IEC 62333-2

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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Noise suppression sheet for digital devices and equipment – Part 2: Measuring methods

Plaque réduisant le bruit des dispositifs et appareils numériques – Partie 2: Méthodes de mesure

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FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.

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International Standard IEC 62333-2 has been prepared IEC technical committee 51: Magnetic components and ferrite materials.

This standard is to be used in conjunction with IEC 62333-1.

This bilingual version (2011-07) replaces the English version.

The text of this standard is based on the following documents:

FDIS	Report on voting
51/853/FDIS	51/861/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

The French version of this standard has not been voted upon.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

IEC 62333 consists of the following parts, under the general title *Noise suppression sheet for digital devices and equipment:*

Part 1: Definitions and general properties

Part 2: Measuring methods

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

NOISE SUPPRESSION SHEET FOR DIGITAL DEVICES AND EQUIPMENT –

Part 2: Measuring methods

1 Scope

This part of IEC 62333 specifies the methods for measuring the electromagnetic characteristics of a noise suppression sheet. Those methods are intended to provide useful and repeatable measurements to characterize the performance of the noise suppression sheets, so that manufacturers and their customers are able to obtain the same results.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendment) applies.

IEC 62333-1, *Noise suppression sheet for digital devices and equipment – Part 1: Definitions and general properties*

CISPR 16-1, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1: Radio disturbance and immunity measuring apparatus*

CISPR 22, *Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement*

3 General

Electromagnetic interference between electronic devices, and emission of radiation from electronic devices are caused, in part, by RF current generated by active devices which are driven at high frequency. Printed-circuit board (PCB), devices mounted on the PCB, and all other connected circuits or cables can act as antennas to radiate the RF noise. Levels of the electromagnetic interference and the emission are proportional to the RF current, and are also affected significantly by PCB design, radiation efficiency of the antennas, and noise coupling coefficients between the devices and the antennas.

The noise suppression sheet (NSS) is used for decoupling of the noise path, suppressing RF noise current, and reducing radiation. The noise suppression effect of the NSS can be evaluated by four parameters. They are defined as intra-decoupling ratio (R_{da}), inter-decoupling ratio (R_{de}), transmission attenuation power ratio (R_{tp}) and radiation suppression ratio (R_{rs}).

A pair of antennas is held close to each other for the measuring intra-decoupling ratio (R_{da}) and inter-decoupling ratio (R_{de}). One antenna acts as a noise source and another one as a receiver. Both decoupling ratios are derived from comparison before and after the NSS is installed nearby the antennas. These measuring procedures represent practical configurations of the NSS. Practically, the NSS is installed near the noise source or the noise interfered part, inside of the electronic equipments.

A micro-strip line (MSL) test fixture is used for the measuring transmission attenuation power ratio (R_{tp}) as a transmission line that would be a noise path. The ratio is derived from comparison before and after the NSS installation. This measuring procedure represents another practical configuration that the NSS is utilized for reducing the RF current along the transmission line.

The MSL test fixture is also used for measuring radiation suppression ratio (R_{rs}) as the antenna. The ratio is derived from a comparison before and after the NSS installation. This measuring procedure represents another practical configuration that the NSS is utilized for reducing the radiation from the antenna.

4 Measuring methods

4.1 Intra-decoupling ratio: R_{da}

4.1.1 Principle

The following measuring method is applied for evaluating a reduction of coupling between lines or circuit boards on one side of the NSS, from 100 MHz to 6 GHz.

A pair of loop antennas is employed. One is for noise source and the other one for receiver. They are simulating a general electromagnetic interference situation that often exists inside electronic equipment (see Figure 1).

The NSS is placed so that the centre of the antenna pair comes to the centre of the NSS. The coupling between two antennas with the NSS is measured, as well as the coupling without the NSS as a reference value. Consequently, intra-decoupling ratio R_{da} (dB) can be obtained.

RF magnetic field raised by one antenna is coupled with another one (see Figure 2a). By setting the NSS, the antennas (see Figure 2b), a part of the magnetic flux is led to the NSS, and the coupling is reduced by electromagnetic loss in the material.

