



BSI Standards Publication

Industrial networks — Profiles

Part 2-3: Additional real-time fieldbus profiles based
on ISO/IEC/IEEE 8802-3 — CPF 3

National foreword

This British Standard is the UK implementation of EN IEC 61784-2-3:2023. It is identical to IEC 61784-2-3:2023. It partially supersedes BS EN IEC 61784-2:2019.

The UK participation in its preparation was entrusted to Technical Committee GEL/65, Measurement and control.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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English Version

**Industrial networks - Profiles - Part 2-3: Additional real-time
fieldbus profiles based on ISO/IEC/IEEE 8802-3 - CPF 3
(IEC 61784-2-3:2023)**

Réseaux industriels - Profils - Partie 2-3: Profils de bus de
terrain supplémentaires pour les réseaux en temps réel
fondés sur l'ISO/IEC/IEEE 8802-3 - CPF 3
(IEC 61784-2-3:2023)

Industrielle Kommunikationsnetze - Profile - Teil 2-3:
Zusätzliche Feldbusprofile für Echtzeitnetzwerke basierend
auf ISO/IEC/IEEE 8802-3 - Kommunikationsprofilfamilie
(CPF) 3
(IEC 61784-2-3:2023)

This European Standard was approved by CENELEC on 2023-05-03. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

European foreword

The text of document 65C/1209/FDIS, future edition 1 of IEC 61784-2-3, prepared by SC 65C "Industrial networks" of IEC/TC 65 "Industrial-process measurement, control and automation" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 61784-2-3:2023.

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- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2026-05-03

This document, together with other parts of the same series, partially supersedes EN IEC 61784-2:2019 and all of its amendments and corrigenda (if any).

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Endorsement notice

The text of the International Standard IEC 61784-2-3:2023 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 standard indicated:

IEC 61158-1	NOTE Approved as EN IEC 61158-1
IEC 61158-2	NOTE Approved as EN IEC 61158-2
IEC 61158-3-3	NOTE Approved as EN 61158-3-3
IEC 61158-4-3	NOTE Approved as EN IEC 61158-4-3
IEC 61158-5-3	NOTE Approved as EN 61158-5-3
IEC 61158-6-3	NOTE Approved as EN IEC 61158-6-3
IEC 61784-1 (series)	NOTE Approved as EN IEC 61784-1 (series)
IEC 61784-1-0	NOTE Approved as EN IEC 61784-1-0
IEC 61784-2 (series)	NOTE Approved as EN IEC 61784-2 (series)
IEC 61918	NOTE Approved as EN IEC 61918

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

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

NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 61158	series	Industrial communication networks - Fieldbus specifications	EN IEC 61158	series
IEC 61158-5-10	2023	Industrial communication networks - Fieldbus specifications - Part 5-10: Application layer service definition - Type 10 elements	EN IEC 61158-5-10	2023
IEC 61158-6-10	2023	Industrial communication networks - Fieldbus specifications - Part 6-10: Application layer protocol specification - Type 10 elements	EN IEC 61158-6-10	2023
IEC 61784-1-3	2023	Industrial networks - Profiles - Part 1-3: Fieldbus profiles - Communication Profile Family 3	EN IEC 61784-1-3	2023
IEC 61784-2-0	2023	Industrial networks - Profiles - Part 2-0: Additional real-time fieldbus profiles based on ISO/IEC/IEEE 8802-3 - General concepts and terminology	EN IEC 61784-2-0	2023
IEC 61784-3-3	2021	Industrial communication networks - Profiles - Part 3-3: Functional safety fieldbuses - Additional specifications for CPF 3	EN IEC 61784-3-3	2021
IEC 61784-5-3	2018	Industrial communication networks - Profiles - Part 5-3: Installation of fieldbuses - Installation profiles for CPF 3	EN IEC 61784-5-3	2018
IEC 62439-2	2021	Industrial communication networks - High availability automation networks - Part 2: Media Redundancy Protocol (MRP)	EN IEC 62439-2	2022
ISO/IEC/IEEE 8802-3		Telecommunications and exchange between information technology systems - Requirements for local and metropolitan area networks - Standard for Ethernet	-	-

EN IEC 61784-2-3:2023 (E)

ISO/IEC 9834-8	2014	Information technology - Procedures for the operation of object identifier registration authorities - Part 8: Generation of universally unique identifiers (UUIDs) and their use in object identifiers	-	-
ISO 15745-4/AMD1	2003/ 2006	Industrial automation systems and integration - Open systems application integration framework - Part 4: Reference description for Ethernet-based control systems - Amendment 1: PROFINET profiles	-	-
IEEE Std 802	2014	IEEE Standard for Local and metropolitan area networks: Overview and Architecture	-	-
IEEE Std 802.1AB	2016	IEEE Standard for Local and metropolitan area networks: Station and Media Access Control Connectivity Discovery	-	-
IEEE Std 802.1AS	2020	IEEE standard for Local and metropolitan area networks - Timing and Synchronization for Time-Sensitive Applications	-	-
IEEE 802.1CB	2017	IEEE Standard for Local and metropolitan area networks - Frame Replication and Elimination for Reliability	-	-
IEEE Std 802.1Q	2018	IEEE Standard for Local and metropolitan area networks - Media Access Control (MAC) Bridges and Bridged Networks	-	-
IEEE Std 802.3	2018	IEEE Standard for Ethernet	-	-
IEEE Std 802.11	2020	IEEE Standard for Information technology -- Telecommunications and information exchange between systems - Local and metropolitan area networks - Specific requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications	-	-
IEEE Std 802.11n	2009	IEEE Standard for Information technology -- Local and metropolitan area networks - Specific requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment 5: Enhancements for Higher Throughput	-	-
IEEE Std 802.15.1	2005	IEEE Standard for Information technology -- Telecommunications and information exchange between systems - Local and metropolitan area networks - Specific requirements. - Part 15.1: Wireless medium access control (MAC) and physical layer (PHY) specifications for wireless personal area networks (WPANs)	-	-
IETF RFC 768	1980	User Datagram Protocol	-	-
IETF RFC 791	1981	Internet Protocol	-	-
IETF RFC 792	1981	Internet Control Message Protocol	-	-
IETF RFC 793	1981	Transmission Control Protocol	-	-

IETF RFC 826	1982	Ethernet Address Resolution Protocol: Or Converting Network Protocol Addresses to 48.bit Ethernet Address for Transmission on Ethernet Hardware	-	-
IETF RFC 1034	1987	Domain names - concepts and facilities	-	-
IETF RFC 1157	1990	Simple Network Management Protocol (SNMP)	-	-
IETF RFC 1213	1991	Management Information Base for Network- Management of TCP/IP-based Internets: MIB-II	-	-
IETF RFC 2131	1997	Dynamic Host Configuration Protocol	-	-
IETF RFC 4836	2007	Definitions of Managed Objects for IEEE 802.3 Medium Attachment Units (MAUs)	-	-
The Open Group - Publication C706	-	Technical Standard DCE1.1: Remote Procedure Call	-	-
Metro Ethernet Forum – MEF 10.4	2018	Subscriber Ethernet Service Attributes	-	-

CONTENTS

FOREWORD.....	8
INTRODUCTION.....	10
1 Scope.....	11
2 Normative references	11
3 Terms, definitions, abbreviated terms, acronyms, symbols and conventions	13
3.1 Terms and definitions.....	13
3.2 Abbreviated terms and acronyms	13
3.3 Symbols.....	15
3.4 Conventions.....	16
4 CPF 3 (PROFIBUS & PROFINET) – RTE communication profiles	16
4.1 General.....	16
4.2 Common	20
4.2.1 Administrative numbers	20
4.2.2 Node Classes	21
4.2.3 Application classes	25
4.2.4 Communication classes	31
4.2.5 Void.....	36
4.2.6 Protocol and timing parameters	36
4.2.7 Media redundancy classes.....	50
4.2.8 Media classes.....	52
4.2.9 Records.....	52
4.2.10 Communication feature list	62
4.3 Conformance class behaviors	63
4.3.1 General	63
4.3.2 IO controller, IO device, IO supervisor and Network Management Entity	64
4.3.3 End station component	65
4.3.4 Bridge component.....	74
4.3.5 Network components	80
4.3.6 Interconnect	81
4.4 Profile 3/4	82
4.4.1 Physical layer	82
4.4.2 Data link layer	82
4.4.3 Application layer.....	83
4.4.4 Performance indicator selection.....	92
4.5 Profile 3/5	99
4.5.1 Physical layer	99
4.5.2 Data link layer	99
4.5.3 Application layer.....	100
4.5.4 Performance indicator selection.....	108
4.6 Profile 3/6	110
4.6.1 Physical layer	110
4.6.2 Data link layer	110
4.6.3 Application layer.....	110
4.6.4 Performance indicator selection.....	118
4.7 Profile 3/7	122
4.7.1 Physical layer	122
4.7.2 Data link layer	122

4.7.3	Application layer	122
4.7.4	Performance indicator selection	130
4.8	Additional information	133
Annex A (informative) CPF 3 (PROFINET) – Performance Indicator calculation		134
A.1	Application Scenario	134
A.2	Structural examples used for calculation	134
A.2.1	CP 3/4	134
A.2.2	CP 3/5	136
A.2.3	CP 3/6	137
A.2.4	CP 3/7	143
A.3	Principles used for calculation.....	143
A.3.1	General	143
A.3.2	Stack traversal time	143
A.3.3	Bridge structure	143
Bibliography.....		146
Figure 1 – Conformance class model		17
Figure 2 – End station and bridge systems.....		17
Figure 3 – Bridge as network component		18
Figure 4 – End station with wireless		18
Figure 5 – Network component with wireless.....		19
Figure 6 – Hierarchical conformance class model		19
Figure 7 – Hierarchical conformance class model – with integrated bridge component.....		20
Figure 8 – Hierarchical conformance class model – network component		20
Figure 9 – Example of network topology using CP 3/4, CP 3/5, and CP 3/6 components		81
Figure 10 – Example of network topology using CP 3/4, CP 3/5, CP 3/6 and CP 3/7 components		82
Figure 11 – Example of network topology with wireless segment.....		85
Figure 12 – Calculation basis for delivery time and throughput RTE		95
Figure A.1 – CP 3/4: Example of line structure.....		134
Figure A.2 – CP 3/4: Example of ring structure		135
Figure A.3 – CP 3/4: Example of a wireless segment		135
Figure A.4 – CP 3/4: Example of an integrated wireless client.....		136
Figure A.5 – CP 3/5: Example of line structure.....		136
Figure A.6 – CP 3/5: Example of ring structure		137
Figure A.7 – CP 3/6: Example of line structure.....		138
Figure A.8 – CP 3/6: Example of line structure.....		139
Figure A.9 – CP 3/6: Example of ring structure		140
Figure A.10 – CP 3/6: Example of tree structure		141
Figure A.11 – CP 3/6: Example of comb structure		142
Figure A.12 – CP 3/6: Example of comb structure (optional)		143
Figure A.13 – Definition of bridge delay		144
Table 1 – CPF 3 symbols		15
Table 2 – Administrative numbers assignment		

