57/815/NP

NEW WORK ITEM PROPOSAL

Proposer	Date of proposal
TC 57 Secretary	2006-03-09
TC/SC	**Secretariat**
TC 57	Germany
Date of circulation	**Closing date for voting**
2006-03-10	2006-06-16

A proposal for a new work item within the scope of an existing technical committee or subcommittee shall be submitted to the Central Office. The proposal will be distributed to the P-members of the technical committee or subcommittee for voting, and to the O-members for information. The proposer may be a National Committee of the IEC, the secretariat itself, another technical committee or subcommittee, an organization in liaison, the Standardization Management Board or one of the advisory committees, or the General Secretary. Guidelines for proposing and justifying a new work item are given in ISO/IEC Directives, Part 1, Annex C (see extract overleaf). **This form is not to be used for amendments or revisions to existing publications.**

The proposal (to be completed by the proposer)

Title of proposal

Mapping of IEC 61850 based Common Data Classes (CDC's), information addressing, services onto IEC 60870-5-104/101

☐ Standard	☒ Technical Specification	☐ Publicly Available Specification

Scope (as defined in ISO/IEC Directives, Part 2, 6.2.1)

The scope of the proposed work is to work out a Technical Specification for the use of IEC 60870-5-104/101 to exchange information according information models based on IEC 61850

Purpose and justification, including the market relevance and relationship to Safety (Guide 104), EMC (Guide 107), Environmental aspects (Guide 109) and Quality assurance (Guide 102) . (attach a separate page as annex, if necessary)

The IEC 60870-5-104/101 protocols have become well-established communication standards for telecontrol, and the protocols are also used for exchanging information between applications used in process control. In particular, the redundancy scheme for the IEC 60870-5-104 (defined in IEC 60870-5-104 Ed.2) has proven to be a success for maintaining high availability in process supervision and control over extended WAN solutions with different bandwidth adoptions. IEC 60870-5-104/101 is currently being introduced in many installations around the world. At the same time information models based on IEC 61850 are on the way to become the foundation for a globally standardized utility communication network.

In order to facilitate the migration from present solutions to the future mix of solutions there must be a way for these two standards to co-exist in real installations. This mapping is a key factor for the success, acceptance and use of IEC 61850 and related information models in applications with low bandwidth communication requirements or with few signals to communicate. It fills the gap between existing solutions based on IEC 60870-5-104/101 and the future use of new standards based on IEC 61850 structures. It will make it possible to introduce the information models for a company dealing with several types of production processes such as wind, hydro, DER etc and network processes such as substations as well as control systems as a whole, and establish a common base for future installations.

A mapping of information models according IEC 61850 onto IEC 60870-5-104/101 shall provide a way to use the services provided by IEC 60870-5-104/101 to exchange information (data) between processes and applications like SCADA. The mapping will support a subset of the services in IEC 61850 and at the same time add functionality to exchange the data according the information models using a redundancy concept.

Target date	for first CD .1 year for 1st DTS...	for IS 2 year for the TS
Estimated number of meetings	Frequency of meetings: 2 per year	Date and place of first meeting: .....
Proposed working methods	☐ E-mail	☐ ftp

Relevant documents to be considered
CDV IEC 61400-25-4, Annex C (88_241e_CDV)

Relationship of project to activities of other international bodies
The proposed work was presented and discussed at TC57 SPAG and TC57 meeting In Cape Town October 19th and 20th 2005, (TC57/793/RM).

Liaison organizations	**Need for coordination within ISO or IEC**
TC88 PT25	

Preparatory work

Ensure that all copyright issues are identified. Check one of the two following boxes

☐ A draft is attached for vote and comment ☒ An outline is attached

We nominate a project leader as follows in accordance with ISO/IEC Directives, Part 1, 2.3.4 (name, address, fax and e-mail):

Wolfgang BRODT

VA TECH SAT GmbH & Co
Ruthnergasse 1
A-1210 Wien

Phone (+43/1) 29129 4621
Fax (+43/1) 29 28 838
e-mail: mailto:wolfgang.brodt@sat-automation.com

Concerns known patented items (see ISO/IEC Directives, Part 2)	**Name and/or signature of the proposer**
☐ yes If yes, provide full information as an annex ☐ no	Andreas Huber TC 57 Secretary

Comments and recommendations from the TC/SC officers

1) Work allocation
☐ Project team ☐ New working group ☒ Existing working group no:

2) Draft suitable for direct submission as
☐ CD ☐ CDV ☐ Publication as a PAS

3) General quality of the draft (conformity to ISO/IEC Directives, Part 2)
☐ Little redrafting needed ☐ Substantial redrafting needed ☐ no draft (outline only)

4) Relationship with other activities
In IEC
- TC57, TC 57 SPAG,
- IEC TC 8,
- IEC TC88

In other organizations

Remarks from the TC/SC officers
The TC 57 Secretary supports this project which is a further step forwards TC 57's strategic goal

Elements to be clarified when proposing a new work item

Title

Indicate the subject matter of the proposed new standard.

Indicate whether it is intended to prepare a standard, a technical report or an amendment to an existing standard.

Scope

Give a clear indication of the coverage of the proposed new work item and, if necessary for clarity, exclusions.

Indicate whether the subject proposed relates to one or more of the fields of safety, EMC, the environment or quality assurance.

Purpose and justification

Give details based on a critical study of the following elements wherever practicable.

a) The specific aims and reason for the standardization activity, with particular emphasis on the aspects of standardization to be covered, the problems it is expected to solve or the difficulties it is intended to overcome.

b) The main interests that might benefit from or be affected by the activity, such as industry, consumers, trade, governments, distributors.

c) Feasibility of the activity: Are there factors that could hinder the successful establishment or general application of the standard?

d) Timeliness of the standard to be produced: Is the technology reasonably stabilized? If not, how much time is likely to be available before advances in technology may render the proposed standard outdated? Is the proposed standard required as a basis for the future development of the technology in question?

e) Urgency of the activity, considering the needs of the market (industry, consumers, trade, governments etc.) as well as other fields or organizations. Indicate target date and, when a series of standards is proposed, suggest priorities.

f) The benefits to be gained by the implementation of the proposed standard; alternatively, the loss or disadvantage(s) if no standard is established within a reasonable time. Data such as product volume of value of trade should be included and quantified.

g) If the standardization activity is, or is likely to be, the subject of regulations or to require the harmonization of existing regulations, this should be indicated.

