

TECHNICAL SPECIFICATION

**Communication networks and systems for power utility automation –
Part 80-1: Guideline to exchanging information from a CDC-based data model
using IEC 60870-5-101 or IEC 60870-5-104**



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TECHNICAL SPECIFICATION

**Communication networks and systems for power utility automation –
Part 80-1: Guideline to exchanging information from a CDC-based data model
using IEC 60870-5-101 or IEC 60870-5-104**

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**COMMUNICATION NETWORKS AND
SYSTEMS FOR POWER UTILITY AUTOMATION –****Part 80-1: Guideline to exchanging information from a CDC-
based data model using IEC 60870-5-101 or IEC 60870-5-104**

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Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC 61850-80-1, which is a technical specification, has been prepared by IEC technical committee 57: Power systems management and associated information exchange.

The text of this technical specification is based on the following documents:

Enquiry draft	Report on voting
57/916/DTS	57/969/RVC

Full information on the voting for the approval of this technical specification can be found in the report on voting indicated in the above table.

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

The bold characters in some tables are used to highlight the most essential terms or functions inside the figures to improve readability. Shading of parts of the figures is used for the same purpose.

A list of all parts of the IEC 61850 series, published 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 this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

- transformed into an International standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual edition of this document may be issued at a later date.

COMMUNICATION NETWORKS AND SYSTEMS FOR POWER UTILITY AUTOMATION –

Part 80-1: Guideline to exchanging information from a CDC-based data model using IEC 60870-5-101 or IEC 60870-5-104

1 Scope and object

This technical specification gives a guideline on how to exchange information from a CDC-based data model (for example IEC 61850) using IEC 60870-5-101 or IEC 60870-5-104 between substation(s) and control center(s). Mostly guidelines for functions needed in a substation gateway device are given.

The goal of this technical specification is to describe standardized mapping of device-oriented data models (for example IEC 61850) with already defined attributes of CDC's and services (for example IEC 61850-7) onto the already defined ASDU's and services of IEC 60870-5-104 or IEC 60870-5-101. It is not the goal of this technical specification to add any extensions to published standards (for example IEC 61850 or IEC 60870-5-104 or IEC 60870-5-101).

After an introduction giving a basic description of the mapping, the mapping of the information model with associated data classes, and the mapping of services are described. Clause 9 shows how the mapped data and services according to the IEC 60870-5-104 and IEC 60870-5-101 protocol are marked (selected) in the interoperability sheet.

The scope of this technical specification is to achieve real-time exchange of process information required for operational purposes between a substation using a CDC-based data model (for example IEC 61850) and (a) control centre(s) using a communication link over a wide area network (WAN) compliant to the definitions of IEC 60870-5-101 or IEC 60870-5-104. The amount of real-time information provided by the substation-gateway device can vary dependent on the operational needs. Actors could be regional and nationwide control centers that receive real-time information in order to monitor and control geographically widespread processes. The described mapping can be used for several fields of application of power utilities, such as substations, hydro and wind power plants, and decentralized energy resources DER. The mapping is based on the definitions of the standard series IEC 61850 Edition 1.0 and IEC 60870-5-104:2006/IEC 60870-5-101:2003. The scope of the mapped IEC 60870-5-104 and IEC 60870-5-101 subset is given in Clause 9.

This technical specification focuses mainly on defining rules and functions of a gateway device as a part of the substation. However, the rules and functions are also valid when an IED may optionally be connected directly to a WAN compliant with IEC 60870-5-101 or IEC 60870-5-104 and therefore, the mapping has to be done inside the IED.

2 Normative references

The following referenced documents are indispensable for the application 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 60870-5-3, *Telecontrol equipment and systems – Part 5: Transmission protocols – Section 3: General structure of application data*

IEC 60870-5-4:1993, *Telecontrol equipment and systems – Part 5: Transmission protocols – Section 4: Definition and coding of application information elements*

IEC 60870-5-5:1995, *Telecontrol equipment and systems – Part 5: Transmission protocols – Section 5: Basic application functions*

IEC 60870-5-101:2003, *Telecontrol equipment and systems – Part 5-101: Transmission protocols – Companion standard for basic telecontrol tasks*

IEC 60870-5-104:2006, *Telecontrol equipment and systems – Part 5-104: Transmission protocols – Network access for IEC 60870-5-101 using standard transport profiles*

IEC 61850 (all parts), *Communication networks and systems in substations*

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

IEC 61850-7-2:2003, *Communication networks and systems in substations – Part 7-2: Basic communication structure for substation and feeder equipment – Abstract communication service interface (ACSI)*

IEC 61850-7-3, *Communication networks and systems in substations – Part 7-3: Basic communication structure for substation and feeder equipment – Common data classes*

IEC 61850-8-1, *Communication networks and systems in substations – Part 8-1: Specific Communications Service Mapping (SCSM) – Mapping to MMS (ISO 9506-1 and ISO 9506-2) and to ISO/IEC 8802-3*

Document 57/963/INF: *IEC 61850 – Technical issues* (see www.tissue.iec61850.com)

IEC 61400-25-2, *Wind turbines – Part 25-2: Communications for monitoring and control of wind power plants – Information models*

IEEE 754:2008, *IEEE Standard for Binary Floating-Point Arithmetic*

RFC 2200, *Internet Official Protocol Standards, Request for Comments 2200* (June 1997)

3 Abbreviated terms

For the purposes of this document, the following abbreviated terms apply.

ACSI	Abstract communication service interface (defined for example in IEC 61850-7-2)
ASDU	Application service data unit
CASDU	Common address of ASDU
CDC	Common data class (defined for example in IEC 61850-7-3)
CI	Counter interrogation
COT	Cause of transmission
GI	General interrogation
GOOSE	Generic object oriented substation event
HMI	Human machine interface
IED	Intelligent electronic device
IOA	Information object address
LD	Logical device

LN	Logical node
PI	Process image
P/N	Positive/negative
QOI	Qualifier of interrogation
QDS	Quality descriptor
RFC	Request for comments
S/E	Select/execute
SCADA	Supervisory control and data acquisition
SCSM	Specific communication service mapping (defined for example in IEC 61850-8-1)
SCL	Substation configuration language (defined for example in IEC 61850-6)
TCP	Transmission control protocol
TI	Type Identification
TISSUE	Technical issue as part of the maintenance process of IEC 61850
WAN	Wide area network
XML	Extensible mark-up language

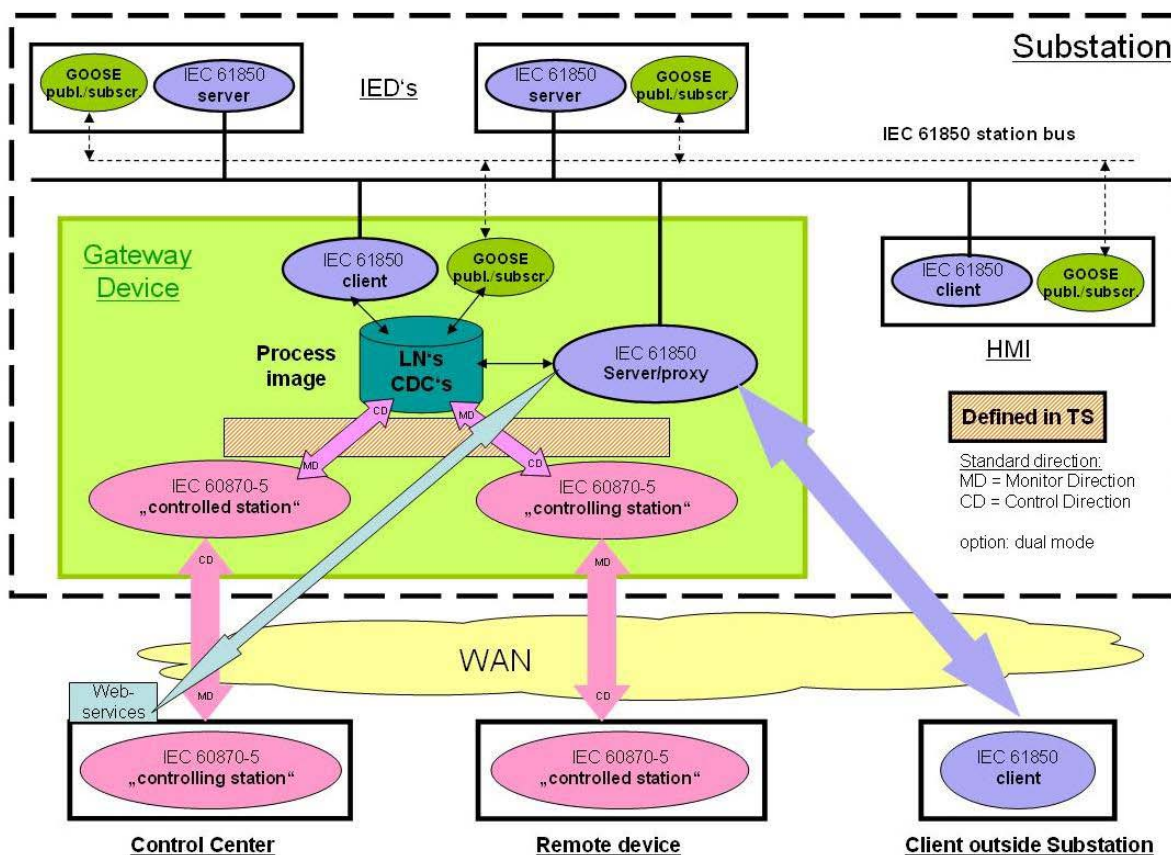
4 The mapping architecture

The mapping architecture consists of 5 parts:

- 1) conceptual architecture of a gateway device and associated use cases;
- 2) conceptual architecture of an IED directly connected to a WAN (optional);
- 3) mapping of the information model;
- 4) mapping of the data (which is in fact part of the information model);
- 5) mapping of the services.

5 Conceptual architectures and associated use cases

5.1 Conceptual architecture of a gateway device



IEC 2255/08

Figure 1 – Conceptual architecture of a gateway device

Figure 1 describes the conceptual architecture of a gateway device within a substation. The gateway device is decoupling the IEC 61850 station bus from the IEC 60870-5-101 or IEC 60870-5-104 WAN via a process image (PI). The advantage of this approach is that only services for control model interaction need to be mapped.

The PI is organized according the data model of IEC 61850 (LDs, LNs, CDCs).

The IEC 61850 client/GOOSE subscriber is used to update the PI with process data made available by the IEDs.

The IEC 61850 server/proxy is used to:

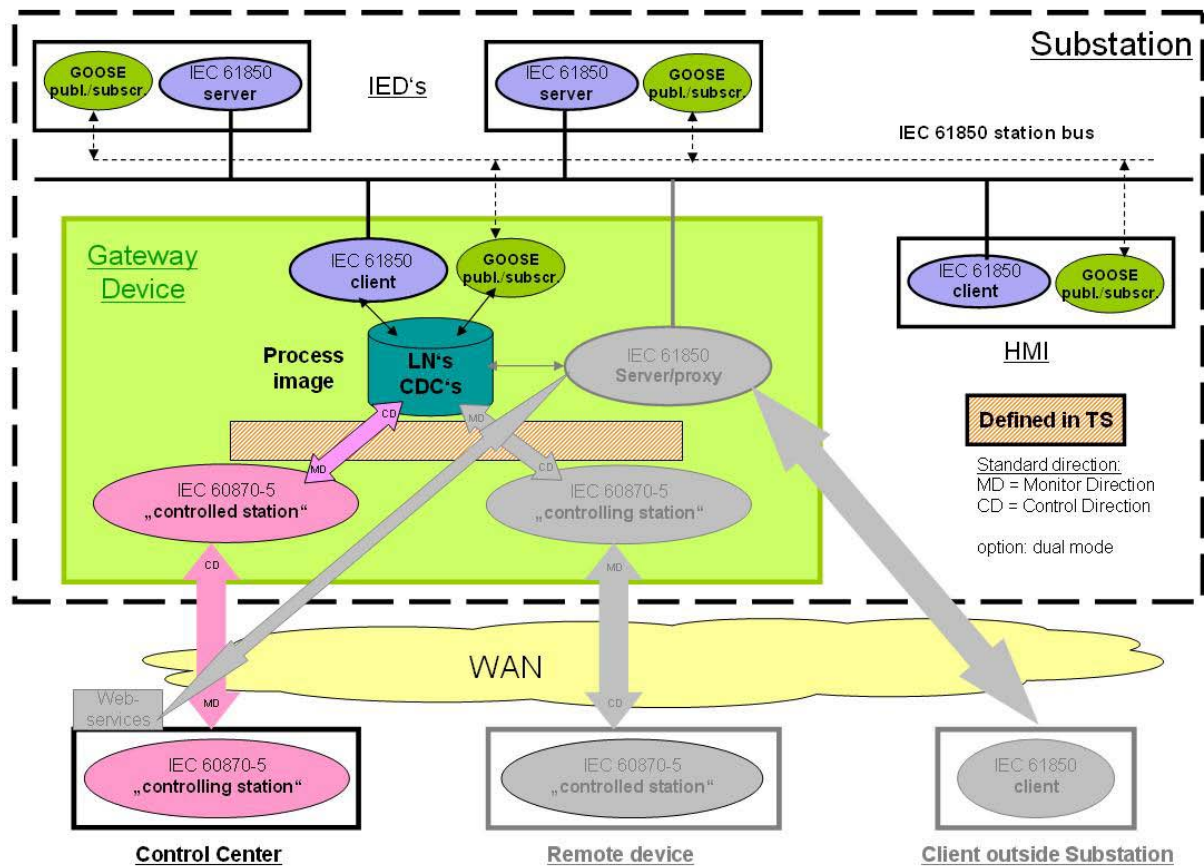
- make process data coming from remote devices available for IEDs inside the substation;
- retrieve the data model for:
 - IEC 61850 clients **inside** the **substation** (for example HMI);
 - IEC 61850 clients **outside** the **substation** (for example future control centers);
 - existing **control centers** using IEC 60870-5-101 or IEC 60870-5-104 for WAN communication by using **additional services** (for example SCL extensions or web services).

The IEC 60870-5-101 or IEC 60870-5-104 controlled and controlling functionality makes use of the attributes of CDCs in a defined way to build up ASDUs to communicate with control centers or “devices on the WAN network” using WAN communication based on IEC 60870-5-101 or IEC 60870-5-104 (including redundant connections).

The IEC 60870-5-101 or IEC 60870-5-104 controlling functionality inside the gateway device is used to connect “devices on the WAN network” with IEC 60870-5-101 or IEC 60870-5-104 controlled functionality to the substation.

The gateway device can optionally act as a “mediator” between the substation and all “devices on the WAN network”. When IEC 60870-5-101 or IEC 60870-5-104 “dual mode functionality” is used, the same ASDUs are used in the monitor and the control direction on the WAN.

5.1.1 Use case a) for a gateway device



IEC 2256/08

Figure 2 – Use case a) for a gateway device

Figure 2 describes use case a) using a subset of functions of the conceptual architecture. The IEC 61850 client/GOOSE subscriber is used to update the PI with process data made available by the IEDs.

The IEC 60870-5-101 or IEC 60870-5-104 controlled functionality makes use of the attributes of CDCs in a defined way to build up ASDUs to communicate with control centers using WAN communication based on IEC 60870-5-101 or IEC 60870-5-104 (including redundant connections).

5.1.2 Use case b) for a gateway device

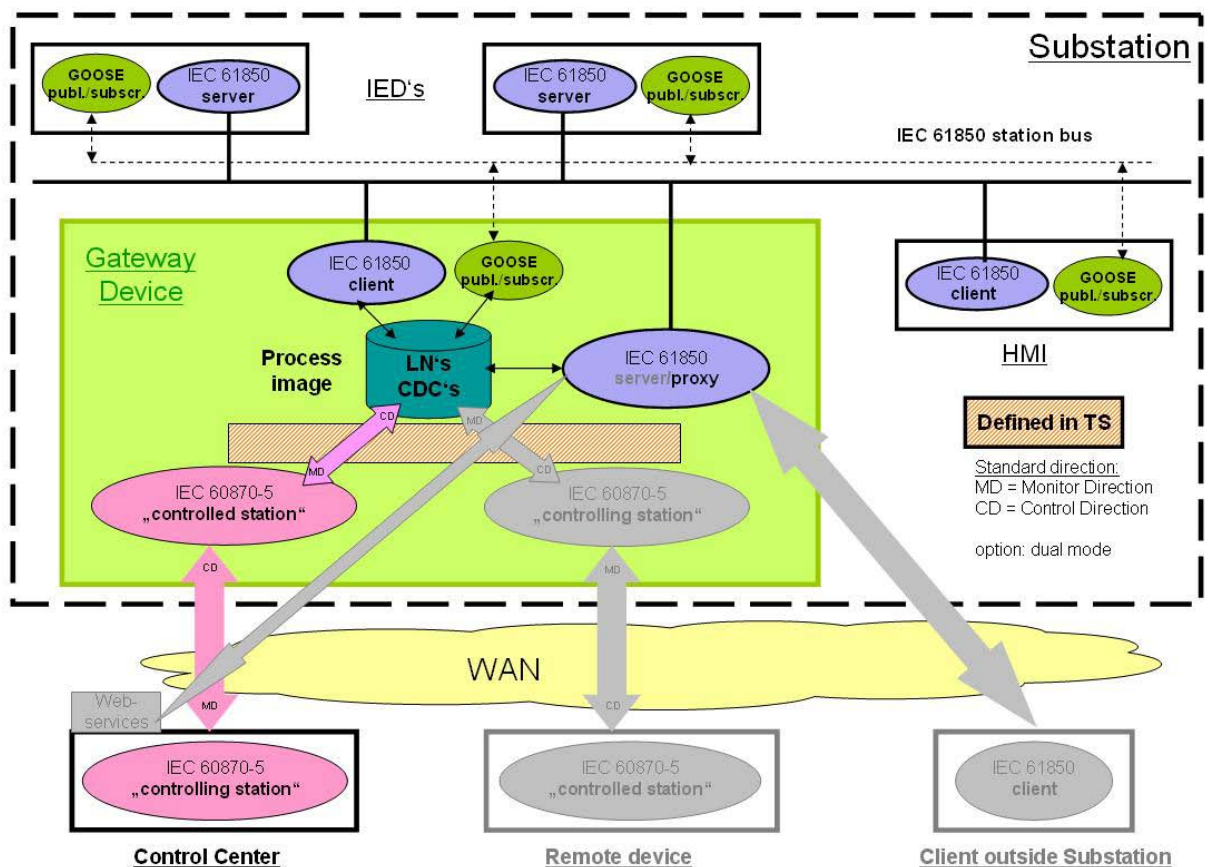


Figure 3 – Use case b) for a gateway device

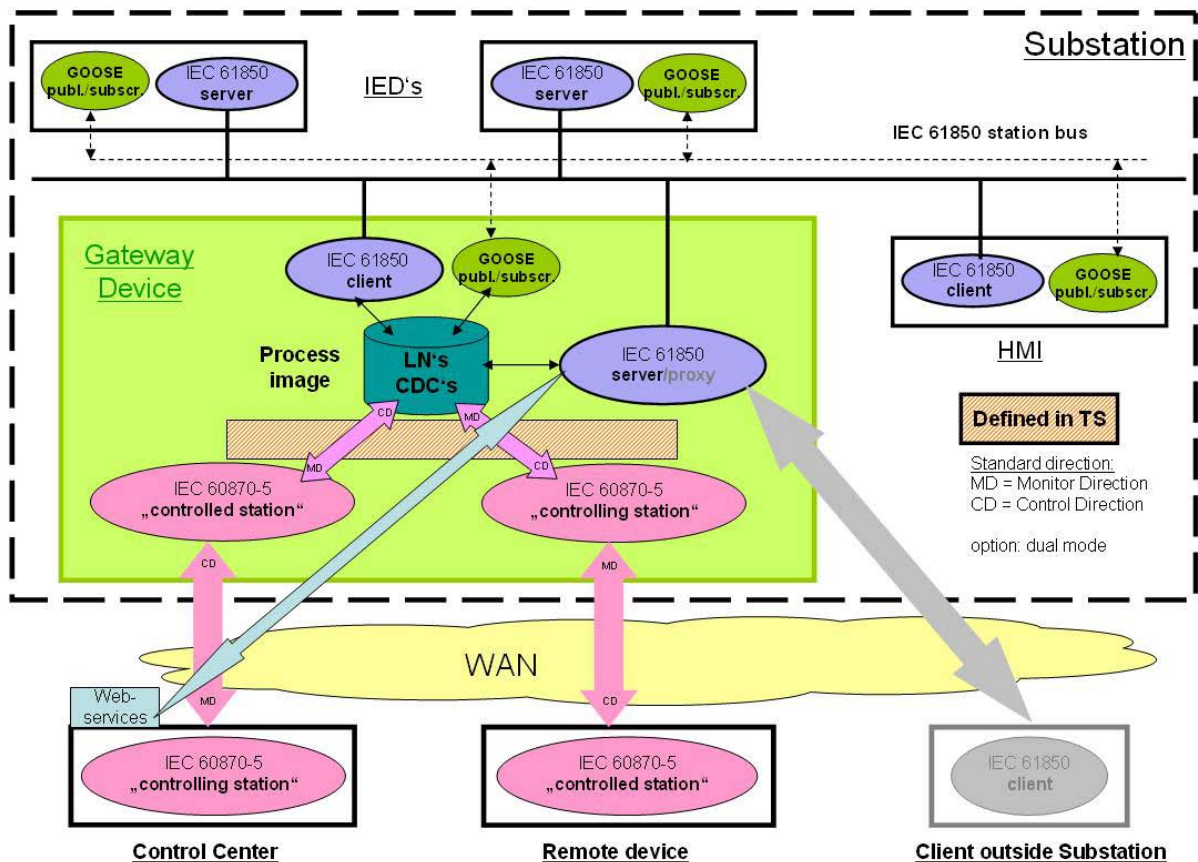
Figure 3 describes use case b) using an extended subset of functions of the conceptual architecture.

The IEC 61850 client/GOOSE subscriber is used to update the PI with process data made available by the IEDs.

The IEC 61850 proxy is used to retrieve the data model for IEC 61850 clients inside the substation (for example HMI).

The IEC 60870-5-101 or IEC 60870-5-104 controlled functionality makes use of the attributes of CDCs in a defined way to build up ASDUs to communicate with control centers using WAN communication based on IEC 60870-5-101 or IEC 60870-5-104 (including redundant connections).

5.1.3 Use case c) for a gateway device



IEC 2258/08

Figure 4 – Use case c) for a gateway device

Figure 4 describes use case c) using nearly all functions of the conceptual architecture. The IEC 61850 client/GOOSE subscriber is used to update the PI with process data made available by the IEDs.

The IEC 61850 server is used to:

- make process data coming from remote devices available for IEDs inside the substation;
- retrieve the data model for:
 - IEC 61850 clients inside substation (for example HMI);
 - existing control centers using IEC 60870-5-101 or IEC 60870-5-104 for WAN communication by using additional services (for example SCL extensions or web services).

The IEC 60870-5-101 or IEC 60870-5-104 controlled and controlling functionality makes use of the attributes of CDCs in a defined way to build up ASDUs to communicate with control centers or “devices on the WAN network” using WAN communication based on IEC 60870-5-101 or IEC 60870-5-104 (including redundant connections).

The IEC 60870-5-101 or IEC 60870-5-104 controlling functionality inside the gateway device is used to connect “devices on the WAN network” with IEC 60870-5-101 or IEC 60870-5-104 controlled functionality to the substation.

The gateway device can optionally act as a “mediator” between the substation and all “devices on the WAN network”. When IEC 60870-5-101 or IEC 60870-5-104 “dual mode functionality” is used, the same ASDUs are used in the monitor and the control direction on the WAN.

5.2 Conceptual architecture of an IED directly connected to a WAN (optional)

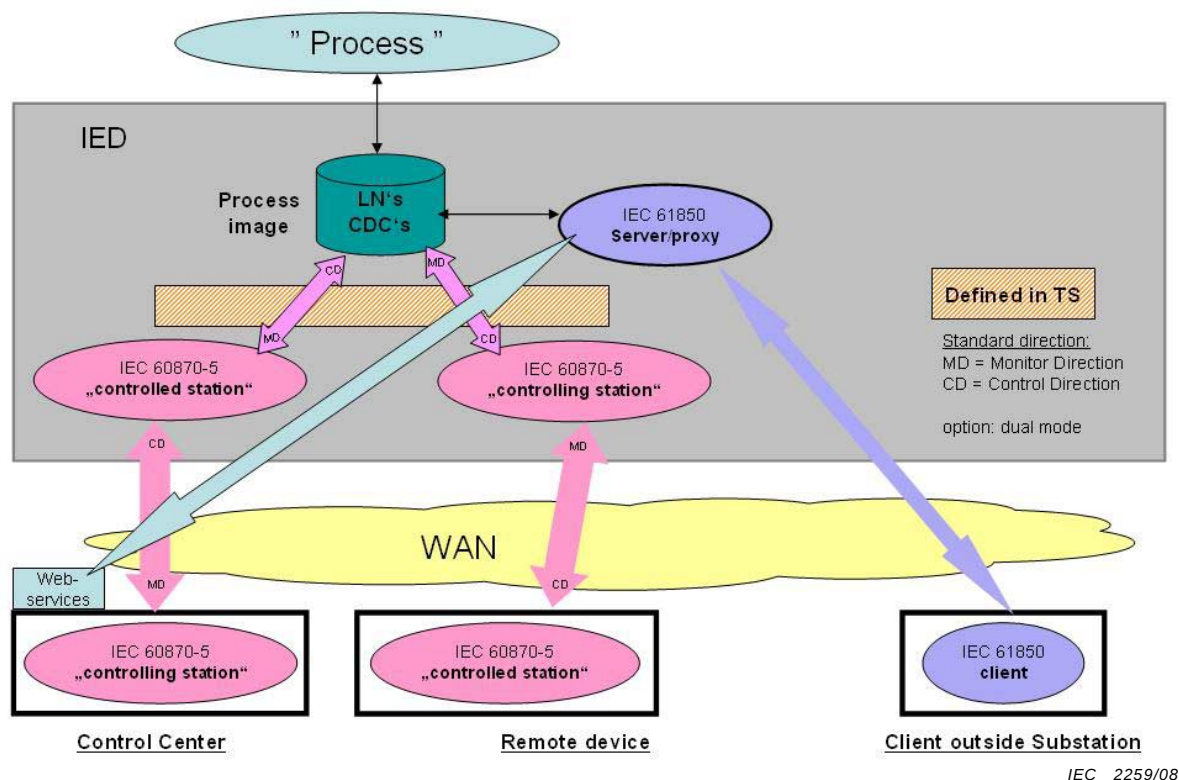


Figure 5 – Conceptual architecture of an IED

Figure 5 is showing the conceptual architecture of an IED which optionally maybe connected directly to a WAN compliant to IEC 60870-5-104 or IEC 60870-5-101. However, the rules and functions defined for a gateway device as a part of a substation are also valid for the mapping inside an IED.

The IED is decoupling the process information from the IEC 60870-5-101 or IEC 60870-5-104 WAN via a process image (PI). The advantage of this approach is that only services for control model interaction need to be mapped.

The PI is organized according the data model of IEC 61850 (LDs, LNs, CDCs).

The IEC 61850 server/proxy is used to:

- make process data coming from remote devices available for the process connected to the IED;
- retrieve the data model for:
 - IEC 61850 clients outside the substation (for example future control centers);
 - existing control centers using IEC 60870-5-101 or IEC 60870-5-104 for WAN communication by using additional services (for example SCL extensions or web services).

The IEC 60870-5-101 or IEC 60870-5-104 controlled and controlling functionality makes use of the attributes of CDCs in a defined way to build up ASDUs to communicate with control centers or “devices on the WAN network” using WAN communication based on IEC 60870-5-101 or IEC 60870-5-104.

The IEC 60870-5-101 or IEC 60870-5-104 controlling functionality inside the IED is used to connect “devices on the WAN network” with IEC 60870-5-101 or IEC 60870-5-104 controlled functionality to the IED.

The IED can optionally act as a “mediator” between the IED and all “devices on the WAN network”. When IEC 60870-5-101 or IEC 60870-5-104 “dual mode functionality” is used, the same ASDUs are used in the monitor and the control direction on the WAN.

6 Mapping of a device-oriented information model to IEC 60870-5-104 or IEC 60870-5-101

6.1 General

The defined mapping for a device-oriented information model is based on using existing functionalities in IEC 60870-5-104 or IEC 60870-5-101 by using the

- common address of ASDU (CASDU), and the
- information object address (IOA)

to accommodate the device model using LD (logical device) and LN (logical node) and transfer of real-time information (data) using standardized ASDUs. The same is applicable for the services and the basic application functions in IEC 60870-5-104 or IEC 60870-5-101.

6.2 Mapping of a device-oriented information model reference

The device-oriented information model (for example IEC 61850) shall be mapped to a hierarchical structure. The conceptual mapping is depicted in Figure 6. The device-oriented information model (for example IEC 61850) is intended to be preserved when mapped to IEC 60870-5-104 or IEC 60870-5-101. This especially means that

- the server/proxy implements the hierarchical device-oriented information model of, for example, IEC 61850 that can be retrieved by the services according to Clause 8;
- the client implements the device-oriented information model by configuration. That can be done in different ways:
 - by using the SCL file, specifying the implemented information model, mapping and addressing details according to the rules in IEC 61850-6;
 - by other configuration methods.
- the master/client station (“controlling station”) accesses the hierarchical device-oriented information model of, for example, IEC 61850 through the services provided by IEC 60870-5-104 or IEC 60870-5-101 to exchange real-time data.

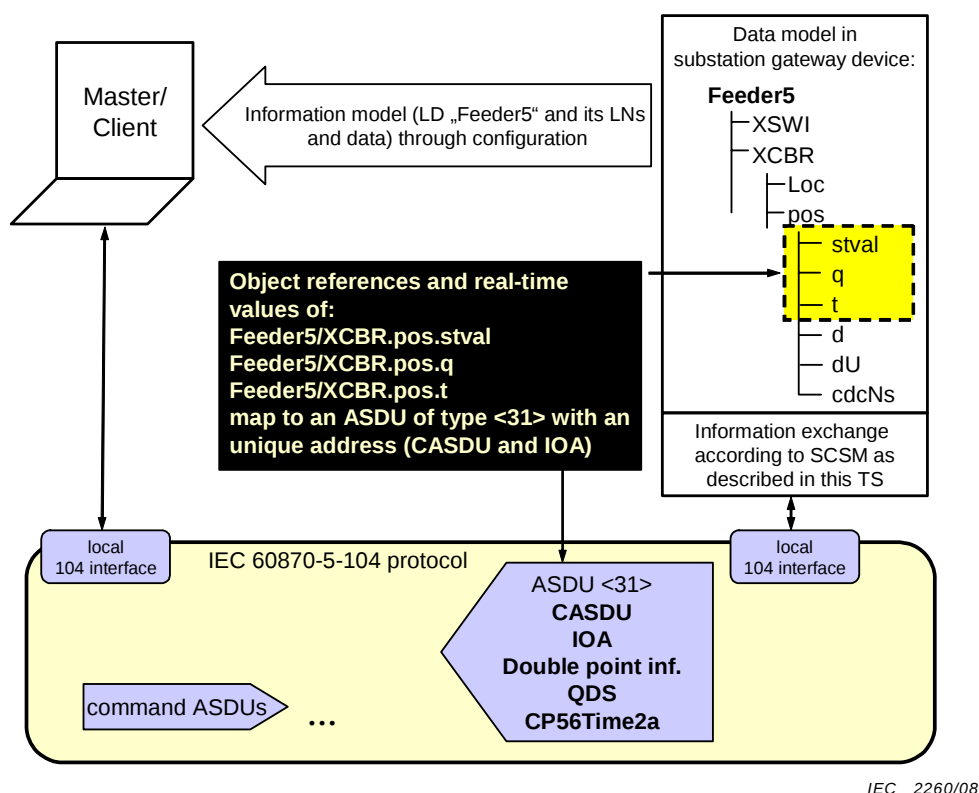


Figure 6 – Mapping architecture (conceptual)

6.3 Logical device class mapping

The logical device reference shall map to the common address of ASDU (CASDU).

NOTE The CASDU may be structured or unstructured. For example, the CASDU may identify the station ID and the logical device instance ID. It is recommended to make an addressing scheme in order to have unique address for the specific station. For example, for small stations, one CASDU can be assigned for a station, all LD will then have the same CASDU. For a large station several CASDU can be used to identify each LD. The maximum number of CASDU for one link is 65 534.

6.4 Logical node class mapping

The logical node instance ID and data attribute reference shall map to the information object address (IOA).

NOTE All attributes of the LN class are implicitly defined and visible. The IOA may be structured or unstructured. For both cases, a decimal approach for defining the IOA addresses is recommended. The maximum number of IOA addresses per CASDU is 65 536.

7 Mapping of the common data classes (CDC)

7.1 List of CDC, type Identifications and corresponding mappings for IEC 61850

Each common data class consists of one or more data attributes of a specific data type. Each data attribute shall be mapped to one specific IOA (as in 6.4). In IEC 60870-5-104 or IEC 60870-5-101, each IOA is directly related to a specific ASDU type (with or without time). Therefore, the CDC is basically mapped as in Table 1.

The mapping shown in Table 1 shall be considered as a default mapping – carefully selected out of a variety of mapping possibilities.

NOTE 1 The requirements for the mapping of LD, LN onto CASDU, IOA can vary in different fields of application. The most suitable way of mapping should be defined on a utility or project basis depending on the specific needs.

CASDU and IOA in IEC 60870-5-101 or IEC 60870-5-104 are just numbers which have to be unique within one Utility/project.