Table 3 – Node Classes and assigned Traffic Classes	22
Table 4 – Maximum diagnosis data for one submodule	22
Table 5 – Maximum storage delay.....	23
Table 6 – Reporting system minimum storage size.....	23
Table 7 – Reporting system storage.....	23
Table 8 – Reporting system Timeouts	24
Table 9 – Maximum storage delay.....	25
Table 10 – NME requirements.....	25
Table 11 – Application classes applicable in conformance classes for IO device and IO controller	26
Table 12 – Application classes applicable in conformance classes for network components	26
Table 13 – Application class "isochronous application" AL service selection	26
Table 14 – Application class "isochronous application" AL protocol selection component.....	27
Table 15 – Application class "high availability" AL service selection	27
Table 16 – Application class "high availability" AL protocol selection component	27
Table 17 – Basis application class for "process automation"	28
Table 18 – Application class "process automation" AL service selection	28
Table 19 – Application class "process automation" AL protocol selection component	28
Table 20 – Application class "High performance" features supported	29
Table 21 – Application class "High performance" parameter values	29
Table 22 – Application class "Controller to Controller" features supported	29
Table 23 – Application class "Functional safety" features supported by IO device	30
Table 24 – Application class "Functional safety" features supported by IO controller.....	30
Table 25 – Application class "Energy saving" AL service selection.....	31
Table 26 – Application class "Energy saving" features supported by IO device	31
Table 27 – Application class "Energy saving" features supported by IO controller	31
Table 28 – Communication classes applicable in conformance classes.....	32
Table 29 – Communication performance parameters	32
Table 30 – FrameSendOffset deviation for RT_CLASS_1 / RT_CLASS_UDP	33
Table 31 – FrameSendOffset deviation for RT_CLASS_1 / RT_CLASS_UDP certification	33
Table 32 – FrameSendOffset deviation factors – SendListControl	34
Table 33 – FrameSendOffset deviation factors – PHY	34
Table 34 – FrameSendOffset deviation	34
Table 35 – Minimum FrameSendOffset	35
Table 36 – FrameSendOffset deviation	35
Table 37 – Parameters for RT_CLASS_3 bridges.....	35
Table 38 – PTCP control loop	36
Table 39 – IEEE Std 802.1AS-2020 control loop	36
Table 40 – Maximum frame size.....	36
Table 41 – IP layer parameters for IO controller.....	37
Table 42 – IP layer parameters for IO device	37

Table 43 – Timeout values for name resolution	37
Table 44 – Values for hello request deviation.....	37
Table 45 – DCP Identify responder resources	38
Table 46 – DCP access control.....	38
Table 47 – DCP Identify pruning support.....	38
Table 48 – Maximum time values for MRP for 10 Mbit/s and for ≥ 100 Mbit/s	38
Table 49 – Maximum packet size for MRP	39
Table 50 – Maximum time values for PTCP.....	39
Table 51 – Precision of timers used for PTCP.....	39
Table 52 – Maximum time values	40
Table 53 – Maximum deviation values for Global Time.....	40
Table 54 – Maximum deviation values for Working Clock	40
Table 55 – Maximum time values for LLDP	41
Table 56 – Required RPC resources	42
Table 57 – Required RPCActivityUUID resources	42
Table 58 – Number of ImplicitARs	42
Table 59 – RTA Timeout deviation	42
Table 60 – Required receive resources	43
Table 61 – Number of LogBookData entries	43
Table 62 – Recommended out of the box default	43
Table 63 – CIMSNMPAdjust.....	43
Table 64 – Community name, default values	44
Table 65 – SNMP timeout values	44
Table 66 – MIB objects update time values	44
Table 67 – DHCP client.....	44
Table 68 – High Availability times	45
Table 69 – Address parameter	45
Table 70 – AR Parameters	46
Table 71 – PDEV parameters.....	47
Table 72 – Reaction time for an IO device	48
Table 73 – Data Hold Time deviation	49
Table 74 – Expected PHY delay.....	50
Table 75 – Expected Bridge delay.....	50
Table 76 – Media redundancy class applicable in conformance classes	51
Table 77 – Media redundancy – additional forwarding rules	51
Table 78 – Media redundancy startup mode.....	52
Table 79 – Version controlled "Read Record".....	52
Table 80 – Index (user specific)	53
Table 81 – Index (subslot specific).....	53
Table 82 – Index (slot specific)	56
Table 83 – Index (AR specific)	57
Table 84 – Index (API specific)	58
Table 85 – Index (device specific).....	59

Table 86 – PDPortDataAdjust (sub blocks)	61
Table 87 – PDPortDataCheck (sub blocks)	62
Table 88 – Communication feature list	62
Table 89 – IO controller, IO device, IO supervisor and Network Management Entity.....	63
Table 90 – Network Component	64
Table 91 – Conformance class behaviors	64
Table 92 – Node classes	65
Table 93 – Link speed dependent local injection per Ethernet interface	65
Table 94 – SNMP feature selection	66
Table 95 – IETF RFC 1213-MIB (MIB-2) objects	67
Table 96 – LLDP-MIB objects – range 1	67
Table 97 – LLDP-MIB objects – range 2	68
Table 98 – LLDP-MIB objects – range 3	68
Table 99 – LLDP-EXT-PNO-MIB objects – range 1	69
Table 100 – LLDP-EXT-PNO-MIB objects – range 2.....	69
Table 101 – LLDP-EXT-DOT3-MIB objects – range 1	69
Table 102 – LLDP-EXT-DOT3-MIB objects – range 2	69
Table 103 – IEEE 802.1Q-BRIDGE-MIB objects	70
Table 104 – NETCONF feature selection	70
Table 105 – IEEE Std 802.3-2018 feature selection	71
Table 106 – IEEE Std 802.1Q-2018 feature selection.....	71
Table 107 – Node classes for bridge	74
Table 108 – Supported concurrent Link Speed for bridges	74
Table 109 – IEEE Std 802.1Q-2018 bridge components for Conformance Class D	74
Table 110 – IEC 61784-5-3 feature selection	75
Table 111 – IEC 62439-2 feature selection	75
Table 112 – Buffering capacity per port.....	76
Table 113 – Special case: Buffering capacity for eight and more ports	76
Table 114 – IEEE Std 802.1AB-2016 feature selection.....	77
Table 115 – IEEE Std 802.1AS-2020 feature selection.....	77
Table 116 – IEEE Std 802.1CB-2017 feature selection	78
Table 117 – IEEE Std 802.1Q-2018 feature selection.....	79
Table 118 – Cut through feature selection.....	80
Table 119 – Wireless feature selection	80
Table 120 – Node classes for network component	80
Table 121 – Conformance class constraints – wireline	81
Table 122 – Conformance class constraints – wireless	81
Table 123 – CP 3/4: AL service selection for an IO device	83
Table 124 – CP 3/4: Additional AL service selection for an IO controller	86
Table 125 – CP 3/4: Additional AL service selection for an IO supervisor.....	86
Table 126 – CP 3/4: AL protocol selection for an IO device.....	87
Table 127 – CP 3/4: AL protocol selection for an IO controller	89
Table 128 – CP 3/4, CP 3/5, CP 3/6 and CP 3/7: performance indicator overview	92

Table 129 – CP 3/4, CP 3/5, CP 3/6 and CP 3/7: performance indicator dependency matrix	93
Table 130 – Media Redundancy Manager (MRM) parameters	96
Table 131 – Media Redundancy Client (MRC) parameters	97
Table 132 – Media redundancy Interconnection Manager (MIM) parameters	97
Table 133 – Media redundancy Interconnection Client (MIC) parameters	97
Table 134 – CP 3/4: Consistent set of PI for MinDeviceInterval=128 ms	98
Table 135 – CP 3/4: Assumed values for consistent set of PI calculation	99
Table 136 – CP 3/5: AL service selection for an IO device	100
Table 137 – CP 3/5: Additional AL service selection for an IO controller	102
Table 138 – CP 3/5: Additional AL service selection for an IO supervisor	102
Table 139 – CP 3/5: AL protocol selection for an IO device	103
Table 140 – CP 3/5: AL protocol selection for an IO controller	105
Table 141 – CP 3/5: Consistent set of PI for MinDeviceInterval=128 ms	108
Table 142 – CP 3/5: Assumed values for consistent set of PI calculation	109
Table 143 – CP 3/6: AL service selection for an IO device	110
Table 144 – CP 3/6: Additional AL service selection for an IO controller	112
Table 145 – CP 3/6: AL protocol selection for an IO device	113
Table 146 – CP 3/6: AL protocol selection for an IO controller	116
Table 147 – CP 3/6: Consistent set of PI for MinDeviceInterval = 1 ms and NumberOfSwitches = 20	119
Table 148 – CP 3/6: Consistent set of PI for MinDeviceInterval = 1 ms and NumberOfSwitches = 63	119
Table 149 – CP 3/6: Assumed values for consistent set of PI calculation	120
Table 150 – CP 3/6: Consistent set of PI for MinDeviceInterval = 31,25 µs and NumberOfSwitches = 10	121
Table 151 – CP 3/6: Assumed values for consistent set of PI calculation	121
Table 152 – CP 3/7: AL service selection for an IO device	122
Table 153 – CP 3/7: Additional AL service selection for an IO controller	124
Table 154 – CP 3/7: AL protocol selection for an IO device	125
Table 155 – CP 3/7: AL protocol selection for an IO controller	127
Table 156 – CP 3/7: Consistent set of PI for MinDeviceInterval = 1 ms and NumberOfSwitches = 20	130
Table 157 – CP 3/7: Consistent set of PI for MinDeviceInterval = 1 ms and NumberOfSwitches = 63	131
Table 158 – CP 3/7: Assumed values for consistent set of PI calculation	131
Table 159 – CP 3/7: Consistent set of PI for MinDeviceInterval = 31,25 µs and NumberOfSwitches = 10	132
Table 160 – CP 3/7: Assumed values for consistent set of PI calculation	133

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**INDUSTRIAL NETWORKS –
PROFILES –****Part 2-3: Additional real-time fieldbus profiles
based on ISO/IEC/IEEE 8802-3 –
CPF 3****FOREWORD**

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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NOTE Combinations of protocol types are specified in the IEC 61784-1 series and the IEC 61784-2 series.

IEC 61784-2-3 has been prepared by subcommittee 65C: Industrial networks, of IEC technical committee 65: Industrial-process measurement, control and automation. It is an International Standard.

This first edition, together with the other parts of the same series, cancels and replaces the fourth edition of IEC 61784-2 published in 2019. This first edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to IEC 61784-2:2019:

- a) split of the original IEC 61784-2 into several subparts, one subpart for the material of a generic nature, and one subpart for each Communication Profile Family specified in the original document;
- b) addition of new profile CP 3/7;
- c) update of the requirements for all conformance classes;
- d) updated timing requirements for IO devices;
- e) refining the added application classes.

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

Draft	Report on voting
65C/1209/FDIS	65C/1237/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts of the IEC 61784-2 series, published under the general title *Industrial networks – Profiles – Part 2: Additional real-time fieldbus profiles based on ISO/IEC/IEEE 8802-3*, 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

- 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 document using a colour printer.

INTRODUCTION

The IEC 61784-2 series provides additional Communication Profiles (CP) to the existing Communication Profile Families (CPF) of the IEC 61784-1 series and additional CPFs with one or more CPs. These profiles meet the industrial automation market objective of identifying Real-Time Ethernet (RTE) communication networks coexisting with ISO/IEC/IEEE 8802-3 – commonly known as Ethernet. These RTE communication networks use provisions of ISO/IEC/IEEE 8802-3 for the lower communication stack layers and additionally provide more predictable and reliable real-time data transfer and means for support of precise synchronization of automation equipment.

More specifically, these profiles help to correctly state the compliance of RTE communication networks with ISO/IEC/IEEE 8802-3, and to avoid the spreading of divergent implementations.

Adoption of Ethernet technology for industrial communication between controllers and even for communication with field devices promotes the use of Internet technologies in the field area. This availability would be unacceptable if it causes the loss of features required in the field area for industrial communication automation networks, such as:

- real-time,
- synchronized actions between field devices like drives,
- efficient, frequent exchange of very small data records.