If a series of new work items is proposed, the purpose and justification of which is common, a common proposal may be drafted including all elements to be clarified and enumerating the titles and scopes of each individual item.

Relevant documents

List any known relevant documents (such as standards and regulations), regardless of their source. When the proposer considers that an existing well-established document may be acceptable as a standard (with or without amendments), indicate this with appropriate justification and attach a copy to the proposal.

Cooperation and liaison

List relevant organizations or bodies with which cooperation and liaison should exist.

Preparatory work

Indicate the name of the project leader nominated by the proposer.

CONTENTS

Mapping of IEC 61850 based Common Data Classes (CDC's), information addressing and services onto IEC 60870-5-104/101

1 General

1.1 Introduction

This draft Technical Specification describes the mapping of IEC 61850 based Common Data Classes (CDC's), information addressing and servies onto IEC 60870-5-104/101. It is derived from IEC 61400-25 part 4. The goal for this Technical specification is to describe the mapping of already defined attributes of CDC's and services (e.g. IEC 61850-7) onto the already defined ASDU's and services of IEC 60870-5-104/101. Extensions may be necessary in the same structure to optimize interoperability and consistency of the mapping. After this introduction with a basic description of the mapping, subsequently the mapping of the information model with associated data classes, and the mapping of services are described. The last clause shows how the mapped data and services according to the IEC 60870-5-104/101 protocol are marked in the interoperability sheet.

1.2 Scope

The scope of the mapping to IEC 60870-5-104/101 is the real-time exchange of process information required for operational purposes. The amount of real-time information provided by the server can vary dependent on the operational needs. Actors could be regional and nationwide control centres that receive real-time information in order to monitor and control geographically wide spread 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 scope of the mapped IEC 60870-5-104/101 subset is given in clause 5.3. Currently the 2nd edition of IEC 60870-5-104 is worked out (FDIS stage), which adds important functions to IEC 60870-5-104 Edition 1.0 like the handling of redundant connections over the WAN and an extention to the transmission of sequences of events (QueryLog). After publication of IEC 60870-5-104 Edition 2.0 this technical report shall be updated accordingly.

1.3 Normative References

IEC 60870-5-101 Edition 2.0:2003 *Telecontrol equipment and systems – Part 5: Transmission Protocols – Section 101: Companion standard for basic telecontrol tasks*

IEC 60870-5-104 Edition 1.0:2000 *Telecontrol equipment and systems – Part 5: Transmission Protocols – Section 104: Network access for IEC 60870-5-101 using standart transport profiles*

IEC 61850-6 Edition 1.0:2004 *Communication networks and systems in substations Part 6: Configuration description language for communication in electrical substations related to IEDs*

IEC 61850-7-1 Edition 1.0:2003 *Communication networks and systems in substations Part 7-1: Basic communication structure for substation and feeder equipment – Principles and models*

IEC 61850-7-2 Edition 1.0:2003 *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 Edition 1.0:2003 *Communication networks and systems in substations Part 7-3: Basic communication structure for substation and feeder equipment – Common data classes*

1.4 The mapping architecture

The mapping architecture consists of 3 parts:

1. Mapping of the information model
2. Mapping of the data (which is in fact part of the information model)
3. Mapping of the services

2 Mapping of a Device oriented Information Model to IEC 60870-5-104/101

2.1 Introduction

The defined mapping for a Device oriented information model is based on using existing functionality in the IEC 60870-5-104/101 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. Same is applicable for the services and the Basic Application functions in the IEC 60870-5-104/101.

2.2 Mapping of a Device oriented Information model references

The Device oriented Information model (e.g. IEC 61850) shall be mapped to a hierarchical structure as defined in IEC 61850-8-1.

The conceptual mapping is depicted in Figure 1. The Device oriented Information model (e.g. IEC 61850) is intended to be preserved when mapped to IEC 60870-5-104/101. This especially means that:

- the mapping proxy implements the hierarchical Device oriented information model of e.g. IEC 61850 that can be retrieved by the services according to clause 4.
- the client implements the Device oriented information model by configuration. That can be done in different ways:
    - o by using the SCL file, specifying the implemented information model, mapping and addressing details according to the rules in IEC 61850-6
    - o by other configuration methods
- the master/client station ("controlling station") accesses the hierarchical Device oriented information model of e.g. IEC 61850 through the services provided by IEC 60870-5-104/101 to exchange real-time data.

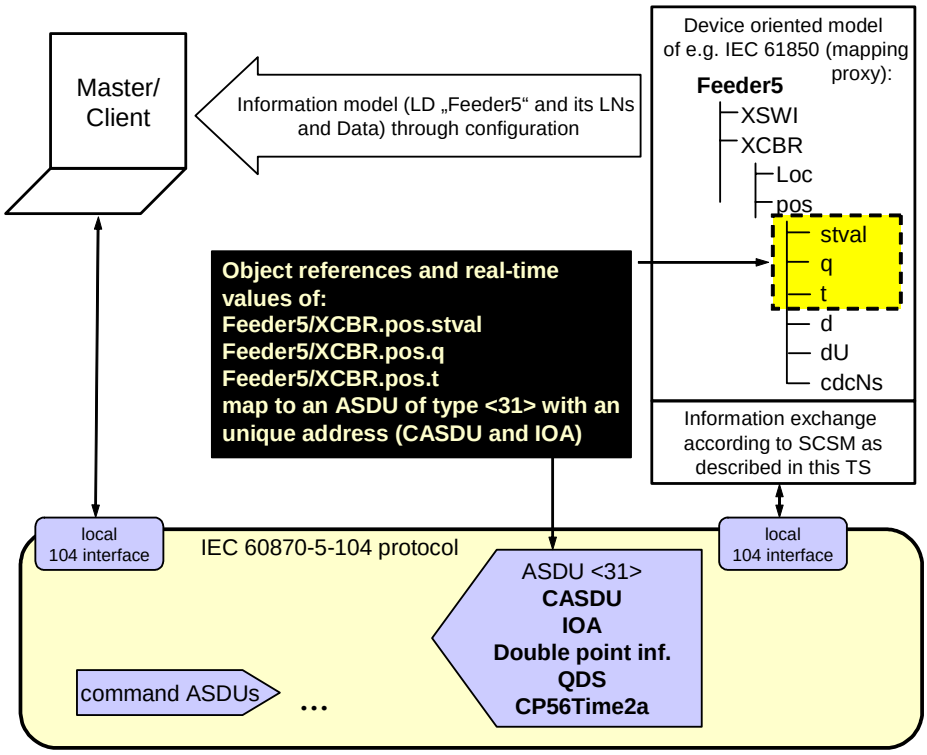

Figure 1 – Mapping architecture (conceptual)

2.3 Logical device class mapping

The logical device reference shall map to the Common Address of ASDU (CASDU).

