

LAPLACE

La précision des mesures en C.E.M

Une nouvelle technique de mesure des émissions conduites

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Arrière Plan

Les normes CEM spécifient une limite pour la quantité d'interférence qu'un produit peut injecter vers la source d'alimentation secteur. Elles spécifient également la technique à utiliser pour réaliser la mesure de ce signal interférant. Bien entendu, pratiquement tous les équipements de test disponibles sur le marché suivent les techniques recommandées et décrites dans les normes pour les mesures des émissions conduites.

Cependant, en analysant les causes et les solutions aux problèmes d'émissions conduites, on constate que la méthode de mesure n'est pas très performante.

La situation actuelle

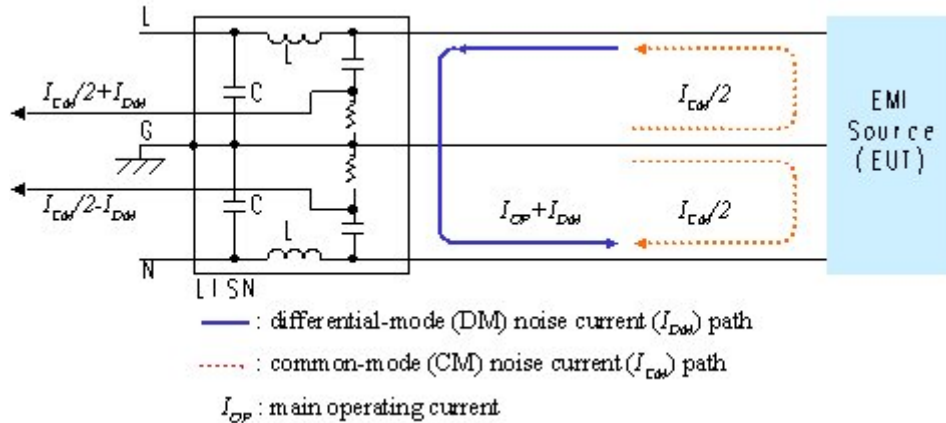
Conducted emissions split into two main types: differential and common mode. The standard test simply measures the aggregate of both and has no means of separating them. Generally an 'equipment-under-test' (EUT) will generate a combination of both types, with one or the other predominant. Knowledge of which type is predominant, and the levels involved, would be of considerable help in locating the cause, identifying a solution and specifying the type and design of a mains filter.

Mains filters use different techniques for reducing the interference levels of each type of emission. It is very easy to use a filter that is totally inappropriate for the task! This, at the very least, may result in frustration and delay and an 'over engineered' solution.

If we look at the interference signals from the EUT from the point of view of current flow, the return path for these may either be via the earth connection or via the 'other' line, see figure 1. The former type would cause the interference signal voltage on the two lines (live and neutral) to be in phase (this

is the common mode situation) and in the latter case the voltages on the two lines would be opposite (differential mode).

Figure 1. Interference current flow.



Mains filters can use up to 4 techniques to suppress interference. Many use a combination of two or more. These are:

- capacitors between the lines (live & neutral). The X capacitors.
- capacitors between each line and ground. The Y capacitors.
- Common mode chokes (each coils wound in same direction so that the flux created by the 50Hz power current (which is differential) will cancel and not saturate the core).
- Differential mode chokes. Each line having its own choke.

The effect of capacitors is to tend to 'short-out' voltages at high (interference) frequencies. On the other hand, chokes offer a high impedance (resistance) at these frequencies.

Figure 2 (a) Differential filter

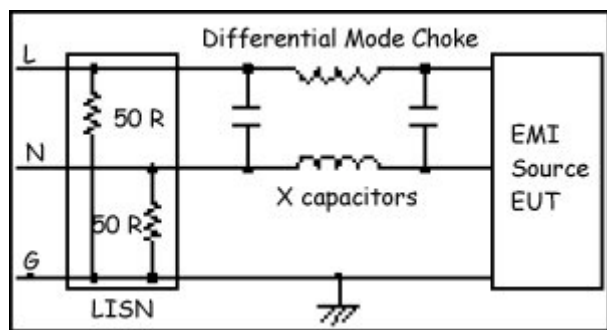
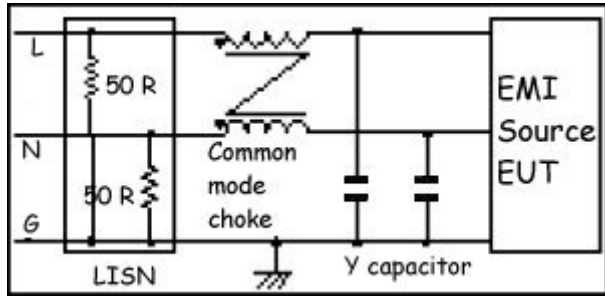


Figure 2 shows the arrangement of each type of filter, in circuit with a LISN for measurement purposes. Intuitively, if there is a common mode 'problem' connecting X type suppression capacitors across live and neutral would have very little effect because the interference voltages are already the same. It follows then that knowledge of the

Figure 2 (b) Common mode filter



nature of the emissions will be of great help in selecting the optimum filter. It can also help in identifying the cause of the problem, offering then possibility of enacting a cure at source.