These new RTE profiles can take advantage of the improvements of Ethernet networks in terms of transmission bandwidth and network span.

Another implicit but essential requirement is that the typical Ethernet communication capabilities, as used in the office world, are fully retained, 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 the diverse application requirements. RTE performance indicators, whose values will be provided with RTE devices based on communication profiles specified in the IEC 61784-2 series, enable the user to match network devices with application-dependent performance requirements of an RTE network.

INDUSTRIAL NETWORKS – PROFILES –

Part 2-3: Additional real-time fieldbus profiles based on ISO/IEC/IEEE 8802-3 – CPF 3

1 Scope

This part of IEC 61784-2 defines extensions of Communication Profile Family 3 (CPF 3) for Real-Time Ethernet (RTE). CPF 3 specifies a set of Real-Time Ethernet (RTE) communication profiles (CPs) and related network components based on the IEC 61158 series (Type 10), ISO/IEC/IEEE 8802-3 and other standards.

For each RTE communication profile, this document also specifies the relevant RTE performance indicators and the dependencies between these RTE performance indicators.

NOTE 1 All CPs are based on standards or draft standards or International Standards published by the IEC or on standards or International Standards established by other standards bodies or open standards processes.

NOTE 2 The RTE communication profiles use ISO/IEC/IEEE 8802-3 communication networks and its related network components and in some cases amend those standards to obtain RTE features.

NOTE 3 Some CPs of CPF 3 are specified in IEC 61784-1-3.

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.

NOTE All parts of the IEC 61158 series, as well as the IEC 61784-1 series and the IEC 61784-2 series, are maintained simultaneously. Cross-references to these documents within the text therefore refer to the editions as dated in this list of normative references.

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

IEC 61158-5-10:2023, *Industrial communication networks – Fieldbus specifications – Part 5-10: Application layer service definition – Type 10 elements*

IEC 61158-6-10:2023, *Industrial communication networks – Fieldbus specifications – Part 6-10: Application layer protocol specification – Type 10 elements*

IEC 61784-1-3:2023, *Industrial networks – Profiles – Part 1-3: Fieldbus profiles – Communication Profile Family 3*

IEC 61784-2-0:2023, *Industrial networks – Profiles – Part 2-0: Additional real-time fieldbus profiles based on ISO/IEC/IEEE 8802-3 – General concepts and terminology*

IEC 61784-3-3:2021, *Industrial communication networks – Profiles – Part 3-3: Functional safety fieldbuses – Additional specifications for CPF 3*

IEC 61784-5-3:2018, *Industrial communication networks – Profiles – Part 5-3: Installation of fieldbuses – Installation profiles for CPF 3*

IEC 62439-2:2021, *Industrial communication networks – High availability automation networks – Part 2: Media Redundancy Protocol (MRP)*

ISO/IEC/IEEE 8802-3, *Telecommunications and exchange between information technology systems – Requirements for local and metropolitan area networks – Part 3: Standard for Ethernet*

ISO/IEC 9834-8:2014, *Information technology – Procedures for the operation of object identifier registration authorities – Part 8: Generation of universally unique identifiers (UUIDs) and their use in object identifiers*

ISO 15745-4:2003/Amd. 1:2006, *Industrial automation systems and integration – Open systems application integration framework – Part 4: Reference description for Ethernet-based control systems – Amendment 1: PROFINET profiles*

IEEE Std 802-2014, *IEEE Standard for Local and Metropolitan Area Networks: Overview and Architecture*

IEEE Std 802.1AB-2016, *IEEE Standard for Local and metropolitan area networks – Station and Media Access Control Connectivity Discovery*

IEEE Std 802.1AS-2020, *IEEE Standard for Local and Metropolitan Area Networks – Timing and Synchronization for Time-Sensitive Applications*

IEEE Std 802.1CB-2017, *IEEE Standard for Local and metropolitan area networks – Frame Replication and Elimination for Reliability*

IEEE Std 802.1Q-2018, *IEEE Standard for Local and Metropolitan Area Networks – Bridges and Bridged Networks*

IEEE Std 802.3-2018, *IEEE Standard for Ethernet*

IEEE Std 802.11-2020, *IEEE Standard for Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications*

IEEE Std 802.11n-2009, *IEEE Standard for Information technology – Local and metropolitan area networks – Specific requirements – Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications – Amendment 5: Enhancements for Higher Throughput*

IEEE Std 802.15.1-2005, *IEEE Standard for Information technology – Local and metropolitan area networks – Specific requirements – Part 15.1a: Wireless Medium Access Control (MAC) and Physical Layer (PHY) specifications for Wireless Personal Area Networks (WPAN)*

IETF RFC 768, J. Postel, *User Datagram Protocol*, August 1980, available at <https://www.rfc-editor.org/info/rfc768> [viewed 2022-02-18]

IETF RFC 791, J. Postel, *Internet Protocol*, September 1981, available at <https://www.rfc-editor.org/info/rfc791> [viewed 2022-02-18]

IETF RFC 792, J. Postel, *Internet Control Message Protocol*, September 1981, available at <https://www.rfc-editor.org/info/rfc792> [viewed 2022-02-18]

IETF RFC 793, J. Postel, *Transmission Control Protocol*, September 1981, available at <https://www.rfc-editor.org/info/rfc793> [viewed 2022-02-18]

IETF RFC 826, D. Plummer, *An Ethernet Address Resolution Protocol: Or Converting Network Protocol Addresses to 48.bit Ethernet Address for Transmission on Ethernet Hardware*, November 1982, available at <https://www.rfc-editor.org/info/rfc826> [viewed 2022-02-18]

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IETF RFC 2131, R. Droms, *Dynamic Host Configuration Protocol*, March 1997, available at <https://www.rfc-editor.org/info/rfc2131> [viewed 2022-02-18]

IETF RFC 4836, E. Beili, *Definitions of Managed Objects for IEEE 802.3 Medium Attachment Units (MAUs)*, April 2007, available at <https://www.rfc-editor.org/info/rfc4836> [viewed 2022-02-18]

The Open Group – Publication C706, *Technical standard DCE1.1: Remote Procedure Call*, available at www.opengroup.org/onlinepubs/9629399/toc.htm [viewed 2022-02-18]

Metro Ethernet Forum – MEF 10.4:2018, *Subscriber Ethernet Service Attributes*, available at <https://www.mef.net/resources/mef-10-4-subscriber-ethernet-services-attributes> [viewed 2022-02-18]

3 Terms, definitions, abbreviated terms, acronyms, symbols and conventions

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61784-2-0, ISO/IEC/IEEE 8802-3, IEEE Std 802-2014, IEEE Std 802.1AB-2016, IEEE Std 802.1AS-2020 and IEEE Std 802.1Q-2018 apply.

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

- IEC Electropedia: available at <https://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

3.2 Abbreviated terms and acronyms

For the purposes of this document, abbreviated terms and acronyms defined in IEC 61784-2-0 and the following apply.

API	Application Process Identifier
AR	Application Relationship
ARP	Address Resolution Protocol (see IETF RFC 826)
ASE	Application Service Element
BMCA	Best Master Clock Algorithm
CBS	Committed Burst Size
CIM	Communication Interface Management

CIR	Committed Information Rate
CMDEV	Context Management Protocol Machine Device
CMSRL	Context Management System Redundancy Layer Device
CP	Communication Profile [according to IEC 61784-1-0]
CPF	Communication Profile Family [according to IEC 61784-1-0]
CR	Communication Relationship
CTLDINA	Context Management Discovery, IP and Name Assignment Protocol Machine
CTLSRL	Context Management System Redundancy Layer Controller
DCP	Discovery and basic Configuration Protocol (see IEC 61158-6-10)
DCPMCR	DCP Multicast Receiver Protocol Machine
DFP	Dynamic Frame Packing
DHCP	Dynamic Host Configuration Protocol (see IETF RFC 2131)
DNS	Domain Name Service (see IETF RFC 1034)
FDB	Filtering Data Base
FrameID	Frame Identifier (see IEC 61158-6-10)
FSO	FrameSendOffset
FSU	Fast StartUp
GMII	Gigabit Media Independent Interface
gPTP	generic Precision Time Protocol
GSD	General Station Description
IANA	Internet Assigned Numbers Authority
ICMP	Internet Control Message Protocol (see IETF RFC 792)
IETF	Internet Engineering Task Force
IOCR	IO Communication Relation
IOD	Input Output Device
IP	Internet Protocol (see IETF RFC 791)
IPG	Inter Packet Gap
IRT	Isochronous Real Time Protocol
LLDP	Link Layer Discovery Protocol (see IEEE Std 802.1AB-2016)
MAC	Media Access Control
MAU	Medium Attachment Unit
MCR	Multicast Communication Relation
MDI	Media Dependent Interface
MIB	Management Information base
MII	Media Independent Interface
MRM	Media Redundancy Manager
MRP	Medium Redundancy Protocol (see IEC 62439-2)
MRPD	Media Redundancy with Planned Duplication of frames
n.a.	Not applicable
NME	Network Management Entity
NoS	Number of Switches
NRT	Non Real-Time
OID	Object IDentifier (see IETF RFC 1157)

PDEV	Physical DEvice
PDU	Protocol Data Unit
PE	Path Entity
PHY	PHYsical layer entity sublayer (see ISO/IEC/IEEE 8802-3)
PI	Performance Indicator
PTCP	Precision Transparent Clock Protocol
PTP	Precision Time Protocol
RGMII	Reduced Gigabit Media Independent Interface
RMII	Reduced Media Independent Interface
RPC	Remote Procedure Call (see The Open Group – Publication C706)
RSO	Reporting System Observer
RSTP	Rapid Spanning Tree Algorithm and Protocol (see IEEE Std 802.1Q-2018)
RTA	Real Time Acyclic (protocol)
RTC	Real Time Cyclic (protocol)
RTE	Real-Time Ethernet
SDU	Service Data Unit
SNMP	Simple Network Management Protocol (see IETF RFC 1157)
Switch	Bridge (see IEEE Std 802.1Q-2018)
TAS	Time Aware Shaper
TCP	Transmission Control Protocol (see IETF RFC 793)
TLV	Type Length Value (coding rule)
UDP	User Datagram Protocol (see IETF RFC 768)
UUID	Universal Unique Identifier
VID	VLAN Identifier
VLAN	Virtual Local Area Network

3.3 Symbols

For the purposes of this document, symbols defined in IEC 61784-2-0 and Table 1 apply.

NOTE Definitions of symbols in this Subclause 3.3 do not use the italic font, as they are already identified as symbols.

Table 1 – CPF 3 symbols

Symbol	Definition	Unit
Cd	Cable delay (see attribute cable_delay in IEC 61158-5-10)	s
Cl _t	Total cable length	m
cta _R	Application cycle time of the Receiver	s
cta _S	Application cycle time of the Sender	s
ctc	Communication cycle time	s
Data	Complete Ethernet frame	octets
data_request	Requested RTE throughput	octets/s
data_RTE	Actual RTE throughput	octets/s
DT	Delivery time	s
endStations	Number of end stations	—
EthernetDataRate	Ethernet data rate of the network	Mbit/s

Symbol	Definition	Unit
MAC_delay	Delay on MAC layer	s
NonRTE	Percentage of non-RTE bandwidth	%
NoS	Number of switches	—
Od	Other delays, e. g. signal forwarding in a ring	s
Pd	Propagation delay	s
Phy_R_delay	PHY delay on receiver side	s
Phy_S_delay	PHY delay on sender side	s
protocolRTE	Percentage of protocol time	s
Queue_delay	Queue delay in a switch	s
RM	Time needed for management functions to support redundancy	s
RR	Attribute <i>Reduction Ratio</i> (see IEC 61158-5-10)	—
SCF	Attribute <i>Send Clock Factor</i> (see IEC 61158-5-10)	—
STTr	Receiver stack traversal time including PHY and MAC	s
STTs	Sender stack traversal time including PHY and MAC	s
Throughput_RTE	Throughput RTE	octets/s
Time_synchron_accuracy	Time synchronization accuracy	s
Tt	Transfer time	s

3.4 Conventions

For the purposes of this document, the conventions defined in IEC 61784-2-0 apply.

