ENEXIS B.V.

Protocol Implementation Document for IEC 60870-5-104 DALI stations

Version 1.9

10 July 2016

Change log				
Revision no.:	**Date:**	**Chapter:**	**Comments:**	**Author:**
0.1	19.04.2006	All	Initial version	RLas KEMA
1.0	28.04.2006	All	Final version	RLas KEMA
1.1	14.06.2006	All	Added COT=1	RLas KEMA
1.2	12.05.2009	All	Added: ASDUs: <15>, <37>, <61>, <62>, <63>, <101> ENEXIS Network Extension description Direct set point command transmission Select and execute set point command C_SE ACTTERM used Integrated totals with Counter freeze with reset, Mode A and D	PCioci KEMA
1.3	15-12-2014		Added: Integrated totals with Counter freeze with reset, Mode B	Bert Claessen
1.4	12-01-2015		Revision for MS-TP rtu's	Bert Claessen
1.5	17-01-2015		Clock synchronization revision	Bert Claessen
1.6	27-2-2015		ASDU 5, 15, 32, 37, 61, 63, 101 not in scope Threshold with setpoint included	Bert Claessen
1.7	13-07-2015		- Document title changed.MS-TP PID is applicable for MS-D - Redundancy functionality removed	Bert Claessen
1.8	02-03-2016		- Removed markings for transmission of Integrated Totals - ASDU 105 removed - ASDU's 9, 11, 34 en 35 removed - ASDU 45 and 46 added - ASDU 62 removed - Select & execute commands removed, and thus also COT= 8 & 9	Robert Lassche DNVGL
1.9	10-07-2016		- Version 1.9 for DALI created Clock sync ASDU 103 removed Test command asdu 107 removed	Bert Claessen

TABLE OF CONTENTS

1 INTRODUCTION

1.1 Background

This document will describe the use of the IEC 60870-5-104 protocol within ENEXIS B.V., The Netherlands.

The telemetry system will control and monitor the 10 kV substations that exchange process data with the central control centre. The systems will be connected with a wireless (LTE) connection or a fixed connection.

1.2 Purpose of this document

The purpose of this document is to unambiguously define and specify the implementation requirements for the interconnection of Telemetry Stations within the ENEXIS B.V. organisation between control centre and substations (also called controlling and controlled station) when using the IEC 60870-5-104 standard (Telecontrol Companion Standard (TCS) 104).

This PID (Protocol Implementation Document) constitutes the basis of the TCS104 implementations for ENEXIS B.V. that are going to be delivered by vendors of substation equipment. This document contains additional information about functionality that is not necessarily covered by the standard. However, the functionality described in this document is needed for use within ENEXIS B.V. and thus it should be implemented as described in this document.

Figure 1 presents an overview of the scope of this PID.

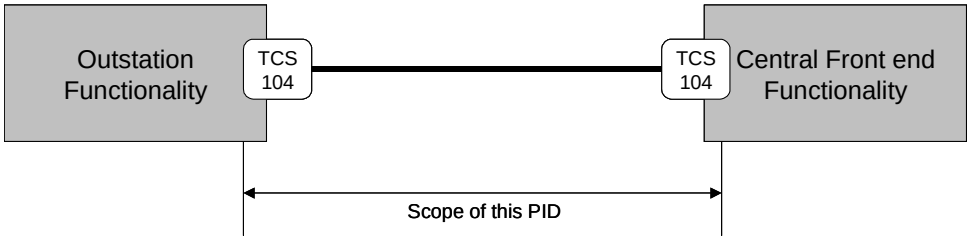

Figure 1 PID Scope

The absolute values mentioned in this document are typical or default values and might differ per ENEXIS B.V. project/substation. These values shall therefore be configurable within a commonly used range. It is the responsibility of the supplier to verify this data before starting the project.

