IpConv
Protocol Stack

IEC104Master

IEC 60870-5-104 Controlling Station Interoperability

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Changed Chapters	Version	Date	Change	Who	Sign
---	1.0	1.08.2005	first release	A. Votteler	
---	1.1	05.04.2007	modifications due to 2006 release of IEC 60870-5-104	A. Votteler	
---	1.2	21.06.2007	Support for commands with time tag included	A.Votteler	
	1.4	22.07.2010	Support for additional command qualifiers	A.Votteler	
	3.1	24.10.2011	Added transmission of information objects in reverse transmission	T. Kauschat	

9 Interoperability

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)

☒ Function or ASDU is used in reverse mode

☒ Function or ASDU is used in standard and reverse mode

The possible selection (blank, X, R, or B) is specified for each specific clause or parameter.

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

9.1 System or device

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

☐ System definition

☒ Controlling station definition (Master)

☐ Controlled station definition (Slave)

9.2 Network configuration

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

■ ~~Point-to-point~~

■ ~~Multipoint-~~

■ ~~Multiple-point-to-point~~

■ ~~Multipoint-star~~

9.3 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 >1 200 bit/s	Balanced interchange Circuit X.24/X.27	
~~100 bit/s~~	~~2 400 bit/s~~	~~2 400 bit/s~~	~~56 000 bit/s~~
~~200 bit/s~~	~~4 800 bit/s~~	~~4 800 bit/s~~	~~64 000 bit/s~~
~~300 bit/s~~	~~9 600 bit/s~~	~~9 600 bit/s~~	
~~600 bit/s~~		~~19 200 bit/s~~	
~~1 200 bit/s~~		~~38 400 bit/s~~	

Transmission speed (monitor direction)

Unbalanced interchange Circuit V.24/V.28 Standard	Unbalanced interchange Circuit V.24/V.28 Recommended if >1 200 bit/s	Balanced interchange Circuit X.24/X.27	
~~100 bit/s~~	~~2 400 bit/s~~	~~2 400 bit/s~~	~~56 000 bit/s~~
~~200 bit/s~~	~~4 800 bit/s~~	~~4 800 bit/s~~	~~64 000 bit/s~~
~~300 bit/s~~	~~9 600 bit/s~~	~~9 600 bit/s~~	
~~600 bit/s~~		~~19 200 bit/s~~	
~~1 200 bit/s~~		~~38 400 bit/s~~	

9.4 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

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

Frame length

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

Address field of the link

- ~~not present (balanced transmission only)~~
- ~~One octet~~
- ~~Two octets~~
- ~~Structured~~
- ~~Unstructured~~

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

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

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

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

Type identification	Cause of transmission

~~Note: (In response to a class 2 poll, a controlled station may respond with class 1 data when there is no class 2 data available).~~

9.5 Application layer

Transmission mode for application data

Mode 1 (Least significant octet first), as defined in 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) The maximum length of APDU for both directions is 253. It is a fixed system parameter

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

Selection of standard ASDUs

Process information in monitor direction

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

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

In this companion standard only the use of the set <30> – <40> for ASDUs with time tag is permitted.

Process information in control direction
(station-specific parameter, mark each Type ID "**X**" if it is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

B	<45> :=	Single command	C_SC_NA_1
B	<46> :=	Double command	C_DC_NA_1
B	<47> :=	Regulating step command	C_RC_NA_1
B	<48> :=	Set point command, normalized value	C_SE_NA_1
B	<49> :=	Set point command, scaled value	C_SE_NB_1
B	<50> :=	Set point command, short floating point value	C_SE_NC_1
B	<51> :=	Bitstring of 32 bit	C_BO_NA_1
B	<58> :=	Single command with time tag CP56Time2a	C_SC_TA_1
B	<59> :=	Double command with time tag CP56Time2a	C_DC_TA_1
B	<60> :=	Regulating step command with time tag CP56Time2a	C_RC_TA_1
B	<61> :=	Set point command, normalized value with time tag CP56Time2a	C_SE_TA_1
B	<62> :=	Set point command, scaled value with time tag CP56Time2a	C_SE_TB_1
B	<63> :=	Set point command, short floating point value with time tag CP56Time2a	C_SE_TC_1
B	<64> :=	Bitstring of 32 bit with time tag CP56Time2a	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).

B	<100>:=	Interrogation command	C_IC_NA_1
B	<101>:=	Counter interrogation command	C_CI_NA_1
	<102>:=	Read command	C_RD_NA_1
X	<103>:=	Clock synchronization command (option see 7.6)	C_CS_NA_1
	~~<104>:=~~	~~Test command~~	~~C_TS_NA_1~~
X	<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).

X	<110>:=	Parameter of measured value, normalized value	P_ME_NA_1
X	<111>:=	Parameter of measured value, scaled value	P_ME_NB_1
X	<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).

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

Type identifier and cause of transmission assignments
(station-specific parameters)

Shaded boxes: option not required.