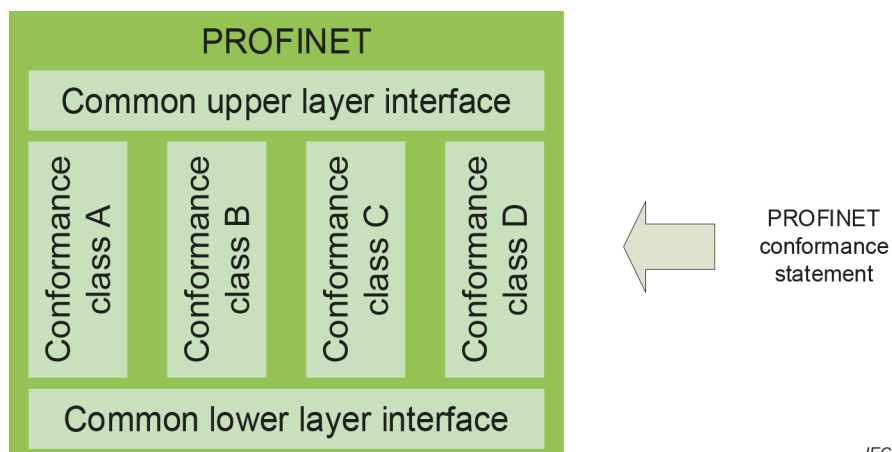
4 CPF 3 (PROFIBUS & PROFINET¹) – RTE communication profiles

4.1 General

Communication Profile Family 3 (CPF 3) defines communication profiles using Type 3 and Type 10 of IEC 61158 series, which corresponds to parts of the communication systems commonly known as PROFIBUS and PROFINET. For PROFIBUS, CP 3/1 and CP 3/2 are specified in IEC 61784-1-3.

RTE specific PROFINET profiles are specified for four conformance classes named A, B, C and D shown in Figure 1. Compliance with a CP out of the CPF 3 is a prerequisite to conform to a conformance class (see Table 89 and Table 90). Those conformance classes require features out of the general classifications given in 4.2 and 4.3.

¹ PROFIBUS and PROFINET are trade names of the non-profit organization PROFIBUS Nutzerorganisation e.V. (PNO). This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of the trade names holder or any of its products. Compliance with this profile does not require use of the registered trade name. Use of the trade names requires permission of the trade name holder.

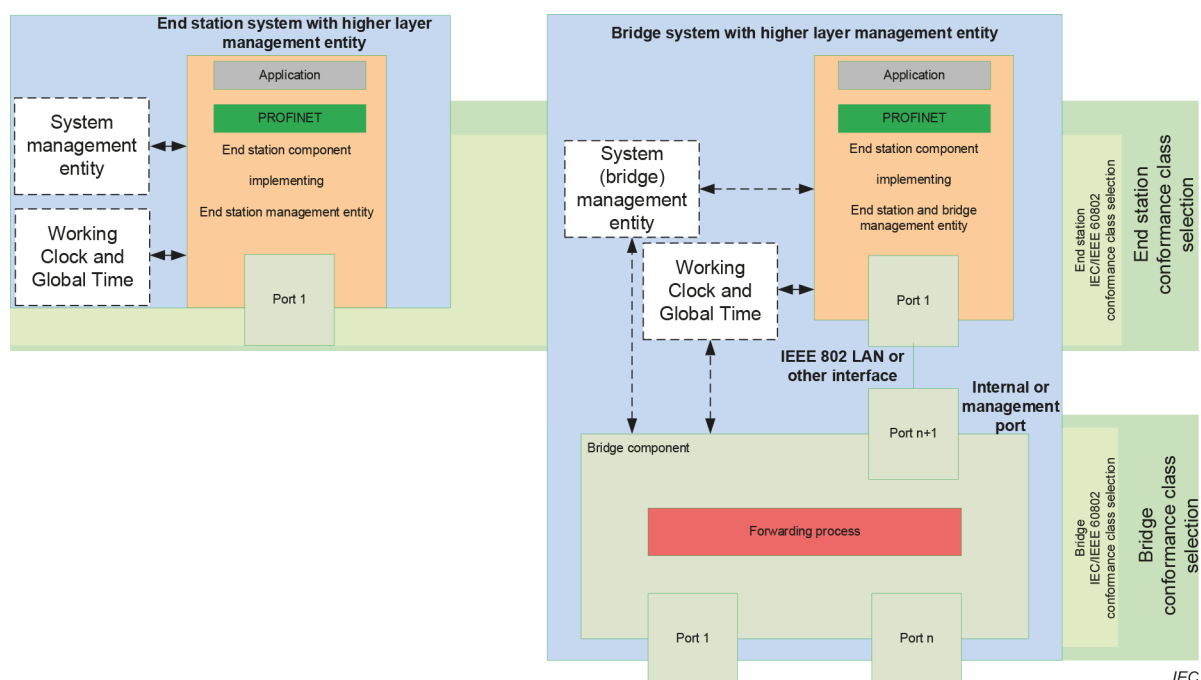


IEC

Figure 1 – Conformance class model

Figure 2, Figure 3, Figure 4 and Figure 5 show the components for conformance class assignment:

- Hierarchical conformance class model according to Figure 6, Figure 7 and Figure 8.
- End station component requires to be conformant to the selected conformance class.
- Bridge component requires to be conformant to the selected conformance class
- Whole selection of components requires to be conformant to the selected conformance class.
- GSD provides attributes to express the supported conformance classes.