In spite of the great care with which the authors have written this document, possible indistinctness and inaccuracies can still occur in this document. It is the responsibility of the vendor to identify possible indistinctness and inaccuracies in this document, and the consistency between the ENEXIS B.V. PID 104 and related IEC60870-5 standards. If indistinctness, inaccuracies, or inconsistencies between the ENEXIS B.V. PID 104 or other ENEXIS B.V. requirements, and the related IEC60870-5 standard are identified, it is the responsibility of the vendor to contact the contact person within ENEXIS B.V. to discuss these issues.

2 TCS104 PROTOCOL IMPLEMENTATION

2.1 Communication Protocol

Communication Protocols are the grammars through which computer-based devices communicate with one another - the way they organise, and transmit the bits and bytes of electronic on-off (binary) signals whose patterns encode data. Simply, a protocol is a set of rules that governs how messages containing data and control information are assembled at a source for their transmission across the network and then dissembled when they reach their destination.

2.2 Normative references

The following normative documents contain provisions that, through reference in this text, constitute provisions of this section of IEC 60870-5. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this section of IEC 60870-5 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 50(371): 1984, International Electrotechnical Vocabulary (IEV)-
Chapter 371: Telecontrol

IEC 60870-1-1: 1988, Telecontrol equipment and systems - Part 1:
General considerations - Section One: General principles

IEC 60870-1-3: 1997 Ed. 2, Telecontrol equipment and systems - Part 1:
General considerations - Section Three: Glossary

IEC 60870-1-4: 1994, Telecontrol equipment and systems - Part 1:
General considerations - Section 4: Basic aspects of telecontrol data transmission and organization of standards of IEC 60870-5 and IEC 60870-6

IEC 60870-5-3: 1992, 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 ed.2: 2003, Telecontrol equipment and systems - Part 5:
Transmission protocols - Section 101: Companion standard for basic telecontrol Tasks

IEC 60870-5-104 2000, Telecontrol equipment and systems - Part 5:
Transmission protocols - Section 104: Network acces for IEC60870-5-101 using standard transport profiles profiles [TCS104ed1]

IEC 60870-5-104 Ed. 2.0: 2006[1], Network access for IEC 60870-5-101 using standard transport profiles [TCS104ed2]

[1] Latest version is applicable, status april 2006 is 57/812/FDIS.

2.3 Physical Layer

2.3.1 Physical Connection

Figure 2 provides an overview of the physical connection between a substation and the controlling station (DALI) of ENEXIS B.V.

The ENEXIS central DALI system has a number of redundant application servers placed in one or two separate locations available. Where there is one main location and one backup location. Both DALI locations can connect via one IEC 104 Front End to the substation RTU's using a GPRS network and a fixed connection line.

GPRS not only offers lower line cost but also provides a permanent connection as required by the IEC-104 protocol which now is able to directly communicate between the substation and the DALI center.

2.3.2 Network Connection

Data is exchanged between the RTUs and the 104 front end using a GPRS connection and a fixed connection line. The default configuration is one GPRS connection to each RTU. Each GPRS connection can be used for establishing 2 logical connections[2]. The 104 front end polls each RTU and the primary EMS (Weert or Roermond) decides per RTU which logical connection is used for updating the EMS database.

The network connection between the 104 front end and the two EMS locations is outside the scope of this document.

2.4 Link Layer

2.4.1 Buffering of data in the RTU

Each RTU must be equipped with a GPRS or fixed communication link with an event buffer. The data generated by the RTU internally is placed in the buffer. The buffer size must be configured in a way that the amount of events configured in a station multiplied with a factor 10 (with a maximum of 2500 events) can be stored in case that no GPRS connection is available.

2.4.2 Priority of data in the buffer

It is required by ENEXIS B.V. that data can be prioritised in at least 5 levels, grouped by Cause of Transmission. Indications, caused by a trip or a (remote) command, will have higher priority than spontaneous measurements and thus will be send before possible measurements that are waiting to be transmitted. General Interrogation information will have the lowest priority. Events (indications or measurements) can interrupt an ongoing General Interrogation. The Controlled Station algorithm must guarantee that the end-state of all data points after a general Interrogation is correct.

