



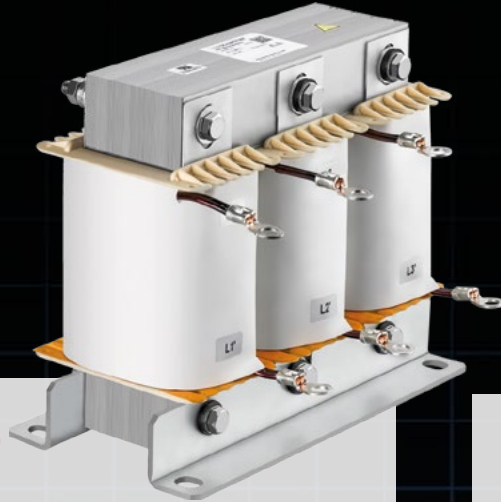
Power Quality solutions  
– more than just products

---

# Content

<b>Overview Power Quality product portfolio</b> Reactors, Ecosine active and passive harmonic filters, Output filters	
<b>Solution provider</b> Line reactors	<b>2</b>
<b>Solution provider</b> Ecosine active and passive filters, Output filters	<b>3</b>
<b>The challenges for consumers of electricity</b>	<b>4</b>
<b>The cost of poor power quality</b>	<b>5</b>
<b>Most electrical loads are non-linear</b>	<b>6</b>
<b>Harmonic mitigation for a wide range of applications</b>	<b>7</b>
<b>Compliance with IEEE-519</b> Compliance with IEEE-519 and other benefits	<b>8</b>
<b>Power Quality Simulator PQS</b>	<b>9</b>
<b>Services and after-sales products</b> Schaffner – more than just filters	<b>10</b>
<b>We care for clean energy</b>	<b>11</b>
<b>Technical data</b>	<b>12</b>

# Overview Power Quality product portfolio



## Reactor

Line and load reactors are the most economical harmonic filter solution, with proven performance to reduce distortion created from variable frequency drives. Reactors are available for either line site, to reduce harmonic distortion; or load side, to minimize long lead effects and help to extend motor life.

### Features and benefits

- Economical, compact, wide ratings selection
- Reduction of mains harmonics and commutation notches
- Help to meet international Power Quality standards such as IEEE-519 or EN 61000-3-2
- Protection of motor drive electronics and DC link capacitors against mains transients
- Reduction of inrush and peak currents
- Prevention from nuisance tripping caused by power line voltage spikes
- Improvement of true power factor



## Ecosine passive harmonic filter

Schaffner ecosine harmonic filters represent an economical solution to the challenge of load-applied harmonics mitigation in 3-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.

### Features and benefits

- The industry standard for 6-pulse rectifier and motor drives
- Help to comply with international Power Quality standards, e.g. IEEE519
- Economical, effective and reliable harmonic mitigation
- Filters for diode rectifier (with or without DC-link choke) and thyristor rectifier
- Best-in-class partial load performance
- Most compact design
- Plug and play, ready to use
- Available from 1.5HP to 500HP, parallel filters for larger ratings
- Open type and enclosed protection



## Ecosine active harmonic filter

Active harmonic filters are intelligent power quality devices that continuously monitor the 3-phase line current and dynamically provide a precisely controlled current spectrum for real-time suppression of harmonic distortions created by non-linear loads. Operating at the Point of Common Coupling (PCC), they facilitate compliance with all international Power Quality standards, e.g. IEEE 519 or EN 61000-3-12 and local regulations.

### Features and benefits

- Most effective harmonic mitigation up to the 50th order, parameter setting for even and odd harmonics
- Compact active harmonic filter for 3-phase loads with and without neutral wire
- THDi < 5%, achievable even on most complex mixed loads and at changing load profiles
- New modular design with intelligent system approach - to offer tailored solutions for different applications and customers
- 3-Level IGBT inverter topology for reduced power losses
- Extended temperature range of modules up to 50°C
- Ultra-fast and dynamic reactive power compensation (inductive and capacitive)
- Load balancing and unloading of neutral wires
- Available in 60A modules, up to 300A enclosed, with parallel capability for higher ratings



## Output Filter

Whenever electricity is used to drive an equipment, in particular when a motor drive is controlling the speed of an electric motor, special attention for the noises generated by the motor drives need to be taken into considerations. Schaffner output filters help avoiding problems that can result in functional difficulties to very severe motor damage.

