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Technical Specification

Electromagnetic compatibility and Radio spectrum Matters (ERM); Expanded measurement uncertainty for the measurement of radiated electromagnetic fields

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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM).

Introduction

The present document has been produced in response to the need for expanded measurement uncertainty information, and to determine practical maximum frequency of measurement which is also cost effective for manufacturers self declaration as well as for test laboratories offering certification testing.

In metrology the term "measurement uncertainty" is nearly always associated with the simple standard deviation (σ). In the case that a different confidence interval is used, the term "Expanded Measurement Uncertainty" is used, stating the associated expansion factor, see EA-4/02 [19].

Considerable work on radio test methods and expanded measurement uncertainty up to 1 GHz has previously been undertaken by ETSI to determine the contributions to the calculation of measurement uncertainty and these have been published in TR 100 028 [1] and [2] and TR 102 273 [3] to [10]. However, more and more ETSI standards and norms are generated for radio devices operating at higher frequencies as far as 100 GHz or even higher.

The expanded measurement uncertainty values have been included based on new information on state-of-the-art measurements for expanded measurement uncertainty for measurements at higher frequencies, also taking into account new work in ERM for radio applications at EHF frequencies.

The changing role of regulation due to the implementation of the Radio and Telecommunications Terminal Equipment (R&TTE) Directive [11] within the European Union has meant that there is a need to review and if necessary revise the previously agreed methods for the comparison of measurement values with limits to determine conformance with standards and specifications.

As a result of discussions with manufacturers, test laboratories, and regulators it is clear that some test methods need to be reviewed and more clearly defined as the frequency of measurement increases above 1 GHz. The re-defining of test methods is not within the scope of the present document, but may result in a more extensive evaluation of the test methods, bearing in mind the globalization of radio products, and the implementation of Mutual Recognition Agreements (MRA) for this purpose.

The present document contains the results of many discussions held with test equipment manufacturers, test laboratories, administrations, trade associations, societies, and members of the GRSC, all who have an interest in expanded measurement uncertainty above 1 GHz.

From an international perspective, measurements for radio testing, both radio parameters and EMC are already required above 1 GHz, notably in US FCC regulations (40 GHz), ITU-R spurious emissions (300 GHz), and CISPR EMC testing (6 GHz). These extensions to the measurement frequency range necessitate a review and some level of co-ordination to ensure that a common approach to test methods and the associated measurement uncertainty calculations are agreed.

Contrary to the requirement of performing measurements at higher frequencies up to 100 GHz or even more, the descriptions on traceable validation or calibration of test sites lacks considerable information leading to another source of uncertainties in the measurement results. The source descriptions for open area test sites, semi-anechoic rooms and anechoic test chambers at/in which radiated measurements can be performed are lacking information regarding frequencies above 40 GHz.

Measurement receivers are also limited regarding their capabilities in terms of fundamental frequency measurements and measurement bandwidth. At the time of writing, an investigation has shown that spectrum analyzers were only available for frequency measurements up to 63 MHz. Non-continuous, impulsive radio technologies could also be measured with a measurement bandwidth of up to 25 MHz. In the case of EHF frequency measurements above 60 GHz, it has therefore been considered to make use of external mixers (either ground wave or harmonic wave) to measure emissions. However, this comes at the expense of great additional measurement uncertainty contributions. The present document does not attempt to repeat the detailed statistical methods to calculate the expanded measurement uncertainty that has already been extensively prepared in other ETSI deliverables. However, to assist test engineers to calculate their own expanded measurement uncertainties associated with their particular test equipment configurations, a series of spread sheets are identified in the present document (see annex B).

The present document captures the state of the art regarding measurement techniques, their capabilities and associated expanded measurement uncertainties. It is offered as an assistive document to ETSI standard makers. Whilst it remains the responsibility of the individual Technical Bodies to define their own test methodologies, the present document should be considered as a source of what is possible, practical and therefore recommended.