2.4.3 Addressing

Within ENEXIS B.V. each RTU can have its unique CAA address, including a fixed IP addressing scheme. This needs to be verified by the supplier for the project. ENEXIS B.V. handles the administration of the addresses and assigns the addresses.

2.4.4 Processing delay (performance)

The maximum reaction (processing) time of the controlled station is 100 milliseconds.

[2] A logical connection is a socket of the IP address and port number of the controlling station and the IP address and port number of the controlled station.

2.5 Application Layer

2.5.1 Common Address of Application Service Data Unit (CAA)

The Common Address of ASDU is a common number used for all objects in one Controlled Station. One Controlled Station can be either an entire Station Control System or only a part of it (a logical unit).

2.5.2 Information Object Address (IOA)

An Information Object Address is an object address to identify Information Objects in Telecontrol systems. The combination of CAA and IOA must be a unique identifier for 1 data object, such as single point, double point, measurands, threshold value etc.
The assignment of Information Object Addresses (IOA) has the following conditions but approval of ENEXIS B.V. is always necessary before configuring the system:

- The ASDU numbers form the basis for the assignment of the IOA addresses; e.g. single point values ASDU 1 use the address range 1000-1xxx, ASDU 45 single commands use the range 45000-45xxx, and so on for each other ASDU; In case ASDU's with time stamps are used the address ranges are based on the ASDU number without time-stamp (address range 1000-1xxx).
- All the configured addresses must be consecutive (e.g. 1000, 1001, 1002 et-cetera)

2.5.3 Selection of Standard (Compatible Range) ASDUs

The used ASDU types by ENEXIS B.V. are selected on the Interoperability form in Chapter 4.

2.5.4 Basic Application Functions

The basic application functions used by ENEXIS B.V. are selected in the Interoperability form (Chapter 4).

2.5.4.1 Station Initialisation

Release of connections can be initiated by either the controlling or the controlled station. Connection establishment is performed by:

- The controlling station in case of a controlled station as a partner
- A fixed selection (parameter) in case of two equivalent controlling stations or partners (not for rtu's)

2.5.4.2 General Interrogation

The general interrogation application function is used to update the controlling station after the internal station initialisation procedure, when the controlling station detects a loss of information or when the controlling station detects a loss of communication.

The general interrogation function of the controlling station requests the controlled station to transmit the actual values of all its process variables. The interrogation procedure completes when the controlling station receives an End of Interrogation message.

The interrogation procedure can be interrupted by events that may eventually occur in the controlled station

2.5.4.3 Command Transmission

The Interoperability form (Chapter 4) shows the used commands that must be configurable, and verified and approved by ENEXIS B.V. before configuring the system.
It shall be possible to switch on or off the public lighting and overrule the autonomous public lighting programs with IEC104 commands.

The use of Select & Execute or Direct Execute might be different per controlled station and must be configurable per command type. ENEXIS B.V. uses a single command to change status of a single point data object, a double command to change status of a double point data object.

The ENEXIS B.V. PID 104 does not specify in which sequence the termination message and the change of state event should arrive. Hence the application in the controlling station must check that the command has been properly executed.

If an EXECUTE command message is not received in the controlled station within a certain time interval after a SELECT message, the select/execute procedure will time out in the controlled station. This time-out interval shall be configurable to a maximum of 60 seconds.

If a TERMINATION command message is not received in the controlled station within a certain time interval after a SELECT message, the command procedure will time out in the controlled station. This time-out interval shall be configurable.

The time tag of a command is always to be checked by the receiving station to determine if the command is excessively delayed. In case of a delayed command no command confirmation is to be returned by the protocol, and the command is not executed.

