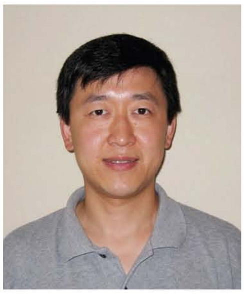

Time-domain Method on Validation of Radiated Emission Test Site above 1 GHz

——An Interview with the Chairman of ANSI C63 SC1, Mr. Zhong Chen

Recently, it was decided in American National Standards Institute (ANSI) Accredited Standards Committee (ASC) C63® committee that a new standard C63.25 will be drafted to include all site validation procedures within ANSI standards. The time domain sVSWR (TD sVSWR) for site validation above 1 GHz is expected to be included. The invited expert, Mr. Zhong Chen, was interviewed to interpret TD sVSWR briefly and to propose some ideas for the development of site validation.

Interviewer: What is TD sVSWR? What is the main differences compared with sVSWR in CISPR 16-1-4?

Zhong Chen: TD sVSWR mimics the test setup in the CISPR 16 sVSWR method, and uses the same transmit antenna. It measures the vector S21 responses (in frequency domain) between an omni-directional transmit antenna, and a user defined receive antenna, and uses the time domain transformation to separate the main antenna response and the late time reflections. The site VSWR versus frequency is calculated from the time domain processed data.

The main difference between the CISPR sVSWR and TD sVSWR is that CISPR sVSWR uses spatial movement to measure the standing wave directly (i.e., move the transmit antenna, typically a mini-biconical antenna, along a 40 cm line to six points, and measure the scalar antenna responses). In the TD sVSWR, there is no need to physically move the antenna. The reflections in the chamber are measure through the time domain transformation of the vector frequency domain data. In time domain, reflections (which takes longer time to arrive at the antennas than the direct antenna response) can be separated. The standing wave ratio can then be calculated based on the reflection coefficient.

Interviewer: What is the advantages/disadvantages of TD sVSWR?

Zhong Chen: The main challenges with the CISPR method needs to be highlighted here: ① CISPR method undersamples the standing wave pattern in spatial domain. For example, at 6 GHz, the wavelength is 5 cm. Since according to the CISPR sVSWR requirements, we will be taking measurements at 0, 2, 10, 18, 30 and 40 cm. In this case, we are taking 6 data points across 8 wavelengths of distances, and hoping to find the peak and valley of the standing wave pattern. ② Based on the CISPR requirements, sVSWR is measured at every 50 MHz. This proves to be too sparse to represent a chamber performance.

TD sVSWR was developed to address these two challenges in the sVSWR measurements. In addition to using the time domain transformation to obtain the sVSWR, another major addition from the TD sVSWR method is to take advantage of the statistical nature of the sVSWR data. If we divide the sVSWR vs. frequency data into sliding frequency windows, we observe that the data in a sliding window is normally distributed. This enables us to fully describe the data statistically (using means and standard deviation). This is significant, as we can set the severity of a sVSWR measurement based on a pre-determined uncertainty bound. We can actually match the severity of the CISPR sVSWR even though the CISPR method yields an under-sampled set of data.

According to the characteristics of test setup and the data processing in TD sVSWR method, the advantages of TD method could be concluded as follows:

- Can correlate closely to the CISPR sVSWR results.
- Better repeatability because a statistical metric is used instead of a randomly chosen number at every 50 MHz. Results are much more immune to small variations in antenna positioning or frequency shift.
- Faster (1/6th of measurement points).
- Bounded and predictable measurement uncertainties, and more mathematically rigorous.
- Smaller uncertainties without the need to move antenna at a given location (cable draping and movement/difficult to arrange absorbers around the antenna stand), nor the need to measure distances. There is neither position related measurement nor uncertainties associated with it.
- Retains the benefit of CISPR VSWR method – antenna calibrations are not required.
- Can aid chamber debugging using time of arrival information: a user can estimate how far a significant reflection comes from.

The only drawback is the need for a *(Continued on Page 12)*

Antenna Extrapolation Range at NIM, China

In definition, an antenna is a transducer designed to transmit or receive electromagnetic waves. Antennas are essential components of all equipment that uses radio. They are used in systems such as radio broadcasting, broadcast television, radar, cell phones, satellite communications. The main antenna parameters include gain, pattern, polarization. Gain is one of the 7 key parameters in radio science defined by Consultative Committee for Electricity and Magnetism (CCEM), International Committee for Weights and Measures (CIPM) .

The National Institute of Metrology (NIM) has being dedicated to establishing a national antenna metrology system in China for many years. Now we have several high level antenna calibration facilities starting from a few kHz to 110 GHz. Figure 1 illustrates the facilities we have now corresponding to different frequency bands.