NOTE The CASDU may be structured. E.g., the CASDU may identify the Station ID and the LOGICAL Device Instance ID. It is recommended to make structured addressing scheme in order to have unique address for the specific information.

2.4 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. E.g., The MSByte Octet of the IOA may identify the LOGICAL NODE Instance ID. The two other bytes of the IOA address may identify the Data Attribute reference within the LN Instance.

3 Mapping of the Common Data Classes (CDC)

3.1 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 type has to be mapped to one specific IOA (as in clause 2.4). In IEC 60870-5-104/101 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.

Table 1 – Mapping structure CDC onto ASDU Type

CDC (Attribute data types)	ASDU type
SPS Single point status	*monitor direction (status):* TI 30 as event TI 1 as part of GI

CDC (Attribute data types)	ASDU type
DPS Double point status	*monitor direction (status):* TI 31 as event TI 3 as part of GI
INS Integer status	*monitor direction (status):* TI 35 as event TI 11 as part of GI
ACT Protection activation information	*monitor direction (status):* TI 39 as event
ACD Directional protection activation Information	*monitor direction (status):* TI 40 as event
SEC Security violation counting	*monitor direction (status):* TI 37 as event TI 15 as part of CI
BCR Binary counter reading	*monitor direction (status):* TI 37 as event TI 15 as part of CI
MV Measured value	*monitor direction (status):* TI 36 as event TI 13 as part of GI
CMV Complex measured value	*monitor direction (status):* TI 36 as event TI 13 as part of GI
SAV Sampled value	*monitor direction (status):* TI 36 as event TI 13 as part of GI
WYE Phase to ground related measured values in a threee phase system	*monitor direction (status):* via **CMV** to TI 36 as event TI 13 as part of GI
DEL Phase to phase related measured values in a threee phase system	*monitor direction (status):* via **CMV** to TI 36 as event TI 13 as part of GI
SEQ Sequence	*monitor direction (status):* via **CMV** to TI 36 as event TI 13 as part of GI
HMV Harmonic value	*monitor direction (status):* TI 36 as event TI 13 as part of GI
HWYE Harmonic value for **WYE**	*monitor direction (status*): via **CMV** to TI 36 as event TI 13 as part of GI
HDEL Harmonic value for **DEL**	*monitor direction (status):* via **CMV** to TI 36 as event TI 13 as part of GI
SPC Controlable Single Point	*monitor direction (status):* TI 30 as event TI 1 as part of GI *control direction (command):* TI 45 (without time tag) or TI 58 (with time tag)
DPC Controllable Double Point	*monitor direction (status):* TI 31 as event TI 3 as part of GI *control direction (command):* TI 46 (without time tag) or TI 59 (with time tag)
INC Controllable Integer status	*monitor direction (status):* TI 35 as event TI 11 as part of GI *control direction (command):* TI 49 (without time tag) or TI 62 (with time tag)
BSC Binary controlled step position information	*monitor direction (status):* TI 32 as event TI 5 as part of GI *control direction (command):* TI 47 (without time tag) or TI 60 (with time tag)

CDC (Attribute data types)	ASDU type
ISC Integer controlled step position information	*monitor direction (status):* TI 32 as event TI 5 as part of GI *control direction (setpoint):* TI 49 (without time tag) or TI 62 (with time tag)
APC Controllable analogue set point information	*monitor direction (status):* TI 36 as event TI 13 as part of GI *control direction (setpoint):* TI 50 (without time tag) or TI 63 (with time tag)
SPG Single point setting	*control direction (command):* TI 45(without time tag) or TI 58 (with time tag)
ING Integer status setting	*control direction (setpoint):* TI 50(without time tag) or TI 63 (with time tag)
ASG Analogue setting	*control direction (setpoint):* TI 50(without time tag) or TI 63 (with time tag)
TI := Type Identification **GI := General Interrogation or station interrogation ASDU TI <100>** **CI := Counter interrogation ASDU TI <101>**	

Common Data Classes **CURVE**, **DPL**, **LPL** and **CSD** cannot be mapped to ASDU's of IEC 60870-5-104/101

NOTE: 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 except the timestamp. All GI, CI data is sent excluding a timestamp.

3.2 CDC Single Point Status (SPS)

The DataAttributes of the common data class MV 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)				
DataAttribute					
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

Attribute Name	**Attribute Type**	**DAComponent**	**IEC 60870-5-104/101 Object Group Mapping**
stVal	BOOLEAN		SPI <0> OFF = FALSE <1> ON = TRUE
t	TimeStamp		Seven octet binary time, CP56Time2a – Time of occurrence for object
q	Quality		QDS validity -> IV/NT good | invalid -> valid | invalid questionable -> not topical detailQual -> OV overflow -> overflow source -> SB substituted -> substituted operatorBlocked -> BL blocked -> blocked

3.3 CDC Double Point Status (DPS)

The DataAttributes 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

Attribute Name	**Attribute Type**	**DAComponent**	**IEC 60870-5-104/101 Object Group Mapping**
stVal	CODED ENUM		DPI <0> indetermined = intermediate state <1> determined state off = OFF <2> determined state on = ON <3> indetermined = bad state
t	TimeStamp		Seven octet binary time, CP56Time2a – Time of occurrence for object
q	Quality		QDS validity -> IV/NT good | invalid -> valid | invalid questionable -> not topical detailQual -> OV overflow -> overflow source -> SB substituted -> substituted operatorBlocked -> BL blocked -> blocked

3.4 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 the ASDU TI <35> "Measured value, scaled value with time tag CP56Time2a" as specified in Table 7.

