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INTERNATIONAL STANDARD

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Integrated circuits – Measurement of electromagnetic immunity – Part 8: Measurement of radiated immunity – IC stripline method

Circuits intégrés – Mesure de l'immunité électromagnétique – Partie 8: Mesure de l'immunité rayonnée – Méthode de la ligne TEM à plaques pour circuit intégré

IEC 62132-8:2012

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INTEGRATED CIRCUITS – MEASUREMENT OF ELECTROMAGNETIC IMMUNITY –

Part 8: Measurement of radiated immunity – IC stripline method

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

FDIS	Report on voting
47A/882/FDIS	47A/886/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.

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

This part of IEC 62132 is to be read in conjunction with IEC 62132-1.

A list of all the parts in the IEC 62132 series, published under the general title *Integrated circuits – Measurement of electromagnetic immunity*, can be found on the IEC website.

Future standards in this series will carry the new general title as cited above. Titles of existing standards in this series will be updated at the time of the next edition.

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INTEGRATED CIRCUITS – MEASUREMENT OF ELECTROMAGNETIC IMMUNITY –

Part 8: Measurement of radiated immunity – IC stripline method

1 Scope

This part of IEC 62132 specifies a method for measuring the immunity of an integrated circuit (IC) to radio frequency (RF) radiated electromagnetic disturbances over the frequency range of 150 kHz to 3 GHz.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050 (all parts), *International Electrotechnical Vocabulary* (available at http://www.electropedia.org)

IEC 62132-1:2006, *Integrated circuits – Measurement of electromagnetic immunity, 150 kHz to 1 GHz – Part 1: General conditions and definitions*

IEC 61000-4-20, *Electromagnetic compatibility (EMC) – Part 4-20: Testing and measurement techniques – Emission and immunity testing in transverse electromagnetic (TEM) waveguides*

3 Terms and definitions

For the purpose of this document, the terms and definitions given in IEC 62132-1:2006, Clause 3, IEC 60050-131 and IEC 60050-161, and the following, apply.

3.1
transverse electromagnetic mode
TEM
waveguide mode in which the components of the electric and magnetic fields in the propagation direction are much less than the primary field components across any transverse cross-section

Note 1 to entry: This note only applies to the French language.

3.2
TEM waveguide
open or closed transmission line system, in which a wave is propagating in the transverse electromagnetic mode to produce a specified field for testing purposes

3.3
IC stripline
TEM waveguide, consisting of an active conductor placed on a defined spacing over an enlarged ground plane, connected to a port structure on each end and an optional shielded enclosure

Note 1 to entry: This arrangement guides a wave propagation in the transverse electromagnetic mode to produce a specific field for testing purposes between the active conductor and the enlarged ground plane. The ground plane of the standard EMC test board according to IEC 62132-1:2006, Annex B, should be used. An optional shielding enclosure may be used for fixing the IC stripline configuration and for shielding purposes. This leads to a closed version of the IC stripline in opposite to the open version without shielding enclosure. For further information see Annex A.

3.4
two-port TEM waveguide
TEM waveguide with input/output measurement ports at both ends

3.5
characteristic impedance
magnitude of the ratio of the voltage between the active conductor and the corresponding ground plane to the current on either conductor for any constant phase wave-front

Note 1 to entry: The characteristic impedance is independent of the voltage/current magnitudes and depends only on the cross sectional geometry of the transmission line. TEM waveguides are typically designed to have a 50 Ω characteristic impedance. For further information and equation to stripline arrangements see Annex A.

3.6
primary field component
primary component
electric field component aligned with the intended test polarization

Note 1 to entry: For example, in IC stripline, the active conductor is parallel to the horizontal floor, and the primary mode electric field vector is vertical at the transverse centre of the IC stripline.

4 General

An IC to be evaluated for EMC performance is referred to as a device under test (DUT). The DUT should be mounted on an EMC test board according to IEC 62132-1. The EMC test board is provided with the appropriate measurement or monitoring points at which the DUT response parameters can be measured. It controls the geometry and orientation of the DUT relative to the active conductor and eliminates in the case of a closed version of the IC stripline any connecting leads within the housing (these are on the backside of the board, which is outside the housing).

For the IC stripline, one of the 50 Ω ports is terminated with a 50 Ω load. The other 50 Ω port is connected to the output of an RF disturbance generator. The injected RF disturbance signal exposes the DUT to an electromagnetic field determined by the injected power, the typical impedance and the distance between the ground plane of the EMC test board and the active conductor of the IC stripline. The relationship is given in Annex A.

Rotating the EMC test board in the four possible orientations in the aperture to accept EMC test board of the IC stripline will affect the sensitivity of the DUT. Dependent upon the DUT, the response parameters of the DUT may vary (e.g. a change of current consumption, deterioration in function performance, waveform jitter). The intent of this test method is to provide a quantitative measure of the RF immunity of DUTs for comparison or other purposes.

