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Elektronisk utrustning för järnvägar – Kommunikationsnätverk för tåg (TCN) – Del 2-8: Provning av överensstämmelse för TCN

*Electronic railway equipment –
Train communication network (TCN) –
Part 2-8: TCN conformance test*

Som svensk standard gäller europastandarden EN IEC 61375-2-8:2021. Den svenska standarden innehåller den officiella engelska språkversionen av EN IEC 61375-2-8:2021.

Nationellt förord

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- **IEC 61375-2-8, First edition, 2021 - Electronic railway equipment - Train communication network (TCN) - Part 2-8: TCN conformance test**

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English Version

**Electronic railway equipment - Train communication network
(TCN) - Part 2-8: TCN conformance test
(IEC 61375-2-8:2021)**

Matériel électronique ferroviaire - Réseau embarqué de
train (TCN) - Partie 2-8 : Essai de conformité TCN
(IEC 61375-2-8:2021)

Elektronische Betriebsmittel für Bahnen - Zug-
Kommunikations-Netzwerk (TCN) - Teil 2-8: TCN-
Konformitätsprüfung
(IEC 61375-2-8:2021)

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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

European foreword

The text of document 9/2746/FDIS, future edition 1 of IEC 61375-2-8, prepared by IEC/TC 9 “Electrical equipment and systems for railways” was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 61375-2-8:2021.

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) 2022-08-29
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2024-11-29

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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.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60571	2012	Railway applications - Electronic equipment used on rolling stock	-	-
IEC 61000-4-4	2012	Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test	EN 61000-4-4	2012
IEC 61076-2-101	2012	Connectors for electronic equipment - Product requirements - Part 2-101: Circular connectors - Detail specification for M12 connectors with screw-locking	EN 61076-2-101	2012
IEC 61076-3-104	-	Connectors for electrical and electronic equipment - Product requirements - Part 3-104: Detail specification for 8-way, shielded free and fixed connectors for data transmissions with frequencies up to 2 000 MHz	EN 61076-3-104	-
IEC 61156-6	-	Multicore and symmetrical pair/quad cables for digital communications - Part 6: Symmetrical pair/quad cables with transmission characteristics up to 1 000 MHz - Work area wiring - Sectional specification	-	-
IEC 61375-1	2012	Electronic railway equipment - Train communication network (TCN) - Part 1: General architecture	EN 61375-1	2012
IEC 61375-2-1	2012	Electronic railway equipment - Train communication network (TCN) - Part 2-1: Wire Train Bus (WTB)	EN 61375-2-1	2012
IEC 61375-2-3	2015	Electronic railway equipment - Train communication network (TCN) - Part 2-3: TCN communication profile	EN 61375-2-3	2015
-	-		+ A11	2017

EN IEC 61375-2-8:2021 (E)

IEC 61375-2-5	2014	Electronic railway equipment - Train communication network (TCN) - Part 2–5: Ethernet train backbone	EN 61375-2-5	2015
IEC 61375-3-4	2014	Electronic railway equipment - Train communication network (TCN) - Part 3–4: Ethernet Consist Network (ECN)	EN 61375-3-4	2014
-	-		+ A11	2017
ISO/IEC 9646-1	1994	Information technology - Open Systems Interconnection - Conformance testing methodology and framework – Part 1: General concepts	-	-
ISO/IEC 9646-7	1995	Information technology - Open Systems Interconnection - Conformance testing methodology and framework – Part 7: Implementation conformance statements	-	-
ISO/IEC 11801	(series)	Information technology - Generic cabling for customer premises	-	-
IEEE 802.1AB	2009	Station and Media Access Control Connectivity Discovery	-	-
IEEE 802.1AX	2008	IEEE Standard for Local and metropolitan area networks - Link Aggregation	-	-
IEEE 802.1Qaz	2011	IEEE Standard for Local and metropolitan area networks - Enhanced Transmission Selection	-	-
IEEE 802.1D	1990	IEEE Standard for local and metropolitan area networks - Media Access Control (MAC) Bridges	-	-
IEEE 802.1Q	-	IEEE Standard for Local and metropolitan area networks – Virtual Bridged Local Area Networks	-	-
IEEE 802.2	-	Logical Link Control	-	-
IEEE 802.3	2012	Information technology - Telecommunications and information exchange between systems - Local and metropolitan area networks - Specific requirements - Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access	-	-
IEEE 802.3az	-	Energy Efficient Ethernet	-	-
IETF RFC 768		User Datagram Protocol	-	-
IETF RFC 791		INTERNET PROTOCOL	-	-
IETF RFC 792		INTERNET CONTROL MESSAGE PROTOCOL		
IETF RFC 793		TRANSMISSION CONTROL PROTOCOL	-	-
IETF RFC 826		An Ethernet Address Resolution Protocol	-	-
IETF RFC 1034	-	DOMAIN NAMES – CONCEPTS AND FACILITIES	-	-
IETF RFC 1035	-	DOMAIN NAMES – IMPLEMENTATION AND SPECIFICATION	-	-