Table 1 – Mapping structure CDC onto ASDU type

CDCs defined in IEC 61850-7-3	
CDC (Attribute data types)	ASDU type
SPS Single point status	<i>monitor direction (status):</i> TI<30> as event TI<1> as part of GI
DPS Double point status	<i>monitor direction (status):</i> TI<31> as event TI<3> as part of GI
INS Integer status	<i>monitor direction (status):</i> TI<35> or TI <33> or TI <30> as event TI<11> or TI<7> or TI <1> as part of GI
ACT Protection activation information	<i>monitor direction (status):</i> TI<39> as event or TI<30> as event TI<1> as part of GI
ACD Directional protection activation Information	<i>monitor direction (status):</i> TI<40> as event or TI<30> as event TI<1> as part of GI
SEC Security violation counting	<i>monitor direction (status):</i> TI<37> as event or as part of CI
BCR Binary counter reading	<i>monitor direction (status):</i> TI<37> as event or as part of CI
MV Measured value	<i>monitor direction (status):</i> TI<36> or TI<35> as event TI<13> or TI<11> as part of GI
CMV Complex measured value	<i>monitor direction (status):</i> TI<36> or TI<35> as event TI<13> or TI<11> as part of GI
WYE Phase to ground related measured values in a three phase system	<i>monitor direction (status):</i> via CMV to TI<36> as event TI<13> as part of GI
DEL Phase to phase related measured values in a three phase system	<i>monitor direction (status):</i> via CMV to TI<36> as event TI<13> as part of GI
SEQ Sequence	<i>monitor direction (status):</i> via CMV to TI<36> as event TI<13> as part of GI
HMV Harmonic value	<i>monitor direction (status):</i> TI<36> as event TI<13> as part of GI
HWYE Harmonic value for WYE	<i>monitor direction (status):</i> via CMV to TI<36> as event TI<13> as part of GI
HDEL Harmonic value for DEL	<i>monitor direction (status):</i> via CMV to TI<36> as event TI<13> as part of GI
SPC Controllable single point	<i>monitor direction (status):</i> TI<30> as event TI<1> as part of GI <i>control direction (command):</i> TI<45> (without time tag) or TI<58> (with time tag)
DPC Controllable double point	<i>monitor direction (status):</i> TI<31> as event TI<3> as part of GI <i>control direction (command):</i> TI<46> (without time tag) or TI<59> (with time tag)

CDCs defined in IEC 61850-7-3	
CDC (Attribute data types)	ASDU type
INC Controllable integer status	<i>monitor direction (status):</i> TI<35> as event TI<11> as part of GI <i>control direction (command):</i> TI<49> (without time tag) or TI<62> (with time tag)
BSC Binary controlled step position information	<i>monitor direction (status):</i> TI<32> as event TI<5> as part of GI <i>control direction (command):</i> TI<47> (without time tag) or TI<60> (with time tag)
ISC Integer-controlled step position information	<i>monitor direction (status):</i> TI<32> as event TI<5> as part of GI <i>control direction (setpoint):</i> TI<49> (without time tag) or TI<62> (with time tag)
APC Controllable analogue set point information	<i>monitor direction (status):</i> TI<36> as event TI<13> as part of GI <i>control direction (command):</i> TI<50> (without time tag) or TI<63> (with time tag)
SPG Single point setting	<i>control direction (command):</i> TI<45> (without time tag) or TI<58> (with time tag)
ING Integer status setting	<i>control direction (setpoint):</i> TI<49> (without time tag) or TI<62> (with time tag)
ASG Analogue setting	<i>control direction (setpoint):</i> TI<50> (without time tag) or TI<63> (with time tag)
Additional CDCs defined in IEC 61400-25-2	
CDC (Attribute data types)	ASDU type
STV Status value	Mapped via CDC INS Integer status
SPV Setpoint value	Mapped via CDC APC Controllable analogue set point information
ALM Alarm	Mapped via CDC INS Integer status for Data Attribute actVal CDC SPC Controllable single point for Data Attribute almAck
CMD Command	Mapped via CDC INC Controllable integer status
CTE Event counting	Mapped via CDC INS Integer status for DataAttribute actCtVal CDC SPC Controllable single point for DataAttribute manRs
TMS State timing	Mapped via CDC SPC Controllable single point for DataAttribute manRs CDC INS Integer status for DataAttribute actTmVal and for DataAttribute oldTmVal
TI:= Type Identification GI:= General Interrogation or station interrogation ASDU TI <100> CI:= Counter interrogation ASDU TI <101>	

Common data classes CURVE, DPL, LPL, CSD and SAV from IEC 61850-7-3 and ASS from IEC 61400-25-4 cannot be mapped to ASDU's of IEC 60870-5-104 or IEC 60870-5-101.

NOTE 2 The mappings shown include the timestamp and are applicable for the monitor information if sent as an event. If the information is sent as part of GI (general interrogation/station interrogation) or CI (counter interrogation), the complete mapping is applicable, apart from the timestamp. All GI and CI data is sent excluding a timestamp.

7.2 CDC single point status (SPS)

The data attributes of the common data class SPS depicted in Table 2 shall be mapped as shown in Table 3.

Table 2 – CDC: Single point status (SPS)

SPS class					
Attribute name	Attribute type	FC	TrgOp	Explanation and value / range	M/O
DataName	Inherited from data class (see IEC 61850-7-2)				
Data attribute					
status					
stVal	BOOLEAN	ST	dchg	TRUE FALSE	M
t	TimeStamp	ST		Time value	M
q	Quality	ST	qchg	Quality	M

The signal [stVal + t + q] shall map to the ASDU TI <30> "Single point information with time tag CP56Time2a" as specified in Table 3.

Table 3 – CDC: Single point status (SPS) mapping

CDC class		IEC 60870-5-101 or IEC 60870-5-104 mapping	
SPS		TI <30>	
Attribute name	Attribute type	information element	IEC 60870-5-104 or IEC 60870-5-101 object group mapping
stVal	BOOLEAN	SIQ	SPI:<0> OFF = FALSE <1> ON = TRUE
q	Quality		validity -> IV good invalid -> valid invalid questionable -> NTI source -> SB substituted -> substituted operatorBlocked -> BL blocked -> blocked
t	TimeStamp	CP56Time2a	Seven octet binary time, CP56Time2a – Time of occurrence of dchg or qchg

7.3 CDC double point status (DPS)

The data attributes of the common data class DPS depicted in Table 4 shall be mapped as shown in Table 5.

Table 4 – CDC: Double point status (DPS)

DPS class					
Attribute name	Attribute type	FC	TrgOp	Explanation and value / Range	M/O
DataName	Inherited from data class (see IEC 61850-7-2)				
DataAttribute					
status					
stVal	CODED ENUM	ST	dchg	intermediate state off on bad state	M
t	TimeStamp	ST		Time	M
q	Quality	ST	qchg	Quality	M

The signals [stVal + t + q] shall map to the ASDU TI <31> "Double point information with time tag CP56Time2a" as specified in Table 5.

Table 5 – CDC: Double point status (DPS) mapping

CDC class		IEC 60870-5-101 or IEC 60870-5-104 mapping	
DPS		TI <31>	
Attribute name	Attribute type	Information element	IEC 60870-5-104 or IEC 60870-5-101 object group mapping
stVal	CODED ENUM	DIQ	DPI <0> intermediate state = intermediate-state <1> determined state OFF = OFF <2> determined state ON = ON <3> indeterminate = bad.state
q	Quality		validity -> IV good invalid -> valid invalid questionable -> NT source -> SB substituted -> substituted operatorBlocked -> BL blocked -> blocked
t	TimeStamp		Seven octet binary time, CP56Time2a – Time of occurrence of dchg or qchg

7.4 CDC integer status (INS)

The DataAttributes of the common data class INS depicted in Table 6 shall be mapped as shown in Table 7.

Table 6 – CDC: Integer status (INS)

INS class					
Attribute name	Attribute type	FC	TrgOp	Explanation and value / Range	M/O
DataName	Inherited from data class (see IEC 61850-7-2)				
DataAttribute					
status					
stVal	INT32	ST	dchg		M
t	TimeStamp	ST		Time	M
q	Quality	ST	qchg	Quality	M

The signals [stVal + t + q] shall map to either ASDU TI <35> "Measured value, scaled value with time tag CP56Time2a" or optionally ASDU TI <33> "Bitstring of 32 bits with time tag CP56Time2a" as specified in Table 7.

For the special use case that the attribute EEHealth of a logical node with the CDC INS has to be mapped onto one single status to meet the requirements of existing control center systems, the signals [stVal + t + q] shall map to ASDU TI <30> "Single point information with time tag CP56Time2a".

NOTE The mapping of CDC INS to ASDU TI<33> (binary state information) is optional. It may be used if the value range for the default mapping to ASDU TI<35> (scaled value) is not sufficient.

Table 7 – CDC: Integer status (INS) mapping

CDC class		IEC 60870-5-101 or IEC 60870-5-104 mapping	
INS		TI <35>	
Attribute name	Attribute type	Information element	IEC 60870-5-104 or IEC 60870-5-101 object group mapping
stVal	INT32	SVA = Scaled value	SVA $16 \times 2^{15} \dots 2^{15}-1$ 0 map on 0 Valid range for INT32 is $<-2^{15} \dots +2^{15}-1$
t	TimeStamp	CP56Time2a	Seven octet binary time, CP56Time2a – Time of occurrence of dchg or qchg
q	Quality	QDS = Quality descriptor	validity -> IV good invalid -> valid invalid questionable -> NT detailQual -> OV overflow -> overflow source -> SB substituted -> substituted operatorBlocked -> BL blocked -> blocked
CDC class		IEC 60870-5-101 or IEC 60870-5-104 mapping	
INS		TI <33>	
Attribute name	Attribute type	Information element	IEC 60870-5-104 or IEC 60870-5-101 object group mapping
stVal	INT32	BSI = Binary state information	BSI := 32BS1[1..32]<0,1>
t	TimeStamp	CP56Time2a	Seven octet binary time, CP56Time2a – Time of occurrence of dchg or qchg
q	Quality	QDS = Quality descriptor	validity -> IV good invalid -> valid invalid questionable -> NT detailQual -> OV overflow -> overflow source -> SB substituted -> substituted operatorBlocked -> BL blocked -> blocked
CDC class		IEC 60870-5-101 or IEC 60870-5-104 mapping	
INS		TI <30>	
Attribute nme	Attribute type	Information element	IEC 60870-5-104 or IEC 60870-5-101 object group mapping
stVal	INT32	SIQ	stVal := <1> ok -> SPI := <0> OFF = FALSE stVal := <3> Alarm -> SPI := <1> ON = TRUE
q	Quality		validity -> IV good invalid -> valid invalid questionable -> NTI source -> SB substituted -> substituted operatorBlocked -> BL blocked -> blocked
t	TimeStamp	CP56Time2a	Seven octet binary time, CP56Time2a – Time of occurrence of dchg or qchg

7.5 CDC protection activated information (ACT)

The data attributes of the common data class ACT depicted in Table 8 shall be mapped as shown in Table 9.

Table 8 – CDC: Protection activated information (ACT)

ACT class					
Attribute name	Attribute type	FC	TrgOp	Explanation and value / Range	M/O
DataName	Inherited from data class (see IEC 61850-7-2)				
DataAttribute					
status					
general	BOOLEAN	ST	dchg	TRUE FALSE	M
phsA	BOOLEAN	ST	dchg	TRUE FALSE	O
phsB	BOOLEAN	ST	dchg	TRUE FALSE	O
phsC	BOOLEAN	ST	dchg	TRUE FALSE	O
neut	BOOLEAN	ST	dchg	TRUE FALSE	O
t	TimeStamp	ST		Time value	M
q	Quality	ST	qchg	Quality	M

The signals [general + phsA + phsB + phsC + neut + t + q] shall map to the ASDU TI <39> "Packed start events of protection equipment with time tag CP56Time2a" or multiple ASDUs TI <30> "Single point information with time tag CP56time 2a" as specified in Table 9.

Table 9 – CDC: Protection activated information (ACT) mapping

a) Mapping to ASDU TI <39>			
CDC class		IEC 60870-5-101 or IEC 60870-5-104 mapping	
ACT		TI <39>	
Attribute name	Attribute type	Information element	IEC 60870-5-104 or IEC 60870-5-101 object group mapping
general	BOOLEAN	SPE	GS = general start of operation:= BS1[1]<0..1> FALSE = <0>:= no general start of operation TRUE = <1>:= general start of operation
phsA	BOOLEAN	SPE	SL1 = start of operation phase L1:= BS1[2]<0..1> FALSE = <0>:= no start of operation L1 TRUE = <1>:= start of operation L1
phsB	BOOLEAN	SPE	SL2 = start of operation phase L2:= BS1[3]<0..1> FALSE = <0>:= no start of operation L2 TRUE = <1>:= start of operation L2
phsC	BOOLEAN	SPE	SL3 = start of operation phase L3:= BS1[4]<0..1> FALSE = <0>:= no start of operation L3 TRUE = <1>:= start of operation L3
neut	BOOLEAN	SPE	SIE = start of operation IE (earth current) FALSE = <0>:= no start of operation IE TRUE = <1>:= start of operation IE
t	TimeStamp	CP56Time2a	Seven octet binary time, CP56Time2a – Time of occurrence of dchg or qchg
q	Quality	QDP	validity -> IV good invalid -> valid invalid questionable -> NT EI not used:= set to zero . = elapsed time valid source -> SB substituted -> substituted operatorBlocked -> BL blocked -> blocked
b) Mapping to ASDU TI<30>			
CDC class		IEC 60870-5-101 or IEC 60870-5-104 mapping	
ACT		TI <30>	
Attribute name	Attribute type	Information element	IEC 60870-5-104 or IEC 60870-5-101 object group mapping
general	BOOLEAN	SIQ	SPI <0> OFF = FALSE <1> ON = TRUE
phsA	BOOLEAN	SIQ	SPI <0> OFF = FALSE <1> ON = TRUE
phsB	BOOLEAN	SIQ	SPI <0> OFF = FALSE <1> ON = TRUE
phsC	BOOLEAN	SIQ	SPI <0> OFF = FALSE <1> ON = TRUE
neut	BOOLEAN	SIQ	SPI <0> OFF = FALSE <1> ON = TRUE
t	TimeStamp	CP56Time2a	Seven octet binary time, CP56Time2a – Time of occurrence of dchg or qchg
q	Quality	SIQ	validity -> IV good invalid -> valid invalid questionable -> NT source -> SB substituted -> substituted operatorBlocked -> BL blocked -> blocked

Each attribute maps to one ASDU TI <30> "Single point information with time tag CP56Time2a" as specified in Table 3 using consecutive indices:

IOA n := general
 IOA n+1 := phsA
 IOA n+2 := phsB
 IOA n+3 := phsC
 IOA n+4 := neut

7.6 CDC directional protection activation information (ACD)

The data attributes of the common data class ACD depicted in Table 10 shall be mapped as shown in Table 11.

Table 10 – CDC: Protection activated information (ACD)

ACD class					
Attribute name	Attribute type	FC	TrgOp	Explanation and value / Range	M/O
DataName	Inherited from Data Class (see IEC 61850-7-2)				
DataAttribute					
status					
general	BOOLEAN	ST	dchg	TRUE FALSE	M
dirGeneral	Enumerated	ST	dchg	unknown,forward,backward,both	M
phsA	BOOLEAN	ST	dchg	TRUE FALSE	GC_2(1)
dirPhsA	Enumerated	ST	dchg	unknown,forward,backward,both	GC_2(1)
phsB	BOOLEAN	ST	dchg	TRUE FALSE	GC_2(2)
dirPhsB	Enumerated	ST	dchg	unknown,forward,backward,both	GC_2(2)
phsC	BOOLEAN	ST	dchg	TRUE FALSE	GC_2(3)
dirPhsC	Enumerated	ST	dchg	unknown,forward,backward,both	GC_2(3)
neut	BOOLEAN	ST	dchg	TRUE FALSE	GC_2(4)
dirNeut	Enumerated	ST	dchg	unknown,forward,backward,both	GC_2(4)
t	TimeStamp	ST		Time value	M
q	Quality	ST	qchg	Quality	M

The signals [general + phsA + phsB + phsC + neut + t + q] shall map to the ASDU TI <40> "Packed output circuit information of protection equipment with time tag CP56Time2a" or multiple ASDUs TI <30> "Single point information with time tag CP56time 2a as specified in Table 11.

Table 11 – CDC: Directional protection activated information (ACD) mapping

a) without using directional attribute

CDC class		IEC 60870-5-101 or IEC 60870-5-104 mapping	
ACD		TI <40>	
Attribute name	Attribute type	Information element	IEC 60870-5-104 or IEC 60870-5-101 object group mapping
general	BOOLEAN	OCI	GC = general command to output circuit:= BS1[1]<0..1> FALSE = <0>:= no general command to output circuit TRUE = <1>:= general command to output circuit
phsA	BOOLEAN	OCI	CL1 = command to output circuit phase L1:= BS1[2]<0..1> FALSE = <0>:= no command to output circuit phase L1 TRUE = <1>:= command to output circuit phase L1
phsB	BOOLEAN	OCI	CL2 = command to output circuit phase L2:= BS1[3]<0..1> FALSE = <0>:= no command to output circuit phase L2 TRUE = <1>:= command to output circuit phase L2
phsC	BOOLEAN	OCI	CL3 = command to output circuit phase L3:= BS1[4]<0..1> FALSE = <0>:= no command to output circuit phase L3 TRUE = <1>:= command to output circuit phase L3
t	TimeStamp	CP56Time2a	Seven octet binary time, CP56Time2a – Time of occurrence of dchg or qchg
q	Quality	QDP	validity -> IV good invalid -> valid invalid questionable -> NT EI not used:= set to zero:= elapsed time valid source -> SB substituted -> substituted operatorBlocked -> BL blocked -> blocked

b) Use of directional attribute

CDC class		IEC 60870-5-101 or IEC 60870-5-104 mapping	
ACD		TI <30>	
Attribute name	Attribute type	Information element	IEC 60870-5-104 or IEC 60870-5-101 object group mapping
general	BOOLEAN	SIQ	SPI <0> OFF:= FALSE <1> ON:= TRUE
phsA	BOOLEAN	SIQ	SPI <0> OFF:= FALSE <1> ON:= TRUE
phsB	BOOLEAN	SIQ	SPI <0> OFF:= FALSE <1> ON:= TRUE
phsC	BOOLEAN	SIQ	SPI <0> OFF:= FALSE <1> ON:= TRUE
neut	BOOLEAN	SIQ	SPI <0> OFF:= FALSE <1> ON:= TRUE
t	TimeStamp	CP56Time2a	Seven octet binary time, CP56Time2a – Time of occurrence for object
q	Quality	SIQ	validity -> IV good invalid -> valid invalid questionable -> NT source -> SB substituted -> substituted operatorBlocked -> BL blocked -> blocked

Each value of direction attribute maps to one ASDU TI <30> "Single point information with time tag CP56Time2a" as specified in Table 3 using consecutive indices:

IOA n := general + unknown
 IOA n+1 := general + forward
 IOA n+2 := general + backward
 IOA n+3 := general + both
 IOA n+4 := phsA + unknown
 ..
 IOA n+7 := phsA + both
 IOA n+8 := phsB + unknown
 ..
 IOA n+11 := phsB + both
 IOA n+12 := phsC + unknown
 ..
 IOA n+15 := phsC + both
 IOA n+16 := neut + unknown
 ..
 IOA n+19 := neut + both

7.7 CDC Security violation counting (SEC)

The data attribute of the common data class SEC depicted in Table 12 shall be mapped as shown in Table 13.

Table 12 – CDC: Security violation counting (SEC)

SEC class					
Attribute name	Attribute type	FC	TrgOp	Explanation and value / Range	M/O
DataName	Inherited from data class (see IEC 61850-7-2)				
DataAttribute					
status					
cnt	INT32U	ST	dchg		M
t	TimeStamp	ST		Time value	M

The signal [cnt + t] shall map to the ASDU TI <37> "Integrated totals with time tag CP56Time2a" as specified in Table 13.

Table 13 – CDC: Security violation counting (SEC) mapping

CDC class		IEC 60870-5-101 or IEC 60870-5-104 mapping	
SEC		TI <37>	
Attribute name	Attribute type	Information element	IEC 60870-5-104 or IEC 60870-5-101 object group mapping
cnt	INT32U	BCR	Counter reading ... I32 <-2 ³¹ ..+2 ³¹ -1>
t	TimeStamp		Seven octet binary time, CP56Time2a – Time of occurrence of dchg
		BCR->sequence notation	SQ:= sequence number = set to zero CY:= carry = set to zero CA:= counter was adjusted = set to zero IV:= validity good -> valid

7.8 CDC binary counter reading (BCR)

The data attribute of the common data class BCR depicted in Table 14 shall be mapped as shown in Table 15.

Table 14 – CDC: Binary counter reading (BCR)

BCR class					
Attribute name	Attribute type	FC	TrgOp	Explanation and value / Range	M/O
DataName	Inherited from Data Class (see IEC 61850-7-2)				
DataAttribute					
status					
actVal	INT128	ST	dchg		M
frVal	INT128	ST	dupd		GC_2(1)
frTm	TimeStamp	ST	dupd	Time value	GC_2(1)
t	TimeStamp	ST		Time value	M
q	Quality	ST	qchg	Quality	M

The signal [actVal + t + q] shall map to ASDU TI <37> "Integrated totals with time tag CP56Time2a" with IOA n and the *optional* signal [frVal + frTm + q] shall map to ASDU TI <37> "Integrated totals with time tag CP56Time2a" with IOA n+1 as specified in Table 15.

Table 15 – CDC: Binary counter reading (BCR) mapping

CDC class		IEC 60870-5-101 or IEC 60870-5-104 mapping	
BCR		TI <37>	
Attribute name	Attribute type	Information element	IEC 60870-5-104 or IEC 60870-5-101 object group mapping
actVal	INT128	BCR = Binary Counter Reading	counter reading $I_{32} <-2^{31} \dots +2^{31}-1>$
t	TimeStamp	CP56Time2a	Seven octet binary time, CP56Time2a – Time of occurrence of dchg or qchg
q	Quality	BCR->sequence notation	SQ:= sequence number = set to zero CY:= carry = set to zero CA:= counter was adjusted = set to zero IV:= validity good -> valid
frVal	INT128	BCR = Binary Counter Reading	counter reading $I_{32} <-2^{31} \dots +2^{31}-1>$
frTm	TimeStamp	CP56Time2a	Seven octet binary time, CP56Time2a – Time of occurrence of dupd, dchg or qchg
q	Quality	BCR->sequence notation	SQ:= sequence number = set to zero CY:= carry = set to zero CA:= counter was adjusted = set to zero IV:= validity good -> valid

7.9 CDC measured value (MV)

The data attributes of the common data class MV depicted in Table 16 shall be mapped as shown in Table 17.

Table 16 – CDC: Measured value (MV)

MV class					
Attribute name	Attribute type	FC	TrgOp	Explanation and value / Range	M/O
DataName	Inherited from data class (see IEC 61850-7-2)				
DataAttribute					
measured attributes					
mag	AnalogueValue	MX	dchg		M
t	TimeStamp	MX		Time value	M
q	Quality	MX	qchg	Quality	M
configuration, description and extension					
db	INT32U	CF		0 ... 100 000	O

The signal [mag + t + q] shall map to the either ASDU TI <36> "Measured value, short floating point value with time tage CP56time2a" or ASDU <35> "Measured value, scaled value with time tag CP56time2a" as specified in Table 17.

Table 17 – CDC: Measured value (MV) mapping

CDC class			IEC 60870-5-101 or IEC 60870-5-104 mapping	
MV			TI <36> or TI<35>	
Attribute name	Attribute type	DAComponent	Information element	IEC 60870-5-104 or IEC 60870-5-101 object group mapping
a) mag	AnalogueValue	mag.f FLOAT32	IEEE STD 754	R32.23{Fraction,Exponent,Sign}
b) mag	AnalogueValue	mag.i INT32	SVA	$16 \times 2^{15} \dots 2^{15}-1$ 0 map on 0 Valid range for INT32 is $-2^{15} \dots +2^{15}-1$
t	TimeStamp		CP56Time2a	Seven octet binary time, CP56Time2a – Time of occurrence of dchg or qchg
q	Quality		QDS	validity -> IV good invalid -> valid invalid questionable -> NT detailQual -> OV overflow -> overflow source -> SB substituted -> substituted operatorBlocked -> BL blocked -> blocked

Either a) or b) shall be mapped.

The optional configuration attribute "db" can be optionally set by ASDU TI<111> "Parameter of measured value, scaled value" or ASDU TI<112> "Parameter of measured value, short floating point value" as described in Clause 8.

7.10 CDC complex measured value (CMV)

The data attributes of the common data class CMV depicted in Table 18 shall be mapped as shown in Table 19.

Table 18 – CDC: Complex measured value (CMV)

CMV class					
Attribute name	Attribute type	FC	TrgOp	Value/Value range	M/O/C
DataName	Inherited from data class (see IEC 61850-7-2)				
DataAttribute					
measured attributes					
cVal	Vector	MX	dchg		M
q	Quality	MX	qchg		M
t	TimeStamp	MX			M
configuration, description and extension					
db	INT32U	CF		0 ... 100 000	O

Table 19 defines the mapping for data attributes of common data class CMV. The data attributes [cVal + t + q] shall map to IEC 60870-5-104 or IEC 60870-5-101 ASDU TI<36> "Measured value, short floating point value with time tag CP56Time2a" or ASDU TI<35> "Measured value, scaled value with time tag CP56Time2a".

Table 19 – CDC: Complex measured value (CMV) mapping

CDC class			IEC 60870-5-101 or IEC 60870-5-104 mapping	
CMV			TI <36> or TI<35>	
Attribute name	Attribute type	DAComponent	Information element	IEC 60870-5-104 or IEC 60870-5-101 object group mapping
a) cVal	Vector	cVal.mag.f FLOAT32	IEEE STD 754	R32.23{Fraction,Exponent,Sign}
b) cVal	Vector	cVal.mag.i INT32	SVA	$16 \times 2^{15} \dots + 2^{15} - 1$ 0 map on 0 Valid range for INT32 is $< -2^{15} \dots + 2^{15} - 1$
t	TimeStamp		CP56Time2a	Seven octet binary time, CP56Time2a – Time of occurrence for object
q	Quality		QDS	validity -> IV good invalid -> valid invalid questionable -> NT detailQual -> OV overflow -> overflow source -> SB substituted -> substituted operatorBlocked -> BL blocked -> blocked
a) cVal	Vector	cVal.ang.f FLOAT32	IEEE STD 754	R32.23{Fraction,Exponent,Sign}
b) cVal	Vector	cVal.ang.i INT32	SVA	$16 \times 2^{15} \dots + 2^{15} - 1$ 0 map on 0 Valid range for INT32 is $< -2^{15} \dots + 2^{15} - 1$
t	TimeStamp		CP56Time2a	Seven octet binary time, CP56Time2a – Time of occurrence of dchg or qchg
q	Quality		QDS	validity -> IV good invalid -> valid invalid questionable -> NT detailQual -> OV overflow -> overflow source -> SB substituted -> substituted operatorBlocked -> BL blocked -> blocked

Either a) or b) shall be mapped in both cases.

If both attributes (mag and angle) have to be mapped, two consecutive IOA addresses shall be used.

IOA n := CMV.cVal.mag.f or CMV.cVal.mag.i

IOA n+1 := CMV.cVal.ang.f or CMV.cVal.ang.i

The optional configuration attribute "db" can be optionally set by ASDU TI<111> "Parameter of measured value, scaled value" or ASDU TI<112> "Parameter of measured value, short floating point value" as described in Clause 8.

7.11 CDC Phase to ground related measured values of a three-phase system (WYE)

The data attributes of the common data class WYE depicted in Table 20 shall be mapped as multiple mappings of the common data Class CMV as shown in Table 19.

Table 20 – CDC: Phase to ground related measured values of a three-phase system (WYE)

WYE class					
Attribute name	Attribute type	FC	TrgOp	Value/Value range	M/O/C
DataName	Inherited from Data Class (see IEC 61850-7-2)				
Data					
phsA	CMV				GC_1
phsB	CMV				GC_1
phsC	CMV				GC_1
neut	CMV				GC_1
net	CMV				GC_1
res	CMV				GC_1

Each data attributes (of common data class CMV) shall map to the ASDU TI <36> "Measured value, short floating point value with time tag CP56Time2a" or ASDU TI<35> "Measured value, scaled value with time tag CP56Time2a". Six ASDU's of TI <36> or TI <35> shall be used with consecutive IOA indices:

IOA n := CMV phsA
 IOA n+1 := CMV phsB
 IOA n+2 := CMV phsC
 IOA n+3 := CMV neut
 IOA n+4 := CMV net
 IOA n+5 := CMV res

If both attributes (mag and angle) of every attribute of attribute type CMV have to be mapped, two consecutive IOA addresses have to be used for each attribute. In that case twelve ASDU's of TI <36> shall be used with consecutive IOA indices:

IOA n := CMV phsA.cVal.mag.f
 IOA n+1 := CMV phsA.cVal.ang.f
 IOA n+2 := CMV phsB.cVal.mag.f
 IOA n+3 := CMV phsB.cVal.ang.f
 IOA n+4 := CMV phsC.cVal.mag.f
 IOA n+5 := CMV phsC.cVal.ang.f
 IOA n+6 := CMV neut.cVal.mag.f
 IOA n+7 := CMV neut.cVal.ang.f
 IOA n+8 := CMV net.cVal.mag.f
 IOA n+9 := CMV net.cVal.ang.f
 IOA n+10 := CMV res.cVal.mag.f
 IOA n+11 := CMV res.cVal.ang.f

The mapping of common data class CMV is shown in detail in Table 19.

7.12 CDC phase to phase measured values of a three phase system (DEL)

The data attributes of the common data class DEL depicted in Table 21 shall be mapped as multiple mappings of the common data class CMV as shown in Table 19.

Table 21 – CDC: Phase to phase measured values of a three phase system (DEL)

DEL class					
Attribute name	Attribute type	FC	TrgOp	Value/Value range	M/O/C
DataName	Inherited from data class (see IEC 61850-7-2)				
Data					
phsAB	CMV				GC_1
phsBC	CMV				GC_1
phsCA	CMV				GC_1

Each data attribute (of common data class CMV) shall map to the ASDU TI <36> "Measured value, short floating point value with time tag CP56Time2a" or ASDU TI<35> "Measured value, scaled value with time tag CP56Time2a". Three ASDU's of TI <36> or TI <35> shall be used with consecutive IOA indices:

IOA n := CMV phsAB

IOA n+1 := CMV phsBC

IOA n+2 := CMV phsCA

If both attributes (mag and angle) of every attribute of attribute type CMV have to be mapped, two consecutive IOA addresses have to be used for each attribute. In that case, six ASDU's of TI <36> shall be used with consecutive IOA indices:

IOA n := CMV phsAB.cVal.mag.f

IOA n+1 := CMV phsAB.cVal.ang.f

IOA n+2 := CMV phsBC.cVal.mag.f

IOA n+3 := CMV phsBC.cVal.ang.f

IOA n+4 := CMV phsCA.cVal.mag.f

IOA n+5 := CMV phsCA.cVal.ang.f

The mapping of common data class CMV is shown in detail in Table 19.

7.13 CDC sequence (SEQ)

The data attributes of the common data class SEQ depicted in Table 22 shall be mapped as multiple mappings of the common data class CMV as shown in Table 19.

Table 22 – CDC: Sequence (SEQ)

SEQ class					
Attribute name	Attribute type	FC	TrgOp	Value/Value range	M/O/C
DataName	Inherited from data class (see IEC 61850-7-2)				
Data					
c1	CMV				M
c2	CMV				M
c3	CMV				M

Each data attribute (of common data class CMV) shall map to the ASDU TI <36> "Measured value, short floating point value with time tag CP56Time2a" or ASDU TI<35> "Measured value, scaled value with time tag CP56Time2a". Three ASDU's of TI <36> or TI <35> shall be used with consecutive IOA indices:

IOA n := c1

IOA n+1 := c2

IOA n+2 := c3

If both attributes (mag and angle) of every attribute of attribute type CMV have to be mapped, two consecutive IOA addresses have to be used for each attribute. In that case, six ASDU's of TI <36> shall be used with consecutive IOA indices:

IOA n := CMV c1.cVal.mag.f
 IOA n+1 := CMV c1.cVal.ang.f
 IOA n+2 := CMV c2.cVal.mag.f
 IOA n+3 := CMV c2.cVal.ang.f
 IOA n+4 := CMV c3.cVal.mag.f
 IOA n+5 := CMV c3.cVal.ang.f

The mapping of common data class CMV is shown in detail in Table 19.

7.14 CDC harmonic value (HVM)

The data attributes of the common data class HVM depicted in Table 23 shall be mapped as shown in Table 24.

Table 23 – CDC: Harmonic value (HVM)

HMV class					
Attribute name	Attribute type	FC	TrgOp	Explanation and value / Range	M/O
DataName	Inherited from data class (see IEC 61850-7-2)				
DataAttribute					
Harmonics and interharmonics					
har	ARRAY[0..numHar] OF Vector	MX	dchg, dupd		M
basics					
q	Quality	MX	qchg	Quality	M
t	TimeStamp	MX		Time value	M

Table 24 defines the mapping for data attributes of common data class HVM. The number of "har" attributes is variable (numHar:= 1...n). The signals [har(n).mag + t + q] shall map to IEC 60870-5-104 or IEC 60870-5-101 ASDU TI<36> "Measured value, short floating point value with time tag CP56Time2a".

Table 24 – CDC: Harmonic value (HVM) mapping

CDC class			IEC 60870-5-101 or IEC 60870-5-104 mapping	
HVM			TI <36>	
Attribute name	Attribute type	DAComponent	Information element	IEC 60870-5-104 or IEC 60870-5-101 object group mapping
har	Vector	har.mag.f FLOAT32	IEEE STD 754	R32.23{Fraction,Exponent,Sign}
t	TimeStamp		CP56Time2a	Seven octet binary time, CP56Time2a – Time of occurrence of dchg, dupd or qchg
q	Quality		QDS	validity -> IV good invalid -> valid invalid questionable -> NT detailQual -> OV overflow -> overflow source -> SB substituted -> substituted operatorBlocked -> BL blocked -> blocked

Each data attribute "har" (of attribute type vector) shall map to the ASDU TI <36> "Measured value, short floating point value with time tag CP56Time2a". The amount of ASDU's of TI <36> for the mapping is defined by the configuration attribute "numHar". The IOA addresses for all necessary ASDUs shall be used with consecutive IOA indices:

IOA n := har[0].mag
 IOA n+1 := har[1].mag
 IOA n+(numHar-1):= har[numHar-1]

7.15 CDC harmonic value for WYE (HWYE)

The data attributes of the common data class HWYE depicted in Table 25 shall be mapped as multiple mappings of the common data class HMV as shown in Table 24.

Table 25 – CDC: Harmonic value for WYE (HWYE)

HWYE class					
Attribute name	Attribute type	FC	TrgOp	Explanation and value / Range	M/O
DataName	Inherited from data class (see IEC 61850-7-2)				
DataAttribute					
Harmonics and interharmonics					
phsAHar	ARRAY[0..numHar] OF Vector	MX	dchg, dupd		M
phsBHar	ARRAY[0..numHar] OF Vector	MX	dchg, dupd		O
phsCHar	ARRAY[0..numHar] OF Vector	MX	dchg, dupd		O
neutHar	ARRAY[0..numHar] OF Vector	MX	dchg, dupd		O
netHar	ARRAY[0..numHar] OF Vector	MX	dchg, dupd		O
resHar	ARRAY[0..numHar] OF Vector	MX	dchg, dupd		O
basics					
q	Quality	MX	qchg	Quality	M
t	TimeStamp	MX		Time value	M

Each used data attribute of the CDC HWYE shall be mapped in the same way as it is defined for the CDC HMV.

The mapping of common data class HMV is shown in detail in Table 24.

7.16 CDC harmonic value for DEL (HDEL)

The data attributes of the common data class HDEL depicted in Table 26 shall be mapped as multiple mappings of the common data class HMV as shown in Table 24.

Table 26 – CDC: Harmonic value for DEL (HDEL)

HDEL class					
Attribute name	Attribute type	FC	TrgOp	Explanation and value / Range	M/O
DataName	Inherited from data class (see IEC 61850-7-2)				
DataAttribute					
Harmonics and interharmonics					
phsABHar	ARRAY[0..numHar] OF Vector	MX	dchg, dupd		M
phsBCHar	ARRAY[0..numHar] OF Vector	MX	dchg, dupd		M
phsCAHar	ARRAY[0..numHar] OF Vector	MX	dchg, dupd		M
basics					
q	Quality	MX	qchg	Quality	M
t	TimeStamp	MX		Time value	M

Each data attribute of the CDC HDEL shall be mapped in the same way as it is defined for the CDC HMV.

The mapping of common data class HMV is shown in detail in Table 24.

7.17 CDC controllable single point (SPC)

The data attributes of the common data class SPC depicted in Table 27 shall be mapped as shown in Table 3 (for the attributes with the functional constraint ST) and Table 28 (for the attributes with the functional constraint CO).