IEC

Figure 2 – End station and bridge systems

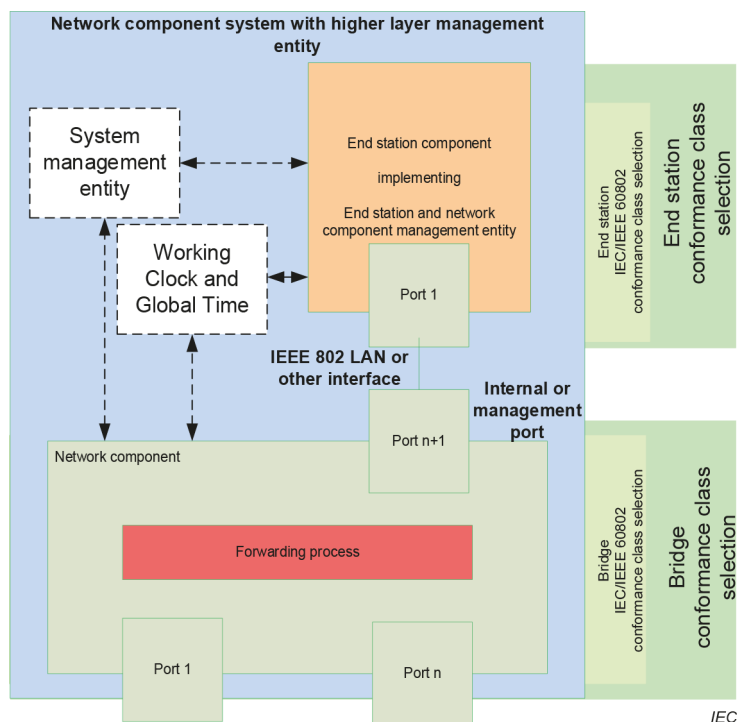


Figure 3 – Bridge as network component

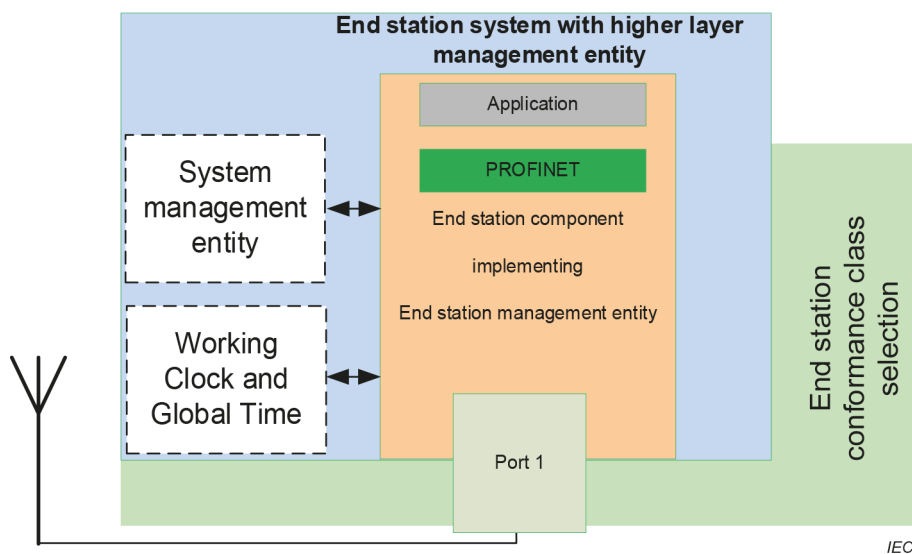


Figure 4 – End station with wireless

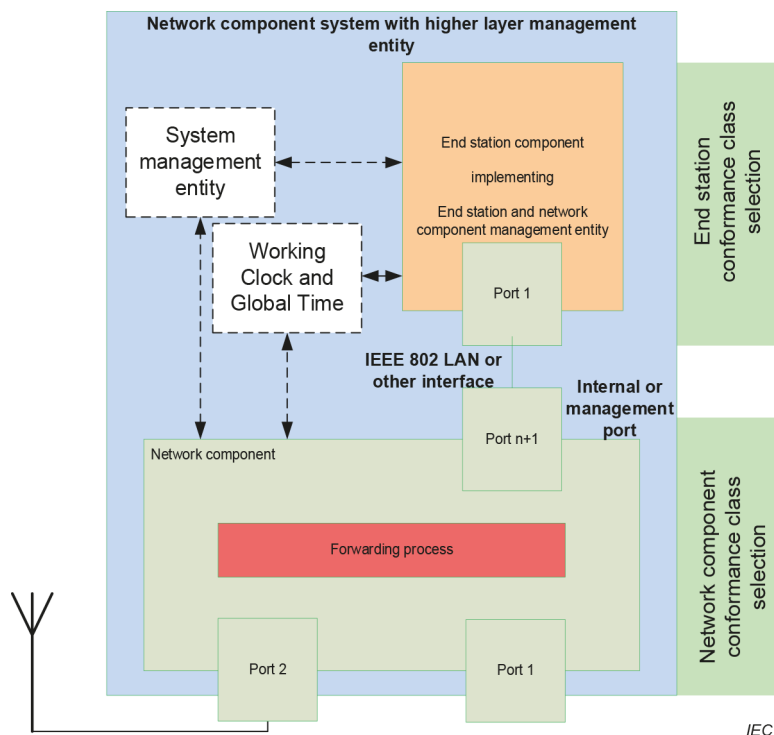


Figure 5 – Network component with wireless

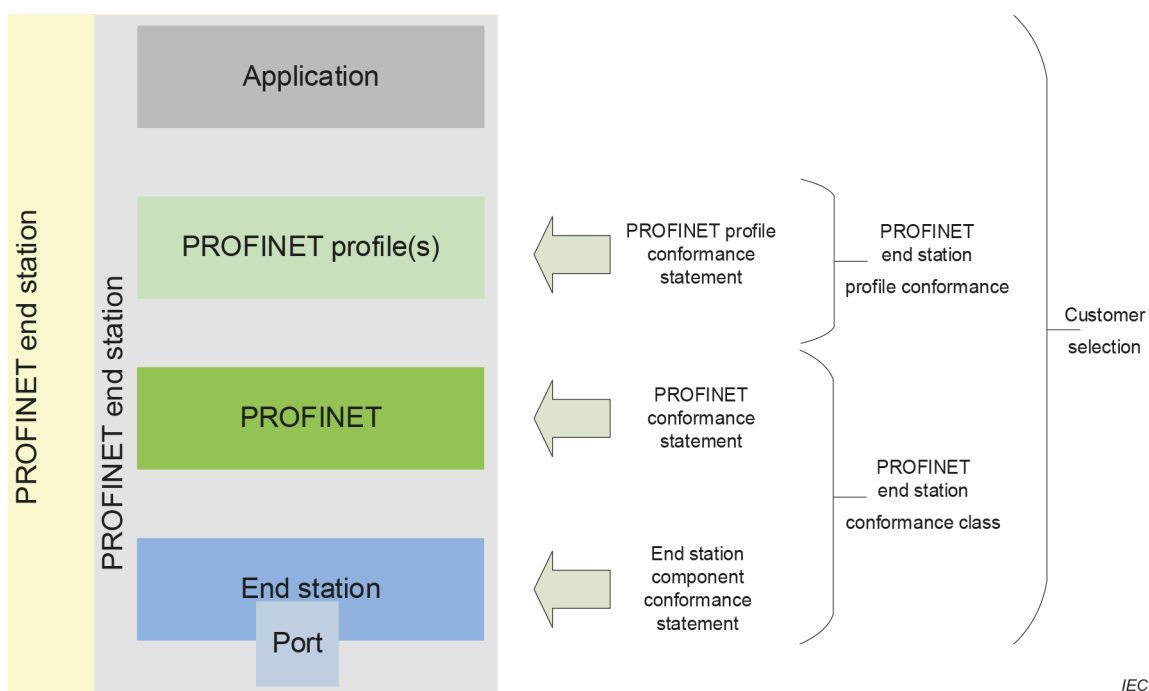


Figure 6 – Hierarchical conformance class model

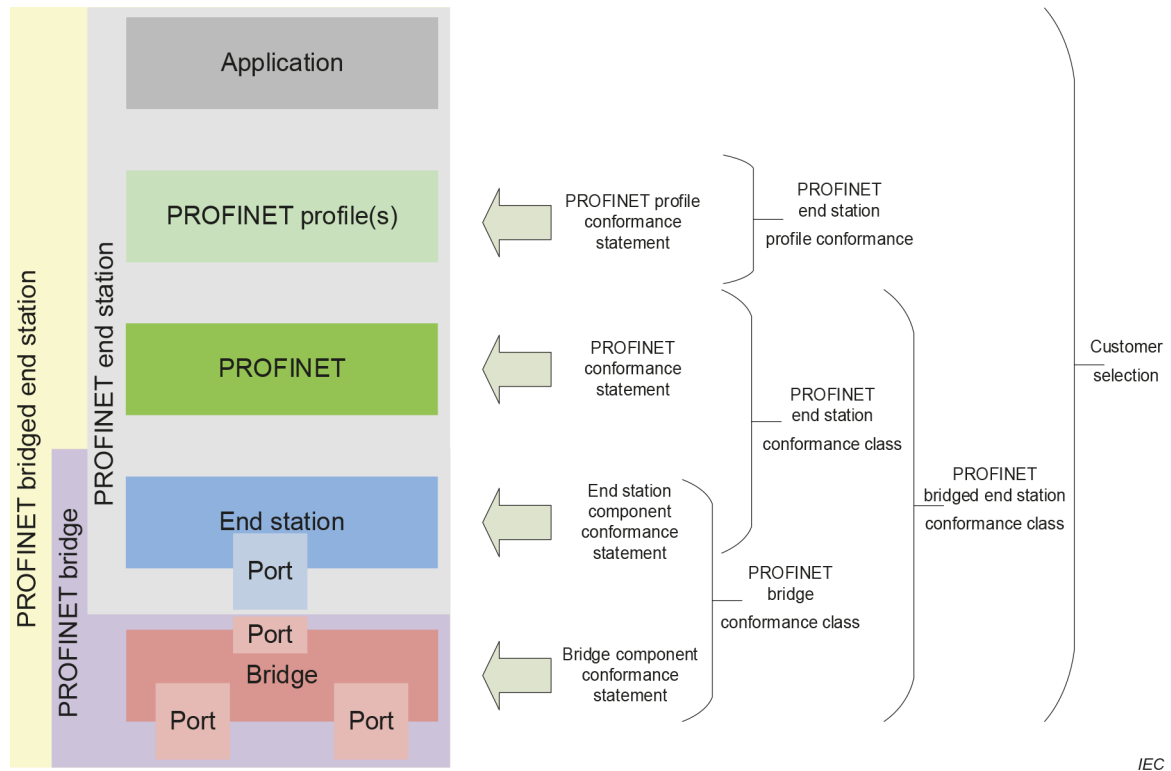


Figure 7 – Hierarchical conformance class model – with integrated bridge component

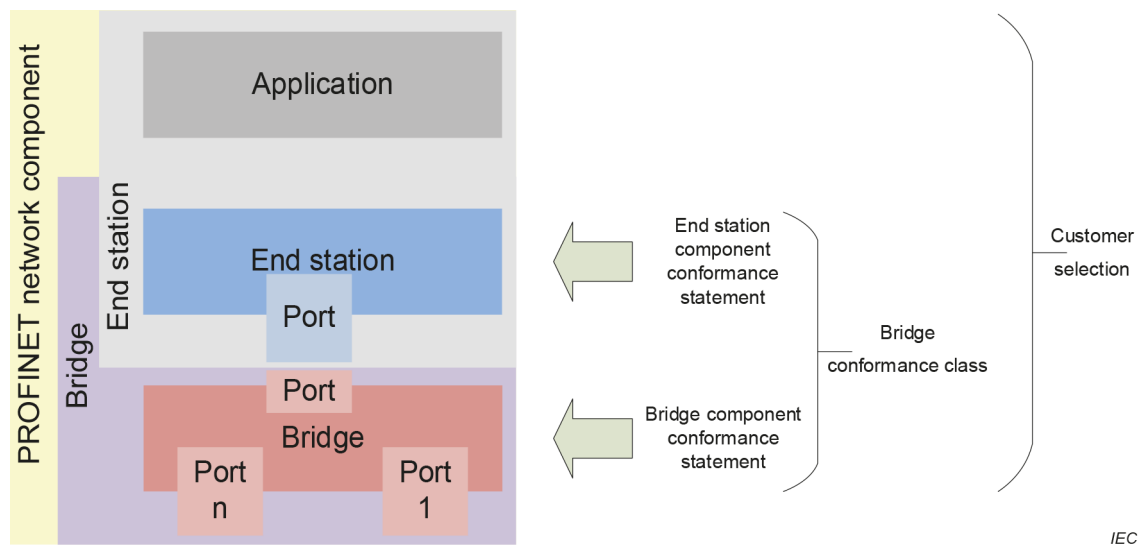


Figure 8 – Hierarchical conformance class model – network component

4.2 Common

4.2.1 Administrative numbers

The administrative numbers shown in IEC 61158-6-10 shall be assigned by the authority shown in Table 2.

Table 2 – Administrative numbers assignment

Parameter	Assigning authority
API application process identifier	PROFIBUS & PROFINET International (PI) See IEC 61158-5-10 and IEC 61158-6-10, Coding of the field API
vendor ID	PROFIBUS & PROFINET International (PI) See IEC 61158-5-10 and IEC 61158-6-10, Coding of fields related to Instance, DeviceID, VendorID
enterprise number	IANA to PROFIBUS & PROFINET International (PI) See IEC 61158-5-10 and IEC 61158-6-10, Enterprise number for PNO MIB
PNO MIB	PROFIBUS & PROFINET International (PI) See IEC 61158-5-10 and IEC 61158-6-10, Enterprise number for PNO MIB
index	PROFIBUS & PROFINET International (PI) See IEC 61158-5-10 and IEC 61158-6-10, Coding of the field Index
IM_Profile_ID	PROFIBUS & PROFINET International (PI) See IEC 61158-5-10 (See Profile ID) and IEC 61158-6-10, Coding of the field IM_Profile_ID
ChannelErrorType	PROFIBUS & PROFINET International (PI) See IEC 61158-5-10 and IEC 61158-6-10, Coding of the field ChannelErrorType

4.2.2 Node Classes

4.2.2.1 General

Node classes are (see Table 3):

- 1) IO device, end station component with or without integrated bridge component;
 - a) IO device requiring IEC 61158-6-10, Traffic Classes, HIGH/ISO and other traffic classes
 - b) IO device requiring IEC 61158-6-10, Traffic Classes, LOW/CYC and other traffic classes
 - c) IO device requiring IEC 61158-6-10, Traffic Classes, RT/A and other traffic classes
 - d) IO device requiring IEC 61158-6-10, Traffic Classes, NW, EV, CO, BEH or BEL traffic classes
- 2) IO controller, end station component with or without integrated bridge component;
 - a) IO controller requiring IEC 61158-6-10, Traffic Classes, HIGH/ISO and other traffic classes
 - b) IO controller requiring IEC 61158-6-10, Traffic Classes, LOW/CYC and other traffic classes
 - c) IO controller requiring IEC 61158-6-10, Traffic Classes, RT/A and other traffic classes
 - d) IO controller requiring IEC 61158-6-10, Traffic Classes, NW, EV, CO, BEH or BEL traffic classes
- 3) IO supervisor, end station component with or without integrated bridge component;
- 4) Network Management Entity, end station component with or without integrated bridge component.

NOTE A node can have several node classes implemented at the same time, e.g. IO controller and IO device, IO controller and network management entity.

Table 3 – Node Classes and assigned Traffic Classes

HIGH/- ISO	LOW/- CYC	RT/A	NW	EV	CO	BEH	BEL	Node class IO device or IO controller
X	—	—	—	—	—	—	—	a)
NO	X	—	—	—	—	—	—	b)
NO	NO	X	—	—	—	—	—	c)
NO	NO	NO	—	—	—	—	—	d)

4.2.2.2 IO device

4.2.2.2.1 Communication

An IO device shall support at least one AR with two IO CRs, one Alarm CR, and one Record Data CR with the following features:

- IO CR:
Maximum C_SDU data length 1 440 octets
Minimum C_SDU data length 40 octets
Usable C_SDU data length according to the GSD

NOTE 1 C_SDU is derived from IEC 61158-6-10.

- Alarm CR:
Maximum RTA-SDU data length 1 432 octets
Minimum RTA-SDU data length 200 octets

NOTE 2 RTA-SDU is derived from IEC 61158-6-10.

- Record data CR:
Up to 2^{32} minus 65 octet data length, minimal 4 132 octets data length (length of the *PROFINETIOServiceReqPDU* or *PROFINETIOServiceResPDU*)

NOTE 3 PROFINETIOServiceReqPDU and PROFINETIOServiceResPDU are derived from IEC 61158-6-10.

