IEC 61850-9-2

Edition 2.1 2020-02
CONSOLIDATED VERSION

INTERNATIONAL STANDARD

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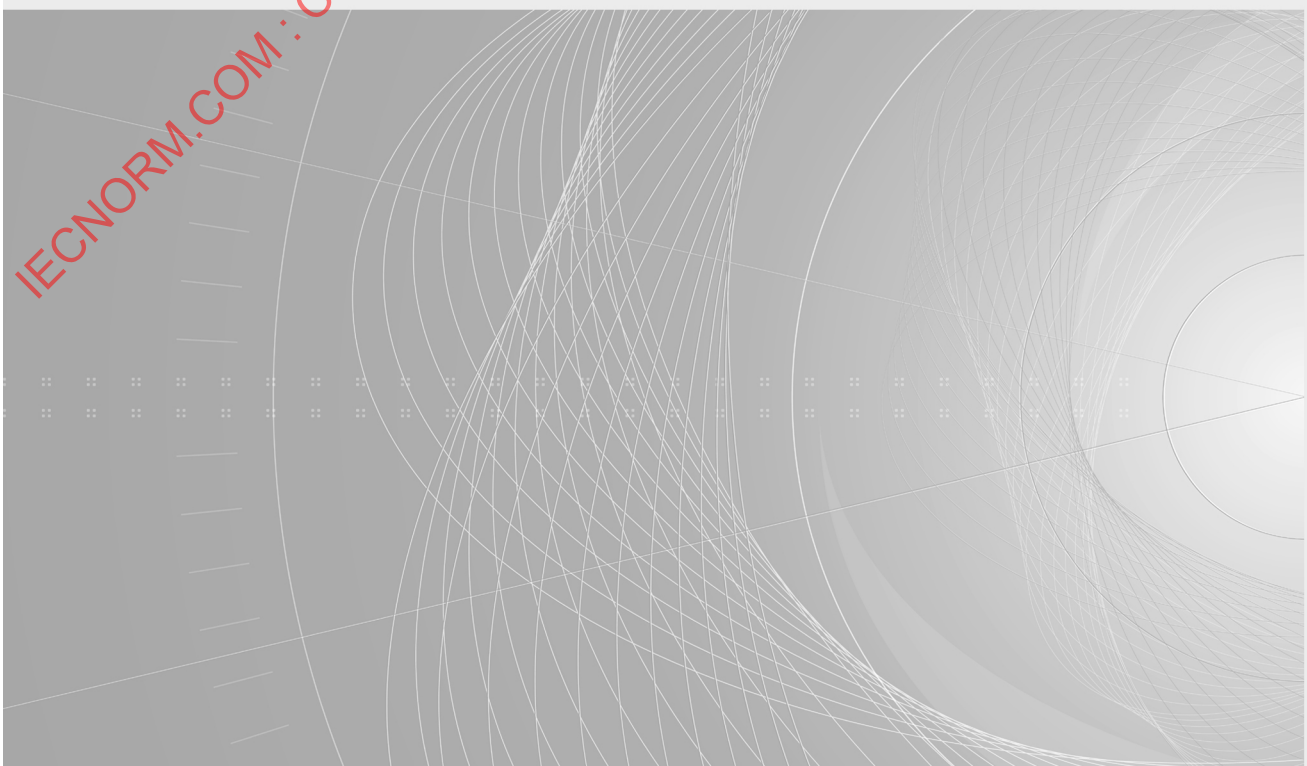
Communication networks and systems for power utility automation – Part 9-2: Specific communication service mapping (SCSM) – Sampled values over ISO/IEC 8802-3



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COMMUNICATION NETWORKS AND SYSTEMS FOR POWER UTILITY AUTOMATION –

Part 9-2: Specific communication service mapping (SCSM) – Sampled values over ISO/IEC 8802-3

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This consolidated version of the official IEC Standard and its amendment has been prepared for user convenience.

IEC 61850-9-2 edition 2.1 contains the second edition (2011-09) [documents 57/1133/FDIS and 57/1161/RVD] and its amendment 1 (2020-02) [documents 57/2112/FDIS and 57/2135/RVD].

International Standard IEC 61850-9-2 has been prepared by IEC technical committee 57: Power systems management and associated information exchange.

Compared to the second edition, this first revision of the second edition:

a) updates the normative references

b) adds a synchronization clause (Clause 9); adds references to IEC 61588:2009 and IEC/IEEE 61850-9-3 for SV synchronization;

c) modifies physical layer specification in T-Profile;

d) modifies MSVCB components (Table 9 and Table 10);

e) deprecates usage of USVCB;

f) modifies encoding for the transmission of the sampled value buffer (Table 14);

g) adds Table 20;

h) adds Table 21;

i) adds Annex C related to possible backward compatibility issues between revisions of this standard;

j) provides clarifications and corrections to the second edition of IEC 61850-9-2, based on the tissues = { 1349, 1272, 1055, 944, 863 }.

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

A list of all parts of the IEC 61850 series, under the general title: *Communication networks and systems for power utility automation,* can be found on the IEC website.

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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
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INTRODUCTION

This part of IEC 61850 defines the SCSM for sampled values over ISO/IEC 8802-3. The intent of this SCSM definition is to include the complete mapping of the sampled value model.

This part of IEC 61850 applies to all electronic sensors related to process measurements of the T logical node group having a digital sampled value output stream such as current and voltage transformers, merging units, or devices acting as T group publishers as well as subscribing intelligent electronic devices, for example protection units, bay controllers and meters.

Process bus communication structures can be arranged in different ways as described in IEC TR 61850-1. In addition to the transmission of sampled value data sets, which are directly connected to ISO/IEC 8802-3, a selection of IEC 61850-8-1 services is necessary to support the access to the SV control block. References to the relevant IEC 61850-8-1 services are provided in this SCSM. For less complex devices (for example merging units), the sampled value control block can be pre-configured, in which case there is no need to implement IEC 61850-8-1 services based on the MMS-Stack.

This document defines the mapping of sampled value class model (IEC 61850-7-2) to ISO/IEC 8802-3. This SCSM, in combination with IEC 61850-7 and IEC 61850-6, allows interoperability between devices from different manufacturers.

This standard does not specify individual implementations or products, nor does it constrain the implementation of entities and interfaces within a computer system. This standard specifies the externally visible functionality of implementations together with conformance requirements for such functionalities.