Black boxes: option not permitted in this companion standard

Blank: functions or ASDU 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		B	B								B	B		B					
~~<2>~~	~~M_SP_TA_1~~																			
<3>	M_DP_NA_1		B	B								B	B		B					
~~<4>~~	~~M_DP_TA_1~~																			
<5>	M_ST_NA_1		B	B								B	B		B					
~~<6>~~	~~M_ST_TA_1~~																			
<7>	M_BO_NA_1		B	B											B					
~~<8>~~	~~M_BO_TA_1~~																			
<9>	M_ME_NA_1	B	B	B											B					
~~<10>~~	~~M_ME_TA_1~~																			
<11>	M_ME_NB_1	B	B	B											B					
~~<12>~~	~~M_ME_TB_1~~																			
<13>	M_ME_NC_1	B	B	B											B					
~~<14>~~	~~M_ME_TC_1~~																			
<15>	M_IT_NA_1			B												B				
~~<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		X	X											X					
<21>	M_ME_ND_1	B	B	B											B					
<30>	M_SP_TB_1			B								B	B							
<31>	M_DP_TB_1			B								B	B							
<32>	M_ST_TB_1			B								B	B							
<33>	M_BO_TB_1			B																
<34>	M_ME_TD_1			B																
<35>	M_ME_TE_1			B																
<36>	M_ME_TF_1			B																
<37>	M_IT_TB_1			B												B				
<38>	M_EP_TD_1			B																
<39>	M_EP_TE_1			B																
<40>	M_EP_TF_1			B																
<45>	C_SC_NA_1						B	B	B	B	B						X	X	X	X
<46>	C_DC_NA_1						B	B	B	B	B						X	X	X	X
<47>	C_RC_NA_1						B	B	B	B	B						X	X	X	X
<48>	C_SE_NA_1						B	B	B	B	B						X	X	X	X
<49>	C_SE_NB_1						B	B	B	B	B						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						B	B	B	B	B						X	X	X	X
<51>	C_BO_NA_1						B	B			B						X	X	X	X
<58>	C_SC_TA_1						B	B	B	B	B						X	X	X	X
<59>	C_DC_TA_1						B	B	B	B	B						X	X	X	X
<60>	C_RC_TA_1						B	B	B	B	B						X	X	X	X
<61>	C_SE_TA_1						B	B	B	B	B						X	X	X	X
<62>	C_SE_TB_1						B	B	B	B	B						X	X	X	X
<63>	C_SE_TC_1						B	B	B	B	B						X	X	X	X
<64>	C_BO_TA_1						B	B			B						X	X	X	X
<70>	M_EI_NA_1*				X															
<100>	C_IC_NA_1						B	B	B	B	B						X	X	X	X
<101>	C_CI_NA_1						X	X			X						X	X	X	X
<102>	C_RD_NA_1																			
<103>	C_CS_NA_1						X	X									X	X	X	X
~~<104>~~	~~C_TS_NA_1~~																			
<105>	C_RP_NA_1						X	X									X	X	X	X
~~<106>~~	~~C_CD_NA_1~~																			
<107>	C_TS_TA_1																			
<110>	P_ME_NA_1						X	X							X		X	X	X	X
<111>	P_ME_NB_1						X	X							X		X	X	X	X
<112>	P_ME_NC_1						X	X							X		X	X	X	X
<113>	P_AC_NA_1																			
<120>	F_FR_NA_1													X			X	X	X	X
<121>	F_SR_NA_1													X			X	X	X	X
<122>	F_SC_NA_1					X								X			X	X	X	X
<123>	F_LS_NA_1													X			X	X	X	X
<124>	F_AF_NA_1													X			X	X	X	X
<125>	F_SG_NA_1													X			X	X	X	X
<126>	F_DR_TA_1*			X		X														
<127>	F_SC_NB_1*																			

* Blank or X only

9.6 Basic application functions

Station initialization
(station-specific parameter, mark "**X**" if function is used)

[X] 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)

[B] 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)

[B] 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.

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

*** This behaviour is subject to configuration**

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).

- [B] global
- [R] group 1
- [R] group 2
- [R] group 3
- [R] group 4
- [R] group 5
- [R] group 6
- [R] group 7
- [R] group 8
- [R] group 9
- [R] group 10
- [R] group 11
- [R] group 12
- [R] group 13
- [R] group 14
- [R] group 15
- [R] 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
- [X] Day of week used
- [ ] RES1, GEN (time tag substituted/ not substituted) used
- [X] SU-bit (summertime) used

optional, see 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).

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

- [B] No additional definition
- [B] Short-pulse duration (duration determined by a system parameter in the outstation)
- [B] 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
- [**adjustable**] Maximum allowable delay of commands and set point commands

Transmission of integrated totals
(station- or object-specific parameter, mark "**X**" if function is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

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

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

- [B] General request counter
- [R] Request counter group 1
- [R] Request counter group 2
- [R] Request counter group 3
- [R] 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).

- [X] Threshold value
- [X] Smoothing factor
- [X] Low limit for transmission of measured values
- [X] High limit for transmission of measured values

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

[X] 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

[X] 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).

[B] Background scan

Acquisition of transmission delay
(station-specific parameter, mark "**X**" if function is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

[■] ~~Acquisition of transmission delay~~

Definition of time outs

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

Maximum range for timeouts t0 to t2: 1 s to 255 s, accuracy 1 s.
Recommended range for timeout t3: 1 s to 48 h, resolution 1 s.
Long timeouts for t3 may be needed in special cases where satellite links or dialup connections are used (for instance to establish connection and collect values only once per day or week).

Maximum number of outstanding I format APDUs *k* and latest acknowledge APDUs (*w*)

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

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 two-thirds of *k*).

Portnumber

Parameter	Value	Remarks
Portnumber	2404	In all cases

Redundant connections

>16 Number N of redundancy group connections used

RFC 2200 suite

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