Table 27 – CDC: Controllable single point (SPC)

SPC class					
Attribute name	Attribute type	FC	TrgOp	Value/Value range	M/O/C
DataName	Inherited from data class (see IEC 61850-7-2)				
DataAttribute					
control and status					
ctlVal	BOOLEAN	CO		off (FALSE) on (TRUE)	AC_CO_M
origin	Originator	CO,ST			AC_CO_O
stVal	BOOLEAN	ST	dchg	FALSE TRUE	AC_ST
q	Quality	ST	qchg		AC_ST
t	TimeStamp	ST			AC_ST
Configuration, description and extension					
ctlModel	ctlModels	CF			M

Table 3 defines the mapping for the data attributes with the functional constraint ST. [stVal + t + q].

Table 28 defines the mapping for data attributes with the functional constraint CO. The data attribute [ctlVal + origin] or [ctlVal + origin + T] shall map to IEC 60870-5-104 or IEC 60870-5-101 ASDU TI<45> "Single command" or to IEC 60870-5-104 ASDU TI<58> "Single command with time tag CP56Time2a".

NOTE The attributes T and ctrlModel are defined in Clause 17 of IEC 61850-7-2:2003.

Table 28 – CDC: Controllable single point (SPC) mapping

CDC class		IEC 60870-5-101 or IEC 60870-5-104 mapping	
SPC		TI <45> (without time tag) or TI <58> (with time tag)	
Attribute name	Attribute type	Information element	IEC 60870-5-104 or IEC 60870-5-101 object group mapping
ctlVal	BOOLEAN	SCO	SCS (Single command state) <0> OFF:= off (FALSE) <1> ON:= on (TRUE) simple SPC -> QU <0> no additional definition other QU values are not used IEC 60870-5-104 and IEC 60870-5-101 support the following modes of the IEC 61850 Control Model (ctlModel): direct control with normal security direct control with enhanced security S/E <0>:= direct control SBO control with enhanced security S/E <1>:= select and execute for details see Subclause 8.8
origin.orIdent	OCTET STRING64	COT	Originator Address:= UI8[9..16] <0..255> <0>:= default <1..255>:= number of originator address The number of originator address shall be mapped to attribute orIdent (OCTET STRING64). NOTE Only values of the length of one octet of orIdent can be mapped to Originator Address because of the limitation in value range.
origin.orCat	ENUMERATED	COT	Cause:= UI6[1..6] <0..63> <u>Valid for FC = CO:</u> remote control <-> activation <6> <u>Valid for FC = ST:</u> not supported <-> not used <0> remote control <-> return information caused by remote command <11> automatic-remote -> return information caused by remote command <11> bay control <-> return information caused by local command <12> station control, automatic bay, automatic station -> return information caused by local command <12> process <-> spontaneous <3> maintenance -> spontaneous <3>

7.18 CDC controllable double point (DPC)

The data attributes of the common data class DPC depicted in Table 29 shall be mapped as shown in Table 5 (for the attributes with the functional constraint ST) and Table 30 (for the attributes with the functional constraint CO).

Table 29 – CDC: Controllable double point (DPC)

DPC class					
Attribute name	Attribute type	FC	TrgOp	Value/Value range	M/O/C
DataName	Inherited from data class (see IEC 61850-7-2)				
DataAttribute					
control and status					
ctlVal	BOOLEAN	CO		off (FALSE) on (TRUE)	AC_CO_M
origin	Originator	CO,ST			AC_CO_O
stVal	CODED ENUM	ST	dchg	intermediate-state off on bad-state	M
q	Quality	ST	qchg		M
t	TimeStamp	ST			M
Configuration, description and extension					
ctlModel	ctlModels	CF			M

Table 5 defines the mapping for data attributes of DPC with the functional constraint ST [stVal + t + q].

Table 30 defines the mapping for data attributes of DPC with the functional constraint CO. The data attribute [ctlVal+ origin] or [ctlVal + origin + T] shall map to IEC 60870-5-104 or IEC 60870-5-101 ASDU TI<46> "Double point command" " or to IEC 60870-5-104 ASDU TI<59> "Double command with time tag CP56Time2a.

NOTE The attributes T and ctrlModel are defined in Clause 17 of IEC 61850-7-2:2003.

Table 30 – CDC: Controllable double point (DPC) mapping

CDC class		IEC 60870-5-101 or IEC 60870-5-104 mapping	
DPC		TI <46> (without time tag) or TI <59> (with time tag)	
Attribute name	Attribute type	Information element	IEC 60870-5-104 or IEC 60870-5-101 object group mapping
ctlVal	BOOLEAN	DCO	DCS (Double command state) <0> not permitted <1> OFF:= off (FALSE) <2> ON:= on (TRUE) <3> not permitted simple DPC -> QU <0> no additional definition other QU values are not used IEC 60870-5-104 and IEC 60870-5-101 support the following modes of the IEC 61850 Control Model (ctlModel): direct control with normal security direct control with enhanced security S/E <0>:= direct control SBO control with enhanced security S/E <1>:= select and execute for details see Subclause 8.8
origin.orIdent	OCTET STRING64	COT	Originator Address:= UI8[9..16] <0..255> <0>:= default <1..255>:= number of originator address The number of originator address shall be mapped to attribute orIdent (OCTET STRING64). NOTE Only values of the length of one octet of orIdent can be mapped to Originator Address because of the limitation in value range.
origin.orCat	ENUMERATED	COT	Cause:= UI6[1..6] <0..63> <u>Valid for FC = CO:</u> remote control <-> activation <6> <u>Valid for FC = ST:</u> not supported <-> not used <0> remote control <-> return information caused by remote command <11> automatic-remote -> return information caused by remote command <11> bay control <-> return information caused by local command <12> station control, automatic bay, automatic station -> return information caused by local command <12> process <-> spontaneous <3> maintenance -> spontaneous <3>

7.19 CDC controllable integer status (INC)

The data attributes of the common data class INC depicted in Table 31 shall be mapped as shown in Table 7 (for the attributes with the functional constraint ST) and Table 32 (for the attributes with the functional constraint CO).

Table 31 – CDC: Controllable integer status (INC)

INC class					
Attribute name	Attribute type	FC	TrgOp	Value/Value range	M/O/C
DataName	Inherited from data class (see IEC 61850-7-2)				
DataAttribute					
control and status					
ctlVal	INT32	CO			AC_CO_M
origin	Originator	CO,ST			AC_CO_O
stVal	INT32	ST	dchg		M
q	Quality	ST	qchg		M
t	TimeStamp	ST			M
Configuration, description and extension					
ctlModel	ctlModels	CF			M

Table 7 defines the mapping for data attributes of INC with the functional constraint ST [stVal + t + q].

Table 32 defines the mapping for data attributes of INC with the functional constraint CO. The data attribute [ctlVal + origin] or [ctlVal + origin + T] shall map to IEC 60870-5-104 or IEC 60870-5-101 ASDU TI<49> "Set point command, scaled value" or to IEC 60870-5-104 ASDU TI<62> "Set point command, scaled value with time tag CP56Time2a".

NOTE The attributes T and ctrlModel are defined in Clause 17 of IEC 61850-7-2:2003.

Table 32 – CDC: Controllable integer status (INC) mapping

CDC class		IEC 60870-5-101 or IEC 60870-5-104 mapping	
INC		TI <49> (without time tag) or TI <62> (with time tag)	
Attribute name	Attribute type	Information element	IEC 60870-5-104 or IEC 60870-5-101 object group mapping
ctlVal	INT32	SVA	SVA ... I16 <-2¹⁵..+2¹⁵-1> simple INC -> QU <0> no additional definition other QU values are not used IEC 60870-5-104 and IEC 60870-5-101 support the following modes of the IEC 61850 Control Model (ctlModel): direct control with normal security direct control with enhanced security S/E <0>:= direct control SBO control with enhanced security S/E <1>:= select and execute for details see Subclause 8.8
origin.orIdent	OCTET STRING64	COT	Originator Address:= UI8[9..16] <0..255> <0>:= default <1..255>:= number of originator address The number of originator address shall be mapped to attribute orIdent (OCTET STRING64). NOTE Only values of the length of one octet of orIdent can be mapped to Originator Address because of the limitation in value range.
origin.orCat	ENUMERATED	COT	Cause:= UI6[1..6] <0..63> <u>Valid for FC = CO:</u> remote control <-> activation <6> <u>Valid for FC = ST:</u> not supported <-> not used <0> remote control <-> return information caused by remote command <11> automatic-remote -> return information caused by remote command <11> bay control <-> return information caused by local command <12> station control, automatic bay, automatic station -> return information caused by local command <12> process <-> spontaneous <3> maintenance -> spontaneous <3>

7.20 CDC binary controlled step position information (BSC)

The data attributes of the common data class BSC depicted in Table 33 shall be mapped as shown in Table 34 (for the attributes with the functional constraint ST) and Table 35 (for the attributes with the functional constraint CO).

Table 33 – CDC: Binary controlled step position information (BSC)

BSC class					
Attribute name	Attribute type	FC	TrgOp	Value/Value range	M/O/C
DataName	Inherited from data class (see IEC 61850-7-2)				
DataAttribute					
control and status					
ctlVal	CODED ENUM	CO		stop lower higher reserved	AC_CO_M
origin	Originator	CO,ST			AC_CO_O
valWTr	ValWithTrans	ST	dchg		AC_ST
q	Quality	ST	qchg		AC_ST
t	TimeStamp	ST			AC_ST
Configuration, description and extension					
ctlModel	ctlModels	CF			M

Table 34 defines the mapping for data attributes of BSC with the functional constraint ST. The data attributes [valWTr + t + q]. shall map to IEC 60870-5-104 or IEC 60870-5-101 ASDU TI<32> "Step position information with time tag CP56Time2a".

Table 35 defines the mapping for data attributes of BSC with the functional constraint CO. The data attribute [ctlVal + origin] or [ctlVal + origin + T] shall map to IEC 60870-5-104 or IEC 60870-5-101 ASDU TI<47> "Regulating step command" or to IEC 60870-5-104 ASDU TI<60> "Regulating step command with time tag CP56Time2a".

NOTE The attribute T and ctrlModel are defined in Clause 17 of IEC 61850-7-2:2003.

Table 34 – CDC: Binary controlled step position information (BSC) mapping of data attributes of the functional constraint ST

CDC class			IEC 60870-5-101 or IEC 60870-5-104 mapping	
BSC			TI <32>	
Attribute name	Attribute type	DAComponent	Information element	IEC 60870-5-104 or IEC 60870-5-101 object group mapping
valWTr	ValWithTrans	valWTr.posVal INT8	VTI	Value 17 <-64 ...+63>
		valWTr.transInd BOOLEAN	VTI	Transient BS1[8] <0> equipment is not in transient state:= FALSE <1> equipment is in transient state:= TRUE
t	TimeStamp		CP56Time2a	Seven octet binary time, CP56Time2a – Time of occurrence of dchg or qchg
q	Quality		QDS	validity -> IV good invalid -> valid invalid questionable -> NT detailQual -> OV overflow -> overflow source -> SB substituted -> substituted operatorBlocked -> BL blocked -> blocked

Table 35 – CDC: Binary controlled step position information (BSC) mapping of data attributes of the functional constraint CO

CDC class		IEC 60870-5-101 or IEC 60870-5-104 mapping	
BSC		TI <47> (without time tag) or TI <60> (with time tag)	
Attribute name	Attribute type	Information element	IEC 60870-5-104 or IEC 60870-5-101 object group mapping
ctlVal	CODED ENUM	RCO	RCS Regulating step command state <0> not permitted <1> next step LOWER:= lower <2> next step HIGHER:= higher <3> not permitted simple BSC -> QU <0> no additional definition other QU values are not used IEC 60870-5-104 and IEC 60870-5-101 support the following modes of the IEC 61850 Control Model (ctlModel): direct control with normal security direct control with enhanced security S/E <0>:= direct control SBO control with enhanced security S/E <1>:= select and execute for details see Subclause 8.8
origin.orIdent	OCTET STRING64	COT	Originator Address:= UI8[9..16] <0..255> <0>:= default <1..255>:= number of originator address The number of originator address shall be mapped to attribute orIdent (OCTET STRING64). NOTE Only values of the length of one octet of orIdent can be mapped to Originator Address because of the limitation in value range.
origin.orCat	ENUMERATED	COT	Cause:= UI6[1..6] <0..63> <u>Valid for FC = CO:</u> remote control <-> activation <6> <u>Valid for FC = ST:</u> not supported <-> not used <0> remote control <-> return information caused by remote command <11> automatic-remote -> return information caused by remote command <11> bay control <-> return information caused by local command <12> station control, automatic bay, automatic station -> return information caused by local command <12> process <-> spontaneous <3> maintenance -> spontaneous <3>

7.21 CDC integer-controlled step position information (ISC)

The data attributes of the common data class ISC depicted in Table 36 shall be mapped as shown in Table 34 (for the attributes with the functional constraint ST) and Table 37 (for the attributes with the functional constraint CO).

Table 36 – CDC: Integer-controlled step position information (ISC)

ISC class					
Attribute name	Attribute type	FC	TrgOp	Value/Value range	M/O/C
DataName	Inherited from data class (see IEC 61850-7-2)				
DataAttribute					
control and status					
ctlVal	INT8	CO		-64 ... +63	AC_CO_M
origin	Originator	CO,ST			AC_CO_O
valWTr	ValWithTrans	ST	dchg		AC_ST
q	Quality	ST	qchg		AC_ST
t	TimeStamp	ST			AC_ST
Configuration, description and extension					
ctlModel	ctlModels	CF			M

Table 34 defines the mapping for data attributes of ISC with the functional constraint ST [valWTr + t + q].

Table 37 defines the mapping for data attributes of ISC with the functional constraint CO. The data attribute [ctlVal + origin] or [ctlVal + origin + T] shall map to IEC 60870-5-104 or IEC 60870-5-101 ASDU TI<49>"Set point command, scaled value" or to IEC 60870-5-104 ASDU TI<62> "Set point command, scaled value with time tag CP56Time2a".

NOTE The attribute T and ctrlModel are defined in Clause 17 of IEC 61850-7-2:2003.

Table 37 – CDC: Integer-controlled step position information (ISC) mapping

CDC class		IEC 60870-5-101 or IEC 60870-5-104 mapping	
ISC		TI <49> (without time tag) or TI <62> (with time tag)	
Attribute name	Attribute type	Information element	IEC 60870-5-104 or IEC 60870-5-101 object group mapping
ctlVal	INT8	SVA	I16 <-2¹⁵..+2¹⁵-1> simple ISC -> QU <0> no additional definition other QU values are not used IEC 60870-5-104 and IEC 60870-5-101 support the following modes of the IEC 61850 Control Model (ctlModel): direct control with normal security direct control with enhanced security S/E <0>:= direct control SBO control with enhanced security S/E <1>:= select and execute for details see Subclause 8.8
origin.orIdent	OCTET STRING64	COT	Originator Address:= UI8[9..16] <0..255> <0>:= default <1..255>:= number of originator address The number of originator address shall be mapped to attribute orIdent (OCTET STRING64). NOTE Only values of the length of one octet of orIdent can be mapped to Originator Address because of the limitation in value range.
origin.orCat	ENUMERATED	COT	Cause:= UI6[1..6] <0..63> <u>Valid for FC = CO:</u> remote control <-> activation <6> <u>Valid for FC = ST:</u> not supported <-> not used <0> remote control <-> return information caused by remote command <11> automatic-remote -> return information caused by remote command <11> bay control <-> return information caused by local command <12> station control, automatic bay, automatic station -> return information caused by local command <12> process <-> spontaneous <3> maintenance -> spontaneous <3>

7.22 CDC controllable analogue set point information (APC)

The data attributes of the common data class APC depicted in Table 38 shall be mapped as shown in Table 39 (for the attributes with the functional constraint MX) and Table 40 (for the attributes with the functional constraint SP).

Table 38 – CDC: Controllable analogue set point information (APC)

APC class					
Attribute name	Attribute type	FC	TrgOp	Value/Value range	M/O/C
DataName	Inherited from data class (see IEC 61850-7-2)				
DataAttribute					
setpoint and measured attributes					
setMag	AnalogueValue	CO,MX	dchg		M
origin	Originator	CO,MX			O
q	Quality	MX	qchg		M
t	TimeStamp	MX			M
Configuration, description and extension					
ctlModel	ctlModels	CF			M

NOTE 1 During the maintenance process of IEC 61850-7-3, TISSUE 28 related to CDC APC has been brought up. 57/963/INF gives a summary of all TISSUES detected during the maintenance process of the standard series IEC 61850 Edition 1.0. According to TISSUE 28, the FC (functional constraint) of the attributes setMag and origin of Table 38 had been changed from SP to CO. The proposed mapping to TI<50> or TI<53> in Table 40 is in accordance with this TISSUE.

Table 39 defines the mapping for data attributes of APC with the functional constraint MX. The data attributes [setMag + t + q]. shall map to IEC 60870-5-104 or IEC 60870-5-101 ASDU TI<36> "Measured value, short floating point value with time tag CP56Time2a".

Table 40 defines the mapping for data attributes of APC with the functional constraint CO. The data attribute [setMag + origin] or [setMag + origin + T] shall map to IEC 60870-5-104 or IEC 60870-5-101 ASDU TI<50> "Set point command, short floating point value" or to IEC 60870-5-104 ASDU TI<63> "Set point command, short floating point value with time tag CP56Time2a".

NOTE 2 The attribute T and ctrlModel are defined in Clause 17 of IEC 61850-7-2:2003.

Table 39 – CDC: Controllable analogue set point information (APC) mapping of data attributes of the functional constraint MX

CDC class			IEC 60870-5-101 or IEC 60870-5-104 mapping	
APC			TI <36>	
Attribute name	Attribute type	DAComponent	Information element	IEC 60870-5-104 or IEC 60870-5-101 object group mapping
setMag	AnalogueValue	setMag.f FLOAT32	IEEE STD 754	R32.23{Fraction,Exponent,Sign}
t	TimeStamp		CP56Time2a	Seven octet binary time, CP56Time2a – Time of occurrence of dchg or qchg
q	Quality		QDS	validity -> IV good invalid -> valid invalid questionable -> NT detailQual -> OV overflow -> overflow source -> SB substituted -> substituted operatorBlocked -> BL blocked -> blocked

Table 40 – CDC: Controllable analogue set point information (APC) mapping of data attributes of the functional constraint SP

CDC class			IEC 60870-5-101 or IEC 60870-5-104 mapping	
APC			TI <50> (without time tag) or TI <63> (with time tag)	
Attribute name	Attribute type	DACComponent	Information element	IEC 60870-5-104 or IEC 60870-5-101 object group mapping
setMag	AnalogueValue	setMag.f FLOAT32	IEEE STD 754	R32.23{Fraction,Exponent,Sign}
origin.orIdent	OCTET STRING64		COT	Originator Address:= UI8[9..16] <0..255> <0>:= default <1..255>:= number of originator address The number of originator address shall be mapped to attribute orIdent (OCTET STRING64). NOTE Only values of the length of one octet of orIdent can be mapped to Originator Address because of the limitation in value range.
origin.orCat	ENUMERATED		COT	Cause:= UI6[1..6] <0..63> <u>Valid for FC = CO:</u> remote control <-> activation <6> <u>Valid for FC = ST:</u> not supported <-> not used <0> remote control <-> return information caused by remote command <11> automatic-remote -> return information caused by remote command <11> bay control <-> return information caused by local command <12> station control, automatic bay, automatic station -> return information caused by local command <12> process <-> spontaneous <3> maintenance -> spontaneous <3>

7.23 CDC Single point setting (SPG)

The data attributes of the common data class SPG depicted in Table 41 shall be mapped as shown in Table 28.

Table 41 – CDC: Single point setting (SPG)

SPG class						
Attribute name	Attribute type	FC	TrgOp	Value/Value range		M/O/C
DataName	Inherited from Data Class (see IEC 61850-7-2)					
DataAttribute						
setting						
setVal	BOOLEAN	SP		off (FALSE) on (TRUE)		AC NSG M

The data attribute [setVal] shall map to IEC 60870-5-104 or IEC 60870-5-101 ASDU TI<45> "Single command" or to IEC 60870-5-104 ASDU TI <58> "Single command with time tag CP56Time2a" as shown in Table 28.

7.24 CDC integer status setting (ING)

The data attributes of the common data class ING depicted in Table 42 shall be mapped as shown in Table 32.

Table 42 – CDC: Integer status setting (ING)

ING class					
Attribute name	Attribute type	FC	TrgOp	Value/Value range	M/O/C
DataName	Inherited from data class (see IEC 61850-7-2)				
DataAttribute					
setting					
setVal	INT32	SP			AC NSG M

The data attribute [setVal] shall map to IEC 60870-5-104 or IEC 60870-5-101 ASDU TI<49> "Set point command, scaled value" or to IEC 60870-5-104 ASDU TI <62> "Set point command, scaled value with time tag CP56Time2a" as shown in Table 32.

7.25 CDC analogue settings (ASG)

The data attributes of the common data class ASG depicted in Table 43 shall be mapped as shown in Table 40.

Table 43 – CDC: Analogue settings (ASG)

ASG class					
Attribute name	Attribute type	FC	TrgOp	Value/Value range	M/O/C
DataName	Inherited from Data Class (see IEC 61850-7-2)				
DataAttribute					
setting					
setMag	AnalogueValue	SP			AC NSG M

The data attribute [setMag] shall map to IEC 60870-5-104 or IEC 60870-5-101 ASDU TI<50> "Set point command, short floating point value" or to IEC 60870-5-104 ASDU TI <63> "Set point command, short floating point value with time tag CP56Time2a" as shown in Table 40.

8 Mapping of services

8.1 List of service models and corresponding mappings

The service models defined in ACSI (for example IEC 61850-7-2) and the corresponding mapping to IEC 60870-5-104 or IEC 60870-5-101 is summarized in Table 44.

Table 44 – Services requiring client/server communication profile

	IEC 61850-7-2 service	Maps to
Server		Outstation (controlled station)
	GetServerDirectory	n.a. (to be added optionally with services outside of IEC 60870-5-104 or IEC 60870-5-101) ^a
Association		Connection
	Associate	Establish; IEC 60870-5-104 Subclause 7.1 Station initialization
	Abort	n.a. ^a
	Release	Close; IEC 60870-5-104 Subclause 7.1 Station initialization
Logical Device		CASDU
	GetLogicalDeviceDirectory	n.a. (to be added optionally with services outside of IEC 60870-5-104 or IEC 60870-5-101) ^a
Logical Node		One or a set of IOA('es)
	GetLogicalNodeDirectory	n.a. (to be added optionally with services outside of IEC 60870-5-104 or IEC 60870-5-101) ^a
	GetAllDataValues	Interrogation command TI <100>
Data		One or a set of ASDU('es)
	GetDataValues	Read command ASDU TI <102> (the Read procedure is defined in IEC 60870-5-101:2003 Subclause 7.4.14)
	SetDataValues	ASDU TI <111> "Parameter of measured value, scaled value" or ASDU TI <112> "Parameter of measured value, short floating point value" are optionally used to set the attribute db of CDCs MV and CMV (the procedure of parameter loading is defined in IEC 60870-5-101:2003 Subclause 7.4.9)
	GetDataDirectory	n.a. (to be added optionally with services outside of IEC 60870-5-104 or IEC 60870-5-101) ^a
	GetDataDefinition	n.a. (to be added optionally with services outside of IEC 60870-5-104 or IEC 60870-5-101) ^a
Data Set		n.a. ^a
	GetDataSetValues	n.a. ^a
	SetDataSetValues	n.a. ^a
	CreateDataSet	n.a. ^a
	DeleteDataSet	n.a. ^a
	GetDataSetDirectory	n.a. ^a
Setting Group Control Block		
	SelectActiveSG	Single command ASDU TI<45>
	SelectEditSG	n.a. ^a
	SetSGValues	n.a. ^a
	ConfirmEditSGValues	n.a. ^a
	GetSGValues	n.a. ^a
	GetSGCBValues	n.a. ^a
Report Control Block		
	Report	Spontaneous transmission with applicable ASDU's ^b
	GetBRCBValues	n.a. ^a
	SetBRCBValues	n.a. ^a
	GetURCBValues	n.a. ^a
	SetURCBValues	n.a. ^a
LOG Control Block		n.a. ^a
	GetLCBValues	n.a. ^a
	SetLCBValues	n.a. ^a
LOG		n.a. ^a

	IEC 61850-7-2 service	Maps to
	GetLogStatusValues	n.a. ^a
	QueryLogByTime	n.a. ^a
	QueryLogAfter	n.a. ^a
Control		Controllable information object
	Select	n.a. ^a
	SelectWithValue	ASDU TI <45,46,47,49,50>or<58,59,60,62,63>
	Cancel	ASDU TI <45,46,47,49,50>or<58,59,60,62,63>
	Operate	ASDU TI <45,46,47,49,50>or<58,59,60,62,63>
	CommandTermination	ASDU TI <45,46,47,49,50>or<58,59,60,62,63>
	TimeActivatedOperate	n.a. ^a
^a Not applicable for the mapping to IEC 60870-5-104 or IEC 60870-5-101. ^b ASDUs for spontaneous transmission: <30>,<31>,<32>,<33>,<35>,<36>,<37>,<39>,<40> (selected in Clause 9).		

8.2 Server class mapping

The server class shall be mapped to services of a controlled station as shown in Table 45.

NOTE Details of the initialization etc. of the controlled station are defined in IEC 60870-5-104 or IEC 60870-5-101.

Table 45 – Server services mapping

	IEC 61850-7-2 service	Maps to
Server		Outstation (controlled station)
	GetServerDirectory	n.a. (to be added optionally with services outside of IEC 60870-5-104 or IEC 60870-5-101) ^a
^a Not applicable for the mapping to IEC 60870-5-104 or IEC 60870-5-101.		

8.3 Association class mapping

The association service shall be mapped to services of IEC 60870-5-104 as shown in Table 46.

NOTE Details of the initialization etc. of controlled and controlling station are defined in IEC 60870-5-104.

Table 46 – Association services mapping

	IEC 61850-7-2 service	Maps to
Association		Connection
	Associate	Establish; IEC 60870-5-104:2006 Subclause 7.1 Station initialization
	Abort	n.a. ^a
	Release	Close; IEC 60870-5-104:2006 Subclause 7.1 Station initialization
^a Not applicable for the mapping to IEC 60870-5-104.		

8.4 Logical node class mapping

The GetAllDataValues service shall be mapped to services of IEC 60870-5-104 or IEC 60870-5-101 as shown in Table 47.

Table 47 – Logical nodes services mapping

		IEC 61850-7-2 service	Maps to
Logical node			One or a set of IOA('es)
		GetAllDataValues	TI <100> General Interrogation with: - applicable CASDU address - Qualifier of interrogation (QOI)=20 <station interrogation (global)>
The corresponding process data response shall be one or more than one of the following ASDU's depending on the type of the applicable signals with cause of transmission (COT) = 20 <interrogated by station interrogation>.			
Type Id	ASDU		Abbreviation
Process information in monitoring direction			
<1>	Single-point information without time tag		M_SP_NA_1
<3>	Double-point information without time tag		M_DP_NA_1
<5>	Step position information without time tag		M_ST_NA_1
<7>	Bitstring of 32 bit		M_BO_NA_1
<11>	Measured value, scaled value without time tag		M_ME_NB_1
<13>	Measured value, short floating point value without time tag		M_ME_NC_1
		IEC 61850-7-2 service	Maps to
Logical node			One or a set of IOA('es)
		GetAllDataValues	TI <101>Counter Interrogation with: - applicable CASDU address - Qualifier of counter interrogation (RQT)=1-4, 5 <request counter group 1-4, general request counter> - FRZ = 0 <read>
The corresponding process data response shall be one or more than one of the following ASDU's depending on the type of the applicable signals with cause of transmission (COT) = 37, 38 - 41 <requested by general counter request, requested by group 1 – 4 counter request>.			
Type Id	ASDU		Abbreviation
Process information in monitoring direction			
<37>	Integrated totals with time tag CP56Time2a		M_IT_TB_1

8.5 Data class mapping

The GetDataValues and SetDataValues services shall be mapped to services of IEC 60870-5-104 or IEC 60870-5-101 as shown in Table 48.

Table 48 – Data services mapping

		IEC 61850-7-2 service	Maps to
Data			One or a set of ASDU('es)
		GetDataValues	TI <102> Read command with: - applicable CASDU address - applicable IOA address - COT <5>:= Request
The corresponding process data response shall be only one of the following ASDU's depending on the type of the of requested signal with cause of transmission (COT) = 5 <requested>			
Type Id	ASDU		Abbreviation
Process information in monitoring direction			
<30>	Single-point information with time tag CP56Time2a		M_SP_TB_1
<31>	Double-point information with time tag CP56Time2a		M_DP_TB_1
<32>	Step position information with time tag CP56Time2a		M_ST_TB_1
<33>	Bitstring of 32 bits with time tag CP56Time2a		M_BO_TB_1
<35>	Measured value, scaled value with time tag CP56Time2a		M_ME_TE_1
<36>	Measured value, short floating point value with time tag CP56Time2a		M_ME_TF_1
		SetDataValues	TI <111> "Parameter of measured value, scaled value" or TI <112> "Parameter of measured value, short floating point value" with: - CASDU address of the related instance of CDCs MV or CMV - unambiguous IOA address related to the instance of CDCs MV or CMV - COT <6>:= activation
These ASDUs (with Qualifier of parameter of measured value KPA <1>:= Threshold value) shall be optionally used to set the optional configuration attribute "db" of instances of CDCs MV or CMV.			

8.6 Setting group class mapping

The SelectActiveSG service shall be mapped as shown in Table 49.

Table 49 – Setting group services mapping

	IEC 61850-7-2 service	Maps to
Setting group control block		Controllable IOA
	SelectActiveSG	Write Request: TI <45> / TI <49> or TI <58> / TI <62> in control direction: - applicable CASDU address - applicable IOA address - Qualifier of command (QOC)=0 <no additional definition> - COT <6>:= Activation - S/E <0>:= Execute Write Respond: TI <45> / TI <49> or TI <58> / TI <62> in monitor direction: - applicable CASDU address - applicable IOA address - Qualifier of command (QOC)=0 <no additional definition> - COT <7>:= Activation confirmation - S/E <0>:= Execute <u>and</u> TI <45> / TI <49> or TI <58> / TI <62> in monitor direction: - applicable CASDU address - applicable IOA address - Qualifier of command (QOC)=0 <no additional definition> - COT <10>:= Activation termination S/E <0>:= Execute

8.7 Report control block class mapping

The GetDataValues service shall be mapped as shown in Table 50.

Table 50 – Report control block services mapping

	IEC 61850-7-2 service	Maps to
Report control block		
	Report	ASDU's with COT <1>:= periodic/cyclic, COT <3>:= spontaneous, COT <11>:= remote controlled, COT <12>:= local controlled
The following ASDU's uses the listed COTs for spontaneous or periodic/cyclic data transfer and for return information caused by a control operation.		
Type Id	ASDU	Abbreviation
Process information in monitoring direction		
<30>	Single-point information with time tag CP56Time2a	M_SP_TB_1
<31>	Double-point information with time tag CP56Time2a	M_DP_TB_1
<32>	Step position information with time tag CP56Time2a	M_ST_TB_1
<33>	Bitstring of 32 bits with time tag CP56Time2a	M_BO_TB_1
<35>	Measured value, scaled value with time tag CP56Time2a	M_ME_TE_1
<36>	Measured value, short floating point value with time tag CP56Time2a	M_ME_TF_1

8.8 Control class mapping

The CONTROL class model (defined in Clause 17 of IEC 61850-7-2) defines, depending on the application, different behaviours of a control object. The different behaviours of a control object are classified in four cases. Only two cases can be mapped almost seamless onto basic application function "command transmission" (defined in IEC 60870-5-5) used in IEC 60870-5-101 and IEC 60870-5-104:

- case 3: Direct control with enhanced security (described in 0) which is mapped onto the function "direct command" defined in Subclause 6.8 of IEC 60870-5-5:1995;
- case 4: SBO control with enhanced security (described in 8.8.3) which is mapped onto the function "select and execute command" defined in Subclause 6.8 of IEC 60870-5-5:1995.

To make use of IEDs in existing installations that use "Direct control with normal security" of the CONTROL class mapping and to avoid changing of parameter settings for control class in these IEDs, an **optional** mapping is defined as:

- case 1: Direct control with normal security (described in 8.8.1) which is mapped onto the function "direct command" defined in Subclause 6.8 of IEC 60870-5-5:1995.

NOTE 1 Not all ASDUs necessary for the function "direct command" of IEC 60870-5-5 have a corresponding IEC 61850 message, which means that in some cases, two ASDUs have to be generated in result of one IEC 61850 message (i.e. no one to one mapping of messages is possible)

For Case 2 "SBO with normal security" of the control model, as an adequate mapping to the basic application function "command transmission" of IEC 60870-5-5 is possible.

The functions for control model mapping for a gateway device and optionally for an IED by an independent function called "Ctrl mapper" are shown in Figure 7 to Figure 35 as examples. These examples shall be used when the mapping is done in a gateway device that communicates with IEDs that interact with the operated device or optionally done in an IED that interacts with the operated device.

The sequence of interactions (starting from top) are identical, irrespective of the Ctrl mapper is implemented in a gateway device or optionally in an IED.

Each controllable object has to be assigned to one ctrlModel in the server implementation. The client must use the same ctrlModel as assigned in the server in order to be able to control the object. It is recommended to decide on a control model that gives satisfactory safety for the controlled object. The ctrlModel must be defined in the SCL file. The SCL file is described in Annex A.

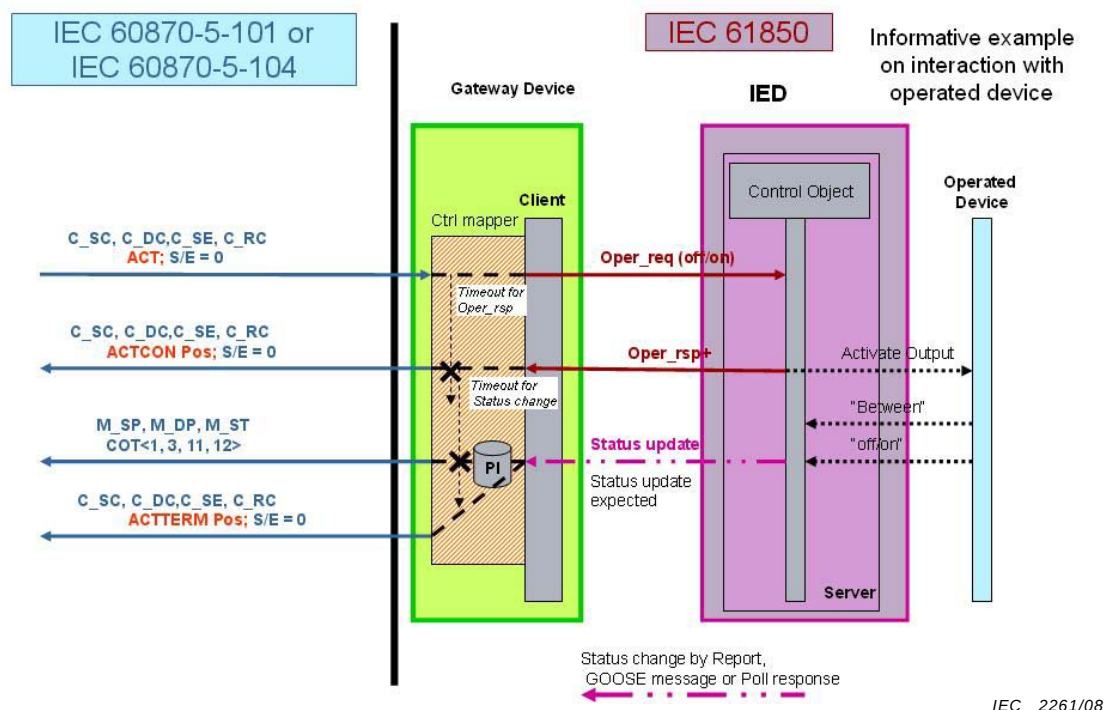
NOTE 2 The mapping of the CONTROL class model onto the basic application function "command transmission" defines the use of QU <0> (Qualifier of command:= no additional definition) for the ASDUs used in control direction. However, IEC 60870-5-101 and IEC 60870-5-104 allow the use of qualifiers of command QU with the range of <9> to <15> for the selection of other predefined functions and the range of <16> to <31> for special use (defined in Subclause 7.2.6.26 of IEC 60870-5-101).

