ICS 25.040.40, 35.100.05 SLOVENSKÁ TECHNICKÁ NORMA Máj 2022

STN	**Priemyselné komunikačné siete Siete s vysokou pohotovosťou pre automatizáciu Časť 3: Protokol PRP (Parallel Redundancy Protocol) a kruhová sieť s vysokou pohotovosťou (HSR)**	**STN EN IEC 62439-3** 18 4020

Industrial communication networks - High availability automation networks - Part 3: Parallel Redundancy Protocol (PRP) and High-availability Seamless Redundancy (HSR)

Táto norma obsahuje anglickú verziu európskej normy.
This standard includes the English version of the European Standard.

Táto norma bola oznámená vo Vestníku ÚNMS SR č. 04/22

Obsahuje: EN IEC 62439-3:2022, IEC 62439-3:2021

Oznámením tejto normy sa od 19.01.2025 ruší
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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN IEC 62439-3

February 2022

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Supersedes EN IEC 62439-3:2018 and all of its amendments and corrigenda (if any)

English Version

Industrial communication networks - High availability automation networks - Part 3: Parallel Redundancy Protocol (PRP) and High-availability Seamless Redundancy (HSR) (IEC 62439-3:2021)

Réseaux de communication industriels - Réseaux de haute disponibilité pour l'automatisation - Partie 3: Protocole de redondance en parallèle (PRP) et redondance transparente de haute disponibilité (HSR) (IEC 62439-3:2021)

Industrielle Kommunikationsnetze - Hochverfügbare Automatisierungsnetze - Teil 3: Parallelredundanz-Protokoll (PRP) und nahtloser Hochverfügbarkeits-Ring (HSR) (IEC 62439-3:2021)

This European Standard was approved by CENELEC on 2022-01-19. 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.

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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 65C/1120/FDIS, future edition 4 of IEC 62439-3, prepared by SC 65C "Industrial networks" of IEC/TC 65 "Industrial-process measurement, control and automation" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 62439-3:2022.

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) 2022-10-19
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2025-01-19

This document supersedes EN IEC 62439-3:2018 and all of its amendments and corrigenda (if any).

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.

Any feedback and questions on this document should be directed to the users' national committee. A complete listing of these bodies can be found on the CENELEC website.

Endorsement notice

The text of the International Standard IEC 62439-3:2021 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 61784-1	NOTE	Harmonized as EN IEC 61784-1
IEC 61784-2	NOTE	Harmonized as EN IEC 61784-2
IEC 61850 (series)	NOTE	Harmonized as EN 61850 (series)
IEC 61850-8-1	NOTE	Harmonized as EN 61850-8-1
IEC 61850-9-2	NOTE	Harmonized as EN 61850-9-2
IEC 62439-2	NOTE	Harmonized as EN 62439-2
IEC 62439-3:2016	NOTE	Harmonized as EN IEC 62439-3:2018 (not modified)
IEC 62439-4	NOTE	Harmonized as EN 62439-4
IEC 62439-6	NOTE	Harmonized as EN 62439-6
IEC 62439-7	NOTE	Harmonized as EN 62439-7

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 60050-192	-	International Electrotechnical Vocabulary (IEV) - Part 192: Dependability	-	-
IEC 61588	2021	Precision Clock Synchronization Protocol for Networked Measurement and Control Systems	-	-
IEC/TR 61850-90-4	2020	Communication networks and systems for power utility automation - Part 90-4: Network engineering guidelines	-	-
IEC 62439-1	-	Industrial communication networks - High availability automation networks - Part 1: General concepts and calculation methods	EN 62439-1	-
ISO/IEC/IEEE 8802-3	2021	Telecommunications and exchange between information technology systems - Requirements for local and metropolitan area networks - Part 3: Standard for Ethernet	-	-
IEC/IEEE 61850-9-3	2016	Communication networks and systems for power utility automation - Part 9-3: Precision time protocol profile for power utility automation	-	-
IEEE 802.1Q	2018	IEEE Standard for Local and metropolitan area networks – Bridges and Bridged Network	-	-
IETF RFC 768	-	User Datagram Protocol (UDP) [online]. August 1980.	-	-
IETF RFC 791	-	Internet Protocol (IP) [online]. September 1981.	-	-
IETF RFC 792	-	Internet Control Message Protocol [online]. September 1981.	-	-

