IEC 61784-2-18

Edition 1.0 2023-05

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Industrial networks – Profiles –
Part 2-18: Additional real-time fieldbus profiles based on ISO/IEC/IEEE 8802-3 – CPF 18

Réseaux industriels – Profils –
Partie 2-18: Profils de bus de terrain supplémentaires pour les réseaux en temps réel fondés sur l'ISO/IEC/IEEE 8802-3 – CPF 18

IEC 61784-2-18:2023-05(en-fr)

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

IEC 61784-2-18 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.

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- withdrawn,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 2-18: Additional real-time fieldbus profiles based on ISO/IEC/IEEE 8802-3 – CPF 18

1 Scope

This part of IEC 61784-2 defines Communication Profile Family 18 (CPF 18). CPF 18 specifies a set of Real-Time Ethernet (RTE) communication profiles (CPs) and related network components based on the IEC 61158 series (Type 22), 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 profile(s) use ISO/IEC/IEEE 8802-3 communication networks and its related network components or IEC 61588 and in some cases amend those standards to obtain RTE features.

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 61158-3-22:2014, *Industrial communication networks – Fieldbus specifications – Part 3-22: Data-link layer service definition – Type 22 elements*

IEC 61158-4-22:2014, *Industrial communication networks – Fieldbus specifications – Part 4-22: Data-link layer protocol specification – Type 22 elements*

IEC 61158-5-22:2014, *Industrial communication networks – Fieldbus specifications – Part 5-22: Application layer service definition – Type 22 elements*

IEC 61158-6-22:2014, *Industrial communication networks – Fieldbus specifications – Part 6-22: Application layer protocol specification – Type 22 elements*

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

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*

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*

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, IEEE Std 802.1Q-2018 and the following 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

3.1.1
logical double line
sequence of root device and all ordinary devices processing the DLPDU in forward and backward direction

3.1.2
real time frame line
RTFL
communication model with devices communicating in a logical double line

3.1.3
real time frame network
RTFN
communication model with devices communicating in a switched network

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)
NoS Number of Switches
PI Performance indicator
PTP Precision Time Protocol (see IEC 61588)
RSTP Rapid Spanning Tree Algorithm and Protocol (see IEEE Std 802.1Q-2018)
RTFL Real time frame line
RTFN Real time frame network
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 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 18 symbols

Symbol	Definition	Unit
l_B	Distance along the cable in backward direction	m
l_C	Cable length	m
l_F	Distance along the cable in forward direction	m
NoDoB	Number of devices in backward direction	–
NoDoF	Number of devices in forward direction	–
NoS	Number of switching devices	–
t_{CD}	Cable delay	ns/m
t_{cyc}	Cycle time of communication system/relation	µs
t_D	Delivery time	µs
t_{data}	Transmit time of DLPDUs	µs
t_{pd}	Propagation delay	µs
t_{STsink}	Sink stack traversal time	µs
t_{STsrc}	Source stack traversal time	µs
t_{SW}	Delay time of a switch	µs

3.4 Conventions

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

4 CPF 18 (SafetyNET p[1]) – RTE communication profiles

4.1 General overview

Communication Profile Family 18 defines profiles based on IEC 61158-3-22, IEC 61158-4-22, IEC 61158-5-22 and IEC 61158-6-22.

In this document, the following communication profiles are specified for CPF 18.

– Profile 18/1

  This profile defines protocol and service selection for devices which utilize the communication model real time frame line (RTFL).

– Profile 18/2

  This profile defines protocol and service selection for devices which utilize the communication model real time frame network (RTFN).

4.2 CP 18/1

4.2.1 Physical layer

The physical layer shall be based on standard Ethernet hardware according to ISO/IEC/IEEE 8802-3.

CP 18/1 devices shall use a data rate of 100 Mbit/s and full-duplex transmission mode. A combination of full-duplex and 100Base-TX with auto crossover function (wire, 2 twisted pairs) should be used.

When using cables, they shall be rated Cat5e or better, and shielded in an appropriate way (FTP, STP or SFTP) depending upon EMC constraints.

