

INTERNATIONAL STANDARD

NORME INTERNATIONALE



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

**Réseaux de communication industriels – Réseaux d'automatisme à haute
disponibilité –
Partie 3: Protocole de redondance en parallèle (PRP) et redondance transparente
de haute disponibilité (HSR)**



THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2016 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

IEC Catalogue - webstore.iec.ch/catalogue

The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

IEC publications search - www.iec.ch/searchpub

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and also once a month by email.

Electropedia - www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing 20 000 terms and definitions in English and French, with equivalent terms in 15 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary

65 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: csc@iec.ch.

A propos de l'IEC

La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications IEC

Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Catalogue IEC - webstore.iec.ch/catalogue

Application autonome pour consulter tous les renseignements bibliographiques sur les Normes internationales, Spécifications techniques, Rapports techniques et autres documents de l'IEC. Disponible pour PC, Mac OS, tablettes Android et iPad.

Recherche de publications IEC - www.iec.ch/searchpub

La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études,...). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC Just Published - webstore.iec.ch/justpublished

Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et aussi une fois par mois par email.

Electropedia - www.electropedia.org

Le premier dictionnaire en ligne de termes électroniques et électriques. Il contient 20 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans 15 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

Glossaire IEC - std.iec.ch/glossary

65 000 entrées terminologiques électrotechniques, en anglais et en français, extraites des articles Termes et Définitions des publications IEC parues depuis 2002. Plus certaines entrées antérieures extraites des publications des CE 37, 77, 86 et CISPR de l'IEC.

Service Clients - webstore.iec.ch/csc

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: csc@iec.ch.

INTERNATIONAL STANDARD

NORME INTERNATIONALE



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

**Réseaux de communication industriels – Réseaux d'automatisme à haute
disponibilité –
Partie 3: Protocole de redondance en parallèle (PRP) et redondance transparente
de haute disponibilité (HSR)**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 25.040, 35.040

ISBN 978-2-8322-3150-0

**Warning! Make sure that you obtained this publication from an authorized distributor.
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.**

CONTENTS

FOREWORD.....	8
INTRODUCTION.....	10
0.1 General.....	10
0.2 Changes with respect to the previous edition	10
0.3 Patent declaration	10
1 Scope.....	12
2 Normative references.....	12
3 Terms, definitions, abbreviations, acronyms, and conventions	13
3.1 Terms and definitions	13
3.2 Abbreviations and acronyms.....	13
3.3 Conventions.....	14
4 Parallel Redundancy Protocol (PRP)	15
4.1 PRP principle of operation.....	15
4.1.1 PRP network topology.....	15
4.1.2 PRP LANs with linear or bus topology.....	15
4.1.3 PRP LANs with ring topology.....	16
4.1.4 DANP node structure	16
4.1.5 PRP attachment of singly attached nodes.....	17
4.1.6 Compatibility between singly and doubly attached nodes	18
4.1.7 Network management	18
4.1.8 Implication on application	18
4.1.9 Transition to non-redundant networks.....	18
4.1.10 Duplicate handling	19
4.1.11 Network supervision.....	24
4.1.12 Redundancy management interface.....	24
4.2 PRP protocol specifications	24
4.2.1 Installation, configuration and repair guidelines	24
4.2.2 Unicast MAC addresses	25
4.2.3 Multicast MAC addresses	25
4.2.4 IP addresses.....	25
4.2.5 Nodes.....	25
4.2.6 Duplicate Accept mode (testing only).....	26
4.2.7 Duplicate Discard mode	26
4.3 PRP_Supervision frame	30
4.3.1 PRP_Supervision frame format.....	30
4.3.2 PRP_Supervision frame contents	31
4.3.3 PRP_Supervision frame for RedBox	32
4.3.4 Reception of a PRP_Supervision frame and NodesTable	32
4.4 Bridging node.....	33
4.5 Constants	33
4.6 PRP service specification	33
5 High-availability Seamless Redundancy (HSR).....	33
5.1 HSR objectives	33
5.2 HSR principle of operation.....	34
5.2.1 Basic operation with a ring topology	34
5.2.2 DANH node structure	35