Because of the lack of an equivalent attribute in IEC 61850 control services it is not possible to map qualifiers of commands QU $\neq$ 0 of ASDU's used in control direction in a standardized way. If QU $\neq$ 0 is used in existing implementations of IEC 60870-5-104 or IEC 60870-5-101, a restricted mapping to the "Check" attribute (for 4 different QU values) of the control services of IEC 61850 is possible. Figure 7 to Figure 35 also show examples of the sequences of interactions with the operated device itself. The interface to the operated device is beyond the scope of this technical specification. Showing the interaction with the operated device itself may be useful for the understanding of the complete control operation.

8.8.1 Direct control with normal security (optional)

8.8.1.1 Direct control with normal security with status update – positive case

8.8.1.1.1 Applied to gateway device



NOTE The return information caused by a command (M_SP, M_DP, M_ST with COT <1,3,11,12>) is supplied to the client either by a Report, GOOSE message or by a Device Object Poll-reply and should be transmitted before the command termination (C_SC, C_DC, C_SE, C_RC with ACTTERM Pos; S/E =0).

Figure 7 – Direct control with normal security with status update – positive case applied to gateway device

8.8.1.2.2 Applied to IED

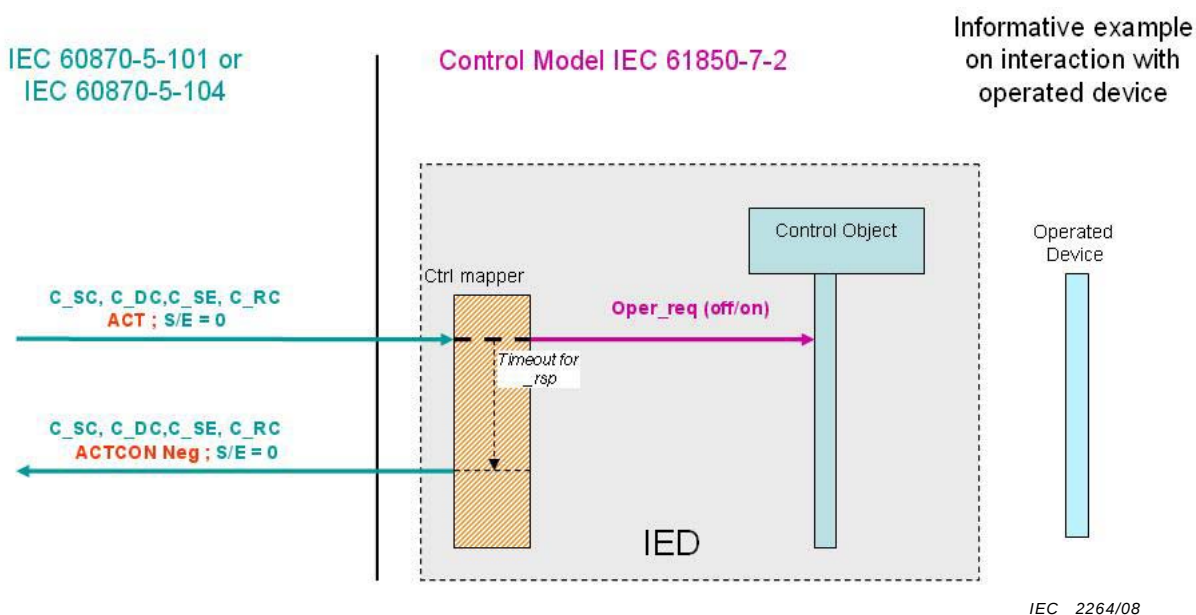


Figure 10 – Direct control with normal security in general – negative case a) applied to IED

8.8.1.3 Direct control with normal security in general – negative case b) negative Oper_rsp from control object/server/IED

8.8.1.3.1 Applied to gateway device

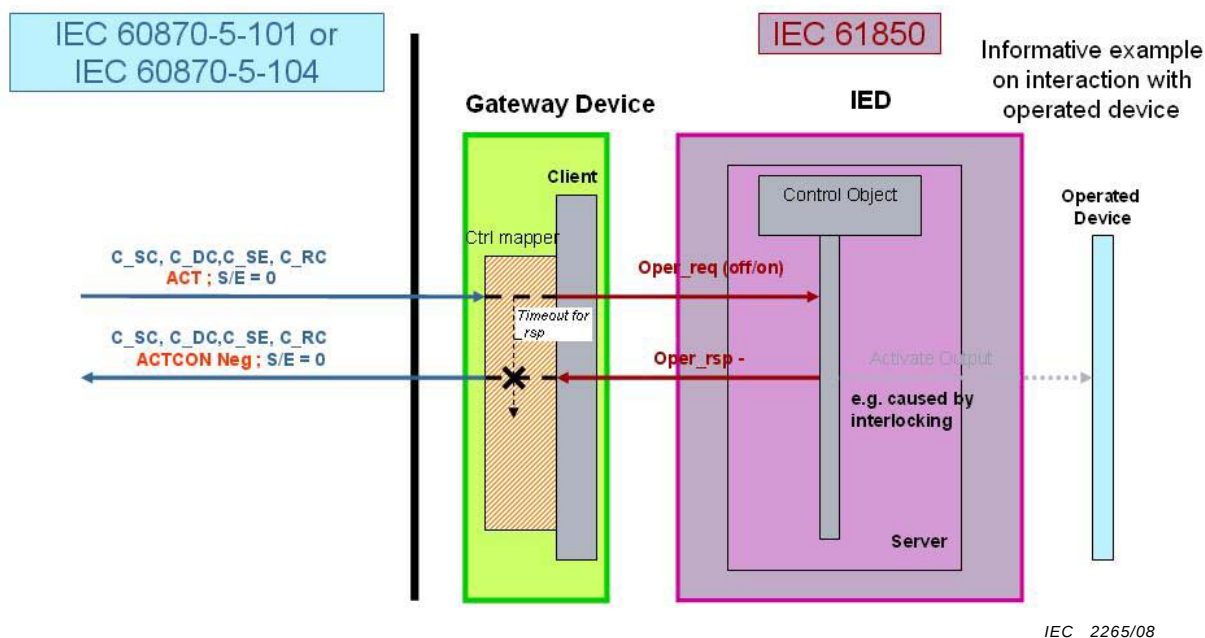


Figure 11 – Direct control with normal security in general – negative case b) applied to gateway device

8.8.1.3.2 Applied to IED

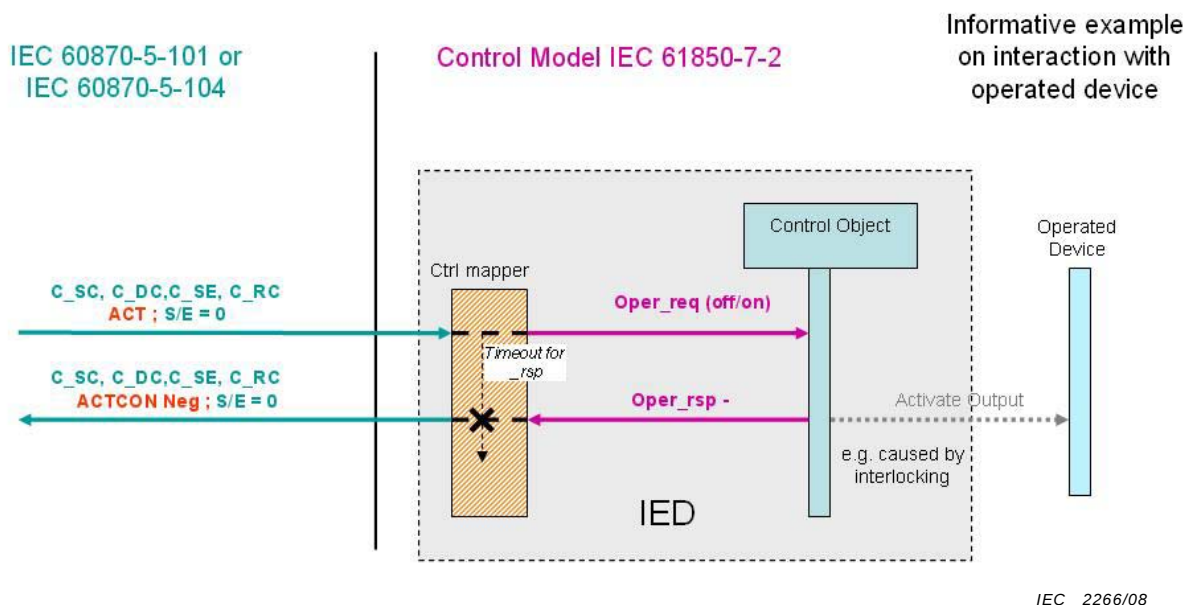


Figure 12 – Direct control with normal security in general – negative case b) applied to IED

8.8.1.4 Direct control with normal security with status update – negative case c) no status update detected

8.8.1.4.1 Applied to gateway device

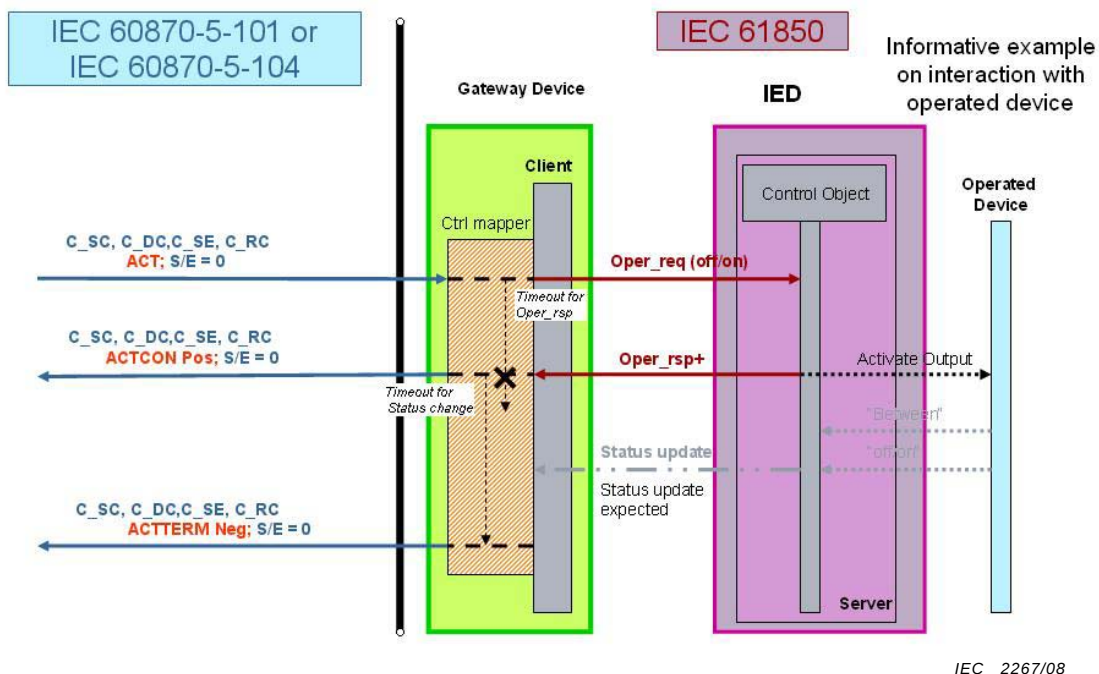


Figure 13 – Direct control with normal security with status update – negative case c) applied to gateway device

8.8.1.4.2 Applied to IED

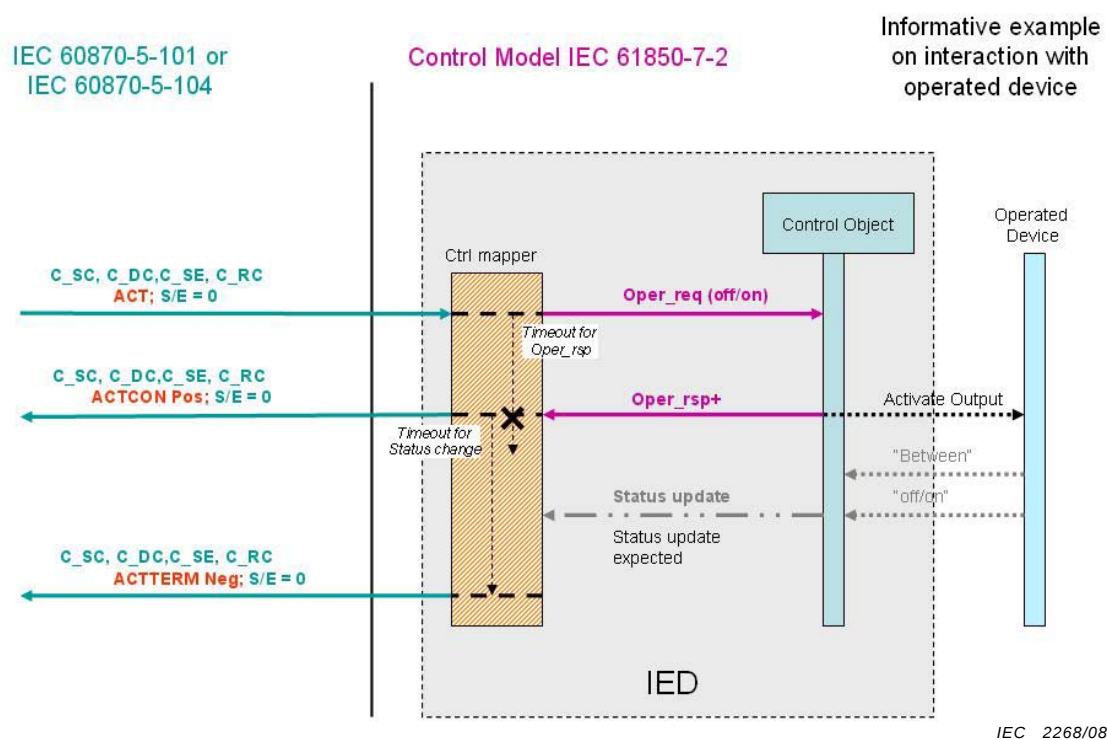


Figure 14 – Direct control with normal security with status update – negative case c) applied to IED

8.8.1.5 Direct control with normal security without status update – positive case

8.8.1.5.1 Applied to IED

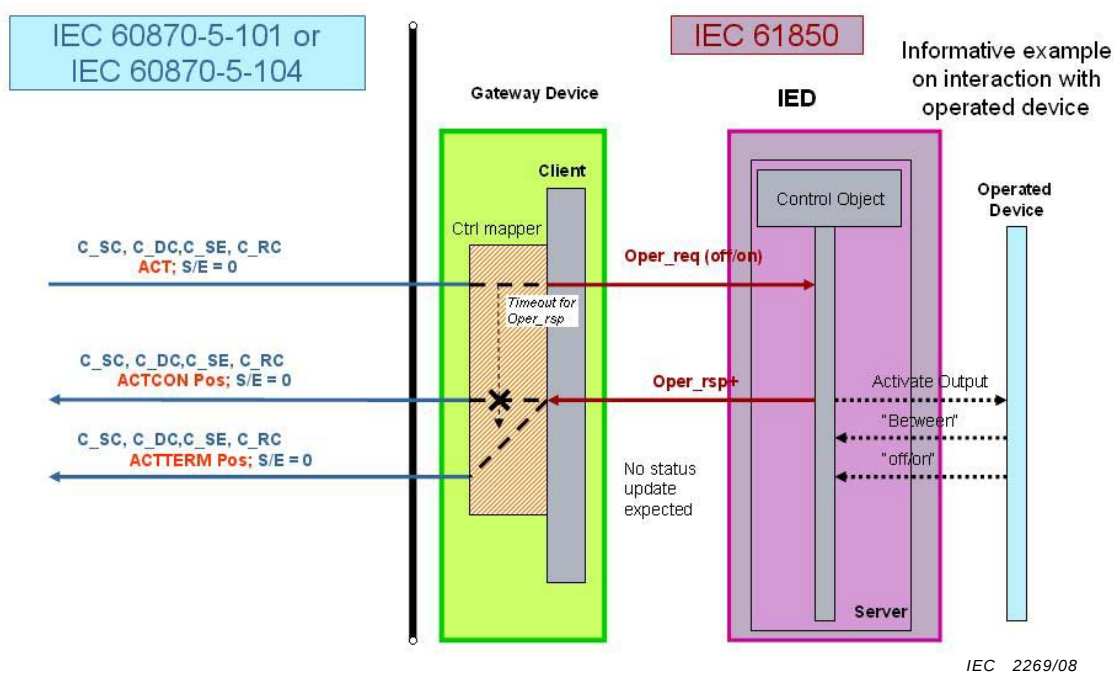


Figure 15 – Direct control with normal security without status update – positive case applied to gateway device

8.8.1.5.2 Applied to IED

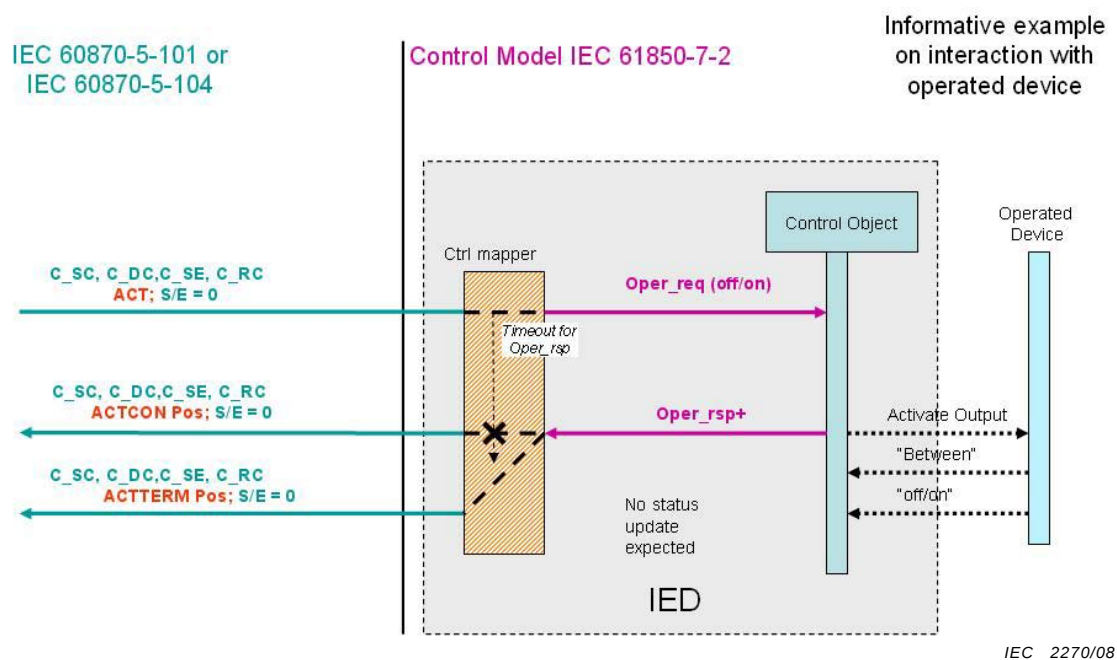


Figure 16 – Direct control with normal security without status update – positive case applied to IED

The direct control with normal security services shall be mapped as shown in Table 51.

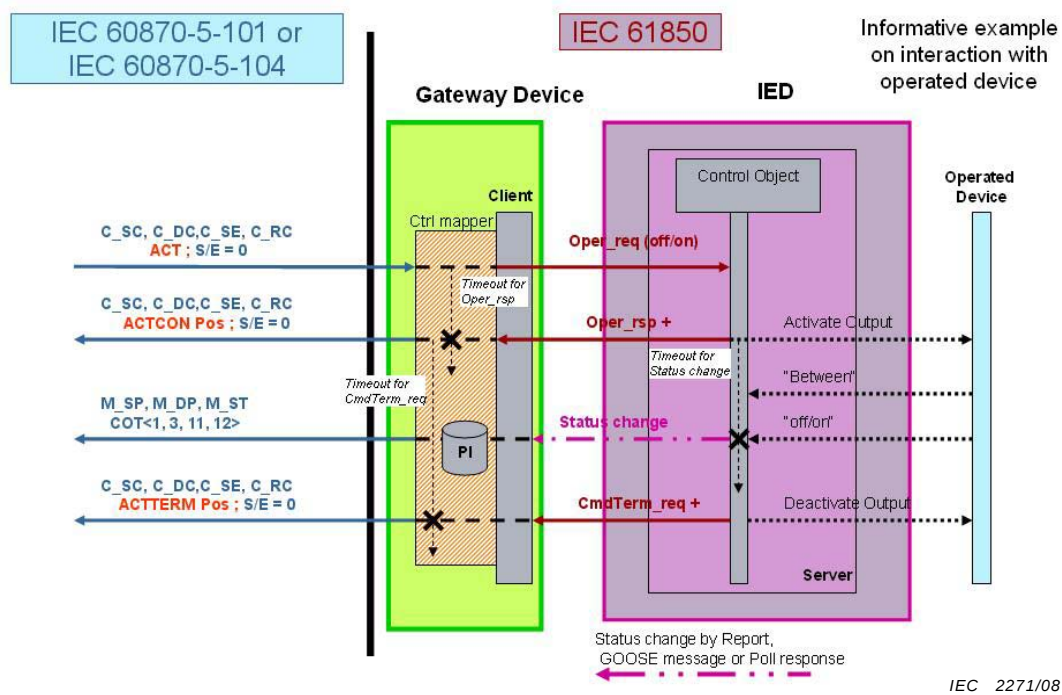
Table 51 – Direct control with normal security services mapping

	IEC 61850-7-2 service	Maps to
Control		Controllable IOA
	Operate	Operate Request: TI <45,46,47,49,50> or <58,59,60,62,63> in control direction: - applicable CASDU address - applicable IOA address - Qualifier of command (QOC)=0 <no additional definition> - COT <6>:= Activation - S/E <0>:= Execute Operate Respond: TI <45,46,47,49,50> or <58,59,60,62,63> in monitor direction: - applicable CASDU address - applicable IOA address - Qualifier of command (QOC)=0 <no additional definition> - COT <7>:= Activation confirmation - S/E <0>:= Execute and TI <45,46,47,49,50> or <58,59,60,62,63> in monitor direction: - applicable CASDU address - applicable IOA address - Qualifier of command (QOC)=0 <no additional definition> - COT <10>:= Activation termination S/E <0>:= Execute

8.8.2 Direct control with enhanced security

8.8.2.1 Direct control with enhanced security – positive case

8.8.2.1.1 Applied to gateway device



NOTE The return information caused by a command (M_SP, M_DP, M_ST with COT <1,3,11,12>) is supplied to the client either by a Report, GOOSE message or by a Device Object Poll-reply and should be transmitted before the command termination (C_SC, C_DC, C_SE, C_RC with ACTTERM Pos; S/E =0).

Figure 17 – Direct control with enhanced security – positive case applied to gateway device

8.8.2.1.2 Applied to IED

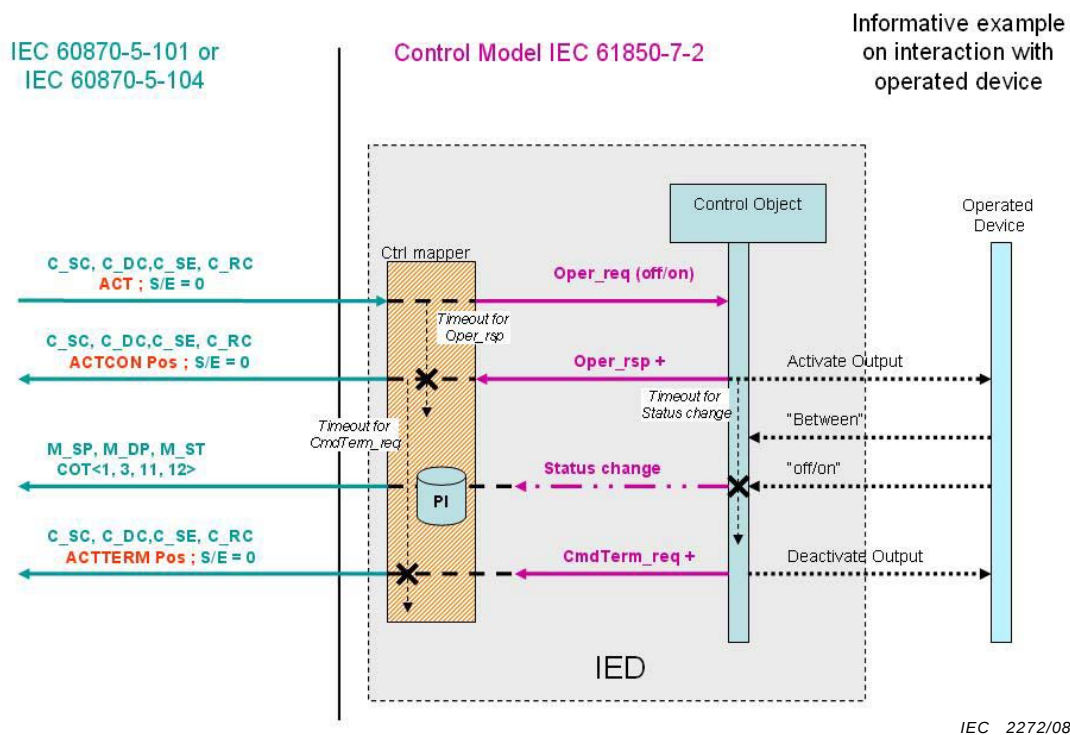


Figure 18 – Direct control with enhanced security – positive case applied to IED

8.8.2.2 Direct control with enhanced security – negative case a) no Oper_resp from control object/server/IED

8.8.2.2.1 Applied to gateway device

See Figure 9.

8.8.2.2.2 Applied to IED

See Figure 10.

8.8.2.3 Direct control with enhanced security – negative case b) negative Oper_resp from control object/server/IED

8.8.2.3.1 Applied to gateway device

See Figure 11.

8.8.2.3.2 Applied to IED

See Figure 12.

8.8.2.4 Direct control with enhanced security – negative case c) no status change detected by control object/server/IED

8.8.2.4.1 Applied to gateway device

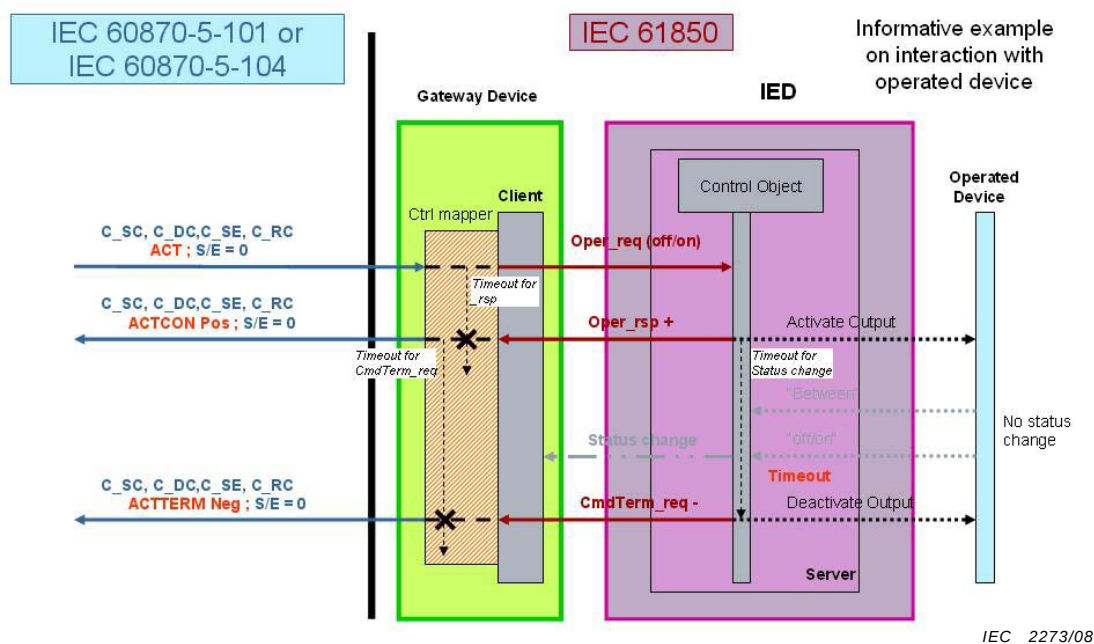


Figure 19 – Direct control with enhanced security – negative case c) applied to gateway device

8.8.2.4.2 Applied to IED

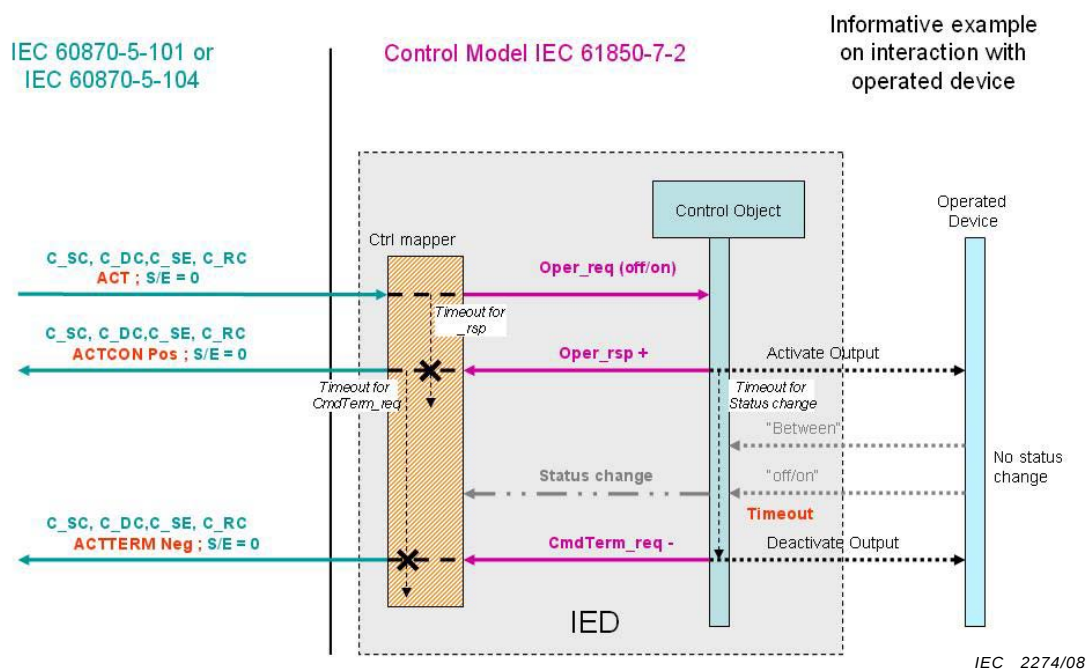


Figure 20 – Direct control with enhanced security – negative case c) applied to IED

8.8.2.5 Direct control with enhanced security – negative case d) no CMDTerm_req from control object/server/IED

8.8.2.5.1 Applied to gateway device

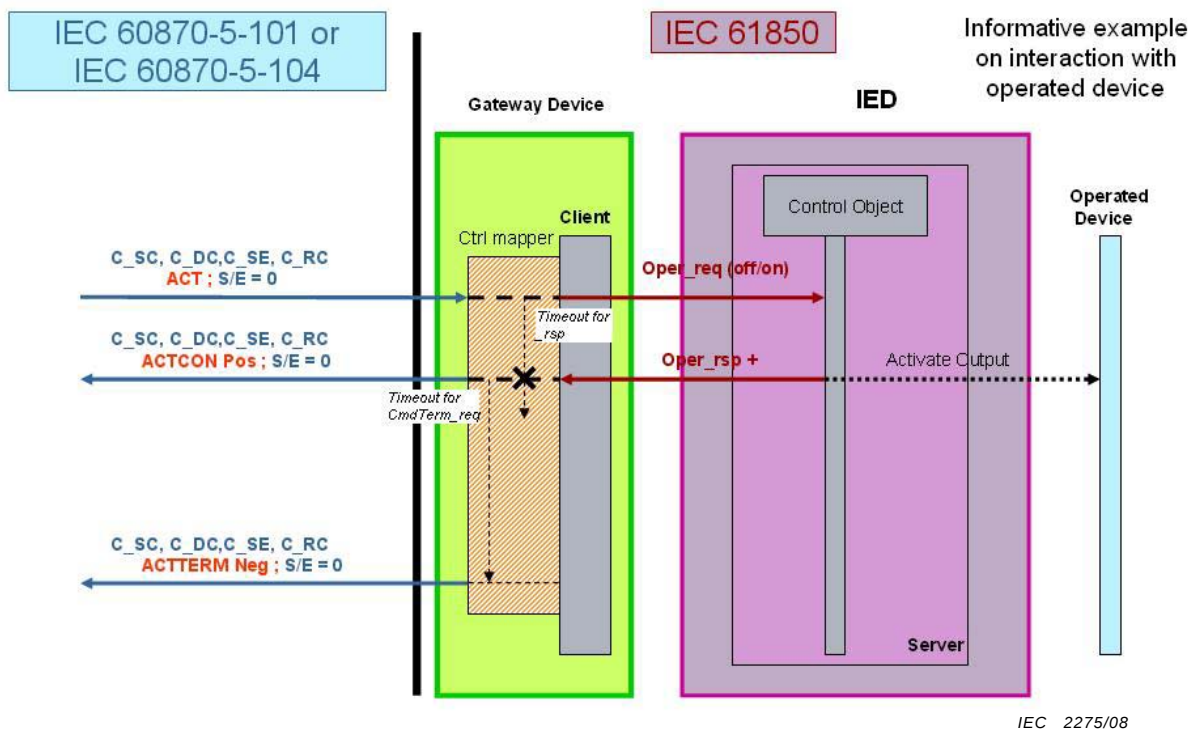


Figure 21 – Direct control with enhanced security – negative case d) applied to gateway device

8.8.2.5.2 Applied to IED

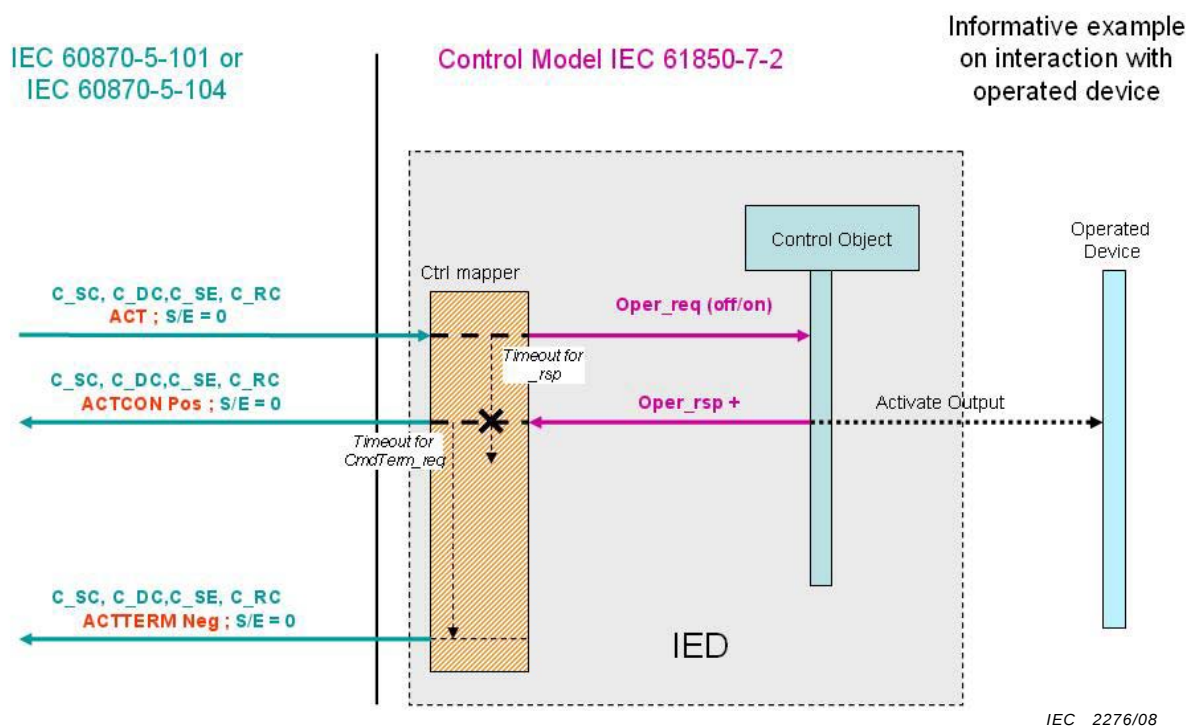


Figure 22 – Direct control with enhanced security – negative case d) applied to IED

The direct control with enhanced security services shall be mapped as shown in Table 52.