### Features and benefits

- Converts the rectangular PWM output voltage of motor drives into a smooth sine wave with low residual ripple
- Eliminates premature motor damage caused by high dv/dt, overvoltage, cable ringing, motor overheating, and eddy current losses
- Motor frequency up to 200 Hz
- Extended motor cable length capability
- Complies with IEC 60034-17\* and NEMA-MG1 requirements for general purpose motors
- Both sine wave and dv/dt filters offered up to 690 VAC

A long, curved aisle in a server room. The racks are filled with server units, each with multiple bays and indicator lights. The lighting is a deep blue, creating a futuristic and high-tech atmosphere. The perspective is from the end of the aisle, looking down its length as it curves to the right.

Power Quality solutions  
– more than just products

# Solution provider

Schaffner is a unique market player, offering the whole power quality solution portfolio including line reactors, passive and active harmonic filters and output filters. This one-stop shop approach incorporates great opportunities for finding solutions with the best cost-benefit ratio for customers. A good example is the area of hybrid solutions applying 3-phase reactors or passive harmonic filters in combination with active harmonic filters.

## Line Reactors

Line Reactors, operated on the line side of power drive systems, efficiently protect inverter electronics and DC link capacitors from inrush, peak and short-circuit currents. Additionally, low-frequency interference and harmonics are reduced significantly. In many cases, combining line reactors together with passive harmonic filters or active harmonic filters, we are able to provide a very optimized solution, technically and commercially.





**Ecosine passive filters** are the industry standard for 6-pulse rectifiers and non-regenerative motor drives to achieve the often-specified level of < 5% THDi.

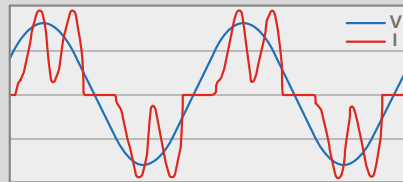
**Ecosine active harmonic filters** are the most efficient and compact solution for mixed load and high dynamic applications. Efficient current harmonics mitigation of < 5% THDi, power factor correction and load balancing are achieved in real time.

## Active and passive harmonic filters

Harmonic filters help to obtain compliance with international standards, e.g. IEEE 519-2014 or EN 61000-3-12 and with local utility codes. They reduce electrical and thermal stress upon the electrical infrastructure, eliminate the risk of harmonics-related reliability problems and support long-term energy efficiency and cost savings.

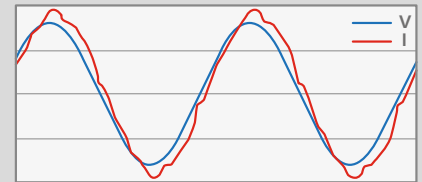
### Current and voltage at PCC

#### Without harmonic filter



THDi 57%

#### With Schaffner harmonic filter



THDi ≤ 5.0%



## Output filters and load reactors

Output components are used for motor protection and the improvement of system reliability, availability and functionality. Deployed at the output side of frequency inverters, these filters ensure reliable operation by avoiding expensive downtimes of installations, manufacturing plants, machinery and a vast array of other industrial and domestic motor drive applications due to premature motor damage. An appropriate output solution will even allow the deployment of unshielded motor cables, the use of multiple motors in parallel on the same drive or the retrofit of modern drives in existing installations with old motors and unshielded cabling.

Schaffner Power Quality products can be easily combined in one installation as customer tailored solution with best technical and economical fit, providing the most efficient harmonic mitigation and system reliability.



