

Site Validation and Re-Calibration of

- Absorber-Lined Chambers,
- Open-Area Test Sites,
- Antenna Test Chambers and
- Pre-Compliance Test Facilities

Description of Test Methods



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1 General Information

- Accreditation:** Austrian Research Centers GmbH - ARC is accredited according to ISO 17025 by the Ministry of Economic Affairs (BMWA) under the reference "Prüfstelle 32".
- References:** More than 290 site validations and expert's reports regarding radiated-emission and radiated susceptibility sites world-wide since 1990 for all major test site producers.
- Choice of validation procedure(s):** The following validations are performed by our validation engineers: Shielding Effectiveness (SE), Normalised Site Attenuation (NSA), Transmission Loss (TL), Field Uniformity (FU), CISPR 25 validation (ALSE), Calibration Test Site validation (CALTS), Ambient Noise (AN), Chamber Factor (CF), Site VSWR, Free Space VSWR validation and CTIA validation.
- If you need support for choosing the proper validation method, please send an email to itr@arcs.ac.at providing a description of your requirements. Our engineers will contact you or send you a quotation.
- Requirements:** All the test equipment can be provided by ARC, except for the automatic antenna mast (needed for measurements with height scan above ground plane) and antenna positioner (needed for CTIA validation) which has to be provided by your company or by your customer. If the measurements shall be done with the customer's equipment we need a complete equipment list to check the suitability and compatibility with our software before we confirm the order.
- For additional work (changing absorber layout ...) we require a local assistant who is familiar with the technical installation on site. For testing we require clean and quiet environment inside and around the chamber, 230V stable mains power and tables for test equipment. The safety of our staff has to be guaranteed according to ARC's assessment of risks.
- Shipment of Test Equipment:** Please provide the correct delivery address of the test site, including the name and telephone number of the contact person who will receive our test equipment on site at time of order.
- Test Results:** The test report will be sent approximately 2 weeks after finishing the tests in paper (signed) and PDF with detailed data in MS-Excel (if appropriate). During the measurements on site no test results can be provided due to internal quality management regulations.

2 Shielding Effectiveness (SE) Measurement

SE is measured in accordance with Mil-Std. 285, NSA 65-6 and EN 50147-1. Typical measurement frequencies are: 10 kHz, 100 kHz, 1 MHz, 10 MHz, 30 MHz, 100 MHz, 500 MHz, 1 GHz, 10 GHz, 18 GHz, 26.5 GHz and 40 GHz. Any selection of these frequencies is possible, any other frequencies possible upon request. The exact location of the test points will be defined together with the customer on site as it is necessary to have full access to all test points.

A leakage test at 433 MHz will be performed when requested at time of order.

Please nominate an assistant to our engineer for setting up the equipment and to handle ladders, tripods and the like.

Required test equipment: calibrated spectrum analyser, signal generator, calibrated power attenuators, suitable transmit and receive antennas, power amplifiers, pre-amplifiers, antenna masts (tripods) and RF-cables.

3 Normalised Site Attenuation (NSA) Measurements

3.1 Normalised Site Attenuation (NSA) Measurements CISPR 16-1-4, EN 50147-2 and ANSI C63.4

NSA is measured in accordance with CISPR 16-1-4, EN 50147-2 and ANSI C63.4 requirements in **semi anechoic chambers** and open area test sites (with weather protection) in the frequency range from 30 MHz to 1 GHz with broadband antennas in horizontal polarisation at 1 m and 2 m height and in vertical polarisation at 1 m and 1.5 m height. The volumetric test method is applied (please specify test volume diameter); test distance: 3 m or 10 m, any other distance upon request. The height scan of the receive antenna is carried out in the range of 1 to 4 m above ground plane, any other scan range upon request.

For **open area test sites** (OATS, without weather protection) the NSA is measured in the frequency range from 30 MHz to 1 GHz (30, 35, 40, 45, 50, 60, 70, 80, 90, 100, 120, 140, 160, 180, 200, 250, 300, 400, 500, 600, 700, 800, 900, 1000 MHz) with tuned Precision Reference Dipoles in horizontal and vertical polarisation at 2 m height, centre of the turntable, test distance: 3 m or 10 m, any other distance upon request.

For **fully anechoic rooms** standardized procedures exist (see 2.2) but we can also provide measurements according to the configuration described. Transmit and receive antenna will be fixed at the same height and free space reference data are used to calculate the site performance.

The use of our calibrated antennas and the RefRad system is included in the price. Additionally we need an automatic antenna mast with GPIB interface, a calibrated test receiver or spectrum analyser and RF-cables.

