
Industrijska komunikacijska omrežja - Avtomatizacija omrežja z visoko razpoložljivostjo - 3. del: Protokol vzporedne redundance (PRP) in brezprehodna zanka z visoko razpoložljivostjo (HSR)

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

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

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TITLE:

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

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NC comments will be addressed during the SC65C/WG15 meeting scheduled on June 8th-10h, 2020 in Baden (Switzerland). Corresponding meeting notice will be provided in due time by the convenor.

CONTENTS

1		
2		
3		
4	FOREWORD.....	9
5	INTRODUCTION.....	11
6	0.1 General.....	11
7	0.2 Changes with respect to the previous edition.....	11
8	0.3 Patent declaration.....	12
9	1 Scope.....	13
10	2 Normative references.....	13
11	3 Terms, definitions, abbreviations, acronyms, and conventions.....	14
12	3.1 Terms and definitions.....	14
13	3.2 Abbreviations and acronyms.....	16
14	3.3 Conventions.....	17
15	4 Parallel Redundancy Protocol (PRP).....	17
16	4.1 PRP principle of operation.....	17
17	4.1.1 PRP network topology.....	17
18	4.1.2 PRP LANs with linear or bus topology.....	18
19	4.1.3 PRP LANs with ring topology.....	19
20	4.1.4 DANP node structure.....	19
21	4.1.5 PRP attachment of singly attached nodes.....	20
22	4.1.6 Compatibility between singly and doubly attached nodes.....	20
23	4.1.7 Network management.....	20
24	4.1.8 Implication on application.....	21
25	4.1.9 Transition to non-redundant networks.....	21
26	4.1.10 Duplicate handling.....	21
27	4.1.11 Network supervision.....	26
28	4.1.12 Redundancy management interface.....	26
29	4.2 PRP protocol specifications.....	26
30	4.2.1 Installation, configuration and repair guidelines.....	26
31	4.2.2 Unicast MAC addresses.....	27
32	4.2.3 Multicast MAC addresses.....	27
33	4.2.4 IP addresses.....	27
34	4.2.5 Nodes.....	27
35	4.2.6 Duplicate Accept mode (testing only).....	28
36	4.2.7 Duplicate Discard mode.....	28
37	4.3 PRP_Supervision frame.....	32
38	4.3.1 PRP_Supervision frame format.....	32
39	4.3.2 PRP_Supervision frame contents.....	33
40	4.3.3 PRP_Supervision frame for RedBox.....	34
41	4.3.4 Reception of a PRP_Supervision frame and NodesTable.....	34
42	4.4 Bridging node (deprecated).....	35
43	4.5 Constants.....	35
44	4.6 PRP layer management entity (LME).....	35
45	5 High-availability Seamless Redundancy (HSR).....	35
46	5.1 HSR objectives.....	35
47	5.2 HSR principle of operation.....	36
48	5.2.1 Basic operation with a ring topology.....	36
49	5.2.2 DANH node structure.....	37