# The challenges for consumers of electricity

**Reliability and efficiency are assessed as being important to business operation. This includes reliable operation of machines, manufacturing systems and office equipment. In practice, this is often not the case, despite the use of UPS and back-up generators.**

- Distribution lines and networks cannot be fully utilized
- High percentage of energy losses in the power lines
- Increased wear and limited system availability
- Downtime for equipment and systems

**Power quality problems in the internal power network are often the reason. Measurements and network analysis can detect the root cause of the problem.**

Whether for machinery, welding equipment, variable-frequency drives, or electric motors: **Almost all non-linear consumers today can cause substantial voltage distortion.**

Non-linear loads like three-phase diode bridge rectifiers cause harmonic distortion of the electricity supply system. This distortion results in currents in the systems, which are of higher magnitude than expected and contain harmonic frequency components. The amplitude of the resulting current is often under-estimated and can reach a level up to 140%, which tremendously loads the installed conductor. Furthermore, overcurrent protections which are typically rated close to the nominal current are prone to so-called nuisance tripping.



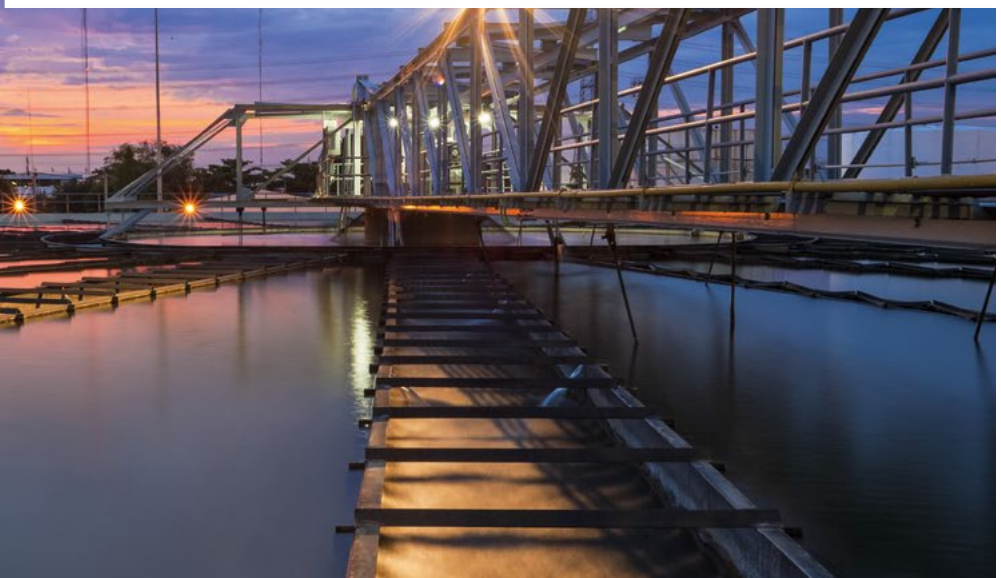
# The cost of poor power quality

**The benefit of investing in harmonic mitigation by installing Schaffner ecosine harmonic filters and reactors is more than just reducing harmonics. Current and voltage harmonics affect the correct operation of equipments sharing the same supply. This is only one – probably the most evident – of the many issues which harm the whole electric installation system.**

- Quality has its cost, but poor quality has definitely a higher cost. If no measures against current harmonics are taken in a power system, the total power factor and system's efficiency decrease, and the transformer and generator capacity are dramatically reduced.
- Financial consequences: Harmonics mitigation is considered to be expensive. The decision to ignore such issues in an early stage can potentially lead to a much more substantial cost impact and troubles such as: the capacity of electric installations may need to be upgraded; equipment fails prematurely; disturbances cause production downtime; Utility companies issue power quality violation penalties.

It is estimated\* that power quality problems are causing costs of about 10 billion Euro per annum for industry and commerce in the EU while expenditure on preventive measures is less than 5% of this. Similar figures can be derived for other countries like the US and China.

(\*European Copper Institute "The Cost of Poor Power Quality", available online)



# Most electrical loads are non-linear

## Harmonics are not generated by the utility

Electric utilities have to constantly deal with customer applications having problems due to harmonics. However, disturbances like electromagnetic interferences or harmonics are not attributable to the utility company, but to the users and the non-linear nature of their loads.

## Most electrical loads do not behave like resistors

This means that a sinusoidal applied voltage, which is typically provided by the utility through the distribution transformers, does not yield to a resulting sinusoidal current. Only for resistive components, for instance resistive heating systems or incandescent-type illumination devices, voltage and current have proportional sinusoidal waveforms.