IETF RFC 1213	-	Management Information Base for Network - Management of TCP/IP-based Internets: MIB-II	-
IETF RFC 1305	-	Network Time Protocol (Version 3) - Specification, Implementation and Analysis	-
IETF RFC 1361	-	Simple Network Time Protocol (SNTP)	-
IETF RFC 1901	-	Introduction to Community-based SNMPv2	-
IETF RFC 1905	-	Protocol Operations for Version 2 of the Simple Network Management Protocol (SNMPv2)	-
IETF RFC 1906	-	Transport Mappings for Version 2 of the Simple Network Management Protocol (SNMPv2)	-
IETF RFC 1918	-	Address Allocation for Private Internets	-
IETF RFC 2131	-	Dynamic Host Configuration Protocol	-
IETF RFC 2236	-	Internet Group Management Protocol, Version 2	-
IETF RFC 2365	-	Administratively Scoped IP Multicast	-
IETF RFC 2474	-	Definition of the Differentiated Services Field (DS Field) in the IPv4 and IPv6 Headers	-
IETF RFC 2544	-	Benchmarking Methodology for Network Interconnect Devices	-
IETF RFC 3203	-	DHCP reconfigure extension	-
IETF RFC 3986	-	Uniform Resource Identifier (URI): Generic Syntax	-
IETF RFC 4122	-	A Universally Unique Identifier (UUID) URN Namespace	-
TIA/EIA-568-B	-	Commercial Building Telecommunications - Cabling Standard	-
ANSI X3.263	1995	Information Technology - Fibre Distributed - Data Interface (FDDI) – Token Ring Twisted Pair Physical Layer Medium Dependent (TP-PMD)	-



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**ELECTRONIC RAILWAY EQUIPMENT –
TRAIN COMMUNICATION NETWORK (TCN) –****Part 2-8: TCN conformance test****FOREWORD**

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FDIS	Report on voting
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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.

A list of all parts in the IEC 61375 series, published under the general title *Electronic railway equipment – Train communication network (TCN)*, can be found on the IEC website.

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

- reconfirmed,
- withdrawn,
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- amended.

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INTRODUCTION

TCN is an International Standard with the aim of defining interfaces so as to achieve plug-in compatibility:

- a) between equipment located in different vehicles or consist, and
- b) between equipment and devices located within the same vehicle or consist.

One of the key success factors for the deployment of any technology is standardisation and ensuring interoperability among various implementations. To facilitate interoperability, a conformance test should be implemented.

In this part of IEC 61375, the conformance testing of the ECN and ETB defined in IEC 61375-2-3:2015, IEC 61375-2-5:2014 and IEC 61375-3-4:2014 is specified.

ELECTRONIC RAILWAY EQUIPMENT – TRAIN COMMUNICATION NETWORK (TCN) –

Part 2-8: TCN conformance test

1 Scope

This part of IEC 61375 applies to all equipment and devices implemented according to IEC 61375-2-3:2015, IEC 61375-2-5:2014 and IEC 61375-3-4:2014, i.e. it covers the procedures to be applied to such equipment and devices when the conformance should be proven.

The applicability of this document to a TCN implementation allows for individual conformance checking of the implementation itself, and is a pre-requisite for further interoperability checking between different TCN implementations.