50	5.2.3	Topology	38
51	5.2.4	RedBox structure	47
52	5.3	HSR node specifications	49
53	5.3.1	HSR operation	49
54	5.3.2	DANH receiving from its link layer interface	50
55	5.3.3	DANH receiving from an HSR port	51
56	5.3.4	DANH forwarding rules	51
57	5.3.5	Class of Service	52
58	5.3.6	Clock synchronization	53
59	5.3.7	Deterministic transmission delay and jitter	53
60	5.4	HSR RedBox specifications	53
61	5.4.1	RedBox properties	53
62	5.4.2	RedBox receiving from interlink	53
63	5.4.3	RedBox forwarding on the ring	55
64	5.4.4	RedBox receiving from an HSR port	55
65	5.4.5	RedBox receiving from its link layer interface	57
66	5.4.6	Redbox ProxyNodeTable handling	57
67	5.4.7	RedBox CoS	57
68	5.4.8	RedBox clock synchronization	57
69	5.4.9	RedBox medium access	58
70	5.5	QuadBox specification	58
71	5.6	Duplicate Discard method	58
72	5.7	Frame format for HSR	58
73	5.7.1	Frame format for all frames	58
74	5.7.2	HSR_Supervision frame	59
75	5.8	HSR constants	62
76	5.9	HSR layer management entity (LME)	63
77	6	Protocol Implementation Conformance Statement (PICS)	64
78	7	PRP/HSR Management Information Base (MIB)	65
79	Annex A (normative)	Clocks synchronization over redundant paths in IEC 62439-3	81
80	A.1	Overview	81
81	A.2	Attachment to redundant LANs by a boundary clock	81
82	A.3	Attachment to redundant LANs by doubly attached ordinary clocks	82
83	A.4	PRP mapping to PTP	84
84	A.4.1	Scenarios and device roles	84
85	A.4.2	Operation in PRP	85
86	A.4.3	Configuration specification	86
87	A.4.4	Specifications of DANP as DAC	87
88	A.4.5	Clock model of a RedBox for PTP	87
89	A.5	HSR Mapping to PTP	104
90	A.5.1	PTP traffic in HSR	104
91	A.5.2	HSR nodes specifications	106
92	A.5.3	Redundant clocks in HSR	107
93	A.5.4	Attachment of an MC to an external LAN	107
94	A.6	PRP to HSR Mapping	108
95	A.6.1	Connection methods	108
96	A.6.2	PRP-HSR connection by BC	108
97	A.6.3	PRP-HSR connection by TCs	109
98	A.7	Doubly attached clock model	110
99	A.7.1	State machine	110
100	A.7.2	Supervision of the port	113

101	A.7.3	BMCA for paired ports	113
102	A.7.4	Selection of the port state	114
103	A.8	PTP datasets for high availability	115
104	A.8.1	General	115
105	A.8.2	Data types	115
106	A.8.3	Datasets for ordinary or boundary clocks	116
107	A.8.4	Object for transparent clocks	120
108	Annex B (normative)	PTP profile for Power Utility Automation (PUP) – Redundant	
109		clock attachment	123
110	B.1	Application domain	123
111	B.2	PTP profile specification	123
112	B.3	Redundant clock attachment	123
113	Annex C (normative)	PTP industry profiles for high-availability automation networks	125
114	C.1	Application domain	125
115	C.2	PTP profile specification	125
116	C.3	Clock types	125
117	C.4	Protocol specification common	126
118	C.5	Protocol specification for L3E2E industry profile	126
119	C.6	Protocol specification for L2P2P industry profile	127
120	C.7	Common timing requirements for L2P2P and L3E2E	127
121	C.7.1	Measurement conditions	127
122	C.7.2	Network time inaccuracy	127
123	C.7.3	Network elements	128
124	C.7.4	Requirements for grandmasters	128
125	C.7.5	Requirements for TCs	129
126	C.7.6	Requirements for BCs	129
127	C.7.7	Requirements for media converters	130
128	C.7.8	Requirements for links	130
129	C.8	Network engineering	130
130	C.9	Default settings	131
131	C.10	Handling of doubly attached clocks	132
132	C.11	Protocol Implementation Conformance Statement (PICS)	133
133	C.11.1	Conventions	133
134	C.11.2	PICS	133
135	C.12	Recommendations for time representation	135
136	C.12.1	Usage of flags in TimePropertyDS	135
137	C.12.2	UTC leap second transition	136
138	C.12.3	ALTERNATE_TIME_OFFSET INDICATOR_TLV	137
139	Annex D (informative)	Precision Time Protocol tutorial for IEC 62439-3	140
140	D.1	Objective	140
141	D.2	Precision and accuracy	140
142	D.3	PTP clock types	141
143	D.4	PTP main options	143
144	D.5	Layer 2 and layer 3 communication	143
145	D.6	1-step and 2-step correction	143
146	D.6.1	Time correction in TCs	143
147	D.6.2	2-step to 1-step translation	145
148	D.7	End-To-End link delay measurement	147
149	D.7.1	General method	147
150	D.7.2	End-to-End link delay measurement with 1-step clock correction	147
151	D.7.3	End-to-End link delay measurement with 2-step clock correction	148