3.2 FAR validation

CISPR 16-1-4 am 1 (2004-03):

NSA measurement in **fully anechoic rooms** (FAR) in accordance with CISPR 16-1-4 am 1 (2004-03) (based on TR EN50147-3) in the frequency range from 30 MHz to 1 GHz with broadband antennas in horizontal and vertical polarisation. The volumetric test method (fixed distance, with "tilting") is applied: 5 points in 3 heights each, nominal test distance: 3 m - any other distance upon request, "Site Reference Method" for antenna calibration applied.

The use of our calibrated antennas (transmit: small biconical PCD 3100; receive: bilog) is included in the price. Additionally we need a calibrated test receiver or spectrum analyser with GPIB interface and RF-cables.

3.3 Normalised Site Attenuation and validation of a fully lined anechoic chamber up to 40 GHz

ETSI TS 102 321

NSA measurements in fully anechoic chambers are done in accordance with ETSI TS 102 321 V1.1.1 (2004-05) in the frequency range from 30 MHz to 40 GHz in horizontal and vertical polarisation at 5 positions each. Range length 3 m or 10 m, test volume radius: $d = 0.7$ m, any other distance and volume upon request. The receive antenna is placed at one fixed position.

In the frequency range 30 MHz – 1 GHz the standard allows 2 procedures: **a) high precision** measurement at discrete frequencies with tuned half-wave dipoles (30, 35, 40, 45, 50, 60, 70, 80, 90, 100, 120, 140, 160, 180, 200, 250, 300, 400, 500, 600, 700, 800, 900, 1000 MHz) and **b) alternatively** the use of broadband antennas which reduces price and measurement time dramatically.

Similar measurements are described in ETR 273-2 (fully anechoic environment) and in ETR 273-3 (chamber with ground plane)

The use of our calibrated antennas is included in the price. Additionally we need a calibrated test receiver or spectrum analyser with GPIB interface and a signal generator with GPIB interface, an antenna mast and RF-cables.

4 Calibration Test Site Validation CISPR 16-1-5:

NSA is measured in accordance with CISPR 16-1-5 in the frequency range from 30 MHz to 1 GHz (30, 35, 40, 45, 50, 60, 70, 80, 90, 100, 120, 140, 160, 180, 200, 250, 300, 400, 500, 600, 700, 800, 900, 1000 MHz) with Precision Reference Dipoles in horizontal polarisation at 2 m height, centre of the turntable, test distance: 10 m, any other distance or vertical polarisation upon request.

The use of our calibrated antennas is included in the price. Additionally we need an automatic antenna mast with GPIB interface, a calibrated test receiver or spectrum analyser with GPIB interface and RF-cables.

5 Site Validation above 1 GHz

5.1 Transmission Loss (TL) Measurement, Free Space Environment

TL measurement done in the frequency range from 1 GHz to 40 GHz using broadband antennas in horizontal and vertical polarisation at 1 m and 2 m height. The volumetric test method is applied (please specify test volume), test distance 3 m. The ground plane has to be covered with absorbing material. Transmit and receive antenna will be fixed at the same height.

The use of our calibrated antennas (broadband horn) is included in the price. Additionally we need a calibrated spectrum analyser with GPIB interface, a signal generator with GPIB interface and RF-cables.

5.2 Site VSWR CISPR 16-1-4, CISPR/A/648/CDV

The Site VSWR measurement is done in the frequency range from 1 GHz to 18 GHz using broadband omni directional antennas in horizontal and vertical polarisation. The volumetric test method is applied (please specify test volume: diameter, height and location in the chamber), test distance 3 m. The ground plane has to be covered with absorbing material.

The use of our calibrated transmit antennas is included in the price. Additionally we need a calibrated receive antenna, a calibrated Network analyser with GPIB interface, low-noise preamplifier and RF-cables.

6 Field Uniformity (FU) Measurements

FU measurement is done according to IEC 61000-4-3 or EN 61000-4-3: 16 points in a vertical plane of 1,5 m x 1,5 m, 26 MHz to 40 GHz, 1 % frequency step size, horizontal and vertical polarisation of the transmit antenna. Up to 1 GHz the transmit antenna is fixed at ONE position to test the uniformity of the 16 points. For Windowing the transmit antenna is set up at 9 different points to test the uniformity. This windowing may be used in the frequencies above 1 GHz and it must be used for frequencies higher than 18 GHz.

The use of our calibrated field-probe system is included in the price. Additionally we need a calibrated power meter (or spectrum analyser) with GPIB interface, a signal generator with GPIB interface, suitable transmit antenna(s), power amplifier(s), antenna mast and RF-cables.