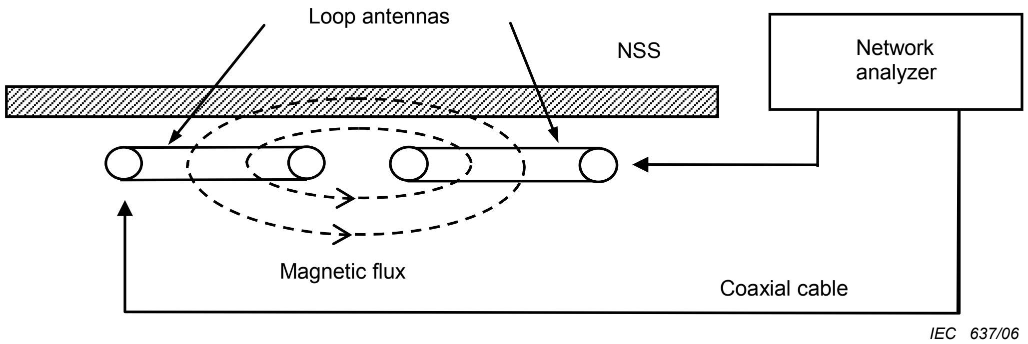


Figure 1 – Schematic diagram of a pair of antennas and NSS under test

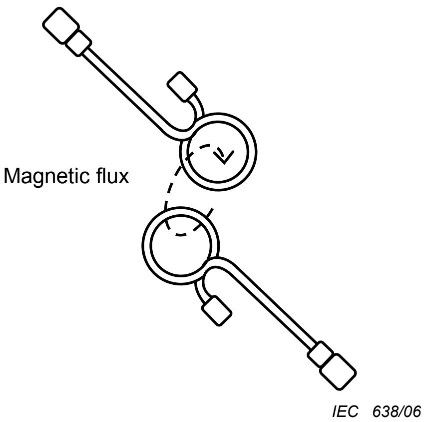


Figure 2a – Loop antennas

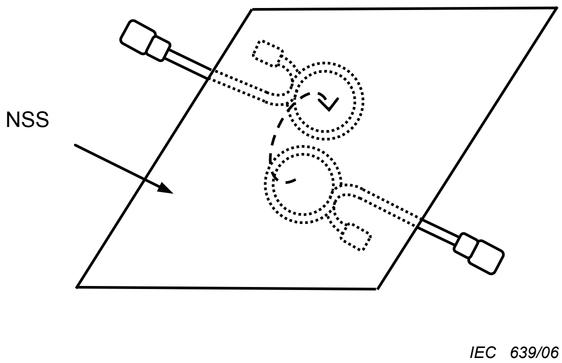


Figure 2b – NSS under test

Figure 2 – A pair of antennas and NSS under test

4.1.2 Apparatus

Figure 1 shows the schematic diagram of the measuring method of intra-decoupling ratio.

NOTE The test sample and the loop antennas are set at least 30 mm away from any other material except for the coaxial cable, using low dielectric and low loss material such as the styrene foam and air gap.

Small loop antennas shall be used for the generation of the RF magnetic field and the detection of the magnetic flux.

The S_{21} of the ideal loop antenna pair is proportional to the frequency. This means that S_{21} increases 20 dB with the decade of frequency. The usable frequency range of the loop antenna is defined by the deviation of S_{21} from the theoretical value. The deviation should be less than ±3 dB as shown in Figure 3.

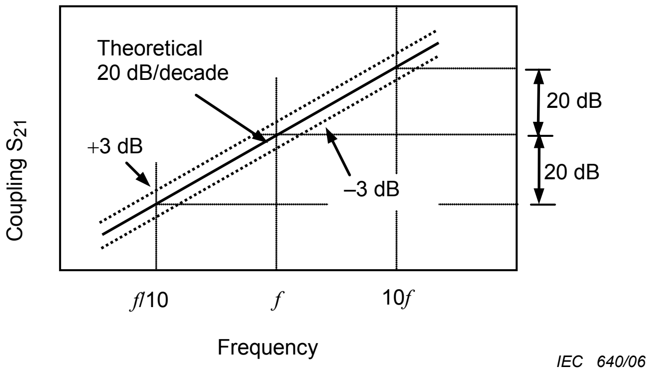


Figure 3 – Frequency response of coupling between a pair of antennas

Several loop antenna designs shown in Figure 4 are capable of achieving the 20 dB/decade frequency response that defines a valid R_{da}/R_{de} measurement.

4.1.2.1 Loop antenna

Recommended examples of the small antennas are shown in Figure 4. Merits and limitations of recommended examples of the antennas are described in Table 1.