152	D.7.4	End-to-End link delay calculation by Delay_Req/Delay_Resp	149
153	D.8	Peer-to-Peer link delay calculation.....	149
154	D.8.1	Peer-to-Peer link delay calculation with 1-step correction	149
155	D.8.2	Peer-to-Peer link delay calculation with 2-step correction	150
156	D.8.3	Consideration of media converters in peer delay calculation	151
157	Annex E (normative)	Management Information base for singly and doubly attached	
158		clocks.....	153
159	Annex F (normative)	Conformance testing for IEC 62439-3.....	180
160	F.1	General.....	180
161	F.2	PRP conformance test	180
162	F.2.1	PRP test set-up	180
163	F.2.2	PRP test components	181
164	F.2.3	Test for documentation and labelling	181
165	F.2.4	Test for (unicast) IP addresses	181
166	F.2.5	Test for configuration.....	182
167	F.2.6	Test of DANP	182
168	F.2.7	Test of PRP Redboxes	185
169	F.2.8	Test for Management.....	186
170	F.2.9	Test of DANP or RedBox for processing of PTP frames	188
171	F.3	HSR conformance test	191
172	F.3.1	HSR test set-up	191
173	F.3.2	HSR test components	192
174	F.3.3	Test for HSR documentation and labelling.....	192
175	F.3.4	Test of DANH or RedBox for IP addresses.....	193
176	F.3.5	Test of DANH for configuration	193
177	F.3.6	Test of DANH	193
178	F.3.7	Test of HSR RedBoxes	196
179	F.3.8	Test of DANH or RedBox for Management.....	197
180	F.3.9	Test of DANH or RedBox for processing of PTP frames	199
181	Bibliography.....		202
182			
183	Figure 1 – PRP example of general redundant network.....		18
184	Figure 2 – PRP example of redundant network as two LANs (bus topology).....		18
185	Figure 3 – PRP example of redundant ring with SANs and DANPs.....		19
186	Figure 4 – PRP with two DANPs communicating		19
187	Figure 5 – PRP RedBox, transition from single to double LAN		21
188	Figure 6 – PRP frame extended by an RCT.....		22
189	Figure 7 – PRP VLAN-tagged frame extended by an RCT.....		23
190	Figure 8 – PRP padded frame closed by an RCT		23
191	Figure 9 – Duplicate Discard algorithm boundaries		24
192	Figure 10 – HSR example of ring configuration for multicast traffic		36
193	Figure 11 – HSR example of ring configuration for unicast traffic		37
194	Figure 12 – HSR structure of a DANH.....		38
195	Figure 13 – HSR example of topology using two independent networks		39
196	Figure 14 – HSR example of peer coupling of two rings		40
197	Figure 15 – HSR example of connected rings		41
198	Figure 16 – HSR example of coupling two redundant PRP LANs to a ring		42
199	Figure 17 – HSR example of coupling from a ring node to redundant PRP LANs.....		43