Reading guide:

- This document is an extended mapping specification of IEC 61850-8-1 to cover sampled value transmission over ISO/IEC 8802-3.
- This document can best be understood if the reader is thoroughly familiar with IEC 61850-7-1, IEC 61850-7-2, IEC 61850-7-3 and IEC 61850-7-4.
- The ACSI services defined in IEC 61850-7-2 are not explained in this part of IEC 61850.

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COMMUNICATION NETWORKS AND SYSTEMS FOR POWER UTILITY AUTOMATION –

Part 9-2: Specific communication service mapping (SCSM) – Sampled values over ISO/IEC 8802-3

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1 Scope

This part of IEC 61850 defines the specific communication service mapping (SCSM) for the transmission of sampled values according to the abstract specification in IEC 61850-7-2. The mapping is that of the abstract model on a mixed stack using direct access to an ISO/IEC 8802-3 link for the transmission of the samples in combination with IEC 61850-8-1.

Each SCSM consists of three parts:

– a specification of the communication stack being used,

– the mapping of the abstract specifications of IEC 61850-7 series on the real elements of the stack being used, and

– the implementation specification of functionality, which is not covered by the stack being used.

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.

IEC 61588:2009, *Precision clock synchronization protocol for networked measurement and control systems*

IEC TS 61850-2, *Communication networks and systems in substations – Part 2: Glossary*

IEC 61850-6, *Communication networks and systems for power utility automation – Part 6: Configuration description language for communication in electrical substations related to IEDs*

IEC 61850-7-2, *Communication networks and systems for power utility automation – Part 7-2: Basic information and communication structure – Abstract communication service interface (ACSI)*

IEC 61850-7-3, *Communication networks and systems for power utility automation – Part 7-3: Basic communication structure – Common data classes*

IEC 61850-8-1, *Communication networks and systems for power utility automation – Part 8-1: Specific communication service mapping (SCSM) – Mappings to MMS (ISO 9506-1 and ISO 9506-2) and to ISO/IEC 8802-3*

IEC/IEEE 61850-9-3, *Communication networks and systems for power utility automation – Part 9-3: Precision Time Protocol profile for power utility automation*

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

IEC 62351-6[1], *Power systems management and associated information exchange – Data and communications security – Part 6: Security for IEC 61850*

IEC 62439-3:2016, *Industrial communication networks – High availability automation networks – Part 3: Parallel Redundancy Protocol (PRP) and High-availability Seamless Redundancy (HSR)*

ISO/IEC 8326:1996, *Information technology – Open Systems Interconnection – Session service definition*

ISO/IEC 8327-1:1996, *Information technology – Open Systems Interconnection – Connection-oriented session protocols: Protocol specification*

ISO/IEC 8649:1996, *Information technology – Open Systems Interconnection – Service definition for the Associated Control Service Element*

ISO/IEC 8650-1:1996, *Information technology – Open Systems Interconnection – Connection-oriented protocol for the Association Control Service Element: Protocol specification*

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

ISO/IEC 8822:1994, *Information technology – Open Systems Interconnection – Presentation service definition*

ISO/IEC 8823-1:1994, *Information technology – Open Systems Interconnection – Connection-oriented presentation protocol: Protocol specification*

ISO/IEC 8824-1:2008, *Information technology – Abstract Syntax Notation One (ASN. 1): Specification of basic notation*

ISO/IEC 8825-1, *Information technology – ASN.1 encoding rules: Specification of Basic Encoding Rules (BER), Canonical Encoding Rules (CER) and Distinguished Encoding Rules (DER)*

ISO 4217:2015, *Code for the representation of currencies*

ISO 9506-1:2003, *Industrial automation systems – Manufacturing Message Specification – Part 1: Service definition*

ISO 9506-2:2003, *Industrial automation systems – Manufacturing Message Specification – Part 2: Protocol specification*

IEEE 754:1985, *IEEE Standard for Binary Floating-Point Arithmetic*

IEEE 802.1Q:1998, *IEEE Standards for Local and Metropolitan Area Networks: Virtual Bridged Local Area Networks*

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[1] Under preparation. Stage at the time of publication: IEC/PRVC 62351-6:2020.

RFC 791, *Internet Protocol; IETF, available at http://www.ietf.org*RFC 792, *Internet Control Message Protocol; IETF*, available at *http://www.ietf.org*

RFC 793, *Transmission Control Procedure; IETF*, available at *http://www.ietf.org*

RFC 826, *Ethernet Address Resolution Protocol or Converting Network Protocol Addresses to 48.bit Ethernet Address for Transmission on Ethernet Hardware; IETF*, available at *http://www.ietf.org*

RFC 894, *A Standard for the Transmission of IP Datagrams over Ethernet Networks; IETF*, available at *http://www.ietf.org*

RFC 919, *Broadcasting Internet Datagrams; IETF*, available at *http://www.ietf.org*

RFC 1006, *ISO transport services on top of TCP: Version 3; IETF*, available at *http://www.ietf.org*

RFC 1112, *Host Extensions for IP multicasting; IETF*, available at *http://www.ietf.org*

RFC 2460, *Internet Protocol, Version 6 (IPv6) Specification, IETF,* available at http://www.ietf.org

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC/TS 61850-2 apply.

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

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

4 Abbreviated terms

ACSI	abstract communication service interface
ASDU	application service data unit
ASN.1	abstract syntax notation number one
APCI	application protocol control information
APDU	application protocol data unit
APPID	application identifier
AUI	attachment unit interface
BER	ASN.1 basic encoding rules
BS	bitstring
c	Conditional support. The item shall be implemented if the stated condition exists.
CFI	canonical format identifier
DF	data frame
DO	data object
F/S	functional standard

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GOOSE	generic object oriented substation event
i	Out-of-scope: The implementation of the item is not within the scope of this standard.
ICD	IED configuration description
IED	intelligent electronic device
LSDU	link layer service data unit
m	Mandatory support. The item shall be implemented.
MAC	media access control
MMS	manufacturing message specification (ISO 9506)
MSVCB	multicast sampled value control block
MU	merging unit
o	Optional support. The implementor may decide to implement the item.
PDU	protocol data unit
PICS	protocol implementation conformance statement
PTP	Precision Time Protocol, referring to IEC 61588:2009
SCSM	specific communication services mapping
r	readable
SV	sampled value
TCI	tag control information
TPID	tag protocol identifier
USVCB	unicast sampled value control block
VID	VLAN identifier
VLAN	virtual local area network
VMD	virtual manufacturing device
w	writeable
x	Excluded. The implementor shall not implement this item.
XML	extensible markup language

5 Communication stack

5.1 Overview of the protocol usage

The OSI reference model (ISO/IEC 7498-1) defines a model based upon the concept of layering of communication functions. The model includes 7 layers and specifies the functional requirements for each layer to achieve a robust communication system. The model does not specify the protocols to be used to achieve the functionality, nor does it restrict the solution to a single set of protocols.