A better approach

In order to obtain the measurements of common mode and differential interference signals we need to do more than is currently available in existing instruments. This problem has been addressed by Prof. Jung, Yong-Chae of EMCI S in Korea. Laplace have been working with EMCI S to develop a new range of analysers that will incorporate this feature as standard.

The common mode and differential mode voltage signals can be extracted by using a special circuit that measures both live and neutral emissions simultaneously and performs the following calculation.

$$\left(\frac{I_{CM}}{2} + I_{DM}\right) + \left(\frac{I_{CM}}{2} - I_{DM}\right) = I_{CM}$$

$$\left(\frac{I_{CM}}{2} + I_{DM}\right) - \left(\frac{I_{CM}}{2} - I_{DM}\right) = 2I_{DM}$$

With this system, a conventional EMC analyser or receiver can now display the three spectra of interest

- total emissions (as required by CI SPR)
- common mode emissions
- Differential mode emissions

Obviously, to make these measurements, a LISN capable of outputting the interference signal from both lines simultaneously is required. Although some LISNs are already available that are able to do this, a new range of LISNs from EMCI S has now been introduced which will accommodate this feature as standard.

An typical example of these results is shown in figure 3

Figure 3 (a). Total noise

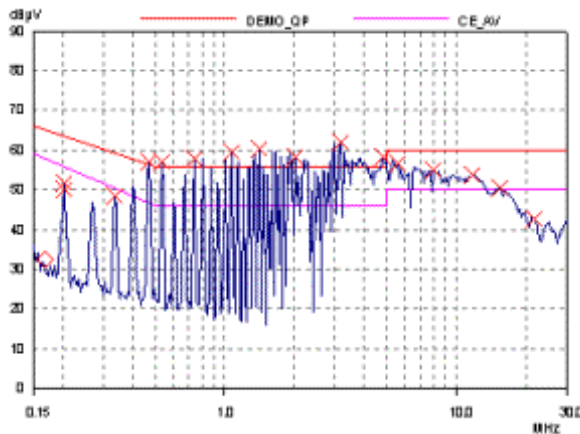


Figure 3 (b). Common mode noise

These plots have been obtained from a Switch Mode Power Supply module (SMPS). The limits shown are EN55022.

The fundamental frequency of the power conversion can be deduced from the harmonic spacing and is about 70KHz.

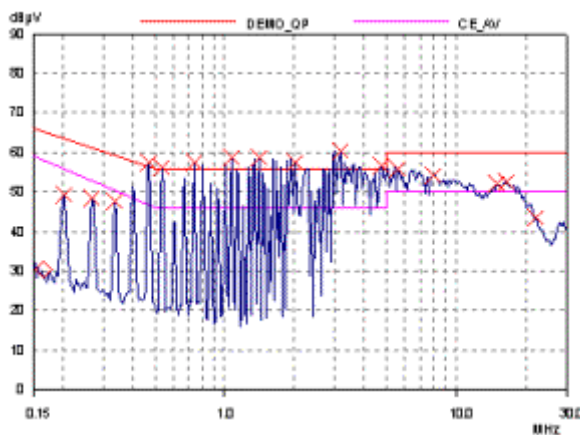
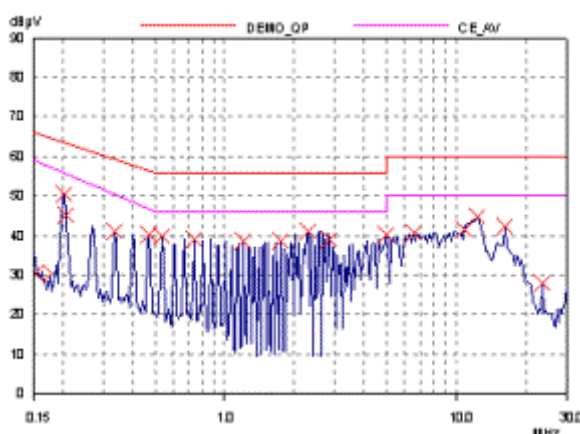


Figure 3 (c) Differential mode noise

It is immediately apparent that the emission level is unacceptable and that the problem is related to common mode noise. The differential mode noise levels, whilst significant, are within the limits. The choice of filter type required is therefore obvious. In this example, a combination of common mode filter plus a modification to the design (improved ground bonding) provided a complete cure.



Normal procedure when faced with a problem as shown above is to use trial and error techniques which can be time consuming and often leads to an over-engineered solution. Whilst this may be acceptable for prototypes and small batch products, the cost of unnecessary components and related assembly time represents wasted margin and profit.

