SLOVENSKI STANDARD
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Industrijska komunikacijska omrežja - Omrežja za avtomatizacijo z visoko razpoložljivostjo - 1. del: Splošni koncepti in metode izračuna

Industrial communication networks - High availability automation networks - Part 1: General concepts and calculation methods

Industrielle Kommunikationsnetze - Hochverfügbare Automatisierungsnetze - Teil 1: Grundlagen und Berechnungsmethoden

Réseaux industriels de communication - Réseaux d'automatisme à haute disponibilité - Partie 1: Concepts généraux et méthodes de calcul

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ICS:

25.040.01	Sistemi za avtomatizacijo v industriji na splošno	Industrial automation systems in general
35.110	Omreževanje	Networking

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65C/1472/CDV

COMMITTEE DRAFT FOR VOTE (CDV)

PROJECT NUMBER: **IEC 62439-1 ED2**	
DATE OF CIRCULATION: **2026-09-25**	CLOSING DATE FOR VOTING: **2026-12-18**
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IEC SC 65C : INDUSTRIAL NETWORKS	
SECRETARIAT: France	SECRETARY: Mr Alexandre NABAIS
OF INTEREST TO THE FOLLOWING COMMITTEES: SC 22G,TC 57	HORIZONTAL FUNCTION(S):
ASPECTS CONCERNED:	
☒ SUBMITTED FOR CENELEC PARALLEL VOTING	☐ NOT SUBMITTED FOR CENELEC PARALLEL VOTING

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TITLE:

Industrial networks - High availability automation networks - Part 1: General concepts and calculation methods

PROPOSED STABILITY DATE: 2035

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Industrial networks - High availability automation networks - Part 1: General concepts and calculation methods

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IEC 62439-1 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 second edition cancels and replaces the first edition published in 2010, Amendment 1:2012 and Amendment 2:2016. This edition constitutes a technical revision.

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

a) *Clause 2*

The references have been revised (for example changed to newer versions if needed).

b) Clause 3 Terms, definitions, abbreviated terms, and conventions

The contents in the subclauses 3.1 and 3.2 have been arranged alphabetically.

c) The terms availability and **high availability** have been revised based on updates in the referenced standards.

d) Annex A Security Considerations

This clause has been newly added.

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

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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.

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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/publications.

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.

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

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INTRODUCTION

The IEC 62439 series specifies relevant principles for high availability networks that meet the requirements for industrial automation networks.

In the fault-free state of the network, the protocols of the IEC 62439 series provide ISO/IEC/IEEE 8802-3:2021/Amd 3 (IEEE 802.3) compatible, reliable data communication, and preserve determinism of real-time data communication. In cases of fault, removal, and insertion of a component, they provide deterministic recovery times.

These protocols retain fully the typical Ethernet communication capabilities as used in the office world, so that the software involved remains applicable.

The market is in need of several network solutions, each with different performance characteristics and functional capabilities, matching diverse application requirements. These solutions support different redundancy topologies and mechanisms which are introduced in IEC 62439-1 and specified in the other Parts of the IEC 62439 series. IEC 62439-1 also distinguishes between the different solutions, giving guidance to the user.

The IEC 62439 series follows the general structure and terms of IEC 61158 (all parts) [1].

The following items were listed in the bibliography but not cited in the text. Please find a suitable place to cite them to justify their inclusion in the bibliography:

IEC/TR 61158-1, *Industrial communication networks – Fieldbus specifications – Part 1: Overview and guidance for the urn:iec:std:iec:61158::ser::IEC 61158 and urn:iec:std:iec:61784::ser::IEC 61784 series*IEC/TR 61158-1 [2]

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IEC/TR 61158-6 (all parts), *Industrial communication networks – Fieldbus specifications – Part 6: Symmetrical pair/quad cables with transmission characteristics up to 1 000 MHz – Work area wiring*IEC/TR 61158-6 (all parts) [3]

