Background information to the draft CD in CISPR/A/WG2(TF CT/Ryser)02-03

1. Introduction

This document presents the background information which led to the formulation of the second draft CD on "Insertion loss measurement of CMAD in the frequency range 30MHz to 1000MHz", as presented in CISPR/A/WG2(TF CT/Ryser)02-03 May 2002 (Ref 23).
The first draft was CISPR/A/WG2(TF/Ryser)01-03 of Nov 2001 (Ref 18).

As decided in Bristol, the draft CD is restricted to the measurement of insertion loss of CMAD (common mode absoorbing devices). This pragmatic approach is describing a simple measurement which is possible in most labs, and which gives a raw indication of the quality of the CMAD.

Further work is planned on the impedance measurement and on the definition of more efficient CMAD types, possibly with defined impedance.
Some questions to be discussed in the next step are collected at the end of this document.

2. Result of the Questionary in CISPR/A/WG2(TF CT/Ryser)02-02 of Feb. 2002 (Ref 22)

I received the response of the following TF members to the questions asked in the questionary:
Mr. Beeckman, Dunker, Gorini, Marshall, Pommerenke, Ryser, Schaefer, Stecher

The result is collected in the following table:

Question		Answer		
		preferred	accepted	not accepted
1.1	"cable termination device"	5	1	1
1.2	"RF boundary device"	1	2	4
1.3	ferrite clamp	1	1	5
1.4	TCM cable termination device	0	5	2
new proposal	CMAD			
2.1	50 Ohm system	4	2	0
2.2	150 Ohm system	3	3	1
3.1	test wire diameter 4mm	5	1	1
3.2	test wire diameter 6mm	0	7	0
3.3	test wire diameter 8mm	0	6	1
new proposal	test wire diameter 10mm			
4.1.1	Jig dimensions adapted to DUT	6	1	0
4.1.2	fixed jig dimensions	0	5	2
4.2.1	cancel Fig. 5	2	3	1
4.2.2	Fig. 5 with 3 examples	2	4	0
4.2.3	Only example 3 of Fig. 5	1	5	0
4.3.1	reference to the outside of the DUT	5	1	1
4.3.2	reference to ferrite (referrence point)	2	5	0

The reference in this table to Fig. 5 means the Fig. 5 of CISPR/A/WG2(TF/Ryser)01-03 of Nov 2001 (Ref 18)

Most of these items were also discussed at the meeting of the "absorbing clamp TF" at Dusseldorf, where Mr Beeckman, Dunker, Ryser and Stecher were present. The reason to discuss them in this group was the attempt to coordinate the result for the jig measurements used for the absorbing clamp with the jig measurement for the CMAD.

3. Discussion of the decisions for the new draft CD

3.1 Terminology (Question 1)

From the response to the questions 1.1 to 1.4 we see a preference for the combination of the terms "cable termination" for the function with "cable termination device" for the device.

However, a new name popped up (proposed by Mr Pommerenke) which is very convincing: "common mode absorbtion device (CMAD)".

I also tried to use "common mode absorbtion" for the function, but it was less convincing in the context where I had to use it to explain the place where we use the CMAD.

Therefore, in the new draft CD, the term "cable termination" is used for the function and the term "common mode absorbing device (CMAD)" is used for the device.

3.2 Measurement impedance (Question 2)

The opinions on the impedance of the measurement are mixed. Four members prefer 50 Ohm and three members prefer 150 Ohm. All members could accept (or prefer) 50 Ohm.

We discussed the question at Dusseldorf and came to the conclusion that 50 Ohm should be used for the insertion loss measurement of CMAD as well as for the measurement of the decoupling factor of the absorbing clamp and the secondary absorbing device used in the absorbing clamp measurement.

Reasons for this decision are:

- The impedance of the empty jig is anyway far from 150 Ohm.
- The impedance will change in general to even higher values as soon as the CMAD is inserted.
- The network analyzer can measure any impedance connected to an appropriate 50 Ohm adaptor.

3.3. Test wire diameter (Question 3)

The majority is preferring 4mm wire diameter. One member was proposing 10mm in order to approach 150 Ohms with a rather low wire higth above the groundplane.

At Dusseldorf we agreed to use 4mm diameter for both applications, the insertion loss measurement of CMAD and the decoupling factor measurement asorbing clamp components.