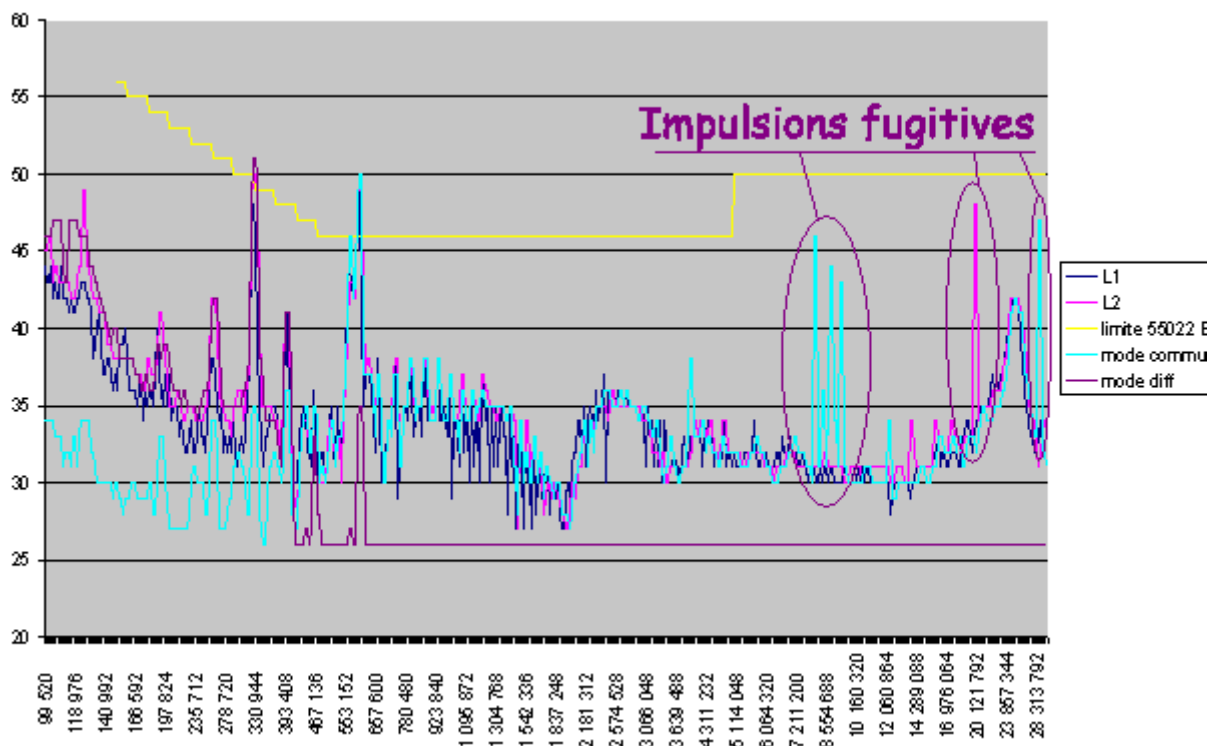
The additional analysis provided by the Laplace instrumentation is estimated to have reduced the time required to obtain a cost effective solution several hours.

UN AUTRE EXEMPLE

Voici, résumé dans un graphique, le résultat des mesures réalisées sur une alimentation de PC. Les courbes L1 et L2 correspondent aux amplitudes relevées sur la phase et le neutre suivant les recommandations des normes, en particulier la CI SPR 16.

Le relevé qui correspond au mode commun indique l'enveloppe d'énergie produite par le produit. Cette information est à mettre en parallèle avec la courbe en mode différentiel. Dans ce cas, la limite haute de l'énergie se situe vers les 800 kHz.

Ainsi dans ce cas, le filtre n'a d'intérêt qu'en dessous d'un MHz. Il paraît intéressant de le dimensionner pour une efficacité maximale en mode différentiel avec des capacités X. Le choix des composants est optimisé et l'économie est évidente.



The Implementation

Two new instruments were introduced at EMV2002, Dusseldorf in Mid April, both of which offer this new measurement technique. These are a conducted mode analyser, the EA2000 and a self contained EMC analyser, the ESA2000. The EA2000 is intended for use with any existing EMC analyser or receiver.

Each mode (total, common or differential) can be output to the analyser in turn for measurement and display. The ESA2000 includes an EMC analyser with Windows software for control from a PC. This provides a complete solution, taking signals from a LISN to and outputting the results on the PC screen/hardcopy/disk. The software includes all common limit and can display all relevant traces on screen simultaneously. The analyser covers the range 10KHz - 1.1GHz, thus fully capable of covering the radiated EMC measurement requirements too. Options for both versions include an 8 section pre-selector for band B (150KHz - 30MHz). (The importance of a pre-selector cannot be overstressed if dealing with noisy broadband sources when using spectrum analysers for conducted emission measurements. See 'Good Reason for Pre-selectors', Approval Jan/Feb 1999). In summary, the new technique offers an insight into the nature of your conducted emissions which can assist in problem location and filter specification, and provide compliance measurements too.

Figure 4. The ESA2000