Table 52 – Direct control with enhanced security services mapping

	IEC 61850-7-2 service	Maps to
Control		Controllable IOA
	Operate	Operate Request: TI <45,46,47,49,50> or <58,59,60,62,63> in control direction: - applicable CASDU address - applicable IOA address - Qualifier of command (QOC)=0 <no additional definition> - COT <6>:= Activation - S/E <0>:= Execute Operate Respond: TI <45,46,47,49,50> or <58,59,60,62,63> in monitor direction: - applicable CASDU address - applicable IOA address - Qualifier of command (QOC)=0 <no additional definition> - COT <7>:= Activation confirmation - S/E <0>:= Execute
	Command Termination	TI <45,46,47,49,50>or <58,59,60,62,63> in monitor direction: - applicable CASDU address - applicable IOA address - Qualifier of command (QOC)=0 <no additional definition> - COT <10>:= Activation Termination - S/E <0>:= Execute - P/N <0>:= no AddCause present AND Error:= NoError <0> <1>:= AddCause present OR Error <> NoError <0>

8.8.3 SBO control with enhanced security

8.8.3.1 SBOw control – positive case

8.8.3.1.1 Applied to gateway device

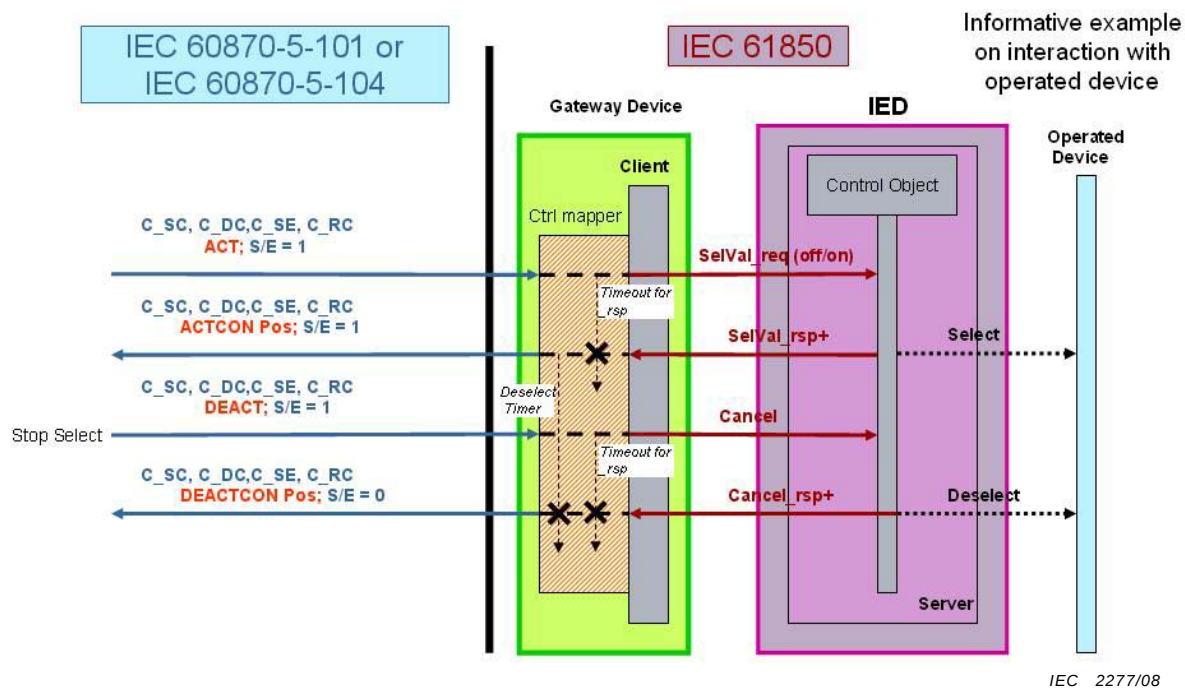


Figure 23 – SBOw control – positive case applied to gateway device

8.8.3.1.2 Applied to IED

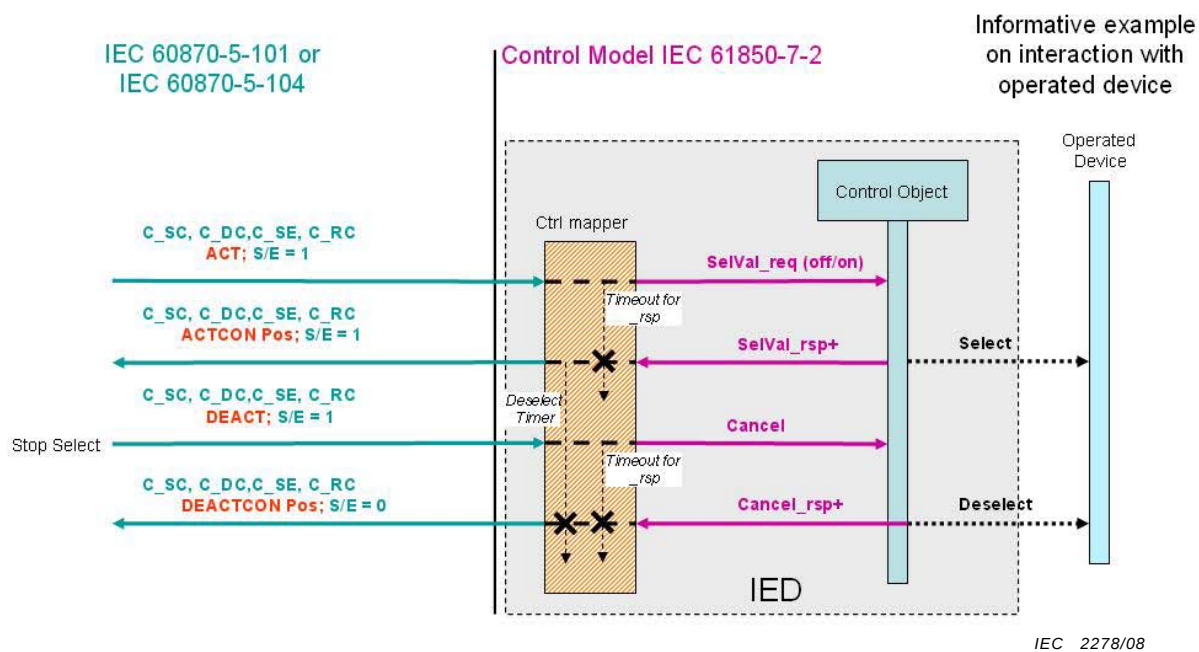


Figure 24 – SBOw control – positive case applied to IED

8.8.3.3 SBOw control – negative case b) negative _rsp from control object/server/IED

8.8.3.3.1 Applied to gateway device

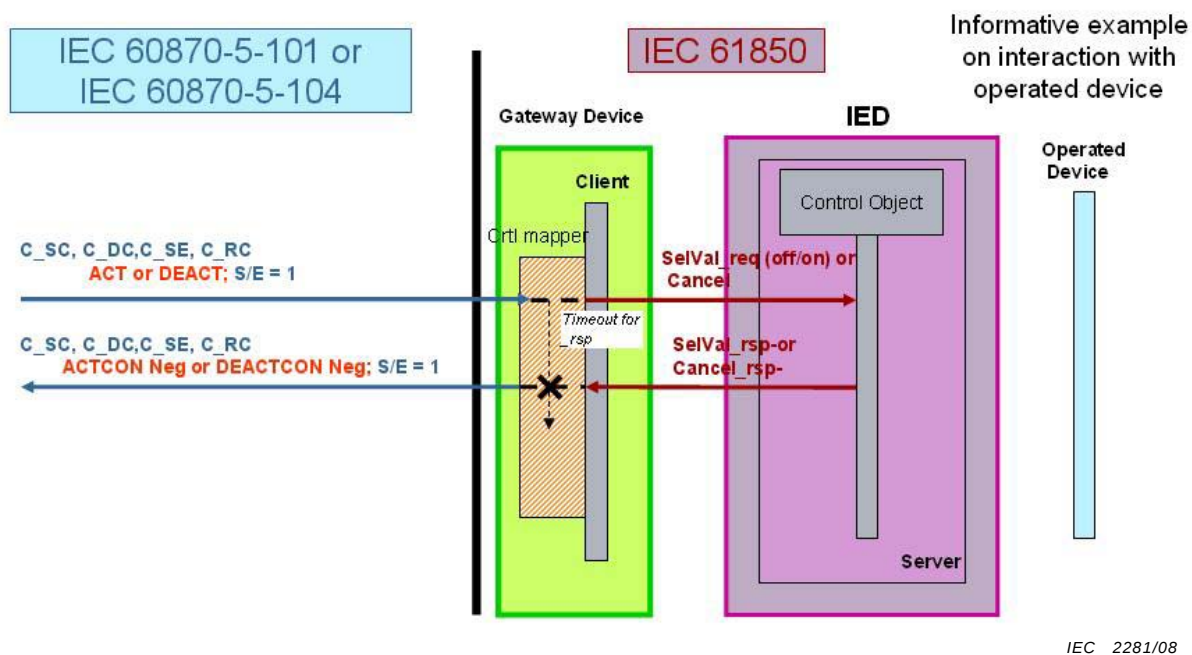


Figure 27 – SBOw control – negative case b) applied to gateway device

8.8.3.3.2 Applied to IED

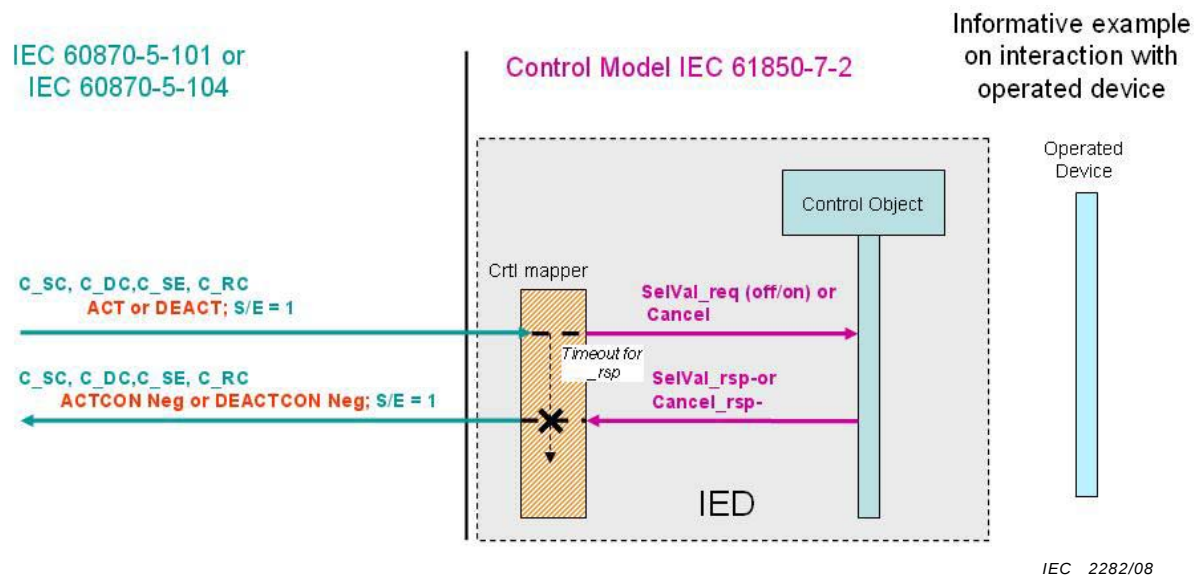


Figure 28 – SBOw control – negative case b) applied to IED

8.8.3.4 SBOw control – negative case c) second select of same object

8.8.3.4.1 Applied to gateway device

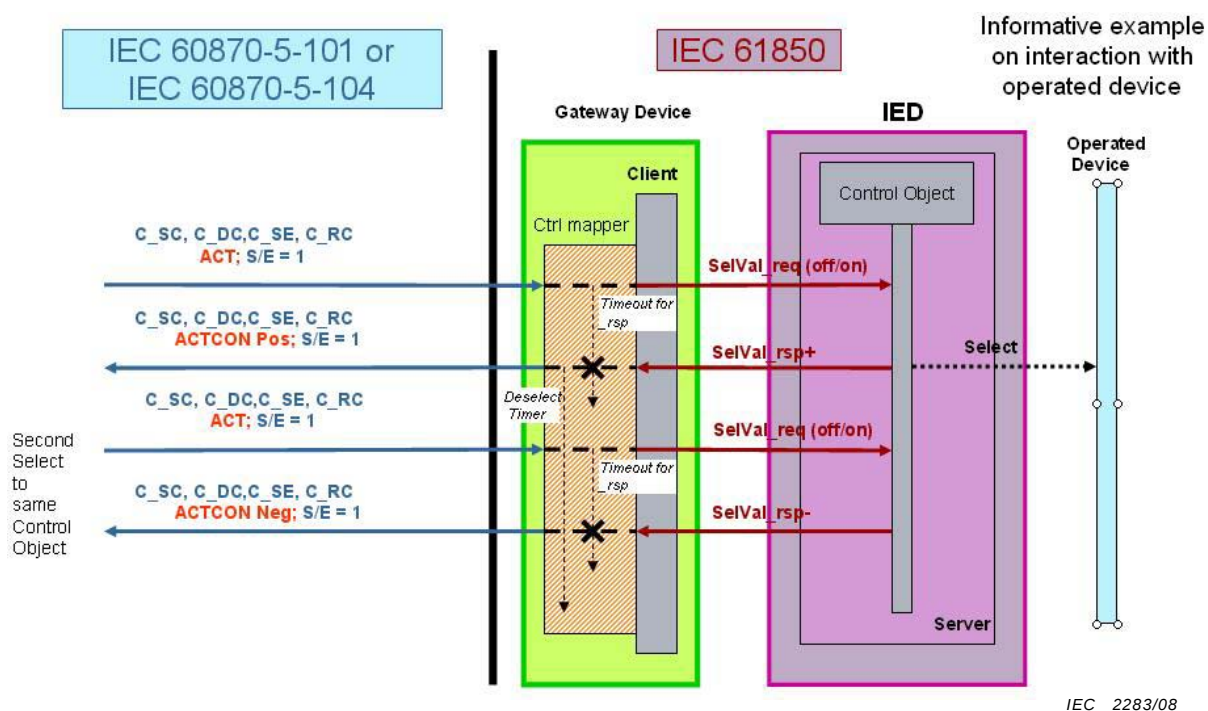


Figure 29 – SBOw control – negative case c) applied to gateway device

8.8.3.4.2 Applied to IED

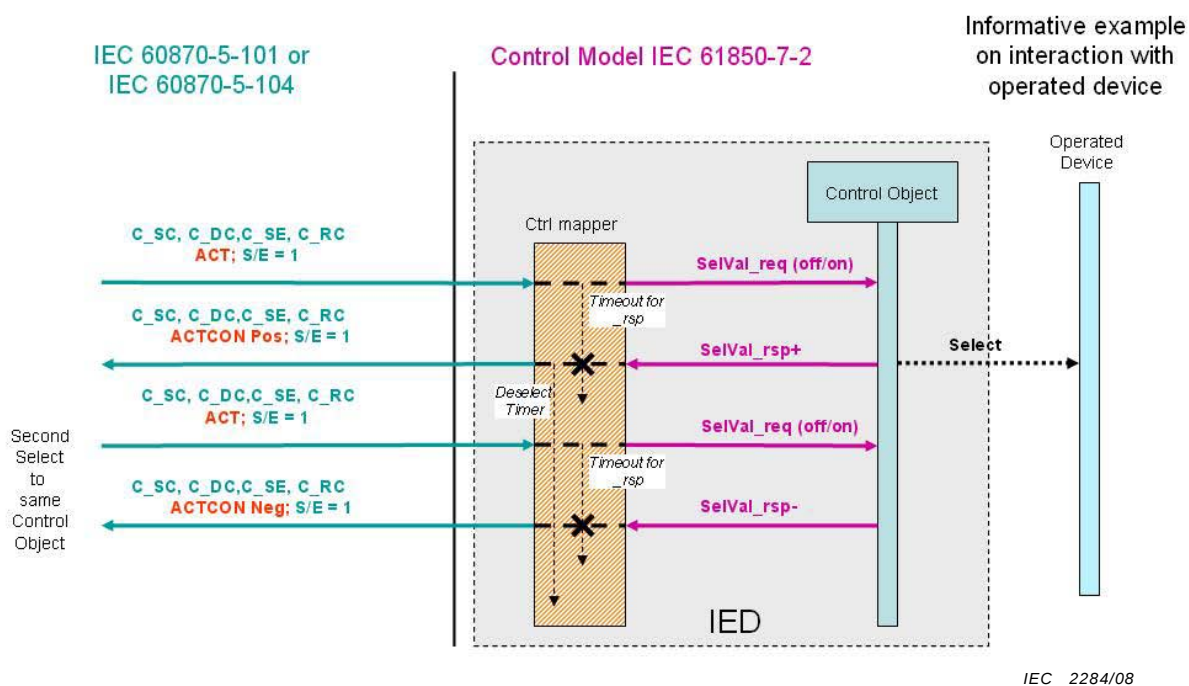
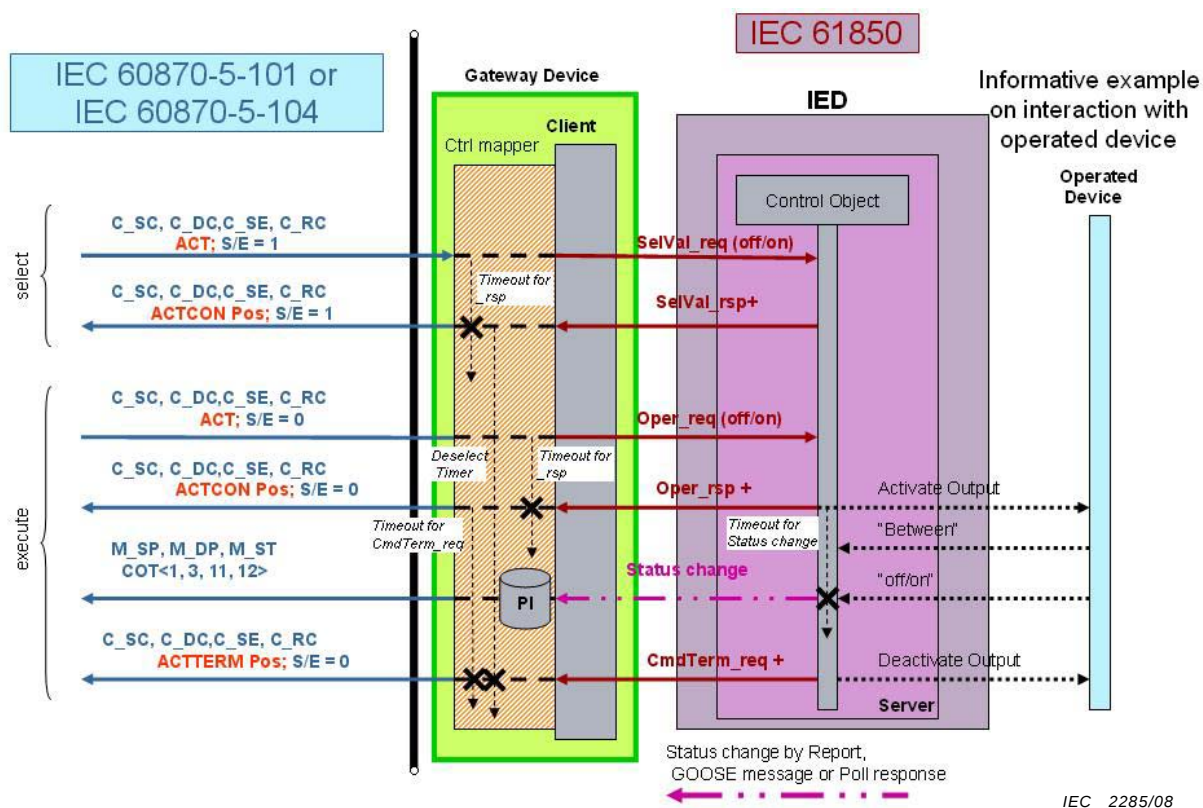


Figure 30 – SBOw control – negative case c) applied to IED

8.8.3.5 SBO with enhanced security – positive case

8.8.3.5.1 Applied to gateway device



NOTE The return information caused by a command (M_SP, M_DP, M_ST with COT <1,3,11,12>) is supplied to the client either by a Report, GOOSE message or by a Device Object Poll-reply and should be transmitted before the command termination (C_SC, C_DC, C_SE, C_RC with ACTTERM Pos; S/E = 0).

Figure 31 – SBO with enhanced security – positive case applied to gateway device

The diagram illustrates the IEC 61850-7-2 Control Model interaction between a Controller (IEC 60870-5-101 or IEC 60870-5-104) and an Operated Device. The interaction is divided into two main phases: **select** and **execute**.

select phase:

- The Controller sends a command: **C_SC, C_DC, C_SE, C_RC** with **ACT; S/E = 1**.
- The Ctrl mapper sends a request to the Control Object: **SelVal_req (off/on)**.
- The Control Object sends a response back to the Ctrl mapper: **SelVal_rsp+**.

execute phase:

- The Controller sends a command: **C_SC, C_DC, C_SE, C_RC** with **ACTCON Pos; S/E = 1**.
- The Ctrl mapper sends a request to the Control Object: **Oper_req (off/on)**.
- The Control Object sends a response back to the Ctrl mapper: **Oper_rsp +**.
- The Controller sends a command: **C_SC, C_DC, C_SE, C_RC** with **ACTCON Pos; S/E = 0**.
- The Ctrl mapper sends a request to the Control Object: **Oper_rsp +**.
- The Control Object sends a response back to the Ctrl mapper: **Oper_rsp +**.
- The Controller sends a command: **M_SP, M_DP, M_ST** with **COT<1, 3, 11, 12>**.
- The Ctrl mapper sends a request to the Control Object: **Status change**.
- The Control Object sends a response back to the Ctrl mapper: **Status change**.
- The Controller sends a command: **C_SC, C_DC, C_SE, C_RC** with **ACTTERM Pos; S/E = 0**.
- The Ctrl mapper sends a request to the Control Object: **CmdTerm_req +**.
- The Control Object sends a response back to the Ctrl mapper: **CmdTerm_req +**.

The diagram also shows the interaction between the Ctrl mapper and the Operated Device. The Ctrl mapper sends requests to the Operated Device: **Activate Output**, **"Between"**, **"off/on"**, and **Deactivate Output**. The Operated Device sends responses back to the Ctrl mapper: **Activate Output**, **"Between"**, **"off/on"**, and **Deactivate Output**.

The diagram includes several timers and a PI (Process Identifier) block. The Ctrl mapper has a **Timeout for _rsp** timer. The Operated Device has a **Timeout for CmdTerm_req** timer. The Control Object has a **Timeout for Status change** timer. The PI block is used to manage the status of the Operated Device.

8.8.3.6 SBO with enhanced security – negative case a) no status change detected by control object/server/IED

Figure 10: Informative example on interaction with operated device

The diagram illustrates the interaction between a Gateway Device, a Client, an IED (Interlocking Equipment Device), and an Operated Device. The interaction is divided into two main phases: **select** and **execute**.

select phase:

- The Client sends a request to the Gateway Device: `C_SC, C_DC, C_SE, C_RC ACT; S/E = 1`.
- The Gateway Device sends a request to the IED: `SelVal_req (off/on)`.
- The IED responds to the Gateway Device: `SelVal_rsp+`.

execute phase:

- The Client sends a request to the Gateway Device: `C_SC, C_DC, C_SE, C_RC ACT; S/E = 0`.
- The Gateway Device sends a request to the IED: `Oper_req (off/on)`.
- The IED responds to the Gateway Device: `Oper_rsp +`.
- The IED sends a request to the Operated Device: `Activate Output`.
- The Operated Device responds to the IED: `"Between"` and `"off/on"`.
- The Client sends a request to the Gateway Device: `C_SC, C_DC, C_SE, C_RC ACTCON Pos; S/E = 0`.
- The Gateway Device sends a request to the IED: `CmdTerm_req -`.
- The IED responds to the Gateway Device: `Status change`.
- The IED sends a request to the Operated Device: `Deactivate Output`.
- The Operated Device responds to the IED: `No status change`.

Timeouts and timers are indicated throughout the sequence:

- `Timeout for rsp` (Response time for the IED to the first request).
- `Deselect Timer` (Timer for the Client's second request).
- `Timeout for CmdTerm_req` (Timer for the Gateway Device's second request).
- `Timeout for Status change` (Timer for the IED's final response).
- `Timeout` (Timer for the IED's final response).

Figure 33 – SBO with enhanced security – negative case a) applied to gateway device

8.8.3.6.2 Applied to IED

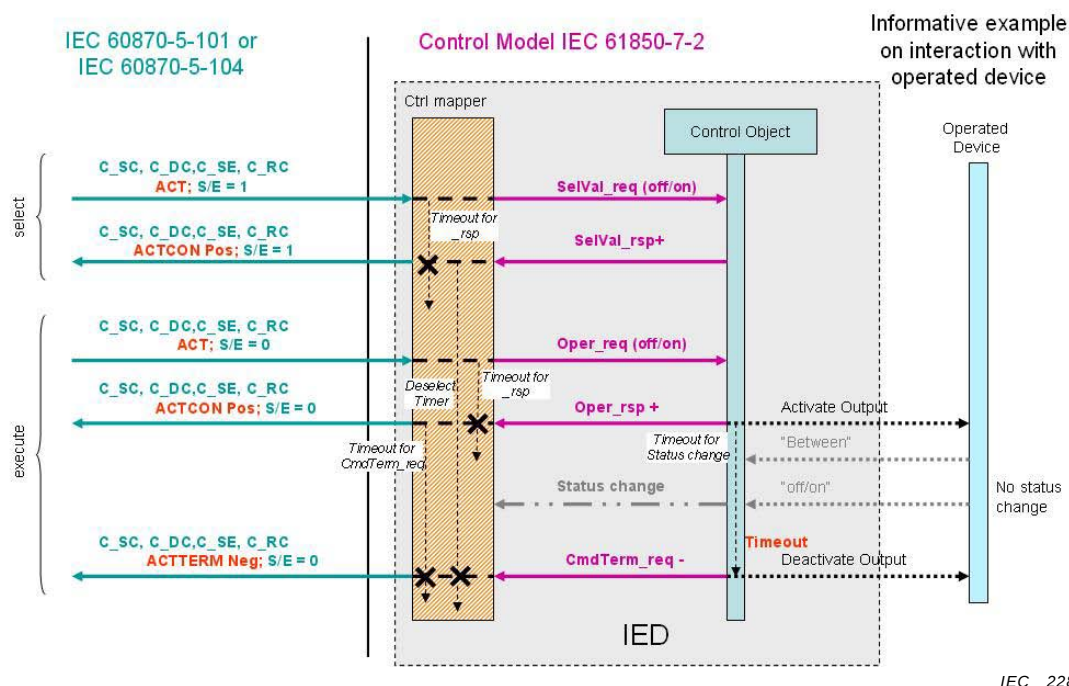


Figure 34 – SBO with enhanced security – negative case a) applied to IED

8.8.3.7 SBO with enhanced security – negative case b) no CmdTerm_req from control object/server/IED

8.8.3.7.1 Applied to gateway device

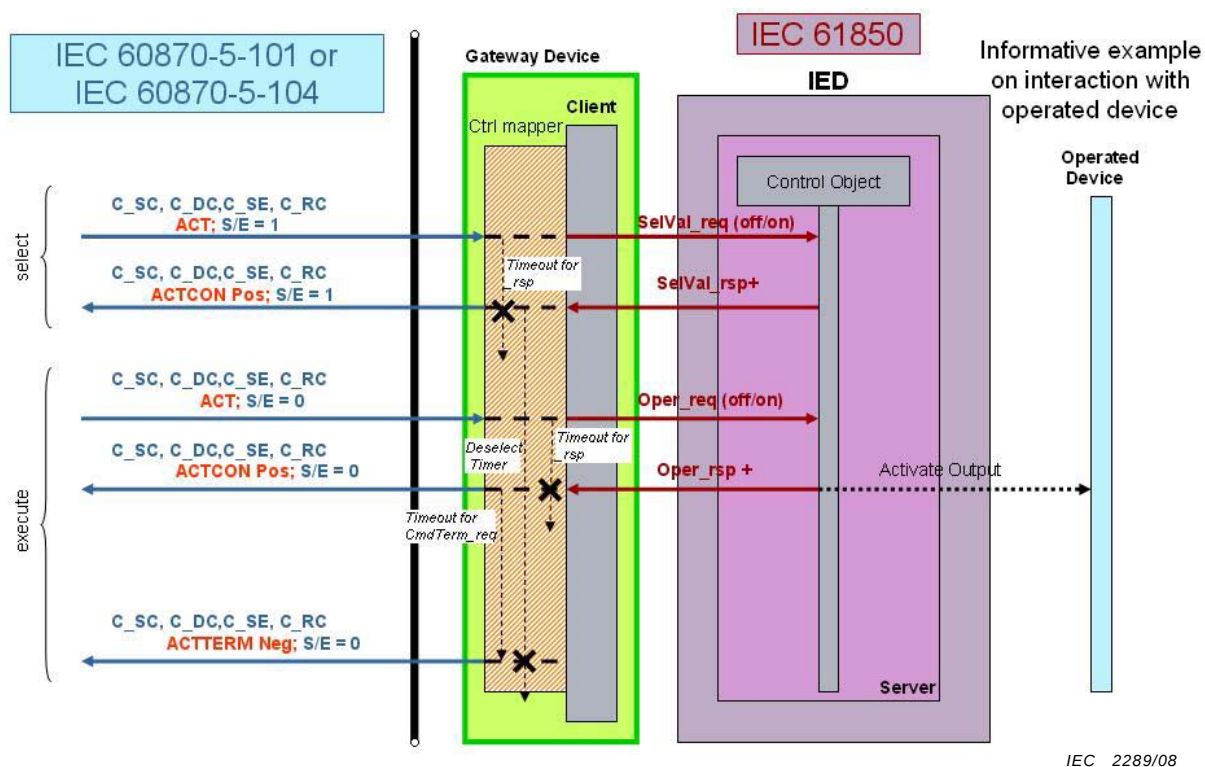


Figure 35 – SBO with enhanced security – negative case b) applied to gateway device

8.8.3.7.2 Applied to IED

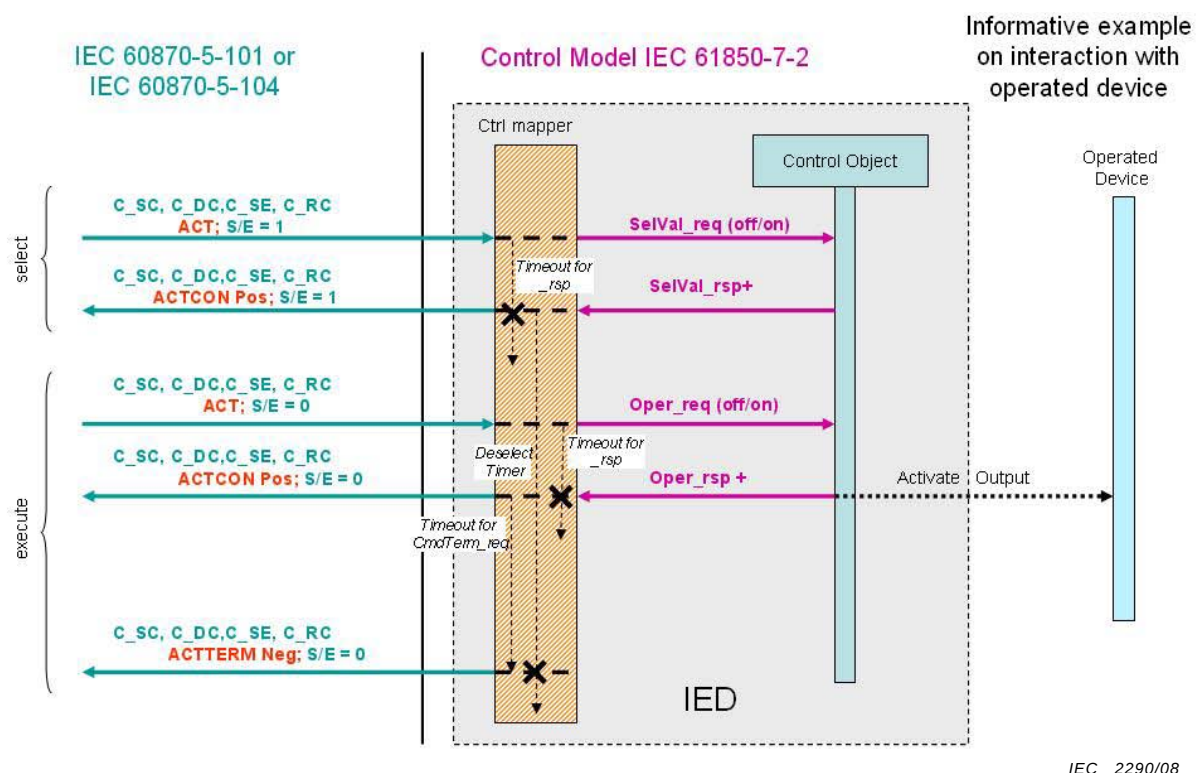


Figure 36 – SBO with enhanced security – negative case b) applied to IED

The SBO control with enhanced security services shall be mapped as shown in Table 53.

