Series PM130 PLUS Powermeters
PM130P/PM130E/PM130EH

IEC60870-5-101/104 Communications Protocol

Reference Guide

BG0503 Rev. A3

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1 General

This document specifies a subset of the IEC60780-5-101/104 communications protocol used to transfer data between a master controlling station and the PM130 PLUS. The document provides the complete information necessary to develop third-party communications software capable of communication with the Series PM130 PLUS meters.

IEC 60870-5-101/104 references:

IEC 60870-5-1:1990, Telecontrol Equipment and Systems - Part 5, Transmission Protocols - Section 1: Transmission frame formats

IEC 60870-5-2:1991, Telecontrol Equipment and Systems - Part 5, Transmission Protocols - Section 2: Link transmission procedures

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 60870-5-101:2003-02, Telecontrol Equipment and Systems - Part 5, Transmission Protocols - Section 101: Companion standard for basic telecontrol tasks

IEC 60870-5-104:2006-06, Telecontrol Equipment and Systems - Part 5, Transmission Protocols - Section 104: Network access for IEC 60870-5-101 using standard transport profiles

NOTE:

In 3-wire connection schemes, the unbalanced current and phase readings for power factor, active power, and reactive power will be zeros, because they have no meaning. Only the total three-phase power values will be available.

Designations used in the guide:

E - available in the PM130E and PM130EH

EH - available in the PM130EH

2 Protocol Implementation

2.1 Configuring IEC 60870-5

The PM130 protocol stack is implemented in a very flexible manner. Most of IEC 60870-5-101/104 protocol features are user-configurable allowing easy adaptation for use in different IEC 60870-5 installations. To keep maximum interoperability with master RTU and SCADA systems, the PM130 supports all standard ASDU types for data interrogation, event reporting and control.

The support PAS configuration software supplied with the meter provides all necessary tools for remote configuration of the meter via serial ports or via a TCP/IP Internet connection using either IEC 60870-5-101/104, or Modbus protocol.

See Chapter 6 for instructions on how to configure IEC 60870-5 options in the meter for your particular installation.

See the PM130 PLUS Installation and Operation Manual for more information on configuring the meter via PAS.

The protocol implementation details are explained in the following sections.

2.2 Communicating via IEC 60870-5 Ports

The PM130 supports unbalanced IEC 60870-5-101 communications via serial ports and multiple balanced IEC 60870-5-104 TCP/IP connections via an Ethernet port.

Serial IEC 60870-5-101 Connections

The PM130 has one standard RS-485 port, and an additional installable RS-232/422/485 port can be ordered to provide communications with two master stations. Both serial ports can operate simultaneously either in IEC 60870-5-101, or in Modbus mode.

TCP/IP IEC 60870-5-104 Connections

The installable Ethernet port provides an IEC 60870-5-104 TCP server on port 2404 that supports two simultaneous connections with controlling stations via IEC 60870-5-104 protocol.

The second Modbus TCP server on port 502 provides two additional simultaneous connections with the meter via Modbus TCP protocol without affecting IEC 60870-5-104 communications, so you can easily configure and monitor your network meters via PAS using its extended Modbus features.

NOTES:

1. To launch the IEC 60870-5-104 TCP server, either configure the COM2 port for operating in IEC 60870-5 mode, or set the TCP port number to 2404 via the meter Network Setup.
2. For cyclic/spontaneous data transmission via the IEC 60870-5-104 port, the installable Ethernet module must have firmware 61.1.6 or higher.

The following functionality is specific for the PM130 IEC 60870-5-104 port:

1. An idling connection is closed in 2 minutes if there is no activity on both sides. To keep a rarely used connection open, either periodically send test APDU to the meter, or configure cyclic data transmission in the meter to maintain some kind of activity on the connection socket.
2. Data transmission is suspended when the number of unacknowledged ASDU sent to a controlling station exceeds the maximum number configured in the meter. The meter has limited memory of about 2K to keep pending messages, so the master station should send acknowledgments as frequently as possible to avoid loss of data.

   You can disable this feature by setting the maximum number of unacknowledged ASDU to zero causing the meter to never suspend data transmission.

2.3 Device Addressing

The data link address field in IEC 60870-5-101 and the COMMON ADDRESS OF ASDU represent the device address assigned in the meter to an IEC 60870-5-101/104 communication port. See the PM130 PLUS Installation and Operation Manual on how to configure the device address in your meter.

The data link address and COMMON ADDRESS OF ASDU length are configurable for IEC 60870-5-101 ports (see Section 6.1 for details).

2.4 Information Object Addressing and Mapping

Information object address length is configurable for IEC 60870-5-101 ports and is fixed to 3 octets in IEC 60870-5-104. See Section 6.1 for more information on selecting the object address length in the meter.

Information object addressing scheme normally uses structured two-octet (three-octet in IEC 60870-5-104) addresses. See Chapter 3 for the full list of the available object points and their addresses.

The PM130 allocates a special configurable address space in the range of 1 to 4095 for user-assignable point addresses called mapped points. Mapped points can be used as aliases of the original point addresses to provide a more convenient and faster way for polling and interrogating data. Event reporting in the PM130 is only available for mapped points.

You can remap any of 64 general object points listed in Section 3.2 to a single range or a number of ranges in the configurable address space. See Section 6.2 for more information on remapping object addresses.

Different classes of objects - measurement values, single points, double points and integrated totals – can be remapped to separate ranges with a configurable starting object address. See Section 6.1 on how to configure the starting address for mapped object points.

When required, one-octet addresses can be used for IEC 60870-5-101 ports by remapping points to the address range of 1 to 255.

2.5 Interrogation

The PM130 supports general and group interrogation commands for binary and analog objects. Address ranges for general and group interrogation are configurable via the IEC 60870-5 Class 2 Data and Counters Setup (see Section 6.3).

Up to 15 groups can be arranged for group interrogation. Any compatible ASDU data type can be separately selected for each range of points regardless of the configured default object type.

Interrogated data are sent in the order they are listed in the Class 2 Data Setup. The meter always responds to interrogation requests with a sequence of information objects ASDU with the SQ bit in the variable structure qualifier set to 0.

2.6 Cyclic Data Transmission

Object address ranges for cyclic data transmission are configurable via the IEC 60870-5 Class 2 Data and Counters Setup (see Section 6.3). Any compatible ASDU data type can be separately selected for each range of points regardless of the configured default object type.

Cyclic data is sent in the order they are listed in the Class 2 Data Setup. The meter always transmits cyclic data using a sequence of information objects ASDU with the SQ bit in the variable structure qualifier set to 0.

IEC 60870-5-101 Cyclic Transmission

In IEC 60870-5-101, the meter responds to class 2 data requests with data configured for cyclic transmission if there are no higher priority messages ready for transmission. An interrogation command interrupts a cyclic transmission sequence, which is automatically restarted after the interrogation command has been responded.

IEC 60870-5-104 Cyclic Transmission

In IEC 60870-5-104, configured cyclic data is transmitted periodically to the selected controlling station after it confirms start of data transfer. An interrogation command interrupts cyclic transmission in progress, which is automatically restarted after the interrogation command has been responded.

See Section 6.1 on how to set up a client IP address for cyclic data transmission and the cyclic transmission period.

2.7 Transmission of Integrated Totals

The PM130 supports modes A, B, C and D of acquisition of integrated totals – local freeze (with or without reset) with spontaneous transmission, local freeze (with or without reset) with counter interrogation, counter interrogation with/without remote freeze (with or without reset), and counter freeze by an interrogation command with spontaneous transmission of frozen values.

Object address ranges for counter transmission are configurable via the IEC 60870-5 Class 2 Data and Counters Setup (see Section 6.3). Up to 4 groups can be arranged for counter group interrogation. Any compatible ASDU data type can be separately selected for each range of points regardless of the configured default counter object type.

Interrogated data is sent in the order they are listed in the Class 2 Data and Counters Setup. The meter always transmits counters using a sequence of information objects ASDU with the SQ bit in the variable structure qualifier set to 0.

NOTES:

1. The sequence number in the counter qualifier is incremented modulo 32 after each local or remote freeze.
2. The counter overflow is indicated in case the actual counter rolls over to zero since last counter reading. The counter adjustment is indicated when the counter has been preset or cleared outside of the standard sequence controlled by local freeze and remote interrogation commands.
3. When using multiple connections via IEC60870-5 ports, only one client should use counter interrogation commands with FRZ qualifiers 1-3 to maintain consistency of the counter freeze buffers.
4. Do not apply interrogation commands with FRZ qualifiers 1-2 to counters with local freeze, as they will disturb frozen counter buffers.

2.7.1 Transmission Counters with Local Freeze

Integrated totals configured for mode A or B transmission (those checked for local freeze in the IEC 60870-5 Class 2 Data and Counters Setup, see Section 6.3), are locally frozen at configurable intervals synchronized with the meter clock. If the local freeze period is evenly divisible into an hour, the counter freeze/transmission intervals will be synchronized with the beginning of the hour. See Section 6.1 on how to set up the local freeze period for mode A or B transmission.

If the counter range is checked for freeze with reset, the actual counters are reset to zero after current counter values are frozen in the freeze buffers.

Frozen values signed for spontaneous transmission are transmitted with spontaneous cause of transmission <3> in response to the class 1 requests in IEC 60870-5-101 and spontaneously to the selected client IP address in IEC 60870-5-104.

Interrogation commands with FRZ=0 for ranges of counters signed for local freeze return locally frozen counter values.

2.7.2 Counter Interrogation with/without Remote Freeze

The PM130 supports general and group counter interrogation commands with FRZ qualifiers 0-3:

<0> - read (no freeze or reset)

<1> - counter freeze without reset

<2> - counter freeze with reset

<3> - counter reset

Interrogation commands with remote freeze qualifiers FRZ=1 and FRZ=2 cause the specified counters' values to be locally frozen to the freeze buffers, optionally followed by the reset of the actual counter values for commands with FRZ=2. Commands with FRZ=1-3 do not cause the counter values to be transmitted.

Interrogation commands with FRZ=0 (no freeze, no reset) are responded either with the frozen counter values if the command was preceded by a remote or local freeze, or with the actual counter values for counters that were not frozen.

For mode D of spontaneous counter transmission with remote freeze, check the required counters for spontaneous transmission without local freeze (see Section 6.3). They will be transmitted with cause of transmission <3> in response to class 1 requests in IEC 60870-5-101 and spontaneously to the client IP address selected for spontaneous data transmission in IEC 60870-5-104.

NOTE:

Integrated totals checked for spontaneous transmission without local freeze that have not been frozen by a remote freeze command will be periodically reported at specified local freeze/transmission intervals with the actual counter values.

2.8 Event Reporting

The PM130 provides up to 64 configurable setpoints for reporting events when a measured value exceeds a predefine threshold or changes by a certain percentage, or a binary point status changes. The scan period for events is one power frequency cycle time for binary events, and 200 ms for analog events.

Events can only be reported for mapped static object points in the address range of 1 to 4095. Default data types for event reporting are configurable via the IEC 60870-5 Options Setup (see Section 6.1) for supported classes of objects. See Section 6.2 on how to select object point addresses and configure thresholds for event reporting.

The meter always reports events in a chronological order by a sequence of information objects ASDU with the SQ bit in the variable structure qualifier set to 0.

The meter data change buffers can hold up to 128 unreported events.

IEC 60870-5-101 Event Reporting

In IEC 60870-5-101, collected events are transmitted in response to class 1 requests. The meter can also respond with class 1 data to class 2 requests if there is no class 2 data in transmission and this option is enabled in the IEC 60870-5 Options Setup (see Section 6.1).

IEC 60870-5-104 Event Reporting

In IEC 60870-5-104, collected events are transmitted spontaneously to the selected controlling station after it confirms start of data transfer. See Section 6.1 on how to set up a client IP address for spontaneous event transmission.

NOTES:

1. Event reports on counter change events always follow the actual counter changes and are reported with the actual counter values.
2. Because the PM130 maintains a single set of data change buffers, only one master connected to the meter can receive spontaneous event reports. You should not send

class 1 requests via a serial connection if you configured a client IP address for spontaneous event transmission via a TCP/IP connection.

2.9 Clock Synchronization

The meter clock time is local time.

The IV Invalid bit in the binary time elements is set to 1 after the meter loses power and is reset to 0 when the meter time is updated by the C_CS_NA_1 Clock synchronization command.

The meter can periodically request clock synchronization by setting the IV Invalid bit in the time tag of the information objects to 1 if the Time sync period in the IEC 60870-5 Options setup is configured to a non-zero value. See Section 6.1 on how to configure the Time sync period in your meter.

In case of using a tree octet CP24Time2a time tag in event ASDU types, the meter sends spontaneous clock synchronization messages to the controlling station at the beginning of each hour. In IEC 60870-5-104 using CP24Time2a time tags should be avoided.

2.10 Single and Double Commands

The PM130 supports single and double commands addressed to meter relay outputs.

See the following table for description of relay output operation using single commands.

Single Command State (SCS)	Qualifier of Command (QU)	Relay Output Operation
0 (Not permitted)	Any	No action
1 (OFF)	0 (No additional definitions)	Short pulsed ON
	1 (Short pulse duration)	Short pulsed ON
	2 (Long pulse duration)	Long pulsed ON
	3 (Persistent output)	Latched OFF
2 (ON)	0 (No additional definitions)	Short pulsed ON
	1 (Short pulse duration)	Short pulsed ON
	2 (Long pulse duration)	Long pulsed ON
	3 (Persistent output)	Latched ON
3 (Not permitted)	Any	No action

Double commands must always be sent to the first relay output address between two adjacent addresses occupied by a double point object. See the following table for description of relay output operation using double commands.

Double Command State (DCS)	Qualifier of Command (QU)	Relay Output Operation	
		RO1	RO2
0 (Not permitted)	Any	No action	No action
1 (OFF)	0 (No additional definitions)	Short pulsed ON	No action
	1 (Short pulse duration)	Short pulsed ON	No action
	2 (Long pulse duration)	Long pulsed ON	No action
	3 (Persistent output)	Latched ON	Latched OFF
2 (ON)	0 (No additional definitions)	No action	Short pulsed ON
	1 (Short pulse duration)	No action	Short pulsed ON
	2 (Long pulse duration)	No action	Long pulsed ON
	3 (Persistent output)	Latched OFF	Latched ON
3 (Not permitted)	Any	No action	No action

The short and long pulse duration for pulsed operations are configurable via the IEC 60870-5 Options Setup (see Section 6.1).