For further information see Annex A.

5 Test conditions

5.1 General

The test conditions shall meet the requirements as described in IEC 62132-1:2006, Clause 4. In addition, the following test conditions shall apply.

5.2 Supply voltage

The supply voltage shall be as specified by the IC manufacturer. If the users of this procedure agree to other values, they shall be documented in the test report.

5.3 Frequency range

The effective frequency range of this radiated immunity procedure is 150 kHz to 3 GHz.

6 Test equipment

6.1 General

The test equipment shall meet the requirements described in IEC 62132-1:2006, Clause 5. In addition, the following test equipment requirements shall apply.

6.2 Cables

Double shielded or semi-rigid coaxial cable may be required depending on the local ambient conditions.

6.3 Shielding

Testing in a shielded room is only necessary for the open IC stripline version. The closed version of the IC stripline is shielded by its housing.

6.4 RF disturbance generator

An RF disturbance generator with sufficient power handling capabilities shall be used. The RF disturbance generator may comprise an RF signal source with a modulation function, an RF power amplifier. The voltage standing wave ratio (VSWR) at the output of the RF disturbance generator shall be less than 1,5 over the frequency range being measured.

The gain (or attenuation) of the RF disturbance generating equipment, without the IC stripline, shall be known with an accuracy ±0,5 dB.

6.5 IC stripline

The IC stripline (open or closed version) used for this test procedure shall be fitted with an aperture to mate with the EMC test board. The IC stripline shall not exhibit higher order modes over the frequency range being measured. For this procedure, the IC stripline frequency range is 150 kHz to 3 GHz. The VSWR over the frequency range of the empty IC stripline being measured shall be less than 1,25.

For further information as to field strength determination, IC stripline designs and the limitation of geometrical dimensions of closed version, see Annexes A, B and C.

6.6 50 Ω termination

A 50 Ω termination with a VSWR less than 1,1 and sufficient power handling capabilities over the frequency range of measurement is recommended for the IC stripline 50 Ω port not connected to the RF disturbance generator.

6.7 DUT monitor

The performance of the DUT shall be monitored for indications of performance degradation. The monitoring equipment shall not be adversely affected by the injected RF disturbance signal.

7 Test setup

7.1 General

A test setup shall meet the requirements described in IEC 62132-1:2006, Clause 6. In addition, the following test setup requirements shall apply.

7.2 Test configuration

See Figure 1 for IC stripline test configurations. One of the IC stripline 50 Ω ports is terminated with a 50 Ω load. The other IC stripline 50 Ω port is connected to the output port of the RF disturbance generator.

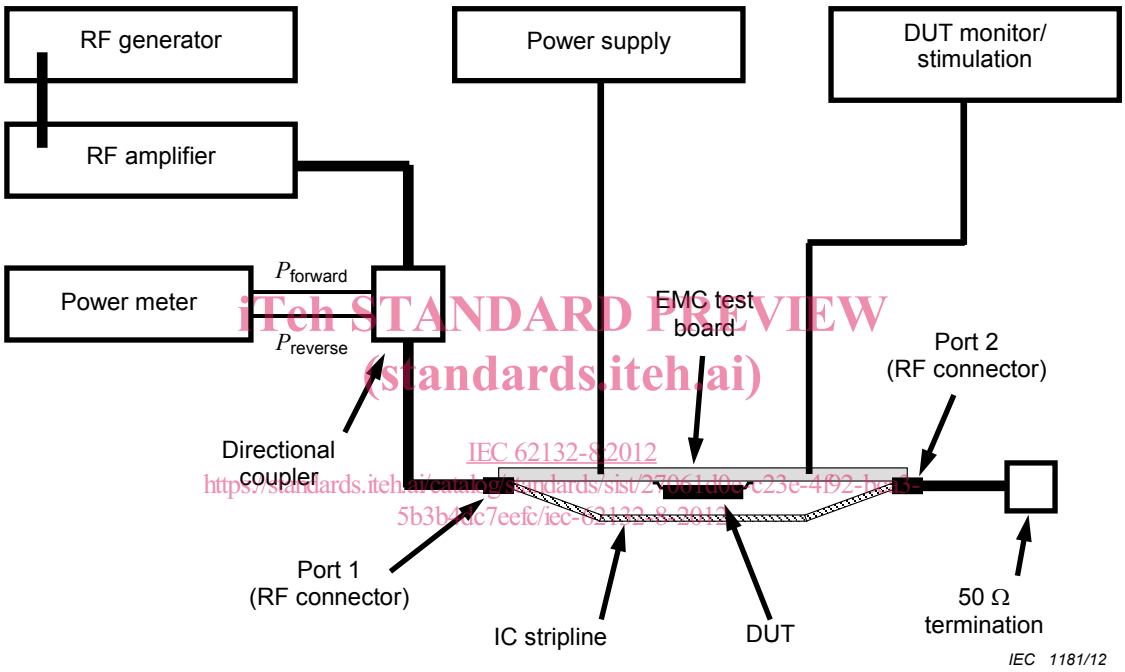

Figure 1 – IC stripline test setup

For further information and cross section view of IC stripline see Annex B.