200	Figure 18 – HSR example of coupling from a ring to two PRP LANs.....	44
201	Figure 19 – HSR example of coupling three rings to one PRP LAN	45
202	Figure 20 – HSR example of meshed topology.....	46
203	Figure 21 – HSR example of coupling an RSTP LAN to HSR by two bridges	47
204	Figure 22 – HSR structure of a RedBox	48
205	Figure 23 – HSR frame without a VLAN tag	58
206	Figure 24 – HSR frame with VLAN tag	59
207	Figure 25 – HSR node with management counters.....	63
208	Figure 26 – HSR RedBox with management counters	64
209	Figure A.1 – Doubly Attached Clock as BC (MCA is best master).....	81
210	Figure A.2 – Doubly Attached Clock when MCA is best master	82
211	Figure A.3 – Doubly attached clocks when OC1 is best master	83
212	Figure A.4 – Elements of PRP networks.....	85
213	Figure A.5 – Connection of a master clock to an ordinary clock over PRP.....	86
214	Figure A.6 – PRP RedBox as BCs (OC3 and BC7 are best masters).....	88
215	Figure A.7 – RedBox DABC clock model.....	89
216	Figure A.8 – PRP RedBoxes as DABC with E2E – BC7 is master	90
217	Figure A.9 – PRP RedBoxes as DABC with E2E – timing	91
218	Figure A.10 – PRP RedBoxes as DABC with P2P – OC5 is best master.....	92
219	Figure A.11 – PRP RedBoxes as DABC with P2P – timing	93
220	Figure A.12 – PRP RedBox as DATC with E2E –signal flow.....	94
221	Figure A.13 – PRP RedBox as DATC with E2E – timing	96
222	Figure A.14 – PRP RedBox as DATC with P2P.....	97
223	Figure A.15 – PRP RedBox as DATC with P2P – timing	98
224	Figure A.16 – PRP RedBox as SLTC with E2E.....	101
225	Figure A.17 – PRP RedBox as SLTC with E2E – timing	102
226	Figure A.18 – PRP RedBox as SLTC with P2P.....	103
227	Figure A.19 – HSR with one GMC.....	104
228	Figure A.20 – PTP messages sent and received by an HSR node (1-step).....	105
229	Figure A.21 – PTP messages sent and received by an HSR node (2-step).....	106
230	Figure A.22 – Attachment of a GMC to an HSR ring through a RedBox as TC and BC	108
231	Figure A.23 – PRP to HSR coupling by BCs.....	109
232	Figure A.24 – PRP to HSR coupling by TCs.....	110
233	Figure A.25 – Port states including transitions for redundant operation	111
234	Figure A.26 – BMCA for redundant masters	114
235	Figure D.1 –Probability distribution function with $\mu = -60$ ns and $\sigma = 40$ ns.....	140
236	Figure D.2 – Precision Time Protocol principle.....	141
237	Figure D.3 – Precision Time Protocol elements.....	143
238	Figure D.4 – Delays and time-stamping logic in TCs	144
239	Figure D.5 – Correction of the Sync message by 1-step and 2-step (peer-to-peer).....	145
240	Figure D.6 – Translation from 2-step to 1-step in TCs	146
241	Figure D.7 – Translation from 2-step to 1-step – message view	147
242	Figure D.8 – End-to-end link delay measurement with 1-step clock correction	148
243	Figure D.9 – End-to-end delay measurement with 2-step clock correction	149
244	Figure D.10 – Peer-to-peer link delay measurement with 1-step clock correction	150

245	Figure D.11 – Peer-to-peer link delay measurement with 2-step clock correction	151
246	Figure D.12 – Peer delay measurement and Sync message delay	152
247	Figure F.1 – Test set-up for PRP	180
248	Figure F.2 – Test set-up for PRP and PTP with L2P2P	188
249	Figure F.3 – Test set-up for HSR (no L2P2P).....	192
250	Figure F.4 – Test set-up for HSR with L2P2P.....	199
251		
252	Table 1 – Duplicate discard cases	25
253	Table 2 – Monitoring data set.....	28
254	Table 3 – NodesTable attributes	29
255	Table 4 – PRP_Supervision frame with no VLAN tag.....	32
256	Table 5 – PRP_Supervision frame with (optional) VLAN tag.....	33
257	Table 6 – PRP_Supervision frame contents	34
258	Table 7 – PRP_Supervision TLV for Redbox.....	34
259	Table 8 – PRP constants	35
260	Table 9 – HSR_Supervision frame with no VLAN tag	60
261	Table 10 – HSR_Supervision frame with optional VLAN tag	61
262	Table 11 – HSR Constants.....	63
263	Table A.1 – States	112
264	Table A.2 – Transitions	113
265	Table A.3 – Variables	113
266	Table C.1 – PTP attributes.....	132
267	Table C.2 – PICS for clocks	134
268	Table C.3 – Transitions with an inserted leap second (UTC binary and C37.118).....	136
269	Table C.4 – Transitions with a removed leap second (UTC binary and C37.118).....	137
270	Table C.5 – ATOI transition to Pacific Summer Time (spring).....	138
271	Table C.6 – ATOI transitions to Pacific Standard Time (autumn).....	138
272	Table C.7 – Transitions with an inserted leap second in Pacific Standard Time.....	139
273	Table C.8 – Transitions with a removed leap second in Pacific Standard Time.....	139
274		

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HIGH AVAILABILITY AUTOMATION NETWORKS –**

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

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FOREWORD

285

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

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

324

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

326

- technical corrections;

327

- extension of HSR specifications (RSTP over HSR);

328

- alignment of the precision time protocol industry profile with IEC/IEEE 61850-9-3;

329

- consideration of IEEE 1588-2019 in PTP over PRP/HSR

330

- conformance testing

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

FDIS	Report on voting
XX/XX/FDIS	XX/XX/RVD

332

333 Full information on the voting for the approval of this International Standard can be found in
334 the report on voting indicated in the above table.