Table 53 – SBO control with enhanced security services mapping

	IEC 61850-7-2 service	Maps to
Control		Controllable IOA
	SelectWithValue	Select with Value Request: TI <45,46,47,49,50> or <58,59,60,62,63> in control direction: - applicable CASDU address - applicable IOA address - Qualifier of command (QOC)=0 <no additional definition> - COT <6>:= Activation - S/E <1>:= Select Select with Value Respond: TI <45,46,47,49,50> or <58,59,60,62,63> in monitor direction: - applicable CASDU address - applicable IOA address - Qualifier of command (QOC)=0 <no additional definition> - COT <7>:= Activation confirmation - S/E <1>:= Select

	IEC 61850-7-2 service	Maps to
	Cancel	Cancel Request: TI <45,46,47,49,50> or <58,59,60,62,63> in control direction: - applicable CASDU address - applicable IOA address - Qualifier of command (QOC)=0 <no additional definition> - COT <8>:= Deactivation - S/E value is irrelevant Cancel Respond: TI <45,46,47,49,50> or <58,59,60,62,63> in monitor direction: - applicable CASDU address - applicable IOA address - Qualifier of command (QOC)=0 <no additional definition> - COT <9>:= Deactivation confirmation S/E value is irrelevant
	Operate	Operate Request: TI <45,46,47,49,50> or <58,59,60,62,63> in control direction: - applicable CASDU address - applicable IOA address - Qualifier of command (QOC)=0 <no additional definition> - COT <6>:= Activation - S/E <0>:= Execute Operate Respond: TI <45,46,47,49,50> or <58,59,60,62,63> in monitor direction: - applicable CASDU address - applicable IOA address - Qualifier of command (QOC)=0 <no additional definition> - COT <7>:= Activation confirmation - S/E <0>:= Execute
	Command Termination	TI <45,46,47,49,50> or <58,59,60,62,63> in monitor direction: - applicable CASDU address - applicable IOA address - Qualifier of command (QOC)=0 <no additional definition> - COT <10>:= Activation Termination - S/E <0>:= Execute - P/N <0>:= no AddCause present AND Error:= NoError <0> <1>:= AddCause present OR Error <> NoError <0>

9 Protocol stack selections for IEC 60870-5-101 and IEC 60870-5-104

9.1 General

The mapping to IEC 60870-5-101 and IEC 60870-5-104 is done for the applicable data (ASDUs) and services (basic application functions) according to the marked check boxes in the interoperability sheet in 9.3.1/ 9.3.2. The interoperability sheets are subsets of the related standards.

NOTE The selections done in the interoperability sheets of IEC 60870-5-101 and IEC 60870-5-104 represent a recommended set of parameters, ASDUs and basic application functions which are conform to the definitions of this guideline.

9.2 Structure of application data

9.2.1 General

IEC 60870-5-3 describes the basic application data units in transmission frames of telecontrol systems. This subclause selects specific field elements out of that standard and defines APPLICATION SERVICE DATA UNITS (ASDU) used in standard IEC 60870-5-104 and IEC 60870-5-101 protocol.

The APPLICATION SERVICE DATA UNIT (ASDU) is composed of a DATA UNIT IDENTIFIER and one or more INFORMATION OBJECTS. ASDU's containing no INFORMATION OBJECTS are permitted as well.

In addition, in some cases, the ASDU consist only of the DATA UNIT IDENTIFIER

The DATA UNIT IDENTIFIER always has the same structure for all ASDUs. The INFORMATION OBJECTS of an ASDU are always of the same structure and type, which are defined in the TYPE IDENTIFICATION field. Each ASDU always contains a single TYPE IDENTIFICATION (TI) and a single CAUSE OF TRANSMISSION.

The COMMON ADDRESS is the station address, which may be structured to permit the addressing of the whole station or just a particular station sector.

There is no data field LENGTH OF ASDU. Each frame has only a single ASDU available.

TIME TAGS (if present) always belong to an individual INFORMATION OBJECT.

If Day of week is not used, the values can be set to 0.

The INFORMATION OBJECT consists of an INFORMATION OBJECT IDENTIFIER, a SET OF INFORMATION ELEMENTS and, if present, a TIME TAG OF INFORMATION OBJECT.

The INFORMATION OBJECT IDENTIFIER consists only of the INFORMATION OBJECT ADDRESS (IOA). In most cases, the COMMON ADDRESS OF ASDU together with the INFORMATION OBJECT ADDRESS distinguishes the complete SET OF INFORMATION ELEMENTS within a specific system. The combination of both addresses shall be unambiguous per system. The TYPE IDENTIFICATION is not a part of a COMMON ADDRESS or an INFORMATION OBJECT ADDRESS.

The SET OF INFORMATION ELEMENTS consists of a individual SINGLE INFORMATION ELEMENT / COMBINATION OF INFORMATION ELEMENTS or a sequence of SINGLE INFORMATION ELEMENTS / COMBINATION OF INFORMATION ELEMENTS.

NOTE The type identification (TI) defines the structure, the type and the format of the information object. All information objects of a specific ASDU (telegrams) are of the same structure, type and format.

9.2.2 Structure of application data defined in IEC 60870-5-101

The structure of the DATA UNIT IDENTIFIER is:

- one octet TYPE IDENTIFICATION (TI)
- one octet VARIABLE STRUCTURE QUALIFIER
- one or two octets CAUSE OF TRANSMISSION (INCLUDED ORIGINATOR ADDRESS)
- one or two octets COMMON ADDRESS OF ASDU
- one, two or three octets INFORMATION OBJECT ADDRESS (IOA)

Octet 3 (and optionally Octet 4:= ORIGINATOR ADDRESS) of the DATA UNIT IDENTIFIER of the ASDU defines the CAUSE OF TRANSMISSION field.

The size of the COMMON ADDRESS OF ASDU is determined by a fixed system (network specific) parameter, in this case one or two octets.

NOTE 1 The use of two octets for common address of ASDU is recommended.

The size of the INFORMATION OBJECT ADDRESS is determined by a fixed system (networkspecific) parameter, in this case one, two or three octets.

NOTE 2 The use of three octets for INFORMATION OBJECT ADDRESS is recommended.

If Day of week is not used, the values shall be set to 0.

The set of information elements consists of a single information element/combination of elements or a sequence of information elements.

9.2.3 Structure of application data defined in IEC 60870-5-104

The structure of the DATA UNIT IDENTIFIER is:

- one octet TYPE IDENTIFICATION (TI)
- one octet VARIABLE STRUCTURE QUALIFIER
- two octets CAUSE OF TRANSMISSION (INCLUDED ORIGINATOR ADDRESS)
- two octets COMMON ADDRESS OF ASDU
- three octets INFORMATION OBJECT ADDRESS (IOA)

The format CP56Time2a for TIME TAGS is used exclusively in IEC 60870-5-104.

If Day of week is not used, the values can be set to 0.

NOTE The TYPE IDENTIFICATION (TI) defines the structure, the type and the format of the INFORMATION OBJECT. All INFORMATION OBJECTS of a specific ASDU (telegrams) are of the same structure, type and format.

9.3 IEC 60870-5 interoperability

9.3.1 IEC 60870-5-101 interoperability

9.3.1.1 General

The companion standard IEC 60870-5-101 presents sets of parameters and alternatives from which subsets shall be selected to implement particular telecontrol systems. Certain parameter values, such as the choice of “structured” or “unstructured” fields of the INFORMATION OBJECT ADDRESS of ASDUs represent mutually exclusive alternatives. This means that only one value of the defined parameters is admitted per system. Other parameters, such as the listed set of different process information in command and in monitor direction, allow the specification of the complete set or subsets, as appropriate for given applications. This clause summarizes the parameters of the previous clauses to facilitate a suitable selection for

a specific application. If a system is composed of equipment stemming from different manufacturers, it is necessary that all partners agree on the selected parameters.

NOTE 1 In addition, the full specification of a system may require individual selection of certain parameters for certain parts of the system, such as the individual selection of scaling factors for individually addressable measured values.

The selected parameters should be marked in the white boxes as follows:

- ☐ Function or ASDU is not used
- ☒ Function or ASDU is used as standardized (default)
- ☒ Function or ASDU is used in reverse mode
- ☒ Function or ASDU is used in standard and reverse mode

The possible selection (blank, X, R, or B) is specified for each specific clause or parameter. The selections made in Subclause 9.3.1 of this technical specification select all parameters and ASDUs which are required for the mapping of CDCs onto IEC 60870-5-101 as described in this technical specification.

NOTE 2 Due to the hierarchical client–server service concept (of, for example, IEC 61850), all functions or ASDUs can be used in standardized (default) mode only.

9.3.1.2 System or device

(system-specific parameter, indicate definition of a system or a device by marking one of the following with 'X')

- ☒ System definition
- ☐ Controlling station definition
- ☐ Controlled station definition

9.3.1.3 Network configuration

(network-specific parameter, all configurations that are used are to be marked 'X')

- | | |
|---|---|
| ☒ Point-to-point | ☐ Multipoint-partyline |
| ☒ Multiple point-to-point | ☐ Multipoint-star |

9.3.1.4 Physical layer

(network-specific parameter, all interfaces and data rates that are used are to be marked 'X')

Transmission speed (control direction)

Unbalanced interchange
Circuit V.24/V.28
Standard

Unbalanced interchange
Circuit V.24/V.28
Recommended if >1 200 bit/s

Balanced interchange
Circuit X.24/X.27

☐ 100 bit/s

☐ 2 400 bit/s

☐ 2 400 bit/s

☒ 56 000 bit/s

☐ 200 bit/s

☐ 4 800 bit/s

☐ 4 800 bit/s

☒ 64 000 bit/s

☐ 300 bit/s

☒ 9 600 bit/s

☒ 9 600 bit/s

☐ 600 bit/s

☒ 19 200 bit/s

☐ 1 200 bit/s

☒ 38 400 bit/s
Transmission speed (monitor direction)

Unbalanced interchange
Circuit V.24/V.28
Standard

Unbalanced interchange
Circuit V.24/V.28
Recommended if >1 200 bit/s

Balanced interchange
Circuit X.24/X.27

☐ 100 bit/s

☐ 2 400 bit/s

☐ 2 400 bit/s

☒ 56 000 bit/s

☐ 200 bit/s

☐ 4 800 bit/s

☐ 4 800 bit/s

☒ 64 000 bit/s

☐ 300 bit/s

☒ 9 600 bit/s

☒ 9 600 bit/s

☐ 600 bit/s

☒ 19 200 bit/s

☐ 1 200 bit/s

☒ 38 400 bit/s

9.3.1.5 Link layer

(network-specific parameter, all options that are used are to be marked 'X'. Specify the maximum frame length. If a non-standard assignment of class 2 messages is implemented for unbalanced transmission, indicate the type ID and COT of all messages assigned to class 2.)

Frame format FT 1.2, single character 1 and the fixed time out interval are used exclusively in IEC 60870-5-101.

Link transmission procedure

- ☒ Balanced transmission
☐ Unbalanced transmission

Frame length

Maximum length L
(number of octets)

Address field of the link

- ☐ Not present (balanced transmission only)
☒ One octet
☒ Two octets
☐ Structured
☐ Unstructured

When using an unbalanced link layer, the following ASDU types are returned in class 2 messages (low priority) with the indicated causes of transmission:

- ☐ The standard assignment of ASDUs to class 2 messages is used as follows:

Type identification	Cause of transmission
9, 11, 13, 21	<1>

- ☐ A special assignment of ASDUs to class 2 messages is used as follows:

Type identification	Cause of transmission

NOTE In response to a class 2 poll, a controlled station may respond with class 1 data when there is no class 2 data available.

9.3.1.6 Application layer

Transmission mode for application data

Mode 1 (least significant octet first), as defined in Subclause 4.10 of IEC 60870-5-4:1993, is used exclusively in companion standard IEC 60870-5-101.

Common address of ASDU

(system-specific parameter, all configurations that are used are to be marked 'X')

☐ One octet ☒ Two octets

Information object address

(system-specific parameter, all configurations that are used are to be marked 'X')

☐ One octet ☒ structured
☐ Two octets ☒ unstructured
☒ Three octets

Cause of transmission

(system-specific parameter, all configurations that are used are to be marked 'X')

☐ One octet ☒ Two octets (with originator address). Originator address is set to zero if not used

Length of APDU

(system-specific parameter, specify the maximum length of the APDU per system)

The maximum length of APDU for both directions is 253. It is a fixed system parameter.

Maximum length of APDU per system in control direction
 Maximum length of APDU per system in monitor direction

Selection of standard ASDUs

Process information in monitor direction

(station-specific parameter, mark each Type ID 'X' if it is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

☒	<1> := Single-point information	M_SP_NA_1
☐	<2> :=Single-point information with time tag	M_SP_TA_1
☒	<3> :=Double-point information	M_DP_NA_1
☐	<4> :=Double-point information with time tag	M_DP_TA_1
☒	<5> := Step position information	M_ST_NA_1
☐	<6> := Step position information with time tag	M_ST_TA_1
☒	<7> := Bitstring of 32 bit	M_BO_NA_1
☐	<8> := Bitstring of 32 bit with time tag	M_BO_TA_1
☐	<9> := Measured value, normalized value	M_ME_NA_1
☐	<10> := Measured value, normalized value with time tag	M_ME_TA_1
☒	<11> := Measured value, scaled value	M_ME_NB_1
☐	<12> := Measured value, scaled value with time tag	M_ME_TB_1
☒	<13> := Measured value, short floating point value	M_ME_NC_1
☐	<14> := Measured value, short floating point value with time tag	M_ME_TC_1
☒	<15> := Integrated totals	M_IT_NA_1
☐	<16> := Integrated totals with time tag	M_IT_TA_1
☐	<17> := Event of protection equipment with time tag	M_EP_TA_1
☐	<18> := Packed start events of protection equipment with time tag	M_EP_TB_1
☐	<19> := Packed output circuit information of protection equipment with time tag	M_EP_TC_1
☐	<20> := Packed single-point information with status change detection	M_PS_NA_1
☐	<21> := Measured value, normalized value without quality descriptor	M_ME_ND_1
☒	<30> := Single-point information with time tag CP56Time2a	M_SP_TB_1
☒	<31> := Double-point information with time tag CP56Time2a	M_DP_TB_1
☒	<32> := Step position information with time tag CP56Time2a	M_ST_TB_1
☒	<33> := Bitstring of 32 bit with time tag CP56Time2a	M_BO_TB_1
☐	<34> := Measured value, normalized value with time tag CP56Time2a	M_ME_TD_1
☒	<35> := Measured value, scaled value with time tag CP56Time2a	M_ME_TE_1
☒	<36> := Measured value, short floating point value with time tag CP56Time2a	M_ME_TF_1
☒	<37> := Integrated totals with time tag CP56Time2a	M_IT_TB_1
☐	<38> := Event of protection equipment with time tag CP56Time2a	M_EP_TD_1
☒	<39> := Packed start events of protection equipment with time tag CP56Time2a	M_EP_TE_1
☒	<40> := Packed output circuit information of protection equipment with time tag CP56Time2a	M_EP_TF_1

Either ASDUs of the set <2>, <4>, <6>, <8>, <10>, <12>, <14>, <16>, <17>, <18>, <19> or of the set <30 –40> are used.

Process information in control direction

(station-specific parameter, mark each type ID 'X' if it is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

☒	<45> := Single command	C_SC_NA_1
☒	<46> := Double command	C_DC_NA_1
☒	<47> := Regulating step command	C_RC_NA_1
☐	<48> := Set point command, normalized value	C_SE_NA_1
☒	<49> := Set point command, scaled value	C_SE_NB_1
☒	<50> := Set point command, short floating point value	C_SE_NC_1
☐	<51> := Bitstring of 32 bit	C_BO_NA_1

System information in monitor direction

(station-specific parameter, mark an 'X' if it is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

☒	<70> := End of initialization	M_EI_NA_1
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System information in control direction

(station-specific parameter, mark each type ID 'X' if it is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

☒	<100>:= Interrogation command	C_IC_NA_1
☒	<101>:= Counter interrogation command	C_CI_NA_1
☒	<102>:= Read command	C_RD_NA_1
☐	<103>:= Clock synchronization command	C_CS_NA_1
☐	<104>:= Test command	C_TS_NA_1
☐	<105>:= Reset process command	C_RP_NA_1
☐	<106>:= Delay acquisition command	C_CD_NA_1

Parameter in control direction

(station-specific parameter, mark each Type ID 'X' if it is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

☐	<110>:= Parameter of measured value, normalized value	P_ME_NA_1
☒	<111>:= Parameter of measured value, scaled value	P_ME_NB_1
☒	<112>:= Parameter of measured value, short floating point value	P_ME_NC_1
☐	<113>:= Parameter activation	P_AC_NA_1

File transfer

(station-specific parameter, mark each Type ID 'X' if it is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

☐	<120>:= File ready	F_FR_NA_1
☐	<121>:= Section ready	F_SR_NA_1
☐	<122>:= Call directory, select file, call file, call section	F_SC_NA_1
☐	<123>:= Last section, last segment	F_LS_NA_1
☐	<124>:= Ack file, ack section	F_AF_NA_1
☐	<125>:= Segment	F_SG_NA_1
☐	<126>:= Directory {blank or X, only available in monitor (standard) direction}	F_DR_TA_1

(station-specific parameters)

Black boxes: option not permitted in companion standard IEC 60870-5-101.

Mark Type Identification/Cause of transmission combinations:

'R' if only used in the reverse direction,

'B' if used in both directions.

Type identification		Cause of transmission																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	20 to 36	37 to 41	44	45	46	47
<1>	M_SP_NA_1			X											X					
<2>	M_SP_TA_1																			
<3>	M_DP_NA_1														X					
<4>	M_DP_TA_1																			
<5>	M_ST_NA_1														X					
<6>	M_ST_TA_1																			
<7>	M_BO_NA_1														X					
<8>	M_BO_TA_1																			
<9>	M_ME_NA_1																			
<10>	M_ME_TA_1																			
<11>	M_ME_NB_1														X					
<12>	M_ME_TB_1																			
<13>	M_ME_NC_1														X					
<14>	M_ME_TC_1																			
<15>	M_IT_NA_1															X				
<16>	M_IT_TA_1																			
<17>	M_EP_TA_1																			
<18>	M_EP_TB_1																			
<19>	M_EP_TC_1																			
<20>	M_PS_NA_1																			
<21>	M_ME_ND_1																			
<30>	M_SP_TB_1			X		X						X	X							
<31>	M_DP_TB_1			X		X						X	X							
<32>	M_ST_TB_1			X		X						X	X							
<33>	M_BO_TB_1			X		X														
<34>	M_ME_TD_1																			
<35>	M_ME_TE_1			X		X														
<36>	M_ME_TF_1			X		X														
<37>	M_IT_TB_1			X																
<38>	M_EP_TD_1																			
<39>	M_EP_TE_1			X																
<40>	M_EP_TF_1			X																
<45>	C_SC_NA_1						X	X	X	X	X						X	X	X	X
<46>	C_DC_NA_1						X	X	X	X	X						X	X	X	X
<47>	C_RC_NA_1						X	X	X	X	X						X	X	X	X
<48>	C_SE_NA_1																			
<49>	C_SE_NB_1						X	X	X	X	X						X	X	X	X

Type identification		Cause of transmission																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	20 to 36	37 to 41	44	45	46	47	
<50>	C_SE_NC_1						X	X	X	X	X						X	X	X	X	
<51>	C_BO_NA_1																				
<70>	M_EI_NA_1 ^{*)}				X																
<100>	C_IC_NA_1						X	X			X						X	X	X	X	
<101>	C_CI_NA_1						X	X			X						X	X	X	X	
<102>	C_RD_NA_1					X											X	X	X	X	
<103>	C_CS_NA_1																				
<104>	C_TS_NA_1																				
<105>	C_RP_NA_1																				
<106>	C_CD_NA_1																				
<110>	P_ME_NA_1																				
<111>	P_ME_NB_1						X	X							X		X	X	X	X	
<112>	P_ME_NC_1						X	X							X		X	X	X	X	
<113>	P_AC_NA_1																				
<120>	F_FR_NA_1																				
<121>	F_SR_NA_1																				
<122>	F_SC_NA_1																				
<123>	F_LS_NA_1																				
<124>	F_AF_NA_1																				
<125>	F_SG_NA_1																				
<126>	F_DR_TA_1 ^{*)}																				

^{*)} blank or X only

9.3.1.7 Basic application functions

Station initialization

(station-specific parameter, mark 'X' if function is used)

☐ Remote initialization

Cyclic data transmission

(station-specific parameter, mark 'X' if function is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

☒ Cyclic data transmission *) Optional

Read procedure

(station-specific parameter, mark 'X' if function is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

☒ Read procedure

Spontaneous transmission

(station-specific parameter, mark 'X' if function is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

☒ Spontaneous transmission

Double transmission of information objects with cause of transmission spontaneous

(station-specific parameter, mark each information type 'X' where both a Type ID without time and corresponding Type ID with time are issued in response to a single spontaneous change of a monitored object)

The following type identifications may be transmitted in succession caused by a single status change of an information object. The particular information object addresses for which double transmission is enabled are defined in a project-specific list.

- ☐ Single-point information M_SP_NA_1, M_SP_TA_1, M_SP_TB_1 and M_PS_NA_1
- ☐ Double-point information M_DP_NA_1, M_DP_TA_1 and M_DP_TB_1
- ☐ Step position information M_ST_NA_1, M_ST_TA_1 and M_ST_TB_1
- ☐ Bitstring of 32 bit M_BO_NA_1, M_BO_TA_1 and M_BO_TB_1 (if defined for a specific project)
- ☐ Measured value, normalized value M_ME_NA_1, M_ME_TA_1, M_ME_ND_1 and M_ME_TD_1
- ☐ Measured value, scaled value M_ME_NB_1, M_ME_TB_1 and M_ME_TE_1
- ☐ Measured value, short floating point number M_ME_NC_1, M_ME_TC_1 and M_ME_TF_1

Station interrogation

(station-specific parameter, mark 'X' if function is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

☒ global		
☐ group 1	☐ group 7	☐ group 13
☐ group 2	☐ group 8	☐ group 14
☐ group 3	☐ group 9	☐ group 15
☐ group 4	☐ group 10	☐ group 16
☐ group 5	☐ group 11	
☐ group 6	☐ group 12	

Information Object Addresses assigned to each group must be shown in a separate table

Clock synchronization

(station-specific parameter, mark 'X' if function is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

☐ Clock synchronization

☐ Day of week used (Optional)

☐ RES1, GEN (time tag substituted/ not substituted) used (Optional)

☐ SU-bit (summertime) used (Optional)

Command transmission

(object-specific parameter, mark 'X' if function is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

☒ Direct command transmission

☒ Direct set point command transmission

☒ Select and execute command

☒ Select and execute set point command

☒ C_SE ACTTERM used

☒ No additional definition

☐ Short pulse duration (duration determined by a system parameter in the outstation)

☐ Long pulse duration (duration determined by a system parameter in the outstation)

☐ Persistent output

NOTE 1 The command transmission for each control model (ctlModel) is described in 8.8.

NOTE 2 If the Option "C_SE ACTTERM used" is selected, the condition (trigger/event) for sending CE_SE ACTTERM and the related monitored information has to be specified individually per project.

Transmission of integrated totals

(station- or object-specific parameter, mark 'X' if function is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

- ☒ Mode A: Local freeze with spontaneous transmission
- ☐ Mode B: Local freeze with counter interrogation
- ☐ Mode C: Freeze and transmit by counter interrogation commands
- ☐ Mode D: Freeze by counter interrogation command, frozen values reported spontaneously

- ☐ Counter read
- ☒ Counter freeze without reset
- ☐ Counter freeze with reset
- ☐ Counter reset

- ☒ General request counter
- ☐ Request counter group 1
- ☐ Request counter group 2
- ☐ Request counter group 3
- ☐ Request counter group 4

Parameter loading

(object-specific parameter, mark 'X' if function is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

- ☒ Threshold value
- ☐ Smoothing factor
- ☐ Low limit for transmission of measured value
- ☐ High limit for transmission of measured value

Parameter activation

(object-specific parameter, mark 'X' if function is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

- ☐ Act/deact of persistent cyclic or periodic transmission of the addressed object

Test procedure

(station-specific parameter, mark 'X' if function is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

- ☐ Test procedure

File transfer

(station-specific parameter, mark 'X' if function is used)

File transfer in monitor direction

- ☐ Transparent file
- ☐ Transmission of disturbance data of protection equipment
- ☐ Transmission of sequences of events
- ☐ Transmission of sequences of recorded analogue values

File transfer in control direction

- ☐ Transparent file

Background scan

(station-specific parameter, mark 'X' if function is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

- ☐ Background scan

Acquisition of transmission delay

(station-specific parameter, mark 'X' if function is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

- ☐ Acquisition of transmission delay

9.3.2 IEC 60870-5-104 interoperability**9.3.2.1 General**

The companion standard IEC 60870-5-104 presents sets of parameters and alternatives from which subsets shall be selected to implement particular telecontrol systems. Certain parameter values, such as the choice of “structured” or “unstructured” fields of the INFORMATION OBJECT ADDRESS of ASDUs represent mutually exclusive alternatives. This means that only one value of the defined parameters is admitted per system. Other parameters, such as the listed set of different process information in command and in monitor direction allow the specification of the complete set or subsets, as appropriate for given applications. This clause summarizes the parameters of the previous clauses to facilitate a suitable selection for a specific application. If a system is composed of equipment stemming from different manufacturers, it is necessary that all partners agree on the selected parameters.

The interoperability list is defined as in IEC 60870-5-101 and extended with parameters used in IEC 60870-5-104. The text descriptions of parameters which are not applicable to IEC 60870-5-104 are struck-through (corresponding check box is marked black).

NOTE In addition, the full specification of a system may require individual selection of certain parameters for certain parts of the system, such as the individual selection of scaling factors for individually addressable measured values.

The selected parameters should be marked in the white boxes as follows:

- ☐ Function or ASDU is not used
- ☒ Function or ASDU is used as standardized (default)
- ☐ Function or ASDU is used in reverse mode
- ☐ Function or ASDU is used in standard and reverse mode

The possible selection (blank, X, R, or B) is specified for each specific clause or parameter. The selections made in Subclause 9.3.2 of this technical specification select all parameters and ASDUs which are required for the mapping of CDCs onto IEC 60870-5-104 as described in this technical specification.

A black check box indicates that the option cannot be selected in IEC 60870-5-104.

NOTE Due to the hierarchical client-server service concept (of, for example, IEC 61850), all functions or ASDUs can be used in standardized (default) mode only.

9.3.2.2 System or device

(system-specific parameter, indicate definition of a system or a device by marking one of the following with 'X')

- ☒ System definition
- ☐ Controlling station definition
- ☐ Controlled station definition

9.3.2.3 Network configuration

(network-specific parameter, all configurations that are used are to be marked 'X')

- ☒ Point-to-point
- ☒ Multipoint-
- ☒ Multiple-point-to-
- ☒ Multipoint-star

9.3.2.4 Physical layer

(network-specific parameter, all interfaces and data rates that are used are to be marked 'X')

Transmission speed (control direction)

Unbalanced interchange
Circuit V.24/V.28
Standard

Unbalanced interchange
Circuit V.24/V.28
Recommended if >1 200 bit/s

Balanced interchange
Circuit X.24/X.27

- | | | | |
|---|---|--|--|
| ☒ 100 bit/s | ☒ 2 400 bit/s | ☒ 2 400 bit/s | ☒ 56 000 bit/s |
| ☒ 200 bit/s | ☒ 4 800 bit/s | ☒ 4 800 bit/s | ☒ 64 000 bit/s |
| ☒ 300 bit/s | ☒ 9 600 bit/s | ☒ 9 600 bit/s | |
| ☒ 600 bit/s | | ☒ 19 200 bit/s | |
| ☒ 1 200 bit/s | | ☒ 38 400 bit/s | |

Transmission speed (monitor direction)

Unbalanced interchange
Circuit V.24/V.28
Standard

Unbalanced interchange
Circuit V.24/V.28
Recommended if >1 200 bit/s

Balanced interchange
Circuit X.24/X.27

☐ 100 bit/s

☐ 2 400 bit/s

☐ 2 400 bit/s

☐ 56 000 bit/s

☐ 200 bit/s

☐ 4 800 bit/s

☐ 4 800 bit/s

☐ 64 000 bit/s

☐ 300 bit/s

☐ 9 600 bit/s

☐ 9 600 bit/s

☐ 600 bit/s

☐ 19 200 bit/s

☐ 1 200 bit/s

☐ 38 400 bit/s

9.3.2.5 Link layer

(network-specific parameter, all options that are used are to be marked 'X'. Specify the maximum frame length. If a non-standard assignment of class 2 messages is implemented for unbalanced transmission, indicate the Type ID and COT of all messages assigned to class 2.)

~~Frame format FT 1.2, single character 1 and the fixed time out interval are used exclusively in IEC 60870-5-101 this companion standard.~~

Link transmission

☐ ~~Balanced transmission~~

☐ ~~Unbalanced transmission~~

Frame length

☐ ~~Maximum length L
(number of octets)~~

Address field of the link

☐ ~~Not present (balanced transmission only)~~

☐ ~~One octet~~

☐ ~~Two octets~~

☐ ~~Structured~~

☐ ~~Unstructured~~

When using an unbalanced link layer, the following ASDU types are returned in class 2 messages (low priority) with the indicated causes of transmission:

☐ ~~The standard assignment of ASDUs to class 2 messages is used as follows:~~

Type identification	Cause of transmission
9, 11, 13, 21	<1>

 A special assignment of ASDUs to class 2 messages is used as follows:

Type identification	Cause of transmission

NOTE In response to a class 2 poll, a controlled station may respond with class 1 data when there is no class 2 data available.

9.3.2.6 Application layer

Transmission mode for application data

Mode 1 (Least significant octet first), as defined in Subclause 4.10 of IEC 60870-5-4:1993, is used exclusively in IEC 60870-5-104.

Common address of ASDU

(system-specific parameter, all configurations that are used are to be marked 'X')

 ~~One octet~~ ☒ Two octets

Information object address

(system-specific parameter, all configurations that are used are to be marked 'X')

 ~~One octet~~ ☒ structured
 ~~Two octets~~ ☒ unstructured
☒ Three octets

Cause of transmission

(system-specific parameter, all configurations that are used are to be marked 'X')

 ~~One octet~~ ☒ Two octets (with originator address). Originator address is set to zero if not used (see Note)

Length of APDU

(system-specific parameter, specify the maximum length of the APDU per system)

The maximum length of APDU for both directions is 253. It is a fixed system parameter.

 Maximum length of APDU per system in control direction

 Maximum length of APDU per system in monitor direction

NOTE If the gateway device acts as "mediator" between the substation and all "devices on the WAN network", the originator address has to be used.

Selection of standard ASDUs

Process information in monitor direction

(station-specific parameter, mark each Type ID 'X' if it is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

☒	<1> := Single-point information	M_SP_NA_1
☐	<2> := Single-point information with time tag	M_SP_TA_1
☒	<3> := Double-point information	M_DP_NA_1
☐	<4> := Double-point information with time tag	M_DP_TA_1
☒	<5> := Step position information	M_ST_NA_1
☐	<6> := Step position information with time tag	M_ST_TA_1
☒	<7> := Bitstring of 32 bit	M_BO_NA_1
☐	<8> := Bitstring of 32 bit with time tag	M_BO_TA_1
☐	<9> := Measured value, normalized value	M_ME_NA_1
☐	<10> := Measured value, normalized value with time tag	M_ME_TA_1
☒	<11> := Measured value, scaled value	M_ME_NB_1
☐	<12> := Measured value, scaled value with time tag	M_ME_TB_1
☒	<13> := Measured value, short floating point value	M_ME_NC_1
☐	<14> := Measured value, short floating point value with time tag	M_ME_TC_1
☒	<15> := Integrated totals	M_IT_NA_1
☐	<16> := Integrated totals with time tag	M_IT_TA_1
☐	<17> := Event of protection equipment with time tag	M_EP_TA_1
☐	<18> := Packed start events of protection equipment with time tag	M_EP_TB_1
☐	<19> := Packed output circuit information of protection equipment with time tag	M_EP_TC_1
☐	<20> := Packed single-point information with status change detection	M_PS_NA_1
☐	<21> := Measured value, normalized value without quality descriptor	M_ME_ND_1
☒	<30> := Single-point information with time tag CP56Time2a	M_SP_TB_1
☒	<31> := Double-point information with time tag CP56Time2a	M_DP_TB_1
☒	<32> := Step position information with time tag CP56Time2a	M_ST_TB_1
☒	<33> := Bitstring of 32 bit with time tag CP56Time2a	M_BO_TB_1
☐	<34> := Measured value, normalized value with time tag CP56Time2a	M_ME_TD_1
☒	<35> := Measured value, scaled value with time tag CP56Time2a	M_ME_TE_1
☒	<36> := Measured value, short floating point value with time tag CP56Time2a	M_ME_TF_1
☒	<37> := Integrated totals with time tag CP56Time2a	M_IT_TB_1
☐	<38> := Event of protection equipment with time tag CP56Time2a	M_EP_TD_1
☒	<39> := Packed start events of protection equipment with time tag CP56Time2a	M_EP_TE_1
☒	<40> := Packed output circuit information of protection equipment with time tag CP56Time2a	M_EP_TF_1

In IEC 60870-5-104, only the use of the set <30> – <40> for ASDUs with time tag is permitted.

Process information in control direction

(station-specific parameter, mark each Type ID 'X' if it is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

☐	<45> := Single command	C_SC_NA_1
☐	<46> := Double command	C_DC_NA_1
☐	<47> := Regulating step command	C_RC_NA_1
☐	<48> := Set point command, normalized value	C_SE_NA_1
☐	<49> := Set point command, scaled value	C_SE_NB_1
☐	<50> := Set point command, short floating point value	C_SE_NC_1
☐	<51> := Bitstring of 32 bit	C_BO_NA_1
☒	<58> := Single command with time tag CP56Time 2a	C_SC_TA_1
☒	<59> := Double command with time tag CP56Time 2a	C_DC_TA_1
☒	<60> := Regulating step command with time tag CP56Time 2a	C_RC_TA_1
☐	<61> := Set point command, normalized value with time tag CP56Time 2a	C_SE_TA_1
☒	<62> := Set point command, scaled value with time tag CP56Time 2a	C_SE_TB_1
☒	<63> := Set point command, short floating point value with time tag CP56Time 2a	C_SE_TC_1
☐	<64> := Bitstring of 32 bit with time tag CP56Time 2a	C_BO_TA_1

Either the ASDUs of the set <45> – <51> or of the set <58> – <64> are used.