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ISO/IEC 2382 (all parts), *Information technology – Vocabulary*ISO/IEC 2382 (all parts) [4]

ISO/IEC 10731, *Information technology – Open Systems Interconnection – Basic Reference Model – Conventions for the definition of OSI services*ISO/IEC 10731 [5]

ISO/IEC 15802-3, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Common specifications – Part 3 : Media Access Control (MAC) Bridges*ISO/IEC 15802-3 [6]

PUSTYLNIK M., ZAFIROVIC-VUKOTIC, M., MOORE, R., Performance of the Rapid Spanning Tree Protocol in Ring Network Topology, Rugged Com. Inc.http://www.ruggedcom.com/pdfs/white_%20papers/performance_of_rapid_spanning_tree_protocol_in_ring_network_topology.pdf[7]

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1 Scope

The IEC 62439 series is applicable to high-availability automation networks based on the ISO/IEC/IEEE 8802-3:2021/Amd 3 (IEEE 802.3) (Ethernet) technology.

This part of the IEC 62439 series specifies

– the common elements and definitions for other parts of the IEC 62439 series;
– the conformance test specification (normative);
– a classification scheme for network characteristics (informative);
– a methodology for estimating network availability (informative);
– the configuration rules, calculation and measurement method for a deterministic recovery time in RSTP.

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 60050-191:1990, *International Electrotechnical Vocabulary – Chapter 191: Dependability and quality of service*

IEC 60050-192, *International Electrotechnical Vocabulary (IEV) - Part 192: Dependability*

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IEC 61158 (all parts), *Industrial communication networks – Fieldbus specifications*

IEC 61158-6-10, *Industrial communication networks – Fieldbus specifications – Part 6-10: Application layer protocol specification – Type 10 elements*

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ISO/IEC/IEEE 8802-3:2021/Amd 3, *Telecommunications and exchange between information technology systems — Requirements for local and metropolitan area networks — Part 3: Standard for Ethernet — Amendment 3: Media access control parameters for 50 Gb/s and physical layers and management parameters for 50 Gb/s, 100 Gb/s, and 200 Gb/s operation*

IEEE 802.1Q, *IEEE standards for local and metropolitan area network. Virtual bridged local area networks*

IEEE 802.1D:2004, *IEEE standard for local Local and metropolitan area networks Media Access Control (MAC) Bridges*

IETF RFC 791, *Internet Protocol;*

3 Terms, definitions, abbreviations, acronyms, and conventions

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-192, as well as the following, apply

3.1.1
availability
ability to be in a state to perform as required unter given conditions

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Note 1 to entry: Availability considers two states, the up state (available) and the down state (unavailable). All time intervals, such as administrative delay (see Figure 1), are defined either as belonging to one of these two states or are excluded. (It is to be noted that the definition of Dependability does not refer to “states” as it has a much broader meaning. See 192-01-22 for further clarification).

Note 2 to entry: Availability depends upon the combined attributes of the reliability (192-01-24), maintainability (192-01-27), supportability (192-01-31) and the maintenance and support provided.

[SOURCE: IEC 60050-192]

3.1.2
bridge
device connecting LAN segments at layer 2 according to IEEE 802.1D:2004

Note 1 to entry: The words “switch” and “bridge” are considered synonyms, the word “bridge” is used in the context of standards such as RSTP (IEEE 802.1D:2004), PTP (IEC 61588 [8]) or IEC 62439-3 [9] (PRP & HSR).

3.1.3
channel
layer 2 connection between two end nodes which consists of one or more paths (for redundancy) between end nodes

3.1.4
common mode failure
failure that affects all redundant elements for a given function at the same time

3.1.5
complete failure
failure characterized by the loss of all required functions

[SOURCE: IEC 60050-192]

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3.1.6
connection
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logical relationship between two nodes

3.1.7
coverage
probability that a failure is discovered within a time short enough for redundancy to handle it, also expressing the percentage of failures caught up by redundancy vs. total number of failures

3.1.8
cut-through switching
a technology in which a switching node starts transmitting a received frame before this frame has been fully received

3.1.9
dependability
ability to perform as and when required

Note 1 to entry: A dependable item is one where there is justified confidence that it operates as desired and satisfies agreed stakeholder expectations.

