicals and with respect to named temperature limits, see section 3.2.

Step 2: Mounting

Ecosine EVO filters are best installed as close as possible to the non-linear load. Ideally they are mounted next to the rectifier or motor drive inside the electrical cabinet or control room.

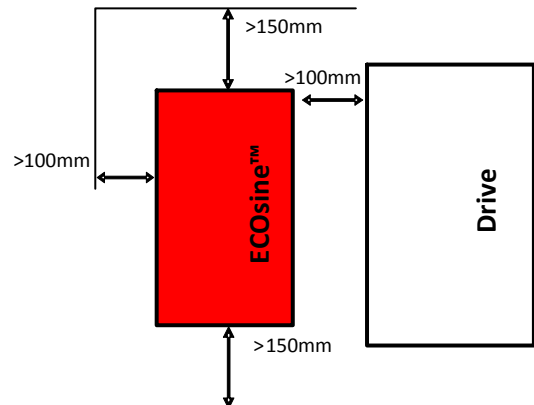
Ecosine EVO filters are designed for wall-mounting installation.

Important:

In order to ensure sufficient air flow, keep a clearance of min.150mm above and below the filter to walls or other components.

Additional work to access the device, caused by not respected clearance distances, will be accounted separately.

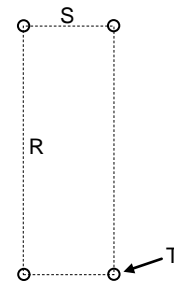
It must be ensured that the environmental temperature is kept below 45°C with appropriate thermal management (e.g. cabinet cooling). Filter operation in environments with higher temperatures require a temperature derating.



II.1 Screw hole positions for wall mounted filters
 (as indicated in Table 10):

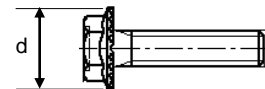
Table 10 Dimensions of frame sizes

Frame	Drill pattern [mm]		
	R	S	T
A	340	120	7
B	405	120	7
C	460	150	7
D	540	180	11
E	680	220	11
F	730	250	11
G	920	280	11
H	1115	390	11



All dimensions in mm; 1 inch = 25.4mm

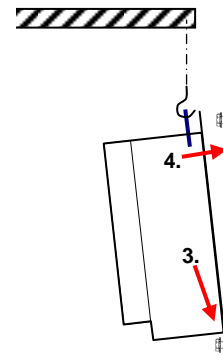
II.2 Screw selection: Schaffner recommends zinc coated hex ribbed flange steel bolts. Respect filter weight for appropriate choice of screws! Head diameters must not exceed these dimensions:



M6: $d \leq 14.2\text{mm}$, M10: $d \leq 21.2\text{mm}$

II.3 Filter placement:

1. Set screws loose into wall, leave 5mm distance from head to wall.
2. Lift filter with appropriate crane, smallest types (up to 25kg) may be lifted manually by two persons.
3. Place filter first onto lower screws...
4. ...then position it through backplane head openings on upper screws.
5. Fix screws with appropriate torque (depending upon the material of the back plane and local standards).



Step 3: Wiring

III.1 Verify safe disconnection of all line side power.

Consult your local safety instructions.



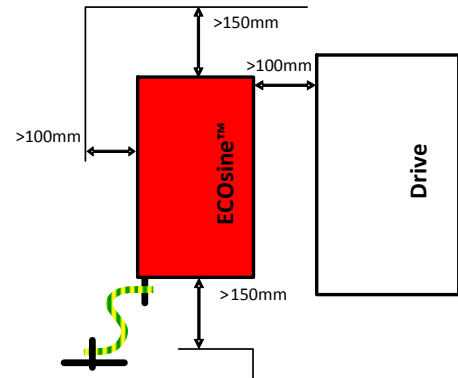
III.2 Carefully connect protective earth (PE) wire to adequate earth potential close to ecosine filter.

Use a wire diameter of equal or bigger size as foreseen for line/load side power cables – according to your local codes and safety instructions.

III.3 Connect PE wire of ecosine filter

with appropriate cable lug to threaded stud.

torque M5:	4Nm
torque M6:	8Nm
torque M8:	14Nm
torque M10:	25Nm



III.4 Connect ecosine load side terminals L1', L2', L3' to respective motor drive or rectifier inputs.