Table 7 – CDC: Integer status (INS) mapping

Attribute Name	**Attribute Type**	**DAComponent**	**IEC 60870-5-104/101 Object Group Mapping**
stVal	INT32		SVA I16<-2^{15}..+2^{15}-1>
t	TimeStamp		Seven octet binary time, CP56Time2a – Time of occurrence for object
q	Quality		SIQ validity -> IV/NT good | invalid -> valid | invalid questionable -> not topical source -> SB substituted -> substituted operatorBlocked -> BL blocked -> blocked

3.5 CDC Protection Activated Information (ACT)

The DataAttributes 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" as specified in Table 9.

Table 9 – CDC: Protection Activated Information (ACT) mapping

Attribute Name	**Attribute Type**	**DAComponent**	**IEC 60870-5-104/101 Object Group Mapping**
general	BOOLEAN		GS = general start of operation := BS1[1]<0..1> FALSE = <0> := no general start of operation TRUE = <1> := general start of operation
phsA	BOOLEAN		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		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		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		SIE = start of operation IE (earth current) FALSE = <0> := no start of operation IE TRUE = <1> := start of operation IE
t	TimeStamp		Seven octet binary time, CP56Time2a – Time of occurrence for object
q	Quality		SIQ validity -> IV/NT good | invalid -> valid | invalid questionable -> not topical source -> SB substituted -> substituted operatorBlocked -> BL blocked -> blocked

3.6 CDC Directional Protection Activation Information (ACD)

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

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
phsA	BOOLEAN	ST	dchg	TRUE | FALSE	GC_2(1)
phsB	BOOLEAN	ST	dchg	TRUE | FALSE	GC_2(2)
phsC	BOOLEAN	ST	dchg	TRUE | FALSE	GC_2(3)
neut	BOOLEAN	ST	dchg	TRUE | FALSE	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" as specified in Table

Table 11 – CDC: Protection Activated Information (ACT) mapping

Attribute Name	**Attribute Type**	**DAComponent**	**IEC 60870-5-104/101 Object Group Mapping**
general	BOOLEAN		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		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		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		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		Seven octet binary time, CP56Time2a – Time of occurrence for object
q	Quality		SIQ validity -> IV/NT good | invalid -> valid | invalid questionable -> not topical source -> SB substituted -> substituted operatorBlocked -> BL blocked -> blocked

3.7 CDC Security violation counting (SEC)

The DataAttribute 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 + q] 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

Attribute Name	**Attribute Type**	**DAComponent**	**IEC 60870-5-104/101 Object Group Mapping**
cnt	INT32U		counter reading … I32 <-2^{31}..+2^{31}-1>
t	TimeStamp		Seven octet binary time, CP56Time2a – Time of occurrence for object

3.8 CDC Binary counter reading (BCR)

The DataAttribute 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
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 signal [frVal + frTm + q] shall map to ASDU TI <37> "Integrated totals with time tag CP56Time2a" with IOA n+1 as specified in Table 13.

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

Attribute Name	**Attribute Type**	**DAComponent**	**IEC 60870-5-104/101 Object Group Mapping**
actVal	INT32U		counter reading I32 <-2^{31}..+2^{31}-1>
t	TimeStamp		Seven octet binary time, CP56Time2a – Time of occurrence for object
q	Quality		SIQ validity -> IV/NT good | invalid -> valid | invalid questionable -> not topical source -> SB substituted -> substituted operatorBlocked -> BL blocked -> blocked
frVal	INT32U		counter reading I32 <-2^{31}..+2^{31}-1>
frTm	TimeStamp		Seven octet binary time, CP56Time2a
q	Quality		SIQ validity -> IV/NT good | invalid -> valid | invalid questionable -> not topical source -> SB substituted -> substituted operatorBlocked -> BL blocked -> blocked

3.9 CDC Measured Value (MV)

The DataAttributes 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					
analogue information					
mag	AnalogueValue	MX			M
t	TimeStamp	ST		Time value	M
q	Quality	ST	qchg	Quality	M

The signal [mag + t + q] shall map to the ASDU TI <36> as specified in Table 17

Table 17 – CDC: Measured Value (MV) mapping

Attribute Name	**Attribute Type**	**DAComponent**	**IEC 60870-5-104/101 Object Group Mapping**
mag	AnalogueValue	mag.f FLOAT32	**R32-IEEE STD 754** := R32.23{Fraction,Exponent,Sign}
t	TimeStamp		Seven octet binary time, CP562a – Time of occurrence for object
q	Quality		QDS validity -> IV/NT good | invalid -> valid | invalid questionable -> not topical detailQual -> OV overflow -> overflow source -> SB substituted -> substituted operatorBlocked -> BL blocked -> blocked

3.10 CDC Complex Measured Value (CMV)

The DataAttributes of the common data class CMV depicted in 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

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

Table 19 – CDC: Complex Measured Value (CMV) mapping

Attribute Name	**Attribute Type**	**DAComponent**	**IEC 60870-5-104/101 Object Group Mapping**
cVal	Vector	cval.mag.f FLOAT32	**R32-IEEE STD 754** := R32.23{Fraction,Exponent,Sign}
t	TimeStamp		Seven octet binary time, CP56Time2a – Time of occurrence for object
q	Quality		QDS validity -> IV/NT good | invalid -> valid | invalid questionable -> not topical detailQual -> OV overflow -> overflow source -> SB substituted -> substituted operatorBlocked -> BL blocked -> blocked

3.11 CDC Sampled Value (SAV)

The DataAttributes of the common data class SAV depicted in Table 20 shall be mapped as shown in Table 21.

Table 20 – CDC: Sampled Value (SAV)

SAV 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					
instMag	AnalogueValue	MX			M
t	TimeStamp	ST		Time value	O
q	Quality	ST	qchg	Quality	M

The signal [instMag + t + q] shall map to the ASDU TI <36> "Measure value, short floating point value with time tag CP56Time2a" as specified in Table 21.
If t is not used [instMag + q] shall map to the ASDU TI <13> "Measured value, short floating point value".

Table 21 – CDC: Sampled Value (SAV) mapping

Attribute Name	**Attribute Type**	**DAComponent**	**IEC 60870-5-104/101 Object Group Mapping**
instMag	AnalogueValue	instMag.f FLOAT32	**R32-IEEE STD 754** := R32.23{Fraction,Exponent,Sign}
t	TimeStamp		Seven octet binary time, CP562a – Time of occurrence for object
q	Quality		QDS validity -> IV/NT good | invalid -> valid | invalid questionable -> not topical detailQual -> OV overflow -> overflow source -> SB substituted -> substituted operatorBlocked -> BL blocked -> blocked

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

The DataAttributes of the common data class WYE depicted in Table 22 shall be mapped as multiple mappings of the Common Data Class CMV as shown in Table 19 .