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 60571:2012, *Railway applications – Electronic equipment used on rolling stock*

IEC 61000-4-4:2012, *Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test*

IEC 61076-2-101:2012, *Connectors for electronic equipment – Product requirements – Part 2-101: Circular connectors – Detail specification for M12 connectors with screw-locking*

IEC 61076-3-104, *Connectors for electrical and electronic equipment – Product requirements – Part 3-104: Detail specification for 8-way, shielded free and fixed connectors for data transmissions with frequencies up to 2 000 MHz*

IEC 61156-6, *Multicore and symmetrical pair/quad cables for digital communications – Part 6: Symmetrical pair/quad cables with transmission characteristics up to 1 000 MHz – Work area wiring – Sectional specification*

IEC 61375-1:2012, *Electronic railway equipment – Train communication network (TCN) – Part 1: General architecture*

IEC 61375-2-1:2012, *Electronic railway equipment – Train communication network (TCN) – Part 2-1: Wire Train Bus (WTB)*

IEC 61375-2-3:2015, *Electronic railway equipment – Train communication network (TCN) – Part 2-3: TCN communication profile*

IEC 61375-2-5:2014, *Electronic railway equipment – Train communication network (TCN) – Part 2-5: Ethernet train backbone*

IEC 61375-3-4:2014, *Electronic railway equipment – Train Communication Network (TCN) – Part 3-4: Ethernet Consist Network (ECN)*

ISO/IEC 9646-1:1994, *Information technology – Open Systems Interconnection – Conformance testing methodology and framework – Part 1: General concepts (Also available as ITU-T Recommendation X.290 (1995))*

ISO/IEC 9646-7:1995, *Information technology – Open Systems Interconnection – Conformance testing methodology and framework – Part 7: Implementation Conformance Statements (Also available as ITU-T Recommendation X.296 (1995))*

ISO/IEC 11801 (all parts), *Information technology – Generic cabling for customer premises*

IEEE 802.1AB: 2009, *Station and Media Access Control Connectivity Discovery*

IEEE 802.1AX:2008, *IEEE Standard for Local and metropolitan area networks – Link Aggregation*

IEEE 802.1Qaz:2011, *IEEE Standard for Local and metropolitan area networks – Enhanced Transmission Selection*

IEEE 802.1D:1990, *IEEE Standard for Local and metropolitan area networks – Media Access Control (MAC) Bridges*

IEEE 802.1Q, *IEEE Standard for Local and metropolitan area networks – Virtual Bridged Local Area Networks*

IEEE 802.2, *Logical Link Control*

IEEE 802.3:2012, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access*

IEEE 802.3az, *Energy Efficient Ethernet*

IETF RFC 768, *User Datagram Protocol*

IETF RFC 791, *INTERNET PROTOCOL*

IETF RFC 792, *INTERNET CONTROL MESSAGE PROTOCOL*

IETF RFC 793, *TRANSMISSION CONTROL PROTOCOL*

IETF RFC 826, *An Ethernet Address Resolution Protocol*

IETF RFC 1034, *DOMAIN NAMES – CONCEPTS AND FACILITIES*

IETF RFC 1035, *DOMAIN NAMES – IMPLEMENTATION AND SPECIFICATION*

IETF RFC 1213, *Management Information Base for Network Management of TCP/IP-based internets: MIB-II*

IETF RFC 1305, *Network Time Protocol (Version 3) Specification, Implementation and Analysis*

IETF RFC 1361, *Simple Network Time Protocol (SNTP)*

IETF RFC 1901, *Introduction to Community-based SNMPv2*

IETF RFC 1905, *Protocol Operations for Version 2 of the Simple Network Management Protocol (SNMPv2)*

IETF RFC 1906, *Transport Mappings for Version 2 of the Simple Network Management Protocol (SNMPv2)*

IETF RFC 1918, *Address Allocation for Private Internets*

IETF RFC 2131, *Dynamic Host Configuration Protocol*

IETF RFC 2236, *Internet Group Management Protocol, Version 2*

IETF RFC 2365, *Administratively Scoped IP Multicast*

IETF RFC 2474, *Definition of the Differentiated Services Field (DS Field) in the IPv4 and IPv6 Headers*

IETF RFC 2544, *Benchmarking Methodology for Network Interconnect Devices*

IETF RFC 3203, *DHCP reconfigure extension*

IETF RFC 3986, *Uniform Resource Identifier (URI): Generic Syntax*

IETF RFC 4122, *A Universally Unique IDentifier (UUID) URN Namespace*

TIA/EIA-568-B, *Commercial Building Telecommunications Cabling Standard*

ANSI X3.263:1995, *Information Technology – Fibre Distributed Data Interface (FDDI) – Token Ring Twisted Pair Physical Layer Medium Dependent (TP-PMD)*