Technical Article

EMC filters for medical devices

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SCHAFFNER

energy efficiency and reliability

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Schaffner, the market leader in EMC filters and power quality devices, has consistently extended its proven IEC Inlet family with single- and dual stage IEC inlet filter adapted to the market needs. The series FN9280 (single stage) and FN9290 (dual stage) convince by high-performance filter characteristics embedded in an ultra-compact and user-friendly design.

The B versions of FN92xx series with minimal leakage currents of 0.5 mA max. meet the requirements of the medical standards IEC/EN 60601 for equipment with patient contact or other medical environments. The single-stage 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 (B type).

The FN92xx series are designed for currents of 1 to 10 A up to 250 VAC, 50/60Hz.

To ensure reliable operation of medical equipment, EMC filters play an important role. In addition to the interference suppression on the components used in switching power supply or controller systems, its central use in the power supply allows a flexible device design.

EMC-compliant design already starts at the power entry side of an electronic device. Therefore a combination of a IEC connector with embedded EMC filter is the most economical solution.
The metal housing of the IEC inlet filters with the flat connection to the device mounting wall, creates a clear separation between the non-suppressed interior of the device and the external environment. Even in the smallest space inside the device, with components, cables closed to the filter there is no crosstalk.

Figure 1: Schaffner's "High performance" IEC inlet filter FN9280/90

The EMC requirements for diagnostic equipment

Regarding EMC, IEC/EN 60601 refers to the corresponding limit values of the CISPR standards. Most electrical medical devices are categorised similar to the generic standards into classes according to use in the household, doctor's surgery (B) or in hospitals with separated AC mains (A). Emissions must comply with the limits of CISPR11. For simple electrical components, reference is CISPR14, for lighting facilities CISPR15 and for IT systems CISPR22.

IEC/EN 60601/10 for medical electrical equipment

Products such as syringe pumps, medical ventilators, lasers or patient monitoring devices with applied parts in direct physical or electrical contact with patients are defined as medical devices (MD). With 250 V AC, 2.5 mm clearance distance and 4 mm creepage distance are required as basic insulation. The maximum permissible leakage current is 0.1 mA in normal operation.

The second device group is the diagnostic unit (IVD = in vitro diagnostics), which are used for preparation and analysis of bodily fluids or human tissue. These include centrifuges, hematology analyzers, gas or liquid chromatographs, for example, as well as various laboratory devices which are classified as medical products but not as electrical medical devices. Here IEC/EN61010 is applied. The limit for leakage current is 0.5 mA under normal conditions as well as maximum 3.5 mA in case of failure.

The EMC requirements for so-called IVDs are governed by the harmonised EN 61326 standard. The table (figure 2) shows the main standard application overview.