7 Chamber Factor (CF) Measurements

CF measurement is done according to CENELEC R210-003 - November 1995, in the frequency range from 30 MHz to 1 GHz using dipole and loop transmit antennas in horizontal polarisation at 1 m and 2 m height and vertical polarisation at 1 m and 1.5 m height. The volumetric test method is applied with a test volume of typically 1 m diameter, test distance 3 m. In fully anechoic chambers the receive antenna is fixed in one height, in chambers with ground plane a height scan is performed. Measurements will be correlated to a 10 m open area test site with 1-4 m height scan range. Correlation to other test situations is possible on request.

The use of our RefRad system and the antennas is included in the price. Additionally we need an automatic antenna mast with GPIB interface, a calibrated test receiver or spectrum analyser with GPIB interface and RF-cables.

8 Absorber Lined Shielding Enclosure (ALSE) Measurements

ALSE validation is done in accordance with CISPR 25 (August 2002). In the frequency range from 150 kHz to 30 MHz measurements with monopole antenna. Field is generated by a test harness that is fed by a generator and terminated with an artificial network. In the frequency range 30 MHz to 1 GHz we use our optimized procedure: the field is generated by a small conical dipole antenna, operated close above the metal plane and placed in five positions (instead of the test harness) Measurements are done with biconical and log. per. antennas in horizontal and vertical polarisation.

The use of our calibrated antennas is included in the price. Additionally we need the test bench, a calibrated test receiver or spectrum analyser with GPIB interface and RF-cables.

9 Ambient Noise (AN) Measurements

AN measurement is done in accordance with CISPR 22 and EN 50022. Broadband antennas are set up in the receive position in one height and in both polarisations. The received field strength is recorded in the range from 30 MHz to 18 GHz with a measurement bandwidth of 120 kHz. The span of the spectrum analyser is set related to the frequency steps so that the whole spectrum is scanned continuously. From each span the peak value is taken as measurement value.

We need a calibrated test receiver or spectrum analyser with GPIB interface, calibrated antenna(s) and cabling.

10 CTIA Validation

CTIA Validation is done according to the "Test Plan for Mobile Station over the Air Performance", April 2005, Revision 2.1.

Section 3: The test includes the Phi-Axis Ripple Test at 6 positions and the Theta-Axis Ripple Test at 7 positions at 2 frequencies: 836.5 MHz and 1880 MHz with 2 antenna types (dipole and loop) at each frequency. The test has to be performed with the customer's antenna positioner. We provide calibrated antennas.

Section 4: Substitution measurement for calibrating the receive path of the test system at 2 frequencies: 836.5 MHz and 1880 MHz using our calibrated antennas.

The measurements in Section 3 and Section 4 will be done with customer's equipment. Network analyser, positioner, antenna adapter, cabling, test software and all other necessary test equipment has to be provided calibrated by the customer. The calibrated antennas can be provided by ARC. If the customer aspires an accreditation it's recommended to perform the test with customer's antennas.

We also offer Software Verification (Appendix B and D), Uncertainty Calculation (Appendix G), Calibration of Antennas and Training & Consulting to prepare for the CTIA Audit.

11 Free Space VSWR Validation

According to J.S. Hollis, T.J. Lyon, L. Clayton: "Microwave Antenna Measurement", Scientific-Atlanta Inc., Atlanta, Georgia, USA, July 1970.

In order to evaluate extraneous energy from several locations in the chamber, scans in transversal and longitudinal directions to the chamber axis are performed at (400 MHz), 836 MHz, 1 GHz, 1.5 GHz, 1.88 GHz, 2.4 GHz, 6 GHz, 10 GHz and 18 GHz in a test volume of 0.5 m (or 1 m) diameter in one height (max. 2 m). Each scan is performed in horizontal and vertical polarisation with a different bore sight angle of the antenna to the measurement axis. This angle is changed in 15° steps to cover a range of 180°.

This measurement is only possible with all the test equipment rented from ARC.

12 Validation of Table Influence (TI)

The Table Influence (TI) is measured according to CISPR/A/614/FDIS (CISPR 16-1-4) in the frequency range 200 MHz – 1 GHz. A small biconical transmit antenna is placed over the setup table in horizontal polarisation and the received field strength is recorded in the nominal test distance. The table is removed and the field strength is recorded again. The uncertainty contribution to be used in the RE-testing uncertainty budget is calculated from these two field strength readings. We need a calibrated test receiver or spectrum analyser with GPIB interface, antennas, cabling and antenna mast with GPIB.