SVENSK STANDARD SS-EN IEC 62228-3

Fastställd	Utgåva	Sida	Ansvarig kommitté
2019-06-12	1	1 (1+76)	SEK Elektro-tekniska rådet

Integrerade kretsar – EMC-bedömning av sändar-mottagarkretsar – Del 3: CAN-kretsar

Integrated circuits – EMC evaluation of transceivers – Part 3: CAN transceivers

Som svensk standard gäller europastandarden EN IEC 62228-3:2019. Den svenska standarden innehåller den officiella engelska språkversionen av EN IEC 62228-3:2019.

Nationellt förord

Europastandarden EN IEC 62228-3:2019

består av:

– **europastandardens ikraftsättningsdokument,** utarbetat inom CENELEC
– **IEC 62228-3, First edition, 2019 - Integrated circuits - EMC evaluation of transceivers - Part 3: CAN transceivers**

utarbetad inom International Electrotechnical Commission, IEC.

ICS 31.200.00

Denna standard är fastställd av SEK Svensk Elstandard,
som också kan lämna upplysningar om **sakinnehållet** i standarden.
Postadress: Box 1284, 164 29 KISTA
Telefon: 08 - 444 14 00.
E-post: sek@elstandard.se. Internet: www.elstandard.se

Standarder underlättar utvecklingen och höjer elsäkerheten

Det finns många fördelar med att ha gemensamma tekniska regler för bl a mätning, säkerhet och provning och för utförande, skötsel och dokumentation av elprodukter och elanläggningar.

Genom att utforma sådana standarder blir säkerhetsfordringar tydliga och utvecklingskostnaderna rimliga samtidigt som marknadens acceptans för produkten eller tjänsten ökar.

Många standarder inom elområdet beskriver tekniska lösningar och metoder som åstadkommer den elsäkerhet som föreskrivs av svenska myndigheter och av EU.

SEK är Sveriges röst i standardiseringsarbetet inom elområdet

SEK Svensk Elstandard svarar för standardiseringen inom elområdet i Sverige och samordnar svensk medverkan i internationell och europeisk standardisering. SEK är en ideell organisation med frivilligt deltagande från svenska myndigheter, företag och organisationer som vill medverka till och påverka utformningen av tekniska regler inom elektrotekniken.

SEK samordnar svenska intressenters medverkan i SEKs tekniska kommittéer och stödjer svenska experters medverkan i internationella och europeiska projekt.

Stora delar av arbetet sker internationellt

Utformningen av standarder sker i allt väsentligt i internationellt och europeiskt samarbete. SEK är svensk nationalkommitté av International Electrotechnical Commission (IEC) och Comité Européen de Normalisation Electrotechnique (CENELEC).

Standardiseringsarbetet inom SEK är organiserat i referensgrupper bestående av ett antal tekniska kommittéer som speglar hur arbetet inom IEC och CENELEC är organiserat.

Arbetet i de tekniska kommittéerna är öppet för alla svenska organisationer, företag, institutioner, myndigheter och statliga verk. Den årliga avgiften för deltagandet och intäkter från försäljning finansierar SEKs standardiseringsverksamhet och medlemsavgift till IEC och CENELEC.

Var med och påverka!

Den som deltar i SEKs tekniska kommittéarbete har möjlighet att påverka framtida standarder och får tidig tillgång till information och dokumentation om utvecklingen inom sitt teknikområde. Arbetet och kontakterna med kollegor, kunder och konkurrenter kan gynnsamt påverka enskilda företags affärsutveckling och bidrar till deltagarnas egen kompetensutveckling.

Du som vill dra nytta av dessa möjligheter är välkommen att kontakta SEKs kansli för mer information.

SEK Svensk Elstandard
Box 1284
164 29 Kista
Tel 08-444 14 00
www.elstandard.se

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN IEC 62228-3

May 2019

ICS 31.200

English Version

Integrated circuits - EMC evaluation of transceivers - Part 3: CAN transceivers (IEC 62228-3:2019)

Circuits intégrés - Évaluation de la CEM des émetteurs-récepteurs - Partie 3: Émetteurs-récepteurs CAN (IEC 62228-3:2019)

Integrierte Schaltungen - Bewertung der elektromagnetischen Verträglichkeit von Sende-Empfangsgeräten - Teil 3: CAN-Sende-Empfangsgeräte (IEC 62228-3:2019)

This European Standard was approved by CENELEC on 2019-04-15. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

Ref. No. EN IEC 62228-3:2019 E

SEK Svensk Elstandard

SS-EN IEC 62228-3, utg 1:2019

European foreword

The text of document 47A/1050/CDV, future edition 1 of IEC 62228-3, prepared by SC 47A "Integrated circuits" of IEC/TC 47 "Semiconductor devices" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 62228-3:2019.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2020-01-15
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2022-04-15

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC shall not be held responsible for identifying any or all such patent rights.