Table 22 – 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> "Measure value, short floating point value with time tag CP56Time2a". Six ASDU's of TI <36> shall be used with consecutive 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.
The mapping of common data class CMV is shown in detail in Table 19 .

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

The DataAttributes of the common data class DEL depicted in Table 23 shall be mapped as multiple mappings of the Common Data Class CMV as shown in Table 19 .

Table 23 – 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> "Measure value, short floating point value with time tag CP56Time2a". Three ASDU's of TI <36> shall be used with consecutive indices:
IOA n := CMV phsAB
IOA n+1 := CMV phsBC.
IOA n+2 := CMV phsCA
The mapping of common data class CMV is shown in detail in Table 19 .

3.14 CDC Sequence (SEQ)

The DataAttributes of the common data class SEQ depicted in Table 24 shall be mapped as multiple mappings of the Common Data Class CMV as shown in Table 19 .

Table 24 – CDC: Sequence (DEL)

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> "Measure value, short floating point value with time tag CP56Time2a". Three ASDU's of TI <36> shall be used with consecutive indices:
IOA n := c1
IOA n+1 := c2
IOA n+2 := c3
The mapping of common data class CMV is shown in detail in Table 19 .

3.15 CDC Harmonic Value (HMV)

The DataAttributes of the common data class HMV depicted in Table 25 shall be mapped as shown in Table 21.

Table 25 – CDC: Harmonic Value (HMV)

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	ST	qchg	Quality	M
t	TimeStamp	ST		Time value	M

Table 26 defines the mapping for data attributes of common data class HMV. The number of "har" attributes is variable (numHar := 1…n) The signals [har(n).mag + t + q] shall map to IEC 60870-5-104/101 ASDU TI<36> "Measured value, short flating point value with time tag CP56Time2a".

Table 26 – CDC: Harmonic value (HMV) mapping

Attribute Name	**Attribute Type**	**DAComponent**	**IEC 60870-5-104/101 Object Group Mapping**
har	Vector	har.mag.f FLOAT32	**R32-IEEE STD 754** := R32.23{Fraction,Exponent,Sign}
t	TimeStamp		Seven octet binary time, CP56Time2a – Time of occurrence for object
q	Quality		QDS validity -> IV/NT good | invalid -> valid | invalid questionable -> not topical 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> "Measure 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 indices:
IOA n := har[0].mag
IOA n+1 := har[1].mag
…
IOA n+(numHar-1) := har[numHar-1]

3.16 CDC Harmonic value for WYE (HWYE)

The DataAttributes of the common data class HWYE depicted in Table 27 shall be mapped as multiple mappings of the Common Data Class HMV as shown in Table 26 .

Table 27 – 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	ST	qchg	Quality	M
t	TimeStamp	ST		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 26 .

3.17 CDC Harmonic value for DEL (HDEL)

The DataAttributes of the common data class HDEL depicted in Table 27 shall be mapped as multiple mappings of the Common Data Class HMV as shown in Table 26 .

Table 28 – 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	ST	qchg	Quality	M
t	TimeStamp	ST		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 26 .

3.18 CDC Controllable single point (SPC)

The DataAttributes of the common data class SPC depicted in Table 29 shall be mapped as shown in Table 3 (for the attributes with the Functional Constraint ST) and Table 30 (for the attributes with the Functional Contraint CO).

Table 29 – 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
stVal	BOOLEAN	ST	dchg	FALSE | TRUE	AC_ST
q	Quality	ST	qchg		AC_ST
t	TimeStamp	ST			AC_ST

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

Table 30 defines the mapping for data attributes with the Functional Constraint CO.
The data attribute [ctlVal] or [ctlVal + T] shall map to IEC 60870-5-104/101 ASDU TI<45> "Single command" or ASDU TI<58> "Single command with time tag CP56Time2a.

NOTE: The attribute T is derived from the service parameters of the Control Model in the ACSI

Table 30 – CDC: Controllable single point (SPC) mapping

Attribute Name	**Attribute Type**	**DAComponent**	**IEC 60870-5-104/101 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 60870-5-104/101 supports 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 clause 4

3.19 CDC Controllable double point (DPC)

The DataAttributes of the common data class DPC depicted in Table 31 shall be mapped as shown in Table 5 (for the attributes with the Functional Constraint ST) and Table 32 (for the attributes with the Functional Constraint CO).

Table 31 – 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
stVal	CODED ENUM	ST	dchg	intermediate-state | off | on | bad-state	M
q	Quality	ST	qchg		M
t	TimeStamp	ST			M

Table 4 defines the mapping for data attributes of DPC with the Functional Constraint ST [stVal + t + q].

Table 32 defines the mapping for data attributes of DPC with the Functional Constraint CO. The data attribute [ctlVal] or [ctlVal + T] shall map to IEC 60870-5-104/101 ASDU TI<46> "Double point command" " or ASDU TI<59> "Double command with time tag CP56Time2a.

NOTE: The attribute T is derived from the service parameters of the Control Model in the ACSI

Table 32 – CDC: Controllable double point (DPC) mapping

Attribute Name	**Attribute Type**	**DAComponent**	**IEC 60870-5-104/101 Object Group Mapping**
ctlVal	CODED ENUM		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 60870-5-104/101 supports 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 clause 4

3.20 CDC Controllable integer status (INC)

The DataAttributes of the common data class INC depicted in Table 33 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 33 – 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
stVal	INT32	ST	dchg		M
q	Quality	ST	qchg		M
t	TimeStamp	ST			M

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

Table 34 defines the mapping for data attributes of INC with the Functional Constraint CO. The data attribute [ctlVal] or [ctlVal + T] shall map to IEC 60870-5-104/101 ASDU TI<49> "Set point command, scaled value" or ASDU TI<62> "Set point command, scaled value with time tag CP56Time2a".

NOTE: The attribute T is derived from the service parameters of the Control Model in the ACSI

Table 34 – CDC: Controllable integer status (INC) mapping

Attribute Name	**Attribute Type**	**DAComponent**	**IEC 60870-5-104/101 Object Group Mapping**
ctlVal	INT32		SVA … I16 <-2^{15}..+2^{15}-1> simple INC -> QU <0> no additional definition other QU values are not used IEC 60870-5-104/101 supports 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 clause 4

3.21 CDC Binary controlled step position information (BSC)

The DataAttributes of the common data class BSC depicted in Table 35 shall be mapped as shown in Table 36 (for the attributes with the Functional Constraint ST) and Table 37(for the attributes with the Functional Constraint CO).

