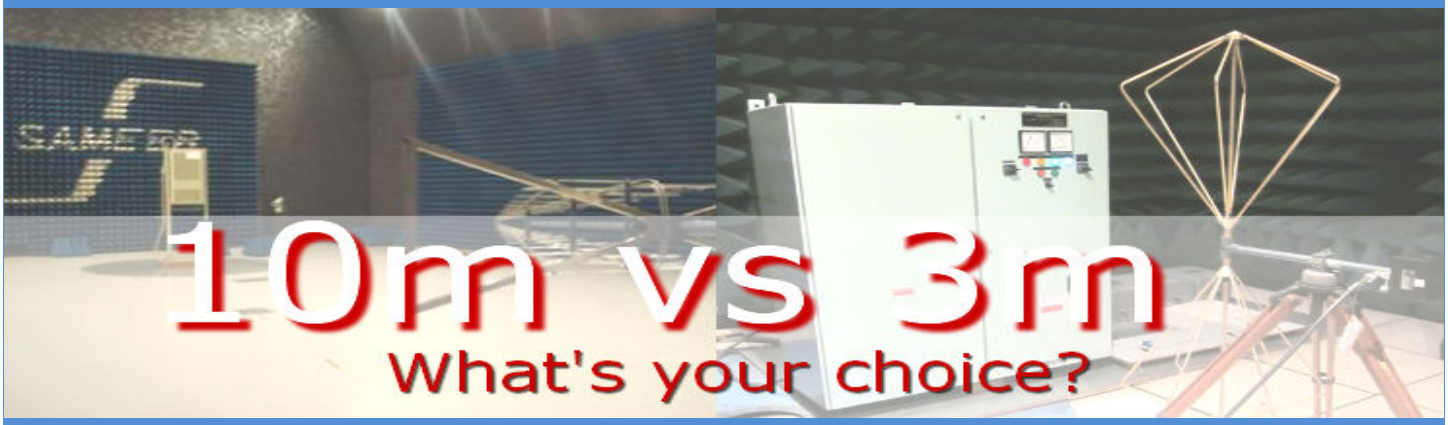
Compliance Measurement at 3m. Is it as per standard?



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Most of the product developers depend on external agencies for their EMC compliance evaluation. It is important to know the implications of the test facility utilized for the testing. Emission measurement, especially the radiated measurement in one of the most complex in terms of the facility. A lot of independent subsystems involved contributes considerably to the uncertainties in the measurement.

The most commonly used international emission standards for civilian products - CISPR 11 and CISPR 22 for specify a 10-meter antenna measurement distance for the Radiated Emission measurement. The limits specified by the standard defines the maximum allowable emission when measured at a distance of 10meter from the equipment being tested. Hence the fully compliant measurement requires a 10meter shielded chamber. But the standard provides a clause for the relaxation for the said requirement. In section 7.2.3, it says that if the measurement cannot be made at the specified distance because of high ambient noise levels, or for other reasons, the measurement may be made at a closer distance. It specifies that the 20dB per decade correction factor can be used for normalising the measured data at the measured distance to the specified distance of 10m. It also required to record in the report, the circumstances of distance deviation.

The rationale behind allowing closer distance is mere technical. However it is observed that many laboratories follow smaller distance such as 3meter as a matter of convenience - mainly the affordability. Huge cost benefit can be achieved by establishing a 3m instead of a 10m RE measurement facility. However this option has got serious technical implications. The standard itself mentions in section 6.1 the circumstances when a measurement can be done at a closer distance - mainly when the limits are low and the noise floor is close to the limits. It also emphasis on care to be taken for 3m measurement on large units due to the near field effects. If 3m measurement is allowed then why not it be standardized for 3m rather that mentioning 10m and using interpolation factors?

The "20dB per decade" rule is obtained from the free space path loss derived from Friss equation

FSPL = 20*log(d) + 20*log(f) - 27.56dB

FSPL:Free Space Path Loss

d: separation distance (m)

f: frequency (MHz)

The linear fall in the field with increase in distance is a direct implication of the Maxwell's theorems. However, it is based on the following assumptions.

a) The source is a point source

b) The measurement site is a free-space environment

c) The measurement is carried out in the far-field region.

It is obvious that the first point is not met as the equipment will have finite dimensions. As far as the measurement site is considered, emission measurements generally are being made in semi-free-space environments, involving metallic planes as ground plane in OATS or as the part of a shielded room with anechoic material on the walls and ceiling.

