INTERNATIONAL ELECTROTECHNICAL COMMISSION

INTERNATIONAL SPECIAL COMMITTEE ON RADIO INTERFERENCE (CISPR)

Subcommittee A: Radio Interference Measurements and Statistical Methods

Working Group 1: EMC measurement instrumentation

Comment on IEC 61000-4-20: The Use of Ferrite Clamps and Clip-On Ferrites

Introduction

This report presents the results of insertion loss measurements performed on different ferrite clamps and clip-on ferrites. At present, IEC 61000-4-20 Annex A, (A.5.2) requires ferrite clamps, as defined by CISPR 22, to terminate each exit cable in the EUT arrangement. The insertion loss of this clamp should be greater than 15 dB for the frequency range 30 MHz to 1000 MHz. On the other hand, according to the test set-up described in Annex B (B.3.3), ferrite clamps as described in IEC 61000-4-6, clause 6.2.4 are required.
These requirements should be harmonised and lead to further discussion points:

- The ferrite clamp described in IEC 61000-4-6 has a poor insertion loss and would therefore not meet the 15 dB requirement.
- In CISPR 22 ferrite clamps are not defined, only their use is described.
- The construction of an absorbing clamp is described in CISPR 16. This clamp could be used for both, emission and immunity testing.
- Can inexpensive clip-on ferrites be used instead of the ferrite Clamps?

To clarify these points, insertion loss measurements were performed on different ferrite clamps and clip-on ferrites.

Measurements

The insertion loss was measured in a 50 Ω system utilising the tracking generator output of a spectrum analyser at a level of -10dBm. The items to be tested were mounted in a jig made by Fischer for calibrating a F-2031-23 mm Electromagnetic Clamp. The jig comprises a 705 mm long centre conductor wire, 52 mm above a ground plane, mounted between N type connectors. For the purposes of this experiment the output of this centre conductor was connected to the input of the spectrum analyser. With no clamp or ferrites fitted to the jig the insertion loss of the system was normalised to a 0dB reference level, thus enabling the insertion loss of any clamp or clip-on ferrite to be measured directly when it was fitted around the centre conductor wire of the jig. In this manner it is possible to measure the loss of the bulk mass of the ferrite absorber in the Clamp.

In Figure 1 the insertion loss of two standard ferrite clamps is compared. The Fischer F-2031-23 mm Electromagnetic Clamp is a standard clamp according to EN61000-4-6. The Luthi MDS21 Absorbing Clamp is a standard clamp according to CISPR 16. The graph illustrates the difference in performance between the Absorbing Clamp and the Electromagnetic Clamp. The required insertion loss of 15 dB is not met by the Electromagnetic Clamp, over a wide frequency range, while the Absorbing Clamp can meet this requirement but only at and above 80 MHz.

In Figure 2 the insertion loss for either 4 Ferrico type NF130 ferrites or 6 Wurth 7427122 clip-on ferrites (typ 33x28x34mm long) is compared with the Electromagnetic Clamp. This shows that only a few clip-on ferrites are needed to achieve the insertion loss of the Electromagnetic Clamp, depending on the frequency of interest.