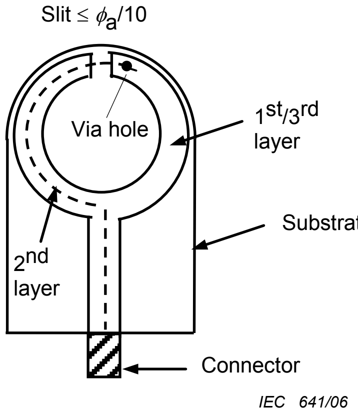


Figure 4a – Shielded multi-layered antenna with slit

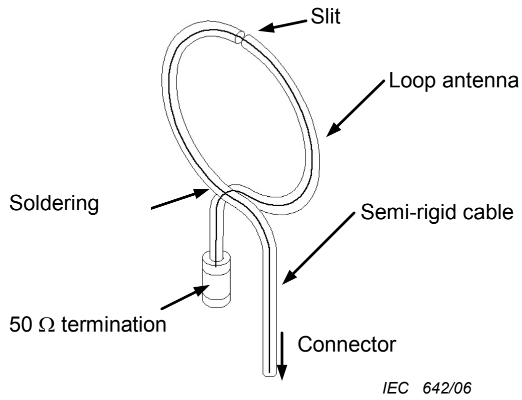


Figure 4b – Shielded loop antenna with slit and 50 Ω termination

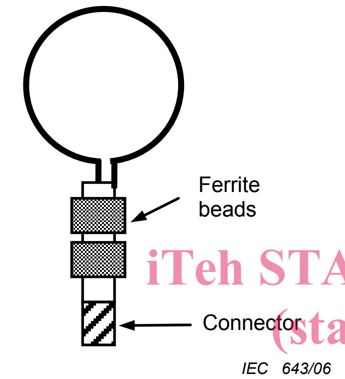


Figure 4c – One turn antenna with ferrite beads

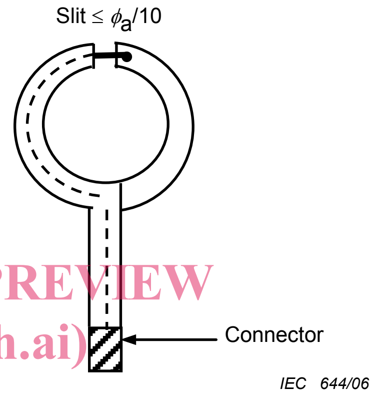


Figure 4d – Shielded coaxial antenna with slit

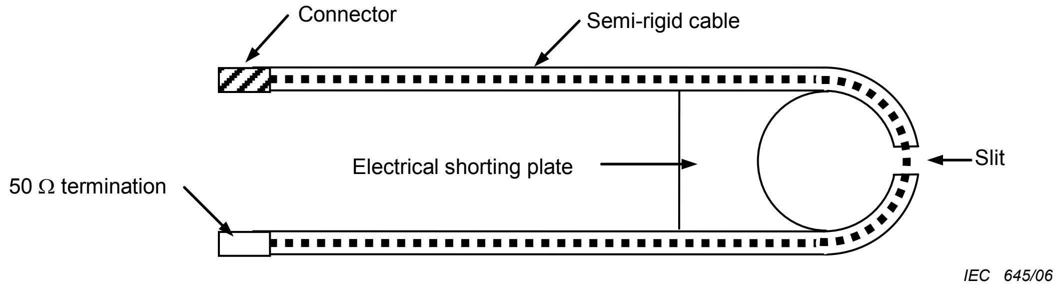


Figure 4e – Shield loop antenna with electrical shorting plate

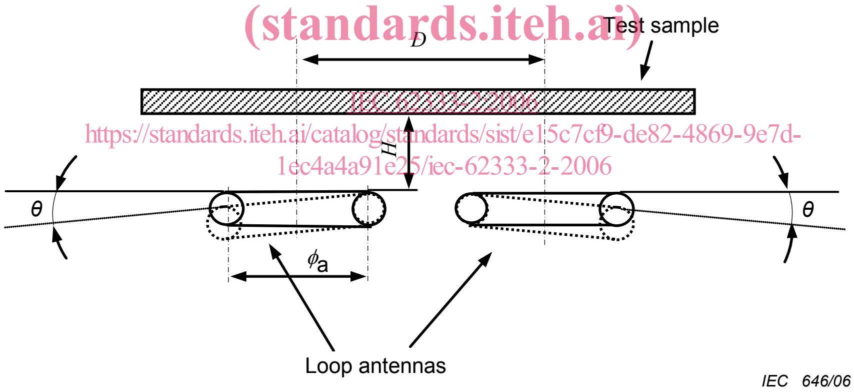
Figure 4 – Recommended examples of small loop antennas for the measurement

Table 1 – Merits and limitations of the recommended antennas

	Loop antenna type	Frequency range (approx.) GHz	Fabrication	Materials
a)	Shielded multi-layer antenna with slit	0,1 to 3	PCB manufacturing process required	PCB material Ex. FR-4
b)	Shielded loop antenna with 50 Ω termination	0,1 to 6	Engineering skills required	Semi-rigid cable
c)	One turn antenna with ferrite beads	0,1 to 2	Easy	Semi-rigid cable Ferrite beads Ex. NiCuZn ferrite
d)	Shielded coaxial antenna with slit	0,1 to 2	Easy	Semi-rigid cable
e)	Shield loop antenna with electrical shorting plate	0,1 to 6	Easy	Semi-rigid cable

Slit width shown in Figures 4a), b), d) and e) shall be less than $\phi_a/10$, where ϕ_a is average diameter of the loop antenna.