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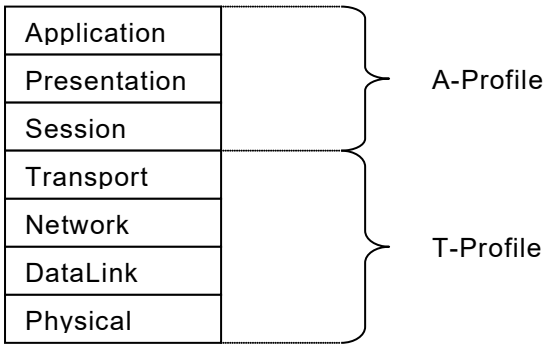

Figure 1 – OSI reference model and profiles

The use of ISO application (A-Profile) and transport (T-Profile) profiles (see Figure 1) describes the various stack profiles. An ISO A-Profile is the set of specifications and agreements relating to the upper three (3) layers of the ISO OSI reference model (for example, the application, presentation, and session layers). An ISO T-Profile is the set of specifications and agreements relating to the lower four (4) layers of the ISO OSI reference model (for example, the transport, network, data link and physical layers).

Two combinations of A-Profiles and T-Profiles are defined in order to support the transmission of sampled values, including access to the associated SV control block, as specified in IEC 61850-7-2. The two different combinations are used for:

- client/server services based on MMS in accordance with IEC 61850-8-1;
- SV services based on data link layer.

5.2 Client/server services and communication profiles

Content removed; see IEC 61850-8-1.

5.3 SV service and communication profile

5.3.1 SV mapping overview

This SV communication profile shall be used for any implementation claiming conformance to this standard and declaring support for one of the following IEC 61850-7-2 services in Table 4.

Table 4 – Service requiring SV communication profile

Model	IEC 61850-7-2 service
Multicast sampled value class model	Multicast SV message
Unicast sampled value class model	Unicast SV message (deprecated)

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5.3.2 A-Profile

Table 5 shows services and protocols of the A-Profile SV.

Table 5 – Service and protocols for SV communication A-Profile

OSI model layer	Specification			m/o
	Name	Service specification	Protocol specification	
Application	SendMSVMessage service	See clause 8.5		m
	Security	IEC 62351-6		o
Presentation	Abstract syntax	ISO/IEC 8824-1:2008	ISO/IEC 8825-1	m
Session				

Presentation layer: see additional definitions in 8.5.

5.3.3 T-Profile

5.3.3.1 General

The T-Profile for SV services is shown in Table 6.

Table 6 – SV T-Profile

OSI model layer	Specification			m/o
	Name	Service specification	Protocol specification	
Transport				
Network				
Link Redundancy	Parallel redundancy protocol and high availability seamless ring	IEC 62439-3:2016		o
DataLink	Priority tagging/VLAN	IEEE 802.1Q		m
	Standard for Ethernet	ISO/IEC/IEEE 8802-3		m
Physical	Interface	IEC TR 61850-90-4		c
c If the product standard profiling this standard is not specifying another physical interface, IEC/TR 61850-90-4 applies				

NOTE This standard only considers layer 2 sampled values transmission. Routable sampled values mechanisms are defined in IEC 61850-8-1.

5.3.3.2 Link layer: Ethernet addresses

The destination ISO/IEC/IEEE 8802-3 multicast address has to be configured for the transmission of sampled values. A unique ISO/IEC/IEEE 8802-3 source address shall be used. Recommendations of multicast address range assignments are given in Annex B.

5.3.3.3 Link layer: Priority tagging/virtual LAN

IEEE 802.1Q field shall be present in the egress frames from a SV publisher.

Priority tagging according to IEEE 802.1Q is used to separate time-critical and high-priority bus traffic for protection-relevant applications from low priority bus loads.

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Subscribers conformant to this document shall be prepared that the Virtual LAN tag might have been removed or modified by the network on the path from the publisher to the subscriber.

See Figure 2 for the structure of the tag header.

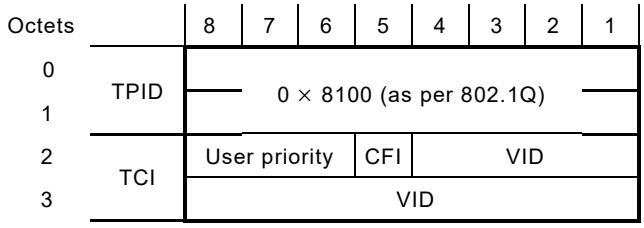

Figure 2 – Structure of the tag header

TPID (tag protocol identifier) field: indicates the Ethernet type assigned for 802.1Q Ethernet encoded frames. This value shall be 0x8100.

TCI (tag control information) fields: user priority: BS3; user priority value shall be set by configuration to separate sampled values from low priority bus load. If the priority is not configured, then the default values of Table 7 shall be used.

CFI (canonical format indicator): BS1 [0]; a single bit flag value. For this standard, the CFI bit value shall be reset (value = 0).

NOTE If set (value = 1), an embedded resource identification field (E-RIF) follows the Length/Type field in the ISO/IEC/IEEE 8802-3 tagged frame.

VID: for backward compatibility reasons, the value of the VLAN Identifier shall be zero (0) if the SMV P-Type VLAN-ID is missing in the configuration.

As IEEE 802.1Q allows implementation with a restricted set of priorities, the higher priority frames should have a priority of 4 to 7 and the lower priority should have a priority of 1 to 3. The value 1 is the priority of untagged frames; thus 0 should be avoided as it may cause unpredictable delay due to normal traffic.

Additionally, since sampled values potentially need to have their own bandwidth allocation, their configured VID will be different from GOOSE.

The default values for priority and VID shall be as defined in Table 7.

Table 7 – Default Virtual LAN IDs and priorities

Service	Default VID	Default priority
Sampled Values	0	4

The general ISO/IEC 8802-3 frame structure for sampled values can be found in Annex A.

All implementations that send Sampled Values and claim conformance to this clause of this standard, shall be capable of configuration of the VID and priority attributes.

All implementations that receive Sampled Values shall be capable of receiving any VID and priority (e.g. these attributes shall not be used for Source address matching). Additionally,

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such implementations shall be capable of processing incoming messages that do not contain IEEE 802.1Q information.