Table 35 – 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
valWTr	ValWithTrans	ST	dchg		AC_ST
q	Quality	ST	qchg		AC_ST
t	TimeStamp	ST			AC_ST

Table 36 defines the mapping for data attributes of BSC with the Functional Constraint ST. The data attributes [valWTr + t + q]. shall map to IEC 60870-5-104/101 ASDU TI<32> "Step position information with time tag CP56Time2a".

Table 37defines the mapping for data attributes of BSC with the Functional Constraint CO. The data attribute [ctlVal] or [ctlVal + T] shall map to IEC 60870-5-104/101 ASDU TI<47> "Regulating step command" or ASDU TI<60> "Regulating step command with time tag CP56Time2a".

NOTE: The attribute T is derived from the service parameters of the Control Model in the ACSI

Table 36 – CDC: Binary controlled step position information (BSC) mapping of data attributes of the Functional Constraint ST

Attribute Name	**Attribute Type**	**DAComponent**	**IEC 60870-5-104/101 Object Group Mapping**
valWTr		valWTr.posVal INT8	VTI value I7 <-64 …+63>
		valWTr.transInd BOOLEAN	VTI Transient BS1 <0> equipment is not in transient state := FALSE <1> equipment is in transient state := TRUE
t	TimeStamp		Seven octet binary time, CP56Time2a – Time of occurrence for object
q	Quality		SIQ validity -> IV/NT good | invalid -> valid | invalid questionable -> not topical source -> SB substituted -> substituted operatorBlocked -> BL blocked -> blocked

Table 37 – CDC: Binary controlled step position information (BSC) mapping of data attributes of the Functional Constraint CO

Attribute Name	Attribute Type	DAComponent	IEC 60870-5-104/101 Object Group Mapping
ctlVal	CODED ENUM		RCO RCS Regulating step command state <0> not permitted := stop <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 60870-5-104/101 supports 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 clause 4

3.22 CDC Integer controlled step position information (ISC)

The DataAttributes of the common data class ISC depicted in Table 38 shall be mapped as shown in Table 36 (for the attributes with the Functional Constraint ST) and Table 39 (for the attributes with the Functional Constraint CO).

Table 38 – 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
valWTr	ValWithTrans	ST	dchg		AC_ST
q	Quality	ST	qchg		AC_ST
t	TimeStamp	ST			AC_ST

Table 36 defines the mapping for data attributes of ISC with the Functional Constraint ST [valWTr + t + q].

Table 39 defines the mapping for data attributes of ISC with the Functional Constraint CO. The data attribute [ctlVal] or [ctlVal + T] shall map to IEC 60870-5-104/101 ASDU TI<49>"Set point command, scaled value" or ASDU TI<62> "Set point command, scaled value with time tag CP56Time2a".

NOTE: The attribute T is derived from the service parameters of the Control Model in the ACSI

Table 39 – CDC: Integer controlled step position information (ISC) mapping

Attribute Name	**Attribute Type**	**DAComponent**	**IEC 60870-5-104/101 Object Group Mapping**
ctlVal	INT8		SVA ... I16 <-2^{15}..+2^{15}-1> simple ISC -> QU <0> no additional definition other QU values are not used IEC 60870-5-104/101 supports 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 clause 4

3.23 CDC Controllable analogue set point information (APC)

The DataAttributes of the common data class APC depicted in Table 40 shall be mapped as shown in Table 36 (for the attributes with the Functional Constraint ST) and Table 37(for the attributes with the Functional Constraint CO).

Table 40 – 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	SP,MX	dchg		M
q	Quality	MX	qchg		M
t	TimeStamp	MX			M

Table 41 defines the mapping for data attributes of APC with the Functional Constraint MX. The data attributes [setMag + t + q]. shall map to IEC 60870-5-104/101 ASDU TI<36> "Measured value, short floating point value with time tag CP56Time2a".

Table 42 defines the mapping for data attributes of APC with the Functional Constraint SP. The data attribute [setMag] or [setMag + T] shall map to IEC 60870-5-104/101 ASDU TI<50>"Set point command, short floating point value" or ASDU TI<63> "Set point command, short floating point value with time tag CP56Time2a".

NOTE: The attribute T is derived from the service parameters of the Control Model in the ACSI

Table 41 – CDC: Controllable analogue set point information (APC) mapping of data attributes of the Functional Constraint MX

Attribute Name	**Attribute Type**	**DAComponent**	**IEC 60870-5-104/101 Object Group Mapping**
setMag	AnalogueValue	setMag.f FLOAT32	**R32-IEEE STD 754** := R32.23{Fraction,Exponent,Sign}
t	TimeStamp		Seven octet binary time, CP56Time2a – Time of occurrence for object
q	Quality		SIQ validity -> IV/NT good | invalid -> valid | invalid questionable -> not topical source -> SB substituted -> substituted operatorBlocked -> BL blocked -> blocked

Table 42 – CDC: Controllable analogue set point information (APC) mapping of data attributes of the Functional Constraint SP

Attribute Name	**Attribute Type**	**DAComponent**	**IEC 60870-5-104/101 Object Group Mapping**
setMag	AnalogueValue	setMag.f FLOAT32	**R32-IEEE STD 754** := R32.23{Fraction,Exponent,Sign}

3.24 CDC Single point setting (SPG)

The DataAttributes of the common data class SPG depicted in Table 42 shall be mapped as shown in Table 30.

Table 43 – 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] or [setVal + T] shall map to IEC 60870-5-104/101 ASDU TI<45> "Single command" or ASDU TI<58> "Single command with time tag CP56Time2a" as shown in Table 30.

NOTE: The attribute T is derived from the service parameters of the Control Model in the ACSI

3.25 CDC Integer status setting (ING)

The DataAttributes of the common data class ING depicted in Table 44 shall be mapped as shown in Table 34 .

Table 44 – 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] or [setVal + T] shall map to IEC 60870-5-104/101 ASDU TI<49> "Set point command, scaled value" or ASDU TI<Set point command, scaled value with time tag CP56time2a" as shown in Table 34 .

