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Integrated circuits – EMC evaluation of transceivers – Part 5: Ethernet transceivers

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INTEGRATED CIRCUITS – EMC EVALUATION OF TRANSCEIVERS –

Part 5: Ethernet transceivers

FOREWORD

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International Standard IEC 62228-5 has been prepared by subcommittee 47A: Integrated circuits, of IEC technical committee 47: Semiconductor devices.

The text of this International Standard is based on the following documents:

Draft	Report on voting
47A/1115/FDIS	47A/1117/RVD

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

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

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- withdrawn,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

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INTEGRATED CIRCUITS – EMC EVALUATION OF TRANSCEIVERS –

Part 5: Ethernet transceivers

1 Scope

This part of IEC 62228 specifies test and measurement methods for EMC evaluation of Ethernet transceiver ICs under network condition. It defines test configurations, test conditions, test signals, failure criteria, test procedures, test setups and test boards. It is applicable for transceiver of the Ethernet systems

- 100BASE-T1 according to ISO/IEC/IEEE 8802-3/AMD1;
- 100BASE-TX according to ISO/IEC/IEEE 8802-3;
- 1000BASE-T1 according to ISO/IEC/IEEE 8802-3/AMD4

and covers

- the emission of RF disturbances;
- the immunity against RF disturbances;
- the immunity against impulses;
- the immunity against electrostatic discharges (ESD).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61967-1, *Integrated circuits – Measurement of electromagnetic emissions – Part 1: General conditions and definitions*

IEC 61967-4, *Integrated circuits – Measurement of electromagnetic emissions, 150 kHz to 1 GHz – Part 4: Measurement of conducted emissions, 1 ohm/150 ohm direct coupling method*

IEC 62132-1, *Integrated circuits – Measurement of electromagnetic immunity – Part 1: General conditions and definitions*

IEC 62132-4, *Integrated circuits – Measurement of electromagnetic immunity 150 kHz to 1 GHz – Part 4: Direct RF power injection method*

IEC 62215-3, *Integrated circuits – Measurement of impulse immunity – Part 3: Non-synchronous transient injection method*

IEC 62228-1, *Integrated circuits – EMC evaluation of transceivers – Part 1: General conditions and definitions*

ISO 10605, *Road vehicles – Test methods for electrical disturbances from electrostatic discharge*

ISO 21111-2, *Road vehicles – In-vehicle Ethernet – Part 2: Common physical entity requirements*

ISO 7637-2, *Road vehicles – Electrical disturbances from conduction and coupling – Part 2: Electrical transient conduction along supply lines only*

ISO/IEC/IEEE 8802-3:2017, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Standard for Ethernet*

ISO/IEC/IEEE 8802-3:2017/AMD1:2017, *Amendment 1 – Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Standard for Ethernet – Physical layer specifications and management parameters for 100 Mb/s operation over a single balanced twisted pair cable (100BASE-T1)*

ISO/IEC/IEEE 8802-3:2017/AMD4:2017, *Amendment 4 – Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Standard for Ethernet – Physical layer specifications and management parameters for 1 Gb/s operation over a single twisted-pair copper cable*

Electronic Components Industry Association, EIA-198-1, *Ceramic Dielectric Capacitors Classes I, II, III and IV*

3 Terms, definitions and abbreviated terms

For the purposes of this document, the terms and definitions given in IEC 61967-1, IEC 62132-1, IEC 62228-1, as well as the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at http://www.iso.org/obp
- IEC Electropedia: available at http://www.electropedia.org/

3.1 Terms and definitions

3.1.1
100BASE-T1 transceiver
transceiver 100 Mbit/s via single balanced twisted pair, with a functionality according to ISO/IEC/IEEE 8802-3/AMD1 (100BASE-T1)

3.1.2
100BASE-TX transceiver
transceiver 100 Mbit/s via two balanced twisted pairs, with a functionality according to ISO/IEC/IEEE 8802-3(100BASE-TX)