7.3 EMC test board (PCB)

The EMC test board shall be designed in accordance with the requirements in IEC 62132-1.

8 Test procedure

8.1 General

Test procedure shall be in accordance with IEC 62132-1:2006, Clause 7, except as modified herein. These default test conditions are intended to assure a consistent test environment. The following steps shall be performed:

a) Operational check (see 8.2)

b) Immunity measurement (see 8.3)

If the users of this procedure agree to other conditions, they shall be documented in the test report.

8.2 Operational check

Energize the DUT and complete an operational check to verify proper function of the device (i.e. run DUT test code) in the ambient test condition. During the operational check, the RF disturbance generator and any monitoring equipment shall be powered; however, the output of the RF disturbance generator shall be disabled. The performance of the DUT shall not be degraded by ambient conditions.

8.3 Immunity measurement

8.3.1 General

With the EMC test board energized and the DUT operated in the intended test mode, measure the immunity to the injected RF disturbance signal over the desired frequency range.

8.3.2 RF disturbance signal

The RF disturbance signal may be:

- CW (continuous wave, no modulation)
- sinusoidal modulated with 80 % amplitude modulated by a 1 kHz sine wave, and
- pulse modulated with 50 % duty cycle and 1 kHz pulse repetition rate.

8.3.3 Test frequency steps and ranges

The RF immunity of the DUT is generally evaluated in the frequency range from 150 kHz to 3 GHz. The frequencies to be tested shall be generated from the requirements specified in Table 1.

Table 1 – Frequency step size versus frequency range

Frequency range (MHz)	0,15 – 1	1 – 100	100 – 1000	1000-3000
Linear steps (MHz)	≤0,1	≤1	≤10	≤20
Logarithmic steps	≤5 % increment			

In addition, the RF immunity of the DUT shall be evaluated at critical frequencies. Critical frequencies are frequencies that are generated by, received by, or operated on by the DUT. Critical frequencies include but are not limited to crystal frequencies, oscillator frequencies, clock frequencies, data frequencies, etc.

8.3.4 Test levels and dwell time

The applied test level shall be increased in steps until a malfunction is observed or the maximum signal generator setting (test level) is reached. The step size and test level shall be documented in the test report.

At each test level and frequency, the RF disturbance signal shall be applied for the time necessary for the DUT to respond and the monitoring system to detect any performance degradation (typically 1 s).

8.3.5 DUT monitoring

The performance of the DUT shall be monitored for indications of performance degradation using suitable test equipment. The monitoring equipment shall not be adversely affected by the injected RF disturbance signal.

8.3.6 Detail procedure

8.3.6.1 Field strength determination

At each frequency to be tested, the signal generator setting to achieve the desired electric field level or levels shall be determined as described in Annex A.

8.3.6.2 Immunity measurement

The test flow, including major steps, is described below. One of two strategies can be employed in performing this measurement as follows:

a) The output of the RF disturbance generator shall be set at a low value (e.g. 20 dB below a desired upper limit) and slowly increased up to the desired limit while monitoring the DUT for performance degradation. Any performance degradation at or below the desired limit shall be recorded.

b) The output of the RF disturbance generator shall be set at the desired performance limit while monitoring the DUT for performance degradation. Any performance degradation at the desired limit shall be recorded. The output of the RF disturbance generator shall then be reduced until normal function returns. This level shall also be recorded.

NOTE The DUT can respond differently to each of the above methods. In such a case, a method in which the interference signal is ramped up as well as down can be required. Additionally, in some cases, it might be necessary to reset or restart the DUT to come back to proper operation.

The RF immunity measurement shall be performed for at least two orientations (0°, 90°). If necessary the other orientations 180° and 270° should be tested too. The first measurement is made with the EMC test board mounted in an arbitrary orientation in the IC stripline aperture to accept EMC test board. The second measurement is made with the EMC test board rotated 90 degrees from the orientation in the first measurement. For each of the third and fourth measurements, the EMC test board is rotated again to ensure immunity is measured in all four possible orientations. The results and their tested orientations shall be documented in the test report.

9 Test report

The test report shall be in accordance with the requirements of IEC 62132-1:2006, Clause 8.

10 RF immunity acceptance level

The RF immunity acceptance level of a DUT, if any, is to be agreed upon between the manufacturer and the user of the DUT and can be defined also differently for special frequency bands.

