IEC 61784-2-8

Edition 1.0 2023-03

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Industrial networks – Profiles –
Part 2-8: Additional real-time fieldbus profiles based on ISO/IEC/IEEE 8802-3 – CPF 8

Réseaux industriels – Profils –
Partie 2-8: Profils de bus de terrain supplémentaires pour les réseaux en temps réel fondés sur l'ISO/IEC/IEEE 8802-3 – CPF 8

IEC 61784-2-8:2023-03(en-fr)

IEC Secretariat
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

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

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NOTE Combinations of protocol types are specified in the IEC 61784-1 series and the IEC 61784-2 series.

IEC 61784-2-8 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 profile CP 8/6.

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.

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 2-8: Additional real-time fieldbus profiles based on ISO/IEC/IEEE 8802-3 – CPF 8

1 Scope

This part of IEC 61784-2 defines extensions of Communication Profile Family 8 (CPF 8) for Real-Time Ethernet (RTE). CPF 8 specifies a set of Real-Time Ethernet (RTE) communication profiles (CPs) and related network components based on the IEC 61158 series (Type 23), 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 8 are specified in IEC 61784-1-8.

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 61158-5-23:2023, *Industrial communication networks – Fieldbus specifications – Part 5-23: Application layer service definition – Type 23 elements*

IEC 61158-6-23:2023, *Industrial communication networks – Fieldbus specifications – Part 6-23: Application layer protocol specification – Type 23 elements*

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 61784-5-8, *Industrial communication networks – Profiles – Part 5-8: Installation of fieldbuses – Installation profiles for CPF 8*

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

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

IEEE Std 1588-2019, *IEEE Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems*

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]

3 Terms, definitions, abbreviated terms, acronyms, 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.

CP	Communication Profile [according to IEC 61784-1-0]
CPF	Communication Profile Family [according to IEC 61784-1-0]
ICMP	Internet Control Message Protocol (see IETF RFC 792)
IETF	Internet Engineering Task Force
IP	Internet Protocol (see IETF RFC 791)
LLDP	Link Layer Discovery Protocol (see IEEE Std 802.1AB-2016)
n.a.	Not applicable
PI	Performance indicator

RSTP Rapid Spanning Tree Algorithm and Protocol (see IEEE Std 802.1Q-2018)

TCP Transmission Control Protocol (see IETF RFC 793)

UDP User Datagram Protocol (see IETF RFC 768)

3.3 Symbols

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

3.4 Conventions

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

4 CPF 8 (CC-Link) – RTE communication profiles

4.1 General overview

Communication Profile Family 8 defines profiles based on ISO/IEC/IEEE 8802-3, IEC 61158-5-23 and IEC 61158-6-23, which specify the communication system protocols commonly known as CC-Link IE[1].

In this document, the following communication profiles are specified for CPF 8:

– Profile 8/4

  a profile using fiber optic cable in a ring topology or copper cable in linear and star topologies (CC-Link IE Control Network)

– Profile 8/5

  a profile using copper cable in linear and star topologies (CC-Link IE Field Network).

– Profile 8/6

  a profile using fiber optic cable in a ring topology or copper cable in linear and star topologies (CC-Link IE TSN).

4.2 CP 8/4

4.2.1 Physical layer

The physical layer of CP 8/4 is as specified in ISO/IEC/IEEE 8802-3.

The bit rate shall be 1 000 Mbit/s. The full duplex and the auto negotiation function shall not be used.

Recommended connectors, cables and installation guidelines are specified in IEC 61784-5-8.

4.2.2 Data link layer

The data link layer of CP 8/4 is as specified in ISO/IEC/IEEE 8802-3.

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[1] CC-Link™ and CC-Link IE™ are trade names of Mitsubishi Electric Co. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of the trade name holder or any of its products. Compliance with this document does not require use of the trade names CC-Link™ or CC-Link IE™. Use of the trade names CC-Link™ or CC-Link IE™ requires permission of CC-Link Partner Association.

4.2.3 Application layer

4.2.3.1 AL service selection

Application Layer services are defined in IEC 61158-5-23. Table 1 shows the subclauses included in this profile.

Table 1 – CP 8/4: AL service selection

Clause	Header	Presence	Constraints
1	Scope	YES	—
2	Normative references	YES	—
3	Terms, definitions, symbols, abbreviated terms and conventions	YES	—
4	Concept	YES	—
5	Data type ASE	YES	—
6	Communication model specification	—	—
6.1	Communication model	YES	—
6.2	ASE	—	—
6.2.1	Overview type C	YES	—
6.2.2	Overview type F	NO	—
6.2.3	Cyclic data ASE type C	YES	—
6.2.4	Cyclic data ASE type F	NO	—
6.2.5	Acyclic data ASE type C	YES	—
6.2.6	Acyclic data ASE type F	NO	—
6.2.7	Management ASE	YES	—
6.2.8	Synchronization ASE	NO	—
6.2.9	Measurement ASE	YES	—
6.3	AR Type C	YES	—
6.4	AR Type F	NO	—

4.2.3.2 AL protocol selection

Application Layer protocols are defined in IEC 61158-6-23. Table 2 shows the subclauses included in this profile.