4.2.2 Data link layer

Data link layer is described in IEC 61158-3-22 and IEC 61158-4-22. Table 2 specifies the use of the services included in this profile. Table 3 specifies the use of the protocol included in this profile.

Table 2 – CP 18/1: DLL service selection

Clause	Header	Presence	Constraints
1	Scope	YES	—
2	Normative references	YES	—
3	Terms, definitions, abbreviations and conventions	Partial	If applicable
4	Data-link layer services and concepts	—	—
4.1	Operating principle	YES	—
4.2	Communication models	—	—
4.2.1	Overview	YES	—
4.2.2	RTFL device reference model	YES	—
4.2.3	RTFN device reference model	NO	—
4.3	Topology	—	—

[1] SafetyNET p is a trade name of the Pilz GmbH & Co. KG. 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 profile does not require use of the trade name SafetyNET p. Use of the trade name SafetyNET p requires permission of the trade name holder.

Clause	Header	Presence	Constraints
4.3.1	RTFL topology	YES	—
4.3.2	RTFN topology	NO	—
4.4	Addressing	—	—
4.4.1	Overview	YES	—
4.4.2	RTFL device addressing	YES	—
4.4.3	RTFN device addressing	NO	—
4.5	Gateway	YES	—
4.6	Interaction models	—	—
4.6.1	Overview	YES	—
4.6.2	Producer-consumer	YES	—
4.6.3	Publisher-subscriber	NO	—
4.7	Synchronization concept	YES	—
5	Communication services	—	—
5.1	Overview	Partial	Only services selected by this CP
5.2	Communication management services	—	—
5.2.1	Overview	YES	—
5.2.2	RTFL-network verification	—	—
5.2.2.1	DL-Network verification service (NV)	YES	—
5.2.2.2	DL-RTFN scan network read service (RTFNSNR)	NO	—
5.2.3	Communication management	—	—
5.2.3.1	DL-RTFN connection establishment service (RTFNCE)	NO	—
5.2.3.2	DL-RTFN connection release service (RTFNCR)	NO	—
5.2.3.3	DL-RTFL control service (RTFLCTL)	YES	—
5.2.3.4	DL-RTFL configuration service (RTFLCFG)	YES	—
5.2.3.5	DL-Read configuration data service (RDCD)	YES	—
5.2.3.6	DL-RTFL configuration service 2 (RTFLCFG2)	YES	—
5.2.3.7	DL-Read configuration data service 2 (RDCD2)	YES	—
5.3	Cyclic data channel service (CDC)	YES	—
5.4	Message channel services (MSC)	YES	—
5.5	Time synchronization	—	—
5.5.1	DL-DelayMeasurement start service (DMS)	YES	—
5.5.2	DL-DelayMeasurement read service (DMR)	YES	—
5.5.3	DL-PCS configuration service (PCSC)	YES	—
5.5.4	DL-Sync master configuration service (SYNC_MC)	YES	—
5.5.5	DL-Sync start service (SYNC_START)	YES	—
5.5.6	DL-Sync stop service (SYNC_STOP)	YES	—
5.6	Media independent interface (MII) management services	YES	—