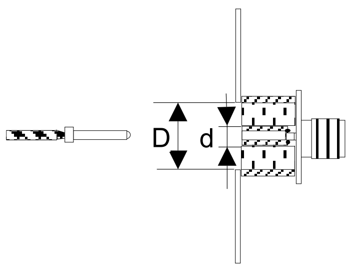
3.4. Fixed or variable dimensions (Question 4.1)

Six members were preferring fixed dimensions, but two members were strongly against. The question is also very important for the absorbing clamp and was discussed extensively at Dusseldorf.

The conclusion was to use a test jig system with fixed higth of test wire above the ground plane (65mm+/-3mm) but to adapt the length of the jig to the device under test. This means that the distance between the jig and some defined point of the device under test is defined instead of the total length of the jig. A possible construction is shown as example in the draft CD.

3.5. Construction of the wire connection (Question 4.2)

There was not a strong preference, wether to delete some of the examples in Fig 5 in the first draft CD CISPR/A/WG2(TF/Ryser)01-03 of Nov 2001 (Ref 18), nor to keep all the three. Most members could also accept (or prefer) to restrict to the example 3 in Fig 5. This was also supported in the discussion at Dusseldorf, because this construction would be a good basis for the impedance measurements in the next phase of the cable termination project.



$$Z = \frac{60}{\sqrt{\varepsilon_r}} * \ln \frac{D}{d}$$

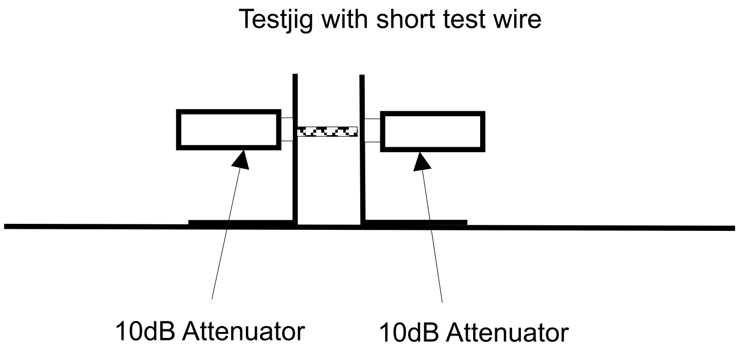
For Z = 50 Ohm we can calculate the Diameter D as:

$$D = d * e^{0.833*\sqrt{\varepsilon_r}}$$

3.6. Reference point (Question 4.3)
The majority of the members would prefer referencing the jig to the outside dimensions of the DUT, but all can accept (or prefer) a reference to a reference point indicating the end position of the elctrically active material (eg. ferrite). This referrrence point is important in case of the the absorbing clamp and the meeting at Dusseldorf decided to use this approach. In the new draft CD, the distance to the reference point has been fixed to 30mm+/- 5mm. The tolerance of +/- 5mm is justified by the measurement results shown in Ref 19: CISPR/A/WG2(TF CT/Ryser)01-04, Annex 4

3.7 Setup for the reference measurement
The first CD (CISPR/A/WG2(TF CT/Ryser)01-03 (Ref 18,) used as reference measurement for the insertion loss the direct connection of the two 10dB attenuators (Fig. YY 2).

At Dusseldorf it was discussed wether it is possible to use a short connection of the two testjig elements for the reference measurement as shown below:



Annex 1 of this paper shows some measurements with different wire lengths in the empty jig. It can be seen that even a rather short wire is forming a significant disturbance of the 50 Ohm system.

Therefore, the new draft CD is coming back to the original version of using the two attenuators directly connected as reference.

3.8 Specification
The specification was originally set to 15dB, a number coming from the Amendment 1 to CISPR22, where an insertion loss of >15dB measured in a 50 Ohm system is required. The reason for this relatively low requirement was the idea that it should be allowed to use the classical absorbing clamps (which have an insertion loss below 20dB) as CMAD.

The experiments showing the improvement of the reproducibility (eg. CISPR/G/WG1(Ryser)96-1 September 1996 (Ref 2) were performed with CMAD fulfilling the higher specification of > 20dB. Experience in the absorbing clamp TF also shows the superior performance of devices with insertion loss > 20 dB. There are commertially available CMAD fulfilling this specification.

After discussion in Dusseldorf we found it appropriate to set the specification to > 20dB.