NOTE:

Single and double commands with QU=0 are executed using a configured short pulse duration by default.

Command execution is always confirmed by C_SC_ACTTERM or C_DC_ACTTERM.

Single and double commands with qualifiers QU=0-2 (pulse operation) will not have effect unless meter relay outputs are configured for pulse mode operation, and commands with qualifier QU=3 (persistent output) will not be effective unless relay outputs are configured for operation in either unlatched, or latched mode (both modes provide latched operations on remote commands).

See the meter Installation and Operation manual on how to configure relay outputs for operation in pulse or latched mode. The IEC 60870-5 pulse duration settings override the default relay pulse width configured for relay outputs in the meter.

2.11 Read Command

Default data types for responses to a C_RD_NA_1 Read command for general and mapped object points listed in Sections 3.1 and 3.2 are configurable via the IEC 60870-5 Options Setup for supported classes of objects (see Sections 6.1 and 6.2). System and configuration parameters are read in a fixed format indicated for each parameter in Sections 3.3 through 3.6.

The PM130 allows a non-standard interpretation of the Read command variable structure qualifier: a master can request more than one information element starting from the specified information object address by setting the SQ bit to 1 and the number of elements N to a value more than 1.

When a single value is requested, or the object type of the requested values has a time tag, the meter responds to a read request with a sequence of information objects ASDU with the SQ bit in the variable structure qualifier set to 0. If more than one value is requested and the object type does not have a time tag, the meter responds with a sequence of information elements ASDU with the SQ bit set to 1.

2.12 Parameter Loading

System and configuration parameters are written with either P_ME_NB_1, or P_ME_NC_1 ASDU type indicated for each parameter in Sections 3.3 through 3.6 with KPA = 32 (private range) in the qualifier of a parameter, and are reported to a Read command with the same object type and attributes.

The PM130 allows a non-standard interpretation of the P_ME_NB_1 and P_ME_NC_1 ASDU variable structure qualifier: a master can write more than one information element starting from the specified information object address by using a sequence of information elements ASDU with the SQ bit set to 1 and the number of elements N more than 1.

2.13 Data Types

2.13.1 Single Point Information

See the following table for decoding the status of a binary input accessed as a single point object.

Single Point Info Qualifier (SPI)	Digital Input Status
0 (OFF)	OFF (Open)
1 (ON)	ON (Closed)

2.13.2 Double Point Information

Double point objects occupy two adjacent object addresses and should always be accessed by addressing the first address of the pair. See the following table for decoding the status of binary inputs accessed as double point objects.

Double Point Info Qualifier (DPI)	Digital Inputs Status	
	DI1	DI2
0 (Intermediate state)	OFF (Open)	OFF (Open)
1 (OFF)	ON (Closed)	OFF (Open)
2 (ON)	OFF (Open)	ON (Closed)
3 (Indeterminate state)	ON (Closed)	ON (Closed)

2.13.3 Normalized Values

A normalized value represents per unit scaled reading of a measured value. Normalized values are transmitted as 16-bit signed fixed point numbers (F16, Type 4.1 IEC 60870-5-4) in the range of $-1..+1-2^{-15}$. On integer platforms, they can be taken as 16-bit signed integer numbers in the range of –32768..+32767 by dividing a value by 32767 to provide same conversion results.

Per unit normalization allows transmission of any measured value within its measurement range being scaled to a 16-bit fixed-point binary number, where $-1+2^{-15}$ corresponds to the minimum negative value measurement and $1-2^{-15}$ corresponds to the maximum value measurement. The actual measurement range and reading resolution are indicated in the object address map for all measured values (see Chapter 3).

To get a true measurement, a normalized value should be converted using the following formula:

$Y = Raw_reading \times Max_Measurement_Range$

When over-range occurs, a positive value is reported as $1-2^{-15}$ and a negative value as -1 with the OV bit in the quality descriptor byte QDS set to 1.

Conversion Example:

If the value you have read at object address 20736, which represents a phase I1 current reading (see Section 3.1), is 201×2^{-15} and the CT primary current setting is 200A, then the current reading in engineering units is as follows:

Max_Measurement_Range (see Section 4) = 2×200A = 400A

Value_Resolution = 0.01A

True value reading = $(201 \times 2^{-15}) \times 400A = 2.45A$

2.13.4 Scaled Values

A scaled value represents the reading of a measured value scaled to a 16-bit integer number. Scaled values are transmitted as 16-bit signed integer numbers (I16, Type 2.1 IEC 60870-5-4) in the range of –32768..+32767.

Integer scaling allows transmission of any measured value within its measurement range being scaled to a 16-bit integer number by dividing by a fixed scale factor.

To get a true measurement, a scaled value should be converted using the following formula:

$Y = Raw_reading \times Scale_Factor$

The scale factor depends on the maximum measurement range and resolution of a measured value as follows:

a) if (Max_Measurement_Range/Value_Resolution) <= 32767 then

Scale_Factor = 1 × Value_Resolution

b) if (Max_Measurement_Range/Value_Resolution) > 32767 then

Scale_Factor = Max_Measurement_Range/32767

The actual scale factor and measurement resolution are indicated in the object address map for all measured values (see Chapter 3).

When over-range occurs, a positive value is reported as 32767 and a negative value as -32768 with the OV bit in the quality descriptor byte QDS set to 1.

Conversion Example:

If the value you have read at object address 20736, which represents a phase I1 current reading (see Section 3.1), is 201 and the CT primary current setting is 200A, then the current reading in engineering units is as follows:

Max_Measurement_Range (see Section 4) = 2×200A = 400A

Value_Resolution = 0.01A

Max_Measurement_Range/Value_Resolution = 400/0.01 = 40000 > 32767

True value reading = 201 × (400A/32767) = 2.45A

2.13.5 Floating Point Numbers

A floating point number represents the true readings of a measured value. Floating point numbers are transmitted in an IEEE single precision floating point format (R32.23, Type 5 IEC 60870-5-4).

The actual measurement resolution is indicated in the object address map for all measured values (see Chapter 3).

2.13.6 Packed Long Integer and Octet String Formats

Some of system and configuration parameters are stored in the meter in 32-bit signed or unsigned integer format or in octet strings that cannot be scaled or represented using floating point numbers. Since IEC-60870-101/104 do not offer compatible ASDU types, the PM130 uses standard scaled value parameter format P_ME_NB_1 for transferring these data types that requires following interpretation in application software.

32-bit integer numbers are packed in two adjacent scaled 16-bit integer numbers in UI32 UNSIGNED INTEGER or I32 SIGNED INTEGER format (Type 1.1 and Type 2.1, IEC 60870-5-4).

Octet strings are packed in continuous 16-bit unsigned integer numbers, two octets in a scaled value, in OCTETSTRING OS8i or OS8iASCII format (Type 7, IEC 60870-5-4).

2.14 Password Protection

System and configuration parameters in the PM130 may be password protected from unauthorized changes via communications. Refer to the meter Installation and Operation Manual for details.

When password protection is enabled in the meter, a user password must be written to the device authorization register before changing parameters. If a correct password is not supplied, the meter will respond to write requests with the cause of transmission “unknown information object address”.

2.15 Interoperability

See Appendix A for the device interoperability profile.

3 Information Object Map

3.1 Mapped Information Objects

IO Address	Point ID	Description	Measurement Range	Units and Resolution	Type	R/W	Notes
1-4095		**Mapped Object Points**					
1		Mapped point				R/W	
2		Mapped point				R/W	
...		...				R/W	
4095		Mapped point				R/W	

NOTE:

Up to 64 general object points can be remapped to addresses 1-4095. See Section 3.2 for the measurement range, resolution and scale factors of the original object points. See Section 6.2 on how to remap object addresses in the meter.

3.2 General Information Objects

3.2.1 Single Point Objects

IO Address	Point ID	Description	Measurement Range [2]	Units and Resolution [2]	Type [4]	R/W	Notes
17920-17931		**Digital Inputs**					
+0	0x0600	Digital Input DI1	0/1		M_SP	R	
+1	0x0601	Digital Input DI2	0/1		M_SP	R	
+2	0x0602	Digital Input DI3	0/1		M_SP	R	
+3	0x0603	Digital Input DI4	0/1		M_SP	R	
+4	0x0604	Digital Input DI5	0/1		M_SP	R	
+5	0x0605	Digital Input DI6	0/1		M_SP	R	
+6	0x0606	Digital Input DI7	0/1		M_SP	R	
+7	0x0607	Digital Input DI8	0/1		M_SP	R	
+8	0x0608	Digital Input DI9	0/1		M_SP	R	
+9	0x0609	Digital Input DI10	0/1		M_SP	R	
+10	0x060A	Digital Input DI11	0/1		M_SP	R	
+11	0x060B	Digital Input DI12	0/1		M_SP	R	
18432-18435		**Relay Outputs**					
+0	0x0800	RO1	0/1		M_SP, C_SC	R/W	
+1	0x0801	RO2	0/1		M_SP, C_SC	R/W	
+2	0x0802	RO3	0/1		M_SP, C_SC	R/W	
+3	0x0803	RO4	0/1		M_SP, C_SC	R/W	
18688-18695		**Internal Static Events**					
+0	0x0900	Phase order error	0/1		M_SP	R	
+1	0x0901	Positive phase order	0/1		M_SP	R	
+2	0x0902	Negative phase order	0/1		M_SP	R	
+3	0x0903	Not used	0		M_SP	R	
+4	0x0904	Not used	0		M_SP	R	
+5	0x0905	Not used	0		M_SP	R	
+6	0x0906	Not used	0		M_SP	R	
+7	0x0907	Device fault [5]	0/1		M_SP	R	ORed device diagnostics (F2)
48128-48143		**Setpoint Status SP1-SP16**			M_SP	R	
+0	0x7C00	Setpoint SP1	0/1		M_SP	R	
+1	0x7C01	Setpoint SP2	0/1		M_SP	R	
...		...					
+15	0x7C0F	Setpoint SP16	0/1		M_SP	R	

3.2.2 Double Point Objects

IO Address	Point ID	Description	Measurement Range [2]	Units and Resolution [2]	Type [4]	R/W	Notes
64512-64522		**Digital Inputs**					
+0	0xBC00	Digital Inputs DI1:2	00/01/10/11		M_DP	R	
+1	0xBC01	Digital Inputs DI2:3	00/01/10/11		M_DP	R	
+2	0xBC02	Digital Inputs DI3:4	00/01/10/11		M_DP	R	
+3	0xBC03	Digital Inputs DI4:5	00/01/10/11		M_DP	R	
+4	0xBC04	Digital Inputs DI5:6	00/01/10/11		M_DP	R	
+5	0xBC05	Digital Inputs DI6:7	00/01/10/11		M_DP	R	
+6	0xBC06	Digital Inputs DI7:8	00/01/10/11		M_DP	R	
+7	0xBC07	Digital Inputs DI8:9	00/01/10/11		M_DP	R	
+8	0xBC08	Digital Inputs DI9:10	00/01/10/11		M_DP	R	
+9	0xBC09	Digital Inputs DI10:11	00/01/10/11		M_DP	R	
+10	0xBC0A	Digital Inputs DI11:12	00/01/10/11		M_DP	R	
64640-64642		**Relay Outputs**					
+0	0xBC80	RO1:2	00/01/10/11		M_DP, C_DC	R/W	
+1	0xBC81	RO2:3	00/01/10/11		M_DP, C_DC	R/W	
+2	0xBC82	RO3:4	00/01/10/11		M_DP, C_DC	R/W	

NOTE:

Double point objects occupy two adjacent object addresses and should always be accessed by addressing the first address of the pair.

3.2.3 Measured Values

IO Address	Point ID	Description	Measurement Range [2]	Units and Resolution [2]	Type [4]	R/W	Notes
16384	0x0000	**None**	0		M_ME	R	Zero object reference
		Special Inputs					
16641	0x0101	Phase rotation order	0=error, 1=positive (ABC), 2=negative (CBA)		M_ME	R	
19456-19488		**1-Cycle Phase Values**					
+0	0x0C00	V1/V12 Voltage	0-Vmax	U1	M_ME	R	[1]
+1	0x0C01	V2/V23 Voltage	0-Vmax	U1	M_ME	R	[1]
+2	0x0C02	V3/V31 Voltage	0-Vmax	U1	M_ME	R	[1]
+3	0x0C03	I1 Current	0-Imax	U2	M_ME	R	
+4	0x0C04	I2 Current	0-Imax	U2	M_ME	R	
+5	0x0C05	I3 Current	0-Imax	U2	M_ME	R	
+6	0x0C06	kW L1	-Pmax-Pmax	U3	M_ME	R	
+7	0x0C07	kW L2	-Pmax-Pmax	U3	M_ME	R	