## Non-linear loads as source of harmonic currents and voltages

Modern consumers of power, such as variable speed motor drives, switched-mode power supplies in home appliances or ballasts in fluorescent lamps contribute significantly to energy savings and to a more efficient use of electricity. However, they cause non-sinusoidal currents to be drawn from the grid.

## Harmonic voltages

Harmonic currents which flow through the system impedances of transformers and reactors give rise to harmonic voltages. The distorted voltage will cause interferences and decrease the equipment lifetime, performance and reliability of other loads connected to the same grid.

## Harmonics have a serious impact

Harmonics reduce the efficiency of a system. Harmonic currents overload electric installations, distribution transformers, breakers, fuses, conductors, etc. They cause overheating and premature system aging or make the increase of the electric system capacity necessary. Harmonics overload capacitor banks in reactive compensation systems and cause malfunctions of electronic controllers, disturbances in sensitive medical devices or crashes in communication networks.

## No risk of system resonance through a patented solution

The impedance of the filter can theoretically resonate with the system's natural inductance or the capacitance of an EMI filter (if installed). Schaffner ecosine filters are designed such that their first natural frequency is below that of any predominant harmonic. Furthermore, for ecosine passive harmonic filters a damper module reduces the amplitude of possible resonance, thus ensuring the system's reliability and availability.

# Harmonic mitigation for a wide range of applications



«Wherever an inverter or motor drive is in use, Schaffner products are in use nearby.»

Schaffner's broad product portfolio, along with its global infrastructure of sales and engineering offices, ensures the best power quality solutions for a wide range of applications. With our leading brand of ecosine active and passive harmonic filters as well as our line reactors and output filters, we offer the best fitted solutions to our partners and customers at point of connection, up- and downstream of variable speed drives.

# Compliance with IEEE-519 and other benefits

International power quality standards such as IEEE 519-2014, EN 61000-3-12, EN 50160, EN 12015, G5/4, AS 2279 or D.A.CH.CZ provide, among other requirements, distortion limits and recommend harmonics mitigation practices. IEEE 519-2014 is a widely recognized set of recommendations which include the maximum permissible current and voltage distortion values at the point of common coupling (PCC).

The distortion limit is given as function of the system loading, i.e. the relation between the maximum short circuit current (ISC) and the maximum demand load current (IL) at the PCC.

Ecosine harmonic filters (passive and active) and reactors once installed in the electric system will reduce the harmonics such that the requirements of most common international standards are met.

Schaffner ecosine filters and reactors unload lines and transformer upstream of the nonlinear load, e.g. a 3-phase diode bridge rectifier, hence reducing the system overall losses and operating temperature.

## **The problem of harmonics is properly solved by the use of Schaffner ecosine filters and reactors with the following benefits:**

- Efficient mitigation of harmonic currents
- Compliance with IEEE 519 and other power quality standards
- Increased equipment operating lifetime, system reliability and availability in mission-critical applications
- Enhanced utilization of electric system capacity
- Power factor correction
- Load balancing and reactive power compensation
- Long-term savings in system operation and maintenance costs
- Fast and simple plug-and-play operation for new and existing installations
- Very compact, modular and light-weight filter concept; high power density
- Seamless integration with previously installed DC-link chokes or EMC/EMI filters

«Efficient energy usage and loss mitigation.»

# Power Quality Simulator

Schaffner Power Quality Simulator PQS is a Power Quality tool for planners, consultants and application engineers which allows the accurate modelling and simulation of low voltage 3-phase network topologies.

## Its main features include:

- Simulation of power, current and voltage at all network nodes
- Support for the proper selection of harmonics mitigation technologies
- Sharing of projects with colleagues/partners by simply copying the URL link
- Verifying of compliance with selected power quality standards
- Simple and easy to use reporting features
- Particularly suitable for systems with variable speed drives
- Most accurate active and passive harmonic filter simulation models
- Generator model included
- Customer specific AC line chokes functionality
- Schaffner 18-pulse autotransformer – «Mitigator» included

The screenshot displays the Schaffner PQS software interface. At the top, there are navigation tabs for PROJECTS, EDITOR, REPORT, PROFILE, SUPPORT, and LOGOUT. Below these, a circuit diagram shows a 3-phase source connected to a PFC, PHF, and VSD. The 'SIMULATION RESULTS' section includes a graph of Voltage (V) and Current (A) versus Harmonic Order, and a table of key parameters:

$I_{rms}$ : 44.32 A	$V_{rms}$ : 230.9 V	P: 30.4 kW
$I_{max}$ : 60.21 A	$V_{max}$ : 326.5 V	Q: 4.01 kVar
$I_{avg}$ : 0 A	$V_{avg}$ : 0 V	S: 30.7 MVA
$I_{base}$ : 44.27 A	$V_{base}$ : 230.8 V	D: 1.7 MVA
THD <sub>i</sub> : 5.06 %	THD <sub>v</sub> : 0.02 %	$S_{eq}$ : 30.7 MVA
PIVHD <sub>i</sub> : 6.5 %	PIVHD <sub>v</sub> : 0.05 %	cosφ: 0.99
		PF: 0.99

Below the results, there are three tables for 'EQUIPMENT SELECTION':

FN344X SERIES FULL PERFORMANCE LINE (400 V)			
Filter	Lead Power @ 300 VAC (kW)	DC-link or AC chokes required	DC Filter in Front of diode
FN3440-1-110	1.05	<input type="checkbox"/>	<input type="checkbox"/>
FN3440-2-110	2.09	<input type="checkbox"/>	<input type="checkbox"/>
FN3440-4-112	3.80	<input type="checkbox"/>	<input type="checkbox"/>
FN3440-6-112	5.22	<input type="checkbox"/>	<input type="checkbox"/>
FN3440-8-113	7.45	<input type="checkbox"/>	<input type="checkbox"/>
FN3440-11-115	10.4	<input type="checkbox"/>	<input type="checkbox"/>
FN3440-15-115	14.3	<input type="checkbox"/>	<input type="checkbox"/>
FN3440-19-115	19.1	<input type="checkbox"/>	<input type="checkbox"/>
FN3440-23-115	25.9	<input type="checkbox"/>	<input type="checkbox"/>
FN3440-30-115	28.5	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
FN3440-37-116	35.1	<input type="checkbox"/>	<input type="checkbox"/>
FN3440-45-115	42.9	<input type="checkbox"/>	<input type="checkbox"/>
FN3440-55-115	52.3	<input type="checkbox"/>	<input type="checkbox"/>
FN3440-75-116	71.3	<input type="checkbox"/>	<input type="checkbox"/>
FN3440-90-116	85.5	<input type="checkbox"/>	<input type="checkbox"/>
FN3440-110-116	109	<input type="checkbox"/>	<input type="checkbox"/>
FN3440-132-116	131	<input type="checkbox"/>	not relevant
FN3440-160-116	152	<input type="checkbox"/>	not relevant
FN3440-200-116	199	<input type="checkbox"/>	not relevant

FN3416 SERIES ECONOMY LINE			
Filter	Lead Power @ 300 VAC (kW)		
FN3416-10-44	4.31		
FN3416-15-44	5.79		
FN3416-20-44	8.26		
FN3416-24-33	11.4		
FN3416-32-33	14.3		
FN3416-38-33	17.6		
FN3416-45-33	22.8		
FN3416-48-34	26.0		
FN3416-75-34	35.1		
FN3416-90-35	42.9		
FN3416-110-35	52.3		
FN3416-130-40	71.3		
FN3416-150-40	85.5		
FN3416-180-40	109		
FN3416-240-99	121		
FN3416-320-99	151		

FN3410 SERIES FOR DIODE RECTIFIERS			
Filter	Lead Power @ 300 VAC (kW)		
FN3410-10-44	3.30		
FN3410-15-44	5.26		
FN3410-20-44	8.26		
FN3410-24-33	11.4		
FN3410-32-33	14.3		
FN3410-38-33	17.6		
FN3410-45-34	22.8		
FN3410-48-34	26.0		
FN3410-75-35	35.1		
FN3410-90-35	42.9		
FN3410-110-35	52.3		
FN3410-130-40	71.3		
FN3410-150-40	85.5		
FN3410-180-40	109		
FN3410-240-99	121		
FN3410-320-99	151		
FN3410-380-99-Q.E2.81	190	DC link or AC chokes mandatory	
FN3410-470-99-Q.E2.81	238	DC link or AC chokes mandatory	
FN3410-550-99-Q.E2.81	299	DC link or AC chokes mandatory	
FN3410-650-99-Q.E2.81	353	DC link or AC chokes mandatory	
FN3410-730-99-Q.E2.81	380	DC link or AC chokes mandatory	