Table 3 – CP 18/1: DLL protocol selection

Clause	Header	Presence	Constraints
1	Scope	YES	—
2	Normative references	YES	—
3	Terms, definitions, abbreviations and conventions	Partial	If applicable
4	Overview of the DL-protocol	—	—
4.1	Operating principle	YES	—
4.2	Communication model	—	—
4.2.1	Overview	YES	—
4.2.2	RTFL device reference model	YES	—
4.2.3	RTFN device reference model	NO	—
4.3	Topology	—	—
4.3.1	RTFL topology	YES	—
4.3.2	RTFN topology	NO	—
4.4	DLPDU processing	—	—
4.4.1	Communication model RTFL	YES	—
4.4.2	Communication model RTFN	NO	—
4.5	General communication mechanisms	YES	—
4.6	Gateway	YES	—
4.7	Interaction models	—	—
4.7.1	Overview	YES	—
4.7.2	Producer-consumer	YES	—
4.7.3	Publisher-subscriber	NO	—
5	DLPDU structure	—	—
5.1	Overview	YES	—
5.2	Data types and encoding rules	YES	—
5.3	DLPDU identification	YES	—
5.4	General DLPDU structure	—	—
5.4.1	Type 22 DLPDU inside an ISO/IEC/IEEE 8802-3 DLPDU	YES	—
5.4.2	Type 22 DLPDU inside a VLAN tagged ISO/IEC/IEEE 8802-3 DLPDU	NO	—
5.4.3	Type 22 DLPDU inside an UDP DLPDU	NO	—
5.4.3	Type 22 DLPDU structure	YES	—
5.5	Communication management DLPDUs	—	—
5.5.1	RTFL-network verification DLPDUs	YES	—
5.5.2	RTFN scan network DLPDUs	NO	—
5.5.3	Identification data	YES	—
5.5.4	RTFN connection management DLPDU	NO	—
5.5.5	ID data	NO	—
5.5.6	RTFL control DLPDU	YES	—
5.5.7	RTFL configuration DLPDU	YES	—
5.6	Cyclic data channel (CDC) DLPDUs	—	—
5.6.1	Cyclic data channel line (CDCL) DLPDU	YES	—
5.6.2	Cyclic data channel network (CDCN) DLPDU	NO	—

Clause	Header	Presence	Constraints
5.7	Cyclic data channel (CDC) DLPDU data	YES	—
5.8	Message channel (MSC) DLPDUs	—	—
5.8.1	Message channel line (MSCL) DLPDU	YES	—
5.8.2	Message channel network (MSCN) DLPDU	NO	—
5.9	Message channel DLPDU data – MSC message transfer protocol (MSC-MTP)	YES	—
5.10	Time synchronization	YES	—
6	Telegram timing and DLPDU handling	—	—
6.1	Communication mechanism	—	—
6.1.1	Communication model RTFL	YES	—
6.1.2	Communication model RTFN	NO	—
6.2	Device synchronization	—	—
6.2.1	Communication model RTFL – precise clock synchronization	YES	—
6.2.2	Communication model RTFN	NO	—
7	Type 22 protocol machines	—	—
7.1	RTFL device protocol machines	YES	—
7.2	RTFN device protocol machines	NO	—
7.3	Message channel – message transfer protocol (MSC-MTP)	YES	—

4.2.3 Application layer

Application layer is described in IEC 61158-5-22 and IEC 61158-6-22. Table 4 specifies the use of the services included in this profile. Table 5 specifies the use of the protocol included in this profile.

Table 4 – CP 18/1: AL service selection

Clause	Header	Presence	Constraints
1	Scope	YES	—
2	Normative references	YES	—
3	Terms, definitions, abbreviations and conventions	Partial	If applicable
4	Concepts	—	—
4.1	Common concepts	YES	—
4.2	Type specific concepts	—	—
4.2.1	Operating principle	YES	—
4.2.2	Communication model overview	—	—
4.2.2.1	Overview	YES	—
4.2.2.2	Communication model RTFL	YES	—
4.2.2.3	Communication model RTFN	NO	—
4.2.3	Application layer element description	YES	—
4.2.4	Producer-consumer interaction	YES	—
4.2.5	Device reference models	—	—
4.2.5.1	RTFL device reference model	YES	—
4.2.5.2	RTFN device reference model	NO	—
5	Data type ASE	YES	—
6	Communication model specification	—	—
6.1	Application service elements (ASEs)	—	—
6.1.1	CeS ASE	YES	—
6.1.2	ISO/IEC/IEEE 8802-3 DLPDU communication ASE	YES	—
6.1.3	Management ASE	YES	—
6.2	Application relationships (ARs)	—	—
6.2.1	Overview	YES	—
6.2.2	Point-to-point network-scheduled unconfirmed producer-consumer AREP	YES	—
6.2.3	Point-to-multipoint network-scheduled unconfirmed producer-consumer AREP	YES	—
6.2.4	Point-to-point network-scheduled confirmed client/server AREP	YES	—
6.2.5	Point-to-point user-triggered confirmed client/server AREP	NO	—
6.2.6	AR classes	Partial	According to the present ARs
6.2.7	FAL services by AREP class	Partial	According to the present ARs
6.2.8	Permitted FAL services by AREP role	Partial	According to the present ARs