IO Address	Point ID	Description	Measurement Range [2]	Units and Resolution [2]	Type [4]	R/W	Notes
+8	0x0C08	kW L3	-Pmax-Pmax	U3	M_ME	R	
+9	0x0C09	kvar L1	-Pmax-Pmax	U3	M_ME	R	
+10	0x0C0A	kvar L2	-Pmax-Pmax	U3	M_ME	R	
+11	0x0C0B	kvar L3	-Pmax-Pmax	U3	M_ME	R	
+12	0x0C0C	kVA L1	0-Pmax	U3	M_ME	R	
+13	0x0C0D	kVA L2	0-Pmax	U3	M_ME	R	
+14	0x0C0E	kVA L3	0-Pmax	U3	M_ME	R	
+15	0x0C0F	Power factor L1	-1.000-1.000	0.001	M_ME	R	
+16	0x0C10	Power factor L2	-1.000-1.000	0.001	M_ME	R	
+17	0x0C11	Power factor L3	-1.000-1.000	0.001	M_ME	R	
+18	0x0C12	V1/V12 Voltage THD	0-999.9	0.1%	M_ME	R	[1] 2-cycle value
+19	0x0C13	V2/V23 Voltage THD	0-999.9	0.1%	M_ME	R	[1] 2-cycle value
+20	0x0C14	V3/V31 Voltage THD	0-999.9	0.1%	M_ME	R	[1] 2-cycle value
+21	0x0C15	I1 Current THD	0-999.9	0.1%	M_ME	R	2-cycle value
+22	0x0C16	I2 Current THD	0-999.9	0.1%	M_ME	R	2-cycle value
+23	0x0C17	I3 Current THD	0-999.9	0.1%	M_ME	R	2-cycle value
+24	0x0C18	I1 K-Factor	1.0-999.9	0.1	M_ME	R	2-cycle value
+25	0x0C19	I2 K-Factor	1.0-999.9	0.1	M_ME	R	2-cycle value
+26	0x0C1A	I3 K-Factor	1.0-999.9	0.1	M_ME	R	2-cycle value
+27	0x0C1B	I1 Current TDD	0-100.0	0.1%	M_ME	R	2-cycle value
+28	0x0C1C	I2 Current TDD	0-100.0	0.1%	M_ME	R	2-cycle value
+29	0x0C1D	I3 Current TDD	0-100.0	0.1%	M_ME	R	2-cycle value
+30	0x0C1E	V12 Voltage	0-Vmax	U1	M_ME	R	
+31	0x0C1F	V23 Voltage	0-Vmax	U1	M_ME	R	
+32	0x0C20	V31 Voltage	0-Vmax	U1	M_ME	R	
20224-20236		**1-Cycle Total Values**					
+0	0x0F00	Total kW	-Pmax-Pmax	U3	M_ME	R	
+1	0x0F01	Total kvar	-Pmax-Pmax	U3	M_ME	R	
+2	0x0F02	Total kVA	0-Pmax	U3	M_ME	R	
+3	0x0F03	Total PF	-1.000-1.000	0.001	M_ME	R	
+4	0x0F04	Total PF lag	0-1000	0.001	M_ME	R	
+5	0x0F05	Total PF lead	0-1000	0.001	M_ME	R	
+6	0x0F06	Total kW import	0-Pmax	U3	M_ME	R	
+7	0x0F07	Total kW export	0-Pmax	U3	M_ME	R	
+8	0x0F08	Total kvar import	0-Pmax	U3	M_ME	R	
+9	0x0F09	Total kvar export	0-Pmax	U3	M_ME	R	
+10	0x0F0A	3-phase average L-N/L-L voltage	0-Vmax	U1	M_ME	R	[1]
+11	0x0F0B	3-phase average L-L voltage	0-Vmax	U1	M_ME	R	
+12	0x0F0C	3-phase average current	0-Imax	U2	M_ME	R	

IO Address	Point ID	Description	Measurement Range [2]	Units and Resolution [2]	Type [4]	R/W	Notes
20480-20484		**1-Cycle Auxiliary Values**					
+0	0x1000	Not used			M_ME	R	
+1	0x1001	In (neutral) Current	0-Imax	U2	M_ME	R	
+2	0x1002	Frequency	0-Fmax	0.01Hz	M_ME	R	
+3	0x1003	Voltage unbalance	0-300	1%	M_ME	R	
+4	0x1004	Current unbalance	0-300	1%	M_ME	R	
20608-20623		**Phasor**					
+0	0x1080	V1/V12 Voltage magnitude	0-Vmax	U1	M_ME	R	1
+1	0x1081	V2/V23 Voltage magnitude	0-Vmax	U1	M_ME	R	1
+2	0x1082	V3/V31 Voltage magnitude	0-Vmax	U1	M_ME	R	1
+3	0x1083	Not used			M_ME	R	
+4	0x1084	I1 Current magnitude	0-Imax	U2	M_ME	R	
+5	0x1085	I2 Current magnitude	0-Imax	U2	M_ME	R	
+6	0x1086	I3 Current magnitude	0-Imax	U2	M_ME	R	
+7	0x1087	Not used			M_ME	R	
+8	0x1088	V1/V12 Voltage angle	-180.0-180.0	0.1º	M_ME	R	1
+9	0x1089	V2/V23 Voltage angle	-180.0-180.0	0.1º	M_ME	R	1
+10	0x108A	V3/V31 Voltage angle	-180.0-180.0	0.1º	M_ME	R	1
+11	0x108B	Not used			M_ME	R	
+12	0x108C	I1 Current angle	-180.0-180.0	0.1º	M_ME	R	
+13	0x108D	I2 Current angle	-180.0-180.0	0.1º	M_ME	R	
+14	0x108E	I3 Current angle	-180.0-180.0	0.1º	M_ME	R	
+15	0x108F	Not used			M_ME	R	
20736-20768		**1-Second Phase Values**					
+0	0x1100	V1/V12 Voltage	0-Vmax	U1	M_ME	R	1
+1	0x1101	V2/V23 Voltage	0-Vmax	U1	M_ME	R	1
+2	0x1102	V3/V31 Voltage	0-Vmax	U1	M_ME	R	1
+3	0x1103	I1 Current	0-Imax	U2	M_ME	R	
+4	0x1104	I2 Current	0-Imax	U2	M_ME	R	
+5	0x1105	I3 Current	0-Imax	U2	M_ME	R	
+6	0x1106	kW L1	-Pmax-Pmax	U3	M_ME	R	
+7	0x1107	kW L2	-Pmax-Pmax	U3	M_ME	R	
+8	0x1108	kW L3	-Pmax-Pmax	U3	M_ME	R	
+9	0x1109	kvar L1	-Pmax-Pmax	U3	M_ME	R	
+10	0x110A	kvar L2	-Pmax-Pmax	U3	M_ME	R	
+11	0x110B	kvar L3	-Pmax-Pmax	U3	M_ME	R	
+12	0x110C	kVA L1	0-Pmax	U3	M_ME	R	
+13	0x110D	kVA L2	0-Pmax	U3	M_ME	R	
+14	0x110E	kVA L3	0-Pmax	U3	M_ME	R	

IO Address	Point ID	Description	Measurement Range [2]	Units and Resolution [2]	Type [4]	R/W	Notes
+15	0x110F	Power factor L1	-1.000-1.000	0.001	M_ME	R	
+16	0x1110	Power factor L2	-1.000-1.000	0.001	M_ME	R	
+17	0x1111	Power factor L3	-1.000-1.000	0.001	M_ME	R	
+18	0x1112	V1/V12 Voltage THD	0-999.9	0.1%	M_ME	R	[1] 3-sec value
+19	0x1113	V2/V23 Voltage THD	0-999.9	0.1%	M_ME	R	[1] 3-sec value
+20	0x1114	V3/V31 Voltage THD	0-999.9	0.1%	M_ME	R	[1] 3-sec value
+21	0x1115	I1 Current THD	0-999.9	0.1%	M_ME	R	3-sec value
+22	0x1116	I2 Current THD	0-999.9	0.1%	M_ME	R	3-sec value
+23	0x1117	I3 Current THD	0-999.9	0.1%	M_ME	R	3-sec value
+24	0x1118	I1 K-Factor	1.0-999.9	0.1	M_ME	R	3-sec value
+25	0x1119	I2 K-Factor	1.0-999.9	0.1	M_ME	R	3-sec value
+26	0x111A	I3 K-Factor	1.0-999.9	0.1	M_ME	R	3-sec value
+27	0x111B	I1 Current TDD	0-100.0	0.1%	M_ME	R	3-sec value
+28	0x111C	I2 Current TDD	0-100.0	0.1%	M_ME	R	3-sec value
+29	0x111D	I3 Current TDD	0-100.0	0.1%	M_ME	R	3-sec value
+30	0x111E	V12 Voltage	0-Vmax	U1	M_ME	R	
+31	0x111F	V23 Voltage	0-Vmax	U1	M_ME	R	
+32	0x1120	V31 Voltage	0-Vmax	U1	M_ME	R	
21504-21516		**1-Second Total Values**					
+0	0x1400	Total kW	-Pmax-Pmax	U3	M_ME	R	
+1	0x1401	Total kvar	-Pmax-Pmax	U3	M_ME	R	
+2	0x1402	Total kVA	0-Pmax	U3	M_ME	R	
+3	0x1403	Total PF	-1.000-1.000	0.001	M_ME	R	
+4	0x1404	Total PF lag	0-1.000	0.001	M_ME	R	
+5	0x1405	Total PF lead	0-1.000	0.001	M_ME	R	
+6	0x1406	Total kW import	0-Pmax	U3	M_ME	R	
+7	0x1407	Total kW export	0-Pmax	U3	M_ME	R	
+8	0x1408	Total kvar import	0-Pmax	U3	M_ME	R	
+9	0x1409	Total kvar export	0-Pmax	U3	M_ME	R	
+10	0x140A	3-phase average L-N/L-L voltage	0-Vmax	U1	M_ME	R	[1]
+11	0x140B	3-phase average L-L voltage	0-Vmax	U1	M_ME	R	
+12	0x140C	3-phase average current	0-Imax	U2	M_ME	R	
21760-21764		**1-Second Auxiliary Values**					
+0	0x1500	Not used			M_ME	R	
+1	0x1501	In (neutral) Current	0-Imax	U2	M_ME	R	
+2	0x1502	Frequency	0-Fmax	0.01Hz	M_ME	R	
+3	0x1503	Voltage unbalance	0-300	1%	M_ME	R	
+4	0x1504	Current unbalance	0-300	1%	M_ME	R	

IO Address	Point ID	Description	Measurement Range [2]	Units and Resolution [2]	Type [4]	R/W	Notes
22016-22050		**Present Volt, Ampere and Power Demands**					
+0	0x1600	V1/V12 Volt demand	0-Vmax	U1	M_ME	R	[1]
+1	0x1601	V2/V23 Volt demand	0-Vmax	U1	M_ME	R	[1]
+2	0x1602	V3/V31 Volt demand	0-Vmax	U1	M_ME	R	[1]
+3	0x1603	I1 Ampere demand	0-Imax	U2	M_ME	R	
+4	0x1604	I2 Ampere demand	0-Imax	U2	M_ME	R	
+5	0x1605	I3 Ampere demand	0-Imax	U2	M_ME	R	
+6	0x1606	kW import block demand	0-Pmax	U3	M_ME	R	
+7	0x1607	kvar import block demand	0-Pmax	U3	M_ME	R	
+8	0x1608	kVA block demand	0-Pmax	U3	M_ME	R	
+9	0x1609	kW import sliding window demand	0-Pmax	U3	M_ME	R	
+10	0x160A	kvar import sliding window demand	0-Pmax	U3	M_ME	R	
+11	0x160B	kVA sliding window demand	0-Pmax	U3	M_ME	R	
+12	0x160C	Not used			M_ME	R	
+13	0x160D	Not used			M_ME	R	
+14	0x160E	Not used			M_ME	R	
+15	0x160F	kW import accumulated demand	0-Pmax	U3	M_ME	R	
+16	0x1610	kvar import accumulated demand	0-Pmax	U3	M_ME	R	
+17	0x1611	kVA accumulated demand	0-Pmax	U3	M_ME	R	
+18	0x1612	kW import predicted sliding window demand	0-Pmax	U3	M_ME	R	
+19	0x1613	kvar import predicted sliding window demand	0-Pmax	U3	M_ME	R	
+20	0x1614	kVA predicted sliding window demand	0-Pmax	U3	M_ME	R	
+21	0x1615	PF (import) at Max. kVA sliding window demand	0-1.000	0.001	M_ME	R	
+22	0x1616	kW export block demand	0-Pmax	U3	M_ME	R	
+23	0x1617	kvar export block demand	0-Pmax	U3	M_ME	R	
+24	0x1618	kW export sliding window demand	0-Pmax	U3	M_ME	R	
+25	0x1619	kvar export sliding window demand	0-Pmax	U3	M_ME	R	
+26	0x161A	kW export accumulated demand	0-Pmax	U3	M_ME	R	
+27	0x161B	kvar export accumulated demand	0-Pmax	U3	M_ME	R	
+28	0x161C	kW export predicted sliding window demand	0-Pmax	U3	M_ME	R	
+29	0x161D	kvar export predicted sliding window demand	0-Pmax	U3	M_ME	R	
+30	0x161E	Not used			M_ME	R	
+31	0x161F	Not used			M_ME	R	
+32	0x1620	Not used			M_ME	R	
+33	0x1621	Not used			M_ME	R	
+34	0x1622	In Ampere demand	0-Imax	U2	M_ME	R	
22784-22823		**V1/V12 Harmonics [EH]**					[1]
+0	0x1900	H01 Harmonic magnitude	0-100.00	0.01%	M_ME	R	

IO Address	Point ID	Description	Measurement Range [2]	Units and Resolution [2]	Type [4]	R/W	Notes
+1	0x1901	H02 Harmonic magnitude	0-100.00	0.01%	M_ME	R	
...		...					
+39	0x1927	H40 Harmonic magnitude	0-100.00	0.01%	M_ME	R	
23040-23079		**V2/V23 Harmonics EH**					1
+0	0x1A00	H01 Harmonic magnitude	0-100.00	0.01%	M_ME	R	
+1	0x1A01	H02 Harmonic magnitude	0-100.00	0.01%	M_ME	R	
...		...					
+39	0x1A27	H40 Harmonic magnitude	0-100.00	0.01%	M_ME	R	
23296-23335		**V3/V31 Harmonics EH**					1
+0	0x1B00	H01 Harmonic magnitude	0-100.00	0.01%	M_ME	R	
+1	0x1B01	H02 Harmonic magnitude	0-100.00	0.01%	M_ME	R	
...		...					
+39	0x1B27	H40 Harmonic magnitude	0-100.00	0.01%	M_ME	R	
23552-23591		**I1 Harmonics EH**					
+0	0x1C00	H01 Harmonic magnitude	0-100.00	0.01%	M_ME	R	
+1	0x1C01	H02 Harmonic magnitude	0-100.00	0.01%	M_ME	R	
...		...					
+39	0x1C27	H40 Harmonic magnitude	0-100.00	0.01%	M_ME	R	
23808-23847		**I2 Harmonics EH**					
+0	0x1D00	H01 Harmonic magnitude	0-100.00	0.01%	M_ME	R	
+1	0x1D01	H02 Harmonic magnitude	0-100.00	0.01%	M_ME	R	
...		...					
+39	0x1D27	H40 Harmonic magnitude	0-100.00	0.01%	M_ME	R	
24064-24103		**I3 Harmonics EH**					
+0	0x1E00	H01 Harmonic magnitude	0-100.00	0.01%	M_ME	R	
+1	0x1E01	H02 Harmonic magnitude	0-100.00	0.01%	M_ME	R	
...		...					
+39	0x1E27	H40 Harmonic magnitude	0-100.00	0.01%	M_ME	R	
26880-26897		**Fundamental (H01) Phase Values EH**					2-cycle values
+0	0x2900	V1/V12 Voltage	0-Vmax	U1	M_ME	R	1
+1	0x2901	V2/V23 Voltage	0-Vmax	U1	M_ME	R	1
+2	0x2902	V3/V31 Voltage	0-Vmax	U1	M_ME	R	1
+3	0x2903	I1 Current	0-Imax	U2	M_ME	R	
+4	0x2904	I2 Current	0-Imax	U2	M_ME	R	
+5	0x2905	I3 Current	0-Imax	U2	M_ME	R	
+6	0x2906	kW L1	-Pmax-Pmax	U3	M_ME	R	
+7	0x2907	kW L2	-Pmax-Pmax	U3	M_ME	R	

