

DIN EN 62439-1

ICS 35.110

Ersatzvermerk
siehe unten

**Industrielle Kommunikationsnetze –
Hochverfügbare Automatisierungsnetze –
Teil 1: Grundlagen und Berechnungsmethoden (IEC 62439-1:2010);
Englische Fassung EN 62439-1:2010**

Industrial communication networks –
High availability automation networks –
Part 1: General concepts and calculation methods (IEC 62439-1:2010);
English version EN 62439-1:2010

Réseaux de communication industrielle –
Réseaux d'automatisme à haute disponibilité –
Partie 1: Concepts généraux et méthodes de calcul (CEI 62439-1:2010);
Version anglaise EN 62439-1:2010

Ersatzvermerk

Mit DIN EN 62439-2:2010-09, DIN EN 62439-3:2010-09, DIN EN 62439-4:2010-09, DIN EN 62439-5:2010-09
und DIN EN 62439-6:2010-09 Ersatz für DIN EN 62439:2009-01
Siehe jedoch Anwendungsbeginn

Gesamtumfang 57 Seiten

DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik im DIN und VDE

Anwendungsbeginn

Anwendungsbeginn für die von CENELEC am 2010-03-01 angenommene Europäische Norm als DIN-Norm ist 2010-09-01.

Daneben darf DIN EN 62439:2009-01 noch bis 2013-03-01 angewendet werden.

Nationales Vorwort

Vorausgegangener Norm-Entwurf: E DIN EN 62439-1:2009-09.

Für diese Norm ist das nationale Arbeitsgremium K 956 „Feldbus“ der DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik im DIN und VDE (www.dke.de) zuständig.

Die enthaltene IEC-Publikation wurde vom SC 65C „Industrial networks“ erarbeitet.

Das IEC-Komitee hat entschieden, dass der Inhalt dieser Publikation bis zu dem Datum (maintenance result date) unverändert bleiben soll, das auf der IEC-Website unter „<http://webstore.iec.ch>“ zu dieser Publikation angegeben ist. Zu diesem Zeitpunkt wird entsprechend der Entscheidung des Komitees die Publikation

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- zurückgezogen,
- durch eine Folgeausgabe ersetzt oder
- geändert.

Für den Fall einer undatierten Verweisung im normativen Text (Verweisung auf eine Norm ohne Angabe des Ausgabedatums und ohne Hinweis auf eine Abschnitsnummer, eine Tabelle, ein Bild usw.) bezieht sich die Verweisung auf die jeweils neueste gültige Ausgabe der in Bezug genommenen Norm.

Für den Fall einer datierten Verweisung im normativen Text bezieht sich die Verweisung immer auf die in Bezug genommene Ausgabe der Norm.

Der Zusammenhang der zitierten Normen mit den entsprechenden Deutschen Normen ergibt sich, soweit ein Zusammenhang besteht, grundsätzlich über die Nummer der entsprechenden IEC-Publikation. Beispiel: IEC 60068 ist als EN 60068 als Europäische Norm durch CENELEC übernommen und als DIN EN 60068 ins Deutsche Normenwerk aufgenommen.

Die Reihe DIN EN 62439 besteht aus folgenden Teilen:

Teil 1: Grundlagen und Berechnungsmethoden

Teil 2: Medienredundanz-Protokoll (MRP)

Teil 3: Parallelredundanz-Protokoll (PRP) und nahtloser Hochverfügbarkeits-Ring (HSR)

Teil 4: Redundanz-Protokoll für vermaschte Netze (CRP)

Teil 5: Funkbaken-Redundanz-Protokoll (BRP)

Teil 6: Protokoll für verteilte Redundanz (DRP)

Da sich die Benutzer des vorliegenden Norm-Entwurfs der englischen Sprache als Fachsprache bedienen, wird die englische Fassung der DIN EN 62439-1 veröffentlicht. Für die meisten der verwendeten Begriffe existieren keine gebräuchlichen deutschen Benennungen, da sich die deutschen Anwender in der Regel ebenfalls der englischen Benennungen bedienen. Dieser Norm-Entwurf steht nicht in unmittelbarem Zusammenhang mit Rechtsvorschriften und ist nicht als Sicherheitsnorm anzusehen.