5.3.3.4 Link layer: Ethertype and other header information

5.3.3.4.1 Ethertype

Ethertypes based on ISO/IEC/IEEE 8802-3 MAC-sublayer are registered by the IEEE authority registration. GSE management, GOOSE and sampled values shall be directly mapped to the reserved Ethertype(s) and the Ethertype PDU. The assigned values are found in Table 8.

Table 8 – Assigned Ethertype values

Use	Ethertype value (hexadecimal)	APPID type
IEC 61850-8-1 GOOSE Type 1	88-B8	0 0
IEC 61850-8-1 GSE Management and SV Management	88-B9	0 0
IEC 61850-9-2 Sampled Values	88-BA	0 1
IEC 61850-8-1 GOOSE Type 1A	88-B8	1 0

The Ethertype PDU and APDU octets shall be as defined in Annex A.

5.3.3.4.2 APPID

Application identifier. The APPID is used to select ISO/IEC/IEEE 8802-3 frames containing sampled value messages and to distinguish the application association.

The value of APPID is the combination of the APPID type, defined as the two most significant bits of the value (as defined in Table 8), and the actual ID.

The reserved value range for sampled values is 0x4000 to 0x7FFF. If no APPID is configured, the default value shall be 0x4000. The default value is reserved to indicate lack of configuration. It is strongly recommended to have unique, source orientated SV APPID within a system, in order to enable a filter on link layer. The configuration of APPID should be enforced by the configuration system.

5.3.3.4.3 Length

Number of octets including the Ethertype PDU header starting at APPID, and the length of the APDU (Application Protocol Data Unit). Therefore, the value of length shall be 8 + m, where m is the length of the APDU and m is less than 1 493. Frames with inconsistent or invalid length field shall be discarded.

5.3.3.4.4 Reserved 1

The structure of Reserved 1 is defined in Figure 3.

Octets	8	7	6	5	4	3	2	1
0	S	R			Reserved Security			
1	Reserved Security							

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Figure 3 – Reserved 1

S: Simulate. When this flag is set, the sampled value telegram has been issued by a publisher located in a test device and not by the publisher as specified in the configuration file of the device.

R: Reserved. The three bits are reserved for future standardized application and shall be set to 0 as default.

Reserved security: See Reserved 2 below.

5.3.3.4.5 Reserved 2

The Reserved 2 field and the “reserved security” of Reserved 1 field form a 28-bit word defined by the security standard IEC 62351-6. It shall be used as defined when SampledValue telegram with security is transmitted, otherwise it shall be set to 0. Subscribers that do not support IEC 62351-6 shall ignore the value of the fields when it is not 0.

5.4 Restrictions

This mapping is restricted to the mapping of the ACSI model for the transmission of sampled values. The model applies to data sets. To get the full benefit of IEC 61850, additional ACSI models need to be supported in accordance with IEC 61850-8-1. As an example, to enable the transmission of a sampled value buffer, the associated control block attribute “SvEna” shall be written. However, if the client will read a list of available data sets or the contents of the data set, further models (for example logical device, logical node or data set) need to be supported.

Data sets for sampled values shall be specified by using the XML language on engineering level in accordance with IEC 61850-6 to ensure interoperability.

For the transmission of sampled value data sets, the ASN.1 basic encoding rules (BER) shall be used in combination with tags notation harmonised with the MMS grammar used in IEC 61850-8-1.

Only FCDA of Basic Types are allowed to be members of data sets for sampled values.

6 Mapping of IEC 61850-7-2 and IEC 61850-7-3 data attributes

The mapping of attributes and common data attributes to MMS are specified in IEC 61850-8-1.

For the transmission of sampled values, the ASN.1, the basic encoding rules (BER), and the common data classes defined in IEC 61850-7-3 apply.

7 Mapping of IEC 61850-7-2 classes and services

7.1 Classes of SV data sets

If a client/server association based on MMS is used in addition to the transmission of SV data sets, the definitions of IEC 61850-8-1 apply for the following classes:

– server class model;
– association model;
– logical device model;

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– logical node model;
– data class model;
– data set class model.

7.2 Definition of SV data sets

For the transmission of sampled values, the data sets are defined in logical node "LLN0". All sampled value data set specifications are part of the IED configuration description (ICD).

NOTE It is assumed that the data sets used for the transmission of sampled values can include data objects from more than one logical node and are therefore allocated in LLN0.

8 Mapping of the model for the transmission of sampled values

8.1 Overview

To ensure interoperability, the data sets for sampled values are specified in XML according to the definition in IEC 61850-6.

The sampled value class model provides reporting of sampled value data sets in an organised and time controlled way, so that transfer is very fast and time of transfer is kept constant. Sampled value control block defines the transmission characteristics of the data set they refer to. A detailed description is given in IEC 61850-7-2.

8.2 Mapping of the multicast sampled value control block class and services

8.2.1 Multicast sampled value control block definition

The sampled value control block, as defined in IEC 61850-7-2, shall be pre-defined by configuration and shall be mapped to an MMS Multicast sampled value control block (MSVCB) as defined in Table 9. All MSVCB components shall be of the functional constraint “MS”.

Table 9 – MMS TypeDescription definition for MSVCB MMS structure

MMS component name	MMS TypeDescription	r/w	m/o	Condi-tion	Comments
MsvCBNam	Identifier	r	m		MMS Identifier of the structure of the MsvCBName within the MMS object named: LLN0$MS e.g. LLN0$MS$<MsvCBNam>
MsvCBRef	Visible-string	r	m		The value of this component shall contain the IEC Reference of the MsvCB. e.g. <MMSDomain>/LLN0MS<MsvCBNam>
SvEna	Boolean	r/w	m		TRUE = transmission of sampled value buffer is activated. FALSE = transmission of sampled value buffer is deactivated.
MsvID	Visible-string	r	m		System-wide unique identification. It is strongly recommended to use a four-byte hexadecimal representation of APPID value as system-wide unique identification
DatSet	Visible-string	r	m		The value of this component shall contain the IEC reference of the DataSet conveyed by the MsvCB. This ObjectReference shall be limited to VMD or Domain scoped NamedVariableLists. Only FCDA of Basic Types are allowed to be members of the DataSet.