4. Questions to the next steps of the cable termination project

4.1 Questions related to theoretical aspects

What means impedance in situations where we do not have a defined transmission line ?
What means impedance in situations where we do not have a defined ground reference ?
In real test setups the cables do not necessarily have a defined relation to any ground reference. Should we avoid to speak about impedance in such cases?

The main purpose of the cable termination is to improve the reproducibility (reduce the compliance uncertainty) of the radiated measurements. What are the main effects which contribute to the compliance uncertainty ?

4.2 Questions to practical aspects

How are the CMAD applied in the different setups (FAR, OATS, Radiation Immunity tests etc.) ?
How is the reference of these devices to the ground plane in the different applications ?
How can a 150 Ohm (or other fixed impedance) device be designed to insure that the impedance seen by the EUT is independent from the impedance at the far end ?
How can such a device be constructed to be useful in the practical application (eg. being able to be clamped to typical cable sizes) ?
Should we concentrate on a CMAD fixed at a defined ground reference ? (Ground plane at the turn table center in case ot the OATS, or outside metal shield in case of the FAR)

4.2 Questions to standardisation aspects

How is the impedance measured ? (Definition of the test jig, reference to ground plane)
What is the optimum impedance ?
Is it a high impedance as with CMAD's actually in use (ferrite clamps)?
Is it 150 Ohm over the full frequency range ?
Is it 150 Ohm up to a specified frequency and a higher impedance above ?

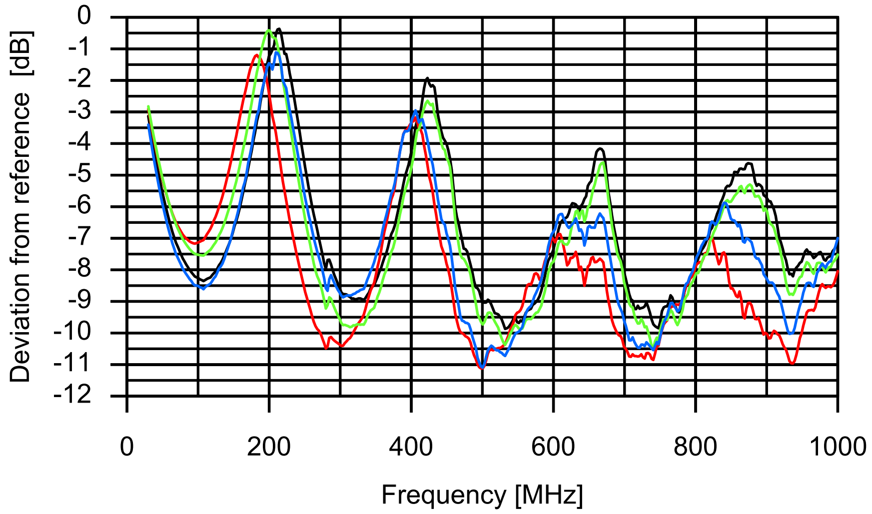
Some of the questions are partially answered in some of the documents in the reference list. Others need still further discussion and experiments. I hope the members of the TF will continue to contribute to the work.

Annex 1: Deviations from the reference in the empty jig

Originally, the reference has been defined as direct connections of the two attenuators, without the jig. It has been discussed, wether the empty jig, or a very short version of the empty jig should be used as a reference. The following measurments illustrate that this should not be recommended.

The figure below shows the measurement of the insertion loss in the emty jig of 650 mm length. The wire higth (with a nominal higth of 65mm as specified) has been varied in such a way that it is hanging by about 10mm or lifted by up to abuot 10mm.

What we see is the standing wave of the mismatch between the 50 Ohm connection and the much higher impedance in the empty jig. Such a measurement can not been used as reference, since by introducing the CMAD, the impedance and the electrical length will change and the standing wave will have its maxima and minima at other frequencies, making reference of the empty jig useless.



At the meeting of the absorbing clamp TF at Dusseldorf it was discussed to try to use a very short connection between of the two jig elements, for example a wire length of 60mm, representing the two open wire ends between reference point of the DUT and jig. The following measurements show that even such a short reference in the empty jig can not be used. The only solution would be the direct connection of the two jig elements as a 50 Ohm system, which would need additional specially constructed hardware elements, but which would be virtually the same as to connect the two 10dB attenuators together via an appropriate N connector adaptor as prescribed in the draft CD.