Das Präsidium des DIN hat mit Präsidialbeschluss 1/2004 festgelegt, dass DIN-Normen, deren Inhalt sich auf internationale Arbeitsergebnisse der Informationsverarbeitung gründet, unter bestimmten Bedingungen allein in englischer Sprache veröffentlicht werden dürfen. Diese Bedingungen sind für die vorliegende Norm erfüllt.

Erklärung zu Schutzrechten

Die Internationale Elektrotechnische Kommission macht darauf aufmerksam, dass ihr gegenüber erklärt wurde, dass die Übereinstimmung mit dem vorgesehenen Norm-Inhalt die Anwendung von Patenten erforderlich machen könnte. Nähere Informationen hierzu befinden sich im Vorwort der Europäischen Norm.

Es wird darauf aufmerksam gemacht, dass Bestandteile der vorliegenden Norm Gegenstand von weiteren Patentrechten sein können. Es liegt nicht im Verantwortungsbereich der DKE, einige oder alle dieser Patentrechte zu benennen.

Der Leser der vorliegenden Norm wird jedoch gebeten, ihm bekannte derartige Patentrechte der Geschäftsstelle mitzuteilen und entsprechende Informationen zur Verfügung zu stellen.

Änderungen

Gegenüber DIN EN 62439:2009-01 wurden folgende Änderungen vorgenommen:

- a) Überführung in eine 6-teilige Normenreihe mit dem Haupttitel „Hochverfügbare Automatisierungsnetze“.
- b) Beschreibung des Rapid Spanning Tree-Protokolls (RSTP) nach IEEE 802.1d im Teil 1.

Frühere Ausgaben

DIN EN 62439: 2009-01

– Leerseite –

**Industrial communication networks –
High availability automation networks –
Part 1: General concepts and calculation methods
(IEC 62439-1:2010)**

Réseaux de communication industrielle –
Réseaux d'automatisme à haute
disponibilité –
Partie 1: Concepts généraux et méthodes
de calcul
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Industrielle Kommunikationsnetze –
Hochverfügbare Automatisierungsnetze –
Teil 1: Grundlagen und
Berechnungsmethoden
(IEC 62439-1:2010)

This European Standard was approved by CENELEC on 2010-03-01. 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 Central Secretariat 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 Central Secretariat 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, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

CENELEC

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

Central Secretariat: Avenue Marnix 17, B – 1000 Brussels

Foreword

The text of document 65C/583/FDIS, future edition 1 of IEC 662439-1, 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 was approved by CENELEC as EN 62439-1 on 2010-03-01.

This EN 62439-1 together with EN 62439-2, EN 62439-3, EN 62439-4, EN 62439-5 and EN 62439-6 supersedes EN 62439:2008.

This EN 62439-1:2010 includes the following significant technical changes with respect to EN 62439:2008:

- adding a calculation method for RSTP (rapid spanning tree protocol, IEEE 802.1Q),
- adding two new redundancy protocols: HSR (High-availability Seamless Redundancy) and DRP (Distributed Redundancy Protocol),
- moving former Clauses 1 to 4 (introduction, definitions, general aspects) and the Annexes (taxonomy, availability calculation) to EN 62439-1, which serves now as a base for the other documents,
- moving Clause 5 (MRP) to EN 62439-2 with minor editorial changes,
- moving Clause 6 (PRP) was to EN 62439-3 with minor editorial changes,
- moving Clause 7 (CRP) was to EN 62439-4 with minor editorial changes, and
- moving Clause 8 (BRP) was to EN 62439-5 with minor editorial changes,
- adding a method to calculate the maximum recovery time of RSTP in a restricted configuration (ring) to EN 62439-1 as Clause 8,
- adding specifications of the HSR (High-availability Seamless Redundancy) protocol, which shares the principles of PRP to EN 62439-3 as Clause 5, and
- introducing the DRP protocol as EN 62439-6.