System information in monitor direction

(station-specific parameter, mark an 'X' if it is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

☒	<70> := End of initialization	M_EI_NA_1
-------------------------------------	-------------------------------	-----------

System information in control direction

(station-specific parameter, mark each Type ID 'X' if it is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

☒	<100>:= Interrogation command	C_IC_NA_1
☒	<101>:= Counter interrogation command	C_CI_NA_1
☒	<102>:= Read command	C_RD_NA_1
☐	<103>:= Clock synchronization command	C_CS_NA_1
☒	<104>:= Test command	C_TS_NA_1
☐	<105>:= Reset process command	C_RP_NA_1
☒	<106>:= Delay acquisition command	C_CD_NA_1
☐	<107>:= Test command with time tag CP56time2a	C_TS_TA_1

Parameter in control direction

(station-specific parameter, mark each Type ID 'X' if it is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

☐	<110>:= Parameter of measured value, normalized value	P_ME_NA_1
☒	<111>:= Parameter of measured value, scaled value	P_ME_NB_1
☒	<112>:= Parameter of measured value, short floating point value	P_ME_NC_1
☐	<113>:= Parameter activation	P_AC_NA_1

File transfer

(station-specific parameter, mark each Type ID 'X' if it is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

☐	<120>:= File ready	F_FR_NA_1
☐	<121>:= Section ready	F_SR_NA_1
☐	<122>:= Call directory, select file, call file, call section	F_SC_NA_1
☐	<123>:= Last section, last segment	F_LS_NA_1
☐	<124>:= Ack file, ack section	F_AF_NA_1
☐	<125>:= Segment	F_SG_NA_1
☐	<126>:= Directory {blank or X, only available in monitor (standard) direction}	F_DR_TA_1
☐	<127>:= Query Log - Request archive file	F_SC_NB_1

(station-specific parameters)

Black boxes: option not permitted in IEC 60870-5-104

Mark type identification/Cause of transmission combinations:

'X' if only used in the standard direction,

'R' if only used in the reverse direction,

'B' if used in both directions.

[illegible]

Type identification		Cause of transmission																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	20 to 36	37 to 41	44	45	46	47	
<50>	C_SE_NC_1																				
<51>	C_BO_NA_1																				
<58>	C_SC_TA_1						X	X	X	X	X						X	X	X	X	
<59>	C_DC_TA_1						X	X	X	X	X						X	X	X	X	
<60>	C_RC_TA_1						X	X	X	X	X						X	X	X	X	
<61>	C_SE_TA_1																				
<62>	C_SE_TB_1						X	X	X	X	X						X	X	X	X	
<63>	C_SE_TC_1						X	X	X	X	X						X	X	X	X	
<64>	C_BO_TA_1																				
<70>	M_EI_NA_1 *)				X																
<100>	C_IC_NA_1						X	X			X						X	X	X	X	
<101>	C_CI_NA_1						X	X			X						X	X	X	X	
<102>	C_RD_NA_1					X											X	X	X	X	
<103>	C_CS_NA_1																				
<104>	C_TS_NA_1																				
<105>	C_RP_NA_1																				
<106>	G_CD_NA_1																				
<107>	C_TS_TA_1																				
<110>	P_ME_NA_1																				
<111>	P_ME_NB_1						X	X							X		X	X	X	X	
<112>	P_ME_NC_1						X	X							X		X	X	X	X	
<113>	P_AC_NA_1																				
<120>	F_FR_NA_1																				
<121>	F_SR_NA_1																				
<122>	F_SC_NA_1																				
<123>	F_LS_NA_1																				
<124>	F_AF_NA_1																				
<125>	F_SG_NA_1																				
<126>	F_DR_TA_1*)																				
<127>	F_SC_NB_1*)																				

*) blank or X only

9.3.2.7 Basic application functions

Station initialization

(station-specific parameter, mark 'X' if function is used)

☐ Remote initialization

Cyclic data transmission

(station-specific parameter, mark 'X' if function is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

☐ Cyclic data transmission

Read procedure

(station-specific parameter, mark 'X' if function is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

☒ Read procedure

Spontaneous transmission

(station-specific parameter, mark 'X' if function is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

☒ Spontaneous transmission

Double transmission of information objects with cause of transmission spontaneous

(station-specific parameter, mark each information type 'X' where both a Type ID without time and corresponding Type ID with time are issued in response to a single spontaneous change of a monitored object)

The following type identifications may be transmitted in succession caused by a single status change of an information object. The particular information object addresses for which double transmission is enabled are defined in a project-specific list.

- ☐ Single-point information M_SP_NA_1, M_SP_TA_1, M_SP_TB_1 and M_PS_NA_1
- ☐ Double-point information M_DP_NA_1, M_DP_TA_1 and M_DP_TB_1
- ☐ Step position information M_ST_NA_1, M_ST_TA_1 and M_ST_TB_1
- ☐ Bitstring of 32 bit M_BO_NA_1, M_BO_TA_1 and M_BO_TB_1 (if defined for a specific project)
- ☐ Measured value, normalized value M_ME_NA_1, M_ME_TA_1, M_ME_ND_1 and M_ME_TD_1
- ☐ Measured value, scaled value M_ME_NB_1, M_ME_TB_1 and M_ME_TE_1
- ☐ Measured value, short floating point number M_ME_NC_1, M_ME_TC_1 and M_ME_TF_1

Station interrogation

(station-specific parameter, mark 'X' if function is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

☒ global	☐ group 7	☐ group 13
☐ group 1	☐ group 8	☐ group 14
☐ group 2	☐ group 9	☐ group 15
☐ group 3	☐ group 10	☐ group 16
☐ group 4	☐ group 11	
☐ group 5	☐ group 12	
☐ group 6		

Information object addresses assigned to each group must be shown in a separate table

Clock synchronization

(station-specific parameter, mark 'X' if function is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

☐ Clock synchronization

☐ Day of week used

☐ RES1, GEN (time tag substituted/ not substituted) used

☐ SU-bit (summertime) used

optional, see Subclause 7.6 of IEC 60870-5-104

Command transmission

(object-specific parameter, mark 'X' if function is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

☒ Direct command transmission

☒ Direct set point command transmission

☒ Select and execute command

☒ Select and execute set point command

☒ C_SE ACTTERM used

☒ No additional definition

☐ Short pulse duration (duration determined by a system parameter in the

☐ Long pulse duration (duration determined by a system parameter in the

☐ Persistent output

☒ Supervision of maximum delay in command direction of commands and set point commands

Maximum allowable delay of commands and set point commands

NOTE 1 The command transmission for each control model (ctlModel) is described in 8.8.

NOTE 2 If the option "C_SE ACTTERM used" is selected, the condition (trigger) for sending CE_SE ACTTERM and the related monitored information has to be specified individually per project.

NOTE 3 The maximum allowable delay of commands and set point commands has to be specified individually per project. The maximum allowable delay is, if the supervision function is selected, valid for all commands and setpoint commands.

Transmission of integrated totals

(station- or object-specific parameter, mark 'X' if function is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

- ☒ Mode A: Local freeze with spontaneous transmission
- ☐ Mode B: Local freeze with counter interrogation
- ☐ Mode C: Freeze and transmit by counter interrogation commands
- ☐ Mode D: Freeze by counter interrogation command, frozen values reported spontaneously

- ☐ Counter read
- ☒ Counter freeze without reset
- ☐ Counter freeze with reset
- ☐ Counter reset

- ☒ General request counter
- ☐ Request counter group 1
- ☐ Request counter group 2
- ☐ Request counter group 3
- ☐ Request counter group 4

Parameter loading

(object-specific parameter, mark 'X' if function is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

- ☒ Threshold value
- ☐ Smoothing factor
- ☐ Low limit for transmission of measured value
- ☐ High limit for transmission of measured value

Parameter activation

(object-specific parameter, mark 'X' if function is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

- ☐ Act/deact of persistent cyclic or periodic transmission of the addressed object

Test procedure

(station-specific parameter, mark 'X' if function is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

- ☐ Test procedure

File transfer

(station-specific parameter, mark '**X**' if function is used)

File transfer in monitor direction

- ☐ Transparent file
- ☐ Transmission of disturbance data of protection equipment
- ☐ Transmission of sequences of events
- ☐ Transmission of sequences of recorded analogue values

File transfer in control direction

- ☐ Transparent file

Background scan

(station-specific parameter, mark '**X**' if function is only used in the standard direction, '**R**' if only used in the reverse direction, and '**B**' if used in both directions)

- ☐ Background scan

Acquisition of transmission delay

(station-specific parameter, mark '**X**' if function is only used in the standard direction, '**R**' if only used in the reverse direction, and '**B**' if used in both directions)

- ☒ Acquisition of transmission delay

Definition of time outs

Parameter	Default value	Remarks	Selected value
t_0	30 s	Time out of connection establishment	
t_1	15 s	Time out of send or test APDUs	
t_2	10 s	Time out for acknowledges in case of no data messages $t_2 < t_1$	
t_3	20 s	Time out for sending test frames in case of a long idle state	

Maximum range of values for timeouts t_0 to t_2 : (1 to 255) s, accuracy 1 s.

Recommended range for timeout t_3 : 1 s to 48 h, resolution 1 s.

Long timeouts for t_3 may be needed in special cases where satellite links or dialup connections are used (for instance to establish connection and collect values only once per day or week).

Maximum number of outstanding I format APDUs k and latest acknowledge

Parameter	Default value	Remarks	Selected value
k	12 APDUs	Maximum difference receive sequence number to send state variable	
w	8 APDUs	Latest acknowledge after receiving w I-format APDUs	

Maximum range of values k: 1 to 32 767 ($2^{15}-1$) APDUs, accuracy 1 APDU

Maximum range of values w: 1 to 32 767 APDUs, accuracy 1 APDU (Recommendation: w should not exceed two-thirds of k).

Portnumber

Parameter	Value	Remarks
Portnumber	2 404	In all cases

Redundant connections

☐ Number N of redundancy group connections used

RFC 2200 suite

RFC 2200 is an official Internet Standard which describes the state of standardization of protocols used in the Internet as determined by the Internet Architecture Board (IAB). It offers a broad spectrum of actual standards used in the Internet. The suitable selection of documents from RFC 2200 defined in this standard for given projects has to be chosen by the user of IEC 60870-5-104.

- ☒ Ethernet 802.3
☐ Serial X.21 interface
☐ Other selection from RFC 2200:

List of valid documents from RFC 2200

1.
2.
3.
4.
5.
6.
- etc.

Annex A

(informative)

Use of SCL (substation configuration language) to include IEC 60870-5-101 or IEC 60870-5-104 information

The SCL (substation configuration language) files include all the information needed to configure IEDs, communication networks and substation topologies. The elements described in this file format can also be used to define the information model of a complete wind power plant. In this annex, only the elements of the SCL file needed to link the process information model with the IEC 60870-5-101 or IEC 60870-5-104 addressing information are described. Apart from that, configuration and descriptive information that is not interchanged by communication means can be described inside the SCL file so both sides in the communication link can share this information.

NOTE The complete definition of the SCL language and its associated schema are defined inside IEC 61850-6.

The SCL file is a configuration file that shall be shared by both client and server. It reflects a contract that links the IEC 60870-5-101 or IEC 60870-5-104 addressing information to the LN and CDC-based information model so both sides are able to know the reference and "meaning" of any data interchanged. The SCL file shall typically be stored at the server and be accessible to clients. The content shall reflect the latest configured information.

The SCL file is described in a XML format so it can be easily interpreted and transformed. Its schema restricts the information allowed and it assures that its information can be processed by different tools.

This annex describes how the IEC 60870-5-101 or IEC 60870-5-104 addressing information can be linked with the LN and CDC-based information model using the substation configuration language (SCL). Three different approaches to hold the IEC 60870-5-101 or IEC 60870-5-104 information inside the SCL files have been analyzed:

- the use of the "sAddr" attribute of the "DAI" element;
- the extension of the "DAI" element including new attributes using a different namespace;
- the use of "private" sections.

The approach selected is based on the definition of a specific syntax to be used inside a private section. The reasons to select this alternative are the following.

- The "sAddr" attribute is an implementation specific attribute whose syntax is vendor specific. The use of this attribute to hold IEC 60870-5-101 or IEC 60870-5-104 information might alter current implementations using this attribute.
- The use of new namespaces have as a drawback that they are not maintained by IED or substation configuration tools, so this information could be lost if different tools are used.
- The syntax of private sections is not defined and the configuration tools shall ensure its persistence. The syntax used inside the private section has been defined so this information could be interpreted unambiguously by different tools.

A.1 SCL information model hierarchy

A.1.1 General

The SCL file includes five top-level elements: header, substation, communication, IED and DataTypeTemplates. The attributes related to IEC 60870-5-101 or IEC 60870-5-104 information are included inside mainly in the IED section, but also the DataTypeTemplates section is used to reduce the need to assign its type identifier to all the DAI elements of the information model.

A.1.2 Mapping of the common address of ASDU

The common address of ASDU (CASDU) can be assigned to any of the following elements in the SCL file: IED, LDevice, LN, LN0, DOI, SDI, DAI. In the case where more than one CASDU are defined in the hierarchy, the CASDU defined in the lower level shall be used. For instance, if there is one CASDU defined in the IED level, and there is a second definition in the LDevice level, the CASDU of all the elements below that logical device shall use the CASDU address specified at the LDevice element.

A.1.3 Mapping of the IOA (information object address)

The IOA shall be defined in the DAI level. The reason to include the IOA at the DAI level and not at the DOI level is that some CDCs need to map more than one of its attributes to different TIs and therefore need more than one IOA.

A.1.4 Mapping of the type identifiers (TI)

The type identifiers can be defined either at the DAI level or inside the DataTypeTemplates inside the DA (data attribute) or BDA (basic data attribute). If it is included in the DataTypeTemplates, all the instances (DAI) where this attribute is referenced shall use the type identifier specified in the templates.

In those cases where the type identifier is specified in the DAI level, this type ident shall be used independently from the DA/BDA definition.

A.2 Use of the SCL elements

A.2.1 General

The elements IED, LDevice, LN, DOI, SDI and DAI are used to create the information model hierarchy and the object references linked to the IEC 60870-5-101 or IEC 60870-5-104 addressing information.

The object reference shall be built as defined in Clause 19 of IEC 61850-7-2:2003:

LDName/LNName.DataName[.DataName[...]].DataAttributeName[.DAComponentName[....]]

NOTE The inner square brackets [...] indicate further recursive definitions of nested data attribute components.

A.2.2 IED

IED is the top-level element in the hierarchy. Its attribute “name” shall be used to create the LDName as specified inside IEC 61850-6.

A.2.3 AccessPoint

The AccessPoint links an IED with the SCL file “communication” section. It is not used to include IEC 60870-5-101 or IEC 60870-5-104 information.

A.2.4 Server

This is the element inside the IED that grants access to its information model expressed by the logical devices information. It is not used to include IEC 60870-5-101 or IEC 60870-5-104 information.

A.2.5 LDevice

The logical device represents the information model of a physical devices.

Its attribute “inst” is used to build the LDName part of the object reference related to the IEC 60870-5-101 or IEC 60870-5-104 information.

LDName = “name” attribute of IEDName element + “inst” attribute of LDevice element

A.2.6 LN

Its attributes, “prefix”, “InClass” and “InInst” define the logical node name (LNName) used to build the object reference related to the IEC 60870-5-101 or IEC 60870-5-104 information.

LNName = “prefix” + “InClass” + “InInst”

A.2.7 DOI

Data object instance. Its attribute “name” is used to build the object reference related to the IEC 60870-5-104 information.

A.2.8 SDI

Instantiated subdata: middle name part of a structured data name. Each element between the top-level DOI and the BasicType represented by the DAI element shall be assigned a SDI type element.

```

<DOI name="X">
  <SDI name="X">
    ...
    <SDI name="X">
      <DAI name="X" />
    </SDI>
    ...
  </SDI>
</DOI>

```

Its attribute “name” is used to build the object reference related to the IEC 60870-5-101 or IEC 60870-5-104 information.

A.2.9 DAI

DAI (data attribute instance) is the lowest element in the information model hierarchy. Its attribute “name” is used to build the object reference related to the IEC 60870-5-101 or IEC 60870-5-104 information.

The attributes “q” and “t” of a CDC are mapped to the same IOA as the DAI.

The ctlModel DAI shall be used to define the control model used.

Inside the hierarchy, the DAI element shall include a private section holding IEC 60870-5-101 or IEC 60870-5-104 related information. The reason to include the private section at the DAI level and not at the DOI level is that some CDCs need to map more than one of its attributes to different TIs and they need more than one IOA.

A.2.10 DA/BDA

DA (data attribute) or BDA (basic data attribute) are the lowest elements in the data type templates hierarchy.

Those elements may include a private section holding IEC 60870-5-101 or IEC 60870-5-104 related information. In that private section, only the definition of a type ident should be included.

A.2.11 Control model

Each controllable data class includes the mandatory attribute “ctlModel”. This attribute specifies the control services that must be used to operate that element. The values available are one of the following:

- 0 - status-only
- 1 - direct-with-normal-security
- 2 - sbo-with-normal-security
- 3 - direct-with-enhanced-security
- 4 - sbo-with-enhanced-security

In the SCL, the control model of each controllable object may be specified or not. This specification recommends the inclusion of the value of the control model used either in the IED section or the DataTypeTemplates section of the SCL.

Example of “ctlModel” definition in the DataTypeTemplate section:

```
<DA name="ctlModel" bType="Enum" type="ctlModel" fc="CF">  
    <Val>direct- with-normal-security</Val>  
  
</DA>
```

Example of “ctlModel” definition in the IED section:

```
<DAI name "ctlModel">  
    <Val>sbo-with-normal-security</Val>  
  
</DAI>
```

A.3 IEC 60870-5-101 or IEC 60870-5-104 private section syntax

A.3.1 General

The private sections may include two attributes named “source” and “type” to describe its content. The use of private sections to describe IEC 60870-5-101 or IEC 60870-5-104 information shall use the “type” attribute with the value “IEC_60870_5_101” or “IEC_60870_5_104”.

The content of the private section is described in the associated schema. Two different schemas have been defined.

A.3.2 IEC 60870-5-101 private section schema

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="http://www.iec.ch/61850-80-1/2007/SCL"
xmlns:xs="http://www.w3.org/2001/XMLSchema" xmlns="http://www.iec.ch/61850-80-1/2007/SCL" xmlns:IEC_60870_5_101="http://www.iec.ch/61850-80-1/2007/SCL" elementFormDefault="qualified"
attributeFormDefault="unqualified" finalDefault="extension" version="1.0">
  <xs:annotation>
    <xs:documentation xml:lang="en">COPYRIGHT IEC, 2007. Version 1.0.
Release.(Uncommented)
    </xs:documentation>
  </xs:annotation>
  <xs:simpleType name="enumUsedBy">
    <xs:restriction base="xs:string">
      <xs:enumeration value="controlled-station"/>
      <xs:enumeration value="controlling-station"/>
    </xs:restriction>
  </xs:simpleType>
  <xs:complexType name="tIEC_60870_5_101Address">
    <xs:attribute name="linkAddr" type="xs:unsignedInt" use="optional" />
    <xs:attribute name="casdu" type="xs:unsignedInt" use="optional" />
    <xs:attribute name="ioa" type="xs:unsignedInt" use="optional" />
    <xs:attribute name="ti" type="xs:unsignedInt" use="optional" />
    <xs:attribute name="usedBy" type="enumUsedBy" use="optional"
default="ControlledStation"/>
  </xs:complexType>
  <xs:element name="Address" type="tIEC_60870_5_101Address" minOccurs="0"
maxOccurs="unbounded" />
</xs:schema>
```

A.3.3 IEC 60870-5-104 Private section schema

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="http://www.iec.ch/61850-80-1/2007/SCL"
xmlns:xs="http://www.w3.org/2001/XMLSchema" xmlns="http://www.iec.ch/61850-80-1/2007/SCL" xmlns:IEC_60870_5_104="http://www.iec.ch/61850-80-1/2007/SCL" elementFormDefault="qualified"
attributeFormDefault="unqualified" finalDefault="extension" version="1.0">
  <xs:annotation>
    <xs:documentation xml:lang="en">COPYRIGHT IEC, 2007. Version 1.0.
Release.(Uncommented)
    </xs:documentation>
  </xs:annotation>
  <xs:simpleType name="enumUsedBy">
    <xs:restriction base="xs:string">
      <xs:enumeration value="controlled-station"/>
      <xs:enumeration value="controlling-station"/>
    </xs:restriction>
  </xs:simpleType>
  <xs:complexType name="tIEC_60870_5_104Address">
    <xs:attribute name="casdu" type="xs:unsignedInt" use="optional" />
```

```

        <xs:attribute name="ioa" type="xs:unsignedInt" use="optional" />
        <xs:attribute name="ti" type="xs:unsignedInt" use="optional" />
        <xs:attribute name="usedBy" type="enumUsedBy" use="optional"
default="ControlledStation"/>
    </xs:complexType>
    <xs:element name="Address" type="tIEC_60870_5_104Address" minOccurs="0"
maxOccurs="unbounded" />
</xs:schema>

```

A.3.4 Use of Private section examples

A.3.4.1 General

The Private section is included inside the “DAI” element. This clause shows examples how it shall be used.

The examples describe the use for IEC 60870-5-104 but these examples are valid for IEC 60870-5-101 as well, when **Private type="IEC_60870_5_101"** is used.

NOTE In the examples all the information has been included at the DAI level.

```

<DAI name="f">
    <Private type="IEC_60870_5_104">
        <IEC_60870_5_104:Address casdu="1" ioa="1010" ti="36"/>
    </Private>
</DAI>

```

A.3.4.2 SPS common data class example

```

<DOI name="SPS01">
    <DAI name="stVal">
        <Private type="IEC_60870_5_104">
            <IEC_60870_5_104:Address casdu="1" ioa="1010" ti="30"/>
        </Private>
    </DAI>
</DOI>

```

A.3.4.3 DPS common data class example

```

<DOI name="DPS01">
    <DAI name="stVal">
        <Private type="IEC_60870_5_104">
            <IEC_60870_5_104:Address casdu="1" ioa="1011" ti="31"/>
        </Private>
    </DAI>
</DOI>

```

A.3.4.4 INS common data class example

a) Using TI<35>

```

<DOI name="INS01">
    <DAI name="stVal">
        <Private type="IEC_60870_5_104">
            <IEC_60870_5_104:Address casdu="1" ioa="1011" ti="35"/>
        </Private>
    </DAI>
</DOI>

```

b) Using TI<33>

```
<DOI name="INS01">
  <DAI name="stVal">
    <Private type="IEC_60870_5_104">
      <IEC_60870_5_104:Address casdu="1" ioa="1011" ti="33"/>
    </Private>
  </DAI>
</DOI>
```

c) Using TI<30>

```
<DOI name="INS01">
  <DAI name="stVal">
    <Private type="IEC_60870_5_104">
      <IEC_60870_5_104:Address casdu="1" ioa="1011" ti="30"
expectedValue="3"/>
      <IEC_60870_5_104:Address casdu="1" ioa="1011" ti="30"
expectedValue="1" inverted="true"/>
    </Private>
  </DAI>
</DOI>
```

NOTE Details of the mapping of the attribute stVal of CDC INS onto TI<30> SPI are defined in Table 7.

A.3.4.5 ACT common data class example

a) Using TI<39>

```

<DOI name="ACT01">
  <DAI name="general">
    <Private type="IEC_60870_5_104">
      <IEC_60870_5_104:Address casdu="1" ioa="1013" ti="39"/>
    </Private>
  </DAI>
</DOI>

```

NOTE The ACT common data class attributes phsA, phsB, phsC, neut, t and q are also mapped to TI<39>.

b) Using multiple TI<30>

```

<DOI name="ACT01">
  <DAI name="general">
    <Private type="IEC_60870_5_104">
      <IEC_60870_5_104:Address casdu="1" ioa="1013" ti="30"/>
    </Private>
  </DAI>
  <DAI name="phsA">
    <Private type="IEC_60870_5_104">
      <IEC_60870_5_104:Address casdu="1" ioa="1014" ti="30"/>
    </Private>
  </DAI>
  <DAI name="phsB">
    <Private type="IEC_60870_5_104">
      <IEC_60870_5_104:Address casdu="1" ioa="1015" ti="30"/>
    </Private>
  </DAI>
  <DAI name="phsC">
    <Private type="IEC_60870_5_104">
      <IEC_60870_5_104:Address casdu="1" ioa="1016" ti="30"/>
    </Private>
  </DAI>
  <DAI name="neut">
    <Private type="IEC_60870_5_104">
      <IEC_60870_5_104:Address casdu="1" ioa="1017" ti="30"/>
    </Private>
  </DAI>
</DOI>

```

A.3.4.6 ACD common data class example

a) Using TI<40>

```

<DOI name="ACD01">
  <DAI name="general">
    <Private type="IEC_60870_5_104">
      <IEC_60870_5_104:Address casdu="1" ioa="1013" ti="40"/>
    </Private>
  </DAI>
</DOI>

```

NOTE The ACD common data class attributes phsA, phsB, phsC, neut, t and q are also mapped to TI<40>.

b) Using multiple TI<30>

```

<DOI name="ACD01">
  <DAI name="general">
    <Private type="IEC_60870_5_104">
      <IEC_60870_5_104:Address casdu="1" ioa="1013" ti="30"/>
    </Private>
  </DAI>
  <DAI name="dirGeneral">
    <Private type="IEC_60870_5_104">
      <IEC_60870_5_104:Address casdu="1" ioa="1014" ti="30"/>
      <IEC_60870_5_104:Address casdu="1" ioa="1015" ti="30"/>
      <IEC_60870_5_104:Address casdu="1" ioa="1016" ti="30"/>
      <IEC_60870_5_104:Address casdu="1" ioa="1017" ti="30"/>
    </Private>
  </DAI>
  <DAI name="phsA">
    <Private type="IEC_60870_5_104">
      <IEC_60870_5_104:Address casdu="1" ioa="1018" ti="30"/>
    </Private>
  </DAI>
  <DAI name="dirPhsA">
    <Private type="IEC_60870_5_104">
      <IEC_60870_5_104:Address casdu="1" ioa="1019" ti="30"/>
      <IEC_60870_5_104:Address casdu="1" ioa="1020" ti="30"/>
      <IEC_60870_5_104:Address casdu="1" ioa="1021" ti="30"/>
      <IEC_60870_5_104:Address casdu="1" ioa="1022" ti="30"/>
    </Private>
  </DAI>
  <DAI name="phsB">
    <Private type="IEC_60870_5_104">
      <IEC_60870_5_104:Address casdu="1" ioa="1023" ti="30"/>
    </Private>
  </DAI>
  <DAI name="dirPhsB">
    <Private type="IEC_60870_5_104">
      <IEC_60870_5_104:Address casdu="1" ioa="1024" ti="30"/>
      <IEC_60870_5_104:Address casdu="1" ioa="1025" ti="30"/>
      <IEC_60870_5_104:Address casdu="1" ioa="1026" ti="30"/>
      <IEC_60870_5_104:Address casdu="1" ioa="1027" ti="30"/>
    </Private>
  </DAI>
  <DAI name="phsC">
    <Private type="IEC_60870_5_104">
      <IEC_60870_5_104:Address casdu="1" ioa="1028" ti="30"/>
    </Private>
  </DAI>
  <DAI name="dirPhsC">
    <Private type="IEC_60870_5_104">
      <IEC_60870_5_104:Address casdu="1" ioa="1029" ti="30"/>
      <IEC_60870_5_104:Address casdu="1" ioa="1030" ti="30"/>
      <IEC_60870_5_104:Address casdu="1" ioa="1031" ti="30"/>
      <IEC_60870_5_104:Address casdu="1" ioa="1032" ti="30"/>
    </Private>
  </DAI>

```

```

    </Private>
</DAI>
  <DAI name="neut">
    <Private type="IEC_60870_5_104">
      <IEC_60870_5_104:Address casdu="1" ioa="1033" ti="30"/>
    </Private>
  </DAI>
  <DAI name="dirNeut">
    <Private type="IEC_60870_5_104">
      <IEC_60870_5_104:Address casdu="1" ioa="1034" ti="30"/>
      <IEC_60870_5_104:Address casdu="1" ioa="1035" ti="30"/>
      <IEC_60870_5_104:Address casdu="1" ioa="1036" ti="30"/>
      <IEC_60870_5_104:Address casdu="1" ioa="1037" ti="30"/>
    </Private>
  </DAI>
</DOI>

```

NOTE The ACD common data class attributes t, q maps to each TI<30>.

c) Using TI<35>

```

<DOI name="ACD01">
  <DAI name="general">
    <Private type="IEC_60870_5_104">
      <IEC_60870_5_104:Address casdu="1" ioa="1013" ti="30"/>
    </Private>
  </DAI>
  <DAI name="dirGeneral">
    <Private type="IEC_60870_5_104">
      <IEC_60870_5_104:Address casdu="1" ioa="2013" ti="35"/>
    </Private>
  </DAI>
  <DAI name="phsA">
    <Private type="IEC_60870_5_104">
      <IEC_60870_5_104:Address casdu="1" ioa="1014" ti="30"/>
    </Private>
  </DAI>
  <DAI name="dirPhsA">
    <Private type="IEC_60870_5_104">
      <IEC_60870_5_104:Address casdu="1" ioa="2014" ti="35"/>
    </Private>
  </DAI>
  <DAI name="phsB">
    <Private type="IEC_60870_5_104">
      <IEC_60870_5_104:Address casdu="1" ioa="1015" ti="30"/>
    </Private>
  </DAI>
  <DAI name="dirPhsB">
    <Private type="IEC_60870_5_104">
      <IEC_60870_5_104:Address casdu="1" ioa="2015" ti="35"/>
    </Private>
  </DAI>
  <DAI name="phsC">
    <Private type="IEC_60870_5_104">

```

```

        <IEC_60870_5_104:Address casdu="1" ioa="1016" ti="30"/>
    </Private>
</DAI>
<DAI name="dirPhsC">
    <Private type="IEC_60870_5_104">
        <IEC_60870_5_104:Address casdu="1" ioa="2016" ti="35"/>
    </Private>
</DAI>
<DAI name="neut">
    <Private type="IEC_60870_5_104">
        <IEC_60870_5_104:Address casdu="1" ioa="1017" ti="30"/>
    </Private>
</DAI>
<DAI name="dirNeut">
    <Private type="IEC_60870_5_104">
        <IEC_60870_5_104:Address casdu="1" ioa="2017" ti="35"/>
    </Private>
</DAI>
</DOI>

```

A.3.4.7 SEC common data class example

```

<DOI name="SEC01">
    <DAI name="cnt">
        <Private type="IEC_60870_5_104">
            <IEC_60870_5_104:Address casdu="1" ioa="1010" ti="37"/>
        </Private>
    </DAI>
</DOI>

```

NOTE The attribute "t" of the CDC SEC is mapped to the same IOA.

A.3.4.8 BCR common data class example

```

<DOI name="BCR01">
    <DAI name="actVal">
        <Private type="IEC_60870_5_104">
            <IEC_60870_5_104:Address casdu="1" ioa="1010" ti="37"/>
        </Private>
    </DAI>
    <DAI name="frVal">
        <Private type="IEC_60870_5_104">
            <IEC_60870_5_104:Address casdu="1" ioa="1011" ti="37"/>
        </Private>
    </DAI>
</DOI>

```

NOTE The attribute "t" of the CDC BCR is mapped to the same IOA as actVal. The attribute "frTm" of the CDC BCR is mapped to the same IOA as frVal.

