IEC 61784-2-14

Edition 1.0 2023-05

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Industrial networks – Profiles –
Part 2-14: Additional real-time fieldbus profiles based on ISO/IEC/IEEE 8802-3 – CPF 14

Réseaux industriels – Profils –
Partie 2-14: Profils de bus de terrain supplémentaires pour les réseaux en temps réel fondés sur l'ISO/IEC/IEEE 8802-3 – CPF 14

IEC 61784-2-14:2023-05(en-fr)

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IEC 61784-2-14 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- withdrawn,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 2-14: Additional real-time fieldbus profiles based on ISO/IEC/IEEE 8802-3 – CPF 14

1 Scope

This part of IEC 61784-2 defines Communication Profile Family 14 (CPF 14). CPF 14 specifies a set of Real-Time Ethernet (RTE) communication profiles (CPs) and related network components based on the IEC 61158 series (Type 14), 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 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 61158-3-14:2014, *Industrial communication networks – Fieldbus specifications – Part 3-14: Data-link layer service definition – Type 14 elements*

IEC 61158-4-14:2014, *Industrial communication networks – Fieldbus specifications – Part 4-14: Data-link layer protocol specification – Type 14 elements*

IEC 61158-5-14:2014, *Industrial communication networks – Fieldbus specifications – Part 5-14: Application layer service definition – Type 14 elements*

IEC 61158-6-14:2014, *Industrial communication networks – Fieldbus specifications – Part 6-14: Application layer protocol specification – Type 14 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*

ISO/IEC/IEEE 8802-11, *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 802-2014, *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 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]

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.

ARP Address Resolution Protocol (see IETF RFC 826)
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
NoS Number of Switches
Phy PHY Physical layer entity sublayer (see ISO/IEC/IEEE 8802-3)
PI Performance indicator
PTP Precision Time Protocol (see IEC 61588)
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 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 14 symbols

Symbol	Definition	Unit
DT	Delivery time	µs
D_size	Data size	octets
L_{Cable}	Cable length	m
N_{data}	Length of complete Ethernet frame	octets
NRTE_BW	Non-RTE bandwidth	%
N_{Switch}	Number of switches between end-stations	
RateofEthernet	Ethernet data rate	Mbit/s
RMData	Redundancy management data	octets
RTEData	Real-time data	octets
T_{Stack_R}	Receiver stack processing time including Phy and MAC	µs
T_{Cable}	Cable delay	µs
TD_Sw	Time delay in switch	µs
$T_{Ethernet\_S}$	Sender traversal time through MAC and Phy based on ISO/IEC/IEEE 8802-3	µs
ThroughputRTE	RTE throughput	octets/s
T_{Queue_S}	Sender queuing delay	µs
TSData	Time synchronization data	octets
T_{Stack_S}	Sender stack processing time	µs
T_{Switch}	Switch delay	µs
T_{Trf_S}	Transfer time for one octet	µs
T_wire	Time per octet on a wire segment	µs
STT_s	Stack traversal time of the sender	µs
STT_r	Stack traversal time of the receiver	µs

3.4 Conventions

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

4 CPF 14 (EPA[1]) – RTE communication profiles

4.1 General overview

Communication Profile Family 14 (CPF 14) defines communication profiles based on IEC 61158-3-14, IEC 61158-4-14, IEC 61158-5-14 and IEC 61158-6-14, which correspond to parts of the communication systems commonly known as real-time EPA (Ethernet for Plant Automation).

– Profile 14/1

  This profile contains a selection of AL, DLL and PHL services and protocol definitions from IEC 61158-3-14, IEC 61158-4-14, IEC 61158-5-14 and IEC 61158-6-14. This profile provides real time communication using communication protocols from IEEE 802 and IETF with accurate time synchronization based on IEC 61588.

  This profile supports communications between master devices and bridges.

– Profile 14/2

  This profile provides ISO/IEC/IEEE 8802-3-based real time communication with deterministic communications defined in IEC 61158-3-14 and IEC 61158-4-14.

  This profile supports communication between field devices and bridges.

– Profile 14/3

  This profile contains a selection of AL, DLL and PHL services and protocol definitions from IEC 61158-3-14, IEC 61158-4-14, IEC 61158-5-14 and IEC 61158-6-14. This profile provides real time communication using communication protocols from IEEE 802. Communication protocols from IETF can be used if necessary. Accurate time synchronization based on IEC 61588 should be used.

– Profile 14/4

  This profile provides ISO/IEC/IEEE 8802-3-based real time communication with deterministic communications defined in IEC 61158-3-14 and IEC 61158-4-14. This profile contains a selection of AL services and protocol definitions from IEC 61158-5-14 and IEC 61158-6-14.

  This profile supports communication between master devices and field devices.

4.2 CPF 14 (EPA) communication concept

4.2.1 General

The EPA system is a distributed system which uses the Ethernet network defined by ISO/IEC/IEEE 8802-3 and the protocols from IEEE 802 and IETF to connect field devices and small systems, and to control/monitor equipment in the industrial field. EPA devices work together to provide I/O and control for automated processes and operations.

The EPA system architecture provides a framework for describing these systems as the collection of physical devices interconnected by an EPA network. The objective of 4.2 is to identify the components of the system, describe their relationships and interactions, and define how they are configured.

4.2.2 Network Topology

Figure 1 shows an example of the EPA network topology with two subnets, process monitor layer subnet (L2-subnet) and field device layer subnet (L1-subnet).

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[1] EPA™ is a trade name of SUPCON Group Co. Ltd. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of the trademark holder or any of its products. Compliance with this profile does not require use of the trade name. Use of the trade name requires permission of the trade name holder.