Publication	Year	Title	EN/HD	Year
IETF RFC 793	-	Transmission Control Protocol [online]. September 1981.	-	-
IETF RFC 826	-	Ethernet Address Resolution Protocol [online]. November 1982.	-	-
IETF RFC 2578	-	Structure of Management Information Version 2 (SMIv2) [online]. April 1999.	-	-
IETF RFC 3418	-	Structure of Management Information Version 2 (SMIv2) [online]. December 2002.	-	-

IEC 62439-3

Edition 4.0 2021-12

INTERNATIONAL STANDARD

NORME INTERNATIONALE

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Industrial communication networks – High availability automation networks – Part 3: Parallel Redundancy Protocol (PRP) and High-availability Seamless Redundancy (HSR)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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INDUSTRIAL COMMUNICATION NETWORKS – HIGH AVAILABILITY AUTOMATION NETWORKS –

Part 3: Parallel Redundancy Protocol (PRP) and High-availability Seamless Redundancy (HSR)

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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IEC 62439-3 has been prepared by subcommittee 65C: Industrial networks, of IEC technical committee 65: Industrial-process measurement, control and automation. It is an International Standard.

This fourth edition cancels and replaces the third edition published in 2016. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) References to Precision Time Protocol (PTP) IEC 61588:2021 replace references to IEC 61588:2009, unless the previous version is explicitly referenced (Clause 2);
b) References to IEC 61850-90-4:2020 replace references to IEC 61850-90-4:2013 with corresponding changes in the Logical Nodes (Clause 2);

c) Terms and abbreviations are aligned with the next edition of IEC/IEEE 61850-9-3 (currently under preparation) (Clause 3);

d) RSTP support in HSR is specified (5.2.2.10);

e) RedBoxes and QuadBoxes specifications are extended to TCs (5.5);

f) Network management (MIB) for PRP and HSR is available as a "Code Component", machine-readable separate document (Clause 7);

g) PTP over PRP specifies a unified operation of DATC and SLTC RedBoxes (A.2.6.4);

h) PTP over HSR specifies the operation of RedBoxes for TCs (A.4.3);

i) PTP datasets are aligned with IEC 61588:2021 (Clause A.6);

j) PTP industry profile is extended:

   – Sync messages padding to support media converters (C.5.4);
   – ClockClass definition aligned with IEC 61588:2021 option a) (C.7.4.3);
   – TC operation over different domains (C.7.5.3);
   – BCs behaviour in holdover and recovery (C.7.6.2);
   – PICS entries renamed and extended (C.13.2);
   – Flags semantics in TimePropertyDS actualized (C.14.1);
   – UTC events handling during a leap second specified (C.14.2);
   – UTC leap second time representation aligned with IEEE C37.118.2 (C.14.2.2);
   – Daylight saving time and leap second events recommended in the ALTERNATE_TIME_OFFSET_INDICATOR TLV (C.14.3.2);

k) Tutorial extended to explain the media converter issue (D.8.3);

l) PTP network management MIB (Annex E) is available as a "Code Component", machine-readable separate document and considers IEC 61588:2021 objects;

m) Conformance testing for PRP, HSR and the doubly attached PTP clocks (Annex F) has been added.

n) Interoperability issues with previous editions of this International Standard are mentioned in a note at the end of the corresponding clause.

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

FDIS	Report on voting
65C/1120/FDIS	65C/1139/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.

This International Standard is to be read in conjunction with IEC 62439-1.

A list of all parts in the IEC 62439 series, published under the general title *Industrial communication networks – High availability automation networks*, can be found on the IEC website.

This IEC standard includes Code Components, i.e., components that are intended to be directly processed by a computer. Such content is any text found between the markers <CODE BEGINS> and <CODE ENDS>, or otherwise is clearly labeled in this standard as a Code Component.