Annex A
(normative)

Field strength determination

A.1 General

The signal level setting of the RF disturbance generator required to achieve the desired electric field level within the IC stripline shall be determined in accordance with this procedure. This measurement shall be performed at each standard frequency (either linear or logarithmic as used in the actual test) as specified in 8.3.1. The RF disturbance signal shall be a CW signal (i.e. no modulation shall be applied).

A.2 Characteristic impedance of stripline arrangements

The nominal, characteristic impedance of an open version of IC stripline can be calculated as follows [3], if $1 < w/h \leq 10$

$$Z = \frac{120 \times \pi}{\frac{w}{h} + 2{,}42 - 0{,}44 \times \frac{h}{w} + \left[1 - \frac{h}{w}\right]^6} \quad \text{(A.1)}$$

Where

Z = characteristic impedance [Ω], typically 50 Ω

w = width [m] of active conductor (see Figure A.1)

h = height [m] between surfaces of the active conductor and ground plane (see Figure A.1)

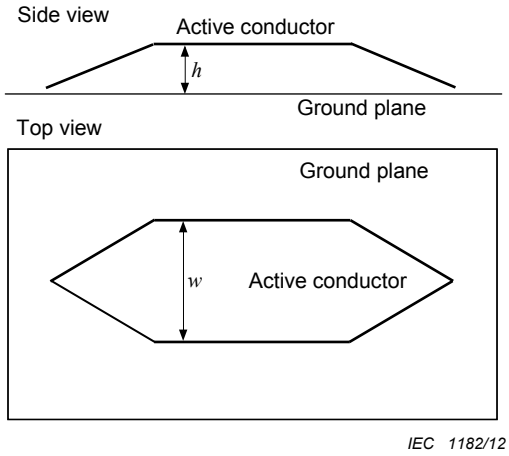

Figure A.1 – Definition of height *(h)* and width *(w)* of IC stripline

For the closed version of the IC stripline the influence of housing has to be taken into account. This correction depends on the housing geometry. For spherical housing surface an analytical formula for the characteristic impedance cannot be provided, empirical investigations are necessary. The characteristic impedance of those stripline arrangements have to be verified by measurement.

A.3 Field strength calculation

The RF disturbance applied at the input to the IC stripline is related to the electromagnetic field by the distance between the active conductor and the ground plane of the EMC test board.

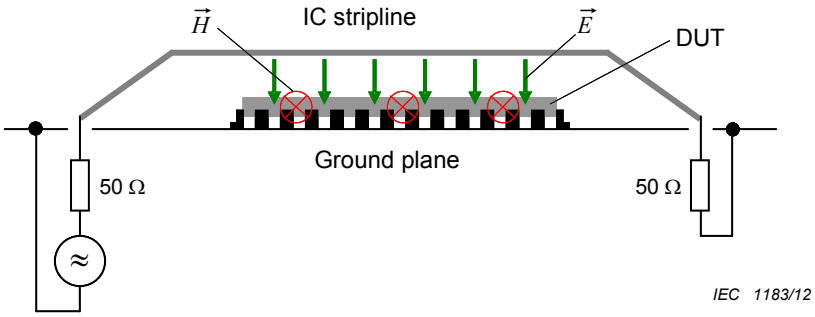

Figure A.2 – EM field distribution

$$E = \frac{\sqrt{P \times Z}}{h} \tag{A.2}$$

Where

E = electric field strength [V/m] within the IC stripline

Z = characteristic impedance [Ω], nominal value

P = measured forward test power [W]

h = height [m] between the surfaces of active conductor and ground plane of the EMC test board

Tests with closed and open version of IC stripline, both with an impedance of 50 Ω, have shown that slightly different coupling between IC stripline versions and DUT appears. The deviation is in the range of approximately 0,5 dB to 1 dB [4]. In practice, this offset can be neglected for proposed geometrical dimensions of the IC stripline as given in Annex B. For any other geometrical dimension, the active conductor width of closed version shall not be less than 70% of the width of the referring open version as described in Annex C.

A.4 Verification of IC stripline RF characteristic

For verification of the IC stripline RF characteristic, the VSWR value of the empty IC stripline with 50 Ω load termination at the second port shall be measured and documented in the test report. The value shall be lower than 1,25.

In addition, it is recommended to check also the DUT loaded IC stripline. In accordance to IEC 61000-4-20, IC stripline resonances with DUT shall be considered, with DUT power off.

$$A_{\text{tloss}} = \left| 10 \times \log\left(\frac{P_{\text{refl}}}{P_{\text{fwd}}} + \frac{P_{\text{output}}}{P_{\text{fwd}}} \right) \right| \leq 1\,\text{dB} \tag{A.3}$$

Where

A_{tloss} = Transmission loss of loaded IC stripline [dB]