[SOURCE: IEC 60050-192]

3.1.10
device
physical entity connected to the network composed of communication element and possibly other functional elements

Note 1 to entry: Devices are for instance nodes, routers and switches.

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3.1.11
doubly attached node
node that has two ports for the purpose of redundant operation

3.1.12
edge port
port of a switch connected to a leaf link

3.1.13
end node
node which is producer or consumer of application data

Note 1 to entry: For the purpose of the IEC 62439 series, further specification is given in 0.

3.1.14
error
discrepancy between a computed, observed or measured value or condition and the specified or theoretically correct value or condition

Note 1 to entry: An error within a system can be caused by failure of one or more of its components, or by the activation of a systematic fault.

Note 2 to entry: See also human error

[SOURCE: IEC 60050-192]

NOTE 1 modified

3.1.15
failure
loss of ability to perform as required

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Note 1 to entry: A failure of an item is an event that results in a fault of that item: see "fault" (IEV 192-04-01).

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[SOURCE: IEC 60050-192]

3.1.16
fault
inability to perform as required, due to an internal state

Note 1 to entry: A fault of an item results from a failure, either of the item itself, or from a deficiency in an earlier stage of the life cycle, such as specification, design, manufacture or maintenance. See latent fault (192-04-08).

[SOURCE: IEC 60050-192]

3.1.17
fault recovery time
time from the fault event, to the time when the network regains its required communication function in the presence of the fault

Note 1 to entry: After fault recovery, the network is operating in a degraded mode using some of the redundancy elements, so it has reduced fault resilience, and may not be able to recover from a second fault.

3.1.18
frame
unit of data transmission on an ISO/IEC/IEEE 8802-3:2021/Amd 3 MAC (Media Access Control) that conveys a protocol data unit (PDU) between MAC service users

[SOURCE: IEEE 802.1Q [10]]

NOTE 2 modified

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3.1.19
high availability
significantly increased availability of communication systems by using topologies and protocols that introduce redundancy and automatically reconfigure redundant communication elements in case of failure

Note 1 to entry: In the case of IEC 62439 technologies, automatic reconfiguration is not necessary for protocols with redundancy managed in the end nodes.

[SOURCE: IEC PAS 63595]

3.1.20
(instantaneous) failure rate
limit, if it exists, of the quotient of the conditional probability that the instant of a failure of a non-repairable item falls within time interval (t, t + Δt) by Δ*t*, when Δ*t* tends to zero, given that failure has not occurred within time interval (0, *t*)

$$\lambda(t) = \lim_{\Delta t \to 0} \frac{1}{\Delta t} \frac{F(t+\Delta t) - F(t)}{R(t)} = \frac{f(t)}{R(t)}$$

where $F(t)$ and $f(t)$ are, respectively, the distribution function and the probability density at the failure instant, and where $R(t)$ is the reliability function, related to the reliability $R(t_1, t_2)$ by $R(t) = R(0, t)$.

Note 1 to entry: See IEC 61703, *Mathematical expressions for reliability, availability, maintainability and maintenance support terms*, for more detail.

[SOURCE: IEC 60050-192]

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3.1.21
inter-switch link
link between two switches

3.1.22
inter-switch port
port of a switch connected to another switch via an inter-switch link

3.1.23
LAN
A layer 2 broadcast domain in which MAC addresses are unique and can be addressed from any other device belonging to that broadcast domain

Note 1 to entry: A VLAN allows multiplexing several LANs on the same network infrastructure.

Note 2 to entry: In the context of redundancy, a network may consist of several LANs operated in redundancy, in which case it is called a redundant LAN.