5.2.3	Topology.....	36
5.2.4	RedBox structure	44
5.3	HSR node specifications	46
5.3.1	HSR operation	46
5.3.2	DANH receiving from its link layer interface	46
5.3.3	DANH receiving from an HSR port	47
5.3.4	DANH forwarding rules.....	48
5.3.5	CoS	49
5.3.6	Clock synchronization	50
5.3.7	Deterministic medium access	50
5.4	HSR RedBox specifications	50
5.4.1	RedBox properties	50
5.4.2	RedBox receiving from interlink	50
5.4.3	RedBox forwarding on the ring	52
5.4.4	RedBox receiving from an HSR port	52
5.4.5	RedBox receiving from its link layer interface.....	54
5.4.6	Redbox ProxyNodeTable handling.....	54
5.4.7	RedBox CoS	54
5.4.8	RedBox clock synchronization	55
5.4.9	RedBox medium access	55
5.5	QuadBox specification.....	55
5.6	Duplicate Discard method.....	55
5.7	Frame format for HSR	55
5.7.1	Frame format for all frames	55
5.7.2	HSR_Supervision frame	56
5.8	Constants	59
5.9	HSR service specification.....	60
6	Protocol Implementation Conformance Statement (PICS)	61
7	PRP/HSR Management Information Base (MIB).....	62
Annex A (normative)	Clocks synchronization over redundant paths in IEC 62439-3	79
A.1	Overview.....	79
A.2	Attachment to redundant LANs by a boundary clock.....	79
A.3	Attachment to redundant LANs by doubly attached ordinary clocks.....	80
A.4	PRP mapping to PTP	82
A.4.1	Scenarios and device roles	82
A.4.2	Operation in PRP	84
A.4.3	Configuration specification	85
A.4.4	Specifications of DANP as DAC.....	86
A.4.5	Clock model of a RedBox for PTP.....	86
A.5	HSR Mapping to PTP	103
A.5.1	PTP traffic in HSR.....	103
A.5.2	HSR nodes specifications.....	106
A.5.3	Redundant clocks in HSR.....	107
A.5.4	Attachment of an MC to an external LAN	107
A.6	PRP to HSR Mapping	108
A.6.1	Connection methods	108
A.6.2	PRP-HSR connection by BC.....	108
A.6.3	PRP-HSR connection by TCs	109

A.7	Doubly attached clock model	110
A.7.1	State machine	110
A.7.2	Supervision of the port	113
A.7.3	BMCA for paired ports	114
A.7.4	Selection of the port state	115
A.8	PTP datasets for high availability	115
A.8.1	General	115
A.8.2	Data types	115
A.8.3	Datasets for ordinary or boundary clocks	116
A.8.4	Object for transparent clocks	120
Annex B (normative)	PTP profile for Power Utility Automation – Redundant clock attachment	123
B.1	Application domain	123
B.2	PTP profile specification	123
B.3	Redundant clock attachment	123
Annex C (normative)	PTP profiles for high-availability automation networks	124
C.1	Application domain	124
C.2	PTP profile specification	124
C.3	Clock types	124
C.4	Protocol specification common	125
C.5	Protocol specification for L3E2E automation profile	125
C.6	Protocol specification for L2P2P automation profile	125
C.7	Timing requirements	126
C.7.1	Measurement conditions	126
C.7.2	Network time inaccuracy	126
C.7.3	Network elements	126
C.7.4	Requirements for grandmasters	126
C.7.5	Requirements for TCs	127
C.7.6	Requirements for BCs	127
C.7.7	Requirements for media converters	127
C.7.8	Requirements for links	127
C.8	Network engineering	128
C.9	Default settings	128
C.10	Redundant clock handling	129
C.11	Protocol Implementation Conformance Statement (PICS)	130
C.11.1	Conventions	130
C.11.2	PICS	130
Annex D (informative)	Precision Time Protocol tutorial for IEC 62439-3	132
D.1	Objective	132
D.2	Precision and accuracy	132
D.3	PTP clock types	133
D.4	PTP main options	134
D.5	Layer 2 and layer 3 communication	135
D.6	1-step and 2-step correction	135
D.6.1	Time correction in TCs	135
D.6.2	2-step to 1-step translation	136
D.7	End-To-End link delay measurement	138
D.7.1	General method	138
D.7.2	End-to-End link delay measurement with 1-step clock correction	138