"It is possible to move the antenna in even closer, say to 1 metre, increasing the limit lines accordingly (proportional to the reciprocal of the antenna distance, so 3 times closer means 10dB higher) but this is very risky because of antenna-to-EUT coupling effects. Even for 10m to 3m, the 10dB correction factor is often inaccurate. "

Excerpts from "EMC testing Part 1 – Radiated emissions" by Tim Williams & Eur Ing Keith Armstrong

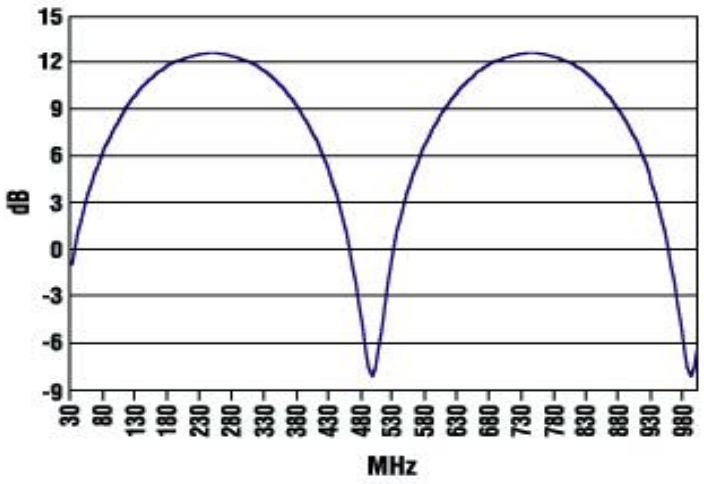
Read full article at at http://www.compliance-club.com/pdf /EMCTestingPart1.pdf

The most important point to note is that most measurements are not made in the far-field environment. Even though no clear boundary can be drawn between the near field and the far field, a far-field environment can be thought to start at 3 times the wavelength. At 30 MHz, the wavelength of the electromagnetic waves is 10-meters, which makes the measurement even at 10m in the near field region. A more precise definition is given by the propagation properties. If the distance is larger than $2D^2/\lambda$, where D is the largest dimension of the source of the radiation, then region is at far field.

Most of the 3m chamber may have a limited ceiling height, making the receiving antennae closer to the ceiling during the height scan, which introduces coupling effects. Antenna height plays an important role in determining the maximum emissions that an EUT produces. The CISPR radiated emissions measurements requires that the antenna is scanned between 1 and 4 m over the ground plane. The importance of the height scanning can be understood from the Term Ed_{max} defined in the ANSI C63.5. *Edmax* is the magnitude of signal received by a tuned dipole antenna from both the direct and reflected signals, assuming a far-field condition.

$$Ed_{max} = 20 \times \mathrm{Log}_{10}\left[\frac{\sqrt{49.2 \times \left(d_r^2 + d^2 + 2 \times d_r \times d \times \mathrm{Cos}\left(\pi - (2\pi/\lambda) d_r - d\right)\right)}}{d_r \times d}\right] \quad (4)$$

where $dr = \sqrt{R^2 \times (h_r + h_t)^2}$, the effective distance traveled by the direct received signal, in meters. and $d = \sqrt{R^2 \times (h_r - h_t)^2}$ the effective distance traveled by the reflected signal in meters; *R* is the measurement distance; *hr* is the receiving antenna height; and *ht* is the transmitting antenna height.



The above plot shows effects of using fixed receiving antenna heights during scanning at a 3-m measurement distance, with transmitting and receiving antennas set at a 1-m height. Without height scanning, signals at 495 and 990 MHz would result in potential emissions the frequencies being missed.

H.F. Gam, E. Zink, R. Kremser of Austrian Research Centre, Seibersdorf, based on their work carried out recommends that the compliance tests at 3 m distance should not be allowed. In their paper published – "Problems with Radiated-Emissions Testing at 3 M Distance According To CISPR 11 And CISPR 22" it reported that results between the interpolated and measured values can vary between 1dB to 18dB.

Conclusion

It is being observed that may EMC RE compliance measurements are being carried out in 3m anechoic chamber. From the discussions presented in this article, it is evident a 3 meter measurement chamber introduces higher uncertainties in measurement. It is required to have a better understanding on the conditions that the CISPR standard allows for closer measurement. It is strongly recommended that the measurement at 3 meter and interpolating for 10 meter be avoided.

Reference.

Dan Hoolihan, "Revisiting 10-Meter and 3-Meter Radiated Emission Measurements: A Technical Perspective", http://www.conformity.com/artman/publish/printer_feature264.shtml

Eur Ing Keith Armstrong , Tim Williams "EMC testing Part 1 – Radiated emissions", http://www.compliance-club.com/pdf/EMCTestingPart1.pdf

Garn, H.F.; Zink, E.; Kremser, R.; "Problems with radiated-emission testing at 3 m distance according to CISPR 11 and CISPR 22", IEEE International Symposium on Electromagnetic Compatibility, 1993., pp. 216 - 221