Endorsement notice

The text of the International Standard IEC 62228-3:2019 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 61000-4-4	NOTE	Harmonized as EN 61000-4-4
CISPR 16-1-1	NOTE	Harmonized as EN 55016-1-1

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

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.

NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

Publication	Year	Title	EN/HD	Year
IEC 61967-1	-	Integrated circuits - Measurement of electromagnetic emissions - Part 1: General conditions and definitions	EN IEC 61967-1	-
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	EN 61967-4	-
IEC 62132-1	-	Integrated circuits - Measurement of electromagnetic immunity - Part 1: General conditions and definitions	EN 62132-1	-
IEC 62132-4	-	Integrated circuits - Measurement of electromagnetic immunity 150 kHz to 1 GHz - Part 4: Direct RF power injection method	EN 62132-4	-
IEC 62215-3	-	Integrated circuits - Measurement of impulse immunity - Part 3: Non-synchronous transient injection method	EN 62215-3	-
IEC 62228-1	-	Integrated circuits - EMC evaluation of transceivers - Part 1: General conditions and definitions	EN IEC 62228-1	-
ISO 7637-2	-	Road vehicles - Electrical disturbances from conduction and coupling - Part 2: Electrical transient conduction along supply lines only	-	-
ISO 10605	-	Road vehicles - Test methods for electrical disturbances from electrostatic discharge	-	-
ISO 11898-1	-	Road vehicles - Controller area network (CAN) - Part 1: Data link layer and physical signalling	-	-
ISO 11898-2	-	Road vehicles - Controller area network (CAN) - Part 2: High-speed medium access unit	-	-

CONTENTS

FOREWORD 6
1 Scope 8
2 Normative references 8
3 Terms, definitions and abbreviated terms 9
3.1 Terms and definitions 9
3.2 Abbreviated terms 10
4 General 10
5 Test and operating conditions 11
5.1 Supply and ambient conditions 11
5.2 Test operation modes 12
5.3 Test configuration 12
5.3.1 General test configuration for transceiver network 12
5.3.2 General test configuration for unpowered ESD test 13
5.3.3 Transceiver network tests – Coupling ports and networks 14
5.3.4 ESD tests – Coupling ports and networks 15
5.4 Test signals 16
5.4.1 General 16
5.4.2 Test signals for normal operation mode 16
5.4.3 Test signal for wake-up from low power mode 18
5.5 Evaluation criteria 22
5.5.1 General 22
5.5.2 Evaluation criteria for functional operation modes 22
5.5.3 Evaluation criteria in unpowered condition after exposure to disturbances 28
5.5.4 Status classes 29
6 Test and measurement 29
6.1 Emission of RF disturbances 29
6.1.1 Test method 29
6.1.2 Test setup 29
6.1.3 Test procedure and parameters 30
6.2 Immunity to RF disturbances 31
6.2.1 Test method 31
6.2.2 Test setup 31
6.2.3 Test procedure and parameters 32
6.3 Immunity to impulses 37
6.3.1 Test method 37
6.3.2 Test setup 37
6.3.3 Test procedure and parameters 38
6.4 Electrostatic discharge (ESD) 41
6.4.1 Test method 41
6.4.2 Test setup 41
6.4.3 Test procedure and parameters 43
7 Test report 44
Annex A (normative) CAN test circuits 45
A.1 General 45
A.2 Test circuit for CAN transceivers for functional tests 45