3.1.3
1000BASE-T1 transceiver
transceiver 1000 Mbit/s via single balanced twisted pair, with a functionality according to ISO/IEC/IEEE 8802-3/AMD4 (1000BASE-T1)

3.1.4
global pin
pin that carries a signal or power, which enters or leaves the application board without any active component in between

3.1.5
local pin
pin that carries a signal or power, which does not leave the application board

3.1.6
mandatory components
pl
components needed for proper function and/or technical requirement of IC as specified by the IC manufacturer

3.1.7
switch
IC with integrated Ethernet transceivers and switch functionality as defined in ISO/IEC/IEEE 8802-3

3.2 Abbreviated terms

ASIC	Application specific integrated circuit
BIN	Bus interface network
BIST	Built in self-test
CMC	Common mode choke
CDMR	Common to differential mode conversion ratio
CMR	Common mode rejection
DCMR	Differential to common mode conversion ratio
DPI	Direct RF power injection
DTT	Data transfer test
DUT	Device under test
FPGA	Field programmable gate array
GMII	Gigabit media independent interface
GPIO	General purpose input or output
IL	Insertion loss
INH	Inhibit
LCL	Longitudinal conversion loss
LPF	Low pass filter
MDI	Medium dependent interface
MII	Media independent interface
PCB	Printed circuit board
PRBS	Pseudo random bit stream
PHY	Ethernet single transceiver
RGMII	Reduced gigabit media independent interface
RL	Return loss
RS-FEC	Reed Solomon forward error correction
SBC	System base chip
SGMII	Serial gigabit media independent interface
SNR	Signal-to-noise ratio
S-parameter	Scattering parameter
SQI	Signal quality indicator
TDR	Time domain reflectometry

TLP	Transmission line pulse
VNA	Vector network analyzer

4 General

The intention of this document is to evaluate the EMC performance of Ethernet transceivers under application conditions in a minimal network.

The evaluation of the EMC characteristics of Ethernet transceivers shall be performed for the implemented functional operation modes as defined in Table 1 under network condition for conducted RF emission and RF immunity tests and impulse immunity tests and on a single transceiver IC for electrostatic discharge tests.

The aim of these tests is to determine the EMC performance on dedicated pins of the Ethernet transceiver which are considered as EMC relevant in the application. For an Ethernet transceiver, these pins are global pins like MDIP, MDIN, V_{BAT} and WAKE as well as local pins like power supply inputs (V_{DDx}). The global pin WAKE is given as an example and represents any global pin other than MDI and voltage supply V_{BAT}.

If the DUT includes additional product specific EMC relevant pins (functions), it shall be tested as well. The test conditions and failure validation criteria shall be adapted to the definitions for the standard functionality of Ethernet transceivers.

The test methods used for the EMC characterization are based on the international standards for IC EMC tests and are described in Table 1.

Table 1 – Overview of measurements and tests

Configuration	Test	Test method	Evaluation	Functional operation mode
Transceiver network	RF conducted emission (EMI)	150 Ω direct coupling (IEC 61967-4)	Spectrum	Normal
	RF conducted immunity (RF)	DPI (IEC 62132-4)	Function	Normal
				Low power
	Impulse immunity (IMP)	Non-synchronous transient injection (IEC 62215-3)	Function	Normal
				Low power
	ESD powered	Contact discharge (ISO 10605)	Function	Normal
				Low power
Single transceiver	ESD unpowered	Contact discharge (ISO 10605)	Damage	Unpowered

The 150 Ω direct coupling, DPI and impulse immunity test methods are chosen for the evaluation of the conducted EMC characteristic of transceivers in network condition. These three test methods are based on the same approach using conductive coupling. Therefore, it is possible to use the same test board for all tests in functional operation mode, which reduces the effort and increases the reproducibility and comparability of test results.

Powered ESD test will be performed using the same approach of testing the Ethernet transceiver under network conditions but a modified test board is used because of RF and ESD tests cannot be combined on one test board if all specific test conditions of each test method should be covered.