Technical contribution FN 9280 and FN 9290

SCHAFFNER
energy efficiency and reliability

Ultra-compact and innovative – new Schaffner IEC inlet filter series

The Schaffner group has expanded its product range of IEC inlet filters by a single-stage (FN 9280) and a dual-stage (FN 9290) series of filtered power entry modules. Due to the ultra-compact design and the patented slide-in module with integrated line switch and fuse holder, the EMC filter modules with IEC appliance inlets type C14 set new standards. The versatile flange system for fast and flexible installation emphasizes the innovative power of the Swiss company. It is also a novelty that the load connections are optionally available with fast-on or with spring cage terminals.

Leadership in the field of EMC/EMI filters

The FN 9280 and FN 9290 IEC inlet filters strengthen the leading position of the Schaffner group in the field of EMC filters, a leadership which is based on more than 50 years of competence, experience and know-how. With a housing height of only 46 mm, Schaffner launches the most compact filter series in the class of the EMC filter modules and thus defines a completely new standard. The FN 9280 series consists of high performance single-stage EMC filters. Designed for the same housing cutout, the FN 9290 has a dual-stage filter with an even better attenuation performance for applications with higher interference levels. The B versions of both series with minimal leakage currents of 0.5 uA max. are suited for the use in medical electrical devices. The single-stage EMC filter series with additional earth line choke for the suppression of EMI noise on ground loops can optionally be delivered as standard version (E type) or medical version (EB type).

Removable slide-in module

Fuse holder for two fuses

Clip for spare fuse

Slide-in module with line switch and fuse holder

The new filter families are characterized by a slide-in module in which the line switch and the fuses are integrated. For the first time, a 2-pole line switch with two fuse holders for fuses 5×20 mm has been integrated in a removable unit. On the bottom side, an additional clip provides space for a spare fuse. The 2-pole line switch is designed for inrush currents up to 82 A. Since switch-mode power supplies without inrush current limitation are used in many applications, this is an important criterion for the service life of a device switch. To replace the fuse, the slide-in module can be removed from the filter module using a simple tool such as a screwdriver or an army knife. To avoid that the device is unintentionally switched on during maintenance, repair or service work, the slide-in module can be explicitly removed. An unintentional contact of the active connections with the fingers or with a wire with a diameter of 1 mm is prevented. The fuse holders of the new EMC filter modules thus meet the protection category PC3.

Small but powerful units with spring cage terminals

The new filter families are available with innovative spring cage terminals or with fast-on plugs that have proven its worth for the IEC inlet filters for years. Due to the improved clamping force, the spring cage terminals are particularly suitable for a vibration-proof wiring. They can be used for rigid or flexible wires with a cross-section of 0.2 mm to 1.5 mm.

The new terminal reveals its strength in applications with increased risk of vibrations.
The spring cage terminal made of a combination of copper and steel makes sure that the cable remains firmly clamped in the terminal even in case of strong vibrations and that the contact resistance remains at a minimum. The application-oriented selection of materials and the intelligent system design reduce cable fractures to an absolute minimum even in challenging environments.

Distribution kit with versatile flange system

Four at one stroke – the new flange mounting system

The flange mounting system with either horizontal or vertical mounting holes has also been completely newly developed. The distribution kit includes all components needed for the front or rear mounting such as the mounting flange frame and the screws for the rear mounting of the filter. The desired frame is snapped onto the front or the rear of the filter depending on the type of mounting. Thanks to the metal insert in the flange produced as a plastic-metal composite part, it is very stable and fits tightly to the filter after snapping on.