A.3 Test circuit for CAN transceiver for ESD test 49
Annex B (normative) Test circuit boards 51
B.1 Test circuit board for functional tests 51
B.2 ESD test 51
Annex C (informative) Examples for test limits for CAN transceiver in automotive application 53
C.1 General 53
C.2 Emission of RF disturbances 53
C.3 Immunity to RF disturbances 54
C.4 Immunity to impulses 57
C.5 Electrostatic discharge (ESD) 57
Annex D (informative) Characterization of common mode choke for CAN bus interfaces 58
D.1 General 58
D.2 Abbreviations 58
D.3 CMC test 58
D.3.1 General 58
D.3.2 Leakage inductance mismatch measurement 59
D.3.3 S-parameter measurement mixed mode 63
D.3.4 ESD damage 68
D.3.5 Saturation test at RF disturbances 71
Bibliography 74

Figure 1 – General test configuration for tests in transceiver network 13
Figure 2 – General test configuration for unpowered ESD test 13
Figure 3 – Transceiver network tests – coupling ports and networks 14
Figure 4 – Coupling ports and networks for ESD tests 16
Figure 5 – Definition for trigger points and violation masks for CAN transceivers with flexible data rate capability 26
Figure 6 – Principal drawing of the maximum deviation on an I-V characteristic 28
Figure 7 – Test setup for measurement of RF disturbances 30
Figure 8 – Test setup for DPI tests 32
Figure 9 – Test setup for impulse immunity tests 37
Figure 10 – Test setup for direct ESD tests – principal arrangement 42
Figure 11 – Test setup for direct ESD tests – stimulation and monitoring 43
Figure A.1 – General drawing of the circuit diagram of test network for CAN standard transceivers for functional test 47
Figure A.2 – General drawing of the circuit diagram of test network for CAN PN transceivers for functional test 49
Figure A.3 – General drawing of the circuit diagram for direct ESD tests of CAN transceivers in unpowered mode 50
Figure B.1 – Example of IC interconnections of CAN signal 51
Figure B.2 – Example of ESD test board for CAN transceivers 52
Figure C.1 – Example of limits for RF emission – CAN with bus filter 53
Figure C.2 – Example of limits for RF emission – other global pins 54
Figure C.3 – Example of limits for RF emission – local supplies 54

Figure C.4 – Example of limits for RF immunity for functional status class A_{IC} – CAN with bus filter 55
Figure C.5 – Example of limits for RF immunity for functional status class A_{IC} – CAN 55
Figure C.6 – Example of limits for RF immunity for functional status class A_{IC} – other global pins 56
Figure C.7 – Example of limits for RF immunity for functional status class C_{IC} or D_{IC} – CAN with bus filter 56
Figure C.8 – Example of limits for RF immunity for functional status class C_{IC} or D_{IC} – other global pins 57
Figure D.1 – General electrical drawing of a CMC 59
Figure D.2 – Test setup for 2-port S-Parameter measurements for leakage inductance evaluation 59
Figure D.3 – Example of a two-port test board for CMC leakage inductance characterization 60
Figure D.4 – Example of CMC characterization measurement results 63
Figure D.5 – Test setup for S-Parameter measurements 64
Figure D.6 – Example test board S-Parameter measurement – mixed mode, top layer 65
Figure D.7 – Example test board S-Parameter measurement – single ended, top layer 65
Figure D.8 – Recommended characteristics for S_{dd21} (IL) 67
Figure D.9 – Recommended characteristic for S_{cc21} (CMR) 68
Figure D.10 – Recommended characteristic for S_{sd21} and S_{sd12} (DCMR) 68
Figure D.11 – Test setup for ESD damage tests 69
Figure D.12 – Example test board ESD, top layer 70
Figure D.13 – Test setup for RF saturation measurements 71
Figure D.14 – Example RF saturation / S-Parameter test board, top layer 72

Table 1 – Overview of measurements and tests 11
Table 2 – Supply and ambient conditions for functional operation 12
Table 3 – Transceiver network tests – component value definitions of coupling ports and networks 15
Table 4 – Definitions of coupling ports for ESD tests 16
Table 5 – Communication test signal TX1 17
Table 6 – Communication test signal TX2a 17
Table 7 – Communication test signal TX2b 18
Table 8 – Wake-up test signal TX3 18
Table 9 – Communication test signal TX4a 19
Table 10 – Communication test signal TX4b 19
Table 11 – Communication test signal TX4c 19
Table 12 – Communication test signal TX4d 20
Table 13 – Communication test signal TX4e 20
Table 14 – Communication test signal TX4f1 20
Table 15 – Communication test signal TX4f2 21
Table 16 – Communication test signal TX4g 21
Table 17 – Communication test signal TX4h 21
Table 18 – Communication test signal TX4i 22