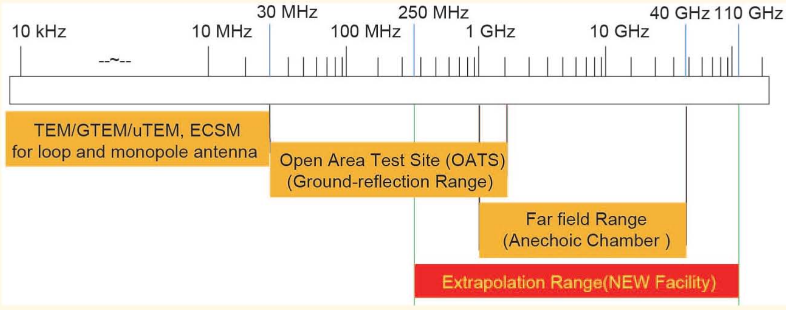

Figure 1 Antenna metrology facilities at NIM

Directly promoted by the fast developing aerospace and communication industry, it is of great necessity for China to have a world-class facility to measure microwave and millimetre-wave antenna parameters. Of the many measurement techniques for determining the gain of an antenna, the most accurate is the three antenna extrapolation technique, which is an absolute measurement method as it does not require a prior knowledge of the gain of any of the antennas used.

A three antenna extrapolation range has been developed at NIM, funded by a long term antenna metrology collaboration plan between National Physical Laboratory (NPL) and NIM. The new facility is developed in a fully anechoic chamber (15.1 m × 7.6 m × 7.75 m), which is shown in Figure 2. The main parts includes a precision rail guidance and covering system, a transmit carriage and drive system, a roll–over–azimuth positioner and control system, laser interferometer, optical alignment equipment, and RF/mm–wave measurement equipment.

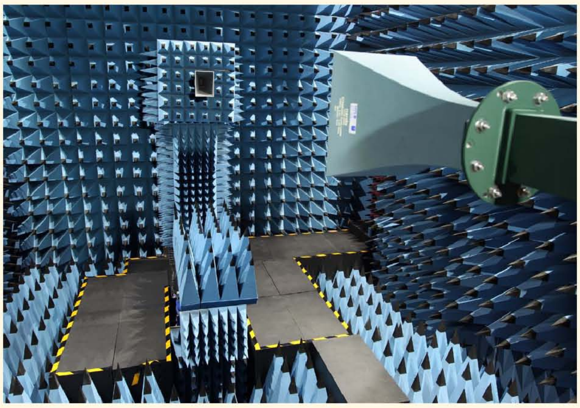
Figure 2 Extrapolation range at NIM

The antenna extrapolation range at NIM will be opreational from 250 MHz to 110 GHz, and the main parameters that can be measured include gain, reflection coefficient, axial ratio, tilt, sense of polarisation. A typical measurement uncertainty of 0.05 dB for standard gain horn (SGHs) antenna measurement has been achieved. With a precision roll–over–azimuth positioner which is also involoved in the extrapolation range, this facility can also be used for sperical near–field scaning.

The new facility will be the fifth high performance extrapolation range in the world after ones at NIST (US), NPL(UK), VNIIFTRI (Russia), KRISS (Korea), which will enable NIM to conduct microwave antenna research on establishing, maintaining and improving the national measurement standards, and disseminating these standards to lower level laboratories and customers for traceability in China. NIM will be able to better participate in international comparisons to ensure the international equivalence of national standards. ***(Dr. Song Zhenfei, NIM)***

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vector network analyzer (VNA), which a modern lab should already own (or can rent) for a variety of reasons.

Interviewer: Is there any restrictions or cautions when using TD sVSWR site validation?

Zhong Chen: It is important to observe the rules of the frequency domain and time domain transformation. The forward and inverse Fourier transforms are built in most modern VNA, so most of the work is done by the analyzers. A user needs to pay attention to the windowing effect, aliasing, time resolution, and gate shapes etc. One should also use antennas with short impulse responses (short ring down time). These will be addressed in the C63.25 standards.

Interviewer: Could you introduce the developing progress about TD sVSWR in standardization?

Zhong Chen: Currently the work is mostly concentrated in ANSI C63.25 working group. A great deal of work, including measurement validations of more than 10 sites has been carried out throughout the United States, China, and Japan. We have seen good correlations between the TD sVSWR and CISPR sVSWR. We believe there is enough technical data to develop the standard, and that is what the current efforts are devoted to. Once that work is finished, we will consider taking the standard to the international arena.

Mr. Zhong Chen *is the Product Manager, RF Materials at ETS–Lindgren, located in Cedar Park, Texas. He has more than 18 years of experience in RF testing as well as EMC antenna and field probe design and measurements. He is an active member of the ANSI ASC C63® committee and Chairman of Subcommittee 1 which is responsible for the antenna calibration and test site validation standards. He is chairman of the IEEE 1309 committee for developing calibration standards for field probes. Zhong Chen received his M.S.E.E. degree in electromagnetics from the Ohio State University at Columbus. He may be reached at zhong.chen@ets–lindgren.com.*