Table 2 – CP 8/4: AL protocol selection

Clause	Header	Presence	Constraints
1	Scope	YES	—
2	Normative references	YES	—
3	Terms, definitions, symbols, abbreviated terms and conventions	YES	—
4	FAL syntax description	—	—
4.1	FALPDU type C abstract syntax	YES	—
4.2	FALPDU type F abstract syntax	NO	—
4.3	Data assignmentds for type C	YES	—
4.4	Data assignmentds for type F	NO	—
5	FAL transfer syntax	—	—
5.1	Encoding rules	YES	—
5.2	FALPDU type C elements encoding	YES	—
5.3	FALPDU type F elements encoding	NO	—
6	Structure of the FAL protocol state machine	YES	—
7	FAL service protocol machine (FSPM)	—	—
7.1	Overview	YES	—
7.2	FSPM type C	YES	—
7.3	FSPM type F	NO	—
8	Application relationship protocol machine (ARPM)	—	—
8.1	ARPM type C	YES	—
8.2	ARPM type F	NO	—
9	DLL mapping protocol machine (DMPM)	—	—
9.1	DMPM type C	YES	—
9.2	DMPM type F	NO	—

4.2.4 Performance indicator selection

4.2.4.1 Performance indicator overview

Table 3 provides an overview of the CP 8/4 performance indicators.

Table 3 – CP 8/4: PI overview

Performance indicator	Applicable	Constraints
Delivery time	YES	—
Number of end-stations	YES	—
Basic network topology	YES	—
Number of switches between end-stations	YES	—
Throughput RTE	YES	—
Non-RTE bandwidth	YES	—
Time synchronization accuracy	NO	—
Non-time-based synchronization accuracy	NO	—
Redundancy recovery time	YES	—

4.2.4.2 Performance indicator dependencies

Table 4 specifies the dependencies of the performance indicators (row) from the influencing performance indicators (column).

Table 4 – CP 8/4: PI dependency matrix

Dependent PI	Influencing PI							
	Delivery time	Number of end-stations	Basic network topology	Number of switches between end-stations	Throughput RTE	Non-RTE bandwidth	Non-time-based synchronization accuracy	Redundancy recovery time
Delivery time		Yes	No	No	Yes	Yes	No	Yes
Number of end-stations	No		No	No	No	No	No	No
Basic network topology	No	No		No	No	No	No	No
Number of switches between end-stations	No	No	No		No	No	No	No
Throughput RTE	Yes	Yes	No	No		Yes	No	Yes
Non-RTE bandwidth	No	No	No	No	No		No	No
Non-time-based synchronization accuracy	No	No	No	No	No	No		No
Redundancy recovery time	No	No	No	No	No	No	No	

4.2.4.3 Delivery time

4.2.4.3.1 Delivery time calculation

The delivery time between any two end-stations is calculated as the sum of the following:

- *sender delay time* (see 4.2.4.3.2),
- *transmission time* (see 4.2.4.3.3),
- *receiver delay time* (see 4.2.4.3.4).

NOTE Unless otherwise specified, the following units apply: all time units are microseconds, all sizes are octets, and all rates are Mbit/s.

4.2.4.3.2 Sender delay time

4.2.4.3.2.1 Sender delay time calculation

The *sender delay time* is calculated as the sum of the following:

- *send buffer transfer time* (see 4.2.4.3.2.2),
- *frame transmission time* (see 4.2.4.3.2.3),
- *transmission delay time* (see 4.2.4.3.2.4).

4.2.4.3.2.2 Send buffer transfer time

The *send buffer transfer time* is calculated as the product of the following:

- *cyclic data transfer size*,
- *send buffer transfer time* (µs/octet).

The *send buffer transfer time* is specified by the manufacturer. A typical value is 0,01 µs/octet.

4.2.4.3.2.3 Frame transmission time

The *frame transmission time* is calculated as the sum of the following:

- *cyclic data transfer time*,
- *cyclic data header transfer time*,
- *frame gap time*,
- *preamble time*.

The *cyclic data transfer time* is calculated as shown in Formula (1):

$$cyclic\ data\ transfer\ time = cyclic\ data\ transfer\ size \times 8 / transmission\ rate \quad (1)$$

The *transmission rate* is specified by the manufacturer. A typical value is 1 000 Mbit/s.

The *cyclic data header transfer time* is calculated as shown in Formula (2):

$$cyclic\ data\ header\ transfer\ time = 44 \times number\ of\ cyclic\ data\ frames \times 8 / transmission\ rate \quad (2)$$

The *number of cyclic data frames* is calculated as shown in Formula (3):

$$number\ of\ cyclic\ data\ frames = 1 + (cyclic\ data\ transfer\ size / (1\ 518 - 44)) \quad (3)$$

NOTE In Formula (3) the calculated value is truncated to yield an integer result.

The *frame gap time* is calculated as shown in Formula (4):

$$frame\ gap\ time = 12 \times (number\ of\ cyclic\ data\ frames - 1) \times 8 / transmission\ rate \quad (4)$$

The *preamble time* is calculated as shown in Formula (5):

$$preamble\ time = 8 \times (number\ of\ cyclic\ data\ frames - 1) \times 8 / transmission\ rate \quad (5)$$