4.2.2.2.2 Network configuration

For IO devices supporting

- configuration over Network Management additionally at least one DeviceAccess AR shall be supported

4.2.2.2.3 Application

4.2.2.2.3.1 Diagnosis

An IO device shall limit the diagnosis added to the Diagnosis ASE for one submodule according to Table 4.

Table 4 – Maximum diagnosis data for one submodule

Parameter	Value	Comment
Maximum amount of diagnosis data for one submodule	< 65 536 octets	The application of a device shall limit the amount of diagnosis data which it adds to the Diagnosis ASE to a given limit. Thus, a controller or an engineering system could in all cases get the existing diagnosis data from the Diagnosis ASE.

4.2.2.2.3.2 Persistence

An IO device shall store the parameterization or communication data according to Table 5.

Table 5 – Maximum storage delay

Service	Timeout	Comment
Startup parameterization during connection establishment, plugging of a submodule or dynamic reconfiguration	Recommended: < 30 s Mandatory: < 300 s	Timeout starts when the Appl_Rdy.req is issued by the IO device.
Record Write outside startup parametrization	Recommended: < 30 s Mandatory: < 300 s	Timeout starts when the RM_Write.rsp is issued by the responder.
SNMP Set to writeable OIDs	Recommended: < 30 s Mandatory: < 300 s	Timeout starts when the SNMP_Set.cnf is issued by the responder.
Set_Storage_Time ^a	Mandatory: < 30 s	Maximum time between the DCP_Set.rsp and the completion of persistent storage.
^a See IEC 61158-6-10; valid for IO controller, too.		

4.2.2.2.3.3 Reporting system

An IO device shall locally store reporting system observer events according to Table 6 and Table 7. The needed storage capacity depends on the RSO event creation frequency.

Table 8 shows the expected times for switching the used timescales.

Table 6 – Reporting system minimum storage size

Minimum storage size	Comment
4 096 octets	Minimum storage size of the reporting system

Table 7 – Reporting system storage

Frequency	Number of storable RSO events	Comment
1 s: 100 s pulse to pause ratio with a burst of 500 RSO events during pulse	550	For a period of 101 s, under normal working conditions, no more than 500 RSO events are expected.
1 s: 100 s pulse to pause ratio with a burst of 100 RSO events during pulse	110	For a period of 101 s, under normal working conditions, no more than 100 RSO events are expected.
1 s: 100 s pulse to pause ratio with a burst of 50 RSO events during pulse	55	For a period of 101 s, under normal working conditions, no more than 50 RSO events are expected.

Table 8 – Reporting system Timeouts

Time Source	Time	Comment
Switch from "0" to "1"	When detecting "Time mismatch"	The connection to the common source of time is lost
Switch from "1" to "2"	Recommended: < 60 s Mandatory: < 300 s	The expected deviation between the global timescale and derived global timescale at the sync slave is no longer given. Thus, the sync slave shall switch to arbitrary timescale.

4.2.2.3 IO controller

4.2.2.3.1 Communication

An IO controller shall support at least one AR for each related IO device including two IO CRs, one Alarm CR, and one Record Data CR with the following features:

- IO CR:
Up to 1 440 octets C_SDU data length, min. 240 octets consistency, support of all defined data types
- Alarm CR:
Up to 1 432 octets data length, minimal 200 octets data length, capability to queue at least one high priority and one low priority alarm for each related IO device
- Record data CR:
Up to 2^{32} minus 65 octets data length, minimal 16 588 octets (recommended 66 412 octets) data length (length of the *PROFINETIOServiceReqPDU* or *PROFINETIOServiceResPDU*), capability to store for each related IO device at least 16 384 octets startup parameter, no parallel access to a record data object
 - WriteMultiple:
Shall be supported for startup parameterization during Connect, Plug and dynamic reconfiguration
- Multi-API:
At least two supported (API = 0 and API = x)
- Connect response:
At least an ARVendorBlockRes size of 512 octets for each used ARVendorBlockReq at the connect request

NOTE ARVendorBlockReq and ARVendorBlockRes are derived from IEC 61158-6-10.

4.2.2.3.2 Network configuration

For IO controller supporting

- configuration over Network Management additionally at least one DeviceAccess AR shall be supported

4.2.2.3.3 Persistence

An IO controller shall store the parameterization or communication data according to Table 9.

Table 9 – Maximum storage delay

Service	Timeout	Comment
Record Write or Record Read Query	Recommended: < 30 s Mandatory: < 300 s	Timeout starts when the RM_Write.rsp is issued by the responder.
SNMP Set to writeable OIDs	Recommended: < 30 s Mandatory: < 300 s	Timeout starts when the SNMP_Set.cnf is issued by the responder.
Set_Storage_Time	Mandatory: < 30 s	Maximum time between the DCP_Set.rsp and the completion of persistent storage.

4.2.2.4 IO supervisor

See 4.2.2.3.

4.2.2.5 Network Management Entity

A Network Management Entity (NME) shall support the features according to Table 10.

Table 10 – NME requirements

Feature	Quantity	Comment
NME domain size	At least 64 nodes (bridges and end stations)	An NME shall be able to setup and maintain a NME domain with its devices.
Stream classes	At least two streams (one for input and one for output) for each supported node.	An NME shall be able to support HIGH/ISO, LOW/CYC and RT/A stream.

4.2.3 Application classes

4.2.3.1 Definition

Devices supporting a specific application class shall support additional features beyond those required for the conformance class. Those features are described below in detail for the specific application class.

The following application classes are defined:

- **Isochronous application** (e.g. motion control)

NOTE Isochronous clock synchronization is a communication class feature and not an application class feature.

- **High availability**
- **Process automation**
- **High performance**
- **Controller to controller**
- **Functional safety**
- **Energy saving**

The support of application classes is shown in Table 11 and Table 12:

Table 11 – Application classes applicable in conformance classes for IO device and IO controller

Application classes	Conformance classes			
	A	B	C	D
Isochronous application	—	—	Optional	Optional
High availability	Optional ^a	Optional	Optional	Optional
Process automation	Optional ^a	Optional	Optional	Optional
High performance	—	—	Optional	—
Controller to controller	—	Optional	Optional	Optional
Functional safety	Optional ^a	Optional	Optional	Optional
Energy saving	Optional ^a	Optional	Optional	Optional
^a Not recommended.				

Table 12 – Application classes applicable in conformance classes for network components

Application classes	Conformance classes			
	A	B	C	D
Isochronous application	—	—	—	—
High availability	—	—	—	—
Process automation	—	—	—	—
High performance	—	—	—	—
Controller to controller	—	—	—	—
Functional safety	—	—	—	—
Energy saving	—	—	—	—

4.2.3.2 Application class "Isochronous application"

Devices (i.e. IO device and IO controller) supporting the application class "isochronous application" shall support the following services additionally to the ones selected by the appropriate conformance class.

Application layer services for a device are defined in IEC 61158-5-10. Table 13 holds the application layer service selections from IEC 61158-5-10 to be supported additionally for this application class.

Table 13 – Application class "isochronous application" AL service selection

Clause	Header	Presence	Constraints
7.3.2.4	Isochronous Mode Application Class	YES	—

Application layer protocols for a device are defined in IEC 61158-6-10. Table 14 holds the application layer protocol selections from IEC 61158-6-10 to be supported additionally for this application class.

Table 14 – Application class "isochronous application" AL protocol selection component

Clause	Header	Presence	Constraints
—	—	—	—

4.2.3.3 Application class "High Availability"

Devices (i.e. IO device and IO controller) supporting the application class "high availability" shall support the following services additionally to the ones selected by the appropriate conformance class.

Application layer services for a device are defined in IEC 61158-5-10. Table 15 holds the application layer service selections from IEC 61158-5-10 to be supported additionally for this application class.

Table 15 – Application class "high availability" AL service selection

Clause	Header	Presence	Constraints
7.3	ASEs	—	—
7.3.1	AR ASE	YES	At least one ARset (mandatory); ARType IOCAR_SR and service Prm Begin shall be supported; AR switchover (backup, primary) shall be supported;
7.3.1.7	Record Data class	YES	Combined Object Container shall be supported by IO device and IO controller

Application layer protocols for a device are defined in IEC 61158-6-10. Table 16 holds the application layer protocol selections from IEC 61158-6-10 to be supported additionally for this application class.

Table 16 – Application class "high availability" AL protocol selection component

Clause	Header	Presence	Constraints
4.5.2	GlobalTime	If needed	Mandatory for IO device or IO controller with more than one port and optional for devices with one port
4.6.1	Media redundancy and loop prevention	YES, if at least two ports are available	MRP client (mandatory); Additional forwarding rules (mandatory); MRP manager with or without auto feature (optional)
4.6.2	Seamless media redundancy	If needed	—
5.2.4.8	Coding of the field ARProperties	YES	The flag ARProperties.CombinedObjectContainer shall be supported
5.2.21	Coding section related to controller to controller communication	If needed	For an integrated IO device instance used for controller to controller communication
5.6.3.9	Context Management Prm Begin End Device	YES	For an IO device

Clause	Header	Presence	Constraints
5.6.3.12.6	Additional rules for Dynamic reconfiguration	YES	For an IO device
5.6.3.13	Context Management System Redundancy Layer Device	YES	For an IO device
5.6.4.11	Context Management Prm Begin End Controller	YES	For an IO controller
5.6.4.13	Context Management System Redundancy Layer Controller	YES	For an IO controller

4.2.3.4 Application class "Process automation"

Devices (i.e. IO device and IO controller) supporting the application class "process automation" shall support the following services additionally to the ones selected by the appropriate conformance class.

Table 17 – Basis application class for "process automation"

Basis application class	Comments
High availability	Process automation is based on the definitions of application class "High availability"

Application layer services for a device are defined in IEC 61158-5-10. Table 17 and Table 18 hold the application layer service selections from IEC 61158-5-10 to be supported additionally for this application class.

Table 18 – Application class "process automation" AL service selection

Clause	Header	Presence	Constraints
7.3.4.1.3	Severity	YES	Diagnosis model covering the five different severities (mandatory)
Annex A	Device instances	YES	"Instance model and device addresses" with at least two instances of an IO device (mandatory)

Application layer protocols for a device are defined in IEC 61158-6-10. Table 17 and Table 19 hold the application layer protocol selections from IEC 61158-6-10 to be supported additionally for this application class.

Table 19 – Application class "process automation" AL protocol selection component

Clause	Header	Presence	Constraints
4.3.1.4.19	Coding of the field DeviceRoleDetails	YES	"multiple IO device interfaces" (mandatory)
5.2.8	Coding section related to Alarm and Diagnosis Data	YES	Diagnosis coding covering the coding of the five different severities (mandatory)
5.6.3.2.2	CMDEV Device Access state machine	YES	Shall be supported for additional engineering systems

4.2.3.5 Application class "High performance"

Devices (i.e. IO device and IO controller) supporting the application class "High performance" shall support the following values shown in Table 20 and Table 21.

Table 20 – Application class "High performance" features supported

Parameter	Value	Meaning
SendClockFactor	Less than 8	Communication cycles less than 250 µs
FastForwarding	Supported	—
Fragmentation	Supported	—
Preamble shortening	Supported	—
Dynamic frame packing	Supported	—

Table 21 – Application class "High performance" parameter values

Parameter	Value	Meaning
REDBeginSafetyMargin	≤ 1 µs	—
MinSupportedFSO	≤ 3 500 ns	Value using standard preamble
MinRTC3Gap	≤ 1 600 ns	—
REDEndSafetyMargin	0 ns	—
MaxFrameStartTime	≤ 3 500 ns	Value using standard preamble
MinNRTGap	≤ 1 600 ns	—
BridgeDelay	≤ 2 µs	Value using FastForwarding and standard preamble
MaxPortTxDelay	Recommended: ≤ 90 ns	The max value from IEEE Std 802.3-2018 applies.
MaxPortRxDelay	Recommended: ≤ 210 ns	The max value from IEEE Std 802.3-2018 applies.
MaxDFP_Feed	Recommended: ≤ 500 ns ≤ 1 500 ns	—
Peer to peer jitter	≤ 250 ns	—

4.2.3.6 Application class "Controller to Controller"

Devices supporting the application class "Controller to Controller" shall support the following values shown in Table 22.