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MMS component name	MMS TypeDescription	r/w	m/o	Condi-tion	Comments
ConfRev	Unsigned integer	r	m		Count of configuration changes regard to MSVCB.
SmpRate	Unsigned integer	r	m		Amount of samples (default per nominal period, see SmpMod).
OptFlds	Bitstring				See Table 20
refresh-time	Boolean	r	m		TRUE = SV buffer contains the attribute “RefrTm”. FALSE = attribute “RefrTm” is not available in the SV buffer.
sample-synchronised	Boolean	r	m		Value will be ignored. Kept to ensure backward compatibility with IEC 61850-9-2:2004
sample-rate	Boolean	r	m		TRUE = SV buffer contains the attribute “SmpRate”. FALSE = attribute “SmpRate” is not available in the SV buffer.
data-set-name	Boolean	r	m		TRUE = SV buffer contains the attribute “DatSet”. FALSE = attribute “DatSet” is not available in the SV buffer.
security	Boolean	r	m		Mapping specific attribute. TRUE = SV buffer contains the attribute “Security”. FALSE = attribute “Security” is not available in the SV buffer.
sample-mode	Boolean	r	m		TRUE = SV buffer contains the attribute “SmpMod”. FALSE = attribute “SmpMod” is not available in the SV buffer.
synch-source-identity	Boolean	r	m		TRUE = SV buffer contains the attribute “GmIdentity”. FALSE = attribute “GmIdentity” is not available in the SV buffer.
SmpMod	Enumerated	r	m		smpMod specifies 0 = samples per nominal period (DEFAULT) 1 = samples per second 2 = seconds per sample If not available (backward compatibility) the default value is 0.
DstAddress	PhyComAddr		m		Mapping specific attribute. See Table 10
noASDU	Unsigned integer	r	m		Mapping specific attribute. Number of ASDU concatenated into one APDU.

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Table 10 – PhyComAddr structure

MMS component name	MMS TypeDescription	r/w	m/o	Condi-tion	Comments
Addr	OCTET-STRING	r	m		Length is 6 octets and contains the value of the destination media access control (MAC) address to which the SV message is to be sent. The DstAddress shall be an Ethernet address that has the multicast bit set to TRUE. In order to facilitate the network traffic filtering, it is recommended to use different Ethernet addresses for each DstAddress. See Annex B for multicast addressing recommendations
PRIORITY	Unsigned8	r	m		Range of values shall be limited from 0 to 7.
VID	Unsigned16	r/w	m		Range of values shall be limited from 0 to 4 095.
APPID	Unsigned16	r	m		As defined in 5.3.3.

Table 20 – Mapping of OptFlds within Bitstring

MMS component name	Bitstring bit position
refresh-time	0
sample-synchronised	1
sample-rate	2
data-set-name	3
security	4
sample-mode	5
synch-source-identity	6

8.2.2 MSV Services

See Table 11.

Table 11 – Mapping of multicast sampled value services

Services of MSVCB Class	Service
SendMSVMessage	Transmission of MSV messages is mapped directly on data link layer as defined in 8.4 and 8.5
GetMSVCBValue	Mapped to MMS read service
SetMSVCBValue	Mapped to MMS write service
GetMsvReference GetMSVElementNumber	Mapped to management service

8.3 Mapping of the unicast sampled value control block class and services

The usage of unicast sampled values frames has been deprecated.

8.4 Mapping of the update of the sampled value buffer

As specified in IEC 61850-7-2, the communication system is responsible for updating the buffer of the subscriber.

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The update is directly mapped to an ethertype reserved for IEC 61850 applications based on ISO/IEC/IEEE 8802-3 MAC – Sublayer.

The communication stack used does not provide the following functionality.

– Initiating and checking the update of the sampled value buffer over the communication link. Optionally, concatenating the update of more than one buffer into the same link layer frame. This is application layer functionality.
– Encoding the abstract data types. This is presentation layer functionality.
– Concatenating the update of more than one transmission buffer into the same link layer frame as transport layer functionality is not supported. The opposite, to segment the update of one buffer to several link layer frames is not considered, since the maximum frame length of the link layer protocols is sufficient.
– Translating the logical address of the subscriber in a physical MAC address.

Therefore, the additional definitions of 8.5 apply.

8.5 Additional definitions for the transmission of sampled values

8.5.1 Application layer functionality

The mapping provides the capability to concatenate more than one ASDU into one APDU before the APDU is posted into the transmission buffer. The numbers of ASDUs which will be concatenated into one APDU are configurable and related to the sample rate. The concatenation of ASDUs is not dynamically changeable in order to reduce the implementation complexity. When concatenating several ASDUs into one frame, the ASDU with the oldest samples is the first one in the frame.

Details are shown in Figure 4.

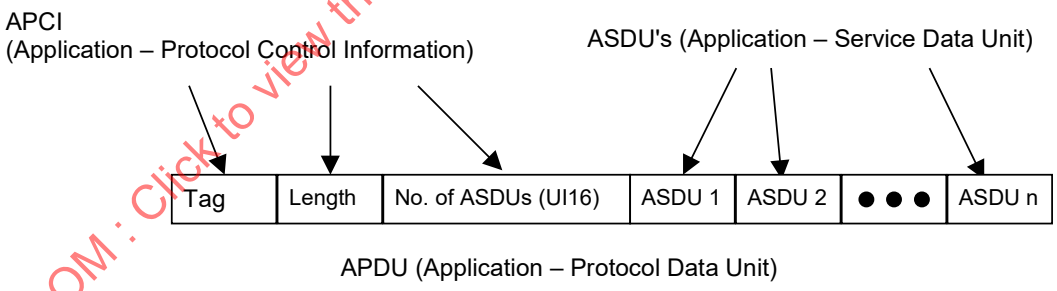

Figure 4 – Concatenation of several ASDU's into one frame

ASN.1 grammar in relation with the basic encoding rules (BER) is used to encode the sampled value messages for transmission on ISO/IEC 8802-3.

8.5.2 Presentation layer functionality

For the transmission, the sampled value buffer is encoded as specified in Table 14.