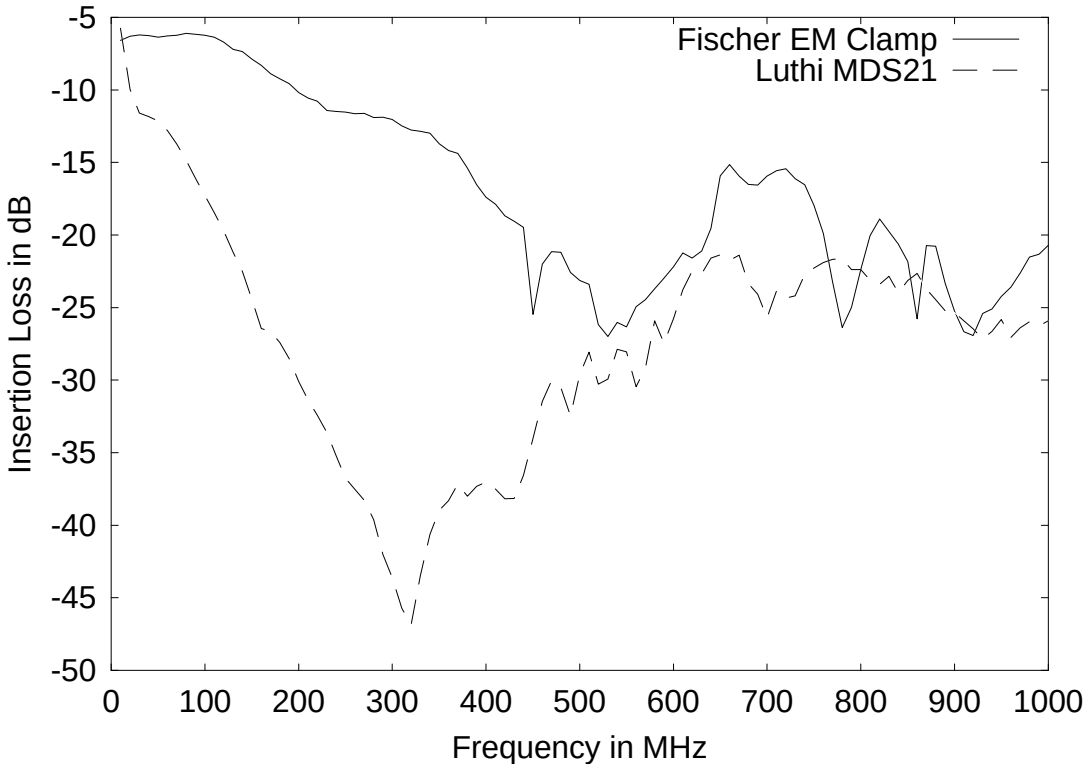

Figure 1: Insertion loss of the Fischer EM Clamp and the Luthi MDS21 Absorbing Clamp