The third part of ecosine EVO designation is a number contains three digits, i.e. FN3440-11-**113**, which indicates power terminal type.

See Table 1 to for the recommended wire size and torque. Use stranded copper wire with a temperature rating of 75°C or higher.

III.5 Use wired trap circuit (default) or install external capacitive current control.

For configurations with TDJ option (refer to Tables 4, 5, 6), terminals D1- D1', D2- D2'and D3- D3' are delivered with installed jumpers. When interconnected via an external capacitor contactor (not supplied by Schaffner) they allow for load dependent disconnection of the trap circuit, if needed. Thus capacitive current can be minimized for low load operation. Estimation of required contactor size: see box to the right.

USE ONLY CAPACITOR CONTACTORS FOR MINIMIZATION OF INRUSH CURRENT. OTHERWISE CAPACITOR LIFETIME MAY BE REDUCED.

Contactor performance estimate:

Example: FN3440-**55**-115

The nominal power rating multiplies 20% and the grid voltage, then divided by the nominal voltage (400V for FN3440, 480V for FN3450 and FN3452) is the approximate reactive power

Contactor rating =

$$55KW * 20\% * \frac{V_{grid}}{V_{nom}} = 55KW * 20\% * \frac{400V}{400V} = 11KVAR$$

III.6 Connect monitor switch TS- TS'

The monitor switch is a relay contact, which is open in ALARM state. It is constituted by a thermal switch NC 180°C (UL-approved) to detect overload of chokes. It may either be used to remotely disconnect the drive's load via respective input of drive control (check drive manual) or as alarm sensor for system control unit.

AN ENGAGED MONITOR SWITCH MUST LEAD TO IMMEDIATE LOAD SHUTDOWN AND INVESTIGATION OF THE PROBLEM.

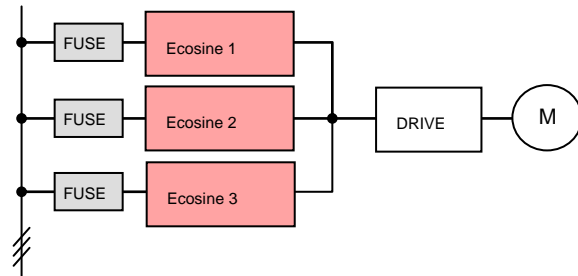
III.7 Connect Ecosine line side terminals L1, L2, L3

to power input protection (current limiting fuses – see below).

III.8 Fuses

Ecosine filters need external over-current protection for compliance with UL/cUL standard. Fuses and associated fuse holders must be UL listed and rated for 100kA SCCR supplies. Table 11 and Table 12 show requested fuse current ratings for UL class J and, where UL compliance is not mandatory, for IEC class gG. The fuse rating is independent of the supply voltage.

A system with multiple ecosine filters paralleled for a high power load need each a separate 3-phase line side fuse block, corresponding to the respective filter and according to above table. The drive's application manual may prescribe line-side fuse protection as well, which in this case either corresponds to the sum of the filter fuse ratings or, if lower, would request separate drive fuses at its input.



An application, having one ecosine filtering harmonics of several drives, requires in any case line side fuse protection of the drives as well as the correct filter protection according to above table.