The purchase of this IEC standard carries a copyright license for the purchaser to sell software containing Code Components from this standard directly to end users and to end users via distributors, subject to IEC software licensing conditions, which can be found at: http://www.iec.ch/CCv1.

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,
- 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 publication using a colour printer.

INTRODUCTION

0.1 General

This document belongs to the IEC 62439 series *"Industrial communication networks – High availability automation networks"*. It was developed jointly with IEC TC57 WG10 as the redundancy method for demanding substation automation networks operating on layer 2 networks, in accordance with IEC 61850-8-1 and IEC 61850-9-2, and extended to encompass the needs of CPF 2 of IEC 61784-1 and IEC 61784-2 for layer 3 networks.

This document specifies two related redundancy protocols that, in the event of failure of any network element, provide seamless switchover with zero recovery time:

- PRP (Parallel Redundancy Protocol), which allows attaching nodes to two separate networks while allowing attachment of nodes to one network only; and
- HSR (High-availability Seamless Redundancy), which allows threading two-port nodes in a ring or multi-port nodes in a meshed network.

This document applies the seamless redundancy principle to clocks compliant with the Precision Time Protocol (PTP).

This document specifies a PTP Industry profile (PIP) that offers the performance needed to achieve sub-microsecond time accuracy. This profile can be applied to any industrial communication network based on Ethernet. Two variants of PIP are specified:

- L3E2E (Layer 3, end-to-end) for clocks operating on layer 3 networks with end-to-end path delay measurement such as CP 2/2 of IEC 61784-1 and IEC 61784-2; and
- L2P2P (Layer 2, peer-to-peer) for clocks operating on layer 2 with peer-to-peer link delay measurement (P2P).

Based on L2P2P, IEC TC57 WG10 and the IEEE PSRC jointly specified the Power Utility Profile (PUP) and copied it to IEC/IEEE 61850-9-3. IEC and IEEE agreed to keep the contents of this document and IEC/IEEE 61850-9-3 aligned, under the umbrella of the Dual Logo Maintenance Team (DLMT) hosted by IEEE PSCC P20.

The specifications of PRP and HSR present no backward compatibility issues as the changes are compatible extensions of the protocol. The minor version of these protocols is kept at value "1".

The specifications of the clock profile PIP are based on IEC 61588:2021, which presents some differences compared with IEC 61588:2009. The minorVersionPTP has been increased to 1.

This document includes guidelines for conformance testing, applicable to PRP, HSR and to the PIP and PUP clock synchronization profiles.

0.2 Patent declaration

The International Electrotechnical Commission (IEC) draws attention to the fact that it is claimed that compliance with this standard may involve the use of a patent. IEC takes no position concerning the evidence, validity, and scope of this patent right.

The holder of this patent right has assured IEC that s/he is willing to negotiate licences under reasonable and non-discriminatory terms and conditions with applicants throughout the world. In this respect, the statement of the holder of this patent right is registered with IEC. Information may be obtained from the patent database available at http://patents.iec.ch.

Attention is drawn to the possibility that some of the elements of this standard may be the subject of patent rights other than those in the patent database. IEC shall not be held responsible for identifying any or all such patent rights.

INDUSTRIAL COMMUNICATION NETWORKS – HIGH AVAILABILITY AUTOMATION NETWORKS –

Part 3: Parallel Redundancy Protocol (PRP) and High-availability Seamless Redundancy (HSR)

1 Scope

1.1 General

The IEC 62439 series is applicable to high-availability automation networks based on the Ethernet technology.

This document:

- specifies PRP and HSR as two related redundancy protocols designed to provide seamless recovery in case of single failure of an inter-bridge link or bridge in the network, which are based on the same scheme: parallel transmission of duplicated information;
- specifies the operation of the precision time protocol (PTP) in networks that implement the two redundancy protocols (Annex A);
- specifies PTP profiles with performance suitable for power utilty automation (Annex B) and industrial automation (Annex C);
- includes for better understanding a tutorial (Annex D) on the PTP features effectively used in high-availability automation networks;
- includes a management information base for PTP (Annex E);
- defines a conformance test suite for the above protocols (Annex F).

