ANNEX TO NPL CERTIFICATE FOR SMALL BICONICAL ANTENNAS

This annex applies to small biconical antennas of dipole tip-tip length in the range 0.3 m to 0.45 m that are specified to cover the frequency range 30 MHz to 1000 MHz.

Antenna Factor

Where the antenna factor has been given for a specific configuration above a ground plane (including free-space), the associated uncertainties only apply when the antenna support structure, including the input cable, does not cause significant reflections which would affect the received signal. If there are any significant sources of reflection the user should asses the resulting uncertainty and treat it as an additional uncertainty term. For calibration purposes the free-space condition is achieved by mounting the antenna vertically polarised at a height above the ground plane at which mutual coupling is negligible.

Where there is a sharp resonance in the antenna factor the uncertainty given in the certificate does not apply. At the frequency where the resonance causes a deviation of greater than 1 dB from the overall trend of the data, the magnitude of the increased uncertainty can be estimated from the height of the spike on the antenna factor graph. The affected range can be taken as ± 1.5 % of the centre frequency. Because the data is sampled at discrete points the maximum error may be much larger than that shown in the antenna factor graph.

If the antenna is used in an unlined screened room the use of these antenna factors may not give the absolute value of field strengths, but a calibration provides an essential check that the antenna is working properly. The antenna factors can be used to compare measurements made in an identical setup using a different antenna of the same type.

During height scans, with the antenna vertically polarised, there will be an additional uncertainty caused by the directivity of the vertical radiation pattern. In normal use, signal maxima on a 10 m range occur for antenna heights below 2.5 m and the error here will be negligible. However, for a 3 m range the received signal could decrease by more than 1 dB.

Balance Test

The balance of the antenna balun may be tested by mounting the vertically polarised antenna in a uniform vertically polarised electric field, and observing the difference in received signal when the antenna is inverted. Any change greater than 0.5 dB is caused by common mode current on the cable which is caused by an unbalance of the balun. It is important for this test that the cable hangs vertically behind the antenna in the usual manner. For this test there should be a horizontal distance of between 0.5 m and 2 m from the antenna element to the point at which the cable drops vertically. The cable should not move during the course of the measurements. An antenna is considered to have a good balun balance when the observed difference is less than ± 0.5 dB.

The inversion test is a qualitative measurement which reveals imbalance of the balun which, for some models of biconical antenna, can cause a large uncertainty in the measured field when the output cable is aligned parallel to the antenna elements. It is recommended that the user conducts tests of their own to quantify this effect in each particular measurement configuration. For antenna models with significant balun imbalance it is recommended that ferrite clamps are placed on the cable near the antenna input when the antenna is used for emission testing. Ferrite clamps on the output cable only provide a partial reduction of the braid current; a better solution is to use a perfectly balanced balun. The uncertainty of Antenna Factors is increased by the magnitude of balun imbalance.

Return Loss

The quoted antenna factors apply when the mismatch between the antenna and the receiver is attenuated. A well matched 10 dB attenuator is recommended. If no attenuator is used (and the receiver front-end attenuation is set to zero), the antenna factor can change by ± 1.4 dB at 30 MHz, assuming a receiver return loss of greater than 14 dB, an antenna return loss of 1 dB and a cable loss of 1 dB.

ARP958 Antenna Factor

Measurements at 1 m distance from an emitter is called for in MIL-STD-461D[1], which stipulates that procedure ARP958[2] is to be used for 1 m calibrations. It is necessary to distinguish between AF_{1m} and conventional AF which enables absolute E-field strength to be obtained from the voltage output of the antenna. ARP958 describes AF_{1m} as "apparent" antenna factor because it is derived from equations which do not take near-field terms into account.

ANSI Height Scan Method

The ANSI C63.5[3] procedure describes how the antenna factor may be measured over a ground plane by a height scanning three antenna method. For each measurement pair, one antenna is at a fixed height and polarisation, and the other is height scanned. The receiver is set to record the maximum measured signal during the scan. In the three pairings each antenna is measured twice, and if the customer supplies two antennas then one of the antennas is always allocated to the height scanning mount, and the other to the fixed mount. An NPL antenna is used for the third antenna which height scans for one pair and is fixed for the other pair. If the customer supplies one antenna it will be placed at the fixed height.

Where standards call for an ANSI calibration (e.g. for NSA measurements), NPL recommends the use of free-space antenna factors for the scanned antenna for measurements at 10 m separation because they agree well with 10 m ANSI antenna factors. However, at 3 m separation the ANSI antenna factors differ significantly from the free-space values, and therefore only the ANSI antenna factors should be used in order to comply fully with the NSA method described in ANSI C63.4:1992 and CISPR 16-1:1998.

References

[1] MIL-STD-461D, Requirements for the control of electromagnetic interference emissions and susceptibility, 1993, Department of Defence, USA.

[2] SAE ARP958:1992, Electromagnetic interference measurement antennas; standard calibration method. Society of Automotive Engineers.

[3] ANSI C63.5-1998, American National Standard: Calibration of antennas used for radiation emission measurements in Electromagnetic Interference (EMI) control.