The hidden curse… electrical noise

The cause and cure for unreliable electronic equipment…. It may be easier than you think!

This article explains why electronic equipment is particularly susceptible to interference transmitted through the mains supply connections, and how the installation of low cost filters can help by 'cleaning' this mains supply.

All 'advanced' countries depend on a vast range of electronic equipment to perform every manner of task on which we all depend. Yet simple reliability is not what it should be….. time and time again, glitches occur causing office machines to crash, POS terminals to go down in supermarkets, control systems of every kind to become erratic and manufacturing equipment to stop. We have all suffered the consequences at one time or another. The cost of all this doesn't bear thinking about.

It therefore follows that if you are responsible for any installation which depends on the efficient and reliable operation of electronic equipment, then what follows could help you achieve significant improvements in equipment reliability.

It is well known that one significant cause of all these reliability problems is electrical noise. Companies who supply electrical and electronic equipment have, for the past 16 years, had to comply with stringent rules regarding high frequency electrical noise. In Europe, this legal requirement is embodied in the EMC (Electro-Magnetic Conformity) Directive, and similar rules apply in all other major countries. However, these rules do not cover low frequency phenomena, despite these being the cause of so many problems.

A major 'route' for noise entering our equipment is via the mains supply. Practically all of the many millions of significant electronic equipment is connected to this supply, so even if only a small percentage of these units is 'susceptible', failures will be common.

Unfortunately, the measurement techniques specified by the EMC 'rules' are such that certain common types of electrical noise are significantly under recorded.
This is shown in figure 1.

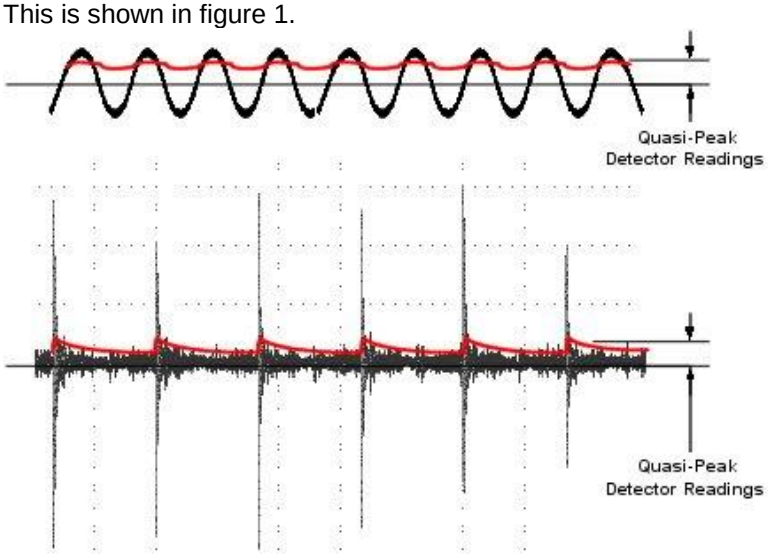

Figure 1
Red line shows how the EMC test methods react to different types of signal (shown in black).
The EMC standards specify a measurement based on a 'Quasi-Peak' technique.
Using this technique it can be seen that transient (spiky) signals are clearly under reported.

The type of noise which is most likely to cause malfunction of equipment is the transient type, the very one which tends not to be 'seen' by the QP detectors fitted to EMC test equipment. This means that the techniques used to ensure EMC compliance tend to overlook one of the main threats.

A frequently used technique that can reduce the effect of electrical mains noise is to use filters. These are commonly used to ensure that the requirements of the EMC Directive and other regulations are complied with. This emphasis on continuous and high frequency noise and has ensured that filter manufacturers have, understandably, refined the designs to be effective at these higher frequencies. At lower frequencies, these filters become largely ineffective, leaving the door wide open for problems to occur. Sensitive (and not-so-sensitive!) equipment all share power lines and ground with many types of machinery and tools, not all of them noise-free. Simple turning on and off one tool can cause severe high-frequency spikes throughout the facility. Such common items as light dimmers, solenoids, stepper and variable frequency motors, controlled heater elements and others are major contributors to noise on power lines and ground.

Filters already present in electronic equipment are designed to bring the noise from this equipment in compliance with EMC regulations in laboratory environment. Real-life installations offer very different environment where even the most EMC-compliant equipment can be a source of high-level noise or fall a victim to its noisy neighbours.