335 This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

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

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

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

- 343 • reconfirmed,
- 344 • withdrawn,
- 345 • replaced by a revised edition, or
- 346 • amended.

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347 The National Committees are requested to note that for this document the stability date
348 is 2025.

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354

INTRODUCTION

355 **0.1 General**

356 IEC 62439-3 belongs to the IEC 62439 series “*Industrial communication networks – High*
 357 *availability automation networks*”. It was developed jointly with IEC TC57 WG10 as the
 358 redundancy method for demanding substation automation networks operating on layer 2
 359 networks, according to IEC 61850-8-1 and IEC 61850-9-3 and extended to encompass the
 360 needs of the Open DeviceNet Vendor Association (ODVA).

361 It specifies two related redundancy protocols that in case of failure of any network element
 362 provide seamless switchover with zero recovery time:

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

367 The seamless redundancy principle has been applied to clocks operating according to the
 368 Precision Time Protocol (IEC 61588, tutorial in Annex D) attached to redundant networks
 369 (Annex A).

370 A PTP Industry profile (PIP) specifies the performance needed to achieve sub-microsecond
 371 time accuracy. This profile can be applied to any industrial communication network based on
 372 Ethernet. Two variants of PIP are specified in Annex C:

- 373 • L3E2E (Layer 3, End-to-End) for clocks operating on layer 3 networks with end-to-end
 374 path delay measurement such as EtherNet/IP™; and
- 375 • L2P2P (Layer 2, Peer-to-Peer) for clocks operating on layer 2 with peer-to-peer link delay
 376 measurement (P2P). L2P2P has been adopted by IEC TC57 WG10 and the IEEE PSRC
 377 as the Power Utility Profile (PUP), and copied to IEC/IEEE 61850-9-3. The involved
 378 standard organisations agreed to keep the contents of the two documents aligned.

379 **0.2 Changes with respect to the previous edition**

380 The major changes with respect to IEC 62439-3:2016 are:

- 381 • Terms and abbreviations have been aligned with IEC/IEEE 61850-9-3;
- 382 • The PRP+HSR network management MIB is now a “code component” available as
 383 machine-readable separate document, errors were corrected;
- 384 • The PRP sequence number is only incremented for frames with PRP trailer;
- 385 • Support of RSTP in HSR is specified;
- 386 • Exclusion of future IEEE 802.1 source address rule for HSR;
- 387 • Annex A (PTP operation L2 over PRP/HSR) has been aligned with IEC/IEEE 61850-9-3;
- 388 • Annex C (PTP profile) has been aligned with IEC/IEEE 61850-9-3 and extended by:
 - 389 – Padding of Sync messages for media converters
 - 390 – Change in ClockClass definition (back in line with IEC 61588)
 - 391 – Support of any time domain in TCs (ensures backward compatibility)
 - 392 – Behaviour of BCs in holdover and recovery
 - 393 – Clarification on timeTraceable
 - 394 – Clarification on currentUtcOffsetValid
 - 395 – Recommendation on handling of UTC leap seconds
 - 396 – Recommendation for handling the ALTERNATE_TIME_OFFSET_INDICATOR;
- 397 • Annex D (Tutorial) has been extended to explain the media converter issue;

- 398 • Annex E (PIP network management MIB) is now a “code component” available as
399 machine-readable separate document, errors were corrected.
- 400 • Annex F (conformance testing for PRP and HSR) has been added.

401 0.3 Patent declaration

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

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

407 The holder of this patent right has assured the IEC that he/she is willing to negotiate licences
408 under reasonable and non-discriminatory terms and conditions with applicants throughout the
409 world. In this respect, the statement of the holder of this patent right is registered with IEC.
410 Information may be obtained from:

411 Siemens Aktiengesellschaft
412 Oto-Hahn-Ring 6
413 81379 Munich, Germany

414 The International Electrotechnical Commission (IEC) draws attention to the fact that it is
415 claimed that compliance with this document may involve the use of patents
416 concerning Reception of redundant and non-redundant frames (ABB Research Ltd – EP
417 1825657, US 8582426, CN 101057483, IN 254425) given in 4.2.7,
418 concerning Identifying improper cabling of devices (ABB Technology AG – EP 2163024, US
419 8344736, CN 101689985) given in 4.3,
420 concerning Critical device with increased availability (ABB Research Ltd – EP 2090950) given
421 in 4.4,
422 concerning Ring coupling nodes for high availability networks (ABB Research Ltd – US
423 8582424, EP 2327185, CN 102106121) given in 5.2.3 and
424 concerning WO 2012/010619 A1-1 (Frame transmission and communication network,
425 applicable to 5.3.7).

