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SERIES K: PROTECTION AGAINST INTERFERENCE

System level radiated emissions compliance using mathematical modelling

ITU-T Recommendation K.62

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System level radiated emissions compliance using mathematical modelling

Summary

This Recommendation supports telecommunication operators in demonstrating the compliance of the radiated emissions generated by telecommunication systems.

Telecommunication operators typically construct their systems from many items of equipment that are each engineered to individually meet EMC requirements, including radiated emissions. This means that a system will typically contain a number of emissions sources (i.e., separate equipment items) at a number of common frequencies. This is true if the system contains many items of the same equipment or many items of different equipment.

For such a system, the superposition of these multiple emissions has the potential to produce a system emission level that is greater than the system emission limit. This is of fundamental concern for telecommunication operators seeking to demonstrate the compliance of the radiated emissions of their systems.

This Recommendation introduces a statistical approach to systems radiated emission compliance. By applying a statistical approach to the treatment of basic variables that are not known by the operator, a method is presented that allows the system emission level to be described statistically in terms of a probability and cumulative probability distributions.

These distributions allow the compliance of the system emission level, with respect to a limit, to be expressed as a statistical confidence level (rather than as a simple "Pass" or "Fail" statement). It is proposed that the 80% confidence level be used for compliance to align with the approach taken for series production equipment within CISPR 22.

The method presented may also be used by other organizations that either build or operate other systems that are formed from the integration of many items of digital electronic equipment that each individually comply with their own radiated emissions limit.

Source

ITU-T Recommendation K.62 was approved on 29 February 2004 by ITU-T Study Group 5 (2001-2004) under the ITU-T Recommendation A.8 procedure.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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Introduction

Telecommunication operators typically construct their systems from many items of equipment that are each engineered to individually meet EMC requirements, including radiated emissions. This means that a system will typically contain a number of emissions sources (i.e., separate equipment items) at a number of common frequencies. This is true if the system contains many items of the same equipment or many items of different equipment.

The system as a whole will generally be expected to comply with a radiated emissions limit. This may be the same or different to the limit applicable to the individual constituent equipment. For each common emission frequency, the presence of many individual sources within the system means that the system emission level may be higher than that of the individual equipment.

A method is presented that allows the radiated emissions to be assessed without performing practical measurement. The method presented is particularly suited to the analysis of systems that are physically very large, for which practical testing is both prohibitively expensive and practically difficult to perform.

ITU-T Recommendation K.62

System level radiated emissions compliance using mathematical modelling

1 Scope

This Recommendation provides a procedure for demonstrating the compliance of the radiated RF emissions from telecommunication systems.

Telecommunication operators typically construct their systems from many items of equipment that are each engineered to individually meet EMC requirements, including radiated emissions. This means that a system will typically contain a number of emissions sources (i.e., separate equipment items) at a number of common frequencies. This is true if the system contains many items of the same equipment or many items of different equipment.

For such a system, the superposition of these multiple emissions has the potential to produce a system emission level that is greater than the system emission limit. This is of fundamental concern for telecommunication operators seeking to demonstrate the compliance of the radiated emissions of their systems.

This Recommendation introduces a statistical approach to systems radiated emission compliance. By applying a statistical approach to the treatment of basic variables that are not known by the operator, a method is presented that allows the system emission level to be described statistically in terms of a probability and cumulative probability distributions.

These distributions allow the compliance of the system emission level with respect to a limit to be expressed as a statistical confidence level (rather than as a simple "Pass" or "Fail" statement). It is proposed that the 80% confidence level be used for compliance to align with the approach taken for series production equipment within CISPR 22.

The method presented may also be used by other organizations that either build or operate other systems that are formed from the integration of many items of digital electronic equipment that each individually comply with their own radiated emissions limit.

This Recommendation does not define radiated emissions limits or methods of measurement for telecommunication systems.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

- [1] CISPR 22 (1997), *Information technology equipment – Radio disturbance characteristics – Limits and method of measurement*.
- [2] ITU-R Recommendation P.525-2 (1994), *Calculation of free-space attenuation*.
- [3] ITU-R Recommendation P.526-8 (2003), *Propagation by diffraction*.

3 Terms and definitions

This Recommendation defines the following terms:

3.1 equipment: Within this Recommendation, the term "equipment" applies to an item that forms a basic building block of a system. An equipment is generally supplied to the telecommunication operator by a third-party manufacturer and is placed on the market as a separate item. As a result, an equipment will have been engineered to meet local EMC requirements, including radiated emissions.

3.2 system: Within this Recommendation, the term "system" applies to that item formed from the integration of many items of equipment, all at the same physical location, to deliver a defined function. All cables used to interconnect the constituent equipment that together form the system, are also part of the system. All interconnect cables that connect a system with other systems are not considered part of the system.

3.3 system emission level: The emission level of the system, generated through the superposition of the emissions radiated at the common frequency by the system's constituent equipment.

Within this Recommendation, this term is represented mathematically as E_S .

3.4 probability distribution: The probability distribution of an unknown, continuous variable, x , that exists within the range $x_{min} \leq x \leq x_{max}$ is written as $p(x)$. The probability distribution quantifies the probability (i.e., the relative frequency of occurrence) with which the variable will exist within the range x and $x + dx$.

By definition,

$$\int_{x_{min}}^{x_{max}} p(x) dx = 1$$

3.5 cumulative probability distribution: The cumulative probability distribution of an unknown, continuous variable, x , that exists within the range $x_{min} \leq x \leq x_{max}$ is written as $CP(x)$. The cumulative probability distribution quantifies the probability (i.e., the relative frequency of occurrence) with which the variable x exists within the range:

$$x_{min} \leq x \leq x'$$

where the value x' falls within the range $x_{min} \leq x \leq x_{max}$

By definition,

$$CP(x) = \int_{x_{min}}^{x'} p(x) dx$$

3.6 compliance probability: The probability (i.e., the relative frequency of occurrence) with which the system emission level, E_S , will exist within the range:

$$E_{Smin} \leq E_S \leq E_L$$

where:

E_{Smin} is the lower limit (i.e., minimum value) of the system emission level

E_L is the system emission limit

The compliance probability is, therefore, the probability with which the system emission level will meet the system emission limit.