IO Address	Point ID	Description	Measurement Range [2]	Units and Resolution [2]	Type [4]	R/W	Notes
+8	0x2908	kW L3	-Pmax-Pmax	U3	M_ME	R	
+9	0x2909	kvar L1	-Pmax-Pmax	U3	M_ME	R	
+10	0x290A	kvar L2	-Pmax-Pmax	U3	M_ME	R	
+11	0x290B	kvar L3	-Pmax-Pmax	U3	M_ME	R	
+12	0x290C	kVA L1	0-Pmax	U3	M_ME	R	
+13	0x290D	kVA L2	0-Pmax	U3	M_ME	R	
+14	0x290E	kVA L3	0-Pmax	U3	M_ME	R	
+15	0x290F	Power factor L1	-1.000-1.000	0.001	M_ME	R	
+16	0x2910	Power factor L2	-1.000-1.000	0.001	M_ME	R	
+17	0x2911	Power factor L3	-1.000-1.000	0.001	M_ME	R	
27136-27139		**Harmonic Total Values EH**					2-cycle values
+0	0x2A00	Total fundamental kW	-Pmax-Pmax	U3	M_ME	R	
+1	0x2A01	Total fundamental kvar	-Pmax-Pmax	U3	M_ME	R	
+2	0x2A02	Total fundamental kVA	0-Pmax	U3	M_ME	R	
+3	0x2A03	Total fundamental PF	-1.000-1.000	0.001	M_ME	R	
27648-27653		**Minimum 1-Cycle Phase Values**					
+0	0x2C00	V1/V12 Voltage	0-Vmax	U1	M_ME	R	1
+1	0x2C01	V2/V23 Voltage	0-Vmax	U1	M_ME	R	1
+2	0x2C02	V3/V31 Voltage	0-Vmax	U1	M_ME	R	1
+3	0x2C03	I1 Current	0-Imax	U2	M_ME	R	
+4	0x2C04	I2 Current	0-Imax	U2	M_ME	R	
+5	0x2C05	I3 Current	0-Imax	U2	M_ME	R	
27904-27907		**Minimum 1-Cycle Total Values**					
+0	0x2D00	Total kW	-Pmax-Pmax	U3	M_ME	R	
+1	0x2D01	Total kvar	-Pmax-Pmax	U3	M_ME	R	
+2	0x2D02	Total kVA	0-Pmax	U3	M_ME	R	
+3	0x2D03	Total PF	0-1.000	0.001	M_ME	R	Absolute value
28160-28162		**Minimum 1-Cycle Auxiliary Values**					
+0	0x2E00	Not used			M_ME	R	
+1	0x2E01	In Current	0-Imax	U2	M_ME	R	
+2	0x2E02	Frequency	0-Fmax	0.01Hz	M_ME	R	
29696-29701		**Maximum 1-Cycle Phase Values**					
+0	0x3400	V1/V12 Voltage	0-Vmax	U1	M_ME	R	1
+1	0x3401	V2/V23 Voltage	0-Vmax	U1	M_ME	R	1
+2	0x3402	V3/V31 Voltage	0-Vmax	U1	M_ME	R	1
+3	0x3403	I1 Current	0-Imax	U2	M_ME	R	
+4	0x3404	I2 Current	0-Imax	U2	M_ME	R	
+5	0x3405	I3 Current	0-Imax	U2	M_ME	R	

IO Address	Point ID	Description	Measurement Range [2]	Units and Resolution [2]	Type [4]	R/W	Notes
29952-29955		**Maximum 1-Cycle Total Values**					
+0	0x3500	Total kW	-Pmax-Pmax	U3	M_ME	R	
+1	0x3501	Total kvar	-Pmax-Pmax	U3	M_ME	R	
+2	0x3502	Total kVA	0-Pmax	U3	M_ME	R	
+3	0x3503	Total PF	0-1.000	0.001	M_ME	R	Absolute value
30208-30210		**Maximum 1-Cycle Auxiliary Values**					
+0	0x3600	Not used			M_ME	R	
+1	0x3601	In Current	0-Imax	U2	M_ME	R	
+2	0x3602	Frequency	0-Fmax	0.01Hz	M_ME	R	
30464-30485		**Maximum Demands**					
+0	0x3700	V1/V12 Maximum volt demand	0-Vmax	U1	M_ME	R	1
+1	0x3701	V2/V23 Maximum volt demand	0-Vmax	U1	M_ME	R	1
+2	0x3702	V3/V31 Maximum volt demand	0-Vmax	U1	M_ME	R	1
+3	0x3703	I1 Maximum ampere demand	0-Imax	U2	M_ME	R	
+4	0x3704	I2 Maximum ampere demand	0-Imax	U2	M_ME	R	
+5	0x3705	I3 Maximum ampere demand	0-Imax	U2	M_ME	R	
+6	0x3706	Not used			M_ME	R	
+7	0x3707	Not used			M_ME	R	
+8	0x3708	Not used			M_ME	R	
+9	0x3709	Maximum kW import sliding window demand	0-Pmax	U3	M_ME	R	
+10	0x370A	Maximum kvar import sliding window demand	0-Pmax	U3	M_ME	R	
+11	0x370B	Maximum kVA sliding window demand	0-Pmax	U3	M_ME	R	
+12	0x3737	Not used			M_ME	R	
+13	0x370D	Not used			M_ME	R	
+14	0x370E	Not used			M_ME	R	
+15	0x370F	Maximum kW export sliding window demand	0-Pmax	U3	M_ME	R	
+16	0x3710	Maximum kvar export sliding window demand	0-Pmax	U3	M_ME	R	
+17	0x3711	Not used			M_ME	R	
+18	0x3712	Not used			M_ME	R	
+19	0x3713	Not used			M_ME	R	
+20	0x3714	Not used			M_ME	R	
+21	0x3715	In Maximum ampere demand	0-Imax	U2	M_ME	R	
31744-31745		**TOU Parameters [E]**					
+0	0x3C00	Active tariff	0-7		M_ME	R	
+1	0x3C01	Active profile	0-15: 1-3 = Season 1 Profile #1-4, 4-7 = Season 2 Profile #1-4, 8-11 = Season 3 Profile #1-4, 12-15 = Season 4 Profile #1-4		M_ME	R	

IO Address	Point ID	Description	Measurement Range [2]	Units and Resolution [2]	Type [4]	R/W	Notes
31872-31875		**Scaled Analog Outputs**					
+0	0x3C80	Analog output AO1	0-4095		M_ME	R/W	
+1	0x3C81	Analog output AO2	0-4095		M_ME	R/W	
+2	0x3C82	Analog output AO3	0-4095		M_ME	R/W	
+3	0x3C83	Analog output AO4	0-4095		M_ME	R/W	
34048-34051		**Billing Summary Accumulated Demands [E]**					
+0	0x4500	Summary register #1 demand	0-Pmax	U3	M_ME	R	
+1	0x4501	Summary register #2 demand	0-Pmax	U3	M_ME	R	
+2	0x4502	Summary register #3 demand	0-Pmax	U3	M_ME	R	
+3	0x4503	Summary register #4 demand	0-Pmax	U3	M_ME	R	
34176-34179		**Billing Summary Block Demands [E]**					
+0	0x4580	Summary register #1 demand	0-Pmax	U3	M_ME	R	
+1	0x4581	Summary register #2 demand	0-Pmax	U3	M_ME	R	
+2	0x4582	Summary register #3 demand	0-Pmax	U3	M_ME	R	
+3	0x4583	Summary register #4 demand	0-Pmax	U3	M_ME	R	
34304-34307		**Billing Summary Sliding Window Demands [E]**					
+0	0x4600	Summary register #1 demand	0-Pmax	U3	M_ME	R	
+1	0x4601	Summary register #2 demand	0-Pmax	U3	M_ME	R	
+2	0x4602	Summary register #3 demand	0-Pmax	U3	M_ME	R	
+3	0x4603	Summary register #4 demand	0-Pmax	U3	M_ME	R	
34688-34691		**Billing Summary Maximum Demands [E]**					
+0	0x4780	Summary register #1 maximum demand	0-Pmax	U3	M_ME	R	
+1	0x4781	Summary register #2 maximum demand	0-Pmax	U3	M_ME	R	
+2	0x4782	Summary register #3 maximum demand	0-Pmax	U3	M_ME	R	
+3	0x4783	Summary register #4 maximum demand	0-Pmax	U3	M_ME	R	
34816-34823		**TOU Maximum Demand Register #1 [E]**					
+0	0x4800	Tariff #1 maximum demand	0-Pmax	U3	M_ME	R	
+1	0x4801	Tariff #2 maximum demand	0-Pmax	U3	M_ME	R	
...		...				R	
+7	0x4807	Tariff #8 maximum demand	0-Pmax	U3	M_ME	R	
35072-35079		**TOU Maximum Demand Register #2 [E]**					
+0	0x4900	Tariff #1 maximum demand	0-Pmax	U3	M_ME	R	
+1	0x4901	Tariff #2 maximum demand	0-Pmax	U3	M_ME	R	
...		...				R	
+7	0x4907	Tariff #8 maximum demand	0-Pmax	U3	M_ME	R	
35328-35335		**TOU Maximum Demand Register #3 [E]**					
+0	0x4A00	Tariff #1 maximum demand	0-Pmax	U3	M_ME	R	

IO Address	Point ID	Description	Measurement Range [2]	Units and Resolution [2]	Type [4]	R/W	Notes
+1	0x4A01	Tariff #2 maximum demand	0-Pmax	U3	M_ME	R	
...		...				R	
+7	0x4A07	Tariff #8 maximum demand	0-Pmax	U3	M_ME	R	
34944-34951		**TOU Maximum Demand Register #4 [E]**					
+0	0x4880	Tariff #1 maximum demand	0-Pmax	U3	M_ME	R	
+1	0x4881	Tariff #2 maximum demand	0-Pmax	U3	M_ME	R	
...		...				R	
+7	0x4887	Tariff #8 maximum demand	0-Pmax	U3	M_ME	R	
41984-42023		**V1/V12 Harmonic Angles [EH]**					1, 3
+0	0x6400	H01 Harmonic angle	-180.0-180.0	0.1º	M_ME	R	
+1	0x6400	H02 Harmonic angle	-180.0-180.0	0.1º	M_ME	R	
...		...					
+39	0x6427	H40 Harmonic angle	-180.0-180.0	0.1º	M_ME	R	
42240-42279		**V2/V23 Harmonic Angles [EH]**					1, 3
+0	0x6500	H01 Harmonic angle	-180.0-180.0	0.1º	M_ME	R	
+1	0x6500	H02 Harmonic angle	-180.0-180.0	0.1º	M_ME	R	
...		...					
+39	0x6527	H40 Harmonic angle	-180.0-180.0	0.1º	M_ME	R	
42496-42535		**V1/V31 Harmonic Angles [EH]**					1, 3
+0	0x6600	H01 Harmonic angle	-180.0-180.0	0.1º	M_ME	R	
+1	0x6600	H02 Harmonic angle	-180.0-180.0	0.1º	M_ME	R	
...		...					
+39	0x6627	H40 Harmonic angle	-180.0-180.0	0.1º	M_ME	R	
42752-42791		**I1 Harmonic Angles [EH]**					3
+0	0x6700	H01 Harmonic angle	-180.0-180.0	0.1º	M_ME	R	
+1	0x6700	H02 Harmonic angle	-180.0-180.0	0.1º	M_ME	R	
...		...					
+39	0x6727	H40 Harmonic angle	-180.0-180.0	0.1º	M_ME	R	
43008-43047		**I2 Harmonic Angles [EH]**					3
+0	0x6800	H01 Harmonic angle	-180.0-180.0	0.1º	M_ME	R	
+1	0x6800	H02 Harmonic angle	-180.0-180.0	0.1º	M_ME	R	
...		...					
+39	0x6827	H40 Harmonic angle	-180.0-180.0	0.1º	M_ME	R	
43264-43303		**I3 Harmonic Angles [EH]**					3
+0	0x6900	H01 Harmonic angle	-180.0-180.0	0.1º	M_ME	R	
+1	0x6900	H02 Harmonic angle	-180.0-180.0	0.1º	M_ME	R	
...		...					

