Reference site method and antenna calibration

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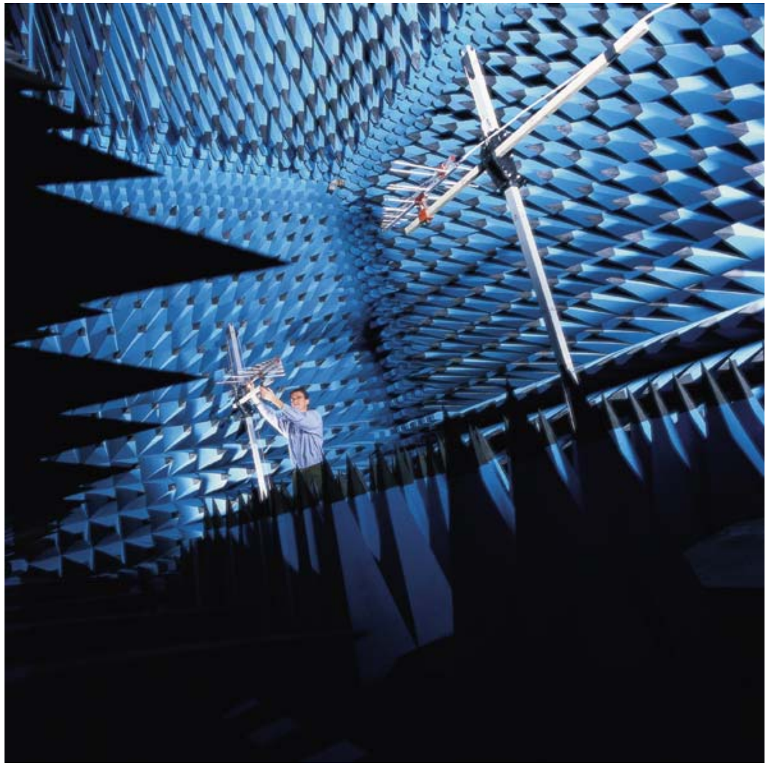
Test Site validation

- Electronic products placed on the market must be tested for emissions – EMC Directive 2004/108/EC.
- EMC disturbance field-strength measurements are normally performed on an open area test site (OATS) or in an anechoic chamber (SAC or FAR).
- OATS are areas of cleared level terrain with a metal ground plane. The terrain shall be void of buildings, electric lines, fences, trees in order to minimise unwanted reflections.
- Chambers shall be large enough and have sufficient RF absorber lining to reduce reflections from the walls and ceiling in a SAC, plus the floor in a FAR.