3.1.24
leaf link
link between an end node and the LAN

Note 1 to entry: For the purpose of the IEC 62439 series, further specification is given in 5.2.1.3.

3.1.25
linear topology
topology where the switches are connected in series, with two switches each connected to only one other switch and all other switch each connected to two other switches (that is, connected in the shape of a line)

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Note 1 to entry: This topology corresponds to that of an open ring.

Note 2 to entry: This configuration is sometimes named “daisy chain”. The IEC 62439 series does not use the term “daisy chain” because of possible confusion with the term “daisy chain” used elsewhere for busses. From the wiring point of view they require two different implementations.

[SOURCE: IEC 61918:2007 [11], 3.1.39]

NOTE 3 modified

3.1.26
link
physical, point-to-point, generally duplex connection between two adjacent nodes

Note 1 to entry: “Link” is different from “bus”, which is a broadcast physical medium.

[SOURCE: ISO/IEC 11801:2002 [12], 3.1.51]

NOTE 4 modified

3.1.27
Link Redundancy Entity
entity at layer 2 that hides port redundancy from the upper layers, by forwarding to the upper layers the frames received from the active redundant ports as if they came from a single port, and by forwarding to the active redundant ports a frame coming from the upper layers

3.1.28
link service data unit
data transported within a protocol layer on behalf of the upper layer

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Note 1 to entry: The link service data unit in an Ethernet frame is the content of the frame located between the Length/Type field and the Frame Check Sequence.

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3.1.29
mean failure rate, average failure rate
average value of the instantaneous failure rate over a given time interval $\lambda(t_1, t_2)$

$$\bar{\lambda}(t_1, t_2) = \frac{1}{t_2 - t_1} \int_{t_1}^{t_2} \lambda(t)\, dt$$

[SOURCE: IEC 60050-192]

3.1.30
mean operating time between failures
MTBF, MOTBF
expectation of the duration of the operating time between failures

Note 1 to entry: Mean operating time between failures should only be applied to repairable items. For non-repairable items, see mean operating time to failure (192-05-11).

[SOURCE: IEC 60050-192]

3.1.31
mean time to failure
MTTF
expectation of the time to failure

[SOURCE: IEC 60050-191:1990]

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3.1.32
mesh topology
topology where each node is connected with three or more inter-switch links

3.1.33
message
ordered series of octets intended to convey information

Note 1 to entry: Normally used to convey information between peers at the application layer.

[SOURCE: IEC 61784-2:2007 [13], 3.1.14]

3.1.34
network
communication system consisting of end nodes, leaf links and LAN(s)

Note 1 to entry: A network may have more than one LAN for the purpose of redundancy.

3.1.35
network recovery time
time span from the moment of the first failure of a component or media inside the network to the moment the network reconfiguration is finished and from which all devices that are still able to participate in network communication are able to reach all other such devices in the network again

Note 1 to entry: When a network redundancy control protocol (like RSTP) reconfigures the network due to a fault, parts of the network may still be available and communication outages may vary in time and location over the whole network. In the calculations, only the worst case scenario is considered.

Sample Document

3.1.36
node
network entity connected to one or more links

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Note 1 to entry: Nodes may be either a switch or an end node or both.

[SOURCE: IEC 61784-2:2007 [13], 3.1.16]

NOTE 5 modified

3.1.37
partial failure
failure which results in the inability of an item to perform some, but not all, required functions

3.1.38
path
set of links and switches joined in series

Note 1 to entry: There may be two or more paths between two switches to provide redundancy.

3.1.39
plant
system that depends on the availability of the automation network to operate

EXAMPLE Plants can be power plants, printing machines, manufacturing systems, substations, vehicles.

3.1.40
port
connection point of a node to the network

Note 1 to entry: This definition is different from a TCP port or a UDP port, which the IEC 62439 series qualifies explicitly if necessary.

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