1.2 Code component distribution

This document is associated with Code components. Each Code Component is a ZIP package containing at least the electronic representation of the Code Component itself and a file describing the content of the package (IECManifest.xml).

The IECManifest contains different sections giving information on:

- the copyright notice;
- the identification of the code component;
- the publication related to the code component;
- the list of the electronic files which compose the code component;
- an optional list of history files to track changes during the evolution process of the code component.

The Code Components associated with this IEC standard are a set of SNMP MIBs. The Code Component IEC-62439-3-MIB.mib is a file containing the MIBs for PRP/HSR and PTP_SNMP. It is available in a full version, which contains the MIBs defined in this document with the documentation associated and access is restricted to purchaser of this document.

The Code Components are freely accessible on the IEC website for download at: https://www.iec.ch/sc65c/supportingdocuments/IEC_62439-3.MIB.{VersionStateInfo}.full.zip but the usage remains under the licensing conditions.

The life cycle of a code component is not restricted to the life cycle of the related publication. The publication life cycle goes through two stages, "Version" (corresponding to an edition) and "Revision" (corresponding to an amendment). Consequently, new release(s) of the Code Component(s) may be released, which supersede(s) the previous release, and will be distributed through the IEC web site at: https://www.iec.ch/sc65c/supportingdocuments.

The latest version/release of the document will be found by selecting the file IEC_62439-3.MIB.{VersionStateInfo}.full.zip for the code component with the highest value for VersionStateInfo.

In case of any differences between the downloadable code and the IEC pdf published content, the downloadable code(s) is(are) the valid one; it may be subject to updates. See history files.

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 60050-192, *International Electrotechnical Vocabulary – Part 192: Dependability*

IEC 61588:2021, *Precision Clock Synchronization Protocol for Networked Measurement and Control Systems*

IEC TR 61850-90-4:2020, *Communication networks and systems for power utility automation – Part 90-4: Network engineering guidelines*

IEC 62439-1, *Industrial communication networks – High availability automation networks – Part 1: General concepts and calculation method*

ISO/IEC/IEEE 8802-3:2021, *Standard for Ethernet*

IEC/IEEE 61850-9-3:2016, *Communication networks and systems for power utility automation – Part 9-3: Precision time protocol profile for power utility automation*

IEEE 802.1Q-2018, *IEEE Standard for Local and metropolitan area networks – Bridges and Bridged Network*

NOTE IETF references are dated with the original Request for Comment (RFC). Subsequent versions receive a new RFC number. Since IETF amends or extends documents and publishes errata on-line, the valid version can be found on the internet at *https://tools.ietf.org/*.

IETF RFC 768, *User Datagram Protocol (UDP)* [online]. August 1980 [viewed 2020-05-07]. Available at https://tools.ietf.org/html/rfc768

IETF RFC 791, *Internet Protocol (IP)* [online]. September 1981 [viewed 2020-05-07]. Available at https://tools.ietf.org/html/rfc791

IETF RFC 792, *Internet Control Message Protocol* [online]. September 1981 [viewed 2020-05-07]. Available at https://tools.ietf.org/html/rfc792

IETF RFC 793, *Transmission Control Protocol* [online]. September 1981 [viewed 2020-05-07]. Available at https://tools.ietf.org/html/rfc793

IETF RFC 826, *Ethernet Address Resolution Protocol* [online]. November 1982 [viewed 2020-05-07]. Available at https://tools.ietf.org/html/rfc826

IETF RFC 2578, *Structure of Management Information Version 2 (SMIv2)* [online]. April 1999 [viewed 2020-05-07]. Available at https://tools.ietf.org/html/rfc2578

IETF RFC 3418, *Structure of Management Information Version 2 (SMIv2)* [online]. December 2002 [viewed 2020-05-07]. Available at https://tools.ietf.org/html/rfc3418