IEC 60870-5-101 Protocol Client Master Interoperability

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IEC 60870-5-101 Protocol

FreyrSCADA Embedded Solution

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Contents

Interoperability

This companion standard presents sets of parameters and alternatives from which subsets have to be selected to implement particular telecontrol systems. Certain parameter values, such as the number of octets in the COMMON 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 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.

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.

System or device

(System-specific parameter, indicate the station's function by marking one of the following with "**X**")

☐ System definition

☒ Controlling station definition (master)

☐ Controlled station definition (slave)

Network Configuration

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

☒ Point-to-point

☒ Multiple point-to-point

☒ Multipoint-party line

☒ Multipoint-star

Physical Layer

(Network-specific parameter, all interfaces and data rates that are used are to be marked with an "**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	☒ 2400 bit/s	☒ 2400 bit/s	☒ 56000 bit/s
☒ 200 bit/s	☒ 4800 bit/s	☒ 4800 bit/s	☒ 64000 bit/s
☒ 300 bit/s	☒ 9600 bit/s	☒ 9600 bit/s	
☒ 600 bit/s		☒ 19200 bit/s	
☒ 1200 bit/s		☒ 38400 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	☒ 2400 bit/s	☒ 2400 bit/s	☒ 56000 bit/s
☒ 200 bit/s	☒ 4800 bit/s	☒ 4800 bit/s	☒ 64000 bit/s
☒ 300 bit/s	☒ 9600 bit/s	☒ 9600 bit/s	
☒ 600 bit/s		☒ 19200 bit/s	
☒ 1200 bit/s		☒ 38400 bit/s	

Link Layer

(Network-specific parameter, all options that are used are to be marked with an "**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 link

☒ Not present (balanced transmission only)

☒ One octet

☒ Two octets

☒ Structured

☒ Unstructured

Frame length

255	Maximum length L (control direction)
255	Maximum length L (monitor direction)

Configurable	Time during which repetitions are permitted (Trp) or number of repetitions

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
Configurable	Configurable

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.

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 ☒ Two octets

Information object address

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

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

Cause of transmission

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

☒ One octet ☒ Two octets (with originator address)
Set to zero in case of no originator address

Selection of standard ASDUs

Process information in monitor direction

(Station-specific parameter, mark each type ID 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)

☒	<1> := Single-point information	M_SP_NA_1
☒	<2> := Single-point information with time tag	M_SP_TA_1
☒	<3> := Double-point information	M_DP_NA_1
☒	<4> := Double-point information with time tag	M_DP_TA_1
☒	<5> := Step position information	M_ST_NA_1
☒	<6> := Step position information with time tag	M_ST_TA_1
☒	<7> := Bitstring of 32 bit	M_BO_NA_1
☒	<8> := Bitstring of 32 bit with time tag	M_BO_TA_1
☒	<9> := Measured value, normalized value	M_ME_NA_1
☒	<10> := Measured value, normalized value with time tag	M_ME_TA_1
☒	<11> := Measured value, scaled value	M_ME_NB_1
☒	<12> := Measured value, scaled value with time tag	M_ME_TB_1
☒	<13> := Measured value, short floating point value	M_ME_NC_I
☒	<14> := Measured value, short floating point value with time tag	M_ME_TC_1
☒	<15> := Integrated totals	M_IT_NA_1
☒	<16> := Integrated totals with time tag	M_IT_TA_1
☒	<17> := Event of protection equipment with time tag	M_EP_TA_1
☒	<18> := Packed start events of protection equipment with time tag	M_EP_TB_1
☒	<19> := Packed output circuit information of protection equipment with time tag	M_EP_TC_1
☐	<20> := Packed single-point information with status change detection	M_PS_NA_1
☒	<21> := Measured value, normalized value without quality descriptor	M_ME_ND_1
☒	<30> := Single-point information with time tag CP56Time2a	M_SP_TB_1
☒	<31> := Double-point information with time tag CP56Time2A	M_DP_TB_1
☒	<32> := Step position information with time tag CP56Time2A	M_ST_TB_1
☒	<33> := Bitstring of 32 bit with time tag CP56Time2A	M_BO_TB_1
☒	<34> := Measured value, normalized value with time tag CP56Time2A	M_ME_TD_1
☒	<35> := Measured value, scaled value with time tag CP56Time2A	M_ME_TE_1
☒	<36> := Measured value, short floating point value with time tag CP56Time2A	M_ME_TF_1
☒	<37> := Integrated totals with time tag CP56Time2A	M_IT_TB_1
☒	<38> := Event of protection equipment with time tag CP56Time2A	M_EP_TD_1
☒	<39> := Packed start events of protection equipment with time tag CP56time2A	M_EP_TE_1
☒	<40> := Packed output circuit information of protection equipment with time tag CP56Time2a	M_EP_TF_1

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

Process information in control direction

(Station-specific parameter, mark each type ID 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)

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

System information in monitor direction

(Station-specific parameter, mark 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)

☒<70> := End of initialization	M_EI_NA_1

System information in control direction

(Station-specific parameter, mark each type ID 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)

☒ <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_NB_1
☒ <105> := Reset process command	C_RP_NC_1
☒ <106> := Delay acquisition command	C_CD_NA_1

Parameter in control direction

(Station-specific parameter, mark each type ID 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)

☒ <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 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)

☒	<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	F_DR_TA_1

Type identification and cause of transmission assignments

(Station-specific parameters)

Shaded boxes are not required.

