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Einladung
zu einem Doktorandenvortrag

Referent: Dipl.-Ing. Marc Dirix

Thema: "Quiet Zone Performance Qualification using Spherical Near-Field Scanning"

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Ort: Hörsaal 4G, 4. Etg. rechts,
Lehrstuhl und Institut für Kommunikationssysteme IKS
Muffeter Weg 3a, 52074 Aachen

Alle Interessenten sind herzlich eingeladen

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Univ.-Prof. Dr.-Ing. Dirk Heberling

Kurzfassung der von Herrn Dipl.-Ing. Marc Dirix vorgelegten Dissertation

“Quiet Zone Performance Qualification using Spherical Near-Field Scanning”

The evaluation of the performance of an antenna measurement chamber becomes an ever more important part of both the validation and maintenance therein. Key antenna performance parameters such as gain, directivity, radiation pattern and polarization depend highly on the planarity of the field distribution of the quiet zone. In order to meet the demands of current and future antenna measurements, modern measurement ranges have to meet strict requirements on the field distribution inside the quiet zone. In order to verify that the measurement range meets these strict requirements the measurement setup and algorithms used for the evaluation of the quiet zone performance need to be improved accordingly.

Quiet zone spherical near-field scanning provides a solid basis for the performance evaluation of a far-field antenna measurement chamber. The reason is that spherical harmonic decomposition provides a complete description of the electromagnetic field distribution inside the quiet zone. This description provides all the information needed for the analysis of the field distribution inside the quiet zone and provides meaningful insight in the expected performance of the range during antenna measurements. For the spherical harmonic decomposition only the measurement of both tangential electric field components on the surface of a sphere surrounding the quiet zone is needed. Therefore, only two full sphere measurements are needed for each range setup. Then on the calculated Spherical Mode Coefficients (SMCs), the weights of the spherical harmonic waves, special algorithms such as the calculation of the electric field on arbitrary locations inside the quiet zone, or angle of arrival estimation can be easily applied without needing further measurements.

The measurement setup itself consists of a sturdy beam and probe antenna. The sturdy beam is mounted on top of a roll-over-azimuth positioning system which commonly is already available in an antenna measurement chamber. At the end of the sturdy beam the probe antenna is placed such that the tangential electric fields on a sphere surrounding the quiet zone can be measured. The resulting measurement data is decomposed into spherical harmonic waves using established algorithms from spherical near-field antenna measurements. The SMCS provide all the necessary information for a full reconstruction of the electromagnetic field distribution inside the quiet zone.

Using the SMCS the electromagnetic field can be calculated on arbitrary coordinates inside the quiet zone. With a newly developed adaptation of the transmission formula a virtual receiving antenna can be placed on these positions. The resulting output of the calculation is the same as the output a physically placed antenna at the same location in the quiet zone would measure. As such the adapted transmission formula can be used to calculate similar data a field probing setup would measure without the need for the additional positioning equipment.

A second and important part of the evaluation and maintenance of an antenna measurement chamber is the detection of unwanted sources of reflection. These sources of reflection cause extraneous signals impinging on the Antenna Under Test (AUT) causing an error in the measured radiation pattern. Although the SMCS provide a complete and highly accurate description of the electromagnetic field distribution inside the quiet zone, signals impinging into the quiet zone are superposed in the SMCS and cannot easily be separated. Due to the finite number of SMCS that can practically be considered, a back-projection into the far-field results in a highly convolved angular map in which small signals cannot be discriminated due to the presence of the large main beam illumination.

By combining the SMCS and the CLEAN algorithm, the superposed signals in the SMCS can be separated and as a result a high resolution angular map can be derived. Using one version of the presented algorithm it is possible to discriminate signals from opposing direction, even if one of both has a power level that is several magnitudes higher than the other.

As a last step, a new performance indicator is derived from the SMCS directly, the quality factor. The quality factor is an important indicator of the planarity of the field distribution of the quiet zone. Since quiet zone spherical near-field scanning is able to determine the field distribution in the quiet zone independently of the used measurement setup, the quality factor can be used for measurement range inter-comparison and provides an upper bound for the error of antenna measurements inside the antenna measurement chamber.

Based on the developed measurement setup and algorithms it can be concluded that quiet zone spherical near-field scanning presents a next step in evaluating and validating the performance of a far-field antenna measurement range. The developed set of tools provide enough information for the range maintenance to track the range performance during its lifetime using only a simple measurement setup.