IO Address	Point ID	Description	Measurement Range [2]	Units and Resolution [2]	Type [4]	R/W	Notes
+39	0x6927	H40 Harmonic angle	-180.0-180.0	0.1º	M_ME	R	

3.2.4 Integrated Totals

IO Address	Point ID	Description	Measurement Range [2]	Units and Resolution [2]	Type [4]	R/W	Notes
18944-18947		**Counters**					
+0	0x0A00	Counter #1	0-99,999		M_IT, C_CI	R/W	
+1	0x0A01	Counter #2	0-99,999		M_IT, C_CI	R/W	
+2	0x0A02	Counter #3	0-99,999		M_IT, C_CI	R/W	
+3	0x0A03	Counter #4	0-99,999		M_IT, C_CI	R/W	
22272-22293		**Total Energies [E]**					
+0	0x1700	kWh import	0-999,999,999	1 kWh	M_IT, C_CI	R	
+1	0x1701	kWh export	0-999,999,999	1 kWh	M_IT, C_CI	R	
+2	0x1702	Not used			M_IT, C_CI	R	
+3	0x1703	Not used			M_IT, C_CI	R	
+4	0x1704	kvarh import	0-999,999,999	1 kvarh	M_IT, C_CI	R	
+5	0x1705	kvarh export	0-999,999,999	1 kvarh	M_IT, C_CI	R	
+6	0x1706	Not used			M_IT, C_CI	R	
+7	0x1707	Not used			M_IT, C_CI	R	
+8	0x1708	kVAh total	0-999,999,999	1 kVAh	M_IT, C_CI	R	
+9	0x1709	Not used			M_IT, C_CI	R	
+10	0x170A	Not used			M_IT, C_CI	R	
+11	0x170B	kVAh import	0-999,999,999	1 kVAh	M_IT, C_CI	R	
+12	0x170C	kVAh export	0-999,999,999	1 kVAh	M_IT, C_CI	R	
+13	0x170D	Not used			M_IT, C_CI	R	
+14	0x170E	Not used			M_IT, C_CI	R	
+15	0x170F	Not used			M_IT, C_CI	R	
+16	0x1710	Not used			M_IT, C_CI	R	
+17	0x1711	Not used			M_IT, C_CI	R	
+18	0x1712	kvarh Q1	0-999,999,999	1 kvarh	M_IT, C_CI	R	
+19	0x1713	kvarh Q2	0-999,999,999	1 kvarh	M_IT, C_CI	R	
+20	0x1714	kvarh Q3	0-999,999,999	1 kvarh	M_IT, C_CI	R	
+21	0x1715	kvarh Q4	0-999,999,999	1 kvarh	M_IT, C_CI	R	
22400-22403		**Billing Summary Registers [E]**					
+0	0x1780	Summary energy register #1	0-999,999,999	1 kWh	M_IT, C_CI	R	
+1	0x1781	Summary energy register #2	0-999,999,999	1 kWh	M_IT, C_CI	R	
+2	0x1782	Summary energy register #3	0-999,999,999	1 kWh	M_IT, C_CI	R	

IO Address	Point ID	Description	Measurement Range [2]	Units and Resolution [2]	Type [4]	R/W	Notes
+3	0x1783	Summary energy register #4	0-999,999,999	1 kWh	M_IT, C_CI	R	
22528-22536		**Phase Energies [E]**					
+0	0x1800	kWh import L1	0-999,999,999	1 kWh	M_IT, C_CI	R	
+1	0x1801	kWh import L2	0-999,999,999	1 kWh	M_IT, C_CI	R	
+2	0x1802	kWh import L3	0-999,999,999	1 kWh	M_IT, C_CI	R	
+3	0x1803	kvarh import L1	0-999,999,999	1 kvarh	M_IT, C_CI	R	
+4	0x1804	kvarh import L2	0-999,999,999	1 kvarh	M_IT, C_CI	R	
+5	0x1805	kvarh import L3	0-999,999,999	1 kvarh	M_IT, C_CI	R	
+6	0x1806	kVAh total L1	0-999,999,999	1 kVAh	M_IT, C_CI	R	
+7	0x1807	kVAh total L2	0-999,999,999	1 kVAh	M_IT, C_CI	R	
+8	0x1808	kVAh total L3	0-999,999,999	1 kVAh	M_IT, C_CI	R	
32000-32007		**TOU Energy Register #1 [E]**					
+0	0x3D00	Tariff #1 register	0-999,999,999	1 kWh	M_IT, C_CI	R	
+1	0x3D01	Tariff #2 register	0-999,999,999	1 kWh	M_IT, C_CI	R	
...		...				R	
+7	0x3D07	Tariff #8 register	0-999,999,999	1 kWh	M_IT, C_CI	R	
32256-32263		**TOU Energy Register #2 [E]**					
+0	0x3E00	Tariff #1 register	0-999,999,999	1 kWh	M_IT, C_CI	R	
+1	0x3E01	Tariff #2 register	0-999,999,999	1 kWh	M_IT, C_CI	R	
...		...				R	
+7	0x3E07	Tariff #8 register	0-999,999,999	1 kWh	M_IT, C_CI	R	
32512-32519		**TOU Energy Register #3 [E]**					
+0	0x3F00	Tariff #1 register	0-999,999,999	1 kWh	M_IT, C_CI	R	
+1	0x3F01	Tariff #2 register	0-999,999,999	1 kWh	M_IT, C_CI	R	
...		...				R	
+7	0x3F07	Tariff #8 register	0-999,999,999	1 kWh	M_IT, C_CI	R	
32768-32775		**TOU Energy Register #4 [E]**					
+0	0x4000	Tariff #1 register	0-999,999,999	1 kWh	M_IT, C_CI	R	
+1	0x4001	Tariff #2 register	0-999,999,999	1 kWh	M_IT, C_CI	R	
...		...				R	
+7	0x4007	Tariff #8 register	0-999,999,999	1 kWh	M_IT, C_CI	R	

NOTES:

1 Voltage and voltage harmonics readings: when the 4LN3, 3LN3 or 3BLN3 wiring mode is selected, the voltages will be line-to-neutral; for any other wiring mode, they will be line-to-line voltages.

2 For volts, amps, power and frequency measurement range, resolution and scale factors refer to Section 4 ”Data Scales and Units”.

3 Harmonic angles are referenced to the fundamental voltage harmonic H01 on phase L1.

[4] Object types: M_ME – measured value, M_SP – single point information, M_DP – double point information, M_IT – integrated total (counter), C_SC – single command, C_CI – counter interrogation command. See F3 through F10 in Section 5 for compatible object types.

[5] The DEVICE FAULT indication is raised when at least one flag is set in the device diagnostics and is removed when the device diagnostics is cleared.

Energy and power demand readings are only available in PM130E and PM130EH meters. Harmonics are only available in PM130EH meters.

3.3 Device Status and Control Parameters

IO Address	Point ID	Description	Options/Range	Units and Resolution	Type	R/W	Notes
Device Port Identification							
6144		Active serial port number	0=COM1, 1=COM2		P_ME_NB_1	R	
Device Diagnostics							
6145		Internal device diagnostics (bits 0:15). Read: bits set to 1 indicate diagnostics failed at least once since last reset. Write: preset bits to 0 to clear corresponding diagnostics flags; bits set to 1 have no effect.	F2		P_ME_NB_1	R/W	
6146		Internal device diagnostics (bits 16:32). Not used	0		P_ME_NB_1	R/W	
Reference Meter Time							
6175		Scaled zero value followed by a meter clock time	0		M_ME_TE_1	R	
Device Reset/Clear Registers							
6176-6186					P_ME_NB_1		
6176		Clear energy registers	0			W	
6177		Clear total maximum demand registers	0 = Clear all maximum demands 1 = Clear power demands [E] 2 = Clear volt and ampere demands			W	
6178		Clear billing/TOU energy registers [E]	0			W	
6179		Clear billing/TOU maximum demand registers [E]	0			W	
6180		Clear pulse counters	0 = Clear all counters 1-4 = Clear counter #1-#4			W	
6181		Clear Min/Max log	0			W	
6186		Clear operation/event counters and status	1=clear device diagnostics 6=reset communication counters			W	
Device Authorization Register							
6208-6209		Read: 0 = access permitted, -1 = authorization required. Write: 4-digit password.	0 - 9999 (write) 0/-1 (read)		P_ME_NB_1 UI32	R/W	

3.4 System Parameters

IO Address	Point ID	Description	Options/Range	Units and Resolution	Type	R/W	Notes
Device Identification							
4224-4255					P_ME_NB_1		
+0,1		Device serial number	0-999999		UI32	R	
+2,3		Device model ID	13010=PM130P, 13011=PM130A, 13020=PM130E, 13030-13032=PM130EH		UI32	R	
+4-11		Device model name	“PM130P”, “PM130E”,“PM130EH”		OS128ASCII	R	Null-terminated octet string
+12-13		Device options (bitmap)	0		UI32	R	
+14-19		Reserved				R	
+20		Device firmware version number	1123-1129			R	Two higher decimal digits = major version number, two lower decimal digits = minor version number
+21		Device firmware build number	1-99			R	
+22,23		Reserved				R	
+24		Boot loader version number	0101-0199			R	Two higher decimal digits = major version number, two lower decimal digits = minor version number
+25		Boot loader build number	1-99			R	
+26-31		Reserved				R	
Factory Device Settings							
4256-4322					P_ME_NB_1		
+0		V1-V3 input range	690, 120 (option U)	V		R	Does not limit the 690V input range
+1		V1-V3 input overload	120	%		R	
+2,3		Reserved				R	
+4		I1-I3 input range	1, 5	A		R	
+5		I1-I3 input overload	200	%		R	
+6-13		Reserved				R	
+14-63		Unused					
+64-66		Ethernet MAC address	0x0005F0000000- 0x0005F000FFFF		OS48	R	

3.5 Device Setup Parameters

IO Address	Point ID	Description	Options/Range	Units and Resolution	Type	R/W	Notes
Communication Ports Setup Parameters							
4096-4127					P_ME_NB_1		
+0		Communication protocol	COM1: 0=SATEC ASCII, 1=Modbus RTU, 7=IEC 60870-5 COM2: 0=SATEC ASCII, 1=Modbus RTU, 5=Profibus DP, 7=IEC 60870-5			R/W	
+1		Interface	COM1: 2=RS-485 COM2: 0=RS-232, 1=RS-422, 2=RS-485, 6=Ethernet, 7=Profibus			R/W	
+2		Device address	SATEC ASCII: 0-99 Modbus RTU: 1-247 IEC 60870-5: 1–65535 Profibus DP: 0-126			R/W	
+3		Baud rate	1=300 bps, 2=600 bps, 3=1200 bps, 4=2400 bps, 5=4800 bps, 6=9600 bps, 7=19200 bps, 8=38400 bps, 9=57600 bps, 10=115200 bps			R/W	
+4		Data format	0=7 bits/even parity, 1=8 bits/no parity, 2=8 bits/even parity			R/W	
+5		Flow control	N/A			R/W	Read as –1
+6		RTS mode	N/A			R/W	Read as –1
+7		Send delay	2-1000 ms			R/W	
+8-15		Reserved				R/W	Read as –1
4096-4111		**COM1 Setup**					
4112-4127		**COM2 Setup**					
Basic Device Setup Parameters							
4352-4372					P_ME_NC_1		
+0		Wiring mode	F2			R/W	
+1		PT ratio	10 to 65000	0.1		R/W	
+2		CT primary current	1 to 50,000	A		R/W	
+3		Power block demand period [E]	1,2,3,5,10,15,20,30,60 min, 255 = external synchronization	min		R/W	If the external synchronization is selected, the DI1 input is considered a pulse or KYZ input. The pulse edge restarts the power demand block accumulation interval.

IO Address	Point ID	Description	Options/Range	Units and Resolution	Type	R/W	Notes
+4		Volt/ampere demand period	0 to 1800	sec		R/W	
+5-7		Reserved				R/W	Read as 65535
+8		Number of blocks in a sliding window [E]	1 to 15			R/W	
+9,10		Reserved				R/W	Read as 65535
+11		Nominal line frequency	25, 50, 60, 400	Hz		R/W	
+12		Maximum demand load current	0 to 50,000 (0=CT primary current)	A		R/W	
+13-19		Reserved				R/W	Read as 65535
+20		PT ratio multiplication factor	×1, ×10			R/W	
Device Options Setup Parameters							
4384-4398					P_ME_NC_1		
+0		Power calculation mode	0=using reactive power: S=f(P,Q), 1=using non-active power: Q=f(S,P)			R/W	
+1		Energy roll value [E]	$0=1\times10^4$, $1=1\times10^5$, $2=1\times10^6$, $3=1\times10^7$, $4=1\times10^8$, $5=1\times10^9$			R/W	Default=4
+2		Phase energy calculation mode [E]	0=disabled, 1=enabled			R/W	
+3-9		Reserved				R/W	Read as 65535
+10		Energy LED test mode [E]	0=disabled, 1=Wh test, 2=varh test			R/W	LED pulse rate is 10,000 pulses/kWh
+11		Starting voltage, percent of FS voltage	15-50	0.1%		R/W	Default 1.5%
+12-13		Reserved				R/W	Read as 65535
+14		Device resolution (see Section 4 for details)	0 = Low resolution, 1 = High resolution			R/W	Default 0
Device Data Scales							
4418-4419					P_ME_NC_1		
+0		Voltage scale, secondary volts	60-828	1V		R/W	Default 144V
+1		Current scale, secondary amps	10-100	×0.1A		R/W	Default 2×CT secondary

3.6 Protocol Setup Parameters

IO Address	Point ID	Description	Options/Range	Units and Resolution	Type	R/W	Notes
IEC 60870-5 Options Setup							
4480-4514					P_ME_NB_1		
+0		Maximum length of variable frame, octets	32-255			R/W	Fixed to 253 in IEC 60870-5-104
+1		Link address length, octets	1-2			R/W	Not used in IEC 60870-5-104
+2		Cause of transmission length, octets	1-2			R/W	Fixed to 2 in IEC 60870-5-104
+3		Length of common address of ASDU, octets	1-2			R/W	Fixed to 2 in IEC 60870-5-104
+4		Length of information object address, octets	1-3			R/W	Fixed to 3 in IEC 60870-5-104
+5		Select-before-operate timeout, s	0-30			R/W	
+6		Short pulse duration, ms	100-3000	ms		R/W	
+7		Long pulse duration, ms	100-3000	ms		R/W	
+8,9		Time synchronization period, s	1-86400, 0=not active	s	UI32	R/W	
+10		Local counter freeze period, min	1-60, 0=not active	min		R/W	
+11		Cyclic data transmission period, ms	100-30000, 0=not active	ms		R/W	Effective in IEC 60870-5-104 only
+12,13		Client IP address for cyclic data transmission	0-0xFFFFFE, 0=not active		UI32	R/W	
+14,15		Client IP address for spontaneous transmission	0-0xFFFFFE, 0=not active		UI32	R/W	
+16,17		Not used	0		UI32	R/W	
+18		Not used	0			R/W	
+19		Respond with class 1 data to class 2 requests	0=disabled, 1=enabled			R/W	
+20		Single point start mapped address	1-4095			R/W	
+21		Single point default static object type	F3			R/W	
+22		Single point default event object type	F4			R/W	
+23		Double point start mapped address	1-4095			R/W	
+24		Double point default static object type	F5			R/W	
+25		Double point default event object type	F6			R/W	
+26		Measured value start mapped address	1-4095			R/W	
+27		Measured value default static object type	F7			R/W	
+28		Measured value default event object type	F8			R/W	
+29		Integrated totals start mapped address	1-4095			R/W	
+30		Integrated totals default static object type	F9			R/W	
+31		Integrated totals default event object type	F10			R/W	
+32		Voltage units	0=V, 1=kV			R/W	
+33		Current units	0=A, 1=kA			R/W	
+34		Power units	0=kW, 1=MW			R/W	
IEC 60870-5 Class 2 Data and Counters Setup							
4544-4639					P_ME_NB_1		