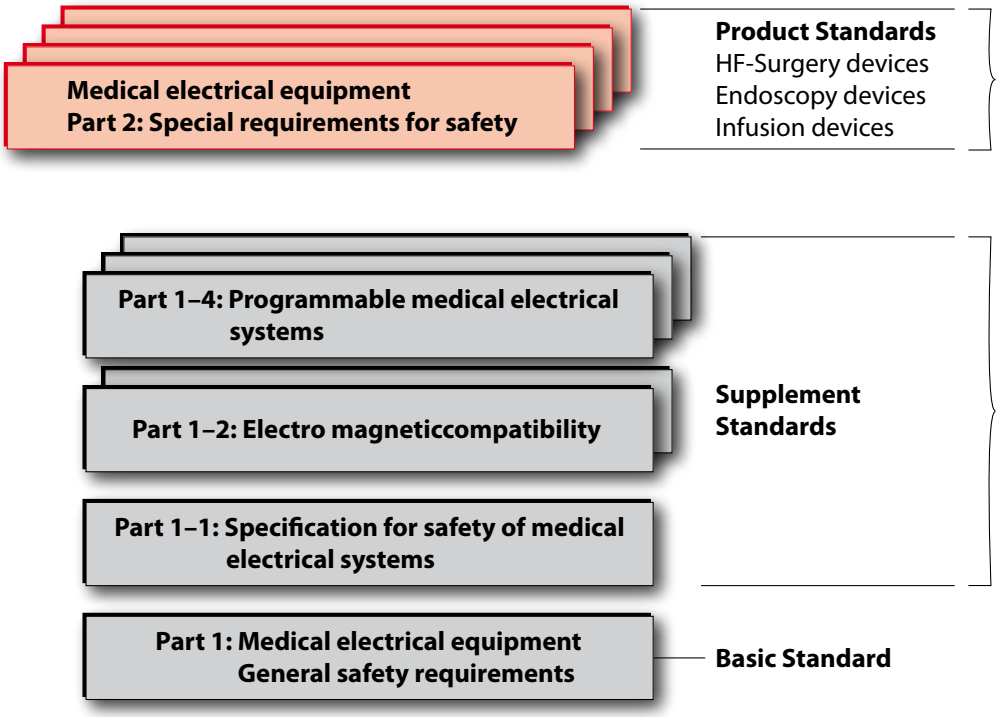


Figure 2: Standards DIN EN 60601

FN 92xx is available from 1-15A and, like the existing series, designed for a maximum permanent operating voltage of 250 VAC with a frequency range of up to 400Hz.

All IEC inlet filters with Y-caps (FN92xx) as well as with an integrated earth line choke (FN92xxE) can be used for IVD devices since their leakage current is normally 0.16 mA and max. 0.373 mA at worst. This allows the IEC inlet filters also to be used in parallel to device-internal power supplies with integrated filtering. Attention must therefore be paid to the total leakage current.

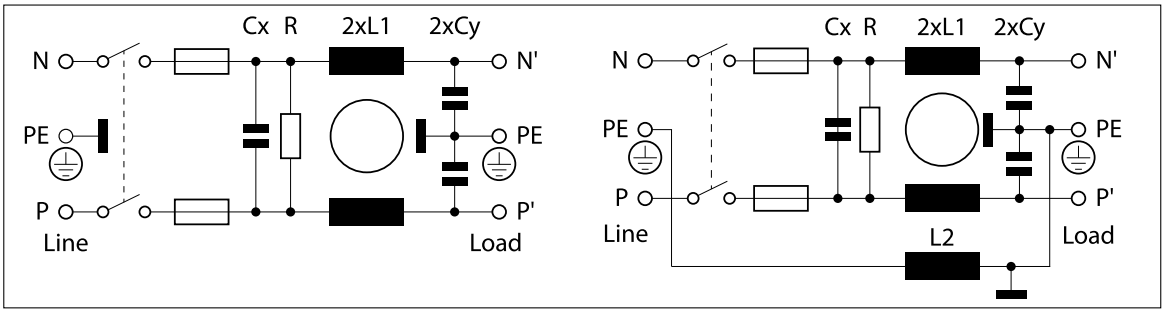


Figure 3: Standard filter FN 9280 and filter with earth line choke FN 9280E

Figure 3 shows the typical schematic of the Schaffner IEC inlet filters. As already mentioned, X-caps as well as Y-caps are used. The X-caps are located between the active conductors, the Y-caps between the active conductors and the earth. They have to comply with increased requirements for electric strength, self-healing, insulation, life time, etc., as described in IEC/EN 60384-14 due to their direct and constant connection to the AC mains.

The B-types contain no Y-caps to fulfill the leakage requirements. All FN92xxB and FN92xxEB (integrated earth line choke) can be used for MD equipment.

Conducted interferences are basically distinguished in two types: Noise, which occurs between the active conductors, is designated as symmetrical interference (DM = differential mode). All interference on the active conductors whose current path returns over the earth is so-called asymmetric interference (CM = common mode). So the Y-caps suppress mainly the CM noise and the X-caps the DM noise.

A further core element of the EMC filters is thus the common mode choke. It attenuates asymmetric interference running from the device to the AC mains as well as DM noise with a low-pass filter out of its leakage inductance and the mains-sided X-cap. The CM choke also suppresses mains disturbances and so contributes to improved device immunity.