The engineers at OnFILTER have focussed on the design and manufacture of filters for reducing noise on power lines and ground for real-life installations.

Figure 2 highlights how the limits on noise emitted by products leave a wide gap at low frequencies and how the characteristics of OnFILTERs differ from standard, regular filters.

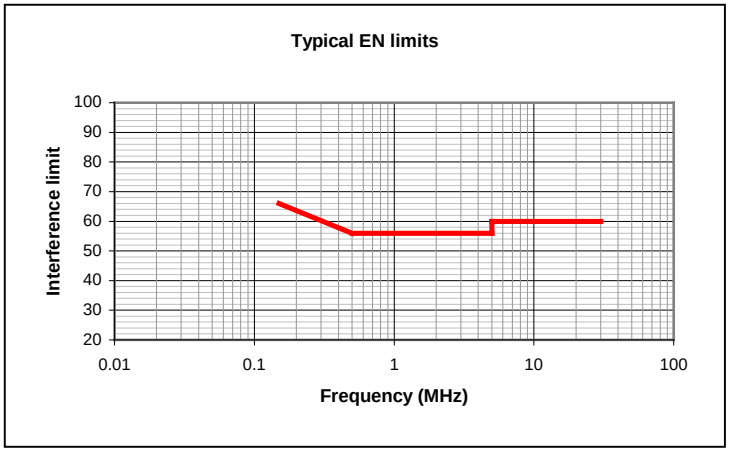

Figure 2a
Typical limit line for common products. Note that there is no limit below 150KHz. This means products can legally create any level of interference below this frequency.

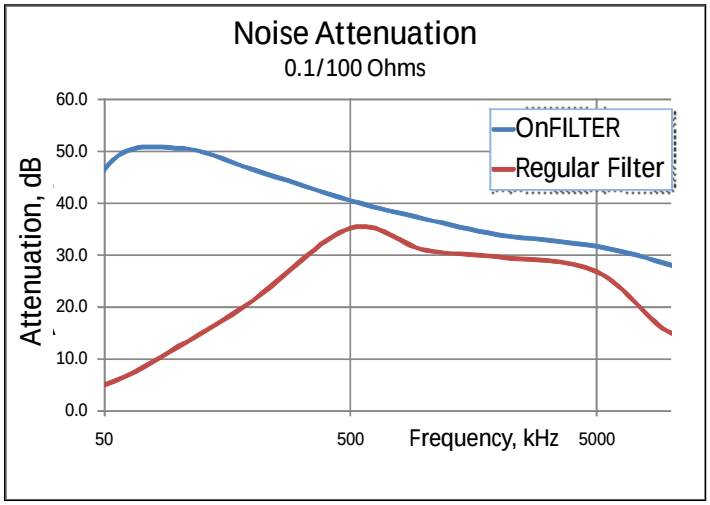

Figure 2b
Typical noise filter and Onfilter characteristics.

Note how at low frequencies (below 500KHz) the regular filter becomes increasingly ineffective. This is a direct result of the requirements of the EMC standards, which do not call for filtering at these lower frequencies

The effectiveness at high frequencies remains the

same, but at lower frequencies, the OnFILTER retains its ability to block noise. Figure 3 shows the effect on a 'real' glitch.

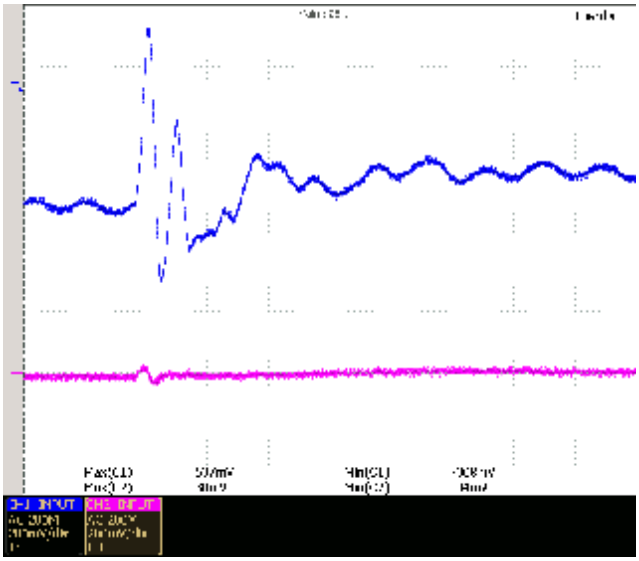

Figure 3
Effect of an OnFILTER on a real transient pulse, a typical and very common example of electrical noise on a mains supply.