The following describes the characteristics of EPA topology:

– a L1-subnet is used to connect field devices (such as transmitters, actuators and analytical instruments, etc.) mounted in field environment;

– a L1-subnet can be separated into more than one micro-segment, where the time-sharing controlling mechanism is used to meet the demands of deterministic communication;

– a L2-subnet is used to connect the devices of control center and HMI devices and one or more micro-segments. In L2-subnet, regular communication schedule based on CSMA/CD defined in ISO/IEC/IEEE 8802-3 is applied when deterministic communication is not necessary;

– devices on both L1-subnets and L2-subnets may be interconnected with standard switches or hubs;

– an EPA device may function as a bridge, which interconnects a L1-subnet micro-segment to a L2-subnet. This EPA bridge performs message filtering and forwarding between L1-subnet and L2-subnet.

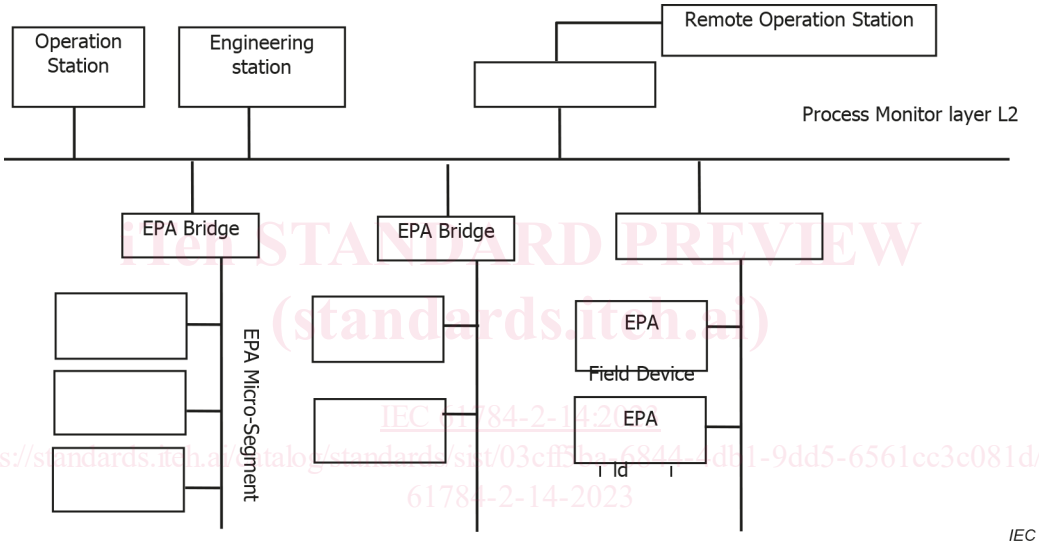

Figure 1 – EPA system network topology example

A micro-segment is a control area, where EPA devices communicate with each other to implement specific measuring and control functions. That is, the devices which need to communicate with each other shall be interconnected in the same L1 micro-segment.

Those devices consisting of a control loop or function block application process, such as transmitters, actuators and controllers which need to communicate with each other, shall be interconnected in the same micro-segment.

4.2.3 EPA devices

4.2.3.1 EPA master device

An EPA master device is connected to a L2-subnet directly. An EPA master device has an EPA communication interface but may have no control function block or function block application. An EPA master device may commonly be a configuration device, a monitoring device or a HMI station.

An EPA master device has a unique IP address in a system.

4.2.3.2 EPA field device

An EPA field device is installed in the industrial field environment. EPA field devices shall have EPA a communication entity and at least include one function block instance.

An EPA field Device has a unique IP address in a system.

4.2.3.3 EPA bridge

An EPA bridge is an optional device that interconnects one L1-subnet micro-segment to a L2-subnet. An EPA bridge has at least two communication interfaces, connecting one L1-subnet micro-segment and one L2-subnet respectively.

An EPA bridge can be configured to provide the following functions:

- communication isolation

  When the traffic occurs between two devices connected in one micro-segment, the EPA bridge shall limit it within the segment. Here, the traffic includes broadcast, multicast and peer to peer communication flows.

- message forwarding and filtering

  An EPA bridge transmit shall forward and filter the messages between one L1-subnet micro-segment and another L1-segment or L2-subnet. That is, when forwarding a message, the EPA bridge shall examine whether it should be forwarded according to configured criteria.

NOTE As an optional device, an EPA bridge is not necessary if the number of nodes in a system is not too large.

4.2.3.4 EPA agent

An EPA agent is an optional device used to interconnect an EPA network and other different networks. It shall provide the function of security control for the remote access.

4.3 CP 14/1

4.3.1 Physical layer

The physical layer of the EPA profile is according to ISO/IEC/IEEE 8802-3 for wired connection, ISO/IEC/IEEE 8802-11 and IEEE Std 802.15.1-2005 for wireless connection.

4.3.2 Data-link layer

The data-link layer shall be according to ISO/IEC/IEEE 8802-3, IEEE Std 802.1Q-2018, ISO/IEC/IEEE 8802-11 and IEEE Std 802.15.1-2005.

4.3.3 Network Layer

Internet standard IETF RFC 791 (IP), IETF RFC 826 (ARP), IETF RFC 792 (ICMP) and their amendments and successors shall be used.

4.3.4 Transport Layer

Internet standard IETF RFC 768 (UDP), IETF RFC 793 (TCP) and their amendments and successors may be used. But for real-time applications, IETF RFC 768 shall be used for field devices, bridges and master devices.

4.3.5 Application layer

4.3.5.1 AL service selection

The application layer services for profile 14/1 are defined in IEC 61158-5-14. Table 2 specifies the clauses included in this profile.