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

The following dates were fixed:

- | | | |
|--|-------|------------|
| – latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement | (dop) | 2010-12-01 |
| – latest date by which the national standards conflicting with the EN have to be withdrawn | (dow) | 2013-03-01 |

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 62439-1:2010 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 61158 series	NOTE Harmonized in EN 61158 series (not modified).
IEC/TR 61158-1	NOTE Harmonized as CLC/TR 61158-1.
IEC/TR 61158-6 series	NOTE Harmonized in EN 61158-6 series (not modified).
IEC 61784-2:2007	NOTE Harmonized as EN 61784-2:2008 (not modified).
IEC 62439-2	NOTE Harmonized as EN 62439-2.
IEC 62439-3	NOTE Harmonized as EN 62439-3.
IEC 62439-4	NOTE Harmonized as EN 62439-4.
IEC 62439-5	NOTE Harmonized as EN 62439-5.
IEC 62439-6	NOTE Harmonized as EN 62439-6.
IEC 61918:2007	NOTE Harmonized as EN 61918:2008 (modified).

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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 8802-3 (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 series.

INDUSTRIAL COMMUNICATION NETWORKS – HIGH AVAILABILITY AUTOMATION NETWORKS –

Part 1: General concepts and calculation methods

1 Scope

The IEC 62439 series is applicable to high-availability automation networks based on the ISO/IEC 8802-3 (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 referenced documents are indispensable for the application 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 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*

ISO/IEC 8802-3:2000, *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 method and physical layer specifications*

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*; available at <<http://www.ietf.org>>

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 60050-191, as well as the following, apply

3.1.1

availability (performance)

ability of an item to be in a state to perform a required function under given conditions at a given instant of time or over a given time interval, assuming that the required external resources are provided

NOTE 1 This ability depends on the combined aspects of the reliability performance, the maintainability performance, and the maintenance support performance.

NOTE 2 Required external resources, other than maintenance resources, do not affect the availability performance of the item.

[IEV 191-02-05]

3.1.2

channel

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

3.1.3

common mode failure

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

3.1.4

complete failure

failure which results in the complete inability of an item to perform all required functions

[IEV 191-04-20]

3.1.5

connection

logical relationship between two nodes

3.1.6

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

3.1.7

cut-through switching

a technology in which a switching node starts transmitting a received frame before this frame has been fully received

3.1.8

degradation failure

failure which is both a gradual failure and a partial failure

[IEV 191-04-22]

3.1.9

dependability

collective term used to describe the availability performance and its influencing factors: reliability performance, maintainability performance and maintenance support performance

NOTE Dependability is used only for general descriptions in non-quantitative terms.

[IEV 191-02-03]

3.1.10

device

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

NOTE Devices are for instance nodes, routers and switches.

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 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 An error can be caused by a faulty item, e.g. a computing error made by faulty computer equipment.

NOTE 2 The French term "erreur" may also designate a mistake (see IEV 191-05-25).

[IEV 191-05-24, modified]

3.1.15

failure

termination of the ability of an item to perform a required function

NOTE 1 After a failure, the item has a fault.

NOTE 2 "Failure" is an event, as distinguished from "fault", which is a state.

NOTE 3 This concept as defined does not apply to items consisting of software only.

[IEV 191-04-01]

3.1.16

fault

state of an item characterized by its inability to perform a required function, excluding the inability during preventive maintenance or other planned actions, or due to lack of external resources

NOTE A fault is often the result of a failure of the item itself, but may exist without prior failure.

[IEV 191-05-01]

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 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 8802-3 MAC (Media Access Control) that conveys a protocol data unit (PDU) between MAC service users

[IEEE 802.1Q, modified]

3.1.19

(instantaneous) failure rate

limit, if it exists, of the quotient of the conditional probability that the instant of a failure of a non-repaired item falls within a given time interval $(t, t + \Delta t)$ and the duration of this time interval, Δt , when Δt tends to zero, given that the item has not failed up to the beginning of the time interval

[IEV 191-12-02]

NOTE The failure rate is the reciprocal number of the MTTF when the failure rate is constant over the lifetime of one item.

