Modification of equipments for compliance in radiated emissions for certification according to CISPR normative

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Abstract: This is a study of radiated emissions generated by electronic equipment. Two different equipments were tested and their respective results presented, where it was observed that their emissions’ values were worse than desired. After some modifications, and a second batch of tests, better results were achieved.

1. Introduction
Electromagnetic Interference (EMI) is a disturbance that affects an electrical circuit due to electromagnetic conduction or electromagnetic radiation emitted from an external source, and that source could be an electric or electronic equipment. Because of that reason, products that need electric power to operate could have the influence of EMI from another equipment while it could be itself producing it, creating problems to other units close to it. It is necessary to verify if products have emissions above the appropriate limits and if they are effectively immune to it.

Experimentally it can be verified that this interference between equipment could occur in two different ways, by conducted induction and radiated induction. This study is only for the radiated interference. In this case, it can also be in two different ways, differential mode and common mode. Some of the energy will propagate as the differential mode (forth on one cable, back on another), and the rest as the common mode (along all of the cables simultaneously and back via an unknown “ground” return). [1]

Cables are a source of EME that cause significant problems in complying with electromagnetic compatibility (EMC) regulations, and even can jeopardize signal integrity. Ferrite cores or flexible absorbing materials on cables are used to suppress common mode radiated from cables. [1]

Filter circuits are used in a wide variety of applications. This filters can be active or passive. They normally are electric circuits with capacitors, inductors and resistors. Low pass filters are those that allow low frequency signal to pass and block the ones with higher frequency. Generally, a major part of electronic equipment employ anti-aliasing low pass filters in their signal conditioning stages. In a higher frequency band, mostly passive components are used. [2]

Cable shielding was also developed to solve problems with EMI radiated interference. The type of shielding that is used for this type of interference is the braided shielding. The braided wire works because the surface area of the braid is significantly greater than solid wire or stranded wire. Since the
skin effect applies to high frequency interference, the greater surface area of the braid can facilitate in reducing the effect of high frequency EMI. Braids are effective for controlling both immunity and emissions. When the interference is less than 100 MHZ within d the shield the braid will represent a large inductive path preventing the coupling in an unintended circuit. [5]

With those techniques described, employed together or apart, can control susceptibility and radiation of EMI of electronic equipment. If the tested unit has its sensitivity to EMI more of desired, or its emissions are above the regulation values, those methods could decrease the emissions. This will assure that the equipment is suitable operate with other different equipment nearby without interfering with their operation.

This paper is about radiated emissions. Its main objective is to compare radiated emissions before and after changes to the equipments, adding ferrite cores, changing low pass filters by adding resistors in series, and applying braided shielding to cables. The results are positive, proving that the described methods are effective for all equipments that could present this kind of problems.

2. Testing method and changes made to the equipment
The electromagnetic compatibility tests were done in semi-anechoic chamber in IPT (Instituto de Pesquisas Tecnológicas do Estado de São Paulo). They follow the specifications of CISPR 11[3] normative and CISPR 22[4] normative.

The first test for both equipment was before of any change from of the shelf units. For both equipment, this first test result had results worse than desired. For the first equipment, the results were above desired in several frequencies although it was above regulatory values only for about 50 MHz and for values between 200 and 700 MHz.

Some changes were made to the cables. A ferrite core was added close the power supply and it was shortened considerably. The aim was to add a magnetic resistance to the circuit, in order to decrease the effect of the inducted current for the frequency were the larger emissions were, and for that the chosen core was the one designed for maximum attenuation at the frequency desired.

Low pass filters were employed. In some cases complete filters, and in other only resistors in series, changing the cut off frequency. This filters let lower frequency pass and block those larger than 50MHz, which were the ones with results higher than desired in the test.

Cables were also replaced by different ones, with braided shielding. Even with all the changes described, the equipment still had emissions above desired. With the shielding in the internal cables, finally the values were under the limit, making possible the operation in the presence of other equipment.

Following the same procedure, the second equipment was also tested without change, and presented results that have higher emissions than allowed.

The first step was to increase the resistance in series with the circuit, changing the frequency for the low pass filter. Installing a ferrite core complete the changes and brought the results to acceptable values.

3. Results
For the first equipments, before the changes, the result is on Figure 1. Many of the frequencies are above the limits prescribed by CISPR11. Particularly the frequencies between 40 MHz and 50 MHz, and above 1 MHz.

After the before mentioned changes, the result is on Figure 2. The emissions results are a lot better, and there was no change on the equipment functionality. The results agree well with CISPR 11 imposed limits.

For the second equipments, the radiated results are presented on Figure 3. Figure 4 shows better results, after the changes. On that case only one frequency was above the limit, at 200 MHz, and that got to acceptable values.
**Figure 1:** Radiated emissions, first equipment 1, before modifications.

**Figure 2:** Radiated emissions, first equipment 1, after modifications.
4. Discussion
Both equipments designed well for their functionalities, but were not suited to CISPR11 and CISPR22 normative, for electromagnetic emissions. The initial tests show that. After the modifications made and described, adding resistors, shielding and ferrites got the results to what is prescribed.

These results are seen on the presented graphs, and it can be observed that the results are below the limits prescribed.
Any type of electronic equipments could be modified following the same rules, using the same method described.

5. Conclusion
There are several ways to correct the electromagnetic emissions that are above the limits stablished by the normative.

Figure 3: Radiated emissions, equipment 2, before modifications.

Figure 4: Radiated emissions, equipment 2, after modifications.
It is demonstrated on the examples described on this article, the ways were successful, making possible for the equipments here tested to be certified. If applied the described way, an association of these methods could be used for any electronic equipments, for any field of application.

6. References
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