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

427 The holder of these patent rights has assured the IEC that he/she is willing to negotiate
428 licences under reasonable and non-discriminatory terms and conditions with applicants
429 throughout the world. In this respect, the statement of the holder of these patent rights is
430 registered with IEC. Information may be obtained from:

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

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

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

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INDUSTRIAL COMMUNICATION NETWORKS – HIGH AVAILABILITY AUTOMATION NETWORKS –

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

451 **1 Scope**

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

454 This part of IEC 62439 specifies two related redundancy protocols designed to provide
455 seamless recovery in case of single failure of an inter-bridge link or bridge in the network,
456 which are based on the same scheme: parallel transmission of duplicated information.

457 **2 Normative references**

458 The following documents are referred to in the text in such a way that some or all of their
459 content constitutes requirements of this document. For dated references, only the edition
460 cited applies. For undated references, the latest edition of the referenced document (including
461 any amendments) applies.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

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

464 IEC 61588:2009, *Precision clock ~~synchronization~~ protocol for networked measurement and*
465 *control systems* <https://standards.iteh.ai/catalog/standards/sist/4ba51387-9133-4b0b-aa0c-65401e394a19/osist-pr-en-iec-62439-3-2020>

466 IEC TR 61850-90-4:2020, *Communication networks and systems for power utility automation*
467 *– Part 90-4: Network engineering guidelines¹*

468 IEC 62439-1:2020, *Industrial communication networks – High availability automation networks*
469 *– Part 1: General concepts and calculation methods²*

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

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

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

475 IEEE 802.1AB-2019, *IEEE Standard for Local and metropolitan area networks – Link Layer*
476 *Discovery Protocol*

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

¹ Edition 2 to be published

² Edition 3 to be published

479 IEEE 1588-2019 *Precision Clock Synchronization Protocol for Networked Measurement and*
480 *Control Systems*³

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

484 IETF RFC 768, *User Datagram Protocol (UDP)*

485 IETF RFC 791, *Internet Protocol (IP)*

486 IETF RFC 792, *Internet Control Message Protocol (ICMP)*

487 IETF RFC 793, *Transmission Control Protocol (TCP)*

488 IETF RFC 826, *Address Resolution Protocol (ARP)*

489 IETF RFC 2578, *Structure of Management Information Version 2 (SMIv2)*

490 IETF RFC 3418, *Management Information Base (MIB) for the Simple Network Management*
491 *Protocol (SNMP)*

492 **3 Terms, definitions, abbreviations, acronyms, and conventions**

493 **3.1 Terms and definitions**

494 For the purposes of this document, the terms and definitions given in definitions given in IEC
495 60050-191 and in IEC 62439-1, and the following apply:

496 ISO and IEC maintain terminological databases for use in standardization at the following
497 addresses:

- 498 • IEC Electropedia: available at <http://www.electropedia.org/>
- 499 • ISO Online browsing platform: available at <http://www.iso.org/obp>

500 **3.1.1**

501 **device time inaccuracy**

502 time inaccuracy evaluated or measured between the time signal applied to the input of a
503 device and the time signal that this device generates

504 Note 1 to entry: This definition applies to TCs, BCs and media converters.

505 Note 2 to entry: Device time inaccuracy includes the uncertainty in the computation of the peer delay from an
506 upstream peer clock, assuming that the peer responds with an ideal Pdelay_Resp message to the Pdelay_Req
507 message, and the uncertainty introduced in the Pdelay_Resp to an ideal Pdelay_Req from a downstream peer.

508 **3.1.2**

509 **frame**

510 the layer 2 protocol data unit from the preamble to the frame check sequence

511 **3.1.3**

512 **grandmaster-capable**

513 ordinary clock or boundary clock that is able to take the role of a grandmaster

514 Note 1 to entry: A grandmaster-capable clock is not necessarily connected to a recognized time source.

³ Approved 2019. to be published