A.3.4.9 MV common data class example

a) Using TI<36>

```

<DOI name="MV01">
  <SDI name="mag">
    <DAI name="f">
      <Private type="IEC_60870_5_104">
        <IEC_60870_5_104:Address casdu="1" ioa="1010" ti="36"/>
      </Private>
    </DAI>
  </SDI>
</DOI>

```

b) Using<TI 35>

```

<DOI name="MV01">
  <SDI name="mag">
    <DAI name="i">
      <Private type="IEC_60870_5_104">
        <IEC_60870_5_104:Address casdu="1" ioa="1010" ti="35"/>
      </Private>
    </DAI>
  </SDI>
</DOI>

```

A.3.4.10 CMV common data class example

a) Using TI<36>

```

<DOI name="CMV01">
  <SDI name="cVal">
    <SDI name="mag">
      <DAI name="f">
        <Private type="IEC_60870_5_104">
          <IEC_60870_5_104:Address casdu="1" ioa="1010" ti="36"/>
        </Private>
      </DAI>
    </SDI>
  <SDI name="ang">
    <DAI name="f">
      <Private type="IEC_60870_5_104">
        <IEC_60870_5_104:Address casdu="1" ioa="1011" ti="36"/>
      </Private>
    </DAI>
  </SDI>
</SDI>
</DOI>

```

a) Using TI<35>

```

<DOI name="CMV01">
  <SDI name="cVal">
    <SDI name="mag">
      <DAI name="i">
        <Private type="IEC_60870_5_104">
          <IEC_60870_5_104:Address casdu="1" ioa="1010" ti="35"/>
        </Private>
      </DAI>
    </SDI>
    <SDI name="ang">
      <DAI name="i">
        <Private type="IEC_60870_5_104">
          <IEC_60870_5_104:Address casdu="1" ioa="1011" ti="35"/>
        </Private>
      </DAI>
    </SDI>
  </SDI>
</DOI>

```

A.3.4.11 WYE common data class example

```

<DOI name="WYE01">
  <SDI name="phsA">
    <SDI name="cVal">
      <SDI name="mag">
        <DAI name="f">
          <Private type="IEC_60870_5_104">
            <IEC_60870_5_104:Address casdu="1" ioa="1010" ti="36"/>
          </Private>
        </DAI>
      </SDI>
    </SDI>
  </SDI>
  <SDI name="phsB">
    <SDI name="cVal">
      <SDI name="mag">
        <DAI name="f">
          <Private type="IEC_60870_5_104">
            <IEC_60870_5_104:Address casdu="1" ioa="1011" ti="36"/>
          </Private>
        </DAI>
      </SDI>
    </SDI>
  </SDI>
  <SDI name="phsC">
    <SDI name="cVal">
      <SDI name="mag">
        <DAI name="f">
          <Private type="IEC_60870_5_104">
            <IEC_60870_5_104:Address casdu="1" ioa="1012" ti="36"/>
          </Private>
        </DAI>
      </SDI>
    </SDI>
  </SDI>

```

```
        </DAI>
      </SDI>
    </SDI>
  </SDI>
  <SDI name="neut">
    <SDI name="cVal">
      <SDI name="mag">
        <DAI name="f">
          <Private type="IEC_60870_5_104">
            <IEC_60870_5_104:Address casdu="1" ioa="1013" ti="36"/>
          </Private>
        </DAI>
      </SDI>
    </SDI>
  </SDI>
  <SDI name="net">
    <SDI name="cVal">
      <SDI name="mag">
        <DAI name="f">
          <Private type="IEC_60870_5_104">
            <IEC_60870_5_104:Address casdu="1" ioa="1014" ti="36"/>
          </Private>
        </DAI>
      </SDI>
    </SDI>
  </SDI>
  <SDI name="res">
    <SDI name="cVal">
      <SDI name="mag">
        <DAI name="f">
          <Private type="IEC_60870_5_104">
            <IEC_60870_5_104:Address casdu="1" ioa="1015" ti="36"/>
          </Private>
        </DAI>
      </SDI>
    </SDI>
  </SDI>
</DOI>
```

A.3.4.12 DEL common data class example

```

<DOI name="DEL01">
  <SDI name="phsAB">
    <SDI name="cVal">
      <SDI name="mag">
        <DAI name="f">
          <Private type="IEC_60870_5_104">
            <IEC_60870_5_104:Address casdu="1" ioa="1010" ti="36"/>
          </Private>
        </DAI>
      </SDI>
    </SDI>
  </SDI>
  <SDI name="phsBC">
    <SDI name="cVal">
      <SDI name="mag">
        <DAI name="f">
          <Private type="IEC_60870_5_104">
            <IEC_60870_5_104:Address casdu="1" ioa="1011" ti="36"/>
          </Private>
        </DAI>
      </SDI>
    </SDI>
  </SDI>
  <SDI name="phsCA">
    <SDI name="cVal">
      <SDI name="mag">
        <DAI name="f">
          <Private type="IEC_60870_5_104">
            <IEC_60870_5_104:Address casdu="1" ioa="1012" ti="36"/>
          </Private>
        </DAI>
      </SDI>
    </SDI>
  </SDI>
</DOI>

```

A.3.4.13 SEQ common data class example

```

<DOI name="SEQ01">
  <SDI name="c1">
    <SDI name="cVal">
      <SDI name="mag">
        <DAI name="f">
          <Private type="IEC_60870_5_104">
            <IEC_60870_5_104:Address casdu="1" ioa="1010" ti="36"/>
          </Private>
        </DAI>
      </SDI>
    </SDI>
  </SDI>
</DOI>

```

```

<SDI name="c2">
  <SDI name="cVal">
    <SDI name="mag">
      <DAI name="f">
        <Private type="IEC_60870_5_104">
          <IEC_60870_5_104:Address casdu="1" ioa="1011" ti="36"/>
        </Private>
      </DAI>
    </SDI>
  </SDI>
</SDI>
<SDI name="c3">
  <SDI name="cVal">
    <SDI name="mag">
      <DAI name="f">
        <Private type="IEC_60870_5_104">
          <IEC_60870_5_104:Address casdu="1" ioa="1012" ti="36"/>
        </Private>
      </DAI>
    </SDI>
  </SDI>
</SDI>
</DOI>

```

A.3.4.14 H MV common data class example

This example shows the use of SCL for two harmonic values. If more than two harmonic values are present, an SDI section has to be created for each harmonic.

```

<DOI name="H MV01">
  <SDI name="har" ix="0">
    <SDI name="cVal">
      <SDI name="mag">
        <DAI name="f">
          <Private type="IEC_60870_5_104">
            <IEC_60870_5_104:Address casdu="1" ioa="1010" ti="36"/>
          </Private>
        </DAI>
      </SDI>
    </SDI>
  </SDI>
  <SDI name="har" ix="1">
    <SDI name="cVal">
      <SDI name="mag">
        <DAI name="f">
          <Private type="IEC_60870_5_104">
            <IEC_60870_5_104:Address casdu="1" ioa="1011" ti="36"/>
          </Private>
        </DAI>
      </SDI>
    </SDI>
  </SDI>
  <SDI name="har" ix="2">

```

```

    <SDI name="cVal">
      <SDI name="mag">
        <DAI name="f">
          <Private type="IEC_60870_5_104">
            <IEC_60870_5_104:Address casdu="1" ioa="1012" ti="36"/>
          </Private>
        </DAI>
      </SDI>
    </SDI>
  </SDI>
</DOI>

```

A.3.4.15 HWYE common data class example

```

<DOI name="HWYE01">
  <SDI name="phsAHar" ix="0">
    <SDI name="cVal">
      <SDI name="mag">
        <DAI name="f">
          <Private type="IEC_60870_5_104">
            <IEC_60870_5_104:Address casdu="1" ioa="1010" ti="36"/>
          </Private>
        </DAI>
      </SDI>
    </SDI>
  </SDI>
  <SDI name="phsAHar" ix="1">
    <SDI name="cVal">
      <SDI name="mag">
        <DAI name="f">
          <Private type="IEC_60870_5_104">
            <IEC_60870_5_104:Address casdu="1" ioa="1011" ti="36"/>
          </Private>
        </DAI>
      </SDI>
    </SDI>
  </SDI>
  <SDI name="phsBHar" ix="0">
    <SDI name="cVal">
      <SDI name="mag">
        <DAI name="f">
          <Private type="IEC_60870_5_104">
            <IEC_60870_5_104:Address casdu="1" ioa="1012" ti="36"/>
          </Private>
        </DAI>
      </SDI>
    </SDI>
  </SDI>
  <SDI name="phsBHar" ix="1">
    <SDI name="cVal">
      <SDI name="mag">
        <DAI name="f">

```

```

        <Private type="IEC_60870_5_104">
            <IEC_60870_5_104:Address casdu="1" ioa="1013" ti="36"/>
        </Private>
    </DAI>
</SDI>
</SDI>
</SDI>
</DOI>

```

A.3.4.16 HDEL common data class example

This example shows the use of SCL for two harmonic values for each "delta". If more than two harmonic values are present, an SDI section has to be created for each harmonic.

```

<DOI name="HDEL01">
    <SDI name="phsABHar" ix="0">
        <SDI name="cVal">
            <SDI name="mag">
                <DAI name="f">
                    <Private type="IEC_60870_5_104">
                        <IEC_60870_5_104:Address casdu="1" ioa="1010" ti="36"/>
                    </Private>
                </DAI>
            </SDI>
        </SDI>
    </SDI>
    <SDI name="phsABHar" ix="1">
        <SDI name="cVal">
            <SDI name="mag">
                <DAI name="f">
                    <Private type="IEC_60870_5_104">
                        <IEC_60870_5_104:Address casdu="1" ioa="1011" ti="36"/>
                    </Private>
                </DAI>
            </SDI>
        </SDI>
    </SDI>
    <SDI name="phsBCHar" ix="0">
        <SDI name="cVal">
            <SDI name="mag">
                <DAI name="f">
                    <Private type="IEC_60870_5_104">
                        <IEC_60870_5_104:Address casdu="1" ioa="1012" ti="36"/>
                    </Private>
                </DAI>
            </SDI>
        </SDI>
    </SDI>
    <SDI name="phsBCHar" ix="1">
        <SDI name="cVal">
            <SDI name="mag">
                <DAI name="f">
                    <Private type="IEC_60870_5_104">
                        <IEC_60870_5_104:Address casdu="1" ioa="1013" ti="36"/>
                    </Private>
                </DAI>
            </SDI>
        </SDI>
    </SDI>

```

```

        </Private>
      </DAI>
    </SDI>
  </SDI>
</SDI>
<SDI name="phsCAHar" ix="0">
  <SDI name="cVal">
    <SDI name="mag">
      <DAI name="f">
        <Private type="IEC_60870_5_104">
          <IEC_60870_5_104:Address casdu="1" ioa="1014" ti="36"/>
        </Private>
      </DAI>
    </SDI>
  </SDI>
</SDI>
<SDI name="phsCAHar" ix="1">
  <SDI name="cVal">
    <SDI name="mag">
      <DAI name="f">
        <Private type="IEC_60870_5_104">
          <IEC_60870_5_104:Address casdu="1" ioa="1015" ti="36"/>
        </Private>
      </DAI>
    </SDI>
  </SDI>
</SDI>
</DOI>

```

A.3.4.17 SPC common data class example

a) If IEC 61850-8-1 extension is not used.

1) for IEC 60870-5-101:

```

<DOI name="SPC01">
  <DAI name="stVal">
    <Private type="IEC_60870_5_101">
      <IEC_60870_5_101:Address casdu="1" ioa="1010" ti="30"/>
    </Private>
  </DAI>
  <DAI name="ctlVal">
    <Private type="IEC_60870_5_101">
      <IEC_60870_5_101:Address casdu="1" ioa="1011" ti="45"/>
    </Private>
  </DAI>
</DOI>

```

2) for IEC 60870-5-104:

```

<DOI name="SPC01">
  <DAI name="stVal">
    <Private type="IEC_60870_5_104">
      <IEC_60870_5_104:Address casdu="1" ioa="1010" ti="30"/>
    </Private>

```

```

    </DAI>
    <DAI name="ctlVal">
      <Private type="IEC_60870_5_104">
        <IEC_60870_5_104:Address casdu="1" ioa="1011" ti="58"/>
      </Private>
    </DAI>
  </DOI>

```

b) If IEC 61850-8-1 extension is used.

1) for IEC 60870-5-101:

```

<DOI name="SPC01">
  <DAI name="stVal">
    <Private type="IEC_60870_5_101">
      <IEC_60870_5_101:Address casdu="1" ioa="1010" ti="30"/>
    </Private>
  </DAI>
  <SDI name="Oper">
    <DAI name="ctlVal">
      <Private type="IEC_60870_5_101">
        <IEC_60870_5_101:Address casdu="1" ioa="1011" ti="45"/>
      </Private>
    </DAI>
  </SDI>
</DOI>

```

2) for IEC 60870-5-104:

```

<DOI name="SPC01">
  <DAI name="stVal">
    <Private type="IEC_60870_5_104">
      <IEC_60870_5_104:Address casdu="1" ioa="1010" ti="30"/>
    </Private>
  </DAI>
  <SDI name="Oper">
    <DAI name="ctlVal">
      <Private type="IEC_60870_5_104">
        <IEC_60870_5_104:Address casdu="1" ioa="1011" ti="58"/>
      </Private>
    </DAI>
  </SDI>
</DOI>

```

A.3.4.18 DPC common data class example

a) If IEC 61850-8-1 extension is not used.

1) for IEC 60870-5-101:

```

<DOI name="DPC01">
  <DAI name="stVal">

```

```

    <Private type="IEC_60870_5_101">
      <IEC_60870_5_101:Address casdu="1" ioa="1010" ti="31"/>
    </Private>
  </DAI>
  <DAI name="ctlVal">
    <Private type="IEC_60870_5_101">
      <IEC_60870_5_101:Address casdu="1" ioa="1011" ti="46"/>
    </Private>
  </DAI>
</DOI>

```

2) for IEC 60870-5-104:

```

<DOI name="DPC01">
  <DAI name="stVal">
    <Private type="IEC_60870_5_104">
      <IEC_60870_5_104:Address casdu="1" ioa="1010" ti="31"/>
    </Private>
  </DAI>
  <DAI name="ctlVal">
    <Private type="IEC_60870_5_104">
      <IEC_60870_5_104:Address casdu="1" ioa="1011" ti="59"/>
    </Private>
  </DAI>
</DOI>

```

b) If IEC 61850-8-1 extension is used.

1) for IEC 60870-5-101:

```

<DOI name="DPC01">
  <DAI name="stVal">
    <Private type="IEC_60870_5_101">
      <IEC_60870_5_101:Address casdu="1" ioa="1010" ti="31"/>
    </Private>
  </DAI>
  <SDI name="Oper">
    <DAI name="ctlVal">
      <Private type="IEC_60870_5_101">
        <IEC_60870_5_101:Address casdu="1" ioa="1011" ti="46"/>
      </Private>
    </DAI>
  </SDI>
</DOI>

```

2) for IEC 60870-5-104:

```

<DOI name="DPC01">
  <DAI name="stVal">
    <Private type="IEC_60870_5_104">
      <IEC_60870_5_104:Address casdu="1" ioa="1010" ti="31"/>
    </Private>
  </DAI>
  <SDI name="Oper">

```

```

    <DAI name="ctlVal">
      <Private type="IEC_60870_5_104">
        <IEC_60870_5_104:Address casdu="1" ioa="1011" ti="59"/>
      </Private>
    </DAI>
  </SDI>
</DOI>

```

A.3.4.19 INC common data class example

a) If IEC 61850-8-1 extension is not used.

1) for IEC 60870-5-101:

```

<DOI name="INC01">
  <DAI name="stVal">
    <Private type="IEC_60870_5_101">
      <IEC_60870_5_101:Address casdu="1" ioa="1010" ti="35"/>
    </Private>
  </DAI>
  <DAI name="ctlVal">
    <Private type="IEC_60870_5_101">
      <IEC_60870_5_101:Address casdu="1" ioa="1011" ti="49"/>
    </Private>
  </DAI>
</DOI>

```

2) for IEC 60870-5-104:

```

<DOI name="INC01">
  <DAI name="stVal">
    <Private type="IEC_60870_5_104">
      <IEC_60870_5_104:Address casdu="1" ioa="1010" ti="35"/>
    </Private>
  </DAI>
  <DAI name="ctlVal">
    <Private type="IEC_60870_5_104">
      <IEC_60870_5_104:Address casdu="1" ioa="1011" ti="62"/>
    </Private>
  </DAI>
</DOI>

```

b) If IEC 61850-8-1 extension is used.

1) for IEC 60870-5-101:

```

<DOI name="INC01">
  <DAI name="stVal">
    <Private type="IEC_60870_5_101">
      <IEC_60870_5_101:Address casdu="1" ioa="1010" ti="35"/>
    </Private>
  </DAI>
  <SDI name="Oper">
    <DAI name="ctlVal">

```

```

    <Private type="IEC_60870_5_101">
        <IEC_60870_5_101:Address casdu="1" ioa="1011" ti="49"/>
    </Private>
</DAI>
</SDI>
</DOI>

```

2) for IEC 60870-5-104:

```

<DOI name="INC01">
    <DAI name="stVal">
        <Private type="IEC_60870_5_104">
            <IEC_60870_5_104:Address casdu="1" ioa="1010" ti="35"/>
        </Private>
    </DAI>
    <SDI name="Oper">
        <DAI name="ctlVal">
            <Private type="IEC_60870_5_104">
                <IEC_60870_5_104:Address casdu="1" ioa="1011" ti="62"/>
            </Private>
        </DAI>
    </SDI>
</DOI>

```

A.3.4.20 BSC common data class example

a) If IEC 61850-8-1 extension is not used.

1) for IEC 60870-5-101:

```

<DOI name="BSC01">
    <SDI name="valWTr">
        <DAI name="posVal">
            <Private type="IEC_60870_5_101">
                <IEC_60870_5_101:Address casdu="1" ioa="1010" ti="32"/>
            </Private>
        </DAI>
    </SDI>
    <DAI name="ctlVal">
        <Private type="IEC_60870_5_101">
            <IEC_60870_5_101:Address casdu="1" ioa="1011" ti="47"/>
        </Private>
    </DAI>
</DOI>

```

2) for IEC 60870-5-104:

```

<DOI name="BSC01">
    <SDI name=" valWTr">
        <DAI name="posVal">
            <Private type="IEC_60870_5_104">
                <IEC_60870_5_104:Address casdu="1" ioa="1010" ti="32"/>
            </Private>

```

```

    </DAI>
  </SDI>
  <DAI name="ctlVal">
    <Private type="IEC_60870_5_104">
      <IEC_60870_5_104:Address casdu="1" ioa="1011" ti="60"/>
    </Private>
  </DAI>
</DOI>

```

b) If IEC 61850-8-1 extension is used.

1) for IEC 60870-5-101:

```

<DOI name="BSC01">
  <SDI name="valWTr">
    <DAI name="posVal">
      <Private type="IEC_60870_5_101">
        <IEC_60870_5_101:Address casdu="1" ioa="1010" ti="32"/>
      </Private>
    </DAI>
  </SDI>
  <SDI name="Oper">
    <DAI name="ctlVal">
      <Private type="IEC_60870_5_101">
        <IEC_60870_5_101:Address casdu="1" ioa="1011" ti="47"/>
      </Private>
    </DAI>
  </SDI>
</DOI>

```

2) for IEC 60870-5-104:

```

<DOI name="BSC01">
  <SDI name="valWTr">
    <DAI name="posVal">
      <Private type="IEC_60870_5_104">
        <IEC_60870_5_104:Address casdu="1" ioa="1010" ti="32"/>
      </Private>
    </DAI>
  </SDI>
  <SDI name="Oper">
    <DAI name="ctlVal">
      <Private type="IEC_60870_5_104">
        <IEC_60870_5_104:Address casdu="1" ioa="1011" ti="60"/>
      </Private>
    </DAI>
  </SDI>
</DOI>

```

A.3.4.21 ISC common data class example

a) If IEC 61850-8-1 extension is not used.

1) for IEC 60870-5-101:

```
<DOI name="ISC01">
  <SDI name="valWTr">
    <DAI name="posVal">
      <Private type="IEC_60870_5_101">
        <IEC_60870_5_101:Address casdu="1" ioa="1010" ti="32"/>
      </Private>
    </DAI>
  </SDI>
  <DAI name="ctlVal">
    <Private type="IEC_60870_5_101">
      <IEC_60870_5_101:Address casdu="1" ioa="1011" ti="49"/>
    </Private>
  </DAI>
</DOI>
```

2) for IEC 60870-5-104:

```
<DOI name="ISC01">
  <SDI name=" valWTr">
    <DAI name="posVal">
      <Private type="IEC_60870_5_104">
        <IEC_60870_5_104:Address casdu="1" ioa="1010" ti="32"/>
      </Private>
    </DAI>
  </SDI>
  <DAI name="ctlVal">
    <Private type="IEC_60870_5_104">
      <IEC_60870_5_104:Address casdu="1" ioa="1011" ti="62"/>
    </Private>
  </DAI>
</DOI>
```

b) If IEC 61850-8-1 extension is used.

1) for IEC 60870-5-101:

```
<DOI name="ISC01">
  <SDI name=" valWTr">
    <DAI name="posVal">
      <Private type="IEC_60870_5_101">
        <IEC_60870_5_101:Address casdu="1" ioa="1010" ti="32"/>
      </Private>
    </DAI>
  </SDI>
  <SDI name="Oper">
    <DAI name="ctlVal">
      <Private type="IEC_60870_5_101">
        <IEC_60870_5_101:Address casdu="1" ioa="1011" ti="49"/>
      </Private>
    </DAI>
  </SDI>
</DOI>
```

```

    </Private>
  </DAI>
</SDI>
</DOI>

```

2) for IEC 60870-5-104:

```

<DOI name="ISC01">
  <SDI name="valWTr">
    <DAI name="posVal">
      <Private type="IEC_60870_5_104">
        <IEC_60870_5_104:Address casdu="1" ioa="1010" ti="32"/>
      </Private>
    </DAI>
  </SDI>
  <SDI name="Oper">
    <DAI name="ctlVal">
      <Private type="IEC_60870_5_104">
        <IEC_60870_5_104:Address casdu="1" ioa="1011" ti="62"/>
      </Private>
    </DAI>
  </SDI>
</DOI>

```

A.3.4.22 APC common data class example

a) If IEC 61850-8-1 extension is not used.

1) for IEC 60870-5-101:

```

<DOI name="APC01">
  <SDI name="setMag">
    <DAI name="f">
      <Private type="IEC_60870_5_101">
        <IEC_60870_5_101:Address casdu="1" ioa="1010" ti="36"/>
        <IEC_60870_5_101:Address casdu="1" ioa="1011" ti="50"/>
      </Private>
    </DAI>
  </SDI>
</DOI>

```

2) for IEC 60870-5-104:

```

<DOI name="APC01">
  <SDI name="setMag">
    <DAI name="f">
      <Private type="IEC_60870_5_104">
        <IEC_60870_5_104:Address casdu="1" ioa="1010" ti="36"/>
        <IEC_60870_5_104:Address casdu="1" ioa="1011" ti="63"/>
      </Private>
    </DAI>
  </SDI>

```

</DOI>

b) If IEC 61850-8-1 extension is used.

1) for IEC 60870-5-101:

```
<DOI name="APC01">
  <SDI name="setMag">
    <DAI name="f">
      <Private type="IEC_60870_5_101">
        <IEC_60870_5_101:Address casdu="1" ioa="1010" ti="36"/>
      </Private>
    </DAI>
  </SDI>
  <SDI name="Oper">
    <SDI name="setMag">
      <DAI name="f">
        <Private type="IEC_60870_5_101">
          <IEC_60870_5_101:Address casdu="1" ioa="1011" ti="50"/>
        </Private>
      </DAI>
    </SDI>
  </SDI>
</DOI>
```

2) for IEC 60870-5-104:

```
<DOI name="APC01">
  <SDI name="setMag">
    <DAI name="f">
      <Private type="IEC_60870_5_104">
        <IEC_60870_5_104:Address casdu="1" ioa="1010" ti="36"/>
      </Private>
    </DAI>
  </SDI>
  <SDI name="Oper">
    <SDI name="setMag">
      <DAI name="f">
        <Private type="IEC_60870_5_104">
          <IEC_60870_5_104:Address casdu="1" ioa="1011" ti="63"/>
        </Private>
      </DAI>
    </SDI>
  </SDI>
</DOI>
```

c) If mxVal is used and IEC 61850-8-1 extension is not used.

```
<DOI name="APC01">
  <SDI name="mxVal">
    <DAI name="f">
      <Private type="IEC_60870_5_104">
        <IEC_60870_5_104:Address casdu="1" ioa="1010" ti="36"/>
      </Private>
    </DAI>
  </SDI>
</DOI>
```

```

    </DAI>
  </SDI>
  <SDI name="ctlVal">
    <DAI name="f">
      <Private type="IEC_60870_5_104">
        <IEC_60870_5_104:Address casdu="1" ioa="1011" ti="50"/>
      </Private>
    </DAI>
  </SDI>
</DOI>

```

d) If mxVal is used and IEC 61850-8-1 extension used.

```

<DOI name="APC01">
  <SDI name="mxVal">
    <DAI name="f">
      <Private type="IEC_60870_5_104">
        <IEC_60870_5_104:Address casdu="1" ioa="1010" ti="36"/>
      </Private>
    </DAI>
  </SDI>
  <SDI name="Oper">
    <SDI name="ctlVal">
      <DAI name="f">
        <Private type="IEC_60870_5_104">
          <IEC_60870_5_104:Address casdu="1" ioa="1011" ti="50"/>
        </Private>
      </DAI>
    </SDI>
  </SDI>
</DOI>

```

A.3.4.23 SPG common data class example

a) for IEC 60870-5-101:

```

<DOI name="SPG01">
  <DAI name="setVal">
    <Private type="IEC_60870_5_101">
      <IEC_60870_5_101:Address casdu="1" ioa="1010" ti="45"/>
    </Private>
  </DAI>
</DOI>

```

b) for IEC 60870-5-104:

```

<DOI name="SPG01">
  <DAI name="setVal">
    <Private type="IEC_60870_5_104">
      <IEC_60870_5_104:Address casdu="1" ioa="1010" ti="58"/>
    </Private>
  </DAI>
</DOI>

```

A.3.4.24 ING common data class example

a) for IEC 60870-5-101:

```
<DOI name="ING01">
  <DAI name="setVal">
    <Private type="IEC_60870_5_101">
      <IEC_60870_5_101:Address casdu="1" ioa="1010" ti="49"/>
    </Private>
  </DAI>
</DOI>
```

b) for IEC 60870-5-104:

```
<DOI name="ING01">
  <DAI name="setVal">
    <Private type="IEC_60870_5_104">
      <IEC_60870_5_104:Address casdu="1" ioa="1010" ti="62"/>
    </Private>
  </DAI>
</DOI>
```

A.3.4.25 ASG common data class example

a) for IEC 60870-5-101:

```
<DOI name="ASG01">
  <SDI name="setMag">
    <DAI name="f">
      <Private type="IEC_60870_5_101">
        <IEC_60870_5_101:Address casdu="1" ioa="1010" ti="50"/>
      </Private>
    </DAI>
  </SDI>
</DOI>
```

b) for IEC 60870-5-104:

```
<DOI name="ASG01">
  <SDI name="setMag">
    <DAI name="f">
      <Private type="IEC_60870_5_104">
        <IEC_60870_5_104:Address casdu="1" ioa="1010" ti="63"/>
      </Private>
    </DAI>
  </SDI>
</DOI>
```

A.4 IEC 60870-5-101 communication parameters configuration using SCL

The communication section of the SCL file can be used to hold the IEC 60870-5-101 specific information about link parameters such as transmission speed, addresses and ASDU structure.

The controlling and controlled stations are linked using the same "SubNetwork" element of the SCL communication section. The "type" attribute shall be "101".

This information shall be kept inside the "P" type of the "Address" element of the SCL. Table A.1 defines the names of the parameters that can be used.

Table A.1 – Extension of the "P" element types to hold IEC 60870-5-101 information

P type attribute value	Description
StationType	Type of station (controlling-station, controlled-station)
NetworkConf	Network configuration (point-to-point, multiple-point-to-point, multipoint-partyline, multipoint-star)
LinkTransProc	Link transmission procedure (balanced, unbalanced)
PhysLayer	Standard of physical layer (V.24/V.28 , X.24/X.27)
SpeedMonDir	Link layer transmission speed in monitor direction
SpeedConDir	Link layer transmission speed in control direction
LinkAddrSize	Number of octets for link address
LinkAddr	Link address
FrameLength	Maximum length of link frame (in octets)
CASDUSize	Number of octets for CASDU
IOASize	Number of octets for IOA
COTSize	Number of octets for COT

An example of use of the SCL communication section for a balanced connection.

```
<Communication>
  <SubNetwork name="sub101-1" type="101">
    <ConnectedAP iedName="IED1" apName="AP1">
      <Address>
        <P type="StationType">controlling-station</P>
        <P type="NetworkConf">point-to-point</P>
        <P type="LinkTransProc">balanced</P>
        <P type="PhysLayer">V.24/V.28</P>
        <P type="SpeedMonDir">9600</P>
        <P type="SpeedConDir">4800</P>
        <P type="LinkAddrSize">1</P>
        <P type="FrameLength">64</P>
        <P type="CASDUSize">2</P>
        <P type="IOASize">3</P>
        <P type="COTSize">2</P>
      </Address>
    </ConnectedAP>
    <ConnectedAP iedName="IED2" apName="AP1">
      <Address>
        <P type="StationType">controlled-station</P>
        <P type="NetworkConf">point-to-point</P>
        <P type="LinkTransProc">balanced</P>
        <P type="PhysLayer">V.24/V.28</P>
        <P type="SpeedMonDir">4800</P>
```

```

        <P type="SpeedConDir">9600</P>
        <P type="LinkAddrSize">1</P>
        <P type="LinkAddr">5</P>
        <P type="FrameLength">64</P>
        <P type="CASDUSize">2</P>
        <P type="101IOASize">3</P>
        <P type="101COTSize">2</P>
    </Address>
</ConnectedAP>
</SubNetwork>
</Communication>

```

NOTE The term SubNetwork is used to define the link between the controlling and controlled station for IEC 60870-5-101 connections. Both devices include a ConnectedAP in the same SubNetwork. In order to communicate properly, both should include the same communication parameter values.

An example of use of the SCL communication section for an unbalanced multipoint-partyline connection.

```

<Communication>
  <SubNetwork name="sub101-1" type="101">
    <ConnectedAP iedName="IED1" apName="AP1">
      <Address>
        <P type="StationType">controlling-station</P>
        <P type="NetworkConf">point-to-point</P>
        <P type="LinkTransProc">balanced</P>
        <P type="PhysLayer">V.24/V.28</P>
        <P type="SpeedMonDir">9600</P>
        <P type="SpeedConDir">4800</P>
        <P type="LinkAddrSize">1</P>
        <P type="FrameLength">64</P>
        <P type="CASDUSize">2</P>
        <P type="IOASize">3</P>
        <P type="COTSize">2</P>
      </Address>
    </ConnectedAP>
    <ConnectedAP iedName="IED2" apName="AP1">
      <Address>
        <P type="StationType">controlled-station</P>
        <P type="NetworkConf">point-to-point</P>
        <P type="LinkTransProc">balanced</P>
        <P type="PhysLayer">V.24/V.28</P>
        <P type="SpeedMonDir">4800</P>
        <P type="SpeedConDir">9600</P>
        <P type="LinkAddrSize">1</P>
        <P type="LinkAddr">5</P>
        <P type="FrameLength">64</P>
        <P type="CASDUSize">2</P>
        <P type="101IOASize">3</P>
        <P type="101COTSize">2</P>
      </Address>
    </ConnectedAP>
    <ConnectedAP iedName="IED3" apName="AP1">

```

```

    <Address>
      <P type="StationType">controlled-station</P>
      <P type="NetworkConf">point-to-point</P>
      <P type="LinkTransProc">balanced</P>
      <P type="PhysLayer">V.24/V.28</P>
      <P type="SpeedMonDir">4800</P>
      <P type="SpeedConDir">9600</P>
      <P type="LinkAddrSize">1</P>
      <P type="LinkAddr">3</P>
      <P type="FrameLength">64</P>
      <P type="CASDUSize">2</P>
      <P type="101IOASize">3</P>
      <P type="101COTSize">2</P>
    </Address>
  </ConnectedAP>
</SubNetwork>
</Communication>

```

A.5 IEC 60870-5-104 communication parameters configuration using SCL

The communication section of the SCL file can be used to hold the IEC 60870-5-104 specific information about delays, addresses and communication ports.

The controlling and controlled stations are linked using the same "SubNetwork" element of the SCL communication section. The "type" attribute shall be "104".

This information shall be kept inside the "P" type of the "Address" element of the SCL. Table A.2 defines the names of the parameters that can be used if redundancy is not used.

Table A.2 – Extension of the "P" element types to hold IEC 60870-5-104 information

P type attribute value	Description
StationType	Type of station (controlling-station, controlled-station)
w-FACTOR	Value of the w parameter
k-FACTOR	Value of the k parameter
TIMEOUT-0	Time-out in seconds of connection establishment (t_0)
TIMEOUT-1	Time-out in seconds of sent or test APDUs (t_1)
TIMEOUT-2	Time-out in seconds for acknowledges in case of no data messages (t_2)
TIMEOUT-3	Time-out in seconds for sending test frames in case of a long idle state (t_3)

An example of use of the SCL communication section with one link and without redundancy is shown.

```

<Communication>
  <SubNetwork name="sub104-1" type="104">
    <ConnectedAP iedName="IED1" apName="AP1">
      <Address>
        <P type="StationType">controlling-station</P>
        <P type="IP">192.168.0.1</P>
        <P type="IP-SUBNET">255.255.255.0</P>
        <P type="w-FACTOR">8</P>
        <P type="k-FACTOR">12</P>
        <P type="TIMEOUT-0">30</P>
        <P type="TIMEOUT-1">15</P>
        <P type="TIMEOUT-2">10</P>
      </Address>
    </ConnectedAP>
  </SubNetwork>
</Communication>

```

```

        <P type="TIMEOUT-3">20</P>
      </Address>
    </ConnectedAP>
    <ConnectedAP iedName="IED2" apName="AP1">
      <Address>
        <P type="StationType">controlled-station</P>
        <P type="IP">192.168.0.51</P>
        <P type="IP-SUBNET">255.255.255.0</P>
        <P type="w-FACTOR">8</P>
        <P type="k-FACTOR">12</P>
        <P type="TIMEOUT-0">30</P>
        <P type="TIMEOUT-1">15</P>
        <P type="TIMEOUT-2">10</P>
        <P type="TIMEOUT-3">20</P>
      </Address>
    </ConnectedAP>
  </SubNetwork>
</Communication>

```

If redundancy groups are used, the IEC 60870-5-104 parameters shall be used as defined in Table A.3.

Table A.3 – Extension of the “P” element types using redundancy groups

P type attribute value	Description
RGx-LLy-IP	IP address of the logical link “y” of the redundancy group “x”
RGx-LLy-IP-SUBNET	Subnetwork mask of the IP address of the logical link “y” of the redundancy group “x”
RGx-w-FACTOR	W factor of the logical link “y” of the redundancy group “x”
RGx-k-FACTOR	K factor of the logical link “y” of the redundancy group “x”
RGx-TIMEOUT-0	Time-out 0 of the redundancy group “x”
RGx-TIMEOUT-1	Time-out 1 of the redundancy group “x”
RGx-TIMEOUT-2	Time-out 2 of the redundancy group “x”
RGx-TIMEOUT-3	Time-out 3 of the redundancy group “x”
NOTE “x” is the number of the redundancy group and “y” is the number of the logical link.	

An example of use of the SCL communication section with two redundancy groups, each redundancy group consisting of three logical links, is shown:

```

<Communication>
  <Subnetwork name="sub104-1" type="104">
    <ConnectedAP iedName="IED1" apName="AP1">
      <Address>
        <P type="StationType">controlling-station</P>
        <P type="RG1-w-FACTOR">8</P>
        <P type="RG1-k-FACTOR">12</P>
        <P type="RG1-TIMEOUT-0">30</P>
        <P type="RG1-TIMEOUT-1">15</P>
        <P type="RG1-TIMEOUT-2">10</P>
        <P type="RG1-TIMEOUT-3">20</P>
        <P type="RG1-LL1-IP">192.168.0.1</P>
        <P type="RG1-LL1-IP-SUBNET">255.255.255.0</P>
        <P type="RG1-LL2-IP">192.168.0.2</P>
        <P type="RG1-LL2-IP-SUBNET">255.255.255.0</P>
        <P type="RG1-LL3-IP">192.168.0.3</P>
      </Address>
    </ConnectedAP>
  </Subnetwork>
</Communication>

```

```

        <P type="RG1-LL3-IP-SUBNET">255.255.255.0</P>
        <P type="RG2-w-FACTOR">8</P>
        <P type="RG2-k-FACTOR">12</P>
        <P type="RG2-TIMEOUT-0">30</P>
        <P type="RG2-TIMEOUT-1">15</P>
        <P type="RG2-TIMEOUT-2">10</P>
        <P type="RG2-TIMEOUT-3">20</P>
        <P type="RG2-LL1-IP">192.168.0.11</P>
        <P type="RG2-LL1-IP-SUBNET">255.255.255.0</P>
        <P type="RG2-LL2-IP">192.168.0.12</P>
        <P type="RG2-LL2-IP-SUBNET">255.255.255.0</P>
        <P type="RG2-LL3-IP">192.168.0.13</P>
        <P type="RG2-LL3-IP-SUBNET">255.255.255.0</P>
    </Address>
</ConnectedAP>

<ConnectedAP iedName="IED1" apName="AP1">
    <Address>
        <P type="StationType">controlled-station</P>
        <P type="RG1-w-FACTOR">8</P>
        <P type="RG1-k-FACTOR">12</P>
        <P type="RG1-TIMEOUT-0">30</P>
        <P type="RG1-TIMEOUT-1">15</P>
        <P type="RG1-TIMEOUT-2">10</P>
        <P type="RG1-TIMEOUT-3">20</P>
        <P type="RG1-LL1-IP">192.168.0.51</P>
        <P type="RG1-LL1-IP-SUBNET">255.255.255.0</P>
        <P type="RG1-LL2-IP">192.168.0.52</P>
        <P type="RG1-LL2-IP-SUBNET">255.255.255.0</P>
        <P type="RG1-LL3-IP">192.168.0.53</P>
        <P type="RG1-LL3-IP-SUBNET">255.255.255.0</P>
        <P type="RG2-w-FACTOR">8</P>
        <P type="RG2-k-FACTOR">12</P>
        <P type="RG2-TIMEOUT-0">30</P>
        <P type="RG2-TIMEOUT-1">15</P>
        <P type="RG2-TIMEOUT-2">10</P>
        <P type="RG2-TIMEOUT-3">20</P>
        <P type="RG2-LL1-IP">192.168.0.61</P>
        <P type="RG2-LL1-IP-SUBNET">255.255.255.0</P>
        <P type="RG2-LL2-IP">192.168.0.62</P>
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        <P type="RG2-LL3-IP">192.168.0.63</P>
        <P type="RG2-LL3-IP-SUBNET">255.255.255.0</P>
    </Address>
</ConnectedAP>
</Subnetwork>
</Communication>

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

3, rue de Varembé
PO Box 131
CH-1211 Geneva 20
Switzerland

Tel: + 41 22 919 02 11
Fax: + 41 22 919 03 00
info@iec.ch
www.iec.ch