**SCHAFFNERPQS**  
power quality simulator

Free download  
«Do not hesitate to log in and try»  
<http://pqs.schaffner.com/>



# Services and after-sales products

## Schaffner – more than just filters

Schaffner ecosine standard filters are available for different supply networks throughout the world. They are UL listed, CE marked, and fulfill the requirements of the low voltage directive.

A broad selection of power, current, voltage and frequency ratings gives the user a flexible choice of filters and solutions.

**Schaffner is in the unique position of being able to support you with problem analysis, engineering advice, testing and measurement support and a worldwide customer service organization. Our goal is to ensure that you obtain the level of harmonics mitigation you actually need – guaranteed.**

## After-sales products and services

In addition to the wide and flexible portfolio of Schaffner Power Quality products, Schaffner provides a variety of services and after-sales products and support. This goes from manufacturer's warranty to extended warranty offers, health check and maintenance contracts.

Please contact your local Schaffner partner for comprehensive support. More information can also be obtained from the Schaffner website: [schaffner.com/service](https://www.schaffner.com/service)

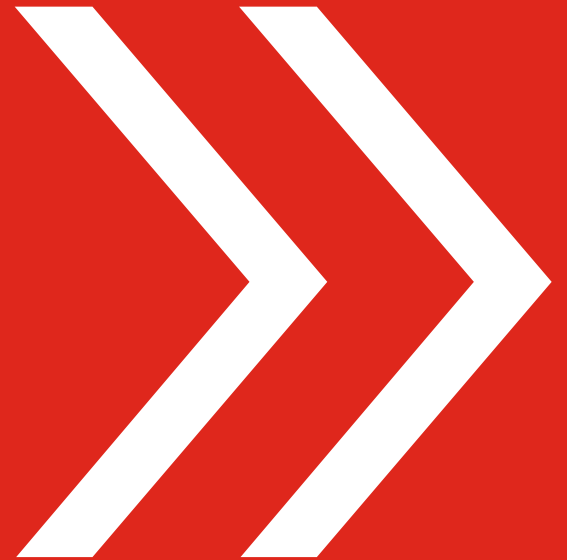


# We care for clean energy

Reliability and quality of power is a major concern for all industries, utilities and any kind of infrastructure segments including modern building technologies. Low equipment performance and premature aging along with breakdowns and poor power factor result in severe issues and wasted energy. As the leading experts for good power quality, Schaffner offers more than just products. We are partners to our valued customers and aim to improve power quality issues, while optimizing the energy usage and enabling compliance with local and international power quality standards. Our international teams of dedicated and well experienced engineers will support you to find the best fitted solution, based on a unique broad products portfolio. Solid application know-how goes along with leading simulation abilities, ensuring best functionality and customer satisfaction.

As we care for clean energy,  
we are your partner for a future with better shaped power.

# Technical data







## Headquarters, global innovation and development center

### Schaffner Group

Nordstrasse 11  
4542 Luterbach  
Switzerland  
T +41 32 681 66 26  
info@schaffner.com  
www.schaffner.com

To find your local partner within Schaffner's global network, please go to [www.schaffner.com](http://www.schaffner.com)

© 2019 Schaffner Group  
SAP 619332

The content of this document has been carefully checked and understood. However, neither Schaffner nor its subsidiaries assume any liability whatsoever for any errors or inaccuracies of this document and the consequences thereof. Published specifications are subject to change without notice. Product suitability for any area of application must ultimately be determined by the customer. In all cases, products must never be operated outside their published specifications. Schaffner does not guarantee the availability of all published products. This disclaimer shall be governed by substantive Swiss law and resulting disputes shall be settled by the courts at the place of business of Schaffner Holding AG. Latest publications and a complete disclaimer can be downloaded from the Schaffner website. All trademarks recognized.