Table 22 – Application class "Controller to Controller" features supported

Parameter	Value	Meaning
IO controller	YES	—
IO device	YES	—
Controller to controller records	YES	Index range 0xF860 to 0xF86F Retrieval of the stored GSD shall be supported
Shared IO device support	YES	—
Shared Input support	YES	—
Number of ARs	4	The integrated IO device of the IO controller shall support at least four concurrent ARs

4.2.3.7 Application class "Functional safety"

Devices (i.e. IO device and IO controller) supporting the application class "Functional safety" shall support the following services additionally to the ones selected by the appropriate conformance class.

Table 23 applies for an IO device and Table 24 for an IO controller.

Table 23 – Application class "Functional safety" features supported by IO device

Parameter	Value	Meaning
I&M0 record read support	YES	The firmware connector of the device supports this functionality for submodules supporting "Functional safety". The functionality of the submodule is specified in IEC 61784-3-3.
I&M4 record read support	YES	The firmware connector of the device supports this functionality for submodules supporting "Functional safety". The functionality of the submodule is specified in IEC 61784-3-3.
I&M4 record write support	NO	The firmware connector of the device supports this functionality for submodules supporting "Functional safety". The functionality of the submodule is specified in IEC 61784-3-3.
DCP service "Factory Reset" or "Reset to Factory"	Limitation	The firmware connector of the device supports this functionality for submodules supporting "Functional safety". These services shall not influence the "Functional safety" application, e.g. iParameter. In particular, the content of I&M4 record, inherited by the "Functional safety" application, shall not be reset.
ChannelErrorType range for "Functional safety" supported	YES	The firmware connector of the device supports this functionality for submodules supporting "Functional safety". The functionality of the submodule is specified in IEC 61784-3-3.
Upload&Retrieval alarm supported	OPTIONAL	The firmware connector of the device supports this functionality for submodules supporting "Functional safety". The functionality of the submodule is specified in IEC 61784-3-3.

Table 24 – Application class "Functional safety" features supported by IO controller

Parameter	Value	Meaning
Upload&Retrieval alarm supported	YES	For each submodule supporting "Functional safety"

4.2.3.8 Application class "Energy saving"

Devices (i.e. IO device and IO controller) supporting the application class "Energy saving" shall support the following services additionally to the ones selected by the appropriate conformance class.

Table 25 and Table 26 apply for an IO device and Table 27 for an IO controller.

Table 25 holds the application layer service selections from IEC 61158-5-10 to be supported additionally from an IO device for this application class.

Table 25 – Application class "Energy saving" AL service selection

Clause	Header	Presence	Constraints
7.3.5	PE ASE	YES	—

Table 26 – Application class "Energy saving" features supported by IO device

Parameter	Value	Meaning
PE_EntityFilterData record read support	YES	For each submodule supporting "Energy saving"
PE_EntityStatusData record read support	YES	For each submodule supporting "Energy saving"
Status alarm supported	YES	For each submodule supporting "Energy saving"

Table 27 – Application class "Energy saving" features supported by IO controller

Parameter	Value	Meaning
Status alarm supported	YES	For each submodule supporting "Energy saving"

4.2.4 Communication classes

4.2.4.1 General

All communication classes allow IEEE 802 and IETF communications combined with the RTE specific additions. Communication classes are:

- RT Class 1 (content specified in attribute RT_CLASS_1, see IEC 61158-6-10, field IOCRProperties.RTClass),
- RT Class 3 (content specified in attribute RT_CLASS_3, see IEC 61158-6-10, field IOCRProperties.RTClass), and
- RT Class UDP (content specified in attribute RT_CLASS_UDP, see IEC 61158-6-10, field IOCRProperties.RTClass), and
- RT Class STREAM (content specified in attribute RT_CLASS_STREAM, see IEC 61158-6-10, field IOCRProperties.RTClass).

RT Class UDP is an optional communication class. It can be used without and in combination with RT Class 1, RT Class 3, and RT Class STREAM. The support of communication classes is shown in Table 28.

Table 28 – Communication classes applicable in conformance classes

Communication classes	Conformance classes			
	A	B	C	D
RT_CLASS_1 ^a	Mandatory	Mandatory	Mandatory ^c	—
RT_CLASS_3 ^b	—	—	Mandatory	—
RT_CLASS_UDP	Optional	Optional	Optional	Optional
RT_CLASS_STREAM	—	—	—	Mandatory
^a Real-time (RT) without bandwidth allocation, Traffic Class GREEN. ^b Isochronous real-time (IRT) with bandwidth allocation, Traffic Class RED. ^c Whether - the support of RT_CLASS_1 is mandatory or optional, and - the support of ReductionRatio ≠ 1 is mandatory or optional, depends on the GSD attribute "IsochroneModeRequired".				

4.2.4.2 Communication performance parameters

The values are shown in Table 29.

NOTE The inter frame gap (12 octets at the transmitter and 8 octets at the receiver) of the IEEE Std 802.3-2018 applies.

Table 29 – Communication performance parameters

Parameter	Value	Meaning
REDBeginSafetyMargin	Minimum: 0 ns Maximum: 1 640 ns	This performance parameter is a RT_CLASS_3 property.
MinSupportedFSO	Minimum: 1 280 ns (using Short Preamble), 1 760 ns (using Long Preamble) Maximum: 5 000 ns	This performance parameter is a RT_CLASS_3 property.
MinRTC3Gap	Minimum: 1 120 ns Maximum: 2 000 ns	This performance parameter is a RT_CLASS_3 property.
REDEndSafetyMargin	0 ns	This performance parameter is a RT_CLASS_3 property.
MaxFrameStartTime	Maximum: 5 000 ns	This performance parameter is a RT_CLASS_1 / RT_CLASS_2 / RT_CLASS_UDP property.
MinNRTGap	Minimum: 12 octets Maximum: 18 octets	This performance parameter is a RT_CLASS_1 / RT_CLASS_2 / RT_CLASS_3 / RT_CLASS_UDP / RT_CLASS_STREAM property.
MinTASGap	Minimum: 12 octets Maximum: 18 octets	This performance parameter is a RT_CLASS_1 / RT_CLASS_2 / RT_CLASS_UDP / RT_CLASS_STREAM property.
TASWindow-BeginSafetyMargin	Minimum: 0 ns Maximum: IPG + Preamble + StartDelimiter	This performance parameter is a RT_CLASS_STREAM property.
TASWindow-EndSafetyMargin	Minimum: 0 ns Maximum: IPG + Preamble + StartDelimiter	This performance parameter is a RT_CLASS_STREAM property.
TASWindow-MinSupportedFSO	Minimum: 0 ns Maximum: IPG + Preamble + StartDelimiter	This performance parameter is a RT_CLASS_STREAM property.

Parameter	Value	Meaning
TASMaxFrameStartTime	Minimum: 0 ns Maximum: 6 octets	This performance parameter is a RT_CLASS_1 / RT_CLASS_2 / RT_CLASS_UDP / RT_CLASS_STREAM property.

4.2.4.3 RT_CLASS_x transmitter

4.2.4.3.1 General

See 4.2.2.1 node class 1) c).

The values for a RT_CLASS_1 / RT_CLASS_UDP transmitter are shown in Table 30. The deviation measurable on the MDI depends on the added jitter of the transition from the MAC, MII to the MDI.

Table 30 – FrameSendOffset deviation for RT_CLASS_1 / RT_CLASS_UDP

Parameter	Value	Meaning
Frame send offset deviation	Minimum (Less than 10 % of the used update interval ^a ; 10 ms)	This performance parameter is a RT_CLASS_1 / RT_CLASS_UDP transmitter property.
^a The update interval (UI) is calculated as $UI = SCF \times RR \times 31,25 \mu s$ with the data from the used IOCR.		

4.2.4.3.2 Certification test

The values for a RT_CLASS_1 / RT_CLASS_UDP transmitter, when applying "Normal netload" test cases during certification testing, are shown in Table 31. The deviation measurable on the MDI depends on the added jitter of the transition from the MAC, MII to the MDI.

Table 31 – FrameSendOffset deviation for RT_CLASS_1 / RT_CLASS_UDP certification

Parameter	Value	Meaning
Frame send offset deviation	Less than 100 % of the used update interval, for ≤ 16 ms Less than 50 % of the used update interval ^a , for > 16 ms	This performance parameter is a RT_CLASS_1 / RT_CLASS_UDP transmitter property.
^a The update interval (UI) is calculated as $UI = SCF \times RR \times 31,25 \mu s$ with the data from the used IOCR.		

4.2.4.4 RT_CLASS_STREAM transmitter

See 4.2.2.1 node class 1) a) or 1) b).

The reference point of the frame send offset for RT_CLASS_STREAM is defined at the MDI. Thus, the deviation values are dependent on the used PHYs and the negotiated MAU type.

The minimum possible values for a RT_CLASS_STREAM transmitter are shown in Table 32. The possible values are the summation of values from Table 32 and Table 33. Table 34 shows the value for certification.

Table 32 – FrameSendOffset deviation factors – SendListControl

Parameter	Value	Meaning
Frame send offset deviation ^a	≤ 10 ns	This performance parameter is a SendListControl property.
IPG ^b	12 octets	This performance parameter is a SendListControl property.
Burst size ^c	255 frames	This performance parameter is a SendListControl property.
^a For the first frame created by SendListControl. See IEC 61158-6-10. ^b For the second and any following frame created by SendListControl. See IEC 61158-6-10. ^c Size of burst created by SendListControl. See IEC 61158-6-10.		

Table 33 – FrameSendOffset deviation factors – PHY

Factor	MII	Value	Meaning
PHY	–	See Table 74	Value provided by the PHY manufacturer
10BaseT1L	MII	0 – 400 ns	Value provided by the PHY manufacturer for this MAU type
100BaseTX	MII	0 – 40 ns	Value provided by the PHY manufacturer for this MAU type
	RMII	0 – 20 ns	
1000BaseTX	GMII	0 – 8 ns	Value provided by the PHY manufacturer for this MAU type
	RGMII	0 – 8 ns	Value provided by the PHY manufacturer for this MAU type
2,5GBaseTX	–	0 – 8 ns	Value provided by the PHY manufacturer for this MAU type
5GBaseTX	–	0 – 8 ns	Value provided by the PHY manufacturer for this MAU type
10GBaseTX	–	0 – 8 ns	Value provided by the PHY manufacturer for this MAU type

Table 34 – FrameSendOffset deviation

Parameter	Value	Meaning
Frame send offset deviation ^a	Mandatory Minimum (≤ 6 octets ^b ; 1 µs)	This performance parameter is a RT_CLASS_STREAM transmitter property.
^a For the first frame created by SendListControl. Following frames should use IPG. See IEC 61158-6-10. ^b Example: Time for 6 octets is 48 ns for 1 Gbit/s or 480 ns for 100 Mbit/s.		

4.2.4.5 RT_CLASS_3 transmitter

See 4.2.2.1 node class 1) a).