IO Address	Point ID	Description	Options/Range	Units and Resolution	Type	R/W	Notes
+0		Information object type and flags	Bits 0:7 – static object type identification (F3, F5, F7, F9), Bit 8=1 – freeze with reset, Bit 9=1 – local freeze, Bit 10=1 – cyclic data transmission, Bit 11=1 – general interrogation, Bits 12:15 – interrogation group = 0-15 (0=no group assigned)			R/W	See Section 3.2 for compatible object types.
+1		Start information object address	1-65535			R/W	
+2		Number of elements in the range	1-128			R/W	
4544-4546		**Object address range #1**					
4547-4549		**Object address range #2**					
...		**...**					
4637-4639		**Object address range #32**					
IEC 60870-5 Assignable Point Map and Events Setup							
4736-4927					P_ME_NB_1		
+0		Point ID	See Section 3.2			R/W	
+1		Information object type and flags	Bits 0:7 – static object type identification (F3, F5, F7), Bits 8:9 – relation (0=delta, 1= more than, 2 = less than) Bit 10=1 – class 1 assignment			R/W	See Section 3.2 for compatible object types.
+2		Deadband/threshold	See Section 3.2 for the point range and resolution			R/W	
4736-4738		**Mapped static/event point #1**					
4739-4741		**Mapped static/event point #2**					
...		**...**					
4625-4927		**Mapped static/event point #64**					

4 Data Scales and Units

Code	Condition	Value/Range	Notes
Data Scales			
Vmax		Voltage scale × PT Ratio, V	2
Imax		Current scale × CT Ratio, A	1, 3
Pmax	Wiring 4LN3, 3LN3, 3BLN3	Vmax × Imax × 3, W	4
	Wiring 4LL3, 3LL3, 3BLL3, 3OP2, 3OP3, 3DIR2	Vmax × Imax × 2, W	4
Fmax	Nominal frequency 25, 50 or 60 Hz	100 Hz	
	Nominal frequency 400Hz	500 Hz	
Data Units – Low Resolution Option			
U1		1 V	5
U2		1 A	5
U3		1 kW/kvar/kVA	5
Data Units – High Resolution Option			
U1	PT Ratio = 1	0.1 V	5
	PT Ratio > 1	1 V	5
U2		0.01 A	5
U3	PT Ratio = 1	0.001 kW/kvar/kVA	5
	PT Ratio > 1	1 kW/kvar/kVA	5

NOTES:

1 CT Ratio = CT primary current/CT secondary current

2 The default Voltage scale is 144V (120V +20%).

3 The default Current scale is 2 × CT secondary current (2.0A with 1A secondaries, 10.A with 5A secondaries).

4 Pmax is rounded to whole kilowatts. With PT=1.0, if Pmax is greater than 9,999,000 W, it is truncated to 9,999,000 W.

5 Units of measured values can be changed via the IEC 60870 Options Setup (see Section 6.1).

The default voltage and current scales and the device resolution can be changed in your meter via the Device Options setup in PAS.

5 Data Formats

Format Code	Value	Description	Notes
Wiring Mode			
F1	0	3OP2 - 3-wire open delta using 2 CTs (2 element)	
	1	4LN3 - 4-wire WYE using 3 PTs (3 element), line-to-neutral voltage readings	
	2	3DIR2 - 3-wire direct connection using 2 CTs (2 element)	
	3	4LL3 - 4-wire WYE using 3 PTs (3 element), line-to-line voltage readings	
	4	3OP3 - 3-wire open delta using 3 CTs (2 1/2 element)	
	5	3LN3 - 4-wire WYE using 2 PTs (2 1/2 element), line-to-neutral voltage readings	
	6	3LL3 - 4-wire WYE using 2 PTs (2 1/2 element), line-to-line voltage readings	
	8	3BLN3 - 3-wire broken delta using 2 PTs (2 1/2 element), line-to-neutral voltage readings	
	9	3BLL3 - 3-wire broken delta using 2 PTs (2 1/2 element), line-to-line voltage readings	
Device Diagnostics			
F2	Bit 0	Reserved	
	Bit 1	Reserved	
	Bit 2 = 1	RAM/Data error	
	Bit 3 = 1	CPU watchdog reset	
	Bit 4 = 1	Sampling fault	
	Bit 5 = 1	CPU exception	
	Bit 6	Reserved	
	Bit 7 = 1	Software watchdog reset	
	Bit 8 = 1	Power down	
	Bit 9 = 1	Device reset	
	Bit 10 = 1	Configuration reset	
	Bit 11 = 1	RTC fault	
	Bit 12	Reserved	
	Bit 13	Reserved	
	Bit 14	Reserved	
	Bit 15 = 1	EEPROM fault	
Single Point Info Static Type			
F3	1	M_SP_NA_1	
	2	M_SP_TA_1 (CP24Time2a)	
	30	M_SP_TB_1 (CP56Time2a)	
Single Point Info Event Type			
F4	2	M_SP_TA_1 (CP24Time2a)	
	30	M_SP_TB_1 (CP56Time2a)	
Double Point Info Static Type			
F5	3	M_DP_NA_1	
	4	M_DP_TA_1 (CP24Time2a)	
	31	M_DP_TB_1 (CP56Time2a)	
Double Point Info Event Type			
F6	4	M_DP_TA_1 (CP24Time2a)	
	31	M_DP_TB_1 (CP56Time2a)	
Measured Value Static Type			
F7	9	M_ME_NA_1	
	10	M_ME_NB_1	
	11	M_ME_NC_1	
	12	M_ME_TA_1 (CP24Time2a)	
	13	M_ME_TB_1 (CP24Time2a)	
	14	M_ME_TC_1 (CP24Time2a)	
	34	M_ME_TD_1 (CP56Time2a)	
	35	M_ME_TE_1 (CP56Time2a)	
	36	M_ME_TF_1 (CP56Time2a)	
Measured Value Event Type			
F8	12	M_ME_TA_1 (CP24Time2a)	
	13	M_ME_TB_1 (CP24Time2a)	
	14	M_ME_TC_1 (CP24Time2a)	
	34	M_ME_TD_1 (CP56Time2a)	
	35	M_ME_TE_1 (CP56Time2a)	

Format Code	Value	Description	Notes
	36	M_ME_TF_1 (CP56Time2a)	
Integrated Totals Static Type			
F9	15	M_IT_NA_1	
	16	M_IT_TA_1 (CP24Time2a)	
	37	M_IT_TB_1 (CP56Time2a)	
Integrated Totals Event Type			
F10	16	M_IT_TA_1 (CP24Time2a)	
	37	M_IT_TB_1 (CP56Time2a)	

6 Configuring IEC 60870-5

Use the PAS software provided with your meter to configure IEC 60870-5 options. See the PM130 PLUS Installation and Operation Manual for more information on installation and operating PAS on your computer.

Configuring IEC 60870-5 is available via both Modbus and IEC 60870-5 ports.

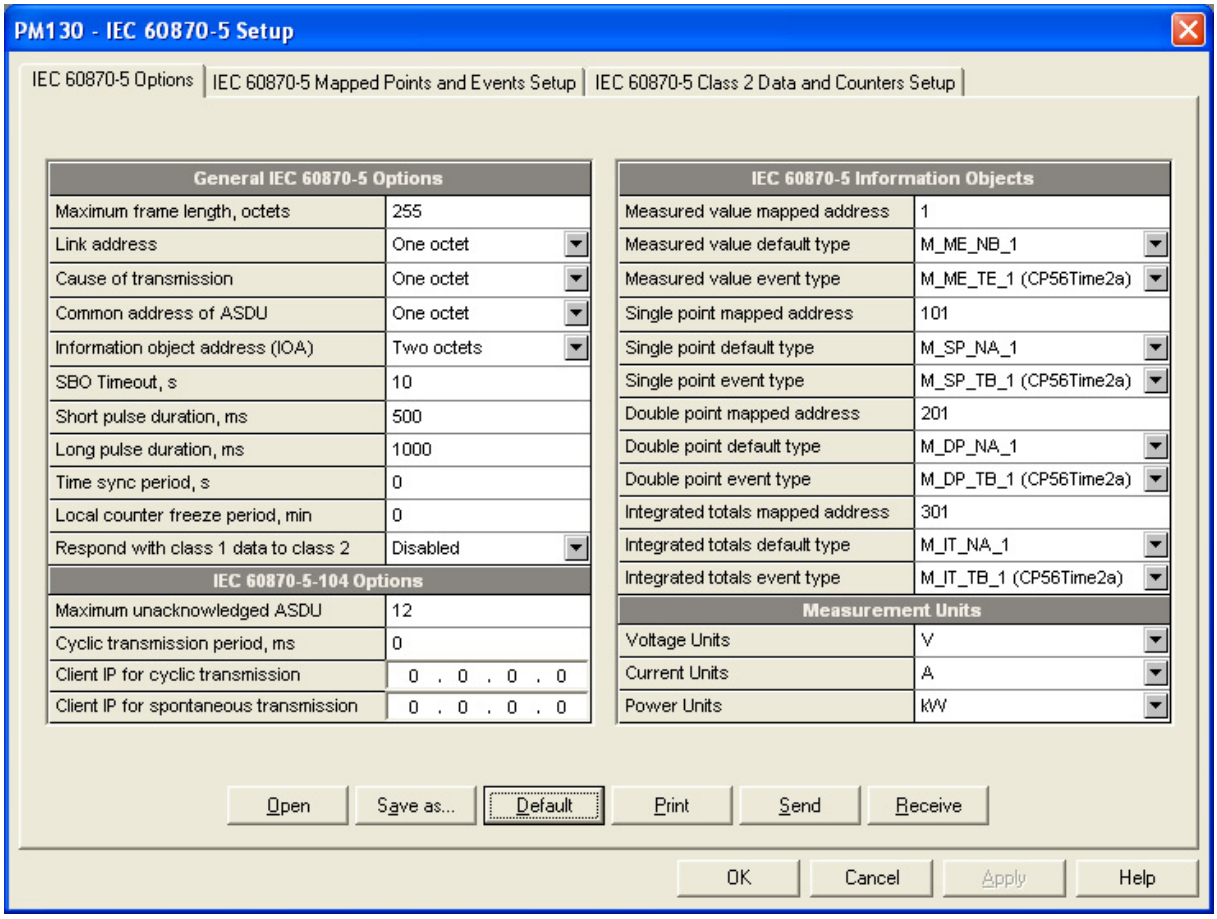
NOTE:

PAS supports only client connections with the meters via TCP ports. To avoid loss of communications via a TCP/IP connection, do not allow sending spontaneous or cyclic messages to the IP address of the computer where PAS is currently running.

6.1 Configuring IEC 60870-5 Options

To configure the IEC 60870-5 options:

1. Select IEC 60870-5 Setup from the Meter Setup menu.



2. Select desired options.
3. Click Save as... to store your setup in the device site database, and click Send to send the setup to the device.

See the following table for available options.

Parameter	Options	Default	Description
General IEC 60870-5 Options			
Maximum frame length	32-255 octets	255	The maximum length of the transmission frame. In IEC 60870-5-104 it is fixed to 253 octets.
Link address	1-2 octets	1	Link address length
Cause of transmission	1-2 octets	1	Cause of transmission length. In IEC 60870-5-104 it is fixed to 2 octets.
Common address of ASDU	1-2 octets	1	Length of common address of ASDU. In IEC 60870-5-104 it is fixed to 2 octets.
Information object address	1-3 octets	2	Length of information object address In IEC 60870-5-104 it is fixed to 3 octets.
SBO Timeout, s	0-30 s	10	Select-before-operate (SBO) timeout for single point commands with a select qualifier
Short pulse duration, ms	100-3000 ms	500	Short pulse duration for single point commands with a short pulse qualifier
Long pulse duration, ms	100-3000 ms	1000	Long pulse duration for single point commands with a long pulse qualifier
Time sync period, s	1-86400 s, 0=not active	0	The time interval between periodic time synchronization requests
Local counter freeze period, min	1-60 min, 0=not active	0	The period of local counter freeze and spontaneous transmission of integrated totals
Respond with class 1 data to class 2	0=disabled, 1=enabled	Disabled	If enabled, the meter will respond with class 1 data to class 2 requests when there is no class 2 data in transmission
IEC 60870-5-104 Options			
Maximum unacknowledged ASDU	1-32, 0=unlimited	12	The maximum number of unacknowledged ASDU allowed before suspending data transmission. Unlimited when set to 0.
Cyclic transmission period, ms	100-30000 ms, 0=not active	0	The period of cyclic/periodic data transmission via the IEC 60870-5-104 port
Client IP for cyclic transmission	0.0.0.0 =not active	0.0.0.0	The IP address of the controlling station for cyclic/periodic data transmission
Client IP for spontaneous transmission	0.0.0.0 =not active	0.0.0.0	The IP address of the controlling station for spontaneous transmission of events and integrated totals
IEC 60870-5 Information Objects			
Measured value mapped address	1-4095	1	Starting address for mapped static measured value objects

Parameter	Options	Default	Description
Measured value default type	M_ME_NA_1 M_ME_NB_1 M_ME_NC_1 M_ME_TA_1 M_ME_TB_1 M_ME_TC_1 M_ME_TD_1 M_ME_TE_1 M_ME_TF_1	M_ME_NB_1	The default type of static measured value objects for Read requests
Measured value event type	M_ME_TA_1 M_ME_TB_1 M_ME_TC_1 M_ME_TD_1 M_ME_TE_1 M_ME_TF_1	M_ME_TE_1	The default type of measured value objects for event reporting
Single point mapped address	1-4095	101	Starting address for mapped static single point objects
Single point default type	M_SP_NA_1 M_SP_TA_1 M_SP_TB_1	M_SP_NA_1	The default type of static single point objects for Read requests
Single point event type	M_SP_TA_1 M_SP_TB_1	M_SP_TB_1	The default type of single point objects for event reporting
Double point mapped address	1-4095	201	Starting address for mapped static double point objects
Double point default type	M_DP_NA_1 M_DP_TA_1 M_DP_TB_1	M_DP_NA_1	The default type of static double point objects for Read requests
Double point event type	M_DP_TA_1 M_DP_TB_1	M_DP_TB_1	The default type of double point objects for event reporting
Integrated totals mapped address	1-4095	301	Starting address for mapped static integrated totals objects
Integrated totals default type	M_IT_NA_1 M_IT_TA_1 M_IT_TB_1	M_IT_NA_1	The default type of static integrated totals for Read requests
Integrated totals event type	M_IT_TA_1 M_IT_TB_1	M_IT_TB_1	The default type of integrated totals for event reporting
Measurement Units			
Voltage units	0=V, 1=kV	V	Units of voltage measured values
Current units	0=A, 1=kA	A	Units of current measured values
Power units	0=kW, 1=MW	kW	Units of power measured values

NOTES:

1. In IEC 60870-5-104 the maximum length of the variable frame, the common address of ASDU, information object address and cause of transmission length are permanently set to values indicated in the table and the optional settings are ignored.
2. Selecting the one-octet information object address length for IEC 60870-5-101 will limit the range of objects to only mapped points in the range of 1 to 255 and will make impossible configuring IEC 60870-5 in the device via IEC 60870-5-101 ports.