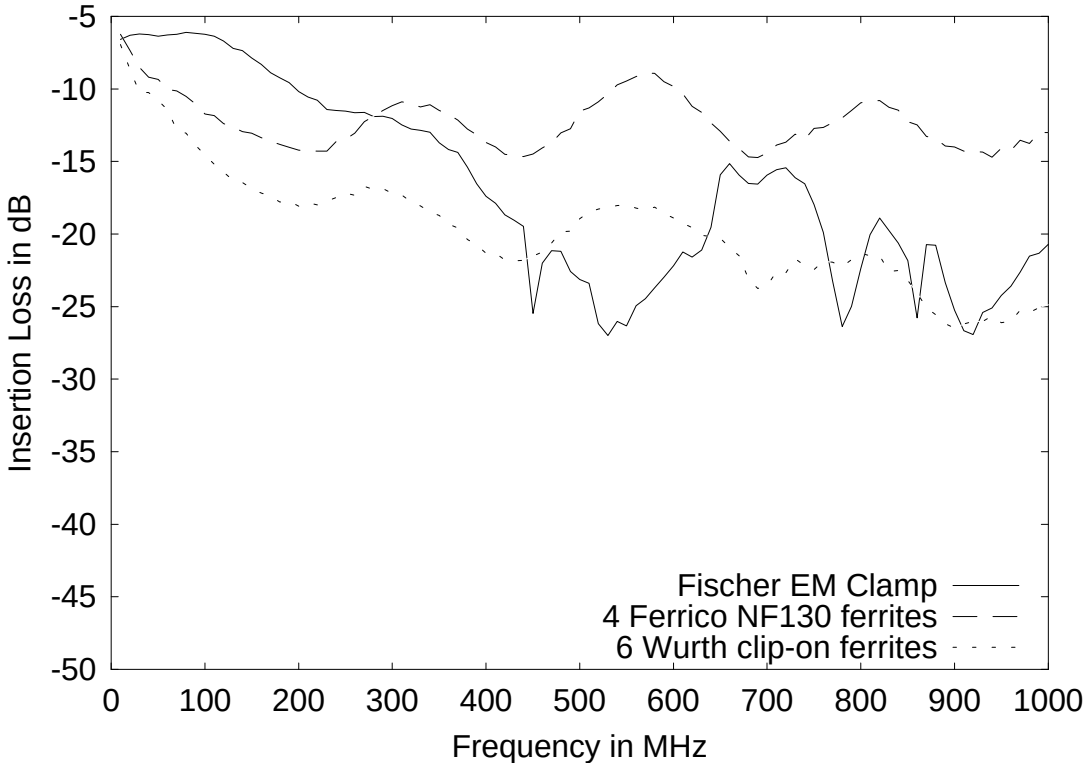

Figure 2: Insertion loss of 4 Ferrico NF130 ferrites and 6 Wurth clip-on ferrites compared with the Fischer Electromagnetic Clamp

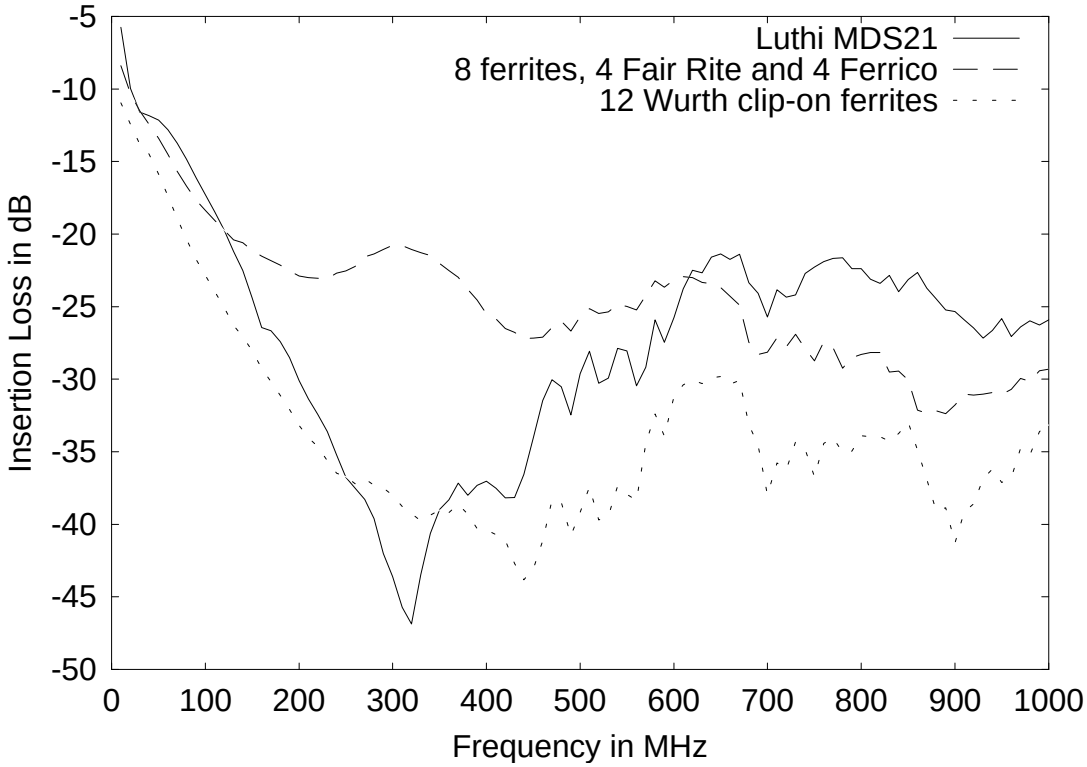

Figure 3: Insertion loss of 8 Ferrico and Fair Rite ferrites, and 12 Wurth clip-on ferrites compared with the Luthi Absorbing Clamp