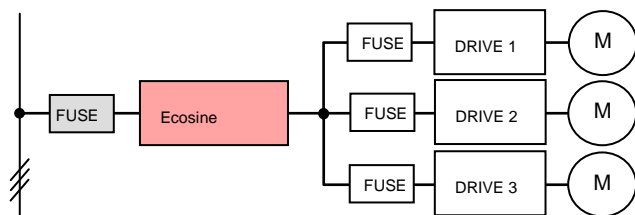


Table 11 Requested fuse current rating for UL class J and for IEC class gG

Ecosine EVO	Ecosine EVO	Fuse class J	Fuse class gG
All FN 3440	All FN 3450	<i>rated A</i>	<i>rated A</i>
	FN3450-1-110	2	2
FN 3440-1-110		2.5	2
	FN 3450-2-110	4.5	4
FN 3440-2-110	FN 3450-4-112	8	8
FN 3440-4-112	FN 3450-6-112	10	10
FN 3440-6-112	FN 3450-8-112	15	10
FN 3440-8-112	FN 3450-11-112	20	16
FN 3440-11-113	FN 3450-15-113	25	20
FN 3440-15-113	FN 3450-19-113	35	35
FN 3440-19-113	FN 3450-22-113	40	35
FN 3440-22-113	FN 3450-30-115	50	50
FN 3440-30-115	FN 3450-37-115	75	63
FN 3440-37-115	FN 3450-45-115	80	80
FN 3440-45-115	FN 3450-55-115	100	100
FN 3440-55-115	FN 3450-75-115	150	125
FN 3440-75-115	FN 3450-90-116	175	160
FN 3440-90-116	FN 3450-110-118	200	200
FN 3440-110-118	FN 3450-132-118	250	224
FN 3440-132-118	FN 3450-160-118	300	250
FN 3440-160-118	FN 3450-200-118	350	300
FN 3440-200-118	FN 3450-250-118	400	400



Table 12 Requested fuse current rating for UL calss J

Ecosine EVO type	Fuse class J
All FN 3452	<i>rated A</i>
FN 3452-1-110	2
FN 3452-3-110	4
FN 3452-5-112	7
FN 3452-8-112	10
FN 3452-10-112	15
FN 3452-15-112	20
FN 3452-20-113	30
FN 3452-25-113	35
FN 3452-30-113	40
FN 3452-40-115	50
FN 3452-50-115	60
FN 3452-60-115	80
FN 3452-75-115	90
FN 3452-100-115	125
FN 3452-125-116	150
FN 3452-150-116	175
FN 3452-200-118	250
FN 3452-250-118	300
FN 3452-300-118	400

8. Filter maintenance

Ecosine EVO filters described in this manual are equipped with long life components that ensure a satisfactory function for many years under normal operating conditions. Any operation under extreme conditions such as over-temperatures, overvoltage situations, polluted environments etc. reduces the life expectancy. Following maintenance recommendation will help maximizing filter lifetime.

Warnings:

	High voltage potentials are involved in the operation of this product. Always remove line side power before attempting to perform maintenance, and let ample time elapse for the capacitors to discharge to safe levels (<42V). Residual voltages are to be measured both line to line and line to earth.
	Line side power must be disconnected prior to replacement of any part.

8.1 Maintenance schedule

Table 13 Maintenance schedule

year	1	2	3	4	5	6	7	8	9	10	11	12
check and clean fan(s)	X	X	X	X	X	X	X	X	X	X	X	X
replace fuse(s) ¹⁾					X					X		
replace fan(s)					X					X		
check & tighten el. Connections ²⁾	X	X	X	X	X	X	X	X	X	X	X	X
check el. values of capacitors		X		X		X		X		X		X
replace power capacitors										X		

¹⁾ Only filters within NEMA (FN3452-xxx-yyy-N3_ _ _ _ _) enclosures.

²⁾ Only external connections need to be checked.

8.2 Fan

Schaffner ecosine EVO filters are reliable low maintenance products. Many products like power supplies, inverters or motor drives utilize fans for forced cooling to minimize size and weight. Ecosine filters are designed with a similar temperature management concept and therefore, fans may have to be maintained and replaced in certain intervals to sustain the function and value of the product. Fans are 100% field replaceable without the need to uninstall and disconnect the filter.

Forced cooling devices are needed for the operation of Schaffner ecosine filters up to their nominal rating. Such cooling devices must be checked and cleaned regularly (if installed) to ensure sufficient air flow at all times.

Note: increased audible noise is a typical indicator of a fan that needs maintenance or replacement also outside of a maintenance schedule.

Before cleaning or replacing the cooling devices, make sure to consult the recommended maintenance procedures and schedules of the supplier of the cooling device in use.

8.3 Power capacitors

The power capacitors supplied with the filter modules are high quality components with an expected life time of up to 100'000 hours (11 years). Nevertheless, their useful service life can be shortened by electrical or thermal stress beyond their specification.

Power capacitor damage may also be caused by severe abnormal supply voltage peaks (i.e. lightning – depending upon system protection), but may only be recognizable through the measurement of line side harmonics distortion. This may be checked with a modern energy meter or by regular checkup with a power quality analyzer. According to the above considerations, a 2 year inspection interval is advisable.

Note: an inspection should as well be performed after extreme overvoltage situations in the system.

Note: Storage of capacitors

Up to 3 years-long storage, electrolytic capacitors can be operated without any restriction and the nominal voltage can be applied without any preliminary preparation. System reliability and life-time expectancy are not affected.