The upper trace is the incoming signal and shows the 'glitch' before the filter. The lower trace is measured after the filter

In technical ,terms, the 'glitch' has been reduced by the OnFilter by 23dB, a factor of 10:1

But this lack of attenuation at lower frequencies commonly seen in standard filters is not the only problem. The EMC regulations not only focus on high frequency noise, they impose an artificial test technique for measuring product performance. This technique imposes a standardised 'impedance' for the mains supply of 50ohm. This is done in order to ensure repeatability of test data so that all measurements are comparable. Unfortunately, the 'real' mains supply will vary from much lower to far higher than the 50ohm test requirement. Filter performance is very influenced by the impedance of the mains supply. So standard filters that are optimised for a 50ohm environment may be far less effective when presented with other impedances.
Figure 4 shows exactly what can happen and demonstrates that sometimes filters can make the problem worse, rather than improving the situation.

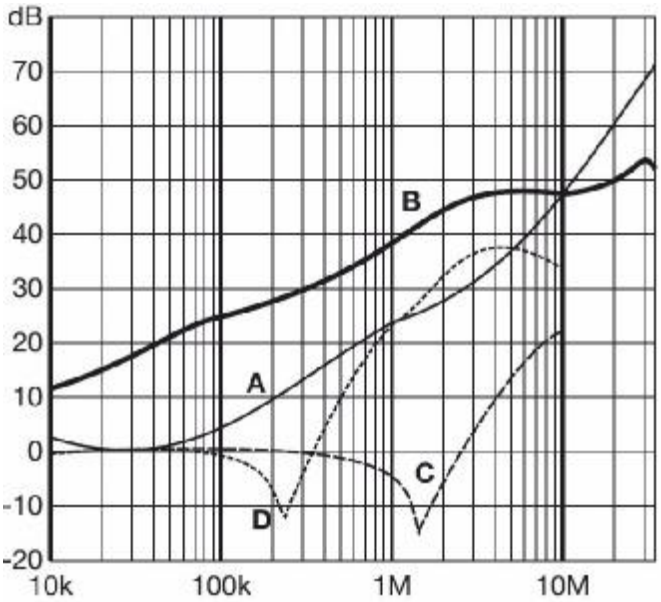

Figure 4.
Effect of cable impedance on filter performance

Published specifications for a typical filter is shown as A and B. Actual performance is shown as lines C and D. These differences are entirely due to changes in the mains impedance.
Any results less than zero indicate that the noise is increased!
It will be obvious that at 230KHz, D actually amplifiers the noise, and similarly filter C amplifies any noise at 1.5MHz

substantially better than regular EMI filters. This is simply because OnFILTER focuses on EMI reduction in actual applications, not just on EMC compliance requirements. Once you have bought and installed an EMC-compliant product in your facility, there isn't much you can do to this equipment in order to reduce its emission or to reduce its sensitivity to EMI on power lines and ground. What you can do is to fi an external filter to (a) reduce emissions

from the product afflicting other equipment, and (b) ensure that pre-existing noise on the mains is blocked.

There are several instances where users have been suffering significant problems which were eliminated by simply installing an OnFILTER.
One such situation relates to a company which planned to test the EMC compliance of its products ‘in-house’. However, when the test equipment was installed, measurements proved to be impossible simply because of the high level of electrical noise present on the power lines. Fitting an OnFILTER instantly cured the problem and resulted in a better-than-average noise level on the mains. This example is quoted because in this instance, the customer had available the test equipment required to be able to see the problem, and the improvement.

OnFILTER didn’t just limit themselves to the EMC regulations, but addressed the problems of EMI in actual use environment. These filters are designed for reduction of noise of all types of waveforms.
Overall, OnFILTER products provide the best value in the industry for managing EMI environment in industrial and in many similar applications. OnFILTER manufactures variety of EMI filters for power lines - single phase 120 and 250V; three phase Delta and Wye with many permutations.

Contact Laplace Instruments Ltd for more information and advice.

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