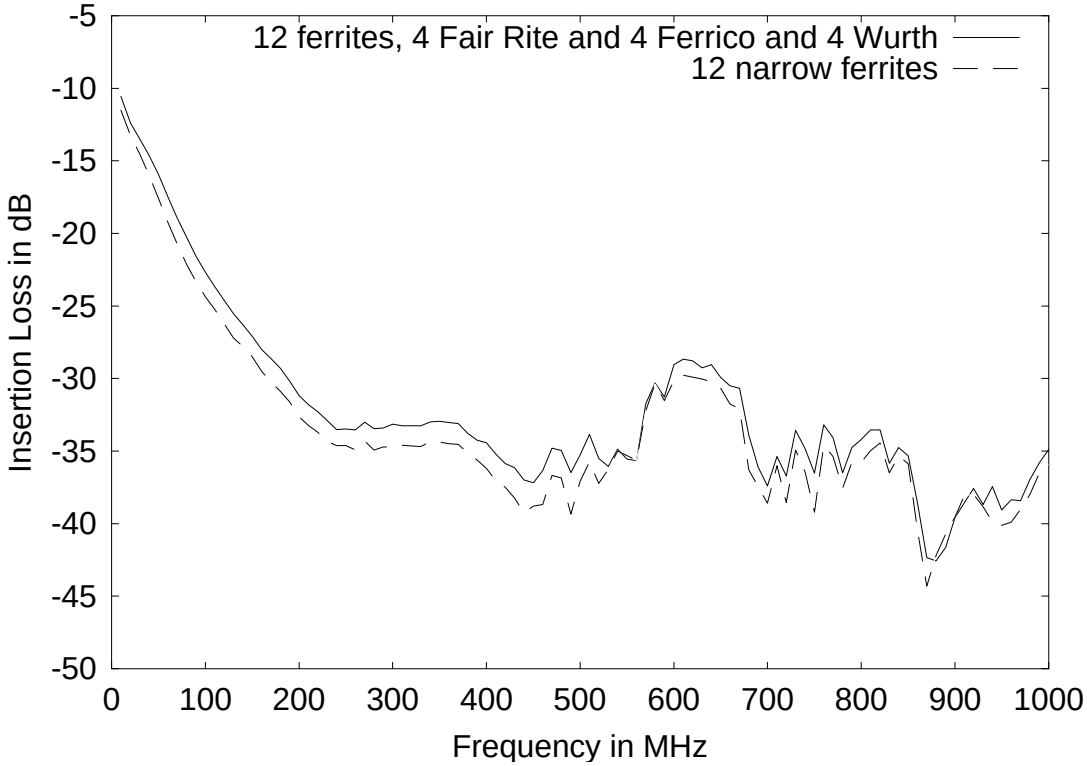

Figure 4: Insertion loss of 12 Fair Rite, Ferrico and Wurth ferrites compared with 12 narrower assorted ferrites.

In Figure 3, four Fair Rite ferrites (Material 2643164151) were added to the Ferrico ferrites. This combination and 12 Wurth ferrites were compared with the Luthi Absorbing Clamp. This shows that the insertion loss of the Absorbing clamp can also be achieved using clip-on ferrites.
In Figure 4, Fair Rite, Ferrico and Wurth ferrites were combined and compared with 12 smaller assorted ferrites (15 by 15 by 28 mm). Both combinations of 12 ferrites showed a good insertion loss, meeting the 15 dB requirement over the whole frequency range.

Conclusion

Clip-on ferrites achieve similar or better insertion loss performance than commercial clamp designs and offer a considerable saving, especially in a test set-up with many exit cables that need decoupling prior to the chamber penetration plate. (The clip-on ferrite material used had a typical impedance of 155ohm at 25MHz and 273ohm at 100MHz)

Proposal

Annex A.5.2 and Annex B.3.3 should be harmonised two avoid contradiction between these two clauses, and duplication of expensive test equipment.

The Electromagnetic Clamp described in EN61000-4-6 does not provide sufficient insertion loss for the 15 dB requirement in Annex A.5.2.

The Absorbing Clamp described in CISPR 16 is sufficient for both immunity and emission tests (above 80 MHz).

Clip-on ferrites may be used to achieve similar or better insertion loss performance than these commercial clamps. The loss depends on the total length of the clip-on ferrites and does not appear to be related to the width. The width of the clip-on required is determined mainly by the diameter of the cable to be decoupled.

(Use of any form of ferrite should still retain the minimum clearance between the end of the cable from the EUT and the floor of the Cell of 100mm)