A pair of loop antennas shall be arranged as shown in Figure 5. The dimensions of loop antennas are specified as shown in Table 2.



D is the distance between centres of the loop antennas;

ϕ_a is the average diameter of the loop antenna;

H is the clearance between test sample and the antenna surface;

θ is the angle between test sample and each loop antenna surface.

Figure 5 – Cross-sectional view of the measuring configuration

Table 2 – Dimensions of loop antennas

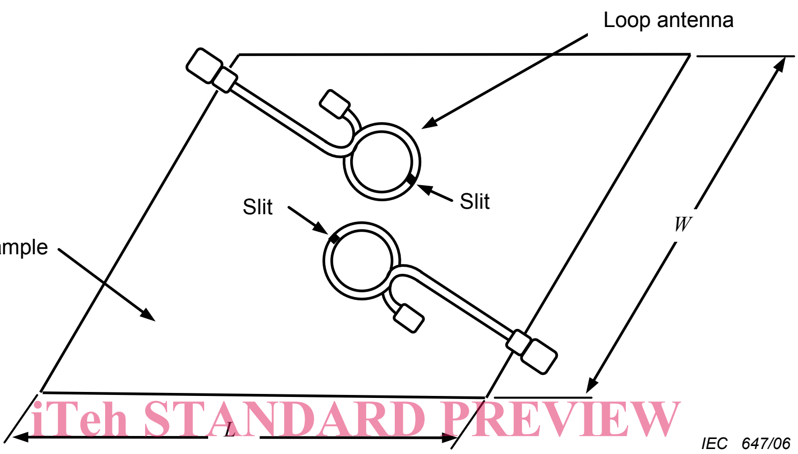
Distance D mm	Diameter ϕ_a mm	Clearance H mm	Angle θ radian
6,0 ± 0,2	3,0 ± 0,2	3,0 ± 0,2	≤ π/18 [a]
[a] ≤ 10 degrees			

4.1.2.2 Network analyzer

A network analyzer should be prepared both for signal source and signal receiver. A calibration of the network analyzer should be done at the nearest point of loop antenna. The combination of a signal generator and a receiver will be used as an alternative measuring equipment.

4.1.3 Test sample

The dimensions of test samples are specified in Figure 6 and Table 3.



L is the length of test sample;
W is the width of test sample.

Figure 6 – Schematic diagram of the measuring configuration

Table 3 – Dimensions of test sample

Length *L* mm	**Width *W*** mm
≥ 40	≥ 40
NOTE Any thickness of the test sample can be used in this measurement as the thickness of the test sample depends on the sample formation.	

NOTE The measurement is not sensitive to the maximum dimensions of the test sample.

4.1.4 Procedure

Arrangement of antennas and the test sample are shown in Table 2, Table 3, Figure 5 and Figure 6.

4.1.4.1 General

a) Loop antennas shall be arranged in a plane as shown in Figure 5.

b) When a loop antenna with slit is used, the slit of two antennas shall be arranged as shown in Figure 6.

4.1.4.2 Measuring configuration

a) A pair of loop antennas shall be prepared as given in 4.1.2.

b) Connect the antennas to network analyzer through coaxial cables as shown in Figure 1.

c) Arrange the test sample and the antennas as shown in Figure 5 and Figure 6.

d) Measure transmission characteristics (S_{21}), first without the test sample (S_{21R}), then with the test sample (S_{21M}).

4.1.4.3 Calculation of R_{da}

Intra-decoupling ratio R_{da} is then calculated by the following formula:

$$R_{da} = S_{21R} - S_{21M} \text{ [dB]}$$

where

S_{21R} is the transmission characteristics (S_{21}) without the test sample;

S_{21M} is the transmission characteristics (S_{21}) with the test sample.

4.1.5 Expression of results

R_{da} shall be expressed.

4.2 Inter-decoupling ratio: R_{de}

4.2.1 Principle

This method is applied for evaluating the reduction of coupling between lines or circuit boards by the NSS between them, at the frequency range from 100 MHz to 6 GHz.

A pair of antennas is employed. One is for noise source and the other is for receiver. An electromagnetic interference actually observed in electronic equipment is simulated by the measurement as shown in Figure 7.

NSS is placed approximately in the middle of the antennas. S_{21} between two antennas with NSS is measured. And the coupling compared without NSS as a reference value, and consequently, inter-decoupling ratio R_{de} (dB) can be obtained.

RF magnetic field generated by one antenna is coupled with another one (see Figure 8). By setting the NSS, between the antennas, a part of the magnetic flux is led to the NSS, and the coupling is reduced by the electromagnetic loss of the material.