Table 19 – Evaluation criteria for CAN transceiver standard functions 23
Table 20 – Evaluation criteria for CAN transceivers with partial networking functionality 23
Table 21 – Specific definition for test procedure for evaluation of CAN transceiver partial networking function 24
Table 22 – Evaluation criteria for CAN transceivers with flexible data rate capability 25
Table 23 – Definitions for violation masks for CAN transceivers with flexible data rate capability 27
Table 24 – Definition of functional status classes 29
Table 25 – Settings of the RF measurement equipment 31
Table 26 – RF emission measurements 31
Table 27 – Specifications for DPI tests 33
Table 28 – DPI tests for functional status class A_{IC} evaluation of CAN transceiver standard function 34
Table 29 – DPI tests for functional status class A_{IC} evaluation of CAN transceiver partial networking function 35
Table 30 – DPI tests for functional status class A_{IC} evaluation of CAN transceiver CAN FD function 36
Table 31 – DPI tests for functional status class C_{IC} or D_{IC} evaluation of CAN transceivers 36
Table 32 – Specifications for impulse immunity tests 38
Table 33 – Parameters for impulse immunity test 38
Table 34 – Impulse immunity tests for functional status class A_{IC} evaluation of CAN transceiver standard function 39
Table 35 – Impulse immunity tests for functional status class A_{IC} evaluation of CAN transceiver partial networking function 40
Table 36 – Impulse immunity tests for functional status class A_{IC} evaluation of CAN transceiver CAN FD function 40
Table 37 – Impulse immunity tests for functional status class C_{IC} or D_{IC} evaluation of CAN transceivers 41
Table 38 – Specifications for direct ESD tests 43
Table 39 – ESD tests in unpowered mode for functional status class D_{IC} evaluation of CAN transceivers 44
Table B.1 – Parameters of ESD test circuit board 52
Table C.1 – Example of limits for impulse immunity for functional status class C_{IC} or D_{IC} 57
Table D.1 – Test procedure and parameters for leakage inductance evaluation 61
Table D.2 – Leakage inductance measurements 62
Table D.3 – Leakage inductance mismatch classes 63
Table D.4 – Test procedure and parameters for 3-port test board characterization 64
Table D.5 – Test procedure and parameters for S-Parameter measurements 66
Table D.6 – Required S-Parameter measurements 67
Table D.7 – Test parameters for ESD damage tests 70
Table D.8 – Required ESD tests for damage 71
Table D.9 – Test procedure and parameters for RF saturation tests 72
Table D.10 – Required RF saturation tests 73

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

INTEGRATED CIRCUITS – EMC EVALUATION OF TRANSCEIVERS –

Part 3: CAN transceivers

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.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 62228-3 has been prepared by subcommittee 47A: Integrated circuits, of IEC technical committee 47: Semiconductor devices.

This first edition cancels and replaces the first edition of IEC TS 62228 published in 2007 and constitutes a technical revision.

This edition includes the following significant technical changes with respect to IEC TS 62228:

a) introduction of CAN transceivers with partial networking functionality and CAN transceivers with flexible data rate capability and addition of operation modes and test descriptions in the respective subclauses of the document;
b) introduction of minimal communication network with two CAN transceivers;
c) update of the test requirements and targets in Annex C;
d) addition of Annex D for common mode choke characterization.

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

CDV	Report on voting
47A/1050/CDV	47A/1069/RVC

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.

A list of all parts in the IEC 62228 series, published under the general *title Integrated circuits – EMC evaluation of transceivers*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website 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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTEGRATED CIRCUITS – EMC EVALUATION OF TRANSCEIVERS –

Part 3: CAN transceivers

1 Scope

This part of IEC 62228 specifies test and measurement methods for EMC evaluation of CAN 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 CAN standard transceivers, CAN transceivers with partial networking functionality and CAN transceivers with flexible data rate capability and covers

- the emission of RF disturbances,
- the immunity against RF disturbances,
- the immunity against impulses, and
- 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 Ω/150 Ω 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 7637-2, *Road vehicles – Electrical disturbances from conduction and coupling – Part 2: Electrical transient conduction along supply lines only*

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

ISO 11898-1, *Road vehicles – Controller area network (CAN) – Part 1: Data link layer and physical signalling*

ISO 11898-2*, Road vehicles – Controller area network (CAN) – Part 2: High speed medium access unit*