While waiting for a SELECT / EXECUTE confirmation no new SELECT / EXECUTE command is sent. This rule is applicable per controlled station.

When a select and execute command (single, double command, etc) has been given by the user process, no new select and execute or direct command is treated by the protocol until the ongoing select and execute command has reached any of the following states:

1. The SELECT command is completed and has been followed by a EXECUTE and TERMINATION indicating that the command is executed correctly
2. Timeout between the command and the command confirmation has occurred in any of the stages
3. A negative command confirmation has been received

These rules are also applicable per controlled station. The aim is to have only one selected point in a controlled station at a time, for security reasons.

2.5.4.4 Clock Synchronisation

NTP is used for clock synchronisation.
Optionally global clock synchronization with broadcast address and clock synchronisation for each specific address can be used.
Enexis will synchronize all DALI-box clocks via the GPRS network using an NTP server (to be defined by Enexis if this is the controlling station, EIserver or another system). The NTP time value is UTC. The ComHub shall convert the UTC to local time with day light saving for the 104 time tags.

Within Enexis the local time is used. For this reason the summertime bit within the CP56Time2a timetag will be used. The day of week bit will not be used and can therefore be set to 0.

It is the responsibility of the vendor that there will be no mismatch in the time tags when displaying time tagged data, exchange time tagged data and storing this time tagged data.

After a change of state of an indication or measurement the event is transferred once with time-stamp.

2.5.4.5 Cyclic Data Transmission an dead band

Sending cyclic analogues must be supported and configurable. Also the dead band values need to be configurable in the controlled station. Sending cyclic data with report of events if the value exceeds the dead band, e.g. every minute with COT=1 cyclic and as an event (COT=3 spontaneous) if the actual value in the slave exceeds the dead band value configured in the slave.

Threshold settings shall be set out of band, not via IEC104-setpoints.

2.5.4.6 Acquisition of Events

Events occur spontaneously at the application level of the local (controlled) station. The local process requires an event buffer to collect events that may appear faster than their transmission to the remote (controlling) station can be accomplished.

The configured maximum frame length of the system determines the maximum number of events in an event ASDU.

2.5.5 Performance

Under normal conditions a minimum of 1000 information objects per minute must be transmitted. All data, and especially the General Interrogation data, must be sent with a minimum of messages. This can be achieved by sending ASDU's containing the maximum of information elements per information type (single point, double point, analogue information, etcetera).

2.5.6 Quality descriptors

The protocol implementations must always support quality bits. Vendors of stations that issue monitoring data should implement the quality bits in the application to a largest possible extent, in accordance with the definitions. Vendors of stations that receive monitoring data should implement all quality bits that are defined in the standard in order to support all received quality information.

QDS	Description According to IEC 60870-5-101, §7.2.1 & §7.2.6.3
<OV>	Overflow/No overflow (Meaning data is exceeding a pre-defined boundary, applies mainly to Measurands and Tap changer indications)
<BL>	Blocked/Not blocked (Meaning data is blocked for transmission, a lock is put on it locally)
<SB>	Substituted/Not substituted (Meaning data was updated in an other way (manually) than by the automatic source)
<NT>	Topical/Not topical (Meaning data is topical if the most recent update was successful. It is not topical if it was not updated successfully during a specified time interval or if it is unavailable; e.g. if the source/IO-rack is not available)
<IV>	Invalid (Meaning data may be incorrect and can not be used, e.g. due to abnormal circumstances in an object)

2.5.7 Time tags

Within ENEXIS B.V. local time is used. For this reason the summertime bit within the CP56Time2a timetag will be used. The day of week bit will not be used and can therefore be set to 0.

It is the responsibility of the vendor that there will be no mismatch in the time tags when displaying time tagged data, exchange time tagged data and storing this time tagged data.

After a change of state of an Indication or measurand the event is transferred once with or without time-stamp. The default function will be without time-stamp as a response to a General Interrogation request and with time-stamp after a change of state event or in case of a measurand after passing the deadband value.