D.7.3	End-to-End link delay measurement with 2-step clock correction	139
D.7.4	End-to-End link delay calculation by Delay_Req/Delay_Resp	140
D.8	Peer-to-Peer link delay calculation	140
D.8.1	Peer-to-Peer link delay calculation with 1-step correction.....	140
D.8.2	Peer-to-Peer link delay calculation with 2-step correction.....	141
Annex E (normative)	Management Information base for singly and doubly attached clocks.....	143
Bibliography	168
Figure 1	– PRP example of general redundant network.....	15
Figure 2	– PRP example of redundant network as two LANs (bus topology)	16
Figure 3	– PRP example of redundant ring with SANs and DANPs	16
Figure 4	– PRP with two DANPs communicating.....	17
Figure 5	– PRP RedBox, transition from single to double LAN.....	19
Figure 6	– PRP frame extended by an RCT	20
Figure 7	– PRP VLAN-tagged frame extended by an RCT	21
Figure 8	– PRP padded frame closed by an RCT	21
Figure 9	– Duplicate Discard algorithm boundaries	22
Figure 10	– HSR example of ring configuration for multicast traffic.....	34
Figure 11	– HSR example of ring configuration for unicast traffic	35
Figure 12	– HSR structure of a DANH	36
Figure 13	– HSR example of topology using two independent networks.....	37
Figure 14	– HSR example of peer coupling of two rings	38
Figure 15	– HSR example of connected rings	39
Figure 16	– HSR example of coupling two redundant PRP LANs to a ring	40
Figure 17	– HSR example of coupling from a ring node to redundant PRP LANs	41
Figure 18	– HSR example of coupling from a ring to two PRP LANs.....	42
Figure 19	– HSR example of coupling three rings to one PRP LAN.....	43
Figure 20	– HSR example of meshed topology	44
Figure 21	– HSR structure of a RedBox.....	45
Figure 22	– HSR frame without a VLAN tag.....	55
Figure 23	– HSR frame with VLAN tag.....	56
Figure 24	– HSR node with management counters.....	60
Figure 25	– HSR RedBox with management counters	61
Figure A.1	– Doubly Attached Clock as BC (MCA is best master).....	79
Figure A.2	– Doubly Attached Clock when MCA is best master	81
Figure A.3	– Doubly attached clocks when OC1 is best master	82
Figure A.4	– Elements of PRP networks	84
Figure A.5	– Connection of a master clock to an ordinary clock over PRP	85
Figure A.6	– PRP RedBox as BCs (OC3 and BC7 are best masters)	87
Figure A.7	– RedBox DABC clock model	88
Figure A.8	– PRP RedBoxes as DABC with E2E – BC7 is master.....	89
Figure A.9	– PRP RedBoxes as DABC with E2E – timing.....	90

Figure A.10 – PRP RedBoxes as DABC with P2P – OC5 is best master	91
Figure A.11 – PRP RedBoxes as DABC with P2P – timing	92
Figure A.12 – PRP RedBox as DATC with E2E –signal flow	93
Figure A.13 – PRP RedBox as DATC with E2E – timing	95
Figure A.14 – PRP RedBox as DATC with P2P	96
Figure A.15 – PRP RedBox as DATC with P2P – timing	97
Figure A.16 – PRP RedBox as SLTC with E2E	100
Figure A.17 – PRP RedBox as SLTC with E2E – timing	101
Figure A.18 – PRP RedBox as SLTC with P2P	102
Figure A.19 – HSR with one GMC	104
Figure A.20 – PTP messages sent and received by an HSR node (1-step).	105
Figure A.21 – PTP messages sent and received by an HSR node (2-step)	106
Figure A.22 – Attachment of a GMC to an HSR ring through a RedBox as TC	108
Figure A.23 – PRP to HSR coupling by BCs	109
Figure A.24 – PRP to HSR coupling by TCs.....	110
Figure A.25 – Port states including transitions for redundant operation	111
Figure A.26 – BMCA for redundant masters.....	114
Figure D.1 –Precision and accuracy example	132
Figure D.2 – Precision Time Protocol principle	133
Figure D.3 – Precision Time Protocol elements.....	134
Figure D.4 – Delays and time-stamping logic in TCs	135
Figure D.5 – Correction of the Sync message by 1-step and 2-step (peer-to-peer).....	136
Figure D.6 – Translation from 2-step to 1-step in TCs	137
Figure D.7 – Translation from 2-step to 1-step – message view.....	138
Figure D.8 – End-to-end link delay measurement with 1-step clock correction	139
Figure D.9 – End-to-end delay measurement with 2-step clock correction	140
Figure D.10 – Peer-to-peer link delay measurement with 1-step clock correction	141
Figure D.11 – Peer-to-peer link delay measurement with 2-step clock correction	142
Table 1 – Duplicate discard cases	23
Table 2 – Monitoring data set.....	26
Table 3 – NodesTable attributes.....	27
Table 4 – PRP_Supervision frame with no VLAN tag	30
Table 5 – PRP_Supervision frame with (optional) VLAN tag	31
Table 6 – PRP_Supervision frame contents	32
Table 7 – PRP_Supervision TLV for Redbox.....	32
Table 8 – PRP constants.....	33
Table 9 – HSR_Supervision frame with no VLAN tag	57
Table 10 – HSR_Supervision frame with optional VLAN tag	58
Table 11 – HSR Constants.....	60
Table A.1 – States	112
Table A.2 – Transitions	113
Table A.3 – Variables.....	113

Table C.1 – PTP attributes for the Industrial Automation profile 129
Table C.2 – PICS for clocks 131

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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.
- 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.

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

This third edition cancels and replaces the second edition published in 2012. This edition constitutes a technical revision.

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

- a) technical corrections and extension of specifications;
- b) consideration of IEC 61588 clock synchronization with end-to-end delay measurement alongside the existing peer-to-peer delay measurement in PRP.