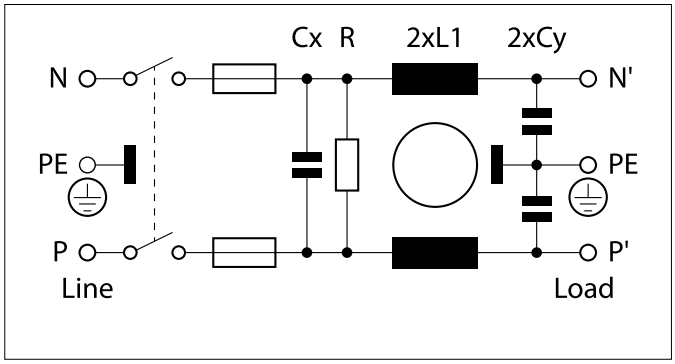
For the rear mounting, the screw supports facilitate the assembly since no additional washers or nuts are required. The metal insert in the frame establishes also a plane connection between the front panel of the device and the filter housing. This provides the best possible shielding and a clear separation between the inside of the device and the outside that is free of interferences. By this, the filter modules are suitable for all mounting types which typically occur in practice. For volume production, the filters are of course also available with completely pre-assembled mounting flange. These options are listed in the order key indicated on the filter data sheet. The versatile Schaffner mounting frame concept embodies innovation, functionality and flexibility.

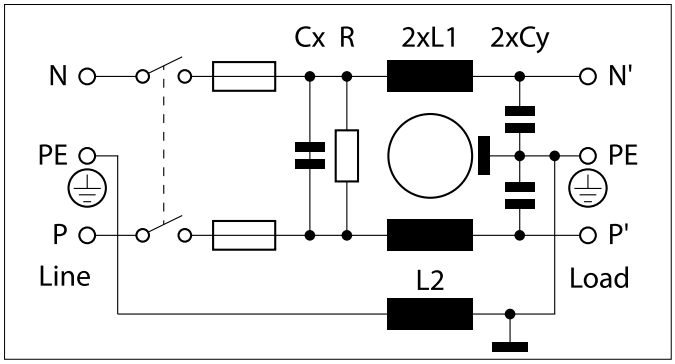
Get the new filters!

As an alternative to the flange mounting, all filters can be delivered as a so-called snap-in version for the fast and reliable snap-in mounting from the front. Thanks to the standard snap-in brackets, the filters can be mounted in front panels with a thickness between 1 and 2.5 mm without using a tool. For a panel thickness of 2.5 mm, the retaining force exceeds 200 N and for thinner panels the retaining force is even higher.

As an alternative to the standard version, the snap-in version is also available as option –30 for front panels of a sheet thickness of >2.5 mm to 3.5 mm.

Standard filter FN 9280 and filter with earth line choke FN 9280E





Safe line disconnection thanks to the 2-pole switch

The pictures show the circuit diagrams of the module series FN 9280 and FN 9280E. In both cases, the line switch is placed on the mains side in front of the fuses and provides all-pole disconnection of the filter from the mains. Therefore, no current can flow into the EMC filter or the downstream components of the application when disconnected from the mains.
Even reactive and leakage currents that the line frequency would generate in the Cx and Cy capacitors are avoided. In order to meet the limit values reduced to 0.5 W as of January 2013 by the EU regulation regarding the energy consumption of all devices with integrated power supply, an all-pole disconnection during the OFF phase is a good solution. Equipped with the shown single-stage EMC filter, the FN 9280 offers good attenuation characteristics which could be improved with regard to conventional solutions despite the compact design.

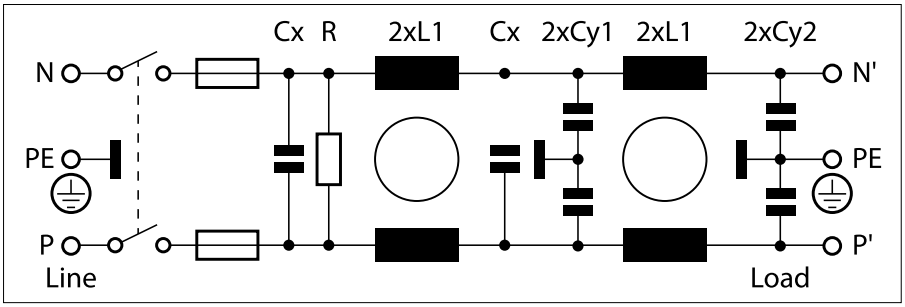
When the earth conductor is the cause of interference

The second circuit diagram shows the version FN 9280E where, in addition to the current-compensated choke L1 of the standard filter, the additional earth line choke L2 is placed in the earth connection on the mains side. High-frequency and asymmetric common-mode interferences caused by the application are still filtered since the interference currents are short-circuited via the Y capacitors by the device grounding. The choke L1 in the active conductors prevents the asymmetric interferences from propagating into the power system. The earth line choke L2 suppresses the propagation of interferences via ground loops by means of the protective earth terminal of the mains. The E types can therefore be used to effectively suppress EMI noise on ground loops and asymmetric interferences.