The B types of the Schaffner IEC inlet filters are designed without Y-caps due to the above mentioned leakage-current requirements of MDs. All filter families are also available with an earth line choke (E-design) in order to suppress ground loops in devices which are linked up to an additional connecting cable, such as interface or bus. The resistance R ensures that the caps are discharged and no shock-hazard voltage remains on the poles, when the equipment is unplugged. Thus the selection of Option R (bleed resistor) is always recommended if no additional measures were taken inside the device.

According to CISPR 17 the insertion loss of EMC filters is measured both with 50 ohms input and termination impedance. The frequency response curve is displayed in all Schaffner data sheets. These diagrams are helpful for an initial orientation. The real insertion loss of an EMC filter depends on the impedance situation in the application. These are not always 50 ohms and are mostly of a complex nature. In practice, often an inductive part on the mains side and a capacitive part on the load side are added.

As a result, the effectiveness of an EMC filter must be tested inside the equipment. Schaffner has a worldwide network of engineering organisations and can offer support. Besides the standard program, customer-specific solutions can also be implemented on request. Versions with smaller Y-caps with leakage current < 0.1 mA are also feasible.

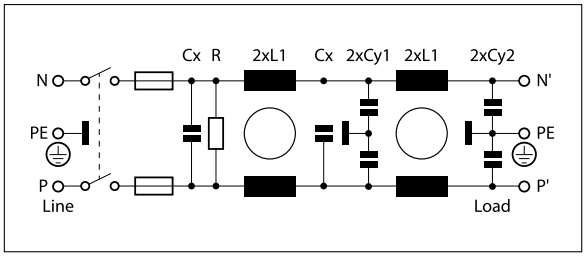
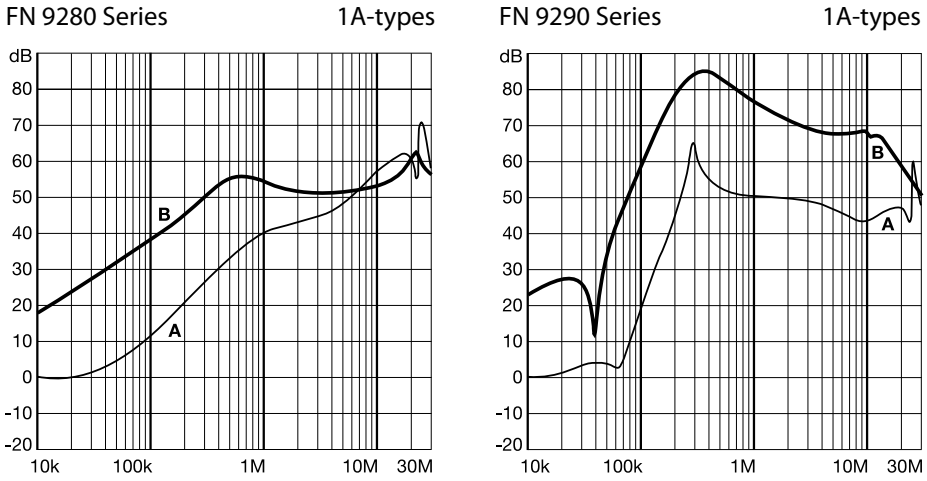


Figure 4: FN 9290 Standard types (B types without Cy)

The external dimensions of the dual-stage version FN 9290 (Figure 4) 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



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

Figure 5:

To show (Figure 5) 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 dB at 150 kHz, which represents the starting point in the generic standards for conducted interferences.

Schaffner ultra compact EMC filters FN92xx Series are instrumental for quick and simple qualification of electronic devices according to international requirements. They effectively control electromagnetic interference so the design comfort of modern electronic devices can be made easy and reliable.

The Schaffner Group is the international leader in the development and production of solutions which ensure the efficient and reliable operation of electronic systems. The Group's broad range of products and services includes EMC/EMI components, harmonic filters and magnetic components as well as the development and implementation of customized solutions. Schaffner components are deployed in energy-efficient drive systems and electronic motor controls, in wind power and photovoltaic systems, rail technology, machine tools and robotics as well as power supplies for numerous electronic devices in sectors such as medical technology or telecommunications. Schaffner provides on-site service to customers around the world through an efficient, global organization and makes ongoing investments in research, development, production and sales to systematically expand its position as leader on the international market.