NOTE: The attribute T is derived from the service parameters of the Control Model in the ACSI

3.26 CDC Analogue settings (ASG)

The DataAttributes of the common data class ASG depicted in Table 45 shall be mapped as shown in Table 42.

Table 45 – 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					
setVal	AnalogueValue	SP			AC_NSG_M

The data attribute [setVal] or [setval + T] shall map to IEC 60870-5-104/101 ASDU TI<50> "Set point command, short floating point value" or ASDU TO<63> "set point command, short floating point value with time tag CP56Time2a" as shown in Table 42.

NOTE: The attribute T is derived from the service parameters of the Control Model in the ACSI

4 Mapping of services

4.1 List of service models and corresponding mappings

The service models defined in IEC 61400-25 and the mapping to IEC 60870-5-104/101 is summarised in Table 46.

Table 46 – 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 60870-5-104/101). [b]
Association		**Connection**
	Associate	Establish; IEC 60870-5-104 clause 7.1 Station initialization
	Abort	n.a. [a]
	Release	Close; IEC 60870-5-104 clause 7.1 Station initialization
Logical Device		**CASDU**
	GetLogicalDeviceDirectory	n.a. (to be added optionally with services outside of IEC 60870-5-104/101). [b]
Logical Node		**not mapped**
	GetLogicalNodeDirectory	n.a. (to be added optionally with services outside of IEC 60870-5-104/101). [b]
	GetAllDataValues	Interrogation command TI <100>
Data		**One or a set of IOA('es).**
	GetDataValues	Read command ASDU TI <102>
	SetDataValues	n.a. [a]
	GetDataDirectory	n.a. (to be added optionally with services outside of IEC 60870-5-104/101). [b]
	GetDataDefinition	n.a. (to be added optionally with services outside of IEC 60870-5-104/101). [b]
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		n.a. [a]
	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		n.a. [a]
	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]

	IEC 61850-7-2 Service	Maps to
	GetLCBValues	n.a. [a]
	SetLCBValues	n.a. [a]
LOG		n.a. [a]
	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>
	Cancel	ASDU TI <45,46,47,49,50>
	Operate	ASDU TI <45,46,47,49,50>
	CommandTermination	ASDU TI <45,46,47,49,50>
	TimeActivatedOperate	n.a. [a]

a not applicable for the mapping to IEC 60870-5-104/101

b ASDUs for spontaneous transmission: <31>, ..., as selected in clause 5.

4.2 Server class mapping

The server class shall be mapped to services of a controlled station as shown in Table 47.

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

Table 47 – 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 60870-5-104/101) [a]
a not applicable for the mapping to IEC 60870-5-104/101		

4.3 Association class mapping

The association service shall be mapped to services of IEC 60870-5-104 as shown in Table 48.

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

Table 48 – Association services mapping

	IEC 61850-7-2 Service	Maps to
Association		**Connection**
	Associate	Establish; IEC 60870-5-104 clause 7.1 Station initialization
	Abort	n.a. [a]
	Release	Close; IEC 60870-5-104 clause 7.1 Station initialization
a not applicable for the mapping to IEC 60870-5-104/101		

4.4 Logical Node class mapping

The GetAllDataValues service shall be mapped to services of IEC 60870-5-104/101 as shown in Table 49.

Table 49 – 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
<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

4.5 Data class mapping

The GetDataValues service shall be mapped to services of IEC 60870-5-104/101 as shown in Table 50.

Table 50 – Data services mapping

	IEC 61850-7-2 Service	Maps to
Data		**One or a set of IOA('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
<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

4.6 Setting Group class mapping

The SelectActiveSG service shall be mapped as shown in Table 51

Table 51 – Setting Group services mapping

	IEC 61850-7-2 Service	Maps to
Setting Group Control Block		**Controllable IOA**

	IEC 61850-7-2 Service	Maps to
	SelectActiveSG	**Write Request:** TI <45> 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> 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> 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

4.7 Report Control Block class mapping

The GetDataValues service shall be mapped as shown in Table 52.

Table 52 – Report Control Block services mapping

	IEC 61850-7-2 Service	Maps to
Report Control Block		
	Report	ASDU's with COT <3> = spontaneous, COT <11> := remote controlled, COT <12> := local controlled

4.8 Control class mapping

4.8.1 Direct Control with Normal Security

The Direct Control with Normal Security services shall be mapped as shown in Table 53.

Table 53 – Direct Control with Normal Security services mapping

	IEC 61850-7-2 Service	Maps to
Control		**Controllable IOA**
	Operate	**Operate Request:** TI <45,46,47,49,50,58,59,60,62,63> 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 <45,46,47,49,50,58,59,60,62,63> 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 <45,46,47,49,50,58,59,60,62,63> 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

4.8.2 Direct Control with Enhanced Security

The Direct Control with Enhanced Security services shall be mapped as shown in Table 54.

Table 54 – Direct Control with Enhanced Security services mapping

	IEC 61850-7-2 Service	Maps to
Control		**Controllable IOA**
	Operate	**Operate Request:** TI <45,46,47,49,50,58,59,60,62,63> 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 <45,46,47,49,50,58,59,60,62,63> 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 <45,46,47,49,50,58,59,60,62,63> 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

4.8.3 SBO Control with Enhanced Security

The SBO Control with Enhanced Security services shall be mapped as shown in Table 55.

Table 55 – SBO Control with Enhanced Security services mapping

	IEC 61850-7-2 Service	Maps to
Control		**Controllable IOA**
	SelectWithValue	**Select with Value Request:** TI <45,46,47,49,50,58,59,60,62,63> 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 <45,46,47,49,50,58,59,60,62,63> 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
	Cancel	**Cancel Request:** TI <45,46,47,49,50,58,59,60,62,63> 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 <45,46,47,49,5,630> 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 <45,46,47,49,50,58,59,60,62,63> 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 <45,46,47,49,50,58,59,60,62,63> 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

	IEC 61850-7-2 Service	Maps to
	Command Termination	TI <45,46,47,49,50,58,59,60,62,63> 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

5 Protocol stack selections for IEC 60870-5-104/101.

5.1 General

The mapping in to 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 clause 5.3. This is subset of the standard.

5.2 Structure of application data defined in IEC 60870-5-104/101

IEC 60870-5-3 describes the Basic Application Data Units in transmission frames of telecontrol systems. This subclass selects specific field elements out of that standard and defines APPLICATION SERVICE DATA UNITS (ASDU) used in standard IEC 60870-5-104 protocol.