Excellent shielding performance

Not only the improved EMC filter performance but also the design of the deep-drawn housing give proof that the Schaffner engineers did a good job. The consequent further development of the housing technology using the know-how regarding material and the knowledge acquired from simulations made it possible to deep-draw a steel sheet housing with a depth of 75 mm and a width of only 28 mm. Compared to the deep-drawn aluminium housings, steel housings have an approx. 10-fold higher shielding performance. Especially in case of low-frequency magnetic fields with superimposed interferences which are often generated by transformers and magnetic components in the device, the correctly mounted steel housing securely prevents any coupling effects to the filter chokes and thus guarantees the effectiveness of the filter. This is particularly important for dual-stage filters with high attenuation performance.

Two-stage filter FN 9290 with an attenuation up to 80 dBuV

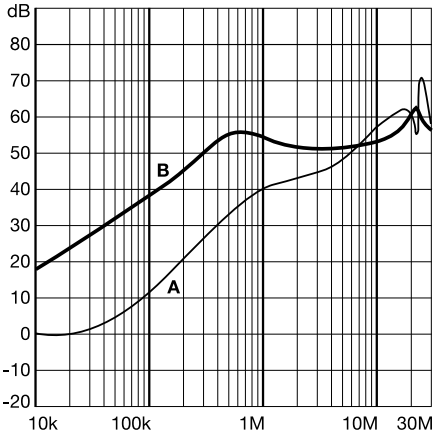


FN 9290 Standard types (B types without Cy)

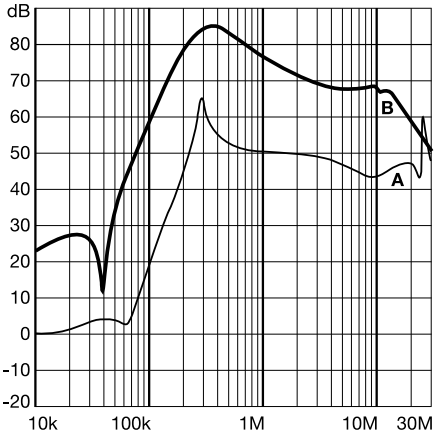
The external dimensions of the dual-stage version FN 9290 are identical to the single-stage version with earth line choke. For the new dual-stage family, a filter has been developed which has the same leakage currents as the FN 9280 and which nevertheless delivers an improved attenuation of up to 80 dBuV regarding the common-mode suppression (curve B).

Typical filter attenuation

FN 9280 Series 1A-types



FN 9290 Series 1A-types



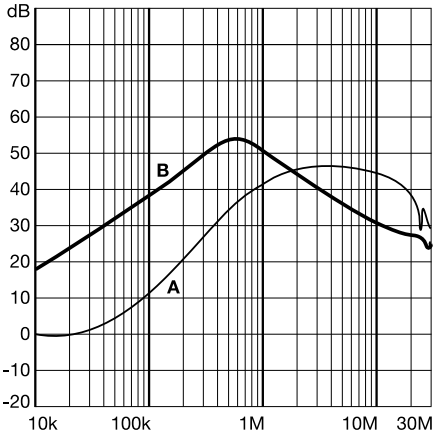
Per CISPR 17; A = 50 Ω/50 Ω sym, B = 50 Ω/50 Ω asym

To show the differences regarding the attenuation of the individual filter versions, the 1A models are compared with each other. The common-mode suppression (curve B) according to CISPR 17 of the dual-stage filter FN 9290 has a higher attenuation of up to 20 dB in the frequency range between 1 MHz and 30 MHz which is important for the common-mode noise suppression. For the differential-mode suppression (curve A), the attenuation of the dual-stage filter is higher by approx. 20 dBat 150 kHz, which represents the starting point in the generic standards for conducted interferences.

