

Muzzling the interference

New EMC filters for converters

Not only efficient components but also comprehensive support in the short-term optimisation of combined AFE converters and filters are the key at the leading edge.



■ Variable-speed drives up to highest powers with frequency converters are now found in all industrial sectors. Whether at the feed point of transport or assembly lines, in ventilators, pumps or bottle-filling installations, rugged drives with asynchronous motors and frequency converters are quite simply indispensable. Epcos also offers matching EMC filters for the new technology of active front-end (AFE) converters.

Today, commercially available converters cover a power range from about 100 VA up to several MVA, and the trend is towards applications with ever higher powers. Thus frequency converters are today even found in high-power applications such as diesel-electric ships drives, loading cranes on oil-drilling platforms and in the pump works of hydroelectric storage power plants.

Frequency converters are also a major source of electromagnetic interference. Because they switch the output voltage on and

off at a clock rate of 1 to 20 kHz and above, they produce high-frequency interference signals in the motor feed lines and at the power terminal. These can impair the operation of other equipment over the long

term – in extreme cases entire assembly lines can cease to operate properly or even stop altogether.

Legislation stipulates that mandatory action must be taken to stop this happening. The protection targets defined in the European EMC directive today apply in all EU member states and under certain conditions equipment must carry the CE conformity mark. This includes a declaration from the manufacturer that the equipment satisfies the harmonised EMC standards – an undertaking for which he bears sole responsibility. Violations result in hefty fines and possible withdrawal of the affected equipment series from circulation. This censure is compounded by damage compensation claims within the scope of product liability: thus if a production machine fails at a customer's facility for only a single day, damages of \$25,000 can quickly mount up. In addition to the image loss, the manufacturer may have to bear the possible subsequent costs from recourse

claims. Liability is borne personally by the company proprietor or other responsible person. For these reasons, observance of electromagnetic compatibility is absolutely mandatory for every manufacturer. However, the later that EMC flows into a development process, the more expensive does it become. For this reason EMC should already play a vital role in the development phase. But the manufacturer must also ensure that the design is EMC-compliant throughout: from the layout of the boards via the placement and positioning of the components, the wiring, grounding and shielding up to the power connection.

Epcos offers its customers comprehensive EMC support with all requisite EMC components such as chokes, filters, varistors and capacitors designed to ensure EMC compliance. This also includes a broad range of converter filters – from standard versions available from stock up to special customised designs.

Special filters for an advanced generation of converters with controlled power rectifiers, known as AFE converters, are a new addition to the Epcos product range. Frequency converters rectify the electric voltage from the power line, buffer it in the DC voltage link circuit and then output it with fast-clocked "switches" to the three phases or inputs of the electric motor.

Michael Krempel
Epcos

The line-side rectifier is as a rule constructed from a passive diode bridge, whereas the switches at the converter output comprise IGBTs. The feed from the power line into the DC voltage link circuit is unregulated in such converters and the curve shape of the derived line current depends only on the current drawn from the converter output. AFE converters now have active power switch IGBTs at their inputs instead of diodes. Although this technology requires a more complex control system, it offers numerous benefits in return. Thus suitably designed AFE converters allow an energy return feed to the power line in cases where larger masses driven by the motor need to be braked. Hitherto this braking power was simply converted to waste heat in braking resistors in applications such as centrifuges. Another important benefit of controlled power rectifiers is an almost sinusoidal current drawn

from the line which contains significantly fewer low-frequency harmonics. Fast dynamic changes of the drive are also possible, i.e. a fast changeover between motor and generator operation (driving/braking).

Typical applications for AFE converters are in all kind of machine tools. AFE converter technology has a disadvantage because under unfavourable circumstances the frequency with which the converter is clocked on the input side (e.g. 10 kHz) may trigger resonant circuits present on the line side. Resonance step-ups can then occur up to a multiple of the exciting stimulation. In an extreme case, these can destroy the power sections of equipment located in the vicinity.

This means that normal converter filters such as the type series B84143-A... from Epcos, which are designed to suppress

interference between 150 kHz and several megahertz in line with EMC standards, are only suited to a limited extent for AFE converters. Depending on the application, filter operation can no longer be guaranteed and even filter overload cannot be excluded.



Figure 4: Epcos standard filter

Epcos has consequently developed special AFE converter filters and registered them as a patent. They attenuate resonances – generated by the clock frequency of the converters – sufficiently even to satisfy the specifications above 2 kHz stipulated by the VDEW (Association of German Electricity Works) recommendations. In addition, they even subject series-connected power chokes to less thermal stress. The RF properties of the AFE converter filters naturally allow the EMC limits for line-based disturbances from 150 kHz to 30 MHz to be observed. But these filters can also be used with universal current-sensitive protection components with nominal residual currents up to 300 mA. The new filters are optimised for use in drives with very long motor cables, a large number of axles and the associated high asymmetrical parasitic currents.

Epcos develops and manufactures AFE filters and offers its customers not only efficient components but also comprehensive support in the short-term optimisation of combined AFE converters and filters at the leading edge. In addition to the new AFE filters, Epcos offers a wide range of other converter filters for high power.

Thus suitable filters are even supplied for drives with a power of several MVA where a filter for 2,500 A is available from stock as a standard product. Only very

few manufacturers worldwide include filters of this kind in their production range. Further examples are filters for rated voltages of up to 760 V, special two-wire filters for streetcars, subways and municipal railway systems with up to 1,000 A at 2,000 V as well as specially designed filters for IT power applications, i.e. non-grounded networks.

The space-saving series of UL-approved filters in book format has also been extended. Users can now choose between filters with current-handling capacities from 8 to 220 A, for 480 or 530 V as well as for high or very high attenuation.

Other newcomers to the product range are the filters of the B84142-Axx-R series for single-phase 230 V systems. These two-wire filters are available for current loads from 10 to 60 A and are attractively priced with metal packages and terminal blocks. All these filters designed for more rigorous demands are available as standard products from stock. Epcos offers comprehensive support on all EMC topics with its accredited EMC laboratory and its experienced staff – who also accompany the entire development phase of a product – as well as a wide range of noise suppression components.

Universal drives with three-phase asynchronous motors and frequency converters have become established for many industrial applications up to highest powers in the megawatt range. Conventional power rectification with both diodes and regulated IGBTs in the advanced active-front-end (AFE) converters requires EMC filters in order to suppress harmonics from the power line. Newly developed AFE converter filters from Epcos not only satisfy the relevant EMC directives but also prevent the generation of damaging resonance phenomena in the immediate vicinity of the filter. They are also compact, rugged and simple to assemble. ■