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Table 14 – Encoding for the transmission of the sampled value buffer

IEC61850 DEFINITIONS::= BEGIN
IMPORTS Data FROM ISO-IEC-9506-2
IEC 61850-9-2 Specific Protocol::= CHOICE {
savPdu [APPLICATION 0] IMPLICIT SavPdu,

Abstract buffer format according to IEC 61850-7-2		Coding in IEC 61850-9-2	Comments
Attribute name	**Attribute type**	**ASN.1 basic encoding rules (BER)** **SavPdu::=** SEQUENCE {	
		noASDU [0] IMPLICIT INTEGER (1..65535),	Mapping specific attribute. Number of ASDUs, which will be concatenated into one APDU.
		security [1] ANY OPTIONAL,	Mapping specific attribute. Reserved for future definition (e.g. digital signature).
		asdu [2] IMPLICIT SEQUENCE OF ASDU … **}**	1 to *n* number of ASDUs as specified before.
		ASDU::= **SEQUENCE {**	
MsvID	VisString129	svID [0] IMPLICIT VisibleString,	Should be a system-wide unique identification. It is strongly recommended to use a four bytes hexadecimal representation of APPID value as this system-wide unique identification
DatSet	ObjectReference	dataset [1] IMPLICIT VisibleString OPTIONAL,	Value from the MSVCB If MsvID allows to have a unique identification of the stream over the subnetwork, it is not recommended to include this field
SmpCnt	INT16U	smpCnt [2] IMPLICIT OCTET STRING (SIZE(2)),	Will be incremented each time a new sampled value is taken. The domain shall define how the counter shall be used. For instance, IEC 61869-9 defines it for time alignment: the counter shall be set to zero when the synchronization occurs. The OCTET STRING is interpreted as INT16U as defined in Table 15. Rollover may occur.
ConfRev	INT32U	confRev [3] IMPLICIT OCTET STRING (SIZE(4)),	Value from the MSVCB. The OCTET STRING is interpreted as INT32U as defined in Table 15.
RefrTm	Timestamp	refrTm [4] IMPLICIT UtcTime OPTIONAL,	Time when the transmission buffer has been refreshed locally. This is the time of the physical event corresponding to the SV transmitted in this ASDU

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Abstract buffer format according to IEC 61850-7-2		Coding in IEC 61850-9-2	Comments
SmpSynch	INT8U	smpSynch [5] IMPLICIT OCTET STRING (SIZE(1)),	Refer to Synchronization clause for details
SmpRate	INT16U	smpRate [6] IMPLICIT OCTET STRING (SIZE(2)) OPTIONAL,	Value from the MSVCB. The OCTET STRING is interpreted as INT16U as defined in Table 15.
Sample [1..n]	Type depends on the CDC defined in IEC 61850-7-3.	sample [7] IMPLICIT OCTET STRING (SIZE(n)),	List of data values related to the data set definition. For the encoding of the Data, the rules for the encoding of the basic data types shall apply as defined in 8.6. Only FCDA of Basic Type are allowed to be members of the data set. The SIZE (n) is the cumulated size of all the data conveyed as defined in the DataSet.
SmpMod	INT16U	smpMod [8] IMPLICIT OCTET STRING (SIZE(2)) OPTIONAL ,	Value from the MSVCB. The OCTET STRING is interpreted as INT16U as defined in Table 15.
SynchSrcID	Ident8	gmIdentity [9] IMPLICIT OCTET STRING (SIZE(8)) OPTIONAL … }	Refer to Synchronization clause for details
NOTE The usage of the OptFlds attribute according to IEC 61850-7-2 is not necessary, because the relating attributes RefrTm, security, SmpRate, SmpMod, SynchSrcID and DatSet will be signed as optional via the ASN.1 attribute directly.			

... }

END

For the tag definition of basic data types, see 8.6.

8.6 Definitions for basic data types – Presentation layer functionality

Table 15 shows the encoding for the basic data types used for the data values referenced by the data set members.

As an exception of the BITSTRING encoding shown in Table 15, for backward compatibility with existing implementations of the standard, Table 21 defines a specific mapping for IEC 61850-7-2 quality.

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Table 15 – Encoding for the basic data types

Data types according to IEC 61850-7-2	Encoding in data set	Comments
BOOLEAN	8-bit set to 0 FALSE; anything else = TRUE	
INT8	8-bit big-endian	Signed
INT16	16-bit big-endian	Signed
INT32	32-bit big-endian	Signed
INT64	64-bit big-endian	Signed
INT8U	8-bit big-endian	Unsigned
INT16U	16-bit big-endian	Unsigned
INT32U	32-bit big-endian	Unsigned
FLOAT32	32-bit IEEE Floating Point (IEEE 754)	
ENUMERATED	32-bit big-endian	Signed
CODED ENUM	32-bit big-endian	
OCTET STRING	20 -byte ASCII text, null terminated	
VISIBLE STRING	35 -byte ASCII text, null terminated	
UNICODE STRING	20 -byte, null terminated	
ObjectName	20 -byte ASCII text, null terminated	
ObjectReference	20 -byte ASCII text, null terminated	
Timestamp	64-bit timestamp as defined in IEC 61850-8-1	
EntryTime	48-bit timestamp as defined in IEC 61850-8-1	
EntryID	8 bytes	
Currency	4-byte ASCII text, null terminated (ISO 4217)	
Data types according to IEC 61850-8-1	**Encoding in data set**	**Comments**
BITSTRING	32-bit – Bit 0 shall be the leftmost (most significant) bit of the first transmitted octet. Bit 7 shall be the rightmost (least significant) bit of the first transmitted octet. Bit 8 shall be the leftmost (most significant) bit of the second octet. Bit 15 shall be the rightmost (least significant) bit of the second octet. This shall be continued in that way in further octets.	

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Table 21 – Mapping for IEC 61850-7-2 quality

Bit number	IEC 61850-7-2		Bit-String	
	Attribute name	Attribute value	Value	Default
31-30	Validity	Good	0 0	0 0
		Invalid	0 1	
		Invalid [1]	1 0	
		Questionable	1 1	
29	Overflow		TRUE	FALSE
28	OutofRange		TRUE	FALSE
27	BadReference		TRUE	FALSE
26	Oscillatory		TRUE	FALSE
25	Failure		TRUE	FALSE
24	OldData		TRUE	FALSE
23	Inconsistent		TRUE	FALSE
22	Inaccurate		TRUE	FALSE
21	Source	Process	0	0
		Substituted	1	
20	Test		TRUE	FALSE
19	OperatorBlocked		TRUE	FALSE

[1] The reserved value has been redefined to "invalid" for backward compatibility.

A value quality with a validity = Invalid, Failure = TRUE and Test = TRUE corresponds to a 0x0842.

9 Synchronization

When several sampled values publishers are used by an application, they all shall be synchronized to a common time reference to have their sampling synchronized. Different methods exist to synchronize IEDs, such as using a 1PPS optical signal from a GPS clock, but the recommended one is using the Precision Time Protocol over Ethernet specified in IEC 61588:2009.

When IEC 61588:2009 synchronization protocol (PTP) is used to synchronize a sampled values publisher, all PTP compatible devices within the system shall comply with IEC/IEEE 61850-9-3.

A synchronized sampled values publisher shall fill SmpCnt, SmpSynch and optionally fields RefrTm and gmIdentity as specified in Table 14.

The required synchronization accuracy of SV during normal operation or in case of clock failure or repair, as well as the specific resetting event for SmpCnt, is out of scope for this standard; relevant standards such as IEC 61869-9 for digital instrument transformers apply.