## Sales and application centers

### China

**Schaffner EMC Ltd. Shanghai**  
T20-3, No 565 Chuangye Road  
Pudong New Area  
Shanghai 201201  
T +86 21 3813 9500  
F +86 21 3813 9501/02  
cschina@schaffner.com  
www.schaffner.com

### Finland

**Schaffner Oy**  
Sauvonrinne 19 H  
08500 Lohja  
T +358 19 35 72 71  
finlandsales@schaffner.com

### France

**France Schaffner EMC S.A.S.**  
16-20 Rue Louis Rameau  
95875 Bezons  
T +33 1 34 34 30 60  
F +33 1 39 47 02 28  
francesales@schaffner.com

### Germany

**Schaffner Deutschland GmbH**  
Schoemperlenstrasse 12B  
76185 Karlsruhe  
T +49 721 56910  
F +49 721 569110  
germanysales@schaffner.com

### India

**Schaffner India EMC Pvt. Ltd.**  
Unit 59, Level, Mfar Greenheart 7  
Manyata Tech Park, Hebbal Outer Ring Road  
560045 Bangalore  
T +91 80 6781 9805  
F +91 80 6781 9998  
indiasales@schaffner.com

### Italy

**Schaffner EMC S.r.l.**  
Via Ticino, 30  
20900 Monza (MB)  
T +39 039 21 41 070  
italysales@schaffner.com

### Japan

**Schaffner EMC K.K.**  
Mitsui-Seimei Sangenjaya Bldg. 7F  
1-32-12, Kamiyama, Setagaya-ku  
Tokyo 154-0011  
T +81 3 5712 3650  
F +81 3 5712 3651  
japansales@schaffner.com  
www.schaffner.jp

### Singapore

**Schaffner EMC Pte Ltd.**  
#05-09, Kg Ubi Ind. Estate  
408705 Singapore  
T +65 6377 3283  
F +65 6377 3281  
singaporesales@schaffner.com

### Spain

**Schaffner EMC España**  
Calle Caléndula 93  
Miniparc III, Edificio E  
El Soto de la Moraleja  
Alcobendas  
28109 Madrid  
T +34 618 176 133  
spainsales@schaffner.com

### Sweden

**Schaffner EMC AB**  
Turebergstorg 1, 6  
19147 Sollentuna  
T +46 8 5792 1121/22  
F +46 8 92 96 90  
swedensales@schaffner.com

### Switzerland

**Schaffner EMV AG**  
Nordstrasse 11  
4542 Luterbach  
T +41 32 681 66 88  
switzerlandsales@schaffner.com

### Taiwan

**Schaffner EMV Ltd.**  
20 Floor-2, No 97  
Section 1, XinTai 5th Road  
22175 XiZhi District  
Taipei City 22175  
T +886 2 2697 5500  
F +886 2 2697 5533  
taiwansales@schaffner.com  
www.schaffner.com.tw

### Thailand

**Schaffner EMC Co. Ltd.**  
Northern Region Industrial Estate  
67 Moo 4 Tambon Ban Klang  
Amphur Muang P.O. Box 14  
Lamphun 51000  
T +66 53 58 11 04  
F +66 53 58 10 19  
thailsales@schaffner.com

### UK

**Schaffner Ltd.**  
5 Ashville Way  
Molly Millars Lane  
Wokingham  
Berkshire RG41 2PL  
T +44 118 9770070  
F +44 118 9792969  
uksales@schaffner.com  
www.schaffner.uk.com

### USA

**Schaffner EMC Inc.**  
52 Mayfield Avenue  
08837 Edison, New Jersey  
T +1 800 367 5566  
T +732 225 9533  
F +732 225 4789  
usasales@schaffner.com  
www.schaffner.com/us

### Schaffner North America

6722 Thirlane Road  
24019 Roanoke, Virginia  
T +1 276 228 7943  
F +1 276 228 7953  
usasales@schaffner.com  
www.schaffnerusa.com

### Schaffner North America

823 Fairview Road  
24382 Wytheville, Virginia  
T +1 276 228 7943  
F +1 276 228 7258  
usasales@schaffner.com  
www.schaffnerusa.com