3.1.20

inter-switch link

link between two switches

3.1.21

inter-switch port

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

3.1.22

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 A VLAN allows multiplexing several LANs on the same network infrastructure.

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

3.1.23

leaf link

link between an end node and the LAN

NOTE For the purpose of the IEC 62439 series, further specification is given in 5.2.1.3.

3.1.24

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)

NOTE 1 This topology corresponds to that of an open ring.

NOTE 2 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.

[IEC 61918, 3.1.39, modified]

3.1.25

link

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

[ISO/IEC 11801, 3.1.51, modified]

NOTE "Link" is different from "bus", which is a broadcast physical medium.

3.1.26

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

3.1.27

link service data unit

data transported within a protocol layer on behalf of the upper layer

NOTE 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.

3.1.28

mean failure rate

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

[IEV 191-12-03]

NOTE The IEC 62439 series uses "failure rate" for the meaning of "mean failure rate" defined by IEV 191-12-03.

3.1.29

mean operating time between failures

MTBF

expectation of the operating time between failures

[IEV 191-12-09]

3.1.30

mean time to failure

MTTF

expectation of the time to failure

[IEV 191-12-07]

3.1.31

mean time to recovery

MTTR

expectation of the time to recovery

[IEV 191-13-08, modified]

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 Normally used to convey information between peers at the application layer.

[IEC 61784-2, 3.1.14]

3.1.34

network

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

NOTE A network may have more than one LAN for the purpose of redundancy.

3.1.35

node

network entity connected to one or more links

NOTE Nodes may be either a switch or an end node or both.

[IEC 61784-2, 3.1.16, modified]

3.1.36

partial failure

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

3.1.37

path

set of links and switches joined in series

NOTE There may be two or more paths between two switches to provide redundancy.

3.1.38

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.

3.1.39

port

connection point of a node to the network

[ISO/IEC 8802-3, modified]

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

NOTE 2 A port includes the layer 1 and 2 implementation.

3.1.40

recovery

event when the network regains the ability to perform its required communication function after a disruption

NOTE Examples of disruptions could be a fault or removal and reinsertion of a component.

3.1.41

recovery time

time period between disruption and recovery

3.1.42

redundancy

existence in an item of two or more means for performing a required function

[IEV 191-15-01]

NOTE In the IEC 62439 series, the existence of more than one path (consisting of links and switches) between end nodes.

3.1.43

reinstatement recovery time

time to reinstate the original, or pre-fault, network configuration, including original operating and management states in each device

3.1.44

reliability

ability of an item to perform a required function under given conditions for a given time interval

[IEV 191-02-06]

NOTE 1 It is generally assumed that the item is in a state to perform this required function at the beginning of the time interval.

NOTE 2 The term "reliability" is also used as a measure of reliability performance (see IEV 191-12-01).

3.1.45

repair

action taken for the re-establishment of the specified condition

3.1.46

repair recovery time

delay between the start of the repair action and the completion of repair of the faulty element such that the network has regained both its required communication function and its required fault resilience

NOTE 1 This time includes any network down time caused by the repair process, for example a network outage to replace a switch with several good ports and one faulty port.

NOTE 2 This time does not include re-instatement time to return the network from its backup mode of operation to the original mode of operation.

3.1.47

ring link

link that connects two switches of a ring

3.1.48

ring port

port of a switch to which a ring link is attached

3.1.49

ring topology

topology in which each node is connected in series to two other nodes

NOTE 1 Nodes are connected to one another in the logical shape of a circle.

NOTE 2 Frames are passed sequentially between active nodes, each node being able to examine or modify the frame before forwarding it.

3.1.50

robustness

behaviour of the network in face of failures

3.1.51

root bridge

switch with the lowest value of an RSTP Bridge Identifier parameter in the network

[IEEE 802.1D]