3 “HIGH LEVEL” TEST CRITERIA

The test criteria will describe the tests to be performed to prove that the protocol implementation delivered by the vendor is according to the IEC standards and the ENEXIS B.V. PID 104.

3.1 Type Registration

Informative: All functions and equipment supplied to this requirement specification must be type registered.

The supplier shall provide an attestation of conformance according to the applicable documents as in paragraph 2.1 from a third party test house for the on-site installed software version and hardware.

The supplier shall also provide completed Type Registration and Self-Certification statements including test report references, model numbers, software and firmware references etc. as necessary, to clearly identify the functionality covered by the protocol implementation.

3.2 Factory Acceptance Test

It is in the power of ENEXIS B.V. to decide if and how the FAT will be organized and which functionality will be tested.

3.3 Site Acceptance test

It is in the power of ENEXIS B.V. to decide if and how the SAT will be organized and which functionality will be tested.

3.4 Test requirements

Conformance testing enables thus the claim of a vendor being conform according the referenced documents, which need to be investigated and assessed by an objective and independent institute to establish its validity.

- An objective and (supplier) independent third party test institute must perform the conformance test. The test institue must be organized according the international standard ISO.IEC17025. Besides this standard the test organisation and test procedures must follow a quality system according ISO9001/9002. If requested ENEXIS B.V. can supply contact information of at least one independent test institute.
- The conformance test must be performed for all to be delivered types of controlling and controlled station protocol implementations.
- The conformance test will be performed against a conformance test plan that, before the conformance test will be performed, needs to be approved by ENEXIS B.V..
- When all tests described in the test plan are successfully performed the test institute will issue an Attestation of Conformance.
- An Attestation of Conformance remains valid as long as the vendor guarantees that no changes in communication hard- and software have been made that can influence the certified protocol implementation. If changes have been made, a retest is mandatory to update the Attestation of Conformity and to assure conformance.

A paper or electronic version of the Attestation of Conformance must be handed over to ENEXIS B.V.. The supplier shall also provide the belonging test reports, model numbers, software and firmware references, etc. as necessary, to clearly identify the functionality covered by the protocol implementation. All this documents, information etc. must be handed over prior to the FAT.

4 INTEROPERABILITY FORM

4.1 Introduction

This Interoperability form presents the selections of the IEC 60870-5-104 implementation by ENEXIS B.V.. Certain parameter values, such as the number of octets in the COMMON ADDRESS of ASDU's 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 summarises the parameters of the previous clauses to facilitate a suitable selection for the ENEXIS B.V. application. If a system is composed of equipment from different manufacturers, or improves vendor independence in the future, it is necessary that all partners agree on the selected parameters and that all the items with "X" marked boxes are CONFIGURABLE.

Unmarked white boxes represent parameters that are currently not required. However, selections of such parameters can be agreed upon in specific projects.

4.2 Interoperability list

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
X	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.

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

4.2.1 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 (Definition for Master and Slave)
- [ ] Controlling station definition (Master)
- [ ] Controlled station definition (Slave)

4.2.2 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~~

4.2.3 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~~	

4.2.4 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 procedure

- ■ ~~Balanced transmission~~
- ■ ~~Unbalanced transmission~~

Address field of the link

- ■ ~~not present (balanced transmission only)~~
- ■ ~~One octet~~
- ■ ~~Two octets~~
- ■ ~~structured~~
- ■ ~~unstructured~~

Frame length

- ■ ~~Maximum length L (number of octets)~~

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).~~

4.2.5 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~~	[X]	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) Length of the APDU must be configurable with a maximum length of 253 (default). The maximum length may be reduced per system.

≤ 253	Maximum length of APDU per system

4.2.6 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). In this project Reversed direction is not used, however the interfaces must be able to communicate in Reversed direction in the future.