A sampled values publisher shall fill the SmpSynch field of SV messages as follows:

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	Synchronization device (3) synchronized to the required accuracy (1) to a global time reference. For instance, a GPS clock receiving the GPS signal or not receiving the GPS signal but still in holdover mode. (2)	Synchronization device (3) **not** synchronized to the required accuracy (1) to a global time reference. (2)
Sampled values publisher synchronized to the required accuracy (1) to the synchronization device. For instance a sampled values publisher receiving clock signal or not receiving clock signal but still in holdover mode	SmpSync = 2 (global synchronization)	SmpSync = 1 (local synchronization)
Sampled values publisher **not** synchronized to the required accuracy (1) to the synchronization device.	SmpSync = 0 (internally synchronized)	SmpSync = 0 (internally synchronized)

NOTE 1 The required accuracy depends on the application and the kind of sampled values transported. The accuracy requirements from the application / product standard should apply.

NOTE 2 The way the sampled values publisher knows if the synchronizing device is synchronized to the required accuracy to a global time reference is out of scope for this standard. The recommended method is using the IEC/IEEE 61850-9-3 for synchronization and quality information sent by the grandmaster clock. For instance, having time traceable flag set to true and a clockClass of 6 for SmpSync = 2.

NOTE 3 "Synchronization device" could be any device used to synchronize a sampled values publisher, for instance a PTP grandmaster clock, Caesium clock, GPS clock etc.

Other values are reserved and shall not be used for SmpSynch.

When PTP is used to synchronize a sampled values publisher, the use of the optional field gmIdentity is strongly recommended to indicate the identity of the grandmaster clock actually synchronizing the device. The value of gmIdentity shall be the network order of the bytes representing grandmasterIdentity according to 13.5 of IEC 61588:2009.

If SmpSynch = 0 or when PTP is not used to synchronize a sampled values publisher, the information in the gmIdentity field is irrelevant and not defined.

NOTE Any means to identify a local area clock other than PTP has been deprecated, refer to C.3.4 for compatibility issues.

10 Conformance

10.1 Notation

For Subclause 10.2 to Clause 12, see the abbreviated terms given in Clause 4.

10.2 PICS

10.2.1 Profile conformance

Table 16 and Table 17 define the basic conformance statement.

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Table 16 – PICS for A-Profile support

		Client		Server		Value/comment
		F/S		F/S		
A1	Security for SV service A-Profile	o		o		Refer to IEC 62351-6
A2	SV service A-Profile	c		c		Refer to 5.3
c: Shall be 'm' if support for service specified in Table 4 is declared within the ACSI basic conformance statement.						

Table 17 – PICS for T-Profile support

		Client		Server		Value/comment
		F/S		F/S		
T1	SV T-Profile	c		c		
c: Shall be 'm' if support for A2 is declared. Otherwise, it shall be 'i'.						

10.2.2 SV Services

This subclause describes the protocol implementation conformance statement for sampled values services based on the IEC 61850-7-2 basic conformance statement. See Table 18.

Table 18 – SV conformance statement

Services	Client/ subscriber	Server/ publisher	Value/comment
Multicast			
SendMSVMessage	c1	c1	
GetMSVCBValues	c2	c2	
SetMSVCBValues	c3	c3	
GetMsvReference	o	o	
GetMSVElementNumber	o	o	
Unicast			
SendUSVMessage	c1	c1	deprecated
GetUSVCBValues	c2	c2	deprecated
SetUSVCBValues	c3	c3	deprecated
c1: Shall declare 'm' for at least one (MSV or USV) as declared within ACSI basic conformance statement. c2: Shall be 'o' as declared within ACSI basic conformance statement. See IEC 61850-8-1, Table 117 "Read Conformance Statement". c3: Shall be 'o' as declared within ACSI basic conformance statement. See IEC 61850-8-1, Table 118 "Write Conformance Statement".			

11 Substation configuration language (SCL)

Conforming implementations shall support the substation configuration language as defined in IEC 61850-6 for exchange between engineering tools.

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12 SCSM specific address element definitions

This clause defines the xs:string types that are allowed for the SV addressing as type parameters of the P element of the address element. The values and character restrictions are defined in Table 19.

Table 19 – Definitions for SV SCL

P-type designation	Description	m/o	Restrictions/comments
MAC-Address	Media Access Address value	m	Shall be 6 groups of 2 visible characters separated by hyphens (-). Characters shall be limited to 0 to 9 and A to F.
APPID	Application Identifier	m	Shall be 4 characters. Characters shall be limited to 0 to 9 and A to F.
VLAN-PRIORITY	VLAN User Priority	m	Shall be a single character. Characters shall be limited to 0 to 7.
VLAN-ID	VLAN ID	m	Shall be 3 characters. Characters shall be limited to 0 to 9 and A to F.

There shall be a scl.SMV element for each fully configured layer 2 scl.SampledValueControl within an SCD file, where it shall include the P elements specified in Table 19.

Implementations claiming conformance to this standard shall be able to be configured to use MAC-Address outside the recommended ranges specified in Annex B.

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Annex A
(informative)

ISO/IEC/IEEE 8802-3 frame format and ASN.1 basic encoding rules

A.1 ISO/IEC/IEEE 8802-3 frame format

See Figures A.1, A.2 and A.3.