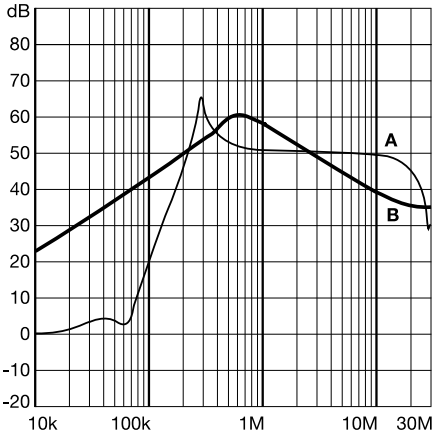
Improved attenuation performance even for the dual-stage medical filter

Typical filter attenuation

FN 9280B Series 1A-types



FN 9290B Series 1A-types



Per CISPR 17; A = 50 Ω/50 Ω sym, B = 50 Ω/50 Ω asym

For patient-coupled medical devices, the leakage current is strictly limited. Here the B versions of the filter modules are used. Due to the absent Y capacitors, extremely low values for the leakage current could be reached but also the common-mode suppression in the upper frequency range has been reduced. The two-stage version FN 9290B reaches a common-mode suppression (curve B) which is by approx. 10 dB higher compared to the single-stage medical filter (FN 9280B). Regarding the differential-mode suppression (curve A), the B types have a similar behaviour as the standard versions.

New application fields thanks to the nearly unlimited flexibility

The combination of IEC plug and filter module is ideal with regard to the EMC because there is no risk of interferences coupling into the filtered mains cables after the filter. Especially the dual-stage version of the new IEC inlet filter modules opens up new fields of application whose problems could only be solved up to now using chassis mounting filters. It is recommended to consider the longer installation depth of FN 9280E and FN 9290 so that they can be used without problems as an upgrade of FN 9280 for applications with higher emissions, if needed. This provides device designers the full flexibility when selecting EMC filters and reduces the risk during the EMC qualification of devices with different versions regarding performance and features.

The filter families fulfill the safety standards for most of the applications for electronic devices such as power supply units, EDP systems, office equipment or test and measuring devices. In most cases, the safety standard IEC/EN 61010 for measuring and test devices, electrical control and regulation devices, electrical laboratory equipment and In-Vitro diagnostic devices require a 2-pole line switch. The two-pole fuse holder makes absolutely sure that the accessible parts cannot become a hazard when an individual error occurs and thus the highest category of the contact protection PC3 is met.

The current edition 3.1 of the IEC 61010-1, the safety standard for medical electrical devices, requests from the manufacturers to provide a risk analysis according to IEC 61508 with an estimation and evaluation. Using the new filter module series, the risks can be reduced to a minimum.

Depending on the category of the application, the standard or medical versions can be used for medical electrical devices. For syringe pumps, respirators, radiation lamps, laser or medical monitoring devices as well as all medical electrical devices that are directly connected with the patient, the medical version (B types) with a leakage current of less than 5 uA are mainly used. Besides the requirements regarding the leakage current, the safety standards IEC/EN 60601-1 requests also higher clearances and creepage distances and a higher voltage resistance. For the B types, this was confirmed by an independent, certified test laboratory during the approval procedure.Therefore the new filter module series are particularly suitable for all products for which the applicable safety standard requires a risk analysis.

Current range and approvals

The new series are designed for currents of 1 to 10 A and for single-phase grids of up to 250 VAC. The filters are approved for worldwide use according to UL, CSA, ENEC and CQC and conform to RoHS and REACH.

Combination with lockable power cord reduces the engineering effort

The advantage of a standardized IEC plug is its global recognition. The type C14 is often used in the IT area. Device manufacturers can serve the global market using one version of the device and a country-specific power cord which simplifies the approval process in most of the cases. According to the IEC 60320, the standard for IEC plugs, no locking feature is required. For all filters and filter modules with standardized C14 plug, Schaffner offers the power cord series IL13 with a suitable locking functionality.

If IEC inlet filters are used combined with the lockable power cord families IL instead of a fixed wiring with separate strain relief, the effort regarding mechanical design, assembly and approval is reduced in many cases. Application examples are high-vibration applications or products for which the product standard prescribes a strain relief test during the safety qualification of the mains power cord, for example household appliances such as dishwashers or air conditioners that are tested according to IEC/EN 60335-1.