On the other side, a longer (> 3 yrs) storage of electrolytic capacitors without applying any voltage can weaken the dielectric properties because of disslution processes. The electrolytic solution is aggressive and it can affect and weaken the dielectric in the timeframe between production and product commissioning. The weak points are responsible for the higher leakage current shortly after the device turn-on on site.

The residual current of electrolytic capacitors depends upon time, voltage and temperature. The residual current increases after long storage without applying voltage.

The amplitude of resulting residual current during unit commissioning can be up to 10 times larger on short term. The capacitor's residual current assumes the typical expected value at steady state for nominal voltage.

During comissioning after long storage, it is recommended to restore the dielectric characteristics by applying voltage progressively and with respect to the time frame the filters have been stored.

8.4 Electrical connections

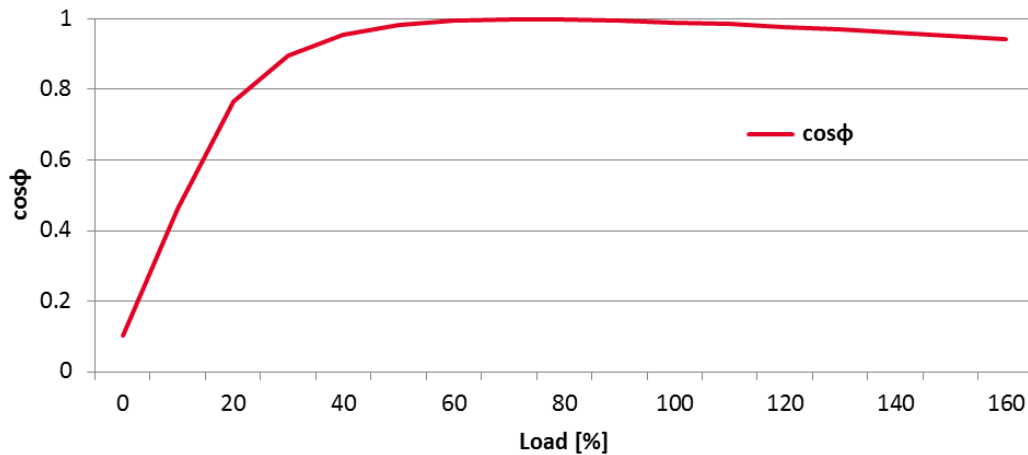
Depending upon the environment and application, electrical connections, in particular threaded bolts and nuts, can degrade over time by means of losing their initial tightening torque. This holds true not only for the filter, but for any such joint within an electrical installation.

Therefore, Schaffner recommends to check and tighten all electrical connections on the occasion of a regular scheduled maintenance of the entire device that incorporates the filter.

Check of internal connections within the filters is not needed or should be conducted by a Schaffner service representative.

9 Trap circuit disconnect

The trap circuit disconnect feature is a built-in option for the purpose of reducing the capacitive current during low load operation, if needed. With permanently connected trap circuit, $\cos\phi$ vs. load shows following characteristics:



When the trap circuit is disconnected, $\cos(\phi)$ returns to ~ 0.98 . At the same time, the THID will increase. This may be negligible, since absolute values are low due to reduced load power. Needed external components (not part of ecosine filter) or system functions for fully automated capacitive current control:

- | Motor load (power factor) monitoring device
- | Capacitor contactor

A reduced load system status may be available as system controller output signal. In this case, only adequate driving of capacitor contactor has to be assured.

Note: It is necessary to take into account overall concept of power factor correction. A system PFC correction unit with large capacitor banks may become obsolete or massively reduced, when harmonic filters are installed. In such cases it may not be necessary to install trap circuit disconnect functions.

Recommended settings:

Schaffner recommends to engage and disengage the trap circuit disconnect at following load levels:

Trap circuit status	Proposed load level
Disconnect	When load level drops under 10–15%
Connect	When load level rises above 20–25%

10. Troubleshooting

Schaffner Ecosine harmonic filters are high quality products and have undergone rigorous testing and qualification procedures. Every unit runs through suitable tests in our ISO 9001:2000 factories. Due to this reason no major issues need to be expected if the filter is installed, operated, and maintained as described in this document.

In the unlikely event of a problem, please contact your local Schaffner partner for assistance.

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