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

FDIS	Report on voting
65C/834/FDIS	65C/841/RVD

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.

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.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site 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 publication using a colour printer.

INTRODUCTION

0.1 General

IEC 62439-3 belongs to the IEC 62439 series “*Industrial communication networks – High availability automation networks*”. It specifies the PRP and HSR seamless redundancy protocols. It was adopted by IEC TC57 WG10 as the redundancy method for demanding substation automation networks operating on layer 2 networks, according to IEC 61850-8-1 and IEC 61850-9-2.

The seamless redundancy principle has been extended to clocks operating according to the Precision Time Protocol (IEC 61588) and attached to redundant networks. Two variants are specified: L3E2E for clocks which operate on layer 3 networks with end-to-end link delay measurement (E2E) and L2P2P for clocks that operate on layer 2 with peer-to-peer link delay measurement (P2P).

0.2 Changes with respect to the previous edition

The major changes with respect to IEC 62439-3:2012 are:

- Subclause 4.1.10.3 has been rewritten to explain the calculation of the duplicate rejection for different speeds.
- Annex A has been redrafted as a general concept for doubly attached clocks applicable to end-to-end (E2E) and to peer-to-peer (P2P) link delay measurement; the principle of paired port operation has now been specified in terms of a state machine based on IEC 61588:2009.
- Annex B of IEC 62439-3:2012 has been deleted; its properties are mentioned in 5.3.7.
- Annex B (new) makes the support of redundancy mandatory for IEC/IEEE 61850-9-3 that specifies doubly attached clocks on layer 2, with peer-to-peer delay measurement.
- Annex C specifies two profiles of a precision clock for industrial automation: L3E2E for layer 3, end-to-end delay measurement and L2P2P for layer 2, peer-to-peer delay measurement.
- Annex D contains the tutorial information on IEC 61588:2009 for understanding the above annexes. It was contained in IEC 62439-3:2012 Annex A.
- Annex E (MIB) contains the SNMP Management Information Base to be used for singly and doubly attached clocks in all profiles.

0.3 Patent declaration

The International Electrotechnical Commission (IEC) draws attention to the fact that it is claimed that compliance with this document may involve the use of a patent concerning filtering of redundant frames in a network node (Siemens Aktiengesellschaft – EP 2127329, US 8184650, CN 101611615B) given in 5.2.3.3.

IEC takes no position concerning the evidence, validity and scope of this patent right.

The holder of this patent right has assured the IEC that he/she 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:

Siemens Aktiengesellschaft
Oto-Hahn-Ring 6
81379 Munich, Germany

The International Electrotechnical Commission (IEC) draws attention to the fact that it is claimed that compliance with this document may involve the use of patents concerning

Reception of redundant and non-redundant frames (ABB Research Ltd – EP 1825657, US 8582426, CN 101057483, IN 254425) given in 4.2.7, concerning Identifying improper cabling of devices (ABB Technology AG – EP 2163024, US 8344736, CN 101689985) given in 4.3, concerning Critical device with increased availability (ABB Research Ltd – EP 2090950) given in 4.4, concerning Ring coupling nodes for high availability networks (ABB Research Ltd – US 8582424, EP 2327185, CN 102106121) given in 5.2.3.

IEC takes no position concerning the evidence, validity and scope of these patent rights.

The holder of these patent rights has assured the IEC that he/she 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 these patent rights is registered with IEC. Information may be obtained from:

ABB Schweiz AG
Intellectual Property CH-IP (CH-150016-L)
Brown Boveri Strasse 6
CH-5400 Baden, Switzerland
ch-ip.patent@abb.com

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

ISO (www.iso.org/patents) and IEC (<http://patents.iec.ch>) maintain on-line data bases of patents relevant to their standards. Users are encouraged to consult the data bases for the most up to date information concerning patents.

INDUSTRIAL COMMUNICATION NETWORKS – HIGH AVAILABILITY AUTOMATION NETWORKS –

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

1 Scope

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

This part of IEC 62439 specifies two 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.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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, *International Electrotechnical Vocabulary – Chapter 191: Dependability and quality of service*

IEC 61588:2009, *Precision clock synchronization protocol for networked measurement and control systems*

IEC TR 61850-90-4:2013, *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*

IEC/IEEE 61850-9-3:—, *Communication networks and systems for power utility automation - Part 9-3: Precision time protocol profile for power utility automation (proposed IEC 61850-9-3)*¹

ISO/IEC/IEEE 8802-3:2014, *Standard for Ethernet*

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

IEEE 802.1Q:2014, *IEEE Standard for Local and metropolitan area networks – Media Access Control (MAC) Bridges and Virtual Bridge Local Area Network*

IETF RFC 2578, *Structure of Management Information Version 2 (SMIPv2)*

¹ To be published.