[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~~
[ ]	<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~~
[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~~
[ ]	<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
	<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
X	<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

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
	<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
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
	<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 with 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)

X	<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
[ ]	<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

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								X	X		X					
~~<2>~~	~~M_SP_TA_1~~			■		■						■	■							
<3>	M_DP_NA_1			X								X	X		X					
~~<4>~~	~~M_DP_TA_1~~			■		■						■	■							
<5>	M_ST_NA_1																			
~~<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																			
~~<12>~~	~~M_ME_TB_1~~			■		■														
<13>	M_ME_NC_1	X		X											X					
~~<14>~~	~~M_ME_TC_1~~			■		■														
<15>	M_IT_NA_1																			
~~<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							
<31>	M_DP_TB_1			X								X	X							
<32>	M_ST_TB_1																			
<33>	M_BO_TB_1																			
<34>	M_ME_TD_1																			
<35>	M_ME_TE_1																			
<36>	M_ME_TF_1			X																
<37>	M_IT_TB_1																			
<38>	M_EP_TD_1																			
<39>	M_EP_TE_1																			
<40>	M_EP_TF_1																			

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
<45>	C_SC_NA_1						X	X			X						X	X	X	X
<46>	C_DC_NA_1						X	X			X						X	X	X	X
<47>	C_RC_NA_1																			
<48>	C_SE_NA_1																			
<49>	C_SE_NB_1																			
<50>	C_SE_NC_1																			
<51>	C_BO_NA_1																			
<58>	C_SC_TA_1						X	X			X						X	X	X	X
<59>	C_DC_TA_1						X	X			X						X	X	X	X
<60>	C_RC_TA_1																			
<61>	C_SE_TA_1																			
<62>	C_SE_TB_1																			
<63>	C_SE_TC_1																			
<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																			
<102>	C_RD_NA_1																			
<103>	C_CS_NA_1			X			X	X									X	X	X	X
~~<104>~~	~~C_TS_NA_1~~																			
<105>	C_RP_NA_1*)																			
~~<106>~~	~~C_CD_NA_1~~																			
<107>	C_TS_TA_1						X	X									X	X	X	X
<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

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)

- [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)

- [X] Clock synchronization (optional)
- [ ] Day of week used
- [ ] RES1, GEN (time tag substituted/not substituted) used
- [X] SU-bit (summertime used)

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

- [X] No additional definition
- [X] Short pulse duration (duration determined by a system parameter in the outstation)
- [X] Long pulse duration (duration determined by a system parameter in the outstation)
- [ ] Persistent output

- [X] Supervision of maximum delay in command direction of commands and set point commands

configurable Maximum allowable delay of commands and set point commands with a maximum of 1 minute.

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

(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)

- ☒ 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[3]
t_0	30s	Time out of connection establishment	30s
t_1	15s	Time out of send or test APDUs	15s
t_2	10s	Time out for acknowledges in case of no data messages $t_2 < t_1$	10s
t_3	20s	Time out for sending test frames in case of a long idle state	20s

Recommended range for timeouts t_0 . t_2 : 1 s to 255 s, acurracy 1 s

Recommended range for timeouts t_3 : 0 s to 48 h, acurracy 1 s

Note: Ammendment 1 of IEC 60870-5-104 offers the possibility to have the t_3 timer configurable between 0 seconds and 48 hours. Long timeouts for t_3 may be needed in special cases where satellite links or dialup connections are used (e.g. to establish connection and collect values only once per day or week).

[3] These values should be configurable in order to meet possible specific GPRS network requirements

Maximum number of outstanding I format APDUs k and latest acknowledge

Parameter	Default value	Remarks	Selected value[4]
K	12 APDUs	Maximum difference receive sequence number to send state variable	12 APDUs
W	8 APDUs	Latest acknowledge after receiving w I-format APDUs	8 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. ……..
7. etc.

[4] These values should be configurable in order to meet possible specific network requirements