Blank = function or ASDU is not used.

Mark type identification/cause of transmission combinations:

"**X**" if used only in the standard direction;

"**R**" if used only in the reverse direction;

"**B**" if used in both directions.

Type identification		Cause of transmission																		
		periodic, cyclic	background scan	spontaneous	initialized	request or requested	activation	activation confirmation	deactivation	deactivation confirmation	activation termination	return info caused by a remote cmd	return info caused by a local cmd	file transfer	interrogated by group <number>	request by group <n> counter request	unknown type identification	unknown cause of transmission	unknown common address of ASDU	unknown information object address
		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	X		X					
<2>	M_SP_TA_1			X		X						X	X							
<3>	M_DP_NA_1		X	X		X						X	X		X					
<4>	M_DP_TA_1			X		X						X	X							
<5>	M_ST_NA_1		X	X		X						X	X		X					
<6>	M_ST_TA_1			X		X						X	X							
<7>	M_BO_NA_1		X	X		X									X					
<8>	M_BO_TA_1			X		X														
<9>	M_ME_NA_1	X	X	X		X									X					
<10>	M_ME_TA_1			X		X														
<11>	M_ME_NB_1	X	X	X		X									X					
<12>	M_ME_TB_1			X		X														
<13>	M_ME_NC_1	X	X	X		X									X					
<14>	M_ME_TC_1			X		X														
<15>	M_IT_NA_1			X												X				
<16>	M_IT_TA_1			X												X				
<17>	M_EP_TA_1			X																
<18>	M_EP_TB_1			X																
<19>	M_EP_TC_1			X																
<20>	M_PS_NA_1																			
<21>	M_ME_ND_1	X	X	X		X									X					
<30>	M_SP_TB_1			X		X						X	X							
<31>	M_DP_TB_1			X		X						X	X							
<32>	M_ST_TB_1			X		X						X	X							
<33>	M_BO_TB_1			X		X														
<34>	M_ME_TD_1			X		X														
<35>	M_ME_TE_1			X		X														
<36>	M_ME_TF_1			X		X														
<37>	M_IT_TB_1			X												X				
<38>	M_EP_TD_1			X																
<39>	M_EP_TE_1			X																
<40>	M_EP_TF_1			X																

Type identification		Cause of transmission																		
		periodic, cyclic	background scan	spontaneous	initialized	request or requested	activation	activation confirmation	deactivation	deactivation confirmation	activation termination	return info caused by a remote cmd	return info caused by a local cmd	file transfer	interrogated by group <number>	request by group <n> counter request	unknown type identification	unknown cause of transmission	unknown common address of ASDU	unknown information object address
		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	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						X	X	X	X	X						X	X	X	X
<49>	C_SE_NB_1						X	X	X	X	X						X	X	X	X
<50>	C_SE_NC_1						X	X	X	X	X						X	X	X	X
<51>	C_BO_NA_1						X	X	X	X	X						X	X	X	X
<70>	M_EI_NA_1*)				X															
<100>	C_IC_NA_1						X	X	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			X			X	X									X	X	X	X
<104>	C_TS_NA_1						X	X									X	X	X	X
<105>	C_RP_NA_1						X	X									X	X	X	X
<106>	C_CD_NA_1			X			X	X									X	X	X	X
<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						X	X	X	X							X	X	X	X
<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														

*** Blank or X only**

Basic Application Functions

Station initialization

(Station-specific parameter, mark with an "**X**" if function is used)

☒ Remote initialization

Cyclic data transmission

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

☒ Cyclic data transmission

Read procedure

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

☒ Read procedure

Spontaneous transmission

(Station-specific parameter, mark with an "**X**" if function is used only in the standard direction, "**R**" if used only 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 with an "**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, see 7.2.1.1)

☒ Measured value, normalized value M_ME_NA_1, M_ME_TA_1, M_ME_ND_1 and M_ME_TD_1

☒ Measured value, scaled value M_ME_NB_1, M_ME_TB_1 and M_ME_TE_1

☒ Measured value, short floating point number M_ME_NC_1, M_ME_TC_1 and M_ME_TF_1

Station Interrogation

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

☒ global

☒ group 1	☒ group 7	☒ group 13
☒ group 2	☒ group 8	☒ group 14
☒ group 3	☒ group 9	☒ group 15
☒ group 4	☒ group 10	☒ group 16
☒ group 5	☒ group 11	
☒ group 6	☒ group 12	Addresses per group have to be defined

Clock synchronization

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

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

Command transmission

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

☒ Direct command transmission
☒ Direct set point command transmission

☒ Select and execute command
☒ Select and execute set point command
☒ C_SE_ACTTERM used

☒ No additional definition
☒ Short pulse duration (duration determined by a system parameter in the outstation)
☒ Long pulse duration (duration determined by a system parameter in the outstation)
☒ Persistent output

Transmission of Integrated totals

(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)

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

☒ Counter read
☒ Counter freeze without reset
☒ Counter freeze without 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 with an "**X**" if function is used only in the standard direction, "**R**" if used only 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 with an "**X**" if function is used only in the standard direction, "**R**" if used only 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
☐ Transmission of sequences of events
☐ Transmission of sequences of recorded analog 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