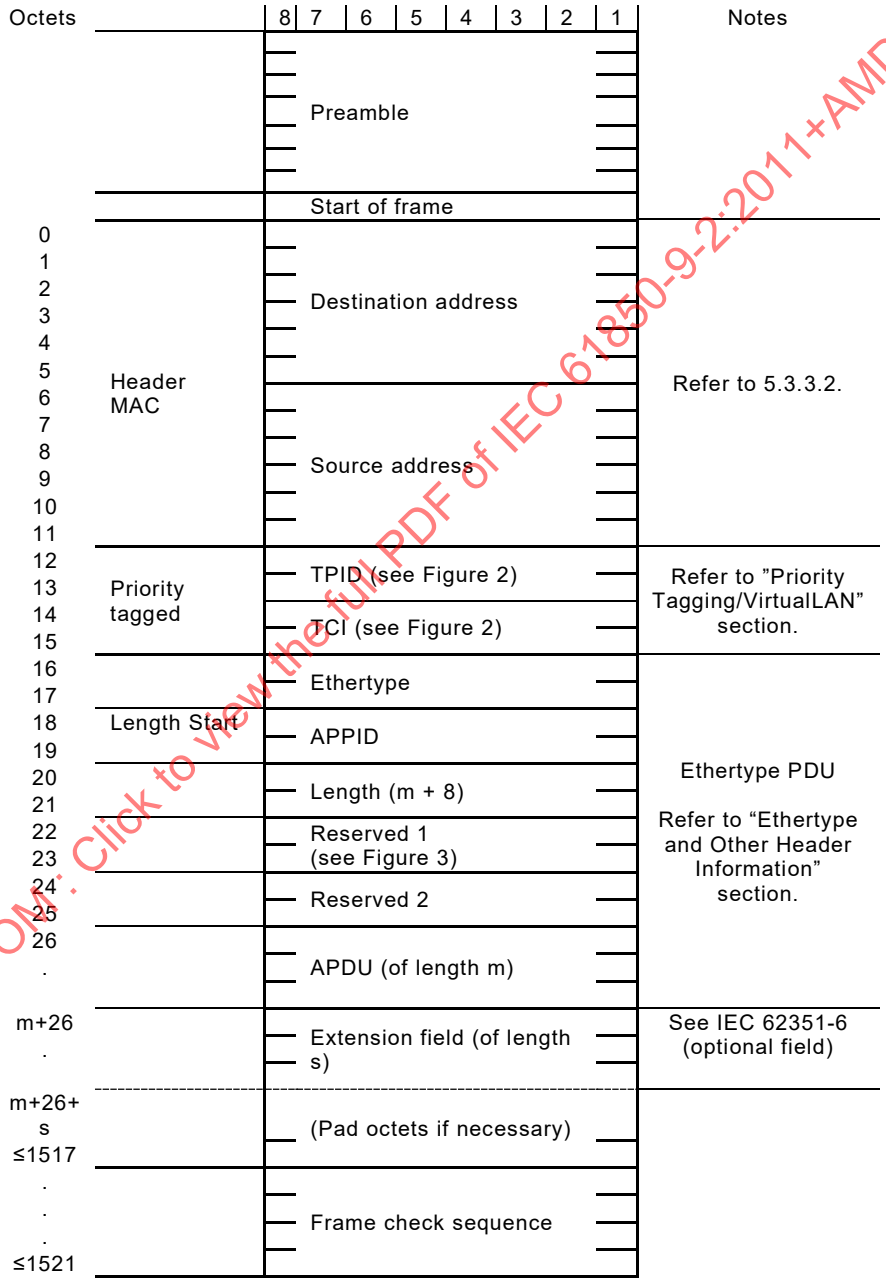

Figure A.1 – ISO/IEC/IEEE 8802-3 frame format – No link redundancy

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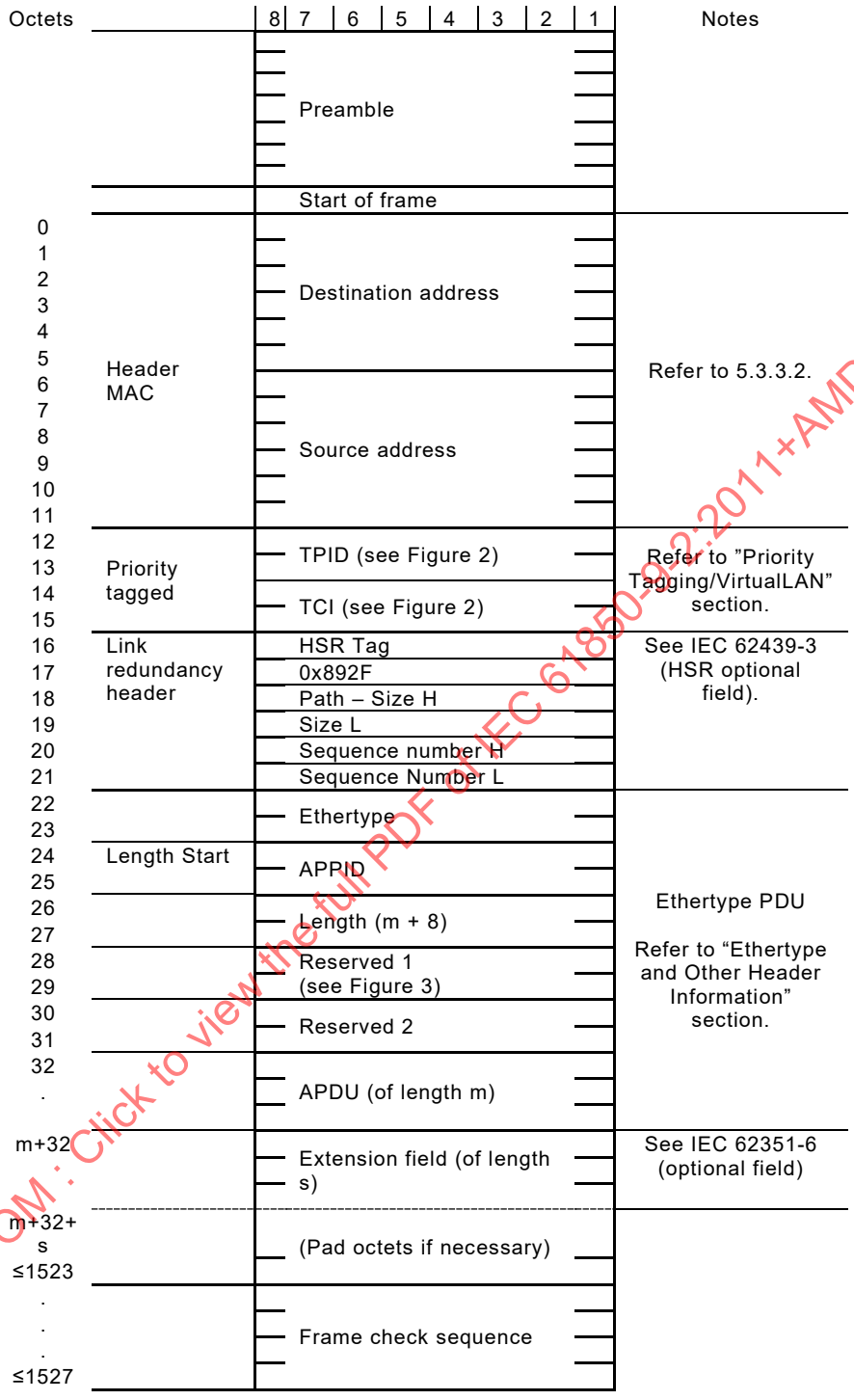

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Figure A.2 – ISO/IEC/IEEE 8802-3 frame format – Link redundancy: HSR