The APPLICATION SERVICE DATA UNIT (ASDU) is composed of a DATA UNIT IDENTIFIER and one or more INFORMATION OBJECTS.

The DATA UNIT IDENTIFIER has always 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.

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 COMMON ADDRESS can 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 belong always to a single INFORMATION OBJECT.

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.

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. 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 single information element/combination of elements or a sequence 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.

5.3 IEC 60870-5-104 Interoperability

5.3.1 Introduction

This companion standard presents sets of parameters and alternatives from which subsets must 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 this standard. The text descriptions of parameters which are not applicable to this companion standard are strike-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)
☒ **R** Function or ASDU is used in reverse mode
☒ **B** 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. For this mapping document the selection(s) as made in this document are mapped in this document.

A black check box indicates that the option cannot be selected in this companion standard.

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

5.3.2 System or device

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

☒ **X** System definition
☐ Controlling station definition
☐ Controlled station definition

5.3.3 Network configuration

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

■ ~~Point-to-point~~ ■ ~~Multipoint-~~
■ ~~Multiple point-to-~~ ■ ~~Multipoint-star~~

5.3.4 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 200bit/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 200bit/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~~	

5.3.5 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 this companion standard.~~

Link transmission proce-

- ■ ~~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).~~

5.3.6 Application layer

Transmission mode for application data
Mode 1 (Least significant octet first), as defined in clause 4.10 of IEC 60870-5-4, is used exclusively in this companion standard.

Common address of ASDU
(system-specific parameter, all configurations that are used are to be marked '**X**')

- ■ ~~One octet~~
- [X] Two octets

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

■	~~One octet~~	☐	structured
■	~~Two octets~~	X	unstructured
X	Three octets		

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

■	~~One octet~~	X	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 the APDU is 253 (default). The maximum length may be reduced per system.

253	Maximum length of APDU per system

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)

X	<1> := Single-point information	M_SP_NA_1
■	~~<2> :=Single-point information with time tag~~	~~M_SP_TA_1~~
X	<3> :=Double-point information	M_DP_NA_1
■	~~<4> :=Double-point information with time tag~~	~~M_DP_TA_1~~
X	<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~~
X	<11> := Measured value, scaled value	M_ME_NB_1
■	~~<12> := Measured value, scaled value with time tag~~	~~M_ME_TB_1~~
X	<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~~
X	<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
X	<30> := Single-point information with time tag CP56Time2a	M_SP_TB_1

[X]	<31> :=	Double-point information with time tag CP56Time2a	M_DP_TB_1
[X]	<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
[X]	<35> :=	Measured value, scaled value with time tag CP56Time2a	M_ME_TE_1
[X]	<36> :=	Measured value, short floating point value with time tag CP56Time2a	M_ME_TF_1
[X]	<37> :=	Integrated totals with time tag CP56Time2a	M_IT_TB_1
[ ]	<38> :=	Event of protection equipment with time tag CP56Time2a	M_EP_TD_1
[X]	<39> :=	Packed start events of protection equipment with time tag CP56Time2a	M_EP_TE_1
[X]	<40> :=	Packed output circuit information of protection equipment with time tag CP56Time2a	M_EP_TF_1

Either the 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)

[X]	<45> :=	Single command	C_SC_NA_1
[X]	<46> :=	Double command	C_DC_NA_1
[X]	<47> :=	Regulating step command	C_RC_NA_1
[ ]	<48> :=	Set point command, normalized value	C_SE_NA_1
[X]	<49> :=	Set point command, scaled value	C_SE_NB_1
[X]	<50> :=	Set point command, short floating point value	C_SE_NC_1
[ ]	<51> :=	Bitstring of 32 bit	C_BO_NA_1
[X]	<58> :=	Single command with time tag CP56Time 2a	C_SC_TA_1
[X]	<59> :=	Double command with time tag CP56Time 2a	C_DC_TA_1
[X]	<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
[X]	<62> :=	Set point command, scaled value with time tag CP56Time 2a	C_SE_TB_1
[X]	<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 '**X**' if used)

[ ]	<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)

[X]	<100>:= Interrogation command	C_IC_NA_1
[X]	<101>:= Counter interrogation command	C_CI_NA_1
[X]	<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

Type Identifier and Cause of Transmission Assignments
(station-specific parameters)

Shaded boxes are not required.
Black boxes are not permitted in this companion standard
Blank = Function or ASDU is not used.
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

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					
~~<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																			
~~<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																			
<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																			
<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*)																			
<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~~																			
<107>	C_TS_TA_1																			
<110>	P_ME_NA_1																			
<111>	P_ME_NB_1																			
<112>	P_ME_NC_1																			
<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

5.3.7 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)

[X] 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)

[X] 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
[ ] 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 spe-
[ ] Measured value, normalized value M_ME_NA_1, M_ME_TA_1, M_ME_ND_1 and
[ ] 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)

[X] global
[ ] group 1
[ ] group 2
[ ] group 3
[ ] group 4
[ ] group 5
[ ] group 6
[ ] group 7
[ ] group 8
[ ] group 9
[ ] group 10
[ ] group 11
[ ] group 12
[ ] group 13
[ ] group 14
[ ] group 15
[ ] group 16

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

optional, see clause 7.6

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)

- [X] Direct command transmission
- [X] Direct set point command transmission
- [X] Select and execute command
- [X] Select and execute set point command
- [X] C_SE ACTTERM used

- [X] 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

[ ] Maximum allowable delay of commands and set point

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)

- [X] 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
- [X] Counter freeze without reset
- [ ] Counter freeze with reset
- [ ] Counter reset

- [X] 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	30s	Time out of connection establishment	
t_1	15s	Time out of send or test APDUs	
t_2	10s	Time out for acknowledges in case of no data messages $t_2 < t_1$	
t_3	20s	Time out for sending test frames in case of a long idle state	

Maximum range of values for all time outs: 1 to 255 s, accuracy 1 s

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 32767 (2^{15}-1) APDUs, accuracy 1 APDU
Maximum range of values w: 1 to 32767 APDUs, accuracy 1 APDU (Recommendation: w should not exceed 2/3 of k).

Portnumber

Parameter	Value	Remarks
Portnumber	2404	In all cases

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 this standard.

☒ 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.