NPL open area site

60 m x 30 m, flatness ±6 mm



NPL fully anechoic room

9 m x 6 m x 6 m

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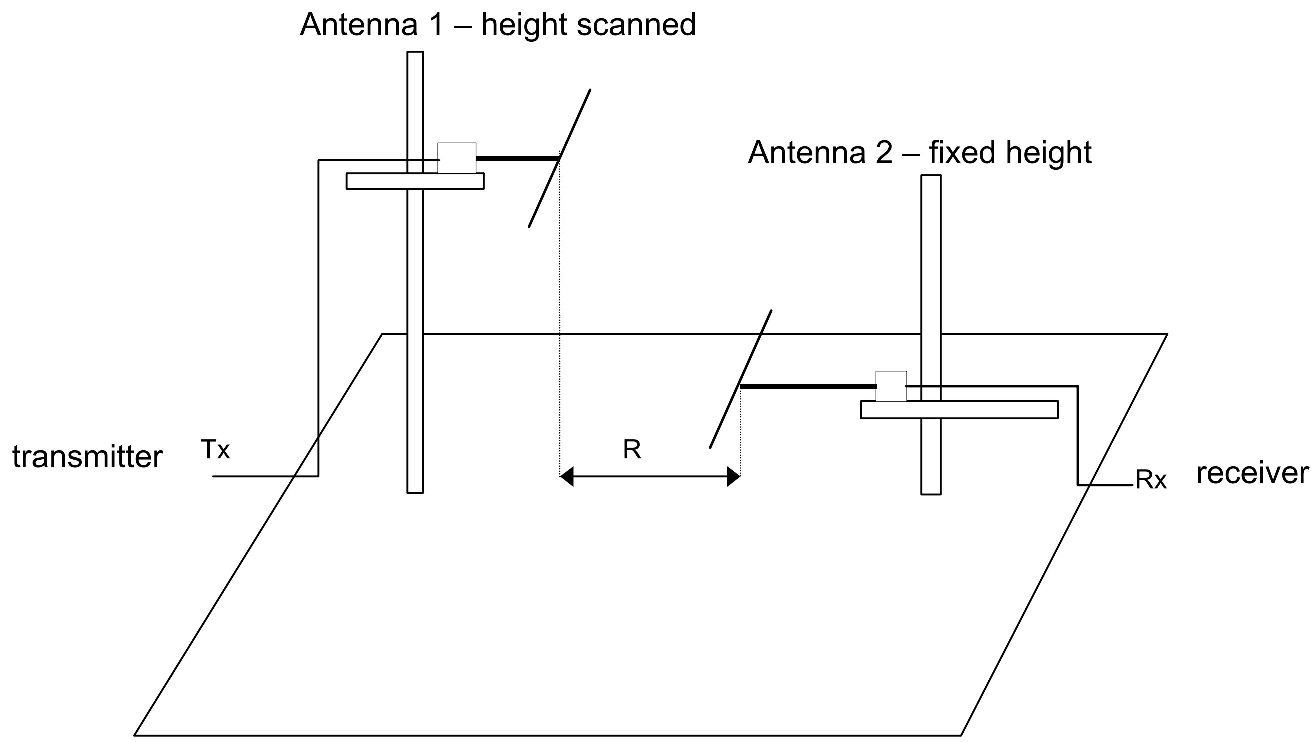
Site validation criteria

- IEC standard CISPR 16-1-4: the criterion for site validation is ± 4 dB.
  The existing criterion is for Normalised Site Attenuation (NSA) in which the measured site attenuation (SA) between two antennas is compared to theoretical values.

- The proposed Reference Site Method is to compare the SA measured on the customer’s site with the SA measured on a Reference Site.

- The specification for the Calibration Test Site is given in CISPR 16-1-5, the first stage for a Reference Site.

Antenna set up for site attenuation measurement



The Normalised Site Attenuation method

- The NSA method was introduced by A A Smith in his seminal 1982 paper in which he provided formulas for the site attenuation between two Hertzian dipoles above a ground plane. The antenna factors of the dipoles are excluded from this model.
- The radiation pattern in the E-plane is simply sin θ
- To compare the measured SA with this model, the antenna factors are subtracted to give:

$$NSA = SA - AF1 - AF2$$

- The antenna factors have to be measured. This is done by scanning one antenna in height in order to avoid nulls caused by the ground plane.

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Problems with the NSA method

- The NSA is only as good as the antenna factors.
- In the three antenna method one antenna has two heights which causes an error in the antenna factors of all three antennas.
- There is inadequate specification in CISPR16-1-4 of the quality of the site on which the antennas are calibrated;

  consequently the errors of the calibration test site are incorporated in the antenna factors.
- The NSA method does not explicitly require a site of high quality, i.e. a reference test site, for the calibration of the antennas.

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Problems with the NSA method (cont.)

- The latest version of NSA in ANSI C63.5 gives only generic corrections for mutual coupling between biconical antennas and their images in the ground plane.
- The model is of Hertzian dipoles whose radiation patterns do not adequately represent the patterns or phase centres of the antennas actually used.