The values for a RT_CLASS_3 transmitter are shown in Table 35 and Table 36. The deviation measurable on the MDI depends on the added jitter of the transition from the MAC, MII to MDI.

Table 35 – Minimum FrameSendOffset

Parameter	Value	Meaning
Minimum frame send offset ^a	SendClockFactor ≥ 8: Mandatory ≤ 5 000 ns	This performance parameter is a RT_CLASS_3 transmitter, receiver and forwarder property.
	SendClockFactor < 8: Mandatory ≤ 2 000 ns	
^a The real value, if lower, is stated in the GSD attribute "MinFSO".		

Table 36 – FrameSendOffset deviation

Parameter	Value	Meaning
Frame send offset deviation ^a	Node with RT_CLASS_3 bridge Mandatory ≤ 10 ns	This performance parameter is a RT_CLASS_3 transmitter property.
	End node ^a Recommended ≤ 10 ns	
^a The value of the deviation shall be as low as needed to avoid any disturbance in a RT_CLASS_3 domain.		

4.2.4.6 RT_CLASS_3 bridges

The values for RT_CLASS_3 bridges are shown in Table 37.

Table 37 – Parameters for RT_CLASS_3 bridges

Parameter	Value	Meaning
Max Retention Time	20 µs (mandatory) 4 ms (optional)	This performance parameter is a RT_CLASS_3 bridge property.
Frame send offset deviation	Mandatory ≤ 10 ns	This performance parameter is a RT_CLASS_3 bridge property.
RFSafetyMargin	0 ns ≤ Mandatory ≤ 100 ns	This performance parameter is a RT_CLASS_3 bridge property if FrameDataProperties.ForwardingMode:= "Relative mode" is supported
NumberOfRTC3Forwarder	Mandatory ≥ 128	This performance parameter is a RT_CLASS_3 bridge property. It defines the maximum network diameter reachable for a RT_CLASS_3 domain. Both InputCRs and OutputCRs are counted. Example: The maximum network diameter with NumberOfRTC3Forwarder:= 128 is - 64 nodes (without MRPD), and - 32 nodes (with MRPD).
MaxRTC3BridgeDelay	Recommended: ≤ 2 µs Mandatory: ≤ 10 µs	This performance parameter is a RT_CLASS_3 bridge property. It defines the maximum bridge delay for RT_CLASS_3 packets.

4.2.4.7 Synchronization

4.2.4.7.1 PTCP

The performance parameters of a PTCP control loop are shown in Table 38.

Table 38 – PTCP control loop

Parameter	Value	Meaning
Allowed frequency changing speed	Mandatory $\leq 5 \frac{\mu\text{Hz}}{\text{Hz/s}}$	This performance parameter is a sync slave property.

4.2.4.7.2 IEEE Std 802.1AS-2020

The performance parameters of an IEEE Std 802.1AS-2020 control loop are shown in Table 39.

Table 39 – IEEE Std 802.1AS-2020 control loop

Parameter	Value	Meaning
Allowed frequency changing speed	Mandatory $\leq 5 \frac{\mu\text{Hz}}{\text{Hz/s}}$	This performance parameter is a sync slave property.

4.2.4.8 Fragmentation

Table 40 shows the allowed maximum frame size transmitted by a node in the GREEN or YELLOW period. This definition does not apply for nodes with FragmentationType == Dynamic.

Table 40 – Maximum frame size

SendClockFactor	Condition	Maximum frame size
1 – 2	FragmentationType ^a == Static	128 octets
3 – 7	FragmentationType ^a == Static	256 octets
8 – 128	FragmentationType ^a == Static && FrameDetails.FragmentationMode == Fragmentation enabled	
	! FragmentationType ^a FrameDetails.FragmentationMode == Fragmentation disabled	Maximum IEEE Std 802.3-2018 frame
^a See GSD specification for the definition of this attribute.		

4.2.5 Void

Intentionally left blank.

4.2.6 Protocol and timing parameters

4.2.6.1 Internet protocol and Dynamic name service

The recommended values for the IP layer defined in IETF RFC 791 are shown in Table 41 and Table 42. An IO controller may optionally use static ARP entries which do not timeout.

Table 41 – IP layer parameters for IO controller

Parameter	Value	Comment
ARP_Cache_Size	Minimum 32	The amount of the supported IODs
ARP_Cache_Timeout	60 s	—

Table 42 – IP layer parameters for IO device

Parameter	Value	Comment
ARP_Cache_Size	Minimum 32	—
ARP_Cache_Timeout	60 s	—

The allowed time values for name resolution defined in IEC 61158-6-10, 4.12 are shown in Table 43 and Table 44.

Table 43 – Timeout values for name resolution

Parameter	Value	Comment
ARP-ResponseTimeout	2 s	See IETF RFC 826
DCP-IdentifyTimeout	≥ 400 ms	See IEC 61158-6-10, 4.3.1.3.5.3, ResponseDelayTimeout
DCP-Set/GetTimeout	1 s	See IEC 61158-6-10, 4.3.2.2.1.5, UC Client Timeout
DCP MaxRetryLimit Set/Get	2	See IEC 61158-6-10, 4.3.2.2.1.5, Max Retry Limit
DNS-RequestTimeout	16 s	See IETF RFC 1034

Table 44 – Values for hello request deviation

Parameter	Value	Comment
DCP-Hello Req deviation	Maximum (10 ms; Less than 10 % of the used FSHelloInterval)	This performance parameter is a DCP Hello transmitter property.

4.2.6.2 Discovery and configuration protocol

The allowed values for DCP defined in IEC 61158-6-10 are shown in Table 45, Table 46 and Table 47.

Table 45 – DCP Identify responder resources

Parameter	Value	Comment
DCPMCR instances for DelayResponseFactor = 1	Mandatory: 1 Recommended: 2 1 – n	Number of concurrent running DCP_Identify services for indications with DelayResponseFactor = 1 The supported number of instances should cover the concurrently supported IOARs to avoid delay during startup.
DCPMCR instances for DelayResponseFactor > 1	Mandatory: 1 Recommended: 2 1 – n	Number of concurrent running DCP_Identify services for indications with DelayResponseFactor > 1 The supported number of instances should cover the expected number concurrently supported network scanning tools.

Table 46 – DCP access control

Service	Support	Comment
ARProperties.RejectDCPsetRequests:= Rejected	Optional	DCPset.req will be rejected if this flag is set for at least one established AR. This flag is used for IO controller, IO device and NME.

Table 47 – DCP Identify pruning support

Parameter	Support	Comment
DCP_Identify with destination MAC defined for pruning	Mandatory	Allow multicast pruning in bridges for resource protection at the egress port of a bridge connected to an end station. End station component: Mandatory if MAUTypeExtension:=APL is supported Recommend for all Bridge component: Mandatory, including PPSM state machine, if MAUTypeExtension:=APL is supported

4.2.6.3 Media redundancy protocol

The allowed values for MRP defined in IEC 61158-6-10 are shown in Table 48 and Table 49.

Table 48 – Maximum time values for MRP for 10 Mbit/s and for ≥ 100 Mbit/s

Parameter	Data rate	Value	Comment
MaxBridgeDelay ^{a b}	10 Mbit/s	≤ 8 ms	Every bridge supporting MRP shall forward a MRP-PDU in this time.
	≥ 100 Mbit/s	≤ 4 ms	
^a For forwarding MRP Test Frames.			
^b A lesser BridgeDelay allows a greater number of switches (NoS) in a ring topology with a given switchover time. With the maximum value, the number of switches (NoS) in a ring topology is reduced to NoS<15.			

Table 49 – Maximum packet size for MRP

Parameter	Value	Comment
MRP test frame size	≤ 98 octets	Maximum packet size of a MRP test frame when used together with this document.

4.2.6.4 Precision transparent clock protocol

The allowed time values for PTCP defined in IEC 61158-6-10 are shown in Table 50 and Table 51.

Table 50 – Maximum time values for PTCP

Parameter	Value	Comment
Max Delay Request Repeat	5	—
Max Delay Response Time	< 10 ms	Recommended
Max Delay Response Time	< 25 ms	Mandatory
Max Bridge Delay ^a	≤ 4 ms	Recommended
Max Bridge Delay ^a	≤ 40 ms	Mandatory
Bridge Delay measurement accuracy ^b	≤ 50 ns	Recommended
Bridge Delay measurement accuracy ^b	≤ 100 ns	Mandatory
Timestamp accuracy	≤ 8 ns	Recommended
Timestamp accuracy	≤ 10 ns	Mandatory
Line/Cable Delay measurement accuracy ^c	≤ 20 ns	Recommended
Line/Cable Delay measurement accuracy ^c	≤ 50 ns	Mandatory
^a For forwarding PTCP Sync Frames. ^b Measurement of the Bridge Delay may have a jitter but should be offset free ("zero mean"). ^c Measurement of the Line/Cable Delay may have a jitter but should be offset free ("zero mean").		

Table 51 – Precision of timers used for PTCP

Parameter	Value	Comment
"DelayT" deviation	[-0; +100 ms]	—
"LineT" deviation	[-0; +100 ms]	—

4.2.6.5 Time synchronization

The allowed time values for time synchronization using IEEE Std 802.1AS-2020 are shown in Table 52, Table 53, and Table 54.

Table 52 – Maximum time values

Parameter	Value	Comment
Max Peer Delay Response Time	< 10 ms	Recommended
Max Peer Delay Response Time	< 25 ms	Mandatory
Max Forwarding Delay ^a	≤ 4 ms	Recommended
Max Forwarding Delay ^a	≤ 40 ms	Mandatory
Forwarding Delay measurement accuracy ^b	≤ 20 ns	Recommended
Forwarding Delay measurement accuracy ^b	≤ 50 ns	Mandatory
Timestamp accuracy	≤ 8 ns	Recommended
Timestamp accuracy	≤ 10 ns	Mandatory
Peer Delay measurement accuracy ^c	≤ 20 ns	Recommended
Peer Delay measurement accuracy ^c	≤ 50 ns	Mandatory
^a For forwarding Sync Frames.		
^b Measurement of the Forwarding Delay may have a jitter but should be offset free ("zero mean").		
^c Measurement of the Peer Delay may have a jitter but should be offset free ("zero mean").		

Table 53 – Maximum deviation values for Global Time

Parameter	Value
Deviation ^a between SyncMaster (Grandmaster) and an arbitrary SyncSlave	< 100 μs
Deviation ^a between two arbitrary SyncSlaves	< 200 μs
^a Measurement principle from PTCIP applies	

Table 54 – Maximum deviation values for Working Clock

Parameter	Value
Deviation ^a between SyncMaster (Grandmaster) and an arbitrary SyncSlave	< 1 μs
Deviation ^a between two arbitrary SyncSlaves	< 2 μs
^a Measurement principle from PTCIP applies	

4.2.6.6 Link layer discovery protocol

4.2.6.6.1 General

IEC 61158-6-10 uses IEEE Std 802.1AB-2016 according to IEEE Std 802.1AB-2016, 11.3.1 in version 1 mode together with version 1 MIB. The additional support of version 2 mode and version 2 MIBs is optional.

The IEEE Std 802.1AB-2016, 9.2.5.20 defined variable txNow:= TRUE is used concurrently with any change of the fields of the LLDP-PDU. In this case, a node transmits LLDP PDUs "on data change".

The IEEE Std 802.1AB-2016 uses the ChassisID/PortID as neighborhood "TAG" to support virtualization. PROFINET IO defines the SourceMAC as additional "TAG" to make sure that "Assigning a name" leads immediately to an updated entry for a neighbor. Thus, false "Multiple neighbors" diagnosis shall be avoided.