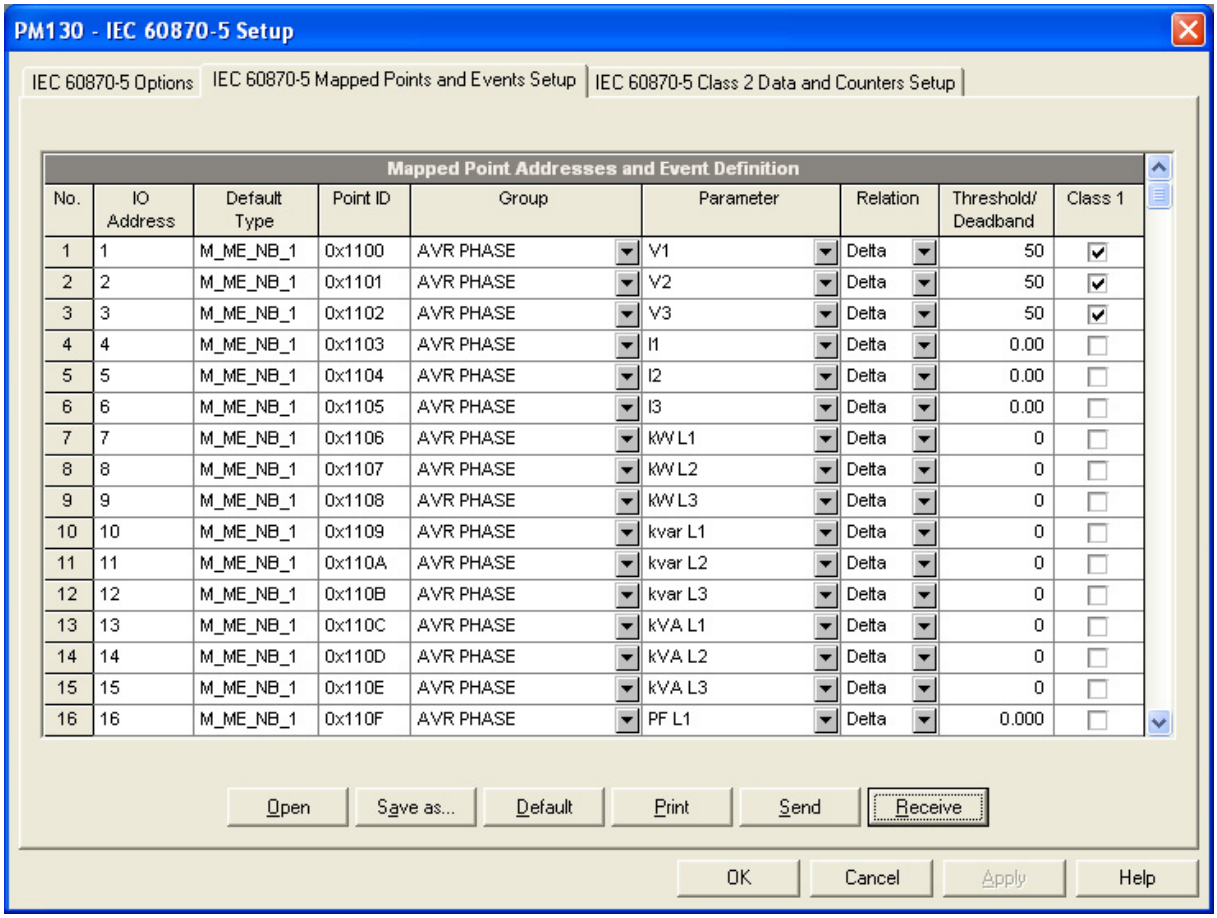
6.2 Remapping Point Addresses and Event Reporting

NOTE:

The process measurement scales for most analog values depend on your external PT and CT settings and on the voltage and current scales defined in the meter. Configure them in your meter and save to the device site database before configuring event deadbands. See Basic Setup and Device Options Setup in the PM130 PLUS Installation and Operation Manual on how to configure these parameters in the meter.

To remap static object point addresses to the configurable address space and to configure corresponding event objects:

1. Select IEC 60870-5 Setup from the Meter Setup menu, and then click on the IEC 60870-5 Mapped Points and Events Setup tab.



2. Select an object group and parameter for points you wish to remap. Object types and addresses are assigned automatically upon the starting mapped address and default static type you selected for the type of objects in the IEC 60870-5 Options Setup (See Section 6.1). When saving the setup to the device database or sending to the meter all points are automatically arranged in the order: measured values, single point objects, double point objects, integrated totals. See Section 3.2 for the entire list of available information objects.
3. If you wish to use a static point for reporting events, select a relation and an operating threshold or a deadband to be used for detecting events and check the Class 1 box for the point. See Section 2.8 for more information on event reporting. The following options are available:
    - Delta – a new event is reported when the absolute value of the difference between the last reported point value and its current value exceeds the

specified deadband value, or the status of a binary point changes. Measured values with a zero deadband will not be checked for events;

- More than (over) - a new event is reported when the point value rises over the specified threshold, and then when it returns below the threshold minus a predefined return hysteresis – applicable for measured values;
- Less than (under) - a new event is reported when the point value drops below the specified threshold, and then when it returns above the threshold plus a predefined return hysteresis – applicable for measured values.

Hysteresis of the return threshold for measured values is 0.05 Hz for frequency and 2% of the operating threshold for other points.

All thresholds/deadbands for measured values should be specified in primary units.

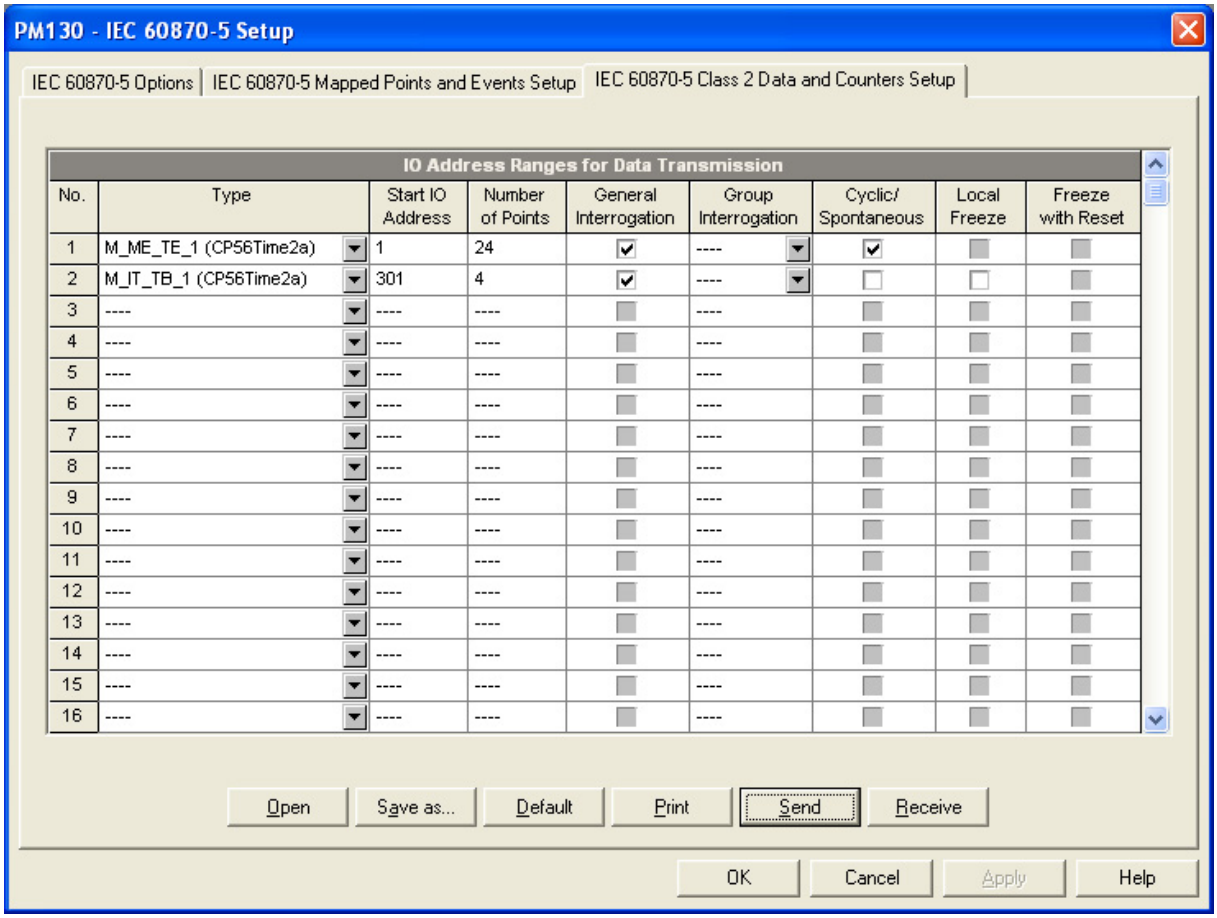
4. Click Save as... to store your setup in the device site database, and click Send to send the setup to the device.

6.3 Configuring Class 2 Data and Counter Transmission

This setup allows you to configure object address ranges for interrogation, cyclic/periodic data transmission, and spontaneous counter transmission with or without local freeze/reset.

To configure object address ranges for data transmission:

1. Select IEC 60870-5 Setup from the Meter Setup menu, and then click on the IEC 60870-5 Class 2 Data and Counters Setup tab.



2. Select object type and specify ranges of points to be included into interrogation responses or/and cyclic/spontaneous data transmission. Only mapped point addresses (see Section 6.2) and general object addresses listed in Section 3.2 can be used for

interrogation and cyclic/spontaneous transmission. See Section 3.2 for compatible object types.

Up to 32 address ranges can be selected. Fill rows in succession without gaps. The first blank row will be taken as the end of a range list.

NOTE:

Though double point objects occupy two adjacent addresses, always specify the actual number of requested double points as you define other object ranges.

Class 2 interrogated and cyclic/spontaneous data are always transmitted in the order they are listed in the setup. If you put ranges of point of the same type at continuous rows, they will be packed together and transmitted using minimum number of frames.

3. Check the “General Interrog” box for ranges you wish to include into the general/station interrogation.
4. Select appropriate groups in the “Group Interrog” box for ranges you wish to include into group interrogation. Each range of points can be allocated for both global and group interrogation.
5. Check the “Cyclic/Spont.” box for ranges you wish to include into cyclic/spontaneous data transmission.

   Analog and binary data checked for cyclic transmission will be transmitted as cyclic messages. The IEC 60870-5-104 cyclic data transmission period is configurable via the IEC 60870-5 Options setup (see Section 6.1).

   Integrated totals checked for spontaneous transmission will be transmitted as spontaneous messages at configurable local counter freeze/transmission intervals (see Section 6.1).
6. Check the “Local Freeze” box for A and B modes of transmission of integrated totals with local freeze. See Section 6.1 on how to set up the local counter freeze period. See Section 2.7 for more information on frozen counters operation and transmission.

   NOTE:

   Counters checked for spontaneous transmission without local freeze will be periodically reported at specified counter freeze/transmission intervals either with the frozen counter values if a remote freeze command was issued for counters before (mode D of acquisition of integrated totals), or with the actual counter values for counters that were not frozen.
7. Check the “Freeze with Reset” box for integrated totals for which local freeze with reset should be applied.
8. Click Save as… to store your setup in the device site database, and click Send to send the setup to the device.

Appendix A IEC 60870-5 Interoperability Profile

The following sections contain the device interoperability profile in a form derived from IEC 60870-5-101:2003 and IEC 60870-5-104:2006.

A.1 IEC 60870-5-101 Protocol Implementation Conformance Statement (PICS)

Excerpt from IEC 60870-5-101:2003, Clause 8:

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.

A.1.1 System or device

(system-specific parameter, indicate the definition of a system or a device by marking one of the following with an “×”)

☐ System definition

☐ Controlling station definition (master)

☒ Controlled station definition (slave)

A.1.2 Network configuration

(network-specific parameter, all configurations that are used are to be marked with an “×”)

☒ Point-to-point

☒ Multipoint-partyline

☒ Multiple point-to-point

☐ Multipoint-star

A.1.3 Physical layer

(network-specific parameter, all interfaces and data rates that are used are to be marked with an “×”)

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	

* Additionally supported baud rates: 57600 bit/s, 115200 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	

* Additionally supported baud rates: 57600 bit/s, 115200 bit/s.