The Reference Site Method (RSM)

- The attenuation between a pair of antennas is simply compared with the attenuation measured with the same pair in the same way on a Reference Test Site.
- The difference between the two results is compared to the site validation criterion (currently ± 4 dB).
- The RSM explicitly requires a reference site of high quality.
- The Reference Test Site is specified in CISPR 16-1-5 which started as a standard for Antenna Calibration.

Advantages of the RSM over the NSA method

- The NSA method does not state the quality of site to be used for antenna calibration:

  - this is a chicken and egg problem.
- For RSM the antennas do not need to be calibrated, which is a potential cost saving.
- The calibration of the two antennas for NSA involves two lots of additional uncertainty terms (not in RSM).
- The radiation patterns and phase centres of antennas have no impact on RSM because it is a comparison method. The influence of mutual coupling is negligible. Unlike for NSA.
- The RSM does not have the errors of NSA associated with an inadequate model.
- The RSM refers to a reference site that has been independently validated using calculable dipole antennas, documented in CISPR 16-1-5.

Introduction of the RSM to international standards

- The RSM enables site validations to lower uncertainties than the NSA method.
- It is probable that OATS just meeting the NSA criterion of ± 4 dB would meet a criterion of ± 2 dB.
- There are fears in CISPR working groups that accepting a smaller criterion would mean that some existing sites would be penalised. It has been accepted to keep ± 4 dB for the RSM for now.
- The flaws in the NSA method have been raised since 1990, and Gissin gave a paper on this at an IEEE EMC Symposium in 1993.

Introduction of the RSM to standards (cont.)

- Some providers of site evaluation services have been using a form of RSM over the last 15 years.
- This form has been justified as the NSA method via the use of dual antenna factors.
- Dual AF is the product of the AF of the two antennas obtained with just one height scan, so limiting the number of uncertainty terms.
- The first CISPR draft of the RSM was circulated to the CISPR/A working group on 12 November 2007.
- New standards take up to 5 years to be published.

Part II Antenna calibration for NSA

- Antenna calibration for NSA use has changed in a confusing manner over the last few years. The standard most commonly used worldwide is ANSI C63.5, which has evolved though several versions.
- The current 2006 version gives a method for obtaining free-space AF, with tabulated corrections to an AF suitable for NSA use.
- The free-space AF has limited accuracy because the method is height scanning above a ground plane, rather than a method with free-space conditions.
- Currently there are only corrections for biconical antennas, so the NSA method over the range 200 MHz to 1000 MHz is uncertain.

Antenna calibration for NSA (cont.)

- Over 200 MHz to 1000 MHz it would be better to use the ANSI C63.5:1988 method, whose AFs have been coined “geometry specific antenna factors”.
- This makes sense because the NSA method mimics the method of antenna calibration. This method is more robust if the antennas are calibrated on a reference site.
- This is probably also be true for biconical antennas, certainly for the 3m range, and also given that the tables of corrections are computed using a generic biconical antenna model.
- Antennas for the RSM do not need to be calibrated, only checked that they are functioning correctly.

CISPR standard for antenna calibration

- Work started on antenna calibration in CISPR/A in 1989. An ad-hoc group was formed to write a standard in 1995.
- The first hurdle, the specification of a test site suitable for antenna calibration, was completed with the publication of the first part of CISPR 16-1-5 in 2004.
- A committee draft on antenna calibration ran out of its allotted time in 2006 and it is intended to be restarted in 2007, with a deadline of 5 years.
- There are a number of antenna types and several competing methods, which have contributed to the delay. Besides the voluntary nature of working on standards.

Conclusions

- The NSA method and the RSM are based on the same principle
- The principle is comparison of one site with another
- The NSA method does not explicitly recognise this, but in fact the site errors are embedded in the antenna factors
- The RSM is the bare essentials of the NSA method and consequently has fewer uncertainty terms.
- CISPR has found it necessary to employ a large site acceptance criterion of ±4 dB because of the NSA errors.
- With RSM a criterion closer to ±2 dB should be feasible