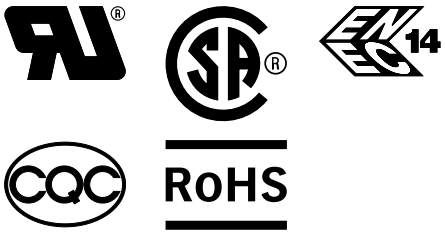
The use of the mains power cord family IL13 combined with the new IEC inlet filter modules does neither require a modification on the filter nor time consuming assembly work for locking devices and can be retrofitted easily any time since the locking function is available with every conventional standard IEC plug.

Comprehensive support for a quick and safe EMC filter design

Further details can be found in the FN 9280 & FN 9290 series data sheet. On its website www.schaffner.com, Schaffner offers in the Download area various tools such as data sheets, application notes, white papers or expert knowledge concerning the topic EMC. The brochure "Basics in EMC and PQ" gives detailed information regarding the topics EMC and power quality, the short form catalogue with overview tables helps you to quickly select the right filter.
All over the world the application engineers of Schaffner give support regarding filter design-ins in cooperation with EMC test laboratories, company-owned EMC test benches or the mobile EMC test service.

For the mechanical 3D design, files in the "STEP" format are available for all products. This file format can be loaded into most of the 3D design programs. For the FN 9280 and FN 9290 filter series, STEP data are available for all mounting types and filter versions.

Approvals



(CQC, approval pending)

Product versions

- The FN 9280 series is a single-stage IEC inlet filter module for standard applications
- The FN 9290 is a dual-stage version for applications with higher interference levels
- All series are available in the current ratings 1, 2, 4, 6, 10 A
- All series can be delivered as medical versions (B type)
- All series can be equipped with flange for screw mounting or with snap-in brackets
- All series are available with fast-on terminals (-06) or spring cage terminals (-100)
- The 9280 series can optionally be delivered with earth line choke as E or EB type

Technical Data

Maximum continuous operating voltage		250 VAC, 50/60 Hz
Operating frequency		50 to 400 Hz
Rated currents		1 to 10 A* @ 40 °C
High potential test voltage		P –> PE 2000 VAC for 2 sec (standard types)
		P –> PE 2500 VAC for 2 sec (B types)
		P –> N 760 VAC for 2 sec
Leakage current		Standard: <500 uA at 250 VAC/50 Hz
		Medical: <5 uA at 250 VAC/50 Hz
Protection category		IP40 according to IEC 60529 (front side)
Terminals		IP20 spring cage safe against finger touch
Spring cage wire range		0.2–1.5 mm^2/24–16 AWG single or flexible wire
Temperature range (operation and storage)		–25 °C to +85 °C (25/85/21)
Design corresponding to		UL 1283, CSA 22.2 No. 8 1986, EN 60939,
		EN 60950, EN 60601-1, UL544, EN 60320
Flammability corresponding to		UL 94V-2 or better
MTBF @ 40°C/230V (Mil-HB-217F)		> 1,000,000 hours
Fuse holder		2 fuses (Ø 5 × 20 mm) max. 250 V
Rocker switch		2-pole, dark not illuminated, Marking I–0
Electrical specifications		Inrush current 82 A
		6.000 on-off operations according to UL 1054
		10.000 on-off operations according to ENEC
Mechanical life		50.000 cycles
Switch ratings	USA (UL) and Canada (C-UL)	10 A, 125 VAC; 10 A, 250 VAC; 1/3 HP
	Europe (ENEC)	10 A (4 A), 250 VAC**

Schaffner – energy efficiency and reliability

Schaffner is the worldwide leading consortium in the fields of "electromagnetic compatibility" and "power quality". With its components it supports solutions for an efficient and reliable use of electric energy. With its products and services Schaffner Group significantly contributes to the promotion of technologies for the generation of renewable energies, ensures the reliable functioning of electronic devices and systems in compliance with all important quality and performance standards, and meets the requirements for increasing energy efficiency. Schaffner provides global and customer-oriented service and technical support including on-site testing.

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Dipl.-Ing. (FH) Harald Barth was Product Marketing Manager for single-phase filters, IEC inlet filters and components for interference suppression at the Schaffner Group in Switzerland.

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