A.1.4 Link layer

(network-specific parameter, all options that are used are to be marked with an "×". 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		**Address field of the link**
☐	Balanced transmission	☐	Not present (balanced transmission only)
☒	Unbalanced transmission	☒	One octet
	Frame length	☒	Two octets
255	Maximum length L (control direction)	☐	Structured
255	Maximum length L (monitor direction)	☒	Unstructured
	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
1, 2, 9-16, 30, 34-37	<20> to <35>, <37> to <41>

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.

A.1.5 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 with an "×")

☒ One octet ☒ Two octets

Information object address

(system-specific parameter, all configurations that are used are to be marked with an "×")

☒ One octet ☒ Structured

☒ Two octets ☐ Unstructured

☒ Three octets

Cause of transmission

(system-specific parameter, all configurations that are used are to be marked with an "×")

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

Selection of standard ASDUs

Process information in monitor direction

(station-specific parameter, mark each type ID with an "×" if it is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions)

☒	<1> := Single-point information	M_SP_NA_1
☒	<2> := Single-point information with time tag	M_SP_TA_1
☒	<3> := Double-point information	M_DP_NA_1
☒	<4> := Double-point information with time tag	M_DP_TA_1
☐	<5> := Step position information	M_ST_NA_1
☐	<6> := Step position information with time tag	M_ST_TA_1
☐	<7> := Bitstring of 32 bit	M_BO_NA_1
☐	<8> := Bitstring of 32 bit with time tag	M_BO_TA_1
☒	<9> := Measured value, normalized value	M_ME_NA_1
☒	<10> := Measured value, normalized value with time tag	M_ME_TA_1
☒	<11> := Measured value, scaled value	M_ME_NB_1
☒	<12> := Measured value, scaled value with time tag	M_ME_TB_1
☒	<13> := Measured value, short floating point value	M_ME_NC_1
☒	<14> := Measured value, short floating point value with time tag	M_ME_TC_1

☒	<15> := Integrated totals	M_IT_NA_1
☒	<16> :=Integrated totals with time tag	M_IT_TA_1
☐	<17> := Event of protection equipment with time tag	M_EP_TA_1
☐	<18> := Packed start events of protection equipment with time tag	M_EP_TB_1
☐	<19> := Packed output circuit information of protection equipment with time tag	M_EP_TC_1
☐	<20> := Packed single-point information with status change detection	M_PS_NA_1
☐	<21> := Measured value, normalized value without quality descriptor	M_ME_ND_1
☒	<30> := Single-point information with time tag CP56Time2a	M_SP_TB_1
☒	<31> := Double-point information with time tag CP56Time2a	M_DP_TB_1
☐	<32> := Step position information with time tag CP56Time2a	M_ST_TB_1
☐	<33> := Bitstring of 32 bit with time tag CP56Time2a	M_BO_TB_1
☒	<34> := Measured value, normalized value with time tag CP56Time2a	M_ME_TD_1
☒	<35> := Measured value, scaled value with time tag CP56Time2a	M_ME_TE_1
☒	<36> := Measured value, short floating point value with time tag CP56Time2a	M_ME_TF_1
☒	<37> := Integrated totals with time tag CP56Time2a	M_IT_TB_1
☐	<38> := Event of protection equipment with time tag CP56Time2a	M_EP_TD_1
☐	<39> := Packed start events of protection equipment with time tag CP56Time2a	M_EP_TE_1
☐	<40> := Packed output circuit information of protection equipment with time tag P56Time2a	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_NA_1

☐ <105> := Reset process command C_RP_NA_1

☐ <106> := Delay acquisition command C_CD_NA_1

Parameter in control direction

(station-specific parameter, mark each type ID with an "**×**" 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 "**×**" 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 identification and cause of transmission assignments

(station-specific parameters)

Blank = function or ASDU is not used.

Mark type identification/cause of transmission combinations:

"**×**" 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**																	
		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	×				×									×					
<2>	M_SP_TA_1	×		×		×									×					
<3>	M_DP_NA_1	×				×									×					
<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	×				×									×					
<14>	M_ME_TC_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
<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	×		×		×									×					
<31>	M_DP_TB_1	×		×		×									×					
<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	×		×		×									×					
<37>	M_IT_TB_1	×		×		×										×				
<38>	M_EP_TD_1																			
<39>	M_EP_TE_1																			
<40>	M_EP_TF_1																			
<45>	C_SC_NA_1						×	×	×	×	×							×	×	×
<46>	C_DC_NA_1						×	×	×	×	×							×	×	×
<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																			
<70>	M_EI_NA_1				×															
<100>	C_IC_NA_1						×	×			×							×	×	
<101>	C_CI_NA_1						×	×			×							×	×	
<102>	C_RD_NA_1					×												×	×	×
<103>	C_CS_NA_1						×	×										×	×	
<104>	C_TS_NA_1																			
<105>	C_RP_NA_1																			
<106>	C_CD_NA_1																			
<110>	P_ME_NA_1																			
<111>	P_ME_NB_1					×														
<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 × only

A.1.6 Basic application functions

Station initialization

(station-specific parameter, mark with an "×" if function is used)

☐ Remote initialization

Cyclic data transmission

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

☒ 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 are configurable (see Section 6.3 in this guide)

Clock synchronization

(station-specific parameter, mark with an "×" if function is used only in the standard direction, "**R**" if used only 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 "×" 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 controlled station)
- ☒ Long-pulse duration (duration determined by a system parameter in the controlled station)
- ☒ Persistent output

Transmission of integrated totals

(station- or object-specific parameter, mark with an "×" if function is used only in the standard direction, "**R**" if used only 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 with an "×" 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

Parameter activation

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

☐ Test procedure

File transfer

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

☐ Background scan

Acquisition of transmission delay

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

☐ Acquisition of transmission delay

A.2 IEC 60870-5-104 Protocol Implementation Conformance Statement (PICS)

Excerpt from IEC 60870-5-104:2006, Clause 9:

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.

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

A.2.1 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)

A.2.2 Network configuration

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

■ ~~Point-to-point~~

■ ~~Multiple-point-to-point~~

■ ~~Multipoint-partyline~~

■ ~~Multipoint-star~~

A.2.3 Physical layer

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

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~~	

A.2.4 Link layer

(network-specific parameter, all options that are used are to be marked "×". 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).~~

A.2.5 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 "×")

- ■ ~~One octet~~
- ☒ Two octets

Information object address

(system-specific parameter, all configurations that are used are to be marked "×")

- ■ ~~One octet~~
- ■ ~~Two octets~~
- ☒ Three octets
- ☒ Structured
- ☐ Unstructured

Cause of transmission

(system-specific parameter, all configurations that are used are to be marked "×")

- ■ ~~One octet~~
- ☒ Two octets (with originator address)
  Originator address is set to zero if not used

Length of APDU

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

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

- 253 Maximum length of APDU per system in control direction
- 253 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 "×" if it is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

☒	<1> := Single-point information	M_SP_NA_1
■	~~<2> := Single-point information with time tag~~	M_SP_TA_1
☒	<3> := Double-point information	M_DP_NA_1
■	~~<4> := Double-point information with time tag~~	M_DP_TA_1
☐	<5> := Step position information	M_ST_NA_1
■	~~<6> := Step position information with time tag~~	M_ST_TA_1
☐	<7> := Bitstring of 32 bit	M_BO_NA_1
■	~~<8> := Bitstring of 32 bit with time tag~~	M_BO_TA_1
☒	<9> := Measured value, normalized value	M_ME_NA_1
■	~~<10> := Measured value, normalized value with time tag~~	M_ME_TA_1
☒	<11> := Measured value, scaled value	M_ME_NB_1
■	~~<12> := Measured value, scaled value with time tag~~	M_ME_TB_1
☒	<13> := Measured value, short floating point value	M_ME_NC_1

■	~~<14> := Measured value, short floating point value with time tag~~	M_ME_TC_1
☒	<15> := Integrated totals	M_IT_NA_1
■	~~<16> := Integrated totals with time tag~~	M_IT_TA_1
■	~~<17> := Event of protection equipment with time tag~~	M_EP_TA_1
■	~~<18> := Packed start events of protection equipment with time tag~~	M_EP_TB_1
■	~~<19> := Packed output circuit information of protection equipment with time tag~~	M_EP_TC_1
☐	<20> := Packed single-point information with status change detection	M_PS_NA_1
☐	<21> := Measured value, normalized value without quality descriptor	M_ME_ND_1
☒	<30> := Single-point information with time tag CP56Time2a	M_SP_TB_1
☒	<31> := Double-point information with time tag CP56Time2a	M_DP_TB_1
☐	<32> := Step position information with time tag CP56Time2a	M_ST_TB_1
☐	<33> := Bitstring of 32 bit with time tag CP56Time2a	M_BO_TB_1
☒	<34> := Measured value, normalized value with time tag CP56Time2a	M_ME_TD_1
☒	<35> := Measured value, scaled value with time tag CP56Time2a	M_ME_TE_1
☒	<36> := Measured value, short floating point value with time tag CP56Time2a	M_ME_TF_1
☒	<37> := Integrated totals with time tag CP56Time2a	M_IT_TB_1
☐	<38> := Event of protection equipment with time tag CP56Time2a	M_EP_TD_1
☐	<39> := Packed start events of protection equipment with time tag CP56Time2a	M_EP_TE_1
☐	<40> := Packed output circuit information of protection equipment with time tag P56Time2a	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 "×" if it is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

☒	<45> := Single command	C_SC_NA_1
☒	<46> := Double command	C_DC_NA_1
☐	<47> := Regulating step command	C_RC_NA_1
☐	<48> := Set point command, normalized value	C_SE_NA_1
☐	<49> := Set point command, scaled value	C_SE_NB_1
☐	<50> := Set point command, short floating point value	C_SE_NC_1
☐	<51> := Bitstring of 32 bit	C_BO_NA_1
■	~~<58> := Single command with time tag CP56Time2a~~	C_SC_TA_1
■	~~<59> := Double command with time tag CP56Time2a~~	C_DC_TA_1
■	~~<60> := Regulating step command with time tag CP56Time2a~~	C_RC_TA_1
■	~~<61> := Set point command, normalized value with time tag CP56Time2a~~	C_SE_TA_1
■	~~<62> := Set point command, scaled value with time tag CP56Time2a~~	C_SE_TB_1
■	~~<63> := Set point command, short floating point value with time tag CP56Time2a~~	C_SE_TC_1
■	~~<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 "×" if it is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

☒	<70> := End of initialization	M_EI_NA_1

System information in control direction

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

☒	<100> := Interrogation command	C_IC_NA_1
☒	<101> := Counter interrogation command	C_CI_NA_1
☒	<102> := Read command	C_RD_NA_1
☒	<103> := Clock synchronization command	C_CS_NA_1
■	~~<104> := Test command~~	C_TS_NA_1
☐	<105> := Reset process command	C_RP_NA_1
☐	<106> := Delay acquisition command	C_CD_NA_1
■	~~<107> := Test command with time tag CP56Time2a~~	C_TS_TA_1

Parameter in control direction

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

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

Type identifier and cause of transmission assignments

(station-specific parameters)

Blank: functions or ASDU not used.

Mark Type Identification/Cause of transmission combinations:

"×" 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	×		×		×									×					
~~<2>~~	~~M_SP_TA_1~~																			
<3>	M_DP_NA_1	×		×		×									×					
~~<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	×		×		×									×					
~~<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	×		×		×									×					
<31>	M_DP_TB_1	×		×		×									×					
<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	×		×		×									×					
<37>	M_IT_TB_1	×		×		×										×				
<38>	M_EP_TD_1																			
<39>	M_EP_TE_1																			
<40>	M_EP_TF_1																			
<45>	C_SC_NA_1						×	×	×	×	×							×	×	×
<46>	C_DC_NA_1						×	×	×	×	×							×	×	×
<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																			
<59>	C_DC_TA_1																			
<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*				×															
<100>	C_IC_NA_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
<101>	C_CI_NA_1						×	×			×							×	×	
<102>	C_RD_NA_1					×												×	×	×
<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*																			
<127>	F_SC_NB_1*																			
* Blank or × only																				

A.2.6 Basic application functions

Station initialization

(station-specific parameter, mark "×" if function is used)

☒ Remote initialization

Cyclic data transmission

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

- ☒ global

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

Information object addresses assigned to each group are configurable (see Section 6.3 in this guide)

Clock synchronization

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

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

optional, see 7.6

Command transmission

(object-specific parameter, mark "×" if function is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

- ☒ Direct command transmission
- ☐ Direct set point command transmission
- ☒ Select and execute command
- ☐ Select and execute set point command
- ☒ C_SE ACTTERM used
- ☒ No additional definition

☒ Short-pulse duration (duration determined by a system parameter in the controlled station)

☒ Long-pulse duration (duration determined by a system parameter in the controlled station)

☒ Persistent output

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

30 s Maximum allowable delay of commands and set point commands

Transmission of integrated totals

(station- or object-specific parameter, mark "×" 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 "×" 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

Parameter activation

(object-specific parameter, mark "×" 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 "×" 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 "×" 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 "**×**" 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 "**×**" 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	Not used
t_1	15 s	Time-out of send or test APDUs	Not used
t_2	10 s	Time-out for acknowledges in case of no data messages $t_2 < t_1$	Not used
t_3	20 s	Time-out for sending test frames in case of a long idle state	5 min

Maximum range for timeouts t_0 to t_2: 1 s to 255 s, accuracy 1 s.

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

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

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

Parameter	Default value	Remarks	Selected value
k	12 APDUs	Maximum difference receive sequence number to send state variable	Configurable from 1 to 32. Can be set to 0 for unlimited number of ASDUs.
w	8 APDUs	Latest acknowledge after receiving *w* I format APDUs	Not used

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*).

Port number

Parameter	Value	Remarks
Portnumber	2404	In all cases

Redundant connections

☐ Number N of redundancy group connections used

RFC 2200 suite

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